Advisory Committee on Fishery Management **ICES CM 2003/ACFM:17**

REPORT OF THE

Herring Assessment Working Group for the Area South of 62°N

ICES Headquarters
11–20 March 2003

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

TECHNICAL MINUTES

Herring Assessment Working Group (HAWG)

Herring Review Subgroup:

North Sea

Generally very sound assessment. The sampling data fall short of EU standards, but given the size of the catches, it would probably be a waste of effort, at least of the age readers, to actually sample at the sizes that are specified in the standards.

The Review Subgroup concurred that the splitting procedures seem time consuming and are not a good use of WG time. Some better method must be available for dealing with this matter.

Inconsistencies were noted between the landings on pages 59 and 99 for the report. These are probably due to the raising procedures, but should reconciled for next year.

Western Baltic

This assessment is "above the line" and accepted, but still has some problems.

The review group agreed that the WG had done a good job with the information available, but the nature of the indicators of stock status (some catches split out from North Sea, lack of complete survey, etc) mean that the assessment will also have some uncertainties and present challenges to the WG.

The process for splitting the North Sea catches is still not transparent to outside reviewers, and the WG should continue to standardize methods and improve the clarity of the description of the splitting method.

There should be a more complete analysis of the uncertainty in the assessment, using the methods that are applied to several of the other stocks assessed by this WG.

There should be a discussion of the biological reference points for this stock. Depending on whether or not their estimates have changed with the data and assessments since they were last calculated, it may be appropriate to consideration of whether new values for the management reference points also need to be calculated.

The working group files do not include all the files necessary for reviewers to check the runs, and explore alternative settings for this stock. The complete run files for the assessments need to stored in the WG files, to make sure a full record of what was done in the WG is maintained.

Celtic Sea & VIIa

This assessment was too uncertain to be accepted.

There was concern about the huge and highly skewed uncertainties from 1997 into the 2000's in the figure on page 261 of the WG report. It was particularly concerning that the median for the simulations over those years was so different from the trajectory of the stock in the assessment . Although the review group thinks it eventually came to understand where the results came from, presenting figures with such bizarre patterns but without explanation in the WG report is unhelpful.

The Subgroup acknowledges that the WG made a serious effort to quantify the uncertainties in the assessment, as it was requested to do last year. However, having quantified the uncertainties, it is clear that the catch-at-age and survey data available are probably not informative enough about the development of the stock as a whole to allow a conventional age-structured assessment. Hence the WG should investigate other approaches to quantify stock status and trends that are less data demanding.

Until there is a more reliable survey index and the fishery fishes in a consistent manner for several years, such methods are likely to be a more robust basis for advice on management that would be provided by variants of age structured models run with such weak data.

VIa North and Clyde

The Subgroup found this assessment to be "above the bar" but not by very much. The indicators are noisy making the whole assessment uncertain.

It was noted in particular that the instability in the selectivity was troubling, because that means that the precision of the individual estimates are possibly unreliable. However the Subgroup agree that the overall patterns in estimates and residuals were consistent with noisy points in the data; i.e. low signal to noise ratio in the catch data. Therefore the assessment could be takes as showing the pattern of trends broadly in stock development.

The Subgroup had several concern with the proposed reference points from the WG, and were not prepared to recommend their adoption in plenary. It was noted that the analyses produce a high $\mathbf{F}_{lim}$ because there have been good recruitment at low SSB, hence the slope of the segmented regression is very steep, compared to other herring stocks.

The subgroup decided that it would like the assessment WG to advise if there are biological reasons for expecting the atypically high productivity at low SSB, or is just a lucky coincidence. It was also noted that the lowest observed SSB, with associated high recruitments are at beginning of time-series. The WG should consider how reliable the catch data were in those years, some of which also were outliers in the North Sea herring. Hence these apparent high productivities could be either immigration or mis-reporting into the area from the North Sea..

Irish Sea VIIa

This assessment was also not accepted. There is no recruitment index, nor a usable survey of the entire stock. The cohorts do not follow the survey data are available.

The productivity data suggest that the big increase in recruitment in the earlier years led to the major pulse in recruitment, it was not produced by it.

Again this seems to be a stock where the WG did as good a job as could be done with the data that were available, but the data series were not consistent and informative enough to be the basis for an age-structured assessment. In this case there seems to be a possibility that there isn't a single stock in the area support the fishery and providing the catches. Rather the fishery may be exploiting multiple stocks that enter the area at different parts of the year, and possibly at different rates among years.

The Subgroup feels this is another stock were the WG should consider alternative simpler assessment methods that are less data demanding. In any case there should not be a great deal of time and effort invested in assessments of this stock until the results of the EU projects on herring stock structure are completed, and it is clearer what stock(s) are supporting the fisheries, and what are the appropriate assessment units.

West of Ireland

This is another assessment that was not accepted. Again the reasons were that the data series are probably insufficiently informative to provide the basis for an age-structured analytical assessment, and not that the WG showed inadequate effort and skill in their work to produce an assessment.

The fishery has changed in where and how it operates so the catch-at-age data may not be comparable over time, and there is no reliable survey that can be used on its own without catch data. The general trends are informative about stock development, and this stock is another candidate for robust but less data demanding assessment methods.

The loss of seasonal components from the catch is a special concern for this stock, and should be documented and investigated further in the next assessment.

North Sea Sprat

The new assessment method seems to perform fairly well and the Subgroup felt it was appropriate for the WG to develop its use further.

The Subgroup did feel that it might be informative to have the Methods Working Group investigate the reliability of the method used on this stock for stocks that are short-lived, suffering relatively high and sometimes variable natural mortality.

Otherwise the evaluation of the stock status seems sound.

EXECUTIVE SUMMARY

The Herring Assessment Working Group reports on the status of the North Sea autumn-spawning herring stock in ICES Division IIIa, Subarea IV and Division VIId, the herring stocks in Division VIa and Subarea VII, the stock of spring-spawning herring in Division IIIa and Subdivisions 22-24 (Western Baltic), and the sprat stocks in Subarea IV and Divisions IIIa and VIId,e. Analytical assessments were carried out for 5 out of the 11 stocks considered, of which three are evaluated as full analytic assessments and two as indicative for the trends in the stock. The assessments of the autumn spawners in the North Sea and VIaN and the Western Baltic spring spawners, are consistent with those presented last year, resulting in little changes in the perception of the stocks. Most of the stocks assessed are considered within safe biological limits. Corresponding catch options for 2004 are provided, by fleets where possible.

This year, the model used for sprat assessment was changed and appeared to be more consistent with the survey indices than previous methods. There is still a need for better input/sampling data for some stocks, and in other stocks there is a lack of fishery independent data. With regard to the model used for the assessment of all herring stocks, ICA, concern has been raised about the instability in the selection patterns at older ages which would affect the stock estimates in the early part of the time series. The WG examined the performance of ICA on North Sea herring with another regularly used assessment model, XSA. The two models gave very similar perceptions of the state of the stock and the WG felt that the use of the ICA model is still appropriate. This also maintains the consistency with assessments in previous years.

The group explored whether existing quantifiable measures of retrospective bias could be applied to the stocks assessed by this WG. The preferred approach was to use metrics that quantified both the bias and the variation of the retrospective patterns.

The group proposed that a system of full assessments and roll-over assessments be adopted by ACFM.

The WG has reviewed the general approach towards revision of biological reference points as provided by SGPA and SGPRP. Their analysis gave significant Biomass limit reference point for only two stocks dealt with by HAWG. While the WG supports the proposal for $\mathbf{B}_{\text{lim}}$ for VIaN herring, it suggested that a reduction of the limit reference point for North Sea autumn spawners is currently not immediately needed. In general, the WG considered the formal approach used by SGPA and SGPRP useful, but still in an early phase of development. Further developments on the implementation of software for estimating reference points should be awaited before the reference points for herring will be revisited.

In reply to a formal request on the evaluation of effects of gravel extraction in the eastern English Channel, the WG is concerned about the serious effects this could have on the Downs herring spawning grounds.

TABLE OF CONTENTS

Section **Page**

PART 1

Section	Page

Section	Page

PART 2

1 INTRODUCTION

1.1 Participants

Massimiliano Cardinale	Sweden
Maurice Clarke (part time)	Ireland
Lotte Worsøe Clausen	Denmark
Jørgen Dalskov	Denmark
Mark Dickey-Collas	The Netherlands
Tomas Gröhsler	Germany
Emma Hatfield	UK/Scotland
Ciarán Kelly (part time)	Ireland
Henrik Mosegaard	Denmark
Peter Munk	Denmark
Richard Nash	UK/Isle of Man
Kay Panten	Germany
Martin Pastoors (part time)	The Netherlands
Ciarán O'Donnell (part time)	Ireland
Beatriz Roel	UK/England
Norbert Rohlf (part time)	Germany
John Simmonds	UK/Scotland
Dankert Skagen	Norway
Reidar Toresen	Norway
Else Torstensen (Chair)	Norway
Christopher Zimmermann	Germany

Contact details for each participant are given in Appendix 1.

1.2 Terms of Reference

[1]The **Herring Assessment Working Group for the Area South of 62°N** [HAWG] (Chair: E. Torstensen, Norway) will meet at ICES Headquarters from 11–20 March 2003 to:

a) assess the status of and provide catch options (by fleet where possible) for 2004 for:

  a. the North Sea autumn-spawning herring stock in Division IIIa, Subarea IV, and Division VIId (separately, if possible, for Divisions IVc and VIId);

  b. the herring stocks in Division VIa and Subarea VII;

  c. the stock of spring-spawning herring in Division IIIa and Subdivisions 22–24 (Western Baltic);

b) forecasts for North Sea autumn-spawning herring 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 2003.

c) catch options for Division IIIa shall be given by fleets taking into account that North Sea herring and Western Baltic herring are taken together in this Division;

d) assess the status of and provide catch options for 2004 for the sprat stocks in Subarea IV and Divisions IIIa and VIId,e;

e) provide specific information on possible deficiencies in the assessments including at least: Major inadequacies in the data on catches, effort or discards; major inadequacies if any in research vessel surveys data and major difficulties if any in model formulation; including inadequacies in available software. The Group should clarify the consequences from these deficiencies for a) assessment of the status of the stocks and b) for the projection;

f) for stocks for which a full analytical assessment is presented, comment on this meeting's assessments compared to the last assessment of the same stock;

g) consider the effects of gravel extraction on herring spawning habitats in the Channel;

[1] W:\acfm\hawg\2003\Report\Sec\sec_1.1_1.2_part_tor

h) comment on the PA reference points proposed by the Study Group on Precautionary Reference Points for Advice on Fishery Management;

i) structure the assessment report following the guidelines as adopted by ACFM in October 2002 with special attention to the quality issues.

HAWG will report by 21 March 2003 for the attention of ACFM.

1.3 Working Group's response to *ad hoc* requests

1.3.1 Effects of gravel extraction on herring spawning habitats in the Channel

The Working Group was asked to address the following ToR:

g) consider the effects of gravel extraction on herring spawning habitats in the Channel;

Advice on resource management must be given under the precautionary principle, so if evidence is lacking, the activity must not occur until relevant information is made available. Gravel is presently extracted from the coastal regions of England, Belgium and the Netherlands (Figure 1.3.1.1). There are proposals to extract gravel from the north of ICES rectangle 29F0 within UK waters (Figure 1.3.1.1). The new area covers 230 km² of which 120 km² will be targeted (at a likely rate of 10 km² per year, East Channel Association, 2003). Atlantic herring spawn on gravel and coarse sediments (Bowers 1952; Parrish et al, 1959; de Groot, 1980) and the eastern English Channel is a well known spawning site for herring, often described as the Downs Stock (Cushing, 1968; Harden-Jones, 1968; Corten, 1986). Non-spawning feeding herring are also closely associated with seabed type (Maravelias et al 2000). Herring in the North Sea and English Channel is currently inside safe biological limits but has just recovered from a period of 27 years below safe limits. Gravel extraction in the close vicinity of any spawning will disturb that spawning activity and the removal of gravel will reduce the available area for successful spawning through the removal of spawning substrate and by covering remaining gravel with fine sediment (East Channel Association, 2003). High turbidity caused by high fine-sediment loading of water will also reduce the feeding of herring larvae (Fox et al., 1999).

There is a substantial herring catch from the region, dominated by catches from rectangle 29F0 (Table 1.3.1.1). Cushing (1968) described this area as the Creux St Nicholas spawning ground. The exact location and persistence of spawning in recent years was investigated using the results of the larval herring surveys (1972-2001). Small herring larvae are common in this area in December and January (Figure 1.3.1.2). From the survey data, the abundance of newly-hatched larvae (6-9 mm) at each station sampled in the southern North Sea and English Channel was estimated. To determine the likely probability of catching newly-hatched larvae during the survey period, the proportion of years (1972-2001) at which the abundance of larval was >1 per m² was estimated for each quarter ICES rectangle (Figure 1.3.1.3). This reflects the persistence of catching newly-hatched herring in each quarter rectangle. From 1972 to 2001, larval surveys stood a greater than 60% chance of catching newly-hatched herring larvae in the proposed extraction area (29F0). The larvae (<10 mm length) are at most 2 weeks old and may have drifted slightly from the hatching area, but drift is limited and apart from winter storms, the current is rectilinear and results in little residual movement over a two-week period. Hence the probability plot reflects the persistent areas of herring spawning and is in agreement with studies earlier in the 20th century (Harden-Jones, 1968).

As shown above, the eastern Channel is important to herring spawning (Figures 1.3.1.2 and 1.3.1.3), particularly ICES rectangles 29F0, 29F1 and 30F1. In recent years the abundance of newly-hatched larvae in these three rectangles has increased dramatically (Figure 1.3.1.4), suggesting that larval production has also greatly increased. Survey intensity has not changed over the time-series. Hence it appears that the proposed extraction site is actively used by herring for spawning and at the moment is of increasing importance for larval production.

The Regional Environmental Assessment for the Aggregate Extraction in the Eastern English Channel (East Channel Association, 2003) notes various impacts of the extraction on the marine biology and fish resources. This assessment was commissioned by the gravel extraction companies that are applying for the licenses. It notes that extraction may occur for up to 18 hours a day, and that a 2-m depth of seabed is removed. The gravel beds are described as immobile and the seabed in the area shows evidence of disruption by fishing gear. The plumes of fine sediment caused by the extraction process settle out on the seabed and are likely to remain as "localised sheets" over the seabed for up to 2 years after each extraction. The environmental assessment suggests that these sheets will spread 100 m beyond the extraction area, and in the long term "the seabed sediments will gradually become sandier than before dredging began". The assessment also notes that this deeper site will recover at a slower rate than those inshore, and the deeper site supports more mature fish. Specifically, spawning herring is listed as "most vulnerable" to the impacts of gravel extraction. However, no measures are given in the report on how to deal with the adverse impact on herring, or how the impact on herring stock dynamics was assessed.

Under the precautionary principle (UNCED, 1992), it should be demonstrated scientifically that extraction does not have a deleterious impact on herring spawning in 29F0 and VIId. The environmental assessments produced thus far have failed to do so, in fact they have emphasised that the spawning of herring is vulnerable. The north of 29F0 (Creux St Nicholas) is a major spawning site for herring and the Working Group considers that there is sufficient scientific information to recommend that under no circumstances should extraction be allowed during the spawning period, i.e. November to February. No licenses should be granted for the rest of the year, until it is proven within the rigors of the precautionary approach, that the extraction process does not have a negative impact of the stock dynamics and larval production of herring in VIId and rectangle 29F0.

1.3.2 Quality control handbook and general quality issues

The WG was requested in ToR (i) to: "structure the assessment report following the guidelines as adopted by ACFM in October 2002 with special attention to the quality issues"

The WG considers three points relevant for discussion in relation to quality control:

- Implementation of a handbook
- Procedures for update and benchmark assessments
- Quality control diagrams

Implementation of a quality control handbook

The HAWG received the guidance on this matter from ICES a few days before the meeting with no time to prepare stock-specific annexes (Lassen & Sparholt, 2003). In order to address the ToR i), the WG discussed how to respond in light of the high workload as preparation of the stock-annexes within the frame work given; this would require significant additional work. The HAWG agreed to produce the 2003-report as last years, including the standard procedures as well as the year-specific parts. Description of the collection and preparation of input data, data aggregation, model parameter settings etc. will be copied into preliminary stock annexes according to recources available. The final first drafts will be prepared and reviewed at the next WG meeting.

Procedure for update and benchmark assessments

The annex 1 of the proposed ICES quality handbook (Lassen and Sparholt 2003) gives a specification of a system of benchmark and update assessments that is to be introduced within ICES. In the annex it is suggested to discriminate the stocks to be assessed into two categories:

- Stocks on an observation list
- Stocks not on an observation list (update stocks)

It is suggested that stocks on the observation list are fully assessed every year and that stocks not on the observation list will be subject to a full assessment at least every 5 years. In other years the assessments will be of the update type. In the proposal only two stocks considered by HAWG are on the observation list:

- Herring in Subdivisions 22-24 and Division IIIa (spring spawners)
- Herring in Subarea IV, Division VIId and Division IIIa (autumn spawners)

The WG agrees with the need to develop a system of benchmark and update assessments. The WG considers that such a system could reduce the workload of both the WGs and ACFM. It would further prevent unnecessary tinkering with assessments and could provide more resources to doing in-depth benchmark assessments.

However, the WG does not agree to the suggestion to work with a observation list and to do full assessments of the stocks on the observation list at the expense of stocks not on the list. Rather, the WG proposes to work with a roll-over system whereby each stock is subject to a thorough evaluation in a benchmark assessment every three years and that in the intermediate years, only updates are presented, unless there are severe problems with the update. This is similar to the approach suggested by WGNSSK (ICES C.M. 2003 / ACFM: 02) and WGSSDS (ICES C.M. 2003 / ACFM: 03).

To implement a system of benchmark and update assessment the WG has attempted to evaluate during this meeting which stocks could be candidates for update assessments and which stocks for benchmark assessments in 2004. Benchmark assessments could then be carried out during that year's Working Group.

Furthermore, the WG considers that a third category of assessment should be included in the system which could be labelled as “exploratory assessments”.

Benchmark assessment

Benchmark assessments are carried out to thoroughly re-evaluate the existing approach for the assessment of a certain stock. The analysis will include:

- Analysis of the basic data (catch-at-age, weights, maturity, surveys, CPUE, time-span)
- Choice of assessment model including settings of the model; this includes also exploring different structural models (e.g. separable models, VPA-type models, biomass models,..)
- Choice of surveys and commercial cpue series to be used in the assessment and procedures for deriving these indices
- Procedures for projection in the short and medium term
- PA reference points

Update assessment

Update assessments will rely on a description of standard procedures to be followed for the stocks:

- Choice of assessment model including settings of the model
- Choice of surveys and commercial cpue series to be used in the assessment and procedures for deriving these indices
- Procedures for projection in the short and medium term
- PA reference points

When the compilation of the basic data for the model are ready (catch-at-age, mean weights, maturity ogives, survey data), the standard procedures can be followed and the results are inspected by the person responsible for that stock. Small deviations from an optimal assessment can be accepted at this stage. However, the assessment should not be accepted with closed eyes. The WG identified a need to develop more efficient diagnostic tools that will allow quick inspection of the assessment results. The update assessment is presented to the WG and when accepted can be published in the WG report with the following details:

- Reference to the standard procedures
- Documentation of all input data
- Documentation of the model output (in table format only)
- One figure with the stock summary
- Short text (maximum 1 A4) with description of results

If the update assessment is not accepted by the WG it will become an exploratory assessment.

Exploratory assessments

Exploratory assessments are those assessments that have not been accepted as final assessments by ACFM, or the WG. Within the HAWG Working Group, a number of stocks would fall within this category (e.g. sprat, VIaS/VIIbc herring, Irish Sea herring, Celtic Sea herring). For these stocks, the exploratory assessments should include:

- Analysis of the basic data (catch-at-age, weights, maturity, surveys, CPUE, time-span)
- Choice of assessment model including settings of the model; this includes also exploring different structural models (e.g. separable models, VPA-type models, biomass models,..). Retrospective analysis.
- Choice of surveys and commercial cpue series to be used in the assessment and procedures for deriving these indices

The exploratory assessments will be presented in the WG report with the following details:

- Is there a suggestion for a default assessment procedure; if so, document the suggested default assessment procedure
- What analyses have been carried out and what are the general results?
- Documentation of all input data
- Documentation of output of trial assessments

Criteria for doing benchmark assessments

The WG considered the following criteria for determining whether a benchmark assessment would be required outside the normal 3-year cycle:

- Something is going wrong in the standard assessment procedure (e.g. residual patterns, selection changes, effort creeping)
- Further analysis are presented from external sources (EU projects, PhD studies, etc.)
- New data sources are available or old data sources are no longer available
- New assessment methods specific to solving identified problems become available
- External review process is being planned

Comments on the scientific review process

The WG notes that the North Sea Commission intends to organize a public review of the North Sea herring assessment in June 2003. Given the experiences with the public reviews of the assessments of North Sea cod, saithe and plaice in August 2002, the WG suggests that while public review is important and useful, a closed detailed scientific review may provide closer scrutiny of the quality of the assessment.

Quality control diagrams

Given that the quality control of both input and output of stock assessment receives more and more attention, the WG recommends to implement a database system that will allow the tracking of the behaviour of historic assessments. During the WG, a modification to the ICES standard graph database was made (in Excel) which includes all the standard information on the summary variables of stock assessment, but includes the year of assessment as an additional variable (see Figure 1.3.1 for an example). This can then be used to generate standardized quality control diagrams (Figure 1.3.2) and to calculate retrospective measures of bias and uncertainty.

1.4 Reviews of groups or work important for the Working Group

1.4.1 Study Group on the Revision of Data for North Sea Herring (SG REDNOSE)

At last year's WG meeting, a number of inconsistencies became apparent in the historic data used for the assessment of North Sea Autumn Spawners:

- catch data showed significant discrepancies between official databases and data used by the WG, which could not be attributed to misreported/unallocated landings or discards;
- the revision of splitting factors for Division IIIa catch was still not applied to the assessment input data for 1991-1998;
- an analysis of the changes of mean weights- and numbers-at-age in the catch showed a significant variability caused by the current procedure for raising national catch data (especially by the Netherlands).

The Working Group felt that it would require a major effort to correct all these data from different sources, and that this could not be done during the WG meeting. In the light of the urgent need for the development of a new system to collate and handle commercial catch and sampling data (see Sec. 1.5), and due to time constraints during the WG sessions, the WG recommended to set up a study group to deal with the issues related to data revisions as soon as the new data base was set up. The study group was approved at the Council Meeting in Oct. 2002 and met in Jan. and Mar. 2003. A new ICES database was not operational at that time. However, the Group felt that the issue of transferring historic data into this database could be postponed and that the catch and catch-at-age information used in the assessment should be corrected as soon as possible. The group aimed at delivering a reference data set for HAWG.

For this purpose, updated national catch and sampling information was obtained for 1995-2001, fed into the system used for reallocating samples since 1999 (see Section 1.5), and a revised reallocation scheme was applied. The majority of discrepancies in historic catch data information could be resolved. The revision of national raising schemes reduced the variability in mean weights-at-age as expected. Preliminary data were available at the beginning of the 2003 HAWG meeting and were used in exploratory NSAS assessment runs for comparison. In spite of the number of corrections, these demonstrated negligible influence on the historic perception of the stock.

At that time it became obvious that the removal of all Norwegian catch from Division IIIa, which is now believed to have been taken in the eastern North Sea, would require another revision of the split of catches in IIIa. The recalculation could not be conducted *ad hoc* at the WG meeting. The study group considered it an unnecessary effort to update all assessment relevant input tables for the HAWG report when it was clear that they would have to be reworked in due course. It was decided therefore to continue the updating by correspondence and provide an up-to-date reference data set as soon as possible.

1.4.2 Study Groups on the Precautionary Approach (SGPA) and Precautionary Reference Points (SGPRP)

The reports from these study groups were presented. The SGPA in December 2002 outlined a procedure for determining suitable values for reference points based on objective criteria in accordance with the formal definitions given by ACFM (ref. Sec. 1 in 2002 ACFM rep). It was suggested to use a segmented regression method applied to the historical stock recruit data to obtain a value for $\mathbf{B}_{\mathrm{lim}}$ that would imply a low risk of impairment of the recruitment. It was assumed that this would lead to a $\mathbf{B}_{\mathrm{lim}}$ which in itself is risk adverse. Accordingly, the $\mathbf{F}_{\mathrm{lim}}$ should be set at the deterministic equilibrium with $\mathbf{B}_{\mathrm{lim}}$, in order to avoid double counting the risk. Then, it was suggested to choose values for $\mathbf{B}_{\mathrm{pa}}$ and $\mathbf{F}_{\mathrm{pa}}$ that account for the uncertainty in assessment and short-term prediction, and it was suggested to estimate this uncertainty based on catch predictions in retrospective assessments. The SGPRP in February 2003, concentrated on considering results of segmented regression calculations as candidate $\mathbf{B}_{\mathrm{lim}}$ reference points. These calculations were evaluated by Working Group chairs at the SGPRP. The general response was to bring possible revisions of $\mathbf{B}_{\mathrm{lim}}$ back to the Working Groups for further considerations, recognising that the expertise in the Working Groups was needed before final recommendations were made. For some stocks, there was some uncertainty as to the validity of the results of the segmented regression, both because of the statistical criteria used to evaluate the significance of the model fit were questioned, and because there were doubts about the quality of the software that had been used.

For the HAWG stocks, the following suggestions were made:

- North Sea autumn spawners: Segmented regression suggested a reduction of $\mathbf{B}_{\mathrm{lim}}$ from the current 800 000 tonnes to approximately 560 000 tonnes.

- VIaNorth herring: $\mathbf{B}_{\mathrm{lim}}$ at 50 000 tonnes (=$\mathbf{B}_{\mathrm{loss}}$) was suggested.

- Irish Sea herring: No value could be derived by the segmented regression. $\mathbf{B}_{\mathrm{loss}}$ is close to the current $\mathbf{B}_{\mathrm{lim}}$ – no change suggested.

- VIaS and VIIbc herring: Uncertain assessment. Somewhat lower $\mathbf{B}_{\mathrm{loss}}$ than that used when defining the current $\mathbf{B}_{\mathrm{lim}}$ – no change suggested.

- Celtic Sea herring: Segmented regression indicated a rather high $\mathbf{B}_{\mathrm{lim}}$, but was probably largely driven by a series of low recruitments in the early 1970ies. Further investigations recommended.

- Baltic spring spawners: The time-series of stock and recruit data was considered to be too short to derive a $\mathbf{B}_{\mathrm{lim}}$.

- Sprat: No $\mathbf{B}_{\mathrm{lim}}$ proposed, since there is no accepted assessment.

The HAWG does not at present recommend any changes in the current reference points, for reasons explained in the sections for the respective stocks in the report. However, a $\mathbf{B}_{\mathrm{lim}}$ for VIaNorth herring at 50 000 tonnes is proposed, in line with the suggestion from the SGPRP and previous suggestions by the HAWG. For this stock, the HAWG also suggests values for $\mathbf{F}_{\mathrm{lim}}$, $\mathbf{F}_{\mathrm{pa}}$ and $\mathbf{B}_{\mathrm{pa}}$. (Section 5.8)

1.4.3 Planning Group for Herring Surveys (PGHERS)

According to C. Res. 2002/2G02 the **Planning Group for Herring Surveys** [PGHERS] (Chair: P.G. Fernandes, UK) met in Aberdeen, UK, from 21 -24 January 2003 to deal with the following **terms of reference**:

a) combine the 2002 survey data to provide indices of abundance for the population within the area;

b) consider a re-allocation of effort by participating countries in the acoustic survey of the North Sea and adjacent waters in 2003;

c) coordinate the timing, area allocation and methodologies for acoustic and larvae surveys for herring and sprat in the North Sea, Divisions VIa and IIIa and Western Baltic in 2003;

d) evaluate the outcome of a maturity staging workshop with a view to harmonising the determination of maturity in herring and sprat;

e) evaluate investigations on the effect of the time of day on the allocation of herring to acoustic data;

f) develop protocols and criteria to ensure standardization of all sampling tools and survey gears.

Review of Larvae Surveys in 2002/2003. When PGHERS met two of the seven surveys in the North Sea remained to be carried out in January 2003. Results will be ready for the Herring Assessment Working Group (HAWG) meeting in March 2003. Estimates from Western Baltic larvae survey in the Greifswalder Bodden area are given from 1992-2002.

Coordination of Larvae Surveys for 2003/2004. In the 2003 period, the Netherlands and Germany will undertake 6 larvae surveys in the North Sea from 1 September 2003 to 31 January 2004. The herring larvae survey in the Greifswalder Bodden (Baltic Sea) will be conducted from 22 April to 27 June using the FRV *Clupea*.

Review of larvae survey results in relation to gravel extraction. As a result of a request at the 2002 ICES ASC, maps of the distribution of early stage herring larvae were compiled from the last 5 years of the larvae survey in the central and southern North Sea. These serve as an indication of herring spawning grounds which may be sensitive to gravel extraction.

North Sea and west of Scotland acoustic surveys in 2002. Six acoustic surveys were carried out during late June and July 2002 covering the North Sea and west of Scotland. The provisional total combined estimate of North Sea spawning stock biomass (SSB) is 2.9 million t, an increase from 2.4 million t in 2001. The survey shows exceptional numbers of 2-ring herring (the 1998 year class) and indicates that the 2000 year class may also be strong. The estimate of Western Baltic spring-spawning herring SSB is 255 000 t, an increase since 2001 (77 000 t). The west of Scotland SSB estimate is 548 000 t (up from 327 500 t). The surveys are reported individually in Appendix II of the PGHERS report (ICES 2003/G:02).

Western Baltic acoustic survey in 2002. A joint German-Danish acoustic survey was carried out with R/V *Solea* from 14 to 25 October in the Western Baltic. The total number of herring was 6,000 million (down from last years 9,800 million) and the total for sprat 6,700 million (down from last years 8,700 million). A full survey report is given in Appendix III of the PGHERS report (ICES 2003/G:02).

Survey overlap between FRV Scotia and FRV G.O. Sars. A provisional analysis of acoustic data from an extended area overlap between these vessels indicated large differences between the two vessels, due primarily to the large temporal difference. A schedule for a more comprehensive analysis of the data was drawn up to be presented next year in order to determine the effect of different scrutiny procedures.

Sprat. Data on sprat were only available from RV *Walther Herwig III*, RV *Tridens* and RV *Dana*. The total sprat biomass estimated was 241 000 t in the North Sea (up from 200 000 t in 2001) and 10 000 t in the Kattegat (up from 8 000 t in 2001). The distribution pattern demonstrates that the southern border was still not reached.

Coordination of acoustic surveys in 2003. Six acoustic surveys will be carried out in the North Sea and west of Scotland in 2003 between 23 June and 21 July. Participants are referred to Figure 8 of the PGHERS report (ICES 2003/G:02) for indications of survey boundaries. *Scotia* and *Tridens* will survey an overlapping area to the south of Shetland. *Scotia* and *G.O. Sars* will survey an overlapping area to the east of Shetland. The survey area in 2003 will be extended further south to 52°N. A survey of the western Baltic and southern part of Kattegat, will be carried out by R/V *Solea* from 29 September to 20 October.

Future planning of acoustic surveys in the North Sea. An analysis of the spatial variability in the distribution of herring was conducted in relation to the requirements of the assessment to determine which areas were most sensitive to the precision of the survey. These areas were plotted using a variety of metrics. Predicted changes in survey variance with changes in track intensity were also made. The results were used to determine which areas would be more appropriate for any future redesigns. The group considered the benefits and drawbacks of implementing a variety of new design options. It was concluded that closer integration of methods and cross-boundary experience was required before any radical changes could be made. In the forthcoming year minor modifications to the design were planned and a number of studies were identified to investigate this further.

Acoustic survey manual revision. A review was made of the current acoustic survey manual in response to TOR (f). Modifications were made to the existing manual and an update is provided in Appendix IV of the PGHERS report (ICES 2003/G:02) as version 3.1. A fuller revision will take place next year.

Maturity determination. Ambiguities in the use of scales for the determination of herring maturity were resolved. The acoustic survey manual has been updated to include a full description of the original 8-point scale and conversion tables for deviations from this scale. A maturity staging workshop was not possible in 2002. Instead digital photographs of herring were collected and these were examined. Procedures for the acquisition of good quality photographs are described in detail to encourage all participants to collect more examples for further examination.

Sprat otolith exchange. A sprat otolith exchange was completed in 2002. In general, there was a reasonable agreement between the age determinations. There is nonetheless potential for improvement and action should be taken to achieve a greater precision within institutes and between the various participants.

The effect of the time of day on the acoustic detection of herring. Further studies of the diurnal vertical migration (DVM) behaviour in North Sea were presented. Although there may be bias associated with herring DVM it is likely to be small. Furthermore any reduction in this bias by elimination of early and late survey hours may have seriously adverse consequences on the precision of the surveys. Future studies should therefore assess the balance between these two sources of uncertainty.

PGHERS will meet again in January 2004 in Flødevigen, Norway.

1.4.4 Planning Group on Commercial Catch, Discards and Biological Sampling (PGCCDBS)

A short summary on the main issues addressed by the Planning Group on Commercial Catch, Discards and Biological Sampling [PGCCDBS] was presented to the WG. The main issues were:

Sampling overview

The PGCCDBS have prepared an overview of the sampling activities and sampling level for the three areas; the Baltic, the North Sea and Western and Southern waters before and after implementation of the EU Commission Regulation 1639/2001 on collection of fisheries data (Data Directive) in 2002. This overview showed that the overall sampling level for many species has been kept at the levels before implementation of the Data Directive. Some of the provisions in the Data Directive on the sampling levels ought to be revised. Especially for the stocks where recovery plans are in force, the sampling levels are not adequate to achieve proper basic assessment data.

Sampling coordinators network

A sampling coordination network will be established in order to achieve a better international cooperation between the different national institutes with the purpose of gaining a better sampling of the landings of the various fish stocks. This should facilitate direct contact and better bilateral cooperation.

Sampling and calculation methodology

The Data Directive requires countries to estimate precision levels for various types of data. Different methods can be implemented to quantify the precision of a sampling plan. Using coefficient of variation or confidence intervals will give different results. In order to implement standardized methods and to use the resources (man-power and other expenditures) most appropriately, a workshop will be held in January 2004 in Nantes. As this issue is very important and due to the time frame, it was decided to run the workshop outside the scope of ICES. Representatives from non-EU member countries will be very welcome. The workshop will report to the PGCCDBS, ICES Assessment WGs and ACFM.

Discard sampling data raising procedures

Many countries are about to start or have just started discard-sampling programmes in order to fulfil the data requirements in the Data Directive. In addition the EU Commission has launched a new action plan on discards. Therefore, the PDCCDBS found it very important to review existing programmes and data series and evaluate procedures in order to have all programmes designed in a way which provides robust estimates for use in stock assessments. The possibility of having an expert (statisticians) meeting in the autumn of 2003 in agreement and cooperation with the EU Commission is proposed.

Age-readers network

As for the sampling coordinators the PGCCDBS has agreed to set up an age-readers network.

Age-reading workshops

Age determination is an essential feature in fish stock assessment to estimate the rates of moralities and growth. In order to arrive at appropriate management advice ageing procedures must be reliable. Otolith processing methods and age-reading methods might differ considerably between countries. Therefore, the PGCCDBS agreed that otolith exchanges should be carried out on a regular basis and if serious problems exist age-reading workshops should be organized to solve them. Otolith exchanges cannot start for all species at the same time. At the PGCCDBS meeting planning was made for 2004-2006 in which 2005 and 2006 are preliminary. At last years PGCCDBS meeting it was decided to have these otolith exchanges and age-reading workshops on a regional basis. However, it appears to be more appropriate to have these exchanges and workshops not restricted to regional areas, but extended over the whole ICES area and, if necessary, including the Mediterranean area. The advantage of this will be that the age-reading methods for all experts age reading a specific species are compared, although difficulties in age might differ by area.

It was agreed as a first priority that age-reading workshops should be organized for those species, which have been identified as being very difficult to age:

1. **Sprat**: for this species only winterrings are counted of otoliths; however, these winterrings cannot be linked to a specific age or year class.
2. **Hake**: it appeared to be very difficult to distinguish the annual rings from other rings;
3. **Monkfish**: different age-reading results come from reading otoliths and illicia.

PGCCDBS recommended that age-reading workshops for sprat, hake and monkfish should be organized in 2004. The countries responsible for organising these workshops are respectively Norway, Spain and Portugal.

1.4.5 The Study Group on Growth, Maturity and Condition in Stock Projections (SGGROMAT)

The first meeting of this study group occurred in December 2002 (ICES CM 2003/D:01). The terms of reference were ambitious:

a) summarize the availability of data on weights, maturity, condition, fecundity, and age-length and length-weight keys for stocks in the North Sea, Irish Sea, Barents Sea and Baltic Sea in the form of standardized tables;
b) develop process-based growth, maturity, condition and fecundity models for a subset of the stocks in a);
c) implement process-based models in a new projection methodology and compare the results to the methodology currently used;
d) agree on an intersessional programme to apply the findings of the Study Group.

The study group made good progress on ToR a) and began on ToR b). Many presentations were given on current models being used and on the variability in survey and catch estimates in growth and condition of fish. Much developmental work is ongoing. An intersessional programme was planned to move the work forward.

1.4.6 Methods WG

A short summary of the main issues addressed by the ICES Working Group on Methods for Fish Stock Assessment (WGMG) was presented to the WG. The summary included:

- Testing of standard software
- Guidelines for simple data analysis
- Evaluation of assessment methods on simulated data and on blue whiting data.

Testing of software

Several assessment packages have been delivered to ICES for certification (e.g. AMCI, ISVPA, LTEQ). In addition a number of packages are currently under development (e.g. XSA, TSA, MedAn, RecAn, StockAn, Surba, CSA). The Methods Working Group has found that the process of certification or quality assurance could not be handled at the meeting. Consequently, the models have not received a formal approval by the methods group. It is unclear what the status of these models is, but the interpretation by the HAWG is that software that has not formally been approved can still be applied to carry out assessments, if the method is considered to be adequate for the purpose of assessing the stock.

Guidelines for simple data analysis

The methods group has initiated guidelines to do simple data analysis before any complex models are applied to the data and to interpret the results from such models. These analyses are aimed at providing information into the key issues for assessment models: detecting mortality signals and influence of data on parameters. Methods of detecting mortality or selection signals can be: plots of catch-at-age by year class, plots of log catch ratios, plots of log index ratios. The influence of data on parameters can be evaluated by scanning over certain terminal F values with a simple separable model and by assessing the effects of making minor changes to the model parameters. Influence of individual data on model parameter estimates can be explained in terms of 'cost' and 'gain' by changing a parameter, i.e. by the increase or decrease of individual terms in the objective function.

Evaluation of assessment methods on simulated data and blue whiting data

Several methods were evaluated using simulated data sets that were relatively simple but included a trend in the catchability of one survey index series. Furthermore, ISVPA, together with AMCI, were investigated with respect to the blue whiting assessment. Considering methods relevant to the HAWG, it was found that ICA sometimes gave misleading estimates of stock abundance in the past. ISVPA may sometimes give strong year class patterns in the residuals, corresponding to over- or under-estimates of whole year classes. The most likely cause seems to be the additional constraints on the structure of the residuals applied by that method. CSA was considered to be a promising alternative to more complex models in data poor situations. It was noted that CSA does not have the convergence properties of fully age-structured models, thus retrospective analyses will not detect e.g. retrospective bias, and the results in absolute terms are very sensitive to the choice of ratio between catchabilities of recruits and recruited fish.

1.4.7 EU-Projects: HERGEN and WESTHER

Conservation of diversity in an exploited species: spatio-temporal variation in the genetics of herring (*Clupea harengus*) in the North Sea and adjacent areas. QLRT-2000-01370

The HERGEN project explores the spatio-temporal variation in the genetics of herring (*Clupea harengus*) in the North Sea and adjacent areas. The project aims to estimate the genetic differentiation among spawning aggregations and the temporal stability of the population differentiation. In addition, HERGEN includes the determination of composition of mixed feeding aggregations and the determination of temporal variability in contributions to mixed aggregations.

Intensive sampling of both spawning and mixed aggregations was conducted throughout 2002. All sampled herring were described with respect to length, weight, sex, and gonadal stage. Sagittal otoliths were extracted, mounted for macro- and microstructure analysis and analysed for age by counting otolith annual zones. All samples were genetically screened to give an initial outline of the levels of spatial structuring.

A workshop was arranged to calibrate which microsatellite loci to employ in the project. Ten microsatellite loci were chosen for the project out of a potential set of 13. The choice was based on a number of criteria, chiefly among them: ease of scoring and repeatability among labs, reasonable polymorphism, and no evidence of null alleles.

In addition, a workshop was arranged to calibrate methods of age reading and spawning type assignment from otolith microstructure and ensure a standardised interpretation of the results among partners. The major conclusions from the otolith microstructure section of the workshop were that the method was relatively easy to acquire, but that experience and frequent inter-calibrations were necessary to ensure standardised interpretations. Furthermore, measurements of ring-widths and definition of reference intervals would improve the consistency of interpretations. Regarding the age-reading calibration section, the conclusion was that the agreement between readers was relatively high. The introduction of an image analysis system tool proved very valuable when discussing readings, and it was concluded that otolith microstructure would assist in reaching a higher degree of agreement.

EU-Project WESTHER. A multidisciplinary approach to the identification of herring (*Clupea harengus* L.) stock components west of the British Isles using biological tags and genetic markers. **Q5RS-2002-01056 (2003-2005)**

Details of the project, which started in January 2003, have been presented to the HAWG.

WESTHER's overall goal is to describe the population structure of herring stocks distributed from the south-west of Ireland and the Celtic Sea to the Northwest of Scotland.

To achieve its goal WESTHER has four research objectives: estimation of genetic and phenotypic differentiation between spawning aggregations; determination of stock origins and life history of juveniles; determination of composition of feeding aggregations and improved guidelines for the conservation and management of biodiversity and stock preservation.

WESTHER's goal will be achieved by integrating the results from several techniques, both innovative and established, including genetic markers and biological tags. The proposed research will therefore set up and improve multidisciplinary tools for herring stock identification, providing a more holistic approach. WESTHER will optimise the determination of stock structure of Atlantic herring west of the British Isles, creating a unified database of individual herring characteristics using the following techniques:

1. Body morphometry
2. Otolith morphometry
3. Meristic analysis (pyloric caeca counts)
4. Microsatellite DNA analysis of tissue
5. Fish parasite assemblages
6. Parasite genetics
7. Otolith microstructure, and
8. Otolith core microchemistry

It is through combining this suite of complementary identification techniques, which cover multiple aspects and stages of herring life history and biology that the strongest inferences on stock structure will be drawn. WESTHER's approach, using a number of different techniques on the same individuals, will allow apparent discrepancies implied by individual methods to be resolved and improve confidence in the results of stock identification.

WESTHER will provide a sound basis for understanding the life history of herring in western European waters. The results of the project will be used to provide guidelines for the conservation and management of biodiversity through input to the ICES Herring Assessment Working Group (HAWG), and ultimately to the management of these stocks.

A number of the members of this consortium are members of the HAWG and this will ensure that the project results are applied quickly to the assessment and available to the fishery managers. The implications of the project will be presented to the HAWG in March 2006.

1.5 Commercial catch data collation, sampling, and terminology

1.5.1 Commercial catch and sampling: data collation and handling

Input spreadsheet and initial data processing. Since 1999 (catch data 1998), the Working Group members have used a spreadsheet to provide all necessary landing and sampling data, which was developed originally for the Mackerel Working Group (WGMHSA) and further adapted to the special needs of the Herring Assessment Working Group. The current version used for reporting the 2002 catch data was v1.6.4. The majority of commercial catch data of multinational fleets was again provided on these spreadsheets and further processed with the SALLOCL-application (Patterson 1998). This program gives the needed standard outputs on sampling status and biological parameters. It also clearly documents any decisions made by the species coordinators for filling in missing data and raising the catch information of one nation/quarter/area with information from another data set. This allows recalculation of data in the future (as done by SG REDNOSE, see Section 1.4.1), 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 input format provided was used by all but one nation, and the quality of the input data has significantly improved over the last years. Unlike the uncomfortable handling of the exchange workbook, no major problems appeared during the transmission of data to the species coordinators. On the coordinators side, problems occurred only when nations filled in unsampled metiers themselves, as the SALLOCL application cannot handle these and filling-in decisions are not properly documented any more. The deadline for delivering the data was unfortunately not met by most nations, and the time-consuming data verification and procedures relevant to the splitting of North Sea autumn spawners and Western Baltic spring spawners in Division IIIa have not been done prior to the WG meeting. To avoid delaying the start of the assessments, it is necessary that the splitting data is made available on the first day of the WG.

Transparency of data handling by the Working Group. The current practice of data handling by the Working Group is that the data received by the coordinators is available in a folder called "archive". These high-resolution data are not reproduced in the report. The archived data contains the disaggregated dataset (disfad), the allocations of samples to unsampled catches (alloc), the aggregated dataset (sam.out) and (in some cases) a document describing any problems with the data in that year. It is the intention of the Working Group that in the interim period until the standard database is developed (see below) the **previous year's archived data will be copied over to the current year directory** and updated at the Working Group. Thus the archive for each year will contain the complete dataset available. Information on official, area misreported, unallocated, discarded and sampled catches are recorded on the WG-data exchange sheet (MS Excel). However, only sampled, official, WG and discards are available in the file Sam.out.

Current methods of compiling fisheries assessment data. As mentioned above each species coordinator is responsible for compiling the national data to produce the input data for the assessments. In addition to checking the input the major task involved is to allocate samples of catch numbers, mean length- and mean weight-at-age to unsampled catches. There are at present no defined criteria on how this should be done, but the following general process is implemented by the species coordinators. Searches are made for appropriate samples by gear (fleet) area quarter; if an exact match is not available the search will move to a neighbouring area if the fishery extends to this area in the same quarter. More than one sample may be allocated to an unsampled catch, in this case a straight mean or weighted mean of the observations may be used. If there are no samples available the search will move to the closest non-adjacent area by gear (fleet) and quarter, but not in all cases. In this context, national data submitters are again strongly encouraged to provide as much detail as possible of their sampling and filling-in procedures in the respective field of the exchange spreadsheet (sheet 2) instead of filling in unsampled metiers themselves.

The Working Group acknowledges the effort some members have made to provide "corrected" data, which in some cases differ significantly from the officially reported catches. Most of this valuable information is gathered on the basis of personal knowledge of the fishery and good relations between the scientist responsible and the fishermen. The WG is aware of the problem that this knowledge might be lost if the scientist leaves, and asks the national laboratories to ensure continuity in data provision. In addition the Working Group recognises and would like to highlight **the inherent conflict of interest in obtaining details of unallocated catches by country and increasing the transparency of data handling** by the Working Group. This issue will have to be carefully considered in light of any future development by ICES of a standard platform to store all fisheries disaggregated data, particularly with regard to confidentiality.

The WG 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 2000 on (catch data for 1999), the latest (consistency checked) versions of the input files together with standard outputs and a documentation of filling-in decisions made by the coordinators, ideally in the SALLOC-formats, are stored in a separate "archive" folder. This is 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 WG members on request. As there was very little historical information available, WG members were asked to provide as much as possible national catch and historical data sets in any available format. National data provided in this year is stored in a "~historic" folder within "Archive"; they will be consistency checked and transferred into a database system as soon as this is available. Table 1.5.1 gives an overview of data available so far, and the source of the data. Members are encouraged to use the latest-version input spreadsheets if it is needed to re-enter catch data. Figure 1.5.1 shows the separation of areas as used for the long-term storage of data.

Future developments. Again a number of problems were encountered with the input data, some of them attributable to the notorious error-prone handling of spreadsheets. E.g., it was found that the direction of transfers and target area(s) of misreported or unallocated catches could not be clearly stated in the present format. 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 noted with satisfaction that after four years of expressing the urgent need for the development of an input file based on a stand-alone **database application**, ICES started to develop such a system. The WG repeats its opinion that the quality of the input data from commercial sampling proved to be crucial for the quality of the whole assessment procedure. The WG will support ICES in this effort wherever needed and recommends to seek the contribution of species coordinators of different groups as early as possible in the process. The application should be usable by all working groups, and any future format should provide an opportunity to clearly track changes of official landings made by WG members to compensate misreported or unallocated landings or discards. Further, a transparent and effective handling of sampling information obtained from market sampling in foreign ports should be possible. Reference is made here again to a number of documents addressing this issue (e.g. Pastoors, 1999 WD to HAWG; Zimmermann *et al*. 2000 WD to WGMHSA, EMAS Project report 2001).

However, if a database input is again not available for next year's WG, the spreadsheet will be used again for the interim period. Obvious errors will be omitted intersessionally, but there will be no more general developments on this sheet. The reason for this is that it would represent a duplication of effort in light of the intention of ICES to develop a standard platform for the collection storage of disaggregated fisheries assessment data.

In this context, the Working Group recommends again that a directory be allocated on the ICES server to store relevant documentation and the most recent versions of exchange sheets and programmes used to aggregate the data, and that these items be available over the ICES web server.

1.5.2 Sampling

Quality of sampling for the whole area. The Working Group again produced a map indicating the level of catch sampling by area for all herring stocks covered by HAWG (Figure 1.5.2). The map indicates that the sampling level (in terms of fraction of catch sampled and number of age readings per 1000 t catch) is very different for the various areas. Further details of the sampling quality can be found by stock in the respective sections (Sec. 2.2.4 for North Sea herring, 3.2.6 for Western Baltic Spring Spawners, 4.2.3 for Celtic Sea and VIIj herring, 5.2. for VIa(N) herring, 6.2.2 for VIa(S) and VIIb,c herring, 7.2.2 for Irish Sea herring).

The new EU sampling regime. HAWG has recommended for years that sampling of commercial catches should be improved for most of the stocks. In January 2002, a new directive for the collection of fisheries data was implemented for all EU member states (Commission Regulation 1639/2001). The provisions in the "data directive" define specific sampling levels. As most of the nations participating in the fisheries on herring assessed here have to obey this data directive, the definitions applicable for herring and the area covered by HAWG are given below:

Area	sampling level per 1000 t catch		
Baltic area (IIIa (S) and IIIb-c)	*1 sample of which*	*100 fish measured and*	*50 aged*
Skagerrak (IIIa (N))	*1 sample*	*100 fish measured*	*100 aged*
North Sea (IV and VId):	*1 sample*	*50 fish measured*	*25 aged*
NE Atlantic and Western Channel ICES areas II, V, VI, VII (excluding d) VIII, IX, X, XII, XIV	*1 sample*	*50 fish measured*	*25 aged*

Exemptions to the sampling rules mentioned above are:

Concerning lengths:

(1) the national programme of a Member State can exclude the estimation of the length distribution of the landings for stocks for which TACs and quotas have been defined under the following conditions:

(i) the relevant quotas must correspond to less than 5 % of the Community share of the TAC or to less than 100 tonnes on average during the previous three years;
(ii) the sum of all quotas of Member States whose allocation is less than 5 %, must account for less than 15 % of the Community share of the TAC.

If the condition set out in point (i) is fulfilled, but not the condition set out in point (ii), the relevant Member States may set up a coordinated programme to achieve for their overall landings the implementation of the sampling scheme described above, or another sampling scheme, leading to the same precision.

Concerning ages:

(1) the national programme of a Member State can exclude the estimation of the age distribution of the landings for stocks for which TACs and quotas have been defined under the following conditions:

(i) the relevant quotas correspond to less than 10 % of the Community share of the TAC or to less than 200 tonnes on average during the previous three years;
(ii) the sum of all quotas of Member States whose allocation is less than 10 %, accounts for less than 25 % of the Community share of the TAC.

If the condition set out in point (i) is fulfilled, but not the condition set out in point (ii), the relevant Member States may set up a coordinated programme as mentioned for length sampling.

If appropriate, the national programme may be adjusted until 31 January of every year to take into account the exchange of quotas between Member States;

The HAWG reviewed the implementation of the new sampling regime for the EU countries. It is expected that the overall sampling level might be improved, and this was demonstrated e.g. for North Sea herring this year (see Section 2.2.3). However, there is concern that the new regime may lead to a deterioration of sampling quality, because it does not assure an appropriate sampling of different métiers (each combination of fleet/nation/area and quarter). Given the diversity of the fleets harvesting most stocks assessed by HAWG, an appropriate spread of sampling effort over the different métiers is more important to the quality of catch-at-age data than a sufficient overall sampling level. The EU data directive appears to not assure this. The WG therefore recommends that all metiers with substantial catch should be sampled (including by-catches in the industrial fisheries), that catches landed abroad should be sampled and information on these samples should be made available to the national laboratories.

Most of the issues raised here have also been addressed by the Planning Group on Commercial Catch, Discard and Biological Sampling (see Section 1.4.4.).

1.5.3 Terminology

The WG noted that the use of “age”, “winter rings” and “rings” still causes confusion outside the group (and sometimes even among WG members). The WG tries to avoid this by consequently using “rings” or “ringers” instead of “age” throughout the report. It should be observed that, for autumn-spawning stocks, there is a difference of one year between “age” and “rings”. HAWG in 1992 (ICES 1992/Assess:11) stated that

“The convention of defining herring age rings instead of years was introduced in various ICES working groups around 1970. The main argument to do so was the uncertainty about the racial identity of the herring in some areas. A herring with one winter ring is classified as 2-years-old if it is an autumn spawner, and one-year-old if it is a spring spawner. Recording the age of the herring in rings instead of in years allowed scientists to postpone the decision on year of birth until a later date when they might have obtained more information on the racial identity of the herring.

The use of winter rings in ICES working groups has introduced a certain amount of confusion and errors. In specifying the age of the herring, people always have to state explicitly whether they are talking about rings or years, and whether the herring are autumn- or spring spawners. These details tend to get lost in working group reports, which can make these reports confusing for outsiders, and even for herring experts themselves. As the age of all other fish species (and of herring in other parts of the world) is expressed in years, one could question the justification of treating West-European herring in a special way. Especially with the present trend towards multispecies assessment and integration of ICES working groups, there might be a case for a uniform system of age definition throughout all ICES working groups.

However, the change from rings to years would create a number of practical problems. Data files in national laboratories and at ICES would have to be adapted, which would involve extra costs and manpower. People that had not been aware of the change might be confused when comparing new data with data from old working group reports. Finally, in some areas (notably Division IIIa), the distinction between spring- and autumn spawners is still hard to make, and scientists preferred to continue using rings instead of years.

The Working Group discussed at length the various consequences of a change from rings to years. The majority of the Group felt that the advantages of such a change did not outweigh the disadvantages, and it was decided to stick to the present system for the time being.”

The text table below gives an overview over the correlation between age, rings and year class for the different spawning types in late 2002:

Year class (*autumn spawners*)	2001/**2002**	2000/**2001**	1999/**2000**	1998/**1999**
Rings	**0**	**1**	**2**	**3**
Age (*autumn spawners*)	1	2	3	4
Year class (*spring spawners*)	**2002**	**2001**	**2000**	**1999**
Rings	**0**	**1**	**2**	**3**
Age (*spring spawners*)	0	1	2	3

1.6 Methods used by this Working Group

1.6.1 Stock assessment methods

Assessment methods available to the Working Group were as described in ICES (ICES C.M. 1996/ASSESS:10 Herring Assessment Working Group report), where reasons for the choice of method are also documented. A detailed documentation of the separable model implementation used by this WG (ICA version 1.4) is given in Patterson (1998) and Needle (2000). For most stocks in this Working Group ICA is the standard method of assessment.

Sprat in the North Sea has been found notoriously difficult to assess. This year, a new implementation of a "modified DeLury" two stage method (Conser 1995) was presented to the WG on Methods of Fish Stock Assessments by Mesnil (2003). The tool, Catch-Survey Analysis (CSA), seems to be particularly appropriate in cases where a full age structure is lacking, but where a "recruits" stage can be easily identified from older ages (aggregated in a "fully recruited" component). Data required are catch numbers and an index of abundance; a survey estimate is preferable, for each stage. The requirements are suitable for the type of data available on sprat. Model-estimated parameters are the catchability of the fully recruited stage, the recruit numbers time-series and the numbers-at-age of the fully recruited stage at the start of the data period. A unique value for natural mortality and the ratio of the catchabilities of the recruits to the fully recruited stage ($s = q_r / q_f$) are fixed externally.

ISVPA (Kizner Z.I. and D.A.Vasilyev. 1997) was used for exploratory assessments on the VIa South and VIIb&c stock. The method was explored by the Methods WG 2003, and its most recent update is described in Vasiliev (2003). A short outline is given in Section 6.6.1.

1.6.2 Short- and medium-term projections

Short-term projections are carried out using the MFDP software and yield-per-recruit analysis using MFYPR. However, for North Sea autumn-spawning herring, a dedicated short-term projection has been written during HAWG 2002 and has been used in the current WG as well (Skagen, 2003 WD 11). This model allows the specification of multiple fleets with different selection patterns and the calculations of solutions that conform to the Harvest Control Rule which has been agreed for this stock. Medium-term projections are carried out using ICP (Needle 2000).

1.6.3 Estimating retrospective bias and uncertainty

The WG noted that the interpretation of the so-called retrospective “spaghetti-plots” is often difficult to quantify. Qualifications like “severe retrospective bias” or “reasonable retrospective bias” are regularly found in WG reports from this and other assessment working groups. The group decided to explore whether existing quantifiable measures of retrospective bias could be applied to the stocks assessed by this WG.

There are two forms of retrospective analysis:

- analytic retrospective analysis: using the selected final assessment and carrying out retrospective assessments by cutting off recent years one by one, but keeping the same model settings.
- historic retrospective analysis: using the data from the quality control diagrams for an analysis of the retrospective differences. This involves a comparison of potential differences in model type, model structure, data (due to revisions) and WG preferences in any single years.

Two approaches to the quantification of the retrospective bias were encountered in the literature. Mohn (1999) carried out a study on retrospective bias using simulated data. His metric for retrospective bias is the sum of the relative vertical distances from the end points of the spaghetti-plot:

$$\rho = \sum_{i=1}^{n-1} \frac{a_{i,i} - a_{i,n}}{a_{i,i}}$$

where a is the variable to be considered (SSB, mean fishing mortality or recruitment), n is the last assessment year for which data is available and for $a_{i,j}$, i is the year when the estimate of a for year j was made. Thus $a_{i,n}$ is the estimate of variable a for year i as carried in the last assessment year (n).

Jónsson and Hjörleifsson (2000) developed a system of two related metrics for retrospective patterns: a measure of retrospective bias and a measure of retrospective variation. They proposed a metric of average bias (ab) as:

$$ab(a)_n = \frac{1}{n-1}\sum_{i=1}^{n-1} \ln \frac{a_{i,i}}{a_{i,n}}$$

which is the mean of the log-ratio's of the estimates. They further proposed a metric of assessment deviation (asd) as:

$$asd(a)_n = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n-1}\left(\ln\frac{a_{i,i}}{a_{i,n}} - ab(a)_n\right)^2}$$

which can be interpreted as an estimator of the standard error of the log-ratio's.

The WG considered that the proposed metrics by Jónsson and Hjörleifsson were the preferred approach because it quantifies both the bias and uncertainty of the retrospective patterns. Furthermore, Mohn's metric is more difficult to interpret because it is measuring the sum of relative differences compared to the first estimate of a quantity rather than the most recent estimate of that quantity.

An Excel macro was developed that will allow the calculation of the bias and uncertainty measures. The calculations were applied to the historic and analytic retrospective analysis that are presented in this report. In the overview section (Section 1.8) the results of the historic retrospective analysis are summarized.

1.7 Biological reference points

Existing reference points

Reference points for herring and sprat stocks south of 62°N were taken from the ACFM Report, May 2000, and summarised in the text table below. The limit reference points for herring West of Scotland (VIa North) was suggested by HAWG 2002.

STOCK	LIMIT	PRECAUTIONARY
North Sea autumn-spawning herring	**B**$_{lim}$ is 800 000 t. Technical basis: Below this value impaired recruitment has been experienced. **F**$_{lim}$ is not defined.	**B**$_{pa}$ = 1.3 mill t. Technical basis: Part of a harvest control rule based on simulations. **F**$_{pa}$ be set at $F_{ages\ 0\text{-}1}$ = 0.12; at $F_{ages\ 2\text{-}6}$ = 0.25. Technical basis: Part of a harvest control rule based on simulations.
Western Baltic spring-spawning herring	Not specified	
Celtic Sea	**B**$_{lim}$ is 26 000 t. Technical basis: The lowest stock observed. **F**$_{lim}$ is not defined	**B**$_{pa}$ be set at 44 000 t. Technical basis: Reduced probability of low recruitment.
West of Scotland	**B**$_{lim}$ **suggested** at 50 000 t Technical basis: **B**$_{loss}$ **F**$_{lim}$ is not defined	**B**$_{pa}$ is not defined **F**$_{pa}$ is not defined
Div. VIaS & VIIb,c	**B**$_{lim}$ is 81 000 t. Technical basis: Lowest reliably estimated SSB. **F**$_{lim}$ is 0.33	**B**$_{pa}$ be set at 110 000 t. Technical basis: Approximately 1.4 **B**$_{lim.}$ **F**$_{pa}$ be set at 0.22
Irish Sea	**B**$_{lim}$ is 6 000 t. Technical basis: Lowest observed SSB. **F**$_{lim}$ is not defined	**B**$_{pa}$ = 9 500 t. Technical basis: **B**$_{lim}$* 1.58; still under consideration. **F**$_{pa}$ under review; 0.36 proposed in 1999, not adopted.
Sprat North Sea	Not specified	Not specified
Sprat in div VIId,e	Not specified	Not specified
Sprat in div IIIa	Not specified	Not specified

Proposed reference points

The WG was requested in ToR (h) to: "comment on the PA reference points proposed by the Study Group on Precautionary Reference Points for Advice on Fishery Management". In this section the WG will consider the results of the SGPRP and how these considerations affect the views of the WG on biological reference points for herring and sprat stocks.

The WG has considered the general approach towards revision of biological reference points and found that the approach is at present not yet developed enough to be used for the revisions. The WG considered that the methodology to estimate changepoints in the segmented regression appears to be problematic for quite a number of stocks and that the diagnostics of the model fits cannot be readily understood. More seriously, the WG considered that the link between limit and PA reference points has only been described theoretically and has not been properly tested, nor has appropriate software been developed to carry out the analysis. Therefore, the WG does not endorse a general revision of biological reference points until the appropriate methodological developments have been finalized so that a coherent approach to the revision process can be made.

Based on the material and analysis that were available, the WG has looked into the changes in limit reference points suggested by the SGPRP:

	Present	Julious method			Grid method		
Herring	Blim						Bloss
Stock		Changepoint	slope	P value	Changepoint	slope	
North Sea	**800 000**	**558 096**	**89.73**	**<0.01**	**556 899**	**89.82**	**48 797**
Her-nirs (Irish Sea-VIIaN)	6 000	32 548	14.05	0.46	5 472	332.22	5 452
Her-irlw (VIaS,VIIbc)	81 000	66 589	11.59	0.74	66 684	11.58	66 487
Her-irls (Celtic Sea & Div.VIIj)	**26 000**	**61 306**	**7.89**	**<0.01**	**61 388**	**7.88**	**27 912**
Her-Via(N)	n.d.	53 121	17.53	0.63	49 996	18.58	49 875
Her-IIIa**							123 367

Of these suggestions, four stocks are considered to require a closer look: North Sea autumn-spawning herring, Celtic Sea herring, West of Scotland herring and Western Baltic spring-spawning herring.

North Sea autumn-spawning herring

The segmented regression analysis gave a significant breakpoint of around 560 000 t, which is lower than the current $\mathbf{B}_{\mathrm{lim}}$ (800 000 t). For this stock a harvest control rule has been agreed between the relevant management authorities. ICES has confirmed that the harvest control rule is consistent with the precautionary approach. In the HCR, trigger points have been defined in the form of a minimum biomass (called MBAL) and an un-named reference point of 1.3 million t under which specific measures will be defined. The trigger point needs not to be directly connected to the limit reference point which has been set. However, ACFM has adopted this point as $\mathbf{B}_{\mathrm{pa}}$. The WG considers that the HCR appears to work satisfactorily with respect to reducing fishing mortality and increasing the spawning stock biomass. Therefore, the WG recommends that there is no immediate need to revise the biological reference points and that further developments on the implementation of software for estimating reference points should be awaited before the reference points for North Sea autumn-spawning herring will be revisited.

West of Scotland herring

In 2002 the WG has suggested reference points for this stock, as the assessments now seemed to be more stable than in the past. ACFM, in May 2002, endorsed the proposed $\mathbf{B}_{\mathrm{lim}}$, but postponed the decision on it awaiting the further evaluations by SGPRP. The analysis using segmented regression has shown that a significant regression cannot be estimated for this stock. Therefore, SGPRP has suggested to use $\mathbf{B}_{\mathrm{loss}}$ as a proxy for $\mathbf{B}_{\mathrm{lim}}$ for this stock. This is consistent with the proposal by HAWG 2002. Given the fact that no biological reference points exist for this stock, the WG proposes a $\mathbf{B}_{\mathrm{lim}}$ of 50 000 t.

Celtic Sea herring

The current $\mathbf{B}_{lim}$=26 000 (1999) is based on $\mathbf{B}_{loss}$ (1999). The segmented regression gives a change point of 61 000 t. The estimated change point seems to be way too high with respect to the historical exploitation. The WG noted that there is a relatively dense concentration of annual points above the estimated change point with SSB in the range of 60 000-100 000 t, which may have high leverage on the estimation of the breakpoint. The sensitivity of the method to these data should be investigated. The WG therefore recommends to await further developments on the implementation of software for estimating reference points and to work on the quality of the assessment itself as a first priority.

Western Baltic spring-spawning herring

The assessment of Western Baltic spring-spawning herring was accepted for the first time by ACFM in 2002. The current assessment indicates that it is consistent with last year which warrants that biological reference points be estimated for this stock. This is especially important because it has been managed very much in relation to North Sea autumn-spawning herring for the recent 7-8 years. Because the stock in the North Sea appears to increase rapidly, it is necessary to set separate reference points for the Baltic which will allow the development of management specifically directed at this stock.

Conclusion

The WG welcomes the work carried out by SGPA2003 (ACFM/:15) and SGPRP on the development of tools for the evaluation of reference points. However, it is still premature to change existing reference points because a full approach to evaluate reference points including appropriate software is not available yet. The WG recommends the use of retrospective measures of uncertainty that are more directly measurable from the historic assessment data. The only stock for which the group considers the proposal of a new reference point is warranted by the analysis and the state of current knowledge, is West of Scotland herring. For this stock a proposal for $\mathbf{B}_{lim}$ was already presented by HAWG 2002 and the assessment is now relatively stable for a number of years already.

1.8 Stock overview

In this WG, a total of 8 herring stocks and 3 sprat stocks are considered. Analytical assessment could be carried out for only 5 out of these 11 stocks. Results of the assessments are presented in the subsequent sections of the report and are summarized below and in Figures 1.8.1 - 1.8.3.

North Sea autumn-spawning herring is the largest stock assessed by this WG. It has experienced very low spawning stock biomass levels in the late 1970s when the fishery was closed for a number of years. In the mid-1990s, the stock again appeared to decrease rapidly after which corrective measures were taken. The stock is currently expanding again due to the combination of strong recruitments and relatively low fishing mortality on both juvenile and adult herring.

Western Baltic Spring Spawners is the only spring-spawning stock assessed within this WG. It is distributed in the eastern part of the North Sea, the Skagerrak, the Kattegat and the SDs 22, 23 and 24. In Div. IIIa, they mix with North Sea Autumn Spawners. The Western Baltic Spring Spawning herring stock is slowly recovering from the historic low SSB level in 1998. Yield and fishing mortality on the adults are considered to have been reduced in the last years. However, fishing mortality on adults still appears to be high as compared to other herring stocks in European waters.

Celtic Sea herring: 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 fishery in the eastern part of the Celtic sea was closed in the early eighties due to poor recruitment. Stock assessments have become unstable in the recent past due to fluctuations in recruitment, for which there is no independent measure. F has reduced sharply since 2000; currently SSB cannot be precisely estimated.

West of Scotland herring is one of the medium-sized stocks covered by the WG, it is currently lightly exploited and with two recent good year classes the stock is at a relatively high level. The stock experienced a heavy fishery in the mid-70s following closure of the North Sea. The fishery was closed before the stock collapsed. The fishery was opened again along with the North Sea. In the 1990s there was substantial area misreporting of catch into this area and sampling of catch deteriorated. Recently the area misreporting has reduced to a low level and information on catch has improved. Instability in the assessment has reduced.

Herring in VIa south and VIIbc are considered to consist of a mixture of autumn- and winter/spring-spawning fish, which spawn from October to March. The winter/spring-spawning component is distributed in the northern part of the area. The main decline in the overall stock since 1998 appears to have taken place on the autumn-spawning component, and this is particularly evident on the traditional spawning grounds in VIIb. The current levels of SSB and F are not precisely known, as there is no tuned assessment available for this stock.

Irish Sea autumn-spawning herring is one of the smaller stocks assessed by the WG and it comprises two spawning groups (Manx and Mourne). This stock complex experienced a very low biomass level in the late 1970s with an increase in the mid-1980s after the introduction of quotas. The stock then declined from the late 1980s to its present relatively low level. During this time period the contribution of the Mourne spawning component has declined and there has been changes in the behaviour of the remaining stock in regard to some spawning locations.

North Sea Sprat is the only sprat stock on which an assessment is carried out within this WG. The recruits account for a large proportion of the stock, and the fishery in a given year is very dependent on that year's incoming year class. The size of the stock has been variable the past 10 years with a large biomass in the early 90's followed by a sharp decline in biomass. The sprat stock now shows signs of being in good condition as the biomass appears to increase and there is indication from the IBTS (February) 2003 survey of a good 2002 year class recruiting to the 2003 fishery.

The main **assessment tools** used by this WG is ICA (Patterson, 1998) which is a separable model over a recent number of years and a conventional VPA over the earlier part of the time-series. This model appears to behave well on the stocks considered by this WG. However, for some stocks additional methods need to be used, e.g. for herring caught in Divisions VIaS and VIIbc where no reliable tuning data are available and for North Sea sprat where the ageing is considered to be problematic. ACFM in May 2002 has accepted the assessment of North Sea autumn-spawning herring, West of Scotland herring and Baltic spring-spawning herring as full analytical assessments. The other assessments were only considered to be indicative of stock trends.

Biological reference points have been defined for a limited number of stocks. The process of revision and introduction of biological reference points is ongoing. For North Sea autumn-spawning herring, biological reference points are included in a harvest control rule which has been agreed between Norway and the EU. North Sea herring is currently exploited within safe biological limits as the fishing mortality is below $\mathbf{F}_{pa}$ and the spawning stock above $\mathbf{B}_{pa}$.

Retrospective patterns arise in some of the assessments carried out by this WG. The text table below summarizes the historic retrospective biases for two of the stocks assessed by the HAWG (based on the quality control diagrams) using the metrics of bias and uncertainty explained in Section 1.6.3. For this analysis, the metrics were calculated over five years.

Stocks	Fishing mortality		SSB		Recruitment	
	Bias	std. error	bias	std. error	bias	std. error
North Sea herring	0.18	0.17	-0.17	0.19	0.06	0.19
Irish Sea	0.06	0.16	-0.06	0.24	0.06	1.19

1.9 Recommendations

The HAWG recommends:

1.9.1 Degradation of spawning grounds

- All decisions about the granting of licenses for gravel extraction in the deeper waters of the eastern English Channel should be carried out within the precautionary principle (UNCED, 1992). This principle (no.15) states "where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason … to prevent environmental degradation". The Working Group considers that there is enough scientific information to recommend that no gravel extraction occur in ICES Statistical Rectangle 29F0 for the four-month period of November to February, as this coincides with herring spawning in the area. Licenses should not be granted for the remainder of the year unless it can be proven unequivocally that gravel extraction does not have a deleterious impact on herring spawning and larval production in ICES Statistical Rectangle 29F0 and Div. VIId. (from Section 1.3)

- 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. All decisions about the granting of licenses for gravel extraction in the Celtic Sea and VIIj should be carried out under the precautionary principle. The Working Group considers that there is enough scientific information to recommend that no gravel extraction occur in areas with spawning grounds during the spawning season or within 1 month before or after this period, as this coincides with herring spawning in the area and egg and larval development. Licenses should not be granted for the remainder of the year unless it can be proven unequivocally that gravel extraction does not have a deleterious impact on herring spawning and larval production in the area (from Section 4).

1.9.2 Data provision and storage

- ICES should carry out a simple amendment to the database system to allow the storage and easy extraction of quality control data from stock assessments (see Section 1.3.2). This will allow the automated generation of quality control diagram and figures and the calculation of measures of retrospective bias and variance. (from Section 1.3)

- National labs should provide information of commercial catch and sampling by fishery, especially if by-catches in non-directed fisheries occur, and/or if there are indications that the age structure in the catches differ between fisheries. (from Section 1.5)

- A directory should be allocated on the ICES server to store relevant documentations and the most recent version of exchange sheets and programmes used to aggregate the data, and that these items be available over the open-access ICES web server. (from Section 1.5)

- All metiers with substantial catch should be sampled (including by-catches in the industrial fisheries), that catches landed abroad should be sampled and information on these samples should be made available to the national laboratories. (from Section 1.5)

- The criteria used for ageing sprat should be reviewed, and further validation of winter ring formation in sprat and year class allocation should be carried out. (from Section 8)

- With regard to the development of a new application to aggregate and store commercial catch and sampling information, to seek the contribution of species coordinators of different working groups as early as possible in the process. The application should be usable by all working groups, and any future format should provide an opportunity to clearly track changes of official landings made by WG members to compensate misreported or unallocated landings or discards. Further, a transparent and effective handling of sampling information obtained from market sampling in foreign ports should be possible (from Section 1.5).

1.9.3 Surveys

- All herring recruitment information that is available from surveys in the Celtic sea should be evaluated and the acoustic surveys should be maintained. (from Section 4)

- Efforts should be made to survey the whole area of Division IIIa during the October survey on Baltic spring-spawning herring (from Section 3).

1.9.4 Assessment methods

- The WG of Methods should again consider assessment methods for short-lived species in the light of recent developments (from Section 8.8).

1.9.5 Management considerations

- A management regime should be established for the Western Baltic Spring Spawning herring stock separate from herring both in the Central Baltic and the North Sea. Due to asynchronous population dynamics of herring in the North Sea, the Central Baltic and the Western Baltic plus Division IIIa, the WG repeats that a proper management of the Western Baltic Spring Spawning herring stock requires a separate management regime. The need for a separate TAC set for the area where WBSS herring is distributed, i.e. Division IIIa and Subdivisions 22-24 should be considered with some urgency. (from Section 3)

- A management approach which includes a mid-year revision of the TAC taking into account an estimate of incoming recruitment should be considered for sprat. (from Section 8.9)

1.9.6 Planning / Study groups

- Planning Group of Herring Surveys (PGHERS) should meet, at Flødevigen, Norway, from 26 to 30 January 2004 (chair to be announced) to:

  a) combine the 2003 survey data to provide indices of abundance for the population within the area;
  b) coordinate the timing, area and effort allocation and methodologies for acoustic and larvae surveys for herring and sprat in the North Sea, Division VIa and IIIa and Western Baltic in 2004;
  c) review and update the PGHERS manual for acoustic surveys to address standardization of all sampling tools and survey gears;
  d) evaluate the results of the investigations of survey overlaps between vessels in the North Sea acoustic survey;
  e) assess the status and future of the HERSUR database

- The 2002 WG recommended a Study Group on Herring in the Irish and Celtic Seas [SGHICS] to meet in 2002/03. This study group was to re-evaluate the current data used for the stock assessment of Irish Sea and Celtic Sea herring by re-compilation of long-term data sets, evaluation of the long-term variation in biological parameters (weights-at-age, length-at-age, maturity and condition) of Irish Sea and Celtic Sea herring, and to carry out an otolith exchange of Irish and Celtic Sea herring, the results of which are to be assessed by the study group. This study group was not approved by ASC in 2002; however, there is still a need to undertake all these tasks. Therefore, the WG recommends that a group is convened to meet the terms of reference presented for SGHICS.

1.9.7 Others

- The Report-CD sent out to HAWG members should also contain a copy of the "Working documents" and "Presentations" folder from the network drive.

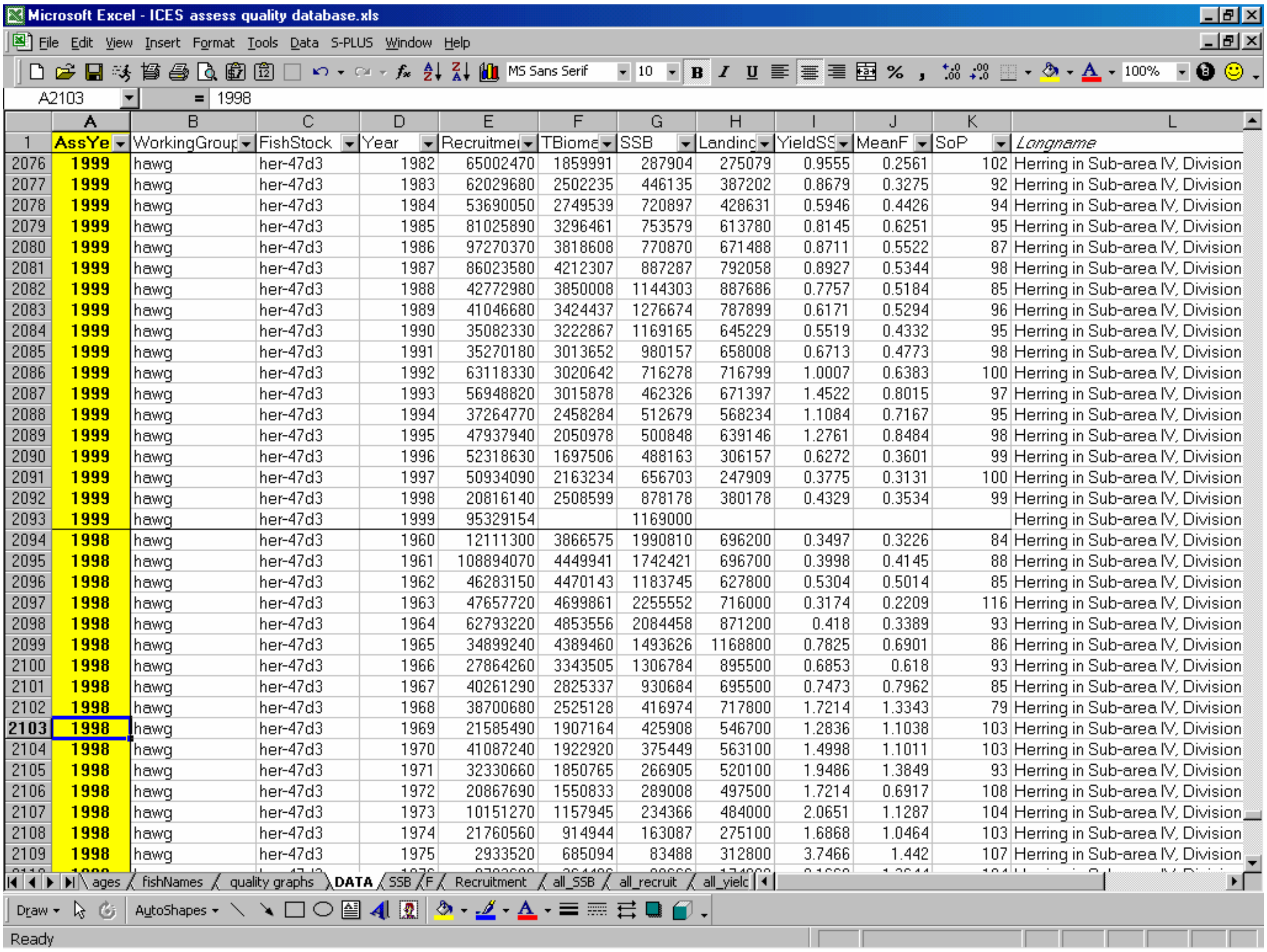
- In the light of the substantial contribution the WGs are expected to deliver for the quality control handbook, the authorship of this handbook is changed from *Lassen and Sparholt* to *Lassen and Sparholt (eds.)* or *ICES*, following rules of good scientific practice.

Table 1.3.1.1 Working group estimates of catch from 29F0 and ICES area VIId, 1998 to 2002.

	ICES rectangle 29F0					Area VIId	
	Q1	Q2	Q3	Q4	total	WG catch	official catch
1998	18	873	16	19,464	20,371	47819	22828
1999	76	10	35	17,021	17,142	43600	23326
2000	20	1	2	16,413	16,436	38718	18109
2001	29	2	2	23,403	23,437	43737	20645
2002	44	12	5	24,853	24,915	45808	37014
average	37	180	12	20,231	20,460	43936	24384

Table 1.5.1: Available disaggregated data for the HAWG per March 2003
X: Multiple spreadsheets (usually xls); W: WG-data national input spreadsheets (xls);
D: Disfad inputs and Alloc-outputs (ascii/txt)

Stock	Catchyear	Format X	Format W	Format D	Comments
Baltic Sea: IIIa and SD 22-24					
her_3a22	1991-2000	X			raw data, provided by Jørgen Dalskov, Mar. 2001, splitting revised
	1998	X			provided by Jørgen Dalskov, Mar. 2001, splitting revised
	1999	X			provided by Jørgen Dalskov, Mar. 2001, splitting revised, catch data revisec
	2000	X			provided by Jørgen Dalskov, Mar. 2001
	2001	X			provided by Jørgen Dalskov, Mar. 2002
	2002	X			provided by Jørgen Dalskov, Mar. 2003
Celtic Sea and VIIj					
her_irls	1999	X			provided by Ciarán Kelly, Mar. 2000
	2000	X			provided by Ciarán Kelly, Mar. 2001
	2001			D	provided by Ciarán Kelly, Mar. 2002
	2002			D	provided by Ciarán Kelly, Mar. 2003
Clyde					
her_clyd	1999	X			provided by Mark Dickey-Collas, Mar. 2000
	2000-2002				included in VIaN
Irish Sea					
her_nirs	1998	X			provided by Mark Dickey-Collas, Mar. 2000
	1999	X			provided by Mark Dickey-Collas, Mar. 2000
	2000	X	W		provided by Mark Dickey-Collas, Mar. 2001
	2001	X			provided by Mark Dickey-Collas, Mar. 2002
	2002	X			provided by Richard Nash, Mar. 2003
North Sea					
her_47d3, her_nsea	1991	X			provided by Yves Verin, Feb. 2001
	1992	X			provided by Yves Verin, Feb. 2001
	1993	X			provided by Yves Verin, Feb. 2001
	1994	X			provided by Yves Verin, Feb. 2001
	1995	X			provided by Yves Verin, Feb. 2001
	1996	X			provided by Yves Verin, Feb. 2001
	1997	X			provided by Yves Verin, Feb. 2001
	1998	X	W		provided by Yves Verin, Mar. 2000
	1999		W	D	provided by Christopher Zimmermann, Mar. 2000
	2000		W	D	provided by Christopher Zimmermann, Mar. 2001
	2001		W	D	provided by Christopher Zimmermann, Mar. 2002
	2002		W	D	provided by Christopher Zimmermann, Mar. 2003
West of Scotland (VIa(N))					
her_vian	1997	X			provided by Ken Patterson, Mar. 2002
	1998	X			provided by Ken Patterson, Mar. 2002
	1999		W	D	provided by Paul Fernandes, Mar. 2000, W included in North Sea
	2000		W	D	provided by Emma Hatfield, Mar. 2001, W included in North Sea
	2001		W	D	provided by Emma Hatfield, Mar. 2002, W included in North Sea
	2002		W	D	provided by Emma Hatfield, Mar. 2003, W included in North Sea
West of Ireland					
her_irlw	1999	X	(W)		provided by Ciaran Kelly, Mar. 2000
	2000	X	(W)		provided by Ciaran Kelly, Mar. 2001
	2001			D	provided by Ciaran Kelly, Mar. 2002
	2002			D	provided by Ciaran Kelly, Mar. 2003
Sprat in IIIa					
spr_kask	1999	X	(W)		provided by Else Torstensen, Mar. 2000
	2000	X	(W)		provided by Else Torstensen, Mar. 2001
	2001	X	(W)		provided by Lotte Askgaard Worsøe, Mar. 2002
	2002	X	(W)		provided by Lotte Askgaard Worsøe, Mar. 2003
Sprat in the North Sea					
spr_nsea	1999	X	(W)		provided by Else Torstensen, Mar. 2000
	2000	X	(W)		provided by Else Torstensen, Mar. 2001
	2001	X	(W)		provided by Lotte Askgaard Worsøe, Mar. 2002
	2002	X	(W)		provided by Lotte Askgaard Worsøe, Mar. 2003
Sprat in VIId & e					
spr_ech	1999	X	(W)		provided by Else Torstensen, Mar. 2000
	2000	X	(W)		provided by Else Torstensen, Mar. 2001
	2001	X	(W)		provided by Lotte Askgaard Worsøe, Mar. 2002
	2002	X	(W)		provided by Lotte Askgaard Worsøe, Mar. 2003
National Data					
Germany: Western Baltic	1991-2000	X			provided by Tomas Gröhsler, Mar. 2001 (with sampling)
Germany: North Sea	1995-1998		W		provided by Christopher Zimmermann, Mar 2001 (without sampling)
Norway: Sprat	1995-1998		W		provided by Else Torstensen, Mar 2001 (without sampling)
Sweden	1990-2000		W		provided by Johan Modin, Mar 2001 (without sampling)
UK/England & Wales	1985-2000	X			database output provided by Marinelle Basson, Mar. 2001 (without samplin
UK/Scotland	1990-1998		W		provided by Sandy Robb/Emma Hatfield, Mar. 2002



Microsoft Excel - ICES assess quality database.xls

A2103 = 1998

	AssYe	WorkingGroup	FishStock	Year	Recruitment	TBiomass	SSB	Landings	YieldSSB	MeanF	SoP	Longname
2076	1999	hawg	her-47d3	1982	65002470	1859991	287904	275079	0.9555	0.2561	102	Herring in Sub-area IV, Division
2077	1999	hawg	her-47d3	1983	62029680	2502235	446135	387202	0.8679	0.3275	92	Herring in Sub-area IV, Division
2078	1999	hawg	her-47d3	1984	53690050	2749539	720897	428631	0.5946	0.4426	94	Herring in Sub-area IV, Division
2079	1999	hawg	her-47d3	1985	81025890	3296461	753579	613780	0.8145	0.6251	95	Herring in Sub-area IV, Division
2080	1999	hawg	her-47d3	1986	97270370	3818608	770870	671488	0.8711	0.5522	87	Herring in Sub-area IV, Division
2081	1999	hawg	her-47d3	1987	86023580	4212307	887287	792058	0.8927	0.5344	98	Herring in Sub-area IV, Division
2082	1999	hawg	her-47d3	1988	42772980	3850008	1144303	887686	0.7757	0.5184	85	Herring in Sub-area IV, Division
2083	1999	hawg	her-47d3	1989	41046680	3424437	1276674	787899	0.6171	0.5294	96	Herring in Sub-area IV, Division
2084	1999	hawg	her-47d3	1990	35082330	3222867	1169165	645229	0.5519	0.4332	95	Herring in Sub-area IV, Division
2085	1999	hawg	her-47d3	1991	35270180	3013652	980157	658008	0.6713	0.4773	98	Herring in Sub-area IV, Division
2086	1999	hawg	her-47d3	1992	63118330	3020642	716278	716799	1.0007	0.6383	100	Herring in Sub-area IV, Division
2087	1999	hawg	her-47d3	1993	56948820	3015878	462326	671397	1.4522	0.8015	97	Herring in Sub-area IV, Division
2088	1999	hawg	her-47d3	1994	37264770	2458284	512679	568234	1.1084	0.7167	95	Herring in Sub-area IV, Division
2089	1999	hawg	her-47d3	1995	47937940	2050978	500848	639146	1.2761	0.8484	98	Herring in Sub-area IV, Division
2090	1999	hawg	her-47d3	1996	52318630	1697506	488163	306157	0.6272	0.3601	99	Herring in Sub-area IV, Division
2091	1999	hawg	her-47d3	1997	50934090	2163234	656703	247909	0.3775	0.3131	100	Herring in Sub-area IV, Division
2092	1999	hawg	her-47d3	1998	20816140	2508599	878178	380178	0.4329	0.3534	99	Herring in Sub-area IV, Division
2093	1999	hawg	her-47d3	1999	95329154		1169000					Herring in Sub-area IV, Division
2094	1998	hawg	her-47d3	1960	12111300	3866575	1990810	696200	0.3497	0.3226	84	Herring in Sub-area IV, Division
2095	1998	hawg	her-47d3	1961	108894070	4449941	1742421	696700	0.3998	0.4145	88	Herring in Sub-area IV, Division
2096	1998	hawg	her-47d3	1962	46283150	4470143	1183745	627800	0.5304	0.5014	85	Herring in Sub-area IV, Division
2097	1998	hawg	her-47d3	1963	47657720	4699861	2255552	716000	0.3174	0.2209	116	Herring in Sub-area IV, Division
2098	1998	hawg	her-47d3	1964	62793220	4853556	2084458	871200	0.418	0.3389	93	Herring in Sub-area IV, Division
2099	1998	hawg	her-47d3	1965	34899240	4389460	1493626	1168800	0.7825	0.6901	86	Herring in Sub-area IV, Division
2100	1998	hawg	her-47d3	1966	27864260	3343505	1306784	895500	0.6853	0.618	93	Herring in Sub-area IV, Division
2101	1998	hawg	her-47d3	1967	40261290	2825337	930684	695500	0.7473	0.7962	85	Herring in Sub-area IV, Division
2102	1998	hawg	her-47d3	1968	38700680	2525128	416974	717800	1.7214	1.3343	79	Herring in Sub-area IV, Division
2103	1998	hawg	her-47d3	1969	21585490	1907164	425908	546700	1.2836	1.1038	103	Herring in Sub-area IV, Division
2104	1998	hawg	her-47d3	1970	41087240	1922920	375449	563100	1.4998	1.1011	103	Herring in Sub-area IV, Division
2105	1998	hawg	her-47d3	1971	32330660	1850765	266905	520100	1.9486	1.3849	93	Herring in Sub-area IV, Division
2106	1998	hawg	her-47d3	1972	20867690	1550833	289008	497500	1.7214	0.6917	108	Herring in Sub-area IV, Division
2107	1998	hawg	her-47d3	1973	10151270	1157945	234366	484000	2.0651	1.1287	104	Herring in Sub-area IV, Division
2108	1998	hawg	her-47d3	1974	21760560	914944	163087	275100	1.6868	1.0464	103	Herring in Sub-area IV, Division
2109	1998	hawg	her-47d3	1975	2933520	685094	83488	312800	3.7466	1.442	107	Herring in Sub-area IV, Division

ages / fishNames / quality graphs / DATA / SSB / F / Recruitment / all_SSB / all_recruit / all_yield

Ready

Figure 1.3.1 Example of a proposed quality control database.

FishStock | her-47d3 | Herring in Sub-area IV, Divisions VIId & IIIa (autumn-spawners)

AssYear \ Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1988														
1989														
1990														
1991	1549000	1411000	1320000	1346000										
1992	1340000	1247000	1277000	1320000	1287000									
1993	1456000	1354000	1307000	1184000	1055000	965000								
1994	1391000	1260000	1149000	986000	730000	974000	981000							
1995	1286000	1138000	993000	778000	484000	790000	718000	690000						
1996	1240000	1135000	939000	699000	458000	517000	496000	410000	434000					
1997	1265076	1154078	949692	691979	464538	547082	550544	538841	688000					
1998	1266239	1151072	957442	702220	470703	543290	549669	518584	745556	1137000				
1999	1276674	1169165	980157	716278	462326	512679	500848	488163	656703	878178	1169000			
2000	1248953	1149110	971648	714005	458257	502026	474149	447538	568037	701465	905645	908000		
2001	1224623	1115764	915372	684053	444981	473353	466975	434421	529153	701800	815482	771796	1244000	
2002	1247511	1174169	960957	680708	448835	502526	480400	483788	584344	781524	935096	943389	1428052	1699000
Rho											0.58468	0.77733	1.62668	2.17035
Ab											**0.0639**	**0.092**	**0.2044**	**0.3**
Asd											0.08519	0.14996	0.23187	0.33663

Figure 1.3.2 Standardized (pivot table) output of the proposed quality control database.

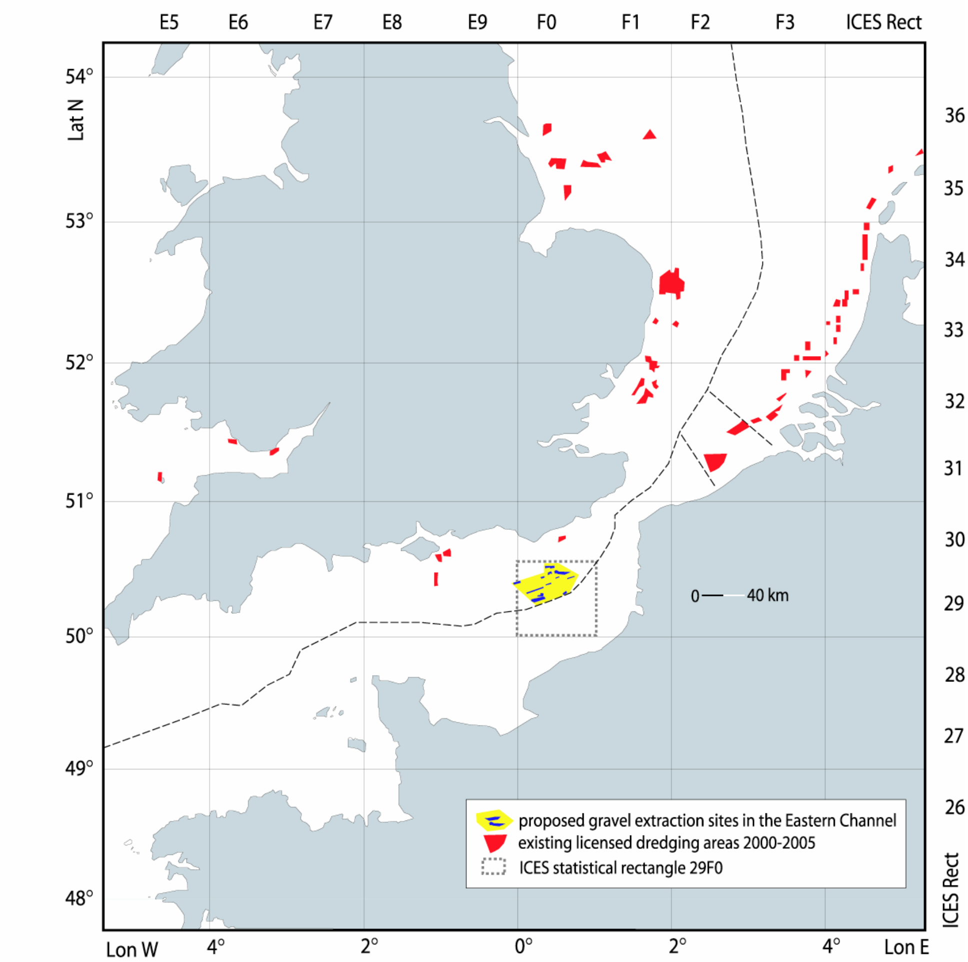


Figure 1.3.1.1 English Channel and southern North Sea (ICES Div. IVc and VIId): existing and proposed gravel extraction sites. Sources: www.eastchannel.info (for proposed sites), www.sandandgravel.com (for licensed sites), redrawn. Rectangle 29F0 highlighted.

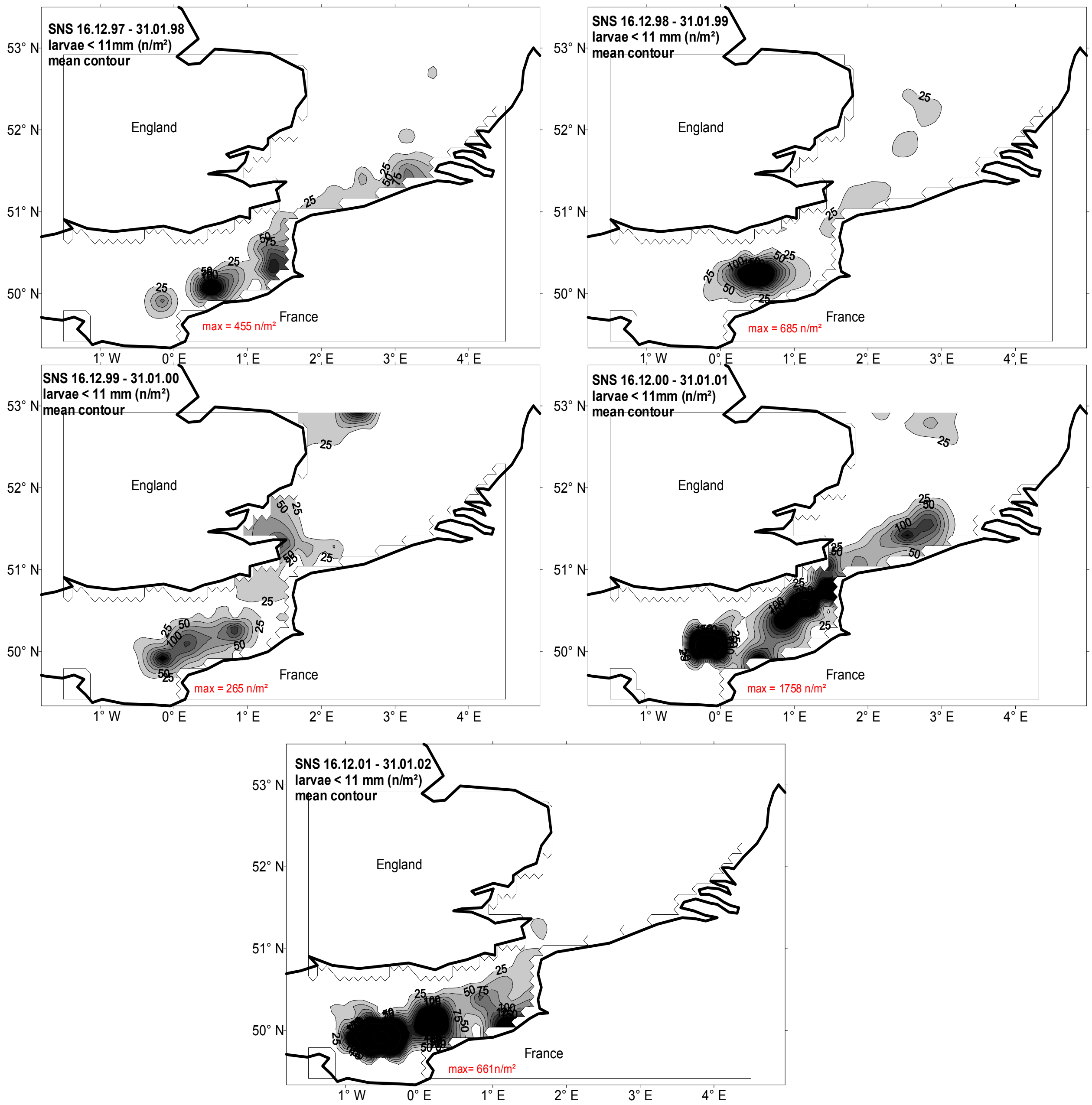


Figure 1.3.1.2 Herring larvae in the English Channel and southern North Sea. Abundance of larvae (<11mm) per m² from 5 survey series, winters 1997 to 2001.

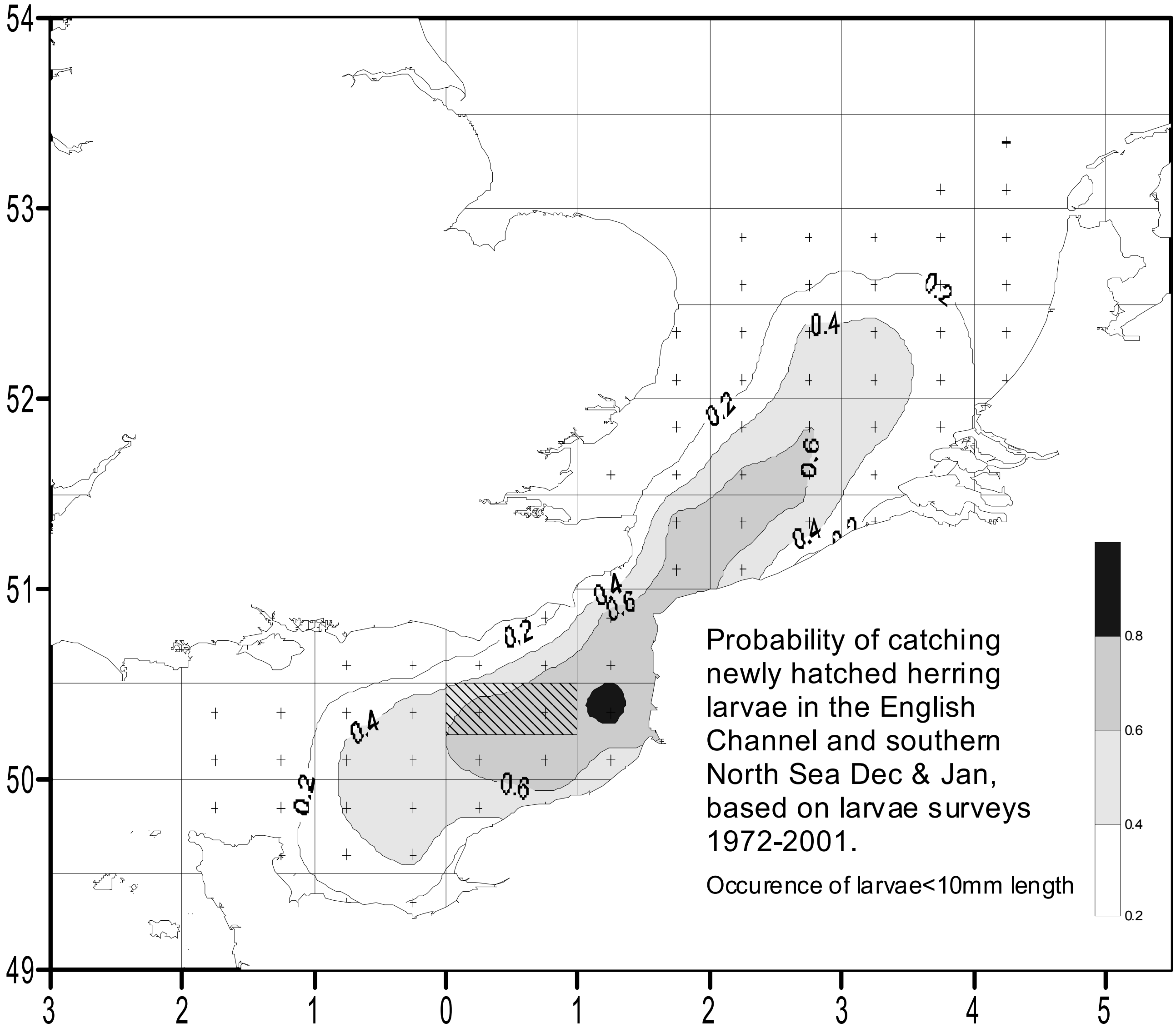


Figure 1.3.1.3 Persistence of catching larvae by year in the English Channel. The probability of catching newly-hatched herring larvae in surveys from 1972 to 2001, by quarter ICES rectangle. Shaded area is northern half of ICES rectangle 29F0.

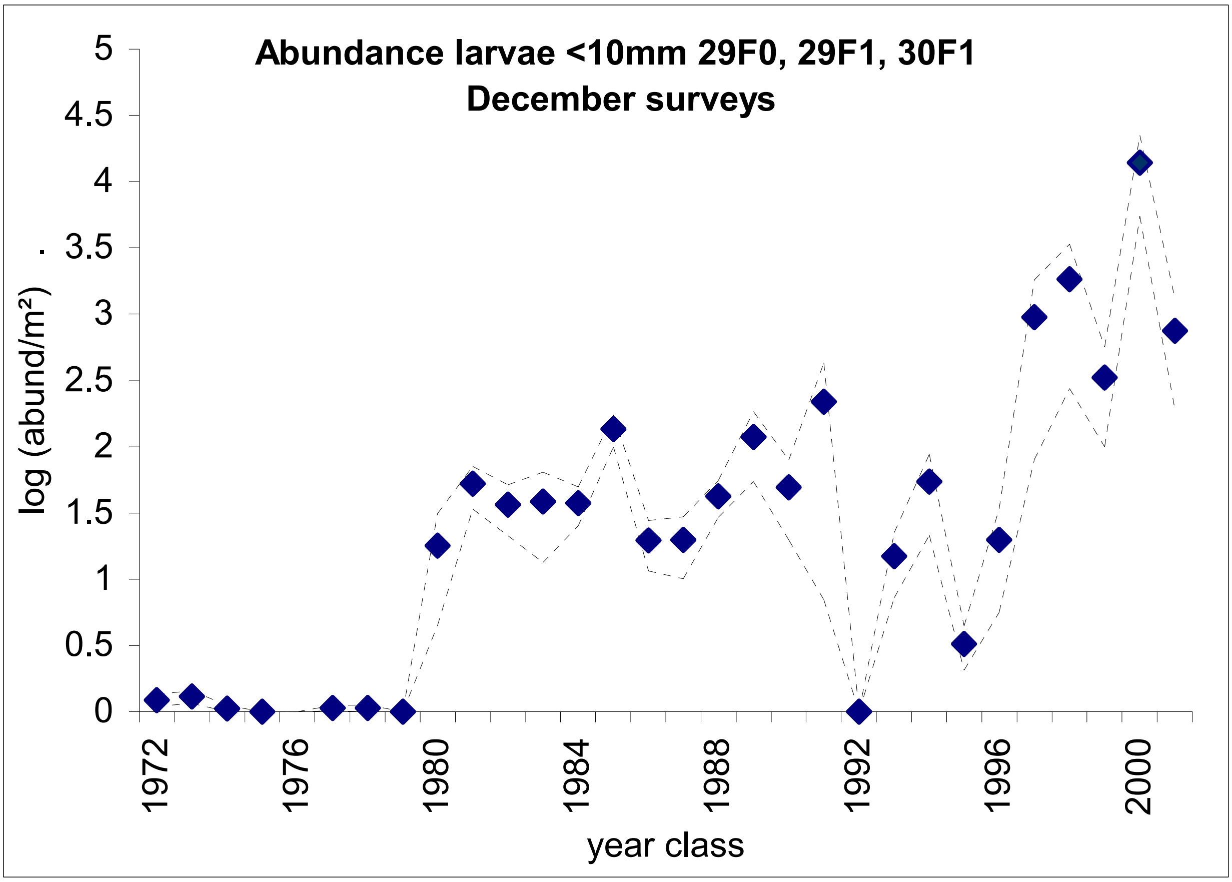


Figure 1.3.1.4 English Channel herring larvae. The abundance of newly-hatched larvae in the eastern Channel (ICES rectangles 29F0, 29F1 & 30F1) for year classes 1972 to 2001. Estimates for December surveys. Dotted line= 95% confidence interval. Note logarithmic scale.

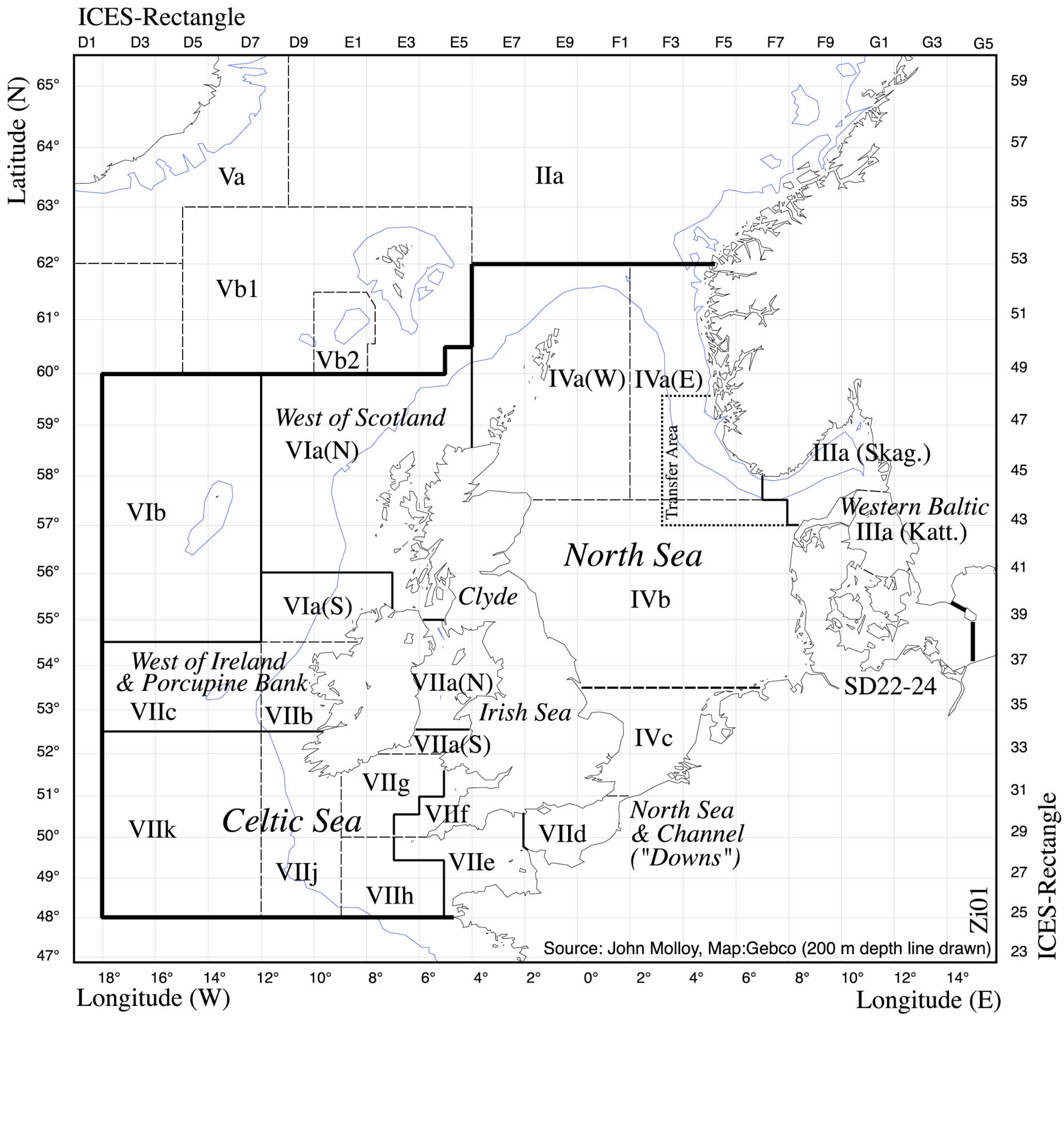


Figure 1.5.1 ICES areas as used for the assessment of herring stocks south of 62°N. Area names in italics indicate the separation used for long-term storage of commercial catch and sampling data. "Transfer area" refers to the transfer of Western Baltic Spring Spawners caught in the North Sea to the Baltic Assessment.

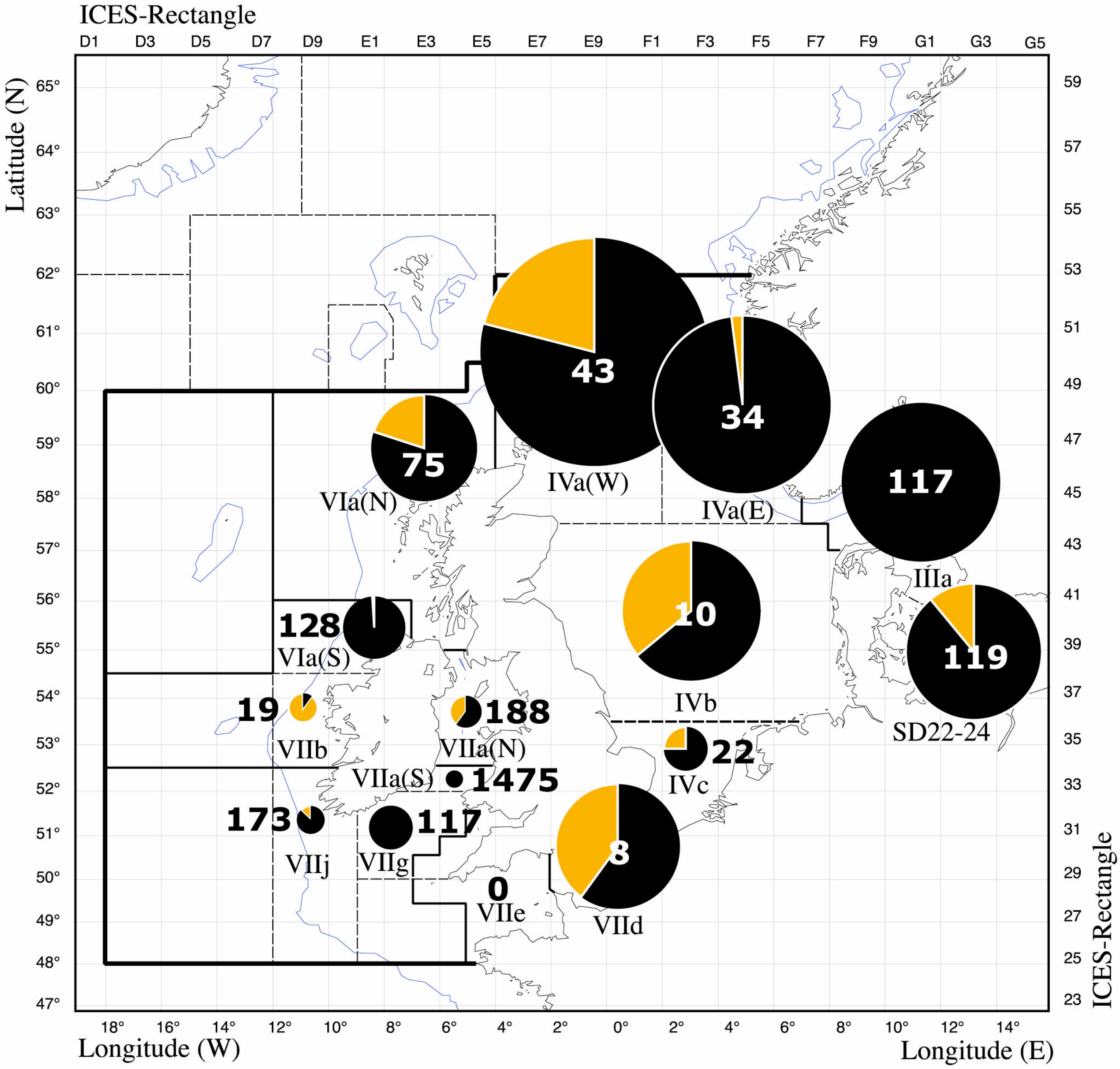


Figure 1.5.2 Herring south of 62°N: Sampling level per ICES areas for the whole year and all fleets. Circle diameter is proportional to Working Group catch; share of sampled catch (black) is indicated. Numbers give the numbers of age readings per 1000 t catch. For the allocation of areas to stocks, see Fig. 1.5.1.

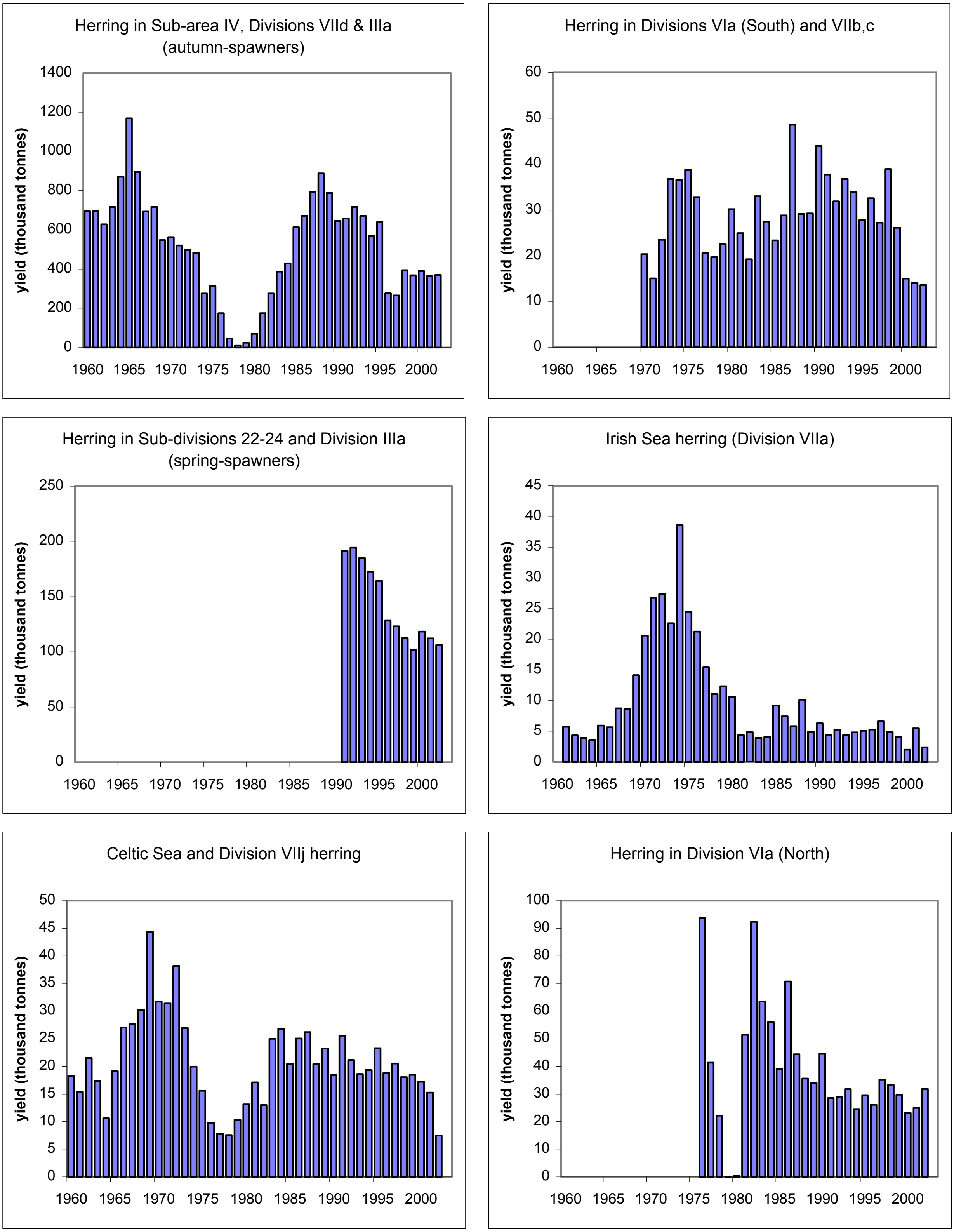


Figure 1.8.1 WG estimates of yield of the stocks presented in HAWG 2003.

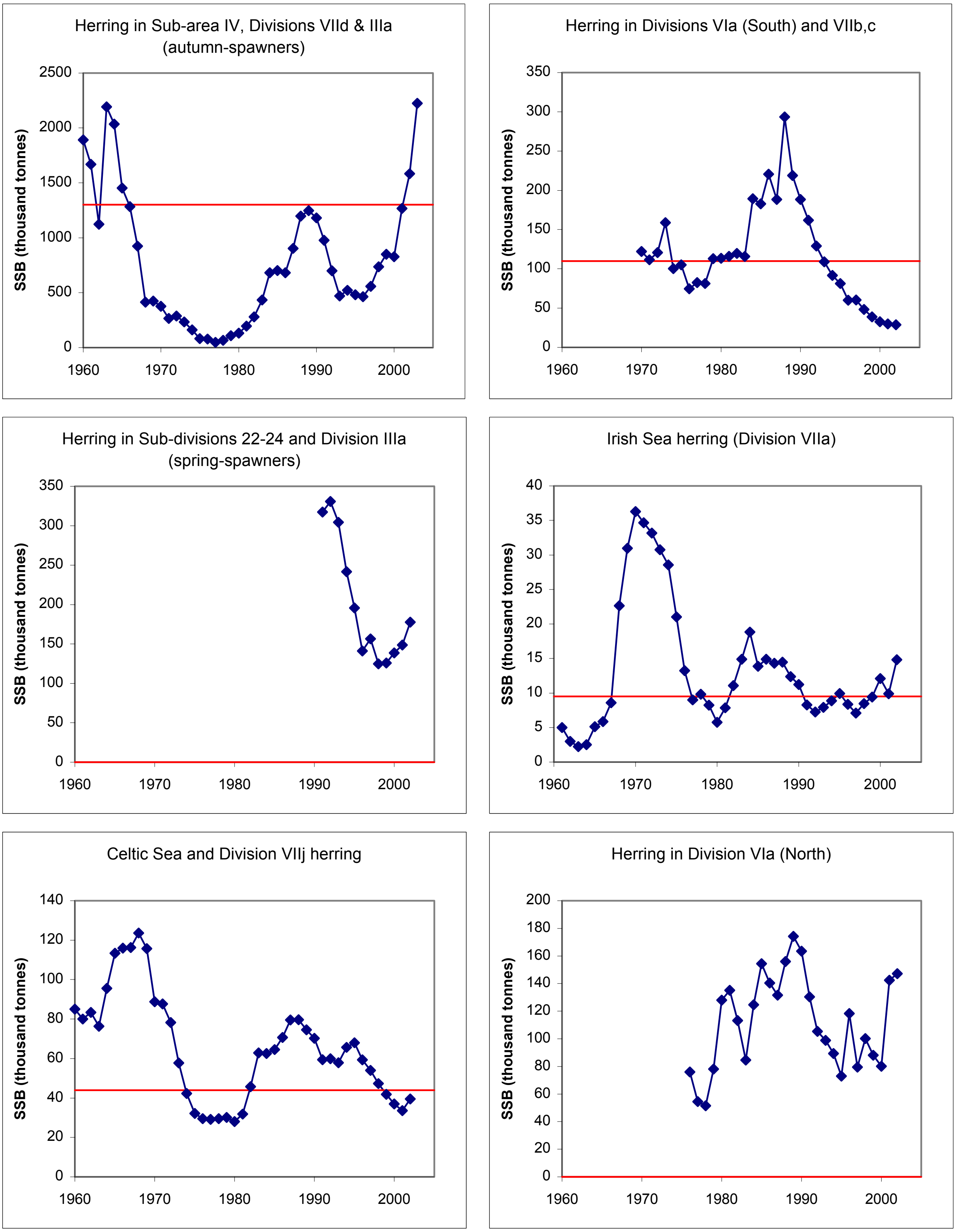


Figure 1.8.2 Spawning stock biomass estimates of the 5 stocks for which analytical assessments were presented in HAWG 2003. The $\mathbf{B}_{pa}$ level (if available) is indicated in the graphs. For the herring stock in Division VIa (South) and VIIb,c the assessment was an exploratory VPA based on a terminal F equal to 0.6.

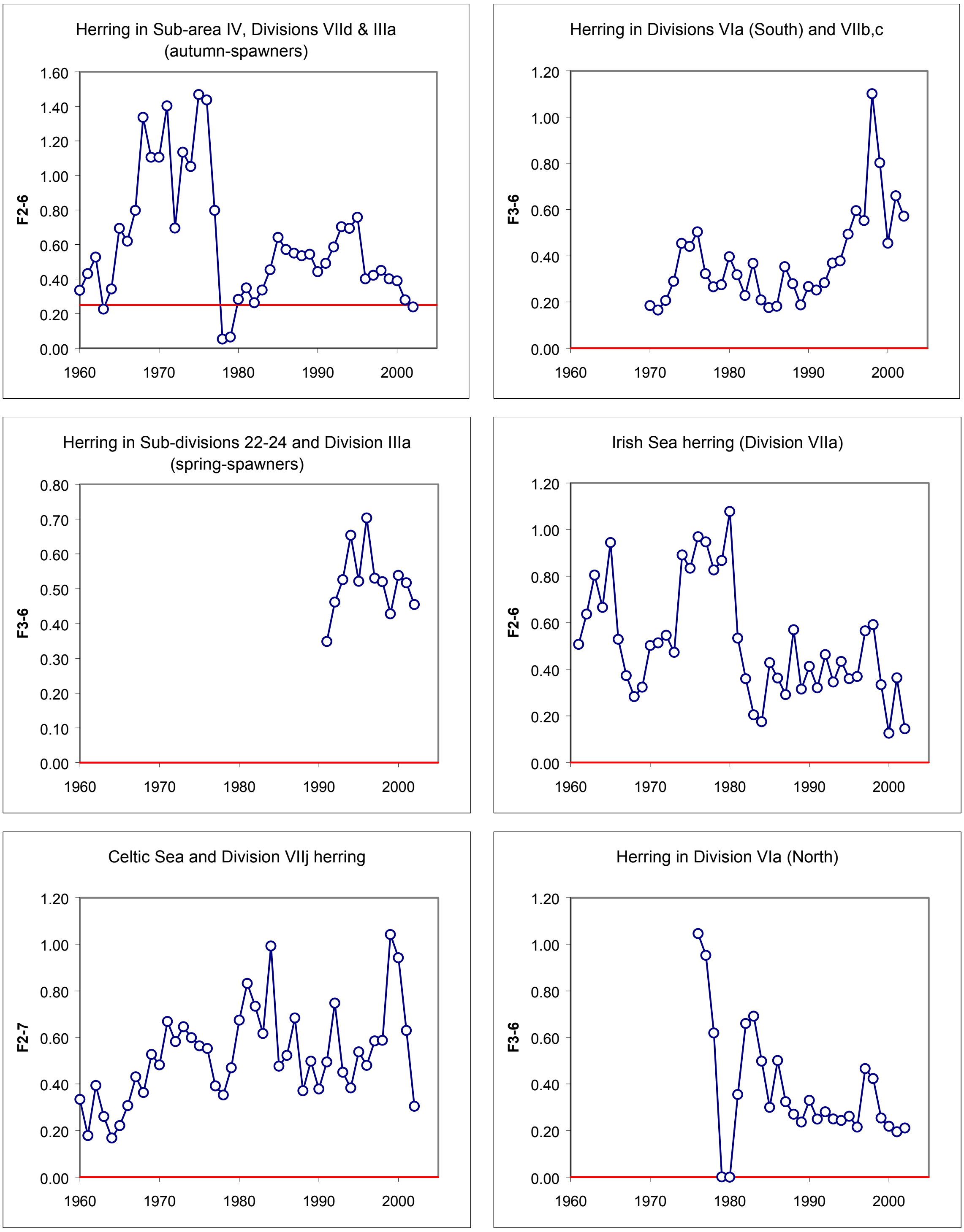


Figure 1.8.3 Estimates of mean F of the stocks for which analytical assessments were presented in HAWG 2003. The $\mathbf{F}_{pa}$ level (if available) is indicated in the graphs.

2 NORTH SEA HERRING

2.1 The Fishery

2.1.1 ACFM advice and management applicable to 2002 and 2003

In 1996, the total allowable catches (TACs) for herring caught in the North Sea (ICES Areas IV and Division VIId) were changed mid-year with the intention of reducing the fishing mortality by 50% for the adult part of the stock and by 75% for the juveniles. For 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 with the 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.

Until 2002, the SSB has been below the precautionary level of 1.3 million tonnes ($\mathbf{B}_{pa}$), and since 1998 other measures taken have consisted of an adoption of a $F_{2\text{-}6}$ of 0.2 and a $F_{0\text{-}1} < 0.1$ to allow the rebuilding of the spawning biomass to above $\mathbf{B}_{pa}$.

Since 2002, SSB is considered to be above $\mathbf{B}_{pa}$. ACFM therefore gave a fleetwise catch option table and advised that catches in 2003 should be within the constraints of fishing mortality agreed by the EU and Norway. Catches in IVc and VIId should not exceed the TAC set for 2002. It was expected that fishing at the recommended level would lead to a further increase in the SSB, mainly due to continued large recruiting year classes entering the fishery.

The final TACs adopted by the management bodies for 1999 to 2001 were 265,000 t for Area IV and Division VIId, whereof not more than 25,000 t should be caught in Divisions IVc and VIId. For 2002, the sub-TAC set for Divisions IVc and VIId was raised to 42,673 t, but the total TAC for herring caught in the North Sea was kept constant (265,000 t). For 2003, the TAC for the whole area was raised to 400,000 t (by 51%) with an increase of the sub-TAC for Divisions IVc and VIId to 59,542 t (by 39%). Catches of herring in the Thames estuary are not included in the TAC. The by-catch ceiling set for fleet B in the North Sea was 36,000 t for 2000 to 2002 and was increased to 52,000 t for 2003 (by 44%). As North Sea autumn spawners are also caught in Division IIIa, regulations for the fleets operating in this area have to be taken into account for the management of the stock (see Section 3).

2.1.2 Catches in 2002

Total landings and estimated catches are given in Table 2.1.1 for the North Sea and for each Division in Tables 2.1.2 to 2.1.5. Total Working Group catches per statistical rectangle and quarter are shown in Figures 2.1.1 a-d, the total for the year in Figure 2.1.1e. All nations provided most of their catch data (either official landings or Working Group catch) by statistical rectangle.

The catch figures in Tables 2.1.1 – 2.1.5 are mostly official landings, but for some nations catch estimates are given by Working Group members, including unallocated or misreported catches. These figures can therefore **not** be used for management purposes. For corrections applied to and inconsistencies in previous year’s data see Sections 1.4.1, 2.2.3 and 2.2.4. Only Denmark and Norway provided information on by-catches of herring in the industrial fishery. These are taken in the small-meshed fishery (B-fleet) under a EU quota by Denmark and are included in the A-fleet figures for Norway. Catch estimates of herring taken as by-catch in other small-mesh fisheries in the North Sea may be an underestimate. The total catch in 2002 as used by the Working Group amounted to 352,800 t. It increased by more than 9% as compared to last year’s catch. By area, catches increased in Division IVa (West) and in Division IVa (East) by about 17 %, by 11 % in the southern North Sea (Divisions IVc and VIId), and decreased by 17 % in Division IVb.

Landings of herring taken as by-catch in the Danish small-meshed fishery were again much lower than the by-catch ceiling set for Denmark (34,450 t), but have increased since 1997 to now 22,000 t (Table 2.1.6). In 2002, the Danish sprat fishery was carried out mainly in the second half of the year with by-catches of herring of about 10% (less than 17,000 t). Herring by-catches in the Danish Norway pout fishery were estimated to be less than 6% (3,100 t), and less than 0.5 % in the sandeel fishery (1,600 t). The quarterly distribution of by-catches in the Norwegian industrial fishery is given in the text table below. These figures are counted against the human consumption quota.

Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
0 t	692 t	2,168 t	1,597 t	4,457 t

Misreporting of landings taken in the North Sea but reported from other areas such IIa, IIIa and VIa (North) is still substantial, and the estimates of the total amount of misreporting have increased compared to last year (to about 32,000 t).

TACs for the human consumption fishery in Subarea IV and Division VIId have been significantly exceeded in several years. Largest relative discrepancies between officially reported landings and WG catch occurred in Divisions IVc and VIId, where TACs have been exceeded by almost 100% between 1996 and 2001 (when the sub-Tac was set to 25,000 t). The WG catch increased only slightly for this area; however, the TAC excess was reduced in 2002 due to an increase of the sub-TAC (42,673 t). The excess for the years 1995 to 2002 is shown in the table below. Since the introduction of yearly by-catch ceilings in 1996, these ceilings have never been exceeded. In the table below (adapted from Table 2.1.6) the landings figures under the legend "Official" landings include for some countries official landings and for other countries landing estimates provided by Working Group members.

Year	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
TAC HC ('000 t)	440	156	159	254	265	265	265	265
"Official" landings HC ('000 t)[1]	436	163	157	250	271	268	276	278
Working Group catch HC ('000 t)	**501**	**228**	**221**[2]	**314**	**321**	**311**	**303**	**331**
Excess of landings over TAC HC ('000 t)	61	72	62	60	56	46	39	66
By-catch ceiling ('000 t) [3]		44	24	22	30	36	36	36
Reported by-catches ('000 t) [4]	65	38	13	14	15	18	20	22
Working Group catch North Sea ('000 t)	**566**	**266**	**234**[2]	**329**	**336**	**329**	**323**	**353**

HC = human consumption fishery

[1] *"Official" landings might be provided by WG members; they do not in all cases correspond to official catches and cannot be used for management purposes. Norwegian by-catches included in this figure.*
[2] *figure altered in 2000 on the basis of a re-evaluation of misreported catches from VIa North.*
[3] *by-catch ceiling for EU industrial fleets only, Norwegian by-catches included in the HC figure.*
[4] *provided by Denmark only.*

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 are 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), 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 IIIa.

Biological information for North Sea Autumn spawners caught in Division IIIa was obtained using splitting procedures described in Sec. 3.2. The total catches of NSAS (SOP figures), mean weights- and numbers-at-age by fleet are given in Table 2.2.6. Data on catch numbers-at-age and SOP catches are shown for the period 1990-2002 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 1991-2002 separately for the different Divisions where NSAS are caught (Tab. 2.2.11).

Note that Tables 2.2.1 to 2.2.11 (and subsequently the assessment input data) have not been updated to account for the changes in Swedish 2002 catch in Division IIIa distribution data, which was made available only very late during the WG meeting (see Section 2.2.3). All tables giving historic data (Tables 2.2.6 to 2.2.11) will need to be updated following the results of SG Rednose (see Section 1.4.1). This was not possible as the latter Group could not finish its work prior to the HAWG meeting.

2.2.1 Catch in numbers-at-age

North Sea catches in numbers-at-age over the years 1990-2002 are given in Table 2.2.7. The total number of herring taken in the North Sea (3 billion) remains roughly constant since 1999; the numbers of North Sea Autumn-spawner catches have decreased by 19%. Catches of 0-ringer NSAS have decreased by 60%, while those of 3-ringers have increased by 83%. 0- and 1-ringers contributed more than 40% of the total catch in numbers of North Sea autumn spawners in 2002. Fig. 2.2.1. shows the relative proportions on the total catch numbers for different periods (1960-2002, 1980-2002 for the total area, and 2002 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, and the removal of local Spring spawners in the Western part of the North Sea, the amount of the total catch used for the assessment of North Sea Autumn spawners was 371,000 tonnes:

Area	Allocated	Unallocated	Discards	Total
IVa West	124,755	14,201	17,093	156,049
IVa East	83,342	5,961	-	89,303
IVb	53,095	4,052	-	57,147
IVc/VIId	42,980	7,338	-	50,318
	Total catch in the North Sea			352,817
	Autumn Spawners caught in Div. IIIa (SOP)			24,776
	Baltic Spring Spawners caught in the North Sea (SOP)			-6,652
	Other Spring Spawners			-60
	Total Catch NSAS used for the assessment			**370,881**

The table above does not include 1,429 t of NSAS additionally transferred from Div. IIIa to the total NSAS catch, which was required to account for the revision of Swedish Div. IIIa catch data late during the WG meeting (see Section 2.2.3). The revised data could not be used for the assessment but has been used for the fleetwise projections (see Section 2.7), as it appeared to have influence only on the projections (if any).

2.2.2 Spring-spawning herring in the North Sea

Norwegian Spring spawners and local fjord-type herring are taken in Div. IVa (East) close to the Norwegian coast under a separate TAC. These catches are not included in the Norwegian North Sea catch figures (Tables 2.1.1 to 2.1.6), but are now listed separately in the respective catch tables. The amount of these catches varied significantly between less than 5,000 t in 1993, 1994, 2001, and 2004, and 55,000 t in 1997. Coastal Spring Spawners in the southern North Sea (e.g. Thames estuary) are caught in small quantities (usually less than 100 t) regulated by a local TAC. The Netherlands reported over the last years increasing catches of Spring Spawners in the Western Part of the North Sea, which were included in the national catch figures and subtracted from the total catch used for the assessment of North Sea Autumn Spawners. This year no such information was available to the WG.

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 1990-2002.

The method of separating these fish, using vertebral counts as described in former reports of 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)/(56.5-55.8), 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 Norwegian part of the summer acoustic survey. For herring 2-ringers, 3-ringers, and 4+-ringers, mean vertebral counts by ICES rectangle were used. For 1-ringers it was assumed that all fish were autumn spawners. Samples from the Norwegian catches that have been taken in May and June 2002 were used for the second quarter. For the third quarter, samples taken in July and September were used (Figure 2.2.2). The resulting proportion of Spring spawners and the quarterly catches of these in the transfer area in 2002 are as follows:

Quarter	1-ringers (%)	2-ringers (%)	3-ringers (%)	4+ ringers (%)	Catch in the transfer area (t)	Catch of WBSS in the North Sea (t)
Q 2	0%	25%	34%	43%	16,860	5,994
Q 3	0%	20%	1%	9%	8,590	658
total					25,450	6,652

The quarterly age distribution in Subdivision 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 Data revisions

In last year's report, this Section provided an extensive elaboration on the corrections required to the catch tables and assessment input data. It was concluded that a study group should be dealing with these corrections prior to this year's HAWG meeting. This study group (SG Rednose) was endorsed by ICES in October 2002 but was unable to finish its work in time (see Section 1.4.1). The results of SG Rednose will affect the catch tables (Tables 2.1.1 to 2.1.6) and historical catch-at-age information (Tables 2.2.6 to 2.2.11).

The revised information on splitting between NSAS and WBSS in Division IIIa, available since 2001, has been included in this year's NSAS assessment for the period from 1996 onwards. It is still not used for the earlier period (1991 to 1995), as new information on the distribution of Norwegian catches in Divisions IIIa and IVa(E) require a second revision of the splitting factors. It is now assumed that all Norwegian catch in IIIa is actually taken in the North Sea. This affects the numbers and mean weights of NSAS in IIIa, as most of the older and heavier fish in IIIa appeared to have been taken by the Norwegian fleet. This information has been included in the assessment data for 2002, but not for earlier years.

However, exploratory assessment runs (using interim data from SG Rednose) demonstrated that neither the previous revision of splitting factors nor the update of catch and catch-at-age information to be derived from the SG Rednose work will have significant impact on the historic perception of the NSAS stock. It is also expected that the pending second revision of splitting factors will have negligible influence. However, it may have an influence on the predictions and is expected to remove some variability of the catch-at-age information, which was attributed to arbitrary raising procedures used in the past.

Sweden reported amendments to their catch figures for Div. IIIa very late during this year's WG meeting. Corrections to the splitting between NSAS and WBSS in that area have an effect on the data for NSAS. The group felt unable to include the corrected data in the primary input tables and the NSAS assessment that late in the process, especially as exploratory assessment runs suggested that the influence on the NSAS stock perception would be negligible. However, an effect on the fleetwise projections could not be excluded, and the group therefore decided to update the input data for the projections. Table 2.2.6 gives the original (a) and the updated (b) catch in numbers and weight-at-age for 2002.

Minor corrections and amendments have again been applied to the catch tables. Following an ACFM request, the catch tables for the total North Sea, Division IVa(E) and the summary ("The Wonderful") table now hold the information on Norwegian catch of Norwegian Spring Spawners and local fjord-type herring south of 62°N. The latter table had to be corrected for UK/England catch in 1993/VIId, which was anticipated but actually not done last year.

2.2.4 Quality of catch and biological data, discards

As in previous years, some nations provided information on misreported and unallocated catches of herring in the North Sea and adjacent areas. Catches made in IVa were mainly misreported to VIa North, IIIa and IIa, but misreporting also occurred from IIIa to IVa, within Area IV, and from Divisions VIId to IVb. The **Working Group catch**, which includes estimates of discards and misreported or unallocated catches (see Section 1.5), was estimated to exceed the official catch significantly (by about 20%). An analysis conducted last year (ICES 2002/ACFM:12) indicated that this figure could be much higher if the mean rate of misreporting and unallocated catch for nations reporting this would be applied to the whole North Sea catch. This corroborates suggestions of the Study Group for Herring Assessment Procedures (ICES 2001/ACFM:22), that a significant uncertainty of the total catch figure exists since the reopening of the fishery in 1980.

Discards were so far considered to be unproblematic in the North Sea herring fishery (less than 5% of the total catch, based on observer sampling programs). Last year (2002) for the first time, onboard sampling by Scotland and Germany observed substantial discards of herring in the mackerel fishery in the 3rd and 4th quarter in Div. IVa (W). At this time, the quotas for herring were already taken and herring occurred in mixed schools with mackerel. The mixing of herring and mackerel is supported by preliminary results of a Norwegian acoustic survey on mackerel in the same area and period. Scottish discard estimates were raised to the total mackerel catch of the same fleet in the same quarter and area, while the German estimate reflects only the discards obtained on the one actually sampled cruise (and is therefore likely to be an underestimate). The discard figure finally used for the assessment is 17,000 t. Discards are considered to occur in the fisheries of most countries. Assuming a distribution and yield of the international mackerel fishery in IVa(W)/ 4th quarter similar to that in 2001, herring discards of all fleets in 2002 could be as high as 50,000 t. This would increase the total catch in the North Sea by almost 15% and would certainly have an influence on the NSAS stock perception. It should be mentioned that, for 2003, the herring TAC has been increased by 50%, and at the same time the mackerel TAC has been reduced by more than 5%. This may change the discarding behaviour again in 2003.

In general, **sampling of commercial landings** for age, length and weight has improved as compared to last year (Table 2.2.12). This was expected as the European Union implemented a new sampling regime, obliging member states to meet specified overall sampling levels. This year, 80% of the catch was sampled (2001:71%), and the number of age readings has been increased by 17%. It should be observed that "sampled catch" in Table 2.2.12 refers to the proportion of the reported catch to which sampling was applied. This figure is limited to 100% but might in fact exceed the official landings due to sampling of discards, unallocated and misreported catches.

However, more important than a sufficient overall sampling level is an appropriate spread of sampling effort over the different metiers (each combination of fleet/nation/area and quarter). Of 91 different *reported* metiers, only 43 were sampled in 2002 (47%; 2001: 26%). The recommended sampling level of more than 1 sample per 1,000 t catch has been met only for 13 metiers. For age readings (recommended level >25 ageings per 1000 t catch) this is slightly worse: only 11 metiers appear to be sampled sufficiently. The catch of France, UK/England and Wales, Sweden, UK/Northern Ireland and the Faroe Islands from the North Sea (combined share 13% of the total North Sea catch) has not been sampled. Information on catches landed abroad was also not available or could not be used. While it is known that by-catches of herring in other than the directed human consumption fisheries occur, most countries have not implemented a sampling scheme for monitoring these fisheries.

In this respect, there is still a need to improve the quality of the catch data for the North Sea herring. It appears that in some instances the new EU data collection directive could even lead to a deterioration of sampling quality, because it does not assure an appropriate sampling of different metiers. This introduces uncertainties in the biological composition of the catches, which affects the quality of the assessment. The WG therefore recommends that all metiers with substantial catch should be sampled (including by-catches in the industrial fisheries), that catches landed abroad should be sampled and information on these samples should be made available to the national laboratories (see Section 1.5).

2.3 Fishery Independent Information

2.3.1 Acoustic Surveys in VIa $_{north}$ and the North Sea in July 2002

Six surveys were carried out during late June and July 2002 covering most of the continental shelf north of 54°N in the North Sea and 56°N to the west of Scotland to a northern limit of 62°N. The eastern edge of the survey area is bounded by the Norwegian, Danish and German coasts, and to the west by the shelf edge at approximately 200 m depth. The individual surveys and the survey methods are given in the report of the Planning Group for Herring Surveys (ICES 2002/ACFM:12). The vessels, areas and dates of cruises are given below and in Figure 2.3.1.1:

Vessel	Period	Area
Charter west Scotland	01 July – 21 July	56°- 60°N, 3° - 6° W
G.O. Sars	27 June – 20 July	56°30'- 62° N, 2° - 6° E
Scotia	27 June – 17 July	58°- 62° N, 2/4° W - 2° E
Tridens	24 June – 19 July	54° 30' – 58° N, west of 3° E
Walther Herwig III	21 June – 12 July	53° 30' - 57° N, east of 3° E
Dana	25 June – 8 July	North of 57° N, east of 6° E

The data has been combined to provide an overall estimate. The areas covered and dates of surveys are shown in Figure 2.3.1.1. Estimates of numbers-at-age, maturity stage and mean weights-at-age are calculated as weighted means of individual survey estimates by ICES statistical rectangle. The weighting applied is proportional to the survey track for each vessel that has covered each statistical rectangle. The data has been combined and the estimate of the stock surveyed is shown in Tables 2.3.1.1-3 by ICES Subarea for North Sea autumn-spawning herring.

Combined Acoustic Survey Results:

The estimates of North Sea Autumn herring SSB in 2001 has risen from 2.6 to 2.9 million tonnes or from 16,000 to 17,000 million individuals of which 8,200 are 3-ring herring (Table 2.3.1.1). This data series is used as a relative index in the assessment of North Sea herring because the absolute abundance cannot be used. The results of the North Sea survey are consistent with previous years, giving a total adult mortality of about 0.4 in each of the last 3 years, which is similar to the estimates from the assessment, (0.5). The survey also shows two very strong year classes of herring (the 1998 and 2000 year classes), which is consistent with the appearance of exceptionally large year classes observed in the MIK and IBTS surveys (ICES 2002/ACFM:12). The 2002 acoustic survey indicates that the abundance of these two year classes are similar and about six times that of the 1997 year class.

The numbers and biomass of adult autumn-spawning herring can be seen in Figure 2.3.1.2, the numbers at 1, 2 and 3+ rings in Figure 2.3.1.3. The spatial distribution of mean weight at 1- and 2-ring, and fraction mature at 2- and 3-ring are given in Figure 2.3.1.4. These show a considerable spatial trend which is observed each year, with larger more mature fish found in the North and smaller less mature fish found in the south and particularly the eastern North Sea. The relative spatial distributions of adult and juvenile autumn-spawning herring can be seen in Figures 2.3.1.5 and 2.3.1.6 respectively. The mean weights-at-age and the fraction mature are used in the assessment, the influence of the precision of this data is discussed in Section 2.10, the quality of the assessment.

2.3.2 Larvae surveys

Internationally coordinated herring larvae surveys have been conducted in the North Sea and adjacent waters since 1972. Last year only The Netherlands and Germany continued to participate in this program. Five cruises covering six survey units (with a double coverage in the Buchan area, 2nd half of September) were carried out in the 2002/2003 period. The data coordination and analysis were carried out by IfM Kiel and BFA Hamburg/Rostock.

The areas and time periods as well as numbers of samples, vessel-days in sampling and area coverage are given in Table 2.3.2.1 and Table 2.3.2.2. The spatial extent of the surveys is shown in Figures 2.3.2.1 – 2.3.2.7.

Newly-hatched larvae less than 10 mm in length (11 mm for the Southern North Sea) were used to calculate larval abundance. Each LAI unit is definite by area and time. To estimate larval abundance, the mean number of larvae per square metre obtained from the ichthyoplankton hauls were raised to rectangles of 30x30 nautical miles and the corresponding surface area and were summed up within the given unit. Estimates of larval abundance by sampling unit and time are given in Table 2.3.2.3.

Compared to 2001/02, a reduction in abundance was observed in the Orkney/Shetland area where the abundance is approximately half of last year's estimate (which was the highest record ever observed in that area), but is still on a high level. In Buchan area the LAI increased significantly and is twice as high as the overall mean for this unit. The situation in the Central North Sea (CNS) showed continuously rising LAI estimates over the last five years. There was no coverage in September, but the survey in the first half of October resulted in the highest estimate ever found in this period. In the Southern North Sea (SNS) the LAI is half of last year's estimate and comparable to the values found in 1998 and 1999. The three surveys show a uncommon pattern of abundance estimates with a drop in the second survey and an increase in the third one. This had never been observed before and may be explained by the length-frequency distribution of the second survey. Only 25% of larvae are in the relevant size range below 11 mm while the other surveys include > 50% in this range (Figure 2.3.2.8). On the other hand, also the total number of larvae caught was low in the second survey (1800 larvae compared to 9200 and 5800 from the others). A comparison of the LAI and the HAWG SSB estimates for the SNS is given in Figure 2.3.2.9.

The traditional LAI and LPE (Larval Production Estimates) rely on a complete coverage of the survey area. Due to the substantial decline in ship time and sampling effort since the end of the 80s, these indices could not be calculated in its traditional form since 1994. Instead, a multiplicative model was introduced 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.

Calculation of the linearized multiplicative model were done using the equation:

$$\ln(\mathrm{Index}_{\mathrm{year,LAI\ unit}}) = \mathrm{MLAI}_{\mathrm{year}} + \mathrm{MLAI}_{\mathrm{LAI\ unit}} + u_{\mathrm{year,\ LAI\ unit}}$$

where $\mathrm{MLAI}_{\mathrm{year}}$ is the relative spawning stock size in each year, $\mathrm{MLAI}_{\mathrm{LAI\ unit}}$ are the relative abundances of larvae in each sampling unit and $u_{\mathrm{year,\ LAI\ unit}}$ are the corresponding residuals. The unit effects are reparameterized 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 differences from the reference unit.

The model was fitted to abundances of larvae less than 10 mm in length (11 mm for SNS). The analysis of variance and the parameter estimates are given in Table 2.3.2.4. The updated MLAI time-series is shown in Table 2.3.2.5. The estimated trend in spawning stock biomass from this model fit is plotted in Figure 2.3.2.10 versus the SSB values obtained from the ICA runs of the Herring Assessment Working Group (ICES 2002).

Both the LAI per unit as well as the MLAI from the larvae surveys in period 2002/2003 indicate that the SSB has decreased somewhat compared to last year's WG estimate. From the MLAI this decrease is ~ 15%. But there are some signs that SSB may be underestimated. The abundance in the Orkney/Shetland area is reduced by half, but still high, while CNS and Buchan area shows a significant increase of larvae. There was no sampling in the CNS in September and in October only 50% of the stations were covered. But this survey results in the highest LAI ever found in the 1st half of October. It is likely that a considerable amount of larvae could also be obtained from a survey in the CNS in September. Thus a better coverage in area and time could have had a larger impact on the index calculation than reflected by this year's estimate.

2.3.3 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. Further examinations of the catch data from the 1st quarter IBTS showed that the surveys also gave indications of the abundances of the adult stages of herring. From 1977 sampling with fine-meshed trawls/nets at night has been used for the estimation of 0-ringer abundance in the survey area. Hence a series of abundance indices are available from this survey programme.

2.3.3.1 Indices of 2-5+ ringer herring abundances

Fishing gear and survey practices were standardised from 1983, and herring abundance estimates of 2-5+ ringers from 1983 onwards has shown the most consistent results in assessments of these age groups. This series is then used in North Sea herring assessment. Table 2.3.3.1 shows the time-series of abundance estimates of 2-5+ ringers from the 1st quarter IBTS for the period 1983-2002, while Table 2.3.3.2 contains area-disaggregated information on the IBTS indices for year 2002.

2.3.3.2 Index of 1-ringer recruitment

The 1-ringer index of recruitment is based on trawl catches in the entire survey area. Indices are available for year classes 1977 to 2001 (Table 2.3.3.3). The new estimate of the 2001 year class strength (2926) indicates a good recruitment, above average for the period.

Figure 2.3.3.1 illustrates the spatial distribution of 1-ringers as estimated by the trawling in February during 2001, 2002 and 2003. In 2003 the primary concentrations of 1-ringers were found in the eastern part of the North Sea and in the Skagerrak/Kattegat area (Div. IIIa). The 1-ringers were exceptionally abundant in Kattegat in 2003.

The Downs herring hatch later than the other autumn-spawned herring and generally appears as a smaller-sized group during the 1st quarter IBTS. A recruitment index of smaller-sized 1-ringers is calculated based on abundance estimates of herring <13 cm (see discussion of procedures in earlier reports (ICES CM 2000/ ACFM:10, and ICES CM 2001/ ACFM:12).

Table 2.3.3.3 includes abundance estimates of 1-ringer herring smaller than 13 cm, based on a standard retrieval of the IBTS database, i.e. the standard index is in this case calculated for herring <13 cm only. Indices for these small 1-ringers are given either for the total area or the area excluding Division IIIa, and their relative proportions are indicated. The proportion of 1-ringers in the total catches that are smaller than 13 cm is in the order of 20%, with a maximum proportion of 57% for year class 1996 (Table 2.3.3.3). The contribution from Division IIIa to the overall abundance of <13 cm herring varies markedly during the period.

This year's group of 1-ringers has only a minor component of small herring in the North Sea (7%), and the 24 % overall abundance of <13 cm herring in the survey area is due to very high abundances in the IIIa area.

2.3.3.3 The MIK index of 0-ringer recruitment

The 0-ringer index is based on depth-integrated hauls with a 2-meter ring-net (the MIK). Index values are calculated as described in the WG report of 1996 (ICES 1996/Assess:10). The series of estimates is shown in Table 2.3.3.4, the new index value indicating the abundance of 0-ringers in 2003 is estimated at 54.4.

This estimate of the 2002 year class indicates a very low recruitment, contrasting the relatively high estimates for the preceding four-year period. 0-ringers were concentrated in northwestern areas of the North Sea, with the highest concentrations in the Moray Firth (Figure 2.3.3.2). This distribution pattern was also seen for the previous 2000 year class, however at much higher 0-ringer densities in most areas, when the 2001 year class was widespread across the North Sea, with major concentrations in the central parts of the North Sea.

2.4 Mean weights-at-age and maturity-at-age

2.4.1 Mean weights-at-age

The mean weights-at-age of fish in the catches in 2002 (weighted by the numbers caught) are presented by ICES Division and by quarter in Table 2.2.11.

Table 2.4.1.1 presents the mean weights at ring in the North Sea stock during the 3rd quarter in Divisions IVa and IVb and IIIa for 1992 to 2002. These values were obtained from the acoustic survey. The data for 2002 are from Table 2.3.1.4. In this quarter most fish are approaching their peak weights just prior to spawning. The spatial distribution of mean weight for 1 and 2-ringers are given in Figure 2.3.1.4. The spatial variability of mean weight is considerable. For comparison the mean weights in the catch from the last ten years are also shown in Table 2.4.1.1 (from Section 2.2.1 for the 2002 values). The mean weights in the catch are generally close to the long-term mean, except for the weight of 2-ringers which are a little low and 3-ringers which are high. The mean weights-at-age in stock from the acoustic survey in 2002 are mostly in the lower quartile of the last 9 years for all ages except 2-ringers which is above the long-term mean. This pattern of mean weights in the stock is similar to the last year. The influence of the measurement variability in mean weight at ring is discussed in Section 2.10, Quality of the assessment.

2.4.2 Maturity Ogive

The percentage of North Sea autumn-spawning herring (at age) that spawned in 2002 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 (using an 8-point scale) 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 values for 2 & 3-ringers are taken from the July acoustic survey results (Table 2.3.1.4.) For 2-ringers the proportion mature was higher than last year, and is now more similar to values seen last in the late 1980s. The proportion of mature 3-ringers was also above the long-term mean for the period. The percentages are given in Table 2.4.2.1. The influence of the measurement variability in fraction mature at 2 and 3-ring is discussed in Section 2.10, Quality of the assessment.

2.5 Recruitment

Information on the development in North Sea herring recruitment is available from the two IBTS indices, the 1-ringer and the 0-ringer index. Further, the ICA assessment provides estimates of the recruitment of herring.

2.5.1 Long-term change in distribution of 0-ringers

The distribution pattern of 0-ringers is very variable, however, a long-term trend of increasing abundances in the northwestern areas is apparent when investigating the time-series. Figure 2.5.1 illustrates changes in relative and absolute abundances of 0-ringers in the area north of 55˚N, west of 2˚E (the areas "North-west" and "Central-west" in Table 2.3.3.4). Both the relative and the absolute abundance in these areas tend to increase, either from the beginning of the investigation period (absolute values) or from the early eighties when the North Sea herring started to recover (relative values). The observed patterns indicate continued changes in herring spawning pattern and/or the larval drift and survival as indicated for the first part of the period (Munk and Christensen 1990, Corten 1999).

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

The 0-ringer MIK index predicts the year class strength one year before the information is available from the IBTS 1-ringer estimates. The relationship between year class estimates from the two indices is illustrated in Figure 2.5.2 and described by the fitted linear regression. Last year's prediction of a 2001 year class above average was confirmed by this year's IBTS 1-ringer index of the year class. The good correlation between the indices is also evident when comparing the respective trends in indices during the period (Figure 2.5.3).

2.5.3 Trends in recruitment from the assessment

Recruitment is estimated in the ICA-assessment, and in Figure 2.5.4 the trends in 1-ringer recruitment based on 2003 assessment is illustrated. The recruitment declined during the sixties and the seventies, followed by a marked increase in the early eighties. After the strong 1985 year class recruitment declined again until recent years when relatively strong year classes have been estimated. ICA estimates of recent 1-ringer recruitment are 30.4 and 21.9 billions for year classes 2000 and 2001 respectively, while the estimates for 0-ringers are 84.6, 60.7 and 20.0 billions for year classes 2000, 2001 and 2002 respectively.

2.6 Assessment of North Sea herring

2.6.1 Data exploration and preliminary modelling

2.6.1.1 Choice and properties of indices for North Sea herring

Acoustic, Bottom trawl, MIK and Larvae surveys are available for the assessment of herring. The surveys and the years for which they are available are given in Table 2.6.1.1. A series of basic analyses have been conducted to check the basic utility of the surveys available.

Table 2.6.1.2 provides an indication of the survey self consistency with the correlation coefficient between estimates of the same cohort at successive rings in successive years. This indicates that the most self-consistent estimates come from the acoustic survey for most rings, the IBTS 1st quarter survey provides reliable estimates of 0-, 1-, and 2-ring herring. The 3rd quarter IBTS seems to provide more repeatable estimates at older rings, but the correlation is much poorer than for the young fish in the 1st quarter IBTS and for the acoustic survey.

Table 2.6.1.3 shows the agreement between the different indices in the same year. The 1st and 3rd quarter IBTS surveys indicate good agreement for the 0-ring herring, and the 1st quarter IBTS and acoustic survey show agreement on 1-ring. However, in general the different surveys seem to contain different information at older rings.

Table 2.6.1.4 shows the agreement between the surveys and the assessment, using the assessment method and weighting factors from the 2002 HAWG. The MLAI, Acoustic and IBTS 1st Quarter indices are used in the assessment, the IBTS 3rd Quarter is not currently used. The correlation values will be affected by the influence of the surveys on the assessment though in all cases the majority of the assessment data comes from the converged VPA. The best agreement occurs for MIK (shown as 0-ring IBTS 1Q), 1-rings from the IBTS 1st quarter, 2-8 with the Acoustic survey and the SSB with the Larvae survey. For the IBTS 3rd Quarter only 0-ring herring seems to be correlated to the VPA results.

Table 2.6.1.5 shows the sampling error by ring by survey. These estimates are obtained from bootstrap resampling for numbers at ring for each survey area, assuming identically independently distributed observations, correcting in all cases for spatial autocorrelation using geostatistical methods (ICES CM 2001/ACFM:22). Sampling error is lowest for the Acoustic survey at 3- and 4-ring and the MIK survey (IBTS 1Q 0-ring). The sampling error is higher but still reasonable for the IBTS 1st Quarter 1-ring, the Acoustic 2-ring and 5-8-ring and the MLAI SSB index. The IBTS 3rd Quarter index and the IBTS 1st Quarter 3-5-ring index has relatively high sampling errors. A similar pattern can be seen for the CV in Table 2.6.1.6.

In conclusion the analysis of variance and correlation indicates that the MLAI provides a good SSB index, the acoustic survey provides good information from 1-8-ring and the IBTS 1st Quarter from 0- & 1-ring. The IBTS 1st Quarter 2-5-ring is useful but noisy, as is the IBTS 3rd Quarter 0-ring index although the latter is still considered too noisy to be included in the assessment. The IBTS 3rd Quarter 1-5 index is not consistent.

All these surveys took time to establish and reach a common operating procedure and a relatively constant area so that subsequent small deviations of area coverage etc. would be acceptable. The issue of which time period should be used has not been examined in detail recently. However, most recently the time period for the acoustic survey was reviewed within the assessment WG report 1996 (ICES CM1996/ Assess:10).

On occasion single values from surveys may look as if they should be discarded or down-weighted. For example, examination of the 2-ring from IBTS 1st Quarter in 1988 suggests that it is an outlier in the series. There could be arguments to remove this value. However, in reviewing the data series we can more easily make these judgements in retrospect. It is more difficult when the 'outlier' is in the terminal year and therefore more difficult to carry out in practice. In any case with a small number of observations on each year class there will almost always be by chance one year class where most of the observations are low (or high), balanced by one or two high (or low) values. One way to examine these issues is to look at statistical properties of the index and to see if an observation appears to be unusual. Mean variance plots for each of the indices are given in Figure 2.6.1.1.

These graphs show no obvious outliers, suggesting that the statistical properties are reasonably consistent and that 'outliers' are really part of the properties of each index. Thus at least for making judgements about weighting factors it is necessary to include all the data. We have to accept that if an index is capable of having an unusual high catchability in one year it may do so again. The WG is generally not in favour of picking out observations simply because they look odd. As a process it is arbitrary and may eventually result in bias. For example the IBTS 2-ring index in 1988 appears high in retrospect and for some reason either in 1988 the catchability did increase or for some other reason this cohort was underestimated on other occasions. However, if we have no basis for judging which of these two alternatives happened, assuming the former could be wrong. Thus, no individual data points have been excluded in the assessment.

2.6.1.2 Selection of weighting of indices in the assessment of North Sea herring

The HAWG in 2002 moved from arbitrary index weighting used for the previous 6 years (1996-2001) to a more objective method. ACFM set up the study group SGEHAP (ICES CM 2001/ACFM:22) with one of its objectives to try to rationalise the survey index weighting in the assessment. SGEHAP produced a final report in October 2001 which provides a full description of the conclusions and supporting arguments, the main issues are summarised here:

SGEHAP investigated the selection of index weighting through two main approaches:

- Sampling variance derived from survey variance.
- Structural variance from residuals between indices and assessment.

The method for estimating survey variance is described in detail in the SGEHAP report. Inverse variance weights were calculated for each index by ring. Where ring-disaggregated indices are provided and correlation between measurement error by ring was observed, the weighting factors at ring were rescaled to a level that reflected the amount of independent information. This was based on the perception that if the error in estimating each ring was independent then the full weight would be required. If the error was completely correlated the appropriate weight would be the weight of a ring spread equally amongst all the rings. The weighting values are given in Table 2.6.1.7. The weighting values for structural error were derived from the residuals between the surveys and the assessment. This method is similar in concept to the index weighting method used in XSA. In ICA index weighting may be adaptively changed to minimise the overall sum of squares in the maximum likelihood function. The sampling error is ignored and only structural error is included, the method incorporates no prior assumption about the relative merits of the sources of data. In the SGEHAP study the structural differences were examined in two ways, first by using the ICA adaptive method of weighting for all the bootstrapped datasets. Secondly by obtaining a single set of adaptive weights from the WG data series and using these as fixed values. The 'structural' weights for the indices are shown along with the inverse variance weights Table 2.6.1.7.

The HAWG in 2002 extended the review to look in more detail at retrospective patterns. In particular the weighting for 0- and 1-ringer in fitting a separable model to catch. The fishery for North Sea herring has been managed by two TACs, for adults and juveniles (0- & 1-ringers). Over recent years the TAC for juveniles has not been set with reference to the observed fluctuation in juvenile abundance but has been linked to the adult TAC. While it might be correct under these circumstances to apply a separable constraint to the adults, it would be inappropriate to include the juveniles so the influence of 0- and 1-ring catches is down-weighted. On this basis the WG in 2002 selected index weighting which both minimised the variability in the assessment output but also reduced the retrospective revision of management parameters (F, SSB and recruitment). However, they could not find a method that minimised the revision of all of these parameters but selected the one that performed best for two out of three. This was done by down-weighting the influence of catch of 0- and 1-ringers in the assessment.

A number of points can be drawn from Table 2.6.1.7:-

- The MIK index is given much more weight in the inverse variance method
- The structural method gives three times the weight to the acoustic index relative to the IBTS survey
- The inverse variance method reduces the influence of the acoustic index, giving twice the weight to the acoustic index relative to the IBTS index
- The structural error method gives relatively higher weights at older ages contrasting with the inverse variance method giving decreasing weights with age.

Both ‘fixed’ structural weights and fully adaptive weighting was tested and found to give higher variance in all management parameters than the inverse variance weights. However, the differences in index weighting were noted and explored further in SGEHAP and two additional weighting methods were tested:

1) Using the mean of both methods. Conceptually the idea was that such weighting would provide a compromise between sampling and structural sources of error, and thus might be expected to give a more optimum overall method.

2) Specifically reducing the weight on the MIK. This reflected the idea that although the survey is rather precise it might be given incorrectly large weight. There were concerns that the assumed constant natural mortality throughout the year might be unreasonable, and in reality natural mortality might be more variable, due for example to seasonal fluctuations in predation on 0 group, i.e. the demands of the model might create problems.

However, the conclusions from investigations were that the inverse variance method outperformed both these options.

In conclusion: while the WG has not considered all possible weighting (by estimating weights through some objective function), it has made an extensive review covering both inverse variance and structural errors, and it considered that the inverse variance method provided the better method. The weights also express the WG view that the young herring are best estimated with MIK and IBTS surveys, and the older herring are best evaluated through the acoustic survey.

2.6.1.3 Period of separable constraint

The ICA model includes the assumption of the exploitation pattern being constant over a number of years. The changes in the regulations in 1996 have affected the various components of the fishery differently. The TACs for the human consumption fleet in the North Sea and Division IIIa were reduced to 50 %. By-catch ceilings for the small-meshed fleets 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 if it extends further back in time than 1997.

At recent meetings of this WG, the separable period has been split up into two different periods: 1992-1996 and 1997 onwards. In the WG 2001 it was considered that the number of years after the change in selection was long enough to use only a single separable period of four years. In this WG, as in 2002, a selection period of 5 years was used. Exploration of a 6-year period showed no important differences in the model fit.

2.6.1.4 Comparison of assessment model

ICA has been used for at least the last eight years for the assessment of North Sea herring. It was felt that after the findings of the recent WGMG (ICES CM2003/D:03), the performance of ICA should be compared with another regularly used assessment model, XSA. Concern at WGMG was raised about the instability in the selection patterns at older ages impacting on the earlier part of the time-series. The approach used was to choose XSA settings that reflect as many of the assumptions of the ICA model of North Sea herring. The shrinkage of F was set very low and for the retrospective run a shifting tuning window was used (different from the single XSA analysis which used the whole series). The model settings are given in Table 2.6.1.8 and the summary of the results in Table 2.6.1.9. It is clear that XSA gives very similar results to ICA.

XSA is very sensitive to the number of ages used for F shrinkage. In the present study the use of only the oldest true age (8-ring) gave a SSB of 1,570,000 t. Dependency on the actual level of shrinkage, compared to number of ages used was much smaller. The XSA assessment is very consistent with the ICA assessment (Figure 2.6.1.2). However, the retrospective bias in XSA is slightly smaller even with the use of a tuning window of 8 years which contributes to instability because of the limited number of years used for the catchability regressions (Figure 2.6.1.3). When using high shrinkage (=0.5) the retrospective bias was much smaller (~0.05) on both F and SSB. As both ICA and XSA gave very similar perceptions of the state of the stock, the Working Group felt that the use of the ICA model was still appropriate. Continuing its use also maintains consistency with assessments in previous years.

2.6.1.5 Conclusions on the use of data in the NS assessment

The final choice of indices by year is given in Table 2.6.2.1. This choice was made on the basis of correlation and variance analysis and on data exploration carried out during the two previous Working Groups. The SGEHAP study group looked extensively at the issue of weighting and has selected values based on a full and careful study treating each index in a consistent manner. The WG has considered this with careful attention to retrospective patterns and come to the conclusion that the inverse variance weights were a good choice. The 0-1-ring catches were down-weighted because they are taken by a separate fleet that works independently of those exploiting older fish, but with a TAC which changes in a similar manner. These juvenile catches are probably a poorer indicator of juvenile abundance than the surveys. A down-weighting of these values seems to improve the analytic retrospective performance of the assessment (ICES 2002/ACFM:12)

2.6.2 The stock assessment

2.6.2.1 Model used

Assessment of the stock was carried out by fitting the integrated catch-at-age model (ICA) including a separable constraint over a five-year period as explained above (Patterson, 1998, Needle 2000), see Section 1.6 and the quality handbook.

2.6.2.2 Results

The ICA output is presented in Tables 2.6.2.2 and 2.6.2.3, with model fit and parameter estimates in Table 2.6.2.4, and in Figures 2.6.2.1 - 2.6.2.6. The standard graphical output of ICA is not shown. Rather a small program was written that could plot the result for each variable on the same page, so that comparisons can be made between indices. This was also motivated by technical difficulties with output from the ICAVIEW program. Uncertainty analysis of the final assessment is presented in Figure 2.6.2.7, although this only reflects the uncertainty in fitting the model and does not include uncertainty in the model specification. Estimates of fishing mortality at 2-6 ringer in 2002 vary between 0.21 and 0.28 (25 and 75 percentile respectively) and SSB in 2002 between 1.44 and 1.75 million 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. Long-term trends in yield, fishing mortality, spawning stock biomass and recruitment are given in Figure 2.6.2.8.

The spawning stock at spawning time 2002 is estimated at approximately 1.6 million tonnes. Around 41% of the estimated SSB in 2002 consists of the 1998 year class (see Section 2.10). However, as noted last year, the 2000 year class is also estimated to be very strong. The current estimate of the 2000 year class as 1-ring fish is the third highest since 1960, so in the near future the stock is expected to increase further. The year classes 1998 and 2000 are now estimated as respectively 70.0 and 84.6 billion fish and are expected to contribute to a further increase of the spawning stock. The first estimate of the 2002 year class is 20.0 billion, which is based on the MIK index only.

Fishing mortality on 2-6 ringer herring in 2002 is estimated at around 0.24, and on 0-1-ringer herring at 0.04.

Analytic retrospective analysis of the assessment (Figure 2.6.2.9) shows a strong bias over the last 5 years (-0.3 in $F_{2\text{-}6}$) but little variation in that bias (0.15 in $F_{2\text{-}6}$, estimation method described in 1.6.3). Bias in the recruitment estimates is lower. The retrospective selection patterns show a marked change in 2001 (Figure 2.6.2.10), this is probably due to separable period moving back into the time of the change in the catching behaviour and management of the fishery in 1996. The issue of the retrospective bias is discussed in Section 2.10.5.

2.7 Short-term projection by fleets

2.7.1 Method

Last year, the work by the SGHAEP (2001) lead the WG to abandon the area-based predictions using local partial fishing mortalities. Instead, the WG decided to give predictions by fleet, assuming that the fleetwise partial fishing mortalities apply to the stock as a whole. The standard tool that is currently available (the MFDP program) has some limitations with regard to management options that can be covered. In particular, when varying the fishing mortality for one fleet, the fishing mortalities for the other fleets are assumed constant at *status quo* F. For the North Sea herring, managers have agreed to constrain the total outtake at levels of fishing mortalities for ages 0-1 and 2-6, and need options to show the trade-off between fleets within those limits. To allow for exploring such options, a short-term prediction program (MFSP) was developed during last year's meeting. This program has been somewhat refined for this year's meeting (Skagen 2003; WD11) and was used for the predictions this year.

2.7.2 Input data

Fleet Definitions

The current fleet definitions are:

North Sea

Fleet A: Directed herring fisheries with purse seiners and trawlers. By-catches in industrial fisheries by Norway are included.

Fleet B: Herring taken as by-catch under EU regulations.

Division IIIa

Fleet C: Directed herring fisheries with purse seiners and trawlers
Fleet D: By-catches of herring caught in the small-mesh fisheries

The fleets are basically the same as last year, but the definitions have been modified slightly to bring them in accordance with actual practise. In previous years the Norwegian by-catches in the industrial fishery in the North Sea were not reported separately. Rather, the whole Norwegian catch was allocated to the A-fleet. This year, these by-catches were reported separately, although without an age distribution based on samples. Traditionally, these by-catches have mainly consisted of adult fish. Therefore, the WG decided to still include the Norwegian by-catches in the industrial fishery in the catches of the A-fleet, even though this fishery is by small-meshed trawl. The B-fleet then covers the by-catches of herring in fisheries in the North Sea under EU regulations. It has also been managers' practise to base the quota shared by EU on Norway on the advice for the A-fleet. This is in principle a TAC for directed fisheries for herring, but Norway uses part of this TAC to cover the by-catches in its industrial fisheries. The by-catch ceiling for the industrial fisheries in the EU-Norway agreement, which is decided based on the advice for the B-fleet, is allocated to EU.

Input Data for Short-term Projections

All the input data for the short-term projections are summarised in Table 2.7.2.1.

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 2003.

Stock Numbers: For the start of 2003 the total stock number was taken from ICA (Population Abundance year 2003, Table 2.6.2.2).

For 0-ringers in 2004 and 2005, the stock number was set to 48 800 million which is the geometric mean of the recruitments in the period 1983 – 1999.

Fishing Mortalities: Selection by fleet at age was calculated by splitting the total fishing mortality for each age proportional to the catches by fleets at that age. Due to the change of fleet allocations of some catches this year, (see Section 2.2.3) only fishing mortalities and catches for 2002 were used.

Mean Weights-at-age in the stock: Since the weights used in the assessment are already smoothed, the values for 2002 (Table 2.6.2.2) were used in the prediction.

Maturity-at-age: The average maturity-at-age for 2001 and 2002 was used (Table 2.6.2.2).

Mean weights in the catch by fleet: The revisions in allocation of catches between fleets C and A (Section 2.2.3), also implies that the weights-at-age in the catch for these fleets needs to be revised. Revised fleetwise weights in the catch could so far only be provided for 2002. Accordingly, these weights were used (Table 2.2.6). The previous practise of taking a weighted mean of the last two years should be resumed when the data have been updated.

Natural Mortality: Unchanged from last year (Table 2.6.2.2).

Proportion of M and F before spawning: Unchanged from last year at 0.67.

The input file to the prediction program is shown as Table 2.7.2.1.

2.7.3 Prediction for 2003 and management option tables for 2004

Assumptions and Predictions for 2003

Two sets of predictions are presented, one assuming $F_{status\ quo}$ in 2003, and one assuming that the agreed TACs are taken. In previous years, overshoot of the TAC was assumed. Due to the large increase in TACs in 2003, the WG decided not to make this assumption for 2003.

The partial fishing mortalities at $F_{status\ quo}$ appear in Tables 2.7.3.1 a-c, and the catches assumed appear in Tables 2.7.3.2 **a-c.**

Management Option Tables for 2004

The EU-Norway agreement specifies fishing mortalities for juveniles ($F_{0\text{-}1}$) and for adults ($F_{2\text{-}6}$). With four fleets there are innumerable combinations of fleetwise fishing mortalities and catches that satisfy this constraint.

In each set, a range of fixed catches were assumed for fleets C and D (20 000-70 000 t in steps of 10 000 t for fleet C and 5 000 – 30 000 t in steps of 5 000 t for fleet D). For each combination of these, the catches by the fleets A and B were adjusted to give an $F_{0\text{-}1}$ and an $F_{2\text{-}6}$ at specified values (0.10 or 0.12 for $F_{0\text{-}1}$ and 0.20 or 0.25 for $F_{2\text{-}6}$).

The text table below is an overview of the options tables (Tables 2.7.3.1 a-c and 2.7.3.2a-c):

Assumption for 2003	$F_{0\text{-}1}$ 2004	$F_{2\text{-}6}$ 2004	Catch fleet C 2004	Catch fleet D 2004	Table
F *status quo*	0.10	0.20	20,30,40,50,60,70	5,10,15,20,25,30	2.7.3.1a
	0.10	0.25	20,30,40,50,60,70	5,10,15,20,25,30	2.7.3.1b
	0.12	0.25	20,30,40,50,60,70	5,10,15,20,25,30	2.7.3.1c
TAC constraint	0.10	0.20	20,30,40,50,60,70	5,10,15,20,25,30	2.7.3.2a
	0.10	0.25	20,30,40,50,60,70	5,10,15,20,25,30	2.7.3.2b
	0.12	0.25	20,30,40,50,60,70	5,10,15,20,25,30	2.7.3.2c

In addition, a limited number of management options with the corresponding estimated fishing mortalities and catches by fleet as well as the predicted SSB is presented in Table 2.7.3.3. The table contains predictions corresponding to three scenarios: the combination of $F_{st\ quo}$ in 2003 and the fishing mortalities specified in the EU - Norway agreement, assuming roll-over TACs in 2003 and in 2004, and assuming $F_{status\ quo}$ for both 2003 and 2004.

All scenarios presented (Tables 2.7.3.1 a-c, Tables 2.7.3.2 a-c) indicate a continued increase in spawning biomass and in yield. This is mainly caused by the 1998 and 2000 year classes. The weak 2002 year class leads to comparatively low catches in the fleets exploiting mainly juveniles. The catches by the A fleet are estimated close to 500 000 tonnes at $F_{2\text{-}6}$ = 0.25, while the catches by the B, C and D fleets is a trade-off between these fleets, the sum of which will be approximately 110 – 130 000 tonnes with an $F_{0\text{-}1}$ = 0.12. The difference in the results for 2004 between the $F_{status\ quo}$ and the TAC constraint assumptions for 2003 is small.

2.7.4 Comments on the short-term projections

Making fleetwise predictions for 4 fleets that are more or less independent remains problematic, in particular when it comes to presenting results in a way that allows managers to overview the range of possible trade-offs between fleets.

It is also worth noticing that the realised F_{2-6} in the past has exceeded that intended when setting the TACs for many years. If managers wish to avoid exceeding the agreed limits, options with lower F-values may be preferable.

2.8 Medium-term analysis

The method used to calculate medium-term projections was that described in ICES (1996/ACFM:10); 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 2002, fishing mortality at reference age in 2002, 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. 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 program (Version 1.4w) was used to implement the method.

A single-fleet medium-term projection was carried out with the assumptions that the fishing mortality from 2003 onwards was equal to that in 2002.

The input to the medium-term analysis was taken from the short-term analysis (Section 2.7.2).

A first run was made assuming a Beverton – Holt stock-recruitment function, with parameters as estimated as part of the ICA assessment. This led to very large recruitments in future years, compared to the recruitments experienced in the past at biomass levels where a high recruitment should be expected.

Therefore, another run was made with the Ockham razor stock recruit function, assuming a constant recruitment at all levels of SSB experienced since 1983, and a linear decline towards the origin for lower SSBs. This was expected to reproduce the distribution of recruitments for the period 1983 – 1999. Figure 2.8.1 shows the cumulated distribution of recruitments for 1983 – 1999, together with the cumulated distribution of recruitment in the last prediction year. The latter distribution is far narrower, but the medians are quite close to each other.

A run with the Ockhams razor stock-recruit function with the same fishing mortality as in 2002 was performed, and the results are shown in Figures 2.8.2 and 2.8.3. The results indicate that the stock will be relative stable with this mortality. The risk that SSB will fall below $\mathbf{B}_{pa}$ is likely to be an underestimate, due to the narrow distribution of recruitments.

2.9 Precautionary reference points

As noted in Section 1.4.2, the SGPRP suggested to reduce the $\mathbf{B}_{lim}$ from the current 800 000 tonnes to about 560 000 tonnes, based on the results of the segmented regression analysis of the stock and recruitment data. Although it is apparent that the recruitment historically has been at about the same level when the SSB was somewhat below 800 000 tonnes as seen above, the HAWG decided not to propose any revision of the reference points at present for the following reasons:

- There is some doubt as to the validity of the calculation procedure by the SGPRP
- The HAWG would prefer to consider all reference points together, rather than revising just $\mathbf{B}_{lim}$.

Moreover, there is a well functioning harvest control rule in place for this stock, and apart from $\mathbf{B}_{lim}$, the current reference points are derived from this HCR. The target F in the HCR was adopted by ACFM as the $\mathbf{F}_{pa}$, while the trigger point at which F should be reduced below the target is adopted as $\mathbf{B}_{pa}$. Future revisons of the reference points should not trigger alterations in this HCR.

2.10 Quality of the Assessment

2.10.1 Sensitivity of the assessment to variability in the input data

The influence of input data on the output of the assessment has been explored through the bootstrap analysis.

Bootstrap replicates of stock weights by age and maturity by age derived from research vessel surveys, Acoustic survey, IBTS, MIK and Larvae surveys, have been estimated for all the years of these time-series used in the assessment. The procedure was to treat each haul or estimate of abundance by ICES statistical rectangle as an independent observation and to bootstrap these to obtain an overall estimate of variance with estimates of between age correlation. Bootstrap replicates for the catch were obtained from an analysis of international catch sampling from 1991 to 1998. Replicates for catch in all other years were simulated using the same mean variance relationship found in these eight years and the same autocorrelation between estimates by age. 800 replicate sets of values were generated. The bootstrap method assumes that all the hauls or rectangles are independent and obtained through a random sampling survey design. This is not the case for some surveys so the spatial autocorrelation by age has been modelled and the variance and distribution of replicates scaled accordingly. The procedure is described in more detail in SGEHAP report (ICES 2001/ACFM:22).

The bootstrap replicates were used for three analyses:-

1) Comparison of fixed or variable mean weights and fraction herring mature by age

   a) Maturity values updated annually, mean weights as 3-year running mean
   b) Single values for maturity and weight-at-age as the mean from 1993 to the terminal year, updated annually with each new observation.

2) varying each data set in turn with all other data sets to assessment values,

3) combination of all of the varying assessment input data sets.

For the first and last of these analyses all the variability in the data is included in the input data for the assessments. For the second analysis each data type is treated separately except for catch numbers and mean weight-at-age, which are taken together. The analyses are conditional on the total catch in tonnes, the fixed natural mortality and the choice of assessment method ICA (Patterson 1998, and Needle 2000) with predefined inverse variance weighting of the data. The model formulation and index weighting is described in Section 2.6.1.

The short-term projection method used was the numerical method used in the MFDP and described in the Multi Fleet Deterministic Projection method (ICES) used by ICES to predict recommended catch for different levels of F, the implementation was supplied by L. Kell (CEFAS Lowestoft) under an EU project EVARES. The input parameters for the prediction were the numbers-at-age in the assessment year, and the exploitation pattern in the fishery. The fishery in the intermediate year was assumed to be at F *status quo*, and F for the TAC year followed the EU-Norway management agreement harvest control rule which had been applied over the last 7 years. This gives a fishing mortality of 0.25 when SSB is above 1.3M tonnes. When the stock is below this threshold the F must be reduced, in practice F=0.20 has been selected as the reduced F for the stock in this state. This two-value F rule was implemented as the control for setting the TAC. Mean weights and maturity in the population were assumed to be the average of the last two years.

Eight different terminal years from 1994 to 2001 were tested. The influence of variable mean weights and variable fraction mature taken as a variable or a long-term mean is seen to be very small (Figure 2.10.1). There is a small shift in the percentiles which is different in each year, however, the influence on the TAC is almost undetectable.

To study the sensitivity of the assessment to variability in all the parameters separately the results for these eight years were combined by expressing the output as the relative deviation from the mean of the set obtained from the assessments based on fixed value input data. These results of showing the relative magnitude of the variability of the terminal SSB, terminal F_{adult}, SSB in TAC year and TAC at $F=\mathbf{F}_{pa}$ due to the variability in the input parameters are shown in Figure 2.10.2. The results of the analysis show that the estimates of terminal SSB and F_{adult} are the most sensitive to the precision of the acoustic survey with the MIK, Larvae and IBTS surveys forming a second group with precision influencing the results at a lower level. The catch, the weights-at-age in the stock and the fraction mature form a third group with the least influence. SSB does vary a little due to mean weights and maturity but F is almost independent of these parameters. The results show that the estimates of TAC show an almost equal dependence on MIK, IBTS and Acoustic surveys, with some influence from catch and MLAI but almost no influence from maturity or mean weights in the stock. All the data combined suggest that the precision of the input data contributes to a range of outputs between 0.75 to 1.21 times the TAC, although there are about 1% of outlying values with greater deviation.

Conclusions

For North Sea herring the relatively high weights on catch (3.1 & 2.6 for 2&3-ring herring respectively) do not make the assessment overly dependent on variability in the catch. While the spatial variability of growth and fraction mature for North Sea herring is considerable (Figure 2.3.1.4), the influence of this variability in the main management criteria for the stock is small and its influence on the TAC is minimal. The state of the stock (SSB & F) from the assessment is most sensitive to the acoustic survey, which seems reasonable because this survey gives the best information on 2-ring and older herring that form the SSB in the terminal year. The advice on TAC is almost equally dependent on MIK, Acoustic and IBTS surveys with a smaller influence on catch and MLAI.

2.10.2 Update of catch weights

SGREDNOSE worked in early 2003 to provide updated catch (see Section 1.4.1) but was unable to deliver a completely revised data set for HAWG this year. There have been some revisions to the catch data and weights-at-age in the catch covering the year 1996 to 2001. Only in 1996 did these changes in catch exceed 4% and the influence of the changes on the assessment was found to be negligible. There is no change in recent recruitment, terminal total stock changed less than 1%, there was a 2% increase in terminal SSB and a 2% reduction in terminal F.

2.10.3 The 2003 assessment

In this year's assessment, the Acoustic and IBTS surveys were both found to display the same substantial upward trend in SSB, though with different magnitudes, the MLAI gave a high value but not as high as the 2001 observation. All three indices lead to an unequivocal indication of rising biomass when used in the assessment on their own along with the catch data (see Figure 2.10.3). From this figure it can be seen that there is little difference in perception of SSB when using each index separately or when they are combined in the final assessment.

The current estimate of 2002 SSB of 1.59 Mt is 7% reduction from the 2002 estimate of 1.69 Mt. The current assessment revises the estimate of SSB in 2001 downward by about 12% from 143,000 t to 127,000 t. In addition, the 2000 SSB is also revised downwards by about 13%, from 937,000 t to 829,000; this is now in better agreement with the WG 2001 estimate at 815,000 t.

The current estimate of SSB is dominated by the highly abundant 4-ringers in 2003 and results from a compromise between the various sources of information. The acoustic survey in 2002 underestimates most year classes, the MLAI gives a small underestimate in 2002 compared with a slightly larger overestimate in 2003, the IBTS 2-5+ ring estimates give low estimates in 2002 and high estimates in 2003.

The residuals between the catch and the separable model are small for all ages except 1- and 8-ring.

Had the weighting in the assessment on the older herring estimates from the IBTS survey been relatively higher (as was the weighting procedure used before 2002) it would be expected that the estimate of SSB might have been slightly higher.

Estimates of incoming year classes are still uncertain, the 2000 year class (2-ring herring in 2003) have been estimated by the MIK at 0-ring, IBTS at 2&1 and Acoustic at 1-ring; these four estimates are all in good agreement with log residuals less than ±0.25. This year class (84 billion) is thought to be third highest in the history of the stock, at 70% above geometric mean recruitment (1983-1999), and larger that the 1998 year class (70 billion) which has provided the recent large rise in the SSB. The 2001 year class (1-ring in 2003) is estimated by the MIK and the IBTS which are in very good agreement and is about 20% above geometric mean recruitment. It is anticipated that these year classes will provide for a rising stock over the next two years. The 2002 year class (0-ring in 2003) is estimated only by the MIK at 40% of geometric mean recruitment (20 billion). This year class is estimated as the lowest for 23 years and is not expected to contribute much to the SSB in the future.

2.10.4 Comparison of ICA with XSA

For comparison two XSA runs are presented in Section 2.6.1.4. The results of the two assessment methods are indistinguishable where the XSA assumptions are similar to those used in ICA: XSA run with no shrinkage, the full data set for all the survey used to obtain the survey catchability (Q). When shrinkage is included there is a small reduction in SSB in the terminal year and a small rise in terminal F. The perception of a stock with SSB rising from around 800,000 t in 2000 to between 1.4 to 1.6 Million tonnes (Mt) in 2002 is seen in all cases.

2.10.5 Comparison with earlier assessments

An historic retrospective of assessments by sequential working groups is presented in Figure 2.10.4. Values for retrospective bias and standard error (see Section 1.6.3 methods) are presented in the figures. This analysis suggests an average bias of about 0.28 for SSB and –0.21 for $F_{2\text{-}6}$ for the period 1991 to 2002. The magnitude of the revision seems to be different in different periods, it is less in the last three years (2000-2002) than for the years 1998 and 1999, and then improves again in 1996 and 1997. Comparison with the analytical retrospective shows a similar pattern.

Assessments in 1996 and 1997 are more similar to the current assessment than those in 1998 and 1999. It is thought this period of the assessment has been made more difficult due to the difficulties in modelling the change in the fishery from 1996 and 1997, following the changes in management advice. The earlier retrospective revision seen from 1990 to 1995 may have been worse than the recent revision since the WG adopted a single model (ICA) and the choice of data series used in the assessment has become stable. However, for the future it remains to be seen if this improvement is sustained or whether the new weighting procedure which provides a more precise assessment suffers more or less from retrospective bias.

2.10.6 Predictions

The short-term prediction method was substantially modified in 2002. Following the review by SGEHAP (ICES 2001/ACFM22), which recommended that a simple multi-fleet method would be preferable, the complex split-factor method used for a number of years prior to 2002 was not used in 2002. A new multi-fleet, multi-option, deterministic short-term prediction programme used in 2002 was accepted by ACFM and has been developed during the year and has been used this year as well. It is intended to continue to use this programme in the future. The current short prediction is that the North Sea autumn-spawning herring stock SSB in 2003 will be around 2.1 Mt which compares well with the 2002 estimate of 2.2 Mt. The current prediction for SSB in 2004 is that it will rise to 2.4 Mt.

Medium-term predictions have been run using ICP. Previous medium-term predictions have assumed that the recruitment is dependant on the assumption of a Beverton and Holt recruitment model which provides high levels of recruitment at high predicted stock size. Exploration of the recruitment values obtained from this option produced unrealistic values for recruitment well outside the historical range. There were doubts concerning the validity of the distribution of recruitment values and it is possible that this effect has distorted medium-term prediction with ICP in the past. This year the medium-term predictions were run with the Ockham model option taking only the period between recovery and recent convergence of VPA: 0-ring recruitment from 1983 to 1999, to define the range of recruitment. The resulting distribution of recruit values covers the correct range but with increased central tendency over the observed recruitment. The median medium-term predictions will therefore be more reliable but the spread of stock sizes will be too narrow, leading to optimist estimates of risk. However, the risk of SSB falling below $\mathbf{B}_{pa}$ in 2004 is thought to be small.

Medium-term predictions have been carried out for *status quo* F (F0-1 = 0.038, F2-6 = 0.238), which gives a median stock estimate in 2004 of about 2.5 Mt which compares well with the short-term prediction. Medium-term suggests that at F*status quo* SSB will then fall to 2.3 Mt in 2005 due to low recruitment in 2003 at 0-ring, and then stabilise at around 2.5 Mt in around 10 years. The predicated level depends entirely on the choice of stock recruit relationship. The Beverton Holt relationship would suggest increased recruitment and increased stock at higher stock sizes, Ricker would suggest lower recruitment at higher stock size; Ockham, the method chosen, is a compromise assuming similar recruitment in the future to that observed in the past. For North Sea herring there is no data to confirm which possibility is likely though the Study Group on Stock Recruitment Relationships for North Sea Autumn-spawning Herring (ICES CM1998/D:2) did not find any evidence for a Ricker-type stock recruit relationship for NS herring.

2.11 Herring in Division IVc and VIId (Downs Herring)

Over many years the Working Group has attempted to assess the contribution of winter spawning Downs herring to the overall population of North Sea herring. There is a separate TAC for herring in areas IVc and VIId as part of the total North Sea TAC. The TAC for IVc and VIId in 2003 was increased from about 42,700 tonnes to 59,500 tonnes, the highest TAC since 1986 (Table 2.11.1). This was despite the ACFM advice in 2002:

> *"..Downs herring (herring in Divisions IVc and VIId) …has shown independent trends in exploitation rate and recruitment, but cannot be assessed separately. Abundance indices from larvae and trawl surveys indicate that since 1995 the SSB of the Downs herring has increased. The Downs fishery is concentrated on the spawning aggregations in a restricted area, which makes this stock component particularly vulnerable to excessive fishing pressure. EU splits its share of the total TAC (Subarea IV and Division VIId) into TACs for Divisions IVa+IVb and for Divisions IVc+VIId. In response to ICES advice in May 1996 the IVc+VIId TAC was reduced by 50% in line with reductions for the whole North Sea. The TAC for Downs herring was reduced from 50,000 t to 25,000 t and has remained there until 2001. TACs for this component have been significantly exceeded in all years. The TAC for this component was increased in 2002 (to 42,000 t) following the advice of ICES in 2001. However, the strong increase in SSB in the North Sea stock in 2001 is not mirrored in the Downs component, and therefore the TAC for Downs herring should not increase."*

A range of simple methods are used by the WG to determine the proportion (relative to the total North Sea) and trend in population size of Downs herring. These are the proportion of 1-ringer juveniles that are less than 13 cm in length in the IBTS 1Q survey, the LAI for the IVc and VIId area and the short time-series of MIK surveys in the region. None of these methods address what proportion of F occurs outside VIId although methods do exist.

In order to use indices in an estimation of relative Downs SSB, a number of assumptions were made (ICES 2002/ACFM:12). These include the assumption that the proportion of Downs 1-ringers are properly assessed by the <13 cm distinction and the proportion is fixed through the fishes life. Also the assumption that the weight and maturity-at-age and timing of spawning are the same in Downs herring and the other part of the population. The available information gives little support to these assumptions, and the WG felt that there was little value in continuing this estimation procedure in its current form. However, if this method was used for this year, it would show a decline in Downs herring over the last two years (30%).

Current evidence gives an uncertain picture of the relative state of the Downs SSB. The proportion of <13 cm fish in the North Sea, for the 2001 year class is the third lowest in the time-series, whilst the year before was the second highest (Figure 2.11.1). This reflects recruitment strengths of year classes rather than the total biomass. These year class strengths are in broad agreement with the preliminary analysis of the very short and patchy MIK time-series (Figure 2.11.2). The LAI, which tends to reflect SSB, shows great variation over the time-series (year class 1986 to 2002, Figure 2.11.2) with order of magnitude differences over the time-series.

There is a vital need for a reassessment of the methods used to investigate the size of the Down herring stock. There are herring larval surveys running from 1972 to the current year (these record larval abundance at length), sea temperature data exist for this period, the IBTS covers juvenile nursery areas. Regular and good quality samples were taken from the spawning aggregations throughout the last three decades and a more intensive MIK net survey of 0-ringers in the channel area began 5 years ago. Data from these sources should provide information of trends in population abundance and must be scrutinized with rigor to investigate Down herring population dynamics. The development of techniques for determining spawning season (autumn, winter or spring) by otolith microstructure also makes possible the estimation of the proportion of Downs herring in older fish and the testing of the assumptions about distinguishing the Downs as a smaller-sized component in the IBTS 1Q catches.

To conclude, the current state of the component is unknown. The WG's understanding of the substock dynamics is unlikely to improve until further examination of the existing time-series of surveys takes place, in light of both alternative assessment methods, and a greater knowledge of the ecology of Downs herring.

2.12 Management Considerations

The stock is inside safe biological limits. SSB in 2002 was estimated at 1.6 million t and is expected to increase to 2.2 million tonnes in 2003, which is above the $\mathbf{B}_{pa}$ of 1.3 million t. SSB has increased gradually since the low stock size in the mid-1990s. This in response to reduced catches, strong recruitment and management measures that reduced exploitation both on juveniles and adults. In 1996 the fishing mortality for the adult part of the stock was reduced to 0.40. It has further decreased in subsequent years, being 0.24 in 2002. For juveniles the fishing mortality remained below 0.1 since 1996. Both, the 1998 year class and the 2000 year class appear to be very strong in all the surveys.

The EU Norway Management agreement was updated in December 2001, the relevant parts of the text are included here for reference:-

1. Every effort shall be made to maintain a level of Spawning Stock Biomass (SSB) greater than the Minimum Biological Acceptable Level (MBAL) of 800,000 tonnes.
2. A medium-term management strategy, by which annual quotas shall be set for the directed fishery and for by-catches in other fisheries as defined by ICES, reflecting a fishing mortality rate of 0.25 for 2-ringers and older and 0.12 for 0-1-ringers, shall be implemented.
3. Should the SSB fall below a reference point of 1.3 million tonnes, the fishing mortality rates referred under paragraph 2, will be adapted in the light of scientific estimates of the precise conditions then prevailing, to ensure rapid recovery of SSB to levels in excess of 1.3 million tonnes.

The recovery plan referred to above may, inter alia, include additional limitations on effort in the form of special licensing of vessels, restrictions on fishing days, closing of areas and/or seasons, special reporting requirements or other appropriate control measures.

4. By-catches of herring may only be landed in ports where adequate sampling schemes to effectively monitor the landings have been set up. All catches landed shall be deducted from the respective quotas set, and the fisheries shall be stopped immediately in the event that the quotas are exhausted.
5. The allocation of the TAC for the directed fishery for herring shall be 29% to Norway and 71% to the Community. The by-catch quota for herring shall be allocated to the Community.
6. The parties shall, if appropriate, consult and adjust management measures and strategies on the basis of any new advice provided by ICES including that from the assessment of the abundance of the most recent year class.
7. A review of this arrangement shall take place no later than 31 December 2004.
8. This arrangement entered into force on 1 January 2002.

Catches on adult herring in recent years have consistently exceeded the agreed TAC, mainly due to misreporting from other ICES areas into and out of the North Sea; this gives rise to overshooting of the TAC.

The 1998 and 2000 year classes are both strong and will comprise 25 and 37% respectively of SSB in 2003. In the past large year classes have tended to have a lower maturation rate than the long-term average. So far these signals have not been detected for the 1998 year class as the proportion which mature appears to be above average.

The ICES advice is based on the projected SSB in 2004 being above 1.3 million t. SSB in 2004 depends on the fisheries in 2003 and that part in 2004 that takes place before spawning. About 2/3 of the total mortality is expected to be realised before spawning each year. The increase in SSB expected in 2004 depends strongly on the incoming 1998 and 2000 year classes. Observations from different surveys indicate that these year classes are strong. Generally, the surveys provide more reliable indications of year class strength than catches of juveniles do. Initial estimates of the 2002 year class are the lowest in the last 23 years, which reduces the catch opportunities in the fisheries exploiting mainly juveniles in 2003 and 2004. If catches in 2004 are increased to take the full catch allowed under the EU Norway agreement (F2-6 = 0.25 and F0-1= 0.12) the medium-term projections show it will be necessary to reduce catches again in 2005 to conform with this agreement.

The medium-term projections are heavily dependent on the stock-recruitment relationship. The estimated parameters for the Beverton and Holt stock-recruitment used previously now tend to give very optimistic trends in SSB at the current levels of SSB. Therefore the HAWG made new medium-term forecasts based on the Ockham razor stock recruitment function giving recruitment levels within the range that has been seen in the stock earlier, although the risk that the stock falls below $\mathbf{B}_{pa}$ is likely to be underestimated. The medium-term forecasts indicate that a fishing mortality of 0.25 on adult herring, and 0.12 on juvenile herring, will give a high probability of SSB being above $\mathbf{B}_{pa}$.

As noted above, assessments of this stock show a tendency to overestimate stock size and underestimate fishing mortality. Compared with the 2002 assessment, the SSB in 2001 according to the 2003 assessment is 12% lower than the estimate in 2002, while the SSB in 2002 is estimated in 2003 to be 7% lower than the prediction made in 2003.

Discards were so far considered to be unproblematic in the North Sea herring fishery (less than 5% of the total catch, based on observer sampling programs). Last year (2002) for the first time, onboard sampling observed substantial discards of herring in the mackerel fishery in the 3rd and 4th quarter in Div. IVa (W). The discard figure used for the assessment is 17,000 t. For 2003, the herring TAC has been increased by 50%, and at the same time the mackerel TAC has been reduced by more than 5%. This may change the discarding behaviour again in 2003.

This stock complex also includes Downs herring (herring in Divisions IVc and VIId), which has shown independent trends in exploitation rate and recruitment, but cannot be assessed separately. Abundance indices from larvae and trawl surveys indicate an uncertainty with regard to this complex. The Downs fishery is concentrated on the spawning aggregations in a restricted area, which makes this stock component particularly vulnerable to excessive fishing pressure. EU splits its share of the total TAC (Subarea IV and Division VIId) into TACs for Divisions IVa+IVb and for Divisions IVc+VIId. In response to ICES advice in May 1996 the IVc+VIId TAC was reduced by 50% in line with reductions for the whole North Sea. The TAC for Downs herring was reduced from 50 000 t to 25 000 t and remained there until 2001. The catches for this component have been significantly exceeded in all years. The TAC for this component was increased in 2002 (to 42,673 t) following the advice of ICES in 2001 and to 59,542 t in 2003 against the advice of ICES. There is no evidence to suggest that the strong increase in SSB in the North Sea stock in 2002 is mirrored in the Downs component. In accordance with last year's advice, and considering the uncertainty in the state of the herring in Divisions IVc and VIId (Downs herring), catches in 2004 in this area should be reduced and not exceed the TAC for 2002 and the corresponding advice of 42,673 t.

Table 2.1.1 HERRING caught in the North Sea (Subarea IV and Division VIId). Catch in tonnes by country, 1992–2002. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	**1993**	**1994**	**1995**	**1996**	**1997**
Belgium	56	144	12	-	1
Denmark	164817	121559	153363 [9]	67496	38431
Faroe Islands	-	-	231 [9]	-	-
France	12623	27941	29499 [9]	12500	14524
Germany, Fed.Rep	41619 [9]	38394	43798	14215	13381
Netherlands	79190	76155	78491	35276	35129
Norway [4]	122815	125522	131026	43739	38745 [13]
Sweden	5782	5425	5017	3090	2253
USSR/Russia			-	-	1619
UK (England)	12002 [10]	14216	14676	6881	3421
UK (Scotland)	55532	49919	44813	17473	22914
UK (N.Ireland)	-	-	-	-	-
Unallocated landings	18410	5749	33584 [9]	24475	27583
Misreporting from VIaN	24397	30234	32146	38254	29763 [6]
Total landings	537243 [9,10]	495258	566656	263399	227763
Discards	3470	2510	-	1469	6005
Total catch	**540713** [9,10]	**497768**	**566656** [9]	**264868**	**233769** [6]
Estimates of the parts of the catches which have been allocated to spring spawning stocks					
IIIa type (WBSS)	8928	13228	10315	855	979
Thames estuary [5]	201	215	203	168	202
Norw. Spring Spawners [13]	4234	2965	28179	28179	54815

Country	**1998**	**1999**	**2000**	**2001**	**2002** [1]
Belgium	1	2	1	-	23
Denmark [7]	58924	61268	64123	67096	70825
Faroe Islands	25	1977	915	1082	1413
France	20783	26962	20952	24515	25422
Germany	22259	26764	26687	29779	27213
Netherlands	50654	54318	54382	52390	55257
Norway [4]	68523 [13]	70718 [1]	72844 [1]	75089 [1]	74974
Sweden	3221	3241	3046	3695	3418
UK (England)	7635	10598	11179	14582	13757
UK (Scotland)	32403	29911	30033	26719	30926
UK (N.Ireland)	-	-	915	1018	944
Unallocated landings	27722	21653	37707 [12]	25849	31552
Misreporting from VIaN	32446	23625	[8]	[8]	[8]
Total landings	324596	331036	322784	321814	335724
Discards	3918	4769	6354 [12]	1386	17093
Total catch	**328514**	**335805**	**329138**	**323200**	**352817**
Estimates of the parts of the catches which have been allocated to spring spawning stocks					
IIIa type (WBSS)	7833	4732	6649	6449	6652
Thames estuary [5]	88	88	76	107	60
Others [11]			378	1097	0
Norw. Spring Spawners [13]	29196	32385	21466	3955	4069

[1] Preliminary.
[4] Catches of Norwegian spring spawners removed (taken under a separate TAC).
[5] Landings from the Thames estuary area are included in the North Sea catch figure for UK (England).
[6] Altered in 2000 based on revised estimates of misreporting into VIa (North)
[7] Including any bycatches in the industrial fishery
[8] Catches misreported into VIaN could not be separated, they are included in unallocated
[9] Figure altered in 2001
[10] Figure altered in 2002 (was 7851 t higher before)
[11] Caught in the whole North Sea, included in the catch figure for The Netherlands
[12] Figure altered in 2002
[13] These catches (including some local fjord-type Spring Spawners) are taken by Norway under a separate quota south of 62°N and are not included in the Norwegian North Sea catch figure for this area.

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

Country	**1993**	**1994**	**1995**	**1996**	**1997**
Denmark	10604	20017	17748	3237	2667
Faroe Islands	-	-	-	-	-
France	3362	11658	10427	3177	361
Germany	17342 [4]	18364	17095	2167	-
Netherlands	28616	16944	24696	2978	6904 [9]
Norway	33442	56422	56124	22187	16485 [12]
Sweden	1372	2159	1007	2398	1617
Russia	-	-	-	-	1619
UK (England)	4742	3862	3091	2391	-
UK (Scotland)	36628 [4]	44687	40159	12762	17120
UK (N. Ireland)	-	-	-	-	-
Unallocated landings	-8271 [5]	3214 [9]	26018	9959	7574
Misreporting from VIa North	24397	30234	32146	38254	29763 [6]
Total Landings	152234	207561	228511	99510	84110
Discards	825	550	-	356	1138
Total catch	**153059**	**208111**	**228511**	**99866**	**85248** [6]

Country	**1998**	**1999**	**2000**	**2001**	**2002** [1]
Denmark [7]	4634	15359	25530	17770	26422
Faroe Islands	25	1977	205	192	-
France	4757	6369	3210	8164	10522
Germany	7752	11206	5811	17753	15189
Netherlands	11851	17038	15117	18560 [10]	18289 [10]
Norway	27218	30585 [1]	32895 [1]	11472 [1]	10836
Sweden	245	859	1479	1418	2397
UK (England)	4306	7163	8859	12283	10142
UK (Scotland)	30552	28537	29055	25105	30014
UK (N. Ireland)	-	-	996	1018	944
Unallocated landings	15952	3889	30581 [11]	17578	14201
Misreporting from VIa North	32446	23625	[8]	[8]	[8]
Total Landings	139738	146607	153738	131313	138956
Discards	730	654	5841 [11]	1386	17093
Total catch	**140468**	**147261**	**159579**	**132699**	**156049**

1 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)
7 Including any bycatches in the industrial fishery
8 Catches misreported into VIaN could not be separated, they are included in unallocated
9 Figure altered in 2001
10 Including 1057 t of local spring spawners
11 Figure altered in 2002

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	1993	1994	1995	1996	1997
Denmark [5]	43224	43787	45257	19166	22882
Faroe Islands	-	-	-	-	-
France	4	14	+	-	3
Germany	- [3]	-	-	-	4576
Netherlands	-	-	-	-	-
Norway [2]	56215	40658	62224	18256	18490
Sweden	711	1010	2081		427
UK (Scotland)	- [3]	-	-	693	
Unallocated landings	-	-	-	-	-
Total landings	100154	85469	109562	38115	46378
Discards	-	-	-	-	-
Total catch	**100154**	**85469**	**109562**	**38115**	**46378**
Norw. Spring Spawners [6]	4234	2965	28179	28179	54815

Country	1998	1999	2000	2001	2002 [1]
Denmark [5]	25750	18259	11300	18466	17846
Faroe Islands	-	-	710	890	1365
France	-	115	-	-	-
Germany	-	-	29	-	81
Netherlands	-	1965	38	-	-
Norway [2]	41260	37433 [1]	39696 [1]	56287 [1]	63482
Sweden	1259	772	1177	517	568
Unallocated landings	-	-1965 [4]	-4 [4]	0	5961
Total landings	68269	56579	52946	76160	89303
Discards	-	-	-	-	-
Total catch	**68269**	**56579**	**52946**	**76160**	**89303**
Norw. Spring Spawners [6]	29196	32385	21466	3955	4069

[1]Preliminary
[2]Catches of Norwegian spring spawners herring removed (taken under a separate TAC).
[3]Included in IVa West.
[4]Negative unallocated catches due to misreporting into other areas.
[5]Including any bycatches in the industrial fishery
[6]These catches (including some local fjord-type Spring Spawners) are taken by Norway under a separate quota south of 62°N and are not included in the Norwegian North Sea catch figure for this area.

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	1993	1994	1995	1996 [6]	1997
Belgium	-	-	-	-	-
Denmark [4]	109994	55060	87917	43749	11636
Faroe Islands	-	-	231 [8]	-	-
France	2086	5492	7639	2373	6069
Germany	23628	14796	21707	11052	7456
Netherlands	31370	39052	30065	18474	14697
Norway	33158	28442	12678	3296	3770
Sweden	3699	2256	1929	-	209
UK (England)	3804	7337	9688	2757	2033
UK (Scotland)	18904	5101	4654	4449	5461
Unallocated landings [3]	-16415	-26988	-10831 [9]	-8826	-1615
Total landings	210228	130548	165677	77324	49716
Discards [1]	245	460	-	592	1855
Total catch	**210473**	**131008**	**165677** [9]	**77916**	**51571**

Country	1998	1999	2000	2001	2002 [1]
Belgium	-	1	-	-	-
Denmark [4]	26667	26211	26825	30277	26387
Faroe Islands	1	-	-	-	48
France	8944	7634	10863	7601	4214
Germany	13591	13529	18818	8340	7577
Netherlands	27408	22825	26845	24160	13154
Norway	45	2700 [1]	253 [1]	7330 [1]	656
Sweden	1717	1610	390	1760	453
UK (England)	1767	1641	669	814	317
UK (Scotland)	1851	1374	978	1614	289
Unallocated landings [3]	-11270	-313	-13769	-12878	4052
Total landings	70720	77212	71872	69018	57147
Discards [1]	1188	873	317	- [2]	- [2]
Total catch	**71908**	**78085**	**72189**	**69018**	**57147**

[1]Preliminary
[2]Discards partly included in unallocated
[3]Negative unallocated catches due to misreporting from other areas.
[4]Including any bycatches in the industrial fishery
[8]Figure inserted in 2001
[9]Figure altered in 2001

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	1993	1994	1995	1996	1997
Belgium	56	144	12	-	1
Denmark	995	2695	2441	1344	1246
France	7171	10777	11433	6950	8091
Germany	649	4964	4996	997	1349
Netherlands	19204	20159	23730	13824	13528
UK (England)	3456 [10]	3016	1896	1733	1388
UK (Scotland)	-	131	-	262	333
Unallocated landings	43096	29792	18397	23934	21624
Total landings	74627 [10]	71678	62905	49044	47559
Discards [1]	2400	2400	-	521	3012
Total catch	**77027** [10]	**74078**	**62905**	**49565**	**50571**
Coastal spring spawners included above [2]	201	215	203	168	143

Country	1998	1999	2000	2001	2002 [1]
Belgium	1	1	1	-	23
Denmark	1873	1439	468	583	170
France	7081	12844	6879	8750	10686
Germany	916	2029	2029	3686	4366
Netherlands	11395	12490	12348	9670	23814
UK (England)	1562	1794	1537	1485	3298
UK (Scotland)	-	-	-	-	623
Unallocated landings	23040	20042	20966	21149	7338
Total landings	45868	50639	44228	45323	50318
Discards	2000	3242	196	- [3]	-
Total catch	**47868**	**53881**	**44424**	**45323**	**50318**
Coastal spring spawners included above [2]	88	88	76	147 [11]	60

[1] Preliminary
[2] Landings from the Thames estuary area are included in the North Sea catch figure for UK (England).
[3] Discards partly included in unallocated
[9] Figure altered in 2001
[10] Figure altered in 2002 (was 7851 t higher before)
[11] Thames/Blackwater herring landings: 107 t, others included in the catch figure for The Netherlands

Table 2.1.6 ("The Wonderful Table"): HERRING in Sub-area IV, Division VIId and Division IIIa. Figures in thousand tonnes

Year	1989	1990	1991	1992	1993	1994	1995 [18]	1996	1997	1998	1999	2000	2001	2002	2003
Sub-Area IV and Division VIId: TAC (IV and VIId)															
Recommended Divisions IVa, b [1]	484	373, 332	363 [6]	352	290 [7]	296 [7]	389 [11]	156	159	254	265	265	265	265	400
Recommended Divisions IVc, VIId	30	30	50-60 [6]	54	50	50	50	- [14]	- [14]	- [14]	- [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	240	223	340.5
Agreed Div. IVc, VIId	30	30	50 [6]	50	50	50	50	50; 25 [13]	25	25	25	25	25	43	59.5
Bycatch ceiling in the small mesh fishery									24	22	30	36	36	36	52
CATCH (IV and VIId)															
National landings Divisions IVa,b [3]	639	499	495	481	463	421	456	176	144	241	255	263	272	261	
Unallocated landings Divisions IVa,b	-2	14	30	14	-1	6	47	39	36	37	25	16	5	24	
Discard/slipping Divisions IVa,b [4]	3	4	2	3	1	1	0	1	3 [16]	2	2	6	1	17	
Total catch Divisions IVa,b [5]	638	516	527	498	463	428	503	216	183 [16]	281	282	285	278	303	
National landings Divisions IVc, VIId [3]	30	24	42	37	32 [20]	42	45	25	26	23	31	23	24	43	
Unallocated landings Divisions IVc,VIId	48	32	16	35	43	30	18	24	22	23	20	21	21	7	
Discard/slipping Divisions IVc, VIId	1	5	3	2	2	2	-	1	3	2	3	0.2	0	0	
Total catch Divisions IVc, VIId	79	61	61	74	77 [20]	74	63	50	51	48	54	44	45	50	
Total catch IV and VIId as used by ACFM [5]	**717**	**578**	**588**	**572**	**540** [20]	**498**	**566**	**266**	**234** [16]	**329**	**336**	**329**	**323**	**353**	
CATCH BY FLEET/STOCK (IV and VIId) [10]															
North Sea autumn spawners directed fisheries (Fleet A)	N.a.	N.a.	446	441	438	447	506	226	220 [16]	306	316	304	295	323	
North Sea autumn spawners industrial (Fleet B)	N.a.	N.a.	134	124	101	38	65	38	13	14	15	18	20	22	
North Sea autumn spawners in IV and VIId total	**696**	**569**	**580**	**564**	**539**	**485**	**559**	**265**	**233** [16]	**320**	**331**	**322**	**308**	**346**	
Baltic-IIIa-type spring spawners in IV	20	8	8	8	9	13	10	0.9	0.9	8	5	7	6	7	
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	0.1	1.2	0.1	
Norw. Spring Spawners caught under a separate quota in IV [20]	N.a.	N.a.	N.a.	N.a.	4	3	28	28	55	29	32	21	4	4	
Division IIIa: TAC (IIIa)															
Predicted catch of autumn spawners			96	153	102	77	98	48	35	58	43	53	67	63	27
Recommended spring spawners	84	67	91	90	93–113	- [9]	- [12]	- [12]	- [15]	- [15]	- [15]	- [15]	- [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	80	80	80	80
Agreed mixed clupeoid TAC	80	65	50	50	45	43	43	43							
Bycatch ceiling in the small mesh fishery									20	17	19	21	21	21	21
CATCH (IIIa)															
National landings	192	202	188	227	214	168	157	115	83	120 [16]	86	108	90	79	
Catch as used by ACFM	162	195	191	227	214	168	157	115	83	105 [16]	86	108	90	73	
CATCH BY FLEET/STOCK (IIIa) [10]															
Autumn spawners human consumption (Fleet C)	N.a.	N.a.	26	47	44	42	21	23	34	54	31 [17]	37	36	17 [21]	
Autumn spawners mixed clupeoid (Fleet D) [19]	N.a.	N.a.	13	23	25	12	6	12	4	5	8 [17]	13	12	9 [21]	
Autumn spawners other industrial landings (Fleet E)	N.a.	N.a.	38	82	63	32	43	7	2						
Autumn spawners in IIIa total	**91**	**77** [8]	**77**	**152**	**132**	**86**	**70**	**42**	**40**	**59**	**39** [17]	**50**	**48**	**26** [21]	
Spring spawners human consumption (Fleet C)	N.a.	N.a.	68	53	68	59	59	69	34	43	44 [17]	53	39	38 [21]	
Spring spawners mixed clupeoid (Fleet D) [19]	N.a.	N.a.	5	2	1	1	2	1	1	3	3 [17]	5	3	9 [21]	
Spring spawners other industrial landings (Fleet E)	N.a.	N.a.	40	20	12	24	29	3	1						
Spring spawners in IIIa total	**71**	**118**	**113**	**75**	**81**	**84**	**90**	**73**	**37**	**46**	**47** [17]	**58**	**42**	**47** [21]	
North Sea autumn spawners Total as used by ACFM	**787**	**646**	**657**	**716**	**671**	**571**	**629**	**307**	**273** [16]	**380**	**370** [17]	**372**	**364**	**372** [21]	

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. 16 Figure altered in 2000. 17 Figure altered in 2001. 18 Data for 1995 show some inconsistencies and need to be revised intersessionally. 19 Fleet D and E are merged from 1999 onwards. 20 These catches (including some local fjord-type Spring Spawners) are taken by Norway under a separate quota south of 62°N and are not included in the Norwegian North Sea catch figure for this area. 20 figure altered in 2003 to account for earlier summarizing errors. 21 Already including revisions of Swedish catch data available only late during the 2003 WG. Data used for the 2003 assessment of NSAS might differ slightly.

Table 2.2.1 North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2002. Catch in numbers (millions) at age (rings), by quarter and division

rings	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	411.5	0.0	0.0	0.0	0.0	315.6	3.2	0.0	315.6	3.2	730.3	318.8
1	344.9	56.4	0.0	56.4	5.1	425.3	3.6	0.0	486.7	3.6	835.3	490.4
2	48.0	151.6	7.6	144.0	144.7	166.2	4.3	45.8	454.9	50.1	553.0	512.6
3	5.3	191.1	14.8	176.2	453.5	112.2	15.4	140.5	741.9	155.9	903.2	912.6
4	0.8	89.2	10.6	78.7	82.0	19.5	7.4	95.6	180.2	103.0	284.0	293.8
5	0.2	36.8	3.3	33.4	64.4	14.5	1.6	19.1	112.3	20.7	133.2	136.4
6	0.1	41.8	2.9	38.9	86.1	11.3	1.6	23.2	136.3	24.8	161.2	163.9
7	0.0	13.2	1.0	12.2	26.0	3.5	0.3	4.3	41.6	4.6	46.3	47.2
8	0.0	8.7	0.5	8.2	18.1	4.6	0.0	2.4	30.9	2.5	33.4	33.8
9+	0.0	2.9	0.1	2.8	4.4	0.0	0.0	0.0	7.2	0.0	7.2	7.3
Sum	811.0	591.6	40.8	550.8	884.2	1072.7	37.4	330.9	2507.7	368.3	3687.0	2916.8
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	34.4	0.0	0.0	0.0	0.1	162.8	0.0	0.0	162.9	0.0	197.3	162.9
2	32.6	55.6	0.0	55.6	3.0	78.7	0.0	0.0	137.3	0.0	169.9	137.3
3	1.4	13.7	0.0	13.7	56.8	12.7	0.9	11.8	83.2	12.7	97.3	95.9
4	0.1	6.1	0.0	6.1	8.6	2.4	0.7	9.1	17.0	9.8	26.9	26.8
5	0.0	2.6	0.0	2.6	7.9	0.0	0.1	0.9	10.5	1.0	11.5	11.5
6	0.0	5.6	0.0	5.6	11.5	2.4	0.1	0.9	19.5	1.0	20.5	20.5
7	0.0	1.0	0.0	1.0	4.4	0.0	0.0	0.0	5.5	0.0	5.5	5.5
8	0.0	0.6	0.0	0.6	2.2	0.0	0.0	0.0	2.8	0.0	2.8	2.8
9+	0.0	0.2	0.0	0.2	1.6	0.0	0.0	0.0	1.8	0.0	1.8	1.8
Sum	68.6	85.3	0.0	85.3	96.2	258.9	1.7	22.7	440.4	24.4	533.4	464.9
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	117.3	1.9	0.0	1.9	2.8	46.4	0.0	0.0	51.1	0.0	168.4	51.1
2	10.6	71.5	6.2	65.3	13.4	20.1	0.0	0.0	98.9	0.0	109.5	105.1
3	0.8	111.6	14.6	96.9	24.7	6.6	0.1	0.3	128.2	0.4	129.4	143.3
4	0.2	62.9	9.7	53.2	9.2	2.9	0.1	0.2	65.3	0.3	65.8	75.3
5	0.1	19.6	3.0	16.6	2.3	0.4	0.0	0.0	19.3	0.0	19.4	22.3
6	0.0	16.0	2.4	13.6	2.0	0.5	0.0	0.0	16.1	0.0	16.2	18.5
7	0.0	5.3	0.8	4.5	0.7	0.7	0.0	0.0	5.9	0.0	5.9	6.7
8	0.0	3.4	0.4	3.0	0.3	0.1	0.0	0.0	3.3	0.0	3.3	3.8
9+	0.0	0.9	0.1	0.8	0.1	0.0	0.0	0.0	0.9	0.0	0.9	1.0
Sum	129.1	293.2	37.3	255.9	55.4	77.8	0.2	0.6	389.0	0.8	518.9	427.1
Quarter: 3												
0	292.4	0.0	0.0	0.0	0.0	193.6	0.0	0.0	193.6	0.0	486.0	193.7
1	127.9	1.3	0.0	1.3	1.4	72.7	0.0	0.0	75.3	0.0	203.2	75.3
2	4.1	8.3	1.4	6.9	73.3	45.0	0.0	0.1	125.3	0.1	129.5	126.7
3	2.5	18.8	0.2	18.6	230.6	67.1	0.1	0.2	316.3	0.3	319.1	316.8
4	0.5	12.8	0.9	11.9	51.1	13.3	0.0	0.1	76.2	0.2	76.9	77.3
5	0.1	5.7	0.4	5.3	39.8	13.0	0.0	0.0	58.1	0.0	58.3	58.6
6	0.1	6.8	0.5	6.3	57.4	8.0	0.0	0.0	71.8	0.0	71.9	72.3
7	0.0	2.1	0.1	1.9	16.1	2.8	0.0	0.0	20.8	0.0	20.9	21.0
8	0.0	1.3	0.1	1.2	9.4	4.5	0.0	0.0	15.1	0.0	15.2	15.2
9+	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0	0.0	2.0	2.0
Sum	427.7	57.0	3.6	53.4	481.1	420.1	0.2	0.5	954.6	0.7	1383.0	958.9
Quarter: 4												
0	119.1	0.0	0.0	0.0	0.0	122.0	3.2	0.0	122.0	3.2	244.3	125.2
1	65.2	53.2	0.0	53.2	0.7	143.4	3.6	0.0	197.4	3.6	266.3	201.0
2	0.7	16.1	0.0	16.1	55.0	22.3	4.3	45.7	93.4	50.0	144.1	143.4
3	0.6	47.0	0.0	47.0	141.4	25.8	14.4	128.1	214.2	142.5	357.3	356.7
4	0.0	7.5	0.0	7.5	13.2	1.0	6.6	86.1	21.6	92.7	114.3	114.3
5	0.0	8.9	0.0	8.9	14.4	1.0	1.5	18.2	24.4	19.7	44.0	44.0
6	0.0	13.4	0.0	13.4	15.2	0.3	1.5	22.2	28.9	23.7	52.7	52.7
7	0.0	4.7	0.0	4.7	4.7	0.0	0.3	4.3	9.5	4.6	14.0	14.0
8	0.0	3.4	0.0	3.4	6.2	0.0	0.0	2.4	9.6	2.4	12.1	12.1
9+	0.0	1.8	0.0	1.8	0.8	0.0	0.0	0.0	2.5	0.0	2.5	2.5
Sum	185.6	156.1	0.0	156.1	251.6	316.0	35.4	307.0	723.6	342.4	1251.6	1066.0

Table 2.2.2 North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2002. Mean weight (kg) at age (rings) in the catch (WECA), by quarter and division

rings	IIIa NSAS	IVa(E) all	IVa(E) WBSS	IVa(W)	IVb	IVc	VIId	IVa & IVb all	IVc & VIId	Total NSAS	Herring caught in the North Sea
Quarters: 1-4											
0	**0.012**	**0.000**	**0.000**	**0.000**	**0.013**	**0.016**	**0.000**	**0.013**	**0.016**	**0.012**	**0.013**
1	**0.040**	**0.082**	**0.000**	**0.093**	**0.027**	**0.032**	**0.000**	**0.034**	**0.032**	**0.037**	**0.034**
2	**0.104**	**0.130**	**0.143**	**0.144**	**0.086**	**0.111**	**0.107**	**0.119**	**0.108**	**0.116**	**0.118**
3	**0.126**	**0.154**	**0.154**	**0.161**	**0.149**	**0.129**	**0.123**	**0.157**	**0.123**	**0.151**	**0.152**
4	**0.144**	**0.167**	**0.165**	**0.191**	**0.161**	**0.165**	**0.152**	**0.177**	**0.153**	**0.169**	**0.168**
5	**0.164**	**0.189**	**0.186**	**0.211**	**0.206**	**0.170**	**0.170**	**0.203**	**0.170**	**0.198**	**0.198**
6	**0.180**	**0.198**	**0.198**	**0.230**	**0.214**	**0.178**	**0.188**	**0.219**	**0.187**	**0.214**	**0.214**
7	**0.180**	**0.212**	**0.208**	**0.242**	**0.189**	**0.210**	**0.219**	**0.228**	**0.219**	**0.228**	**0.227**
8	**0.218**	**0.229**	**0.219**	**0.261**	**0.270**	**0.208**	**0.208**	**0.253**	**0.208**	**0.250**	**0.250**
9+	**0.000**	**0.238**	**0.241**	**0.263**	**0.241**	**0.000**	**0.000**	**0.253**	**-**	**0.253**	**0.253**
Quarter: 1											
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	**0.000**	**0.000**
1	0.019	0.000	0.000	0.083	0.016	0.000	0.000	0.016	-	**0.017**	**0.016**
2	0.110	0.114	0.000	0.123	0.061	0.000	0.000	0.084	-	**0.089**	**0.084**
3	0.134	0.126	0.000	0.114	0.090	0.080	0.080	0.112	0.080	**0.108**	**0.108**
4	0.166	0.147	0.000	0.141	0.133	0.117	0.117	0.142	0.117	**0.133**	**0.133**
5	0.172	0.177	0.000	0.162	0.161	0.128	0.128	0.166	0.128	**0.163**	**0.163**
6	0.183	0.182	0.000	0.176	0.184	0.136	0.136	0.179	0.136	**0.177**	**0.177**
7	0.248	0.200	0.000	0.184	0.165	0.000	0.000	0.187	-	**0.187**	**0.187**
8	0.208	0.205	0.000	0.200	0.000	0.000	0.000	0.201	-	**0.201**	**0.201**
9+	0.000	0.200	0.000	0.228	0.000	0.000	0.000	0.225	-	**0.225**	**0.225**
Quarter: 2											
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	**0.000**	**0.000**
1	0.023	0.081	0.081	0.089	0.017	0.000	0.000	0.023	-	**0.023**	**0.024**
2	0.087	0.140	0.139	0.127	0.059	0.000	0.000	0.123	-	**0.118**	**0.123**
3	0.097	0.154	0.154	0.146	0.110	0.080	0.080	0.150	0.080	**0.150**	**0.150**
4	0.117	0.164	0.163	0.166	0.139	0.117	0.117	0.163	0.117	**0.163**	**0.163**
5	0.125	0.184	0.184	0.207	0.183	0.128	0.128	0.186	0.128	**0.186**	**0.186**
6	0.155	0.196	0.195	0.246	0.180	0.136	0.136	0.201	0.136	**0.201**	**0.201**
7	0.130	0.208	0.207	0.251	0.149	0.000	0.000	0.206	-	**0.206**	**0.206**
8	0.180	0.217	0.215	0.303	0.270	0.000	0.000	0.225	-	**0.226**	**0.225**
9+	0.000	0.239	0.241	0.191	0.000	0.000	0.000	0.236	-	**0.236**	**0.236**
Quarter: 3											
0	0.011	0.000	0.000	0.000	0.013	0.016	0.000	0.013	0.016	**0.012**	**0.013**
1	0.056	0.094	0.094	0.094	0.037	0.032	0.000	0.039	0.032	**0.050**	**0.039**
2	0.107	0.162	0.162	0.154	0.117	0.109	0.108	0.142	0.108	**0.140**	**0.142**
3	0.131	0.180	0.180	0.183	0.159	0.130	0.128	0.177	0.128	**0.177**	**0.177**
4	0.152	0.189	0.189	0.212	0.169	0.164	0.158	0.201	0.159	**0.200**	**0.201**
5	0.181	0.206	0.206	0.231	0.210	0.172	0.172	0.224	0.172	**0.224**	**0.224**
6	0.196	0.212	0.212	0.250	0.228	0.185	0.188	0.244	0.187	**0.244**	**0.244**
7	0.199	0.211	0.211	0.266	0.199	0.215	0.218	0.252	0.217	**0.252**	**0.252**
8	0.255	0.239	0.240	0.292	0.270	0.208	0.208	0.281	0.208	**0.281**	**0.281**
9+	0.000	0.000	0.000	0.298	0.000	0.000	0.000	0.298	-	**0.298**	**0.298**
Quarter: 4											
0	0.014	0.000	0.000	0.000	0.012	0.016	0.000	0.012	0.016	**0.013**	**0.012**
1	0.052	0.082	0.000	0.107	0.038	0.032	0.000	0.050	0.032	**0.051**	**0.050**
2	0.089	0.125	0.000	0.135	0.138	0.111	0.107	0.134	0.108	**0.125**	**0.125**
3	0.117	0.151	0.000	0.148	0.161	0.132	0.127	0.150	0.127	**0.141**	**0.141**
4	0.000	0.177	0.000	0.160	0.194	0.171	0.156	0.168	0.157	**0.159**	**0.159**
5	0.000	0.193	0.000	0.181	0.175	0.172	0.172	0.185	0.172	**0.179**	**0.179**
6	0.000	0.199	0.000	0.191	0.174	0.180	0.190	0.195	0.189	**0.192**	**0.192**
7	0.000	0.219	0.000	0.211	0.215	0.210	0.219	0.215	0.219	**0.216**	**0.216**
8	0.000	0.240	0.000	0.233	0.233	0.208	0.208	0.235	0.208	**0.230**	**0.230**
9+	0.000	0.241	0.000	0.249	0.241	0.000	0.000	0.243	-	**0.243**	**0.243**

Table 2.2.3 North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2002. Mean length (cm) at age (rings) in the catch, by quarter and division.

rings	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**	**11.9**	**13.0**	**0.0**	**11.9**	**13.0**	**11.9**
1	**n.d.**	**22.2**	**n.d.**	**22.1**	**15.2**	**16.2**	**0.0**	**16.1**	**16.2**	**16.1**
2	**n.d.**	**24.8**	**n.d.**	**25.6**	**22.0**	**24.0**	**23.9**	**24.1**	**23.9**	**24.0**
3	**n.d.**	**25.9**	**n.d.**	**26.6**	**25.8**	**25.0**	**24.8**	**26.3**	**24.8**	**26.1**
4	**n.d.**	**26.4**	**n.d.**	**27.7**	**26.4**	**26.5**	**26.4**	**27.0**	**26.4**	**26.8**
5	**n.d.**	**27.8**	**n.d.**	**28.8**	**28.1**	**26.7**	**27.2**	**28.4**	**27.1**	**28.2**
6	**n.d.**	**28.5**	**n.d.**	**29.5**	**28.8**	**27.7**	**28.1**	**29.2**	**28.1**	**29.0**
7	**n.d.**	**29.1**	**n.d.**	**30.0**	**27.6**	**28.4**	**28.8**	**29.6**	**28.7**	**29.5**
8	**n.d.**	**30.0**	**n.d.**	**31.3**	**31.3**	**29.6**	**29.6**	**30.9**	**29.6**	**30.8**
9+	**n.d.**	**30.4**	**n.d.**	**31.5**	**30.8**	**0.0**	**0.0**	**31.1**	**-**	**31.1**
Quarter: 1										
0	n.d.	0.0	n.d.	0.0	0.0	0.0	0.0	-	-	**0.0**
1	n.d.	0.0	n.d.	21.3	13.0	0.0	0.0	13.0	-	**13.0**
2	n.d.	24.9	n.d.	24.4	20.3	0.0	0.0	22.3	-	**22.3**
3	n.d.	25.8	n.d.	25.1	23.5	23.0	23.0	25.0	23.0	**24.7**
4	n.d.	27.1	n.d.	26.6	25.9	25.4	25.4	26.7	25.4	**26.2**
5	n.d.	28.6	n.d.	28.2	25.9	27.3	27.3	28.3	27.3	**28.2**
6	n.d.	28.8	n.d.	29.0	28.0	27.8	27.8	28.8	27.8	**28.8**
7	n.d.	29.2	n.d.	29.6	26.5	0.0	0.0	29.5	-	**29.5**
8	n.d.	29.9	n.d.	30.1	0.0	0.0	0.0	30.1	-	**30.1**
9+	n.d.	30.0	n.d.	31.5	0.0	0.0	0.0	31.3	-	**31.3**
Quarter: 2										
0	n.d.	0.0	n.d.	0.0	0.0	0.0	0.0	-	-	**0.0**
1	n.d.	20.4	n.d.	21.6	13.2	0.0	0.0	13.9	-	**13.9**
2	n.d.	24.5	n.d.	24.0	19.8	0.0	0.0	23.5	-	**23.5**
3	n.d.	25.2	n.d.	25.0	23.8	23.0	23.0	25.1	23.0	**25.1**
4	n.d.	25.9	n.d.	26.1	25.3	25.4	25.4	25.9	25.4	**25.9**
5	n.d.	27.0	n.d.	27.9	26.9	27.3	27.3	27.1	27.3	**27.1**
6	n.d.	27.6	n.d.	29.3	27.6	27.8	27.8	27.8	27.8	**27.8**
7	n.d.	28.4	n.d.	29.4	26.1	0.0	0.0	28.3	-	**28.3**
8	n.d.	29.1	n.d.	31.7	31.3	0.0	0.0	29.3	-	**29.3**
9+	n.d.	29.7	n.d.	28.8	0.0	0.0	0.0	29.6	-	**29.6**
Quarter: 3										
0	n.d.	0.0	n.d.	0.0	12.0	13.0	0.0	12.0	13.0	**12.0**
1	n.d.	22.0	n.d.	22.2	16.9	16.2	0.0	17.1	16.2	**17.1**
2	n.d.	25.7	n.d.	25.8	24.1	24.0	23.9	25.2	23.9	**25.2**
3	n.d.	26.3	n.d.	27.0	26.2	25.1	25.0	26.8	25.0	**26.8**
4	n.d.	27.1	n.d.	28.2	26.6	26.6	26.5	27.7	26.5	**27.7**
5	n.d.	28.0	n.d.	29.0	28.2	26.9	27.1	28.7	27.0	**28.7**
6	n.d.	28.1	n.d.	29.6	29.2	27.9	28.1	29.5	28.0	**29.5**
7	n.d.	28.2	n.d.	30.1	28.0	28.6	28.7	29.7	28.7	**29.7**
8	n.d.	29.2	n.d.	31.3	31.3	29.6	29.6	31.1	29.6	**31.1**
9+	n.d.	0.0	n.d.	31.6	0.0	0.0	0.0	31.6	-	**31.6**
Quarter: 4										
0	n.d.	0.0	n.d.	0.0	11.8	13.0	0.0	11.8	13.0	**11.8**
1	n.d.	22.3	n.d.	24.0	17.6	16.2	0.0	18.9	16.2	**18.9**
2	n.d.	25.7	n.d.	25.9	25.4	24.0	23.9	25.8	23.9	**25.1**
3	n.d.	27.2	n.d.	26.8	26.6	25.1	25.0	26.9	25.0	**26.1**
4	n.d.	28.6	n.d.	27.7	28.6	26.6	26.5	28.1	26.5	**26.8**
5	n.d.	29.1	n.d.	28.8	27.9	26.7	27.2	28.9	27.1	**28.1**
6	n.d.	29.6	n.d.	29.5	29.0	27.7	28.2	29.5	28.1	**28.9**
7	n.d.	30.3	n.d.	30.3	30.2	28.4	28.8	30.3	28.7	**29.8**
8	n.d.	31.2	n.d.	31.7	31.1	29.6	29.6	31.5	29.6	**31.1**
9+	n.d.	30.8	n.d.	31.8	30.8	0.0	0.0	31.1	-	**31.1**

Table 2.2.4: North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2002. Catches (tonnes, SOP figures) at age (rings), by quarter and division.

rings	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	**5.0**	**0.0**	**0.0**	**0.0**	**0.0**	**4.0**	**0.1**	**0.0**	**4.0**	**0.1**	**9.0**	**4.0**
1	**13.9**	**4.6**	**0.0**	**4.6**	**0.5**	**11.6**	**0.1**	**0.0**	**16.7**	**0.1**	**30.7**	**16.8**
2	**5.0**	**19.7**	**1.1**	**18.6**	**20.8**	**14.3**	**0.5**	**4.9**	**53.8**	**5.4**	**64.2**	**60.2**
3	**0.7**	**29.4**	**2.3**	**27.1**	**73.1**	**16.7**	**2.0**	**17.2**	**116.9**	**19.2**	**136.7**	**138.3**
4	**0.1**	**14.9**	**1.7**	**13.2**	**15.7**	**3.2**	**1.2**	**14.5**	**32.0**	**15.7**	**47.8**	**49.5**
5	**0.0**	**6.9**	**0.6**	**6.3**	**13.6**	**3.0**	**0.3**	**3.3**	**22.9**	**3.5**	**26.4**	**27.0**
6	**0.0**	**8.2**	**0.6**	**7.7**	**19.8**	**2.4**	**0.3**	**4.4**	**29.9**	**4.6**	**34.5**	**35.1**
7	**0.0**	**2.8**	**0.2**	**2.6**	**6.3**	**0.7**	**0.1**	**0.9**	**9.5**	**1.0**	**10.5**	**10.7**
8	**0.0**	**2.0**	**0.1**	**1.9**	**4.7**	**1.2**	**0.0**	**0.5**	**7.8**	**0.5**	**8.3**	**8.5**
9+	**0.0**	**0.7**	**0.0**	**0.7**	**1.2**	**0.0**	**0.0**	**0.0**	**1.8**	**0.0**	**1.8**	**1.8**
Sum	**24.8**	**89.3**	**6.7**	**82.7**	**155.5**	**57.0**	**4.5**	**45.7**	**295.2**	**50.2**	**370.1**	**352.0**
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	0.6	0.0	0.0	0.0	0.0	2.6	0.0	0.0	2.6	0.0	**3.3**	**2.6**
2	3.6	6.3	0.0	6.3	0.4	4.8	0.0	0.0	11.5	0.0	**15.1**	**11.5**
3	0.2	1.7	0.0	1.7	6.5	1.1	0.1	0.9	9.3	1.0	**10.5**	**10.3**
4	0.0	0.9	0.0	0.9	1.2	0.3	0.1	1.1	2.4	1.1	**3.6**	**3.6**
5	0.0	0.5	0.0	0.5	1.3	0.0	0.0	0.1	1.7	0.1	**1.9**	**1.9**
6	0.0	1.0	0.0	1.0	2.0	0.4	0.0	0.1	3.5	0.1	**3.6**	**3.6**
7	0.0	0.2	0.0	0.2	0.8	0.0	0.0	0.0	1.0	0.0	**1.0**	**1.0**
8	0.0	0.1	0.0	0.1	0.4	0.0	0.0	0.0	0.6	0.0	**0.6**	**0.6**
9+	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.4	0.0	**0.4**	**0.4**
Sum	**4.5**	**10.8**	**0.0**	**10.8**	**13.0**	**9.3**	**0.2**	**2.3**	**33.1**	**2.4**	**39.9**	**35.5**
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	2.7	0.2	0.0	0.2	0.3	0.8	0.0	0.0	1.2	0.0	**3.9**	**1.2**
2	0.9	10.0	0.9	9.2	1.7	1.2	0.0	0.0	12.0	0.0	**13.0**	**12.9**
3	0.1	17.2	2.2	14.9	3.6	0.7	0.0	0.0	19.2	0.0	**19.3**	**21.5**
4	0.0	10.3	1.6	8.7	1.5	0.4	0.0	0.0	10.7	0.0	**10.7**	**12.3**
5	0.0	3.6	0.5	3.1	0.5	0.1	0.0	0.0	3.6	0.0	**3.6**	**4.2**
6	0.0	3.1	0.5	2.7	0.5	0.1	0.0	0.0	3.2	0.0	**3.3**	**3.7**
7	0.0	1.1	0.2	0.9	0.2	0.1	0.0	0.0	1.2	0.0	**1.2**	**1.4**
8	0.0	0.7	0.1	0.6	0.1	0.0	0.0	0.0	0.8	0.0	**0.8**	**0.8**
9+	0.0	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.2	0.0	**0.2**	**0.2**
Sum	**3.8**	**46.5**	**6.0**	**40.5**	**8.3**	**3.4**	**0.0**	**0.1**	**52.2**	**0.1**	**56.0**	**58.2**
Quarter: 3												
0	3.3	0.0	0.0	0.0	0.0	2.5	0.0	0.0	2.5	0.0	**5.9**	**2.5**
1	7.1	0.1	0.0	0.1	0.1	2.7	0.0	0.0	2.9	0.0	**10.1**	**2.9**
2	0.4	1.3	0.2	1.1	11.3	5.3	0.0	0.0	17.7	0.0	**18.2**	**17.9**
3	0.3	3.4	0.0	3.4	42.1	10.7	0.0	0.0	56.1	0.0	**56.5**	**56.2**
4	0.1	2.4	0.2	2.2	10.8	2.2	0.0	0.0	15.3	0.0	**15.4**	**15.5**
5	0.0	1.2	0.1	1.1	9.2	2.7	0.0	0.0	13.0	0.0	**13.1**	**13.1**
6	0.0	1.4	0.1	1.3	14.4	1.8	0.0	0.0	17.5	0.0	**17.5**	**17.6**
7	0.0	0.4	0.0	0.4	4.3	0.6	0.0	0.0	5.3	0.0	**5.3**	**5.3**
8	0.0	0.3	0.0	0.3	2.7	1.2	0.0	0.0	4.3	0.0	**4.3**	**4.3**
9+	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.6	0.0	**0.6**	**0.6**
Sum	**11.4**	**10.6**	**0.7**	**10.0**	**95.5**	**29.7**	**0.0**	**0.1**	**135.2**	**0.1**	**146.7**	**136.0**
Quarter: 4												
0	1.6	0.0	0.0	0.0	0.0	1.5	0.1	0.0	1.5	0.1	**3.1**	**1.5**
1	3.4	4.4	0.0	4.4	0.1	5.5	0.1	0.0	10.0	0.1	**13.5**	**10.1**
2	0.1	2.0	0.0	2.0	7.4	3.1	0.5	4.9	12.5	5.4	**18.0**	**17.9**
3	0.1	7.1	0.0	7.1	20.9	4.2	1.9	16.2	32.2	18.1	**50.4**	**50.3**
4	0.0	1.3	0.0	1.3	2.1	0.2	1.1	13.4	3.6	14.5	**18.1**	**18.1**
5	0.0	1.7	0.0	1.7	2.6	0.2	0.3	3.1	4.5	3.4	**7.9**	**7.9**
6	0.0	2.7	0.0	2.7	2.9	0.1	0.3	4.2	5.6	4.5	**10.1**	**10.1**
7	0.0	1.0	0.0	1.0	1.0	0.0	0.1	0.9	2.0	1.0	**3.0**	**3.0**
8	0.0	0.8	0.0	0.8	1.4	0.0	0.0	0.5	2.3	0.5	**2.8**	**2.8**
9+	0.0	0.4	0.0	0.4	0.2	0.0	0.0	0.0	0.6	0.0	**0.6**	**0.6**
Sum	**5.2**	**21.5**	**0.0**	**21.5**	**38.7**	**14.6**	**4.3**	**43.3**	**74.8**	**47.6**	**127.5**	**122.4**

Table 2.2.5 North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2002. Percentage age composition (based on numbers, 3+ group summarised), by quarter and division.

rings	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	**50.7%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**29.4%**	**8.5%**	**0.0%**	**12.6%**	**0.9%**	**19.8%**	**10.9%**
1	**42.5%**	**9.5%**	**0.0%**	**10.2%**	**0.6%**	**39.6%**	**9.7%**	**0.0%**	**19.4%**	**1.0%**	**22.7%**	**16.8%**
2	**5.9%**	**25.6%**	**18.6%**	**26.1%**	**16.4%**	**15.5%**	**11.6%**	**13.8%**	**18.1%**	**13.6%**	**15.0%**	**17.6%**
3	**0.7%**	**32.3%**	**36.3%**	**32.0%**	**51.3%**	**10.5%**	**41.2%**	**42.4%**	**29.6%**	**42.3%**	**24.5%**	**31.3%**
4	**0.1%**	**15.1%**	**25.9%**	**14.3%**	**9.3%**	**1.8%**	**19.6%**	**28.9%**	**7.2%**	**28.0%**	**7.7%**	**10.1%**
5	**0.0%**	**6.2%**	**8.2%**	**6.1%**	**7.3%**	**1.3%**	**4.2%**	**5.8%**	**4.5%**	**5.6%**	**3.6%**	**4.7%**
6	**0.0%**	**7.1%**	**7.1%**	**7.1%**	**9.7%**	**1.1%**	**4.3%**	**7.0%**	**5.4%**	**6.7%**	**4.4%**	**5.6%**
7	**0.0%**	**2.2%**	**2.4%**	**2.2%**	**2.9%**	**0.3%**	**0.8%**	**1.3%**	**1.7%**	**1.2%**	**1.3%**	**1.6%**
8	**0.0%**	**1.5%**	**1.2%**	**1.5%**	**2.0%**	**0.4%**	**0.1%**	**0.7%**	**1.2%**	**0.7%**	**0.9%**	**1.2%**
9+	**0.0%**	**0.5%**	**0.3%**	**0.5%**	**0.5%**	**0.0%**	**0.0%**	**0.0%**	**0.3%**	**0.0%**	**0.2%**	**0.3%**
Sum 3+	**0.8%**	**64.8%**	**81.4%**	**63.6%**	**83.1%**	**15.4%**	**70.2%**	**86.2%**	**49.9%**	**84.5%**	**42.5%**	**54.7%**
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	50.2%	0.0%	-	0.0%	0.1%	62.9%	0.0%	0.0%	37.0%	0.0%	**37.0%**	**35.0%**
2	47.5%	65.2%	-	65.2%	3.1%	30.4%	0.0%	0.0%	31.2%	0.0%	**31.8%**	**29.5%**
3	2.1%	16.1%	-	16.1%	59.1%	4.9%	52.0%	52.0%	18.9%	52.0%	**18.2%**	**20.6%**
4	0.1%	7.1%	-	7.1%	9.0%	0.9%	40.0%	40.0%	3.9%	40.0%	**5.0%**	**5.8%**
5	0.0%	3.0%	-	3.0%	8.3%	0.0%	4.0%	4.0%	2.4%	4.0%	**2.2%**	**2.5%**
6	0.0%	6.5%	-	6.5%	11.9%	0.9%	4.0%	4.0%	4.4%	4.0%	**3.8%**	**4.4%**
7	0.0%	1.2%	-	1.2%	4.6%	0.0%	0.0%	0.0%	1.2%	0.0%	**1.0%**	**1.2%**
8	0.0%	0.6%	-	0.6%	2.3%	0.0%	0.0%	0.0%	0.6%	0.0%	**0.5%**	**0.6%**
9+	0.0%	0.2%	-	0.2%	1.6%	0.0%	0.0%	0.0%	0.4%	0.0%	**0.3%**	**0.4%**
Sum 3+	**2.3%**	**34.8%**	**-**	**34.8%**	**96.7%**	**6.7%**	**100.0%**	**100.0%**	**31.8%**	**100.0%**	**31.2%**	**35.4%**
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	90.9%	0.6%	0.0%	0.7%	5.1%	59.7%	0.0%	0.0%	13.1%	0.0%	**32.5%**	**12.0%**
2	8.2%	24.4%	16.7%	25.5%	24.3%	25.9%	0.0%	0.0%	25.4%	0.0%	**21.1%**	**24.6%**
3	0.6%	38.1%	39.2%	37.9%	44.5%	8.5%	52.0%	52.0%	33.0%	52.0%	**24.9%**	**33.5%**
4	0.2%	21.5%	26.0%	20.8%	16.5%	3.7%	40.0%	40.0%	16.8%	40.0%	**12.7%**	**17.6%**
5	0.0%	6.7%	7.9%	6.5%	4.1%	0.5%	4.0%	4.0%	5.0%	4.0%	**3.7%**	**5.2%**
6	0.0%	5.5%	6.5%	5.3%	3.5%	0.7%	4.0%	4.0%	4.1%	4.0%	**3.1%**	**4.3%**
7	0.0%	1.8%	2.2%	1.8%	1.2%	0.9%	0.0%	0.0%	1.5%	0.0%	**1.1%**	**1.6%**
8	0.0%	1.2%	1.1%	1.2%	0.6%	0.1%	0.0%	0.0%	0.9%	0.0%	**0.6%**	**0.9%**
9+	0.0%	0.3%	0.3%	0.3%	0.1%	0.0%	0.0%	0.0%	0.2%	0.0%	**0.2%**	**0.2%**
Sum 3+	**0.9%**	**75.0%**	**83.3%**	**73.7%**	**70.7%**	**14.4%**	**100.0%**	**100.0%**	**61.4%**	**100.0%**	**46.4%**	**63.4%**
Quarter: 3												
0	68.4%	0.0%	0.0%	0.0%	0.0%	46.1%	10.4%	0.0%	20.3%	2.6%	**35.1%**	**20.2%**
1	29.9%	2.2%	0.0%	2.3%	0.3%	17.3%	11.9%	0.0%	7.9%	3.0%	**14.7%**	**7.9%**
2	1.0%	14.6%	38.1%	13.0%	15.2%	10.7%	11.7%	14.9%	13.1%	14.1%	**9.4%**	**13.2%**
3	0.6%	33.0%	6.1%	34.8%	47.9%	16.0%	35.8%	43.2%	33.1%	41.3%	**23.1%**	**33.0%**
4	0.1%	22.4%	25.0%	22.2%	10.6%	3.2%	19.8%	27.2%	8.0%	25.3%	**5.6%**	**8.1%**
5	0.0%	9.9%	11.1%	9.9%	8.3%	3.1%	4.3%	5.8%	6.1%	5.4%	**4.2%**	**6.1%**
6	0.0%	11.9%	13.2%	11.8%	11.9%	1.9%	4.9%	6.9%	7.5%	6.4%	**5.2%**	**7.5%**
7	0.0%	3.6%	3.9%	3.6%	3.4%	0.7%	1.0%	1.3%	2.2%	1.2%	**1.5%**	**2.2%**
8	0.0%	2.3%	2.6%	2.3%	2.0%	1.1%	0.3%	0.7%	1.6%	0.6%	**1.1%**	**1.6%**
9+	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.2%	0.0%	**0.1%**	**0.2%**
Sum 3+	**0.8%**	**83.2%**	**61.9%**	**84.7%**	**84.5%**	**25.9%**	**66.0%**	**85.1%**	**58.7%**	**80.3%**	**40.8%**	**58.7%**
Quarter: 4												
0	64.2%	0.0%	-	0.0%	0.0%	38.6%	9.0%	0.0%	16.9%	0.9%	**19.5%**	**11.7%**
1	35.1%	34.1%	-	34.1%	0.3%	45.4%	10.2%	0.0%	27.3%	1.1%	**21.3%**	**18.9%**
2	0.4%	10.3%	-	10.3%	21.9%	7.1%	12.2%	14.9%	12.9%	14.6%	**11.5%**	**13.5%**
3	0.3%	30.1%	-	30.1%	56.2%	8.2%	40.7%	41.7%	29.6%	41.6%	**28.5%**	**33.5%**
4	0.0%	4.8%	-	4.8%	5.2%	0.3%	18.5%	28.1%	3.0%	27.1%	**9.1%**	**10.7%**
5	0.0%	5.7%	-	5.7%	5.7%	0.3%	4.2%	5.9%	3.4%	5.7%	**3.5%**	**4.1%**
6	0.0%	8.6%	-	8.6%	6.0%	0.1%	4.3%	7.2%	4.0%	6.9%	**4.2%**	**4.9%**
7	0.0%	3.0%	-	3.0%	1.9%	0.0%	0.9%	1.4%	1.3%	1.3%	**1.1%**	**1.3%**
8	0.0%	2.2%	-	2.2%	2.5%	0.0%	0.1%	0.8%	1.3%	0.7%	**1.0%**	**1.1%**
9+	0.0%	1.1%	-	1.1%	0.3%	0.0%	0.0%	0.0%	0.4%	0.0%	**0.2%**	**0.2%**
Sum 3+	**0.3%**	**55.5%**	**-**	**55.5%**	**77.8%**	**8.9%**	**68.6%**	**85.1%**	**42.9%**	**83.4%**	**47.7%**	**55.9%**

Table 2.2.6a 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).

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	42.0	0.018	554.0	0.010	**1,565.2**	**0.009**
1	36.9	0.066	44.1	0.039	180.6	0.054	68.4	0.023	**329.9**	**0.047**
2	479.7	0.124	21.0	0.067	129.3	0.091	17.4	0.065	**647.4**	**0.114**
3	1004.7	0.153	20.4	0.128	50.2	0.118	2.0	0.080	**1,077.2**	**0.151**
4	280.7	0.170	4.3	0.149	13.0	0.139	0.4	0.073	**298.4**	**0.168**
5	130.9	0.208	1.0	0.178	6.0	0.159	0.2	0.088	**138.2**	**0.205**
6	66.6	0.233	0.8	0.174	1.2	0.191	0.0	0.026	**68.6**	**0.232**
7	25.8	0.244	0.2	0.200	0.4	0.202	0.1	0.095	**26.5**	**0.243**
8	8.5	0.264			0.4	0.210	0.0	0.066	**8.9**	**0.260**
9+	3.3	0.292							**3.3**	**0.292**
TOTAL	2,038.0		1,060.1		423.2		642.5		**4,163.7**	
SOP catch		**315.8**		**15.2**		**31.2**		**8.4**		**370.6**

Figures for the C and D fleet have been revised in 2001. Fleet D contains the former fleet E from 1999 on.

2000	**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			872.6	0.013	63.1	0.022	173.1	0.021	**1,108.8**	**0.015**
1	89.2	0.077	95.3	0.037	485.4	0.041	498.9	0.016	**1,168.8**	**0.033**
2	475.2	0.127	22.4	0.065	105.8	0.078	9.8	0.056	**613.2**	**0.115**
3	460.1	0.160	5.5	0.130	21.4	0.108	0.5	0.127	**487.5**	**0.157**
4	576.8	0.180	3.2	0.140	19.8	0.164	3.0	0.158	**602.8**	**0.180**
5	177.3	0.200	0.8	0.112	7.5	0.191	0.1	0.168	**185.6**	**0.199**
6	75.3	0.219			2.9	0.183	0.3	0.189	**78.5**	**0.218**
7	27.2	0.245			0.3	0.212	0.3	0.170	**27.8**	**0.244**
8	15.3	0.273	1.4	0.200	0.1	0.198	0.0	0.177	**16.8**	**0.267**
9+	2.5	0.262							**2.5**	**0.262**
TOTAL	1,898.8		1,001.3		706.2		686.0		**4,292.2**	
SOP catch		**308.4**		**17.8**		**37.0**		**13.1**		**376.3**

Figures for A and B fleets have been revised in 2002

2001	**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			1,024.9	0.015	16.1	0.025	791.7	0.008	**1,832.7**	**0.012**
1	35.6	0.104	47.0	0.029	344.0	0.066	219.7	0.023	**646.3**	**0.051**
2	682.4	0.126	21.9	0.050	140.9	0.076	9.1	0.058	**854.4**	**0.116**
3	469.2	0.149	8.6	0.096	16.6	0.108	0.5	0.099	**494.9**	**0.147**
4	258.2	0.175	10.7	0.126	1.4	0.130	0.0	0.133	**270.2**	**0.173**
5	293.0	0.194	1.1	0.121	0.3	0.147	0.0	0.149	**294.4**	**0.194**
6	70.2	0.216	4.8	0.122	0.5	0.221	0.0	0.155	**75.5**	**0.210**
7	39.7	0.229	0.5	0.154	0.0	0.179	0.0	0.166	**40.3**	**0.228**
8	38.6	0.218	0.1	0.251	0.0	0.211	0.0	0.184	**38.6**	**0.218**
9+	2.4	0.285							**2.4**	**0.285**
TOTAL	1,889.3		1,119.6		519.8		1,021.0		**4,549.7**	
SOP catch		**295.3**		**20.4**		**36.1**		**12.3**		**364.0**

2002	**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			318.8	0.013	14.0	0.015	397.5	0.012	**730.3**	**0.012**
1	77.5	0.082	412.9	0.025	196.9	0.056	148.0	0.019	**835.3**	**0.037**
2	427.2	0.129	77.8	0.050	40.5	0.106	7.5	0.096	**553.0**	**0.116**
3	874.3	0.153	23.5	0.114	4.6	0.124	0.8	0.136	**903.2**	**0.151**
4	281.5	0.169	1.7	0.169	0.7	0.144	0.1	0.143	**284.0**	**0.169**
5	131.4	0.199	1.6	0.180	0.2	0.163	0.0	0.170	**133.2**	**0.198**
6	159.7	0.215	1.4	0.193	0.1	0.180	0.0	0.180	**161.2**	**0.214**
7	46.0	0.228	0.2	0.228	0.0	0.180			**46.3**	**0.228**
8	33.2	0.250	0.2	0.244	0.0	0.224	0.0	0.179	**33.4**	**0.250**
9+	7.2	0.253	0.0						**7.2**	**0.253**
TOTAL	2,037.9		838.1		257.0		554.0		**3,687.0**	
SOP catch		**323.4**		**22.1**		**16.3**		**8.4**		**370.3**

Figures for A fleet include 4457 t unsampled bycatch in the industrial fishery

Table 2.2.6b: Updated 2002 data following the revision of Swedish catch data (C & D fleet) which became available late c
the WG meeting. This data was used for the fleetwise projections but differ slightly from the ones used for the a

2002	**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			318.8	0.013	10.2	0.015	468.3	0.012	**797.3**	**0.013**
1	77.5	0.082	412.9	0.025	201.0	0.054	161.6	0.018	**852.9**	**0.036**
2	427.2	0.129	77.8	0.050	51.5	0.101	5.2	0.096	**561.7**	**0.115**
3	874.3	0.153	23.5	0.114	5.1	0.120	0.5	0.136	**903.4**	**0.151**
4	281.5	0.169	1.7	0.169	0.7	0.143	0.1	0.143	**283.9**	**0.169**
5	131.4	0.199	1.6	0.180	0.2	0.161	0.0	0.170	**133.2**	**0.198**
6	159.7	0.215	1.4	0.193	0.1	0.179	0.0	0.180	**161.2**	**0.214**
7	46.0	0.228	0.2	0.228	0.0	0.177	0.0	0.000	**46.3**	**0.227**
8	33.2	0.250	0.2	0.244	0.0	0.221	0.0	0.179	**33.4**	**0.250**
9+	7.2	0.253	0.0						**7.2**	**0.253**
TOTAL	2,037.9		838.1		268.8		635.7		**3,780.5**	
SOP catch		**323.4**		**22.1**		**17.1**		**9.1**		**371.7**

Figures for A fleet include 4457 t unsampled bycatch in the industrial fishery

Table 2.2.7: Catch at age (numbers in millions) of herring caught in the North Sea, 1990-2002.

Year/rings	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**
2000	873	185	506	475	590	184	78	28	17	3	**2938**
2001	1025	83	716	488	275	301	78	42	39	2	**3049**
2002	319	490	513	913	294	136	164	47	34	7	**2917**

Table 2.2.8: Catch at age (numbers in millions) of Baltic Spring spawning Herring taken in the North Sea, and transfered to the assessment of the spring spawning stock in IIIa, 1990-2002.

Year/rings	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**
2000			8.2	9.8	10.2	5.7	2.5	0.6	0.7	0.1	**37.6**
2001		0.5	11.3	10.2	6.1	7.2	2.7	1.6	0.4	0.0	39.9
2002			7.6	14.8	10.6	3.3	2.9	1.0	0.5	0.1	40.8

Table 2.2.9: Catch at age (numbers in millions) of North Sea Autumn Spawners taken in IIIa, and transfered to the assessment of NSAS, 1990 - 2002. Figures for 1991-1999 were altered in 2001 and 2002, but for 1991-1995 still not used in the assessment. Revision of 2002 splitting is not included (see Sect. 2.2.3).

Year/rings	0	1	2	3	4	5	6	7	8+	Total
1990	398	1424	284							**2106**
1991	677	748	298	52	8	5	1	0	0	**1791**
1992	2298	1409	220	22	10	7	3	1	0	**3971**
1993	2795	2033	238	27	8	4	3	2	1	**5109**
1994	482	1087	201	27	6	3	2	0	0	**1807**
1995	1145	1189	162	13	3	1	1	0	0	**2514**
1996	516	961	161	17	3	2	1	0	0	**1662**
1997	68	305	132	21	2	1	0	0	0	**529**
1998	51	745	162	27	19	3	3	1	0	**1012**
1999	599	303	149	47	13	6	1	0	0	**1119**
2000	235	984	116	22	23	8	3	1	0	**1392**
2001	808	564	150	17	1	0	0	0	0	**1541**
2002	411	345	48	5	1	0	0	0	0	**811**

Table 2.2.10: Catch at age (numbers in millions) of the total North Sea Autumn Spawning stock 1990 - 2002. Figures for 1991-1999 were altered in 2001 and 2002, but for 1991-1995 still not used in the assessment. Revision of 2002 splitting is not included (see Sect. 2.2.3).

Year/rings	0	1	2	3	4	5	6	7	8	9+	Total
1990	1286	2982	888	769	850	383	79	54	29	12	**7331**
1991	2405	2198	1157	500	537	493	203	39	25	13	**7570**
1992	10390	2470	1342	445	376	368	383	156	40	23	**15994**
1993	10280	4160	1305	577	295	210	221	184	86	41	**17358**
1994	4437	1890	1839	449	332	103	88	74	68	45	**9325**
1995	9096	1533	1555	894	241	121	55	41	54	73	**13663**
1996	2544	1516	706	644	192	58	20	11	8	18	**5716**
1997	483	573	759	546	269	99	26	12	11	9	**2787**
1998	256	921	1209	525	276	161	85	16	10	10	**3469**
1999	1562	276	646	1082	298	138	69	27	9	3	**4110**
2000	1110	1169	613	487	603	186	79	28	17	2	**4293**
2001	1833	646	854	495	270	294	76	40	39	2	**4550**
2002	730	835	553	903	284	133	161	46	33	7	**3687**

Table 2.2.11: Comparison of mean weights (kg) at age (rings) in the catch of adult herri
the North Sea and North Sea Autumn Spawners caught in Div IIIa in 1991-

		Age (Rings)							
Div.	**Year**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9+**
IIIa*	1991	0.073	0.097	0.136	0.150	0.156	0.160	0.177	-
	1992	0.073	0.097	0.136	0.150	0.156	0.160	0.177	-
	1993	0.080	0.141	0.132	0.233	0.239	0.181	0.203	-
	1994	0.083	0.111	0.138	0.159	0.185	0.199	0.214	-
	1995	0.088	0.146	0.166	0.205	0.212	0.236	0.244	-
	1996	0.080	0.127	0.165	0.186	0.216	0.216	0.239	-
	1997	0.069	0.124	0.171	0.185	0.189	0.189	0.192	-
	1998	0.080	0.118	0.163	0.180	0.197	0.179	0.226	-
	1999	0.088	0.114	0.137	0.156	0.188	0.187	0.199	-
	2000	0.076	0.109	0.163	0.190	0.184	0.189	0.200	-
	2001	0.075	0.108	0.130	0.147	0.219	0.176	0.198	-
	2002	0.104	0.126	0.144	0.164	0.180	0.180	0.218	-
IVa	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
	2000	0.129	0.156	0.184	0.204	0.224	0.254	0.283	0.263
	2001	0.130	0.154	0.179	0.204	0.218	0.243	0.276	0.285
	2002	0.137	0.159	0.179	0.203	0.219	0.232	0.250	0.253
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
	2000	0.130	0.155	0.174	0.199	0.204	0.217	0.267	0.256
	2001	0.121	0.148	0.165	0.177	0.197	0.219	0.261	0.238
	2002	0.130	0.154	0.167	0.189	0.198	0.212	0.229	0.238
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
	2000	0.129	0.157	0.186	0.208	0.234	0.268	0.294	0.265
	2001	0.134	0.161	0.190	0.221	0.231	0.264	0.281	0.294
	2002	0.144	0.161	0.191	0.211	0.230	0.242	0.261	0.263
IVb	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
	2000	0.125	0.173	0.191	0.220	0.232	0.258	0.222	0.268
	2001	0.102	0.143	0.165	0.176	0.192	0.190	0.188	0.275
	2002	0.086	0.149	0.161	0.206	0.214	0.189	0.270	0.241
IVa & IVb	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
	2000	0.128	0.162	0.185	0.206	0.225	0.254	0.267	0.263
	2001	0.125	0.152	0.176	0.197	0.214	0.230	0.219	0.284
	2002	0.119	0.157	0.177	0.203	0.219	0.228	0.253	0.253
IVc & VIId	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	-	-
	2000	0.109	0.137	0.154	0.185	0.202	0.209	-	-
	2001	0.113	0.138	0.166	0.164	0.155	0.168	0.180	-
	2002	0.108	0.123	0.153	0.170	0.187	0.219	0.208	-
Total North Sea Catch	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
	2000	0.125	0.160	0.180	0.200	0.219	0.244	0.267	0.263
	2001	0.124	0.148	0.174	0.194	0.209	0.228	0.218	0.284
	2002	0.116	0.151	0.169	0.198	0.214	0.228	0.250	0.253

999 altered in 2002 but the1991-1995 updated figures were still not included in the assessment.

Table 2.2.12: Sampling of commercial landings of Herring in the North Sea (Div. IV and VIId) in 2002 by quarter. Sampled c
means the proportion of the reported catch to which sampling was applied. It is limited to 100% but might exce
the official landings due to sampling of discards, unallocated and misreported catches. It is not possible to judg
the quality of the sampling by this figure alone. Note that only one nation sampled their by-catches in the indust
fishery (Denmark, fleet B). Metiers are each **reported** combination of nation/fleet/area/quarter.

Country (fleet)	Quarter	No of metiers	Metiers sampled	Sampled Catch %	Official Catch	No. of samples	No. fish aged	No. fish measured	>1 sample per 1 kt catch
Belgium	4	1	0	0%	23	0	0	0	n
total		**1**	**0**	**0%**	**23**	**0**	**0**	**0**	**n**
Denmark (A)	1	3	3	100%	19322	6	150	1302	n
	2	2	2	100%	1113	2	48	490	y
	3	3	2	82%	11352	15	551	2336	y
	4	3	3	100%	16948	21	196	3530	y
total		**11**	**10**	**96%**	**48736**	**44**	**945**	**7658**	**n**
Denmark (B)	1	3	2	2%	5756	2	0	3	n
	2	2	2	100%	1565	36	0	233	y
	3	4	2	98%	5317	14	0	474	y
	4	4	4	100%	9450	28	0	634	y
total		**13**	**10**	**74%**	**22090**	**80**	**0**	**1344**	**y**
England & Wal	1	2	0	0%	21	0	0	0	n
	2	4	0	0%	996	0	0	0	n
	3	3	0	0%	9477	0	0	0	n
	4	2	0	0%	3263	0	0	0	n
total		**11**	**0**	**0%**	**13757**	**0**	**0**	**0**	**n**
Faroe Isl	4	2	0	0%	1413	0	0	0	n
total		**2**	**0**	**0%**	**1413**	**0**	**0**	**0**	**n**
France	1	3	0	0%	1342	0	0	0	n
	2	3	0	0%	1349	0	0	0	n
	3	4	0	0%	13191	0	0	0	n
	4	3	0	0%	9539	0	0	0	n
total		**13**	**0**	**0%**	**25421**	**0**	**0**	**0**	**n**
Germany	1	1	0	0%	678	0	0	0	n
	2	1	0	0%	999	0	0	0	n
	3	2	1	64%	20979	24	579	9426	y
	4	3	1	5%	4556	16	212	5469	y
total		**7**	**2**	**50%**	**27212**	**40**	**791**	**14895**	**y**
Netherlands	1	3	1	100%	668	1	25	264	n
	2	1	1	12%	2102	5	125	837	y
	3	2	2	100%	25102	34	850	4188	n
	4	5	5	100%	27384	24	600	3930	n
total		**11**	**9**	**100%**	**55257**	**64**	**1600**	**9219**	**n**
Northern Irelan	3	1	0	0%	944	0	0	0	n
total		**1**	**0**	**0%**	**944**	**0**	**0**	**0**	**n**
Norway	1	2	1	100%	2949	4	372	380	y
	2	3	3	100%	45669	27	2638	2654	n
	3	2	2	100%	6760	3	298	300	n
	4	2	1	71%	19596	2	200	200	n
total		**9**	**7**	**99%**	**74974**	**36**	**3508**	**3534**	**n**
Scotland	1	1	1	100%	3612	7	421	1043	y
	2	1	1	100%	1431	2	160	964	y
	3	3	2	99%	25260	67	3360	14273	y
	4	2	1	100%	623	5	141	701	n
total		**5**	**3**	**100%**	**30926**	**72**	**3503**	**14802**	**y**
Sweden	2	1	0	0%	149	0	0	0	n
	3	3	0	0%	2035	0	0	0	n
	4	3	0	0%	1234	0	0	0	n
total		**7**	**0**	**0%**	**3418**	**0**	**0**	**0**	**n**
grand total		**99**	**49**	**100%**	**304170**	**351**	**10932**	**53637**	**n**
Period total	**1**	18	8	79%	34349	20	968	2992	n
Period total	**2**	18	9	99%	55374	72	2971	5178	y
Period total	**3**	27	11	84%	120418	157	5638	30997	y
Period total	**4**	29	15	101%	94007	96	1349	14464	n
Total for stock 2002		**91**	**41**	**100%**	**304170**	**351**	**10932**	**53637**	**n**
Human Cons. only		78	31	100%	282081	271	10932	52293	n
Total for stock 2000		90	30	97%	285117	314	11797	41692	y
Total for stock 2001		98 (93)	26	71%	294865	230	9477	38976	n
Human Cons. only 2001		85 (78)	19	69%	274512	196	9362	38521	n

Table 2.3.1.1 North Sea herring numbers (millions) at ring and maturity by ICES Subarea from July acoustic survey 2002

ICES A	IIIa	IVa	IVb
0	1364.8	48.7	6015.2
1i	4362.4	2921.3	14452.2
1m	0.0	79.1	1239.9
2i	132.6	449.1	100.3
2m	18.1	3870.6	304.4
3i	61.4	138.2	29.2
3m	6.8	7650.7	334.2
4	15.5	1320.4	54.2
5	7.5	752.8	34.3
6	0.0	1006.5	24.7
7	0.0	241.5	2.9
8	0.0	120.9	0.1
9+	0.0	148.1	1.3
Immature	5921.3	3557.4	20596.9
Mature	47.9	15190.7	1995.9
Total	5969.2	18748.1	22592.8

Table 2.3.1.2 North Sea herring biomass (thousands of tonnes) at ring and maturity by ICES subarea from July acoustic survey 2002

ICES A	IIIa	Iva	IVb
0	9.64	0.70	30.70
1I	163.05	204.41	562.93
1m	0.00	6.87	94.59
2i	12.13	43.22	7.35
2m	1.65	576.46	32.15
3i	6.12	15.40	2.57
3m	0.68	1351.66	44.56
4	1.92	260.68	8.16
5	1.16	171.68	5.72
6	0.00	250.48	4.19
7	0.00	63.32	0.52
8	0.00	33.81	0.01
9+	0.00	37.03	0.20
Immature	190.94	263.74	603.55
Mature	5.41	2751.99	190.10
Total	196.35	3015.73	793.65

Table 2.3.1.3 North Sea herring mean weight (g) at ring and maturity by ICES Subarea from July acoustic survey 2002

ICES A	IIIa	IVa	IVb
0	7.06	14.41	5.10
1i	37.38	69.97	38.95
1m		86.90	76.29
2i	91.46	96.22	73.29
2m	91.46	148.93	105.62
3i	99.62	111.44	88.15
3m	99.62	176.67	133.33
4	123.98	197.42	150.70
5	154.50	228.05	166.63
6		248.85	169.47
7		262.16	179.69
8		279.56	248.00
9+		250.00	151.00
Mean (i)	32.25	74.14	29.30
Mean (m)	112.99	181.16	95.25
Mean (all)	32.89	160.85	35.13

Table 2.3.1.4 North Sea autumn-spawning herring in the area surveyed in the acoustic surveys July 2002 Total numbers (millions) and biomass (thousands of tonnes) with mean weights (g) and fraction mature by ring.

North Sea ring	Numbers (millions)	Biomass Tonnes $*10^3$	Maturity (fraction)	Mean weight (g)	Mean length (cm)
0	7428.8	41.0	0.00	6	9.3
1	23054.9	1031.9	0.06	45	18.1
2	4875.1	673.0	0.86	138	24.7
3	8220.6	1421.0	0.97	172	26.4
4	1390.0	270.8	1.00	194	27.4
5	794.6	178.6	1.00	224	28.6
6	1031.2	254.7	1.00	247	29.4
7	244.4	63.8	1.00	261	29.9
8	121.0	33.8	1.00	280	30.6
9+	149.5	37.2	1.00	249	29.2
Immature	30075.6	1058.2			
Mature	17234.5	2947.5			
Total	47310.1	4005.7			

Table 2.3.1.5 North Sea autumn spawners, estimates of (millions) at age from acoustic surveys, and SSB (thousands of tonnes) 1984-2002. 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 2000 estimates are from the summer survey in Divisions IVa,b, and IIIa excluding estimates of Division IIIa/Baltic spring spawners. For 1999 & 2000 the Kattegat was excluded from the results because it was not surveyed. The 1996 to 1999 surveys have been revised due to changes in methods for calculating mean weight and proportion adult. The earlier surveys were revised in March 2002 following recent reorganisation of archive, removal of a 9% calibration error on Scottish survey 1999-2000.

Year/ring	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	551	726	1,639	13,736	6,431	6,333	6,249	3,182	6,351	10,399	3,646	4,202	6,198	9,416	4,449	5,087	24,735	6,837	23,055
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	4,557	6,363	5,747	3,078	2,922	12,290	4,875
3	1,005	1,433	1,637	955	1,732	3,751	3,530	1,501	1,633	1,855	957	2,056	2,824	3,287	2,520	4,725	2,156	3,083	8,220
4	394	323	833	657	528	1,612	3,370	2,102	1,397	909	429	656	1,087	1,696	1,625	1,116	3,139	1,462	1,390
5	158	113	135	368	349	488	1,349	1,984	1,510	795	363	272	311	692.1	982.4	506.4	1,006	1,676	794.6
6	44	41	36	77	174	281	395	748	1,311	788	321	175	98.7	259.2	445.2	313.6	482.5	449.6	1,031
7	52	17	24	38	43	120	211	262	474	546	238	135	82.8	78.6	170.3	138.6	266.4	169.6	244.4
8	39	23	6	11	23	44	134	112	155	178	220	110	132.9	78.3	45.2	54.3	120.4	97.7	121.0
9+	41	19	8	20	14	22	43	56	163	116	132	84	206	158.3	121.4	87.2	97.2	58.9	149.5
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	16,104	15,107	34,928	26,124	39,881
$Z_{2+/3+}$	.	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	0.76	0.52	0.32	0.38	0.47
Smooth $Z_{2+/3+}$	.	.	0.73	0.76	0.91	0.30	0.11	0.25	0.46	0.52	0.94	0.80	0.48	0.41	0.55	0.63	0.41	0.35	0.42
SSB (‘000 t)	807	697	942	817	897	1,637	2,174	1,874	1,545	1,216	1,035	1,082	1446.2	1,780	1,792	1,534	1,833	2,622	2,948

Table 2.3.2.1 Fortnights, time periods sampled and survey effort in 2002/2003.
NL – Netherlands, FRG – Federal Republic of Germany

Area	Time period	Samples available	Vessel days	Nation	Coverage
Orkney/Shetland	01-15 Sep.	None			
	16-30 Sep.	93	6	FRG	Total
Buchan	01-15 Sep.	None			
	16-30 Sep.	128	8	NL/FRG	Total
Central North Sea	01-15 Sep.	None			
	16-30 Sep.	None			
	01-15 Oct.	43	3	NL	Partial
Southern North Sea	16-31 Dec.	70	4	NL	Total
	01-15 Jan.	116	6	FRG	Total
	16-31 Jan.	86	5	NL	Total

Table 2.3.2.2 Number of samples taken and sampling effort for the herring larvae surveys in Orkney/Shetland, Buchan, Central North Sea and Southern North Sea by year

Year	Samples	Vessel-days (sampling)
1988/89	1355	98
1989/90	1300	96
1990/91	634	49
1991/92	738	51
1992/93	498	31
1993/94	491	34
1994/95	450	33
1995/96	421	26
1996/97	469	32
1997/98	456	29
1998/99	531	37
1999/00	645	38
2000/01	696	53
2001/02	534	32
2002/03	533	35

Table 2.3.2.3 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

	Orkney/Shetland		Buchan		Central North Sea				Southern North Sea		
Period	1-15 Sep.	16-30 Sep.	1-15 Sep.	16-30 Sep.	1-15 Sep.	16-30 Sep.	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
2000		3352	28	83		376		*	7346	338	106
2001		11918		164		1604		*	971	5531	909
2002		6669		1038			3291	*	2008	260	925

* This sampling period in the CNS is omitted from the surveys since 1999.

Table 2.3.2.4 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	40	154.1	3.85	8,11	<0,0001
Error	218	103.5	0.475		
C Total	258	257.6			

b) Estimates of parameters

Reference Mean

Estimate	Standard Error	
6.8312	0.5603	Reference: 1972, Orkney/Shetland 09/01 – 09/15

Year Effects

Year	Estimate	Standard Error	Year	Estimate	Standard Error
1973	0.3613	0.6966	1988	2.7111	0.6020
1974	-0.1457	0.7463	1989	2.6765	0.6160
1975	-1.2201	0.7584	1990	2.9212	0.6391
1976	-1.3209	0.7444	1991	2.2805	0.6925
1977	-0.4159	0.7135	1992	1.5171	0.7320
1978	-0.2218	0.7242	1993	1.2071	0.7085
1979	0.4874	0.6972	1994	0.8025	0.7467
1980	0.1070	0.6941	1995	0.9500	0.7362
1981	0.5106	0.6911	1996	1.6432	0.7754
1982	0.8521	0.6271	1997	1.8522	0.7274
1983	1.1081	0.6430	1998	2.1562	0.6836
1984	1.7054	0.6243	1999	1.9710	0.6876
1985	2.1263	0.6022	2000	1.5559	0.7028
1986	1.4676	0.6221	2001	2.6772	0.7156
1987	2.0195	0.6139	2002	2.5021	0.6946

Sampling Unit Effects

Sampling Unit	Estimate	Standard Error
Or/Shet 16-30 Sep	-0.6466	0.3316
Buchan 01-15 Sep	-1.8230	0.4241
Buchan 16-30 Sep	-2.5486	0.3670
CNS 01-15 Sep	-1.6544	0.4105
CNS 16-30 Sep	-1.4824	0.3664
CNS 01-15 Oct	-2.0769	0.3908
CNS 16-31 Oct	-4.1685	0.5339
SNS 12-31 Dec	-1.8602	0.3946
SNS 01-15 Jan	-2.5536	0.3402
SNS 16-31 Jan	-3.6870	0.3840

Table 2.3.2.5 updated MLAI time-series obtained from a multiplicative model

Reference: **6,83116** (Orkney/Shetland, 1st-15th September 1972)

Year	MLAI	MLAI plus	eMLAI	div 100
1973	0,3613	7,1925	1329,4	13,3
1974	-0,1457	6,6854	800,7	8,0
1975	-1,2201	5,6110	273,4	2,7
1976	-1,3209	5,5102	247,2	2,5
1977	-0,4159	6,4153	611,1	6,1
1978	-0,2218	6,6094	742,0	7,4
1979	0,4874	7,3186	1508,0	15,1
1980	0,1070	6,9382	1030,9	10,3
1981	0,5106	7,3418	1543,5	15,4
1982	0,8521	7,6833	2171,7	21,7
1983	1,1081	7,9393	2805,3	28,1
1984	1,7054	8,5366	5097,9	51,0
1985	2,1263	8,9575	7765,8	77,7
1986	1,4676	8,2987	4018,7	40,2
1987	2,0195	8,8507	6979,1	69,8
1988	2,7111	9,5423	13936,8	139,4
1989	2,6765	9,5077	13462,7	134,6
1990	2,9212	9,7524	17194,6	171,9
1991	2,2805	9,1117	9060,7	90,6
1992	1,5171	8,3483	4222,8	42,2
1993	1,2071	8,0382	3097,1	31,0
1994	0,8025	7,6336	2066,5	20,7
1995	0,9500	7,7812	2395,0	24,0
1996	1,6432	8,4744	4790,3	47,9
1997	1,8522	8,6834	5904,0	59,0
1998	2,1562	8,9873	8000,9	80,0
1999	1,9710	8,8022	6648,7	66,5
2000	1,5559	8,3871	4389,9	43,9
2001	2,6772	9,5084	13472,3	134,7
2002	2,5021	9,3332	11307,6	113,1

Table 2.3.3.1 North Sea herring. Indices of 2-5+ ringers from the 1st quarter IBTS

	2 wr	3 wr	4 wr	5+ wr
1983	137.4	46.4	15.3	28.5
1984	169.9	67.0	30.0	10.8
1985	748.1	301.5	47.6	31.2
1986	820.1	288.9	84.1	28.5
1987	946.3	124.0	63.2	53.6
1988	4725.8	915.0	65.4	28.0
1989	933.9	401.2	111.8	10.5
1990	482.1	312.9	292.7	77.1
1991	821.0	288.4	258.7	174.3
1992	410.1	195.1	68.5	109.4
1993	840.8	225.1	46.9	68.6
1994	1176.5	214.4	68.4	43.0
1995	1263.1	251.0	33.2	6.2
1996	209.0	46.6	13.5	9.1
1997	526.6	204.1	42.8	24.3
1998	799.7	96.4	22.0	20.7
1999	456.8	547.8	109	40.3
2000	232.2	169.3	65.5	9.7
2001	1228.1	337.0	106.8	79.0
2002	666.2	323.9	22.8	19.2
2003	1597.7	452.7	354.8	51.5

Table 2.3.3.2 North Sea herring. Estimates of mean number per hour per statistical rectangle from 1st quarter IBTS 2002. Means for age groups in "Roundfish areas" (*) and in all areas. In the index 2-5+ for all areas, the findings in RF8 and RF9 are not included.

Area	Total	Mean per statistical rectangle				
		Age group (wr)				
		1	2	3	4	5+
All areas	5383.3	2926.5	1597.7	452.7	354.8	51.5
RF1	4911.4	17.3	1851.8	1454.3	1416.7	171.3
RF2	2482.7	170.2	2028.4	238.7	34.9	10.4
RF3	168.3	93.9	40.2	21.8	10.6	1.9
RF4	3421.0	73.6	3004.4	323.6	17.9	1.5
RF5	1013.2	191.1	698.7	122.9	0.0	0.4
RF6	6120.4	3258.6	2683.4	178.3	0.0	0.0
RF7	3197.5	2739.2	453.3	5.0	0.0	0.0
RF8	8218.9	7758.1	450.8	6.6	2.7	0.8
RF9	67541.8	57345.5	10011.9	152.6	31.8	0.0

(*) Roundfish areas are shown in the IBTS Manual (Add. ICES CM 2002/D:03)

Table 2.3.3.3 North Sea herring. Indices of 1-ringers, estimation of the small sized component (Downs herring). "North Sea" = total area of sampling minus IIIa.

Year class	Year of sampling	All 1-ringers (no/hour)	Small<13cm 1-ringers in total area (no/hour)	Proportion of small in total area vs. all sizes	Small<13cm 1-ringers in North Sea (no/hour)	Proportion of small in North Sea vs. all sizes	Proportion of small in IIIa vs small in total area
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	1469	330.25	0.23	278.5	0.19	0.21
1983	1985	2082	295.46	0.14	276.2	0.13	0.13
1984	1986	2593	585.93	0.23	372.45	0.15	0.41
1985	1987	3734	640.27	0.17	526.85	0.14	0.23
1986	1988	4470	2365.73	0.52	697.49	0.15	0.72
1987	1989	2187	548.79	0.24	488.36	0.21	0.17
1988	1990	1025	69.01	0.07	60.07	0.06	0.19
1989	1991	1180	299.97	0.26	305.38	0.26	0.05
1990	1992	1204	120.9	0.10	125.44	0.11	0.03
1991	1993	2989	754.89	0.26	163.09	0.06	0.8
1992	1994	1644	266.99	0.16	224.91	0.13	0.21
1993	1995	1215	386.34	0.33	379.98	0.32	0.08
1994	1996	1728	537.1	0.31	408.92	0.24	0.29
1995	1997	3993	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	3639	1062.18	0.29	936.11	0.26	0.18
1999	2001	2696	322.57	0.12	302.19	0.11	0.06
2000	2002	3948	1510.9	0.38	1427.64	0.36	0.12
2001	2003	**2926**	708.4	0.24	201.6	0.07	0.73

Table 2.3.3.4 North Sea herring**.** 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	Northea st	Central west	Central east	South west	Southea st	Division IIIa	South Bight	0-ringers abundance
Area m^2 x 10^9	83	34	86	102	37	93	31	31	no. in 10^9
Year class									
1976	0.054	0.014	0.122	0.005	0.008	0.002	0.002	0.016	17.1
1977	0.024	0.024	0.050	0.015	0.056	0.013	0.006	0.034	13.1
1978	0.176	0.031	0.061	0.020	0.010	0.005	0.074	0.000	52.1
1979	0.061	0.195	0.262	0.408	0.226	0.143	0.099	0.053	101.1
1980	0.052	0.001	0.145	0.115	0.089	0.339	0.248	0.187	76.7
1981	0.197	0.000	0.289	0.199	0.215	0.645	0.109	0.036	133.9
1982	0.025	0.011	0.068	0.248	0.290	0.309	0.470	0.140	91.8
1983	0.019	0.007	0.114	0.268	0.271	0.473	0.339	0.377	115.0
1984	0.083	0.019	0.303	0.259	0.996	0.718	0.277	0.298	181.3
1985	0.116	0.057	0.421	0.344	0.464	0.777	0.085	0.084	177.4
1986	0.317	0.029	0.730	0.557	0.830	0.933	0.048	0.244	270.9
1987	0.078	0.031	0.417	0.314	0.159	0.618	0.483	0.495	168.9
1988	0.036	0.020	0.095	0.096	0.151	0.411	0.181	0.016	71.4
1989	0.083	0.030	0.040	0.094	0.013	0.035	0.041	0.000	25.9
1990	0.075	0.053	0.202	0.158	0.121	0.198	0.086	0.196	69.9
1991	0.255	0.390	0.431	0.539	0.500	0.369	0.298	0.395	200.7
1992	0.168	0.039	0.672	0.444	0.734	0.268	0.345	0.285	190.1
1993	0.358	0.212	0.260	0.187	0.120	0.119	0.223	0.028	101.7
1994	0.148	0.024	0.417	0.381	0.332	0.148	0.252	0.169	126.9
1995	0.260	0.086	0.699	0.092	0.266	0.018	0.001	0.020	106.2
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
2000	0.284	0.011	1.052	0.197	1.156	0.376	0.063	0.006	214.8
2001	0.080	0.019	0.566	0.473	0.567	0.247	0.209	0.226	161.8
2002	0.141	0.040	0.287	0.028	0.121	0.045	0.003	0.157	54.4

Table 2.4.1.1: Herring in the North Sea: Mean weight at age in the third quarter, in Division IVa and IVb and IIIa

Ring	Mean weights at age (g)																			
	Third quarter mean weights in catch (Divisions IVa and IVb)										July acoustic Survey									
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	53	55	52	10	38	42	62	54	75	50	69	60	58	45	45	52	52	46	50	45
2	145	131	151	126	125	132	130	126	134	140	115	138	132	119	120	109	118	118	127	138
3	161	164	190	165	157	172	164	169	163	177	147	209	180	196	168	198	171	180	162	172
4	179	192	221	203	198	208	193	198	194	200	202	220	200	253	233	238	207	218	204	194
5	199	218	231	219	232	240	229	225	212	224	225	251	195	262	256	275	236	232	228	224
6	221	245	277	240	243	262	251	237	238	244	277	289	228	299	245	307	267	261	237	247
7	239	258	276	258	236	270	262	265	241	252	286	315	257	306	265	289	272	295	255	261
8	240	277	316	259	236	288	276	274	214	281	305	323	302	325	269	308	230	300	286	280
9+	283	292	316	281	302	315	292	271	298	298	340	346	324	335	329	363	260	280	294	249

Weights at age in the catch for 1999 to 2002 were revised to include North Sea herring in IIIa which compares better with the area covered by the acoustic survey. Mean weights at age in earlier years cannot be revised as data by separate areas is not available in the catch archive.

Table 2.4.2.1 Maturity at 2, 3 and 4+ ring for Autumn-spawning herring in the North Sea. The values are derived from the acoustic survey.

Year \ 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	64.0	94.2	100
1998	64.0	89.0	100
1999	81.0	91.0	100
2000	66.0	96.0	100
2001	77.0	92.0	100
2002	86.0	97.0	100

Table 2.6.1.1 North Sea Herring. Years of duration of survey and years used in the assessment

Survey	Years survey has been running	Years used in assessment
MLAI (Larvae survey) SSB	1972-2002	1973-2002
IBTS 1st Quarter (Trawl survey) 1wr 2-5wr	 1971-2003 1971-2003	 1979-2003 1983-2003
IBTS 3rd Quarter (Trawl survey)	1991-2002	------------
Acoustic (+trawl) 2-9+ 1wr	 1984-2002 1995-2002	 1989-2002 1997-2002

Table 2.6.1.2 North Sea Herring within-survey consistency, correlation coefficients(r) and number of observations (n)

	Acoustic		**IBTS 1Q**		**IBTS 3Q**	
Rings	R	N	r	N	r	N
0-1			0.82	20	0.39	9
1-2	0.90	12	0.69	19	0.24	8
2-3	0.62	11	0.23	18	0.42	7
3-4	0.83	10	0.30	17	0.51	6
4-5	0.88	9	0.49	16	0.56	5
5-6	0.85	8				
6-7	0.88	7				
7-8	0.73	6				

Table 2.6.1.3 North Sea Herring between-survey consistency, correlation coefficients (r) and number of observations (n)

	IBTS 1/3		**IBTS1 Acoustic**		**IBTS 3 Acoustic**	
Rings	R	N	r	N	R	N
0	0.70	10				
1	0.30	10	0.65	13	0.57	9
2	0.37	10	0.25	13	-0.34	9
3	0.12	10	0.24	13	-0.45	9
4	0.40	10	0.43	13	0.88	9
5	0.51	10	0.71	13	0.29	9

Table 2.6.1.4 North Sea Herring consistency between survey indices and stock abundance, correlation coefficients (r) and number of observations (N)

Rings	MLAI		Acoustic		IBTS 1Q		IBTS 3Q	
	r	N	r	N	r	N	r	N
0					0.85	24*	0.70	10
1			0.85	13	0.95	20	0.36	10
2			0.78	13	0.62	20	0.44	10
3			0.85	13	0.65	20	-0.12	10
4			0.85	13	0.73	20	0.06	10
5			0.95	13	0.61	20	0.29	10
6			0.93	13				
7			0.86	13				
8			0.66	13				
SSB	0.94	29						

* MIK survey index

Table 2.6.1.5 North Sea Herring variance of the natural logarithm of age-disaggregated indices

Rings	MLAI	Acoustic	IBTS 1Q	IBTS 3Q
0			0.014*	0.122
1			0.037	0.171
2		0.033	0.089	0.076
3		0.013	0.137	0.082
4		0.018	0.147	0.095
5		0.026	0.180	0.094
6		0.028		
7		0.032		
8		0.050		
9		0.050		
SSB	0.038			

* MIK survey index

Table 2.6.1.6 North Sea Herring coefficient of variation of the un-transformed age-disaggregated indices

Rings	MLAI	Acoustic	IBTS 1Q	IBTS 3Q
0			0.11*	0.33
1		.12	0.20	0.36
2		.12	0.27	0.26
3		.15	0.34	0.27
4		.18	0.35	0.28
5		.18	0.39	0.28
6		.20		
7		.24		
8		.24		
9		.28		
SSB	0.18			

* MIK survey index

Table 2.6.1.7 North Sea Herring. Comparison of structurally derived weights with inverse variance weights used in 2002 assessment.

	Weights from Structural Differences				Weights from index Inverse sampling Variance			
Rings	Mlai	Acoustic	IBTS 1-5	MIK	Mlai	Acoustic	IBTS 1-5	MIK
0				0.165				2.050
1			0.384				0.674	
2		0.345	0.073			0.746	0.241	
3		0.377	0.085			0.639	0.063	
4		0.363	0.122			0.274	0.031	
5		0.579	0.074			0.140	0.027	
6		0.516				0.133		
7		0.380				0.115		
8		0.174				0.074		
9		0.062				0.075		
SSB	0.180				0.645			

Table 2.6.1.8 North Sea Herring Model settings for XSA with low shrinkage of F. Age= ringer.

```
CPUE data from file fleet.txt
Catch data for  43 years. 1960 to 2002. Ages  0 to   9.

     Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
Acoustic survey 2-8 ,   1989, 2002,   1,     8,   .540,   .560
IBTS: 1-4 wr        ,   1979, 2002,   1,     4,   .080,   .170
MIK 0-wr            ,   1977, 2002,   0,     0,   .080,   .170

Time-series weights :
     Tapered time weighting not applied

Catchability analysis :
     Catchability dependent on stock size for ages <    2
        Regression type = C
        Minimum of   5 points used for regression
        Survivor estimates shrunk to the population mean for ages <  2
     Catchability independent of age for ages >=    4

Terminal population estimation :
     Survivor estimates shrunk towards the mean F
     of the final   5 years or the   1 oldest ages.
     S.E. of the mean to which the estimates  are shrunk =   2.000
     Minimum standard error for population
     estimates derived from each fleet =    .300
     Prior weighting not applied

Tuning converged after   24 iterations
```

Table 2.6.1.9 North Sea Herring **EXPLORATORY** stock summary results from **XSA Model** with low shrinkage. Model settings given in Table 2.6.1.8.

```
    Run title : Autumn-spawning herring in IV, V 3/14/2003 14:32
        Table 16    Summary     (without SOP correction)
                   Terminal Fs derived using XSA (With F shrinkage)
```

	RECRUITS,	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 2-6,
0 Units,	(Thousands), 0-ring	(Tonnes),	(Tonnes),	(Tonnes),		
1960,	12255914,	4582571,	2633146,	696200,	.2644,	.2575,
1961,	110236976,	5118709,	2345005,	696700,	.2971,	.3459,
1962,	46997728,	4962379,	1617116,	627800,	.3882,	.4058,
1963,	49158444,	5205647,	2690566,	716000,	.2661,	.2085,
1964,	64750076,	5276343,	2422004,	871200,	.3597,	.3376,
1965,	35940912,	4715112,	1742672,	1168800,	.6707,	.7056,
1966,	28998078,	3464784,	1377209,	895500,	.6502,	.6187,
1967,	41614944,	2868202,	920454,	695500,	.7556,	.7952,
1968,	40151736,	2600217,	424888,	717800,	1.6894,	1.3351,
1969,	22286846,	1963269,	436831,	546700,	1.2515,	1.0724,
1970,	43373468,	1994515,	386554,	563100,	1.4567,	1.0335,
1971,	34064624,	1938940,	281169,	520100,	1.8498,	1.3074,
1972,	22208846,	1624553,	303170,	497500,	1.6410,	.6796,
1973,	10620503,	1204752,	240758,	484000,	2.0103,	1.1228,
1974,	23327802,	958464,	169192,	275100,	1.6260,	1.0179,
1975,	3048237,	723009,	87749,	312800,	3.5647,	1.3465,
1976,	2824165,	380273,	87453,	174800,	1.9988,	1.2494,
1977,	4557533,	227632,	57846,	46000,	.7952,	.6199,
1978,	4678671,	242717,	76386,	11000,	.1440,	.0374,
1979,	10825311,	399775,	118285,	25100,	.2122,	.0580,
1980,	17208216,	654127,	142563,	70764,	.4964,	.2674,
1981,	39541972,	1204781,	207745,	174879,	.8418,	.3290,
1982,	67375768,	1907317,	292195,	275079,	.9414,	.2583,
1983,	64436720,	2808639,	447054,	387202,	.8661,	.3267,
1984,	55765160,	2946381,	695412,	428631,	.6164,	.4488,
1985,	83173752,	3562501,	721410,	613780,	.8508,	.6299,
1986,	101336064,	3569513,	699245,	671488,	.9603,	.5590,
1987,	90116088,	4060535,	924557,	792058,	.8567,	.5391,
1988,	44316024,	3693008,	1228789,	887686,	.7224,	.5120,
1989,	40567180,	3404546,	1284537,	787899,	.6134,	.5220,
1990,	36744328,	3062672,	1229225,	645229,	.5249,	.4258,
1991,	35354448,	2794483,	1017819,	658008,	.6465,	.4832,
1992,	66379708,	2533864,	735508,	716799,	.9746,	.5669,
1993,	53683552,	2650750,	498488,	671397,	1.3469,	.6824,
1994,	34332484,	2147763,	565332,	568234,	1.0051,	.6781,
1995,	44303060,	1957652,	517712,	639146,	1.2346,	.7704,
1996,	51060708,	1650240,	481117,	276923,	.5756,	.3956,
1997,	27461790,	1954284,	557823,	265424,	.4758,	.3914,
1998,	22999024,	2025065,	733579,	394308,	.5375,	.4629,
1999,	74160360,	2272600,	845506,	368346,	.4357,	.3893,
2000,	40392260,	2867771,	793484,	389457,	.4908,	.4149,
2001,	76928744,	3130902,	1266850,	364953,	.2881,	.3235,
2002,	52413548,	3860208,	1573247,	370941,	.2358,	.2604,
Arith. Mean ,	42603999,	2585383,	834364,	510705,	.8937,	.5859,

Results of Exploratory XSA Assessment.

Table 2.6.2.1 North Sea Autumn-spawning herring. Final model fit ICA log. Note age=ringer.

```
                         Integrated Catch-at-age Analysis
                           Version 1.4 w K.R.Patterson
Enter the name of the index file -->index.txt    canum.txt  weca.txt
 Stock weights in 2003  used for the year 2002    west.txt
 Natural mortality in 2003  used for the year 2002   natmor.txt
 Maturity ogive in 2003  used for the year 2002    matprop.txt
Name of age-structured index file (Enter if none) : -->fleet.txt
 Name of the SSB index file (Enter if none) -->ssb.txt
 No of years for separable constraint ?--> 5
 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 0-->    0.10     Weight for age 1-->    0.10
 Weight for age 2-->    3.17     Weight for age 3-->    2.65
 Weight for age 4-->    1.94     Weight for age 5-->    1.31
 Weight for age 6-->    0.97     Weight for age 7-->    0.75
 Weight for age 8-->    0.55     Weight for age 9-->    0.54
Enter relative weights by year
 Weight for year 1998-->    1.     Weight for year 1999-->    1.
 Weight for year 2000-->    1.     Weight for year 2001-->    1.
 Weight for year 2002-->    1.
Enter new weights for specified years and ages if needed
 Enter year, age, new weight or -1,-1,-1 to end.  -1 -1   -1.
 Is the last age of Acoustic survey 2-9+ wr a plus-group (Y/N) ?-->y
 Is the last age of IBTS: 1-5+ wr a plus-group (Y/N) ?-->y
 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 IBTS: 1-5+ 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--> 0.05        Enter highest feasible F--> 2.000
Mapping the F-dimension of the SSQ surface
                                 F             SSQ
                          +--------+------------------
                            0.05        94.6564165368
                            0.15        27.9925349330
                            0.26        19.6464622765
                            0.36        19.7469589148
                            0.46        21.7018511151
                            0.56        24.1780855894
                            0.67        26.8244056237
                            0.77        29.5406393262
                            0.87        32.3204615962
                            0.97        35.2380060528
                            1.08        38.1914448213
                            1.18        40.4589128197
```

Table 2.6.2.1 cont. North Sea Autumn-spawning herring.

```
                              1.28        42.6653280095
                              1.38        44.8204252433
                              1.49        46.9355960792
                              1.59        49.0242816945
                              1.69        51.1031894614
                              1.79        53.1952153284
                              1.90        55.2420276692
                              2.00        56.9722115453
                           Lowest SSQ is for F =     0.297
             -----------------------------------------------------------------
No of years for separable analysis : 5
Age range in the analysis : 0  . . . 9
Year range in the analysis : 1960  . . . 2002
Number of indices of SSB : 1
Number of age-structured indices : 3
Stock-recruit relationship to be fitted.
Parameters to estimate : 45
Number of observations : 371
Conventional single selection vector model to be fitted.
-----------------------------------------------------------------
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->m
 Enter weight for   MLAI-->    0.650000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 1-->    0.740
 Enter weight for Acoustic survey 2-9+ wr  at age 2-->    0.750
 Enter weight for Acoustic survey 2-9+ wr  at age 3-->    0.640
 Enter weight for Acoustic survey 2-9+ wr  at age 4-->    0.270
 Enter weight for Acoustic survey 2-9+ wr  at age 5-->    0.140
 Enter weight for Acoustic survey 2-9+ wr  at age 6-->    0.130
 Enter weight for Acoustic survey 2-9+ wr  at age 7-->    0.120
 Enter weight for Acoustic survey 2-9+ wr  at age 8-->   7.007E-02
 Enter weight for Acoustic survey 2-9+ wr  at age 9-->   7.007E-02
 Enter weight for IBTS: 1-5+ wr  at age 1-->    0.670
 Enter weight for IBTS: 1-5+ wr  at age 2-->    0.240
 Enter weight for IBTS: 1-5+ wr  at age 3-->   5.9999999999999998E-02
 Enter weight for IBTS: 1-5+ wr  at age 4-->   2.9999999999999999E-02
 Enter weight for IBTS: 1-5+ wr  at age 5-->   2.9999999999999999E-02
 Enter weight for MIK 0-wr  at age 0-->    2.050
 Enter weight for stock-recruit model-->    0.10
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-->  0.0E+00
  Enter value for IBTS: 1-5+ wr-->  0.0E+00
  Enter value for MIK 0-wr-->  0.0E+00
 Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.
SSB index weights    0.650
Aged index weights
Acoustic survey 2-9+ wr
 Age   :       1     2     3     4     5     6     7     8     9
 Wts :     0.740 0.750 0.640 0.270 0.140 0.130 0.120 0.070 0.070
IBTS: 1-5+ wr
 Age   :       1     2     3     4     5
 Wts :     0.670 0.240 0.060 0.030 0.030
MIK 0-wr
 Age   :       0   Wts :     2.050   Stock-recruit weight 0.100

F in 2002  at age 4  is 0.261694  in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->D
Output page width in characters (e.g. 80..132) ?--> 80

Estimate historical assessment uncertainty ?-->n

Succesful exit from ICA
```

Table 2.6.2.2 North Sea Autumn-spawning herring. Final model fit ICA output. Note age=ringer.

Output Generated by ICA Version 1.4

Catch in Number x 10 ^ 6

AGE	1960	1961	1962	1963	1964	1965	1966	1967
0	195.	1269.	142.	443.	497.	157.	375.	645.
1	2393.	336.	2147.	1262.	2972.	3209.	1383.	1674.
2	1142.	1889.	270.	2961.	1548.	2218.	2570.	1172.
3	1967.	480.	797.	177.	2243.	1325.	741.	1365.
4	166.	1456.	335.	158.	148.	2039.	450.	372.
5	168.	124.	1082.	81.	149.	145.	890.	298.
6	113.	158.	127.	230.	95.	152.	45.	393.
7	126.	61.	145.	22.	256.	118.	65.	68.
8	129.	56.	86.	42.	26.	413.	96.	82.
9	142.	88.	87.	51.	58.	78.	236.	173.

AGE	1968	1969	1970	1971	1972	1973	1974	1975
0	839.	112.	898.	684.	750.	289.	996.	264.
1	2425.	2503.	1196.	4379.	3341.	2368.	846.	2461.
2	1795.	1883.	2003.	1147.	1441.	1344.	773.	542.
3	1494.	296.	884.	663.	344.	659.	362.	260.
4	621.	133.	125.	208.	131.	150.	126.	141.
5	157.	191.	50.	27.	33.	59.	56.	57.
6	145.	50.	61.	31.	5.	31.	22.	16.
7	163.	43.	8.	27.	0.	4.	5.	9.
8	14.	27.	12.	0.	1.	1.	2.	3.
9	92.	25.	12.	12.	0.	1.	1.	1.

AGE	1976	1977	1978	1979	1980	1981	1982	1983
0	238.	257.	130.	542.	1263.	9520.	11957.	13297.
1	127.	144.	169.	159.	245.	872.	1116.	2449.
2	902.	45.	5.	34.	134.	284.	299.	574.
3	117.	186.	6.	10.	92.	57.	230.	216.
4	52.	11.	5.	10.	32.	40.	34.	105.
5	35.	7.	0.	2.	22.	29.	14.	26.
6	6.	4.	0.	0.	2.	23.	7.	23.
7	4.	2.	0.	1.	1.	19.	8.	13.
8	1.	1.	0.	1.	0.	6.	4.	11.
9	0.	0.	0.	0.	0.	1.	1.	12.

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

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	10331.	10265.	4499.	8426.	2311.	431.	260.	1564.
1	2303.	3827.	1785.	1635.	1606.	480.	994.	322.
2	1285.	1176.	1783.	1573.	650.	694.	1236.	631.
3	443.	609.	489.	898.	530.	448.	540.	1072.
4	362.	306.	348.	242.	172.	285.	277.	297.
5	361.	216.	109.	121.	58.	109.	176.	137.
6	376.	226.	92.	55.	23.	31.	89.	70.
7	152.	188.	76.	41.	9.	12.	15.	27.
8	39.	87.	70.	54.	17.	19.	17.	10.
9	23.	42.	47.	72.	4.	6.	4.	2.

Table 2.6.2.2 cont. North Sea Herring.

Catch in Number cont.

AGE	2000	2001	2002
0	1109.	1833.	730.
1	1178.	621.	835.
2	626.	817.	553.
3	464.	480.	903.
4	642.	274.	284.
5	215.	312.	133.
6	83.	89.	161.
7	36.	38.	46.
8	16.	17.	33.
9	2.	2.	7.

x 10 ^ 6

Predicted Catch in Number

AGE	1998	1999	2000	2001	2002
0	585.4	1422.4	833.7	1202.8	737.8
1	603.6	529.4	1408.0	614.8	1067.3
2	1207.3	551.8	533.1	1077.1	575.8
3	571.3	1022.3	520.2	390.2	991.0
4	296.0	317.2	639.2	254.9	246.8
5	158.6	155.5	188.4	298.5	154.9
6	73.9	79.3	88.1	84.0	174.0
7	17.6	31.1	37.7	32.7	40.7
8	15.9	10.1	20.1	19.2	21.4

x 10 ^ 6

Weights-at-age in the catches (Kg)

AGE	1960 to 1980		1981	1982	1983
0	0.01500	0.01500	0.00700	0.01000	0.01000
1	0.05000	0.05000	0.04900	0.05900	0.05900
2	0.12600	0.12600	0.11800	0.11800	0.11800
3	0.17600	0.17600	0.14200	0.14900	0.14900
4	0.21100	0.21100	0.18900	0.17900	0.17900
5	0.24300	0.24300	0.21100	0.21700	0.21700
6	0.25100	0.25100	0.22200	0.23800	0.23800
7	0.26700	0.26700	0.26700	0.26500	0.26500
8	0.27100	0.27100	0.27100	0.27400	0.27400
9	0.27100	0.27100	0.27100	0.27500	0.27500

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

Table 2.6.2.2 cont. North Sea Herring.

Weights-at-age in the catches cont. (Kg)

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	0.01000	0.01000	0.00600	0.00900	0.01500	0.01500	0.02100	0.00900
1	0.05300	0.03300	0.05600	0.04800	0.01800	0.04400	0.05100	0.04600
2	0.10200	0.11500	0.13000	0.13600	0.11200	0.10800	0.11300	0.11500
3	0.17500	0.14500	0.15900	0.16700	0.15600	0.14800	0.14500	0.15100
4	0.18900	0.18900	0.18100	0.19600	0.18800	0.19500	0.18300	0.17100
5	0.20700	0.20400	0.21400	0.20000	0.20400	0.22700	0.21900	0.20600
6	0.22300	0.22800	0.24000	0.24700	0.21200	0.22600	0.23800	0.23200
7	0.23700	0.24400	0.25500	0.24900	0.26100	0.23500	0.24700	0.24500
8	0.24900	0.25600	0.27300	0.27800	0.27900	0.24400	0.28900	0.26100
9	0.28700	0.31000	0.28100	0.28700	0.28800	0.29100	0.28300	0.30100

AGE	2000	2001	2002
0	0.01500	0.01200	0.01200
1	0.03300	0.04800	0.03700
2	0.11300	0.11700	0.11600
3	0.15600	0.14900	0.15100
4	0.18000	0.17700	0.16900
5	0.20200	0.19700	0.19800
6	0.21600	0.21200	0.21400
7	0.24600	0.23700	0.22800
8	0.27600	0.26700	0.25000
9	0.26200	0.28600	0.25300

Weights-at-age in the stock (Kg)

AGE	1960 to 1980		1981	1982	1983
0	0.01500	0.01500	0.01500	0.01500	0.01700
1	0.05000	0.05000	0.05000	0.05000	0.05700
2	0.15500	0.15500	0.15500	0.15500	0.15000
3	0.18700	0.18700	0.18700	0.18700	0.19000
4	0.22300	0.22300	0.22300	0.22300	0.23000
5	0.23900	0.23900	0.23900	0.23900	0.24300
6	0.27600	0.27600	0.27600	0.27600	0.28200
7	0.29900	0.29900	0.29900	0.29900	0.31100
8	0.30600	0.30600	0.30600	0.30600	0.33800
9	0.31200	0.31200	0.31200	0.31200	0.34700

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	0.01600	0.01400	0.00900	0.00800	0.00800	0.01200	0.01100	0.01000
1	0.05600	0.06100	0.05000	0.04800	0.04400	0.05200	0.05900	0.06400
2	0.13800	0.13000	0.12200	0.12300	0.12200	0.12600	0.13900	0.13700
3	0.18700	0.18300	0.17000	0.16600	0.16500	0.17400	0.18400	0.19400
4	0.23200	0.23200	0.21200	0.20800	0.20500	0.21200	0.21200	0.21400
5	0.24700	0.25200	0.23000	0.22900	0.22800	0.24400	0.23900	0.23400
6	0.27500	0.27300	0.24200	0.24800	0.25200	0.27000	0.26500	0.25300
7	0.32100	0.31500	0.27500	0.25900	0.26100	0.28400	0.28000	0.27100
8	0.34100	0.33200	0.26800	0.26300	0.27700	0.29800	0.30000	0.29100
9	0.36500	0.39200	0.34300	0.32500	0.31500	0.33100	0.32800	0.31200

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	0.00600	0.00700	0.00600	0.00600	0.00500	0.00600	0.00600	0.00600
1	0.06100	0.06000	0.05700	0.05400	0.04900	0.04700	0.05100	0.05100
2	0.13400	0.12700	0.13000	0.13000	0.12300	0.11600	0.11600	0.11600
3	0.18400	0.19200	0.18600	0.19900	0.18300	0.18700	0.17900	0.18400
4	0.21300	0.21400	0.21100	0.22800	0.23000	0.24100	0.22600	0.22100
5	0.23500	0.24000	0.22400	0.23400	0.23700	0.26400	0.25600	0.24800
6	0.26200	0.27500	0.26800	0.27400	0.25700	0.28400	0.27300	0.27900
7	0.27300	0.29100	0.29300	0.30100	0.28000	0.28700	0.27600	0.28600
8	0.30200	0.30900	0.31800	0.32400	0.30300	0.30100	0.27000	0.28100
9	0.32000	0.33800	0.34600	0.34400	0.33400	0.34200	0.31800	0.30300

Table 2.6.2.2 cont. North Sea Herring.

Weights-at-age in the stock cont. (Kg)

AGE	2000	2001	2002
0	0.00600	0.00600	0.00700
1	0.05100	0.04700	0.04800
2	0.12200	0.12800	0.13300
3	0.17200	0.17200	0.16700
4	0.21000	0.20500	0.19900
5	0.23300	0.22800	0.22600
6	0.25500	0.24800	0.24200
7	0.27500	0.27000	0.25800
8	0.27400	0.28900	0.28300
9	0.28000	0.27500	0.27200

Natural Mortality (per year)

AGE	1960	1970	1980	1990	20000
0	1.0000	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000

Proportion of fish spawning

AGE	1960	1961	1962	1963	1964	1965	1975	1983
0	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
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
AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	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
2	0.8200	0.7000	0.7500	0.8000	0.8500	0.8200	0.9100	0.8600
3	1.0000	1.0000	1.0000	1.0000	0.9300	0.9400	0.9700	0.9900
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 2.6.2.2 cont. North Sea Herring.

Proportion of fish spawning cont. Note age=ringer.

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	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
2	0.5000	0.4700	0.7300	0.6700	0.6100	0.6400	0.6400	0.6900
3	0.9900	0.6100	0.9300	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	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

AGE	2000	2001	2002
0	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000
2	0.6700	0.7700	0.8700
3	0.9600	0.9200	0.9700
4	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000

INDICES OF SPAWNING BIOMASS

MLAI

	1973	1974	1975	1976	1977	1978	1979	1980
	13.30	8.00	2.70	2.50	6.10	7.40	15.10	10.30

	1981	1982	1983	1984	1985	1986	1987	1988
	15.40	21.70	28.10	51.00	77.70	40.20	69.80	139.40

	1989	1990	1991	1992	1993	1994	1995	1996
	134.60	171.90	90.60	42.20	31.00	20.70	24.00	47.90

	1997	1998	1999	2000	2001	2002
	59.00	80.00	66.50	43.90	134.70	113.10

AGE-STRUCTURED INDICES

Acoustic survey 2-9+ wr

AGE	1989	1990	1991	1992	1993	1994	1995	1996
1	999990.	999990.	999990.	999990.	999990.	999990.	999990.	999990.
2	4090.	3306.	2634.	3734.	2984.	3185.	3849.	4497.
3	3903.	3521.	1700.	1378.	1637.	839.	2041.	2824.
4	1633.	3414.	1959.	1147.	902.	399.	672.	1087.
5	492.	1366.	1849.	1134.	741.	381.	299.	311.
6	283.	392.	644.	1246.	777.	321.	203.	99.
7	120.	210.	228.	395.	551.	326.	138.	83.
8	44.	133.	94.	114.	180.	219.	119.	133.
9	22.	43.	51.	104.	116.	131.	93.	206.

x 10 ^ 3

Table 2.6.2.2 cont. North Sea Herring.

Acoustic survey 2-9+ wr cont. Note age=ringer.

AGE	1997	1998	1999	2000	2001	2002
1	9361.	4449.	5087.	24736.	6837.	23055.
2	5960.	5747.	3078.	2923.	12290.	4875.
3	2935.	2520.	4725.	2156.	3083.	8220.
4	1441.	1625.	1116.	3140.	1462.	1390.
5	601.	982.	506.	1007.	1676.	795.
6	215.	445.	314.	483.	450.	1031.
7	46.	170.	139.	266.	170.	244.
8	78.	45.	54.	120.	98.	121.
9	159.	121.	87.	97.	59.	149.

x 10 ^ 3

IBTS: 1-5+ wr

AGE	1979	1980	1981	1982	1983	1984	1985	1986
1	156.3	342.8	517.7	799.3	1230.7	1468.9	2082.4	2593.0
2	*******	*******	*******	*******	137.4	169.9	748.1	820.1
3	*******	*******	*******	*******	46.4	67.0	301.5	288.9
4	*******	*******	*******	*******	15.3	30.0	47.6	84.1
5	*******	*******	*******	*******	28.5	10.8	31.2	28.5

AGE	1987	1988	1989	1990	1991	1992	1993	1994
1	3733.8	4469.6	2187.0	1024.6	1180.3	1204.0	2988.5	1644.3
2	946.3	4725.8	933.9	482.1	821.0	410.1	840.8	1176.5
3	124.0	915.0	401.2	312.9	288.4	195.1	225.1	214.4
4	63.2	65.4	111.8	292.7	258.7	68.5	46.9	68.4
5	53.6	28.0	10.5	77.1	174.3	109.4	68.6	43.0

AGE	1995	1996	1997	1998	1999	2000	2001	2002
1	1215.4	1728.3	3992.7	2067.1	714.8	3638.9	2496.4	3948.0
2	1263.1	209.0	526.6	799.7	456.8	232.2	1228.1	666.0
3	251.0	46.6	204.1	96.4	547.8	169.3	337.0	324.0
4	33.2	13.5	42.8	22.0	109.0	65.5	106.8	23.0
5	6.2	9.1	24.3	20.7	40.3	9.7	79.0	19.0

AGE	2003
1	2926.5
2	1597.7
3	452.7
4	354.8
5	51.5

MIK 0-wr

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

AGE	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	177.40	270.90	168.90	71.40	25.90	69.90	200.70	190.10	101.70

AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	127.00	106.50	148.10	53.10	244.00	137.10	214.80	161.80	54.40

Table 2.6.2.2 cont. North Sea Herring.

Fishing Mortality (per year)

AGE	1960	1961	1962	1963	1964	1965	1966	1967
0	0.0257	0.0186	0.0049	0.0148	0.0126	0.0071	0.0215	0.0256
1	0.2558	0.1293	0.0897	0.1241	0.3084	0.2461	0.1852	0.2980
2	0.4346	0.6169	0.2500	0.2975	0.3890	0.7753	0.5921	0.4222
3	0.3268	0.3505	0.6265	0.2753	0.4123	0.7389	0.7082	0.8045
4	0.3364	0.4058	0.4183	0.2267	0.3699	0.7765	0.5718	0.9244
5	0.2645	0.4007	0.5286	0.1489	0.3073	0.6588	0.8342	0.8276
6	0.3096	0.3781	0.8109	0.1791	0.2345	0.5185	0.3892	1.0088
7	0.5947	0.2462	0.6268	0.2809	0.2765	0.4477	0.3867	1.5198
8	0.5585	0.5108	0.5664	0.3278	0.5446	0.8319	0.7048	1.0599
9	0.5585	0.5108	0.5664	0.3278	0.5446	0.8319	0.7048	1.0599

AGE	1968	1969	1970	1971	1972	1973	1974	1975
0	0.0348	0.0082	0.0351	0.0340	0.0583	0.0462	0.0749	0.1569
1	0.3002	0.3291	0.2680	0.6021	0.5782	0.6739	0.4517	0.6877
2	1.3271	0.7844	0.9728	0.8825	0.8121	1.0221	1.0284	1.3116
3	1.8719	0.9122	1.2668	1.2147	0.8013	1.3336	0.9729	1.5032
4	1.0714	0.8739	1.3295	1.2261	0.7995	0.9874	0.9936	1.3729
5	1.2340	1.0538	0.8751	1.0823	0.5492	0.9511	1.1848	1.8819
6	1.1748	1.9008	1.0791	2.6054	0.5154	1.3761	1.0775	1.2710
7	1.5935	1.3000	4.1165	2.6942	0.0971	0.7989	0.7700	2.0222
8	1.5892	1.3029	1.7503	1.9270	1.0027	1.5154	1.3012	1.9921
9	1.5892	1.3029	1.7503	1.9270	1.0027	1.5154	1.3012	1.9921

AGE	1976	1977	1978	1979	1980	1981	1982	1983
0	0.1465	0.0974	0.0455	0.0837	0.1258	0.4819	0.3343	0.3995
1	0.2483	0.2967	0.1999	0.1665	0.1132	0.2855	0.2250	0.2517
2	1.3372	0.2242	0.0242	0.0946	0.3634	0.3241	0.2606	0.3021
3	1.4361	1.4040	0.0423	0.0664	0.4186	0.2751	0.5083	0.3246
4	1.7319	0.4307	0.1031	0.0933	0.2966	0.3029	0.2469	0.4365
5	1.6010	1.1870	0.0167	0.0517	0.2640	0.4116	0.1540	0.2751
6	1.0785	0.7409	0.0753	0.0125	0.0664	0.4289	0.1445	0.3437
7	1.4843	0.7522	0.0614	0.4229	0.1023	0.9482	0.2278	0.3898
8	1.6015	0.9225	0.1816	0.2351	0.3439	0.6268	0.4123	0.5071
9	1.6015	0.9225	0.1816	0.2351	0.3439	0.6268	0.4123	0.5071

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	0.2263	0.0852	0.0619	0.1624	0.1246	0.1302	0.0588	0.1173
1	0.2051	0.3827	0.3156	0.3720	0.5850	0.4305	0.4521	0.3075
2	0.3144	0.4041	0.4592	0.4059	0.3553	0.4040	0.3766	0.5728
3	0.4296	0.6711	0.5221	0.5052	0.4004	0.4094	0.3774	0.4541
4	0.5374	0.7376	0.5818	0.5884	0.5812	0.5549	0.4663	0.4726
5	0.6272	0.6644	0.5540	0.6163	0.6626	0.6551	0.4988	0.4815
6	0.3591	0.7296	0.7333	0.6357	0.6744	0.6975	0.4906	0.4760
7	0.6922	0.5553	0.8161	0.6139	0.6916	0.7065	0.6741	0.4203
8	0.6090	0.8501	0.8016	0.7859	0.9181	0.8318	0.7669	0.6938
9	0.6090	0.8501	0.8016	0.7859	0.9181	0.8318	0.7669	0.6938

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	0.2914	0.3658	0.2305	0.3563	0.0746	0.0266	0.0366	0.0326
1	0.3850	0.4115	0.2369	0.2940	0.2531	0.0448	0.1073	0.0957
2	0.5708	0.6622	0.6538	0.6351	0.3208	0.2890	0.2598	0.2315
3	0.4962	0.6369	0.7027	0.9127	0.4903	0.4093	0.4381	0.3904
4	0.5715	0.7274	0.8993	0.8889	0.4111	0.5075	0.4943	0.4405
5	0.5765	0.7084	0.5489	0.8226	0.4770	0.4402	0.5210	0.4643
6	0.7159	0.7752	0.6640	0.5291	0.3078	0.4583	0.5328	0.4748
7	0.6916	0.8626	0.5766	0.6262	0.1389	0.2342	0.4447	0.3963
8	0.8530	0.9931	0.8293	0.9213	0.5190	0.4041	0.4943	0.4405
9	0.8530	0.9931	0.8293	0.9213	0.5190	0.4041	0.4943	0.4405

Table 2.6.2.2 cont. North Sea Herring.

Fishing Mortality cont. (per year)

AGE	2000	2001	2002
0	0.0317	0.0227	0.0194
1	0.0930	0.0666	0.0568
2	0.2250	0.1611	0.1375
3	0.3795	0.2717	0.2319
4	0.4282	0.3066	0.2617
5	0.4513	0.3231	0.2758
6	0.4615	0.3304	0.2820
7	0.3852	0.2758	0.2354
8	0.4282	0.3066	0.2617
9	0.4282	0.3066	0.2617

Population Abundance (1 January) x 10 ^ 9

AGE	1960	1961	1962	1963	1964	1965	1966	1967
0	12.10	108.87	46.28	47.66	62.79	34.90	27.86	40.26
1	16.43	4.34	39.31	16.94	17.27	22.81	12.75	10.03
2	3.71	4.68	1.40	13.22	5.51	4.67	6.56	3.90
3	7.74	1.78	1.87	0.81	7.27	2.76	1.59	2.69
4	0.61	4.57	1.03	0.82	0.50	3.94	1.08	0.64
5	0.76	0.39	2.76	0.61	0.59	0.31	1.64	0.55
6	0.44	0.53	0.24	1.47	0.48	0.39	0.15	0.64
7	0.29	0.30	0.33	0.10	1.11	0.34	0.21	0.09
8	0.31	0.15	0.21	0.16	0.07	0.76	0.20	0.13
9	0.35	0.23	0.21	0.19	0.14	0.14	0.49	0.28

AGE	1968	1969	1970	1971	1972	1973	1974	1975
0	38.70	21.58	41.07	32.31	20.86	10.11	21.71	2.84
1	14.43	13.75	7.87	14.59	11.49	7.24	3.55	7.41
2	2.74	3.93	3.64	2.22	2.94	2.37	1.36	0.83
3	1.89	0.54	1.33	1.02	0.68	0.97	0.63	0.36
4	0.98	0.24	0.18	0.31	0.25	0.25	0.21	0.20
5	0.23	0.31	0.09	0.04	0.08	0.10	0.08	0.07
6	0.22	0.06	0.10	0.03	0.01	0.04	0.04	0.02
7	0.21	0.06	0.01	0.03	0.00	0.01	0.01	0.01
8	0.02	0.04	0.02	0.00	0.00	0.00	0.00	0.00
9	0.12	0.04	0.02	0.02	0.00	0.00	0.00	0.00

AGE	1976	1977	1978	1979	1980	1981	1982	1983
0	2.73	4.34	4.61	10.61	16.73	37.88	64.78	61.84
1	0.89	0.87	1.45	1.62	3.59	5.43	8.61	17.06
2	1.37	0.26	0.24	0.44	0.50	1.18	1.50	2.53
3	0.17	0.27	0.15	0.17	0.29	0.26	0.63	0.86
4	0.07	0.03	0.05	0.12	0.13	0.16	0.16	0.31
5	0.04	0.01	0.02	0.04	0.10	0.09	0.11	0.11
6	0.01	0.01	0.00	0.02	0.04	0.07	0.05	0.08
7	0.01	0.00	0.00	0.00	0.02	0.03	0.04	0.04
8	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	53.48	80.98	97.68	85.72	42.30	39.21	35.94	33.78
1	15.26	15.69	27.36	33.78	26.81	13.74	12.66	12.47
2	4.88	4.57	3.94	7.34	8.57	5.49	3.29	2.96
3	1.38	2.64	2.26	1.84	3.62	4.45	2.72	1.67
4	0.51	0.74	1.10	1.10	0.91	1.99	2.42	1.53
5	0.18	0.27	0.32	0.56	0.55	0.46	1.03	1.37
6	0.08	0.09	0.12	0.17	0.27	0.26	0.22	0.57
7	0.05	0.05	0.04	0.05	0.08	0.13	0.12	0.12
8	0.03	0.02	0.03	0.02	0.03	0.04	0.06	0.05
9	0.04	0.03	0.03	0.02	0.01	0.02	0.02	0.03

Table 2.6.2.2 cont. North Sea Herring.

Population Abundance cont. (1 January) x 10 ^ 9

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	63.15	51.46	33.93	43.21	50.54	25.96	25.68	69.92
1	11.05	17.36	13.13	9.91	11.13	17.25	9.30	9.11
2	3.37	2.77	4.23	3.81	2.72	3.18	6.07	3.07
3	1.24	1.41	1.06	1.63	1.50	1.46	1.76	3.47
4	0.87	0.62	0.61	0.43	0.54	0.75	0.79	0.93
5	0.86	0.44	0.27	0.23	0.16	0.32	0.41	0.44
6	0.77	0.44	0.20	0.14	0.09	0.09	0.19	0.22
7	0.32	0.34	0.18	0.09	0.08	0.06	0.05	0.10
8	0.07	0.14	0.13	0.09	0.04	0.06	0.04	0.03
9	0.04	0.07	0.09	0.12	0.01	0.02	0.01	0.01

AGE	2000	2001	2002	2003
0	42.14	84.60	60.71	20.04
1	24.90	15.02	30.42	21.91
2	3.05	8.35	5.17	10.57
3	1.81	1.80	5.26	3.34
4	1.92	1.01	1.12	3.42
5	0.54	1.13	0.67	0.78
6	0.25	0.31	0.74	0.46
7	0.12	0.14	0.20	0.51
8	0.06	0.08	0.10	0.15
9	0.01	0.01	0.03	0.09

Weighting factors for the catches in number

AGE	1998	1999	2000	2001	2002
0	0.1000	0.1000	0.1000	0.1000	0.1000
1	0.1000	0.1000	0.1000	0.1000	0.1000
2	3.1700	3.1700	3.1700	3.1700	3.1700
3	2.6500	2.6500	2.6500	2.6500	2.6500
4	1.9400	1.9400	1.9400	1.9400	1.9400
5	1.3100	1.3100	1.3100	1.3100	1.3100
6	0.9700	0.9700	0.9700	0.9700	0.9700
7	0.7500	0.7500	0.7500	0.7500	0.7500
8	0.5500	0.5500	0.5500	0.5500	0.5500

Predicted SSB Index Values

MLAI

	1973	1974	1975	1976	1977	1978	1979	1980
1	17.05	11.48	5.47	5.21	3.07	4.29	7.38	9.18

	1981	1982	1983	1984	1985	1986	1987	1988
1	14.16	20.74	33.42	54.45	56.23	54.49	73.96	100.47

	1989	1990	1991	1992	1993	1994	1995	1996
1	105.04	99.00	80.51	56.14	36.45	40.72	37.41	35.86

	1997	1998	1999	2000	2001	2002
1	43.84	59.23	69.30	67.45	107.18	136.47

Table 2.6.2.2 cont. North Sea Herring.

Predicted Age-Structured Index Values   Note age = ringers.

Acoustic survey 2-9+ wr Predicted x 10 ^ 3

AGE	1989	1990	1991	1992	1993	1994	1995	1996
1	999990.	999990.	999990.	999990.	999990.	999990.	999990.	999990.
2	5808.	3526.	2856.	3252.	2537.	3899.	3548.	3007.
3	5933.	3689.	2174.	1575.	1661.	1200.	1649.	1909.
4	2687.	3433.	2158.	1163.	759.	684.	482.	784.
5	635.	1551.	2081.	1238.	594.	394.	283.	242.
6	364.	343.	907.	1075.	593.	285.	219.	157.
7	163.	153.	182.	416.	403.	253.	125.	133.
8	50.	81.	80.	98.	185.	181.	123.	74.
9	57.	86.	104.	149.	225.	307.	423.	43.

AGE	1997	1998	1999	2000	2001	2002
1	10650.	5547.	5468.	14966.	9161.	18656.
2	3580.	6945.	3572.	3552.	10082.	6327.
3	1948.	2316.	4673.	2449.	2592.	7738.
4	1041.	1110.	1342.	2785.	1568.	1785.
5	499.	606.	671.	837.	1874.	1144.
6	145.	290.	351.	402.	542.	1320.
7	102.	77.	153.	191.	233.	341.
8	105.	72.	51.	106.	142.	187.
9	81.	43.	27.	33.	44.	159.

IBTS: 1-5+ wr Predicted

AGE	1979	1980	1981	1982	1983	1984	1985	1986
1	198.3	442.4	654.6	1045.9	2066.1	1858.7	1869.6	3286.9
2	*******	*******	*******	*******	385.7	743.2	688.7	589.0
3	*******	*******	*******	*******	94.1	150.1	277.7	242.3
4	*******	*******	*******	*******	20.5	33.0	46.9	71.6
5	*******	*******	*******	*******	10.6	13.2	15.7	18.4

AGE	1987	1988	1989	1990	1991	1992	1993	1994
1	4030.2	3114.7	1627.3	1496.0	1499.4	1316.3	2061.0	1593.6
2	1105.4	1298.2	827.7	496.7	437.3	497.4	403.4	617.9
3	197.9	394.3	483.5	296.6	180.6	133.2	149.1	110.7
4	71.1	59.0	129.2	159.0	100.2	56.4	39.3	38.1
5	27.9	32.3	30.6	50.3	75.0	70.6	48.2	29.7

AGE	1995	1996	1997	1998	1999	2000	2001	2002
1	1194.4	1348.1	2144.6	1146.9	1125.0	3075.8	1861.7	3775.8
2	557.9	413.7	485.9	930.9	473.0	469.1	1295.9	805.1
3	166.4	161.0	158.8	191.1	377.8	197.1	199.2	584.8
4	26.7	35.5	49.1	52.0	61.5	126.9	67.9	75.8
5	22.9	13.4	19.3	24.4	27.9	34.6	59.8	62.9

AGE	2003
1	2718.8
2	1646.8
3	370.9
4	230.4
5	71.6

Table 2.6.2.2 cont. North Sea Herring.

MIK 0-wr Predicted

AGE	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	11.67	12.47	28.57	44.82	97.07	169.08	160.10	141.50	218.05

AGE	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	263.81	228.62	113.35	105.00	97.09	90.59	165.72	133.80	89.73

AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	112.48	136.26	70.42	69.58	189.51	114.24	229.60	164.84	54.40

Fitted Selection Pattern

AGE	1960	1961	1962	1963	1964	1965	1966	1967
0	0.0765	0.0458	0.0116	0.0652	0.0340	0.0092	0.0375	0.0277
1	0.7605	0.3186	0.2144	0.5472	0.8339	0.3169	0.3240	0.3224
2	1.2919	1.5201	0.5978	1.3121	1.0516	0.9985	1.0354	0.4567
3	0.9715	0.8638	1.4978	1.2141	1.1148	0.9515	1.2387	0.8703
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.7864	0.9874	1.2638	0.6568	0.8307	0.8483	1.4590	0.8953
6	0.9204	0.9317	1.9387	0.7897	0.6340	0.6677	0.6807	1.0912
7	1.7678	0.6066	1.4984	1.2390	0.7476	0.5766	0.6763	1.6440
8	1.6603	1.2587	1.3541	1.4457	1.4724	1.0713	1.2326	1.1465
9	1.6603	1.2587	1.3541	1.4457	1.4724	1.0713	1.2326	1.1465

AGE	1968	1969	1970	1971	1972	1973	1974	1975
0	0.0325	0.0094	0.0264	0.0277	0.0729	0.0468	0.0754	0.1143
1	0.2802	0.3766	0.2016	0.4911	0.7232	0.6824	0.4546	0.5009
2	1.2387	0.8975	0.7317	0.7198	1.0158	1.0351	1.0351	0.9554
3	1.7473	1.0438	0.9529	0.9907	1.0022	1.3506	0.9792	1.0949
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.1518	1.2058	0.6582	0.8827	0.6870	0.9632	1.1924	1.3707
6	1.0965	2.1750	0.8116	2.1249	0.6446	1.3937	1.0844	0.9258
7	1.4874	1.4875	3.0962	2.1973	0.1215	0.8091	0.7750	1.4729
8	1.4833	1.4908	1.3165	1.5716	1.2542	1.5347	1.3096	1.4510
9	1.4833	1.4908	1.3165	1.5716	1.2542	1.5347	1.3096	1.4510

AGE	1976	1977	1978	1979	1980	1981	1982	1983
0	0.0846	0.2263	0.4414	0.8964	0.4240	1.5911	1.3543	0.9153
1	0.1434	0.6888	1.9391	1.7840	0.3816	0.9425	0.9114	0.5766
2	0.7721	0.5207	0.2345	1.0131	1.2254	1.0700	1.0556	0.6922
3	0.8292	3.2600	0.4107	0.7109	1.4112	0.9084	2.0589	0.7437
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.9244	2.7561	0.1622	0.5542	0.8900	1.3589	0.6237	0.6304
6	0.6227	1.7205	0.7308	0.1339	0.2239	1.4159	0.5855	0.7874
7	0.8570	1.7466	0.5954	4.5301	0.3449	3.1306	0.9227	0.8932
8	0.9247	2.1421	1.7619	2.5189	1.1597	2.0693	1.6700	1.1619
9	0.9247	2.1421	1.7619	2.5189	1.1597	2.0693	1.6700	1.1619

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	0.4210	0.1155	0.1064	0.2760	0.2144	0.2346	0.1260	0.2483
1	0.3816	0.5188	0.5424	0.6323	1.0064	0.7759	0.9695	0.6507
2	0.5851	0.5478	0.7892	0.6900	0.6112	0.7281	0.8077	1.2121
3	0.7994	0.9098	0.8974	0.8586	0.6888	0.7378	0.8093	0.9608
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.1671	0.9007	0.9521	1.0475	1.1400	1.1805	1.0696	1.0188
6	0.6682	0.9891	1.2604	1.0805	1.1603	1.2570	1.0521	1.0072
7	1.2879	0.7529	1.4027	1.0434	1.1899	1.2732	1.4456	0.8893
8	1.1331	1.1525	1.3778	1.3357	1.5795	1.4990	1.6448	1.4682
9	1.1331	1.1525	1.3778	1.3357	1.5795	1.4990	1.6448	1.4682

Table 2.6.2.2 cont. North Sea Herring.

Fitted Selection Pattern cont

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	0.5098	0.5028	0.2563	0.4008	0.1815	0.0523	0.0741	0.0741
1	0.6737	0.5657	0.2635	0.3308	0.6157	0.0883	0.2171	0.2171
2	0.9987	0.9103	0.7270	0.7145	0.7804	0.5694	0.5255	0.5255
3	0.8682	0.8755	0.7814	1.0269	1.1925	0.8065	0.8862	0.8862
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0087	0.9739	0.6104	0.9255	1.1603	0.8673	1.0539	1.0539
6	1.2527	1.0657	0.7384	0.5953	0.7487	0.9031	1.0778	1.0778
7	1.2101	1.1859	0.6412	0.7045	0.3378	0.4614	0.8995	0.8995
8	1.4925	1.3652	0.9222	1.0365	1.2625	0.7963	1.0000	1.0000
9	1.4925	1.3652	0.9222	1.0365	1.2625	0.7963	1.0000	1.0000

AGE	2000	2001	2002
0	0.0741	0.0741	0.0741
1	0.2171	0.2171	0.2171
2	0.5255	0.5255	0.5255
3	0.8862	0.8862	0.8862
4	1.0000	1.0000	1.0000
5	1.0539	1.0539	1.0539
6	1.0778	1.0778	1.0778
7	0.8995	0.8995	0.8995
8	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000

Table 2.6.2.3 North Sea Herring. STOCK SUMMARY

STOCK SUMMARY NORTH SEA HERRING

Year	recruits 0-rings Thousands	Total Biomass tonnes	Spawning Biomass tonnes	landings tonnes	yield /SSB ratio	Mean F rings 0-1	Mean F rings 2-6	Sop %
1960	12095090	3757003	1891573	696200	0.3681	0.1408	0.3344	84
1961	108865690	4370834	1668624	696700	0.4175	0.0739	0.4304	88
1962	46275430	4407116	1123869	627800	0.5586	0.0473	0.5269	85
1963	47657610	4633460	2193348	716000	0.3264	0.0694	0.2255	116
1964	62786870	4801377	2035255	871200	0.4281	0.1605	0.3426	93
1965	34895870	4348038	1453175	1168800	0.8043	0.1266	0.6936	86
1966	27859650	3319780	1283859	895500	0.6975	0.1033	0.6191	93
1967	40256960	2817982	923300	695500	0.7533	0.1618	0.7975	85
1968	38698990	2522032	413649	717800	1.7353	0.1675	1.3358	79
1969	21582500	1905730	424493	546700	1.2879	0.1687	1.1050	103
1970	41074570	1922059	374783	563100	1.5025	0.1516	1.1047	103
1971	32309390	1849625	266209	520100	1.9537	0.3181	1.4022	93
1972	20860990	1549666	288422	497500	1.7249	0.3182	0.6955	108
1973	10108530	1156216	233506	484000	2.0728	0.3600	1.1341	104
1974	21705750	912344	162139	275100	1.6967	0.2633	1.0514	103
1975	2838060	680907	81848	312800	3.8217	0.4223	1.4681	107
1976	2732070	359340	78227	174800	2.2345	0.1974	1.4370	104
1977	4340750	211393	48063	46000	0.9571	0.1971	0.7974	83
1978	4607430	226019	65487	11000	0.1680	0.1227	0.0523	82
1979	10609420	383322	107890	25100	0.2326	0.1251	0.0637	99
1980	16730750	631845	131932	70764	0.5364	0.1195	0.2818	91
1981	37879500	1160289	196690	174879	0.8891	0.3837	0.3485	99
1982	64776810	1845198	279678	275079	0.9836	0.2797	0.2629	102
1983	61838860	2721787	434195	387202	0.8918	0.3256	0.3364	92
1984	53481920	2867653	680851	428631	0.6296	0.2157	0.4536	94
1985	80975120	3465885	701259	613780	0.8753	0.2339	0.6414	95
1986	97682700	3476453	681231	671488	0.9857	0.1887	0.5701	87
1987	85723300	3936561	902862	792058	0.8773	0.2672	0.5503	98
1988	42302190	3574900	1197423	887686	0.7413	0.3548	0.5348	85
1989	39213190	3306393	1247516	787899	0.6316	0.2804	0.5442	96
1990	35936540	2973117	1181277	645229	0.5462	0.2554	0.4419	95
1991	33777960	2713594	976306	658008	0.6740	0.2124	0.4914	98
1992	63149020	2443159	700235	716799	1.0237	0.3382	0.5862	100
1993	51462950	2549822	470334	671397	1.4275	0.3886	0.7020	97
1994	33931650	2065811	520849	568234	1.0910	0.2337	0.6937	95
1995	43211630	1904369	481688	639146	1.3269	0.3251	0.7577	98
1996	50535260	1628282	463302	276923	0.5977	0.1639	0.4014	100
1997	25961040	1940865	557492	265424	0.4761	0.0357	0.4209	99
1998	25683720	2012390	735699	394308	0.5360	0.0720	0.4492	100
1999	69917400	2293214	850315	368346	0.4332	0.0641	0.4003	99
2000	42142310	2850994	829379	389457	0.4696	0.0623	0.3891	99
2001	84600490	3197866	1270958	364953	0.2871	0.0446	0.2786	100
2002	60714070	4096287	1587990	370941	0.2336	0.0381	0.2378	100
2003	20037000	4320882	2231358					

NOTE :North Sea herring (autumn spawners) are 0-ringers the year after they are spawned

---

No of years for separable analysis : 5
Age range in the analysis : 0 . . . 9 age=rings
Year range in the analysis : 1960 . . . 2002
Number of indices of SSB : 1
Number of age-structured indices : 3
Stock-recruit relationship to be fitted.
Parameters to estimate : 45
Number of observations : 371

Conventional single selection vector model to be fitted.

Table 2.6.2.4 North Sea Herring. Model fit parameter estimates, residuals and diagnostics.

PARAMETER ESTIMATES **Note age=ringer.**

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	1998		0.4943	11	0.3928	0.6221	0.4396	0.5558	0.4977
2	1999		0.4405	12	0.3468	0.5596	0.3899	0.4977	0.4438
3	2000		0.4282	12	0.3322	0.5520	0.3762	0.4874	0.4318
4	2001		0.3066	13	0.2345	0.4008	0.2674	0.3515	0.3095
5	2002		0.2617	14	0.1981	0.3458	0.2270	0.3017	0.2644
Separable Model: Selection (S) by age									
6	0		0.0741	38	0.0345	0.1590	0.0502	0.1093	0.0799
7	1		0.2171	36	0.1053	0.4476	0.1501	0.3141	0.2325
8	2		0.5255	11	0.4175	0.6614	0.4673	0.5909	0.5291
9	3		0.8862	11	0.7073	1.1103	0.7899	0.9942	0.8921
	4		1.0000	Fixed : Reference Age					
10	5		1.0539	13	0.8163	1.3608	0.9251	1.2007	1.0629
11	6		1.0778	14	0.8124	1.4298	0.9330	1.2450	1.0890
12	7		0.8995	17	0.6416	1.2612	0.7571	1.0688	0.9130
	8		1.0000	Fixed : Last true age					
Separable model: Populations in year 2002									
13	0		60714071	16	44324860	83163226	51709943	71286066	61501384
14	1		30424070	14	23115762	40042982	26445107	35001713	30724393
15	2		5169442	11	4139037	6456365	4615155	5790299	5202799
16	3		5262467	10	4296984	6444884	4745460	5835801	5290681
17	4		1123987	10	908631	1390385	1008398	1252826	1130625
18	5		673781	12	528852	858427	595461	762403	678945
19	6		742131	13	567206	971001	647022	851219	749143
20	7		203406	17	145061	285217	171182	241695	206454
21	8		97667	20	64911	146951	79291	120301	99812
Separable model: Populations at age									
22	1998		42594	35	21421	84696	29995	60486	45296
23	1999		29708	26	17714	49825	22819	38677	30760
24	2000		60559	23	38399	95506	47999	76405	62217
25	2001		76102	21	49513	116968	61115	94762	77954
Recruitment in year 2003									
26	2002		20036656	19	13784859	29123809	16556038	24249014	20404758
SSB Index catchabilities									
MLAI									
Power model fitted. Slopes (Q) and exponents (K) at age									
27	1	Q	2.959	17	2.247	4.418	2.652	3.744	3.198
28	1	K	.2557E-04	17	.4109E-04	.8077E-04	.4848E-04	.6845E-04	.6279E-04
Age-structured index catchabilities									
Acoustic survey 2-9+ wr									
Linear model fitted. Slopes at age :									
29	1	Q	1.097	13	.9627	1.638	1.097	1.438	1.267
30	2	Q	1.557	8	1.435	2.003	1.557	1.846	1.701
31	3	Q	1.865	9	1.707	2.448	1.865	2.241	2.053
32	4	Q	1.938	13	1.694	2.933	1.938	2.564	2.251
33	5	Q	2.088	19	1.733	3.705	2.088	3.076	2.582
34	6	Q	2.195	20	1.807	3.997	2.195	3.291	2.743
35	7	Q	2.016	21	1.643	3.790	2.016	3.089	2.553
36	8	Q	2.330	27	1.785	5.301	2.330	4.061	3.197
37	9	Q	5.938	27	4.569	13.33	5.938	10.25	8.100
IBTS: 1-5+ wr									
Linear model fitted. Slopes at age :									
38	1	Q	.1416E-03	6	.1328E-03	.1726E-03	.1416E-03	.1619E-03	.1518E-03
39	2	Q	.1645E-03	12	.1466E-03	.2348E-03	.1645E-03	.2092E-03	.1868E-03
40	3	Q	.1173E-03	23	.9326E-04	.2379E-03	.1173E-03	.1892E-03	.1533E-03
41	4	Q	.7056E-04	33	.5103E-04	.1917E-03	.7056E-04	.1386E-03	.1047E-03
42	5	Q	.3767E-04	33	.2723E-04	.1025E-03	.3767E-04	.7408E-04	.5594E-04
MIK 0-wr									
Linear model fitted. Slopes at age :									
43	0	Q	.3084E-05	3	.2972E-05	.3457E-05	.3084E-05	.3331E-05	.3208E-05

Table 2.6.2.4 cont. North Sea Herring.

Parameters of the stock-recruit relationship

44	1	a	.8410E+08	38	.5797E+08	.2649E+09	.8410E+08	.1826E+09	.1336E+09
45	1	b	.6774E+06	65	.3601E+06	.4752E+07	.6774E+06	.2526E+07	.1624E+07

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1998	1999	2000	2001	2002
0	-0.8134	0.0951	0.2851	0.4211	-0.0103
1	0.4987	-0.4975	-0.1786	0.0102	-0.2452
2	0.0237	0.1334	0.1608	-0.2770	-0.0403
3	-0.0571	0.0477	-0.1138	0.2065	-0.0929
4	-0.0680	-0.0650	0.0044	0.0730	0.1403
5	0.1033	-0.1269	0.1340	0.0441	-0.1510
6	0.1848	-0.1274	-0.0607	0.0617	-0.0763
7	-0.1420	-0.1236	-0.0397	0.1372	0.1289
8	0.0551	0.0079	-0.2611	-0.1072	0.4416

SPAWNING BIOMASS INDEX RESIDUALS MLAI

	1973	1974	1975	1976	1977	1978	1979	1980
	-0.2486	-0.3612	-0.7057	-0.7336	0.6868	0.5444	0.7160	0.1152
	1981	1982	1983	1984	1985	1986	1987	1988
	0.0842	0.0452	-0.1735	-0.0655	0.3235	-0.3041	-0.0579	0.3275
	1989	1990	1991	1992	1993	1994	1995	1996
	0.2480	0.5518	0.1181	-0.2854	-0.1620	-0.6766	-0.4439	0.2894
	1997	1998	1999	2000	2001	2002		
	0.2971	0.3006	-0.0413	-0.4295	0.2285	-0.1878		

AGE-STRUCTURED INDEX RESIDUALS

Acoustic survey 2-9+ wr

Age	1989	1990	1991	1992	1993	1994	1995	1996
1	*******	*******	*******	*******	*******	*******	*******	*******
2	-0.351	-0.064	-0.081	0.138	0.162	-0.202	0.081	0.402
3	-0.419	-0.047	-0.246	-0.134	-0.015	-0.357	0.213	0.392
4	-0.498	-0.005	-0.097	-0.014	0.172	-0.539	0.332	0.327
5	-0.255	-0.127	-0.118	-0.088	0.221	-0.034	0.056	0.250
6	-0.252	0.133	-0.343	0.147	0.270	0.119	-0.076	-0.460
7	-0.305	0.319	0.228	-0.052	0.313	0.252	0.103	-0.471
8	-0.134	0.493	0.155	0.148	-0.025	0.190	-0.034	0.588
9	-0.955	-0.688	-0.714	-0.359	-0.661	-0.853	-1.515	1.564

Age	1997	1998	1999	2000	2001	2002
1	-0.129	-0.221	-0.072	0.503	-0.293	0.212
2	0.510	-0.189	-0.149	-0.195	0.198	-0.261
3	0.410	0.084	0.011	-0.127	0.174	0.060
4	0.325	0.381	-0.184	0.120	-0.070	-0.250
5	0.187	0.482	-0.282	0.185	-0.112	-0.364
6	0.397	0.427	-0.113	0.184	-0.186	-0.247
7	-0.775	0.798	-0.094	0.332	-0.316	-0.333
8	-0.293	-0.464	0.049	0.129	-0.369	-0.433
9	0.677	1.023	1.184	1.077	0.282	-0.063

Table 2.6.2.4 cont. North Sea Herring.

IBTS: 1-5+ wr

Age	1979	1980	1981	1982	1983	1984	1985	1986
1	-0.238	-0.255	-0.235	-0.269	-0.518	-0.235	0.108	-0.237
2	*******	*******	*******	*******	-1.032	-1.476	0.083	0.331
3	*******	*******	*******	*******	-0.707	-0.807	0.082	0.176
4	*******	*******	*******	*******	-0.294	-0.096	0.015	0.161
5	*******	*******	*******	*******	0.987	-0.200	0.689	0.437

Age	1987	1988	1989	1990	1991	1992	1993	1994
1	-0.076	0.361	0.296	-0.379	-0.239	-0.089	0.372	0.031
2	-0.155	1.292	0.121	-0.030	0.630	-0.193	0.734	0.644
3	-0.468	0.842	-0.187	0.054	0.468	0.382	0.412	0.661
4	-0.118	0.103	-0.145	0.610	0.948	0.195	0.177	0.586
5	0.654	-0.143	-1.070	0.427	0.844	0.438	0.352	0.370

Age	1995	1996	1997	1998	1999	2000	2001	2002
1	0.017	0.248	0.622	0.589	-0.454	0.168	0.293	0.045
2	0.817	-0.683	0.080	-0.152	-0.035	-0.703	-0.054	-0.190
3	0.411	-1.240	0.251	-0.684	0.371	-0.152	0.526	-0.591
4	0.217	-0.966	-0.137	-0.861	0.573	-0.662	0.454	-1.193
5	-1.304	-0.391	0.228	-0.165	0.369	-1.273	0.278	-1.197

Age	2003
1	0.074
2	-0.030
3	0.199
4	0.432
5	-0.329

MIK 0-wr

Age	1977	1978	1979	1980	1981	1982	1983	1984
0	0.382	0.049	0.601	0.813	-0.235	-0.233	-0.556	-0.207

Age	1985	1986	1987	1988	1989	1990	1991	1992
0	-0.185	-0.397	0.170	0.399	-0.386	-1.321	-0.259	0.192

Age	1993	1994	1995	1996	1997	1998	1999	2000
0	0.351	0.125	0.121	-0.246	0.743	-0.270	0.253	0.182

Age	2001	2002	2003
0	-0.067	-0.019	0.000

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES-AT-AGE)

Separable model fitted from 1998 to 2002	
Variance	0.0575
Skewness test stat.	-0.5209
Kurtosis test statistic	0.9451
Partial chi-square	0.0929
Significance in fit	0.0000
Degrees of freedom	20

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR MLAI

Power catchability relationship assumed	
Variance	0.1057
Skewness test stat.	-0.1956

Table 2.6.2.4. North Sea Herring. Note age= ringer

Kurtosis test statistic	-0.8012
Partial chi-square	1.3564
Significance in fit	0.0000
Number of observations	30
Degrees of freedom	28
Weight in the analysis	0.6500

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR Acoustic survey 2-9+ wr

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8	9
Variance	0.0671	0.0491	0.0398	0.0241	0.008	0.0101	0.0204	0.0072	0.0651
Skewness test stat.	0.7869	0.9116	0.048	-0.6165	0.5181	-0.0198	-0.052	0.2991	0.2924
Kurtosis test statisti	-0.3944	-0.5067	-0.5535	-0.6437	-0.5265	-0.8844	-0.3531	-0.555	-0.978
Partial chi-square	0.0206	0.0419	0.0353	0.0226	0.0078	0.0104	0.0226	0.0082	0.0752
Significance in fit	0	0	0	0	0	0	0	0	0
Number of observations	6	14	14	14	14	14	14	14	14
Degrees of freedom	5	13	13	13	13	13	13	13	13
Weight in the analysis	0.74	0.75	0.64	0.27	0.14	0.13	0.12	0.07	0.07

DISTRIBUTION STATISTICS FOR IBTS: 1-5+ wr

Linear catchability relationship assumed

Age	1	2	3	4	5
Variance	0.0652	0.0979	0.0186	0.0093	0.0149
Skewness test stat.	0.6457	-0.4957	-1.1219	-1.0556	-1.2995
Kurtosis test statisti	-0.7880	0.2088	-0.5753	-0.2802	-0.6232
Partial chi-square	0.2145	0.3035	0.0714	0.0444	0.0894
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	25	21	21	21	21
Degrees of freedom	24	20	20	20	20
Weight in the analysis	0.6700	0.2400	0.0600	0.0300	0.0300

DISTRIBUTION STATISTICS FOR MIK 0-wr

Linear catchability relationship assumed

Age	0
Variance	0.3905
Skewness test stat.	-1.3264
Kurtosis test statisti	1.6703
Partial chi-square	2.3673
Significance in fit	0.0000
Number of observations	27
Degrees of freedom	26
Weight in the analysis	2.0500

ANALYSIS OF VARIANCE

Unweighted Statistics	Variance				
	SSQ	Data	Parameters	d.f.	Variance
Total for model	79.7407	371	45	326	0.2446
Catches-at-age	2.2272	45	25	20	0.1114
SSB Indices MLAI	4.5523	30	2	28	0.1626
Aged Indices Acoustic survey 2-9+ wr	20.6528	118	9	109	0.1895
IBTS: 1-5+ wr	32.7776	109	5	104	0.3152
MIK 0-wr	4.9531	27	1	26	0.1905
Stock-recruit model	14.5777	42	2	40	0.3644
Weighted Statistics	Variance				
	SSQ	Data	Parameters	d.f.	Variance
Total for model	26.8617	371	45	326	0.0824
Catches-at-age	1.1507	45	25	20	0.0575
SSB Indices MLAI	1.9233	30	2	28	0.0687
Aged Indices Acoustic survey 2-9+ wr	1.2719	118	9	109	0.0117
IBTS: 1-5+ wr	1.5545	109	5	104	0.0149
MIK 0-wr	20.8155	27	1	26	0.8006
Stock-recruit model	0.1458	42	2	40	0.0036

Table 2.7.2.1 Input file for short term prediction

```
North sea herring 2003
2003
0 9
4
F ref. age for each fleet
1 2 6
2 0 1
3 0 1
4 0 1
Two age ranges for overall F
0 1
2 6
Init numbers
0 20037
1 21907
2 10574
3 3338
4 3417
5  783
6  462
7  506
8  145
9   91
recruitments
48800
48800
selection by age and fleet
0 0.0000  0.00776 0.00025 0.01139
1 0.00516 0.02749 0.01338 0.01076
2 0.10458 0.01904 0.01261 0.00127
3 0.22443 0.00603 0.00131 0.00013
4 0.25940 0.00157 0.00065 0.00009
5 0.27207 0.00331 0.00041 0
6 0.27938 0.00245 0.00017 0
7 0.23438 0.00102 0       0
8 0.26013 0.00157 0       0
9 0.26170 0       0       0
natmor at age
0 1.0
1 1.0
2 0.3
3 0.2
4 0.1
5 0.1
6 0.1
7 0.1
8 0.1
9 0.1
```

Table 2.7.2.1 cont.

```
weca by fleet
0 0.000 0.013 0.015 0.012
1 0.082 0.025 0.054 0.018
2 0.129 0.050 0.101 0.096
3 0.153 0.114 0.120 0.136
4 0.169 0.169 0.143 0.143
5 0.199 0.180 0.161 0.170
6 0.215 0.193 0.179 0.180
7 0.228 0.228 0.177 0.000
8 0.250 0.244 0.221 0.179
9 0.253 0      0      0
west
0 0.007
1 0.048
2 0.133
3 0.167
4 0.199
5 0.226
6 0.242
7 0.258
8 0.283
9 0.272
maturity
0 0
1 0
2 0.82
3 0.95
4 1
5 1
6 1
7 1
8 1
9 1
Proportion of F and M before spawning
0.67 0.67
```

Table 2.7.3.1a

Output from short term prediction assuming F*status quo* in 2003 and F0-1 = 0.10, F2-6 = 0.20

North sea herring 2003
Input data from: input

Results for the intermediate year 2003
with the folllowing constraints:
Fleet 1 F constraint: 0.2280
Fleet 2 F constraint: 0.0176
Fleet 3 F constraint: 0.0068
Fleet 4 F constraint: 0.0111

F-values by fleet and total						Catches by fleet				
F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2003
0.228	0.018	0.007	0.011	0.038	0.238	434.4	22.0	21.4	5.5	2170.4

Results for the prediction year 2004
with the following types of constraints:
Fleet 1 Screen for total Fs
Fleet 2 Screen for total Fs
Fleet 3 Catch constraint
Fleet 4 Catch constraint

F-values by fleet and total						Catches by fleet					
F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2004	SSB2005
0.166	0.077	0.011	0.010	0.100	0.200	399.5	78.2	20.0	5.0	2540.6	2465.2
0.169	0.068	0.011	0.019	0.100	0.200	407.3	68.6	20.0	10.0	2541.8	2466.0
0.173	0.058	0.011	0.029	0.100	0.200	415.1	59.0	20.0	15.0	2543.0	2466.7
0.176	0.049	0.011	0.038	0.100	0.200	422.9	49.4	20.0	20.0	2544.3	2467.7
0.179	0.039	0.011	0.048	0.100	0.200	430.8	39.8	20.0	25.0	2545.5	2468.4
0.183	0.030	0.011	0.057	0.100	0.200	438.6	30.1	20.0	30.0	2546.8	2469.5
0.166	0.072	0.017	0.009	0.100	0.200	398.5	72.5	30.0	5.0	2540.3	2465.2
0.169	0.062	0.017	0.019	0.100	0.200	406.3	62.9	30.0	10.0	2541.5	2465.9
0.172	0.053	0.017	0.029	0.100	0.200	414.1	53.4	30.0	15.0	2542.7	2466.6
0.176	0.043	0.017	0.038	0.100	0.200	422.0	43.7	30.0	20.0	2543.9	2467.3
0.179	0.034	0.017	0.048	0.100	0.200	429.8	34.1	30.0	25.0	2545.2	2468.3
0.182	0.024	0.017	0.057	0.100	0.200	437.7	24.5	30.0	30.0	2546.4	2469.2
0.165	0.066	0.023	0.009	0.100	0.200	397.5	66.7	40.0	5.0	2540.1	2465.3
0.169	0.057	0.022	0.019	0.100	0.200	405.3	57.2	40.0	10.0	2541.2	2465.9
0.172	0.047	0.022	0.029	0.100	0.200	413.2	47.6	40.0	15.0	2542.4	2466.5
0.175	0.038	0.022	0.038	0.100	0.200	421.0	38.1	40.0	20.0	2543.6	2467.2
0.178	0.028	0.022	0.048	0.100	0.200	428.8	28.4	40.0	25.0	2544.8	2468.1
0.182	0.019	0.022	0.057	0.100	0.200	436.7	18.8	40.0	30.0	2546.1	2469.0
0.165	0.060	0.028	0.009	0.100	0.200	396.5	61.0	50.0	5.0	2539.8	2465.2
0.168	0.051	0.028	0.019	0.100	0.200	404.2	51.5	50.0	10.0	2541.0	2465.8
0.171	0.042	0.028	0.029	0.100	0.200	412.2	41.9	50.0	15.0	2542.1	2466.3
0.175	0.032	0.028	0.038	0.100	0.200	420.0	32.4	50.0	20.0	2543.3	2467.1
0.178	0.023	0.028	0.048	0.100	0.200	427.8	22.8	50.0	25.0	2544.5	2467.9
0.181	0.013	0.028	0.057	0.100	0.200	435.6	13.2	50.0	30.0	2545.8	2468.8
0.164	0.055	0.034	0.009	0.100	0.200	395.4	55.2	60.0	5.0	2539.5	2465.2
0.168	0.045	0.034	0.019	0.100	0.200	403.3	45.7	60.0	10.0	2540.6	2465.7
0.171	0.036	0.034	0.029	0.100	0.200	411.1	36.2	60.0	15.0	2541.8	2466.3
0.174	0.026	0.034	0.038	0.100	0.200	419.0	26.7	60.0	20.0	2543.0	2467.0
0.178	0.017	0.034	0.048	0.100	0.200	426.8	17.1	60.0	25.0	2544.2	2467.8
0.181	0.007	0.033	0.057	0.100	0.200	434.7	7.4	60.0	30.0	2545.5	2468.7
0.164	0.049	0.040	0.009	0.100	0.200	394.5	49.4	70.0	5.0	2539.2	2465.2
0.167	0.040	0.040	0.019	0.100	0.200	402.3	40.0	70.0	10.0	2540.4	2465.7
0.171	0.030	0.039	0.028	0.100	0.200	410.1	30.5	70.0	15.0	2541.5	2466.2
0.174	0.021	0.039	0.038	0.100	0.200	418.0	21.0	70.0	20.0	2542.7	2466.9
0.177	0.011	0.039	0.048	0.100	0.200	425.8	11.3	70.0	25.0	2544.0	2467.8
0.180	0.002	0.039	0.057	0.100	0.200	433.7	1.8	70.0	30.0	2545.1	2468.5

Table 2.7.3.1b

Output from short term prediction assuming F*status quo* in 2003 and F0-1 = 0.10, F2-6 = 0.25

North sea herring 2003
Input data from: input

Results for the intermediate year 2003
with the folllowing constraints:
Fleet 1 F constraint: 0.2280
Fleet 2 F constraint: 0.0176
Fleet 3 F constraint: 0.0068
Fleet 4 F constraint: 0.0111

F-values by fleet and total						Catches by fleet				
F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2003
0.228	0.018	0.007	0.011	0.038	0.238	434.4	22.0	21.4	5.5	2170.4

Results for the prediction year 2004
with the following types of constraints:
Fleet 1 Screen for total Fs
Fleet 2 Screen for total Fs
Fleet 3 Catch constraint
Fleet 4 Catch constraint

F-values by fleet and total						Catches by fleet					
F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2004	SSB2005
0.216	0.077	0.011	0.010	0.100	0.250	508.3	76.5	20.0	5.0	2462.3	2279.3
0.220	0.067	0.011	0.019	0.100	0.250	515.8	67.1	20.0	10.0	2463.5	2280.2
0.223	0.058	0.011	0.029	0.100	0.250	523.5	57.6	20.0	15.0	2464.7	2281.2
0.226	0.048	0.011	0.038	0.100	0.250	531.1	48.1	20.0	20.0	2466.0	2282.3
0.230	0.038	0.011	0.048	0.100	0.250	538.9	38.5	20.0	25.0	2467.2	2283.4
0.233	0.029	0.011	0.057	0.100	0.250	546.6	28.9	20.0	30.0	2468.5	2284.6
0.216	0.071	0.017	0.010	0.100	0.250	507.2	70.8	30.0	5.0	2462.0	2279.2
0.219	0.062	0.017	0.019	0.100	0.250	514.9	61.4	30.0	10.0	2463.1	2280.0
0.222	0.052	0.017	0.029	0.100	0.250	522.5	52.0	30.0	15.0	2464.4	2281.0
0.226	0.042	0.017	0.038	0.100	0.250	530.2	42.4	30.0	20.0	2465.6	2282.0
0.229	0.033	0.017	0.048	0.100	0.250	537.9	32.9	30.0	25.0	2466.9	2283.1
0.232	0.023	0.017	0.057	0.100	0.250	545.6	23.4	30.0	30.0	2468.2	2284.3
0.216	0.065	0.023	0.010	0.100	0.250	506.3	65.1	40.0	5.0	2461.6	2278.9
0.219	0.056	0.023	0.019	0.100	0.250	513.9	55.7	40.0	10.0	2462.9	2279.8
0.222	0.046	0.023	0.029	0.100	0.250	521.6	46.3	40.0	15.0	2464.0	2280.7
0.225	0.037	0.023	0.038	0.100	0.250	529.2	36.8	40.0	20.0	2465.3	2281.7
0.229	0.027	0.023	0.048	0.100	0.250	536.9	27.3	40.0	25.0	2466.5	2282.8
0.232	0.018	0.022	0.057	0.100	0.250	544.6	17.7	40.0	30.0	2467.8	2284.0
0.215	0.060	0.028	0.010	0.100	0.250	505.3	59.4	50.0	5.0	2461.3	2278.8
0.218	0.050	0.028	0.019	0.100	0.250	512.9	50.0	50.0	10.0	2462.5	2279.7
0.222	0.041	0.028	0.029	0.100	0.250	520.6	40.6	50.0	15.0	2463.7	2280.5
0.225	0.031	0.028	0.038	0.100	0.250	528.3	31.1	50.0	20.0	2465.0	2281.5
0.228	0.022	0.028	0.048	0.100	0.250	535.9	21.6	50.0	25.0	2466.2	2282.5
0.231	0.012	0.028	0.057	0.100	0.250	543.6	12.1	50.0	30.0	2467.5	2283.7
0.215	0.054	0.034	0.010	0.100	0.250	504.3	53.7	60.0	5.0	2461.1	2278.7
0.218	0.044	0.034	0.019	0.100	0.250	512.0	44.3	60.0	10.0	2462.2	2279.4
0.221	0.035	0.034	0.029	0.100	0.250	519.6	34.9	60.0	15.0	2463.4	2280.3
0.224	0.025	0.034	0.038	0.100	0.250	527.3	25.4	60.0	20.0	2464.6	2281.2
0.228	0.016	0.034	0.048	0.100	0.250	535.0	15.9	60.0	25.0	2465.9	2282.3
0.231	0.006	0.034	0.057	0.100	0.250	542.7	6.4	60.0	30.0	2467.1	2283.3
0.214	0.048	0.040	0.010	0.100	0.250	503.4	47.9	70.0	5.0	2460.7	2278.5
0.217	0.039	0.040	0.019	0.100	0.250	511.0	38.6	70.0	10.0	2461.9	2279.3
0.221	0.029	0.040	0.029	0.100	0.250	518.6	29.2	70.0	15.0	2463.1	2280.2
0.224	0.020	0.040	0.038	0.100	0.250	526.3	19.7	70.0	20.0	2464.3	2281.0
0.227	0.010	0.040	0.048	0.100	0.250	534.0	10.3	70.0	25.0	2465.6	2282.0
0.231	0.001	0.039	0.057	0.100	0.250	541.6	0.8	70.0	30.0	2466.8	2283.1

Table 2.7.3.1c

Output from short term prediction assuming F*status quo* in 2003 and F0-1 = 0.12, F2-6 = 0.25

North sea herring 2003
Input data from: input

Results for the intermediate year 2003
with the folllowing constraints:
Fleet 1 F constraint: 0.2280
Fleet 2 F constraint: 0.0176
Fleet 3 F constraint: 0.0068
Fleet 4 F constraint: 0.0111

F-values by fleet and total						Catches by fleet				
F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2003
0.228	0.018	0.007	0.011	0.038	0.238	434.4	22.0	21.4	5.5	2170.4

Results for the prediction year 2004
with the following types of constraints:
Fleet 1 Screen for total Fs
Fleet 2 Screen for total Fs
Fleet 3 Catch constraint
Fleet 4 Catch constraint

F-values by fleet and total						Catches by fleet					
F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2004	SSB2005
0.209	0.097	0.011	0.010	0.120	0.250	491.0	95.9	20.0	5.0	2459.5	2274.3
0.212	0.087	0.011	0.019	0.120	0.250	498.6	86.5	20.0	10.0	2460.8	2275.1
0.216	0.077	0.011	0.029	0.120	0.250	506.3	77.0	20.0	15.0	2461.9	2275.9
0.219	0.068	0.011	0.038	0.120	0.250	514.0	67.5	20.0	20.0	2463.2	2276.8
0.222	0.058	0.011	0.048	0.120	0.250	521.7	58.1	20.0	25.0	2464.4	2277.8
0.226	0.049	0.011	0.058	0.120	0.250	529.5	48.4	20.0	30.0	2465.6	2278.6
0.209	0.091	0.017	0.010	0.120	0.250	490.0	90.2	30.0	5.0	2459.3	2274.3
0.212	0.081	0.017	0.019	0.120	0.250	497.7	80.8	30.0	10.0	2460.4	2274.9
0.215	0.072	0.017	0.029	0.120	0.250	505.3	71.4	30.0	15.0	2461.6	2275.8
0.218	0.062	0.017	0.038	0.120	0.250	513.1	61.9	30.0	20.0	2462.8	2276.5
0.222	0.053	0.017	0.048	0.120	0.250	520.8	52.3	30.0	25.0	2464.1	2277.5
0.225	0.043	0.017	0.058	0.120	0.250	528.6	42.7	30.0	30.0	2465.3	2278.5
0.208	0.085	0.023	0.010	0.120	0.250	489.0	84.5	40.0	5.0	2459.0	2274.2
0.211	0.076	0.023	0.019	0.120	0.250	496.7	75.1	40.0	10.0	2460.1	2274.9
0.215	0.066	0.023	0.029	0.120	0.250	504.4	65.6	40.0	15.0	2461.3	2275.5
0.218	0.056	0.023	0.038	0.120	0.250	512.1	56.2	40.0	20.0	2462.5	2276.4
0.221	0.047	0.023	0.048	0.120	0.250	519.8	46.7	40.0	25.0	2463.7	2277.2
0.225	0.037	0.023	0.058	0.120	0.250	527.5	37.1	40.0	30.0	2465.0	2278.3
0.208	0.079	0.029	0.010	0.120	0.250	488.0	78.7	50.0	5.0	2458.7	2274.2
0.211	0.070	0.029	0.019	0.120	0.250	495.6	69.4	50.0	10.0	2459.9	2274.8
0.214	0.060	0.029	0.029	0.120	0.250	503.4	59.9	50.0	15.0	2461.0	2275.4
0.218	0.051	0.028	0.038	0.120	0.250	511.2	50.5	50.0	20.0	2462.2	2276.2
0.221	0.041	0.028	0.048	0.120	0.250	518.8	41.0	50.0	25.0	2463.4	2277.1
0.224	0.032	0.028	0.058	0.120	0.250	526.5	31.5	50.0	30.0	2464.6	2278.0
0.207	0.074	0.035	0.010	0.120	0.250	487.0	73.0	60.0	5.0	2458.4	2274.1
0.211	0.064	0.034	0.019	0.120	0.250	494.8	63.6	60.0	10.0	2459.5	2274.6
0.214	0.055	0.034	0.029	0.120	0.250	502.4	54.2	60.0	15.0	2460.7	2275.3
0.217	0.045	0.034	0.038	0.120	0.250	510.1	44.8	60.0	20.0	2461.9	2276.0
0.220	0.035	0.034	0.048	0.120	0.250	517.8	35.3	60.0	25.0	2463.1	2276.9
0.224	0.026	0.034	0.058	0.120	0.250	525.5	25.8	60.0	30.0	2464.3	2277.8
0.207	0.068	0.040	0.010	0.120	0.250	486.1	67.2	70.0	5.0	2458.1	2274.0
0.210	0.058	0.040	0.019	0.120	0.250	493.8	57.8	70.0	10.0	2459.3	2274.6
0.213	0.049	0.040	0.029	0.120	0.250	501.4	48.5	70.0	15.0	2460.4	2275.3
0.217	0.039	0.040	0.038	0.120	0.250	509.2	39.0	70.0	20.0	2461.6	2276.0
0.220	0.030	0.040	0.048	0.120	0.250	516.9	29.6	70.0	25.0	2462.8	2276.8
0.223	0.020	0.040	0.058	0.120	0.250	524.7	20.1	70.0	30.0	2464.0	2277.5

Table 2.7.3.2a

Output from short term prediction assuming TAC constraint in 2003 and F0-1 = 0.10, F2-6 = 0.20 in 2004

North sea herring 2003
Input data from: input

Results for the intermediate year 2003
with the folllowing constraints:
Fleet 1 Catch constraint: 400.0
Fleet 2 Catch constraint: 54.0
Fleet 3 Catch constraint: 25.0
Fleet 4 Catch constraint: 10.5

F-values by fleet and total						Catches by fleet				
F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2003
0.209	0.044	0.008	0.022	0.076	0.230	399.9	54.0	25.0	10.5	2170.9

Results for the prediction year 2004
with the following types of constraints:
Fleet 1 Screen for total Fs
Fleet 2 Screen for total Fs
Fleet 3 Catch constraint
Fleet 4 Catch constraint

F-values by fleet and total						Catches by fleet					
F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2004	SSB2005
0.166	0.077	0.012	0.010	0.100	0.200	396.3	75.7	20.0	5.0	2507.8	2429.6
0.169	0.067	0.012	0.019	0.100	0.200	404.1	66.3	20.0	10.0	2508.8	2430.0
0.173	0.058	0.012	0.029	0.100	0.200	411.9	56.9	20.0	15.0	2509.8	2430.4
0.176	0.048	0.012	0.038	0.100	0.200	419.6	47.4	20.0	20.0	2510.9	2431.0
0.179	0.038	0.012	0.048	0.100	0.200	427.5	37.9	20.0	25.0	2511.9	2431.6
0.183	0.029	0.012	0.058	0.100	0.200	435.4	28.3	20.0	30.0	2513.0	2432.1
0.166	0.071	0.018	0.010	0.100	0.200	395.2	69.9	30.0	5.0	2507.6	2429.6
0.169	0.061	0.018	0.019	0.100	0.200	403.0	60.6	30.0	10.0	2508.5	2429.9
0.172	0.052	0.018	0.029	0.100	0.200	410.8	51.1	30.0	15.0	2509.6	2430.4
0.176	0.042	0.017	0.038	0.100	0.200	418.7	41.6	30.0	20.0	2510.6	2430.8
0.179	0.033	0.017	0.048	0.100	0.200	426.5	32.2	30.0	25.0	2511.6	2431.4
0.182	0.023	0.017	0.058	0.100	0.200	434.4	22.6	30.0	30.0	2512.7	2432.0
0.165	0.065	0.024	0.010	0.100	0.200	394.2	64.1	40.0	5.0	2507.4	2429.8
0.169	0.056	0.023	0.019	0.100	0.200	402.0	54.7	40.0	10.0	2508.3	2430.1
0.172	0.046	0.023	0.029	0.100	0.200	409.7	45.4	40.0	15.0	2509.4	2430.5
0.175	0.036	0.023	0.038	0.100	0.200	417.7	35.9	40.0	20.0	2510.4	2430.9
0.179	0.027	0.023	0.048	0.100	0.200	425.5	26.4	40.0	25.0	2511.4	2431.3
0.182	0.017	0.023	0.058	0.100	0.200	433.4	16.9	40.0	30.0	2512.5	2431.9
0.165	0.059	0.029	0.010	0.100	0.200	393.2	58.3	50.0	5.0	2507.1	2429.8
0.168	0.050	0.029	0.019	0.100	0.200	400.9	48.9	50.0	10.0	2508.1	2430.2
0.171	0.040	0.029	0.029	0.100	0.200	408.8	39.5	50.0	15.0	2509.1	2430.4
0.175	0.030	0.029	0.038	0.100	0.200	416.6	30.1	50.0	20.0	2510.1	2430.8
0.178	0.021	0.029	0.048	0.100	0.200	424.5	20.6	50.0	25.0	2511.2	2431.3
0.181	0.011	0.029	0.058	0.100	0.200	432.3	11.1	50.0	30.0	2512.2	2431.9
0.164	0.053	0.035	0.010	0.100	0.200	392.1	52.4	60.0	5.0	2507.0	2430.0
0.168	0.044	0.035	0.019	0.100	0.200	400.0	43.1	60.0	10.0	2507.9	2430.1
0.171	0.034	0.035	0.029	0.100	0.200	407.8	33.7	60.0	15.0	2508.9	2430.5
0.174	0.025	0.035	0.038	0.100	0.200	415.6	24.3	60.0	20.0	2509.9	2430.8
0.178	0.015	0.035	0.048	0.100	0.200	423.4	14.9	60.0	25.0	2510.9	2431.3
0.181	0.005	0.035	0.058	0.100	0.200	431.3	5.4	60.0	30.0	2512.0	2431.9
0.164	0.047	0.041	0.010	0.100	0.200	391.2	46.5	70.0	5.0	2506.7	2430.0
0.167	0.038	0.041	0.019	0.100	0.200	398.9	37.2	70.0	10.0	2507.7	2430.2
0.171	0.028	0.041	0.029	0.100	0.200	406.8	27.9	70.0	15.0	2508.7	2430.5
0.174	0.019	0.041	0.038	0.100	0.200	414.6	18.5	70.0	20.0	2509.7	2430.9
0.177	0.009	0.041	0.048	0.100	0.200	422.4	9.1	70.0	25.0	2510.7	2431.3
0.180	0.000	0.041	0.058	0.100	0.200	430.3	-0.5	70.0	30.0	2511.8	2431.9

Table 2.7.3.2b

Output from short term prediction assuming TAC constraint in 2003 and F0-1 = 0.10, F2-6 = 0.25 in 2004

North sea herring 2003
Input data from: input

Results for the intermediate year 2003
with the folllowing constraints:
Fleet 1 Catch constraint: 400.0
Fleet 2 Catch constraint: 54.0
Fleet 3 Catch constraint: 25.0
Fleet 4 Catch constraint: 10.5

F-values by fleet and total / Catches by fleet

F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2003
0.209	0.044	0.008	0.022	0.076	0.230	399.9	54.0	25.0	10.5	2170.9

Results for the prediction year 2004
with the following types of constraints:
Fleet 1 Screen for total Fs
Fleet 2 Screen for total Fs
Fleet 3 Catch constraint
Fleet 4 Catch constraint

F-values by fleet and total / Catches by fleet

F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2004	SSB2005
0.216	0.076	0.012	0.010	0.100	0.250	504.0	74.2	20.0	5.0	2429.8	2245.2
0.220	0.067	0.012	0.019	0.100	0.250	511.7	64.9	20.0	10.0	2430.9	2245.9
0.223	0.057	0.012	0.029	0.100	0.250	519.3	55.5	20.0	15.0	2431.9	2246.6
0.226	0.047	0.012	0.039	0.100	0.250	526.9	46.2	20.0	20.0	2433.0	2247.4
0.230	0.038	0.012	0.048	0.100	0.250	534.7	36.7	20.0	25.0	2434.1	2248.2
0.233	0.028	0.012	0.058	0.100	0.250	542.4	27.3	20.0	30.0	2435.2	2249.1
0.216	0.070	0.018	0.010	0.100	0.250	503.0	68.4	30.0	5.0	2429.6	2245.2
0.219	0.061	0.018	0.019	0.100	0.250	510.7	59.1	30.0	10.0	2430.6	2245.8
0.223	0.051	0.018	0.029	0.100	0.250	518.3	49.8	30.0	15.0	2431.7	2246.5
0.226	0.041	0.018	0.039	0.100	0.250	525.9	40.4	30.0	20.0	2432.8	2247.3
0.229	0.032	0.018	0.048	0.100	0.250	533.7	31.0	30.0	25.0	2433.8	2248.0
0.233	0.022	0.018	0.058	0.100	0.250	541.4	21.5	30.0	30.0	2434.9	2248.9
0.215	0.064	0.024	0.010	0.100	0.250	502.0	62.6	40.0	5.0	2429.4	2245.2
0.219	0.055	0.024	0.019	0.100	0.250	509.6	53.3	40.0	10.0	2430.4	2245.7
0.222	0.045	0.024	0.029	0.100	0.250	517.3	44.0	40.0	15.0	2431.4	2246.2
0.225	0.035	0.024	0.039	0.100	0.250	525.0	34.6	40.0	20.0	2432.4	2247.0
0.229	0.026	0.023	0.048	0.100	0.250	532.7	25.2	40.0	25.0	2433.5	2247.8
0.232	0.016	0.023	0.058	0.100	0.250	540.3	15.9	40.0	30.0	2434.6	2248.7
0.215	0.058	0.030	0.010	0.100	0.250	501.0	56.8	50.0	5.0	2429.1	2245.1
0.218	0.049	0.030	0.019	0.100	0.250	508.7	47.5	50.0	10.0	2430.1	2245.5
0.222	0.039	0.030	0.029	0.100	0.250	516.3	38.2	50.0	15.0	2431.1	2246.1
0.225	0.030	0.029	0.039	0.100	0.250	524.0	28.9	50.0	20.0	2432.2	2246.9
0.228	0.020	0.029	0.048	0.100	0.250	531.7	19.5	50.0	25.0	2433.2	2247.6
0.232	0.010	0.029	0.058	0.100	0.250	539.3	10.1	50.0	30.0	2434.3	2248.5
0.215	0.052	0.036	0.010	0.100	0.250	500.0	51.0	60.0	5.0	2428.9	2245.1
0.218	0.043	0.036	0.019	0.100	0.250	507.7	41.7	60.0	10.0	2429.9	2245.5
0.221	0.033	0.035	0.029	0.100	0.250	515.3	32.4	60.0	15.0	2430.9	2246.1
0.224	0.024	0.035	0.038	0.100	0.250	523.0	23.1	60.0	20.0	2431.9	2246.8
0.228	0.014	0.035	0.048	0.100	0.250	530.6	13.7	60.0	25.0	2433.0	2247.5
0.231	0.004	0.035	0.058	0.100	0.250	538.3	4.4	60.0	30.0	2434.1	2248.3
0.214	0.046	0.042	0.010	0.100	0.250	499.1	45.1	70.0	5.0	2428.7	2245.0
0.217	0.037	0.042	0.019	0.100	0.250	506.7	35.8	70.0	10.0	2429.7	2245.5
0.221	0.027	0.041	0.029	0.100	0.250	514.3	26.6	70.0	15.0	2430.7	2246.0
0.224	0.018	0.041	0.038	0.100	0.250	522.0	17.2	70.0	20.0	2431.7	2246.7
0.227	0.008	0.041	0.048	0.100	0.250	529.6	8.0	70.0	25.0	2432.8	2247.4
0.231	-0.001	0.041	0.058	0.100	0.250	537.3	-1.4	70.0	30.0	2433.8	2248.2

Table 2.7.3.2c

Output from short term prediction assuming TAC constraint in 2003 and F0-1 = 0.12, F2-6 = 0.25 in 2004

North sea herring 2003
Input data from: input

Results for the intermediate year 2003
with the folllowing constraints:
Fleet 1 Catch constraint: 400.0
Fleet 2 Catch constraint: 54.0
Fleet 3 Catch constraint: 25.0
Fleet 4 Catch constraint: 10.5

F-values by fleet and total / Catches by fleet

F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2003
0.209	0.044	0.008	0.022	0.076	0.230	399.9	54.0	25.0	10.5	2170.9

Results for the prediction year 2004
with the following types of constraints:
Fleet 1 Screen for total Fs
Fleet 2 Screen for total Fs
Fleet 3 Catch constraint
Fleet 4 Catch constraint

F-values by fleet and total / Catches by fleet

F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2004	SSB2005
0.209	0.096	0.012	0.010	0.120	0.250	487.0	93.1	20.0	5.0	2427.5	2241.0
0.212	0.086	0.012	0.019	0.120	0.250	494.6	83.8	20.0	10.0	2428.6	2241.5
0.216	0.077	0.012	0.029	0.120	0.250	502.3	74.5	20.0	15.0	2429.6	2242.0
0.219	0.067	0.012	0.039	0.120	0.250	510.0	65.2	20.0	20.0	2430.6	2242.6
0.222	0.057	0.012	0.048	0.120	0.250	517.7	55.7	20.0	25.0	2431.7	2243.3
0.226	0.048	0.012	0.058	0.120	0.250	525.5	46.3	20.0	30.0	2432.7	2243.9
0.209	0.090	0.018	0.010	0.120	0.250	486.0	87.3	30.0	5.0	2427.3	2241.1
0.212	0.080	0.018	0.019	0.120	0.250	493.7	78.0	30.0	10.0	2428.3	2241.4
0.215	0.071	0.018	0.029	0.120	0.250	501.3	68.7	30.0	15.0	2429.4	2242.0
0.219	0.061	0.018	0.039	0.120	0.250	509.1	59.3	30.0	20.0	2430.3	2242.4
0.222	0.051	0.018	0.048	0.120	0.250	516.7	50.0	30.0	25.0	2431.4	2243.1
0.225	0.042	0.018	0.058	0.120	0.250	524.5	40.5	30.0	30.0	2432.5	2243.8
0.208	0.084	0.024	0.010	0.120	0.250	484.9	81.5	40.0	5.0	2427.1	2241.2
0.211	0.075	0.024	0.019	0.120	0.250	492.6	72.2	40.0	10.0	2428.1	2241.5
0.215	0.065	0.024	0.029	0.120	0.250	500.4	62.9	40.0	15.0	2429.1	2241.9
0.218	0.055	0.024	0.039	0.120	0.250	508.1	53.6	40.0	20.0	2430.1	2242.4
0.221	0.045	0.024	0.048	0.120	0.250	515.8	44.2	40.0	25.0	2431.1	2243.0
0.225	0.036	0.024	0.058	0.120	0.250	523.5	34.8	40.0	30.0	2432.2	2243.7
0.208	0.078	0.030	0.010	0.120	0.250	483.9	75.6	50.0	5.0	2426.9	2241.1
0.211	0.068	0.030	0.019	0.120	0.250	491.7	66.4	50.0	10.0	2427.8	2241.4
0.214	0.059	0.030	0.029	0.120	0.250	499.3	57.1	50.0	15.0	2428.9	2241.9
0.218	0.049	0.030	0.039	0.120	0.250	507.0	47.8	50.0	20.0	2429.9	2242.4
0.221	0.040	0.030	0.048	0.120	0.250	514.7	38.4	50.0	25.0	2430.9	2242.9
0.224	0.030	0.030	0.058	0.120	0.250	522.4	29.0	50.0	30.0	2431.9	2243.5
0.207	0.072	0.036	0.010	0.120	0.250	482.9	69.8	60.0	5.0	2426.7	2241.3
0.210	0.062	0.036	0.019	0.120	0.250	490.6	60.5	60.0	10.0	2427.6	2241.5
0.214	0.053	0.036	0.029	0.120	0.250	498.3	51.3	60.0	15.0	2428.6	2241.9
0.217	0.043	0.036	0.039	0.120	0.250	506.0	41.9	60.0	20.0	2429.6	2242.3
0.220	0.034	0.036	0.048	0.120	0.250	513.7	32.6	60.0	25.0	2430.7	2242.9
0.224	0.024	0.035	0.058	0.120	0.250	521.4	23.3	60.0	30.0	2431.7	2243.5
0.207	0.066	0.042	0.010	0.120	0.250	482.0	63.9	70.0	5.0	2426.5	2241.2
0.210	0.056	0.042	0.019	0.120	0.250	489.6	54.7	70.0	10.0	2427.4	2241.5
0.213	0.047	0.042	0.029	0.120	0.250	497.3	45.4	70.0	15.0	2428.4	2241.9
0.217	0.037	0.042	0.039	0.120	0.250	505.0	36.1	70.0	20.0	2429.4	2242.3
0.220	0.028	0.042	0.048	0.120	0.250	512.7	26.8	70.0	25.0	2430.4	2242.8
0.223	0.018	0.041	0.058	0.120	0.250	520.4	17.4	70.0	30.0	2431.5	2243.5

Table 2.7.3.3
Selected management scenarios

F status quo in 2003

For 2003 with F0-1= 0.038 and F2-6=0.238

F 2-6	F 0-1			Catch				SSB 2003
A-fleet	B-fleet	C-fleet	D-fleet	A-fleet	B-fleet	C-fleet	D-fleet	
0.228	0.018	0.007	0.011	434	22	21	6	2170

F2004=F2003 for all fleets

F 2-6	F 0-1			Catch				SSB 2004	SSB 2005
A-fleet	B-fleet	C-fleet	D-fleet	A-fleet	B-fleet	C-fleet	D-fleet		
0.209	0.097	0.011	0.010	491	96	20	5	2460	2274
0.212	0.087	0.011	0.019	499	87	20	10	2461	2275
0.216	0.077	0.011	0.029	506	77	20	15	2462	2276
0.219	0.068	0.011	0.038	514	68	20	20	2463	2277
0.209	0.091	0.017	0.010	490	90	30	5	2459	2274
0.212	0.081	0.017	0.019	498	81	30	10	2460	2275
0.215	0.072	0.017	0.029	505	71	30	15	2462	2276
0.218	0.062	0.017	0.038	513	62	30	20	2463	2277
0.208	0.085	0.023	0.010	489	85	40	5	2459	2274
0.211	0.076	0.023	0.019	497	75	40	10	2460	2275
0.215	0.066	0.023	0.029	504	66	40	15	2461	2276
0.218	0.056	0.023	0.038	512	56	40	20	2463	2276

F2004=F2003 for all fleets

0.228	0.018	0.007	0.011	538	18	12	6	2491	2343

Assuming TAC constraint in 2003 and 2004

For 2003 with F0-1 = 0.076 and F2-6 = 0.23

F 2-6	F 0-1			Catch					
A-fleet	B-fleet	C-fleet	D-fleet	A-fleet	B-fleet	C-fleet	D-fleet	SSB 2003	
0.209	0.044	0.008	0.022	400	54	25	11	2171	
For 2004 with F0-1=0.091 and F2-6=0.194								SSB 2004	SSB 2005
0.167	0.055	0.015	0.020	400	54	25	11	2519	2453

Table 2.11.1 Downs herring (IVc+VIId). TAC and ACFM catch from 1986 to 2003. Weights in 1000 tonnes.

	TAC			Catch	
	IVa+IVb	IVc+VIId	Total	IVa+IVb	IVc+VIId
1986	500	70	570	493	51
1987	560	40	600	577	45
1988	500	30	530	646	52
1989	484	30	514	638	79
1990	385	30	415	516	61
1991	370	50	420	527	61
1992	380	50	430	498	74
1993	380	50	430	463	77
1994	390	50	440	428	74
1995	264	50	440	503	63
1996	86	25	156	216	50
1997	88	25	159	183	51
1998	156	25	254	281	48
1999	164	25	265	282	54
2000	164	25	265	285	44
2001	164	25	265	278	45
2002	146	43	265	303	50
2003	340	60	400		

Herring catches 2002, 1st Quarter

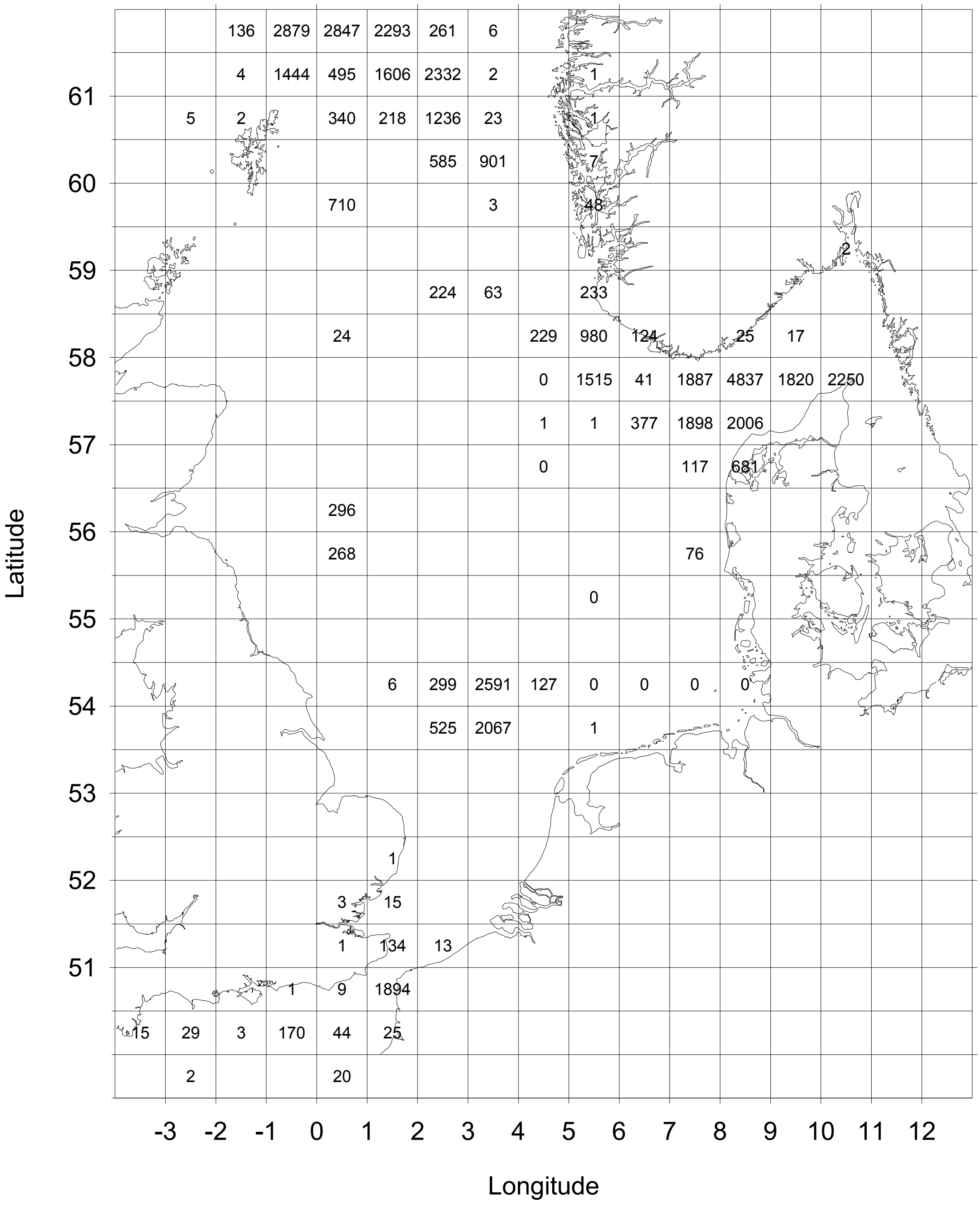


Figure 2.1.1 Herring catches in the North Sea (in tonnes) in 2002 by statistical rectangle. Working group estimates (if available). **a.:** 1st quarter

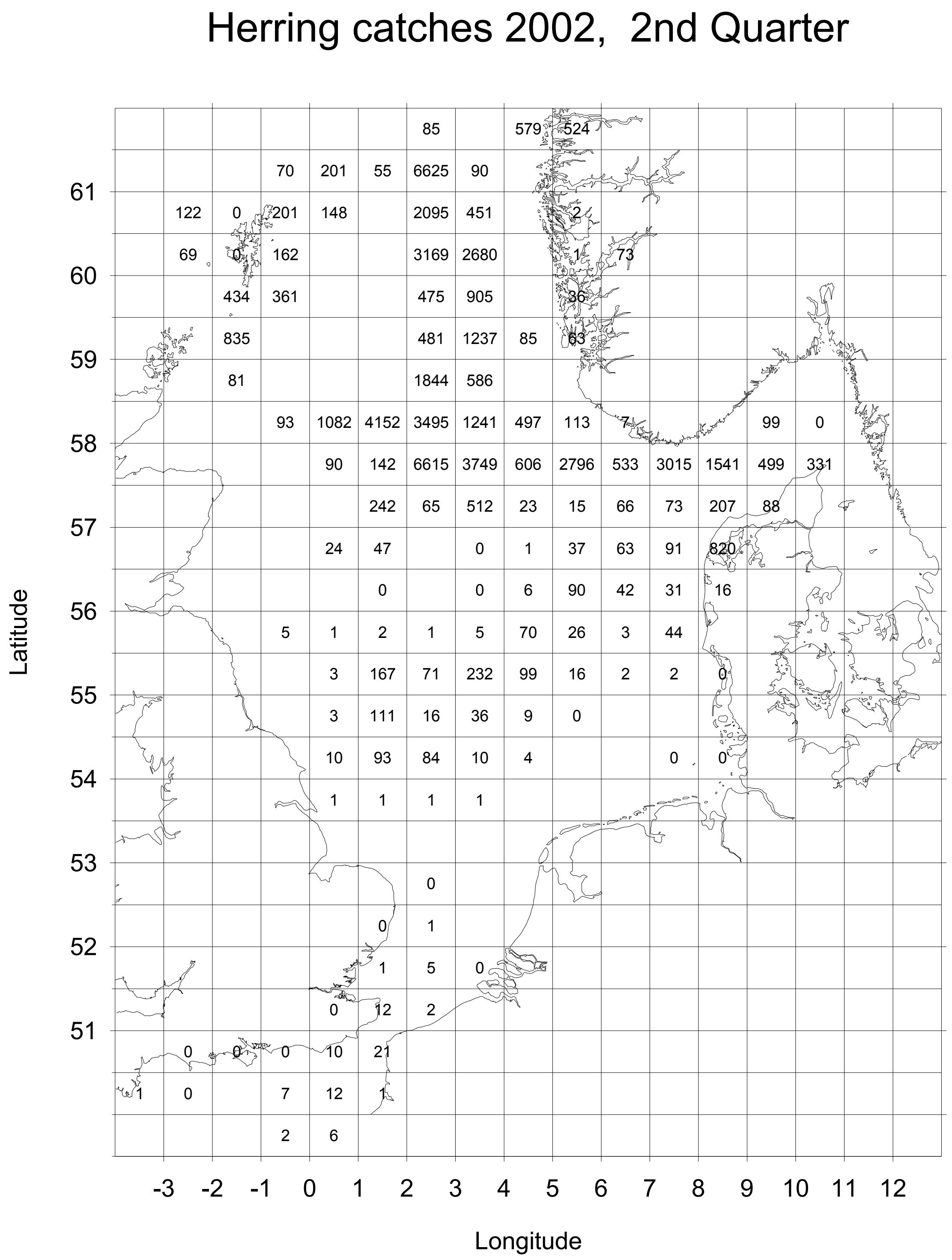


Figure 2.1.1 Herring catches in the North Sea (in tonnes) in 2002 by statistical rectangle. Working group estimates (if available). **b.:** 2nd quarter

Herring catches 2002, 3rd Quarter

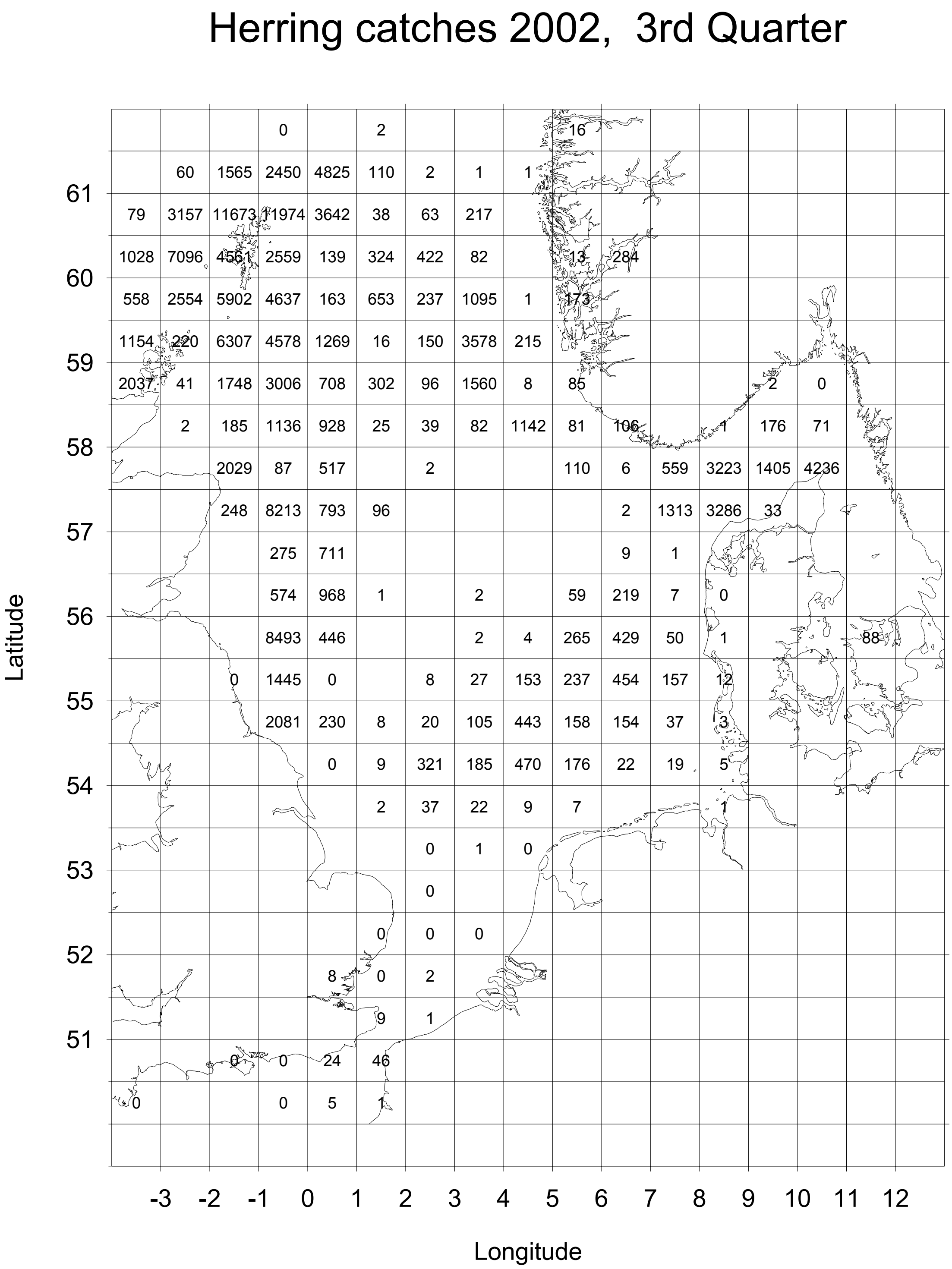


Figure 2.1.1 Herring catches in the North Sea (in tonnes) in 2002 by statistical rectangle. Working group estimates (if available). **c.:** 3rd quarter

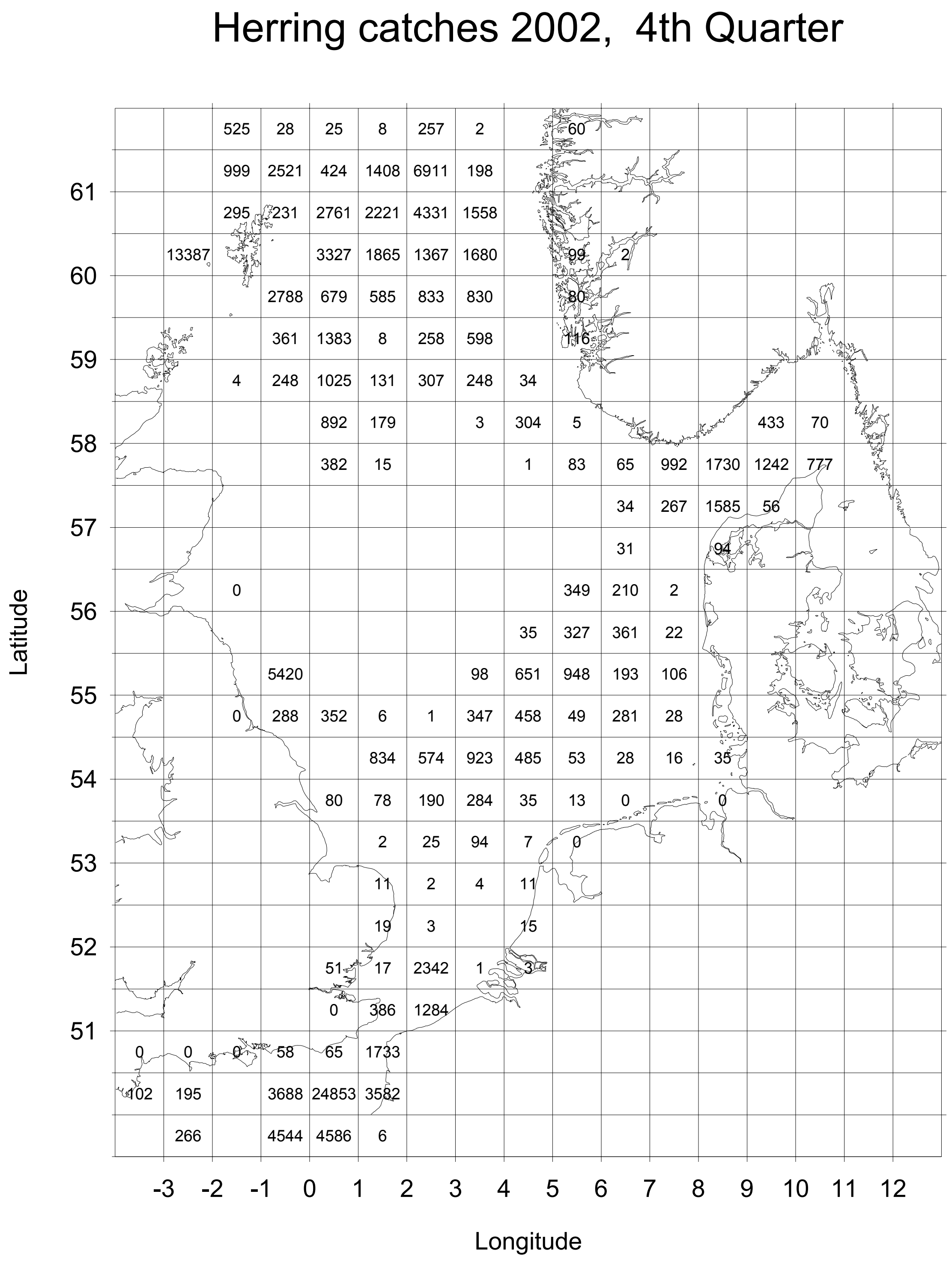


Figure 2.1.1 Herring catches in the North Sea (in tonnes) in 2002 by statistical rectangle. Working group estimates (if available). **d.:** 4th quarter

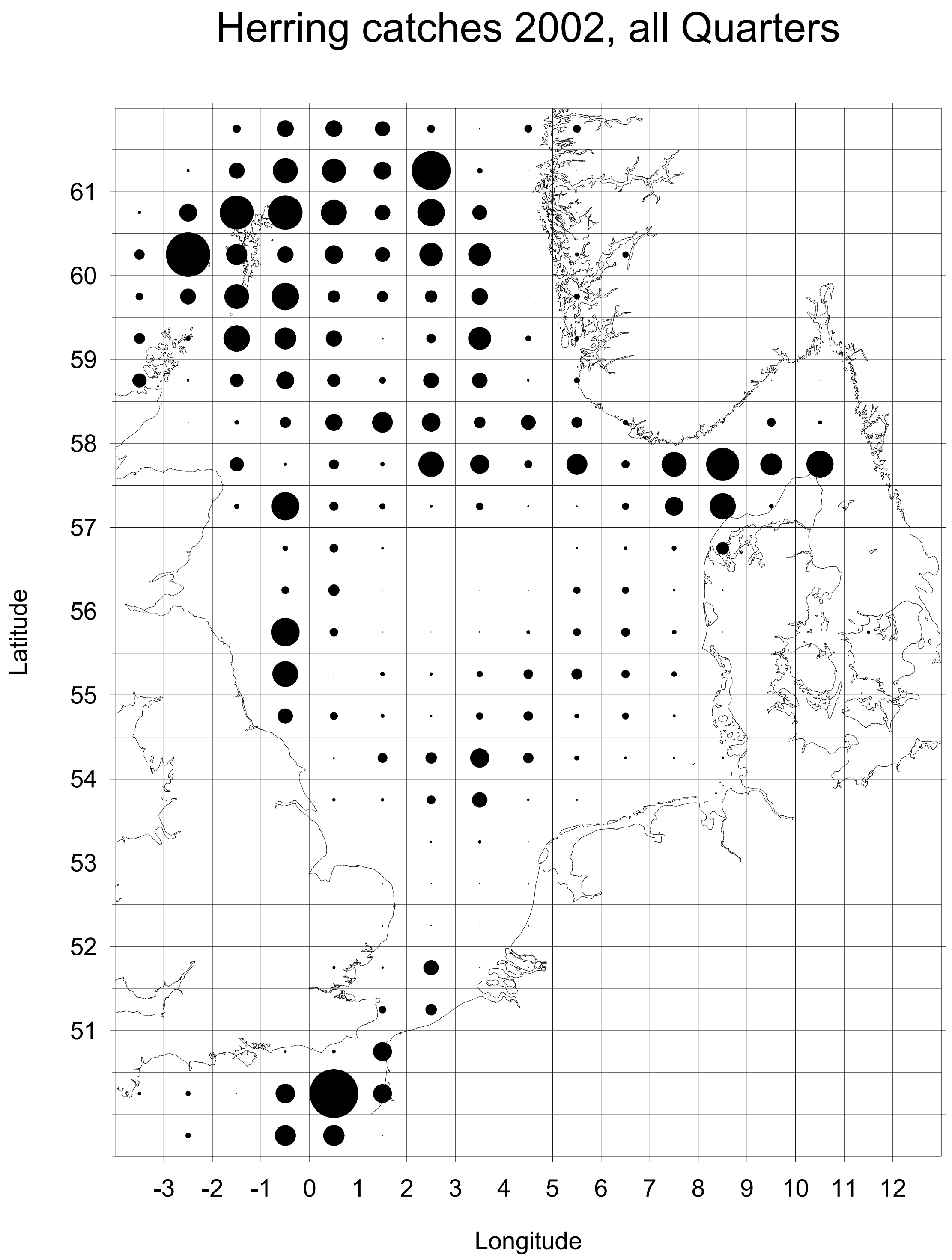


Figure 2.1.1 Herring catches in the North Sea (in tonnes) in 2002 by statistical rectangle. Working group estimates (if available). **e.:** all quarters

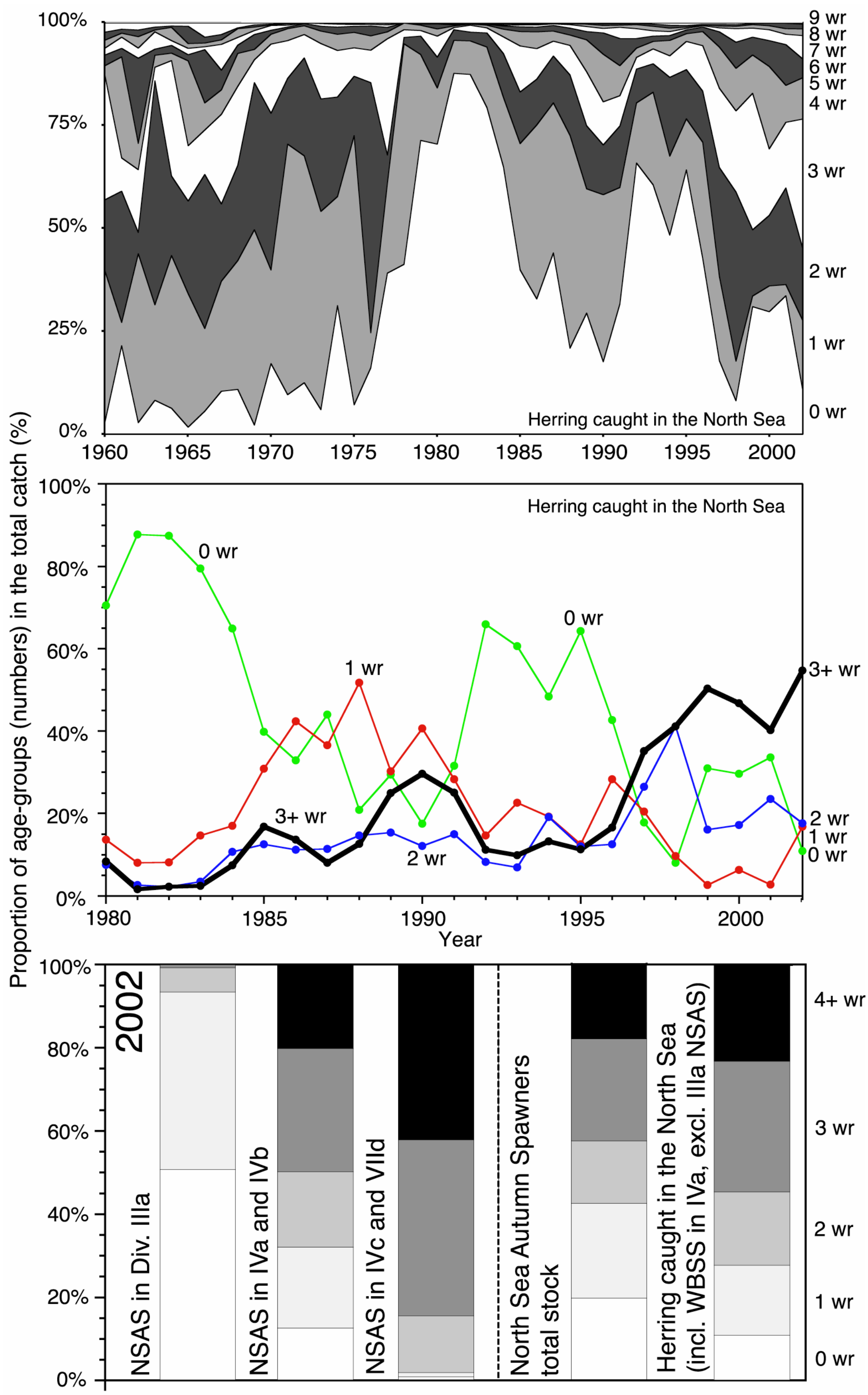


Figure 2.2.1 Proportions of age groups (numbers) in the total catch of herring in the North Sea (upper, 1960-2002, and middle panel, 1980-2002), and in the total catch of North Sea Autumn Spawners in 2002 (lower panel).

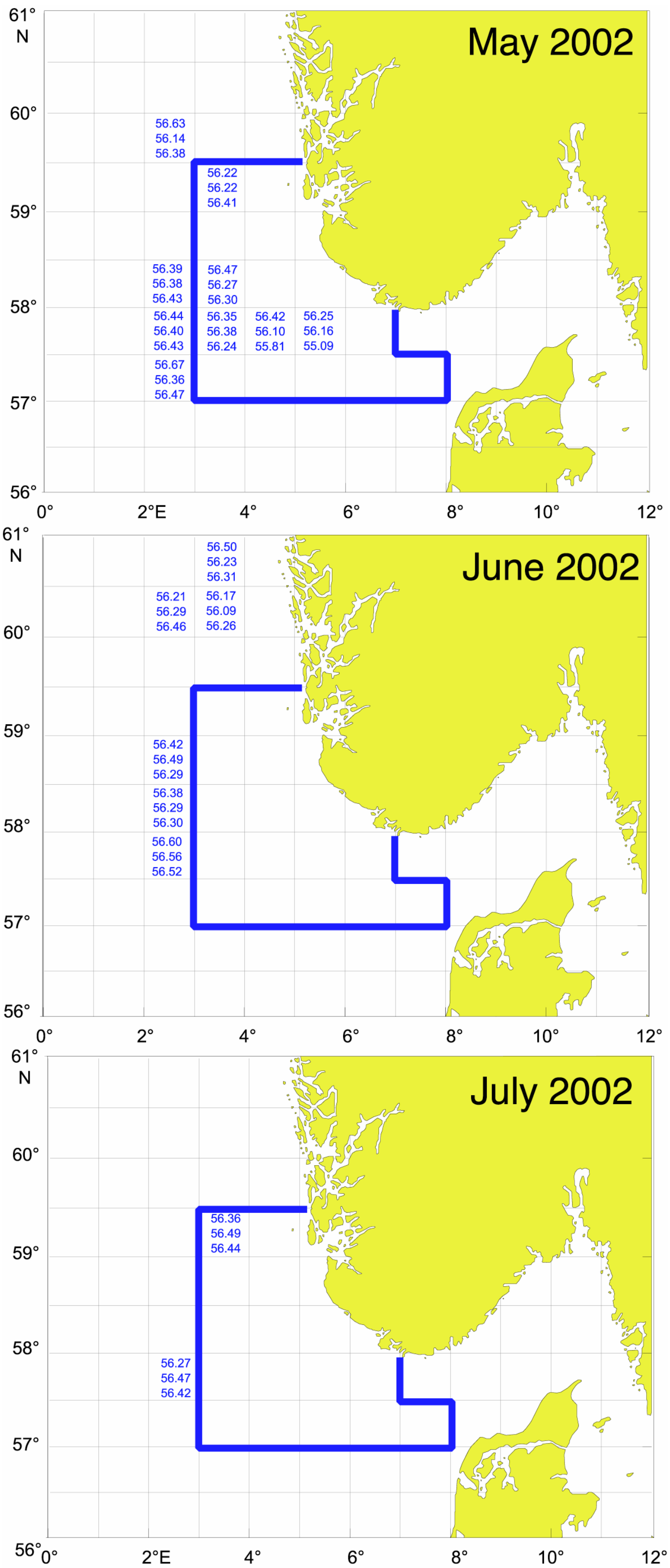


Figure 2.2.2 Mean vertebrae counts of 2 (upper number), 3 (middle) and 4+ herring (lower) in the North Sea and Div. IIIa as obtained by Norwegian sampling in the 2nd and 3rd quarter 2002. The transfer area (Western Baltic Spring Spawners transfered to the assessment of IIIa herring) is indicated.

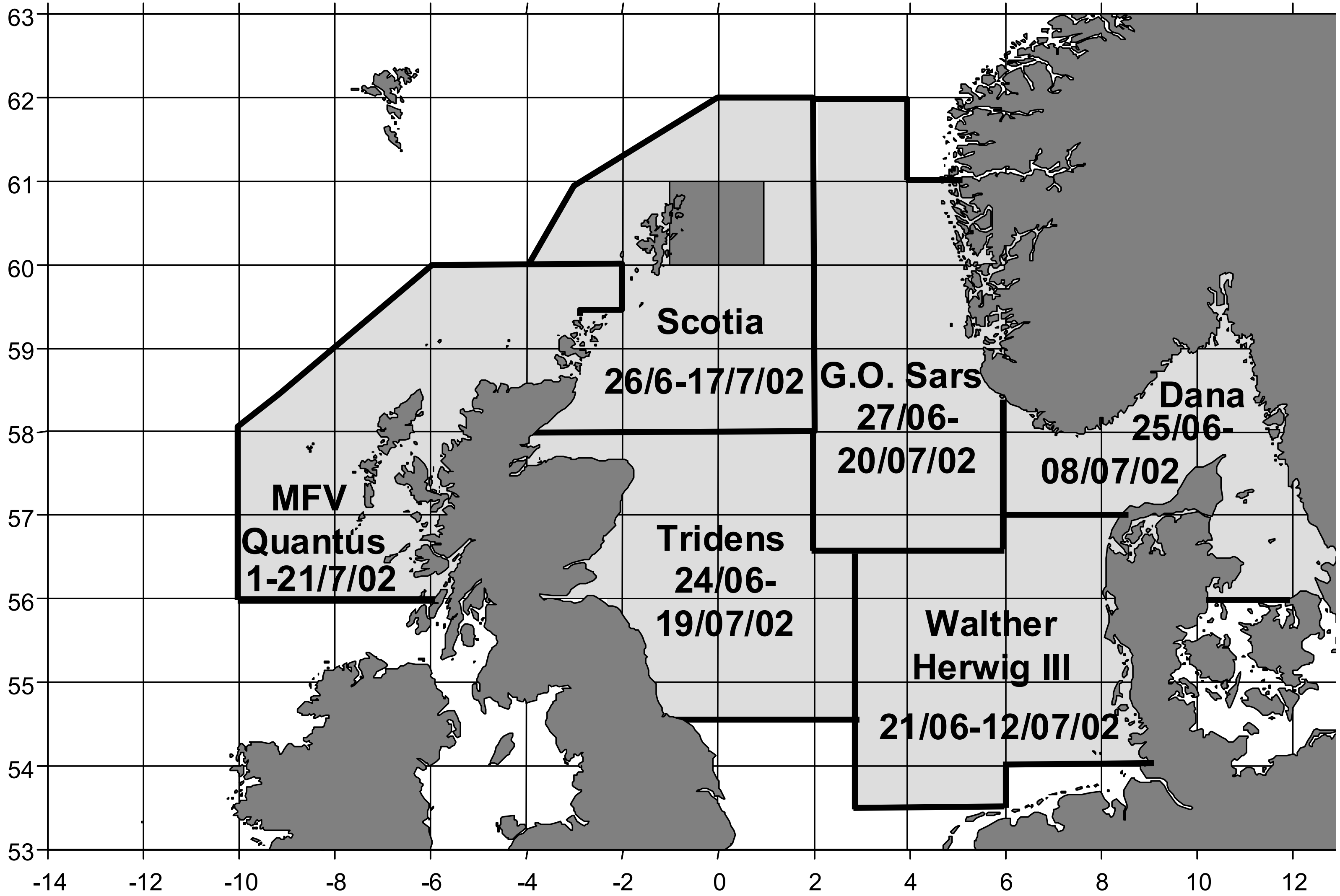


Figure 2.3.1.1 Herring, survey area layouts and dates for all participating vessels in the 2002 acoustic survey of the North Sea and adjacent areas. Shaded areas indicate areas of overlap.

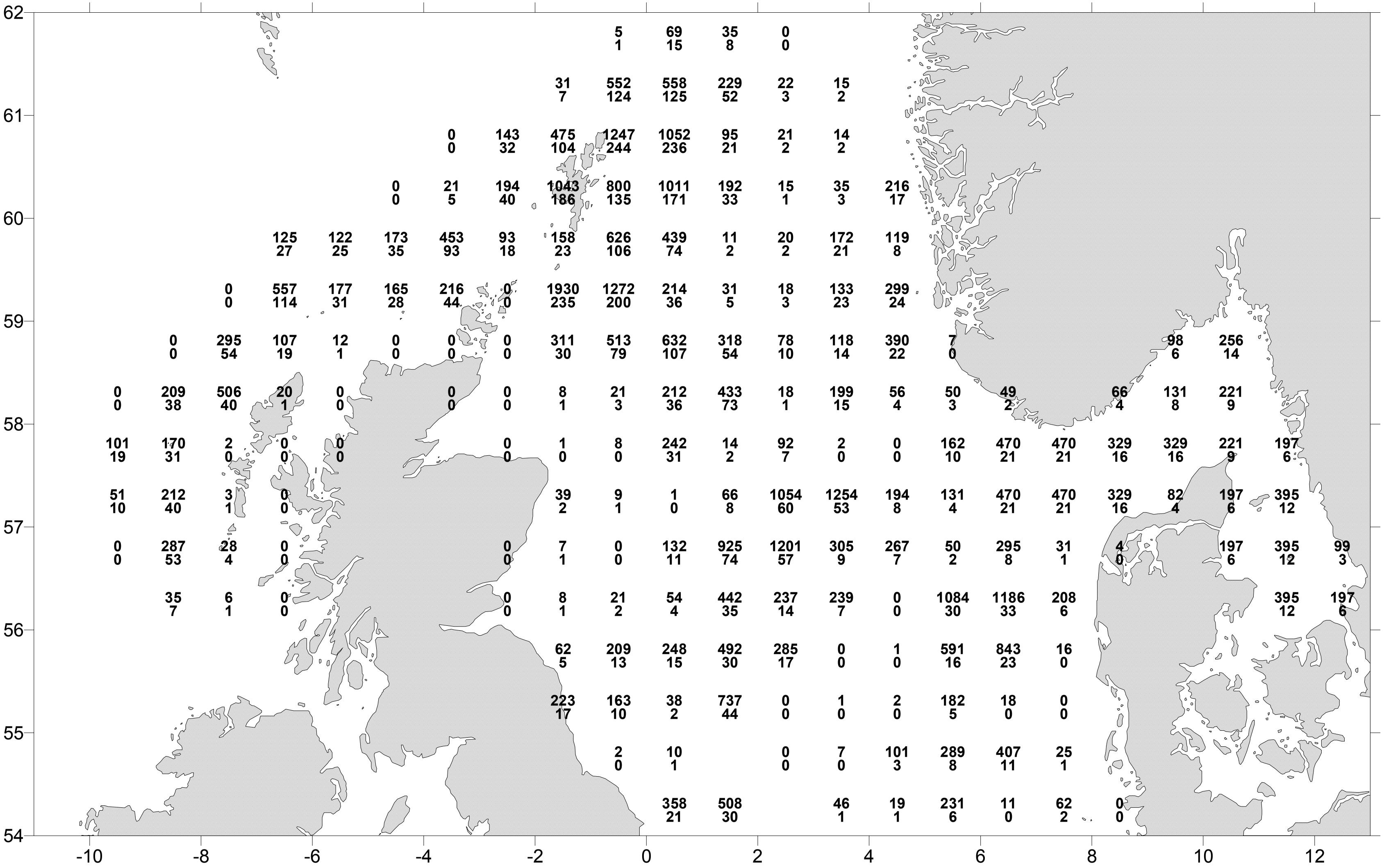


Figure 2.3.1.2 Autumn-spawning herring abundance from combined acoustic survey July 2002. Numbers (millions) (upper figure), and biomass (thousands of tonnes) (lower figure)

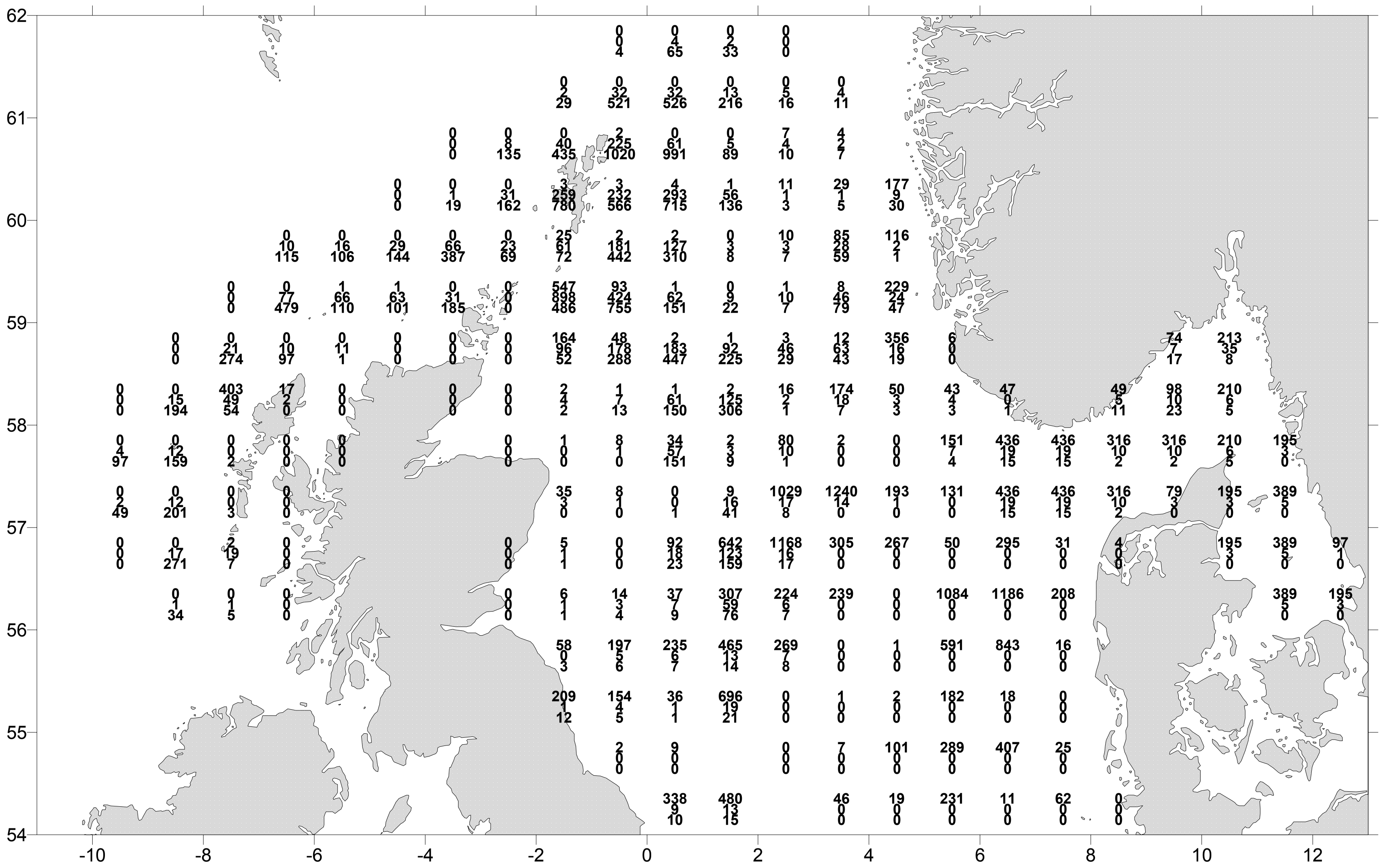


Figure 2.3.1.3 Autumn Spwaning herring numbers (millions) from combined acoustic survey July 2002. 1-ring (upper figure), 2-ring (centre figure), 3+ (lower figure)

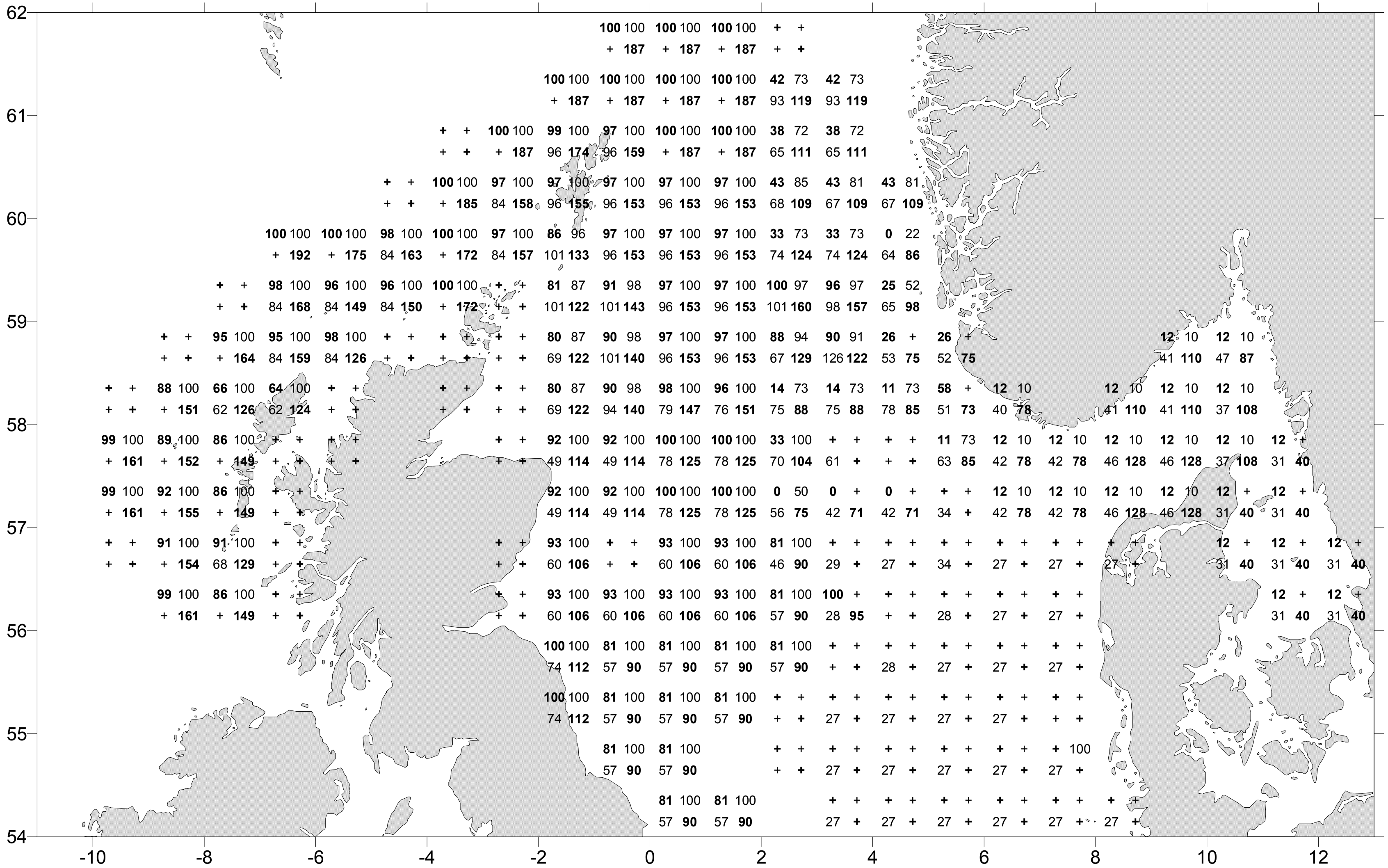


Figure 2.3.1.4 Autumn-spawning herring , mean weight & maturity from combined acoustic survey July 2002. Fraction mature (upper) 2-ring (left), 3-ring (right), mean weights (lower) 1-ring (left), 2-ring (right), 0 indicates measured fraction mature, + indicates surveyed with zero abundance, blank unsurveyed rectangle.

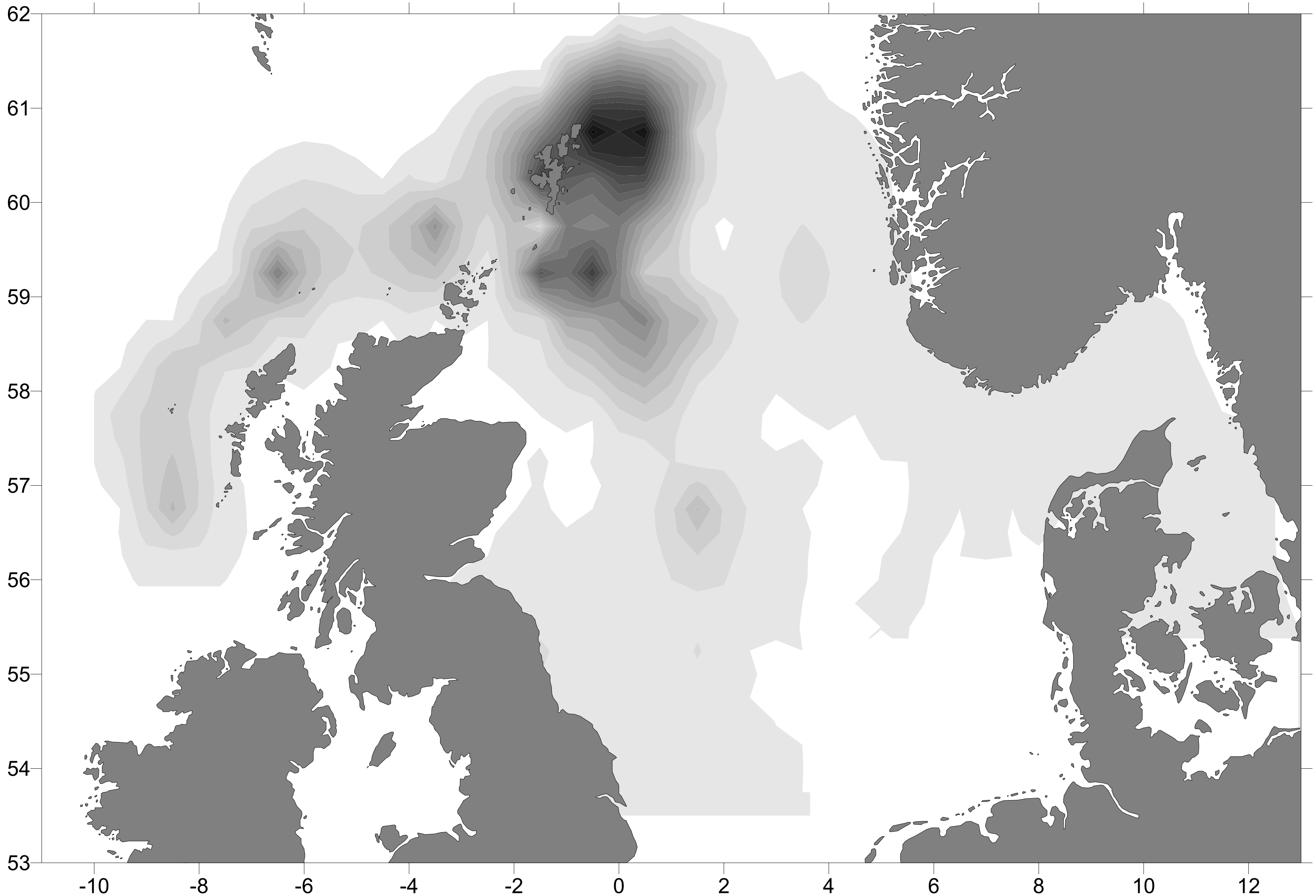


Figure 2.3.1.5 **Autumn-spawning** herring, abundance of mature autumn-spawning herring from combined acoustic survey July 2002. Numbers of herring, (dark areas indicate higher density).

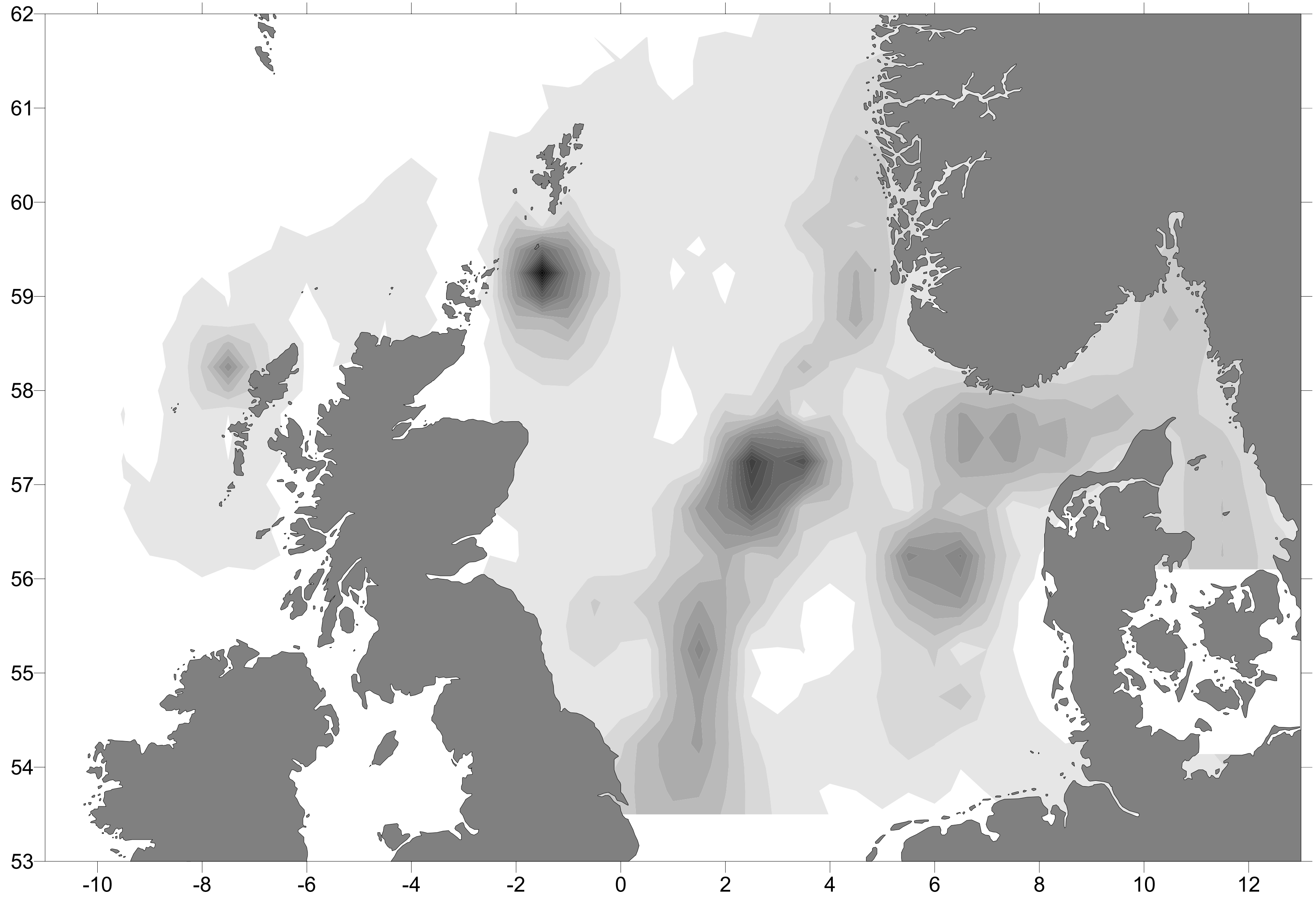


Figure 2.3.1.6 Autumn-spawning herring, abundance of immature autumn-spawning herring from combined acoustic survey July 2002. Numbers of herring.(dark areas indicate higher density)

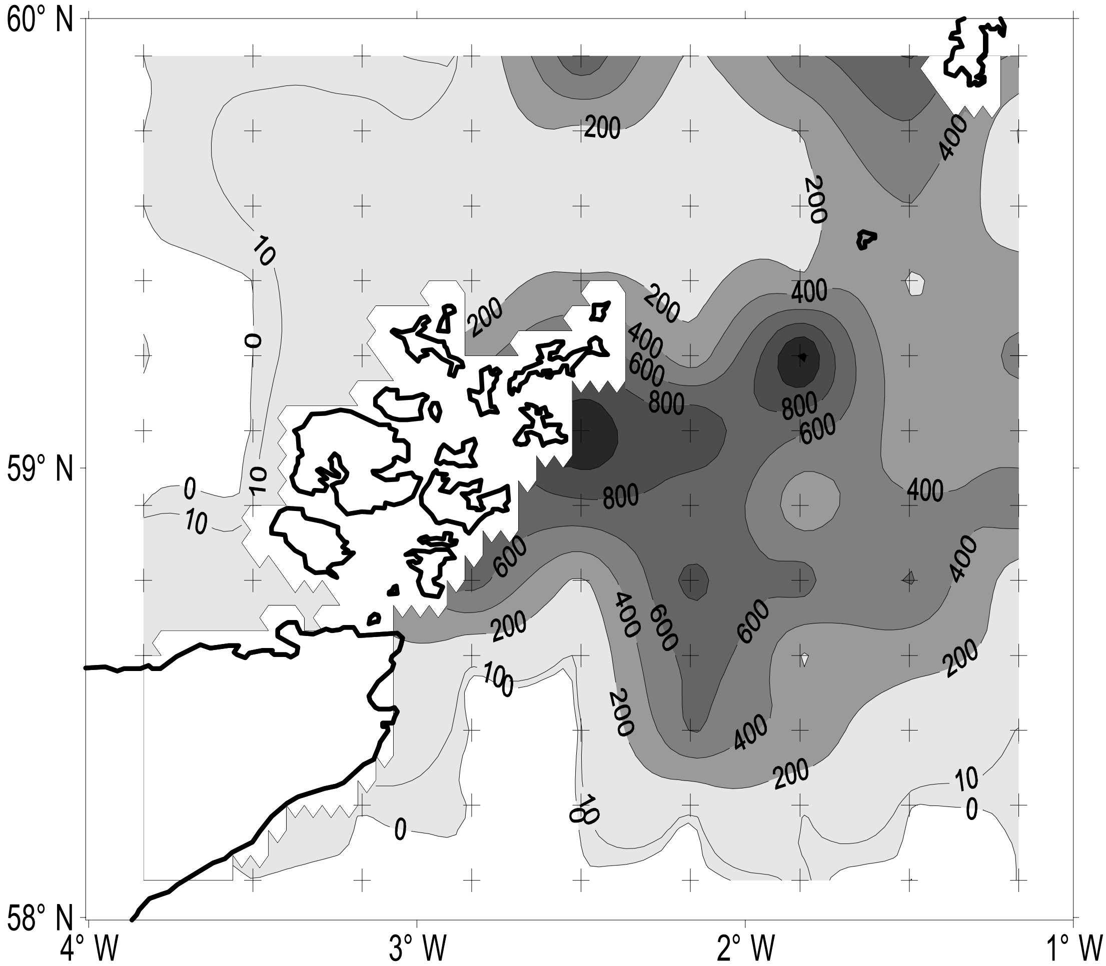


Figure 2.3.2.1 Orkney/Shetlands 16–30 September 2002 (FRG). Abundance of larvae < 10 mm (n/m²)

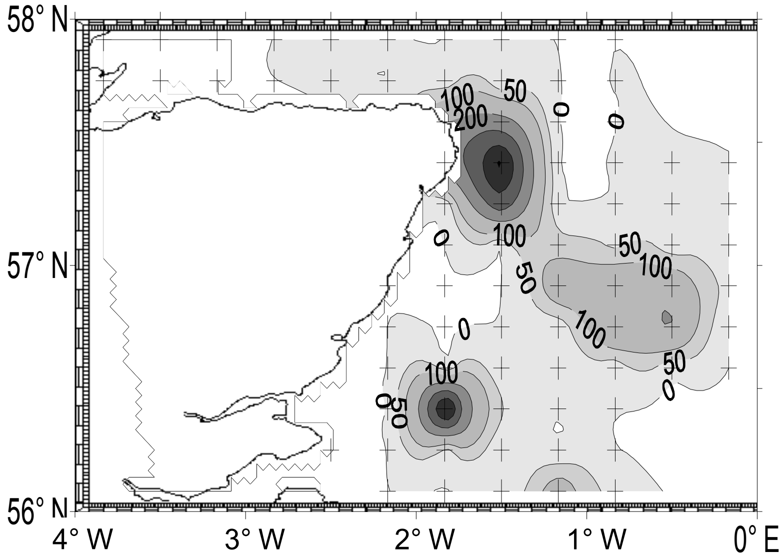


Figure 2.3.2.2 Buchan 16–30 September 2002 (FRG). Abundance of larvae < 10 mm (n/m²)

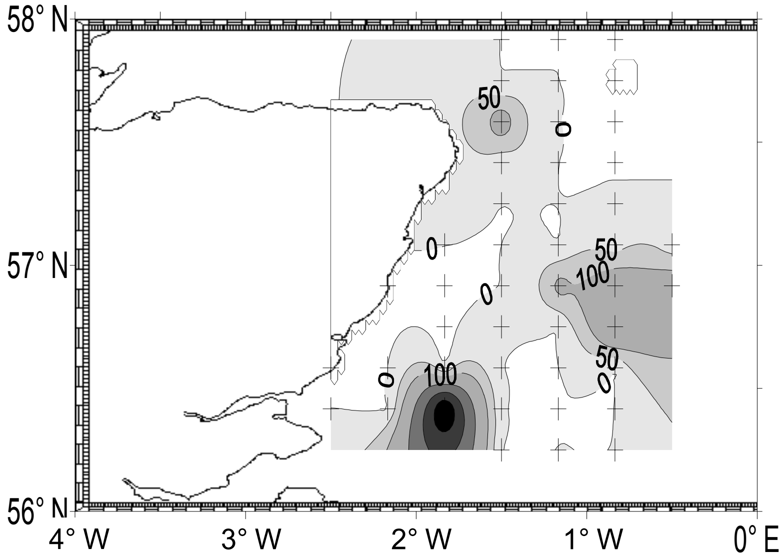


Figure 2.3.2.3 Buchan 16–30 September 2002 (NL). Abundance of larvae < 10 mm (n/m²)

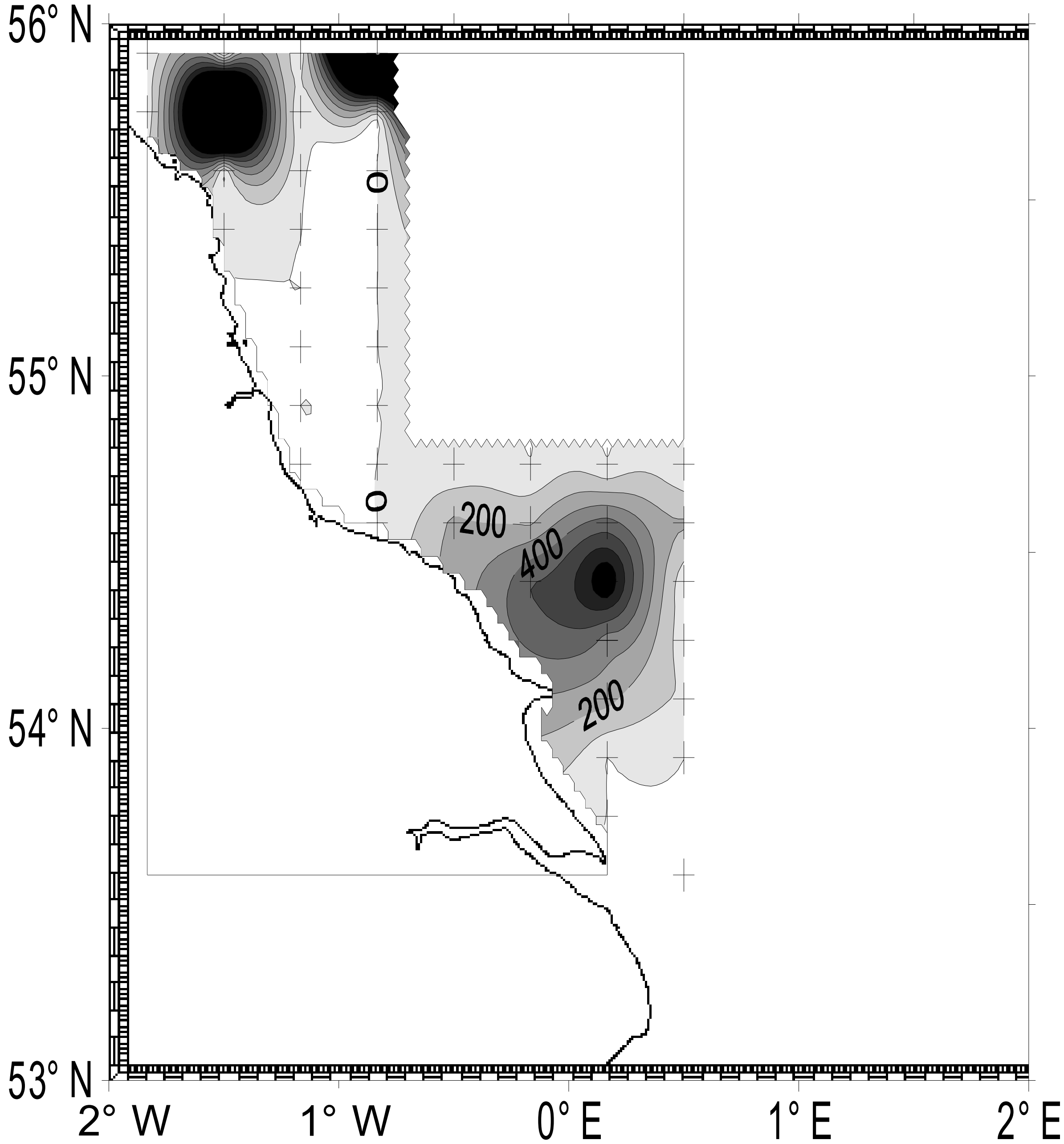


Figure 2.3.2.4 Central North Sea 01-15 October 2002 (NL). Abundance of larvae < 10 mm (n/m²)

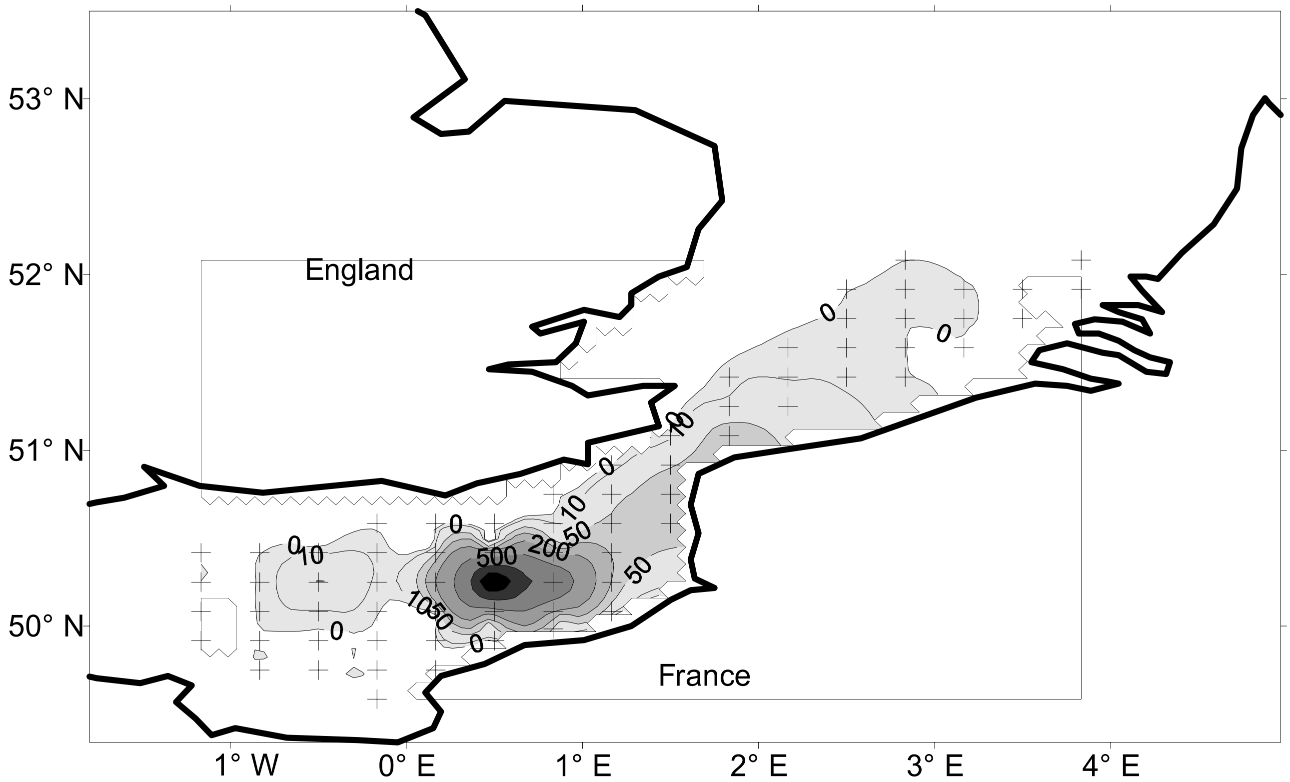


Figure 2.3.2.5 Southern North Sea 16-31 December 2002 (NL). Abundance of larvae < 11 mm (n/m²)

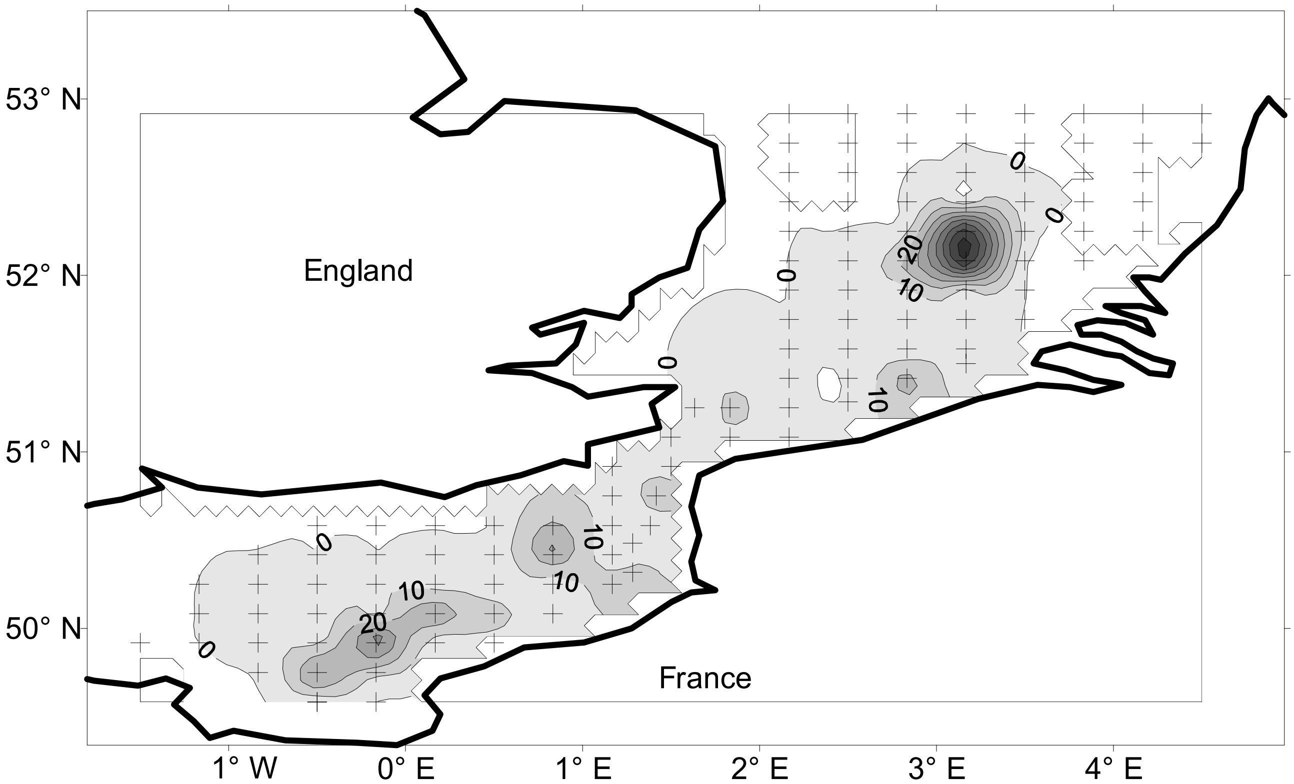


Figure 2.3.2.6 Southern North Sea 1-15 January 2003 (FRG). Abundance of larvae < 11 mm (n/m²)

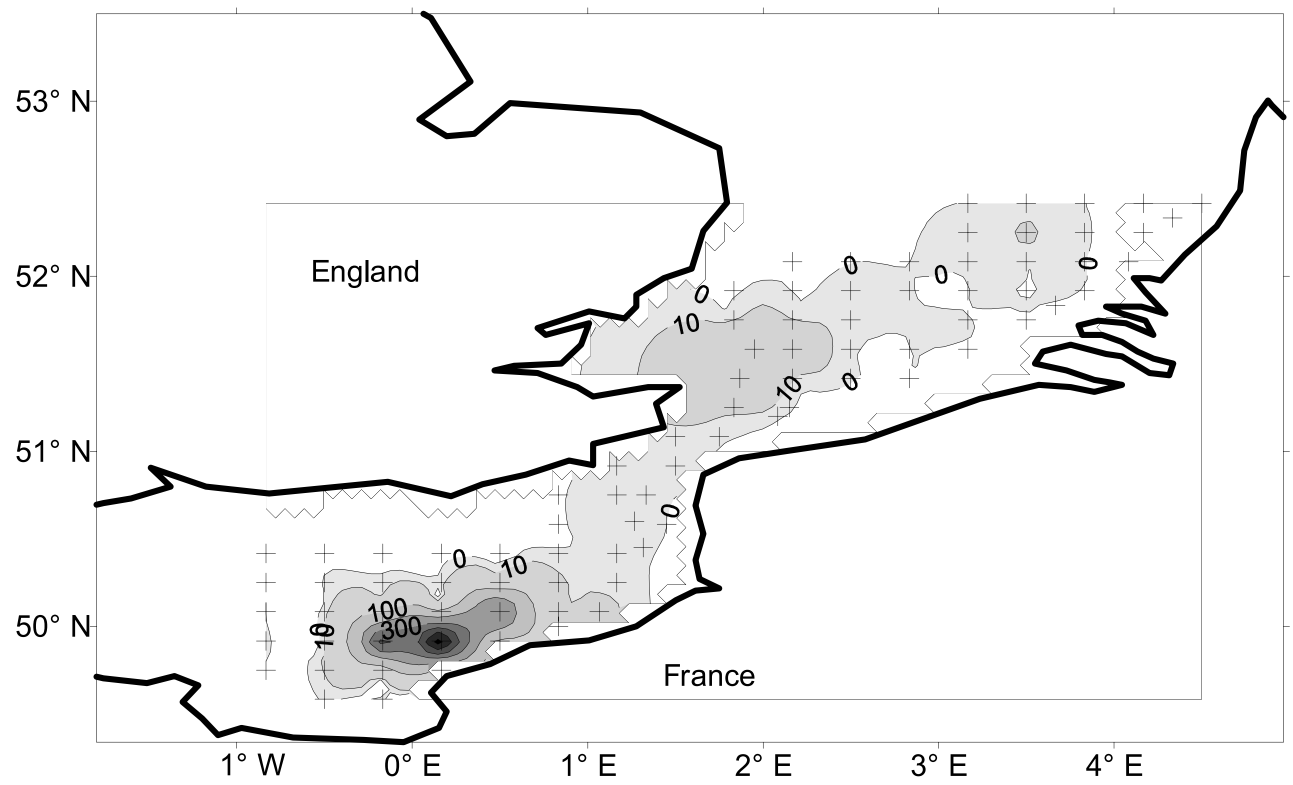


Figure 2.3.2.7 Southern North Sea 16-31 January 2003 (NL). Abundance of larvae < 11 mm (n/m²)

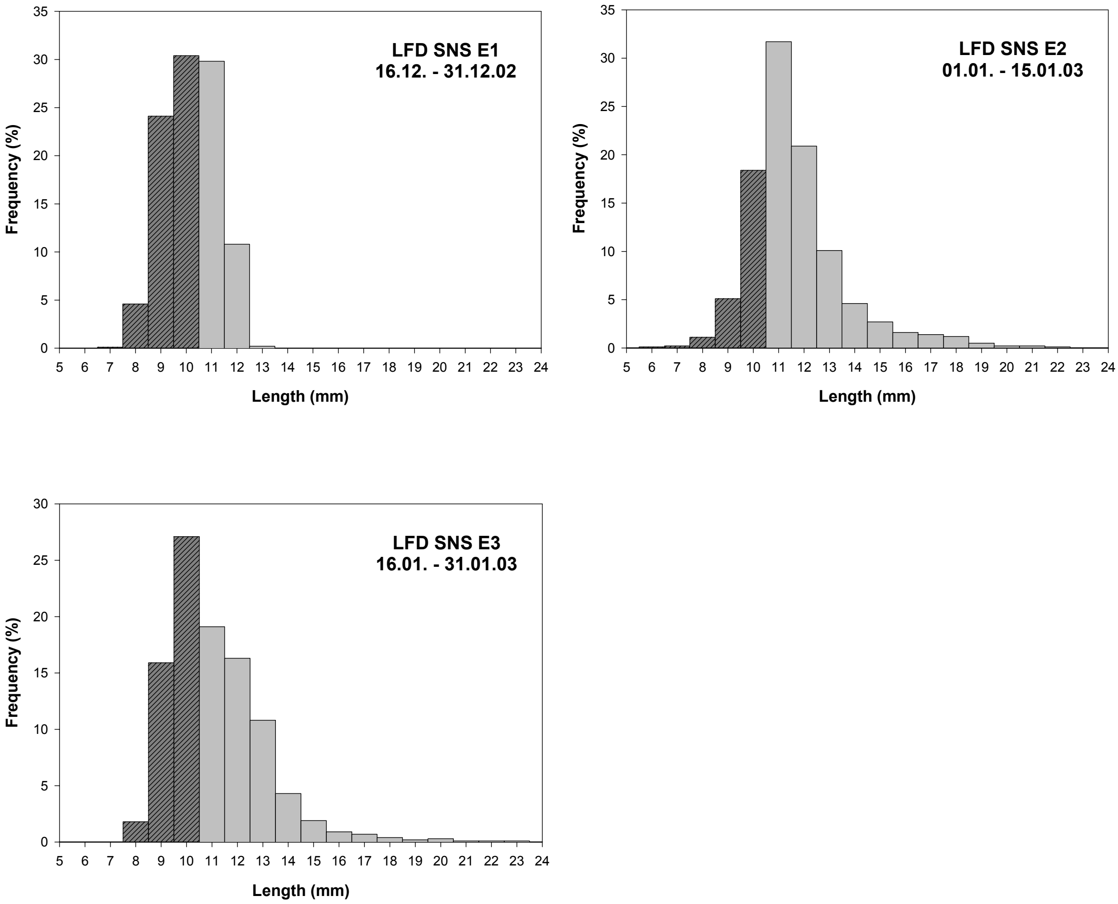


Figure 2.3.2.8 Length-frequency distribution of the three surveys in the SNS

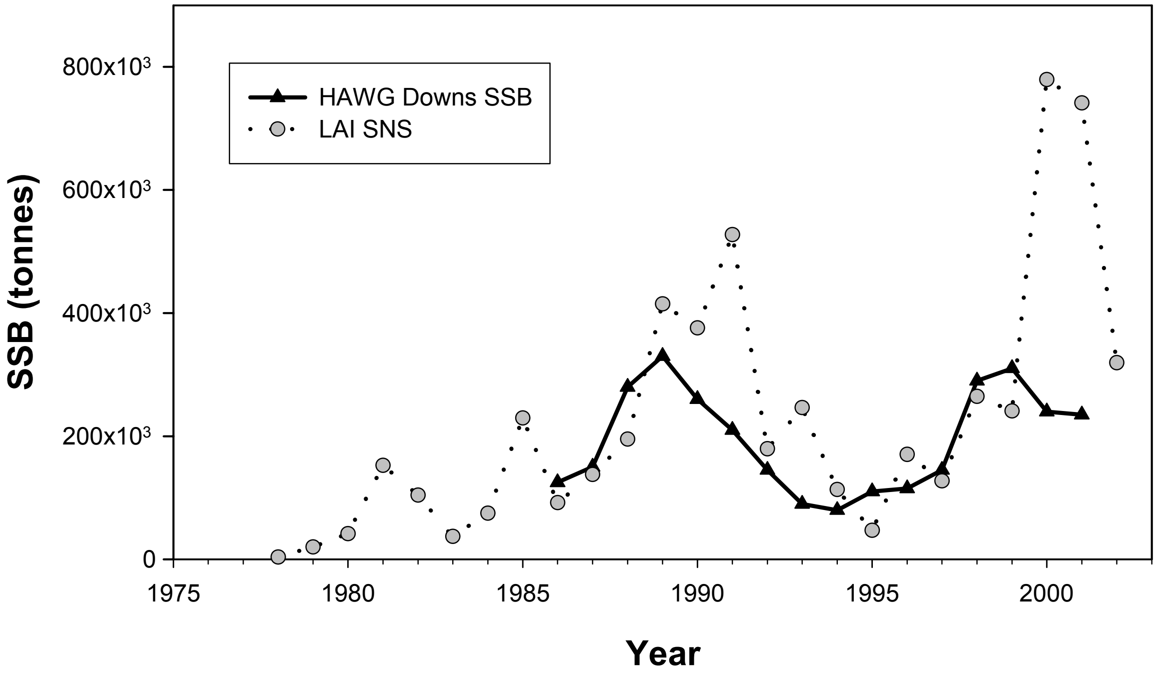


Figure 2.3.2.9 Comparison of spawning stock size HAWG estimates for the Downs herring and the LAI for the Southern North Sea. LAI estimates (Table 3) are multiplied by 100 to fit the same scale.

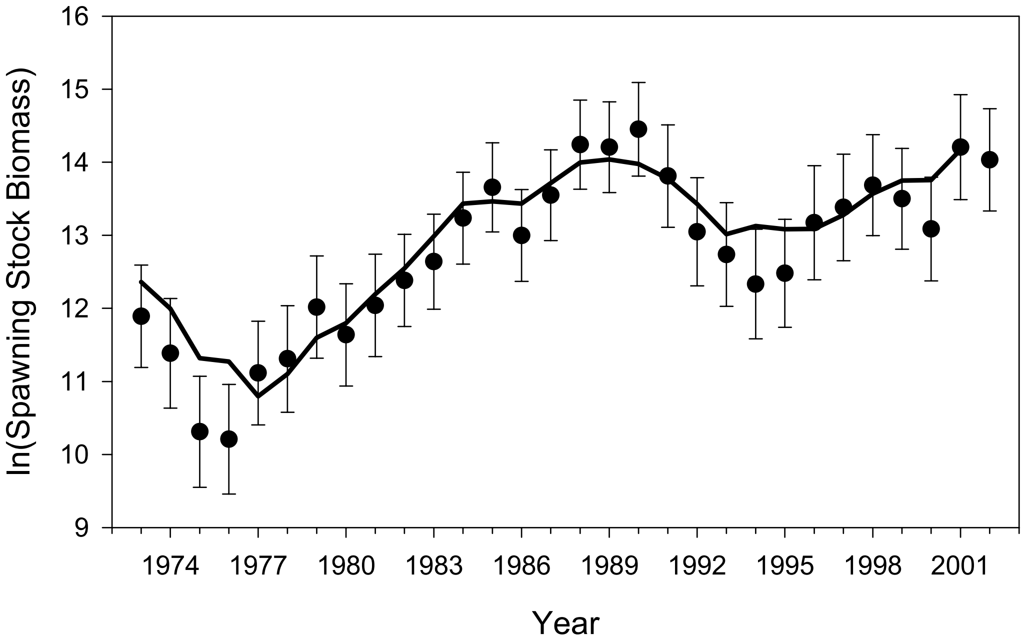


Figure 2.3.2.10 Comparison of spawning stock size estimates from the Herring Working Group (ICES, 2002; bold line) and the year effects fitted to the larval abundances in the multiplicative model (symbols with error bars). The MLAI estimates have been rescaled to the mean of the WG estimates. Error bars indicate +/- one standard error of larval survey abundance estimates.

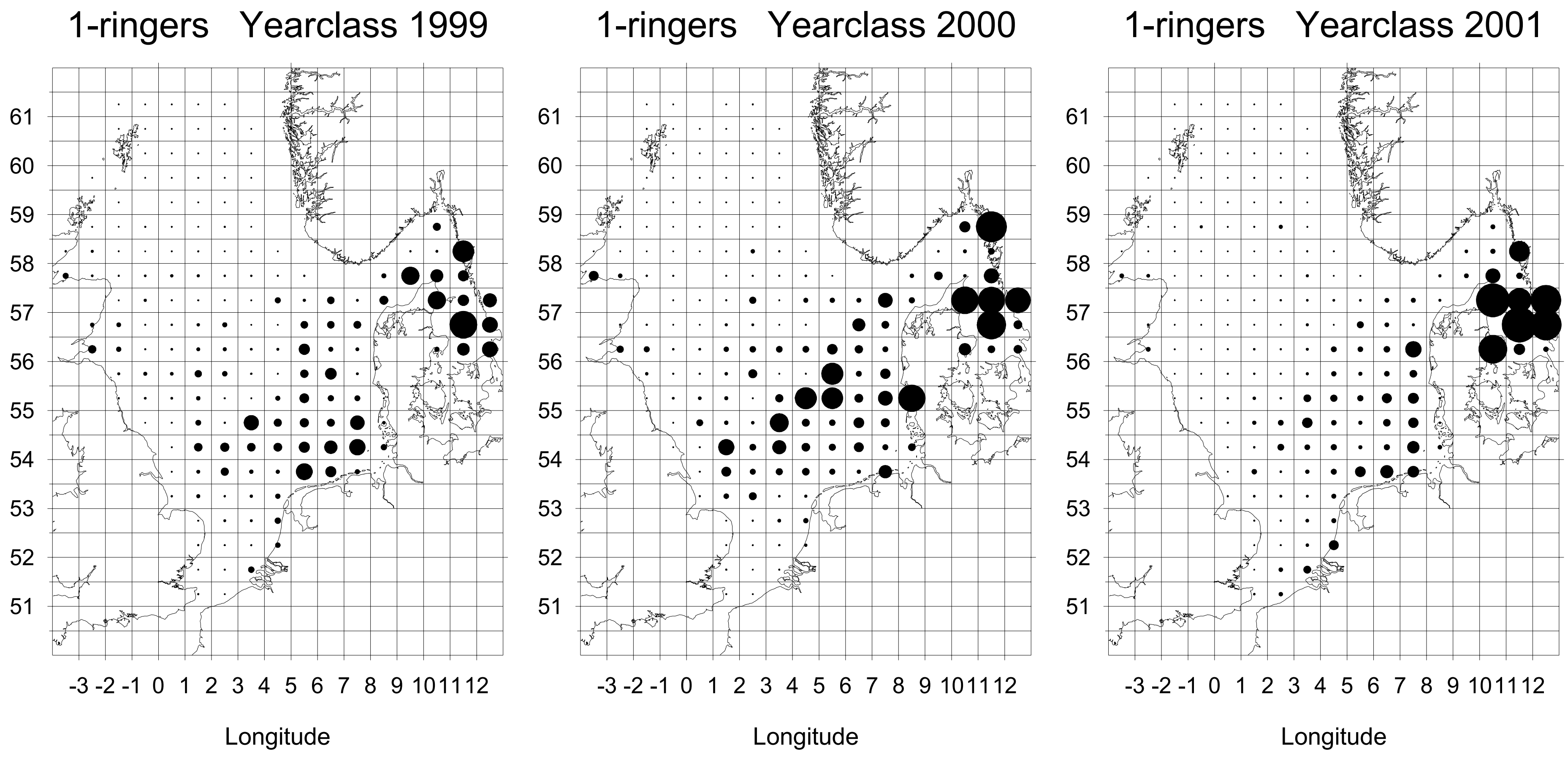


Figure 2.3.3.1 **North Sea herring**. Distribution of 1-ringer herring, year classes 1999-2001. Abundance estimates of 1-ringers within each statistical rectangle are based on GOV catches during IBTS in February 2003. Areas of filled circles illustrate numbers per hour, the area of a circle extending to the border of a rectangle represents 45000.

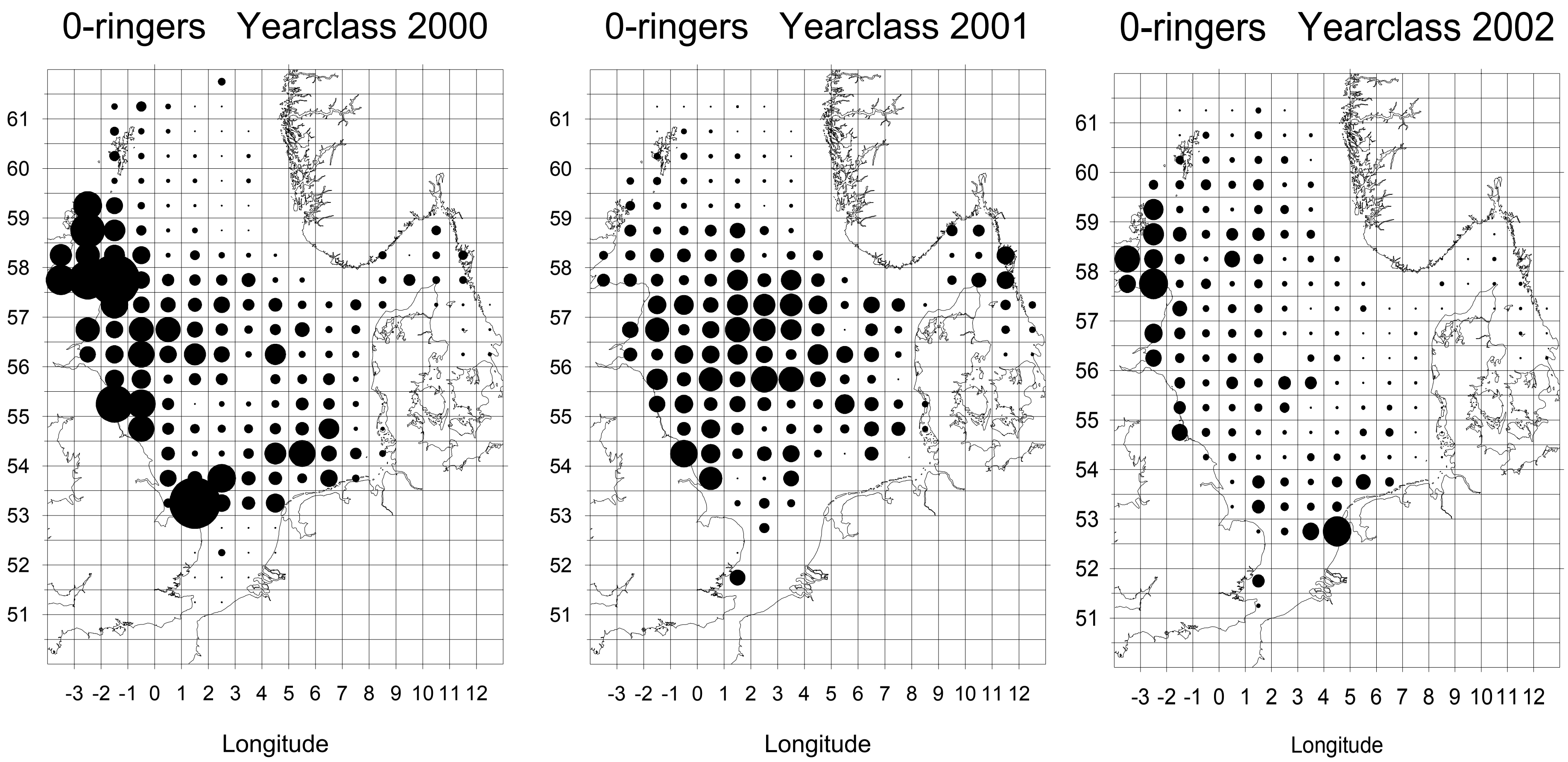


Figure 2.3.3.2 North Sea herring. Distribution of 0-ringer herring, year classes 2000-2002. Abundance estimates of 0-ringers within each statistical rectangle are based on MIK catches during IBTS in February 2003. Areas of filled circles illustrate densities in no m^{-2}, the area of a circle extending to the border of a rectangle represents 1 m^{-2}

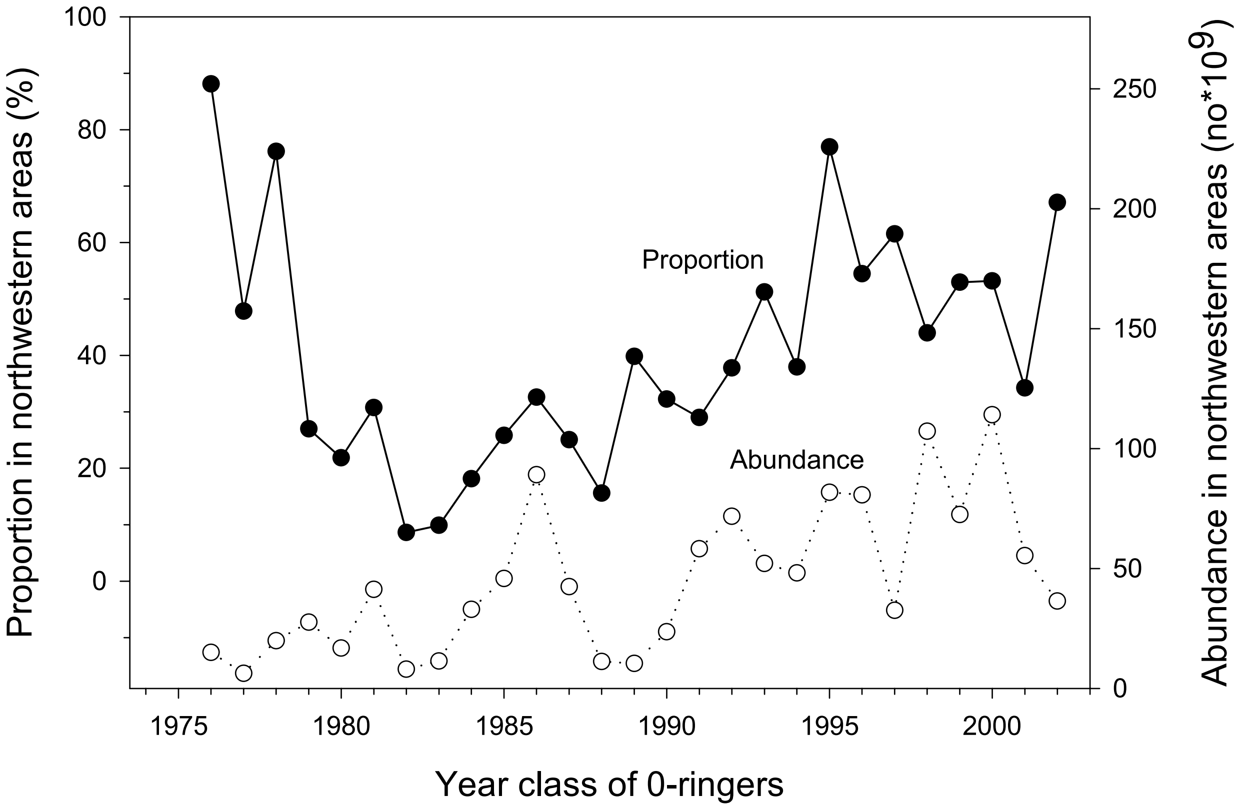


Figure 2.5.1 North Sea herring. Changes in abundance of 0-ringers in the north-western part of the survey area. Relative abundance (percentage of total) and absolute abundance (number within area) is illustrated by filled and open circles, respectively.

Relationship between herring recruitment indices

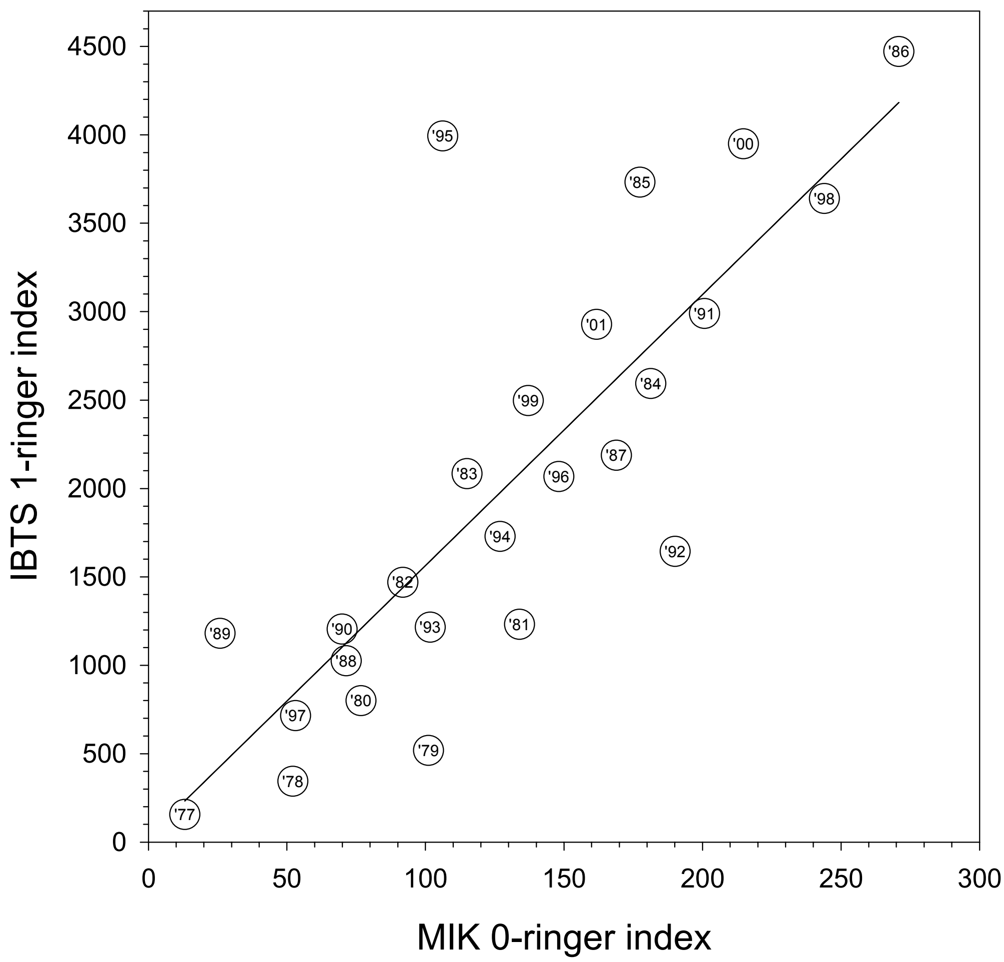


Figure 2.5.2 North Sea herring. Regression between the MIK 0-ringer index and the IBTS 1-ringer indices for year classes 1977 to 2001. Numbers in symbols indicate year class.

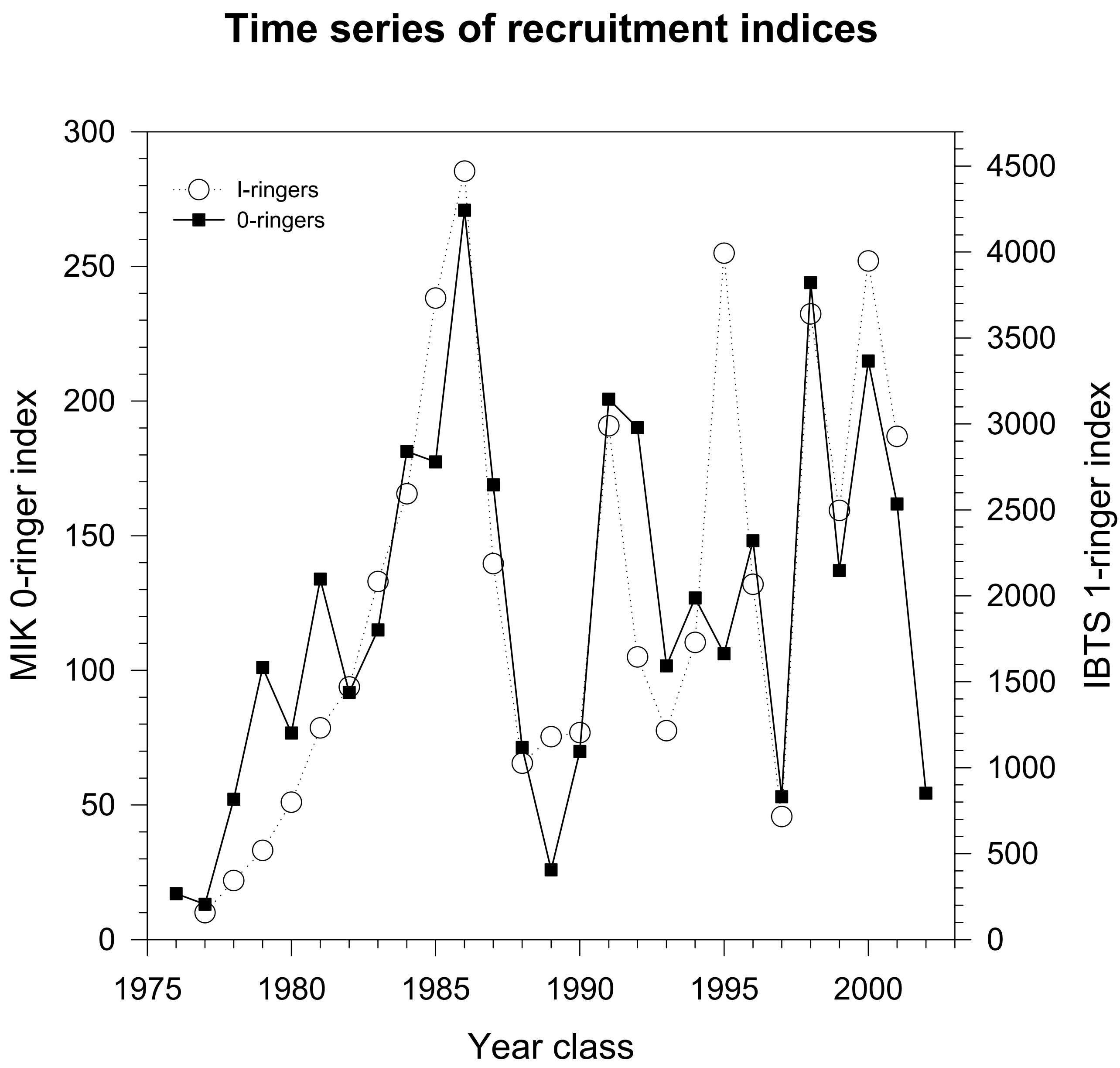


Figure 2.5.3 North Sea herring. Time-series of recruitment indices based on catches of either 0-ringers or 1-ringers during the IBTS. Year class 1976 to 2002 (0-ringers) or 1977 to 2001 (1-ringers).

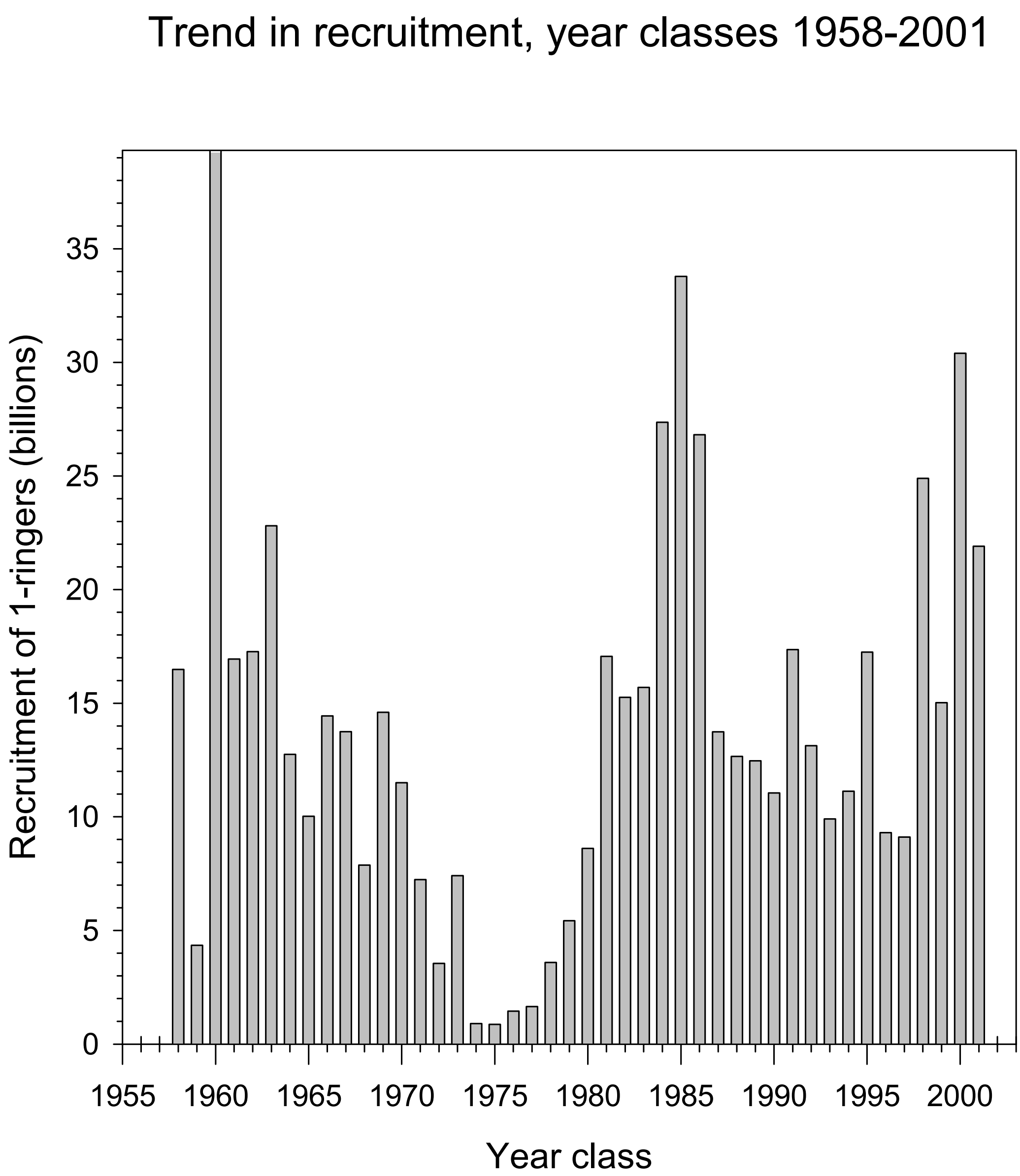


Figure 2.5.4 North Sea herring. Trend in recruitment of 1-ringers from year class 1958 to 2001. Data from the 2003 ICA assessment of the North Sea autumn-spawned herring.

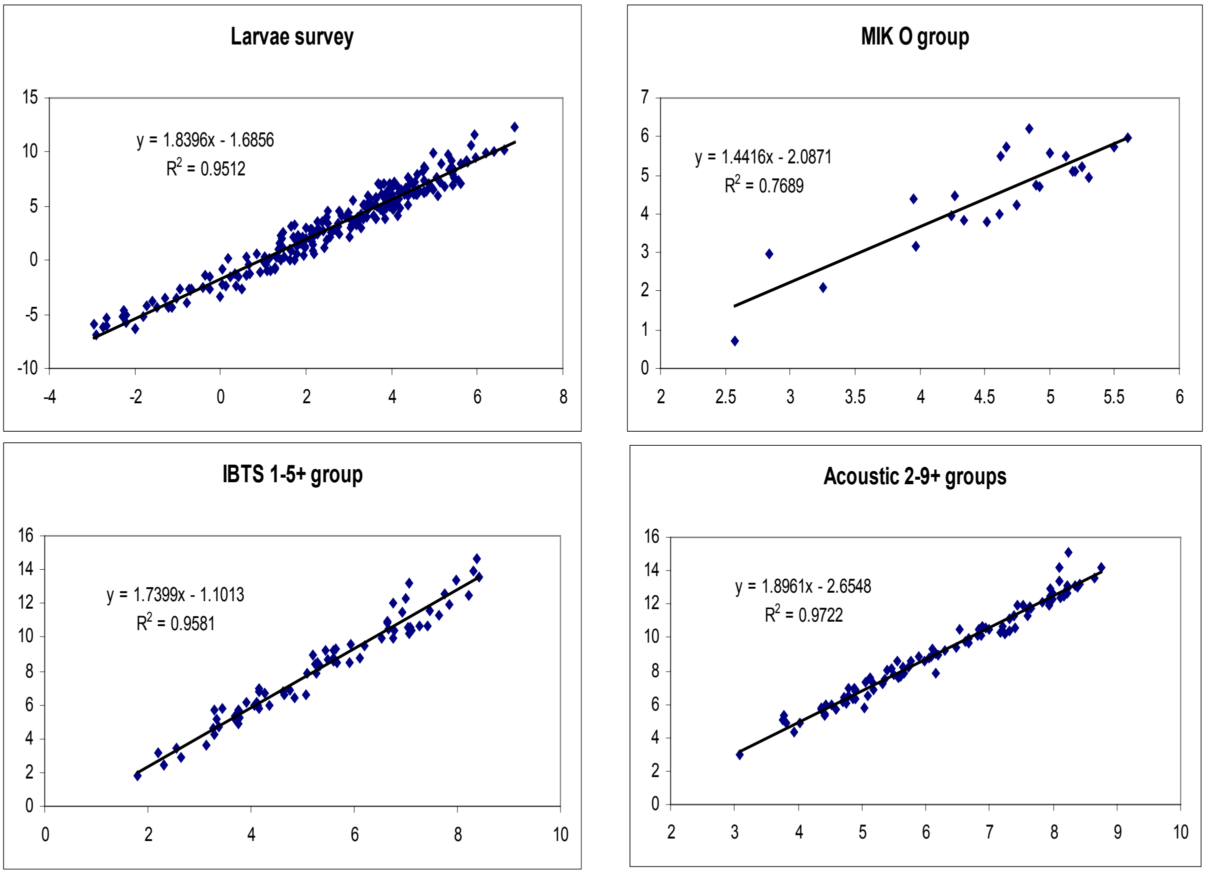
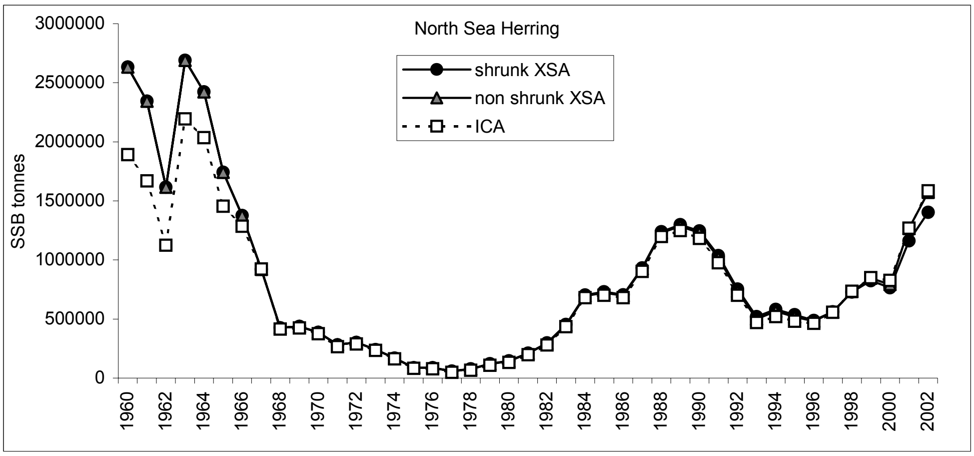


Figure 2.6.1.1 North Sea Herring. Scatter plots of ln(variance(index)) against ln(mean(index)).



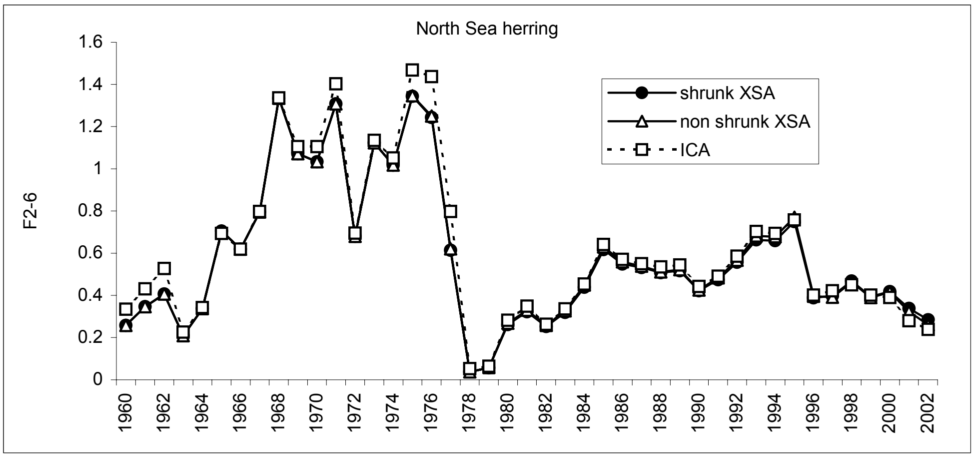


Figure 2.6.1.2 North Sea herring. Comparison of results of ICA and XSA model fits of North Sea herring, 1960-2002. Shrunk XSA=0.5, non shrunk= 2.0 (Table 2.6.1.8). ICA settings of final assessment (Section 2.6.2).

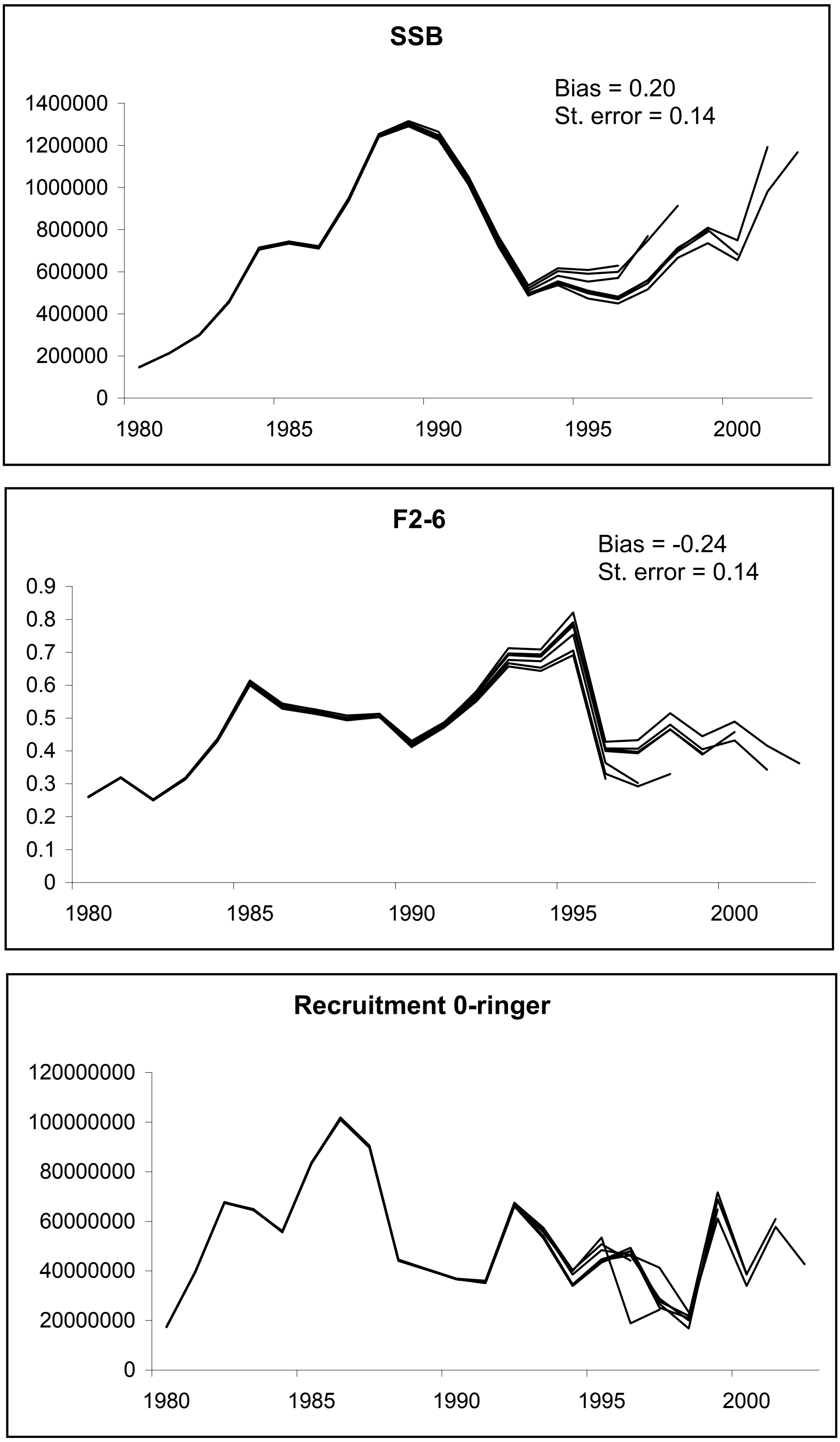


Figure 2.6.1.3 North Sea herring. Retrospective analysis using XSA with an 8-year shifting tuning window. Low shrinkage = 2.0.

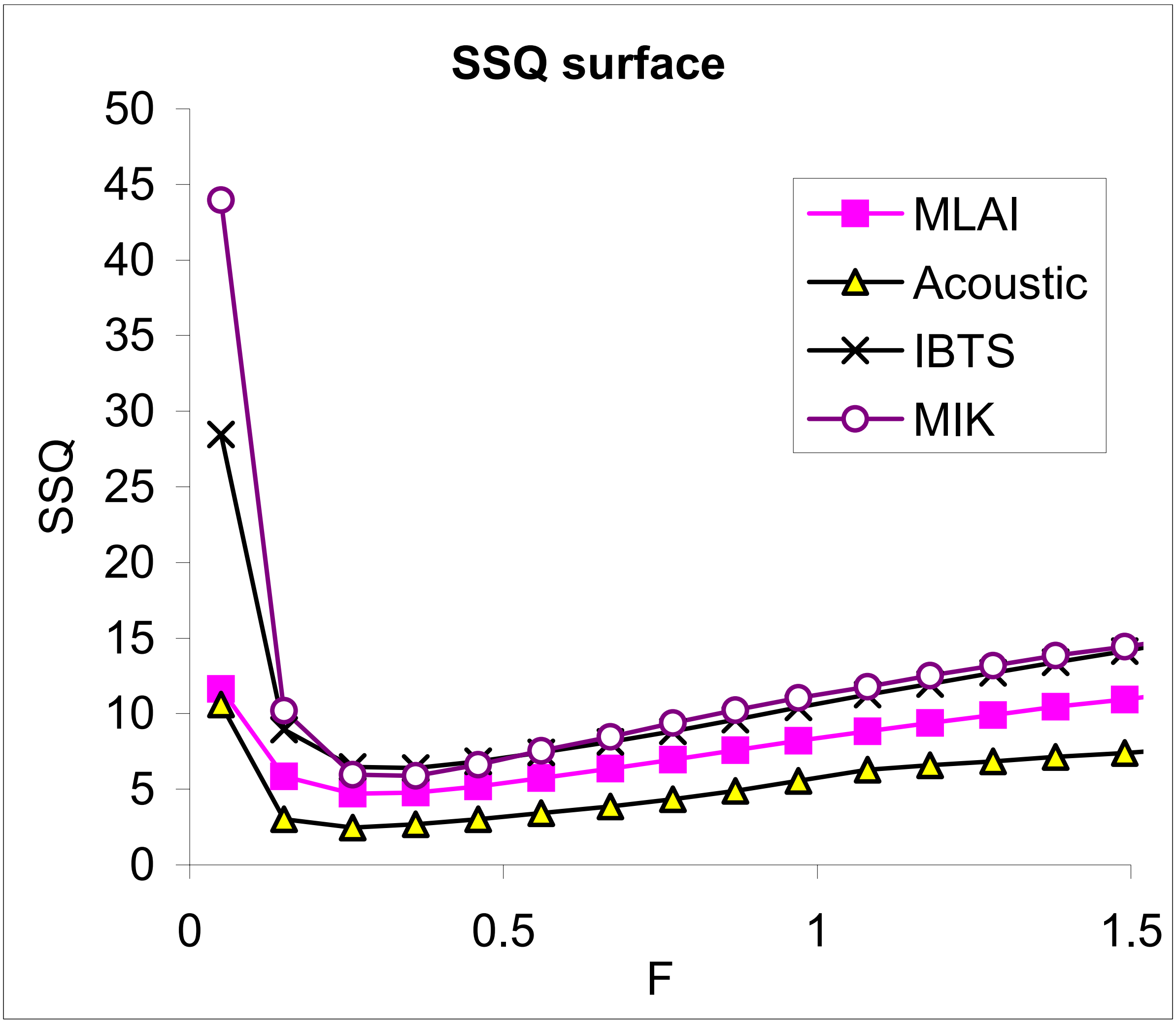
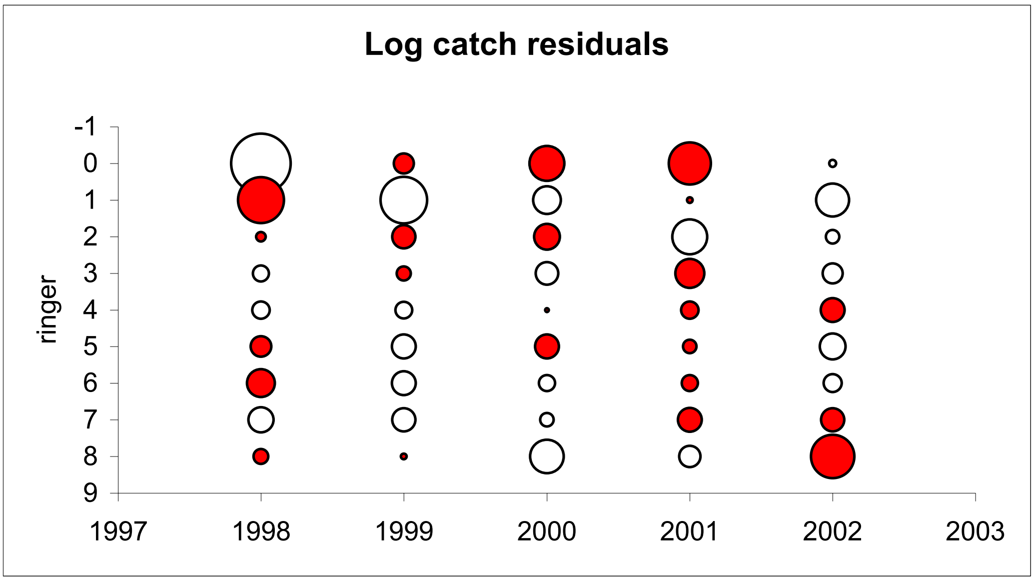


Figure 2.6.2.1 North Sea herring. Sum of square surface for tuning fleets from the final model fit.



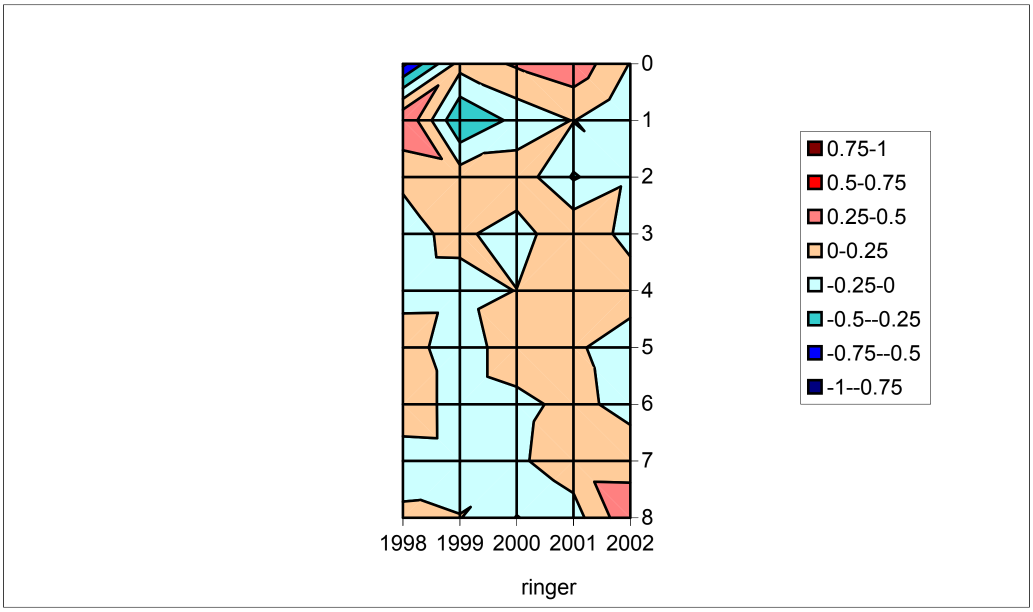


Figure 2.6.2.2 North Sea herring.. Log catch residuals of the separable period (5 years) from the final model fit.

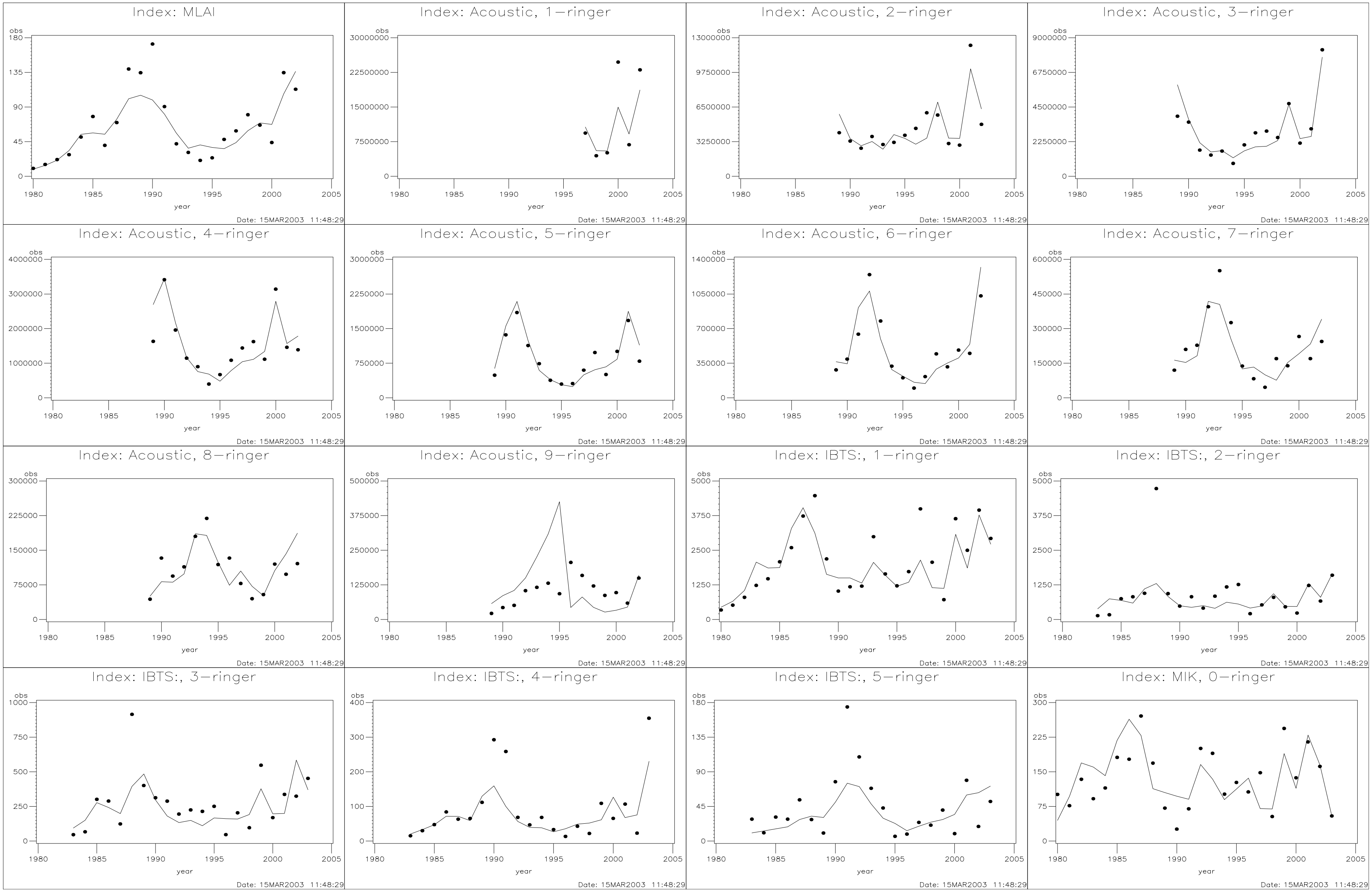


Figure 2.6.2.3 North Sea herring. Time-series of survey indices and predicted stock numbers from the final model fit.

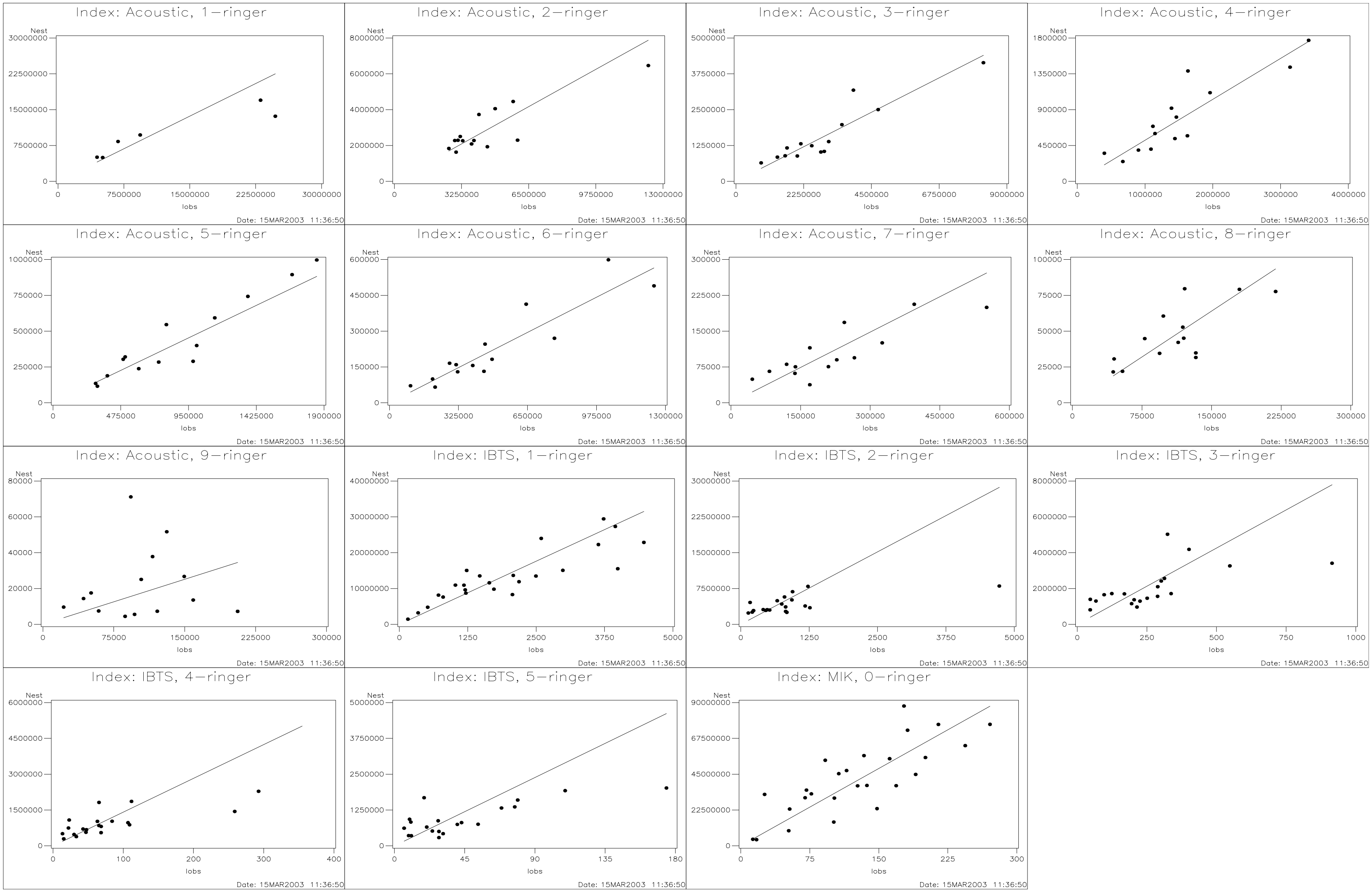


Figure 2.6.2.4 North Sea herring. Regression of survey indices against stock numbers using the catchability estimates from the final model fit.

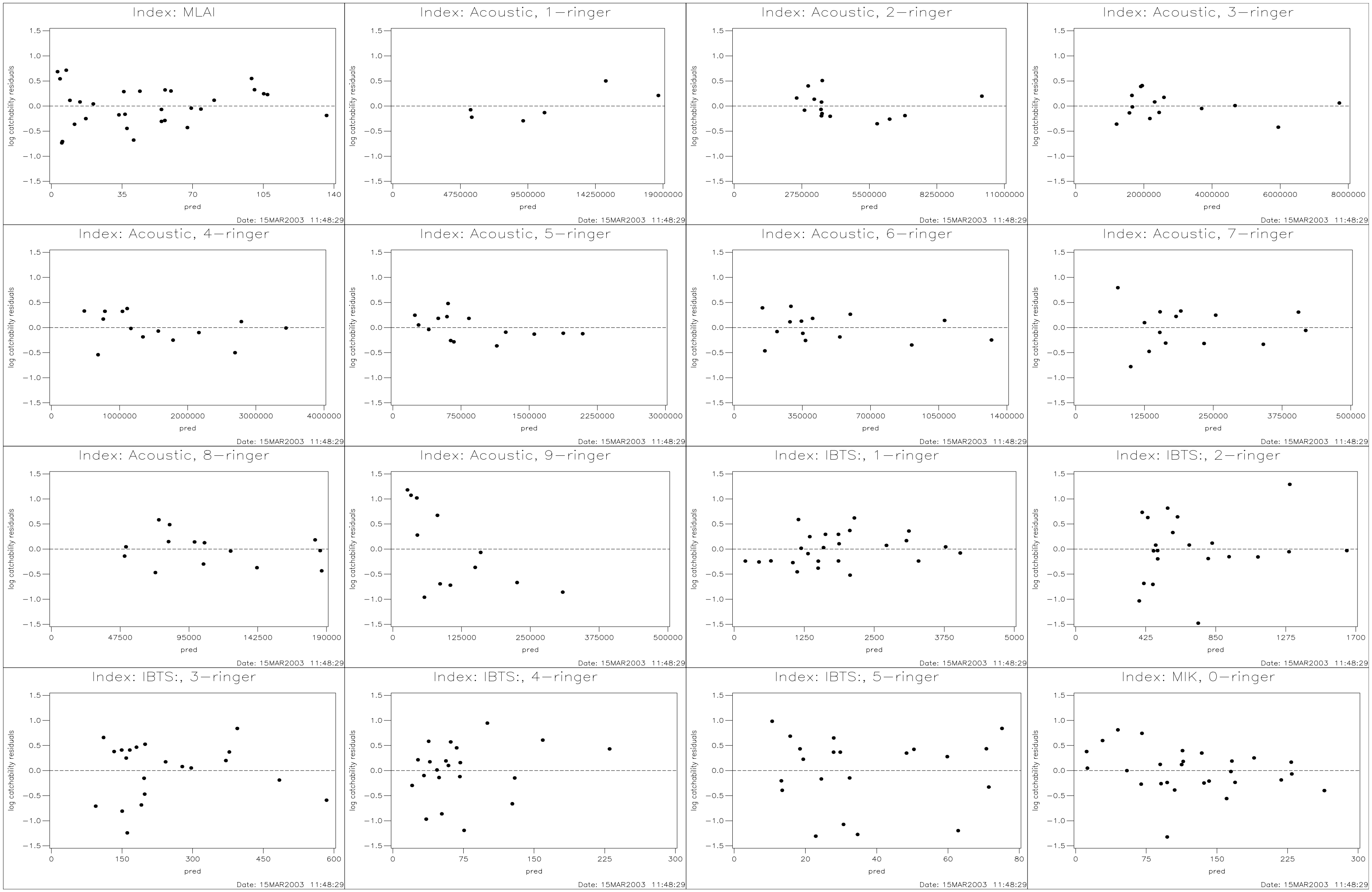


Figure 2.6.2.5. North Sea herring. Log catchability residuals plotted against the expected value of the index.

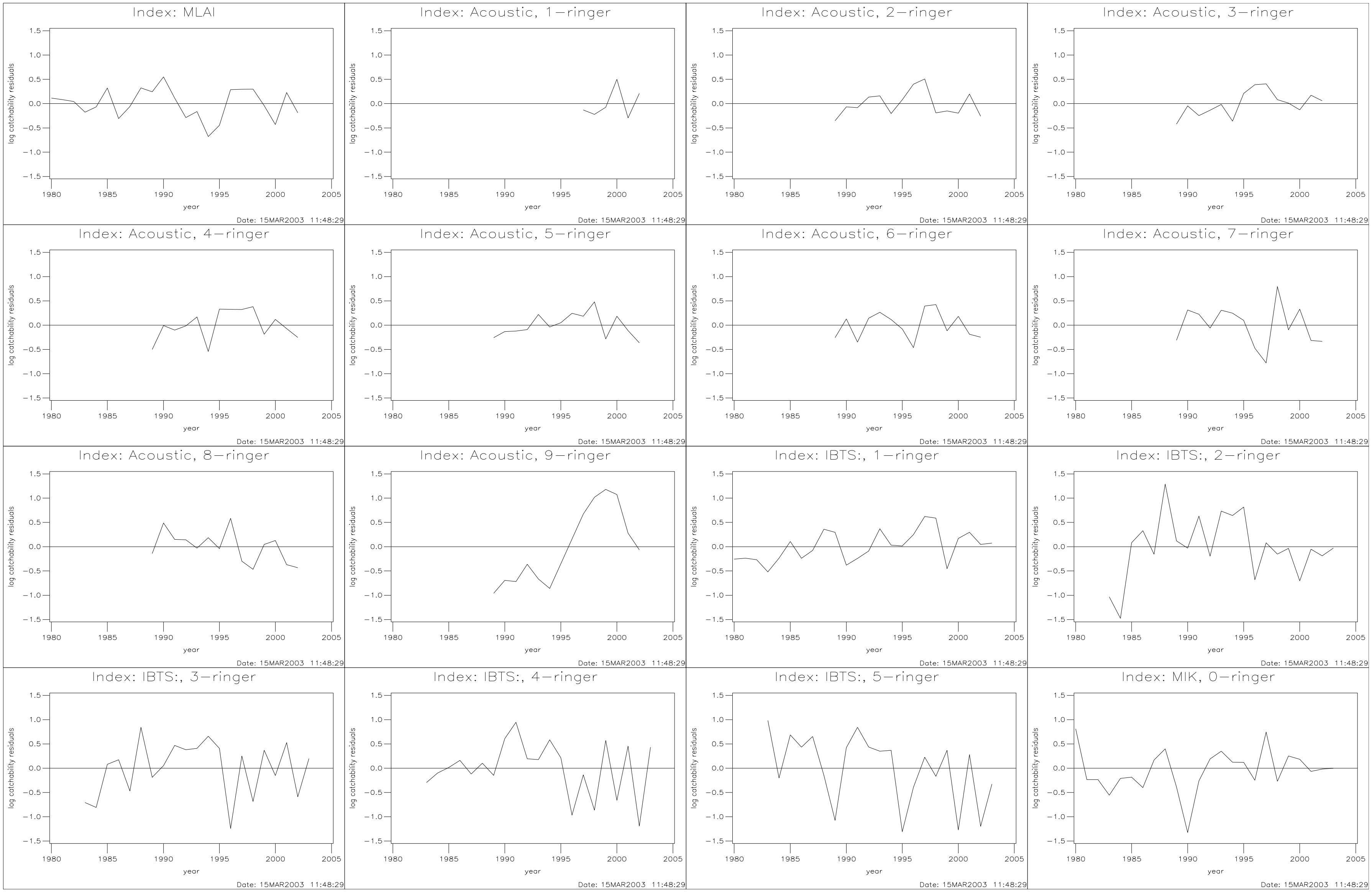


Figure 2.6.2.6 North Sea herring.. Log catchability residuals from fitted model plotted against time.

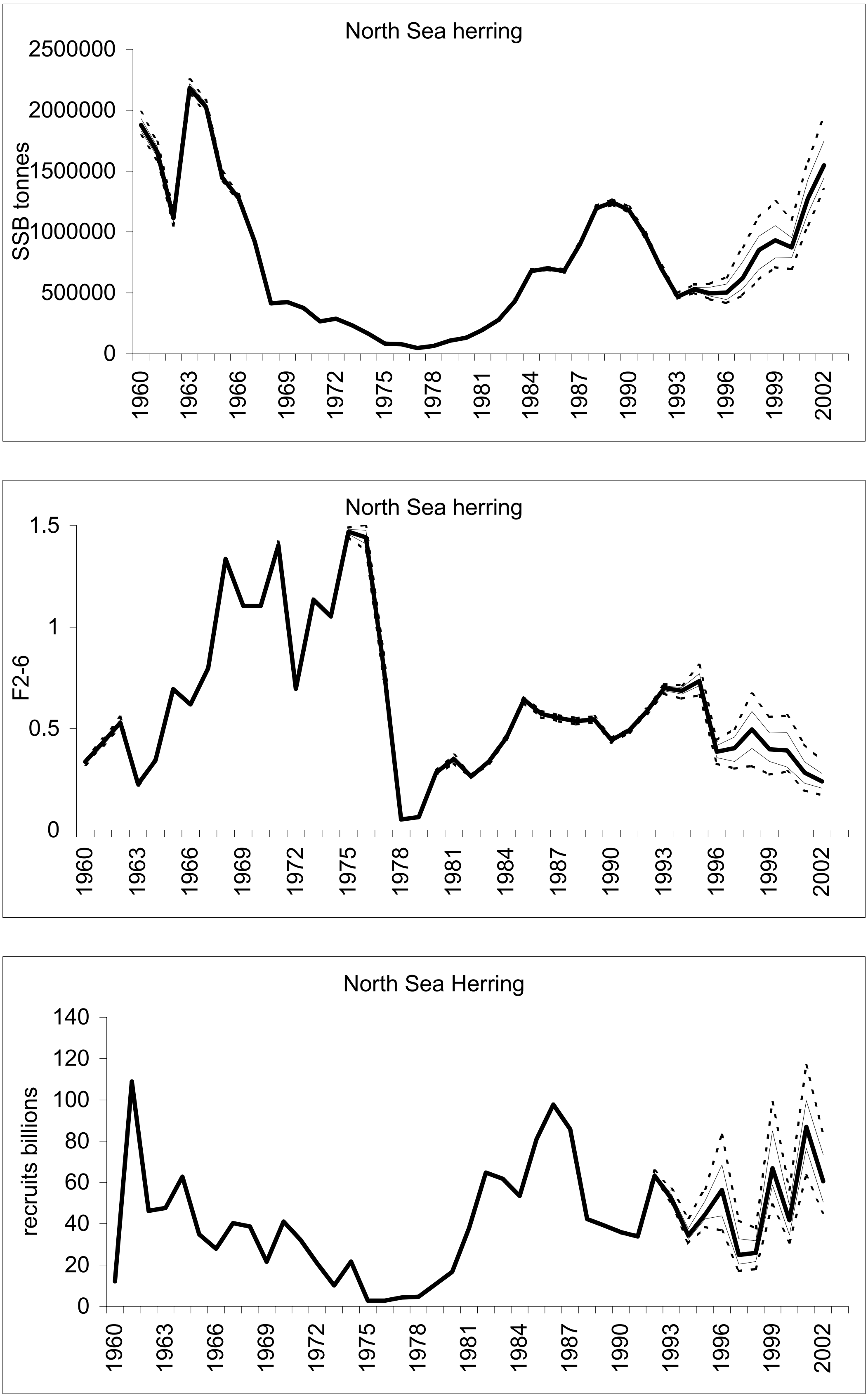


Figure 2.6.2.7 North Sea herring. Historic uncertainty in the final model fit (ICA assessment). Percentiles 10, 25, 50, 75 and 90%.

Herring in Sub-area IV, Divisions VIId & IIIa (autumn-spawners)

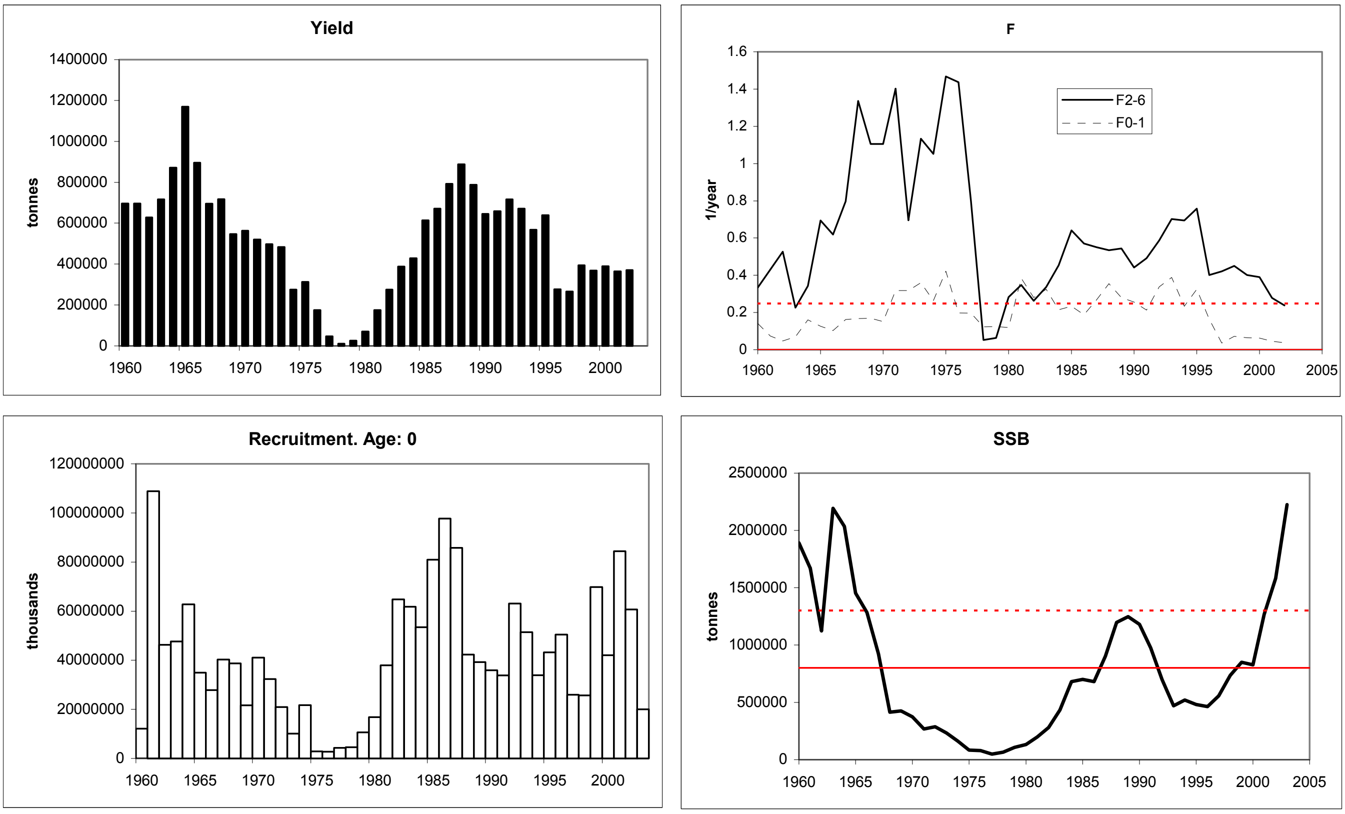


Figure 2.6.2.8 North Sea herring. Stock summary. Yield, F, recruitment and SSB from current assessment.

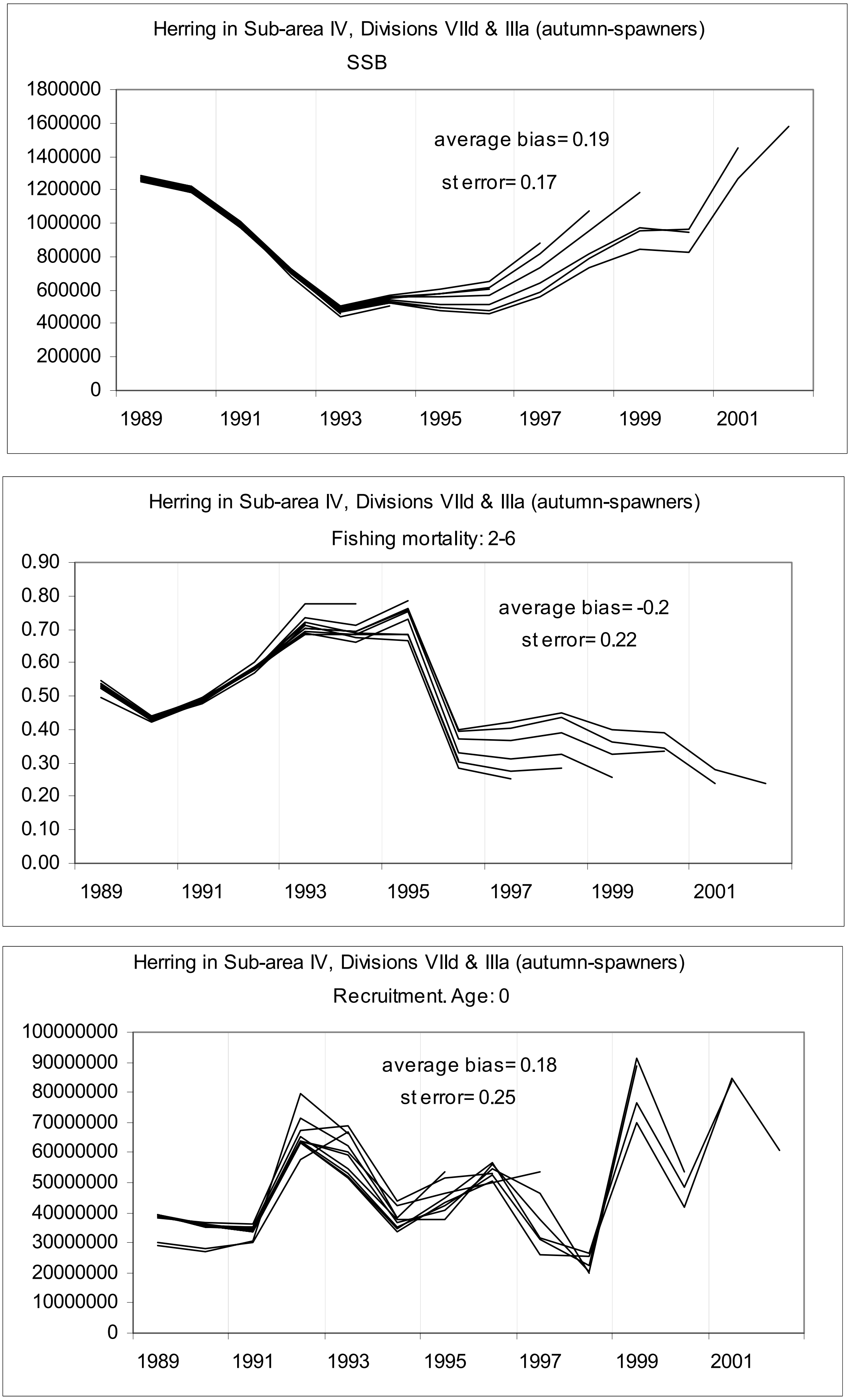


Figure 2.6.2.9 North Sea herring. Retrospective analysis of final model fit (ICA), from 2002 to 1993.

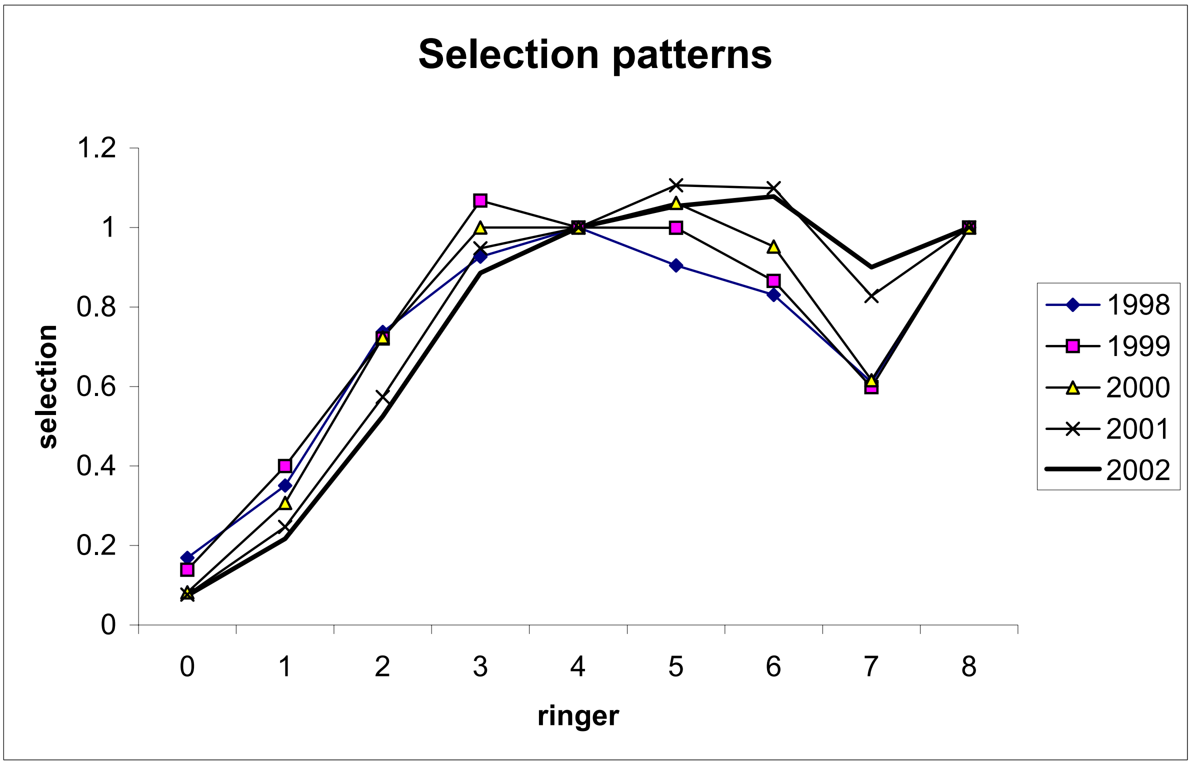


Figure 2.6.2.10 North Sea herring. Retrospective analysis of selection pattern of final model fit (ICA), from 2002 to 1998.

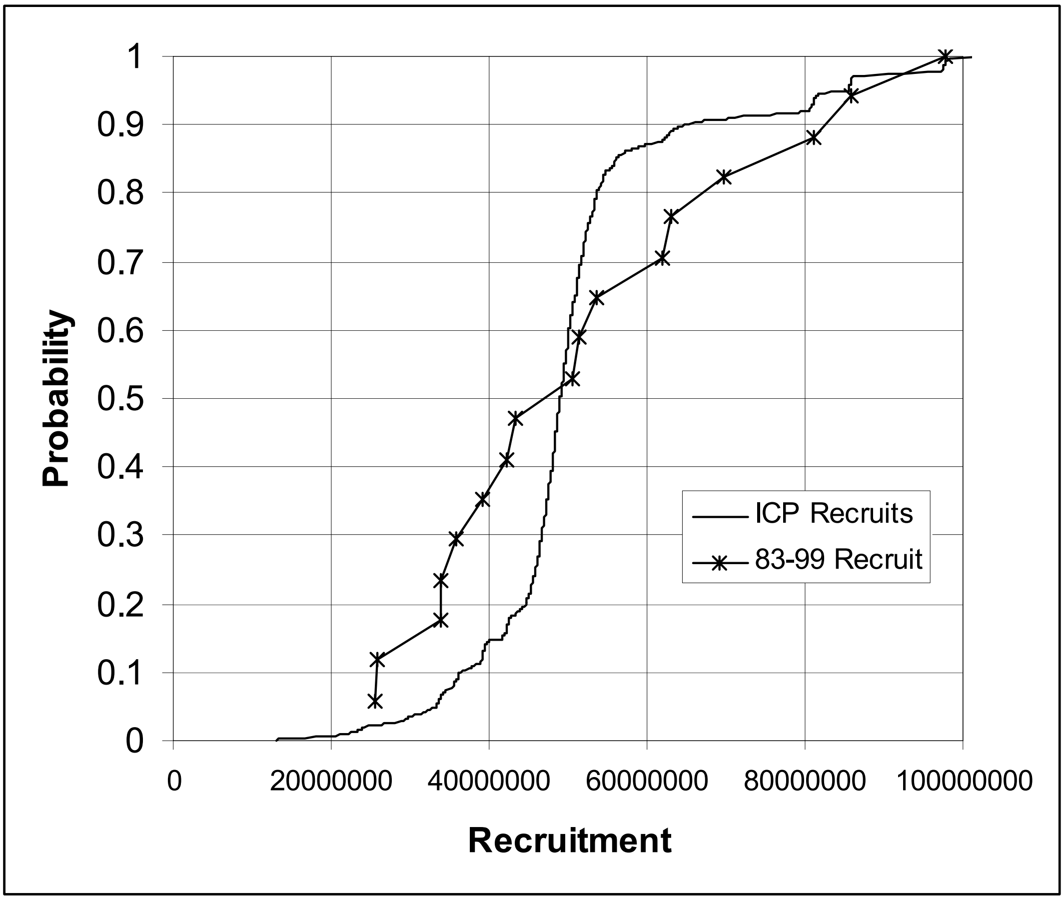
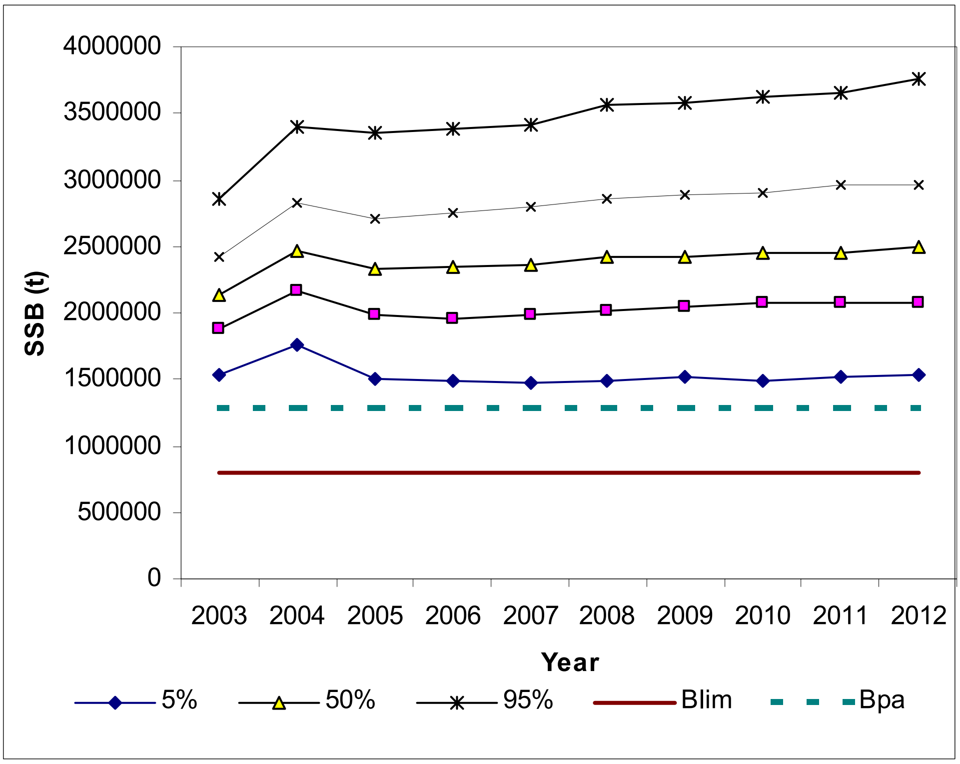


Figure 2.8.1 Medium-Term Prediction with ICP. Comparison of cumulative probability distributions for recruitment used for the medium-term projections by ICP with stock recruit relationship option Ockham with data restricted to recruitment years 1983 to 1999, (O group) the period after recovery. Showing the agreement in spread of recruitment values but the reduced dispersion in ICP.



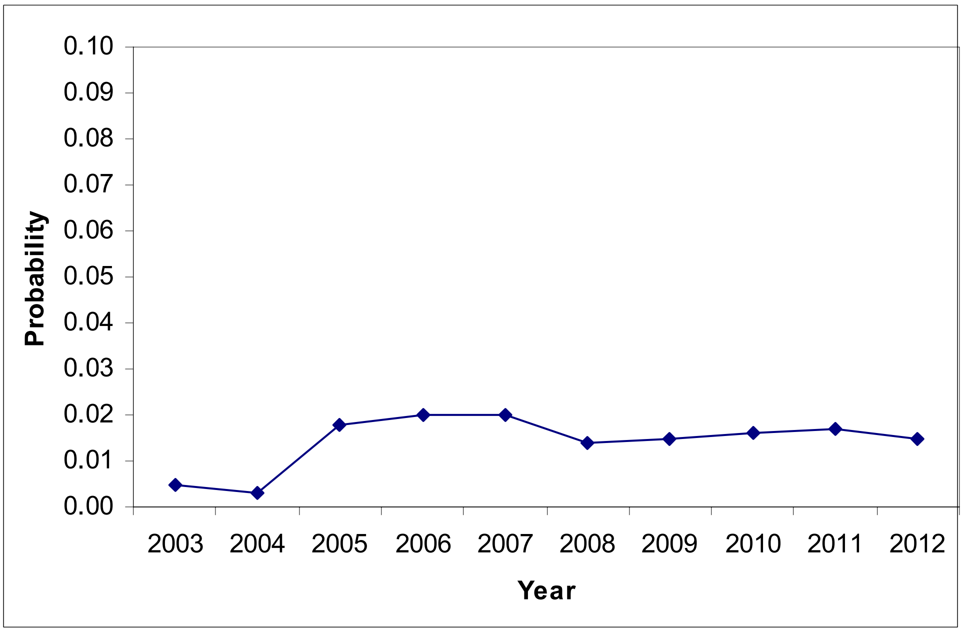


Figure 2.8.2 Medium-Term Prediction with ICP. SSB and risk of SSB falling below $\mathbf{B}_{pa}$ (1.3M t) from 2003 to 2012 the risk if SSB falling below $\mathbf{B}_{lim}$ is 0 for F= F*status quo.* For the medium-term projections by ICP with stock recruit relationship option Ockham with data restricted to recruitment years 1983 to 1999, (O group), the period after recovery. (Note maximum scale on the risk graph is 0.1 or 10%)

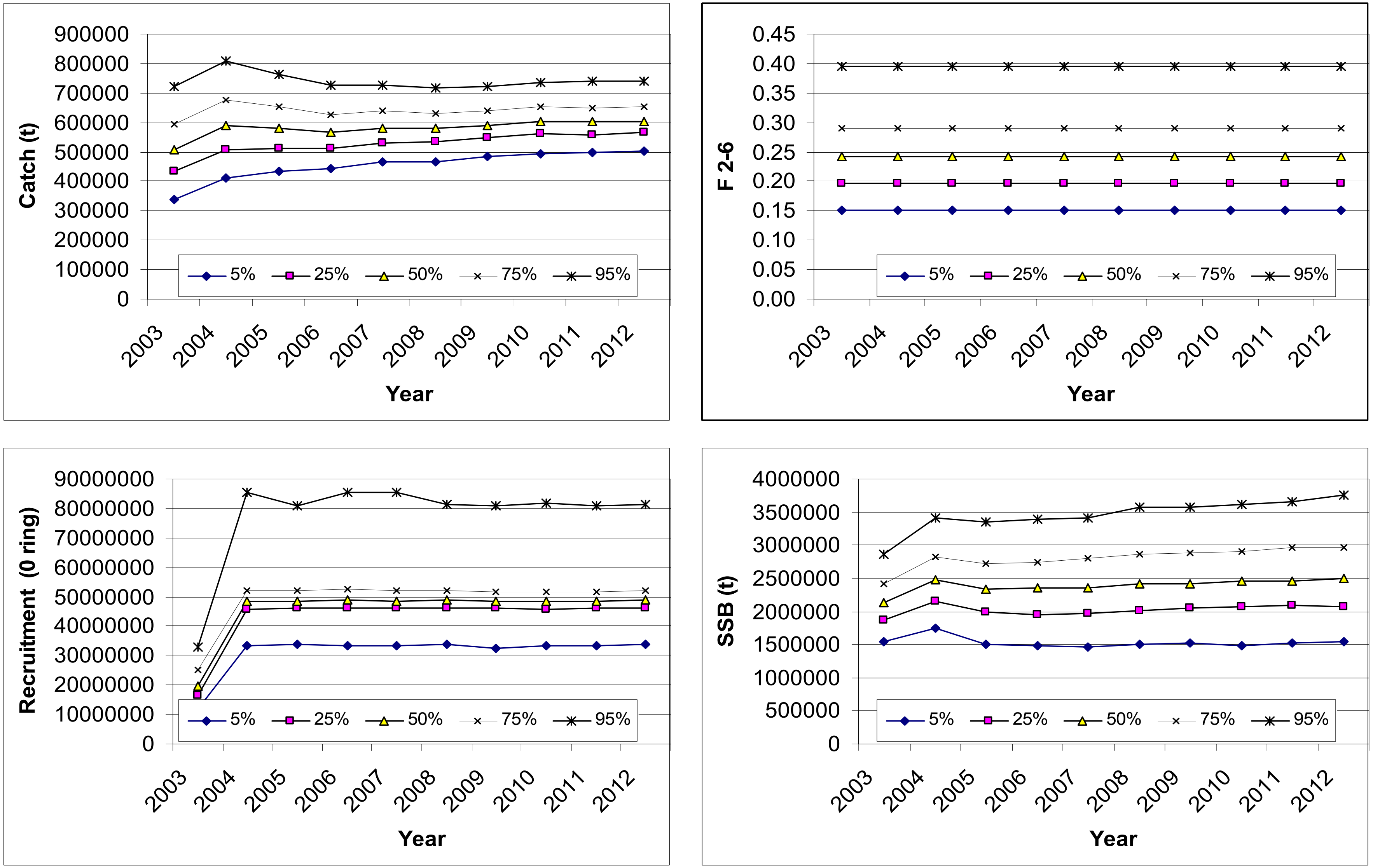


Figure 2.8.3 Catch, Fishing mortality, recruitment and SSB from ICP Medium-Term Projection. ICP with stock recruit relationship option Ockham with data recruitment years 1983 to 1999, (O group), the period after recovery. (The low recruitment in 2003 is estimated from MIK index)

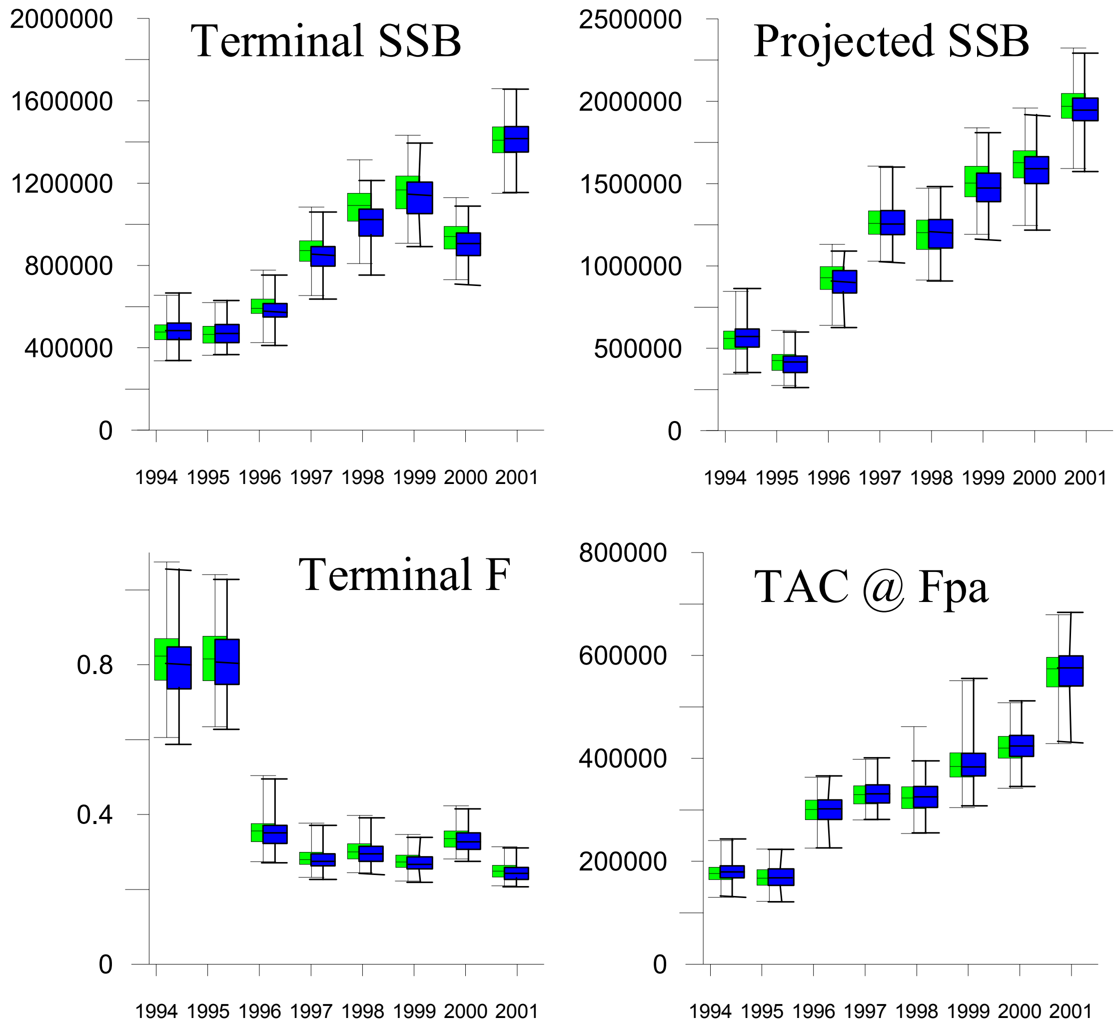


Figure 2.10.1 The variability in terminal SSB & F, and projected TAC year SSB & TAC and over the period 1995 to 2002 coming from variability in the input data with a) mean weights and fraction mature updated annually as in the current assessment (blue) and b) with overall means (1993- terminal year) used for mean weights and fraction mature updated annually with new values (green). The difference is negligible. (year refers to the last catch data year in the assessment)

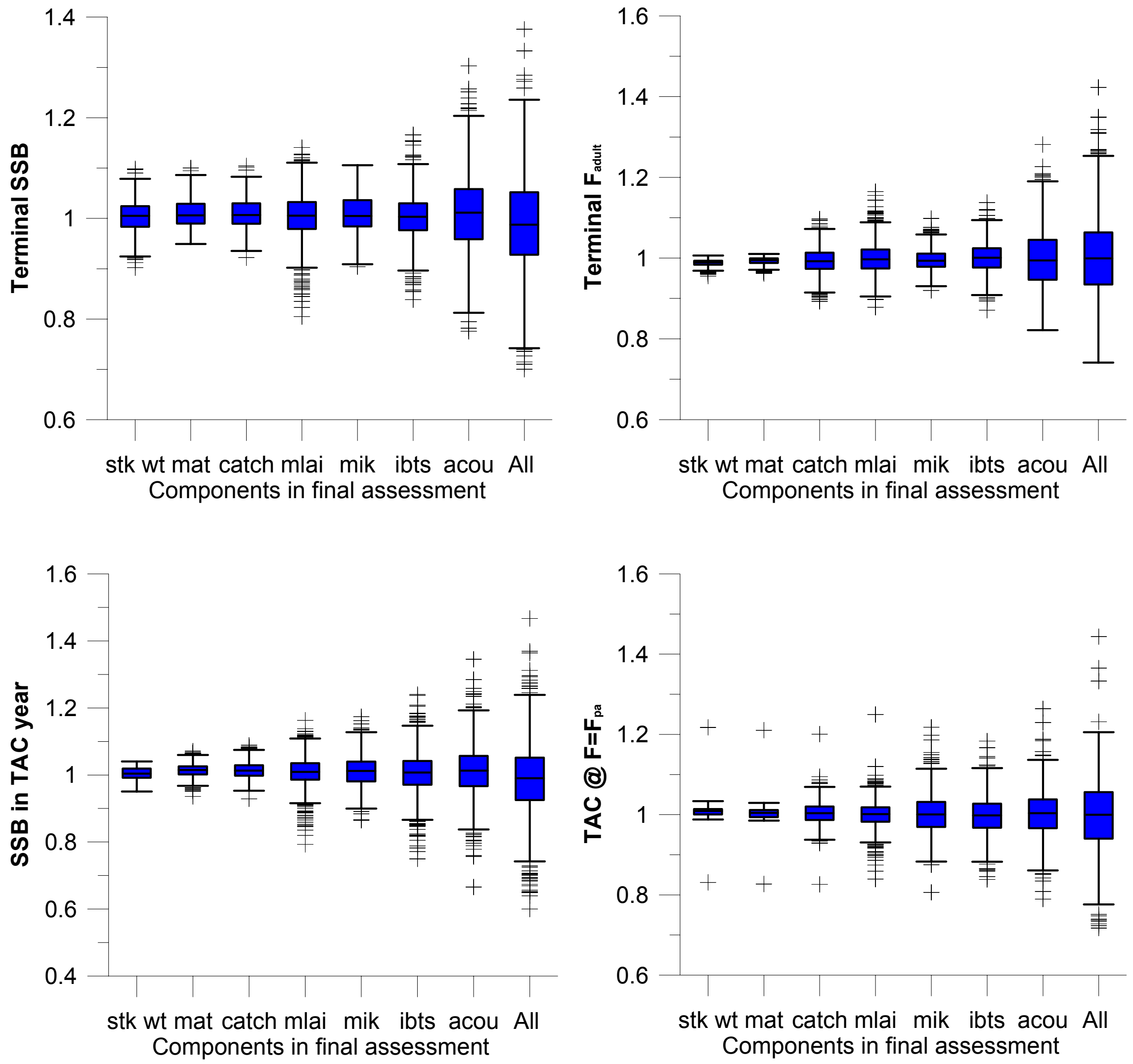


Figure 2.10.2 Variability in terminal SSB, Fadult, SSB in TAC year and TAC at F=$\mathbf{F}_{pa}$ due to the different sources of data in the assessment. Conditional on the catch in tonnes, the ICA model specification, preselected inverse variance weighting and fixed natural mortality.

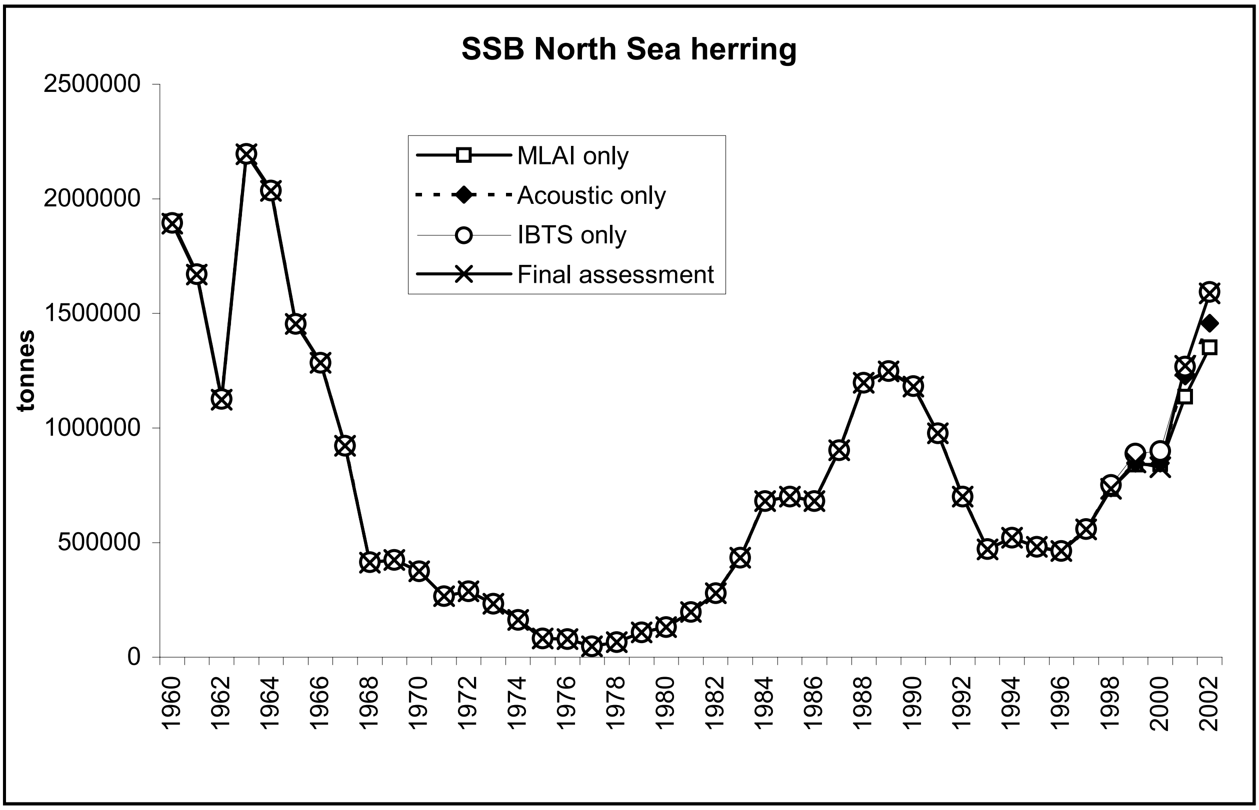


Figure 2.10.3 Assessment of North Sea herring in 2003 using adult herring tuning indices (MLAI SSB index, Acoustic 1-9+ ring indices and IBTS 1-5+ ring indices) one at a time in the ICA assessment model. The final assessment is included for comparison. All other data and model setting are used in the same manner as in the final assessment. All these indices give a similar perception of a rising stock.

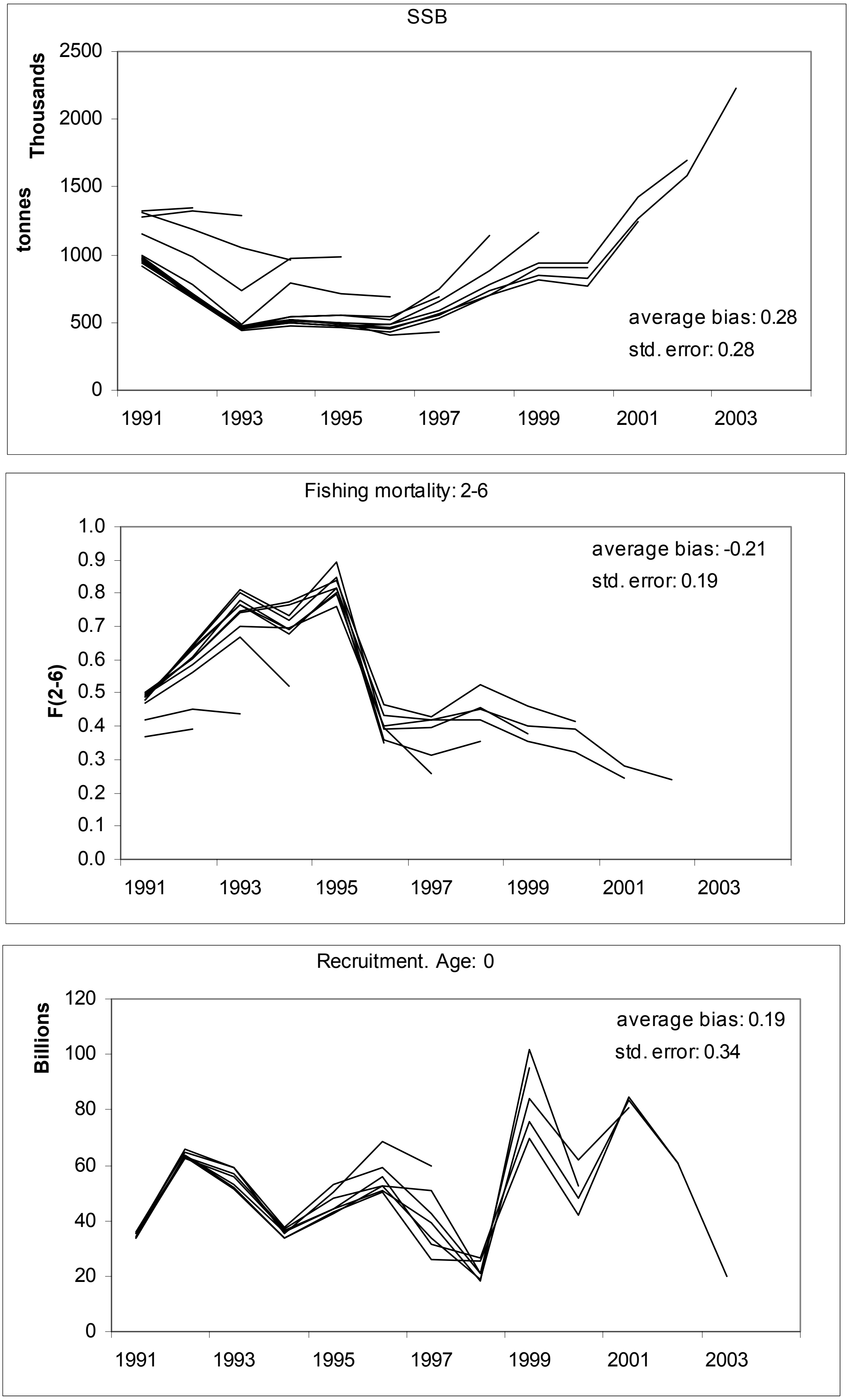


Figure 2.10.4 Autumn-spawning herring in IV, VIId and IIIa. Historic retrospective of assessments by sequential working groups

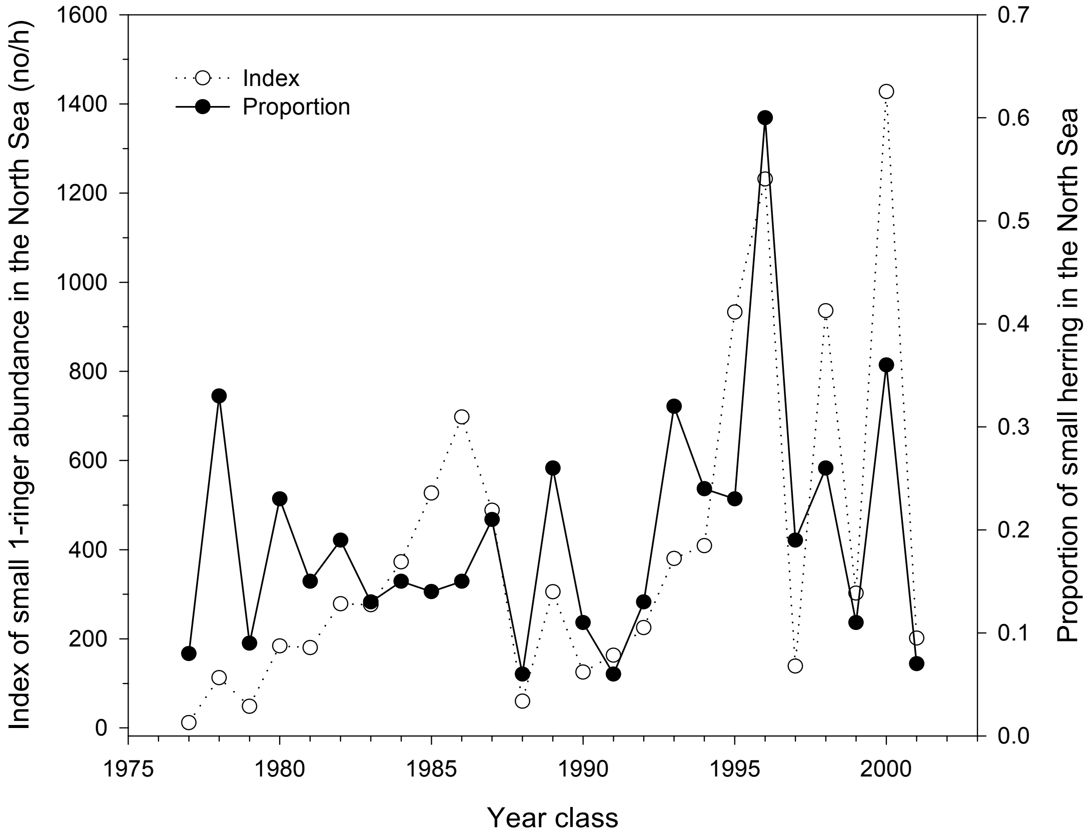


Figure 2.11.1 **Downs Herring.** Index (numbers per hour) of small (<13 cm) 1-ringers in the North Sea area, and proportion of small 1-ringers versus all sizes in the North Sea area. See Table 2.3.3.3.

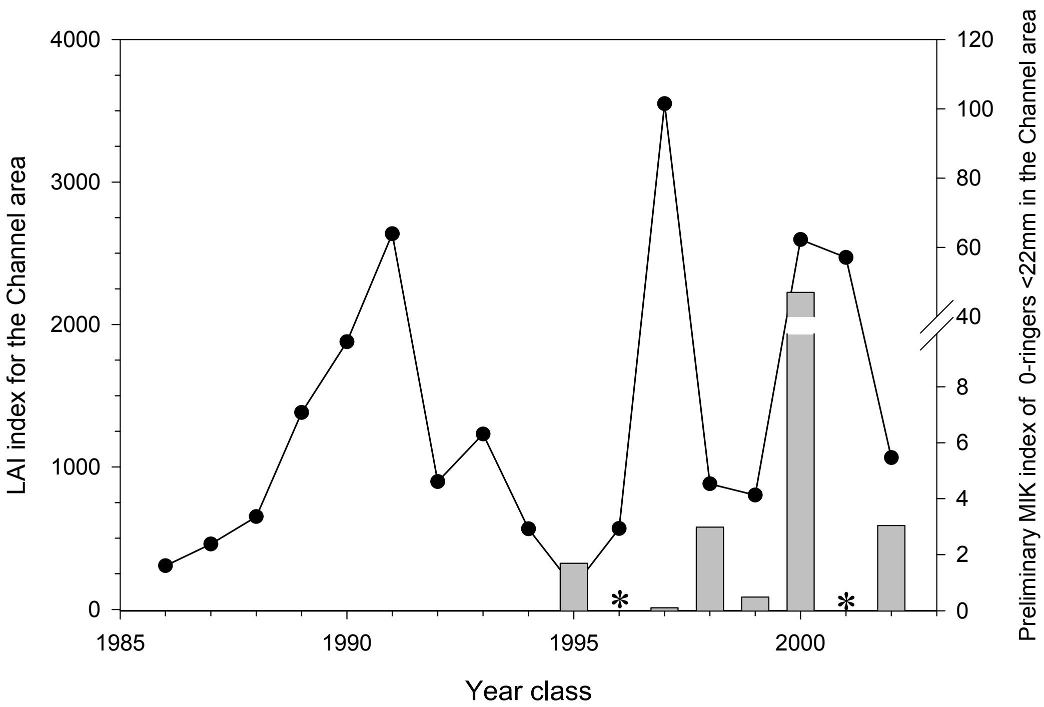


Figure 2.11.2 **Downs herring.** Larval Abundance Index (LAI) in the Channel area, calculated as mean of surveys per year class 1986-2002, and preliminary MIK survey results in the Channel (1995-2001). Asterisks denote no data.

3 HERRING IN DIVISION IIIA AND SUBDIVISIONS 22–24

3.1 The Fishery

3.1.1 ACFM advice and management applicable to 2002 and 2003

At the ACFM (May) meeting in 2002, it was stated that SSB has been relative stable over the last five years, but the stock is being harvested outside of biological limits. Fishing mortality is 0.50 for adults and 0.25 for juveniles (0- and 1-ringers), which is substantially greater that $\mathbf{F}_{max}$.

ACFM recommended that the fishing mortality should be reduced to less than $\mathbf{F}_{max}$ corresponding to catches in 2003 less than 84,000 t and according to the recent geographic distribution of catches, approximately half of the total catches should be taken from Subdivisions 22-24.

The EU and Norway agreement on a herring TACs set for 2003 was 80,000 t in Division IIIa for the human consumption fleet and a by-catch ceiling of 21,000 t to be taken in the small mesh fishery. The EU and Norway agreement for 2003 was the same as for 2001 and 2002.

As in previous years the International Baltic Sea Fishery Commission (IBSFC) on the stock component in the Western Baltic area set no special TAC for 2002. For the Baltic there was for 2001 a TAC of 300,000 t for the SDs 22–29 South and 32. The TAC was reduced to 200,000 t for the same area in 2002 and for 2003 further reduced to 143,349 t.

3.1.2 Catches in 2002

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 SDs 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.

Landings from 1985 to 2002 are given in Table 3.1.1. In 2002 the total landings decreased to 125,600 t in Division IIIa and SDs 22–24 compared with 2001 where the landings were 154,000 t, resulting in a landing figure for 2002 at the lowest level for the whole time-series. In 2002, 29,700 t were taken in the Kattegat, about 43,400 t from the Skagerrak and 52,500 t from SDs 22–24. These landings represent a decrease of 28,200 t compared to 2001. The decrease in landings from fishery in the Skagerrak compared to the 2001 landings is mainly caused by misreporting. The Danish national management regime for herring and sprat fishery in Subdivision 22 was changed in 2002 compared to the years prior to 2002. This change has implied a decrease in the total herring landings for this area. The Danish decrease has been counterbalanced by an increase in the German landings which have been doubled compared to 2001.

The increase of German landings was caused by an overall change in fishing pattern. In former years the dominant part of herring was caught in the passive gears, gillnets and trapnets. In 2002 the German trawl fishery increased. The total amount of herring, which was caught by trawlers in the area off the Rügen Island coast up to the Arcona Sea, increased from 3,100 t in 2001 (26 %) to 11,026 t in 2002 (49 %). This significant change in fishing pattern was caused by the perspective of a new fish factory on Rügen Island in the near future. This factory expects to process 50,000 t per year and will start during summer 2003. In 2002 the fishermen already began experimental fishery in order to evaluate the possibilities to extend the landing capacities by trawl fishery.

In 2002 the landing data are calculated by fleet according to the fleet definitions used when setting TACs.

The fleet definitions used since 1998 are:

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

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 SDs 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 SDs22–24 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**: Fleet using mesh size less than 32 mm Division IIIa.
- **F**: Landings from SDs 22–24.

In the table below the landings are given for 1997 to 2002 in thousands of tonnes by fleet and quarter. The landings figures in the text table below are SOP figures. Fleets C and D refer to Division IIIa, and fleet F to SDs 22-24. The 2001 figures for fleet F were updated.

Herring landings by fleet ('000 t)		**Div. IIIa**		**SD 22-24**	**Div. IIIa+ SD 22-24**
Year	**Quarter**	**Fleet C**	**Fleet D**	**Fleet F**	**Total**
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	17.9	4.0	20.6	42.5
	2	15.5	0.2	13.4	29.1
	3	28.7	3.6	5.3	37.6
	4	13.1	3.3	10.8	27.2
	Total	75.2	11.1	50.1	136.4
2000	1	16.0	6.9	23.9	46.8
	2	18.3	0.4	15.8	34.5
	3	34.8	3.2	3.4	40.7
	4	20.8	7.4	10.7	36.7
	Total	89.9	17.9	53.8	161.6
2001	1	20.1	3.8	20.8	44.7
	2	18.7	1.9	20.7	41.3
	3	25.0	7.9	7.5	40.4
	4	11.1	1.7	14.8	27.6
	Total	74.9	15.3	63.8	154.0
2002	1	6.7	6.9	14.7	28.3
	2	8.3	2.4	22.0	32.7
	3	28.0	7.0	6.0	41.0
	4	12.3	1.6	9.6	23.5
	Total	55.3	17.9	52.3	125.5

The landings from fleets C-F are SOP figures.

3.2 Biological Composition of the Catch

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): mainly 2+ ringers of the Western Baltic spring spawners and 0-2-ringers from the North Sea autumn spawners, including winter-spawning Downs herring. In addition, several local spawning stocks have been identified with unassessed importance to the herring fisheries (ICES, 2001/ACFM 12).

Experience within the Herring Assessment Working Group has shown that separation procedures based on size distributions often will fail. On the other hand, comparison between separation methods using frequency distributions of vertebral counts and otolith microstructure showed reasonable correspondence. Using this information the years from

1991 to 1996 were reworked in 2001, applying common splitting keys for all years by using a combination of the vertebral count and otolith microstructure methods (ICES, 2001/ACFM:12). For the present year the otolith-based method exclusively has been applied for the Div. IIIa split.

3.2.1 Spring-spawning herring in the North Sea

The split was performed on age classes 2, 3, and 4+ ringers using proportion of spring spawners f(sp) calculated from weighted mean vertebral counts from samples of Norwegian commercial landings using the equation:

$$f(sp) = [56.5\text{-}v(sample)]/[56.5–55.8]$$

where v (sample) was the sample mean vertebral count (ICES 1992/H:5). For 1-ringers it was assumed that all fish were autumn spawners. For the total commercial landings in May, June and July from the North Sea in 2002, the proportion of spring spawners was calculated using samples from commercial landings split by age, ICES rectangle and month, and then raised to total number using the overall mean weight-at-age in the landings. For the actual split see Section 2.2.2.

3.2.2 Autumn spawners in Division IIIa

For commercial landings in 2002 the split of the Swedish and Danish landings was conducted using an age-class stratified random sub-sample of herring where analysis of individual otolith microstructure determined the spawning type (Mosegaard and Popp-Madsen, 1996). A total of 3643 otoliths in 2002 were analysed for spawning type in Division IIIa. The estimation of the proportion spring and autumn spawners in the landings from Division IIIa was performed on the basis of totally 2772 Danish and 871 Swedish otolith microstructure analyses in 2002. Data were disaggregated by area (Kattegat and Skagerrak), age group (0–4+ WR) and quarter (1–4). The proportions and the analysed numbers are presented in Table 3.2.1.

The fishery was covered for all age classes, area and season combinations in 2002. For the 2002 split of catches primarily samples from commercial landings were used, and for quarter 3 in Division IIIa these were supplemented by samples from the Danish acoustic survey in July.

3.2.3 Autumn spawners in the fishery in Subdivisions 22 and 24

After the introduction of otolith microstructure analysis in 1996 it was discovered that in the western Baltic a small percentage of the herring landings might consist of autumn-spawned individuals. Compared to the 1997 year's assessment (ICES 1998/ACFM:14) the problem in later years appears minor. In 2002 only the herring by-catches from landings in Subdivision 23 were analysed for otolith microstructure, and among the small number of individuals analysed (n=28) no autumn-spawned herring were found in the samples. The existence of varying proportions of autumn spawners in Subdivisions 22–24 in different years however, indicates a potential problem for the assessment that should be kept in mind.

3.2.4 Accuracy and precision in stock identification

The introduction of otolith microstructure analysis in 1996-97 enables an accurate and precise split between three groups, autumn, winter and spring spawners; however, different populations with similar spawning periods are not resolved with the present level of analysis. Different stock components not easily distinguished by their otolith microstructure (OM) are considered to have different mean vertebral counts (vs) as, e.g., winter-spawning Downs herring: 56.6 (Hulme, 1995), and the small local stocks, the Skagerrak winter/spring spawners: 57 (Rosenberg and Palmén, 1982). Further, the estimated stock specific mean vs count varies somewhat among different studies; North Sea: 56.53, Western Baltic Sea: 55.6 (Gröger and Gröhsler, 2001) and North Sea: 56.5, Western Baltic Sea: 55.8 (ICES 1992/H:5).

In an EU CFP study project (EC study 98/026) different methods of identifying herring stocks in the Division IIIa and Subdivisions 22-24 were evaluated. The study involved several intercalibration sessions between microstructure readers in the different laboratories involved with the WBSS herring. After the study was finished a close collaboration concerning reader interpretations has been kept between the Danish and Swedish laboratories. Sub-samples of the 2002 Danish and Swedish microstructure analyses were double checked by the same Danish reader for consistency in interpretation. The overall impression is that readers are in good agreement.

New molecular genetic approaches for stock separation are being developed within the EU-FP5 project HERGEN (EU project QLRT 200-01370). Sampling of spawning aggregations during spring, autumn and winter has been carried out in 2002 and will continue in 2003 in Div. IIIa and the Western Baltic at more than 10 different locations.

3.2.5 Catch in Numbers and Mean Weights-at-age

The level of sampling of the landings for human consumption and the industrial landings was generally acceptable in the Skagerrak and Kattegat and SDs 22-24. Where sampling was missing in areas and quarters on national landings, sampling from either other nations or adjacent areas and quarters were used to estimate catch in numbers and mean weight-at-age (see Table 3.2.17).

Table 3.2.2 and Table 3.2.3 show the total catch (autumn and spring spawners) in numbers and mean weight-at-age for herring by quarter and fleet landed from Skagerrak and Kattegat, respectively. The total numbers and mean weights-at-age for herring landed from the Kattegat, Skagerrak and SDs 22 - 24 by fleets is shown in Table 3.2.10.

Based on the proportions of spring- and autumn spawners (see Section 3.2.1 and Section 3.2.2) in the landings, number and mean weights by age and spawning stock are calculated. The total numbers and mean weight of North Sea autumn spawners herring landed from Kattegat and Skagerrak by quarter and fleet is shown in Table 3.2.4 and 3.2.6. The total numbers and mean weight of Baltic Spring spawners herring landed from Kattegat and Skagerrak by quarter and fleet is shown in Table 3.2.5 and 3.2.7.

The total numbers and mean weight of North Sea autumn spawners by quarter and fleet landed from Division IIIa is shown in Table 3.2.8 and Baltic Spring spawners herring in Table 3.2.9.

The total catch in numbers of WBSS in Division IIIa and the North Sea is shown in Tables 3.2.11 (2002), 3.2.11a (2001 revised) and 3.2.12 (see also Tables 2.2.1 – 2.2.5) The landings (SOP) of spring spawners taken in Division IIIa and the North Sea in 2002 were estimated to be about 54,000 t (Table 3.2.15) compared to about 48,000 t in 2001 and 64,000 t in 2000. This increase in landings (SOP) was mainly due to an increase in the estimated number of spring spawners in Kattegat. Some of this increase was compensated by a decrease in landings (SOP) in SDs 22-24 of 9,000 tonnes. The landings (SOP) of North Sea autumn spawners in Division IIIa amounted to 26,000 t compared to 48,000 t in 2001 and 50,000 t in 2000 (Table 3.2.13). The total catch in number and mean weight-at-age of Baltic spring spawners in the North Sea, Division IIIa and in SDs 22–24 for 1991–2001 are given in Tables 3.2.14 and 3.2.15.

3.2.6 Quality of Catch Data and Biological Sampling Data

The sampling intensity of the landings in 2002 was acceptable and above the recommended level. Danish landings were sampled in the most important quarters for the Skagerrak, the Kattegat and for SDs22 and 24. In 2002 the sampling was carried out for the most important quarters from the limited fishery in SD 23.

Tables 3.2.16 and 3.2.17 show the number of fish aged by country, area, fishery and quarter. The total landings from Divisions IIIa, IIIb and IIIc were 126,000 t from which 292 samples (1 sample per 450 t landed) were taken, 31,000 fish were measured and 15,000 aged – compared to 2001 where the landings were 154,000 t from which 220 samples (1 sample per 690 t landed) were taken, 43,000 fish were measured and 15,000 fish were aged. Despite the high and increased sampling level compared to 2001, the sampling coverage can still be improved. It should be mentioned that the sampling level is more than double the recommended level.

Swedish landings from the human consumption and the small-meshed fishery were sampled in all quarters from the Skagerrak and the Kattegat. On the other hand only 1 quarter of the Swedish small-meshed fishery were sampled in the Div. IIIa.

Sampling of the Danish landings for industrial purposes were at the same high level in 2002 as in the three previous years. The number of samples and number of fish investigated were considered to be adequate. Again in 2002 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 were actually taken. Some 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. Some Danish landings, reported as taken in this triangle, may have been taken outside this area. These landings are listed under Kattegat.

Misreporting of fishing area 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. These landings are included in the values for the North Sea. Some landings, reported as taken in this triangle, (an area in the southern Kattegat, which is a part of the Baltic area: Gilleleje, DK - Kullen, S - Helsingborg, S - Helsingør, DK), may have been taken outside this area. These landings are listed under Kattegat. The Norwegian landings reported as having been taken in Skagerrak may have been caught in the North Sea.

No estimates of discards were available to the Working Group. The amount of discards for 2002 is regarded as being insignificant.

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 in relation to the fisheries (i.e. the Kattegat autumn spawners and the Skagerrak winter spawners) and their possible influence on the stock assessment. Although the overall sampling more than 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.

3.3 Fishery-Independent Information

3.3.1 German bottom trawl surveys in Subdivisions 22 and 24

From 2001 onwards a new standardised bottom trawl was used within the frame of the 'Baltic International Trawl Surveys'. Unfortunately this new bottom trawl is only catching herring to a low extent. In consequence no fishery independent estimates based on German bottom trawl surveys have been used.

3.3.2 International Bottom Trawl Survey in Division IIIa

The IBTS in Div. IIIa (the Skagerrak and the Kattegat) has been conducted annually in the 1st quarter since 1977. From 1983 and onwards the survey was standardised according to the IBTS manual (ICES 2002/D:03). During the HAWG 2002 the survey data was revised for the 1st and available 3rd quarters from 1990 to 2002. Historical catch rates are heavily skewed and therefore the survey indices by winter rings 1-5 were calculated as geometric means from observed abundances at trawl stations within each of the Skagerrak and the Kattegat. The survey indices were further decomposed into spring and autumn-spawning components by microstructure analysis of otoliths (Section 3.2) except for 2001, third quarter and 2002, first quarter where vertebrae counting methods were used. The new estimates of the relative abundance by age of the spring-spawning component are presented in Table 3.3.1 and Table 3.3.2, respectively. The survey estimates for spring spawners showed a consistent pattern between quarters and between areas. The mean value for 1-ringers in 2003 is slightly smaller than the previous year for the 1st quarter. However, the mean value for 1-ringers for the 3rd quarter in 2002 is the largest ever observed. The variability within year classes 1990 to 2002 is slightly less in the 3rd quarter (CV 66%) than in the 1st quarter (CV 75%).

3.3.3 Summer acoustic survey in Division IIIa

This survey is part of an annual survey covering the North Sea and Division IIIa in July-August. R/V DANA conducted the survey in Division IIIa. The echo integration survey from 25 June to 8 July 2002 covered the area in the Skagerrak and the Kattegat. In principal the survey design was planned with north-south survey tracks in the area west of 10°E. Due to the fixed time periods for fishing this design could not be implemented fully, resulting in a non-standard survey track in the western part of Skagerrak.

Further details of the survey are given in the 'Report of the Planning Group for Herring Surveys' (ICES 2003/G:02).

For each subarea the mean back-scattering cross Section was estimated for herring, sprat, gadoids and mackerel by the TS relationships given in the Manual for Herring Acoustic Surveys in ICES Division III, IV, and IVa (ICES 2001/G:02). For the spring-spawning herring the following maturity key was estimated:

W-ring	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**
% mature	0	7	62	85	95	100	100	100	100

Approximately 1155 nautical miles were surveyed and 32 trawl hauls were conducted.

The biomass of the Western Baltic spring-spawning herring in the survey area was estimated as 454,000 tonnes. This is 2.8 times the biomass estimated in 2001 and 1.3 times the biomass estimated in 2000. The results are summarised in Table 3.3.3.

3.3.4 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" between 14 and 25 October 2002 in the Western Baltic. This survey is traditionally coordinated by the International Acoustic Survey for Pelagic Fish Stocks in the Baltic Sea. Due to technical problems with the winch of the research vessel, the survey started with a delay of more than two weeks. Since the survey time was shortened, the Kattegat area (Subdivision 21) could not be covered in 2002. The joint German-Danish acoustic survey covered the whole Subdivisions 22, 23 and 24. As in previous years, the survey was carried out during the night.

A full survey report is given in the 'Report of the Planning Group for Herring Surveys' (ICES CM 2003/G:02).

The result for 2002 is presented in Table 3.3.4. The herring stock was estimated to be 6.0 x 10^9 fish or about 195,200 tonnes in Subdivisions 22-24. Young herring dominated the abundance estimates. Adult herring, which were concentrated in former years only in the Sound, could this year also be found in the deeper areas of the Arkona sea (Subdivision 24).

3.3.5 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 and adjacent waters.

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.

Further details concerning the surveys and the treatment of the samples are given in Brielmann (1989), Müller and Klenz (1994) and Klenz (2002). The estimated numbers of larvae for the period 1977 to 2001 are summarised in Table 3.3.5. Compared to the previous two years with relatively low estimates, the 2002 estimate of the larvae index has risen back to the very high level of the years 1998 and 1999.

3.4 Mean Weights- and Maturity-at-age in the Stock

Mean weights-at-age in the catch in the 1st quarter were used as stock weights (Table 3.2.11).

The maturity ogive was assumed constant between years. The same maturity ogive was used as in the HAWG 2002:

W-rings	0	1	2	3	4	5	6	7	8+
Maturity	0.00	0.00	0.20	0.75	0.90	1.00	1.00	1.00	1.00

3.5 Recruitment estimates

German Bottom Trawl Survey (GBTS) was not carried out from 2001 and onwards and Sweden RV Argos does not cover the area of Subdivisions 22-24. Thus, indices of 0-ringer abundance on the spring-spawning herring in Subdivisions 22-24 for 2002 were available only from the larval surveys during the spawning season for the main spawning area (Table 3.3.5) and from the Acoustic survey (September/October). Log-transformed indices were compared by year class in Figure 3.5.1 The indices illustrated in Figure 3.5.1 show the following general time trends with poor recruitment year classes in 1980–82 followed by an increase to a high level of recruitment in 1983–88. From 1990, the recruitment declined until 1992 when recruitment was the lowest observed in the time-series. From 1992, recruitment year classes, as estimated by the larval index, showed an increase with three large year classes in 1998, 1999 and 2002. Historical high recruitment of the 1998 and 1999 year classes were supported by 0-ringer and 1-ringer indices in the acoustic survey in Subdivisions 22–24 (Table 3.3.4). After 1998-1999, there was a significant drop in recruitment in 2000 while the 2002 year class has the third largest values observed in the time-series. The larval index and the 0-ringer from the acoustic survey showed very similar trends in the last 5 years.

3.6 Stock Assessment

3.6.1 Data exploration and preliminary modelling

3.6.1.1 Input data

Catch in numbers by age for spring spawners in Division IVe, Division IIIa and Subdivisions 22-24 were available for 1991 to 2002 (Table 3.6.1, Figure 3.6.1). Mean weights-at-age in the landings for spring-spawning herring are found in Table 3.6.2 and in Figure 3.6.2.

The 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.

Natural mortality was assumed constant at 0.2 for all years and 2+ ringers. A predation mortality of 0.10 and 0.20 was added to the 0- and 1-ringers, which resulted in an increase in their natural mortality to 0.3 and 0.5, respectively (Table 3.6.4). The estimates of predation mortality were derived as a mean for the years 1977–1995 from the Baltic MSVPA (ICES 1997/J:2).

Available survey indices were:

a) Hydroacoustic survey in Division IIIa, July 1989–2002, 0–8+ ringers
b) Hydroacoustic survey in Subdivisions 22, 23 and 24, Oct. 1989–2002, 0–8+ ringers
c) Larvae survey in Subdivision 24 (Greifswalder Bodden), March-June 1977-2002
d) IBTS in Division IIIa, Quarter 1, 1991-2003, 1-5 ringers
e) IBTS in Division IIIa, Quarter 3, 1991-2002, 1–5 ringers

All are age-structured indices with c) being calculated as an index of recruiting 0-ringers.

None of the indices covered the total spatial distribution of the WBSS stock and the indices covered the following quarters and areas:

Survey area	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Division IIIa	Index d		Index a,e	
Subdivisions 22-24	Index c	Index c		Index b

Subsets of these data series representing selected age groups were constructed to give a better representation of the stock.

3.6.1.2 ICA settings

The following ICA settings were used for the final run in 2002 and used again this year:

- The period for the separable constraint: 5 years (1998-2002).
- The weighing factor to all indices (lambda = 1).
- A linear catchability model for all indices.
- The reference F set at age 4 and the selection 1 for oldest age.
- The catch data were down-weighted to 0.1 for 0-ringer herring.

3.6.1.3 Exploration by individual survey indices

The runs from last year's assessment (ICES 2002/ACFM:12) with the data series 1991-2001 were repeated to cross check the results for the change from IFAP to Lowestoft data format.

For the present year's assessment the following individual survey time-series were used to tune catches in the different exploratory runs. Although data was available in some indices starting from years earlier than 1991, all series started in 1991 because of the catch date and the spawning type proportions had only been revised that far back.

- **FLT 1a**: DK Hydroacoustic survey in Division IIIa, July 1991–2002, excl. 1999, 0–8+ ringers
- **FLT 1b**: DK Hydroacoustic survey in Division IIIa, July 1991–2002, excl. 1999, 2–8+ ringers

FLT 1a, and 1b are different subsets of the hydroacoustic suvey in Division IIIa in July leaving out the 1999 cruise due to only partial coverage of the area, a different method (vs count) of stock identification, a different research vessel (the Norwegian R/V GO Sars), and a different acoustic set up. FLT 1a was the total 1991-2002 time-series with all age groups 0-8+ ringers. In FLT 1b the 0- and 1-ringers were excluded since only a small fraction of the WBSS have migrated to the Division IIIa at these ages.

- **FLT 2a**: GER Hydroacoustic survey in Subdivisions 22, 23 and 24, Oct. 1991–2002, 0–8+ ringers
- **FLT 2b**: GER Hydroacoustic survey in Subdivisions 22, 23 and 24, Oct. 1991–2002, 0–5 ringers

FLT2a contains all age-classes in the German hydroacoustic survey in the Western Baltic (Subdivisions 22-24) and is adjusted into FLT2b by excluding the oldest age classes.

- **FLT 3**: IBTS in Kattegat, Quarter 3, 1991-2002, 1–5 ringers

FLT3 refers to the Swedish IBTS survey covering the Kattegat in quarter 3. No survey was carried out in 2000. Old age-classes (6-8+ ringers) are very poorly represented in these IBTS surveys and therefore excluded from the selected indices.

- **FLT 4**: IBTS in Kattegat, Quarter 1, 1991-2003, 1-5 ringers

FLT4 refers to the Swedish IBTS survey covering the Kattegat in quarter 1. No data are available for 2001 due to the lack of updated separation of stock components.

- **FLT 5a**: Larval survey in Subdivision 24 (Greifswalder Bodden), March-June 1991-2002
- **FLT 5b:** Larval survey in Subdivision 24 (Greifswalder Bodden), March-June 1991-2002, excluding 1998

FLT5a is the German larval survey conducted in Subdivision 24 on estimating the abundance of 30 mm larvae to give an estimate of the recruitment from the Rügen spawning grounds. FLT5b is a subset of FLT5a excluding 1998 due to hydrographical anomalies.

Individual exploratory runs of catch data with single combinations of each of these indices were performed using the general ICA-setting mentioned earlier (Section 3.6.2). A summary of the results from these runs is presented in Figure 3.6.4.

The runs with the larval survey index including all years did not converge to a minimum SSQ, and only the restricted time-series (excluding 1998) using a power model exhibited realistic F and SSB values.

The hydroacoustic survey indices in Division IIIa, (FLT1a and FLT1b) the IBTS in Kattegat Q3 (FLT3) and the Acoustic survey in Subdivisions 22- 24, Q4 (FLT2a and FLT2b) indices suggest intermediate Fs of between 0.4-0.51. On the other hand the IBTS in Kattegat Q1 (FLT4) indicates a very high F of 1.5 while the larval survey in Subdivision 24 (FLT5a and FLT5b) suggests a very low fishing mortality ($F<0.15$).

Errors in landings data were discovered at a late stage. All tables were updated with the revised data. Exploratory runs however were conducted with preliminary data. For the combined final run a comparison between results from preliminary and revised input data was performed. The performance of the two sets of data was almost similar (Figure 3.6.4) and it was decided that the results from the exploratory runs without revision could be trusted for the selection of the combined final run.

Based on the present results and additional exploratory runs performed in last year's assessment a combined ICA run was performed based on the definitions of FLTs in Section 3.6.1.3. The run was selected fully in accordance with the procedure from last year's assessment and it included FLT1b, FLT2b and FLT3 (leaving out young ages in the Division IIIa summer acoustic and leaving out old ages in the autumn SD22-24 acoustic survey). The biological reasoning behind the choice of indices with restricted numbers of age classes is that there is only partial migration of age 0-1 ringers to the Division IIIa in the summer and that there is poor representation of ages higher than 5-ringers in the Subdivision 22-24 acoustic surveys.

3.6.2 Final Assessment

For the final run we chose FLT1b (the hydroacoustic survey 1991-2002 in Division IIIa 2-8+ ringers, excluding 1999), FLT2b (the hydroacoustic survey in Subdivisions 22-24, 0-5 ringers), and FLT3 (the IBTS 3rd quarter survey in the Kattegat 1-5 ringers).

The hydroacoustic survey 1991-2002 in Division IIIa excluding 1999 showed high negative residuals for younger ages in 2001. This pattern was contrasted by positive residuals for 2001 in the hydroacoustic survey in Subdivisions 22-24, only including 0-5 ringers (Figure 3.6.3).

The ICA input data (years 1991-2001, Ages 0-8+ ringers) are given in Tables 3.6.1-3.6.4:

- Catch in number (Table 3.6.1)
- Weight in catch (Table 3.6.2)
- Weight in stock (Table 3.6.3)
- Natural mortality (Table 3.6.4)
- Maturity (see text table in Section 3.4)

The following surveys were included (Tables 3.6.5a-c):

- FLT 1b: IBTS in Kattegat, Quarter 3, 1991-2002, 1–5 ringers
- FLT 2b: GER Hydroacoustic survey in Subdivisions 22, 23 and 24, Oct 1991–2002, 0–5 ringers
- FLT 3: DK Hydroacoustic survey in Division IIIa, July 1991–2002, excl. 1999, 2–8+ ringers

The final model settings are shown in Table 3.6.6.

The output data are given in Tables 3.6.7-3.6.16. The assessment results in an SSB for 2002 of 178,000 tonnes and a mean fishing mortality (ages 3-6) of 0.454 (Table 3.6.9).

The model diagnostics show a somewhat flat SSQ response-curve; however, all three indices are pointing in the same direction (Figure 3.6.5). After a decrease from a period of high fishing mortality in the mid-1990s the F (3-6) values in the recent 5 years have been fluctuating between 0.43 and 0.54. The SSB shows an increasing trend over the recent years after a marked decline in the mid-1990s.

The marginal totals of residuals between the catch and the separable model are overall small, with almost no residuals for younger ages and a small increasing trend at older ages 4-7, as well as a reasonably trend-free separable period (1998-2002) (Figure 3.6.6). The catch-at-age variance component is between twenty-five and fifty percent of the individual survey variance components. Among the survey indices the IBTS has the largest variance component with the two acoustic indices showing variances of about half to two-thirds of the trawl survey (Table 3.6.16).

The fit of the surveys to the population number is relatively similar between the Division IIIa and Subdivisions 22-24 acoustic surveys (FLT1b and FLT2b), whereas the Kattegat Q3 IBTS-index (FLT3) does not show such a clear picture. Age-specific catchabilities and their residuals exhibit a somewhat unstable picture for the last two years in the IBTS (Table 3.6.11).

The reason for the poorer performance of the 3rd quarter Kattegat IBTS survey may be the fluctuating migration pattern of mature age-classes quickly passing through the area on their way to the wintering area of Subdivision 23.

3.7 Short-term Projection

The assessment was used to provide a yield-per-recruit plot for herring in Division IIIa and Subdivisions 22-24 (Figure 3.7.1). The values for $\mathbf{F}_{0.1}$ and $\mathbf{F}_{max}$ are 0.20 and 0.37, respectively.

Short-term predictions were carried out using MFDP v.1a software. ICA estimates of population numbers and fishing mortalities were used except for the numbers of 0-ringers in 2003-2005, where a geometric mean of the recruitment over the period 1991−2000 was taken, and for the numbers of 1-ringers in 2003, where the geometric mean over the period 1992-2001 was used. Mean weights-at-age in the catch and in the stock were taken as a mean for the years 1999−2002. A *status quo* exploitation pattern for 2003 was assumed, with values calculated as the average of 2000-2002. Input data for catch predictions are presented in Table 3.7.1.

Short-term predictions were carried out assuming a *status quo* fishing mortality for 2003. For 2004 onwards either *status quo* F or $\mathbf{F}_{max}$ were used for the predictions. Single options tables are available for 2004 and 2005 (Tables 3.7.2 and 3.7.4).

Scenario	2003	2004	2005
1) *status quo* F	$F_{2003}= F_{2002} = 0.50$ *Status quo* F Catch = 122,000 t	$F_{2003}= F_{2002} = 0.50$ *Status quo* F Catch = 119,000 t	$F_{2003}= F_{2002} = 0.50$ *Status quo* F Catch = 115,000 t
2) *status quo* F followed by $\mathbf{F}_{max}$	$F_{2003}= F_{2002} = 0.50$ *Status quo* F Catch = 122,000 t	$F = 0.74 * F_{2002} = 0.37$ $\mathbf{F}_{max} = 0.37$ Catch = 92,000 t	$F = 0.74 * F_{2002} = 0.37$ $\mathbf{F}_{max} = 0.37$ Catch = 98,000 t

The results of the short-term predictions are given in Tables 3.7.2 – 3.7.4. Table 3.7.2 shows single option predictions for 2004 and 2005 and Table 3.7.3 multiple options for 2004 at *status quo* fishing mortality. The catches for 2004 and 2005 at *status quo* fishing mortality were predicted to be 119,000 t and 115,000 t, respectively, which is an overall increase in relation to the current catch level of 106,000 t. The SSB in 2004 is predicted to remain at the current level of about 177,000 t and to decrease in 2005 to 170,000 t.

Table 3.7.4 shows single option predictions for 2004 and 2005 at *status quo* fishing mortality for 2003 and $\mathbf{F}_{max}$ in 2004 and 2005, respectively. The catches for 2004 and 2005 at $\mathbf{F}_{max}$ were predicted to be 92,000 t and 98,000 t, respectively, which is an overall decrease in relation to the current catch level. The SSB in 2004 and 2005 is predicted to increase to 179,000 t and 194,000 t, respectively.

3.8 Reference Points

Reference points have neither been defined nor proposed for this stock (see Section 1.7).

3.9 Quality of the Assessment

Prior to this year's assessment a revision of the catch-at-age data was performed, however, the changes do not seem to influence the results and the assessment model appears to perform generally well under a five-years-separable assumption. North Sea autumn spawners dominate catches of 0-group herring taken in Division IIIa. Since representation of WBSS 0-ringers is varying and this component is generally not well represented in the catch, the numbers are highly influenced by split-data for separation of the two stocks. Exploratory runs have shown that down-weighting of the 0-group results in an improved fit of the separable model.

Ongoing work on updating maturity-at-age data was presented. The data coverage was too sparse to allow using annual values, however international collaboration in this area may result in a different perception of SSB in the future, once new estimates replace the current mean values.

The influence of different surveys was investigated by repeating key exploratory runs from last year's assessment. Generally surveys behaved quite similarly this year compared to last year. The larval survey was found to be heavily influenced by noisy years and no solution was found when 1998 was included. Generally the larval survey gives extremely high SSB and low F values. The 1st quarter IBTS on the other hand estimates a quite low SSB and a high F with high residual values. These results were quite in line with the 2002 year's assessment, and lead to the subsequent exclusion of these indices from the final model run.

A comparison of the estimates of SSB based on the information from the individual surveys and the combination of all three is illustrated in Figure 3.9.1. A similar signal in relation to SSB is picked up from all indices. Estimates of annual Fs for the separable period appear to be quite precise (CVs in the order of 12-15%), and reinforce the perception of high fishing pressure on this stock, which was suggested by previous year's analyses.

Five years of retrospective patterns were investigated in accordance with a separable period of 1998-2002. No patterns in F or SSB were observed (Figure 3.9.2). The recruitment estimates are noisy for the most recent year (Figure 3.9.2).

The selection pattern over ages exhibited a reasonable smooth increasing pattern for all retrospective runs (Figure 3.9.3).

The comparison between the results of the HAWG-2002 and HAWG-2003 assessments shows considerable similarity with no more than a few percent difference in the fishing mortality and the stock for 2002 (see the following text table).

Category	Parameter	Assessment 2002	Assessment 2003	Diff. (+/-) %
ICA input	No. of years for separable constraints	5	5	No
	Reference age for separable constraint	4	4	No
	Selection to be fixed on last age	1	1	No
	Weighting factor to all indices	1	1	No
	Catch down-weighted to 0.1 for 0-ringer	Yes	Yes	No
	Tuning data	Acoust. Surv. Div. IIIa	Acoust. Surv. Div. IIIa	No
		Acoust. Surv. SDs 22-24	Acoust. Surv. SDs 22-24 (revised for 1991 & 1992)	Small
		IBTS Surv. Quarter 3	IBTS Surv. Quarter 3	No
ICA results	SSB 2001	138,000 t (144,000 t)*	149,000 t	+7% (+3%)*
	F(3-6) 2001	0.54 (0.53)*	0.52	-4% (-2%)*

*Including the revised catch input data for 2001 and the revised Acoustic Survey results in SDs 22-24, re-run at the 2003 WG.

3.10 Management Considerations

The stock in Division IIIa is at present managed in accordance with the North Sea herring stock because a considerable proportion of the juveniles of that stock are present in Division IIIa. The herring fishery in Subdivisions 22-24 is managed in accordance with the whole Baltic area as only one TAC is set for that area.

This year's assessment corroborates the perception that the Western Baltic Spring-spawning herring stock is slowly recovering from the historic low SSB level in 1998. Yield and fishing mortality on the adults are considered to have been reduced by 5% and 12%, respectively. However, $F_{3\text{-}6}$ still appears to be high as compared to other herring stocks in European waters.

Increasing German landings from Subdivisions 22 and 24 have counterbalanced decreasing Danish landings in 2002. An increasing fishing pressure in the coming years may be expected due to the opening of a new herring processing plant on Rügen.

Short-term predictions demonstrate that a *status quo* fishing mortality and geometric mean recruitment would lead to an increase of yield (by 13%) and a slight decrease in SSB in 2003. Different scenarios for 2004 and 2005 show either a decrease of yield and SSB for the two years ($\mathbf{F}_{sq}$) or a decrease in yield and slight increase in SSB ($\mathbf{F}_{max}$). Considering that SSB in recent years (1998) has been historically low and that the increasing SSB heavily relies on the maturing 1999 year class, the WG recommends to limit the fishing mortality effectively to no more than $\mathbf{F}_{max}$ for 2004. This would equal a yield of no more than 92,000 t.

Following the rebuilding of the North Sea stock to levels above 2 million t the TACs for this stock are expected to continue to increase. The two stocks are exploited simultaneously in Division IIIa. Due to asynchronous population dynamics of herring in the North Sea, the Central Baltic and the Western Baltic plus Division IIIa, the WG repeats that a proper management of the Western Baltic Spring-spawning herring stock requires a management regime separately from herring both in the Central Baltic and the North Sea. The need for a separate TAC set for the area where WBSS herring is distributed, i.e. Division IIIa and Subdivisions 22-24 should be considered with some urgency.

Table 3.1.1 **HERRING in Division IIIa and Sub. Division 22-24. 1986 - 2002**
Landings in thousands of tonnes.
(Data provided by Working Group members 2002).

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 [2]	2000	2001	2002 [1]
Skagerrak								
Denmark	43.7	28.7	14.3	10.3	10.1	16.0	16.2	17.0
Faroe Islands								
Norway	16.7	9.4	8.8	8.0	7.4	9.7	8.3	5.9
Sweden	48.5	32.7	32.9	46.9	36.4	45.8	30.8	26.4
Misreporting								-5.9
Total	108.9	70.8	56.0	65.2	53.9	71.5	55.3	43.4
Kattegat								
Denmark	16.9	17.2	8.8	23.7	17.9	18.9	18.8	22.5
Sweden	30.8	27.0	18.0	29.9	14.6	17.3	16.2	7.2
Total	47.7	44.2	26.8	53.6	32.5	36.2	35.0	29.7
Sub. Div. 22+24								
Denmark	36.8	34.4	30.5	30.1	32.5	32.6	28.3	11.0
Germany	13.4	7.3	12.8	9.0	9.8	9.3	**11.4**	22.4
Poland	7.3	6.0	6.9	6.5	5.3	6.6	9.3	7.0
Sweden	15.8	9.0	14.5	4.3	2.6	4.8	13.9	10.7
Total	73.3	56.7	64.7	49.9	50.2	53.3	62.9	51.1
Sub. Div. 23								
Denmark	0.9	0.7	2.2	0.4	0.5	0.9	0.6	0.4
Sweden	0.2	0.3	0.1	0.3	0.1	0.1	0.2	1.0
Total	1.1	1.0	2.3	0.7	0.6	1.0	0.8	1.4
Grand Total	231.0	172.7	149.8	169.4	137.2	162.0	154.0	125.6

[1] Preliminary data.
2 Revised data for 1998 and 1999
Bold= German revised data for 2001

Table 3.2.1 Proportion of North Sea autumn spawners and Baltic given in % in Skagerrak and Kattegat by age

Year: 2002

Quarter	W-rings	Skagerrak		n	source	Kattegat		n	source
		North Sea	Baltic			autumn SP	Baltic		
1	1	47.6%	52.4%	21		0.0%	100.0%	38	
	2	90.6%	9.4%	32		0.0%	100.0%	26	
	3	23.8%	76.2%	21		0.0%	100.0%	29	
	4	2.9%	97.1%			0.0%	100.0%		
	5	2.9%	97.1%			0.0%	100.0%		
	6	2.9%	97.1%	34	(4-8+)	0.0%	100.0%	9	(4-8+)
	7	2.9%	97.1%			0.0%	100.0%		
	8+	2.9%	97.1%			0.0%	100.0%		
2	1	100.0%	0.0%	8		0.0%	100.0%	13	
	2	51.3%	48.7%	39		0.0%	100.0%	10	
	3	12.5%	87.5%	24		0.0%	100.0%	9	
	4	8.7%	91.3%			0.0%	100.0%		
	5	8.7%	91.3%			0.0%	100.0%		
	6	8.7%	91.3%	23	(4-8+)	0.0%	100.0%	6	(4-8+)
	7	8.7%	91.3%			0.0%	100.0%		
	8+	8.7%	91.3%			0.0%	100.0%		
3	0	59.4%	40.6%	32		100.0%	0.0%	110	
	1	77.0%	23.0%	612		32.8%	67.2%	411	
	2	11.1%	88.9%	378		0.9%	99.1%	234	
	3	5.5%	94.5%	525		0.0%	100.0%	199	
	4	2.6%	97.4%			0.0%	100.0%		
	5	2.6%	97.4%			0.0%	100.0%		
	6	2.6%	97.4%	345	(4-8+)	0.0%	100.0%	100	(4-8+)
	7	2.6%	97.4%			0.0%	100.0%		
	8+	2.6%	97.4%			0.0%	100.0%		
4	0	100.0%	0.0%	8		100.0%	0.0%	6	
	1	70.9%	29.1%	55		42.9%	57.1%	49	
	2	3.8%	96.2%	53		2.1%	97.9%	48	
	3	2.7%	97.3%	37		2.0%	98.0%	49	
	4	0.0%	100.0%			0.0%	100.0%		
	5	0.0%	100.0%			0.0%	100.0%		
	6	0.0%	100.0%	11	(4-8+)	0.0%	100.0%	39	(4-8+)
	7	0.0%	100.0%			0.0%	100.0%		
	8+	0.0%	100.0%			0.0%	100.0%		

Values are calculated using combined otolith microstructure data from Denmark and Sweden in 2002

(4-8+) For age-classes 4 to 8+ all values from the combined age-class 4+ is used.

Table 3.2.2
Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet.
Division: Skagerrak Year: 2002 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	18.01	22	64.62	18	82.63	19
	2	40.41	105	5.65	96	46.06	104
	3	6.06	118	2.24	136	8.30	123
	4	1.22	191	1.80	143	3.02	162
	5	0.26	159	0.17	170	0.43	164
	6	0.64	185	0.16	180	0.81	184
	7	0.13	248			0.13	248
	8+	0.40	213	0.06	179	0.46	209
	Total	67.15		74.70		141.85	
	SOP		5,877		2,345		8,222
2	1	38.15	45	99.39	13	137.53	22
	2	20.72	86			20.72	86
	3	6.08	92			6.08	92
	4	2.19	109			2.19	109
	5	0.60	120			0.60	120
	6	0.46	151			0.46	151
	7	0.21	130			0.21	130
	8+	0.04	180			0.04	180
	Total	68.43		99.39		167.82	
	SOP		4,451		1,290		5,741
3	0	2.97	10	168.44	10	171.41	10
	1	93.67	67	4.14	21	97.81	65
	2	30.83	109			30.83	109
	3	40.04	132			40.04	132
	4	17.66	153			17.66	153
	5	3.72	182			3.72	182
	6	2.16	196			2.16	196
	7	0.98	200			0.98	200
	8+	0.29	253			0.29	253
	Total	192.31		172.58		364.89	
	SOP		18,992		1,802		20,794
4	0	4.40	17	84.24	13	88.64	13
	1	92.45	53	0.94	42	93.39	53
	2	9.64	96	0.26	86	9.90	95
	3	9.03	125			9.03	125
	4	2.30	144			2.30	144
	5	0.43	182			0.43	182
	6	0.21	175			0.21	175
	7	0.11	175			0.11	175
	8+						
	Total	118.56		85.43		204.00	
	SOP		7,451		1,177		8,627
Total	0	7.37	14	252.67	11	260.04	11
	1	242.28	54	169.09	15	411.37	38
	2	101.59	102	5.91	95	107.50	101
	3	61.21	126	2.24	136	63.45	126
	4	23.37	150	1.80	143	25.16	149
	5	5.00	174	0.17	170	5.18	173
	6	3.47	187	0.16	180	3.63	186
	7	1.43	192			1.43	192
	8+	0.73	227	0.06	179	0.79	224
	Total	446.46		432.10		878.56	
	SOP		36,771		6,614		43,385

Table 3.2.3
Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet.
Division: Kattegat Year: 2002 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	20.11	27	253.65	15	273.76	16
	2	39.10	73	0.25	43	39.35	73
	3	19.77	86			19.77	86
	4	4.18	109			4.18	109
	5	0.07	104			0.07	104
	6	0.02	138			0.02	138
	7						
	8+						
	Total	83.25		253.90		337.15	
	SOP		5,556		3,864		9,420
2	1	5.62	26	123.81	4	129.43	5
	2	13.31	72	22.71	15	36.02	36
	3	6.08	85			6.08	85
	4	1.79	92			1.79	92
	5	0.53	106			0.53	106
	6	0.35	132			0.35	132
	7						
	8+						
	Total	27.67		146.52		174.18	
	SOP		1,885		841		2,726
3	0	2.14	15	185.78	12	187.92	12
	1	12.77	42	84.02	33	96.80	34
	2	12.97	80	3.00	61	15.97	77
	3	14.74	110			14.74	110
	4	4.98	132			4.98	132
	5	1.25	157			1.25	157
	6	0.30	225			0.30	225
	7						
	8+	0.27	198			0.27	198
	Total	49.43		272.80		322.23	
	SOP		4,212		5,209		9,421
4	0	1.86	16	98.31	14	100.17	14
	1	28.91	49			28.91	49
	2	18.52	82			18.52	82
	3	21.37	112			21.37	112
	4	7.15	133			7.15	133
	5	1.84	158			1.84	158
	6	0.41	225			0.41	225
	7	0.07	175			0.07	175
	8+	0.37	198			0.37	198
	Total	80.49		98.31		178.81	
	SOP		6,797		1,349		8,146
Total	0	4.00	16	284.09	13	288.09	13
	1	67.42	39	461.48	15	528.89	19
	2	83.90	76	25.96	21	109.86	63
	3	61.95	101			61.95	101
	4	18.09	123			18.09	123
	5	3.69	149			3.69	149
	6	1.09	194			1.09	194
	7	0.07	175			0.07	175
	8+	0.64	198			0.64	198
	Total	240.84		771.53		1,012.36	
	SOP		18,450		11,263		29,713

Table 3.2.4
Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***North Sea Autumn spawners***
Division: Kattegat Year: 2002 Country: All

		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8+						
	Total						
	SOP						
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8+						
	Total						
	SOP						
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0	2.14	15	185.78	12	187.92	12
	1	4.20	42	27.60	33	31.79	34
	2	0.11	80	0.03	61	0.14	77
	3						
	4						
	5						
	6						
	7						
	8+						
	Total	6.45		213.40		219.85	
	SOP		216		3,146		3,362
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	1.86	16	98.31	14	100.17	14
	1	12.39	49			12.39	49
	2	0.39	82			0.39	82
	3	0.44	112			0.44	112
	4						
	5						
	6						
	7						
	8+						
	Total	15.07		98.31		113.38	
	SOP		722		1,349		2,070
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	4.00	16	284.09	13	288.09	13
	1	16.59	47	27.60	33	44.19	39
	2	0.50	82	0.03	61	0.52	81
	3	0.44	112			0.44	112
	4						
	5						
	6						
	7						
	8+						
	Total	21.52		311.71		333.23	
	SOP		938		4,495		5,433

Table 3.2.5
Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***Baltic Spring spawners***
Division: Kattegat Year: 2002 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	20.11	27	253.65	15	273.76	16
	2	39.10	73	0.25	43	39.35	73
	3	19.77	86			19.77	86
	4	4.18	109			4.18	109
	5	0.07	104			0.07	104
	6	0.02	138			0.02	138
	7						
	8+						
	Total	83.25		253.90		337.15	
	SOP		5,556		3,864		9,420

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
2	1	5.62	26	123.81	4	129.43	5
	2	13.31	72	22.71	15	36.02	36
	3	6.08	85			6.08	85
	4	1.79	92			1.79	92
	5	0.53	106			0.53	106
	6	0.35	132			0.35	132
	7						
	8+						
	Total	27.67		146.52		174.18	
	SOP		1,885		841		2,726

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
3	0						
	1	8.58	42	56.42	33	65.00	34
	2	12.86	80	2.98	61	15.83	77
	3	14.74	110			14.74	110
	4	4.98	132			4.98	132
	5	1.25	157			1.25	157
	6	0.30	225			0.30	225
	7						
	8+	0.27	198			0.27	198
	Total	42.98		59.40		102.38	
	SOP		3,996		2,063		6,059

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
4	0						
	1	16.52	49			16.52	49
	2	18.14	82			18.14	82
	3	20.93	112			20.93	112
	4	7.15	133			7.15	133
	5	1.84	158			1.84	158
	6	0.41	225			0.41	225
	7	0.07	175			0.07	175
	8+	0.37	198			0.37	198
	Total	65.43				65.43	
	SOP		6,075				6,075

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
Total	0						
	1	50.83	37	433.88	14	484.71	17
	2	83.40	76	25.94	21	109.34	63
	3	61.51	101			61.51	101
	4	18.09	123			18.09	123
	5	3.69	149			3.69	149
	6	1.09	194			1.09	194
	7	0.07	175			0.07	175
	8+	0.64	198			0.64	198
	Total	219.32		459.82		679.13	
	SOP		17,512		6,768		24,280

Table 3.2.6
Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***North Sea Autumn spawners***
Division: Skagerrak Year: 2002 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	8.58	22	30.77	18	39.35	19
	2	36.62	105	5.12	96	41.74	104
	3	1.44	118	0.53	136	1.98	123
	4	0.04	191	0.05	143	0.09	162
	5	0.01	159	0.01	170	0.01	164
	6	0.02	185	0.00	180	0.02	184
	7	0.00	248			0.00	248
	8+	0.01	213	0.00	179	0.01	209
	Total	46.72		36.49		83.21	
	SOP		4,227		1,132		5,359

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
2	1	38.15	45	99.39	13	137.53	22
	2	10.62	86			10.62	86
	3	0.76	92			0.76	92
	4	0.19	109			0.19	109
	5	0.05	120			0.05	120
	6	0.04	151			0.04	151
	7	0.02	130			0.02	130
	8+	0.00	180			0.00	180
	Total	49.83		99.39		149.22	
	SOP		2,721		1,290		4,011

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
3	0	1.76	10	100.01	10	101.77	10
	1	72.09	67	3.19	21	75.28	65
	2	3.43	109			3.43	109
	3	2.21	132			2.21	132
	4	0.46	153			0.46	153
	5	0.10	182			0.10	182
	6	0.06	196			0.06	196
	7	0.03	200			0.03	200
	8+	0.01	253			0.01	253
	Total	80.14		103.20		183.33	
	SOP		5,585		1,085		6,670

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
4	0	4.40	17	84.24	13	88.64	13
	1	65.56	53	0.67	42	66.22	53
	2	0.36	96	0.01	86	0.37	95
	3	0.24	125			0.24	125
	4						
	5						
	6						
	7						
	8+						
	Total	70.56		84.91		155.48	
	SOP		3,588		1,144		4,732

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	3.2.6 Numbers	3.2.6 Mean W.	Total Numbers	Total Mean W.
Total	0	6.16	15	184.25	12	190.41	12
	1	184.37	55	134.01	14	318.38	38
	2	51.03	101	5.13	96	56.16	101
	3	4.66	121	0.53	136	5.19	122
	4	0.69	143	0.05	143	0.74	143
	5	0.16	161	0.01	170	0.16	161
	6	0.11	179	0.00	180	0.12	179
	7	0.05	177			0.05	177
	8+	0.02	221	0.00	179	0.02	219
	Total	247.25		323.99		571.24	
	SOP		16,122		4,651		20,773

Table 3.2.7
Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***Baltic Spring spawners***
Division: Skagerrak Year: 2002 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	9.44	22	33.85	18	43.28	19
	2	3.79	105	0.53	96	4.32	104
	3	4.62	118	1.71	136	6.33	123
	4	1.19	191	1.74	143	2.93	162
	5	0.25	159	0.17	170	0.42	164
	6	0.62	185	0.16	180	0.78	184
	7	0.13	248			0.13	248
	8+	0.39	213	0.05	179	0.45	209
	Total	20.43		38.21		58.64	
	SOP		1,650		1,213		2,863

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
2	1						
	2	10.09	86			10.09	86
	3	5.32	92			5.32	92
	4	2.00	109			2.00	109
	5	0.54	120			0.54	120
	6	0.42	151			0.42	151
	7	0.19	130			0.19	130
	8+	0.03	180			0.03	180
	Total	18.60				18.60	
	SOP		1,730				1,730

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
3	0	1.21	10	68.43	10	69.63	10
	1	21.58	67	0.95	21	22.53	65
	2	27.40	109			27.40	109
	3	37.83	132			37.83	132
	4	17.20	153			17.20	153
	5	3.63	182			3.63	182
	6	2.10	196			2.10	196
	7	0.96	200			0.96	200
	8+	0.28	253			0.28	253
	Total	112.18		69.38		181.56	
	SOP		13,407		717		14,124

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
4	0						
	1	26.89	53	0.27	42	27.17	53
	2	9.28	96	0.25	86	9.52	95
	3	8.79	125			8.79	125
	4	2.30	144			2.30	144
	5	0.43	182			0.43	182
	6	0.21	175			0.21	175
	7	0.11	175			0.11	175
	8+						
	Total	48.00		0.52		48.52	
	SOP		3,863		33		3,895

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
Total	0	1.21	10	68.43	10	69.63	10
	1	57.91	53	35.07	18	92.99	40
	2	50.56	102	0.78	93	51.33	102
	3	56.55	126	1.71	136	58.26	126
	4	22.68	150	1.74	143	24.42	150
	5	4.85	174	0.17	170	5.01	174
	6	3.35	187	0.16	180	3.51	187
	7	1.38	193			1.38	193
	8+	0.71	227	0.05	179	0.76	224
	Total	199.21		108.11		307.31	
	SOP		20,649		1,963		22,612

Table 3.2.8

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

Division: IIIa Year: 2002 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	8.58	22	30.77	18	39.35	19
	2	36.62	105	5.12	96	41.74	104
	3	1.44	118	0.53	136	1.98	123
	4	0.04	191	0.05	143	0.09	162
	5	0.01	159	0.01	170	0.01	164
	6	0.02	185	0.00	180	0.02	184
	7	0.00	248			0.00	248
	8+	0.01	213	0.00	179	0.01	209
	Total	46.72		36.49		83.21	
	SOP		4,227		1,132		5,359
2	1	38.15	45	99.39	13	137.53	22
	2	10.62	86			10.62	86
	3	0.76	92			0.76	92
	4	0.19	109			0.19	109
	5	0.05	120			0.05	120
	6	0.04	151			0.04	151
	7	0.02	130			0.02	130
	8+	0.00	180			0.00	180
	Total	49.83		99.39		149.22	
	SOP		2,721		1,290		4,011
3	0	3.91	12	285.78	11	289.69	11
	1	76.28	65	30.79	32	107.07	56
	2	3.54	108	0.03	61	3.56	108
	3	2.21	132			2.21	132
	4	0.46	153			0.46	153
	5	0.10	182			0.10	182
	6	0.06	196			0.06	196
	7	0.03	200			0.03	200
	8+	0.01	253			0.01	253
	Total	86.59		316.60		403.18	
	SOP		5,801		4,231		10,032
4	0	6.26	17	182.55	13	188.81	14
	1	77.95	52	0.67	42	78.61	52
	2	0.75	89	0.01	86	0.76	89
	3	0.68	117			0.68	117
	4						
	5						
	6						
	7						
	8+						
	Total	85.63		183.23		268.86	
	SOP		4,310		2,493		6,803
Total	0	10.16	15	468.33	12	478.50	12
	1	200.95	54	161.61	18	362.57	38
	2	51.53	101	5.16	96	56.69	101
	3	5.10	120	0.53	136	5.63	122
	4	0.69	143	0.05	143	0.74	143
	5	0.16	161	0.01	170	0.16	161
	6	0.11	179	0.00	180	0.12	179
	7	0.05	177			0.05	177
	8+	0.02	221	0.00	179	0.02	219
	Total	268.77		635.70		904.47	
	SOP		17,059		9,146		26,205

Table 3.2.9
Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***Baltic Spring spawners***
Division: IIIa Year: 2002 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	29.55	25	287.49	16	317.04	16
	2	42.89	76	0.78	79	43.67	76
	3	24.39	92	1.71	136	26.09	95
	4	5.37	127	1.74	143	7.11	131
	5	0.32	148	0.17	170	0.48	156
	6	0.65	183	0.16	180	0.81	182
	7	0.13	248			0.13	248
	8+	0.39	213	0.05	179	0.45	209
	Total	103.68		292.11		395.78	
	SOP		7,206		5,077		12,283
2	1	5.62	26	123.81	4	129.43	5
	2	23.40	78	22.71	15	46.11	47
	3	11.40	88			11.40	88
	4	3.79	101			3.79	101
	5	1.07	113			1.07	113
	6	0.76	142			0.76	142
	7	0.19	130			0.19	130
	8+	0.03	180			0.03	180
	Total	46.26		146.52		192.78	
	SOP		3,615		841		4,456
3	0	1.21	10	68.43	10	69.63	10
	1	30.16	60	57.38	33	87.54	42
	2	40.26	100	2.98	61	43.23	97
	3	52.57	126			52.57	126
	4	22.17	148			22.17	148
	5	4.88	176			4.88	176
	6	2.41	200			2.41	200
	7	0.96	200			0.96	200
	8+	0.55	226			0.55	226
	Total	155.16		128.78		283.94	
	SOP		17,403		2,780		20,183
4	0						
	1	43.42	51	0.27	42	43.69	51
	2	27.41	87	0.25	86	27.66	87
	3	29.72	116			29.72	116
	4	9.44	136			9.44	136
	5	2.27	162			2.27	162
	6	0.62	208			0.62	208
	7	0.18	175			0.18	175
	8+	0.37	198			0.37	198
	Total	113.43		0.52		113.95	
	SOP		9,938		33		9,970
Total	0	1.21	10	68.43	10	69.63	10
	1	108.74	45	468.95	15	577.69	20
	2	133.96	86	26.72	23	160.68	75
	3	118.07	113	1.71	136	119.77	113
	4	40.77	138	1.74	143	42.51	138
	5	8.53	163	0.17	170	8.70	163
	6	4.44	189	0.16	180	4.60	188
	7	1.46	192			1.46	192
	8+	1.35	213	0.05	179	1.40	212
	Total	418.52		567.93		986.45	
	SOP		38,161		8,731		46,892

Table 3.2.10
Landings in numbers (mill.), mean weight (g.) and SOP (t) by age and quarter.
Division: 22-24 Year: 2002 Country: ALL

		Subdivision 22		Subdivision 23		Subdivision 24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	17.21	13	0.20	18	12.27	21	29.68	16
	2	3.16	50	4.89	68	39.20	51	47.24	53
	3	5.23	88	3.35	81	47.45	89	56.02	88
	4	4.15	132	0.83	110	21.63	121	26.62	122
	5	3.46	183			13.83	172	17.29	174
	6	4.64	200			16.08	198	20.72	199
	7	1.00	204			3.72	195	4.72	197
	8+	0.35	218			1.44	199	1.79	202
	Total	39.20		9.28		155.60		204.08	
	SOP		3,231		699		15,659		19,589

		Subdivision 22		Subdivision 23		Subdivision 24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	9.09	19	0.02	21	2.44	13	11.56	17
	2	4.31	56	0.10	70	15.97	46	20.37	48
	3	3.36	73	0.03	88	62.16	75	65.55	75
	4	2.84	114	0.01	91	63.52	111	66.37	111
	5	0.67	137	0.00	120	14.40	122	15.08	123
	6	0.54	176			7.70	160	8.24	161
	7	0.32	184			5.85	162	6.17	163
	8+	0.18	195			4.05	140	4.23	142
	Total	21.32		0.16		176.08		197.56	
	SOP		1,264		11		16,989		18,264

		Subdivision 22		Subdivision 23		Subdivision 24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0	3.51	14			0.83	11	4.34	14
	1	1.64	31			1.94	42	3.58	37
	2	0.00	85			4.89	73	4.90	73
	3	0.01	117	0.22	158	4.76	85	5.00	89
	4	0.01	140	0.19	176	2.97	85	3.17	91
	5	0.00	173	0.16	182	0.94	72	1.10	89
	6	0.00	202	0.10	189	0.28	92	0.39	119
	7	0.00	195	0.06	227	0.11	66	0.17	125
	8+			0.01	187	0.20	69	0.21	76
	Total	5.18		0.75		16.92		22.85	
	SOP		107		133		1,221		1,461

		Subdivision 22		Subdivision 23		Subdivision 24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	71.73	11			4.57	13	76.30	11
	1	11.92	37	1.50	49	23.19	38	36.62	38
	2	0.98	81	0.79	89	39.30	66	41.06	66
	3	2.34	117	1.27	133	56.53	80	60.14	82
	4	1.70	140	0.88	168	20.45	81	23.03	89
	5	0.49	173	0.24	195	10.91	80	11.64	86
	6	0.28	202	0.15	200	1.27	166	1.71	175
	7	0.06	195	0.04	237	0.25	208	0.36	209
	8+			0.03	190	0.05	190	0.08	190
	Total	89.51		4.91		156.53		250.95	
	SOP		1,946		554		10,833		13,333

		Subdivision 22		Subdivision 23		Subdivision 24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
t	0	75.24	11			5.40	12	80.64	11
	1	39.87	22	1.73	45	39.84	32	81.44	27
	2	8.45	56	5.77	71	99.35	57	113.58	58
	3	10.94	90	4.87	98	170.90	81	186.71	82
	4	8.71	128	1.91	143	108.57	107	119.19	109
	5	4.63	175	0.40	189	40.08	127	45.11	132
	6	5.47	198	0.26	195	25.33	184	31.05	187
	7	1.38	199	0.10	231	9.93	174	11.41	178
	8+	0.53	210	0.04	189	5.73	153	6.31	158
	Total	155.22		15.09		505.13		675.44	
	SOP		6,548		1,397		44,702		52,647

Table 3.2.11 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)
Area: IV + IIIa + 22-24 Year: 2002

		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			317.04	16	29.68	16	346.72	16
	2			43.67	76	47.24	53	90.92	64
	3			26.09	95	56.02	88	82.12	90
	4			7.11	131	26.62	122	33.73	124
	5			0.48	156	17.29	174	17.77	174
1	6			0.81	182	20.72	199	21.52	198
	7			0.13	248	4.72	197	4.85	198
	8+			0.45	209	1.79	202	2.24	204
	Total	0.00		395.78		204.08		599.87	
	SOP		0		12,283		19,589		31,871
		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			129.43	5	11.56	17	140.98	6
	2	6.23	139.00	46.11	47	20.37	48	72.71	55
	3	14.61	153.80	11.40	88	65.55	75	91.55	89
	4	9.69	163.00	3.79	101	66.37	111	79.85	117
	5	2.96	183.80	1.07	113	15.08	123	19.10	132
2	6	2.41	194.80	0.76	142	8.24	161	11.41	167
	7	0.83	207.00	0.19	130	6.17	163	7.19	167
	8+	0.53	220.65	0.03	180	4.23	142	4.79	151
	Total	37.25		192.78		197.56		427.60	
	SOP		5,994		4,456		18,264		28,714
		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0			69.63	10	4.34	14	73.97	10
	1			87.54	42	3.58	37	91.11	42
	2	1.36	161.70	43.23	97	4.90	73	49.49	97
	3	0.22	179.70	52.57	126	5.00	89	57.78	123
	4	0.89	188.90	22.17	148	3.17	91	26.23	143
3	5	0.39	205.70	4.88	176	1.10	89	6.38	162
	6	0.47	211.70	2.41	200	0.39	119	3.26	192
	7	0.14	210.70	0.96	200	0.17	125	1.26	191
	8+	0.09	240.00	0.55	226	0.21	76	0.86	190
	Total	3.56		283.94		22.85		310.34	
	SOP		658		20,183		1,461		22,302
		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0					76.30	11	76.30	11
	1			43.69	51	36.62	38	80.31	45
	2			27.66	87	41.06	66	68.72	75
	3			29.72	116	60.14	82	89.86	93
	4			9.44	136	23.03	89	32.47	103
4	5			2.27	162	11.64	86	13.91	98
	6			0.62	208	1.71	175	2.33	184
	7			0.18	175	0.36	209	0.54	198
	8+			0.37	198	0.08	190	0.45	196
	Total	0.00		113.95		250.95		364.90	
	SOP		0		9,970		13,333		23,304
		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0			69.63	10	80.64	11	150.27	11
T	1			577.69	20	81.44	27	659.13	21
	2	7.59	143	160.68	75	113.58	58	281.84	70
o	3	14.82	154	119.77	113	186.71	82	321.31	97
	4	10.58	165	42.51	138	119.19	109	172.29	120
t	5	3.35	186	8.70	163	45.11	132	57.16	140
	6	2.88	198	4.60	188	31.05	187	38.53	188
a	7	0.97	208	1.46	192	11.41	178	13.84	181
	8+	0.62	223	1.40	212	6.31	158	8.33	172
l	Total	40.81		986.45		675.44		1,702.70	
	SOP		6,652		46,892		52,647		106,191

Table 3.2.11a 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)

Area: IV + IIIa + 22-24 Year: 2001

		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			14.19	29	252.74	16	266.93	17
	2			90.69	58	73.64	42	164.33	51
	3			36.82	95	50.49	67	87.31	79
	4			10.54	148	32.91	106	43.45	116
	5			4.17	190	25.39	166	29.56	169
	6			2.61	184	9.00	174	11.62	176
	7			1.33	175	5.18	167	6.51	168
	8+			1.38	194	0.84	161	2.22	181
	Total	0.00		161.73		450.20		611.93	
	SOP		0		12,540		20,799		33,339
		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	0.45	79.00	6.29	35	151.83	22	158.57	22
	2	2.91	123.00	39.35	75	121.68	42	163.94	52
	3	6.33	148.20	35.31	111	64.03	62	105.67	84
	4	3.59	171.10	19.21	144	24.99	93	47.79	119
	5	4.34	185.90	13.52	166	15.90	153	33.77	162
	6	1.55	198.20	5.74	166	13.50	156	20.79	162
	7	0.89	221.10	2.59	175	5.93	165	9.41	173
	8+	0.22	257.60	1.04	201	2.42	168	3.67	183
	Total	20.28		123.05		400.29		543.62	
	SOP		3,312		13,718		20,670		37,700
		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			118.57	9	47.72	16	166.29	11
	1	0.00	0.00	7.13	70	47.92	40	55.04	44
	2	8.43	129.00	49.32	92	32.18	45	89.93	79
	3	3.90	156.50	34.81	114	15.23	66	53.94	103
	4	2.54	188.60	4.85	123	13.83	71	21.22	97
	5	2.81	192.20	0.72	88	6.05	87	9.58	118
	6	1.11	198.30	1.38	228	6.01	83	8.50	121
	7	0.67	220.40	0.01	160	2.42	78	3.10	109
	8+	0.19	276.90			0.89	114	1.08	143
	Total	19.65		216.78		172.26		408.69	
	SOP		3,137		10,989		7,468		21,594
		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			3.11	22	586.88	13	589.99	13
	1			9.10	84	34.05	45	43.15	53
	2			25.37	97	53.21	65	78.59	75
	3			9.70	119	17.01	105	26.71	110
	4			0.94	123	4.30	71	5.24	80
	5					1.36	130	1.36	130
	6			0.40	231	0.74	106	1.13	150
	7					0.60	63	0.60	63
	8+					0.12	89	0.12	89
	Total	0.00		48.62		698.27		746.89	
	SOP		0		4,662		14,787		19,450
		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			121.68	9	634.60	13	756.28	12
	1	0.45	79	36.71	51	486.53	22	523.70	24
	2	11.34	127	204.72	75	280.71	47	496.78	60
	3	10.22	151	116.64	107	146.76	69	273.63	88
	4	6.12	178	35.54	142	76.04	94	117.70	112
	5	7.15	188	18.41	168	48.71	151	74.27	159
	6	2.66	198	10.13	182	29.25	145	42.05	157
	7	1.56	221	3.92	175	14.14	146	19.62	158
	8+	0.41	267	2.42	197	4.27	153	7.09	175
	Total	39.93		550.18		1,721.02		2,311.13	
	SOP		6,450		41,910		63,724		112,083

Table 3.2.12 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 1991-2002.

Year	W-rings	0	1	2	3	4	5	6	7	8+	Total
1991	Numbers	100.00	157.43	382.91	394.77	166.97	112.35	21.86	7.33	3.15	1,346.77
	Mean W.	33.0	48.6	69.5	99.9	135.7	146.2	166.9	179.7	193.2	
	SOP	3,300	7,656	26,614	39,455	22,657	16,430	3,648	1,318	609	121,687
1992	Numbers	109.08	246.00	321.85	174.02	154.47	78.33	55.83	17.91	8.53	1,166.03
	Mean W.	13.9	44.1	87.0	112.9	136.2	166.3	183.5	194.4	203.6	
	SOP	1,516	10,841	27,986	19,653	21,035	13,030	10,243	3,481	1,737	109,523
1993	Numbers	161.25	371.50	315.82	219.05	94.08	59.43	40.97	21.71	8.22	1,292.03
	Mean W.	15.1	25.9	81.4	127.5	150.1	171.1	195.9	209.1	239.0	
	SOP	2,435	9,612	25,696	27,936	14,120	10,167	8,027	4,541	1,966	104,498
1994	Numbers	60.62	153.11	261.14	221.64	130.97	77.30	44.40	14.39	8.62	972.19
	Mean W.	20.2	42.6	94.8	122.7	150.3	168.7	194.7	209.9	220.2	
	SOP	1,225	6,524	24,767	27,206	19,686	13,043	8,642	3,022	1,898	106,013
1995	Numbers	50.31	302.51	217.81	129.64	108.89	35.33	23.77	14.62	7.69	890.57
	Mean W.	17.9	41.5	101.0	148.2	167.0	199.9	212.0	229.6	235.2	
	SOP	902	12,551	22,001	19,218	18,188	7,062	5,040	3,356	1,809	90,127
1996	Numbers	166.23	228.05	320.21	87.44	53.54	34.80	14.97	7.71	6.01	918.96
	Mean W.	10.5	27.6	90.5	140.8	175.8	190.1	207.6	211.5	220.0	
	SOP	1,748	6,296	28,984	12,309	9,412	6,615	3,107	1,631	1,323	71,426
1997	Numbers	25.97	73.43	167.53	192.51	42.69	18.20	6.22	2.09	3.22	531.85
	Mean W.	19.2	49.7	79.2	130.9	171.8	187.7	194.2	203.1	211.4	
	SOP	498	3,648	13,269	25,208	7,335	3,416	1,207	425	681	55,686
1998	Numbers	36.26	177.52	347.41	102.36	60.57	13.01	9.26	2.30	2.30	750.99
	Mean W.	27.8	51.3	73.3	109.4	143.5	172.6	194.5	187.0	229.6	
	SOP	1,009	9,110	25,458	11,200	8,692	2,246	1,800	431	529	60,475
1999	Numbers	38.53	137.13	168.86	138.58	47.79	23.99	4.87	3.26	2.74	565.76
	Mean W.	11.6	42.0	85.6	116.7	123.2	147.8	173.0	130.1	160.5	
	SOP	446	5,764	14,450	16,176	5,889	3,547	843	425	440	47,979
2000	Numbers	117.66	318.92	316.80	113.84	66.44	26.18	9.86	1.60	1.54	972.85
	Mean W.	22.6	31.9	70.3	113.2	146.0	170.2	160.7	191.1	211.4	
	SOP	2,662	10,185	22,266	12,886	9,701	4,454	1,585	306	327	64,372
2001	Numbers	121.68	37.16	216.07	126.87	41.66	25.56	12.79	5.48	2.83	590.11
	Mean W.	9.0	51.7	77.3	111.0	147.0	174.0	185.4	187.8	206.9	
	SOP	1,096	1,921	16,707	14,076	6,125	4,448	2,372	1,029	585	48,359
2002	Numbers	69.63	577.69	168.26	134.60	53.09	12.05	7.48	2.43	2.02	1,027.26
	Mean W.	10.2	20.4	78.2	117.7	143.8	169.8	191.9	198.2	215.5	
	SOP	709	11,795	13,162	15,848	7,632	2,046	1,435	481	435	53,544

Table 3.2.13 Transfers of North Sea autumn spawners from Div. IIIa to the North Sea Numbers (mill) and mean weight, SOP in (tonnes) 1991-2002.

Year	W-Rings	0	1	2	3	4	5	6	7	8+	Total
1991	Number	677.1	748.3	298.3	52.4	7.7	5.1	1.1	0.4	0.1	1,790.6
	Mean W.	25.6	40.5	72.9	97.2	135.8	149.7	155.7	159.8	176.8	
	SOP	17,314	30,336	21,744	5,098	1,049	771	178	59	26	76,575
1992	Number	2,298.4	1,408.8	220.3	22.1	10.4	6.6	2.9	1.0	0.4	3,970.9
	Mean W.	12.3	51.8	84.2	131.4	162.0	173.4	185.3	198.4	201.2	
	SOP	28,159	72,985	18,557	2,907	1,683	1,143	533	200	84	126,251
1993	Number	2,795.4	2,032.5	237.6	26.5	7.7	3.6	2.7	2.2	0.7	5,109.0
	Mean W.	12.5	28.6	79.7	141.4	132.3	233.4	238.5	180.6	203.1	
	SOP	34,903	58,107	18,939	3,749	1,016	850	647	390	133	118,734
1994	Number	481.6	1,086.5	201.4	26.9	6.0	2.9	1.6	0.4	0.2	1,807.5
	Mean W.	16.0	42.9	83.4	110.7	138.3	158.6	184.6	199.1	213.9	
	SOP	7,723	46,630	16,790	2,980	831	460	287	75	37	75,811
1995	Number	1,144.5	1,189.2	161.5	13.3	3.5	1.1	0.6	0.4	0.3	2,514.4
	Mean W.	11.2	39.1	88.3	145.7	165.5	204.5	212.2	236.4	244.3	
	SOP	12,837	46,555	14,267	1,940	573	225	133	86	65	76,680
1996	Number	516.1	961.1	161.4	17.0	3.4	1.6	0.7	0.4	0.3	1,661.9
	Mean W.	11.0	23.4	80.2	126.6	165.0	186.5	216.1	216.3	239.1	
	SOP	5,697	22,448	12,947	2,151	565	307	145	77	66	44,403
1997	Number	67.6	305.3	131.7	21.2	1.7	0.8	0.2	0.1	0.1	528.7
	Mean W.	19.3	47.7	68.5	124.4	171.5	184.7	188.7	188.7	192.4	
	SOP	1,304	14,571	9,025	2,643	285	146	40	16	25	28,057
1998	Number	51.3	745.1	161.5	26.6	19.2	3.0	3.1	1.2	0.5	1,011.6
	Mean W.	27.4	56.4	79.8	117.8	162.9	179.7	197.2	178.9	226.3	
	SOP	1,409	41,994	12,896	3,137	3,136	547	608	211	108	64,045
1999	Number	598.8	303.0	148.6	47.2	13.4	6.2	1.2	0.5	0.5	1,119.4
	Mean W.	10.4	50.5	87.7	113.7	137.4	156.5	188.1	187.3	198.8	
	SOP	6,255	15,297	13,037	5,369	1,841	974	230	90	92	43,186
2000	Number	235.3	984.3	116.0	21.9	22.9	7.5	3.3	0.6	0.1	1,391.8
	Mean W.	21.3	28.5	76.1	108.8	163.1	190.3	183.9	189.4	200.2	
	SOP	5,005	28,012	8,825	2,377	3,731	1,436	601	114	13	50,115
2001	Number	807.8	563.6	150.0	17.2	1.4	0.3	0.5	0.0	0.0	1,540.8
	Mean W.	8.7	49.4	75.3	108.2	130.1	147.1	219.1	175.8	198.1	
	SOP	7,029	27,849	11,300	1,856	177	43	109	8	5	48,376
2002	Number	478.5	362.6	56.7	5.6	0.7	0.2	0.1	0.0	0.0	904.5
	Mean W.	12.2	38.0	100.6	121.5	142.7	160.9	178.7	177.4	218.6	
	SOP	5,859	13,790	5,705	684	106	26	21	8	5	26,205

Corrections for the years 1991-1998 was made in WG2001, but are NOT included in the North Sea assessment.

Table 3.2.14 **Total catch in numbers (mill) of spring spawners in Division IIIa and the North Sea + in Sub-Divisions 22-24 in the years 1991-2002**

Year	Area / W-rings	0	1	2	3	4	5	6	7	8+	Total
1991	Div. IV+Div. IIIa	100.0	157.4	382.9	394.8	167.0	112.4	21.9	7.3	3.2	1246.8
	Sub-div. 22-24	19.0	668.5	158.3	169.7	112.8	65.1	24.6	5.9	1.8	1206.8
1992	Div. IV+Div. IIIa	109.1	246.0	321.9	174.0	154.5	78.3	55.8	17.9	8.5	1056.9
	Sub-div. 22-24	36.0	210.7	280.8	190.8	179.5	104.9	84.0	34.8	14.0	1099.5
1993	Div. IV+Div. IIIa	161.3	371.5	315.8	219.0	94.1	59.4	41.0	21.7	8.2	1130.8
	Sub-div. 22-24	44.9	159.2	180.1	196.1	166.9	151.1	61.8	42.2	16.3	973.7
1994	Div. IV+Div. IIIa	60.6	153.1	261.1	221.6	131.0	77.3	44.4	14.4	8.6	911.6
	Sub-div. 22-24	202.6	96.3	103.8	161.0	136.1	90.8	74.0	35.1	24.5	721.6
1995	Div. IV+Div. IIIa	50.3	302.5	217.8	129.6	108.9	35.3	23.8	14.6	7.7	840.3
	Sub-div. 22-24	491.0	1,358.2	233.9	128.9	104.0	53.6	38.8	20.9	13.2	1951.5
1996	Div. IV+Div. IIIa	166.2	228.1	320.2	87.4	53.5	34.8	15.0	7.7	6.0	752.7
	Sub-div. 22-24	4.9	410.8	82.8	124.1	103.7	99.5	52.7	24.0	19.5	917.1
1997	Div. IV+Div. IIIa	26.0	73.4	167.5	192.5	42.7	18.2	6.2	2.1	3.2	505.9
	Sub-div. 22-24	350.8	595.2	130.6	96.9	45.1	29.0	35.1	19.5	21.8	973.2
1998	Div. IV+Div. IIIa	36.3	177.5	347.4	102.4	60.6	13.0	9.3	2.3	2.3	714.7
	Sub-div. 22-24	513.5	447.9	115.8	88.3	92.0	34.1	15.0	13.2	12.0	818.4
1999	Div. IV+Div. IIIa	38.5	137.1	168.9	138.6	47.8	24.0	4.9	3.3	2.7	527.2
	Sub-div. 22-24	528.3	425.8	178.7	123.9	47.1	33.7	11.1	6.5	3.7	830.5
2000	Div. IV+Div. IIIa	117.7	318.9	316.8	113.8	66.4	26.2	9.9	1.6	1.5	855.2
	Sub-div. 22-24	37.7	616.3	194.3	86.7	77.8	53.0	30.1	12.4	9.3	1079.9
2001	Div. IV+Div. IIIa	121.7	37.2	216.1	126.9	41.7	25.6	12.8	5.5	2.8	590.1
	Sub-div. 22-24	634.6	486.5	280.7	146.8	76.0	48.7	29.3	14.1	4.3	1721.0
2002	Div. IV+Div. IIIa	69.6	577.7	168.3	134.6	53.1	12.0	7.5	2.4	2.0	1027.3
	Sub-div. 22-24	80.6	81.4	113.6	186.7	119.2	45.1	31.1	11.4	6.3	675.4

Table 3.2.15 **Mean weight (g) and SOP (tons) of spring spawners in Division IIIa + the North Sea and in Sub-Divisions 22-24 in the years 1991 - 2002**

Year	Area / W-rings	0	1	2	3	4	5	6	7	8+	SOP
1991	Div. IV+Div. IIIa	33.0	48.6	69.5	99.9	135.7	146.2	166.9	179.7	193.2	121,687
	Sub-div. 22-24	11.5	31.5	60.4	83.2	105.2	126.6	145.6	160.0	163.7	69,886
1992	Div. IV+Div. IIIa	13.9	44.1	87.0	112.9	136.2	166.3	183.5	194.4	203.6	109,523
	Sub-div. 22-24	19.1	23.3	44.8	77.4	99.2	123.3	152.9	166.2	184.2	84,888
1993	Div. IV+Div. IIIa	15.1	25.9	81.4	127.5	150.1	171.1	195.9	209.1	239.0	104,498
	Sub-div. 22-24	16.2	24.5	44.5	73.6	94.1	122.4	149.4	168.5	178.7	80,512
1994	Div. IV+Div. IIIa	20.2	42.6	94.8	122.7	150.3	168.7	194.7	209.9	220.2	106,013
	Sub-div. 22-24	12.9	28.2	54.2	76.4	95.0	117.7	133.6	154.3	173.9	66,425
1995	Div. IV+Div. IIIa	17.9	41.5	101.0	148.2	167.0	199.9	212.0	229.6	235.2	90,127
	Sub-div. 22-24	9.3	16.3	42.8	68.3	88.9	125.4	150.4	193.3	207.4	74,157
1996	Div. IV+Div. IIIa	10.5	27.6	90.5	140.8	175.8	190.1	207.6	211.5	220.0	71,426
	Sub-div. 22-24	12.1	22.9	45.8	74.0	92.1	116.3	120.8	139.0	182.5	56,817
1997	Div. IV+Div. IIIa	19.2	49.7	79.2	130.9	171.8	187.7	194.2	203.1	211.4	55,686
	Sub-div. 22-24	30.4	24.7	58.4	101.0	120.7	155.2	181.3	197.1	208.8	67,513
1998	Div. IV+Div. IIIa	27.8	51.3	73.3	109.4	143.5	172.6	194.5	187.0	229.6	60,475
	Sub-div. 22-24	13.3	26.3	52.2	78.6	103.0	125.2	150.0	162.1	179.5	51,911
1999	Div. IV+Div. IIIa	11.6	42.0	85.6	116.7	123.2	147.8	173.0	130.1	160.5	47,979
	Sub-div. 22-24	11.1	26.9	50.4	81.6	112.0	148.4	151.4	167.8	161.0	50,060
2000	Div. IV+Div. IIIa	22.6	31.9	70.3	113.2	146.0	170.2	160.7	191.1	211.4	64,372
	Sub-div. 22-24	16.5	22.2	42.8	80.4	123.5	133.2	143.4	155.4	151.4	53,904
2001	Div. IV+Div. IIIa	9.0	51.7	77.3	111.0	147.0	174.0	185.4	187.8	206.9	48,359
	Sub-div. 22-24	12.9	22.3	46.8	69.0	93.5	150.8	145.1	146.3	153.1	63,724
2002	Div. IV+Div. IIIa	10.2	20.4	78.2	117.7	143.8	169.8	191.9	198.2	215.5	53,544
	Sub-div. 22-24	10.8	27.3	57.8	81.7	108.8	132.1	186.6	177.8	157.7	52,647

Table 3.2.16 Herring in Division IIIa, IIIb and IIIc. Samples of commercial landings by quarter and area for 2002 available to the Working Group.

	Country	Quarter	Landings in '000 tons	Numbers of samples	Numbers of fish meas.	Numbers of fish aged
Skagerrak	**Denmark**	**1**	4.6	8	940	201
		2	1.0	29	590	106
		3	7.2	33	2,738	1,337
		4	4.2	6	1,282	491
	Total		17.0	76	5,550	2,135
	Norway	**1**	0.3			
		2	4.7		No data available	
		3	0.3			
		4	0.7			
	Total		6.0	0	0	0
	Sweden	**1**	3.7	11	657	654
		2	4.7	13	650	648
		3	13.5	21	1,011	1,008
		4	4.4	16	784	780
	Total		26.3	61	3,102	3,090
Kattegat	**Denmark**	**1**	6.5	8	1,113	429
		2	1.6	2	314	152
		3	8.6	11	1,595	951
		4	5.8	1	213	97
	Total		22.5	22	3,235	1,629
	Sweden	**1**	2.9	17	850	850
		2	1.1	3	150	150
		3	0.8	4	200	200
		4	2.4	10	500	496
	Total		7.2	34	1,700	1,696
Sub-Division 22	**Denmark**	**1**	0.4	1	205	46
		2	0.5	3	282	133
		3	0.1	2	66	50
		4	1.2	9	985	419
	Total		2.2	15	1,538	648
	Germany	**1**	2.8			
		2	0.8		No data available	
		3	+			
		4	0.6			
	Total		4.2	0	0	0
Sub-Division 23	**Denmark**	**1**	0.2	1	55	50
		2	+		No data available	
		3	+			
		4	0.1	4	591	245
	Total		0.3	5	646	295
	Sweden	**1**	0.5			
		2	0.0		No data available	
		3	0.1			
		4	0.4			
	Total		1.0	0	0	0
Sub-Division 24	**Denmark**	**1**	0.7	4	454	212
		2	2.1	3	406	147
		3	0.2		No data available	
		4	5.7	3	512	147
	Total		8.7	10	1,372	506
	Germany	**1**	9.4	20	5,660	1,484
		2	7.4	15	4,528	1,294
		3	+		No data available	
		4	1.4	5	1,977	534
	Total		18.2	40	12,165	3,312
	Poland	**1**	1.2	1	151	44
		2	5.5	6	1,469	412
		3	0.1		No data available	
		4	0.2			
	Total		7.0			
	Sweden	**1**	4.4	13	624	622
		2	2.0	7	349	347
		3	0.8	2	200	199
		4	3.5	7	315	315
	Total		10.7	29	1,488	1,483

Table 3.2.17 Herring in Division IIIa. Samples of landings by quarter and area for 2002 of mean weight at age.

	Country	Quarter	Fleet	Sampling used to estimate mean weight at age.
Skagerrak	**Denmark**	**1**	**C**	Danish sampling in Q1
		2	**C**	Danish sampling in Q2
		3	**C**	Danish sampling in Q3
		4	**C**	Danish sampling in Q4
	Norway	**1**	**C**	No data
		2	**C**	
		3	**C**	
		4	**C**	
	Sweden	**1**	**C**	Swedish sampling in Q1
		2	**C**	Swedish sampling in Q2
		3	**C**	Swedish sampling in Q3
		4	**C**	Swedish sampling in Q4
Kattegat	**Denmark**	**1**	**C**	Danish sampling in Q1
		2	**C**	Swedish sampling in Q2
		3	**C**	Danish sampling in Q3
		4	**C**	Danish sampling in Q4
	Sweden	**1**	**C**	Swedish sampling in Q1
		2	**C**	Swedish sampling in Q2
		3	**C**	Swedish sampling in Q3
		4	**C**	Swedish sampling in Q4
Skagerrak	**Denmark**	**1**	**D**	Danish sampling in Q1
		2	**D**	Danish sampling in Q2
		3	**D**	Danish sampling in Q3
		4	**D**	Danish sampling in Q4
	Sweden	**1**	**D**	Swedish sampling in Q1
		2	**D**	Danish sampling in Q2
		3	**D**	Danish sampling in Q3
		4	**D**	Danish sampling in Q4
Kattegat	**Denmark**	**1**	**D**	Danish sampling in Q1
		2	**D**	Danish sampling in Q2
		3	**D**	Danish sampling in Q3
		4	**D**	Danish sampling in Q3
	Sweden	**1**	**D**	Danish sampling in Q1
		2	**D**	Danish sampling in Q2
		3	**D**	Danish sampling in Q3
		4	**D**	Danish sampling in Q3

Fleet C= Human consumption, Fleet D= Industrial landings.

Table 3.2.17 continued   Herring in Division IIIb and IIIc.
Samples of landings by quarter and area for 2002 available to of mean weight at age.

	Country	Quarter	Fleet	Sampling used to estimate mean weight at age
Sub-Division 22	**Denmark**	1	F	Danish sampling in Q1
		2	F	Danish sampling in Q2
		3	F	Danish sampling in Q3
		4	F	Danish sampling in Q4
	Germany	1	F	German sampling in Q1 in Sub-div 24
		2	F	German sampling in Q2 in Sub-div 24
		3	F	German sampling in Q4 in Sub-div 24
		4	F	German sampling in Q4 in Sub-div 24
Sub-Division 23	**Denmark**	1	F	Danish sampling in Q1 in Kattegat
		2	F	Danish sampling in Q2 in Kattegat
		3	F	Danish sampling in Q3
		4	F	Danish sampling in Q4
	Sweden	1	F	Danish sampling in Q1 in Kattegat
		2	F	Danish sampling in Q2 in Kattegat
		3	F	Danish sampling in Q3
		4	F	Danish sampling in Q4
Sub-Division 24	**Denmark**	1	F	Danish sampling in Q1
		2	F	Danish sampling in Q2
		3	F	Danish sampling in Q4
		4	F	Danish sampling in Q4
	Germany	1	F	German sampling in Q1
		2	F	German sampling in Q2
		3	F	No landings
		4	F	German sampling in Q4
	Poland	1	F	Polish sampling in Q1
		2	F	Polish sampling in Q2
		3	F	German sampling in Q3
		4	F	German sampling in Q4
	Sweden	1	F	Swedish sampling in Q1
		2	F	Danish sampling in Q2
		3	F	Swedish sampling in Q3
		4	F	Swedish sampling in Q4

Fleet C= Human consumption, Fleet D= Industrial landings.

Table 3.3.1 International Bottom Trawl Survey in the Kattegat in quarter 1. Mean catch of spring-spawning herring at age in number per haul.

Year	Winter rings				
	1	2	3	4	5
1990	416	681	65	43	11
1991	190	206	144	25	20
1992	588	82	33	21	13
1993	3140	554	81	35	50
1994	1380	256	112	22	31
1995	781	132	30	42	24
1996	1312	1405	160	42	22
1997	3267	229	119	15	18
1998	407	853	165	74	8
1999	309	66	43	21	14
2000	1933	219	28	10	7
2001*	-	-	-	-	-
2002	2335	178	222	23	7
2003	1364	1495	41	10	0

Table 3.3.2 International Bottom Trawl Survey in the Kattegat in quarter 3. Mean catch of spring-spawning herring at age in number per haul.

Year	Winter rings				
	1	2	3	4	5
1991	141	83	101	41	24
1992	372	108	70	63	25
1993	404	159	42	36	25
1994	265	229	154	49	36
1995	687	192	113	99	29
1996	631	322	31	17	11
1997	52	122	33	8	13
1998	118	86	22	27	5
1999	292	116	71	34	14
2000**	-	-	-	-	-
2001	313	190	72	18	2
2002	1568	169	100	16	6

* = no data available

** = no survey was carried out in 2000

Table 3.3.3 Acoustic surveys on the Spring Spawning HERRING in the North Sea / Division IIIa in 1991-2002 (July).

Year	1991	1992*	1993*	1994*	1995*	1996*	1997	1998	1999**	2000	2001	2002
	Numbers in millions											
W-rings												
0		3,853	372	964								
1		277	103	5	2,199	1,091	128	138	1367	1509	66	3346
2	1,864	2,092	2,768	413	1,887	1,005	715	1,682	1143	1891	641	1577
3	1,927	1,799	1,274	935	1,022	247	787	901	523	674	452	1393
4	866	1,593	598	501	1,270	141	166	282	135	364	153	524
5	350	556	434	239	255	119	67	111	28	186	96	88
6	88	197	154	186	174	37	69	51	3	56	38	40
7	72	122	63	62	39	20	80	31	2	7	23	18
8+	10	20	13	34	21	13	77	53	1	10	12	17
Total	**5,177**	**10,509**	**5,779**	**3,339**	**6,867**	**2,673**	**2,088**	**3,248**	**3,201**	**4,696**	**1,481**	**7,002**
3+ group	**3,313**	**4,287**	**2,536**	**1,957**	**2,781**	**577**	**1,245**	**1,428**	**691**	**1,295**	**774**	**2,079**
	Biomass ('000 tonnnes)											
W-rings												
0		34.3	1	8.7								
1		26.8	7	0.4	77.4	52.9	4.7	7.1	74.8	61.4	3.5	137.2
2	177.1	169.0	139	33.2	108.9	87.0	52.2	136.1	101.6	138.1	55.8	107.2
3	219.7	206.3	112	114.7	102.6	27.6	81.0	84.8	59.5	68.8	51.2	126.9
4	116.0	204.7	69	76.7	145.5	17.9	21.5	35.2	14.7	45.3	21.5	55.9
5	51.1	83.3	65	41.8	33.9	17.8	9.8	13.1	3.4	25.1	17.9	12.8
6	19.0	36.6	26	38.1	27.4	5.8	9.8	6.9	0.5	10.0	6.9	7.4
7	13.0	24.4	16	13.1	6.7	3.3	14.9	4.8	0.3	1.4	4.7	3.5
8+	2.0	5.0	2	7.8	3.8	2.7	13.6	9.0	0.1	1.3	2.7	3.1
Total	597.9	756.1	436.5	325.8	506.2	215.1	207.5	297.0	254.9	351.4	164.2	454.0
3+ group	420.9	560.3	291.0	292.3	319.9	75.2	150.6	153.7	78.5	151.9	104.9	209.6
	Mean weight (g)											
W-rings												
0		8.9	4.0	9.0								
1		96.8	66.3	80.0	35.2	48.5	36.9	51.9	54.7	40.7	54.0	41.0
2	95	80.8	50.1	80.3	57.7	86.6	73.0	80.9	88.9	73.1	87.0	68.0
3	114	114.7	87.9	122.7	100.4	111.9	103.0	94.1	113.8	102.2	113.2	91.1
4	134	128.5	116.2	153.0	114.6	126.8	129.6	124.7	109.1	124.4	140.5	106.6
5	146	149.8	149.9	175.1	132.9	149.4	145.0	118.7	120.0	135.4	185.2	145.8
6	216	185.7	169.6	205.0	157.2	157.3	143.1	135.8	179.9	179.2	182.6	186.5
7	181	199.7	256.9	212.0	172.9	166.8	185.6	156.4	179.9	208.8	206.3	198.7
8+	200	252.0	164.2	230.3	183.1	212.9	178.0	168.0	181.7	135.2	226.9	183.4
Total	115.6	123.9	75.8	100.2	73.7	80.5	99.4	91.4	78.5	74.8	110.9	64.8

* revised in 1997

**the survey only covered the Skagerrak area by Norway. Additional estimates for the Kattegat area were ad
(see ICES 2000/ACFM:10, Table 3.5.8)

Table 3.3.4 Acoustic survey on the Spring Spawning Herring in Sub-divisions 22-24 in 1991-2002 (September/October).

Year	1991[3)]	1992[3)]	1993[1)]	1994[1)]	1995[1)]	1996[1)]	1997[1)]	1998[1)]	1999[1)]	2000	2001[2)]	2002
	Numbers in millions											
W-rings												
0	5,577	3,467	768	4,383	4,001	1,418	2,608	2,179	4,821	1,021	1,831	3,984
1	2,507	2,179	345	412	1,163	1,084	1,389	451	1,145	1,208	1,314	611
2	880	1,015	354	823	307	541	492	557	246	477	1,761	372
3	852	465	485	540	332	413	343	364	187	348	1,013	566
4	259	233	381	433	342	282	151	232	129	206	357	337
5	102	71	122	182	247	283	112	99	44	81	92	61
6	49	32	52	56	124	110	92	51	8	39	55	23
7	6	8	28	22	40	44	32	23	1	5	5	3
8+	27	9	13	2	27	18	46	9	2	4	0	13
Total	10,259	7,480	2,547	6,854	6,583	4,193	5,265	3,966	6,582	3,389	6,428	5,970
3+ group	1,295	818	1,080	1,235	1,112	1,151	775	778	370	682	1,522	1,002
	Biomass ('000 tonnnes)											
W-rings												
0	62.0	48.9	11.1	49.3	41.1	12.3	25.6	20.4	54.2	12.8	21.4	33.9
1	97.8	77.8	12.3	14.3	39.6	32.9	49.4	18.2	42.3	47.5	59.1	23.9
2	60.0	57.5	15.7	38.1	19.8	26.8	29.2	41.4	18.8	29.7	118.7	27.1
3	76.9	39.5	29.7	39.2	28.5	29.2	31.9	32.9	22.0	29.0	93.4	56.1
4	29.4	28.5	23.5	41.3	39.1	20.0	21.0	27.5	13.1	24.1	34.2	39.8
5	13.5	10.6	12.3	22.9	26.7	33.9	16.0	11.2	5.6	9.2	11.6	8.6
6	6.4	5.1	6.7	11.5	14.7	14.7	13.2	6.1	0.8	5.6	7.6	3.3
7	0.8	1.6	2.2	4.9	8.8	5.7	5.1	3.7	0.2	1.1	0.9	0.5
8+	3.6	2.1	1.8	0.6	6.6	2.7	10.2	2.2	0.4	0.7	0.0	1.9
Total	350.3	271.6	115.3	222.1	224.8	178.4	201.6	163.5	157.4	159.7	346.9	195.2
3+ group	130.5	87.4	76.2	120.4	124.4	106.3	97.4	83.5	42.1	69.6	147.7	110.3
	Mean weight (g)											
W-rings												
0	11.11	14.10	14.42	11.24	10.26	8.66	9.82	9.36	11.24	12.57	11.69	8.50
1	39.03	35.72	35.65	34.74	34.00	30.39	35.57	40.25	36.97	39.33	45.00	39.14
2	68.19	56.66	44.28	46.31	64.48	49.59	59.41	74.26	76.41	62.25	67.39	72.79
3	90.20	84.89	61.32	72.60	85.87	70.75	93.11	90.40	117.57	83.35	92.25	99.19
4	113.47	122.29	61.64	95.46	114.53	71.05	139.16	118.27	101.76	117.13	95.74	118.22
5	132.20	148.66	100.90	125.90	108.02	119.68	142.28	113.98	127.52	114.13	125.98	142.63
6	130.36	161.01	129.59	203.98	118.13	133.54	143.37	120.50	107.15	142.99	137.01	142.84
7	133.03	205.68	80.16	222.60	222.04	128.46	161.65	158.10	232.70	202.91	175.65	205.51
8+	132.53	224.36	137.54	269.56	241.09	154.73	222.18	232.86	219.08	180.94	-	143.51
Total	34.15	36.32	45.26	32.41	34.15	42.54	38.30	41.22	23.92	47.13	53.96	32.71

1) revised in 2001 due to new presented area of strata in the 'Manual for the Baltic International Acoustic Survey'. ICES CM 2000/H:2 Ref.: D: Annex 3 (Table 2.2)

2) incl. estimates for Sub-division 23, which was covered by RV ARGOS (Sweden) in November 2001

3) revised in 2003 due to revised Sa values

Table 3.3.5 Estimation of the herring 0-Group (TL >=30 mm) Greifswalder Bodden and adjacent waters (March/April to June)

Year	Number in Millions
1977	2000[1]
1978	100[1]
1979	2200[1]
1980	360[1]
1981	200[1]
1982	180[1]
1983	1760[1]
1984	290[1]
1985	1670[1]
1986	1500[1]
1987	1370[1]
1988	1223[2]
1989	63[2]
1990	57[2]
1991	236[3]
1992	18[4]
1993	199[4]
1994	788[4]
1995	171[4]
1996	31[4]
1997	54[4]
1998	2553[4]
1999	1945[4]
2000	151[4]
2001	421[4]
2002	2051[4]

[1] Brielmann 1989
[2] Klenz 1999 Inf.Fischwirtsch. Fischereiforsch. 46(2), 1999: 15-17
[3] Müller & Klenz 1994
[4] Klenz 2002 Inf.Fischwirtsch. Fischereiforsch. 49(4), 2002: 143-144

Table. 3.6.1 WESTERN BALTIC HERRING. Input to ICA.

Catch in number (millions)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	119.0	145.1	206.1	263.2	541.3	171.1	376.8	549.8	569.6	155.4	756.3	150.3
1	826.0	456.7	530.7	249.4	1660.7	638.9	668.6	625.5	617.1	935.2	523.7	659.1
2	541.2	602.6	495.9	365.0	451.8	403.1	298.2	463.2	349.4	511.1	496.8	281.8
3	564.4	364.9	415.1	382.6	258.5	211.5	289.4	190.7	257.6	200.6	273.6	321.3
4	279.8	334.0	260.9	267.0	212.9	157.3	87.8	152.5	94.9	144.2	117.7	172.3
5	177.5	183.2	210.5	168.1	88.9	134.3	47.2	47.1	57.7	79.1	74.3	57.2
6	46.5	139.8	102.8	118.4	62.6	67.7	41.4	24.3	15.9	39.9	42.0	38.5
7	13.2	52.7	63.9	49.5	35.5	31.7	21.6	15.5	9.7	14.0	19.6	13.8
8	4.9	22.6	24.5	33.1	20.9	25.5	25.0	14.3	6.4	10.9	7.1	8.3

Table. 3.6.2 WESTERN BALTIC HERRING. Input to ICA.
Mean weight in catch (kg)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0.02957	0.01519	0.01535	0.01458	0.01010	0.01056	0.02962	0.01426	0.01110	0.02110	0.01230	0.01050
1	0.03476	0.03447	0.02545	0.03704	0.02092	0.02458	0.02748	0.03341	0.03440	0.02550	0.02440	0.02130
2	0.06685	0.06732	0.06797	0.08328	0.07087	0.08132	0.07009	0.06802	0.06760	0.05980	0.06010	0.07000
3	0.09490	0.09435	0.10204	0.10323	0.10839	0.10158	0.12092	0.09515	0.09930	0.09900	0.08850	0.09680
4	0.12342	0.11630	0.11428	0.12213	0.12884	0.12061	0.14556	0.11909	0.11770	0.13390	0.11250	0.11960
5	0.13901	0.14169	0.13615	0.14115	0.15501	0.13541	0.16774	0.13833	0.14820	0.14540	0.15880	0.14000
6	0.15560	0.16511	0.16795	0.15648	0.17379	0.14002	0.18327	0.16693	0.15800	0.14770	0.15740	0.18760
7	0.17091	0.17576	0.18228	0.17046	0.20825	0.15668	0.19770	0.16580	0.15520	0.15950	0.15790	0.18140
8	0.18256	0.19152	0.19890	0.18596	0.21766	0.19139	0.20913	0.18758	0.16080	0.15990	0.17460	0.17170

Table. 3.6.3 WESTERN BALTIC HERRING. Input to ICA .
Mean weight in stock (kg)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010
1	0.03085	0.02029	0.01563	0.01855	0.01305	0.01815	0.01310	0.02209	0.02110	0.01400	0.01690	0.01650
2	0.05277	0.04513	0.04020	0.05288	0.04590	0.05456	0.05147	0.05578	0.05670	0.04330	0.05090	0.06370
3	0.07873	0.08176	0.09671	0.08357	0.07081	0.09051	0.10633	0.08293	0.08710	0.08490	0.07860	0.09050
4	0.10412	0.10751	0.10793	0.10767	0.13269	0.11703	0.13334	0.11280	0.10810	0.12650	0.11640	0.12390
5	0.12447	0.13127	0.14087	0.13921	0.16745	0.11974	0.16618	0.13378	0.14800	0.14500	0.16920	0.17360
6	0.14492	0.15934	0.16715	0.15656	0.18923	0.15383	0.19429	0.16779	0.16010	0.16300	0.17630	0.19830
7	0.15943	0.17102	0.18273	0.17676	0.20970	0.14667	0.20895	0.16832	0.14390	0.16550	0.16840	0.19800
8	0.16398	0.18693	0.18906	0.20275	0.23377	0.12803	0.22635	0.18432	0.15040	0.18370	0.18120	0.20360

Table. 3.6.4 WESTERN BALTIC HERRING. Input to ICA .
Natural mortality

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0.30000	0.30000	0.30000	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	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	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	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	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	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	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	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	0.20000	0.20000	0.20000

Table. 3.6.5 a WESTERN BALTIC HERRING. Input to ICA.
AGE - STRUCTURED INDICES.
Acoustic Survey in SD 22-24, Ages 0-5 (Catch: Number in millions)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	5577.0	3467.0	768.0	4383.0	4001.0	1418.0	2608.0	2179.0	4821.0	1021.0	1831.0	3984.0
1	2507.0	2179.0	345.0	412.0	1163.0	1084.0	1389.0	451.0	1145.0	1208.0	1314.0	611.0
2	880.0	1015.0	354.0	823.0	307.0	541.0	492.0	557.0	246.0	477.0	1761.0	372.0
3	852.0	465.0	485.0	540.0	332.0	413.0	343.0	364.0	187.0	348.0	1013.0	566.0
4	259.0	233.0	381.0	433.0	342.0	282.0	151.0	232.0	129.0	206.0	357.0	337.0
5	102.0	71.0	121.0	182.0	247.0	283.0	112.0	99.0	44.0	81.0	92.0	61.0

Table. 3.6.5 b WESTERN BALTIC HERRING. Input to ICA.
AGE - STRUCTURED INDICES.
Acoustic Survey in Div. IIIa+IVaE, Ages 2-8+ (Catch: Number in millions)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	1864.0	2092.0	2768.0	413.0	1887.0	1005.0	715.0	1682.0	*******	1891.1	641.2	1576.6
3	1927.0	1799.0	1274.0	935.0	1022.0	247.0	787.0	901.0	*******	673.6	452.3	1392.8
4	866.0	1593.0	598.0	501.0	1270.0	141.0	166.0	282.0	*******	363.9	153.1	524.3
5	350.0	556.0	434.0	239.0	255.0	119.0	67.0	111.0	*******	185.7	96.4	87.5
6	88.0	197.0	154.0	186.0	174.0	37.0	69.0	51.0	*******	55.6	37.6	39.5
7	72.0	122.0	63.0	62.0	39.0	20.0	80.0	31.0	*******	6.9	23.0	17.8
8	10.0	20.0	13.0	34.0	21.0	13.0	77.0	53.0	*******	9.6	11.9	17.1

Table. 3.6.5 c WESTERN BALTIC HERRING. Input to ICA.
AGE - STRUCTURED INDICES.
IBTS in Kattegat, Quarter 3, Ages 1-5 (Catch: Number)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	141.2	371.5	404.0	264.5	687.3	631.3	52.4	117.5	292.0	*******	313.0	1567.8
2	83.2	107.6	158.7	229.4	191.5	321.8	122.2	85.8	116.3	*******	190.0	169.0
3	100.9	69.9	41.9	154.2	113.2	30.8	33.2	22.4	71.2	*******	72.0	100.2
4	41.2	63.0	36.0	49.0	99.1	17.5	8.4	27.3	33.6	*******	18.0	15.5
5	23.8	24.7	25.1	35.7	29.4	11.3	13.2	5.0	14.3	*******	2.0	5.8

Table 3.6.6 WESTERN BALTIC HERRING:

Input parameters for ICA FINAL Run

```
                         Integrated Catch-at-age Analysis
                                 Version 1.4 w
                                 K.R.Patterson
                          Fisheries Research Services
                               Marine Laboratory
                                    Aberdeen
                                 24 August 1999

Enter the name of the index file -->index.dat
canum.low
weca.low
 Stock weights in 2003  used for the year 2002
west.low
 Natural mortality in 2003  used for the year 2002
natmor.low
 Maturity ogive in 2003  used for the year 2002
matprop.low
 Name of age-structured index file (Enter if none) : -->dagaiyfd.dat
 Name of the SSB index file (Enter if none) -->
No indices of spawning biomass to be used.
 No of years for separable constraint ?--> 5
 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) ?-->n
Enter relative weights-at-age
 Weight for age 0-->    0.100000000000000
 Weight for age 1-->    1.000000000000000
 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 1998-->    1.000000000000000
 Weight for year 1999-->    1.000000000000000
 Weight for year 2000-->    1.000000000000000
 Weight for year 2001-->    1.000000000000000
 Weight for year 2002-->    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 Acoustic  Survey in  Div IIIa+IVaE WR 2-8+ a plus-group (Y/-->y
 Is the last age of Acoustic Survey in Sub div 22-24 WR 0-5    a plus-group (Y-->n
 Is the last age of IBTS Katt Quart3 WR 1-5                    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 Acoustic  Survey in  Div IIIa+IVaE WR 2-8+ is to be A/L/P ?-->L
 Model for Acoustic Survey in Sub div 22-24 WR 0-5   is to be A/L/P ?-->L
 Model for IBTS Katt Quart3 WR 1-5                   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        34.3127874575
    0.10        20.1497850962
    0.15        15.1399364901
    0.20        12.9162843242
    0.25        11.8034023346
    0.30        11.2283136787
    0.35        10.9557849111
    0.40        10.8734190692
    0.45        10.9205285659
    0.50        11.0608197651
    0.55        11.2709087824
    0.60        11.5348354635
    0.65        11.8413213938
    0.70        12.1824120576
    0.75        12.5521166561
    0.80        12.9461579126
    0.85        13.3614551593
    0.90        13.7958746135
    0.95        14.2480380124
    1.00        14.7172117724
Lowest SSQ is for F =     0.404
```

Table 3.6.6 continued

```
-----------------------------------------------------------------
No of years for separable analysis : 5
Age range in the analysis : 0  . . . 8
Year range in the analysis : 1991  . . . 2002
Number of indices of SSB : 0
Number of age-structured indices : 3

Parameters to estimate : 41
Number of observations : 244

Conventional single selection vector model to be fitted.


-----------------------------------------------------------------
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for Acoustic  Survey in  Div IIIa+IVaE      at age 2-->    1.000000000000000
 Enter weight for Acoustic  Survey in  Div IIIa+IVaE      at age 3-->    1.000000000000000
 Enter weight for Acoustic  Survey in  Div IIIa+IVaE      at age 4-->    1.000000000000000
 Enter weight for Acoustic  Survey in  Div IIIa+IVaE      at age 5-->    1.000000000000000
 Enter weight for Acoustic  Survey in  Div IIIa+IVaE      at age 6-->    1.000000000000000
 Enter weight for Acoustic  Survey in  Div IIIa+IVaE      at age 7-->    1.000000000000000
 Enter weight for Acoustic  Survey in  Div IIIa+IVaE      at age 8-->    1.000000000000000
 Enter weight for Acoustic Survey in Sub div 22-24        at age 0-->    1.000000000000000
 Enter weight for Acoustic Survey in Sub div 22-24        at age 1-->    1.000000000000000
 Enter weight for Acoustic Survey in Sub div 22-24        at age 2-->    1.000000000000000
 Enter weight for Acoustic Survey in Sub div 22-24        at age 3-->    1.000000000000000
 Enter weight for Acoustic Survey in Sub div 22-24        at age 4-->    1.000000000000000
 Enter weight for Acoustic Survey in Sub div 22-24        at age 5-->    1.000000000000000
 Enter weight for IBTS Katt Quart3 Age groups 1-5         at age 1-->    1.000000000000000
 Enter weight for IBTS Katt Quart3 Age groups 1-5         at age 2-->    1.000000000000000
 Enter weight for IBTS Katt Quart3 Age groups 1-5         at age 3-->    1.000000000000000
 Enter weight for IBTS Katt Quart3 Age groups 1-5         at age 4-->    1.000000000000000
 Enter weight for IBTS Katt Quart3 Age groups 1-5         at age 5-->    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 Acoustic  Survey in  Div IIIa+IVaE WR 2-8+-->    1.000000000000000
  Enter value for Acoustic Survey in Sub div 22-24 WR 0-5  --->    1.000000000000000
  Enter value for IBTS Katt Quart3 WR 1-5                   -->    1.000000000000000
 Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.

Aged index weights
Acoustic  Survey in  Div IIIa+IVaE WR 2-8+
 Age   :       2     3     4     5     6     7     8
 Wts :     0.143 0.143 0.143 0.143 0.143 0.143 0.143
Acoustic Survey in Sub div 22-24 WR 0-5
 Age   :       0     1     2     3     4     5
 Wts :     0.167 0.167 0.167 0.167 0.167 0.167
IBTS Katt Quart3 WR 1-5
 Age   :       1     2     3     4     5
 Wts :     0.200 0.200 0.200 0.200 0.200
F in 2002  at age 4  is 0.459188  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. 3.6.7 WESTERN BALTIC HERRING. Output from ICA Final Run FISHING MORTALITY (per year)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0.02727	0.04482	0.07725	0.04995	0.15981	0.04722	0.12478	0.08869	0.07299	0.09186	0.08817	0.07750
1	0.25692	0.16992	0.28222	0.15475	0.62979	0.35647	0.32376	0.30935	0.25458	0.32039	0.30751	0.27029
2	0.31617	0.36722	0.34012	0.38961	0.56685	0.37222	0.34069	0.41477	0.34135	0.42958	0.41232	0.36240
3	0.41439	0.36518	0.46635	0.47948	0.52969	0.57297	0.50186	0.45102	0.37117	0.46711	0.44834	0.39407
4	0.39062	0.46329	0.48496	0.62665	0.54076	0.72844	0.49873	0.52555	0.43251	0.54430	0.52243	0.45919
5	0.35981	0.48072	0.60258	0.67271	0.43909	0.79888	0.50090	0.54308	0.44695	0.56247	0.53987	0.47451
6	0.22787	0.53704	0.54894	0.83470	0.57438	0.71373	0.61914	0.56076	0.46149	0.58078	0.55744	0.48996
7	0.37872	0.43522	0.50606	0.56253	0.65156	0.65255	0.52170	0.52555	0.43251	0.54430	0.52243	0.45919
8	0.37872	0.43522	0.50606	0.56253	0.65156	0.65255	0.52170	0.52555	0.43251	0.54430	0.52243	0.45919

Table. 3.6.8 WESTERN BALTIC HERRING. Output from ICA Final Run POPULATION ABUNDANCE (millions)- 1 January

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	5115.6	3827.1	3203.0	6245.2	4225.4	4289.7	3706.2	5177.7	6392.2	3690.4	5844.9	4702.2	4106.5
1	4583.6	3687.8	2710.9	2196.4	4401.2	2668.0	3031.3	2423.5	3510.2	4402.1	2494.0	3964.6	3223.7
2	2191.6	2150.2	1887.2	1239.9	1141.2	1422.0	1133.0	1330.1	1078.8	1650.5	1938.1	1112.2	1835.1
3	1823.1	1307.9	1219.4	1099.6	687.6	530.1	802.4	659.8	719.3	627.8	879.4	1050.6	633.8
4	948.4	986.2	743.2	626.3	557.4	331.5	244.7	397.7	344.1	406.3	322.2	459.9	580.0
5	644.2	525.4	508.1	374.7	274.0	265.7	131.0	121.7	192.5	182.8	193.0	156.5	237.9
6	250.8	368.0	266.0	227.7	156.5	144.6	97.9	65.0	57.9	100.8	85.3	92.1	79.7
7	46.0	163.5	176.1	125.8	80.9	72.2	58.0	43.1	30.4	29.9	46.2	40.0	46.2
8	17.2	70.1	67.6	84.1	47.7	58.1	67.4	38.3	20.0	28.3	19.1	24.8	33.5

Table. 3.6.9 WESTERN BALTIC HERRING. Output from ICA Final Run STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 6	SoP (%)
1991	5115610	626518	317522	191573	0.6033	0.3482	99
1992	3827050	553880	330795	194411	0.5877	0.4616	100
1993	3202980	477693	304461	185010	0.6077	0.5257	100
1994	6245210	393346	241608	172438	0.7137	0.6534	99
1995	4225420	336504	195773	164284	0.8392	0.5210	100
1996	4289650	285285	141119	128243	0.9088	0.7035	100
1997	3706190	284496	156595	123199	0.7867	0.5302	100
1998	5177740	269329	124696	112386	0.9013	0.5201	99
1999	6392200	280858	125867	101573	0.8070	0.4280	100
2000	3690430	291237	138698	118278	0.8528	0.5387	100
2001	5844850	306929	148730	112083	0.7536	0.5170	99
2002	4702220	347176	177755	106191	0.5974	0.4544	99

Table. 3.6.10 WESTERN BALTIC HERRING. Output from ICA Final Run 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	1998	0.5255	12	0.4134	0.6680	0.4650	0.5940	0.5295
2	1999	0.4325	12	0.3382	0.5531	0.3815	0.4903	0.4359
3	2000	0.5443	12	0.4286	0.6912	0.4818	0.6149	0.5484
4	2001	0.5224	13	0.4036	0.6763	0.4580	0.5960	0.5270
5	2002	0.4592	15	0.3384	0.6231	0.3930	0.5366	0.4648
Separable Model: Selection (S) by age								
6	0	0.1688	34	0.0863	0.3302	0.1198	0.2377	0.1790
7	1	0.5886	14	0.4423	0.7834	0.5087	0.6811	0.5949
8	2	0.7892	14	0.5994	1.0391	0.6859	0.9081	0.7970
9	3	0.8582	13	0.6544	1.1255	0.7473	0.9855	0.8664
	4	1.0000	Fixed : Reference Age					
10	5	1.0334	12	0.8079	1.3218	0.9114	1.1717	1.0416
11	6	1.0670	12	0.8415	1.3530	0.9452	1.2044	1.0749
	7	1.0000	Fixed : Last true age					
Separable model: Populations in year 2002								
12	0	4702222	47	1867745	11838281	2935747	7531606	5254002
13	1	3964549	20	2642353	5948354	3223252	4876332	4050405
14	2	1112231	15	818805	1510809	951328	1300348	1125894
15	3	1050622	13	798788	1381852	913533	1208282	1060941
16	4	459861	12	357064	592252	404171	523224	463708
17	5	156449	12	121869	200841	137729	177713	157724
18	6	92098	14	69449	122133	79746	106363	93058
19	7	39982	16	28773	55558	33804	47290	40550
Separable model: Populations at age								
20	1998	43140	22	27526	67610	34302	54255	44289
21	1999	30367	19	20831	44268	25054	36806	30933
22	2000	29864	16	21799	40914	25433	35068	30252
23	2001	46176	16	33595	63467	39259	54311	46788

Table. 3.6.11 WESTERN BALTIC HERRING. Output from ICA Final Run AGE-STRUCTURED INDEX OF CATCHABILITIES

Acoustic Survey in Div IIIa+IVaE WR 2-8+									
Linear model fitted. Slopes at age :									
24	2	Q	1.252	18	1.049	2.159	1.252	1.809	1.531
25	3	Q	1.495	18	1.253	2.576	1.495	2.159	1.827
26	4	Q	1.369	18	1.147	2.359	1.369	1.977	1.673
27	5	Q	1.100	18	.9215	1.901	1.100	1.592	1.346
28	6	Q	.8922	18	.7458	1.551	.8922	1.296	1.094
29	7	Q	.8645	18	.7207	1.515	.8645	1.263	1.064
30	8	Q	.7506	18	.6275	1.304	.7506	1.090	.9205
Acoustic Survey in Sub div 22-24 WR 0-5									
Linear model fitted. Slopes at age :									
31	0	Q	.7516	16	.6391	1.239	.7516	1.054	.9027
32	1	Q	.5686	16	.4855	.9259	.5686	.7905	.6796
33	2	Q	.6066	16	.5182	.9857	.6066	.8421	.7244
34	3	Q	.8482	16	.7247	1.378	.8482	1.177	1.013
35	4	Q	.9652	16	.8244	1.569	.9652	1.340	1.153
36	5	Q	.7582	16	.6469	1.237	.7582	1.056	.9070
IBTS Katt Quart3 WR 1-5									
Linear model fitted. Slopes at age :									
37	1	Q	.1600E-03	15	.1376E-03	.2545E-03	.1600E-03	.2190E-03	.1895E-03
38	2	Q	.1470E-03	15	.1266E-03	.2334E-03	.1470E-03	.2009E-03	.1740E-03
39	3	Q	.1026E-03	15	.8832E-04	.1627E-03	.1026E-03	.1401E-03	.1214E-03
40	4	Q	.9524E-04	15	.8199E-04	.1512E-03	.9524E-04	.1301E-03	.1127E-03
41	5	Q	.7826E-04	15	.6732E-04	.1245E-03	.7826E-04	.1071E-03	.9270E-04

Table. 3.6.12 WESTERN BALTIC HERRING. Output from ICA Final Run RESIDUALS ABOUT THE MODEL FIT Separable Model Residuals (log(Observed Catch)-log(Expected Catch))

Age	1998	1999	2000	2001	2002
0	0.3680	0.3802	-0.5904	0.5714	-0.7030
1	0.1963	-0.0166	-0.0285	-0.0048	-0.1254
2	0.1168	0.2058	-0.0290	-0.1848	-0.0897
3	-0.1371	0.2363	-0.0648	-0.0586	0.0289
4	0.0260	-0.1504	-0.0783	-0.0182	0.1081
5	0.0110	-0.0935	0.0954	0.0086	0.0570
6	-0.0489	-0.2037	-0.0179	0.2323	0.1672
7	-0.0384	-0.0007	0.2019	0.1329	0.0289

Table. 3.6.13 WESTERN BALTIC HERRING. Output from ICA Final Run Aged Index Residuals: Log(Observed Index) - Log(Expected Index)

Acoustic Survey in Div. IIIa+IVaE WR 2-8+

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	-0.064	0.102	0.496	-0.956	0.757	-0.214	-0.347	0.394	*******	0.305	-0.948	0.476
3	0.037	0.270	0.058	-0.140	0.450	-0.683	0.017	0.316	*******	0.085	-0.662	0.251
4	-0.036	0.580	-0.103	-0.020	0.973	-0.588	-0.265	-0.204	*******	0.041	-0.606	0.229
5	-0.356	0.387	0.249	0.000	0.232	-0.275	-0.328	0.277	*******	0.397	-0.327	-0.255
6	-0.666	-0.050	0.036	0.558	0.704	-0.678	0.276	0.347	*******	0.007	-0.232	-0.301
7	0.954	0.250	-0.441	-0.085	-0.052	-0.605	0.918	0.269	*******	-0.854	-0.100	-0.252
8	0.109	-0.570	-0.920	-0.142	-0.001	-0.677	0.871	1.064	*******	-0.328	0.267	0.328

Acoustic Survey in Subdiv. 22-24 WR 0-5

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0.634	0.463	-0.841	0.211	0.599	-0.544	0.274	-0.269	0.302	-0.686	-0.565	0.422
1	0.567	0.574	-0.871	-0.585	0.137	0.349	0.443	-0.470	0.048	-0.072	0.570	-0.689
2	0.000	0.203	-0.742	0.562	-0.200	-0.009	0.098	0.121	-0.545	-0.238	0.894	-0.145
3	-0.105	-0.417	-0.224	-0.003	0.020	0.533	-0.124	0.091	-0.726	0.108	0.825	0.021
4	-0.790	-0.877	-0.085	0.328	0.140	0.617	0.112	0.077	-0.440	-0.048	0.716	0.252
5	-1.118	-1.180	-0.516	0.253	0.684	1.139	0.681	0.665	-0.682	0.073	0.128	-0.125

IBTS Katt Quart3 Age groups WR 1-5

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	-1.174	-0.044	0.418	0.125	0.682	0.927	-1.711	-0.688	-0.182	*******	0.262	1.386
2	-1.031	-0.723	-0.221	0.598	0.612	0.789	0.028	-0.439	0.028	*******	-0.023	0.384
3	-0.233	-0.299	-0.677	0.737	0.929	-0.086	-0.470	-0.701	0.321	*******	0.180	0.299
4	-0.417	0.014	-0.247	0.319	1.087	-0.010	-0.589	0.127	0.421	*******	-0.082	-0.624
5	-0.399	-0.085	0.043	0.741	0.714	0.013	0.690	-0.188	0.352	*******	-1.559	-0.320

Table. 3.6.14 WESTERN BALTIC HERRING. Output from ICA Final Run PARAMETERS OF THE DISTRIBUTION OF Ln CATCHES-AT-AGE

Separable model fitted from 1998 to 2002

Variance	0.0372
Skewness test stat.	0.8944
Kurtosis test statistic	-1.0527
Partial chi-square	0.0542
Significance in fit	0.0000
Degrees of freedom	17

Table. 3.6.15 WESTERN BALTIC HERRING. Output from ICA Final Run. PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR **Acoustic Survey in Div IIIa+IVaE Ages WR 0-8+**
Linear catchability relationship assumed

Age	2	3	4	5	6	7	8
Variance	0.0470	0.0196	0.0311	0.0140	0.0294	0.0466	0.0549
Skewness test stat.	-0.7707	-1.2588	0.9421	0.0774	-0.0930	0.5563	0.3639
Kurtosis test statisti	-0.5613	-0.1785	-0.0272	-1.1898	-0.6527	-0.4507	-0.5560
Partial chi-square	0.0335	0.0146	0.0240	0.0116	0.0258	0.0455	0.0543
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	11	11	11	11	11	11	11
Degrees of freedom	10	10	10	10	10	10	10
Weight in the analysis	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429

DISTRIBUTION STATISTICS FOR **Acoustic Survey in Sub div 22-24 WR 0-5**
Linear catchability relationship assumed

Age	0	1	2	3	4	5
Variance	0.0489	0.0472	0.0325	0.0267	0.0409	0.0931
Skewness test stat.	-0.4870	-0.5384	0.4808	0.5147	-0.6588	-0.3448
Kurtosis test statisti	-1.0633	-0.9522	-0.0261	0.2113	-0.4401	-0.7498
Partial chi-square	0.0367	0.0378	0.0268	0.0228	0.0355	0.0866
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	12	12	12	12	12	12
Degrees of freedom	11	11	11	11	11	11
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

DISTRIBUTION STATISTICS FOR **IBTS Katt Quart3 WR 1-5**
Linear catchability relationship assumed

Age	1	2	3	4	5
Variance	0.1664	0.0666	0.0590	0.0491	0.0879
Skewness test stat.	-0.5782	-0.4289	0.4163	1.0028	-1.3410
Kurtosis test statisti	-0.3762	-0.6082	-0.6887	0.1243	0.5708
Partial chi-square	0.2876	0.1303	0.1459	0.1463	0.3773
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	11	11	11	11	11
Degrees of freedom	10	10	10	10	10
Weight in the analysis	0.2000	0.2000	0.2000	0.2000	0.2000

Table. 3.6.16 WESTERN BALTIC HERRING. Output from ICA Final Run ANALYSIS OF VARIANCE TABLE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	59.4633	244	41	203	0.2929
Catches-at-age	1.9363	40	23	17	0.1139
Aged Indices					
Acoustic Survey in Div IIIa+IVaE	16.9758	77	7	70	0.2425
Acoustic Survey in Sub div 22-24	19.0960	72	6	66	0.2893
IBTS Katt Quart3	21.4551	55	5	50	0.4291

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	2.3671	244	41	203	0.0117
Catches-at-age	0.6320	40	23	17	0.0372
Aged Indices					
Acoustic Survey in Div IIIa+IVaE	0.3464	77	7	70	0.0049
Acoustic Survey in Sub div 22-24	0.5304	72	6	66	0.0080
IBTS Katt Quart3	0.8582	55	5	50	0.0172

Table 3.7.1 WESTERN BALTIC HERRING. Input table for short term predictions

MFDP version 1a
Run: WBSS Final revised data
Time and date: 17:32 17/03/2003
Fbar age range: 3-6

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	4473994	0.3	0.00	0.1	0.25	0.000	0.086	0.015
1	3064298	0.5	0.00	0.1	0.25	0.016	0.299	0.024
2	1807400	0.2	0.20	0.1	0.25	0.053	0.401	0.063
3	621800	0.2	0.75	0.1	0.25	0.085	0.437	0.095
4	581100	0.2	0.90	0.1	0.25	0.122	0.509	0.122
5	239400	0.2	1.00	0.1	0.25	0.163	0.526	0.148
6	79100	0.2	1.00	0.1	0.25	0.179	0.543	0.164
7	46500	0.2	1.00	0.1	0.25	0.177	0.509	0.166
8	33900	0.2	1.00	0.1	0.25	0.190	0.509	0.169

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	4473994	0.3	0.00	0.1	0.25	0.000	0.086	0.015
1		0.5	0.00	0.1	0.25	0.016	0.299	0.024
2		0.2	0.20	0.1	0.25	0.053	0.401	0.063
3		0.2	0.75	0.1	0.25	0.085	0.437	0.095
4		0.2	0.90	0.1	0.25	0.122	0.509	0.122
5		0.2	1.00	0.1	0.25	0.163	0.526	0.148
6		0.2	1.00	0.1	0.25	0.179	0.543	0.164
7		0.2	1.00	0.1	0.25	0.177	0.509	0.166
8		0.2	1.00	0.1	0.25	0.190	0.509	0.169

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	4473994	0.3	0.00	0.1	0.25	0.000	0.086	0.015
1		0.5	0.00	0.1	0.25	0.016	0.299	0.024
2		0.2	0.20	0.1	0.25	0.053	0.401	0.063
3		0.2	0.75	0.1	0.25	0.085	0.437	0.095
4		0.2	0.90	0.1	0.25	0.122	0.509	0.122
5		0.2	1.00	0.1	0.25	0.163	0.526	0.148
6		0.2	1.00	0.1	0.25	0.179	0.543	0.164
7		0.2	1.00	0.1	0.25	0.177	0.509	0.166
8		0.2	1.00	0.1	0.25	0.190	0.509	0.169

Input units are thousands and kg - output in tonnes

Table 3.7.2 WESTERN BALTIC HERRING.
Short term prediction single option table, status quo F.

MFDP version 1a
Run: WBSS Final revised data
Time and date: 17:32 17/03/2003
Fbar age range: 3-6

Year:	2003	F multiplier: 1		Fbar:	0.5034				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0858	318646	4663	4473994	447	0	0	0	0
1	0.2994	631675	14992	3064298	48416	0	0	0	0
2	0.4014	545248	34514	1807400	95129	361480	19026	330320	17386
3	0.4365	200786	19028	621800	52646	466350	39484	424659	35954
4	0.5086	211754	25834	581100	71049	522990	63944	472812	57809
5	0.5256	89478	13249	239400	38926	239400	38926	216064	35132
6	0.5427	30298	4976	79100	14175	79100	14175	71267	12771
7	0.5086	16945	2817	46500	8244	46500	8244	42039	7453
8	0.5086	12353	2084	33900	6424	33900	6424	30647	5808
Total		2057182	122157	10947492	335457	1749720	190224	1587809	172314

Year:	2004	F multiplier: 1		Fbar:	0.5034				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0858	318646	4663	4473994	447	0	0	0	0
1	0.2994	627031	14882	3041766	48060	0	0	0	0
2	0.4014	415621	26309	1377709	72513	275542	14503	251790	13253
3	0.4365	319843	30310	990501	83862	742876	62897	676464	57274
4	0.5086	119895	14627	329018	40228	296116	36205	267705	32731
5	0.5256	106926	15832	286083	46517	286083	46517	258197	41983
6	0.5427	44384	7289	115876	20765	115876	20765	104402	18709
7	0.5086	13715	2280	37637	6673	37637	6673	34026	6033
8	0.5086	14424	2434	39582	7501	39582	7501	35784	6781
Total		1980483	118626	10692166	326567	1793712	195061	1628368	176763

Year:	2005	F multiplier: 1		Fbar:	0.5034				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0858	318646	4663	4473994	447	0	0	0	0
1	0.2994	627031	14882	3041766	48060	0	0	0	0
2	0.4014	412565	26115	1367578	71980	273516	14396	249939	13155
3	0.4365	243804	23104	755020	63925	566265	47944	515641	43658
4	0.5086	190987	23300	524112	64081	471700	57673	426444	52140
5	0.5256	60541	8964	161980	26338	161980	26338	146190	23771
6	0.5427	53039	8711	138472	24814	138472	24814	124760	22357
7	0.5086	20091	3341	55135	9776	55135	9776	49846	8838
8	0.5086	13853	2337	38016	7204	38016	7204	34369	6513
Total		1940557	115418	10556072	316625	1705084	188145	1547188	170431

Input units are thousands and kg - output in tonnes

Table 3.7.3 **WESTERN BALTIC HERRING.**
Short-term prediction multiple option table, Status quo F.

MFDP version 1a
Run: WBSS Final revised data
Western Baltic Herring (combined sex; plus group)
Time and date: 17:32 17/03/2003
Fbar age range: 3-6

2003				
Biomass	SSB	FMult	FBar	Landings
335457	172314	1.0000	0.5034	122157

2004					2005	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
326567	185547	0.0000	0.0000	0	459149	280479
.	184649	0.1000	0.0503	14177	442040	266793
.	183756	0.2000	0.1007	27778	425643	253786
.	182867	0.3000	0.1510	40828	409926	241425
.	181982	0.4000	0.2013	53350	394859	229676
.	181102	0.5000	0.2517	65368	380415	218510
.	180225	0.6000	0.3020	76904	366566	207896
.	179354	0.7000	0.3524	87978	353287	197806
.	178486	0.8000	0.4027	98611	340552	188216
.	177623	0.9000	0.4530	108821	328340	179098
.	176763	1.0000	0.5034	118626	316625	170431
.	175908	1.1000	0.5537	128045	305389	162190
.	175058	1.2000	0.6040	137093	294609	154355
.	174211	1.3000	0.6544	145787	284266	146906
.	173368	1.4000	0.7047	154141	274342	139823
.	172530	1.5000	0.7551	162170	264818	133088
.	171696	1.6000	0.8054	169889	255678	126683
.	170865	1.7000	0.8557	177309	246905	120593
.	170039	1.8000	0.9061	184444	238483	114801
.	169217	1.9000	0.9564	191306	230398	109292
.	168399	2.0000	1.0067	197907	222634	104053

Input units are thousands and kg - output in tonnes

Table 3.7.4 WESTERN BALTIC HERRING.
Short term prediction single option table, status quo F, F_{max}=0.37.

MFDP version 1a
Run: WBSS Fmax
Time and date: 20:31 18/03/2003
Fbar age range: 3-6

Year:	2003	F multiplier: 1		Fbar:	0.5034				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0858	318646	4663	4473994	447	0	0	0	0
1	0.2994	631675	14992	3064298	48416	0	0	0	0
2	0.4014	545248	34514	1807400	95129	361480	19026	330320	17386
3	0.4365	200786	19028	621800	52646	466350	39484	424659	35954
4	0.5086	211754	25834	581100	71049	522990	63944	472812	57809
5	0.5256	89478	13249	239400	38926	239400	38926	216064	35132
6	0.5427	30298	4976	79100	14175	79100	14175	71267	12771
7	0.5086	16945	2817	46500	8244	46500	8244	42039	7453
8	0.5086	12353	2084	33900	6424	33900	6424	30647	5808
Total		2057182	122157	10947492	335457	1749720	190224	1587809	172314

Year:	2004	F multiplier: 0.7356		Fbar:	0.3703				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0631	236903	3467	4473994	447	0	0	0	0
1	0.2202	477489	11332	3041766	48060	0	0	0	0
2	0.2953	320842	20309	1377709	72513	275542	14503	254477	13394
3	0.3211	247877	23490	990501	83862	742876	62897	684316	57939
4	0.3742	93658	11426	329018	40228	296116	36205	271330	33175
5	0.3866	83681	12390	286083	46517	286083	46517	261810	42570
6	0.3992	34799	5715	115876	20765	115876	20765	105911	18979
7	0.3742	10714	1781	37637	6673	37637	6673	34487	6114
8	0.3742	11267	1901	39582	7501	39582	7501	36269	6873
Total		1517231	91813	10692166	326567	1793712	195061	1648599	179044

Year:	2005	F multiplier: 0.7356		Fbar:	0.3703				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0631	236903	3467	4473994	447	0	0	0	0
1	0.2202	488451	11593	3111594	49163	0	0	0	0
2	0.2953	344719	21821	1480237	77910	296047	15582	273415	14391
3	0.3211	210104	19911	839564	71083	629673	53312	580037	49110
4	0.3742	167445	20428	588229	71921	529406	64729	485093	59311
5	0.3866	54200	8025	185296	30129	185296	30129	169574	27573
6	0.3992	47786	7848	159117	28514	159117	28514	145433	26062
7	0.3742	18117	3012	63643	11284	63643	11284	58316	10339
8	0.3742	12379	2089	43488	8241	43488	8241	39848	7551
Total		1580103	98193	10945163	348692	1906671	211791	1751716	194336

Input units are thousands and kg - output in tonnes

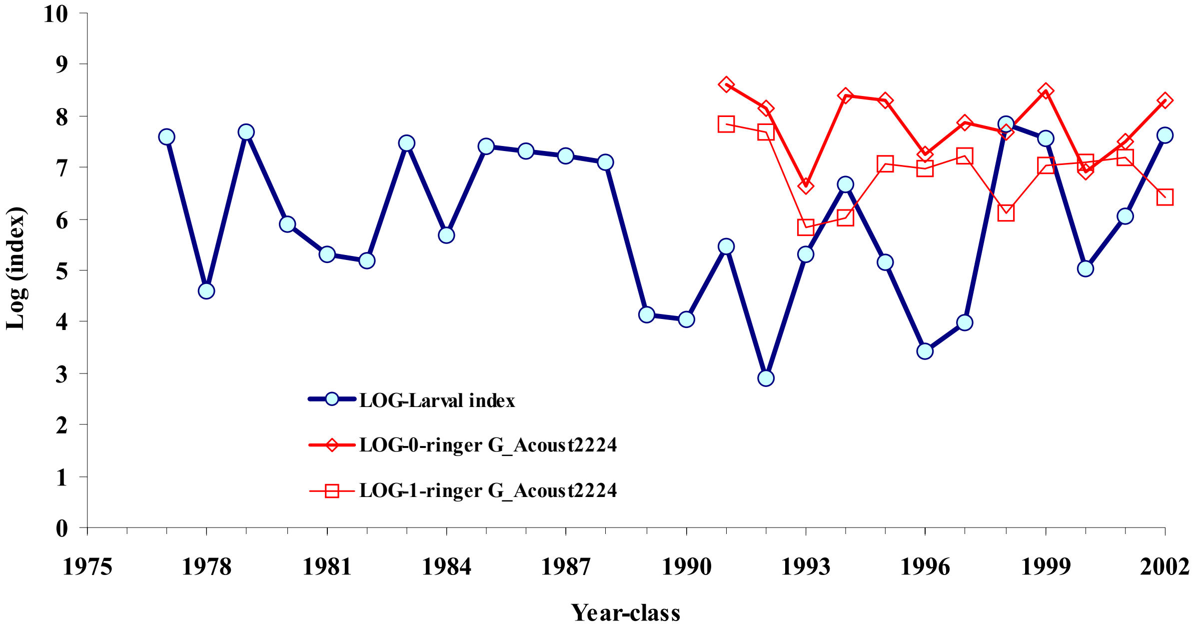


Figure 3.5.1 WESTERN BALTIC HERRING. Recruitment indices (natural log) adjusted to year class, versus time.

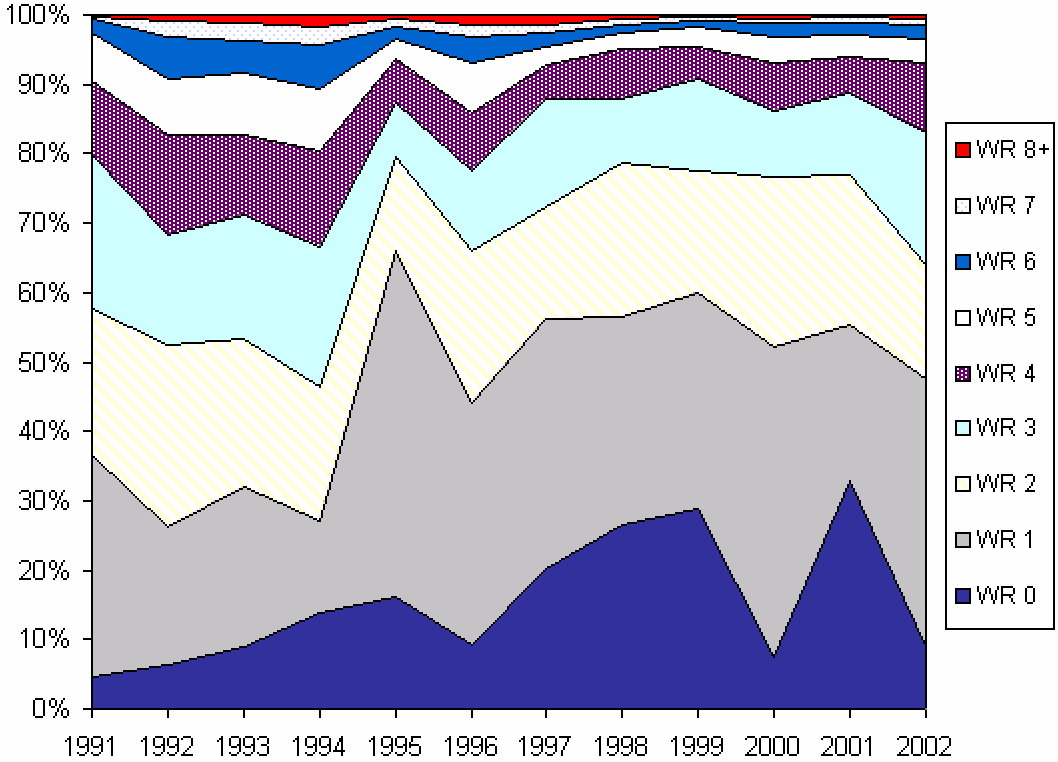


Figure 3.6.1 WESTERN BALTIC HERRING.
Proportions of age groups (numbers) in the total catch.

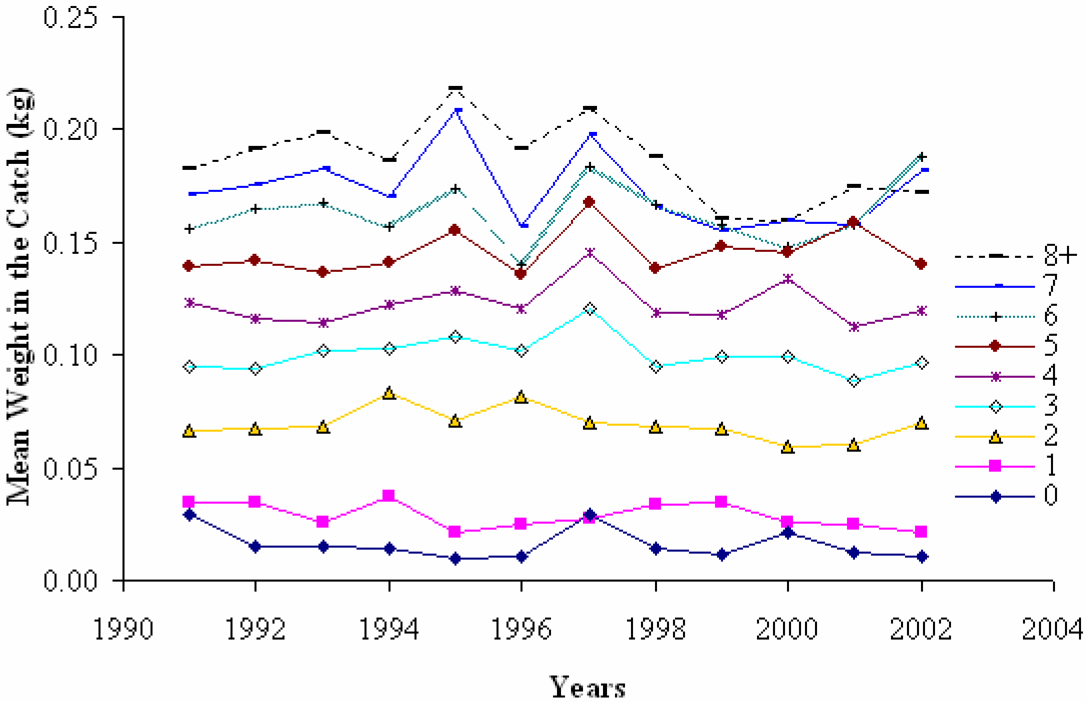


Figure 3.6.2 WESTERN BALTIC HERRING.
Mean weight in the catch (kg).

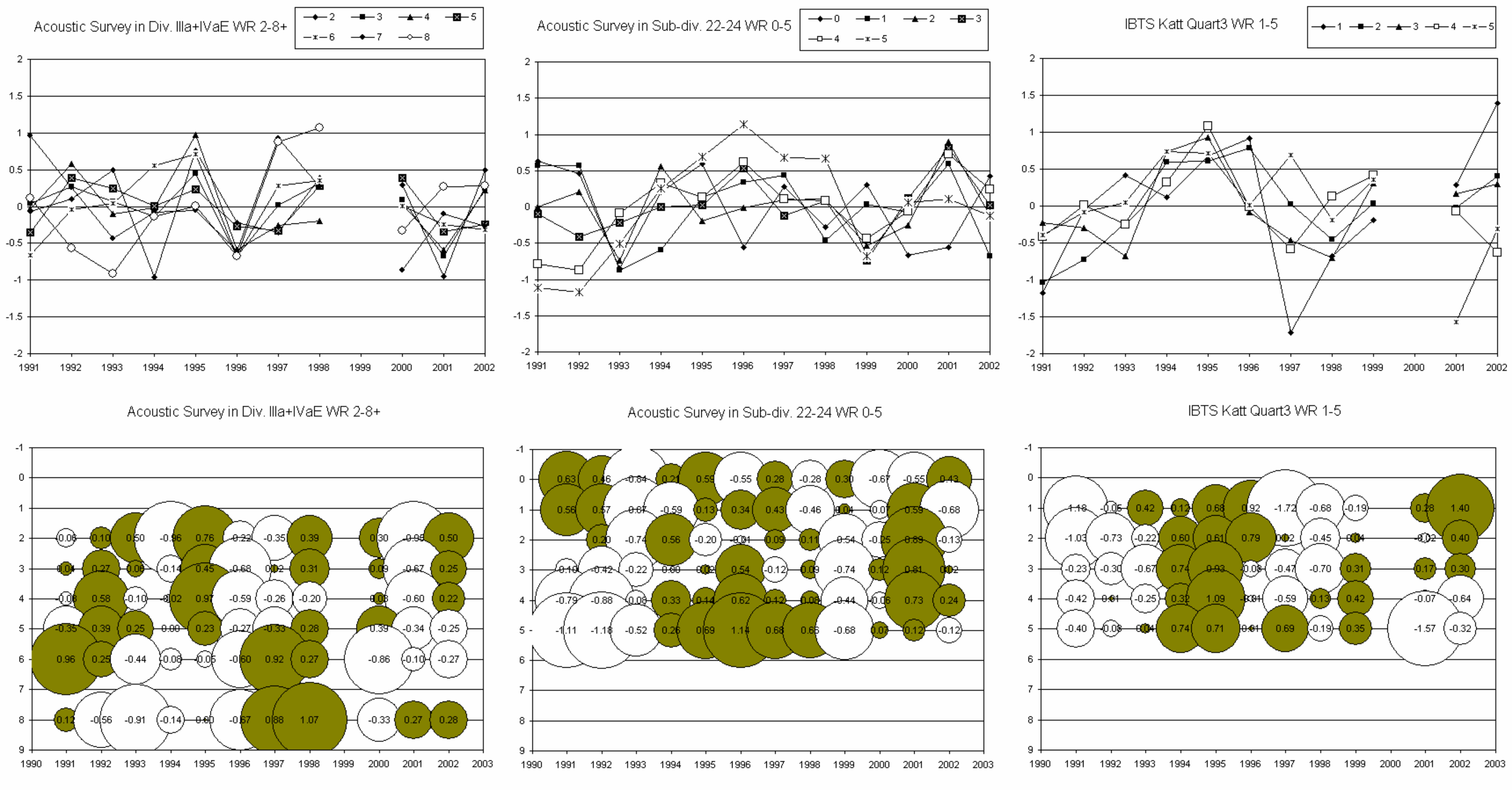
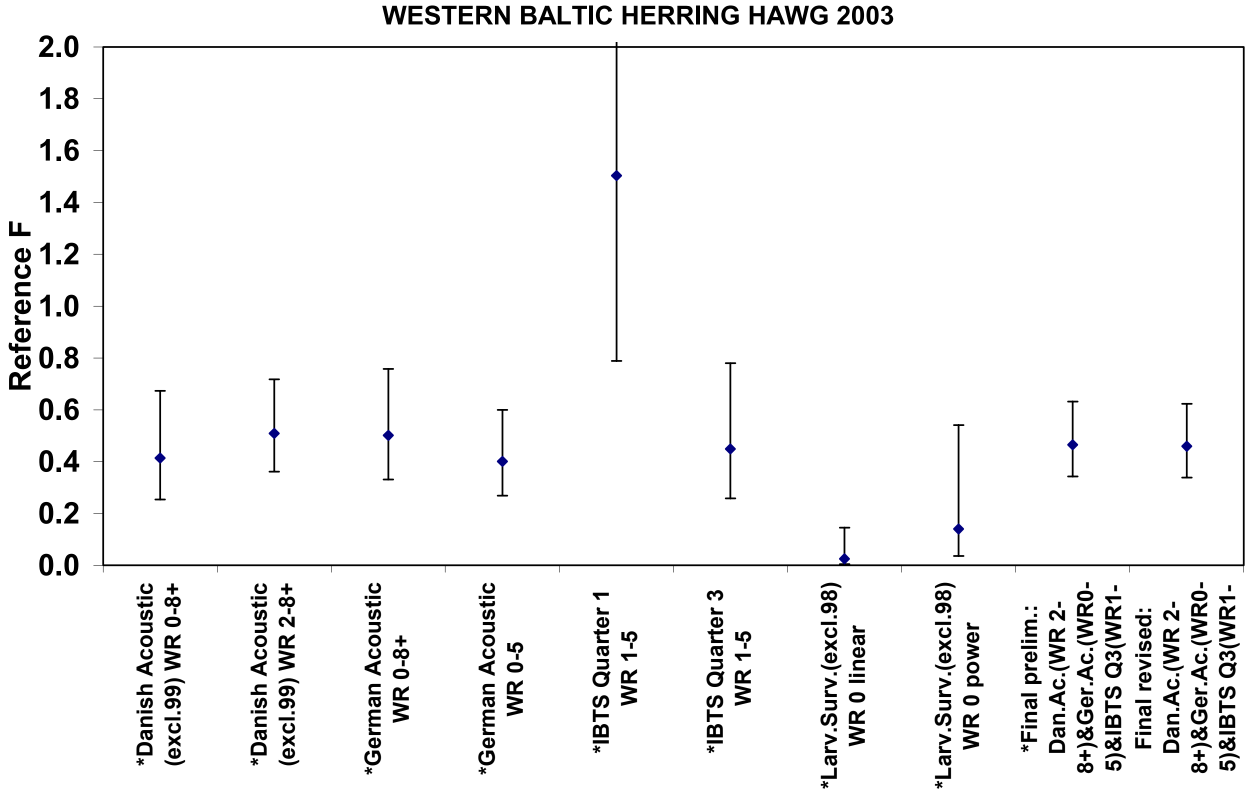


Figure 3.6.3 WESTERN BALTIC HERRING. Log catchability residual plots.



Fleet No.	Survey	Area	Quarter	WR	Mean F 2002	Lower 95% CL	Upper 95% CL	SSB 2002
1a	*Danish Acoustic (excl.99) WR 0-8+	Div. IIIa incl. Katt.	3	0-8+	0.414	0.254	0.673	189,272
1b	*Danish Acoustic (excl.99) WR 2-8+	Div. IIIa incl. Katt.	3	2-8+	0.509	0.361	0.717	156,953
2a	*German Acoustic WR 0-8+	SD 22, 23, 24	4	0-8+	0.501	0.331	0.758	174,886
2b	*German Acoustic WR 0-5	SD 22, 23, 24	4	0-5	0.401	0.268	0.599	206,669
3	*IBTS Quarter 1 WR 1-5	Kattegat	1	1-5	1.503	0.788	2.886	84,477
4	*IBTS Quarter 3 WR 1-5	Kattegat	3	1-5	0.449	0.258	0.780	181,265
5a	*Larv.Surv.(excl.98) WR 0 linear	SD 24	1-2	1-5	0.025	0.004	0.145	3,015,456
5b	*Larv.Surv.(excl.98) WR 0 power	SD 24	1-2	0-3+	0.140	0.036	0.540	568,067
1b+2b+4	*Final prelim.: Dan.Ac.(WR 2-8+)&Ger.Ac.(WR0-5)&IBTS Q3(WR1-5)	SD 24	1-2	0-3+	0.465	0.343	0.632	177,609
1b+2b+4	Final revised: Dan.Ac.(WR 2-8+)&Ger.Ac.(WR0-5)&IBTS Q3(WR1-5)	SD 24	1-2	0-3+	0.459	0.338	0.623	177,755

Figure 3.6.4 WESTERN BALTIC HERRING. Estimates of mean F and SSB by ICA runs by individual fleets and catch at age data for 1991-2002.
(*run with preliminary catch input data for 2002)

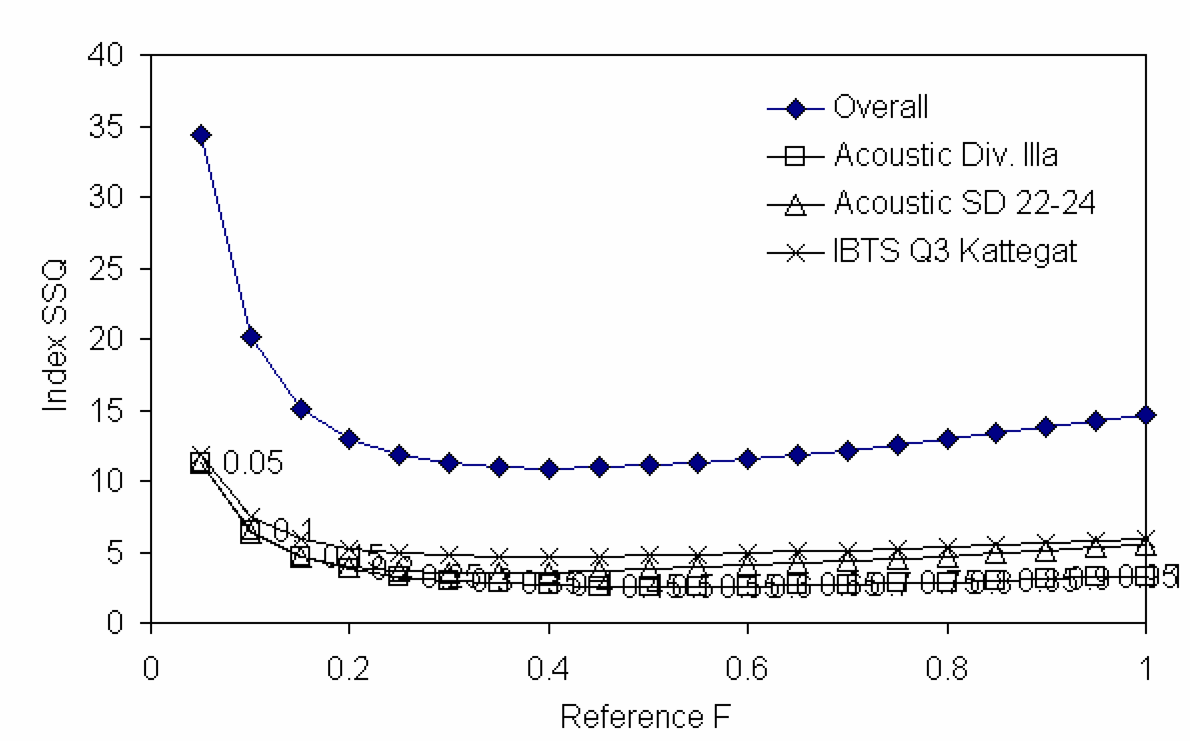


Figure 3.6.5 **WESTERN BALTIC HERRING. Output from ICA Final run 2003. Index sum of squares of deviations between model and observations (survey index) as a function of the reference F in 2002.**

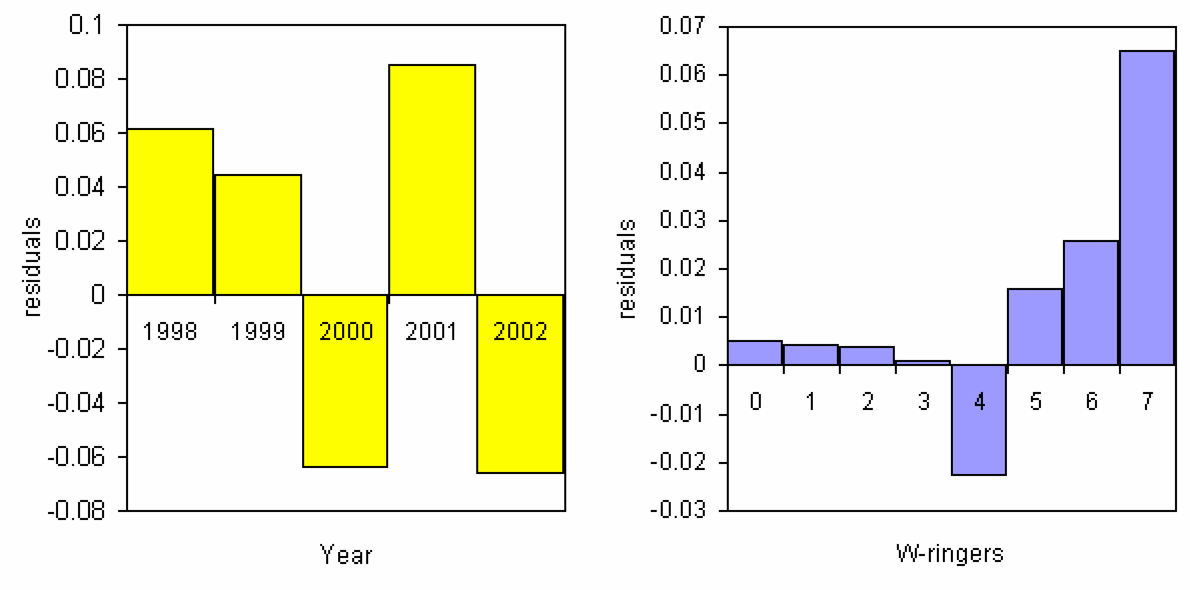
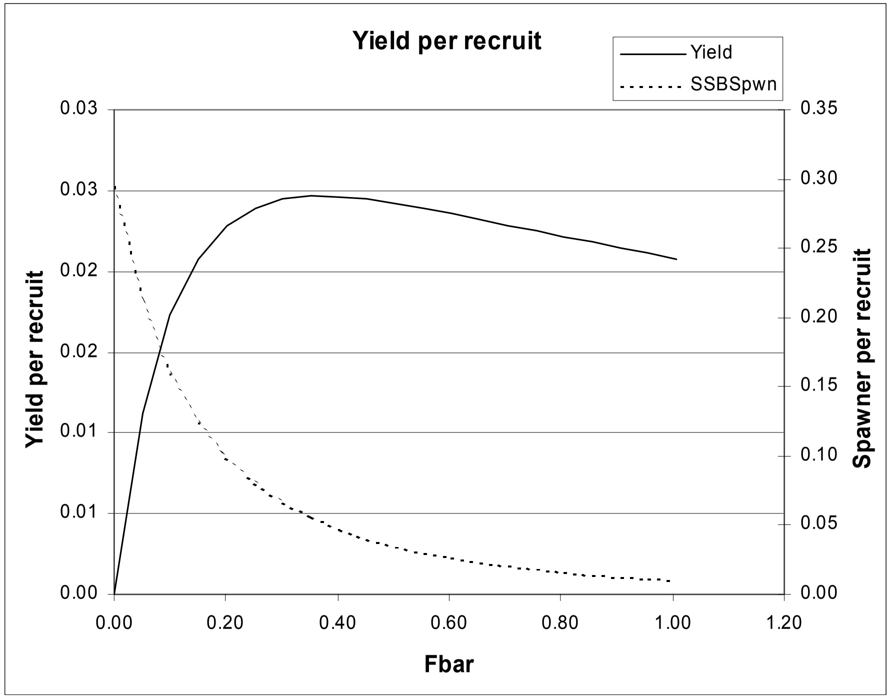
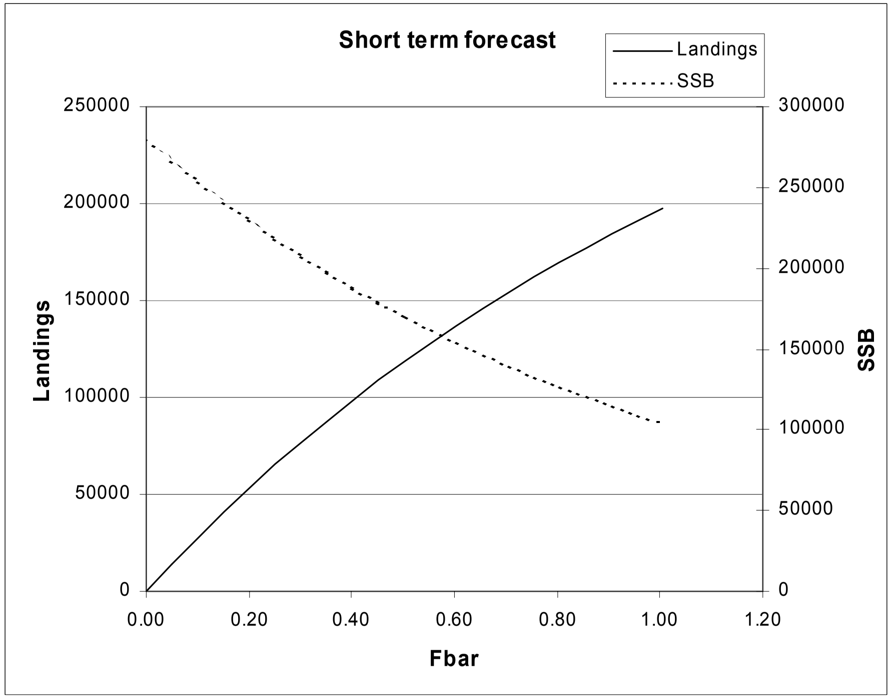


Figure 3.6.6 **WESTERN BALTIC HERRING. Output from ICA Final Run 2003: Separable Model Diagnostics.**





MFYPR version 2a
Run: WBSS Final revised data
Time and date: 17:34 17/03/2003

Reference point	F multiplier	Absolute F
Fbar(3-6)	1.0000	0.5034
FMax	0.7356	0.3703
F0.1	0.3972	0.1999
F35%SPR	0.3837	0.1932

Weights in kilograms

MFDP version 1a
Run: WBSS Final revised data
Western Baltic Herring (combined sex; plus group)
Time and date: 17:32 17/03/2003
Fbar age range: 3-6

Input units are thousands and kg - output in tonnes

Figure 3.7.1 **WESTERN BALTIC HERRING. Long and short term yield and SSB, derived by MFYPR v2a**

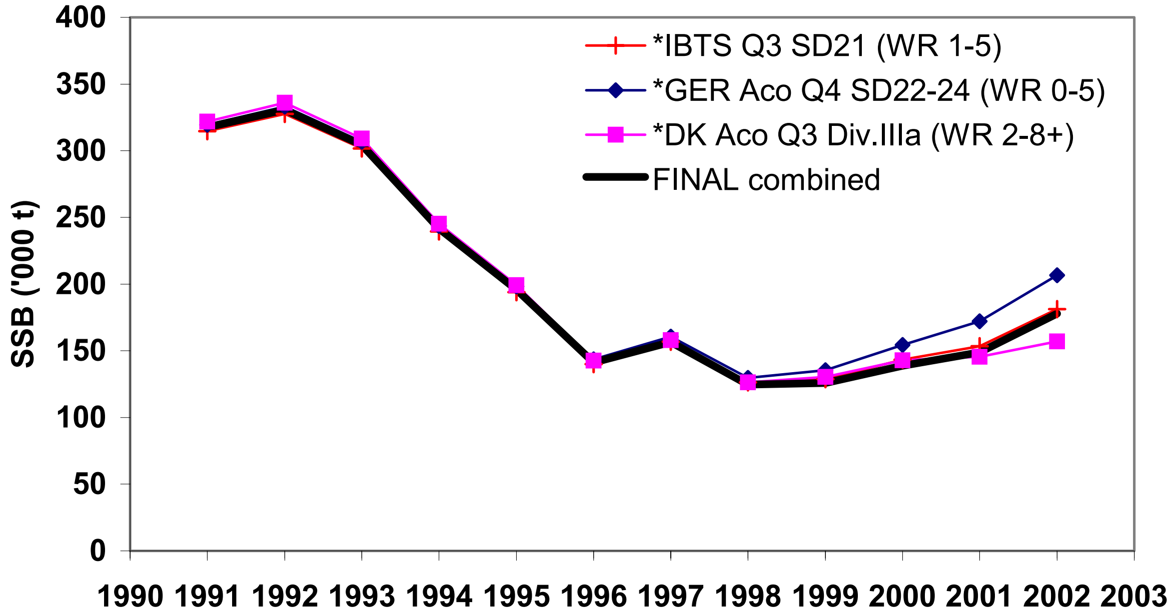


Figure 3.9.1 **Western Baltic herring. SSB estimates from ICA model with separate indices and with all indices combined.**
(*run with preliminary catch input data for 2002)

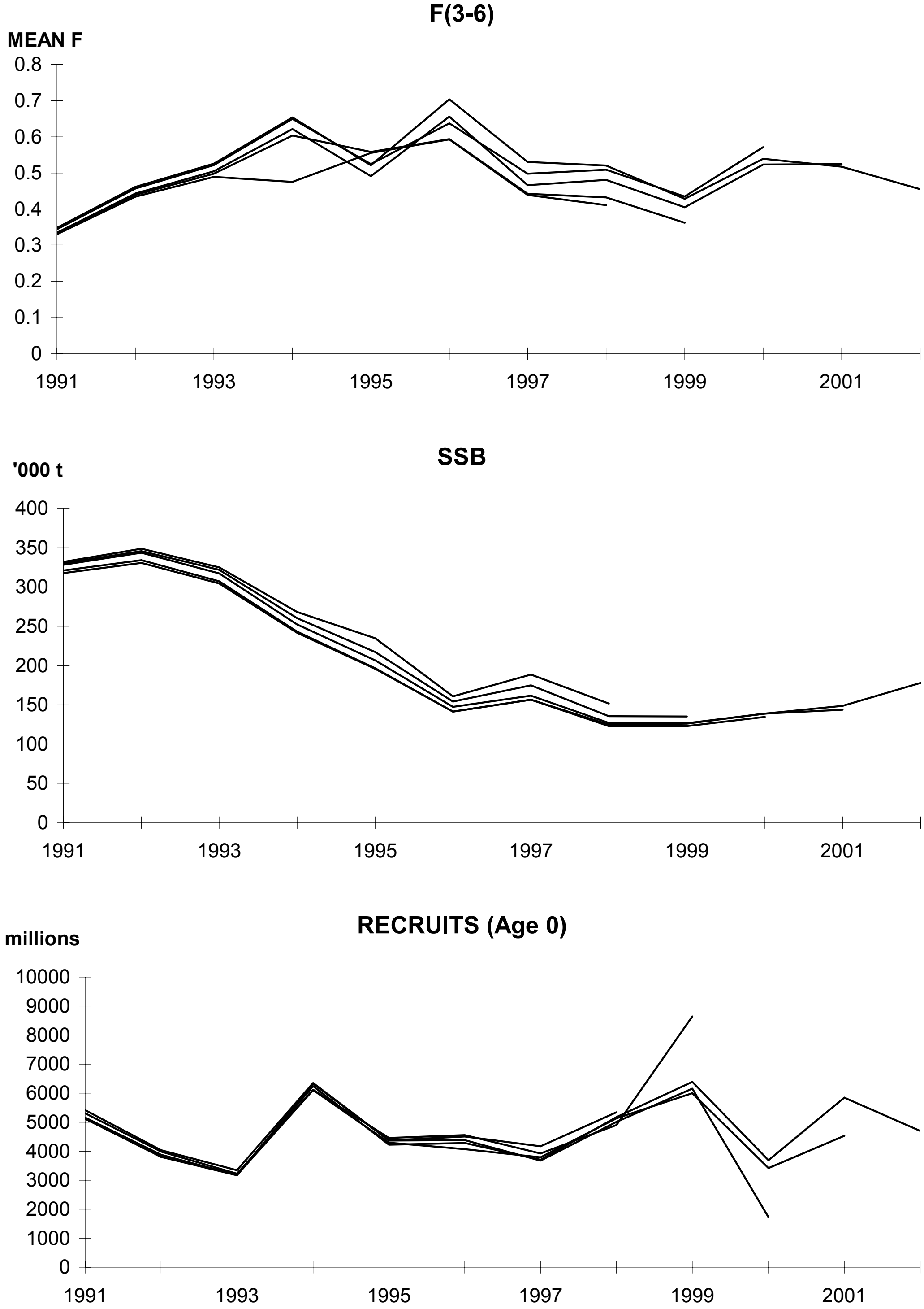


Figure 3.9.2 WESTERN BALTIC HERRING: Restrospective Analysis

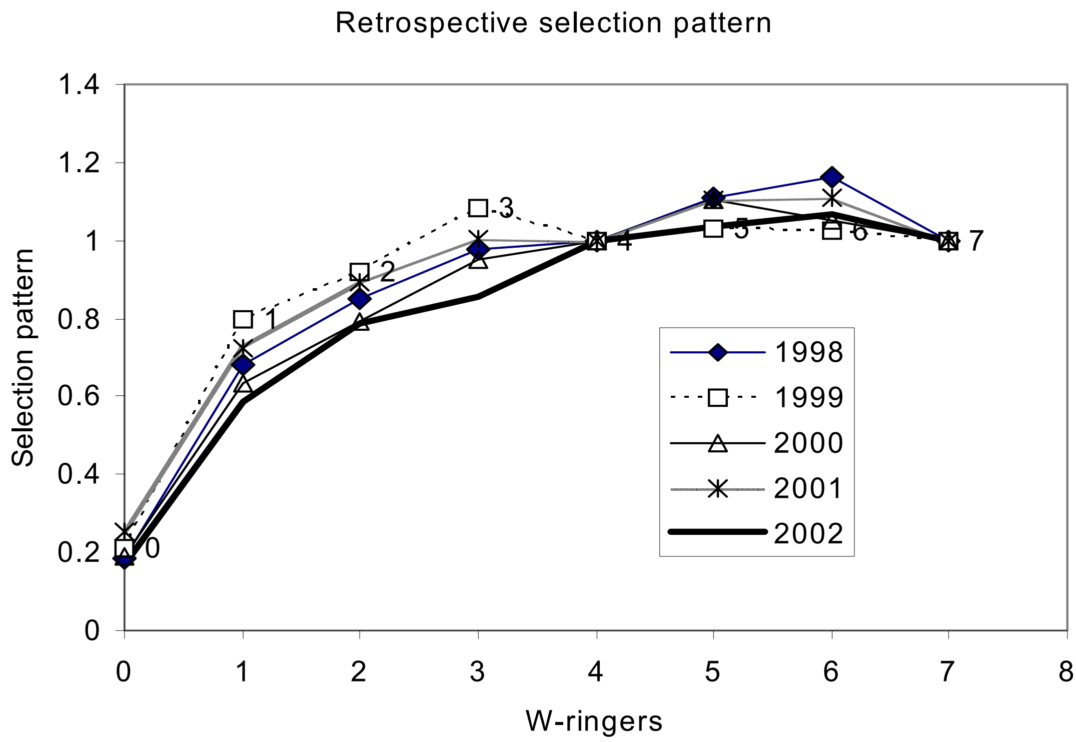


Figure 3.9.3 **WESTERN BALTIC HERRING.**
Restrospective selection pattern

4 CELTIC SEA AND DIVISION VIIJ HERRING

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 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 almost all of the official catch is taken from VIIg, VIIj and VIIa(S). For the second year in succession the only real catches taken in the area were from the Irish fleet.

4.1 The Fishery in 2002-2003

4.1.1 Advice and management applicable to 2002 - 2003

In 2002 ACFM considered the status of this stock to be unknown. ACFM stated that it was difficult to give appropriate management advice for 2003 because of the uncertainty about the current stock size. ACFM recommended that catches be restricted to 8,000 t for the first half of 2002. For the second half of 2002 ICES initially advised that catches should be restricted to 11,000 tonnes. This was subsequently changed to 13,000 tonnes by the EU. In May 2002 ACFM advised that the assessment was too uncertain to give catch advice and advised that catches be significantly reduced until such time as the age structure of the stock improved. The EU subsequently set a TAC for 2003 of 13,000 t on the basis that this was 20% below the average of the previous three years.

The fishery for the 2002/2003 season was opened on the 1st October 2002. The spawning box closure system was expanded to an area east of Mine Head based on an industry initiative to avoid the capture of first time spawning fish. The closed area was strictly observed throughout the season (Figure 4.1.1.1).

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 about 4,500 t in the January – February (2002) period and the remainder (8,500 t) in October - December (2002). From this a quota of 1,000 t was taken for a limited summer fishery targeting pre-spawning fish.

4.1.2 The fishery in 2002/2003

As has been the case for a number of years the majority of the catch in this area was taken by the Irish fishery during the spawning season, which normally lasts from October to February. There were some small catches misreported from outside the Celtic Sea. The landings in this fishery since 1958 are shown in Figure 4.1.2.1.

Unlike last season domestic marketing conditions have deteriorated due to the influence of other herring producing countries. This was reflected in the poor market price attained throughout the season. The continued closure of the eastern Celtic Sea combined with the market state and a change in licensing requirements has resulted in a large decrease in effort. The pelagic licensing policy of the Department of the Marine required vessels to target pelagic species for 16 weeks in order to keep their licensing requirements. For the last 2 years, at the request of the South West Pelagic Committee, there has been a moratorium on this requirement so vessels have not been forced into the fishery to maintain their licenses. This was reflected in the national landings figures, around 7,400 t this season compared to 15,200 t in the 20001/2002 season, the lowest ever recorded since the 1980`s. This season saw a maximum of 8 vessels involved as compared with 33 vessels for 2000/2001 season and 30 for the 1999/2000 season. Over 100 vessels participated in this fishery during the early sixties.

The 2002/2003 fishery started in October and was conducted in the western Celtic Sea. In September a 1,000 tonne derogation was permitted to target pre-spawning adults in the Labadie bank area. The industry led voluntary closure of the eastern Celtic Sea spawning areas was maintained and strictly observed throughout the season after experimental hauls yielded a high percentage of first time spawning fish (more than 50% of individuals being below 23 cm). As the season progressed periodic trial shots were carried out on commercial vessels to monitor the size of fish in the spawning box area. As a result the bulk of commercial landings were taken in the western areas. Vessels from the eastern part of the Celtic Sea also concentrated effort in and around western areas, although it must be noted that overall effort was considerably lower than previous years. The fish landed from this area were composed of mixed sizes, lacking a bulk of small juvenile fish encountered in the closed areas. The volume of landings over the season was approximately half of the amount taken for the previous season. Offshore components of the stock were located in the areas to the east and west of the Kinsale gas platforms and around the Labadie bank. Herring shoals were also located in inshore areas along the southern coastline. In VIIj larger shoals were seen around Kerry Head, Slea Head and Ballinskelligs Bay and a number of vessels targeted fish in these areas. A map of the locations mentioned in the text is given in Figure 4.1.1.1.

4.1.3 The catches in 2002/2003

The estimated national catches from 1988–2002 for the combined areas by year and by season (1 April–31 March) are given in Table 4.1.3.1 and Table 4.1.3.2 respectively. The total catches for the fishery over the longer period from 1958 to 2002 are shown in Figure 4.1.2.1 The reported catch, taken during the 2002/2003 season was about 7,500 t compared with 15,200 t during the previous season.

4.2 Biological Composition of the Catch

4.2.1 Catches in numbers-at-age

The total catches in numbers-at-age, including discards, per season from 1958 to 2002 are shown in Table 4.6.2.2. The age composition in 2002/2003 was again dominated by 2-ringers (1999/2000 year class), which constituted 46% of the catch and 3-ringers (1998/1999 year class) constituted 33% of the catch. The numbers of 4-ring and older fish remain relatively low. The numbers of 1-ringers constituted 6% of the catch in numbers which is half of the numbers observed in last seasons catch. These young fish were again mainly taken in the trial catches from VIIa(S).

4.2.2 Distribution of juvenile fish

A recent study on herring otolith microstructure has elucidated several points with respect to the natal origin of juvenile herring in the Irish and Celtic Seas (Brophy, 2002). Variation in mean length-at-age for 0-rings was observed between nursery areas for both winter- and autumn-spawned fish (Celtic Sea > East Irish Sea > West Irish Sea). Herring, spawning as 1-ringer in the Celtic Sea had larger "O1" measurements (Otolith size at onset of 1st winter ring) than herring spawning as 2- or 3-ringers in the same areas. Back-calculation of fish length from O1 measurements showed that juveniles <11.5cm at the end of the first growing season were unlikely to recruit to the spawning population until they are 2-ringers. These results show that juvenile distribution affects length-at-age for 0-ring fish and subsequently influences age at recruitment.

4.2.3 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 is good for this period. In addition the industry continued to provide samples of the landings, although these numbers are slightly down on last season.

Biological sampling of the catches throughout the area was slightly down on last season's levels. Details of the sampling data per quarter are shown in Table 4.2.3.1, while the length distributions of the catches taken by the Irish fleet per quarter are shown in Table 4.2.3.2.

Discards

The level of discards in this fishery is believed to have decreased considerably in recent years with the decline in the demand for "roe" fish for the Japanese market. There were no reports of any discarding from the fishery in the 2002/2003 season. The lack of fish on the grounds and the poor market conditions led to all fish being landed and little if any discarding.

4.3 Fishery-independent Information

4.3.1 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 and has been continued since. A summary of these surveys is given in ICES (2001/ACFM:12). For the 2002/2003 season one acoustic survey was carried out to determine stock abundance. It was decided that a single survey carried out on fish approaching the grounds would be sufficient to contain the stock.

For 2002/2003 two attempts were made to survey VIIg and VIIa(S). The first survey was curtailed because of SE gales which were considered to affect the shoaling behaviour of the fish. The second survey was carried out 10 days later. Due to the potential problems of double counting the survey track was started at the western end working in an easterly direction. Due to time restrictions and the size of the area to be covered it was decided that transect spacing should be widened and the survey run over 24 hrs. The second attempt covered the same grounds but with less intensity and was deemed to have missed components of the stock. This may have been because the shoals were dispersed during the hours of darkness and areas of fish density may have been missed due to the width of transect spacing. Given the stock was contained between 7°30W and 8°15W during the 2001 survey the Working Group decided to use the first attempted survey as the 2002 stock abundance (Figure 4.3.1.1a,b). The composition of the catch in numbers-at-age from the commercial landings and the acoustic survey show very close agreement indicating that the population covered in the first survey attempt was the same population exploited by the fishery (Figure 4.3.1.2).

The timing of the survey appeared to be slightly early as only a small proportion of the fish encountered were spent, indicating that the majority of the fish had not yet begun to spawn or indeed form spawning aggregations. The majority of the biomass estimate from the Celtic Sea and Division VIIj was composed of mature 2-ringers (1999/2000 year class) and 3-ringers (1998/99 year class). During all components of this survey no 0-ringers (2001/2002 year class) were encountered and 1-ringers (2000/2001 year class) made up less than 12% of the biomass recorded. The SSB estimate (26,700 t) was considerably less than the biomass estimate of 69,100 tonnes recorded during the September 2001 Celtic Sea survey. It should be noted, however, that one very large shoal of herring contributed to the majority (>80%) of the September 2001 estimate. The estimate for Division VIIj is likely to be an underestimate of the spawning component as it was only possible to survey part of the survey track intended (Figure 4.3.1.1 b). An increase in the number of spent fish encountered was noted when compared with the Celtic Sea. Mature 2-ringers (1999/2000 year class) and 3-ringers (1998/1999 year class) were the dominant year classes encountered.

The concentrations of herring encountered were very sparse; however, the biomass estimate was based on clear herring marks and was believed to be a close estimate of the biomass of herring in the area at the time. Given the small area surveyed it is possible that part of the stock was outside the survey area at the time.

The age-structured index corresponding to a low SSB determined by the acoustic survey in 2000/2001 had a significant effect on the perception of the stock, whereby it appeared that there had been a large increase in F and decrease in SSB from 1999/2000 to 2000/2001. In addition problems in the acoustic index over the past several years have led to uncertainty in the assessment in the recent period. In 2002, in an effort to improve the acoustic survey index, a programme was again initiated to monitor the distribution and age structure of the population over the summer months, so the acoustic survey could be successfully directed temporally and spatially. As a result of the summer programme (described in Section 4.3.2.), acoustic surveys were carried out from the 2nd week in September to the 3rd week in October. The surveys were focused on those areas where the concentrations of herring had been located during the scientific surveys carried out during August. By September shoals had appeared to migrate nearer to shore in comparison to July and August and the main concentration was located in a discrete area in VIIg. Post plots showing the distribution of S_A values attributed to herring are shown in Figures 4.3.1.1 a and b. The age composition of samples taken from the acoustic survey, and the commercial catch data show very similar patterns (Figure 4.3.1.2).

The age distribution of the stock from all acoustic surveys carried out since 1990 is shown in Table 4.3.1.1.

4.3.2 Summer programme to examine stock distribution and age structure

The scientific programme implemented out by the Irish Marine Institute in 2001, working with the local Southwest Pelagic Management Committee (SWPMC) continued in 2002. This ongoing programme aims to collect information on the age composition and distribution of the adult stocks in the Celtic Sea and Division VIIj.

In August 2002 a pair of dedicated herring midwater trawlers equipped with data loggers worked a pre-determined grid in the Celtic Sea and VIIj. Onboard scientific observers collected data on the age composition and temporal and spatial distributions of herring in the area. The information was then used to identify the area that needed to be covered to ensure satisfactory containment of the stock for the September/October 2002 herring acoustic survey. During the summer survey and fishery samples were obtained from a number of areas and retained for biological examination, Table 4.3.2.1. These samples show greater proportions of older fish being taken in the commercial catches in the 2002/03 season. Good concentrations of herring were located in a number of areas, particularly in the central area of the Celtic Sea (Division VIIg), Fig. 4.1.1.1. Herring appeared to be scarce throughout the western parts of Division VIIj. No herring were located in the eastern part of the Celtic Sea (Division VIIa(S)) despite a large area being covered. Herring usually taken from the northern part of this area are thought to be those that migrate down from the Irish Sea (Division VIIaN) and are usually young fish.

4.3.3 Bottom trawl surveys

In 2000 some information from a UK bottom trawl survey in the first quarter was made available to the HAWG. This information was useful in examining for major changes in Z in the previous year as indicated by the 1999/2000 acoustic survey index. While there was no updated information from this survey series available to the WG in 2003, it is hoped that its usefulness in addition to the Irish Sea/Celtic Sea bottom trawl survey carried out by the MI since 1997 will also be investigated as a recruitment index for the 2004 WG.

4.4 Mean weights- and maturity-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 2001/2002 were lower than previous years for 1 to 3-ringers and similar to previous years for 4-ringers and older (Table 4.6.2.2). These low mean weights may be due to the apparent high abundance of these year classes in the population.

The maturity-at-age for this stock has been assumed to be constant throughout the whole time period (50% of 1-ring fish are assumed to be mature at age 1 and 100% mature at 2-ring). This maturity ogive reflects the current rate of maturation of fish caught in the Celtic Sea, however it is understood that a proportion of 1 & 2-ringers present in the Irish Sea recruit to the Celtic Sea and in Division VIIj stock. This may have an effect on the maturity ogive and this still needs to be investigated before biological reference points are finalised.

4.5 Recruitment

At present there are no recruitment estimates for this stock that can be used for predictive purposes. The numbers of 1-ringers estimated from the ICA model suggest that recruitment for the years 1996, 1998 and 2001 may have been below average.

In this stock a proportion of juvenile fish are present in the Irish Sea and do not recruit to the Celtic Sea and Division VIIj until they are mature. Therefore neither the numbers of 1-ringers 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-ringers taken per hour in the Northern Irish ground fish surveys in the Irish Sea and the numbers of 1-ringers estimated by ICA for the Celtic Sea and Division VIIj was examined in a working document presented to the 1999 WG (Armstrong et al., 1999) and the results suggest that these surveys may become a useful indicator of recruitment to the Celtic Sea and Division VIIj when a longer time-series is established. Recent information on mean length of 0-group herring (measured in October) in the eastern and western Irish Sea suggests that the proportion of juvenile herring from the Celtic Sea and Division VIIj stock in the Irish Sea may have been relatively low in recent years.

4.6 Stock Assessment

4.6.1 Preliminary data exploration

Recent WG's have used the results of the acoustic surveys in the ICA programme but stated that the results should be taken as minimum estimates. In 1998 the WG decided to use the age-disaggregated data but only over the 2-5 ringers as a relative index in the ICA programme. This was because the survey appears to track the mortalities of the 2-5 ringers but is very noisy on the older age groups, which are not very abundant in this stock. However, it is apparent that the time-series of these surveys has considerable inter-annual variation and that the SSB estimates from these surveys do not track well the perceived abundance of the stock over the time period.

This year several options were examined initially to test the sensitivity of the model to the period of separable constraint, the number of age groups included in the acoustic index and the inclusion of the 1999 acoustic index (which had been excluded from previous assessments). The inclusion of older ages in the acoustic index led to large residuals on age groups 6 and 7. Therefore further runs were conducted with 2-5 ringers in the index. ACFM in May 2002 recommended that the January 2000 survey (1999 value) should be included in the index as this survey tracked the abundance of 3-ringers from the 1998 survey and showed the lower abundances of older age group fish, which was reflected in subsequent surveys. The inclusion of this survey made very little difference to the model fit, and was therefore included for the reasons given above.

An examination of the retrospective pattern from the baseline run (as 2002 WG) is shown in Figure 4.6.1.1. This analysis shows a shift in the selection pattern at older ages in the three most recent years. This shift in selection pattern is concomitant with a shift in the SSB and F between 1999 and 2000. Because of this it was decided to examine two periods of separable constraint in the model specification. In the first case allowing the terminal selection to increase to 1.2 and in the second case keeping the terminal selection at 1.0 for both periods of three years. When compared to a run with a single 6-year period of separable constraint, the runs with two periods of separability showed a slightly better model fit. This change in selection pattern is caused by a reduced numbers of older fish in the catches in the recent period. However it is not clear if this is due to a change in fishing pattern. The improvement in the model fit may therefore be due to an adaptation to local noise in the most recent years. It can be seen from the residuals on the acoustic survey that there are relatively strong year effects in 2000, 2001 and 2002. These year effects influence the magnitude mortality signal from the index over these years. In the most recent year almost all the residuals are negative, indicating that the abundances of 2-5 ringers as measured by the survey is less than expected.

A comparison of SSB, F, and recruitment trajectories from three runs is given in Figure 4.6.1.2. It can be seen from this that there is very little difference in the perception of either SSB, F, or recruitment between these runs. The WG therefore decided to continue using a single 6-year period of separable constraint for this assessment, as a single period of six years is less subject to noise in the data and the perception of F in the final year is not sensitive to either assumption. This said, however, it is apparent that there is a lag in the ability of this assessment to measure fishing mortality on 1-ringers and that this leads to instability in the retrospective pattern in F. Given that 50% of the 1-ringers are mature, the estimate of SSB in the final year is subject to this instability.

A table is given below showing the options used in the assessment since 1998.

Working Group	Age-structured acoustic Index (ages 2-5 rings)	Shrinkage	Separable period
1998	1990-1996	No	1992-1997
1999	1990-1996, 1998	No	1993-1998
2000	1990-1996, 1998	Yes (5yr)	1994-1999
2001	1990-1996, 1998, 2000	No	1995-2000
2002	1990-1996, 1998, 2000-2001	No	1996-2001
2003	1990-1996, 1998-2002	No	1997-2002

4.6.2 Results of the assessment

The run log of this year's assessment is shown in Table 4.6.2.1. The results of the assessment and the diagnostics are shown in Table 4.6.2.2 and Figures 4.6.2.1 – 4.6.2.7. The current perception is of a declining SSB from 1995 to 2001 followed by an increase in the final year. The value of SSB in the final year should be treated with caution as it is influenced by geometric mean recruitment and inherent instability in the assessment. Given the uncertainty in the current value of SSB, the trend in fishing mortality ($F_{2\text{-}7}$) may be a more useful indication of the development of this stock. The trajectory of fishing mortality shows a sharp increase from 1998 to 1999 and a subsequent sharp decrease since. The value of $F_{2\text{-}7}$ in 2002 is 0.30, which is well below the long-term average for this stock (0.52). This figure reflects the significantly reduced catch taken in 2002, which is the lowest in the time-series.

The value of F estimated for 2001 is 0.62, and for 2000 is 0.94. Corresponding estimates of F estimated by last year's WG were 0.44 for 2001 and 0.76 and 2000. Plots of the stock trajectory from this year's assessment are presented in Figure 4.6.2.8 along with the trajectories from the final runs in 2002 and 2001. All these plots use recruitment in the final year based on a geometric mean (2000-1959).

The number of 1-ringers in the stock indicate that recruitment was below average in the years 1996, 1998 and 2001 (although 2001 is poorly estimated by the current assessment) and about average for other years. This may provide some explanation for the reduction in SSB since 1995.

4.6.3 Comments on the assessment

Figure 4.6.2.8 shows the trajectories of SSB, F, and recruitment with uncertainty estimates (based on 100 bootstrap samples) according to this year's assessment. For comparison the final run from the two most recent HAWG's (2002 and 2001) are also included. The estimates of SSB, F and recruitment have fluctuated slightly between assessments since 1999 but retain a consistent pattern. This recent pattern shows a fishing mortality which increased sharply from 1998 to 1999 and has decreased sharply since. The increase in F may have been due to poor recruitment in 1996 and

1998 while catches were maintained at 18,000 to 20,000 t up to 2000. There has been no sign of poor recruitment since 1999 and the catches have been reduced from 18,000 t to about 7,500 t in 2002. This has caused a significant reduction in F, and the SSB trajectory indicates that the stock may be recovering. However, the current level of SSB must be considered to be uncertain given the lack of information on 1-ringers (which are 50% mature).

4.7 Short-term projection

A short-term projection was carried out under the following assumptions: The number of 1-ringers was based on the geometric mean from 1958 to 2000. This value was 408 million fish. This method was the same as applied for the last 2 years, but in contrast to previous years where the geometric mean was calculated over the more recent period (1982 – 1998). Given the continuing uncertainty about the current stock size it was considered more appropriate to use the entire period, including a period of recruitment failure. This value is about 4 million lower than last year and about 150 million lower than that used by the 2000 WG.

The mean weights used in the catches and in the stock were based on average values over the period 1997 – 2002. The input data used for the predictions are shown in Table 4.7.1.

A single option management table based on $\mathbf{F}_{sq}$=F_{2002} is given in Table 4.7.2. A management option table based on $\mathbf{F}_{sq}$ in 2003 with options for 2004 is given in Table 4.7.3. The calculated SSB for 2002 comes to 39,509 t. The overall results of the predictions are influenced by the number of recruits in 2002 and their survivors as 2-ringers in 2003. In addition the relatively high proportion of 3- and 4-ringers in the population in 2003 affect an increasing SSB in the short-term prediction. If fishing in 2003 remains at $\mathbf{F}_{sq}$ the catch in 2003 will be 8,913 t and the SSB in 2003 will rise to 46,871 t. Continued fishing at this effort in 2004 will yield catches of 10,439 t and the SSB will rise to 55,465 t in 2005.

A single option management table based on a catch constraint of 13,000 t is given in Table 4.7.4. This catch is based on the current TAC. If the Landings in 2003 are constrained to 13,000 t the SSB will rise to 45,848 t and the F in 2002 will be 0.47. A management option table based on a TAC constraint of 13,000 t with options for 2004 is given in Table 4.7.5. If the 2003 TAC is again taken in 2004 the F will fall slightly and the SSB will rise to above 48,000 t in 2005.

Plots of yield per recruit and short term yield are given in Figure 4.7.1.

4.8 Quality of the assessment

This assessment has become unstable in recent years due to problems with acoustic survey and an apparent change in the recruitment levels between 1996 and 1998, which was not detected by the assessments in those years. This said, however, the uncertainty around the current estimates of SSB and F is considerably lower for the most recent year than in the period 1999-2001. As 50% of the recruiting 1-ringers are mature the development of this stock in the short term is more strongly influenced by recruitment than by any other factor. Without an independent measure of this there is very little information in assessment about the current levels of recruitment.

4.9 Biological reference points

Biological reference points were discussed in detail in the 2000 WG report (ICES 2000/ACFM:12) and in the report of the previous years (ICES 1999/ACFM:12, ICES 1998/ACFM:14). A summary of this discussion was presented in last year's HAWG report. $\mathbf{B}_{pa}$ is currently at 44,000 t and $\mathbf{B}_{lim}$ at 26,000 t for this stock; $\mathbf{F}_{pa}$ and $\mathbf{F}_{lim}$ are not defined. The SGPRP (ACFM 15:2003) has reviewed the methodology for the calculation of biological reference points, and applying a segmented regression to the stock and recruit data from the 2002 HAWG assessment gave a breakpoint at 61,306 t. This change point appears to be very high with respect to the historical exploitation of the stock. Given that there is a cluster of observations just above this value the sensitivity of the method to these data needs to be further investigated. The HAWG decided that the first priority for this stock should be to achieve a stable assessment and that once this was done the reference points would be reinvestigated (see Section 1.4.2).

4.10 Management considerations

Current management of the fishery is very proactive and is attempting to change the pattern of the fishery from a dependence on spawning fish for the roe market, to a late summer fishery when the fish are in better condition. To this effect the eastern part of the Celtic Sea (east of Mine Head) has been kept closed for the past season and a half. This measure prevents fishing on some of the most important spawning grounds during the main spawning period, it also affords protection to a significant proportion of recruits which are first time spawners (1-ringers). In addition a change in licensing requirements has resulted in a large decrease in effort. The pelagic licensing policy of the Irish Department of the Marine required vessels to target pelagic species for 16 weeks in order to keep their pelagic licences. For the last 2 years, at the request of the South West Pelagic Committee, there has been a moratorium on this requirement so vessels have not been forced into the fishery to maintain their licenses. This was reflected in the national landings figures, around 7,400 t this season which was the lowest ever recorded since the 1980`s. This season saw a maximum of 8 vessels involved as compared with 33 vessels for 2000/2001 season. Over 100 vessels participated in this fishery during the early sixties.

The HAWG notes that these management measures are likely to reduce fishing mortality and improve the age profile of the stock.

The most recent assessment shows that fishing mortality has decreased significantly in the past year but has revised recent fishing mortality estimates upwards again from last year's assessment. This fluctuation may be due to strong year effects in the only available tuning index. The reduction in F is concomitant with a reduction in catches over the past 2 years and catches in the 2002/2003 season were the lowest ever recorded. The reduction in SSB from the mid-nineties to 2001 appears to have been due to poor recruitment in 1993, 1996 and again in 1998. Because of the age profile of the catches, such poor recruitments can cause an acute rise in F in the following years. Recruitment since 1999 appears to have been about average. This is reflected in an increased abundance of 3-, 4-, and 5-ringer fish in the catches.

The SSB estimate in the past two years is less uncertain than in previous assessments; however, the SSB estimate in the final year is still strongly influenced by recruitment at age 1 (in the final year) and without a recruitment index it is not possible to estimate the current SSB more precisely. For this reason the assessment will remain unstable if recruitment continues to fluctuate. Consequently without a recruitment index the assessment will stabilise only if recruitment returns to geometric mean values for a number of years. The decrease in uncertainty this year may be an indication that this is beginning to happen.

The Working Group recommends that all herring recruitment information that is available from surveys in the Celtic sea is evaluated and that the acoustic surveys be maintained.

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.

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. All decisions about the granting of licenses for gravel extraction in the Celtic Sea and VIIj should be carried out under the precautionary principle. **The Working Group** considers that there is enough scientific information to **recommend that no gravel extraction occur in areas with spawning grounds during the spawning season or within 1 month before or after this period**, as this coincides with herring spawning in the area and egg and larval development. Licenses should not be granted for the remainder of the year unless it can be proven unequivocally that gravel extraction does not have a deleterious impact on herring spawning and larval production in the area .

Table 4.1.2.1 Celtic Sea and Division VIIj. Catch-at-age 1958-2002, predicted catch for the separable period (OUTPUT from ICA).

NB In this table age refers to number of rings (winter rings in otilith).

Output Generated by ICA Version 1.4
RUN 27 Ages 2-5 in index, 6 year separable period, and 2000 index included

Herring Celtic VIIj (run:as 02WG)

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

Table 4.1.2.1 Continued.

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	2000	2001	2002
1	5.82	14.27	9.95	15.72	3.50
2	41.51	34.07	77.38	62.15	26.47
3	27.10	36.09	18.95	35.82	18.53
4	28.27	14.64	12.06	5.95	5.31
5	13.18	15.52	5.23	4.25	1.42
6	3.75	8.88	6.23	1.77	1.27
7	2.67	1.86	2.32	1.15	0.44
8	0.60	2.01	0.66	0.47	0.15
9	0.39	0.55	0.58	0.39	0.20

x 10 ^ 6

Predicted Catch in Number

AGE	1997	1998	1999	2000	2001	2002
1	7839.	4931.	14599.	12559.	7046.	3495.
2	35654.	47912.	46257.	70977.	49856.	22686.
3	46314.	21297.	42565.	17978.	23930.	15755.
4	28498.	24329.	16495.	13835.	5150.	6662.
5	7225.	16351.	20243.	5747.	4303.	1584.
6	7642.	4456.	13854.	7054.	1868.	1477.
7	1291.	2664.	2224.	2536.	1199.	348.
8	827.	531.	1624.	537.	545.	259.

x 10 ^ 3

Table 4.1.3.1 Celtic Sea and Division VIIj herring landings by calendar year (t), 1988–2002. (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	-	20,300
1999		200	17,900	1300	+	-1300	-	18,100
2000	573	228	18,038	44	1	-617	-	18,267
2001	1,359	219	17,729	-	-	-1578	-	17,729
2002	734	-	10,550	257	-	991	-	5,536

Table 4.1.3.2 Celtic Sea & Division VIIj herring landings (t) by season (1 April–31 March) 1988/1989-2002/2003. (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
1988/1989	-	-	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	-	20,500
1998/1999	+	-	17,700	1,200	-	-700	-	18,200
1999/2000		200	18,300	1300	+	-1300	-	18,500
2000/2001	573	228	16,962	44	1	-617	-	17,191
2001/2002	-	-	15,236	-	-	-	-	15,236
2002/2003	734	-	7,465	257	-	-991	-	7,465

Table 4.2.3.1 Celtic Sea & Division VIIj (2002–2003). 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 2 2002	1.88	0	0	0	0	No
	Q 3 2002	732	11	245	1170	335	No
	Q 4 2002	4802	13	600	2823	125	No
	Q 1 2003	1929	19	724	2122	375	No

Table 4.2.3.2 Celtic Sea and Division VIIj. Length distribution of Irish catches/quarter (thousands) 2002/2003.

	Q3 2002	Q4 2002			Q1 2003		
Length	**VIIg**	**VIIaS**	**VIIg**	**VIIj**	**VIIaS**	**VIIg**	**VIIj**
15.5							
16							
16.5		1					
17		0					
17.5		0					
18		0					
18.5		0					
19		0					
19.5		0	23	6	7		
20	3	0	23	24	9	33	
20.5	8	0	180	66	44	33	12
21	11	2	113	72	68	66	0
21.5	24	4	451	265	123	462	12
22	46	9	1196	355	235	760	0
22.5	117	14	1353	596	288	859	87
23	95	15	1714	680	323	1057	87
23.5	128	16	2165	951	387	1156	112
24	206	20	2978	1221	521	910	150
24.5	337	22	3744	1493	519	1718	299
25	375	20	3857	1360	433	1222	237
25.5	413	19	2955	1149	305	1255	162
26	347	13	1917	776	196	925	112
26.5	304	6	1399	373	75	363	100
27	261	2	632	325	59	264	50
27.5	195	1	383	259	24	165	62
28	187		158	138	7	0	25
28.5	71		113	169	2	99	50
29	38		45	72		33	0
29.5	11			42			12
30				6			
30.5				6			
Totals:	3177	164	25934	10404	3625	11380	1569

Table 4.3.1.1 Celtic Sea & Division VIIj. Total stock numbers at age (10^6) estimated using combined acoustic surveys (N.B. age refers to age in rings)

Age	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
Total Biomass (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.

Age (Rings)	2000/01	2001/02	2002/03
0	22.75	19	0.00
1	17.58	30.25	41.41
2	142.66	160.37	176.11
3	36.17	175.72	141.99
4	18.67	39.83	27.46
5	6.56	43.54	6.31
6	3.28	22.59	8.21
7	1.72	17.29	2.73
8	0.26	10.67	0.00
9+	0.50	23.18	0.00
Total	250.17	542.37	404.21
Total Biomass (000't)	33.34	79.53	48.64
SSB (000't)	31.79	73.66	38.69

Table 4.3.2.1 Comparison of age distributions in the catches of Celtic Sea herring over the period 2001/02 to 2002/03

Celtic Sea and Div VIIj Age distributions %

	Age in W.Rings								
SOURCE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2001/02 Season	10.1	51.3	26.4	4.9	3.6	2	1	0.5	0.2
Trial Fishery August	2.4	36.6	45.5	11.7	2.8	1			
Commercial Fishery September (Labadie bank)	0.4	9.8	28.6	20.6	15.7	15.4	4.5	2.7	2.4
Commercial Fishery September (Gas Rigs)	2.6	31.9	47.5	11.7	2.4	2.4	0.8	0.2	0.6
Commercial Fishery (Combined)	1.8	19.6	34.6	16.5	10.7	10.3	3	1.8	1.7
Acoustic Survey September	10.8	38.6	38.1	8	2.3	1.7	0.6		

Table 4.6.2.1 Herring in Celtic Sea and Division VIIj. ICA run for the maximum-likelihood ICA calculation for the 6-year separable period.

```
      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.dat
canum.dat
weca.dat
 Stock weights in 2003  used for the year 2002
west.dat
 Natural mortality in 2003  used for the year 2002
natmor.dat
 Maturity ogive in 2003  used for the year 2002
matprop.dat
 Name of age-structured index file (Enter if none) : -->fleet.dat
 Name of the SSB index file (Enter if none) -->
No indices of spawning biomass to be used.
 No of years for separable constraint ?--> 6
 Reference age for separable constraint ?--> 3
 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 ?--> 7
 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
 Weight for age 9-->    1.000000000000000
Enter relative weights by year
 Weight for year 1997-->    1.000000000000000
 Weight for year 1998-->    1.000000000000000
 Weight for year 1999-->    1.000000000000000
 Weight for year 2000-->    1.000000000000000
 Weight for year 2001-->    1.000000000000000
 Weight for year 2002-->    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
```

Table 4.6.2.1 Continued.

Is the last age of FLT02: Celtic combined acc data (Catch: 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 FLT02: Celtic combined acc data (Catch: 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--> 1.500000000000000
Mapping the F-dimension of the SSQ surface

F	SSQ
0.05	7.7951949245
0.13	4.0459457186
0.20	3.2400840792
0.28	3.0944584712
0.36	3.1961038475
0.43	3.4122761042
0.51	3.6887298852
0.58	4.0003657464
0.66	4.3349929507
0.74	4.6870678749
0.81	5.0552528061
0.89	5.4418980306
0.97	5.8539463863
1.04	6.3054652389
1.12	6.8232076999
1.19	7.4604836224
1.27	8.3432924135
1.35	9.5116479678
1.42	10.0815921543
1.50	10.7810651093

Lowest SSQ is for F = 0.276

No of years for separable analysis : 6
Age range in the analysis : 1 . . . 9
Year range in the analysis : 1958 . . . 2002
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 29
Number of observations : 96

Conventional single selection vector model to be fitted.

Table 4.6.2.1 Continued.

Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
Enter weight for FLT02: Celtic combined acc data (Catch: at age 2--> 1.000000000000000
Enter weight for FLT02: Celtic combined acc data (Catch: at age 3--> 1.000000000000000
Enter weight for FLT02: Celtic combined acc data (Catch: at age 4--> 1.000000000000000
Enter weight for FLT02: Celtic combined acc data (Catch: at age 5--> 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 FLT02: Celtic combined acc data (Catch:--> 5.0000000000000003E-02
Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.

Aged index weights
FLT02: Celtic combined acc data (Catch:
Age : 2 3 4 5
Wts : 0.962 0.962 0.962 0.962
F in 2002 at age 3 is 0.269560 in iteration 1
Detailed, Normal or Summary output (D/N/S)-->D
Output page width in characters (e.g. 80..132) ?--> 80
E

Table 4.6.2.2 Celtic Sea and Division VIIj. Catch at age 1958-2002, predicted catch for the separable period (OUTPUT from ICA). NB In this table age refers to number of rings (winter rings in otolith).

```
Output Generated by ICA Version 1.4
RUN 27 Ages 2-5 in index, 6 year separable period, and 2000 index included
 -----------------------------------

        Herring Celtic VIIj (run:as 02WG )
        ---------------------------------

        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 4.6.2.2 Continued.

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	2000	2001	2002
1	5.82	14.27	9.95	15.72	3.50
2	41.51	34.07	77.38	62.15	26.47
3	27.10	36.09	18.95	35.82	18.53
4	28.27	14.64	12.06	5.95	5.31
5	13.18	15.52	5.23	4.25	1.42
6	3.75	8.88	6.23	1.77	1.27
7	2.67	1.86	2.32	1.15	0.44
8	0.60	2.01	0.66	0.47	0.15
9	0.39	0.55	0.58	0.39	0.20

x 10 ^ 6

Predicted Catch in Number

AGE	1997	1998	1999	2000	2001	2002
1	7839.	4931.	14599.	12559.	7046.	3495.
2	35654.	47912.	46257.	70977.	49856.	22686.
3	46314.	21297.	42565.	17978.	23930.	15755.
4	28498.	24329.	16495.	13835.	5150.	6662.
5	7225.	16351.	20243.	5747.	4303.	1584.
6	7642.	4456.	13854.	7054.	1868.	1477.
7	1291.	2664.	2224.	2536.	1199.	348.
8	827.	531.	1624.	537.	545.	259.

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
9	0.25700	0.26400	0.26600	0.26200	0.27200	0.28300	0.28500	0.28500

Table 4.6.2.2 Continued

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	2000	2001	2002
1	0.09900	0.09000	0.09200	0.08200	0.09600
2	0.12100	0.12000	0.11100	0.10700	0.11500
3	0.15300	0.14900	0.14800	0.13900	0.13900
4	0.16300	0.16700	0.16800	0.16200	0.15600
5	0.17300	0.18000	0.18500	0.17700	0.18500
6	0.18500	0.18300	0.18700	0.19000	0.19600
7	0.19900	0.20200	0.19700	0.18500	0.20300
8	0.20400	0.20900	0.21000	0.20400	0.21100
9	0.22500	0.20800	0.22400	0.22900	0.22600

.

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 4.6.2.2 Continued.

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	2000	2001	2002
1	0.09900	0.09000	0.09200	0.08200	0.09600
2	0.12100	0.12000	0.11100	0.10700	0.11500
3	0.15300	0.14900	0.14800	0.13900	0.13900
4	0.16300	0.16700	0.16800	0.16200	0.15600
5	0.17300	0.18000	0.18500	0.17700	0.18400
6	0.18500	0.18300	0.18700	0.19000	0.19600
7	0.19900	0.20200	0.19700	0.18500	0.20300
8	0.20400	0.20900	0.21000	0.20400	0.21100
9	0.22500	0.20800	0.22400	0.22900	0.22300

Table 4.6.2.2 Continued.

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 4.6.2.2 Continued.

Natural Mortality (per year)

AGE	1998	1999	2000	2001	2002
1	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	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 4.6.2.2 Continued

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	2000	2001	2002
1	0.5000	0.5000	0.5000	0.5000	0.5000
2	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	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	2000	2001	2002
2	157.13	96.60	142.66	160.37	176.11
3	149.62	85.13	36.17	175.72	141.99
4	201.48	16.25	18.67	39.83	27.46
5	108.53	21.37	6.56	43.54	6.31

Fishing Mortality (per year)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	0.0080	0.0018	0.0126	0.0134	0.0025	0.0017	0.0115	0.0002
2	0.1173	0.2864	0.2366	0.1534	0.2651	0.3964	0.1836	0.2406
3	0.3439	0.1025	0.5250	0.1658	0.3067	0.3209	0.2346	0.1762
4	0.4901	0.3267	0.2340	0.2042	0.3777	0.0921	0.2556	0.3303
5	0.3743	0.3558	0.3619	0.1706	0.4437	0.2467	0.0449	0.1796
6	0.4701	0.2656	0.2110	0.1966	0.4486	0.2303	0.1397	0.1437
7	0.6960	0.6787	0.4325	0.1810	0.5211	0.2789	0.1497	0.2617
8	0.3595	0.3004	0.3073	0.1623	0.3495	0.2476	0.1596	0.2087
9	0.3595	0.3004	0.3073	0.1623	0.3495	0.2476	0.1596	0.2087

Table 4.6.2.2 Continued

Fishing Mortality (per year)

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	0.0170	0.0176	0.0229	0.0330	0.0086	0.0231	0.0495	0.1233
2	0.1803	0.2130	0.2922	0.4294	0.3026	0.3593	0.6875	0.6013
3	0.3545	0.3019	0.3599	0.5758	0.4647	0.6110	0.5551	0.7303
4	0.2714	0.5217	0.2700	0.5487	0.5759	0.8581	0.5371	0.4170
5	0.4498	0.3854	0.4286	0.4493	0.6108	0.9363	0.7364	0.6506
6	0.4426	0.5947	0.3257	0.6274	0.5154	0.7286	0.5544	0.5819
7	0.1450	0.5660	0.5054	0.5283	0.4216	0.5205	0.4195	0.8900
8	0.2723	0.3746	0.3289	0.4764	0.4333	0.5984	0.5429	0.5893
9	0.2723	0.3746	0.3289	0.4764	0.4333	0.5984	0.5429	0.5893

Fishing Mortality (per year)

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	0.0649	0.1399	0.1058	0.0765	0.0331	0.0780	0.0801	0.1622
2	0.6385	0.4641	0.3024	0.2346	0.3000	0.4005	0.5539	0.6697
3	0.6539	0.6540	0.4468	0.4341	0.3923	0.5385	0.7610	1.1652
4	0.7099	0.6177	0.5552	0.6459	0.5295	0.5189	0.5844	0.9825
5	0.4223	0.6107	0.4626	0.2058	0.3580	0.5097	0.2814	0.8914
6	0.4988	0.6596	0.6812	0.5609	0.2679	0.5037	0.8190	0.5759
7	0.6691	0.3780	0.8667	0.2692	0.2706	0.3495	1.0451	0.7053
8	0.5593	0.5142	0.4836	0.3511	0.3294	0.4307	0.6047	0.7762
9	0.5593	0.5142	0.4836	0.3511	0.3294	0.4307	0.6047	0.7762

Fishing Mortality (per year)

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	0.0371	0.0295	0.0555	0.0489	0.0123	0.0092	0.0086	0.0252
2	0.4793	0.6888	0.5190	0.4004	0.3765	0.4979	0.2879	0.3743
3	0.7045	0.6934	0.7185	0.4212	0.6461	0.5912	0.4866	0.4430
4	0.8494	0.5846	1.1808	0.6537	0.8063	0.8419	0.2309	0.6216
5	0.6999	0.8480	1.0910	0.4473	0.8172	0.9049	0.4770	0.2884
6	1.1276	0.2817	1.9161	0.2291	0.3637	0.5666	0.4267	0.5697
7	0.5420	0.6086	0.5322	0.7058	0.1306	0.7011	0.3148	0.6906
8	0.6487	0.5862	0.8530	0.4424	0.4900	0.6232	0.3350	0.4472
9	0.6487	0.5862	0.8530	0.4424	0.4900	0.6232	0.3350	0.4472

Fishing Mortality (per year)

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0095	0.0163	0.0186	0.0078	0.0262	0.0226	0.0169	0.0283
2	0.2946	0.5880	0.5976	0.4081	0.4231	0.4174	0.3507	0.4232
3	0.4156	0.5180	0.8331	0.4640	0.5551	0.5597	0.3905	0.5180
4	0.4088	0.5321	0.8418	0.5896	0.2775	0.7186	0.3692	0.5361
5	0.5022	0.5958	0.6254	0.2727	0.3057	0.5032	0.7185	0.5943
6	0.1883	0.5661	0.8468	0.3078	0.4583	0.5900	0.5229	0.8001
7	0.4618	0.1691	0.7369	0.6623	0.2806	0.4415	0.5315	0.6374
8	0.3510	0.4625	0.6783	0.4180	0.3554	0.4907	0.4288	0.5180
9	0.3510	0.4625	0.6783	0.4180	0.3554	0.4907	0.4288	0.5180

Fishing Mortality (per year)

AGE	1998	1999	2000	2001	2002
1	0.0285	0.0505	0.0456	0.0305	0.0147
2	0.4251	0.7544	0.6820	0.4556	0.2202
3	0.5203	0.9234	0.8348	0.5577	0.2696
4	0.5385	0.9557	0.8640	0.5772	0.2790
5	0.5970	1.0595	0.9578	0.6399	0.3093
6	0.8038	1.4264	1.2895	0.8614	0.4164
7	0.6403	1.1363	1.0272	0.6862	0.3317
8	0.5203	0.9234	0.8348	0.5577	0.2696
9	0.5203	0.9234	0.8348	0.5577	0.2696

Table 4.6.2.2 Continued

Population Abundance (1 January)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	325.2	1074.6	358.4	252.6	495.7	281.6	1039.2	371.4
2	39.0	118.7	394.6	130.2	91.7	181.9	103.4	377.9
3	124.8	25.7	66.0	230.7	82.7	52.1	90.7	63.8
4	69.5	72.4	19.0	32.0	160.1	49.8	31.0	58.7
5	42.1	38.5	47.3	13.6	23.6	99.3	41.1	21.7
6	66.8	26.2	24.4	29.8	10.4	13.7	70.2	35.6
7	33.5	37.8	18.2	17.9	22.1	6.0	9.8	55.2
8	32.6	15.1	17.3	10.7	13.5	11.9	4.1	7.7
9	19.4	29.7	16.4	34.6	18.9	13.3	15.6	41.7

x 10 ^ 6

Population Abundance (1 January)

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	663.7	687.4	851.1	460.6	242.9	876.7	274.9	317.8
2	136.6	240.0	248.4	306.0	163.9	88.6	315.2	96.2
3	220.1	84.5	143.7	137.4	147.6	89.7	45.8	117.4
4	43.8	126.4	51.2	82.1	63.3	75.9	39.9	21.5
5	38.2	30.2	67.9	35.3	42.9	32.2	29.1	21.1
6	16.4	22.0	18.6	40.0	20.4	21.1	11.4	12.6
7	27.9	9.5	11.0	12.1	19.3	11.0	9.2	5.9
8	38.5	21.8	4.9	6.0	6.5	11.5	5.9	5.5
9	16.9	22.7	18.5	9.6	10.0	5.2	2.5	2.8

x 10 ^ 6

Population Abundance (1 January)

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	137.9	153.0	208.1	174.1	135.8	237.4	146.2	410.3
2	103.4	47.5	48.9	68.9	59.3	48.3	80.8	49.6
3	39.1	40.4	22.1	26.8	40.4	32.6	24.0	34.4
4	46.3	16.6	17.2	11.6	14.2	22.3	15.6	9.2
5	12.8	20.6	8.1	8.9	5.5	7.6	12.0	7.8
6	10.0	7.6	10.1	4.6	6.6	3.5	4.1	8.2
7	6.4	5.5	3.6	4.6	2.4	4.6	1.9	1.6
8	2.2	3.0	3.4	1.4	3.2	1.6	2.9	0.6
9	2.0	3.1	4.8	1.7	1.8	1.9	1.3	1.7

x 10 ^ 6

Population Abundance (1 January)

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	663.4	734.0	569.4	592.0	537.5	1033.8	427.1	524.1
2	128.3	235.2	262.2	198.2	207.4	195.3	376.8	155.8
3	18.8	58.9	87.5	115.6	98.4	105.4	88.0	209.3
4	8.8	7.6	24.1	34.9	62.1	42.2	47.8	44.3
5	3.1	3.4	3.8	6.7	16.4	25.1	16.5	34.3
6	2.9	1.4	1.3	1.2	3.9	6.6	9.2	9.2
7	4.2	0.9	1.0	0.2	0.8	2.4	3.4	5.4
8	0.7	2.2	0.4	0.5	0.1	0.7	1.1	2.2
9	1.3	0.7	0.3	0.4	0.0	1.0	0.3	2.0

x 10 ^ 6

Population Abundance (1 January)

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	449.7	187.4	890.8	325.3	741.5	667.9	327.2	443.1
2	188.0	163.9	67.8	321.7	118.7	265.7	240.2	118.4
3	79.4	103.7	67.4	27.6	158.5	57.6	129.7	125.3
4	110.1	42.9	50.6	24.0	14.2	74.5	27.0	71.8
5	21.5	66.2	22.8	19.7	12.0	9.8	32.8	16.9
6	23.3	11.8	33.0	11.0	13.6	8.0	5.3	14.5
7	4.7	17.5	6.1	12.8	7.3	7.8	4.0	2.9
8	2.5	2.7	13.3	2.6	6.0	5.0	4.5	2.1
9	1.6	1.7	1.5	1.6	1.7	2.3	3.1	1.6

x 10 ^ 6

Table 4.6.2.2 Continued

Population Abundance (1 January)

AGE	1998	1999	2000	2001	2002	2003
1	277.5	467.2	443.6	370.2	377.5	437.6
2	158.5	99.2	163.4	155.9	132.1	136.8
3	57.4	76.7	34.6	61.2	73.2	78.5
4	61.1	27.9	25.0	12.3	28.7	45.8
5	38.0	32.3	9.7	9.5	6.2	19.6
6	8.4	18.9	10.1	3.4	4.5	4.1
7	5.9	3.4	4.1	2.5	1.3	2.7
8	1.4	2.8	1.0	1.3	1.1	0.8
9	1.0	1.0	1.1	0.9	0.9	1.4

x 10 ^ 6

Weighting factors for the catches in number

AGE	1997	1998	1999	2000	2001	2002
1	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
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

Predicted Age-Structured Index Values

FLT02: Celtic combined acc data (Catch: Predicted

AGE	1990	1991	1992	1993	1994	1995	1996	1997
2	296.88	192.93	79.10	453.44	164.89	371.09	358.63	*******
3	147.83	174.39	82.70	49.04	256.67	92.91	247.62	*******
4	175.52	60.47	52.34	31.94	25.88	87.12	44.73	*******
5	29.16	81.66	27.31	33.64	19.86	13.21	35.85	*******

FLT02: Celtic combined acc data (Catch: Predicted

AGE	1998	1999	2000	2001	2002
2	219.60	98.92	175.14	209.59	224.72
3	96.31	86.00	42.33	98.88	157.84
4	85.62	25.79	25.24	16.55	52.10
5	46.88	25.05	8.35	11.24	10.26

Fitted Selection Pattern

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	0.0233	0.0173	0.0240	0.0809	0.0080	0.0052	0.0491	0.0014
2	0.3410	2.7940	0.4506	0.9251	0.8642	1.2353	0.7828	1.3655
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.4252	3.1879	0.4456	1.2316	1.2314	0.2872	1.0895	1.8742
5	1.0885	3.4716	0.6893	1.0291	1.4467	0.7688	0.1914	1.0193
6	1.3670	2.5917	0.4019	1.1858	1.4627	0.7176	0.5953	0.8156
7	2.0237	6.6222	0.8238	1.0915	1.6990	0.8692	0.6381	1.4849
8	1.0454	2.9308	0.5854	0.9790	1.1393	0.7717	0.6802	1.1842
9	1.0454	2.9308	0.5854	0.9790	1.1393	0.7717	0.6802	1.1842

Table 4.6.2.2 Continued

Fitted Selection Pattern

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	0.0480	0.0584	0.0636	0.0573	0.0186	0.0377	0.0891	0.1689
2	0.5086	0.7053	0.8121	0.7458	0.6512	0.5881	1.2387	0.8234
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.7656	1.7280	0.7502	0.9530	1.2394	1.4044	0.9676	0.5710
5	1.2689	1.2764	1.1910	0.7804	1.3146	1.5324	1.3267	0.8908
6	1.2484	1.9695	0.9051	1.0896	1.1092	1.1925	0.9989	0.7969
7	0.4090	1.8744	1.4044	0.9176	0.9073	0.8519	0.7557	1.2187
8	0.7681	1.2406	0.9140	0.8275	0.9326	0.9794	0.9780	0.8070
9	0.7681	1.2406	0.9140	0.8275	0.9326	0.9794	0.9780	0.8070

Fitted Selection Pattern

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	0.0992	0.2139	0.2367	0.1763	0.0843	0.1449	0.1053	0.1392
2	0.9764	0.7096	0.6769	0.5404	0.7646	0.7437	0.7278	0.5748
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0856	0.9445	1.2426	1.4881	1.3497	0.9637	0.7680	0.8432
5	0.6459	0.9339	1.0355	0.4741	0.9124	0.9465	0.3698	0.7651
6	0.7628	1.0086	1.5247	1.2922	0.6828	0.9354	1.0762	0.4943
7	1.0232	0.5779	1.9400	0.6201	0.6897	0.6489	1.3733	0.6053
8	0.8554	0.7863	1.0825	0.8088	0.8396	0.7999	0.7946	0.6661
9	0.8554	0.7863	1.0825	0.8088	0.8396	0.7999	0.7946	0.6661

Fitted Selection Pattern

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	0.0527	0.0426	0.0772	0.1160	0.0190	0.0155	0.0176	0.0569
2	0.6803	0.9934	0.7224	0.9508	0.5827	0.8421	0.5917	0.8449
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.2057	0.8431	1.6434	1.5522	1.2479	1.4241	0.4746	1.4032
5	0.9934	1.2230	1.5184	1.0620	1.2647	1.5307	0.9802	0.6510
6	1.6005	0.4063	2.6668	0.5441	0.5628	0.9584	0.8770	1.2861
7	0.7693	0.8778	0.7407	1.6759	0.2021	1.1859	0.6470	1.5591
8	0.9208	0.8455	1.1873	1.0505	0.7583	1.0542	0.6884	1.0095
9	0.9208	0.8455	1.1873	1.0505	0.7583	1.0542	0.6884	1.0095

Fitted Selection Pattern

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0230	0.0314	0.0224	0.0169	0.0471	0.0404	0.0433	0.0547
2	0.7089	1.1351	0.7173	0.8795	0.7623	0.7458	0.8980	0.8170
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.9836	1.0271	1.0104	1.2708	0.4999	1.2840	0.9454	1.0350
5	1.2084	1.1502	0.7506	0.5877	0.5507	0.8991	1.8399	1.1474
6	0.4530	1.0929	1.0164	0.6635	0.8257	1.0542	1.3389	1.5447
7	1.1112	0.3265	0.8845	1.4273	0.5055	0.7889	1.3609	1.2306
8	0.8446	0.8929	0.8142	0.9010	0.6402	0.8768	1.0981	1.0000
9	0.8446	0.8929	0.8142	0.9010	0.6402	0.8768	1.0981	1.0000

Fitted Selection Pattern

AGE	1998	1999	2000	2001	2002
1	0.0547	0.0547	0.0547	0.0547	0.0547
2	0.8170	0.8170	0.8170	0.8170	0.8170
3	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0350	1.0350	1.0350	1.0350	1.0350
5	1.1474	1.1474	1.1474	1.1474	1.1474
6	1.5447	1.5447	1.5447	1.5447	1.5447
7	1.2306	1.2306	1.2306	1.2306	1.2306
8	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000

Table 4.6.2.2 Continued

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	325220	111542	78501	22978	0.2927	0.4153	89
1959	1074570	157030	83409	15086	0.1809	0.3360	88
1960	358410	121984	84972	18283	0.2152	0.3335	88
1961	252610	106923	79985	15372	0.1922	0.1786	128
1962	495690	131602	83304	21552	0.2587	0.3938	98
1963	281600	106990	76330	17349	0.2273	0.2609	99
1964	1039190	179331	95578	10599	0.1109	0.1680	97
1965	371440	156139	113455	19126	0.1686	0.2220	86
1966	663700	187212	116005	27030	0.2330	0.3073	103
1967	687360	189729	116299	27658	0.2378	0.4304	90
1968	851060	211255	123658	30236	0.2445	0.3636	100
1969	460590	177154	115709	44389	0.3836	0.5265	99
1970	242930	126478	88830	31727	0.3572	0.4818	99
1971	876680	172950	87710	31396	0.3580	0.6689	96
1972	274860	122373	78266	38203	0.4881	0.5817	100
1973	317830	97568	57759	26936	0.4663	0.6452	95
1974	137910	65150	42304	19940	0.4713	0.5987	97
1975	152950	52869	32186	15588	0.4843	0.5640	107
1976	208120	53831	29515	9771	0.3310	0.5525	94
1977	174110	49826	29202	7833	0.2682	0.3917	100
1978	135750	46164	29483	7559	0.2564	0.3531	91
1979	237420	55787	30203	10321	0.3417	0.4701	100
1980	146200	45719	27989	13130	0.4691	0.6741	107
1981	410320	70759	31787	17103	0.5380	0.8317	101
1982	663420	105159	45730	13000	0.2843	0.7338	101
1983	734010	130648	62920	24981	0.3970	0.6175	104
1984	569360	113067	62496	26779	0.4285	0.9929	99
1985	592030	118114	64597	20426	0.3162	0.4763	102
1986	537530	125641	70677	25024	0.3541	0.5234	100
1987	1033780	161647	79588	26200	0.3292	0.6839	99
1988	427130	122237	79647	20447	0.2567	0.3707	100
1989	524120	125350	74601	23254	0.3117	0.4979	100
1990	449660	111648	70236	18404	0.2620	0.3785	99
1991	187380	83499	59422	25562	0.4302	0.4949	101
1992	890810	128369	59828	21127	0.3531	0.7470	95
1993	325320	89896	57831	18618	0.3219	0.4507	100
1994	741450	125534	65668	19300	0.2939	0.3834	99
1995	667900	120899	67962	23305	0.3429	0.5384	100
1996	327210	90145	59287	18816	0.3174	0.4805	100
1997	443110	91912	53976	20496	0.3797	0.5848	99
1998	277480	75207	47344	18041	0.3811	0.5875	99
1999	467160	80801	41796	18485	0.4423	1.0426	99
2000	443640	73209	36949	17191	0.4653	0.9426	99
2001	370240	60821	33557	15269	0.4550	0.6297	99
2002	407532*	68826	39509*	7465	0.1931	0.3044	100

No of years for separable analysis : 6
Age range in the analysis : 1 . . . 9
Year range in the analysis : 1958 . . . 2002
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 29
Number of observations : 96

Conventional single selection vector model to be fitted.

*geometric mean recruitment

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	1997	0.5180	20	0.3477	0.7717	0.4226	0.6348	0.5288
2	1998	0.5203	19	0.3558	0.7610	0.4286	0.6317	0.5302
3	1999	0.9234	16	0.6630	1.2861	0.7798	1.0935	0.9367
4	2000	0.8348	17	0.5930	1.1752	0.7011	0.9939	0.8476
5	2001	0.5577	21	0.3693	0.8421	0.4519	0.6882	0.5701
6	2002	0.2696	25	0.1626	0.4470	0.2083	0.3489	0.2787

Table 4.6.2.2 Continued

Separable Model: Selection (S) by age

7	1	0.0547	59	0.0169	0.1767	0.0301	0.0995	0.0654
8	2	0.8170	22	0.5298	1.2600	0.6550	1.0191	0.8372
	3	1.0000		Fixed : Reference Age				
9	4	1.0350	20	0.6870	1.5593	0.8397	1.2757	1.0579
10	5	1.1474	19	0.7857	1.6755	0.9458	1.3919	1.1690
11	6	1.5447	17	1.1046	2.1603	1.3018	1.8330	1.5675
12	7	1.2305	18	0.8624	1.7558	1.0265	1.4752	1.2510
	8	1.0000		Fixed : Last true age				

Separable model: Populations in year 2002

13	1	377454	143	22448	6346531	89438	1592969	1064343
14	2	132115	31	71623	243696	96670	180557	138720
15	3	73240	23	46514	115322	58097	92330	75231
16	4	28687	20	19205	42851	23376	35205	29295
17	5	6238	19	4249	9158	5128	7588	6359
18	6	4539	21	2968	6943	3655	5638	4647
19	7	1289	26	761	2185	985	1687	1337
20	8	1148	31	617	2136	836	1576	1207

Separable model: Populations at age

21	1997	2139	43	904	5060	1378	3319	2356
22	1998	1368	33	703	2660	974	1921	1449
23	1999	2807	29	1582	4982	2095	3762	2930
24	2000	989	29	553	1769	735	1331	1034
25	2001	1332	29	740	2398	987	1798	1393

Age-structured index catchabilities

FLT02: Celtic combined acc data (Catch:

Linear model fitted. Slopes at age :

26	2	Q	.2862E-02	13	.2522E-02	.4225E-02	.2862E-02	.3723E-02	.3293E-02
27	3	Q	.3447E-02	13	.3042E-02	.5065E-02	.3447E-02	.4471E-02	.3959E-02
28	4	Q	.2653E-02	13	.2340E-02	.3906E-02	.2653E-02	.3445E-02	.3049E-02
29	5	Q	.2475E-02	13	.2178E-02	.3669E-02	.2475E-02	.3229E-02	.2852E-02

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1997	1998	1999	2000	2001	2002
1	-0.7114	0.1653	-0.0225	-0.2326	0.8027	0.0000
2	0.0489	-0.1434	-0.3057	0.0864	0.2205	0.1543
3	0.1356	0.2410	-0.1651	0.0528	0.4033	0.1623
4	0.0983	0.1503	-0.1191	-0.1373	0.1449	-0.2270
5	0.1409	-0.2157	-0.2660	-0.0942	-0.0126	-0.1120
6	-0.2186	-0.1735	-0.4451	-0.1247	-0.0517	-0.1517
7	-0.1172	0.0041	-0.1762	-0.0891	-0.0459	0.2286
8	0.0000	0.1172	0.2145	0.2087	-0.1564	-0.5198

AGE-STRUCTURED INDEX RESIDUALS

FLT02: Celtic combined acc data (Catch:

Age	1990	1991	1992	1993	1994	1995	1996	1997
2	-0.176	0.012	0.391	-0.035	-0.260	0.395	0.747	*******
3	-0.308	-0.611	0.060	0.180	-0.471	0.399	0.009	*******
4	-0.141	-0.113	-0.054	0.686	-0.902	0.071	0.123	*******
5	0.106	0.038	-0.207	-0.257	-0.628	-0.514	0.156	*******

FLT02: Celtic combined acc data (Catch:

Age	1998	1999	2000	2001	2002
2	-0.335	-0.024	-0.205	-0.268	-0.244
3	0.441	-0.010	-0.157	0.575	-0.106
4	0.856	-0.462	-0.302	0.878	-0.640
5	0.839	-0.159	-0.242	1.354	-0.486

Table 4.6.2.2 Continued

```
 PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)
 -----------------------------------------------------

 Separable model fitted from 1997  to 2002
 Variance                            0.0754
Skewness test stat.                 -1.6793
Kurtosis test statistic             -0.0077
Partial chi-square                   0.2123
Significance in fit                  0.0000
Degrees of freedom                       23

 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                0.1096    0.1264    0.3113    0.3205
Skewness test stat.      1.5226   -0.0604    0.3660    1.7741
Kurtosis test statisti  -0.0242   -0.6132   -0.6216    0.5049
Partial chi-square       0.2200    0.2875    0.9967    1.3038
Significance in fit      0.0000    0.0000    0.0000    0.0002
Number of observations       12        12        12        12
Degrees of freedom           11        11        11        11
Weight in the analysis   0.9625    0.9625    0.9625    0.9625

 ANALYSIS OF VARIANCE
--------------------------

 Unweighted Statistics

Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                      12.7612      96          29   67   0.1905
Catches at age                        2.8430      48          25   23   0.1236

 Aged Indices
FLT02: Celtic combined acc data (Catch  9.9182      48           4   44   0.2254

 Weighted Statistics

Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                      10.9222      96          29   67   0.1630
Catches at age                        1.7339      48          25   23   0.0754

 Aged Indices
FLT02: Celtic combined acc data (Catch  9.1883      48           4   44   0.2088
```

Table 4.7.1 Celtic Sea and Division VIIj- Input data for short-term predictions. NB In this table age refers to number of rings (winter rings in otolith).

MFDP version 1a
Run: Catch13000
Time and date: 18:48 18/03/2003
Fbar age range: 2-7

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	407532	1	0.5	0.2	0.5	0.092	0.014738	0.092
2	149920	0.3	1	0.2	0.5	0.116333	0.22023	0.116333
3	78528	0.2	1	0.2	0.5	0.144833	0.26956	0.144833
4	45796	0.1	1	0.2	0.5	0.162167	0.27899	0.162167
5	19639	0.1	1	0.2	0.5	0.1785	0.30929	0.178667
6	4143.9	0.1	1	0.2	0.5	0.188833	0.4164	0.188833
7	2709.4	0.1	1	0.2	0.5	0.198667	0.33171	0.198667
8	838.18	0.1	1	0.2	0.5	0.209	0.26956	0.209
9	1410.5	0.1	1	0.2	0.5	0.2215	0.26956	0.222

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	407532	1	0.5	0.2	0.5	0.092	0.014738	0.092
2		0.3	1	0.2	0.5	0.116333	0.22023	0.116333
3		0.2	1	0.2	0.5	0.144833	0.26956	0.144833
4		0.1	1	0.2	0.5	0.162167	0.27899	0.162167
5		0.1	1	0.2	0.5	0.1785	0.30929	0.178667
6		0.1	1	0.2	0.5	0.188833	0.4164	0.188833
7		0.1	1	0.2	0.5	0.198667	0.33171	0.198667
8		0.1	1	0.2	0.5	0.209	0.26956	0.209
9		0.1	1	0.2	0.5	0.2215	0.26956	0.222

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	407532	1	0.5	0.2	0.5	0.092	0.014738	0.092
2		0.3	1	0.2	0.5	0.116333	0.22023	0.116333
3		0.2	1	0.2	0.5	0.144833	0.26956	0.144833
4		0.1	1	0.2	0.5	0.162167	0.27899	0.162167
5		0.1	1	0.2	0.5	0.1785	0.30929	0.178667
6		0.1	1	0.2	0.5	0.188833	0.4164	0.188833
7		0.1	1	0.2	0.5	0.198667	0.33171	0.198667
8		0.1	1	0.2	0.5	0.209	0.26956	0.209
9		0.1	1	0.2	0.5	0.2215	0.26956	0.222

Input units are thousands and kg - output in tonnes

Table 4.7.2 Celtic Sea and Division VIIj. Single option prediction table with F. NB In this table age refers to number of rings (winter rings in otolith).

MFDP version 1a

Run: $\mathbf{F}_{sq}$

Time and date: 17:45 18/03/2003

Fbar age range: 2-7

	Year:	2003	F multiplier:	1	Fbar:	0.3044			
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0147	3773	347	407532	37493	203766	18746	123227	11337
2	0.2202	25743	2995	149920	17441	149920	17441	123477	14365
3	0.2696	16893	2447	78528	11373	78528	11373	67326	9751
4	0.279	10634	1725	45796	7427	45796	7427	41198	6681
5	0.3093	4985	891	19639	3506	19639	3506	17561	3135
6	0.4164	1348	254	4144	783	4144	783	3627	685
7	0.3317	730	145	2709	538	2709	538	2412	479
8	0.2696	189	39	838	175	838	175	755	158
9	0.2696	318	71	1411	312	1411	312	1271	282
Total		64612	8913	710517	79048	506751	60301	380854	46871

	Year:	2004	F multiplier:	1	Fbar:	0.3044			
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0147	3773	347	407532	37493	203766	18746	123227	11337
2	0.2202	25367	2951	147729	17186	147729	17186	121673	14155
3	0.2696	19169	2776	89110	12906	89110	12906	76398	11065
4	0.279	11402	1849	49102	7963	49102	7963	44172	7163
5	0.3093	7957	1422	31350	5596	31350	5596	28032	5004
6	0.4164	4242	801	13043	2463	13043	2463	11415	2156
7	0.3317	666	132	2473	491	2473	491	2201	437
8	0.2696	397	83	1759	368	1759	368	1586	331
9	0.2696	350	78	1554	344	1554	344	1401	310
Total		73323	10439	743651	84810	539885	66063	410105	51958

	Year:	2005	F multiplier:	1	Fbar:	0.3044			
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0147	3773	347	407532	37493	203766	18746	123227	11337
2	0.2202	25367	2951	147729	17186	147729	17186	121673	14155
3	0.2696	18889	2736	87808	12718	87808	12718	75282	10903
4	0.279	12939	2098	55718	9036	55718	9036	50125	8129
5	0.3093	8531	1524	33613	6000	33613	6000	30056	5365
6	0.4164	6771	1279	20820	3932	20820	3932	18222	3441
7	0.3317	2096	416	7782	1546	7782	1546	6927	1376
8	0.2696	362	76	1606	336	1606	336	1447	302
9	0.2696	516	115	2290	507	2290	507	2064	457
Total		79245	11542	764898	88752	561132	70006	429022	55465

Input units are thousands and kg - output in tonnes

Table 4.7.3 Celtic Sea and Division VIIj. Short-term predictions with management options based on $\mathbf{F}_{sq}$ =F2002.

MFDP version 1a
Run: $\mathbf{F}_{sq}$
Celtic Sea 2001Projection index file Tuesday 18th March 2003.
Time and date: 17:45 18/03/2003
Fbar age range: 2-7

2003				
Biomass	SSB	FMult	FBar	Landings
79048	46871	1	0.3044	8913

2004					2005	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
84810	54225	0	0	0	99379	67924
.	53993	0.1	0.0304	1170	98184	66494
.	53762	0.2	0.0609	2309	97020	65108
.	53532	0.3	0.0913	3419	95887	63766
.	53303	0.4	0.1217	4501	94784	62465
.	53076	0.5	0.1522	5556	93711	61205
.	52850	0.6	0.1826	6583	92665	59984
.	52625	0.7	0.2131	7584	91648	58801
.	52402	0.8	0.2435	8560	90657	57654
.	52179	0.9	0.2739	9512	89692	56542
.	51958	1	0.3044	10439	88752	55465
.	51738	1.1	0.3348	11343	87837	54421
.	51519	1.2	0.3652	12224	86946	53408
.	51302	1.3	0.3957	13084	86078	52426
.	51085	1.4	0.4261	13921	85233	51474
.	50870	1.5	0.4565	14738	84410	50551
.	50656	1.6	0.487	15535	83609	49656
.	50443	1.7	0.5174	16311	82828	48787
.	50231	1.8	0.5479	17069	82067	47945
.	50021	1.9	0.5783	17808	81326	47128
.	49811	2	0.6087	18528	80604	46335

Input units are thousands and kg - output in tonnes

Table 4.7.4 Celtic Sea and Division VIIj. Single option prediction table with catch constraint. NB In this table age refers to number of rings (winter rings in otolith).

MFDP version 1a

Run: Catch13000

Time and date: 18:48 18/03/2003

Fbar age range: 2-7

	Year:	2003	F multiplier:	1.5551	Fbar:	0.4733			
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0229	5848	538	407532	37493	203766	18746	123025	11318
2	0.3425	37882	4407	149920	17441	149920	17441	120495	14018
3	0.4192	24542	3554	78528	11373	78528	11373	65341	9464
4	0.4339	15396	2497	45796	7427	45796	7427	39942	6477
5	0.481	7164	1280	19639	3506	19639	3506	16968	3029
6	0.6476	1890	357	4144	783	4144	783	3463	654
7	0.5159	1044	207	2709	538	2709	538	2325	462
8	0.4192	274	57	838	175	838	175	733	153
9	0.4192	461	102	1411	312	1411	312	1234	273
Total		94501	13000	710517	79048	506751	60301	373525	45848

	Year:	2004	F multiplier:	1	Fbar:	0.3044			
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0147	3773	347	407532	37493	203766	18746	123227	11337
2	0.2202	25160	2927	146526	17046	146526	17046	120681	14039
3	0.2696	16963	2457	78855	11421	78855	11421	67606	9792
4	0.279	9817	1592	42277	6856	42277	6856	38033	6168
5	0.3093	6815	1218	26852	4793	26852	4793	24010	4286
6	0.4164	3573	675	10985	2074	10985	2074	9614	1815
7	0.3317	529	105	1962	390	1962	390	1747	347
8	0.2696	330	69	1464	306	1464	306	1319	276
9	0.2696	302	67	1338	296	1338	296	1206	267
Total		67262	9456	717791	80675	514025	61929	387444	48327

	Year:	2005	F multiplier:	1	Fbar:	0.3044			
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0147	3773	347	407532	37493	203766	18746	123227	11337
2	0.2202	25367	2951	147729	17186	147729	17186	121673	14155
3	0.2696	18735	2713	87092	12614	87092	12614	74668	10814
4	0.279	11450	1857	49306	7996	49306	7996	44356	7193
5	0.3093	7346	1312	28941	5166	28941	5166	25878	4619
6	0.4164	5800	1095	17833	3367	17833	3367	15608	2947
7	0.3317	1766	351	6554	1302	6554	1302	5835	1159
8	0.2696	287	60	1274	266	1274	266	1149	240
9	0.2696	436	97	1936	429	1936	429	1745	386
Total		74959	10784	748199	85819	544433	67073	414138	52851

Input units are thousands and kg - output in tonnes

Table 4.7.5 Celtic Sea and Division VIIj. Short-term predictions with TAC constraint and management options.

MFDP version 1a
Run: Catch13000
Celtic Sea 2001Projection index file Tuesday 18th March 2003.
Time and date: 18:48 18/03/2003
Fbar age range: 2-7

2003				
Biomass	SSB	FMult	FBar	Landings
79048	45848	1.5551	0.4733	13000

2004					2005	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
80675	50374	0	0	0	95449	64191
.	50164	0.1	0.0304	1058	94367	62892
.	49955	0.2	0.0609	2089	93314	61633
.	49748	0.3	0.0913	3094	92288	60412
.	49542	0.4	0.1217	4073	91289	59229
.	49336	0.5	0.1522	5028	90316	58082
.	49132	0.6	0.1826	5959	89369	56971
.	48929	0.7	0.2131	6867	88446	55893
.	48727	0.8	0.2435	7752	87547	54848
.	48526	0.9	0.2739	8615	86672	53834
.	48327	1	0.3044	9456	85819	52851
.	48128	1.1	0.3348	10277	84989	51898
.	47930	1.2	0.3652	11077	84179	50973
.	47734	1.3	0.3957	11857	83391	50076
.	47538	1.4	0.4261	12619	82623	49206
.	47344	1.5	0.4565	13361	81875	48362
.	47150	1.6	0.487	14086	81146	47543
.	46958	1.7	0.5174	14792	80436	46748
.	46766	1.8	0.5479	15482	79743	45976
.	46576	1.9	0.5783	16154	79069	45227
.	46387	2	0.6087	16811	78412	44500

Input units are thousands and kg - output in tonnes

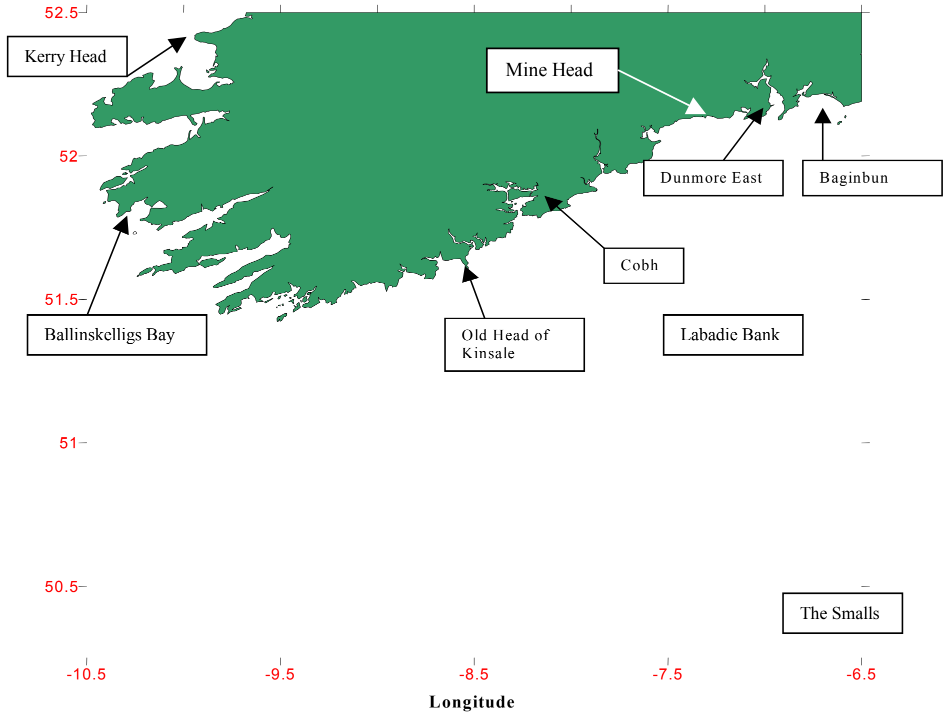


Figure 4.1.1.1 Celtic Sea and Division VIIj acoustic surveys, map of locations mentioned in text.

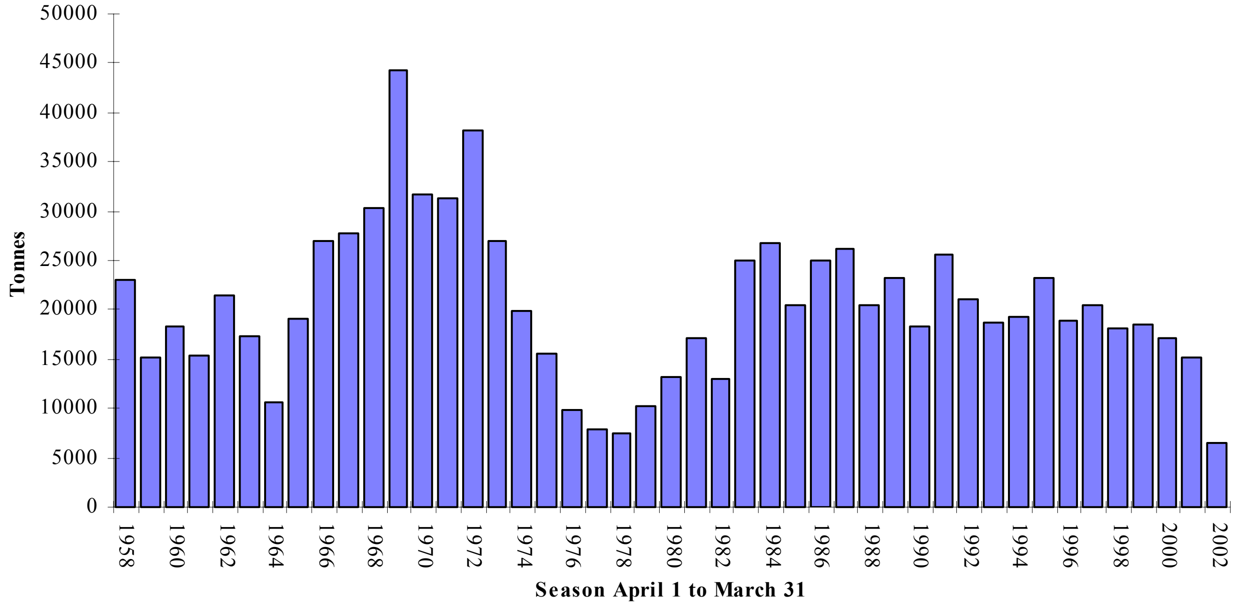


Figure 4.1.2.1 Celtic Sea and Division VIIj – Working Group estimates of herring landings per season.

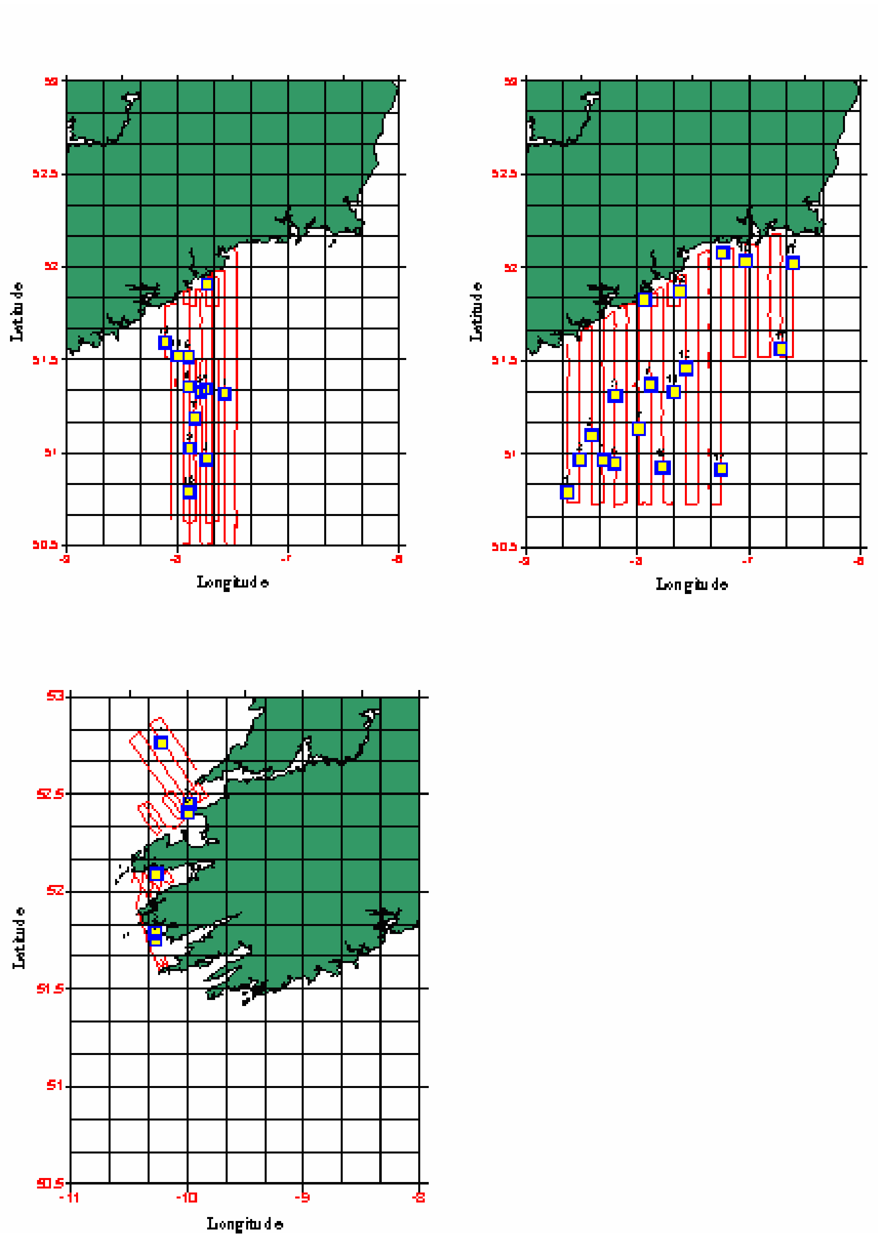


Figure 4.3.1.1a Celtic Sea and Division VIIj acoustic survey 2002, survey track and haul positions from acoustic survey, September and October 2002. First and third grids used as abundance index (l-r).

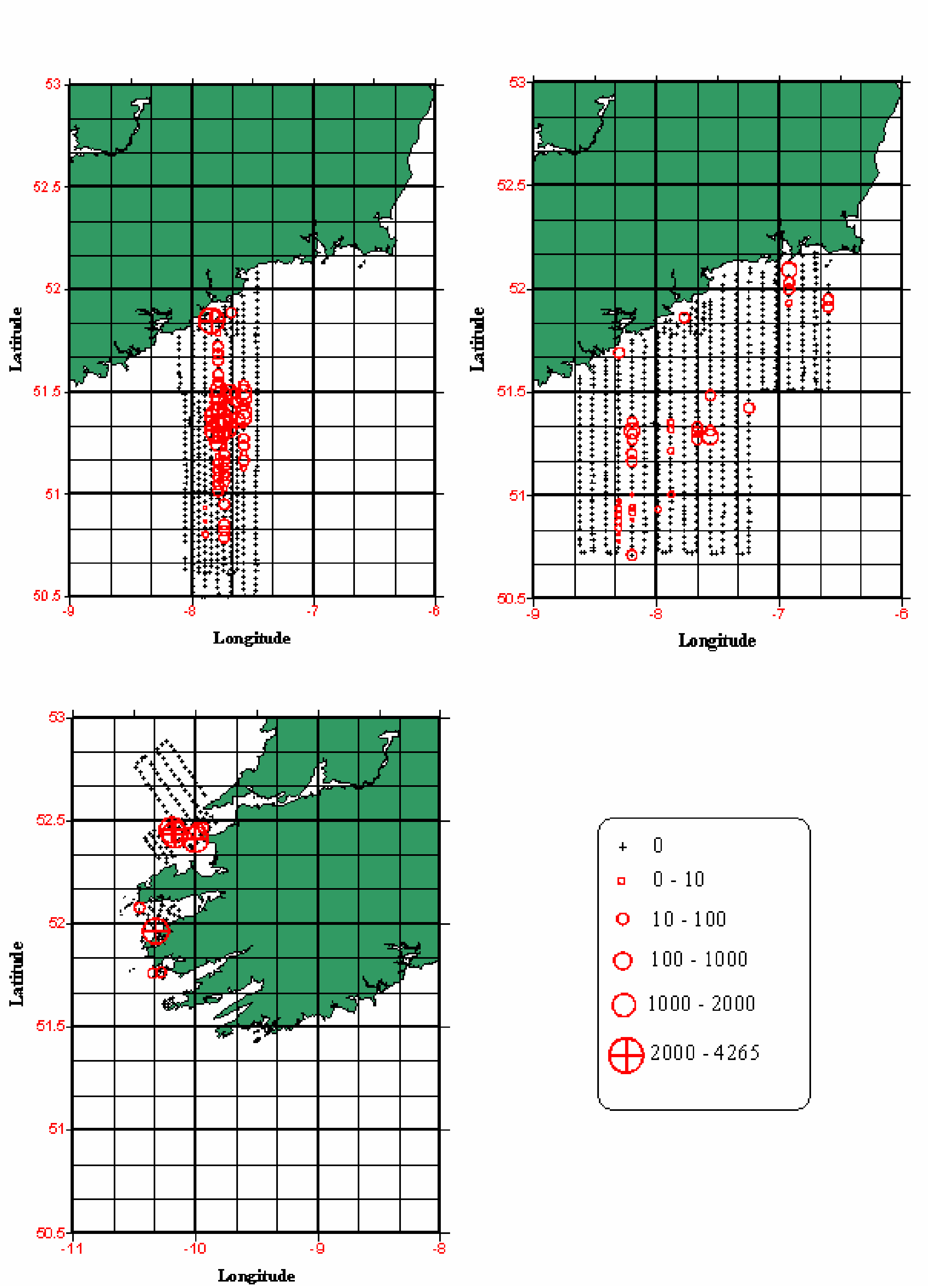


Figure 4.3.1.1b Celtic Sea and Division VIIj acoustic survey 2003, post plots showing total SA values for herring obtained in September 2002. First and third grids used as abundance index (l-r).

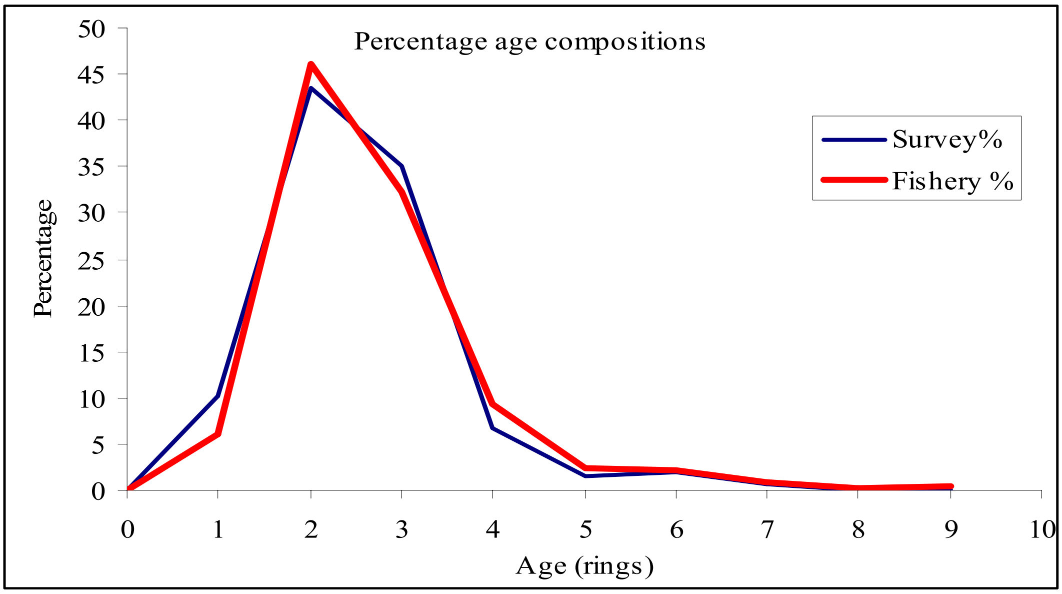


Figure 4.3.1.2 Celtic Sea & Division VIIj herring, comparison of percentage catches-at-age from the commercial fishery and from the acoustic survey in the 2002/2003 season.

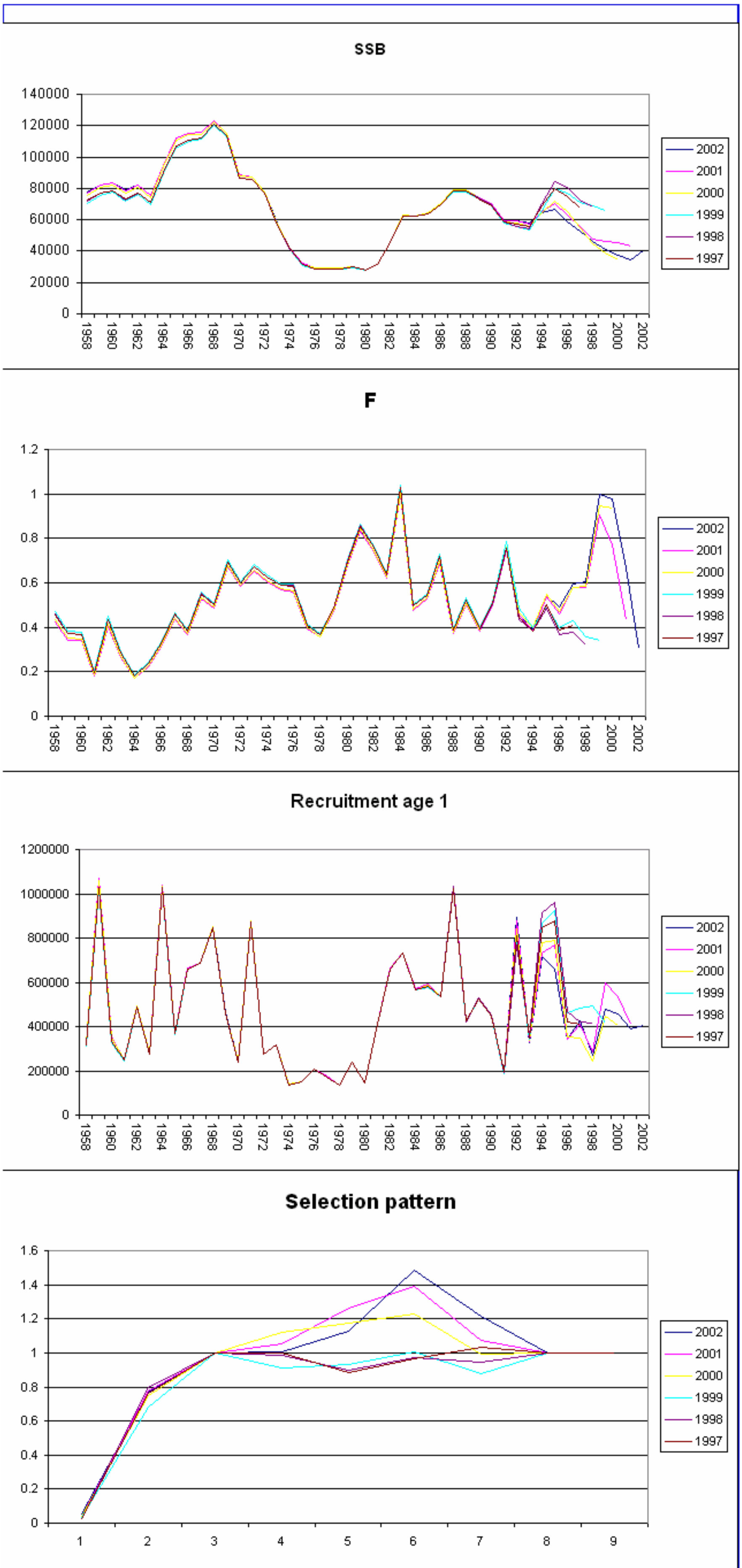
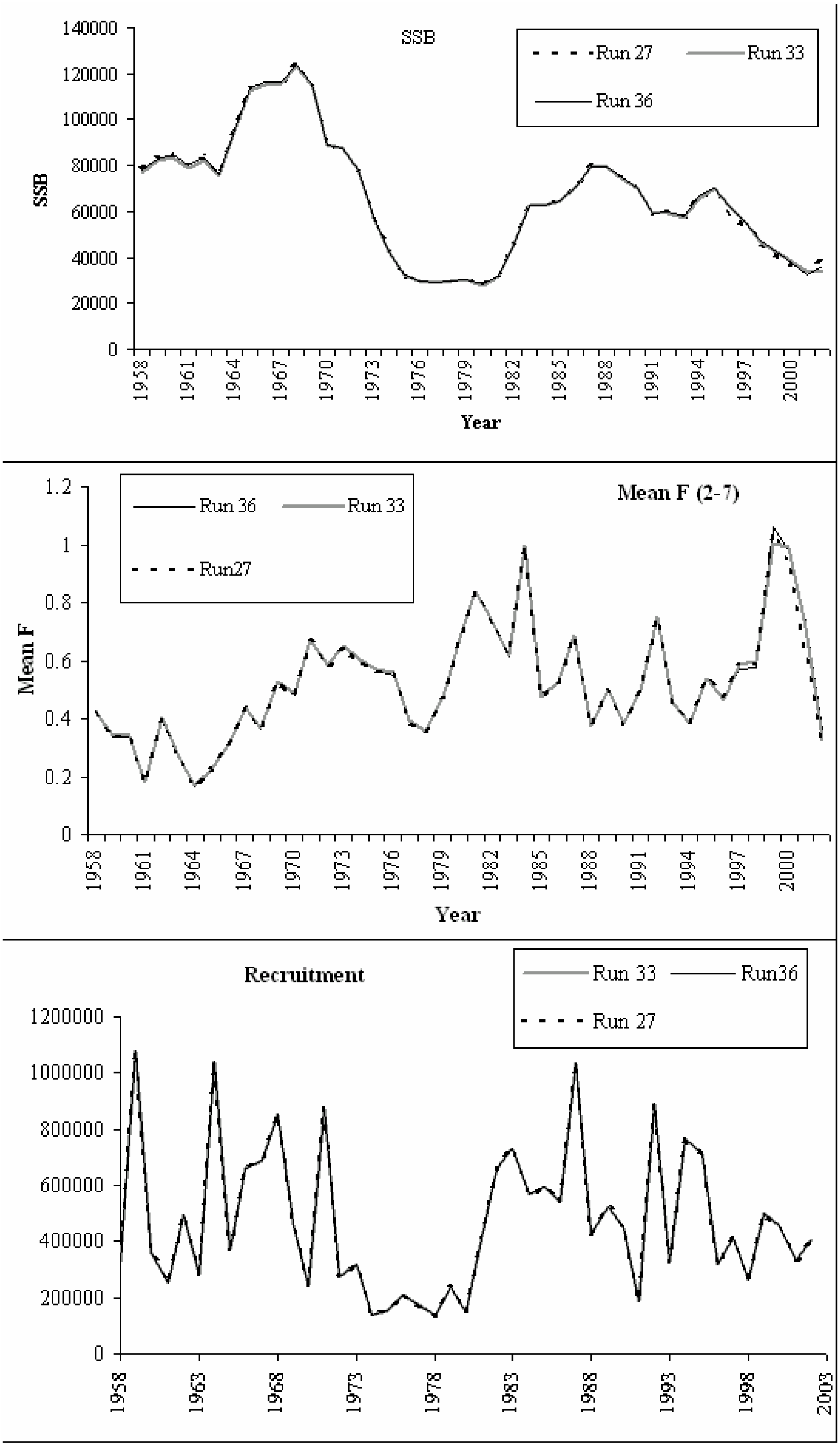


Figure 4.6.1.1 Plots of SSB, F, recruitment and selection pattern from a six year retrospective analysis of the Celtic Sea herring assessment



Run 27 one 6 year separable period terminal selection =1.0
Run 33 two 3 year separable periods terminal selection 1.0 for both periods
Run 36 two 3 year separable periods terminal selection 1.0 and 1.2 for the first and second periods respectively

Figure 4.6.1.2 Comparison of SSB,F and Recruitment trajectories between runs

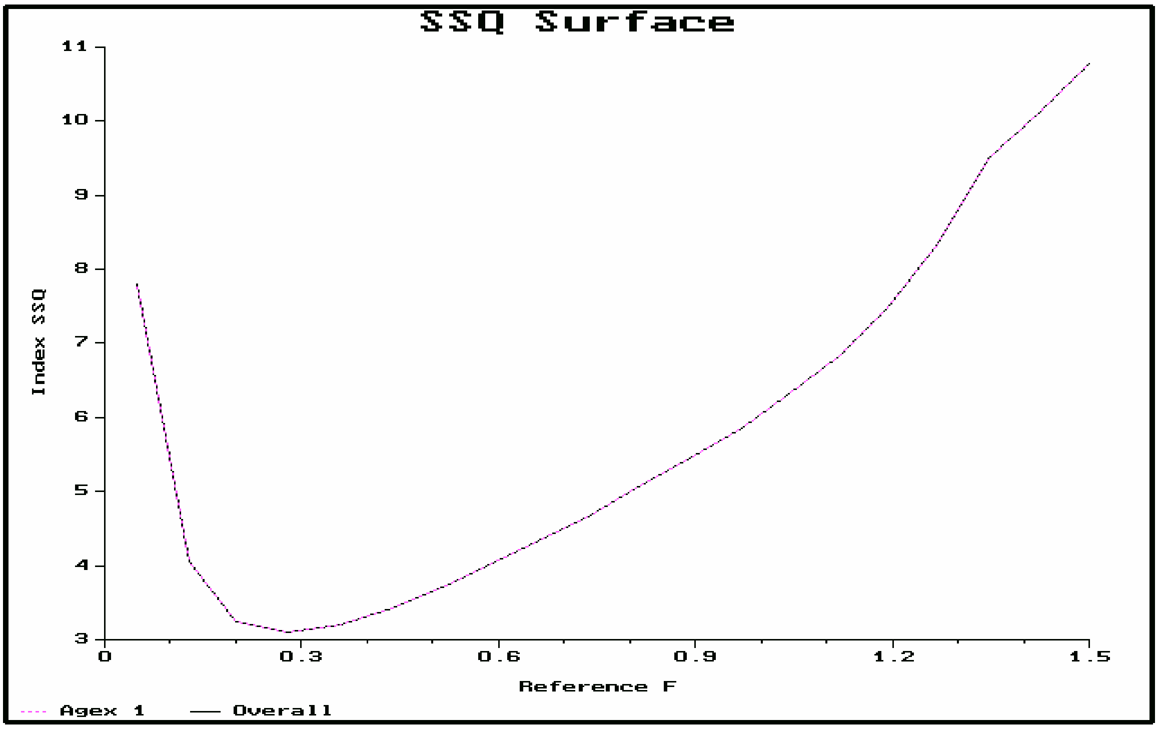


Figure 4.6.2.1 Herring in Celtic Sea and Division VIIj. SSQ for the baseline assessment.

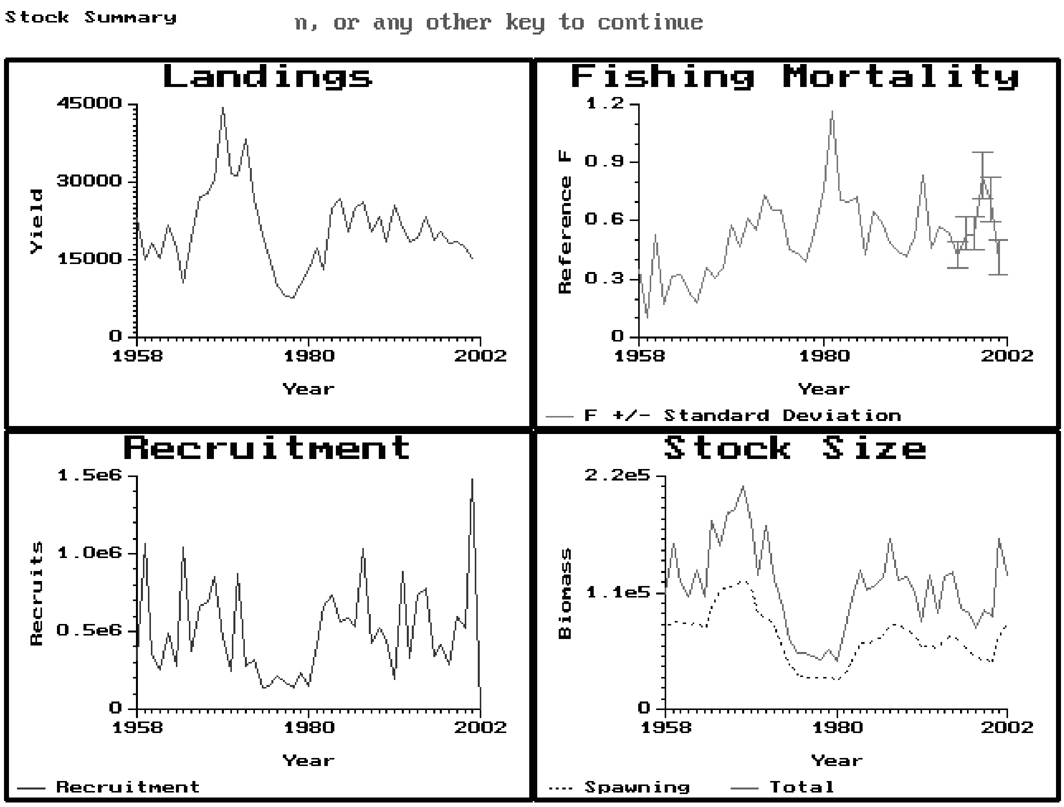


Figure 4.6.2.2 Herring in Celtic Sea and Division VIIj. Results of baseline assessment. Summary of estimates of landings, fishing mortality at age 3, recruitment age 1, stock size on Jan. 1 and spawning stock size at spawning time. Note: age corresponds to winter rings.

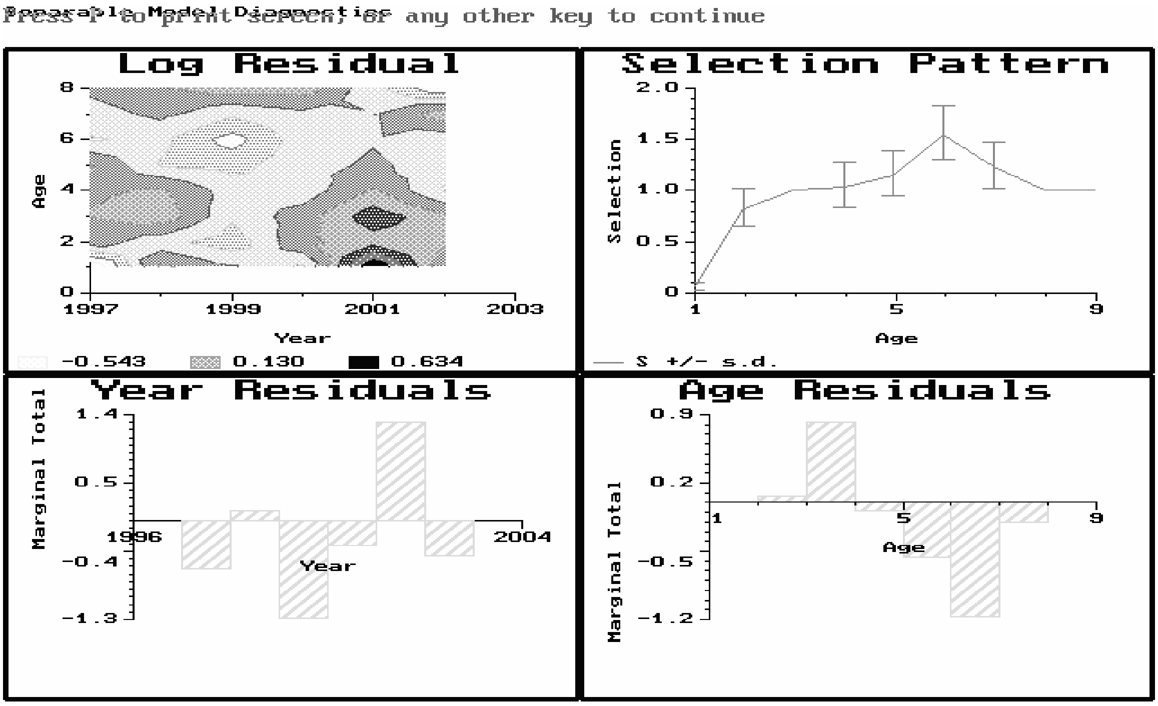


Figure 4.6.2.3 Herring in the Celtic Sea and Division VIIj. Results of the baseline assessment. Selection pattern diagnostics. Top left, contour plot of selection pattern residuals. Top right, estimated selection (relative to age 3) +/- standard deviation. Bottom, marginal totals of residuals by year and age(rings).

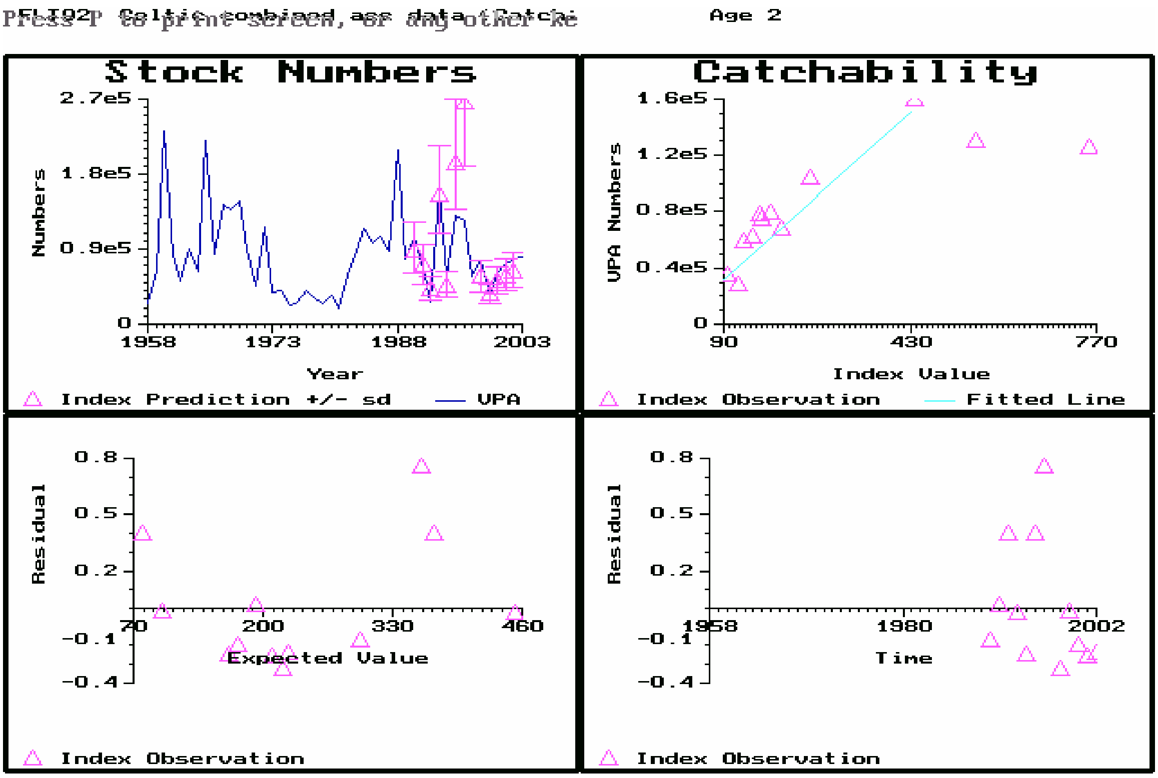


Figure 4.6.2.4 Herring in the Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic survey index at age 2 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each 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 time.

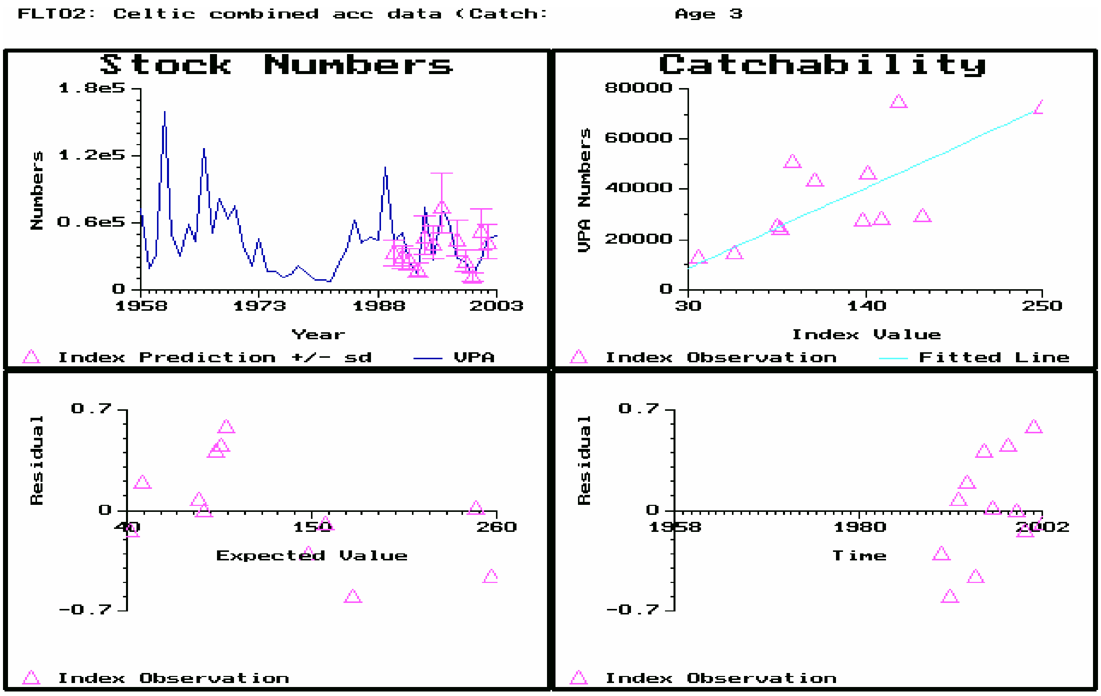


Figure 4.6.2.5 Herring in the Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic survey index at age 3 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each 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 time.

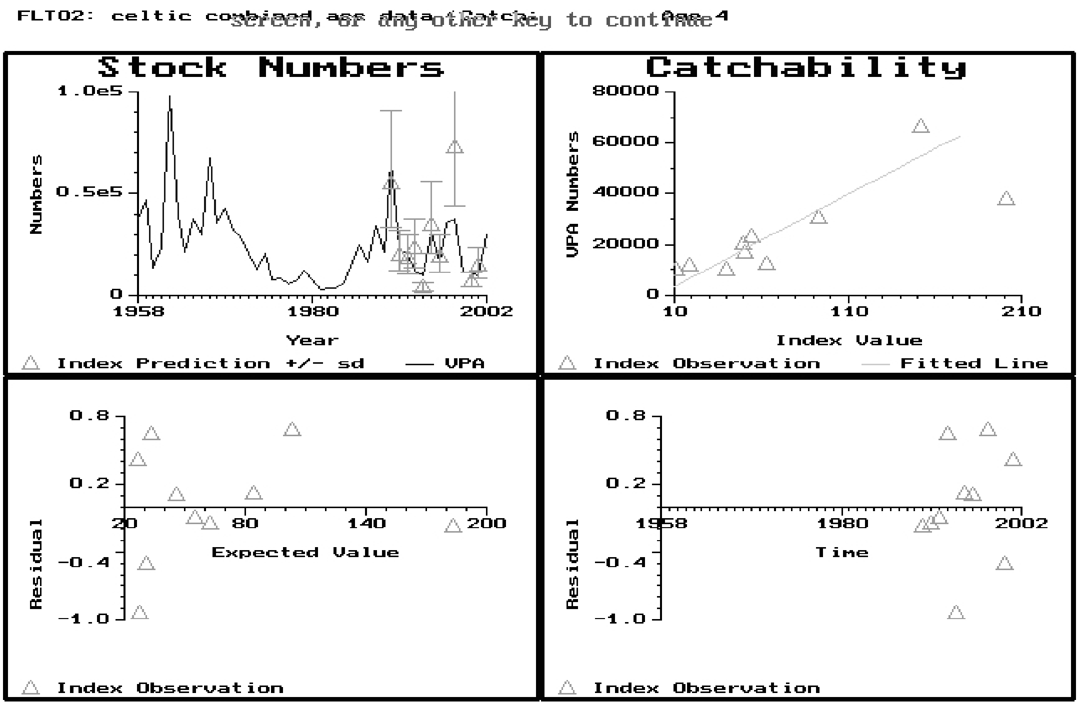


Figure 4.6.2.6 Herring in the Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic survey index at age 4 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each 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 time.

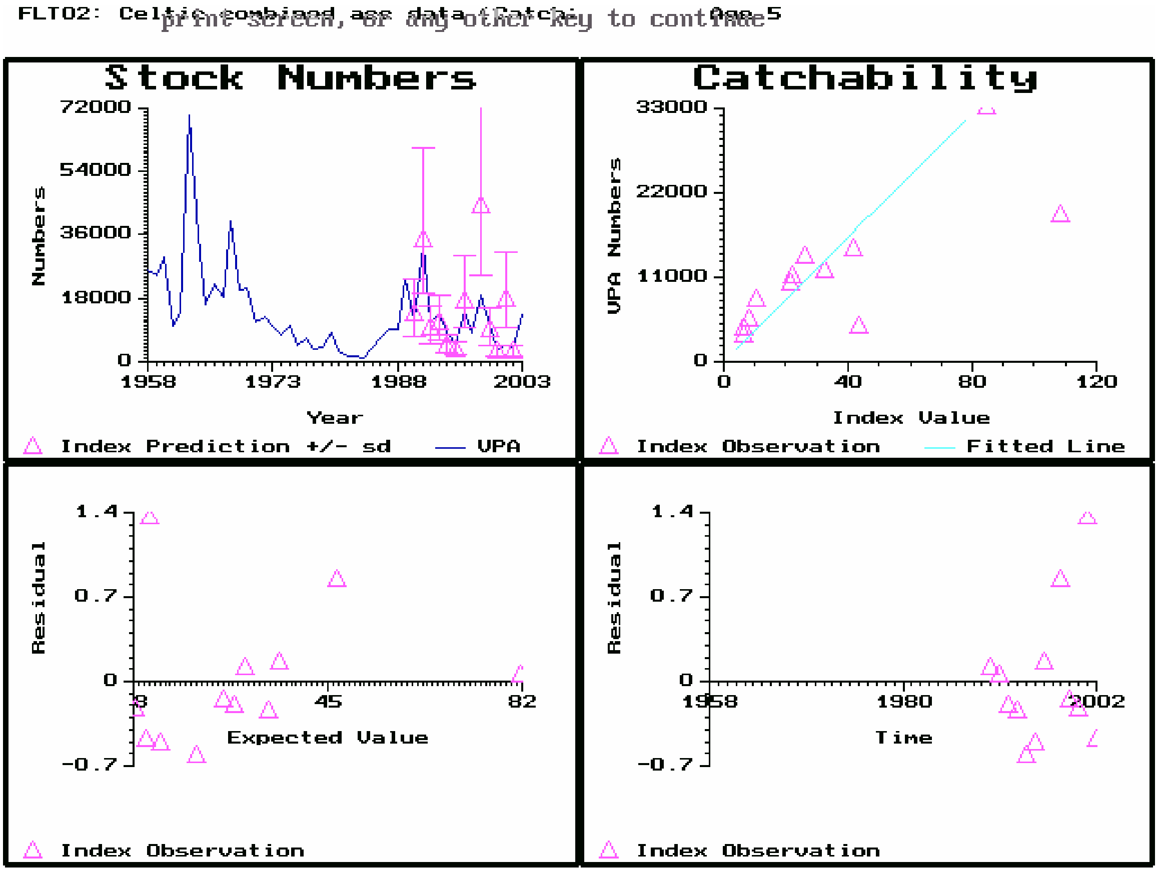


Figure 4.6.2.7 Herring in the Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic survey index at age (rings) 5 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass 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 time.

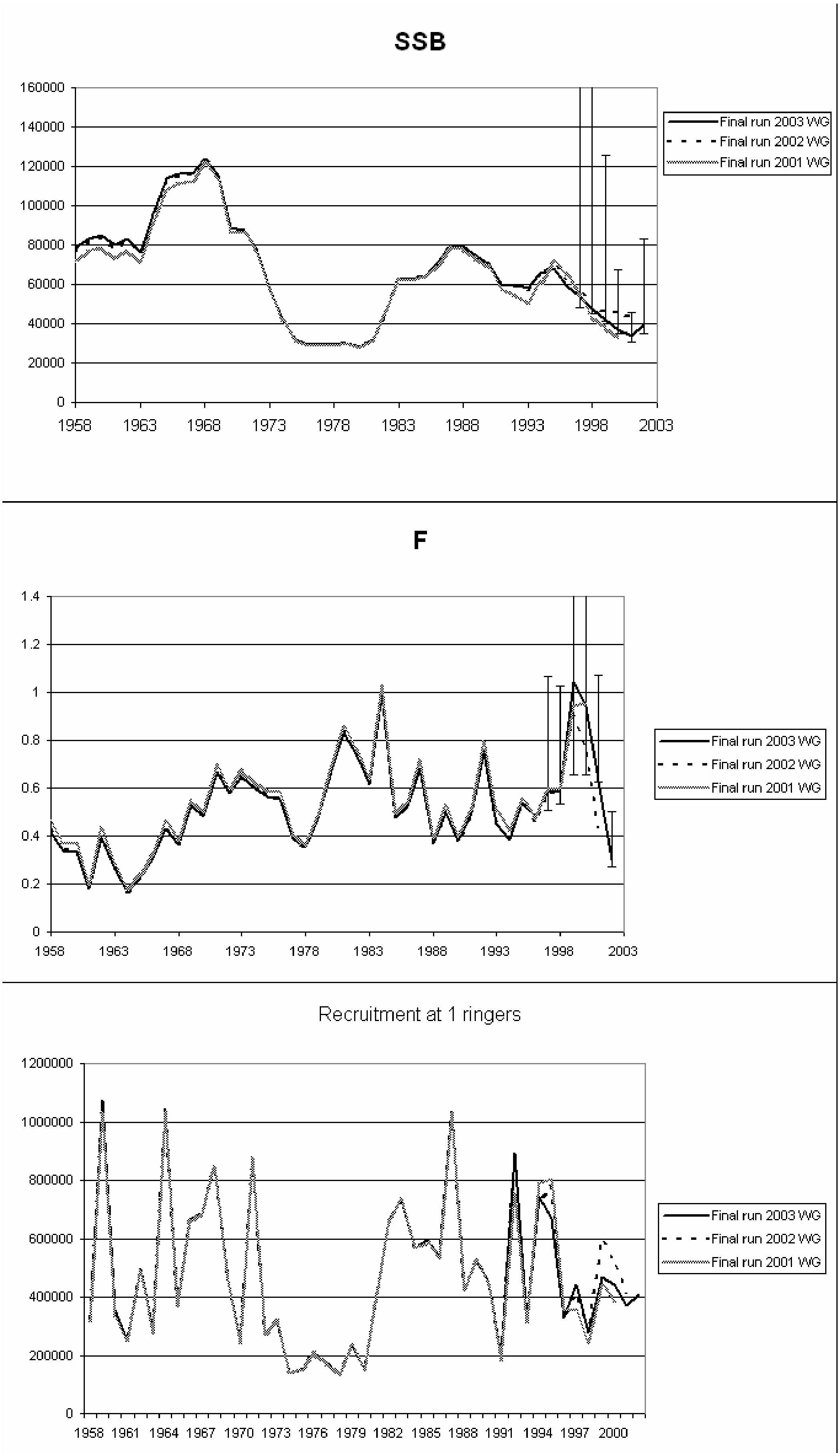
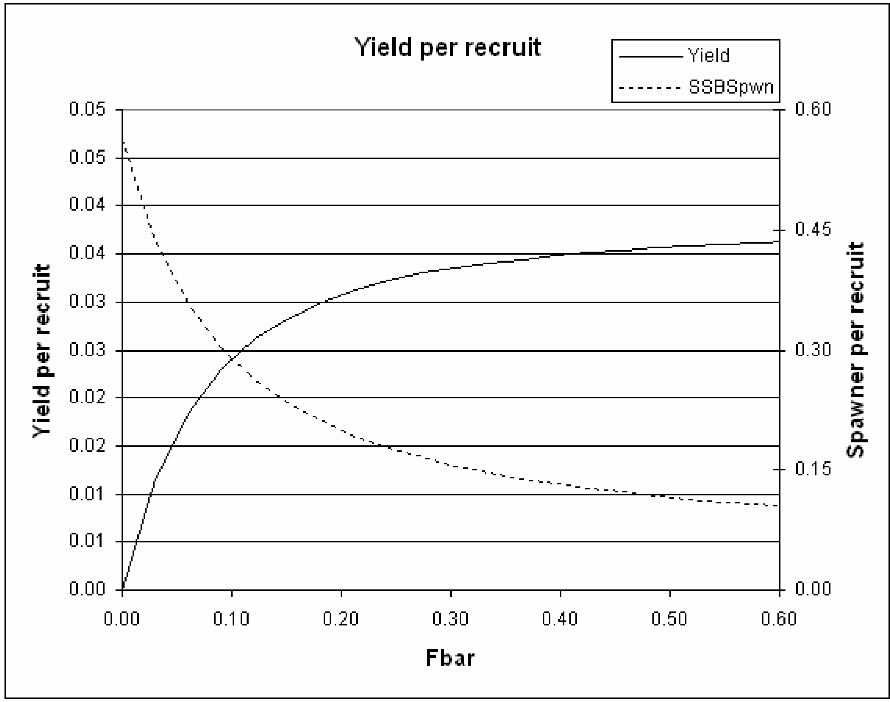
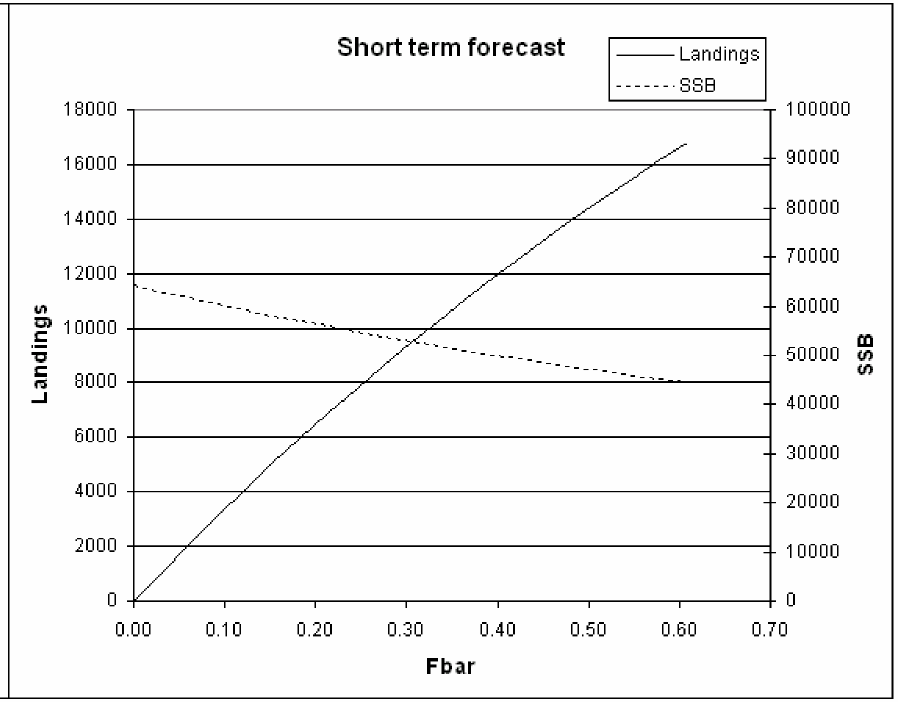


Figure 4.6.2.8 Historical comparison of Celtic sea herring assessments from the past three WG's with error bars indicating the 25th and 75th percentiles from the bootstrap estimates of uncertainty from the 2003 assessment.





MFYPR version 2a
Run: run1
Time and date: 11:03 20/03/2003

Reference point	F multiplier	Absolute F
Fbar(2-7)	1.0000	0.3044
FMax	>=1000000	
F0.1	0.5704	0.1736
F35%SPR	0.6721	0.2046

Weights in kilograms

MFDP version 1a
Run: Catch13000
Celtic Sea 2001Projection index file Tuesday 18th March 2002.
Time and date: 18:48 18/03/2003
Fbar age range: 2-7

Input units are thousands and kg - output in tonnes

Figure 4.7.1

Figure 4.7.1

5 WEST OF SCOTLAND HERRING

5.1 Division VIa(North)

5.1.1 ACFM Advice Applicable to 2002 and 2003

ACFM reported in 2002 that the state of the stock remained uncertain although all the indications are that the stock is lightly exploited. Consequently, ACFM recommended that fishing mortality be maintained at *status quo* (=0.20), corresponding to catches in 2003 of less than 30,000 t.

The agreed TAC for 2003 is 30,000 t. The TAC in 2002 was initially set at 36,360 t. However, in the course of 2002 it was revised down to 33,000 t.

There are no explicit management objectives for this stock; however, because of uncertainties about the historical catch data, the size of the biomass, and about estimates of recruitment and fishing mortality, a $\mathbf{B}_{\text{lim}}$ of 50,000 t has been proposed for this stock (ICES 2003/ACFM:15).

5.1.2 The Fishery

Catches are taken from this area by three fisheries. The Scottish domestic pair trawl fleet and the Northern Irish fleet operate 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. In 2002 there was an Irish pair trawl fishery operating in shelf waters. 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. In recent years the catch of these fleets has become more similar and has been dominated by the younger adults in the stock. Catch-at-age data this year indicate that the catches are similar in age composition.

As a result of perceived problems of misreporting, Scotland introduced a new fishery regulation in 1997 aiming to improve 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 (VIa (N)). Only one of these options can be held at any one time.

5.1.3 Catches in 2002 and Allocation of Catches to Area

Serious problems with misreporting of catches from this stock have been reduced in recent years from some 30,000 t to around 5,000 t in 2002, 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 has been detailed in the Herring Assessment WG report in 2002 (ICES 2002/ACFM:12).

Improved information from the fishery in 1998 - 2002 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 only some of the fleets.

For 2002, the preliminary report of official catches corresponding to the VIa (N) herring stock unit total 36,283 t, compared with the TAC of 36,360 t. The Working Group's estimates of area misreported catches are 4,496 t. No herring has been reported as discarded. Currently, discarding is not perceived to be a problem.

The Working Group’s best estimate of removals from the stock in 2002 is 31,787 t. Details of estimated national catches from 1982 to 2002 are given in Table 5.1.1.

5.2 Biological Composition of Commercial Catches

Age composition data, by country and by quarter, is detailed in Table 5.2.1. The number of samples used to allocate an age-distribution for the Scottish catches increased from 19 in 2001 to 35 in 2002. Comparison of the age structure of the German, Netherlands, Northern Irish and Scottish samples indicated that there was little difference in the age structure of the catch for these fleets in 2002. There was, however, some difference in the age structure of the Irish catch compared to the other samples. This may be due to the fact that the Irish fishery took place in a different area and at a different time of the year.

Unsampled catches were allocated a mean age-structure (weighted by the sampled catch) of either the Scottish/Northern Irish, or the German/Netherlands sampled fleets in the same quarter, or in adjacent quarters if no samples were available in the corresponding quarter. If no sampling data were available for a quarter, a mean age-structure of all samples from adjacent quarters was used. The Irish samples were used to raise Irish catches but were not used for un-allocated catches as the age structure was different (see above). 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).

Catch in number-at-age information is given in Table 5.2.2.

In the past concern has been raised over the quality of sampling of commercial catch. It was suggested in the 2001 ACFM technical minutes that an analysis of catch by quarter and country might shed some light on the variability in the catch information. In practice the fishery is often dominated by a single quarter catch, and a single country dominates sampling. Thus such an analysis is impossible. In 2002 the Working Group conducted an extensive analysis of the sensitivity of the assessment to missing catch information (Section 5.1.12 in ICES 2002/ACFM:12).

5.3 Fishery-independent Information

5.3.1 Acoustic Survey

The 2002 acoustic survey was carried out from 1-21 July using a chartered commercial fishing vessel (MFV Quantus). The total biomass estimate obtained was higher than in the previous year (548, 800 t this year compared to 359,200 t in 2001). Biomass estimated from the acoustic survey tends to be variable. Herring were found in similar areas, namely south of the Hebrides off Barra Head, west of the Hebrides and along the shelf edge. Further details are available in the Report of the Planning Group for Herring Surveys (ICES 2003/G:02). A retrospective analysis of biomass estimates in the assessment is presented in Section 5.9 (Quality of the assessment). Estimates of abundance by age and in aggregate spawning stock biomass for 2002 and for previous years are given in Table 5.3.1.

5.4 Mean Weight-at-age and Maturity-at-age

5.4.1 Mean Weight-at-age

Weights-at-age in the catches and weights-at-age in the stock from acoustic surveys are given in Table 5.4.1. The weights-at-age in the stock appear to be higher than the long-term mean for 1-2-ringers but are generally lower for 3-ring and older herring.

Catch weights-at-age for 2002 are generally lower than the long-term average, except for 1 and 2-ring herring. Catch of 1-ring herring is very low in the fishery and down-weighted in the assessment.

5.4.2 Maturity Ogive

The maturity ogive is obtained from the acoustic survey (Table 5.4.2).

ACFM commented in 2002 that unlike in other years when maturity and size at age were correlated, in 2001 maturity-at-age increased and weight-at-age decreased. In 2002, maturity-at-age is essentially the same as in 2001, however, weights-at-age in the catch are higher than in 2001 and weights-at-age in the stock are lower. Examination of the relationship between weight-at-age and proportion mature showed no relationship between the two (Figure 5.4.1). Confidence intervals on the slope of a regression include zero for both 2 and 3-ringers.

5.5 Recruitment

There are no specific recruitment indices for this stock. The first reasonably reliable appearance of a cohort appears at 2-ring in both the catch and the stock.

5.6 Stock Assessment

5.6.1 Data Exploration and Preliminary Modelling

Assessment of the stock was carried out by fitting an integrated catch-at-age model (ICA version 1.4w) (refer to the methods section in this report, Section 1.6.1), including a separable constraint. An aged-structured index was available from the acoustic survey from 1987, 1991-1996 and 1998-2002 (Section 5.3.1).

An initial assessment was run with the same settings as in the 2002 WG, i.e., a six-year separable period with 1-ringers in both the catch and survey down-weighted. Examination of the residuals pattern showed a large positive value in the age residuals pattern for 4-ringers (Figure 5.6.1), that was not apparent in the 2002 WG assessment. This was traced to the 1993 cohort, (these are 8-ringers in the 2002 data (the current assessment)). The data set on numbers-at-age in the catch was explored for sensitivity to use of samples. An alternative method of combining samples was tested, using weighting by the numbers aged, but this made no difference to the perception of numbers-at-age in the catch in 2002. A retrospective analysis (1998-2002), using the six-year separable period assessment settings, was performed. In particular the 1993 cohort was examined to look for any instability in the cohort but none was found (in fact the 1993 cohort appeared very stable). The appearance of the large value in the age residuals was due to removal of a negative residual in 1995 and the addition of a positive value in 2002, relative to the assessment in the 2002 WG. An examination of log catch ratios was carried out and showed little consistent difference in exploitation patterns between ages or over years (Figure 5.6.2), rather the variability looked more like noise. An analysis of the retrospective pattern of selection showed fluctuations in the selection pattern in each year; in 1998 selection appeared higher on the younger herring and lower in older herring; in 1999 – 2001 this pattern shifted around between younger and older fish but not in any consistent fashion; in 2002 older fish had a higher selection value (Figure 5.6.3). Examination of the retrospective patterns of F and SSB showed some difference, between years, in the historic perception of the stock (Figure 5.6.4). An assessment was carried out using a four-year separable period to determine if reducing the smoothing and allowing the separable period to respond to the observed changes helped to reduce the variability in the assessment. Retrospective analysis of that assessment showed an even greater divergence between F and SSB in 2002 and poorer convergence of the historic estimates of SSB and F in the assessment (Figure 5.6.4).

The conclusion was that there is no apparent pattern to the change in selection over years, rather that there is inconsistency between years, mostly on the older ages, reflecting either noise in the measurement or variability in the fishery. A detailed examination of the influence of the catch reported in the 2002 WG report concluded that the uncertainty in catch in years 1994 to 2001 did not suggest that specific years or ages should be removed from the assessment. Therefore, this year, it was concluded that increased smoothing through an increased separable period would be preferable. It was decided, therefore, to run an assessment using an eight-year separable period, to include more years in an effort to smooth some of the noise in the fishery data. Retrospective patterns of selection, F and SSB for an eight-year separable period show more stability and less fluctuation (Figure 5.6.3 and Figure 5.6.4). The divergence far back in time in F and SSB in both the four- and six-year separable periods is not seen in assessment with the eight-year separable period and is probably a result of the way ICA uses F for the older ages in the model. In addition, the total residuals at age around the separable model were reduced considerably (Figure 5.6.1).

In the 2002 WG assessments were run with different periods of separable constraint, from four to eight-years. Examination of the pattern of residuals for each separable period in that WG showed there were no distinct differences in both catch residuals and acoustic surveys residuals at that time and, overall, the differences between the assessments were small. A six-year separable period was chosen as a compromise between dependence on uncertain catches over a short period and forcing a consistent pattern over a longer period. Investigations this year demonstrate that the choice of separable period is more important than was suspected in the 2002 WG. The WG considers that an eight-year separable period is more appropriate for this stock.

5.6.2 Stock Assessment

Assessment of the stock was carried out by fitting an integrated catch-at-age model (ICA version 1.4w) (refer to the methods section in this report, Section 1.6.1), including a separable constraint. The run log for the assessment is shown in Table 5.6.1. The period for the separable constraint is 8-years. The catch and survey data were down-weighted for 1-ring herring (see the 2001WG assessment report (ICES 2001/ACFM:12). The input data are given in Tables 5.6.2 to 5.6.8. The output data are given in Tables 5.6.9 to 5.6.18. The assessment results in an SSB for 2002 of 147,263 t and a mean fishing mortality (3-6 ringers) of 0.2115 (Table 5.6.14). The model diagnostics (Tables 5.6.13 to 5.6.18 and Figs. 5.6.5 to 5.6.16) show that the marginal totals of residuals by age and year between the catch and the separable model are reasonably trend-free and small. The acoustic survey residual pattern is trend-free by year but shows some trend in the age pattern (largest at 7- to 9- ringers). The acoustic survey residuals are larger than the catch model residuals and show evidence of year effects. The assessment SSB estimate of 147,263 t is the fifth highest in the time-series and an increase from the 2002 WG assessment. The large recruitment of 2-ringers to the population in 2001 is seen as a peak in numbers of 3-ringers in 2002 in both the catch and acoustic survey data. Maturity-at-age for 2-ringers is again one of the highest values in the time-series, adding to the increase in SSB. Figure 5.6.17 shows the trajectories of 5, 25, 50, 75 and 95 percentiles from the estimates of historical uncertainty of F, SSB and recruits produced in the final assessment. These are based on 1000 samples. Uncertainty is considerably reduced from previous years, reflecting the stability of the input data over the last two or three years. The greatest uncertainty in F is in 1997/98. Discussion of the precision of the assessment is presented in Section 5.9 below.

5.7 Projections

5.7.1 Deterministic short-term projections

Area misreporting of the 2002 catch for VIa (N) resulted in approximately 12% of total catch being moved to adjacent areas. Two scenarios for deterministic short-term projections are presented: *status quo* F for 2003, which is consistent with the current level of misreporting, and at a suggested $\mathbf{F}_{pa}$=0.35. Multiple options tables are available for 2004 (Tables 5.7.3 and 5.7.5).

Short-term projections were carried out using MFDP. Input data are stock numbers on 1st January in 2003 from the 2003 ICA assessment (Section 5.6, Table 5.6.11), with geometric mean replacing recruitment at 1 and 2-ring in 2003 and 1-ring in 2002. Figure 5.7.1 shows the substantial revision of 1 and 2-ring herring abundance in subsequent assessments, justifying the use of geometric means for these ages. The selection pattern used is as estimated by ICA (Table 5.6.13). For the projections, data for maturity, natural mortality, mean weights-at-age in the catch and in the stock are means of the three previous years (i.e., 2000 - 2002) (Table 5.7.1).

Scenario	2003	2004	2005
1 – *status quo* F	$F_{2003}= F_{2002} = 0.21$ *Status quo* F Catch = 28,822 t	$F_{2004}= F_{2002} = 0.21$ *Status quo* F Catch = 29,986 t	$F_{2005}= F_{2002} = 0.21$ *Status quo* F Catch = 30,181 t
2 – *status quo* F followed by suggested $\mathbf{F}_{pa}$	$F_{2003}= F_{2002} = 0.21$ *Status quo* F Catch = 28,822 t	$F = 1.68 * F_{2002} = 0.35$ F=suggested $\mathbf{F}_{pa}$=0.35 Catch = 47,314 t	$F = 1.68 * F_{2002} = 0.35$ F=suggested $\mathbf{F}_{pa}$=0.35 Catch = 42,844 t

The results of the short-term projections can be seen in Tables 5.7.2 – 5.7.5. Tables 5.7.2 and 5.7.4 show single option predictions for 2004 and 2005 for the two scenarios respectively. Tables 5.7.3 and 5.7.5 show the multiple options for 2004 under both scenarios. The short-term forecast for landings and SSB under scenario 1 is shown in Figure 5.7.2. The two scenarios give different results. Under scenario 1 SSB remains at about 145,000 t in 2003 and increases to 149,000 t in 2005. Under scenario 2 SSB decreases to 135,000 t in 2004 and to 123,000 t in 2005.

5.7.2 Yield-per-recruit

A yield-per-recruit analysis was carried out using MFYPR to provide a yield-per-recruit plot for VIa (N) (Figure 5.7.2). The values for $\mathbf{F}_{0.1}$ and $\mathbf{F}_{med}$ are 0.17 and 0.32 respectively. These may be compared with the current F (2003 assessment) of 0.2115. The yield-per-recruit relationship suggests that at geometric mean recruitment (908 million) a yield of approximately 35,000 t is possible at F =0.35.

5.7.3 Stochastic medium-term projections

No biological reference points are currently available for this stock, although a value for $\mathbf{B}_{lim}$ of 50,000 t has been proposed by the SGPRP (ICES 2003/ACFM:15). Possible values for $\mathbf{F}_{pa}$ and $\mathbf{B}_{pa}$ for this stock are presented in Section 5.8. Three sets of medium-term projections, to assist with the evaluation of these reference points, were carried out on the basis of (i) exploitation at *status quo* F, and with two F values (ii) F=0.3 and (iii) F=0.4, both with a preliminary year in 2003 at *status quo* F. The method used to calculate medium-term projections was that described in ICES 1996/ACFM:10; 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 2003, fishing mortality at reference age in 2003, 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 by re-sampling randomly from the residuals according to a conventional non-parametric bootstrap method (Figure 5.7.3). Weights-at-age in the catch were calculated as the mean weights-at-age from 2000-2002. Weights-at-age in the stock, maturity ogives and natural mortality were as given in Section 5.6.2. Geometric mean recruitment for 1 and 2-ringers was used to replace the values in the assessment for 2003, however, the covariance values produced by ICA were retained. The stock recruit relationship used in the medium-term prediction was the Ockham option using the converged VPA 1976 to 1998 (Fig.5.7.4). Figure 5.7.5 shows a comparison between the cumulative distribution of recruitment from the assessment and the simulated recruitment in ICP. The agreement is good. The procedure was implemented using the ICP program; the input parameters are summarised in Table 5.7.6 and the run log is given in Table 5.7.7. Three scenarios are presented, based on the assessment using the eight-year separable period (Figure 5.7.6).

The results of the stochastic medium-term projection are given in Figure 5.7.6. and summarised in the text table below. For the *status quo* F scenario, given a constant F exploitation pattern, catches and SSB both rise gently and stabilise to Landings of 35,000 t and SSB of 160,000 t. For F=0.3, catches rise in 2004 to around 43,000 t and then decrease slightly to stabilise around 38,000 t in the medium term. SSB decreases constantly from 145,000 t to around 130,000 t by 2012. The third scenario (F =0.4) shows catches increasing in 2004 to 55,000 t and stabilising in the longer term around 40,000 t. SSB falls continuously from an initial high of 145,000 t to around 100,000 t in the longer term. The risk of SSB falling below $\mathbf{B}_{lim}$ or suggested $\mathbf{B}_{pa,}$ and the SSB in year 10, is given in the text table below.

	Status quo F (F=0.21)	F=0.30	F=0.40
Average Yield	34,900 t	39,500 t	43,100 t
SSB in 2012	165,000 t	129,000 t	98,600 t
Risk of stock falling below suggested $\mathbf{B}_{lim}$	0.5%	2%	10%
Risk of stock falling below suggested $\mathbf{B}_{pa}$	3%	10%	30%

5.8 Reference Points

The assessment provided this year and the retrospective pattern suggests that the current assessment gives a stable historic part and although the current perception of the stock is not precisely known the historic part can be used to establish reference points. The main reason for the lack of assessment in previous working groups has been uncertainty in the catch data, particularly 1996-98, coupled with noise in the acoustic survey data and a missing survey in 1997. These past problems still exist but the current data situation is better and the assessment is stable enough to be sure that the stock is likely to be above any suggested $\mathbf{B}_{pa}$ and that F is low, and likely to be below a suggested $\mathbf{F}_{pa}$.

An analysis has been carried out following the method suggested in the report of SGPRP (ICES 2003/ACFM:15).

The report proposes a $\mathbf{B}_{lim}$ of 50,000 t. This is calculated from the values in the converged part of the VPA and the WG endorses the value.

Geometric mean recruitment at $\mathbf{B}_{lim}$ is geometric mean recruitment for the historic time-series = 900,800.

SSB/Recruit at $\mathbf{B}_{lim}$ is 50,000 / 900,800 = 0.055

$\mathbf{F}_{lim}$ corresponding to $\mathbf{B}_{lim}$ from the yield-per-recruit graph is $\mathbf{F}_{lim}$= 0.75

These LIM points are intended to be risk averse i.e., the likelihood of recruitment falling while the SSB is above $\mathbf{B}_{lim}$ should be small. However, the use of $\mathbf{B}_{loss}$ to derive $\mathbf{B}_{lim}$ means that there are no data for this stock below $\mathbf{B}_{lim}$ and we cannot be sure that $\mathbf{B}_{lim}$ is indeed risk averse. The high value of $\mathbf{F}_{lim}$ may similarly have poor risk attributes. Nevertheless these values are the best we can currently obtain.

Estimates of retrospective error in terminal SSB are available for 4 years and give a mean of the absolute values of 20% and a maximum of 38%. Since there are so few data points and they are close in time to the current year the maximum value might be an underestimate of the range of values. The 90th percentile on a normal distribution that had a mean error of 20% might be more appropriate measure, this would give a factor close to 50%.

$\mathbf{B}_{pa}$ = $\mathbf{B}_{lim}$* 1.50 and gives $\mathbf{B}_{pa}$ = 75,000 t

Estimates of historic uncertainty of F in TAC year are shown in Figure 5.8.1. Although there are a range of estimates plotted the number of independent observations is only three, less than for SSB. With such a small number of observations it is difficult to obtain well founded conclusions, however, the largest error is 32% which could be used as an upper bound on $\mathbf{F}_{pa}$:

$\mathbf{F}_{pa} = \mathbf{F}_{lim}$ * 68%   error limit F = 0.51

However, as the largest error (32%) is not very different from the 38% for the SSB, and the year range is even shorter, the same 50% error interval used for SSB could also be used to define a suggested value for $\mathbf{F}_{pa}$:

$\mathbf{F}_{pa} = \mathbf{F}_{lim}$ * 50%   error limit F = 0.35

All these $\mathbf{F}_{pa}$ values are rather poorly supported by the data. To explore the performance of these values the medium-term predictions described above have been examined. They suggest that exploitation at F = 0.4 or above would lead to a decline in stock and a rise in risk of SSB falling below $\mathbf{B}_{lim}$. Given that the error limit value of F =0.51 is thought to be an over estimate for $\mathbf{F}_{pa}$ the value of F = 0.35 is preferred as the possible value for $\mathbf{F}_{pa}$. The medium-term projection suggests that F=0.40 would be an upper bound.

In 2002 the WG suggested an alternative approach for estimating the $\mathbf{F}_{pa}$ point for this stock. The WG has repeated the analysis carried out in 2002 and obtained similar results; this analysis may form the basis for obtaining a lower bound on $\mathbf{F}_{pa}$.

To illustrate the history of the stock, the data have been entered in PASoft (input data in Table 5.8.1) and the results are presented in Figure 5.8.2. As the historic part of the current assessment appears reasonably stable this may be used to evaluate suitable F values. Given the suggested $\mathbf{B}_{pa}$ of 75,000 the history of the exploitation was examined and there are 20 years in the converged VPA when SSB is above the $\mathbf{B}_{pa}$. Fishing was at a mean F_{3-6} of 0.30 for 90% of these years, suggesting that this fishing mortality would be a candidate value for safe exploitation and would be compatible with a suggested $\mathbf{B}_{pa}$ of 75,000 t. The medium-term projections described in Section 5.7.3 show that at an exploitation rate of F = 0.30 the risk of the biomass falling below $\mathbf{B}_{lim}$ in the medium term would be 2%, which is very small (Figure 5.7.6). This suggests that F=0.30 would be the lower bound value for $\mathbf{F}_{pa}$. The WG therefore considers that $\mathbf{F}_{pa}$ should lie above 0.30 and below 0.40 and the value of $\mathbf{F}_{pa}$ = 0.35 from the error analysis seems reasonable.

The reference limits and the historic stock trajectory are shown in Figure 5.8.3 and show that the stock is currently within the suggested precautionary limits and that these suggested values are compatible with a reasonable part of the history of the stock.

If ACFM does not wish to set PA points in 2003 it is strongly suggested that the values proposed below be used for management until new points can be agreed.

The suggested reference values are tabulated below.

Suggested Precautionary Approach reference points:

$\mathbf{B}_{lim}$ is 50,000 t	$\mathbf{B}_{pa}$ be set at 75,000 t
$\mathbf{F}_{lim}$ is 0.75	$\mathbf{F}_{pa}$ = 0.35

Technical basis:

$\mathbf{B}_{lim}$: $\mathbf{B}_{loss}$ Estimated SSB for sustained recruitment	$\mathbf{B}_{pa}$: = 1.5 * $\mathbf{B}_{lim}$
$\mathbf{F}_{lim}$ corresponding to $\mathbf{B}_{lim}$ from the yield-per-recruit $\mathbf{F}_{lim}$= 0.75	$\mathbf{F}_{pa}$ = 0.5 * $\mathbf{B}_{lim}$

5.9 Quality of the Assessment

There has been concern about the annual revision of the perception of the stock, in particular sensitivity to poor sampling of catch, over the last 4 or 5 years. In the 2002 WG the sensitivity of the assessment was inspected for a number of possible sources of perturbation, including sensitivity to choice of length of separable period, sensitivity to a small number of isolated large cohort estimates in the Acoustic survey and sensitivity to missing catch-at-age data (ICES 2002/ACFM:12). It was concluded that the data, while noisy, did not change the perception of the stock relative to suggested PA reference points. In the course of data exploration for this stock it was determined that the choice of separable period was rather more important than had been recognised in 2002. This aspect is discussed in detail in Section 5.6.1. An eight-year separable period was selected for the assessment. The catch data remain noisy either because sampling is insufficient or because the fishery is not stable. Sample allocation was reanalysed to explore its influence of the on estimates of catch-at-age. This suggested that it is the instability in the catch-at-age rather than the sampling that gives the major affect. Nevertheless it is not currently possible to be sure that this is the case and more effort is required to ensure that all fleets are sufficiently sampled. The choice of a longer separable period has been selected mainly on the basis of the retrospective analysis results.

In 2001 ACFM noted that there appeared to be two values with high leverage in the catchability factors for the acoustic survey. These values were identified as the 1995 year class for 3-ringers and 4-ringers in 1999 and 2000 respectively. These values are still apparent but now include an additional two years as 5- and 6-ringers in 2001 and 2002 respectively. In addition there is a second large year class apparent as 2-ringers in 2001 and 3-ringers in 2002. In the 2002 WG, the influence of these points was tested by removing those observations, individually and together, in three assessment runs. The results showed that the catchabilities were not sensitive to these points. ICA effectively fits the catchability through the origin and the mean of all the observations, thus large values influence the result but do not have particularly increased leverage. It was thought unnecessary to repeat the analysis this year.

Retrospective analyses of the assessment from 1998 to 2002 were carried out. Figure 5.8.1 shows the F_{3-6} and SSB from ICA assessments with an 8-year separable period for assessments in 2001 to 2002, 7 years in 2000, 6 years in 1999 and 5 years in 1998. The separable period is reduced from 8 to 5 years to exclude catch in 1993 that appears to have a different selection. These retrospective analyses show rather stable estimation of F but more variable estimates of SSB; these recent estimates of SSB are both above and below the current trajectory, and in all cases show SSB above the suggested $\mathbf{B}_{pa}$ of 75,000 t since 1998 and in most cases since 1994. Current and historic estimates of F show F_{3-6} below 0.30 for 13 out of the last 16 years in all retrospective analyses. Figure 5.7.1 shows the retrospective estimates of 1- and 2-ringer herring, estimates of these recruiting year classes remain uncertain.

The current assessment seems very robust for estimation of F and although it gives a rather imprecise estimate of SSB it is sufficiently accurate to conclude that SSB is above suggested $\mathbf{B}_{pa}$. The retrospective analysis indicates that the problems in estimating catch-at-age in both 1997 and 1998 are now causing little influence to the current assessment. All of the analyses demonstrate that the current F_{3-6} is close to 0.2 and that the SSB is well above the suggested $\mathbf{B}_{pa}$.

5.10 Clyde herring

5.10.1 Advice and management applicable to 2001 and 2002

Management of herring in the Clyde is complicated by the presence of two stocks that are not separated currently; a resident spring-spawning population and the immigrant autumn-spawning component. 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 2002 and 2003 were maintained at the same level as in recent years (1,000 tonnes).

5.10.2 The fishery in 2001

Annual landings from 1955 to 2002 are presented in Table 5.10.1. Landings in 2002 were 381 t. 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 (Table 5.10.2). In 2002, for the first time, no samples of Clyde herring were taken.

5.10.3 Weight-at-age and stock composition

The catch in numbers-at-age for the period 1970 to 2001 is given in Table 5.10.3. Weights-at-age are given in Table 5.10.4. 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. No data are available for 2002.

5.10.4 Fishery-independent information

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 2002. Historical estimates from these surveys are tabulated in (ICES 1995/ACFM:13).

5.10.5 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.

5.10.6 Stock and catch projections

In the absence of an analytical assessment no stock projections can be provided.

5.11 Management Considerations

5.11.1 VIa (N) Management Considerations

The assessment presented here is less uncertain than those from the mid-1990s due to the improvements in the quality of the catch-at-age input data and the longer time-series for the acoustic survey. Current $F_{3\text{-}6}$ is very close to 0.2 and SSB is well above the suggested $\mathbf{B}_{pa}$. Though the SSB is more uncertain than $F_{3\text{-}6}$, this assessment provides a sound basis for assuming that the stock is currently lightly exploited and able to sustain the current fishery. The yield-per-recruit and the short-term and medium-term projections all indicate that a fishery at the same or slightly higher level is sustainable, with only limited risk of the stock falling below $\mathbf{B}_{pa}$ in the medium term. Indications from the medium-term projections suggest that exploitation at F=0.3 is sustainable, it provides a higher yield and a stable stock in the medium term. Exploitation at F=0.4 is not advised as, although this gives a higher medium-term yield, it gives an increased risk of SSB being below $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa.}$ Exploitation at $\mathbf{F}_{pa}$=0.35 would give a low risk of SSB falling below $\mathbf{B}_{pa}$ but with a declining stock and TAC. However, exploitation at F=3.0 would provide a more stable SSB and TAC in the medium-term.

5.11.2 Clyde herring 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 t per year in the 1960's. Landings began to decline through the 1970's and 1980's. In 1991 there was a dramatic drop in both landings and effort and since then landings have fluctuated at, or more usually below, 1,000 t.

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 the current low level until more is known about the dynamics of this stock.

Table 5.1.1 Herring in VIa (N). Catch in tonnes by country, 1982-2002. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1982	1983	1984	1985	1986	1987	1988
Denmark			96				
Faroes	74	834	954	104	400		
France	2069	1313		20	18	136	44
Germany	8453	6283	5564	5937	2188	1711	1860
Ireland					6000	6800	6740
Netherlands	11317	20200	7729	5500	5160	5212	6131
Norway	13018	7336	6669	4690	4799	4300	456
UK	38471	31616	37554	28065	25294	26810	26894
Unallocated	18958	-4059	16588	-502	37840	18038	5229
Discards							
Total	92360	63523	75154	43814	81699	63007	47354
Area-Misreported			-19142	-4672	-10935	-18647	-11763
WG Estimate	**92360**	**63523**	**56012**	**39142**	**70764**	**44360**	**35591**
Source (WG)	1984	1985	1986	1987	1988	1989	1990

Country	1989	1990	1991	1992	1993	1994	1995
Denmark							
Faroes		326	482				
France	1342	1287	1168	119	818	274	3672
Germany	4290	7096	6450	5640	4693	5087	3733
Ireland	8000	10000	8000	7985	8236	7938	3548
Netherlands	5860	7693	7979	8000	6132	6093	7808
Norway		1607	3318	2389	7447	8183	4840
UK	29874	38253	32628	32730	32602	30676	42661
Unallocated	2123	2397	-10597	-5485	-3753	-4287	-4541
Discards	1550	1300	1180	200		700	
Total	53039	69959	50608	51578	56175	54664	61271
Area-Misreported	-19013	-25266	-22079	-22593	-24397	-30234	-32146
WG Estimate	**34026**	**44693**	**28529**	**28985**	**31778**	**24430**	**29575**
Source (WG)	1991	1992	1993	1994	1995	1996	1997

Country	1996	1997	1998	1999	2000	2001	2002
Denmark							
Faroes							800
France	2297	3093	1903	463	870	760	1340
Germany	7836	8873	8253	6752	4615	3944	3810
Ireland	9721	1875	11199	7915	4841	4311	4239
Netherlands	9396	9873	8483	7244	4647	4534	4612
Norway	6223	4962	5317	2695			
UK	46639	44273	42302	36446	22816	21862	20604
Unallocated	-17753	-8015	-11748	-8155			878
Discards		62	90				
Total	64359	64995	65799	61514	37789	35411	36283
Area-Misreported	-38254	-29766	-32446	-23623	-14626	-10437	-4496
WG Estimate	**26105**	**35233***	**33353**	**29736**	**23163**	**24974**	**31787**
Source (WG)	1997	1998	1999	2000	2001	2002	2003

*WG estimate for 1997 has been revised according to the Bayesian assessment (see text Section 5.1.3).

Table 5.2.1 Herring in VIa (N). Catch and sampling effort by nations participating in the fishery.

Total over all Areas and Periods

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
England & Wales	0.00	2443.00	0	0	0	0.00
Faroes	0.00	800.00	0	0	0	0.00
France	0.00	1340.00	0	0	0	0.00
Germany	3491.00	3810.00	6	1945	280	100.96
Ireland	2824.00	4239.00	1	260	50	100.00
N. Ireland	1503.00	1521.00	5	452	249	99.97
Netherlands	5490.00	4612.00	5	737	125	100.02
Scotland	12055.00	16640.00	35	6859	1680	99.99
Total for Stock	25363.00	35405.00	52	10253	2384	100.13

Sum of Offical Catches : 35405.00
Unallocated Catch : -3618.00
Working Group Catch : 31787.00

PERIOD : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
France	0.00	480.00	0	0	0	0.00
Germany	0.00	319.00	0	0	0	0.00
Ireland	0.00	1415.00	0	0	0	0.00
Netherlands	4467.00	149.00	1	176	25	100.04
Scotland	0.00	2.00	0	0	0	0.00
Period Total	4467.00	2365.00	1	176	25	100.04

Sum of Offical Catches : 2365.00
Unallocated Catch : 4318.00
Working Group Catch : 6683.00

PERIOD : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
England & Wales	0.00	2443.00	0	0	0	0.00
France	0.00	105.00	0	0	0	0.00
N. Ireland	0.00	18.00	0	0	0	0.00
Period Total	0.00	2566.00	0	0	0	0.00

Sum of Offical Catches : 2566.00
Unallocated Catch : 0.00
Working Group Catch : 2566.00

PERIOD : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
France	0.00	755.00	0	0	0	0.00
Germany	3491.00	3491.00	6	1945	280	100.96
N. Ireland	1503.00	1503.00	5	452	249	99.97
Netherlands	1023.00	4463.00	4	561	100	99.89
Scotland	12055.00	16551.00	35	6859	1680	99.99
Period Total	18072.00	26763.00	50	9817	2309	100.17

Sum of Offical Catches : 26763.00
Unallocated Catch : -7936.00
Working Group Catch : 18827.00

PERIOD : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroes	0.00	800.00	0	0	0	0.00
Ireland	2824.00	2824.00	1	260	50	100.00
Scotland	0.00	87.00	0	0	0	0.00
Period Total	2824.00	3711.00	1	260	50	100.00

Sum of Offical Catches : 3711.00
Unallocated Catch : 0.00
Working Group Catch : 3711.00

Table 5.2.2 Herring in VIa (N). Estimated catch numbers-at-age (thousands), 1976-2002. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

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	2000	2001	2002
1	9092	7635	4511	147	1145
2	74167	35252	22960	82214	35410
3	34571	93910	21825	15295	90204
4	31905	25078	51420	9490	9506
5	22872	13364	15505	24896	19916
6	14372	7529	9002	9493	29288
7	8641	3251	3898	6785	9628
8	2825	1257	1836	4271	1290
9	3327	1089	576	1015	1203

Table 5.3.1 Herring in VIa (N). Estimates of abundance from Scottish acoustic surveys. Thousands of fish at age and spawning biomass (SSB, tonnes). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

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	2000	2001	2002
1	534 200	447 600	313 100	424 700
2	322 400	316 200	1 062 000	436 000
3	1 388 800	337 100	217 700	1436 900
4	432 000	899 500	172 800	199 800
5	308 000	393 400	437 500	161 700
6	138 700	247 600	132 600	424 300
7	86 500	199 500	102 800	152 300
8	27 600	95 000	52 400	67 500
9+	35 400	65 000	34 700	59 500
SSB:	460 200	500 500	359 200	548 800

*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 5.4.1 Herring in VIa (N). Mean weights-at-age (g). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Weight in the catch																	
Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	113	73	80	82	79	84	91	89	83	105	81	89	97	76	83	49	107
2	145	143	112	142	129	118	122	128	142	142	134	136	138	130	137	140	146
3	173	183	157	145	173	160	172	158	167	180	178	177	159	158	164	163	159
4	196	211	177	191	182	203	194	197	190	191	210	205	182	175	183	183	171
5	215	220	203	190	209	211	216	206	195	198	230	222	199	191	201	192	156
6	230	238	194	213	224	229	224	228	201	213	233	223	218	210	215	196	173
7	242	241	240	216	228	236	236	223	244	207	262	219	227	225	239	205	182
8	251	253	213	204	237	261	251	262	234	227	247	238	212	223	281	224	245
9+	258	256	228	243	247	271	258	263	266	277	291	263	199	226	253	271	277

Weight in the stock from Acoustic surveys											
Age	Historical	1992	1993	1994	1995	1996	1997#	1998	1999	2000	2001	2002
1	90	68	75	52	45	45	57	65	54	62	62	62
2	164	152	162	150	144	140	150	138	137	141	132	153
3	208	186	196	192	191	180	189	177	166	173	170	177
4	233	206	206	220	202	209	209	193	188	183	190	198
5	246	232	226	221	225	219	225	214	203	194	198	212
6	252	252	234	233	226	222	233	226	219	204	212	215
7	258	271	254	241	247	229	248	234	225	211	220	225
8	269	296	260	270	260	242	266	225	235	222	236	243
9+	292	305	276	296	293	263	287	249	245	230	254	259

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 5.4.2 Herring in VIa (N). 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. The mean value 92-96 is used in the assessment for the years 1976-1991 and 1997.

Year \Age (Winter 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
2000	0.45	0.92	1.00
2001	0.93	0.99	1.00
2002	0.92	1.00	1.00

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 5.6.1 Herring in VIa (N). ICA run log for the maximum-likelihood ICA calculation for the 8-year separable period. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

```
                                    Integrated Catch-at-age Analysis
                                    --------------------------------

                                             Version 1.4 w

                                             K.R.Patterson
                                       Fisheries Research Services
                                            Marine Laboratory
                                                Aberdeen

 Enter the name of the index file -->index.dat
canum.dat
weca.dat
 Stock weights in 2003  used for the year 2002
west.dat
 Natural mortality in 2003  used for the year 2002
natmor.dat
 Maturity ogive in 2003  used for the year 2002
matprop.dat
 Name of age-structured index file (Enter if none) : -->fleet.dat
 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) ?-->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) ?-->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
 Weight for age 9-->    1.000000000000000
Enter relative weights by year
 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
 Weight for year 2000-->    1.000000000000000
 Weight for year 2001-->    1.000000000000000
 Weight for year 2002-->    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: 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 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-->   2.0000000000000000E-02
 Enter highest feasible F-->    0.500000000000000
```

Table 5.6.1. continued.

```
Mapping the F-dimension of the SSQ surface

    F                 SSQ
+--------+-------------------
    0.02        12.6282549199
    0.05         9.8279617164
    0.07         8.4087651216
    0.10         7.7212835643
    0.12         7.4065414999
    0.15         7.2916149720
    0.17         7.2895631347
    0.20         7.3540519218
    0.22         7.4590958389
    0.25         7.5894567970
    0.27         7.7359154155
    0.30         7.8927419016
    0.32         8.0563669991
    0.35         8.2245418457
    0.37         8.3959346162
    0.40         8.5698395578
    0.42         8.7459925832
    0.45         8.9246198183
    0.47         9.1062524933
    0.50         9.2918813812
Lowest SSQ is for F =     0.159
-----------------------------------------------------------------
No of years for separable analysis : 8
Age range in the analysis : 1  . . . 9
Year range in the analysis : 1976  . . . 2002
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 38
Number of observations : 172

Conventional single selection vector model to be fitted.



-----------------------------------------------------------------
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 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.

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 2002  at age 4  is 0.189591  in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->D
 Output page width in characters (e.g. 80..132) ?--> 80
 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]-->  0.0000000000000000E+000
Succesful exit from ICA
```

Table 5.6.2 Herring in VIa (N). Catch number-at-age (millions). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

```
Output Generated by ICA Version 1.4
 ---------------------------------
Herring VIa (north) (run: ICAPGF08/I08)
---------------------------------------
Catch in Number
---------------
```

AGE	1976	1977	1978	1979	1980	1981	1982	1983
1	69.05	34.84	22.52	0.25	2.69	36.74	13.30	81.92
2	319.60	47.74	46.28	0.14	0.28	77.96	250.01	77.81
3	101.55	95.83	20.59	0.08	0.10	105.60	72.18	92.74
4	35.50	22.12	40.69	0.02	0.05	61.34	93.54	29.26
5	25.20	10.08	6.88	0.01	0.01	21.47	58.45	42.53
6	76.29	12.21	3.83	0.01	0.01	12.62	23.58	27.32
7	10.92	20.99	2.10	0.00	0.01	11.58	11.52	14.71
8	3.91	2.76	6.28	0.00	0.00	1.31	13.81	8.44
9	12.01	1.49	1.54	0.00	0.00	1.33	4.03	8.48

AGE	1984	1985	1986	1987	1988	1989	1990	1991
1	2.21	40.79	33.77	19.46	1.71	6.22	14.29	26.40
2	188.78	68.84	154.96	65.95	119.38	36.76	40.87	23.01
3	49.83	148.40	86.07	45.46	41.73	109.50	40.78	25.23
4	35.00	17.21	118.86	32.02	28.42	18.92	74.28	28.21
5	14.95	15.21	18.84	50.12	19.76	18.11	26.52	37.52
6	11.37	6.63	18.00	8.43	28.55	7.59	13.30	13.53
7	9.30	6.91	2.58	7.31	3.25	15.01	9.88	7.58
8	4.43	3.32	1.43	3.51	2.22	1.62	21.46	6.89
9	1.96	2.19	1.97	5.98	2.36	3.50	5.52	4.46

AGE	1992	1993	1994	1995	1996	1997	1998	1999
1	5.25	17.72	1.73	0.27	1.95	1.19	9.09	7.63
2	24.47	95.29	36.55	82.18	37.85	55.81	74.17	35.25
3	24.92	18.71	40.19	30.40	30.90	34.97	34.57	93.91
4	23.73	10.98	6.01	21.27	9.22	31.66	31.91	25.08
5	21.82	13.27	7.43	5.38	7.51	23.12	22.87	13.36
6	33.87	14.80	8.10	4.21	2.50	17.50	14.37	7.53
7	6.35	19.19	10.52	8.80	4.70	10.33	8.64	3.25
8	4.32	4.71	12.16	7.97	8.46	5.21	2.83	1.26
9	5.51	3.74	10.21	9.79	31.11	9.88	3.33	1.09

AGE	2000	2001	2002
1	4.51	0.15	1.14
2	22.96	82.21	35.41
3	21.83	15.30	90.20
4	51.42	9.49	9.51
5	15.50	24.90	19.92
6	9.00	9.49	29.29
7	3.90	6.78	9.63
8	1.84	4.72	1.29
9	0.58	1.02	1.20

x 10 ^ 6

Table 5.6.3 Herring in VIa (N). Weight in the catch (kg). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Weights-at-age in the catches (Kg)

AGE	1976	1977	1978	1979	1980	1981	1982	1983
1	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.08000	0.08000
2	0.12100	0.12100	0.12100	0.12100	0.12100	0.12100	0.14000	0.14000
3	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.17500	0.17500
4	0.17500	0.17500	0.17500	0.17500	0.17500	0.17500	0.20500	0.20500
5	0.18600	0.18600	0.18600	0.18600	0.18600	0.18600	0.23100	0.23100
6	0.20600	0.20600	0.20600	0.20600	0.20600	0.20600	0.25300	0.25300
7	0.21800	0.21800	0.21800	0.21800	0.21800	0.21800	0.27000	0.27000
8	0.22400	0.22400	0.22400	0.22400	0.22400	0.22400	0.28400	0.28400
9	0.22400	0.22400	0.22400	0.22400	0.22400	0.22400	0.29500	0.29500

AGE	1984	1985	1986	1987	1988	1989	1990	1991
1	0.08000	0.06900	0.11300	0.07300	0.08000	0.08200	0.07900	0.08400
2	0.14000	0.10300	0.14500	0.14300	0.11200	0.14200	0.12900	0.11800
3	0.17500	0.13400	0.17300	0.18300	0.15700	0.14500	0.17300	0.16000
4	0.20500	0.16100	0.19600	0.21100	0.17700	0.19100	0.18200	0.20300
5	0.23100	0.18200	0.21500	0.22000	0.20300	0.19000	0.20900	0.21100
6	0.25300	0.19900	0.23000	0.23800	0.19400	0.21300	0.22400	0.22900
7	0.27000	0.21300	0.24200	0.24100	0.24000	0.21600	0.22800	0.23600
8	0.28400	0.22300	0.25100	0.25300	0.21300	0.20400	0.23700	0.26100
9	0.29500	0.23100	0.25800	0.25600	0.22800	0.24300	0.24700	0.27100

AGE	1992	1993	1994	1995	1996	1997	1998	1999
1	0.09100	0.08900	0.08300	0.10600	0.08100	0.08900	0.09700	0.07600
2	0.11900	0.12800	0.14200	0.14200	0.13400	0.13600	0.13800	0.13000
3	0.18300	0.15800	0.16700	0.18100	0.17800	0.17700	0.15900	0.15800
4	0.19600	0.19700	0.19000	0.19100	0.21000	0.20500	0.18200	0.17500
5	0.22700	0.20600	0.19500	0.19800	0.23000	0.22200	0.19900	0.19100
6	0.21900	0.22800	0.20100	0.21400	0.23300	0.22300	0.21800	0.21000
7	0.24400	0.22300	0.24400	0.20800	0.26200	0.21900	0.22700	0.22500
8	0.25600	0.26200	0.23400	0.22700	0.24700	0.23800	0.21200	0.22300
9	0.25600	0.26300	0.26600	0.27700	0.29100	0.26300	0.19900	0.22600

AGE	2000	2001	2002
1	0.08340	0.04900	0.10660
2	0.13730	0.13960	0.14620
3	0.16370	0.16270	0.15940
4	0.18290	0.18260	0.17090
5	0.20140	0.19200	0.15640
6	0.21470	0.19570	0.17250
7	0.23940	0.20450	0.18200
8	0.28120	0.22440	0.24510
9	0.25260	0.27130	0.27710

Table 5.6.4 Herring in VIa (N). Weight in the stock (kg). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Weights-at-age in the stock (Kg)

AGE	1976	1977	1978	1979	1980	1981	1982	1983
1	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
3	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
5	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
7	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
9	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200

AGE	1984	1985	1986	1987	1988	1989	1990	1991
1	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
3	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
5	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
7	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
9	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200

AGE	1992	1993	1994	1995	1996	1997	1998	1999
1	0.09000	0.07500	0.05200	0.04200	0.04500	0.05700	0.06600	0.05400
2	0.16400	0.16200	0.15000	0.14400	0.14000	0.15000	0.13800	0.13700
3	0.20800	0.19600	0.19200	0.19100	0.18000	0.18900	0.17600	0.16600
4	0.23300	0.20600	0.22000	0.20200	0.20900	0.20900	0.19400	0.18800
5	0.24600	0.22600	0.22100	0.22500	0.21900	0.22500	0.21400	0.20300
6	0.25200	0.23400	0.23300	0.22700	0.22200	0.23300	0.22600	0.21900
7	0.25800	0.25400	0.24100	0.24700	0.22900	0.24800	0.23400	0.22500
8	0.26900	0.26000	0.27000	0.26000	0.24200	0.26600	0.22500	0.23500
9	0.29200	0.27600	0.29600	0.29300	0.26300	0.28700	0.24900	0.24500

AGE	2000	2001	2002
1	0.06200	0.06200	0.06200
2	0.14100	0.13200	0.15300
3	0.17300	0.17000	0.17700
4	0.18300	0.19000	0.19800
5	0.19400	0.19800	0.21200
6	0.20400	0.21200	0.21500
7	0.21100	0.22000	0.22500
8	0.22200	0.23600	0.24300
9	0.23000	0.25400	0.25900

Table 5.6.5 Herring in VIa (N). Natural mortality. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Natural Mortality (per year)

AGE	1976	1977	1978	……	1999	2000	2001	2002
1	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
3	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
5	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
7	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
9	0.1000	0.1000	0.1000	……	0.1000	0.1000	0.1000	0.1000

Table 5.6.6 Herring in VIa (N). Proportion mature. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Proportion of fish spawning

AGE	1976	1977	1978	1979	1980	1981	1982	1983
1	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
3	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
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

AGE	1984	1985	1986	1987	1988	1989	1990	1991
1	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
3	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
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

AGE	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
2	0.4700	0.9300	0.4800	0.1900	0.7600	0.5700	0.8500	0.5700
3	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
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

AGE	2000	2001	2002
1	0.0000	0.0000	0.0000
2	0.4500	0.9300	0.9200
3	0.9200	0.9900	1.0000
4	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000

Table 5.6.7 Herring in VIa (N). Tuning indices. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

AGE-STRUCTURED INDICES

AGE	1987	1988	1989	1990	1991	1992	1993	1994
1	249.1	*******	*******	*******	338.3	74.3	2.8	494.2
2	578.4	*******	*******	*******	294.5	503.4	750.3	542.1
3	551.1	*******	*******	*******	327.9	211.0	681.2	607.7
4	353.1	*******	*******	*******	367.8	258.1	653.0	285.6
5	752.6	*******	*******	*******	488.3	414.8	544.0	306.8
6	111.6	*******	*******	*******	176.3	240.1	865.2	268.1
7	48.1	*******	*******	*******	98.7	105.7	284.1	406.8
8	15.9	*******	*******	*******	89.8	56.7	151.7	173.7
9	6.5	*******	*******	*******	58.0	63.4	156.2	131.9

AGE	1995	1996	1997	1998	1999	2000	2001	2002
1	460.6	41.2	*******	1221.7	534.2	447.6	313.1	424.7
2	1085.1	576.5	*******	794.6	322.4	316.2	1062.0	436.0
3	472.7	802.5	*******	666.8	1388.0	337.1	217.7	1436.9
4	450.2	329.1	*******	471.1	432.0	899.5	172.8	199.8
5	153.0	95.4	*******	179.1	308.0	393.4	437.5	161.7
6	187.1	60.6	*******	79.3	138.7	247.6	132.6	424.3
7	169.2	77.4	*******	28.1	86.5	199.5	102.8	152.3
8	236.6	78.2	*******	13.8	27.6	95.0	52.4	67.5
9	201.5	114.8	*******	36.8	35.4	65.0	34.7	59.5

x 10 ^ 3

Table 5.6.8 Herring in VIa (N). Weighting factors for the catch in numbers. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Weighting factors for the catches in number

AGE	1995	1996	1997	1998	1999	2000	2001	2002
1	0.1000	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	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 5.6.9 Herring in VIa (N). Predicted catch in number. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Predicted Catch in Number

AGE	1995	1996	1997	1998	1999	2000	2001	2002
1	1.17	1.27	5.16	1.72	0.76	3.12	0.85	1.23
2	45.07	30.57	81.08	139.49	32.43	21.01	89.22	29.31
3	22.82	29.69	48.75	49.94	61.76	22.48	15.41	79.54
4	13.68	12.73	40.29	24.93	18.43	36.29	14.02	11.71
5	6.99	9.79	21.67	26.03	11.79	13.88	29.05	13.65
6	6.47	4.04	13.49	11.04	9.76	7.17	9.01	22.99
7	13.14	4.11	6.03	7.46	4.54	6.53	5.13	7.85
8	8.49	5.43	4.16	2.20	1.98	1.97	3.03	2.92

x 10 ^ 6

Table 5.6.10 Herring in VIa (N). Fishing mortality (per year). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Fishing Mortality (per year)

AGE	1976	1977	1978	1979	1980	1981	1982	1983
1	0.1903	0.0906	0.0392	0.0003	0.0047	0.0353	0.0274	0.0433
2	0.7605	0.3429	0.2886	0.0005	0.0007	0.3177	0.6543	0.3861
3	1.2038	0.5861	0.2587	0.0007	0.0004	0.4280	0.5881	0.5865
4	1.0683	0.9118	0.5039	0.0003	0.0006	0.3922	0.8003	0.4777
5	0.8796	0.9171	0.7186	0.0002	0.0002	0.2988	0.7022	0.9556
6	1.0334	1.3952	0.9961	0.0014	0.0002	0.2981	0.5477	0.7460
7	1.0477	0.8021	0.8660	0.0020	0.0015	0.2908	0.4305	0.6974
8	0.9183	0.7300	0.5235	0.0007	0.0005	0.3171	0.5865	0.5711
9	0.9183	0.7300	0.5235	0.0007	0.0005	0.3171	0.5865	0.5711

AGE	1984	1985	1986	1987	1988	1989	1990	1991
1	0.0030	0.0544	0.0605	0.0145	0.0028	0.0129	0.0533	0.1193
2	0.2260	0.2051	0.5419	0.2769	0.1959	0.1276	0.1851	0.1928
3	0.4924	0.2965	0.4547	0.3199	0.3014	0.2949	0.2159	0.1764
4	0.4344	0.2973	0.3889	0.2883	0.3214	0.2060	0.3164	0.2161
5	0.4244	0.3033	0.5410	0.2507	0.2587	0.3105	0.4364	0.2331
6	0.6420	0.3003	0.6201	0.4389	0.1979	0.1340	0.3504	0.3692
7	0.5409	0.9244	0.1633	0.4876	0.2682	0.1360	0.2309	0.3070
8	0.4099	0.3338	0.4286	0.3099	0.2378	0.1860	0.2613	0.2235
9	0.4099	0.3338	0.4286	0.3099	0.2378	0.1860	0.2613	0.2235

AGE	1992	1993	1994	1995	1996	1997	1998	1999
1	0.0108	0.0497	0.0033	0.0028	0.0023	0.0050	0.0045	0.0027
2	0.2669	0.4892	0.2339	0.1902	0.1563	0.3390	0.3083	0.1846
3	0.3509	0.3584	0.4220	0.2383	0.1958	0.4247	0.3863	0.2313
4	0.2375	0.2436	0.1764	0.2343	0.1925	0.4176	0.3798	0.2274
5	0.2308	0.1812	0.2312	0.2850	0.2342	0.5080	0.4620	0.2766
6	0.3035	0.2165	0.1439	0.2877	0.2364	0.5128	0.4664	0.2792
7	0.2638	0.2511	0.2105	0.3245	0.2667	0.5783	0.5260	0.3149
8	0.2564	0.2842	0.2231	0.2343	0.1925	0.4176	0.3798	0.2274
9	0.2564	0.2842	0.2231	0.2343	0.1925	0.4176	0.3798	0.2274

AGE	2000	2001	2002
1	0.0023	0.0021	0.0023
2	0.1594	0.1422	0.1539
3	0.1997	0.1782	0.1928
4	0.1964	0.1752	0.1896
5	0.2389	0.2131	0.2306
6	0.2411	0.2151	0.2328
7	0.2720	0.2427	0.2626
8	0.1964	0.1752	0.1896
9	0.1964	0.1752	0.1896

Table 5.6.11 Herring in VIa (N). Population abundance (1 January, millions). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Population Abundance (1 January)

AGE	1976	1977	1978	1979	1980	1981	1982	1983
1	620.6	631.5	923.8	1220.4	898.5	1670.0	778.0	3049.4
2	681.8	188.7	212.2	326.8	448.8	329.0	593.0	278.5
3	157.0	236.1	99.2	117.8	242.0	332.2	177.4	228.4
4	56.3	38.6	107.6	62.7	96.4	198.0	177.3	80.7
5	44.9	17.5	14.0	58.8	56.7	87.2	121.0	72.1
6	123.4	16.9	6.3	6.2	53.2	51.3	58.5	54.3
7	17.5	39.7	3.8	2.1	5.6	48.1	34.5	30.6
8	6.8	5.6	16.1	1.4	1.9	5.0	32.6	20.3
9	20.9	3.0	4.0	10.8	11.0	5.1	9.5	20.4

AGE	1984	1985	1986	1987	1988	1989	1990	1991
1	1165.5	1214.1	905.2	2131.8	965.0	767.4	433.6	367.8
2	1074.3	427.5	423.0	313.5	772.9	354.0	278.7	151.2
3	140.2	634.9	258.0	182.3	176.1	470.7	230.8	171.6
4	104.0	70.2	386.4	134.0	108.4	106.6	287.0	152.3
5	45.3	60.9	47.2	237.0	90.9	71.1	78.5	189.2
6	25.1	26.8	40.7	24.8	166.9	63.5	47.2	45.9
7	23.3	11.9	18.0	19.8	14.5	123.9	50.2	30.1
8	13.8	12.3	4.3	13.8	11.0	10.0	97.8	36.1
9	6.1	8.1	5.9	23.5	11.7	21.7	25.2	23.3

AGE	1992	1993	1994	1995	1996	1997	1998	1999
1	773.9	576.2	817.6	664.0	881.9	1649.8	605.3	448.1
2	120.1	281.6	201.7	299.8	243.6	323.7	603.9	221.7
3	92.4	68.1	127.9	118.3	183.6	154.3	170.8	328.7
4	117.8	53.3	39.0	68.7	76.3	123.6	82.6	95.1
5	111.0	84.0	37.8	29.6	49.2	56.9	73.7	51.1
6	135.6	79.8	63.4	27.1	20.1	35.2	31.0	42.0
7	28.7	90.6	58.1	49.7	18.4	14.4	19.1	17.6
8	20.0	20.0	63.8	42.6	32.5	12.8	7.3	10.2
9	25.5	15.8	53.5	49.1	186.3	30.3	11.0	5.6

AGE	2000	2001	2002	2003
1	2114.9	645.3	861.9	992.7
2	164.4	776.2	236.9	316.4
3	136.5	103.8	498.8	150.5
4	213.5	91.5	71.1	336.8
5	68.5	158.8	69.5	53.3
6	35.1	48.8	116.1	49.9
7	28.7	25.0	35.6	83.2
8	11.6	19.8	17.7	24.8
9	3.4	6.6	7.0	19.0

x 10 ^ 6

Table 5.6.12 Herring in VIa (N). Predicted index values. N.B. In this table “age” refers to number of rings (winter rings in the otolith).

Predicted Age-Structured Index Values

AGE	1987	1988	1989	1990	1991	1992	1993	1994
1	565.1	*******	*******	*******	92.1	205.5	149.8	218.0
2	649.5	*******	*******	*******	328.0	250.2	519.7	427.8
3	609.2	*******	*******	*******	620.1	303.6	223.0	404.4
4	527.7	*******	*******	*******	623.8	476.7	214.9	163.1
5	899.4	*******	*******	*******	725.1	425.9	331.2	144.9
6	91.6	*******	*******	*******	175.8	538.1	331.8	274.6
7	67.7	*******	*******	*******	113.4	110.9	352.2	231.0
8	41.8	*******	*******	*******	114.7	62.5	61.4	202.7
9	75.2	*******	*******	*******	78.1	84.0	51.3	179.3

AGE	1995	1996	1997	1998	1999	2000	2001	2002
1	177.1	235.3	*******	161.3	119.5	564.3	172.2	230.0
2	651.1	539.0	*******	1230.0	483.0	363.2	1730.7	524.9
3	413.2	656.6	*******	550.7	1152.9	487.2	375.0	1786.6
4	278.5	316.5	*******	309.6	386.9	884.0	383.4	295.6
5	110.1	188.2	*******	249.1	191.4	261.7	615.0	266.7
6	108.5	82.8	*******	112.6	168.8	144.1	203.3	478.7
7	185.7	71.0	*******	63.8	66.1	110.5	97.5	137.7
8	134.6	105.0	*******	21.3	32.3	37.5	64.6	57.3
9	163.5	634.5	*******	33.9	18.8	11.5	22.8	25.1

x 10 ^ 3

Table 5.6.13 Herring in VIa (N). Fitted selection pattern. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Fitted Selection Pattern

AGE	1976	1977	1978	1979	1980	1981	1982	1983
1	0.1782	0.0994	0.0778	1.0059	8.5380	0.0900	0.0342	0.0906
2	0.7119	0.3761	0.5726	1.5803	1.2940	0.8099	0.8175	0.8084
3	1.1269	0.6428	0.5133	2.2664	0.7789	1.0913	0.7349	1.2280
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8234	1.0058	1.4259	0.7298	0.4329	0.7617	0.8775	2.0006
6	0.9674	1.5301	1.9765	4.2735	0.3196	0.7601	0.6844	1.5618
7	0.9807	0.8797	1.7184	6.2432	2.7068	0.7413	0.5379	1.4601
8	0.8596	0.8006	1.0388	2.2939	0.9884	0.8085	0.7328	1.1957
9	0.8596	0.8006	1.0388	2.2939	0.9884	0.8085	0.7328	1.1957

AGE	1984	1985	1986	1987	1988	1989	1990	1991
1	0.0069	0.1829	0.1556	0.0504	0.0087	0.0625	0.1685	0.5520
2	0.5201	0.6900	1.3936	0.9604	0.6095	0.6195	0.5848	0.8921
3	1.1335	0.9975	1.1693	1.1094	0.9380	1.4315	0.6823	0.8167
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.9769	1.0201	1.3912	0.8696	0.8050	1.5073	1.3791	1.0789
6	1.4778	1.0102	1.5947	1.5223	0.6156	0.6507	1.1072	1.7090
7	1.2450	3.1095	0.4200	1.6911	0.8346	0.6603	0.7296	1.4207
8	0.9435	1.1229	1.1020	1.0749	0.7398	0.9027	0.8256	1.0344
9	0.9435	1.1229	1.1020	1.0749	0.7398	0.9027	0.8256	1.0344

AGE	1992	1993	1994	1995	1996	1997	1998	1999
1	0.0454	0.2039	0.0190	0.0119	0.0119	0.0119	0.0119	0.0119
2	1.1241	2.0085	1.3260	0.8117	0.8117	0.8117	0.8117	0.8117
3	1.4775	1.4715	2.3922	1.0171	1.0171	1.0171	1.0171	1.0171
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.9719	0.7437	1.3105	1.2164	1.2164	1.2164	1.2164	1.2164
6	1.2781	0.8888	0.8158	1.2279	1.2279	1.2279	1.2279	1.2279
7	1.1108	1.0310	1.1930	1.3849	1.3849	1.3849	1.3849	1.3849
8	1.0799	1.1668	1.2648	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0799	1.1668	1.2648	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	2000	2001	2002
1	0.0119	0.0119	0.0119
2	0.8117	0.8117	0.8117
3	1.0171	1.0171	1.0171
4	1.0000	1.0000	1.0000
5	1.2164	1.2164	1.2164
6	1.2279	1.2279	1.2279
7	1.3849	1.3849	1.3849
8	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000

Table 5.6.14 Herring in VIa (N). Stock summary. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

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	620600	268033	75939	93642	1.2331	1.0463	100
1977	631500	167062	54571	41341	0.7576	0.9526	109
1978	923830	175162	51553	22156	0.4298	0.6193	99
1979	1220350	222642	77996	60	0.0008	0.0007	99
1980	898460	259789	127960	306	0.0024	0.0004	99
1981	1669950	369131	135093	51420	0.3806	0.3543	103
1982	778020	310421	113195	92360	0.8159	0.6596	96
1983	3049410	437122	84526	63523	0.7515	0.6914	97
1984	1165520	363437	124638	56012	0.4494	0.4983	105
1985	1214090	358269	154303	39142	0.2537	0.2994	99
1986	905220	323910	140389	70764	0.5041	0.5012	95
1987	2131840	392668	131616	44360	0.3370	0.3245	102
1988	965040	350019	156029	35591	0.2281	0.2698	97
1989	767380	324369	174266	34026	0.1953	0.2364	98
1990	433550	277448	163389	44693	0.2735	0.3298	101
1991	367800	211476	130395	28529	0.2188	0.2487	93
1992	773860	217737	105386	28985	0.2750	0.2807	99
1993	576150	183387	98944	31778	0.3212	0.2499	100
1994	817590	176097	89413	24430	0.2732	0.2434	100
1995	663990	158071	72981	29575	0.4052	0.2614	99
1996	881850	199101	118246	26105	0.2208	0.2147	95
1997	1649780	234258	79498	35233	0.4432	0.4658	99
1998	605280	201006	100167	33353	0.3330	0.4236	100
1999	448110	154309	88140	29736	0.3374	0.2536	99
2000	2114900	246878	80102	23163	0.2892	0.2190	100
2001	645330	231153	142402	24974	0.1754	0.1954	99
2002	861890	245880	147263	31787	0.2159	0.2115	99

No of years for separable analysis : 8
Age range in the analysis : 1 . . . 9
Year range in the analysis : 1976 . . . 2002
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 38
Number of observations : 172

Conventional single selection vector model to be fitted.

Table 5.6.15 Herring in VIa (N). Parameter estimates. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

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	1995	0.2343	16	0.1705	0.3221	0.1992	0.2756	0.2374
2	1996	0.1925	15	0.1411	0.2628	0.1643	0.2257	0.1950
3	1997	0.4176	15	0.3093	0.5639	0.3583	0.4867	0.4225
4	1998	0.3798	16	0.2736	0.5272	0.3213	0.4490	0.3852
5	1999	0.2274	19	0.1563	0.3308	0.1878	0.2753	0.2316
6	2000	0.1964	21	0.1296	0.2975	0.1589	0.2427	0.2008
7	2001	0.1752	23	0.1097	0.2799	0.1380	0.2225	0.1803
8	2002	0.1896	28	0.1095	0.3284	0.1432	0.2509	0.1972
Separable Model: Selection (S) by age								
9	1	0.0119	37	0.0057	0.0246	0.0082	0.0172	0.0127
10	2	0.8117	15	0.5967	1.1043	0.6937	0.9497	0.8218
11	3	1.0171	14	0.7631	1.3556	0.8784	1.1776	1.0281
	4	1.0000		Fixed : Reference Age				
12	5	1.2164	13	0.9356	1.5814	1.0639	1.3906	1.2273
13	6	1.2279	12	0.9573	1.5749	1.0814	1.3941	1.2378
14	7	1.3849	12	1.0839	1.7695	1.2221	1.5694	1.3958
	8	1.0000		Fixed : Last true age				
Separable model: Populations in year 2002								
15	1	861891	97	126580	5868641	323898	2293485	1391384
16	2	236910	37	114080	491987	163177	343959	253962
17	3	498800	30	274444	906567	367741	676567	522521
18	4	71144	27	41555	121803	54075	93601	73872
19	5	69520	25	42084	114841	53813	89811	71837
20	6	116085	25	70905	190054	90270	149283	119816
21	7	35623	25	21768	58296	27707	45800	36766
22	8	17710	26	10611	29561	13637	23001	18326
Separable model: Populations at age								
23	1995	42605	30	23283	77960	31302	57989	44678
24	1996	32508	24	20254	52174	25536	41382	33469
25	1997	12754	20	8458	19231	10343	15727	13037
26	1998	7290	21	4815	11038	5899	9008	7455
27	1999	10195	22	6507	15973	8108	12820	10466
28	2000	11618	22	7432	18160	9250	14592	11923
29	2001	19808	23	12393	31661	15593	25163	20384

Age-structured index catchabilities

FLT01: West Scotland Summer Acoustic Su

Linear model fitted. Slopes at age :

30	1	Q	.4607	80	.2122	5.030	.4607	2.317	1.432
31	2	Q	2.837	26	2.195	6.259	2.837	4.843	3.842
32	3	Q	4.437	26	3.439	9.731	4.437	7.543	5.992
33	4	Q	4.866	26	3.775	10.64	4.866	8.256	6.563
34	5	Q	4.594	26	3.564	10.06	4.594	7.800	6.200
35	6	Q	4.944	26	3.829	10.87	4.944	8.420	6.685
36	7	Q	4.708	27	3.632	10.48	4.708	8.085	6.399
37	8	Q	3.790	27	2.910	8.561	3.790	6.573	5.184
38	9	Q	3.994	26	3.084	8.863	3.994	6.844	5.421

Table 5.6.16 Herring in VIa (N). Residuals about the model fit. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Separable Model Residuals

Age	1995	1996	1997	1998	1999	2000	2001	2002
1	-1.479	0.427	-1.465	1.664	2.302	0.370	-1.752	-0.068
2	0.601	0.214	-0.373	-0.632	0.083	0.089	-0.082	0.189
3	0.287	0.040	-0.332	-0.368	0.419	-0.030	-0.007	0.126
4	0.442	-0.323	-0.241	0.247	0.308	0.348	-0.390	-0.209
5	-0.263	-0.265	0.065	-0.129	0.125	0.111	-0.154	0.378
6	-0.431	-0.479	0.260	0.264	-0.259	0.228	0.052	0.242
7	-0.401	0.135	0.538	0.148	-0.333	-0.515	0.280	0.205
8	-0.063	0.444	0.226	0.250	-0.453	-0.073	0.442	-0.815

AGE-STRUCTURED INDEX RESIDUALS

FLT01: West Scotland Summer Acoustic Su

Age	1987	1988	1989	1990	1991	1992	1993	1994
1	-0.819	*******	*******	*******	1.301	-1.017	-3.994	0.818
2	-0.116	*******	*******	*******	-0.108	0.699	0.367	0.237
3	-0.100	*******	*******	*******	-0.637	-0.364	1.117	0.407
4	-0.402	*******	*******	*******	-0.528	-0.614	1.112	0.560
5	-0.178	*******	*******	*******	-0.395	-0.027	0.496	0.750
6	0.198	*******	*******	*******	0.003	-0.807	0.958	-0.024
7	-0.342	*******	*******	*******	-0.138	-0.048	-0.215	0.566
8	-0.967	*******	*******	*******	-0.244	-0.096	0.905	-0.154
9	-2.448	*******	*******	*******	-0.297	-0.281	1.113	-0.307

Age	1995	1996	1997	1998	1999	2000	2001	2002
1	0.956	-1.742	*******	2.025	1.497	-0.232	0.598	0.613
2	0.511	0.067	*******	-0.437	-0.404	-0.138	-0.488	-0.186
3	0.135	0.201	*******	0.191	0.186	-0.368	-0.544	-0.218
4	0.480	0.039	*******	0.420	0.110	0.017	-0.797	-0.392
5	0.329	-0.680	*******	-0.330	0.476	0.408	-0.341	-0.501
6	0.544	-0.312	*******	-0.351	-0.197	0.542	-0.427	-0.121
7	-0.093	0.087	*******	-0.822	0.269	0.591	0.053	0.101
8	0.564	-0.295	*******	-0.429	-0.158	0.930	-0.210	0.163
9	0.209	-1.710	*******	0.081	0.635	1.730	0.421	0.864

Table 5.6.17 Herring in VIa (N). Parameters of distributions. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

```
PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES-AT-AGE)
 -----------------------------------------------------

Separable model fitted from 1995  to 2002
Variance                           0.2112
Skewness test stat.               -0.5842
Kurtosis test statistic           -1.1922
Partial chi-square                 0.8514
Significance in fit                0.0000
Degrees of freedom                     35


 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
  0.0314    0.0163    0.0260    0.0361    0.0246    0.0268    0.0165    0.0343   0.1493
Skewness test stat.
 -1.5508    0.6208    1.1365    0.5262    0.2224    0.5908   -0.4705    0.5394  -1.0517
Kurtosis test statisti
 0.4362   -0.6590    0.2921   -0.5405   -0.9845   -0.3125    0.1186   -0.3243    0.0417
Partial chi-square
 0.0288    0.0136    0.0225    0.0315    0.0220    0.0237    0.0158    0.0349    0.1495
Significance in fit      0
 0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
Number of observations
     12        12        12        12        12        12        12        12        12
Degrees of freedom
     11        11        11        11        11        11        11        11        11
Weight in the analysis
 0.0111    0.1111    0.1111    0.1111    0.1111    0.1111    0.1111    0.1111    0.1111
```

Table 5.6.18 Herring in VIa (N). Analysis of variance. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

```
Unweighted Statistics

Variance
                                         SSQ     Data    Parameters d.f. Variance
Total for model                      85.3706      172          38  134   0.6371
Catches-at-age                       21.6052       64          29   35   0.6173

 Aged Indices
FLT01: West Scotland Summer Acoustic S 63.7654     108           9   99   0.6441


Weighted Statistics

Variance
                                           SSQ     Data    Parameters d.f. Variance
Total for model                        7.8005      172          38  134   0.0582
Catches-at-age                         7.3934       64          29   35   0.2112

 Aged Indices
FLT01: West Scotland Summer Acoustic S  0.4071      108           9   99   0.0041
```

Table 5.7.1 Herring in VIa (N). Input data for short-term predictions, numbers-at-age from the assessment with ages 1 and 2 replaced by geometric mean values - natural mortality (M), proportion mature (Mat), proportion of fishing mortality prior to spawning (PF), proportion of natural mortality prior to spawning (PM), mean weights-at-age in the stock (SWt), selection pattern (Sel), mean weights-at-age in the catch (CWt). All biological data are taken as mean of the last 3 years. VIa (N) herring appears to have considerable annual variability in mean weights and in fraction mature. Last years values are not applicable. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	900801	1	0	0.67	0.67	0.062	0.002222	7.97E-02
2	329966	0.3	0.92	0.67	0.67	0.142	0.15184	0.141033
3	150470	0.2	1	0.67	0.67	0.173333	0.19026	0.161933
4	336760	0.1	1	0.67	0.67	0.190333	0.18706	0.1788
5	53258	0.1	1	0.67	0.67	0.201333	0.227537	0.183267
6	49950	0.1	1	0.67	0.67	0.210333	0.229693	0.1943
7	83224	0.1	1	0.67	0.67	0.218667	0.25907	0.208633
8	24791	0.1	1	0.67	0.67	0.233667	0.18706	0.250233
9	19021	0.1	1	0.67	0.67	0.247667	0.18706	0.267

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	900801	1	0	0.67	0.67	0.062	0.002222	7.97E-02
2	.	0.3	0.92	0.67	0.67	0.142	0.15184	0.141033
3	.	0.2	1	0.67	0.67	0.173333	0.19026	0.161933
4	.	0.1	1	0.67	0.67	0.190333	0.18706	0.1788
5	.	0.1	1	0.67	0.67	0.201333	0.227537	0.183267
6	.	0.1	1	0.67	0.67	0.210333	0.229693	0.1943
7	.	0.1	1	0.67	0.67	0.218667	0.25907	0.208633
8	.	0.1	1	0.67	0.67	0.233667	0.18706	0.250233
9	.	0.1	1	0.67	0.67	0.247667	0.18706	0.267

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	900801	1	0	0.67	0.67	0.062	0.002222	7.97E-02
2	.	0.3	0.92	0.67	0.67	0.142	0.15184	0.141033
3	.	0.2	1	0.67	0.67	0.173333	0.19026	0.161933
4	.	0.1	1	0.67	0.67	0.190333	0.18706	0.1788
5	.	0.1	1	0.67	0.67	0.201333	0.227537	0.183267
6	.	0.1	1	0.67	0.67	0.210333	0.229693	0.1943
7	.	0.1	1	0.67	0.67	0.218667	0.25907	0.208633
8	.	0.1	1	0.67	0.67	0.233667	0.18706	0.250233
9	.	0.1	1	0.67	0.67	0.247667	0.18706	0.267

Table 5.7.2 Herring in VIa (N). Short-term prediction single option table, *status quo* F. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Year:	2003	F multiplier:	1	Fbar:	0.2086				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0022	1264	101	900801	55850	0	0	0	0
2	0.1518	40311	5685	329966	46855	303569	43107	224276	31847
3	0.1903	23703	3838	150470	26081	150470	26081	115849	20081
4	0.1871	54759	9791	336760	64097	336760	64097	277839	52882
5	0.2275	10334	1894	53258	10723	53258	10723	42764	8610
6	0.2297	9774	1899	49950	10506	49950	10506	40050	8424
7	0.2591	18114	3779	83224	18198	83224	18198	65429	14307
8	0.1871	4031	1009	24791	5793	24791	5793	20453	4779
9	0.1871	3093	826	19021	4711	19021	4711	15693	3887
Total		165383	28822	1948241	242814	1021043	183216	802352	144816

Year:	2004	F multiplier:	1	Fbar:	0.2086				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0022	1264	101	900801	55850	0	0	0	0
2	0.1518	40395	5697	330651	46952	304199	43196	224741	31913
3	0.1903	33082	5357	210009	36402	210009	36402	161689	28026
4	0.1871	16561	2961	101850	19386	101850	19386	84030	15994
5	0.2275	49036	8987	252727	50882	252727	50882	202930	40857
6	0.2297	7510	1459	38383	8073	38383	8073	30775	6473
7	0.2591	7819	1631	35921	7855	35921	7855	28240	6175
8	0.1871	9450	2365	58117	13580	58117	13580	47949	11204
9	0.1871	5346	1427	32879	8143	32879	8143	27127	6718
Total		170465	29986	1961339	247123	1034086	187517	807481	147360

Year:	2005	F multiplier:	1	Fbar:	0.2086				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0022	1264	101	900801	55850	0	0	0	0
2	0.1518	40395	5697	330651	46952	304199	43196	224741	31913
3	0.1903	33151	5368	210445	36477	210445	36477	162025	28084
4	0.1871	23115	4133	142151	27056	142151	27056	117279	22322
5	0.2275	14831	2718	76435	15389	76435	15389	61374	12357
6	0.2297	35639	6925	182140	38310	182140	38310	146040	30717
7	0.2591	6008	1253	27603	6036	27603	6036	21701	4745
8	0.1871	4079	1021	25085	5861	25085	5861	20696	4836
9	0.1871	11104	2965	68290	16913	68290	16913	56342	13954
Total		169585	30181	1963600	248845	1036347	189239	810197	148929

Table 5.7.3 Herring in VIa (N). Short-term prediction multiple option table, *status quo* F.

2003				
Biomass	SSB	FMult	FBar	Landings
242814	144816	1	0.2086	28822

2004					2005	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
247123	168093	0	0	0	280325	198757
.	165891	0.1	0.0209	3266	276888	193020
.	163719	0.2	0.0417	6470	273518	187465
.	161577	0.3	0.0626	9612	270215	182088
.	159463	0.4	0.0835	12694	266977	176881
.	157377	0.5	0.1043	15717	263803	171840
.	155319	0.6	0.1252	18682	260691	166959
.	153289	0.7	0.146	21590	257641	162232
.	151286	0.8	0.1669	24443	254650	157655
.	149310	0.9	0.1878	27241	251719	153222
.	147360	1	0.2086	29986	248845	148929
.	145437	1.1	0.2295	32678	246027	144770
.	143539	1.2	0.2504	35319	243265	140743
.	141666	1.3	0.2712	37910	240557	136841
.	139819	1.4	0.2921	40451	237902	133062
.	137996	1.5	0.313	42944	235300	129400
.	136197	1.6	0.3338	45390	232748	125853
.	134423	1.7	0.3547	47790	230246	122416
.	132672	1.8	0.3755	50144	227793	119086
.	130944	1.9	0.3964	52453	225388	115859
.	129240	2	0.4173	54719	223030	112732

Table 5.7.4 Herring in VIa (N). Short-term prediction single option table, *status quo* F, $\mathbf{F}_{pa}$=0.35. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Year:	2003	F multiplier:	1	Fbar:	0.2086				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0022	1264	101	900801	55850	0	0	0	0
2	0.1518	40311	5685	329966	46855	303569	43107	224276	31847
3	0.1903	23703	3838	150470	26081	150470	26081	115849	20081
4	0.1871	54759	9791	336760	64097	336760	64097	277839	52882
5	0.2275	10334	1894	53258	10723	53258	10723	42764	8610
6	0.2297	9774	1899	49950	10506	49950	10506	40050	8424
7	0.2591	18114	3779	83224	18198	83224	18198	65429	14307
8	0.1871	4031	1009	24791	5793	24791	5793	20453	4779
9	0.1871	3093	826	19021	4711	19021	4711	15693	3887
Total		165383	28822	1948241	242814	1021043	183216	802352	144816

Year:	2004	F multiplier:	1.68	Fbar:	0.3505				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0037	2122	169	900801	55850	0	0	0	0
2	0.2551	64728	9129	330651	46952	304199	43196	209719	29780
3	0.3196	52352	8478	210009	36402	210009	36402	148264	25699
4	0.3143	26206	4686	101850	19386	101850	19386	77165	14687
5	0.3823	76646	14047	252727	50882	252727	50882	182947	36833
6	0.3859	11731	2279	38383	8073	38383	8073	27718	5830
7	0.4352	12107	2526	35921	7855	35921	7855	25096	5488
8	0.3143	14953	3742	58117	13580	58117	13580	44032	10289
9	0.3143	8460	2259	32879	8143	32879	8143	24911	6170
Total		269305	47314	1961339	247123	1034086	187517	739851	134776

Year:	2005	F multiplier:	1.68	Fbar:	0.3505				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0037	2122	169	900801	55850	0	0	0	0
2	0.2551	64630	9115	330152	46882	303739	43131	209403	29735
3	0.3196	47314	7662	189800	32899	189800	32899	133997	23226
4	0.3143	32136	5746	124900	23773	124900	23773	94628	18011
5	0.3823	20412	3741	67306	13551	67306	13551	48722	9809
6	0.3859	47689	9266	156030	32818	156030	32818	112675	23699
7	0.4352	7958	1660	23611	5163	23611	5163	16496	3607
8	0.3143	5412	1354	21033	4915	21033	4915	15935	3724
9	0.3143	15472	4131	60133	14893	60133	14893	45559	11283
Total		243146	42844	1873766	230742	946553	171142	677415	123095

Table 5.7.5 Herring in VIa (N). Short-term prediction multiple option table, *status quo* F, $\mathbf{F}_{pa}$=0.35.

2003				
Biomass	SSB	FMult	FBar	Landings
242814	144816	1	0.2086	28822

2004					2005	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
247123	168093	0	0	0	280325	198757
.	164411	0.168	0.0351	5452	274589	189223
.	160812	0.336	0.0701	10729	269042	180194
.	157294	0.504	0.1052	15837	263677	171642
.	153855	0.672	0.1402	20781	258489	163540
.	150493	0.84	0.1753	25568	253471	155864
.	147206	1.008	0.2103	30203	248617	148591
.	143992	1.176	0.2454	34690	243923	141698
.	140850	1.344	0.2804	39034	239383	135163
.	137779	1.512	0.3155	43240	234991	128969
.	134776	1.68	0.3505	47314	230742	123095
.	131840	1.848	0.3856	51258	226633	117524
.	128969	2.016	0.4206	55077	222657	112241
.	126163	2.184	0.4557	58776	218812	107228
.	123419	2.352	0.4907	62359	215091	102472
.	120736	2.52	0.5258	65829	211492	97958
.	118113	2.688	0.5608	69190	208009	93673
.	115548	2.856	0.5959	72446	204640	89605
.	113040	3.024	0.6309	75599	201380	85743
.	110588	3.192	0.666	78654	198225	82074
.	108191	3.36	0.701	81614	195173	78589

Table 5.7.6 Herring in VIa (N). Medium-term Projection Input control data. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Age	Fleet Catch Ratio	Retention Ogive	Mean weight at age	Year	F*status quo* F multiplier	"$\mathbf{F}_{pa}$=0.30" F multiplier	"$\mathbf{F}_{pa}$=0.40" F multiplier	CV on target F multiplier
1	1	1	0.080	2003	1.00	1.00	1.00	0.0001
2	1	1	0.141	2004	1.00	1.35	1.80	0.0001
3	1	1	0.162	2005	1.00	1.35	1.80	0.0001
4	1	1	0.179	2006	1.00	1.35	1.80	0.0001
5	1	1	0.183	2007	1.00	1.35	1.80	0.0001
6	1	1	0.195	2008	1.00	1.35	1.80	0.0001
7	1	1	0.209	2009	1.00	1.35	1.80	0.0001
8	1	1	0.250	2010	1.00	1.35	1.80	0.0001
9+	1	1	0.267	2011	1.00	1.35	1.80	0.0001
				2012	1.00	1.35	1.80	0.0001

Table 5.7.7 Herring in VIa (N). Medium-Term Projections control file

Medium-Term Projections

ICP
K.R. Patterson
SOAEFD Marine Laboratory
Aberdeen

Written December 1997 for ICA v1.4 w
Revision March 1999

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 2002 back to--> 2000
Use mean maturity ogive from 2002 back to--> 2000
Use mean weight-at-age in the stock from 2002 back to--> 2000
Enter the reference spawning stock size (e.g. MBAL, $\mathbf{B}_{pa}$)--> 7.5500000000000000E+04
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) ?-->o
Enter first year of data for stock-recruit model--> 1976
Enter last year of data for stock-recruit model--> 1998
Autocorrelated or Independent errors (I/A)-->i
Use ICA or SRR (I/S) model value for recruitment in 2002-->s
Use ICA or SRR (I/S) model value for recruitment in 2003-->s
Use default percentiles (Y/N) ?-->y
Use ICA-derived resamples ?-->y

Table 5.8.1 Herring VIa (N) Input data for PA plots (Figure 5.8.2) For stock summary data see Table 5.6.14. N.B. In this table “age” refers to number of rings (winter rings in the otolith).

Age	Number	Nat Mortality	Catch Weights	Stock Weights	Maturity	Fleet Selection Pattern
1	13.7	1.0	0.080	0.062	0.00	0.012
2	236910.3	0.3	0.141	0.142	0.77	0.812
3	498800.5	0.2	0.162	0.173	0.97	1.017
4	71144.9	0.1	0.179	0.190	1.00	1.000
5	69520.4	0.1	0.183	0.201	1.00	1.216
6	116085.5	0.1	0.194	0.210	1.00	1.228
7	35623.6	0.1	0.209	0.219	1.00	1.385
8	17711.0	0.1	0.250	0.234	1.00	1.000
9+	6965.7	0.1	0.267	0.248	1.00	1.000
			Coefficients of Variation			
Age	Number	Nat Mortality	Catch Weights	Stock Weights	Maturity	Fleet Selection Pattern
1	0.038	0.000	0.0381	0.0000	0.0000	0.7443
2	0.373	0.000	0.3728	0.0742	0.1000	0.3141
3	0.305	0.000	0.3048	0.0203	0.1000	0.2931
4	0.274	0.000	0.2743	0.0394	0.0000	0.0000
5	0.256	0.000	0.2561	0.0469	0.0000	0.2678
6	0.252	0.000	0.2515	0.0270	0.0000	0.2540
7	0.251	0.000	0.2513	0.0324	0.0000	0.2501
8	0.261	0.000	0.2614	0.0458	0.0000	0.0000
9+	0.261	0.000	0.2614	0.0626	0.0000	0.0000

Table 5.10.1 HERRING from the Firth of Clyde. Catch in tonnes by country, 1955–2002. Spring and autumn-spawners combined.

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	-	-	-	-	-	-	-	1
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	853

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002
Scotland	608	392	598	371	779	16	1	78	46
Other UK	-	194	127	475	310	240	0	392	335
Unallocated[1]	-	-	-	-	-	-	-	-	-
Discards	-[2]	-[2]	-	-	-	-	-	-	-
Agreed TAC	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Total	608	586	725	846	1089	256	1	480	381

[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, for 1898-1995.
[3]Based on sampling.
[4]Estimated assuming the same discarding rate as in 1986.

Table 5.10.2 HERRING from the Firth of Clyde. Sampling levels 1988-2001.

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	853	16	3,408	798	No information
1994	608	16	3,903	1,388	No information
1995	586	16	2,727	1,073	No information
1996	725	9	1,915	679	No information
1997	846	3	650	383	No information
1998	1089	3	462	196	
1999	256	3	251	126	
2000[1]	1	1	105	96	
2001	480	3	799	143	
2002	381	0	0	0	

[1] One sample collected in first quarter, but not applied to catch, which was taken in third quarter.

Table 5.10.3 HERRING from the Firth of Clyde. Catch in numbers-at-age. Spring- and autumn-spawners combined. Thousands of fish. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Age(Rings)	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	5008	2207	1351	9139	53081	2694	6194	1041	14123	507	333
2	7551	6503	8983	5258	8841	1876	10480	7524	1796	4859	5633
3	10338	1976	3181	4548	2817	2483	913	6976	2259	807	1592
4	8745	4355	1684	1811	2559	1024	1049	1062	2724	930	567
5	2306	3432	3007	918	1140	1072	526	1112	634	888	341
6	741	1090	1114	1525	494	451	638	574	606	341	204
7	760	501	656	659	700	175	261	409	330	289	125
8	753	352	282	307	253	356	138	251	298	156	48
9	227	225	177	132	87	130	178	146	174	119	56
10+	117	181	132	114	59	67	100	192	236	154	68

Age(Rings)	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	312	220	314	4156	1639	678	508	0	845	716	42
2	2372	11311	10109	11829	2951	4574	1376	1062	1523	1004	615
3	2785	4079	5232	5774	4420	4431	3669	1724	9239	839	472
4	1622	2440	1747	3406	4592	4622	4379	2506	876	7533	703
5	1158	1028	963	1509	2806	2679	3400	2014	452	576	1908
6	433	663	555	587	2654	1847	1983	1319	252	359	169
7	486	145	415	489	917	644	1427	510	146	329	92
8	407	222	189	375	681	287	680	234	29	119	113
9	74	63	85	74	457	251	308	66	16	49	22
10+	18	53	38	80	240	79	175	16	5	16	9

Age(Rings)	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	145	3	399	118	494	275	323	123	0	0	-
2	411	418	964	1425	1962	2005	2731	418	3	1427	-
3	493	261	964	186	1189	429	1779	318	2	67	-
4	385	268	358	189	273	346	667	393	1	20	-
5	1947	1305	534	149	544	18	344	122	1	406	-
6	333	327	319	130	183	52	77	36	0	40	-
7	91	78	76	66	208	0	55	36	0	0	-
8	69	111	57	35	127	5	35	13	0	22	-
9	32	38	16	15	52	61	55	19	0	0	-
10+	10	0	17	1	9	*					

*change to 9+ in 1997.

Table 5.10.4 HERRING in the Firth of Clyde. Mean weights-at-age in the catch and stock (g). N.B. In this table “age” refers to number of rings (winter rings in the otolith).

Age	Weight in the catch																		
(rings)	1970-81	1982-85	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	-	-	-	-	-	-	-	-	-	-	-	102	90	112	103	87	97	-	-
2	225	149	166	149	156	149	170	143	141	141	92	151	146	142	148	152	140	136	-
3	270	187	199	194	194	174	186	163	187	174	157	174	184	174	174	169	162	156	-
4	290	228	224	203	207	203	202	188	188	198	184	201	203	192	189	184	180	201	-
5	310	253	253	217	211	221	216	192	216	213	212	226	233	231	204	197	194	196	-
6	328	272	265	225	222	227	237	198	227	216	249	241	255	228	218	202	213	235	-
7	340	307	297	236	230	235	234	210	206	229	248	249	257	189	229	220	242	-	-
8	345	291	298	247	225	237	234	222	218	261	240	252	255	286	240	229	249	288	-
9	350	300	298	255	244	219	257	200	201	233	249	242	284	218	246	241	256	-	-
10+	350	300	321	258	230	254	272	203	221	254	294	270	239	*					

* change to 9+ in 1997

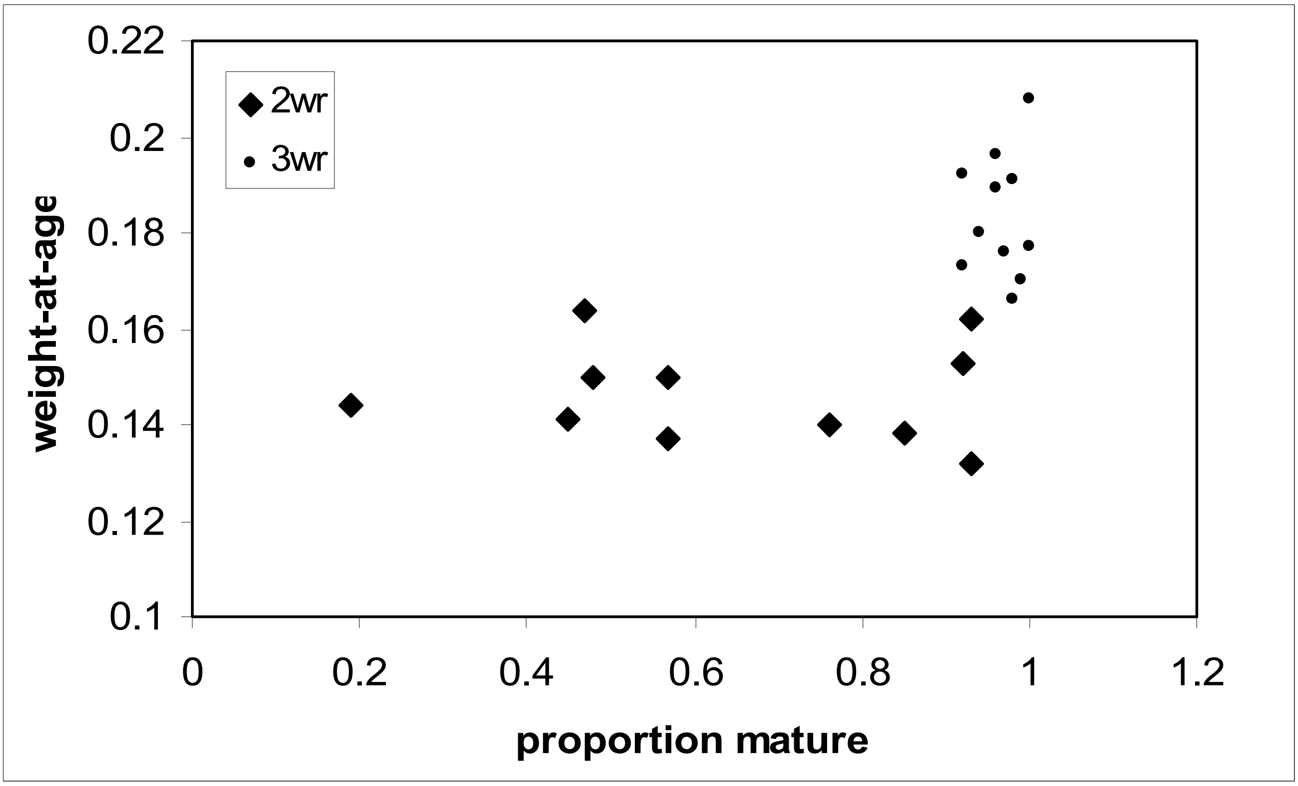


Figure 5.4.1 Herring in VIa (N). The relationship between maturity and weight-at-age in 2- and 3-ring herring.

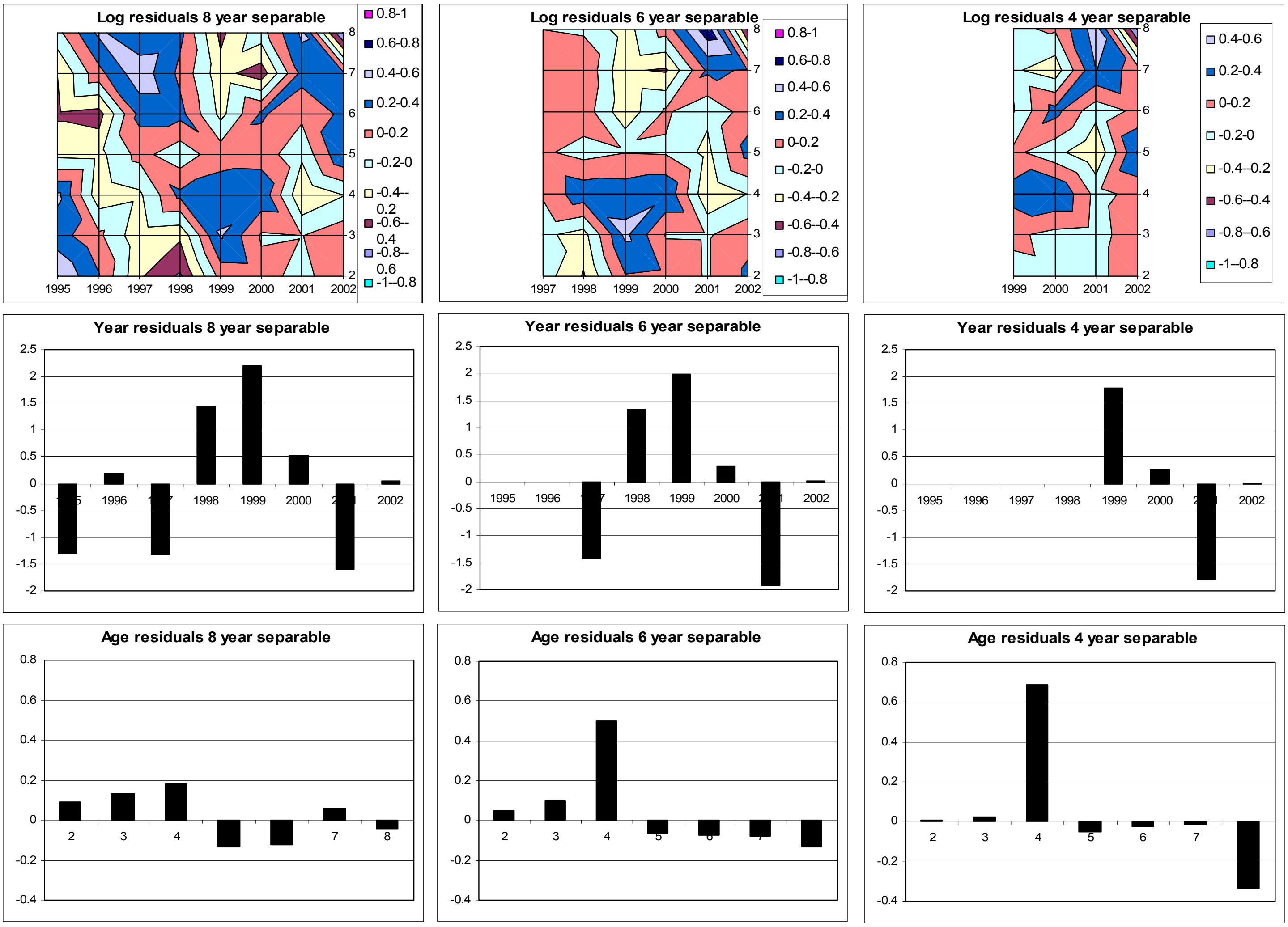


Figure 5.6.1 Herring in VIa (N). Residual plots for three assessments with separable periods of 8, 6 and 4 years respectively to show the consistency in the year residuals in overlapping periods and differences in the age residuals using 6- and 4-year separable periods.

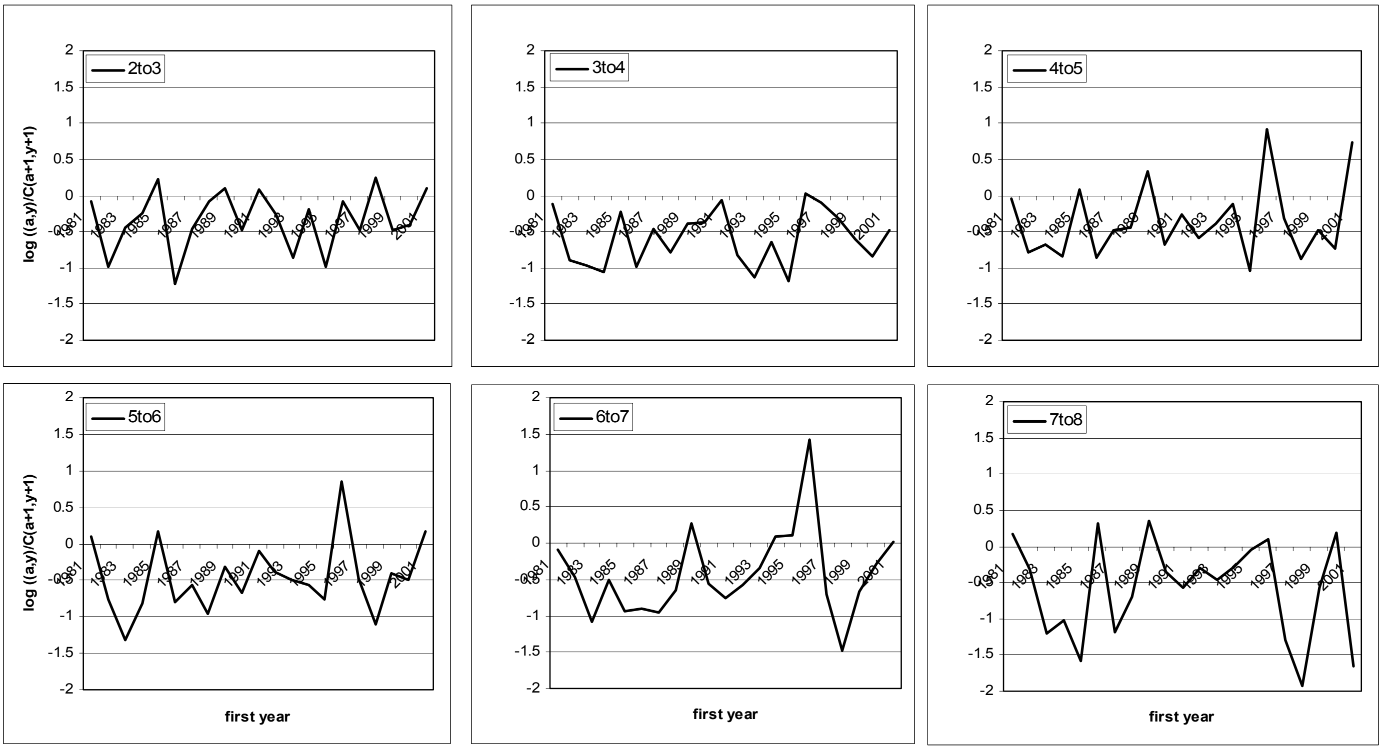


Figure 5.6.2 Herring in VIa (N). Log catch ratios, 6-year separable period, showing the noisy characteristic of the catch data, with no apparent trends or patterns in catch over all age classes.

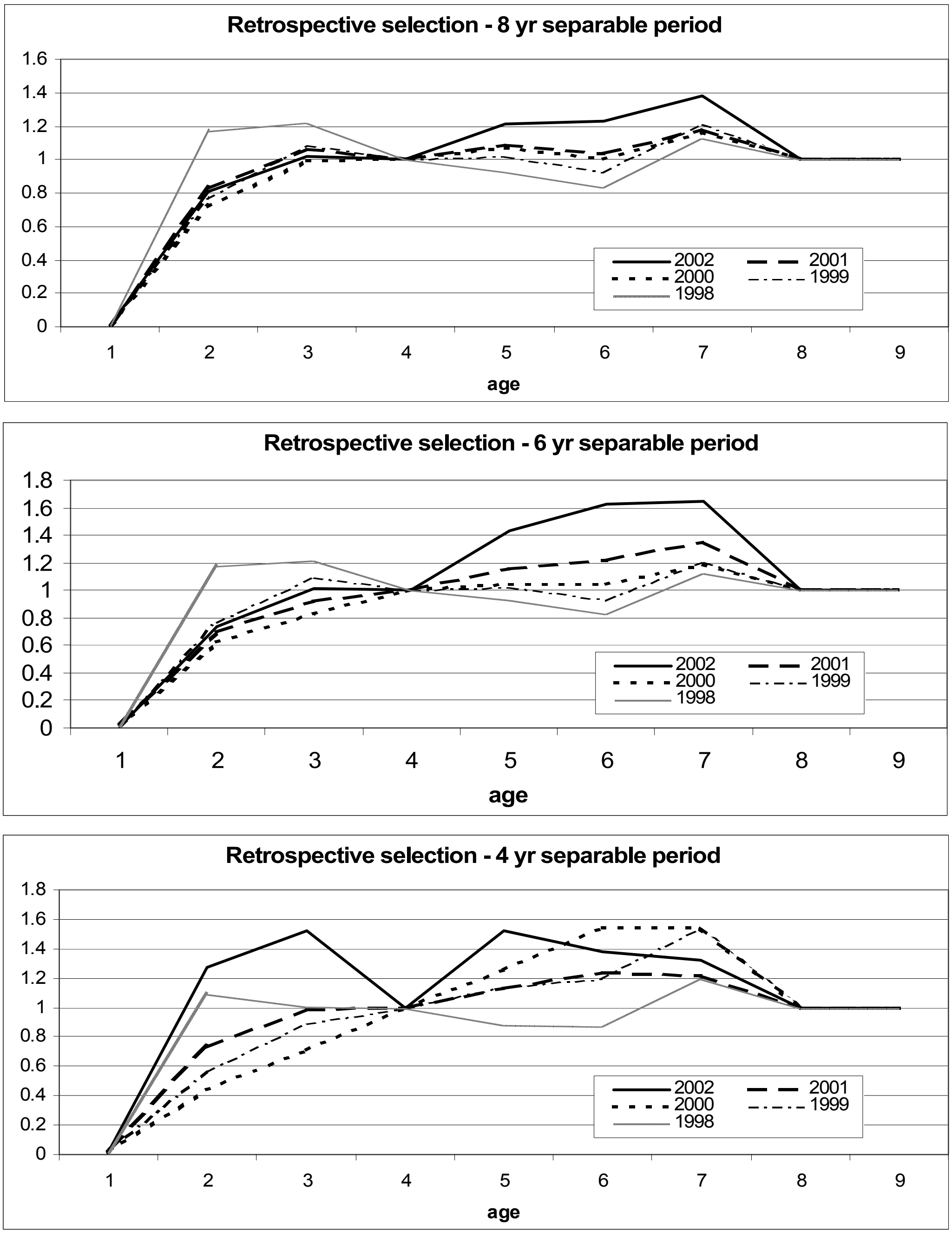


Figure 5.6.3 Herring in VIa (N). Retrospective analysis of selection pattern of model fit (ICA), from 2002 to 1998, using 8-, 6-, and 4-year separable periods to show the greater fluctuations in selection pattern with decreasing separable period and inconsistency in selection on different age groups in different years.

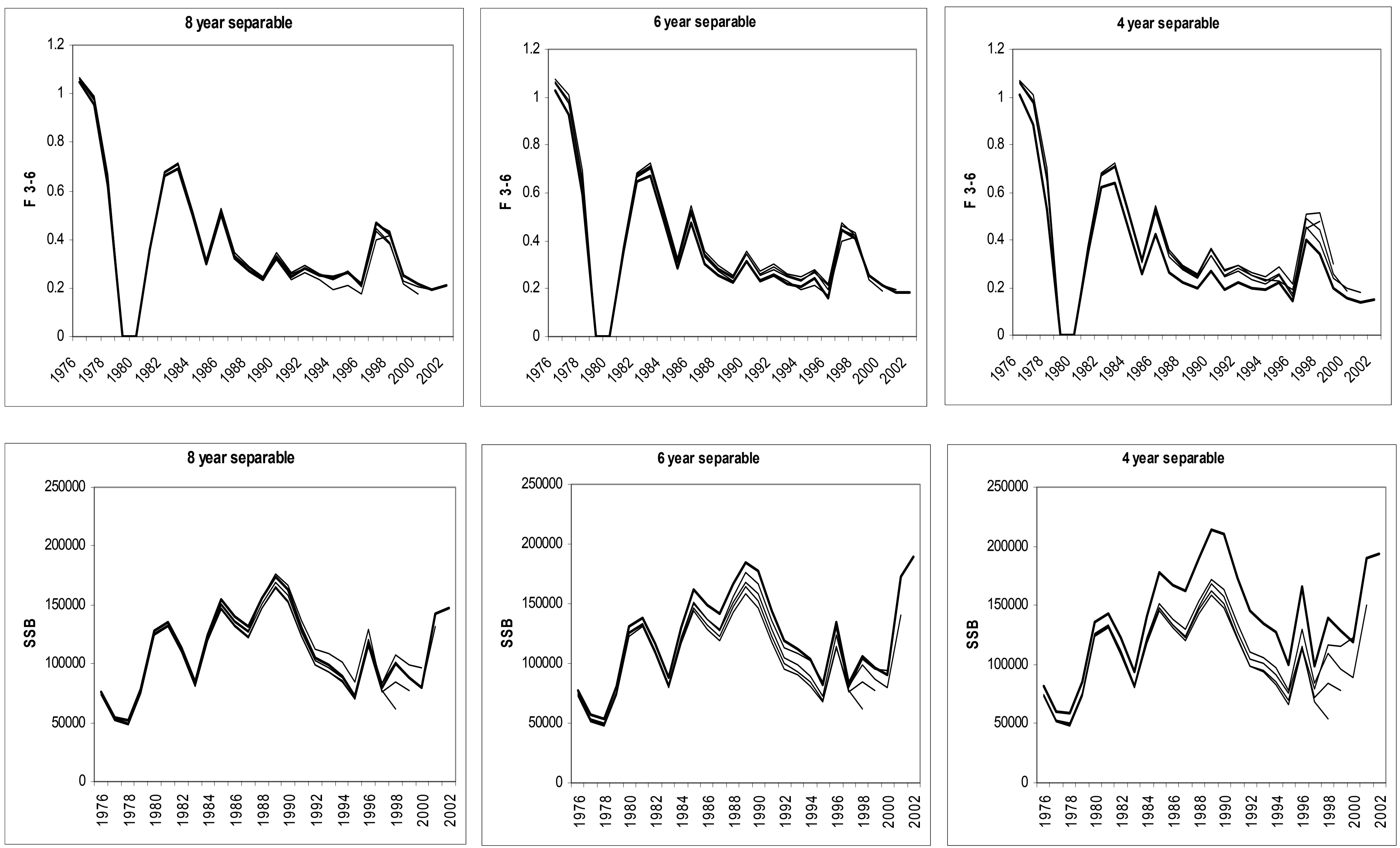


Figure 5.6.4 Herring in VIa (N). Analytical retrospective patterns of Fbar and SSB from three separate sets of assessments using 8-, 6-, and 4-year separable periods respectively. The divergence far back in time in F and SSB in both the 6- and 4-year separable periods is not seen in assessment with the 8-year separable period and is probably a result of the way ICA uses F for the older ages in the model.

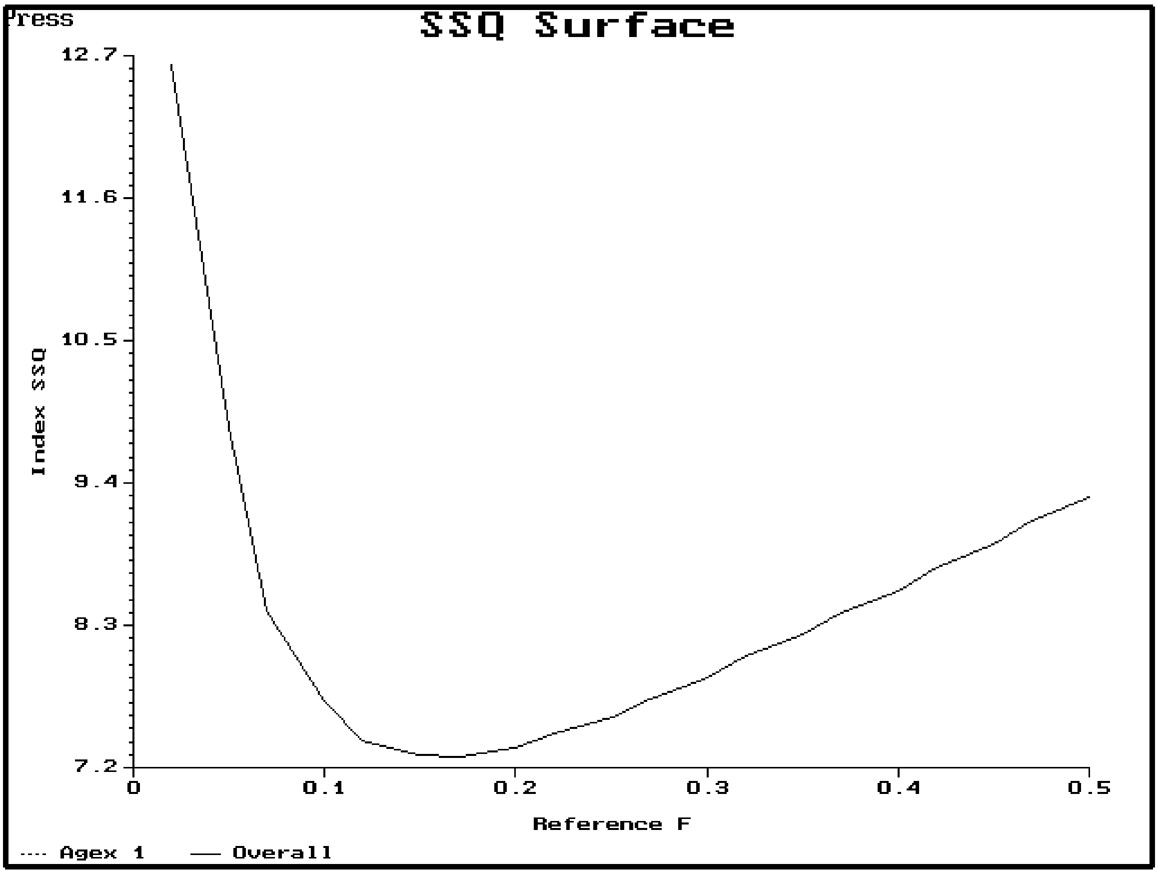


Figure 5.6.5 Herring in VIa (N). SSQ surface for the deterministic calculation of the 8-year separable period. Agex1- age disaggregated acoustic estimates.

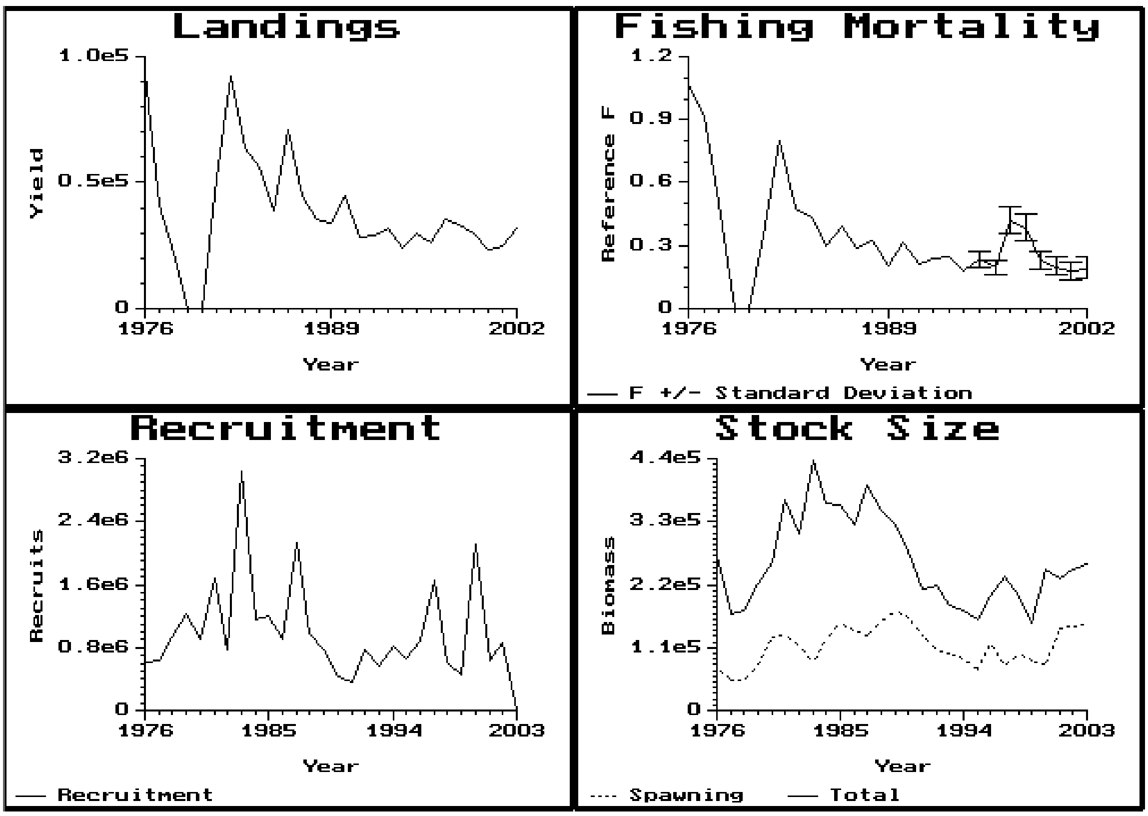


Figure 5.6.6 Herring in VIa (N). Illustration of stock trends from deterministic calculation (8-year separable period). Summary of estimates of landings, fishing mortality at 4-ring, recruitment at 1-ring, stock size on 1 January and spawning stock at spawning time.

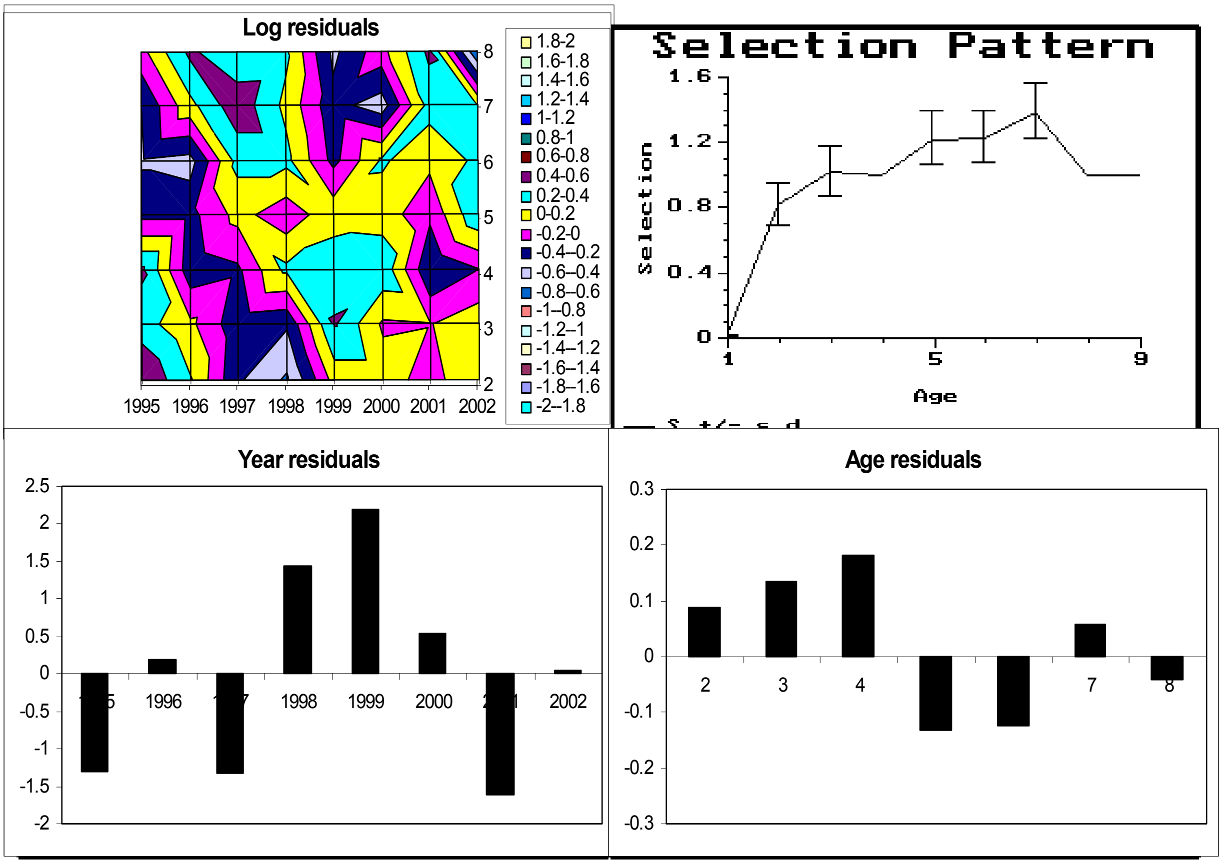


Figure 5.6.7 Herring in VIa (N). Illustration of selection patterns diagnostics, from deterministic calculation (8-year separable period). Top left, a contour plot of selection pattern residuals. Top right, estimated selection (relative to 4-ringers) +/- standard deviation. Bottom, marginal totals of residuals by year and ring.

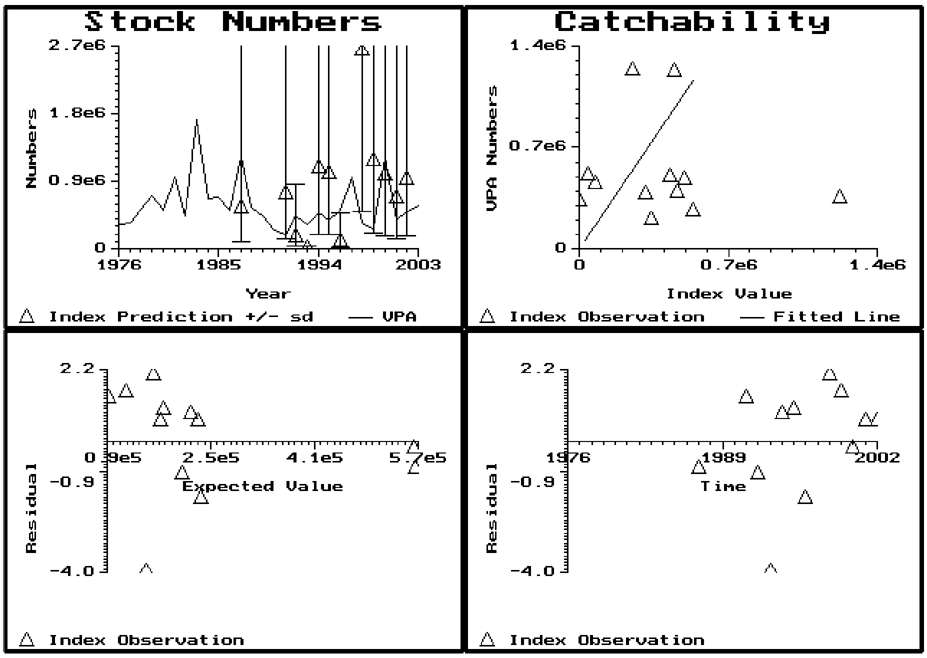


Figure 5.6.8 Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **1-ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 1-ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time. **N.B. 1-ringers are down-weighted in the catch and survey in the assessment.**

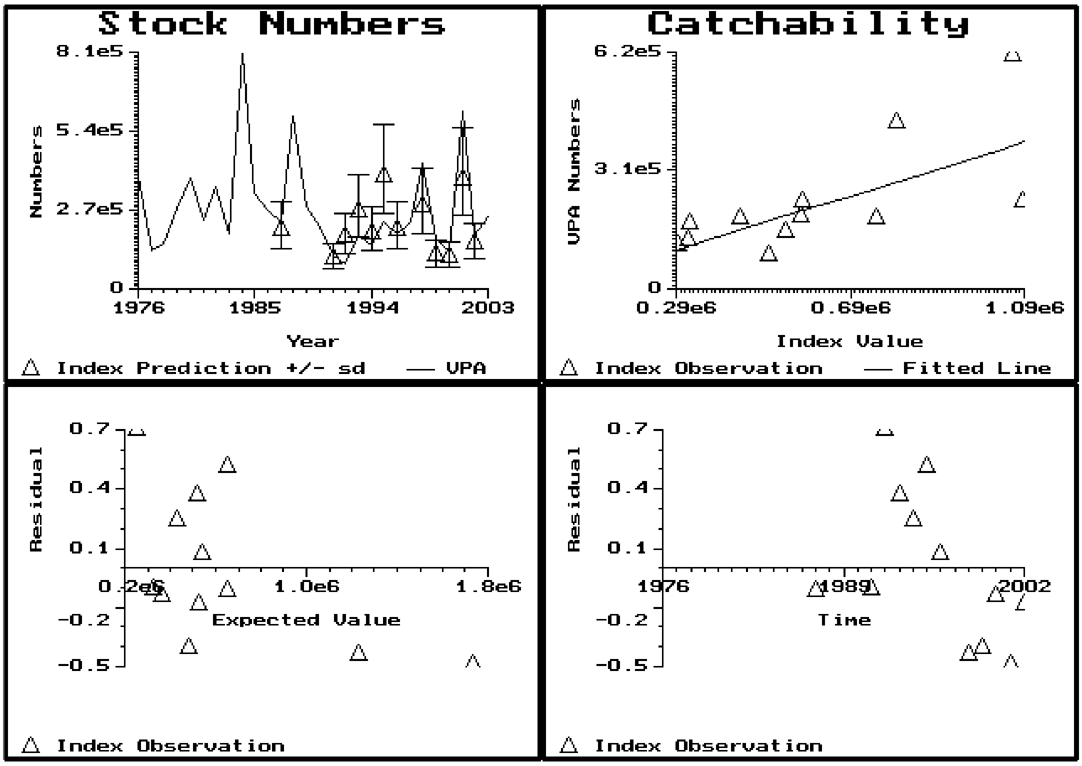


Figure 5.6.9 Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **2-ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 2-ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

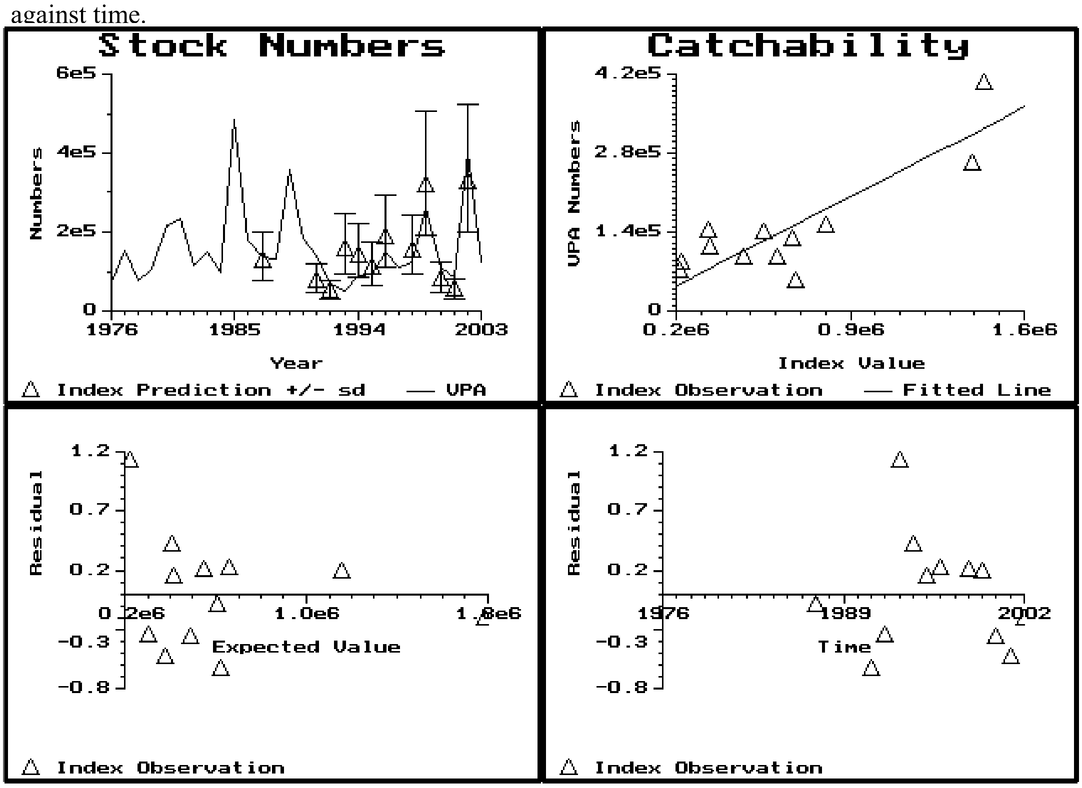


Figure 5.6.10 Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **3-ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 3-ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

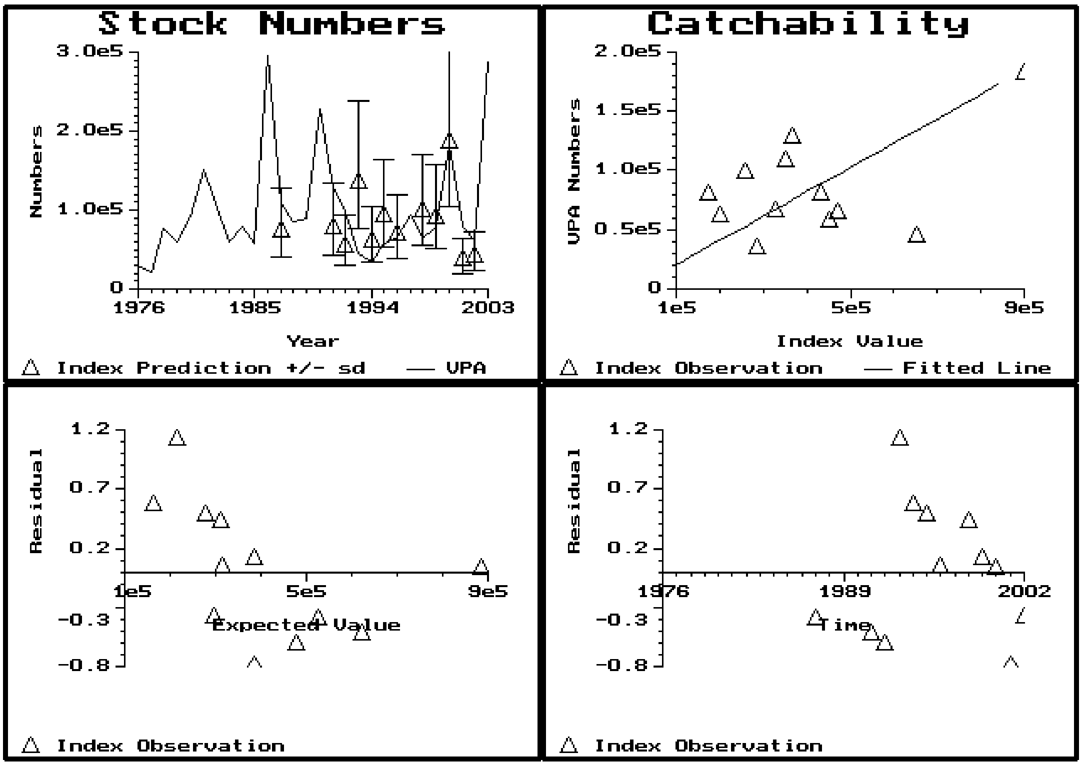


Figure 5.6.11 Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **4-ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 4-ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

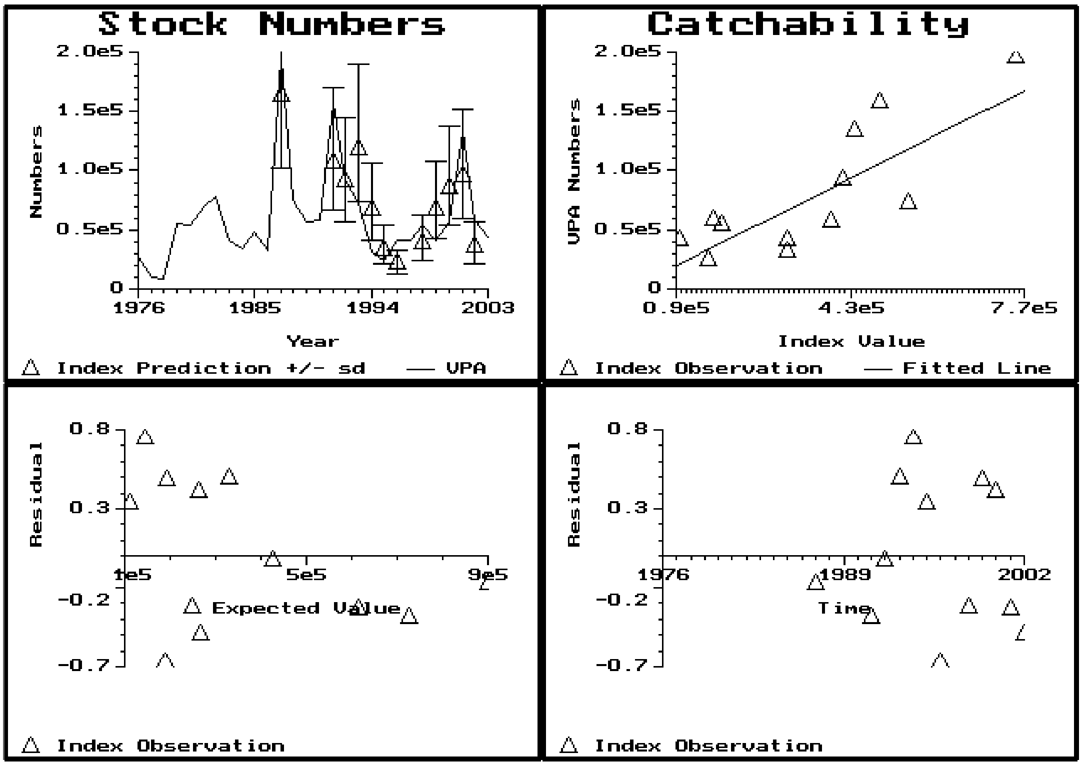


Figure 5.6.12. Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **5 ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 5 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

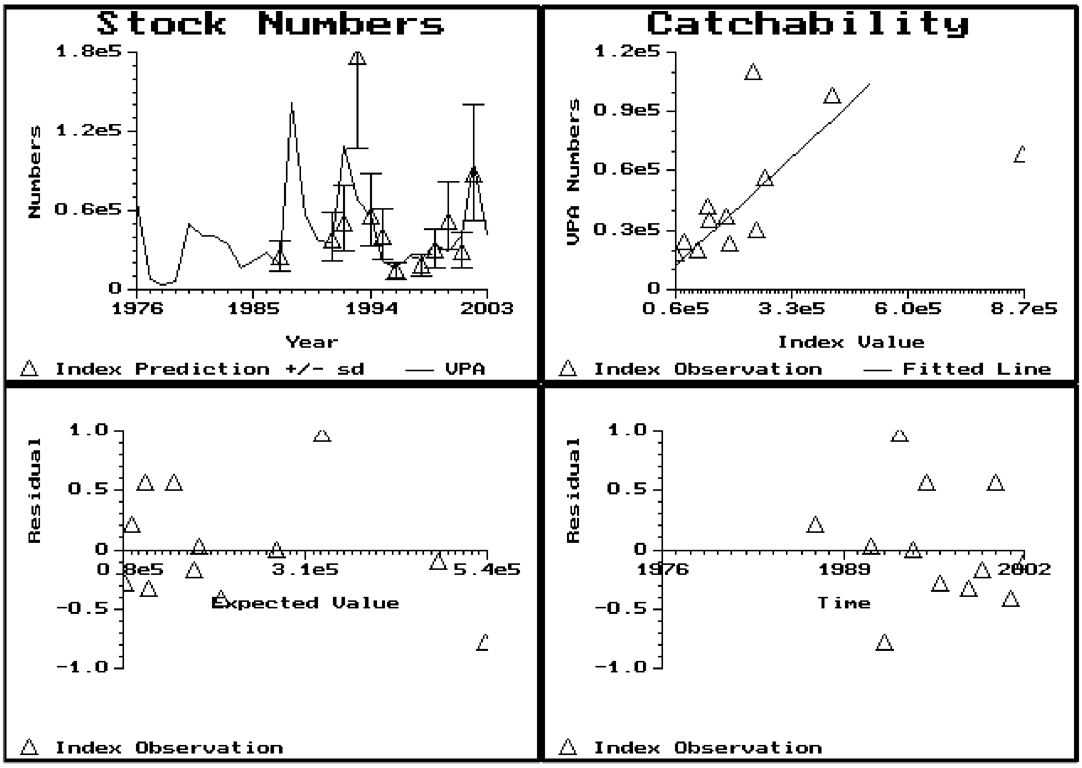


Figure 5.6.13. Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **6 ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 6 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

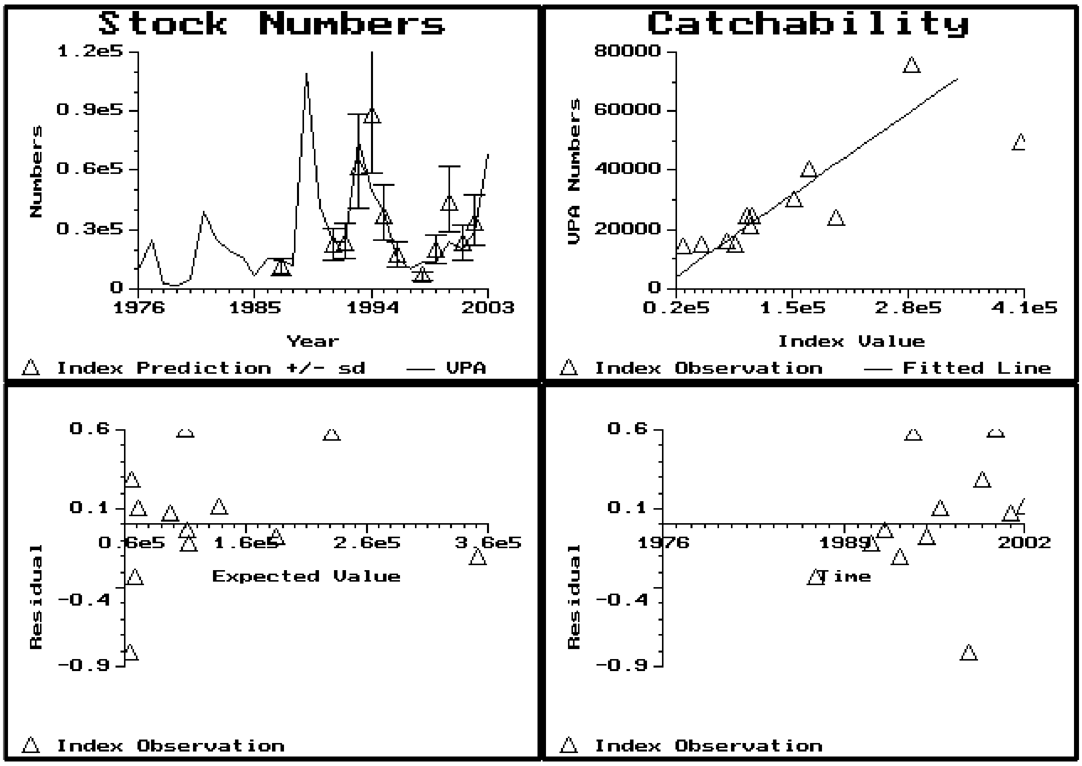


Figure 5.6.14. Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **7 ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 7 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

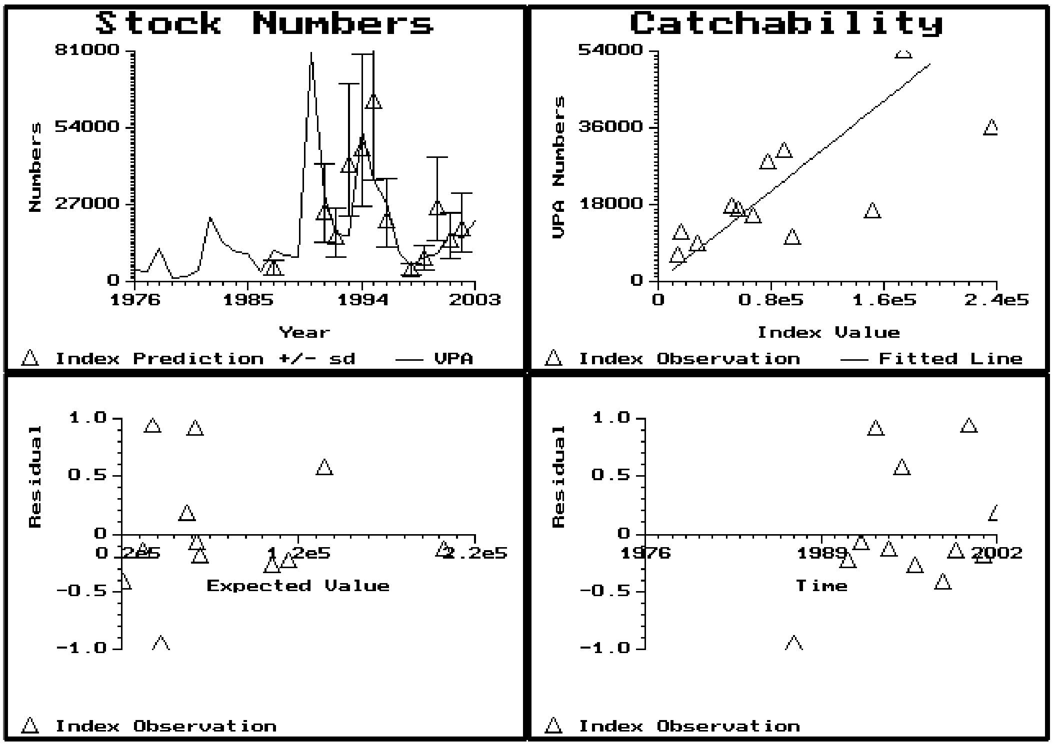


Figure 5.6.15. Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **8 ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 8 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

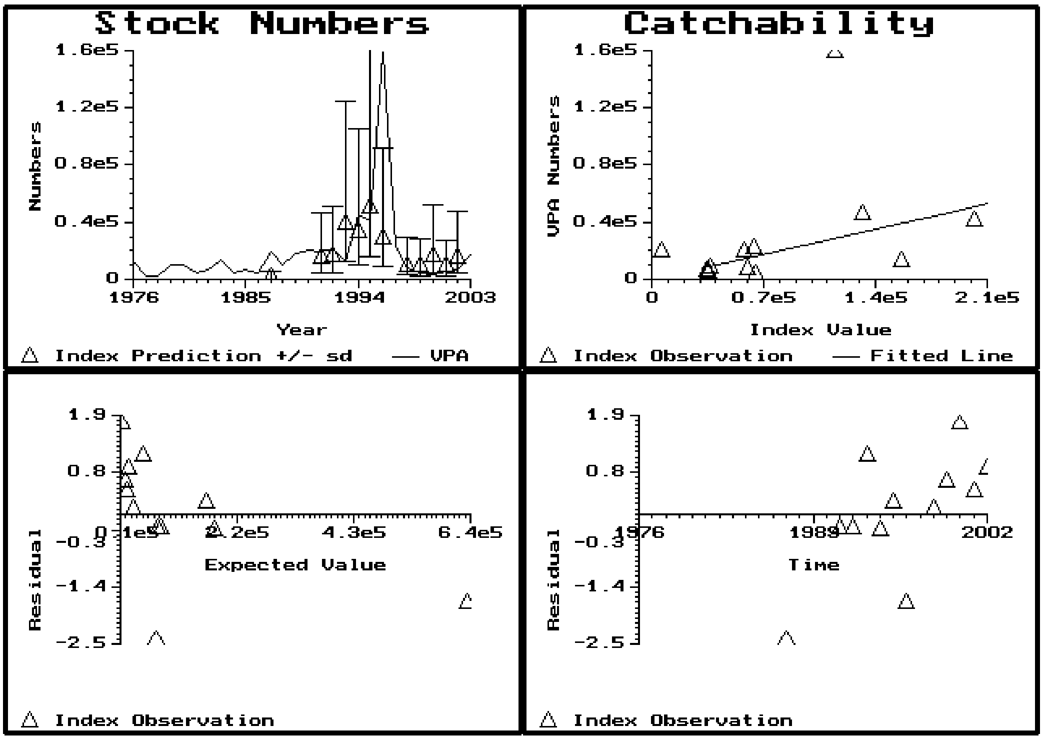


Figure 5.6.16. Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **9 ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 9 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

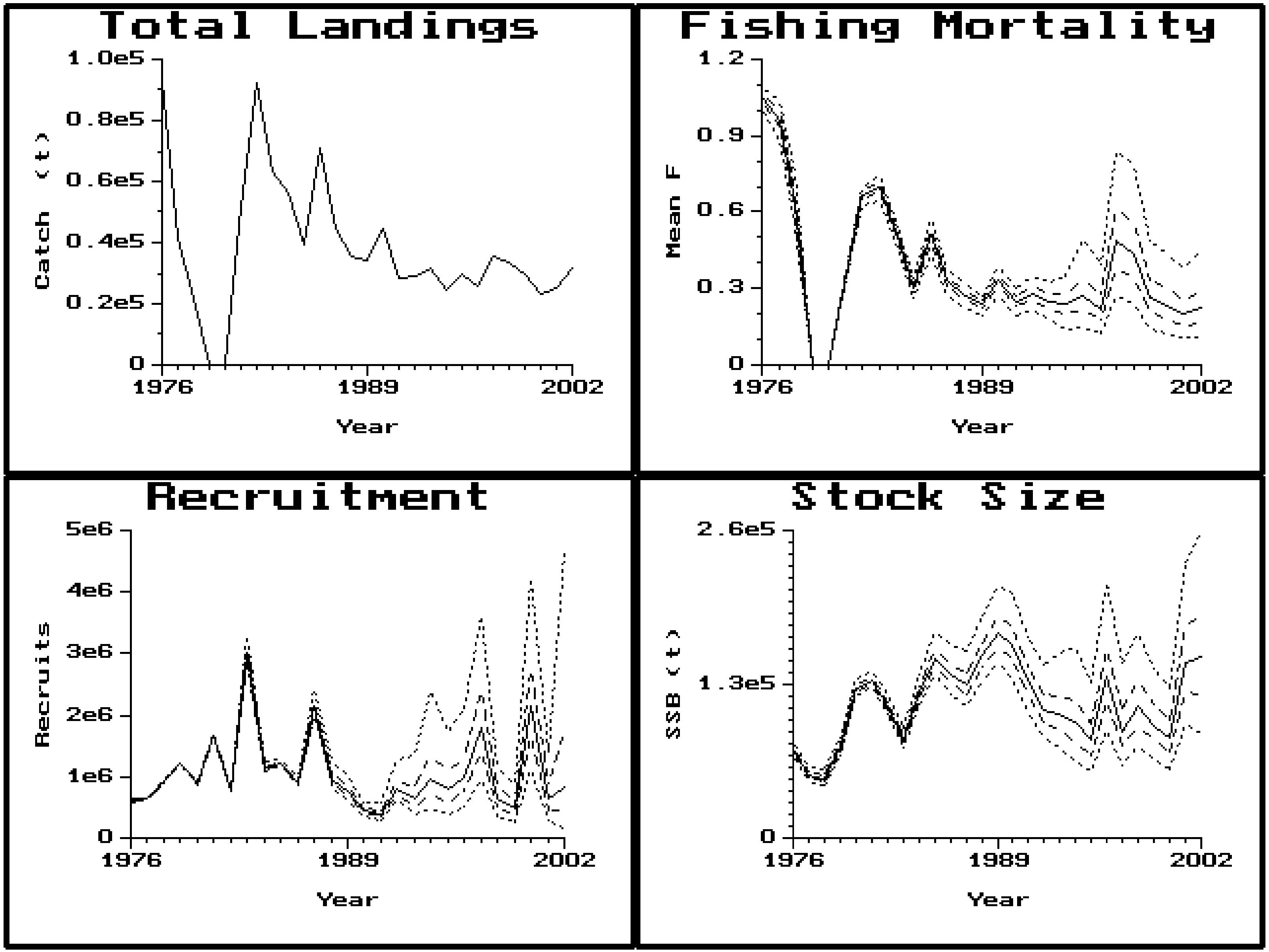


Figure 5.6.17 Herring in VIa (N). Trajectories of 5, 25, 50, 75 and 95 percentiles from the estimates of historical uncertainty of F, SSB and recruits produced in the final assessment. These were based on 1000 samples.

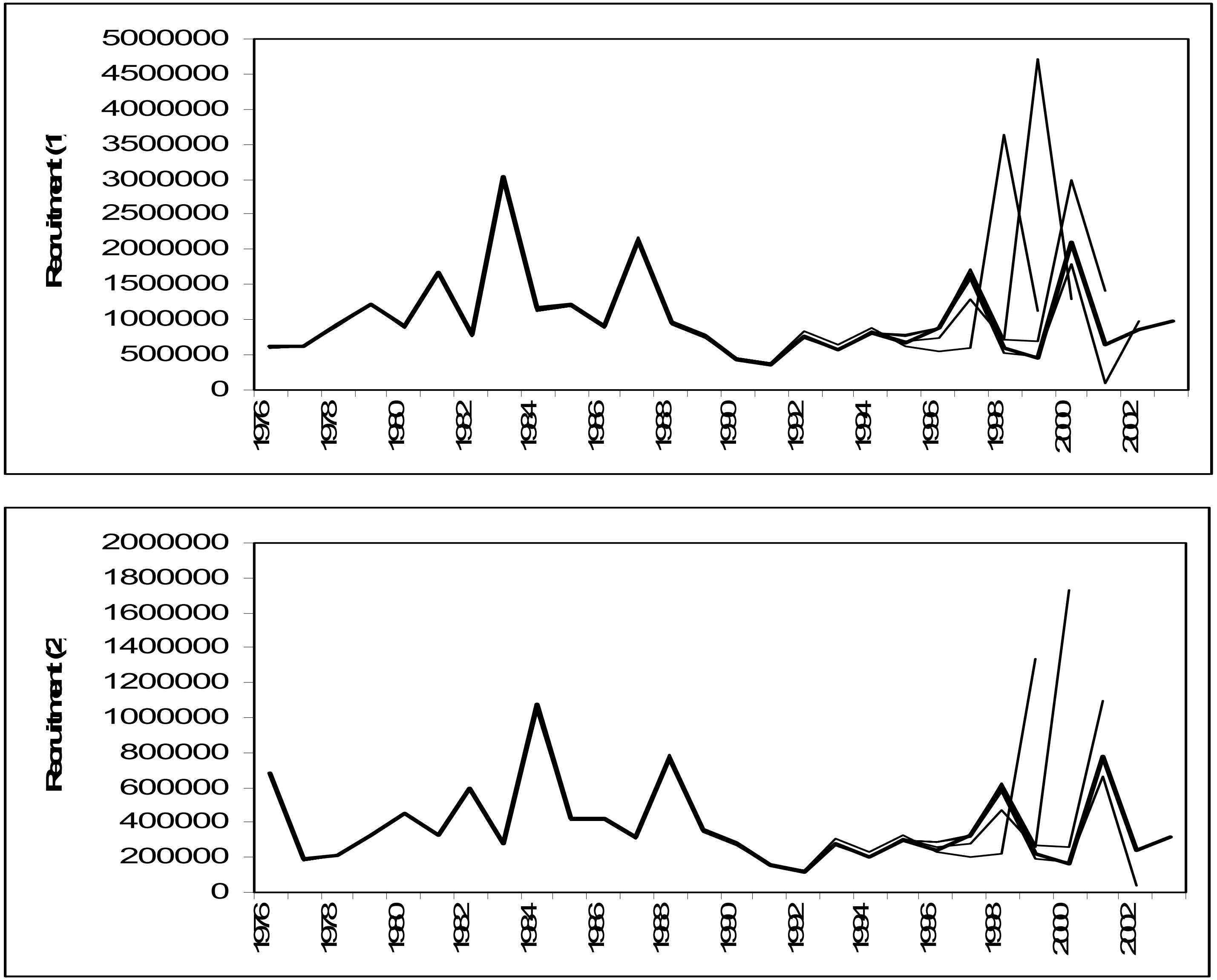
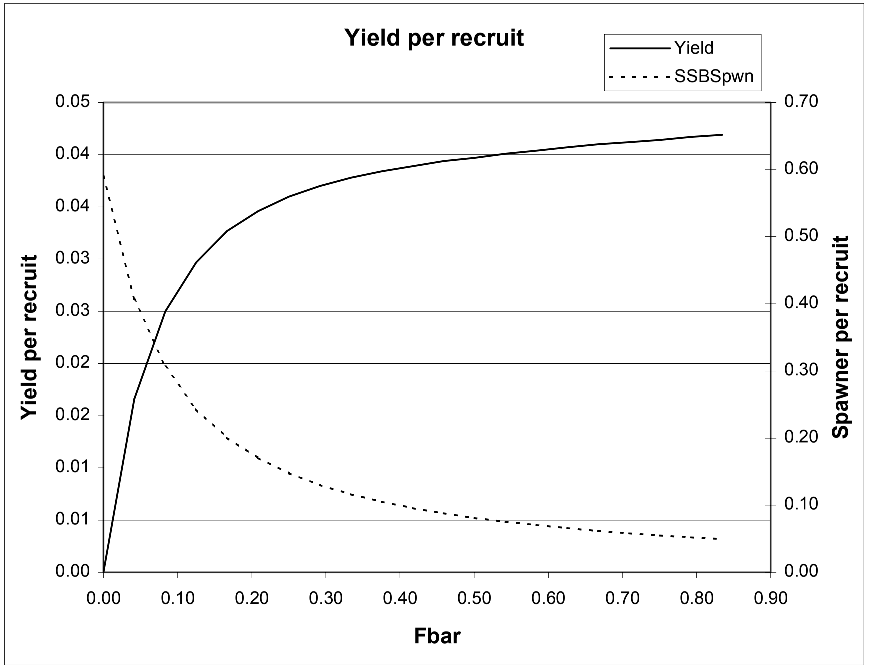
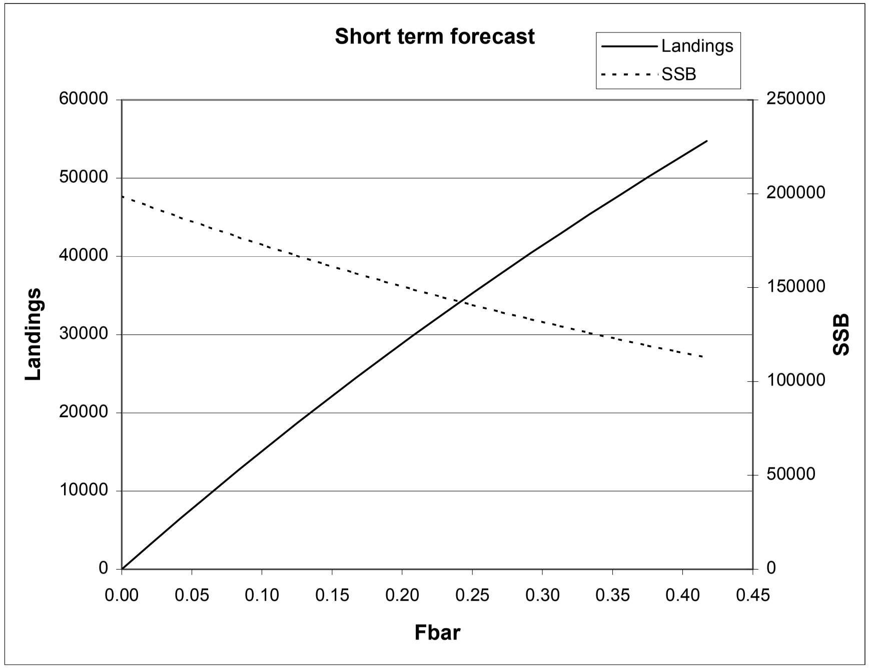


Figure 5.7.1 Herring In VIa (N). Analytical retrospective patterns of recruitment at 1 and 2-ring to show the discrepancy in final year values in each assessment.





MFYPR version 2a
Run: test2
Time and date: 13:54 17/03/2003

Reference point	F multiplier	Absolute F
Fbar(3-6)	1.00	0.21
Fmax		
F0.1	0.79	0.17
F35%SPR	0.75	0.16
Flow	0.48	0.10
Fmed	1.53	0.32
Fhigh	3.91	0.82
Floss	3.84	0.80
FSPR(4)	1.76	0.37

MFDP version 1a
Run: Fsqfinalrun
Herring VIa (north) (run: ICAPGF08/I08)
Time and date: 14:15 15/03/2003
Fbar age range: 3-6

Input units are thousands and kg - output in tonnes

Figure 5.7.2 Herring in VIa (N). Yield-per-recruit and short-term forecast. (Note that $\mathbf{F}_{low}$, $\mathbf{F}_{med}$ and $\mathbf{F}_{high}$ were calculated from the stock and recruit data using the correct time lag of one year for autumn spawning herring).

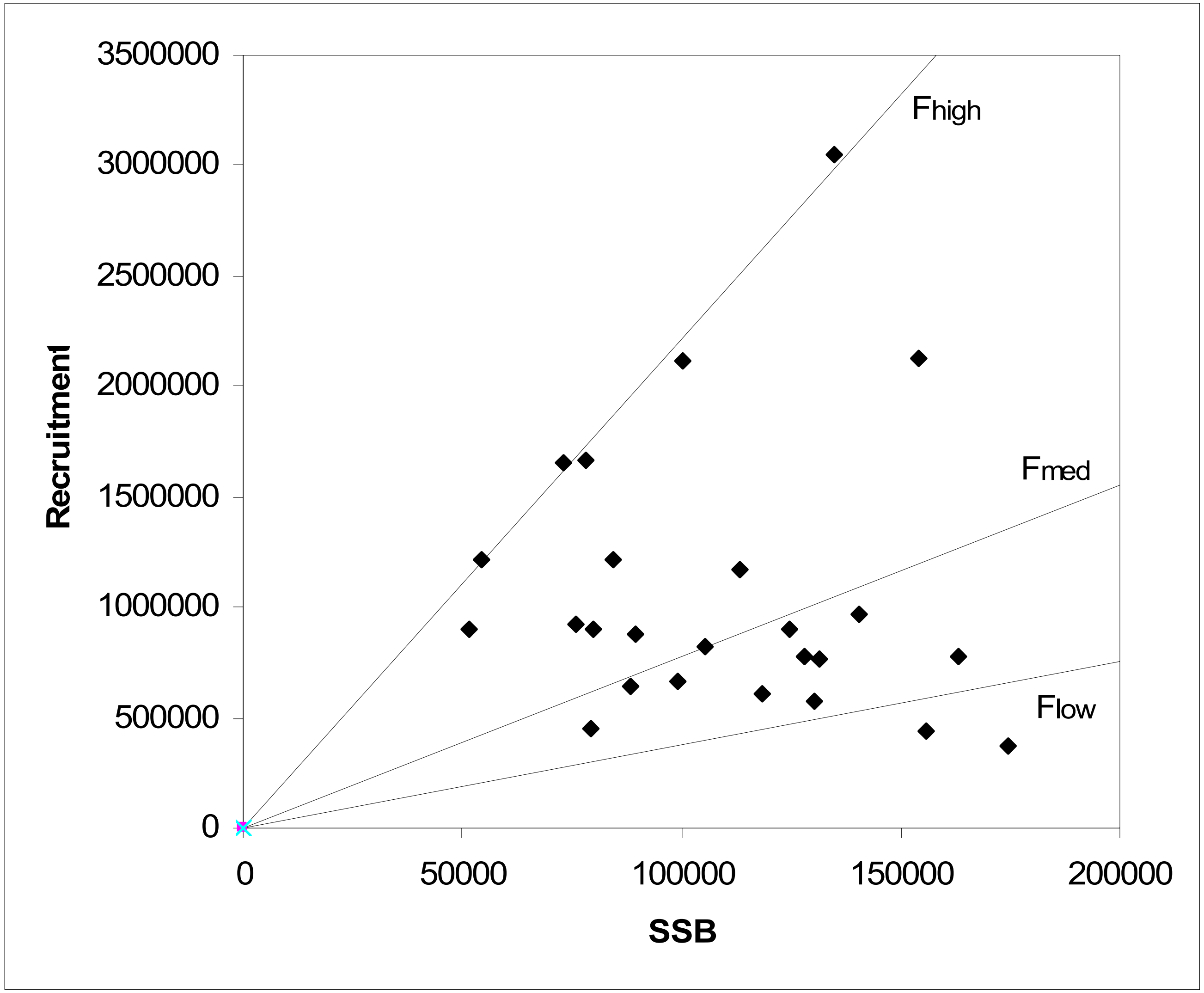


Figure 5.7.3 Herring in VIa (N). Stock-recruit relationship. (assessment years 1976 to 2002). $\mathbf{F}_{low}$ = 0.10 $\mathbf{F}_{med}$ =0.32, $\mathbf{F}_{high}$= 0.82

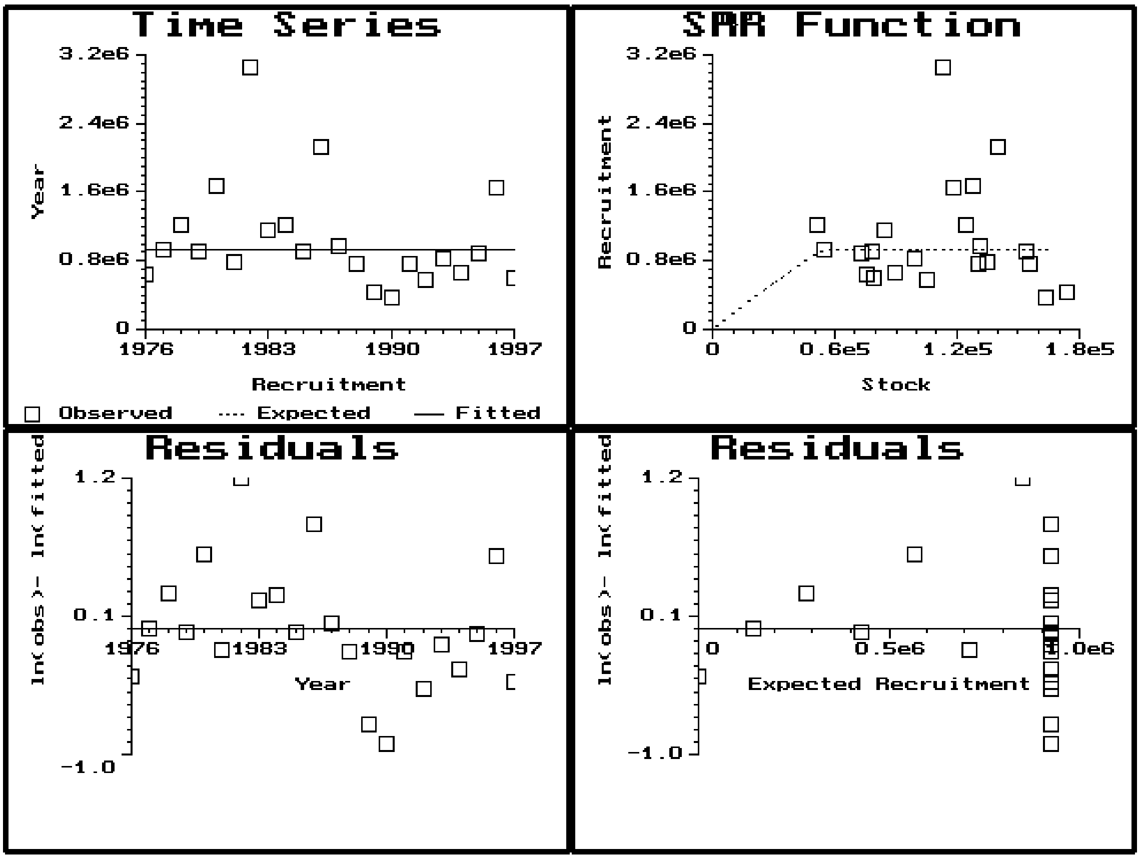


Figure 5.7.4 Herring in VIa (N). Stock-recruit data for input to medium-term projections.

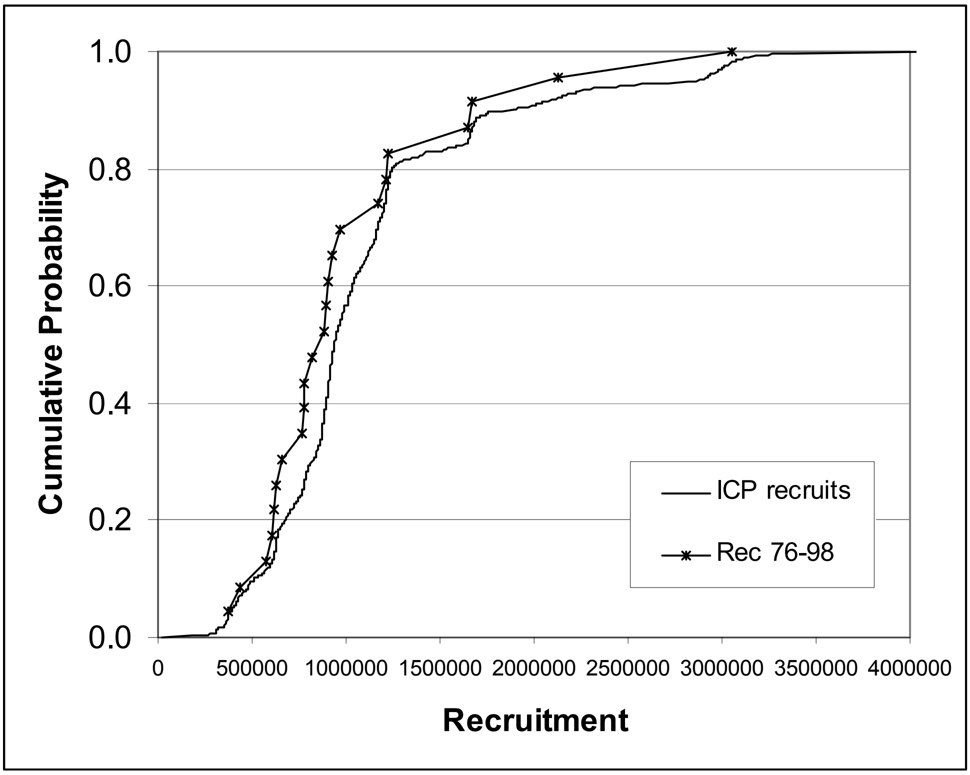


Figure 5.7.5 Herring in VIa (N). Graph to show the good agreement between the cumulative distribution of recruitment from the assessment and the simulated recruitment in ICP.

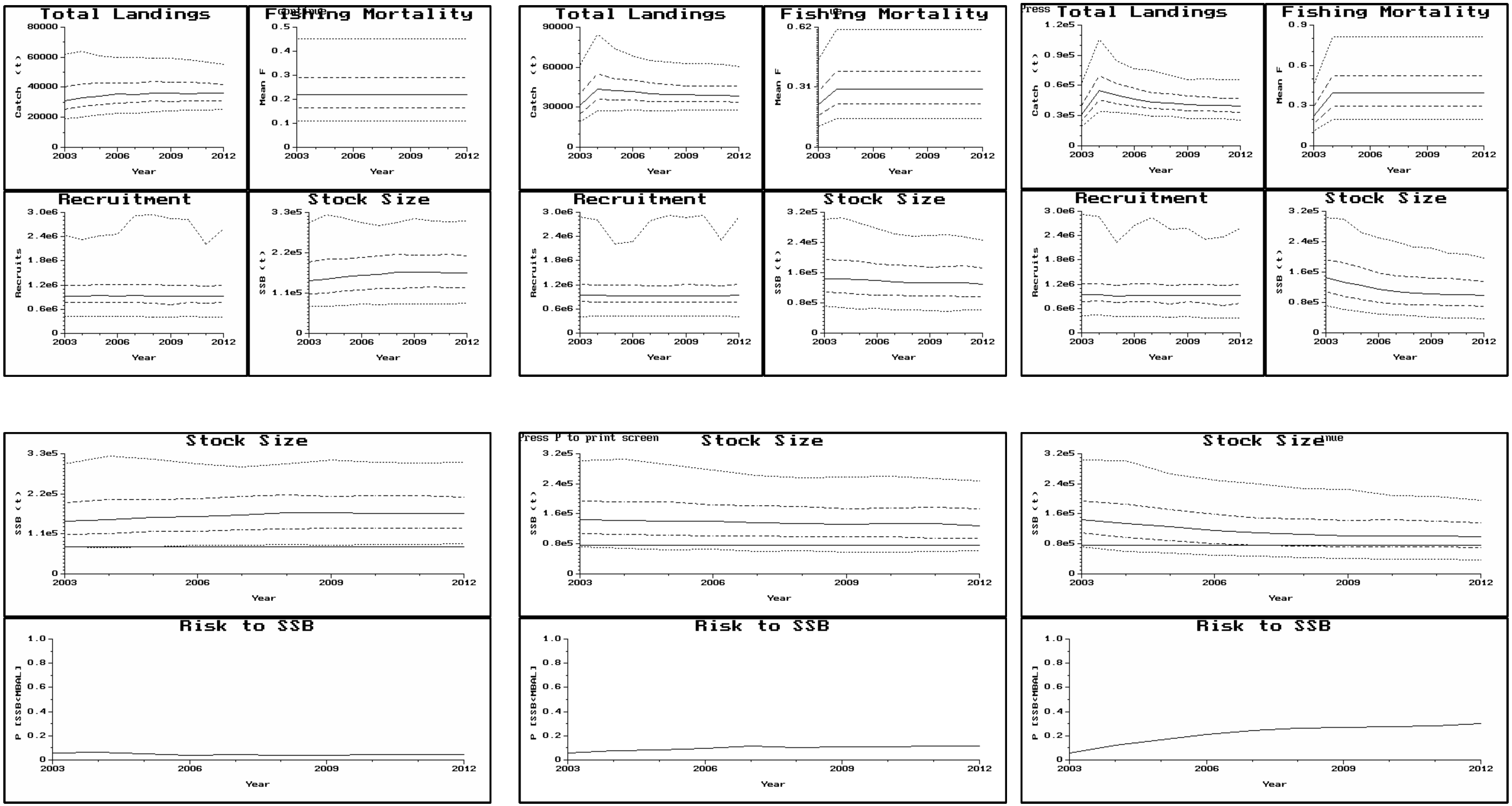
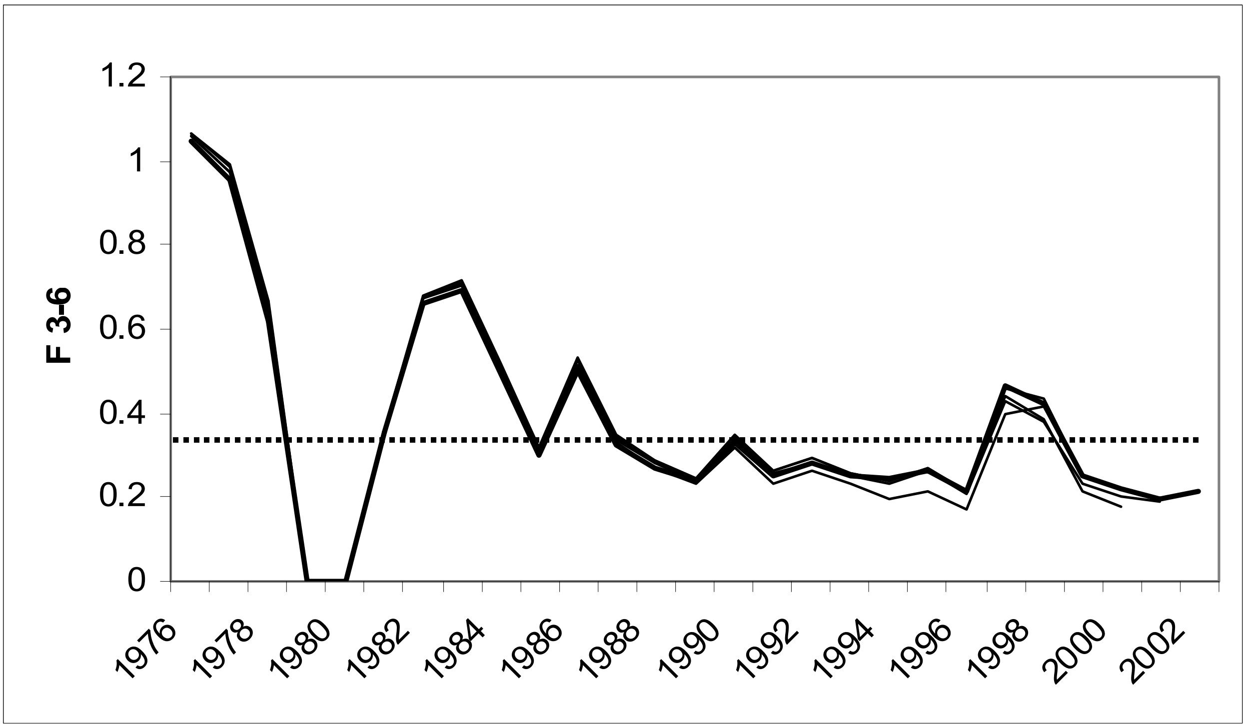


Figure 5.7.6 Herring in VIa (N). Medium-term predictions (upper row) with exploitation at F *status quo* 2003-2012, F *status quo* in 2003 followed by an F multiplier of 1.35 on F*status quo* (F = 0.30) and lastly F *status quo* in 2003 followed by an F multiplier of 1.80 (F = 0.40). Medium-term and risk to SSB decreasing below suggested $\mathbf{B}_{pa}$ with exploitation at F*status quo*, F=0.30 and F=0.40, respectively.



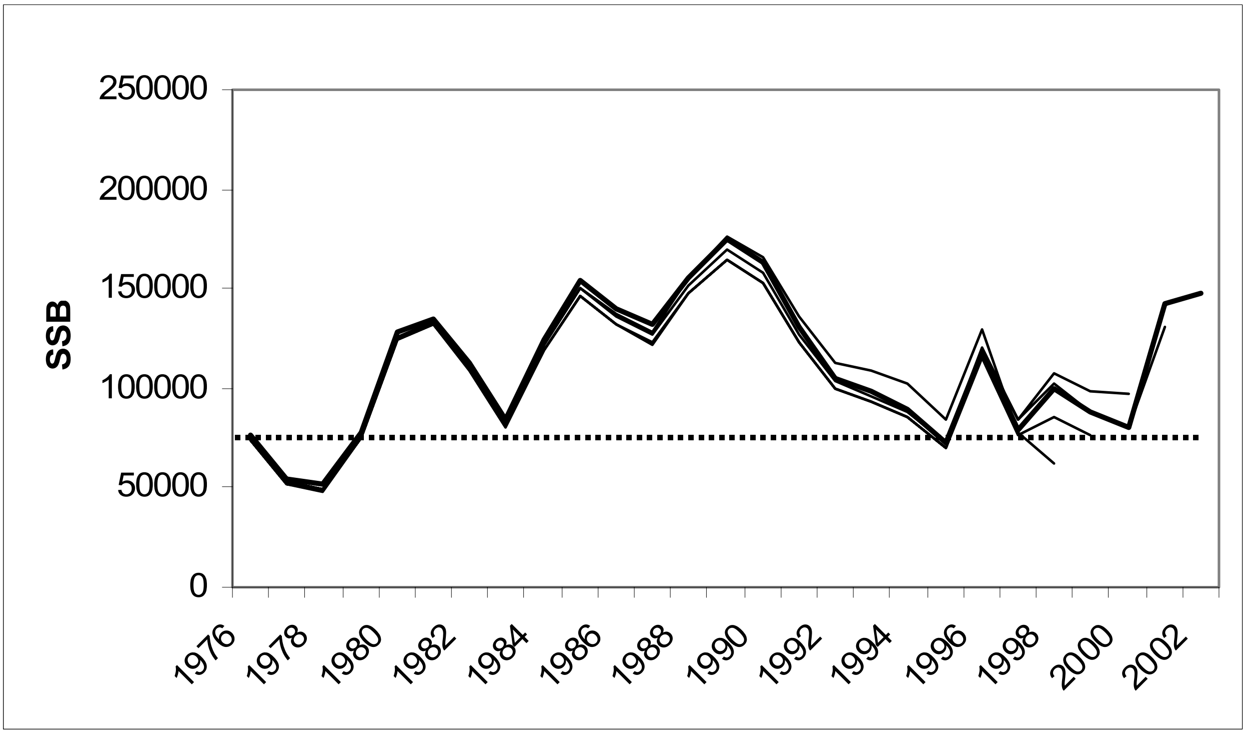


Figure 5.8.1 Herring in VIa (N). Retrospective analysis of the assessment 1998 to 2002. $F_{3\text{-}6}$ and SSB from ICA assessment with 8-year separable period for assessments in 2001 and 2002, 7 years in 2000, 6 years in 1999 and 5 years in 1998, excluding catch in 1993 which appears to have a different selection pattern from later years. Suggested $\mathbf{F}_{pa}$ and $\mathbf{B}_{pa}$ are included on the graphs.

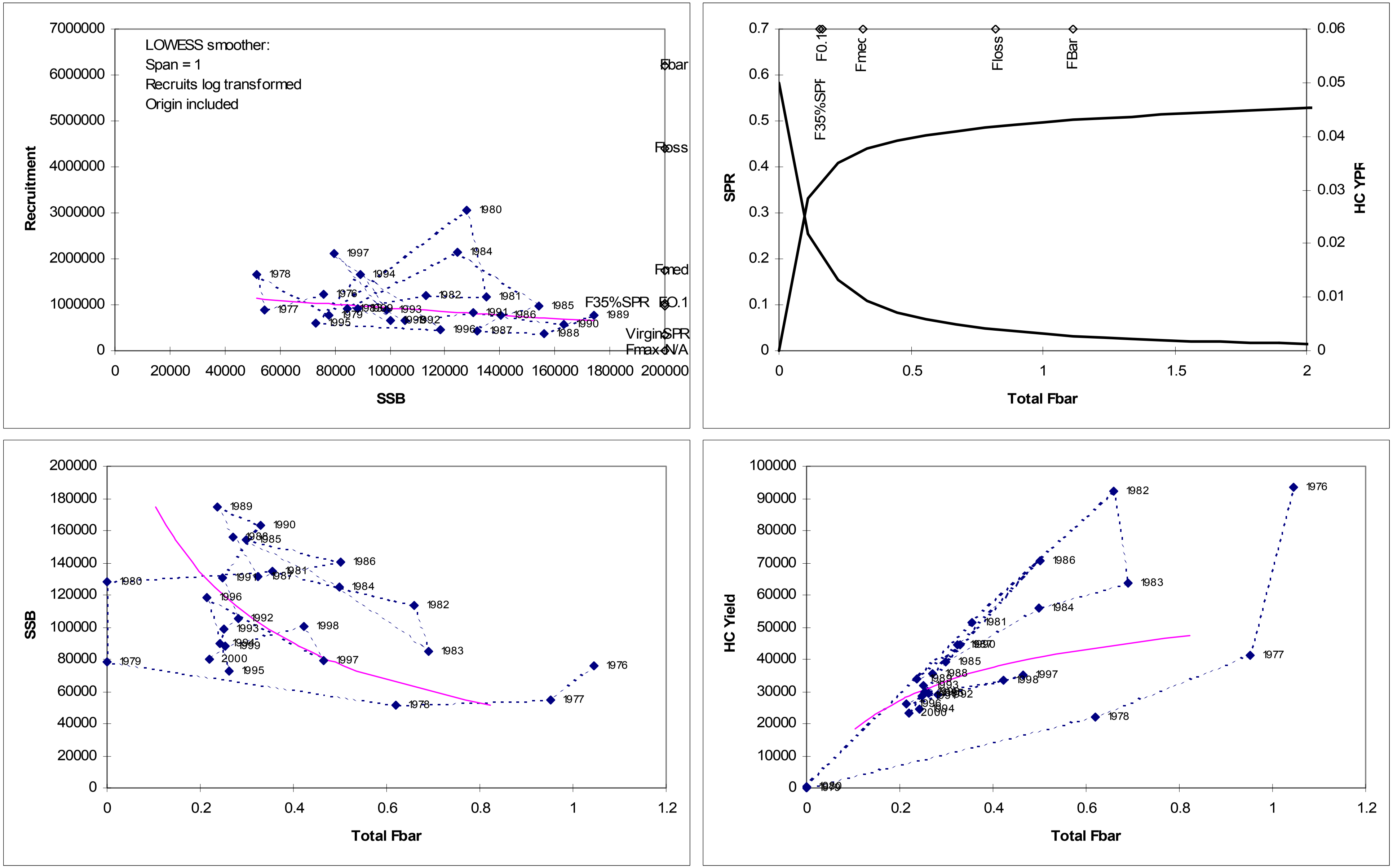


Figure 5.8.2 Herring in VIa (N). PA plots for the assessment period 1976-2002: Recruitment versus SSB, S/R versus Fbar, SSB versus Fbar and Yield / Fbar.

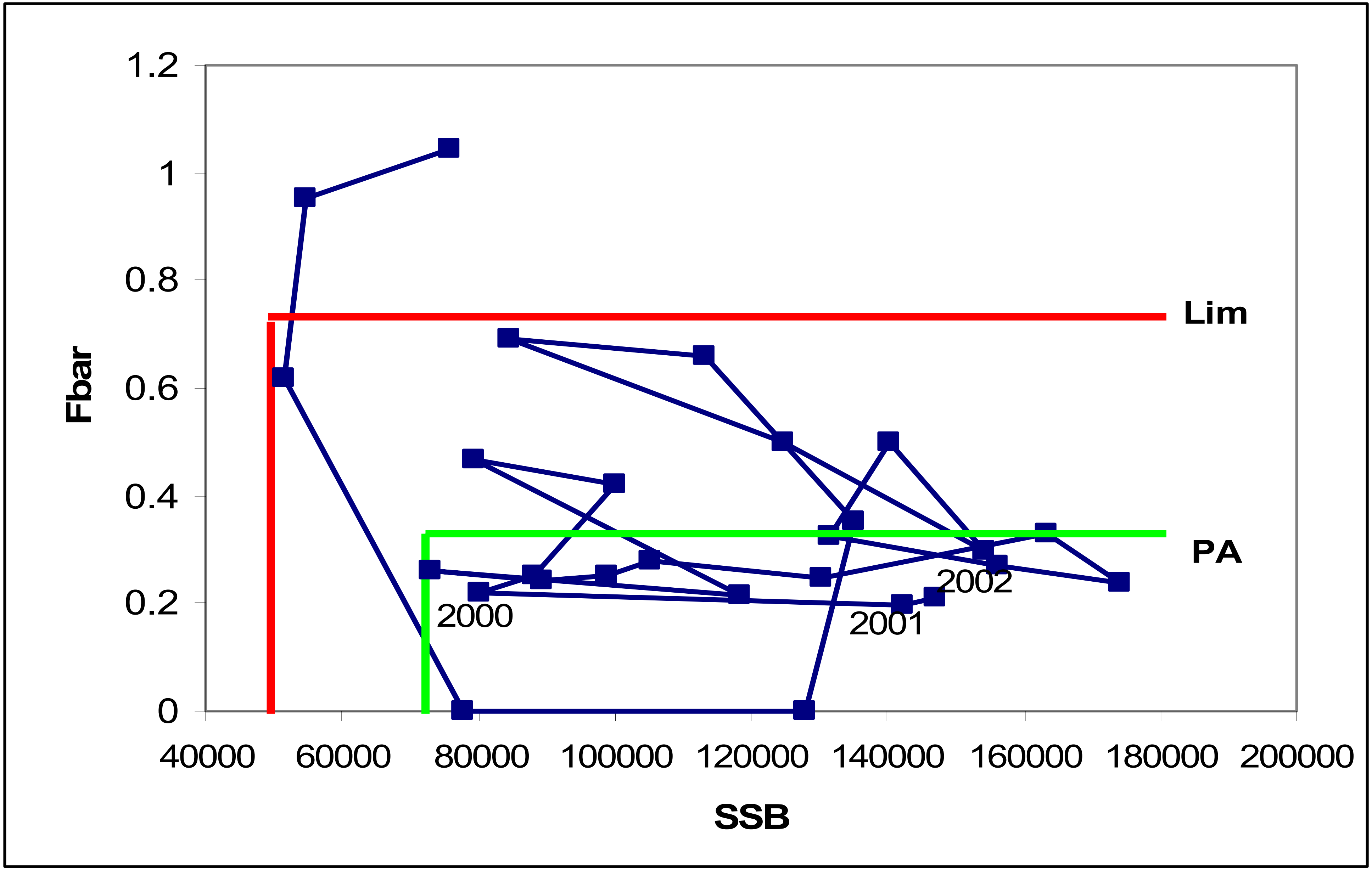


Figure 5.8.3 Herring in VIa (N). Mean F_{3-6} against SSB for the period 1976 to 2002 with proposed LIM and PA reference points.

6 HERRING IN DIVISIONS VIA (SOUTH) AND VIIB,C

6.1 The fishery

6.1.1 Advice and management applicable to 2002 and 2003

The TAC for this area for 2002 was 13,900 t. This was the same TAC as in the previous two years. Prior to this the "precautionary" TAC of 28,000 t was based on the historical catches.

In 2002 ACFM considered the state of the stock to be unknown but that the SSB was likely to be below the proposed $\mathbf{B}_{pa}$. ACFM considered the current F to be in excess of the proposed $\mathbf{F}_{pa}$ but acknowledged that fishing mortality had decreased from a very high level, and that a management and a rebuilding plans were in place. ACFM therefore advised that the catches in 2002 should not exceed 14,000 t. The TAC set by the EU for 2003 was again 13,900 t.

6.1.2 Catches in 2002

The main Working Group landings from this fishery in 2002 are given in Table 6.1.2.1. Fleet based estimates have shown that misreporting has decreased significantly in recent years and is now well below 1,000 t. The total catch recorded for 2002 was about 14,000 t which is the same as last year. This figure is down over 1,000 t on the total for 2000.

The total amount of unallocated catches in 2002 was about 400 t, compared with 700 t in 2001 and about 3,500 t in 2000. The overshoot of the TAC was negligible. Unallocated catches in here not included in this table prior to 2000.

The main reason for the decrease in the total catch was a decrease in the quota, coupled with the decrease in misreported catches.

The catches and landings recorded by each country fishing in this area from 1988–2002 are shown in Table 6.1.2.1 and the total catches from 1970 to 2002 are shown in Figure 6.1.2.1. There were no estimates of discards reported for 2002 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.

6.1.3 The fishery in 2002

The number of Irish vessels that participated in the fishery was the same as in recent years. Landings were reported from the end of October until the year end. The fishery continued in 2003 with landings occurring until late February. Peak landings were reported in the last few weeks of 2002. There were very few landings of fish from Division VIIb after November, as the fish were scarce. This was the same pattern as last year. Winter/Spring-spawning herring were fished off the north coast (Malin Head to Tory Island) and persistent concentrations of shoals were fished in the area north of Lough Swilly from December. Figure 6.1.3.1.

6.2 Biological composition of the catch

6.2.1 Catch in numbers-at-age

The catches-at-age for this fishery since 1970 are shown in Table 6.2.1.1. In recent years the catches in numbers-at-age have been derived mainly from Irish sampling data. Dominant year classes are represented by the 2- and 3-ringers as was the case in 2002. There was a decrease in the number of 4-, 5-, and 6-ringers appearing in the commercial catches. This is most prevalent in the 5-ringers with numbers from the commercial catch down by over 50% compared with 2001. This decrease in the catches of older fish may be due to a concentration of effort on mackerel in the first quarter of 2002.

6.2.2 Quality of the catch and biological data

The management of the Irish fishery in recent years has tightened considerably and the accuracy of reported catches in recent years is believed to have improved. The numbers of samples and the biological data are shown in Table 6.2.2.1. The length distributions of the catches taken per quarter by the Irish fleet are shown in Table 6.2.2.2. Good sampling conditions prevailed in quarter one and quarter four of 2002 with over 100 fish aged per thousand tonnes.

6.3 Fishery-independent Information

6.3.1 Ground Fish Surveys

Ground fish surveys have been carried out during November along the west coast of Ireland since 1993. 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 have not yet been properly evaluated.

6.3.2 Acoustic Surveys

Acoustic surveys were carried out on this stock during the period 1994–1996. 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. There were no surveys in 1997 & 1998. Acoustic surveys were undertaken again in 1999 and annually since. Details of these surveys are given in Molloy and Kelly WD 2000 (refer to ICES 2000 ACFM:12).

Analysis of the commercial catch data over the past six years indicates that an increasing proportion of the catch is taken in the spring. In order to provide a more accurate estimate of spring-spawning herring a further survey was carried out in March 2002 in Divisions VIa(S) and VIIb (Figure 6.3.2.1). The results of this survey indicate that the timing of the survey did not coincide with the peak spawning time for this component. Bad weather delayed the start of the survey until 1st March and the majority of fish encountered were spent and were mostly offshore, indicating that fish were migrating and possibly outside the survey area (Figure 6.3.2.2). This is further substantiated by the occurrence of fish at the end of offshore transects in VIa(S). Consequently, the entire stock may have not been contained within the survey area and estimates must be treated with caution. As this was the first survey to be carried out at this time of year there is no time-series of data with which to make comparisons. Fishing success was good and the majority of the estimate was attributed to definite herring marks, relating to over 68% of the total biomass estimate. The dominant year classes were composed of 3-ringers (1998 year class) at 24% biomass, 4-ringers (1997 year class) and 1-ringers (2000 year class) featuring strongly, comprising 19% and 11% of biomass respectively. The total SSB for the spring-spawning component was estimated at 7,200 tonnes.

In November/December 2002 an acoustic survey was carried out in VIa(S) and VIIb-c. This survey had fewer problems with gear and area coverage than in previous years and the intended survey track was completed. However, it still failed to produce a realistic estimate of SSB (28,400 t). The dominant year class was composed of 2-ringers (1999 year class) at 40% biomass. Other prominent year classes were composed of 1-ringers and 3-ringers representing 15% and 24% of biomass, respectively. The survey track and post plots from this survey are shown in Figure 6.3.2.3 and Figure 6.3.2.4.

In March a survey was carried out on the spring-spawning component of this stock for 2003. The results will be available to the group in March 2004.

6.4 Mean weights-at-age

The mean weights (kg) at age in the catches in 2002 are based on Irish catches and are very similar to 2001 for ringers 1-6 (Table 6.4.1).

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 (Table 6.4.2). These fish are also lighter at 3-4-ringers than in 2001.

6.5 Recruitment

There are currently no recruitment indices available for this stock. However, an Irish ground fish survey conducted in the 4th quarter since 1996 regularly catches herring. The data from this survey series will be investigated as a potential 1-ringer index and a presentation will be made to the HAWG in 2004.

6.6 Stock Assessment

Tuned assessments have not been carried out on this stock for a number of years because of the absence of a useable index. Recent WGs have therefore only carried out VPA analyses to study the development of the stock and only tentative stock projections have been made. The stock was considered to comprise 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 last century, but the autumn spawners dominated in the sixties and seventies. In recent years both components have been present but increasing catches have been made on the winter/spring spawners. An analysis of the development of the two components that constitute the stock was carried out in 1999 and this concluded that there may not in fact be two separate stock components because of the similarities in recruitment and age distributions. It was believed therefore that the increase in the winter/spring spawners could be due to a gradual change in spawning time rather than the emergence of a new spawning component.

6.6.1 Date exploration and preliminary assessments

As in the last years, the WG explored ISVPA (Kizner and Vasilyev 1997, Vasilyev *et al,* 2000) as a possible means of assessing the stock using only catch numbers-at-age data. The latest version (Version 4.3) was used, which is the version that was presented to the Methods WG earlier this year (ACFM 2003 D:O3).

The ISVPA model is designed specifically to assess stocks where only catch-at-age data are available. Instead of assuming the fishing mortality to be separable, it considers the instantaneous mortality:

$$\varphi_{a,y} = C(a,y)/(N(a,y)*exp(-M(a,y)/2)$$

and regards phi as separable:

$$\varphi_{a,y} = G(y)*s(a)$$

In addition, it puts constraints on the matrix of phi residuals. The standard constraint is that all row sums and all column sums in the matrix of phi residuals be zero, but other constraints are possible. The objective function which is minimised is the median of the squared log catch residuals. Using the median instead of the sum renders the estimate more robust to outliers in the data (Kizner and Vasilyev 1997, Vasilyev *et al,* 2000).

ISVPA relies on a separable model for the 'instantaneous mortality' $\varphi_{a,y}$, which is the fraction of the abundance of the *a*-th age group, taken as catch in the middle of the year *y*. There is a direct correspondence between φ -values and fishing mortalities. In addition, there is the constraint that each row and column in the matrix of residuals shall sum to zero, which allows for a unique solution of the parameters in the model. There are several options for which residuals this shall apply to. Within this framework, ISVPA has two alternative ways of arriving at stock numbers and fishing mortality. In the version called "effort-controlled", the errors are attributed to the catch-at-age data. Thus, this is a strictly separable model. In the version called the "catch-controlled", errors are attributed to the separable model of fishing mortality. This is effectively a VPA but uses the separable model to arrive at terminal fishing mortalities.

The WG explored both versions for the catch data of herring in Division VIaS and VIIbc. In both cases, the objective function to be minimised was the median of the squared log catch residuals. The response curves for the fit as function of the terminal φ is shown in Figure 6.6.1.1. Both approaches give a distinct minimum, but at quite different levels of φ. The selections at age were virtually equal in the two cases. With the effort-controlled version, there were very strong year class patterns in the residuals, both of the catch and the φ -values. The catch-controlled version gave better-behaved residuals, but indicated rapidly declining recruitments in recent years, along with a rapidly increasing fishing mortality.

These runs were compared with a series of runs with the standard separable VPA (Pope and Shepherd 1982), screening over a range of terminal fishing mortalities. The selection at oldest age was assumed equal to that at reference age, and the terminal fishing mortality was set a 0.6, which is close to the estimate by the effort-controlled version of ISVPA. The difference in numbers-at-age by year class between each of the ISVPA runs and the separable VPA, relative to the separable VPA numbers, are plotted in Figure 6.6.1.2. Apart from the most recent year classes, the catch-controlled version gives numbers in accordance with the separable VPA, which is to be expected. The effort-controlled version estimates some year classes consistently lower, other consistently higher, than the separable VPA, which is in accordance with the patterns in the residuals with this method.

The WG concluded that the catch-controlled version of ISVPA gave a perception of recent recruitment failure for which there is no indication in the fishery. The effort-controlled version indicated a relatively stable fishing mortality in the last few years, at a level which is consistent with previous assessments, but the residual pattern and the fact that the abundance estimates of some year classes is incompatible with the appearance of these year classes in the fishery, precludes this as a candidate for the final assessment (see Figures 6.6.1.3 –6.6.1.7).

6.6.2 Results of the assessment

Given the current uncertainty about the level of terminal fishing mortality, the Working Group returned to the practice of carrying out separable VPA's using a range terminal F value's to illustrate the current development of the stock. The period of 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. Consistent with previous years' assessments the weight of the 1-ringers was reduced to account for poor selectivity at this age. An example assessment output given in Tables 6.6.2.1. and 6.6.2.2.

The general development of the stock is in the past 2 assessments is shown in Figure 6.6.2.1. This development shows a spawning stock which has declined from 1988 to 1996 and the trend since is dependent on the assumption on terminal F. Recruitment patterns show two very strong year classes, those of 1981 and 1985, and recruitment may have been below average in the late nineties. The values of F fluctuated between 1970 and 1996. F increased in the late 80's to a high in 1998 and has subsequently decreased.

From this year's assessment an F as low as 0.2 looks unlikely as this is only explained by blowing up the recruitment in the recent past. An F higher than 0.6 is explained if recruitment has declined significantly in recent years, and there is no strong evidence of this from the catch data. The sharp rise and subsequent drop in F from 2000 to 2002 may be due to inconsistent fishing patterns by the fleet. A spring-spawning aggregation, which traditionally is composed of large and relatively old fish, was targeted in 2001 but not in 2002 due to the availability of mackerel at the time. This absence of older fish in the catches is interpreted as a mortality signal.

6.7 Stock Forecasts and Catch Predictions

The present assessment is based on a crude analysis, therefore the WG felt that it was not useful to present short-term predictions. However, for illustrative purposes only a short-term prediction using the TAC in 2003 as a catch constraint is provided. Tables for the inputs and single option and management options are given in Tables 6.7.3.1, 6.7.3.2, and 6.7.3.3, respectively.

6.8 Medium-term Projections

It has not been possible to carry out medium-term projections for this stock because of the absence of information. A management plan is currently being implemented to rebuild this stock. More specific advice will not be possible until more information becomes available on stock sizes.

6.10 Reference Points

As this assessment is still uncertain there was no revision of the precautionary reference points. The precautionary reference points for this stock were discussed in the 1999 Working Group Report (ICES 1999 ACFM:12). The present analysis, although it is uncertain, presents a similar picture of the stock as that shown in recent years. The SGPRP (ICES 2003 ACFM 15) has reviewed the methodology for the calculation of biological reference points, and applying a segmented regression to the stock and recruit data from the 2002 HAWG assessment showed that the fit to the stock and recruit data for this stock was not significant. This may be due to the fact 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 (see section 1.4.2). The stock may be still below $\mathbf{B}_{pa}$ (110,000 t) but the fishing mortality has been reduced.

6.11 Quality of the Assessment

The exploration of the stock status presented here does not constitute a tuned assessment. The only data used for this exploration is the catch in numbers-at-age. In the absence of a tuning index it is impossible to scale the SSB or F's to an independent measure. Therefore caution should be applied when referring to specific values of F or SSB.

6.12 Management Considerations

The results of the non-tuned assessment suggest that the sharp decline in SSB may have stopped but the current level of SSB is uncertain. There is no evidence of large year classes have recruited to the stock in recent years and F appears to have been reduced due to the reduction in catch. Traditionally the fisheries in this area, which were extremely important in the early part of the last 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. Over the past several years the fishery has shifted to the winter/spring period again. The management of the Irish fishery (which takes most of the catch) has improved over the past year and catches have been considerably reduced since 1999. The Irish fishery is operated on a closed season basis and individual boat quotas are applied. On scientific advice the Irish fishery was closed in early in February 2002 by the Irish Northwest Pelagic Management Committee (NWPMC), and was reopened in October. Misreporting appears to have reduced and the total catches are now in line with the reduced TAC. The Irish NWPMC has stated the following management objectives: “*As regards the herring stock in this area the management policy of the North West Pelagic Management Committee is to rebuild the stock to above the* $\boldsymbol{B}_{pa}$ *level of 110,000 t (*$\boldsymbol{B}_{pa}$ *is the minimum safe stock size). The time period over which this rebuilding process can be achieved will depend on annual catches and recruitment. In the longer term it is the policy of the committee to further rebuild the stock to the level at which it can sustain annual catches of around 25,000 t. This rebuilding process will be based on scientific advice. In the event of the stock remaining below the required level additional conservation measures will be implemented. It is the policy of the committee to ensure that adequate research is carried out, including sampling and surveys, to enable an accurate assessment of the stock*”.

The HAWG notes that increased accuracy in the catch data over the past 3 years gives a greater confidence in the perception of stock development. The HAWG also notes that the reduced catches over this period have resulted in a reduction in fishing mortality, although it is not possible to be precise about the current levels.

Table 6.1.2.1 VIa(S) & VIIb,c. Estimated Herring catches in tonnes, 1988–2002. 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
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

Country	2000	2001	2002
France	-	-	515
Germany	-	-	-
Ireland	10,164	11,278	13,072
Netherlands	1,234	2,088	366
UK	-	-	-
Unallocated	3,607	695	366
Total landings	15,005	14,060	13586.9
Discards	-	-	-
Total catch	15,005	14,060	13586.9

Table 6.2.1.1 VIa(S) & VIIb,c herring. Catch in numbers-at-age (ringers) from 1970 to 2002. NB In this table "age" refers to number of rings (winter rings in otolith).

Years	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1970	135	35114	26007	13243	3895	40181	2982	1667	1911
1971	883	6177	7038	10856	8826	3938	40553	2286	2160
1972	1001	28786	20534	6191	11145	10057	4243	47182	4305
1973	6423	40390	47389	16863	7432	12383	9191	1969	50980
1974	3374	29406	41116	44579	17857	8882	10901	10272	30549
1975	7360	41308	25117	29192	23718	10703	5909	9378	32029
1976	16613	29011	37512	26544	25317	15000	5208	3596	15703
1977	4485	44512	13396	17176	12209	9924	5534	1360	4150
1978	10170	40320	27079	13308	10685	5356	4270	3638	3324
1979	5919	50071	19161	19969	9349	8422	5443	4423	4090
1980	2856	40058	64946	25140	22126	7748	6946	4344	5334
1981	1620	22265	41794	31460	12812	12746	3461	2735	5220
1982	748	18136	17004	28220	18280	8121	4089	3249	2875
1983	1517	43688	49534	25316	31782	18320	6695	3329	4251
1984	2794	81481	28660	17854	7190	12836	5974	2008	4020
1985	9606	15143	67355	12756	11241	7638	9185	7587	2168
1986	918	27110	24818	66383	14644	7988	5696	5422	2127
1987	12149	44160	80213	41504	99222	15226	12639	6082	10187
1988	0	29135	46300	41008	23381	45692	6946	2482	1964
1989	2241	6919	78842	26149	21481	15008	24917	4213	3036
1990	878	24977	19500	151978	24362	20164	16314	8184	1130
1991	675	34437	27810	12420	100444	17921	14865	11311	7660
1992	2592	15519	42532	26839	12565	73307	8535	8203	6286
1993	191	20562	22666	41967	23379	13547	67265	7671	6013
1994	11709	56156	31225	16877	21772	13644	8597	31729	10093
1995	284	34471	35414	18617	19133	16081	5749	8585	14215
1996	4776	24424	69307	31128	9842	15314	8158	12463	6472
1997	7458	56329	25946	38742	14583	5977	8351	3418	4264
1998	7437	72777	80612	38326	30165	9138	5282	3434	2942
1999	2392	51254	61329	34901	10092	5887	1880	1086	949
2000	3101	26133	29430	23216	10090	2068	1107	522	1211
2001	2207	20694	20754	16707	17581	9484	1659	979	484
2002	3093	24878	28772	14392	8859	7786	2094	1223	491

Table 6.2.2.1 Divisions VIa (S) and VIIb,c. Sampling intensity of herring catches in 2002.

Country	Q	Catch (t)	No. of samples	No. of age readings	No. of fish measured	Aged per 1000 t.	Estimate of discards
Ireland	1	7,458	7	780	3287	105	No
	2	14	0	0	0	0	No
	3	10	0	0	249	0	No
	4	4,467	26	763	3112	171	No

Table 6.2.2.2 VIa(S) and Division VIIb,c herring. Length distribution of Irish catches/quarter (thousands) 2002.

	VIIb	VIaS	
Length	Q1 2002	Q1 2002	Q4 2002
19			
19.5		23	114
20		46	0
20.5		130	343
21	43	222	2172
21.5	43	283	4230
22	43	329	7088
22.5	43	413	11090
23	43	581	10976
23.5	86	1063	15206
24	86	1767	27554
24.5	300	2126	38529
25	214	2730	50305
25.5	214	3052	38872
26	129	3136	43788
26.5	171	3082	31784
27	171	3166	36929
27.5	129	2753	24581
28	171	2264	26182
28.5	257	1377	17721
29		658	12462
29.5		252	4459
30		199	2287
30.5		138	686
31		145	114
31.5		130	114
32		275	
32.5		199	
33		130	
33.5		23	
34		15	
34.5		8	
35		0	
35.5		8	
Totals:	2143	30723	407586

Table 6.4.1 VIa(S) & VIIb,c herring. Mean weight-at-age in the catch. NB In this table "age" refers to number of rings (winter rings in otolith).

Years	**Age 1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1970	0.11	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1971	0.11	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1972	0.11	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1973	0.11	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1974	0.11	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1975	0.11	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1976	0.11	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1977	0.11	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1978	0.11	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1979	0.11	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1980	0.11	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1981	0.11	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1982	0.11	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1983	0.09	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1984	0.106	0.141	0.181	0.21	0.226	0.237	0.243	0.247	0.248
1985	0.077	0.122	0.161	0.184	0.196	0.206	0.212	0.225	0.23
1986	0.095	0.138	0.164	0.194	0.212	0.225	0.239	0.208	0.288
1987	0.085	0.102	0.15	0.169	0.177	0.193	0.205	0.215	0.22
1988	0	0.098	0.133	0.153	0.166	0.171	0.183	0.191	0.201
1989	0.08	0.13	0.141	0.164	0.174	0.183	0.192	0.193	0.203
1990	0.094	0.138	0.148	0.16	0.176	0.189	0.194	0.208	0.216
1991	0.089	0.134	0.145	0.157	0.167	0.185	0.199	0.207	0.23
1992	0.095	0.141	0.147	0.157	0.165	0.171	0.18	0.194	0.219
1993	0.112	0.138	0.153	0.17	0.181	0.184	0.196	0.229	0.236
1994	0.081	0.141	0.164	0.177	0.189	0.187	0.191	0.204	0.22
1995	0.08	0.14	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	0.22	0.233	0.237
1997	0.093	0.135	0.155	0.181	0.201	0.217	0.217	0.231	0.239
1998	0.095	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	0.2	0.216	0.222
2000	0.102	0.129	0.154	0.172	0.18	0.184	0.204	0.203	0.204
2001	0.09	0.12	0.14	0.17	0.18	0.19	0.22	0.22	0.21
2002	0.10	0.13	0.14	0.16	0.17	0.20	0.20	0.22	0.23

Table 6.4.2 Mean weight in the stock for herring in VIaS and VIIb,c. NB In this table "age" refers to number of rings (winter rings in otolith).

Years	**Age 1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1970	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1971	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1972	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1973	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1974	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1975	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1976	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1977	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1978	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1979	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1980	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1981	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1982	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1983	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1984	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1985	0.1	0.15	0.196	0.227	0.238	0.251	0.252	0.269	0.284
1986	0.098	0.169	0.209	0.238	0.256	0.276	0.28	0.287	0.312
1987	0.097	0.164	0.206	0.233	0.252	0.271	0.28	0.296	0.317
1988	0.097	0.164	0.206	0.233	0.252	0.271	0.28	0.296	0.317
1989	0.138	0.157	0.168	0.182	0.2	0.217	0.227	0.238	0.245
1990	0.113	0.152	0.17	0.18	0.2	0.217	0.225	0.233	0.255
1991	0.102	0.149	0.174	0.19	0.195	0.206	0.226	0.236	0.248
1992	0.102	0.144	0.167	0.182	0.194	0.197	0.214	0.218	0.242
1993	0.118	0.166	0.196	0.205	0.214	0.22	0.223	0.242	0.258
1994	0.098	0.156	0.192	0.209	0.216	0.223	0.226	0.23	0.247
1995	0.09	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	0.21	0.224	0.231	0.23	0.239
1998	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	0.2	0.222	0.23	0.24	0.246
2000	0.1	0.134	0.157	0.177	0.197	0.207	0.217	0.23	0.245
2001	0.091	0.125	0.15	0.172	0.191	0.2	0.203	0.203	0.216
2002	0.092	0.127	0.146	0.17	0.19	0.201	0.21	0.227	0.229

Table 6.6.2.1 VIa(S) and Division VIIb,c. Outputs from the separable VPA with F2003=0.6. NB In this table age refers to number of rings (winter rings in otolith).

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:15

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR,	1970,	1971,	1972,
AGE			
1,	.0005,	.0017,	.0022,
2,	.3825,	.0492,	.1176,
3,	.2420,	.1290,	.2424,
4,	.1780,	.1431,	.1521,
5,	.1692,	.1550,	.1917,
6,	.1479,	.2306,	.2369,
7,	.1897,	.1957,	.3688,
8,	.2279,	.1947,	.3253,
+gp,	.2279,	.1947,	.3253,
0 FBAR 3- 6,	.1843,	.1644,	.2058,

Table 8 Fishing mortality (F) at age

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
1,	.0193,	.0091,	.0290,	.0392,	.0124,	.0154,	.0097,	.0086,	.0038,	.0017,
2,	.1902,	.1945,	.2509,	.2607,	.2386,	.2503,	.1648,	.1401,	.1442,	.0889,
3,	.3062,	.3205,	.2692,	.4051,	.1955,	.2374,	.1917,	.3546,	.2255,	.1655,
4,	.3045,	.4982,	.3750,	.4781,	.3108,	.2873,	.2617,	.3892,	.2753,	.2220,
5,	.2456,	.5374,	.4777,	.5716,	.3738,	.2885,	.2989,	.4554,	.3122,	.2277,
6,	.3001,	.4573,	.6366,	.5581,	.4073,	.2484,	.3442,	.3840,	.4576,	.2967,
7,	.3145,	.4158,	.5550,	.6512,	.3641,	.2735,	.3803,	.4685,	.2631,	.2308,
8,	.2600,	.6077,	.6717,	.6901,	.3087,	.3843,	.4457,	.5237,	.3017,	.3739,
+gp,	.2600,	.6077,	.6717,	.6901,	.3087,	.3843,	.4457,	.5237,	.3017,	.3739,
0 FBAR 3- 6,	.2891,	.4533,	.4396,	.5032,	.3218,	.2654,	.2741,	.3958,	.3177,	.2280,

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:15

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
1,	.0011,	.0048,	.0126,	.0016,	.0061,	.0000,	.0050,	.0018,	.0021,	.0100,
2,	.2194,	.1190,	.0526,	.0737,	.1612,	.0294,	.0469,	.1186,	.1479,	.1031,
3,	.3934,	.2325,	.1445,	.1209,	.3424,	.2691,	.1095,	.1909,	.1988,	.2916,
4,	.3734,	.2270,	.1460,	.1964,	.2877,	.2793,	.2274,	.3002,	.1698,	.2839,
5,	.3696,	.1535,	.1952,	.2223,	.4429,	.2327,	.2065,	.3048,	.2953,	.2317,
6,	.3326,	.2229,	.2166,	.1855,	.3366,	.3339,	.2057,	.2717,	.3420,	.3244,
7,	.3777,	.1536,	.2200,	.2223,	.4396,	.2256,	.2731,	.3203,	.2934,	.2418,
8,	.2659,	.1653,	.2651,	.1751,	.3473,	.1280,	.1860,	.1212,	.3414,	.2332,
+gp,	.2659,	.1653,	.2651,	.1751,	.3473,	.1280,	.1860,	.1212,	.3414,	.2332,
0 FBAR 3- 6,	.3672,	.2090,	.1756,	.1813,	.3524,	.2787,	.1873,	.2669,	.2515,	.2829,

Table 8 Fishing mortality (F) at age

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	FBAR
AGE											
1,	.0005,	.0235,	.0010,	.0094,	.0153,	.0251,	.0116,	.0131,	.0098,	.0118,	.0116,
2,	.1713,	.3372,	.1495,	.1867,	.2480,	.3537,	.4236,	.2906,	.1915,	.2480,	.2433,
3,	.2278,	.4523,	.3945,	.5364,	.3289,	.7242,	.6151,	.4952,	.4226,	.4722,	.4633,
4,	.4926,	.2511,	.5074,	.6833,	.6223,	1.0990,	.7730,	.4725,	.5530,	.5539,	.5265,
5,	.3795,	.4543,	.4416,	.4882,	.7082,	1.3416,	.8756,	.4677,	.7024,	.5668,	.5790,
6,	.3715,	.3535,	.6325,	.6738,	.5485,	1.2398,	.9448,	.3833,	.9598,	.6903,	.6778,
7,	.4912,	.3791,	.2202,	.6821,	.8643,	1.2370,	.8211,	.3978,	.5338,	.5019,	.4778,
8,	.3168,	.4018,	.7079,	.8844,	.6036,	.9769,	.8153,	.4970,	.6473,	.8514,	.6652,
+gp,	.3168,	.4018,	.7079,	.8844,	.6036,	.9769,	.8153,	.4970,	.6473,	.8514,	
0 FBAR 3- 6,	.3679,	.3778,	.4940,	.5954,	.5520,	1.1012,	.8021,	.4547,	.6594,	.5708,	

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:15

Traditional vpa Terminal populations from weighted Separable populations

Table 9 Relative F at age

YEAR,	1970,	1971,	1972,
AGE			
1,	.0029,	.0104,	.0105,
2,	2.0757,	.2995,	.5714,
3,	1.3130,	.7849,	1.1781,
4,	.9661,	.8702,	.7390,
5,	.9182,	.9426,	.9316,
6,	.8027,	1.4023,	1.1513,
7,	1.0293,	1.1904,	1.7921,
8,	1.2365,	1.1844,	1.5808,
+gp,	1.2365,	1.1844,	1.5808,
0 REFMEAN,.	1843,	.1644,	.2058,

Table 6.6.2.1 Continued

Table 9 Relative F at age

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
1,	.0667,	.0201,	.0659,	.0778,	.0384,	.0582,	.0354,	.0218,	.0120,	.0075,
2,	.6579,	.4290,	.5707,	.5181,	.7414,	.9430,	.6013,	.3540,	.4539,	.3899,
3,	1.0592,	.7069,	.6124,	.8050,	.6074,	.8946,	.6992,	.8959,	.7099,	.7260,
4,	1.0532,	1.0990,	.8530,	.9501,	.9656,	1.0825,	.9548,	.9834,	.8668,	.9737,
5,	.8495,	1.1854,	1.0865,	1.1360,	1.1614,	1.0870,	1.0904,	1.1505,	.9829,	.9988,
6,	1.0381,	1.0087,	1.4480,	1.1090,	1.2655,	.9359,	1.2555,	.9702,	1.4404,	1.3016,
7,	1.0880,	.9172,	1.2625,	1.2940,	1.1314,	1.0306,	1.3874,	1.1837,	.8283,	1.0124,
8,	.8994,	1.3405,	1.5279,	1.3714,	.9594,	1.4479,	1.6259,	1.3231,	.9497,	1.6401,
+gp,	.8994,	1.3405,	1.5279,	1.3714,	.9594,	1.4479,	1.6259,	1.3231,	.9497,	1.6401,
0 REFMEAN,	.2891,	.4533,	.4396,	.5032,	.3218,	.2654,	.2741,	.3958,	.3177,	.2280,

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:15

Traditional vpa Terminal populations from weighted Separable populations

Table 9 Relative F at age

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
1,	.0029,	.0227,	.0717,	.0086,	.0172,	.0000,	.0269,	.0066,	.0085,	.0352,
2,	.5974,	.5696,	.2998,	.4063,	.4575,	.1054,	.2505,	.4443,	.5880,	.3643,
3,	1.0713,	1.1124,	.8229,	.6670,	.9716,	.9654,	.5847,	.7154,	.7906,	1.0309,
4,	1.0167,	1.0862,	.8317,	1.0835,	.8163,	1.0019,	1.2142,	1.1247,	.6752,	1.0035,
5,	1.0063,	.7347,	1.1119,	1.2263,	1.2568,	.8349,	1.1029,	1.1421,	1.1744,	.8189,
6,	.9057,	1.0667,	1.2336,	1.0232,	.9552,	1.1978,	1.0983,	1.0178,	1.3598,	1.1467,
7,	1.0283,	.7352,	1.2529,	1.2260,	1.2473,	.8094,	1.4583,	1.2002,	1.1667,	.8546,
8,	.7241,	.7910,	1.5100,	.9655,	.9856,	.4591,	.9930,	.4541,	1.3578,	.8244,
+gp,	.7241,	.7910,	1.5100,	.9655,	.9856,	.4591,	.9930,	.4541,	1.3578,	.8244,
0 REFMEAN,	.3672,	.2090,	.1756,	.1813,	.3524,	.2787,	.1873,	.2669,	.2515,	.2829,

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:15

Traditional vpa Terminal populations from weighted Separable populations

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

YEAR,	1970,	1971,	1972,
AGE			
1,	404220,	815433,	731904,
2,	126653,	148626,	299468,
3,	132971,	64002,	104814,
4,	85202,	85469,	46056,
5,	26254,	64521,	67026,
6,	306680,	20058,	50000,
7,	18107,	239337,	14412,
8,	8580,	13553,	178065,
+gp,	9836,	12806,	16247,
0 TOTAL,	1118504,	1463805,	1507991,

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

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
1,	531097,	587402,	406755,	682108,	576506,	1048542,	969944,	524410,	672025,	695118,
2,	268671,	191647,	214131,	145363,	241295,	209477,	379825,	353380,	191259,	246282,
3,	197240,	164566,	116882,	123431,	82972,	140813,	120825,	238622,	227561,	122664,
4,	67340,	118896,	97791,	73107,	67398,	55870,	90923,	81670,	137044,	148699,
5,	35794,	44939,	65369,	60814,	41011,	44695,	37930,	63325,	50071,	94157,
6,	50067,	25336,	23759,	36685,	31069,	25536,	30306,	25453,	36340,	33155,
7,	35698,	33558,	14511	11374,	18997,	18708,	18023,	19437,	15687,	20808,
8,	9018,	23584,	20035,	7538,	5366,	11943,	12877,	11149,	11009,	10911,
+gp,	233492,	70140,	68426,	32916,	16376,	10913,	11907,	13690,	21011,	9655,
TOTAL,	1428417,	1260068,	1027658,	1173337,	1080990,	1566497,	1672561,	1331136,	1362006,	1381449,

Table 6.6.2.1 Continued

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:15

Traditional vpa Terminal populations from weighted Separable populations

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

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
1,	2280065,	932298,	1214000,	930759,	3182784,	474482,	704331,	786743,	498421,	413379,
2,	255285,	837908,	341348,	441020,	341874,	1163813,	174552,	257805,	288917,	182967,
3,	166933,	151862,	551075,	239909,	303512,	215552,	837210,	123385,	169632,	184614,
4,	85111,	92218,	98544,	390485,	174047,	176446,	134841,	614358,	83460,	113845,
5,	107765,	53015,	66499,	77053,	290309,	118115,	120754,	97193,	411749,	63725,
6,	67849,	67383,	41142,	49499,	55822,	168685,	84686,	88873,	64838,	277295,
7,	22298,	44021,	48789,	29977,	37205,	36073,	109307,	62382,	61286,	41676,
8,	14948,	13830,	34159,	35428,	21719,	21691,	26048,	75267,	40975,	41354,
+gp,	19087,	27687,	9761,	13898,	36378,	17164,	18771,	10392,	27749,	31690,
0 TOTAL,	3019340,	2220222,	2405316,	2208029,	4443651,	2392020,	2210499,	2116399,	1647027,	1350544,

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

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	GMST 70	AMST 70
AGE													
1,	612421,	796460,	449691,	809540,	773755,	473884,	327498,	376793,	357721,	416976,	0,	689733,	796218,
2,	150566,	225186,	286199,	165267,	295036,	280313,	170012,	119089,	136812,	130315,	151599,	250694,	290104,
3,	122272,	93986,	119070,	182573,	101587,	170563,	145801,	82458,	65976,	83692,	75338,	158035,	187076,
4,	112914,	79710,	48953,	65705,	87424,	59862,	67689,	64531,	41143,	35399,	42733,	97964,	119536,
5,	77552,	62428,	56111,	26667,	30021,	42456,	18049,	28273,	36402,	21414,	18409,	60983,	78827,
6,	45737,	48012,	35864,	32646,	14809,	13379,	10043,	6804,	16025,	16318,	10992,	41057,	60252,
7,	181391,	28543,	30508,	17240,	15059,	7742,	3504,	3533,	4196,	5553,	7404,	25916,	40619,
8,	29611,	100432,	17678,	22148,	7886,	5741,	2033,	1395,	2147,	2227,	3042,	16368,	26967,
+gp,	23211,	31947,	29272,	11502,	9838,	4919,	1777,	3236,	1062,	894,	1205,		
TOTAL	1355675,	1466704,	1073346,	1333288,	1335414,	1058860,	746405,	686111,	661484,	712788,	310722,		

1

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:15

Traditional vpa Terminal populations from weighted Separable populations

Table 11 Spawning stock number-at-age (spawning time) Numbers*10**-3

YEAR,	1970,	1971,	1972,
AGE			
1,	0,	0,	0,
2,	80170,	117618,	226382,
3,	98890,	51339,	77926,
4,	70721,	72624,	38899,
5,	21921,	54389,	55126,
6,	259743,	16073,	39896,
7,	14913,	196318,	10527,
8,	6888,	11125,	133914,
+gp,	7896,	10511,	12219,

Table 11 Spawning stock number-at-age (spawning time) Numbers*10**-3

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	193460,	137600,	148040,	99837,	168202,	144884,	278182,	263133,	142029,	189791,
3,	140511,	116116,	85351,	82293,	63658,	105042,	92938,	164566,	171115,	96021,
4,	51355,	79635,	71135,	49631,	51183,	43101,	71354,	58844,	106573,	119846,
5,	28396,	29320,	44390,	38777,	29857,	34452,	29034,	43649,	37987,	75597,
6,	38294,	17441,	14504,	23605,	22117,	20219,	22506,	18404,	25012,	25417,
7,	27042,	23753,	9357,	6876,	13920,	14566,	13064,	13280,	12300,	16672,
8,	7085,	14679,	11947,	4440,	4081,	8634,	8933,	7341,	8411,	7943,
+gp,	183452,	43656,	40802,	19387,	12453,	7889,	8261,	9014,	16054,	7028,

1

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:15

Traditional vpa Terminal populations from weighted Separable populations

Table 11 Spawning stock number-at-age (spawning time) Numbers*10**-3

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	180256,	632800,	269517,	343344,	250989,	933341,	138351,	194759,	214019,	139666,
3,	112167,	113661,	437496,	193491,	211032,	157417,	680421,	94953,	129858,	132803,
4,	61979,	74075,	83569,	320144,	134234,	136853,	108282,	469876,	69659,	88026,
5,	78677,	44732,	54564,	62087,	201783,	94514,	98334,	74105,	315936,	51027,
6,	50776,	54274,	33279,	40881,	41663,	126133,	69003,	69283,	48220,	208662,
7,	16191,	37141,	39374,	24156,	25918,	29003,	85129,	47071,	47087,	33147,
8,	11697,	11578,	26746,	29466,	16094,	18619,	21506,	64899,	30483,	33079,
+gp,	14937,	23178,	7643,	11559,	26957,	14733,	15498,	8961,	20644,	25349,

Table 6.6.2.1 Continued

Table 11 Spawning stock number-at-age (spawning time) Numbers*10**-3

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	109800,	146936,	211770,	119284,	204372,	180902,	104697,	80172,	98428,	90271,
3,	91798,	60710,	79947,	111472,	71277,	91827,	84447,	51753,	43473,	53345,
4,	75912,	63003,	32586,	38876,	53884,	26809,	37713,	43972,	26564,	22842,
5,	56243,	43062,	39034,	17981,	17468,	16161,	9388,	19327,	21264,	13698,
6,	33348,	35432,	21954,	19439,	9590,	5452,	4987,	4922,	7878,	9610,
7,	122067,	20706,	24617,	10208,	7892,	3161,	1890,	2531,	2744,	3710,
8,	22397,	71756,	10288,	11453,	4922,	2790,	1101,	935,	1302,	1177,
+gp,	17556,	22826,	17036,	5947,	6140,	2391,	962,	2169,	643,	473,

1

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:15

Traditional vpa Terminal populations from weighted Separable populations

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1970,	1971,	1972,
AGE			
1,	48506,	97852,	87828,
2,	21404,	25118,	50610,
3,	27924,	13440,	22011,
4,	20108,	20171,	10869,
5,	6826,	16775,	17427,
6,	83724,	5476,	13650,
7,	5124,	67732,	4078,
8,	2488,	3930,	51639,
+gp,	2911,	3791,	4809,
0 TOTALBIO,	219016,	254285,	262922,

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
1,	63732,	70488,	48811,	81853,	69181,	125825,	116393,	62929,	80643,	83414,
2,	45405,	32388,	36188,	24566,	40779,	35402,	64190,	59721,	32323,	41622,
3,	41420,	34559,	24545,	25921,	17424,	29571,	25373,	50111,	47788,	25759,
4,	15892,	28059,	23079,	17253,	15906,	13185,	21458,	19274,	32342,	35093,
5,	9306,	11684,	16996,	15812,	10663,	11621,	9862,	16464,	13018,	24481,
6,	13668,	6917,	6486,	10015,	8482,	6971,	8274,	6949,	9921,	9051,
7,	10102,	9497,	4107,	3219,	5376,	5294,	5101,	5501,	4439,	5889,
8,	2615,	6839,	5810,	2186,	1556,	3464,	3734,	3233,	3193,	3164,
+gp,	69114,	20762,	20254,	9743,	4847,	3230,	3525,	4052,	6219,	2858,
0 TOTALBIO,	271256,	221193,	186275,	190568,	174214,	234563,	257910,	228235,	229886,	231331,

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:15

Traditional vpa Terminal populations from weighted Separable populations

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
1,	273608,	111876,	121400,	91214,	308730,	46025,	97198,	88902,	50839,	42165,
2,	43143,	141606,	51202,	74532,	56067,	190865,	27405,	39186,	43049,	26347,
3,	35056,	31891,	108011,	50141,	62523,	44404,	140651,	20976,	29516,	30831,
4,	20086,	21764,	22370,	92935,	40553,	41112,	24541,	110585,	15857,	20720,
5,	28019,	13784,	15827,	19725,	73158,	29765,	24151,	19439,	80291,	12363,
6,	18523,	18396,	10327,	13662,	15128,	45714,	18377,	19285,	13357,	54627,
7,	6310,	12458,	12295,	8394,	10418,	10100,	24813,	14036,	13851,	8919,
8,	4335,	4011,	9189,	10168,	6429,	6421,	6199,	17537,	9670,	9015,
+gp,	5650,	8195,	2772,	4336,	11532,	5441,	4599,	2650,	6882,	7669,
0 TOTALBIO,	434730,	363980,	353391,	365108,	584537,	419846,	367933,	332596,	263311,	212655,

Table 6.6.2.1 Continued

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
1,	72266,	78053,	40472,	69620,	72733,	45019,	34060,	37679,	32553,	38362,
2,	24994,	35129,	41213,	22642,	39830,	38123,	24652,	15958,	17101,	16550,
3,	23965,	18045,	21552,	33959,	17168,	24732,	22453,	12946,	9896,	12219,
4,	23147,	16659,	9937,	13535,	16960,	10356,	11778,	11422,	7077,	6018,
5,	16596,	13484,	12176,	5840,	6304,	8109,	3610,	5570,	6953,	4069,
6,	10062,	10707,	8105,	7639,	3317,	2622,	2229,	1408,	3205,	3280,
7,	40450,	6451,	6925,	4017,	3479,	1564,	806,	767,	852,	1166,
8,	7166,	23099,	4225,	5515,	1814,	1275,	488,	321,	436,	505,
+gp,	5988,	7891,	7201,	2910,	2351,	1067,	437,	793,	229,	205,
0 TOTALBIO,	224635,	209519,	151807,	165677,	163956,	132867,	100513,	86863,	78302,	82374,

1

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:15

Traditional vpa Terminal populations from weighted Separable populations

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1970,	1971,	1972,
AGE			
1,	0,	0,	0,
2,	13549,	19877,	38259,
3,	20767,	10781,	16364,
4,	16690,	17139,	9180,
5,	5699,	14141,	14333,
6,	70910,	4388,	10892,
7,	4220,	55558,	2979,
8,	1997,	3226,	38835,
+gp,	2337,	3111,	3617,
0 TOTSPBIO,	136170,	128222,	134459,

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	32695,	23254,	25019,	16873,	28426,	24485,	47013,	44470,	24003,	32075,
3,	29507,	24384,	17924,	17282,	13368,	22059,	19517,	34559,	35934,	20164,
4,	12120,	18794,	16788,	11713,	12079,	10172,	16839,	13887,	25151,	28284,
5,	7383,	7623,	11541,	10082,	7763,	8957,	7549,	11349,	9877,	19655,
6,	10454,	4761,	3960,	6444,	6038,	5520,	6144,	5024,	6828,	6939,
7,	7653,	6722,	2648,	1946,	3939,	4122,	3697,	3758,	3481,	4718,
8,	2055,	4257,	3465,	1287,	1183,	2504,	2591,	2129,	2439,	2303,
+gp,	54302,	12922,	12077,	5738,	3686,	2335,	2445,	2668,	4752,	2080,
0 TOTSPBIO,	156169,	102718,	93421,	71365,	76483,	80155,	105795,	117844,	112465,	116218,

1

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:15

Traditional vpa Terminal populations from weighted Separable populations

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	30463,	106943,	40427,	58025,	41162,	153068,	21721,	29603,	31889,	20112,
3,	23555,	23869,	85749,	40440,	43473,	32428,	114311,	16142,	22595,	22178,
4,	14627,	17482,	18970,	76194,	31277,	31887,	19707,	84578,	13235,	16021,
5,	20456,	11630,	12986,	15894,	50849,	23817,	19667,	14821,	61608,	9899,
6,	13862,	14817,	8353,	11283,	11291,	34182,	14974,	15034,	9933,	41106,
7,	4582,	10511,	9922,	6764,	7257,	8121,	19324,	10591,	10642,	7093,
8,	3392,	3358,	7195,	8457,	4764,	5511,	5118,	15122,	7194,	7211,
+gp,	4421,	6861,	2171,	3606,	8545,	4670,	3797,	2285,	5120,	6134,
0 TOTSPBIO,	115359,	195470,	185774,	220663,	198618,	293685,	218619,	188176,	162216,	129755,

Table 6.6.2.1 Continued

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	18227,	22922,	30495,	16342,	27590,	24603,	15181,	10743,	12304,	11464,
3,	17992,	11656,	14470,	20734,	12046,	13315,	13005,	8125,	6521,	7788,
4,	15562,	13168,	6615,	8008,	10453,	4638,	6562,	7783,	4569,	3883,
5,	12036,	9301,	8470,	3938,	3668,	3087,	1878,	3808,	4062,	2603,
6,	7337,	7901,	4962,	4549,	2148,	1069,	1107,	1019,	1576,	1932,
7,	27221,	4680,	5588,	2379,	1823,	639,	435,	549,	557,	779,
8,	5420,	16504,	2459,	2852,	1132,	619,	264,	215,	264,	267,
+gp,	4529,	5638,	4191,	1505,	1467,	519,	237,	531,	139,	108,
0 TOTSPBIO,	108324,	91770,	77250,	60306,	60329,	48487,	38668,	32773,	29991,	28825,

1

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:15

Traditional vpa Terminal populations from weighted Separable populations

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR,	1970,	1971,	1972,
AGE			
1,	43498,	85201,	78823,
2,	19195,	21870,	45421,
3,	25041,	11703,	19754,
4,	18032,	17563,	9755,
5,	6121,	14607,	15640,
6,	75080,	4768,	12250,
7,	4595,	58976,	3660,
8,	2231,	3422,	46344,
+gp,	2611,	3301,	4316,
0 TOTALBIO,	196404,	221411,	235964,

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
1,	64761,	68809,	54846,	85716,	74565,	127857,	124119,	60636,	83158,	85922,
2,	46139,	31617,	40663,	25726,	43952,	35973,	68451,	57545,	33331,	42873,
3,	42090,	33735,	27581,	27144,	18780,	30048,	27057,	48284,	49278,	26534,
4,	16149,	27391,	25933,	18068,	17144,	13398,	22882,	18572,	33351,	36148,
5,	9457,	11406,	19098,	16558,	11493,	11808,	10516,	15864,	13424,	25217,
6,	13889,	6752,	7288,	10488,	9142,	7084,	8823,	6695,	10230,	9324,
7,	10266,	9271,	4615,	3371,	5795,	5380,	5439,	5300,	4578,	6066,
8,	2658,	6677,	6529,	2289,	1677,	3520,	3982,	3115,	3292,	3259,
+gp,	70230,	20267,	22759,	10203,	5224,	3282,	3758,	3905,	6413,	2944,
0 TOTALBIO,	275639,	215923,	209310,	199562,	187772,	238350,	275029,	219916,	237055,	238286,

1

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:15

Traditional vpa Terminal populations from weighted Separable populations

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
1,	274755,	108387,	119531,	91229,	292916,	45990,	97292,	88957,	50694,	41957,
2,	43324,	137191,	50414,	74544,	53195,	190722,	27431,	39211,	42926,	26218,
3,	35203,	30897,	106348,	50149,	59321,	44370,	140788,	20988,	29432,	30679,
4,	20170,	21085,	22025,	92950,	38476,	41081,	24565,	110653,	15812,	20618,
5,	28136,	13354,	15583,	19729,	69411,	29743,	24174,	19451,	80062,	12302,
6,	18600,	17822,	10168,	13664,	14353,	45679,	18395,	19297,	13319,	54358,
7,	6337,	12069,	12105,	8395,	9884,	10093,	24837,	14045,	13811,	8875,
8,	4353,	3886,	9047,	10170,	6099,	6416,	6205,	17548,	9642,	8971,
+gp,	5674,	7940,	2729,	4337,	10941,	5437,	4603,	2652,	6862,	7631,
0 TOTALBIO,	436553,	352631,	347951,	365167,	554596,	419531,	368292,	332801,	262560,	211609,

Table 6.6.2.1 Continued

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
1,	72696,	77897,	42597,	69307,	72851,	44963,	34121,	37721,	32512,	38327,
2,	25143,	35059,	43376,	22540,	39894,	38075,	24696,	15976,	17080,	16535,
3,	24108,	18009,	22683,	33806,	17196,	24701,	22494,	12960,	9884,	12208,
4,	23285,	16626,	10459,	13474,	16988,	10343,	11799,	11435,	7068,	6012,
5,	16695,	13457,	12815,	5814,	6315,	8099,	3616,	5576,	6944,	4065,
6,	10122,	10685,	8531,	7605,	3323,	2619,	2233,	1410,	3201,	3277,
7,	40691,	6438,	7289,	3999,	3484,	1562,	807,	767,	851,	1165,
8,	7209,	23053,	4447,	5490,	1817,	1273,	489,	321,	435,	505,
+gp,	6024,	7875,	7579,	2897,	2355,	1066,	438,	794,	229,	205,
0 TOTALBIO,	225974,	209099,	159776,	164932,	164222,	132701,	100694,	86960,	78205,	82298,

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:15

Traditional vpa Terminal populations from weighted Separable populations

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR,	1970,	1971,	1972,
AGE			
1,	0,	0,	0,
2,	12150,	17308,	34336,
3,	18623,	9387,	14687,
4,	14967,	14923,	8239,
5,	5111,	12313,	12863,
6,	63589,	3821,	9775,
7,	3785,	48375,	2674,
8,	1791,	2809,	34853,
+gp,	2096,	2709,	3246,
0 TOTSPBIO,	122111,	111646,	120672,

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	33223,	22700,	28113,	17669,	30638,	24881,	50133,	42849,	24751,	33039,
3,	29984,	23803,	20140,	18097,	14409,	22415,	20812,	33299,	37055,	20771,
4,	12316,	18346,	18864,	12266,	13019,	10336,	17957,	13381,	25936,	29134,
5,	7502,	7442,	12968,	10558,	8367,	9102,	8050,	10935,	10185,	20246,
6,	10623,	4648,	4449,	6748,	6508,	5609,	6552,	4841,	7041,	7147,
7,	7776,	6562,	2975,	2038,	4246,	4189,	3943,	3621,	3589,	4860,
8,	2088,	4156,	3893,	1348,	1276,	2544,	2763,	2051,	2515,	2373,
+gp,	55179,	12614,	13571,	6009,	3973,	2373,	2608,	2571,	4900,	2143,
0 TOTSPBIO,	158692,	100271,	104973,	74733,	82435,	81449,	112817,	113549,	115972,	119713,

1

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:15

Traditional vpa Terminal populations from weighted Separable populations

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	30591,	103608,	39805,	58034,	39054,	152953,	21742,	29622,	31798,	20013,
3,	23654,	23125,	84429,	40446,	41246,	32404,	114422,	16152,	22531,	22069,
4,	14688,	16937,	18678,	76207,	29675,	31863,	19727,	84630,	13197,	15942,
5,	20542,	11268,	12786,	15897,	48245,	23800,	19686,	14830,	61432,	9851,
6,	13920,	14355,	8224,	11285,	10712,	34156,	14988,	15044,	9905,	40904,
7,	4601,	10183,	9769,	6765,	6885,	8115,	19343,	10598,	10611,	7059,
8,	3406,	3253,	7084,	8458,	4520,	5507,	5123,	15131,	7174,	7176,
+gp,	4440,	6647,	2137,	3607,	8108,	4667,	3801,	2286,	5105,	6104,
0 TOTSPBIO,	115843,	189375,	182914,	220699,	188444,	293464,	218832,	188292,	161753,	129118,

Table 6.6.2.1 Continued

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	18335,	22876,	32096,	16268,	27635,	24572,	15208,	10755,	12288,	11454,
3,	18100,	11633,	15230,	20641,	12065,	13298,	13028,	8134,	6513,	7781,
4,	15655,	13141,	6962,	7972,	10470,	4632,	6574,	7792,	4563,	3880,
5,	12108,	9283,	8915,	3920,	3674,	3083,	1881,	3812,	4056,	2600,
6,	7380,	7886,	5222,	4528,	2152,	1067,	1109,	1020,	1574,	1930,
7,	27383,	4670,	5881,	2368,	1826,	638,	436,	550,	556,	778,
8,	5452,	16471,	2588,	2839,	1134,	619,	265,	215,	264,	267,
+gp,	4556,	5627,	4411,	1498,	1470,	518,	237,	532,	139,	108,
0 TOTSPBIO,	108970,	91586,	81305,	60035,	60426,	48427,	38738,	32810,	29954,	28798,

1

Run title : Herring VIa(S) VIIbc (run 1: wg 2003) ,

At 18/03/2003 8:15

Table 16 Summary (without SOP correction)

Traditional vpa Terminal populations from weighted Separable populations

,	RECRUITS,	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 3- 6,
	Age 1					
1970,	404220,	219016,	136170,	20306,	.1491,	.1843,
1971,	815433,	254285,	128222,	15044,	.1173,	.1644,
1972,	731904,	262922,	134459,	23474,	.1746,	.2058,
1973,	531097,	271256,	156169,	36719,	.2351,	.2891,
1974,	587402,	221193,	102718,	36589,	.3562,	.4533,
1975,	406755,	186275,	93421,	38764,	.4149,	.4396,
1976,	682108,	190568,	71365,	32767,	.4591,	.5032,
1977,	576506,	174214,	76483,	20567,	.2689,	.3218,
1978,	1048542,	234563,	80155,	19715,	.2460,	.2654,
1979,	969944,	257910,	105795,	22608,	.2137,	.2741,
1980,	524410,	228235,	117844,	30124,	.2556,	.3958,
1981,	672025,	229886,	112465,	24922,	.2216,	.3177,
1982,	695118,	231331,	116218,	19209,	.1653,	.2280,
1983,	2280065,	434730,	115359,	32988,	.2860,	.3672,
1984,	932298,	363980,	195470,	27450,	.1404,	.2090,
1985,	1214000,	353391,	185774,	23343,	.1257,	.1756,
1986,	930759,	365108,	220663,	28785,	.1304,	.1813,
1987,	3182784,	584537,	198618,	48600,	.2447,	.3524,
1988,	474482,	419846,	293685,	29100,	.0991,	.2787,
1989,	704331,	367933,	218619,	29210,	.1336,	.1873,
1990,	786743,	332596,	188176,	43969,	.2337,	.2669,
1991,	498421,	263311,	162216,	37700,	.2324,	.2515,
1992,	413379,	212655,	129755,	31856,	.2455,	.2829,
1993,	612421,	224635,	108324,	36763,	.3394,	.3679,
1994,	796460,	209519,	91770,	33908,	.3695,	.3778,
1995,	449691,	151807,	77250,	27792,	.3598,	.4940,
1996,	809540,	165677,	60306,	32534,	.5395,	.5954,
1997,	773755,	163956,	60329,	27225,	.4513,	.5520,
1998,	473884,	132867,	48487,	38895,	.8022,	1.1012,
1999,	327498,	100513,	38668,	26109,	.6752,	.8021,
2000,	376793,	86863,	32773,	15005,	.4578,	.4547,
2001,	357721,	78302,	29991,	14061,	.4688,	.6594,
2002,	416976,	82374,	28825,	13587,	.4714,	.5708,
Arith. Mean ,	771438,	244129,	118683,	28475,	.3056,	.3809,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

Table 6.6.2.1 Continued

Run title : Herring VIa(S) VIIbc (run 1: wg 2003) ,

At 18/03/2003 8:15

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,	404220,	196404,	122111,	20306,	.1663,	.8968,	.1843,
1971,	815433,	221411,	111646,	15044,	.1347,	.8707,	.1644,
1972,	731904,	235964,	120672,	23474,	.1945,	.8975,	.2058,
1973,	531097,	275639,	158692,	36719,	.2314,	1.0162,	.2891,
1974,	587402,	215923,	100271,	36589,	.3649,	.9762,	.4533,
1975,	406755,	209310,	104973,	38764,	.3693,	1.1237,	.4396,
1976,	682108,	199562,	74733,	32767,	.4385,	1.0472,	.5032,
1977,	576506,	187772,	82435,	20567,	.2495,	1.0778,	.3218,
1978,	1048542,	238350,	81449,	19715,	.2421,	1.0161,	.2654,
1979,	969944,	275029,	112817,	22608,	.2004,	1.0664,	.2741,
1980,	524410,	219916,	113549,	30124,	.2653,	.9636,	.3958,
1981,	672025,	237055,	115972,	24922,	.2149,	1.0312,	.3177,
1982,	695118,	238286,	119713,	19209,	.1605,	1.0301,	.2280,
1983,	2280065,	436553,	115843,	32988,	.2848,	1.0042,	.3672,
1984,	932298,	352631,	189375,	27450,	.1450,	.9688,	.2090,
1985,	1214000,	347951,	182914,	23343,	.1276,	.9846,	.1756,
1986,	930759,	365167,	220699,	28785,	.1304,	1.0002,	.1813,
1987,	3182784,	554596,	188444,	48600,	.2579,	.9488,	.3524,
1988,	474482,	419531,	293464,	29100,	.0992,	.9992,	.2787,
1989,	704331,	368292,	218832,	29210,	.1335,	1.0010,	.1873,
1990,	786743,	332801,	188292,	43969,	.2335,	1.0006,	.2669,
1991,	498421,	262560,	161753,	37700,	.2331,	.9971,	.2515,
1992,	413379,	211609,	129118,	31856,	.2467,	.9951,	.2829,
1993,	612421,	225974,	108970,	36763,	.3374,	1.0060,	.3679,
1994,	796460,	209099,	91586,	33908,	.3702,	.9980,	.3778,
1995,	449691,	159776,	81305,	27792,	.3418,	1.0525,	.4940,
1996,	809540,	164932,	60035,	32534,	.5419,	.9955,	.5954,
1997,	773755,	164222,	60426,	27225,	.4505,	1.0016,	.5520,
1998,	473884,	132701,	48427,	38895,	.8032,	.9988,	1.1012,
1999,	327498,	100694,	38738,	26109,	.6740,	1.0018,	.8021,
2000,	376793,	86960,	32810,	15005,	.4573,	1.0011,	.4547,
2001,	357721,	78205,	29954,	14061,	.4694,	.9988,	.6594,
2002,	416976,	82298,	28798,	13587,	.4718,	.9991,	.5708,
Arith. Mean ,	771438,	242642,	117843,	28475,	.3043		.3809,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 6.6.2.2 VIa(S) and Division VIIb,c, herring. Residuals from the separable VPA with F2003=0.6

Title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:23

Separable analysis
from 1970 to 2002 on ages 1 to 8
with Terminal F of .400 on age 4 and Terminal S of 1.000

Initial sum of squared residuals was 579.059 and
final sum of squared residuals is 76.654 after 148 iterations

Matrix of Residuals

Years, Ages (rings)	1970/71,	1971/72,
1/ 2,	-1.792,	-.710,
2/ 3,	1.555,	-.512,
3/ 4,	.543,	.538,
4/ 5,	-.111,	.201,
5/ 6,	-.657,	-.028,
6/ 7,	-.787,	-.097,
7/ 8,	-.364,	-.031,
TOT ,	.000,	.000,
WTS ,	.001,	.001,

Years,	1972/73,	1973/74,	1974/75,	1975/76,	1976/77,	1977/78,	1978/79,	1979/80,	1980/81,	1981/82,
1/ 2,	-1.141,	1.144,	-.134,	1.083,	.834,	-.075,	.725,	.705,	-.014,	-.308,
2/ 3,	-.056,	.497,	.343,	.342,	.399,	.484,	.944,	.222,	-.144,	.267,
3/ 4,	.335,	.241,	.161,	-.197,	.030,	-.329,	.195,	-.112,	.295,	.089,
4/ 5,	-.244,	-.095,	.209,	-.251,	-.230,	-.076,	.040,	-.152,	.024,	.038,
5/ 6,	-.298,	-.353,	-.059,	-.087,	-.228,	.134,	-.210,	.004,	-.240,	-.183,
6/ 7,	-.225,	-.161,	-.275,	.068,	-.290,	.029,	-.588,	-.109,	-.111,	.370,
7/ 8,	.603,	-.244,	-.365,	.015,	.236,	-.235,	-.453,	.077,	.178,	-.550,
TOT ,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years,	1982/83,	1983/84,	1984/85,	1985/86,	1986/87,	1987/88,	1988/89,	1989/90,	1990/91,	1991/92,
1/ 2,	-1.266,	-2.326,	.560,	1.351,	-.875,	.979,	-3.938,	.221,	-1.356,	-.788,
2/ 3,	-.325,	-.040,	.363,	-.180,	-.191,	-.312,	-.783,	-.502,	.094,	.025,
3/ 4,	-.028,	.246,	.708,	.057,	.084,	.097,	.502,	-.413,	.350,	-.030,
4/ 5,	.051,	.273,	.180,	-.274,	.006,	-.209,	.390,	.124,	.113,	-.277,
5/ 6,	.038,	-.219,	-.469,	.081,	.243,	-.145,	.059,	-.011,	-.127,	-.083,
6/ 7,	.115,	-.136,	-.205,	-.098,	-.296,	-.265,	.093,	-.282,	-.254,	.219,
7/ 8,	.276,	.108,	-.634,	.279,	.241,	.736,	.133,	1.061,	-.041,	.224,
TOT ,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years,	1992/93,	1993/94,	1994/95,	1995/96,	1996/97,	1997/98,	1998/99,	1999/**,	2000/**,	2001/**,	TOT,	WTS,
1/ 2,	.547,	-3.349,	1.224,	-1.742,	-.186,	.490,	-.010,	-.737,	.536,	-.268,	.000,	.100,
2/ 3,	.111,	-.232,	.615,	-.167,	-.003,	.117,	-.256,	-.022,	.500,	-.342,	.000,	1.000,
3/ 4,	.188,	.146,	.335,	.300,	.237,	-.367,	-.107,	-.020,	.487,	.003,	.000,	1.000,
4/ 5,	.107,	.286,	-.529,	.576,	.149,	-.014,	.038,	-.034,	-.029,	.038,	.000,	1.000,
5/ 6,	-.239,	.028,	-.242,	.020,	-.268,	.043,	.139,	.138,	-.388,	.071,	.000,	1.000,
6/ 7,	-.197,	-.175,	.200,	.368,	-.269,	-.386,	-.017,	.103,	-.344,	.648,	.000,	1.000,
7/ 8,	-.024,	.282,	-.502,	-.924,	.173,	.558,	.205,	-.092,	-.280,	-.391,	.000,	1.000,
TOT ,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	-9.557,	
WTS ,	.001,	.001,	.001,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)

,	1970,	1971,	1972,
F-values,	.2350,	.1699,	.2625,

,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
F-values,	.3306,	.4767,	.5165,	.6200,	.3780,	.3068,	.3031,	.4116,	.3081,	.2438,

,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
F-values,	.3965,	.1988,	.1791,	.1856,	.3656,	.2237,	.2135,	.2874,	.2813,	.2850,

,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
F-values,	.3853,	.3933,	.3891,	.6018,	.6065,	1.0796,	.7862,	.4093,	.4683,	.4000,

Selection-at-age (S)

,	1,	2,	3,	4,	5,	6,	7,	8,
S-values,	.0179,	.3874,	.7286,	1.0000,	1.1295,	1.1414,	1.0010,	1.0000,

1

Table 6.6.2.2 Continued

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:23

Traditional vpa Terminal populations from weighted Separable populations

Fishing mortality residuals

YEAR,	1970,	1971,	1972,
AGE (rings)			
1,	-.0037,	-.0013,	-.0025,
2,	.2933,	-.0164,	.0163,
3,	.0726,	.0061,	.0522,
4,	-.0551,	-.0255,	-.1094,
5,	-.0937,	-.0350,	-.1027,
6,	-.1175,	.0408,	-.0591,
7,	-.0410,	.0300,	.1150,
8,	-.0001,	.0306,	.0723,

Fishing mortality residuals

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE (rings)										
1,	.0135,	.0007,	.0199,	.0284,	.0057,	.0101,	.0044,	.0014,	-.0016,	-.0026,
2,	.0629,	.0108,	.0523,	.0226,	.0940,	.1336,	.0490,	-.0177,	.0264,	-.0047,
3,	.0668,	-.0250,	-.1053,	-.0434,	-.0780,	.0162,	-.0271,	.0592,	.0040,	-.0100,
4,	-.0245,	.0251,	-.1385,	-.1373,	-.0636,	-.0159,	-.0381,	-.0166,	-.0280,	-.0181,
5,	-.1257,	.0035,	-.1002,	-.1211,	-.0477,	-.0535,	-.0384,	-.0012,	-.0292,	-.0425,
6,	-.0731,	-.0812,	.0567,	-.1386,	-.0154,	-.0968,	.0056,	-.0766,	.1192,	.0269,
7,	-.0101,	-.0531,	.0493,	.0497,	-.0029,	-.0253,	.0873,	.0719,	-.0366,	-.0037,
8,	-.0619,	.1508,	.1787,	.0970,	-.0546,	.0952,	.1622,	.1351,	.0082,	.1473,

1

Run title : Herring VIa(S) VIIbc (run 1: wg 2003)

At 18/03/2003 8:23

Traditional vpa Terminal populations from weighted Separable populations

Fishing mortality residuals

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE (rings)										
1,	-.0060,	.0012,	.0095,	-.0017,	-.0004,	-.0040,	.0012,	-.0034,	-.0029,	.0049,
2,	.0682,	.0432,	-.0163,	.0023,	.0207,	-.0571,	-.0356,	.0075,	.0389,	-.0075,
3,	.1094,	.0908,	.0155,	-.0131,	.0792,	.1083,	-.0454,	-.0176,	-.0056,	.0839,
4,	-.0168,	.0321,	-.0307,	.0134,	-.0743,	.0591,	.0162,	.0148,	-.1106,	-.0002,
5,	-.0699,	-.0676,	-.0030,	.0171,	.0380,	-.0162,	-.0312,	-.0157,	-.0197,	-.0888,
6,	-.1100,	.0029,	.0179,	-.0216,	-.0717,	.0874,	-.0338,	-.0507,	.0272,	.0030,
7,	-.0040,	-.0394,	.0492,	.0439,	.0892,	.0097,	.0694,	.0412,	.0199,	-.0375,
8,	-.1164,	-.0246,	.0988,	-.0022,	-.0026,	-.0897,	-.0194,	-.1608,	.0729,	-.0433,

Fishing mortality residuals

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE (rings)										
1,	-.0064,	.0164,	-.0060,	-.0015,	.0039,	.0037,	-.0043,	.0026,	-.0017,	.0000,
2,	.0217,	.1841,	-.0018,	-.0485,	.0080,	-.0820,	.0755,	.0805,	-.0397,	.0058,
3,	-.0532,	.1646,	.1098,	.0949,	-.1175,	-.0860,	-.0057,	.1211,	-.0181,	.0260,
4,	.1071,	-.1427,	.1163,	.0777,	.0097,	-.0117,	-.0646,	.0033,	-.0449,	-.0312,
5,	-.0540,	.0098,	.0010,	-.1948,	.0155,	.0864,	-.0743,	-.0486,	.0279,	-.0821,
6,	-.0652,	-.0931,	.1879,	-.0162,	-.1499,	-.0282,	-.0244,	-.1309,	.2223,	-.0024,
7,	.1146,	-.0100,	-.1672,	.0788,	.2488,	.1221,	-.0266,	-.0659,	-.0316,	-.0759,
8,	-.0581,	.0202,	.3342,	.2969,	-.0045,	-.1261,	-.0287,	.0221,	.0434,	.1909,

Table 6.7.3.1. Division VIa(S) and VII b,c herring. Input data for short term projections, based on separable VPA with F=0.6.
NB In this table age refers to number of rings (winter rings in otilith).
MFDP version 1a
Run: TAC constr
Time and date: 12:04 19/03/2003
Fbar age range: 3-6

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	689732	1	0	0.67	0.67	0.096	0.012	0.097
2	180603	0.3	1	0.67	0.67	0.134	0.248	0.132
3	75338	0.2	1	0.67	0.67	0.154	0.472	0.146
4	42733	0.1	1	0.67	0.67	0.177	0.554	0.169
5	18409	0.1	1	0.67	0.67	0.197	0.567	0.186
6	10992	0.1	1	0.67	0.67	0.208	0.690	0.196
7	7404	0.1	1	0.67	0.67	0.216	0.502	0.208
8	3042	0.1	1	0.67	0.67	0.225	0.851	0.219
9	1205	0.1	1	0.67	0.67	0.232	0.851	0.220

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	689732	1	0	0.67	0.67	0.096	0.012	0.097
2	.	0.3	1	0.67	0.67	0.134	0.248	0.132
3	.	0.2	1	0.67	0.67	0.154	0.472	0.146
4	.	0.1	1	0.67	0.67	0.177	0.554	0.169
5	.	0.1	1	0.67	0.67	0.197	0.567	0.186
6	.	0.1	1	0.67	0.67	0.208	0.690	0.196
7	.	0.1	1	0.67	0.67	0.216	0.502	0.208
8	.	0.1	1	0.67	0.67	0.225	0.851	0.219
9	.	0.1	1	0.67	0.67	0.232	0.851	0.220

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	689732	1	0	0.67	0.67	0.096	0.012	0.097
2	.	0.3	1	0.67	0.67	0.134	0.248	0.132
3	.	0.2	1	0.67	0.67	0.154	0.472	0.146
4	.	0.1	1	0.67	0.67	0.177	0.554	0.169
5	.	0.1	1	0.67	0.67	0.197	0.567	0.186
6	.	0.1	1	0.67	0.67	0.208	0.690	0.196
7	.	0.1	1	0.67	0.67	0.216	0.502	0.208
8	.	0.1	1	0.67	0.67	0.225	0.851	0.219
9	.	0.1	1	0.67	0.67	0.232	0.851	0.220

Input units are thousands and kg - output in tonnes

Table 6.7.3.2. Divisions VIa(S) and VIIb,c herring. Single option short-term projection based on VPA with F=0.6.
NB In this table age refers to number of rings (winter rings in otilith).
MFDP version 1a
Run: TAC constr
Time and date: 12:04 19/03/2003
Fbar age range: 3-6

	Year:	2003	F multiplier	0.896	Fbar:	0.5114			
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0106	4589	443	689732	66214	0	0	0	0
2	0.2222	31262	4132	180603	24141	180603	24141	127284	17014
3	0.4231	23722	3471	75338	11564	75338	11564	49626	7618
4	0.4963	15975	2692	42733	7549	42733	7549	28659	5063
5	0.5079	7006	1303	18409	3617	18409	3617	12251	2407
6	0.6185	4850	951	10992	2290	10992	2290	6792	1415
7	0.4497	2561	533	7404	1596	7404	1596	5123	1104
8	0.7629	1555	340	3042	685	3042	685	1706	385
9	0.7629	616	136	1205	280	1205	280	676	157
	Total	92135	14000	1029458	117937	339726	51722	232116	35162

	Year:	2004	F multiplier	1	Fbar:	0.5708			
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0118	5119	494	689732	66214	0	0	0	0
2	0.248	47937	6336	251070	33560	251070	33560	173916	23247
3	0.4722	36833	5390	107135	16445	107135	16445	68287	10482
4	0.5539	16427	2768	40402	7138	40402	7138	26070	4606
5	0.5668	9737	1811	23539	4625	23539	4625	15058	2959
6	0.6903	4783	937	10024	2088	10024	2088	5903	1230
7	0.5019	2021	421	5358	1155	5358	1155	3580	772
8	0.8514	2347	513	4273	963	4273	963	2259	509
9	0.8514	984	217	1792	416	1792	416	947	220
	Total	126189	18887	1133326	132604	443594	66390	296020	44023

	Year:	2005	F multiplier	1	Fbar:	0.5708			
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0118	5119	494	689732	66214	0	0	0	0
2	0.248	47878	6328	250762	33518	250762	33518	173702	23218
3	0.4722	49901	7302	145145	22280	145145	22280	92514	14201
4	0.5539	22241	3748	54702	9664	54702	9664	35296	6236
5	0.5668	8691	1617	21010	4128	21010	4128	13440	2641
6	0.6903	5766	1130	12084	2517	12084	2517	7116	1483
7	0.5019	1715	357	4548	980	4548	980	3039	655
8	0.8514	1612	353	2935	661	2935	661	1552	350
9	0.8514	1287	283	2342	543	2342	543	1238	287
	Total	144210	21611	1183259	140507	493527	74293	327897	49070

Input units are thousands and kg - output in tonnes

Table 6.7.3.3 Divisions VIa(S) and VIIb,c herring. Management option table based on TAC constraint based on output from seperable VPA with F=0.6

MFDP version 1a
Run: TAC constr
VIaS VIIbc stock Projection index file wednesday 19th March 2003.
Time and date: 12:04 19/03/2003
Fbar age range: 3-6

2003				
Biomass	SSB	FMult	FBar	Landings
117937	35162	0.896	0.5114	14000

					2005	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
132604	57155	0	0	0	160119	82111
.	55655	0.1	0.0571	2267	157745	77635
.	54200	0.2	0.1142	4439	155476	73479
.	52789	0.3	0.1712	6519	153306	69617
.	51421	0.4	0.2283	8514	151230	66027
.	50093	0.5	0.2854	10426	149244	62685
.	48805	0.6	0.3425	12260	147342	59572
.	47556	0.7	0.3996	14020	145522	56670
.	46343	0.8	0.4566	15708	143778	53962
.	45166	0.9	0.5137	17330	142108	51433
.	44023	1	0.5708	18887	140507	49070
.	42914	1.1	0.6279	20383	138973	46859
.	41838	1.2	0.685	21820	137502	44789
.	40792	1.3	0.742	23202	136091	42849
.	39777	1.4	0.7991	24531	134737	41029
.	38791	1.5	0.8562	25810	133438	39321
.	37833	1.6	0.9133	27040	132191	37716
.	36902	1.7	0.9704	28224	130994	36206
.	35998	1.8	1.0274	29365	129844	34785
.	35120	1.9	1.0845	30463	128739	33446
.	34266	2	1.1416	31521	127677	32184

Input units are thousands and kg - output in tonnes

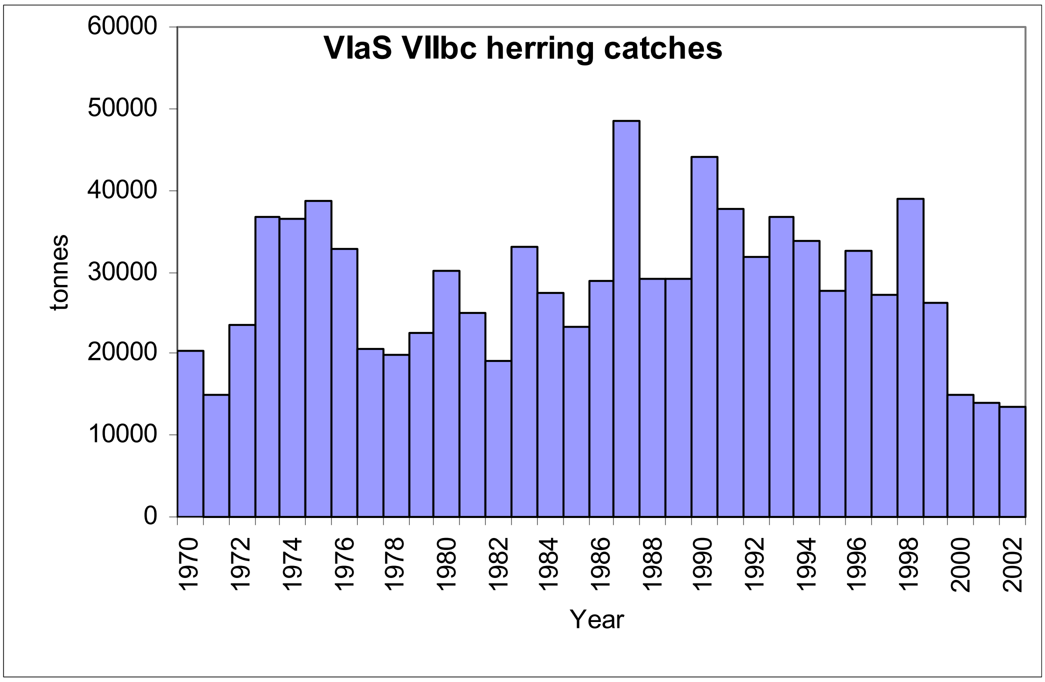


Figure 6.1.2.1 VIa(S) & VIIb,c herring catches from 1970-2002.

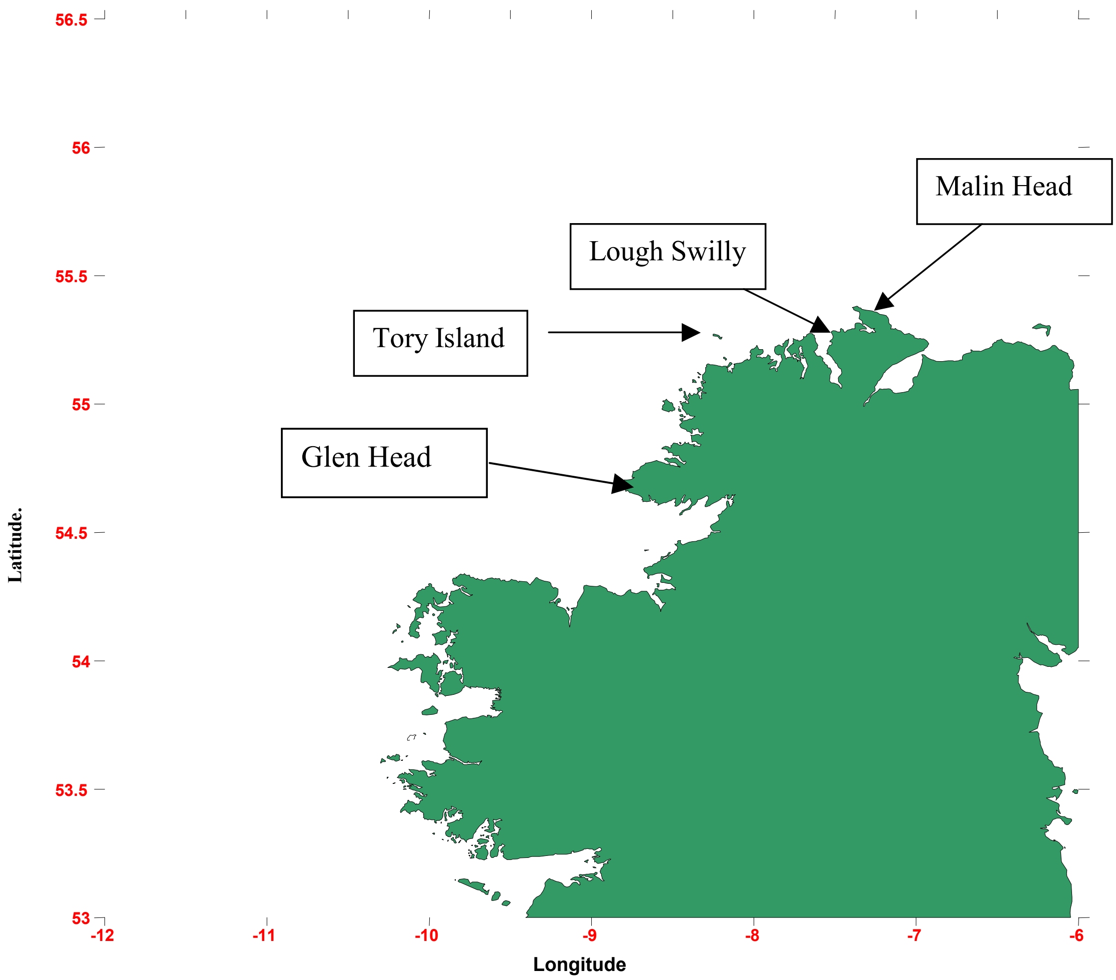


Figure 6.1.3.1 VIa(S) & Division VIIb,c herring. Map of locations mentioned in the text.

Fi

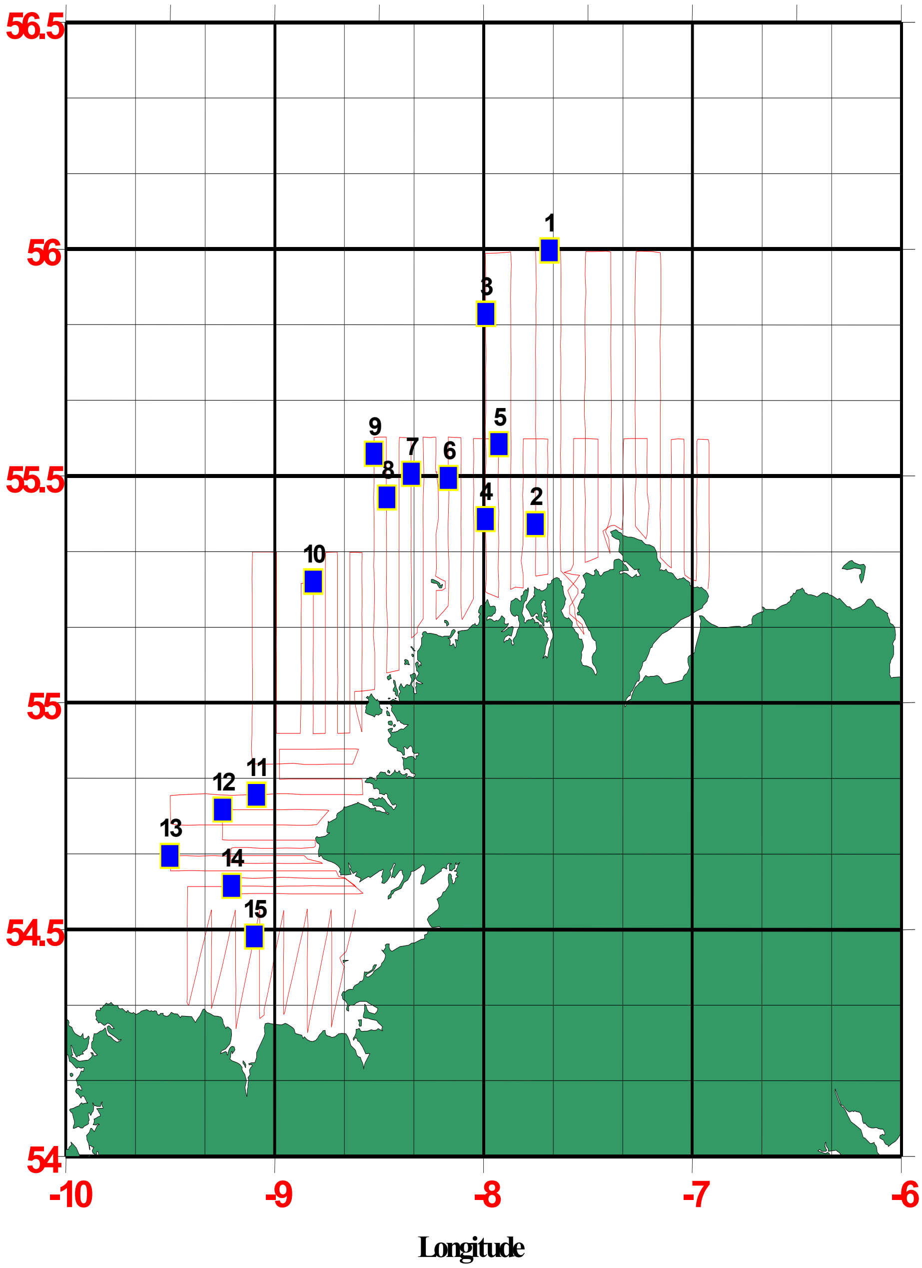


Figure 6.3.2.1 Cruise track and positions of fishing trawls undertaken during the March 2002 North West Coast herring survey.

F

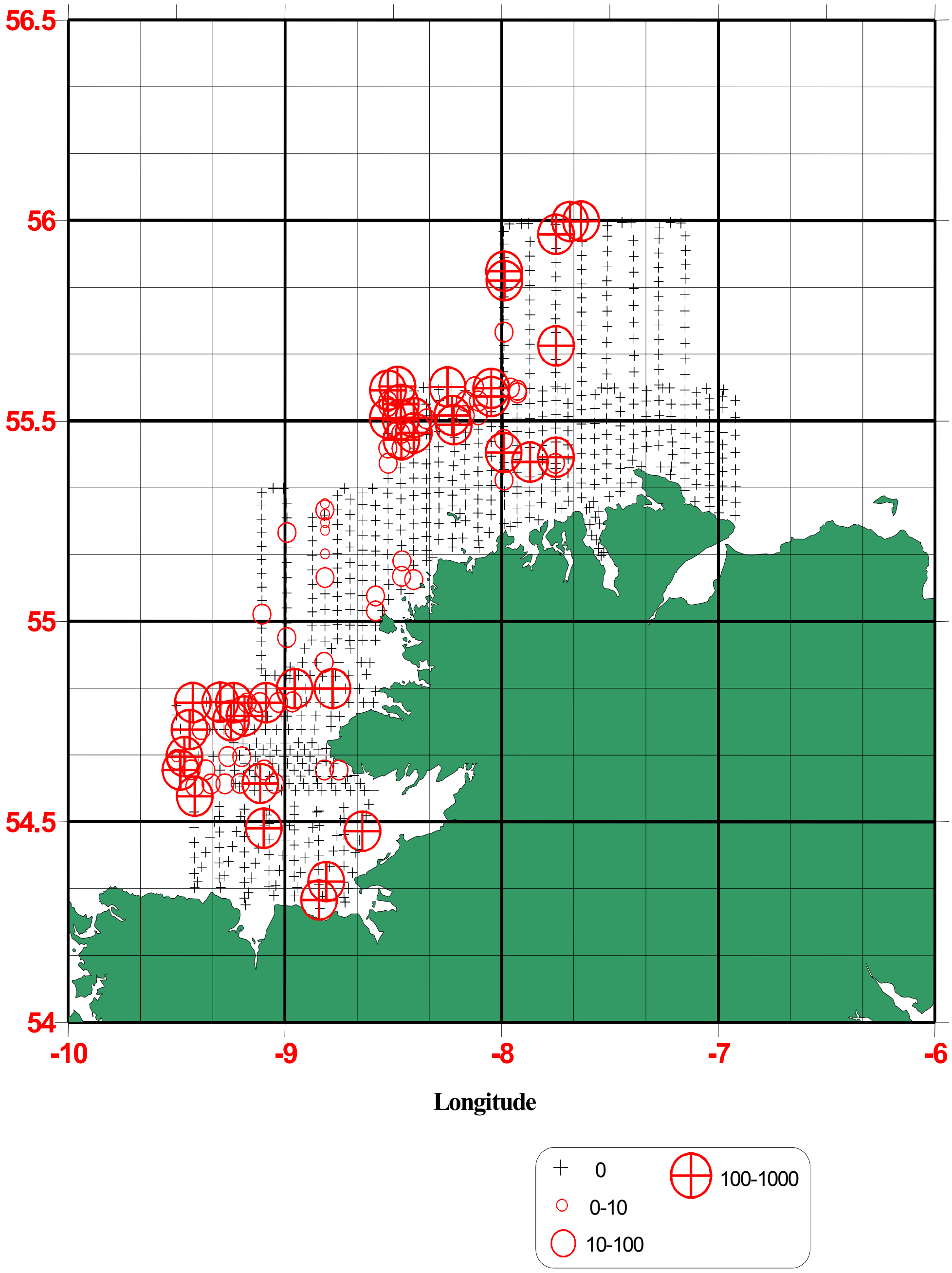


Figure 6.3.2.2 Post plot showing the distribution of total herring SA values obtained during the March 2002 North West Coast herring acoustic survey.

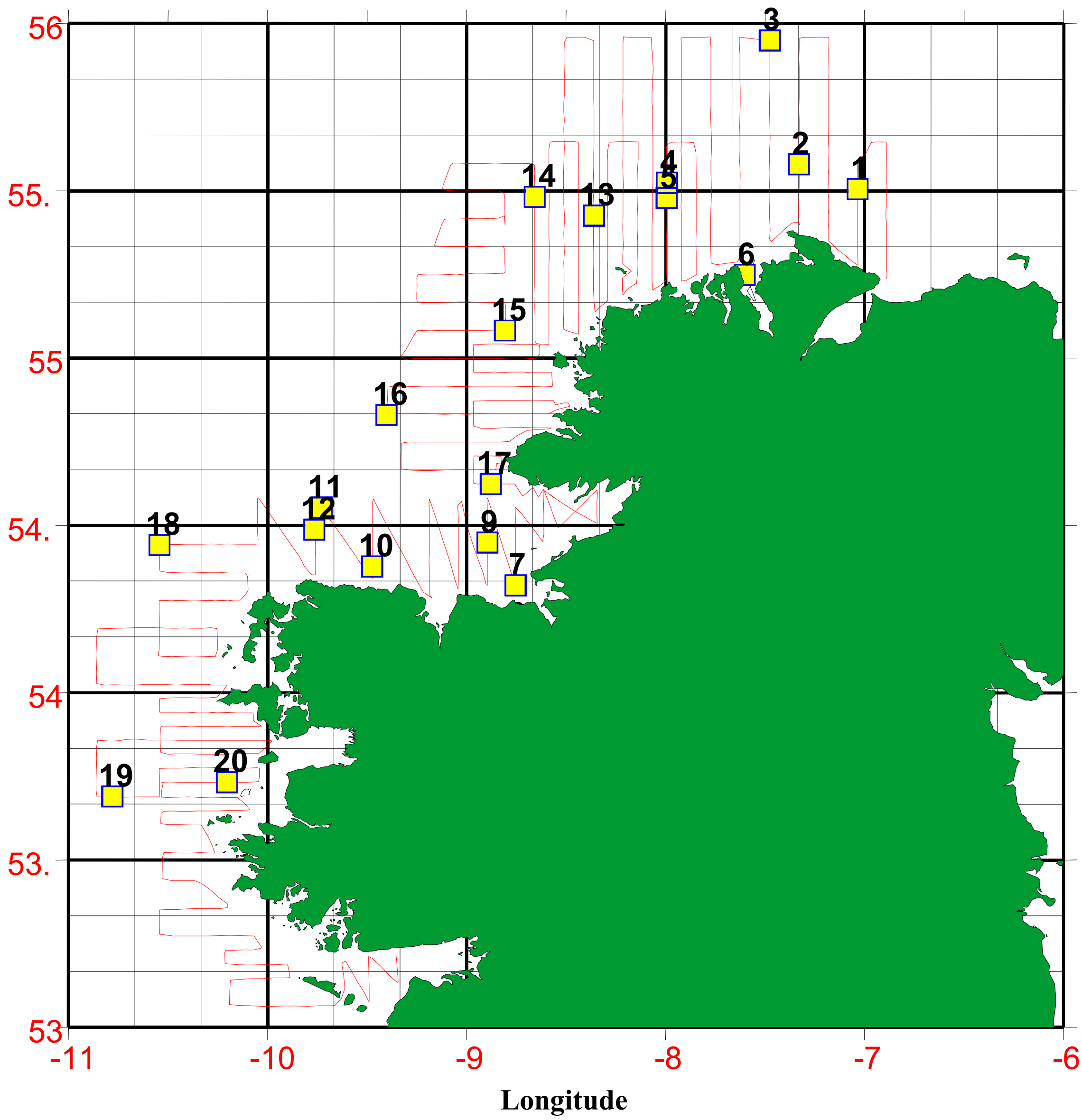


Figure 6.3.2.3 Cruise track and positions of fishing trawls undertaken during the North West Coast herring acoustic survey, November 2002

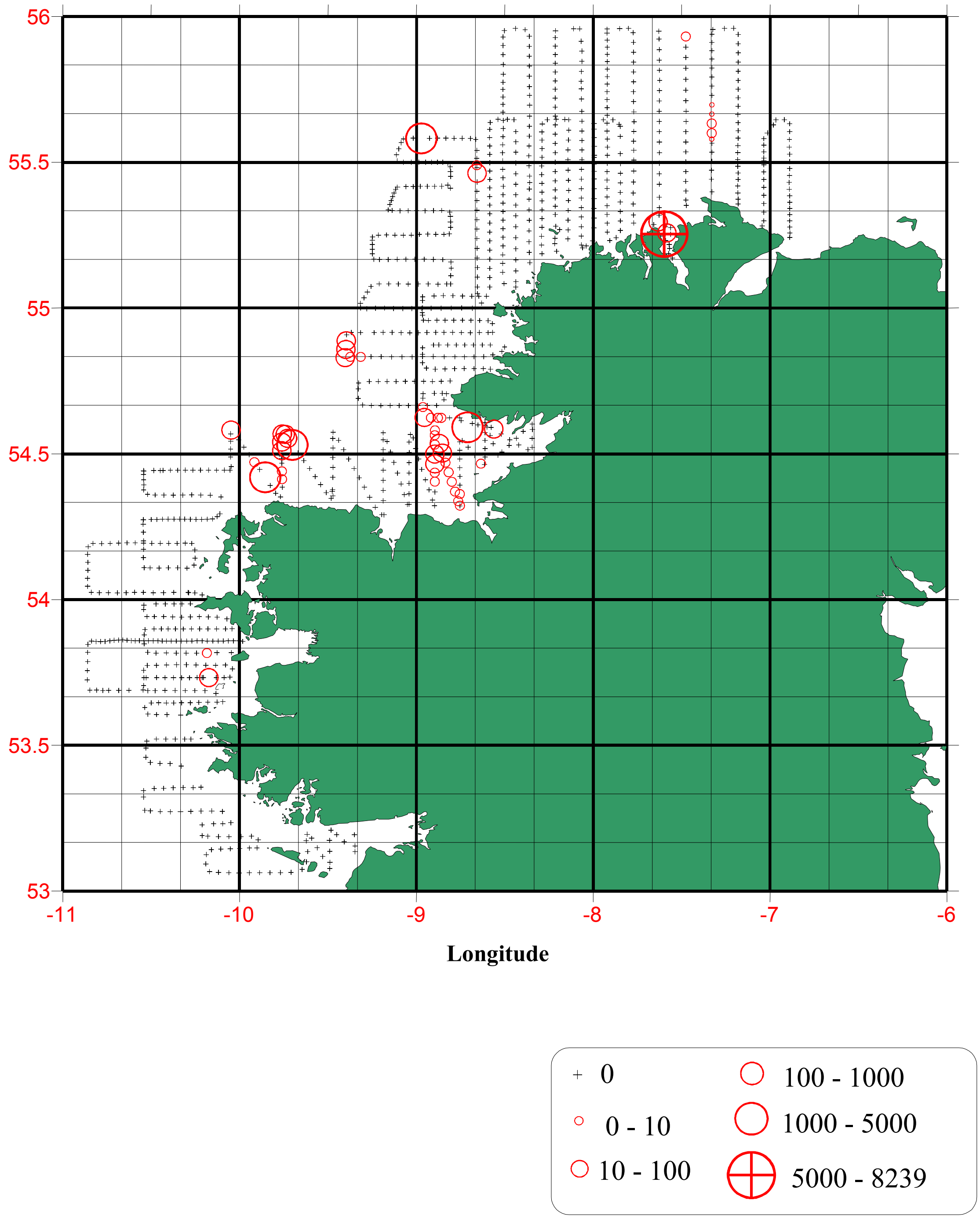


Figure 6.3.2.4 Post plot showing the distribution of total herring NASC values obtained during the North West Coast herring acoustic survey, November 2002.

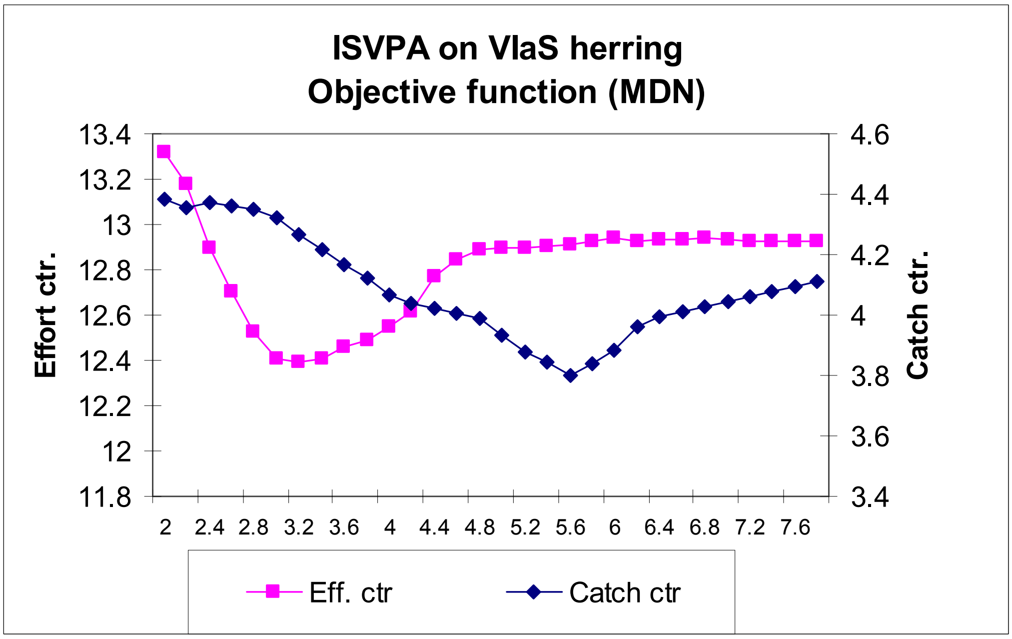


Figure 6.6.1.1 Objective function as function of φ for the catch-controlled and effort-controlled version of ISVPA

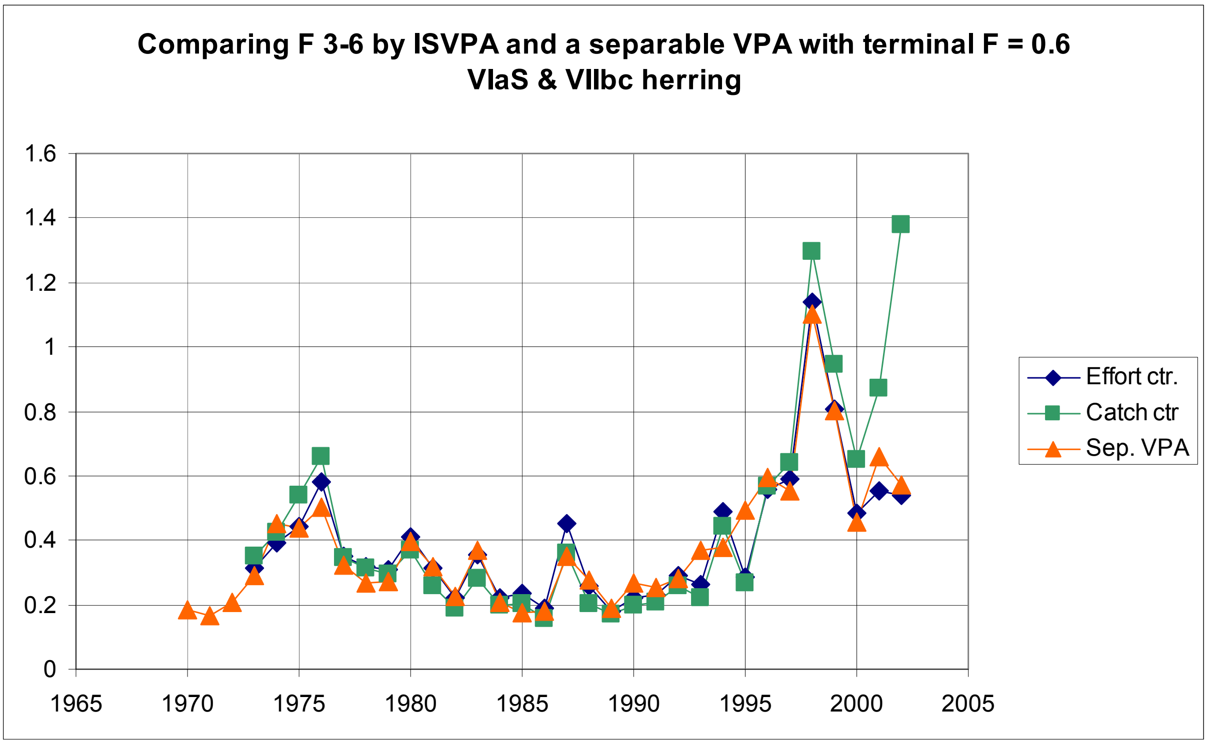


Figure 6.6.1.2. Comparing fishing mortalities by the catch-controlled and effort-controlled versions of ISVPA and by a separable VPA with terminal F = 0.6

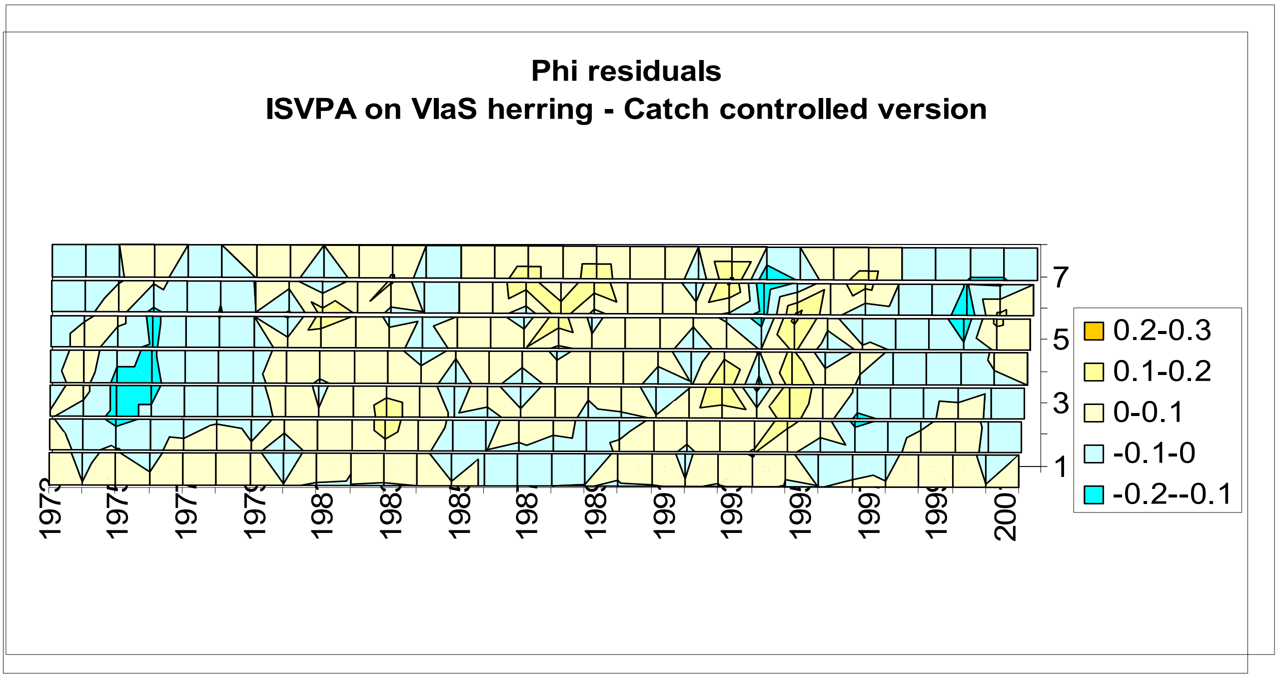


Figure 6.6.1.3 Residuals of φ with the catch-controlled version of ISVPA

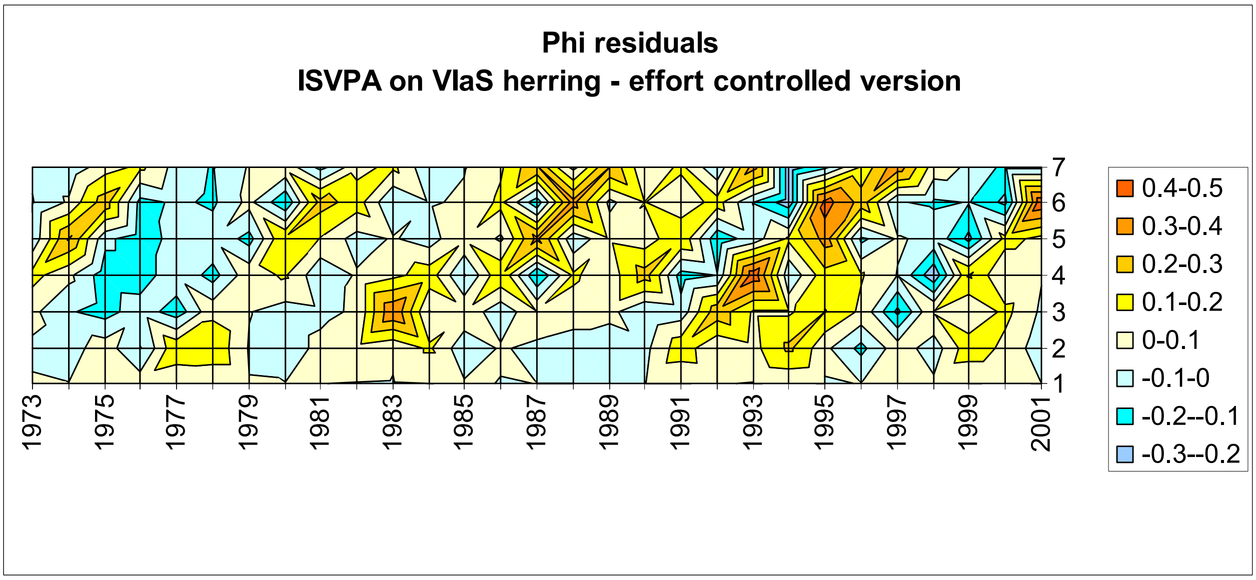


Figure 6.6.1.4 Residuals of φ with the effort-controlled version of ISVPA

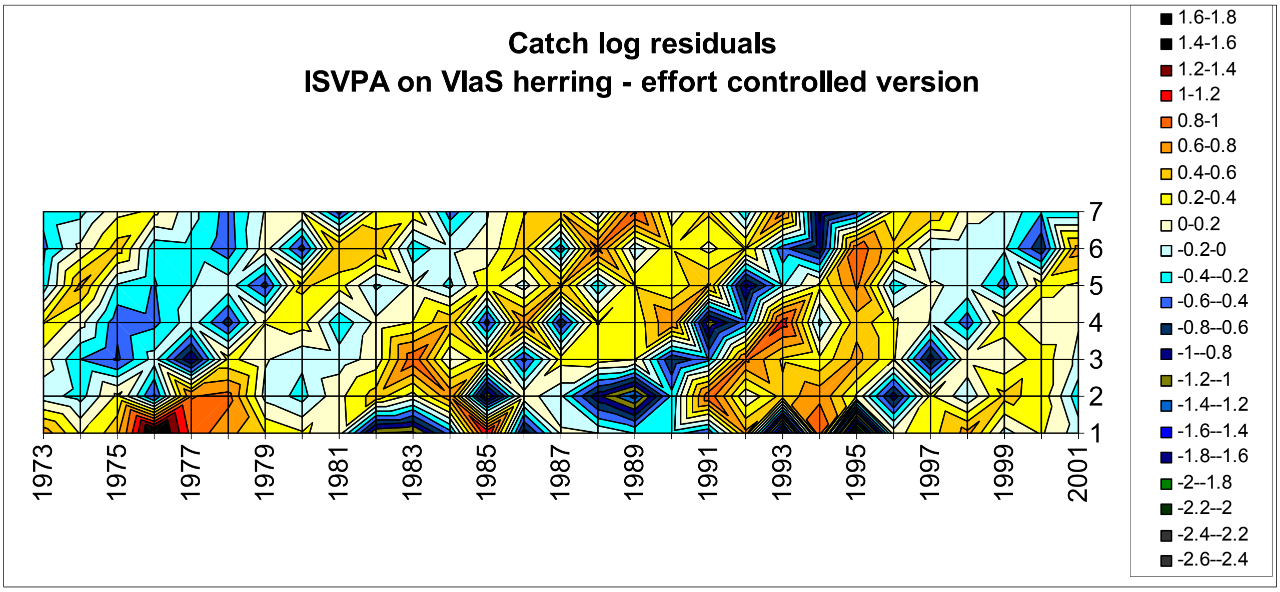


Figure 6.6.1.5 Log catch residuals with the effort-controlled version of ISVPA

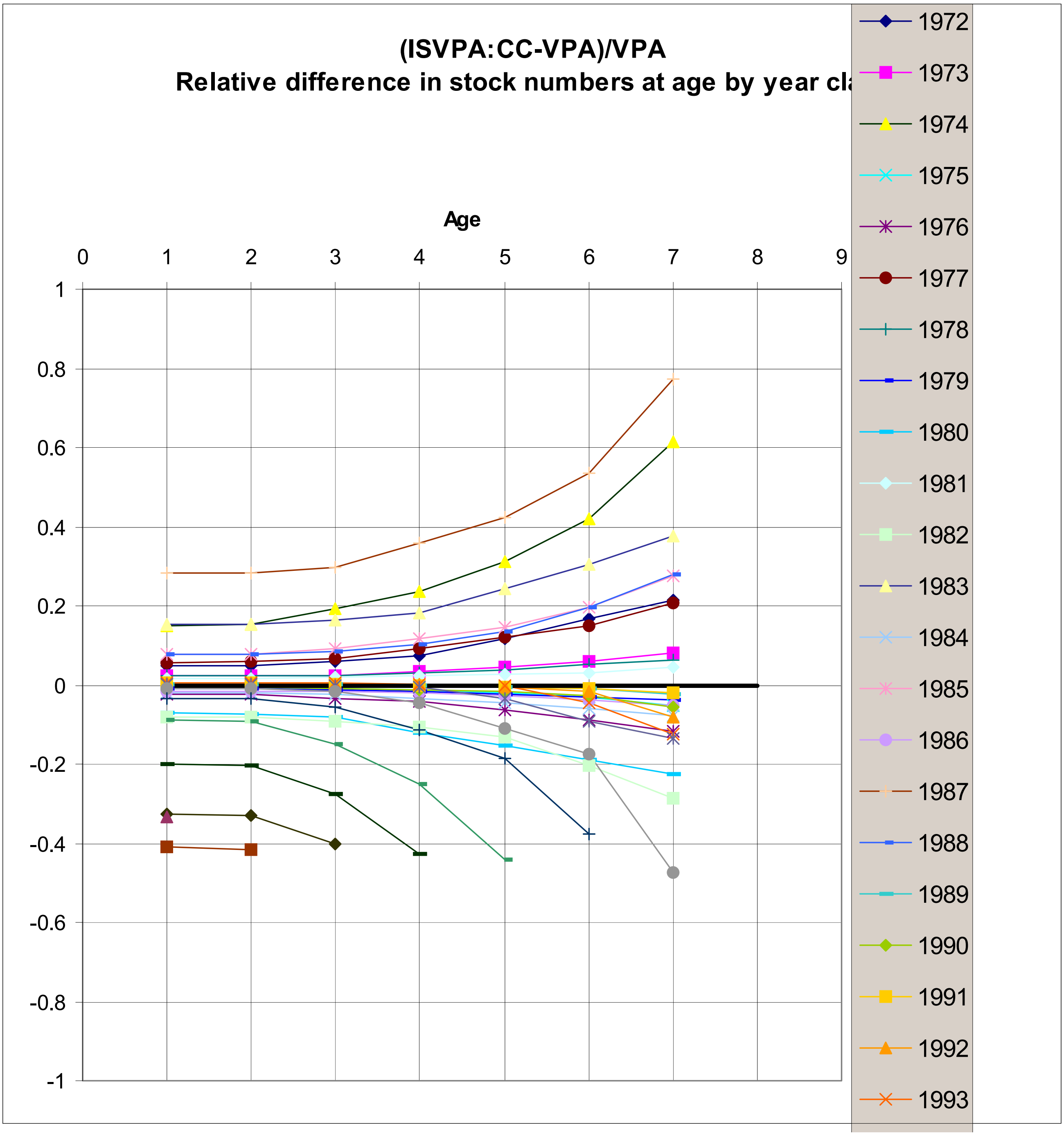


Figure 6.6.1.6 Difference in stock numbers-at-age estimated with ISVPA – catch-controlled version and a separable VPA with terminal F = 0.6, relative to the numbers with the separable VPA

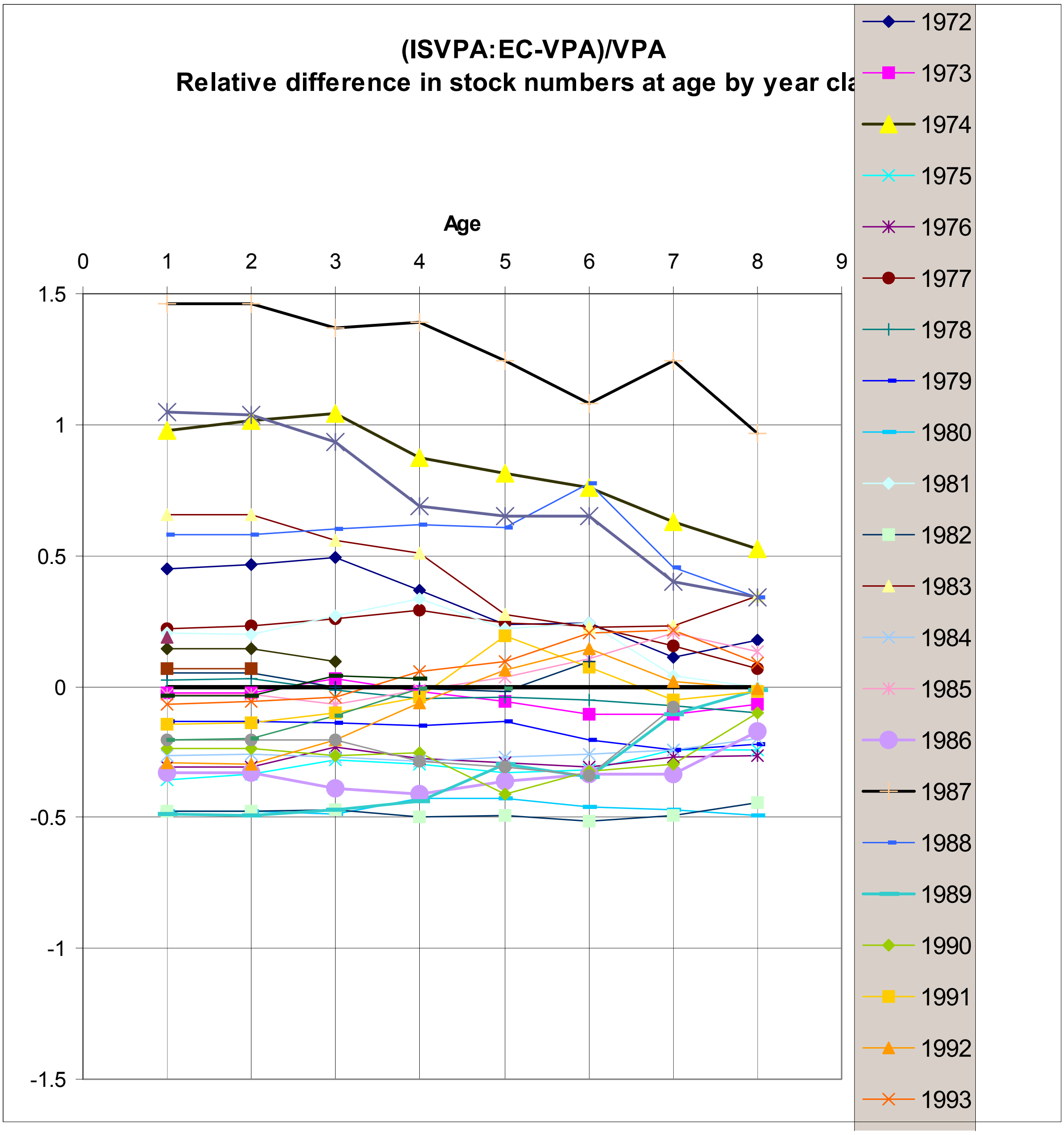


Figure 6.6.1.7 Difference in stock numbers-at-age estimated with ISVPA – effort-controlled version and a separable VPA with terminal F = 0.6, relative to the numbers with the separable VPA

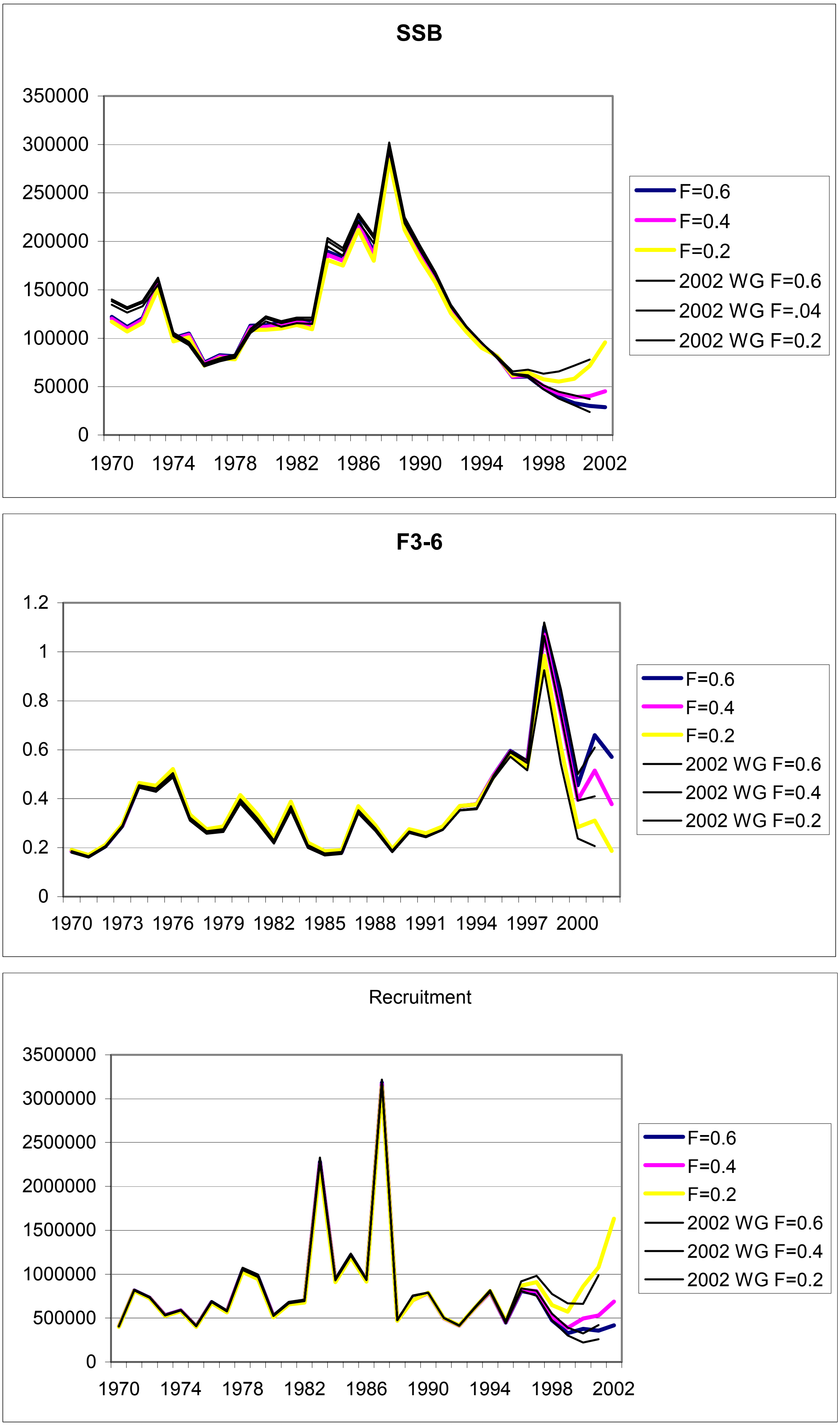


Figure 6.6.2.1 Comparison of exploratory seperable VPAs runs carried out by the HAWG in 2003 and 2002, over a range of terminal F's

7 IRISH SEA HERRING (DIVISION VIIA (NORTH))

7.1 The Fishery

7.1.1 Advice and management applicable to 2002 and 2003

In 1998 and 1999 the shrinkage option in ICA was applied due to the instability in the assessment. The model estimate of F was shrunk to the mean of the ten previous years. In 1999, ACFM commented that F was still above $\mathbf{F}_{pa} = 0.36$, and should be reduced. In 2000 there was uncertainty in the size of the actual catches so a catch (6,900 t) reflecting *status quo* F (0.26) was recommended. In 2001, there was again uncertainty concerning the actual catches so a catch (4,800 t) based on the mean of the last five years was recommended for 2002.

In the 2002 assessment, there was a suggestion of uncertainty in the size of the catches and the assessment was based on the official catches with the proviso that the SSB estimates were uncertain due to the unreliability of the size of the catch. Once again, ACFM felt that the HAWG 2002 assessment was too different from previous perceptions of the stock and advised that the catch in 2003 should not be allowed to increase above the advised 2002 TAC (4,800 t). This was partitioned 3,550 t to the UK and 1,250 t to the Republic of Ireland.

In 2002 the UK fishery opened in July and the Republic of Ireland boats fished in the third quarter. 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 2002. The area to the east of the Isle of Man, encompassing the Douglas Bank spawning ground (described in ICES 2000, ACFM:10), was closed from 21 September to 15 November. Boats from the Republic of Ireland are not permitted to fish east of the Isle of Man.

7.1.2 The fishery in 2002

The catches reported from each country, for the period 1985 to 2002 are given in Table 7.1.1 and total catches from 1967 to 2002 in Figure 7.1.1. Reported landings in 2002 for the Irish Sea amounted to 2,393 t. The size of the actual catch from the Irish Sea (VIIa(N)) is probably no more uncertain than any other area (see Section 7.2.2). In 2002, neither the UK nor the Republic of Ireland took their entire quota from Division VIIa (N). The number of vessels targeting herring in the Irish Sea in 2002 was similar to last year with Republic of Ireland, Northern Ireland and Scottish boats all reporting catches from VIIa (N). According to the reported landings all of the catch was taken in the 3rd and 4th quarters. There was no Mourne gillnet fishery.

7.2 Biological composition of the Catch

7.2.1 Catch in numbers

Catches in numbers-at-age are given in Table 7.2.1 for the years 1972 to 2002. The predominant year classes in 2002 were the 2-rings and 5-rings (1996-year class), which were prevalent in 1999 to 2001. In 2002 there was a low proportion of 1-ring fish in the catch. This probably reflects the majority of the catches coming from spawning aggregations on the east side of the Isle of Man. The catch in numbers at length is given in Table 7.2.2 for 1988 to 2002. In 2001 two modes were evident, reflecting the 2- and 5-ring fish in the catch (see Table 7.2.2). The strong 1996-year class (5-ring) was also evident in the acoustic estimates (see Section 7.3.1).

7.2.2 Quality of catch and biological data

There was a suggestion that the landings data for herring in Division VIIa(N) were un-reliable between 1998 and 2001 (ICES 2002 ACFM:12). A re-examination of these data, by the institute where most of the landings occur, resulted in the conclusion that the landings data for this time period are no more un-reliable than landings data in any adjacent management area. There are still no estimates of discarding or slippage of herring in the Irish Sea fisheries that target herring. Estimates of discarding by other fleets active in the Irish Sea suggest that approximately 2% of the total catch is discarded (Dickey-Collas *et al*., 2002 WD 1). Biological sampling of this fishery remains fairly high; however, in 2002 sampling was lower than in previous years (Table 7.2.3). An otolith exchange program was undertaken between the principal age readers for this and adjacent stocks (namely Northern Ireland, Republic of Ireland, Scotland and the Isle of Man) (McCurdy 2003 WD 4). Based on the otoliths circulated to date, there is no evidence of cause for concern regarding the precision of the age readings.

7.3 Fishery-independent information

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.

The acoustic survey was carried out from 9 to 20 September 2002, using a similar survey design of stratified, systematic transects as used in previous years. The expected distribution pattern for autumn is herring schools at the end of August and beginning of September being concentrated in the coastal waters of the Isle of Man, with some marks off the Irish and Scottish coasts. Hence, survey effort was maximised in strata around the Isle of Man to improve precision of estimates of adult herring biomass. This resulted in relatively low effort employed around the periphery of the Irish Sea, where the acoustic targets comprise mainly extended school groups of sprats and 0-group herring. Although this survey design yields high-precision estimates for small clupeoids due to their extended distribution, the probability of encountering highly aggregated and patchy schools of larger herring remains low around the periphery of the Irish Sea compared with around the Isle of Man. The survey followed the methods described in Armstrong *et al.,* 2003 WD 1). Targets were identified where possible by midwater trawling, and appropriate ALKs constructed from catch samples.

Well-defined schools of herring, comprising mainly 1-ring and older fish of around 18 cm and longer, were found mainly in coastal waters around the Isle of Man and on the Mull of Galloway in the North Channel (Fig. 7.3.1a). The largest aggregation of adult herring was located close to the NE coast of the Isle of Man. Commercial herring trawlers had also located aggregations in this area after extensive searching. Sprats and 0-ring herring were abundant around the periphery of the Irish Sea and off the west coast of the Isle of Man (Fig. 7.3.1b).

The estimate of herring SSB of 25,800 t for 2002 was above the average of 20,600 t for the short time-series. The approximate coefficient of variation (estimated from the variation between 15-minute density estimates within strata) was very high at 0.83 despite the close transect spacing of 2 nautical miles around the Isle of Man. This was a result of the very high density estimate from one 15-minute interval of acoustic data off the NE of the Isle of Man, which accounted for 82% of the SSB estimate. The biomass estimate for 1+ ringers (41,400 t) was above the series average of 32,000 t, although the CV of 0.56 for the stratified mean estimate was high. The estimated age composition of the herring population, excluding 0-ring fish, is given in Table 7.3.2.

7.3.2 Larvae surveys

Larvae surveys were undertaken by Northern Ireland (3-5 and 11-13 November 2002) and the Port Erin Marine Laboratory (5-6 December 2002). These followed the methods and designs of previous surveys in the time-series. Poor weather prevented any Douglas Bank larval herring surveys being carried out by Port Erin Marine Laboratory. The production estimate for 2002 in the NE Irish Sea was lower than the previous year for both the November and December surveys (Table 7.3.3). Once again, there were very few Mourne larvae caught in the Northern Irish survey.

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-ring herring in the Irish Sea (Table 7.3.4) (Armstrong *et al.* 2003 WD1). The ground fish survey index, based on these data and used by the 1997 to 1999 Working Groups was a variance weighted mean abundance of each year class across the surveys. In 2000 the working group analysed these data and decided that the arithmetic mean abundance data (within strata) of 0-ringer and 1-ringer fish were more suitable as a prospective index of recruitment strength (Table 7.6.1). The standard errors are generally high over the series (coefficients of variation $\pm$ 50%). There is no consistent pattern between indices from the western and eastern Irish Sea and further investigations are required into the dynamics of juvenile abundance and distribution in the seas around Ireland. Both series are influenced by the variable number of Celtic Sea fish in the Irish Sea (Brophy & Danilowicz 2002).

7.4 Mean length, weight, maturity and natural mortality-at-age

Mean lengths-at-age were calculated for the 3rd quarter only (due to a lack of biological samples from the 4th quarter) using the Northern Ireland data and are given for the years 1985 to 2002 in Table 7.4.1. In general, mean lengths were longer than in the year before, but are still lower than the 1980s and 1990s.

Mean weights-at-age in the catch are given in Table 7.4.2. Mean weights-at-age of the younger fish in 2002 were still generally low, while older fish weights were comparable with previous years. There has been a change in mean weight over the time period 1961 to the present (ICES 2002 ACFM:12). Mean weights-at-age increased between the early 1960s and the late 1970s whereupon there was been a steady decline to the early 1990s. From the early 1990s to the present, mean weights-at-age have been relatively stable. In the assessment, mean weights-at-age for the period 1972 to 1984 are taken as unchanging. In extending the data series back from 1971 to 1961 mean weights-at-age in the catch were taken from samples recorded by the Port Erin Marine Laboratory (see Dickey-Collas et al. 2003 WD2).

Mean weights-at-age in the third-quarter catches (for the whole time-series 1961 to present) have been used as estimates of stock weights at spawning time.

Previous examinations of the historical time-series of maturity-at-age suggest that there may have been substantial variations over time (HAWG 2002). Stock specific, annually changing, maturity ogives were estimated from combined data sets from the Isle of Man and Northern Ireland (see Dickey-Collas et al. 2003 WD2) and the present time-series was extended back to 1961 (Table 7.4.3). The annual maturity ogives were estimated to reflect the population, using weighting factors to reflect the spatial and temporal distribution of the catches.

As in previous years, natural mortality per year was assumed to be 1.0 on 1-rings, 0.3 on 2-rings, 0.2 on 3-rings and 0.1 on all older age classes. These are based on the natural mortality rates determined for herring in the North Sea.

7.5 Recruitment

There are no recruitment indices for this stock.

7.6 Stock Assessment

7.6.1 Data exploration and preliminary modelling

This year, the preliminary modelling used catch-at-age data derived from the official landings, extended back to 1961. New data were added to the Northern Irish larvae series (NINEL), the Northern Irish acoustic survey (AC-VIIa(N), and ACAGE), October and March groundfish surveys for the east, west and combined areas (Table 7.6.1). No new data were added to the Douglas Bank larvae series (DBL). 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 herring stocks.

The following survey series were available for inclusion in an assessment using the ICA package:

1. Larval production estimates from the Northern Ireland surveys in the Northeast Irish Sea: 1993 - 2002 (**NINEL**)
2. Larval production estimates from Douglas Bank surveys to provide an SSB index: 1989 - 1999 (**DBL**)
3. The arithmetic mean abundance data (within strata) of 0-ringer and 1-ringer fish from October surveys in the northern Irish Sea as a prospective index of recruitment strength of 1- and 2-ringer fish, 1993-2004 (**GFS-octtot**).
4. The arithmetic mean abundance data (within strata) of 1-ringer fish from March surveys in the northern Irish Sea as a prospective index of recruitment strength, 1992-2002 (**GFS-martot**).
5. Age-disaggregated acoustic estimates for the SSB of herring in Division VIIa(N) in September 1994 - 2002 (**ACAGE**, Table 7.3.2).
6. Age-aggregated acoustic estimates for the SSB of herring in Division VIIa(N) in September 1994 - 2002 (**AC_VIIa(N)**)

Due to the problems associated with mixing of Irish Sea and Celtic Sea juveniles none of the groundfish surveys were considered as suitable. Only the three indices used last year were considered suitable for this year (NINEL, DBL and ACAGE). Initial fits within integrated catch-at-age analysis (ICA), were found in 2003 with all three indices. The following input values were used:

- Separable constraint over the 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-rings = 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 with the 1-ringers in the acoustic survey weighted to 0.1.
- Correlated errors assumed i.e., = 1.0
- No shrinkage applied

The Northern Irish larvae index (NINEL) indicated the lowest reference F (0.128) compared to the Douglas Bank larvae (DBL 0.206) and the acoustic index (ACAGE 0.204) (Figure 7.6.1). The precision in F was greater for NINEL and ACAGE than DBL and the precision appeared greater than last year.

There was still no resolution of the questions raised in 2001 concerning the differences between the 2001 and 2000 assessments. It is clear that the shorter a survey series, the greater the chance of instability in the estimation of catchabilities. Hence short series will introduce a source of uncertainty into the assessment. Explorations were made on the retrospective use of the three tuning series (NINEL, DBL and ACAGE). In each case a 6-year separable constraint was used and the years back-stepped annually from 2003 to 1999 to recreate the perception of SSB, $F_{(2\text{-}6)}$ and recruitment for each assessment year (Figure 7.6.2). The largest deviation from all other values was the extremely high estimate of recruitment in 2002 and very low estimate of recruitment in 2003. The present perception of the stock was similar to that for 2001 and 2002. The acoustic survey (ACAGE) was too short to give a robust assessment in 1999.

7.6.2 Stock Assessment

The results of the baseline model fit (with ACAGE, NINEL and DBL) are shown in Figures 7.6.3-7.6.7. The run log is given in Table 7.6.2. Some of the plots for the indices are not shown due to problems encountered with using IcaView in Windows 2000, the residuals and fitted values are given in Table 7.6.3. The SSQ for the index shows a minimum at a low level of fishing mortality (Figure 7.6.3). The estimate for $F_{(2\text{-}6)}$ for 2002 using the official landing data was 0.15 (Table 7.6.3) with a corresponding SSB estimate of approximately 14,812 t. The assessment shows estimated fishing mortality and SSB in the last few years to be similar to previous estimates. The historical uncertainty in SSB was estimated (Figure 7.6.8) and takes into account the uncertainty within the parameter estimates of the model. The estimation of the stock for the period 1994 to 1997 is very poor. This coincides with changes in the fishery when a few large vessels dominated it. The standard fish stock summary plots are shown in Figure 7.6.9 and the stock recruitment plot with $\mathbf{F}_{low}$ (0.20), $\mathbf{F}_{med}$ (0.42) and $\mathbf{F}_{high}$ (1.33) in Figure 7.6.10. The increased levels of the reference F levels, from previous years, are due to the inclusion of data prior to 1972 where there were perceived to be relatively high fishing mortalities and high recruitment with relatively low SSBs.

7.7 Stock and Catch Projection

Short-term predictions were carried out using the ICA estimates of population numbers and fishing mortalities (Section 7.6) using MFDP ver.1a. The Working Group was of the opinion that the estimate of 1-ring abundance in 2002 was exceptionally low, primarily due to the low catches in 2002. The instability in estimating 1-ringers for VIIa(N) is illustrated by the variability in the retrospective analyses (see Figure 7.6.2) and the positive residual for 1-ringers in the acoustic index and negative residual for the 1-ringers in the separable model. Therefore, the 2-ringers for 2003 were replaced with a geometric mean of 2-ringers for the period 1990-2001. The 10-year time period was allocated to reflect the current state of the stock. The numbers of 1-ringers in 2002-2004 were assumed to be a geometric mean of the recruitment over the period 1983–2000 (Table 7.7.1). Mean weights in the catch and in the stock were taken as a mean for the years 2000–2002. This time period includes the 2001 mean weights that were very low. It was decided to use these since they do reflect recent dynamics within the stock. The relevant ICA estimates of F at age in (mean 2000–2002) were used for the exploitation pattern.

In 2002, the UK did not take its full quota, nor did vessels from the Republic of Ireland. However, there is no evidence to suggest whether the fleets will take their quota or not in 2003. Therefore, the options are given assuming that the TAC is taken in 2003.

The Management Option Table is given in Table 7.7.2. The Single Option Table, giving age-disaggregated information, is given in Table 7.7.3. A summary is given below:

Year	$F_{(2\text{-}6)}$	Landings	SSB (t)	Comment	
2003	0.27	4800	14,560		
2003	$0.21=F_{(2000\text{-}02)}$	3960	15,152	Rising SSB	
2004	$0.21=F_{(2000\text{-}02)}$	4076	15,670	Rising SSB	Table 7.7.3

7.8 Medium-term predictions of stock size

The Working Group decided that there was no real basis for undertaking a meaningful medium-term projection of stock size until it becomes clear that the assessment is stable and there is agreement that advice can be given based on the assessment. The current state of herring recruitment to VIIa(N) 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.

7.9 Reference points

Until there is confidence in the assessment the Working Group decided not to revisit the estimation of $\mathbf{B}_{pa}$ (9,500 t) and $\mathbf{B}_{lim}$ (6,000 t). There were no new points to add to the discussions and deliberations presented in 2000 (ICES 2000/ACFM:10). Candidate F reference points are given in Figure 7.6.9.

7.10 Quality of the Assessment

The current time-series of survey data are relatively short and were prone to providing variable perceptions of stock development due to variability in catchabilities of the indices. The current SSB is approximately the same as that perceived by the Working Group in 2002 and previous assessments lie within the 95% confidence limits of the current SSB estimates. There have probably been changes in this stock since the early 1990s, with reductions in weights-at-age and changes in spawning behaviour. Spawning sites have varied with notable spawning to the north of the Isle of Man and the reduction in the Mourne component. This change in stock dynamics and the variability in the tuning data imply that assessments on this stock should continue to be treated with caution. It is likely, however, that the SSB has stabilised over recent years.

7.11 Spawning and Juvenile Fishing Area Closures

The arrangement of closed areas in Division VIIa(N) prior to 1999 are discussed in detail in ICES (1996/ACFM:10) with a change to the closed area to the east of the Isle of Man being altered in 1999 (see ICES 2001/ACFM:10). The closed areas consist of: all year juvenile closures along part of 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 from 21st September- 15th November, and along the east coast of Ireland all year round. 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.

7.12 Management considerations

There was considerable between-year variation in SSB indices and the relevant 2002 data are generally close to the mean of each series. The perception of the stock is similar to the previous two assessment years (2001 and 2002). Therefore, maintaining catch levels, in the short term, of approximately 5,000 t should not be detrimental to the stock.

Table 7.1.1 Irish Sea herring Division VIIa(N). Official catch in tonnes by country, 1985-2002. The total catch does 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	2000	2001	2002
Ireland	0	0	100	0	0	0	0	862	286
UK	4,828	5,076	5,180	6,651	4,905	4,127	2002	4599	2107
Unallocated	-	-	22	-	-	-	-	-	
Total	4,828	5,076	5,302	6,651	4,905	4,127	2,002	5,461	2,393

Table 7.2.1 Irish Sea herring Division VIIa(N). Catch in numbers (thousands) by year.

	Age (rings)							
Year	1	2	3	4	5	6	7	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
2000	1221	3743	5873	2065	558	347	251	147
2001	2713	11473	7151	13050	3386	936	650	803
2002	179	9021	1894	1866	2395	953	474	343

Table 7.2.2 Irish Sea herring Division VIIa (N). Catch-at-length for 1988-2002. Numbers of fish in thousands

Length	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
14	1														
	1														
15	1				95										
	10				169							10			
16	13		6		343			21	21	17		19	12	9	
	16		6	2	275			55	51	94		53	49	27	
17	29		50	1	779		84	139	127	281	26	97	67	53	
	44	24	7	4	1106		59	148	200	525	30	82	97	105	
18	46	44	224	31	1263		69	300	173	1022	123	145	115	229	
	85	43	165	56	1662		89	280	415	1066	206	135	134	240	36
19	247	116	656	168	1767	39	226	310	554	1720	317	234	164	385	18
	306	214	318	174	1189	75	241	305	652	1263	277	82	97	439	0
20	385	226	791	454	1268	75	253	326	749	1366	427	218	109	523	0
	265	244	472	341	705	57	270	404	867	1029	297	242	85	608	18
21	482	320	735	469	705	130	400	468	886	1510	522	449	115	1086	307
	530	401	447	296	597	263	308	782	1258	1192	549	362	138	1201	433
22	763	453	935	438	664	610	700	1509	1530	2607	1354	1261	289	1748	1750
	1205	497	581	782	927	1224	785	2541	2190	2482	1099	2305	418	1763	1949
23	2101	612	2400	1790	1653	2016	1035	4198	2362	3508	2493	4784	607	2670	2490
	3573	814	1908	1974	1156	2368	1473	4547	2917	3902	2041	4183	951	2254	1552
24	5046	1183	3474	2842	1575	2895	2126	4416	3649	4714	3695	4165	1436	3489	1029
	5447	1656	2818	2311	2412	2616	2564	3391	4077	4138	2769	3397	1783	4098	758
25	5276	2206	4803	2734	2792	2207	3315	3100	4015	5031	2625	2620	2144	5566	776
	4634	2720	3688	2596	3268	2198	3382	2358	3668	3971	2797	1817	1791	4785	1335
26	4082	3555	4845	3278	3865	2216	3480	2334	2480	3871	3115	1694	1349	3814	1570
	4570	3293	3015	2862	3908	2176	2617	1807	2177	2455	2641	1547	840	2243	1552
27	4689	2847	3014	2412	3389	2299	2391	1622	1949	1711	2992	1475	616	1489	776
	4124	2018	1134	1449	2203	2047	1777	990	1267	1131	1747	867	479	644	433
28	3406	1947	993	922	1440	1538	1294	834	906	638	1235	276	212	496	162
	2916	1586	582	423	569	944	900	123	564	440	170	169	58	179	108
29	2659	1268	302	293	278	473	417	248	210	280	111	61	42	10	36
	1740	997	144	129	96	160	165	56	79	59	92		12	0	36
30	1335	801	146	82	70	83	9	40	32	8	84		6	9	
	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 7.2.3 Irish Sea herring Division VIIa (N). Sampling intensity of commercial landings in 2002.

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	286	0	0	0	-
	UK (N. Ireland)	1440	9	949	450	Yes**
	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
4	Ireland	0	-	-	-	-
	UK (N. Ireland)	611	0	0	0	No
	UK (Isle of Man)	4	0	0	0	-
	UK (Scotland)	51	0	0	0	-
	UK (England & Wales)	0	-	-	-	-

** estimates for NI whitefish and *Nephrops* fleets

Table 7.3.1 Irish Sea herring Division VIIa (N): Summary of acoustic survey information for the period 1989-2002. 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
2000	Area VIIa(N)	11-21 Sept	40,200	0.26	33,750	0.32	234,700	0.11
2001	Area VIIa(N)	10-18 Sept	35,400	0.40	15,300	0.42	299,700	0.08
2002	Area VIIa(N)	9-20 Sept	41,400	0.56	25,810	0.83	413,900	0.09

[1] sprat only

Table 7.3.2 Irish Sea herring Div. VIIa (N). Age-disaggregated acoustic estimates of herring abundance from the Northern Ireland surveys in September.

Age (rings)	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	66.8	319.1	11.3	134.1	110.4	157.8	78.5	387.6	391.0
2	68.3	82.3	42.4	50.0	27.3	77.7	103.4	93.4	71.9
3	73.5	11.9	67.5	14.8	8.1	34.0	105.3	10.1	31.7
4	11.9	29.2	9.0	11.0	9.3	5.1	27.5	17.5	24.8
5	9.3	4.6	26.5	7.8	6.5	10.3	8.1	7.7	31.3
6	7.6	3.5	4.2	4.6	1.8	13.5	5.4	1.4	14.8
7	3.9	4.9	5.9	0.6	2.3	1.6	4.9	0.6	2.8
8+	10.1	6.9	5.8	1.9	0.8	6.3	2.4	2.2	4.5

Table 7.3.3 Irish Sea herring Division VIIa (N). Larval production (10^{11}) indices for the Manx component.

Year	Douglas Bank			Northeast Irish Sea					
		Isle of Man			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
2000							11 Nov	35.5	4.4
2001				11 Dec	198.6		7 Nov	55.3	30.4
2002				6 Dec	19.8		4 Nov	31.5	14.8

SE = Standard Error

Table 7.3.4 Irish Sea herring Division VIIa (N). Northern Ireland groundfish survey indices for herring (Nos. per 3 miles.)

(a) 0-ring herring: October survey

	Western Irish Sea			Eastern Irish Sea			Total Irish Sea		
Survey	Mean	N.obs	SE	Mean	N.obs.	SE	Mean	N. obs	SE
1991	54	34	22						
1992	210	31	99	240	8	149	177	46	68
1993	633	26	331	498	10	270	412	44	155
1994	548	26	159	8	7	5	194	41	55
1995	67	22	23	35	9	18	37	35	11
1996	90	26	58	131	9	79	117	42	50
1997	281	26	192	68	9	42	138	43	70
1998	980	26	417	12	9	10	347	43	144
1999	389	26	271	90	9	29	186	43	96
2000	202	24	144	367	9	190	212	38	89
2001	553	26	244	236	11	104	284	45	93
2002	132	26	84	18	11	10	63	45	31

(b) 1-ring herring: March Surveys. a. Unusually large catch removed, b. unusually large catch retained.

	Western Irish Sea			Eastern Irish Sea			Total Irish Sea		
Survey	Mean	N.obs	SE	Mean	N.obs.	SE	Mean	N.obs	SE
1992	392	20	198	115	10	73	190	34	77
1993	1755	27	620	175	10	66	681	45	216
1994	2472	25	1852	106	9	51	923	39	641
1995	1299	26	679	73	8	32	480	42	235
1996	1055	22	638	285	9	164	487	39	230
1997	1473	26	382	260	9	96	612	43	137
1998	3953	26	1331	250	9	184	1472	43	466
1999	5845	26	1860	736	9	321	2308	42	655
2000	2303	26	853	546	10	217	1009	44	306
2001	3518	26	916	1265	11	531	1763	45	381
2002[a]	2255	25	845	185	11	84	852	44	294
2002[b]	7870	26	5667	185	11	84	2794	45	1960

(c) 1-ring herring: October Surveys

	Western Irish Sea			Eastern Irish Sea			Total Irish Sea		
Survey	Mean	N.obs	SE	Mean	N.obs.	SE	Mean	N.obs	SE
1991	102	34	34	n/a	n/a	n/a	n/a	n/a	n/a
1992	36	31	18	20	8	11	21	46	8
1993	122	26	66	4	10	2	44	44	23
1994	490	26	137	17	6	10	176	40	47
1995	153	22	61	3	9	1	55	35	21
1996	30	26	13	2	9	1	11	42	5
1997	612	26	369	0.2	9	0.2	302	43	156
1998	39	26	15	13	9	10	53	43	35
1999	81	26	41	104	9	95	74	43	40
2000	455	24	250	74	9	52	579	38	403
2001	1412	26	641	5	11	3	513	45	223
2002	370	26	111	4	11	2	291	45	158

Table 7.4.1 Irish Sea herring Division VIIa (N). 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
2000	19.7	23.8	25.3	26.3	27.1	27.7	27.7	28.1
2001	20.0	22.9	24.8	25.7	26.2	26.9	27.5	27.8
2002	21.1	23.1	24.8	26.0	26.6	26.7	27.0	28.1

Table 7.4.2 Irish Sea herring Division VIIa (N). 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
2000	64	120	148	168	188	204	200	213
2001	67	106	139	156	168	185	198	205
2002	85	113	144	167	180	184	191	217

Table 7.4.3 Irish Sea herring Division VIIa(N). Maturity ogive.

Year	Age (rings)							
	1	2	3	4	5	6	7	8+
1961	0.00	0.22	0.63	1.00	1.00	1.00	1.00	1.00
1962	0.00	0.24	0.83	0.92	1.00	1.00	1.00	1.00
1963	0.00	0.34	0.88	0.89	1.00	1.00	1.00	1.00
1964	0.00	0.53	0.81	1.00	1.00	1.00	1.00	1.00
1965	0.00	0.61	0.90	1.00	1.00	1.00	1.00	1.00
1966	0.00	0.47	0.91	1.00	1.00	1.00	1.00	1.00
1967	0.02	0.37	0.75	0.83	1.00	1.00	1.00	1.00
1968	0.00	0.88	0.94	0.94	1.00	1.00	1.00	1.00
1969	0.00	0.71	0.92	0.94	1.00	1.00	1.00	1.00
1970	0.02	0.92	0.94	0.96	1.00	1.00	1.00	1.00
1971	0.15	0.87	0.97	0.98	1.00	1.00	1.00	1.00
1972	0.11	0.88	0.90	1.00	1.00	1.00	1.00	1.00
1973	0.12	0.77	0.89	0.97	1.00	1.00	1.00	1.00
1974	0.36	0.99	0.96	1.00	1.00	1.00	1.00	1.00
1975	0.40	0.99	1.00	0.94	1.00	1.00	1.00	1.00
1976	0.07	0.96	0.98	1.00	1.00	1.00	1.00	1.00
1977	0.03	0.92	0.96	1.00	1.00	1.00	1.00	1.00
1978	0.04	0.81	0.88	0.91	1.00	1.00	1.00	1.00
1979	0.00	0.84	0.81	0.78	1.00	1.00	1.00	1.00
1980	0.20	0.88	0.95	0.95	1.00	1.00	1.00	1.00
1981	0.19	0.89	0.90	0.94	1.00	1.00	1.00	1.00
1982	0.10	0.80	0.89	0.91	1.00	1.00	1.00	1.00
1983	0.02	0.73	0.88	0.90	1.00	1.00	1.00	1.00
1984	0.00	0.69	0.83	0.93	1.00	1.00	1.00	1.00
1985	0.14	0.62	0.71	0.88	1.00	1.00	1.00	1.00
1986	0.31	0.73	0.66	0.81	1.00	1.00	1.00	1.00
1987	0.00	0.85	0.91	0.87	1.00	1.00	1.00	1.00
1988	0.00	0.90	0.96	0.99	1.00	1.00	1.00	1.00
1989	0.07	0.63	0.93	0.95	1.00	1.00	1.00	1.00
1990	0.06	0.66	0.90	0.95	1.00	1.00	1.00	1.00
1991	0.04	0.30	0.74	0.82	1.00	1.00	1.00	1.00
1992	0.28	0.48	0.72	0.81	1.00	1.00	1.00	1.00
1993	0.00	0.46	0.99	1.00	1.00	1.00	1.00	1.00
1994	0.19	0.68	0.99	0.97	1.00	1.00	1.00	1.00
1995	0.10	0.86	0.94	0.99	1.00	1.00	1.00	1.00
1996	0.02	0.60	0.96	0.83	1.00	1.00	1.00	1.00
1997	0.04	0.82	0.95	1.00	1.00	1.00	1.00	1.00
1998	0.30	0.83	0.97	0.99	1.00	1.00	1.00	1.00
1999	0.02	0.84	0.95	0.97	1.00	1.00	1.00	1.00
2000	0.14	0.79	0.99	1.00	1.00	1.00	1.00	1.00
2001	0.15	0.54	0.88	0.97	1.00	1.00	1.00	1.00
2002	0.02	0.92	0.95	0.98	1.00	1.00	1.00	1.00

Table 7.6.1 Irish Sea herring Division VIIa (N). Tuning indices used for the assessment. Values and CVs are given. Age = rings.

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					190	15.64 (2.32)		-
1993	240	20	177	21	681	4.81 (0.77)	38.3 (0.48)	-
1994	498	4	412	44	923	7.30 (2.26)	71.2 (0.12)	26190 (na)
1995	8	17	194	176	480	1.58 (1.68)	15.1 (0.62)	19900 (na)
1996	35	3	37	55	487	-	4.7 (0.30)	23390 (0.25)
1997	131	2	117	11	612	5.59 (1.25)	29.1 (0.11)	11300 (0.28)
1998	68	0	138	302	1472	2.27 (1.43)	5.8 (1.02)	7760 (0.18)
1999	12	13	347	53	2308	3.87 (0.88)	16.7 (0.57)	21,970 (0.75)
2000	90	104	186	74	1009		35.5 (0.12)	33,750 (0.32)
2001	367	74	212	579	1763		55.3 (0.55)	15,300 (0.42)
2002	236	5	284	513	852		31.5 (.47)	25,810 (0.83)
2003	18	4	63	291				

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.
2. Mean abundance of juveniles (within strata) per 3nm trawl, aged 1 in March from the eastern Irish Sea.
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- Northeast Larvae. AC- Acoustic.

Table 7.6.2 **Herring in Div. VIIa(N).** Run log of HAWG 2003 Irish Sea final run. Age = ring.

```
          Integrated Catch-at-age Analysis
   Version 1.4 w      K.R.Patterson       8 March 1998
 Enter the name of the index file -->index.txt  canum.txt    weca.txt
Stock weights in 2003  used for the year 2002 west.txt

 Natural mortality in 2003  used for the year 2002   natmor.txt
Maturity ogive in 2003  used for the year 2002   matprop.txt
Name of age-structured index file (Enter if none) : -->fleet.txt
 Name of the SSB index file (Enter if none) -->ssb.txt
 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 ?-->    1.000
 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-->    0.1        Weight for age 2-->    1.0
 Weight for age 3-->    1.0        Weight for age 4-->    1.0
 Weight for age 5-->    1.0        Weight for age 6-->    1.0
 Weight for age 7-->    1.0        Weight for age 8-->    1.0
Enter relative weights by year
 Weight for year 1997-->    1.0000 Weight for year 1998-->    1.000
 Weight for year 1999-->    1.000  Weight for year 2000-->    1.000
 Weight for year 2001-->    1.000  Weight for year 2002-->    1.000
Enter new weights for specified years and ages if needed
 Enter year, age, new weight or -1,-1,-1 to end.  -1 -1   -1.000
 Is the last age of FLT01: Northern Ireland acoustic surveys 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 ?-->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
 Fit a stock-recruit relationship (Y/N) ?-->n
 Enter lowest feasible F-->   5.0000003E-02       Enter highest feasible F-->    2.00000
Mapping the F-dimension of the SSQ surface
                                          F   SSQ
                                   +-------+-----------------
                                    0.05        20.7061422571
                                    0.15        18.3122256734
                                    0.26        19.6310171163
                                    0.36        21.2861099592
                                    0.46        22.9749247191
                                    0.56        24.6352057091
                                    0.67        26.2602489090
                                    0.77        27.8622424992
                                    0.87        29.4634887289
                                    0.97        31.0979804096
                                    1.08        32.8250786526
                                    1.18        34.7825771982
                                    1.28        36.1799348818
                                    1.38        37.4046030454
                                    1.49        38.6298327553
                                    1.59        39.8631337091
                                    1.69        41.1121552825
                                    1.79        42.3850111395
                                    1.90        43.6907325035
                                    2.00        44.8443324509
                                  Lowest SSQ is for F =     0.121
                              ---------------------------------------

No of years for separable analysis : 6          Age range in the analysis : 1  . . . 8
Year range in the analysis : 1961  . . . 2002   Number of indices of SSB : 2
Number of age-structured indices : 1   Parameters to estimate : 33  Number of observations : 135
Conventional single selection vector model to be fitted.
Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for   INDEX1-->    1.00   Enter weight for   INDEX2-->    1.00
 Enter weight for age 1-->    0.100     Enter weight for age 2-->    1.00
 Enter weight for age 3-->    1.00      Enter weight for age 4-->    1.00
 Enter weight for age 5-->    1.00      Enter weight for age 6-->    1.00
 Enter weight for age 7-->    1.00      Enter weight for 8-->    1.00
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
 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 :     0.012 0.125 0.125 0.125 0.125 0.125 0.125 0.125
F in 2002  at age 4  is 0.158520  in iteration 1
Detailed, Normal or Summary output (D/N/S)-->D Output page width in characters (e.g. 80..132) ?-->
80
Estimate     historical     assessment     uncertainty     ?-->n     Succesful     exit     from     ICA
```

Table 7.6.3 Herring Irish Sea VIIa(N).ICA assessment of Irish Sea herring catches from official landings. Output Generated by ICA Version 1.4 . Age = rings

Catch in Number

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	4.54	0.38	4.84	1.51	0.85	0.94	4.44	1.02
2	11.47	12.30	9.44	18.09	27.08	15.05	40.92	30.18
3	2.63	7.34	2.34	4.35	8.18	15.63	5.60	13.46
4	12.43	1.81	2.89	0.71	0.99	2.00	4.63	4.08
5	0.24	5.43	2.26	0.53	0.70	0.12	1.35	0.82
6	0.48	0.19	2.26	0.71	0.99	0.35	0.00	0.61
7	1.20	0.19	0.55	0.00	0.42	0.12	0.00	0.00
8	2.15	0.67	0.62	0.18	0.70	0.00	0.00	0.00

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	1.32	5.61	12.17	40.64	42.15	43.25	33.33	34.74
2	42.80	31.18	66.92	46.66	32.74	109.55	48.24	56.16
3	16.91	33.63	31.94	26.95	38.24	39.75	39.41	20.78
4	12.68	16.46	29.41	13.18	11.49	24.51	10.84	15.22
5	1.32	12.61	5.07	13.75	6.92	10.65	7.87	4.58
6	2.64	1.75	3.55	6.76	5.07	4.99	4.21	2.81
7	0.53	2.10	1.01	2.66	2.59	5.15	2.09	2.42
8	0.00	1.05	1.01	1.67	2.60	1.63	1.64	1.27

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	30.28	15.54	11.77	5.84	5.05	5.10	1.30	1.17
2	39.04	36.95	38.27	25.76	15.79	16.03	12.16	8.42
3	22.69	13.41	23.49	19.51	3.20	5.67	5.60	7.24
4	6.75	6.78	4.25	8.52	2.79	2.15	2.82	3.84
5	4.52	1.74	2.20	1.98	2.30	0.33	0.45	2.22
6	1.46	1.34	1.05	0.91	0.33	1.11	0.48	0.38
7	0.91	0.67	0.40	0.36	0.29	0.14	0.26	0.23
8	1.12	0.35	0.29	0.23	0.24	0.38	0.06	0.48

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	2.43	4.49	2.23	2.61	1.16	2.31	2.00	12.14
2	10.05	15.27	12.98	21.25	6.38	12.84	9.75	6.88
3	17.34	7.46	6.15	13.34	12.04	5.73	6.74	6.74
4	13.29	8.55	3.00	7.16	4.71	9.70	2.83	6.69
5	7.21	4.53	4.18	4.61	1.88	3.60	5.07	3.26
6	2.65	3.20	2.78	5.08	1.25	1.66	1.49	5.12
7	0.67	1.46	2.33	3.23	1.56	1.04	0.72	1.04
8	0.72	0.88	1.67	4.21	1.96	1.61	0.81	0.39

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.65	1.97	3.20	5.33	9.55	3.07	1.81	1.22
2	14.64	7.00	21.33	17.53	21.39	11.88	16.93	3.74
3	3.01	12.16	3.39	9.76	7.56	3.88	5.94	5.87
4	3.02	1.83	5.27	1.16	7.34	4.45	1.57	2.06
5	2.90	2.57	1.20	3.60	1.64	6.67	1.48	0.56
6	1.61	2.10	1.15	0.78	2.28	1.03	1.99	0.35
7	2.18	1.28	0.93	0.96	0.84	2.05	0.44	0.25
8	0.85	1.99	1.45	1.36	1.43	0.45	0.62	0.15

AGE	2001	2002
1	2.71	0.18
2	11.47	9.02
3	7.15	1.89
4	13.05	1.87
5	3.39	2.40
6	0.94	0.95
7	0.65	0.47
8	0.80	0.34

x 10 ^ 6

Predicted Catch in Number

AGE	1997	1998	1999	2000	2001	2002
1	3808.	6488.	1836.	728.	3851.	243.
2	12381.	18355.	18702.	3909.	10834.	8597.
3	7319.	5677.	4958.	4211.	6782.	2523.
4	9772.	4559.	2134.	1573.	10004.	2224.
5	2060.	4884.	1369.	556.	3137.	2682.
6	2840.	994.	1405.	338.	1059.	799.
7	777.	1606.	339.	410.	747.	319.

Table 7.6.3. continued. Herring Irish Sea VIIa(N). Age = rings.

Weights-at-age in the catches (Kg)

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	0.08200	0.06700	0.06700	0.07800	0.06500	0.09200	0.09300	0.09100
2	0.12300	0.12500	0.13100	0.12900	0.13200	0.14000	0.14900	0.15300
3	0.17800	0.15200	0.18400	0.15600	0.17600	0.18500	0.18000	0.19600
4	0.19800	0.17700	0.20800	0.17100	0.19200	0.21800	0.19900	0.23100
5	0.23200	0.19900	0.22800	0.22600	0.21000	0.25800	0.22300	0.24600
6	0.22600	0.21400	0.23400	0.24000	0.23000	0.25300	0.24300	0.26900
7	0.25300	0.27500	0.26600	0.00000	0.27200	0.22500	0.22700	0.23400
8	0.24800	0.25100	0.25800	0.29600	0.26500	0.26400	0.27500	0.26400

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	0.07400	0.10100	0.10800	0.07400	0.07400	0.07400	0.07400	0.07400
2	0.15200	0.16200	0.15800	0.15500	0.15500	0.15500	0.15500	0.15500
3	0.20400	0.20600	0.18900	0.19500	0.19500	0.19500	0.19500	0.19500
4	0.23100	0.22500	0.21400	0.21900	0.21900	0.21900	0.21900	0.21900
5	0.25400	0.24500	0.22500	0.23200	0.23200	0.23200	0.23200	0.23200
6	0.26600	0.25100	0.26600	0.25100	0.25100	0.25100	0.25100	0.25100
7	0.23900	0.26900	0.24100	0.25800	0.25800	0.25800	0.25800	0.25800
8	0.27000	0.25800	0.24100	0.27800	0.27800	0.27800	0.27800	0.27800

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07600
2	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.14200
3	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.18700
4	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21300
5	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.22100
6	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.24300
7	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.24000
8	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27300

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	0.08700	0.06800	0.05800	0.07000	0.08100	0.09600	0.07300	0.06200
2	0.12500	0.14300	0.13000	0.12400	0.12800	0.14000	0.12300	0.11400
3	0.15700	0.16700	0.16000	0.16000	0.15500	0.16600	0.15500	0.14000
4	0.18600	0.18800	0.17500	0.17000	0.17400	0.17500	0.17100	0.15500
5	0.20200	0.21500	0.19400	0.18000	0.18400	0.18700	0.18100	0.16500
6	0.20900	0.22800	0.21000	0.19800	0.19500	0.19500	0.19000	0.17400
7	0.22200	0.23900	0.21800	0.21200	0.20500	0.20700	0.19800	0.18100
8	0.25800	0.25400	0.22900	0.23200	0.21800	0.21800	0.21700	0.19700

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.08900	0.07000	0.07500	0.06700	0.06400	0.08000	0.06900	0.06400
2	0.12700	0.12300	0.12100	0.11600	0.11800	0.12300	0.12000	0.12000
3	0.15700	0.15300	0.14600	0.14800	0.14600	0.14800	0.14500	0.14800
4	0.17100	0.17000	0.16400	0.16200	0.16500	0.16300	0.16700	0.16800
5	0.18200	0.18000	0.17600	0.17700	0.17600	0.18100	0.17600	0.18800
6	0.19100	0.18900	0.18100	0.19900	0.18800	0.17700	0.18800	0.20400
7	0.19800	0.20200	0.19300	0.20000	0.20400	0.18800	0.19000	0.20000
8	0.21200	0.21200	0.20700	0.21400	0.21600	0.22200	0.21000	0.21300

AGE	2001	2002
1	0.06700	0.08500
2	0.10600	0.11300
3	0.13900	0.14400
4	0.15600	0.16700
5	0.16800	0.18000
6	0.18500	0.18400
7	0.19800	0.19100
8	0.20500	0.21700

Table 7.6.3. continued. Herring Irish Sea VIIa(N). Age = rings

Weights-at-age in the stock (Kg)

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	0.08200	0.06700	0.06700	0.07800	0.06500	0.09200	0.09300	0.09100
2	0.12300	0.12500	0.13100	0.12900	0.13200	0.14000	0.14900	0.15300
3	0.17800	0.15200	0.18400	0.15600	0.17600	0.18500	0.18000	0.19600
4	0.19800	0.17700	0.20800	0.17100	0.19200	0.21800	0.19900	0.23100
5	0.23200	0.19900	0.22800	0.22600	0.21000	0.25800	0.22300	0.24600
6	0.22600	0.21400	0.23400	0.24000	0.23000	0.25300	0.24300	0.26900
7	0.25300	0.27500	0.26600	0.00000	0.27200	0.22500	0.22700	0.23400
8	0.24800	0.25100	0.25800	0.29600	0.26500	0.26400	0.27500	0.26400

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	0.07400	0.10100	0.10800	0.07400	0.07400	0.07400	0.07400	0.07400
2	0.15200	0.16200	0.15800	0.15500	0.15500	0.15500	0.15500	0.15500
3	0.20400	0.20600	0.18900	0.19500	0.19500	0.19500	0.19500	0.19500
4	0.23100	0.22500	0.21400	0.21900	0.21900	0.21900	0.21900	0.21900
5	0.25400	0.24500	0.22500	0.23200	0.23200	0.23200	0.23200	0.23200
6	0.26600	0.25100	0.26600	0.25100	0.25100	0.25100	0.25100	0.25100
7	0.23900	0.26900	0.24100	0.25800	0.25800	0.25800	0.25800	0.25800
8	0.27000	0.25800	0.24100	0.27800	0.27800	0.27800	0.27800	0.27800

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07600
2	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.14200
3	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.18700
4	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21300
5	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.22100
6	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.24300
7	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.24000
8	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27300

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	0.08700	0.06800	0.05800	0.07000	0.08100	0.07700	0.07000	0.06100
2	0.12500	0.14300	0.13000	0.12400	0.12800	0.13500	0.12100	0.11100
3	0.15700	0.16700	0.16000	0.16000	0.15500	0.16300	0.15300	0.13600
4	0.18600	0.18800	0.17500	0.17000	0.17400	0.17500	0.16700	0.15100
5	0.20200	0.21500	0.19400	0.18000	0.18400	0.18800	0.18000	0.15900
6	0.20900	0.22900	0.21000	0.19800	0.19500	0.19600	0.18900	0.17100
7	0.22200	0.23900	0.21800	0.21200	0.20500	0.20700	0.19500	0.17900
8	0.25800	0.25400	0.22900	0.23200	0.21800	0.21700	0.21400	0.19100

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.08800	0.07300	0.07200	0.06700	0.06300	0.07300	0.06800	0.06300
2	0.12600	0.12600	0.12000	0.11500	0.11900	0.12100	0.12100	0.12000
3	0.15700	0.15400	0.14700	0.14800	0.14800	0.15000	0.14500	0.14900
4	0.17100	0.17400	0.16800	0.16200	0.16700	0.16600	0.16800	0.17100
5	0.18300	0.18100	0.18000	0.17700	0.17800	0.17900	0.17800	0.18800
6	0.19100	0.19000	0.18500	0.19500	0.18900	0.19000	0.18900	0.20400
7	0.19800	0.20300	0.19700	0.19900	0.20600	0.20000	0.19900	0.20500
8	0.21400	0.21400	0.21200	0.21200	0.21400	0.23000	0.21400	0.21500

AGE	2001	2002
1	0.06600	0.08500
2	0.10500	0.11300
3	0.13900	0.14400
4	0.15600	0.16700
5	0.16700	0.18000
6	0.18300	0.18400
7	0.19900	0.19100
8	0.20500	0.21700

Table 7.6.3. continued. Herring Irish Sea VIIa(N). Age = rings

Natural Mortality (per year)

AGE	1972-96	1997	1998	1999	2000	2001
1	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
3	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
5	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
7	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

Proportion of fish spawning

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0200	0.0000
2	0.2200	0.2400	0.3400	0.5300	0.6100	0.4700	0.3700	0.8800
3	0.6300	0.8300	0.8800	0.8100	0.9000	0.9100	0.7500	0.9400
4	1.0000	0.9200	0.8900	1.0000	1.0000	1.0000	0.8300	0.9400
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	1969	1970	1971	1972	1973	1974	1975	1976
1	0.0000	0.0200	0.1500	0.1100	0.1200	0.3600	0.4000	0.0700
2	0.7100	0.9200	0.8700	0.8800	0.7700	0.9900	0.9900	0.9600
3	0.9200	0.9400	0.9700	0.9000	0.8900	0.9600	1.0000	0.9800
4	0.9400	0.9600	0.9800	1.0000	0.9700	1.0000	0.9400	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	1977	1978	1979	1980	1981	1982	1983	1984
1	0.0300	0.0400	0.0000	0.2000	0.1900	0.1000	0.0200	0.0000
2	0.9200	0.8100	0.8400	0.8800	0.8900	0.8000	0.7300	0.6900
3	0.9600	0.8800	0.8100	0.9500	0.9000	0.8900	0.8800	0.8300
4	1.0000	0.9100	0.7800	0.9500	0.9400	0.9100	0.9000	0.9300
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	1985	1986	1987	1988	1989	1990	1991	1992
1	0.1400	0.3100	0.0000	0.0000	0.0700	0.0600	0.0400	0.2800
2	0.6200	0.7300	0.8500	0.9000	0.6300	0.6600	0.3000	0.4800
3	0.7100	0.6600	0.9100	0.9600	0.9300	0.9000	0.7400	0.7200
4	0.8800	0.8100	0.8700	0.9900	0.9500	0.9500	0.8200	0.8100
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	1993	1994	1995	1996	1997	1998	1999	2000
1	0.0000	0.1900	0.1000	0.0200	0.0400	0.3000	0.0200	0.1400
2	0.4600	0.6800	0.8600	0.6000	0.8200	0.8300	0.8400	0.7900
3	0.9900	0.9900	0.9400	0.9600	0.9500	0.9700	0.9500	0.9900
4	1.0000	0.9700	0.9900	0.8300	1.0000	0.9900	0.9700	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	2001	2002
1	0.1500	0.0200
2	0.5400	0.9200
3	0.8800	0.9500
4	0.9700	0.9800
5	1.0000	1.0000
6	1.0000	1.0000
7	1.0000	1.0000
8	1.0000	1.0000

Table 7.6.3. continued. Herring Irish Sea VIIa(N). Age = rings

INDICES OF SPAWNING BIOMASS

INDEX1	1989	1990	1991	1992	1993	1994	1995	1996
	339.0	192.0	156.0	1564.0	481.0	730.0	158.0	480.0

	1997	1998	1999	2000	2001	2002
	559.0	227.0	387.0	*******	*******	*******

INDEX2	1989	1990	1991	1992	1993	1994	1995	1996
	999990.	999990.	999990.	999990.	38300.	71200.	15100.	4700.

	1997	1998	1999	2000	2001	2002
	29100.	5800.	16700.	35500.	55300.	31500.

x 10 ^ -3

AGE-STRUCTURED INDICES FLT01: Northern Ireland acoustic surveys

AGE	1994	1995	1996	1997	1998	1999	2000	2001
1	66.83	319.12	11.34	134.15	110.44	157.76	78.52	387.56
2	68.29	82.26	42.37	49.98	27.31	77.72	103.44	93.40
3	73.53	11.94	67.47	14.81	8.08	34.02	105.29	10.19
4	11.86	29.25	8.95	10.98	9.27	5.11	27.54	17.49
5	9.30	4.57	26.47	1.75	6.48	10.26	8.07	7.70
6	7.55	3.50	4.17	4.55	1.78	13.52	5.43	1.37
7	3.87	4.89	5.91	0.57	2.25	1.59	4.90	0.63
8	10.12	6.89	5.82	1.91	0.78	6.29	2.36	2.26

AGE	2002
1	390.98
2	71.94
3	31.70
4	24.80
5	31.28
6	14.83
7	2.76
8	4.46

x 10 ^ 3

Table 7.6.3. continued. Herring Irish Sea VIIa(N). Age = rings

Fishing Mortality (per year)

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	0.1145	0.0114	0.0616	0.0108	0.0111	0.0041	0.0201	0.0029
2	0.5151	1.0306	0.8135	0.6303	0.4828	0.4934	0.4304	0.3192
3	0.3166	0.8086	0.5950	1.3565	0.7189	0.6197	0.3671	0.2602
4	0.7693	0.3555	0.8513	0.3409	1.4663	0.3592	0.3539	0.4728
5	0.1634	0.8196	0.8842	0.3211	0.5885	0.5860	0.3897	0.0865
6	0.7681	0.1706	0.8774	0.6804	1.4663	0.5860	0.3248	0.2729
7	0.5529	0.7145	0.8774	0.3409	1.0215	0.5860	0.3539	0.4728
8	0.5529	0.7145	0.8774	0.3409	1.0215	0.5860	0.3539	0.4728

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	0.0056	0.0186	0.0393	0.1664	0.1044	0.2141	0.1525	0.2301
2	0.2735	0.3020	0.5792	0.3623	0.3448	0.8254	0.7533	0.7945
3	0.3171	0.3830	0.6227	0.5257	0.6159	1.0162	0.9089	0.9796
4	0.3946	0.5499	0.6446	0.5398	0.4228	1.0104	0.8317	1.1072
5	0.2443	0.7554	0.2877	0.6309	0.5367	0.7711	0.9677	0.9295
6	0.3891	0.5187	0.4337	0.6726	0.4445	0.8317	0.7092	1.0318
7	0.3551	0.5408	0.5703	0.5962	0.5220	0.9824	0.9165	1.0612
8	0.3551	0.5408	0.5703	0.5962	0.5220	0.9824	0.9165	1.0612

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	0.1589	0.1045	0.1453	0.0635	0.0390	0.0370	0.0093	0.0147
2	0.8604	0.5409	0.7634	1.1101	0.4321	0.2880	0.1967	0.1273
3	1.0018	0.9324	0.8825	1.3820	0.4033	0.2893	0.1633	0.1824
4	1.0037	0.9268	0.8503	0.9214	0.7019	0.4931	0.2165	0.1529
5	1.0937	0.6805	0.7941	1.1661	0.6024	0.1435	0.1581	0.2362
6	0.7782	1.0516	1.0449	0.8078	0.5260	0.5814	0.2873	0.1762
7	1.0394	0.9079	0.9542	1.1959	0.5773	0.3929	0.2241	0.1914
8	1.0394	0.9079	0.9542	1.1959	0.5773	0.3929	0.2241	0.1914

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	0.0269	0.0433	0.0134	0.0389	0.0126	0.0327	0.0484	0.1030
2	0.2898	0.4135	0.2926	0.2949	0.2141	0.3271	0.3249	0.4120
3	0.4429	0.3876	0.3101	0.5949	0.2885	0.3223	0.3043	0.4185
4	0.5562	0.3872	0.2514	0.6782	0.4091	0.3767	0.2479	0.5289
5	0.4181	0.3295	0.2953	0.6617	0.3310	0.5559	0.3071	0.4413
6	0.4321	0.2942	0.3073	0.6171	0.3327	0.4837	0.4176	0.5121
7	0.4667	0.4004	0.3218	0.6192	0.3424	0.4491	0.3536	0.5061
8	0.4667	0.4004	0.3218	0.6192	0.3424	0.4491	0.3536	0.5061

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.0158	0.0151	0.0385	0.0854	0.0437	0.0457	0.0258	0.0097
2	0.3015	0.4143	0.3915	0.5498	0.5259	0.5507	0.3107	0.1172
3	0.3396	0.4719	0.3873	0.3331	0.5039	0.5277	0.2977	0.1123
4	0.3169	0.3374	0.3643	0.2096	0.6173	0.6465	0.3648	0.1375
5	0.4074	0.4310	0.3441	0.4036	0.6093	0.6380	0.3600	0.1357
6	0.3604	0.5150	0.3121	0.3500	0.5666	0.5933	0.3348	0.1262
7	0.3785	0.4800	0.3974	0.4107	0.6173	0.6465	0.3648	0.1375
8	0.3785	0.4800	0.3974	0.4107	0.6173	0.6465	0.3648	0.1375

AGE	2001	2002
1	0.0281	0.0112
2	0.3383	0.1350
3	0.3241	0.1294
4	0.3971	0.1585
5	0.3919	0.1564
6	0.3645	0.1455
7	0.3971	0.1585
8	0.3971	0.1585

Table 7.6.3. continued. Herring Irish Sea VIIa(N). Age = rings

Population Abundance (1 January)

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	65.77	52.91	127.50	222.21	121.43	365.69	351.81	560.56
2	32.56	21.58	19.24	44.10	80.87	44.18	133.98	126.84
3	10.63	14.41	5.70	6.32	17.40	36.97	19.98	64.54
4	24.18	6.34	5.26	2.58	1.33	6.94	16.29	11.33
5	1.66	10.14	4.02	2.03	1.66	0.28	4.38	10.34
6	0.93	1.28	4.04	1.50	1.33	0.83	0.14	2.69
7	2.94	0.39	0.98	1.52	0.69	0.28	0.42	0.09
8	5.30	1.36	1.11	0.64	1.15	0.60	0.44	0.55

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	375.57	480.98	497.95	413.63	667.18	348.80	368.18	262.38
2	205.63	137.40	173.69	176.13	128.83	221.12	103.58	116.29
3	68.29	115.88	75.25	72.10	90.83	67.61	71.76	36.13
4	40.74	40.72	64.69	33.05	34.90	40.17	20.04	23.67
5	6.39	24.84	21.26	30.72	17.43	20.69	13.23	7.89
6	8.59	4.53	10.56	14.43	14.79	9.22	8.66	4.55
7	1.85	5.26	2.44	6.19	6.66	8.58	3.63	3.86
8	0.36	2.63	2.44	3.89	6.69	2.72	2.85	2.02

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	321.88	245.70	136.07	149.29	208.08	221.34	223.18	126.65
2	76.68	101.02	81.42	43.29	51.54	73.62	78.47	81.34
3	38.92	24.03	43.57	28.11	10.57	24.79	40.89	47.75
4	11.11	11.70	7.74	14.76	5.78	5.78	15.20	28.44
5	7.08	3.68	4.19	2.99	5.31	2.59	3.19	11.07
6	2.82	2.15	1.69	1.71	0.84	2.63	2.03	2.47
7	1.47	1.17	0.68	0.54	0.69	0.45	1.33	1.38
8	1.81	0.61	0.49	0.34	0.57	1.23	0.31	2.88

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	144.21	166.93	263.43	107.79	145.41	113.38	66.65	194.65
2	45.91	51.64	58.80	95.62	38.14	52.82	40.37	23.36
3	53.06	25.46	25.30	32.51	52.75	22.81	28.22	21.61
4	32.58	27.90	14.14	15.19	14.68	32.36	13.53	17.04
5	22.08	16.90	17.14	9.95	6.98	8.83	20.09	9.55
6	7.91	13.15	11.00	11.54	4.65	4.53	4.58	13.37
7	1.87	4.65	8.87	7.32	5.63	3.01	2.53	2.73
8	2.03	2.78	6.37	9.54	7.07	4.67	2.87	1.03

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	65.30	208.28	133.70	102.40	140.54	228.84	113.81	118.93
2	64.60	23.65	75.48	47.33	34.59	49.49	80.42	40.80
3	11.46	35.40	11.58	37.80	20.23	15.14	21.14	43.67
4	11.64	6.68	18.08	6.43	22.18	10.01	7.32	12.85
5	9.09	7.67	4.31	11.36	4.72	10.82	4.74	4.60
6	5.56	5.47	4.51	2.77	6.87	2.32	5.17	2.99
7	7.25	3.51	2.96	2.99	1.76	3.53	1.16	3.35
8	2.82	5.47	4.64	4.24	3.25	0.99	2.13	1.20

AGE	2001	2002	2003
1	219.49	34.42	119.68
2	43.33	78.51	12.52
3	26.89	22.89	50.82
4	31.95	15.92	16.46
5	10.13	19.44	12.29
6	3.63	6.20	15.04
7	2.39	2.28	4.85
8	2.57	2.41	3.62

x 10 ^ 6

Table 7.6.3. continued. Herring Irish Sea VIIa(N). Age = rings

Weighting factors for the catches in number

AGE	1997	1998	1999	2000	2001	2002
1	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
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

Predicted SSB Index Values

INDEX1	1989	1990	1991	1992	1993	1994	1995	1996
	518.33	470.97	346.64	304.29	332.26	372.54	416.03	350.53
	1997	1998	1999	2000	2001	2002		
	297.88	354.64	394.85	*******	*******	*******		

INDEX2	1989	1990	1991	1992	1993	1994	1995	1996
	999990.	999990.	999990.	999990.	18757.	21030.	23486.	19788.
	1997	1998	1999	2000	2001	2002		
	16816.	20020.	22290.	28577.	23426.	35060.		

x 10 ^ -3

Predicted Age-Structured Index Values

FLT01: Northern Ireland acoustic survey Predicted

AGE	1994	1995	1996	1997	1998	1999	2000	2001
1	203.08	128.09	94.72	134.13	218.07	110.08	116.43	211.94
2	29.76	96.62	53.80	40.03	56.23	109.38	64.16	57.72
3	36.26	12.63	42.97	20.23	14.88	24.67	58.58	30.77
4	7.44	19.71	7.88	20.00	8.83	7.97	16.61	34.00
5	8.36	5.02	12.64	4.50	10.10	5.45	6.25	11.37
6	5.60	5.38	3.21	6.76	2.24	6.06	4.10	4.16
7	3.02	2.71	2.71	1.37	2.68	1.09	3.73	2.19
8	6.99	6.31	5.71	3.75	1.12	2.97	1.98	3.49

AGE	2002
1	33.66
2	121.82
3	30.31
4	20.25
5	26.03
6	8.37
7	2.50
8	3.92

x 10 ^ 3

Table 7.6.3. continued. Herring Irish Sea VIIa(N). Age = rings

Fitted Selection Pattern

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	0.1489	0.0322	0.0723	0.0316	0.0076	0.0113	0.0569	0.0061
2	0.6696	2.8993	0.9556	1.8490	0.3293	1.3736	1.2163	0.6751
3	0.4116	2.2747	0.6990	3.9793	0.4903	1.7251	1.0372	0.5503
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.2125	2.3056	1.0387	0.9418	0.4014	1.6313	1.1012	0.1829
6	0.9984	0.4798	1.0307	1.9959	1.0000	1.6313	0.9178	0.5771
7	0.7187	2.0099	1.0307	1.0000	0.6967	1.6313	1.0000	1.0000
8	0.7187	2.0099	1.0307	1.0000	0.6967	1.6313	1.0000	1.0000

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	0.0141	0.0338	0.0610	0.3083	0.2468	0.2119	0.1834	0.2078
2	0.6931	0.5493	0.8985	0.6711	0.8156	0.8169	0.9057	0.7176
3	0.8035	0.6965	0.9660	0.9737	1.4567	1.0058	1.0929	0.8847
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.6191	1.3738	0.4463	1.1687	1.2694	0.7631	1.1636	0.8394
6	0.9861	0.9433	0.6728	1.2459	1.0514	0.8232	0.8527	0.9318
7	0.9000	0.9836	0.8847	1.1045	1.2348	0.9723	1.1020	0.9584
8	0.9000	0.9836	0.8847	1.1045	1.2348	0.9723	1.1020	0.9584

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	0.1583	0.1127	0.1709	0.0690	0.0556	0.0751	0.0429	0.0960
2	0.8572	0.5836	0.8978	1.2048	0.6155	0.5841	0.9084	0.8324
3	0.9981	1.0060	1.0379	1.4999	0.5745	0.5867	0.7542	1.1929
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0897	0.7342	0.9339	1.2656	0.8581	0.2909	0.7301	1.5449
6	0.7754	1.1347	1.2288	0.8768	0.7494	1.1791	1.3272	1.1527
7	1.0356	0.9796	1.1221	1.2979	0.8225	0.7968	1.0352	1.2520
8	1.0356	0.9796	1.1221	1.2979	0.8225	0.7968	1.0352	1.2520

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	0.0484	0.1119	0.0535	0.0573	0.0309	0.0868	0.1953	0.1948
2	0.5210	1.0680	1.1639	0.4348	0.5233	0.8683	1.3107	0.7790
3	0.7964	1.0012	1.2338	0.8771	0.7052	0.8555	1.2274	0.7912
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.7518	0.8511	1.1746	0.9757	0.8091	1.4756	1.2386	0.8343
6	0.7769	0.7599	1.2227	0.9099	0.8131	1.2839	1.6843	0.9683
7	0.8391	1.0341	1.2801	0.9130	0.8368	1.1923	1.4265	0.9568
8	0.8391	1.0341	1.2801	0.9130	0.8368	1.1923	1.4265	0.9568

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.0497	0.0446	0.1057	0.4073	0.0707	0.0707	0.0707	0.0707
2	0.9514	1.2281	1.0745	2.6227	0.8519	0.8519	0.8519	0.8519
3	1.0715	1.3989	1.0631	1.5893	0.8162	0.8162	0.8162	0.8162
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.2856	1.2776	0.9446	1.9252	0.9869	0.9869	0.9869	0.9869
6	1.1372	1.5265	0.8566	1.6696	0.9178	0.9178	0.9178	0.9178
7	1.1943	1.4227	1.0909	1.9592	1.0000	1.0000	1.0000	1.0000
8	1.1943	1.4227	1.0909	1.9592	1.0000	1.0000	1.0000	1.0000

AGE	2001	2002
1	0.0707	0.0707
2	0.8519	0.8519
3	0.8162	0.8162
4	1.0000	1.0000
5	0.9869	0.9869
6	0.9178	0.9178
7	1.0000	1.0000
8	1.0000	1.0000

Table 7.6.3. continued. Herring Irish Sea VIIa(N). Age = rings

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 6	SoP (%)
1961	65770	18733	5004	5710	1.1409	0.5065	99
1962	52900	12296	2988	4343	1.4533	0.6370	100
1963	127490	15615	2226	3947	1.7727	0.8043	100
1964	222210	25457	2498	3593	1.4379	0.6658	99
1965	121420	23031	5120	5923	1.1567	0.9445	99
1966	365690	48683	5846	5666	0.9691	0.5289	99
1967	351810	60748	8599	8721	1.0141	0.3732	99
1968	560560	89119	22631	8660	0.3827	0.2823	100
1969	375560	86835	30964	14141	0.4567	0.3237	99
1970	480980	113188	36285	20622	0.5683	0.5018	100
1971	497950	118055	34666	26807	0.7733	0.5136	100
1972	413630	92634	33167	27350	0.8246	0.5462	112
1973	667180	106030	30744	22600	0.7351	0.4729	100
1974	348790	92149	28539	38640	1.3539	0.8910	99
1975	368180	68653	21016	24500	1.1658	0.8341	102
1976	262380	54200	13227	21250	1.6065	0.9685	99
1977	321870	48957	8993	15410	1.7134	0.9475	95
1978	245700	42953	9827	11080	1.1275	0.8265	92
1979	136070	34589	8223	12338	1.5003	0.8671	92
1980	149280	27830	5749	10613	1.8458	1.0775	97
1981	208080	28495	7853	4377	0.5573	0.5331	90
1982	221330	35608	11064	4855	0.4388	0.3590	98
1983	223170	41659	14882	3933	0.2643	0.2044	98
1984	126640	40327	18827	4066	0.2160	0.1750	96
1985	144210	39729	13868	9187	0.6625	0.4278	102
1986	166920	36695	14877	7440	0.5001	0.3624	97
1987	263430	38472	14324	5823	0.4065	0.2913	103
1988	107790	35029	14473	10172	0.7028	0.5693	105
1989	145410	32277	12362	4949	0.4003	0.3151	100
1990	113380	29428	11232	6312	0.5619	0.4131	101
1991	66640	21715	8267	4398	0.5320	0.3203	100
1992	194640	24470	7257	5270	0.7262	0.4626	101
1993	65300	22440	7924	4409	0.5564	0.3452	101
1994	208270	29108	8884	4828	0.5434	0.4339	102
1995	133690	26599	9922	5076	0.5116	0.3599	99
1996	102400	22985	8360	5301	0.6341	0.3692	100
1997	140530	22865	7104	6651	0.9362	0.5646	100
1998	228840	29939	8458	4905	0.5799	0.5912	100
1999	113810	24274	9417	4127	0.4382	0.3336	99
2000	118920	23512	12073	2002	0.1658	0.1258	100
2001	219490	31116	9897	5461	0.5518	0.3632	99
2002	34410	23349	14812	2393	0.1616	0.1450	100

```
No of years for separable analysis : 6
Age range in the analysis : 1  . . . 8
Year range in the analysis : 1961  . . . 2002
Number of indices of SSB : 2
Number of age-structured indices : 1
Parameters to estimate : 33
Number of observations : 135
Conventional single selection vector model to be fitted.
```

Table 7.6.3. continued. Herring Irish Sea VIIa(N). Age = rings

```
PARAMETER ESTIMATES
 ³Parm.³      ³ Maximum ³    ³         ³         ³         ³         ³ Mean of ³
 ³ No. ³      ³ Likelh. ³ CV ³  Lower  ³ Upper   ³  -s.e.  ³   +s.e. ³ Param.  ³
 ³     ³      ³ Estimate³ (%)³ 95% CL  ³ 95% CL  ³         ³         ³ Distrib.³
 Separable model : F by year
    1   1997     0.6173  22    0.3969    0.9601    0.4928    0.7734    0.6332
    2   1998     0.6465  23    0.4057    1.0302    0.5097    0.8200    0.6650
    3   1999     0.3648  26    0.2176    0.6115    0.2802    0.4748    0.3777
    4   2000     0.1375  27    0.0801    0.2363    0.1044    0.1813    0.1429
    5   2001     0.3971  28    0.2278    0.6924    0.2991    0.5274    0.4134
    6   2002     0.1585  31    0.0854    0.2942    0.1156    0.2173    0.1666
 Separable Model: Selection (S) by age
    7      1     0.0707  62    0.0209    0.2395    0.0379    0.1318    0.0858
    8      2     0.8519  24    0.5249    1.3825    0.6654    1.0906    0.8783
    9      3     0.8162  23    0.5128    1.2992    0.6439    1.0347    0.8395
           4     1.0000     Fixed : Reference Age
   10      5     0.9869  20    0.6564    1.4840    0.8015    1.2153    1.0085
   11      6     0.9178  20    0.6138    1.3722    0.7475    1.1269    0.9373
           7     1.0000     Fixed : Last true age
 Separable model: Populations in year 2002
   12      1      34416 140      2184    542310      8429    140516     92578
   13      2      78510  43     33716    182816     51007    120841     86161
   14      3      22884  36     11084     47244     15809     33125     24504
   15      4      15916  31      8518     29741     11570     21896     16747
   16      5      19436  28     11212     33693     14679     25734     20217
   17      6       6195  30      3437     11165      4586      8367      6481
   18      7       2280  31      1233      4217      1666      3121      2395


Separable model: Populations at age
   19   1997       1763  42       765      4061      1152      2699      1930
   20   1998       3525  34      1805      6884      2505      4960      3736
   21   1999       1160  33       600      2239       829      1622      1227
   22   2000       3349  32      1758      6380      2410      4653      3535
   23   2001       2387  29      1340      4251      1778      3204      2493
 SSB Index catchabilities
   INDEX1
 Linear model fitted. Slopes at age :
   24   1  Q  .4193E-01  13 .3696E-01 .6185E-01 .4193E-01 .5452E-01 .4823E-01
   INDEX2
 Linear model fitted. Slopes at age :
   25   2  Q  .2367E-02  16 .2023E-02 .3840E-02 .2367E-02 .3282E-02 .2825E-02

 Age-structured index catchabilities
                                            FLT01: Northern Ireland acoustic survey
 Linear model fitted. Slopes at age :
   26   1  Q  2.088      127 .6153     90.29     2.088     26.61     16.75
   27   2  Q  2.150       41 1.446     7.302     2.150     4.912     3.539
   28   3  Q  1.695       41 1.142     5.738     1.695     3.864     2.786
   29   4  Q  1.545       41 1.040     5.234     1.545     3.523     2.540
   30   5  Q  1.623       41 1.089     5.564     1.623     3.731     2.684
   31   6  Q  1.623       42 1.080     5.709     1.623     3.797     2.717
   32   7  Q  1.330       43 .8736     4.861     1.330     3.193     2.268
   33   8  Q  1.975       42 1.312     6.970     1.975     4.630     3.311

 RESIDUALS ABOUT THE MODEL FIT
        Separable Model Residuals
------+------------------------------------------------
Age   |    1997    1998    1999    2000    2001    2002
------+------------------------------------------------
  1   |  0.9194 -0.7487 -0.0142  0.5168 -0.3503 -0.3046
  2   |  0.5466 -0.4351 -0.0996 -0.0434  0.0573  0.0482
  3   |  0.0327 -0.3819  0.1801  0.3328  0.0529 -0.2867
  4   | -0.2860 -0.0241 -0.3095  0.2720  0.2663 -0.1753
  5   | -0.2275  0.3122  0.0760  0.0039  0.0764 -0.1133
  6   | -0.2192  0.0355  0.3477  0.0252 -0.1230  0.1758
  7   |  0.0774  0.2435  0.2705 -0.4911 -0.1397  0.3968
------+------------------------------------------------
```

Table 7.6.3. continued. Herring Irish Sea VIIa(N). Age = rings

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1	1989	1990	1991	1992	1993	1994	1995	1996
	-0.425	-0.897	-0.798	1.637	0.370	0.673	-0.968	0.314
	1997	1998	1999	2000	2001	2002		
	0.629	-0.446	-0.020	*******	*******	*******		

INDEX2	1989	1990	1991	1992	1993	1994	1995	1996
	*******	*******	*******	*******	0.714	1.220	-0.442	-1.438
	1997	1998	1999	2000	2001	2002		
	0.548	-1.239	-0.289	0.217	0.859	-0.107		

AGE-STRUCTURED INDEX RESIDUALS
FLT01: Northern Ireland acoustic survey

Age	1994	1995	1996	1997	1998	1999	2000	2001
1	-1.111	0.913	-2.123	0.000	-0.680	0.360	-0.394	0.604
2	0.831	-0.161	-0.239	0.222	-0.722	-0.342	0.478	0.481
3	0.707	-0.057	0.451	-0.312	-0.610	0.321	0.586	-1.105
4	0.467	0.394	0.128	-0.599	0.048	-0.445	0.506	-0.665
5	0.106	-0.093	0.739	-0.944	-0.444	0.632	0.256	-0.390
6	0.299	-0.429	0.263	-0.396	-0.232	0.802	0.281	-1.109
7	0.247	0.590	0.780	-0.876	-0.173	0.375	0.273	-1.251
8	0.370	0.089	0.018	-0.674	-0.359	0.750	0.173	-0.433

Age	2002
1	2.452
2	-0.527
3	0.045
4	0.203
5	0.184
6	0.572
7	0.097
8	0.128

Table 7.6.3. continued. Herring Irish Sea VIIa(N). Age = rings

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES-AT-AGE)

Separable model fitted from 1997 to 2002

Variance	0.1248
Skewness test stat.	0.3143
Kurtosis test statistic	-0.7262
Partial chi-square	0.3079
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	0.6524
Skewness test stat.	0.7325
Kurtosis test statistic	-0.3553
Partial chi-square	1.1132
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	0.7749
Skewness test stat.	-0.4427
Kurtosis test statistic	-0.6384
Partial chi-square	2.3130
Significance in fit	0.0067
Number of observations	10
Degrees of freedom	9
Weight in the analysis	1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR FLT01: Northern Ireland acoustic survey

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8
Variance	0.0214	0.0343	0.0445	0.0264	0.0360	0.0443	0.0563	0.0238
Skewness test stat.	0.3235	0.2527	-0.7082	-0.4929	-0.3254	-0.5759	-1.0024	0.0910
Kurtosis test statisti	-0.1023	-0.7522	-0.4369	-0.8653	-0.4675	-0.3848	-0.3265	-0.4283
Partial chi-square	0.0154	0.0253	0.0344	0.0217	0.0326	0.0415	0.0591	0.0237
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	9
Degrees of freedom	8	8	8	8	8	8	8	8
Weight in the analysis	0.0125	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	48.2678	135	33	102	0.4732
Catches-at-age	4.0701	42	23	19	0.2142
SSB Indices					
INDEX1	6.5240	11	1	10	0.6524
INDEX2	6.9737	10	1	9	0.7749
Aged Indices					
FLT01: Northern Ireland acoustic surve	30.6999	72	8	64	0.4797

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	16.1359	135	33	102	0.1582
Catches-at-age	2.3704	42	23	19	0.1248
SSB Indices					
INDEX1	6.5240	11	1	10	0.6524
INDEX2	6.9737	10	1	9	0.7749
Aged Indices					
FLT01: Northern Ireland acoustic surve	0.2678	72	8	64	0.0042

Table 7.7.1 **Herring VIIa(N).** Input table for short-term predictions.

2003

Age (rings)	N	M	Mat	PF	PM	SWt	Sel	CWt
1	139349	1	0.10	0.9	0.75	0.0713	0.0163	0.0720
2	46820	0.3	0.75	0.9	0.75	0.1127	0.1968	0.1130
3	50816	0.2	0.94	0.9	0.75	0.1440	0.1886	0.1437
4	16463	0.1	0.98	0.9	0.75	0.1647	0.2311	0.1637
5	12292	0.1	1	0.9	0.75	0.1783	0.2280	0.1787
6	15041	0.1	1	0.9	0.75	0.1903	0.2121	0.1910
7	4847.4	0.1	1	0.9	0.75	0.1983	0.2311	0.1963
8	3625	0.1	1	0.9	0.75	0.2123	0.2311	0.2117

2004

Age (rings)	N	M	Mat	PF	PM	SWt	Sel	CWt
1	139349	1	0.10	0.9	0.75	0.0713	0.0163	0.0720
2	.	0.3	0.75	0.9	0.75	0.1127	0.1968	0.1130
3	.	0.2	0.94	0.9	0.75	0.1440	0.1886	0.1437
4	.	0.1	0.98	0.9	0.75	0.1647	0.2311	0.1637
5	.	0.1	1	0.9	0.75	0.1783	0.2280	0.1787
6	.	0.1	1	0.9	0.75	0.1903	0.2121	0.1910
7	.	0.1	1	0.9	0.75	0.1983	0.2311	0.1963
8	.	0.1	1	0.9	0.75	0.2123	0.2311	0.2117

2005

Age (rings)	N	M	Mat	PF	PM	SWt	Sel	CWt
1	139349	1	0.10	0.9	0.75	0.0713	0.0163	0.0720
2	.	0.3	0.75	0.9	0.75	0.1127	0.1968	0.1130
3	.	0.2	0.94	0.9	0.75	0.1440	0.1886	0.1437
4	.	0.1	0.98	0.9	0.75	0.1647	0.2311	0.1637
5	.	0.1	1	0.9	0.75	0.1783	0.2280	0.1787
6	.	0.1	1	0.9	0.75	0.1903	0.2121	0.1910
7	.	0.1	1	0.9	0.75	0.1983	0.2311	0.1963
8	.	0.1	1	0.9	0.75	0.2123	0.2311	0.2117

Input units are thousands and kg - output in tonnes

Table 7.7.2 **Herring VIIa(N).** Management option table for 2003, assuming TAC is taken in 2003.

MFDP version 1
Run: TAC constraint
Herring Irish Sea 2003 projection file
Time and date: 09:00 19/03/2003
Fbar age range: 2-6

	2003				
	Biomass	SSB	FMult	FBar	Landings
	32030	14560	1.2679	0.2679	4800

	2004					2005	
	Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
	31728	18293	0	0	0	36508	22541
.		17950	0.1	0.0211	433	36060	21727
.		17615	0.2	0.0423	858	35621	20943
.		17286	0.3	0.0634	1274	35192	20190
.		16963	0.4	0.0845	1682	34771	19466
.		16646	0.5	0.1057	2081	34359	18770
.		16336	0.6	0.1268	2472	33956	18100
.		16031	0.7	0.1479	2856	33561	17456
.		15733	0.8	0.1691	3231	33175	16837
.		15440	0.9	0.1902	3599	32796	16242
.		15152	1	0.2113	3960	32425	15670
.		14871	1.1	0.2325	4314	32062	15119
.		14594	1.2	0.2536	4660	31707	14589
.		14323	1.3	0.2747	4999	31358	14080
.		14058	1.4	0.2958	5332	31017	13590
.		13797	1.5	0.317	5658	30683	13118
.		13541	1.6	0.3381	5977	30356	12665
.		13291	1.7	0.3592	6291	30036	12229
.		13045	1.8	0.3804	6597	29722	11809
.		12803	1.9	0.4015	6898	29415	11405
.		12567	2	0.4226	7193	29114	11016

Input units are thousands and kg - output in tonnes

Table 7.7.3 **Herring VIIa(N).** Single option table for TAC taken in 2002 and F $_{2001\text{-}02}$ in 2004.

MFDP version 1
Run: TAC constraint
Time and date: 09:00 19/03/2003
Fbar age range: 2-6

Year: 2003 F multiplier: 1.2679 Fbar: 0.2679

Age (rings)	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0207	1809	130	139349	9940	14399	1027	6676	476
2	0.2496	8989	1016	46820	5275	35115	3956	22399	2524
3	0.2391	9834	1413	50816	7318	47767	6878	33153	4774
4	0.293	3988	653	16463	2711	16189	2666	11538	1900
5	0.2891	2944	526	12292	2192	12292	2192	8791	1568
6	0.2689	3382	646	15041	2863	15041	2863	10955	2085
7	0.293	1174	231	4847	961	4847	961	3455	685
8	0.293	878	186	3625	770	3625	770	2584	549
Total		32999	4800	289253	32030	149275	21314	99551	14560

Year: 2004 F multiplier: 1 Fbar: 0.2113

Age (rings)	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0163	1430	103	139349	9940	14399	1027	6702	478
2	0.1968	7789	880	50213	5657	37659	4243	25190	2838
3	0.1886	4223	607	27025	3892	25403	3658	18451	2657
4	0.2311	6443	1055	32757	5394	32211	5304	24272	3997
5	0.228	2161	386	11114	1982	11114	1982	8397	1498
6	0.2121	1517	290	8330	1585	8330	1585	6385	1215
7	0.2311	2046	402	10401	2063	10401	2063	7838	1554
8	0.2311	1125	238	5719	1214	5719	1214	4310	915
Total		26734	3960	284906	31728	145236	21077	101546	15152

Year: 2005 F multiplier: 1 Fbar: 0.2113

Age (rings)	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0163	1430	103	139349	9940	14399	1027	6702	478
2	0.1968	7823	884	50433	5682	37825	4262	25300	2850
3	0.1886	4774	686	30552	4399	28719	4136	20860	3004
4	0.2311	3604	590	18323	3017	18018	2967	13577	2236
5	0.228	4574	817	23525	4195	23525	4195	17775	3170
6	0.2121	1458	279	8005	1524	8005	1524	6137	1168
7	0.2311	1199	235	6097	1209	6097	1209	4594	911
8	0.2311	2277	482	11577	2458	11577	2458	8724	1852
Total		27140	4076	287860	32425	148164	21777	103669	15670

Input units are thousands and kg - output in tonnes

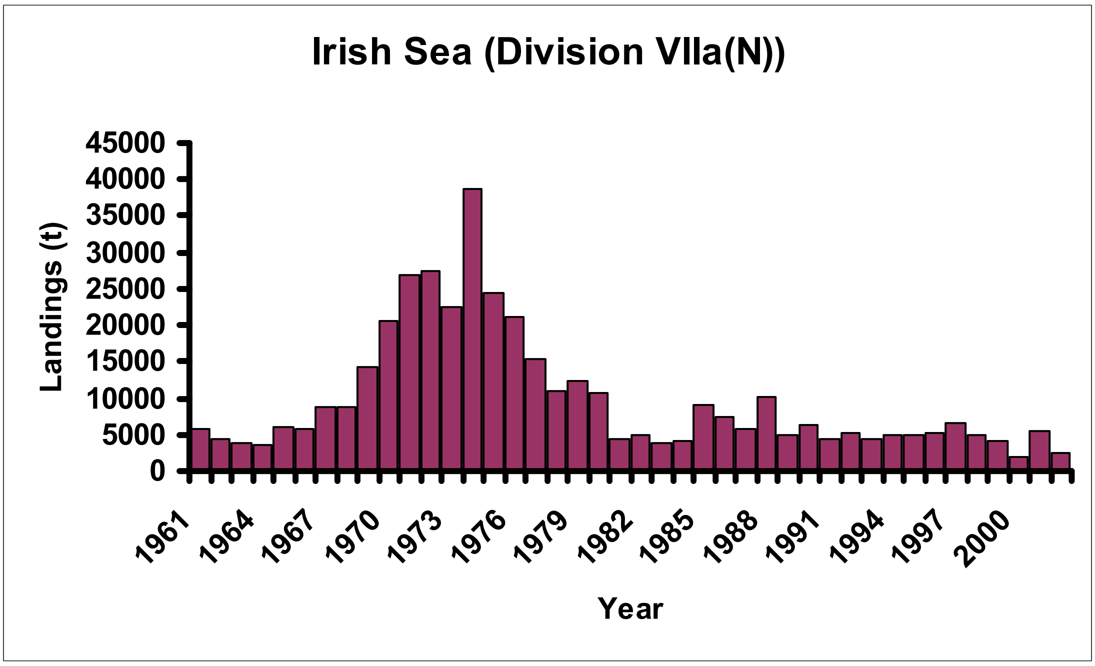


Figure 7.1.1 Herring VIIa(N). Landings of herring from VIIa(n) from 1961 to 2002.

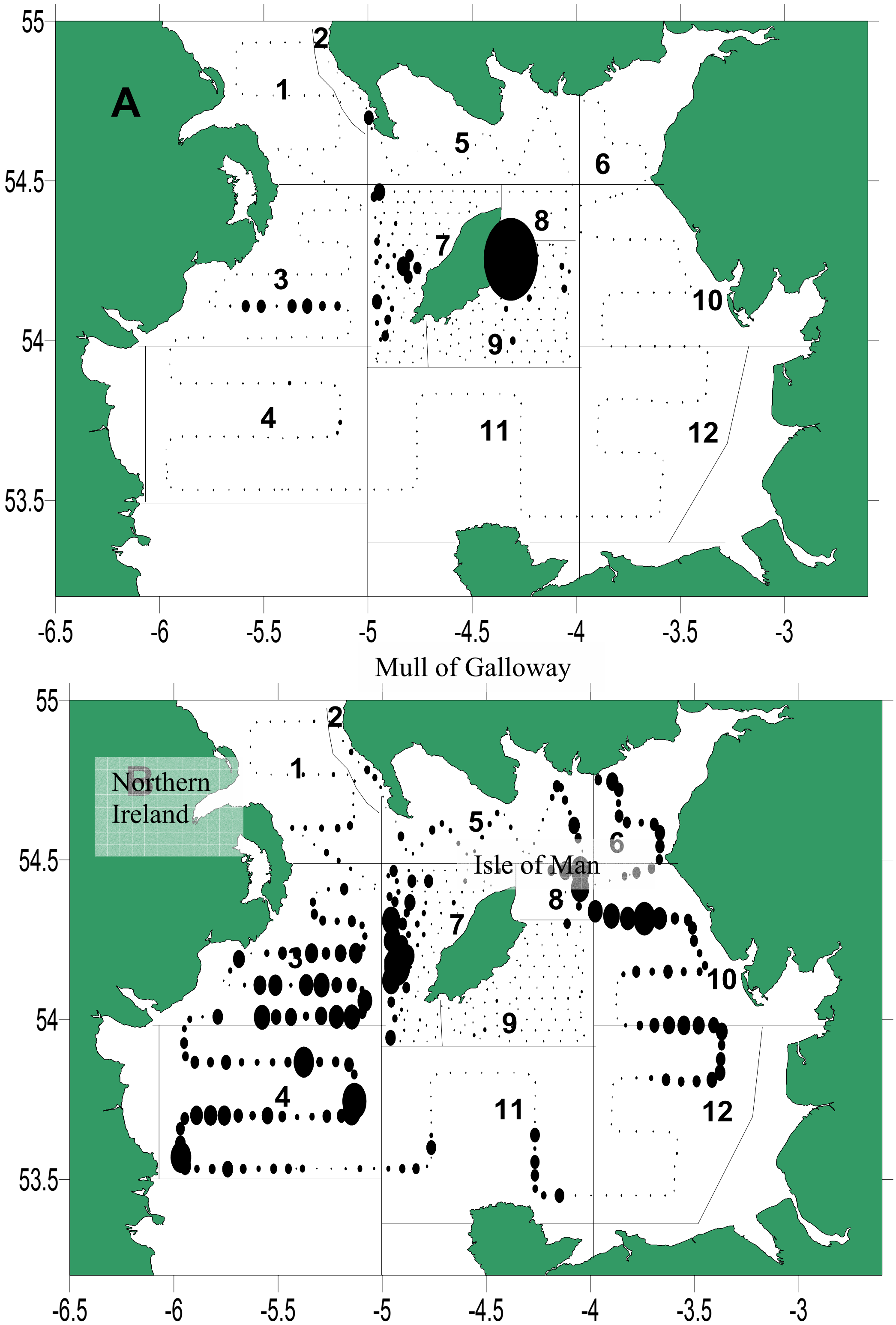


Figure 7.3.1 Irish Sea Herring VIIa(N). DARD acoustic survey. Density distribution of (A) herring schools (mainly 1-ring and older) and (B) sprats and 0-group herring. Size of elipses is proportional to square root of the S_A value for each 15-minute interval (same scale for figures A and B). Crosses indicate starting positions for 15-minute EDSUs. Acoustic survey strata are indicated.

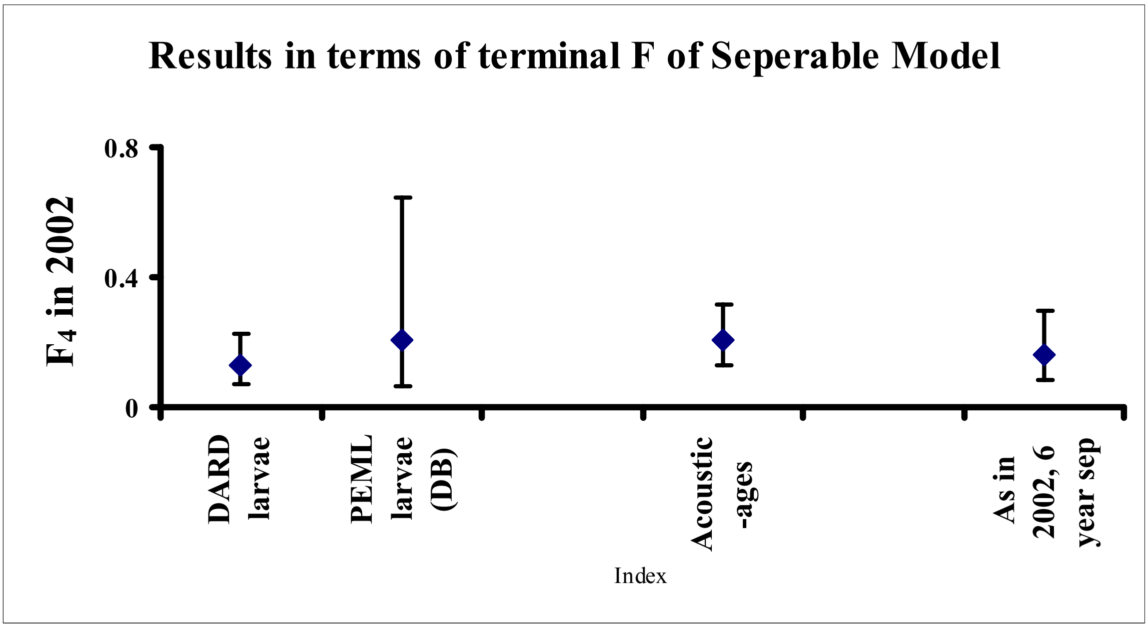


Figure 7.6.1 Irish Sea Herring VIIa(N). Results in terms of reference F (age 4), of the preliminary modelling with ICA of survey indices described in Table 7.6.1. Error bars show the upper and lower 95% confidence limits.

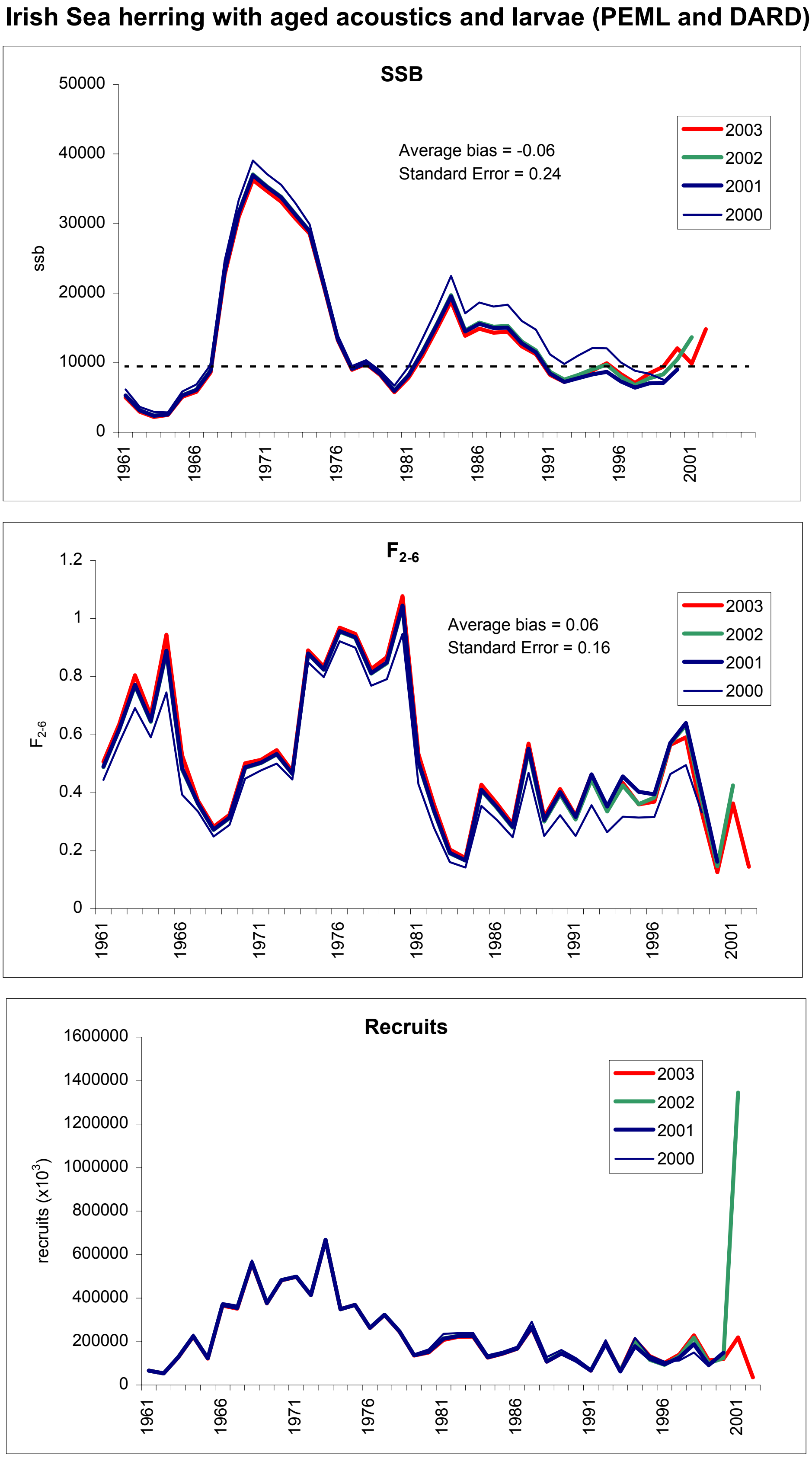


Figure 7.6.2 Herring VIIA (N). Retrospective analysis of the performance of DBL, NINEL and ACAGE series as tuning indices in the assessments of 2000 to 2003.

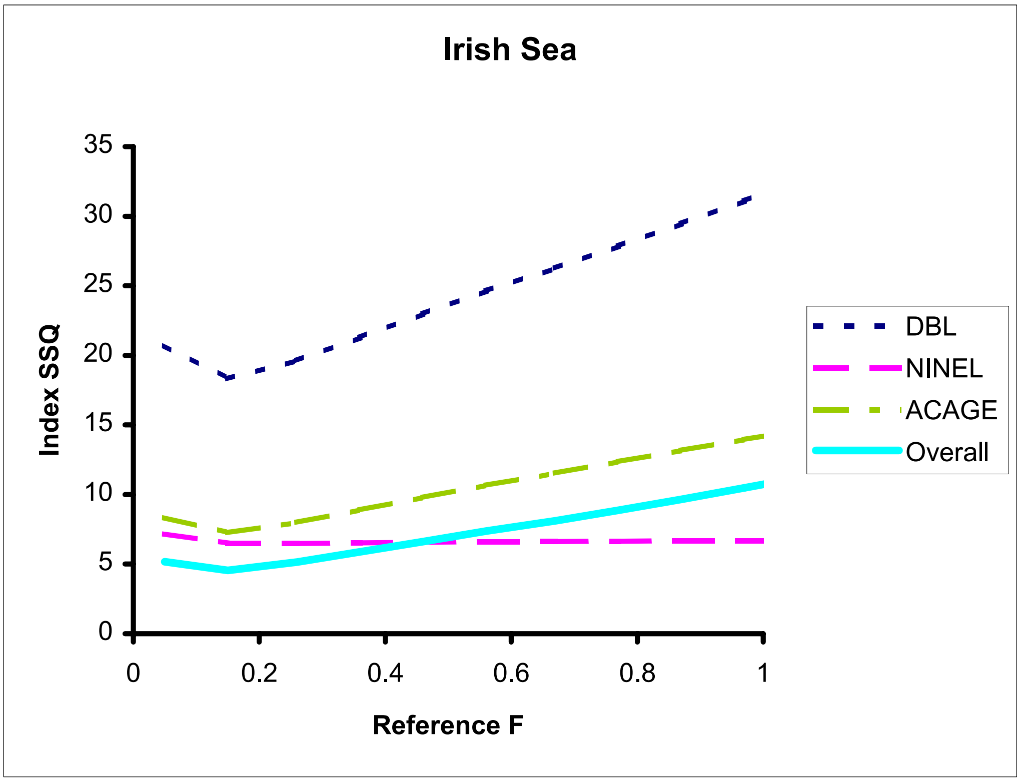


Figure 7.6.3 Herring in VIIa(N). SSQ surface for the deterministic calculation of the 6-year separable period.

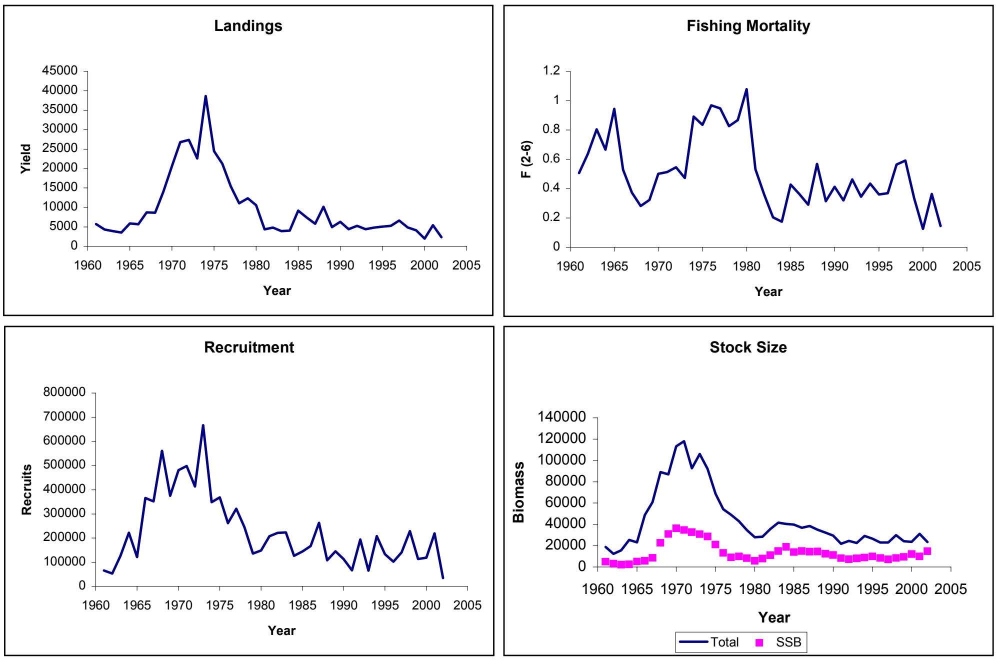


Figure 7.6.4 Herring in VIIa(N). Illustration of stock trends from deterministic calculation (6-year separable period). Summary of estimates of landings, fishing mortality-at-age 4, recruitment at age 1, stock size on 1 January and SSB at spawning.

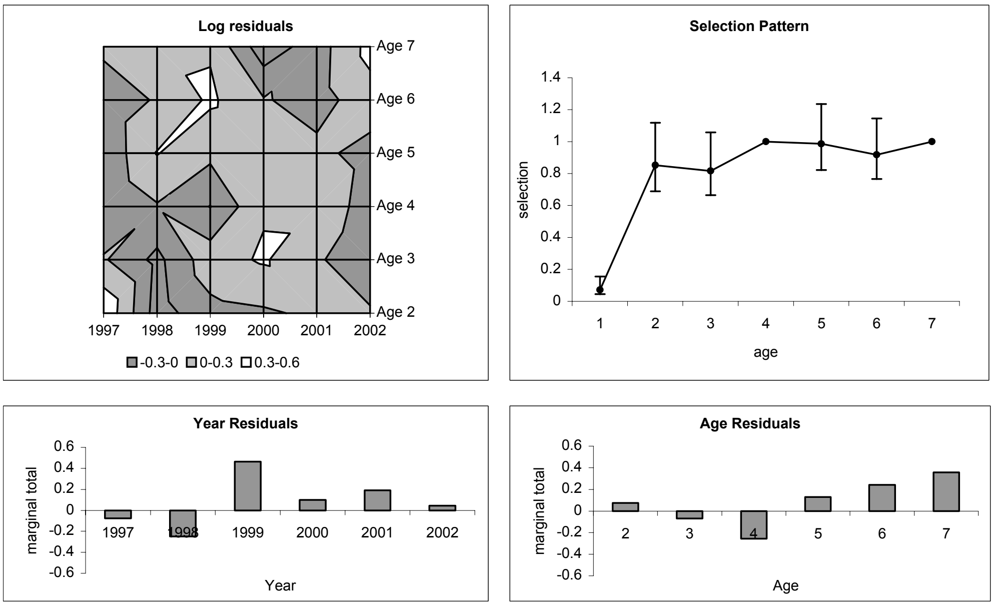


Figure 7.6.5 Herring in VIIa(N). Illustration of selection patterns diagnostics, from deterministic calculation (6-year separable period). Top left, a contour plot of selection pattern residuals. Top right, estimated selection (relative to age 4) +/- standard deviation. Bottom, marginal totals of residuals by year and age

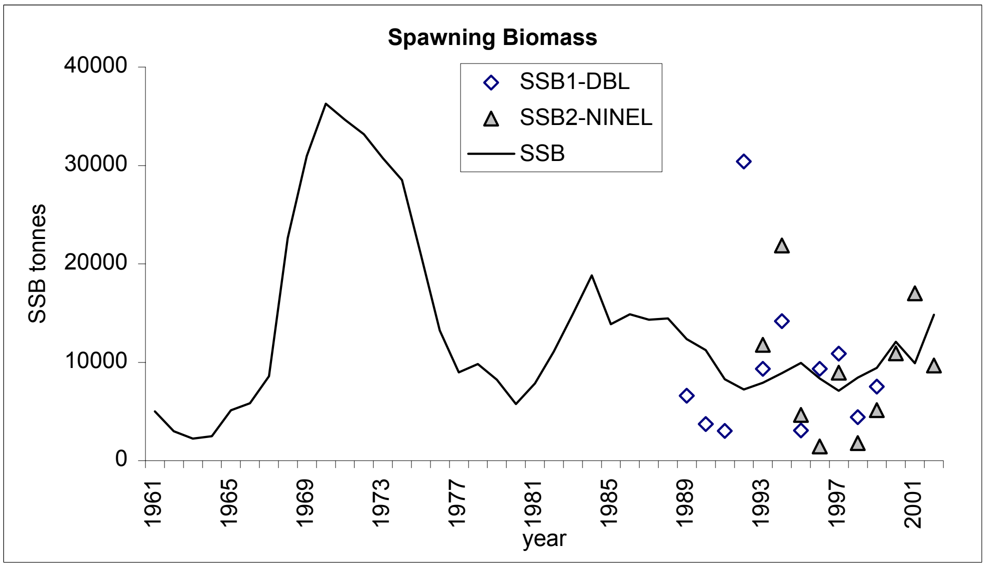


Figure 7.6.6 Herring VIIa(N). Fitted SSB (line) and predicted SSB from indices and estimated catchability. Indices described in Table 7.6.1.

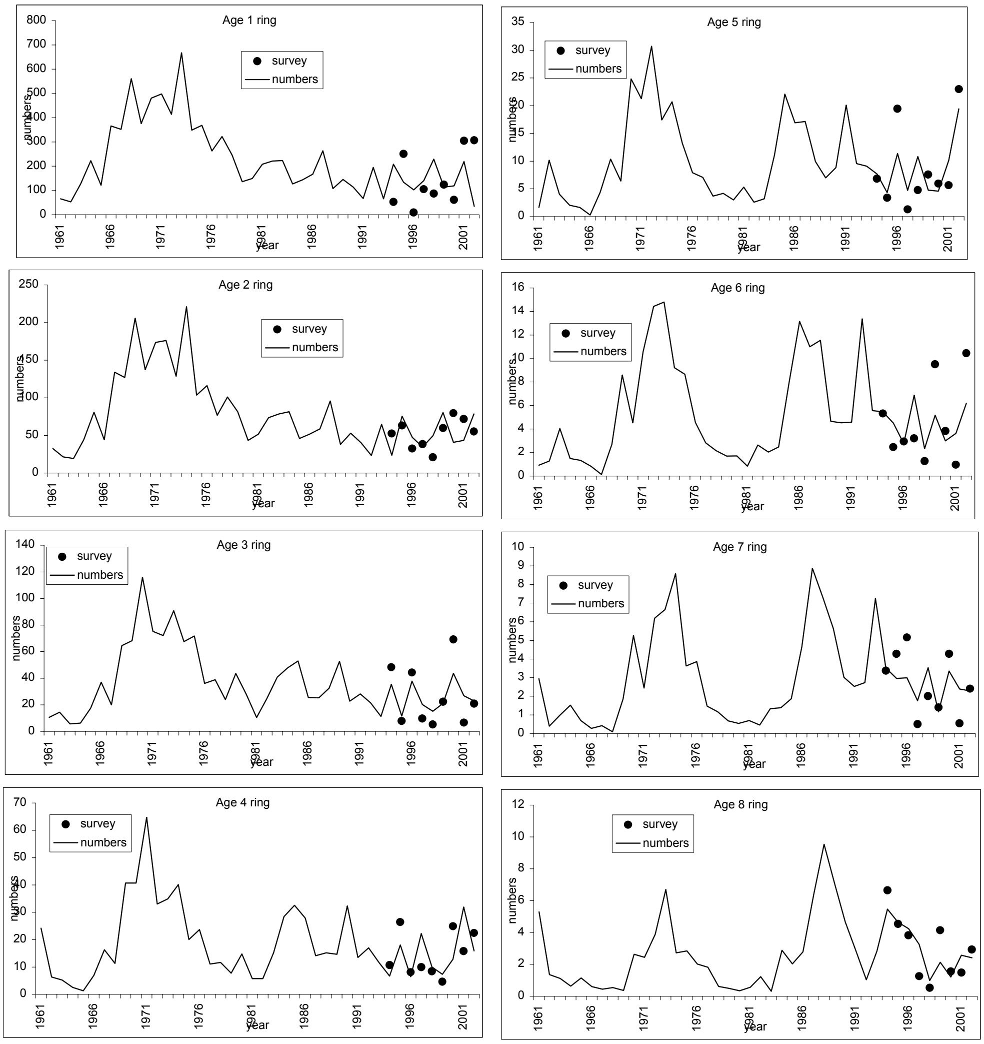


Figure 7.6.7 Herring VIIa(N). Fitted numbers-at-age (line) and predicted numbers from acoustic estimates of age and estimated catchability.

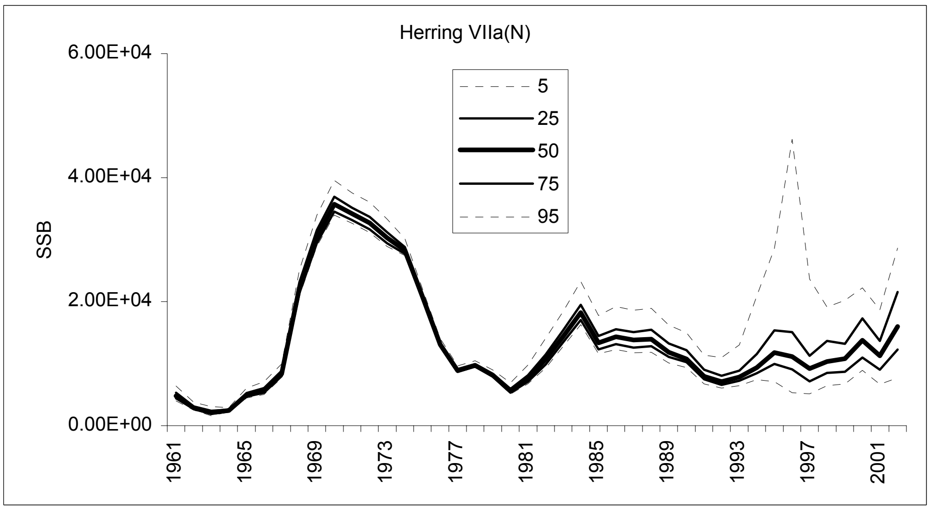
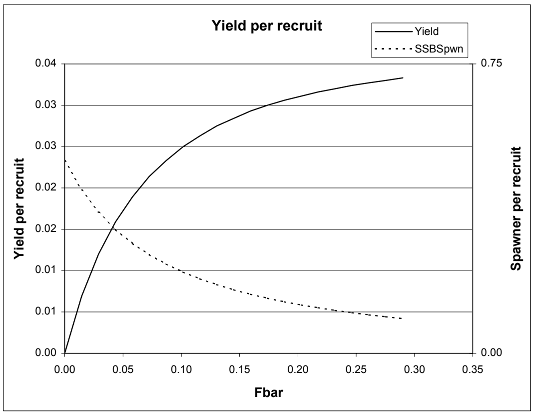
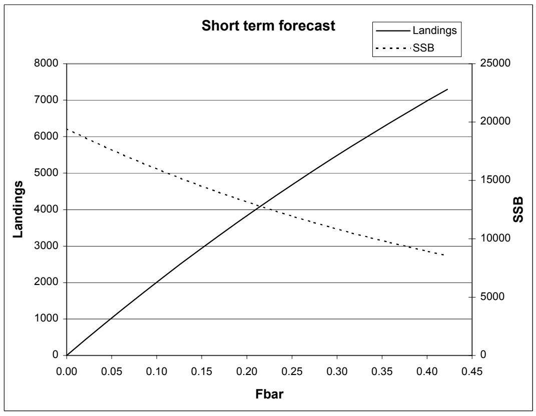


Figure 7.6.8 Herring VIIa(N). Estimates of historical uncertainty of the SSB from 1972 to 2002. Light lines denote 25% and 75% confidence interval and dotted lines denote 5% and 95% confidence intervals.





MFYPR version 1
Run: TAC constraint2
Time and date: 10:30 19/03/2003

Reference point	F multiplier	Absolute F
Fbar(2-6)	1.0000	0.1450
FMax	>=1000000	
F0.1	1.0674	0.1548
F35%SPR	0.9223	0.1337
Flow	1.4040	0.2036
Fmed	2.8820	0.4178
Fhigh	9.1891	1.3322
FSPR(4)	1.1763	0.1705

Weights in kilograms

MFDP version 1
Run: testing
Herring Irish Sea 2003 projection file
Time and date: 19:37 18/03/2003
Fbar age range: 2-6

Input units are thousands and kg - output in tonnes

Figure 7.6.9 Herring VIIa(N). Long- and short-term yield and SSB, derived from MFDP V1a.

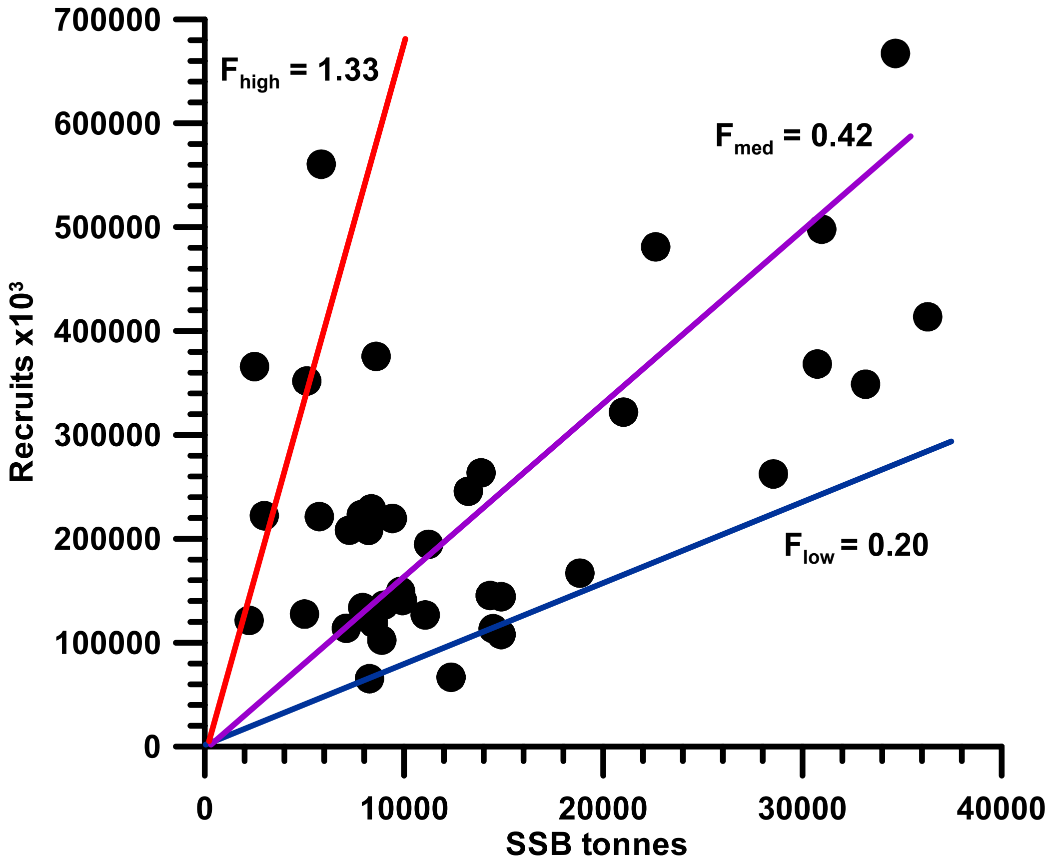


Figure 7.6.10 Herring VIIa(N). Recruitment to SSB plot for herring from 1961 to 1999. Lines donate the locations of $\mathbf{F}_{high}$, $\mathbf{F}_{med}$ and $\mathbf{F}_{low}$.

8 SPRAT IN THE NORTH SEA

8.1 The Fishery

8.1.1 ACFM advice applicable for 2002 and 2003

ACFM advised that a catch of 160,000 t in 2002 would allow the SSB to remain stable or increase. This was based on the historic relationship between survey and catch. The TAC set by management was 232,000 t for 2001 [Subarea IV (EU zone) + Division IIa (EU zone)] and 257,000 t for 2002. The TAC agreed for 2003 between the EU and Norway was 257,000 t.

8.1.2 Total landings in 2002

Landing statistics for sprat for the North Sea by area and country are presented in Table 8.1.1 for 1987–2002. 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 1994–2002 by year, quarter, and area in the North Sea.

The landings in 2002, 157,000 t, were lower compared to the 2001 landings of 170,000 t. This reduction was partly due to the closure of the Danish fishery in the 2nd part of the 1st quarter. The Norwegian fishery in 2002 was minimal, with a catch of only 13.4 t. The Danish fishery was responsible for all catches taken in the third and fourth quarter. In November and December the sprat stock was more widely spread, and by-catch of herring was a limiting factor, therefore the small-meshed fishing fleet moved towards Norway pout instead. Neither Denmark nor Norway took their quota in 2002.

The quarterly and annual distributions of catches by rectangle for Subarea IV are shown in Figures 8.1.1–8.1.2.

The Norwegian sprat fishery is carried out by purse seiners. A closure of the Norwegian fishery was introduced for the second and third quarter in 1999 and this management regime is still in force. On top of this management regime, a maximum quota (900 t) per vessel was set for the Norwegian vessels in 2002 and 600 t in 2003; and they are not allowed to fish in Norwegian waters until the Norwegian quota in EU waters has been taken.

8.2 Biological Composition of the Catch

8.2.1 By-catches in the North Sea sprat fishery

As requested by ACFM, data on the species composition of the by-catch is given. Only data on by-catch from the Danish fishery were available to the WG and are shown in Table 8.2.1. In general, more than 80% of the catches consist of sprat. The amount of herring caught as by-catch in the sprat fishery is in general less than 8% of the total catch although there is a slight increase in the total landings of herring in 2002 compared to previous years. No Norwegian landings by the purse seiners have been sampled in 2002.

8.2.2 Catches in number

The estimated quarterly catch-at-age in numbers for the years 1995 to 2002 is presented in Table 8.2.2. Denmark provided age composition data of commercial landings in 2002 for all quarters. Danish samples were used to raise both the Norwegian catches and the catches from England and Wales.

There is a predominance of 1-ringer sprat in the catches over all the years although the absolute composition varies from year to year being higher in 2002, at the level of the 1998-2000, compared to 2001. In contrast, 0-ringer sprat catches in 2002 were lower than the ones reported in 2001. During the second quarter all landings are very low.

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 sampling level in 2002 is lower than in previous years. In Denmark the provisions in the EU regulation 1639/2001 have been implemented. This provision requires 1 sample per 2000 tonnes landed. This sampling level is lower than the guidelines (1 sample per 1000 tonnes) previously used by the HAWG, but as the fishery was carried out in a limited area, the recommended sampling level can be regarded as adequate.

The Danish monitoring schemes for management purposes for species composition in the Danish small-meshed fisheries has again worked well in 2002. A total of 1054 samples were collected from landings by Danish vessels taken in the North Sea. The sampling figure for 2001 was 1191 samples. The total landings from the Danish small mesh fishery in 2002 was 885,000 t (all species) compared to 893,000 t in 2001. The recommended sampling levels for species composition were achieved. The species composition in the Danish sprat fishery is shown in Table 8.2.1.

No samples for species composition were taken from the Norwegian North Sea sprat fishery.

No sprat was reported as by-catch in the landings from the Norwegian or the Swedish small-meshed fishery targeted at sandeel and Norway pout.

8.3 Fishery-independent information

The acoustic surveys for the North Sea Herring in June-July have estimated sprat abundance since 1996. In June-July 1998, sprat was 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 to 210,000 t. 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 CM 2000/D:07), the area expected to have the highest abundance of sprat in the North Sea. In 2000 the survey was extended by 30 n.mi to the south and covered for the first time the south-eastern area considered to have the highest abundance of sprat in the North Sea. By doing so, the estimate of sprat increased significantly. The distribution pattern in 2002 demonstrates, however, that the southern distribution border was still not reached by the survey. The total sprat biomass estimated in 2002 was 241,000 t, 41,000 higher than in 2001 (ICES/2002:G:02).

8.4 Mean Weight-at-age and Maturity at age

Mean weights (g) at age in the catches during 2002 are presented by quarter in Table 8.2.4. The table includes mean weights-at-age for 1995-2001 for comparison.

During the Working Group in 2002, data on maturity and age were compiled from the Danish commercial catches during quarters 1, 3 and 4 in 2001. Data on maturity were provided from the German Acoustic surveys in June-July during 1996-2001. The data has not been further analysed during this Working Group. No other countries contributed with data on maturity. No maturity data was available from the IBTS survey during the third quarter in 2001.

8.5 Recruitment

The IBTS (February) sprat indices (no. per hour) in IVb (sprat standard area) are used as an index of abundance. The historical data were revised in 1995 (ICES 1995/Assess:13) and 1999 (ICES 1999/ACFM:12). The IBTS Working Group redefined the sprat index to be calculated as an area weighted mean over means by rectangles for the entire North Sea sprat stock. Based on this, the IBTS WG asked ICES Secretariat to carry out new calculations in 2001 (ICES 2000/D:07), which are the ones used in the present report. The fishing method (gear) in the IBTS-survey was standardised in 1983 and the data series from 1984, are comparable. The IBTS-indices for 1984–2003 are shown in Table 8.5.1 for age groups 1–4, 5+ and total, along with the number of rectangles sampled and the number of hauls considered. The index of 1-group increased and is now above the mean of the time-series. The abundance of the 1998 year class was not detected as higher than average and is as 4-group below the average. The total-abundance index shows a small increase compared to 2002, and is well above the average for the whole time-series. The old IBTS-indices are available in ICES 2001/ACFM:12.

The IBTS data by rectangle are given in Figure 8.3.1a-c for age groups 1, 2 and 3+. Age 1-group was again found to be concentrated in the south-eastern areas of Division IVb and Division IVc. The mean lengths (mm) of age group 1 by rectangle are presented in Figure 8.3.2.

8.6 State of the Stock

8.6.1 Data Exploration and Preliminary Modelling

Sprat is a relatively short-lived species, the stock and the catches consisting mostly of 1- and 2-year-olds. In addition, there are difficulties in age reading resulting in unreliable estimates of numbers-at-age both from the surveys and the commercial catch. Given those limitations a data exploration using Catch-Survey Analysis (CSA), an assessment method designed for cases where full age-structured data are missing, was undertaken by the WG using an executable version made available by B. Mesnil. The method is based on the "modified DeLury" two-stage model (Conser 1995) and on an implementation tested on simulated data presented to the Methods Working Group in 2003 (Mesnil 2003). The model assumes that the population consists of two stages: the recruits (preferably a single year class) and the fully recruited ages.

Model input data consisting of the time-series of catch numbers for each stage, mean weight for each stage in the stock at the start of the year and the 1st quarter IBTS index of abundance for the 1-year-old sprat (age = number of winter rings) and older than 2-years-old are shown in Table 8.6.1 Given low sampling levels in years previous to 1995, constant weight-at-age based on commercial data from the 1st quarter was assumed for the whole period. Reservations regarding the ability of the IBTS 1-year-old index to fully reflect strong and weak cohorts for sprat were expressed in previous WG reports (see ICES 1998 ACFM:14). Those were linked to difficulties in age reading and/or a possible prolonged spawning and recruitment season. Another problem identified in some surveys was related to large catches in small areas which could have been very influential on the results. Examination of the biomass and the 1-year-old index trajectories in Fig 8.6.1 suggests that fluctuations in the biomass index are related to a large extent to fluctuations in the 1-year-old index as would be expected in a population where the recruits account for a large proportion of the stock. A decision to fit the model to the IBTS recruitment index was made on that basis. Natural mortality (*M*) assumed constant across ages and a parameter corresponding to the ratio of the survey catchability of the recruits to the fully recruited ages (*s*) were fixed externally. The model results are sensitive to the choice of the M and *s* parameters. A value of M = 0.6 was based on predation mortality estimates from a multi-species VPA (ICES 2002 CM/D:04). In the absence of data that would support an alternative value *s* was equated to 1. An observation-error only model which estimates catchability of the fully recruited stage analytically was implemented. Numbers at the start of the year of fish >2-year-old in the first year of data and all the recruit (1-year-old) numbers, with the exception of the ones corresponding to the last year in the series which were computed from the survey index and the recruitment catchability, were estimated by least-squares minimisation. Model output is shown in Table 8.6.2.

Model fits to the IBTS indices are shown in Figures 8.6.2 and 8.6.3 showing a reasonably good fit. Some conflict between the recruitment and the 2+ indices resulted in lack of fit to the high recruitment estimated by IBTS in 1989. The model does not fit well the high IBTS 2+ index in 1998 given a low recruitment index in 1997; this could be an example of a late recruitment scenario where IBTS underestimated total recruitment. Examination of the residuals did not suggest obvious patterns. Confidence intervals for the parameters were estimated by means of non-parametric bootstrapping. Total stock (1+ yr-old) biomass point estimates and 95% confidence intervals are shown in Figure 8.6.4. Results from a retrospective analysis are shown in Figure 8.6.5 suggesting a recent period of negative bias preceded by a long period where the biomass was revised upwards. The Mohn's rho bias index is low as a result. The WG concluded that although the index in this particular case was not useful as a measure of bias, examination of Fig 8.6.5 suggested that the retrospective bias was relatively small.

8.7 Projections of Catch and Stock

The SHOT- approach (Shepherd, 1991) was used in the past by the WG to estimate the landings in the assessment year. The WG considered that approach inappropriate for a short-lived stock like sprat; therefore the projection was based on the results from CSA. Biomass projections to the start of 2004, assuming geometric mean recruitment in 2004, for annual catches of 150,000 t, 200,000 t and 250,000 t as input values, are shown in Figure 8.7.1. The biomass trajectories suggest that the stock would remain relatively stable or decrease under those catch levels. Such perception, however, is sensitive to model assumptions that need to be validated and to the recruitment level assumed in 2004.

A catch prediction for the assessment year was provided in the past on the basis of a linear regression of catch versus IBTS estimated biomass. The results for 2003 are shown on Figure 8.7.2 and the corresponding catch prediction for the current year is about 175,000 t.

8.8 Quality of the Assessment

Trends in the mean weights-at-age during the first quarter used to compute the biomass index from the IBTS have been reviewed. No trend was observed in the mean weights-at-age over time, therefore an average over all the years was used to compute stock biomass by means of Catch Survey Analysis. The model fits time-series of abundance for 2 stages in the stock: the recruits and the fully recruited to the fishery. The IBTS indices for the 1st quarter were used as indicators. The WG is aware of problems associated with the underestimation of the autumn-hatched sprat in the IBTS (February). However, examination of the residuals from the model fit suggests that the problem results in additional noise in the data, but the model still attains a reasonably good fit to the data. The results are sensitive to the value assumed for the catchability ratio *s*, the estimated biomass being scaled accordingly. Therefore, when examining the model output, emphasis should be placed on stock trends rather than on absolute values until an independent estimate of *s* becomes available. Results from sensitivity tests to the assumed value of M showed that if M was higher than 0.6 the stock biomass would be scaled upwards, and vice versa. Further research for an appropriate value of M for sprat needs to be undertaken inter-sessionally. The WG agreed that an approach like CSA seemed a promising tool to assess sprat in the North Sea. Furthermore, the method, although not specifically designed for short-lived species, does show potential for assessment in that context and therefore **it is recommended that the WG of Methods again considers assessment methods for short-lived species in the light of recent developments.**

8.9 Management Considerations

Prior to 1993, the sprat was 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.

The sprat stock shows signs of being in good condition as the biomass appears to increase and there is indication from the IBTS (February)-2003-survey of a good 2002 year class recruiting to the 2003 fishery. In 1998–2000 the by-catch of herring was not a limiting factor in the sprat fishery and the main controlling factor was the TAC limits. The Working Group is not able to assess the impact on the biomass of catch levels in 2004 other than assuming average recruitment. The fishery in a given year is very dependent on that year's incoming year class, therefore a catch projection for 2004 assuming average recruitment is meaningless. **The WG recommends that a management approach which includes a revision of the TAC taking into account an estimate of incoming recruitment is considered for sprat.**

Attempts to assess this stock have demonstrated the need for a better sampling coverage for both length and age composition. 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 with reference to January 1 as the birthday this will result in incorrect allocation to year classes. The group recommends a review of the criteria used for ageing sprat and further validation of the formation of winter rings and allocation to year classes.

Table 8.1.1. Sprat catches in the North Sea (' 000 t) 1987-2002. 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	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Division IVa West (North Sea) stock																
Denmark	0.2	0.1				0.3	0.6						0.7		0.1	1.14
Netherlands																
Norway					0.1											
Sweden															0.1	
UK(Scotland)								0.1								
Total	0.2	0.1			0.1	0.3	0.6	0.1					0.7		0.2	1.1
Division IVa East (North Sea) stock																
Denmark										0.3						
Norway						0.5	2.5		0.1							
Sweden					2.5											
Total					2.5	0.5	2.5		0.1	0.3						
Division IVb West																
Denmark	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	18.8	11.1	16.3
Norway		3.5	0.1	1.2	4.4	18.4	16.8	12.6	21.0	1.9	2.3				0.9	+
UK(Engl.&Wales)						0.5	0.5									
UK(Scotland)	0.1						0.5						0.8			
Total	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	18.8	12.0	16.3
Division IVb East																
Denmark	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	144.1	132.9	110
Germany																
Norway		0.6		0.6	25.1	9.5	24.1	19.1	14.7	50.9	0.8	15.3	13.1	0.9	5.0	
Sweden				+	+				0.2	0.5		1.7	2.1		1.4	
UK(Scotland)													0.6			
Total	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	145.0	139.3	109.8
Division IVc																
Denmark		0.1	0.5	1.5	1.7	2.5	3.5	10.1	11.4	3.9	5.7	11.8	3.3	28.2	13.1	14.8
France									+							
Netherlands		0.4	0.4										0.2			
Norway							0.4	4.6	0.4		0.1	16.0	5.7	1.8	3.6	
UK(Engl.&Wales)	0.7	0.6	0.9	0.2	1.8	6.1	2.0	2.9	0.2	2.6	1.4	0.2	1.6	2.0	2.0	1.63
Total	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	32.0	18.7	16.4
Total North Sea																
Denmark	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	191.1	157.2	142.0
France									+							
Germany																
Netherlands		0.4	0.4										0.2			
Norway		4.1	0.1	1.8	29.6	28.4	43.8	36.3	36.2	52.8	3.2	31.3	18.8	2.7	9.5	+
Sweden					2.5								2.7		1.4	
UK(Engl.&Wales)	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	2.0	2.0	1.63
UK(Scotland)	0.1						0.5	0.1					0.8			
Total	32.4	87.4	63.1	72.7	112.0	124.3	200.1	320.1	357.0	136.1	103.4	162.6	188.4	195.9	170.1	143.6

Table 8.1.2. Sprat catches (' 000 t) in the fjords of western Norway, 1985-2002.

1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002 [1]
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	3.3	3.4	1.5	1.5

[1] = preliminary

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		42	2,616	17,227	16,081	35,966
	2			242	10,857	1	11,100
	3			10,479	184,747		195,226
	4	109		18,224	57,959	1,503	77,796
	Total	109	42	31,561	270,790	17,586	320,088
1995	1			17,752	16,900	7,324	41,976
	2			1,138	5,752	1	6,891
	3		86	25,305	183,500	6	208,897
	4		5	2,826	92,054	4,693	99,578
	Total		91	47,021	298,206	12,024	357,342
1996	1		459	2,471	81,020	6,103	90,053
	2			615	2,102	18	2,735
	3			242	6,259		6,501
	4		353	411	36,273	386	37,423
	Total		812	3,739	125,654	6,507	136,712
1997	1			1,025	147	7,089	8,261
	2			189	1,054		1,243
	3		3	27,487	569		28,059
	4		81	55,814	9,878		65,773
	Total		84	84,515	11,648	7,089	103,336
1998	1			1,917	3,726	1,616	7,259
	2		4	529	206	4	743
	3			4,926	55,155	215	60,296
	4			13,712	54,433	25,984	94,129
	Total		4	21,084	113,520	27,819	162,427
1999	1			450	20,862	9,071	30,383
	2			108	1,048		1,156
	3	1	17	7,840	121,186	415	129,459
	4	679	31	5,550	19,731	1,167	27,158
	Total	680	48	13,948	162,827	10,653	188,156
2000	1			2,686	15,440	28,063	46,189
	2			1,599	123	45	1,767
	3			14,405	116,901	1,216	132,522
	4			158	12,522	2,718	15,398
	Total			18,848	144,986	32,042	195,876
2001	1	115		1,643	39,260	9,716	50,734
	2	0		699	372		1,071
	3	0		947	43,226	480.9284	44,655
	4	79		8,681	56,421	8537.876	73,719
	Total	194		11,970	139,279	18,735	170,177
2002	1	1,136		222	1,960	2,789	6,108
	2	0		122	313	93.81538	529
	3	0		9,131	61,373	646.5546	71,151
	4	1		6,809	46,133	12910.59	65,853
	Total	1,136		16,284	109,779	16,440	143,640

Table 8.2.1. Species composition in the Danish sprat fishery in tonnes and percentage of the total catch. Data is reported for 1998-2002.

	Year	Sprat	Herring	Horse-mackerel	Whiting	Haddock	Mackerel	Cod	Sandeel	Other species	Total
Tonnes	1998	129,315	11,817	573	673	6	220	11	2,174	1,188	145,978
Tonnes	1999	157,003	7,256	413	1,088	62	321	7	4,972	635	171,757
Tonnes	2000	188,463	11,662	3,239	2,107	66	766	4	423	1,911	208,641
Tonnes	2001	136,443	13,953	67	1,700	223	312	4	17,020	1,142	170,862
Tonnes	2002	140,568	16,644	2,078	2,537	27	715	0	4,102	800	167,471
Percent	1998	88.6	8.1	0.4	0.5	0.0	0.2	0.0	1.5	0.8	100
Percent	1999	91.4	4.2	0.2	0.6	0.0	0.2	0.0	2.9	0.4	100
Percent	2000	90.3	5.6	1.6	1.0	0.0	0.4	0.0	0.2	0.9	100
Percent	2001	79.9	8.2	0.0	1.0	0.1	0.2	0.0	10.0	0.7	100
Percent	2002	83.9	9.9	1.2	1.5	0.0	0.4	0.0	2.4	0.5	100

Table 8.2.2 North Sea Sprat. Catch in numbers (millions) by quarter and by age 1995-2002.

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		13,903.7
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	19,139.5
2000	1		559.2	3,177.3	797.5	247.5	72.0	4,853.7
	2		6.8	107.4	60.1	12.8	0.5	187.6
	3		9,928.9	1,111.9	77.8			11,118.6
	4		1,153.7	129.2	9.0			1,291.9
	Total		11,648.7	4,525.8	944.4	260.3	72.6	17,451.8
2001	1		746.3	3,197.7	1,321.9	22.2		5,023.1
	2		15.9	66.2	26.1			108.2
	3	0.4	3,338.8	299.9				3,559.1
	4	1,205.0	4,178.7	1,224.6	261.9			6,651.4
	Total	1,205.4	8,279.8	4,788.4	1,609.9	22.2		15,341.7
2002	1		104.7	400.3	30.2	11.2		546.4
	2		13.7	27.9	2.4	0.6		44.6
	3	40.9	5,745.6	582.1	42.3	4.1		6,415.0
	4	415.0	4,578.0	626.2	119.8	3.1		5,742.1
	Total	455.9	10,441.9	1,636.5	194.8	19.0		12,748.1

Table 8.2.3 North Sea Sprat. Sampling commercial landings for biological samples in 2002

Country	Quarter	Landings 000t	No samples	No fish meas.	No fish aged
2002					
Denmark	1	4.59	3	113	113
	2	0.34	19	51	51
	3	71.15	11	999	51
	4	65.82	28	2 748	2748
Total		141.89	61	3911	2963
Norway	1	+			
	2				
	3				
	4				
Total					
UK-England/Wales	1	1.51			
	2	0.09			
	3				
	4	0.03			
Total		1.63			
Total North Sea		143.53	61	3911	2963

Table 8.2.4 North Sea Sprat. Mean weight (g) by quarter and by age for 1995 - 2002.

Year	Quarter	Age						SOP
		0	1	2	3	4	5+	Tonnes
1995	1		3.0	9.4	12.9	19.4		41 976.0
	2		3.0	8.4	10.3			6 891.0
	3	2.4	7.6	13.9	16.4	20.7		208 897.0
	4		10.5	13.9	16.2			99 578.0
Weighted mean		2.40	8.38	12.79	13.83	19.47		357 342.0
1996	1		3.9	9.3	14.9	15.3	16.1	88 807.0
	2		6.9	8.4	11.6	20.0	15.2	2 735.0
	3		11.6	14.2	18.2	21.5		6 501.0
	4		12.1	15.9	17.2	20.5		37 359.0
Weighted mean			9.97	10.49	15.12	15.58	16.03	135 401.0
1997	1		8.0	10.0	15.0	17.0	19.0	8 161.0
	2		8.0	10.0	15.0	17.0	19.0	1 243.0
	3		14.2					28 285.0
	4	3.7	11.9	16.4	19.1	19.6		63 083.0
Weighted mean		3.73	12.67	14.66	16.26	18.24	19.00	100 772.0
1998	1		5.6	6.0	8.7	15.0		7 232.0
	2		5.6	6.0	8.3			743.0
	3	3.7	14.7	15.3				60 149.0
	4	4.1	10.6	13.8	16.3	14.6		94 173.0
Weighted mean		4.03	11.69	12.80	15.98	14.65		162 297.0
1999	1		3.3	8.7	12.5	14.4	16.3	30 168.0
	2		3.1	10.1	13.6	15.4		993.0
	3		10.0	18.3				129 383.0
	4	4.4	11.0	14.4				27 126.0
Weighted mean		4.42	9.78	9.39	12.49	14.43	16.34	187 670.0
2000	1		4.2	10.1	10.7	10.2	10.5	46 192.0
	2		3.3	9.0	10.2	12.8	10.5	1 767.0
	3		11.9	11.9	11.0			132 563.0
	4		11.9	11.9	11.0			15 403.0
Weighted mean			11.55	10.56	10.68	10.33	10.52	195 925.0
2001	1		3.3	9.7	12.9	16.5		50 794.0
	2		3.3	10.3	12.9			1 071.0
	3	4.0	12.0	15.3				44 656.0
	4	3.8	11.6	12.6	19.1			73 444.0
Weighted mean		3.75	10.99	10.80	13.91	16.53		169 967.0
2002	1		7.0	12.0	14.0	13.0		6.105.7
	2		5.3	11.2	12.5	12.4		423.1
	3	2.0	10.9	15.0	15.0	24.0		72.173.2
	4	3.9	12.0	15.0	15.7	24.0		67.901.8
Weighted mean		3.73	11.24	13.43	14.93	14.80		146 603.8

Table 8.5.1 North Sea sprat. Abundance indices by age from IBTS (February). New standard area (the whole North Sea) index.

	Age				
Year	1	2	3	4	5+
1984	232.4	330.2	39.6	6.2	0.3
1985	375.9	195.3	26.7	3.8	0.4
1986	44.2	73.6	22.0	1.2	0.2
1987	542.4	66.8	19.6	2.0	0.2
1988	91.4	887.2	61.6	6.9	0.0
1989	2297.2	472.8	269.8	5.4	1.6
1990	234.9	452.0	102.1	28.1	2.2
1991	677.3	93.3	23.3	2.6	0.1
1992	1041.0	291.9	42.4	7.1	0.5
1993	1030.6	604.4	118.4	6.1	0.3
1994	2428.5	932.6	91.4	3.6	0.5
1995	647.4	1613.9	87.3	2.5	0.8
1996	182.4	387.2	146.8	18.3	0.7
1997	591.4	412.4	179.6	15.5	2.2
1998	1171.1	1457.2	306.1	15.8	3.4
1999	2509.5	562.4	80.4	4.8	25.1
2000	1058.8	907.0	277.5	43.9	0.9
2001	883.1	1055.8	185.2	17.5	0.1
2002	1382.6	604.5	74.4	8.4	0.6
2003	1823.1	292.3	39.2	2.3	0.0

Table 8.6.1 : CSA Input data: catch in numbers by stage (CatRec & CatFull), abundance indices (Urec & Ufull), weight in the catch and catchability ration (Srat)

Year	CatRec	CatFull	Urec	Ufull	Wrec	Wfull	Srat
1984	6455.2	1432.4	232.4	376.3	4.5	9.67	1
1985	2361.16	1680.36	375.9	226.2	4.5	9.67	1
1986	917.3294	385.2029	44.2	97	4.5	9.67	1
1987	2102.31	464.56	542.4	88.6	4.5	9.67	1
1988	529.28	5460.05	91.4	955.7	4.5	9.67	1
1989	2658.36	3431.79	2297.2	749.6	4.5	9.67	1
1990	1415.95	1421.13	234.9	584.4	4.5	9.67	1
1991	2653.3	1890.71	677.3	119.3	4.5	9.67	1
1992	8801.13	2590.83	1041	341.9	4.5	9.67	1
1993	4992.73	4069.87	1030.6	729.2	4.5	9.67	1
1994	36190.2	5173	2428.5	1028.1	4.5	9.67	1
1995	16646.7	16756.9	647.4	1704.5	4.5	9.67	1
1996	2117.9	9392.9	182.4	553	4.5	9.67	1
1997	5674.8	1864.6	591.4	609.7	4.5	9.67	1
1998	8933.1	4124.1	1171.1	1782.5	4.5	9.67	1
1999	15828.9	3205.5	2509.5	672.7	4.5	9.67	1
2000	11648.7	5803.1	1058.8	1229.3	4.5	9.67	1
2001	8279.8	6420.5	883.1	1258.6	4.5	9.67	1
2002	10441.9	1850.3	1382.6	687.9	4.5	9.67	1
2003	16921.29	4449.204	1823.116	333.7776	4.5	9.67	1

Table 8.6.2 CSA Output: Estimated 1 year-od (RecN) and 2+ (FullN) numbers in the stock, total stock biomass, fishing mortality and harvest rates for the 1-yr-old and the 2+

Year	RecN	FullN	TSBiom	F	Hrrec	Hrfull
1984	9705.8	15144.7	190125.3	0.559	0.665	0.095
1985	10776.5	7795	123871.4	0.348	0.219	0.216
1986	1948.7	7198.2	78375.8	0.213	0.471	0.054
1987	54825.7	4055	285927.7	0.061	0.038	0.115
1988	4329.7	30412.9	313576	0.265	0.122	0.18
1989	40152.7	14630.1	322160.3	0.163	0.066	0.235
1990	7512.2	25553.7	280909.6	0.123	0.188	0.056
1991	25442	16045.2	269646.4	0.16	0.104	0.118
1992	51757.7	19402.4	420530.7	0.243	0.17	0.134
1993	53566.7	30614.1	537088.5	0.157	0.093	0.133
1994	159226.3	39485.7	1098345	0.33	0.227	0.131
1995	34045.7	78412.8	911457.6	0.512	0.489	0.214
1996	9883.4	36972.6	401999.8	0.403	0.214	0.254
1997	51994.7	17187.7	400180.7	0.159	0.109	0.108
1998	45555	32382.7	518138.7	0.256	0.196	0.127
1999	97930.3	33100.1	760764.8	0.218	0.162	0.097
2000	44710.8	57810	760221.6	0.261	0.261	0.1
2001	31152.1	43336	559243.8	0.31	0.266	0.148
2002	37564.5	29989.7	459040.6	0.282	0.278	0.062
2003	80353.7	27968.2	632044.5	0	0.211	0.159

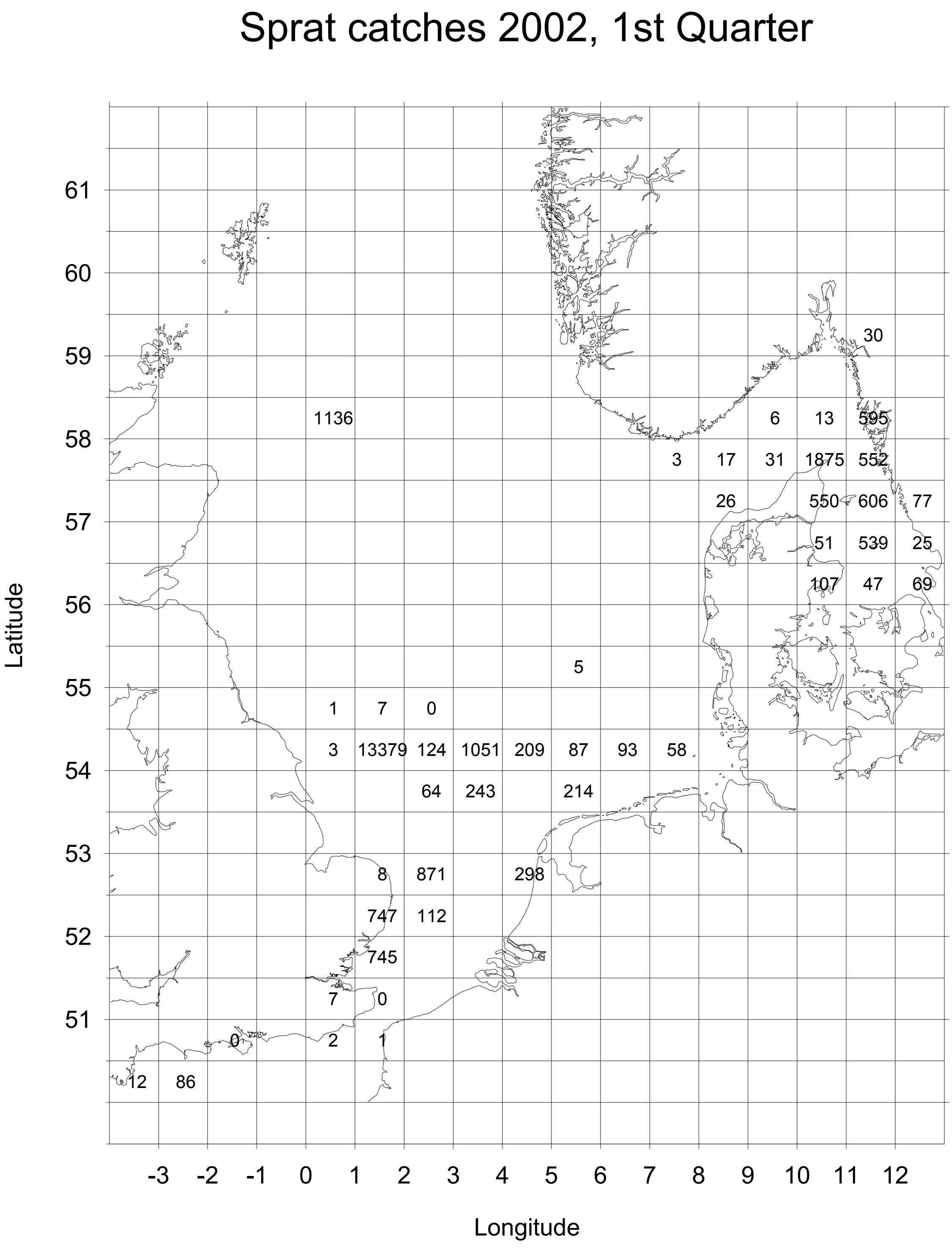


Figure 8.1.1a Sprat catches (in tonnes) in the North Sea in 2002 by statistical rectangle. Working group estimates (if available). First quarter.

Sprat catches 2002, 2nd Quarter

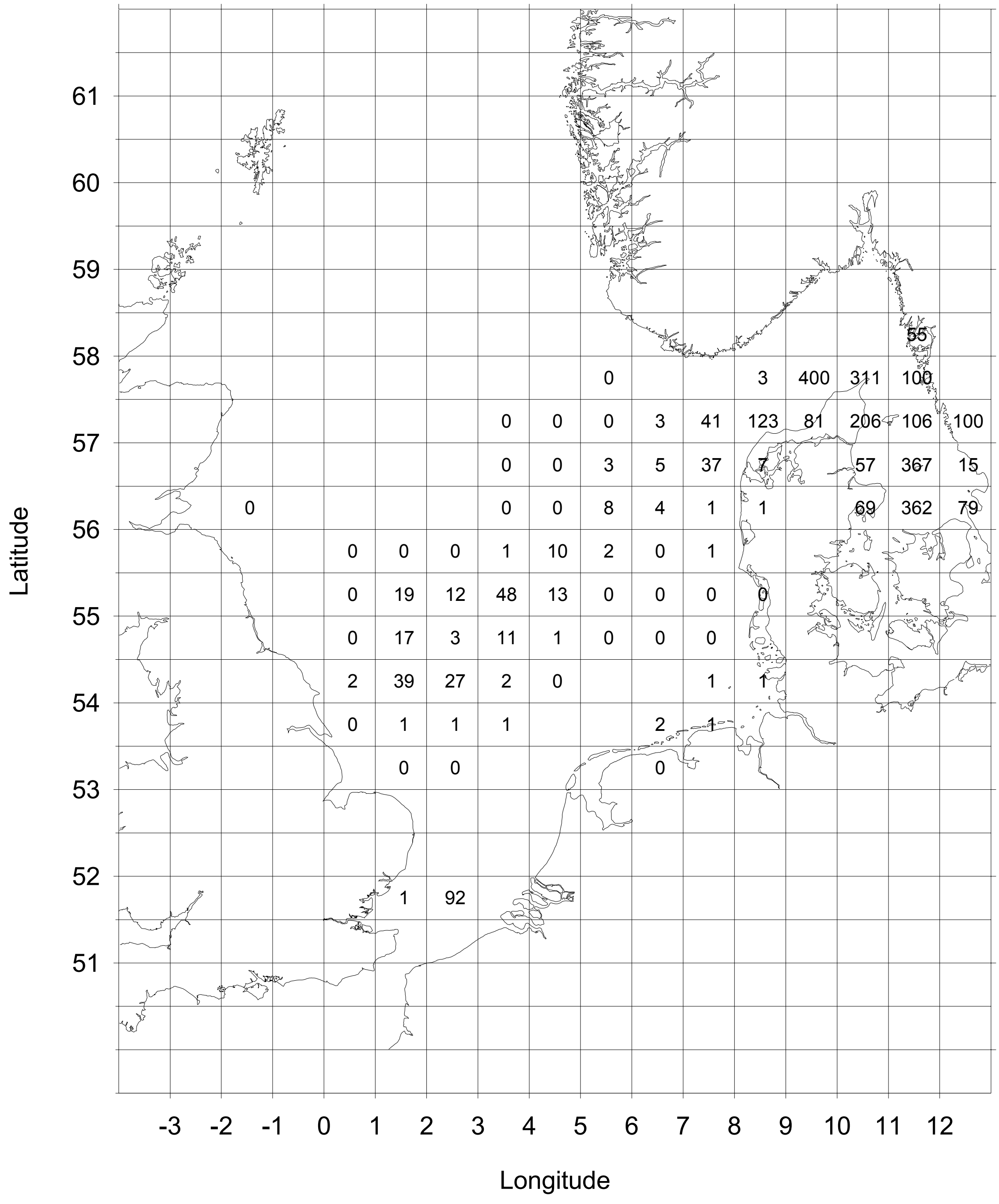


Figure 8.1.1b Sprat catches (in tonnes) in the North Sea in 2002 by statistical rectangle. Working group estimates (if available). Second quarter.

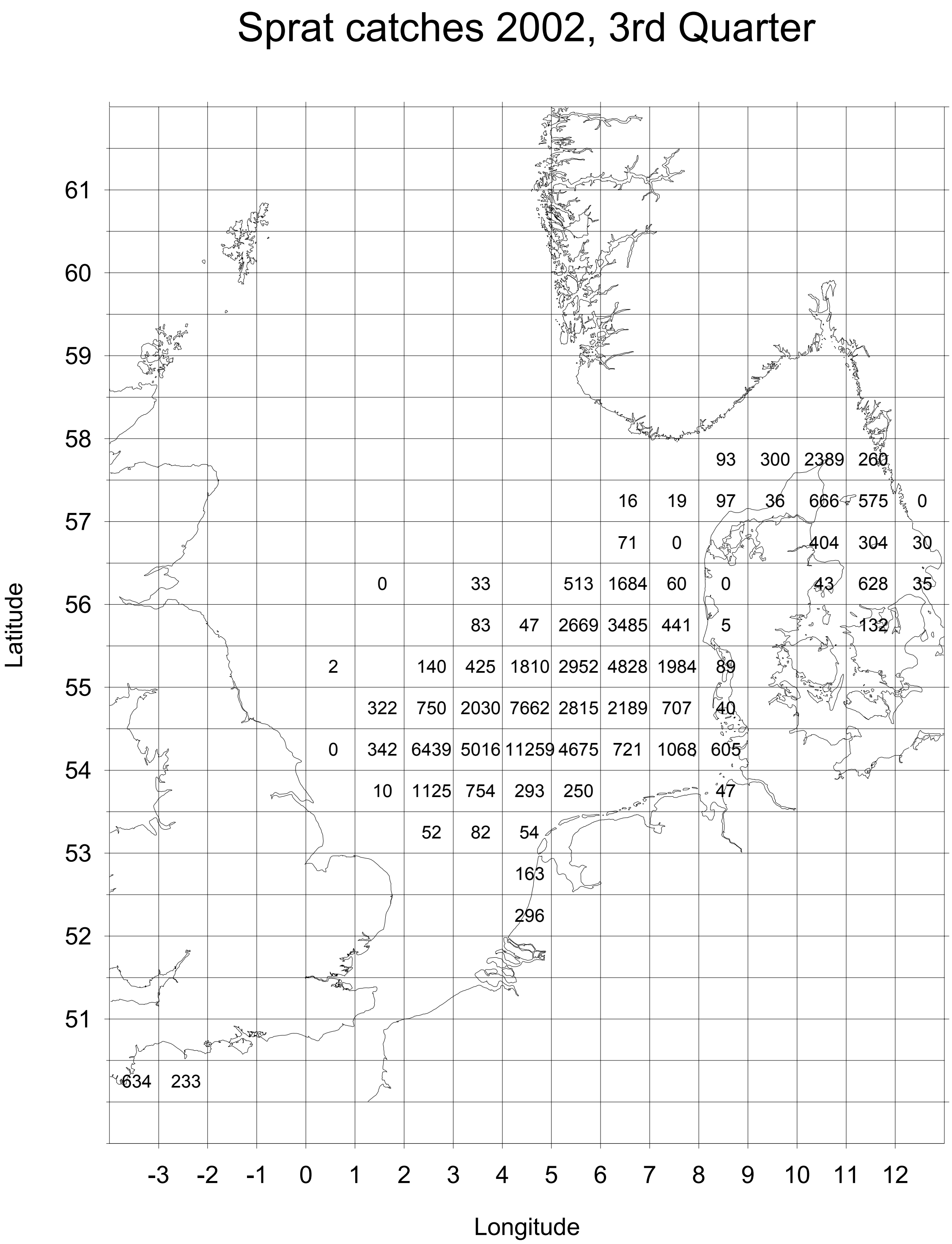


Figure 8.1.1c Sprat catches (in tonnes) in the North Sea in 2002 by statistical rectangle. Working group estimates (if available). Third quarter.

Sprat catches 2002, 4th Quarter

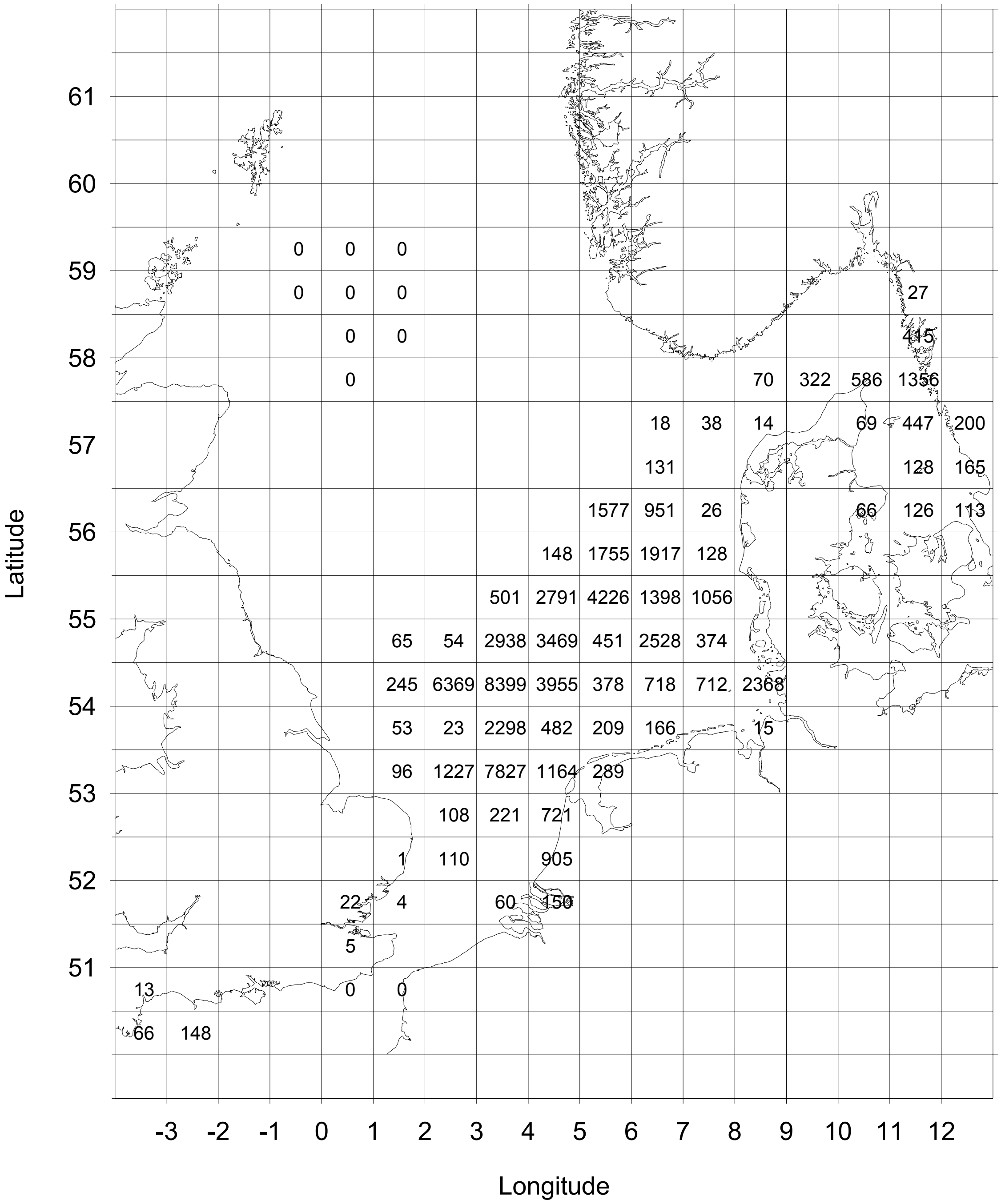


Figure 8.1.1d Sprat catches (in tonnes) in the North Sea in 2002 by statistical rectangle. Working group estimates (if available). Fourth quarter.

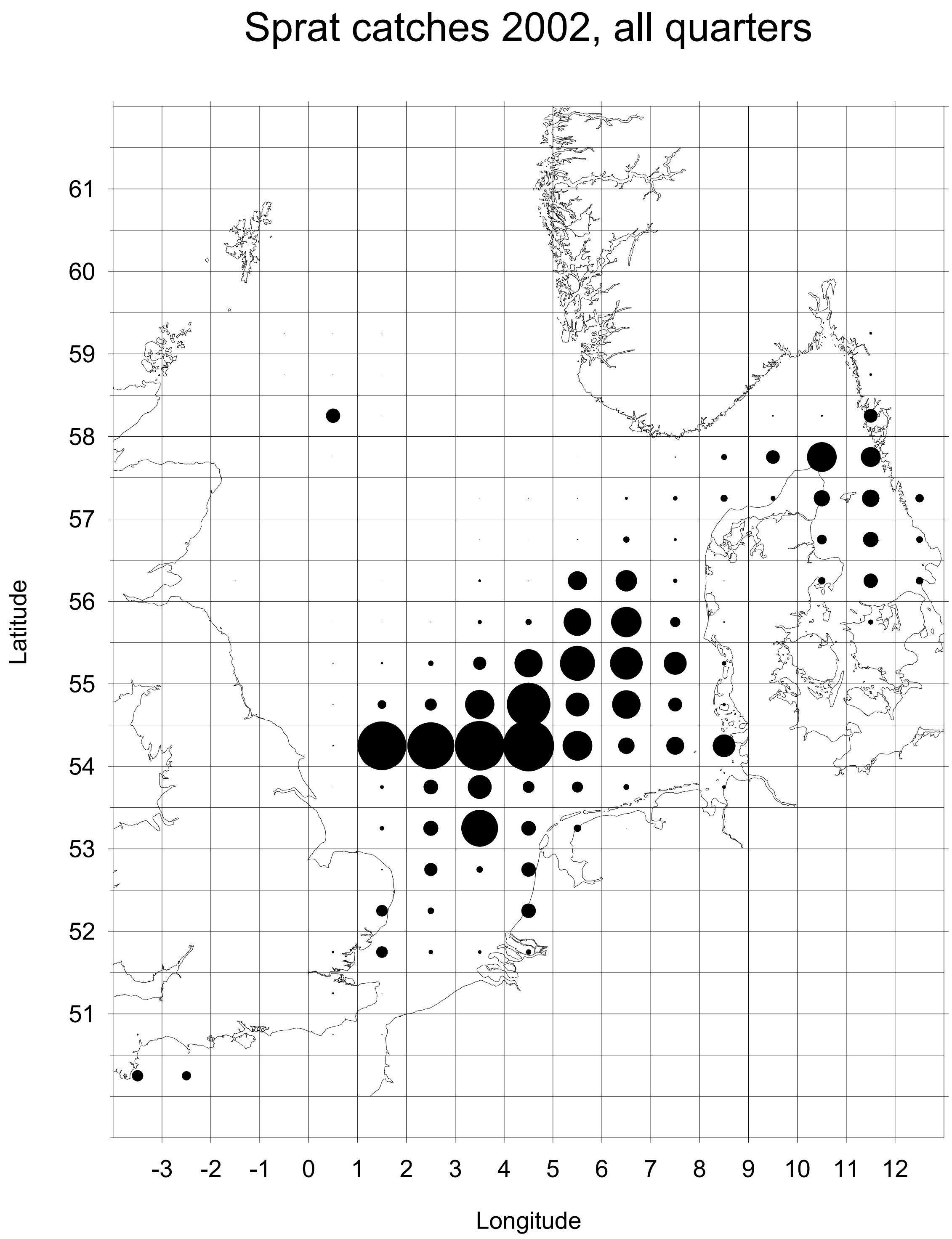


Figure 8.1.2 Total Sprat catches (in tonnes) in the North Sea in 2002 by statistical rectangle. Circle diameter is proportional to catch in tonnes. Working group estimates (if available).

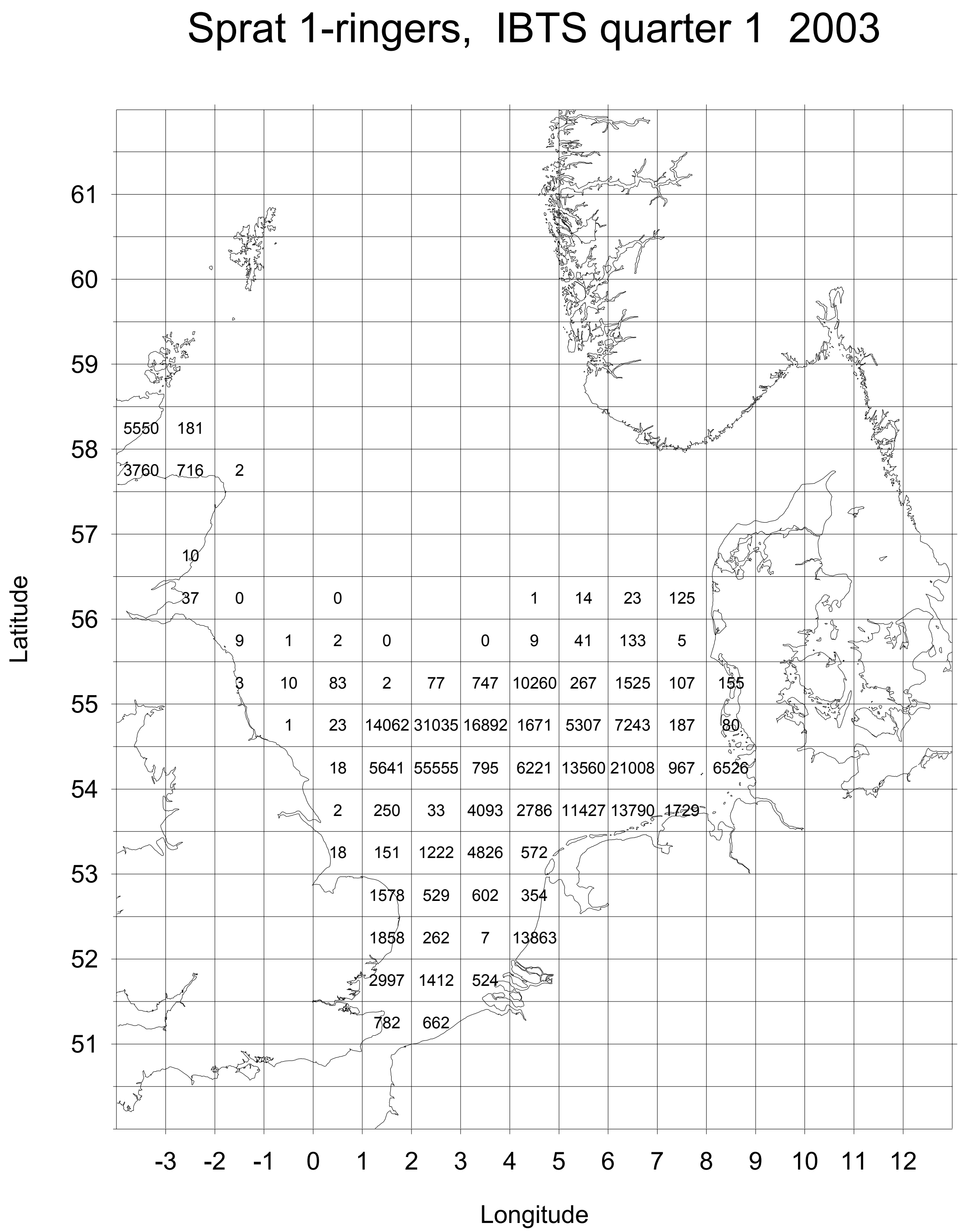


Figure 8.3.1a Distribution of age group 1 in the IBTS (February) 2003 in the North Sea and Division IIIa.

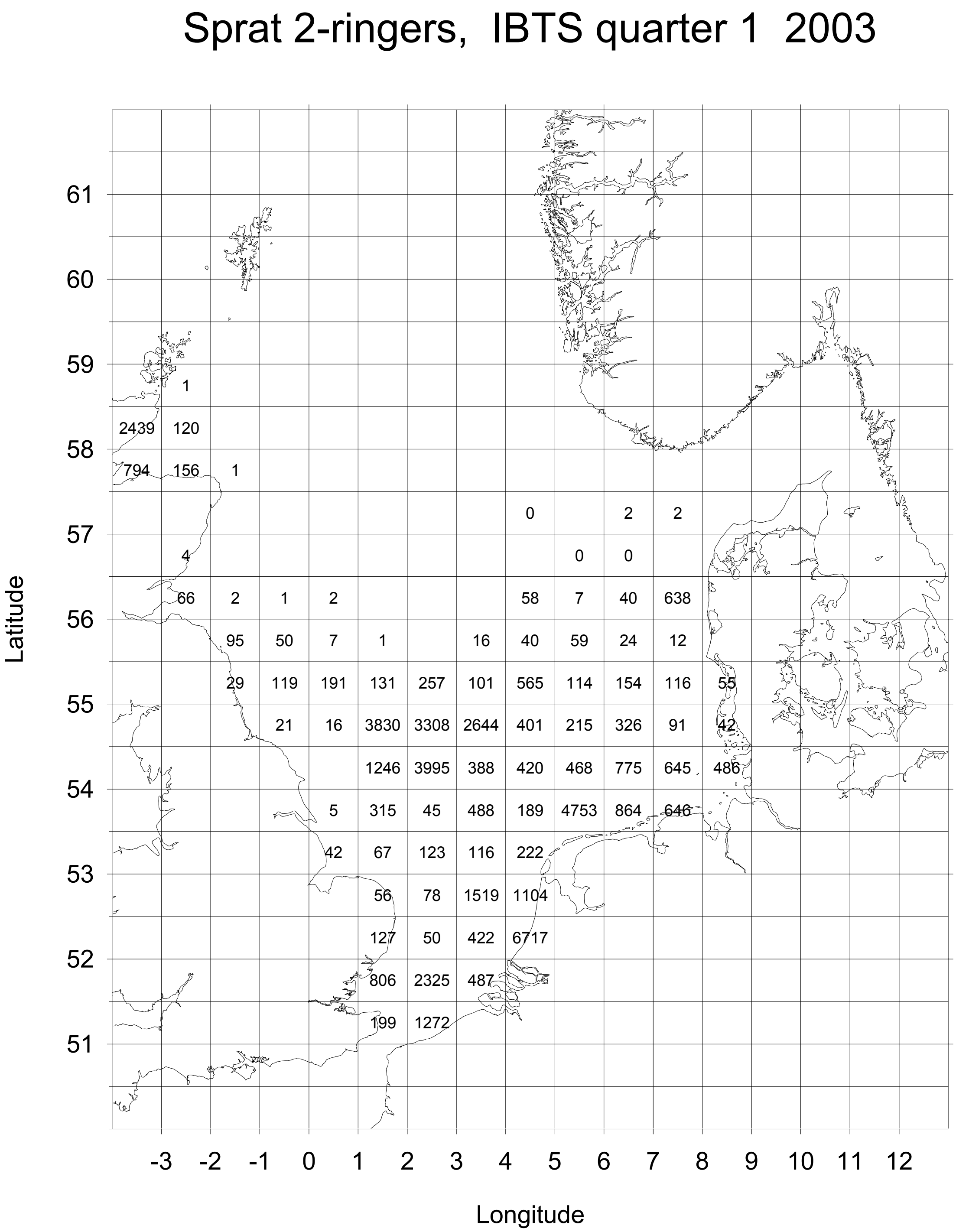


Figure 8.3.1b Continued. Distribution by age groups in the IBTS (February) 2003 in the North Sea and Division IIIa. Sprat age group 2.

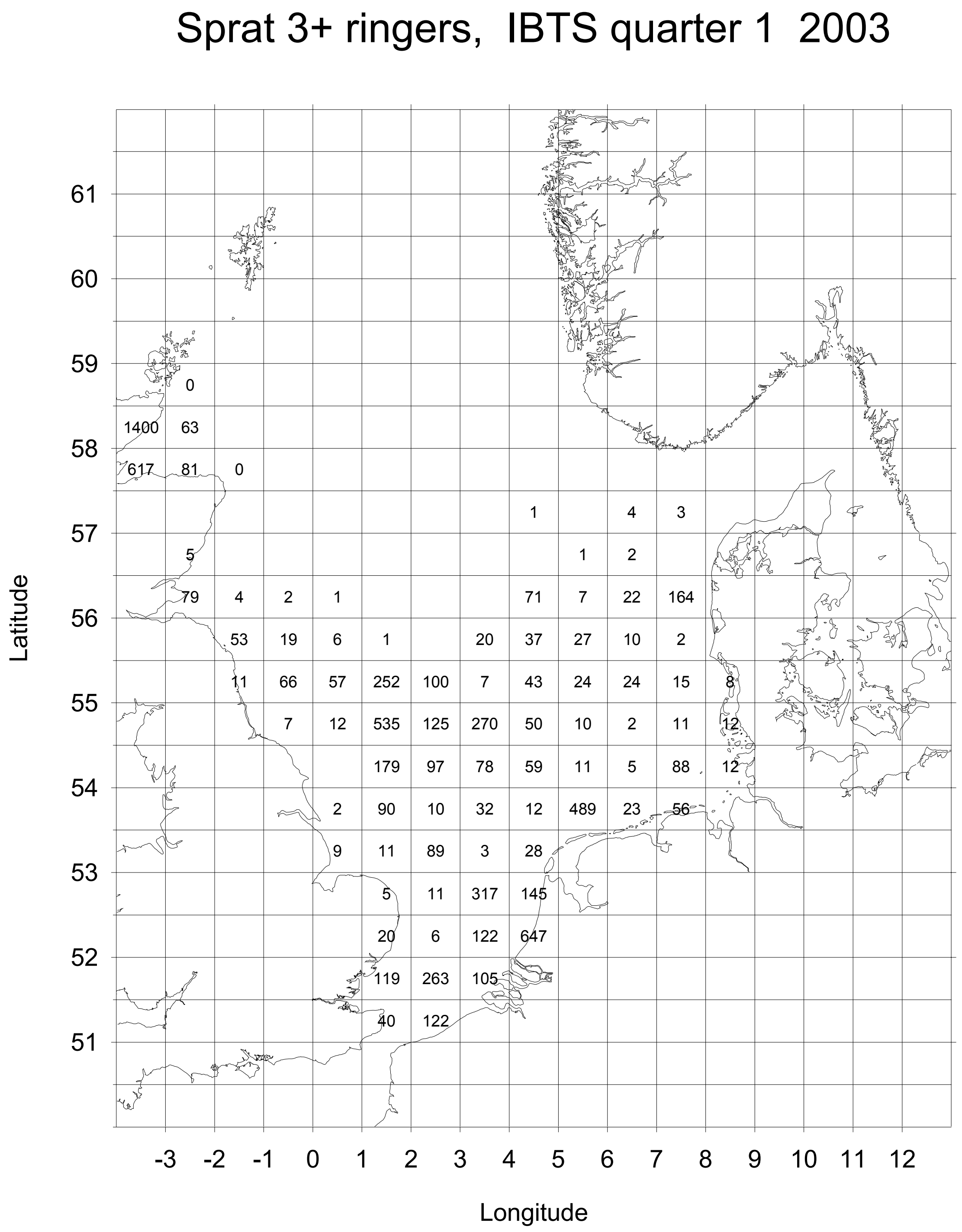


Figure 8.3.1c Continued. Distribution by age groups in the IBTS (February) 2003 in the North Sea and Division IIIa. Sprat age group 3.

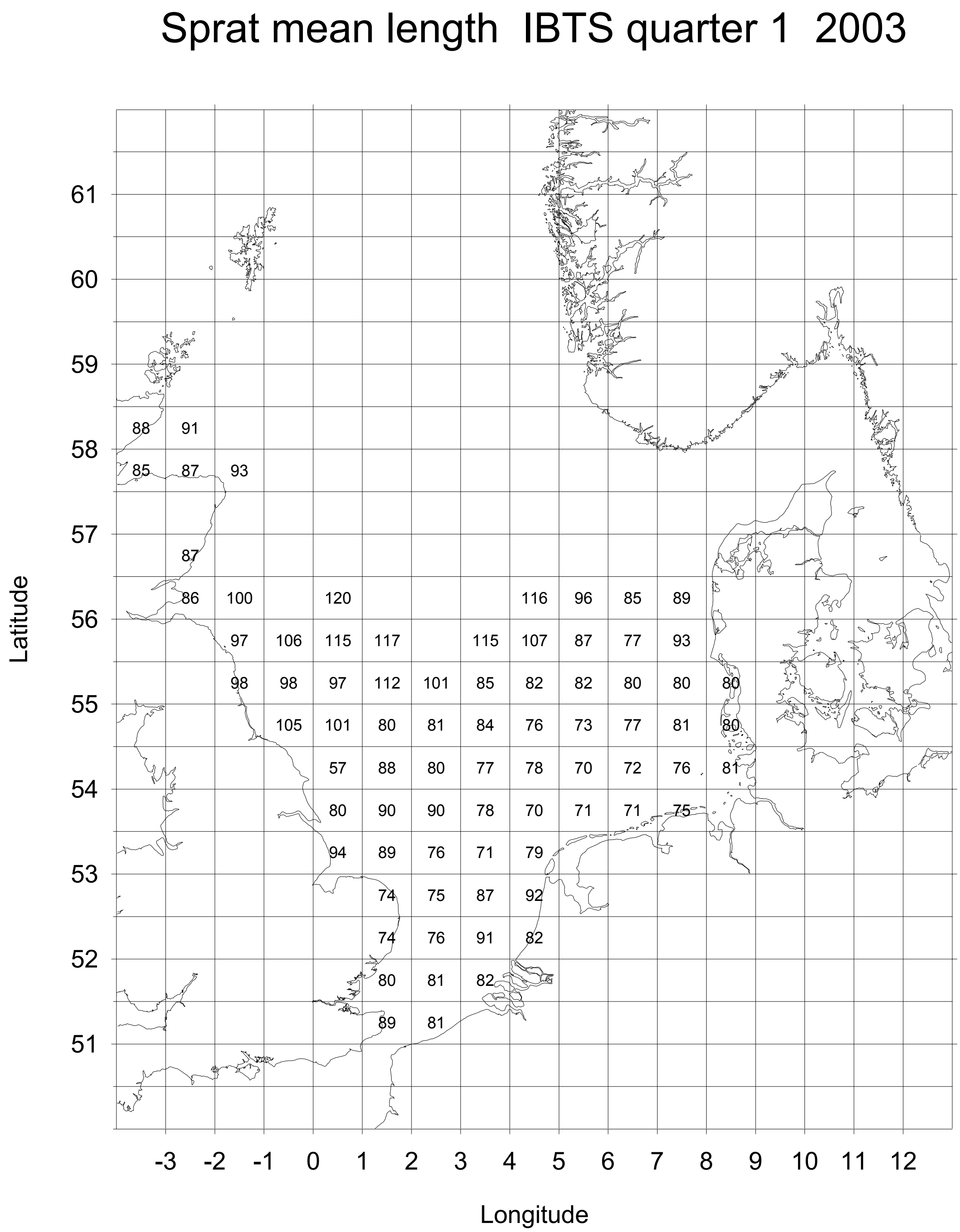


Figure 8.3.2 Mean length (mm) of age group 1 sprat in the IBTS (February) 2003 in the North Sea and Division IIIa.

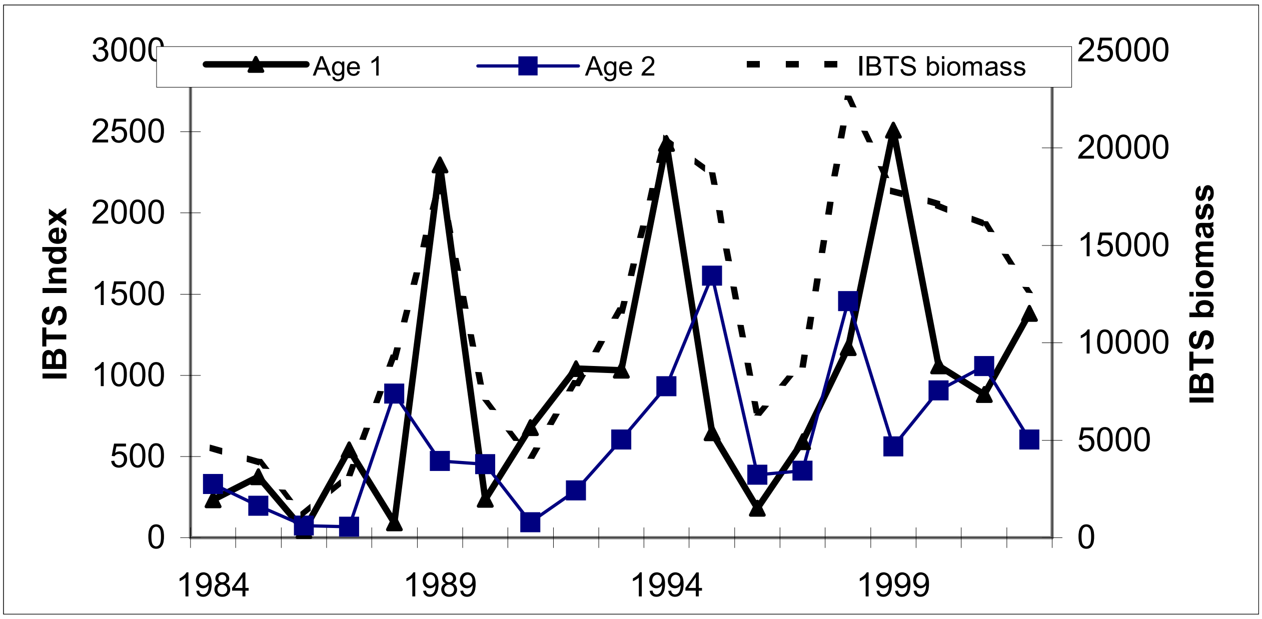


Figure 8.6.1 Sprat biomass estimated from IBTS abundance indices and the average weight-at-age based on sampling from 1st quarter commercial catch, IBTS indices of 1- and 2-year-olds.

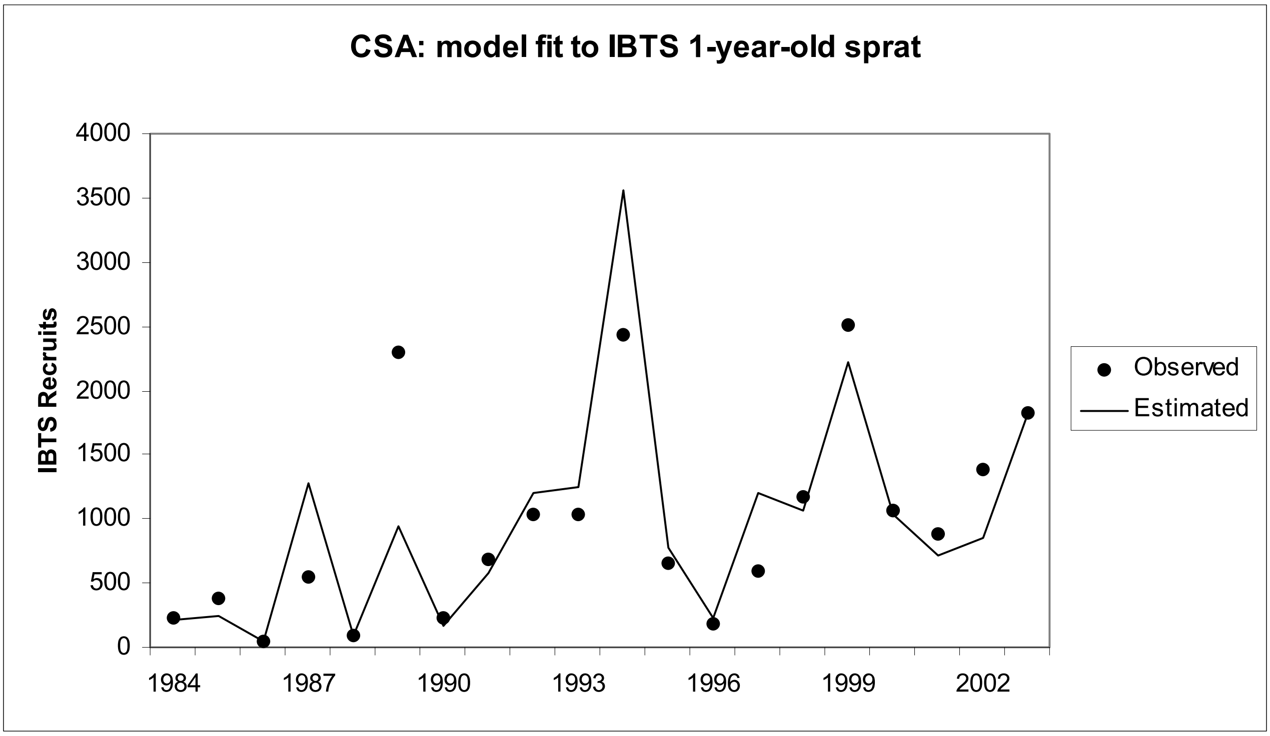


Figure 8.6.2 CSA model fit to IBTS 1-year-old sprat index.

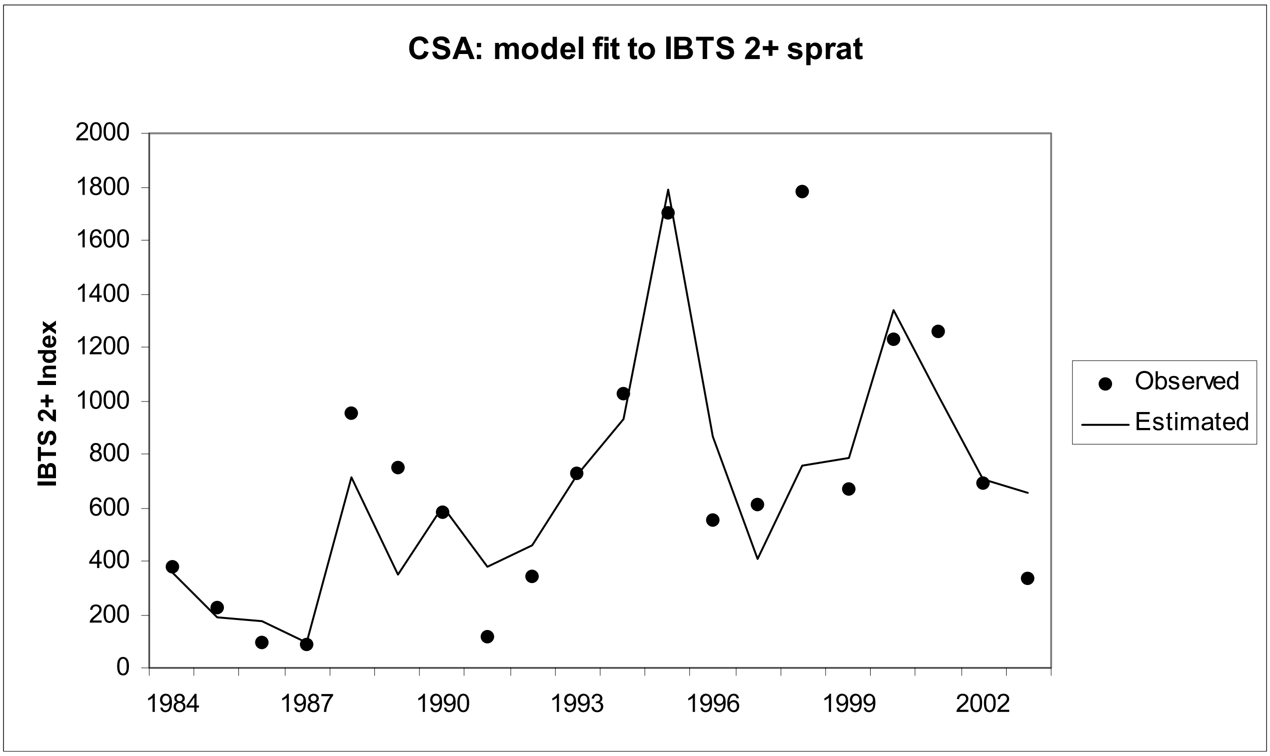


Figure 8.6.3 CSA model fit to the IBTS index for 2-year-old sprat.

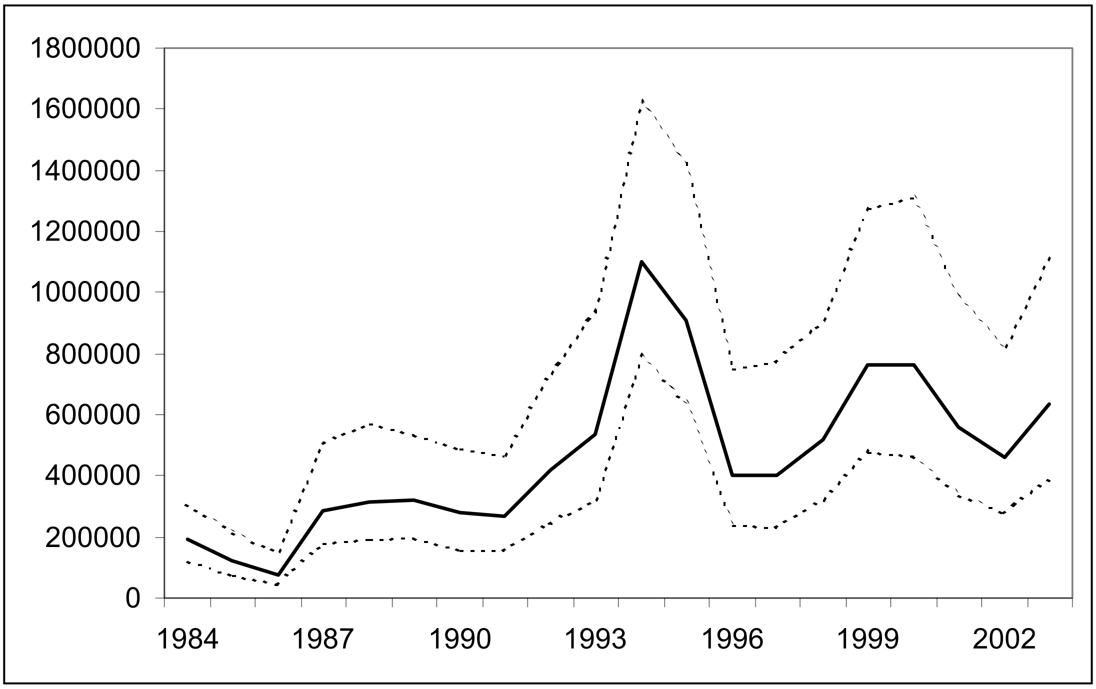


Figure 8.6.4 Model estimated stock biomass and 95% Confidence Intervals estimated by means of bootstrapping.

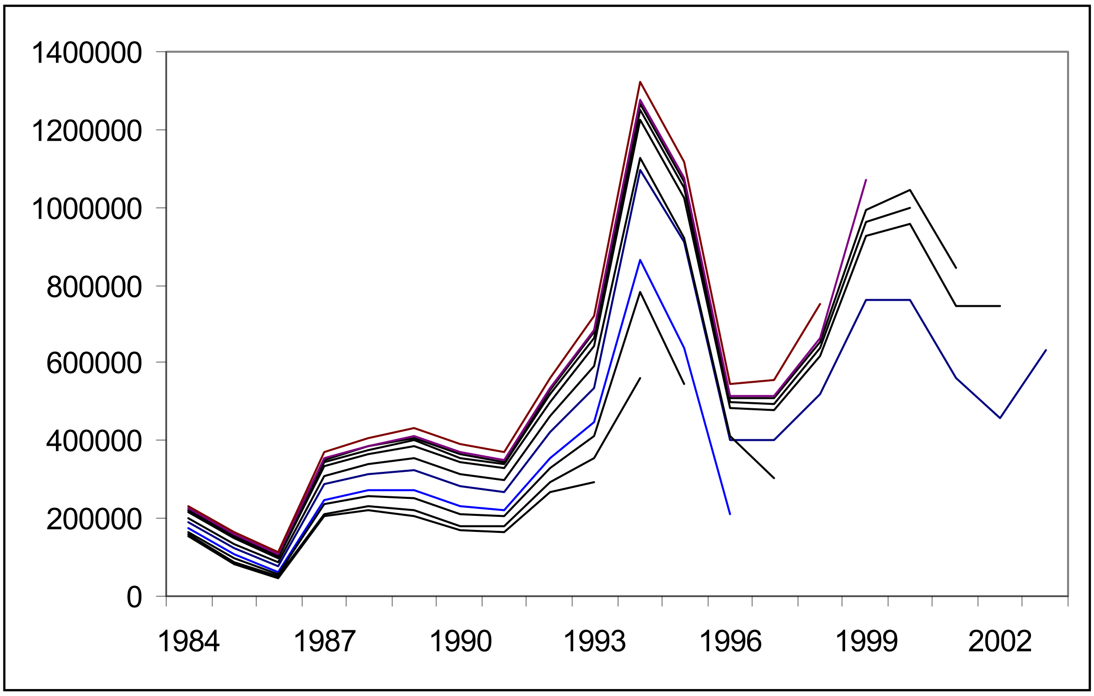


Figure 8.6.5 Retrospective analysis of CSA estimates of stock biomass.

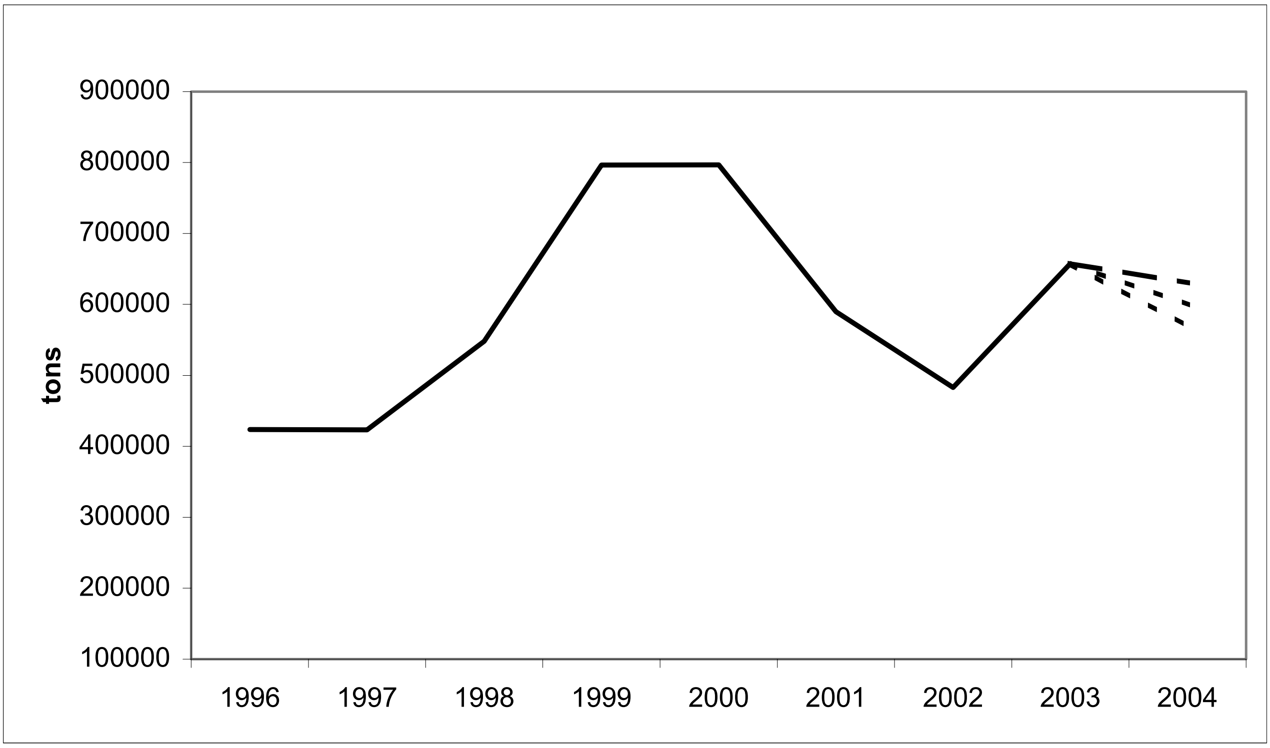


Figure 8.7.1 Biomass projection to the start of 2004 (assuming geometric mean recruitment in 2004) for three catch levels in 2003: 250, 200 and 150 thousand tons.

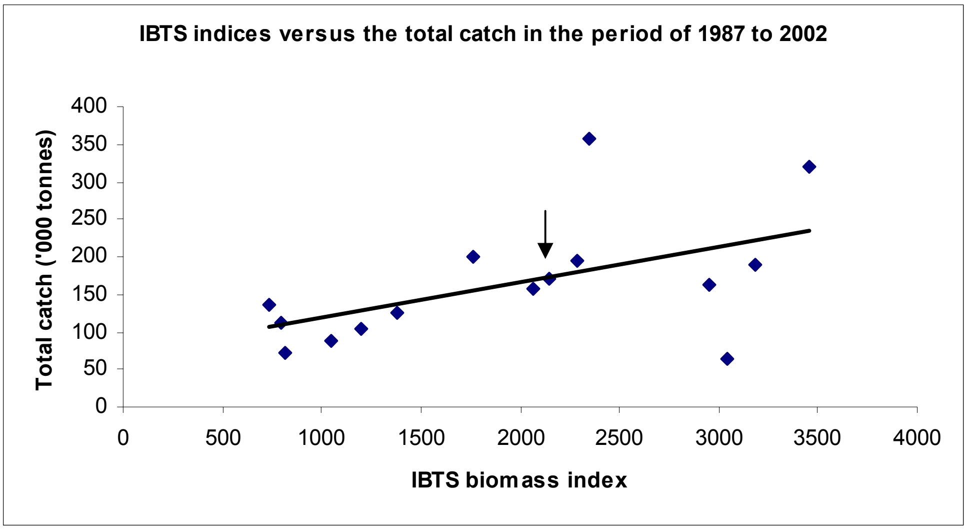


Figure 8.7.2 IBTS indices versus the total catch (1987 – 2002). A fitted regression line to the data result in a R-square of 0.34. The arrow indicates the biomass index for 2003 (2157).

9 SPRAT IN DIVISIONS VIID,E

9.1 The fishery

9.1.1 ACFM advice applicable for 2002

The TAC for this fishery was set to 12,000 t for 2002 and 9,600 for 2003. No ACFM advice has been provided in recent years.

9.1.2 Catches in 2002

Table 9.1.1 shows the nominal landings in 1985–2002. The landings in 2002, as reported by UK (England and Wales), decreased in 2002 and were lower than the average 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 in the period from 1991 to early 2003 is shown in Table 9.1.2. Catches are mainly taken in the third and fourth quarter.

9.1.3 Catch Composition

Catch compositions and the mean weights for 1991–1998 are given in Table 9.1.3. No samples of commercial catches have been available for 1999, 2000, 2001 and 2002.

Table 9.1.1 Nominal catch of sprat (t) in Divisions VIId,e,1985–2002.

Country	1985	1986	1987	1988	1989	1990	1991	1992
Denmark		15	250	2,529	2,092	608		
France	14		23	2	10			35
Germany								
Netherlands								
UK (Engl.&Wales)	3,771	1,163	2,441	2,944	1,319	1,508	2,567	1,790
Total	3,785	1,178	2,714	5,475	3,421	2,116	2,567	1,825

Country	1993	1994	1995	1996	1997	1998*	1999*	2000*
Denmark								
France	2	1	0					18
Germany								
Netherlands							1	1
UK (Engl.&Wales)	1,798	3,177	1,515	1,789	1,621	2,024	3,559	1,692
Total	1,800	3,178	1,515	1,789	1,621	2,024	3,560	1,711

Country	2001	2002*
Denmark		
France		
Germany		
Netherlands		
UK (Engl.&Wales)	1,349	1,196
Total	1,349	1,196

* Preliminary

Table 9.1.2 Lyme Bay sprat fishery. Monthly catches (t) 1991-2002. 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	15	149	33	0	1842
1999/00	0	0	0	699	1306	547	544	242	75	34	0	0	3447
2000/01	0	0	0.02	173	541	586	163	114	74	35.6	0	0	1686
2001/02	0	0	0	458	338	171	50	213	60	34	5	0	1329
2002/03	0	0	0	236	631	121	51	55					1094

Table 9.1.3. 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	
1999				No data			
2000				No data			
2001				No data			
2002				No data			

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)

10 SPRAT IN DIVISION IIIA

10.1 The Fishery

10.1.1 ACFM advice applicable for 2002 and 2003

The ACFM advice on sprat management is that exploitation of sprat will be limited by the restrictions imposed on fisheries for juvenile herring. This is a result of sprat being fished mainly together with juvenile herring. The sprat fishery is controlled by by-catch ceilings of herring as well as by-catch percentage limits. No ACFM advice on sprat TAC has been given in recent years. The sprat TAC for 2002 was 50,000 t, with a restriction on by-catches of herring not exceeding 21,000 t. For 2003 the same values were set as in 2002.

10.1.2 Landings

In 1997 a mixed-clupeoid fishery management regime was changed to a new agreement between the EU and Norway that resulted in a TAC for sprat as well as a by-catch ceiling for herring.

The total annual landings for Division IIIa by area and country are given in Table 10.1.1 for 1974 -2002. The total landings decreased by approximately 10,000 t from 2001 to 2002, and are the lowest since 1999.

The Norwegian and Swedish landings include the coastal and fjord fisheries. The Swedish coastal sprat fishery decreased in 2002.

Landings by countries and by quarter are shown in Table 10.1.2. For 2002 the landings were taken in all quarters with the bulk of the catch in the 3rd quarter. In the second quarter 2,400 t were landed. Denmark has a total ban on the sprat fishery in Div.IIIa from May to September.

10.1.3 Fleets

Fleets from Denmark, Norway and Sweden carry out the sprat fishery in Division IIIa.

The Danish sprat fishery consists of trawlers using a 16 mm-mesh size codend and all landings are used for fishmeal and oil production. Some of the sprat landings from Denmark and Sweden are by-catches in the herring fishery using 32 mm mesh-size cod ends.

A Swedish directed 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 for human consumption.

The Norwegian sprat fishery in Division IIIa is an inshore purse seine fishery for human consumption.

10.2 Biological Composition of the Catch

10.2.1 Catches in number and weight-at-age

The numbers and the mean weight by age in the landings from 1995 to 2002 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. Quarterly and annual distributions of catches by rectangle are shown in Figures 8.1.1–8.1.2.

10.2.2 Quality of catch and biological data

Denmark reorganised and improved its monitoring system for management and scientific purposes in 1996. The required level of one sample per 1,000 t landed was more than met in 2002 with 53 samples from a total landing of 13,400 tonnes.

Denmark has provided biological samples of all the quarters where there were landings in both the Skagerrak and the Kattegat. Sweden provided biological samples from the fishery in Skagerrak from quarter 1 and 4 and from quarter 3 and 4 from the fishery in the Kattegat. No Norwegian samples were collected.

The samples were used to estimate the numbers of sprat-at-age and the mean weight-at-age, in all sprat landings (Tables 10.2.1 and Table 10.2.2 respectively). The sample size (75 samples) has increased compared to the level in 2001 (62 samples). 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 Fishery-independent information

Acoustic estimates of sprat have been available from the ICES co-ordinated Herring Acoustic surveys since 1996. In 1996 the total estimate was 7.9 x 10^8 fish or 14,267 tonnes. About 95 % of the biomass was recorded in Kattegat. There were very low estimates of sprat from 1997 to 2001, but the estimates increased in 2002 in Kattegat, where total biomass was estimated to be 10,000 tonnes.

10.4 Mean weight-at-age

Mean weights (g) at age in the catches during 2002 are presented, by quarter, in Table 10.2.2. The table includes mean weights-at-age for 1995-2001 for comparison. These have been very variable over time, but whether this is due to actual variation in mean weight or difficulties in ageing of sprat is uncertain.

10.5 Recruitment

The IBTS (February) sprat indices for 1984-2003 are presented in Table 10.5.1. 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-ringer 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/Assess:13). The indices were revised in 2002 (ICES 2002/ACFM:12) based on an agreement in the IBTS WG in 1999, where it was decided to calculate the sprat index as an area weighted mean over means by rectangles for the IIIa (ICES 1999/D:2). The old time-series of IBTS indices (from 1984-2001) is shown in ICES 2001/ACFM:10.

The 2002 IBTS index for age-group 1 is considerably lower than the 2002-index and is below the average. The high index for age-group 1 in 2002 is recognised in a high index for age-group 2 in 2003, and the remaining age-group indices are higher than in 2002.

10.6 State of the Stock

No assessments of the sprat stock in Division IIIa have been presented since 1985 and this year is no exception. A Schaefer model was fit to the data in 1999 (ICES 1999/ACFM:12) but that attempt was not successful and was subsequently abandoned. The WG agreed to explore the data for sprat in Division IIIa by means of Catch-Survey Analysis as performed for sprat in the North Sea in the current year, see Section 8.

According to the IBTS (February)-index for 2002, the sprat stock in the area has increased from last year; however, the index for age-group 1 is lower than in previous years, being the lowest on record since 2000.

10.7 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=0.01)—the data is shown in Figure 10.7.1—and the index was not considered useful for management of sprat in Div. IIIa.

The estimated yield for 2003 using the total IBTS index was 16,000 tonnes (Table 10.7.1) in a SHOT-estimate (Shepherd, 1991). This is a bit higher than the estimated yield for 2002 (14,000 tonnes); however, this method is not considered to provide any reliable projection under the present management regime and the IBTS index is poor for this particular stock.

10.8 Reference Points

There are no reference points for this stock.

10.9 Management Considerations

Sprat in Division IIIa is short-lived with large inter-annual fluctuations in stock biomass. The natural inter-annual variability in stock abundance, mainly driven by recruitment variability, is high and does not appear to be strongly influenced by the observed levels of fishing effort.

The sprat 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 and a suitable biomass index. 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 Division IIIa sprat. Landings in ('000 t) 1974-2002.
(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.
In the period from 1982 to 1992 Sweden only reported total catches from division IIIa.

	Skagerrak				Kattegat			Div. IIIa	**Div. IIIa**
Year	Denmark	Sweden	Norway	**Total**	Denmark	Sweden	**Total**	Sweden	**total**
1974	17.9	2	1.2	21.1	31.6	18.6	50.2		71.3
1975	15	2.1	1.9	19	60.7	20.9	81.6		100.6
1976	12.8	2.6	2	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	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	3.4	39.1	35.8	9	44.8		83.9
1981	26.4	6.3	4.6	37.3	23	16	39		76.3
1982	10.5		1.9	12.4	21.4		21.4	5.9	39.7
1983	3.4		1.9	5.3	9.1		9.1	13.0	27.4
1984	13.2		1.8	15	10.9		10.9	10.2	36.1
1985	1.3		2.5	3.8	4.6		4.6	11.3	19.7
1986	0.4		1.1	1.5	0.9		0.9	8.4	10.8
1987	1.4		0.4	1.8	1.4		1.4	11.2	14.4
1988	1.7		0.3	2	1.3		1.3	5.4	8.7
1989	0.9		1.1	2	3.0		3	4.8	9.8
1990	1.3		1.3	2.6	1.1		1.1	6.0	9.7
1991	4.2		1.0	5.2	2.2		2.2	6.6	14.0
1992	1.1		0.6	1.7	2.2		2.2	6.6	10.5
1993	0.6	4.7	1.3	6.6	0.8	1.7	2.5		9.1
1994	47.7	32.2	1.8	81.7	11.7	2.6	14.3		96.0
1995	29.1	9.7	0.5	39.3	11.7	4.6	16.3		55.6
1996	7.0	3.5	1.0	11.5	3.4	3.1	6.5		18.0
1997	7.0	3.1	0.4	10.5	4.6	0.7	5.3		15.8
1998	3.9	5.2	1.0	10.1	7.3	1.0	8.3		18.4
1999	6.8	6.4	0.2	13.4	10.4	2.9	13.3		26.7
2000	5.1	4.3	0.9	10.3	7.7	2.1	9.8		20.1
2001	5.2	4.5	1.4	11.2	14.9	3.0	18.0		29.1
2002	3.5	2.8	1.3	7.7	9.9	1.4	11.4		19.0

Table 10.1.2. Division IIIa sprat. Landings of sprat ('000 t) by quarter by countries, 1994-2002.
(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
2000	1	4.1	0.1	2.3	6.5
	2	0.0		1.9	1.9
	3	4.8	0.1	0.0	4.9
	4	3.8	0.7	2.3	6.8
	Total	12.7	0.9	6.4	20.0
2001	1	2.5		2.6	5.2
	2	6.6		0.1	6.7
	3	10.2		0.1	10.2
	4	0.9	1.4	4.8	7.1
	Total	20.2	1.4	7.6	29.1
2002	1	3.8	0.5 [1]	1.4	5.2
	2	2.1	0.0 [1]	0.4	2.4
	3	5.9	0.4 [1]	0.1	6.0
	4	1.7	0.4 [1]	2.4	4.1
	Total	13.4	1.3	4.3	17.7

+ Catch record, but amount not precisely known.

[1] Preliminary data

Table 10.2.1 Division IIIa sprat. Landed numbers (millions) of sprat by age groups in 1995-2002.

	Quarter	Age						Total
		0	1	2	3	4	5+	
1995	1		312.04	784.37	53.50	27.29	9.01	1,186.20
	2		1248.72	993.29	61.06	15.24	4.77	2,323.08
	3		1724.02	133.56	14.17			1,871.74
	4		902.76	139.95	29.95	10.58		1,083.25
	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	1,242.38
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
2000	1		116.6	384.3	40.3	7.3	1.6	550.0
	2		17.3	127.4	11.2			155.9
	3	2.1	223.3	51.4	12.2			289.1
	4	18.0	277.6	81.4	13.1	0.8		390.9
	Total	20.2	634.8	644.6	76.8	8.1	1.6	1,386.0
2001	1	0.0	342.6	173.0	73.3	10.0	1.6	600.4
	2	0.0	1746.4	13.4	0.4	0.0	0.0	1,760.2
	3	5.7	924.1	31.7	0.0	0.0	0.0	961.5
	4	22.9	488.1	39.1	18.5	1.5	0.5	570.6
	Total	28.6	3,501.2	257.2	92.2	11.5	2.1	3,892.8
2002	1	0.0	63.8	323.2	38.5	24.7	2.4	452.6
	2	0.0	185.5	63.2	4.8	1.0	0.0	254.5
	3	1.3	326.2	102.0	23.9	6.6	0.6	460.5
	4	21.3	205.4	45.9	10.6	5.9	0.4	289.6
	Total	22.5	780.9	534.3	77.9	38.2	3.4	1,457.2

Table 10.2.2. Division IIIa Sprat. Quarterly mean weight (g) at age in the landings in 1995-
(1994-1995 Danish and Swedish data, 1996-1997 Danish data, 1998-2002 Danish and Swedish data)

Year	Age							**SOP**
	Quarter	0	1	2	3	4	5+	Corrected landings
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
Weighted mean			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
Weighted mean			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
Weighted mean		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
Weighted mean		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
Weighted mean		3.8	10.2	8.8	17.4	13.9	13.7	26,361.0
2000	1		5.3	13.1	15.3	20.7	22.7	6,438
	2		5.2	12.8	14.1			1,873
	3	4.3	16.6	18.0	21.9			4,897
	4	7.0	16.9	19.9	22.1	24.6		6,742
Weighted mean		6.7	14.3	14.3	17.3	21.1	22.7	19,949.3
2001	1		3.77	14.34	16.24	17.75	17.33	5,168
	2		3.72	6.49	21.00			6,598
	3	5.35	10.50	12.06		13.00		10,114
	4	5.06	12.00	19.66	22.64	19.35	25.60	7,200
Weighted mean		5.1	6.7	14.5	17.5	18.0	19.2	29,078.5
2002	1		5.70	12.70	17.30	19.30	20.60	5,661
	2		7.90	13.70	16.00	17.00		2,425
	3	8.00	12.40	15.10	18.10	17.00	17.00	6,150
	4	5.70	15.60	18.20	21.60	21.50	22.00	4,528
Weighted mean		5.8	11.6	13.7	18.1	19.2	20.1	18,763.2

Table 10.2.3 Division IIIa sprat. Sampling commercial landings for biological samples in 2002.

Country Area	Quarter	Landings ('000 t)	No. samples	No. meas.	No. aged
Denmark	1	1	7	759	149
Skagerrak	2	1	18	276	149
	3	2	7	825	241
	4	1	2	260	96
	Total	3.5	34	2,120	635
Denmark	1	3	8	935	356
Kattegat	2	1	2	269	97
	3	4	8	948	563
	4	1	1	362	104
	Total	9.9	19	2,514	1,120
Norway	1	0.5 [1]			
Skagerrak	2	0.0 [1]			
	3	0.4 [1]			
	4	0.4 [1]			
	Total	1.3			
Sweden	1	1.1	2	150	147
Skagerrak	2	0.1			
	3	0.0			
	4	1.6	17	1,110	1,096
	Total	2.8	19	1,260	1,243
Sweden	1	0.4			
Kattegat	2	0.2			
	3	0.1	1	38	36
	4	0.8	2	77	77
	Total	1.4	3	115	113
Denmark		13.4	53	4,634	1,755
Norway		1.3			
Sweden		4.3	22	1,375	1,356
	Total	19.0	75	6,009	3,111

[1] Preliminary data

Table 10.5.1. Division IIIa sprat. IBTS(February) indices of sprat per age group 1984-2002. (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	5,676	869	205	79	64	6,892
1985	14	38	2,158	2,347	393	140	51	5,089
1986	15	38	629	1,979	2,035	144	38	4,825
1987	16	38	2,736	2,846	3,003	2,582	157	11,324
1988	13	38	915	5,263	1,485	2,088	453	10,203
1989	14	38	414	911	989	555	136	3,004
1990	15	38	418	224	65	61	46	814
1991	14	38	496	732	700	128	376	2,433
1992	16	38	5,994	599	264	204	75	7,135
1993	16	38	1,590	4,169	907	199	240	7,105
1994	16	38	1,789	716	1,021	313	70	3,908
1995	17	38	2,204	1,770	35	45	4	4,058
1996	15	38	186	5,627	751	128	218	6,909
1997	16	41	233	391	1,239	139	135	2,137
1998	15	39	72	1,585	620	1,618	522	4,416
1999	16	42	4,535	355	250	44	314	5,498
2000	16	41	292	738	60	51	24	1,165
2001	16	42	6,540	1,144	677	92	46	8,499
2002	16	42	1,119	966	87	58	13	2,242
2003	17	46	463	1,247	1,172	381	125	3,388

Table 10.7.1 SHOT forecast of landings in 2003 using total landings and the total IBTS indices as input data.

```
IIIa Sprat                          SHOT forecast spreadsheet version 4
Total Index                                             April 1996

running recruitment weights
      older    0.00                         G-M =  0.00
      central  1.00                        exp(d)  1.00
      younger  0.00                      exp(d/2)  1.00
```

Year	Land -ings	Recrt Index	W'td Index	Y/B Ratio	Hang -over	Act'l Prodn	Est'd Prodn	Est'd SQC.	Act'l Expl Biom	Est'd Expl Biom	Est'd Land -ings
1984	36.1	6892		0.77	0.23				47		
1985	19.7	5089	5089	0.77	0.23	15			26		
1986	10.8	4825	4825	0.77	0.23	8	14	15	14	20	15
1987	14.4	11324	11324	0.77	0.23	15	26	23	19	29	23
1988	8.7	10203	10203	0.77	0.23	7	18	18	11	23	18
1989	9.8	3004	3004	0.77	0.23	10	4	5	13	7	5
1990	9.7	814	814	0.77	0.23	10	1	3	13	4	3
1991	14	2433	2433	0.77	0.23	15	4	6	18	7	6
1992	10.5	7135	7135	0.77	0.23	9	15	15	14	19	15
1993	9.1	7105	7105	0.77	0.23	9	14	13	12	17	13
1994	96	3908	3908	0.77	0.23	122	7	8	125	10	8
1995	55.6	4058	4058	0.77	0.23	44	16	34	72	45	34
1996	18	6909	6909	0.77	0.23	7	30	36	23	47	36
1997	15.8	2137	2137	0.77	0.23	15	9	11	21	14	11
1998	18.4	4416	4416	0.77	0.23	19	18	18	24	23	18
1999	26.7	5498	5498	0.77	0.23	29	23	22	35	28	22
2000	20.1	1165	1165	0.77	0.23	18	5	10	26	13	10
2001	29.1	8499	8499	0.77	0.23	32	37	33	38	43	33
2002	19	2242	2242	0.77	0.23	16	10	14	25	18	14
2003		3388	3388	0.77	0.23		15	16		21	16

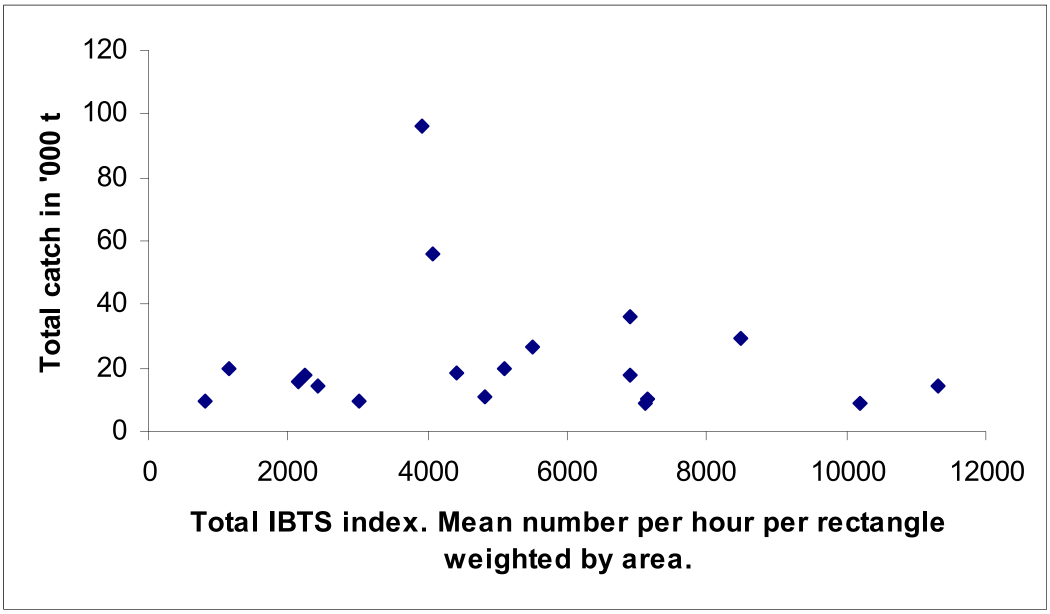


Figure 10.7.1 Division IIIa sprat IBTS indices vs. the total catches in 1984 to 2002. The R-square equal 0.01

11 REFERENCES

Bowers, A.B., 1952. Studies on the herring (*Clupea harengus* L.) in Manx waters: the autumn spawning and the larval and post-larval stages. Proceedings and Transactions of the Liverpool Biology Society, 58, 47-74.

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.

Brophy, D. 2002. Analysis of juvenile herring dynamics in the Irish and Celtic Sea using otolith microstructure and microchemistry. PhD thesis, National University of Ireland, Dublin 4, Republic of Ireland, in prep.

Conser, R.J. 1995. A modified DeLury modelling framework for data-limited assessments: bridging the gap between surplus production models and age-structured models. WD at WGMFSA, ICES CM 1995/D:03.

Corten, A. 1986. On the causes of the recruitment failure of herring in the central and northern North Sea in the years 1972-1978. J. Cons. Int. Explor Mer, 42: 281-294.

Cushing, D.H. 1968. The Downs stock of herring during the period 1955-1966. J. Cons. Int. Explor Mer, 32: 262-269.

East Channel Association, 2003. Regional environmental assessment for aggregate extraction in the eastern English Channel. Posford Haskoning, French Jones Ltd, Henley on Thames, Oxon. 26pp.

EU Commission Regulation 1639/2001.

Fox, C.J., Harrop, R., Wimpenny, A. 1999. Feeding ecology of herring (*Clupea harengus*) larvae in the turbid Blackwater Estuary. Marine Biology, 134: 353-365.

de Groot, S.J., 1980. The consequences of marine gravel extraction on the spawning of herring *Clupea harengus* Linne. J. Fish Biol. 16:355-359.

Gröger, J. and Gröhsler, T. 2001. Comparative analysis of alternative statistical models for herring stock discrimination based on meristic characters. J. Appl. Ichthy. 17(5):207-219.

Harden-Jones, F.R. 1968. Fish migration. Edward Arnold, London.

HERGEN 2000. EU Project QLRT 200-01370.

Hulme, T.J. 1995. The use of vertebral counts to discriminate between North Sea herring stocks. ICES J. Mar. Sci., 52: 775–779.

ICES 1991. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1991/Assess:15.

ICES 1992. Report of the Workshop on Methods of Forecasting Herring Catches in Div. IIIa and the North Sea. ICES CM 1992/H:5.

ICES 1995. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1995/Assess:13.

ICES 1996. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1996/Assess:10.

ICES 1996. Manual for the International Bottom Trawl Surveys. Revision V. Addendum to ICES CM 1996/H:1 (Ref. Assess+G).

ICES 1997. Study Group on Multispecies Model Implementation in the Baltic. ICES CM 1997/J:2.

ICES 1998. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1998/ACFM:14.

ICES 1998. Study Group on Stock Recruitment Relationships for the North Sea Autumn-Spawning Herring. ICES CM 1998/D:02.

ICES 1999. Report of the International Bottom Trawl Survey Working Group. ICES CM 1999/D:2.

ICES 1999. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1999/ACFM:12.

ICES 2000. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 2000/ACFM:10.

ICES 2000. Report of the International Bottom Trawl Survey Working Group ICES CM 2000/D:07.

ICES 2001. Herring Assessment WG for the Area South of 62° N. CM 2001/ACFM:12.

ICES 2001. Report of the Study Group on Evaluation of Current Assessment Procedures for North Sea Herring. CM 2001/ACFM:22.

ICES 2001. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 2001/ACFM:10.

ICES 2002. Report of the Planning Group for Herring Surveys. 2002/G:02.

ICES 2002. Herring Assessment WG for the Area South of 62° N. CM 2001/ACFM:12.

ICES 2002. Manual for the international bottom trawl surveys in the western and southern areas**.** ICES CM 2002/D:03

ICES 2002. Report of the Workshop on the MSVPA in the North Sea. ICES CM 2002/D:04.

ICES 2003. Report of the Working Group on Methods of Fish Stock Assessment. ICES CM 2003/D:03

ICES 2003. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skaggerak. ICES CM 2003/ACFM:02.

ICES 2003. Report of the Working Group on the Assessment of Southern Shelf Demersal Stocks. ICES CM 2003/ACFM:03.

ICES 2003. Report of the Study Group on Precautionary Reference Points for Advice on Fishery Management. ICES CM 2003/ACFM:15

ICES 2003. Report of the Study Group on the Further Development of the Precautionary Approach to Fisheries Management. ICES 2003/ACFM:xx.

ICES 2003. Report of the Planning Group for Herring Surveys. 2003/G:02.

ICES 2003. Study Group on Growth, Maturity and Conditions in Stock Projections. ICES CM 2003/D:01.

ICES 2003. Planning group on Commercial Catch, Discards and Biological Sampling. ICES 2003 ACFM:25.

Kizner Z.I. and D. Vasilyev 1997. Instantaneous Separable VPA (ISVPA). ICES Journal of Marine Science, 54(3): 399–411.

Klenz, B. 1993. Quantitative Larvenanalyse des Rügenschen Frühjahrsherings in den Laichsaisons 1991 und 1992. Infn. Fischw., 40(3): 118–124.

Klenz, B. 2002. Starker Nachwuchsjahrgang 2002 des Herings der westlichen Ostsee. Inf. Fishwirtsch. 49(4): 143-144.

Jonsson, S. T. and Hjorleifsson, E. 2000. Stock assessment bias and variation analysed retrospectively and introducing the PA-residual. ICES C.M. 2000 / X:9.

Lassen, H. and Sparholt, H.2003. The ICES Quality Handbook, (Not numbered).

Maravelias, C.D., Reid, D.G., Swartzman, G. 2000. Seabed substrate, water depth and zooplankton as determinants of the prespawning spatial aggregation of North Atlantic herring. Marine Ecology Progress Series, 195: 249-259.

Mesnil, B. 2003. Catch-Survey Analysis (CSA): A very promising method for stock assessment, particularly when age data are missing or uncertain. WD at WGMFSA, ICES CM 2003/D:03

Mohn, R. 1999. The retrospective problem in sequential population analysis: an investigation using cod fishery and simulated data. ICES Journal of Marine Science 56: 473-488.

Mosegaard, H. and Popp-Madsen, K. 1996. Racial discrimination of herring stocks, comparing vertebral counts and otolith microstructure analysis. ICES CM 1996/H:17.

Munk, P., Christensen, V. 1990. Larval growth and drift pattern and the separation of herring spawning groups in the North Sea. J. Fish Biol., 37 (1): 135-148.

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.

Needle, C.L. 2000. The ins and outs of ICA. Marine Laboratory Aberdeen, Report no. 04/00.

Parrish, B.B., Saville, A., Craig, R.E., Baxter, I.G. and Priestley, R. 1959. Observations on herring spawning and larval distribution in the Firth of Clyde in 1958. Journal of the Marine Biological Association of the UK, 38: 445-453.

Patterson, K.R. and D.S. Beveridge 1995: Report of the Herring Larvae Surveys in the North Sea and Adjacent Waters in 1993/1994. ICES CM 1995/H:22.

Patterson, K.R. 1998: A programme for calculating total international catch-at-age and weight-at-age. WD to HAWG 1998.

Patterson, K.R. 1998. Integrated Catch at Age Analysis Version 1.4. Scottish Fisheries Research Report. No. 38.

Pope, J. G., and J. G. Shepherd, 1982. A simple method for the consistent interpretation of catch-at-age data. J. Cons. Int. Explor. Mer, 40: 176-184.

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.

Shepherd, J.G. 1991. Simple Methods for Short Term Forecasting of Catch and Biomass. ICES J. Mar. Sci., 48: 67–78.

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/J:36.

Smith, P.E. and Richardson, S.L. 1977. Standard techniques for pelagic fish egg and larva surveys. FAO Fish. Techn. Pap., 175 pp.

UNCED, 1992. Declaration of the UN conference on Environment and Development. Rio de Janeiro, 1992.

Vasilyev, D., Belikov, S., S. Shamray, E 2000. Tuning of the natural mortality for North East Atlantic Mackerel. Working document for the ICES working group on the assessment of mackerel, horse mackerel, sardine and anchovy 2000.

Vasilyev, D.A 2003. Description of the ISVPA. WD at WGMFSA, ICES CM 2003/D:03.

12 WORKING DOCUMENTS

Armstrong, M., Dickey-Collas, M., Peel, J., McAliskey, M., McCurdy, W., McCorriston, P., Briggs, R., 2003. Survey indices of abundance for herring in the Irish Sea (Area VIIaN): 1992-2002. ICES. WD 1

Dickey-Collas, M., Nash, R.D.M. and Armstrong, M.J., 2003. Re-evaluation of VIIa(N) herring time series of catch and maturity at age, and the impact on the assessment. WD 2

Gröhsler, T., 2003. German Herring Fisheries and stock assessment data in the Western Baltic in 2002. WD 3

Mc Curdy, W., 2003. Preliminary Report on the SCHICS 2002 Irish Sea and Celtic Sea Herring Otolith Exchange. WD 4

Oeberst R. and Klenz, B., 2003. Comparison of different year-class indices of the western Baltic Sea spring spawning herring stock. WD 5

Oeberst R. and Klenz, B., 2003. Estimation of daily growth parameters of larval spring-spawning herring spawned in the Greifswalder Bodden using two independent methods. WD6

PGHERS Summary 2003. WD 7

Roel, B. A., 2003. Exploration of a Sprat data-set using a Schaefer Production Model. WD 9

Simmonds, E.J., Zimmermann, C., Jansen, S., Götze, E., Torstensen, E. 2003 ICES coordinated acoustic survey of ICES Division IIIa, Iva and VIa (north). WD 8

Skagen, D. MFSP – a multifleet deterministic short term prediction program. WD 11

Rohlf, N. and Gröger, J., 2003. Report of the herring larvae surveys in the North Sea in 2002/2003. WD 10

APPENDIX 1

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

11 - 20 March 2003

LIST OF PARTICIPANTS

NAME	ADDRESS	TELEPHONE	FAX	E-MAIL
Else Torstensen (Chair)	Institute of Marine Research Research Station, Flødevigen NO-4817 His Norway	+47 370 59 000 Direct +47 370 59 053	+44 370 59 001	else.torstensen@ imr.no
Max Cardinale	Institute for Marine Research P.O. Box 4 SE-45332 Lysekil Sweden	+46 523 18750	+46 523 13977	massimiliano.cardinale@ fiskeriverket.se
Maurice Clarke	The Marine Institute Parkmore Galway Ireland	+353 1 8228354	+353 1 8205078	maurice.clarke@marine.ie
Lotte Worsøe Clausen	Danish Institute of Fisheries Research Charlottenlund Castle DK-2920 Charlottenlund Denmark	+45 33 96 33 64	+45 33 96 33 33	law@dfu.min.dk
Mark Dickey-Collas	RIVO P.O. Box 68 NL-1970 AB IJmuiden The Netherlands	+31 255 564 685	+31 255 564 644	m.dickey-collas@rivo.wag-ur.nl
Jørgen Dalskov	Danish Institute of Fisheries Research Charlottenlund Castle DK-2920 Charlottenlund Denmark	+45 33 96 33 80	+45 33 96 33 33	jd@dfu.min.dk
Tomas Gröhsler	Institute for Baltic Sea Fisheries An der Jägerbäk 2 DE-18069 Rostock-Marienehe Germany	+49 381 810 267	+49 381 810 445	tomas.groehsler@ior.bfa-fisch.de
Emma Hatfield	FRS Marine Laboratory Aberdeen P.O. Box 101 Victoria Road Aberdeen AB11 9DB United Kingdom	+44 1224 295 434	+44 1224 295511	e.hatfield@ marlab.ac.uk
Ciaran Kelly	MFSD Marine Institute Roshine Road Killybegs Co. Donegal Ireland	+35 373 32 991	+353 73 329 92	Ciaran.Kelly@ marine.ie
Henrik Mosegaard	Danish Institute of Fisheries Research Charlottenlund Castle DK-2920 Charlottenlund Denmark	+45 33 96 34 61	+45 33 96 33 33	hm@dfu.min.dk
Peter Munk	Danish Institute of Fisheries Research Charlottenlund Castle DK-2920 Charlottenlund Denmark	+45 33 96 34 09	+45 33 96 34 34	pm@dfu.min.dk
Richard Nash	Port Erin Marine Laboratory Port Erin Isle of Man IM9 6JA British Isles	+44 1 624 831 009	+44 1 624 831 001	rdmnash@ liv.ac.uk

NAME	ADDRESS	TELEPHONE	FAX	E-MAIL
Ciaran O'Donnell	The Marine Institute Parkmore Galway Ireland	+353 91 730 494	+353 91 730 470	ciaran.odonnell@ marine.ie
Kay Panten	Bundesforschungsanstalt f. Fischerei Institut für Seefischerei Palmaille 9 DE-22767 Hamburg Germany	+49 403 890 5108	+49 403 890 5263	kay.panten@ish.bfa -fisch.de
Martin Pastoors	RIVO P.O. Box 68 NL-1970 AB IJmuiden Netherlands	+31 255 564 690	+31 255 564 644	m.a.pastoors@rivo. wag-ur.nl
Beatriz Roel	CEFAS Laboratory Pakefield Road Lowestoft Suffolk NR33 OHT United Kingdom	+44 1 502 52 4358	+44 1502 524 511	b.a.roel@ cefas.co.uk
Norbert Rohlf	Institut für Meereskunde Kiel Düsternbrooker Weg 20 DE-24105 Kiel Germany	+49 431 600 1821	+49 431 600 1800	nrohlf@ ifm.uni-kiel.de
John Simmonds	FRS Marine Laboratory Aberdeen P.O. Box 101 Victoria Road Aberdeen AB11 9DB United Kingdom	+44 1224 295 366	+44 1224 295511	simmondsej@ marlab.ac.uk
Dankert Skagen	Institute of Marine Research P.O. Box 1870, Nordnes NO-5024 Bergen Norway	+47 55 238 419	+47 55 238 555	dankert@imr.no
Henrik Sparholt	ICES Palaegade 2-4 DK-1261 Copenhagen Denmark	+45 3315 4225		henriks@ices.dk
Reidar Toresen	Institute of Marine Research P.O. Box 1870 Nordnes NO-5817 Bergen Norway	+47 55 238 420	+47 55 238 555	reidar@imr.no
Christopher Zimmermann	Institute for Sea Fisheries Palmaille 9 DE-22767 Hamburg Germany	+49 40 38905 266	+49 40 38905 263	czimmermann@ish. bfa-fisch.de