REPORT OF THE

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

ICES Headquarters
12–21 March 2002

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International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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TECHNICAL MINUTES

ACFM Subgroup Review of Herring Assessment Working Group (HAWG) Report

ACFM Meeting May, 2002

Subgroup Chair: Steve Cadrin
Working Group Chair: Else Torstensen
Reviewers: Bengt Sjòstrand, Denis Rivard
Others: Nils Hammer, Ciaran Kelley, Eskild Kirkegaard, Georges Kornilovs, Martin Pastoors, Henrik Sparholt

General Comments:

- The Subgroup complemented the Working Group on a well-produced report.

- It was noted that some herring jargon (e.g., "ringers") is used extensively. The Subgroup was concerned that year classes can easily be confused and may produce assessment errors. The Subgroup recommends that cohorts are consistently labelled throughout the text, tables and figures. Whatever convention is used by the Working Group, an explanation with a schematic time line of spawning in introduction would help to present the report as a whole.

- Quality control sheets indicate a general tendency to overestimate SSB in the terminal year in all assessments.

- The results from otolith exchanges and problems with species identification suggests that more work on general biology is needed.

- The general practice of using acoustic surveys as relative indices was noted. The Working Group chair explained that target strengths and resulting biomass estimates may not be accurate due to variation in fish behaviour and distribution. Others noted that using acoustic surveys as absolute biomass estimates has been problematic in the past.

- The Subgroup encouraged the Working Group to estimate variance for all assessments to allow risk analysis and evaluation of uncertainty.

- In general, the Subgroup advises the Working Group and ICES to provide stochastic short-term projections in the form of risk analyses so that information from some provisional assessments can be used in advise.

North Sea Autumn Spawning Herring (IV, VIId, IIIa; HAWG sec.2, p27; ACFM sec. 3.5.8)

- Input Data:

  -Substantial catch data revisions were not included in this assessment. The Working Group proposed to ICES that a more comprehensive revision of catch data is needed. The Working Group plans to revise the assessment after all changes are made to the catch data.

  -A reviewer asked what the affect of low sample intensity for some components of the catch is. A Working Group member described sensitivity analyses that suggested catch at age estimates were not substantially changed with different data, but the analyses assumed that the total catch estimate was correct. Changes in overall catch estimates may change the sensitivity to sampling.

  -Catches of Norwegian spring spawners in the North Sea are not considered in the catch statistics. The Subgroup noted that all herring catches in the NS should be reported, (similar to the way Western Baltic spring spawners are considered.

  -The Subgroup questioned why historical catches were not revised with the new stock splitting procedures. A Working Group member replied that reconstruction of historic data requires more detailed catch data than currently available.

- A reviewer noted that mean weights for ages 4-6 in 2001were extremely low, particularly in IVb. The Subgroup noted that this pattern may reflect the decrease in sampling intensity.

- The Subgroup found the use of labels like “the 1998 year class” to be confusing, and noted that the cohort should be labelled “the 1998-99 year class or simply “1 ringers in 2000.”

- Assessment:

  -There was a change in the VPA calibration. The 2001 assessment assumed a 4-year separability period and applied equal weighting. The 2002 assessment assumed a 5-year separability period and applied inverse variance weighting and down-weighting of 0-1 catch.

  -The Working Group reported a sensitivity of the SSB estimate to the weighting scheme. A sensitivity analysis was presented to the Subgroup by H. Sparholt with a recommendation to reconsider the weighting scheme. The analysis indicated that inverse variance weighting was not appropriate because the MLAI index is modelled to agree with SSB from the VPA. A response to the recommendation by J. Simmonds defended the use of inverse variance weighting because it was advocated by SGHAP as an improvement over equal weighting, sampling variance (not structural variance) was used as a weighting criterion, and evaluation of recruitment and F are improved through inverse variance weighting. The Subgroup agreed that the Working Group assessment was acceptable because inverse variance weighting uses more information for the assessment (i.e., information on sampling variance), but noted that revised evaluation of sampling variance (particularly for the MLAI index) may be needed for future assessments. Furthermore, the Subgroup suggested that evaluation of catch bias should also be included in estimates of catch variance.

  -As a background to the issue of down-weighting age 0-1 catches, a Working Group member explained that surveys are currently more reliable for predicting recruitment than catches because of recent management actions. Human consumption fisheries are affected by TACs, but other fisheries are affected by by-catch restrictions.

  -The Subgroup noted the substantial retrospective error and historical error (from quality control sheets) with a tendency to overestimate SSB. Similarly, it was noted that the perception of strength of the 1998/99 year class has decreased by approximately 10%.

- Short-term Projections:

  -A new methodology was used based on ACFM feedback and SGHAP conclusions that the more complex methods used in 2001 were not performing well.

- The Subgroup discussed the relative merits of assuming status quo F or catch in 2002. Assuming a catch constraint implies a 34% decrease in F, which was not considered to be realistic. Therefore, the Subgroup decided to report the projections that assume status quo F in2002.

- PA Reference Points:

  - The Subgroup asked if changes to earlier estimates of SSB will affect our perception of $\mathbf{B}_{\mathrm{lim}}$. Working Group members replied that changes were slight and should have little affect on the estimate of $\mathbf{B}_{\mathrm{lim}}$.

- Downs Component:

- The Subgroup noted that partial F by area would be helpful for management and requested that they be explored by the Working Group. Working Group members responded that planned research on otolith microstructure and genetics may help to estimate partial catches.

- Response to 2001 ACFM comments:

  -The Working Group responded to ACFM feedback by simplifying short-term projection methodology and providing a status quo F projection.

- Species composition in Danish fleet and associated level of sampling were reported. However, the Subgroup concluded that species composition needs to be sampled and reported by fleet.

- Advice:

  -In order to monitor compliance with the management plan, the summary sheet needs to list both fully-recruited and juvenile F. Therefore, the format of Table 3.5.8.7 in the ACFM report needs to be revised.

  -A reviewer noted that although the 1998-99 year class and the 2000-01 year class appear to be very strong in all the surveys, they have are not been well represented in the catches.

  -Consideration of retrospective errors in advice was discussed. The Subgroup decided that more information on the relative performance of adjusted and unadjusted projections is needed before advise can be based on adjustments for retrospective error.

  -To allow complete accounting of catches, the Working Group and Subgroup would like Table 3.5.81 n the ACFM report to be in the same format of Table 2.1.6 in Working Group report.

- The improvement in status of North Sea autumn spawning herring and the advice for substantial reductions in F for Western Baltic spring spawners, a shift is needed in the focus of management in which NSAS are managed in accordance with the objectives for WBSS.

Western Baltic Spring Spawning Herring (IIIa, 22-24; HAWG sec.3, p139; ACFM sec. 3.4.7)

- Input Data:

  -The Working Group concluded that there was a considerable improvement in the assessment data. For such a short assessment series, 1991-2001, each additional year should improve the reliability of the assessment. There was approximately a doubling in the number of age observations. However some patterns in mean weights at age in 2001 may indicate that some sampling errors persist.

  -The Subgroup felt that the revised method for splitting stock components is an improvement.

  -The Working Group concluded that discards were not substantial, because there was a market for all sizes. The Subgroup was concerned that discards may still be a problem.

- The Subgroup recommended that information on data quality (e.g., measurements of precision, sampling adequacy, survey variance) would help to determine the adequacy of input data for stock assessment modelling.

- Assessment:

  -Last year the assessment was not considered to be reliable enough to provide projections. This year the assessment was very consistent with the provisional assessment in 2001. The Subgroup considered the 2002 assessment and associated projections to be a reliable basis for management advice.

  -A reviewer noted that the criteria used to choose among alternative model runs should be described. The Working Group chair responded that the choice was based on residual analyses. The Subgroup noted that the final run also had the greatest precision in the estimate of F.

- The Subgroup noted that the solution was not very precise, but is adequate to conclude that F is too high, because the lower 95% confidence limit of F was greater than $\mathbf{F}_{max}$.

- Short-term Projections:

- The Subgroup requested a projection at $\mathbf{F}_{max}$.

- Medium-term Projections: Medium-term projections were not performed. The Subgroup concluded that the time-series of stock and recruitment does not provide an adequate basis for predicting recruitment in the medium term.

- PA Reference Points:

-PA reference points were not proposed, because this is the first year that the assessment was accepted

-The Working Group concluded that the current level of F is not sustainable in the long-term.

- Subgroup members concluded that current F is greater than any candidate $\mathbf{F}_{pa}$, based on experience with other herring stocks.

- Advice:

-Taking into account the uncertainty in the assessment, there is greater than95% probability that 2001 F was greater than $\mathbf{F}_{max}$.

- The improvement in status of North Sea autumn spawning herring and the advice for substantial reductions in F for Western Baltic spring spawners, a shift is needed in the focus of management in which NSAS are managed in accordance with the objectives for WBSS.

Herring West of Scotland (VIa north; HAWG sec.5.1, p.257; ACFM sec. 3.7.8a)

- Input Data:

-Some sampling problems persist, but the observed maturity of the 1999 cohort is still within the observed range.

- Unlike other years when maturity and size at age were correlated, in 2001 maturity at age increased and weight at age decreased.

- Assessment:

- The Subgroup agreed that instability in terminal recruitment estimates among alternative runs justifies the replacement of 1 and 2 ring abundance in 2002 with the geometric means, but including recruitment in retrospective analysis would also help to justify the replacement.

- Projections: The Working Group chair clarified that mean maturity at age 1999-2001 were assumed.

- PA Reference Points:

-The Subgroup endorsed the proposal for $\mathbf{F}_{pa}$ and the approach used to estimate $\mathbf{F}_{pa}$, noting that it is greater than $\mathbf{F}_{0.1}$, but is within the range of $\mathbf{F}_{pa}$ used for other herring stocks.

- The Subgroup noted that $\mathbf{F}_{pa}$ should be based on long-term projections, but trajectories appear to approach equilibrium at the end of the medium term

- Advice: Stock status and advice were phrased in the context of the proposed PA reference points.

Clyde Herring (VIa; HAWG sec.5.2, p.263; ACFM sec. 3.7.8b)

- The Subgroup concurred with the proposal to not review this stock in Plenum.

North Sea Sprat (IV; HAWG sec.8, p.373; ACFM sec.3.5.9)

- Input Data:

-Unlike the assessment in previous years, the Working Group decided to include the 1989 survey observation (which had a relatively high survey index and low catch) in the regression this year, because there was no a priori or statistical basis for the removal. The Subgroup agreed with the Working Group decision.

- A Subgroup member noted that some western Baltic catches were included in the catch distribution figures.

- Assessment:

- The Working Group based their advice on a Schaefer production model. However, the Subgroup rejected the model results as a basis for management advice, because the solution was highly imprecise and unstable. For example a different version of the CEDA software found a different solution

- Contrary to the proposal to not review this stock in Plenum, the Subgroup felt this stock should be reviewed, because the Subgroup made a different determination than the Subgroup.

VIId,e Sprat (HAWG sec.9, p.400; ACFM sec.3.9.10)

- The Subgroup concurred with the proposal to not review this stock in Plenum.

IIIa Sprat (HAWG sec.10, p.404; ACFM sec.3.4.8)

- The Subgroup concurred with the proposal to not review this stock in Plenum.

Celtic Sea Herring (VIIj; HAWG sec.4, p.205; ACFM sec.3.9.9)

- Input Data:

  -The recent change in perception of the stock was discussed. Prior to 1999, approximately half the catch was 3+ ringers, but the proportion of 3-5ringers was variable in the survey. In 2000 there were very few adults in the catch and in the survey. The assessment was rejected, because the survey had limited geographic range and was considered to have not completely sampled the population of adults. In 2001, more adults were in the catch, but nearly as much as prior to 1999.

  -The Subgroup noted that the July 1999 and January 2001 were excluded from the assessment because they did not agree with the age composition in the past. Given the subsequent changes in perception of age structure, the Subgroup recommends that the Working Group include all surveys in future exploratory analyses.

  -The Subgroup noted that catch sampling improvement in 2002.

  -The issue of stock identification and the movement of some juveniles to the Irish Sea was noted as a source of uncertainty in the assessment.

- The Subgroup recommended that the Working Group monitor effort in the fishery to corroborate trends in F from the assessment.

- Assessment:

  -The assessment used the same configuration as last year. A Working Group member noted an error in 4.5.1 where the “run as 2001 Working Group” assumes geometric mean recruitment but the other runs do not.

  -Used 2000 survey, but not 1999 survey in calibration.

  -The replacement of estimated recruitment with geometric mean recruitment greatly affected the perception of 2002 SSB with respect to $\mathbf{B}_{pa}$.

  -A reviewer noted that large interannual variations in F may not be realistic for a licensed fishery with stable effort.

  -The Subgroup recommended that a weighted F that excludes untuned ages may perform better for monitoring F.

  -The Subgroup requested that an uncertainty analysis (e.g., bootstrapping) be applied to measure precision.

- The Subgroup concluded that the assessment did not provide a reliable basis for management advice

- Advice:

-The suggestion of truncated age structure from the catch and surveys was noted.

-ICES provided advice earlier this month that 2002 F be less than 0.35 for remainder of 2002 season based on the Working Group assessment.

- If catch forecasts were stochastic, such provisional assessments could be considered along with their uncertainty.

Herring West of Ireland (VIa south, VIIb,c; HAWG sec.6, p.311; ACFM sec.3.10.3)

- Input Data:

-The Subgroup noted that sampling has improved.

- No survey data were available, but groundfish data is being considered. Acoustic data have been explored in the past for tuning indices.

- Assessment:

-The solution was considered to be imprecise, based on the relatively flat objective function.

-The substantial retrospective error remains a large source of uncertainty in this assessment.

-The Subgroup concluded that the assessment can only be used for illustrative purposes. The trend in stock size until 1995 appears to be stable, but recent estimates are unreliable.

- Tuning indices and estimates of variance are needed to improve the assessment.

- Advice: The assessment was considered provisional and advice was based on low catches and more older fish in the catch.

Irish Sea Herring (VIIa; HAWG sec.7, p.341; ACFM sec.3.8.7)

- Input Data:

-A reviewer noted that mean weights at age in 2001 were record low for several ages, but sampling was relatively intense.

- Large uncertainty in the magnitude of catch continues to be a major source of uncertainty for this assessment.

- Assessment:

-Assessment results are substantially inconsistent with recent assessments.

-Model estimates have very high variance.

- The Subgroup agrees with Working Group decision that the assessment does not provide a reliable basis for management advice.

- Advice: The Subgroup noted that the 95% confidence interval of 2001 F is 0.19-0.68, which is not informative for management.

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1.1 Participants

Patricia Reglero Barón	Denmark
Max Cardinale	Sweden
Jørgen Dalskov	Denmark
Mark Dickey-Collas	UK
Tomas Gröhsler	Germany
Emma Hatfield	UK
Graham Johnston	Ireland
Ciarán Kelly	Ireland
Henrik Mosegaard	Denmark
Peter Munk (part time)	Denmark
Richard Nash	UK
Martin Pastoors	The Netherlands
Gerjan Piet (part time)	The Netherlands
Beatriz Roel	UK
Norbert Rohlf (part time)	Germany
John Simmonds	UK
Dankert Skagen	Norway
Else Torstensen (Chair)	Norway
Lotte Askgaard Worsøe	Denmark
Christopher Zimmermann	Germany

Contact details for each participant are given in Appendix I.

Invited speaker:
Deirdre Brophy Ireland

1.2 Terms of Reference

The **Herring Assessment Working Group for the Area South of 62°N** [HAWG] (Chair: E. Torstensen, Norway) will meet at ICES Headquarters from 12–21 March 2002 to:

a) assess the status of and provide catch options (by fleet where possible) for 2003 for the North Sea autumn-spawning herring stock in Division IIIa, Subarea IV, and Division VIId (separately, if possible, for Divisions IVc and VIId), for the herring stocks in Division VIa and Subarea VII, and the stock of spring-spawning herring in Division IIIa and Subdivisions 22–24 (Western Baltic); in the case of North Sea autumn-spawning herring the forecasts should be provided by fleet for a range of fishing mortalities that have a high probability of rebuilding or maintaining the stock above 1.3 mill tonnes by spawning time in 2002;

b) assess the status of and provide catch options for 2003 for the sprat stocks in Subarea IV and Divisions IIIa and VIId,e;

c) consider the results of SGEHAP;

d) 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;

e) 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;

f) consider the results presented in the reports of the WGMG and the SGPA with a view to applying these in the assessments;

g) review the draft Quality Handbook.

HAWG will report by 22 March 2002 for the attention of ACFM.

In addition, HAWG was asked to consider a request from the EU Commission, to review the state of the herring stock in VIIghjk (Celtic stock) and appropriate catch:

- To evaluate any new relevant information concerning the state of the stock;

- To review the catch advice provided for the year 2002.

The group has evaluated relevant information and then reviewed the state of the stock and catch advice, as seen in Sections 4.5 and 4.6.

1.3 Study Group on the Evaluation of Herring Assessment Procedures report

The SGEHAP report provides an extensive review of North Sea herring assessment input data, assessment, and prediction methods (ICES 2001/ACFM:22).

1.3.1 ICA Assessment Review

The impact of sampling uncertainty in catch and survey indices were investigated extensively. Assessments were carried out using bootstrap realisations of all the variable assessment data (i.e., catch numbers, catch weights, stock weights, proportion mature, and survey indices). The following weighting methods were examined: (a) the previous WG weighting, (b) inverse variance weighting, and (c) adaptive weighting. This investigation provides an objective basis for selecting a weighting method for the different indices in the assessment of North Sea herring. The inverse variance weighting method within ICA reduces the CV on the assessment and on all the main management parameters to the greatest extent (Figure 1.3.1). The use of adaptive weighting, based on the residuals within the assessment model, gives poorer results than using the inverse variance weighting method, in which residuals are derived from the input data.

Some inconsistencies between catch data and survey data are apparent from the retrospective performance of the different assessments. The estimated SSB and $F_{2\text{-}6}$ from three assessments (2001, 1999, 1996) are shown in Figures 1.3.2 and 1.3.3 respectively. The 1996 assessment of SSB agrees quite well with the converged VPA and the two 2001 assessments using the different weighting methods ((a) and (b) described above). There are more differences with intermediate assessments. The 1999 assessment is shown in Figures 1.3.2 and 1.3.3 to provide an example of these differences. The intermediate assessment results are very sensitive to the choice of both number and length of independent separable periods, and the way these are used in the assessment model. In particular the way in which the catches on either side of 1996 (a year in which a management change occurred) are fitted in the separable model. The intermediate assessments were carried out using the choice of separable periods as used in the HAWG. However, it was not possible to simulate exactly the WG model as this used a specific version of ICA to allow a single separable period for 4-9+ ringers and two different separable periods for 0-3 ringers. These issues do not affect either the 2001 or the 1996 assessments. The WG has previously used arbitrarily selected weights for indices. The evaluation presented here gives an objective method for deciding between a range of possible alternatives.

1.3.2 Use of AMCI for assessment of North Sea herring

One possible way to improve assessment and prediction for North Sea herring discussed by the SGEHAP was to extend the AMCI software to incorporate multiple areas, and use that both as a tool for historic assessment and to provide fleet-wise stochastic predictions in the short term. Earlier versions of this program have been used as a support for the assessment of several stocks, notably mackerel (ICES CM 2001/ACFM: 06), and (as version 1.4) for the final assessment of blue whiting in 2001 (ICES CM 2001/ACFM: 17). The software has recently been extended to allow for multiple areas. Some trial runs with this data set were presented. A brief description of the program is given in the SGEHAP report.

A limited number of trial runs were made using two areas and the standard fleets A, B, C and D. The parameters indicating the fraction of the stock-at-age in each area were either estimated by the model, or fixed at the adopted values of the split-factor as used by the HAWG.

Attempting to estimate the split-factors within the model gave clear signals of over-parameterisation, as indicated by a singular Hessian matrix and extremely slow convergence of the optimisation of the objective function. Using input split-factors ameliorated some of these problems, but some fishing mortalities with very large variances were produced, and there were strong correlations between parameters, in particular between the various fleets with respect to fishing mortalities.

The impression from these studies was that doing the assessment by areas to get a basis for area-based predictions cannot be expected to improve the predictions, because the estimates of the split and of the local catches are too imprecise to provide more information than noise.

1.3.3 Review of the use of the Split factor in short-term predictions

During the 1990's the HAWG introduced a method for predicting catch (partial F's) that included the variability in proportions of 0 and 1 ringers in the North Sea and IIIa. The proportion of North Sea 0 and 1 ringers that occur in Division IIIa varies between years depending on the size of the year class. Annual split factors have been used for short-term predictions for the North Sea autumn-spawning stock to distinguish the proportions of the North Sea Autumn spawners present in the North Sea and in Division IIIa. Some of the split factors have been directly estimated from surveys, other values have been estimated from a general linear model (GLM), which relates the proportion of 1-ringers in Division IIIa to the MIK index of 0-ringers. The SGEHAP was asked to review the use of these split factors in these predictions.

Introducing local partial F's produces a conflict between the introduction of noise by estimating those local F's and the advantages of taking into account the local supply of fish for the fishery. These local partial F's are obtained from the combination of local population data and data on local catches, by applying a split-factor in each year. The investigation attempted to evaluate whether or not the increase in complexity of a split-factor delivered improved estimates of catch per fleet and population numbers-at-age. The investigation suggested that most of the errors in predicting catch were common to both methods (with and without the split-factor, Figure 1.3.4). For some years and some fleets there were indications of improved prediction with the inclusion of a split, however, in the majority of cases there was no improvement or a small degradation in prediction when including the split. There did not seem to be any obvious pattern in the instances where the predictions were improved so the conclusion was that increased complexity did not deliver any overall gain in the quality of the prediction. Given the current levels of uncertainty of both catch and population distribution it is recommended that the simpler method for short-term prediction (i.e., without a split) should be used. However, it is important that the issue of the inclusion or exclusion of a split-factor is kept under consideration. If there are changes in distribution of herring, or the data on catch or population distribution change, this issue should be reviewed again.

N.B. It should be remembered that the analysis here only investigated the facility for the use of year-class dependent distributions of North Sea herring in fleet-based predictions. This should not be confused with the need to separate North Sea and Western Baltic Spring-spawning herring in the fishery and in the surveys for the stock assessment of these stocks.

1.3.4 Fleet Review

A review of the procedures used for generating fleet-based selection patterns suggested these are performing satisfactorily. The fleets are administratively and physically distinct and operate separately. All fleets operate in separate areas with the possible exception of fleet C, which may have area misreporting between IV and area IIIa but probably exploits the same part of the North Sea stock in either area. The fishery by fleet C and D are also important for the assessment of Western Baltic Spring-spawning herring. However, this year there are indications that sampling in the B fleet fishery has not been adequate to provide sufficient data on the age structure in the catch for this fleet (section 2.2.4).

1.3.5 Harvest control of reference points

Following the work presented above the basis for the biological reference points implemented in the management plan for North Sea autumn-spawning herring were discussed. The work carried out under this study group has not changed the current perception of the biological reference points and the appropriate management plan for North Sea herring.

1.4 Working Group on Methods in Fish Stock Assessments (WGMG)

The WG was requested to consider the report of the WGMG, which met in December 2001. The main issue at that meeting was retrospective bias in the assessments. It was recognised that this to a large extent is a problem with data and their interpretation. Generic properties of the models may also cause bias, but hardly to the extent often experienced in practise.

Candidate causes for retrospective bias that were identified by the WGMG included creeping of effective effort in the fishery as well as in surveys and trends in misreporting, discards and in natural mortality. Diagnostics that were suggested included careful scrutinising of residuals and experimenting with changing data that are suspected of creating problems to see whether the changes needed to remove retrospective bias can be realistic. It was also recommended to concentrate on a limited number of reliable surveys rather than using all possible tuning series.

The HAWG considered these points. CPUE data are not used in any assessment by this WG. Trends in the efficiency in surveys were discussed, but the general perception was that such trends were unlikely, except when going back to years that are not included in the assessments. Misreporting by stock does occur, but is largely accounted for in the catch numbers. Other misreporting and discards remains a matter of concern, although it is not perceived to be a major problem with respect to the assessments.

Retrospective runs are made routinely for most stocks. For North Sea herring, where retrospective bias has been a problem, an extensive study of retrospective error with various model formulation and data sources was made. The results of these studies, and the fact that the juvenile fishery is regulated independently of the adult fishery, led to down-weighting of the catches of juveniles in the objective function. The assessment this year gives somewhat higher values for the stock abundance in recent years than last years assessment.

1.5 Study Group on the Further Development of the Precautionary Approach to Fisheries Management

This study group, which met the week before the HAWG, has outlined a time schedule for a revision of the precautionary reference points, and discussed possible extensions of the precautionary approach as applied by ICES.

The WG took note of this development, but concluded that no specific action would be required by the WG this year.

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

PGHERS met at the Institute for Sea Fisheries, in Hamburg, Germany, from 10-14 December 2001, to:

a) co-ordinate the timing, area allocation and methodologies for acoustic and larval surveys for herring in the North Sea, Divisions VIa and IIIa and the Western Baltic in 2002;

b) combine the survey data from 2001 to provide estimates of abundance for the population within the area;

c) examine consistency in the measurement of biological parameters, specifically:

   I. verification of maturity stage measurements of herring and sprat;
   II. age reading of herring and sprat;

d) investigate the effect of time of day on the detection of herring during the acoustic survey.

1.6.1 Review of larvae surveys

At the time of the PG-meeting, three of the six surveys in the North Sea were still to be carried out in December 2001 and January 2002. Final results were presented to the HAWG, see Sec. 2.5.

Estimates from Western Baltic larvae survey in the Greifswalder Bodden area were given for the years 1992-2000.

Outcome of double area coverage on larvae abundance estimation: In the 2000 period, certain areas of the North Sea were sampled twice. The assumption that double sampling would result in a more stable estimate of LAI was not valid in this particular case due to the absence of newly hatched larvae in the second survey. As a general conclusion survey effort should be spent to cover the whole spawning period and to sample the major peaks of spawning instead of double sampling within the same period.

1.6.2 Review of the acoustic surveys in 2001

North Sea, west of Scotland and Western Baltic, June/July

Herring

Six acoustic surveys were carried out during late June and July 2001 covering the North Sea and west of Scotland. A small part of the area was not surveyed in 2001. Abundance in this area was estimated from a linear interpolated value from adjacent rectangles. The total combined estimate of North Sea spawning stock biomass (SSB) were 2.4 million t, an increase from 1.7 million t in 2000. The survey had exceptional numbers of 2-ring herring (the 1998 yearclass). The estimate of Western Baltic Spring-spawning herring SSB was 99,000 t, a decrease since 2000 (196,000 t). The west of Scotland SSB estimate was 327,500 t (down from 443,850 t). The surveys are reported individually in Appendix II of the PGHERS report.

Sprat

Data on sprat were only available from RV *Solea*, RV *Tridens* and RV *Dana*. The total sprat biomass estimated was 200,000 t in the North Sea and 8,000 t in the Kattegat. The entire stock was not covered by the survey as abundances of fish were still high at the southern boundary. The group recommends that the coverage in the south at least be maintained, as it expects this to be a precondition for a sprat index in the future. It was concluded that if the southern coverage was not maintained, it would not be possible to develop an acoustic abundance index. Hence, the southern coverage should be maintained.

Western Baltic acoustic survey, September-October

A joint German-Danish acoustic survey was carried out with RV *Solea* from 28 September to 15 October in the Western Baltic. The total number of herring was 9,800 million and the total for sprat 8,700 million. A full survey report is given in Appendix III of the PGHERS report.

1.6.3 Co-ordination of Surveys in 2002/2003

Larvae Surveys for 2002/2003

In the 2002 period, the Netherlands and Germany will undertake 7 larvae surveys in the North Sea from 1 September 2002 to 31 January 2003. The herring larvae survey in the Greifswalder Bodden (Baltic Sea) will be conducted from 23 April to 28 June using the RV *Clupea*.

Co-ordination of acoustic surveys in 2002

Six acoustic surveys will be carried out in the North Sea and west of Scotland in 2002 between 21 June and 26 July. RV *Scotia* and RV *G.O. Sars* will survey an overlapping area to the east of Shetland. RV *Walther Herwig III* and RV *Tridens* will have an intercalibration exercise. A survey of the western Baltic and southern part of Kattegat will be carried out by RV *Solea* from 26 September to 17 October.

1.6.4 Quality Control

Intercalibration between RV *Solea* and RV *Walter Herwig III*

These fisheries research vessels conducted an intercalibration of acoustic equipment on 11 July 2001. The targets were very small, and these were dense shoals of sprat. Acoustic values for the two vessels were not significantly different, suggesting that the systems on board these ships are not operating in an inconsistent manner.

Survey overlap between RV *Scotia* and RV *Michael Sars*

A provisional analysis of acoustic data from an extended area of overlap of survey by these vessels indicated that the Scotland/Norway ratio of acoustic values allocated to herring in these areas was about 2.0 in the northern area and 1.5 in the southern area. This is most likely due to differences in allocation of traces, as the two sets of results are based on data from different fishing patterns. Additional survey overlaps will take place in the Shetland area in 2002 to conduct an intercalibration of pelagic and bottom trawls.

Future planning of acoustic surveys in the North Sea

In recent years participating nations in the North Sea acoustic survey have been restricted to national waters or areas close by. As a result, some areas have a much higher biomass to sampling ratio than others. The survey should be redesigned to make the best use of the vessel resources available and the first implementation should be in the summer of 2003. In addition, it was noted that areas not surveyed in recent years may actually need to be covered in 2002 due to the substantial expansion of the stock.

1.6.5 Biological parameters

Maturity determination

There are at least two different maturity scales used by participants in the North Sea acoustic survey: an 8 and a 4-point scale. Small mistakes in maturity determination highlighted the need for consistent measurements between participants. In the 2001 surveys digital photographs of herring were collected to show the various maturity stages, but images were only comparable under ideal conditions. The best approach to harmonising maturity determination would be by means of a workshop.

Herring otolith exchange

A herring otolith exchange was carried out with at least 150 otoliths circulated among 8 readers from 6 nations. The measured ages were analysed using modal length as the reference age with no prior allocation of reader performance and equal weight for all readers. The accuracy revealed relatively good results: while there were statistically significant differences between readers there was only one reader with statistically significant differences between the modal age and estimated age. Intra-national variation was very much less than the inter-national variation, suggesting that there is scope for improvement by increasing the contact between staff who age herring.

In a separate exercise, 717 herring otoliths were circulated among 7 readers from 4 nations with the objective of verifying the species. Uniform agreement on the species origin of the otolith occurred for only 67% of otoliths.

Sprat otolith exchange

A sprat otolith exchange is in progress and some preliminary results of readings were presented. There are indications of disagreements in the ageing of larger and older sprat and it is recommended that age readings of sprat otoliths be part of a combined herring/sprat age-reading workshop in 2002.

The effect of time of day on the acoustic detection of herring

In the North Sea during summer, herring generally occur as schools by day near the seabed and at night disperse, rising into surface waters. Image analysis of six years of acoustic data from the Orkney-Shetland survey was used to extract the number of schools and descriptors such as length and height. A model describing how these parameters vary with time of day was devised. The times of school dispersal (upward migration) and school aggregation (downward migration) derived from the model were within 7 minutes of sunset and sunrise times (respectively) calculated from astronomical algorithms. The survey data were truncated to contain only values collected when the herring were identifyable to the survey and the abundance recalculated. The results indicate that the behaviour does not have a consistent effect on the estimation of abundance from the survey. Examination of the acoustic data attributed to herring reveals that herring can be detected in those hours adjacent to the start and end of the daily vertical migration (DVM), although at these times values are lower than average. More such analyses are required and PGHERS will carry this item onto next years meeting by which time other participants will prepare similar analyses on their acoustic data.

Measurement of the band filter delay of the EK500

During the 2001 survey of RV *Walther Herwig III* the filter delay of the Simrad EK500 echosounder was measured. The study demonstrates that the necessary delays have not been introduced to the EK500 despite previous identification and assurance that they would be dealt with by the manufacturers. This issue remains one of concern and merits further thought and investigation by PGHERS over the course of the coming year.

1.6.6 Other issues

CLUPEA.NET: The clupea website (http://www.clupea.net) has been updated with stock specific data for north east Atlantic stocks following the ACFM spring session. A new brief Biology section was also added. A number of additions are planned.

Acoustic survey manual revision: The current acoustic survey annual is attached as Appendix IV of the PGHERS report.

HERSUR database: An update on the status of the HERSUR project was presented to the group. During 2001 the conversion of data from national acoustic survey formats to HERSUR formats was carried out and data have now been uploaded to the HERSUR database. It is now possible to send data by e-mail. The HERSUR website has been restructured and the exchange format has been revised. A number of report types are now available (sample reports are given in Appendix V of the PGHERS report).

1.7 HAWG Recommendations

1.7.1 Data provision, manipulation, transparency, and storage

The HAWG recommends:

a) that **ICES develops an input database application** as an urgently required service to all working groups. The quality of the input data from commercial sampling is considered to be crucial for the quality of the whole assessment procedure. The 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. Detailed information on the functionality of such an application is available in various documents produced over the last years and made available to ICES.

b) to **search for national catch and sampling data** from previous years either within ICES or at the national institutes (see Section 1.9: official catches and WG estimates by rectangle, sampling level and sampling details – catch in numbers-at-age, mean weights-at-age – by area as defined in Figure 1.10.1). Files should be send to Chris Zimmermann, Hamburg, intersessionally, or provided to next year's WG. This is especially needed for Denmark, Norway and the Netherlands.

c) that national labs 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.

d) that a directory 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.

e) that the Report-CD sent out to HAWG members also contains a copy of the "Working documents" and "Presentations" folder from the network drive.

1.7.2 The Planning Group of Herring Surveys

Planning Group of Herring Surveys [PGHERS] should meet, at a venue to be decided, from 21 to 24 January 2003 chaired by P.G. Fernandes (UK, Scotland) to:

a) combine the 2002 survey data to provide estimates 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) co-ordinate the timing, area allocation and methodologies for acoustic and larvae surveys for herring and sprat in the North Sea, Division 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 time of day on the allocation of herring to acoustic data.

1.7.3 Other recommendations on surveys

a) Strong efforts should be made to exchange staff between nations in the North Sea acoustic survey.

b) An area overlap between RV *Scotia* and RV *G.O. Sars* should be surveyed in 2002 to include ICES rectangles 49E9, 49F0, 50E9 and 50F0 with a spacing between tracks to be of no more than 7.5 n.mi.

c) The determination of maturity in herring and sprat should be standardised (perhaps through a workshop).

d) Due consideration should be given to establishing a sprat, herring 0-ring and herring 1-ring index from the acoustic survey.

e) A review should be made of existing documentation on practical aspects of larvae survey methods.

f) A workshop to determine the age of herring and sprat from otoliths should be held in summer 2002. HAWG considers it of value to invite other interested parties (e.g. Republic of Ireland and Northern Ireland).

1.7.4 Degradation of spawning grounds

The Working Group recommends that gravel extraction or dumping of dredge spoils or silt or the location of fish farms should not be permitted in areas that are known to contain herring spawning grounds.

1.7.5 Sprat

a) That IBTS time-series data on sprat (catch rates, weight-at-length and –at-age, maturity-at-length and –at-age), and from the catch (where collected), for the first and third quarter be made available before the meeting of the next HAWG.

b) That an intersessional study be carried out to evaluate the apparent different recruitment patterns shown between the first and third quarter in North Sea sprat.

c) That a review of the criteria used for ageing sprat be undertaken.

d) That consideration be given to alternative assessment models for sprat, including those that account for recruitment variability, once a realistic recruitment index becomes available.

1.7.6 Study groups

A Study Group on the Revision of Data for North Sea Herring [SGREDNOSE] will be established under the chair of Chris Zimmerman to meet at a venue to be decided, in late 2002, to re-evaluate the current data used for the stock assessment of North Sea Autumn-spawning herring.

The group will:

a) collate the revised Norwegian catch data for 1997- to date;

b) use the revised data on the splitting of North Sea Autumn Spawners caught in Division. IIIa (1991-1998);

c) collate the revised biological sampling data for The Netherlands (based on a retrospective analysis of the national raising procedure and changes resulting from this analysis);

d) thoroughly examine the catch table information and correct it where necessary;

e) transfer historic catch and sampling information into the new database (minimum 1997-to date);

f) re-run the allocation and raising procedures for this time frame;

g) update all relevant input data for the assessment of North Sea Autumn-spawners and make them available to the Herring Assessment WG.

Priority:	The work of the study group is essential to improving the precision and transparency of the assessment of North Sea Autumn-spawning Herring
Scientific justification:	An number of significant revisions have been made during the last two years to sub-sets of data used for the assessment of North Sea Autumn-spawning herring. Due to time constraints, the assessment WG using the data felt unable to revise all data, starting with reallocations of commercial catch information, within a WG meeting. Additionally, the group is expected to implement a long-term data storage and handling system still to be developed for the basic input data and explore different approaches to the reallocation of sampling information.
Relation to Strategic Plan:	This specifically addresses the remit of Goal 1- increase knowledge of the life history, stock structure, dynamics, and trophic relationships of living marine resources, Goal 4- improve the assessment of fish stocks.
Resource requirements:	A new database must be operational.
Participants:	Include scientists working on herring biology and assessment in the North Sea.
Secretariat Facilities:	None.
Financial:	No financial implications.
Linkages to advisory committees:	An obvious and close link to ACFM activities.
Linkages to other committees or groups:	The correction of the catch time-series of North Sea herring has clear links with many other groups that use the output of fish assessments in their remit.
Linkages to other organisations:	The work of the group is closely aligned to other organisations with an interest in stock assessments and the dynamics of living marine resources.

A Study Group on Herring in the Irish and Celtic Seas [SGHICS], will be established under the chair of Richard Nash to meet in Dublin, December 2002 to:

a) 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.

b) evaluate the long-term variation in biological parameters (weights-at-age, length-at-age, maturity and condition) of Irish Sea and Celtic Sea herring.

c) carry out an otolith exchange of Irish and Celtic Sea herring, the results of which will be assessed by the study group.

Priority:	The work of the study group is essential to improving the precision of the assessment of herring in divisions VIIa and Celtic Sea VIIg and j as requested by ACFM.
Scientific justification:	In 2001, ACFM technical minutes questioned the failure to apply the re-calculated weights-at-age and maturities at age to the stock assessment of VIIa(N) herring. This could not be done, as the sampling was not apportioned to appropriate catches. The proposed study group would use data sets held at relevant institutes to recompile the catch data for herring in the Irish and Celtic Seas. There is no transparency or record as to how the catch-at-age numbers and weights-at-age for the stock (or combination of Manx and Mourne stocks prior to 1982) were determined. This is needed to provide a full and accountable record of the assessment of the development and dynamics of herring to the east and south of Ireland. There has not been an otolith exchange since 1995 for either Irish or Celtic Sea herring, otolith exchanges are required frequently to ensure consistency in ageing between institutes and between stocks stock that share geographic distributions at certain life stages.
Relation to Strategic Plan:	This specifically addresses the remit of Goal 1- increase knowledge of the life history, stock structure, dynamics, and trophic relationships of living marine resources, Goal 4- improve the assessment of fish stocks.
Resource requirements	The research programmes which provide the main input to this group are already underway, and resources committed. The additional resource required to undertake additional activity in the framework of this group is negligible.
Participants:	Include scientists working on herring biology and assessment in the Irish and Celtic Seas.
Secretariat Facilities:	None.
Financial:	No financial implications.
Linkages to advisory committees:	An obvious and close link to ACFM activities.
Linkages to other committees or groups:	The construction of a clear and comprehensive data set of catch by age and biological characteristics for herring around Ireland is of use to the proposed SGGROMAT.
Linkages to other organisations:	The work of the group is closely aligned to other organisations with an interest in stock assessments and the dynamics of living marine resources.

1.8 Summary of the report of the Planning Group on Commercial catch, Discards and Biological Sampling (PGCCDBS)

The Planning Group on Commercial Catch, Discards and Biological Sampling PGCCDBS met in Lisbon at IPIMAR from 5-8 February 2002 to:

a) evaluate the commercial catch (landings), discard and biological sampling programmes being implemented in the Baltic Sea, North Sea, Western and Southern waters, and assess whether or how these require ICES coordination;

b) evaluate the need for developing sampling methodology, calculation methodology, data storage procedures, and software for aggregating national catch-at-age data to international catch-at-age data in a form suitable for assessment working groups, and prepare relevant proposals and work plans.

The ICES fisheries advice critically depends on the quality of data from the commercial fisheries. The quality of these data has not in all cases been satisfactory and ICES has raised this point repeatedly. For the last 6-8 years, the EU Commission has financially supported several projects, whose objectives have been to support the Common Fisheries Policy CFP.

Most of these projects have been carried out in co-operation between different national fisheries research institutes and through this co-operation international coordination of the work including data collection has been achieved. The current initiative by the EU Commission (DG FISH) in providing financial support for the collection of fisheries data is much welcomed. But, as the financial support is given to national data collection programmes the existing element of international coordination may be missed and may cause inappropriate or missing data collection of certain species. In order to provide focal points for coordinating sampling activities and strategies among ICES member countries this Planning Group was established.

The PG divided the work in three sub-topics:

- Landings (tonnes).
- Discards and biological sampling, including sampling and calculation methodology.
- Data storage procedures and software for data aggregation.

Concerning landings, the general view was that the assessments carried out by ICES are using the best landings data available to ICES. These data are not necessarily identical with the official statistics and where appropriate, include estimates of unreported landings as well as corrections for misallocation of landings by area and species. Despite considerable effort exerted on this problem, there is no guarantee that all instances of misreporting are identified.

The opinion of the PG was that most problems cannot be resolved in the short term but two issues should addressed almost immediately:

- The chairs of the relevant ICES Working Groups will be approached and asked to review Commission Regulation (EC) No 1639/2001 to ascertain whether the levels of stratification outlined in Appendices I and XII to the Commission Regulation are sufficient for their purposes.
- Introduce the use of standard templates to enable each ICES Assessment Working Group to provide an evaluation of the quality of the data for each species/stock. The completed templates should be returned to PGCCDBS. This will highlight any particular weaknesses and provide a basis for action at the next meeting of the PGCCDBS.

For discards and biological sampling, including sampling and calculation methodology, the PG considered the need for co-ordination for following topics:

- Length & Age Sampling of Commercial Landings
- Sampling of other biological data (SWALMF, ie. Sex, Weight, Age, Length, Maturity and Fecundity)
- Length & Age Sampling of Discarded Catch

Some areas where international co-ordination is needed were highlighted:

- Co-ordinate sampling to ensure adequate spatial and temporal sampling coverage
- Review methodologies for collection of data
- Agree on otolith exchange programmes
- Agree on mechanisms for evaluation of input data

Suggestions for TOR for future PGCCDBS meetings to include:

- evaluating sampling in the previous year in terms of:
  - Spatial & Temporal Coverage
  - Precision levels (including age reading)
- establishing quality assurance protocols for assessment data.

PGCCDBS meetings will also provide an opportunity to organise exchange of otolith reading between countries.

PG recognized that members of the assessment working groups are probably best placed to identify the problems in data quality affecting their assessments. PGCCDBS agreed it would not be realistic to ask assessment working groups to take on the additional task of international co-ordination and planning of sampling.

The PG considered the option of undertaking the task of international co-ordination within the PGCCDBS. It was agreed that such an arrangement would retain the flexibility to convene sub-groups of PGCCDBS to work on matters of international co-ordination both inter-sessionally and at the PGCCDBS.

Some of the recommendations from PGCCDBS are listed below:

- ICES Assessment Working Groups participate in the attempts to secure adequate data for stock assessment purposes by highlighting any particular weaknesses in the quality of the data and providing a basis for action at the next meeting of this Planning Group.
- Identify on a regional basis, the stocks and species requiring improved ageing.
- To examine the possibility of sharing / transferring otoliths between laboratories.
- In general, the country into which fish are landed should process data sampled from the foreign fleet to produce assessment inputs which can be scaled to any level of landings. These data, and length distributions and age estimates, should then be provided to the flag country or country of fleet origin.
- In cases where this is not practical, the country into which fish are landed should process data sampled from the foreign fleet to produce length distributions and ensure that ageing occurs. These data should then be provided to the flag country or country of fleet origin.
- That regional planning occurs in the collection of biological data to ensure that minimum requirements for data collection are met.
- The available data should be reviewed on a regional basis to ensure that sampling coverage reflects the relative impact of each fishery in each area.
- DIFRES be requested to develop a test version of VPAbase (see section 1.9.1), using a range of WG data.
- ICES should establish and maintain standard codes (definitions) for data to minimize problems associated with data exchange.
- Data exchange formats should be based on text files (delimited or XML), and variables should be clearly described and in agreement with the standard codes.

The draft report of the PGCCBDS was made available to the working group (ICES 2001/ACFM:26).

1.9 Summary of the Report of the Study Group on the Incorporation of Process Information into Stock-Recruitment Models (SGPRISM)

ICES Study Group on the Incorporation of Process Information into Stock-Recruitment Models [SGPRISM] held its final meeting in January 2002. The three meetings of the study group considered environmental forcing of recruitment processes and its predictability, spatial models and projections and biological processes, and management. It commented that the general problem at present is the very few process studies that have been directly undertaken with the intention of input to the assessment and management process. In general process studies are aimed at understanding what has happened in the past, and hence the models they use are detailed and descriptive, and are often based on multiple-regression-type approaches. These models are not usually suitable for use in projections, partly because of the need to forecast a large number of variables which have poor predictability, and partly because they generate undesirable dynamics at low stock and recruitment levels. The Study Group examined the use of process information in the north-east Arctic, Baltic Sea, North Sea and Bay of Biscay. Part of its remit was to consider the further development of projection tools. Methods that use time-series characteristics of recruitment, weights-at-age and proportion mature-at-age are being investigated as potential tools. The group recommended the formation of a Study Group on Growth, Maturity and Condition in Stock Projections [SGGROMAT], to report to the Methods Working Group and further develop these projection tools.

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

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 2001 catch data was v1.4.1. The majority of commercial catch data of multinational fleets was again provided on these spreadsheets and further processed with the SALLOCL-application (Patterson *et al*., 1997). This program gives the needed standard outputs on sampling status and biological parameters. It also clearly documents any decisions made by the species co-ordinators for filling in missing data and raising the catch information of one nation/quarter/area with information from another data set. This allows recalculation of data in the future, choosing the same (subjective) decisions made today. Ideally, all data for the various areas should be provided on the standard spreadsheet and processed similarly, resulting in a single output file for all stocks covered by this working group.

The 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 co-ordinators. On the co-ordinators 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 met by most nations. However, in contrast to last year's procedure and recommendation, 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 during a separate meeting prior to the WG meeting. The WG again had to wait for the results of the splitting procedure before initial assessments could be conducted. It is therefore necessary that the splitting data is made available on the first day of the WG.

Quality of sampling for the whole area. The working group this year produced a map indicating the level of catch sampling by area for all stocks covered by HAWG (Figure 1.10.1). 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, 3.4 for Western Baltic Spring Spawners, 4.2.4 for Celtic Sea and VIIj herring, 5.1.3 and 5.1.4 for VIa(N) herring, 6.1.5 for VIa(S) and VIIb,c herring, 7.1.2 for Irish Sea herring).

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 co-ordinators 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 years 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 co-ordinator is responsible for compiling the national data to produce the input data for the assessments. In addition to checking 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 co-ordinators. 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 as possible details of their sampling and filling-in procedures in the respective field of the exchange spreadsheet (sheet 2) **instead of filling in unsampled metiers themselves**.

Future developments

Still 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.

For the third time, the Working Group repeats its opinion that an input file based on a stand-alone **database application** would be most preferable, because it is less error-prone than a spreadsheet, and results can easily be interpreted. As the quality of the input data from commercial sampling proved to be crucial for the quality of the whole assessment procedure, the WG again strongly recommends to develop an input application for the 2003 Working Group meeting by ICES, which has the advantage of a general usage by all working groups. 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. 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).

VPA Base. In response to the suggestions of different WGs on this issue, a MS Visual Basic application VPABASE was developed by DIFRES and presented to WGMHSA, at the ICES Annual Science Conference, and now to HAWG. VPABASE is a prototype for storage and processing of Working Group input data for fish stock assessment. Input data are total catches by fleet and country combined with age distribution samples. The processing of data applies the available age distribution samples to convert the national catches into age compositions. The national data are summed to give total stock age composition, which is the input to the VPA. The database will maintain records on the processing of data. The database uses MS Access 2000/Excel and has a user-friendly interface. The database was developed as a part of the EU-funded project EMAS (CFP Study Project 98/075). Further description is available in ICES CM 2001/P:23. The prototype was made available to the WG and effort will be put into further development, and hopefully the software will be tested by WGMHSA.

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.

The Working Group recommends 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.

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 co-ordinators, 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 1.10.1 gives an overview over 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 1.10.2 shows the separation of areas as used for the long-term storage of data.

Most of the issues raised her have also been addressed by the Planning Group on Commercial Catch, Discard and Biological Sampling (see Section 1.8.).

1.11 Comments on the ICES quality control handbook

The WG was again asked to comment on the ICES quality control handbook (see Terms of reference: g). In the light of the little development the QC handbook has undergone in the last year, and that ACFM has been unable to review the comments of the different working groups, HAWG decided not to comment on this issue again. However, the group is prepared to revisit the topic whenever significant progress is visible.

1.12 Fleet Descriptions

No new data on the fleets operation for herring and sprat fishing were available to the WG. It was agreed that new data should be made available at the 2003 HAWG. The data to be provided next year is:

Per area for herring and sprat respectively:

Mesh size group	8-31 mm	32-40
Trawlers	No vessels/tonnes	
Purse seiners		
Gill-netters		
Others vessels		

The data on fleets shall be forwarded to the species co-ordinators prior to the HAWG-meeting in 2003.

1.13 Reference Points

Reference points for herring and sprat stocks south of 62°N were taken from the ACFM Report, May 2000, and updated by the WG2002. These are summarised in the text table below:

STOCK	LIMIT	PRECAUTIONARY
North Sea Herring	$\mathbf{B}_{lim}$ is 800 000 t. Technical basis: Below this value poor recruitment has been experienced. $\mathbf{F}_{lim}$ is not defined.	$\mathbf{B}_{pa}$ = 1.3 mill t. Technical basis: Part of a harvest control rule based on simulations. $\mathbf{F}_{pa}$ 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.
Sub-div 22-24 & Div IIIa	Not specified	
Celtic Sea	$\mathbf{B}_{lim}$ is 26 000 t. Technical basis: The lowest stock observed. $\mathbf{F}_{lim}$ is not defined	$\mathbf{B}_{pa}$ be set at 44 000 t. Technical basis: Reduced probability of low recruitment.
West of Scotland	Not specified	$\mathbf{B}_{pa}$ suggested at 75 500 t Technical basis: 1.5*$\mathbf{B}_{lim}$ $\mathbf{F}_{pa}$ = suggested at 0.28 Technical basis: 10% risk of $\mathbf{B}_{pa}$ $\mathbf{B}_{lim}$ suggested at 50 000 t Technical basis: $\mathbf{B}_{loss}$ $\mathbf{F}_{lim}$ suggested at 0.42 Technical basis: 1.5*$\mathbf{F}_{pa}$
Div. VIaS & VIIb,c	$\mathbf{B}_{lim}$ is 81 000 t. Technical basis: Lowest reliable estimated SSB. $\mathbf{F}_{lim}$ is 0.33	$\mathbf{B}_{pa}$ be set at 110 000 t. Technical basis: Approximately 1.4 $\mathbf{B}_{lim.}$ $\mathbf{F}_{pa}$ be set at 0.22
Irish Sea	$\mathbf{B}_{lim}$ is 6 000 t. Technical basis: Lowest observed SSB. $\mathbf{F}_{lim}$ is not defined	$\mathbf{B}_{pa}$ = 9 500 t. Technical basis: $\mathbf{B}_{lim}$* 1.58; still under consideration. $\mathbf{F}_{pa}$ 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

1.14 Overview

An overview of landings, SSB and mean fishing mortalities of the stocks assessed in this WG is presented in Figures 1.14.1-1.14.3. It was found that several stocks exhibit a strong increase in SSB in 2001 (North Sea herring, Celtic Sea herring and herring in VIaN. Landings have generally declined since the beginning of the 1990s.

Table 1.10.1: Available disaggregated data for the HAWG per March 2002

X: Multiple spreadsheets (usually xls); W: WG-data national input spreadsheets (xls); D: Disfad and Alloc-outputs (ascii/txt)

Stock	**Catchyear**	**Format**			**Comments**
		X	**W**	**D**	
Baltic Sea: IIIa and SD 22-24					
her_3a22	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 revised
	2000	X			provided by Jørgen Dalskov, Mar. 2001
	2001	X			provided by Jørgen Dalskov, Mar. 2002
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
Clyde					
her_clyd	1999	X			provided by Mark Dickey-Collas, Mar. 2000
	2000				provided by Emma Hatfield, Mar. 2001, included in VIaN
	2001				provided by Emma Hatfield, Mar. 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
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
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
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
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
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
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
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 sampling)
UK/Scotland	1990-1998		W		provided by Sandy Robb/Emma Hatfield, Mar. 2002

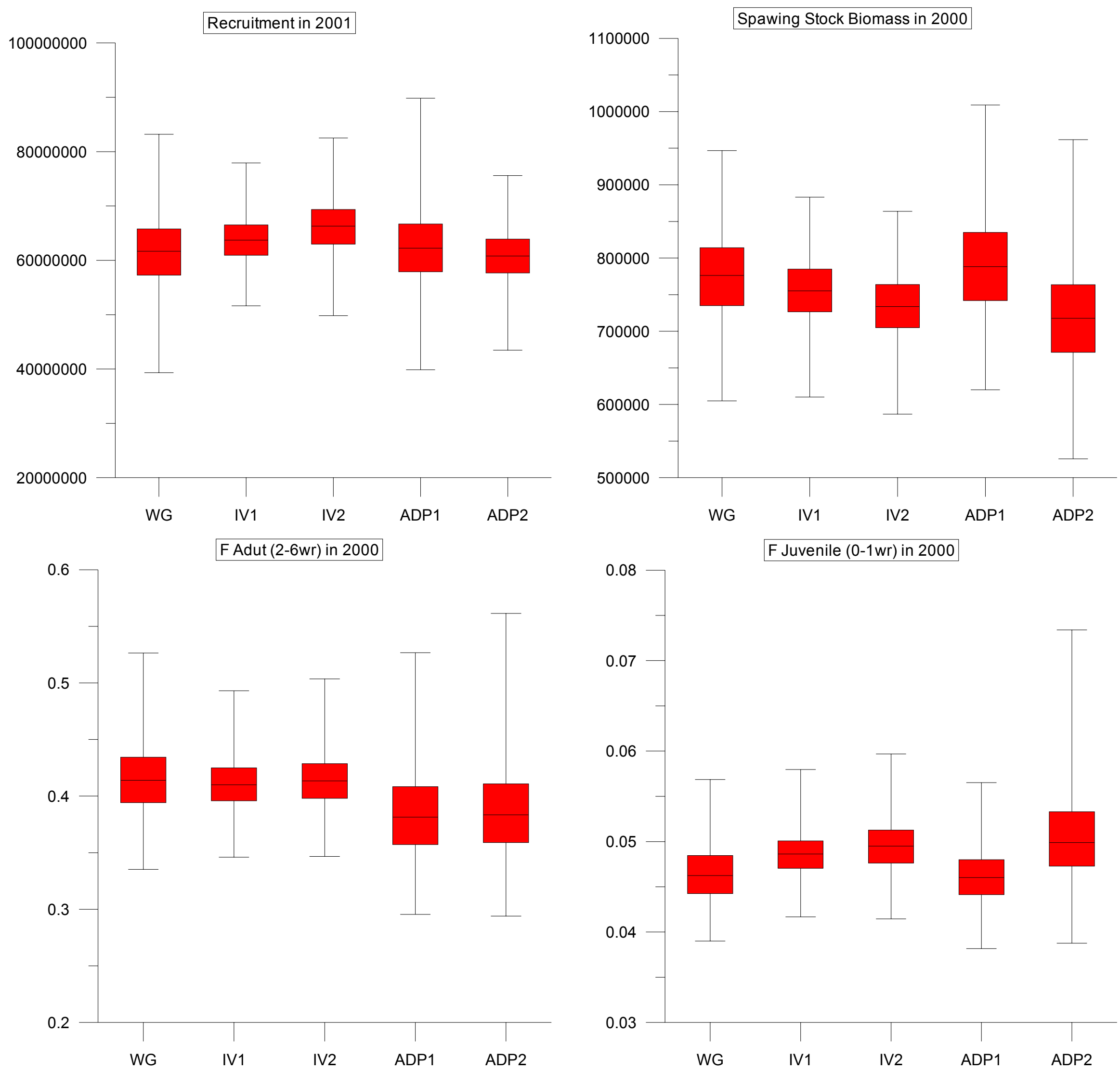


Figure 1.3.1 Comparison of the precision of ICA assessment of North Sea herring in 2001 using different weighting for input data. WG = equal weighting for each survey index, IV1 = inverse variance weighting, IV2 inverse variance with reduced weighting on MIK, ADP1= ICA weights adaptively selected on all assessments. ADP2 = One set of ICA adaptive weights used on all assessments.

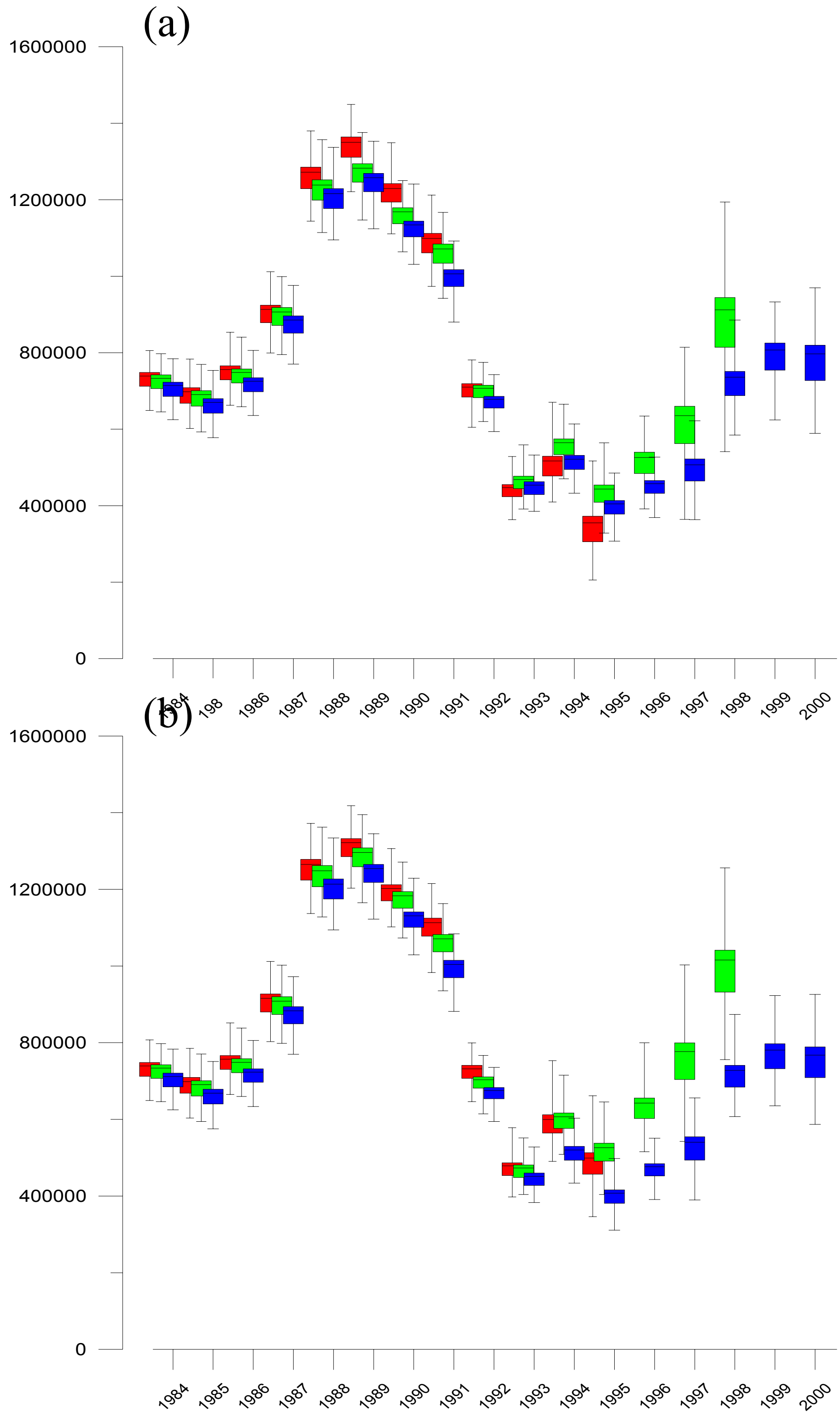


Figure 1.3.2 Comparison of SSB retrospective patterns in three assessments of North Sea herring (2001, 1999, 1996) using ICA with bootstrapped survey indices, and catch input data using two different data weighting methods (a) equal weighted indices (WG method 1994-2001) and (b) inverse variance weighted input data. The box and whisker plots show the median, quartiles and limits of results. The retrospective pattern shows good agreement with the 1996 assessment with either weighting method but with slightly better agreement with the WG weighting method. The intermediate retrospective pattern at 1999 is closer using the WG weighting method. The inverse variance weighting method gives a more precise estimate. The retrospective is very sensitive to choice of separable period. Both methods give the same results in 2001.

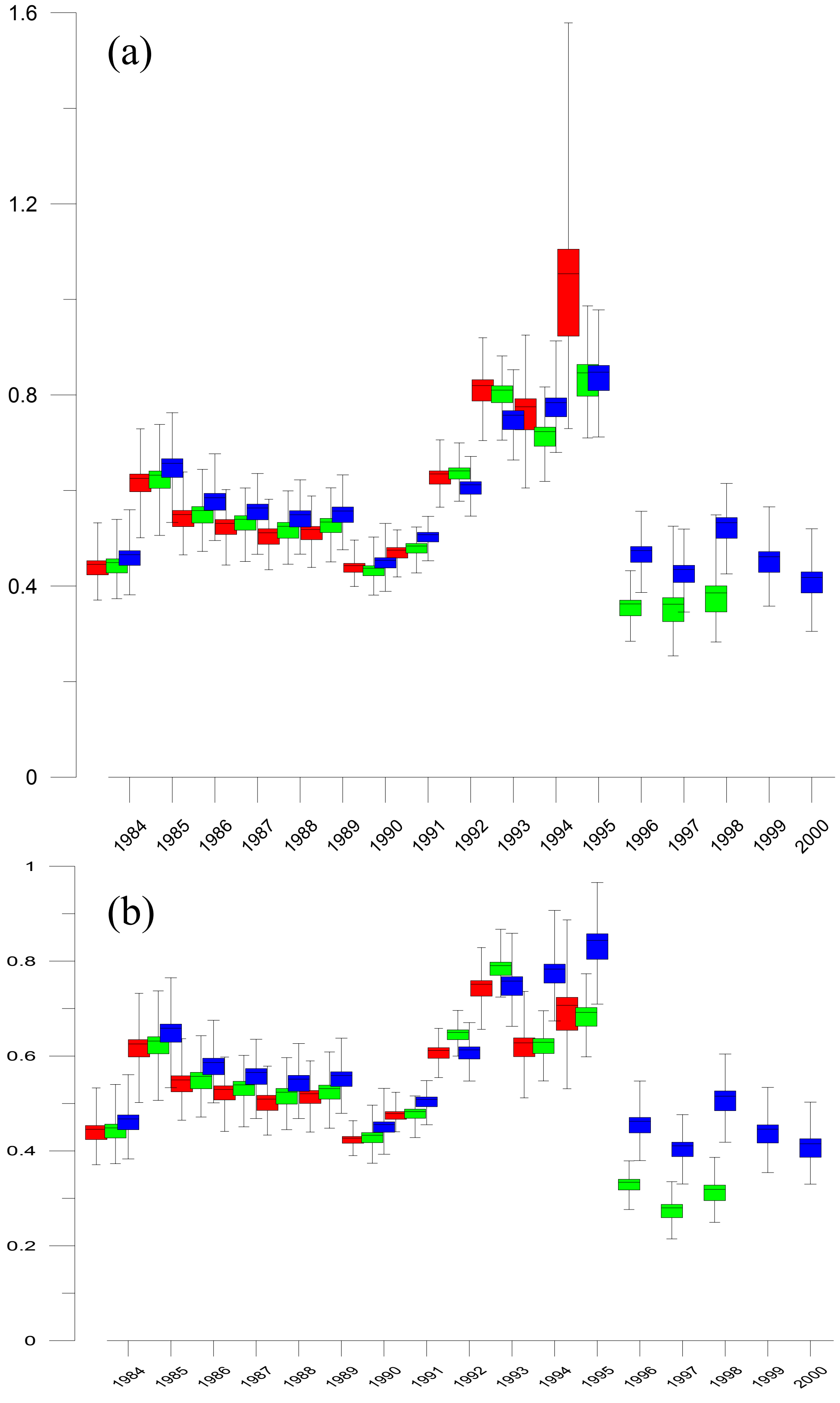
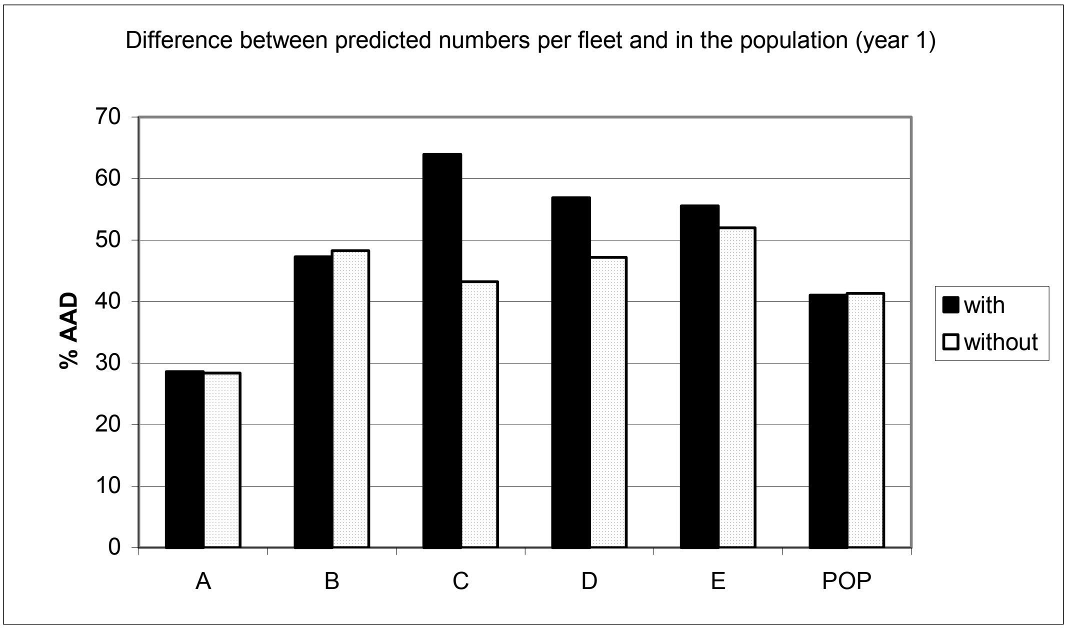


Figure 1.3.3 Comparison of F_{2-6} retrospective patterns in three assessments of North Sea herring (2001, 1999, 1996) using ICA with bootstrapped survey indices, and catch input data using two different data weighting methods (a) equal weighted indices (WG method 1994-2001) and (b) inverse variance weighted input data. The box and whisker plots show the median, quartiles and limits of results. The retrospective pattern shows good agreement with the 1996 assessment with either weighting method but a greater variability with the WG weighting method. The intermediate retrospective pattern at 1999 is closer using the WG weighting method. The 1996 value illustrates clearly that the inverse variance weighting method gives a more precise estimate. The retrospective is very sensitive to choice of separable period. Both methods give the same results in 2001.



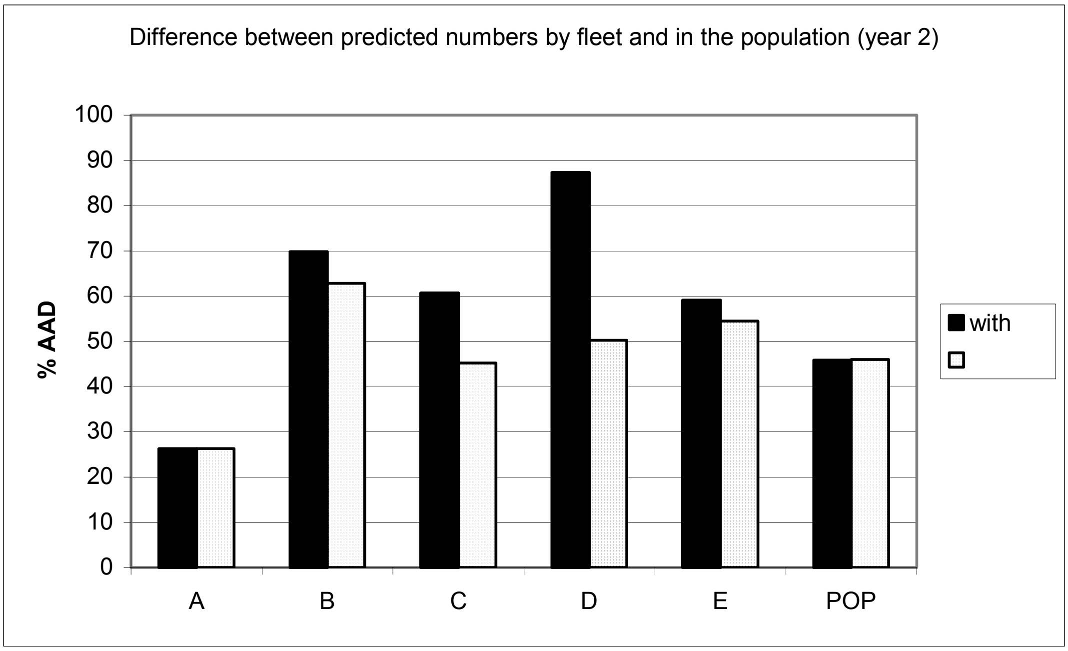


Figure 1.3.4: Percentage Average Absolute Difference between predicted and observed numbers caught by fleet and in the population 'with' and 'without' the split-factor, for projections one and two years ahead.

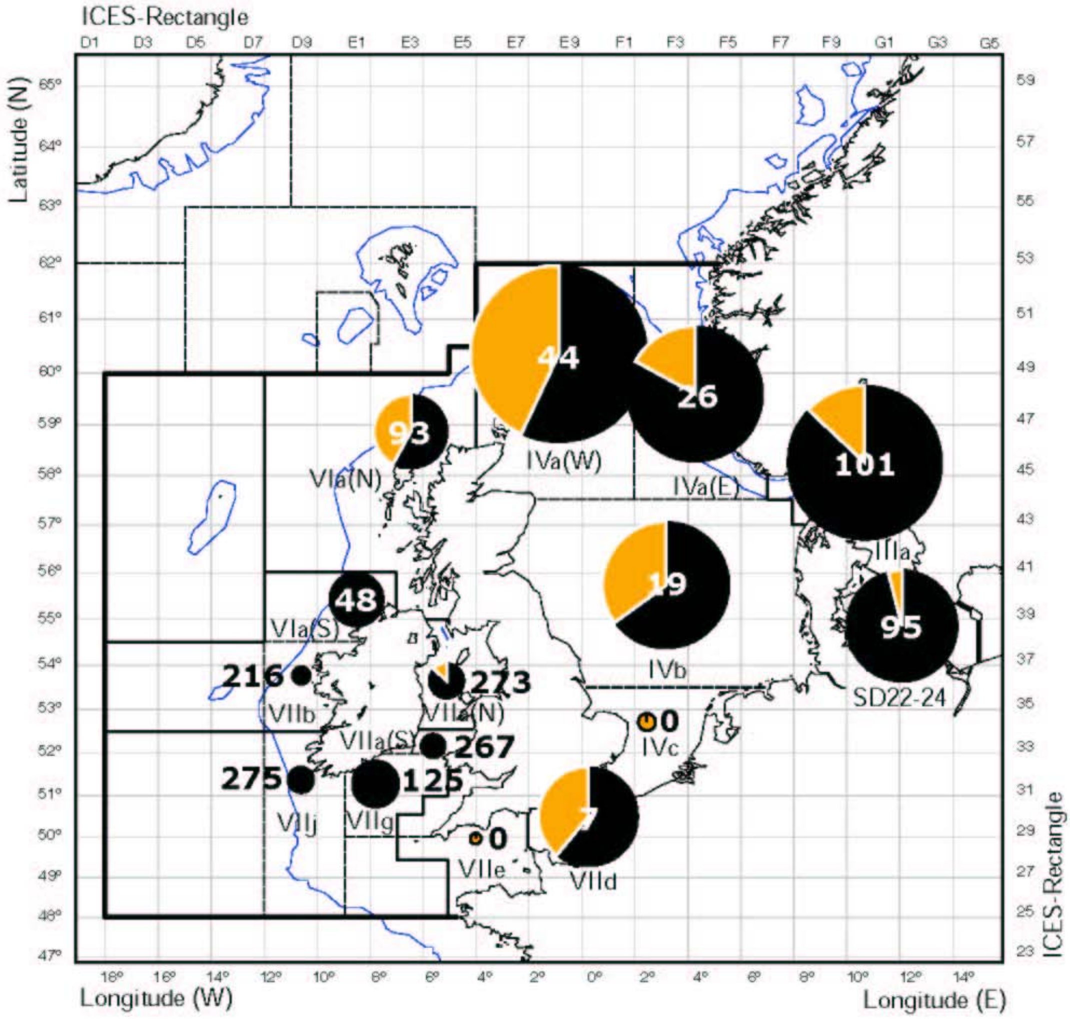


Figure 1.10.1 Herring south of 62°N: Sampling level per ICES areas for the whole year and all fleets. Circle diameter is proportional to working group catch; share of sampled catch (black) is indicated. Numbers give the numbers of age readings per 1000 t catch. For the allocation of areas to stocks, see Fig. 1.10.2

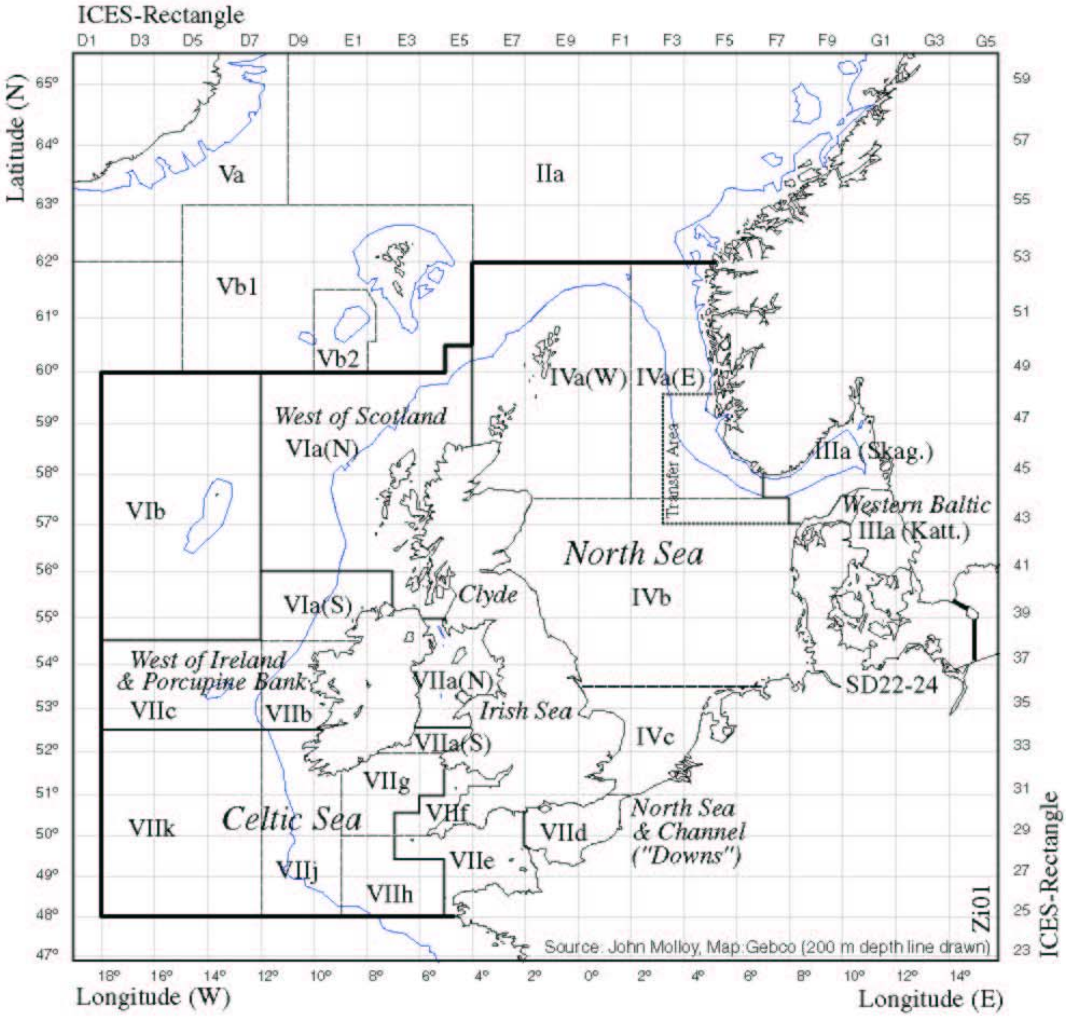


Figure 1.10.2: ICES areas as used for the assessment of herring stocks south of 62°N. Area names in italics indicate the separation used for long term storage of commercial catch and sampling data. "Transfer area" refers to the transfer of Spring Spawners caught in the North Sea to the Western Baltic Spring Spawner Assessment.

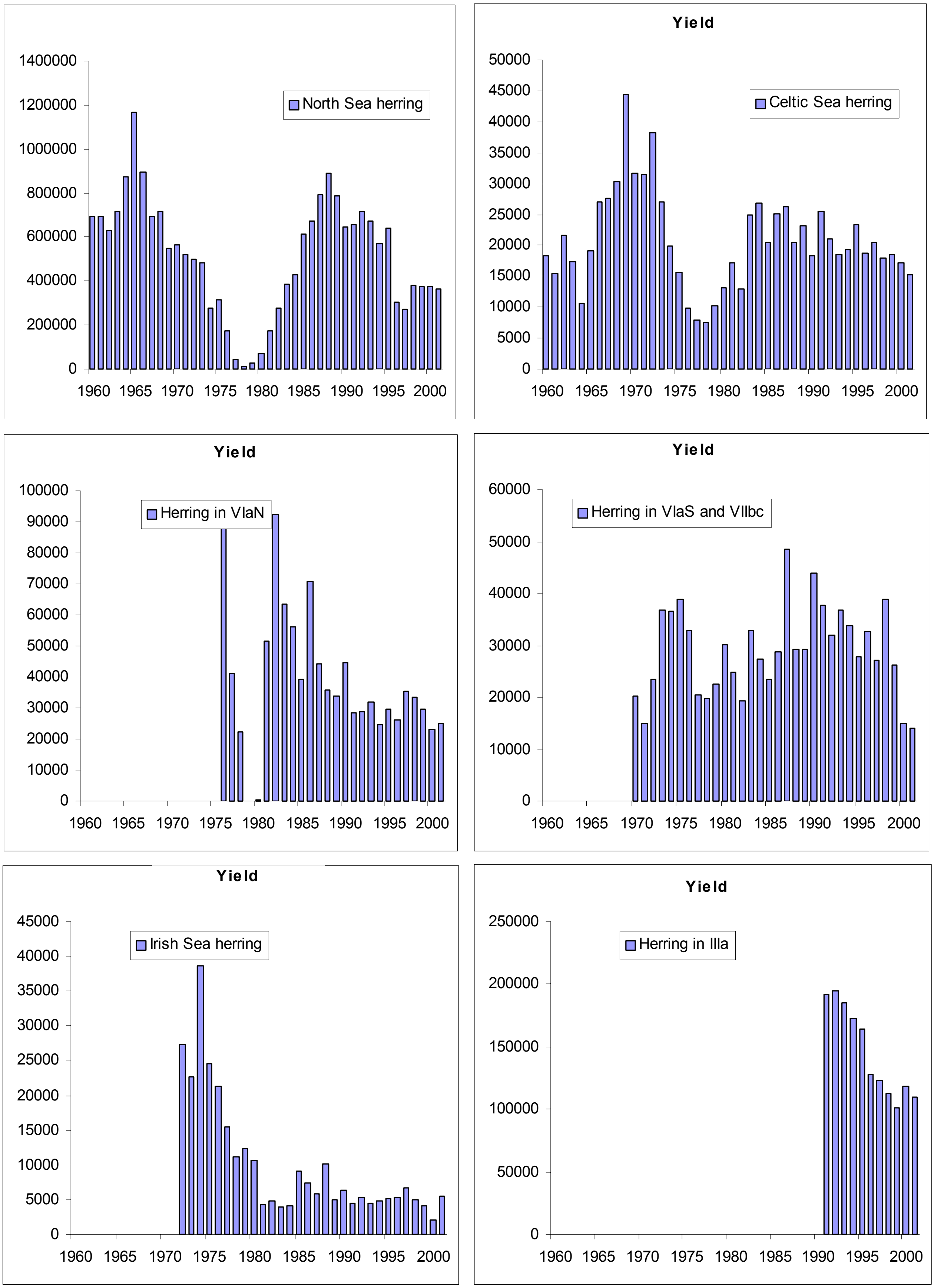


Figure 1.14.1 Overview of herring landings from different stocks.

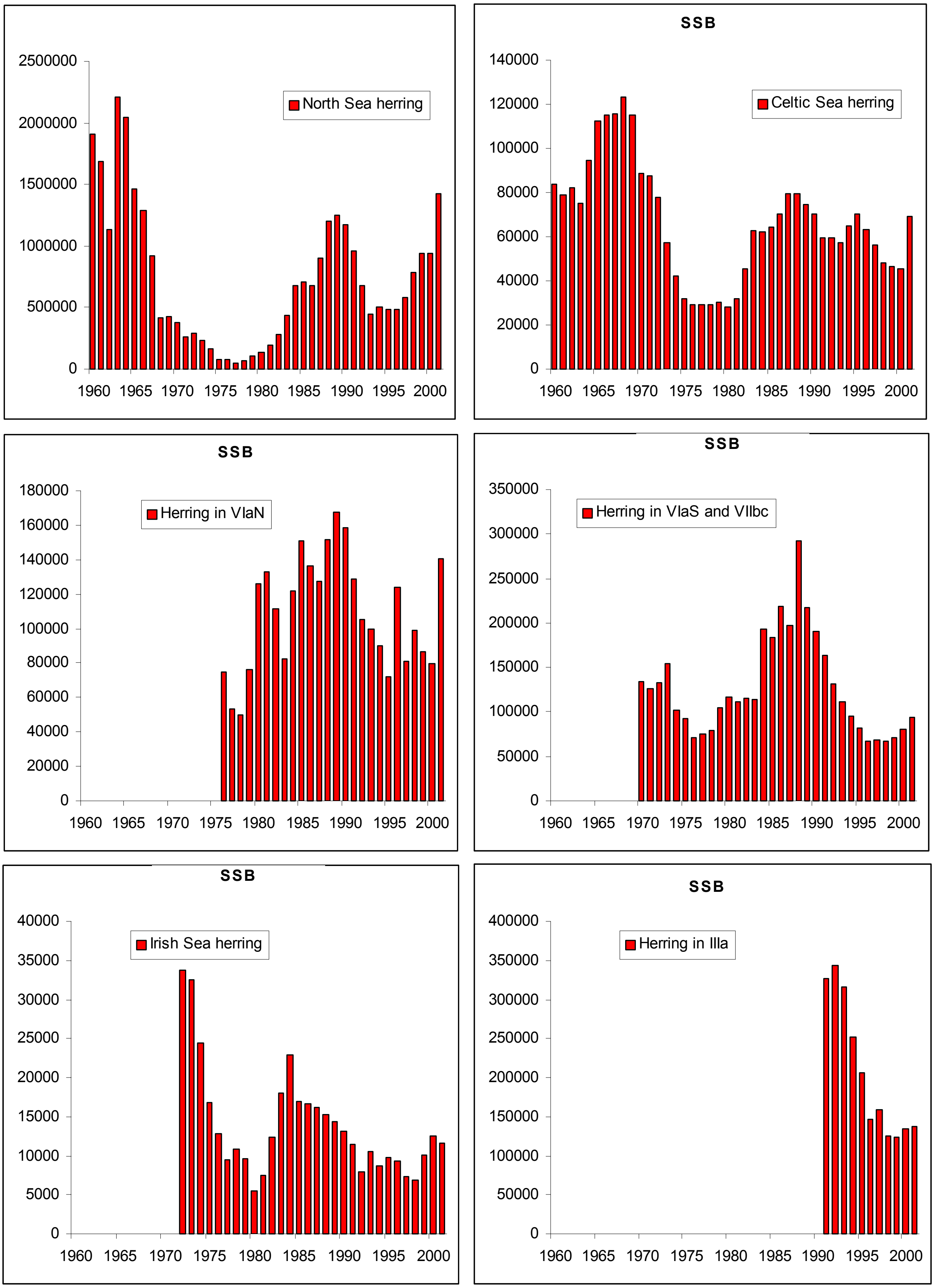


Figure 1.14.2 Overview of herring SSB from different stocks.

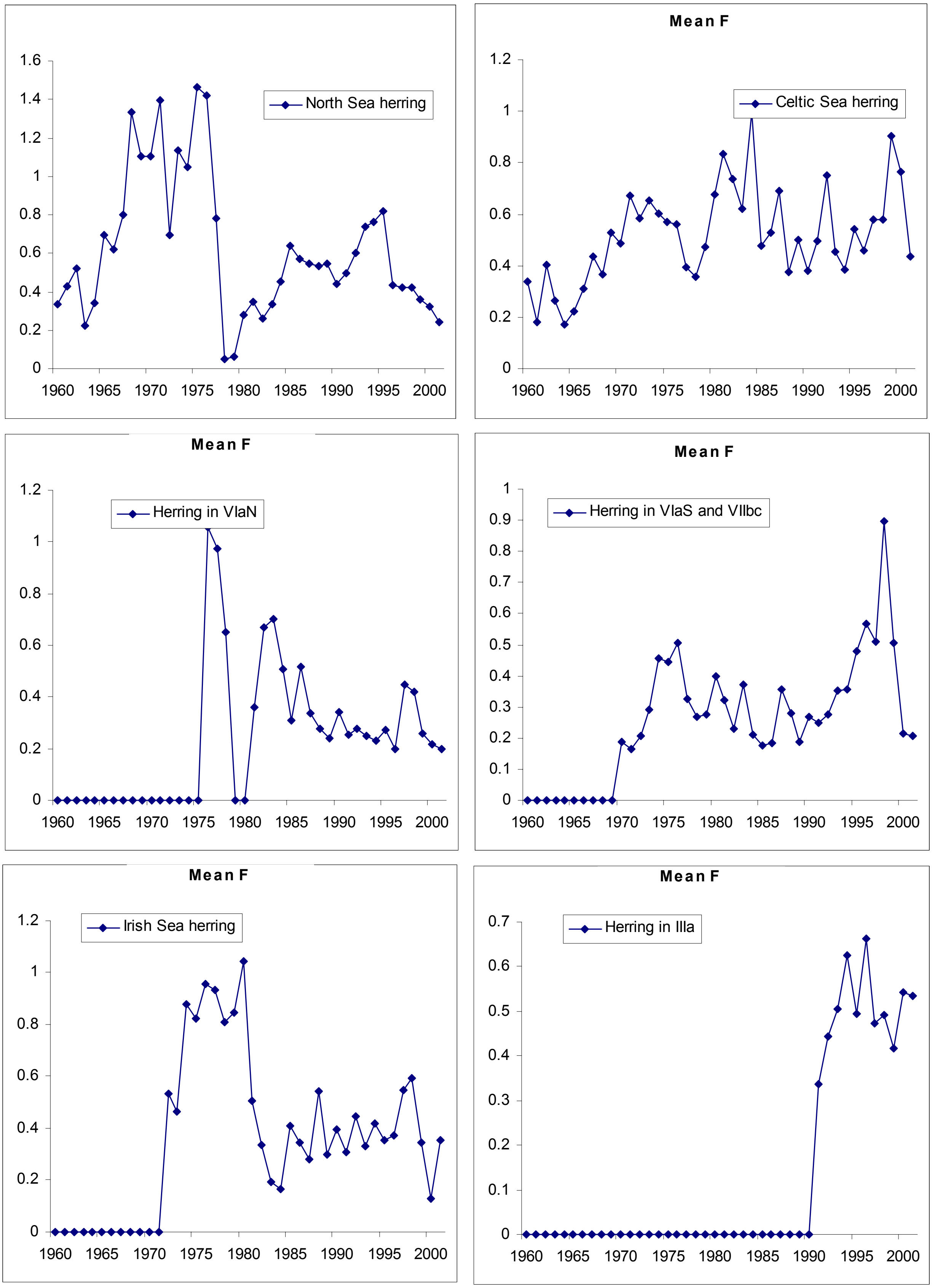


Figure 1.14.3 Overview of fishing mortalities of different herring stocks.

2 NORTH SEA HERRING

2.1 The Fishery

2.1.1 ACFM advice and management applicable to 2001 and 2002

In 1996, the total allowable catches (TACs) 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.

In recent years, 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 $\mathbf{B}_{pa}$.

ACFM recommended for 2002 that the management for 2001 should be continued to ensure the rebuilding of the spawning stock biomass. It was expected that fishing at a *status quo* level would lead to an increase in the SSB to almost $\mathbf{B}_{pa}$ in 2001, mainly due to a strong incoming yearclass.

The final TACs adopted by the management bodies for 1999, 2000 and 2001 were 265,000 t for Divisions IV and VIId, whereof not more than 25,000 t should be caught in Div. IVc and VIId. For 2002, the sub-TAC set for Div. IVc and VIId was raised to 42,000 t but the total TAC for herring caught in the North Sea was kept constant. Catches of herring in the Thames estuary are not included in the TAC. The bycatch ceiling set for fleet B in the North Sea was 36,000 t for 2000 and 2001 and kept constant for 2002. As North Sea autumn spawners are also caught in Div. IIIa, regulations for the fleets operating in this area have to be taken into account for the management of the stock (see Sec. 3).

2.1.2 Catches in 2001

Total landings and estimated catches are given in the Table 2.1.1 for the North Sea and for each Division in Tables 2.1.2 to 2.1.5. 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 2.2.3 and 2.2.4. As in previous years, only one EU nation (Denmark) provided information on by-catches of herring (in the small-mesh fishery, fleet B). By-catches in the Norwegian fishery are not reported separately but included within the official statistics. 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 2001 as used by the Working Group amounted to 323,200 t. It decreased again slightly (by about 2%) as compared to last year's catch. By area, catches decreased in Division IVa (West) by about 17 %, increased in Div. IVa (East) by 44 % and remained almost constant in all other areas.

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 20,000 t (Table 2.2.6). In 2001, the Danish sprat fishery was carried out mainly in the second half of the year with by-catches of herring of about 8% (less than 14,000 t). Herring bycatches in the Danish Norway pout fishery were estimated to be less than 5%, and less than 1 % in the sandeel fishery.

Misreporting of landings taken in the North Sea but reported from other areas such IIa, IIIa and VIa (North) is still substantial, but the estimates of the amount of misreporting out of the area have again decreased compared to the previous years (to about 37,000 t).

TACs in Sub-area IV and Division VIId, for the human consumption fishery, have been significantly exceeded in several years. This excess for the years 1995 to 2001 is shown in the table below. Since the introduction of yearly by-catch ceilings, implemented 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
TAC HC (‘000 t)	440	156	159	254	265	265	265
“Official” landings HC (‘000 t)[1]	436	163	157	250	271	268	276
Working Group catch HC (‘000 t)	**501**	**228**	**221[2]**	**314**	**321**	**311**	**303**
Excess of landings over TAC HC (‘000 t)	61	72	62	60	56	46	39
By-catch ceiling (‘000 t)		44	24	22	30	36	36
Reported by-catches (‘000 t) [3]	65	38	13	14	15	18	20
Working Group catch North Sea (‘000 t)	**566**	**266**	**234[2]**	**329**	**336**	**329**	**323**

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.*
[2] *figure altered in 2000 on the basis of a re-evaluation of misreported catches from VIa North.*
[3] *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 Div. 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 1990-2001 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 Div. IIIa) and 2.2.10 (total numbers of NSAS). Mean weights-at-age are given for 1991-2001 separately for the different Divisions where NSAS are caught (Tab. 2.2.11). Note that Tables 2.2.9, 2.2.10 and the IIIa-part of Table 2.2.11 have been updated this year for the years 1991-1998 based on last year’s revision of the splitting between NSAS and WBSS. However, data corrections prior to 1999 have not been included in this year’s assessment for NSAS.

2.2.1 Catch in numbers-at-age

North Sea catches in numbers-at-age over the years 1990-2001 are given in Table 2.2.7. The total number of herring taken in the North Sea in 2001 (3 billion) has slightly increased as compared to last year; the numbers of North Sea Autumn-spawners have increased by 6%. Catches of 0-ringer NSAS have increased by 65%, while those of 1-ringers have almost halved. This is again likely to be caused by high catches of the strong incoming yearclass. 0- and 1-ringers contributed almost half of the total catch in numbers of North Sea autumn spawners in 2001. Fig. 2.2.1. shows the relative proportions on the total catch numbers for different periods (1960-2001, 1980-2001 for the total area, and 2001 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 Div. 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 364,000 tonnes:

Area	Allocated	Unallocated	Discards	Total
IVa West	113,735	17,578	1,386	132,699
IVa East	76,160	0	-	76,160
IVb	81,896	-12,878	-	69,018
IVc/VIId	24,174	21,149	-	45,323
	Total catch in the North Sea			323,200
	Autumn Spawners caught in Div. IIIa (SOP)			48,375
	Baltic Spring Spawners caught in the North Sea (SOP)			-6,449
	Other Spring Spawners			-1,097
	Total Catch NSAS used for the assessment			**364,029**

Note that 193 t reported to be taken by UK/England and Wales during all quarters in Divisions VIIe and VIIf are not included in any herring assessment.

2.2.2 Spring-spawning herring in the North Sea

Norwegian Spring-spawners are taken in Div. IVa (East) close to the Norwegian coast under a separate TAC. These catches are not included in the catch tables. Coastal Spring Spawners in the southern North Sea (e.g. Thames estuary) are caught in small quantities regulated by a local TAC. The Netherlands report increasing catches of Spring Spawners in the Western Part of the North Sea, which are included in the national catch figures and subtracted from the total catch used for the assessment of North Sea Autumn Spawners. These catches are given in Table 2.1.1 to 2.1.5.

Western Baltic and Division IIIa Spring-spawners (WBSS) are taken in the eastern North Sea during the summer feeding migration. These catches are included in Table 2.1.1 and listed as IIIa type. Table 2.2.8 specifies the estimated catch numbers of WBSS caught in the North Sea, which are transferred from the North Sea assessment to the assessment of Division IIIa/Western Baltic in 1990-2001.

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)/0.7, where v is the mean vertebral count of the (mixed) sample. The method is quite sensitive to within-stock variation (e.g. between year classes) in mean vertebral counts. The same method has been applied to separate the two components in the Norwegian part of the summer acoustic survey.

To calculate the proportion of Spring-spawners caught in the transfer area, the 1-ringers caught in the first and second quarter were all split by otolith microstructure (see section 3.2) according to the average proportion for the transfer area in the third quarter. For herring age groups 2-ringers, 3-ringers, and 4+-ringers mean vertebral counts by ICES rectangle were used. Samples from the Norwegian catches that have been taken in May and June 2001 were used for the second quarter. For the third quarter, samples taken in July were used (Figure 2.2.2).

The resulting proportion of Spring-spawners and the quarterly catches of these in the transfer area in 2001 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	32%	15%	30%	41%	10,277	3,312
Q 3	32%	47%	34%	53%	6,832	3,137
total					17,109	6,449

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

2.2.3 Data revisions

The numbers-at-age and mean weights-at-age in the catch were revised for Div. IIIa for 1991-1999, which required updating of a number of tables for North Sea Autumn-spawners and Western Baltic Spring-spawners (see Section 3). The revision was due to corrections in proportions of catches by fleets of the Swedish landings. A revision of the historic data caused by the application of new splitting factors for catches in Div. IIIa was thought to have minor influence on the North Sea Autumn-spawner assessment. Nevertheless, most of the tables have been updated, but the changes for the years 1991-1998 have not been implemented in the NSAS assessment.

A revision of the catch tables (Tables 2.1.1 to 2.1.6) showed significant discrepancies between the data used in the assessment and updated figures from official databases, which could not be attributed to misreported or unallocated catches. e.g. the catch figure for UK/England and Wales for 1993, IVc and VIId, had to be reduced by 7851 t. On the other hand, Norway has increased its official landings for 1997 by 54815 t and for 1998 by 29196 t. Norwegian catch statistics for 1999 and 2000 are still preliminary and could change as well. While catch tables could be corrected, catch numbers and mean weights could not be revised during this WG meeting. However, these changes will most likely have a significant influence on the perception of the stock.

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 by the Netherlands. Currently, catches are raised on a monthly basis, which increased the number of metiers and reduced the biological information in some metiers to as little as four age readings/weightings. In the data for 2001 (Tab. 2.2.1-2, 2.2.11), at least three examples have been found where the weights are thought to be highly biased and the distribution of numbers-at-age were based on very few fish. If the raising procedure was changed to a quarterly treatment of sampling and catches, e.g. a reduction of mean weight-at-age for 1-ringers caught in VIb in one quarter from 119 to 82 g and a reduction of the numbers-at-age 8 in the same area from 20,000 to 6,000 individuals was obtained. In the light of these findings, the Netherlands have agreed to rework their raising scheme. These data have a significant influence on the total North Sea catch, as they are usually used to raise the unsampled catches of Germany, France and UK/England and Wales. The catches of these 4 fleets contribute more than 40 % to the total catch of herring in the North Sea.

The Working Group felt that it would require a major effort to correct all these data from different sources, and this could not be done during this year's 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. 1.9), and due to time constraints during the WG sessions, the WG recommends to set up a study group to deal with the issues related to data revisions as soon as the new data base is set up.

2.2.4 Quality of catch and biological data

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 within Area IV and from VIId to IVb.

Only Scotland provided estimates of discards, which amounted to less than 4%. Estimations of discards in the Dutch fleet were this year included in "unallocated". However, discards are known to occur in the fisheries of most countries and their impact is unknown, and hence they are not included in the assessment.

The Working Group catch, which includes estimates of discards and misreported or unallocated catches (see Section 1.9), was estimated to exceed the official catch significantly (by more than 20%, range 12-25%). If the mean rate of misreporting and unallocated catch for nations reporting this is applied to the whole North Sea catch, this would give a total catch for the human consumption fleet of 340,000 t (compared to 277,000 t official landings and 303,000 t used here). In some areas of the North Sea, there was a WG catch of up to 300% of the official catch. These estimates corroborate recent 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.

In general, sampling of commercial landings for age, length and weight has deteriorated compared to last year (Table 2.2.12). If unallocated and misreported catches are taken into account, the recommended level of one sample per 1000 t catch is met only for 10 out of 93 metiers. For age readings (recommended level >25 ageings per 1000 t catch) this is worse: only 6 metiers are sampled sufficiently (by The Netherlands (3 metiers), Scotland (2) and Norway (1)). In this respect, there is still a need to improve the quality of the catch data for the North Sea herring.

Germany, France, UK/England and Wales, Sweden, UK/Northern Ireland and the Faroese (combined share 25% of the total North Sea catch) have not sampled any of their North Sea herring catches. The sampling level was slightly worse than last year for The Netherlands and Norway, deteriorated dramatically for the Danish industrial fleet (to one tenth of the age readings), but improved slightly for the Danish human consumption fleet and UK/Scotland. As it is known that by-catches of herring in other fisheries occur and most of the countries have not implemented a sampling scheme for monitoring these fisheries, Table 2.2.12 can not be used alone to judge whether a country has met the recommended sampling levels or not. The WG recommends that all countries conducting small-mesh fisheries in the North Sea sample and report their herring bycatch in these fisheries.

It should be observed that "sampled catch" 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. It is not possible to judge the quality of the sampling from this figure alone. Of 93 different *reported* metiers (each combination of fleets/nations/areas/quarters), only 26 were sampled. This introduces uncertainties in the biological composition of the catches, which affects the quality of the assessment. The Working Group repeats that there is a need for an increased sampling effort, especially to assure that catches landed abroad are reasonably sampled. The new EU directive for the sampling of commercial catch is expected to improve the sampling level at least for EU member states in the course of the next few years.

2.3 Recruitment

2.3.1 The IBTS index of 1-ringer recruitment

The 1-ringer index of recruitment is based on the IBTS, 1st quarter (trawl catches at daytime February 2002). The index, calculated for the entire survey area (ICES 1995), is used as an estimate of the strength of year classes 1977 to 2000 (Table 2.3.1). The temporal trend in indices is illustrated in Figure 2.3.1. The estimate of the 2000 year class (3948) indicates a strong recruitment, among the highest during the period.

Figure 2.3.2 illustrates the spatial distribution of 1-ringers as estimated by the trawling in February during 2000, 2001 and 2002. In 2002 the primary concentrations of 1-ringers were found in the Central North Sea and in the Skagerrak/Kattegat area. (div. IIIa), however, abundances were generally high in most of the south-eastern areas of the North Sea.

2.3.2 The MIK index of 0-ringer recruitment

The 0-ringer index is based on night-time catches by a fine-meshed ring net (the MIK) during the February survey of the IBTS. Data was not available in 12 standard rectangles because of low gear catchability by one of the participants in the IBTS. Index values are calculated as described in the WG report of 1996 (ICES 1996/Assess:10). The index value indicating the abundance of 0-ringers in 2002, the 2001 year class, is estimated at 161.8 (Table 2.3.2).

This estimate of the 2001 year class indicates an above average recruitment. Year class strength is not as high as predicted for the 2000 year class, and in contrast to the preceding year class, 0-ringers were widespread across the North Sea, with major concentrations of 0-ringers in the central parts. This easterly displacement of 0-ringer concentrations was also observed in 1999, while the general trend during the last decade has been 0-ringers concentrated in the north-westerly parts of the North Sea.

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

The relationship between the two indices is illustrated in Figure 2.3.4 and described by the fitted linear regression. Last years prediction of a large 2000 year class was confirmed by this year's IBTS 1-ringer index of the year class, and their relative sizes are in accordance with the overall relationship.

2.3.4 Trends in recruitment as estimated by the assessment

The long-term trend in recruitment of 1-ringers to the stock of North Sea autumn spawners is illustrated by Figure 2.3.5. Recruitment estimates are based on the present 2002 ICA assessment. The figure illustrates the decline during the sixties and the seventies, followed by a marked increase in the early eighties. After the strong 1985 year class a new decline was observed, followed by relatively strong year classes in the most recent years. ICA estimates of recent 1-ringer recruitment are 17.3 and 30.1 billions for year classes 1999 and 2000 respectively, while the estimates for 0-ringers are 48.3, 83.5 and 61.1 billions for year classes 1999, 2000 and 2001 respectively.

2.3.5 Separate recruitment index of the Downs herring

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 smaller than 13 cm (see discussion of procedures in earlier reports, ICES 2000, and ICES 2001b).

Table 2.3.3. 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). The contribution of small 1-ringers from Division IIIa also varies significantly, for example two prominent peaks in the abundance estimates (year classes 1986 and 1991) are due to high relative abundance in IIIa.

This year's group of 1-ringers has a large component of small herring in the total area of IBTS coverage (38%), of which only a minor part is found in the IIIa area.

2.4 Acoustic surveys in the VIa $_{north}$ and the North Sea July 2000

Six surveys were carried out during late June and July covering most of the continental shelf north of 54ºN in the North Sea and 56ºN to the west of Scotland to a northern limit of 62ºN. 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 methods surveys are reported in the report of the Planning Group for Herring Surveys (ICES, 2002/G:12). The vessels, areas and dates of cruises are given below and in Figure 2.4.1:

Vessel	Dates	Area Surveyed	Days
RV Taits	10-30 July	56º-60ºN, 4º-10ºW	21
M. Sars	29 June – 24 July	57º61'-30ºN, 2º- 8ºE	27
Scotia	3 July – 23 July	58º61'-30ºN, 4ºW - 2ºE	21
Tridens	25 June – 20 July	54º30'- 58ºN, west of 3ºE	26
Solea	29 June – 20 July	54º-57ºN, east of 3ºE	22
Dana	30 June – 11 July	North of 57ºN, east of 6ºE	13

The data has been combined to provide an overall estimate. The areas covered and dates of surveys are shown in Figure 2.4.1. 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 2.4.1-3 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 1.7 to 2.6 million tonnes or from 8,750 to 16,198 million individuals of which 9,400 are 2wr herring (Table 2.4.1). This data series is used as an index in the assessment of North Sea herring because the TS relationship for herring used is not known precisely, and the absolute abundance cannot be obtained reliably. The North Sea survey is consistent with previous years, giving a total adult mortality of about 0.4 in each of the last 2 years, which is similar to the estimates from the assessment (0.5). The survey shows the exceptional high numbers of 2 ring herring, 1998 year class, in the North Sea, which is consistent with the observation of an exceptionally large year class observed in the Acoustic, MIK and IBTS surveys in previous years (ICES 2001/ACFM:12). The acoustic survey indicates that the abundance of this year class is 4 times the preceding (1997) year class. The numbers and biomass of adult autumn-spawning herring can be seen in Figure 2.4.2, the numbers at 1, 2 and 3+ rings in Figure 2.4.3. The spatial distribution of mean weight at 1 and 2 ring, and fraction mature at 2 and 3 ring are given in Figure 2.4.4. These show 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 2.4.5 and 2.4.6 respectively.

Revision of acoustic survey data for 1989 to 2000

The HAWG in 2001 noted some small discrepancies between the historic data in the archive and the summary table and requested PGHERS to examine the historic data archive from the acoustic survey for the North Sea prior to 1996. In reviewing this it was found that there were 9% discrepancies in the 1999 and 2000 Scottish surveys due to calibration error with the change of transducer with the new SCOTIA. The details of these revisions are presented in the report of the combined herring acoustic survey report ICES herring surveys (WD3 2002). Early surveys were combined with equal weight; more recent surveys had been combined using weighting based on the amount of survey effort. The older surveys were recalculated using this weighted method. The revisions to the database have been made and the revised estimates for the North Sea Autumn-spawning herring are given in Table 2.4.5. An assessment was carried out using the 2001 assessment settings with the revised time-series. The influence of the revision expressed as % change in Recruitment, Stock, SSB and F can be seen in Table 2.4.6. The recruitment is not affected and changes in 2001 are less than 3%, but there are a few historic revisions of up to 5%.

Use of 1 ring data from the survey in the assessment of NS herring

The acoustic survey has been providing estimates of 1 ring herring since 1995. These have not been included in the assessment in previous years. Table 2.4.7 indicates the correlations between the data used to tune the assessments and the assessment in 2001. The 1 ring herring index from the acoustic survey has a correlation of 0.85 similar to the IBTS estimate of 1 ring of 0.86. However, this correlation for the Acoustic survey 1 ring index is independent of the assessment. The correlation between the 1 group index and subsequent estimates of the same year class as 2wr is 0.5 for the IBTS and 0.66 for the Acoustic survey. This suggests that the information should be considered for inclusion in the assessment. The ratio of abundance at 1 ring to 2 ring is a lower estimate than the ratio observed in years 1997 to 2001 as the area surveyed was increased and survey methodology became more stable during this period. So initially only 1997 onwards should be tested in the assessment.

2.5 Larvae Surveys

Internationally co-ordinated 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 were carried out in the 2001/2002 period. The data coordination and analysis were carried out by IfM Kiel and BFA Hamburg/Rostock.

The traditional LAI and LPE (Larval Production Estimates) rely on a complete coverage of the survey areas. Due to the substantial decline in ship time and sampling effort since the end of the 1980s, these indices have not been calculated in this form since 1994. Instead, a multiplicative model was used for calculating a Multiple Larvae Abundance Index (MLAI, Patterson & Beveridge, 1995). In this approach, the larvae abundances are calculated for a series of sampling units. The total time-series of data is used to estimate the year and sampling unit effects on the abundance values. The unit effects are used to fill unsampled units so that an abundance index can be estimated for each year.

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

There were no modifications to the methods. Newly hatched larvae less than 10 mm in length (11 mm for the Southern North Sea) were used to calculate larval abundance. Each larvae abundance index (LAI) unit is defined for area and time. To estimate larval abundance, the mean number of larvae per m^2 obtained from the ichthyoplankton hauls for each 30x30 nautical mile rectangles was estimated and raised by the corresponding surface area of the rectangle. Rectangle estimates are summed to give unit abundance. Estimates of larval abundance by sampling unit and time are given in Table 2.5.1.

Compared to 2000, a strong increase in abundance was observed in the Orkney/Shetland area where the abundance was approximately four times higher than last year's estimate. In the Buchan area the LAI increased but was still below the long-term mean. The situation in the Central North Sea (CNS) showed continuously rising LAI estimates over the last four years, representing a recovery from very low records to the long term mean of this unit. In the Southern North Sea (SNS) the abundance did not change substantially and was comparable to last year's estimate. Both years showed high larvae abundances and indicated a higher SSB of the Downs component.

The MLAI-model was fitted to the log difference in abundance of larvae. The analysis of variance and the parameter estimates are given in Table 2.5.2, including year effects and standard errors. The updated normalised log MLAI, the re-scaled, un-logged and un-logged/100 MLAI used in the assessment are shown in Table 2.5.3.

Both the LAI per unit as well as the MLAI from the larvae surveys in period 2001/2002 indicate that the SSB has increased and almost doubled when compared to last years WG estimate.

2.6 International Bottom Trawl Survey (IBTS)

The International Bottom Trawl Survey (IBTS) started out as a young herring fish survey in 1966 with the objective of obtaining annual recruitment indices for the combined North Sea herring stocks. It has been carried out every year since and it was realised that the survey could provide recruitment indices not only for herring, but for roundfish species as well. Further examinations of the catch data from the 1st quarter IBTS showed that these surveys also gave indications of the abundances of the adult stages of herring. Thus, the IBTS herring catches are used for estimation of age-disaggregated indices, as 1 ringers, discussed in section 2.3 on recruitment, and indices of 2-5+ ringers.

Fishing gear and survey practices were standardised from 1983, and abundance estimates of 2-5+ ringers from 1983 onwards have shown the most consistent results in assessments of these age groups. This series is therefore used in the North Sea herring assessment. Table 2.6.1 shows the time-series of abundance estimates of 2-5+ ringers from the 1st quarter IBTS for the period 1983-2002, while Table 2.6.2 contains area-disaggregated information on the IBTS indices for year 2002.

2.7 Mean weights-at-age and maturity-at-age

2.7.1 Mean weights-at-age

The mean weights-at-age of fish in the catches in 2001 (weighted by the numbers caught) are presented by ICES division and by quarter in Table 2.2.11.

Table 2.7.1 presents the mean weights-at-age in the North Sea stock during the 3rd quarter in Divisions IVa and IVb and IIIa for 1991 to 2001. These values are obtained from the acoustic survey. The data for 2001 are from Table 2.4.4. In this quarter most fish are approaching their peak weights just prior to spawning. For comparison the mean weights in the catch from the last ten years are also shown in the Table 2.7.1 (from section 2.2 for the 2001 values). The mean weights in the catch are generally close to but lower than the long-term mean, except for the weight of 1 ringers which are very high. This high value is partly due to generally high weights found in the area, but is also sensitive to low levels of sampling, see Section 2.2. Similarly the mean weights-at-age in stock from the acoustic survey in 2001 are mostly in the lower quartile of the last 9 years for all ages, except for 2 ringers which is close to the long-term mean. The 1 ringer mean weight in the stock is not seen to be unusually high, suggesting the high weight in the catch may not be typical for the whole stock.

2.7.2 Maturity ogive

The percentage of North Sea autumn-spawning herring (at age) that spawned in 2001 was estimated from the acoustic survey. This was determined from samples of herring from the research vessel catches examined for maturity stage, and raised by the local abundance. All herring at maturity stage between 3 and 6 inclusive in June or July were assumed to spawn in the autumn. The method and justification for the use of values derived from a single years data was described fully in ICES (1996/Assess:10). The maturity in 2001 was higher than the long-term mean (over the last 12 years) for 2 ring herring. This is 11% higher than last year. The proportion of mature 3 ring was close to the long-term mean for the period. The percentages are given in Table 2.7.2.

2.8 Stock assessment

2.8.1 Data exploration and preliminary modeling

Catch-at-age data

Catch-numbers-at-age (Section 2.2) were available for the period 1947-2001. The year range 1960 to 2001 was chosen for the assessment, because of large discrepancies in the sum of products in earlier years. The official landings reported by Norway for 1997 and 1998 were revised upwards this year with substantial amounts (Section 2.2.3). These changes could not be taken into account for the current assessment but will be incorporated next year.

Survey indices available

The following survey indices were available:

- MIK 0-ringer index. Available and used since 1977 as a recruitment index (Section 2.3).
- Acoustic 2-9+ ringer index. Available since 1984, used since 1989 (Section 2.4). In addition the 1-ringer acoustic index was made available to the WG. This index is also available as a biomass index but is not used as such in the assessment.
- IBTS 1-5+ ringer index. Available since 1971. Separated into a 1 ringer index (used since 1979) and a 2-5+ ringer index which is used since 1983 (see sections 2.3 and 2.6).
- Multiplicative larvae abundance index (MLAI). Available since 1973, used since 1979 as an SSB index (section 2.5).

Data exploration

The available survey indices are shown in Figures 2.8.1 for age-based indices up to age 5 and 2.8.2 for SSB indices. Recruitment indices (MIK 0-ringer and IBTS 1-ringer) and indices for ages 4 and higher (not shown) are fairly consistent. However, the IBTS and Acoustic indices for 2 and 3-ringer are not very consistent. The 1985 year class shows up very strong in the IBTS 2 ringer index, whereas in the 3-ringer index it appears to be the 1984 year class, which indicates that there may be a problem with ageing. The available SSB indices show the same dynamics over time, although the absolute level has tended to diverge since 1990. Both indices indicate a high spawning stock biomass in 2001, comparable to the level of the early 1990s.

In previous working groups the weighting of the survey indices in the tuning process has always been set on a more or less arbitrary basis. All survey indices were assumed to have correlated errors and each survey received a weighting of one in the tuning. Because the IBTS 1-ringer was used as a separate index it received a separate weighting. The Study Group on the Evaluation of the Herring Assessment Procedures (ICES 2000d) has provided an objective procedure to estimate the weighting of the different component of the model. Both the catch-at-age data in the separable period and the survey indices received weighting that was the inverse of the variance of the data series as estimated from bootstrap analysis (See Section 1.3). The weighting was corrected for correlations between ages. The following weighting was explored in the WG:

age (rings)	catch	MLAI	Acou	IBTS	MIK
0	3.13				2.05
1	4.07		0.74	0.67	
2	3.17		0.75	0.24	
3	2.65		0.64	0.06	
4	1.94		0.27	0.03	
5	1.31		0.14	0.03	
6	0.97		0.13		
7	0.75		0.12		
8	0.55		0.07		
9	0.54		0.07		
SSB		0.65			

Two sets of comparisons were carried out using the ICA model:

- Comparison of the effects of weighting the model components and the addition of the 1-ringer index in the acoustic survey.
- Comparison of the contribution of the survey indices separately.

The comparison between the different weighting options is presented in Figure 2.8.3. In this case the comparison has been between a weighting as used in WG 2001, a weighting based on the SGEHAP inverse variance weighting and a similar option but with down-weighting of the juvenile catches of 0-ringer and 1-ringer. The latter option is presented as the final run in section 2.8.2. It was found that the addition of the acoustic 1-ringer index (which only covers 5 years) had little impact on the estimate of the spawning stock, but that it did contribute to the recruitment estimates. It was further noted that using the inverse variance weighting resulted in the highest weighting being applied to the 0- and 1-group. The estimates of recruitment will therefore be heavily dependent on what has been seen in the catches. Since the TAC for the industrial fisheries is set independently of the TAC for adult herring, it was considered that the assumption of separability between the human consumption and the industrial fleet may not hold. Therefore the catches of juveniles were down-weighted (to an arbitrary value of 0.1) in the exploration.

The comparison between different weighting schemes shows that the estimate of SSB in 2001 is sensitive to the weighting applied. SSB in 2001 can be between 1.1 million tonnes (weighting as WG 2001), 1.2 million tonnes (inverse variance weighting), or 1.4 million tonnes (inverse variance, but down-weighting juveniles).

The effects on the catch residuals in the separable period between the two inverse variance weighted runs are shown in the text table below. When using all the inverse variance weighting there is a high negative residual on the 1998 year class in 2001 (2 ringer). This is a strong year class in all the surveys, but has not shown up as expected in the landings. Therefore, the catches will result in a lower estimate of the size of this year class. If the juvenile catches are down-weighted, the model is allowed to fit the adult catches more freely, and the estimates of the recruitment in the most recent years is mainly determined by the survey information. This causes the residuals on the 1998 year class to be lower and the residuals on the juveniles to be higher, since the model is allowed to fit with higher residuals for the juveniles.

INVERSE VARIANCE WEIGHTING

rings	1997	1998	1999	2000	2001
0	-0.1488	-0.4876	0.1872	0.1949	0.2495
1	-0.3076	0.4276	-0.0552	-0.0455	-0.0475
2	0.2283	0.0160	-0.1311	0.2653	-0.4395
3	0.0983	-0.2769	0.0836	-0.3767	0.2872
4	0.1625	-0.1388	-0.0586	0.1212	-0.1526
5	-0.0042	-0.1228	-0.1752	-0.0413	0.0897
6	0.0123	0.1910	-0.1749	-0.1058	-0.1106
7	0.1204	-0.0001	-0.0716	-0.3383	0.1717
8	-0.0084	-0.0340	-0.2005	-0.2793	0.4386

DOWNWEIGHTING 0- and 1 ringer

rings	1997	1998	1999	2000	2001
0	-0.4218	-0.8093	0.0981	0.2976	0.5386
1	-0.9379	0.1987	-0.5288	-0.2333	-0.0999
2	0.0802	-0.0591	-0.0061	0.1920	-0.2825
3	-0.0204	-0.1799	0.0330	-0.1833	0.2252
4	0.0234	-0.0687	-0.0175	0.0589	-0.0350
5	-0.1100	-0.0024	-0.0873	0.0606	0.0261
6	-0.1046	0.2696	-0.1164	-0.0345	-0.0888
7	0.0149	0.0813	-0.0372	-0.2775	0.1810
8	-0.0345	0.0789	-0.1319	-0.2146	0.4689

Because the catch of juveniles cannot be regarded as a reliable indicator of the year class strength, the WG decided to apply a down-weighting of 0.1 to the catches of 0- and 1-ringers. This implies that the estimates of the youngest age in the most recent years are predominantly determined by the survey data.

To evaluate the contribution of the individual survey indices in the assessment model, runs were carried out whereby the catch-at-age data was tuned by one single index at a time. All model runs were carried out with the appropriate inverse variance weighting for both the indices and the catches. Results are shown in Figure 2.8.3 and indicate that all the surveys are consistent in the predicted SSB in the recent years.

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, a selection period of 5 years was used.

Retrospective analysis

The impact of the different model options were examined through retrospective analysis with assessment years 1995 to 2002. These were run under a number of different separable assumptions and input data weighting methods. The three different data weighting procedures were:

- The inverse variance weighting suggested from the evaluation of index precision presented in the SGEHAP report (ICES 2001/G:02)
- The inverse variance weighting with 0 and 1 ringer catch down-weighted to 0.1
- The 2001 HAWG weighting which is an arbitrary weighting method, giving a weighting of 1 to each index and a weighting of 1 to each year in the catch. An overview of the weighting options are presented in Table 2.8.1.

Two different separable periods were tested:

- A five year separable period covering the period immediately preceding the terminal year
- The historic separable period used by the WG, which varies in both duration and number of independent periods and is given in Table 2.8.1 for recent years and the 1998 assessment WG report (ICES 1998/ACFM/14).

Four scenarios were explored:

A) Inverse variance weighting for input data with historic WG separable periods,

B) Inverse variance weighting for input data and down-weighting 0 and 1 ringer catch, and 5-year separable periods,

C) Inverse variance weighting for input data and down-weighting 0 and 1 ringer catch and historic WG separable periods,

D) HAWG 2001 input data weighting and historic WG separable periods.

The results of the four scenarios are shown in Figure 2.8.4 giving estimates of SSB and F_{2-6} for the years 1990 to 2000 evaluated for assessment years 1995 to 2002. The results may be summarised by considering the change in the estimates of three parameters from one terminal year to another over the period: F2-6, Recruitment and SSB. Change is measured as the difference between the parameter estimate in one year to the estimate of the following year expressed as an absolute value (i.e. without sign). Two criteria are selected,

- The 1st year change (1YC)---the change in the terminal value of the parameter when the assessment year is increased by one.
- The average annual change (AAC) --- the mean of all the changes of each of the parameters during the period 1994 to 2002.

The results are given in Table 2.8.2, which together with Figure 2.8.4 show that:

- the changes in all the retrospective patterns between 2002 and 2001 assessments are small for all the scenarios,
- the differences between the converged VPA from the current assessment (WG 2002) and the assessment in 1994 are small for all scenarios (though a little larger for scenario A), indicating that retrospective patterns in recent years occurred over the period of management- and fishery change,
- there is considerable reduction in the AAC from scenario A to scenario B when the inverse variance weighting is used with the 0 and 1 ringer catch down-weighted,
- there are only small differences between scenario B (the fixed separable period) and scenario C (the varying WG separable periods),
- Both the 1YC and AAC for F is lowest for scenario B (inverse variance weighting with 0 and 1 ringer catch down-weighted) (Table 2.8.2),
- The 1YC for recruitment is lowest with scenario B,
- The AAC for recruitment is lowest for scenario C, but this is only marginally lower than scenario B,
- Both the 1YC and AAC for SSB were lowest with scenario D.

Conclusions from explorations

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

- acoustic survey 1989–2001 (1-9+ ringer)
- IBTS 1983–2002 (2-5+ ringer)
- IBTS 1979–2002 (1-ringer)
- MIK 1977–2002 (0-ringer)
- MLAI<10mm 1979–2001 (biomass index).

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

The use of inverse variance weighting provides a more precise estimate of all parameters than the WG 2001 weighting method (ICES 2001/ACFM:12, see also Section 1.3). In addition, the use of down-weighting of 0 and 1 ringer catches in the separable period provided the most repeatable estimates of F and recruitment in the retrospective analysis. However, the use of WG 2001 weighting and multiple separable periods provided the least changes of SSB. It is not possible to find a solution that satisfies all management parameters at the same time. The weighting scheme selected for the final run then was the inverse variance weighting for both the catches and the survey indices, except for the catches of juveniles (0- and 1 ringer), which were down-weighted to an arbitrary weighting of 0.1.

2.8.2 Stock assessment

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

Details on input parameters and model set-up for the final ICA assessment are presented in Tables 2.8.1 and 2.8.3. Input data are given in Tables 2.8.4-2.8.10. The ICA program operates by minimising the following general objective function:

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

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

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

$$\begin{aligned}
&\sum_{a=0,y=1997}^{a=8,y=2001} \lambda_a \left(\ln(\hat{C}_{a,y}) - \ln(C_{a,y})\right)^2 + \\
&\sum_{y=1979}^{y=2001} \lambda_{mlai} \cdot \left(\ln(q_{mlai} . S\hat{S}B_y^K) - \ln(MLAI_y)\right)^2 + \\
&\sum_{a=2,y=1983}^{a=5+,y=2002} \lambda_{a,ibtsa} \left(\ln(q_{a,ibtsa} \cdot \hat{N}_{a,y}) - \ln(IBTS_{a,y})\right)^2 + \\
&\sum_{y=1979}^{y=2002} \lambda_{ibtsy} \left(\ln(q_{ibtsy} \cdot \hat{N}_{1,y}) - \ln(IBTS_{1,y})\right)^2 + \\
&\sum_{a=1,y=1989}^{a=9+,y=2000} \lambda_{a,acoust} \left(\ln(q_{a,acoust} \cdot \hat{N}_{a,y}) - \ln(ACOUST_{a,y})\right)^2 + \\
&\sum_{y=1977}^{y=2002} \lambda_{mik} \left(\ln(q_{mik} \cdot \hat{N}_{0,y}) - \ln(MIK_y)\right)^2 + \\
&\sum_{y=1960}^{y=2001} \lambda_{ssr} \left(\ln(\hat{N}_{0,y+1}) - \ln\left(\frac{\alpha\, S\hat{S}B_y}{\beta + S\hat{S}B_y}\right)\right)^2
\end{aligned}$$

with the following variables:

a,y	age and year
C	Catch-at-age
$\hat{C}$	Estimated catch-at-age in the separable model
$\hat{N}$	Estimated population numbers
$S\hat{S}B$	Estimated spawning stock size
MLAI	MLAI index (biomass index)
ACOUST	Acoustic index (age disaggregated)
IBTSA	IBTS index (2-5+ ringers)
IBTSY	IBTS index (1 ringers)
MIK	MIK index (0-ringers)
q	Catchability
k	power of catchability model
α, β	parameters to the Beverton stock-recruit model
λ	Weighting factor

Results

The ICA output is presented in Tables 2.8.11-2.8.20 and Figures 2.8.5 - 2.8.11**.** 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 2.8.12. Long-term trends in yield, fishing mortality, spawning stock biomass and recruitment are given in Figure 2.8.13.

The spawning stock at spawning time 2001 is estimated at 1.43 million tonnes. Around 45% of the estimated SSB in 2001 consists of the 1998 year class. However, the 2000 year class is also estimated to be very strong, so that in the near future the stock is expected to increase further. The estimates of SSB in earlier years are higher than in previous assessments. This is due to the use of the inverse variance weighting scheme and the down-weighting of the juvenile catches. For further discussion, see also quality of assessment (section 2.12).

Fishing mortality on 2-6 ringer herring in 2001 is estimated at around 0.24, and on 0-1 ringer herring at 0.04.

Geometric mean recruitment over the period 1983-1998 (the period after the recovery of the collapse) is estimated as 49.0 billion and over the whole time-series as 30.0 billion. The year classes 1998 and 2000 are now estimated as respectively 75.8 and 83.5 billion fish and are expected to contribute to a further increase of the spawning stock. The first estimate of the 2001 year class is 61.1 billion, which is based on the MIK index only.

Sensitivity

The sensitivity of the assessment was explored using a covariance matrix method where 1000 random draws were taken from the parameter-distributions of the ICA model. Using these random parameter vectors, the historical assessment uncertainty was calculated and plotted in Figure 2.8.12. Estimates of fishing mortality at 2-6 ringer and recruitment at 0-ringer are highly sensitive to the parameter estimates. There appears to be a relatively good agreement between the point estimates of the final assessment and the median values of the Monte Carlo evaluations.

2.9 Herring in Divisions IVc and VIId

The estimation and evaluation of the stock component of herring in Divisions IVc and VIId (Downs component) is based on the assessment results of North Sea herring and an algorithm that calculates the proportion of Downs herring in each year class from the 1st quarter IBTS 1-ringer recruitment indices (see Section 2.3).

The observed pattern is corroborated by patterns in abundance of herring larvae in the southern North Sea (see Section 2.5) and the mean age of the Dutch December catch in Division VIId. Periods of high Downs herring SSB should coincide with high abundance of herring larvae and a larger proportion of older fish and hence higher mean age in the catch.

Spawning stock biomass

The IBTS 1-ringer index was used to distinguish the fraction ($P_{a,y}$) of Downs herring for the corresponding year classes per age group (Figure 2.9.1). The Downs component was assumed to consist of the proportion of the stock smaller than 13 cm (Figure 2.9.1, see Section 2.3.5 and ICES 2001/ACFM:12). The spawning stock biomass at age and year ($SSB_{a,y}$) of Downs herring was calculated as:

$$SSB_{a,y} = \Sigma\, N_{a,y} * W_{a,y} * P_{a,y} * O_{a,y} * \exp^{(-F_{a,y} * PF - M_{a,y} * PM)}$$

where N is numbers, W is weight per individual, P is proportion of Downs, O is the proportion of fish spawning, F is fishing mortality, M is natural mortality, and PF and PM are the proportion of F and M that occur before spawning.

It was assumed that weight-at-age, maturity-at-age, fishery mortality and natural mortality of Downs herring were similar to that of the North Sea stock. This approach resulted in a calculated proportion of Downs in the SSB that varied between 18 and 41% (Figure 2.9.2).

Based on the larvae surveys in the southern North Sea and Eastern Channel (see Table 2.5.1) an abundance index was calculated for the southern North Sea only. Mean age of the herring caught in Division VIId can be calculated by weighting the age-at-length with the numbers catch-at-length.

For an evaluation of the estimated SSB of Downs herring in the North Sea stock a comparison could be made with the larval abundance index in the southern North Sea and the mean age in the Dutch December catches in Division VIId, both of which are presented in Figure 2.9.3. All series show a similar pattern, i.e. an increase in the second half of the eighties followed by a decrease to a minimum around 1995 or 1996, after which the level increased again. Although the observed fluctuations in SSB are not exactly in phase with those in larval abundance and mean age, the overall impression is that the present level of the stock is near the high level observed in the late 1980s and early 1990s.

However, the strong increase in SSB in the North Sea stock in 2001 is not mirrored in the Downs component.

Recruitment

The trends in estimated recruitment of 1-ringers of the Downs component are shown in Figure 2.9.1 and show an increase in recruitment in recent years. There is no 0-ringer Downs index presently available because the survey coverage of the MIK does not allow a separation into North Sea and Downs components.

Catch separation

Catches of Downs herring cannot be separated from catches of other North Sea components at present. However, the possibility of using otolith microstructure will be explored in the EU-funded HERGEN project (2002-2004) that would possibly allow for stock separation of winter and autumn-spawners from the entire stock.

2.10 Short-term projection by fleets

2.10.1 Method

As explained in Section 1.3.3, the WG decided to abandon the previous practise of projecting the stock forwards by area, 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. Thus, a multifleet prediction with 4 fleets is provided.

The standard tool that is currently available (the MFDP program) has some limitations with regard to management options that should 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. To allow for exploring a wider range of options, a short-term prediction program (MFSP) was developed during the meeting.

This program, which is written in Fortran, can assume a catch constraint or an F-constraint for each fleet in the intermediate year, and screen over a range of fishing mortalities for each fleet independently in the prediction year. Fishing mortalities by fleet and total fishing mortality for the ages 0-1 and 2-6, as well as catches by fleet and SSB in the prediction year are printed for each set of fishing mortalities. Comparative runs with MFDP confirmed that the results were the same for the intermediate year and for selected combinations of fishing mortalities in the prediction year that could be produced by the MFDP program. A copy of the program can be found in the HAWG WG files (Software directory).

Input to the new MFSP program is stock numbers-at-age at the start of the intermediate year, selection pattern for each of the fleets, weights and maturities-at-age and proportion of mortality realised before spawning. The MFDP program was used to generate fleetwise selections-at-age, weights-at-age and maturities-at-age, taking averages over the last two years, as well as status quo fleetwise partial fishing mortalities.

2.10.2 Input data

Fleet definitions

The fleet definitions are the same as last year. The fleet definitions are:

North Sea

Fleet A: Directed herring fisheries with purse seiners and trawlers
Fleet B: All other vessels where herring is taken as by-catch

Division IIIa

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

Input data for short-term projections

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

The starting point for the projection is the stock of North Sea autumn-spawners in the North Sea and Division IIIa combined at 1 January 2002.

Stock numbers:

For the start of 2002 the total stock number was taken from ICA (Population abundance year 2002, Table 2.8.12).

For 0-ringers in 2003, the stock number was set to 49 000 million, which is the geometric mean of the recruitments in the period 1983 – 1998. This value is somewhat larger that the value used in previous years, to reflect the present perception of the recent recruitments and that the stock now appears to be increasing.

Fishing mortalities: Selection by fleet-at-age was calculated using the MFDP software based on the catches-at-age by fleet, by taking the fishing mortalities-at-age from Table 2.8.11 and split them by fleet proportional to the catches-at-age by fleet from Table 2.2.6. The selections were the averages of these mortalities over the last two years.

Mean weights-at-age in the stock: The averages of the last 2 years' mean weights (2000 and 2001) were used (Table 2.8.5). Note that weights used in the assessment are already smoothed.

Maturity-at-age: The average maturity-at-age for 2000 and 2001 was used (Table 2.8.7)

Mean weights in the catch by fleet: A weighted mean of the last two years was taken i.e., 2000 and 2001 (Table 2.2.6).

Natural Mortality: Unchanged from last year. Table 2.8.6.

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 2.10.1.

2.10.3 Prediction for 2002 and management option tables for 2003

Assumptions and predictions for 2002

Two alternative options were used for the fishery in 2002, either $F_{status\ quo} = F_{2001}$, or a catch constraint. As in recent years, there has been some overshoot of the overall TAC for North Sea autumn spawners. The TACs for 2002 are the same as for 2001. Hence, the catches in 2001 were used for catch constraints for 2002, implying that the same overshoot as in 2001 was assumed. The values appear in Table 2.10.3.

Management option tables for 2003

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.

The options table (Tables 2.10.2 and 2.10.3) shows some of these combinations.

A projection assuming F status quo for all fleets is presented. This implies an F on adults close to 0.25, but a low fishing mortality on juveniles.

Two runs are included where the fishing mortality of the C and D fleets varies in proportion to the B fleet, maintaining the ratios between these fleets as in the status quo fishing mortalities. The examples have $F_{2\text{-}6}$ close to 0.2, but different fishing mortalities for the 0-1 ringers.

In the remaining examples, some combinations of fishing mortalities for the four fleets that give an $F_{0\text{-}1}$ close to 0.12 and $F_{2\text{-}6}$ close to 0.25 are shown. The combinations in addition satisfy constrains that the catch by the C fleet shall be close to either 30, 50 or 70 thousand tonnes, and the catch of the D fleet close to either 10, 20 or 30 thousand tonnes.

All scenarios indicate a rapid increase in spawning biomass and in yield. This is mainly caused by the 1998 year class, which is estimated to be strong, and the 2000 year class, which also appears strong in the surveys.

2.10.4 Comments on the short-term projections

Assuming $F_{status\ quo}$ for 2002 leads to larger catches in 2002 and lower catches and biomasses for 2003 than assuming catches in 2002 as estimated for 2001. This is because the stock is expected to increase so that keeping the catch constant from 2001 to 2002 will imply a reduced fishing mortality in 2002 compared to 2001.

The work by the SGEHAP leads to abandoning the area-based predictions. Making fleetwise predictions for 4 fleets that are more or less independent remains problematic, however, both due to the lack of software that has the necessary flexibility, and in terms of presenting results. The software solution applied here was an ad hoc solution, which should be regarded as provisional, and further development should be done with such software.

Presenting results that allow managers to overview the range of possible trade-offs between fleets remains a challenge. The examples presented here intend to indicate the range of catches that are possible for the A and B fleets within the constraints set by the EU-Norway agreement, and with plausible levels of the catches in Division IIIa. In order to make precise estimates of the correspondence between catches by the A and B fleets, extensions of the present software are needed, in particular implementation of catch constraints for some fleets in the prediction year. Due to time constraints, this could not be done during the meeting, but it is intended to amend the program before the report is presented to ACFM.

2.11 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. Recruitment, however, is treated differently. A Beverton-Holt stock-recruit relationship with no autocorrelation is fitted (Figure 2.11.1). A non-parametric bootstrap method was used to generate recruitments in the pseudo-data sets used for the projections: Uncertainty in future recruitments around the stock-recruitment relationship was modelled by randomly drawing values from the historic time-series of log residuals. The ICP program (Version 1.4w) was used to implement the method.

Two medium-term projections were carried out with the following assumptions about the fishing mortality from 2002 onwards.

1. **F(0-1)** = $F(0\text{-}1)_{2001}$=0.044, **F(2-6)** = $F(2\text{-}6)_{2001}$=0.24
2. **F(0-1)** = $\mathbf{F}_{pa}(0\text{-}1)$=0.12, **F(2-6)** = $\mathbf{F}_{pa}(2\text{-}6)$=0.25

The input to the medium-term analysis was taken from the short-term analysis:

- The mean maturity ogive as measured in 2000-2001 has been assumed to hold for the years 2002 and thereafter.
- The natural mortality that was used for the assessment has been assumed to hold for the years 2002 and thereafter.
- The proportions of F and M before spawning in the projections were as used in the assessment.
- The weight-at-age in the stock were taken as the mean values from 2000 and 2001.
- The weights-at-age in the catches by fleet were taken as the mean values from 2000 and 2001.
- The projections start from the populations on 1 January 2002 (ages 1–9+) and recruitment on 1 January 2002 (age 0) calculated in the assessment procedure.
- The overall exploitation pattern generated by ICA, was assumed to hold for 2002 and thereafter.
- The relative fishing mortality by fleet and at age as estimated for 2000 and 2001 was assumed to hold in future years.

An example of the projection file (for run 1) is provided as Table 2.11 1. The medium-term projection scenarios modelled are given in detail in Figures 2.11.1–2.11.2.

A strong increase in SSB is expected in all scenarios. This is due to the strong 1998 and 2000 year classes which are expected to contribute to the rebuilding of the stock. Once the predicted stock is at a high level, the stock recruitment relationship will then tend to keep the predicted SSB at high levels. The risk of SSB falling below $\mathbf{B}_{lim}$ (0.8 million tonnes) or below $\mathbf{B}_{pa}$ (1.3 million tonnes) is very small when fishing at F *status quo* or according to the EU-Norway agreement.

It should be emphasized that the predictions are conditional on the stock recruitment relationship which drives the catches proportional to the assumed recruitment. The absolute levels estimated from the medium-term analysis are not considered appropriate for management purposes.

2.12 Biological reference points

Biological reference points were estimated using the PA software. Input for the estimation was identical to the input to the short-term forecast (Table 2.12.1). Resulting estimates of biological reference points are shown in the text table below and the uncertainty of the estimates in Figure 2.12.1.

Fmax	F0.1	Flow	Fmed	Fhigh	F35%SPR	Floss
0.43	0.13	0.23	0.68	1.48	0.13	2.28

2.13 Quality of the assessment

The assessment data and assessment methodology for North Sea herring have been evaluated extensively, first within the study group SGEHAP (ICES 2001/ACFM 22) and then during HAWG 2002.

SGEHAP evaluated the impact of sampling uncertainty in catch and survey indices. Assessments were carried out using bootstrap realisations of all the variable assessment data, i.e., the catch numbers, catch weights, stock weights, proportion mature, and all the survey indices. The variance of the input data was evaluated using the same methodology for all the data sets and followed the bootstrap methodology developed by O' Brien *et al*. (2002). A number of weighting methods were evaluated including the previous WG weighting, inverse variance weighting and ICA adaptive weighting. This investigation provided an objective basis for selecting a weighting method for the different input data in the assessment of North Sea herring. The inverse variance weighting method provided the lowest variance estimates for the management parameters in the terminal year of the 2001 assessment. A brief review is included in Section 1.3 and a more detailed evaluation can be obtained in the Study Group report (ICES 2001/ACFM22).

The WG considered the influence of the separable period on the assessment, and in particular the estimation of 0, 1 and 2 ringers in the final assessment year. There was considerable conflict between the survey data and the indications from the catch. However, there is also conflict between catch of the same year classes in different years and thus the assumption of a separable period. In contrast the survey estimates of year classes in recent years were in relatively good agreement. This can be seen, for example, in Figure 2.3.4 where the successive estimates of year class strength estimated at 0 and 1 ring in the MIK and IBTS are compared. The 1997 – 2000 year classes are all close to the fitted line. This aspect is discussed extensively within section 2.8.1. The WG concluded that it was preferable to give more weight to survey data than to the catch data for these age groups. The influence of this was evaluated through a retrospective analysis, presented within section 2.8.1. The extent of annual revision of F, Recruitment and SSB was evaluated for different models and weighting options. This evaluation concluded that the best overall option was to select inverse variance weights, with down-weighting for catch of 0 and 1 ring in a five-year separable model.

There have been some minor revisions to the catch data, weights-at-age in the stock, and the acoustic survey index at age. The results of these changes were found to be small (see for example Table 2.4.6).

In this year's assessment, the different surveys were all found to display the same substantial upward trend in SSB, though with different magnitudes, when used as a single tuning index with the catch-at-age data (Figure 2.8.3).

The current assessment revises the estimate of SSB in 2000 upward by about 20% from 772,000 t to 946,000 t. In addition, the 1999 SSB is also revised upward by about 15%, from 815,000 to 937,000 t; this is now in better agreement with the WG 2000 estimate at 906,000 t. It is believed that more consistent results are obtained by giving more weighting to the survey data compared to the 0 and 1 ringer catch data within the separable model.

While there is unequivocal evidence that the 2001 SSB has increased substantially from SSB in 2000, the exact scale of this increase and the size of the future recruiting year classes are still uncertain. The three incoming year classes are not yet well known. The 2000 year class is estimated in good agreement with two surveys (MIK and IBTS1) but the catch in 2001 gives a higher estimate. For the 1999 year class the Acoustic survey 1 ring, MIK 0 ring, IBTS 1 ring, and catch at 1 ring are all in close agreement contrasting with the catch at 0 ring, which tends to overestimate this year class. For the 1998 year class, which is thought to be 77% mature and contribute 45% of the current SSB, there are a number of sources of information, some with quite substantial sources of conflict; the MIK, IBTS 1-2 ring, and Acoustic 2 indices all agree. The catch at 1 and 2 ring moderately under estimate, the acoustic 1 ring tends to overestimate, while the IBTS 3 ring underestimates by more. Uncertainty in abundance or proportion mature of this 1998 year class influences the precision of the assessment. While we believe that the current assessment is the best evaluation of the current state of the stock it is likely that the size of these three years classes will be revised in future.

While the choices between assessment model settings influence the estimate of SSB and F in 2001, there is less influence on the future development of the stock. The current choice of model, compared with one without down-weighting of 0 and 1 ring in the catch, decreases the apparent abundance of 2 ringers but in compensation elevates the older ages. It also decreases the estimate of the 2000 year class by about 25%. The result is a similar perception of SSB in two years time.

The current estimate of SSB is 1,428,000 t; this can be compared to the prediction in 2001 of 1,244,000 t. However, this prediction was from a lower baseline of 772,000 t; following the revision in the model settings this year the SSB in 1999 is now closer to the 2000 assessment. The prediction for SSB in 2001, from the 2000 WG, assuming a TAC overshoot, was given as 1,470,000 t. This compares well with the current estimate.

The short-term prediction method has been substantially modified. 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 over the last few years has not been used this year. A multi-fleet, multi-option, deterministic short-term prediction programme has been written and used to provide a range of fleet-wise catch options for 2003; the results of these are given in section 2.11. To validate the calculations in the multi-option programme a multi-fleet F status quo run was carried out using both this programme and MDFP and the results were the same. This programme is still under development. The current short prediction is that the North Sea autumn-spawning herring stock SSB in 2003 will be around 2.2 Mt.

Medium-term predictions have been carried out for two scenarios, *status quo* F ($F_{0-1} = 0.044$, $F_{2-6} = 0.24$), which gives a stock of about 3.3Mt and the EU-Norway agreement ($F_{0-1} = 0.12$, $F_{2-6} = 0.25$), which gives a stock of about 2.5Mt in ten years. Both of these predictions should be viewed with caution, they assume that the fishery will be constrained by the TAC to the required F, the recruitment is dependant on the assumption of a Beverton and Holt recruitment model which provides high levels of recruitment at the predicted stock size. There is insufficient data to support the estimates of recruitment at these stock sizes.

2.14 Management considerations

The current assessment suggests that the spawning stock biomass is now increasing rapidly, and is expected to increase further in the coming year. The point estimate of the spawning stock biomass at spawning time in 2001 was 1.43 million tonnes, and in 2002 it is expected to increase to approximately 1.7 million tonnes.

According to the harvest control rule agreed by EU and Norway, the fishing mortality at spawning stock biomass above 1.3 million tonnes should be constrained by F=0.12 for the ages 0 to 1 and to F = 0.25 for the ages 2-6. This rule is considered to be in accordance with the precautionary approach by ACFM.

The encouraging perception of the state of the stock relies heavily on the strong 1998 year class. This year class has appeared to be strong in all surveys so far, but has not appeared in the fishery for adults as one might expect. Furthermore, the 2000 year class also appears to be very strong in the surveys, and the indications for the 2001 year class is that it is also above average. In general, recruitment of herring is the last 3 years is well above average and similar to the high level in the mid-1980s.

The assessments in previous years have tended to overestimate the stock abundance and underestimate the fishing mortality. This has been attributed to the estimation problems created by the change in exploitation of juveniles in 1996, which implied a shift in the selection pattern. This year's assessment estimates a somewhat larger stock and lower mortality in the recent past than in last years assessment, suggesting that last year's assessment may have underestimated the stock. Whether this implies that the problem has been solved remains to be seen.

The current adult stock is dominated by one large year class. The aim of the harvest control regime is to provide an adult stock with a broader age composition, giving a buffer stock to withstand variations in recruitment. In this sense, the stock is still in a rebuilding phase. At least in the medium term it is therefore mandatory that the fishing mortality is kept at a moderate level, as defined in the EU–Norway agreement, to allow establishing a better balance between young and old fish in the stock.

The agreed harvest control rule allows for some outtake of juvenile herring, at a predefined fishing mortality. The information of the year classes that enter this fishery is sparse when quota decisions are taken, However, more information becomes available at the time when the fishery takes place. Thus, regulations of this juvenile fishery face the same challenges as regulating fisheries on short-lived species. Some kind of in-year adaptation of the TAC as new information comes in may be necessary to set quotas that take the recruitment variation properly into account.

The medium-term predictions (see Section 2.11) are extremely optimistic about the development of the stock with different scenarios of fishing mortality. However, it should be recognized that the results are very dependent on the stock-recruitment curve that underlies the simulation. The WG considered that the absolute values in medium-term analysis using the Beverton and Holt stock recruitment relationship were unrealistic and should not be used for management purposes.

Misreporting of catches in several parts of the North Sea and adjacent areas is still a major source of uncertainty. The WG has included the patterns of misreporting within the short-term projections. Catches taken in the period 1984 to 2001 in Division IV, VIId and reported in areas VIa North, IIa and IIIa, were included in the catch-in-numbers used for the assessment of this stock. However, there is little hard evidence for the extent of this misreporting and the catch reallocation is carried out with limited confidence. Permission for scientists in all countries to get access to VMS data could improve the estimation of the amount of misreporting.

The level of discards and slippage is largely unknown, and the discard estimates supplied are thought to be an under-estimate of the total discards. Several discard sampling programs have recently been started to address this issue.

The Downs component of the North Sea herring stock is managed separately because this component is believed to be very susceptible to intense fishing pressure during spawning (in IVc and VIId) in the winter months. In line with the reduction in TAC for the North Sea herring fishery in the middle of 1996, the TAC for IVc and VIId was reduced to 25,000 tonnes and has been kept fixed until 2002, when it was increased to 42 000 t. In general the catches estimated by the WG have overshot the agreed TAC's considerably. In the last five years, catches were about twice as high as the TAC (Figure 2.13.1). Considerable catches taken in Divisions IVc and VIId were misreported to other Divisions. Although it is not possible to estimate separate fishing mortalities for the Downs component (because the catches occur mixed with the North Sea herring during a large part of the year), there are at least indications of the relative change of the Downs component SSB. The available information indicates that the stock component has increased over the last 4 to 5 years and is presently at around the high level of the late 1980s. However, the strong increase in SSB in the North Sea stock in 2001 is not mirrored in the Downs component.

Table 2.1.1 HERRING caught in the North Sea (Sub-area IV and Division VIId).
Catch in tonnes by country, 1992–2001. These figures do not an all cases correspond to the official statistics and cannot be used for management purposes.

Country	1992	1993	1994	1995	1996
Belgium	242	56	144	12	-
Denmark	193968	164817	121559	153363 [9]	67496
Faroe Islands	-	-	-	231 [9]	-
France	16587	12623	27941	29499 [9]	12500
Germany, Fed.Rep	42665	41619 [9]	38394	43798	14215
Netherlands	75683	79190	76155	78491	35276
Norway [4]	116863	122815	125522	131026	43739
Sweden	4939	5782	5425	5017	3090
USSR/Russia				-	-
UK (England)	11314	12002 [10]	14216	14676	6881
UK (Scotland)	56171	55532	49919	44813	17473
UK (N.Ireland)	-	-	-	-	-
Unallocated landings	25867	18410	5749	33584 [9]	24475
Misreporting from VIaN	22594	24397	30234	32146	38254
Total landings	566892	537243 [9,10]	495258	566656	263399
Discards	4950	3470	2510	-	1469
Total catch	**571842**	**540713** [9,10]	**497768**	**566656** [9]	**264868**
Estimates of the parts of the catches which have been allocated to spring-spawning stocks					
IIIa type (WBSS)	7854	8928	13228	10315	855
Thames estuary [5]	202	201	215	203	168

Country	1997	1998	1999	2000 [1]	2001 [1]
Belgium	1	1	2	1	-
Denmark [7]	38431	58924	61268	64123	67096
Faroe Islands	-	25	1977	915	1082
France	14524	20783	26962	20952	24515
Germany	13381	22259	26764	26687	29779
Netherlands	35129	50654	54318	54382	52390
Norway [4]	38745 [13]	68523 [13]	70718	72844	75089
Sweden	2253	3221	3241	3046	3695
Russia	1619	-	-	-	-
UK (England)	3421	7635	10598	11179	14582
UK (Scotland)	22914	32403	29911	30033	26719
UK (N.Ireland)	-	-	-	915	1018
Unallocated landings	27583	27722	21653	37707 [12]	25849
Misreporting from VIaN	29763 [6]	32446	23625	[8]	[8]
Total landings	227763	324596	331036	322784	321814
Discards	6005	3918	4769	6354 [12]	1386
Total catch	**233769** [6]	**328514**	**335805**	**329138**	**323200**
Estimates of the parts of the catches which have been allocated to spring-spawning stocks					
IIIa type (WBSS)	979	7833	4732	6649	6449
Thames estuary [5]	202	88	88	76	107
Others [11]				378	1097

[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] not in accordance with official final catch figures, should be corrected prior to next year's working group.

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	1992	1993	1994	1995	1996
Denmark	10751	10604	20017	17748	3237
Faroe Islands	-	-	-	-	-
France	4714 [4]	3362	11658	10427	3177
Germany	21836	17342 [4]	18364	17095	2167
Netherlands	29845	28616	16944	24696	2978
Norway	39244	33442	56422	56124	22187
Sweden	985	1372	2159	1007	2398
UK (England)	4916	4742	3862	3091	2391
UK (Scotland)	39269	36628 [4]	44687	40159	12762
UK (N. Ireland)	-	-	-	-	-
Unallocated landings	4855	-8271 [5]	3214 [9]	26018	9959
Misreporting from VIa North	22593	24397	30234	32146	38254
Total Landings	179008	152234	207561	228511	99510
Discards	850	825	550	-	356
Total catch	**179858**	**153059**	**208111**	**228511**	**99866**

Country	1997	1998	1999	2000	2001 [1]
Denmark [7]	2667	4634	15359	25530	17770
Faroe Islands	-	25	1977	205	192
France	361	4757	6369	3210	8164
Germany	-	7752	11206	5811	17753
Netherlands	6904 [9]	11851	17038	15117	18560 [10]
Norway	16485 [12]	27218 [12]	30585	32895	11472
Sweden	1617	245	859	1479	1418
Russia	1619	-	-	-	-
UK (England)	-	4306	7163	8859	12283
UK (Scotland)	17120	30552	28537	29055	25105
UK (N. Ireland)	-	-	-	996	1018
Unallocated landings	7574	15952	3889	30581 [11]	17578
Misreporting from VIa North	29763 [6]	32446	23625	[8]	[8]
Total Landings	84110	139738	146607	153738	131313
Discards	1138	730	654	5841 [11]	1386
Total catch	**85248** [6]	**140468**	**147261**	**159579**	**132699**

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.
12 not in accordance with official final catch figures, should be corrected prior to next year's working group.

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	1992	1993	1994	1995	1996
Denmark [5]	53692	43224	43787	45257	19166
Faroe Islands	-	-	-	-	-
France	- [3]	4	14	+	-
Germany	- [3]	- [3]	-	-	-
Netherlands	-	-	-	-	-
Norway [2]	61379	56215	40658	62224	18256
Sweden	508	711	1010	2081	
UK (Scotland)	196	- [3]	-	-	693
Unallocated landings	-	-	-	-	-
Total landings	115775	100154	85469	109562	38115
Discards	-	-	-	-	-
Total catch	**115775**	**100154**	**85469**	**109562**	**38115**

Country	1997	1998	1999	2000	2001 [1]
Denmark [5]	22882	25750	18259	11300	18466
Faroe Islands	-	-	-	710	890
France	3	-	115	-	-
Germany	4576	-	-	29	-
Netherlands	-	-	1965	38	-
Norway [1]	18490 [6]	41260 [6]	37433	39696	56287
Sweden	427	1259	772	1177	517
Unallocated landings	-	-	-1965 [4]	-4 [4]	0 [4]
Total landings	46378	68269	56579	52946	76160
Discards	-	-	-	-	-
Total catch	**46378**	**68269**	**56579**	**52946**	**76160**

1 Preliminary
2 Catches of Norwegian spring-spawning 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 not in accordance with official final catch figures, should be corrected prior to next year's working group

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	1992	1993	1994	1995	1996 [6]
Belgium	13	-	-	-	-
Denmark [4]	125229	109994	55060	87917	43749
Faroe Islands	-	-	-	231 [8]	-
France	2313	2086	5492	7639	2373
Germany	20005	23628	14796	21707	11052
Netherlands	26987	31370	39052	30065	18474
Norway	16240	33158	28442	12678	3296
Sweden	3446	3699	2256	1929	-
UK (England)	3026	3804	7337	9688	2757
UK (Scotland)	16707	18904	5101	4654	4449
Unallocated landings [3]	-13637	-16415	-26988	-10831 [9]	-8826
Total landings	200329	210228	130548	165677	77324
Discards [1]	1900	245	460	-	592
Total catch	**202229**	**210473**	**131008**	**165677** [9]	**77916**

Country	1997	1998	1999	2000	2001 [1]
Belgium	-	-	1	-	-
Denmark [4]	11636	26667	26211	26825	30277
Faroe Islands	-	1	-	-	-
France	6069	8944	7634	10863	7601
Germany	7456	13591	13529	18818	8340
Netherlands	14697	27408	22825	26845	24160
Norway	3770	45	2700	253	7330
Sweden	209	1717	1610	390	1760
UK (England)	2033	1767	1641	669	814
UK (Scotland)	5461	1851	1374	978	1614
Unallocated landings [3]	-1615	-11270	-313	-13769	-12878
Total landings	49716	70720	77212	71872	69018
Discards [1]	1855	1188	873	317	- [2]
Total catch	**51571**	**71908**	**78085**	**72189**	**69018**

[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	**1992**	**1993**		**1994**	**1995**	**1996**
Belgium	229	56		144	12	-
Denmark	4296	995		2695	2441	1344
France	9560	7171		10777	11433	6950
Germany	824	649		4964	4996	997
Netherlands	18851	19204		20159	23730	13824
UK (England)	3372	3456	10	3016	1896	1733
UK (Scotland)	-	-		131	-	262
Unallocated landings	34649	43096		29792	18397	23934
Total landings	71781	66776	10	71678	62905	49044
Discards [1]	2200	2400		2400	-	521
Total catch	**73981**	**69176**	#	**74078**	**62905**	**49565**
Coastal spring spawners included above [2]	202	201		215	203	168

Country	**1997**	**1998**	**1999**	**2000**	**2001**	
						1
Belgium	1	1	1	1	-	
Denmark	1246	1873	1439	468	583	
France	8091	7081	12844	6879	8750	
Germany	1349	916	2029	2029	3686	
Netherlands	13528	11395	12490	12348	9670	
UK (England)	1388	1562	1794	1537	1485	
UK (Scotland)	333	-	-	-	-	
Unallocated landings	21624	23040	20042	20966	21149	
Total landings	47559	45868	50639	44228	45323	
Discards	3012	2000	3242	196	-	3
Total catch	**50571**	**47868**	**53881**	**44424**	**45323**	
Coastal spring spawners included above [2]	143	88	88	76	147	11

[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**
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
Recommended Divisions IVc, VIId	30	30	50-60 [6]	54	50	50	50	- [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
Agreed Div. IVc, VIId	30	30	50 [6]	50	50	50	50	50; 25 [13]	25	25	25	25	25	42
Bycatch ceiling in the small mesh fishery									24	22	30	36	36	36
CATCH (IV and VIId)														
National landings Divisions IVa,b [3]	639	499	495	481	463	421	456	176	144	241	255	263	272	
Unallocated landings Divisions IVa,b	-2	14	30	14	-1	6	47	39	36	37	25	16	5	
Discard/slipping Divisions IVa,b [4]	3	4	2	3	1	1	0	1	3 [16]	2	2	6	1	
Total catch Divisions IVa,b [5]	638	516	527	498	463	428	503	216	183 [16]	281	282	285	278	
National landings Divisions IVc, VIId [3]	30	24	42	37	40	42	45	25	26	23	31	23	24	
Unallocated landings Divisions IVc,VIId	48	32	16	35	43	30	18	24	22	23	20	21	21	
Discard/slipping Divisions IVc, VIId	1	5	3	2	2	2	-	1	3	2	3	0.2	0	
Total catch Divisions IVc, VIId	79	61	61	74	85	74	63	50	51	48	54	44	45	
Total catch IV and VIId as used by ACFM [5]	**717**	**578**	**588**	**572**	**548**	**498**	**566**	**266**	**234** [16]	**329**	**336**	**329**	**323**	
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	
North Sea autumn spawners industrial (Fleet B)	N.a.	N.a.	134	124	101	38	65	38	13	14	15	18	20	
Baltic-IIIa-type spring spawners	20	8	8	8	9	13	10	0.9	0.9	8	5	7	6	
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	
North Sea autumn spawners in IV and VIId total	**696**	**569**	**580**	**564**	**539**	**485**	**559**	**265**	**233** [16]	**320**	**331**	**322**	**308**	
Division IIIa: TAC (IIIa)														
Predicted catch of autumn spawners			96	153	102	77	98	48	35	58	43	53	67	63
Recommended spring spawners	84	67	91	90	93–113	- [9]	- [12]	- [12]	- [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
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
CATCH (IIIa)														
National landings	192	202	188	227	214	168	157	115	83	120 [16]	86	108	90	
Catch as used by ACFM	162	195	191	227	214	168	157	115	83	105 [16]	86	108	90	
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	
Autumn spawners mixed clupeoid (Fleet D) [19]	N.a.	N.a.	13	23	25	12	6	12	4	5	8 [17]	13	12	
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**	
Spring spawners human consumption (Fleet C)	N.a.	N.a.	68	53	68	59	59	69	34	43	44 [17]	53	39	
Spring spawners mixed clupeoid (Fleet D) [19]	N.a.	N.a.	5	2	1	1	2	1	1	3	3 [17]	5	3	
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**	
North Sea autumn spawners Total as used by ACFM	**787**	**646**	**657**	**716**	**671**	**571**	**629**	**307**	**273** [16]	**380**	**370** [17]	**372**	**364**	

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.

Table 2.2.1: North Sea Autumn-spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2001. Catch in numbers (millions) at age (CANUM), by quarter and division

WR	IIIa NSAS	IVa(E) all	IVa(E) WBBS	IVa(E) NSAS only	IVa(W)	IVb	IVc	VIId	IVa & IVb NSAS	IVc & VIId	Total NSAS	Herring caught in the North Sea
Quarters: 1-4												
0	**807.8**	**0.0**	**0.0**	**0.0**	**0.0**	**1008.8**	**16.1**	**0.0**	**1008.8**	**16.1**	**1832.7**	**1024.9**
1	**563.6**	**5.5**	**0.5**	**5.0**	**5.3**	**67.5**	**4.8**	**0.0**	**77.9**	**4.8**	**646.3**	**83.1**
2	**150.0**	**172.9**	**11.3**	**161.6**	**365.9**	**98.3**	**4.4**	**74.2**	**625.8**	**78.6**	**854.4**	**715.7**
3	**17.2**	**135.7**	**10.2**	**125.5**	**133.0**	**85.2**	**4.0**	**129.9**	**343.8**	**133.9**	**494.9**	**487.9**
4	**1.4**	**72.9**	**6.1**	**66.8**	**89.8**	**48.5**	**1.2**	**62.6**	**205.0**	**63.8**	**270.2**	**275.0**
5	**0.3**	**80.0**	**7.2**	**72.9**	**124.8**	**63.8**	**1.6**	**31.1**	**261.5**	**32.7**	**294.4**	**301.3**
6	**0.5**	**22.5**	**2.7**	**19.8**	**37.2**	**12.1**	**0.5**	**5.5**	**69.1**	**5.9**	**75.5**	**77.7**
7	**0.0**	**14.2**	**1.6**	**12.6**	**16.1**	**9.8**	**0.2**	**1.5**	**38.5**	**1.7**	**40.3**	**41.8**
8	**0.0**	**3.6**	**0.4**	**3.2**	**9.8**	**24.6**	**0.2**	**0.8**	**37.6**	**1.0**	**38.6**	**39.0**
9+	**0.0**	**0.4**	**0.0**	**0.4**	**1.9**	**0.2**	**0.0**	**0.0**	**2.4**	**0.0**	**2.4**	**2.5**
Sum	**1540.8**	**507.7**	**39.9**	**467.8**	**783.9**	**1418.7**	**32.8**	**305.7**	**2670.4**	**338.5**	**4549.7**	**3048.9**
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	232.8	0.0	0.0	0.0	0.1	8.7	4.7	0.0	8.7	4.7	**246.2**	**13.4**
2	73.6	22.8	0.0	22.8	16.4	12.2	3.4	0.9	51.5	4.3	**129.4**	**55.8**
3	4.2	17.3	0.0	17.3	8.6	6.8	2.6	13.1	32.7	15.8	**52.6**	**48.4**
4	0.1	20.7	0.0	20.7	7.7	5.2	0.4	4.6	33.6	5.0	**38.7**	**38.7**
5	0.0	20.9	0.0	20.9	8.7	4.5	1.3	13.2	34.1	14.5	**48.7**	**48.6**
6	0.0	2.6	0.0	2.6	5.6	0.1	0.5	4.8	8.3	5.2	**13.6**	**13.5**
7	0.0	2.1	0.0	2.1	1.1	0.2	0.1	1.5	3.4	1.7	**5.1**	**5.1**
8	0.0	1.1	0.0	1.1	0.7	0.2	0.1	0.8	2.0	0.9	**2.9**	**2.9**
9+	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	**0.1**	**0.1**
Sum	**310.8**	**87.6**	**0.0**	**87.6**	**48.9**	**37.9**	**13.2**	**39.0**	**174.4**	**52.1**	**537.4**	**226.6**
Quarter: 2												
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	**0.0**
1	87.0	5.5	0.5	5.0	3.8	28.5	0.1	0.0	37.4	0.1	**124.4**	**37.9**
2	40.6	75.9	2.9	73.0	60.7	31.7	0.1	0.0	165.4	0.1	**206.1**	**168.4**
3	5.6	82.1	6.3	75.8	37.9	23.3	0.0	0.1	137.0	0.1	**142.6**	**143.4**
4	0.2	34.0	3.6	30.4	9.8	10.0	0.0	0.0	50.1	0.1	**50.4**	**53.8**
5	0.1	41.1	4.3	36.8	8.4	12.3	0.1	0.1	57.5	0.1	**57.8**	**62.0**
6	0.1	14.7	1.6	13.2	2.5	4.0	0.0	0.0	19.6	0.0	**19.7**	**21.2**
7	0.0	8.4	0.9	7.5	0.9	2.3	0.0	0.0	10.7	0.0	**10.7**	**11.6**
8	0.0	1.8	0.2	1.6	0.9	1.0	0.0	0.0	3.6	0.0	**3.6**	**3.8**
9+	0.0	0.3	0.0	0.3	0.2	0.2	0.0	0.0	0.7	0.0	**0.7**	**0.7**
Sum	**133.6**	**263.8**	**20.3**	**243.5**	**125.2**	**113.2**	**0.3**	**0.2**	**481.9**	**0.5**	**616.0**	**502.7**
Quarter: 3												
0	791.8	0.0	0.0	0.0	0.0	268.9	1.1	0.0	268.9	1.1	**1061.7**	**269.9**
1	165.7	0.0	0.0	0.0	1.4	30.3	0.1	0.0	31.7	0.1	**197.4**	**31.8**
2	26.9	31.2	8.4	22.8	275.8	40.3	0.0	0.2	339.0	0.2	**366.0**	**347.6**
3	4.6	19.7	3.9	15.8	78.5	31.1	0.0	0.3	125.5	0.3	**130.4**	**129.7**
4	0.9	8.4	2.5	5.9	60.1	24.5	0.0	0.1	90.5	0.2	**91.6**	**93.2**
5	0.1	9.3	2.8	6.5	104.8	36.7	0.0	0.0	147.9	0.1	**148.1**	**150.8**
6	0.3	3.7	1.1	2.6	28.8	3.8	0.0	0.0	35.2	0.0	**35.5**	**36.3**
7	0.0	2.2	0.7	1.5	13.8	5.3	0.0	0.0	20.7	0.0	**20.7**	**21.3**
8	0.0	0.6	0.2	0.4	8.1	22.9	0.0	0.0	31.4	0.0	**31.4**	**31.6**
9+	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	1.7	0.0	**1.7**	**1.7**
Sum	**990.2**	**75.2**	**19.6**	**55.5**	**573.0**	**463.8**	**1.3**	**0.6**	**1092.3**	**1.9**	**2084.5**	**1113.9**
Quarter: 4												
0	16.0	0.0	0.0	0.0	0.0	740.0	15.0	0.0	740.0	15.0	**771.0**	**755.0**
1	78.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**78.2**	**0.0**
2	8.9	43.0	0.0	43.0	12.9	14.0	0.8	73.2	69.9	74.0	**152.8**	**143.9**
3	2.8	16.5	0.0	16.5	8.1	24.1	1.3	116.5	48.7	117.8	**169.2**	**166.5**
4	0.2	9.8	0.0	9.8	12.1	8.8	0.7	57.9	30.8	58.5	**89.5**	**89.3**
5	0.0	8.7	0.0	8.7	3.0	10.3	0.2	17.7	22.0	17.9	**39.9**	**39.9**
6	0.1	1.5	0.0	1.5	0.3	4.2	0.0	0.7	6.0	0.7	**6.7**	**6.7**
7	0.0	1.5	0.0	1.5	0.4	1.9	0.0	0.0	3.8	0.0	**3.8**	**3.8**
8	0.0	0.1	0.0	0.1	0.1	0.5	0.0	0.0	0.6	0.0	**0.6**	**0.6**
9+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	**0.0**
Sum	**106.2**	**81.1**	**0.0**	**81.1**	**36.8**	**803.8**	**18.1**	**265.9**	**921.8**	**283.9**	**1311.9**	**1205.7**

Table 2.2.2: North Sea Autumn-spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2001. Mean weight-at-age (kg) in the catch (WECA), by quarter and division

WR	IIIa NSAS	IVa(E) all	IVa(E) WBSS	IVa(W)	IVb	IVc	VIId	IVa & IVb all	IVc & VIId	Total NSAS	Herring caught in the North Sea
Quarters: 1-4											
0	0.009	0.000	0.000	0.000	0.014	0.015	0.000	**0.014**	**0.015**	**0.012**	**0.014**
1	0.049	0.079	0.079	0.080	0.061	0.027	0.000	**0.064**	**0.027**	**0.051**	**0.061**
2	0.075	0.121	0.127	0.134	0.102	0.055	0.117	**0.125**	**0.113**	**0.116**	**0.124**
3	0.108	0.148	0.151	0.161	0.143	0.103	0.139	**0.152**	**0.138**	**0.147**	**0.148**
4	0.130	0.165	0.178	0.190	0.165	0.149	0.167	**0.176**	**0.166**	**0.173**	**0.174**
5	0.147	0.177	0.188	0.221	0.176	0.139	0.165	**0.197**	**0.164**	**0.194**	**0.194**
6	0.219	0.197	0.198	0.231	0.192	0.149	0.155	**0.214**	**0.155**	**0.210**	**0.209**
7	0.176	0.219	0.221	0.264	0.190	0.168	0.168	**0.230**	**0.168**	**0.228**	**0.228**
8	0.198	0.261	0.269	0.281	0.188	0.182	0.180	**0.219**	**0.180**	**0.218**	**0.218**
9+	0.000	0.238	0.238	0.294	0.275	0.000	0.000	**0.284**	**-**	**0.285**	**0.284**
Quarter: 1											
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	**0.000**	**0.000**
1	0.028	0.000	0.000	0.076	0.025	0.025	0.000	0.025	0.025	**0.028**	**0.025**
2	0.060	0.095	0.000	0.097	0.065	0.038	0.076	0.088	0.046	**0.071**	**0.085**
3	0.100	0.137	0.000	0.159	0.112	0.081	0.089	0.137	0.088	**0.120**	**0.121**
4	0.177	0.140	0.000	0.173	0.137	0.112	0.112	0.147	0.112	**0.143**	**0.143**
5	0.194	0.155	0.000	0.182	0.148	0.128	0.128	0.161	0.128	**0.151**	**0.151**
6	0.184	0.186	0.000	0.146	0.212	0.148	0.148	0.160	0.148	**0.155**	**0.155**
7	0.175	0.211	0.000	0.228	0.214	0.168	0.168	0.216	0.168	**0.201**	**0.201**
8	0.194	0.243	0.000	0.242	0.235	0.180	0.180	0.242	0.180	**0.222**	**0.222**
9+	0.000	0.238	0.000	0.284	0.000	0.000	0.000	0.245	-	**0.245**	**0.245**
Quarter: 2											
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	**0.000**	**0.000**
1	0.034	0.079	0.079	0.075	0.034	0.085	0.000	0.045	0.085	**0.037**	**0.045**
2	0.080	0.123	0.123	0.115	0.099	0.103	0.076	0.116	0.100	**0.108**	**0.116**
3	0.107	0.148	0.148	0.139	0.139	0.145	0.089	0.144	0.108	**0.143**	**0.144**
4	0.147	0.171	0.171	0.172	0.154	0.168	0.112	0.168	0.145	**0.168**	**0.168**
5	0.169	0.186	0.186	0.188	0.188	0.165	0.128	0.186	0.143	**0.186**	**0.186**
6	0.169	0.198	0.198	0.205	0.190	0.210	0.148	0.197	0.151	**0.197**	**0.197**
7	0.177	0.221	0.221	0.217	0.207	0.169	0.168	0.218	0.168	**0.218**	**0.218**
8	0.204	0.261	0.261	0.230	0.224	0.184	0.180	0.243	0.184	**0.241**	**0.242**
9+	0.000	0.238	0.238	0.270	0.275	0.000	0.000	0.257	-	**0.258**	**0.257**
Quarter: 3											
0	0.008	0.000	0.000	0.000	0.012	0.012	0.000	0.012	0.012	**0.009**	**0.012**
1	0.071	0.000	0.000	0.090	0.097	0.077	0.000	0.096	0.077	**0.075**	**0.096**
2	0.102	0.129	0.129	0.141	0.110	0.108	0.117	0.136	0.115	**0.134**	**0.136**
3	0.111	0.157	0.157	0.174	0.147	0.145	0.145	0.165	0.145	**0.163**	**0.165**
4	0.125	0.189	0.189	0.206	0.172	0.170	0.171	0.195	0.171	**0.195**	**0.195**
5	0.095	0.192	0.192	0.228	0.170	0.165	0.193	0.212	0.178	**0.212**	**0.212**
6	0.228	0.198	0.198	0.250	0.188	0.210	0.204	0.238	0.207	**0.239**	**0.238**
7	0.160	0.220	0.220	0.271	0.173	0.169	0.000	0.241	0.169	**0.242**	**0.241**
8	0.000	0.277	0.277	0.291	0.185	0.184	0.000	0.214	0.184	**0.214**	**0.214**
9+	0.000	0.000	0.000	0.298	0.000	0.000	0.000	0.298	-	**0.298**	**0.298**
Quarter: 4											
0	0.022	0.000	0.000	0.000	0.015	0.015	0.000	0.015	0.015	**0.015**	**0.015**
1	0.084	0.000	0.000	0.090	0.000	0.000	0.000	0.090	-	**0.084**	**0.090**
2	0.099	0.124	0.000	0.125	0.118	0.117	0.117	0.123	0.117	**0.119**	**0.120**
3	0.119	0.151	0.000	0.131	0.152	0.145	0.145	0.148	0.145	**0.145**	**0.146**
4	0.125	0.174	0.000	0.141	0.175	0.171	0.171	0.161	0.171	**0.167**	**0.168**
5	0.000	0.176	0.000	0.187	0.191	0.193	0.193	0.185	0.193	**0.188**	**0.188**
6	0.231	0.193	0.000	0.234	0.197	0.204	0.204	0.197	0.204	**0.199**	**0.198**
7	0.000	0.217	0.000	0.238	0.213	0.000	0.000	0.217	-	**0.217**	**0.217**
8	0.000	0.347	0.000	0.293	0.244	0.000	0.000	0.267	-	**0.267**	**0.267**
9+	0.000	0.000	0.000	0.299	0.000	0.000	0.000	0.299	-	**0.299**	**0.299**

Table 2.2.3: North Sea Autumn-spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2001. Mean length-at-age (cm) in the catch, by quarter and division.

WR	IIIa NSAS	IVa(E) all	IVa(E) WBSS	IVa(W)	IVb	IVc	VIId	IVa & IVb all	IVc & VIId	Herring caught in the North Sea
Quarters: 1-4										
0	**n.d.**	**0.0**	**n.d.**	**0.0**	**13.4**	**13.9**	**0.0**	**13.4**	**13.9**	**13.4**
1	**n.d.**	**20.0**	**n.d.**	**20.9**	**18.3**	**14.7**	**0.0**	**18.6**	**14.7**	**18.4**
2	**n.d.**	**24.0**	**n.d.**	**24.7**	**22.7**	**19.4**	**23.7**	**24.2**	**23.4**	**24.1**
3	**n.d.**	**25.3**	**n.d.**	**26.0**	**25.2**	**23.5**	**25.1**	**25.6**	**25.1**	**25.4**
4	**n.d.**	**26.6**	**n.d.**	**27.5**	**26.5**	**26.2**	**26.4**	**27.0**	**26.4**	**26.9**
5	**n.d.**	**27.2**	**n.d.**	**28.7**	**26.9**	**26.5**	**27.1**	**27.8**	**27.1**	**27.7**
6	**n.d.**	**27.6**	**n.d.**	**29.2**	**27.8**	**27.7**	**27.7**	**28.5**	**27.7**	**28.4**
7	**n.d.**	**29.2**	**n.d.**	**30.5**	**27.6**	**27.9**	**28.0**	**29.3**	**28.0**	**29.3**
8	**n.d.**	**31.3**	**n.d.**	**31.2**	**27.4**	**28.3**	**29.2**	**28.8**	**29.1**	**28.8**
9+	**n.d.**	**30.6**	**n.d.**	**31.8**	**31.8**	**0.0**	**0.0**	**31.6**	**-**	**31.6**
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.	20.5	14.6	14.6	0.0	14.6	14.6	**14.6**
2	n.d.	23.6	n.d.	23.2	20.8	18.2	22.7	22.8	19.1	**22.5**
3	n.d.	26.2	n.d.	26.4	24.5	22.6	23.8	25.9	23.6	**25.2**
4	n.d.	26.6	n.d.	27.2	26.6	25.7	25.7	26.7	25.7	**26.6**
5	n.d.	27.3	n.d.	27.6	27.2	26.4	26.4	27.3	26.4	**27.1**
6	n.d.	28.2	n.d.	27.1	29.5	27.7	27.7	27.5	27.7	**27.6**
7	n.d.	29.6	n.d.	29.8	29.8	28.0	28.0	29.7	28.0	**29.2**
8	n.d.	31.4	n.d.	30.9	31.2	29.2	29.2	31.2	29.2	**30.6**
9+	n.d.	30.6	n.d.	31.2	0.0	0.0	0.0	30.7	-	**30.7**
Quarter: 2										
0	n.d.	0.0	n.d.	0.0	0.0	0.0	0.0	-	-	**0.0**
1	n.d.	20.0	n.d.	20.4	16.5	20.3	0.0	17.4	20.3	**17.4**
2	n.d.	23.6	n.d.	23.3	22.2	22.4	22.7	23.2	22.5	**23.2**
3	n.d.	24.9	n.d.	24.8	24.7	24.9	23.8	24.8	24.2	**24.8**
4	n.d.	26.2	n.d.	26.4	25.8	26.4	25.7	26.2	26.1	**26.2**
5	n.d.	27.1	n.d.	27.1	27.5	25.9	26.4	27.2	26.2	**27.2**
6	n.d.	27.6	n.d.	27.4	27.6	28.2	27.7	27.6	27.7	**27.6**
7	n.d.	29.2	n.d.	28.6	28.5	26.4	28.0	29.0	27.2	**29.0**
8	n.d.	31.4	n.d.	28.9	29.0	27.2	29.2	30.1	27.4	**30.1**
9+	n.d.	30.6	n.d.	30.8	31.8	0.0	0.0	31.0	-	**31.0**
Quarter: 3										
0	n.d.	0.0	n.d.	0.0	11.8	11.8	0.0	11.8	11.8	**11.8**
1	n.d.	0.0	n.d.	22.3	21.2	19.7	0.0	21.2	19.7	**21.2**
2	n.d.	24.1	n.d.	25.1	23.2	22.8	23.7	24.8	23.5	**24.8**
3	n.d.	25.6	n.d.	26.7	25.2	24.9	25.3	26.2	25.3	**26.2**
4	n.d.	27.0	n.d.	28.0	26.7	26.5	26.5	27.6	26.5	**27.6**
5	n.d.	27.2	n.d.	29.0	26.3	25.9	27.6	28.2	26.7	**28.2**
6	n.d.	27.4	n.d.	29.8	27.7	28.2	27.8	29.3	28.0	**29.3**
7	n.d.	28.7	n.d.	30.7	26.6	26.4	0.0	29.5	26.4	**29.5**
8	n.d.	30.9	n.d.	31.5	27.3	27.2	0.0	28.4	27.2	**28.4**
9+	n.d.	0.0	n.d.	32.0	0.0	0.0	0.0	32.0	-	**32.0**
Quarter: 4										
0	n.d.	0.0	n.d.	0.0	14.0	14.0	0.0	14.0	14.0	**14.0**
1	n.d.	0.0	n.d.	22.4	0.0	0.0	0.0	22.4	-	**22.4**
2	n.d.	24.6	n.d.	25.0	24.2	23.7	23.7	24.6	23.7	**24.1**
3	n.d.	25.9	n.d.	25.5	25.8	25.3	25.3	25.8	25.3	**25.4**
4	n.d.	27.4	n.d.	26.5	26.8	26.5	26.5	26.9	26.5	**26.6**
5	n.d.	27.5	n.d.	28.3	27.8	27.6	27.6	27.8	27.6	**27.7**
6	n.d.	27.3	n.d.	29.1	28.0	27.8	27.8	27.9	27.8	**27.9**
7	n.d.	28.9	n.d.	30.2	28.7	0.0	0.0	28.9	-	**28.9**
8	n.d.	31.3	n.d.	31.4	30.0	0.0	0.0	30.4	-	**30.4**
9+	n.d.	0.0	n.d.	32.0	0.0	0.0	0.0	32.0	-	**32.0**

Table 2.2.4: North Sea Autumn-spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2001. Catches (tonnes) at age (SOP figures), by quarter and division.

WR	IIIa NSAS	IVa(E) all	IVa(E) WBSS	IVa(E) NSAS only	IVa(W)	IVb	IVc	VIId	IVa & IVb NSAS	IVc & VIId	Total NSAS	Herring caught in the North Sea
Quarters: 1-4												
0	**7.0**	**0.0**	**0.0**	**0.0**	**0.0**	**14.3**	**0.2**	**0.0**	**14.3**	**0.2**	**21.6**	**14.6**
1	**27.8**	**0.4**	**0.0**	**0.4**	**0.4**	**4.1**	**0.1**	**0.0**	**4.9**	**0.1**	**32.9**	**5.1**
2	**11.3**	**20.8**	**1.4**	**19.4**	**49.1**	**10.0**	**0.2**	**8.6**	**78.5**	**8.9**	**98.7**	**90.3**
3	**1.9**	**20.1**	**1.5**	**18.6**	**21.4**	**12.2**	**0.4**	**18.1**	**52.2**	**18.5**	**72.5**	**73.8**
4	**0.2**	**12.0**	**1.1**	**10.9**	**17.1**	**8.0**	**0.2**	**10.4**	**36.0**	**10.6**	**46.8**	**48.8**
5	**0.0**	**14.2**	**1.3**	**12.8**	**27.6**	**11.2**	**0.2**	**5.1**	**51.6**	**5.3**	**57.0**	**59.7**
6	**0.1**	**4.4**	**0.5**	**3.9**	**8.6**	**2.3**	**0.1**	**0.8**	**14.8**	**0.9**	**15.8**	**16.8**
7	**0.0**	**3.1**	**0.3**	**2.8**	**4.3**	**1.9**	**0.0**	**0.3**	**8.9**	**0.3**	**9.2**	**9.9**
8	**0.0**	**0.9**	**0.1**	**0.8**	**2.8**	**4.6**	**0.0**	**0.2**	**8.2**	**0.2**	**8.4**	**8.6**
9+	**0.0**	**0.1**	**0.0**	**0.1**	**0.6**	**0.0**	**0.0**	**0.0**	**0.7**	**0.0**	**0.7**	**0.7**
Sum	**48.4**	**76.1**	**6.4**	**69.7**	**131.7**	**68.7**	**1.5**	**43.6**	**270.1**	**45.1**	**363.6**	**328.1**
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	6.5	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.2	0.1	**6.8**	**0.3**
2	4.4	2.2	0.0	2.2	1.6	0.8	0.1	0.1	4.5	0.2	**9.2**	**4.7**
3	0.4	2.4	0.0	2.4	1.4	0.8	0.2	1.2	4.5	1.4	**6.3**	**5.9**
4	0.0	2.9	0.0	2.9	1.3	0.7	0.1	0.5	4.9	0.6	**5.5**	**5.5**
5	0.0	3.2	0.0	3.2	1.6	0.7	0.2	1.7	5.5	1.9	**7.3**	**7.3**
6	0.0	0.5	0.0	0.5	0.8	0.0	0.1	0.7	1.3	0.8	**2.1**	**2.1**
7	0.0	0.4	0.0	0.4	0.2	0.0	0.0	0.3	0.7	0.3	**1.0**	**1.0**
8	0.0	0.3	0.0	0.3	0.2	0.0	0.0	0.2	0.5	0.2	**0.7**	**0.7**
9+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	**0.0**
Sum	**11.4**	**11.9**	**0.0**	**11.9**	**7.1**	**3.3**	**0.8**	**4.6**	**22.3**	**5.3**	**39.0**	**27.6**
Quarter: 2												
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	**0.0**
1	3.0	0.4	0.0	0.4	0.3	1.0	0.0	0.0	1.7	0.0	**4.7**	**1.7**
2	3.3	9.3	0.4	9.0	7.0	3.1	0.0	0.0	19.1	0.0	**22.4**	**19.8**
3	0.6	12.2	0.9	11.2	5.3	3.2	0.0	0.0	19.7	0.0	**20.4**	**21.6**
4	0.0	5.8	0.6	5.2	1.7	1.5	0.0	0.0	8.4	0.0	**8.5**	**9.7**
5	0.0	7.6	0.8	6.8	1.6	2.3	0.0	0.0	10.7	0.0	**10.8**	**12.4**
6	0.0	2.9	0.3	2.6	0.5	0.7	0.0	0.0	3.9	0.0	**3.9**	**4.5**
7	0.0	1.9	0.2	1.7	0.2	0.5	0.0	0.0	2.3	0.0	**2.3**	**2.7**
8	0.0	0.5	0.0	0.4	0.2	0.2	0.0	0.0	0.9	0.0	**0.9**	**1.0**
9+	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.2	0.0	**0.2**	**0.2**
Sum	**6.9**	**40.7**	**3.3**	**37.4**	**16.8**	**12.7**	**0.0**	**0.0**	**66.9**	**0.1**	**73.9**	**73.6**
Quarter: 3												
0	6.7	0.0	0.0	0.0	0.0	3.2	0.0	0.0	3.2	0.0	**9.9**	**3.2**
1	11.8	0.0	0.0	0.0	0.1	2.9	0.0	0.0	3.1	0.0	**14.8**	**3.1**
2	2.7	4.0	1.1	2.9	38.9	4.4	0.0	0.0	46.3	0.0	**49.0**	**48.5**
3	0.5	3.1	0.6	2.5	13.7	4.6	0.0	0.0	20.7	0.0	**21.3**	**22.0**
4	0.1	1.6	0.5	1.1	12.4	4.2	0.0	0.0	17.7	0.0	**17.8**	**18.7**
5	0.0	1.8	0.5	1.2	23.9	6.2	0.0	0.0	31.4	0.0	**31.4**	**32.5**
6	0.1	0.7	0.2	0.5	7.2	0.7	0.0	0.0	8.4	0.0	**8.5**	**8.9**
7	0.0	0.5	0.1	0.3	3.7	0.9	0.0	0.0	5.0	0.0	**5.0**	**5.3**
8	0.0	0.2	0.1	0.1	2.3	4.2	0.0	0.0	6.7	0.0	**6.7**	**6.8**
9+	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.5	0.0	**0.5**	**0.5**
Sum	**21.9**	**11.9**	**3.1**	**8.7**	**102.7**	**31.5**	**0.0**	**0.1**	**143.0**	**0.1**	**165.0**	**149.4**
Quarter: 4												
0	0.4	0.0	0.0	0.0	0.0	11.1	0.2	0.0	11.1	0.2	**11.7**	**11.3**
1	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**6.6**	**0.0**
2	0.9	5.3	0.0	5.3	1.6	1.7	0.1	8.6	8.6	8.7	**18.1**	**17.2**
3	0.3	2.5	0.0	2.5	1.1	3.7	0.2	16.9	7.2	17.1	**24.6**	**24.3**
4	0.0	1.7	0.0	1.7	1.7	1.5	0.1	9.9	5.0	10.0	**15.0**	**15.0**
5	0.0	1.5	0.0	1.5	0.6	2.0	0.0	3.4	4.1	3.5	**7.5**	**7.5**
6	0.0	0.3	0.0	0.3	0.1	0.8	0.0	0.1	1.2	0.1	**1.3**	**1.3**
7	0.0	0.3	0.0	0.3	0.1	0.4	0.0	0.0	0.8	0.0	**0.8**	**0.8**
8	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.0	**0.2**	**0.2**
9+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	**0.0**
Sum	**8.2**	**11.7**	**0.0**	**11.7**	**5.1**	**21.3**	**0.7**	**38.9**	**38.1**	**39.6**	**85.8**	**77.6**

Table 2.2.5: North Sea Autumn-spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2001. Percentage age composition (based on numbers, 3+ group summarised), by quarter and division.

WR	IIIa NSAS	IVa(E) all	IVa(E) WBSS	IVa(E) NSAS only	IVa(W)	IVb	IVc	VIId	IVa & IVb NSAS	IVc & VIId	Total NSAS	Herring caught in the North Sea
Quarters: 1-4												
0	**52.4%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**71.1%**	**49.0%**	**0.0%**	**37.8%**	**4.8%**	**40.3%**	**33.6%**
1	**36.6%**	**1.1%**	**1.1%**	**1.1%**	**0.7%**	**4.8%**	**14.6%**	**0.0%**	**2.9%**	**1.4%**	**14.2%**	**2.7%**
2	**9.7%**	**34.1%**	**28.4%**	**34.5%**	**46.7%**	**6.9%**	**13.3%**	**24.3%**	**23.4%**	**23.2%**	**18.8%**	**23.5%**
3	**1.1%**	**26.7%**	**25.6%**	**26.8%**	**17.0%**	**6.0%**	**12.2%**	**42.5%**	**12.9%**	**39.6%**	**10.9%**	**16.0%**
4	**0.1%**	**14.4%**	**15.3%**	**14.3%**	**11.5%**	**3.4%**	**3.6%**	**20.5%**	**7.7%**	**18.8%**	**5.9%**	**9.0%**
5	**0.0%**	**15.8%**	**17.9%**	**15.6%**	**15.9%**	**4.5%**	**4.8%**	**10.2%**	**9.8%**	**9.6%**	**6.5%**	**9.9%**
6	**0.0%**	**4.4%**	**6.7%**	**4.2%**	**4.7%**	**0.9%**	**1.4%**	**1.8%**	**2.6%**	**1.8%**	**1.7%**	**2.5%**
7	**0.0%**	**2.8%**	**3.9%**	**2.7%**	**2.1%**	**0.7%**	**0.5%**	**0.5%**	**1.4%**	**0.5%**	**0.9%**	**1.4%**
8	**0.0%**	**0.7%**	**0.9%**	**0.7%**	**1.3%**	**1.7%**	**0.5%**	**0.3%**	**1.4%**	**0.3%**	**0.8%**	**1.3%**
9+	**0.0%**	**0.1%**	**0.1%**	**0.1%**	**0.2%**	**0.0%**	**0.0%**	**0.0%**	**0.1%**	**0.0%**	**0.1%**	**0.1%**
Sum 3+	**1.3%**	**64.9%**	**70.5%**	**64.4%**	**52.6%**	**17.2%**	**23.1%**	**75.7%**	**35.9%**	**70.6%**	**26.7%**	**40.2%**
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	74.9%	0.0%	-	0.0%	0.1%	22.9%	35.6%	0.0%	5.0%	9.0%	**45.8%**	**5.9%**
2	23.7%	26.0%	-	26.0%	33.6%	32.2%	26.1%	2.3%	29.5%	8.3%	**24.1%**	**24.6%**
3	1.4%	19.8%	-	19.8%	17.6%	17.8%	19.9%	33.7%	18.7%	30.2%	**9.8%**	**21.4%**
4	0.0%	23.6%	-	23.6%	15.8%	13.7%	3.4%	11.8%	19.3%	9.7%	**7.2%**	**17.1%**
5	0.0%	23.9%	-	23.9%	17.7%	11.9%	9.8%	34.0%	19.5%	27.9%	**9.1%**	**21.5%**
6	0.0%	3.0%	-	3.0%	11.4%	0.4%	3.5%	12.2%	4.8%	10.0%	**2.5%**	**6.0%**
7	0.0%	2.4%	-	2.4%	2.2%	0.6%	1.1%	3.9%	2.0%	3.2%	**1.0%**	**2.2%**
8	0.0%	1.2%	-	1.2%	1.5%	0.5%	0.6%	2.2%	1.2%	1.8%	**0.5%**	**1.3%**
9+	0.0%	0.1%	-	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	**0.0%**	**0.0%**
Sum 3+	**1.4%**	**74.0%**	**-**	**74.0%**	**66.3%**	**44.9%**	**38.4%**	**97.7%**	**65.5%**	**82.7%**	**30.1%**	**69.5%**
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	65.1%	2.1%	2.2%	2.1%	3.1%	25.2%	22.1%	0.0%	7.8%	12.6%	**20.2%**	**7.5%**
2	30.4%	28.8%	14.4%	30.0%	48.5%	28.0%	17.8%	2.3%	34.3%	11.2%	**33.5%**	**33.5%**
3	4.2%	31.1%	31.2%	31.1%	30.3%	20.5%	12.6%	33.7%	28.4%	21.6%	**23.2%**	**28.5%**
4	0.2%	12.9%	17.7%	12.5%	7.8%	8.8%	12.7%	11.8%	10.4%	12.3%	**8.2%**	**10.7%**
5	0.1%	15.6%	21.4%	15.1%	6.7%	10.9%	17.9%	34.0%	11.9%	24.8%	**9.4%**	**12.3%**
6	0.0%	5.6%	7.7%	5.4%	2.0%	3.5%	0.5%	12.2%	4.1%	5.5%	**3.2%**	**4.2%**
7	0.0%	3.2%	4.4%	3.1%	0.7%	2.0%	2.8%	3.9%	2.2%	3.3%	**1.7%**	**2.3%**
8	0.0%	0.7%	0.9%	0.7%	0.8%	0.9%	13.6%	2.2%	0.7%	8.7%	**0.6%**	**0.8%**
9+	0.0%	0.1%	0.2%	0.1%	0.2%	0.1%	0.0%	0.0%	0.1%	0.0%	**0.1%**	**0.1%**
Sum 3+	**4.5%**	**69.1%**	**83.4%**	**68.0%**	**48.4%**	**46.8%**	**60.1%**	**97.7%**	**57.9%**	**76.2%**	**46.3%**	**59.0%**
Quarter: 3												
0	80.0%	0.0%	0.0%	0.0%	0.0%	58.0%	81.0%	0.0%	24.6%	56.1%	**50.9%**	**24.2%**
1	16.7%	0.0%	0.0%	0.0%	0.3%	6.5%	4.8%	0.0%	2.9%	3.4%	**9.5%**	**2.9%**
2	2.7%	41.6%	42.9%	41.1%	48.1%	8.7%	3.0%	27.5%	31.0%	10.6%	**17.6%**	**31.2%**
3	0.5%	26.2%	19.8%	28.5%	13.7%	6.7%	2.3%	43.8%	11.5%	15.1%	**6.3%**	**11.6%**
4	0.1%	11.2%	12.9%	10.5%	10.5%	5.3%	2.3%	21.8%	8.3%	8.3%	**4.4%**	**8.4%**
5	0.0%	12.4%	14.3%	11.7%	18.3%	7.9%	3.3%	6.7%	13.5%	4.3%	**7.1%**	**13.5%**
6	0.0%	4.9%	5.6%	4.6%	5.0%	0.8%	0.1%	0.3%	3.2%	0.1%	**1.7%**	**3.3%**
7	0.0%	3.0%	3.4%	2.8%	2.4%	1.1%	0.5%	0.0%	1.9%	0.4%	**1.0%**	**1.9%**
8	0.0%	0.8%	1.0%	0.8%	1.4%	4.9%	2.5%	0.0%	2.9%	1.8%	**1.5%**	**2.8%**
9+	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	0.2%	0.0%	**0.1%**	**0.1%**
Sum 3+	**0.6%**	**58.4%**	**57.1%**	**58.9%**	**51.6%**	**26.8%**	**11.1%**	**72.5%**	**41.5%**	**30.0%**	**22.0%**	**41.7%**
Quarter: 4												
0	15.1%	0.0%	-	0.0%	0.0%	92.1%	83.1%	0.0%	80.3%	5.3%	**58.8%**	**62.6%**
1	73.7%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**6.0%**	**0.0%**
2	8.4%	53.0%	-	53.0%	35.1%	1.7%	4.6%	27.5%	7.6%	26.1%	**11.6%**	**11.9%**
3	2.6%	20.4%	-	20.4%	21.9%	3.0%	7.4%	43.8%	5.3%	41.5%	**12.9%**	**13.8%**
4	0.2%	12.1%	-	12.1%	32.9%	1.1%	3.7%	21.8%	3.3%	20.6%	**6.8%**	**7.4%**
5	0.0%	10.7%	-	10.7%	8.2%	1.3%	1.1%	6.7%	2.4%	6.3%	**3.0%**	**3.3%**
6	0.1%	1.8%	-	1.8%	0.7%	0.5%	0.0%	0.3%	0.6%	0.2%	**0.5%**	**0.6%**
7	0.0%	1.8%	-	1.8%	1.0%	0.2%	0.0%	0.0%	0.4%	0.0%	**0.3%**	**0.3%**
8	0.0%	0.1%	-	0.1%	0.2%	0.1%	0.0%	0.0%	0.1%	0.0%	**0.0%**	**0.1%**
9+	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**	**0.0%**
Sum 3+	**2.9%**	**47.0%**	**-**	**47.0%**	**64.9%**	**6.2%**	**12.2%**	**72.5%**	**12.1%**	**68.7%**	**23.6%**	**25.4%**

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

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

1999	**Fleet A**		**Fleet B**		**Fleet C**		**Fleet D**		**TOTAL**	
Total		Mean		Mean		Mean		Mean		**Mean**
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight	**Numbers**	**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**

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

2000	**Fleet A**		**Fleet B**		**Fleet C**		**Fleet D**		**TOTAL**	
Total		Mean		Mean		Mean		Mean		**Mean**
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight	**Numbers**	**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		Mean		Mean		Mean		Mean		**Mean**
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight	**Numbers**	**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**

Table 2.2.7: Catch-at-age (numbers in millions) of herring caught in the North Sea, 1990-2001.

Year/WR	0	1	2	3	4	5	6	7	8	9+	Total
1990	888	1557	616	784	872	386	82	56	29	12	**5283**
1991	1658	1301	801	568	563	507	207	40	26	13	**5684**
1992	7874	705	995	424	344	351	370	149	39	24	**11274**
1993	7254	1385	792	614	315	222	230	191	88	42	**11133**
1994	3834	497	1438	504	355	117	98	78	71	46	**7038**
1995	6795	583	1486	919	259	126	59	43	55	73	**10398**
1996	1796	738	549	600	197	60	21	11	8	18	**3997**
1997	364	175	472	426	248	89	23	11	9	9	**1825**
1998	208	251	1068	512	269	165	85	16	10	10	**2594**
1999	969	81	504	1039	291	136	69	27	9	3	**3127**
2000	873	185	506	475	590	184	78	28	17	3	**2938**
2001	1025	83	716	488	275	301	78	42	39	2	**3049**

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, 1990-2001.

Year/WR	0	1	2	3	4	5	6	7	8	9+	Total
1990			12.4	14.7	21.8	3.6	3.0	2.1	0.7	0.4	**58.7**
1991			6.7	15.1	18.0	9.1	3.1	0.8	0.3		**53.0**
1992			0.3	9.9	11.1	8.4	8.6	2.5	0.7	0.6	**42.1**
1993			4.2	10.8	12.3	8.4	5.9	4.7	1.7	1.0	**49.0**
1994			8.8	28.2	16.3	11.0	8.6	3.4	3.2	0.7	**80.2**
1995			22.4	11.0	14.9	4.0	2.9	1.9	0.5	0.2	**57.8**
1996			0.0	2.8	0.8	0.4	0.1	0.1	0.1	0.2	**4.4**
1997			2.2	1.3	1.5	0.4	0.2	0.1	0.1	0.1	**5.9**
1998			11.0	13.0	11.8	6.6	3.2	0.4	0.4	0.5	**47.1**
1999			3.3	14.3	5.6	3.6	1.4	0.6	0.4	0.1	**29.3**
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

Table 2.2.9: Catch-at-age (numbers in millions) of North Sea Autumn Spawners taken in IIIa, and transfered to the assessment of North Sea Autumn Spawners, 1990 - 2001. Figures for 1999 were altered in 2001, those for 1991-1998 in 2002 but the latter **still not used in the assessment**.

Year/WR	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**

Table 2.2.10: Catch-at-age (numbers in millions) of the total North Sea Autumn-spawning stock 1990 - 2001. Figures for 1999 were altered in 2001, those for 1991-1998 in 2002 but the latter **still not used in the assessment**.

Year/WR	0	1	2	3	4	5	6	7	8	9+	Total
1990	1286	2982	888	769	850	383	79	54	29	12	**7331**
1991	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**

Table 2.2.11: Comparison of mean weights (kg) at age in the catch of adult herring in the the North Sea and North Sea Autumn Spawners caught in Div IIIa in 1991-2001.

		Age (Winter 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	-
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
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
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
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
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
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	-
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

*Figures for 1991-1999 altered in 2002 but the1991-1998 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 2001 by quarter. Sampled catch means the proportion of the reported catch to which sampling was applied. It is limited to 100% but might exceed the official landings due to sampling of discards, unallocated and misreported catches. It is not possible to judge the quality of the sampling by this figure alone. Note that only one nation provided information on by-catches (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
Denmark (A)	1	3	1	54%	17835	3	154	743	n
Denmark (A)	2	3	0	0%	1415	0	0	0	n
Denmark (A)	3	3	3	100%	15005	4	200	995	n
Denmark (A)	4	3	1	16%	12488	2	100	474	n
	total	**12**	**5**	**57%**	**46743**	**9**	**454**	**2212**	n
Denmark (B)	1	4	3	85%	2200	10	29	31	y
Denmark (B)	2	2	1	100%	1085	16	11	229	y
Denmark (B)	3	4	1	96%	3637	3	55	106	n
Denmark (B)	4	3	2	98%	13431	5	20	89	n
	total	**13**	**7**	**96%**	**20353**	**34**	**115**	**455**	y
England and Wales	1	2	0	0%	46	0	0	0	n
England and Wales	2	4	0	0%	1200	0	0	0	n
England and Wales	3	3	0	0%	11916	0	0	0	n
England and Wales	4	2	0	0%	1420	0	0	0	n
	total	**11**	**0**	**0%**	**14582**	**0**	**0**	**0**	n
Faroe Isl	2	1	0	0%	108	0	0	0	n
Faroe Isl	4	2	0	0%	974	0	0	0	n
	total	**3**	**0**	**0%**	**1082**	**0**	**0**	**0**	n
France	1	3	0	0%	1387	0	0	0	n
France	2	4	0	0%	1326	0	0	0	n
France	3	4	0	0%	14163	0	0	0	n
France	4	3	0	0%	7639	0	0	0	n
	total	**14**	**0**	**0%**	**24515**	**0**	**0**	**0**	n
Germany	1	1	0	0%	92	0	0	0	n
Germany	2	2	0	0%	5089	0	0	0	n
Germany	3	2	0	0%	14968	0	0	0	n
Germany	4	3	0	0%	9631	0	0	0	n
	total	**8**	**0**	**0%**	**29779**	**0**	**0**	**0**	n
Netherlands	1	2	1	90%	4003	7	175	1435	y
Netherlands	2	2	1	47%	2806	8	200	1659	y
Netherlands	3	2	2	100%	24999	37	900	5273	y
Netherlands	4	2	2	100%	19482	11	275	1706	n
	total	**8**	**6**	**100%**	**51290**	**63**	**1550**	**10073**	y
Northern Ireland	3	1	0	0%	1003	0	0	0	n
Northern Ireland	4	1	0	0%	15	0	0	0	n
	total	**2**	**0**	**0%**	**1018**	**0**	**0**	**0**	n
Norway	1	2	0	0%	2108	0	0	0	n
Norway	2	3	3	100%	52831	28	2521	2701	n
Norway	3	2	1	63%	14649	1	100	100	n
Norway	4	2	0	0%	5501	0	0	0	n
	total	**9**	**4**	**83%**	**75089**	**29**	**2621**	**2801**	n
Scotland	2	2	2	100%	1544	6	420	1080	y
Scotland	3	2	1	100%	25014	83	4122	20040	y
Scotland	4	1	0	0%	161	0	0	0	n
	total	**5**	**3**	**100%**	**26719**	**95**	**4737**	**23435**	y
Sweden	2	3	0	0%	2588	0	0	0	n
Sweden	3	3	0	0%	1064	0	0	0	n
Sweden	4	1	0	0%	43	0	0	0	n
	total	**7**	**0**	**0%**	**3695**	**0**	**0**	**0**	n
Period total	**1**	**19 (17)**	**5**	**55%**	**27671**	**20**	**358**	**2209**	n
Period total	**2**	**27 (26)**	**7**	**81%**	**69991**	**58**	**3152**	**5669**	n
Period total	**3**	**28 (27)**	**9**	**75%**	**126418**	**134**	**5572**	**28829**	n
Period total	**4**	**24 (23)**	**5**	**59%**	**70785**	**18**	**395**	**2269**	n
Total for stock 2001		**98 (93)**	**26**	**71%**	**294865**	**230**	**9477**	**38976**	n
Human Cons. only		**85 (78)**	**19**	**69%**	**274512**	**196**	**9362**	**38521**	n
total for stock 2000		90	30	97%	285117	314	11797	41692	y

Table 2.3.1 North Sea herring. IBTS 1-ringer indices (1st quarter)

Year class	Year of sampling	1-ringer index
1977	1979	156
1978	1980	342
1979	1981	518
1980	1982	799
1981	1983	1231
1982	1984	1469
1983	1985	2083
1984	1986	2593
1985	1987	3734
1986	1988	4470
1987	1989	2187
1988	1990	1025
1989	1991	1180
1990	1992	1204
1991	1993	2989
1992	1994	1644
1993	1995	1215
1994	1996	1728
1995	1997	3993
1996	1998	2067
1997	1999	715
1998	2000	3639
1999	2001	2496
2000	2002	3948

Table 2.3.2. 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	North east	Central west	Central east	South west	South east	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

Table 2.3.3 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

Table 2.4.1 North Sea herring numbers (millions) at age and maturity by ICES Subarea

ICES A	IIIa	IVa	IVb
0	169.74	0.00	13882.93
1i	998.85	1585.19	4250.88
1m	0.00	0.00	2.16
2i	157.94	1799.68	887.72
2m	10.09	7751.61	1683.45
3i	41.41	188.17	16.52
3m	4.14	2293.66	538.88
4	8.82	1320.83	132.28
5	2.14	1614.05	59.86
6	0.53	433.29	15.83
7	0.00	153.86	15.73
8	0.00	91.09	6.62
9+	0.00	50.20	8.68
Immature	1367.94	3573.03	19038.05
Mature	25.71	13708.59	2463.49
Total	1393.66	17281.62	21501.55

Table 2.4.2 North Sea herring biomass (thousands of tonnes) at age and maturity by ICES Subarea

ICES A	IIIa	Iva	IVb
0	1.43	0.00	111.55
1I	54.33	85.31	203.26
1m	0.00	0.00	0.11
2i	14.87	192.09	76.60
2m	0.97	1084.92	192.11
3i	4.49	24.19	1.98
3m	0.45	392.43	75.53
4	0.85	276.56	21.53
5	0.28	371.21	9.97
6	0.07	103.78	2.91
7	0.00	40.34	2.85
8	0.00	26.72	1.17
9+	0.00	16.70	0.62
Immature	75.12	301.60	393.40
Mature	2.61	2312.66	306.80
Total	77.73	2614.25	700.19

Table 2.4.3 North Sea herring mean weight (g) at age and maturity by ICES Subarea

ICES A	IIIa	IVa	IVb
0	8.41		8.04
1i	54.40	53.82	47.82
1m			49.00
2i	94.18	106.74	86.29
2m	96.48	139.96	114.12
3i	108.34	128.57	120.12
3m	108.34	171.09	140.16
4	95.81	209.38	162.73
5	128.87	229.99	166.55
6	131.15	239.51	184.01
7		262.17	180.99
8		293.38	177.40
9+		332.67	71.93
Mean (i)	54.92	84.41	20.66
Mean (m)	101.56	168.70	124.54
Mean (all)	55.78	151.27	32.56

Table 2.4.4 North Sea autumn-spawning herring in the area surveyed in the acoustic surveys July 2001. Total numbers (millions) and biomass (thousands of tonnes) with mean weights (g) and fraction mature by winter ring.

North Sea	Numbers	Biomass	Maturity	mean weight	Mean length
	(millions)	Tonnes $*10^3$	(fraction)	(g)	(cm)
0	14052.7	113.0	0.00	8	10.6
1	6837.1	343.0	0.00	50	18.4
2	12290.5	1561.6	0.77	127	24.1
3	3082.8	499.1	0.92	162	25.9
4	1461.9	298.9	1.00	204	27.8
5	1676.1	381.5	1.00	228	28.7
6	449.6	106.8	1.00	237	29.0
7	169.6	43.2	1.00	255	29.7
8	97.7	27.9	1.00	286	30.6
9+	58.9	17.3	1.00	294	31.6
Immature	23979.0	770.1			
Mature	16197.8	2622.1			
Total	40176.8	3392.2			

Table 2.4.5 North Sea autumn-spawners, estimates of (millions) at age from acoustic surveys, and SSB (thousands of tonnes) 1984-2001. 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 have been revised in 2002 following recent reorganisation of archive, removal of a 9% calibration error on Scottish survey 1999-2000.

	Numbers (millions)																	
Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Age (ring)																		
1	551	726	1,639	13,736	6,431	6,333	6,249	3,182	6,351	10,399	3,646	4,202	6,198	9,416	4,449	5,087	24,735	6,837
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
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
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
5	158	113	135	368	349	488	1,349	1,984	1,510	795	363	272	311.0	692.1	982.4	506.4	1,006	1,676
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
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
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
9+	41	19	8	20	14	22	43	56	163	116	132	84	206.0	158.3	121.4	87.2	97.2	58.9
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
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	0.60	0.34	0.37
Smoothed Z(2+/3+)		0.78	0.70	0.82	0.46	0.13	0.32	0.44	0.53	0.92	0.91	0.57	0.45	0.50	0.91	0.46	0.22	0.45
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

Table 2.4.6 North Sea Autumn-spawning herring, percentage change in Recruitment, Stock, SSB and F due to revision of acoustic time-series, Terminal values are changed by less than 3%.

Year	Recruits	Stock	SSB	F2-6
1981	0.01%	0.03%	0.13%	-0.20%
1982	0.01%	0.03%	0.10%	-0.11%
1983	0.01%	0.02%	0.09%	-0.09%
1984	0.01%	0.47%	-2.58%	-0.09%
1985	0.01%	0.02%	0.06%	-0.08%
1986	0.01%	-1.98%	-3.33%	-0.10%
1987	0.01%	-2.06%	-3.17%	-0.09%
1988	0.01%	-1.61%	-3.07%	-0.09%
1989	0.02%	0.03%	0.07%	-0.11%
1990	-0.04%	-0.07%	-0.17%	-0.11%
1991	0.01%	-3.12%	-1.55%	-0.08%
1992	0.03%	-4.41%	-0.99%	-0.05%
1993	0.04%	-5.87%	-0.14%	-0.07%
1994	0.17%	-2.00%	2.17%	-0.03%
1995	0.31%	0.89%	1.46%	0.01%
1996	0.32%	0.55%	0.80%	0.06%
1997	0.37%	1.29%	0.55%	-0.89%
1998	0.54%	1.10%	0.99%	-1.54%
1999	0.55%	1.11%	1.57%	-2.22%
2000	0.48%	2.95%	2.15%	-2.43%

Table 2.4.7 North Sea Autumn-spawning herring, correlation between survey data and assessment in 2001 and between estimates of cohorts in the same survey in subsequent years.

	MLAI	IBTS/MIK	Acoustic		Age 1	Age 2	IBTS/MIK	Acoustic
SSB	0.907411							
0		0.83			0	1	0.80	
1		0.86	0.85		1	2	0.50	0.66
2		0.59	0.87		2	3	0.34	0.73
3		0.70	0.75		3	4	0.46	0.91
4		0.79	0.85		4	5	0.84	0.88
5		0.86	0.95		5	6		0.90
6			0.94		6	7		0.92
7			0.92		7	8		0.82
8			0.80		8	9+		0.26
9			0.27					

Table 2.5.1: North Sea herring. Estimated abundances of herring larvae < 10 mm long (11 mm for the Southern North Sea), by standard sampling area and time periods. The number of larvae are expressed as mean number per ICES rectangle * 10^9.

Year	Orkney and Shetland		Buchan		Central North Sea				Southern North Sea/Eastern Channel		
	1-15 Sept.	16-30 Sept.	1-15 Sept.	16-30 Sept.	1-15 Sept.	16-30 Sept.	1-15 Oct.	16-31 Oct.	16-31 Dec.	1-15 Jan.	16-31 Jan.
1972	1133	4583	30		165	88	134	22	2	46	
1973	2029	822	3	4	492	830	1213	152			1
1974	758	421	101	284	81		1184			10	
1975	371	50	312			90	77	6	1	2	
1976	545	81		1	64	108		10		3	
1977	1133	221	124	32	520	262	89	3	1		
1978	3047	50		162	1406	81	269	2	33	3	
1979	2882	2362	197	10	662	131	507	7		111	89
1980	3534	720	21	1	317	188	9	13	247	129	40
1981	3667	277	3	12	903	235	119		1456		70
1982	2353	1116	340	257	86	64	1077	23	710	275	54
1983	2579	812	3647	768	1459	281	63		71	243	58
1984	1795	1912	2327	1853	688	2404	824	433	523	185	39
1985	5632	3432	2521	1812	130	13039	1794	215	1851	407	38
1986	3529	1842	3278	341	1611	6112	188	36	780	123	18
1987	7409	1848	2551	670	799	4927	1992	113	934	297	146
1988	7538	8832	6812	5248	5533	3808	1960	206	1679	162	112
1989	11477	5725	5879	692	1442	5010	2364	2	1514	2120	512
1990		10144	4590	2045	19955	1239	975		2552	1204	
1991	1021	2397		2032	4823	2110	1249		4400	873	
1992	189	4917		822	10	165	163		176	1616	
1993		66		174		685	85		1358	1103	
1994	26	1179				1464	44		537	595	
1995		8688					43		74	230	164
1996		809		184		564			337	675	691
1997		3611		23					9374	918	355
1998		8528		1490	205	66			1522	953	170
1999		4064		185		134	181		804	1260	344
2000		3352	28	83		376			7346	338	106
2001		11918		164		1604			971	5531	909

Table 2.5.2: North Sea herring. 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	39	150,1	3,85	8,006	0,0001
Error	213	102,4	0,4807		
C Total	252	252,5			

b) Estimates of parameters

Reference Mean

Estimate	Standard Error	
6,8194	0,5637	Reference: 1972, Orkney/Shetland 09/01 – 09/15

Year Effects

Year	Estimate	Standard Error	Year	Estimate	Standard Error
1973	0,3787	0,7008	1988	2,7247	0,6057
1974	-0,1388	0,7508	1989	2,6889	0,6198
1975	-1,2079	0,7630	1990	2,9253	0,6429
1976	-1,3127	0,7488	1991	2,2881	0,6967
1977	-0,4007	0,7179	1992	1,5169	0,7363
1978	-0,2094	0,7287	1993	1,2124	0,7128
1979	0,5051	0,7015	1994	0,8032	0,7511
1980	0,1201	0,6983	1995	0,9511	0,7407
1981	0,5343	0,6954	1996	1,6521	0,7802
1982	0,8608	0,6309	1997	1,8596	0,7318
1983	1,1168	0,6469	1998	2,1599	0,6878
1984	1,7169	0,6281	1999	1,9889	0,6918
1985	2,1396	0,6059	2000	1,5673	0,7071
1986	1,4769	0,6259	2001	2,6950	0,7200
1987	2,0307	0,6176			

Sampling Unit Effects

Sampling Unit	Estimate	Standard Error
Or/Shet 16-30 Sep	-0,6515	0,3359
Buchan 01-15 Sep	-1,8225	0,4265
Buchan 16-30 Sep	-2,5583	0,3737
CNS 01-15 Sep	-1,6535	0,4129
CNS 16-30 Sep	-1,4814	0,3687
CNS 01-15 Oct	-2,0955	0,3956
CNS 16-31 Oct	-4,1683	0,5370
SNS 12-31 Dec	-1,8640	0,4001
SNS 01-15 Jan	-2,4991	0,3448
SNS 16-31 Jan	-3,7295	0,3896

Table 2.5.3: North Sea herring. Updated MLAI time-series obtained from a multiplicative model.

Reference: **6.819394** (Orkney/Shetland, 1st-15th September 1972)

Year	**MLAI**	MLAIrefer	un-logged	div 100
1973	0.3787	7.1981	1336.9	13.4
1974	-0.1388	6.6806	796.8	8.0
1975	-1.2079	5.6115	273.6	2.7
1976	-1.3127	5.5067	246.3	2.5
1977	-0.4007	6.4187	613.2	6.1
1978	-0.2094	6.6100	742.5	7.4
1979	0.5051	7.3245	1517.1	15.2
1980	0.1201	6.9395	1032.2	10.3
1981	0.5343	7.3537	1561.9	15.6
1982	0.8608	7.6802	2165.0	21.7
1983	1.1168	7.9362	2796.7	28.0
1984	1.7169	8.5363	5096.3	51.0
1985	2.1396	8.9590	7777.6	77.8
1986	1.4769	8.2963	4009.1	40.1
1987	2.0307	8.8501	6974.8	69.7
1988	2.7247	9.5441	13962.1	139.6
1989	2.6889	9.5083	13471.3	134.7
1990	2.9253	9.7447	17063.3	170.6
1991	2.2881	9.1075	9023.0	90.2
1992	1.5169	8.3363	4172.7	41.7
1993	1.2124	8.0318	3077.1	30.8
1994	0.8032	7.6226	2043.9	20.4
1995	0.9511	7.7705	2369.6	23.7
1996	1.6521	8.4715	4776.7	47.8
1997	1.8596	8.6790	5878.2	58.8
1998	2.1599	8.9793	7937.0	79.4
1999	1.9889	8.8083	6689.4	66.9
2000	1.5673	8.3867	4388.2	43.9
2001	2.6950	9.5143	13552.7	135.5

Table 2.6.1. 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

Table 2.6.2. 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.

Area	Total	Mean per statistical rectangle				
		Age group (wr)				
		1	2	3	4	5+
All areas	779038	3948.2	666.2	323.9	22.8	19.2
RF1	23798	21.3	248.6	265.8	26.2	25.7
RF2	83314	744.0	1583.0	884.9	53.4	67.3
RF3	24509	512.7	647.4	185.7	2.9	0.1
RF4	40189	2350.2	1137.6	290.5	20.1	7.3
RF5	17790	1494.5	261.7	214.5	0	3.7
RF6	262191	7598.0	632.2	200.5	21.5	0
RF7	111570	8142.9	218.9	23.9	3.0	0
RF8	58008	8557.8	356.3	93.3	19.3	8.8
RF9	171051	33768.3	1207.5	839.7	71.5	48.1

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

Age	Mean weights-at-age (winter rings) in the catch (g)																			
	Third quarter mean weights in catch (Divisions IVa and IVb)										July acoustic Survey									
(WR)	1992	1993	1994	1995	1996	1997	1998	1999#	2000#	2001#	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	51	53	55	52	10	38	42	62	54	75	78	69	60	58	45	45	52	52	46	50
2	127	145	131	151	126	125	132	130	126	134	142	115	138	132	119	120	109	118	118	127
3	200	161	164	190	165	157	172	164	169	163	209	147	209	180	196	168	198	171	180	162
4	215	179	192	221	203	198	208	193	198	194	219	202	220	200	253	233	238	207	218	204
5	235	199	218	231	219	232	240	229	225	212	243	225	251	195	262	256	275	236	232	228
6	252	221	245	277	240	243	262	251	237	238	255	277	289	228	299	245	307	267	261	237
7	276	239	258	276	258	236	270	262	265	241	272	286	315	257	306	265	289	272	295	255
8	286	240	277	316	259	236	288	276	274	214	312	305	323	302	325	269	308	230	300	286
9+	330	283	292	316	281	302	315	292	271	298	311	340	346	324	335	329	363	260	280	294

\# Weights-at-age in the catch for 1999, 2000 and 2001 have been 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 Since these are not available in the catch archive.

Table 2.7.2 Maturity at 2, 3 and 4+ ring for Autumn-spawning herring in the North Sea. The values are derived from the acoustic survey. The acoustic survey data archive has been revised this year and the values for maturity updated. No changes in maturity (to 3 significant figures) were found and no values in this table were changed.

Year \Age (W ring)	2	3	>3
1988	65.6	87.7	100
1989	78.7	93.9	100
1990	72.6	97.0	100
1991	63.8	98.0	100
1992	51.3	100	100
1993	47.1	62.9	100
1994	72.1	85.8	100
1995	72.6	95.4	100
1996	60.5	97.5	100
1997	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

Table 2.8.1. North Sea herring. Input parameters of the final ICA assessments for the years 1998-2002.

Assessment year			**2002**	**2001**	**2000**	**1999**	**1998**
First data year			1960	1960	1960	1960	1960
Last data year			2001	2000	1999	1998	1997
No of years for separable constraint			**5**	4	8	7	6
Reference age for separable constraint			4	4	4	4	4
Constant selection pattern			**yes**	yes	s1 (92-96), s2(97-99)-constrained	s1 (92-96), s2(97-98)-constrained	s1 (92-95), s2(96-97)-constrained
S on last age			1.0	1.0	1 / 1	1 / 1	1 / 1
Shrink final population			no	no	no	no	no

Tuning indices	*survey*	*age (WR)*					
Year ranges for survey indices	MLAI		1979-2001	1979-2000	1979-1999	79-98	77-96
	Acoustic survey	1-9+	**1989-2001**				
	Acoustic survey	2-9+		1989-2000	1989-1999	89-98	89-97
	IBTSA	2-5+	1983-2002	1983-2001	1983-2000	83-99	83-98
	IBTSY	1	1979-2002	1979-2001	1979-2000	79-99	79-98
	MIK	0	1977-2002	1977-2001	1977-2000	77-99	77-98
Catchability models	MLAI		power	power	power	power	power
	Acoustic survey	2-9+	linear	linear	linear	linear	linear
	IBTSA	2-5+	linear	linear	linear	linear	linear
	IBTSY	1	linear	linear	linear	linear	linear
	MIK	0	linear	linear	linear	linear	linear

Model weighting							
Weights in the catch at age	Catch	0	**0.10**	1	1	1	1
	Catch	1	**0.10**	1	1	1	1
	Catch	2	**3.17**	1	1	1	1
	Catch	3	**2.65**	1	1	1	1
	Catch	4	**1.94**	1	1	1	1
	Catch	5	**1.31**	1	1	1	1
	Catch	6	**0.97**	1	1	1	1
	Catch	7	**0.75**	1	1	1	1
	Catch	8	**0.55**	1	1	1	1
	Catch	9	**0.54**	1	1	1	1
	Catch	years	**all 1**	all 1	all 1	all 1	all 1
Total weight catch at age matrix			**60.4**	36	72	63	54
Survey indices weights	MLAI		**0.65**	1.0	1.0	1.0	1.0
	Acoustic survey	1	**0.74**	NA	NA	NA	NA
	Acoustic survey	2	**0.75**	0.125	0.125	0.125	0.125
	Acoustic survey	3	**0.64**	0.125	0.125	0.125	0.125
	Acoustic survey	4	**0.27**	0.125	0.125	0.125	0.125
	Acoustic survey	5	**0.14**	0.125	0.125	0.125	0.125
	Acoustic survey	6	**0.13**	0.125	0.125	0.125	0.125
	Acoustic survey	7	**0.12**	0.125	0.125	0.125	0.125
	Acoustic survey	8	**0.07**	0.125	0.125	0.125	0.125
	Acoustic survey	9+	**0.07**	0.125	0.125	0.125	0.125
	IBTSA	2	**0.24**	0.25	0.25	0.25	0.25
	IBTSA	3	**0.06**	0.25	0.25	0.25	0.25
	IBTSA	4	**0.03**	0.25	0.25	0.25	0.25
	IBTSA	5+	**0.03**	0.25	0.25	0.25	0.25
	IBTSY	1	**0.67**	1.0	1.0	1.0	1.0
	MIK	0	**2.05**	1.0	1.0	1.0	1.0
Total weight survey indices			**6.7**	5	5	5	5
Stock recruitment weight			0.1	0.1	0.1	0.1	0.1

Parameters to be estimated	**45**	42	57	55	53
Number of observations	354	324	338	313	289

Table 2.8.2 North Sea herring. Absolute annual change in annual estimates of F2-6, Recruitment and SSB over the period 1995 to 2001. Expressed as average change over the period (AAC) and average absolute change in the first year (1YC) for the four modelling and weighting methods shown in Figure 2.8.4. The smallest change for each management parameter is shown in bold.

Method		**Criteria**	**F 2-6**	**Recr 0**	**SSB**
A	IV weight, WG Sep	absolute revision 1995 -2002	0.044	4922000	52991
		absolute revision Ist year	0.057	10100000	96257
B	IV weight, 5year Sep 0,1dw	absolute revision 1995 -2002	**0.024**	3890000	38840
		absolute revision Ist year	**0.043**	**2900000**	85643
C	IV weight WG Sep 0,1dw	absolute revision 1995 -2002	0.029	**3461143**	36809
		absolute revision Ist year	0.043	2907143	72314
D	WG 2001 weight WG Sep	absolute revision 1995 -2002	0.036	3736857	**25594**
		absolute revision Ist year	0.069	6290000	**60229**

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

```
Integrated Catch-at-age Analysis, Version 1.4 w
-----------------------------------------------

 Enter the name of the index file -->index
canum
weca
 Stock weights in 2002  used for the year 2001
west
 Natural mortality in 2002  used for the year 2001
natmor
 Maturity ogive in 2002  used for the year 2001
matprop
 Name of age-structured index file (Enter if none) : -->fleet
 Name of the SSB index file (Enter if none) -->ssb
 No of years for separable constraint ?--> 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-->    0.100000000000000
 Weight for age 1-->    0.100000000000000
 Weight for age 2-->    3.170000000000000
 Weight for age 3-->    2.650000000000000
 Weight for age 4-->    1.940000000000000
 Weight for age 5-->    1.310000000000000
 Weight for age 6-->    0.970000000000000
 Weight for age 7-->    0.750000000000000
 Weight for age 8-->    0.550000000000000
 Weight for age 9-->    0.540000000000000
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
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 Acou a plus-group (Y--> y
 Is the last age of IBTSA: 2-5+ wr a plus-group (Y/N) ?--> y
 Is the last age of IBTSY 1-wr a plus-group (Y/N) ?--> n
 Is the last age of MIK 0-wr a plus-group (Y/N) ?--> n

You must choose a catchability model for each index.
 Model for MLAI  is to be A/L/P ?-->p
 Model for Acoustic survey 2-9+ wr Acou  is to be A/L/P ?-->L
 Model for IBTSA: 2-5+ wr  is to be A/L/P ?-->L
 Model for IBTSY 1-wr  is to be A/L/P ?-->L
 Model for MIK 0-wr  is to be A/L/P ?-->L
 Fit a stock-recruit relationship (Y/N) ?-->y
Enter the time lag in years between spawning and the stock size
 of fish aged 0  years on 1 January.
This will probably be 0 unless the stock is an autumn-spawning herring
 in which case it will probably be 1  years.
 Enter the lag in years (rounded up)--> 1
 Enter lowest feasible F-->   5.0000000000000003E-02
 Enter highest feasible F-->    1.000000000000000
Mapping the F-dimension of the SSQ surface

    F                 SSQ
+--------+-------------------
    0.05       135.0628273943
    0.10        66.2406995757
    etc.
    0.95        34.1795083325
    1.00        35.8108327557
```

Table 2.8.3 Continued.

```
Lowest SSQ is for F =     0.365
-----------------------------------------------------------------
No of years for separable analysis : 5
Age range in the analysis : 0  . . . 9
Year range in the analysis : 1960  . . . 2001
Number of indices of SSB : 1
Number of age-structured indices : 4
Stock-recruit relationship to be fitted.
Parameters to estimate : 45
Number of observations : 354
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 Acou  at age 1-->    0.740000000000000
 Enter weight for Acoustic survey 2-9+ wr Acou  at age 2-->    0.750000000000000
 Enter weight for Acoustic survey 2-9+ wr Acou  at age 3-->    0.640000000000000
 Enter weight for Acoustic survey 2-9+ wr Acou  at age 4-->    0.270000000000000
 Enter weight for Acoustic survey 2-9+ wr Acou  at age 5-->    0.140000000000000
 Enter weight for Acoustic survey 2-9+ wr Acou  at age 6-->    0.130000000000000
 Enter weight for Acoustic survey 2-9+ wr Acou  at age 7-->    0.120000000000000
 Enter weight for Acoustic survey 2-9+ wr Acou  at age 8-->   7.0000000000000007E-02
 Enter weight for Acoustic survey 2-9+ wr Acou  at age 9-->   7.0000000000000007E-02
 Enter weight for IBTSA: 2-5+ wr  at age 2-->    0.240000000000000
 Enter weight for IBTSA: 2-5+ wr  at age 3-->   5.9999999999999998E-02
 Enter weight for IBTSA: 2-5+ wr  at age 4-->   2.9999999999999999E-02
 Enter weight for IBTSA: 2-5+ wr  at age 5-->    0.670000000000000
 Enter weight for IBTSY 1-wr  at age 1-->    0.670000000000000
 Enter weight for MIK 0-wr  at age 0-->    2.050000000000000
 Enter weight for stock-recruit model-->    0.100000000000000
Enter estimates of the extent to which errors
in the age-structured indices are correlated
across ages. This can be in the range 0 (independence)
to 1 (correlated errors).
  Enter value for Acoustic survey 2-9+ wr Acou-->  0.0000000000000000E+000
  Enter value for IBTSA: 2-5+ wr-->  0.0000000000000000E+000
  Enter value for IBTSY 1-wr-->  0.0000000000000000E+000
  Enter value for MIK 0-wr-->  0.0000000000000000E+000
 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             Acou
 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
IBTSA: 2-5+ wr
 Age   :       2     3     4     5
 Wts :     0.240 0.060 0.030 0.670
IBTSY 1-wr
 Age   :       1
 Wts :     0.670
MIK 0-wr
 Age   :       0
 Wts :     2.050
 Stock-recruit weight           0.100
F in 2001  at age 4  is 0.342621  in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->D
 Output page width in characters (e.g. 80..132) ?--> 132
 Estimate historical assessment uncertainty ?-->y
 Sample from Covariances or Bayes MCMC (C/B) ?-->c
 Use default percentiles (Y/N)  ?-->y
 How many samples to take  ?--> 1000
 Enter SSB reference level (e.g. MBAL, Bpa..) [t]-->   8.0000000000000000E+05
Succesful exit from ICA
```

Table 2.8.4 North Sea herring. Catch number at age (millions).

Catch in Number

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

x 10 ^ 6

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

x 10 ^ 6

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

x 10 ^ 6

AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	10265.	4499.	8426.	2429.	457.	258.	1565.	1109.	1833.
1	3827.	1785.	1635.	1608.	527.	959.	330.	1169.	646.
2	1176.	1783.	1573.	709.	738.	1214.	647.	613.	854.
3	609.	489.	898.	629.	527.	525.	1077.	487.	495.
4	306.	348.	242.	196.	285.	276.	298.	603.	270.
5	216.	109.	121.	59.	107.	161.	138.	186.	294.
6	226.	92.	55.	20.	28.	85.	69.	79.	76.
7	188.	76.	41.	11.	12.	16.	27.	28.	40.
8	87.	70.	54.	8.	11.	10.	9.	17.	39.
9	42.	47.	72.	18.	12.	10.	3.	2.	2.

x 10 ^ 6

Table 2.8.5 North Sea herring. Weight in the catch (kg).

Weights-at-age in the catches (Kg)

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

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

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

AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.01000	0.00600	0.00900	0.01600	0.01600	0.02000	0.00900	0.01500	0.01200
1	0.03300	0.05600	0.04800	0.01000	0.03200	0.04900	0.04700	0.03300	0.05100
2	0.11500	0.13000	0.13600	0.12300	0.10400	0.11300	0.11400	0.11600	0.11600
3	0.14500	0.15900	0.16700	0.16000	0.14600	0.14400	0.15100	0.15700	0.14700
4	0.18900	0.18100	0.19600	0.19200	0.19400	0.18200	0.16800	0.18000	0.17300
5	0.20400	0.21400	0.20000	0.20700	0.22800	0.22000	0.20500	0.19900	0.19400
6	0.22800	0.24000	0.24700	0.21100	0.22900	0.23600	0.23200	0.21800	0.21000
7	0.24400	0.25500	0.24900	0.25200	0.22800	0.24500	0.24300	0.24400	0.22800
8	0.25600	0.27300	0.27800	0.25400	0.22600	0.27300	0.26000	0.26700	0.21800
9	0.31000	0.28100	0.28700	0.28100	0.29600	0.28600	0.29200	0.26200	0.28500

Table 2.8.6 North Sea herring. Weight in the stock (kg).

Weights-at-age in the stock (Kg)

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

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

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	0.01500	0.01700	0.01600	0.01400	0.00900	0.00800	0.00800	0.01200	0.01100	0.01000	0.00600
1	0.05000	0.05700	0.05600	0.06100	0.05000	0.04800	0.04400	0.05200	0.05900	0.06400	0.06100
2	0.15500	0.15000	0.13800	0.13000	0.12200	0.12300	0.12200	0.12600	0.13900	0.13700	0.13400
3	0.18700	0.19000	0.18700	0.18300	0.17000	0.16600	0.16500	0.17400	0.18400	0.19400	0.18400
4	0.22300	0.23000	0.23200	0.23200	0.21200	0.20800	0.20500	0.21200	0.21200	0.21400	0.21300
5	0.23900	0.24300	0.24700	0.25200	0.23000	0.22900	0.22800	0.24400	0.23900	0.23400	0.23500
6	0.27600	0.28200	0.27500	0.27300	0.24200	0.24800	0.25200	0.27000	0.26500	0.25300	0.26200
7	0.29900	0.31100	0.32100	0.31500	0.27500	0.25900	0.26100	0.28400	0.28000	0.27100	0.27300
8	0.30600	0.33800	0.34100	0.33200	0.26800	0.26300	0.27700	0.29800	0.30000	0.29100	0.30200
9	0.31200	0.34700	0.36500	0.39200	0.34300	0.32500	0.31500	0.33100	0.32800	0.31200	0.32000

AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.00700	0.00600	0.00600	0.00500	0.00500	0.00600	0.00600	0.00600	0.00700
1	0.06000	0.05700	0.05400	0.04900	0.04800	0.05100	0.05100	0.05100	0.04800
2	0.12700	0.13000	0.13000	0.12300	0.11600	0.11600	0.11500	0.12100	0.12300
3	0.19200	0.18600	0.19900	0.18300	0.18700	0.18000	0.18400	0.17200	0.17100
4	0.21400	0.21100	0.22700	0.23000	0.24100	0.22600	0.22100	0.21000	0.21100
5	0.24000	0.22400	0.23400	0.23700	0.26500	0.25600	0.24800	0.23200	0.23000
6	0.27500	0.26800	0.27400	0.25700	0.28400	0.27300	0.27900	0.25500	0.24900
7	0.29100	0.29300	0.30100	0.28000	0.28700	0.27600	0.28600	0.27500	0.27500
8	0.30900	0.31800	0.32400	0.30300	0.30100	0.27000	0.28100	0.27400	0.29400
9	0.33800	0.34600	0.34400	0.33500	0.34200	0.31800	0.30300	0.28000	0.28900

Table 2.8.7 North Sea herring. Natural mortality, proportion F and M before spawning.

Natural Mortality (per year)

AGE	1960	1961	1962	1963	....	1996	1997	1998	1999	2000	2001
0	1.0000	1.0000	1.0000	1.0000	....	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	....	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	....	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	....	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	....	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	....	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	....	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	....	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	....	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	....	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Proportion of F before spawning: 0.67

Proportion of M before spawning: 0.67

Table 2.8.8 North Sea herring. Proportion mature at age.

Proportion of fish spawning

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

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

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.8200	0.8200	0.8200	0.7000	0.7500	0.8000	0.8500	0.8200	0.9100	0.8600	0.5000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9300	0.9400	0.9700	0.9900	0.9900
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.4700	0.7300	0.6700	0.6100	0.6400	0.6400	0.6900	0.6700	0.7700
3	0.6100	0.9300	0.9500	0.9800	0.9400	0.8900	0.9100	0.9600	0.9200
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.8.9 North Sea herring. Tuning indices.

INDICES OF SPAWNING BIOMASS

MLAI

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	13.40	8.00	2.70	2.50	6.10	7.40	15.20	10.30	15.60	21.70	28.00

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	51.00	77.80	40.10	69.70	139.60	134.70	170.60	90.20	41.70	30.80	20.40

	1995	1996	1997	1998	1999	2000	2001
1	23.70	47.80	58.80	79.40	66.90	43.90	135.50

AGE-STRUCTURED INDICES

Acoustic survey 1-9+ wr

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1									9361.	4449.	5087.
2	4090.	3306.	2634.	3734.	2984.	3185.	3849.	4497.	5960.	5747.	3078.
3	3903.	3521.	1700.	1378.	1637.	839.	2041.	2824.	2935.	2520.	4725.
4	1633.	3414.	1959.	1147.	902.	399.	672.	1087.	1441.	1625.	1116.
5	492.	1366.	1849.	1134.	741.	381.	299.	311.	601.	982.	506.
6	283.	392.	644.	1246.	777.	321.	203.	99.	215.	445.	314.
7	120.	210.	228.	395.	551.	326.	138.	83.	46.	170.	139.
8	44.	133.	94.	114.	180.	219.	119.	133.	78.	45.	54.
9	22.	43.	51.	104.	116.	131.	93.	206.	159.	121.	87.

AGE	2000	2001
1	24736.	6837.
2	2923.	12290.
3	2156.	3083.
4	3140.	1462.
5	1007.	1676.
6	483.	450.
7	266.	170.
8	120.	98.
9	97.	59.

x 10 ^ 3

Table 2.8.9 Continued.

IBTSA: 2-5+ wr

AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	137.4	169.9	748.1	820.1	946.3	4725.8	933.9	482.1	821.0	410.1	840.8
3	46.4	67.0	301.5	288.9	124.0	915.0	401.2	312.9	288.4	195.1	225.1
4	15.3	30.0	47.6	84.1	63.2	65.4	111.8	292.7	258.7	68.5	46.9
5	28.5	10.8	31.2	28.5	53.6	28.0	10.5	77.1	174.3	109.4	68.6

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	1176.5	1263.1	209.0	526.6	799.7	456.8	232.2	1228.1	666.0
3	214.4	251.0	46.6	204.1	96.4	547.8	169.3	337.0	324.0
4	68.4	33.2	13.5	42.8	22.0	109.0	65.5	106.8	23.0
5	43.0	6.2	9.1	24.3	20.7	40.3	9.7	79.0	19.0

IBTSY 1-wr

AGE	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	156.3	342.8	517.7	799.3	1230.7	1468.9	2082.4	2593.0	3733.8	4469.6	2187.0

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	1024.6	1180.3	1204.0	2988.5	1644.3	1215.4	1728.3	3992.7	2067.1	714.8	3638.9

AGE	2001	2002
1	2496.4	3948.0

MIK 0-wr

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

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

AGE	1999	2000	2001	2002
0	244.00	137.10	214.80	161.80

Table 2.8.10 North Sea herring. Weighting factors for the catches in number.

Weighting factors for the catches in number

AGE	1997	1998	1999	2000	2001
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

Table 2.8.11 North Sea herring. Predicted catch in number.

Predicted Catch in Number

AGE	1997	1998	1999	2000	2001
0	696.2	579.4	1420.1	824.3	1070.2
1	1345.4	786.0	560.4	1479.0	715.1
2	681.0	1287.0	651.3	506.5	1134.0
3	537.4	629.0	1042.5	585.9	395.3
4	279.0	296.2	304.4	569.3	280.1
5	119.4	161.5	150.7	174.8	286.4
6	31.2	65.0	77.1	81.2	82.4
7	12.0	15.1	27.5	36.7	33.5
8	11.3	9.2	10.2	20.8	24.1

x 10 ^ 6

Table 2.8.12 North Sea herring. Fishing mortality (per year).

Fishing Mortality (per year)

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	0.0257	0.0186	0.0049	0.0148	0.0126	0.0071	0.0215	0.0256	0.0348	0.0082	0.0351
1	0.2558	0.1293	0.0897	0.1241	0.3084	0.2461	0.1852	0.2980	0.3002	0.3291	0.2680
2	0.4328	0.6169	0.2500	0.2975	0.3890	0.7753	0.5920	0.4222	1.3270	0.7843	0.9728
3	0.3249	0.3484	0.6266	0.2752	0.4123	0.7390	0.7082	0.8045	1.8717	0.9120	1.2667
4	0.3331	0.4023	0.4146	0.2268	0.3697	0.7765	0.5719	0.9244	1.0711	0.8736	1.3283
5	0.2608	0.3950	0.5214	0.1472	0.3074	0.6582	0.8342	0.8281	1.2340	1.0530	0.8742
6	0.3085	0.3707	0.7898	0.1756	0.2312	0.5188	0.3886	1.0087	1.1766	1.9008	1.0768
7	0.5789	0.2450	0.6067	0.2688	0.2699	0.4388	0.3871	1.5133	1.5934	1.3070	4.1162
8	0.5338	0.4878	0.5625	0.3114	0.5097	0.7972	0.6800	1.0622	1.5581	1.3024	1.7963
9	0.5338	0.4878	0.5625	0.3114	0.5097	0.7972	0.6800	1.0622	1.5581	1.3024	1.7963

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.0340	0.0583	0.0461	0.0748	0.1557	0.1461	0.0972	0.0454	0.0836	0.1256	0.4817
1	0.6021	0.5781	0.6738	0.4514	0.6870	0.2462	0.2956	0.1992	0.1662	0.1131	0.2851
2	0.8825	0.8120	1.0218	1.0281	1.3095	1.3336	0.2218	0.0241	0.0942	0.3625	0.3238
3	1.2146	0.8012	1.3329	0.9722	1.5016	1.4273	1.3897	0.0418	0.0661	0.4166	0.2741
4	1.2257	0.7994	0.9870	0.9919	1.3694	1.7224	0.4244	0.1010	0.0921	0.2950	0.3009
5	1.0791	0.5488	0.9508	1.1834	1.8678	1.5832	1.1614	0.0164	0.0506	0.2597	0.4085
6	2.5882	0.5121	1.3731	1.0766	1.2662	1.0473	0.7170	0.0725	0.0123	0.0649	0.4192
7	2.6510	0.0953	0.7891	0.7653	2.0135	1.4623	0.7015	0.0585	0.4025	0.1003	0.9121
8	1.9255	0.9280	1.4474	1.2557	1.9408	1.5637	0.8809	0.1631	0.2225	0.3203	0.6094
9	1.9255	0.9280	1.4474	1.2557	1.9408	1.5637	0.8809	0.1631	0.2225	0.3203	0.6094

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	0.3342	0.3993	0.2262	0.0852	0.0619	0.1625	0.1261	0.1319	0.0593	0.1172	0.2889
1	0.2249	0.2515	0.2050	0.3825	0.3156	0.3722	0.5858	0.4370	0.4599	0.3111	0.3845
2	0.2602	0.3019	0.3142	0.4038	0.4589	0.4059	0.3555	0.4050	0.3853	0.5898	0.5813
3	0.5075	0.3239	0.4291	0.6702	0.5214	0.5046	0.4003	0.4099	0.3787	0.4702	0.5217
4	0.2457	0.4354	0.5358	0.7360	0.5803	0.5870	0.5801	0.5548	0.4671	0.4751	0.6064
5	0.1527	0.2734	0.6247	0.6606	0.5517	0.6135	0.6598	0.6527	0.4985	0.4829	0.5818
6	0.1431	0.3400	0.3561	0.7237	0.7251	0.6309	0.6685	0.6916	0.4875	0.4756	0.7197
7	0.2207	0.3849	0.6797	0.5480	0.8020	0.6006	0.6815	0.6943	0.6628	0.4161	0.6907
8	0.3831	0.4847	0.5963	0.8178	0.7808	0.7565	0.8760	0.8062	0.7399	0.6713	0.8369
9	0.3831	0.4847	0.5963	0.8178	0.7808	0.7565	0.8760	0.8062	0.7399	0.6713	0.8369

AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.3529	0.2161	0.3454	0.0705	0.0353	0.0353	0.0300	0.0273	0.0204
1	0.4066	0.2258	0.2708	0.2431	0.1161	0.1160	0.0987	0.0897	0.0672
2	0.6605	0.6405	0.5898	0.3173	0.2677	0.2676	0.2275	0.2069	0.1551
3	0.6586	0.6993	0.8731	0.5381	0.4535	0.4533	0.3855	0.3506	0.2627
4	0.8006	0.9695	0.8793	0.4426	0.4610	0.4608	0.3919	0.3564	0.2670
5	0.7959	0.6623	0.9916	0.4830	0.4698	0.4696	0.3993	0.3632	0.2721
6	0.7895	0.8489	0.7491	0.3824	0.4476	0.4475	0.3805	0.3460	0.2593
7	0.8728	0.5976	1.0753	0.2819	0.3613	0.3612	0.3072	0.2793	0.2093
8	0.9900	0.8524	0.9964	0.5327	0.4610	0.4608	0.3919	0.3564	0.2670
9	0.9900	0.8524	0.9964	0.5327	0.4610	0.4608	0.3919	0.3564	0.2670

Table 2.8.13 North Sea herring. Population abundance (1 January, billions).

Population Abundance (1 January)

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	12.10	108.87	46.27	47.66	62.79	34.90	27.86	40.26	38.70	21.58	41.08
1	16.42	4.34	39.31	16.94	17.27	22.81	12.75	10.03	14.44	13.75	7.87
2	3.72	4.68	1.40	13.22	5.50	4.67	6.56	3.90	2.74	3.93	3.64
3	7.78	1.79	1.87	0.81	7.27	2.76	1.59	2.69	1.89	0.54	1.33
4	0.61	4.60	1.03	0.82	0.50	3.94	1.08	0.64	0.98	0.24	0.18
5	0.77	0.40	2.79	0.62	0.59	0.31	1.64	0.55	0.23	0.31	0.09
6	0.45	0.53	0.24	1.50	0.48	0.39	0.15	0.64	0.22	0.06	0.10
7	0.30	0.30	0.33	0.10	1.14	0.35	0.21	0.09	0.21	0.06	0.01
8	0.33	0.15	0.21	0.16	0.07	0.78	0.20	0.13	0.02	0.04	0.01
9	0.36	0.24	0.21	0.20	0.15	0.15	0.50	0.28	0.12	0.04	0.02

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	32.31	20.86	10.11	21.72	2.86	2.74	4.35	4.62	10.62	16.75	37.89
1	14.59	11.49	7.24	3.55	7.41	0.90	0.87	1.45	1.62	3.59	5.43
2	2.22	2.94	2.37	1.36	0.83	1.37	0.26	0.24	0.44	0.51	1.18
3	1.02	0.68	0.97	0.63	0.36	0.17	0.27	0.15	0.17	0.30	0.26
4	0.31	0.25	0.25	0.21	0.20	0.07	0.03	0.05	0.12	0.13	0.16
5	0.04	0.08	0.10	0.08	0.07	0.05	0.01	0.02	0.04	0.10	0.09
6	0.03	0.01	0.04	0.04	0.02	0.01	0.01	0.00	0.02	0.04	0.07
7	0.03	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.02	0.03
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
9	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	64.80	61.86	53.50	80.98	97.64	85.64	41.84	38.73	35.59	33.81	63.63
1	8.61	17.07	15.27	15.70	27.36	33.76	26.78	13.57	12.49	12.34	11.06
2	1.50	2.53	4.88	4.58	3.94	7.34	8.56	5.48	3.22	2.90	3.33
3	0.63	0.86	1.39	2.64	2.26	1.84	3.62	4.44	2.71	1.62	1.19
4	0.16	0.31	0.51	0.74	1.11	1.10	0.91	1.99	2.41	1.52	0.83
5	0.11	0.11	0.18	0.27	0.32	0.56	0.55	0.46	1.03	1.37	0.85
6	0.05	0.08	0.08	0.09	0.13	0.17	0.27	0.26	0.22	0.57	0.76
7	0.04	0.04	0.05	0.05	0.04	0.06	0.08	0.13	0.12	0.12	0.32
8	0.01	0.03	0.03	0.02	0.03	0.02	0.03	0.04	0.06	0.05	0.07
9	0.00	0.03	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.03	0.04

AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	53.07	35.98	44.38	56.12	31.66	26.36	75.81	48.33	83.50	61.09
1	17.53	13.72	10.67	11.56	19.24	11.24	9.36	27.07	17.30	30.10
2	2.77	4.30	4.03	2.99	3.33	6.30	3.68	3.12	9.10	5.95
3	1.38	1.06	1.68	1.65	1.61	1.89	3.57	2.17	1.88	5.77
4	0.58	0.58	0.43	0.57	0.79	0.84	0.98	1.99	1.25	1.18
5	0.41	0.24	0.20	0.16	0.33	0.45	0.48	0.60	1.26	0.87
6	0.43	0.17	0.11	0.07	0.09	0.19	0.26	0.29	0.38	0.87
7	0.34	0.18	0.06	0.05	0.04	0.05	0.11	0.16	0.19	0.26
8	0.14	0.13	0.09	0.02	0.03	0.03	0.03	0.07	0.11	0.14
9	0.07	0.08	0.12	0.05	0.03	0.03	0.01	0.01	0.01	0.08

x 10 ^ 9

Table 2.8.14 North Sea herring. Predicted index values.

MLAI

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	16.88	11.37	5.43	5.18	3.09	4.31	7.37	9.16	14.10	20.62	33.20

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	54.00	55.77	54.04	73.30	99.46	103.87	97.26	78.26	53.84	34.27	38.74

	1995	1996	1997	1998	1999	2000	2001
1	36.89	37.17	45.62	62.54	75.98	76.71	120.27

Acoustic survey 2-9+ wr Aco Predicted

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1									9891.	5780.	4859.
2	5677.	3374.	2712.	3125.	2493.	3907.	3766.	3251.	3722.	7037.	4204.
3	5714.	3544.	2021.	1440.	1545.	1163.	1671.	1982.	2026.	2372.	4655.
4	2669.	3402.	2130.	1085.	679.	624.	484.	819.	1118.	1187.	1444.
5	654.	1593.	2130.	1259.	537.	331.	236.	252.	522.	707.	780.
6	382.	359.	944.	1112.	605.	227.	157.	118.	153.	318.	447.
7	180.	169.	200.	453.	433.	265.	75.	83.	71.	89.	191.
8	59.	96.	94.	114.	210.	199.	128.	37.	62.	51.	66.
9	44.	66.	80.	112.	166.	220.	285.	142.	105.	87.	36.

AGE	2000	2001
1	14117.	9137.
2	3602.	10812.
3	2887.	2620.
4	2978.	1971.
5	999.	2201.
6	519.	709.
7	281.	345.
8	149.	233.
9	30.	39.

x 10 ^ 3

Table 2.8.14 Continued

IBTSA: 2-5+ wr Predicted

AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	374.5	721.6	668.6	571.7	1072.5	1258.6	801.3	472.3	414.1	475.4	392.2
3	90.8	144.8	267.8	233.7	190.9	379.9	465.4	284.9	168.9	123.0	139.9
4	19.7	31.8	45.1	68.8	68.4	56.7	124.1	152.4	95.7	51.5	35.0
5	10.8	13.3	15.8	18.5	28.0	32.5	30.8	50.5	74.9	70.3	46.6

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	609.4	575.0	442.1	495.6	936.9	550.2	467.3	1372.2	897.2
3	107.1	165.7	170.5	168.1	196.8	375.3	229.3	200.5	615.9
4	34.6	25.9	36.3	49.9	53.0	62.6	127.3	81.1	76.5
5	26.9	19.2	12.0	18.6	26.2	31.5	40.3	69.9	79.9

IBTSY 1-wr Predicted

AGE	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	192.6	429.3	635.5	1014.8	2004.7	1803.5	1813.7	3187.6	3906.3	3016.7	1557.1

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	1429.0	1438.6	1278.1	2020.0	1616.6	1249.7	1358.9	2298.5	1343.2	1120.7	3243.9

AGE	2001	2002
1	2079.6	3617.5

MIK 0-wr Predicted

AGE	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	11.42	12.19	27.90	43.77	94.74	165.03	156.26	138.09	212.75	257.26	222.83

AGE	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	109.35	101.15	93.81	88.48	162.96	134.84	93.00	112.86	147.71	83.70	69.68

AGE	1999	2000	2001	2002
0	200.55	127.90	221.16	161.80

Table 2.8.15 North Sea herring. Fitted selection pattern.

Fitted Selection Pattern

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	0.0772	0.0462	0.0117	0.0652	0.0340	0.0092	0.0375	0.0277	0.0325	0.0094	0.0264
1	0.7681	0.3213	0.2163	0.5470	0.8343	0.3169	0.3239	0.3224	0.2803	0.3767	0.2018
2	1.2994	1.5335	0.6030	1.3117	1.0522	0.9985	1.0351	0.4567	1.2389	0.8978	0.7324
3	0.9754	0.8660	1.5116	1.2132	1.1154	0.9516	1.2383	0.8702	1.7475	1.0439	0.9536
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.7830	0.9818	1.2577	0.6489	0.8315	0.8476	1.4586	0.8958	1.1521	1.2054	0.6582
6	0.9263	0.9215	1.9052	0.7743	0.6253	0.6682	0.6795	1.0912	1.0985	2.1759	0.8107
7	1.7380	0.6091	1.4636	1.1850	0.7301	0.5651	0.6768	1.6370	1.4877	1.4962	3.0988
8	1.6028	1.2124	1.3568	1.3730	1.3787	1.0266	1.1889	1.1490	1.4547	1.4909	1.3523
9	1.6028	1.2124	1.3568	1.3730	1.3787	1.0266	1.1889	1.1490	1.4547	1.4909	1.3523

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.0277	0.0729	0.0468	0.0755	0.1137	0.0848	0.2290	0.4495	0.9079	0.4258	1.6010
1	0.4912	0.7232	0.6826	0.4551	0.5017	0.1429	0.6965	1.9725	1.8046	0.3833	0.9477
2	0.7200	1.0157	1.0352	1.0365	0.9563	0.7743	0.5225	0.2383	1.0232	1.2286	1.0761
3	0.9910	1.0022	1.3504	0.9801	1.0965	0.8286	3.2741	0.4138	0.7174	1.4120	0.9111
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8804	0.6865	0.9633	1.1931	1.3639	0.9192	2.7363	0.1626	0.5496	0.8803	1.3579
6	2.1116	0.6406	1.3911	1.0853	0.9247	0.6080	1.6893	0.7175	0.1333	0.2200	1.3932
7	2.1629	0.1192	0.7995	0.7716	1.4703	0.8489	1.6528	0.5792	4.3707	0.3401	3.0313
8	1.5709	1.1609	1.4664	1.2660	1.4172	0.9078	2.0755	1.6147	2.4160	1.0854	2.0255
9	1.5709	1.1609	1.4664	1.2660	1.4172	0.9078	2.0755	1.6147	2.4160	1.0854	2.0255

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	1.3601	0.9171	0.4222	0.1158	0.1067	0.2769	0.2173	0.2377	0.1271	0.2467	0.4764
1	0.9152	0.5776	0.3826	0.5197	0.5438	0.6341	1.0099	0.7878	0.9845	0.6548	0.6340
2	1.0591	0.6933	0.5864	0.5486	0.7907	0.6915	0.6129	0.7300	0.8249	1.2413	0.9585
3	2.0657	0.7440	0.8009	0.9106	0.8985	0.8596	0.6901	0.7389	0.8107	0.9896	0.8603
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.6215	0.6280	1.1659	0.8976	0.9506	1.0452	1.1373	1.1765	1.0672	1.0163	0.9594
6	0.5825	0.7809	0.6647	0.9834	1.2494	1.0748	1.1525	1.2466	1.0435	1.0010	1.1868
7	0.8984	0.8840	1.2687	0.7445	1.3820	1.0232	1.1748	1.2516	1.4189	0.8758	1.1389
8	1.5593	1.1133	1.1130	1.1111	1.3454	1.2888	1.5100	1.4532	1.5839	1.4128	1.3800
9	1.5593	1.1133	1.1130	1.1111	1.3454	1.2888	1.5100	1.4532	1.5839	1.4128	1.3800

AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.4408	0.2229	0.3928	0.1593	0.0766	0.0766	0.0766	0.0766	0.0766
1	0.5078	0.2329	0.3080	0.5493	0.2518	0.2518	0.2518	0.2518	0.2518
2	0.8250	0.6606	0.6707	0.7170	0.5807	0.5807	0.5807	0.5807	0.5807
3	0.8227	0.7213	0.9929	1.2157	0.9837	0.9837	0.9837	0.9837	0.9837
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.9940	0.6831	1.1277	1.0912	1.0191	1.0191	1.0191	1.0191	1.0191
6	0.9860	0.8756	0.8519	0.8639	0.9710	0.9710	0.9710	0.9710	0.9710
7	1.0902	0.6163	1.2229	0.6369	0.7838	0.7838	0.7838	0.7838	0.7838
8	1.2366	0.8792	1.1331	1.2036	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.2366	0.8792	1.1331	1.2036	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.8.16 North Sea herring. Stock summary. This table is taken directly from ICA.OUT except that a column for mean fishing mortality for juveniles has been added!

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	**Mean F Ages 0-1**	Mean F Ages 2- 6	SoP (%)
1960	12097900	3778955	1911811	696200	0.3642	0.141	0.3320	84
1961	108865820	4387806	1684621	696700	0.4136	0.074	0.4267	88
1962	46272650	4419877	1136203	627800	0.5525	0.047	0.5205	85
1963	47657610	4648231	2207286	716000	0.3244	0.069	0.2245	116
1964	62788650	4813525	2046742	871200	0.4257	0.161	0.3419	93
1965	34896680	4357548	1462521	1168800	0.7992	0.127	0.6936	86
1966	27860680	3325185	1289112	895500	0.6947	0.103	0.6190	93
1967	40257670	2817910	923195	695500	0.7534	0.162	0.7976	85
1968	38699260	2522428	414076	717800	1.7335	0.168	1.3361	79
1969	21583200	1905778	424520	546700	1.2878	0.169	1.1048	103
1970	41077280	1922103	374758	563100	1.5026	0.152	1.1038	103
1971	32312470	1849816	266324	520100	1.9529	0.318	1.3980	93
1972	20862860	1549902	288554	497500	1.7241	0.318	0.6947	108
1973	10113630	1156502	233666	484000	2.0713	0.360	1.1331	104
1974	21719920	912842	162321	275100	1.6948	0.263	1.0504	103
1975	2857050	681720	82110	312800	3.8095	0.421	1.4629	107
1976	2739360	360318	78696	174800	2.2212	0.196	1.4228	104
1977	4351920	212560	48797	46000	0.9427	0.196	0.7829	83
1978	4615780	227349	66361	11000	0.1658	0.122	0.0512	82
1979	10616800	384694	108857	25100	0.2306	0.125	0.0631	99
1980	16745490	633405	133007	70764	0.5320	0.119	0.2798	91
1981	37893580	1162085	197901	174879	0.8837	0.383	0.3453	99
1982	64802850	1847388	281046	275079	0.9788	0.280	0.2619	102
1983	61862590	2724667	435943	387202	0.8882	0.325	0.3349	92
1984	53498420	2870295	682523	428631	0.6280	0.216	0.4520	94
1985	80979990	3468522	703223	613780	0.8728	0.234	0.6389	95
1986	97640080	3478147	683046	671488	0.9831	0.189	0.5675	87
1987	85641680	3937023	904630	792058	0.8756	0.267	0.5484	98
1988	41837460	3570910	1198630	887686	0.7406	0.356	0.5329	85
1989	38728880	3291174	1247511	787899	0.6316	0.284	0.5428	96
1990	35593590	2949417	1174169	645229	0.5495	0.260	0.4434	95
1991	33814610	2686998	960957	658008	0.6847	0.214	0.4987	98
1992	63627580	2422438	680708	716799	1.0530	0.337	0.6022	100
1993	53073310	2547324	448835	671397	1.4959	0.380	0.7410	97
1994	35983550	2096133	502526	568234	1.1308	0.221	0.7641	95
1995	44377750	1963441	480400	639146	1.3304	0.308	0.8166	98
1996	56121940	1739867	483788	306157	0.6328	0.157	0.4327	99
1997	31660860	2107773	584344	272627	0.4666	0.076	0.4199	100
1998	26359460	2189692	781524	380178	0.4865	0.076	0.4198	99
1999	75812270	2464359	935096	372341	0.3982	0.064	0.3569	100
2000	48332960	3118870	943389	372420	0.3948	0.059	0.3246	98
2001	83504000	3590636	1428052	364029	0.2549	0.044	0.2433	99

No of years for separable analysis : 5
Age range in the analysis : 0 . . . 9
Year range in the analysis : 1960 . . . 2001
Number of indices of SSB : 1
Number of age-structured indices : 4
Stock-recruit relationship to be fitted.
Parameters to estimate : 45
Number of observations : 354

Conventional single selection vector model to be fitted.

Table 2.8.17 North Sea herring. 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	0.4610	11	0.3648	0.5825	0.4091	0.5194	0.4643
2	1998	0.4608	12	0.3620	0.5867	0.4074	0.5213	0.4643
3	1999	0.3919	13	0.3033	0.5063	0.3438	0.4466	0.3952
4	2000	0.3564	13	0.2718	0.4672	0.3104	0.4092	0.3598
5	2001	0.2670	14	0.2009	0.3549	0.2310	0.3087	0.2699
Separable Model: Selection (S) by age								
6	0	0.0766	38	0.0357	0.1644	0.0518	0.1131	0.0826
7	1	0.2518	36	0.1234	0.5135	0.1750	0.3622	0.2690
8	2	0.5807	11	0.4606	0.7320	0.5160	0.6535	0.5847
9	3	0.9837	11	0.7853	1.2322	0.8769	1.1035	0.9902
	4	1.0000		Fixed : Reference Age				
10	5	1.0191	13	0.7888	1.3165	0.8942	1.1613	1.0278
11	6	0.9710	14	0.7286	1.2940	0.8387	1.1242	0.9815
12	7	0.7838	17	0.5564	1.1043	0.6581	0.9336	0.7959
	8	1.0000		Fixed : Last true age				
Separable model: Populations in year 2001								
13	0	83504008	16	60968923	114368421	71123654	98039387	84586163
14	1	17302053	14	13126995	22804994	15028224	19919920	17474643
15	2	9102348	11	7281260	11378902	8122519	10200375	9161575
16	3	1879386	10	1522212	2320369	1687763	2092766	1890285
17	4	1253123	11	1003213	1565289	1118685	1403718	1261219
18	5	1260497	12	983090	1616183	1110366	1430928	1270674
19	6	378378	14	285272	501870	327598	437029	382327
20	7	186214	17	131599	263495	155989	222296	189158
21	8	108037	20	71691	162809	87640	133181	110428
Separable model: Populations at age								
22	1997	32041	35	16096	63781	22551	45525	34080
23	1998	26170	26	15625	43832	20116	34048	27092
24	1999	32982	23	20867	52129	26112	41658	33894
25	2000	72583	21	47531	110839	58483	90082	74296
Recruitment in year 2002								
26	2001	61091296	19	42032448	88792031	50480648	73932221	62213236
SSB Index catchabilities								
MLAI								
Power model fitted. Slopes (Q) and exponents (K) at age								
27	1 Q	2.959	17	2.240	4.445	2.649	3.758	3.204
28	1 K	.2533E-04	17	.4118E-04	.8174E-04	.4871E-04	.6911E-04	.6332E-04
Acoustic survey 2-9+ wr								
Linear model fitted. Slopes at age :								
29	1 Q	.9498	15	.8222	1.482	.9498	1.283	1.116
30	2 Q	1.526	8	1.401	1.982	1.526	1.821	1.673
31	3 Q	1.798	9	1.640	2.387	1.798	2.178	1.988
32	4 Q	1.924	14	1.673	2.960	1.924	2.574	2.249
33	5 Q	2.143	20	1.766	3.890	2.143	3.206	2.675
34	6 Q	2.282	21	1.864	4.258	2.282	3.478	2.880
35	7 Q	2.194	22	1.773	4.232	2.194	3.420	2.807
36	8 Q	2.639	28	2.000	6.201	2.639	4.700	3.672
37	9 Q	4.374	28	3.332	10.12	4.374	7.711	6.046
IBTSA: 2-5+ wr								
Linear model fitted. Slopes at age :								
38	2 Q	.1596E-03	12	.1418E-03	.2297E-03	.1596E-03	.2041E-03	.1819E-03
39	3 Q	.1130E-03	24	.8936E-04	.2331E-03	.1130E-03	.1843E-03	.1487E-03
40	4 Q	.6772E-04	34	.4860E-04	.1884E-03	.6772E-04	.1352E-03	.1016E-03
41	5 Q	.3765E-04	34	.2700E-04	.1049E-03	.3765E-04	.7525E-04	.5652E-04

Table 2.8.17 Continued.

```
 IBTSY 1-wr
 Linear model fitted. Slopes at age :
   42   1  Q  .1373E-03   6 .1286E-03 .1681E-03 .1373E-03 .1574E-03 .1474E-03


 MIK 0-wr
 Linear model fitted. Slopes at age :
   43   0  Q  .3009E-05   3 .2897E-05 .3381E-05 .3009E-05 .3255E-05 .3132E-05

Parameters of the stock-recruit relationship
   44   1  a  .8482E+08  39 .5820E+08 .2710E+09 .8482E+08 .1859E+09 .1356E+09
   45        1     b     .6773E+06     66   .3585E+06   .4816E+07   .6773E+06   .2549E+07   .1637E+07
```

Table 2.8.18 North Sea herring. Residuals about the model fit.

Separable Model Residuals

Age	1997	1998	1999	2000	2001
0	-0.4206	-0.8090	0.0973	0.2965	0.5379
1	-0.9374	0.1987	-0.5300	-0.2354	-0.1011
2	0.0805	-0.0584	-0.0059	0.1912	-0.2831
3	-0.0199	-0.1806	0.0328	-0.1839	0.2248
4	0.0212	-0.0699	-0.0199	0.0572	-0.0360
5	-0.1099	-0.0028	-0.0866	0.0603	0.0276
6	-0.1054	0.2699	-0.1165	-0.0334	-0.0876
7	0.0160	0.0801	-0.0372	-0.2777	0.1831
8	-0.0331	0.0800	-0.1332	-0.2145	0.4698

SPAWNING BIOMASS INDEX RESIDUALS

MLAI

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	-0.2309	-0.3515	-0.6984	-0.7292	0.6812	0.5409	0.7238	0.1173	0.1014	0.0509	-0.1704

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	-0.0571	0.3328	-0.2983	-0.0503	0.3390	0.2599	0.5619	0.1420	-0.2555	-0.1067	-0.6412

	1995	1996	1997	1998	1999	2000	2001
1	-0.4425	0.2515	0.2537	0.2387	-0.1272	-0.5581	0.1192

AGE-STRUCTURED INDEX RESIDUALS

Acoustic survey 2-9+ wr Aco

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	*******	*******	*******	*******	*******	*******	*******	*******	-0.055	-0.262	0.046
2	-0.328	-0.020	-0.029	0.178	0.180	-0.204	0.022	0.324	0.471	-0.202	-0.312
3	-0.381	-0.006	-0.173	-0.044	0.058	-0.326	0.200	0.354	0.371	0.060	0.015
4	-0.491	0.004	-0.084	0.056	0.284	-0.447	0.327	0.283	0.254	0.314	-0.257
5	-0.285	-0.154	-0.142	-0.104	0.322	0.139	0.239	0.210	0.141	0.329	-0.433
6	-0.301	0.087	-0.382	0.114	0.251	0.348	0.257	-0.173	0.342	0.335	-0.354
7	-0.408	0.216	0.133	-0.138	0.241	0.205	0.616	-0.006	-0.429	0.647	-0.319
8	-0.293	0.330	-0.005	0.002	-0.153	0.096	-0.070	1.272	0.228	-0.120	-0.207
9	-0.684	-0.421	-0.444	-0.075	-0.359	-0.517	-1.120	0.375	0.416	0.335	0.884

Age	2000	2001
1	0.561	-0.290
2	-0.209	0.128
3	-0.292	0.163
4	0.053	-0.299
5	0.008	-0.273
6	-0.073	-0.454
7	-0.055	-0.707
8	-0.217	-0.866
9	1.186	0.420

Table 2.8.18. Continued.

IBTSA: 2-5+ wr

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	-1.003	-1.446	0.112	0.361	-0.125	1.323	0.153	0.021	0.684	-0.148	0.763
3	-0.672	-0.771	0.119	0.212	-0.431	0.879	-0.148	0.094	0.535	0.461	0.476
4	-0.255	-0.058	0.055	0.200	-0.079	0.143	-0.104	0.653	0.994	0.285	0.292
5	0.973	-0.208	0.681	0.430	0.649	-0.149	-1.076	0.424	0.844	0.442	0.386

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	0.658	0.787	-0.749	0.061	-0.158	-0.186	-0.699	-0.111	-0.298
3	0.694	0.415	-1.297	0.194	-0.714	0.378	-0.303	0.519	-0.642
4	0.682	0.250	-0.989	-0.154	-0.880	0.554	-0.664	0.276	-1.202
5	0.470	-1.131	-0.279	0.267	-0.235	0.248	-1.424	0.122	-1.437

IBTSY 1-wr

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	-0.2090	-0.2250	-0.2049	-0.2387	-0.4879	-0.2052	0.1381	-0.2065	-0.0452	0.3931	0.3397

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.3327	-0.1979	-0.0597	0.3917	0.0170	-0.0278	0.2405	0.5522	0.4311	-0.4497	0.1149

Age	2001	2002
1	0.1827	0.0874

MIK 0-wr

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	0.404	0.072	0.625	0.837	-0.211	-0.209	-0.532	-0.183	-0.160	-0.372	0.195

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.435	-0.348	-1.287	-0.236	0.208	0.343	0.089	0.118	-0.327	0.571	-0.272

Age	1999	2000	2001	2002
0	0.196	0.069	-0.029	0.000

Table 2.8.19 North Sea herring. Parameters of distributions.

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

Separable model fitted from 1997 to 2001

Variance	0.0684
Skewness test stat.	-1.0792
Kurtosis test statistic	0.8783
Partial chi-square	0.1096
Significance in fit	0.0000
Degrees of freedom	20

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR MLAI

Power catchability relationship assumed

Last age is a plus-group

Variance	0.1075
Skewness test stat.	-0.2289
Kurtosis test statistic	-0.7825
Partial chi-square	1.3338
Significance in fit	0.0000
Number of observations	29
Degrees of freedom	27
Weight in the analysis	0.6500

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR Acoustic survey 2-9+ wr Aco

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8	9
Variance	0.0874	0.0463	0.0376	0.0234	0.0088	0.0119	0.0194	0.0161	0.0309
Skewness test stat.	0.8430	0.5044	-0.1088	-0.6174	-0.2872	-0.3307	0.0089	1.6309	0.2271
Kurtosis test statisti	-0.2365	-0.6565	-0.7169	-0.8932	-0.9008	-1.1214	-0.5538	1.8309	-0.6234
Partial chi-square	0.0215	0.0365	0.0308	0.0202	0.0078	0.0111	0.0196	0.0174	0.0332
Significance in fit	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	5	13	13	13	13	13	13	13	13
Degrees of freedom	4	12	12	12	12	12	12	12	12
Weight in the analysis	0.7400	0.7500	0.6400	0.2700	0.1400	0.1300	0.1200	0.0700	0.0700

DISTRIBUTION STATISTICS FOR IBTSA: 2-5+ wr

Linear catchability relationship assumed

Age	2	3	4	5
Variance	0.1057	0.0209	0.0100	0.0163
Skewness test stat.	-0.3153	-0.9703	-0.9586	-1.4811
Kurtosis test statisti	-0.0898	-0.6585	-0.2848	-0.4646
Partial chi-square	0.3122	0.0762	0.0458	0.0908
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	20	20	20	20
Degrees of freedom	19	19	19	19
Weight in the analysis	0.2400	0.0600	0.0300	0.0300

DISTRIBUTION STATISTICS FOR IBTSY 1-wr

Linear catchability relationship assumed

Age	1
Variance	0.0559
Skewness test stat.	0.4464
Kurtosis test statisti	-0.9315
Partial chi-square	0.1754
Significance in fit	0.0000
Number of observations	24
Degrees of freedom	23
Weight in the analysis	0.6700

DISTRIBUTION STATISTICS FOR MIK 0-wr

Linear catchability relationship assumed

Age	0
Variance	0.3790
Skewness test stat.	-1.3256
Kurtosis test statisti	1.5818
Partial chi-square	2.2375
Significance in fit	0.0000
Number of observations	26
Degrees of freedom	25
Weight in the analysis	2.0500

Table 2.8.20 North Sea herring. Analysis of variance.

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance	SSQ	Data	Parameters	d.f.	Variance
Total for model	75.2779	354	45	309	0.2436
Catches-at-age	3.2791	45	25	20	0.1640
SSB Indices					
MLAI	4.4665	29	2	27	0.1654
Aged Indices					
Acoustic survey 2-9+ wr	14.7921	109	9	100	0.1479
IBTSA: 2-5+ wr	31.6397	80	4	76	0.4163
IBTSY 1-wr	1.9201	24	1	23	0.0835
MIK 0-wr	4.6225	26	1	25	0.1849
Stock-recruit model	14.5579	41	2	39	0.3733

Weighted Statistics

Variance	SSQ	Data	Parameters	d.f.	Variance
Total for model	39.7617	354	45	309	0.1287
Catches-at-age	1.3677	45	25	20	0.0684
SSB Indices					
MLAI	1.8871	29	2	27	0.0699
Aged Indices					
Acoustic survey 2-9+ wr	1.1403	109	9	100	0.0114
IBTSA: 2-5+ wr	0.5208	80	4	76	0.0069
IBTSY 1-wr	0.8619	24	1	23	0.0375
MIK 0-wr	19.4259	26	1	25	0.7770
Stock-recruit model	14.5579	41	2	39	0.3733

Table 2.10.1. Input file for the short-term prediction programme for North Sea herring.

```
North sea herring downw
0 9
4
1 2 6
2 0 1
3 0 1
4 0 1
Init numbers
0 61090
1 30098
2 5951.2
3 5774.6
4 1183.2
5   868.14
6   868.81
7   264.17
8   136.67
9   82.36
recruitments
49000
49000
selection by age and fleet
0 0.0001  0.0132  0.0007  0.0061
1 0.0057  0.0065  0.0329  0.0212
2 0.1190  0.0046  0.0277  0.0029
3 0.2469  0.0040  0.0109  0.0003
4 0.2533  0.0047  0.0078  0.0006
5 0.2629  0.0014  0.0084  0.0002
6 0.2494  0.0054  0.0055  0.0003
7 0.2056  0.0013  0.0020  0.0011
8 0.2552  0.0073  0.0051  0
9 0.2685  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
weca by fleet
0 0.0085 0.0140 0.0235 0.0145
1 0.0905 0.0320 0.0535 0.0195
2 0.1265 0.0620 0.0770 0.0570
3 0.1545 0.1130 0.1080 0.1130
4 0.1775 0.1330 0.1470 0.1455
5 0.1970 0.1165 0.1690 0.1585
6 0.2170 0.0610 0.2020 0.1720
7 0.2360 0.0770 0.1955 0.1680
8 0.2450 0.2250 0.2045 0.1805
9 0.2735 0      0      0
```

Table 2.10.1. cont.

```
west
0 0.0065
1 0.0495
2 0.1220
3 0.1715
4 0.2105
5 0.2310
6 0.2520
7 0.2750
8 0.2840
9 0.2845
maturity
0 0
1 0
2 0.72
3 0.94
4 1
5 1
6 1
7 1
8 1
9 1
props
0.67 0.67
intermediate year
f
0.2263
f
0.0099
f
0.0168
f
0.0137
```

Table 2.10.2.
Short-term prediction table for North Sea herring.

Assuming F status quo in 2002

	F2-6	F0-1	F0-1	F0-1	F 0-1	F 2-6	Yield 2002						
2002	**A**	**B**	**C**	**D**			**A**	**B**	**C**	**D**	**B-D**	**Total**	**SSB 2002**
	0.226	0.01	0.017	0.014	0.043	0.243	403	16	52	12	80	483	1699

F for fleets B-D maintain proportion from 2002

	F2-6	F0-1	F0-1	F0-1	F 0-1	F 2-6	Yield 2003						
2003	**A**	**B**	**C**	**D**			**A**	**B**	**C**	**D**	**B-D**	**Total**	**SSB 2003**
	0.185	0.009	0.015	0.012	0.039	0.2	414.1	13.7	46.9	9.4	70	484.1	2276.4
	0.155	0.026	0.044	0.036	0.108	0.2	346.4	39	132.1	26.2	197	543.7	2269.0

Combinations of catches by the various fleets that give F0-1 = 0.12 and F2-6 = 0.25

	F2-6	F0-1	F0-1	F0-1	F 0-1	F 2-6	Yield 2003						
2003	**A**	**B**	**C**	**D**			**A**	**B**	**C**	**D**	**B-D**	**Total**	**SSB 2003**
	0.2	0.096	0.01	0.014	0.123	0.247	438	142	30	10	182	620	2207
	0.205	0.083	0.01	0.027	0.123	0.248	449	123	30	20	172	621	2207
	0.215	0.066	0.011	0.04	0.12	0.252	470	98	33	29	160	629	2201
	0.2	0.085	0.016	0.014	0.118	0.247	438	126	48	10	184	622	2207
	0.205	0.071	0.017	0.028	0.119	0.248	449	105	51	20	176	625	2205
	0.21	0.059	0.017	0.041	0.12	0.249	460	87	51	30	168	627	2204
	0.2	0.078	0.023	0.014	0.118	0.249	438	115	69	10	194	632	2202
	0.205	0.067	0.024	0.028	0.122	0.251	448	99	72	20	191	639	2199
	0.21	0.05	0.024	0.042	0.119	0.25	459	74	72	31	176	635	2201

F status quo in 2003

	F2-6	F0-1	F0-1	F0-1	F 0-1	F 2-6	Yield 2003						
2003	**A**	**B**	**C**	**D**			**A**	**B**	**C**	**D**	**B-D**	**Total**	**SSB 2003**
	0.226	0.01	0.017	0.014	0.043	0.243	497	14.9	51.1	10.2	2216.3	573.2	2216.3

Table 2.10.3
Short-term prediction table for North Sea herring.

Assume Catch constraints in 2002

	F2-6	F0-1	F0-1	F0-1	F 0-1	F 2-6	Yield 2002						
	A	B	C	D			A	B	C	D	B-D	Total	SSB 2002
2002	0.165	0.013	0.011	0.013	0.04	0.179	302	20	36	12	68	370	1772

F for fleets B-D maintain proportion from 2002

	F2-6	F0-1	F0-1	F0-1	F 0-1	F 2-6	Yield 2003						
	A	B	C	D			A	B	C	D	B-D	Total	SSB 2003
2003	0.195	0.004	0.004	0.004	0.014	0.2	458.1	6.2	11.5	3.3	21	479.1	2388.5
2003	0.15	0.044	0.04	0.047	0.133	0.2	351.4	66.7	121.8	34.1	223	574	2376

Combinations of catches by the various fleets that give F0-1 = 0.12 and F2-6 = 0.25

	F2-6	F0-1	F0-1	F0-1	F 0-1	F 2-6	Yield 2003						
	A	B	C	D			A	B	C	D	B-D	Total	SSB 2003
2003	0.205	0.097	0.01	0.013	0.123	0.253	470	145	31	10	185	655	2303
2003	0.21	0.082	0.01	0.027	0.122	0.252	481	123	30	20	173	654	2304
2003	0.215	0.067	0.01	0.041	0.121	0.252	493	101	30	30	161	654	2305
2003	0.2	0.087	0.017	0.014	0.121	0.249	459	131	52	10	193	651	2308
2003	0.205	0.071	0.017	0.027	0.118	0.248	470	107	52	20	178	649	2310
2003	0.215	0.058	0.016	0.041	0.118	0.253	492	87	49	30	166	658	2303
2003	0.2	0.078	0.023	0.014	0.118	0.249	459	117	70	10	197	656	2307
2003	0.205	0.069	0.023	0.028	0.123	0.251	470	104	70	20	194	663	2303
2003	0.21	0.051	0.024	0.042	0.12	0.251	481	77	73	31	180	661	2305

F status quo in 2003

	F2-6	F0-1	F0-1	F0-1	F 0-1	F 2-6	Yield 2003						
	A	B	C	D			A	B	C	D	B-D	Total	SSB 2003
2003	0.226	0.01	0.017	0.014	0.043	0.243	521	15.2	51.8	10.3	2216.3	598.3	2320.6

Table 2.11.1 North Sea herring. Input to the medium term analysis (fmult.dat)

```
Projection input file, North Sea herring19/03/2002 19:57
Number of Fleets and projection years
      4      10
Mean Catch Ratio by Fleet (2000-2001)
        A       B       C       D
      0  0.0049  0.6399  0.0269  0.3283
      1  0.0714  0.0760  0.4568  0.3958
      2  0.7938  0.0276  0.1659  0.0127
      3  0.9476  0.0134  0.0379  0.0010
      4  0.9574  0.0154  0.0238  0.0034
      5  0.9803  0.0038  0.0157  0.0001
      6  0.9462  0.0301  0.0214  0.0023
      7  0.9840  0.0068  0.0045  0.0047
      8  0.9750  0.0233  0.0015  0.0002
      9  1.0000  0.0000  0.0000  0.0000
Retention Ogive  for each fleet by age valid for all years
      0       1       1       1       1
      1       1       1       1       1
      2       1       1       1       1
      3       1       1       1       1
      4       1       1       1       1
      5       1       1       1       1
      6       1       1       1       1
      7       1       1       1       1
      8       1       1       1       1
      9       1       1       1       1
Exploitation  Constraint  by  Year  (-ve  values:  F-constraints;  +ve  values,  Catch
constraints)
   2002      -1      -1      -1      -1
   2003      -1      -1      -1      -1
   2004      -1      -1      -1      -1
   2005      -1      -1      -1      -1
   2006      -1      -1      -1      -1
   2007      -1      -1      -1      -1
   2008      -1      -1      -1      -1
   2009      -1      -1      -1      -1
   2010      -1      -1      -1      -1
   2011      -1      -1      -1      -1
Mean Weight-at-age in the catches of each fleet
      0  0.0085   0.014  0.0235  0.0145
      1  0.0905   0.032  0.0535  0.0195
      2  0.1265   0.062   0.077   0.057
      3  0.1545   0.113   0.108   0.113
      4  0.1775   0.133   0.147  0.1455
      5   0.197  0.1165   0.169  0.1585
      6   0.217   0.061   0.202   0.172
      7   0.236   0.077  0.1955   0.168
      8   0.245   0.225  0.2045  0.1805
      9  0.2735   0.225  0.2045  0.1805
Mean weights-at-age in the discard by fleet
      0  0.0085   0.014  0.0235  0.0145
      1  0.0905   0.032  0.0535  0.0195
      2  0.1265   0.062   0.077   0.057
      3  0.1545   0.113   0.108   0.113
      4  0.1775   0.133   0.147  0.1455
      5   0.197  0.1165   0.169  0.1585
      6   0.217   0.061   0.202   0.172
      7   0.236   0.077  0.1955   0.168
      8   0.245   0.225  0.2045  0.1805
      9  0.2735   0.225  0.2045  0.1805
First year for F-constraint
   2003
```

Table 2.11.1 continued.

```
Target Multiplier by fleet and by year
    2003    -1.0    -1.0    -1.0    -1.0
    2004    -1.0    -1.0    -1.0    -1.0
    2005    -1.0    -1.0    -1.0    -1.0
    2006    -1.0    -1.0    -1.0    -1.0
    2007    -1.0    -1.0    -1.0    -1.0
    2008    -1.0    -1.0    -1.0    -1.0
    2009    -1.0    -1.0    -1.0    -1.0
    2010    -1.0    -1.0    -1.0    -1.0
    2011    -1.0    -1.0    -1.0    -1.0
CV          of          Target     F-Multipliers
    2003  0.0001  0.0001  0.0001  0.0001
    2004  0.0001  0.0001  0.0001  0.0001
    2005  0.0001  0.0001  0.0001  0.0001
    2006  0.0001  0.0001  0.0001  0.0001
    2007  0.0001  0.0001  0.0001  0.0001
    2008  0.0001  0.0001  0.0001  0.0001
    2009  0.0001  0.0001  0.0001  0.0001
    2010  0.0001  0.0001  0.0001  0.0001
    2011  0.0001  0.0001  0.0001  0.0001
```

Table 2.11.2 North Sea herring. Logfile of the ICP program (status quo run).

```
Medium-Term Projections: ICP
Written  December 1997 for ICA v1.4 w
=========================================

Enter Random-Number seed--> 120
 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 2001  back to--> 1998
 Use mean maturity ogive from 2001  back to--> 2000
 Use mean weight-at-age in the stock from 2001  back to--> 2000
 Enter the reference spawning stock size (e.g. MBAL, Bpa)-->   8.0000000000000000E+05
 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) ?-->b
 Enter first year of data for stock-recruit model--> 1960
 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 2001-->i
 Use ICA or SRR (I/S) model value for recruitment in 2002-->i
 Use default percentiles (Y/N)  ?-->y
 Use ICA-derived resamples ?-->y
```

Table 2.12.1 North Sea herring. Input to the estimation of biological reference points.

Age/WR	N	M	CWt	SWt	Mat	F	FPreSpwn	MPreSpwn
0	107130000	1	0.012	0.006	0	0.066	0.67	0.67
1	18847695	1	0.044	0.050	0	0.180		
2	8965928	0.3	0.115	0.120	0.71	0.576		
3	1454673	0.2	0.152	0.176	0.93	1.014		
4	1191881	0.1	0.174	0.214	1	1.000		
5	963059	0.1	0.199	0.237	1	1.069		
6	321060	0.1	0.220	0.261	1	0.994		
7	158652	0.1	0.238	0.279	1	0.783		
8	94346	0.1	0.248	0.283	1	1.000		
9	9175	0.1	0.280	0.291	1	1.000		

FbarMinAge	2
FbarMaxAge	6
M year CV	0.1

NCV	MCV	CWtCV	SWtCV	MatCV	FCV
0.140	0	0.250	0.091	0	0.273
0.114	0	0.216	0.035	0	0.254
0.098	0	0.010	0.035	0.1	0.252
0.095	0	0.033	0.041	0.1	0.247
0.104	0	0.035	0.028	0	0.000
0.124	0	0.028	0.042	0	0.284
0.155	0	0.051	0.061	0	0.318
0.193	0	0.038	0.023	0	0.379
0.229	0	0.107	0.036	0	0.000
0.229	0	0.056	0.040	0	0.000

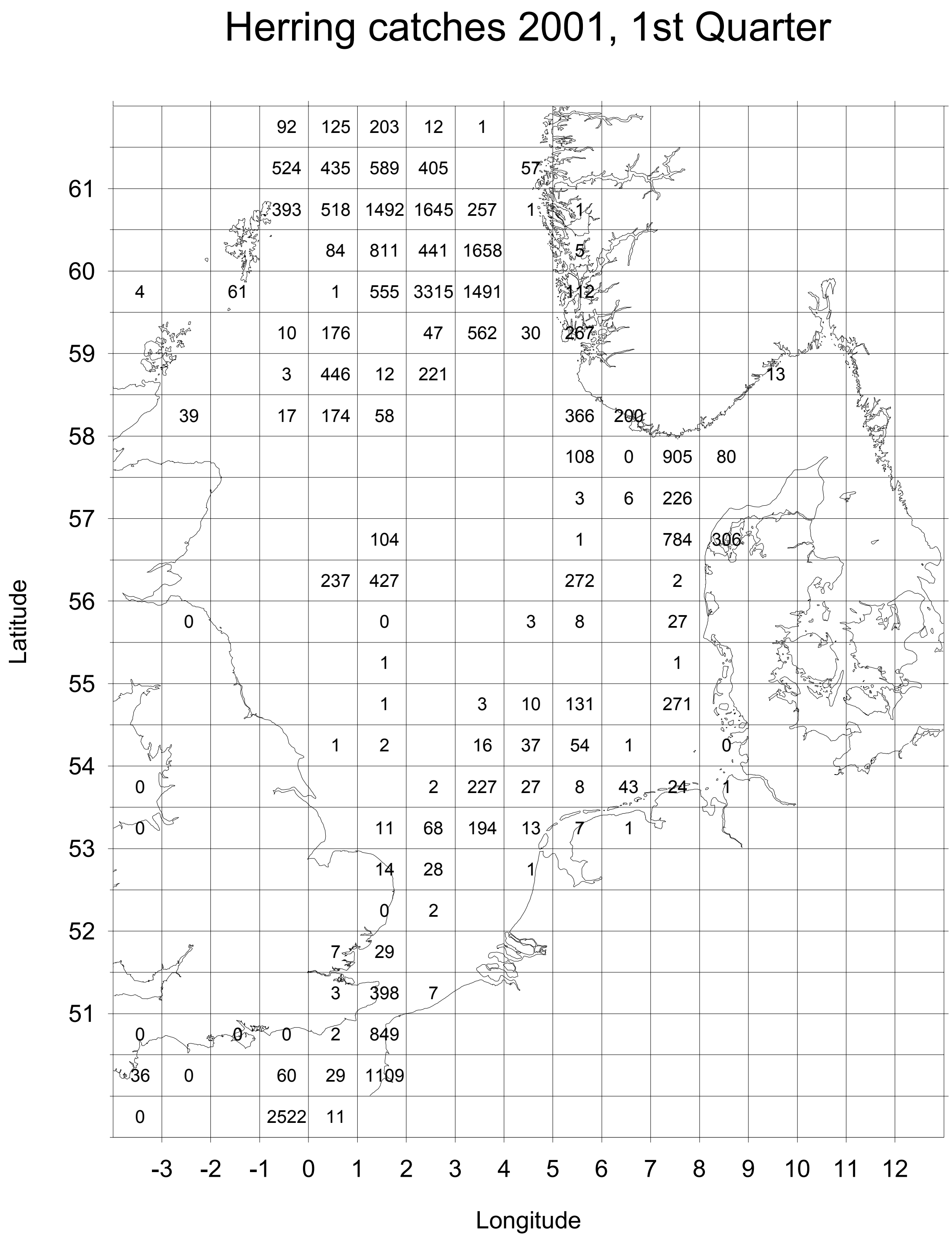


Figure 2.1.1: Herring catches in the North Sea (in tonnes) in 2001 by statistical rectangle. Working group estimates (if available). **a.:** 1st quarter

Herring catches 2001, 2nd Quarter

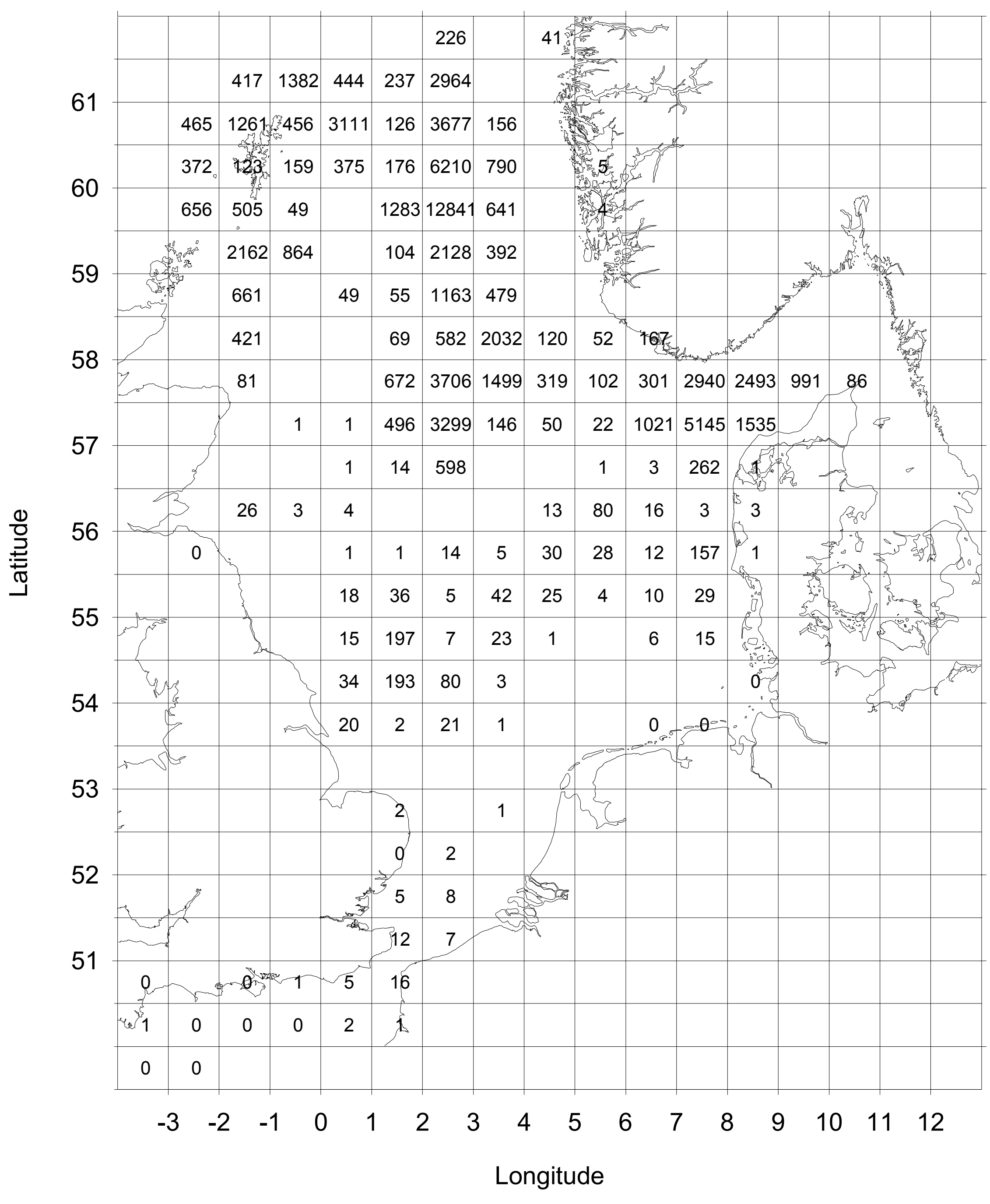


Figure 2.1.1: Herring catches in the North Sea (in tonnes) in 2001 by statistical rectangle. Working group estimates (if available). **b.:** 2nd quarter

Herring catches 2001, 3rd Quarter

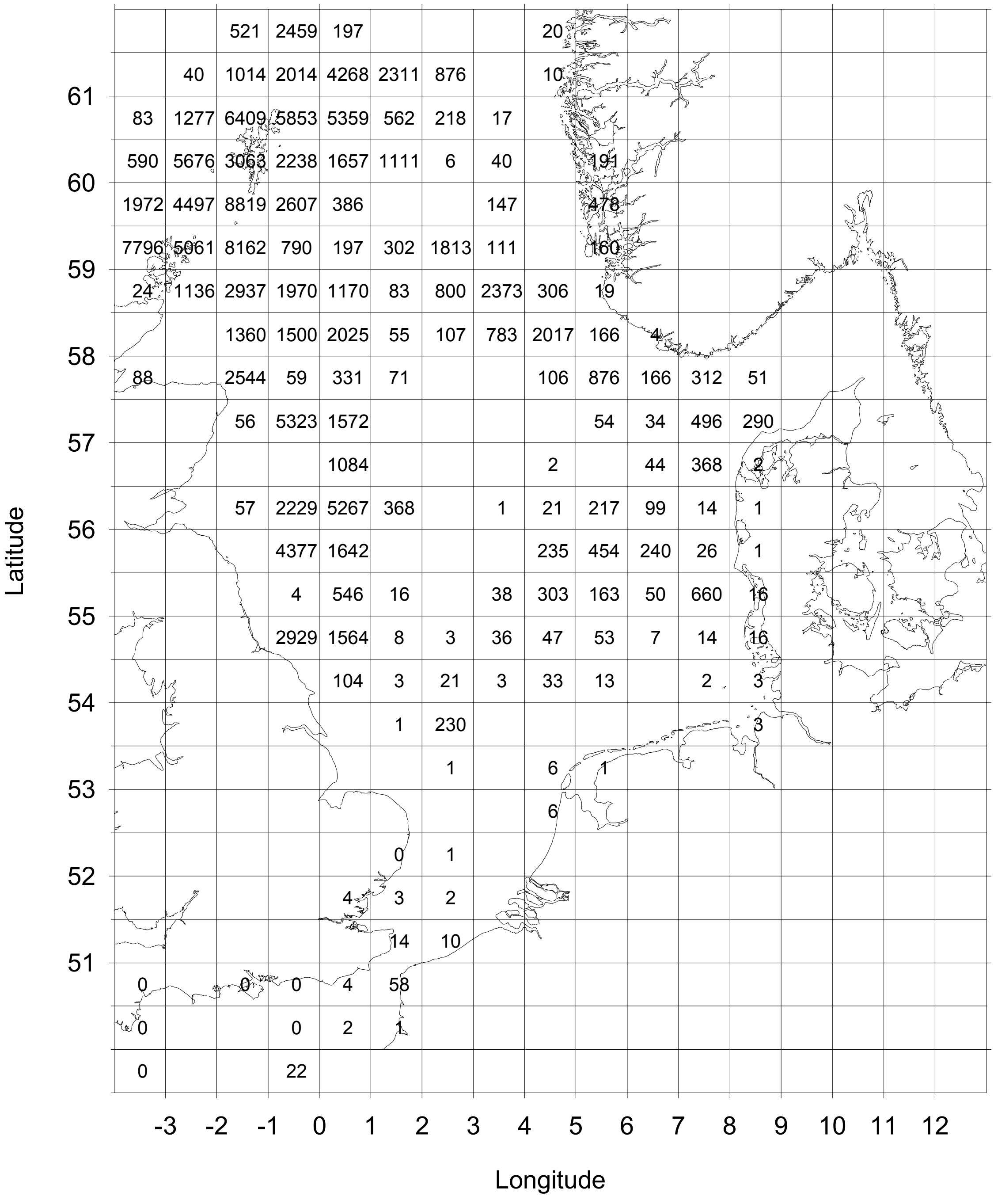


Figure 2.1.1: Herring catches in the North Sea (in tonnes) in 2001 by statistical rectangle. Working group estimates (if available). **c.:** 3rd quarter

Herring catches 2001, 4th Quarter

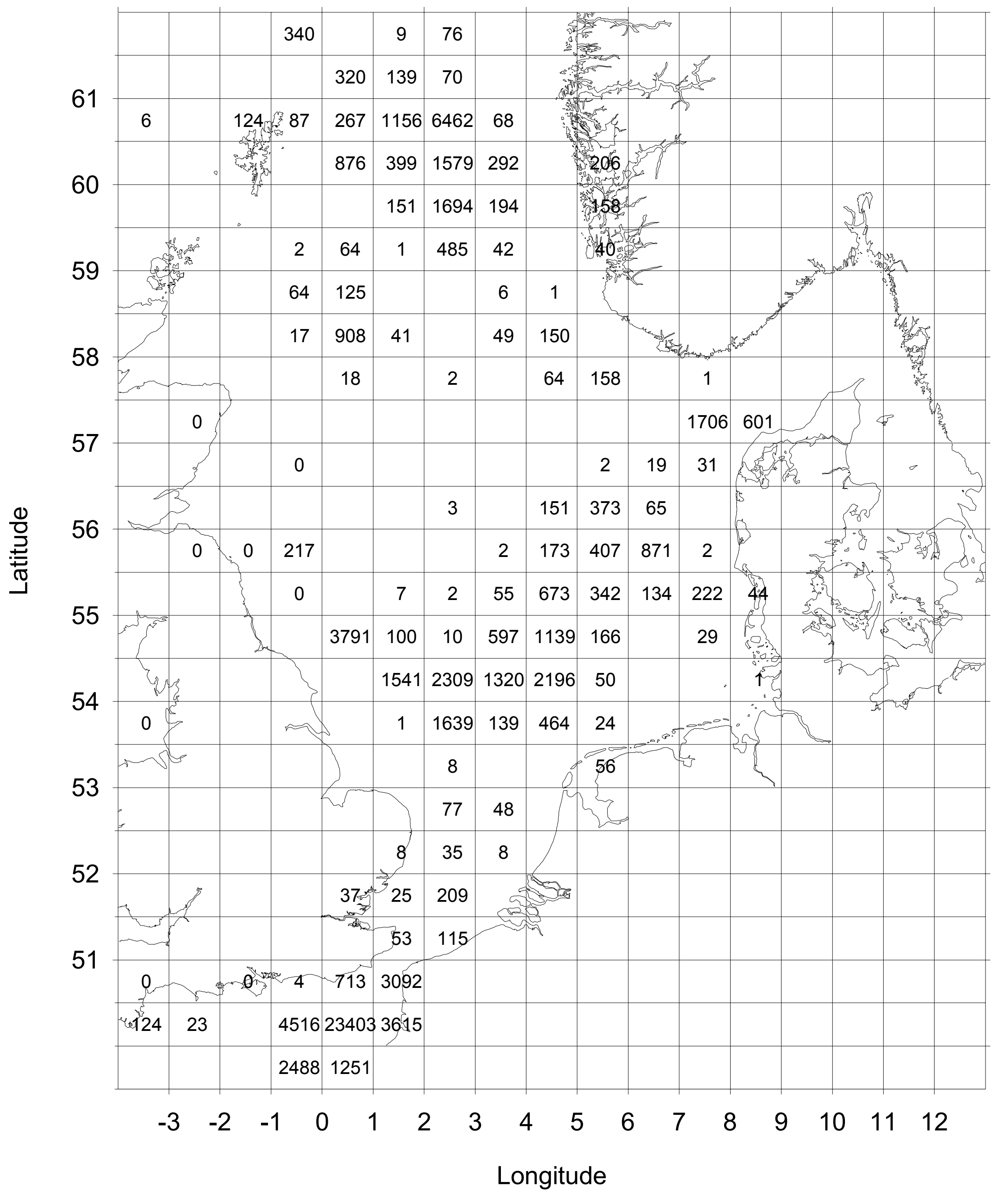


Figure 2.1.1: Herring catches in the North Sea (in tonnes) in 2001 by statistical rectangle. Working group estimates (if available). **d.:** 4th quarter

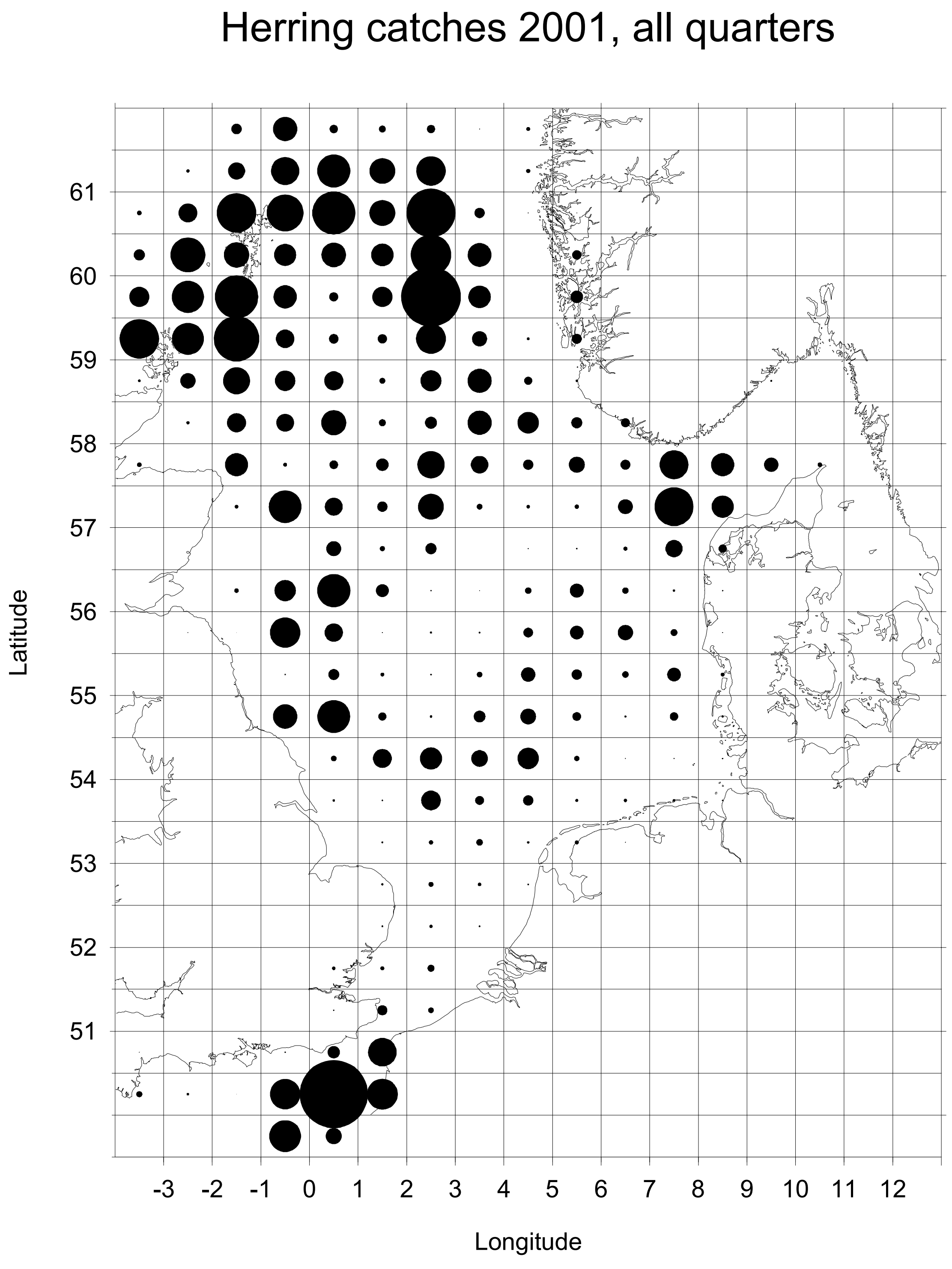


Figure 2.1.1: Herring catches in the North Sea (in tonnes) in 2001 by statistical rectangle. Working group estimates (if available). **e.:** all quarters

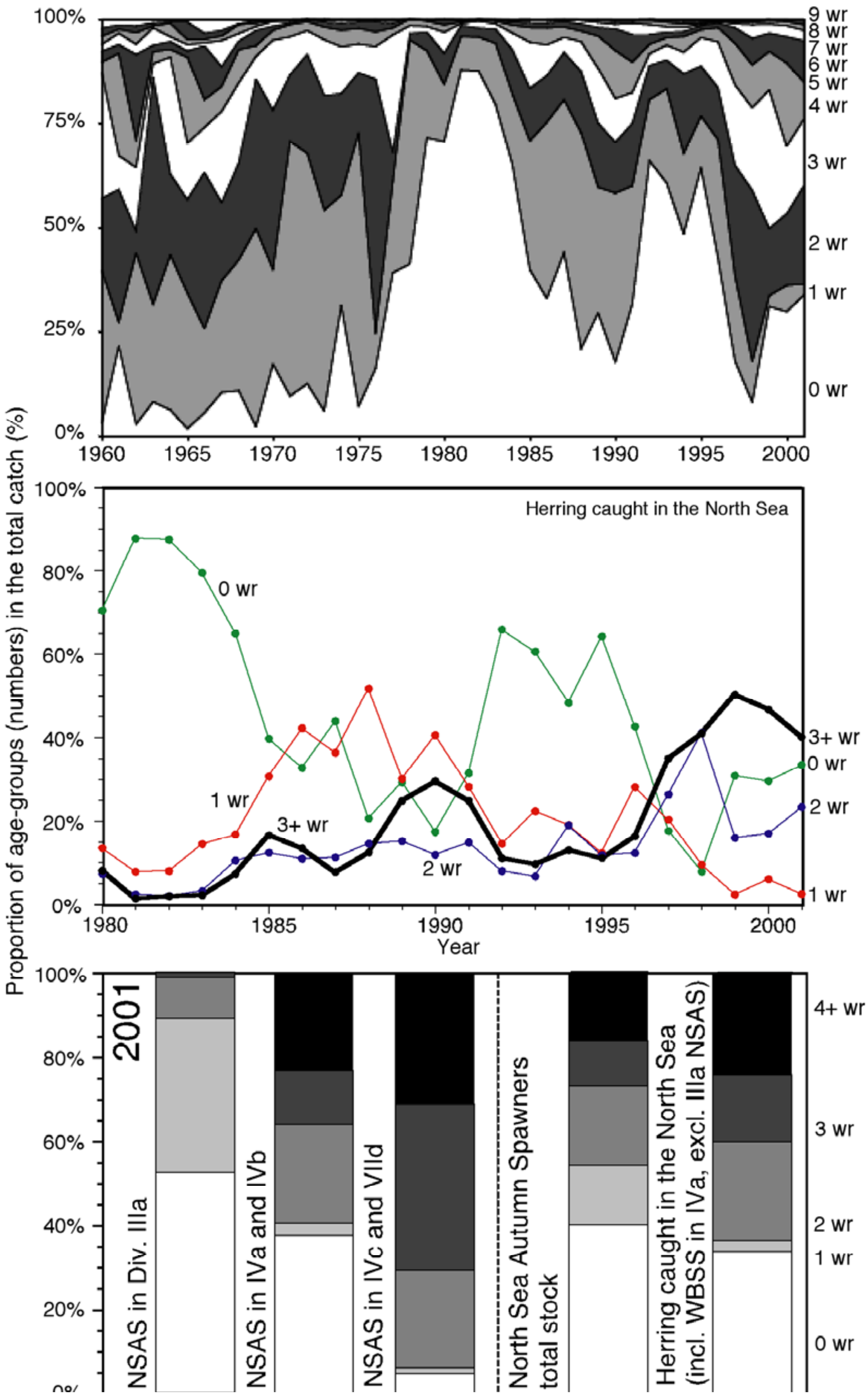


Figure 2.2.1: Proportions of age groups (numbers) in the total catch of herring in the North Sea (upper, 1960-2001, and middle panel, 1980-2001), and in the total catch of North Sea Autumn Spawners in 2001(lower panel).

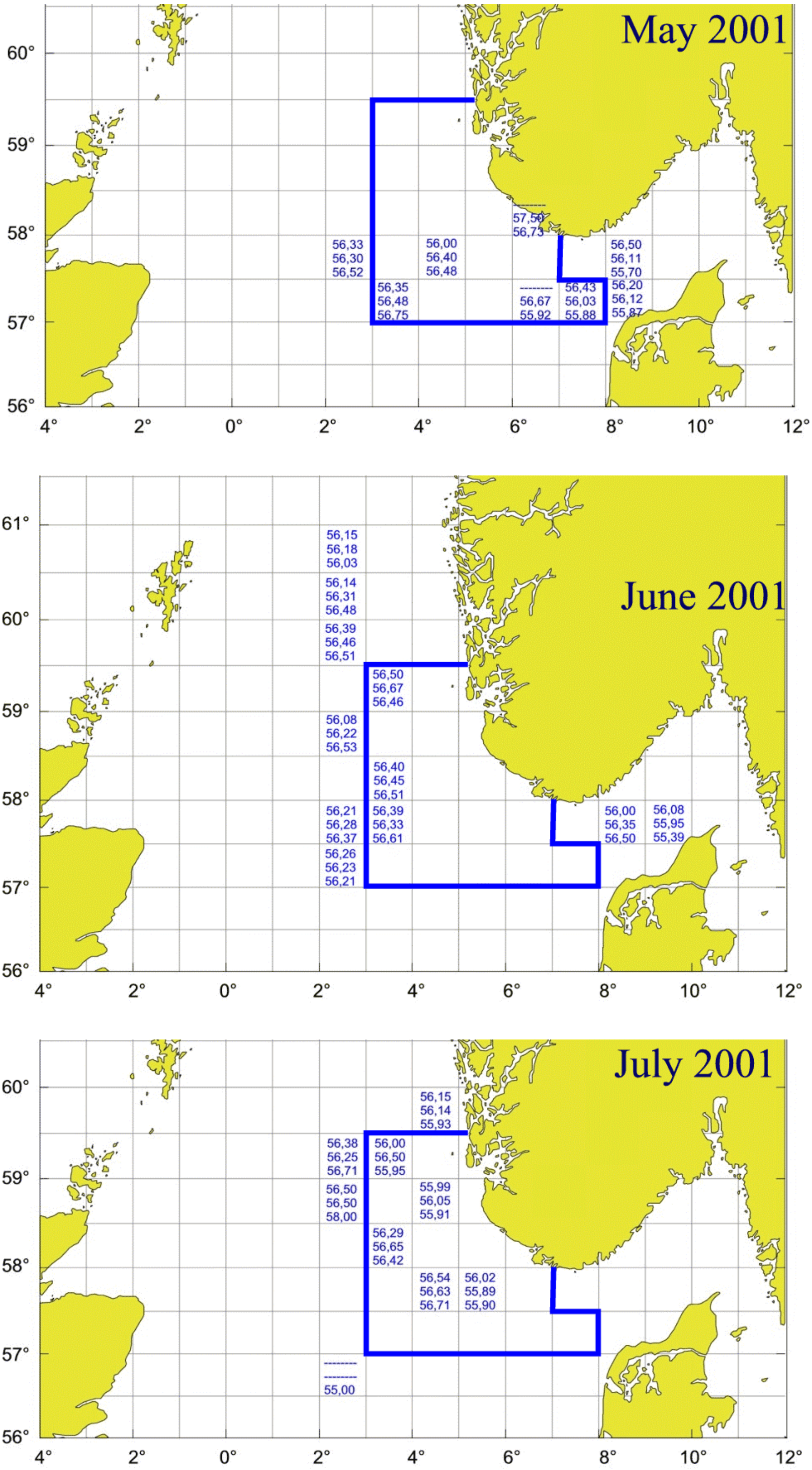


Figure 2.2.2: Mean vertebrae counts of 2 (upper number), 3 (middle) and 4+ herring in the North Sea and Div. IIIa as obtained by Norwegian sampling in the 2nd and 3rd quarter 2001. The transfer area, where a fraction of the total catch is assumed to be Western Baltic Spring-spawners and transferred to the assessment of IIIa herring, is indicated.

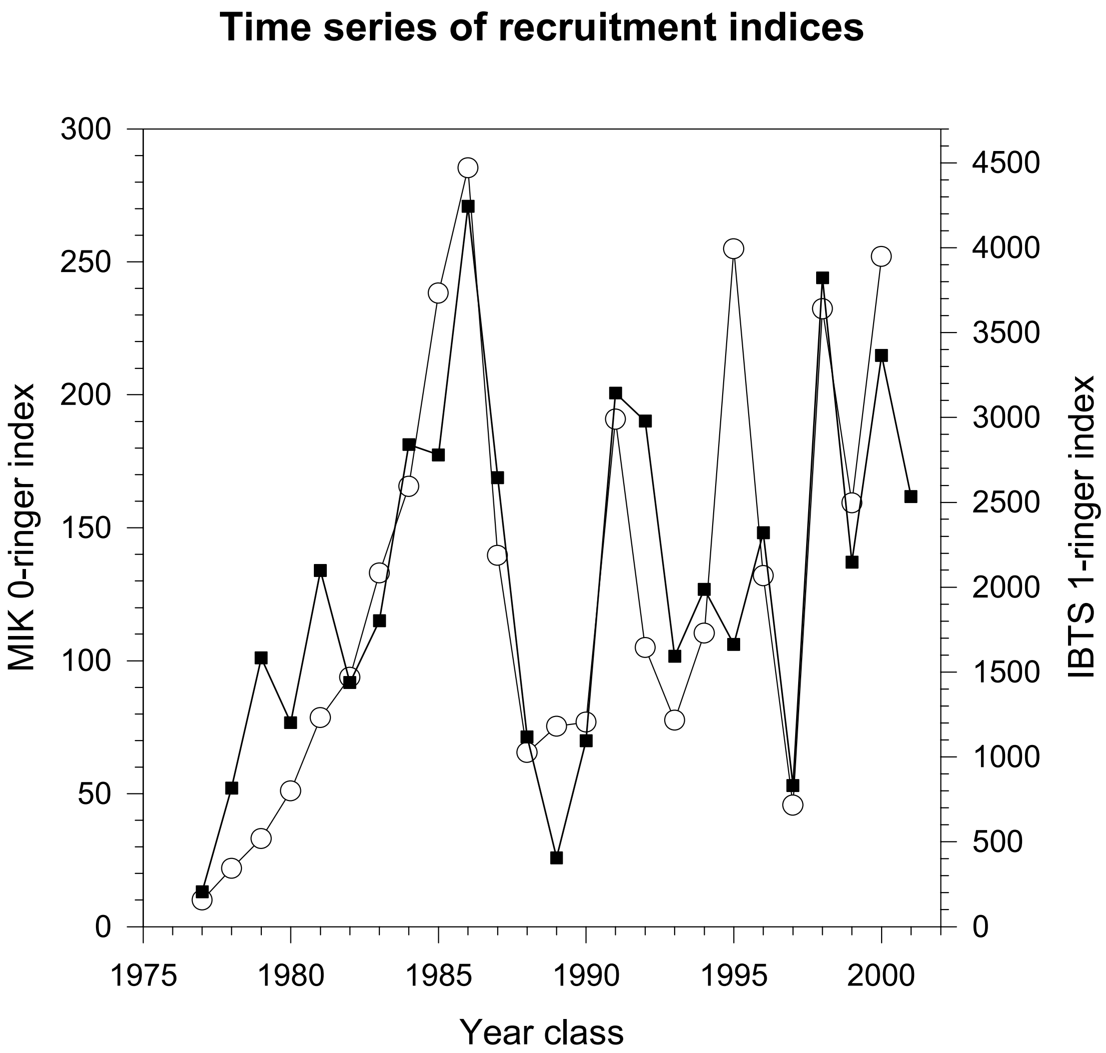


Figure 2.3.1. North Sea herring. Time-series of the 0-ringer and the 1-ringer indices, 0-ringers are illustrated by filled squares, 1-ringers by open circles.

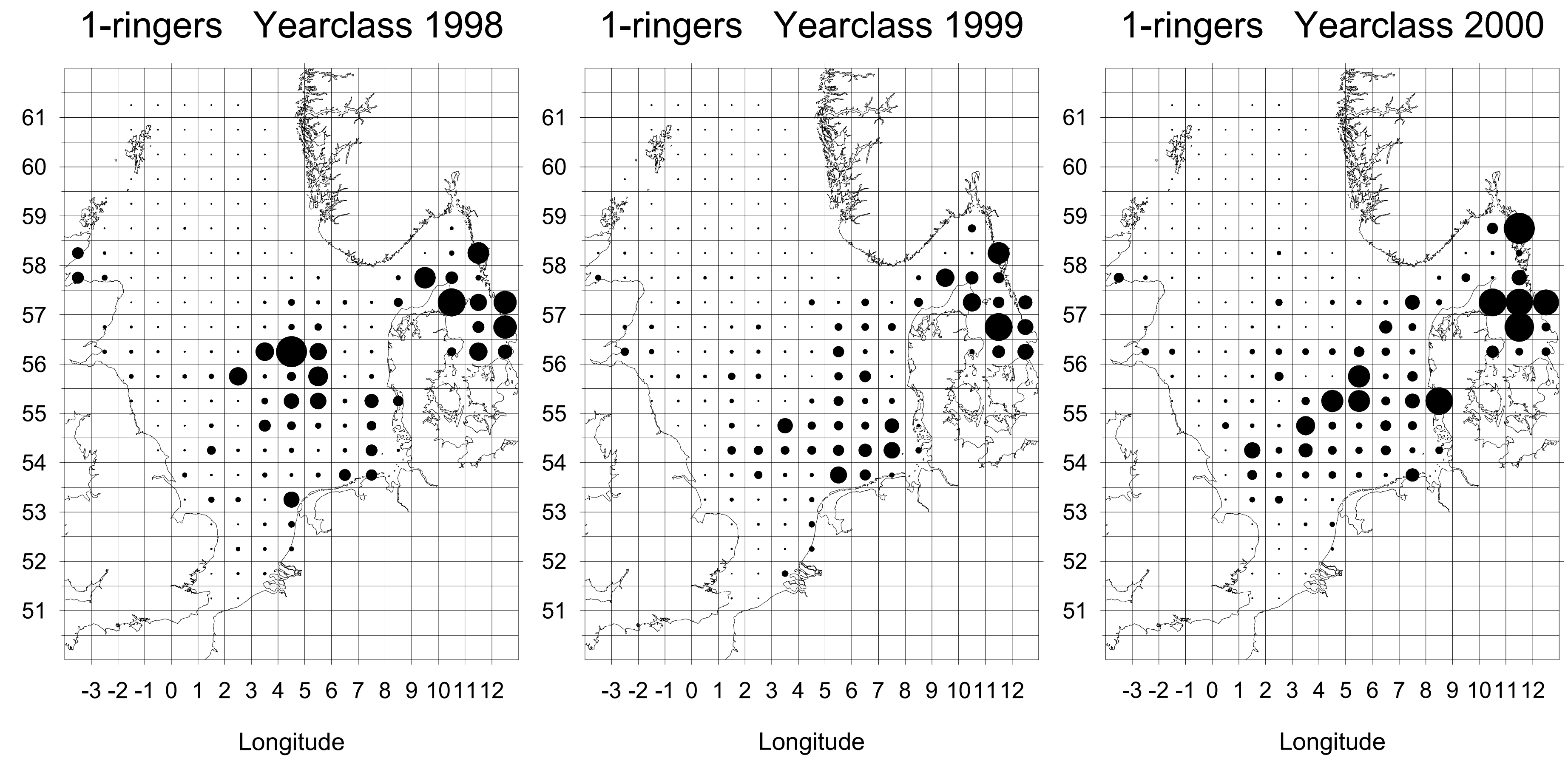


Figure 2.3.2. North Sea herring. Distribution of 1-ringer herring, year classes 1998-2000. Abundance estimates of 1-ringers within each statistical rectangle are based on GOV catches during IBTS in February. Areas of filled circles illustrate numbers per hour, the area of a circle extending to the border of a rectangle represents 45000.

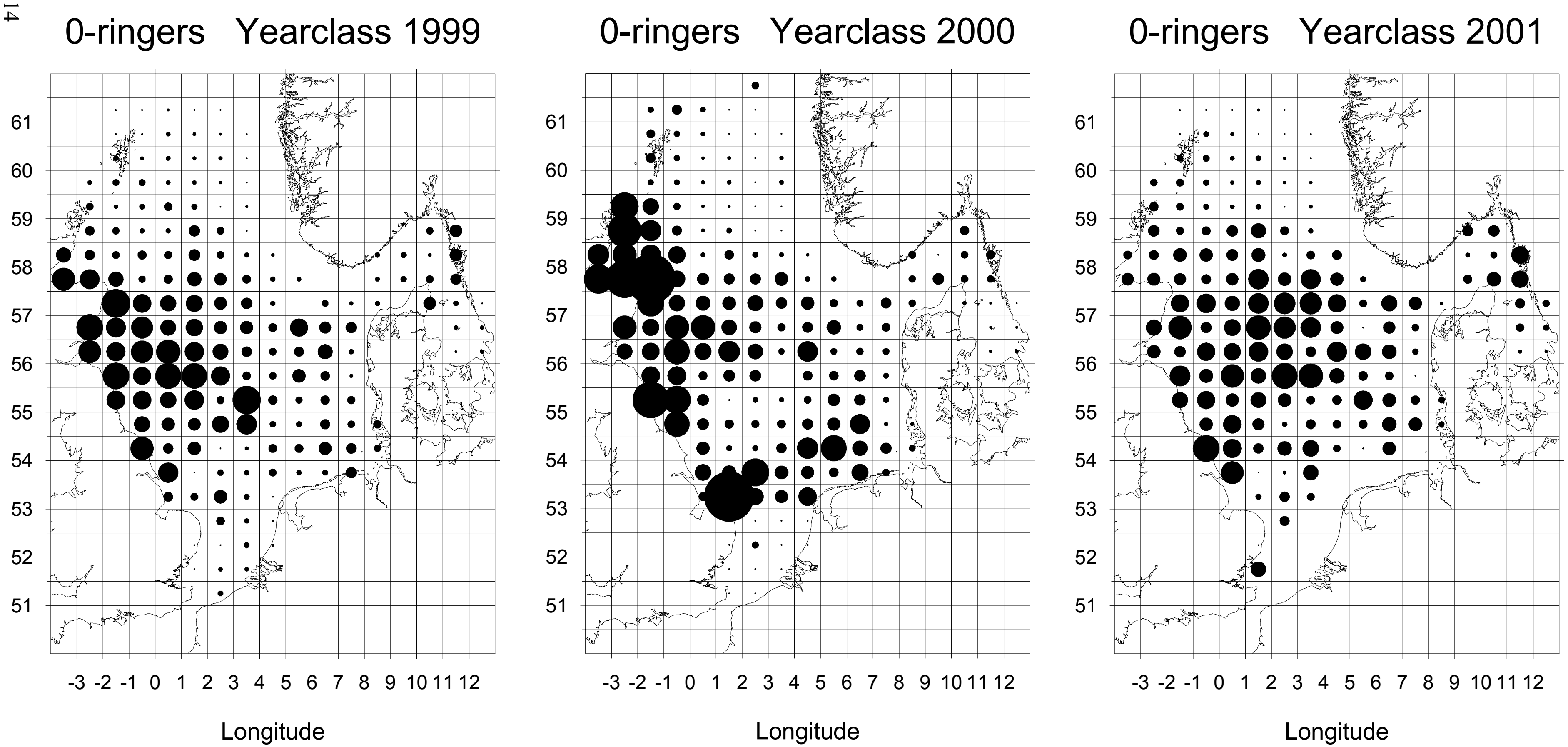


Figure 2.3.3. North Sea herring. Distribution of 0-ringer herring, year classes 1999-2001. Abundance estimates of 0-ringers within each statistical rectangle are based on MIK catches during IBTS in February. Areas of filled circles illustrate densities in no m^{-2}, the area of a circle extending to the border of a rectangle represents 1 m^{-2}.

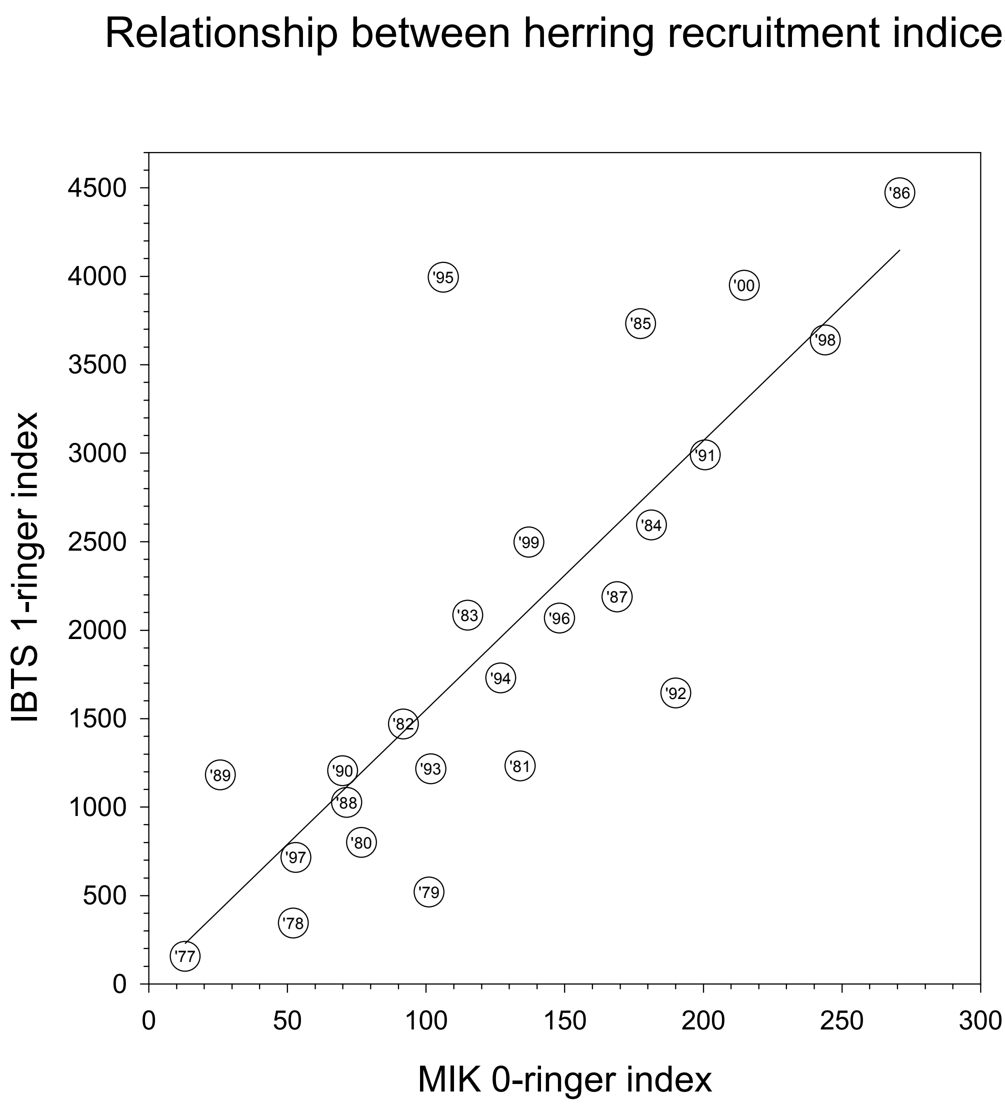


Figure 2.3.4. North Sea herring. Regression between the MIK 0-ringer index and the IBTS 1-ringer indices for year classes 1977 to 2000. Numbers in symbols indicate year class

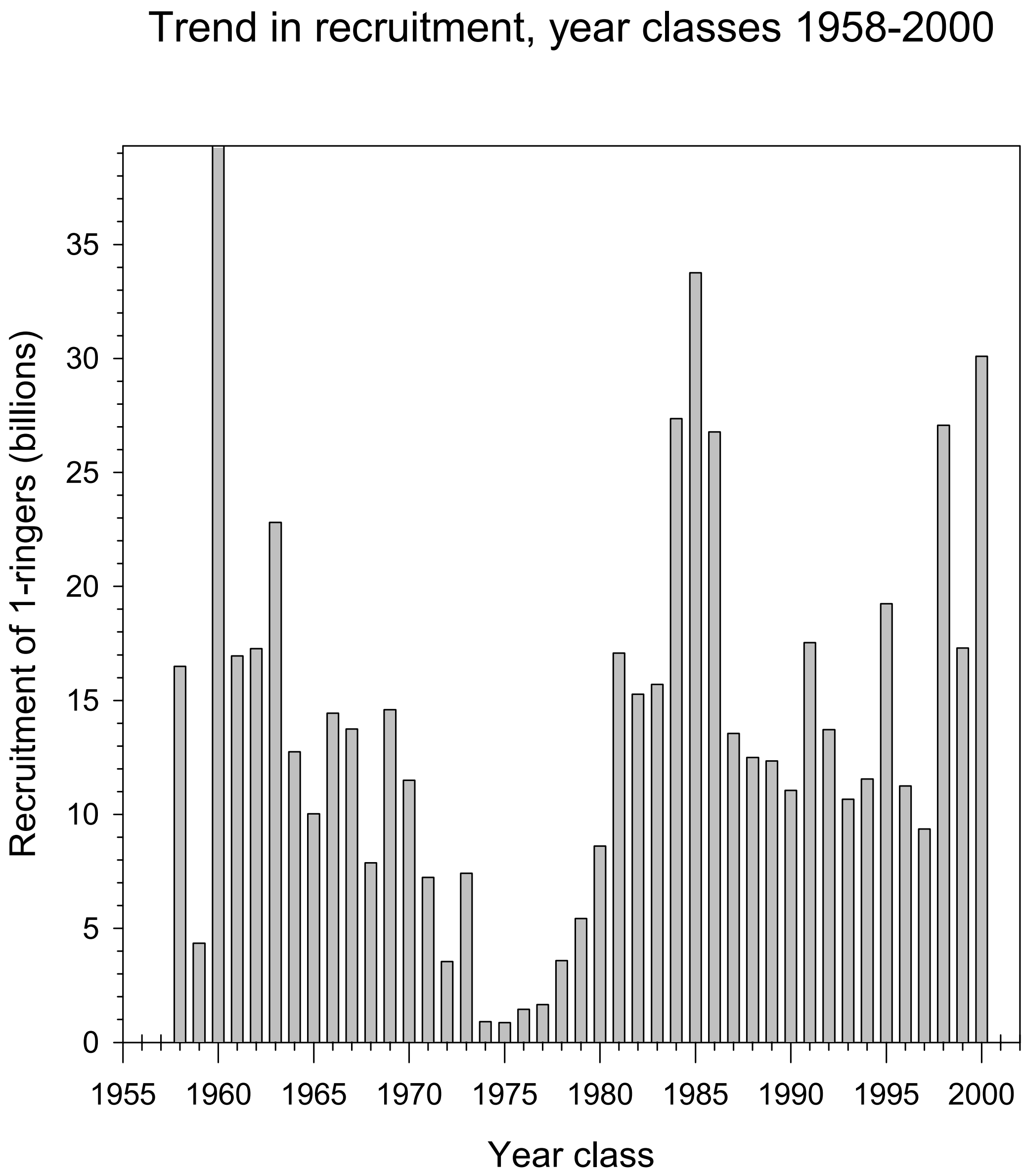


Figure 2.3.5. **North Sea herring**. Recruitment of 1-ringer North Sea autumn spawners. Estimates from the ICA assessment in 2002.

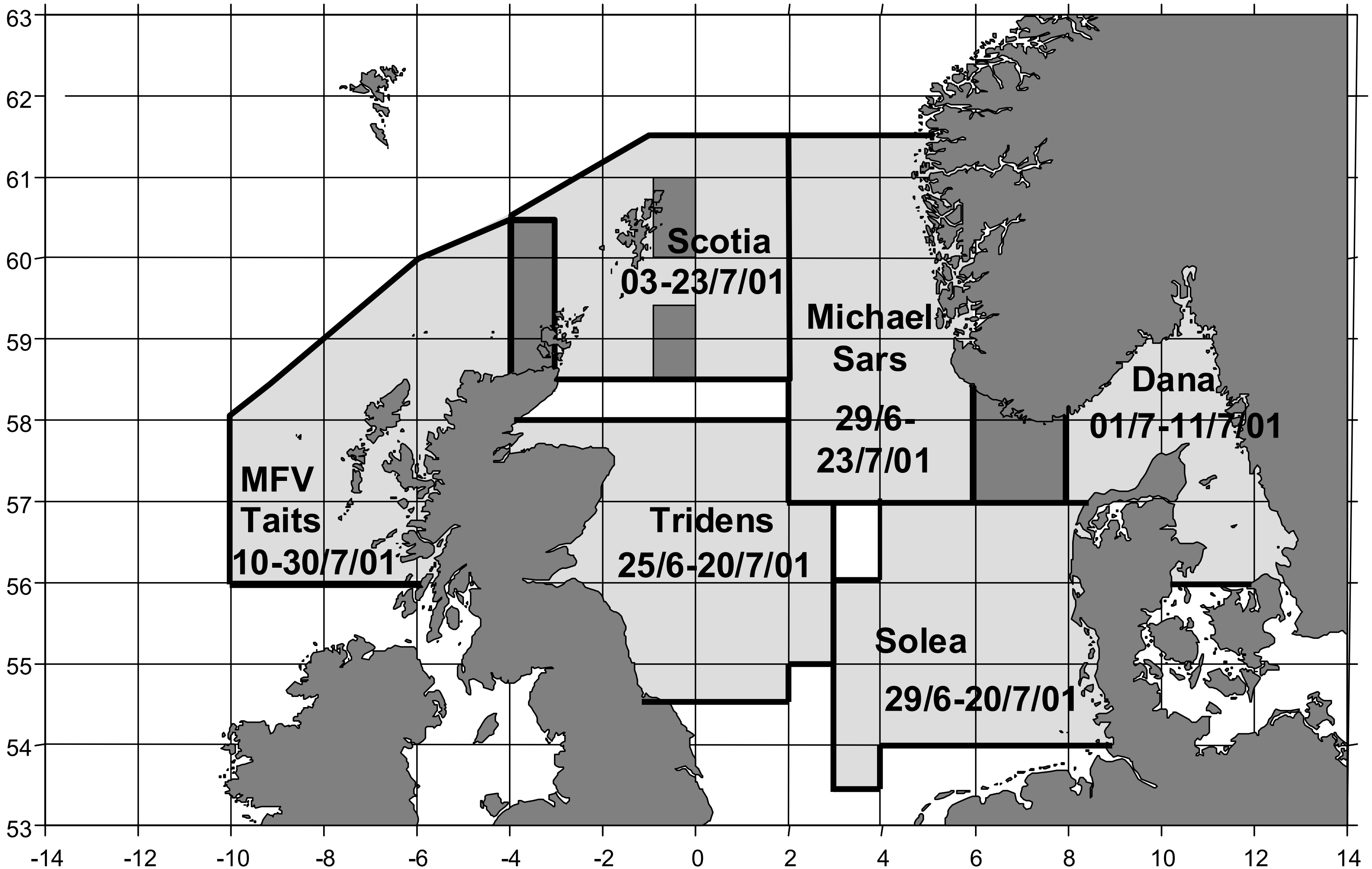


Figure 2.4.1. Herring survey area layouts and dates for all participating vessels in the 2001 acoustic survey of the North Sea and adjacent areas. Shaded areas indicate areas of overlap.

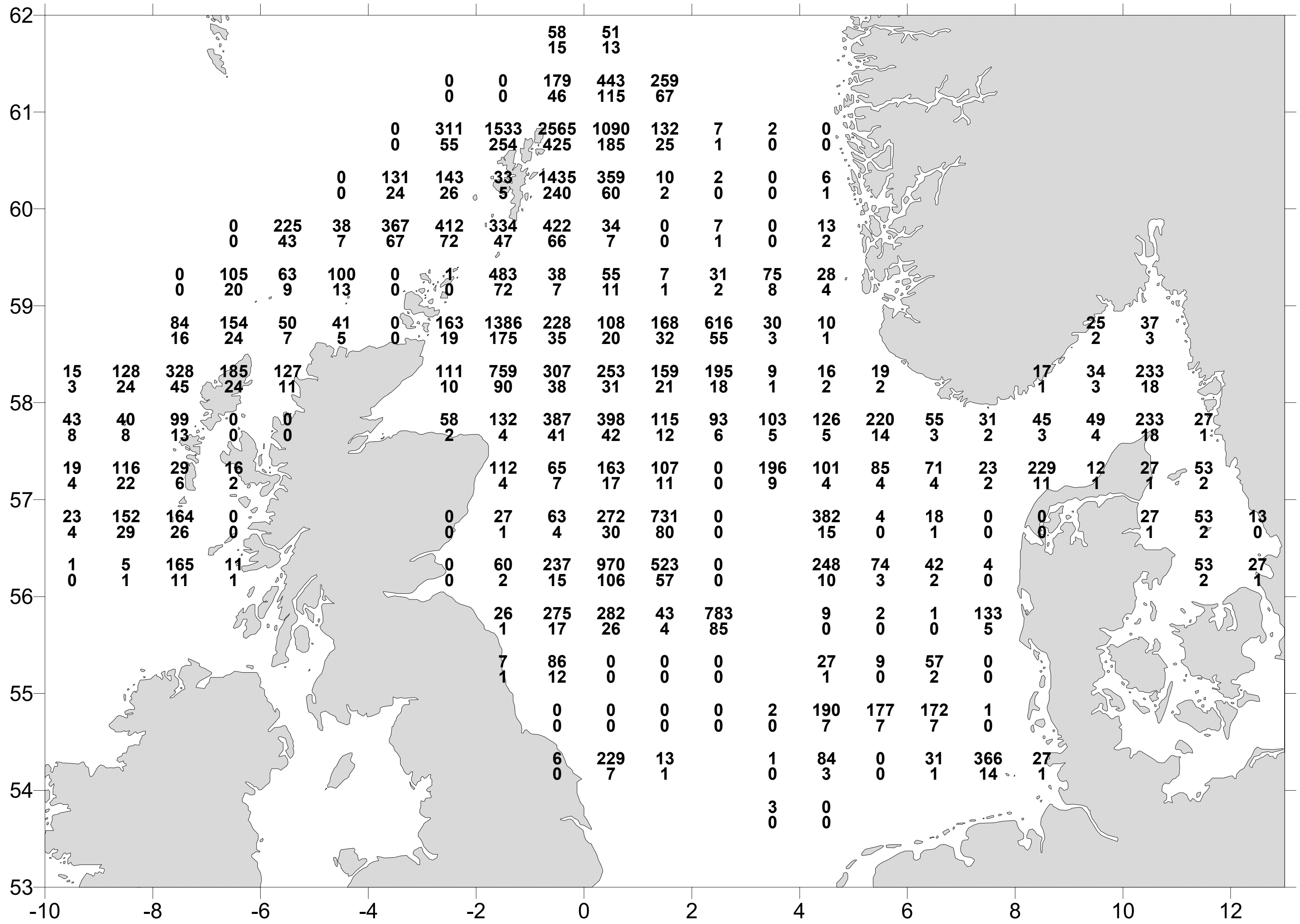


Figure 2.4.2 Autumn-spawning herring abundance from combined acoustic survey July 2001. Numbers (millions) (upper figure), and biomass (thousands of tonnes) (lower figure).

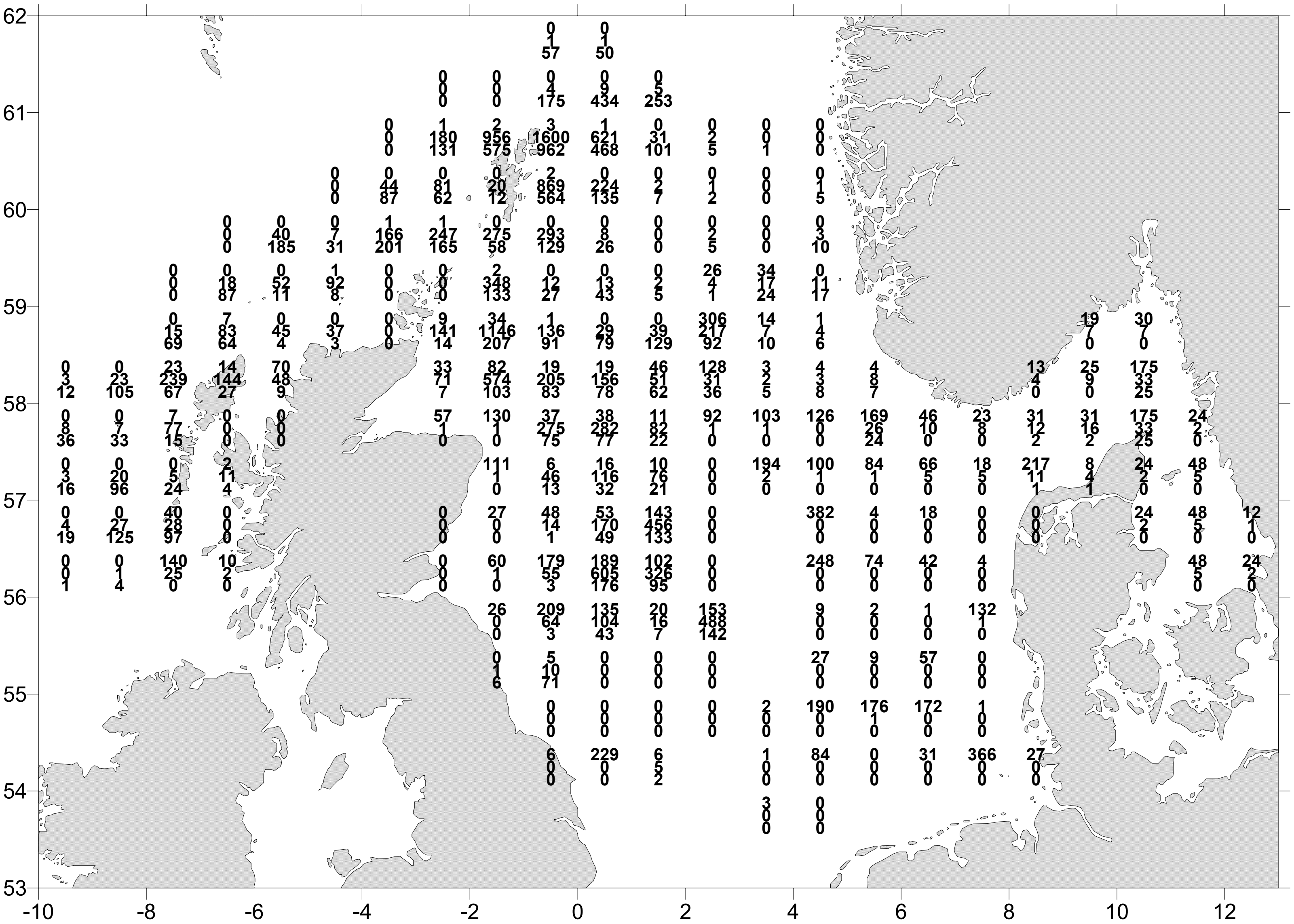


Figure 2.4.3 Autumn-Spawning herring numbers (millions) from combined acoustic survey July 2001. 1 ring (upper figure), 2 ring (centre figure), 3+ (lower figure).

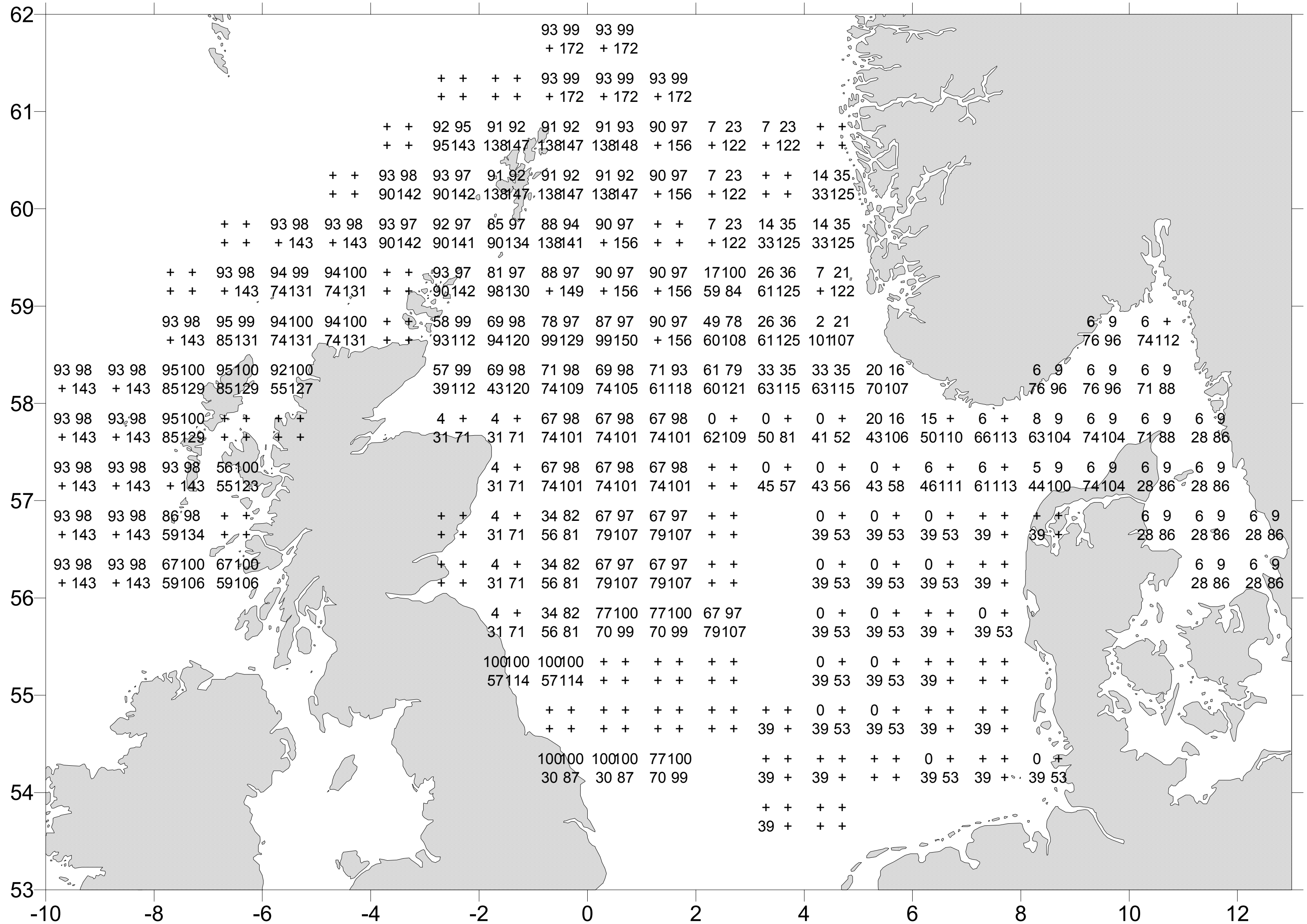


Figure 2.4.4 Autumn-spawning herring , mean weight & maturity from combined acoustic survey July 2001. Fraction mature (upper): 2 ring (left), 3 ring (right); mean weights (lower): 1 ring (left), 2 ring (right); 0 indicates measured fraction mature, + indicates surveyed with zero abundance, blank indicates unsurveyed rectangle.

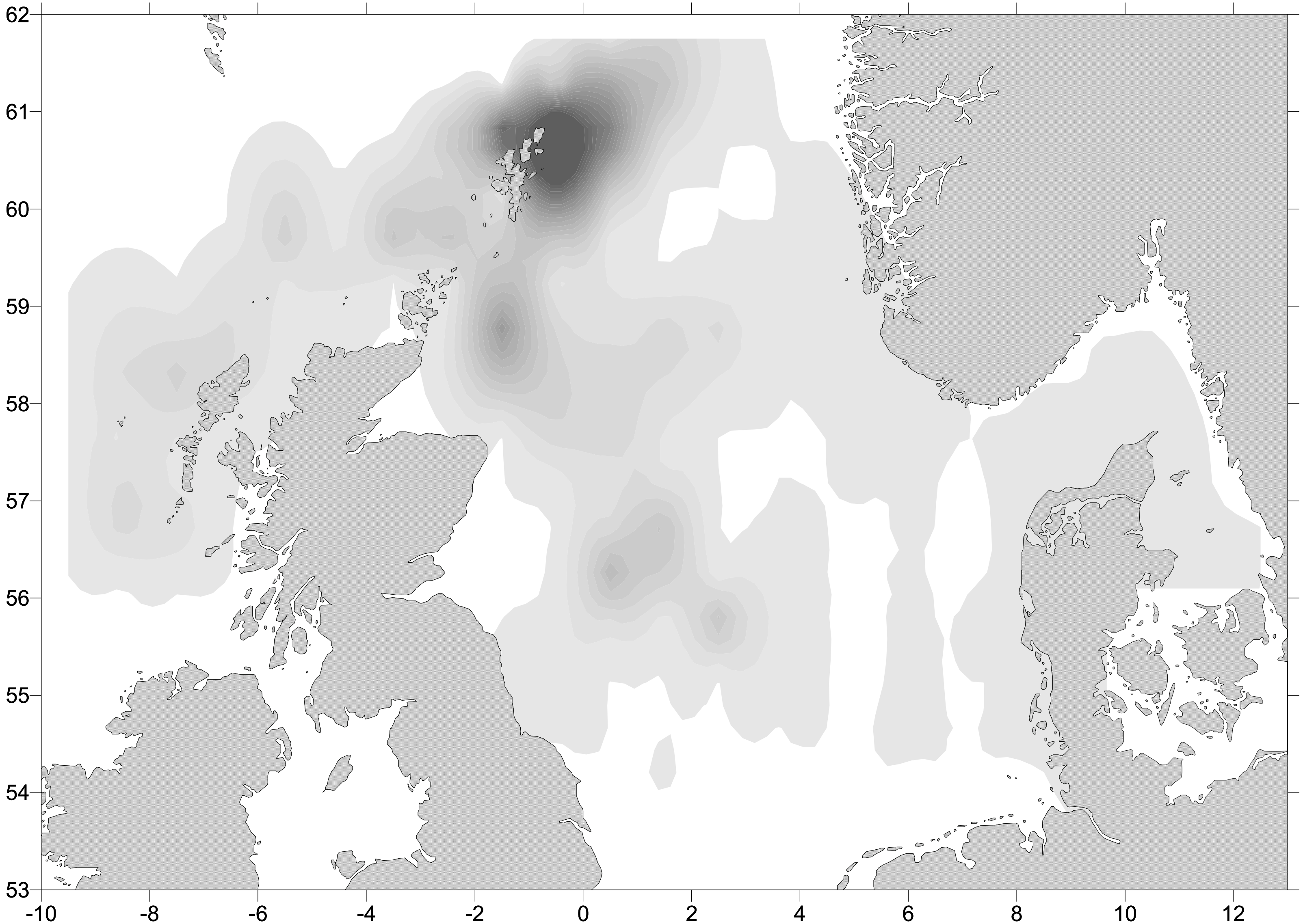


Figure 2.4.5 Autumn-spawning herring, abundance of mature autumn-spawning herring from combined acoustic survey July 2001. Numbers of herring.

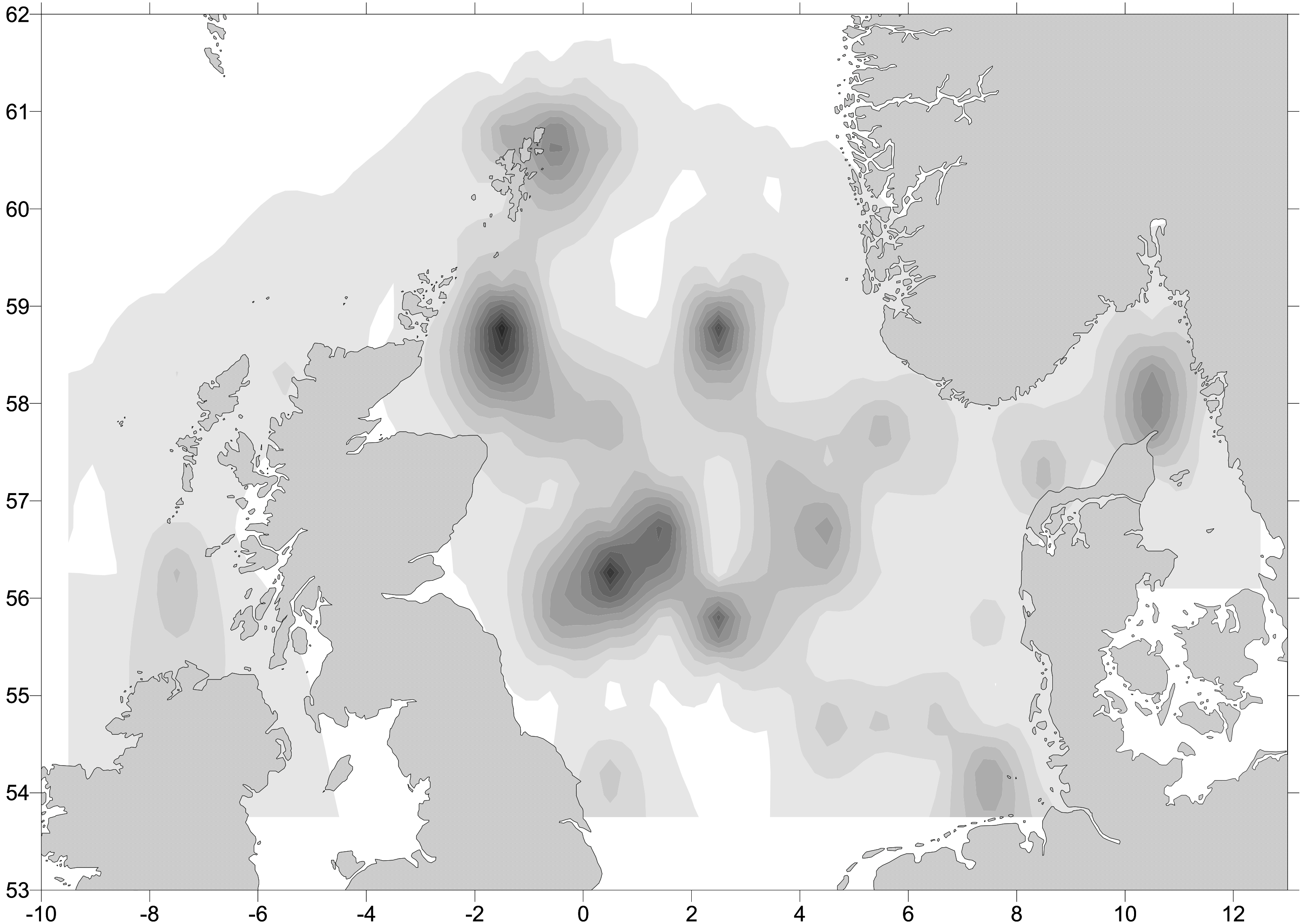


Figure 2.4.6 Autumn-spawning herring, abundance of immature autumn-spawning herring from combined acoustic survey July 2001. Numbers of herring.

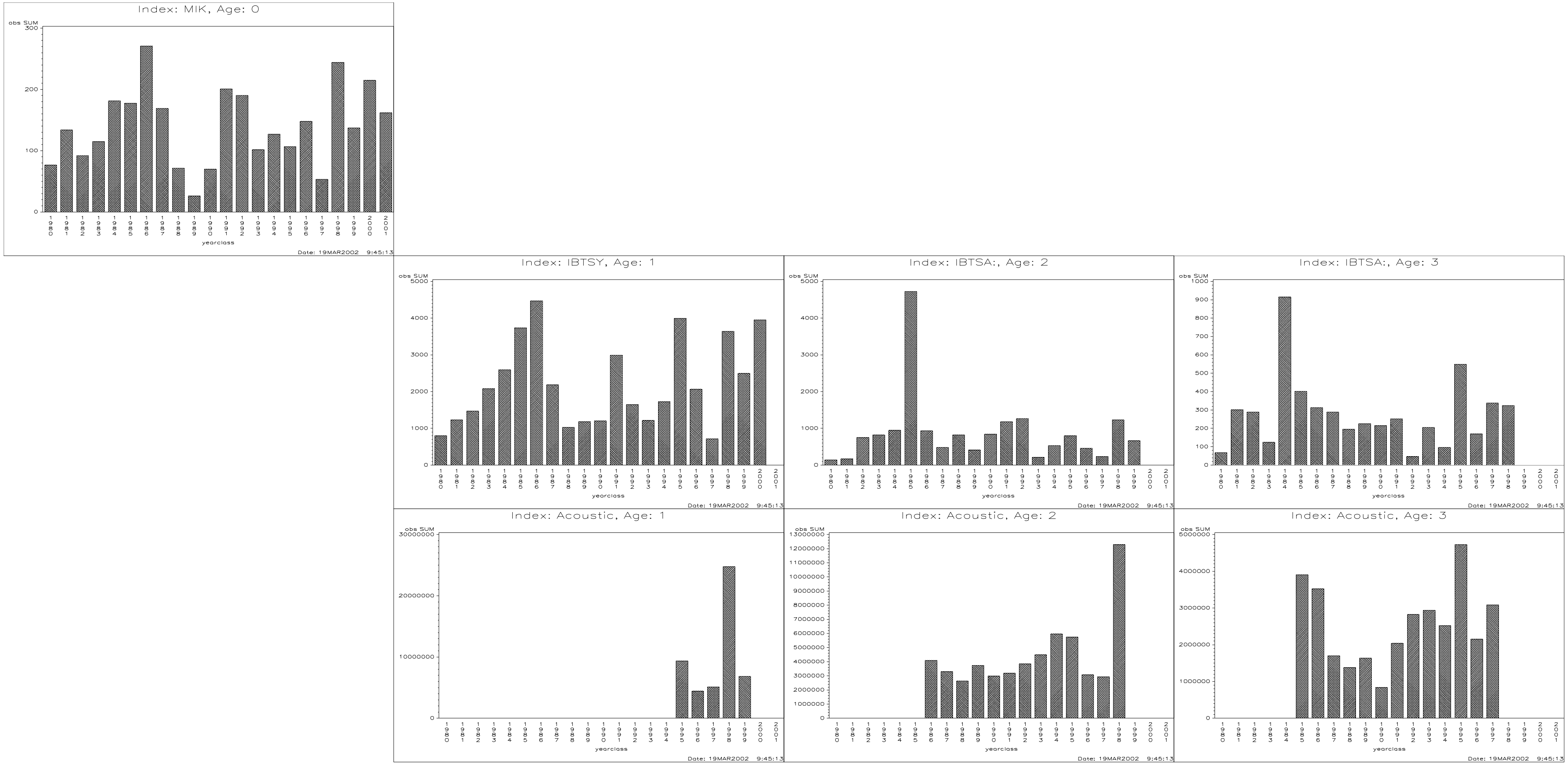


Figure 2.8.1 North Sea herring. Abundance indices by age (WR): MIK, IBTS and Acoustic index.

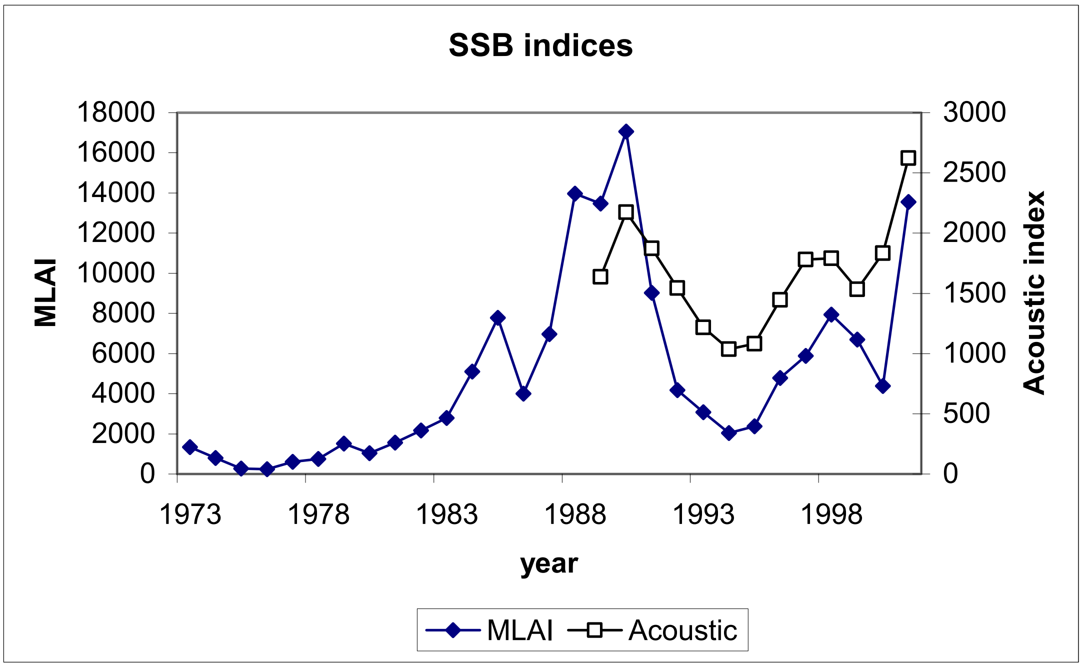


Figure 2.8.2. North Sea herring. Available SSB indices: MLAI and Acoustic index (latter not used as an SSB index in the assessment, but as an age-based index).

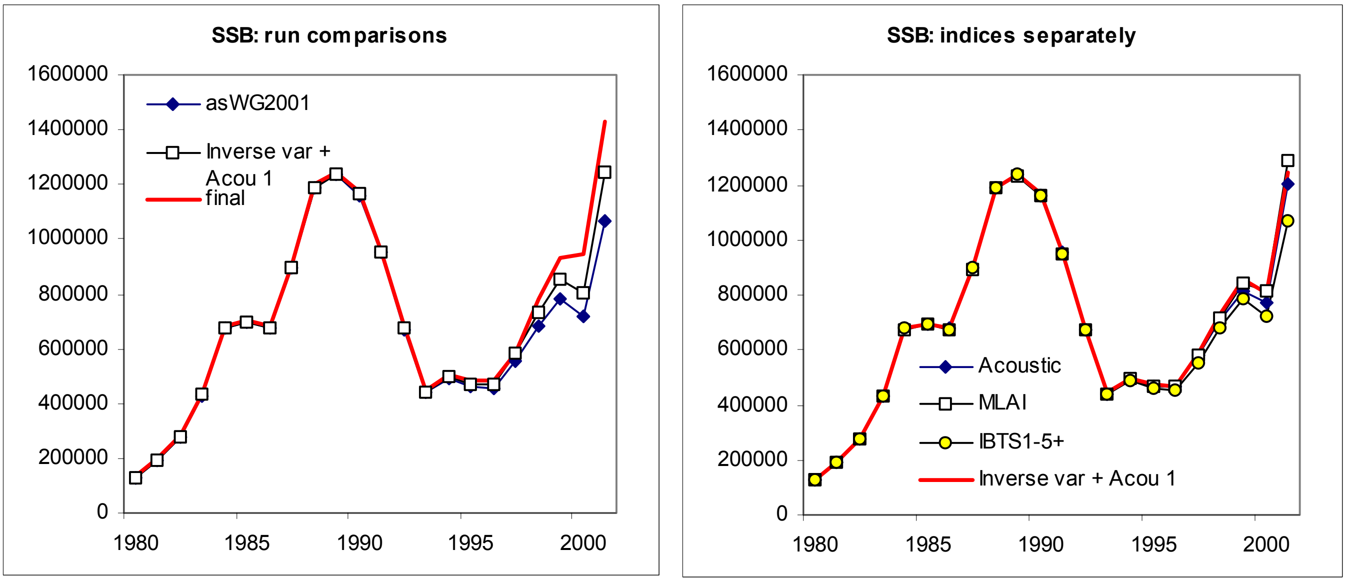


Figure 2.8.3 North Sea herring. SSB estimates from different settings of the assessment model (left) and indices separately (right). Note: the comparison with indices separately was carried out with a run with full inverse variance weighting and is thus not equal to the final run.

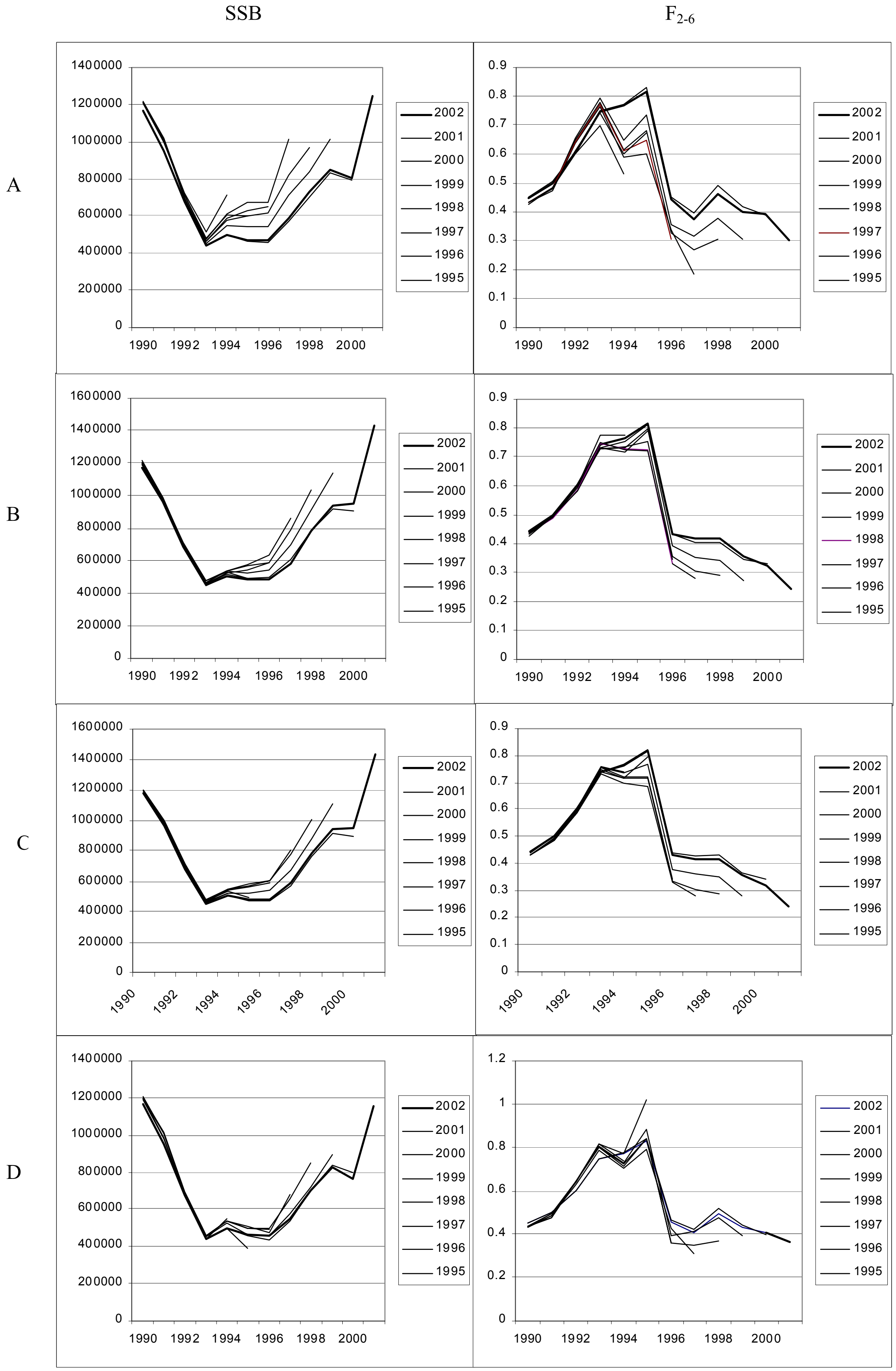


Figure 2.8.4 North Sea herring. Retrospective analysis showing SSB (left) and $F_{2\text{-}6}$ (right) under different separable assumptions and weighting methods. A) Inverse variance weights with historic WG separable periods, B) Inverse variance weights, and 5-year separable periods , C) Inverse variance and historic WG separable periods, D) 2001 assessment weights and historic WG separable periods (note the scale change required on the F diagram for the 2001 WG method).

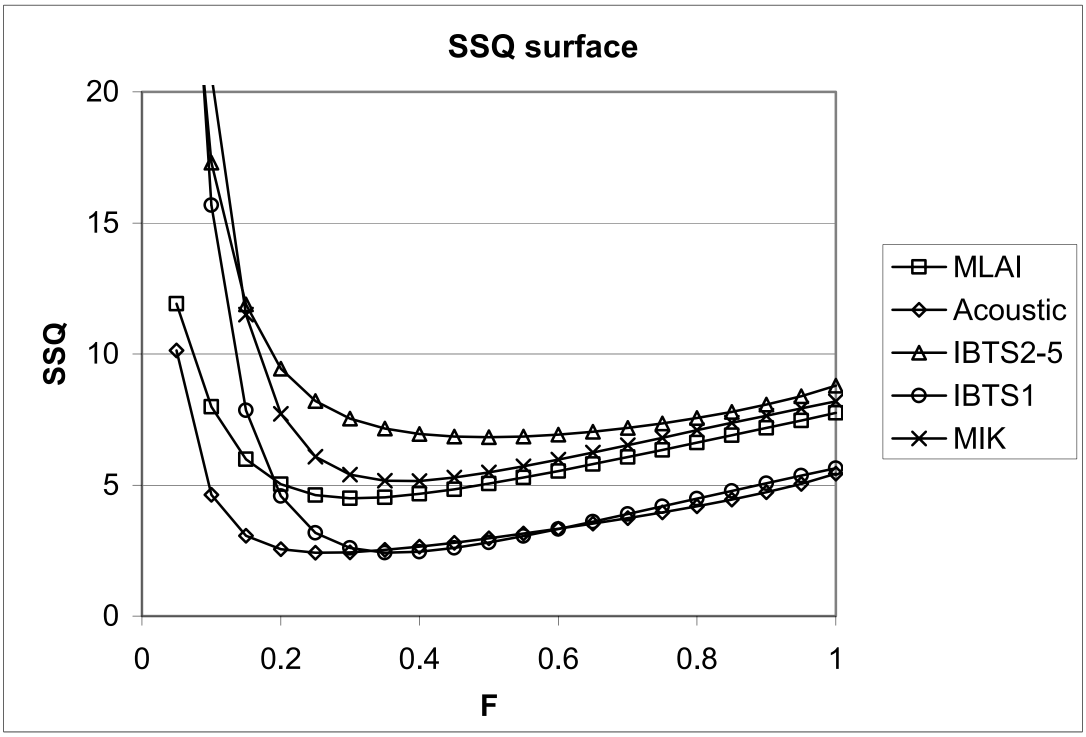


Figure 2.8.5 North Sea herring. Sum of squares (SSQ) surfaces for the tuning indices from a separable analysis.

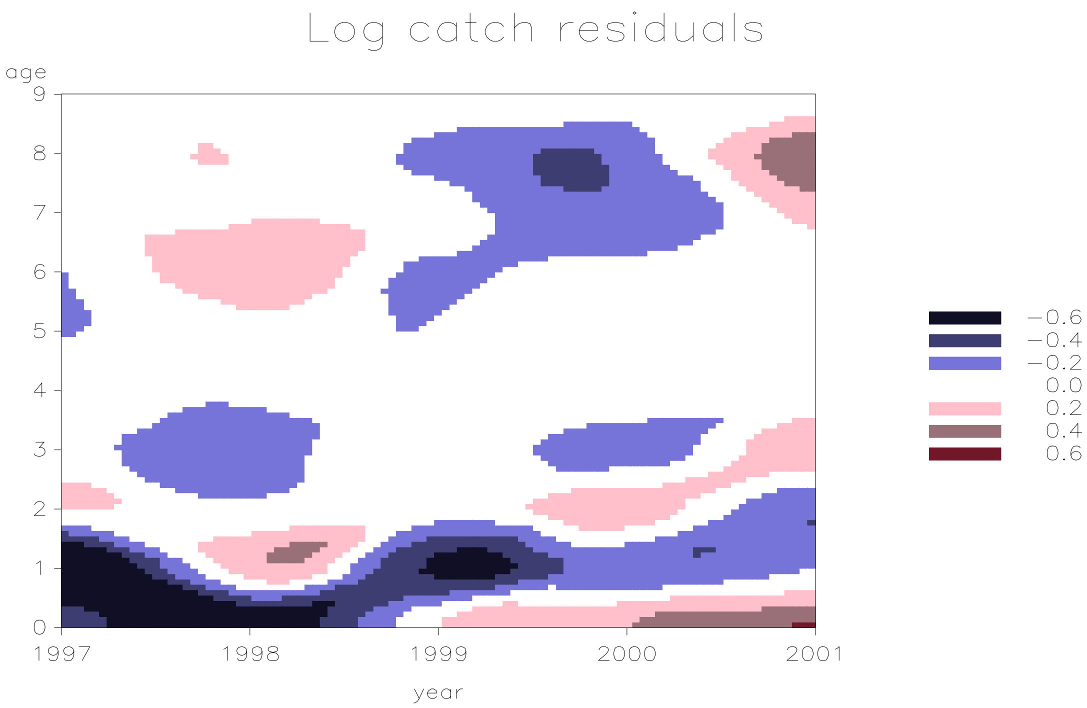


Figure 2.8.6. North Sea herring. Contour plot of unweighted catch residuals.

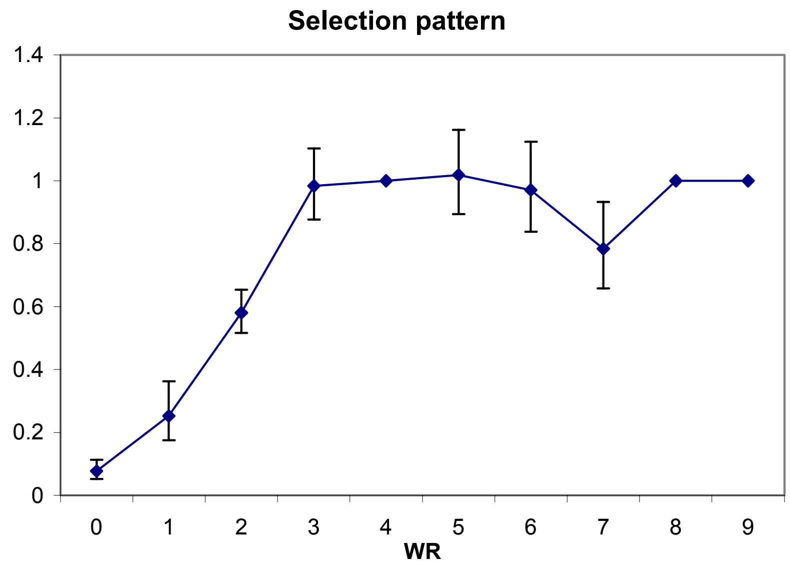


Figure 2.8.7. North Sea herring. Estimated selection pattern (+/- SD).

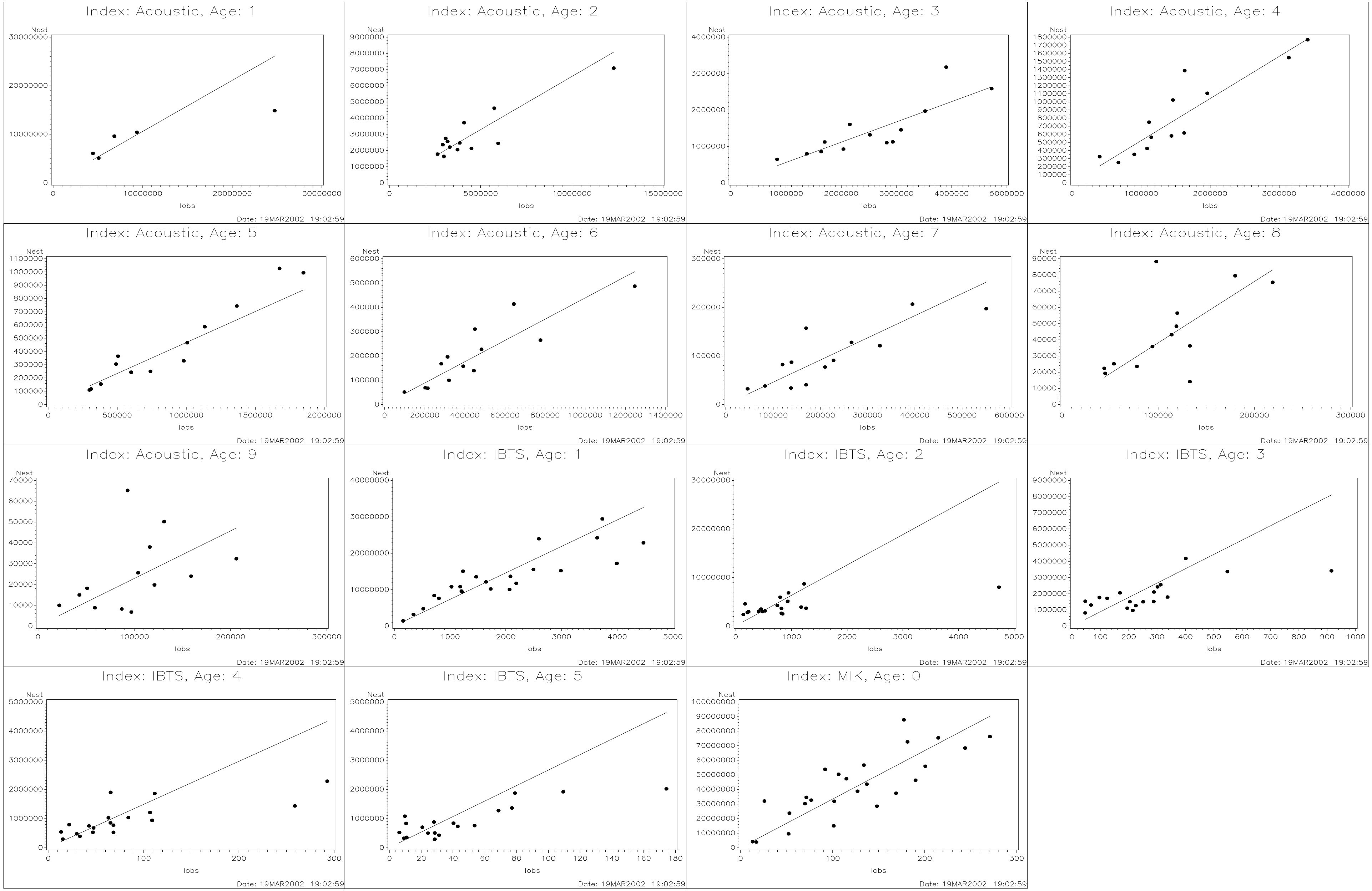


Figure 2.8.8 North Sea herring. Scatterplot and fitted catchability model (line) from the fitted populations and the tuning index observations (dots).

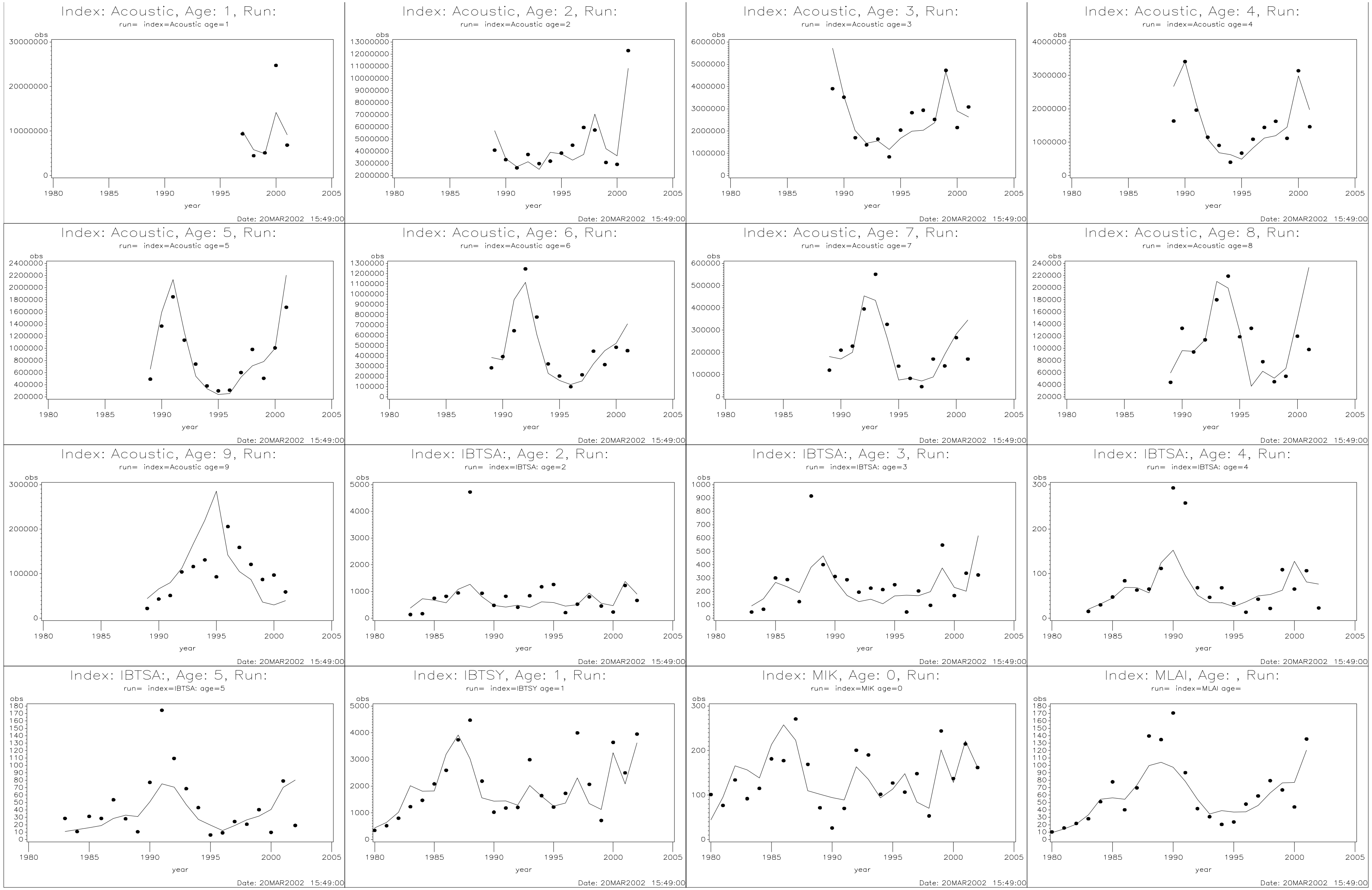


Figure 2.8.9 North Sea herring. Observed (dots) and predicted (line) values for the indices.

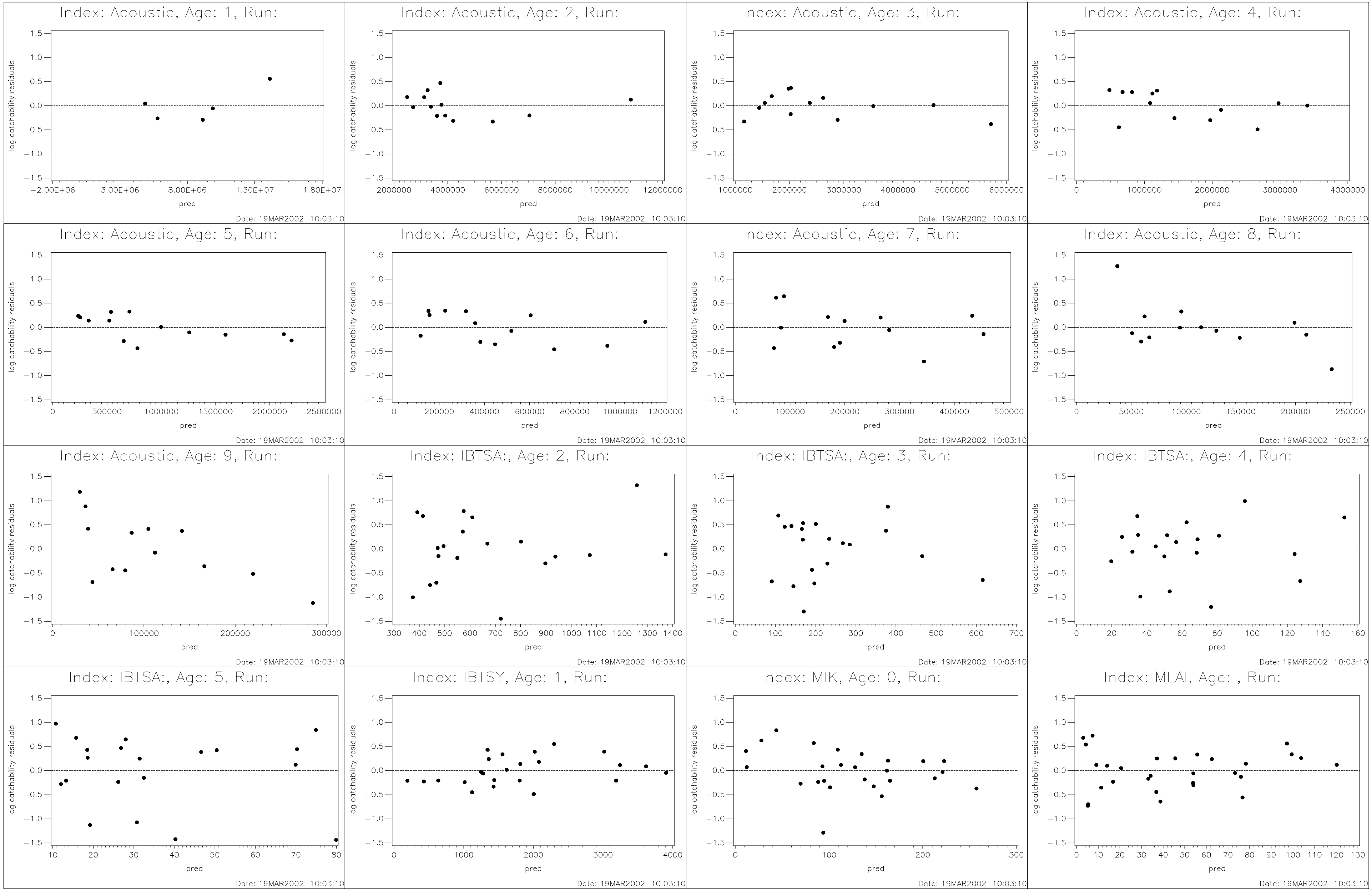


Figure 2.8.10 North Sea herring. Residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations.

.

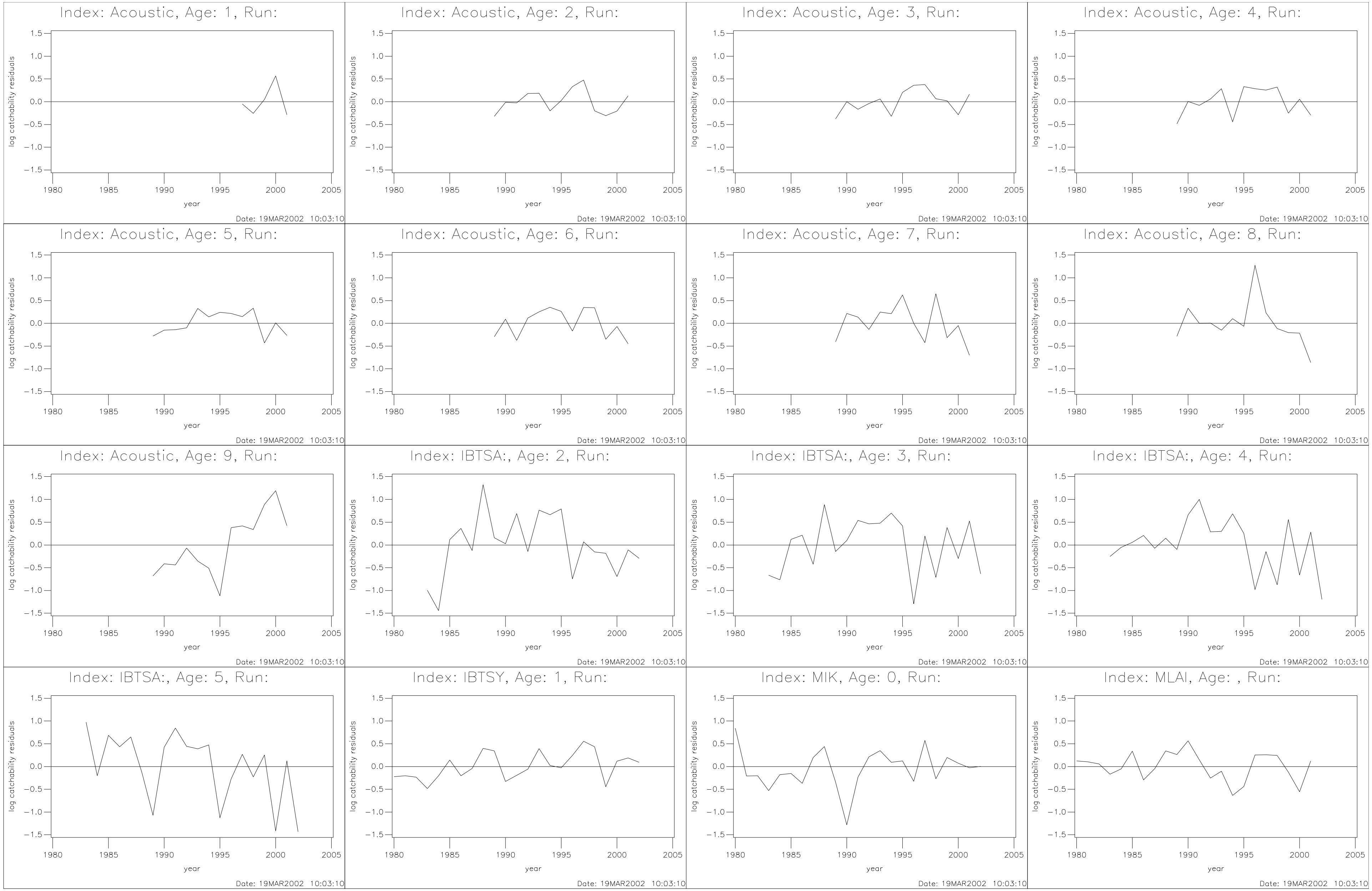


Figure 2.8.11 North Sea herring. Residuals as [ln(observed index)-ln(expected index)] plotted against time.

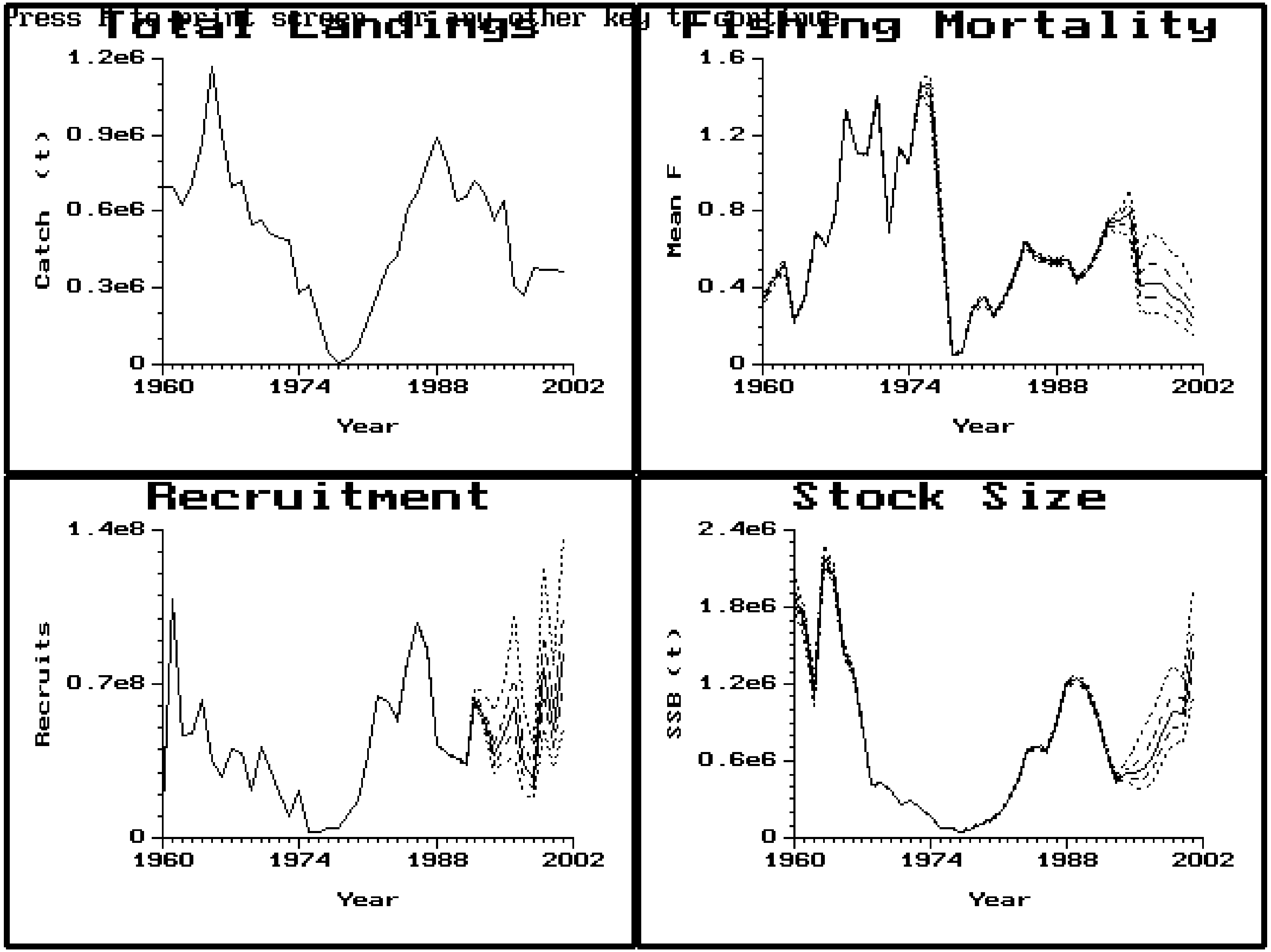


Figure 2.8.12 North Sea herring. Evaluation of assessment uncertainty using a covariance matrix method with 1000 random draws from the estimated parameter distribution. Summary of landings, estimated mean fishing mortality (age 2-6), recruitment of 0-ringers and spawning biomass. Shown are the 5, 25, 50, 75 and 95 percentiles.

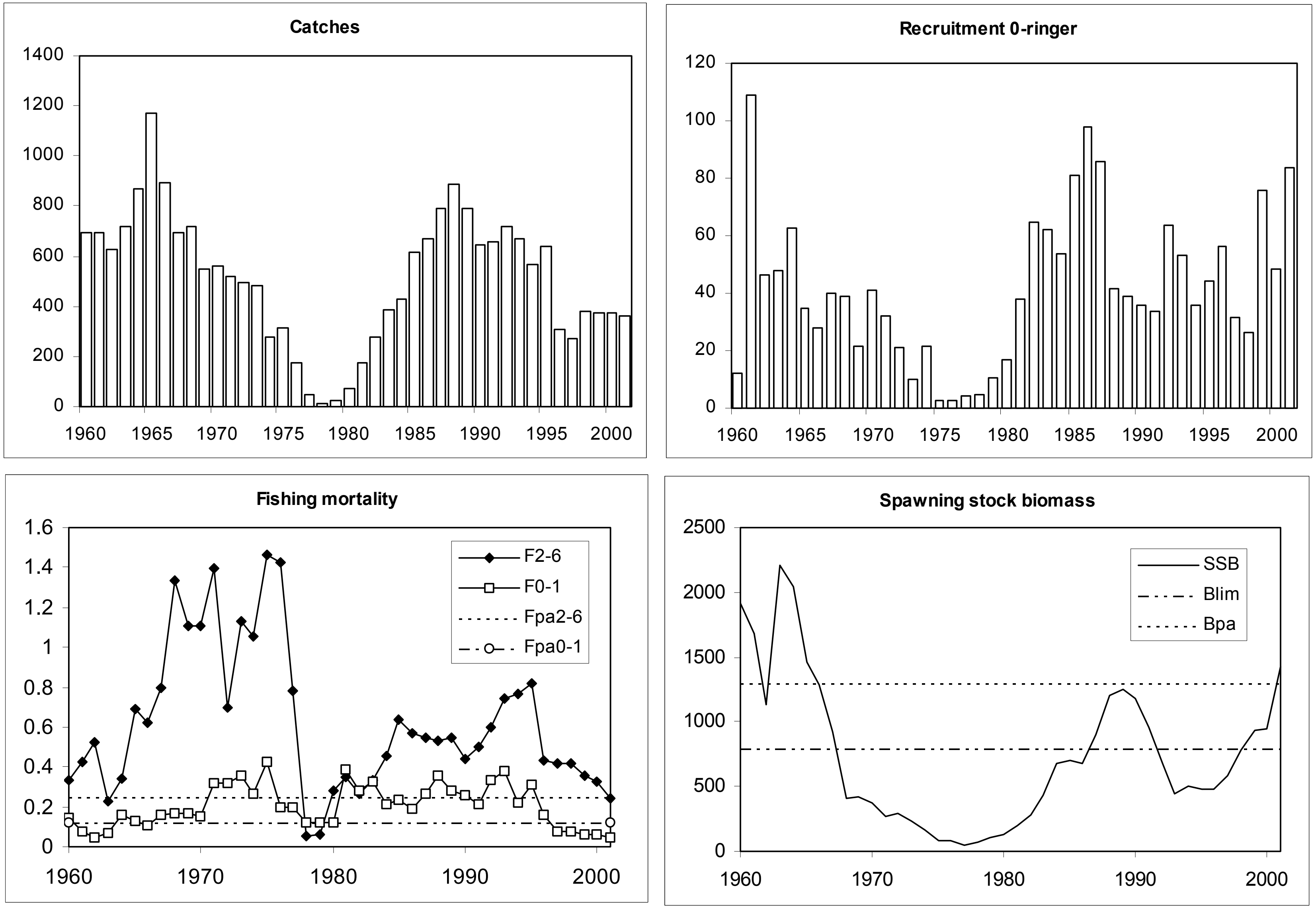


Figure 2.8.13 North Sea autumn-spawning herring. Long-term trends in catches (top left), recruitment as 0-ringers (bottom left), fishing mortality on ages 2-6 and 0-1 (bottom left) and spawning stock biomass (bottom right). Note that two different PA values are set for the fishing mortality, both for juveniles and adults.

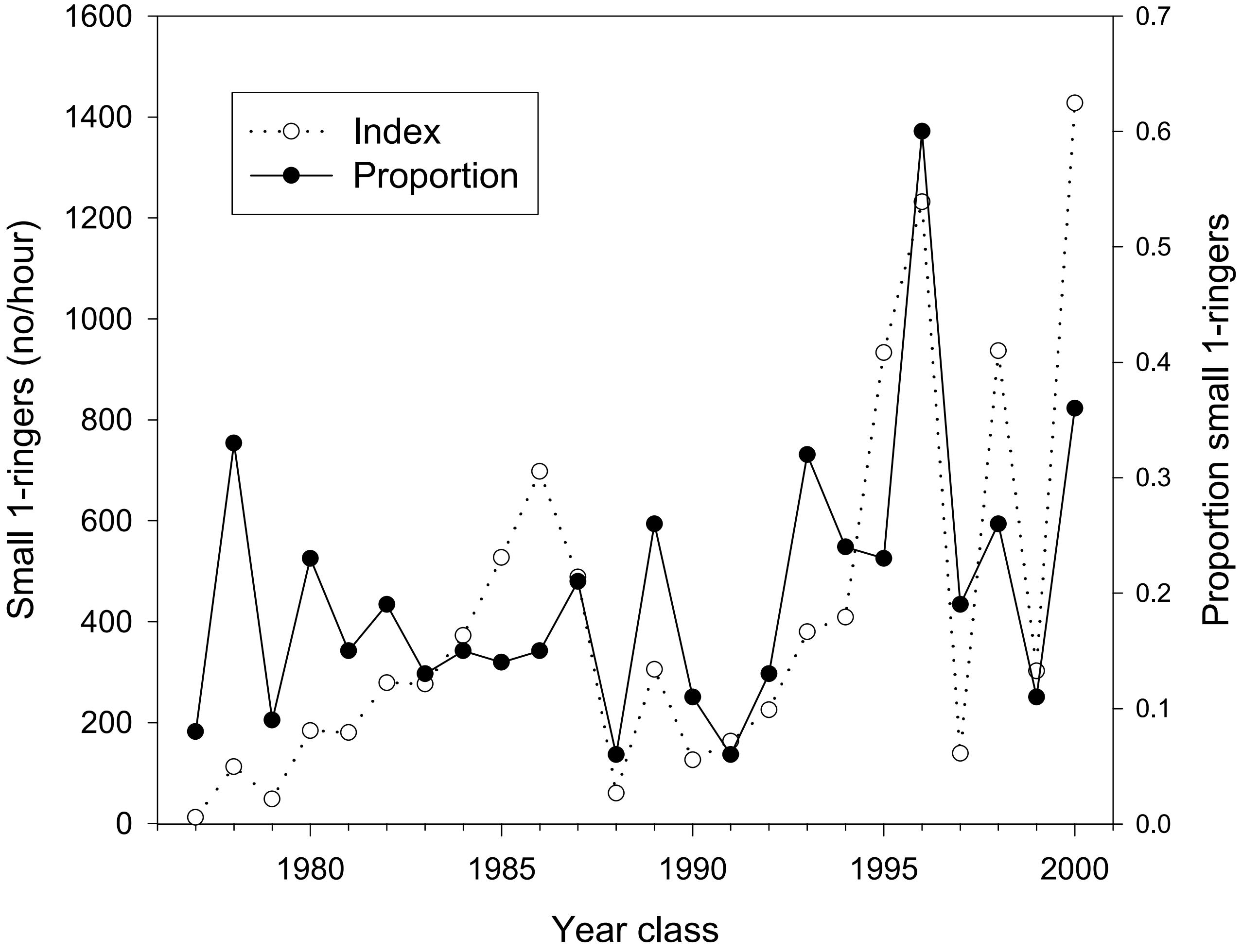


Figure 2.9.1. North Sea herring. Index (numbers per hour) of small (<13 cm) 1-ringers in the North Sea area, and proportion of small 1-ringers versus all sizes in the North Sea area. See Table 2.3.3.

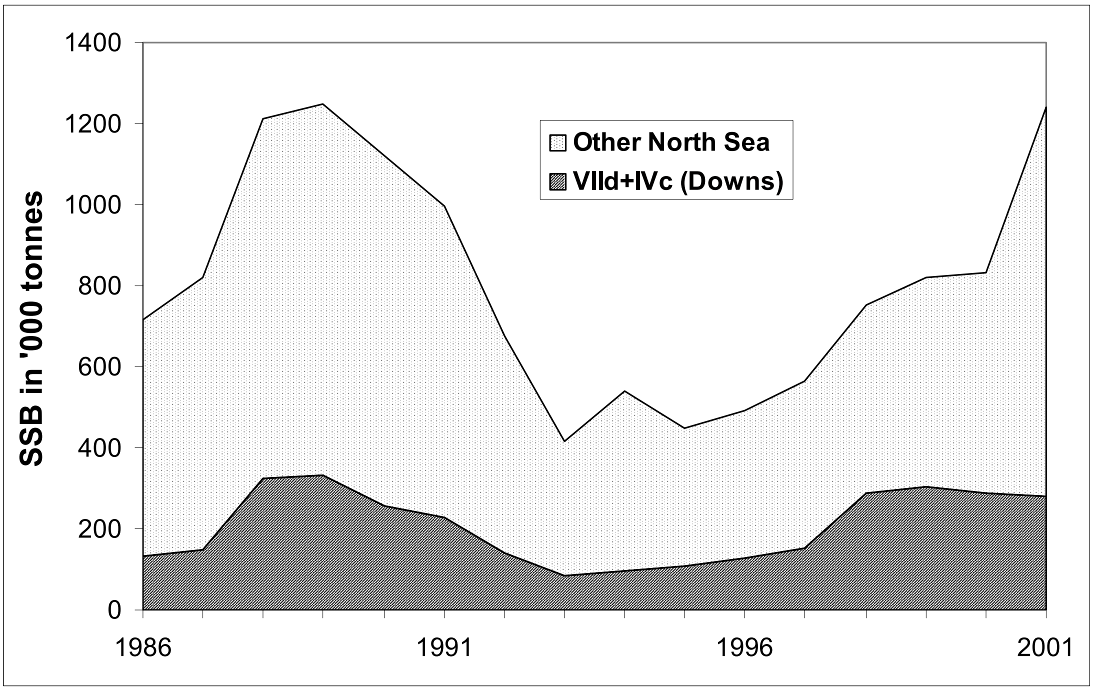


Figure 2.9.2. North Sea herring. Estimates of SSB distinguishing a Downs component (divisions VIId+IVc).

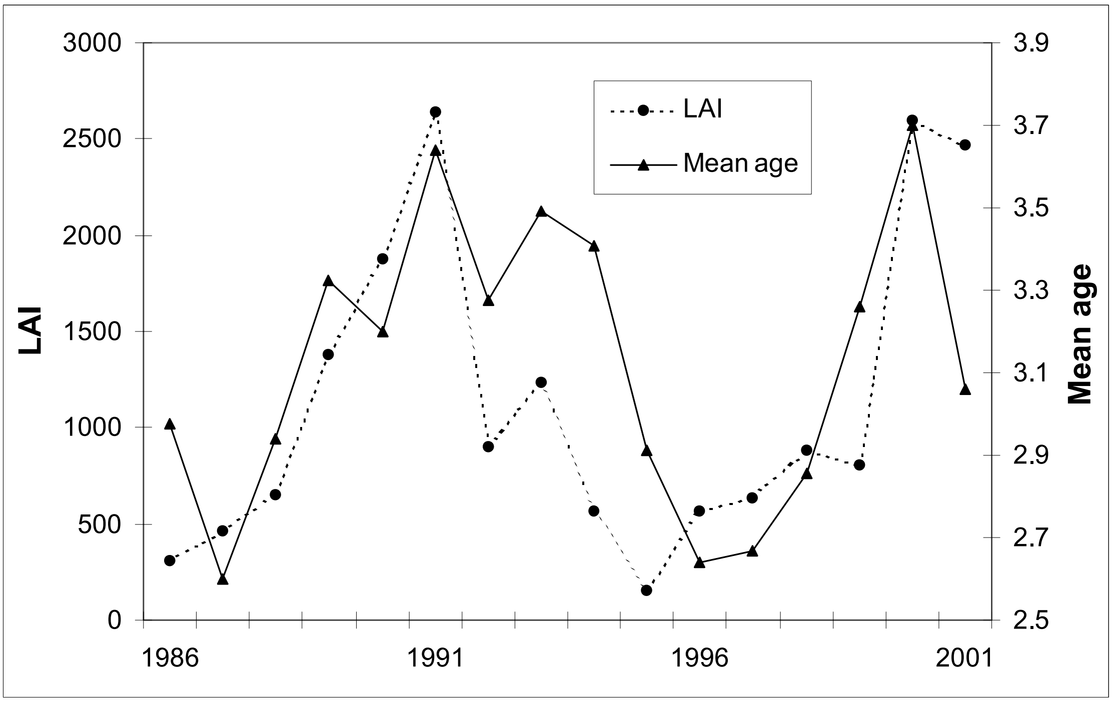


Figure 2.9.3 North Sea herring. Larval Abundance Index (LAI) in the southern North Sea and mean age (winter-ring) in catch.

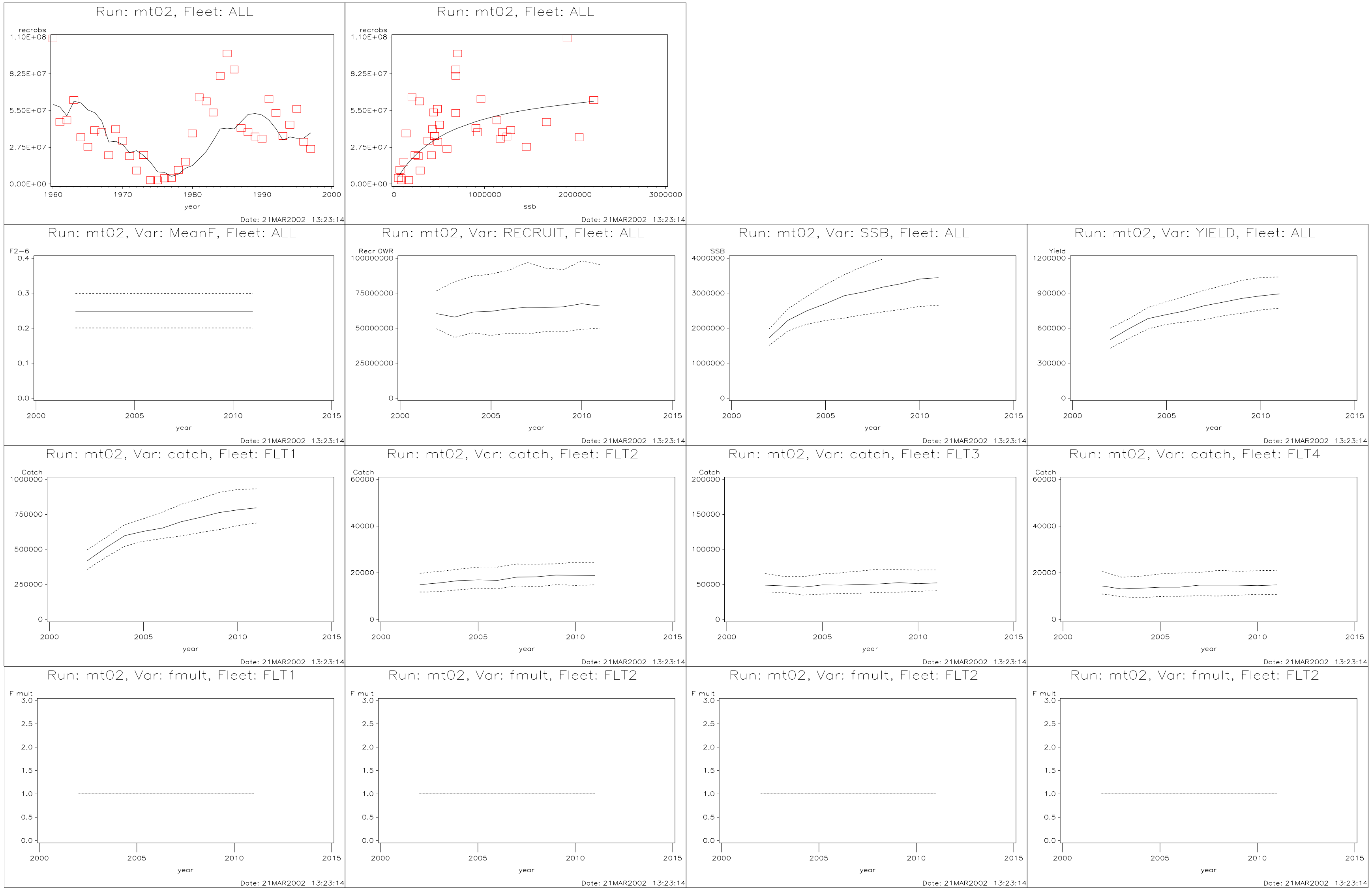


Figure 2.11.1 North Sea herring. Medium-term forecast using a Beverton and Holt stock recruitment relationship. F multiplier of 1 on all fleets.

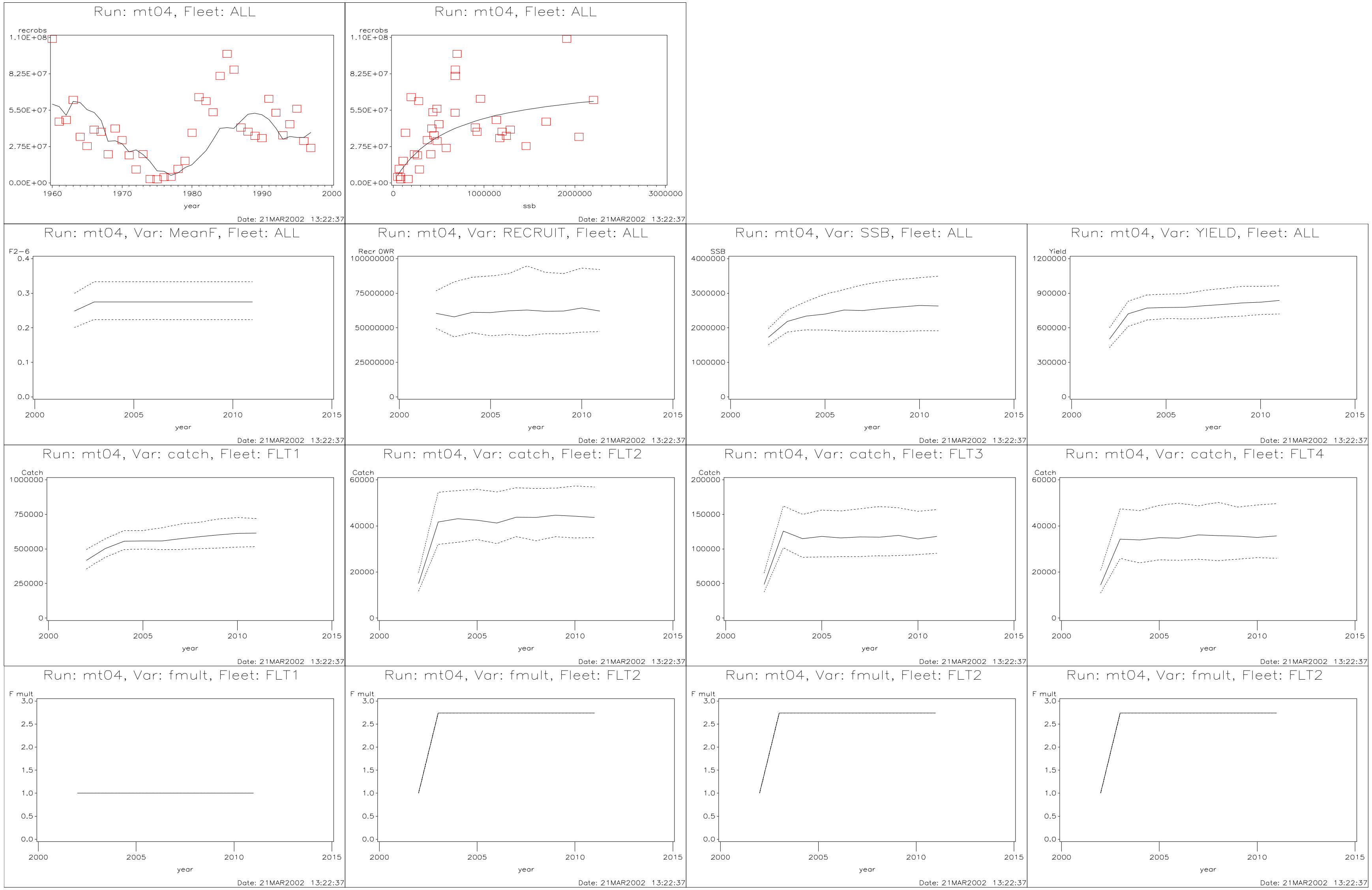


Figure 2.11.2 North Sea herring. Medium-term forecast using a Beverton and Holt stock recruitment relationship. F multiplier of 1 on fleet A ($F_{2\text{-}6}$=0.24) and 2.74 on fleets B-D ($F_{0\text{-}1}$=0.12).

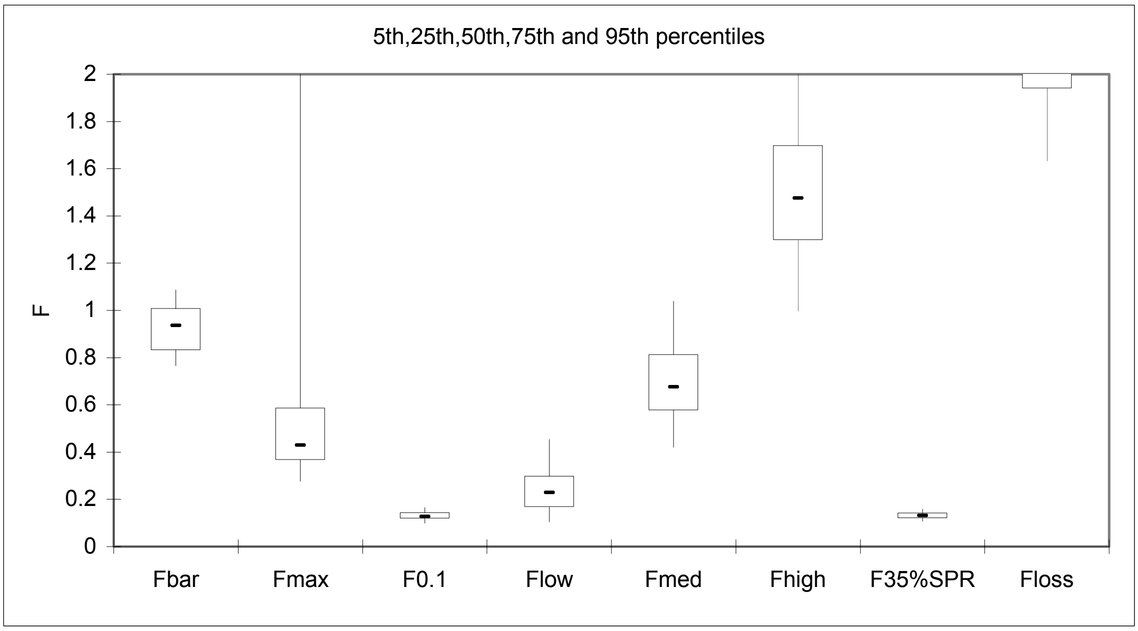


Figure 2.12.1 North Sea herring. Estimates of uncertainty of biological reference points.

3 HERRING IN DIVISION IIIA AND SUBDIVISIONS 22–24

3.1 The Fishery

3.1.1 ACFM advice and management applicable to 2001 and 2002

At the ACFM (May) meeting in 2001, it was stated that the state of the stock was uncertain. However, the available information provided reasons for concern, as the fishing mortality appeared stable at a high level during the last 4 years while the catches have declined over the same period.

ACFM recommended that the fisheries on herring in Division IIIa should continue to be managed in accordance with the management advice given on autumn-spawning herring in the North Sea. If a catch limit is required in Subdivisions 22–24, ACFM advised that it should not exceed recent catches in that area in the order of 50,000 t.

The EU and Norway agreement on a herring TACs set for 2001 and 2002 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.

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 2001. For the Baltic there was for 2001 a TAC of 300,000 t for the Subdivisions 22–29South and 32. The TAC was reduced to 200,000 t for the same area in 2002.

3.1.2 Total landings

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 Subdivisions 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 2001 are given in Table 3.1.1. In 2001 the total landings decreased to 152,500 t in Division IIIa and Subdivisions 22–24 compared to 2000 where the landings were 162,000 t, resulting in a landing figure for 2001 at the mean level for the period 1997-2000. In 2001, 35,000 t were taken in the Kattegat, about 55,300 t from the Skagerrak and 62,200 t from Subdivisions 22–24. These landings represent a decrease of 9,500 t compared to 2000.

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

No estimates of discards were available to the Working Group. The magnitude of discarding in Skagerrak may, in some periods and some years, be at a high level, especially in the summer period where there is a special demand for high quality herring for the Dutch market. Due to high prices for most herring landings in 2001, the amount of discards are regarded as being insignificant.

In 2001 the landing data are calculated by fleet according to the fleet definitions used when setting TACs. In the autumn of 1998 the EU and Norway have agreed on setting TACs for only two fleets, and this agreement was also in force for 2001. Therefore, HAWG in 1998 decided to merge Fleet D and Fleet E and only present data according to these new fleet definitions for fisheries in Division IIIa (ICES 1999/ACFM:12)).

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

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

All Norwegian landings for 2001 and all landings from fisheries with minimum mesh sizes of 32 mm are categorised in Fleet C. Danish and Swedish by-catches of herring from the sprat fishery and the Norway pout and blue whiting fisheries are listed under fleet D.

In Subdivisions 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 Subdivisions 22–24 are treated as one fleet. The landings of the autumn spawning component in Division IIIa plus the entire spring-spawning stock could therefore be split into three fleets:

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

In the table below the landings are given for 1996 to 2001 in thousands of tonnes by fleet and quarter. The landings figures in the text table below are SOP figures. Fleet C and D refer to Division IIIa, and fleet F to Subdivisions 22-24.

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**
1996	1	13.9	12.1	9.3	35.3
	2	12.5	2.2	23.9	38.6
	3	46.2	3.2	10.1	39.5
	4	19.4	8.3	13.5	41.2
	Total	92.0	25.8	56.8	174.6
1997	1	11.7	2.5	17.4	31.6
	2	16.9	1.3	27.2	45.4
	3	22.6	1.1	7.8	31.5
	4	21.7	4.2	15.1	41.0
	Total	72.9	9.1	67,5	149.5
1998	1	17.6	3.1	18.5	39.2
	2	8.2	0.9	16.9	26.0
	3	44.2	2.0	14.7	60.9
	4	34.3	2.6	13.6	50.5
	Total	104.3	8.6	63.7	176.6
1999	1	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	20.1	44.0
	2	18.7	1.9	20.1	40.7
	3	25.0	7.9	7.4	40.3
	4	11.1	1.7	14.3	27.1
	Total	74.9	15.3	61.9	152.1

The landings from fleets C-F are SOP figures.

3.2 Stock Composition

Catches of herring in the Kattegat, the Skagerrak and the Eastern part of the North Sea are taken from a mixture of two main spawning stocks (ICES 1991/Assess:15): 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 have failed. 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 have been reworked, 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 has been applied (see the following Sections 3.2.1 and 3.2.2).

3.2.1 Treatment of spring-spawning herring in the North Sea

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

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

where VS (sample) was the sample mean vertebral count (ICES 1992/H:5). For age 1 WR the split was performed by otolith microstructure from Danish samples. For the total commercial landings in May, June and July from the North Sea in 2001, the proportion of spring-spawners was calculated using samples from 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 Treatment of autumn spawners in Division IIIa

For commercial landings in 2001 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 2604 otoliths from the year 2001 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 2012 Danish and 592 Swedish otolith microstructure analyses in 2001. Data were disaggregated by area (Kattegat and Skagerrak), age group (0–4+ WR) and quarter (1–4). The proportions of analysed numbers were given in column “n” (Table 3.2.1).

Despite a reasonable coverage of the fishery, the proportion for several age, area and season combinations had to be estimated from adjacent areas, age groups or seasons. These data are indicated in the column “source” in Table 3.2.1. No changes in earlier years’ split data were made in the present HAWG 2002 year’s assessment. For the 2001 split of catches samples from commercial landings were used primarily, 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 years assessment (ICES 1998/ACFM:14) the magnitude of the problem in later years appears minor. In 2001 only the herring by-catches from landings in Subdivision 22 were analysed for otolith microstructure, and among the small number of individuals analysed (n=18) no juvenile 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

Stock identification and splitting methods

During the last decade the HAWG has encountered a series of difficulties in the assessment of the Western Baltic Spring-spawning (WBSS) stock. It was impossible to separate the WBSS from a North Sea stock component (autumn spawner) in Division IIIa (Skagerrak, Kattegat, Sound), where both stocks mix. 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, 1981). 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, 2000a) and North Sea: 56.5, Western Baltic Sea: 55.8 (ICES 1992/ACFM:5).

From the Swedish individual determination of spawning type also vs counts were made. Based on spring spawned and autumn/winter spawned components in the Kattegat and Skagerrak mean vs were calculated for each of the four components by age group. Significant differences between observed and expected mean vs for spring-spawners (WBSS vs=55.8) of age groups 3 and 4+ in the 1st quarter in Skagerrak were found, indicating that at this time of year local spring-spawners are an important component. In the same quarter age 1 and 2 WR of autumn spawners in the Kattegat had a small, but significant difference in mean vs count from expected values (NSAS vs=56.5), also indicating some local influence.

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. Initial comparisons showed high deviations between readers but improved during the exercise. After the exercise was finished a close collaboration concerning reader interpretations was kept between the Danish and Swedish laboratories. Sub-samples of the 2001 Danish and Swedish microstructure analyses were double checked by the same Danish reader for consistency in interpretation. The overall impression was that readers were in good agreement.

A high number of Swedish and Danish commercial samples from Kattegat 1st quarter 2001 allowed a comparison between proportions of spring-spawners in the landings from the two countries. A high degree of correspondence was found (no significant overall difference between Swedish and Danish proportions CHI-Square 8.44, df=4 p>0.05):

Proportion of spring-spawners in the Kattegat in the 1st quarter 2001

	1WR	2WR	3WR	4+WR	n
Swedish	2%	58%	100%	100%	403
Danish	6%	57%	67%	100%	164
n	282	257	23	5	567

This analysis shows a reasonable robustness towards the combined sources of bias from the different fisheries and the different laboratories working up samples.

3.3 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 Subdivisions 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 3.4.2).

Tables 3.3.1, 3.3.2 shows 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 Subdivisions 22 - 24 by fleets is shown in Table 3.3.9.

Based on the proportions of spring and autumn spawners (see Section 3.2.3) in the landings, number and mean weights by age and spawning stock are calculated. The total numbers and mean weight of North Sea autumn-spawners herring landed from Skagerrak and Kattegat by quarter and fleet is shown in Tables 3.3.3 and 3.3.4. The total numbers and mean weight of Baltic spring-spawning herring landed from Skagerrak and Kattegat by quarter and fleet is shown in Tables 3.3.5 and 3.3.6.

The total numbers and mean weight of North Sea autumn spawners by quarter and fleet landed from Division IIIa is shown in Table 3.3.7 and Baltic spring-spawning herring in Table 3.3.8.

The total catch in numbers of BSS in Division IIIa and the North Sea is shown in Tables 3.3.10 and 3.3.13 (see also Tables 2.2.1–2.2.5). The landings of spring-spawners taken in Division IIIa and the North Sea in 2001 were estimated to be about 48,000 tons (Table 3.3.14) compared to about 64,000 t in 2000 and 50,000 t in 1999. This decrease in landings was mainly due to a decrease in total landings in Skagerrak. Some of this decrease was compensated by an increase in landings in Subdivisions 22-24 of 8,000 tonnes. The landings of North Sea autumn spawners in Division IIIa amounted to 48,000 tonnes compared to 50,000 t in 2000 and 41,000 t in 1999 (Table 3.3.12). The total catch in number and mean weight-at-age of Baltic spring-spawners in the North Sea, Division IIIa and in Subdivisions 22–24 for 1991–2001 are given in Tables 3.3.13 and 3.3.14. Mean weights-at-age in 2001 were, in general, comparable to the mean weights in 2000 for the ages 2 to 8+, but variable for 0 and 1 ringers.

3.4 Quality of Catch Data and Biological Sampling Data

The sampling intensity of the landings in 2001 was acceptable and above the recommended level. Danish landings were sampled in the most important quarters for the Skagerrak, the Kattegat and for Subdivisions 22 and 24. In 2001 no sampling was carried out from the limited fishery in Subdivision 23 (800 t) except for one Swedish sample in the quarter 4.

Table 3.4.1 shows the number of fish aged by country, area, fishery and quarter. The total landings from Divisions IIIa, IIIb and IIIc were 152,500 t from which 220 samples were taken, 43,000 fish measured and 15,000 aged compared to 2000, where the landings were 162,000 t from which 255 samples were taken, 70,800 fish were measured and 15,100 fish were aged. Despite the high sampling level, the sampling coverage can still be improved.

Swedish landings from the human consumption and the small meshed fishery were sampled in most quarters from the Skagerrak and the Kattegat. As mentioned in Section 3.1.2 some of the Swedish landings taken in Skagerrak may have been misreported to the Baltic.

Sampling of the Danish landings for industrial purposes were at the same high level in 2001 as in the three previous years. The number of samples and number of fish investigated were considered to be adequate. Again in 2001 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 are 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.

The Norwegian landings from quarter 2 were sampled. However, there may be a misreporting of Norwegian landings listed as being taken in Skagerrak but possibly taken in adjacent areas in the North Sea. These landings are listed under Skagerrak.

As the herring market conditions were very good in 2001, discards of herring caught in Division IIIa, and Subdivisions 22-24 are regarded as being insignificant.

There is an unknown effect of variability in the stock composition in Division 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 meets the recommended level of one sample per 1000 t landed per quarter, there is an unequal coverage of some areas and times of the year.

3.5 Fishery-Independent Estimates

3.5.1 German bottom trawl surveys in Subdivisions 22 and 24

From 2001 onwards a new standardised bottom trawl was used within the frame of the ‘Baltic International Trawl Surveys’. This new bottom trawl is only catching herring to a low extent. In consequence no fishery-independent estimates based on German bottom trawl surveys will be available in the future.

Abundance indices for 0, 1, 2, and 3+ ringed herring obtained by bottom-trawl surveys carried out in November/ December of each year in Subdivisions 22 and 24 until 2000 are given in Tables 3.5.1 and 3.5.2.

Combined estimates for the total area are calculated by weighting each single survey estimate by the survey areas of each Subdivision. The resulting time index series is shown in Table 3.5.3.

Abundance indices for 1 to 8+ ringed herring from bottom-trawl surveys conducted each year in January/February in Subdivision 24 until 2000 are given in Table 3.5.4.

3.5.2 International Bottom Trawl Survey in Division IIIa

The IBTS in Division IIIa (the Skagerrak and the Kattegat) has been conducted annually in the 1^{st} quarter since 1977. From 1983 and onwards the survey was standardised with a standard bottom trawl and fishing and sampling protocols as recommended by the ICES International Young Herring Survey Working Group. The later established IBTS WG issues regularly updated manuals with instructions for standardised fishing and sampling practices (current version V, ICES 1996/H:1). The survey was intended for and is still used to obtain recruitment estimates for herring stocks in the Division IIIa (e.g. Section 2.3). In later years relative abundance was also calculated for older age groups, and from 1991 up to 1995 the survey was also performed during the 2nd and 3rd quarters. The 3rd quarter surveys were not carried out in 2000 but conducted in 2001. Around 45 hauls have been taken within each quarterly survey from 1991 to 2002.

The IBTS survey in Division IIIa was designed as a depth stratified survey. Herring abundance by winter rings 1 to 3 was calculated from fixed trawl stations that represented relative depth strata between 10 and 150 m depths. 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 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 was used. The new estimates for the relative abundance by age and the spring-spawning component by age are presented in Tables 3.5.5 and 3.5.6, respectively.

The survey estimates for spring-spawners showed a consistent pattern between quarters and between areas. As an illustration, the overall abundances were separated into spring and autumn spawners by the observed mean proportions by age, area and quarter over the years 1990 to 2002. The results indicate that the variability within year classes 1990 to 1999 are less in the 3rd quarter in the Kattegat than in the 1st quarter in the Skagerrak. The annual CV of the survey estimates are high (33% to 60%) but considerably lower than if estimated by applying depth stratification. The average instantaneous mortality of the year classes 1990 to 1996 (over 1 to 4 year) exceeds 1.0 in both areas but increases with years.

3.5.3 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 28 June to 11 July 2001 covered the area in the Skagerrak and the Kattegat. In principal the survey design were 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 2002/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 2000/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	10	36	69	85	92	100	100	100

Approximately 1155 nautical miles were surveyed and 33 trawl hauls were conducted.

The total stock size of Western Baltic spring-spawning herring in 2001 was estimated by combining the results from the Danish (Division IIIa) and Norwegian Acoustic Survey (Subareas IVa and IVb). The result is summarised in Table 3.5.7. The total stock estimate of 164,200 t is the lowest estimate in the time-series since 1989.

3.5.4 October acoustic survey in western Baltic and the southern part of Division IIIa (Kattegat)

A joint German-Danish acoustic survey was carried out with R/V “SOLEA” from 28 September to 15 October 2001 in the Western Baltic. This survey is traditionally coordinated by the International Acoustic Survey for Pelagic Fish Stocks in the Baltic Sea. It was planned to cover the whole of Subdivisions 21-24, however, permission to enter the Swedish 12-mile zone was not given despite early application. As a result Subdivision 23 and parts of Subdivisions 21 and 24 could not be surveyed. As in previous years, the survey was carried out during the night. Subdivision 23 was surveyed after the present German-Danish survey in November by Sweden with RV “ARGOS”.

A full survey report is given in the ‘Report of the Planning Group for Herring Surveys’ (ICES 2002/G:02).

The result for 2001, including the Swedish estimates for Subdivision 23, is presented in Table 3.5.8. In 2001 the total estimated stock size of herring in Subdivisions 22–24 was 347,000 t, which represents the third highest estimate in the time-series since 1990.

3.5.5 Larvae surveys

The German herring larvae monitoring started in 1977 and takes place every year from March/April to June in the main spawning grounds of the spring-spawning herring in the Western Baltic. These are the Greifswalder Bodden 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 (2001). The estimated numbers of larvae for the period 1977 to 2001 are summarised in Table 3.5.9. The last year's estimate is only about half of the whole time-series' average.

3.6 Recruitment Estimates

Indices of 0-ringer abundance were available from larval surveys during the spawning season on the main spawning area (Table 3.5.9). German Bottom Trawl Survey (GBTS) was not carried out in 2001 and Sweden RV Argos does not cover the area 22-24 (Table 3.5.3 and 3.5.4). Thus, indices of 0-ringer abundance for 2001 were available only from The acoustic survey (September/October) on the spring-spawning herring in Subdivisions 22-24. Log-transformed indices were compared by year class in Figure 3.6.1 The larval 0-ringer and GBTS-Q4 0-ringer indices for the year classes 1977 to 2000 show similar year-to-year variability (correlation $R^2 = 0.44$). For the year classes 1978 to 1999 the GBTS-Q4 0-ringer and the GBTS-Q1 1-ringer showed co-variation (correlation $R^2 = 0.34$), whereas the GBTS-Q3 0-ringer and the GBTS-Q4 1-ringer indices showed no significant co-variation. The indices illustrated in Figure 3.6.1 show the following general time trends: Poor recruitment of year classes 1980–82 was followed by an increase to a high level of recruitment for year classes 1983–88. From year class 1990 the recruitment declined until 1992 when recruitment was low. An increase in year classes 1993−1994 is indicated. The year class 1996 was below average, but the estimates for 1998 and 1999 are comparable to historical high levels of recruitment. The high larval indices of the 1998 and 1999 year classes were followed by high values of in the subsequent 0-ringer GBTS-Q4 and the 1-ringer GBTS-Q1 indices. The very consistent signal of historical high recruitment of the 1998 and 1999 year classes is further supported by 0-ringer and 1-ringer indices in the acoustic survey in Subdivisions 22–24 (Table 3.5.8). After the 1998-1999 year-class peak there is an indicated significant drop in recruitment of the 2000 year class. Both the larval index and the subsequent GBTS-Q4 and the acoustic survey in Subdivisions 22–24, 0-ringer indices are far below average. The 2001 indices showed that the 0-ringer index was slightly larger than 2000 year class but still far below average. The 1-ringer index was similar to the 2000 year class.

3.7 Data Exploration

3.7.1 Input data

Catch in numbers by age for spring-spawners in Division IVe, Division IIIa and Subdivisions 22-24 were available for 1991 to 2001 (Table 3.7.1). Mean weights-at-age in the landings for spring-spawning herring are found in Table 3.7.2. Mean weights-at-age in the catch in the 1st quarter were used as stock weights (Table 3.7.3).

The maturity ogive used and proportions of F and M before spawning was assumed constant between years. F-prop was set to be 0.1 and M-prop 0.25 for all age groups. The maturity ogive used was the same as that used at the HAWG in 2001:

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

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

3.7.4). 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 1989–2001, 0–8+ ringers
b) Hydroacoustic survey in Subdivisions 22, 23 and 24, Oct. 1989–2001, 0–8+ ringers
c) Larvae survey in Subdivision 24 (Greifswalder Bodden), March-June 1977-2001
d) German bottom trawl survey (GBTS) in Subdivision, Nov. 1979–00, 0–3+ ringers
e) German bottom trawl survey (GBTS) in Subdivision 24, Nov. 1978–00, 0–3+ ringers
f) German bottom trawl survey (GBTS) in Subdivision 24, Feb. 1979–00, 1–8+ ringers
g) IBTS in Div. IIIa, Quarter 1, 1991-2002, 1-5 ringers
h) IBTS in Div. IIIa, Quarter 3, 1991-2001, 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
Div. IIIa	Index g		Index a,h	
SDs 22-24	Index c,f			Index b,d,e

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

3.7.2 ICA settings

The following ICA settings were used:

- One separable period from 1997 to 2001 was selected (Assessment 2001: 1997 to 2000). The period represents a fishery with a different selectivity pattern than before the international regulation in 1996.
- 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.
- No shrinkage applied.

3.7.3 Exploration by individual survey indices

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 selected were taken with 1991 because of the catch date and the spawning type proportions had only been revised that far back.

- **FLT 9**: DK Hydroacoustic survey in Division IIIa, July 1991–2001, 0–8+ ringers
- **FLT 28**: DK Hydroacoustic survey in Division IIIa, July 1991–2001, 2–8+ ringers
- **FLT 29**: DK Hydroacoustic survey in Division IIIa, July 1991–2001, excl. 1991-1995 and 1999, 2–8+ ringers
- **FLT 33**: DK Hydroacoustic survey in Division IIIa, July 1991–2001, excl. 1999, 2–8+ ringers

FLT 9, 28, 29, and 33 are different subsets of the Danish hydroacoustic suvey in Division IIIa in July. In FLT 28 the 0 and 1-ringers were excluded since only a small fraction of the WBSS have migrated to the Division IIIa at these ages, FLT29 was a subset of FLT28 with only the part of the time-series where spring-spawners had been individually identified by otolith microstructure, and FLT33 was another subset of FLT28, 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 4**: GER Hydroacoustic survey in Subdivisions 22, 23 and 24, Oct. 1991–2001, 0–8+ ringers
- **FLT 27**: GER Hydroacoustic survey in Subdivisions 22, 23 and 24, Oct. 1991–2001, 0–5 ringers

FLT 4 contains all age-classes in the German hydroacoustic survey in the Western Baltic (Subdivisions 22-24) and is adjusted into FLT27 by excluding the oldest age classes.

- **FLT 3**: Larval survey in Subdivision 24 (Greifswalder Bodden), March-June 1991-2001

FLT3 is the German larval survey conducted in Subdivision 24 on intermediate to large larvae to give an estimate of the recruitment from the Rügen spawning grounds.

- **FLT 1**: German bottom trawl survey (GBTS) in Subdivision 24, Nov. 1991–2000, 0–3+ ringers

FLT1 is the Subdivision 24 part of the quarter 4 German Bottom trawl survey. The survey has stopped after 2000 but until then covered the Subdivision 24. In FLT1 old age-classes are combined into a 3+ WR group, assuming that older age groups are primarily migrating from Division IIIa for wintering in Subdivision 23.

- **FLT 23**: IBTS in Kattegat, Quarter 1, 1991-2002, 1-5 ringers

FLT23 is the Kattegat part of the 1st quarter Swedish IBTS survey missing data from 2001 due to lack of updated separation of stock components.

- **FLT 22**: IBTS in Kattegat, Quarter 3, 1991-2001, 1–5 ringers

FLT22 is the Kattegat part of the 3rd quarter Swedish IBTS survey missing data from 2000 due to lack of survey. Old age-classes are very poorly represented in these IBTS surveys and therefore excluded from the selected indices.

Individual exploratory runs of catch data with single combinations of each of these indices were performed using the general ICA-setting mentioned earlier (Section 3.7.2). A summary of the results from these runs are presented in Figure 3.7.1a.

The hydroacoustic survey indices in Division IIIa, (FLT9 and FLT28) and the IBTS in Kattegat Q3 (FLT22) indices suggest high Fs of between 0.6-0.8, while the larval (FLT3) and German trawl surveys in Subdivision 24 (FLT1) suggest considerably lower values (=< 0.2).

The hydroacoustic surveys 1991-2001 in Division IIIa showed high residuals for younger ages and outstanding high negative residuals for age 2+ in 1999. These high residuals coincide with the deviation from the standard survey procedure in that single year (the area was covered incompletely and by a different vessel). A change in this index leaving out 1999 (FLT33) or leaving out both 1999 and earlier surveys before 1996 (FLT29), gave similar results in both cases with a substantial reduction in residual trends and an overall reduction from 0.79 to about 0.24 in the unweighted variance.

The hydroacoustic survey in Subdivisions 22-24 showed large oscillating residuals for older ages (5 to 8+) in the time-series (FLT4) due to the poor coverage of the age-groups in the survey. This effect was removed in FLT27 by only including ages 0-5, resulting in a substantial reduction in unweighted variances. Both FLT4 and FLT27 indicated that the year-class strength for 2001 was larger than in 2000.

The IBTS 3rd quarter survey in the Kattegat showed varying fishing mortalities somewhat above 0.5 for the recent seven years and a SSB levelling out at about 120,000 t during the latest five years. Compared to other indices in the present assessment of the WBSS, residuals for FLT22 were relatively low and the unweighted variance was intermediate among the conducted index runs.

The German bottom trawl survey in the 4th quarter indicated recent declining fishing mortalities down to 0.2 and concurrent increases in SSB to a level of more than 350,000 tonnes in 2001. The survey time-series was stopped in 2000 due to a change in the survey design. It was felt that this index (FLT1) performed badly due to poor coverage of the stock.

The IBTS 1st quarter survey in the Kattegat gave very unstable residuals for most age-classes and especially for the 2WR, probably reflecting the intermittent occurrence of these groups during their migration through the area. Year class specific comparisons between this index (FLT23) and the German acoustic (FLT27) index showed none or negative correlations. The IBTS 1st quarter survey in the Kattegat was therefore left out from further exploratory combined survey indices.

The German larval survey in Subdivision 24 (FLT3) suggested a dramatic change in the recent fishery and in the stock reaching very low fishing mortalities (0.05) and a correspondingly very high SSB in 2001 (1,400,000 t). The inconsistencies both within and between this and other indices lead the group to decide to exclude this index (FLT3) from further exploratory combined indices.

3.7.4 Exploration by combined survey indices

A series of combined ICA runs based on the definitions of FLTs in Section 3.7.3:

- **Run 6**: FLT4, FLT9 and FLT22
- **Run 10**: FLT 1, FLT22, FLT27 and FLT28
- **Run 11**: FLT1, FLT22, FLT27 and FLT28 as Run 10, but with 0-WR in the catches down-weighted to 0.1
- **Run 13**: FLT22, FLT27 and FLT28
- **Run 18**: FLT22, FLT27 and FLT29
- **Run 21**: FLT22, FLT27 and FLT29 as Run 18, but with new maturity ogives for 1996-2001
- **Run 22**: FLT22, FLT27 and FLT33 with 0-WR in the catches down-weighted to 0.1

Run 6 was based on the entire age range of the two time-series of the 4th quarter German Hydroacoustic survey in Subdivisions 22, 23 and 24, and the 3rd quarter Danish Hydroacoustic survey in Division IIIa, plus the 0-5 WR in the 3rd quarter Swedish IBTS in the Kattegat. The run showed the same type of deficiencies as the runs with the same individual indices.

Run 10 included four indices: the 4th quarter German Bottom Trawl Survey, the 0-5 WR in the 3rd quarter Swedish IBTS in the Kattegat, the 0-5 WR in the 4th quarter German Hydroacoustic survey in Subdivisions 22, 23 and 24, and the 2-8+ WR in the 3rd quarter Danish Hydroacoustic survey in Division IIIa.

Run 11 repeated the set-up from run 10 with a down-weighting of the 0-WR in the catches with 0.1. The down-weighing had little effect except on the last year's recruitment index, which for 2001 was reduced to about 60% of the one from Run 10.

Run 13 is similar to Run 10 but with FLT1 taken out, after the initial combined runs had shown persistent problems with large residual patterns in this index. The same large negative residual pattern for year 1999 was found in individual runs with FLT28.

Run 18 was performed as Run 13 but with FLT29 instead of FLT28 (with years 1991-1995 and 1999 excluded). The exercise resulted in stabilising the residual pattern in the Division IIIa acoustic survey, although it was felt that the whole time-series without 1999 would be more informative.

Run 21 was an exploratory run with the new maturity ogive from the German investigations applied (Gröhsler and Müller, WD 6) but otherwise the same as Run 18. The only change in the output was a change to a 20 thousand tons lower level of SSB in the last five years, but since the revision of the maturity ogive will be continued this combination was not pursued further.

Run 22 was similar to Run 18 but with FLT33 instead of FLT29 bringing back the early years but still excluding 1999. One further change was a down-weighting of the 0-WR in the catches due to their large between-year variation.

3.7.5 The final run

Run 22 was chosen as the final run.

The ICA input data (years 1991-2001, Ages 0-8+ ringers) are given in Tables 3.7.1-3.7.4:

- Catch in number (Tble 3.7.1):
- Weight in catch (Table 3.7.2)
- Weight in stock (Table 3.7.3)
- Natural mortality (Table 3.7.4)
- Maturity (see text table in section 3.7.1)

The following surveys were included (Tables 3.7.5a-c):

- FLT 22: IBTS in Kattegat, Quarter 3, 1991-2001, 1–5 ringers
- FLT 27: GER Hydroacoustic survey in Subdivisions 22, 23 and 24, Oct 1991–2001, 0–5 ringers
- FLT 33: DK Hydroacoustic survey in Division IIIa, July 1991–2001, excl. 1999, 2–8+ ringers

The final model settings were (Table 3.7.6):

- The period for the separable constraint: 5 years (1997-2001).
- The weighting 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.
- No shrinkage applied.
- The catch data were down-weighted to 0.1 for 0-ringer herring.

The output data are given in Tables 3.7.7-3.7.16. The assessment results in an SSB for 2001 of 138,000 tonnes and a mean fishing mortality (ages 3-6) of 0.535 (Table 3.7.9).

The model diagnostics (Tables 3.7.10 to 3.7.16 and Figures 3.7.2 to 3.7.7g) show a somewhat flat SSQ response-curve, however, all three indices are pointing in the same direction. The F (3-6) values in the recent 5 years are at a flat level varying between 0.42 and 0.54. The SSB shows a stable levelling out over the recent years after a marked decline in the early 1990s.

The marginal totals of residuals between the catch and the separable model by age are relatively small except for age 4 and reasonably trend-free for the separable period (1997-2001). The catch-at-age variance component is between twenty and thirty 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 sixty percent of the trawl survey.

The fit of the surveys to the population number is relatively similar between the Division IIIa and Subdivisions 22-24 acoustic surveys (FLT27 and FLT33), whereas the Kattegat Q3 IBTS-index (FLT22) does not show such a clear picture. Age-specific catchabilities and their residuals showed the best performance for older age-groups in the IBTS.

The reason for the poorer performance of the 3rd quarter Kattegat IBTS survey may be the migration pattern of mature age-classes quickly passing through the area on their way to the wintering area of Subdivision 23.

3.8 Stock and Catch Projection

Short-term predictions were carried out using MFDP v1a software. ICA estimates of population numbers and fishing mortalities were used except for the numbers of 0-ringers in 2001–2003, where a geometric mean of the recruitment over the period 1991−1999 was taken, and for the numbers of 1-ringers in 2002, where the geometric mean over the period 1991-2000 was used. Mean weights-at-age in the catch and in the stock were taken as a mean for the years 1999−2001. The relevant ICA estimates of F (0.498) at age were taken as the mean of 1999–2001 and this was assumed to be the status quo fishing mortality. Input data for catch predictions are presented in Table 3.8.1.

The management option table is given in Table 3.8.2. The F *status quo* catches for 2002 and 2003 were predicted to be 107,000 t, which is close to the current catch level of 110,000 t. The SSB in 2004 is predicted to be at a level of 136,000 t.

It was discussed whether a prediction for 2003 with a catch constraint for 2002 should be explored or not. The WG did not consider this useful as the catches in Subdivisions 22-24 are managed jointly with the catches in Subdivisions 25-32 (only one TAC is set for the whole area). The TAC set for Subdivisions 22-32 for 2001 was 300,000 t and for 2002 reduced to 200,000 t.

Yield per recruit

The assessment was used to provide a yield per recruit plot for herring in Division IIIa and Subdivisions 22-24 (Figure 3.8.1). The values for $\mathbf{F}_{0.1}$ and $\mathbf{F}_{max}$ are 0.20 and 0.37 respectively.

3.9 Quality of Assessment

There have been no further revisions of the catch-at-age data since last year and the assessment model seems to perform generally well under the five-years-separable assumption. However, the 0-ringers are not well represented in the catches and down-weighting of this group resulted in an improved fit of the separable model. Further revision of the maturity at age data may result in a different perception of SSB in the future, once new estimates replace the current mean values.

Sensitivity to noisy years in the surveys was explored, and it was found that excluding 1999 from the Danish acoustic series, which had different coverage, vessel used and splitting method applied from the rest, resulted in considerable reduction of the variance associated with this survey. Examination of the age-structured indices residuals suggest that lack of consistency in the methodology applied to splitting autumn and spring-spawners result in noisy survey years, i.e. 2001 IBTS.

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 of the order of 12-15%, and reinforce the perception of high fishing pressure on this stock, which was suggested by previous year's analyses.

Only three years retrospective patterns were investigated as the separable period cannot be extended beyond 1997 because a change of management system took place that year. No patterns in F or SSB were observed (Figure 3.9.2). Despite there being no robust recruitment index (see Figure 3.6.1) no retrospective pattern in the estimated 0- ringers recruitment was apparent.

3.10 Status of the Stock

For the first time the HAWG in the 2002 agreed an analytical assessment for the Western Baltic Spring-spawning herring stock. Based on outputs from the ICA model runs and general observations on catch and biological samples the stock size did not decrease since 1996.

During the 1990s the total landings have decreased except for a small increase in 2000. The estimated recruitment shows a peak in 1999 and suggests an average year class in 2001. The combined index runs indicate that the SSB and mean F of the Western Baltic stock has stabilised. However, the flat SSQ-curve of the total model makes a precise estimate of F and SSB from this year's assessment difficult.

The assessment results however, give reason for concern. Fishing mortalities in the Western Baltic appear to be stable at a higher level (0.42 –0.54) than in the North Sea during the last 5 years, while catches have declined over the same period. A temporary improvement is expected, however, when the large 1999 year class enters the human consumption fishery in the coming years.

The short-term predictions with *status quo* F indicate a stable SSB although the Working Group stresses that the present level of fishing mortality may not be sustainable in the long term.

The Working Group also underlines that, if fishing mortality for North Sea autumn spawners is allowed to increase due to the predicted increase in SSB of the North Sea autumn spawners, fishing mortalities on spring-spawners in Division IIIa may also increase. This is an additional cause for concern.

3.11 Management Considerations

For the first time the HAWG has carried out a successful analytical assessment for the Western Baltic Spring-spawning herring. This assessment shows that the Baltic Spring-spawning herring biomass in 2001 was 138,000 t, which is in line with the SSB estimates for the previous 5 years (2002 assessment). Mean F for the adult part of the population (3-6 ringers) is estimated to vary between 0.42 and 0.54. The total landings for the same period are also stable at a level of 115,000 t.

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.

As described in Section 3.3 and Table 3.3.9 most of the juvenile herring is caught in Subdivisions 22-24 by the human consumption fishery. The estimated F's for the juveniles (0-1 ringers) have varied between 0.19 and 0.25 for the period 1996-2000. F for the juveniles in 2001 is estimated at 0.24.

A short-term prediction has been carried out (see section 3.8) and with a *status quo* F equals 0.498 (mean of 1999-2001) in 2002 and 2003. Total landing in 2002 and 2003 will be 107,000 t with an estimated SSB of 136,000 t in 2004.

There is misreporting of catches from the North Sea to Skagerrak and from Skagerrak to the Baltic (Subdivisions 25-28). The HAWG has estimated the amounts of this misreporting and has taken these catches into account for the last 8-10 years.

If discarding and slippage occur it will probably only be in the Skagerrak and the consequences for the Baltic Spring-spawning herring are expected to be minor.

Table 3.1.1 **HERRING in Division IIIa and Subdivisions 22-24. 1985 - 2001**
Landings in thousands of tonnes.
(Data provided by Working Group members 2001).

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	1999	2000	2001 [1]
Skagerrak							
Denmark	43.7	28.7	14.3	10.3	10.1	16.0	16.2
Faroe Islands							
Norway	16.7	9.4	8.8	8.0	7.4	9.7	8.3
Sweden	48.5	32.7	32.9	46.9	36.4	45.8	30.8
Total	108.9	70.8	56.0	65.2	53.9	71.5	55.3
Kattegat							
Denmark	16.9	17.2	8.8	23.7	17.9	18.9	18.8
Sweden	30.8	27.0	18.0	29.9	14.6	17.3	16.2
Total	47.7	44.2	26.8	53.6	32.5	36.2	35.0
Sub. Div. 22+24							
Denmark	36.8	34.4	30.5	30.1	32.5	32.6	28.3
Germany	13.4	7.3	12.8	9.0	9.8	9.3	9.9
Poland	7.3	6.0	6.9	6.5	5.3	6.6	9.3
Sweden	15.8	9.0	14.5	4.3	2.6	4.8	13.9
Total	73.3	56.7	64.7	49.9	50.2	53.3	61.4
Sub. Div. 23							
Denmark	0.9	0.7	2.2	0.4	0.5	0.9	0.6
Sweden	0.2	0.3	0.1	0.3	0.1	0.1	0.2
Total	1.1	1.0	2.3	0.7	0.6	1.0	0.8
Grand Total	231.0	172.7	149.8	169.4	137.2	162.0	152.5

[1] Preliminary data.

Table 3.2.1 Proportion of North Sea autumn spawners and Baltic spring-spawners given in % in Skagerrak and Kattegat by age and quarter.

Year: 2001

Quarter	**W-rings**	**Skagerrak** North Sea autumn SP	**Skagerrak** Baltic Spring SP	**n**	**source**	**Kattegat** North Sea autumn SP	**Kattegat** Baltic Spring SP	**n**	**source**
1	1	80.0%	20.0%	85		96.1%	3.9%	282	
	2	61.1%	38.9%	18		41.6%	58.4%	257	
	3	15.0%	85.0%	20		8.7%	91.3%	23	
	4	1.1%	98.9%	90		0.0%	100.0%	5	
	5	**1.1%**	**98.9%**	0		**0.0%**	**100.0%**	0	
	6	**1.1%**	**98.9%**	0		**0.0%**	**100.0%**	0	
	7	**1.1%**	**98.9%**	0		**0.0%**	**100.0%**	0	
	8	**1.1%**	**98.9%**	0		**0.0%**	**100.0%**	0	
2	1	92.3%	7.7%	52		95.0%	5.0%	20	
	2	**55.9%**	**44.1%**	0	1	**22.7%**	**77.3%**	20	2
	3	**12.3%**	**87.7%**	0	1	**30.0%**	**70.0%**	14	2
	4	**1.1%**	**98.9%**	0	3	**0.0%**	**100.0%**	0	
	5	**1.1%**	**98.9%**	0		**0.0%**	**100.0%**	0	
	6	**1.1%**	**98.9%**	0		**0.0%**	**100.0%**	0	
	7	**1.1%**	**98.9%**	0		**0.0%**	**100.0%**	0	
	8	**1.1%**	**98.9%**	0		**0.0%**	**100.0%**	0	
3	0	90.3%	9.7%	93		83.4%	16.6%	380	
	1	98.2%	1.8%	220		80.1%	19.9%	196	
	2	50.7%	49.3%	201		18.0%	82.0%	128	
	3	9.6%	90.4%	166		16.7%	83.3%	60	
	4	18.7%	81.3%	166		11.4%	88.6%	35	
	5	**18.7%**	**81.3%**	0		**11.4%**	**88.6%**	0	
	6	**18.7%**	**81.3%**	0		**11.4%**	**88.6%**	0	
	7	**18.7%**	**81.3%**	0		**11.4%**	**88.6%**	0	
	8	**18.7%**	**81.3%**	0		**11.4%**	**88.6%**	0	
4	0	**90.3%**	**9.7%**	0	5	**83.4%**	**16.6%**	0	6
	1	90.0%	10.0%	20		88.9%	11.1%	18	
	2	33.3%	66.7%	12		22.2%	77.8%	18	
	3	25.0%	75.0%	4		**16.7%**	**83.3%**	1	7
	4	**18.7%**	**81.3%**	0	8	**11.4%**	**88.6%**	0	
	5	**18.7%**	**81.3%**	0		**11.4%**	**88.6%**	0	
	6	**18.7%**	**81.3%**	0		**11.4%**	**88.6%**	0	
	7	**18.7%**	**81.3%**	0		**11.4%**	**88.6%**	0	
	8	**18.7%**	**81.3%**	0		**11.4%**	**88.6%**	0	

1 Average between Q1 and Q3, Age=2 sd=20
2 Estimated from split of length distribution based on subsample of OM identified NSAS and WBSS
3 Taken from the OM Age=4 Q=1 sd=20
4 Taken from the OM Age=4 Q=1 sd=21
5 Taken from the OM Age=0 Q=3 sd=20
6 Taken from the OM Age=0 Q=3 sd=21
7 Taken from the OM Age=3 Q=3 sd=21
8 Taken from the OM Age=4 Q=3 sd=20
9 Taken from the OM Age=4 Q=3 sd=21

Table 3.2.2 Proportion of Baltic spring-spawning herring in the Skagerrak and the Kattegat by year, age and quarter for the years 1991-2001. These proportions were applied to revise the split of commercial landings.

		Average of WBSS-Split																	
		Skagerrak									Kattegat								
		Winter-rings																	
Year	**Quarter**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**
1991	**1**	0.00	0.08	0.37	0.41	0.50	0.50	0.50	0.50	0.50	0.00	0.28	0.67	0.97	0.95	0.95	0.95	0.95	0.95
	2	0.00	0.00	0.13	0.68	0.98	0.98	0.98	0.98	0.98	0.00	0.12	0.63	1.00	1.00	1.00	1.00	1.00	1.00
	3	0.00	0.10	0.78	0.96	0.95	0.95	0.95	0.95	0.95	0.00	0.55	0.96	0.98	0.99	0.99	0.99	0.99	0.99
	4	0.00	0.00	0.49	0.94	0.99	0.99	0.99	0.99	0.99	0.52	0.56	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1992	**1**	0.00	0.08	0.37	0.41	0.50	0.50	0.50	0.50	0.50	0.00	0.28	0.67	0.97	0.95	0.95	0.95	0.95	0.95
	2	0.00	0.00	0.13	0.68	0.98	0.98	0.98	0.98	0.98	0.00	0.12	0.63	1.00	1.00	1.00	1.00	1.00	1.00
	3	0.00	0.10	0.78	0.96	0.95	0.95	0.95	0.95	0.95	0.00	0.55	0.96	0.98	0.99	0.99	0.99	0.99	0.99
	4	0.00	0.00	0.49	0.94	0.99	0.99	0.99	0.99	0.99	0.52	0.56	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1993	**1**	0.00	0.08	0.37	0.41	0.50	0.50	0.50	0.50	0.50	0.00	0.28	0.67	0.97	0.95	0.95	0.95	0.95	0.95
	2	0.00	0.00	0.13	0.68	0.98	0.98	0.98	0.98	0.98	0.00	0.12	0.63	1.00	1.00	1.00	1.00	1.00	1.00
	3	0.00	0.10	0.78	0.96	0.95	0.95	0.95	0.95	0.95	0.00	0.55	0.96	0.98	0.99	0.99	0.99	0.99	0.99
	4	0.00	0.00	0.49	0.94	0.99	0.99	0.99	0.99	0.99	0.52	0.56	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1994	**1**	0.00	0.08	0.37	0.41	0.50	0.50	0.50	0.50	0.50	0.00	0.28	0.67	0.97	0.95	0.95	0.95	0.95	0.95
	2	0.00	0.00	0.13	0.68	0.98	0.98	0.98	0.98	0.98	0.00	0.12	0.63	1.00	1.00	1.00	1.00	1.00	1.00
	3	0.00	0.10	0.78	0.96	0.95	0.95	0.95	0.95	0.95	0.00	0.55	0.96	0.98	0.99	0.99	0.99	0.99	0.99
	4	0.00	0.00	0.49	0.94	0.99	0.99	0.99	0.99	0.99	0.52	0.56	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1995	**1**	0.00	0.08	0.37	0.41	0.50	0.50	0.50	0.50	0.50	0.00	0.28	0.67	0.97	0.95	0.95	0.95	0.95	0.95
	2	0.00	0.00	0.13	0.68	0.98	0.98	0.98	0.98	0.98	0.00	0.12	0.63	1.00	1.00	1.00	1.00	1.00	1.00
	3	0.00	0.10	0.78	0.96	0.95	0.95	0.95	0.95	0.95	0.00	0.55	0.96	0.98	0.99	0.99	0.99	0.99	0.99
	4	0.00	0.00	0.49	0.94	0.99	0.99	0.99	0.99	0.99	0.52	0.56	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1996	**1**	0.00	0.08	0.37	0.41	0.50	0.50	0.50	0.50	0.50	0.00	0.28	0.67	0.97	0.95	0.95	0.95	0.95	0.95
	2	0.00	0.00	0.13	0.68	0.98	0.98	0.98	0.98	0.98	0.00	0.12	0.63	1.00	1.00	1.00	1.00	1.00	1.00
	3	0.00	0.10	0.78	0.96	0.95	0.95	0.95	0.95	0.95	0.00	0.55	0.96	0.98	0.99	0.99	0.99	0.99	0.99
	4	0.00	0.00	0.49	0.94	0.99	0.99	0.99	0.99	0.99	0.52	0.56	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1997	**1**	0.00	0.13	0.13	0.75	1.00	1.00	1.00	1.00	1.00	0.00	0.46	0.45	0.89	1.00	1.00	1.00	1.00	1.00
	2	0.00	0.12	0.61	0.97	0.97	0.97	0.97	0.97	0.97	0.00	0.12	0.63	1.00	1.00	1.00	1.00	1.00	1.00
	3	0.00	0.07	0.55	0.81	0.94	0.94	0.94	0.94	0.94	0.00	0.07	0.76	0.89	0.97	0.97	0.97	0.97	0.97
	4	0.07	0.17	0.67	1.00	0.94	0.94	0.94	0.94	0.94	0.52	0.56	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1998	**1**	0.00	0.00	0.23	0.07	0.07	0.07	0.07	0.07	0.07	0.00	0.29	0.83	0.98	1.00	1.00	1.00	1.00	1.00
	2	0.00	0.41	0.56	0.71	0.95	0.95	0.95	0.95	0.95	0.00	0.76	0.57	0.90	0.99	0.99	0.99	0.99	0.99
	3	0.00	0.05	0.73	0.92	0.97	0.97	0.97	0.97	0.97	0.61	0.43	0.92	0.99	0.92	0.92	0.92	0.92	0.92
	4	0.25	0.13	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.32	0.86	0.95	0.95	0.95	0.95	0.95	0.95
1999	**1**	0.00	0.00	0.23	0.57	0.64	0.64	0.64	0.64	0.64	0.00	0.43	0.60	0.84	0.96	0.96	0.96	0.96	0.96
	2	0.00	0.36	0.71	0.53	0.82	0.82	0.82	0.82	0.82	0.00	0.62	0.57	0.90	0.99	0.99	0.99	0.99	0.99
	3	0.00	0.05	0.22	0.62	0.61	0.61	0.61	0.61	0.61	0.11	0.74	0.88	0.94	1.00	1.00	1.00	1.00	1.00
	4	0.00	0.04	0.82	0.92	0.00	0.00	0.00	0.00	0.00	0.10	0.60	0.56	0.77	0.91	0.91	0.91	0.91	0.91
2000	**1**	0.00	0.00	0.33	0.57	0.57	0.57	0.57	0.57	0.57	0.00	0.27	0.83	0.85	1.00	1.00	1.00	1.00	1.00
	2	0.00	0.10	1.00	0.92	1.00	1.00	1.00	1.00	1.00	0.00	0.20	0.92	0.82	1.00	1.00	1.00	1.00	1.00
	3	0.01	0.09	0.25	0.76	0.71	0.71	0.71	0.71	0.71	0.08	0.71	0.93	0.88	1.00	1.00	1.00	1.00	1.00
	4	0.50	0.10	0.82	0.92	0.00	0.00	0.00	0.00	0.00	0.33	0.75	0.88	0.84	0.85	0.85	0.85	0.85	0.85
2001	**1**	0.00	0.20	0.39	0.85	0.99	0.99	0.99	0.99	0.99	0.00	0.04	0.58	0.91	1.00	1.00	1.00	1.00	1.00
	2	0.00	0.08	0.44	0.88	0.99	0.99	0.99	0.99	0.99	0.00	0.05	0.77	0.70	1.00	1.00	1.00	1.00	1.00
	3	0.10	0.02	0.49	0.90	0.81	0.81	0.81	0.81	0.81	0.17	0.20	0.82	0.83	0.89	0.89	0.89	0.89	0.89
	4	0.10	0.10	0.67	0.75	0.81	0.81	0.81	0.81	0.81	0.17	0.11	0.78	0.83	0.89	0.89	0.89	0.89	0.89

Table 3.3.1 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet.

Division: **Skagerrak** **Year:** **2001** **Country:** **All**

		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	14.98	42	13.31	17	28.29	30
	2	26.33	72	0.47	56	26.80	72
	3	8.04	126	2.25	117	10.28	124
	4	4.57	183	0.59	133	5.16	177
	5	3.67	198	0.38	149	4.04	194
	6	1.47	207	1.17	155	2.64	184
	7	0.40	198	0.94	166	1.34	175
	8+	0.26	236	1.14	184	1.40	194
	Total	59.72		20.24		79.96	
	SOP		5,549		1,200		6,749
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	18.95	64	41.58	22	60.53	35
	2	62.99	83	4.60	70	67.59	82
	3	37.55	114	0.28	55	37.83	113
	4	18.14	147			18.14	147
	5	12.83	169			12.83	169
	6	5.44	169			5.44	169
	7	2.53	177			2.53	177
	8+	0.99	204			0.99	204
	Total	159.41		46.46		205.87	
	SOP		17,130		1,246		18,375
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0	2.53	30	466.28	8	468.81	8
	1	107.43	98	43.32	5	150.75	71
	2	40.21	108			40.21	108
	3	27.95	119			27.95	119
	4	3.41	129			3.41	129
	5	0.11	177			0.11	177
	6	1.70	228			1.70	228
	7	0.01	160			0.01	160
	8+						
	Total	183.35		509.60		692.95	
	SOP		19,167		3,744		22,911
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	0.76	30			0.76	30
	1	31.98	98	22.25	72	54.23	87
	2	11.74	108			11.74	108
	3	8.17	119			8.17	119
	4	0.97	128			0.97	128
	5						
	6	0.49	231			0.49	231
	7						
	8+						
	Total	54.12		22.25		76.37	
	SOP		5,649		1,595		7,244
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	3.29	30	466.28	8	469.57	8
	1	173.34	90	120.46	24	293.80	63
	2	141.27	90	5.07	69	146.34	90
	3	81.71	117	2.52	110	84.24	117
	4	27.09	150	0.59	133	27.68	150
	5	16.61	176	0.38	149	16.99	175
	6	9.10	190	1.17	155	10.27	186
	7	2.94	180	0.94	166	3.88	176
	8+	1.24	211	1.14	184	2.38	198
	Total	456.59		598.54		1,055.14	
	SOP		47,495		7,784		55,279

Table	**3.3.2**	Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet.

Division: Kattegat **Year:** **2001** **Country:** **ALL**

Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet D** Numbers	Mean W.	**Total** Numbers	Mean W.
1	1	125.81	33	92.89	20	218.70	28
	2	123.62	57	13.90	53	137.52	57
	3	29.68	87	1.08	61	30.75	86
	4	5.41	121	0.02	69	5.44	121
	5	0.17	97			0.17	97
	6						
	7						
	8+						
	Total	284.69		107.89		392.58	
	SOP		14,515		2,648		17,163
Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet E** Numbers	Mean W.	**Total** Numbers	Mean W.
2	1	14.68	36	18.04	31	32.72	33
	2	11.01	53	1.35	51	12.36	53
	3	2.93	75	0.13	83	3.06	76
	4	1.17	98	0.11	109	1.28	99
	5	0.74	117	0.09	123	0.83	118
	6	0.32	125	0.04	126	0.36	125
	7	0.08	103	0.01	108	0.09	103
	8+	0.06	147	0.00	169	0.06	148
	Total	30.99		19.76		50.75	
	SOP		1,597		666		2,264
Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet E** Numbers	Mean W.	**Total** Numbers	Mean W.
3	0			441.53	9	441.53	9
	1	21.15	70	0.89	37	22.03	69
	2	35.53	82	0.44	56	35.98	81
	3	11.46	98			11.46	98
	4	2.35	115			2.35	115
	5	0.71	75			0.71	75
	6						
	7						
	8+						
	Total	71.21		442.85		514.06	
	SOP		5,833		4,142		9,974
Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet E** Numbers	Mean W.	**Total** Numbers	Mean W.
4	0	15.72	24	2.62	10	18.34	22
	1	32.02	79	1.09	63	33.10	78
	2	22.31	93	0.25	80	22.56	92
	3	4.25	120	0.04	101	4.29	119
	4	0.16	95			0.16	95
	5						
	6						
	7						
	8+						
	Total	74.45		4.00		78.45	
	SOP		5,488		119		5,607
Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet E** Numbers	Mean W.	**Total** Numbers	Mean W.
Total	0	15.72	24	444.15	9	459.87	10
	1	193.65	45	112.90	22	306.55	37
	2	192.47	65	15.95	53	208.42	65
	3	48.32	92	1.24	64	49.56	91
	4	9.10	116	0.13	102	9.23	116
	5	1.63	97	0.09	123	1.72	98
	6	0.32	125	0.04	126	0.36	125
	7	0.08	103	0.01	108	0.09	103
	8+	0.06	147	0.00	169	0.06	148
	Total	461.35		574.50		1,035.85	
	SOP		27,433		7,575		35,008

Table 3.3.3 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***North Sea Autumn spawners***

Division: **Skagerrak** **Year:** **2001** **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	11.98	42	10.65	17	22.63	30
	2	16.09	72	0.29	56	16.38	72
	3	1.21	126	0.34	117	1.54	124
	4	0.05	183	0.01	133	0.06	177
	5	0.04	198	0.00	149	0.04	194
	6	0.02	207	0.01	155	0.03	184
	7	0.00	198	0.01	166	0.01	175
	8+	0.00	236	0.01	184	0.02	194
	Total	29.40		11.32		40.71	
	SOP		1,839		247		2,086

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
2	1	17.49	64	38.38	22	55.87	35
	2	35.23	83	2.57	70	37.80	82
	3	4.63	114	0.03	55	4.66	113
	4	0.20	147			0.20	147
	5	0.14	169			0.14	169
	6	0.06	169			0.06	169
	7	0.03	177			0.03	177
	8+	0.01	204			0.01	204
	Total	57.79		40.99		98.78	
	SOP		4,649		1,020		5,669

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
3	0	2.29	30	421.16	8	423.44	8
	1	105.48	98	42.53	5	148.00	71
	2	20.41	108			20.41	108
	3	2.69	119			2.69	119
	4	0.64	129			0.64	129
	5	0.02	177			0.02	177
	6	0.32	228			0.32	228
	7	0.00	160			0.00	160
	8+						
	Total	131.84		463.68		595.52	
	SOP		13,126		3,397		16,523

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
4	0	0.68	30			0.68	30
	1	28.79	98	20.03	72	48.81	87
	2	3.91	108			3.91	108
	3	2.04	119			2.04	119
	4	0.18	128			0.18	128
	5						
	6	0.09	231			0.09	231
	7						
	8+						
	Total	35.70		20.03		55.73	
	SOP		3,563		1,435		4,999

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
Total	0	2.97	30	421.16	8	424.13	8
	1	163.73	91	111.58	24	275.32	63
	2	75.64	89	2.86	69	78.50	88
	3	10.57	118	0.37	111	10.94	117
	4	1.07	134	0.01	133	1.08	134
	5	0.20	176	0.00	149	0.21	175
	6	0.48	221	0.01	155	0.50	219
	7	0.03	179	0.01	166	0.04	176
	8+	0.01	211	0.01	184	0.03	198
	Total	254.72		536.02		790.74	
	SOP		23,178		6,099		29,277

Table **3.3.4** Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***North Sea Autumn spawners***

Division: **Kattegat** **Year:** **2001** **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	120.90	33	89.27	20	210.17	28
	2	51.47	57	5.79	53	57.26	57
	3	2.58	87	0.09	61	2.67	86
	4						
	5						
	6						
	7						
	8+						
	Total	174.95		95.15		270.10	
	SOP		7,201		2,085		9,286
Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet D+E** Numbers	Mean W.	**Total** Numbers	Mean W.
2	1	13.94	36	17.14	31	31.08	33
	2	2.50	53	0.31	51	2.80	53
	3	0.88	75	0.04	83	0.92	76
	4						
	5						
	6						
	7						
	8+						
	Total	17.32		17.48		34.80	
	SOP		702		549		1,251
Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet D+E** Numbers	Mean W.	**Total** Numbers	Mean W.
3	0			368.33	9	368.33	9
	1	16.94	70	0.71	37	17.65	69
	2	6.38	82	0.08	56	6.46	81
	3	1.91	98			1.91	98
	4	0.27	115			0.27	115
	5	0.08	75			0.08	75
	6						
	7						
	8+						
	Total	25.59		369.11		394.70	
	SOP		1,935		3,438		5,373
Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet D+E** Numbers	Mean W.	**Total** Numbers	Mean W.
4	0	13.11	24	2.19	10	15.30	22
	1	28.46	79	0.97	63	29.42	78
	2	4.96	93	0.06	80	5.01	92
	3	0.71	120	0.01	101	0.71	119
	4	0.02	95			0.02	95
	5						
	6						
	7						
	8+						
	Total	47.25		3.22		50.47	
	SOP		3,102		88		3,190
Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet D+E** Numbers	Mean W.	**Total** Numbers	Mean W.
Total	0	13.11	24	370.51	9	383.63	10
	1	180.24	44	108.08	22	288.32	36
	2	65.31	62	6.23	53	71.54	61
	3	6.08	93	0.14	68	6.22	92
	4	0.29	114			0.29	114
	5	0.08	75			0.08	75
	6						
	7						
	8+						
	Total	265.11		484.96		750.07	
	SOP		12,940		6,159		19,100

Table 3.3.5 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***Baltic Spring-spawners***

Division: **Skagerrak** **Year:** **2001** **Country:** **All**

		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	3.00	42	2.66	17	5.66	30
	2	10.24	72	0.18	56	10.42	72
	3	6.83	126	1.91	117	8.74	124
	4	4.52	183	0.58	133	5.10	177
	5	3.62	198	0.37	149	4.00	194
	6	1.46	207	1.16	155	2.61	184
	7	0.40	198	0.93	166	1.33	175
	8+	0.25	236	1.13	184	1.38	194
	Total	30.32		8.92		39.24	
	SOP		3,710		953		4,663
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	1.46	64	3.20	22	4.66	35
	2	27.76	83	2.03	70	29.79	82
	3	32.93	114	0.24	55	33.17	113
	4	17.94	147			17.94	147
	5	12.69	169			12.69	169
	6	5.38	169			5.38	169
	7	2.50	177			2.50	177
	8+	0.98	204			0.98	204
	Total	101.62		5.47		107.09	
	SOP		12,480		226		12,706
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0	0.25	30	45.12	8	45.37	8
	1	1.95	98	0.79	5	2.74	71
	2	19.81	108			19.81	108
	3	25.26	119			25.26	119
	4	2.77	129			2.77	129
	5	0.09	177			0.09	177
	6	1.38	228			1.38	228
	7	0.01	160			0.01	160
	8+						
	Total	51.51		45.91		97.42	
	SOP		6,041		347		6,388
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	0.07	30			0.07	30
	1	3.20	98	2.23	72	5.42	87
	2	7.83	108			7.83	108
	3	6.13	119			6.13	119
	4	0.79	128			0.79	128
	5						
	6	0.40	231			0.40	231
	7						
	8+						
	Total	18.42		2.23		20.64	
	SOP		2,086		159		2,245
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	0.32	30	45.12	8	45.44	8
	1	9.60	76	8.87	31	18.48	54
	2	65.63	92	2.21	69	67.84	91
	3	71.15	117	2.15	110	73.30	117
	4	26.02	151	0.58	133	26.60	150
	5	16.40	176	0.37	149	16.78	175
	6	8.61	188	1.16	155	9.77	184
	7	2.90	180	0.93	166	3.84	176
	8+	1.23	211	1.13	184	2.36	198
	Total	201.87		62.53		264.40	
	SOP		24,317		1,685		26,002

Table 3.3.6 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***Baltic Spring-spawners***

Division: **Kattegat** **Year:** **2001** **Country:** **All**

		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	4.91	33	3.62	20	8.53	28
	2	72.15	57	8.11	53	80.27	57
	3	27.10	87	0.98	61	28.08	86
	4	5.41	121	0.02	69	5.44	121
	5	0.17	97			0.17	97
	6						
	7						
	8+						
	Total	109.74		12.74		122.49	
	SOP		7,313		564		7,877

		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	0.73	36	0.90	31	1.64	33
	2	8.52	53	1.04	51	9.56	53
	3	2.05	75	0.09	83	2.14	76
	4	1.17	98	0.11	109	1.28	99
	5	0.74	117	0.09	123	0.83	118
	6	0.32	125	0.04	126	0.36	125
	7	0.08	103	0.01	108	0.09	103
	8+	0.06	147	0.00	169	0.06	148
	Total	13.68		2.28		15.95	
	SOP		895		117		1,013

		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0			73.20	9	73.20	9
	1	4.21	70	0.18	37	4.38	69
	2	29.15	82	0.36	56	29.51	81
	3	9.55	98			9.55	98
	4	2.08	115			2.08	115
	5	0.63	75			0.63	75
	6						
	7						
	8+						
	Total	45.62		73.74		119.36	
	SOP		3,897		704		4,601

		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	2.61	24	0.44	10	3.04	22
	1	3.56	79	0.12	63	3.68	78
	2	17.35	93	0.19	80	17.54	92
	3	3.54	120	0.03	101	3.57	119
	4	0.14	95			0.14	95
	5						
	6						
	7						
	8+						
	Total	27.20		0.78		27.98	
	SOP		2,387		31		2,417

		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	2.61	24	73.64	9	76.24	10
	1	13.41	57	4.82	24	18.23	48
	2	127.16	67	9.72	54	136.88	66
	3	42.24	92	1.10	63	43.35	91
	4	8.81	116	0.13	102	8.94	116
	5	1.55	98	0.09	123	1.63	99
	6	0.32	125	0.04	126	0.36	125
	7	0.08	103	0.01	108	0.09	103
	8+	0.06	147	0.00	169	0.06	148
	Total	196.24		89.54		285.78	
	SOP		14,492		1,416		15,908

Table 3.3.7 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***North Sea Autumn spawners***

Division: **IIIa** **Year:** **2001** **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	132.88	34.2	99.91	19.6	232.80	27.9
	2	67.56	60.6	6.07	53.2	73.63	60.0
	3	3.79	99.5	0.43	104.4	4.22	100.0
	4	0.05	182.6	0.01	133.4	0.06	177.0
	5	0.04	198.4	0.00	148.9	0.04	193.8
	6	0.02	207.1	0.01	155.0	0.03	184.1
	7	0.00	197.6	0.01	165.9	0.01	175.3
	8+	0.00	236.2	0.01	184.1	0.02	193.7
	Total	204.35		106.46		310.81	
	SOP		9,040		2,331		11,371

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
2	1	31.43	51.5	55.52	24.6	86.95	34.4
	2	37.72	81.4	2.88	68.2	40.60	80.4
	3	5.50	107.5	0.07	69.6	5.58	107.0
	4	0.20	146.9			0.20	146.9
	5	0.14	169.3			0.14	169.3
	6	0.06	169.3			0.06	169.3
	7	0.03	177.0			0.03	177.0
	8+	0.01	204.2			0.01	204.2
	Total	75.10		58.47		133.57	
	SOP		5,351		1,569		6,920

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
3	0	2.29	30.0	789.48	8.4	791.77	8.4
	1	122.42	94.5	43.24	5.2	165.66	71.2
	2	26.79	101.7	0.08	56.0	26.87	101.5
	3	4.61	110.6			4.61	110.6
	4	0.90	124.6			0.90	124.6
	5	0.10	95.4			0.10	95.4
	6	0.32	228.4			0.32	228.4
	7	0.00	160.0			0.00	160.0
	8+						
	Total	157.43		832.80		990.22	
	SOP		15,061		6,835		21,896

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
4	0	13.80	24.0	2.19	9.9	15.98	22.1
	1	57.24	88.7	20.99	71.3	78.24	84.0
	2	8.87	99.4	0.06	80.3	8.93	99.3
	3	2.75	119.3	0.01	101.0	2.76	119.3
	4	0.20	124.8			0.20	124.8
	5						
	6	0.09	231.0			0.09	231.0
	7						
	8+						
	Total	82.95		23.24		106.20	
	SOP		6,665		1,523		8,188

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
Total	0	16.08	24.8	791.67	8.4	807.75	8.7
	1	343.98	66.3	219.66	23.0	563.64	49.4
	2	140.95	76.4	9.09	58.1	150.03	75.3
	3	16.65	108.5	0.51	99.4	17.16	108.2
	4	1.36	130.1	0.01	133.4	1.36	130.1
	5	0.29	147.1	0.00	148.9	0.29	147.1
	6	0.48	220.8	0.01	155.0	0.50	219.1
	7	0.03	178.8	0.01	165.9	0.04	175.8
	8+	0.01	210.8	0.01	184.1	0.03	198.1
	Total	519.83		1,020.97		1,540.80	
	SOP		36,118		12,258		48,376

Table 3.3.8 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet. ***Baltic Spring-spawners***

Division: IIIa **Year: 2001** **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	7.90	37	6.29	19	14.19	29
	2	82.39	59	8.30	53	90.69	58
	3	33.93	95	2.89	98	36.82	95
	4	9.94	149	0.60	131	10.54	148
	5	3.80	194	0.37	149	4.17	190
	6	1.46	207	1.16	155	2.61	184
	7	0.40	198	0.93	166	1.33	175
	8+	0.25	236	1.13	184	1.38	194
	Total	140.07		21.66		161.73	
	SOP		11,024		1,517		12,540
Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
2	1	2.19	55	4.10	24	6.29	35
	2	36.27	76	3.07	64	39.35	75
	3	34.98	111	0.33	62	35.31	111
	4	19.10	144	0.11	109	19.21	144
	5	13.44	166	0.09	123	13.52	166
	6	5.70	167	0.04	126	5.74	166
	7	2.58	175	0.01	108	2.59	175
	8+	1.03	201	0.00	169	1.04	201
	Total	115.30		7.75		123.05	
	SOP		13,375		343		13,718
Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
3	0	0.25	30	118.32	9	118.57	9
	1	6.16	79	0.96	11	7.13	70
	2	48.95	92	0.36	56	49.32	92
	3	34.81	114			34.81	114
	4	4.85	123			4.85	123
	5	0.72	88			0.72	88
	6	1.38	228			1.38	228
	7	0.01	160			0.01	160
	8+						
	Total	97.13		119.65		216.78	
	SOP		9,938		1,051		10,989
Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
4	0	2.68	24	0.44	10	3.11	22
	1	6.76	88	2.35	71	9.10	84
	2	25.18	97	0.19	80	25.37	97
	3	9.67	119	0.03	101	9.70	119
	4	0.94	123			0.94	123
	5						
	6	0.40	231			0.40	231
	7						
	8+						
	Total	45.62		3.01		48.62	
	SOP		4,472		190		4,662
Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
Total	0	2.92	24	118.76	9	121.68	9
	1	23.01	65	13.70	29	36.71	51
	2	192.80	76	11.93	56	204.72	75
	3	113.39	108	3.26	94	116.64	107
	4	34.83	142	0.71	128	35.54	142
	5	17.95	169	0.46	144	18.41	168
	6	8.93	186	1.20	154	10.13	182
	7	2.99	178	0.94	166	3.92	175
	8+	1.29	208	1.13	184	2.42	197
	Total	398.11		152.07		550.18	
	SOP		38,810		3,100		41,910

Table 3.3.9 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age and quarter.

Division: 22-24 Year: 2001 Country: ALL

Quarter	W-rings	Subdivision 22 Numbers	Subdivision 22 Mean W.	Subdivision 23 Numbers	Subdivision 23 Mean W.	Subdivision 24 Numbers	Subdivision 24 Mean W.	Total Numbers	Total Mean W.
1	1	191.74	14			61.00	22	252.74	16
	2	13.10	44	2.90	60	57.64	40	73.64	42
	3	2.50	56	2.60	90	45.33	66	50.42	66
	4	0.62	141	0.50	130	31.18	104	32.30	105
	5					23.15	165	23.15	165
	6					8.11	173	8.11	173
	7					4.88	165	4.88	165
	8+					0.77	156	0.77	156
	Total	207.96		6.00		232.05		446.02	
	SOP		3,538		472		16,053		20,063

Quarter	W-rings	Subdivision 22 Numbers	Subdivision 22 Mean W.	Subdivision 23 Numbers	Subdivision 23 Mean W.	Subdivision 24 Numbers	Subdivision 24 Mean W.	Total Numbers	Total Mean W.
2	1	82.65	22			69.18	21	151.83	22
	2	65.02	44	0.42	60	56.13	40	121.57	42
	3	30.67	57	0.37	90	32.45	67	63.50	62
	4	4.78	83	0.07	130	19.61	94	24.46	92
	5	0.55	120			14.14	153	14.69	151
	6					12.58	154	12.58	154
	7					5.50	163	5.50	163
	8+					2.23	166	2.23	166
	Total	183.67		0.86		211.82		396.35	
	SOP		6,897		68		13,104		20,069

Quarter	W-rings	Subdivision 22 Numbers	Subdivision 22 Mean W.	Subdivision 23 Numbers	Subdivision 23 Mean W.	Subdivision 24 Numbers	Subdivision 24 Mean W.	Total Numbers	Total Mean W.
3	0	44.02	16			2.50	17	46.52	16
	1	33.78	41			13.21	39	46.99	40
	2	8.84	41	0.05	163	23.05	47	31.94	45
	3	0.88	49	0.41	170	13.92	64	15.21	66
	4			0.05	196	13.78	70	13.83	71
	5			0.14	197	5.92	85	6.05	87
	6			0.09	197	5.93	81	6.01	83
	7					2.42	78	2.42	78
	8+			0.01	248	0.87	112	0.89	114
	Total	87.51		0.75		81.60		169.86	
	SOP		2,490		136		4,774		7,400

Quarter	W-rings	Subdivision 22 Numbers	Subdivision 22 Mean W.	Subdivision 23 Numbers	Subdivision 23 Mean W.	Subdivision 24 Numbers	Subdivision 24 Mean W.	Total Numbers	Total Mean W.
4	0	559.11	13			9.68	16	568.79	13
	1	12.95	44			20.60	45	33.55	45
	2	16.48	50	0.06	163	35.03	71	51.57	65
	3			0.49	170	15.75	102	16.24	104
	4			0.07	196	4.15	67	4.22	69
	5			0.16	197	1.14	119	1.30	129
	6			0.11	197	0.57	85	0.68	102
	7					0.60	63	0.60	63
	8+			0.02	248	0.10	63	0.12	89
	Total	588.53		0.90		87.63		677.07	
	SOP		8,438		163		5,700		14,301

Quarter	W-rings	Subdivision 22 Numbers	Subdivision 22 Mean W.	Subdivision 23 Numbers	Subdivision 23 Mean W.	Subdivision 24 Numbers	Subdivision 24 Mean W.	Total Numbers	Total Mean W.
Total	0	603.12	13			12.18	17	615.31	13
	1	321.12	20			163.99	26	485.12	22
	2	103.44	45	3.43	63	171.85	47	278.72	47
	3	34.04	56	3.87	108	107.45	71	145.37	69
	4	5.40	90	0.69	142	68.72	92	74.81	93
	5	0.55	120	0.30	197	44.35	149	45.19	149
	6			0.19	197	27.19	142	27.38	143
	7					13.40	144	13.40	144
	8+			0.03	248	3.98	150	4.01	150
	Total	1,067.67		8.51		613.11		1,689.30	
	SOP		21,363		839		39,630		61,832

Table 3.3.10 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age and quarter from. (values from the North Sea, see Table 2.2.1-2.2.5)

Western Baltic Spring-spawners

Division: **IV + IIIa + 22-24** **Year:** **2001**

		Division IV		**Division IIIa**		**Subdivision 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	50.42	66	87.24	79
	4			10.54	148	32.30	105	42.84	116
	5			4.17	190	23.15	165	27.32	169
	6			2.61	184	8.11	173	10.72	176
	7			1.33	175	4.88	165	6.20	167
	8+			1.38	194	0.77	156	2.15	180
	Total	0.00		161.73		446.02		607.75	
	SOP		0		12,540		20,063		32,603
		Division IV		**Division IIIa**		**Subdivision 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	121.57	42	163.83	52
	3	6.33	148.20	35.31	111	63.50	62	105.13	84
	4	3.59	171.10	19.21	144	24.46	92	47.26	119
	5	4.34	185.90	13.52	166	14.69	151	32.55	162
	6	1.55	198.20	5.74	166	12.58	154	19.87	161
	7	0.89	221.10	2.59	175	5.50	163	8.98	172
	8+	0.22	257.60	1.04	201	2.23	166	3.49	182
	Total	20.28		123.05		396.35		539.68	
	SOP		3,312		13,718		20,069		37,100
		Division IV		**Division IIIa**		**Subdivision 22-24**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0			118.57	9	46.52	16	165.09	11
	1	0.00	0.00	7.13	70	46.99	40	54.12	44
	2	8.43	129.00	49.32	92	31.94	45	89.68	79
	3	3.90	156.50	34.81	114	15.21	66	53.92	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		169.86		406.30	
	SOP		3,137		10,989		7,400		21,526
		Division IV		**Division IIIa**		**Subdivision 22-24**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0			3.11	22	568.79	13	571.90	13
	1			9.10	84	33.55	45	42.65	53
	2			25.37	97	51.57	65	76.94	75
	3			9.70	119	16.24	104	25.95	110
	4			0.94	123	4.22	69	5.15	79
	5					1.30	129	1.30	129
	6			0.40	231	0.68	102	1.07	150
	7					0.60	63	0.60	63
	8+					0.12	89	0.12	89
	Total	0.00		48.62		677.07		725.69	
	SOP		0		4,662		14,301		18,963
		Division IV		**Division IIIa**		**Subdivision 22-24**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0			121.68	9	615.31	13	736.99	12
	1	0.45	79	36.71	51	485.12	22	522.28	24
	2	11.34	127	204.72	75	278.72	47	494.79	60
	3	10.22	151	116.64	107	145.37	69	272.23	88
	4	6.12	178	35.54	142	74.81	93	116.47	112
	5	7.15	188	18.41	168	45.19	149	70.76	158
	6	2.66	198	10.13	182	27.38	143	40.17	156
	7	1.56	221	3.92	175	13.40	144	18.88	157
	8+	0.41	267	2.42	197	4.01	150	6.84	174
	Total	39.93		550.18		1,689.30		2,279.41	
	SOP		6,450		41,910		61,832		110,192

Table 3.3.11 Total catch in numbers (mill) and mean weight (g), SOP (tonnes)of Western Baltic Spring-spawners in Division IIIa and the North Sea in the years 1991-2001.

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

Table 3.3.12 Transfers of North Sea autumn spawners from Division IIIa to the North Sea Numbers (mill) and mean weight, SOP in (tonnes) 1991-2001.

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

Corrections for the years 1991-1998 was made in WG2001, but are NOT included in the North Sea assessment.

Table 3.3.13 Total catch in numbers (mill) of spring-spawners in Division IIIa and the North Sea + in Sub-divisions 22-24 in the years 1991-2001

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	615.3	485.1	278.7	145.4	74.8	45.2	27.4	13.4	4.0	1689.3

Table 3.3.14 Mean weight (g) and SOP (tons) of spring-spawners in Division IIIa + the North Sea and in Subdivisions 22-24 in the years 1991 - 2001

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	22.2	46.6	68.7	92.7	149.0	142.7	143.7	150.3	61,832

Table 3.4.1 Herring in Division IIIa, IIIb and IIIc.
Samples of commercial landings by quarter and area for 2001 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**	3.3	6	479	296
		2	3.2	11	243	224
		3	5.0	26	2635	957
		4	4.7	13	635	108
	Total		16.2	56	3992	1585
	Norway	**1**	0.3	No data available		
		2	7.7	7	693	683
		3	0.3	No data available		
		4	0.0			
	Total		8.3	7	693	683
	Sweden	**1**	3.1	9	835	835
		2	7.5	7	700	697
		3	17.6	7	700	700
		4	2.6	0	0	0
	Total		30.8	23	2235	2232
Kattegat	**Denmark**	**1**	5.9	3	849	424
		2	1.0	5	140	138
		3	7.9	11	1864	1089
		4	4.0	1	216	50
	Total		18.8	20	3069	1701
	Sweden	**1**	11.3	27	2700	2696
		2	1.3	9	900	897
		3	2.0	1	100	100
		4	1.6	2	200	200
	Total		16.2	39	3900	3893
Subdivision 22	**Denmark**	**1**	3.5	2	456	102
		2	6.9	2	879	98
		3	2.5	2	168	49
		4	8.4	7	556	227
	Total		21.3	13	2059	476
	Germany	**1**	0.2	No data available		
		2	0.2			
		3	+			
		4	+			
	Total		0.4	0	0	0
Subdivision 23	**Denmark**	**1**	0.4	No data available		
		2	0.1			
		3	+			
		4	+			
	Total		0.5			
	Sweden	**1**	+	No data available		
		2	0.0			
		3	0.1			
		4	0.1	1	100	99
	Total		0.2	1	100	99
Subdivision 24	**Denmark**	**1**	5.9	3	1139	155
		2	1.0	2	5237	94
		3	0.0	No data available		
		4	+	1	180	51
	Total		6.9	6	6556	300
	Germany	**1**	4.7	12	3087	665
		2	4.8	15	4346	998
		3	+	No data available		
		4	0.1			
	Total		9.6	50	18660	2633
	Poland	**1**	2.5	No data reported		
		2	5.6			
		3	0.7			
		4	0.5			
	Total		9.3			
	Sweden	**1**	3.0	1	500	500
		2	1.8	No data available		
		3	4.0	1	493	493
		4	5.1	3	450	450
	Total		13.9	5	1443	1443

Table 3.4.2 Herring in Division IIIa.
Samples of landings by quarter and area for 2001 available to estimation 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 Q1
		3	**C**	Danish sampling in Q4
		4	**C**	Danish sampling in Q4
	Norway	**1**	**C**	Norwegian sampling i Q2
		2	**C**	Norwegian sampling i Q2
		3	**C**	Norwegian sampling i Q2
		4	**C**	No landings
	Sweden	**1**	**C**	Swedish sampling in Q1
		2	**C**	Swedish sampling in Q2
		3	**C**	Swedish sampling in Q3
		4	**C**	Danish 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**	Danish 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**	Swedish 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 Q4
	Sweden	**1**	**D**	Swedish sampling in Q1
		2	**D**	Swedish sampling in Q2
		3	**D**	Swedish sampling in Q3
		4	**D**	Swedish sampling in Q4

Fleet C= Human consumption, Fleet D= Industrial landings.

Table 3.4.2 continued **Herring in Division IIIb and IIIc.**
Samples of landings by quarter and area for 2001 available for estimation of mean weight-at-age.

	Country	Quarter	Fleet	Sampling used to estimate mean weight at age
Subdivision 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**	Danish sampling in Q1
		2	**F**	Danish sampling in Q2
		3	**F**	Danish sampling in Q3
		4	**F**	Danish sampling in Q4
Subdivision 23	**Denmark**	**1**	**F**	Danish sampling in Q1 in Kattegat
		2	**F**	Danish sampling in Q1 in Kattegat
		3	**F**	Swedish sampling in Q4
		4	**F**	Swedish sampling in Q4
	Sweden	**1**	**F**	Danish sampling in Q1 in Kattegat
		2	**F**	No landings
		3	**F**	Swedish sampling in Q4
		4	**F**	Swedish sampling in Q4
Subdivision 24	**Denmark**	**1**	**F**	Danish sampling in Q1
		2	**F**	Danish sampling in Q2
		3	**F**	No landings
		4	**F**	Danish sampling in Q4
	Germany	**1**	**F**	German sampling in Q1
		2	**F**	German sampling in Q2
		3	**F**	Danish sampling in Q4
		4	**F**	Danish sampling in Q4
	Poland	**1**	**F**	No information on sampling available
		2	**F**	No information on sampling available
		3	**F**	No information on sampling available
		4	**F**	No information on sampling available
	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 3.5.1 German Bottom Trawl Survey in Sub-Div. 24.
Young Fish survey in November/December
Mean Herring catch-at-age in numbers per haul.

Year	Month	Winter rings				Total	Mean catch
		0	1	2	3+	numbers	(kg)
1979	Nov.	8,665.90	240.47	103.36	10.33	9,020.06	89.61
1981	Nov.	332.63	96.79	60.05	21.30	510.77	16.36
1982	Dec.	695.71	108.21	70.63	34.72	909.27	24.57
1983	Dec.	1,995.97	387.11	63.71	46.11	2,492.90	46.68
1984	Nov.	1,581.66	377.15	88.03	24.26	2,071.10	39.79
1985	Nov.	3,085.64	340.92	169.95	74.76	3,671.27	45.99
1986	Dec.	2,984.47	368.35	46.41	69.30	3,468.53	44.42
1989	Nov.	2,881.81	319.38	48.99	55.12	3,305.30	47.76
1990	Nov.	103.92	14.79	21.69	32.90	173.30	7.09
1991	Nov.	117.38	134.20	103.14	144.63	499.35	27.16
1992	Nov.	233.85	88.05	57.15	113.58	492.63	19.86
1993	Nov.	1,116.34	25.09	50.01	476.29	1,667.30	53.97
1994	Nov.	1,020.49	13.21	73.47	583.23	1,690.40	79.34
1995	Nov.	635.09	33.22	47.97	324.98	1,041.27	47.53
1996	Nov.	514.52	36.12	49.04	349.44	949.12	25.82
1997	Nov.	627.20	66.33	93.57	126.50	913.60	18.30
1998	Nov.	4,651.43	273.67	146.42	563.65	5,635.18	88.85
1999	Nov.	2,629.67	310.92	62.25	43.34	3,046.18	49.36
2000	Nov.	175.83	86.09	85.35	95.74	445.67	21.89

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

Year	Month	Winter rings				Total	Mean catch
		0	1	2	3+	numbers	(kg)
1979	Nov.	3,561.79	1,358.84	137.11	7.68	5,065.42	86.91
1981	Nov.	1,033.40	118.85	28.35	9.10	1,189.70	17.69
1982	Dec.	354.00	239.45	44.50	26.20	664.15	19.97
1983	Dec.	7,917.00	834.70	80.10	29.50	8,861.30	117.51
1984	Nov.	6,596.32	1,830.32	150.47	40.47	8,617.58	147.45
1985	Nov.	3,506.20	958.80	219.80	25.25	4,710.05	83.38
1986	Nov.	6,863.75	175.35	16.55	5.60	7,061.25	54.18
1989	Nov.	10,587.70	1,444.50	117.75	76.45	12,226.40	176.53
1992	Nov.	572.68	87.68	19.16	17.26	696.78	13.13
1993	Nov.	8,419.70	1,644.05	1,293.70	898.10	12,255.55	301.71
1994	Nov.	2,158.10	317.35	1,588.45	326.35	4,390.25	135.65
1995	Nov.	1,226.63	158.75	29.00	123.31	1,537.69	31.17
1996	Nov.	8.76	193.71	101.24	57.76	361.47	15.23
1997	Nov.	11,289.45	2,196.45	257.75	159.90	13,903.55	209.24
1998	Nov.	3,042.10	597.05	113.40	112.50	3,865.05	70.79
1999	Nov.	1,060.72	76.91	76.22	128.08	1,341.93	25.62
2000	Nov.	2,406.89	2,146.21	54.74	14.53	4,622.37	127.39

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

Sum weighted by area of Subdivision :

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

Year	Month	Winter rings				Total	Mean catch
		0	1	2	3+	numbers	(kg)
1979	Nov.	7784.9	433.5	109.2	9.9	8337.5	89.1
1981	Nov.	453.6	100.6	54.6	19.2	628.0	16.6
1982	Dec.	636.7	130.9	66.1	33.2	867.0	23.8
1983	Dec.	3017.9	464.4	66.5	43.2	3592.1	58.9
1984	Nov.	2447.2	628.0	98.8	27.1	3201.0	58.4
1985	Nov.	3158.2	447.6	178.6	66.2	3850.6	52.4
1986	Nov.	3654.0	335.0	41.3	58.3	4088.6	46.1
1989	Nov.	4211.8	513.6	60.9	58.8	4845.1	70.0
1992	Nov.	292.3	88.0	50.6	97.0	527.9	18.7
1993	Nov.	2376.9	304.5	264.7	549.1	3494.8	96.7
1994	Nov.	1216.8	65.7	335.0	538.9	2156.4	89.1
1995	Nov.	737.2	54.9	44.7	290.2	1127.0	44.7
1996	Nov.	427.2	63.3	58.0	299.1	847.7	24.0
1997	Nov.	2467.5	434.0	121.9	132.3	3155.6	51.3
1998	Nov.	4373.7	329.5	140.7	485.8	5329.7	85.7
1999	Nov.	2358.9	270.5	64.7	58.0	2752.0	45.3
2000	Nov.	560.9	441.7	80.1	81.7	1166.6	40.1

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

Year	Winter rings								Total
	1	2	3	4	5	6	7	8+	numbers
1979	1597.6	702.2	106.5	23.0	4.9	0.0	0.5	0.0	2434.7
1981	1038.7	642.8	67.9	54.9	13.0	1.4	0.4	0.6	1819.7
1984	4865.4	1094.8	153.7	32.0	11.4	0.8	0.6	0.0	6158.7
1985	3018.3	3253.6	1012.2	307.8	87.9	38.8	8.8	0.8	7728.2
1986	7585.8	514.0	386.7	85.4	20.0	10.5	3.6	0.9	8606.9
1987	712.9	338.1	154.7	201.7	51.2	21.2	2.6	0.9	1483.3
1988	5031.7	2553.0	291.6	31.8	20.9	4.4	1.6	0.2	7935.2
1989	6654.5	2099.3	612.6	103.7	21.8	6.1	5.7	1.3	9505.0
1990	4568.5	1393.1	124.4	52.1	4.4	8.5	0.8	0.2	6152.0
1991	1961.0	636.2	261.4	87.1	34.5	8.8	2.0	2.1	2993.1
1992	2778.1	820.6	251.2	79.7	26.8	9.7	3.1	1.1	3970.3
1993	959.9	371.2	94.8	61.3	44.4	13.9	5.6	1.0	1552.1
1994	996.3	214.9	201.9	329.5	130.6	75.8	30.3	21.0	2000.3
1995	1949.0	91.7	328.7	131.1	83.6	24.4	27.9	11.3	2647.7
1996	1221.7	188.9	83.3	87.9	86.7	41.4	33.3	35.2	1778.4
1997	1163.1	206.0	395.8	163.5	61.2	32.6	23.2	28.4	2073.7
1998	2253.7	836.3	321.1	74.4	33.1	15.5	10.2	7.1	3551.4
1999	10035.6	1378.9	656.9	338.0	116.7	1.7	15.2	0.3	12543.3
2000	6080.6	926.5	75.2	54.6	27.3	3.2	1.2	0.0	7168.7

Table 3.5.5 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[1]	-	-	-	-	-
2002	2335	178	222	23	7

Table 3.5.6 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[2]	-	-	-	-	-
2001	313	190	72	18	2

[1] = no data available

[2] = no survey was carried out in 2000

Table 3.5.7 Acoustic surveys on the Spring-spawning HERRING in the North Sea / Division IIIa in 1989-2001 (July).

Year	1989	1990	1991	1992*	1993*	1994*	1995*	1996*	1997	1998	1999**	2000	2001
Numbers in millions													
W-rings													
0		31		3,853	372	964							
1		135		277	103	5	2,199	1,091	128	138	1367	1509	66
2	1,105	1,497	1,864	2,092	2,768	413	1,887	1,005	715	1,682	1143	1891	641
3	714	549	1,927	1,799	1,274	935	1,022	247	787	901	523	674	452
4	317	319	866	1,593	598	501	1,270	141	166	282	135	364	153
5	81	110	350	556	434	239	255	119	67	111	28	186	96
6	51	24	88	197	154	186	174	37	69	51	3	56	38
7	16	10	72	122	63	62	39	20	80	31	2	7	23
8+	4	5	10	20	13	34	21	13	77	53	1	10	12
Total	**2,288**	**2,680**	**5,177**	**10,509**	**5,779**	**3,339**	**6,867**	**2,673**	**2,088**	**3,248**	**3,201**	**4,696**	**1,481**
3+ group	**1,183**	**1,017**	**3,313**	**4,287**	**2,536**	**1,957**	**2,781**	**577**	**1,245**	**1,428**	**691**	**1,295**	**774**
Biomass ('000 tonnnes)													
W-rings													
0		0.5		34.3	1	8.7							
1		6.8		26.8	7	0.4	77.4	52.9	4.7	7.1	74.8	61.4	3.5
2	86.2	122.8	177.1	169.0	139	33.2	108.9	87.0	52.2	136.1	101.6	138.1	55.8
3	83.5	59.8	219.7	206.3	112	114.7	102.6	27.6	81.0	84.8	59.5	68.8	51.2
4	54.2	41.2	116.0	204.7	69	76.7	145.5	17.9	21.5	35.2	14.7	45.3	21.5
5	16.0	15.8	51.1	83.3	65	41.8	33.9	17.8	9.8	13.1	3.4	25.1	17.9
6	11.4	3.8	19.0	36.6	26	38.1	27.4	5.8	9.8	6.9	0.5	10.0	6.9
7	3.4	1.8	13.0	24.4	16	13.1	6.7	3.3	14.9	4.8	0.3	1.4	4.7
8+	0.9	0.8	2.0	5.0	2	7.8	3.8	2.7	13.6	9.0	0.1	1.3	2.7
Total	255.7	252.7	597.9	756.1	436.5	325.8	506.2	215.1	207.5	297.0	254.9	351.4	164.2
3+ group	169.5	123.2	420.9	560.3	291.0	292.3	319.9	75.2	150.6	153.7	78.5	151.9	104.9
Mean weight (g)													
W-rings													
0		17		8.9	4.0	9.0							
1		50		96.8	66.3	80.0	35.2	48.5	36.9	51.9	54.7	40.7	54.0
2	78	82	95	80.8	50.1	80.3	57.7	86.6	73.0	80.9	88.9	73.1	87.0
3	117	109	114	114.7	87.9	122.7	100.4	111.9	103.0	94.1	113.8	102.2	113.2
4	171	129	134	128.5	116.2	153.0	114.6	126.8	129.6	124.7	109.1	124.4	140.5
5	198	144	146	149.8	149.9	175.1	132.9	149.4	145.0	118.7	120.0	135.4	185.2
6	211	159	216	185.7	169.6	205.0	157.2	157.3	143.1	135.8	179.9	179.2	182.6
7	215	176	181	199.7	256.9	212.0	172.9	166.8	185.6	156.4	179.9	208.8	206.3
8+	226	156	200	252.0	164.2	230.3	183.1	212.9	178.0	168.0	181.7	135.2	226.9
Total	111.6	95.8	115.6	123.9	75.8	100.2	73.7	80.5	99.4	91.4	78.5	74.8	110.9

* revised in 1997

**the survey only covered the Skagerrak area near Norway. Additional estimates for the Kattegat area were added (see ICES 2000/ACFM:10, Table 3.5.8).

Table 3.5.8 Acoustic survey on the Spring-spawning Herring in Subdivisions 22-24 in 1989-2001 (September/October).

Year	1989	1990	1991[1]	1992[1]	1993[1]	1994[1]	1995[1]	1996[1]	1997[1]	1998[1]	1999[1]	2000	2001[3]
Numbers in millions													
W-rings													
0	3,825	21,157	7,180	2,876	768	4,383	4,001	1,418	2,608	2,179	4,821	1,021	1,831
1	2,137	1,785	2,864	1,961	345	412	1,163	1,084	1,389	451	1,145	1,208	1,314
2	213	892	1,418	1,051	354	823	307	541	492	557	246	477	1,761
3	161	146	1,403	588	485	540	332	413	343	364	187	348	1,013
4	102	79	472	283	381	433	342	282	151	232	129	206	357
5	23	19	241	86	121	182	247	283	112	99	44	81	92
6	4	8	85	40	52	56	124	110	92	51	8	39	55
7	3	4	13	9	28	22	40	44	32	23	1	5	5
8+	1	2	28	9	13	2	27	18	46	9	2	4	0
Total	6,469	24,092	13,705	6,902	2,547	6,854	6,583	4,193	5,265	3,966	6,582	3,389	6,428
3+ group	294	258	2,243	1,014	1,080	1,235	1,112	1,151	775	778	370	682	1,522
Biomass ('000 tonnnes)													
W-rings													
0	[2]	287.7	76.3	41.3	11.3	49.3	41.1	12.3	25.6	20.4	54.2	12.8	21.4
1	[2]	65.9	121.4	71.4	12.3	14.3	39.6	32.9	49.4	18.2	42.3	47.5	59.1
2	[2]	56.2	111.1	64.7	15.7	38.1	19.8	26.8	29.2	41.4	18.8	29.7	118.7
3	[2]	12.3	141.3	53.8	29.7	39.2	28.5	29.3	31.9	32.9	22.0	29.0	93.4
4	[2]	7.6	59.6	34.7	23.5	41.3	39.1	20.0	21.0	27.5	13.1	24.1	34.2
5	[2]	1.9	35.5	13.0	12.3	22.9	26.7	33.9	16.0	11.3	5.6	9.2	11.6
6	[2]	0.9	12.7	6.3	6.7	11.5	14.7	14.7	13.2	6.1	0.8	5.6	7.6
7	[2]	0.4	1.7	1.8	2.2	4.9	8.8	5.7	5.1	3.7	0.2	1.1	0.9
8+	[2]	0.2	3.8	2.2	2.3	0.6	6.6	2.7	10.2	2.2	0.4	0.7	0.0
Total	[2]	438.5	563.3	289.3	116.0	222.1	224.9	178.4	201.7	163.5	157.5	159.7	346.9
3+ group	[2]	23.4	254.5	111.8	76.7	120.4	124.5	106.3	97.4	83.5	42.1	69.6	147.7
Mean weight (g)													
W-rings													
0	[2]	13.6	10.6	14.4	14.7	11.2	10.3	8.7	9.8	9.4	11.2	12.6	11.7
1	[2]	36.9	42.4	36.4	35.7	34.7	34.0	30.4	35.6	40.3	37.0	39.3	45.0
2	[2]	63.0	78.4	61.6	44.3	46.3	64.5	49.6	59.4	74.3	76.4	62.3	67.4
3	[2]	84.5	100.7	91.5	61.3	72.6	85.9	70.8	93.1	90.4	117.6	83.3	92.3
4	[2]	96.6	126.4	122.7	61.6	95.5	114.5	71.1	139.2	118.3	101.8	117.1	95.7
5	[2]	101.4	147.3	151.3	101.3	125.9	108.0	119.7	142.3	114.0	127.5	114.1	126.0
6	[2]	112.2	148.2	159.1	129.6	204.0	118.1	133.5	143.4	120.5	107.2	143.0	137.0
7	[2]	100.6	126.6	205.7	80.2	222.6	222.0	128.5	161.6	158.1	231.1	202.9	175.7
8+	[2]	102.5	132.5	259.2	172.7	269.6	241.1	154.7	222.2	232.9	219.1	180.9	-
Total	[2]	18.2	41.1	41.9	45.5	32.4	34.2	42.5	38.3	41.2	23.9	47.1	54.0

[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] no data available

[3] incl. estimates for Subdivision 23, which was covered by RV ARGOS (Sweden) in Novemebr 2001

Table 3.5.9 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]

[1] Brielmann 1989
[2] Klenz 1999 Inf.Fischwirtsch. Fischereiforsch. 46(2), 1999: 15-17
[3] Müller & Klenz 1994
[4] Klenz 2001 Inf.Fischwirtsch. Fischereiforsch. 48(4), 2001: 164-165

Table. 3.7.1 WESTERN BALTIC HERRING. Input to ICA.
Catch in number (millions)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	119.0	145.1	206.1	263.2	541.3	171.1	376.8	549.8	569.6	155.4	737.0
1	826.0	456.7	530.7	249.4	1660.7	638.9	668.6	625.5	617.1	935.2	522.3
2	541.2	602.6	495.9	365.0	451.8	403.1	298.2	463.2	349.4	511.1	494.8
3	564.4	364.9	415.1	382.6	258.5	211.5	289.4	190.7	257.6	200.6	272.2
4	279.8	334.0	260.9	267.0	212.9	157.3	87.8	152.5	94.9	144.2	116.5
5	177.5	183.2	210.5	168.1	88.9	134.3	47.2	47.1	57.7	79.1	70.8
6	46.5	139.8	102.8	118.4	62.6	67.7	41.4	24.3	15.9	39.9	40.2
7	13.2	52.7	63.9	49.5	35.5	31.7	21.6	15.5	9.7	14.0	18.9
8	4.9	22.6	24.5	33.1	20.9	25.5	25.0	14.3	6.4	10.9	6.8

Table. 3.7.2 WESTERN BALTIC HERRING. Input to ICA.
Mean weight in catch (kg)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.03000	0.01500	0.01500	0.01500	0.01000	0.01100	0.03000	0.01400	0.01100	0.02100	0.01200
1	0.03500	0.03400	0.02500	0.03700	0.02100	0.02500	0.02700	0.03300	0.03400	0.02600	0.02400
2	0.06700	0.06700	0.06800	0.08300	0.07100	0.08100	0.07000	0.06800	0.06800	0.06000	0.06000
3	0.09500	0.09400	0.10200	0.10300	0.10800	0.10200	0.12100	0.09500	0.09900	0.09900	0.08800
4	0.12300	0.11600	0.11400	0.12200	0.12900	0.12100	0.14600	0.11900	0.11800	0.13400	0.11200
5	0.13900	0.14200	0.13600	0.14100	0.15500	0.13500	0.16800	0.13800	0.14800	0.14500	0.15800
6	0.15600	0.16500	0.16800	0.15600	0.17400	0.14000	0.18300	0.16700	0.15800	0.14800	0.15600
7	0.17100	0.17600	0.18200	0.17000	0.20800	0.15700	0.19800	0.16600	0.15500	0.16000	0.15700
8	0.18300	0.19200	0.19900	0.18600	0.21800	0.19100	0.20900	0.18800	0.16100	0.16000	0.17400

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

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	0.03100	0.02000	0.01600	0.01900	0.01300	0.01800	0.01300	0.02200	0.02100	0.01400	0.01700
2	0.05300	0.04500	0.04000	0.05300	0.04600	0.05500	0.05100	0.05600	0.05700	0.04300	0.05100
3	0.07900	0.08200	0.09700	0.08400	0.07100	0.09100	0.10600	0.08300	0.08700	0.08500	0.07900
4	0.10400	0.10800	0.10800	0.10800	0.13300	0.11700	0.13300	0.11300	0.10800	0.12700	0.11600
5	0.12400	0.13100	0.14100	0.13900	0.16700	0.12000	0.16600	0.13400	0.14800	0.14500	0.16900
6	0.14500	0.15900	0.16700	0.15700	0.18900	0.15400	0.19400	0.16800	0.16000	0.16300	0.17600
7	0.15900	0.17100	0.18300	0.17700	0.21000	0.14700	0.20900	0.16800	0.14400	0.16600	0.16700
8	0.16400	0.18700	0.18900	0.20300	0.23400	0.12800	0.22600	0.18400	0.15000	0.18400	0.18000

Table. 3.7.4 WESTERN BALTIC HERRING. Input to ICA .
Natural mortality

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	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
2	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
4	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
6	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
8	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000

Table. 3.7.5 a WESTERN BALTIC HERRING. Input to ICA.
AGE - STRUCTURED INDICES.
FLT27: 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
0	7180.0	2876.0	768.0	4383.0	4001.0	1418.0	2608.0	2179.0	4821.0	1021.0	1831.0
1	2864.0	1961.0	345.0	412.0	1163.0	1084.0	1389.0	451.0	1145.0	1208.0	1314.0
2	1418.0	1051.0	354.0	823.0	307.0	541.0	492.0	557.0	246.0	477.0	1761.0
3	1403.0	588.0	485.0	540.0	332.0	413.0	343.0	364.0	187.0	348.0	1013.0
4	472.0	283.0	381.0	433.0	342.0	282.0	151.0	232.0	129.0	206.0	357.0
5	241.0	86.0	121.0	182.0	247.0	283.0	112.0	99.0	44.0	81.0	92.0

Table. 3.7.5 b WESTERN BALTIC HERRING. Input to ICA.
AGE - STRUCTURED INDICES.
FLT33: 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
2	1864.0	2092.0	2768.0	413.0	1887.0	1005.0	715.0	1682.0	*******	1891.1	641.2
3	1927.0	1799.0	1274.0	935.0	1022.0	247.0	787.0	901.0	*******	673.6	452.3
4	866.0	1593.0	598.0	501.0	1270.0	141.0	166.0	282.0	*******	363.9	153.1
5	350.0	556.0	434.0	239.0	255.0	119.0	67.0	111.0	*******	185.7	96.4
6	88.0	197.0	154.0	186.0	174.0	37.0	69.0	51.0	*******	55.6	37.6
7	72.0	122.0	63.0	62.0	39.0	20.0	80.0	31.0	*******	6.9	23.0
8	10.0	20.0	13.0	34.0	21.0	13.0	77.0	53.0	*******	9.6	11.9

Table. 3.7.5 c WESTERN BALTIC HERRING. Input to ICA.
AGE - STRUCTURED INDICES.
FLT22: IYFS in Kattegat, Quarter 3, Ages 1-5 (Catch: Number)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	141.21	371.52	403.96	264.55	687.33	631.33	52.37	117.53	292.00	*******	313.00
2	83.21	107.60	158.74	229.37	191.54	321.79	122.16	85.82	116.29	*******	190.00
3	100.87	69.92	41.93	154.22	113.17	30.78	33.19	22.35	71.17	*******	72.00
4	41.17	62.96	36.03	48.96	99.09	17.50	8.36	27.32	33.64	*******	18.00
5	23.84	24.69	25.13	35.66	29.36	11.28	13.19	4.96	14.30	*******	2.00

Table 3.7.6 WESTERN BALTIC HERRING

Input parameters for ICA FINAL Run 22

```
                         Integrated Catch-at-age Analysis
                                 Version 1.4 w
                                 K.R.Patterson
                          Fisheries Research Services
                              Marine Laboratory
                                   Aberdeen
                                24 August 1999
 Type * to change language
 Enter the name of the index file -->index
canum
weca
 Stock weights in 2002  used for the year 2001
west
 Natural mortality in 2002  used for the year 2001
natmor
 Maturity ogive in 2002  used for the year 2001
matprop
 Name of age-structured index file (Enter if none) : -->fleet
 Name of the SSB index file (Enter if none) -->
No indices of spawning biomass to be used.
 No of years for separable constraint ?--> 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 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
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 FLT22: IYFS Katt/Quarter 3/Age groups 1- a plus-group (Y-->n
 Is the last age of FLT27: Acoustic Survey in Sub div 22-24 a plus-group (Y/-->n
 Is the last age of FLT33: Acoustic Survey in Div IIIa+IVaE a plus-group (Y/-->y
You must choose a catchability model for each index.
Models:   A  Absolute:  Index = Abundance . e
          L  Linear:    Index = Q. Abundance . e
          P  Power:     Index = Q. Abundance^ K .e

   where Q and K are parameters to be estimated, and
   e is a lognormally-distributed error.
 Model for FLT22: IYFS Katt/Quarter 3/Age groups 1-  is to be A/L/P ?-->L
 Model for FLT27: Acoustic Survey in Sub div 22-24  is to be A/L/P ?-->L
 Model for FLT33: Acoustic Survey in Div IIIa+IVaE  is to be A/L/P ?-->L
 Fit a stock-recruit relationship (Y/N) ?-->n
 Enter lowest feasible F-->   5.0000000000000003E-02
 Enter highest feasible F-->    1.000000000000000
Mapping the F-dimension of the SSQ surface
    F                  SSQ
+--------+-------------------
    0.05        34.5274960936
    0.10        20.8655515904
    0.15        15.5343883491
    0.20        12.9169535819
    0.25        11.4390704088
    0.30        10.5326784383
    0.35         9.9547343188
    0.40         9.5859162598
    0.45         9.3607820897
    0.50         9.2399183534
    0.55         9.1977404017
    0.60         9.2168010306
    0.65         9.2845167691
    0.70         9.3916507420
    0.75         9.5312167119
    0.80         9.6978823523
    0.85         9.8874628997
    0.90        10.0967185324
    0.95        10.3231674492
    1.00        10.5648726694
Lowest SSQ is for F =     0.558
```

Table 3.7.6 continued

```
No of years for separable analysis : 5
Age range in the analysis : 0  . . . 8
Year range in the analysis : 1991  . . . 2001
Number of indices of SSB : 0
Number of age-structured indices : 3

Parameters to estimate : 41
Number of observations : 226

Conventional single selection vector model to be fitted.



-----------------------------------------------------------------
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for FLT22: IYFS Katt/Quarter 3/Age groups 1-  at age 1-->    1.000000000000000
 Enter weight for FLT22: IYFS Katt/Quarter 3/Age groups 1-  at age 2-->    1.000000000000000
 Enter weight for FLT22: IYFS Katt/Quarter 3/Age groups 1-  at age 3-->    1.000000000000000
 Enter weight for FLT22: IYFS Katt/Quarter 3/Age groups 1-  at age 4-->    1.000000000000000
 Enter weight for FLT22: IYFS Katt/Quarter 3/Age groups 1-  at age 5-->    1.000000000000000
 Enter weight for FLT27: Acoustic Survey in Sub div 22-24  at age 0-->    1.000000000000000
 Enter weight for FLT27: Acoustic Survey in Sub div 22-24  at age 1-->    1.000000000000000
 Enter weight for FLT27: Acoustic Survey in Sub div 22-24  at age 2-->    1.000000000000000
 Enter weight for FLT27: Acoustic Survey in Sub div 22-24  at age 3-->    1.000000000000000
 Enter weight for FLT27: Acoustic Survey in Sub div 22-24  at age 4-->    1.000000000000000
 Enter weight for FLT27: Acoustic Survey in Sub div 22-24  at age 5-->    1.000000000000000
 Enter weight for FLT33: Acoustic Survey in Div IIIa+IVaE  at age 2-->    1.000000000000000
 Enter weight for FLT33: Acoustic Survey in Div IIIa+IVaE  at age 3-->    1.000000000000000
 Enter weight for FLT33: Acoustic Survey in Div IIIa+IVaE  at age 4-->    1.000000000000000
 Enter weight for FLT33: Acoustic Survey in Div IIIa+IVaE  at age 5-->    1.000000000000000
 Enter weight for FLT33: Acoustic Survey in Div IIIa+IVaE  at age 6-->    1.000000000000000
 Enter weight for FLT33: Acoustic Survey in Div IIIa+IVaE  at age 7-->    1.000000000000000
 Enter weight for FLT33: Acoustic Survey in Div IIIa+IVaE  at age 8-->    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 FLT22: IYFS Katt/Quarter 3/Age groups 1--->    1.000000000000000
  Enter value for FLT27: Acoustic Survey in Sub div 22-24-->    1.000000000000000
  Enter value for FLT33: Acoustic Survey in Div IIIa+IVaE-->    1.000000000000000
 Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.

Aged index weights
FLT22: IYFS Katt/Quarter 3/Age groups 1-
 Age   :       1     2     3     4     5
 Wts :     0.200 0.200 0.200 0.200 0.200
FLT27: Acoustic Survey in Sub div 22-24
 Age   :       0     1     2     3     4     5
 Wts :     0.167 0.167 0.167 0.167 0.167 0.167
FLT33: Acoustic Survey in Div IIIa+IVaE
 Age   :       2     3     4     5     6     7     8
 Wts :     0.143 0.143 0.143 0.143 0.143 0.143 0.143
F in 2001  at age 4  is 0.509485  in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->n
 Output page width in characters (e.g. 80..132) ?--> 132
 Estimate historical assessment uncertainty ?-->n
Succesful exit from ICA
```

Table. 3.7.7 WESTERN BALTIC HERRING. Output from ICA Run 22.
FISHING MORTALITY (per year)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.02707	0.04430	0.07815	0.05127	0.15837	0.05053	0.11240	0.11636	0.09871	0.12848	0.12693
1	0.25278	0.16855	0.27842	0.15678	0.65309	0.35239	0.32134	0.33267	0.28220	0.36731	0.36288
2	0.31303	0.35914	0.33658	0.38227	0.57766	0.39551	0.39964	0.41374	0.35097	0.45682	0.45132
3	0.40962	0.36012	0.45097	0.47202	0.51408	0.59246	0.45071	0.46662	0.39582	0.51520	0.50899
4	0.38052	0.45510	0.47476	0.59185	0.52691	0.68923	0.45115	0.46707	0.39620	0.51571	0.50949
5	0.34322	0.46180	0.58467	0.64791	0.39944	0.75988	0.49543	0.51291	0.43509	0.56631	0.55949
6	0.20972	0.49929	0.51382	0.78540	0.53645	0.60672	0.49788	0.51545	0.43724	0.56912	0.56226
7	0.33357	0.38843	0.44918	0.50295	0.57673	0.57754	0.45115	0.46707	0.39620	0.51571	0.50949
8	0.33357	0.38843	0.44918	0.50295	0.57673	0.57754	0.45115	0.46707	0.39620	0.51571	0.50949

Table. 3.7.8 WESTERN BALTIC HERRING. Output from ICA Run 22.
POPULATION ABUNDANCE (millions)- 1 January

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	5153.0	3870.9	3167.2	6087.8	4260.8	4014.9	3749.8	5081.0	5928.2	3393.1	4446.5	4607.7
1	4650.3	3715.5	2743.3	2169.9	4284.5	2694.2	2827.7	2482.6	3350.6	3978.9	2210.6	2901.4
2	2210.3	2190.6	1904.0	1259.6	1125.2	1352.5	1148.8	1243.8	1079.6	1532.6	1671.5	932.7
3	1840.4	1323.3	1252.4	1113.3	703.6	517.0	745.6	630.7	673.3	622.3	794.6	871.4
4	969.2	1000.3	755.8	653.2	568.6	344.5	234.1	389.0	323.8	371.0	304.4	391.1
5	670.2	542.4	519.6	384.9	295.9	274.8	141.6	122.0	199.6	178.4	181.4	149.7
6	270.2	389.3	279.8	237.1	164.9	162.5	105.2	70.6	59.8	105.8	82.9	84.9
7	51.2	179.3	193.5	137.0	88.5	78.9	72.5	52.4	34.5	31.6	49.0	38.7
8	19.1	76.9	74.3	91.6	52.2	63.5	75.5	42.0	21.5	29.5	18.7	33.3

Table. 3.7.9 WESTERN BALTIC HERRING. Output from ICA Run 22.
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	5152960	641045	327477	191573	0.5850	0.3358	99
1992	3870880	567424	342905	194411	0.5670	0.4441	100
1993	3167210	492581	316405	185010	0.5847	0.5061	100
1994	6087790	405618	251977	172438	0.6843	0.6243	100
1995	4260820	344390	205460	164284	0.7996	0.4942	99
1996	4014880	287969	146638	128243	0.8745	0.6621	99
1997	3749770	281659	159142	123199	0.7741	0.4738	100
1998	5080980	265318	124774	112386	0.9007	0.4905	100
1999	5928180	272766	123367	101573	0.8233	0.4161	100
2000	3393080	275404	134518	118278	0.8793	0.5416	99
2001	4446510	277710	137931	110192	0.7989	0.5351	100

Table. 3.7.10 WESTERN BALTIC HERRING. Output from ICA Run 22.
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	0.4512	12	0.3547	0.5738	0.3991	0.5100	0.4546
2	1998	0.4671	12	0.3674	0.5938	0.4132	0.5279	0.4706
3	1999	0.3962	12	0.3092	0.5076	0.3491	0.4496	0.3994
4	2000	0.5157	12	0.3999	0.6650	0.4530	0.5871	0.5201
5	2001	0.5095	15	0.3758	0.6908	0.4362	0.5951	0.5157
Separable Model: Selection (S) by age								
6	0	0.2491	33	0.1303	0.4764	0.1790	0.3468	0.2631
7	1	0.7123	14	0.5375	0.9439	0.6169	0.8223	0.7196
8	2	0.8858	13	0.6754	1.1618	0.7713	1.0173	0.8943
9	3	0.9990	13	0.7665	1.3021	0.8727	1.1436	1.0082
	4	1.0000	Fixed : Reference Age					
10	5	1.0981	12	0.8611	1.4003	0.9700	1.2431	1.1066
11	6	1.1036	12	0.8719	1.3968	0.9786	1.2446	1.1116
	7	1.0000	Fixed : Last true age					

Table. 3.7.10 continued

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model: Populations in year 2001								
12	0	4446509	45	1812779	10906702	2813233	7028013	4937715
13	1	2210594	19	1495426	3267781	1810944	2698442	2254987
14	2	1671461	15	1227986	2275091	1428165	1956203	1692270
15	3	794628	13	606778	1040635	692471	911856	802187
16	4	304359	13	235850	392767	267227	346649	306946
17	5	181384	12	141723	232145	159929	205718	182827
18	6	82902	14	62551	109873	71805	95714	83763
19	7	49016	16	35435	67803	41538	57840	49692
Separable model: Populations at age								
20	1997	72514	22	46530	113008	57825	90935	74396
21	1998	52374	18	36741	74658	43708	62757	53238
22	1999	34537	16	25035	47645	29308	40698	35005
23	2000	31633	15	23238	43063	27027	37025	32028

Table. 3.7.11 WESTERN BALTIC HERRING. Output from ICA Run 22.
Age-structured index catchabilities

FLT22: IYFS Katt/Quarter 3/Age groups 1-

Linear model fitted. Slopes at age :

24	1	Q	.1433E-03	16	.1228E-03	.2304E-03	.1433E-03	.1975E-03	.1704E-03
25	2	Q	.1457E-03	15	.1249E-03	.2338E-03	.1457E-03	.2005E-03	.1731E-03
26	3	Q	.1020E-03	15	.8753E-04	.1637E-03	.1020E-03	.1404E-03	.1212E-03
27	4	Q	.1000E-03	15	.8579E-04	.1606E-03	.1000E-03	.1377E-03	.1189E-03
28	5	Q	.7768E-04	16	.6656E-04	.1251E-03	.7768E-04	.1072E-03	.9244E-04

FLT27: Acoustic Survey in Sub div 22-24
Linear model fitted. Slopes at age :

29	0	Q	.7694E-03	17	.6518E-03	.1283E-02	.7694E-03	.1087E-02	.9284E-03
30	1	Q	.6318E-03	16	.5375E-03	.1040E-02	.6318E-03	.8848E-03	.7584E-03
31	2	Q	.6682E-03	16	.5688E-03	.1098E-02	.6682E-03	.9345E-03	.8014E-03
32	3	Q	.9296E-03	16	.7914E-03	.1527E-02	.9296E-03	.1300E-02	.1115E-02
33	4	Q	.1004E-02	16	.8541E-03	.1650E-02	.1004E-02	.1404E-02	.1204E-02
34	5	Q	.8138E-03	16	.6915E-03	.1344E-02	.8138E-03	.1142E-02	.9781E-03

FLT33: Acoustic Survey in Div IIIa+IVaE
Linear model fitted. Slopes at age :

35	2	Q	.1240E-02	18	.1034E-02	.2167E-02	.1240E-02	.1808E-02	.1524E-02
36	3	Q	.1488E-02	18	.1242E-02	.2599E-02	.1488E-02	.2169E-02	.1828E-02
37	4	Q	.1324E-02	18	.1105E-02	.2314E-02	.1324E-02	.1931E-02	.1628E-02
38	5	Q	.1093E-02	18	.9108E-03	.1915E-02	.1093E-02	.1596E-02	.1345E-02
39	6	Q	.8452E-03	19	.7031E-03	.1491E-02	.8452E-03	.1240E-02	.1043E-02
40	7	Q	.7700E-03	19	.6385E-03	.1372E-02	.7700E-03	.1138E-02	.9539E-03
41	8	Q	.6504E-03	19	.5411E-03	.1147E-02	.6504E-03	.9542E-03	.8024E-03

Table. 3.7.12 WESTERN BALTIC HERRING. Output from ICA Run 22.
RESIDUALS ABOUT THE MODEL FIT Separable Model Residuals
(log(Observed Catch)-log(Expected Catch))

Age	1997	1998	1999	2000	2001
0	0.0871	0.1283	0.1658	-0.8248	0.4727
1	0.0760	0.1096	-0.0610	-0.0439	-0.0285
2	-0.1468	0.1859	0.1817	-0.0042	-0.1137
3	0.1582	-0.1191	0.2492	-0.1327	-0.0622
4	0.1236	0.1403	-0.0183	0.0538	0.0477
5	-0.0693	0.0518	-0.1080	0.1147	-0.0048
6	0.0922	-0.0679	-0.1938	-0.0507	0.2084
7	-0.1095	-0.1402	-0.0580	0.1858	0.0542

Table. 3.7.13 WESTERN BALTIC HERRING. Output from ICA Run 22.
Aged Index Residuals: log(Observed Index) - log(Expected Index)

FLT22: IYFS Katt/Quarter 3/Age groups 1-

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-1.081	0.058	0.514	0.249	0.834	1.025	-1.533	-0.587	-0.008	*******	0.527
2	-1.032	-0.738	-0.223	0.587	0.642	0.863	0.060	-0.364	0.043	*******	0.159
3	-0.240	-0.308	-0.707	0.726	0.901	-0.043	-0.423	-0.641	0.408	*******	0.324
4	-0.494	-0.054	-0.319	0.206	1.010	-0.122	-0.623	0.063	0.410	*******	-0.082
5	-0.442	-0.121	0.017	0.706	0.619	-0.038	0.616	-0.202	0.316	*******	-1.478

FLT27: Acoustic Survey in Sub div 22-24

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.855	0.240	-0.852	0.215	0.566	-0.498	0.229	-0.251	0.374	-0.596	-0.284
1	0.577	0.355	-0.992	-0.677	0.078	0.231	0.405	-0.580	0.011	-0.039	0.629
2	0.370	0.116	-0.850	0.443	-0.274	-0.037	0.035	0.091	-0.635	-0.239	0.976
3	0.289	-0.290	-0.355	-0.113	-0.107	0.482	-0.183	0.057	-0.731	0.064	0.883
4	-0.259	-0.742	-0.149	0.219	0.070	0.508	0.079	0.013	-0.447	-0.020	0.723
5	-0.382	-1.106	-0.623	0.135	0.505	1.003	0.528	0.567	-0.798	0.030	0.135

FLT33: Acoustic Survey in Div IIIa+IVaE

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	-0.065	0.089	0.495	-0.966	0.788	-0.140	-0.314	0.471	*******	0.406	-0.766
3	0.030	0.260	0.027	-0.152	0.422	-0.641	0.063	0.376	*******	0.129	-0.518
4	-0.031	0.594	-0.093	-0.051	0.977	-0.619	-0.218	-0.186	*******	0.147	-0.525
5	-0.399	0.350	0.222	-0.035	0.137	-0.326	-0.402	0.262	*******	0.431	-0.246
6	-0.697	-0.076	0.017	0.541	0.682	-0.807	0.182	0.290	*******	0.006	-0.146
7	0.935	0.244	-0.455	-0.092	-0.073	-0.626	0.767	0.154	*******	-0.814	-0.052
8	0.117	-0.549	-0.907	-0.122	0.006	-0.670	0.856	1.079	*******	-0.244	0.420

Table. 3.7.14 WESTERN BALTIC HERRING. Output from ICA Run 22.
PARAMETERS OF THE DISTRIBUTION OF ln CATCHES-AT-AGE

Separable model fitted from 1997 to 2001

Variance	0.0345
Skewness test stat.	0.7116
Kurtosis test statistic	-0.9657
Partial chi-square	0.0507
Significance in fit	0.0000
Degrees of freedom	17

Table. 3.7.15 WESTERN BALTIC HERRING. Output from ICA Run 22. PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR FLT22: IYFS Katt/Quarter 3/Age groups 1-
Linear catchability relationship assumed

Age	1	2	3	4	5
Variance	0.1381	0.0739	0.0634	0.0443	0.0844
Skewness test stat.	-0.8200	-0.3010	0.4072	1.0308	-1.3608
Kurtosis test statisti	-0.4761	-0.5952	-0.7963	0.1604	0.4613
Partial chi-square	0.2230	0.1302	0.1410	0.1169	0.3273
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	10	10	10	10	10
Degrees of freedom	9	9	9	9	9
Weight in the analysis	0.2000	0.2000	0.2000	0.2000	0.2000

DISTRIBUTION STATISTICS FOR FLT27: Acoustic Survey in Sub div 22-24
Linear catchability relationship assumed

Age	0	1	2	3	4	5
Variance	0.0470	0.0476	0.0428	0.0318	0.0280	0.0716
Skewness test stat.	-0.0926	-0.8510	0.1819	0.6085	0.0041	-0.3462
Kurtosis test statisti	-0.7295	-0.5693	-0.1572	-0.0228	-0.2083	-0.6844
Partial chi-square	0.0607	0.0697	0.0660	0.0526	0.0500	0.1463
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	11	11	11	11	11	11
Degrees of freedom	10	10	10	10	10	10
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

DISTRIBUTION STATISTICS FOR FLT33: Acoustic Survey in Div IIIa+IVaE
Linear catchability relationship assumed

Age	2	3	4	5	6	7	8
Variance	0.0461	0.0176	0.0330	0.0148	0.0324	0.0448	0.0593
Skewness test stat.	-0.4971	-0.8946	1.0152	-0.1073	-0.5067	0.3505	0.4149
Kurtosis test statisti	-0.5976	-0.3811	-0.0553	-1.0233	-0.4299	-0.5191	-0.5952
Partial chi-square	0.0590	0.0247	0.0493	0.0258	0.0637	0.1205	0.1705
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	10	10	10	10	10	10	10
Degrees of freedom	9	9	9	9	9	9	9
Weight in the analysis	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429

Table. 3.7.16 WESTERN BALTIC HERRING. Output from ICA Run 22. ANALYSIS OF VARIANCE TABLE

Unweighted Statistics
Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	51.3840	226	41	185	0.2778
Catches-at-age	1.4463	40	23	17	0.0851
Aged Indices					
FLT22: IYFS Katt/Quarter 3/Age groups	18.1838	50	5	45	0.4041
FLT27: Acoustic Survey in Sub div 22-2	16.1285	66	6	60	0.2688
FLT33: Acoustic Survey in Div IIIa+IVa	15.6254	70	7	63	0.2480

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	2.0808	226	41	185	0.0112
Catches-at-age	0.5866	40	23	17	0.0345
Aged Indices					
FLT22: IYFS Katt/Quarter 3/Age groups	0.7274	50	5	45	0.0162
FLT27: Acoustic Survey in Sub div 22-2	0.4480	66	6	60	0.0075
FLT33: Acoustic Survey in Div IIIa+IVa	0.3189	70	7	63	0.0051

Table 3.8.1 WESTERN BALTIC HERRING. Input table for short-term predictions.

MFDP version 1a
Run: WBSS
Time and date: 16:04 19/03/02
Fbar age range: 3-6

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	4490961	0.3	0	0.1	0.25	0.000	0.118	0.015
1	3195800	0.5	0	0.1	0.25	0.017	0.337	0.028
2	932700	0.2	0.2	0.1	0.25	0.050	0.420	0.062
3	871400	0.2	0.75	0.1	0.25	0.084	0.473	0.096
4	391100	0.2	0.9	0.1	0.25	0.117	0.474	0.121
5	149700	0.2	1	0.1	0.25	0.154	0.520	0.151
6	84900	0.2	1	0.1	0.25	0.166	0.523	0.154
7	38700	0.2	1	0.1	0.25	0.159	0.474	0.157
8	33300	0.2	1	0.1	0.25	0.171	0.474	0.165

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	4490961	0.3	0	0.1	0.25	0.000	0.118	0.015
1	.	0.5	0	0.1	0.25	0.017	0.337	0.028
2	.	0.2	0.2	0.1	0.25	0.050	0.420	0.062
3	.	0.2	0.75	0.1	0.25	0.084	0.473	0.096
4	.	0.2	0.9	0.1	0.25	0.117	0.474	0.121
5	.	0.2	1	0.1	0.25	0.154	0.520	0.151
6	.	0.2	1	0.1	0.25	0.166	0.523	0.154
7	.	0.2	1	0.1	0.25	0.159	0.474	0.157
8	.	0.2	1	0.1	0.25	0.171	0.474	0.165

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	4490961	0.3	0	0.1	0.25	0.000	0.118	0.015
1	.	0.5	0	0.1	0.25	0.017	0.337	0.028
2	.	0.2	0.2	0.1	0.25	0.050	0.420	0.062
3	.	0.2	0.75	0.1	0.25	0.084	0.473	0.096
4	.	0.2	0.9	0.1	0.25	0.117	0.474	0.121
5	.	0.2	1	0.1	0.25	0.154	0.520	0.151
6	.	0.2	1	0.1	0.25	0.166	0.523	0.154
7	.	0.2	1	0.1	0.25	0.159	0.474	0.157
8	.	0.2	1	0.1	0.25	0.171	0.474	0.165

Input units are thousands and kg - output in tonnes

Table 3.8.2 **WESTERN BALTIC HERRING.**

Management option table for 2003, assuming status quo F in 2002

MFDP version 1a
Run: WBSS
Western Baltic Herring (combined sex; plus group)
Time and date: 16:04 19/03/02
Fbar age range: 3-6

2002				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
270242	139690	1.0000	0.4976	107394

2003					2004	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
270737	140505	0.0000	0.0000	0	394446	224223
.	139829	0.1000	0.0498	12763	379714	213227
.	139156	0.2000	0.0995	25018	365589	202776
.	138487	0.3000	0.1493	36784	352045	192842
.	137820	0.4000	0.1990	48084	339058	183399
.	137157	0.5000	0.2488	58937	326602	174423
.	136497	0.6000	0.2985	69363	314657	165890
.	135841	0.7000	0.3483	79378	303199	157779
.	135187	0.8000	0.3981	89002	292207	150069
.	134537	0.9000	0.4478	98249	281663	142738
.	133890	1.0000	0.4976	107137	271547	135770
.	133246	1.1000	0.5473	115680	261840	129145
.	132605	1.2000	0.5971	123894	252525	122846
.	131967	1.3000	0.6468	131791	243586	116858
.	131332	1.4000	0.6966	139385	235006	111164
.	130701	1.5000	0.7464	146689	226770	105751
.	130072	1.6000	0.7961	153715	218864	100604
.	129446	1.7000	0.8459	160474	211274	95710
.	128824	1.8000	0.8956	166978	203986	91057
.	128204	1.9000	0.9454	173238	196988	86632
.	127587	2.0000	0.9952	179262	190267	82424

Input units are thousands and kg - output in tonnes

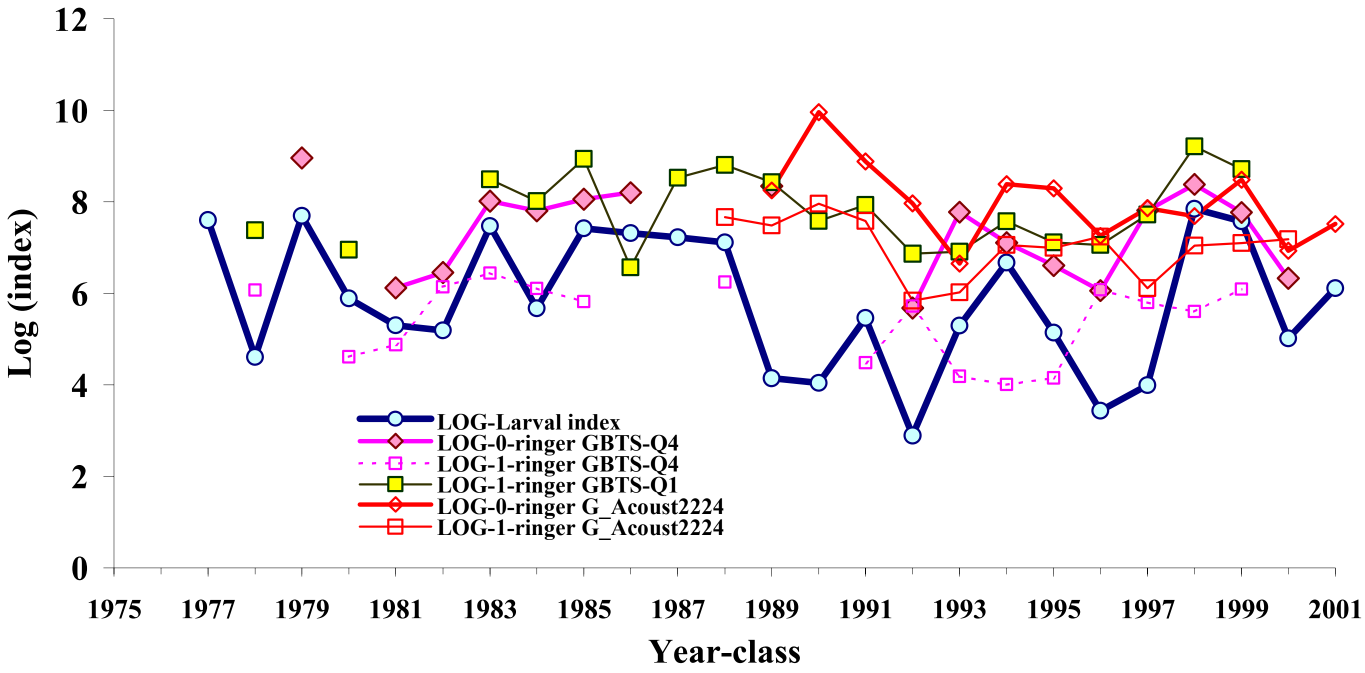
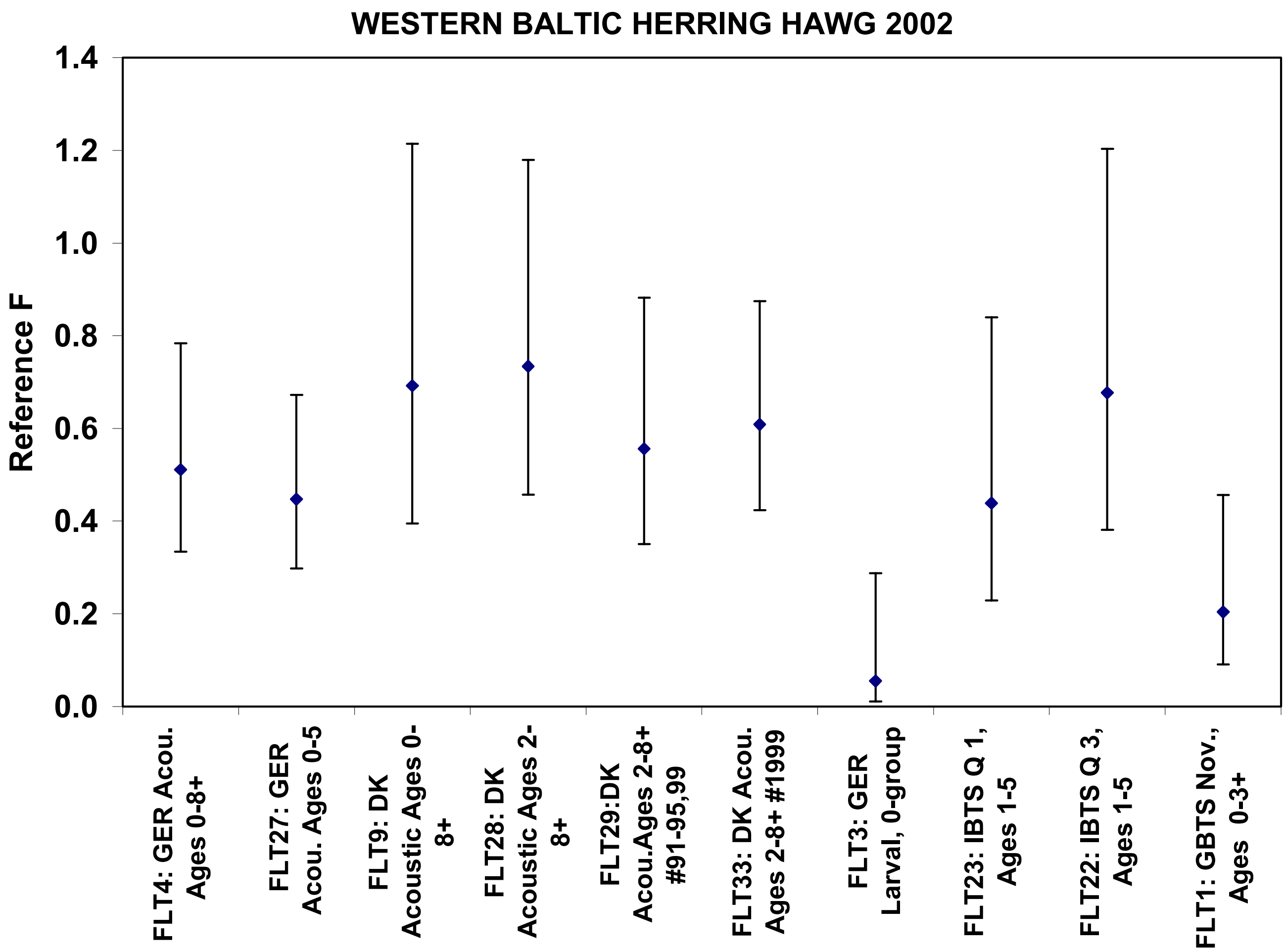
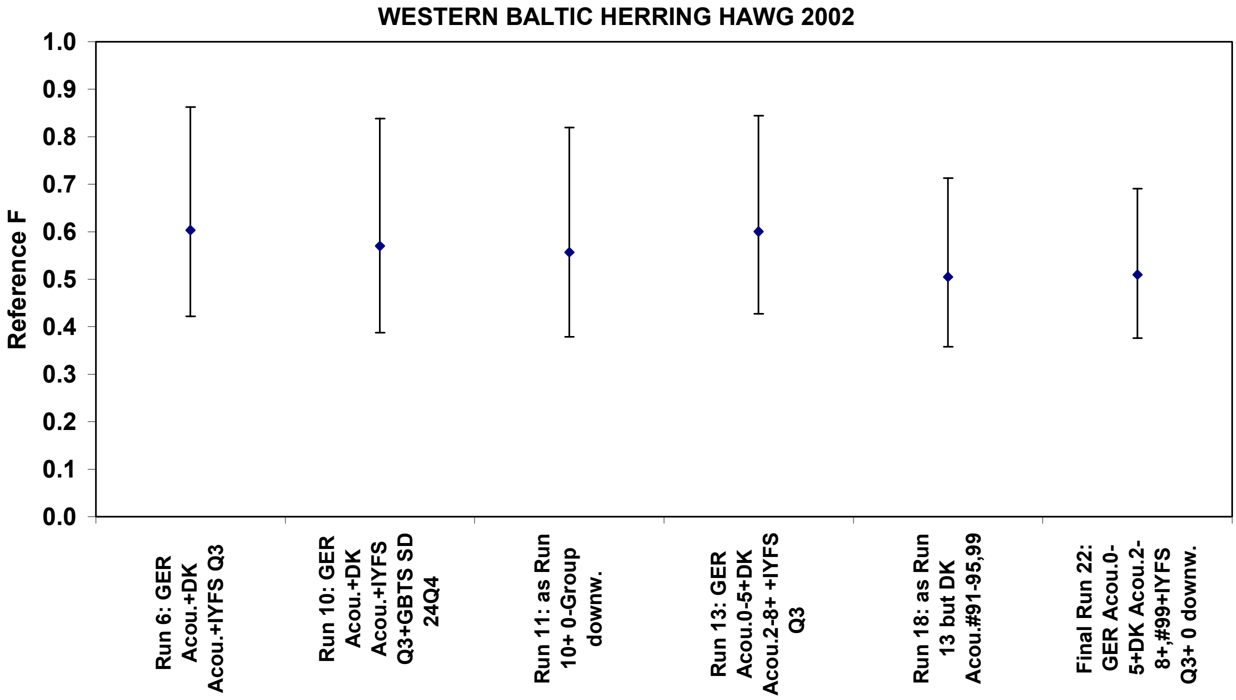


Figure 3.6.1 **WESTERN BALTIC HERRING. Recruitment indices (natural log) adjusted to year-class, versus time. (GBTS = German Bottom Traw Survey)**



Fleet No.	Survey	Area	Quarter	Ages	Mean F 2001	Lower 95% CL	Upper 95% CL	SSB 2001
4	FLT4: GER Acou. Ages 0-8+	SD 22, 23, 24	4	0-8+	0.51	0.33	0.78	151376
27	FLT27: GER Acou. Ages 0-5	SD 22, 23, 24	4	0-5	0.45	0.30	0.67	170268
9	FLT9: DK Acoustic Ages 0-8+	Div. IIIa incl. Katt.	3	0-8+	0.69	0.39	1.21	119292
28	FLT28: DK Acoustic Ages 2-8+	Div. IIIa incl. Katt.	3	2-8+	0.73	0.46	1.18	110020
29	FLT29:DK Acou.Ages 2-8+ #91-95,99	Div. IIIa incl. Katt.	3	2-8+	0.56	0.35	0.88	134745
33	FLT33: DK Acou. Ages 2-8+ #1999	Div. IIIa incl. Katt.	3	2-8+	0.61	0.42	0.87	122721
3	FLT3: GER Larval, 0-group	SD 24	1-2	0	0.05	0.01	0.29	1479850
23	FLT23: IBTS Q 1, Ages 1-5	Kattegat	1	1-5	0.44	0.23	0.84	164989
22	FLT22: IBTS Q 3, Ages 1-5	Kattegat	3	1-5	0.68	0.38	1.20	122026
1	FLT1: GBTS Nov., Ages 0-3+	SD 24	4	0-3+	0.20	0.09	0.46	358073

Figure 3.7.1a WESTERN BALTIC HERRING. Estimates of mean F and SSB by ICA runs by individual fleets and catch at age data for 1991-2001



Run No.	Fleet No.	Survey	Area	Quarter	Ages	Mean F 2001	Lower 95% CL	Upper 95% CL	SSB 2001
6	4+9+22	Run 6: GER Acou.+DK Acou.+IYFS Q3	Div. IIIa+ Katt.+SD 22, 23, 24	3+4	0-8+	0.60	0.42	0.86	132671
10	1+22+27+28	Run 10: GER Acou.+DK Acou.+IYFS Q3+GBTS SD 24Q4	Div. IIIa+ Katt.+SD 22, 23, 24	3+4	0-8+	0.57	0.39	0.84	147597
11	1+22+27+28	Run 11: as Run 10+ 0-Group downw.	Div. IIIa+ Katt.+SD 22, 23, 24	3+4	0-8+	0.56	0.38	0.82	145512
13	22+27+28	Run 13: GER Acou.0-5+DK Acou.2-8+ +IYFS Q3	Div. IIIa+ Katt.+SD 22, 23, 24	3+4	0-8+	0.60	0.43	0.84	131767
18	22+27+29	Run 18: as Run 13 but DK Acou.#91-95,99	Div. IIIa+ Katt.+SD 22, 23, 24	3+4	0-8+	0.50	0.36	0.71	147550
22	22+27+33	Final Run 22: GER Acou.0-5+DK Acou.2-8+,#99+IYFS Q3+ 0 downw.	Div. IIIa+ Katt.+SD 22, 23, 24	3+4	0-8+	0.51	0.38	0.69	137931
21	22+27+29	Run 21: as Run 18 + new maturity ogives	Div. IIIa+ Katt.+SD 22, 23, 24	3+4	0-8+	0.50	0.36	0.71	128895

Figure 3.7.1b WESTERN BALTIC HERRING:
Estimates of mean F and SSB by ICA runs by combined fleets and catc h at age data for 1991 to 2001

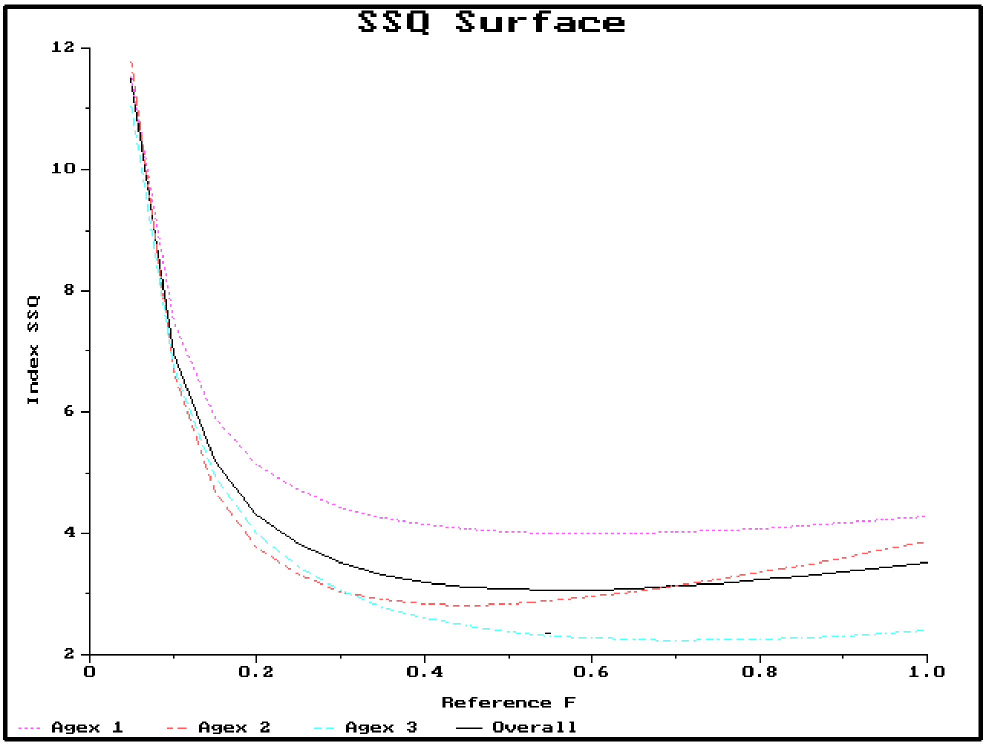


Figure 3.7.2 Western Baltic Herring. Output from ICA Run 22:
Index sum of squares of deviations between model and observations (survey index) as a function of the reference F in 2001.
INDEX 22: IYFS in Kattegat, Quarter 3, Ages 1-5
INDEX 27: Acoustic Survey, Subdivisions 22-24, Sept./Oct., Ages 0-5
INDEX 33: Acoustic Survey, Div. IIIa+IvaE, July, Ages 2-8+

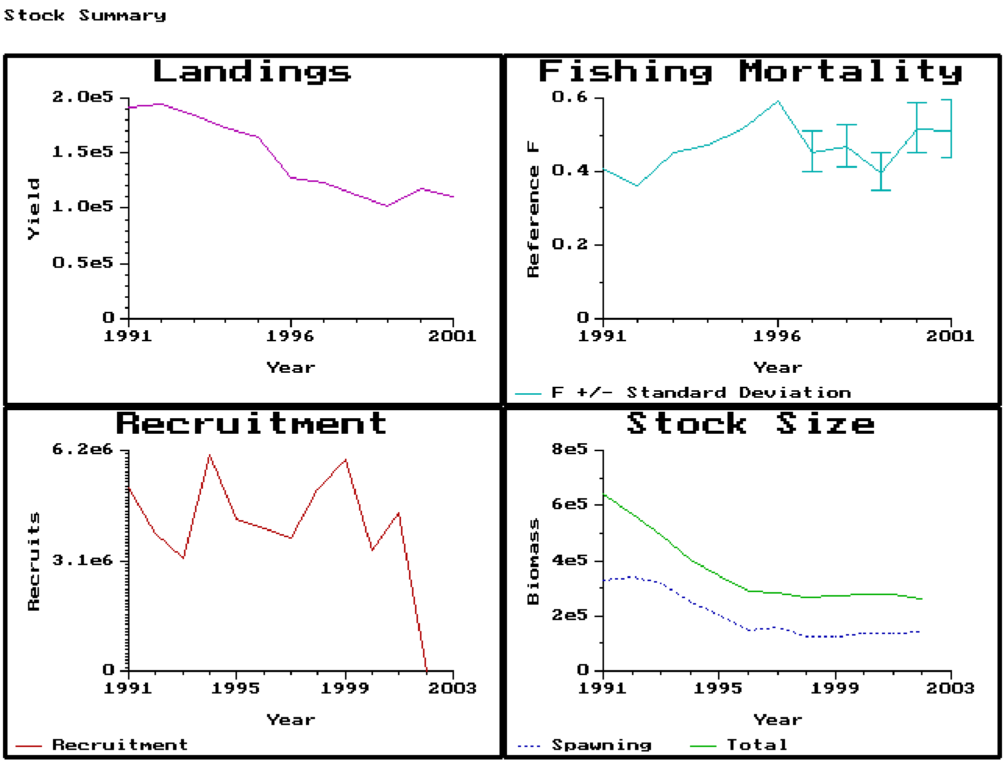


Figure 3.7.3 Western Baltic Herring. Out put from ICA Run 22: Stock Summary

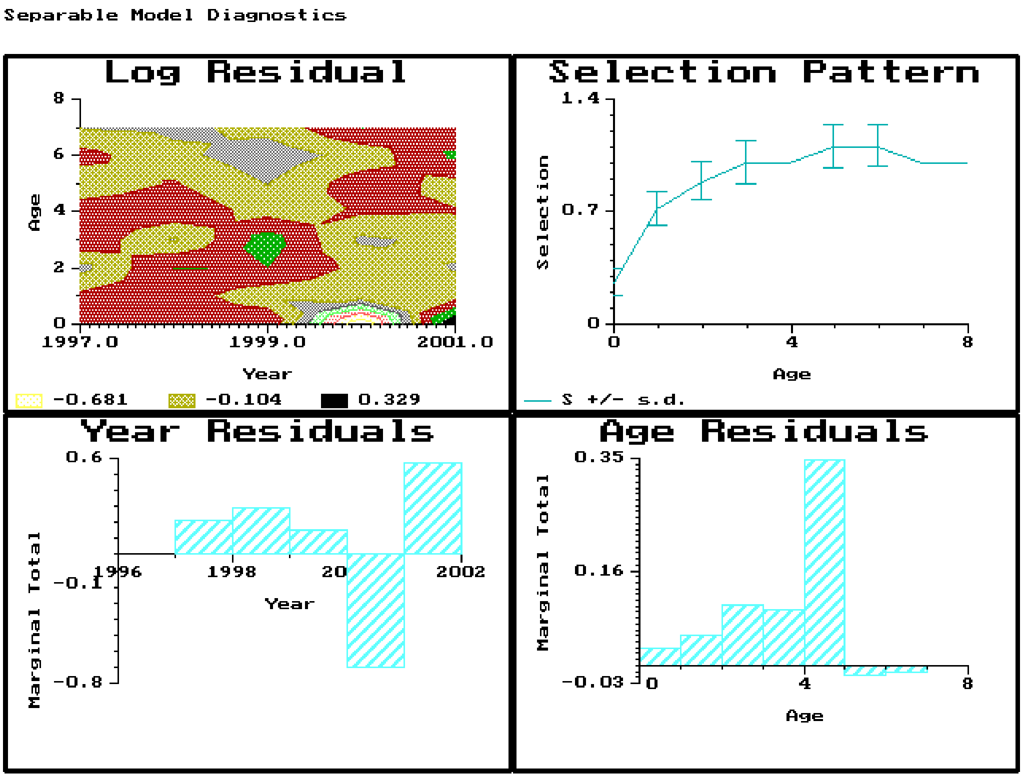


Figure 3.7.4 Western Baltic Herring. Out put from ICA Run 22: Separable Model Diagnostics

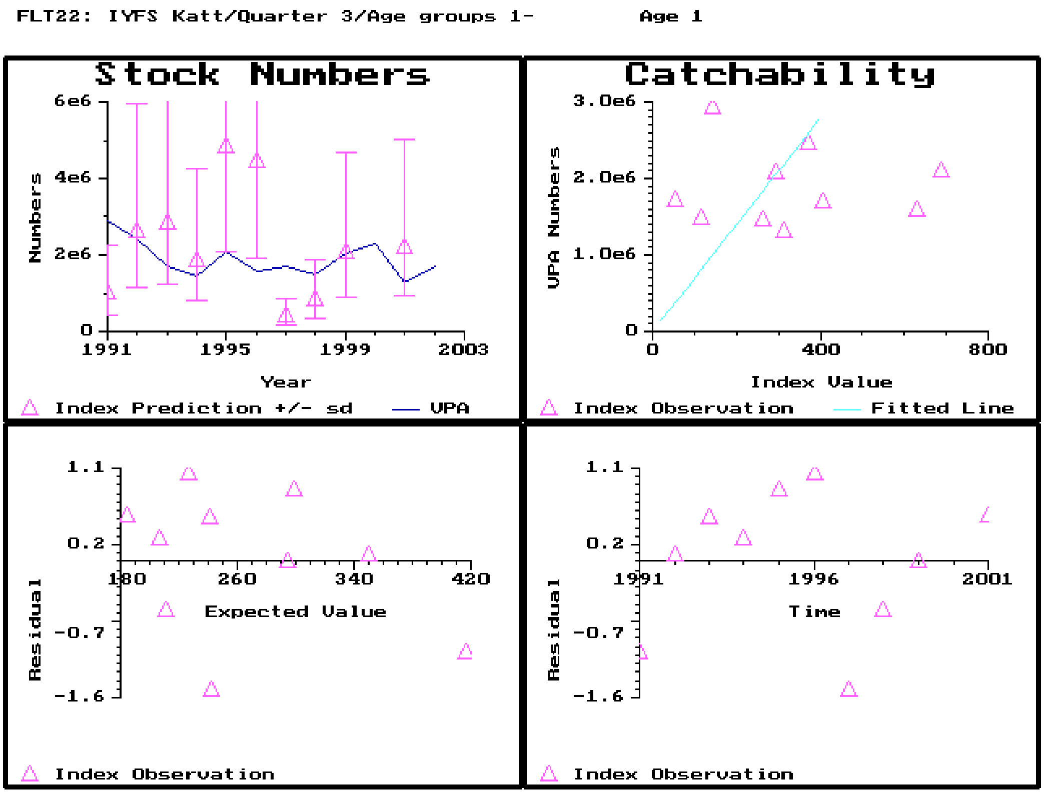


Figure 3.7.5a Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics. Index 22: IYFS, Kattegat, Quarter 3, Age 1

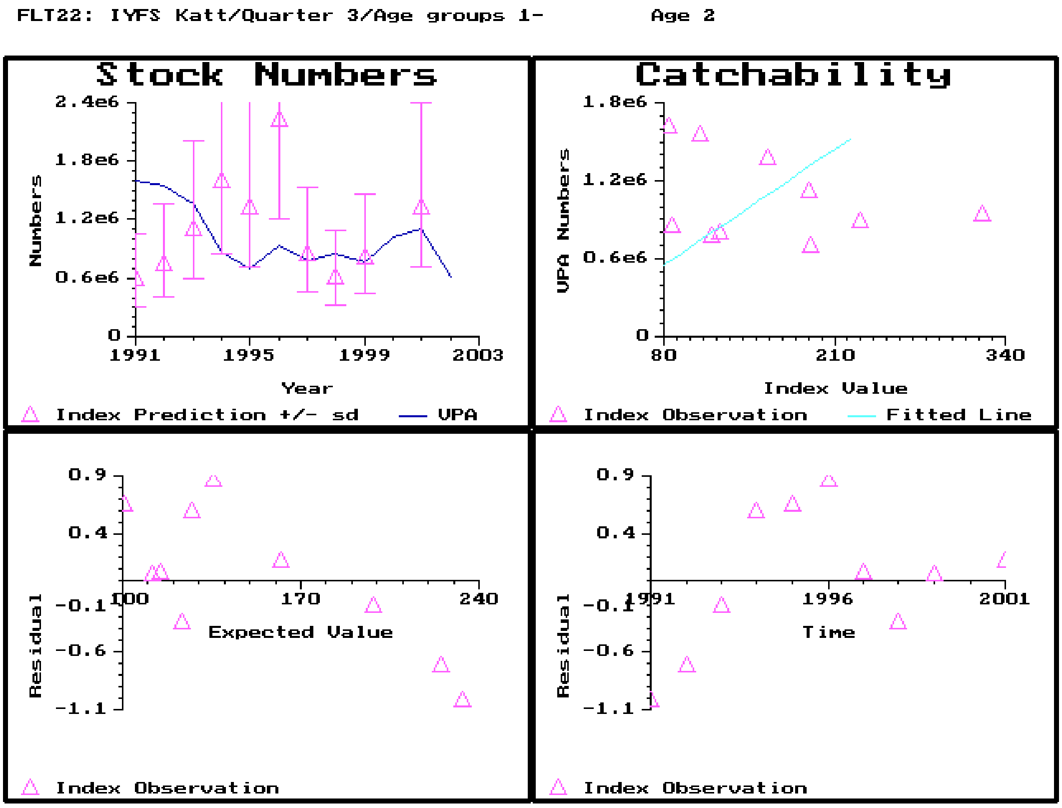


Figure 3.7.5b Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics. Index 22: IYFS, Kattegat, Quarter 3, Age 2

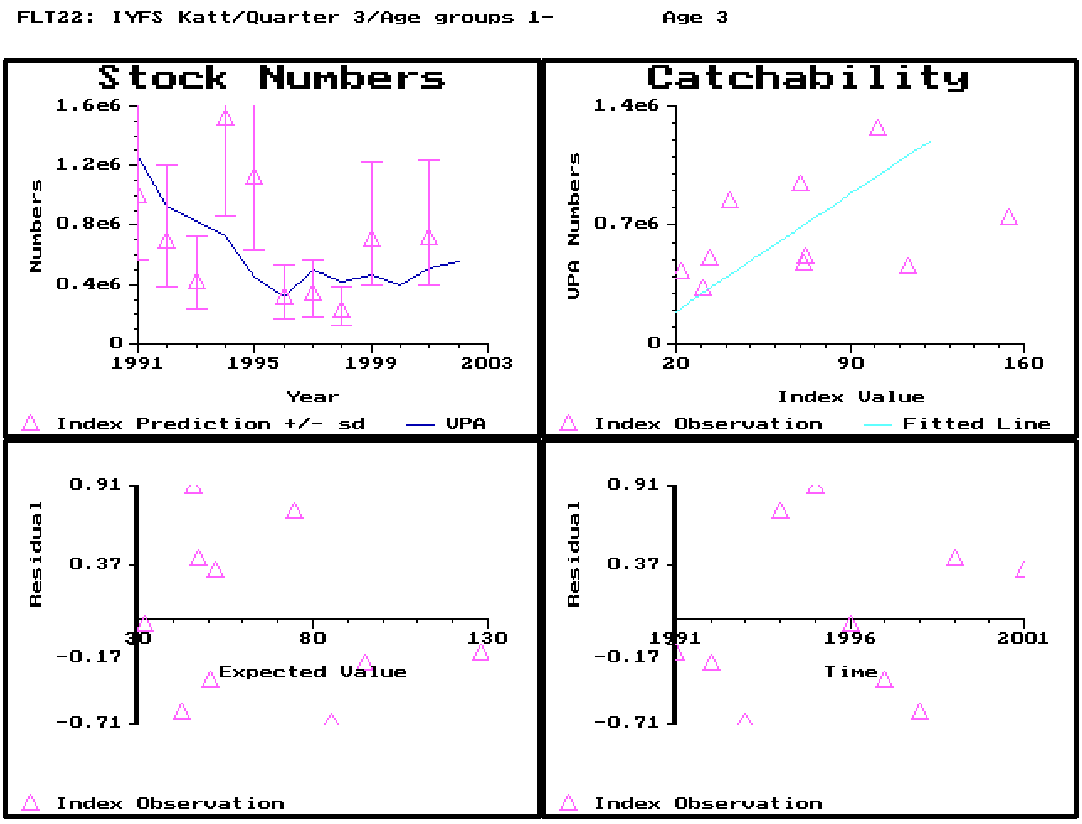


Figure 3.7.5c Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics. Index 22: IYFS, Kattegat, Quarter 3, Age 3

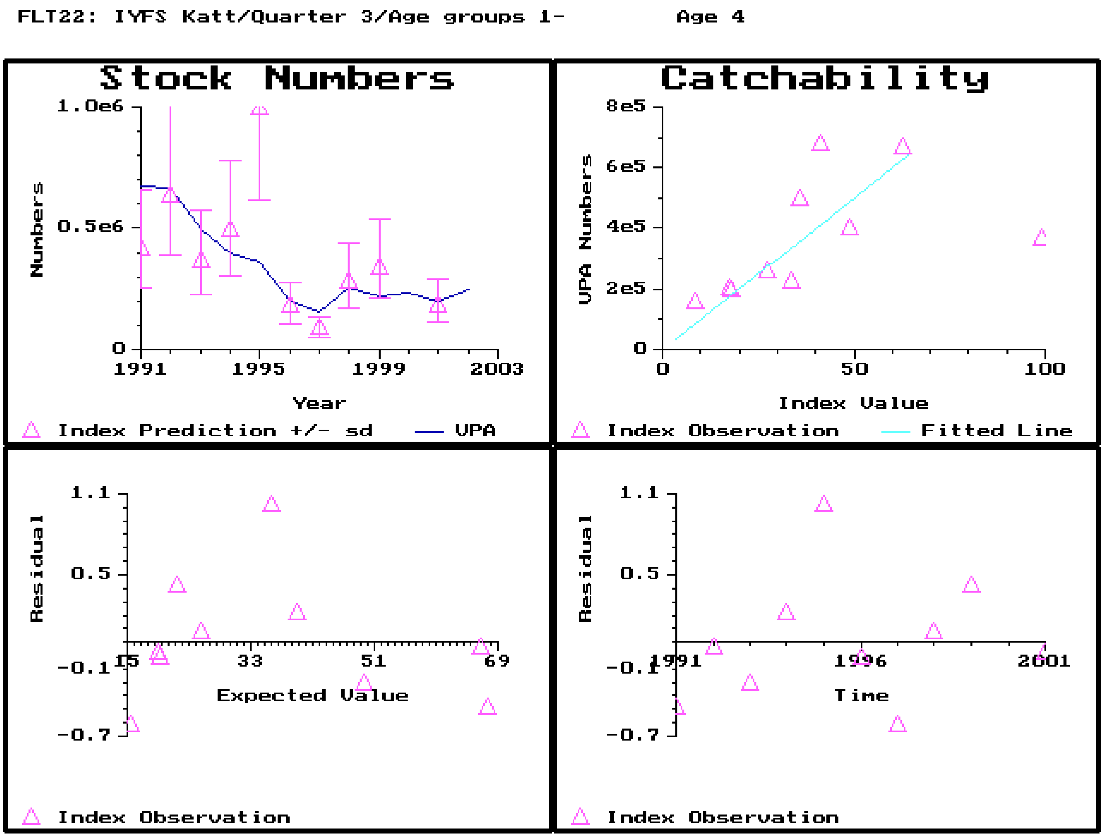


Figure 3.7.5d Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics.
Index 22: IYFS, Kattegat, Quarter 3, Age 4

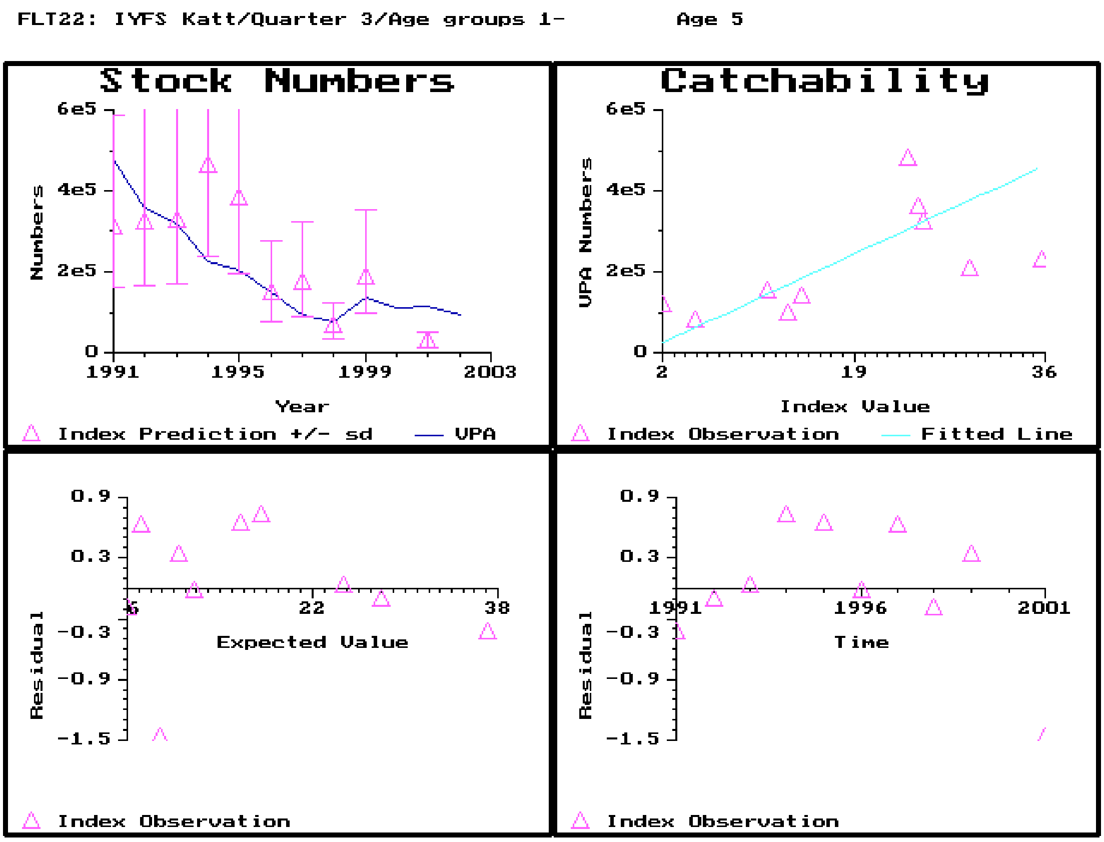


Figure 3.7.5e Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics.
Index 22: IYFS, Kattegat, Quarter 3, Age 5

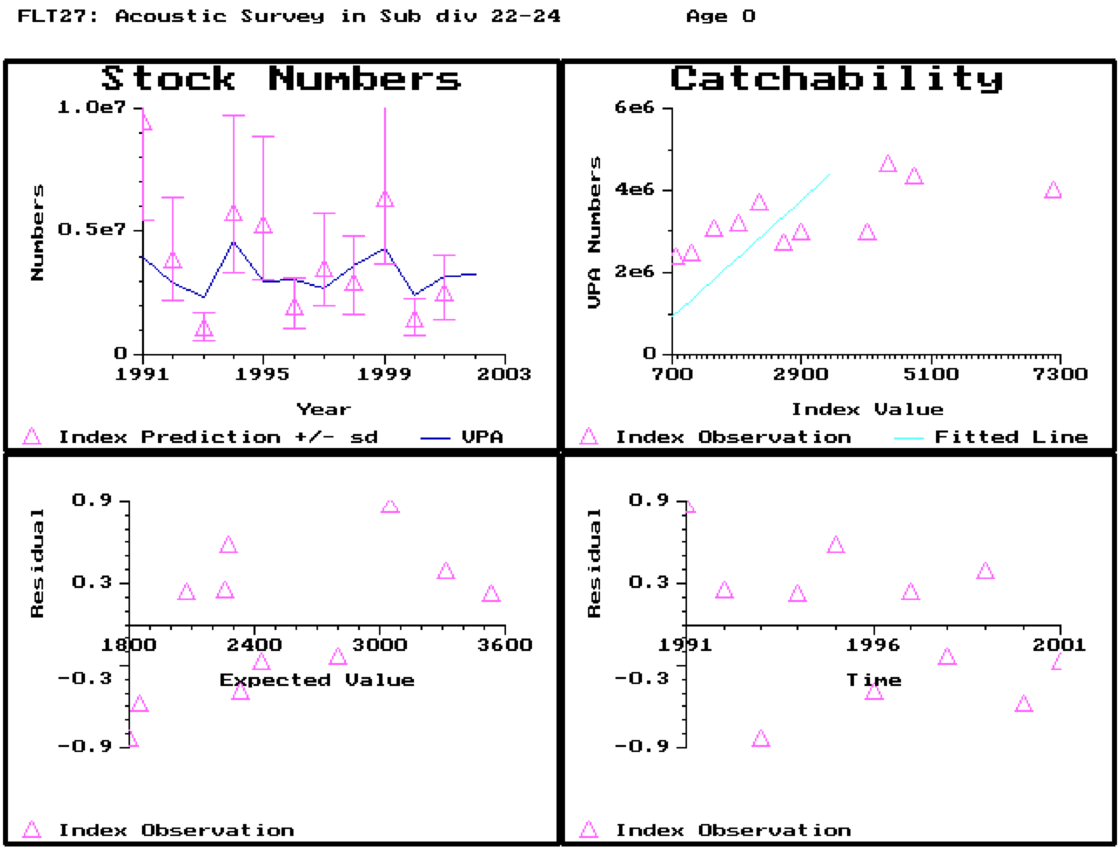
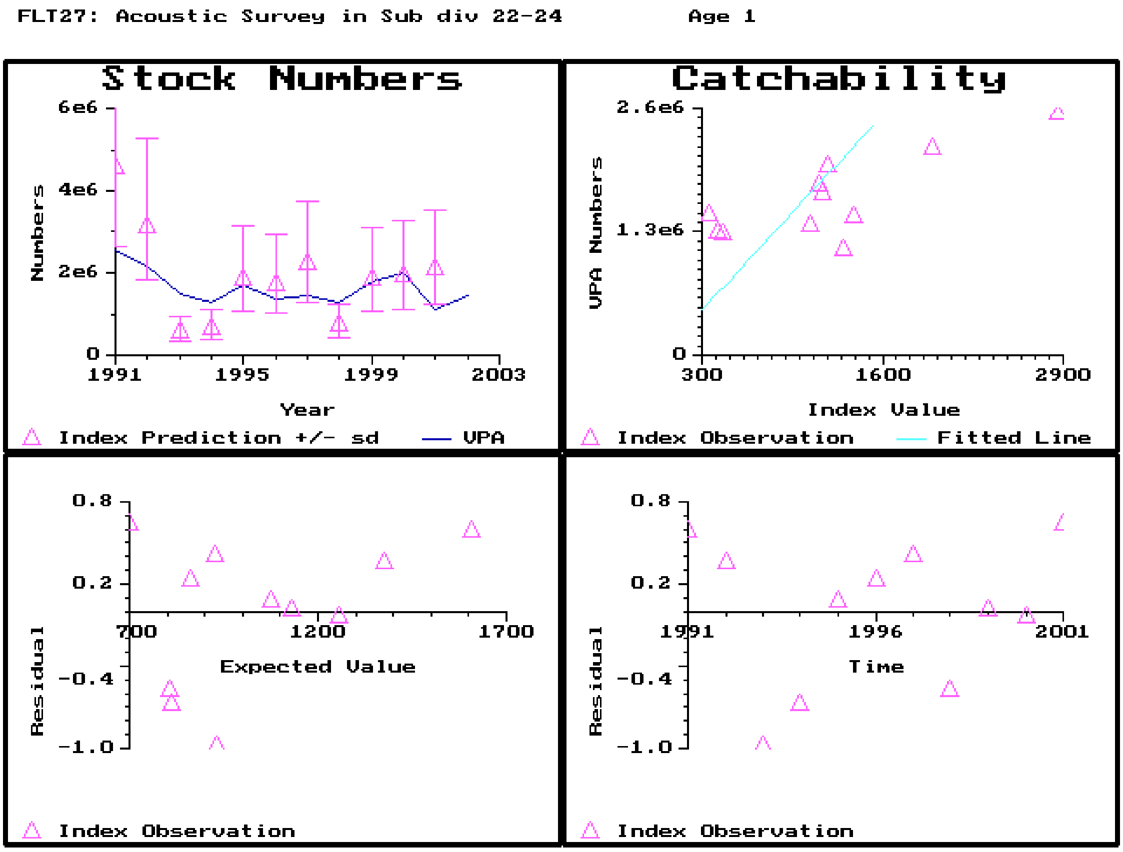


Figure 3.7.6a Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics.



Index 27: Acoustic Survey, SD 22-24, Sep./Oct., Age group 0

Figure 3.7.6b Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics.
Index 27: Acoustic Survey, SD 22-24, Sep./Oct., Age group 1

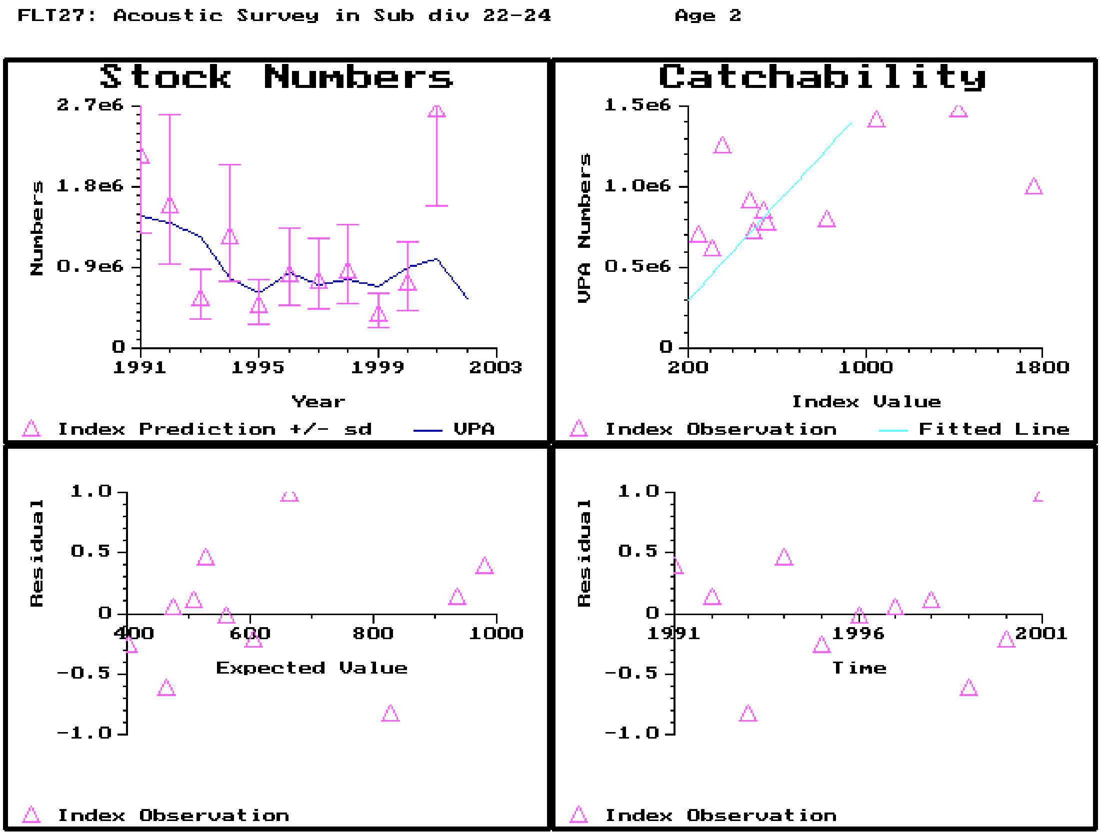


Figure 3.7.6c Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics.
Index 27: Acoustic Survey, SD 22-24, Sep./Oct., Age group 2

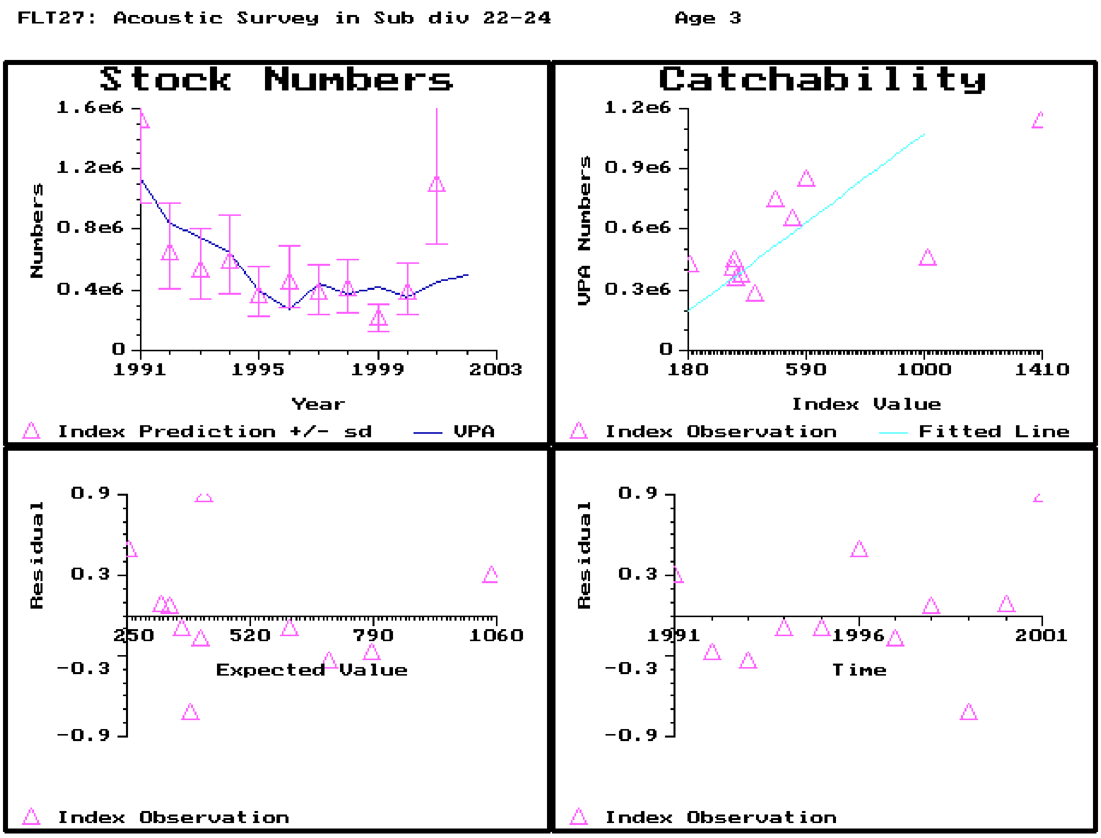


Figure 3.7.6d Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics.
Index 27: Acoustic Survey, SD 22-24, Sep./Oct., Age group 3

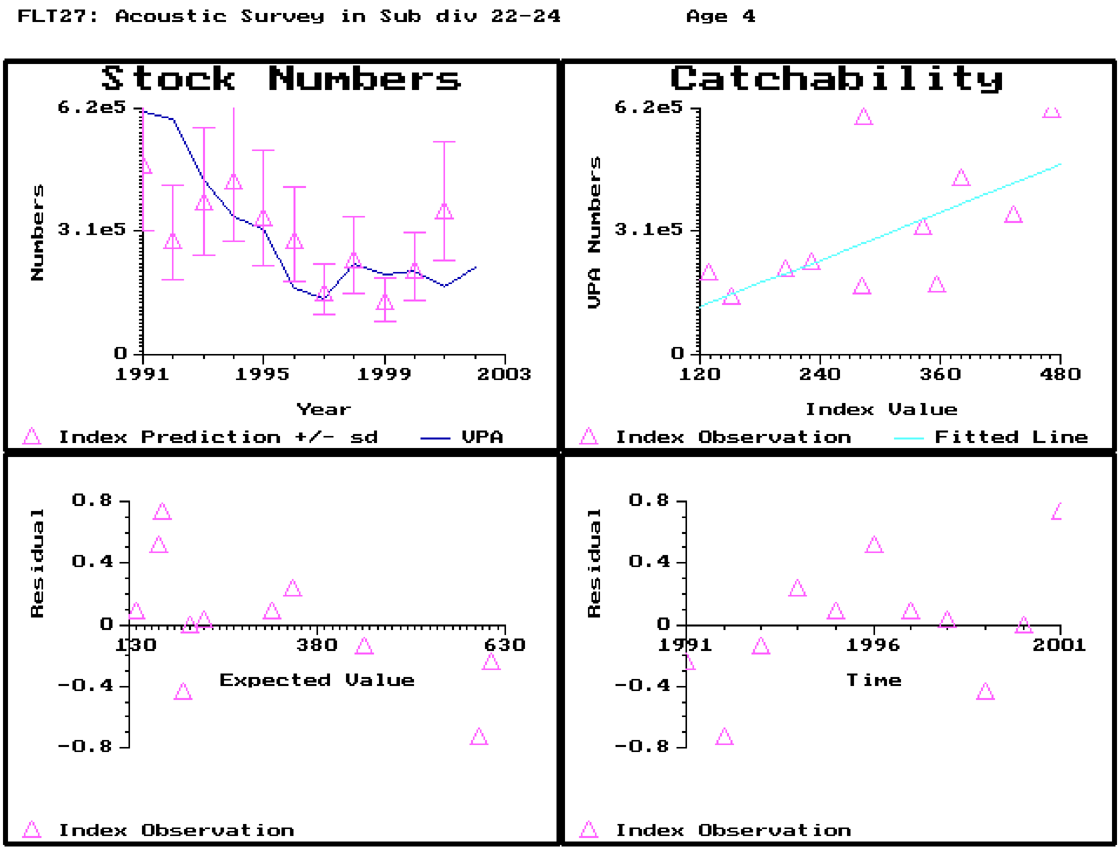


Figure 3.7.6e Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics.
Index 27: Acoustic Survey, SD 22-24, Sep./Oct., Age group 4

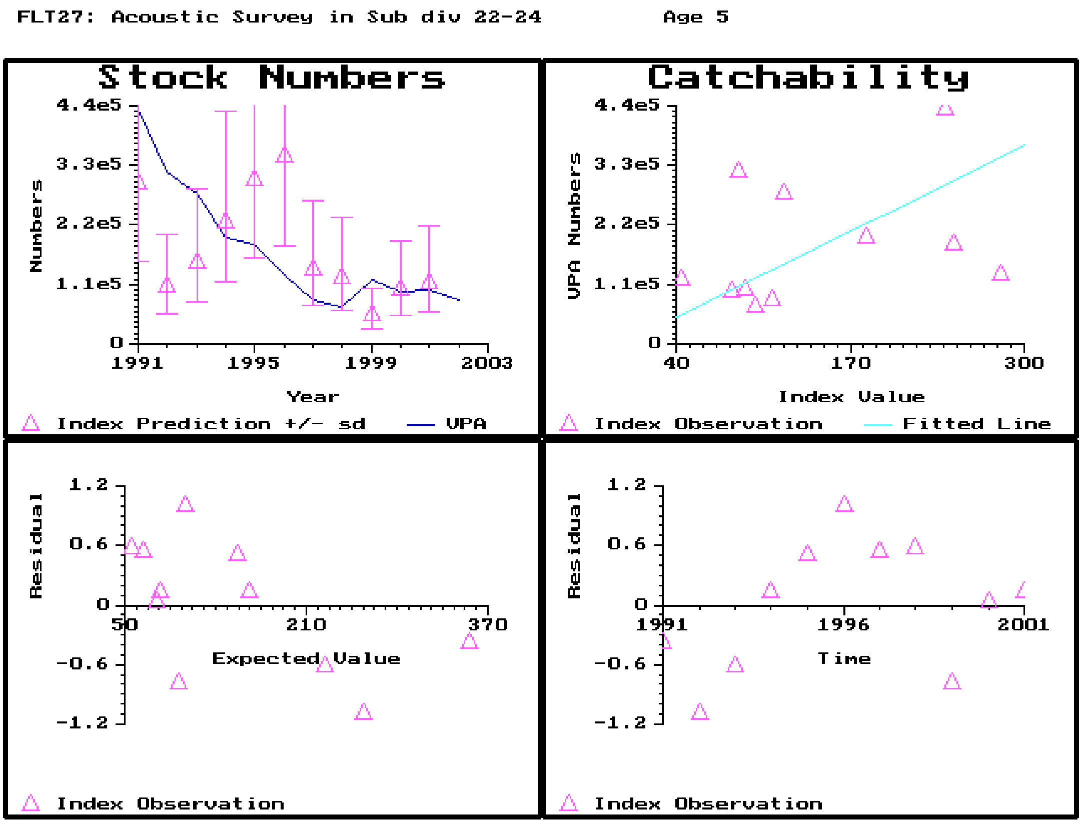


Figure 3.7.6f Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics.
Index 27: Acoustic Survey, SD 22-24, Sep./Oct., Age group 5

FLT33: Acoustic Survey in Div IIIa+IVaE Age 2

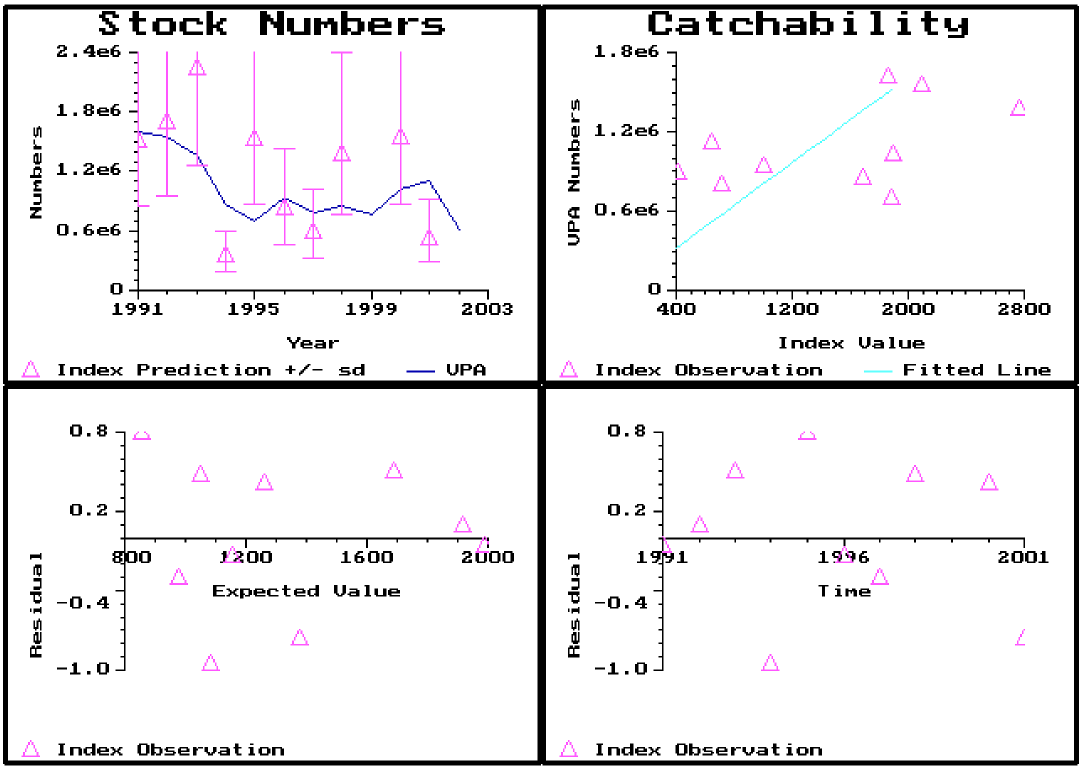


Figure 3.7.7a Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics. Index 33: Acoustic Survey, Division IIIa+IvaE, July, Age group 2

FLT33: Acoustic Survey in Div IIIa+IVaE Age 3

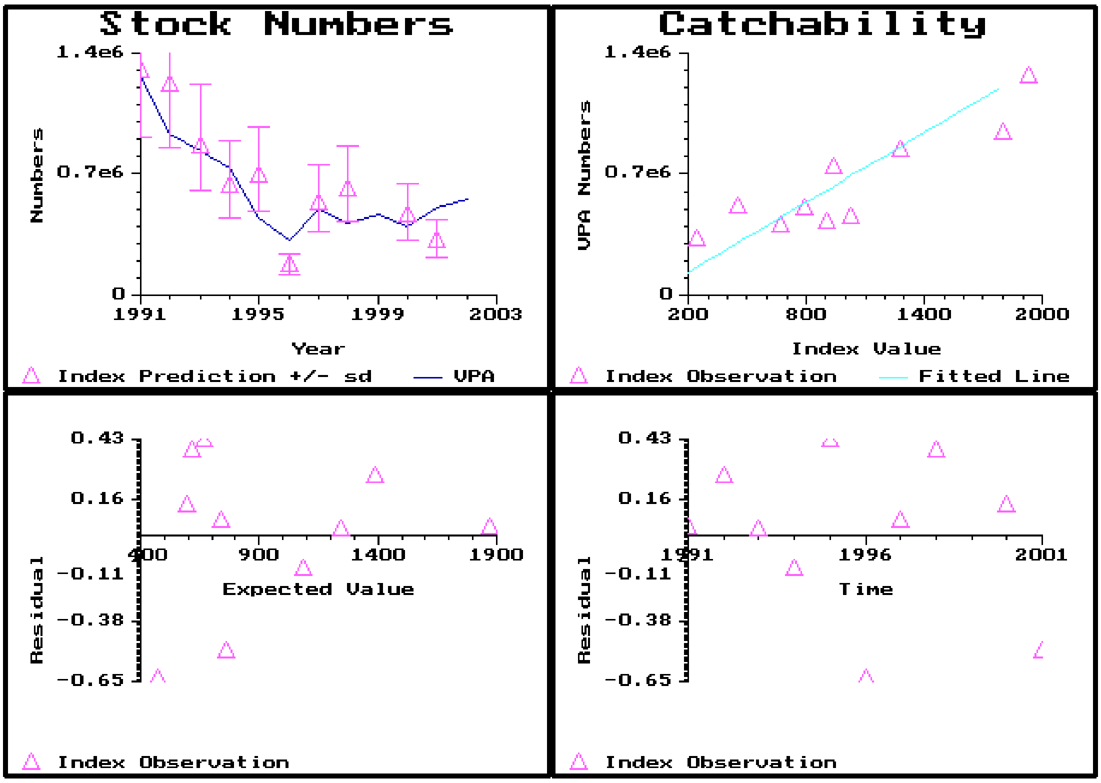


Figure 3.7.7b Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics. Index 33: Acoustic Survey, Division IIIa+IvaE, July, Age group 3

FLT33: Acoustic Survey in Div IIIa+IVaE Age 4

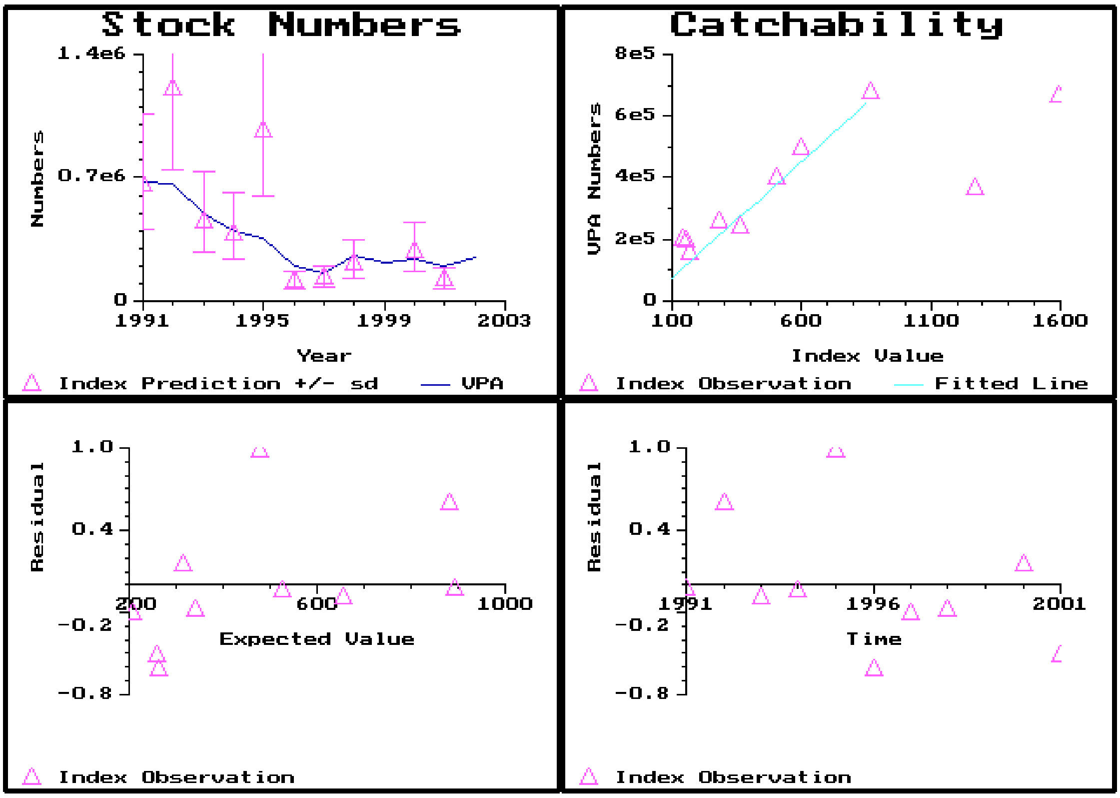


Figure 3.7.7c Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics. Index 33: Acoustic Survey, Division IIIa+IvaE, July, Age group 4

FLT33: Acoustic Survey in Div IIIa+IVaE Age 5

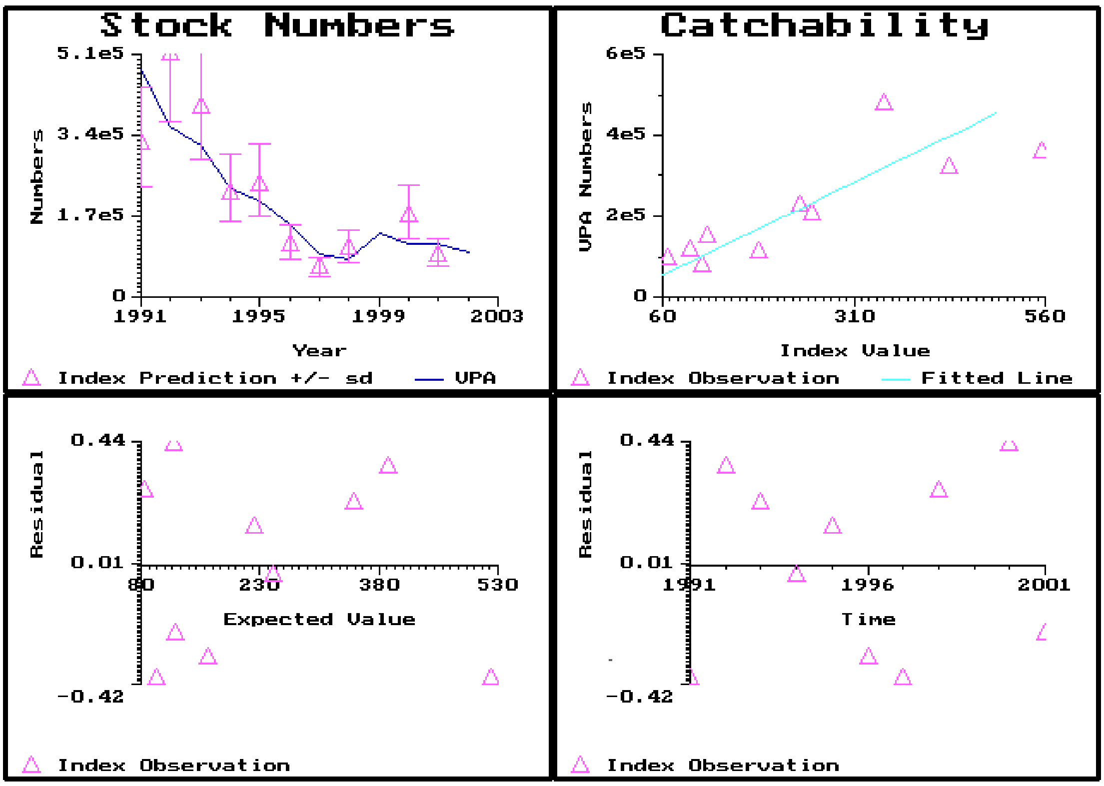


Figure 3.7.7d Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics. Index 33: Acoustic Survey, Division IIIa+IvaE, July, Age group 5

FLT33: Acoustic Survey in Div IIIa+IVaE   Age 6

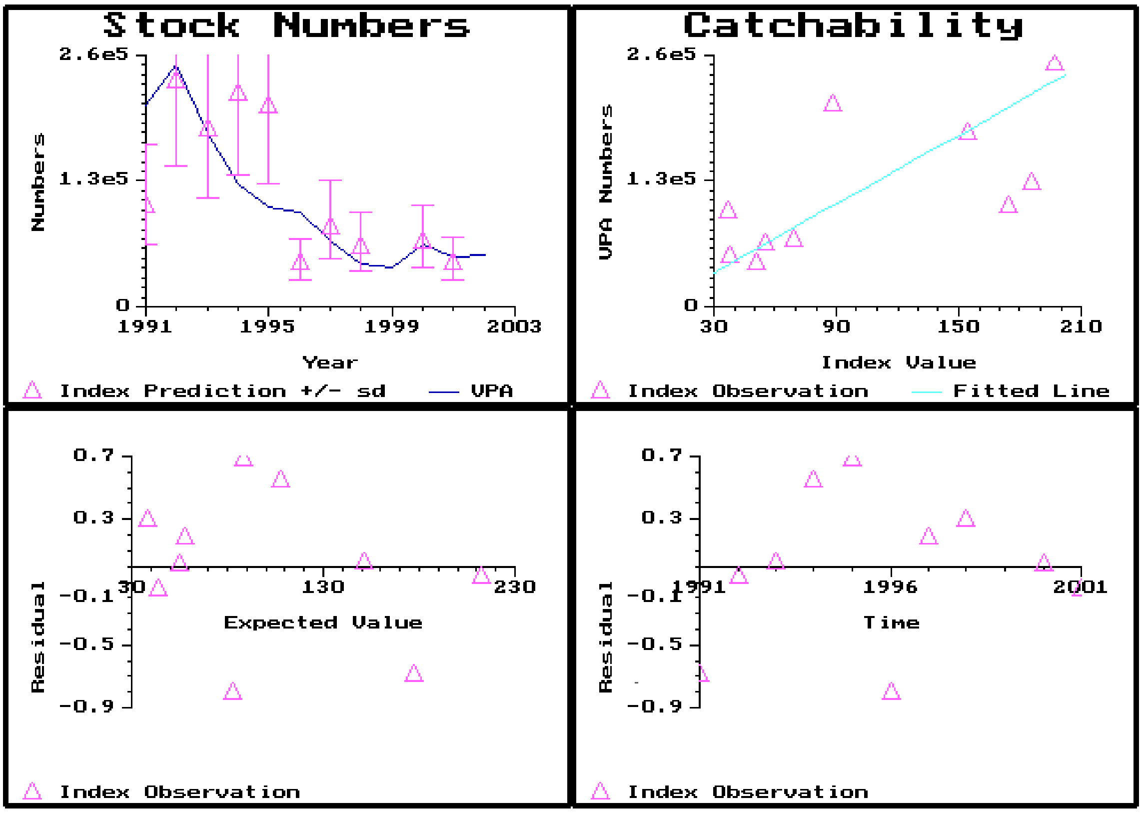


Figure 3.7.7e Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics. Index 33: Acoustic Survey, Division IIIa+IvaE, July, Age group 6

FLT33: Acoustic Survey in Div IIIa+IVaE   Age 7

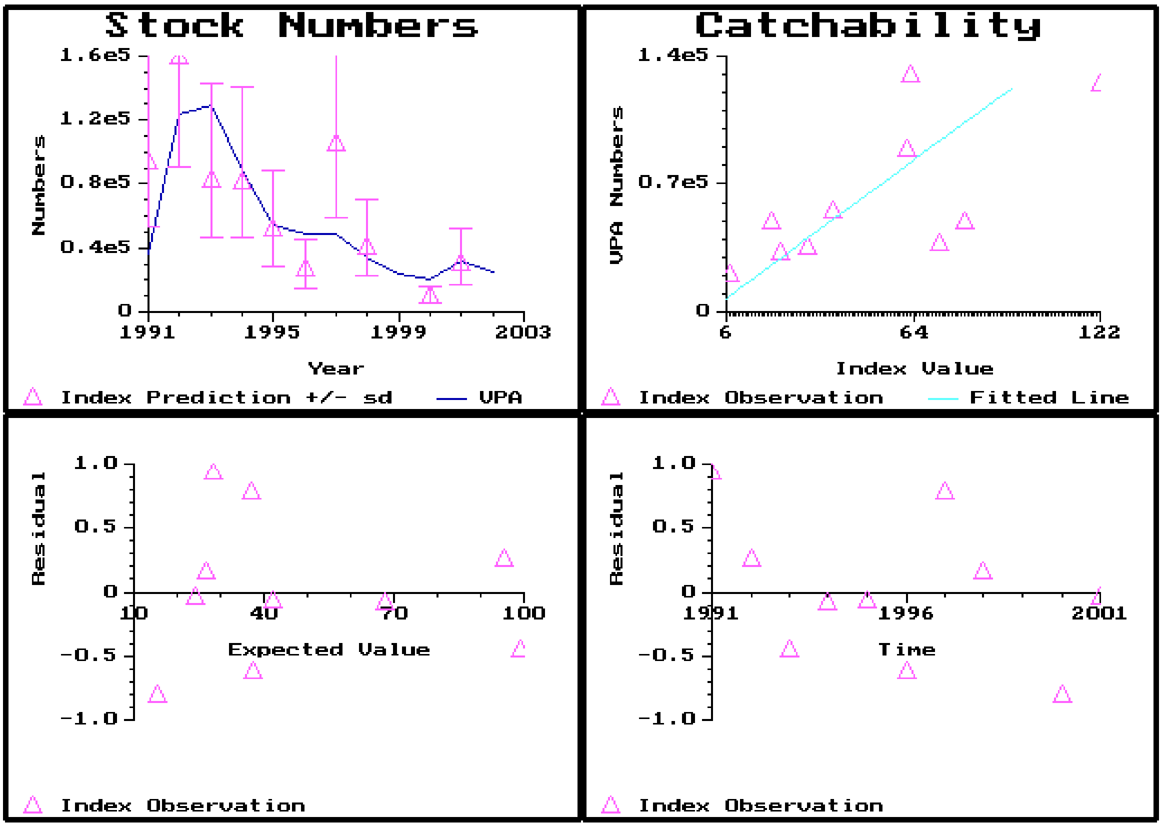


Figure 3.7.7f Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics. Index 33: Acoustic Survey, Division IIIa+IvaE, July, Age group 7

FLT33: Acoustic Survey in Div IIIa+IVaE Age 8

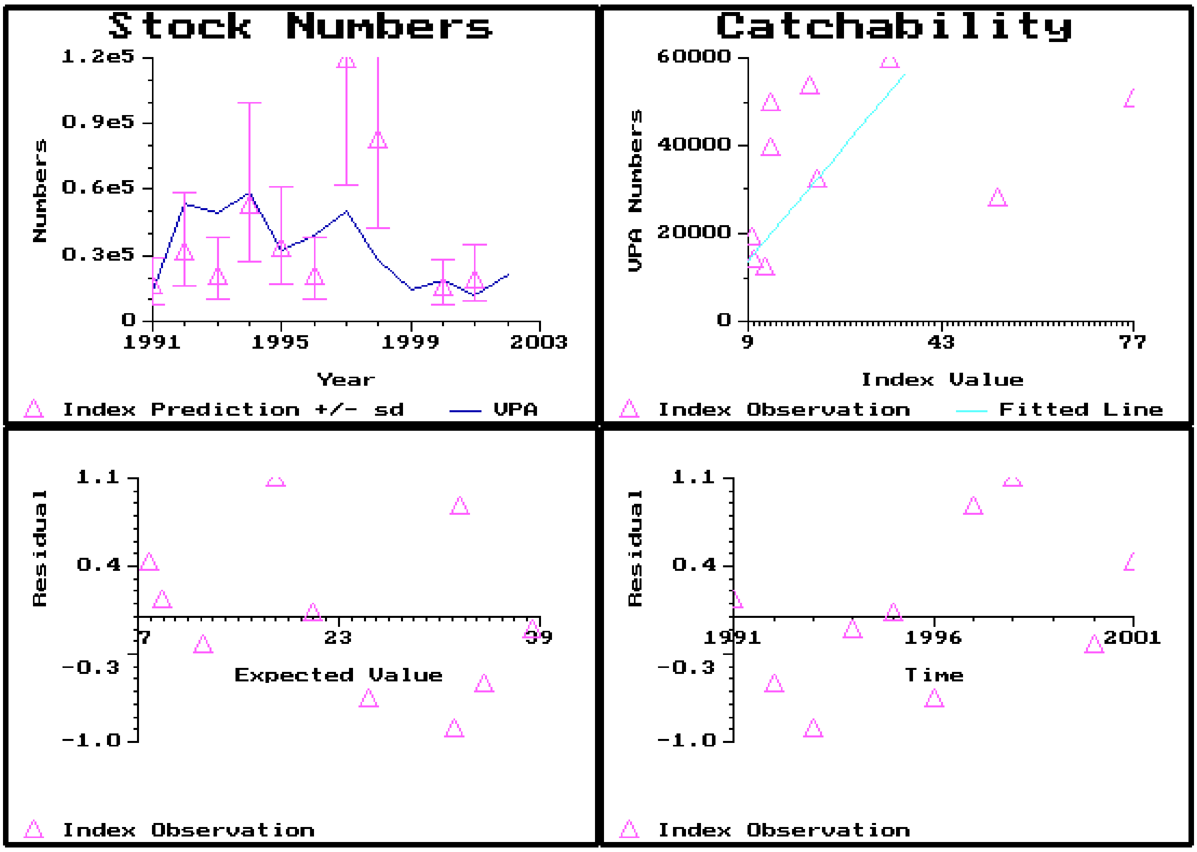
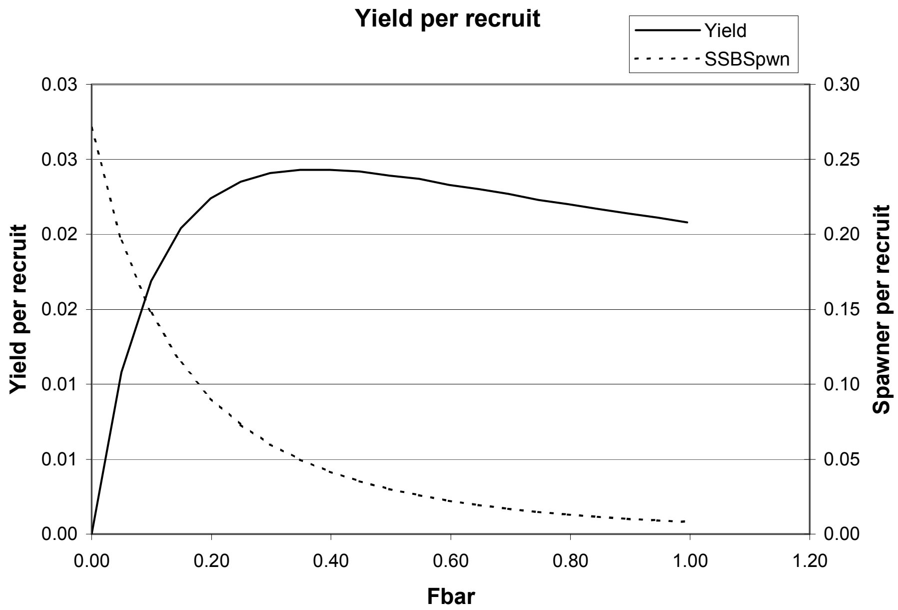
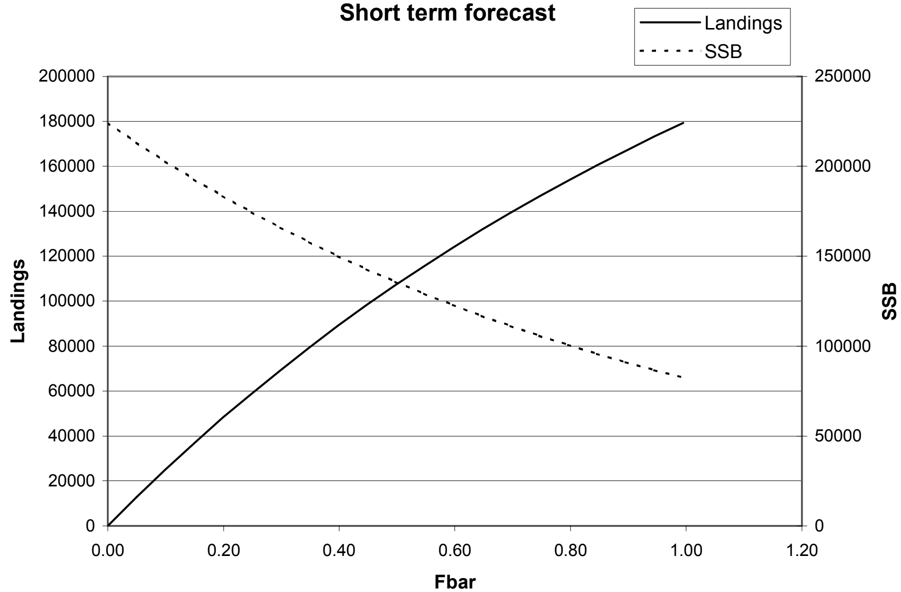


Figure 3.7.7g Western Baltic Herring. Output from ICA Run 22: Tuning Diagnostics.
Index 33: Acoustic Survey, Division IIIa+IVaE July, Age group 8+





MFYPR version 2a
Run: WBSS
Time and date: 16:12 19/03/02

Reference poi	F multiplier	Absolute F
Fbar(3-6)	1	0.5
FMax	0.7484	0.37
F0.1	0.4065	0.2
F35%SPR	0.3797	0.19

Weights in kil

MFDP version 1a
Run: WBSS
Western Baltic Herring (combined sex; plus group)
Time and date: 16:04 19/03/02
Fbar age range: 3-6

Input units are thousands and kg - output in tonnes

Figure 3.8.1 **WESTERN BALTIC HERRING. Long and short term yield and SSB, derived by MFYPR v2a**

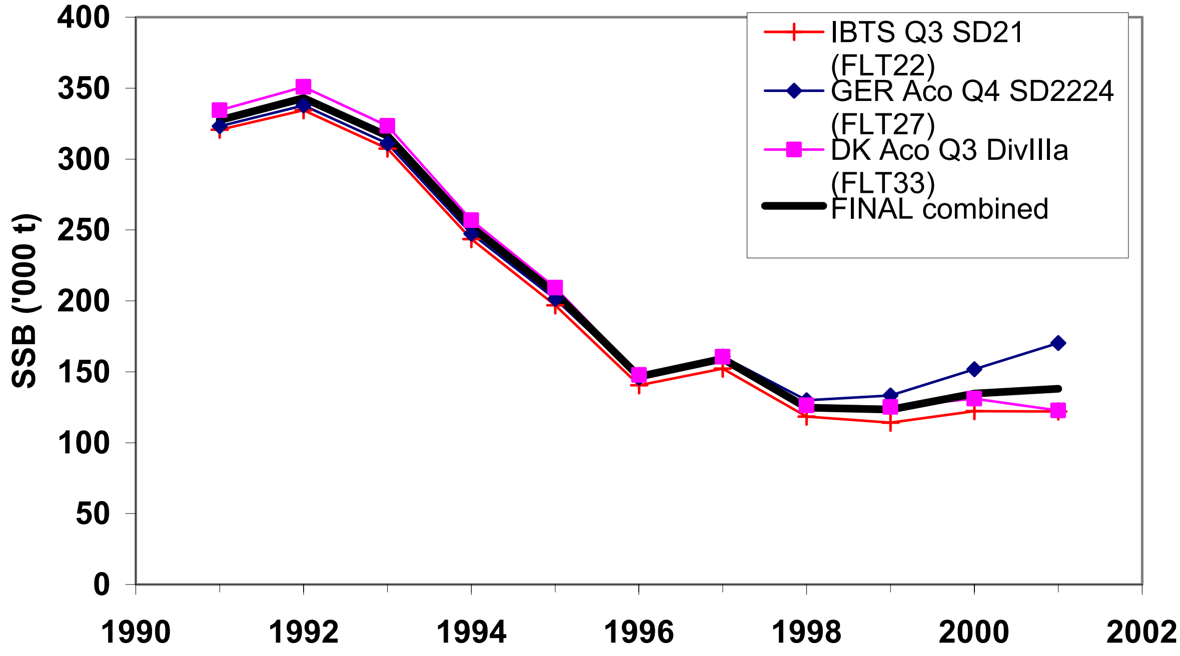


Figure 3.9.1 Western Baltic herring. SSB estimates from ICA model with separate indices and with all indices combined.

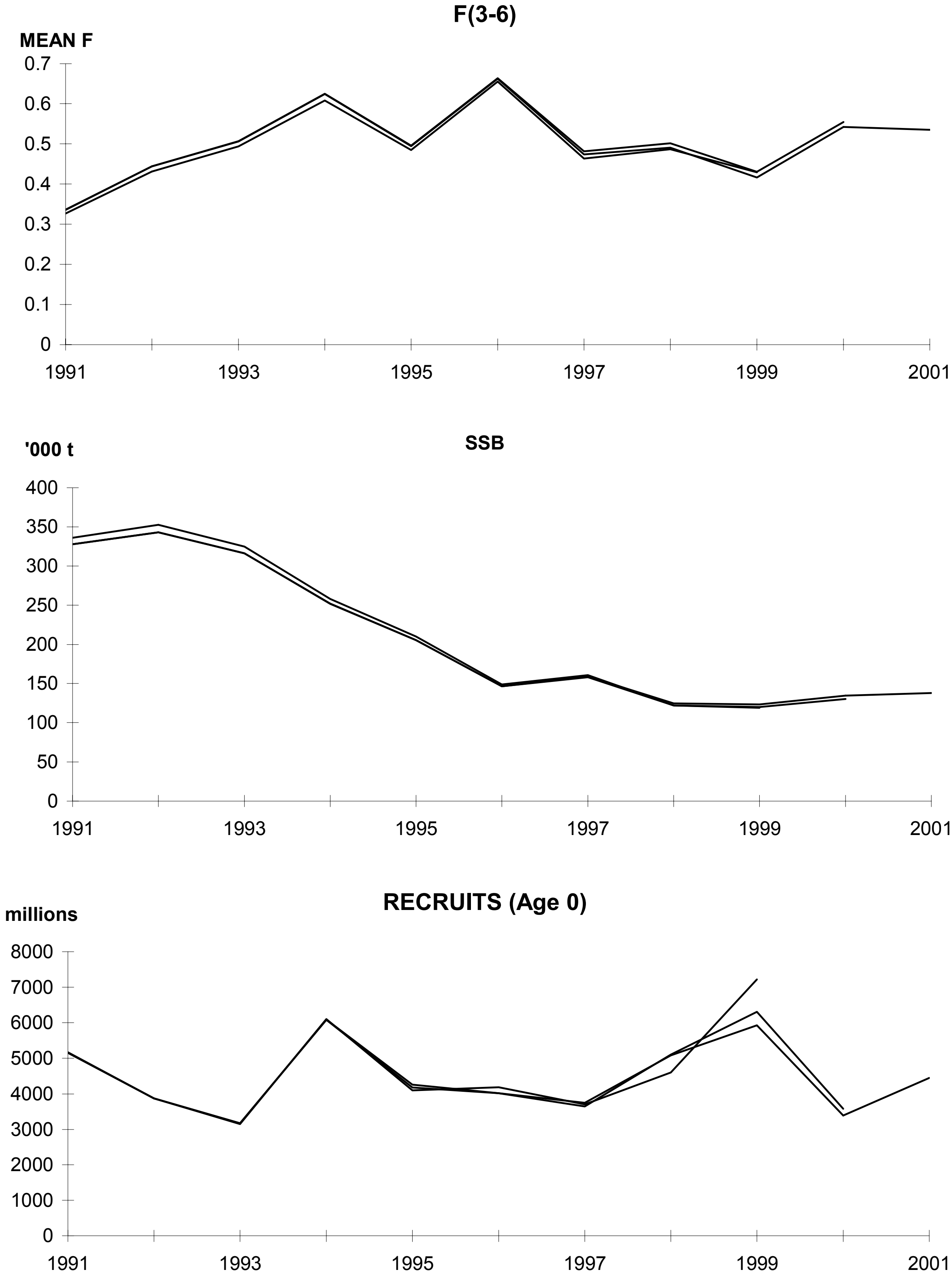


Figure 3.9.2 **WESTERN BALTIC HERRING: Restrospective Analysis**

4 CELTIC SEA AND DIVISION VIIJ HERRING

4.1 Introduction

The herring fisheries to the south of Ireland in the Celtic Sea and in Division VIIj have been considered to exploit the same stock. For the purpose of stock assessment and management these areas have been combined since 1982. The areas for which the assessments are now made, together with the area for which the TAC is set by the EU are shown in Figure 1.5.1. It should be noted that, although the management unit covers all of Divisions VIIg,h,j and k and the southern part of Division VIIa, the Irish catch which constitutes over 95 % of the total catch is taken from the inshore waters along the Irish coast. This year for the first time the only real catches taken in the area were from the Irish fleet.

4.2 The Fishery in 2001-2002

4.2.1 Advice and management applicable to 2001 - 2002

In 2001 ACFM considered the status of this stock to be unknown. ACFM stated that it was difficult to give appropriate management advice for 2002 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. ACFM further stated that advice for the second half of 2002 would be given in June 2002 subsequent to the assessment and evaluation of new data to be carried out by the HAWG in March 2002.

The fishery for the 2001/2002 season was opened on the 30th September 2001. The spawning box closure system implemented was in VIIg during November 2001, However, the enforcement was not as strict as in previous years. A further closure was instigated by an Industry initiative and was strictly observed. This area closure was in place from 16th January 2002 to the end of the fishing season on the 23rd February 2002 and applied to an area east of a line from 52º 30'N 6º W, north to the land.

The total Irish quota was subdivided into boat quotas on a week-by-week basis. All vessels were again regulated by licences which restrict landings to specific ports and to specific times. The total catch that was permitted to be taken in the Irish fishery was 8,000 t in the January – February (2001) period and the remainder of the national quota (9,290t) in the October to December (2001) period.

4.2.2 The fishery in 2000/2001

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 4.2.1.

Similar to last season marketing conditions remained favourable throughout the season with some herring being processed for fillets. The number of vessels participating in the fishery increased. The average number participating during the 2000/2001 season was about 33, compared with an average of 30 in the previous season. Over 100 vessels participated in this fishery during the early sixties.

The start of the 2001/2002 fishery in October was marked by a low volume of landings, and vessels from the eastern part of the Celtic Sea did not begin fishing until three weeks after the opening of the season. The fish landed from the western part of the Celtic Sea were of mixed sizes. However,, this situation was markedly different on the Eastern side of the Celtic Sea (VIIa(S)), where two types of shoal were observed: shoals consisting of mainly large fish, found 5 or more miles offshore, and those found closer inshore, referred to as 'river fish' by the fishermen. These 'river fish' were targeted by some boats as, although they made less when sold, they were easier to find and catch than other shoals. This fishery lasted for a period of about three weeks, before a voluntary closure was put in place to protect the smaller fish (see section 4.2.1 above).

A map of the locations mentioned in the text is given in Figure 4.2.2.

4.2.3 The catch data

The estimated national catches from 1988–2002 for the combined areas by year and by season (1 April–31 March) are given in Tables 4.2.1 and 4.2.2 respectively. The total catches for the fishery over the longer period from 1958 to 2002 are shown in Figure 4.2.1. The reported catch, taken during the 2001/2002 season was about 15,200 t compared with 17,800 t during the previous season.

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 2001/2002 season. This may have been due to the buoyant market for all grades of fillets, which prevailed throughout the season.

4.2.4 Quality of catch and biological data

Since 1997 there has been a major increase in the monitoring of landings from this fishery and the management measures were again tightly enforced throughout the season. As a result the accuracy of the landing figures is good for this period. In addition the industry has begun to provide samples of the landings, which have greatly augmented the existing sampling programme.

Biological sampling of the catches throughout the area has greatly increased and the number of fish measured and fish aged per tonne has doubled. Details of the sampling data per quarter are shown in Table 4.2.3, while the length distributions of the catches taken by the Irish fleet per quarter are shown in Table 4.2.4.

4.2.5 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 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.

4.2.6 Catches in numbers-at-age

The total catches in numbers-at-age, including discards, per season from 1958 to 2002 are shown in Table 4.2.5. The age composition in 2001/2002 was again dominated by 2 ringers (1998/99 year class), which constituted 48% of the catch. 3 ringers (1997/98 year class) constituted 29% of the catch. The numbers of 4 ring and older fish remain relatively low. The numbers of 1 ringers constituted 12% of the catch in numbers which is above the average since the fishery was fully re-opened in 1983. These young fish were mainly taken in the catches from VIIa (S).

4.3 Mean Weights & 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 4.2.5). 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.

4.4 Surveys

4.4.1 Acoustic surveys

A series of acoustic surveys have been carried out on this stock from 1990-1996. The series was interrupted in 1997 when no surveys were possible but was resumed in 1998 and has been continued since. A summary of these surveys is given in ICES (2001/ACFM:12).

Acoustic surveys for the 2000/2001 season were carried out in September 2000 and January 2001. The first survey in September was carried out several weeks earlier than in previous years and designed to run further offshore, in an effort to cover the stock during the peak spawning period. This survey was curtailed in the western area due to bad weather and at the southern edge due to lack of time. The concentrations of herring encountered on this survey were very sparse, However, the biomass estimate was based on clear herring marks and there is confidence that this is an accurate estimate of the biomass of herring in the area at the time. There is a possibility that part of the stock was outside the survey area at the time, and this is consistent with reports from the fishery that spawning occurred earlier in 2000 than in previous years. The SSB estimate from the September/October 2000 survey was 18,765t.

The timing of the survey in January 2001 appeared to be consistent with a peak spawning period of the winter-spawning component. There were some indications that the stock was not contained within the survey area, but there was no conflict between the age and maturity distributions of fish observed during the survey and in the fishery. The survey did not cover any ground west of the Old Head of Kinsale (Figure 4.2.2) as there had been no landings of fish from this area since December 2000. A repeat survey was conducted concentrating on the inshore ground. This survey produced a considerably different biomass for the Baginbun area than a survey completed 2 days previously. Information from the fishery suggested that shoals of fish were dispersed during the first survey due to prevailing SE winds, and as the wind direction changed before the second survey the shoals of fish had aggregated during this period. The two surveys gave SSB estimates of 5,300t and 14,400t. Therefore it was decided to average the estimate of the Baginbun area between the two surveys. The estimate of SSB from the January survey for the Celtic Sea and Division VIIj was 12,385t.

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 2001, in an effort to improve the acoustic survey index, a programme was 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 4.4.2), acoustic surveys were carried out from the 2nd week in September to the 3rd week in October. The coverage of these surveys is shown in Figures 4.4.1a and b. The surveys were focused on those areas where the concentrations of herring had been located during the scientific surveys carried out during July and August and areas where herring had been located by white fish trawlers. By September shoals had appeared to migrate nearer to shore in comparison to July and August and concentrations were located in a number of areas throughout VIIg. Post plots showing the distribution of S_A values attributed to herring are shown in Figures 4.4.2a and b. These surveys did not encounter problems with area coverage as in previous years. Information gathered throughout the summer suggests that reasonable confidence can be held that the stock was contained within the survey. The age composition of samples taken from the acoustic survey, and the commercial catch data show very similar patterns (Figure 4.4.3).

The age distribution of the stock from all acoustic surveys carried out since 1990 is shown in Table 4.4.1.

4.4.2 Summer programme to examine stock distribution and age structure

A new scientific programme carried out by the Irish Marine Institute, working with the local Southwest Pelagic Management Committee (SWPMC) was aimed at obtaining information on:

1. The abundance of the stock, which appeared to be unusually low in 2000, based on the most recent acoustic surveys.
2. The age composition and the distribution of the adult stock. Following from the absence of older fish in the catches in 2000 it was felt that if the older herring were still present in the stock they may be distributed in the off shore areas.

The programme was carried out in four main phases:

- A questionnaire was distributed to "white fish" trawlers working throughout the Celtic Sea and Division VIIj and Division VIIj to obtain information on where herring shoals were observed and to obtain samples from catches. This information was to be used to design the acoustic surveys and also to obtain biological information.
- A fishing survey was carried out during July and August using a pair of dedicated herring midwater trawlers in each month, equipped with automatic data loggers and working on a pre-determined grid, with scientific observers on board.
- An acoustic survey was carried out, using a commercial herring vessel, for two weeks during September 2001.
- An acoustic survey using the *RV Celtic Voyager* was started on 4 October 2001.

Results

- White fish trawlers. Some information was obtained on herring distribution from this part of the programme and samples were obtained from the area off the Smalls and south of Dunmore East (Figure 4.2.2).

- Fishing Survey. During the scientific survey samples were obtained from a number of areas and retained for biological examination. A total of 875 herring were aged and over 3,000 fish were measured from 78 trawl stations. Good concentrations of herring were located in a number of areas, particularly in the central area of the Celtic Sea (Division VIIg), Figure 4.4.4. The age composition of these herring is shown in the Table 4.4.2 and a comparison with the commercial catch data from last season is shown in Figure 4.4.5. Herring appeared to be scarce throughout the western parts of Div 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 (Div VIIaN) and are usually young fish.

- In addition to the samples obtained from the scientific survey age, compositions are also available from catches taken in a small-scale experimental fishery carried out for “Matje” herring in June throughout Divisions VIIg and VIIj. This age composition, based on 240 herring age readings and 1,200 length measurements, is also shown in Table 4.4.2. The age composition of the catches taken from the 2000/2001 fishery is also shown.

4.4.3 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 2001, it was made available, along with data from 2001, to this year’s WG. While the time-series is still short it is hoped that its usefulness as an index may be investigated in the future.

4.5 Stock Assessment

4.5.1 Preliminary data exploration

Recent WG’s have used the results of the acoustic surveys in the ICA programme but stated that the results of the 1996/97 surveys and 1998/99 surveys should be taken as 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. It was clear that the 1996 survey had failed to estimate the older fish in the population because of the small proportion of older fish recorded by the survey relative to the catch. The surveys, which are used as a relative index of numbers for 2-5 ringers, appear to perform well as indicators of mortalities over these age groups. However, it is apparent that the time-series of these surveys is noisy and that the SSB estimates from these surveys do not track well the perceived abundance of the stock over the time period (Figure 4.5.1). A table is given below showing the options used in the assessment since 1998.

Working Group	Age structured acoustic index (ages 2-5)	Shrinkage	Separable period
1998	1990-1996	No	1992-1997
1999	1990-1996, November 1998	No	1993-1998
2000	1990-1996, November 1998	Yes (5yr)	1994-1999
2001	1990-1996, November 1998, 2000	No	1995-2000
2002	1990-1996, November 1998, 2000-2001	No	1996-2001

This year some options were run to test the sensitivity of the model to assumptions on the period of separable constraint, and to the down-weighting of 2 ringers in the catch (in addition to the down-weighting of 1 ringers which is traditionally applied). The results of these exploratory runs show that the assessment is not sensitive to these assumptions (Figure 4.5.1). However, it is evident that the best fit produces very high estimates of recruitment at age 1. As these are poorly estimated by the model, the group decided to replace the number of 1 ringers in 2001 with the value of the geometric mean calculated over the period (1958-1999). This replacement dramatically alters the perception of the biomass in the final year. However, this perception is consistent with a conservative approach, given the uncertainty in the current estimation of stock size.

4.5.2 Results of the assessment

The run log of this year's assessment is shown in Table 4.5.2.1. The results of the assessment and the diagnostics are shown in Table 4.5.2.2 and Figures 4.5.2.1 – 4.5.2.7. The current perception of a declining SSB is strongly influenced by the replacement of the number of 1 ringers (in 2001) by the geometric mean recruitment over the period 1958-1999. Replacing the number of recruits in 2001 with the geometric mean (1958-1999), alters the estimate of SSB in the final year from 69,276t to 42,816t. Given the uncertainty in recruitment perhaps a more useful indication of the status of this stock is shown by the sharp decline in F_{2-7} from 2000. The value of F_{2-7} in 2001 is 0.44, which is below the long-term average for this stock (0.51). This figure reflects the relatively large numbers of 2 and 3 ringers in the 2001 catches which make up the bulk of the catch.

The value of F estimated for 2001 is 0.44, and for 2000 is 0.76. Estimates of F estimated by the 2001 WG were 0.94 for 2000 and 0.95 and 1999. Plots of the stock trajectory from this year's assessment are presented in Figure 4.5.2.8 along with the trajectories from the final runs in 2001 and 2000. All these plots have been corrected for geometric mean recruitment.

The number of 1 ringers in the stock indicate that recruitment was below average in the period 1996 – 1998, but recruitment appears to have been above average for the past 3 years.

4.5.3 Comments on the assessment

Figure 4.5.2.8 shows the trajectories of SSB, F, and recruitment according to this year's assessment. For comparison the final run from the last 2 years are also included. The estimates of SSB in the period 1999-2000 are revised upwards, but the estimate of SSB in the final year is highly uncertain as it was not possible to carry out uncertainty analyses in ICA as the data set is too noisy. It is very difficult to assess the SSB of this stock in the final year because, although it comprised 12% of the total catch (in 2001/2002) the recruiting 1 ringers are poorly selected by the fishery. This age group is down-weighted in the assessment and there is only a single catch data point for 1 ringers. Therefore there is relatively small contribution to the SSQ (and thus the model fit) for this age group. However, according to the maturity ogive used, 50% of this age class are mature and thus they have a significant contribution to the SSB. The problem becomes compounded when a short-term deterministic prediction is run, as the geometric mean recruitment and their survivors (age 2 in beginning 2002/2003 season) account for around 50% of the spawning stock in numbers.

4.5.4 Recruitment estimates

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 during the period 1996-1998 may have been below average, but that recruitment may be above average since 1999. This may explain the low numbers of 3-5 ringers in the population and the relatively high number of 1 and 2 ringers.

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 be relatively low.

4.6 Short Term Projection

Because of the uncertainty about the current stock size and the lack of information on recruitment it was decided that projections over a medium or long-term basis would be unrealistic. A short-term projection was carried out under the following assumptions.

The number of 1 ringers was based on the geometric mean from 1958 to 1999. This value was 412 million fish. This method was the same as applied last year but in contrast to previous years, where the geometric mean was calculated over the more recent period (1982 – 1998). Given the 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 similar to 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 1996 – 2001. The input data used for the predictions are shown in Table 4.6.1.

Results of Predictions

A single option management table based on $\mathbf{F}_{sq}$ is given in Table 4.6.2. A management option table based on $\mathbf{F}_{sq}$ in 2002 with options for 2003 is given in Table 4.6.3. The calculated SSB for 2002 comes to 48,800t. The overall results of the predictions are strongly influenced by the number of recruits in 2001 and, concomitantly, the survivors at age 2 in 2002. If fishing in 2002 remains at $\mathbf{F}_{sq}$ the catch in 2002 will be 13,192t and the SSB in 2003 will rise to 50,100t. Continued fishing at this effort will yield catches of 13,900t and the SSB will rise slightly to 50,700t in 2004.

A single option management table based on a catch constraint of 8,000t is given in Table 4.6.4. This catch is based on the current TAC, which applies only to the first six months of 2002. If the landings in 2002 are constrained to 8,000t the SSB will rise to 50,000t and the F in 2002 will fall 0.25. A management option table based on $\mathbf{F}_{sq}$ in 2002 with options for 2003 is given in Table 4.6.5. Continued fishing at this effort in 2003 will yield catches of about 9,000t in 2003 and the SSB will rise to around 60,000t in 2004.

It is very difficult to suggest appropriate catch options for 2002, given that predictions are heavily dependent on the recruitment of 1 ringers in 2001 and that these are poorly estimated by the assessment. Nonetheless, using the conservative estimate based on the geometric mean (1958-2000) would suggest that only catches in excess of 27,000t would reduce the SSB below $\mathbf{B}_{pa}$ in 2002. Using an F option suggests that fishing at $\mathbf{F}_{sq}$ would maintain SSB above $\mathbf{B}_{pa}$. These options are summarised below and presented in the management option tables.

Basis	F_{2002}	SSB in 2002	Catch in 2002	Comments
TAC Freeze	0.25	50,087	8,000t	Rising SSB
F_{2002}=$\mathbf{F}_{sq}$	0.44	48,809	13,192t	Rising SSB

Plots of yield per recruit and short-term yield are given in Figure 4.6.1.

4.6.1 Biological reference points and management considerations

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). The following paragraphs are a summary of this information.

There has been a period of recruitment failure in the stock from around 1970 to the early 1980's, when recruitments were in the order of 100 million-300 million individuals, as opposed to 400 million to 1000 million in most other years. This recruitment failure apparently was not induced by a low SSB. Rather, it started when the SSB was at a high level and recruitment returned to normal while the SSB was at its lowest. Overall, the recruitment does not appear to be strongly dependent on the SSB.

In the periods with good recruitment, the fishing mortalities have mostly been in the range of 0.35 - 0.6, and the stock seems to have tolerated this fishing mortality well. This fishing mortality is higher than that which most herring stocks will tolerate. The background for this may be partly because the recruits per SSB are quite high, except in the period with poor recruitment, and partly because the fishery is almost exclusively on mature fish, which gives a favourable SSB per recruit.

The 1998 Working Group suggested a $\mathbf{B}_{lim}$ at 26,000 tonnes, which is the lowest SSB observed and is just below the biomass level which gave rise to the first strong year classes after the collapse. Assuming a 30% CV on the current SSB estimates leads to a $\mathbf{B}_{pa}$ of 40,000 t. The Working Group also proposed an $\mathbf{F}_{pa}$ =0.4 as being appropriate to the present position where the stock was at a reasonably high level. The $\mathbf{B}_{pa}$=40,000 t was accepted by ACFM, but it considered that the $\mathbf{F}_{pa}$=0.4 was too high and it proposed that it should be equal to F med=0.29.

The 1999 Working Group re-examined the $\mathbf{F}_{pa}$ and suggested that it might be appropriate to have different $\mathbf{F}_{pa}$ for periods of high and low recruitments. On this basis it was suggested that an $\mathbf{F}_{pa}$ =0.3 would be appropriate for a period of high recruitment and an $\mathbf{F}_{pa}$=0.2 for a period of low recruitment. It was also pointed out that the mean weights-at-age should be re-evaluated for the earlier time period, and that values of F lower than the proposed $\mathbf{F}_{pa}$=0.29 had only been evident in 4 years out of 40 years in the time-series. ACFM did not accept the proposal of two different $\mathbf{F}_{pa}$ and asked that the biological reference points be re-evaluated after the examination of the weight-at-age data.

The 2001 Working Group therefore re-examined the stock recruit relationship over the 1958 to 1999 period using the new SSB estimated on the revised stock weights for the 1958 to 1983 period. It was concluded that the revised stock weights have had no effect on the stock recruitment relationship.

It has also been suggested that the catches of juvenile fish taken in the industrial fishery in the Irish Sea (Div. VIIa North) may also have had an effect on the stock recruit relationship. This is because these catches contained an unknown proportion of Celtic Sea and Division VIIj recruits and these have never been included in the catch in number at age for the Celtic Sea. The 2000 Working Group examined the numbers-at-age taken in the industrial fishery which were presented in an earlier Working Group report (ICES 1980/H:4). It was concluded that the numbers, although substantial in some years, were unlikely to have had any major effect on the Celtic Sea and Division VIIj recruitment. However, it was decided to examine the stock recruitment relationship over the period after the industrial fishery ceased, and when the Celtic Sea and Division VIIj stock had recovered, after the collapse that caused its closure from 1977 to 1982. Accordingly, a new stock recruitment plot was calculated over the period 1982 to 1999. The F med for this period is very different from that calculated for the earlier period (1958-1997) and was estimated as F =0.44. This is very similar to the value proposed by the 1998 Working Group of 0.40. This would imply that an $\mathbf{F}_{pa}$=0.44 would be appropriate for periods when the stock is high as a result of good recruitments. It would also imply that, as suggested by earlier working groups, the biological characteristics of this stock are such that it can withstand higher rates of fishing mortality than other stocks. This is partially due to the fact that 50% of the age 1 fish are mature and these spawning fish are not fully selected by the fishery. As the period of low recruitment is strongly correlated with the juvenile fishery in the Irish Sea and appears to be atypical of the 40 years history of the stock the inclusion of this period for the management of the stock in its current state seems inappropriate. While a $\mathbf{F}_{pa}$=0.44 seems high, an $\mathbf{F}_{pa}$=0.29 is rather low and fishing mortalities below this value have only been observed in 3 out of the 40 years time period.

As there is no new information and as the current assessment is unstable, the WG did not propose any change to the reference points suggested by last years WG. No suggestions or proposals to the precautionary reference points have been provided by the WG since 2000.

4.6.2 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. 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 the assessment about the current levels of recruitment.

4.6.3 Management considerations

The most recent assessment shows that fishing mortality has decreased significantly in the past year and that fishing mortality in 2000 was overestimated by last years assessment. However, the point estimate of SSB in 2001 is very imprecise and is greatly influenced by the number of age 1 recruits assumed in 2001. If a conservative view of recruitment in 2001 is taken, the trajectory of the stock biomass shows a decreasing trend since 1996. This may be due to poor recruitment in the period 1996-1998. Projections based on this perception of the stock are naturally sensitive to recruitment. However, recruitment in the most recent years appears to be above average (although these data points are relatively poorly estimated). When conservative recruitment estimates are used, fishing at the current effort will stabilise the SSB in 2003 and 2004. If the current recruitment is an underestimate then the SSB will rise. Following the 2000-2001 fishery it was decided by the Irish fishing industry (who account for the vast majority of the catches) to form a Pelagic Management Committee. Among the aims of the Committee was: To put in place a programme that would help to obtain scientific information that might explain the unusual features of the recent herring fishery; and to obtain sufficient information that would enable the stock to be exploited in such a way that the maximum benefit could be obtained for all stake holders on a long-term basis. In addition, the Committee drew up a management policy for the fishery that states: "*The South and West Pelagic Management Committee have agreed to manage this herring stock according to the best available scientific advice. It is the policy of the Committee to maintain the stock at a level whereby it can sustain annual catches of around 20,000 t. In the event of the stock falling below the level at which these catches can be sustained the Committee will take appropriate rebuilding measures. The Committee will also introduce such measures as are necessary to prevent landings of small and juvenile herring including closed areas, and/or appropriate time closures. It is an objective of the Committee that all landings of herring should contain at least 50% of individual fish above 23 cm. Spawning Box closures, as are at present in operation, should be retained and may, if necessary, be expanded both in time and area*".

Because of concerns about the small size of herring throughout Div VIIg, in the first quarter of 2002, this policy was successfully put into effect, by the closure of an area south of Dunmore (see section 4.2.1). One pair of boats was allowed to fish for a small catch on two occasions to monitor the size composition of fish in the area. The herring sampled showed no improvement in size distribution. However, the skipper did report that substantial quantities of herring were spawning on the traditional spawning grounds south off Dunmore East during late February. Notwithstanding the fact that 2,000t of quota had yet to be taken the Committee recommended a closure in mid-January 2002, and the fishery was closed by statute for the area for the remainder of the season.

The stock is so dependent on recruitment that the Working Group stresses the importance of obtaining and evaluating all recruitment information that is available from surveys in the area. It is also essential that the acoustic surveys should 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.

The Working Group therefore recommends that gravel extraction or dumping of dredge spoils or silt or the location of fish farms should not be permitted in areas that are known to contain herring spawning grounds.

Table 4.2.1 Celtic Sea and Division VIIj herring landings by calendar year (t), 1988–2001. (Data provided by Working Group members.) These figures may not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	France	Germany	Ireland	Netherlands	U.K.	Unallocated	Discards	Total
1988	-	-	16,800	-	-	-	2,400	19,200
1989	+	-	16,000	1,900	-	1,300	3,500	22,700
1990	+	-	15,800	1,000	200	700	2,500	20,200
1991	+	100	19,400	1,600	-	600	1,900	23,600
1992	500	-	18,000	100	+	2,300	2,100	23,000
1993	-	-	19,000	1,300	+	-1,100	1,900	21,100
1994	+	200	17,400	1,300	+	-1,500	1,700	19,100
1995	200	200	18,000	100	+	-200	700	19,000
1996	1,000	0	18,600	1,000	-	-1,800	3,000	21,800
1997	1,300	0	18,000	1,400	-	-2,600	700	18,800
1998	+	-	19,300	1,200	-	-200	0	20,300
1999		200	17,900	1300	+	-1300	0	18,100
2000	573	228	18,038	44	1	-617	0	18,267
2001	1,359	219	17,729	-	-	-1578	0	17,729

Table 4.2.2 Celtic Sea & Division VIIj herring landings (t) by season (1 April–31 March) 1988/1989-2001/2002. (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
1988/1989	-	-	17,000	-	-	-	3,400	20,400
1989/1990	+	-	15,000	1,900	-	2,600	3,600	23,100
1990/1991	+	-	15,000	1,000	200	700	1,700	18,600
1991/1992	500	100	21,400	1,600	-	-100	2,100	25,600
1992/1993	-	-	18,000	1,300	-	-100	2,000	21,200
1993/1994	-	-	16,600	1,300	+	-1,100	1,800	18,600
1994/1995	+	200	17,400	1,300	+	-1,500	1,900	19,300
1995/1996	200	200	20,000	100	+	-200	3,000	23,300
1996/1997	1,000	-	17,900	1,000	-	-1,800	750	18,800
1997/1998	1,300	-	19,900	1,400	-	-2100	0	20,500
1998/1999	+	-	17,700	1,200	-	-700	-0	18,200
1999/2000		200	18,300	1300	+	-1300	0	18,500
2000/2001	573	228	16,962	44	1	-617	0	17,191
2001/2002	-	-	15,236	-	-	-	0	15,236

Table 4.2.3 Celtic Sea & Division VIIj (2001–2002). 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 2001	323	11	118	1073	365	No
	Q 4 2001	9,934	65	1619	9907	163	No
	Q 1 2002	4,979	53	977	9250	196	No

Table 4.2.4. Celtic Sea and Division VIIj. Length distribution of Irish catches/quarter (thousands) 2000/2001.

	Q2 2001	Q4 2001			Q1 2002		
Length	**VIIj**	**VIIaS**	**VIIg**	**VIIj**	**VIIaS**	**VIIg**	**VIIj**
15.5	2						
16.0	0						
16.5	0						
17.0	0						
17.5	0						
18.0	14				1		
18.5	7	8			0		
19.0	86	8	14	6	0	7	
19.5	107	75	14	58	0	0	
20.0	162	359	229	28	4	20	46
20.5	95	451	330	178	16	93	31
21.0	102	1043	1032	410	53	253	61
21.5	88	1427	2079	874	102	633	215
22.0	102	1719	2882	1136	224	1420	307
22.5	124	1527	3097	1316	315	2233	353
23.0	171	2019	4244	1400	498	3266	461
23.5	188	1560	4287	1394	524	3766	261
24.0	254	1644	4717	1317	468	4172	353
24.5	295	1394	4315	1414	346	4019	231
25.0	268	1485	4602	1395	228	3832	138
25.5	159	1302	4344	1349	174	3672	292
26.0	126	1110	3341	1085	131	2886	323
26.5	78	651	2194	936	58	1659	384
27.0	55	459	1362	830	42	1166	369
27.5	31	284	1061	620	23	766	154
28.0	26	250	487	630	14	620	31
28.5	2	83	315	456	4	287	61
29.0	7	67	100	265	4	187	31
29.5		25	43	74	0	47	46
30.0			14	57	1	53	
30.5				14			
31.0				3			
31.5							
Totals:	2549	18950	45104	20477	3232	35056	4150

Table 4.2.5(a) Celtic Sea and Division VIIj. Catch-at-age 1958-2001, predicted catch for the separable period (OUTPUT from ICA).

Output Generated by ICA Version 1.4

Herring Celtic VIIj (run: Final 2002 WG)

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

Table 4.2.5(a) Continued

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

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
1	5.82	14.27	9.95	15.72
2	41.51	34.07	77.38	60.25
3	27.10	36.09	18.95	36.13
4	28.27	14.64	12.06	6.00
5	13.18	15.52	5.23	4.25
6	3.75	8.88	6.23	1.82
7	2.67	1.86	2.32	1.25
8	0.60	2.01	0.66	0.47
9	0.39	0.55	0.58	0.39

x 10 ^ 6

Predicted Catch in Number

AGE	1996	1997	1998	1999	2000	2001
1	3810.	5777.	3987.	13000.	9705.	15716.
2	67301.	36151.	43219.	42213.	77464.	43179.
3	39829.	56265.	22787.	37508.	18445.	27433.
4	9702.	27921.	29323.	16223.	12962.	5300.
5	11842.	7690.	16416.	23045.	6201.	4230.
6	2281.	8083.	3842.	10812.	7149.	1695.
7	1427.	1144.	2941.	1902.	2425.	1381.
8	1507.	919.	545.	1926.	595.	631.

x 10 ^ 3

Table 4.2.5(b) Celtic Sea and Div. Viij. Weights-at-age in the catch.

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

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

Table 4.2.5(b) continued

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
1	0.09900	0.09000	0.09200	0.08200
2	0.12100	0.12000	0.11100	0.10700
3	0.15300	0.14900	0.14800	0.13900
4	0.16300	0.16700	0.16800	0.16200
5	0.17300	0.18000	0.18500	0.17700
6	0.18500	0.18300	0.18700	0.19000
7	0.19900	0.20200	0.19700	0.18500
8	0.20400	0.20900	0.21000	0.20400
9	0.22500	0.20800	0.22400	0.22000

Table 4.2.5(c) Celtic Sea and Div. VIIj. Weights-at-age in the stock

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

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

Table 4.2.5(c) Continued

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
1	0.09900	0.09000	0.09200	0.08200
2	0.12100	0.12000	0.11100	0.10700
3	0.15300	0.14900	0.14800	0.13900
4	0.16300	0.16700	0.16800	0.16200
5	0.17300	0.18000	0.18500	0.17700
6	0.18500	0.18300	0.18700	0.19000
7	0.19900	0.20200	0.19700	0.18500
8	0.20400	0.20900	0.21000	0.20400
9	0.22500	0.20800	0.22400	0.22000

Table 4.2.5(d) Celtic Sea and Div. VIIj. Natural mortality (constant for all years)

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

Table 4.2.5(d) continued

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

Natural Mortality (per year)

AGE	1998	1999	2000	2001
1	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.0000

Table 4.2.5(e) Celtic Sea and Div. VIIj. Maturity-at-age (constant for all years)

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

Table 4.2.5(e) continued

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

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
1	0.5000	0.5000	0.5000	0.5000
2	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000

Table 4.4.1 Celtic Sea & Division VIIj. Total stock numbers-at-age (10^6) estimated using combined acoustic surveys

Age (Rings)	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
0	22.75	19
1	17.58	30.25
2	142.66	160.37
3	36.17	175.72
4	18.67	39.83
5	6.56	43.54
6	3.28	22.59
7	1.72	17.29
8	0.26	10.67
9+	0.50	23.18
Total	250.17	542.37
Total Biomass (000't)	33.34	79.53
SSB (000't)	31.79	73.66

Table 4.4.2. Celtic Sea & Division VIIA. Age Composition of Summer Survey Herring

Age (ringers)

Source	1	2	3	4	5	6	7	8	9
2000/2001 Canum	7.5	58	14.2	9	3.9	4.7	1.7	05	
"Matje" fishery June	12.4	33.4	27.5	16.6	6.7	2.8	0.3	0.4	
Div VIIg Jul/Aug	7.4	37.1	24.9	11.7	8.7	4.1	2.4	2.1	1.6
Div VIIj Jul/Aug	27.6	21.2	27.5	7.2	9.5	3.3	1.6	1.6	0.5

Table 4.5.2.1 Run Log of the assessment in 2002

```
                         Integrated Catch-at-age Analysis
                         --------------------------------

                                 Version 1.4 w

                                 K.R.Patterson
                          Fisheries Research Services
                               Marine Laboratory
                                   Aberdeen

                                 24 August 1999

 Type * to change language
 Enter the name of the index file -->index
canum
weca
 Stock weights in 2002  used for the year 2001
west
 Natural mortality in 2002  used for the year 2001
natmor
 Maturity ogive in 2002  used for the year 2001
matprop
 Name of age-structured index file (Enter if none) : -->fleet.txt
 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 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
Enter new weights for specified years and ages if needed
```

Table 4.5.2.1 (Continued)

```
 Enter year, age, new weight or -1,-1,-1 to end.  -1 1    1.000000000000000
 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        10.0019614358
    0.13         5.1305062994
    0.20         3.5820971828
    0.28         2.8934462948
    0.36         2.5790750153
    0.43         2.4670579430
    0.51         2.4794575001
    0.58         2.5757916061
    0.66         2.7332876246
    0.74         2.9386298797
    0.81         3.1841038818
    0.89         3.4656884534
    0.97         3.7821371378
    1.04         4.1346670196
    1.12         4.5271341447
    1.19         4.9667800377
    1.27         5.4658971180
    1.35         6.0453342975
    1.42         6.7423170282
    1.50         7.4520956645
Lowest SSQ is for F =     0.461
-----------------------------------------------------------------
No of years for separable analysis : 6
Age range in the analysis : 1  . . . 9
Year range in the analysis : 1958  . . . 2001
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 29
Number of observations : 88

Conventional single selection vector model to be fitted.



-----------------------------------------------------------------
 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
```

Table 4.5.2.1 (Continued)

```
 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:-->
0.500000000000000
 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 :     0.625 0.625 0.625 0.625
F in 2001  at age 3  is 0.400320  in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->D
 Output page width in characters (e.g. 80..132) ?--> 80
```

Table 4.5.2.2 Celtic Sea & Division VIIj. Output from the assessment.

Output Generated by ICA Version 1.4

Herring Celtic VIIj (Final 2002 WG)

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
2	157.13	*******	142.66	160.37
3	149.62	*******	36.17	175.72
4	201.48	*******	18.67	39.83
5	108.53	*******	6.56	43.54

Fishing Mortality (per year)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	0.0081	0.0018	0.0128	0.0135	0.0025	0.0017	0.0115	0.0002
2	0.1186	0.2883	0.2380	0.1561	0.2664	0.3975	0.1843	0.2410
3	0.3471	0.1038	0.5303	0.1670	0.3136	0.3231	0.2355	0.1770
4	0.4984	0.3311	0.2375	0.2071	0.3813	0.0947	0.2580	0.3321
5	0.3816	0.3650	0.3687	0.1738	0.4526	0.2499	0.0462	0.1817
6	0.4776	0.2727	0.2182	0.2015	0.4601	0.2367	0.1419	0.1484
7	0.7243	0.6982	0.4491	0.1886	0.5400	0.2892	0.1548	0.2667
8	0.3821	0.3207	0.3218	0.1708	0.3689	0.2609	0.1670	0.2173
9	0.3821	0.3207	0.3218	0.1708	0.3689	0.2609	0.1670	0.2173

Table 4.5.2.2 Continued – Celtic Sea & Division VIIj

Fishing Mortality (per year)

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	0.0171	0.0176	0.0229	0.0331	0.0086	0.0231	0.0495	0.1236
2	0.1808	0.2134	0.2925	0.4297	0.3033	0.3598	0.6881	0.6021
3	0.3552	0.3029	0.3609	0.5765	0.4652	0.6133	0.5563	0.7314
4	0.2729	0.5233	0.2712	0.5511	0.5772	0.8600	0.5408	0.4185
5	0.4534	0.3883	0.4306	0.4522	0.6155	0.9407	0.7400	0.6587
6	0.4496	0.6028	0.3292	0.6325	0.5208	0.7397	0.5599	0.5874
7	0.1504	0.5811	0.5174	0.5371	0.4273	0.5297	0.4308	0.9084
8	0.2792	0.3931	0.3428	0.4952	0.4450	0.6122	0.5593	0.6163
9	0.2792	0.3931	0.3428	0.4952	0.4450	0.6122	0.5593	0.6163

Fishing Mortality (per year)

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	0.0649	0.1400	0.1059	0.0766	0.0331	0.0780	0.0802	0.1623
2	0.6409	0.4644	0.3027	0.2349	0.3001	0.4009	0.5539	0.6704
3	0.6555	0.6587	0.4472	0.4347	0.3932	0.5389	0.7622	1.1652
4	0.7122	0.6206	0.5625	0.6470	0.5308	0.5207	0.5851	0.9862
5	0.4247	0.6145	0.4664	0.2097	0.3590	0.5118	0.2828	0.8936
6	0.5099	0.6659	0.6893	0.5686	0.2745	0.5059	0.8256	0.5803
7	0.6809	0.3911	0.8848	0.2743	0.2762	0.3612	1.0552	0.7175
8	0.5832	0.5307	0.5101	0.3644	0.3379	0.4436	0.6385	0.7946
9	0.5832	0.5307	0.5101	0.3644	0.3379	0.4436	0.6385	0.7946

Fishing Mortality (per year)

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	0.0372	0.0296	0.0555	0.0490	0.0123	0.0092	0.0086	0.0252
2	0.4797	0.6897	0.5194	0.4008	0.3783	0.4986	0.2882	0.3751
3	0.7059	0.6943	0.7204	0.4216	0.6470	0.5959	0.4878	0.4438
4	0.8495	0.5868	1.1850	0.6571	0.8080	0.8442	0.2337	0.6244
5	0.7060	0.8482	1.1007	0.4508	0.8262	0.9093	0.4794	0.2929
6	1.1352	0.2857	1.9179	0.2329	0.3679	0.5791	0.4307	0.5747
7	0.5493	0.6181	0.5435	0.7080	0.1332	0.7153	0.3256	0.7019
8	0.6711	0.6001	0.8813	0.4579	0.4927	0.6417	0.3464	0.4700
9	0.6711	0.6001	0.8813	0.4579	0.4927	0.6417	0.3464	0.4700

Table 4.5.2.2 Continued – Celtic Sea & Division VIIj

Fishing Mortality (per year)

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0095	0.0162	0.0189	0.0077	0.0265	0.0195	0.0178	0.0225
2	0.2943	0.5875	0.5960	0.4155	0.4125	0.4243	0.3246	0.4100
3	0.4169	0.5172	0.8316	0.4620	0.5716	0.5369	0.4207	0.5314
4	0.4099	0.5349	0.8391	0.5875	0.2758	0.7606	0.4415	0.5577
5	0.5061	0.5986	0.6314	0.2712	0.3040	0.4985	0.5259	0.6643
6	0.1920	0.5737	0.8549	0.3125	0.4546	0.5848	0.5827	0.7361
7	0.4686	0.1732	0.7560	0.6756	0.2863	0.4360	0.4569	0.5772
8	0.3606	0.4734	0.7036	0.4374	0.3673	0.5056	0.4207	0.5314
9	0.3606	0.4734	0.7036	0.4374	0.3673	0.5056	0.4207	0.5314

Fishing Mortality (per year)

AGE	1998	1999	2000	2001
1	0.0225	0.0350	0.0297	0.0170
2	0.4093	0.6384	0.5418	0.3089
3	0.5304	0.8274	0.7021	0.4003
4	0.5567	0.8684	0.7369	0.4202
5	0.6631	1.0343	0.8778	0.5004
6	0.7348	1.1462	0.9727	0.5546
7	0.5762	0.8988	0.7627	0.4349
8	0.5304	0.8274	0.7021	0.4003
9	0.5304	0.8274	0.7021	0.4003

Population Abundance (1 January)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	323.4	1069.0	352.7	251.5	494.5	280.7	1037.9	370.6
2	38.6	118.0	392.6	128.1	91.3	181.5	103.1	377.4
3	123.8	25.4	65.5	229.2	81.2	51.8	90.3	63.5
4	68.6	71.6	18.7	31.6	158.8	48.6	30.7	58.4
5	41.4	37.7	46.5	13.4	23.2	98.1	40.0	21.5
6	66.0	25.6	23.7	29.1	10.2	13.4	69.2	34.5
7	32.6	37.1	17.6	17.2	21.5	5.8	9.5	54.3
8	31.0	14.3	16.7	10.2	12.9	11.4	3.9	7.4
9	18.4	28.1	15.8	33.1	18.1	12.7	15.0	40.2

x 10 ^ 6

Table 4.5.2.2 Continued – Celtic Sea & Division VIIj

Population Abundance (1 January)

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	662.5	686.9	850.6	459.7	242.6	876.2	274.6	317.1
2	136.3	239.6	248.3	305.8	163.6	88.5	315.0	96.1
3	219.7	84.3	143.4	137.3	147.4	89.5	45.7	117.3
4	43.6	126.1	51.0	81.8	63.2	75.8	39.7	21.5
5	37.9	30.0	67.6	35.2	42.7	32.1	29.0	20.9
6	16.2	21.8	18.4	39.8	20.2	20.9	11.3	12.5
7	26.9	9.3	10.8	12.0	19.1	10.9	9.0	5.9
8	37.6	21.0	4.7	5.8	6.3	11.3	5.8	5.3
9	16.5	21.8	17.8	9.3	9.8	5.1	2.5	2.7

x 10 ^ 6

Population Abundance (1 January)

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	137.9	152.8	207.9	174.1	135.7	237.4	146.1	410.1
2	103.1	47.5	48.9	68.8	59.3	48.3	80.8	49.6
3	39.0	40.2	22.1	26.8	40.3	32.5	24.0	34.4
4	46.2	16.6	17.0	11.6	14.2	22.3	15.5	9.2
5	12.8	20.5	8.1	8.8	5.5	7.5	12.0	7.8
6	9.8	7.6	10.0	4.6	6.4	3.5	4.1	8.2
7	6.3	5.3	3.5	4.6	2.3	4.4	1.9	1.6
8	2.1	2.9	3.3	1.3	3.1	1.6	2.8	0.6
9	2.0	3.0	4.6	1.6	1.8	1.9	1.3	1.6

x 10 ^ 6

Population Abundance (1 January)

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	662.8	733.6	569.0	589.8	536.9	1032.7	426.4	524.6
2	128.3	234.9	262.0	198.0	206.6	195.1	376.4	155.5
3	18.8	58.8	87.3	115.5	98.3	104.8	87.8	209.0
4	8.8	7.6	24.0	34.8	62.0	42.1	47.3	44.1
5	3.1	3.4	3.8	6.7	16.3	25.0	16.4	33.9
6	2.9	1.4	1.3	1.2	3.8	6.5	9.1	9.2
7	4.1	0.8	0.9	0.2	0.8	2.4	3.3	5.4
8	0.7	2.2	0.4	0.5	0.1	0.7	1.1	2.1
9	1.3	0.7	0.3	0.4	0.0	1.0	0.3	1.9

x 10 ^ 6

Table 4.5.2.2 Continued – Celtic Sea & Division VIIj

Population Abundance (1 January)

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	450.0	187.7	878.0	332.1	731.9	772.8	340.8	409.9
2	188.2	164.0	68.0	317.0	121.2	262.2	278.8	123.1
3	79.2	103.9	67.5	27.7	155.0	59.5	127.1	149.3
4	109.8	42.7	50.7	24.1	14.3	71.6	28.5	68.3
5	21.4	65.9	22.6	19.8	12.1	9.8	30.3	16.6
6	22.9	11.7	32.8	10.9	13.7	8.1	5.4	16.2
7	4.7	17.1	5.9	12.6	7.2	7.9	4.1	2.7
8	2.4	2.6	13.0	2.5	5.8	4.9	4.6	2.3
9	1.6	1.6	1.4	1.5	1.6	2.2	3.1	1.5

x 10 ^ 6

Population Abundance (1 January)

AGE	1998	1999	2000	2001	2002
1	283.4	595.4	522.6	1476.6	529.3
2	147.4	101.9	211.5	186.6	534.1
3	60.5	72.5	39.9	91.1	101.5
4	71.8	29.2	26.0	16.2	50.0
5	35.4	37.3	11.1	11.2	9.6
6	7.7	16.5	12.0	4.2	6.2
7	7.0	3.3	4.7	4.1	2.2
8	1.4	3.6	1.2	2.0	2.4
9	1.0	1.0	1.2	1.2	2.0

x 10 ^ 6

Weighting factors for the catches in number

AGE	1996	1997	1998	1999	2000	2001
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

Table 4.5.2.2 Continued – Celtic Sea & Division VIIj

Predicted Age-Structured Index Values

FLT02: celtic combined acc data (Catch: Predicted

AGE	1990	1991	1992	1993	1994	1995	1996	1997
2	280.75	182.43	74.97	418.88	160.72	343.48	403.49	*******
3	136.88	162.46	77.09	45.85	229.55	91.18	218.91	*******
4	183.02	62.83	55.02	33.57	27.27	84.09	45.96	*******
5	29.33	82.46	27.40	34.39	20.31	13.58	40.74	*******

FLT02: celtic combined acc data (Catch: Predicted

AGE	1998	1999	2000	2001
2	196.05	*******	246.34	274.38
3	93.44	*******	51.84	160.22
4	103.40	*******	31.20	26.69
5	41.49	*******	10.47	15.51

Fitted Selection Pattern

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	0.0232	0.0172	0.0242	0.0806	0.0079	0.0052	0.0490	0.0014
2	0.3417	2.7770	0.4488	0.9348	0.8497	1.2304	0.7824	1.3616
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.4356	3.1894	0.4479	1.2404	1.2159	0.2930	1.0952	1.8763
5	1.0992	3.5161	0.6953	1.0408	1.4434	0.7734	0.1962	1.0267
6	1.3757	2.6275	0.4116	1.2067	1.4674	0.7327	0.6022	0.8385
7	2.0866	6.7261	0.8470	1.1294	1.7222	0.8952	0.6572	1.5071
8	1.1006	3.0898	0.6069	1.0227	1.1765	0.8076	0.7090	1.2277
9	1.1006	3.0898	0.6069	1.0227	1.1765	0.8076	0.7090	1.2277

Table 4.5.2.2 Continued – Celtic Sea & Division VIIj

Fitted Selection Pattern

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	0.0480	0.0582	0.0635	0.0573	0.0186	0.0376	0.0890	0.1691
2	0.5089	0.7044	0.8105	0.7454	0.6520	0.5867	1.2369	0.8232
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.7683	1.7273	0.7515	0.9559	1.2408	1.4021	0.9721	0.5721
5	1.2767	1.2817	1.1934	0.7844	1.3232	1.5338	1.3302	0.9006
6	1.2660	1.9898	0.9123	1.0971	1.1196	1.2060	1.0064	0.8031
7	0.4235	1.9182	1.4339	0.9316	0.9187	0.8636	0.7744	1.2420
8	0.7861	1.2977	0.9499	0.8590	0.9566	0.9981	1.0054	0.8426
9	0.7861	1.2977	0.9499	0.8590	0.9566	0.9981	1.0054	0.8426

Fitted Selection Pattern

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	0.0990	0.2126	0.2368	0.1761	0.0842	0.1448	0.1052	0.1393
2	0.9776	0.7050	0.6769	0.5404	0.7634	0.7439	0.7267	0.5753
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0864	0.9422	1.2578	1.4884	1.3502	0.9662	0.7677	0.8464
5	0.6478	0.9329	1.0429	0.4825	0.9131	0.9498	0.3710	0.7669
6	0.7779	1.0109	1.5413	1.3080	0.6981	0.9389	1.0832	0.4980
7	1.0386	0.5938	1.9784	0.6309	0.7026	0.6704	1.3845	0.6158
8	0.8897	0.8057	1.1406	0.8382	0.8595	0.8232	0.8377	0.6820
9	0.8897	0.8057	1.1406	0.8382	0.8595	0.8232	0.8377	0.6820

Fitted Selection Pattern

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	0.0527	0.0426	0.0771	0.1163	0.0190	0.0154	0.0176	0.0567
2	0.6795	0.9933	0.7210	0.9505	0.5848	0.8368	0.5909	0.8452
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.2034	0.8451	1.6450	1.5586	1.2489	1.4167	0.4791	1.4069
5	1.0001	1.2216	1.5280	1.0691	1.2771	1.5260	0.9828	0.6600
6	1.6081	0.4114	2.6623	0.5525	0.5687	0.9717	0.8829	1.2951
7	0.7781	0.8902	0.7545	1.6793	0.2059	1.2004	0.6675	1.5817
8	0.9507	0.8644	1.2234	1.0861	0.7616	1.0769	0.7100	1.0591
9	0.9507	0.8644	1.2234	1.0861	0.7616	1.0769	0.7100	1.0591

Table 4.5.2.2 Continued – Celtic Sea & Division VIIj

Fitted Selection Pattern

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0229	0.0314	0.0227	0.0166	0.0464	0.0363	0.0424	0.0424
2	0.7058	1.1360	0.7167	0.8994	0.7216	0.7902	0.7716	0.7716
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.9831	1.0343	1.0089	1.2717	0.4824	1.4166	1.0496	1.0496
5	1.2138	1.1574	0.7592	0.5870	0.5317	0.9284	1.2501	1.2501
6	0.4605	1.1092	1.0280	0.6765	0.7954	1.0892	1.3853	1.3853
7	1.1239	0.3348	0.9091	1.4625	0.5009	0.8120	1.0863	1.0863
8	0.8649	0.9154	0.8461	0.9469	0.6426	0.9417	1.0000	1.0000
9	0.8649	0.9154	0.8461	0.9469	0.6426	0.9417	1.0000	1.0000

Fitted Selection Pattern

AGE	1998	1999	2000	2001
1	0.0424	0.0424	0.0424	0.0424
2	0.7716	0.7716	0.7716	0.7716
3	1.0000	1.0000	1.0000	1.0000
4	1.0496	1.0496	1.0496	1.0496
5	1.2501	1.2501	1.2501	1.2501
6	1.3853	1.3853	1.3853	1.3853
7	1.0863	1.0863	1.0863	1.0863
8	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000

Table 4.5.2.2 Continued – Celtic Sea & Division VIIj

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 7	SoP (%)
1958	323380	109881	77022	22978	0.2983	0.4246	89
1959	1068990	155254	82028	15086	0.1839	0.3432	88
1960	352700	120356	83784	18283	0.2182	0.3403	88
1961	251480	105414	78653	15372	0.1954	0.1824	128
1962	494490	130308	82163	21552	0.2623	0.4023	98
1963	280690	105868	75327	17349	0.2303	0.2652	99
1964	1037900	178269	94660	10599	0.1120	0.1701	97
1965	370550	154893	112333	19126	0.1703	0.2245	86
1966	662500	186267	115204	27030	0.2346	0.3104	103
1967	686890	188896	115540	27658	0.2394	0.4353	90
1968	850570	210698	123165	30236	0.2455	0.3670	100
1969	459650	176667	115314	44389	0.3849	0.5298	99
1970	242640	126087	88482	31727	0.3586	0.4849	99
1971	876210	172612	87417	31396	0.3592	0.6739	96
1972	274600	122100	78026	38203	0.4896	0.5860	100
1973	317060	97250	57515	26936	0.4683	0.6511	95
1974	137850	64938	42108	19940	0.4735	0.6040	97
1975	152830	52671	32006	15588	0.4870	0.5692	107
1976	207860	53600	29313	9771	0.3333	0.5588	94
1977	174050	49694	29082	7833	0.2693	0.3949	100
1978	135650	46040	29373	7559	0.2573	0.3556	91
1979	237420	55695	30115	10321	0.3427	0.4732	100
1980	146100	45633	27912	13130	0.4704	0.6775	107
1981	410110	70690	31737	17103	0.5389	0.8355	101
1982	662830	105040	45661	13000	0.2847	0.7376	101
1983	733630	130535	62840	24981	0.3975	0.6204	104
1984	569030	112965	62418	26779	0.4290	0.9978	99
1985	589750	117796	64448	20426	0.3169	0.4785	102
1986	536880	125369	70473	25024	0.3551	0.5268	100
1987	1032680	161320	79348	26200	0.3302	0.6904	99
1988	426350	121915	79393	20447	0.2575	0.3743	100
1989	524600	125144	74373	23254	0.3127	0.5021	100
1990	449950	111485	70059	18404	0.2627	0.3813	99
1991	187730	83366	59269	25562	0.4313	0.4975	101
1992	878030	127012	59325	21127	0.3561	0.7515	95
1993	332120	89860	57436	18618	0.3241	0.4540	100
1994	731910	124333	65112	19300	0.2964	0.3841	99
1995	772760	129462	70133	23305	0.3323	0.5402	100
1996	340750	95325	63016	18816	0.2986	0.4587	100
1997	409890	92528	55991	20496	0.3661	0.5794	99
1998	283350	76317	48009	18041	0.3758	0.5784	99
1999	595420	92858	46367	18485	0.3987	0.9023	99
2000	522630	87574	45436	17191	0.3784	0.7657	99
2001	1476610*	160553	69276$	15236	0.2199	0.4365	99

No of years for separable analysis : 6
Age range in the analysis : 1 . . . 9
Year range in the analysis : 1958 . . . 2001
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 29
Number of observations : 88

Conventional single selection vector model to be fitted.

* Adjusted for Geometric Mean, recruitment 2001 = 411981
$ Adjusted for Geometric Mean, SSB 2001 = 42874.

Table 4.5.2.2 Continued – Celtic Sea & Division VIIj

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	1996	0.4207	16	0.3029	0.5841	0.3558	0.4973	0.4266
2	1997	0.5314	15	0.3896	0.7247	0.4536	0.6225	0.5381
3	1998	0.5304	15	0.3924	0.7170	0.4548	0.6186	0.5367
4	1999	0.8274	14	0.6246	1.0961	0.7168	0.9551	0.8360
5	2000	0.7021	16	0.5074	0.9715	0.5949	0.8287	0.7118
6	2001	0.4003	22	0.2595	0.6175	0.3209	0.4994	0.4102
Separable Model: Selection (S) by age								
7	1	0.0424	47	0.0168	0.1065	0.0265	0.0678	0.0473
8	2	0.7716	18	0.5419	1.0987	0.6443	0.9241	0.7843
	3	1.0000	Fixed : Reference Age					
9	4	1.0496	17	0.7505	1.4678	0.8845	1.2454	1.0650
10	5	1.2501	15	0.9158	1.7065	1.0666	1.4652	1.2660
11	6	1.3853	14	1.0390	1.8469	1.1962	1.6042	1.4003
12	7	1.0863	15	0.8083	1.4598	0.9342	1.2631	1.0987
	8	1.0000	Fixed : Last true age					
Separable model: Populations in year 2001								
13	1	1476617	112	162635	13406700	479142	4550624	2781918
14	2	186631	27	109935	316833	142467	244485	193560
15	3	91143	20	61269	135582	74425	111615	93033
16	4	16177	18	11159	23451	13385	19551	16470
17	5	11242	18	7892	16012	9385	13465	11426
18	6	4164	20	2795	6203	3397	5103	4251
19	7	4098	24	2556	6570	3221	5214	4218
20	8	2001	26	1193	3356	1537	2605	2072
Separable model: Populations at age								
21	1996	4594	34	2328	9067	3248	6499	4879
22	1997	2332	26	1384	3929	1787	3043	2416
23	1998	1385	23	872	2199	1094	1753	1424
24	1999	3570	20	2365	5388	2894	4404	3649
25	2000	1231	22	789	1921	981	1545	1263

Age-structured index catchabilities

FLT02: celtic combined acc data (Catch:

Linear model fitted. Slopes at age :

26	2	Q	.2703E-02	13	.2370E-02	.4053E-02	.2703E-02	.3554E-02	.3128E-02
27	3	Q	.3204E-02	13	.2813E-02	.4786E-02	.3204E-02	.4202E-02	.3703E-02
28	4	Q	.2775E-02	13	.2436E-02	.4148E-02	.2775E-02	.3641E-02	.3208E-02
29	5	Q	.2514E-02	13	.2204E-02	.3776E-02	.2514E-02	.3309E-02	.2912E-02

Table 4.5.2.2 Continued – Celtic Sea & Division VIIj

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1996	1997	1998	1999	2000	2001
1	-0.0916	-0.4061	0.3780	0.0935	0.0253	0.0000
2	-0.0833	0.0350	-0.0404	-0.2143	-0.0011	0.3331
3	-0.0406	-0.0590	0.1734	-0.0386	0.0271	0.2755
4	-0.2000	0.1188	-0.0364	-0.1025	-0.0721	0.1240
5	0.3080	0.0785	-0.2197	-0.3956	-0.1704	0.0058
6	-0.0936	-0.2746	-0.0253	-0.1972	-0.1380	0.0717
7	0.1058	0.0033	-0.0947	-0.0198	-0.0443	-0.0978
8	0.0000	-0.1058	0.0903	0.0438	0.1064	-0.3007

AGE-STRUCTURED INDEX RESIDUALS

FLT02: celtic combined acc data (Catch:

Age	1990	1991	1992	1993	1994	1995	1996	1997
2	-0.120	0.068	0.445	0.044	-0.234	0.472	0.629	*******
3	-0.231	-0.540	0.130	0.247	-0.359	0.417	0.132	*******
4	-0.182	-0.152	-0.104	0.636	-0.954	0.106	0.096	*******
5	0.100	0.028	-0.210	-0.280	-0.650	-0.542	0.028	*******

FLT02: celtic combined acc data (Catch:

Age	1998	1999	2000	2001
2	-0.221	*******	-0.546	-0.537
3	0.471	*******	-0.360	0.092
4	0.667	*******	-0.514	0.400
5	0.962	*******	-0.468	1.032

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

Separable model fitted from 1996 to 2001	
Variance	0.0451
Skewness test stat.	-1.1188
Kurtosis test statistic	0.6177
Partial chi-square	0.1144
Significance in fit	0.0000
Degrees of freedom	23

Table 4.5.2.2 Continued – Celtic Sea & Division VIIj

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	0.1061	0.0766	0.1578	0.2125
Skewness test stat.	0.2153	-0.2296	-0.4716	1.0856
Kurtosis test statisti	-0.7661	-0.8493	-0.3249	-0.3422
Partial chi-square	0.1746	0.1480	0.3947	0.6386
Significance in fit	0.0000	0.0000	0.0000	0.0001
Number of observations	10	10	10	10
Degrees of freedom	9	9	9	9
Weight in the analysis	0.6250	0.6250	0.6250	0.6250

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	9.2925	88	29	59	0.1575
Catches-at-age	1.3299	48	25	23	0.0578
Aged Indices					
FLT02: celtic combined acc data (Catch	7.9625	40	4	36	0.2212

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	4.1473	88	29	59	0.0703
Catches-at-age	1.0369	48	25	23	0.0451
Aged Indices					
FLT02: celtic combined acc data (Catch	3.1104	40	4	36	0.0864

Table 4.6.1 Celtic Sea and Division VIIj – Input data for short-term predictions.

MFDP version 1a
Run: adj surv age 2
Time and date: 11:46 18/03/02
Fbar age range: 2-7

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	411981	1	0.5	0.2	0.5	9.07E-02	0.016957	9.07E-02
2	151560	0.3	1	0.2	0.5	0.116833	0.3089	0.116833
3	101520	0.2	1	0.2	0.5	0.146167	0.40032	0.146167
4	50005	0.1	1	0.2	0.5	0.162667	0.42017	0.162667
5	9616.6	0.1	1	0.2	0.5	0.178667	0.50044	0.178667
6	6167.7	0.1	1	0.2	0.5	0.188833	0.55455	0.188833
7	2164.5	0.1	1	0.2	0.5	0.199333	0.43486	0.199333
8	2401.2	0.1	1	0.2	0.5	0.210333	0.40032	0.210333
9	2014.7	0.1	1	0.2	0.5	0.222833	0.40032	0.222833

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	411981	1	0.5	0.2	0.5	9.07E-02	0.016957	9.07E-02
2	.	0.3	1	0.2	0.5	0.116833	0.3089	0.116833
3	.	0.2	1	0.2	0.5	0.146167	0.40032	0.146167
4	.	0.1	1	0.2	0.5	0.162667	0.42017	0.162667
5	.	0.1	1	0.2	0.5	0.178667	0.50044	0.178667
6	.	0.1	1	0.2	0.5	0.188833	0.55455	0.188833
7	.	0.1	1	0.2	0.5	0.199333	0.43486	0.199333
8	.	0.1	1	0.2	0.5	0.210333	0.40032	0.210333
9	.	0.1	1	0.2	0.5	0.222833	0.40032	0.222833

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	411981	1	0.5	0.2	0.5	9.07E-02	0.016957	9.07E-02
2	.	0.3	1	0.2	0.5	0.116833	0.3089	0.116833
3	.	0.2	1	0.2	0.5	0.146167	0.40032	0.146167
4	.	0.1	1	0.2	0.5	0.162667	0.42017	0.162667
5	.	0.1	1	0.2	0.5	0.178667	0.50044	0.178667
6	.	0.1	1	0.2	0.5	0.188833	0.55455	0.188833
7	.	0.1	1	0.2	0.5	0.199333	0.43486	0.199333
8	.	0.1	1	0.2	0.5	0.210333	0.40032	0.210333
9	.	0.1	1	0.2	0.5	0.222833	0.40032	0.222833

Input units are thousands and kg - output in tonnes

Table 4.6.2. Celtic Sea and Division VIIj. Single option prediction table with TAC constraint.

MFDP version 1a
Run: adj surv age 2
Time and date: 11:46 18/03/02
Fbar age range: 2-7

Year:		2002	F multiplier:		1	Fbar:	0.4365			
Age	F		CatchNos	Yield		StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	1	0.017	4385	398	411981	37353	205991	18676	124517	11290
	2	0.3089	35065	4097	151560	17707	151560	17707	122634	14328
	3	0.4003	30556	4466	101520	14839	101520	14839	84791	12394
	4	0.4202	16382	2665	50005	8134	50005	8134	43732	7114
	5	0.5004	3618	646	9617	1718	9617	1718	8276	1479
	6	0.5546	2510	474	6168	1165	6168	1165	5251	992
	7	0.4349	729	145	2165	431	2165	431	1887	376
	8	0.4003	756	159	2401	505	2401	505	2108	443
	9	0.4003	635	141	2015	449	2015	449	1769	394
Total			94636	13192	737431	82301	531440	63625	394966	48809

Year:		2003	F multiplier:		1	Fbar:	0.4365			
Age	F		CatchNos	Yield		StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	1	0.017	4385	398	411981	37353	205991	18676	124517	11290
	2	0.3089	34475	4028	149011	17409	149011	17409	120571	14087
	3	0.4003	24814	3627	82441	12050	82441	12050	68856	10064
	4	0.4202	18247	2968	55698	9060	55698	9060	48711	7924
	5	0.5004	11184	1998	29724	5311	29724	5311	25581	4571
	6	0.5546	2147	405	5275	996	5275	996	4491	848
	7	0.4349	1080	215	3205	639	3205	639	2795	557
	8	0.4003	399	84	1268	267	1268	267	1113	234
	9	0.4003	843	188	2678	597	2678	597	2351	524
Total			97573	13911	741280	83682	535290	65005	398986	50098

Year:		2004	F multiplier:		1	Fbar:	0.4365			
Age	F		CatchNos	Yield		StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	1	0.017	4385	398	411981	37353	205991	18676	124517	11290
	2	0.3089	34475	4028	149011	17409	149011	17409	120571	14087
	3	0.4003	24397	3566	81054	11847	81054	11847	67698	9895
	4	0.4202	14818	2410	45230	7357	45230	7357	39556	6435
	5	0.5004	12457	2226	33108	5915	33108	5915	28494	5091
	6	0.5546	6635	1253	16306	3079	16306	3079	13882	2621
	7	0.4349	923	184	2741	546	2741	546	2391	477
	8	0.4003	591	124	1877	395	1877	395	1648	347
	9	0.4003	754	168	2392	533	2392	533	2100	468
Total			99434	14357	743701	84436	537710	65760	400857	50709

Input units are thousands and kg - output in tonnes

Table 4.6.3. Celtic Sea & Division VIIj – Short-term predictions with management options.

MFDP version 1a
Run: adj surv age 2
Celtic Sea 2001Projection index file Tuesday 18th March 2002.
Time and date: 11:46 18/03/02
Fbar age range: 2-7

2002				
Biomass	SSB	FMult	FBar	Landings
82301	48809	1	0.4365	13192

2003					2004	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
83682	53262	0	0	0	98615	67251
.	52934	0.1	0.0437	1638	96936	65235
.	52609	0.2	0.0873	3215	95322	63310
.	52287	0.3	0.131	4733	93770	61473
.	51966	0.4	0.1746	6196	92277	59717
.	51649	0.5	0.2183	7604	90840	58041
.	51334	0.6	0.2619	8961	89459	56439
.	51021	0.7	0.3056	10268	88129	54908
.	50711	0.8	0.3492	11528	86851	53445
.	50403	0.9	0.3929	12741	85620	52047
.	50098	1	0.4365	13911	84436	50709
.	49795	1.1	0.4802	15039	83297	49431
.	49495	1.2	0.5238	16125	82200	48208
.	49197	1.3	0.5675	17173	81144	47038
.	48901	1.4	0.6112	18183	80128	45919
.	48607	1.5	0.6548	19157	79150	44848
.	48316	1.6	0.6985	20097	78209	43823
.	48027	1.7	0.7421	21003	77302	42841
.	47740	1.8	0.7858	21877	76429	41901
.	47456	1.9	0.8294	22721	75588	41001
.	47174	2	0.8731	23535	74778	40138

Input units are thousands and kg - output in tonnes

Table 4.6.4. Celtic Sea & Division VIIj herring. Single option prediction table with catch constraint.

MFDP version 1a
Run: Catch constraint 8,000t
Time and date: 10:06 20/03/02
Fbar age range: 2-7

Year:	2002	F multiplier:	0.5624	Fbar:	0.2455				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0095	2473	224	411981	37353	205991	18676	124702	11306
2	0.1737	20970	2450	151560	17707	151560	17707	125995	14720
3	0.2251	18617	2721	101520	14839	101520	14839	87815	12836
4	0.2363	10034	1632	50005	8134	50005	8134	45371	7380
5	0.2814	2250	402	9617	1718	9617	1718	8647	1545
6	0.3119	1577	298	6168	1165	6168	1165	5512	1041
7	0.2445	448	89	2165	431	2165	431	1961	391
8	0.2251	461	97	2401	505	2401	505	2184	459
9	0.2251	387	86	2015	449	2015	449	1832	408
Total		57218	8000	737431	82301	531440	63625	404017	50087

Year:	2003	F multiplier:	1	Fbar:	0.4365				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.017	4385	398	411981	37353	205991	18676	124517	11290
2	0.3089	34732	4058	150121	17539	150121	17539	121469	14192
3	0.4003	28406	4152	94375	13794	94375	13794	78823	11521
4	0.4202	21741	3537	66363	10795	66363	10795	58038	9441
5	0.5004	13441	2402	35725	6383	35725	6383	30746	5493
6	0.5546	2672	505	6567	1240	6567	1240	5591	1056
7	0.4349	1376	274	4086	814	4086	814	3563	710
8	0.4003	483	102	1534	323	1534	323	1347	283
9	0.4003	1005	224	3190	711	3190	711	2801	624
Total		108241	15650	773940	88952	567950	70276	426894	54610

Year:	2004	F multiplier:	1	Fbar:	0.4365				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.017	4385	398	411981	37353	205991	18676	124517	11290
2	0.3089	34475	4028	149011	17409	149011	17409	120571	14087
3	0.4003	24578	3593	81658	11936	81658	11936	68202	9969
4	0.4202	16963	2759	51777	8422	51777	8422	45282	7366
5	0.5004	14842	2652	39447	7048	39447	7048	33950	6066
6	0.5546	7975	1506	19597	3701	19597	3701	16685	3151
7	0.4349	1149	229	3413	680	3413	680	2976	593
8	0.4003	754	159	2393	503	2393	503	2101	442
9	0.4003	902	201	2864	638	2864	638	2515	560
Total		106023	15524	762142	87691	556152	69015	416799	53523

Input units are thousands and kg - output in tonnes

Table 4.6.5. Celtic Sea & Division VIIj herring. Short-term predictions with TAC constraint and management options.

MFDP version 1a
Run: Catch constraint 8,000t
Celtic Sea 2001Projection index file Tuesday 18th March 2002.
Time and date: 10:06 20/03/02
Fbar age range: 2-7

2002				
Biomass	SSB	FMult	FBar	Landings
82301	50087	0.5624	0.2455	8000

2003					2004	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
88952	58183	0	0	0	103631	72017
.	57813	0.1	0.0437	1847	101740	69756
.	57445	0.2	0.0873	3624	99922	67599
.	57081	0.3	0.131	5335	98175	65540
.	56719	0.4	0.1746	6981	96495	63576
.	56361	0.5	0.2183	8566	94880	61701
.	56005	0.6	0.2619	10092	93327	59911
.	55652	0.7	0.3056	11561	91834	58202
.	55302	0.8	0.3492	12975	90399	56570
.	54955	0.9	0.3929	14338	89019	55012
.	54610	1	0.4365	15650	87691	53523
.	54268	1.1	0.4802	16914	86414	52100
.	53929	1.2	0.5238	18131	85186	50741
.	53593	1.3	0.5675	19304	84005	49442
.	53259	1.4	0.6112	20435	82868	48200
.	52928	1.5	0.6548	21524	81774	47012
.	52599	1.6	0.6985	22574	80722	45876
.	52273	1.7	0.7421	23586	79710	44790
.	51950	1.8	0.7858	24562	78736	43750
.	51629	1.9	0.8294	25502	77798	42756
.	51311	2	0.8731	26410	76895	41804

Input units are thousands and kg - output in tonnes

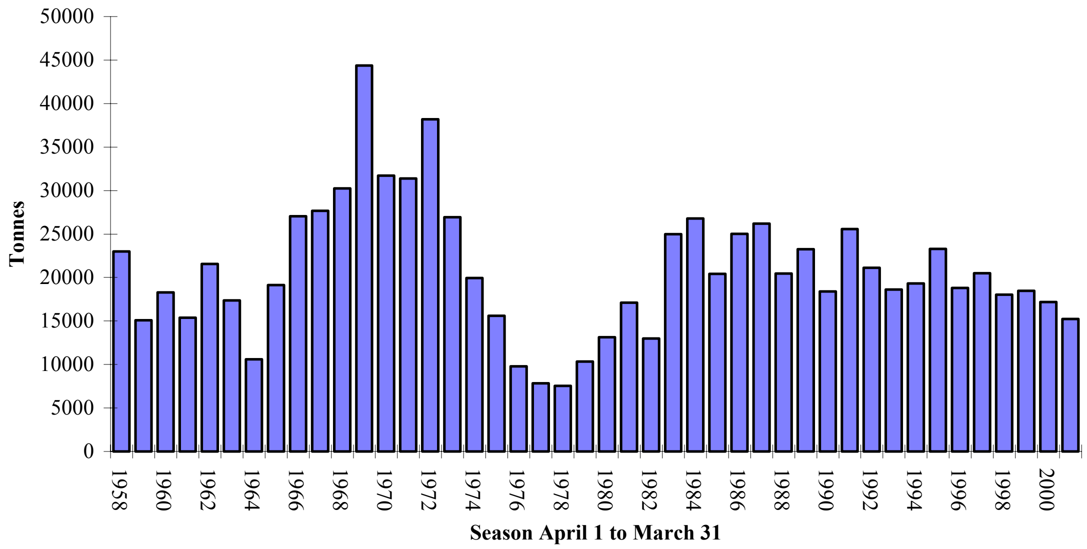


Figure 4.2.1 Celtic Sea & Division VIIj – Estimated herring landings per year.

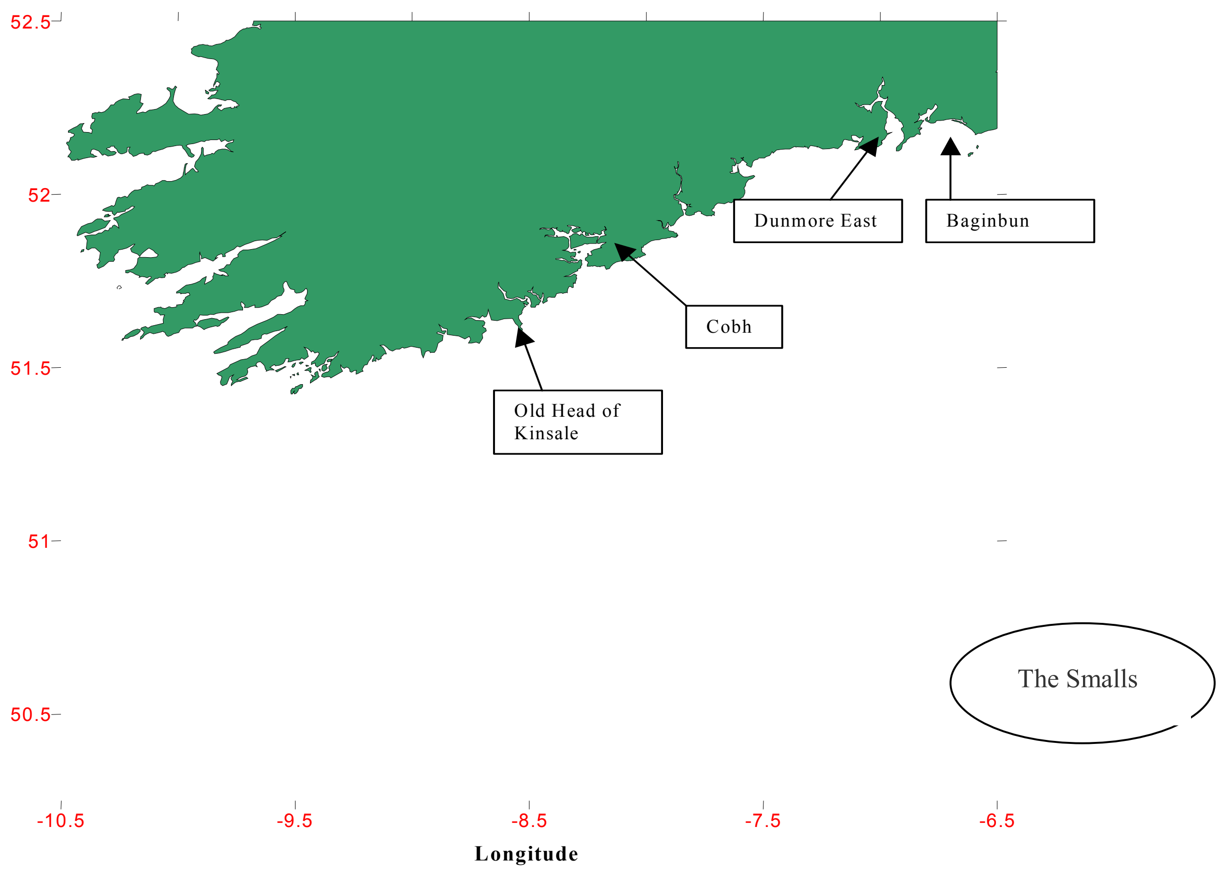


Figure 4.2.2. Celtic Sea & Division VIIj. Map of locations mentioned in the text.

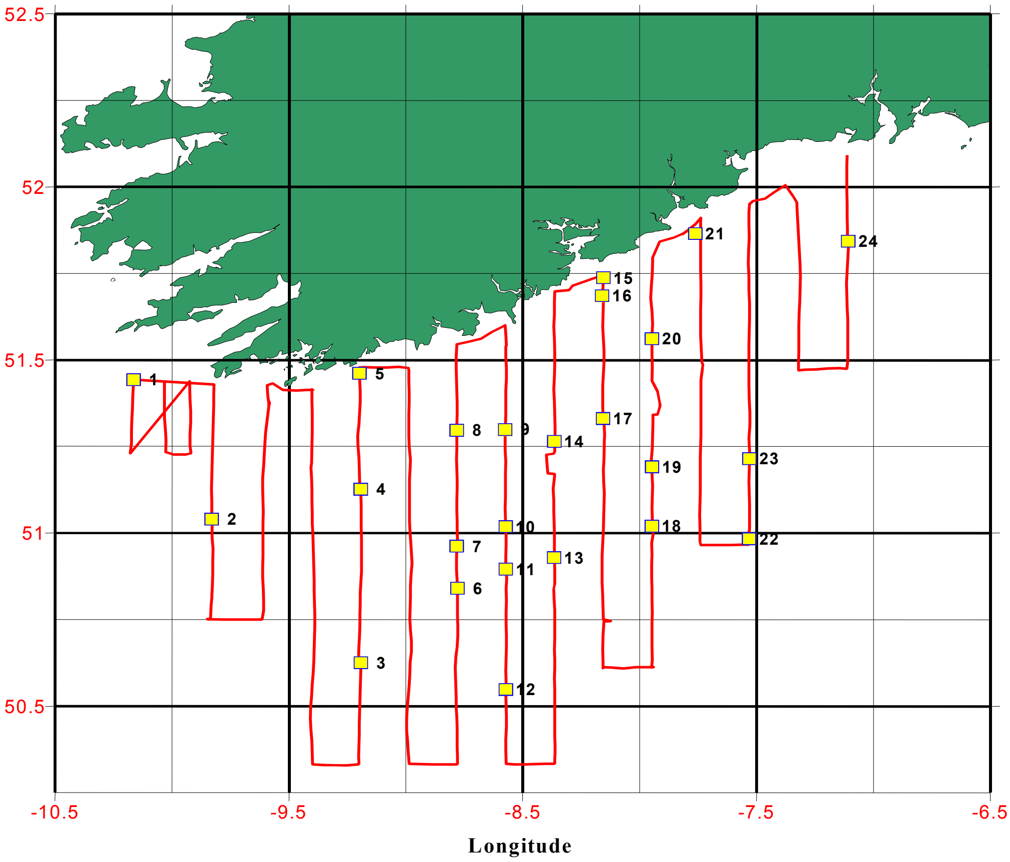


Figure 4.4.1a. Celtic Sea & Division VIIj. Cruise track and haul positions from acoustic survey – September 2001.

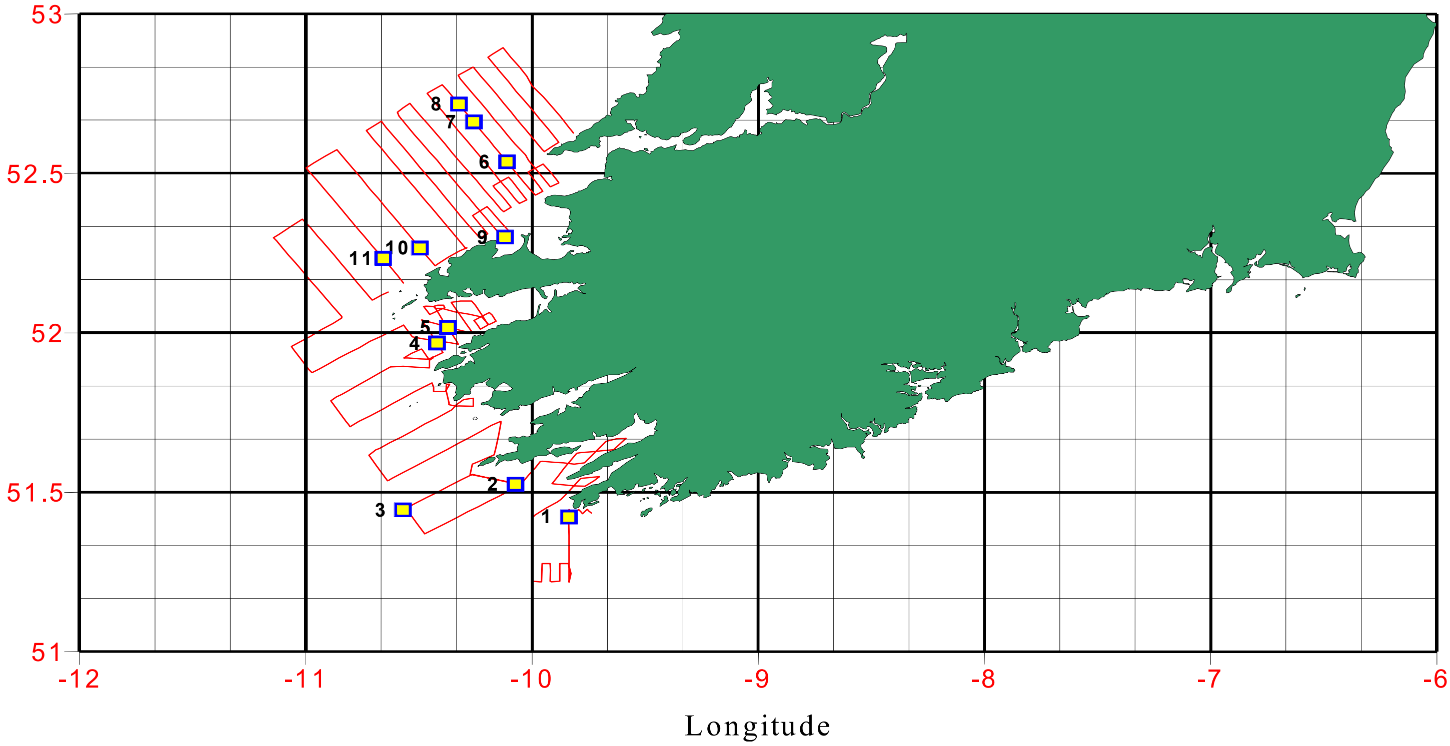


Figure 4.4.1b. Celtic Sea & Division VIIj. Cruise track and haul positions from acoustic survey – October 2001.

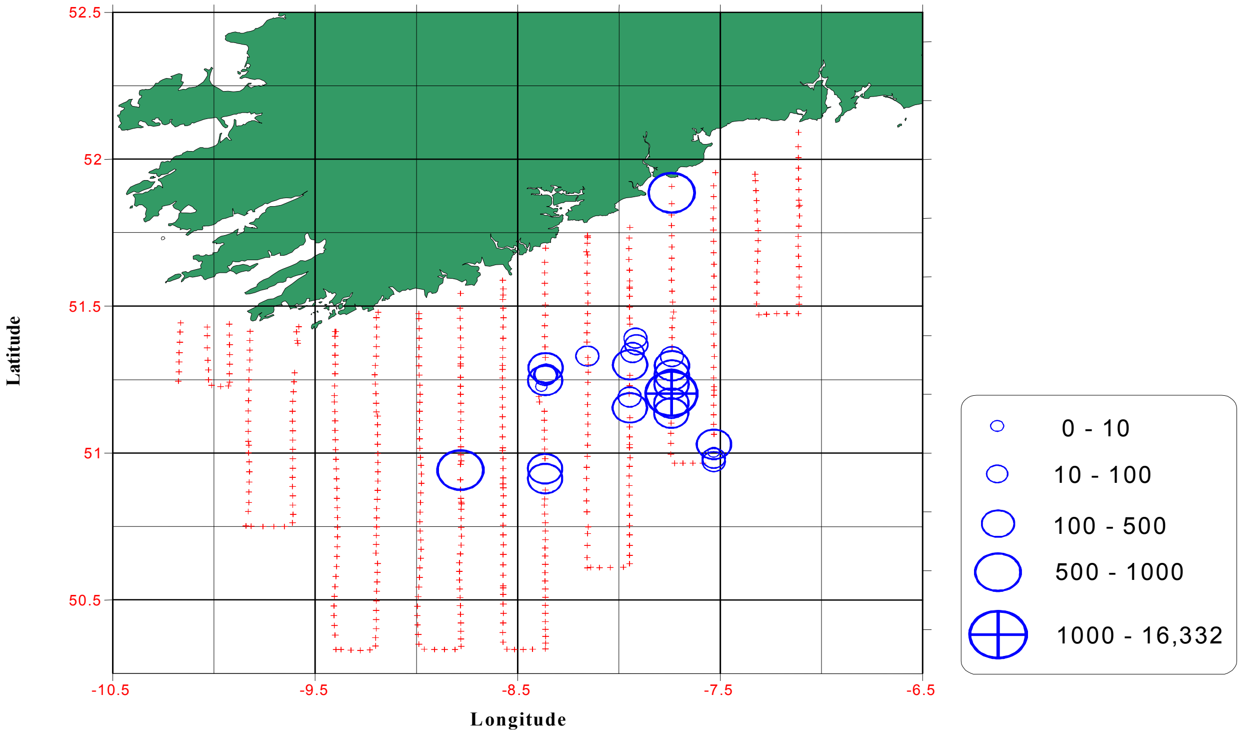


Figure 4.4.2a. Celtic Sea & Division VIIj herring. Post plot showing the distribution of total herring SA values obtained during the September 2001 acoustic survey.

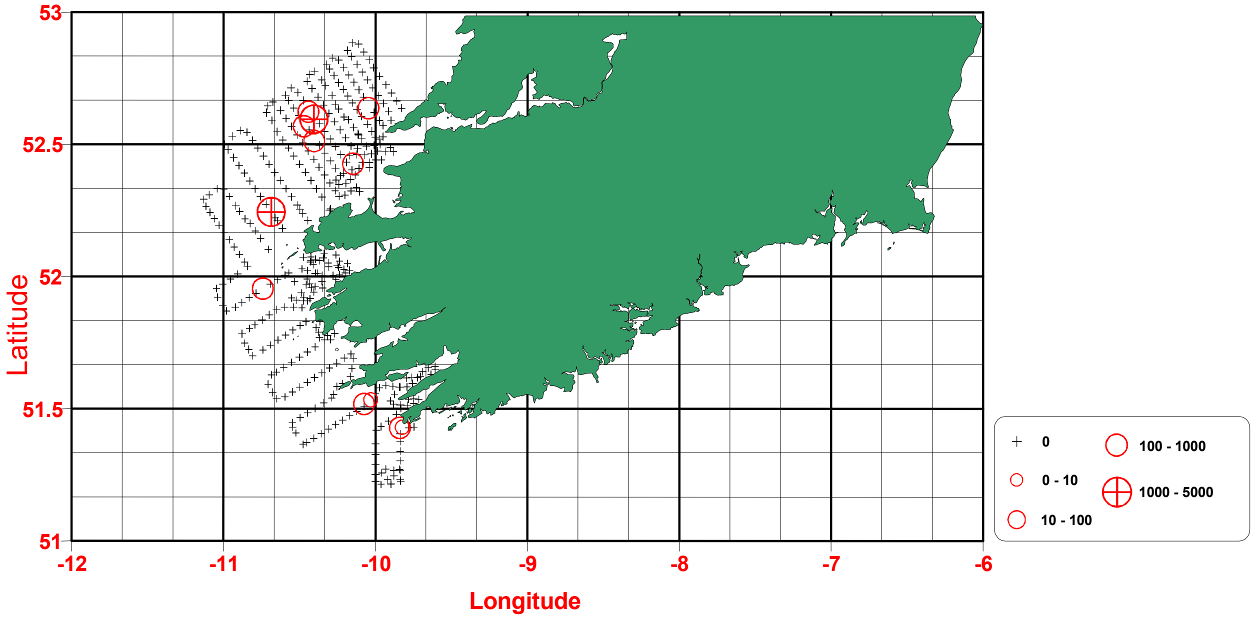


Figure 4.4.2b. Celtic Sea & Division VIIj herring. Post plot showing the distribution of total herring SA values obtained during the October 2001 acoustic survey.

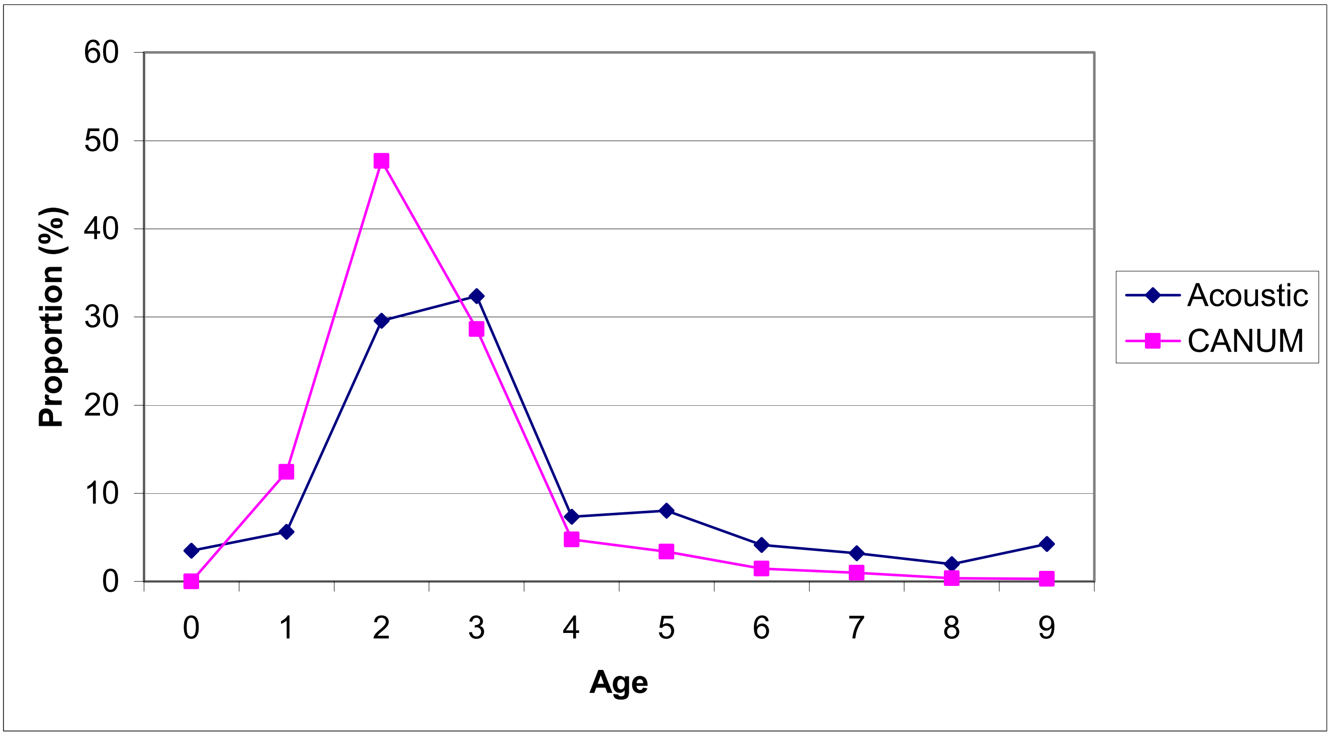


Figure 4.4.3 Celtic Sea & Division VIIj herring**.** Comparison of Catch-at-age from CANUM 2002 and acoustic survey.

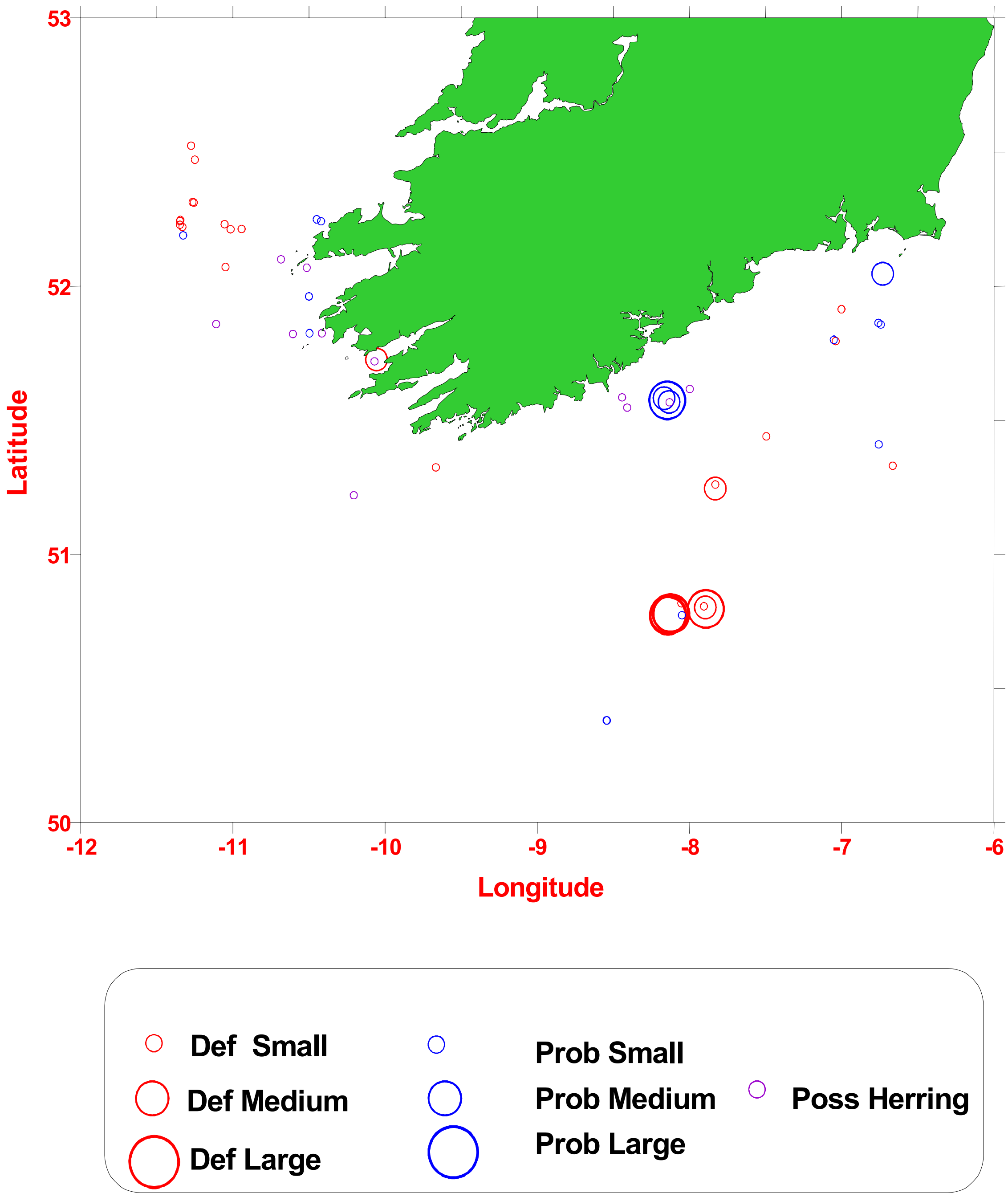


Figure 4.4.4. Celtic Sea & Division VIIj. Positions of "Definite", "Probable" and "Possible" herring marks as recorded by survey, July – September 2001.

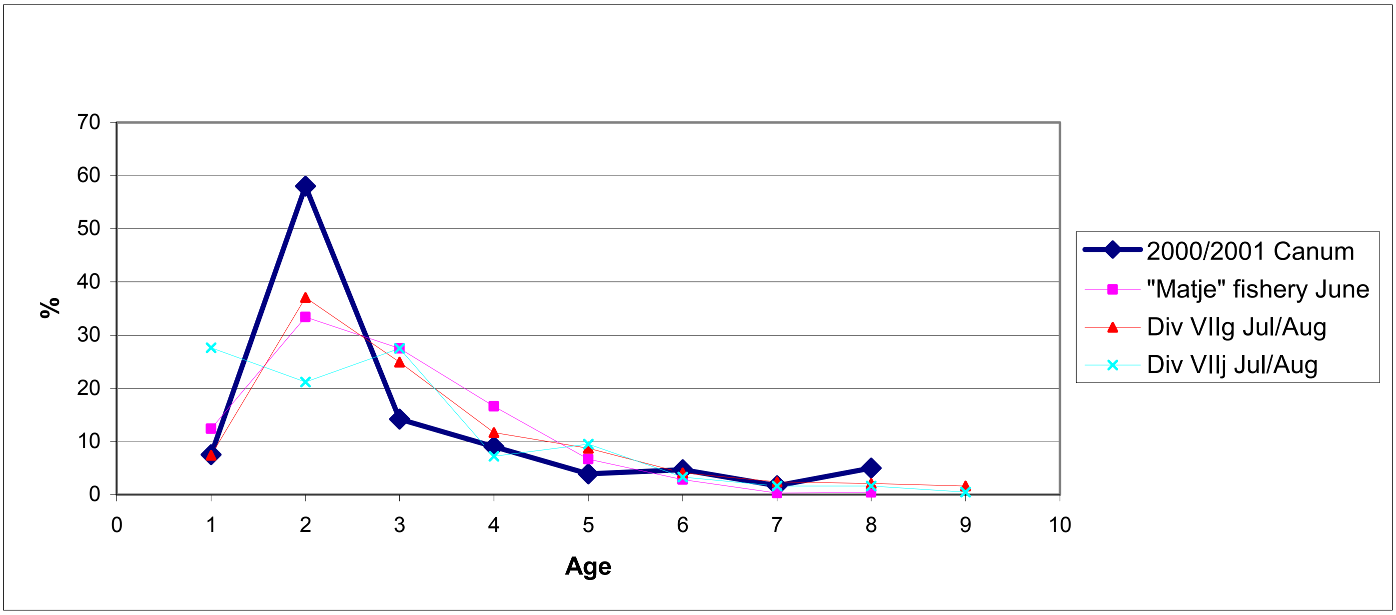


Figure 4.4.5: Celtic Sea & Division VIIj Herring. Comparison of porportions at age from 2001 data.

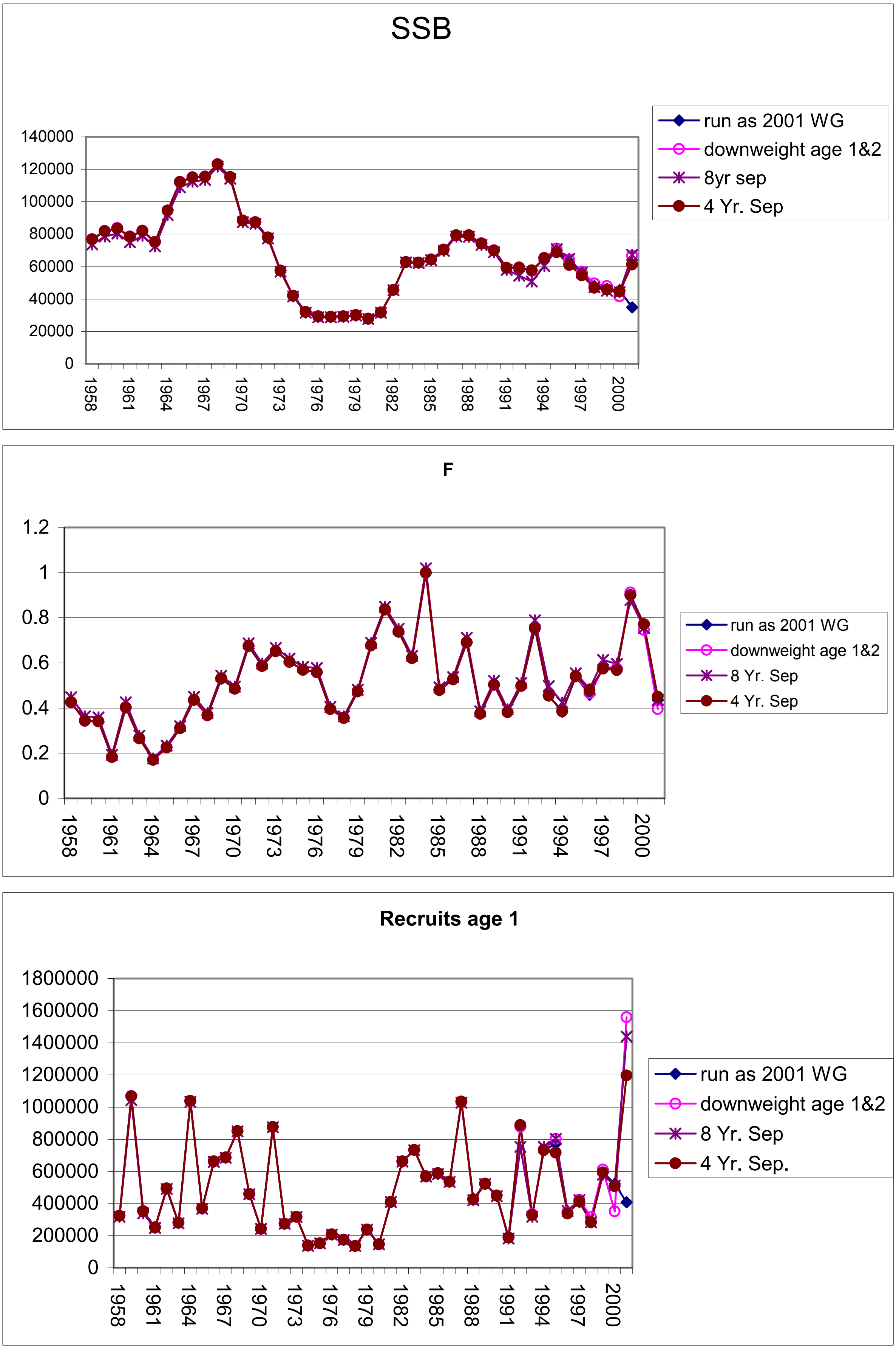


Figure 4.5.1. Celtic Sea & Division VIIj – Comparison of Runs.

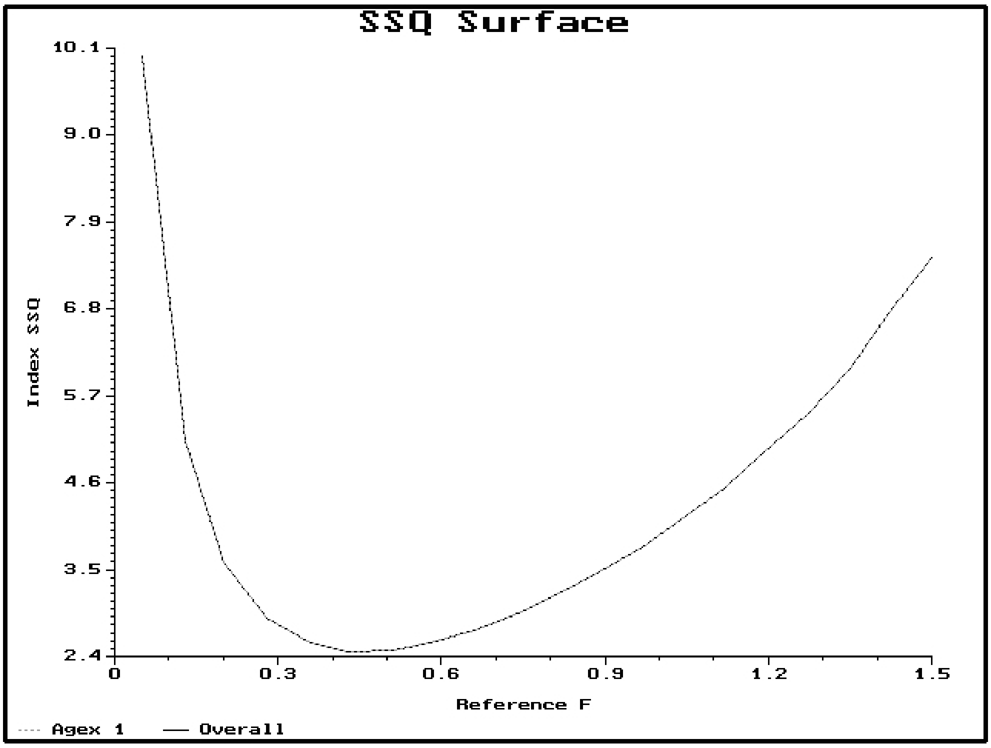


Figure 4.5.2.1 Herring in Celtic Sea and Division VIIj. SSQ for the baseline assessment.

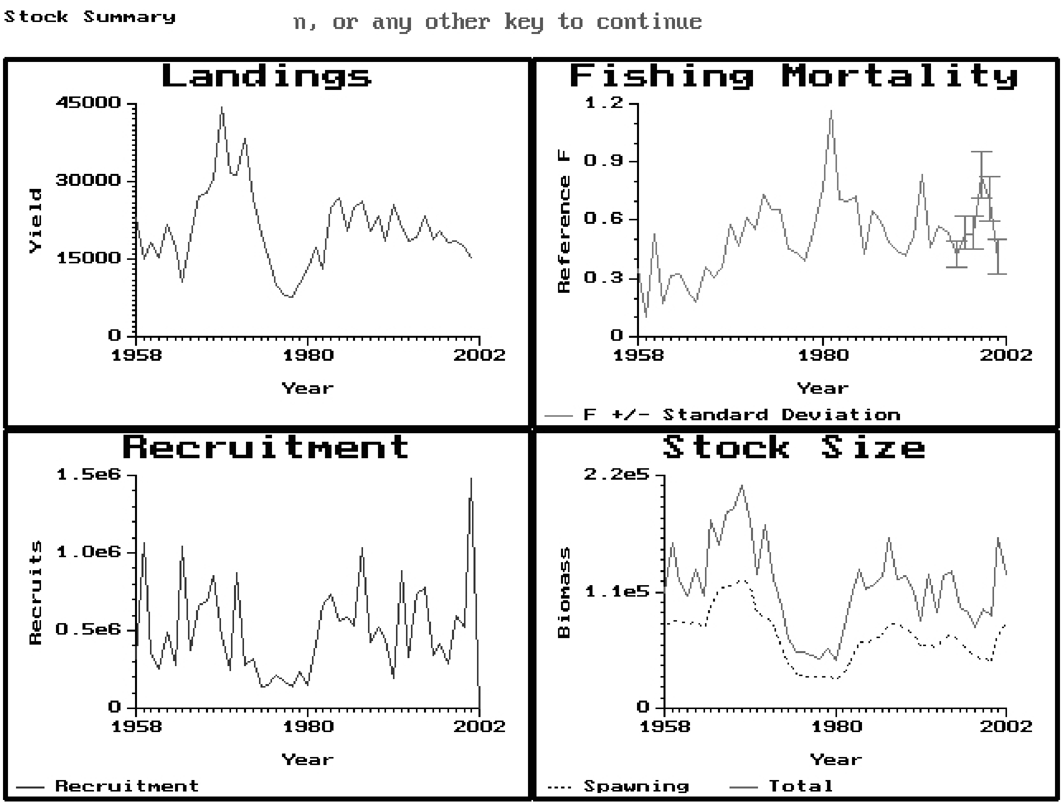


Figure 4.5.2.2. Herring in Celtic Sea and Division VIIj. Results of baseline assessment. Summary of estimates of landings, fishing mortality at age 3, recruitment age 1, stock size on Jan. 1 and spawning stock size at spawning time.

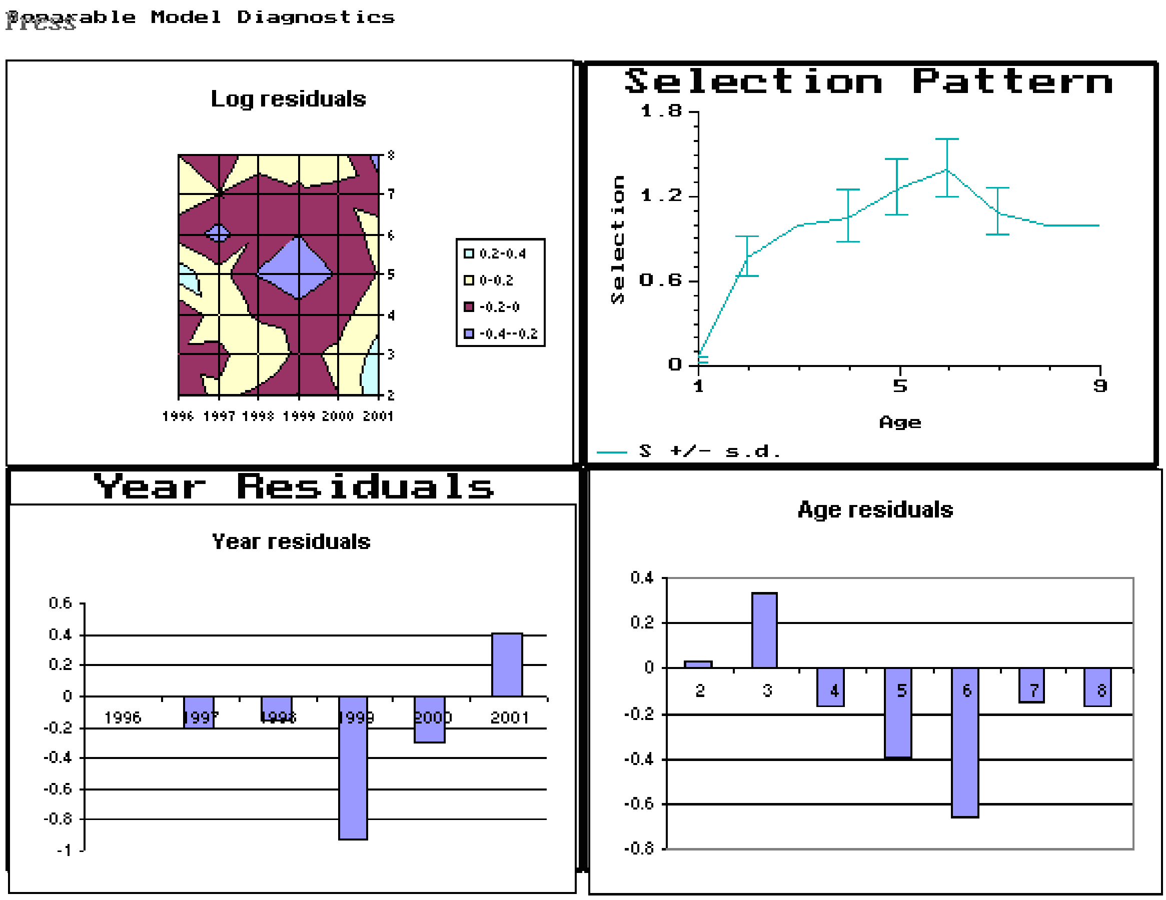


Figure 4.5.2.3 Herring in the Celtic Sea and Division VIIj. Results of the baseline assessment. Selection pattern diagnostics. Top left, contour plot of selection pattern residuals. Top right, estimated selection (relative to age 3) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

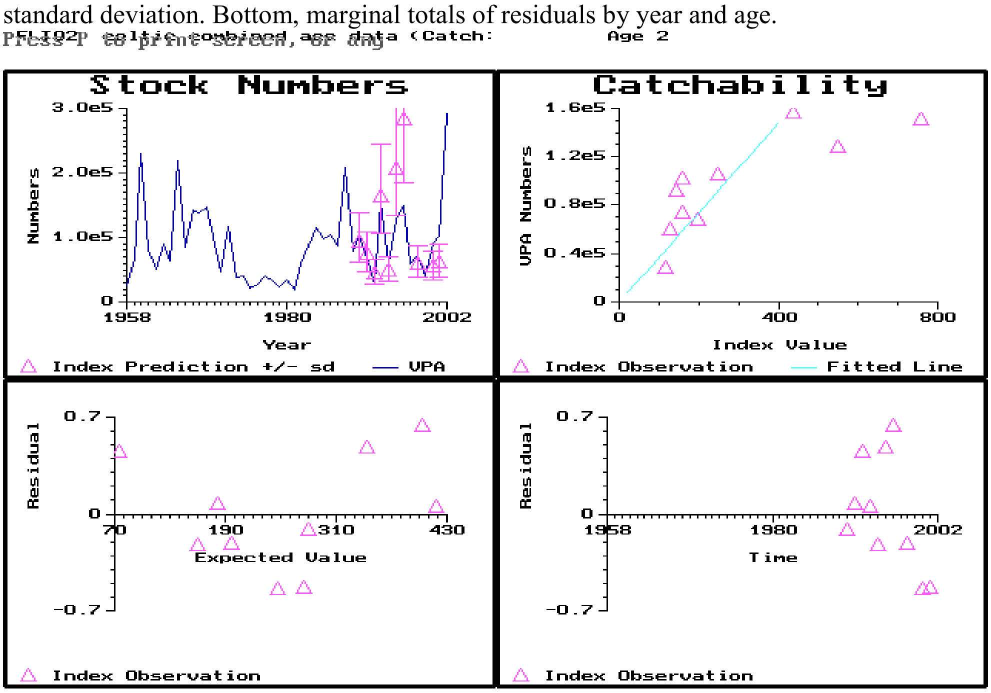


Figure 4.5.2.4. Herring in the Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic survey index at age 2 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each 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.

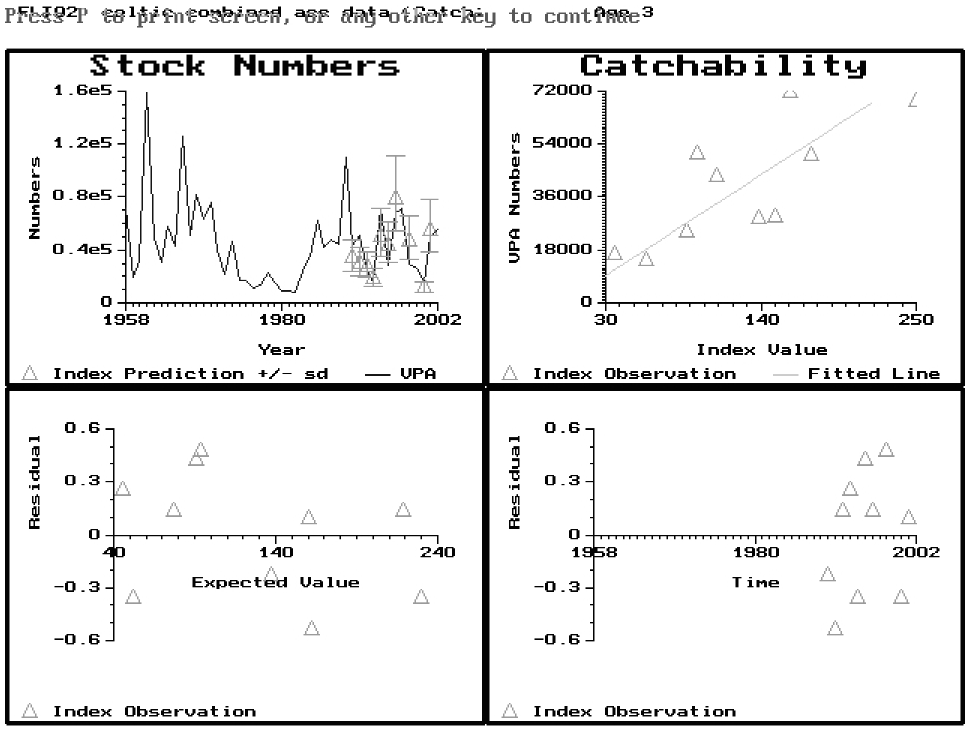


Figure 4.5.2.5 Herring in the Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic survey index at age 3 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each 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.

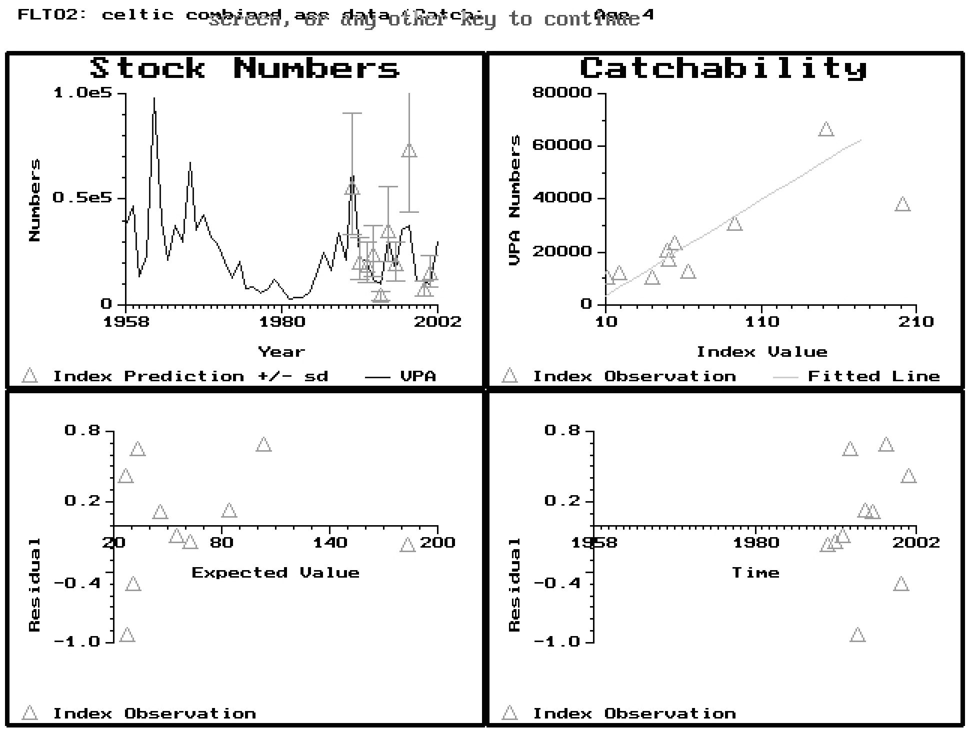


Figure 4.5.2.6 Herring in the Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic survey index at age 4 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each 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.

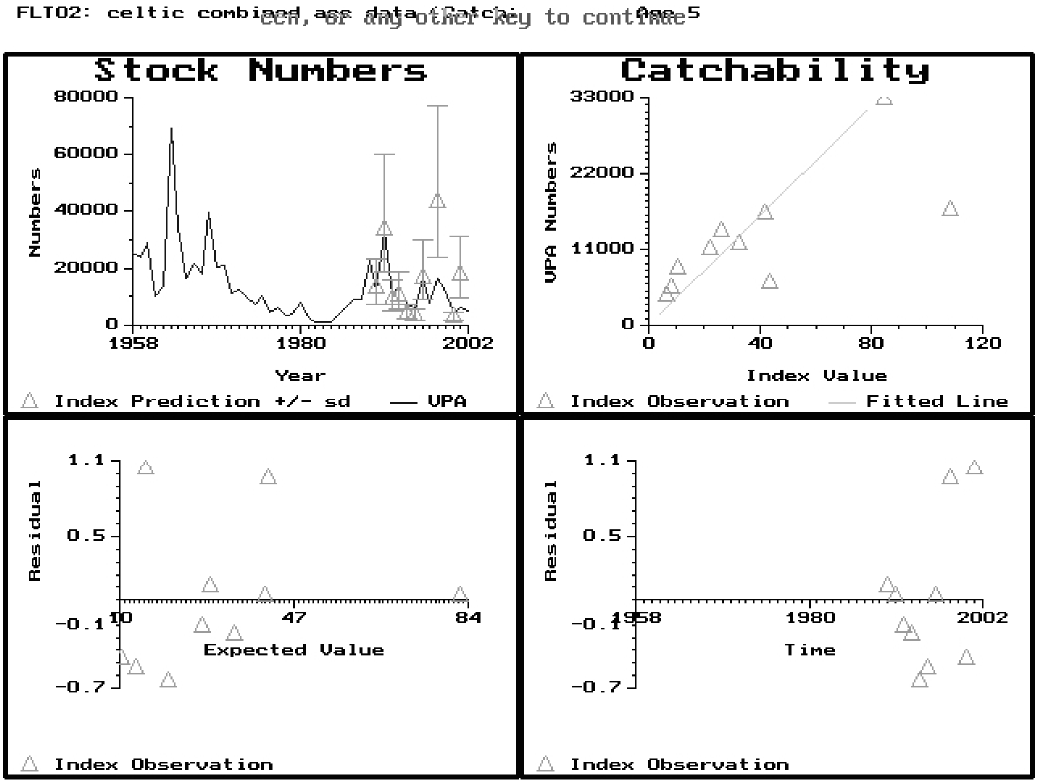


Figure 4.5.2.7 Herring in the Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic survey index at age 5 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each 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.

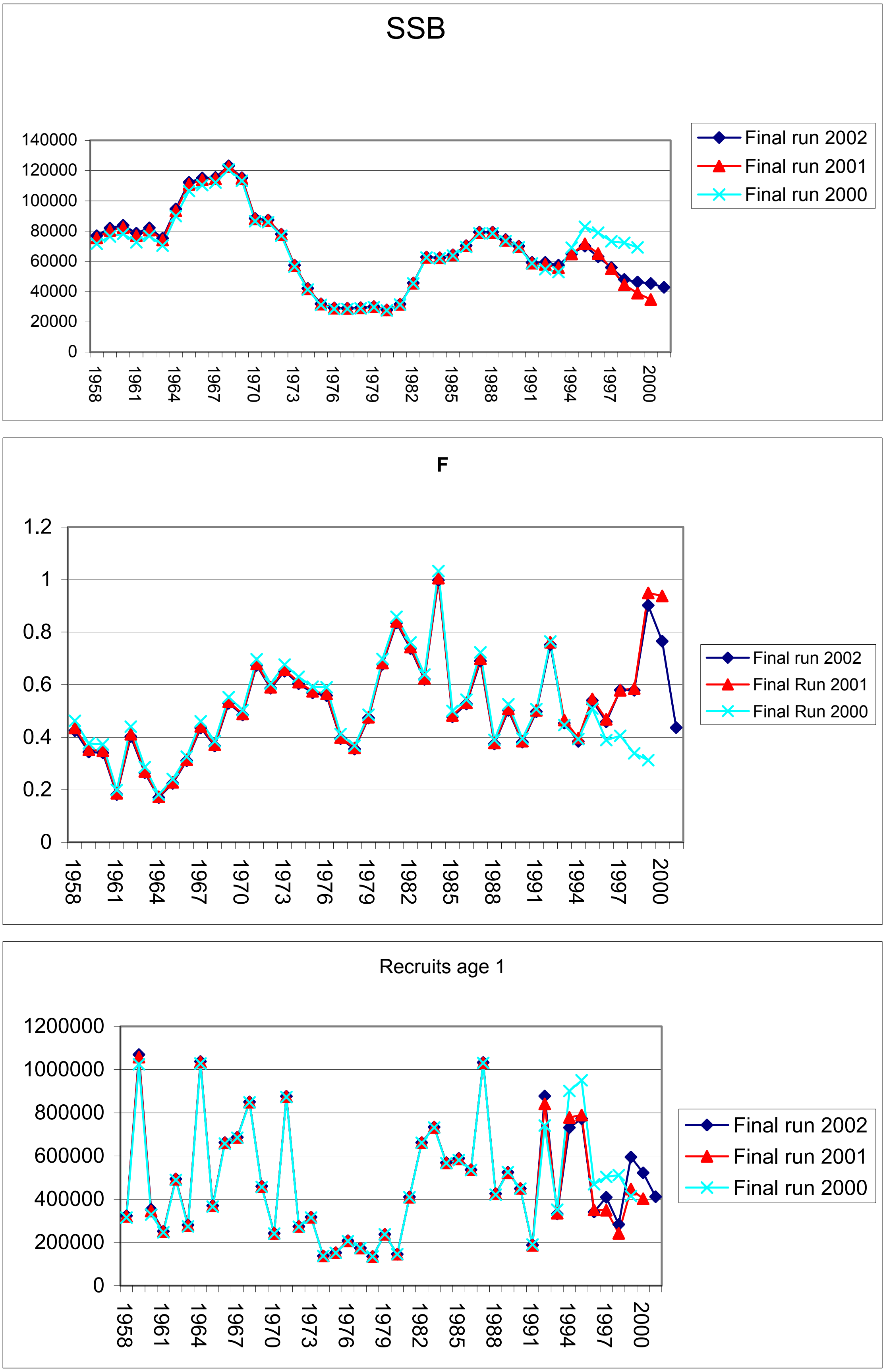
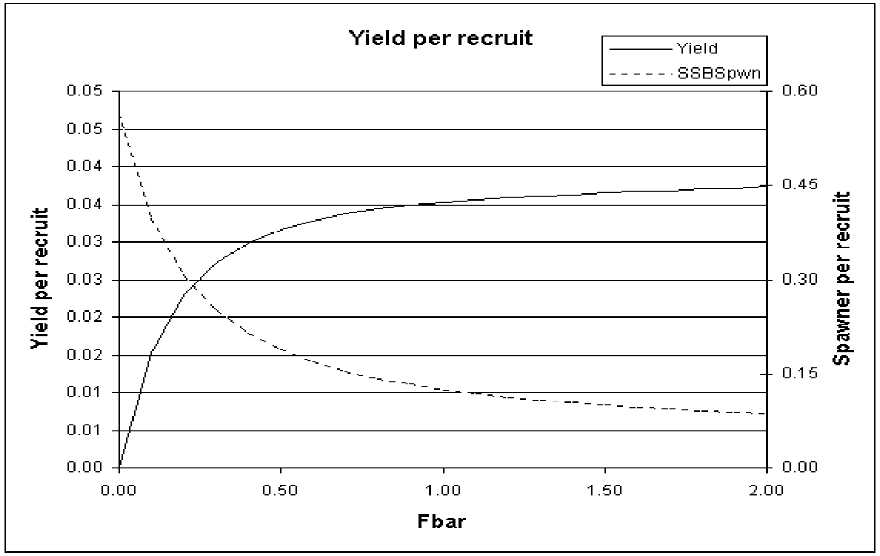
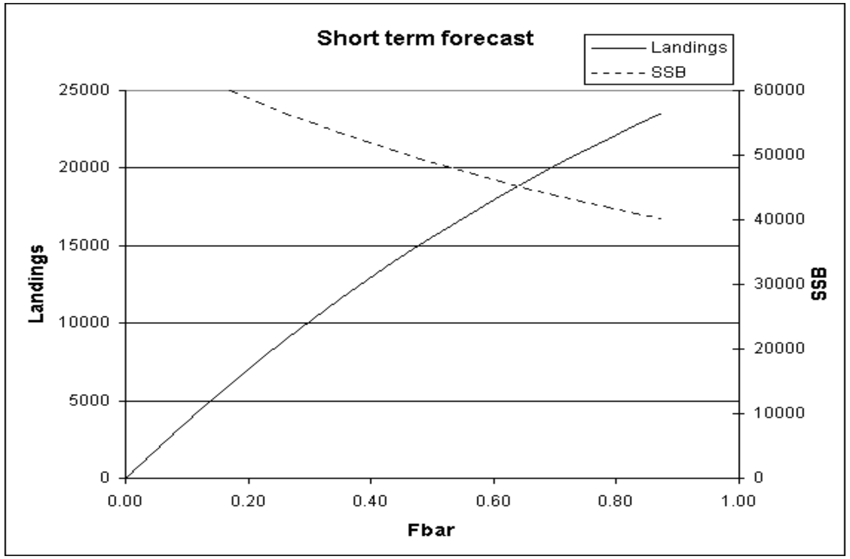


Figure 4.5.2.8. Celtic Sea & Division VIIj – Comparison of stock trajectories from the past 3 assessments.





MFYPR version 2a

Run: first run

Time and date: 14:19 18/03/02

Reference point	F multiplier	Absolute F
Fbar(2-7)	1.0000	0.4365
F_{max}	>=1000000	
$F_{0.1}$	0.3890	0.1698
F35%SPR	0.4609	0.2012
F_{low}	0.2261	0.0987
F_{med}	0.6016	0.2626
F_{high}	2.5823	1.1273

Weights in kilograms

MFDP version 1a

Run: adj surv age 2

Celtic Sea 2001Projection index file Tuesday 18th March 2002.

Time and date: 11:46 18/03/02

Fbar age range: 2-7

Input units are thousands and kg - output in tonnes

Figure 4.6.1. Yield per recruit and short-term yield for Celtic Sea and VIIj Herring.

5 WEST OF SCOTLAND HERRING

5.1 Division VIa(North)

5.1.1 ACFM advice applicable to 2001 and 2002

ACFM reported in 2001 that the state of the stock was uncertain although all the indications are that the stock is lightly exploited. Consequently, ACFM recommended that catches in 2002 should not exceed the average of the 1991–1999 period, which was about 30,000 t.

The agreed TAC for 2002 is 33,000 t compared with a TAC in 2001 of 36,360 t.

There are no explicit management objectives for this stock and because of uncertainties about the historical catch data, the size of the biomass, and about estimates of recruitment and fishing mortality, no biological reference points have been proposed for this stock.

5.1.2 The fishery

Catches are taken from this area by three 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 2001 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. During the months of the peak of the Shetland fishery, vessels requiring west of Scotland licenses are required to collect them from ports on the west coast of Scotland, and *vice versa* for the North Sea.

5.1.3 Landings estimates and allocation of catches to area

Serious problems with misreporting of catches from this stock have occurred, with many examples of vessels operating and landing herring catches distant from VIa (N) but reporting catches from that area. Fishery-independent information confirmed that large catches were being reported from areas with low abundances of fish, and informal information from the fishery and from other sources confirmed that most catches of fish recorded between 4°W and 5°W were most probably misreported North Sea catches. The problem was particularly acute during the peak months of the Shetland herring fishery (August to October). Such misreporting is believed to have been significant since 1984. In 1997 new legislation was introduced to correct this (see above). In 1998 it was assumed that there was no misreporting by Scotland. In 1999 this conclusion was questioned, as misreporting in 1998 was thought to be similar to 1996 levels. Misreporting for 1997 was then estimated by Bayesian assessment (ICES 1999/ACFM:12) and the catch was thought to be 33,000 t. Recent investigations of the 1997 fishery have indicated that the behaviour of the Scottish fleet was not affected by changes in legislation. The extent of area misreporting in 1997 is difficult to estimate. The value of 33,000 t used in the 2000 assessment is an acceptable point estimate of the total catch in 1997, since it reflects a similar assumption about the level of misreporting in 1996.

Improved information from the fishery in 1998 - 2001 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 some, though not all, of the fleets.

For 2001, the preliminary report of official catches corresponding to the VIa (N) herring stock unit total 35,411 t compared with the TAC of 36,360 t. The Working Group's estimates of area misreported catches are 10,437 t. No herring has been reported as discarded.

The Working Group’s best estimate of removals from the stock in 2001 is 24,974 t. Details of estimated national catches from 1981 to 2001 are given in Table 5.1.1.

5.1.4 Age-composition of commercial catches

Age composition data for the commercial catches for 2001 were available from Scotland (quarters 3 and 4), Northern Ireland (quarter 3) and the Netherlands (quarter 3). The number of samples used to allocate an age-distribution for the Scottish catches decreased from 36 in 2000 to 19 in 2001. However, 20 samples were available from the Northern Irish fishery. A single sample was again available from the offshore freezer-trawl fishery comprising 25 fish, a decrease of 50 fish from 2000. These vessels often land in foreign ports and do not, therefore, get sampled. Catch and sampling effort information by country and by quarter is given in Table 5.1.2. Comparison of the age structure of the Scottish, Northern Irish and Netherlands samples indicated that there was no difference in the age structure of the catch for these fleets in 2001. Concern was raised in the 2001 ACFM technical minutes that samples were being missed from the analysis of catch because no samples were evident from Ireland. However, in practice, the national allocation does not reflect the location of the sampling but the flag of the vessel being sampled, and therefore the flag of the catch being raised. In this particular case, the samples taken in Ireland were from Scottish vessels. They were therefore included in the Scottish sampling information. This year, the Scottish quarter 4 samples were provided by Ireland, from Scottish catch landed into Ireland, and included as Scottish samples.

Unsampled catches were allocated a mean age-structure (weighted by the sampled catch) of either the Scottish/Northern Irish or the 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 allocation of age-structures to unsampled catches, and the calculation of total international catch-at-age and mean weight-at-age in the catches were made using the 'sallocl' programme (Patterson, 1998).

New and historic catch in number-at-age information is given in Table 5.1.3.

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. However, section 5.1.12 presents an analysis of the sensitivity of the assessment to missing catch information.

5.1.5 Larvae surveys

Larvae surveys for this stock have been discontinued since 1994. The historical time-series has however been reproduced for convenience (Table 5.1.4). The inclusion of the larval SSB index in the assessment was investigated. This index has no influence on the assessment and has not been used this year. Documentation of this survey time-series is given in ICES (1994/H:3).

5.1.6 Acoustic survey

The survey in 1997 recorded an unexpectedly low estimate of abundance. Interpretation of survey results is not straightforward because the survey was completed one month earlier than other surveys in the historical time-series. Therefore, the 1997 survey has been excluded from the stock assessment calculation, as for last year's assessment.

The 2001 acoustic survey was carried out from 10-30 July using a chartered commercial fishing vessel (MFV Taits). The total biomass estimate obtained was lower than that from the previous year (359,200 t this year compared to 500,500 t in 2000). 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 off Galan Head, and along the shelf edge. Further details are available in the Report of the Planning Group for Herring Surveys (ICES 2002/G:02). A retrospective analysis of biomass estimates in the assessment is presented in Section 5.1.12 (Quality of the assessment). Estimates of abundance by age and in aggregate spawning stock biomass for 2001 and for previous years are given in Table 5.1.5.

5.1.7 Mean weights-at-age

Weights-at-age in the catches and from acoustic surveys are given in Table 5.1.6. Due to the different timing of the acoustic survey in 1997 the estimates of weight-at-age in the stock in that year are not consistent with previous estimates (Section 5.1.6). To maintain historically consistent estimates of spawning biomass these values were not used for assessment purposes, instead mean values over the period 1992 to 1996 were used for 1997. The weights-at-age in the stock appear to be similar to the long-term mean for ages 1-2 ring, but are generally lower for 3 ring and older herring.

Catch weights-at-age for 2001 are generally lower than the long-term average, especially 1 ring. Catch of 1 ring herring is very low in the fishery and down-weighted in the assessment.

5.1.8 Maturity ogive

The maturity ogive is obtained from the acoustic survey. The earlier timing of the acoustic survey in 1997 also occasioned lower values of maturity to be recorded (Table 5.1.7). As for the weights-at-age, these values were not used for assessment purposes and a mean value over the years 1992−1996 was used for 1997 and for years prior to 1991. In 2001 the proportion of 2 and 3 ringers is high relative to the long-term mean, but not above previously observed high values.

5.1.9 Data exploration and preliminary modelling

Assessment of the stock was carried out by fitting an integrated catch-at-age model (ICA version 1.4w) (Patterson, 1998, Needle, 2000), including a separable constraint. An aged-structured index was available from the acoustic survey from 1987, 1991-1996 and 1998-2000 (Section 5.1.6). Indices of spawning stock biomass were available from the larval survey from 1976-1991 and 1993 (Section 5.1.5).

The inclusion of the larval SSB index in the assessment was investigated. The survey providing this index was last carried out nine years ago, in 1993. This index had no influence on the assessment and has not been used.

The appropriate usage of period of separable constraint was investigated. Assessments were run with different periods of separable constraint, from four to eight years. A period longer than eight years was not considered for two reasons. Inclusion of years prior to 1994 showed a distinct shift in residuals, resulting from the distinct change in the pattern of catch-at-age from 1993 to 1994. Additionally, it was thought unrealistic to expect the fishery to maintain a consistent selection pattern for more than eight years. Examination of the pattern of residuals for each separable period showed no distinct differences in both catch and acoustic surveys. The stock summary data for the final three years of the assessment for the three different separable periods (Table 5.1.8) show that, overall, differences between the assessments are small. There is a spread of 2% (a negligible difference) for the terminal F value and approximately 12% for SSB. 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.

5.1.10 Stock assessment

The run log for the assessment is shown in Table 5.1.9. The period for the separable constraint is 6 years. The catch and survey data were down-weighted for 1 ring herring (see last year's Working Group assessment report (ICES 2001/ACFM:12b). The input data are given in Tables 5.1.10 to 5.1.16. The output data are given in Tables 5.1.17 to 5.1.26. The assessment results in an SSB for 2001 of 140,331 tonnes and a mean fishing mortality (ages 3-6) of 0.197 (Table 5.1.22). The model diagnostics (Tables 5.1.23 to 5.1.26 and Figures. 5.1.1 to 5.1.12) 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 ages 8 and 9). The acoustic survey residuals are larger than the catch model residuals. The assessment SSB estimate of 140,000 t is the second highest in the time-series. Both catch and acoustic survey data indicate a large recruitment of 2 ringers to the population. Maturity-at-age for 2 ringers is also one of the highest values in the time-series, adding to the increase in SSB. Figure 5.1.13 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 5.1.12 below.

5.1.11 Projections

Deterministic short-term projections

Area misreporting of the 2001 TAC (36,360 t) for VIa(N) was approximately 30%. This proportion was taken in other areas, leading to a low F of 0.197 in area VIa (N). Two scenarios for deterministic short-term projections are presented: *status quo* F for 2002, which is consistent with the current level of misreporting, and a catch constraint of 33,000 t, which is consistent with the TAC for 2002. Multiple options tables are available for 2003 (Tables 5.1.29 and 5.1.31).

Scenario	2002	2003	2004
1 – status quo F	F_{2002}= F_{2001} = 0.197 Status quo F Catch Eq. = 28,000 t	F = 1.42 * F_{2001} = 0.28 F= suggested $\mathbf{F}_{pa}$ Catch Eq. = 40,000 t	F = 1.42 * F_{2001} = 0.28 F= suggested $\mathbf{F}_{pa}$ Catch Eq. = 39,000 t
2 – TAC for 2002	$Catch_{2002}$ = 33,000 t Catch = TAC_{2002}	F = 1.42 * F_{2001} = 0.28 F= suggested $\mathbf{F}_{pa}$ Catch Eq. = 39,000 t	F = 1.42 * F_{2001} = 0.28 F= suggested $\mathbf{F}_{pa}$ Catch Eq. = 38,000 t

Input data are stock numbers on 1st January in 2002 from the 2002 ICA assessment (Section 5.1.10, Table 5.1.19), with geometric mean replacing recruitment at 1 and 2 ring in 2002 and 1 ring in 2001. In the assessment information on 1 ring herring is poor and the fishery variable; for this reason 1 ring herring were down-weighted in both the catch and the survey. This led to a spuriously low estimate of 1 ring numbers in the final year of the assessment (2001) and consequently a low value in the survivors (January 1st 2002), which are taken forward into the projection. These values were replaced by geometric mean values. The selection pattern used is the fishery in 2001 (Table 5.1.21). 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., 1999 - 2001) (Table 5.1.27).

The results of the short-term projections can be seen in Tables 5.1.28 – 31. Tables 5.1.28 and 5.1.30 show single option predictions for 2003 and 2004 for the two scenarios respectively. Tables 5.1.29 and 5.1.31 show the multiple options for 2003. The short-term forecast for landings and SSB at different levels of F under scenario 1 is shown in Figure 5.1.15. Under both scenarios, SSB remains at about 138,000 t in 2002 and decreases towards its long-term equilibrium level of around 125,000 t (see medium-term projections), reaching 130,000 t in 2004. The reason for the current increase in abundance is due to the large year class of 2 ringers recruiting to the fishery in 2001.

Yield per recruit

The assessment was used to provide a yield per recruit plot for VIa(N) (Figure 5.1.15). The values for $\mathbf{F}_{0.1}$ and $\mathbf{F}_{med}$ are 0.168 and 0.32 respectively. These may be compared with the current F (2002 assessment) of 0.197. The yield per recruit relationship suggests that at, geometric mean recruitment (914 million) a yield of approximately 38,400 t is possible at F = suggested $\mathbf{F}_{pa}$ = 0.28.

Stochastic medium-term projections

No biological reference points are currently available for this stock. Possible values for $\mathbf{F}_{pa}$ and $\mathbf{B}_{pa}$ for this stock are presented in Section 5.1.14. Medium-term projections, to assist with the evaluation of these reference points, were carried out on the basis of exploitation at suggested $\mathbf{F}_{pa,}$ with a preliminary year in 2002 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 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. 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 5.1.16). Weights-at-age in the catch were calculated as the mean weights-at-age from 1999-2001. Weights-at-age in the stock, maturity ogives and natural mortality were as given in section 5.1.10. The procedure was implemented using the ICP program; the input parameters are summarised in Table 5.1.32 and the run log is given in Table 5.1.33. Only one scenario is presented, based on the assessment using the 6-year separable period (Figure 5.1.14). Target multipliers were given a value of 1 in 2002 and 1.42 in subsequent years to give an F = suggested $\mathbf{F}_{pa}$ = 0.28.

The results of the stochastic medium-term projection are given in Figure 5.1.17. Given a constant F exploitation pattern, catches and SSB rise initially due to the large 1998 year class, SSB stabilises at 125,000 tonnes with F = suggested $\mathbf{F}_{pa}$. Landings rise to 45,000 t in 2003 and settle to around 40,000 t in the longer term. The suggested $\mathbf{B}_{pa}$ is 75,500 tonnes, and the risk of the stock falling below $\mathbf{B}_{pa}$ is less than 10% for the period (Figure 5.1.18). This suggests consistency between the suggested $\mathbf{F}_{pa}$ and $\mathbf{B}_{pa}$ reference points.

5.1.12 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. The current assessment seems to be more stable and not particularly sensitive to any uncertainty in the input data. To evaluate the sensitivity of the current situation the assessment has been inspected for a number of possible sources of perturbation.

a) Sensitivity to choice of length of separable period.

> This aspect is discussed in Section 5.1.9. The plot of separable model residuals (Figure 5.1.19) shows that pattern of the residuals is insensitive to the choice of period although the amplitude changes very slightly, decreasing with a shorter separable period. Table 5.1.8 shows that the estimated F is insensitive to the separable period and the biomass is changed by about ±7%.

b) Sensitivity to a small number of isolated large cohort estimates in the acoustic survey.

> 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. To test the influence of these points they were removed, individually and together, in three assessment runs. Table 5.1.34 shows that the catchabilities are 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.

c) Sensitivity to missing catch-at-age data.

> Over the last few years sampling for age of catch has been patchy and there are different fleets that have exploited large and small herring at different times. To test the effect of uncertainty in estimates of proportions at age in these two fleets, two groups of ages were identified, 1-4 ringers and 4-9+ ringers. Data on the proportions at age in each group were assumed unknown in each year of the 6 year separable period, giving 12 different scenarios. Figure 5.1.20 shows box and whisker plots of the range and quartiles from the 12 assessments. The F values in 1997 and 1998 are shown to be particularly sensitive to availability of data. However, the estimate of F in the current assessment is relatively insensitive to availability of catch-at-age information. Though the range of SSB is quite large all the estimates are well above the suggested $\mathbf{B}_{pa}$ of 75,500 t.

In addition to the above sensitivity analyses retrospective analyses of the assessment from 1999 to 2002 were carried out. Figure 5.1.21 shows the $F_{3\text{-}6}$ and SSB from ICA assessments with a 6-year separable period for assessments in 2000 to 2002 and 5 years in 1999. The separable period in 1999 is reduced from 6 to 5 years to exclude catch in 1993 that appears to have a different selection. These retrospective analyses show very stable estimation of F but more variable estimates of SSB, giving recent estimates both above and below the current trajectory, although all are above the suggested $\mathbf{B}_{pa}$ of 75,500 t.

The current assessment seems very robust for estimation of F and very reasonable for estimation of SSB, given the sensitivity analysis and the retrospective patterns observed. 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 $F_{3\text{-}6}$ is very close to 0.2 and that the SSB is well above the suggested $\mathbf{B}_{pa}$.

5.1.13 Management considerations

The assessment presented here is less uncertain 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.

5.1.14 Reference points

The assessment provided this year and the retrospective pattern suggests that the current assessment may be reasonably reliable. 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. As the assessment now looks more stable it may be useful to consider provisionally the possible reference points for this stock. The stock data have been entered in PASoft and the results are presented in Figure 5.1.22. As the current assessment appears reasonably reliable it has been used as the basis for the suggestion of biological reference points for this stock. Examination of the stock recruit plot (Figure 5.1.22) indicates there is no evidence of any stock recruit relationship for this stock at these biomass levels.

The estimated value of $\mathbf{B}_{loss}$ from the assessment is 49,880, the lowest observed biomass which is near the beginning of the series in the converged part of the VPA and would therefore be unlikely to change in the future. The value for $\mathbf{B}_{lim}$ is therefore $\mathbf{B}_{loss}$ = 50,000 t. Given $\mathbf{B}_{lim}$ then $\mathbf{B}_{pa}$ could be suggested as 75,500 t based on the relationship:

$$\mathbf{B}_{pa} = \mathbf{B}_{lim}\, e^{-1.645*s}$$

where s is given as the mid-range value 0.25.

Given the suggested $\mathbf{B}_{pa}$ of 75,500 the history of the exploitation was examined and there are 22 years when SSB is above the $\mathbf{B}_{pa}$. Fishing was at a mean $F_{3\text{-}6}$ of 0.28 for 90% of these years, suggesting that this fishing mortality would be a candidate value of $\mathbf{F}_{pa}$ and that this value would be compatible with a suggested $\mathbf{B}_{pa}$ of 75,500 t. The medium-term projections described in Section 5.1.11. show that at an exploitation rate of F = suggested $\mathbf{F}_{pa}$= 0.28 the risk of the biomass falling below $\mathbf{B}_{pa}$ would be 10% in the medium-term (Figure 5.1.18). This supports the contention that an $\mathbf{F}_{pa}$ of 0.28 would be compatible with the suggested $\mathbf{B}_{pa}$.

A compatible $\mathbf{F}_{lim}$ would be:

$$\mathbf{F}_{lim} = \mathbf{F}_{pa}\, e^{1.645*s} \qquad = \qquad \mathbf{F}_{lim} = 0.42$$

Where s is given the mid range value of 0.25

The reference limits and the historic stock trajectory are shown in Figure 5.1.23 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.

The suggested values are tabulated below:

Suggested Precautionary Approach reference points:

$\mathbf{B}_{lim}$ is 50,000 t	$\mathbf{B}_{pa}$ be set at 75,500 t
$\mathbf{F}_{lim}$ is 0.42	$\mathbf{F}_{pa}$ be set at 0.28

Technical basis:

$\mathbf{B}_{lim}$: Lowest reliable estimated SSB	$\mathbf{B}_{pa}$: Approximately 1.5 $\mathbf{B}_{lim}$
$\mathbf{F}_{lim}$: 1.5*$\mathbf{F}_{pa}$	$\mathbf{F}_{pa}$ is the F for a 10% risk of stock falling below $\mathbf{B}_{pa}$

5.2 Clyde Herring

5.2.1 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 2001 and 2002 were maintained at the same level as in recent years (1,000 tonnes).

5.2.2 The fishery in 2001

Annual landings from 1955 to 2001 are presented in Table 5.2.1. Landings in 2001 were 480 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 5.2.2). They are still above recommended levels but should not go any lower.

5.2.3 Weight-at-age and stock composition

The catch in numbers-at-age for the period 1970 to 2001 is given in Table 5.2.3. Weights-at-age are given in Table 5.2.4. Mean weights in the stock have not been available from research vessel surveys since 1991, therefore the weights in the stock used are the weights-at-age in the catches.

5.2.4 Surveys

No demersal egg surveys on the Ballantrae Bank and Brown Head spawning sites, no acoustic surveys in the Clyde and no spring trawl surveys were carried out in 2001. Historical estimates from these surveys are tabulated in (ICES 1995/ACFM:13).

5.2.5 Stock assessment

The structure of the stock in the Clyde remains uncertain. No survey data are available from recent years, therefore no assessment could be attempted.

5.2.6 Stock and catch projections

In the absence of an analytical assessment no stock projections can be provided.

5.2.7 Management considerations

The management of this fishery is made difficult by the presence of a mixture of a severely depleted spring-spawning component and autumn spawners from Division VIa. The management objectives for these two components are necessarily distinct. The absence of fishery-independent data from surveys further compounds the problem. Historically the spring-spawning stock supported a fishery with catches up to 15,000 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 a 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, 1981-2001. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1981	1982	1983	1984	1985	1986	1987
Denmark	1580			96			
Faroes		74	834	954	104	400	
France	1243	2069	1313		20	18	136
Germany	3029	8453	6283	5564	5937	2188	1711
Ireland						6000	6800
Netherlands	5602	11317	20200	7729	5500	5160	5212
Norway	3850	13018	7336	6669	4690	4799	4300
UK	31483	38471	31616	37554	28065	25294	26810
Unallocated	4633	18958	-4059	16588	-502	37840	18038
Discards							
Total	51420	92360	63523	75154	43814	81699	63007
Area-Misreported				-19142	-4672	-10935	-18647
WG Estimate	**51420**	**92360**	**63523**	**56012**	**39142**	**70764**	**44360**
Source (WG)	1983	1984	1985	1986	1987	1988	1989

Country	1988	1989	1990	1991	1992	1993	1994
Denmark							
Faroes			326	482			
France	44	1342	1287	1168	119	818	274
Germany	1860	4290	7096	6450	5640	4693	5087
Ireland	6740	8000	10000	8000	7985	8236	7938
Netherlands	6131	5860	7693	7979	8000	6132	6093
Norway	456		1607	3318	2389	7447	8183
UK	26894	29874	38253	32628	32730	32602	30676
Unallocated	5229	2123	2397	-10597	-5485	-3753	-4287
Discards		1550	1300	1180	200		700
Total	47354	53039	69959	50608	51578	56175	54664
Area-Misreported	-11763	-19013	-25266	-22079	-22593	-24397	-30234
WG Estimate	**35591**	**34026**	**44693**	**28529**	**28985**	**31778**	**24430**
Source (WG)	1990	1991	1992	1993	1994	1995	1996

Country	1995	1996	1997	1998	1999	2000	2001
Denmark							
Faroes							
France	3672	2297	3093	1903	463	870	760
Germany	3733	7836	8873	8253	6752	4615	3944
Ireland	3548	9721	1875	11199	7915	4841	4311
Netherlands	7808	9396	9873	8483	7244	4647	4534
Norway	4840	6223	4962	5317	2695		
UK	42661	46639	44273	42302	36446	22816	21862
Unallocated	-4541	-17753	-8015	-11748	-8155		
Discards			62	90			
Total	61271	64359	64995	65799	61514	37789	35411
Area-Misreported	-32146	-38254	-29766	-32446	-23623	-14626	-10437
WG Estimate	**29575**	**26105**	**35233***	**33353**	**29736**	**23163**	**24974**
Source (WG)	1997	1997	1998	1999	2000	2001	2002

*WG estimate for 1997 has been revised according to the Bayesian assessment (see text section 5.1.3).

Table 5.1.2. Herring in VIa(N). Catch and sampling effort by nation participating in the fishery

Total over all Areas and Quarters

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
England & Wales	0.00	2059.00	0	0	0	0.00
France	0.00	760.00	0	0	0	0.00
Germany	305.00	3944.00	2	1241	316	100.12
Ireland	0.00	4311.00	0	0	0	0.00
N. Ireland	3000.00	3120.00	20	2752	1000	99.96
Netherlands	588.00	4534.00	1	118	25	100.05
Scotland	10622.00	16683.00	19	3900	994	100.18
Total for Stock	14515.00	35411.00	42	8011	2335	100.13

Sum of Offical Catches : 35411.00
Unallocated Catch : -10437.00
Working Group Catch : 24974.00

QUARTER : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Germany	305.00	305.00	2	1241	316	100.12
Ireland	0.00	834.00	0	0	0	0.00
Netherlands	0.00	169.00	0	0	0	0.00
Scotland	0.00	41.00	0	0	0	0.00
Period Total	305.00	1349.00	2	1241	316	100.12

Sum of Offical Catches : 1349.00
Unallocated Catch : 55.00
Working Group Catch : 1404.00

QUARTER : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
England & Wales	0.00	2059.00	0	0	0	0.00
Germany	0.00	627.00	0	0	0	0.00
N. Ireland	0.00	120.00	0	0	0	0.00
Netherlands	0.00	13.00	0	0	0	0.00
Period Total	0.00	2819.00	0	0	0	0.00

Sum of Offical Catches : 2819.00
Unallocated Catch : -13.00
Working Group Catch : 2806.00

QUARTER : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
France	0.00	760.00	0	0	0	0.00
Germany	0.00	3012.00	0	0	0	0.00
N. Ireland	3000.00	3000.00	20	2752	1000	99.96
Netherlands	588.00	3405.00	1	118	25	100.05
Scotland	10603.00	16623.00	18	3762	944	100.18
Period Total	14191.00	26800.00	39	6632	1969	100.13

Sum of Offical Catches : 26800.00
Unallocated Catch : -8837.00
Working Group Catch : 17963.00

QUARTER : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Ireland	0.00	3477.00	0	0	0	0.00
Netherlands	0.00	947.00	0	0	0	0.00
Scotland	19.00	19.00	1	138	50	100.26
Period Total	19.00	4443.00	1	138	50	100.26

Sum of Offical Catches : 4443.00
Unallocated Catch : -1642.00
Working Group Catch : 2801.00

Table 5.1.3. Herring in VIa(N). Estimated catch numbers-at-age (thousands), 1976-2001.

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**
1	9092	7635	4511	147
2	74167	35252	22960	82214
3	34571	93910	21825	15295
4	31905	25078	51420	9490
5	22872	13364	15505	24896
6	14372	7529	9002	9493
7	8641	3251	3898	6785
8	2825	1257	1836	4271
9	3327	1089	576	1015

Table 5.1.4. Herring in VIa(N). Larval abundance indices (LAI - numbers in billions), larval mortality rates (Z/K), fecundity estimate (10^5 eggs/g). Larval production estimate (LPE - biomass estimate in thousands of tonnes).

Year	LAI	10% Trim LAI	Z/K	LPE		
				Larvae	Fecundity	SSB
1973	2 442	46.49	0.74	318	(1.39)	229
1974	1 186	17.44	0.42	238	(1.39)	171
1975	878	22	0.46	157	1.46	108
1976	189	11.04	-	60	1.23	49
1977	787	25	-	223	1.49	150
1978	332	32.8	-	132	1.37	109
1979	1 071	26.94		118	1.49	79
1980	1 436	26.33	0.39	287	2.04	141
1981	2 154	35.61	0.34	448	2.12	211
1982	1 890	32.58	0.39	267	1.95	137
1983	668	24.55	-	112	1.88	60
1984	2 133	45.99	0.57	253	1.75	145
1985	2 710	50.03	0.37	418	(1.86)	225
1986	3 037	45.36	0.24	907	(1.86)	488
1987	4 119	45.47	0.53	423	(1.86)	227
1988	5 947	75.13	0.47	781	(1.86)	420
1989	4 320	82.68	0.40	752	(1.86)	404
1990	6 525	86.2	0.64	426	(1.86)	229
1991	4 430	63.06	0.60	632	(1.86)	340
1992	12 252	41.79	0.66	463	(1.86)	248
1993	2 941	65.01	0.56	538	(1.86)	289

Table 5.1.5. Herring in VIa(N). Estimates of abundance from Scottish acoustic surveys. Thousands of fish at age and spawning biomass (SSB, tonnes).

Age	**1987**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997#**	**1998**
1	249 100	338 312	74 310	2 760	494 150	441 240	41 220	792 320	1 221 700
2	578 400	294 484	503 430	750 270	542 080	1103 400	576 460	641 860	794 630
3	551 100	327 902	210 980	681 170	607 720	473 220	802 530	286 170	666 780
4	353 100	367 830	258 090	653 050	285 610	450 270	329 110	167 040	471 070
5	752 600	488 288	414 750	544 000	306 760	152 970	95 360	66 100	179 050
6	111 600	176 348	240 110	865 150	268 130	187 100	60 600	49 520	79 270
7	48 100	98 741	105 670	284 110	406 840	169 080	77 380	16 280	28 050
8	15 900	89 830	56 710	151 730	173 740	236 540	78 190	28 990	13 850
9+	6 500	58 043	63 440	156 180	131 880	201 500	114 810	24 440	36 770
SSB:	273 000*	452 000	351 460	866 190	533 740	452 120	370300	140 910	375 890

Age	**1999**	**2000**	**2001**
1	534 200	447 600	313 100
2	322 400	316 200	1 062 000
3	1 388 800	337 100	217 700
4	432 000	899 500	172 800
5	308 000	393 400	437 500
6	138 700	247 600	132 600
7	86 500	199 500	102 800
8	27 600	95 000	52 400
9+	35 400	65 000	34 700
SSB:	460 200	500 500	359 200

*Biomass of 2+ ringers in November.

The 1997 survey is not on the same basis as the other years, it was conducted in June (all other surveys were carried out in July) and it is not used for assessment purposes.

Table 5.1.6. Herring in VIa(N). Mean weights-at-age (g).

Weight in the catch																	
Age, Rings	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	69	113	73	80	82	79	84	91	89	83	105	81	89	97	76	83	49
2	103	145	143	112	142	129	118	122	128	142	142	134	136	138	130	137	140
3	134	173	183	157	145	173	160	172	158	167	180	178	177	159	158	164	163
4	161	196	211	177	191	182	203	194	197	190	191	210	205	182	175	183	183
5	182	215	220	203	190	209	211	216	206	195	198	230	222	199	191	201	192
6	199	230	238	194	213	224	229	224	228	201	213	233	223	218	210	215	196
7	213	242	241	240	216	228	236	236	223	244	207	262	219	227	225	239	205
8	223	251	253	213	204	237	261	251	262	234	227	247	238	212	223	281	224
9+	231	258	256	228	243	247	271	258	263	266	277	291	263	199	226	253	271

Weight in the stock from Acoustic surveys											
(Age, Rings)	Historical	1992	1993	1994	1995	1996	1997#	1998	1999	2000	2001
1	90	68	75	52	45	45	57	65	54	62	62
2	164	152	162	150	144	140	150	138	137	141	132
3	208	186	196	192	191	180	189	177	166	173	170
4	233	206	206	220	202	209	209	193	188	183	190
5	246	232	226	221	225	219	225	214	203	194	198
6	252	252	234	233	226	222	233	226	219	204	212
7	258	271	254	241	247	229	248	234	225	211	220
8	269	296	260	270	260	242	266	225	235	222	236
9+	292	305	276	296	293	263	287	249	245	230	254

The 1997 survey is not on the same basis as the other years, it was conducted in June (all other surveys were carried out in July) and it is not used for assessment purposes.

Table 5.1.7 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 (W ring)	2	3	>3
Mean 92-96	0.57	0.96	1.00
1992	0.47	1.00	1.00
1993	0.93	0.96	1.00
1994	0.48	0.92	1.00
1995	0.19	0.98	1.00
1996	0.76	0.94	1.00
1997#	0.41	0.88	1.00
1998	0.85	0.97	1.00
1999	0.57	0.98	1.00
2000	0.45	0.92	1.00
2001	0.93	0.99	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 5.1.8. Herring in VIa(N). ICA Assessment: comparison using a 4, 6 or 8 year period of separable constraint showing the stock summary table for the final 3 years.

	4 yr separable			**6 yr separable**			**8 yr separable**		
	1999	2000	2001	1999	2000	2001	1999	2000	2001
Recruits '000	527040	2006410	42550	516800	2004690	76750	473080	1801980	104470
Biomass t	167124	252090	199554	154413	241452	192023	153346	226961	182130
SSB t	96559	89470	149696	86602	79944	140331	88368	79786	131328
Landings t	29736	23163	24974	29736	23163	24974	29736	23163	24974
Yield/SSB	0.308	0.259	0.167	0.343	0.290	0.178	0.337	0.290	0.190
mean F_{3-6}	0.236	0.194	0.179	0.258	0.216	0.197	0.230	0.204	0.193
SoP	99	100	99	99	100	99	99	100	99

Table 5.1.9. Herring in VIa(N). ICA run log 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



Enter the name of the index file -->index.dat
canum.dat
weca.dat
 Stock weights in 2002  used for the year 2001
west.dat
 Natural mortality in 2002  used for the year 2001
natmor.dat
 Maturity ogive in 2002  used for the year 2001
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 ?--> 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 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
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 5.1.9. continued.

```
Mapping the F-dimension of the SSQ surface

    F                  SSQ
+--------+-------------------
    0.02        14.6137464782
    0.05        10.2083574135
    0.07         8.7840203404
    0.10         8.3476283908
    0.12         8.3006503723
    0.15         8.4238822885
    0.17         8.6259825085
    0.20         8.8653387509
    0.22         9.1216400825
    0.25         9.3845268065
    0.27         9.6485845603
    0.30         9.9110122345
    0.32        10.1704199568
    0.35        10.4262231310
    0.37        10.6783325868
    0.40        10.9269288219
    0.42        11.1724188581
    0.45        11.4153283195
    0.47        11.6562991243
    0.50        11.8960977965
Lowest SSQ is for F =     0.113
-----------------------------------------------------------------
No of years for separable analysis : 6
Age range in the analysis : 1  . . . 9
Year range in the analysis : 1976  . . . 2001
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 34
Number of observations : 147

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 2001  at age 4  is 0.183666  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
Successful exit from ICA
```

Table 5.1.10. Herring in VIa(N). Catch number-at-age (millions)

Output Generated by ICA Version 1.4

Herring VIa (north)

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
1	4.51	0.15
2	22.96	82.21
3	21.83	15.30
4	51.42	9.49
5	15.50	24.90
6	9.00	9.49
7	3.90	6.78
8	1.84	4.72
9	0.58	1.02

x 10 ^ 6

Table 5.1.11. Herring in VIa(N). Weight in the catch (kg)

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
1	0.08340	0.04900
2	0.13730	0.13960
3	0.16370	0.16270
4	0.18290	0.18260
5	0.20140	0.19200
6	0.21470	0.19570
7	0.23940	0.20450
8	0.28120	0.22440
9	0.25260	0.27130

Table 5.1.12. Herring in VIa(N). Weight in the stock (kg)

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
1	0.06200	0.06200
2	0.14100	0.13200
3	0.17300	0.17000
4	0.18300	0.19000
5	0.19400	0.19800
6	0.20400	0.21200
7	0.21100	0.22000
8	0.22200	0.23600
9	0.23000	0.25400

Table 5.1.13. Herring in VIa(N). Natural mortality

Natural Mortality (per year)

AGE	1976	1977	1978	……	1998	1999	2000	2001
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 5.1.14. Herring in VIa(N). Proportion mature

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
1	0.0000	0.0000
2	0.4500	0.9300
3	0.9200	0.9900
4	1.0000	1.0000
5	1.0000	1.0000
6	1.0000	1.0000
7	1.0000	1.0000
8	1.0000	1.0000
9	1.0000	1.0000

Table 5.1.15. Herring in VIa(N). Tuning indices

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
1	460.6	41.2	*******	1221.7	534.2	447.6	313.1
2	1085.1	576.5	*******	794.6	322.4	316.2	1062.0
3	472.7	802.5	*******	666.8	1388.0	337.1	217.7
4	450.2	329.1	*******	471.1	432.0	899.5	172.8
5	153.0	95.4	*******	179.1	308.0	393.4	437.5
6	187.1	60.6	*******	79.3	138.7	247.6	132.6
7	169.2	77.4	*******	28.1	86.5	199.5	102.8
8	236.6	78.2	*******	13.8	27.6	95.0	52.4
9	201.5	114.8	*******	36.8	35.4	65.0	34.7

x 10 ^ 3

Table 5.1.16. Herring in VIa(N). Weighting factors for the catch in numbers

Weighting factors for the catches in number

AGE	1996	1997	1998	1999	2000	2001
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

Table 5.1.17. Herring in VIa(N). Predicted catch in number.

Predicted Catch in Number

AGE	1996	1997	1998	1999	2000	2001
1	2.10	8.97	3.00	1.73	5.61	0.20
2	28.88	65.62	116.73	26.83	21.38	76.28
3	23.28	52.65	45.84	57.51	19.41	17.26
4	11.42	36.88	31.10	19.28	36.24	13.72
5	7.95	19.60	23.47	14.25	13.34	28.21
6	4.12	12.05	10.80	9.37	8.72	9.22
7	4.71	6.43	6.79	4.45	5.96	6.28
8	7.80	5.14	2.48	1.88	1.91	2.90

x 10 ^ 6

Table 5.1.18. Herring in VIa(N). Fishing mortality (per year)

Fishing Mortality (per year)

AGE	1976	1977	1978	1979	1980	1981	1982	1983
1	0.1928	0.0915	0.0395	0.0003	0.0048	0.0354	0.0276	0.0439
2	0.7680	0.3489	0.2918	0.0005	0.0007	0.3207	0.6575	0.3896
3	1.2130	0.5975	0.2648	0.0007	0.0004	0.4290	0.5969	0.5920
4	1.0773	0.9315	0.5210	0.0003	0.0006	0.3953	0.8036	0.4899
5	0.8860	0.9380	0.7540	0.0002	0.0002	0.3034	0.7119	0.9652
6	1.0528	1.4281	1.0574	0.0015	0.0002	0.3075	0.5607	0.7675
7	1.0777	0.8401	0.9289	0.0022	0.0016	0.3055	0.4504	0.7291
8	0.9878	0.7815	0.5729	0.0008	0.0006	0.3438	0.6344	0.6162
9	0.9878	0.7815	0.5729	0.0008	0.0006	0.3438	0.6344	0.6162

AGE	1984	1985	1986	1987	1988	1989	1990	1991
1	0.0030	0.0547	0.0611	0.0147	0.0030	0.0117	0.0520	0.1194
2	0.2294	0.2080	0.5467	0.2803	0.1984	0.1361	0.1658	0.1872
3	0.4995	0.3025	0.4638	0.3242	0.3064	0.2997	0.2331	0.1548
4	0.4412	0.3036	0.4000	0.2967	0.3274	0.2104	0.3235	0.2379
5	0.4416	0.3101	0.5588	0.2606	0.2687	0.3186	0.4494	0.2400
6	0.6562	0.3181	0.6428	0.4628	0.2077	0.1404	0.3632	0.3859
7	0.5709	0.9711	0.1757	0.5192	0.2894	0.1441	0.2441	0.3228
8	0.4428	0.3632	0.4719	0.3403	0.2604	0.2048	0.2805	0.2398
9	0.4428	0.3632	0.4719	0.3403	0.2604	0.2048	0.2805	0.2398

AGE	1992	1993	1994	1995	1996	1997	1998	1999
1	0.0107	0.0490	0.0032	0.0006	0.0041	0.0092	0.0086	0.0053
2	0.2673	0.4834	0.2303	0.3550	0.1281	0.2900	0.2718	0.1669
3	0.3376	0.3591	0.4142	0.3247	0.1699	0.3849	0.3607	0.2214
4	0.2026	0.2314	0.1768	0.3814	0.1842	0.4172	0.3910	0.2400
5	0.2607	0.1495	0.2167	0.2123	0.2132	0.4828	0.4525	0.2777
6	0.3154	0.2527	0.1152	0.1641	0.2236	0.5064	0.4746	0.2913
7	0.2803	0.2642	0.2558	0.1585	0.2491	0.5640	0.5286	0.3245
8	0.2742	0.3081	0.2381	0.2800	0.1842	0.4172	0.3910	0.2400
9	0.2742	0.3081	0.2381	0.2800	0.1842	0.4172	0.3910	0.2400

AGE	2000	2001
1	0.0044	0.0041
2	0.1397	0.1277
3	0.1854	0.1695
4	0.2010	0.1837
5	0.2326	0.2126
6	0.2439	0.2230
7	0.2717	0.2483
8	0.2010	0.1837
9	0.2010	0.1837

Table 5.1.19. Herring in VIa(N). Population abundance (1 January, millions)

Population Abundance (1 January)

AGE	1976	1977	1978	1979	1980	1981	1982	1983
1	613.1	625.9	918.2	1218.2	891.3	1664.1	772.3	3010.0
2	677.2	186.0	210.1	324.7	448.0	326.3	590.9	276.4
3	156.4	232.8	97.2	116.3	240.4	331.6	175.4	226.8
4	56.1	38.1	104.9	61.1	95.1	196.8	176.8	79.1
5	44.7	17.3	13.6	56.3	55.2	86.0	119.9	71.6
6	122.1	16.7	6.1	5.8	51.0	50.0	57.5	53.2
7	17.2	38.5	3.6	1.9	5.2	46.1	33.2	29.7
8	6.5	5.3	15.1	1.3	1.7	4.7	30.7	19.2
9	20.0	2.9	3.7	9.6	9.8	4.8	9.0	19.3

AGE	1984	1985	1986	1987	1988	1989	1990	1991
1	1150.8	1206.4	896.2	2107.8	908.8	848.2	444.7	367.4
2	1059.8	422.1	420.2	310.1	764.1	333.3	308.4	155.3
3	138.7	624.2	253.9	180.2	173.6	464.2	215.5	193.6
4	102.7	68.9	377.6	130.8	106.7	104.6	281.6	139.8
5	43.8	59.8	46.0	229.1	87.9	69.6	76.7	184.4
6	24.7	25.5	39.7	23.8	159.7	60.8	45.8	44.3
7	22.4	11.6	16.8	18.9	13.6	117.4	47.8	28.8
8	13.0	11.4	4.0	12.7	10.2	9.2	92.0	33.9
9	5.7	7.5	5.5	21.7	10.8	19.9	23.7	21.9

AGE	1992	1993	1994	1995	1996	1997	1998	1999
1	781.1	583.7	860.4	754.0	817.4	1546.9	551.7	516.8
2	120.0	284.3	204.5	315.5	277.2	299.5	563.9	201.2
3	95.4	68.0	129.9	120.3	163.9	180.7	166.0	318.3
4	135.8	55.7	38.9	70.3	71.2	113.2	100.7	94.8
5	99.7	100.3	40.0	29.5	43.4	53.6	67.5	61.6
6	131.2	69.5	78.2	29.2	21.6	31.7	29.9	38.8
7	27.2	86.6	48.8	63.0	22.4	15.6	17.3	16.8
8	18.9	18.6	60.2	34.2	48.7	15.8	8.0	9.2
9	24.1	14.8	50.5	42.0	194.0	30.3	10.8	5.4

AGE	2000	2001	2002
1	2004.7	76.8	916.0
2	189.1	734.2	28.1
3	126.2	121.8	478.7
4	208.8	85.8	84.2
5	67.4	154.6	64.6
6	42.2	48.4	113.1
7	26.3	29.9	35.0
8	11.0	18.1	21.1
9	3.3	6.3	18.4

x 10 ^ 6

Table 5.1.20. Herring in VIa(N). Predicted index values

Predicted Age-Structured Index Values

FLT01: West Scotland Summer Acoustic Su Predicted

AGE	1987	1988	1989	1990	1991	1992	1993	1994
1	635.4	*******	*******	*******	104.6	236.0	172.7	261.0
2	645.6	*******	*******	*******	340.2	251.5	529.7	437.4
3	607.6	*******	*******	*******	715.9	319.5	225.1	417.0
4	529.0	*******	*******	*******	583.9	578.1	233.7	168.0
5	900.8	*******	*******	*******	733.3	392.0	419.1	161.2
6	86.2	*******	*******	*******	167.0	514.5	281.9	341.7
7	62.6	*******	*******	*******	106.3	102.9	330.2	187.0
8	38.8	*******	*******	*******	109.0	59.6	57.7	193.7
9	67.2	*******	*******	*******	71.6	77.2	46.5	165.1

AGE	1995	1996	1997	1998	1999	2000	2001
1	229.0	247.8	*******	166.9	156.6	607.7	23.3
2	630.6	627.0	*******	1179.1	445.6	425.0	1660.9
3	405.6	601.2	*******	548.8	1135.2	458.9	447.0
4	271.5	306.2	*******	386.9	395.4	890.1	369.2
5	119.1	175.2	*******	239.1	240.1	269.3	624.0
6	124.1	88.9	*******	107.5	154.3	172.1	199.4
7	254.5	86.1	*******	57.1	62.1	99.7	115.1
8	107.7	161.3	*******	23.8	29.7	36.2	60.1
9	134.2	653.0	*******	32.4	17.5	11.1	21.4

x 10 ^ 3

Table 5.1.21. Herring in VIa(N). Fitted selection pattern

Fitted Selection Pattern

AGE	1976	1977	1978	1979	1980	1981	1982	1983
1	0.1790	0.0982	0.0757	0.9812	8.4946	0.0897	0.0343	0.0895
2	0.7129	0.3745	0.5602	1.5485	1.2795	0.8111	0.8182	0.7954
3	1.1259	0.6414	0.5082	2.2357	0.7737	1.0852	0.7428	1.2085
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8224	1.0070	1.4472	0.7416	0.4388	0.7674	0.8859	1.9703
6	0.9773	1.5332	2.0296	4.4548	0.3292	0.7780	0.6977	1.5666
7	1.0004	0.9019	1.7829	6.6921	2.8606	0.7729	0.5605	1.4882
8	0.9169	0.8390	1.0996	2.4851	1.0742	0.8698	0.7895	1.2580
9	0.9169	0.8390	1.0996	2.4851	1.0742	0.8698	0.7895	1.2580

AGE	1984	1985	1986	1987	1988	1989	1990	1991
1	0.0069	0.1803	0.1529	0.0495	0.0091	0.0554	0.1606	0.5019
2	0.5200	0.6852	1.3670	0.9447	0.6058	0.6467	0.5123	0.7868
3	1.1321	0.9962	1.1596	1.0927	0.9358	1.4245	0.7206	0.6508
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0010	1.0214	1.3971	0.8783	0.8206	1.5143	1.3890	1.0090
6	1.4874	1.0478	1.6072	1.5598	0.6343	0.6672	1.1226	1.6222
7	1.2940	3.1985	0.4393	1.7497	0.8839	0.6849	0.7546	1.3569
8	1.0037	1.1961	1.1799	1.1469	0.7952	0.9732	0.8669	1.0082
9	1.0037	1.1961	1.1799	1.1469	0.7952	0.9732	0.8669	1.0082

AGE	1992	1993	1994	1995	1996	1997	1998	1999
1	0.0527	0.2118	0.0180	0.0015	0.0221	0.0221	0.0221	0.0221
2	1.3193	2.0895	1.3027	0.9307	0.6952	0.6952	0.6952	0.6952
3	1.6664	1.5520	2.3424	0.8514	0.9226	0.9226	0.9226	0.9226
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.2866	0.6460	1.2255	0.5565	1.1573	1.1573	1.1573	1.1573
6	1.5565	1.0922	0.6515	0.4303	1.2139	1.2139	1.2139	1.2139
7	1.3835	1.1421	1.4468	0.4157	1.3520	1.3520	1.3520	1.3520
8	1.3535	1.3317	1.3464	0.7340	1.0000	1.0000	1.0000	1.0000
9	1.3535	1.3317	1.3464	0.7340	1.0000	1.0000	1.0000	1.0000

AGE	2000	2001
1	0.0221	0.0221
2	0.6952	0.6952
3	0.9226	0.9226
4	1.0000	1.0000
5	1.1573	1.1573
6	1.2139	1.2139
7	1.3520	1.3520
8	1.0000	1.0000
9	1.0000	1.0000

Table 5.1.22. Herring in VIa(N). Stock summary

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	613130	265622	74572	93642	1.2557	1.0573	100
1977	625870	164779	53121	41341	0.7782	0.9738	109
1978	918160	172689	49875	22156	0.4442	0.6493	99
1979	1218170	220257	76139	60	0.0008	0.0007	99
1980	891330	256980	126025	306	0.0024	0.0004	99
1981	1664130	366433	133253	51420	0.3859	0.3588	103
1982	772340	307544	111116	92360	0.8312	0.6683	96
1983	3009950	431308	82530	63523	0.7697	0.7036	97
1984	1150750	358090	121989	56012	0.4592	0.5096	105
1985	1206360	353071	150687	39142	0.2598	0.3086	99
1986	896180	318694	136499	70764	0.5184	0.5163	95
1987	2107780	385499	127192	44360	0.3488	0.3361	102
1988	908810	339329	151468	35591	0.2350	0.2776	97
1989	848170	322932	167820	34026	0.2028	0.2423	98
1990	444740	275450	158549	44693	0.2819	0.3423	101
1991	367420	210838	129053	28529	0.2211	0.2546	93
1992	781080	218186	105165	28985	0.2756	0.2791	99
1993	583740	184512	99385	31778	0.3197	0.2482	100
1994	860420	178939	89704	24430	0.2723	0.2307	100
1995	754010	164310	72155	29575	0.4099	0.2706	99
1996	817420	202208	123623	26105	0.2112	0.1977	95
1997	1546920	227145	80829	35233	0.4359	0.4478	99
1998	551720	192723	99078	33353	0.3366	0.4197	100
1999	516800	154413	86602	29736	0.3434	0.2576	99
2000	2004690	241452	79944	23163	0.2897	0.2157	100
2001	76750	192023	140331	24974	0.1780	0.1972	99

No of years for separable analysis : 6
Age range in the analysis : 1 . . . 9
Year range in the analysis : 1976 . . . 2001
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 34
Number of observations : 147

Conventional single selection vector model to be fitted.

Table 5.1.23. Herring in VIa(N). Parameter estimates

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	1996	0.1842	15	0.1363	0.2490	0.1580	0.2148	0.1864
2	1997	0.4172	14	0.3123	0.5572	0.3599	0.4836	0.4217
3	1998	0.3910	16	0.2849	0.5366	0.3327	0.4595	0.3961
4	1999	0.2400	18	0.1660	0.3470	0.1988	0.2897	0.2443
5	2000	0.2010	21	0.1319	0.3062	0.1621	0.2491	0.2057
6	2001	0.1837	25	0.1121	0.3009	0.1428	0.2363	0.1896
Separable Model: Selection (S) by age								
7	1	0.0221	39	0.0102	0.0479	0.0149	0.0328	0.0239
8	2	0.6952	16	0.5027	0.9616	0.5892	0.8203	0.7048
9	3	0.9226	15	0.6821	1.2480	0.7908	1.0763	0.9336
	4	1.0000		Fixed : Reference Age				
10	5	1.1573	13	0.8800	1.5218	1.0063	1.3308	1.1686
11	6	1.2139	13	0.9384	1.5703	1.0645	1.3843	1.2244
12	7	1.3520	12	1.0491	1.7424	1.1879	1.5388	1.3634
	8	1.0000		Fixed : Last true age				
Separable model: Populations in year 2001								
13	1	76752	90	13120	448984	31167	189012	115202
14	2	734220	34	372929	1445528	519666	1037357	779409
15	3	121832	28	70370	210928	92076	161206	126704
16	4	85811	24	52779	139517	66965	109961	88491
17	5	154564	23	98217	243237	122642	194795	158756
18	6	48364	22	30991	75478	38539	60694	49627
19	7	29940	22	19166	46771	23846	37592	30725
20	8	18112	24	11288	29062	14230	23054	18647
Separable model: Populations at age								
21	1996	48669	28	28059	84417	36747	64459	50629
22	1997	15791	22	10243	24345	12662	19694	16181
23	1998	8035	21	5324	12128	6513	9913	8215
24	1999	9231	21	6035	14119	7432	11466	9451
25	2000	11014	22	7076	17144	8788	13804	11298

Age-structured index catchabilities

FLT01: West Scotland Summer Acoustic Survey

Linear model fitted. Slopes at age :

26	1	Q	.5240	75	.2533	4.931	.5240	2.383	1.489
27	2	Q	2.856	24	2.249	5.968	2.856	4.699	3.779
28	3	Q	4.487	24	3.541	9.316	4.487	7.351	5.921
29	4	Q	5.022	24	3.967	10.39	5.022	8.207	6.617
30	5	Q	4.787	24	3.782	9.897	4.787	7.820	6.305
31	6	Q	4.916	24	3.881	10.19	4.916	8.044	6.482
32	7	Q	4.649	24	3.661	9.705	4.649	7.644	6.148
33	8	Q	3.870	25	3.039	8.152	3.870	6.402	5.138
34	9	Q	3.929	24	3.097	8.191	3.929	6.455	5.194

Table 5.1.24. Herring in VIa(N). Residuals about the model fit

Separable Model Residuals

Age	1996	1997	1998	1999	2000	2001
1	-0.072	-2.017	1.109	1.487	-0.218	-0.289
2	0.270	-0.162	-0.454	0.273	0.071	0.075
3	0.283	-0.409	-0.282	0.490	0.117	-0.121
4	-0.214	-0.153	0.025	0.263	0.350	-0.369
5	-0.057	0.165	-0.026	-0.064	0.150	-0.125
6	-0.500	0.373	0.286	-0.218	0.032	0.030
7	-0.002	0.473	0.241	-0.315	-0.425	0.078
8	0.080	0.013	0.129	-0.402	-0.041	0.488

AGE-STRUCTURED INDEX RESIDUALS

FLT01: West Scotland Summer Acoustic Survey

Age	1987	1988	1989	1990	1991	1992	1993	1994
1	-0.936	*******	*******	*******	1.174	-1.155	-4.136	0.638
2	-0.110	*******	*******	*******	-0.144	0.694	0.348	0.215
3	-0.098	*******	*******	*******	-0.781	-0.415	1.107	0.377
4	-0.404	*******	*******	*******	-0.462	-0.806	1.028	0.531
5	-0.180	*******	*******	*******	-0.407	0.056	0.261	0.643
6	0.259	*******	*******	*******	0.054	-0.762	1.121	-0.243
7	-0.264	*******	*******	*******	-0.074	0.026	-0.150	0.777
8	-0.892	*******	*******	*******	-0.194	-0.049	0.967	-0.109
9	-2.336	*******	*******	*******	-0.209	-0.196	1.211	-0.225

FLT01: West Scotland Summer Acoustic Survey

Age	1995	1996	1997	1998	1999	2000	2001
1	0.699	-1.794	*******	1.991	1.227	-0.306	2.599
2	0.543	-0.084	*******	-0.395	-0.324	-0.296	-0.447
3	0.153	0.289	*******	0.195	0.201	-0.308	-0.719
4	0.506	0.072	*******	0.197	0.089	0.010	-0.759
5	0.251	-0.608	*******	-0.289	0.249	0.379	-0.355
6	0.410	-0.384	*******	-0.305	-0.107	0.364	-0.408
7	-0.408	-0.106	*******	-0.711	0.331	0.693	-0.113
8	0.787	-0.724	*******	-0.541	-0.073	0.965	-0.136
9	0.406	-1.738	*******	0.127	0.706	1.769	0.485

Table 5.1.25. Herring in VIa(N). Parameters of distributions

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

Separable model fitted from 1996  to 2001
 Variance                            0.1623
Skewness test stat.                 -0.3009
Kurtosis test statistic             -0.8587
Partial chi-square                   0.4094
Significance in fit                  0.0000
Degrees of freedom                       23


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


   DISTRIBUTION STATISTICS FOR FLT01: West Scotland Summer Acoustic Survey


 Linear catchability relationship assumed

Age
   1         2         3         4         5         6         7         8        9
Variance
   0.0413    0.0170    0.0329    0.0361    0.0170    0.0298    0.0221    0.0464    0.1569
Skewness test stat.
  -0.9808    0.7839    0.4453    0.1888    0.0065    0.9528    0.6178    0.5426   -0.8604
Kurtosis test statistic
  -0.0240   -0.6998   -0.1468   -0.5574   -0.7837    0.0657   -0.3428   -0.6973   -0.1199
Partial chi-square
   0.0353    0.0129    0.0257    0.0284    0.0137    0.0240    0.0191    0.0425    0.1434
Significance in fit
   0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
Number of observations
  11        11        11        11        11        11        11        11        11
Degrees of freedom
  10        10        10        10        10        10        10        10        10
Weight in the analysis
   0.0111    0.1111    0.1111    0.1111    0.1111    0.1111    0.1111    0.1111    0.1111
```

Table 5.1.26. Herring in VIa(N). Analysis of variance

```
Unweighted Statistics

Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                        79.9895     147          34  113   0.7079
Catches-at-age                         10.6152      48          25   23   0.4615

 Aged Indices
FLT01: West Scotland Summer Acoustic S 69.3743      99           9   90   0.7708


 Weighted Statistics


Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                         4.1364     147          34  113   0.0366
Catches-at-age                          3.7338      48          25   23   0.1623

 Aged Indices
FLT01: West Scotland Summer Acoustic S  0.4026      99           9   90   0.0045
```

Table 5.1.27. 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.

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	913633	1	0	0.67	0.67	5.93E-02	0.004595	6.95E-02
2	323817	0.3	0.65	0.67	0.67	0.136667	0.144753	0.135633
3	478720	0.2	0.963333	0.67	0.67	0.169667	0.192087	0.161467
4	84201	0.1	1	0.67	0.67	0.187	0.208207	0.180167
5	64619	0.1	1	0.67	0.67	0.198333	0.240947	0.1948
6	113080	0.1	1	0.67	0.67	0.211667	0.252747	0.2068
7	35017	0.1	1	0.67	0.67	0.218667	0.281497	0.222967
8	21135	0.1	1	0.67	0.67	0.231	0.208207	0.242867
9	18420	0.1	1	0.67	0.67	0.243	0.208207	0.249967

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	913633	1	0	0.67	0.67	5.93E-02	0.004595	6.95E-02
2	.	0.3	0.65	0.67	0.67	0.136667	0.144753	0.135633
3	.	0.2	0.963333	0.67	0.67	0.169667	0.192087	0.161467
4	.	0.1	1	0.67	0.67	0.187	0.208207	0.180167
5	.	0.1	1	0.67	0.67	0.198333	0.240947	0.1948
6	.	0.1	1	0.67	0.67	0.211667	0.252747	0.2068
7	.	0.1	1	0.67	0.67	0.218667	0.281497	0.222967
8	.	0.1	1	0.67	0.67	0.231	0.208207	0.242867
9	.	0.1	1	0.67	0.67	0.243	0.208207	0.249967

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	913633	1	0	0.67	0.67	5.93E-02	0.004595	6.95E-02
2	.	0.3	0.65	0.67	0.67	0.136667	0.144753	0.135633
3	.	0.2	0.963333	0.67	0.67	0.169667	0.192087	0.161467
4	.	0.1	1	0.67	0.67	0.187	0.208207	0.180167
5	.	0.1	1	0.67	0.67	0.198333	0.240947	0.1948
6	.	0.1	1	0.67	0.67	0.211667	0.252747	0.2068
7	.	0.1	1	0.67	0.67	0.218667	0.281497	0.222967
8	.	0.1	1	0.67	0.67	0.231	0.208207	0.242867
9	.	0.1	1	0.67	0.67	0.243	0.208207	0.249967

Table 5.1.28. Herring in VIa(N). Short-term prediction single option table, scenario 1 - *status quo* F.

Year:	2002	F multiplier:	1	Fbar:	0.1972					
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0041		2337	162	913633	54209	0	0	0	0
2	0.1277		33643	4563	323817	44255	210481	28766	158039	21599
3	0.1695		67821	10951	478720	81223	461167	78245	360045	61088
4	0.1837		13465	2426	84201	15746	84201	15746	69627	13020
5	0.2126		11796	2298	64619	12816	64619	12816	52410	10395
6	0.223		21546	4456	113080	23935	113080	23935	91078	19278
7	0.2483		7343	1637	35017	7657	35017	7657	27728	6063
8	0.1837		3380	821	21135	4882	21135	4882	17477	4037
9	0.1837		2946	736	18420	4476	18420	4476	15232	3701
Total			164276	28050	2052642	249199	1008120	176523	791635	139181

Year:	2003	F multiplier:	1.42	Fbar:	0.28					
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0058		3316	230	913633	54209	0	0	0	0
2	0.1813		48176	6534	334747	45749	217586	29737	157608	21540
3	0.2406		41088	6634	211133	35822	203392	34509	151399	25687
4	0.2608		72437	13051	330850	61869	330850	61869	259803	48583
5	0.3018		15759	3070	63405	12575	63405	12575	48440	9607
6	0.3166		12241	2531	47274	10006	47274	10006	35760	7569
7	0.3526		23219	5177	81870	17902	81870	17902	60454	13219
8	0.2608		5412	1314	24718	5710	24718	5710	19410	4484
9	0.2608		6521	1630	29786	7238	29786	7238	23389	5684
Total			228169	40172	2037415	251080	998879	179546	756262	136373

Year:	2004	F multiplier:	1.42	Fbar:	0.28					
Age	F		CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0058		3316	230	913633	54209	0	0	0	0
2	0.1813		48094	6523	334178	45671	217216	29686	157340	21503
3	0.2406		40257	6500	206863	35098	199278	33811	148337	25168
4	0.2608		29753	5360	135893	25412	135893	25412	106711	19955
5	0.3018		57325	11167	230639	45743	230639	45743	176203	34947
6	0.3166		10985	2272	42424	8980	42424	8980	32092	6793
7	0.3526		8839	1971	31167	6815	31167	6815	23014	5032
8	0.2608		11400	2769	52066	12027	52066	12027	40886	9445
9	0.2608		8319	2079	37995	9233	37995	9233	29836	7250
Total			218287	38872	1984858	243188	946678	171707	714417	130092

Table 5.1.29. Herring in VIa (N). Short-term prediction multiple option table, scenario 1 - *status quo* F.

2002				
Biomass	SSB	FMult	FBar	Landings
249199	139181	1	0.1972	28050

2003					2004	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
251080	144986	0.92	0.1814	27179	256530	149193
.	144100	0.97	0.1912	28532	255140	147150
.	143220	1.02	0.2011	29872	253763	145137
.	142345	1.07	0.211	31200	252399	143155
.	141475	1.12	0.2208	32516	251047	141203
.	140611	1.17	0.2307	33821	249707	139281
.	139753	1.22	0.2405	35114	248379	137387
.	138900	1.27	0.2504	36396	247064	135522
.	138052	1.32	0.2602	37666	245760	133684
.	137210	1.37	0.2701	38925	244468	131875
.	136373	1.42	0.28	40172	243188	130092
.	135541	1.47	0.2898	41409	241920	128337
.	134715	1.52	0.2997	42635	240663	126607
.	133894	1.57	0.3095	43850	239417	124904
.	133077	1.62	0.3194	45054	238183	123226
.	132266	1.67	0.3293	46247	236960	121573
.	131461	1.72	0.3391	47430	235748	119945
.	130660	1.77	0.349	48602	234546	118341
.	129864	1.82	0.3588	49764	233356	116761
.	129073	1.87	0.3687	50916	232177	115205
.	128287	1.92	0.3785	52057	231008	113672

Table 5.1.30. Herring in VIa(N). Short-term prediction single option table, scenario 2 – TAC for 2002, catch = 33,000 t.

Year:	2002	F multiplier:	1.1962	Fbar:	0.2358				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0048	2794	194	913633	54209	0	0	0	0
2	0.1527	39778	5395	323817	44255	210481	28766	155409	21239
3	0.2027	79873	12897	478720	81223	461167	78245	352115	59742
4	0.2197	15833	2853	84201	15746	84201	15746	67966	12710
5	0.2542	13834	2695	64619	12816	64619	12816	50966	10108
6	0.2667	25247	5221	113080	23935	113080	23935	88448	18721
7	0.297	8584	1914	35017	7657	35017	7657	26838	5869
8	0.2197	3974	965	21135	4882	21135	4882	17060	3941
9	0.2197	3464	866	18420	4476	18420	4476	14868	3613
Total		193382	33000	2052642	249199	1008120	176523	773671	135943

Year:	2003	F multiplier:	1.42	Fbar:	0.28				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0058	3316	230	913633	54209	0	0	0	0
2	0.1813	48138	6529	334481	45712	217413	29713	157482	21523
3	0.2406	40072	6470	205910	34936	198360	33655	147654	25052
4	0.2608	70069	12624	320034	59846	320034	59846	251309	46995
5	0.3018	15202	2961	61161	12130	61161	12130	46725	9267
6	0.3166	11741	2428	45343	9598	45343	9598	34300	7260
7	0.3526	22225	4956	78367	17136	78367	17136	57867	12654
8	0.2608	5154	1252	23542	5438	23542	5438	18487	4270
9	0.2608	6291	1572	28731	6982	28731	6982	22562	5482
Total		222207	39023	2011203	245988	972952	174499	736386	132503

Year:	2004	F multiplier:	1.42	Fbar:	0.28				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0058	3316	230	913633	54209	0	0	0	0
2	0.1813	48094	6523	334178	45671	217216	29686	157340	21503
3	0.2406	40225	6495	206698	35070	199120	33784	148219	25148
4	0.2608	29017	5228	132532	24783	132532	24783	104072	19461
5	0.3018	55451	10802	223099	44248	223099	44248	170442	33804
6	0.3166	10596	2191	40923	8662	40923	8662	30956	6552
7	0.3526	8478	1890	29894	6537	29894	6537	22074	4827
8	0.2608	10912	2650	49838	11513	49838	11513	39136	9040
9	0.2608	7978	1994	36441	8855	36441	8855	28615	6954
Total		214067	38004	1967236	239548	929062	168068	700853	127290

Table 5.1.31. Herring in VIa(N). Short-term prediction multiple option table, scenario 2 – TAC for 2002, catch = 33,000 t.

2002				
Biomass	SSB	FMult	FBar	Landings
249199	135943	1.1962	0.2358	33000

2003					2004	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
245988	140853	0.92	0.1814	26399	252515	145884
.	139994	0.97	0.1912	27712	251165	143895
.	139141	1.02	0.2011	29014	249827	141937
.	138292	1.07	0.211	30305	248500	140007
.	137450	1.12	0.2208	31584	247186	138107
.	136612	1.17	0.2307	32851	245884	136235
.	135780	1.22	0.2405	34108	244594	134392
.	134953	1.27	0.2504	35353	243315	132576
.	134131	1.32	0.2602	36587	242048	130787
.	133315	1.37	0.2701	37810	240792	129025
.	132503	1.42	0.28	39023	239548	127290
.	131697	1.47	0.2898	40224	238315	125580
.	130895	1.52	0.2997	41416	237093	123896
.	130099	1.57	0.3095	42596	235882	122237
.	129308	1.62	0.3194	43766	234682	120603
.	128522	1.67	0.3293	44926	233493	118994
.	127740	1.72	0.3391	46075	232314	117408
.	126964	1.77	0.349	47215	231147	115846
.	126192	1.82	0.3588	48344	229989	114307
.	125425	1.87	0.3687	49463	228843	112791
.	124664	1.92	0.3785	50573	227706	111298

Table 5.1.32. Herring in VIa(N). Medium-term projection input control data.

Age	Fleet Catch Ratio	Retention Ogive	Mean wt at age	Year	F multiplier	CV on target F multiplier
1	1	1	0.0694	2002	1.00	0.0001
2	1	1	0.126	2003	1.42	0.0001
3	1	1	0.161	2004	1.42	0.0001
4	1	1	0.180	2005	1.42	0.0001
5	1	1	0.195	2006	1.42	0.0001
6	1	1	0.207	2007	1.42	0.0001
7	1	1	0.223	2008	1.42	0.0001
8	1	1	0.243	2009	1.42	0.0001
9+	1	1	0.250	2010	1.42	0.0001
				2011	1.42	0.0001

Table 5.1.33. Herring in VIa(N). Medium-term projections control file

Programme 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 2001 back to--> 1999
Use mean maturity ogive from 2001 back to--> 1999
Use mean weight-at-age in the stock from 2001 back to--> 1999
Enter the reference spawning stock size (e.g. MBAL, $\mathbf{B}_{pa}$)--> 7.5254000000000000E+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) ?-->n
Enter first year of data for stock-recruit model--> 1976
Enter last year of data for stock-recruit model--> 1999
Autocorrelated or Independent errors (I/A)-->i
Use ICA or SRR (I/S) model value for recruitment in 2001-->s
Use ICA or SRR (I/S) model value for recruitment in 2002-->s
Use default percentiles (Y/N) ?-->y
Use ICA-derived resamples ?-->y

Table 5.1.34. Herring in VIa (N). Sensitivity of the assessment to large values in some ages in the acoustic survey. Comparison of catchability coefficients (Q) in the acoustic survey for the final assessment, compared with assessments with 1999 3 ringers and 2000 4 ringers removed individually and together. The catchabilities are not sensitive to the presence of these values.

Q / age	final assessment	99 3 ringers down-weighted	00 4 ringers down-weighted	both down-weighted
1	0.524	0.525	0.524	0.525
2	2.856	2.863	2.856	2.864
3	4.487	4.405	4.488	4.406
4	5.022	5.034	5.017	5.026
5	4.787	4.798	4.787	4.799
6	4.916	4.925	4.917	4.926
7	4.649	4.657	4.649	4.658
8	3.870	3.876	3.871	3.877
9	3.929	3.936	3.930	3.937

Table 5.1.35. Herring VIa (N) Input data for Pa plots (Figure 5.1.22). For stock summary data see Table 5.1.22

Age	Number	Nat Mortality	Catch Weights	Stock Weights	Maturity	Fleet Selection Pattern
1	13.7	1	0.069	0.059	0.00	0.022
2	734220.7	0.3	0.136	0.137	0.65	0.695
3	121833.0	0.2	0.161	0.170	0.96	0.923
4	85811.8	0.1	0.180	0.187	1.00	1.000
5	154564.6	0.1	0.195	0.198	1.00	1.157
6	48364.7	0.1	0.207	0.212	1.00	1.214
7	29940.5	0.1	0.223	0.219	1.00	1.352
8	18112.6	0.1	0.243	0.231	1.00	1.000
9+	6347.6	0.1	0.250	0.243	1.00	1.000

Coefficients of Variation

Age	Number	Nat Mortality	Catch Weights	Stock Weights	Maturity	Fleet Selection Pattern
1	0.0357	0.0000	0.2607	0.0778	0.0000	0.7904
2	0.3456	0.0000	0.0370	0.0330	0.1000	0.3309
3	0.2800	0.0000	0.0188	0.0207	0.1000	0.3082
4	0.2480	0.0000	0.0248	0.0193	0.0000	0.0000
5	0.2313	0.0000	0.0295	0.0227	0.0000	0.2795
6	0.2271	0.0000	0.0479	0.0355	0.0000	0.2627
7	0.2276	0.0000	0.0787	0.0324	0.0000	0.2588
8	0.2412	0.0000	0.1367	0.0338	0.0000	0.0000
9+	0.2412	0.0000	0.0911	0.0499	0.0000	0.0000

Table 5.2.1. HERRING from the Firth of Clyde. Catch in tonnes by country, 1955–2001. 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
Scotland	608	392	598	371	779	16	1	78
Other UK	-	194	127	475	310	240	0	392
Unallocated[1]	-	-	-	-	-	-	-	-
Discards	-[2]	-[2]	-	-	-	-	-	-
Agreed TAC	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

[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 5.2.2. 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	

[1] One sample collected in first quarter, but not applied to catch, which was taken in third quarter.

Table 5.2.3. HERRING from the Firth of Clyde. Catch in numbers-at-age. Spring- and autumn-spawners combined. Thousands of fish.

Age(Rings)	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	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
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 5.2.4. HERRING in the Firth of Clyde. Mean weights-at-age in the catch and stock (g).

Age (rings)	Weight in the catch 1970-81	1982-85	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
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

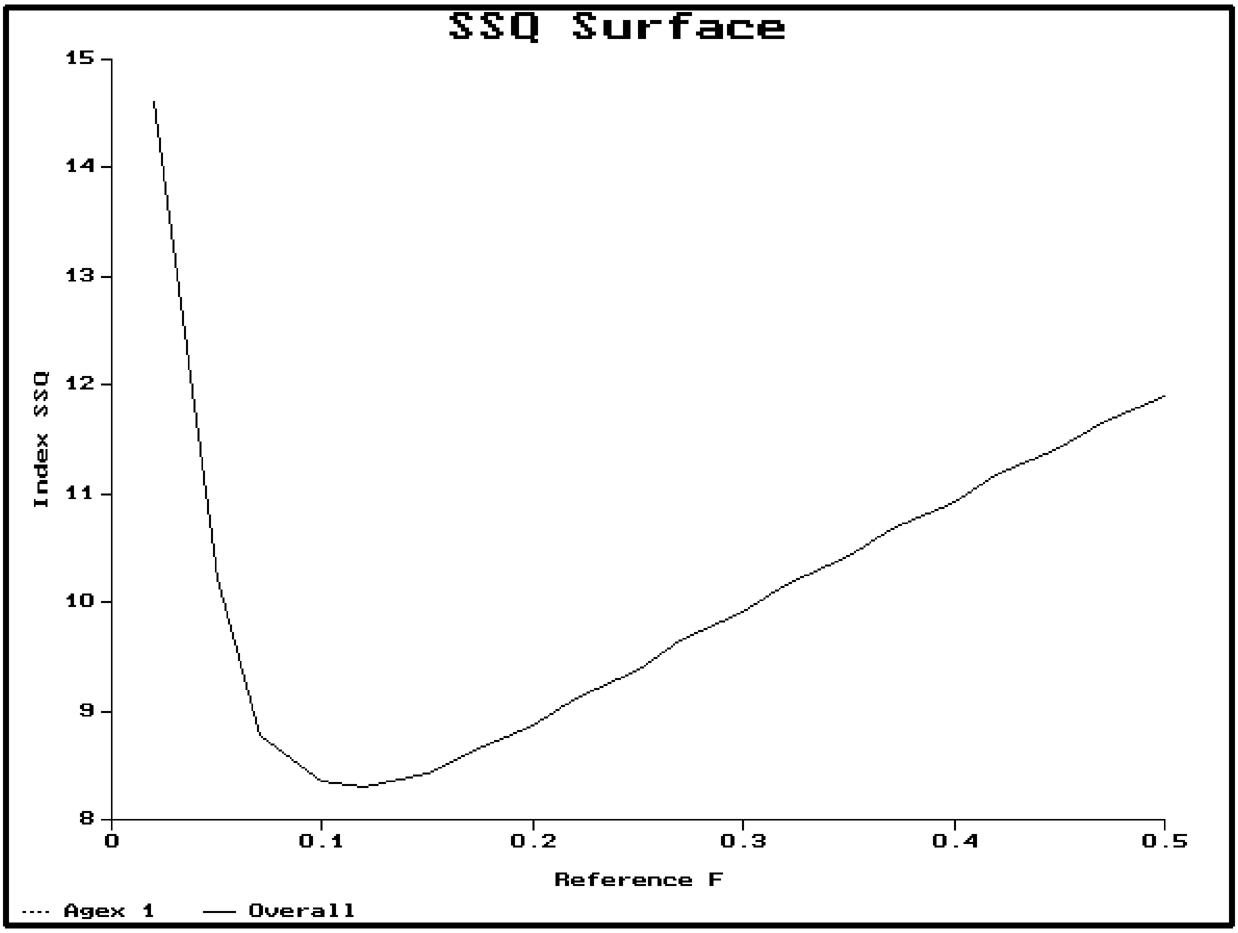


Figure 5.1.1. Herring in VIa(N). SSQ surface for the deterministic calculation of the 6-year separable period. Agex1-age disaggregated acoustic estimates.

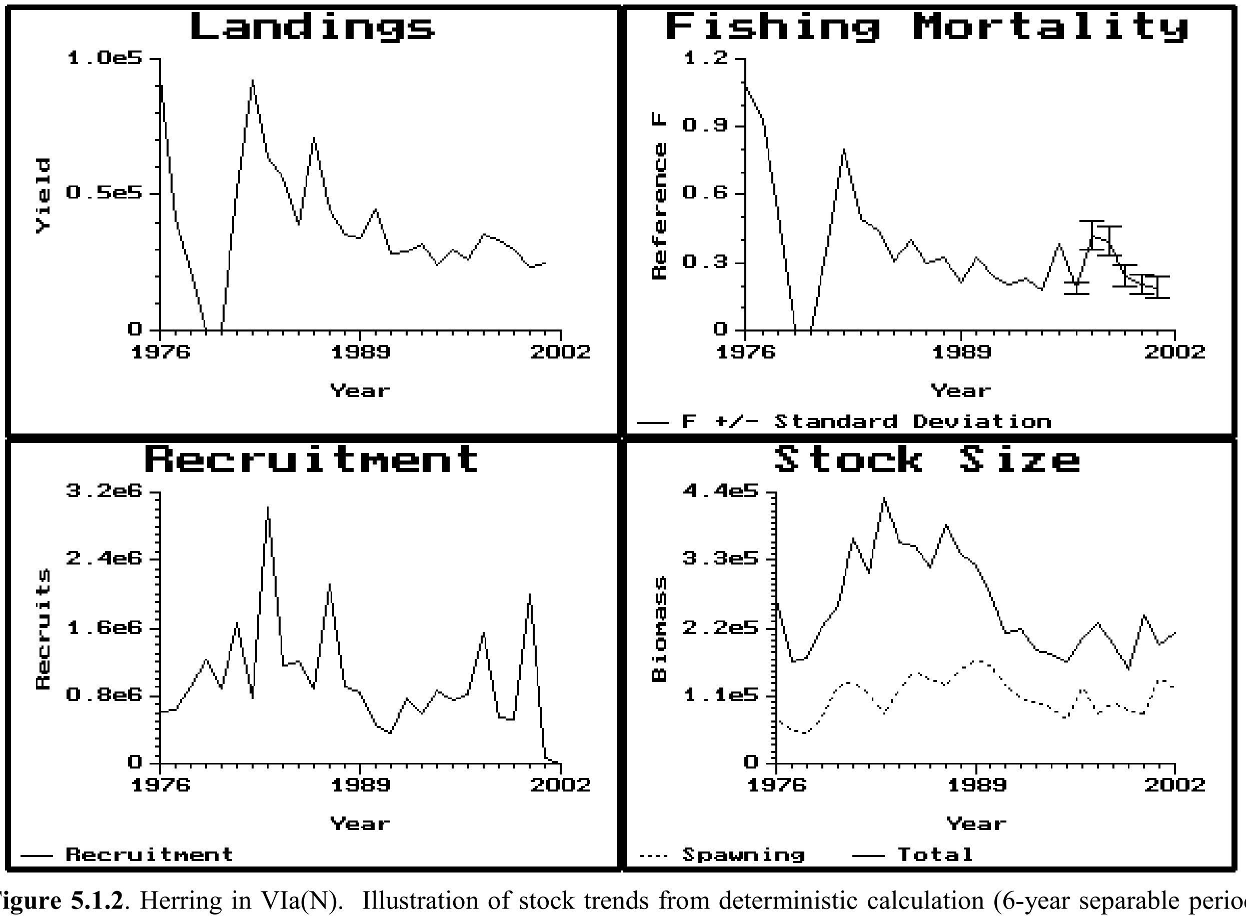


Figure 5.1.2. Herring in VIa(N). Illustration of stock trends from deterministic calculation (6-year separable period). Summary of estimates of landings, fishing mortality at age 4, recruitment at age 1, stock size on 1 January and spawning stock at spawning time.

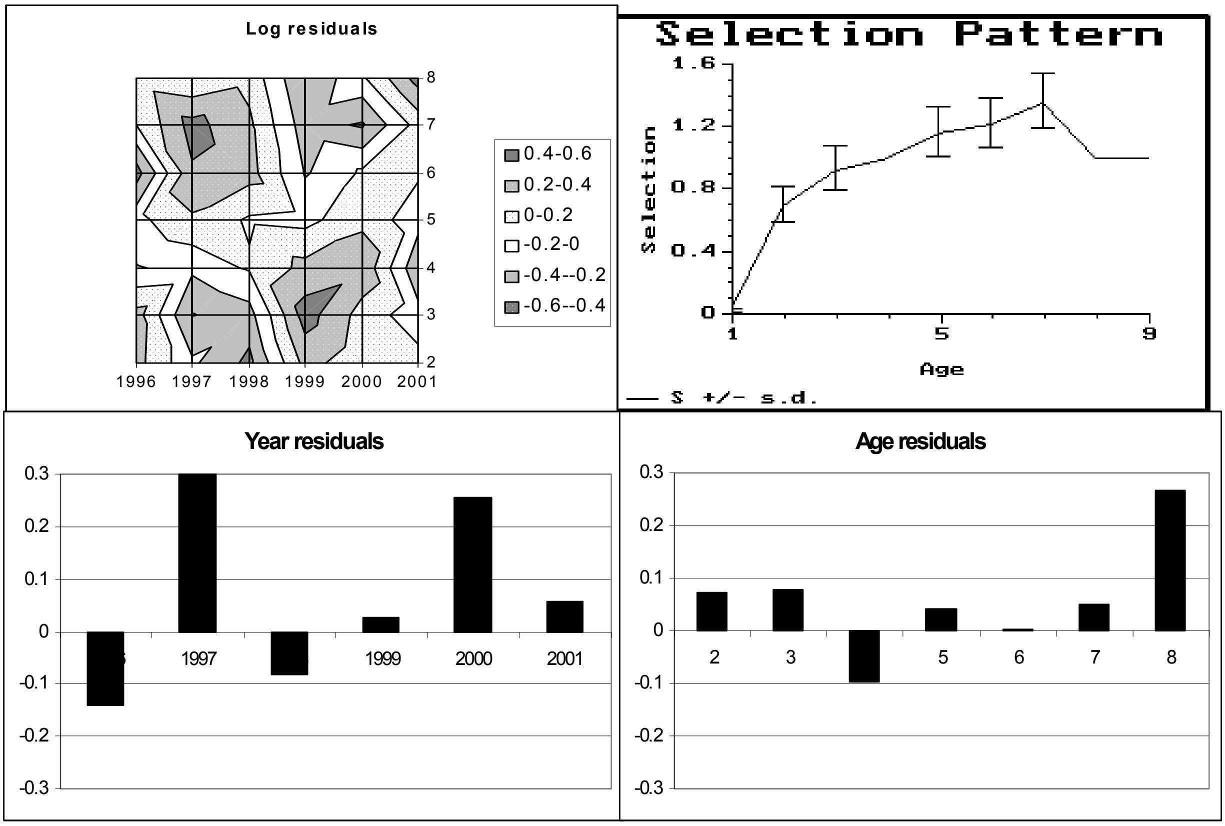


Figure 5.1.3. Herring in VIa(N). Illustration of selection patterns diagnostics, from deterministic calculation (6-year separable period). Top left, a contour plot of selection pattern residuals. Top right, estimated selection (relative to age 4) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

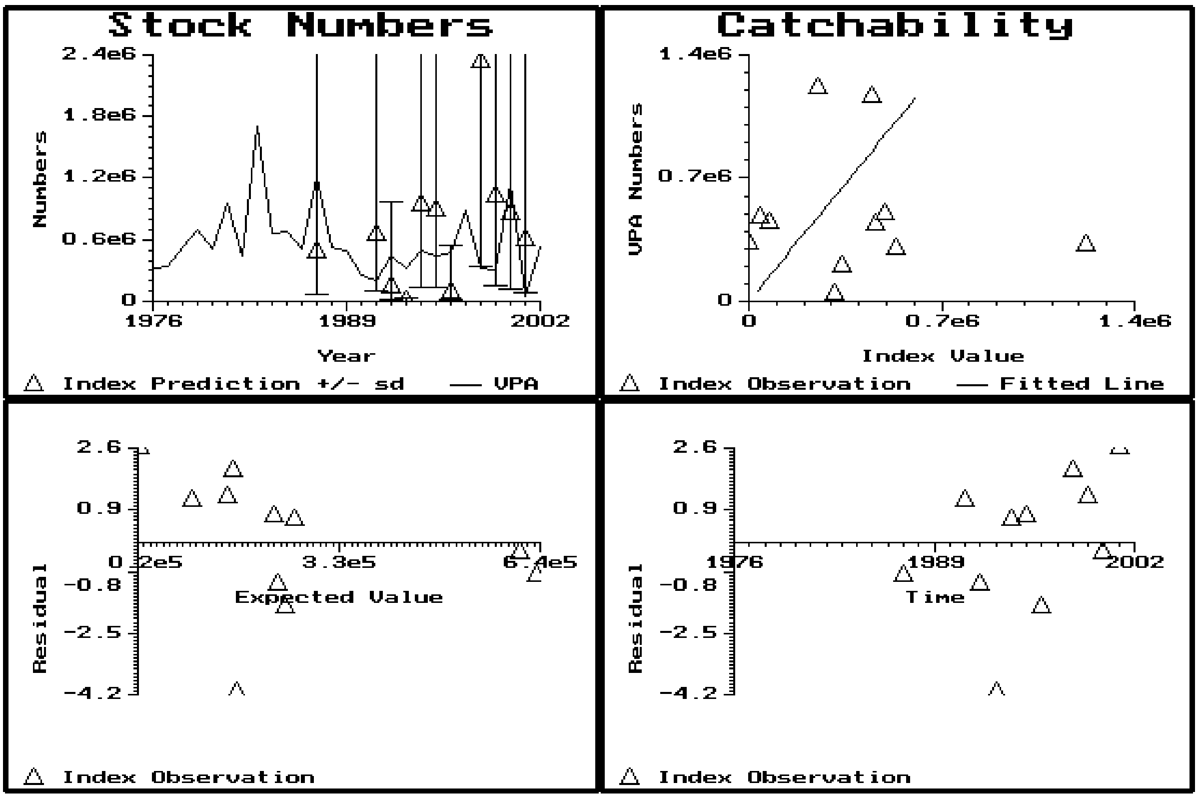


Figure 5.1.4. Herring in VIa(N). Illustration of residuals from deterministic calculation (6-year separable period). Diagnostics of the fit of the **age 1** index against **from acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 1 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time. N.B. 1 ringers are down-weighted in the catch and survey in the assessment.

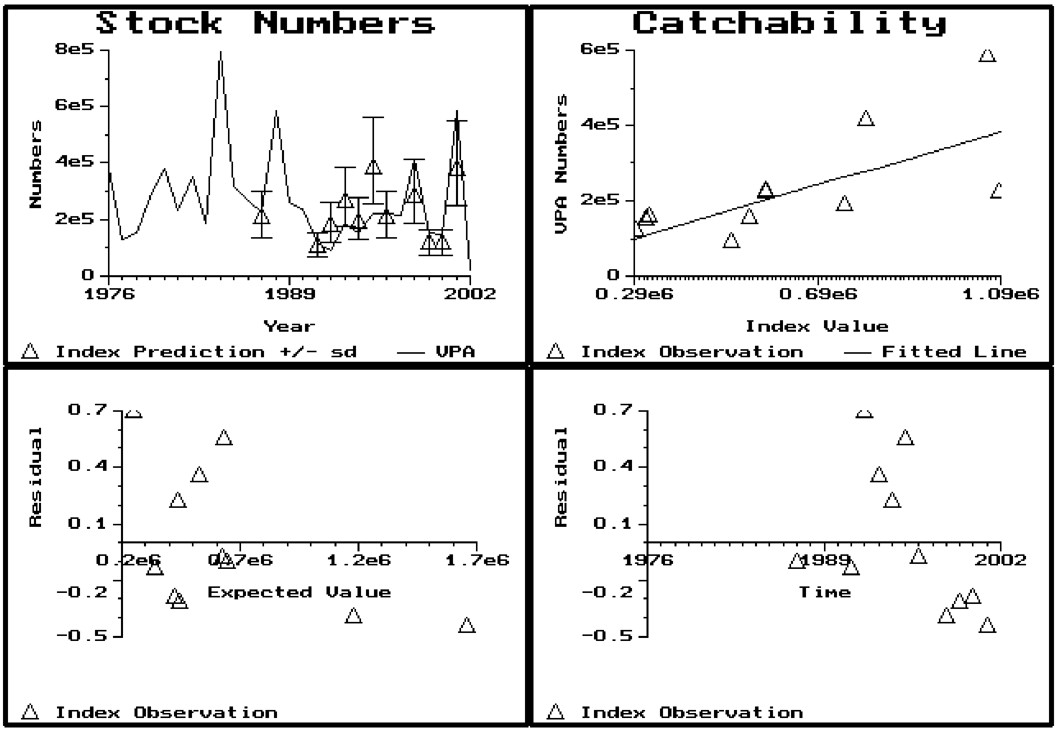


Figure 5.1.5. Herring in VIa(N). Illustration of residuals from deterministic calculation (6-year separable period). Diagnostics of the fit of the **age 2** index against **from acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 2 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

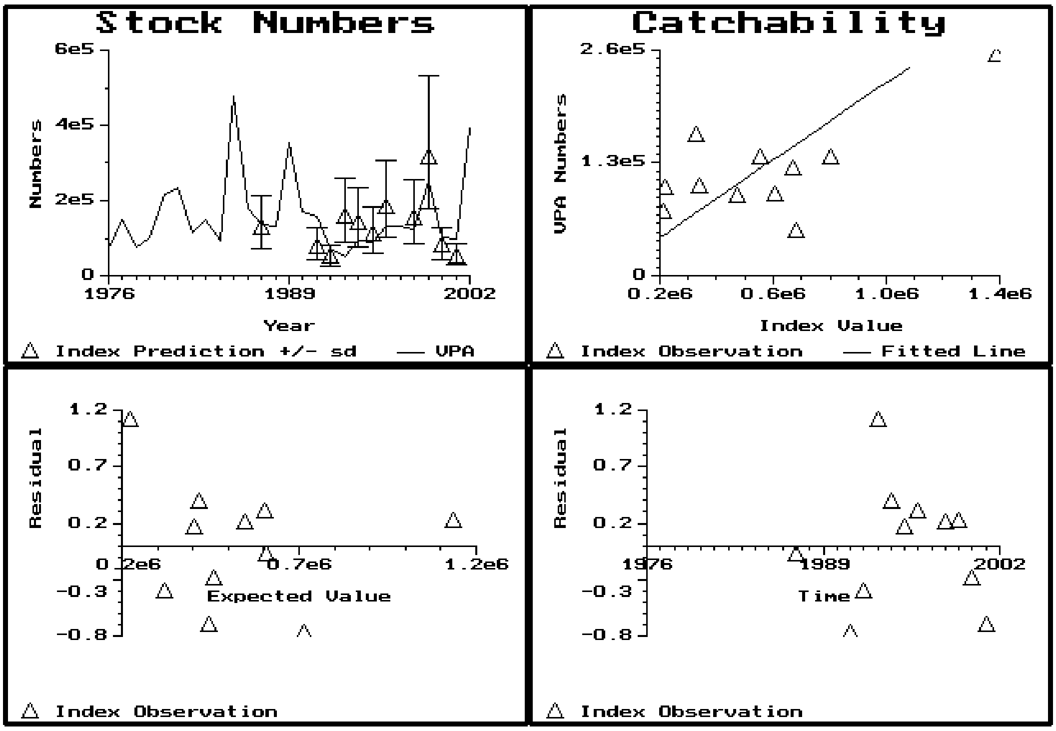


Figure 5.1.6. Herring in VIa(N). Illustration of residuals from deterministic calculation (6-year separable period). Diagnostics of the fit of the **age 3** index against **from acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 3 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

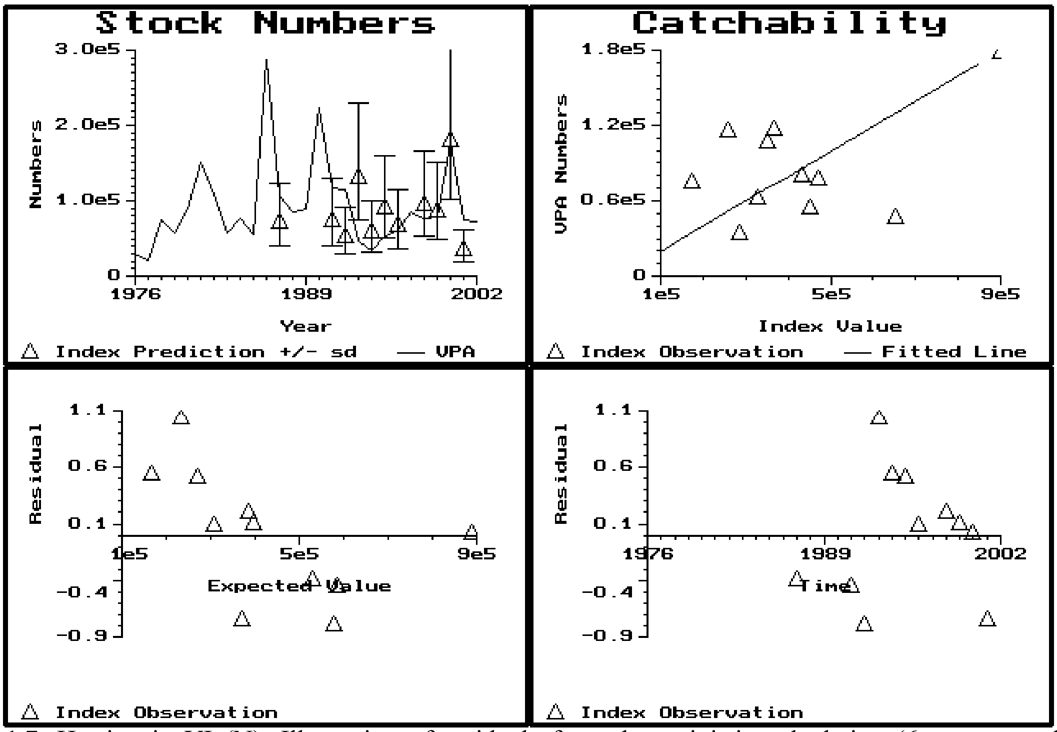


Figure 5.1.7. Herring in VIa(N). Illustration of residuals from deterministic calculation (6-year separable period). Diagnostics of the fit of the **age 4** index against **from acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 4 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

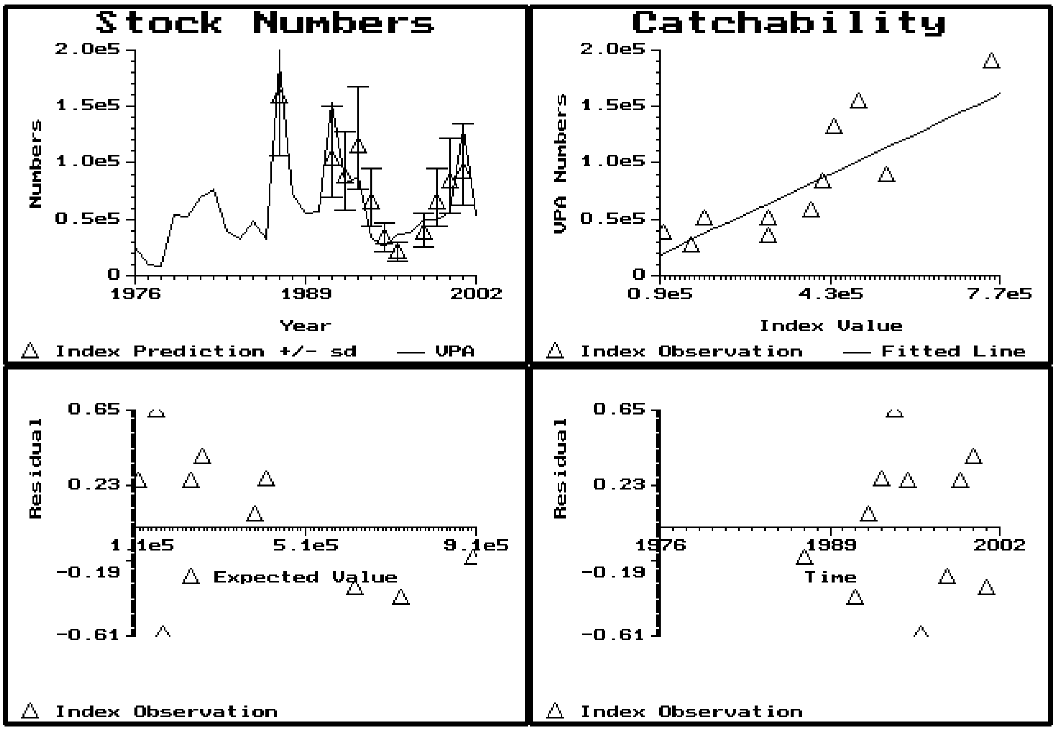


Figure 5.1.8. Herring in VIa(N). Illustration of residuals from deterministic calculation (6-year separable period). Diagnostics of the fit of the **age 5** index against **from acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 5 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

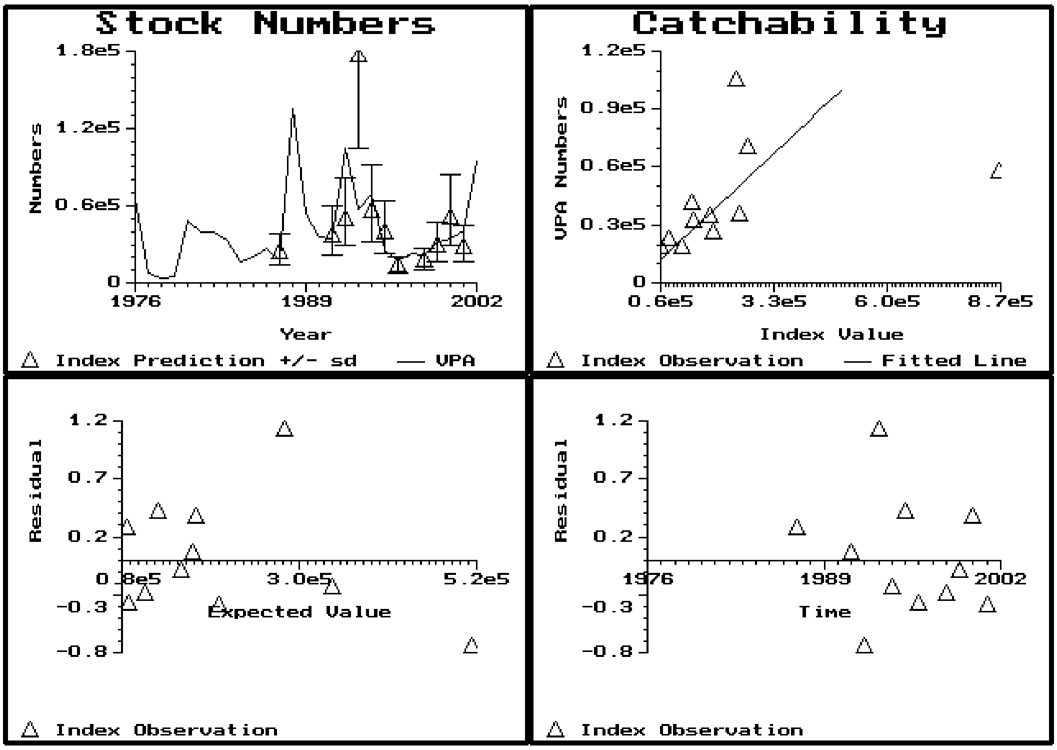


Figure 5.1.9. Herring in VIa(N). Illustration of residuals from deterministic calculation (6-year separable period). Diagnostics of the fit of the **age 6** index against **from acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 6 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

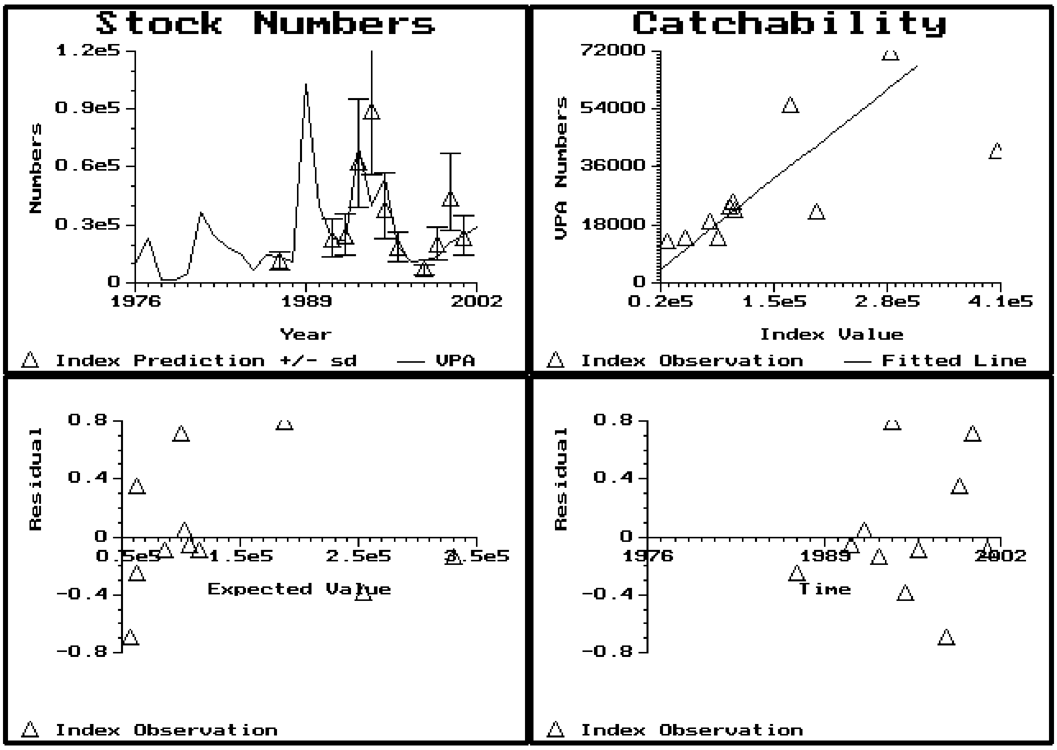


Figure 5.1.10. Herring in VIa(N). Illustration of residuals from deterministic calculation (6-year separable period). Diagnostics of the fit of the **age 7** index against **from acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 7 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

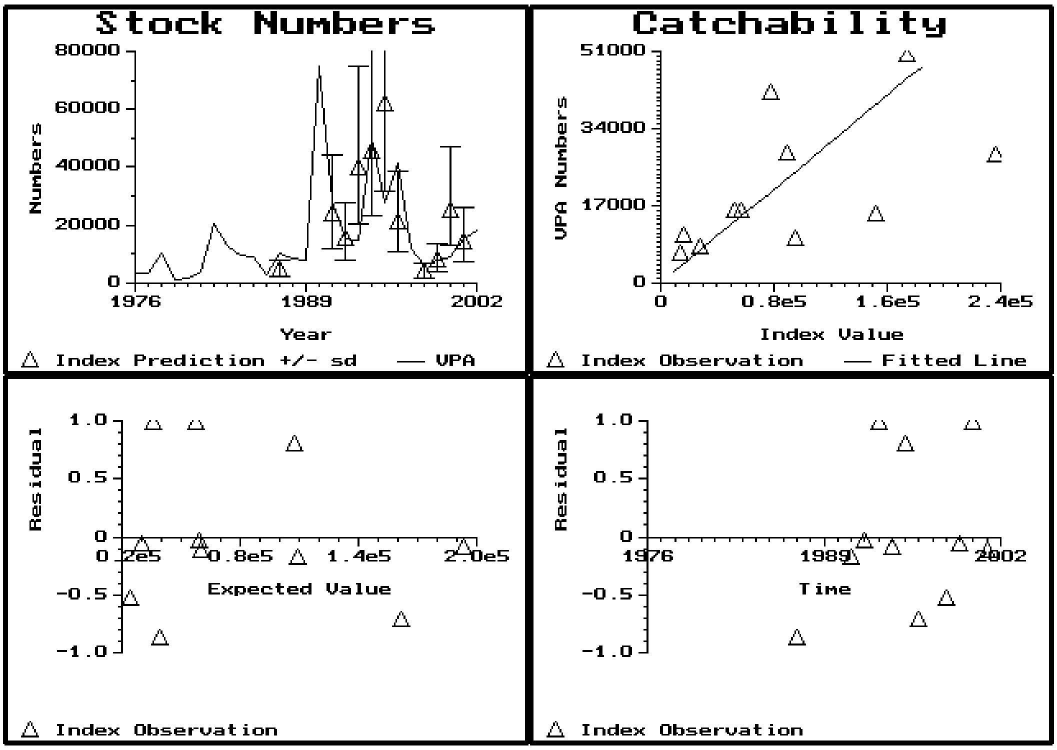


Figure 5.1.11. Herring in VIa(N). Illustration of residuals from deterministic calculation (6-year separable period). Diagnostics of the fit of the **age 8** index against **from acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 8 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

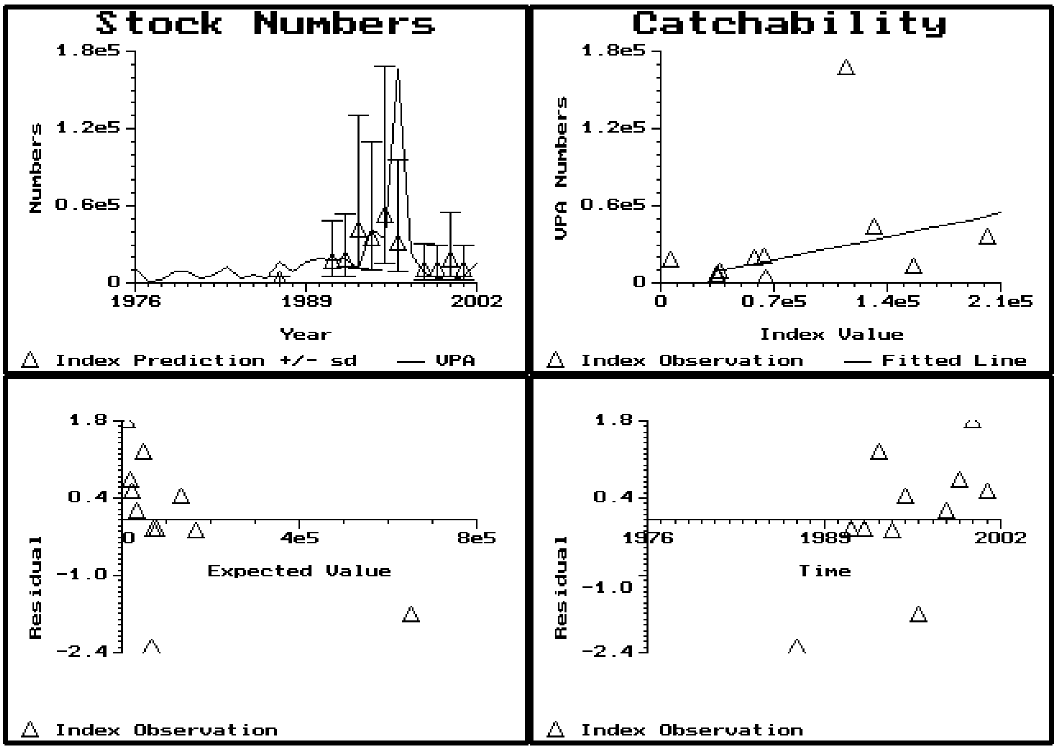


Figure 5.1.12. Herring in VIa(N). Illustration of residuals from deterministic calculation (6-year separable period). Diagnostics of the fit of the **age 9** index against **from acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 9 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

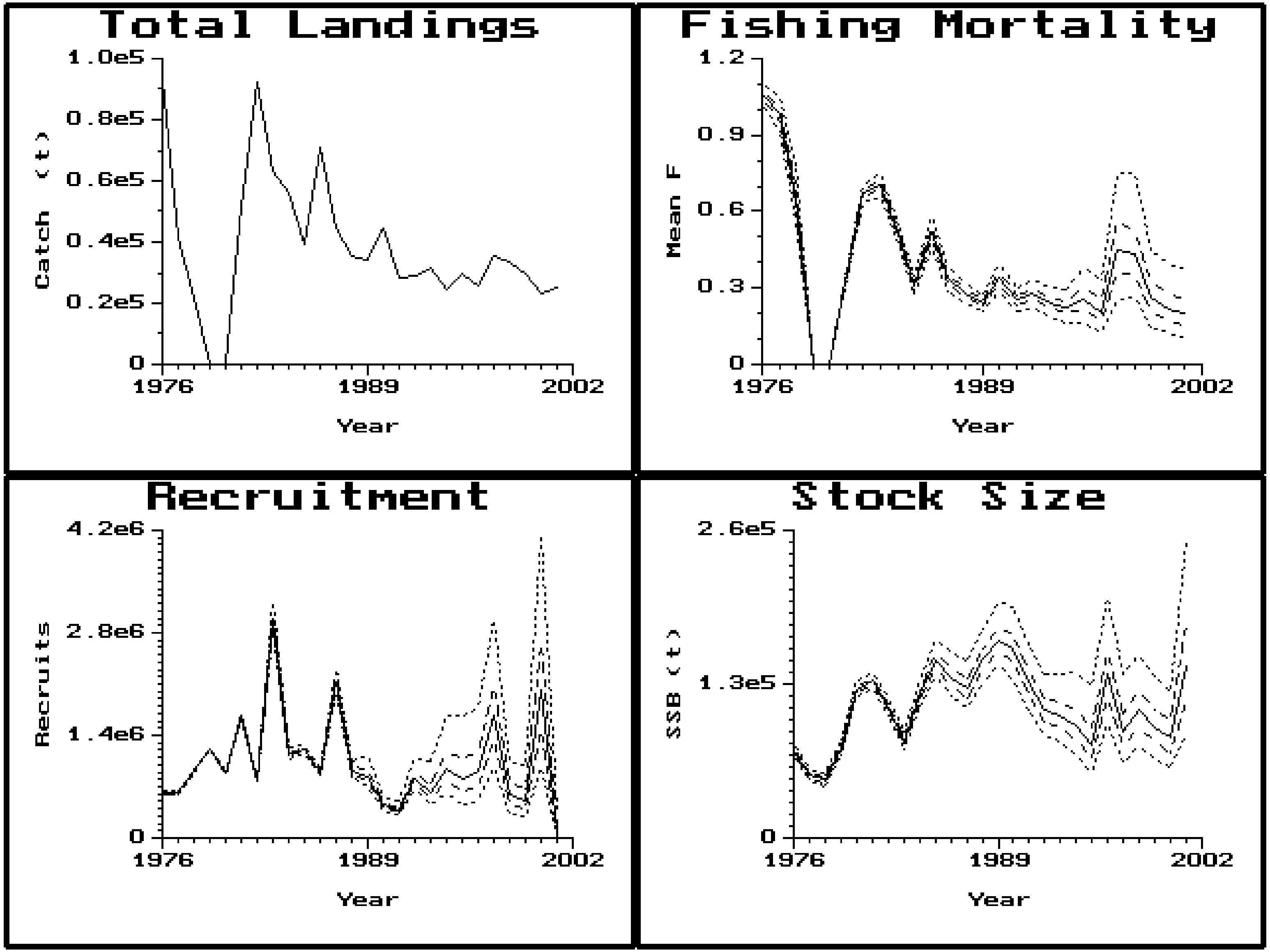


Figure 5.1.13. Herring in VIa(N). Trajectories of 5, 25, 50, 75 and 95 percentiles from the estimates of historical uncertainty of F, SSB and recruits produced in the final assessment. These were based on 1000 samples.

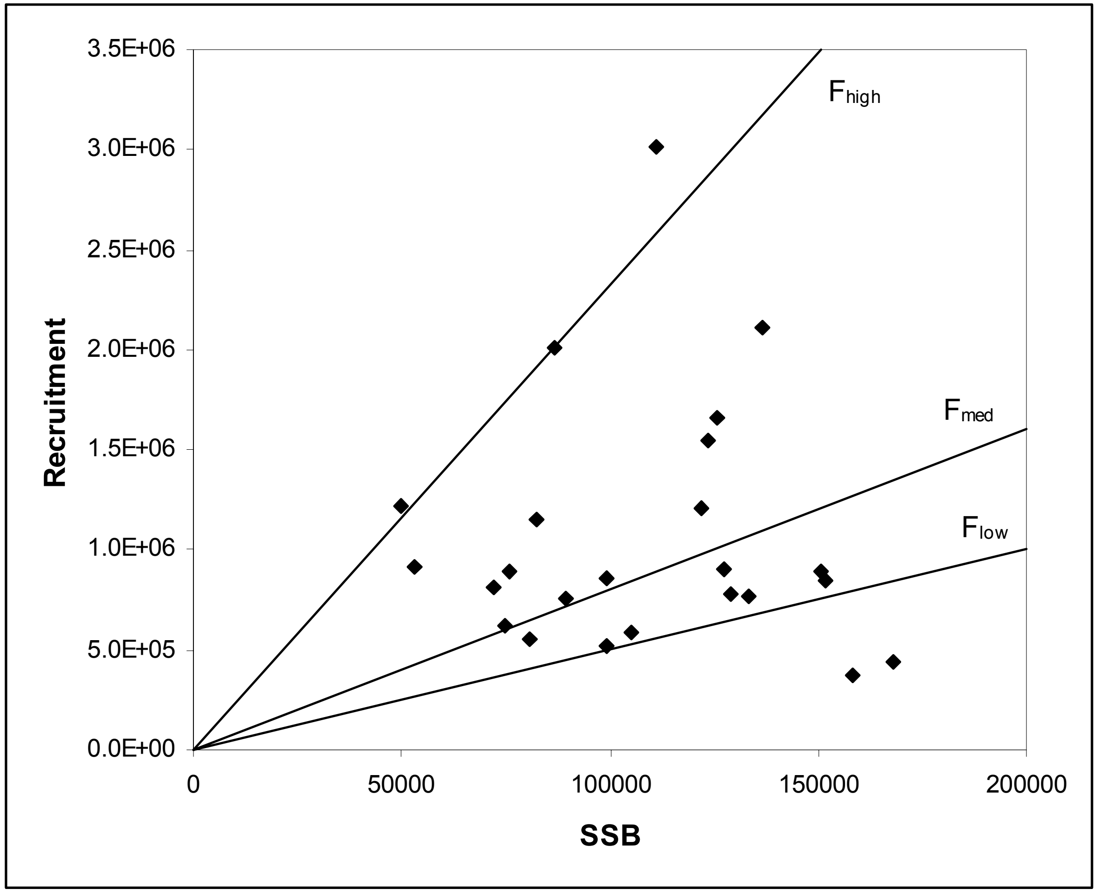
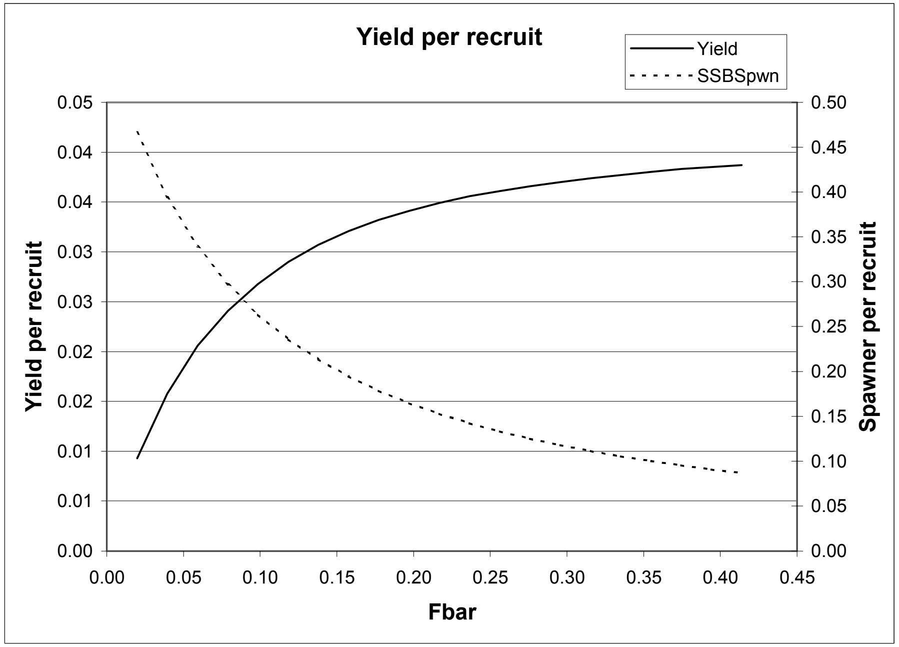
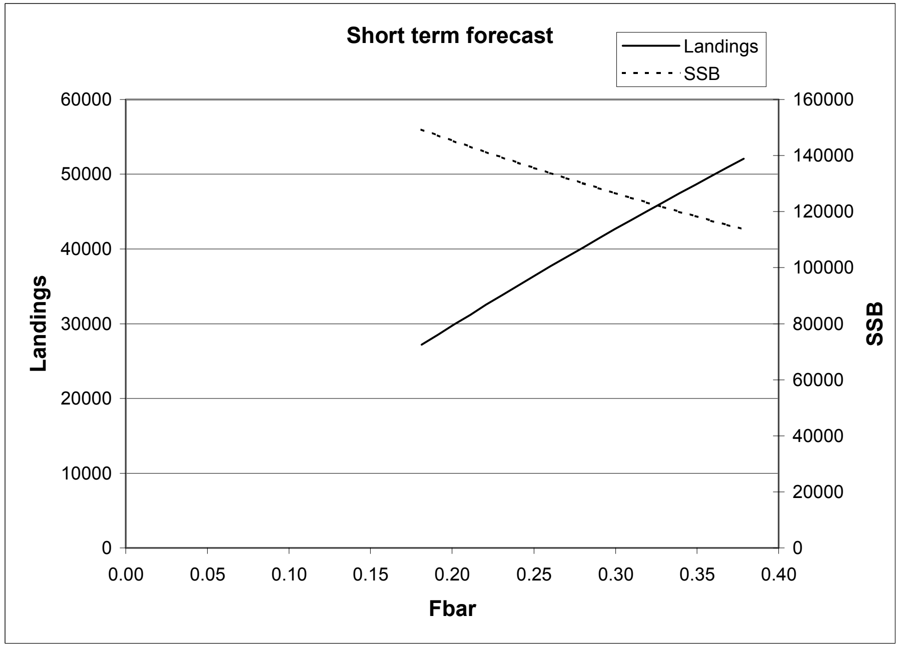


Figure 5.1.14. Herring in VIa(N). Stock-recruit relationship. (assessment years 1996 to 1999). $\mathbf{F}_{low}$ = 0.13 $\mathbf{F}_{med}$ =0.32, $\mathbf{F}_{high}$= 0.78





MFYPR version 1
Run: vian ypr1
Time and date: 18:38 16/03/2002

Reference point	F multiplier	Absolute F
Fbar(3-6)	1.0000	0.1972
FMax		
F0.1	0.8494	0.1675
F35%SPR	0.7767	0.1532
Flow	0.6561	0.1294
Fmed	1.6247	0.3204
Fhigh	3.9472	0.7784
FSPR(4)	0.3879	0.0765

Weights in kilograms

MFDP version 1a
Run: vian 3fpa
Herring VIa (north) (run: ICAPGF08/I08)
Time and date: 18:21 16/03/2002
Fbar age range: 3-6

Input units are thousands and kg - output in tonnes

Figure 5.1.15. 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 two years for autumn-spawning herring).

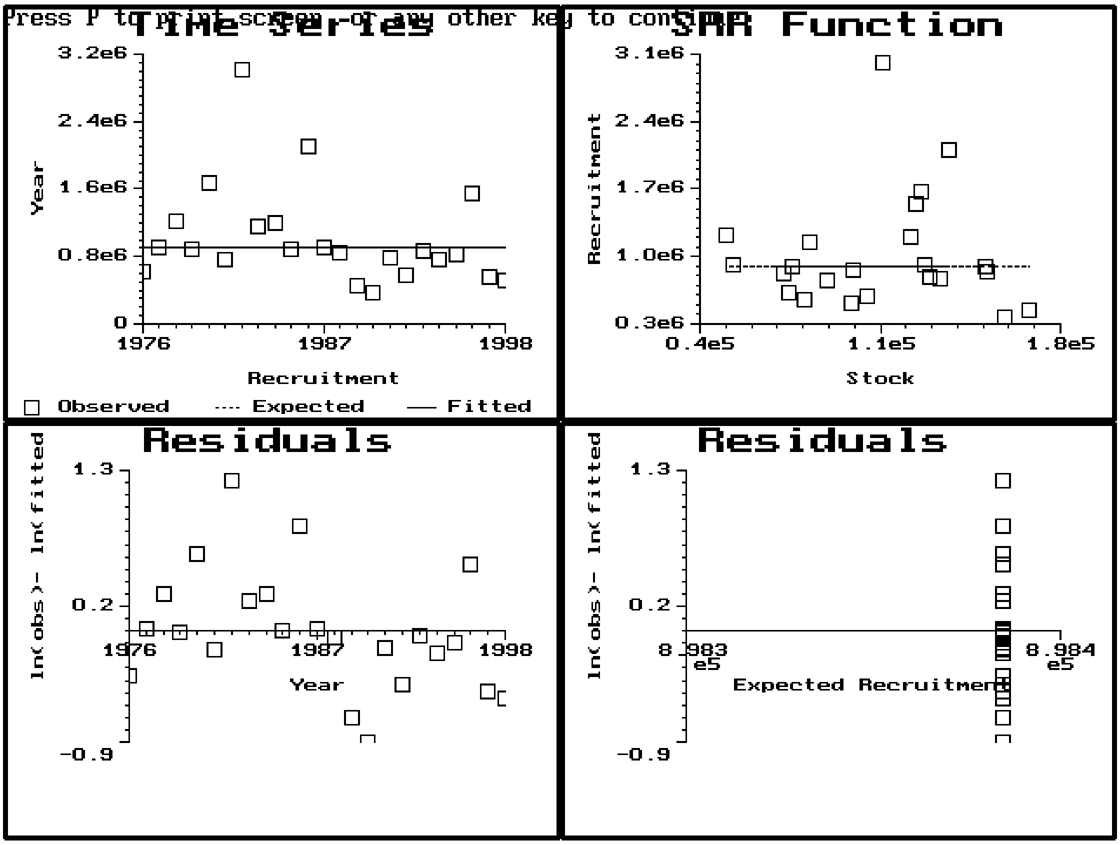


Figure 5.1.16. Herring in VIa(N). Stock-recruit data for input to medium-term projections.

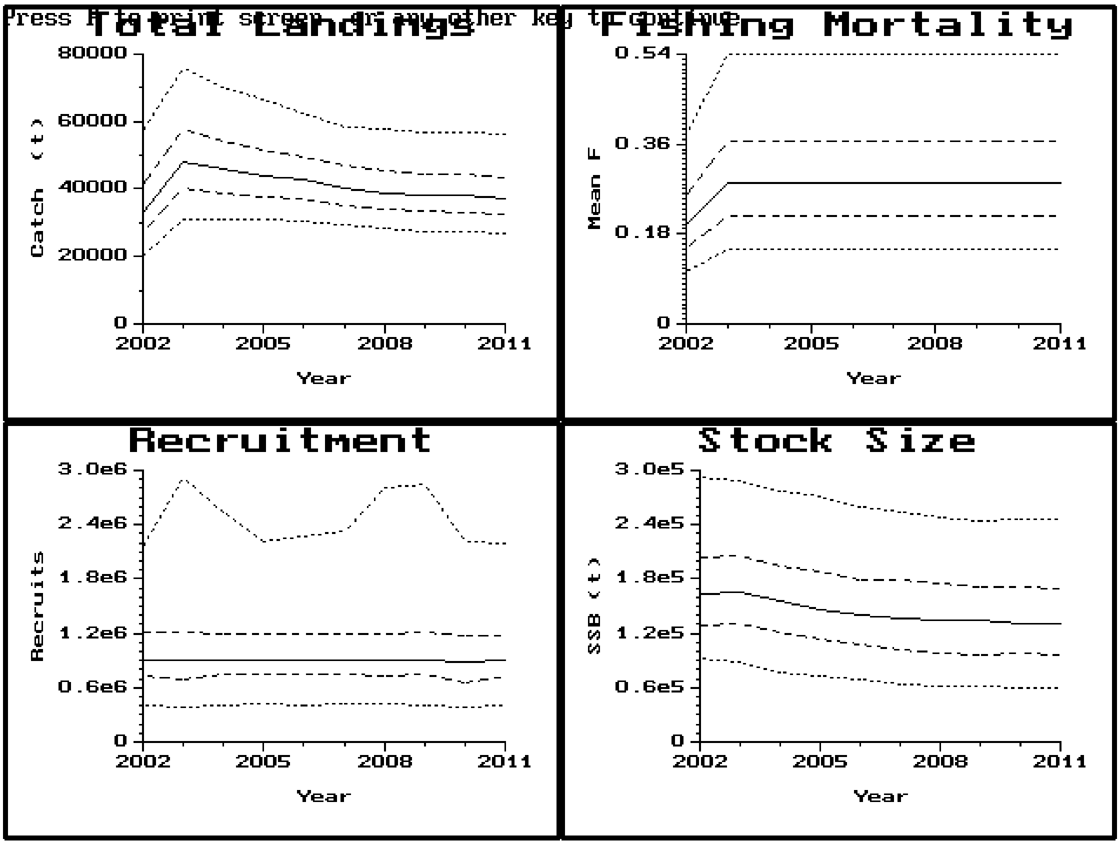


Figure 5.1.17. Herring in VIa(N). Medium-term projections with exploitation at *status quo* F in 2002 and F = proposed $\mathbf{F}_{pa}$ 2003-2011. The large 2 ringer year class seen in 2002 assessment gives an initial rise in stock which stabilises at about 130,000 tonnes.

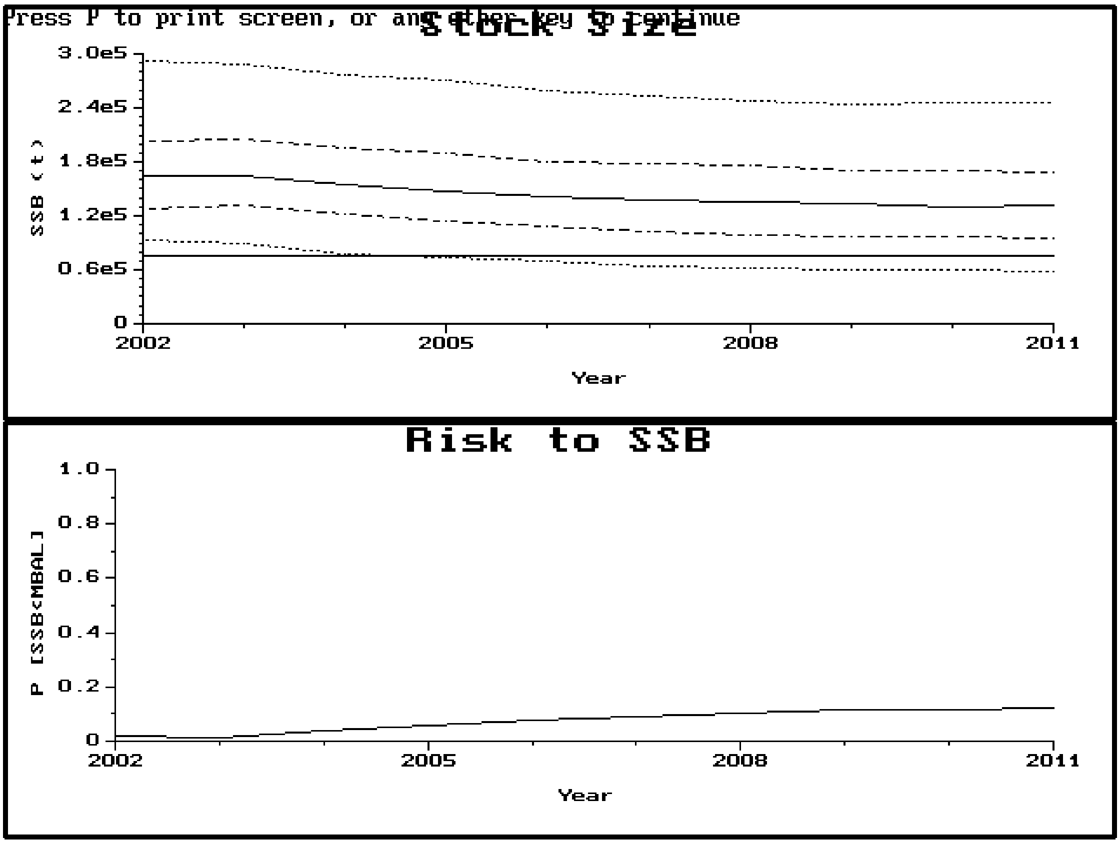


Figure 5.1.18. Herring in VIa(N). Medium-term and risk to SSB decreasing below proposed $\mathbf{B}_{pa}$ with exploitation at $\mathbf{F}_{pa}$.

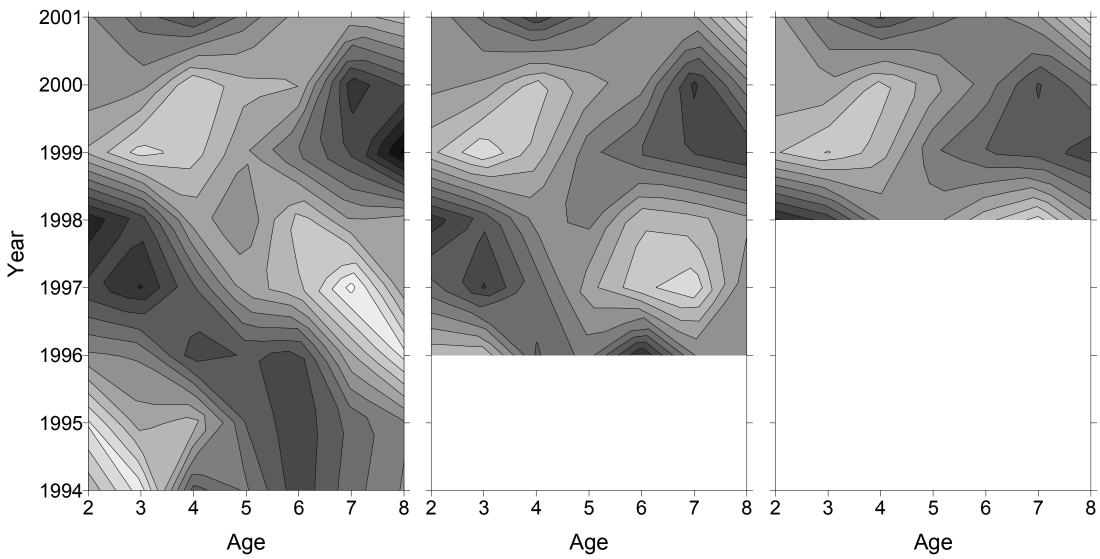


Figure 5.1.19. Herring in VIa(N). Residual plots for three assessments with separable periods of 8, 6 and 4 years respectively to show the consistency between the residual patterns in the overlapping periods.

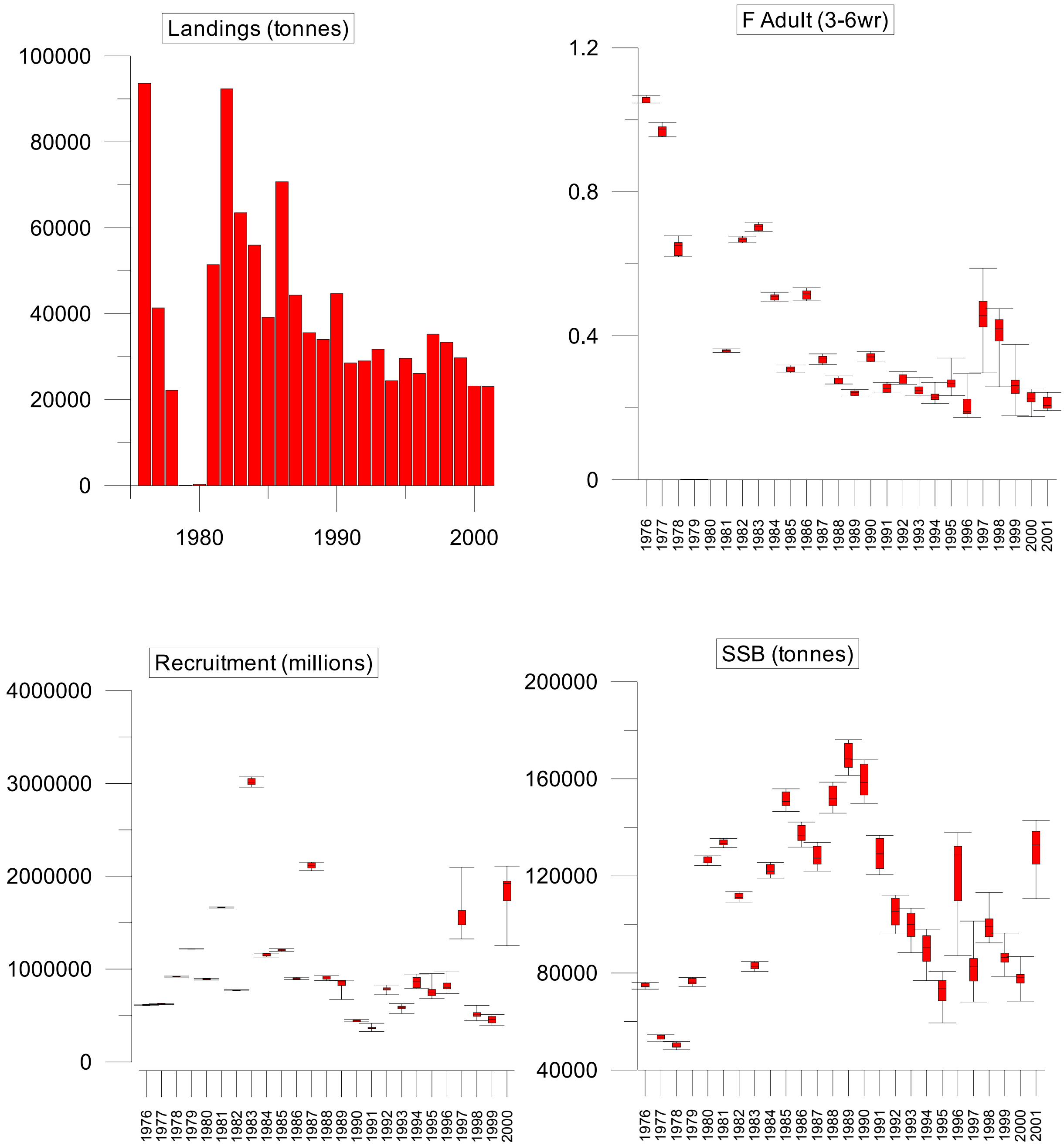
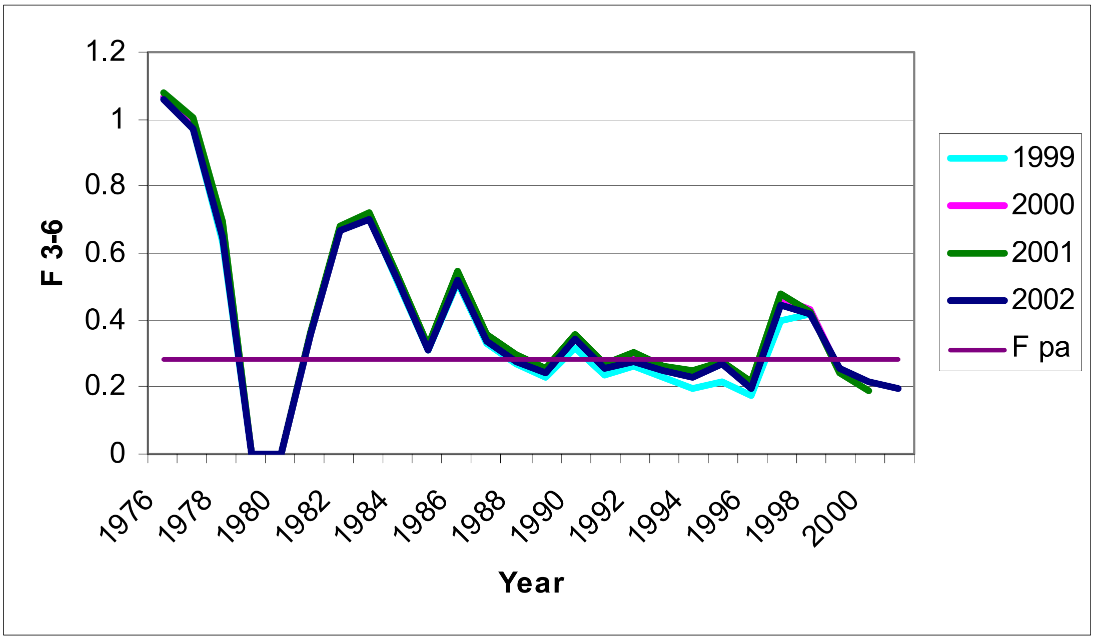


Figure 5.1.20. Herring in VIa (N). Sensitivity of the assessment to estimates of numbers-at-age in the catch. Historically catch-at-age in old ages or young ages has been uncertain due to poor sampling. Ages 1-4rings or 4-9+rings were set unknown in the 6 years of the separable period one group at a time (12 groups). The box and whisker plots show the range and quartiles in the 12 assessments. The F in 1997 and 1998 are shown to be particularly sensitive to availability of data but the 2002 assessment is relatively insensitive to availability of catch-at-age information.



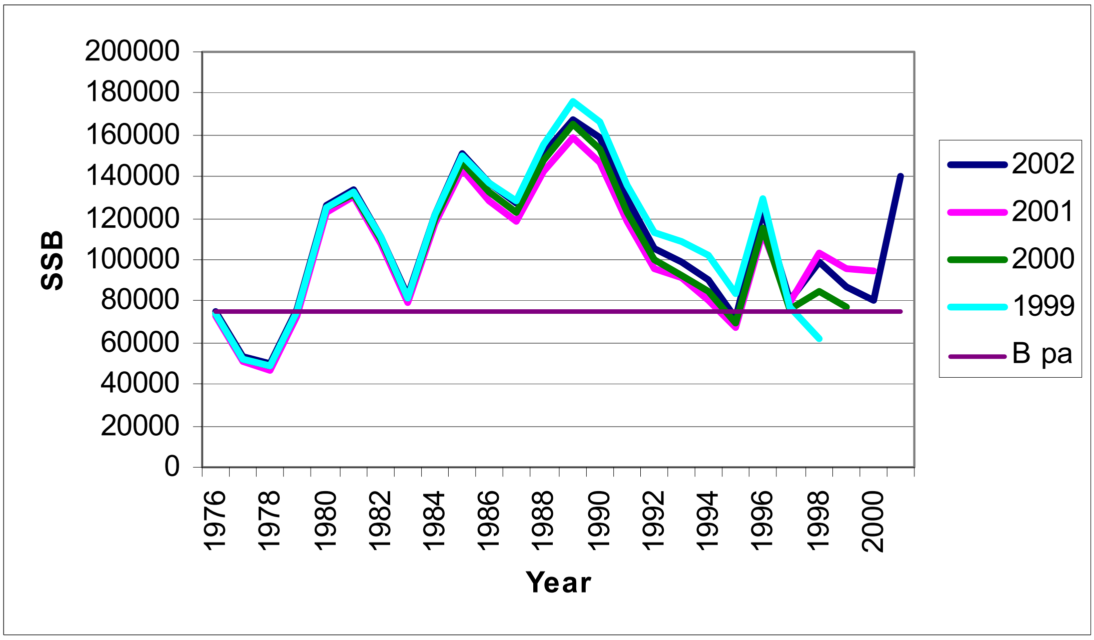


Figure 5.1.21. Herring in VIa (N). Retrospective analysis of the assessment 1999 to 2002. $F_{3\text{-}6}$ and SSB from ICA assessment with 6-year separable period for assessments in 2000 to 2002 and 5 years in 1999, excluding catch in 1993 which appears to have a different selection pattern from later years. Suggested $\mathbf{F}_{pa}$ and $\mathbf{B}_{pa}$ are included on the graphs.

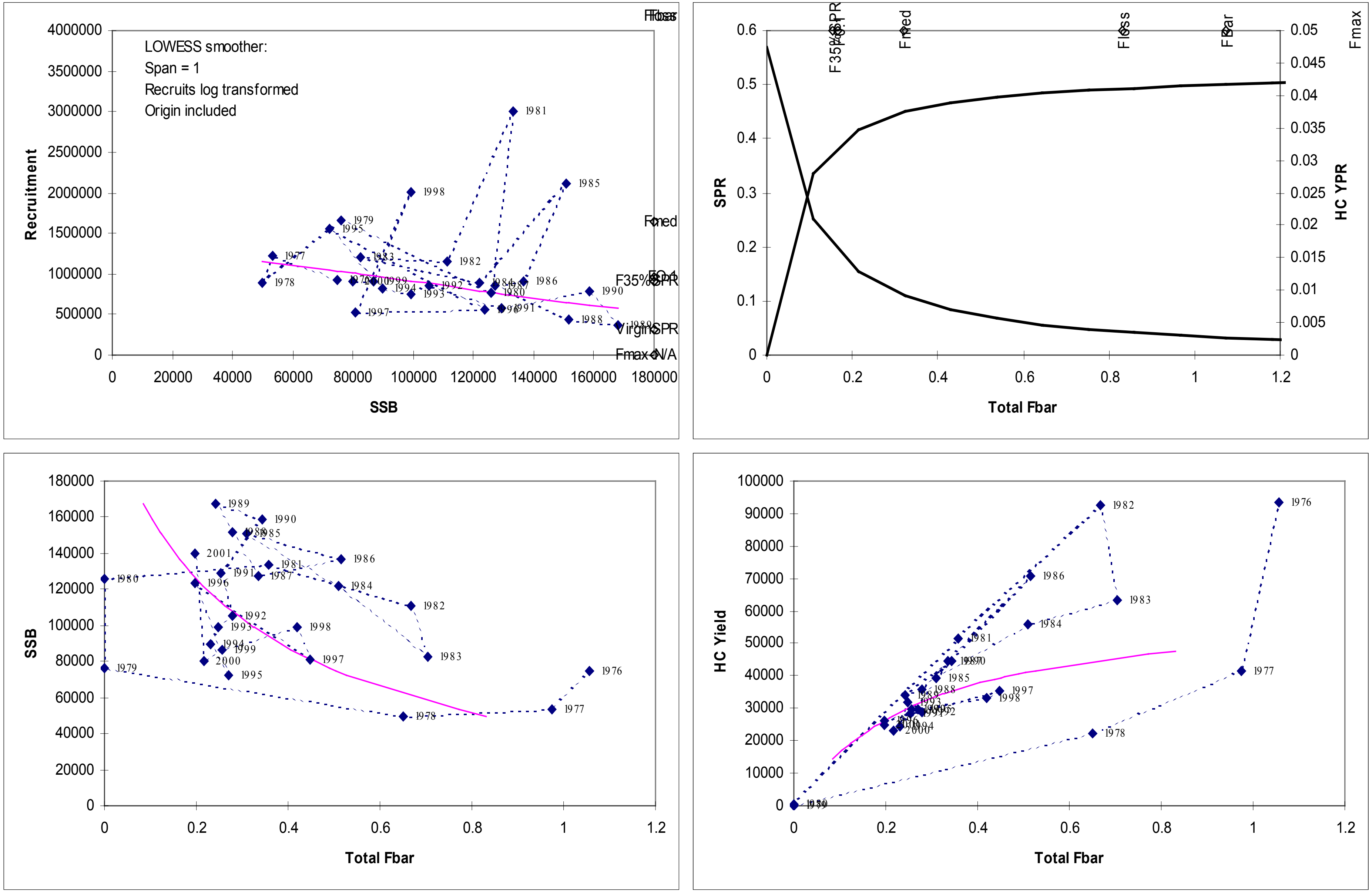


Figure 5.1.22. Herring in VIa (N). PA plots for the assessment period 1976-2001: Recruitment versus SSB, S/R versus Fbar, SSB versus Fbar and Yield / Fbar.

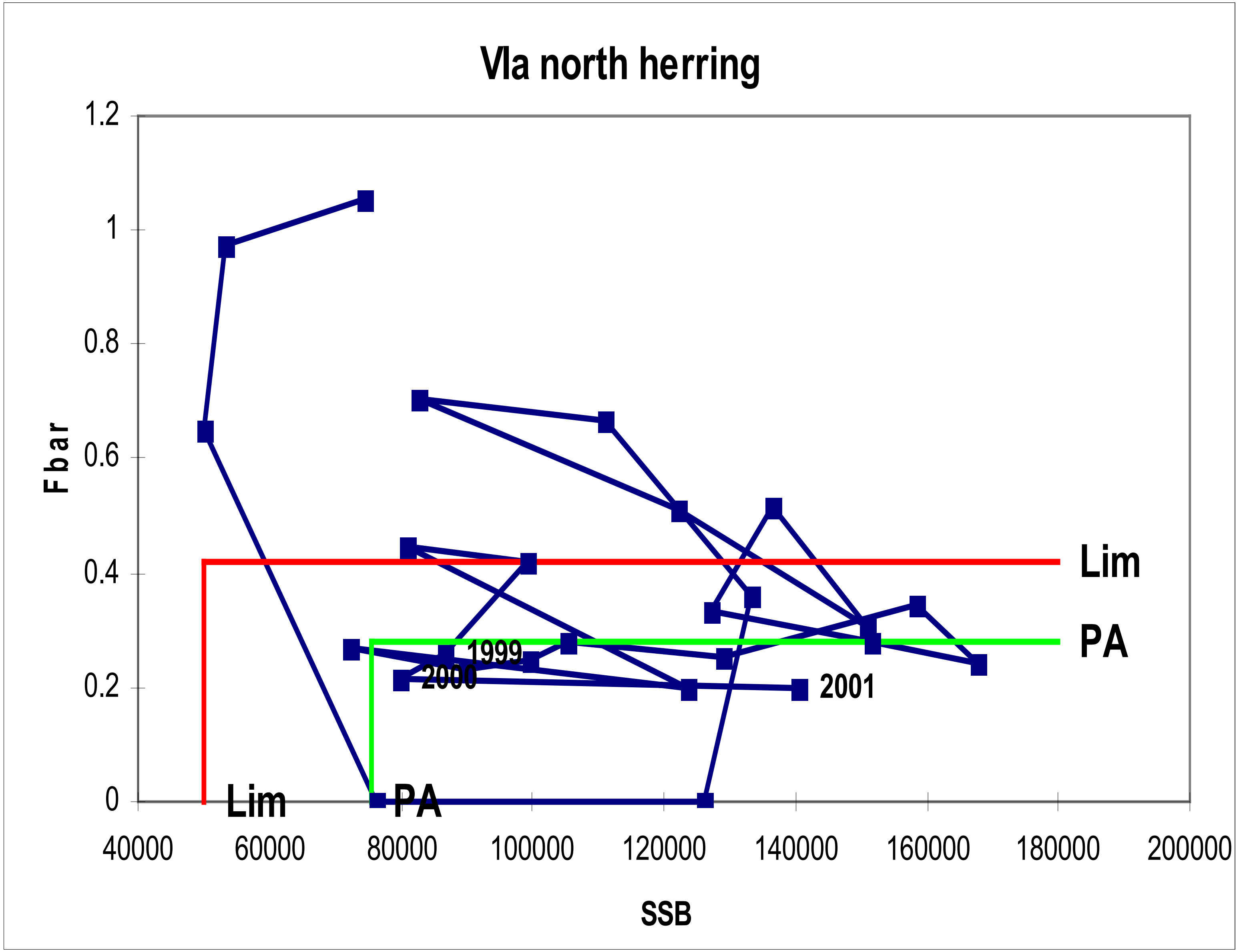


Figure 5.1.23. Herring in VIa (N). Mean $F_{3\text{-}6}$ against SSB for the period 1976 to 2001 with proposed Lim and Pa reference points.

6 HERRING IN DIVISIONS VIA (SOUTH) AND VIIB,C

6.1 The Fishery

6.1.1 Advice and management applicable to 2001 and 2002

The TAC for this area for 2001 was 13,900 t. This was the same TAC as in the previous year. The TAC in 1999 was reduced to 21,000t from the previous "precautionary" TAC of 28,000 t, which was based on the historical catches.

In 2001 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 plan were in place. ACFM therefore advised that the catches in 2001 should not exceed 14,000t. The TAC set by the EU for 2002 was again 13,900 t.

6.1.2 Catch data

The main landings from this fishery in 2001 are given in Table 6.1.1. Fleet-based estimates have shown that misreporting has decreased significantly in recent years and is now well below 1,000t. The total catch recorded for 2001, was about 14,000 t, which is a decrease of almost 1,000 t on the total for 2000.

The total amount of unallocated catches in 2001 was about 700 t, compared with 3,600 t in 2000 and almost 8,000t in 1999. The overshoot of the TAC was negligible.

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 1988–2001 are shown in Table 6.1.1 and the total catches from 1970 to 2000 are shown in Figure 6.1.1. There were no estimates of discards reported for 2001 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 2001

The number of Irish vessels that participated in the fishery was the same as in recent years. 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. During 2001 the Irish fishery was again divided into two periods with no directed fishing taking place from February to September. After scientific advice on the state of the stock, the Irish directed fishery was closed early in February 2001 by the Irish Northwest Pelagic Management Committee.

A map of the locations mentioned in the text is given in Figure 6.1.3.1.

6.1.4 Catch in numbers-at-age

The catches-at-age for this fishery since 1970 are shown in Table 6.1.2. In recent years the catches in numbers-at-age have been derived mainly from Irish sampling data. The age distributions in the catch were different to last year with proportionally more 5 & 6 ringers in the catches than in recent years.

6.1.5 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 6.1.3. The length distributions of the catches taken per quarter by the Irish fleet are shown in Table 6.1.4. Sampling of catches throughout 2001 was maintained at a satisfactory level, although no samples were obtained from very small bycatches in the 2^{nd} & 3^{rd} quarter.

6.2 Mean Weights-at-age

The mean weights (kg) at age in the catches in 2001 are based on Irish & Dutch samples taken throughout the year and are lighter than 2000 for 1 to 3 ringers (Table 6.2.1).

The mean weights in the stock at spawning time have been calculated from Irish samples taken during the main spawning period that extends from October to February (Table 6.2.2). For 1-3 ringers these fish are also lighter than in 2000.

6.3 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.

6.4 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 in 1999 and annually since. Details of these surveys are given in Molloy and Kelly WD 2000.

In November 2001 an acoustic survey was carried out in Divisions VIa(S) and VIIbc. This survey had fewer problems with gear and area coverage than in previous years. However, it still failed to produce a realistic estimate of SSB. The survey track and post plots from this survey are shown in Figure 6.4.1a,b. It can be seen from this that a high proportion of the marks attributed to herring were at the northern limit of the survey. However, a large proportion of these fish was juvenile and did not contribute to the SSB estimate. In addition, the survey failed to detect significant shoals of herring, which provided the basis of the fishery in Q4 2001. These shoals appeared north of Lough Swilly the week after the survey had covered this area. In order to provide a more accurate estimate of spring-spawning herring a further survey was carried out in March 2002, However, the results of this survey will not be available to the HAWG until 2003.

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 the absence of a second survey to estimate the biomass of the spring-spawning component of this stock, the current survey should not be used as an index of total stock size. Therefore the results of this survey are inconclusive.

6.5 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.

In an effort to provide some objectivity to the selection of terminal F the 2001 Working Group carried out some preliminary modelling with ISVPA. This 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:

*phi(a,y) = C(a,y)/(N(a,y)*exp(-M(a,y)/2)*

and regards phi as separable:

*phi(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 is 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).

6.5.1 Date exploration & preliminary assessments

Given the continuing absence of an acoustic index, the ISVPA model was again used this year to provide some objectivity in the selection of terminal F. Since this model relies strongly on the separable hypothesis some exploratory runs were compared which varied the period of the separable constraint. Comparisons of the objective function profiles are shown in Figure 6.5.1.1. Initial runs showed that the data was sensitive to the choice of minimisation function. Last year the minimisation function used was *median (residuals)*^{2} where the residual is given by *(lnC-lnCest)*. However, this year the model was unstable with this function and several local minima were found. In order to overcome this problem a more robust minimisation function of *abs [residual-median residual]* was used. Using this minimisation function the model proved very stable to the separable period and the age groups used in the analysis. The text table below shows the value of G(y) at the minimum and corresponding Fbar (3-6) in the final year for the different runs:

Separable period	Age range used	G(y) at the minimum Instantaneous mortality rate parameter	Fbar(3-6) in 2001
31 years (entire data series)	1-9	1.174	0.142
8 years	2-9	1.161	0.181
6 years	2-9	1.224	0.167
5 years	2-9	1.05	0.145

Plots of the minimisation profiles and the selection pattern of these runs are shown in Figure 6.5.1.1 and 6.5.1.2. Mortality (phi) and catch residuals from runs at either extreme of the separable period are given in Figures 6.5.1.3 and 6.5.1.4. There are some strong year-class effects in the residual patterns, which are particularly evident when the longer time period is used. This type of pattern suggests that the fleet is targeting particular year classes over time, and that is not surprising. However, when trying to estimate selectivity for 8 or 9 ages with no auxiliary information it is a better practice to use a longer time period. Even though the selectivity of the fishery may have changed over time, these changes are not as great as the influence of errors in the data when a shorter period is used (D. Vasilyev pers com). Figure 6.5.1.5 shows the F trajectory from several runs. A comparison with an SVPA run using a terminal $F_{3\text{-}6}$ of 0.2 is also shown. The ISVPA runs produce estimates of $F_{3\text{-}6}$ in the final year of 0.14 to 0.18. In an effort to remain consistent with previous years it was decided to produce a run using a traditional separable VPA model assuming a $F_{3\text{-}6}$ in 2001 rounded up to 0.2. This was considered to be consistent with a conservative approach, given the uncertainty about the state of this stock.

6.5.2 Results of the assessment

As an example of the current development of the stock, the Working Group carried out a separable VPA using a terminal F value of 0.2. 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. The assessment output is given in Tables 6.5.2.1 and 6.5.2.2.

The general development of the stock is similar in the past 3 assessments (Figure 6.5.2.1.). This development shows a spawning stock which has declined from 1988 to 1996 and which now appears to have increased and may still be increasing. The SSB may be currently around 90,000 t. 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 to a level, which is amongst the lowest in the time-

[*] in the original document the nomenclature *phi(a,y)=f(y)*s(a)* is used, but changed here to G(y)avoid confusion with fishing mortality F.

series in 2001. Recruitment patterns show two very strong year classes, those of 1981 and 1985, and recruitment in recent years is similar to that early in the time-series (1970-1980).

6.5.3 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 2002 as a catch constraint is provided. Tables for the inputs and single option and management options are given in Tables 6.5.3.1, 6.5.3.2.and 6.5.3.3 respectively.

6.6 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.

6.7 Management Considerations

The results of the non-tuned assessment suggest that the spawning stock, which had declined considerably in recent years may now be beginning to showing signs of recovery. Even though it appears that no large year classes have recruited to the stock in recent years, F now appears to be at a relatively low level and similar to that in the early part of the time-series. 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. For the first time in 2002 an acoustic survey in the Spring has been carried out and it is hoped that it will be possible to present a more precise assessment on this stock in the future. An index of recruitment could be made available as soon as the ground fish surveys carried out by Ireland have been properly evaluated. 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 quota are applied. The Irish fishery was closed in early in February 2002 by the Irish Northwest Pelagic Management Committee (NWPMC), on scientific advice. 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 base 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*".

Precautionary 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 1999 WG showed that recruitment does not show any clear dependence on the SSB that apart from the very high 1985 year class has been quite stable, but at a much lower level. The suggested $\mathbf{F}_{\mathrm{loss}}$ value is about 0.33 and the $\mathbf{F}_{\mathrm{pa}}$ may be about 0.22. The present analysis, although it is uncertain, presents a similar picture of the stock as that shown in recent years. The stock may be still below $\mathbf{B}_{\mathrm{pa}}$ (110,000 t); however, the fishing mortality has been reduced and may now be as low as in the early part of the time-series.

6.8 Medium-Term Projections and Management Considerations

It has not been possible to carry out medium-term projections for this stock because of the absence of information. 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.

Table 6.1.1. VIa(S) & VIIb,c. Estimated herring catches in tonnes, 1988–2001. 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
France	-	-
Germany	-	-
Ireland	10,164	11,278
Netherlands	1,234	2,088
UK	-	-
Unallocated	3,607	695
Total landings	15,005	14,060
Discards	-	-
Total catch	15,005	14,060

Table 6.1.2 VIa(S) & VIIb,c herring. Catch in numbers-at-age (ringers) from 1970 to 2001

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

Table 6.1.3. Divisions VIa (S) and VIIb,c. Sampling intensity of herring catches in 2001.

Country	Q	Catch	No. of samples	No. of age readings	No. of fish measured	Aged per 1000 t.	Estimate of discards
Ireland	1	7,458	7	243	1,508	32	No
	2	14	0	0	0	0	No
	3	10	0	0	0	0	No
	4	4,467	26	590	7,053	132	No
Netherlands	3	2088	3	75	424	36	No

Table 6.1.4 VIa(S) and Division VIIb,c herring. Length distribution of Irish catches/quarter (thousands) 2001.

	VIIb		VIaS	
Length	**Q1 2001**	**Q4 2001**	**Q1 2001**	**Q4 2001**
19.0				43
19.5		6		55
20.0		12		123
20.5		6	84	295
21.0		41	126	560
21.5		70	168	640
22.0		146	462	831
22.5		58	378	658
23.0		116	504	1132
23.5		204	378	1551
24.0	10	373	925	3145
24.5	14	361	1345	3243
25.0	34	378	3741	3342
25.5	51	320	4329	2259
26.0	99	378	5296	2142
26.5	89	553	5338	1908
27.0	136	937	7317	1939
27.5	174	1042	6305	1895
28.0	174	961	5464	2086
28.5	85	722	2816	1428
29.0	48	338	2354	862
29.5	27	134	1051	332
30.0	20	58	294	142
30.5	0	12	504	31
31.0	10		462	43
31.5	7		420	0
32.0	7		715	6
32.5	0		210	
33.0	3		168	
33.5			0	
34.0			0	
34.5			0	
35.0			42	
Totals:	990	7225	51197	30691

Table 6.2.1 VIa(S) & VIIb,c herring. Mean weight-at-age in the catch.

	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	0.086	0.122	0.139	0.167	0.183	0.188	0.222	0.222	0.213

Table 6.2.2 Mean weight in the stock for herring in VIaS and VIIb,c.

	1	2	3	4	5	6	7	8	9
1970	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1971	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1972	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1973	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1974	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1975	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1976	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1977	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1978	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1979	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1980	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1981	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1982	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1983	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1984	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1985	0.100	0.150	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	0.280	0.287	0.312
1987	0.097	0.164	0.206	0.233	0.252	0.271	0.280	0.296	0.317
1988	0.097	0.164	0.206	0.233	0.252	0.271	0.280	0.296	0.317
1989	0.138	0.157	0.168	0.182	0.200	0.217	0.227	0.238	0.245
1990	0.113	0.152	0.170	0.180	0.200	0.217	0.225	0.233	0.255
1991	0.102	0.149	0.174	0.190	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	0.220	0.223	0.242	0.258
1994	0.098	0.156	0.192	0.209	0.216	0.223	0.226	0.230	0.247
1995	0.090	0.144	0.181	0.203	0.217	0.226	0.227	0.239	0.246
1996	0.086	0.137	0.186	0.206	0.219	0.234	0.233	0.249	0.253
1997	0.094	0.135	0.169	0.194	0.210	0.224	0.231	0.230	0.239
1998	0.095	0.136	0.145	0.173	0.191	0.196	0.202	0.222	0.217
1999	0.104	0.145	0.154	0.174	0.200	0.222	0.230	0.240	0.246
2000	0.100	0.134	0.157	0.177	0.197	0.207	0.217	0.230	0.245
2001	0.091	0.125	0.150	0.172	0.191	0.200	0.203	0.203	0.216

Table 6.5.2.1. VIa(S) and Division VIIb,c herring. Outputs from the separable VPA with F2001=0.2.

Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

At 19/03/2002 23:34

Table 8 Fishing mortality (F) at age

YEAR,	1970,	1971,
AGE		
1,	.0005,	.0017,
2,	.3842,	.0494,
3,	.2439,	.1298,
4,	.1796,	.1444,
5,	.1712,	.1566,
6,	.1512,	.2339,
7,	.2006,	.2009,
8,	.2328,	.2085,
+gp,	.2328,	.2085,
0 FBAR 3- 6,	.1865,	.1662,

Table 8 Fishing mortality (F) at age

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
1,	.0022,	.0194,	.0092,	.0291,	.0393,	.0125,	.0155,	.0097,	.0087,	.0039,
2,	.1178,	.1906,	.1952,	.2522,	.2620,	.2396,	.2521,	.1656,	.1409,	.1452,
3,	.2434,	.3069,	.3214,	.2705,	.4080,	.1967,	.2387,	.1935,	.3568,	.2271,
4,	.1531,	.3060,	.4999,	.3766,	.4813,	.3140,	.2896,	.2636,	.3941,	.2777,
5,	.1939,	.2475,	.5415,	.4803,	.5755,	.3776,	.2925,	.3021,	.4601,	.3178,
6,	.2400,	.3044,	.4625,	.6456,	.5634,	.4118,	.2519,	.3508,	.3899,	.4651,
7,	.3760,	.3199,	.4245,	.5656,	.6689,	.3696,	.2778,	.3876,	.4822,	.2687,
8,	.3366,	.2670,	.6244,	.6964,	.7150,	.3223,	.3927,	.4557,	.5397,	.3147,
+gp,	.3366,	.2670,	.6244,	.6964,	.7150,	.3223,	.3927,	.4557,	.5397,	.3147,
0 FBAR 3- 6,	.2076,	.2912,	.4563,	.4432,	.5070,	.3250,	.2682,	.2775,	.4002,	.3219,

1

Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

At 19/03/2002 23:34

Table 8 Fishing mortality (F) at age

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	.0017,	.0011,	.0048,	.0126,	.0016,	.0061,	.0000,	.0047,	.0018,	.0021,
2,	.0897,	.2205,	.1195,	.0529,	.0739,	.1614,	.0294,	.0468,	.1098,	.1470,
3,	.1668,	.3978,	.2340,	.1452,	.1217,	.3438,	.2695,	.1096,	.1905,	.1818,
4,	.2239,	.3774,	.2305,	.1472,	.1975,	.2898,	.2808,	.2278,	.3004,	.1693,
5,	.2303,	.3739,	.1557,	.1989,	.2244,	.4463,	.2349,	.2080,	.3056,	.2956,
6,	.3040,	.3376,	.2264,	.2202,	.1898,	.3409,	.3376,	.2081,	.2741,	.3432,
7,	.2361,	.3907,	.1566,	.2244,	.2270,	.4536,	.2294,	.2773,	.3253,	.2968,
8,	.3849,	.2739,	.1729,	.2714,	.1793,	.3572,	.1334,	.1898,	.1235,	.3489,
+gp,	.3849,	.2739,	.1729,	.2714,	.1793,	.3572,	.1334,	.1898,	.1235,	.3489,
0 FBAR 3- 6,	.2312,	.3717,	.2116,	.1779,	.1833,	.3552,	.2807,	.1884,	.2676,	.2475,

Table 8 Fishing mortality (F) at age

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	FBAR 99-**
AGE											
1,	.0099,	.0005,	.0228,	.0009,	.0081,	.0115,	.0144,	.0051,	.0054,	.0033,	.0046,
2,	.1015,	.1692,	.3310,	.1446,	.1760,	.2095,	.2535,	.2206,	.1163,	.0741,	.1370,
3,	.2894,	.2237,	.4450,	.3841,	.5119,	.3049,	.5578,	.3752,	.2018,	.1348,	.2373,
4,	.2537,	.4870,	.2453,	.4943,	.6526,	.5732,	.9441,	.4750,	.2248,	.1601,	.2867,
5,	.2309,	.3254,	.4461,	.4274,	.4678,	.6474,	1.0884,	.6130,	.2165,	.2370,	.3555,
6,	.3248,	.3697,	.2852,	.6130,	.6367,	.5112,	.9913,	.5562,	.2135,	.2890,	.3529,
7,	.2429,	.4920,	.3764,	.1671,	.6429,	.7677,	1.0465,	.4892,	.1686,	.2369,	.2982,
8,	.2368,	.3188,	.4029,	.6994,	.5696,	.5413,	.7443,	.5474,	.2158,	.1977,	.3203,
+gp,	.2368,	.3188,	.4029,	.6994,	.5696,	.5413,	.7443,	.5474,	.2158,	.1977,	
0 FBAR 3- 6,	.2747,	.3515,	.3554,	.4797,	.5672,	.5092,	.8954,	.5049,	.2142,	.2052,	

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Table 6.5.2.1 (Continued)

Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

At 19/03/2002 23:34

Table 9 Relative F at age

YEAR,	1970,	1971,
AGE		
1,	.0028,	.0103,
2,	2.0602,	.2973,
3,	1.3077,	.7809,
4,	.9632,	.8692,
5,	.9181,	.9424,
6,	.8110,	1.4075,
7,	1.0757,	1.2091,
8,	1.2483,	1.2546,
+gp,	1.2483,	1.2546,
0 REFMEAN,	.1865,	.1662,

Table 9 Relative F at age

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
1,	.0104,	.0665,	.0201,	.0657,	.0775,	.0383,	.0578,	.0351,	.0217,	.0120,
2,	.5675,	.6546,	.4277,	.5690,	.5168,	.7373,	.9402,	.5969,	.3521,	.4510,
3,	1.1725,	1.0538,	.7044,	.6102,	.8046,	.6052,	.8902,	.6972,	.8916,	.7053,
4,	.7374,	1.0508,	1.0955,	.8496,	.9492,	.9660,	1.0799,	.9500,	.9848,	.8628,
5,	.9340,	.8500,	1.1867,	1.0837,	1.1351,	1.1618,	1.0907,	1.0888,	1.1495,	.9873,
6,	1.1561,	1.0454,	1.0134,	1.4565,	1.1111,	1.2670,	.9392,	1.2641,	.9741,	1.4446,
7,	1.8116,	1.0984,	.9301,	1.2760,	1.3192,	1.1371,	1.0358,	1.3969,	1.2047,	.8346,
8,	1.6218,	.9169,	1.3683,	1.5711,	1.4103,	.9918,	1.4643,	1.6423,	1.3485,	.9775,
+gp,	1.6218,	.9169,	1.3683,	1.5711,	1.4103,	.9918,	1.4643,	1.6423,	1.3485,	.9775,
0 REFMEAN,	.2076,	.2912,	.4563,	.4432,	.5070,	.3250,	.2682,	.2775,	.4002,	.3219,

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Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

At 19/03/2002 23:34

Table 9 Relative F at age

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	.0074,	.0028,	.0226,	.0710,	.0085,	.0171,	.0000,	.0249,	.0066,	.0085,
2,	.3877,	.5934,	.5647,	.2976,	.4031,	.4545,	.1047,	.2485,	.4103,	.5939,
3,	.7215,	1.0703,	1.1055,	.8161,	.6635,	.9679,	.9601,	.5816,	.7118,	.7347,
4,	.9683,	1.0154,	1.0889,	.8274,	1.0773,	.8159,	1.0002,	1.2095,	1.1223,	.6841,
5,	.9957,	1.0060,	.7356,	1.1183,	1.2241,	1.2565,	.8369,	1.1041,	1.1419,	1.1945,
6,	1.3145,	.9083,	1.0699,	1.2382,	1.0351,	.9597,	1.2028,	1.1049,	1.0240,	1.3868,
7,	1.0212,	1.0512,	.7399,	1.2614,	1.2379,	1.2770,	.8171,	1.4720,	1.2155,	1.1995,
8,	1.6643,	.7369,	.8167,	1.5259,	.9780,	1.0056,	.4752,	1.0076,	.4613,	1.4098,
+gp,	1.6643,	.7369,	.8167,	1.5259,	.9780,	1.0056,	.4752,	1.0076,	.4613,	1.4098,
0 REFMEAN,	.2312,	.3717,	.2116,	.1779,	.1833,	.3552,	.2807,	.1884,	.2676,	.2475,

Table 9 Relative F at age

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	MEAN 99-**
AGE											
1,	.0359,	.0014,	.0641,	.0020,	.0142,	.0226,	.0161,	.0100,	.0251,	.0160,	.0171,
2,	.3694,	.4815,	.9312,	.3015,	.3102,	.4115,	.2831,	.4369,	.5429,	.3612,	.4470,
3,	1.0536,	.6366,	1.2520,	.8007,	.9024,	.5988,	.6229,	.7432,	.9423,	.6567,	.7807,
4,	.9235,	1.3857,	.6902,	1.0304,	1.1505,	1.1258,	1.0544,	.9409,	1.0499,	.7803,	.9237,
5,	.8404,	.9259,	1.2552,	.8910,	.8247,	1.2715,	1.2156,	1.2142,	1.0111,	1.1548,	1.1267,
6,	1.1825,	1.0518,	.8026,	1.2779,	1.1224,	1.0039,	1.1071,	1.1018,	.9967,	1.4083,	1.1689,
7,	.8844,	1.3999,	1.0591,	.3483,	1.1334,	1.5078,	1.1688,	.9690,	.7872,	1.1543,	.9702,
8,	.8621,	.9069,	1.1335,	1.4579,	1.0041,	1.0630,	.8313,	1.0843,	1.0076,	.9636,	1.0185,
+gp,	.8621,	.9069,	1.1335,	1.4579,	1.0041,	1.0630,	.8313,	1.0843,	1.0076,	.9636,	
0 REFMEAN,	.2747,	.3515,	.3554,	.4797,	.5672,	.5092,	.8954,	.5049,	.2142,	.2052,	

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Table 6.5.2.1 (Continued)

Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

At 19/03/2002 23:34

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

YEAR,	1970,	1971,
AGE		
1,	402909,	814011,
2,	126197,	148144,
3,	132054,	63665,
4,	84511,	84719,
5,	25973,	63896,
6,	300460,	19803,
7,	17211,	233710,
8,	8418,	12742,
+gp,	9650,	12040,
0 TOTAL,	1107384,	1452730,

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

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
1,	730378,	529389,	584763,	405023,	679554,	572762,	1043880,	964773,	521046,	666446,
2,	298945,	268110,	191019,	213160,	144726,	240356,	208100,	378110,	351478,	190021,
3,	104457,	196853,	164151,	116417,	122713,	82501,	140118,	119806,	237352,	226152,
4,	45780,	67048,	118579,	97451,	72727,	66812,	55484,	90355,	80836,	136006,
5,	66347,	35545,	44675,	65083,	60508,	40668,	44165,	37581,	62811,	49318,
6,	49434,	49453,	25110,	23520,	36427,	30792,	25225,	29827,	25138,	35876,
7,	14182,	35187,	33003,	14308,	11159,	18764,	18458,	17743,	19004,	15402,
8,	172975,	8810,	23122,	19534,	7354,	5173,	11733,	12650,	10896,	10617,
+gp,	15783,	228108,	68766,	66714,	32113,	15784,	10720,	11698,	13379,	20264,
0 TOTAL,	1498282,	1418502,	1253188,	1021210,	1167281,	1073611,	1557883,	1662544,	1321939,	1350102,

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Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

At 19/03/2002 23:34

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

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	691900,	2271353,	927372,	1210275,	929701,	3181307,	475488,	757149,	791267,	505803,
2,	244229,	254101,	834703,	339536,	439650,	341485,	1163270,	174922,	277236,	290581,
3,	121748,	165413,	150986,	548702,	238566,	302497,	215263,	836807,	123660,	184022,
4,	147546,	84361,	90977,	97828,	388542,	172948,	175617,	134605,	614029,	83685,
5,	93219,	106723,	52337,	65376,	76404,	288552,	117121,	120004,	96980,	411451,
6,	32474,	67000,	66441,	40529,	48484,	55235,	167098,	83788,	88195,	64645,
7,	20389,	21682,	43254,	47937,	29423,	36287,	35543,	107872,	61569,	60673,
8,	10653,	14568,	13273,	33465,	34658,	21217,	20861,	25568,	73970,	40240,
+gp,	9427,	18603,	26573,	9563,	13596,	35538,	16507,	18425,	10213,	27251,
0 TOTAL,	1371585,	3003805,	2205917,	2393210,	2199024,	4435066,	2386769,	2259141,	2137118,	1668352,

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

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	GMST 70-99	AMST 70-99
AGE													
1,	417898,	622215,	820997,	474617,	940203,	1028046,	821948,	750725,	914682,	1060103,	0,	750979,	851107,
2,	185683,	152229,	228789,	295226,	174437,	343103,	373860,	298054,	274785,	334689,	388708,	266864,	305649,
3,	185846,	124283,	95216,	121732,	189256,	108374,	206127,	214949,	177095,	181222,	230231,	165432,	194656,
4,	125619,	113922,	81356,	49957,	67879,	92871,	65410,	96611,	120929,	118497,	129666,	101188,	122802,
5,	63928,	88199,	63338,	57599,	27574,	31981,	47370,	23024,	54363,	87388,	91356,	63478,	80925,
6,	277025,	45920,	57636,	36685,	33990,	15628,	15145,	14433,	11286,	39613,	62388,	44354,	62047,
7,	41502,	181148,	28709,	39209,	17981,	16271,	8482,	5085,	7488,	8249,	26847,	28086,	41705,
8,	40800,	29454,	100212,	17828,	30019,	8554,	6832,	2695,	2821,	5724,	5890,	17914,	27630,
+gp,	31265,	23088,	31877,	29520,	15589,	10672,	5853,	2355,	6545,	2830,	6352,		
0 TOTAL,	1369567,	1380458,	1508131,	1122374,	1496928,	1655500,	1551027,	1407934,	1569994,	1838315,	941439,		

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Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

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Table 11 Spawning stock number-at-age (spawning time) Numbers*10**-3

YEAR,	1970,	1971,
AGE		
1,	0,	0,
2,	79792,	117223,
3,	98084,	51044,
4,	70073,	71921,
5,	21657,	53803,
6,	253912,	15834,
7,	14071,	191035,
8,	6736,	10363,
+gp,	7722,	9792,

Table 6.5.2.1 (Continued)

Table 11 Spawning stock number-at-age (spawning time) Numbers*10**-3

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	225954,	192999,	137084,	147242,	99313,	167430,	143751,	276776,	261574,	141014,
3,	77612,	140169,	115749,	84942,	81656,	63245,	104431,	92044,	163442,	169877,
4,	38641,	51080,	79331,	70813,	49267,	50629,	42737,	70818,	58052,	105595,
5,	54490,	28161,	29066,	44116,	38481,	29531,	33952,	28705,	43158,	37275,
6,	39364,	37715,	17226,	14272,	23356,	21853,	19927,	22052,	18105,	24568,
7,	10309,	26559,	23225,	9160,	6667,	13699,	14330,	12798,	12866,	12031,
8,	129102,	6890,	14231,	11457,	4259,	3898,	8434,	8718,	7098,	8042,
+gp,	11780,	178381,	42324,	39129,	18600,	11894,	7706,	8061,	8715,	15349,

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Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

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Table 11 Spawning stock number-at-age (spawning time) Numbers*10**-3

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	188111,	179283,	630175,	268034,	342223,	250670,	932897,	138654,	210670,	215383,
3,	95218,	110818,	112891,	435416,	192316,	210135,	157164,	680069,	95194,	142487,
4,	118762,	61267,	72908,	82898,	318321,	133198,	136072,	108060,	469565,	69870,
5,	74715,	77689,	44097,	53510,	61477,	200108,	93580,	97629,	73903,	315655,
6,	24774,	49974,	53389,	32703,	39928,	41109,	124632,	68159,	68644,	48038,
7,	16277,	15607,	36422,	38573,	23635,	25042,	28504,	83777,	46303,	46508,
8,	7698,	11340,	11056,	26092,	28743,	15620,	17841,	21056,	63684,	29788,
+gp,	6812,	14481,	22133,	7456,	11275,	26162,	14118,	15174,	8793,	20173,

Table 11 Spawning stock number-at-age (spawning time) Numbers*10**-3

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	141890,	111163,	149912,	219167,	126806,	243871,	258024,	210289,	207907,	260484,
3,	133890,	93566,	61807,	82309,	117464,	77269,	124060,	146206,	135298,	144811,
4,	99117,	76877,	64552,	33548,	40997,	59154,	32496,	65722,	97276,	99545,
5,	51218,	66324,	43930,	40452,	18849,	19382,	21365,	14280,	43974,	69726,
6,	208408,	33522,	44524,	22752,	20749,	10377,	7290,	9299,	9148,	30525,
7,	32983,	121834,	20864,	32785,	10931,	9097,	3934,	3427,	6255,	6582,
8,	32558,	22248,	71547,	10435,	19168,	5567,	3880,	1747,	2283,	4689,
+gp,	24949,	17439,	22759,	17279,	9954,	6944,	3324,	1526,	5297,	2318,

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Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

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Table 12 Stock biomass at age (start of year) Tonnes

	YEAR,	1970,	1971,
	AGE		
	1,	48349,	97681,
	2,	21327,	25036,
	3,	27731,	13370,
	4,	19945,	19994,
	5,	6753,	16613,
	6,	82026,	5406,
	7,	4871,	66140,
	8,	2441,	3695,
	+gp,	2856,	3564,
0	TOTALBIO,	216299,	251499,

Table 6.5.2.1 (Continued)

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
1,	87645,	63527,	70172,	48603,	81547,	68731,	125266,	115773,	62525,	79973,
2,	50522,	45311,	32282,	36024,	24459,	40620,	35169,	63901,	59400,	32114,
3,	21936,	41339,	34472,	24448,	25770,	17325,	29425,	25159,	49844,	47492,
4,	10804,	15823,	27985,	22999,	17164,	15768,	13094,	21324,	19077,	32097,
5,	17250,	9242,	11615,	16921,	15732,	10574,	11483,	9771,	16331,	12823,
6,	13496,	13501,	6855,	6421,	9945,	8406,	6887,	8143,	6863,	9794,
7,	4013,	9958,	9340,	4049,	3158,	5310,	5224,	5021,	5378,	4359,
8,	50163,	2555,	6705,	5665,	2133,	1500,	3403,	3669,	3160,	3079,
+gp,	4672,	67520,	20355,	19747,	9505,	4672,	3173,	3463,	3960,	5998,
0 TOTALBIO,	260501,	268775,	219780,	184877,	189411,	172907,	233122,	256223,	226538,	227729,

1

Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

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Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	83028,	272562,	111285,	121028,	91111,	308587,	46122,	104486,	89413,	51592,
2,	41275,	42943,	141065,	50930,	74301,	56003,	190776,	27463,	42140,	43297,
3,	25567,	34737,	31707,	107546,	49860,	62314,	44344,	140584,	21022,	32020,
4,	34821,	19909,	21471,	22207,	92473,	40297,	40919,	24498,	110525,	15900,
5,	24237,	27748,	13608,	15559,	19559,	72715,	29515,	24001,	19396,	80233,
6,	8866,	18291,	18138,	10173,	13382,	14969,	45283,	18182,	19138,	13317,
7,	5770,	6136,	12241,	12080,	8238,	10160,	9952,	24487,	13853,	13712,
8,	3089,	4225,	3849,	9002,	9947,	6280,	6175,	6085,	17235,	9497,
+gp,	2790,	5507,	7866,	2716,	4242,	11265,	5233,	4514,	2604,	6758,
0 TOTALBIO,	229443,	432058,	361229,	351240,	363113,	582592,	418319,	374300,	335327,	266325,

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
1,	42626,	73421,	80458,	42716,	80857,	96636,	78085,	78075,	91468,	96469,
2,	26738,	25270,	35691,	42512,	23898,	46319,	50845,	43218,	36821,	41836,
3,	31036,	24360,	18282,	22034,	35202,	18315,	29888,	33102,	27804,	27183,
4,	22863,	23354,	17003,	10141,	13983,	18017,	11316,	16810,	21404,	20382,
5,	12402,	18875,	13681,	12499,	6039,	6716,	9048,	4605,	10709,	16691,
6,	54574,	10103,	12853,	8291,	7954,	3501,	2968,	3204,	2336,	7923,
7,	8881,	40396,	6488,	8900,	4190,	3759,	1713,	1170,	1625,	1675,
8,	8894,	7128,	23049,	4261,	7475,	1967,	1517,	647,	649,	1162,
+gp,	7566,	5957,	7874,	7262,	3944,	2551,	1270,	579,	1604,	611,
0 TOTALBIO,	215581,	228862,	215378,	158616,	183541,	197781,	186651,	181411,	194421,	213932,

1

Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

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Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1970,	1971,
AGE		
1,	0,	0,
2,	13485,	19811,
3,	20598,	10719,
4,	16537,	16973,
5,	5631,	13989,
6,	69318,	4323,
7,	3982,	54063,
8,	1953,	3005,
+gp,	2286,	2898,
0 TOTSPBIO,	133790,	125781,

Table 6.5.2.1 (Continued)

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	38186,	32617,	23167,	24884,	16784,	28296,	24294,	46775,	44206,	23831,
3,	16299,	29435,	24307,	17838,	17148,	13281,	21931,	19329,	34323,	35674,
4,	9119,	12055,	18722,	16712,	11627,	11949,	10086,	16713,	13700,	24920,
5,	14167,	7322,	7557,	11470,	10005,	7678,	8827,	7463,	11221,	9692,
6,	10746,	10296,	4703,	3896,	6376,	5966,	5440,	6020,	4943,	6707,
7,	2917,	7516,	6573,	2592,	1887,	3877,	4055,	3622,	3641,	3405,
8,	37439,	1998,	4127,	3322,	1235,	1130,	2446,	2528,	2058,	2332,
+gp,	3487,	52801,	12528,	11582,	5506,	3521,	2281,	2386,	2580,	4543,
0 TOTSPBIO,	132361,	154040,	101684,	92297,	70568,	75698,	79360,	104837,	116672,	111105,

1

Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

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Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	31791,	30299,	106500,	40205,	57836,	41110,	152995,	21769,	32022,	32092,
3,	19996,	23272,	23707,	85342,	40194,	43288,	32376,	114252,	16183,	24793,
4,	28028,	14459,	17206,	18818,	75760,	31035,	31705,	19667,	84522,	13275,
5,	19426,	20199,	11465,	12735,	15738,	50427,	23582,	19526,	14781,	61553,
6,	6763,	13643,	14575,	8208,	11020,	11140,	33775,	14790,	14896,	9896,
7,	4606,	4417,	10307,	9720,	6618,	7012,	7981,	19017,	10418,	10511,
8,	2232,	3289,	3206,	7019,	8249,	4623,	5281,	5011,	14838,	7030,
+gp,	2016,	4286,	6551,	2117,	3518,	8293,	4475,	3718,	2242,	5003,
0 TOTSPBIO,	114859,	113863,	193518,	184165,	218933,	196929,	292170,	217750,	189902,	164152,

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	20432,	18453,	23386,	31560,	17372,	32923,	35091,	30492,	27859,	32561,
3,	22360,	18339,	11867,	14898,	21848,	13059,	17989,	22516,	21242,	21722,
4,	18039,	15760,	13491,	6810,	8445,	11476,	5622,	11436,	17218,	17122,
5,	9936,	14193,	9489,	8778,	4128,	4070,	4081,	2856,	8663,	13318,
6,	41056,	7375,	9929,	5142,	4855,	2324,	1429,	2064,	1894,	6105,
7,	7058,	27169,	4715,	7442,	2547,	2101,	795,	788,	1357,	1336,
8,	7098,	5384,	16456,	2494,	4773,	1280,	861,	419,	525,	952,
+gp,	6038,	4499,	5622,	4251,	2518,	1660,	721,	375,	1298,	501,
0 TOTSPBIO,	132017,	111172,	94955,	81375,	66487,	68893,	66589,	70946,	80056,	93615,

1

Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

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Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR,	1970,	1971,
AGE		
1,	43357,	85053,
2,	19125,	21800,
3,	24868,	11641,
4,	17886,	17409,
5,	6056,	14465,
6,	73557,	4707,
7,	4368,	57589,
8,	2189,	3217,
+gp,	2562,	3103,
0 TOTALBIO,	193968,	218985,

Table 6.5.2.1 (Continued)

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
1,	78659,	64553,	68500,	54613,	85395,	74080,	127288,	123457,	60247,	82468,
2,	45342,	46043,	31513,	40479,	25613,	43781,	35737,	68142,	57235,	33115,
3,	19687,	42007,	33650,	27471,	26986,	18673,	29900,	26829,	48027,	48973,
4,	9696,	16079,	27318,	25843,	17974,	16995,	13306,	22739,	18382,	33098,
5,	15482,	9391,	11339,	19014,	16474,	11396,	11668,	10420,	15736,	13222,
6,	12112,	13719,	6692,	7215,	10414,	9060,	6998,	8683,	6612,	10099,
7,	3602,	10119,	9117,	4550,	3307,	5724,	5308,	5355,	5182,	4495,
8,	45019,	2596,	6546,	6365,	2233,	1617,	3457,	3912,	3045,	3175,
+gp,	4193,	68611,	19870,	22189,	9954,	5036,	3224,	3692,	3816,	6185,
0 TOTALBIO,	233791,	273118,	214544,	207738,	198351,	186363,	236887,	273230,	218282,	234831,

1

Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

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Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	85524,	273705,	107815,	119164,	91125,	292780,	46088,	104588,	89469,	51445,
2,	42516,	43123,	136666,	50146,	74313,	53135,	190633,	27490,	42166,	43173,
3,	26336,	34882,	30718,	105890,	49868,	59123,	44311,	140721,	21035,	31929,
4,	35868,	19993,	20801,	21865,	92488,	38233,	40888,	24522,	110594,	15855,
5,	24966,	27864,	13183,	15320,	19563,	68990,	29492,	24024,	19408,	80004,
6,	9132,	18368,	17573,	10016,	13384,	14202,	45249,	18200,	19150,	13279,
7,	5944,	6162,	11859,	11894,	8240,	9640,	9944,	24511,	13862,	13673,
8,	3182,	4243,	3729,	8863,	9948,	5959,	6170,	6091,	17246,	9470,
+gp,	2874,	5530,	7620,	2674,	4243,	10688,	5229,	4519,	2606,	6739,
0 TOTALBIO,	236341,	433870,	349965,	345833,	363171,	552750,	418005,	374665,	335534,	265565,

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
1,	42416,	73859,	80296,	44958,	80494,	96793,	77988,	78216,	91570,	96350,
2,	26607,	25421,	35620,	44744,	23790,	46394,	50782,	43296,	36862,	41784,
3,	30884,	24505,	18245,	23190,	35043,	18345,	29851,	33162,	27835,	27150,
4,	22750,	23493,	16969,	10674,	13920,	18046,	11302,	16841,	21428,	20356,
5,	12341,	18987,	13654,	13155,	6012,	6727,	9036,	4613,	10721,	16670,
6,	54306,	10163,	12827,	8726,	7918,	3506,	2965,	3210,	2339,	7913,
7,	8838,	40637,	6475,	9368,	4171,	3765,	1711,	1172,	1627,	1673,
8,	8851,	7170,	23003,	4485,	7441,	1971,	1515,	648,	650,	1161,
+gp,	7529,	5992,	7858,	7643,	3926,	2555,	1269,	580,	1605,	611,
0 TOTALBIO,	214521,	230227,	214947,	166943,	182715,	198101,	186418,	181738,	194636,	213668,

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Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

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Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR,	1970,	1971,
AGE		
1,	0,	0,
2,	12093,	17250,
3,	18471,	9333,
4,	14830,	14779,
5,	5050,	12180,
6,	62161,	3764,
7,	3571,	47074,
8,	1752,	2617,
+gp,	2050,	2524,
0 TOTSPBIO,	119977,	109520,

Table 6.5.2.1 (Continued)

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	34271,	33144,	22615,	27961,	17576,	30498,	24686,	49880,	42595,	24575,
3,	14627,	29911,	23728,	20044,	17957,	14315,	22285,	20612,	33072,	36787,
4,	8184,	12250,	18276,	18778,	12176,	12878,	10249,	17823,	13201,	25698,
5,	12715,	7440,	7377,	12889,	10477,	8276,	8970,	7959,	10812,	9994,
6,	9645,	10463,	4591,	4378,	6677,	6430,	5528,	6420,	4762,	6916,
7,	2618,	7638,	6416,	2913,	1976,	4179,	4121,	3862,	3508,	3511,
8,	33601,	2030,	4029,	3733,	1294,	1218,	2485,	2696,	1983,	2405,
+gp,	3129,	53654,	12229,	13014,	5766,	3795,	2318,	2545,	2486,	4685,
0 TOTSPBIO,	118790,	156529,	99261,	103710,	73898,	81589,	80642,	111796,	112420,	114570,

1

Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

At 19/03/2002 23:34

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	32747,	30426,	103179,	39586,	57845,	39004,	152880,	21790,	32042,	32001,
3,	20597,	23369,	22968,	84028,	40200,	41070,	32351,	114363,	16193,	24722,
4,	28871,	14520,	16670,	18528,	75772,	29446,	31681,	19686,	84574,	13237,
5,	20010,	20284,	11108,	12539,	15741,	47844,	23564,	19545,	14790,	61377,
6,	6967,	13700,	14121,	8082,	11022,	10570,	33750,	14805,	14905,	9868,
7,	4745,	4435,	9986,	9571,	6619,	6653,	7975,	19036,	10425,	10481,
8,	2300,	3302,	3106,	6911,	8250,	4387,	5277,	5016,	14848,	7010,
+gp,	2077,	4304,	6347,	2085,	3519,	7868,	4472,	3721,	2244,	4989,
0 TOTSPBIO,	118312,	114341,	187484,	181330,	218968,	186842,	291951,	217962,	190019,	163684,

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	20332,	18563,	23339,	33217,	17294,	32976,	35047,	30547,	27890,	32520,
3,	22250,	18448,	11843,	15680,	21750,	13080,	17966,	22556,	21265,	21695,
4,	17951,	15854,	13464,	7168,	8407,	11495,	5615,	11456,	17237,	17101,
5,	9887,	14278,	9470,	9239,	4109,	4077,	4076,	2861,	8673,	13301,
6,	40854,	7419,	9909,	5412,	4833,	2328,	1427,	2068,	1896,	6097,
7,	7024,	27331,	4706,	7833,	2535,	2105,	794,	790,	1359,	1335,
8,	7063,	5416,	16423,	2625,	4751,	1282,	860,	420,	526,	951,
+gp,	6008,	4526,	5610,	4474,	2507,	1662,	720,	376,	1299,	500,
0 TOTSPBIO,	131368,	111835,	94765,	85647,	66188,	69005,	66506,	71074,	80145,	93500,

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Table 6.5.2.1 (Continued)

Run title : Herring VIa(S) VIIbc (run: PRE wg 2002) ,

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Table 16 Summary (without SOP correction)

	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 3- 6,
1970,	402909,	216299,	133790,	20306,	.1518,	.1865,
1971,	814011,	251499,	125781,	15044,	.1196,	.1662,
1972,	730378,	260501,	132361,	23474,	.1773,	.2076,
1973,	529389,	268775,	154040,	36719,	.2384,	.2912,
1974,	584763,	219780,	101684,	36589,	.3598,	.4563,
1975,	405023,	184877,	92297,	38764,	.4200,	.4432,
1976,	679554,	189411,	70568,	32767,	.4643,	.5070,
1977,	572762,	172907,	75698,	20567,	.2717,	.3250,
1978,	1043880,	233122,	79360,	19715,	.2484,	.2682,
1979,	964773,	256223,	104837,	22608,	.2156,	.2775,
1980,	521046,	226538,	116672,	30124,	.2582,	.4002,
1981,	666446,	227729,	111105,	24922,	.2243,	.3219,
1982,	691900,	229443,	114859,	19209,	.1672,	.2312,
1983,	2271353,	432058,	113863,	32988,	.2897,	.3717,
1984,	927372,	361229,	193518,	27450,	.1418,	.2116,
1985,	1210275,	351240,	184165,	23343,	.1268,	.1779,
1986,	929701,	363113,	218933,	28785,	.1315,	.1833,
1987,	3181307,	582592,	196929,	48600,	.2468,	.3552,
1988,	475488,	418319,	292170,	29100,	.0996,	.2807,
1989,	757149,	374300,	217750,	29210,	.1341,	.1884,
1990,	791267,	335327,	189902,	43969,	.2315,	.2676,
1991,	505803,	266325,	164152,	37700,	.2297,	.2475,
1992,	417898,	215581,	132017,	31856,	.2413,	.2747,
1993,	622215,	228862,	111172,	36763,	.3307,	.3515,
1994,	820997,	215378,	94955,	33908,	.3571,	.3554,
1995,	474617,	158616,	81375,	27792,	.3415,	.4797,
1996,	940203,	183541,	66487,	32534,	.4893,	.5672,
1997,	1028046,	197781,	68893,	27225,	.3952,	.5092,
1998,	821948,	186651,	66589,	38895,	.5841,	.8954,
1999,	750725,	181411,	70946,	26109,	.3680,	.5049,
2000,	914682,	194421,	80056,	15005,	.1874,	.2142,
2001,	1060103,	213932,	93615,	14061,	.1502,	.2052,
Arith. Mean ,	859625,	262431,	126579,	28941,	.2623,	.3351,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

Run title : Herring VIa(S) VIIbc (run: PRE wg 2002) ,

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Table 17 Summary (with SOP correction)

	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 3- 6,
1970,	402909,	193968,	119977,	20306,	.1692,	.8968,	.1865,
1971,	814011,	218985,	109520,	15044,	.1374,	.8707,	.1662,
1972,	730378,	233791,	118790,	23474,	.1976,	.8975,	.2076,
1973,	529389,	273118,	156529,	36719,	.2346,	1.0162,	.2912,
1974,	584763,	214544,	99261,	36589,	.3686,	.9762,	.4563,
1975,	405023,	207738,	103710,	38764,	.3738,	1.1237,	.4432,
1976,	679554,	198351,	73898,	32767,	.4434,	1.0472,	.5070,
1977,	572762,	186363,	81589,	20567,	.2521,	1.0778,	.3250,
1978,	1043880,	236887,	80642,	19715,	.2445,	1.0161,	.2682,
1979,	964773,	273230,	111796,	22608,	.2022,	1.0664,	.2775,
1980,	521046,	218282,	112420,	30124,	.2680,	.9636,	.4002,
1981,	666446,	234831,	114570,	24922,	.2175,	1.0312,	.3219,
1982,	691900,	236341,	118312,	19209,	.1624,	1.0301,	.2312,
1983,	2271353,	433870,	114341,	32988,	.2885,	1.0042,	.3717,
1984,	927372,	349965,	187484,	27450,	.1464,	.9688,	.2116,
1985,	1210275,	345833,	181330,	23343,	.1287,	.9846,	.1779,
1986,	929701,	363171,	218968,	28785,	.1315,	1.0002,	.1833,
1987,	3181307,	552750,	186842,	48600,	.2601,	.9488,	.3552,
1988,	475488,	418005,	291951,	29100,	.0997,	.9992,	.2807,
1989,	757149,	374665,	217962,	29210,	.1340,	1.0010,	.1884,
1990,	791267,	335534,	190019,	43969,	.2314,	1.0006,	.2676,
1991,	505803,	265565,	163684,	37700,	.2303,	.9971,	.2475,
1992,	417898,	214521,	131368,	31856,	.2425,	.9951,	.2747,
1993,	622215,	230227,	111835,	36763,	.3287,	1.0060,	.3515,
1994,	820997,	214947,	94765,	33908,	.3578,	.9980,	.3554,
1995,	474617,	166943,	85647,	27792,	.3245,	1.0525,	.4797,
1996,	940203,	182715,	66188,	32534,	.4915,	.9955,	.5672,
1997,	1028046,	198101,	69005,	27225,	.3945,	1.0016,	.5092,
1998,	821948,	186418,	66506,	38895,	.5848,	.9988,	.8954,
1999,	750725,	181738,	71074,	26109,	.3673,	1.0018,	.5049,
2000,	914682,	194636,	80145,	15005,	.1872,	1.0011,	.2142,
2001,	1060103,	213668,	93500,	14061,	.1504,	.9988,	.2052,
Arith. Mean ,	859625,	260928,	125738,	28941,	.2610		.3351,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 6.5.2.2. VIa(S) & DIvision VIIb,c herring. Residuals from the separable VPA with F2001=0.21.

```
Title : Herring VIa(S) VIIbc (run: PRE wg 2002)

At 19/03/2002  23:33

Separable analysis
from 1970 to 2001 on ages  1 to  8
with Terminal F of  .200 on age  4 and Terminal S of 1.000

Initial sum of squared residuals was   507.954 and
  final sum of squared residuals is     73.486 after 142 iterations

Matrix of Residuals

 Years,    1970/71,
  Ages

  1/ 2,    -1.685,
  2/ 3,     1.557,
  3/ 4,      .513,
  4/ 5,     -.162,
  5/ 6,     -.643,
  6/ 7,     -.628,
  7/ 8,     -.468,

  TOT ,      .000,
  WTS ,      .001,


 Years,    1971/72,1972/73,1973/74,1974/75,1975/76,1976/77,1977/78,1978/79,1979/80,1980/81,

  1/ 2,     -.602, -1.034,  1.250,  -.029,  1.187,   .939,   .031,   .831,   .810,   .091,
  2/ 3,     -.511,  -.057,   .495,   .339,   .336,   .395,   .483,   .943,   .220,  -.145,
  3/ 4,      .509,   .304,   .209,   .127,  -.230,  -.005,  -.361,   .164,  -.143,   .262,
  4/ 5,      .153,  -.291,  -.137,   .167,  -.290,  -.275,  -.122,  -.007,  -.196,  -.023,
  5/ 6,     -.013,  -.279,  -.326,  -.026,  -.050,  -.194,   .158,  -.189,   .027,  -.216,
  6/ 7,      .055,  -.072,  -.011,  -.122,   .219,  -.124,   .188,  -.432,   .042,   .049,
  7/ 8,     -.132,   .497,  -.354,  -.483,  -.105,   .109,  -.348,  -.562,  -.031,   .063,

  TOT ,      .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,
  WTS ,      .001,   .001,   .001,   .001,   .001,   .001,   .001,   .001,   .001,   .001,

 Years,    1981/82,1982/83,1983/84,1984/85,1985/86,1986/87,1987/88,1988/89,1989/90,1990/91,

  1/ 2,     -.202, -1.161, -2.220,   .667,  1.458,  -.769,  1.084, -3.832,   .327, -1.251,
  2/ 3,      .267,  -.326,  -.041,   .364,  -.179,  -.192,  -.313,  -.782,  -.503,   .093,
  3/ 4,      .058,  -.058,   .214,   .679,   .028,   .055,   .065,   .472,  -.443,   .319,
  4/ 5,     -.011,   .007,   .224,   .130,  -.325,  -.039,  -.258,   .340,   .077,   .066,
  5/ 6,     -.164,   .059,  -.198,  -.456,   .093,   .261,  -.124,   .074,   .006,  -.107,
  6/ 7,      .529,   .264,   .028,  -.048,   .058,  -.148,  -.103,   .250,  -.129,  -.098,
  7/ 8,     -.658,   .171,  -.005,  -.736,   .178,   .140,   .625,   .030,   .958,  -.148,

  TOT ,      .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,
  WTS ,      .001,   .001,   .001,   .001,   .001,   .001,   .001,   .001,   .001,   .001,


Years,    1991/92,1992/93,1993/94,1994/95,1995/96,1996/97,1997/98,1998/99,1999/**,2000/**,        TOT,         WTS,

 1/ 2,      -.683,   .650, -3.249,  1.322, -1.650,  -.110,   .522,  -.073,  -.813,   .481,        .000,        .100,
 2/ 3,       .024,   .109,  -.237,   .609,  -.177,  -.023,   .076,  -.351,  -.123,   .418,        .000,       1.000,
 3/ 4,      -.061,   .157,   .113,   .302,   .267,   .200,  -.405,  -.164,  -.077,   .443,        .000,       1.000,
 4/ 5,      -.324,   .063,   .242,  -.573,   .539,   .114,  -.033,   .025,  -.054,  -.051,        .000,       1.000,
 5/ 6,      -.063,  -.217,   .055,  -.214,   .054,  -.223,   .106,   .234,   .216,  -.330,        .000,       1.000,
 6/ 7,       .375,  -.045,  -.019,   .357,   .518,  -.108,  -.234,   .187,   .313,  -.159,        .000,       1.000,
 7/ 8,       .117,  -.131,   .170,  -.614, -1.035,   .051,   .439,   .077,  -.194,  -.370,        .000,       1.000,

 TOT ,       .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,   .000,      -6.940,
 WTS ,       .001,   .001,   .001,   .001,   .001,  1.000,  1.000,  1.000,  1.000,  1.000,

  Fishing Mortalities (F)

         ,    1970,   1971,
F-values,   .2329,  .1686,

         ,    1972,   1973,   1974,   1975,   1976,   1977,   1978,   1979,   1980,   1981,
F-values,   .2607,  .3286,  .4739,  .5134,  .6154,  .3747,  .3040,  .3004,  .4076,  .3048,

         ,    1982,   1983,   1984,   1985,   1986,   1987,   1988,   1989,   1990,   1991,
F-values,   .2412,  .3918,  .1962,  .1769,  .1834,  .3610,  .2206,  .2105,  .2832,  .2767,

         ,    1992,   1993,   1994,   1995,   1996,   1997,   1998,   1999,   2000,   2001,
F-values,   .2799,  .3769,  .3822,  .3744,  .5680,  .5506,  .8820,  .5172,  .2161,  .2000,

 Selection-at-age (S)

         ,       1,       2,       3,       4,       5,       6,       7,       8,
S-values,   .0165,  .3981,  .7506, 1.0000, 1.0651, 1.0738, 1.1005, 1.0000,
```

1

Table 6.5.2.2 (Continued)

Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

At 19/03/2002 23:33

Traditional vpa Terminal populations from weighted Separable populations

Fishing mortality residuals

YEAR,	1970,	1971,
AGE		
1,	-.0033,	-.0011,
2,	.2915,	-.0177,
3,	.0690,	.0033,
4,	-.0533,	-.0241,
5,	-.0769,	-.0229,
6,	-.0989,	.0529,
7,	-.0557,	.0154,
8,	-.0001,	.0399,

Fishing mortality residuals

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
1,	-.0021,	.0139,	.0013,	.0206,	.0292,	.0063,	.0105,	.0048,	.0020,	-.0012,
2,	.0140,	.0598,	.0065,	.0478,	.0171,	.0905,	.1311,	.0461,	-.0213,	.0238,
3,	.0477,	.0602,	-.0343,	-.1149,	-.0540,	-.0845,	.0105,	-.0320,	.0509,	-.0017,
4,	-.1077,	-.0226,	.0260,	-.1368,	-.1342,	-.0607,	-.0144,	-.0367,	-.0134,	-.0271,
5,	-.0838,	-.1025,	.0367,	-.0664,	-.0800,	-.0215,	-.0313,	-.0178,	.0260,	-.0068,
6,	-.0400,	-.0484,	-.0465,	.0943,	-.0975,	.0094,	-.0746,	.0282,	-.0478,	.1377,
7,	.0891,	-.0418,	-.0971,	.0006,	-.0084,	-.0428,	-.0568,	.0571,	.0336,	-.0668,
8,	.0759,	-.0616,	.1505,	.1830,	.0996,	-.0524,	.0887,	.1554,	.1321,	.0099,

1

Run title : Herring VIa(S) VIIbc (run: PRE wg 2002)

At 19/03/2002 23:33

Traditional vpa Terminal populations from weighted Separable populations

Fishing mortality residuals

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
1,	-.0023,	-.0054,	.0015,	.0097,	-.0015,	.0001,	-.0036,	.0012,	-.0029,	-.0025,
2,	-.0063,	.0646,	.0414,	-.0175,	.0009,	.0177,	-.0584,	-.0370,	-.0029,	.0368,
3,	-.0142,	.1037,	.0867,	.0124,	-.0160,	.0728,	.1039,	-.0485,	-.0221,	-.0259,
4,	-.0172,	-.0144,	.0342,	-.0297,	.0141,	-.0712,	.0601,	.0173,	.0172,	-.1074,
5,	-.0266,	-.0434,	-.0533,	.0105,	.0291,	.0618,	-.0001,	-.0163,	.0040,	.0008,
6,	.0450,	-.0832,	.0157,	.0303,	-.0071,	-.0468,	.1007,	-.0179,	-.0300,	.0460,
7,	-.0292,	-.0405,	-.0594,	.0297,	.0251,	.0563,	-.0134,	.0456,	.0137,	-.0077,
8,	.1437,	-.1180,	-.0234,	.0945,	-.0041,	-.0038,	-.0872,	-.0207,	-.1597,	.0721,

Table 6.5.3.1. Division VIa(S) and VII b,c herring. Input data for short term projections, based on separable VPA with F=0.2.

MFDP version 1a
Run: $\mathbf{F}_{sq}$
Time and date: 15:27 20/03/02
Fbar age range: 3-6

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	750979	1	0	0.67	0.67	0.095	0.003	0.095
2	267116	0.3	1	0.67	0.67	0.135	0.074	0.134
3	230231	0.2	1	0.67	0.67	0.160	0.148	0.152
4	129666	0.1	1	0.67	0.67	0.183	0.215	0.173
5	91356	0.1	1	0.67	0.67	0.201	0.232	0.190
6	62388	0.1	1	0.67	0.67	0.214	0.227	0.198
7	26847	0.1	1	0.67	0.67	0.219	0.238	0.211
8	5890	0.1	1	0.67	0.67	0.229	0.200	0.221
9	6352	0.1	1	0.67	0.67	0.236	0.200	0.222

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	750979	1	0	0.67	0.67	0.095	0.003	0.095
2	.	0.3	1	0.67	0.67	0.135	0.074	0.134
3	.	0.2	1	0.67	0.67	0.160	0.148	0.152
4	.	0.1	1	0.67	0.67	0.183	0.215	0.173
5	.	0.1	1	0.67	0.67	0.201	0.232	0.190
6	.	0.1	1	0.67	0.67	0.214	0.227	0.198
7	.	0.1	1	0.67	0.67	0.219	0.238	0.211
8	.	0.1	1	0.67	0.67	0.229	0.200	0.221
9	.	0.1	1	0.67	0.67	0.236	0.200	0.222

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	750979	1	0	0.67	0.67	0.095	0.003	0.095
2	.	0.3	1	0.67	0.67	0.135	0.074	0.134
3	.	0.2	1	0.67	0.67	0.160	0.148	0.152
4	.	0.1	1	0.67	0.67	0.183	0.215	0.173
5	.	0.1	1	0.67	0.67	0.201	0.232	0.190
6	.	0.1	1	0.67	0.67	0.214	0.227	0.198
7	.	0.1	1	0.67	0.67	0.219	0.238	0.211
8	.	0.1	1	0.67	0.67	0.229	0.200	0.221
9	.	0.1	1	0.67	0.67	0.236	0.200	0.222

Input units are thousands and kg - output in tonnes

Table 6.5.3.2. Divisions VIa(S) and VIIb,c herring. Single option short-term projection based on VPA with F=0.2.

MFDP version 1a
Run: TAC constraint
Time and date: 15:46 20/03/02
Fbar age range: 3-6

Year:	2002	F multiplier:	0.7491	Fbar:	0.1537				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0025	1203	114	750979	71343	0	0	0	0
2	0.0557	12528	1673	267116	36150	267116	36150	210469	28483
3	0.1108	21918	3324	230231	36875	230231	36875	186957	29944
4	0.1608	18357	3176	129666	23686	129666	23686	108875	19888
5	0.1736	13874	2636	91356	18393	91356	18393	76055	15312
6	0.1698	9283	1840	62388	13341	62388	13341	52072	11135
7	0.1779	4170	879	26847	5888	26847	5888	22286	4888
8	0.1495	779	172	5890	1349	5890	1349	4983	1141
9	0.1495	840	187	6352	1499	6352	1499	5374	1268
Total		82953	14000	1570825	208524	819846	137181	667071	112060

Year:	2003	F multiplier:	1	Fbar:	0.2052				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0034	1606	152	750979	71343	0	0	0	0
2	0.0744	17103	2283	275570	37294	275570	37294	214431	29020
3	0.1479	23371	3545	187156	29976	187156	29976	148248	23744
4	0.2147	31081	5377	168735	30822	168735	30822	136657	24963
5	0.2317	19701	3743	99896	20112	99896	20112	79987	16104
6	0.2266	13434	2662	69489	14859	69489	14859	55832	11939
7	0.2375	9603	2025	47637	10448	47637	10448	37996	8334
8	0.1996	3506	775	20333	4656	20333	4656	16635	3809
9	0.1996	1645	365	9539	2251	9539	2251	7804	1842
Total		121051	20927	1629333	221762	878354	150419	697590	119754

Year:	2004	F multiplier:	1	Fbar:	0.2052				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0034	1606	152	750979	71343	0	0	0	0
2	0.0744	17089	2281	275336	37262	275336	37262	214249	28995
3	0.1479	23665	3589	189508	30353	189508	30353	150111	24043
4	0.2147	24346	4212	132171	24143	132171	24143	107044	19553
5	0.2317	24292	4616	123177	24800	123177	24800	98629	19857
6	0.2266	13860	2747	71693	15330	71693	15330	57602	12317
7	0.2375	10105	2130	50127	10994	50127	10994	39982	8769
8	0.1996	5862	1296	33991	7784	33991	7784	27810	6368
9	0.1996	3818	848	22139	5225	22139	5225	18113	4275
Total		124642	21871	1649121	227234	898142	155891	713540	124178

Input units are thousands and kg - output in tonnes

Table 6.5.3.3 Divisions VIa(S) and VIIb,c herring. Multiple options of short-term projections based on VPA with F=0.2

MFDP version 1a
Run: TAC constraint
VIaS VIIbc Sea 2002 Projection index file Wednesday 20th March 2002.
Time and date: 15:46 20/03/02
Fbar age range: 3-6

2002				
Biomass	SSB	FMult	FBar	Landings
208524	112060	0.7491	0.1537	14000

2003					2004	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
221762	134481	0	0	0	249527	160270
.	132920	0.1	0.0205	2275	247099	156119
.	131379	0.2	0.041	4507	244717	152100
.	129859	0.3	0.0616	6698	242381	148208
.	128358	0.4	0.0821	8847	240090	144438
.	126877	0.5	0.1026	10956	237843	140788
.	125415	0.6	0.1231	13026	235639	137251
.	123972	0.7	0.1437	15057	233477	133826
.	122548	0.8	0.1642	17051	231356	130508
.	121142	0.9	0.1847	19007	229275	127293
.	119754	1	0.2052	20927	227234	124178
.	118385	1.1	0.2257	22812	225232	121160
.	117033	1.2	0.2463	24662	223268	118235
.	115699	1.3	0.2668	26478	221341	115400
.	114382	1.4	0.2873	28260	219450	112653
.	113082	1.5	0.3078	30010	217595	109989
.	111798	1.6	0.3284	31728	215775	107407
.	110532	1.7	0.3489	33414	213990	104904
.	109281	1.8	0.3694	35069	212237	102477
.	108047	1.9	0.3899	36694	210518	100123
.	106828	2	0.4105	38290	208831	97841

Input units are thousands and kg - output in tonnes

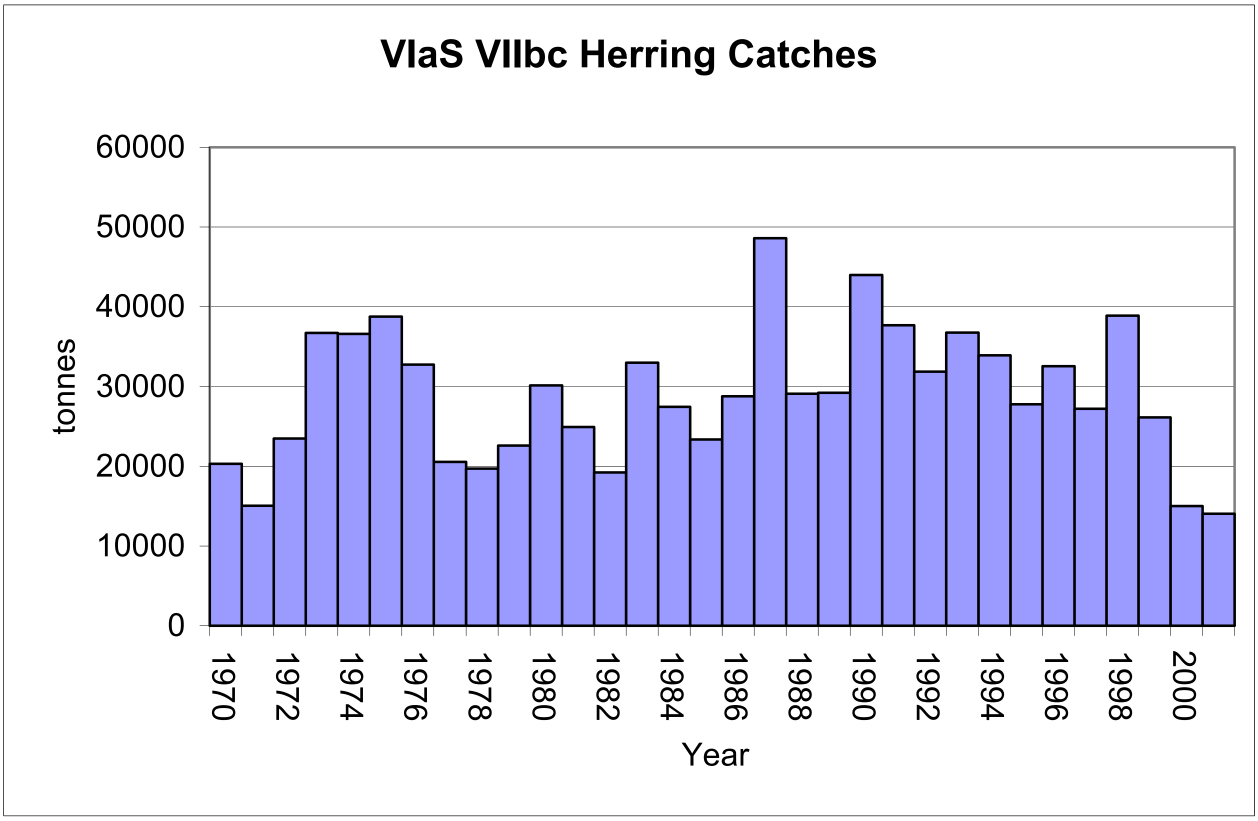


Figure 6.1.1. VIa(S) & VIIb,c herring catches from 1970-2001.

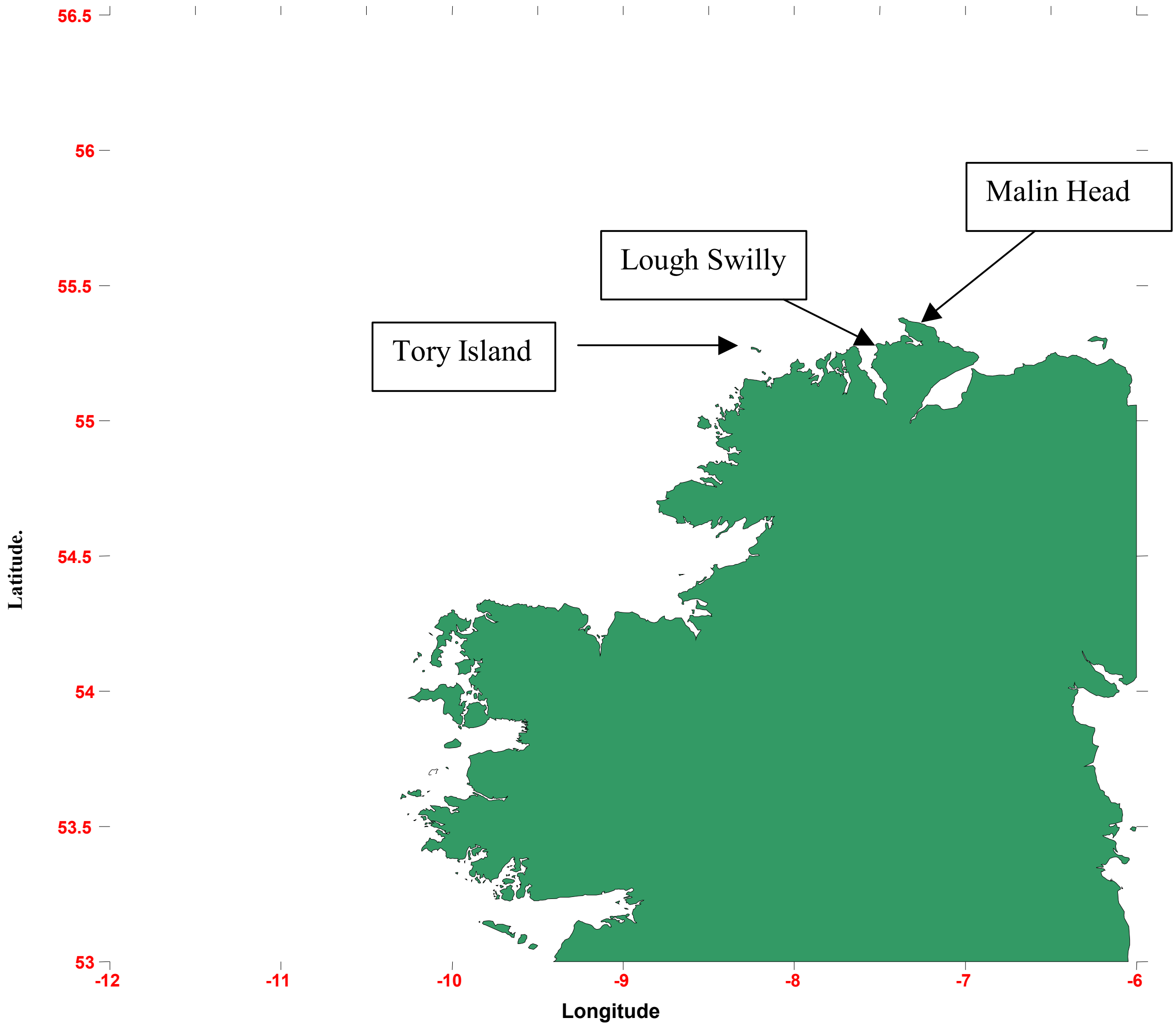


Figure 6.1.3.1. VIa(S) & Division VIIb,c herring. Map of locations mentioned in the text.

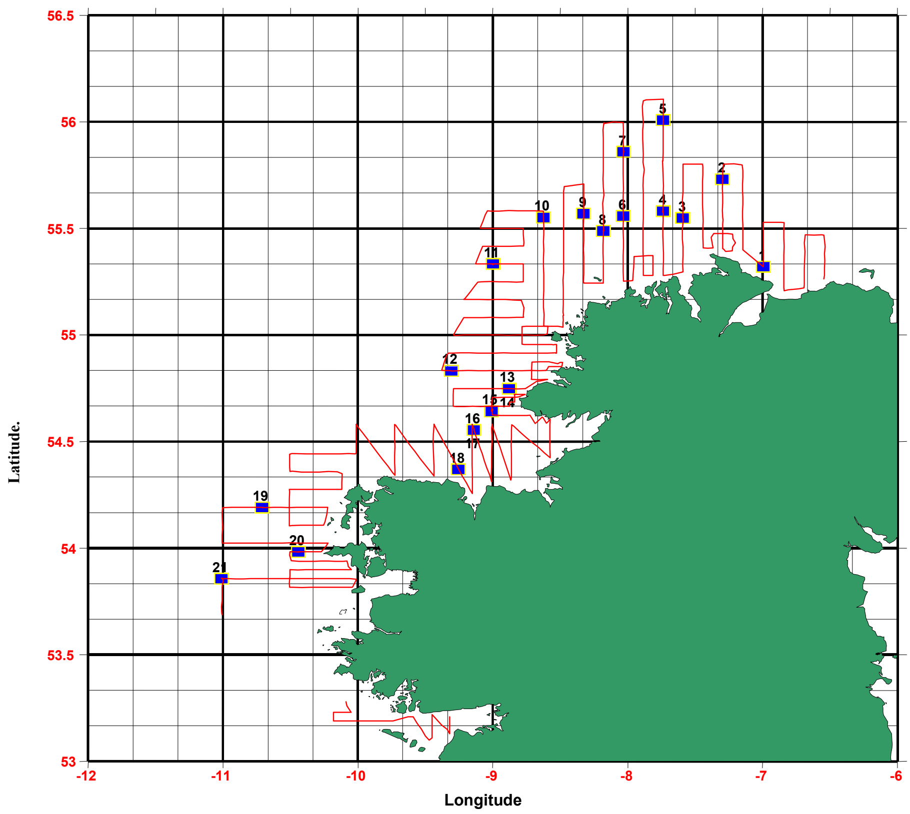


Figure 6.4.1a VIa(S) & VIIb,c herring. Tracks and trawl positions of acoustic survey, November 2001.

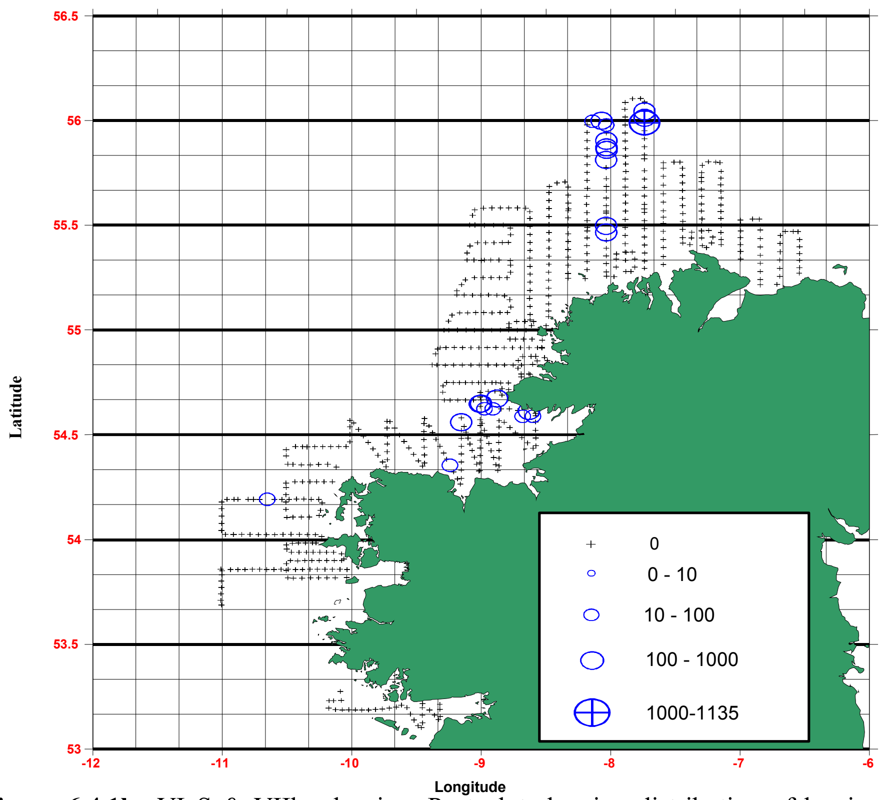


Figure 6.4.1b VIaS & VIIb,c herring. Post plot showing distribution of herring S_A values during November 2001 survey.

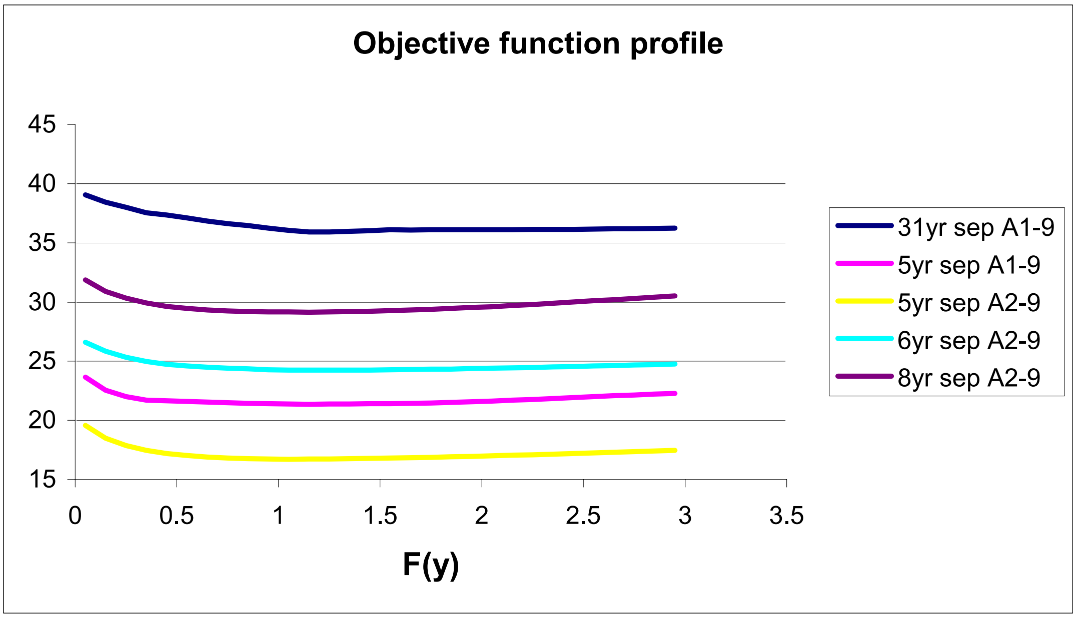


Figure 6.5.1.1. Herring in VIa(S) and VIIb,c. Comparison of objective function profiles for runs using a range of years of separability and including or excluding 1 ringers.

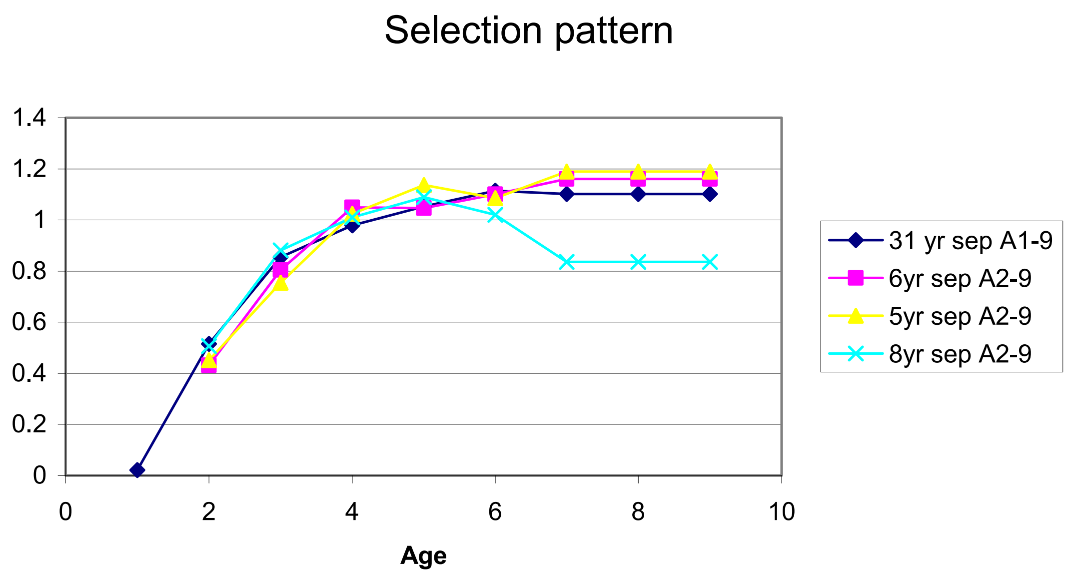


Figure 6.5.1.2 Herring in VIa(S) and VIIb,c. Selection patterns as estimated by the ISVPA runs.

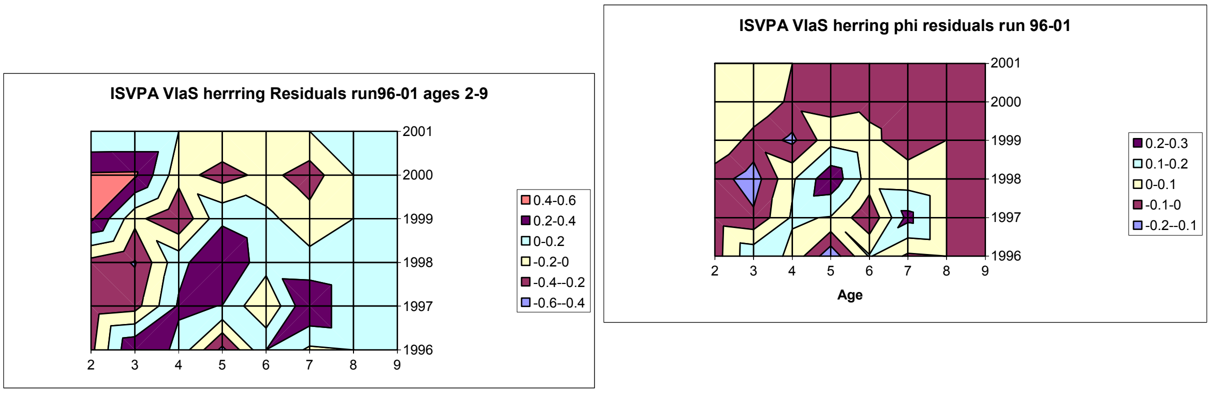


Figure 6.5.1.3 Division VIa(S) and VIIb,c. Residuals in catches and instantaneous mortality phi, with ISVPA for the period 1996 to 2001 and ages 2-9.

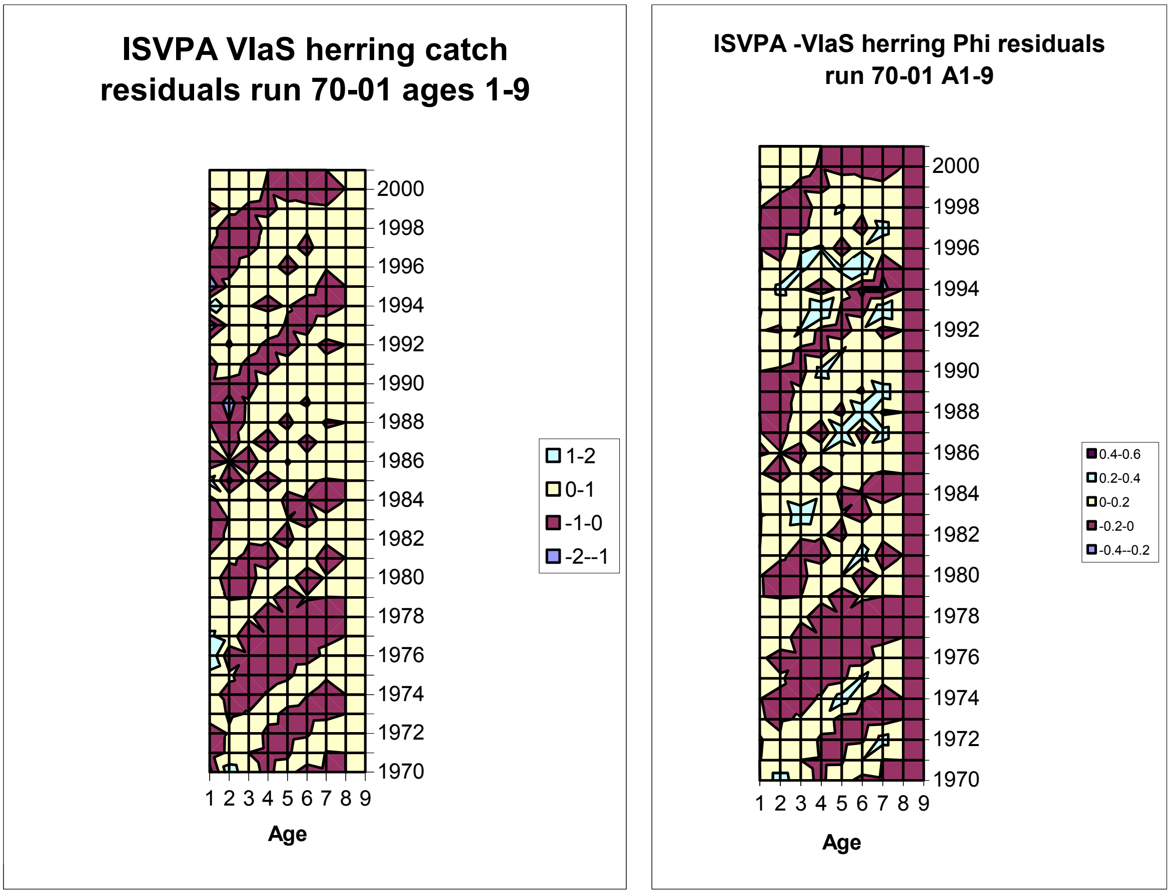


Figure 6.5.1.4 Division VIa(S) and VIIb,c. Residuals in catches and instantaneous mortality phi, with ISVPA for the period 1970 to 2001 and ages 1-9.

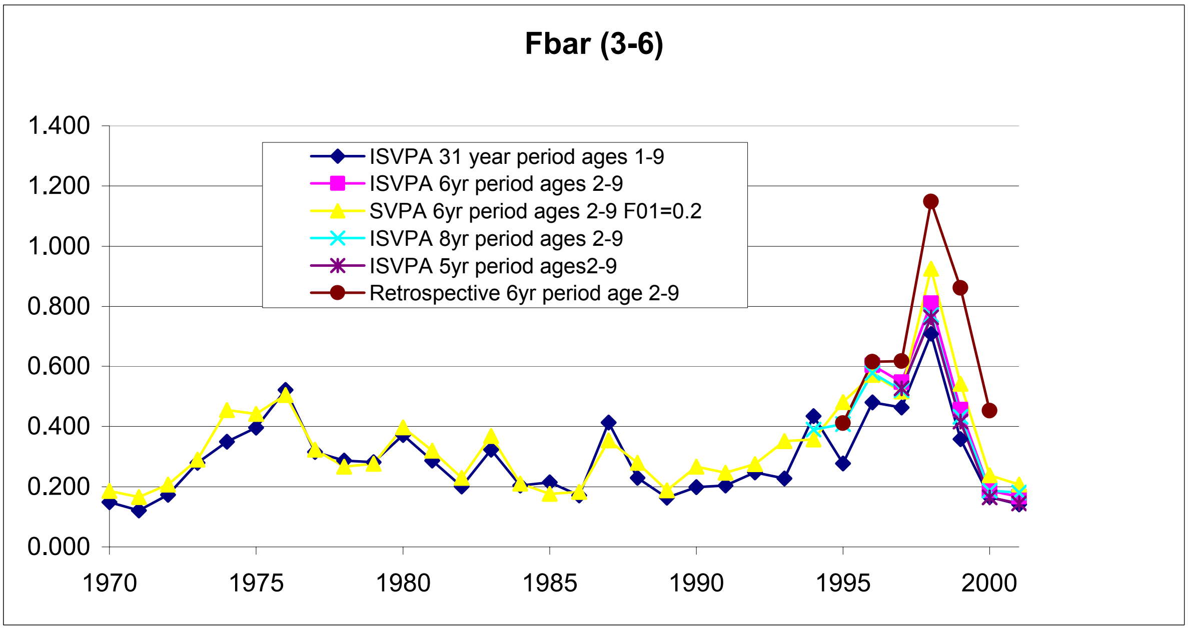


Figure 6.5.1.5. Herring in VIa(S) and VIIb,c. Comparison of Fbar(3-6) trajectories for the ISVPA runs with various separable periods. A retrospective run for 2000 using a 6-year period and the minimisation function used this year, and a traditional SVPA run with F_{2001}=0.2 are also shown for comparison.

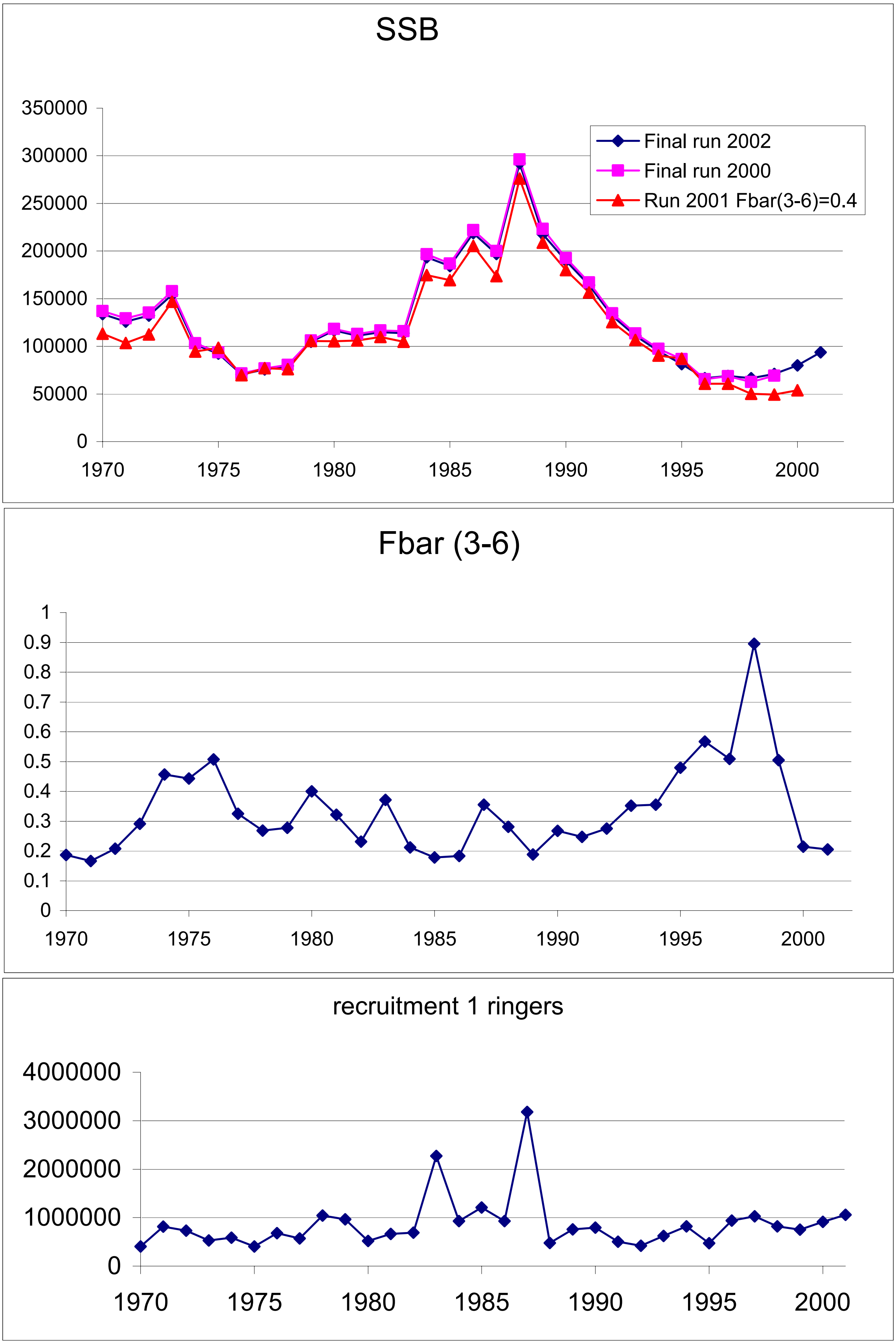


Figure 6.5.2.1 Herring in VIa(S) and VIIb,c. Comparison of SSB trajectories from the past 3 years assessments and F and recruitment developments from this year.

7 IRISH SEA HERRING (DIVISION VIIA, NORTH)

7.1 The Fishery

7.1.1 Advice and management applicable to 2001 and 2002

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. This resulted in a TAC of 5,350 t for 2000. In 2000, there was uncertainty concerning the actual catches, so three scenarios with differing catches were presented. ACFM recommended a catch of 5,100 t, and hence a TAC of 6,900 t was adopted for 2001 reflecting *status quo* F (0.26).

In the 2001 assessment, there was again 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. ACFM felt that the HAWG 2001 assessment was too different from previous perceptions of the stock, thus a catch based on the mean of the last five years was recommended (4,800 tonnes) for 2002. This was partitioned 3550t to the UK and 1250t to the Republic of Ireland.

In 2001 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 2001. 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 21September 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 2001

The catches reported from each country for the period 1985 to 2001 are given in Table 7.1.1, and total catches from 1967 to 2001 in Figure 7.1.1. Reported landings for the Irish Sea amounted to 5,460t. The size of the actual catch from the Irish Sea (VIIaN) is still uncertain. In 2001, the Republic of Ireland took some of their quota of 860t from Division VIIa (N). The number of vessels that target herring in the Irish Sea in 2001 increased compared to recent years as Republic of Ireland, Manx and Scottish boats all reported catches from VIIa (N). According to the reported landings all of the catch was taken in the 3rd and 4th quarters. There were no landings from the Mourne gillnet fishery.1,500 t of herring reportedly from VIIa (N) were landed outside of the Irish Sea in Londonderry, Northern Ireland.

7.1.3 Quality of catch and biological data

There are still no estimates of discarding or slippage of herring in the Irish Sea fisheries 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). Working Group landing statistics are assumed to be accurate up to 1997, However, there are no reliable estimates of landings from 1998 to 2001. It is likely that the landings lie between 2,000 and 7,000 tonnes. The data in the Tables 7.1.1 and 7.1.3 for 1998 to 2001 should be treated as highly unreliable. Biological sampling of this fishery remains fairly high (Table 7.1.2).

7.1.4 Catch in numbers

Catches in numbers-at-age are given in Table 7.1.3 for the years 1972 to 2001. The official catches were used for 1998 to 2001. The predominant year class in 2001 was the 4-rings (1996 year class), which was prevalent in 1999 and 2000. The catch in numbers at length is given in Table 7.1.4 for 1988 to 2001. In 2001 the mode was similar to that in 2000 (see Table 7.1.3) reflecting the increased prevalence of 4 and 5-rings in the catches and in the acoustic estimates (see Sectiion 7.3.1).

7.2 Mean Length, Weight, Maturity and Natural Mortality at Age

Mean lengths-at-age were calculated for the 3rd and 4th quarters using the Northern Ireland data and are given for the years 1985 to 2001 in Table 7.2.1. In general, mean lengths are smaller than previously recorded.

Mean weights-at-age in the catch are given in Table 7.2.2. Mean weights-at-age of the younger fish in 2001 were the lowest since 1992, 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 (HAWG 2001). 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 an unchanging.

Mean weights-at-age in the third-quarter catches 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 2001). To present stock-specific, annually changing, maturity ogives it will be necessary to combine data sets from the Isle of Man and Northern Ireland. Since the samples were obtained from fisheries targeting different parts of the population a more detailed examination of the historical data sets needs to be undertaken before these data can be used in the assessment. Therefore the maturity ogive used since 1994 (ICES 1994/H:5) was used again: 0.08 for 1-rings, 0.85 for 2-rings and 1.00 for 3+-rings.

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.

7.3 Research Surveys

7.3.1 Acoustic surveys

The information on the time-series of acoustic surveys in the Irish Sea is given in Table 7.3.1.

The acoustic survey was carried out from 10 to 18 September 2001, using a survey design of stratified, systematic transects. Distribution maps prepared regularly by herring fishermen showed herring schools at the end of August and beginning of September to be concentrated in the coastal waters of the Isle of Man, with some marks off the Irish and Scottish coasts. This is the expected pattern for autumn. 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.,* WD 2). Targets were identified where possible by midwater trawling, and appropriate ALKs constructed from catch samples. The survey was terminated early due to damage of the towed body. Data from the missed strata (north Wales and English coasts) were collected during a subsequent groundfish survey (8-24 October, Armstrong *et al.*, WD2).

Well-defined schools of herring, comprising mainly 1-ringer and older fish (> 18cm length), were found in coastal waters around the Isle of Man and the Mull of Galloway (Fig. 7.3.1). Herring on the spawning grounds to the east of the Isle of Man were in relatively low abundance compared to previous years. An extensive school of mixed adult and juvenile fish was detected off the west coast of the Isle of Man. No herring schools were detected in the area immediately north of the Isle of Man, despite the occurrence of early-stage larvae in this area in November. The estimated SSB of herring in VIIa (N) was 15,300 t (Table 7.3.1), near the mean of the series. Sprat and 0-ringer herring were abundant around the periphery of the Irish Sea and off the west coast of the Isle of Man. The estimated biomass of sprats (approximately 300 $x10^3$ t) was similar to recent years. The age structure of herring from the acoustic survey is given in Table 7.3.2. The 1+ herring form a large component of the total biomass estimate and reflect the large biomass of mixed juveniles and adult fish off the NW of the Isle of Man.

7.3.2 Larvae surveys

A larvae survey was undertaken by Northern Ireland in 2001. This followed the methods and design 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 2001 in the NE Irish Sea was the second highest in the series, the highest since 1994 and had an average CV (Table 7.3.3).

The estimated spawning time of Irish Sea herring in 2001, determined by length distributions of the larvae, was just prior to the mean of the series of Northern Ireland surveys. The mean spawning date for the survey was around 25 September, compared with an average of 1 October over the series. Over 80% of the spawning was estimated to have occurred during a 2-week period, commencing the week after the period of the Northern Ireland acoustic survey of the NE Irish Sea (see Section 7.3.1).

Once again, there were very few Mourne larvae caught in the Northern Irish survey and spawning to the north of the Isle of Man was sizeable (Armstrong *et al*., WD2).

A survey of the north-eastern Irish Sea was also completed in December by the Port Erin Marine Laboratory. Since there is now a two-year gap in the survey index and the series is not used for tuning purposes, the results will only be reported next year.

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). 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 7.4.1). The stanNorthern Ireland 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 of the series (October and March) show an increase in the number of juvenile fish from 1994 to the present day. The March series in particular suggests a ten-fold increase in juvenile abundance.

7.3.4 Analysis of otolith microstructure of juveniles

Separation of autumn- and winter-spawned juveniles in the Irish Sea was achieved using otolith microstructure measurements of larval growth (Brophy 2002). These results confirmed that there was considerable movement of winter-spawned herring, probably of Celtic sea origin, into the Irish Sea in 1999 and 2000. In general, nursery grounds on the western Irish Sea predominately housed winter spawned fish, while autumn-spawned juveniles were found on the eastern Irish Sea. Relative proportions of the two spawning types varied between years. Otolith microstructure analysis of 1 and 2 ringer fish from the same year classes showed that winter-spawned herring (Celtic sea stock) remained in the Irish Sea throughout the juvenile phase.

7.4 Data Exploration and Preliminary Modelling

This year, the preliminary modelling used catch-at-age data derived from the official landings. New data were added to the 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 7.4.1). 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 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 north-east Irish Sea: 1993 - 2001 (**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, 1993-2003 (**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, 1992-2001 (**GFS-martot**).
5. Age-disaggregated acoustic estimates for the SSB of herring in Division VIIa (N) in September 1994 - 2001 (**ACAGE**, Table 7.3.2).
6. Age-aggregated acoustic estimates for the SSB of herring in Division VIIa (N) in September 1994 - 2001 (**AC_VIIa(N)**).

Initial fits within integrated catch-at-age analysis (ICA) including a separable constraint (Deriso *et al.* 1985), were found in 2002 with all indices. The ICA model was fitted using each survey series (1-7). The following input values were used:

- Separable constraint over last 6 years (weighting = 1.0 for each year)
- Reference age = 4
- Constant selection pattern model
- Selectivity on oldest age = 1.0
- First age for calculation of mean F = 2

- Last age for calculation of mean F = 6
- Weighting on 1-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

In general, the acoustic indices (ACAGE and AC_VIIa(N)) indicated higher F at reference age 4 (0.466 and 0.474 respectively) than either the larvae indices (NINEL and DBL, 0.330 and 0.242 respectively) or the two groundfish surveys (GFS-octtot and GFS-martot, 0.197, 0.079 respectively, Figure 7.4.1). The precision in F was greater for the age-disaggregated acoustic index and GFS-martot. In an attempt to explore further the performance of these tuning indices, some of the indices were combined. The combinations that were tested included the indices that were used last year (NINEL, DBL and ACAGE) for 6 and 8 separable periods and the exclusion of DBL since there were no new data for 2001. The use of 6 or 8 years separable periods had no significant effect on the estimates of F (Figure 7.4.1).

Due to the variable presence of Celtic Sea juveniles in the Irish Sea and the lack of correspondence between year classes in the surveys, the groundfish surveys were thought not appropriate as tuning indices for recruitment. This situation could be rectified when suitable methods based on length analysis, otoliths or hydrodynamic modelling identify the source of juveniles in the catch. The indices used in last years assessment appeared to give the best performance in terms of precision of the estimates and patterns in the residuals. These were chosen for the final assessment.

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 2002 to 1999 to recreate the perception of SSB, $F_{(2-6)}$ and recruitment for each assessment year (Figure 7.4.2). The present perception of the stock was similar to that for 2001. The acoustic survey (ACAGE) was too short to give a robust assessment in 1999.

There is still doubt concerning the actual landings. However,, since the extent of any misreporting is still uncertain (this was investigated in HAWG 2000, official landings were used for all runs.

7.5 Stock assessment

The results of the baseline model fit (with ACAGE, NINEL and DBL) are shown in Figures 7.5.1-7.5.5. The run log is given in Table 7.5.1. Some of the plots for the indices are not shown due to problems encountered with using two SSB indices in IcaView, the residuals and fitted values are given in Table 7.5.2. The SSQ surface for the index shows a minimum at a low level of fishing mortality (Figure 7.5.1). The estimate for $F_{(2-6)}$ for 2001 using the official landing data was 0.36 (Table 7.5.2) with a corresponding SSB estimate of approximately 11,500 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 7.5.6) and takes into account the uncertainty within the parameter estimates of the model. The historical uncertainty does not reflect the uncertainty in the official landings (see 7.1.2). 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 7.5.7 and the stock recruitment plot with $\mathbf{F}_{low}$ (0.17), $\mathbf{F}_{med}$ (0.37) and $\mathbf{F}_{high}$ (0.65) in Figure 7.5.8.

7.6 Stock and Catch Projection

Short-term predictions were carried out using all the ICA estimates of population numbers and fishing mortalities (Section 7.5) using MFDP ver.1a. These projections are for illustrative purposes only as the Working Group is very unsure of the actual status of this stock. The numbers of 1-ringers in 2001-2003 were assumed to be a geometric mean of the recruitment over the period 1972–2000 (Table 7.6.1). Mean weights in the catch and in the stock were taken as a mean for the years 1999–2001. The relevant ICA estimates of F at age in (mean 1999–2001) were used for the exploitation pattern.

There is still uncertainty in the actual catches; however, the official statistics are taken as the landings. In 2001, the UK took its full quota and vessels from the Republic of Ireland joined the fishery. One option table is presented based on the TAC being taken in 2002.

The Management Option Table is given in Table 7.6.2. The Single Option Table, giving age-disaggregated information, is given in Table 7.6.3. A summary is given below:

Year	**$F_{(2\text{-}6)}$**	**Landings**	**SSB (t)**	**Comment**	
2002	0.27	4800	13,946		
2003	$0.28{=}F_{(2001)}$	5148	15,153	Rising SSB	
2004	$0.28{=}F_{(2001)}$	5421	15,957	Rising SSB	Table 7.6.3

7.7 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 as the assessment is still not stable and the level of catches is uncertain. The current state of herring recruitment to VIIaN is unclear, considering the imprecision in the assessments and the variable mixing of Celtic Sea and western Irish Sea juveniles. Also the historical assessments of recruitment have incorporated both Manx and Mourne components and the contribution of the Mourne component is now thought to be negligible.

7.8 Management Considerations

7.8.1 Precision of the assessment

The current time-series of survey data are short and are prone to providing variable perceptions of stock development due to variability in catchabilities of the indices. The current SSB is slightly larger to that perceived by the Working Group in 2001 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.

There is considerable between-year variation in SSB indices and the relevant 2001 data are generally close to the mean of each series. Therefore, maintaining catch levels, in the short term, of approximately 5,000t should not be detrimental to the stock.

7.8.2 Reference points

Due to uncertainties in the catch data and the assessment the Working Group decided not to revisit the estimation of $\mathbf{B}_{pa}$. 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 7.5.7.

7.8.3 Spawning and juvenile fishing area closures

The arrangement of closed boxes in Division VIIa (N) prior to 1999 are discussed in detail in ICES (ICES 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.

Table 7.1.1 Irish Sea herring Division VIIa(N). Official catch in tonnes by country, 1985-2001. 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
Ireland	0	0	100	0	0	0	0	862
UK	4,828	5,076	5,180	6,651	4,905	4,127	2002	4599
Unallocated	-	-	22	-	-	-	-	-
Total	4,828	5,076	5,302	6,651	4,905*	4,127*	2002*	5461*

* Reliability uncertain.

Table 7.1.2 Irish Sea herring Division VIIa (N). Sampling intensity of commercial landings in 2001.

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	862	8	1031	222	-
	UK (N. Ireland)	2970	22	2751	1099	Yes**
	UK (Isle of Man)	86	-	-	-	-
	UK (Scotland)	687	2*	419	137	-
	UK (England & Wales)	0	-	-	-	-
4	Ireland	0	-	-	-	-
	UK (N. Ireland)	816	1	164	50	No
	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	40	-	-	-	-
	UK (England & Wales)	0	-	-	-	-

* not used, Scottish catches raised using NI sampling.

** estimates for NI whitefish and *Nephrops* fleets

Table 7.1.3 Irish Sea herring Division VIIa(N). Catch in numbers (thousands) by year.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1972	40640	46660	26950	13180	13750	6760	2660	1670
1973	42150	32740	38240	11490	6920	5070	2590	2600
1974	43250	109550	39750	24510	10650	4990	5150	1630
1975	33330	48240	39410	10840	7870	4210	2090	1640
1976	34740	56160	20780	15220	4580	2810	2420	1270
1977	30280	39040	22690	6750	4520	1460	910	1120
1978	15540	36950	13410	6780	1740	1340	670	350
1979	11770	38270	23490	4250	2200	1050	400	290
1980	5840	25760	19510	8520	1980	910	360	230
1981	5050	15790	3200	2790	2300	330	290	240
1982	5100	16030	5670	2150	330	1110	140	380
1983	1305	12162	5598	2820	445	484	255	59
1984	1168	8424	7237	3841	2221	380	229	479
1985	2429	10050	17336	13287	7206	2651	667	724
1986	4491	15266	7462	8550	4528	3198	1464	877
1987	2225	12981	6146	2998	4180	2777	2328	1671
1988	2607	21250	13343	7159	4610	5084	3232	4213
1989	1156	6385	12039	4708	1876	1255	1559	1956
1990	2313	12835	5726	9697	3598	1661	1042	1615
1991	1999	9754	6743	2833	5068	1493	719	815
1992	12145	6885	6744	6690	3256	5122	1036	392
1993	646	14636	3008	3017	2903	1606	2181	848
1994	1970	7002	12165	1826	2566	2104	1278	1991
1995	3204	21330	3391	5269	1199	1154	926	1452
1996	5335	17529	9761	1160	3603	780	961	1364
1997	9551	21387	7562	7341	1641	2281	840	1432
1998	3069	11879	3875	4450	6674	1030	2049	451
1999	1810	16929	5936	1566	1477	1989	444	622
2000	1221	3743	5873	2065	558	347	251	147
2001	2713	11473	7151	13050	3386	936	650	803

Table 7.1.4 Irish Sea herring Division VIIa (N). Catch at length for 1988-2001. Numbers of fish in thousands

Length	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
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	1,106		59	148	200	525	30	82	97	105
18	46	44	224	31	1,263		69	300	173	1,022	123	145	115	229
	85	43	165	56	1,662		89	280	415	1,066	206	135	134	240
19	247	116	656	168	1,767	39	226	310	554	1,720	317	234	164	385
	306	214	318	174	1,189	75	241	305	652	1,263	277	82	97	439
20	385	226	791	454	1,268	75	253	326	749	1,366	427	218	109	523
	265	244	472	341	705	57	270	404	867	1,029	297	242	85	608
21	482	320	735	469	705	130	400	468	886	1,510	522	449	115	1086
	530	401	447	296	597	263	308	782	1,258	1,192	549	362	138	1201
22	763	453	935	438	664	610	700	1,509	1,530	2,607	1354	1261	289	1748
	1,205	497	581	782	927	1,224	785	2,541	2,190	2,482	1099	2305	418	1763
23	2,101	612	2,400	1,790	1,653	2,016	1,035	4,198	2,362	3,508	2493	4784	607	2670
	3,573	814	1,908	1,974	1,156	2,368	1,473	4,547	2,917	3,902	2041	4183	951	2254
24	5,046	1,183	3,474	2,842	1,575	2,895	2,126	4,416	3,649	4,714	3695	4165	1436	3489
	5,447	1,656	2,818	2,311	2,412	2,616	2,564	3,391	4,077	4,138	2769	3397	1783	4098
25	5,276	2,206	4,803	2,734	2,792	2,207	3,315	3,100	4,015	5,031	2625	2620	2144	5566
	4,634	2,720	3,688	2,596	3,268	2,198	3,382	2,358	3,668	3,971	2797	1817	1791	4785
26	4,082	3,555	4,845	3,278	3,865	2,216	3,480	2,334	2,480	3,871	3115	1694	1349	3814
	4,570	3,293	3,015	2,862	3,908	2,176	2,617	1,807	2,177	2,455	2641	1547	840	2243
27	4,689	2,847	3,014	2,412	3,389	2,299	2,391	1,622	1,949	1,711	2992	1475	616	1489
	4,124	2,018	1,134	1,449	2,203	2,047	1,777	990	1,267	1,131	1747	867	479	644
28	3,406	1,947	993	922	1,440	1,538	1,294	834	906	638	1235	276	212	496
	2,916	1,586	582	423	569	944	900	123	564	440	170	169	58	179
29	2,659	1,268	302	293	278	473	417	248	210	280	111	61	42	10
	1,740	997	144	129	96	160	165	56	79	59	92		12	0
30	1,335	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 7.2.1 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

Table 7.2.2 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

Table 7.3.1 Irish Sea herring Division VIIa (N): Summary of acoustic survey information for the period 1989-2001. 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

[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
1	66.8	319.1	11.3	134.1	110.4	157.8	78.5	387.6
2	68.3	82.3	42.4	50.0	27.3	77.7	103.4	93.4
3	73.5	11.9	67.5	14.8	8.1	34.0	105.3	10.1
4	11.9	29.2	9.0	11.0	9.3	5.1	27.5	17.5
5	9.3	4.6	26.5	7.8	6.5	10.3	8.1	7.7
6	7.6	3.5	4.2	4.6	1.8	13.5	5.4	1.4
7	3.9	4.9	5.9	0.6	2.3	1.6	4.9	0.6
8+	10.1	6.9	5.8	1.9	0.8	6.3	2.4	2.2

Table 7.3.3 Irish Sea herring Division VIIa (N). Larval production (10^{11}) indices for the Manx component.

Year	Douglas Bank			North East 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

SE = StanNorthern Ireland 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

(b) 1-ring herring: March Surveys

	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

(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

Table 7.4.1 Irish Sea herring Division VIIa (N). Tuning indices used for the assessment. Values and CVs are given.

Year	GFS-octeast[1]		GFS-octtot[1]		GFS-martot[2]	DBL[3]	NINEL[3]	AC_VIIa(N)[4]
	Age 1	Age 2	Age 1	Age 2	Age 1	SSB	SSB	SSB
1989						3.39 (1.54)		-
1990						1.92 (0.78)		-
1991						1.56 (0.73)		-
1992					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				

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- North East Larvae. AC- Acoustic.

Table 7.5.1. Herrring in Division VIIa(N). Run log of HAWG 2002, Irish Sea VIIa(N) final run.

Integrated Catch-at-age Analysis

```
Enter the name of the index file -->index canum weca
Stock weights in 2002  used for the year 2001 west
Natural mortality in 2002  used for the year 2001 natmor
Maturity ogive in 2002  used for the year 2001 matprop
Name of age-structured index file (Enter if none) : -->fleet
Name of the SSB index file (Enter if none) -->ssb
No of years for separable constraint ?--> 6  Reference age for separable constraint ?--> 4
Constant selection pattern model (Y/N) ?-->y S to be fixed on last age ?-->    1.00
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-->    0.10        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 1996-->    1.0     Weight for year 1997-->    1.0
Weight for year 1998-->    1.0     Weight for year 1999-->    1.0
Weight for year 2000-->    1.0     Weight for year 2001-->    1.0
Enter new weights for specified years and ages if needed
Enter year, age, new weight or -1,-1,-1 to end.  -1 -1   -1.00
Is the last age of FLT01: Northern Ireland acoustic surveys a plus-group (Y-->y
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-->   0.05   Enter highest feasible F-->    2.0
Mapping the F-dimension of the SSQ surface
    F                 SSQ
+--------+-------------------
    0.05        26.3812111347
    0.15        18.7257520463
    0.26        17.4579269370
    0.36        17.4703861338
    0.46        17.9620307337
    0.56        18.6933723113
    0.67        19.5758603381
    0.77        20.5876745624
    0.87        21.7776335457
    0.97        22.7410425858
    1.08        23.5653422426
    1.18        24.3832619097
    1.28        25.1962506036
    1.38        26.0082742633
    1.49        26.8275396489
    1.59        27.5734391445
    1.69        28.1445343250
    1.79        28.6878337265
    1.90        29.2043949814
    2.00        29.6952585435
Lowest SSQ is for F =     0.300
No of years for separable analysis : 6  Age range in the analysis : 1  . . . 8
Year range in the analysis : 1972  . . . 2001    Number of indices of SSB : 2
Number of age-structured indices : 1   Parameters to estimate : 33   Number of observations : 1
Conventional single selection vector model to be fitted.
Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
Enter weight for   INDEX1-->    1.0 Enter weight for   INDEX2-->    1.0
Enter weight for age 1-->    0.10   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 age 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-->    1.00
Do you want to shrink the final fishing mortality (Y/N) ?-->N
SSB index weights  1.00 1.00
Aged index weights    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 2001  at age 4  is 0.358187  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 7.5.2. Herring Irish Sea VIIa(N). ICA assessment of Irish Sea herring catches from official landings. Output generated by ICA Version 1.4

Catch in Number

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	40.64	42.15	43.25	33.33	34.74	30.28	15.54	11.77
2	46.66	32.74	109.55	48.24	56.16	39.04	36.95	38.27
3	26.95	38.24	39.75	39.41	20.78	22.69	13.41	23.49
4	13.18	11.49	24.51	10.84	15.22	6.75	6.78	4.25
5	13.75	6.92	10.65	7.87	4.58	4.52	1.74	2.20
6	6.76	5.07	4.99	4.21	2.81	1.46	1.34	1.05
7	2.66	2.59	5.15	2.09	2.42	0.91	0.67	0.40
8	1.67	2.60	1.63	1.64	1.27	1.12	0.35	0.29

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	5.84	5.05	5.10	1.30	1.17	2.43	4.49	2.23
2	25.76	15.79	16.03	12.16	8.42	10.05	15.27	12.98
3	19.51	3.20	5.67	5.60	7.24	17.34	7.46	6.15
4	8.52	2.79	2.15	2.82	3.84	13.29	8.55	3.00
5	1.98	2.30	0.33	0.45	2.22	7.21	4.53	4.18
6	0.91	0.33	1.11	0.48	0.38	2.65	3.20	2.78
7	0.36	0.29	0.14	0.26	0.23	0.67	1.46	2.33
8	0.23	0.24	0.38	0.06	0.48	0.72	0.88	1.67

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	2.61	1.16	2.31	2.00	12.14	0.65	1.97	3.20
2	21.25	6.38	12.84	9.75	6.88	14.64	7.00	21.33
3	13.34	12.04	5.73	6.74	6.74	3.01	12.16	3.39
4	7.16	4.71	9.70	2.83	6.69	3.02	1.83	5.27
5	4.61	1.88	3.60	5.07	3.26	2.90	2.57	1.20
6	5.08	1.25	1.66	1.49	5.12	1.61	2.10	1.15
7	3.23	1.56	1.04	0.72	1.04	2.18	1.28	0.93
8	4.21	1.96	1.61	0.81	0.39	0.85	1.99	1.45

AGE	1996	1997	1998	1999	2000	2001
1	5.33	9.55	3.07	1.81	1.22	2.71
2	17.53	21.39	11.88	16.93	3.74	11.47
3	9.76	7.56	3.88	5.94	5.87	7.15
4	1.16	7.34	4.45	1.57	2.06	13.05
5	3.60	1.64	6.67	1.48	0.56	3.39
6	0.78	2.28	1.03	1.99	0.35	0.94
7	0.96	0.84	2.05	0.44	0.25	0.65
8	1.36	1.43	0.45	0.62	0.15	0.80

x 10 ^ 6

Predicted Catch in Number

AGE	1996	1997	1998	1999	2000	2001
1	2061.	4442.	8877.	2347.	1161.	4194.
2	10904.	12083.	18671.	22409.	4162.	14249.
3	9732.	7847.	5724.	5196.	4943.	7052.
4	1946.	8245.	4385.	1894.	1366.	9870.
5	3666.	1743.	4847.	1539.	536.	2919.
6	827.	2697.	836.	1366.	350.	942.
7	992.	727.	1565.	287.	373.	725.

Weights-at-age in the catches (Kg)

AGE	1972-80	1981	1982	1983	1984	1985	1986	1987
1	0.07400	0.07400	0.07400	0.07400	0.07600	0.08700	0.06800	0.05800
2	0.15500	0.15500	0.15500	0.15500	0.14200	0.12500	0.14300	0.13000
3	0.19500	0.19500	0.19500	0.19500	0.18700	0.15700	0.16700	0.16000
4	0.21900	0.21900	0.21900	0.21900	0.21300	0.18600	0.18800	0.17500
5	0.23200	0.23200	0.23200	0.23200	0.22100	0.20200	0.21500	0.19400
6	0.25100	0.25100	0.25100	0.25100	0.24300	0.20900	0.22800	0.21000
7	0.25800	0.25800	0.25800	0.25800	0.24000	0.22200	0.23900	0.21800
8	0.27800	0.27800	0.27800	0.27800	0.27300	0.25800	0.25400	0.22900

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	0.07000	0.08100	0.09600	0.07300	0.06200	0.08900	0.07000	0.07500
2	0.12400	0.12800	0.14000	0.12300	0.11400	0.12700	0.12300	0.12100
3	0.16000	0.15500	0.16600	0.15500	0.14000	0.15700	0.15300	0.14600
4	0.17000	0.17400	0.17500	0.17100	0.15500	0.17100	0.17000	0.16400
5	0.18000	0.18400	0.18700	0.18100	0.16500	0.18200	0.18000	0.17600
6	0.19800	0.19500	0.19500	0.19000	0.17400	0.19100	0.18900	0.18100
7	0.21200	0.20500	0.20700	0.19800	0.18100	0.19800	0.20200	0.19300
8	0.23200	0.21800	0.21800	0.21700	0.19700	0.21200	0.21200	0.20700

AGE	1996	1997	1998	1999	2000	2001
1	0.06700	0.06400	0.08000	0.06900	0.06400	0.06700
2	0.11600	0.11800	0.12300	0.12000	0.12000	0.10600
3	0.14800	0.14600	0.14800	0.14500	0.14800	0.13900
4	0.16200	0.16500	0.16300	0.16700	0.16800	0.15600
5	0.17700	0.17600	0.18100	0.17600	0.18800	0.16800
6	0.19900	0.18800	0.17700	0.18800	0.20400	0.18500
7	0.20000	0.20400	0.18800	0.19000	0.20000	0.19800
8	0.21400	0.21600	0.22200	0.21000	0.21300	0.20500

Table 7.5.2. continued. Herring Irish Sea VIIa(N).

Weights-at-age in the stock (Kg)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400
2	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500
3	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500
4	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900
5	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200
6	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100
7	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800
8	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	0.07400	0.07400	0.07400	0.07400	0.07600	0.08700	0.06800	0.05800
2	0.15500	0.15500	0.15500	0.15500	0.14200	0.12500	0.14300	0.13000
3	0.19500	0.19500	0.19500	0.19500	0.18700	0.15700	0.16700	0.16000
4	0.21900	0.21900	0.21900	0.21900	0.21300	0.18600	0.18800	0.17500
5	0.23200	0.23200	0.23200	0.23200	0.22100	0.20200	0.21500	0.19400
6	0.25100	0.25100	0.25100	0.25100	0.24300	0.20900	0.22900	0.21000
7	0.25800	0.25800	0.25800	0.25800	0.24000	0.22200	0.23900	0.21800
8	0.27800	0.27800	0.27800	0.27800	0.27300	0.25800	0.25400	0.22900

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	0.07000	0.08100	0.07700	0.07000	0.06100	0.08800	0.07300	0.07200
2	0.12400	0.12800	0.13500	0.12100	0.11100	0.12600	0.12600	0.12000
3	0.16000	0.15500	0.16300	0.15300	0.13600	0.15700	0.15400	0.14700
4	0.17000	0.17400	0.17500	0.16700	0.15100	0.17100	0.17400	0.16800
5	0.18000	0.18400	0.18800	0.18000	0.15900	0.18300	0.18100	0.18000
6	0.19800	0.19500	0.19600	0.18900	0.17100	0.19100	0.19000	0.18500
7	0.21200	0.20500	0.20700	0.19500	0.17900	0.19800	0.20300	0.19700
8	0.23200	0.21800	0.21700	0.21400	0.19100	0.21400	0.21400	0.21200

AGE	1996	1997	1998	1999	2000	2001
1	0.06700	0.06300	0.07300	0.06800	0.06300	0.06600
2	0.11500	0.11900	0.12100	0.12100	0.12000	0.10500
3	0.14800	0.14800	0.15000	0.14500	0.14900	0.13900
4	0.16200	0.16700	0.16600	0.16800	0.17100	0.15600
5	0.17700	0.17800	0.17900	0.17800	0.18800	0.16700
6	0.19500	0.18900	0.19000	0.18900	0.20400	0.18300
7	0.19900	0.20600	0.20000	0.19900	0.20500	0.19900
8	0.21200	0.21400	0.23000	0.21400	0.21500	0.20500

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	1972-96	1997	1998	1999	2000	2001
1	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800
2	0.8500	0.8500	0.8500	0.8500	0.8500	0.8500
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

INDICES OF SPAWNING BIOMASS

INDEX1	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	339	192	156	1564	481	730	158	480	559	227	387	none	none

INDEX2	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	38300.	71200.	15100.	4700.	29100.	5800.	16700.	35500.	55300.

x 10 ^ -3

AGE-STRUCTURED INDICES FLT01: Northern Ireland acoustic surveys

AGE	1994	1995	1996	1997	1998	1999	2000	2001
1	66.83	319.10	11.34	134.15	110.40	157.80	78.52	387.56
2	68.29	82.30	42.37	49.98	27.30	77.70	103.44	93.40
3	73.53	11.90	67.47	14.81	8.10	34.00	105.29	10.19
4	11.86	29.20	8.95	10.98	9.30	5.10	27.54	17.49
5	9.30	4.60	26.47	1.75	6.50	10.30	8.07	7.70
6	7.55	3.50	4.17	4.55	1.80	13.50	5.43	1.37
7	3.87	4.90	5.91	0.57	2.30	1.60	4.90	0.63
8	10.12	6.90	5.82	1.91	0.80	6.30	2.36	2.26

x 10 ^ 3

Table 7.5.2. continued. Herring Irish Sea VIIa(N).

Fishing Mortality (per year)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	0.1662	0.1043	0.2140	0.1523	0.2298	0.1583	0.1039	0.1439
2	0.3617	0.3442	0.8248	0.7523	0.7927	0.8582	0.5379	0.7574
3	0.5221	0.6144	1.0129	0.9073	0.9766	0.9963	0.9266	0.8726
4	0.5328	0.4182	1.0050	0.8249	1.1017	0.9953	0.9139	0.8375
5	0.6125	0.5249	0.7560	0.9540	0.9115	1.0777	0.6678	0.7687
6	0.6323	0.4230	0.7960	0.6809	0.9933	0.7443	1.0086	0.9993
7	0.5350	0.4683	0.8887	0.8279	0.9633	0.9385	0.8211	0.8563
8	0.5350	0.4683	0.8887	0.8279	0.9633	0.9385	0.8211	0.8563

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	0.0621	0.0378	0.0363	0.0091	0.0144	0.0266	0.0429	0.0132
2	1.0895	0.4199	0.2778	0.1924	0.1249	0.2844	0.4070	0.2890
3	1.3497	0.3882	0.2777	0.1561	0.1776	0.4322	0.3776	0.3032
4	0.8963	0.6596	0.4647	0.2055	0.1450	0.5351	0.3732	0.2425
5	1.1188	0.5690	0.1308	0.1458	0.2213	0.3901	0.3106	0.2805
6	0.7528	0.4806	0.5258	0.2566	0.1603	0.3950	0.2669	0.2836
7	1.0502	0.5046	0.3420	0.1937	0.1661	0.4104	0.3506	0.2824
8	1.0502	0.5046	0.3420	0.1937	0.1661	0.4104	0.3506	0.2824

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	0.0381	0.0125	0.0321	0.0481	0.1029	0.0157	0.0157	0.0444
2	0.2887	0.2093	0.3230	0.3182	0.4084	0.3010	0.4120	0.4118
3	0.5837	0.2804	0.3128	0.2991	0.4060	0.3353	0.4709	0.3841
4	0.6534	0.3967	0.3621	0.2383	0.5152	0.3035	0.3314	0.3631
5	0.6252	0.3117	0.5289	0.2906	0.4175	0.3908	0.4050	0.3356
6	0.5694	0.3039	0.4423	0.3857	0.4719	0.3322	0.4825	0.2855
7	0.5463	0.3019	0.3939	0.3098	0.4475	0.3342	0.4251	0.3594
8	0.5463	0.3019	0.3939	0.3098	0.4475	0.3342	0.4251	0.3594

AGE	1996	1997	1998	1999	2000	2001
1	0.0352	0.0516	0.0557	0.0327	0.0120	0.0335
2	0.3646	0.5340	0.5769	0.3379	0.1245	0.3470
3	0.3573	0.5233	0.5654	0.3312	0.1220	0.3401
4	0.3763	0.5512	0.5955	0.3488	0.1285	0.3582
5	0.4101	0.6008	0.6490	0.3802	0.1400	0.3904
6	0.3623	0.5307	0.5733	0.3358	0.1237	0.3449
7	0.3763	0.5512	0.5955	0.3488	0.1285	0.3582
8	0.3763	0.5512	0.5955	0.3488	0.1285	0.3582

Population Abundance (1 January)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	414.12	667.49	349.05	368.65	262.74	323.05	246.92	137.34
2	176.34	129.01	221.23	103.67	116.46	76.81	101.45	81.87
3	72.48	90.98	67.74	71.84	36.20	39.05	24.12	43.89
4	33.38	35.20	40.30	20.14	23.74	11.16	11.80	7.82
5	31.39	17.73	20.97	13.35	7.99	7.14	3.73	4.28
6	15.08	15.39	9.49	8.91	4.65	2.90	2.20	1.73
7	6.72	7.25	9.12	3.87	4.08	1.56	1.25	0.73
8	4.22	7.28	2.89	3.04	2.14	1.92	0.65	0.53

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	152.58	214.47	225.68	227.06	128.70	146.05	168.62	268.27
2	43.76	52.75	75.97	80.06	82.77	46.67	52.32	59.43
3	28.44	10.90	25.68	42.63	48.93	54.12	26.02	25.80
4	15.01	6.04	6.05	15.93	29.86	33.55	28.76	14.60
5	3.06	5.54	2.82	3.44	11.73	23.37	17.77	17.92
6	1.80	0.91	2.84	2.24	2.69	8.51	14.32	11.79
7	0.58	0.77	0.51	1.52	1.57	2.08	5.19	9.92
8	0.37	0.63	1.37	0.35	3.28	2.25	3.11	7.12

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	109.95	146.98	115.36	67.11	194.88	65.60	199.92	116.34
2	97.40	38.94	53.40	41.10	23.53	64.69	23.76	72.40
3	32.97	54.06	23.40	28.64	22.15	11.59	35.46	11.66
4	15.60	15.06	33.44	14.01	17.39	12.08	6.78	18.13
5	10.37	7.34	9.16	21.06	9.99	9.40	8.07	4.41
6	12.25	5.02	4.87	4.89	14.25	5.95	5.75	4.87
7	8.03	6.27	3.35	2.83	3.01	8.05	3.86	3.21
8	10.47	7.87	5.20	3.21	1.14	3.13	6.02	5.04

AGE	1996	1997	1998	1999	2000	2001	2002
1	93.93	139.12	257.80	115.23	153.43	200.62	138.62
2	40.94	33.36	48.60	89.70	41.03	55.77	71.37
3	35.53	21.06	14.49	20.22	47.40	26.84	29.20
4	6.50	20.35	10.22	6.74	11.89	34.35	15.64
5	11.41	4.04	10.61	5.10	4.30	9.46	21.72
6	2.85	6.85	2.00	5.02	3.15	3.38	5.79
7	3.31	1.80	3.65	1.02	3.25	2.52	2.17
8	4.56	3.53	1.05	2.21	1.28	2.79	3.36

x 10 ^ 6

Table 7.5.2. continued. Herring Irish Sea VIIa(N).

Weighting factors for the catches in number

AGE	1996	1997	1998	1999	2000	2001
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
1	553.02	508.29	445.18	306.33	406.11	337.96	378.30	357.54

	1997	1998	1999	2000	2001
1	283.92	263.44	389.14	*******	*******

INDEX2	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	24130.	20080.	22477.	21244.	16870.	15653.	23122.	28581.	26483.

x 10 ^ -3

Predicted Age-Structured Index Values FLT01: Northern Ireland acoustic survey Predicted

AGE	1994	1995	1996	1997	1998	1999	2000	2001
1	143.25	81.59	66.33	97.03	179.26	81.52	110.24	141.84
2	31.28	95.35	55.86	40.09	56.56	124.86	67.03	77.10
3	36.83	12.92	40.18	21.03	14.02	23.32	63.94	30.74
4	7.53	19.64	6.97	19.15	9.30	7.38	15.36	37.35
5	9.01	5.18	12.69	3.89	9.86	5.80	5.86	10.68
6	5.62	5.52	3.05	6.46	1.83	5.48	4.04	3.67
7	3.27	2.86	2.91	1.38	2.72	0.92	3.43	2.24
8	7.21	6.34	5.66	3.85	1.11	2.81	1.91	3.52

x 10 ^ 3

Fitted Selection Pattern

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	0.3120	0.2494	0.2129	0.1846	0.2086	0.1590	0.1137	0.1718
2	0.6789	0.8231	0.8207	0.9120	0.7195	0.8622	0.5886	0.9043
3	0.9799	1.4692	1.0079	1.0998	0.8864	1.0010	1.0139	1.0419
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.1496	1.2550	0.7522	1.1565	0.8273	1.0828	0.7308	0.9178
6	1.1867	1.0114	0.7921	0.8254	0.9016	0.7478	1.1036	1.1932
7	1.0040	1.1198	0.8843	1.0036	0.8744	0.9429	0.8984	1.0224
8	1.0040	1.1198	0.8843	1.0036	0.8744	0.9429	0.8984	1.0224

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	0.0693	0.0574	0.0781	0.0444	0.0996	0.0497	0.1149	0.0544
2	1.2156	0.6366	0.5978	0.9360	0.8613	0.5314	1.0907	1.1920
3	1.5059	0.5886	0.5976	0.7595	1.2242	0.8077	1.0119	1.2503
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.2483	0.8626	0.2815	0.7095	1.5260	0.7289	0.8324	1.1567
6	0.8399	0.7287	1.1314	1.2485	1.1053	0.7382	0.7151	1.1697
7	1.1717	0.7651	0.7360	0.9428	1.1453	0.7670	0.9396	1.1647
8	1.1717	0.7651	0.7360	0.9428	1.1453	0.7670	0.9396	1.1647

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	0.0583	0.0315	0.0888	0.2017	0.1997	0.0517	0.0474	0.1222
2	0.4418	0.5276	0.8918	1.3353	0.7928	0.9920	1.2434	1.1342
3	0.8934	0.7070	0.8637	1.2549	0.7882	1.1048	1.4209	1.0580
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.9569	0.7857	1.4605	1.2196	0.8104	1.2879	1.2220	0.9244
6	0.8716	0.7661	1.2214	1.6186	0.9160	1.0947	1.4560	0.7864
7	0.8361	0.7612	1.0878	1.3000	0.8687	1.1012	1.2827	0.9900
8	0.8361	0.7612	1.0878	1.3000	0.8687	1.1012	1.2827	0.9900

AGE	1996	1997	1998	1999	2000	2001
1	0.0936	0.0936	0.0936	0.0936	0.0936	0.0936
2	0.9688	0.9688	0.9688	0.9688	0.9688	0.9688
3	0.9494	0.9494	0.9494	0.9494	0.9494	0.9494
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0899	1.0899	1.0899	1.0899	1.0899	1.0899
6	0.9628	0.9628	0.9628	0.9628	0.9628	0.9628
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 7.5.2. continued. Herring Irish Sea VIIa(N).

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 6	SoP (%)
1972	414110	93393	33741	27350	0.8106	0.5323	112
1973	667480	106712	32548	22600	0.6944	0.4649	100
1974	349050	92558	24447	38640	1.5805	0.8789	99
1975	368650	68946	16870	24500	1.4522	0.8239	102
1976	262730	54419	12754	21250	1.6660	0.9552	99
1977	323040	49190	9417	15410	1.6364	0.9343	95
1978	246910	43206	10888	11080	1.0176	0.8109	92
1979	137340	34885	9568	12338	1.2894	0.8471	92
1980	152570	28319	5452	10613	1.9465	1.0414	97
1981	214470	29382	7422	4377	0.5897	0.5035	90
1982	225670	36689	12303	4855	0.3946	0.3354	98
1983	227050	42863	18066	3933	0.2177	0.1913	98
1984	128700	41565	22898	4066	0.1776	0.1658	96
1985	146040	40816	16973	9187	0.5412	0.4073	102
1986	168620	37827	16630	7440	0.4474	0.3470	97
1987	268270	39713	16247	5823	0.3584	0.2798	103
1988	109950	36125	15333	10172	0.6634	0.5441	105
1989	146970	33219	14311	4949	0.3458	0.3004	100
1990	115360	30255	13153	6312	0.4799	0.3938	101
1991	67100	22345	11520	4398	0.3818	0.3064	100
1992	194880	24918	7927	5270	0.6648	0.4438	101
1993	65590	22927	10509	4409	0.4195	0.3326	101
1994	199920	28856	8745	4828	0.5520	0.4203	102
1995	116340	25219	9789	5076	0.5185	0.3560	99
1996	93930	21514	9252	5301	0.5729	0.3741	100
1997	139110	22390	7347	6651	0.9052	0.5480	100
1998	257800	31821	6817	4905	0.7195	0.5920	100
1999	115220	25286	10070	4127	0.4098	0.3468	99
2000	153430	26077	12447	2002	0.1608	0.1277	100
2001	200610	31459	11534	5461	0.4735	0.3561	99

No of years for separable analysis : 6 Age range in the analysis : 1 . . . 8
Year range in the analysis : 1972 . . . 2001 Number of indices of SSB : 2
Number of age-structured indices : 1
Parameters to estimate : 33 Number of observations : 126

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	1996	0.3763	25	0.2302	0.6151	0.2928	0.4835	0.3883
2	1997	0.5512	23	0.3444	0.8821	0.4337	0.7007	0.5673
3	1998	0.5955	25	0.3605	0.9837	0.4609	0.7693	0.6153
4	1999	0.3488	29	0.1971	0.6174	0.2607	0.4668	0.3639
5	2000	0.1285	30	0.0708	0.2333	0.0948	0.1742	0.1346
6	2001	0.3582	33	0.1874	0.6848	0.2573	0.4985	0.3783
Separable Model: Selection (S) by age								
7	1	0.0936	64	0.0265	0.3305	0.0492	0.1782	0.1152
8	2	0.9688	26	0.5797	1.6191	0.7455	1.2590	1.0026
9	3	0.9494	25	0.5785	1.5582	0.7374	1.2225	0.9802
	4	1.0000		Fixed : Reference Age				
10	5	1.0899	22	0.7029	1.6899	0.8713	1.3632	1.1175
11	6	0.9628	21	0.6283	1.4755	0.7744	1.1971	0.9859
	7	1.0000		Fixed : Last true age				
Separable model: Populations in year 2001								
12	1	200618	143	12101	3325976	47879	840600	559887
13	2	55769	45	23065	134840	35544	87502	61723
14	3	26835	35	13385	53800	18819	38267	28579
15	4	34346	27	20044	58853	26094	45207	35667
16	5	9459	28	5402	16564	7108	12589	9854
17	6	3383	29	1891	6050	2514	4551	3535
18	7	2520	31	1362	4664	1841	3450	2648
Separable model: Populations at age								
19	1996	3311	45	1351	8117	2095	5232	3676
20	1997	1794	35	892	3607	1256	2562	1912
21	1998	3645	32	1925	6901	2632	5048	3843
22	1999	1020	35	507	2050	714	1457	1087
23	2000	3244	34	1647	6388	2295	4584	3443
SSB Index catchabilities								
INDEX1 Linear model fitted. Slopes at age :								
24	1 Q	.3864E-01	14	.3377E-01	.5854E-01	.3864E-01	.5116E-01	.4490E-01
INDEX2 Linear model fitted. Slopes at age :								
25	2 Q	.2296E-02	18	.1931E-02	.3918E-02	.2296E-02	.3295E-02	.2796E-02
Age-structured index catchabilities **FLT01: Northern Ireland acoustic survey**								
Linear model fitted. Slopes at age :								
26	1 Q	1.535	140	.3979	98.58	1.535	25.56	16.83
27	2 Q	2.246	45	1.448	8.704	2.246	5.609	3.941
28	3 Q	1.718	45	1.109	6.615	1.718	4.272	3.005
29	4 Q	1.533	45	.9895	5.919	1.533	3.819	2.686
30	5 Q	1.630	46	1.045	6.414	1.630	4.113	2.882
31	6 Q	1.513	47	.9593	6.171	1.513	3.912	2.723
32	7 Q	1.255	49	.7830	5.377	1.255	3.355	2.315
33	8 Q	1.775	47	1.125	7.241	1.775	4.590	3.195

RESIDUALS ABOUT THE MODEL Separable Model Residuals

Age	1996	1997	1998	1999	2000	2001
1	0.951	0.766	-1.062	-0.260	0.050	-0.436
2	0.475	0.571	-0.452	-0.280	-0.106	-0.217
3	0.003	-0.037	-0.390	0.133	0.172	0.014
4	-0.517	-0.116	0.015	-0.190	0.413	0.279
5	-0.017	-0.061	0.320	-0.041	0.041	0.148
6	-0.058	-0.167	0.209	0.376	-0.007	-0.006
7	-0.031	0.144	0.270	0.436	-0.395	-0.109

Table 7.5.2. continued. Herring Irish Sea VIIa(N).

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1	1989	1990	1991	1992	1993	1994	1995	1996
1	-0.489	-0.974	-1.049	1.630	0.169	0.770	-0.873	0.295

	1997	1998	1999	2000	2001
1	0.677	-0.149	-0.006	*******	*******

INDEX2	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.462	1.266	-0.398	-1.509	0.545	-0.993	-0.325	0.217	0.736

AGE-STRUCTURED INDEX RESIDUALS FLT01: Northern Ireland acoustic survey

Age	1994	1995	1996	1997	1998	1999	2000	2001
1	-0.762	1.364	-1.766	0.324	-0.485	0.660	-0.339	1.005
2	0.781	-0.147	-0.276	0.221	-0.728	-0.474	0.434	0.192
3	0.691	-0.082	0.518	-0.351	-0.548	0.377	0.499	-1.104
4	0.455	0.396	0.250	-0.556	0.000	-0.370	0.584	-0.759
5	0.032	-0.119	0.735	-0.798	-0.417	0.575	0.321	-0.326
6	0.294	-0.456	0.313	-0.350	-0.016	0.902	0.297	-0.984
7	0.167	0.539	0.709	-0.884	-0.166	0.558	0.356	-1.277
8	0.339	0.085	0.027	-0.701	-0.325	0.809	0.209	-0.441

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

Separable model fitted from 1996 to 2001

Variance	0.1447
Skewness test stat.	0.7399
Kurtosis test statistic	-0.5501
Partial chi-square	0.3463
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	0.6897
Skewness test stat.	0.5627
Kurtosis test statistic	-0.4056
Partial chi-square	1.1697
Significance in fit	0.0004
Number of observations	11
Degrees of freedom	10
Weight in the analysis	1.0000

DISTRIBUTION STATISTICS FOR INDEX2

Linear catchability relationship assumed

Variance	0.7784
Skewness test stat.	-0.4282
Kurtosis test statistic	-0.5320
Partial chi-square	2.0733
Significance in fit	0.0043
Number of observations	9
Degrees of freedom	8
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	0.0133	0.0310	0.0498	0.0319	0.0341	0.0426	0.0661	0.0288
Skewness test stat.	-0.3575	0.0828	-0.6361	-0.3930	0.0032	-0.2411	-0.9368	0.1801
Kurtosis test statisti	-0.5029	-0.5851	-0.5583	-0.8179	-0.6395	-0.3664	-0.4763	-0.4290
Partial chi-square	0.0082	0.0200	0.0337	0.0229	0.0271	0.0354	0.0609	0.0251
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	8	8	8	8	8	8	8	8
Degrees of freedom	7	7	7	7	7	7	7	7
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	41.8420	126	33	93	0.4499
Catches-at-age	5.3391	42	23	19	0.2810
SSB Indices					
INDEX1	6.8969	11	1	10	0.6897
INDEX2	6.2273	9	1	8	0.7784
Aged Indices					
FLT01: Northern Ireland acoustic surve	23.3788	64	8	56	0.4175

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	16.1229	126	33	93	0.1734
Catches-at-age	2.7489	42	23	19	0.1447
SSB Indices					
INDEX1	6.8969	11	1	10	0.6897
INDEX2	6.2273	9	1	8	0.7784
Aged Indices					
FLT01: Northern Ireland acoustic surve	0.2499	64	8	56	0.0045

Table 7.6.1 **Herring VIIa(N).** Input table for short-term predictions.

MFDP version 1 Run: TAC constraint Fbar age range: 2-6

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	182000	1	0.08	0.9	0.75	0.066	0.026	0.067
2	71370	0.3	0.85	0.9	0.75	0.115	0.270	0.115
3	29200	0.2	1	0.9	0.75	0.144	0.264	0.144
4	15640	0.1	1	0.9	0.75	0.165	0.279	0.164
5	21720	0.1	1	0.9	0.75	0.178	0.304	0.177
6	5790	0.1	1	0.9	0.75	0.192	0.268	0.192
7	2170	0.1	1	0.9	0.75	0.201	0.279	0.196
8	3360	0.1	1	0.9	0.75	0.211	0.279	0.209

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	182000	1	0.08	0.9	0.75	0.066	0.026	0.067
2.		0.3	0.85	0.9	0.75	0.115	0.270	0.115
3.		0.2	1	0.9	0.75	0.144	0.264	0.144
4.		0.1	1	0.9	0.75	0.165	0.279	0.164
5.		0.1	1	0.9	0.75	0.178	0.304	0.177
6.		0.1	1	0.9	0.75	0.192	0.268	0.192
7.		0.1	1	0.9	0.75	0.201	0.279	0.196
8.		0.1	1	0.9	0.75	0.211	0.279	0.209

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	182000	1	0.08	0.9	0.75	0.066	0.026	0.067
2.		0.3	0.85	0.9	0.75	0.115	0.270	0.115
3.		0.2	1	0.9	0.75	0.144	0.264	0.144
4.		0.1	1	0.9	0.75	0.165	0.279	0.164
5.		0.1	1	0.9	0.75	0.178	0.304	0.177
6.		0.1	1	0.9	0.75	0.192	0.268	0.192
7.		0.1	1	0.9	0.75	0.201	0.279	0.196
8.		0.1	1	0.9	0.75	0.211	0.279	0.209

Input units are thousands and kg - output in tonnes

Table 7.6.2. Herring VIIa(N). Management option table for 2003, assuming TAC is taken in 2002.

MFDP version 1 Run: TAC constraint Fbar age range: 2-6

Irish Sea 2002Projection index file Sunday, 17 March 2002.

2002

Biomass	SSB	FMult	FBar	Landings
33095	13946	0.9889	0.2738	4800

2003					**2004**	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
34672	19265	0	0	0	41088	25093
.	18807	0.1	0.0277	576	40491	23966
.	18360	0.2	0.0554	1137	39910	22892
.	17924	0.3	0.0831	1685	39344	21871
.	17498	0.4	0.1108	2218	38793	20898
.	17083	0.5	0.1384	2738	38256	19971
.	16678	0.6	0.1661	3245	37733	19088
.	16283	0.7	0.1938	3739	37224	18248
.	15897	0.8	0.2215	4221	36728	17447
.	15520	0.9	0.2492	4690	36245	16684
.	15153	1	0.2769	5148	35775	15957
.	14795	1.1	0.3046	5595	35316	15264
.	14445	1.2	0.3323	6030	34870	14604
.	14104	1.3	0.3599	6454	34435	13975
.	13771	1.4	0.3876	6868	34011	13376
.	13446	1.5	0.4153	7272	33599	12805
.	13129	1.6	0.443	7665	33197	12260
.	12820	1.7	0.4707	8049	32805	11741
.	12518	1.8	0.4984	8424	32423	11246
.	12224	1.9	0.5261	8789	32052	10773
.	11936	2	0.5538	9145	31689	10323

Input units are thousands and kg - output in tonnes

Table 7.6.3 Herring VIIa(N). Single option table for TAC taken in 2002 and F $_{status\ quo}$ in 2003.

MFDP version 1 Run: TAC constraint Fbar age range: 2-6

Year: 2002 F multiplier: 0.9889 Fbar: 0.2738

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0258	2934	196	182000	11951	14560	956	6720	441
2	0.2668	14536	1676	71370	8231	60665	6997	38100	4394
3	0.2615	6116	881	29200	4215	29200	4215	19862	2867
4	0.2754	3591	588	15640	2581	15640	2581	11324	1869
5	0.3002	5373	953	21720	3859	21720	3859	15380	2733
6	0.2652	1286	247	5790	1112	5790	1112	4231	812
7	0.2754	498	98	2170	436	2170	436	1571	316
8	0.2754	772	162	3360	710	3360	710	2433	514
Total		35107	4800	331250	33095	153105	20865	99622	13946

Year: 2003 F multiplier: 1 Fbar: 0.2769

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0261	2966	198	182000	11951	14560	956	6718	441
2	0.2698	13420	1548	65250	7526	55463	6397	34740	4007
3	0.2644	8565	1233	40490	5844	40490	5844	27469	3965
4	0.2785	4268	698	18406	3037	18406	3037	13290	2193
5	0.3035	2684	476	10745	1909	10745	1909	7585	1348
6	0.2681	3265	628	14557	2795	14557	2795	10609	2037
7	0.2785	932	183	4019	808	4019	808	2902	583
8	0.2785	881	184	3799	803	3799	803	2743	580
Total		36980	5148	339266	34672	162038	22548	106057	15153

Year: 2004 F multiplier: 1 Fbar: 0.2769

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0261	2966	198	182000	11951	14560	956	6718	441
2	0.2698	13416	1547	65231	7523	55447	6395	34730	4006
3	0.2644	7807	1124	36908	5327	36908	5327	25039	3614
4	0.2785	5900	966	25448	4199	25448	4199	18375	3032
5	0.3035	3148	558	12606	2240	12606	2240	8899	1581
6	0.2681	1610	310	7177	1378	7177	1378	5231	1004
7	0.2785	2336	458	10074	2025	10074	2025	7274	1462
8	0.2785	1241	260	5354	1132	5354	1132	3866	817
Total		38425	5421	344798	35775	167573	23651	110132	15957

Input units are thousands and kg - output in tonnes

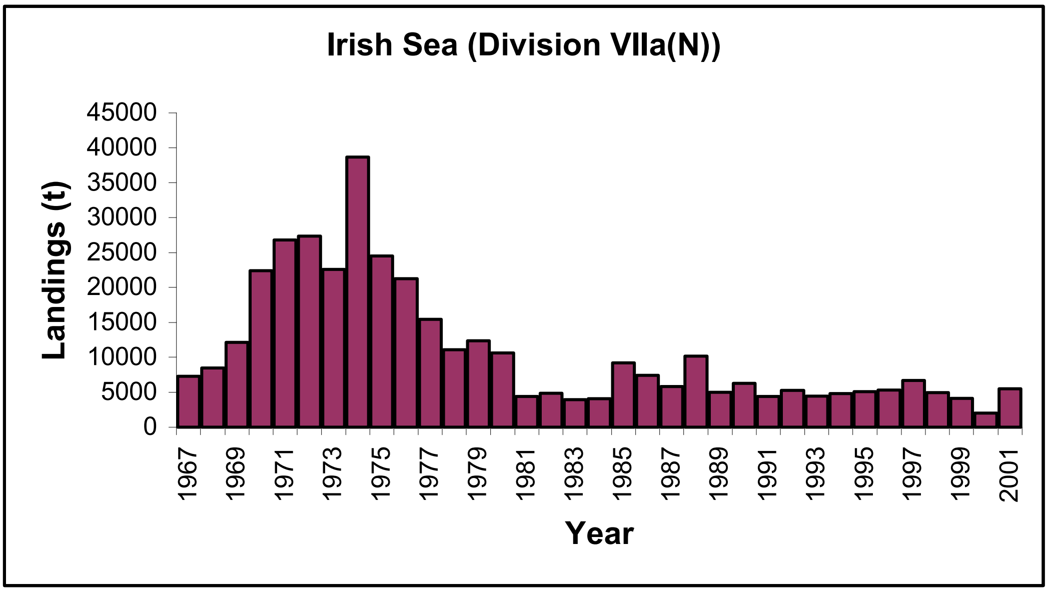


Figure 7.1.1 Herring VIIa(N). Landings of herring from VIIa(n) from 1967 to 2001.

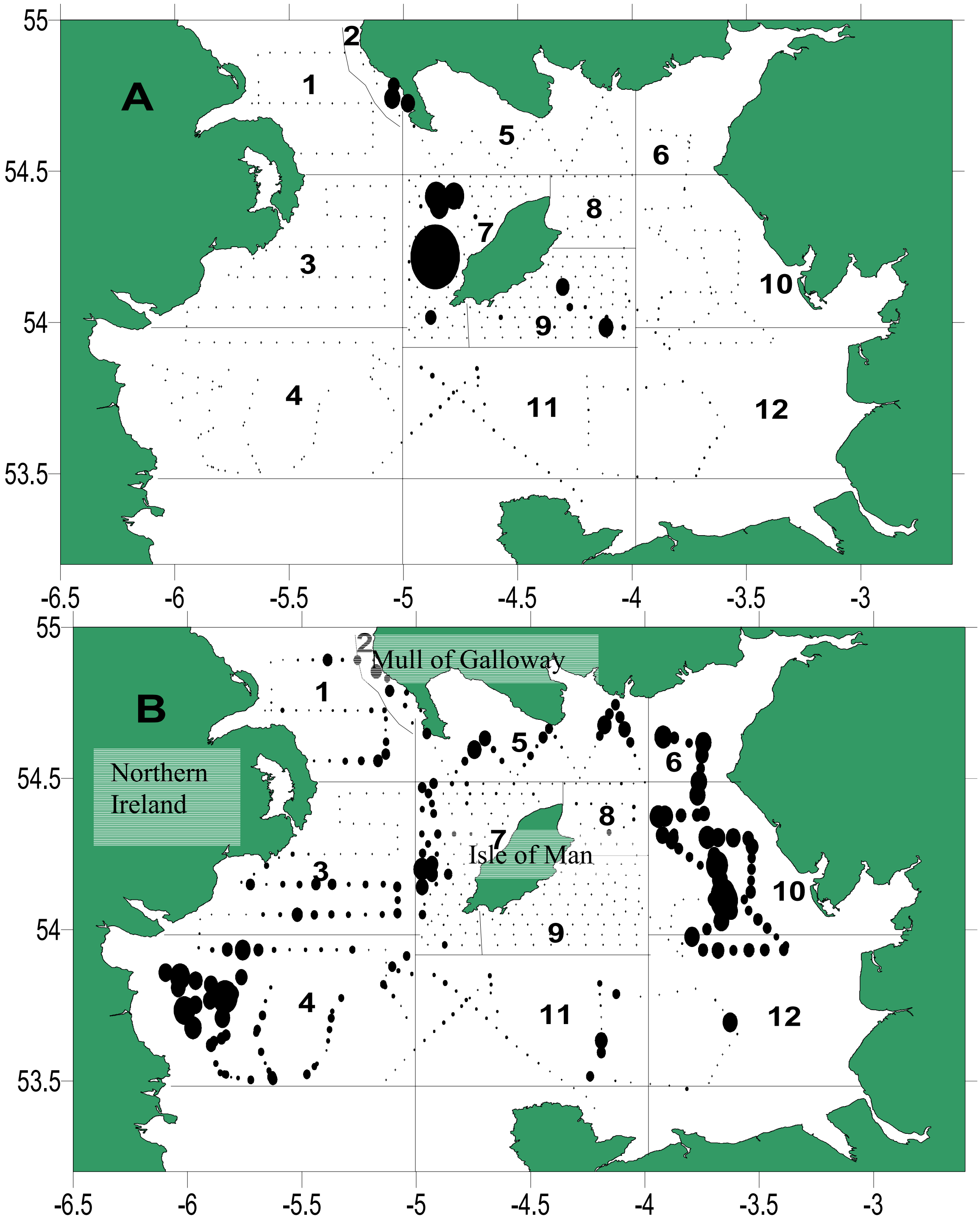


Figure 7.3.1 Irish Sea Herring VIIa(N). DARD acoustic survey. Density distribution of (A) herring schools (mainly 1-ring and older) and (B) sprats and 0-group herring. Size of elipses is proportional to square root of the S_A value for each 15-minute interval (same scale for figures A and B). Crosses indicate starting positions for 15-minute EDSUs. Acoustic survey strata are indicated.

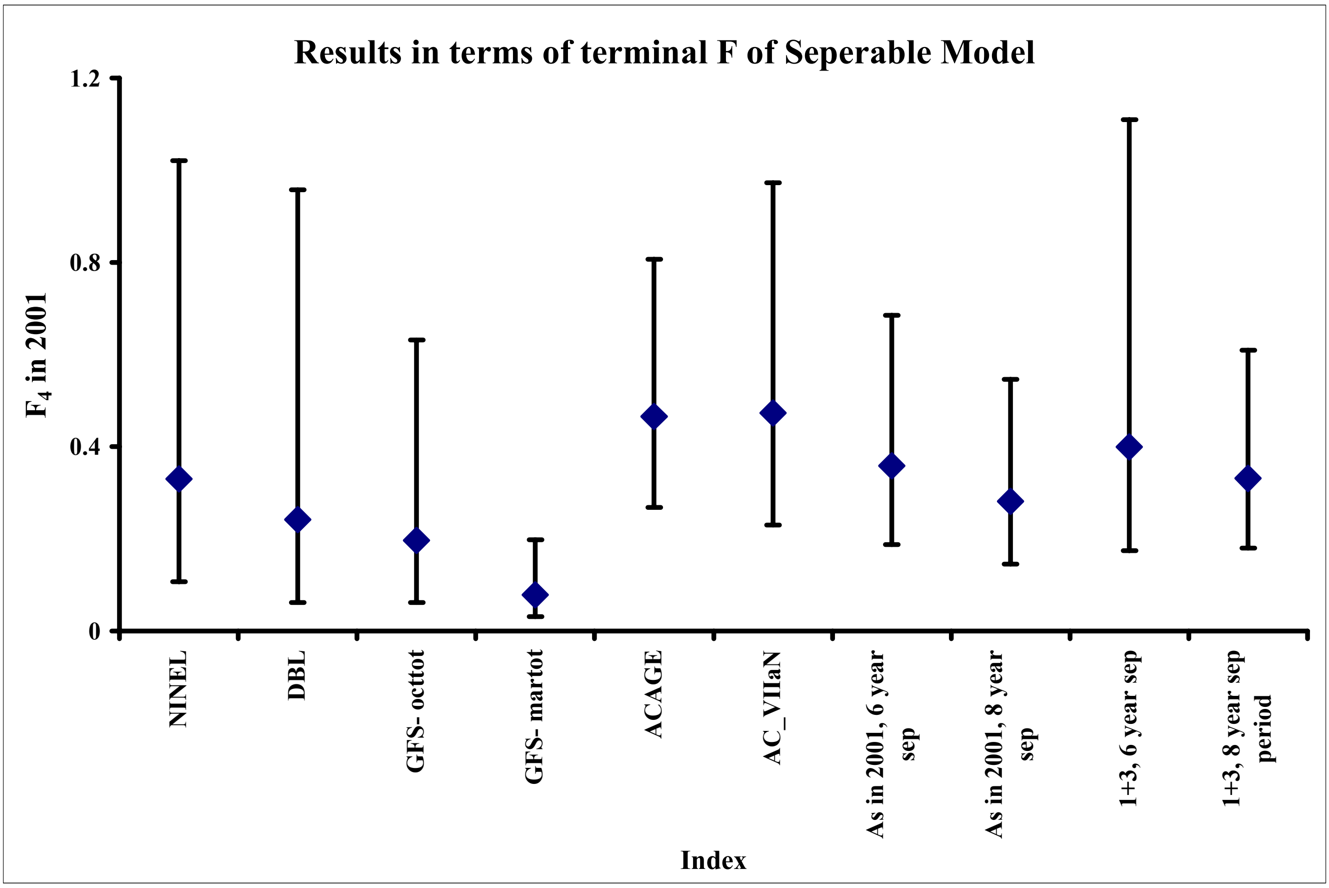


Figure 7.4.1 Irish Sea Herring VIIa(N). Results in terms of reference F (age 4), of the preliminary modelling with ICA of survey indices described in Table 7.4.1. Error bars show the upper and lower 95% confidence limits.

Irish Sea herring with aged acoustics and larvae (PEML and DARD)

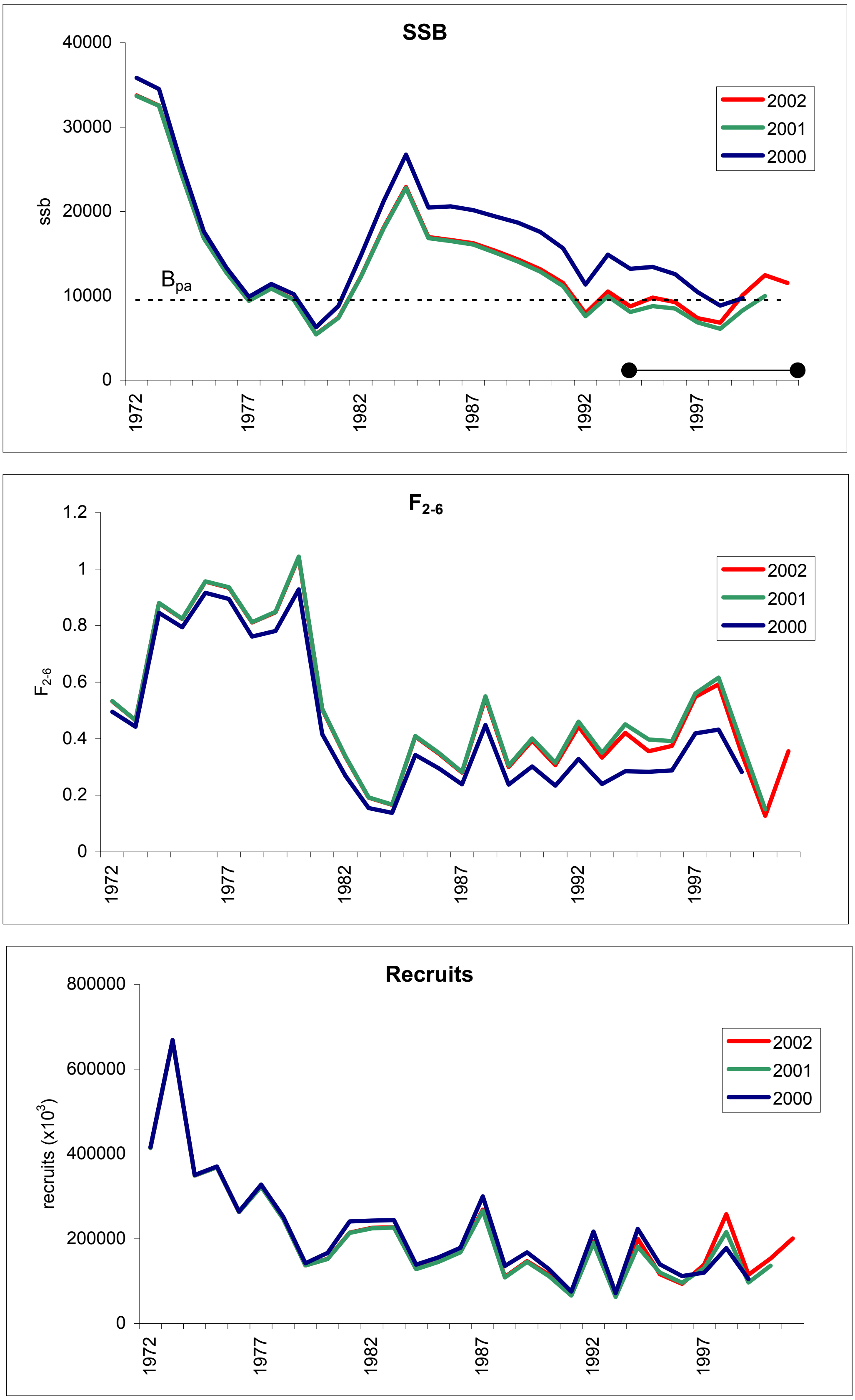


Figure 7.4.2. Herring VIIA (N). Retrospective analysis of the performance of DBL, NINEL and ACAGE series as tuning indices in the assessments of 2000 to 2002. Bar denotes period of acoustic surveys.

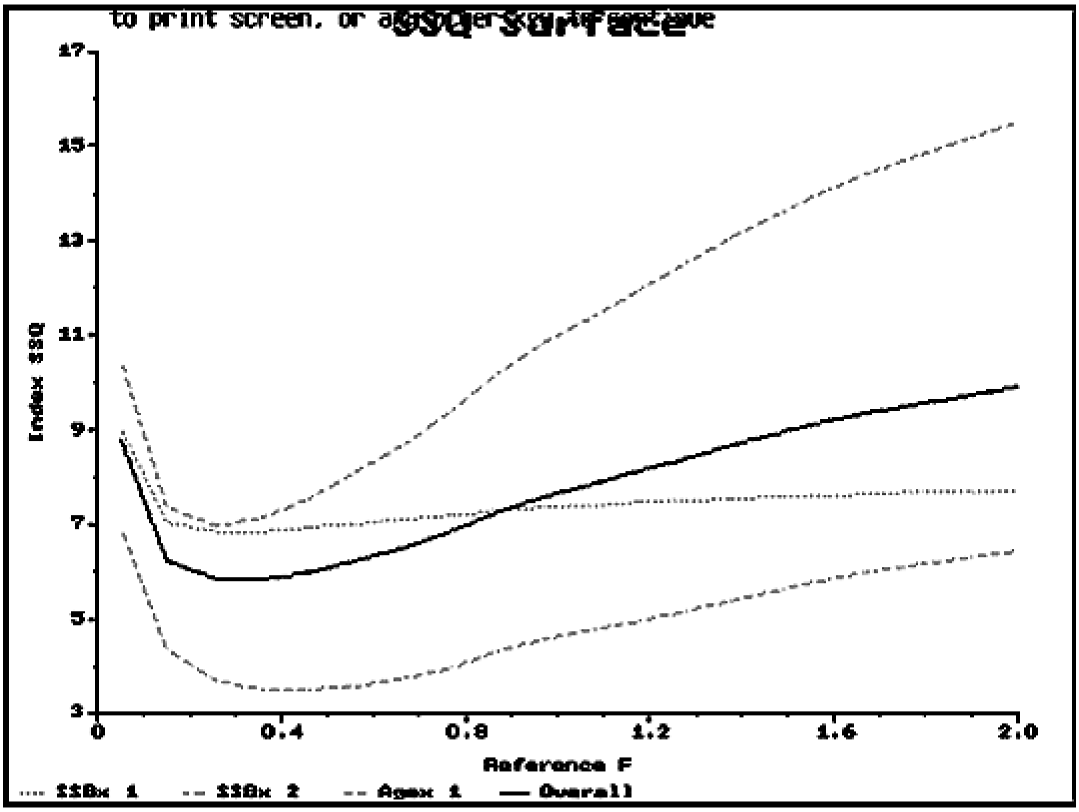


Figure 7.5.1. Herring in VIIa(N). SSQ surface for the deterministic calculation of the 6-year separable period. SSBx1-DBL, SSBx2-NINEL, Agex1- ACAGE (see Table 7.4.1).

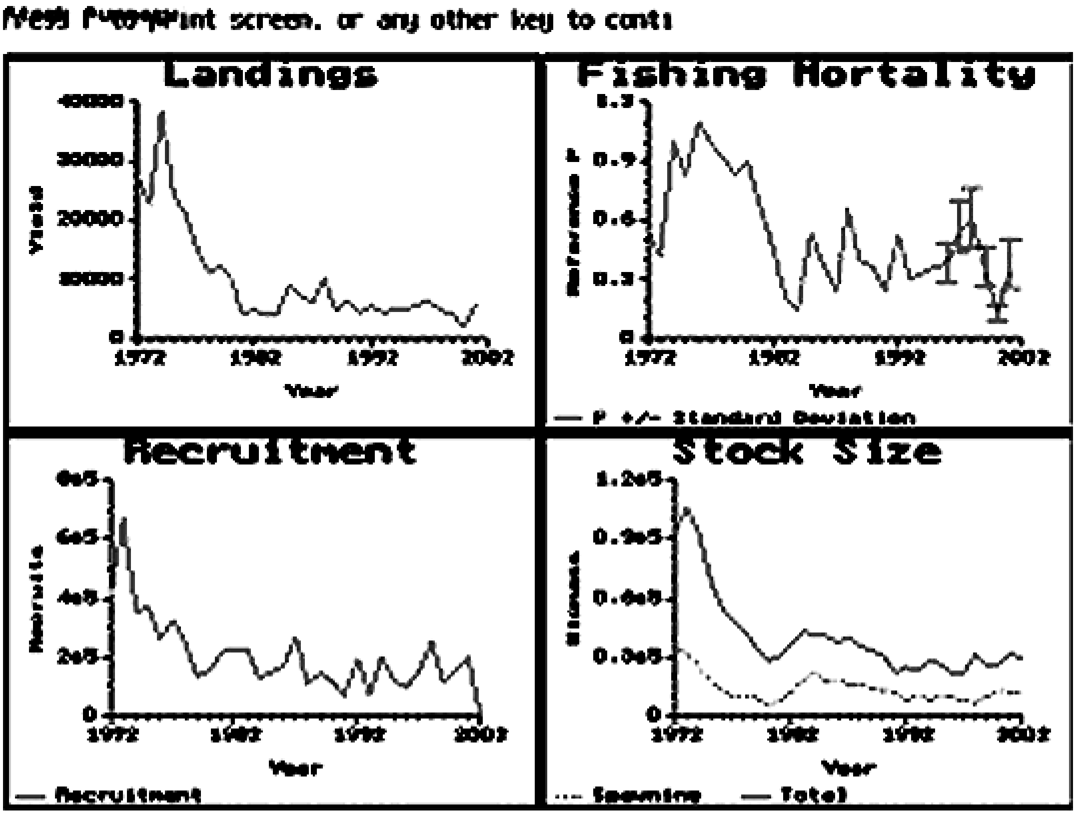


Figure 7.5.2 Herring in VIIa(N). Illustration of stock trends from deterministic calculation (6-year separable period). Summary of estimates of landings, fishing mortality at age 4, recruitment at age 1, stock size on 1 January and SSB at spawning.

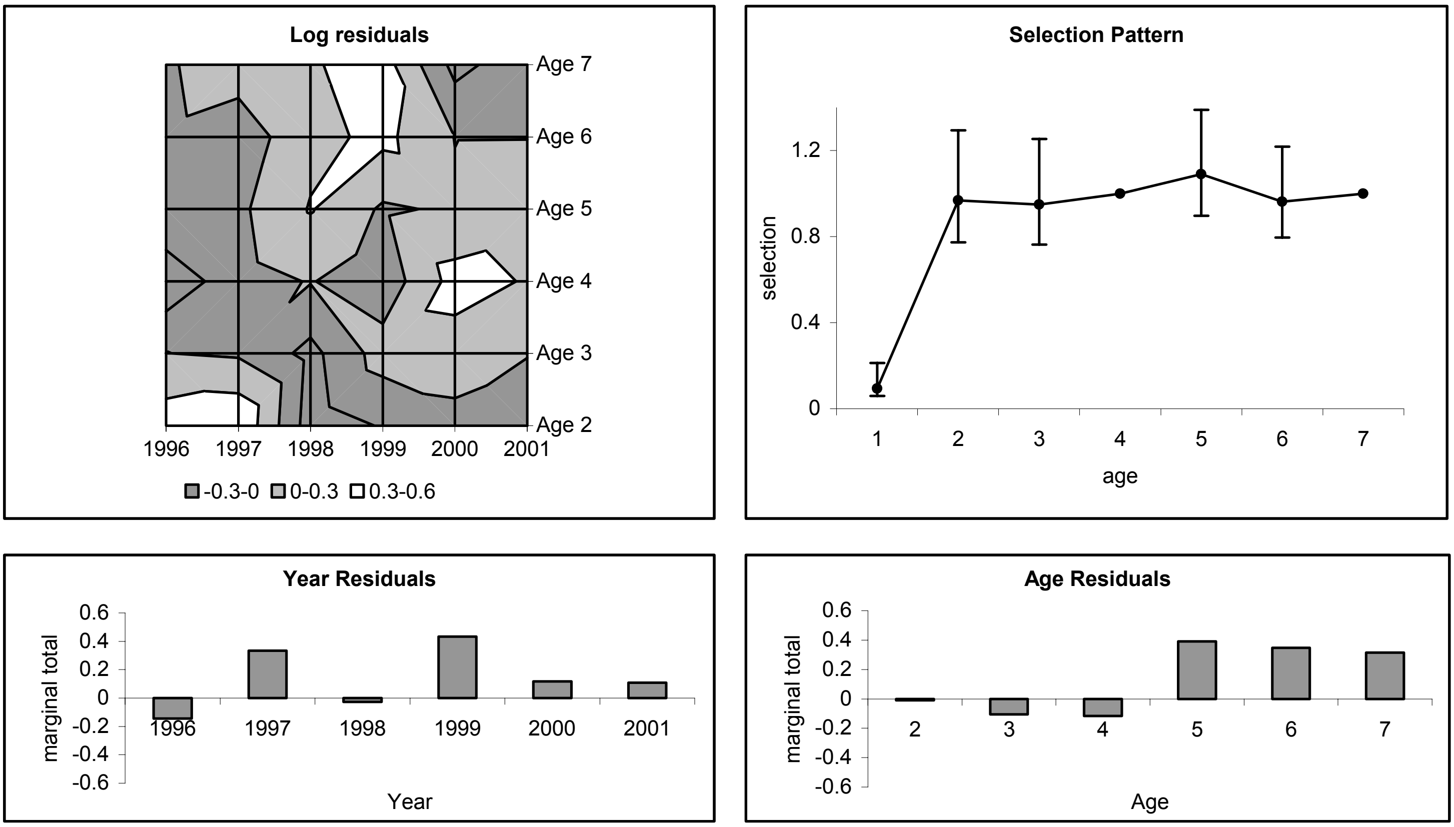


Figure 7.5.3. Herring in VIIa(N). Illustration of selection patterns diagnostics, from deterministic calculation (6-year separable period). Top left, a contour plot of selection pattern residuals. Top right, estimated selection (relative to age 4) +/- standard deviation. Bottom, marginal totals of residuals by year and age

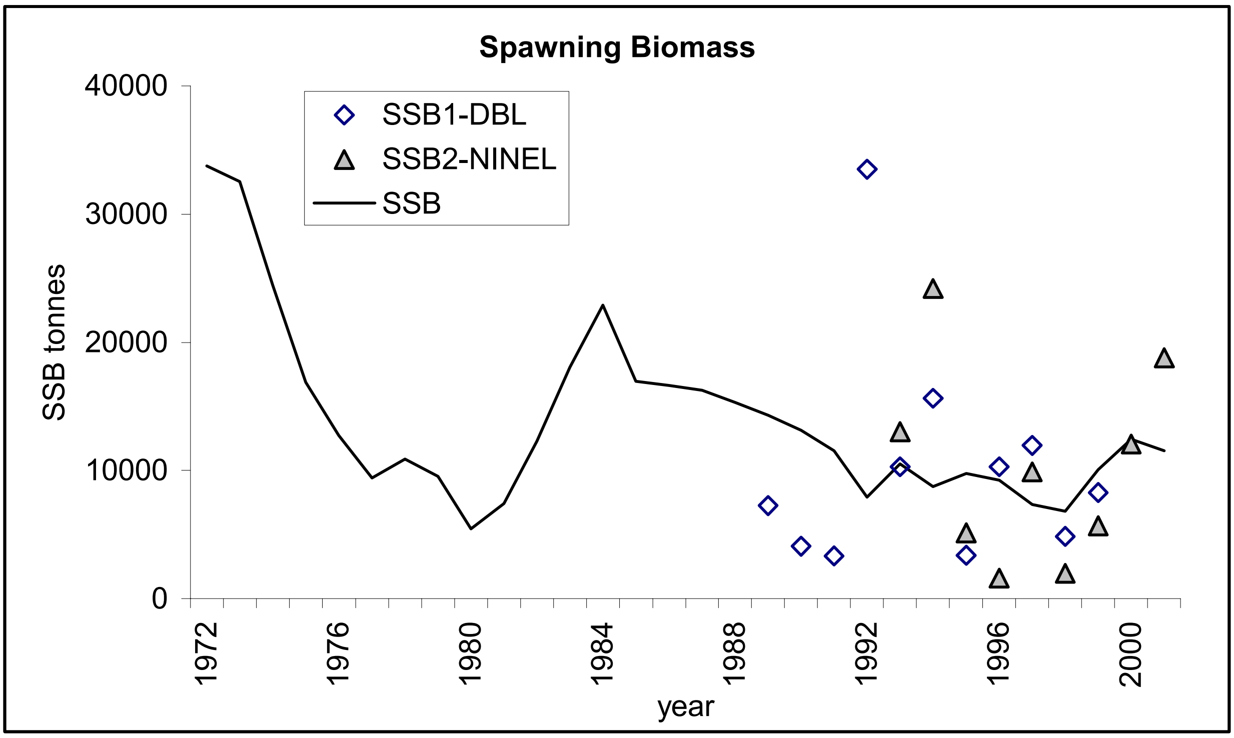


Figure 7.5.4. Herring VIIa(N). Fitted SSB (line) and predicted SSB from indices and estimated catchability. Indices described in Table 7.4.1.

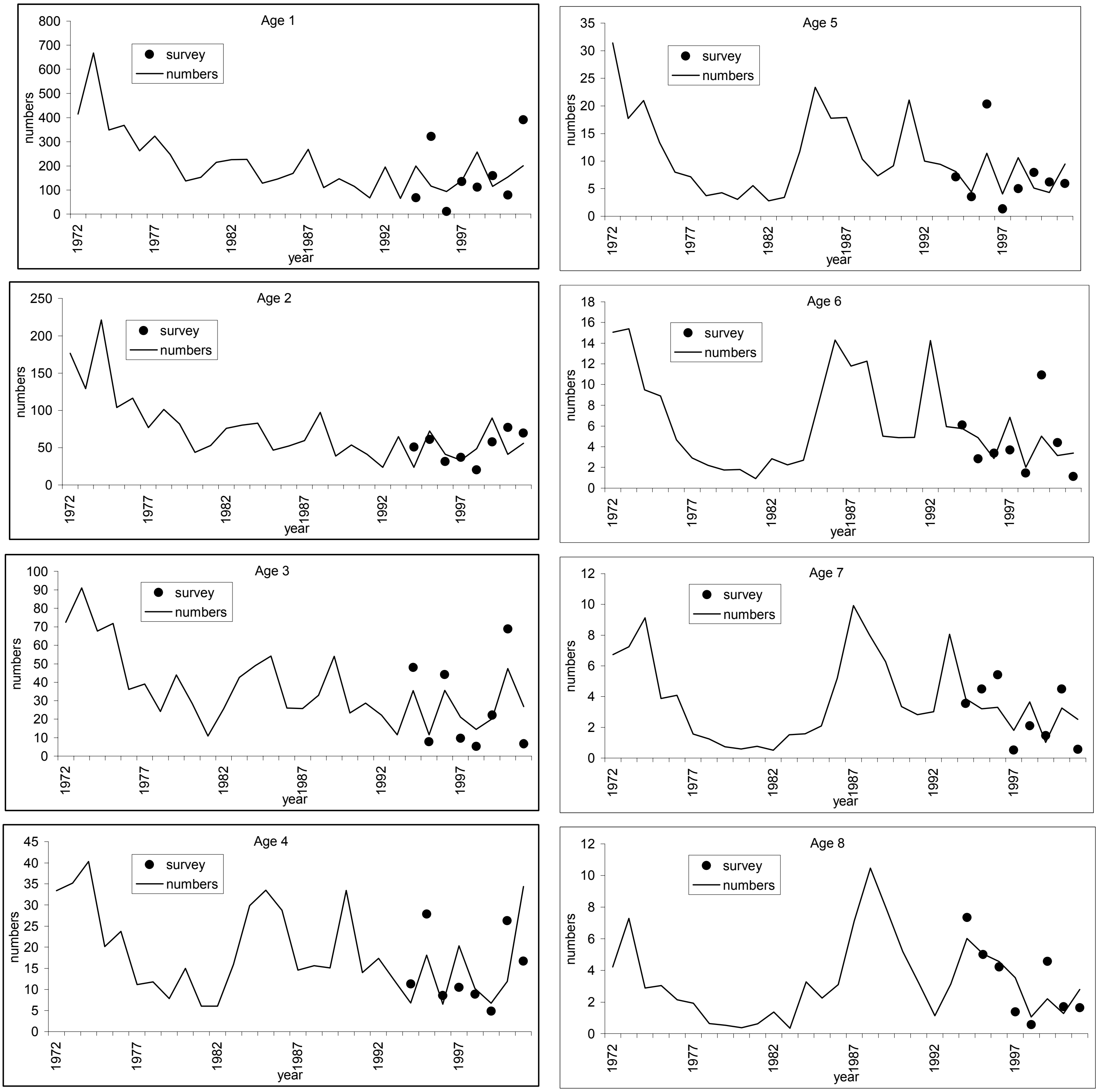


Figure 7.5.5. Herring VIIa(N). Fitted numbers-at-age (line) and predicted numbers from acoustic estimates of age and estimated catchability.

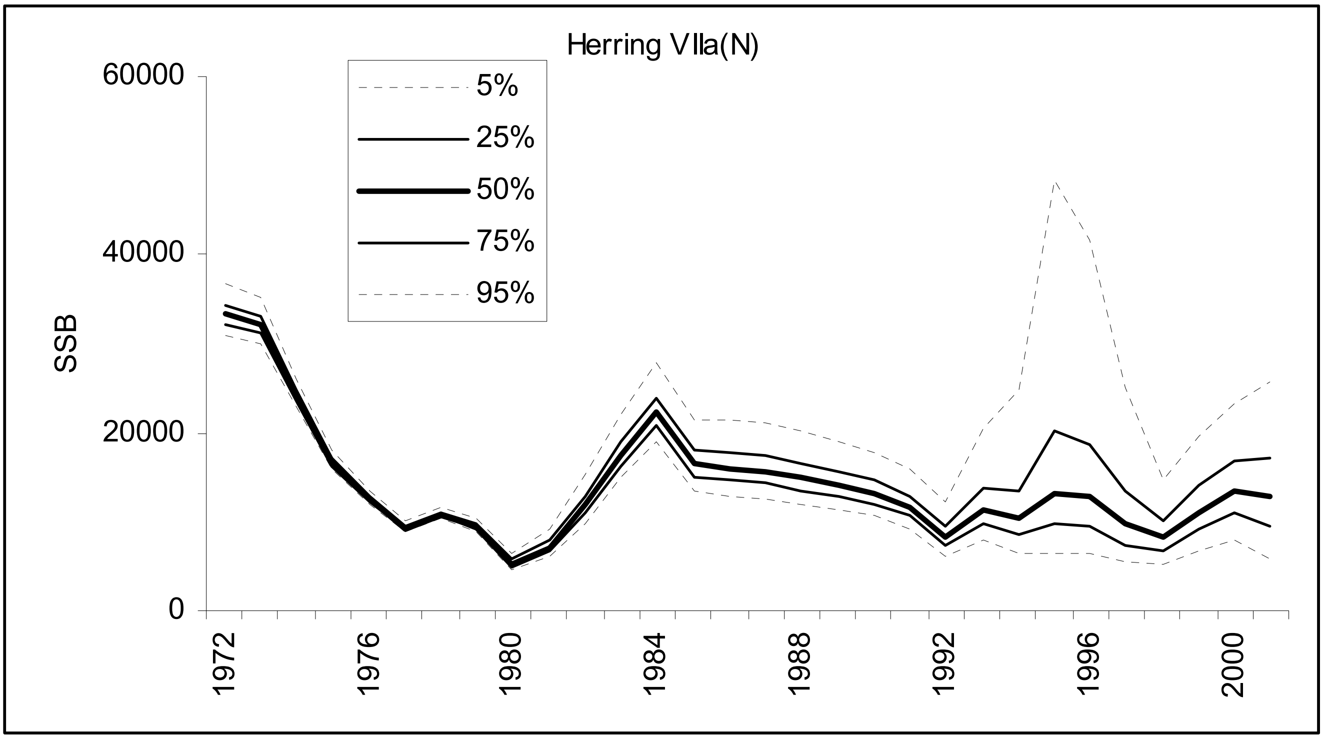
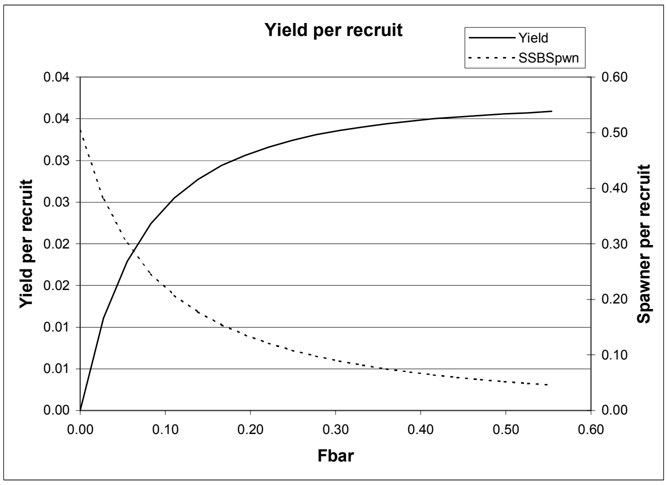
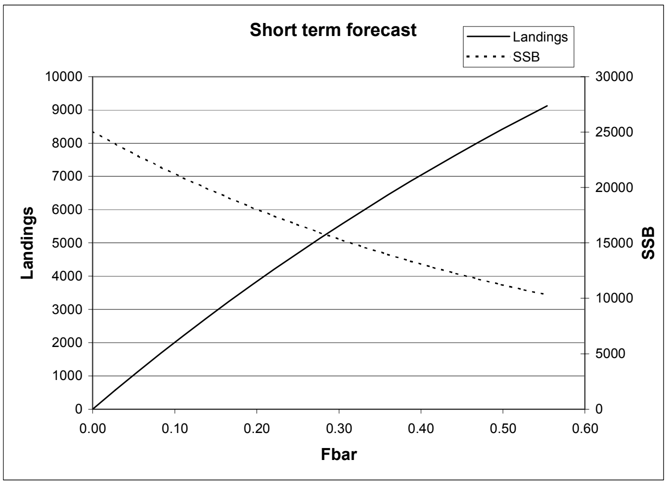


Figure 7.5.6. Herring VIIa(N). Estimates of historical uncertainty of the SSB from 1972 to 2001. Light lines denote 25% and 75% confidence interval and dotted lines denote 5% and 95% confidence intervals.





MFYPR version 1
Run: final nirs ypr
Time and date: 17:21 16/03/2002

Reference point	F multiplier	Absolute F
Fbar(2-6)	1.0000	0.2769
FMax	>=1000000	
F0.1	0.5995	0.1660
F35%SPR	0.5037	0.1395
Flow	0.6211	0.1720
Fmed	1.3323	0.3689
Fhigh	2.3398	0.6479

Weights in kilograms

MFDP version 1
Run: nirs1
Irish Sea 2001Projection index file Saturday, 17 March 2001.
Time and date: 15:05 16/03/2002
Fbar age range: 2-6

Input units are thousands and kg - output in tonnes

Figure 7.5.7. Herring VIIa(N). Long- and short-term yield and SSB, derived from MFDP V1a.

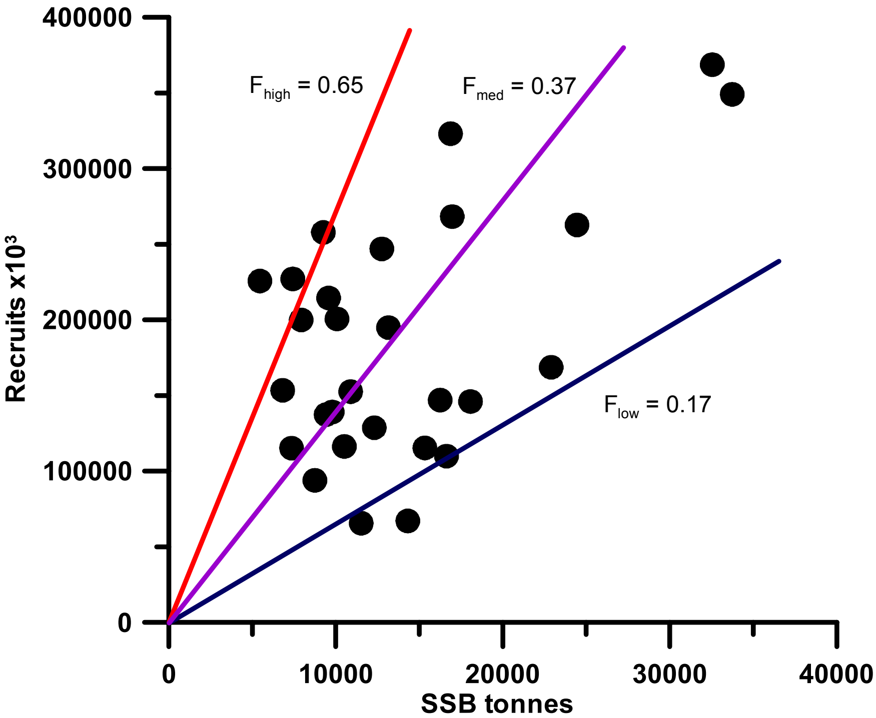


Figure 7.5.8. Herring VIIa(N). Recruitment to SSB plot for herring from 1972 to 1999. Lines donate the locations of **F**$_{high}$, **F**$_{med}$ and **F**$_{low}$.

8 SPRAT IN THE NORTH SEA

8.1 The Fishery

8.1.1 ACFM advice applicable for 2000 and 2001

ACFM advised that based on the historic relationship between the IBTS (February) survey index and catch, the 2001 survey values indicates that a catch of 225,000 t in 2001 would allow the SSB to remain stable or increase. The TAC set by management was 225,000t for 2000 [Subarea IV(EU zone) + Division IIa (EU zone)] and 232,000 t for 2001. For 2002, the TAC agreed between the EU and Norway was set at 257,000t.

8.1.2 Total landings in 2001

Landing statistics for sprat for the North Sea by area and country are presented in Table 8.1.1 for 1987–2001. 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 1994–2001 by year, quarter, and area in the North Sea.

The landings in 2001 were lower, 170,000 t, compared to 2000 where the landings were 196,000 t. This reduction was caused by a reduction in the Danish fishery, from 190,000 tonnes to 157,000 tonnes. An increase in the Norwegian sprat fishery from 2,700 t in 2001 to 9,500 t in 2001 could not counteract the decrease in the Danish fishery. The Danish fishery had high landings in January, September and October (37,000; 27,000 and 33,000 tonnes respectively). In November and December the sprat stock was more widely spread according to reports from the Danish fishing industry and therefore, the small meshed fishing fleet moved towards Norway pout instead. Neither Denmark nor Norway took their quota in 2001.

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 is set for the Norwegian vessels which are not allowed to fish in Norwegian waters in the period where fishery in EU-waters is open.

8.2 Catch Composition

8.2.1 By-catches in the North Sea sprat fishery

As requested by ACFM, data on the species composition of the by-catch of the Danish sprat fishery since 1998 is shown in Table 8.2.1. In general, more than 80% of the catches are 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 2001 compared to previous years. No Norwegian landings by the purse seiners have been sampled in 2001.

The abundance of 0 and 1 ringer herring at the beginning of the year was plotted against 0 and 1 ringer herring in the Danish by-catch respectively over 1989-1995 when no by-catch ceiling was imposed to the sprat fishery (Figures 8.2.1. and 8.2.2.). There was an increasing by-catch of 0 ringer herring with increasing abundance of 0 ringer herring at the beginning of the year, thus herring abundance at the beginning of the year seems to be a good predictor of by-catches of 0 ringer herring by the sprat fishery. In contrast, no similar trend was found between abundance of 1 ringer herring and 1 ringer herring in the by-catches. By-catches of 0 and 1 ringer herring and sprat IBTS index of abundance during 1989-1995 are presented in Figure 8.2.3. The highest by-catch of herring was observed in 1992 when the sprat abundance was relatively low. However, the same pattern did not hold for 1990 and 1991 when sprat abundances were the lowest observed, but the abundance of 0 ringer herring was also relatively low. Although a relationship may be expected between sprat abundance and herring by-catch, the data suggest that this relationship is dependent on other processes too.

8.2.2 Catches in number

The estimated quarterly catch-at-age in numbers by country for the years 1995 to 2001 is presented in Table 8.2.2. Denmark provided age composition data of commercial landings in 2001 for quarters 1 to 3. The same age composition as in quarter 3 was used to estimate the Danish landings in numbers during the fourth quarter. Data on age composition of the Norwegian landings were reported in the first quarter. Danish samples were use to raise the Norwegian catches during the fourth quarter and the Swedish catches.

There is a predominance of age 1 sprat in the catches over all the years although the absolute composition varies from year to year, being higher in 1998-2000 compared to 2001. In contrast, age 0 sprat catches in 2001 were the highest reported since 1995, representing around 10% of the whole catch. During the second quarter Danish landings are very low.

8.2.3 Mean weight-at-age

Mean weights (g) at age in the catches during 2001 are presented by quarter in Table 8.2.3. The table includes mean weights-at-age for 1995-2000 for comparison.

8.2.4 Quality of catch and biological data

The sampling intensity for biological samples, i.e., age and weight-at-age, is given in Table 8.2.4. The sampling level in 2001 is lower than in previous years. The recommended level of one sample per 1,000t landed was not reached, but as the fishery was carried out in a limited area, the 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 in 2001 worked well. A total of 2471 samples were collected from landings by Danish vessels taken in the North Sea. The sampling figure for 2000 was 1209 samples. The total landings from the Danish small mesh fishery in 2001 was 893,000 t (all species) compared to 936,000 t in 2000. The recommended sampling levels for species composition were achieved. The species composition in the Danish sprat fishery is shown in Table 8.2.4.

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 small meshed fishery targeted at sandeel and Norway pout.

8.2.5 Maturity-at-age

During the Working Group, 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 the Working Group but will be considered in the next Working Group together with data from 2002. No other countries contributed with data on maturity. No data was available from the IBTS survey during the third quarter in 2001.

8.3 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 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 1984–2002 are shown in Table 8.3.1 for age groups 1–4, 5+ and total, along with the number of rectangles sampled and the number of hauls considered. The index of 1-group increased and is now above the mean of the time-series. The abundance of the 1998-year class was not detectable as higher than average and is as 4-group below the average. The total-abundance index shows a small decrease compared to 2001, but is still well above 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.

8.4 Acoustic Survey

The acoustic surveys for the North Sea herring in June-July have estimated sprat abundance since 1996. In June-July 1998, sprat 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 40,000t to 210,000t. In 1999 the acoustic estimate of sprat was very low. The low value was not thought to be representative mainly due to inappropriate coverage of the south-eastern area (ICES 2000), the area expected to have the highest abundance of sprat in the North Sea. 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 was significantly increased. The distribution pattern demonstrates, However,, that the southern distribution border was still not reached. The total sprat biomass estimated was 200,000 t, while 98,000 t were estimated in the south-eastern part of the North Sea (ICES/2002:G:02).

8.5 State of the Stock

8.5.1 Catch-survey data analysis

As has also been demonstrated by previous Working Groups (see ICES 1998/ACFM:14), the IBTS surveys do not fully reflect strong and weak cohorts for sprat. This may be due to difficulties in age reading and/or a possible prolonged spawning and recruitment season. However,, the IBTS-survey may still be a useful indicator of the level of the stock biomass used as such in production models.

The Biomass dynamic model (Schaefer model) was fitted using the Catch and Effort Data Analysis (CEDA) program, ver.1.01, (see ICES 1993/ACFM:13 and Holden *et al*., 1995), assuming that the sprat in the North Sea belongs to one stock. The annual landings for 1972–2001 and the IBTS (February) abundance indices for 1984 to 2001 were used as input data. Mean weights-at-age for age groups 1 to 4+ calculated from the biological data from commercial landings in 1st quarter of 1995–2001 were used to compute a total IBTS-biomass index to be fitted by the model (Table 8.5.1).

The level of the initial proportion, i.e. the ratio of stock size at the start of catch data to unexploited stock size (*K*), is a fixed parameter in the fit. It is difficult to decide on what value to use for the initial proportion as the initial, unexploited stock size is not known and the catches were exceptionally high at that time. This year's analysis was performed using 0.8 as an initial proportion based on the results from sensitivity tests carried out by the WG in 2001. The model fits the data reasonably well, as shown in Figure 8.5.1. Point estimates and 95% confidence intervals for the model parameters *K, r* (stock intrinsic growth rate) and *q* (catchability) are shown below.

Parameter	Estimate (95% CI)
K	1,777E3 (1643E3 -2395E3)
Q	3.423E-5 (7.5E-6 - 4.41E-5)
R	0.71 (0.42 - 0.81)

Preliminary runs were performed using CEDA program ver. 2.01 as this version has a better user inter-face than version 1.01 and has apparently incorporated improved techniques for non-linear minimisation. However,, comparison of results from both versions showed significant differences in the point estimates of the parameters. That resulting in similar trends in biomass but, in the case of V 2.01, in a higher biomass level throughout the period considered. The WG decided to use version 1.01 for this assessment based on the fact that it gave consistent results for the past two years. An explanation for the observed differences in parameter estimates will be sought before the 2003WG meeting.

8.6 Projections of Catch and Stock

The regressions of the total catches and the total IBTS indices for 1984–2001 are given in Figure 8.6.1 ($r^2 = 0.368$). From this a predicted yield for 2002 is about 180,000 t. The TAC set for 2002 is 225,000 t.

The SHOT- approach (Shepherd, 1991) was used to estimate the 2002 landings. Using the total IBTS abundance index and the annual exploitation ratio based on the CEDA assessment estimates of biomass; the predicted landings for 2002 are 181,000 tonnes (Table 8.6.1).

Three year forward biomass projections, obtained by means of the CEDA package (v 1.01), for five scenarios of annual catches: 175,000 t, 200,000 t, 225,000 t, 250,000 t and 300,000 t, are illustrated in Figure 8.6.2. Those scenarios were based on the current catch level and the projections from the regression and the SHOT-estimate. The biomass trajectories suggest that the stock would remain stable or increase under those catch levels, However, the 95%

confidence levels as estimated from the model include a wide range of biomass levels (roughly between 200,000-1800,000 t) for the lower catch level considered (Figure 8.6.3).

The biomass dynamic model has some attractions over the SHOT method for stock projections. First, the biomass dynamic model is based on a production function (the Schaefer function, in this case) with parameters (*r*, *K*), which are interpretable in terms of population dynamics. The SHOT procedure, although also based on the concept of production, is more ad-hoc, and the estimated parameters are not as easily interpreted. Second, the biomass dynamic model projections give useful indications of how the stock may evolve under different future catches, and the estimated stock dynamics. Nonetheless, young fish dominates the sprat catches and the population is strongly driven by recruitment. Most of the production of the stock is therefore likely to be due to recruitment and the growth of recruits rather than the growth of post-recruits. Care should therefore be taken not to over-interpret the biomass dynamic model.

8.7 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. Problems with the IBTS abundance index were highlighted. Problems associated with the underestimation of the autumn-hatched sprat in the IBTS (February) survey used as an abundance index were discussed. No data was provided to the W.G. from the IBTS survey conducted during the third quarter. If this data were available prior to W.G. in 2003 a comparison between both indices could be performed with the aim of combining both indices and ultimately to obtain an index of abundance of age 1 sprat. Further, examination on maturity at length and at age, available from the IBTS conducted in the 3rd quarter, could provide important insight into the maturity dynamics during the autumn, resulting in a better understanding of the spawning and recruitment processes.

Alternative assessment methods for this stock were considered by the WG. Age-structured models are not an option because of fundamental problems associated with ageing the stock. Delay-difference models that would fit both an index of total biomass and an index of abundance of age-1 sprat could capture the dynamics of the stock more precisely than the basic biomass dynamic model used at present.

8.8 Management Considerations

The sprat stock shows signs of being in good condition as both catch and biomass appear to increase and there is indication from the IBTS (February)-2002-survey of a good 2001 year class recruiting to the 2002 fishery. The natural inter-annual variability in stock abundance, mainly driven by recruitment variability, is high and does not appear to be strongly influenced by fishing effort. A TAC for 2002 could lie within a range of 200–250 000 tonnes. Because the fishery in a given year is very dependent on that year’s incoming year class, the Working Group is not able to predict catches for 2003. The sprat fishery is also controlled by the amount of herring caught as by-catch, and in some periods the sprat fishery has been closed due to high proportions of herring in the catch. High by-catch of 0 and 1 ringer herring is expected to occur during the third and the forth quarter in 2002 as herring in-coming year classes are estimated to be relatively strong. Therefore, the sprat fishery in 2002 may be driven by the herring by-catch rather than by the actual sprat TAC.

Attempts to assess this stock have highlighted the need for a better survey coverage of the S-SE areas of the North Sea and for the collection of age data. Also, a need to gain understanding of the spawning and recruitment processes, focusing on autumn-spawning, has been noted. Data from the IBTS in the third quarter together with data of maturity around the year could be used for that purpose. Therefore, the group recommends that countries involved in IBTS analyse data on maturity-at-age of sprat and make available the results prior to the 2003 WG meeting. There are indications that larvae from autumn-spawning over-winter as larvae and metamorphose the year after without forming a winter-ring during the first winter (Alshuth, 1988). A fraction of the population may be incorrectly allocated to a year class as a result, producing cumulative errors in the ageing as reported by Torstensen (2002, WD5). 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) 1987-2001. 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
Division IVa West (North Sea) stock															
Denmark	0.2	0.1				0.3	0.6						0.7		0.1
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
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
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
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
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
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
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
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
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
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
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

Table 8.1.2. Sprat catches (' 000 t) in the fjords of western Norway, 1985-2001.

1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001 [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	1,9

[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

Table 8.2.1 Species composition in the Danish sprat fishery in tonnes and percentage of the total catch. Data is reported for 1998-2001.

	Year	Sprat	Herring	Horse-mackerel	Whiting	Haddock	Mackerel	Cod	Other species	Total
Tonnes	1998	129,315	11,817	573	673	6	220	11	3,362	145,978
Tonnes	1999	157,003	7,256	413	1,088	62	321	7	5,607	171,757
Tonnes	2000	188,463	11,662	3,239	2,107	66	766	4	2,334	208,641
Tonnes	2001	136,443	13,953	67	1,700	223	312	4	18,162	170,862
Percent	1998	88.6	8.1	0.4	0.5	0.0	0.2	0.0	2.3	
Percent	1999	91.4	4.2	0.2	0.6	0.0	0.2	0.0	3.3	
Percent	2000	90.3	5.6	1.6	1.0	0.0	0.4	0.0	1.1	
Percent	2001	79.9	8.2	0.0	1.0	0.1	0.2	0.0	10.6	

Table 8.2.2. North Sea Sprat. Catch in numbers (millions) by quarter and by age 1995-2001.

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

Table 8.2.3 North Sea Sprat. Mean weight (g) by quarter and by age for 1995 - 2001.

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

Table 8.2.4 North Sea Sprat. Sampling commercial landings for biological samples in 2001

Country	Quarter	Landings 000t	No samples	No fish meas.	No fish aged
2001					
Denmark	1	39.5	12	1,071	49
	2	1.1	37	258	
	3	44.7	4	354	50
	4	71.7	5	640	151
	Total	156.9	58	2,323	250
Norway	1	9.2	5	450	400
	2				
	3				
	4	0.3			
	Total	9.5	5	450	400
Sweden	1	0.4			
	2				
	3				
	4	1.085			
	Total	1.5			
UK-England/Wales	1	1.6			
	2				
	3				
	4	0.4			
	Total	2.0			
UK-Scotland	1				
	2				
	3				
	4				
	Total				
Total North Sea		170.0	63	2773	650

Table 8.3.1 North Sea Sprat. Abundance indices by age group from IBTS(February), 1984-2001, in the standard sprat area (Div. IVb). **NEW revised data.**

Year	No rect.	No hauls	Age					
			1	2	3	4	5+	Total
1984	80	251	232.40	330.20	39.60	6.20	0.30	608.70
1985	79	289	375.90	195.30	26.70	3.80	0.40	602.10
1986	78	285	44.20	73.60	22.00	1.20	0.20	141.20
1987	78	299	542.40	66.80	19.60	2.00	0.20	631.00
1988	78	208	91.40	887.20	61.60	6.90	0.00	1047.10
1989	79	236	2297.20	472.80	269.80	5.40	1.60	3046.80
1990	78	192	234.90	452.00	102.10	28.10	2.20	819.30
1991	78	179	677.30	93.30	23.30	2.60	0.10	796.60
1992	79	185	1041.00	291.90	42.40	7.10	0.50	1382.90
1993	79	181	1030.60	604.40	118.40	6.10	0.30	1759.80
1994	78	173	2428.50	932.60	91.40	3.60	0.50	3456.60
1995	79	166	647.40	1613.90	87.30	2.50	0.80	2351.90
1996	78	146	182.40	387.20	146.80	18.30	0.70	735.40
1997	79	159	591.40	412.40	179.60	15.50	2.20	1201.10
1998	79	197	1171.10	1457.20	306.10	15.80	3.40	2953.60
1999	78	177	2509.50	562.40	80.40	4.80	25.10	3182.2
2000	78	177	1058.80	907	277.5	43.9	0.9	2288.1
2001	78	171	883.10	1055.80	185.20	17.50	0.10	2141.70
2002	78	171	1382.60	604.50	74.40	8.40	0.60	2070.50

Table 8.5.1 North Sea Sprat. IBTS(February) " indices of biomass". by age group 1984-2000. The mean weights are calculated from data in the commercial landings, 1st.quarter, in 1995-2001.

Year	Age				
	1	2	3	4+	Total
1984	1046	2972	495	100	4613
1985	1692	1758	334	65	3848
1986	199	662	275	22	1158
1987	2441	601	245	34	3321
1988	411	7985	770	106	9272
1989	10337	4255	3373	108	18073
1990	1057	4068	1276	467	6868
1991	3048	840	291	42	4220
1992	4685	2627	530	117	7959
1993	4638	5440	1480	99	11656
1994	10928	8393	1143	63	20527
1995	2913	14525	1091	51	18580
1996	821	3485	1835	293	6433
1997	2661	3712	2245	273	8890
1998	5270	13115	3826	296	22507
1999	11293	5062	1005	460	17820
2000	4765	8163	3469	690	17086
2001	3974	9502	2315	271	16062
2002	6222	5441	930	139	12731
Mean W (g)	4.5	9.0	12.5	15.4	

Table 8.6.1. SHOT forecast.

North Sea 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		609		0.84	0.16				0		
1985		602	602	0.65	0.35	0	0	0	0	0	0
1986	16.0	141	141	0.20	0.80	79	0	0	79	0	0
1987	32.4	631	631	0.28	0.72	54	67	26	117	130	36
1988	87.4	1047	1047	0.54	0.46	77	101	51	162	186	100
1989	63.1	3047	3047	0.35	0.65	104	265	183	179	339	120
1990	72.7	819	819	0.32	0.68	114	47	57	230	163	52
1991	112.0	797	797	0.37	0.63	143	54	67	300	212	79
1992	124.3	1383	1383	0.34	0.66	177	112	112	365	300	102
1993	200.1	1760	1760	0.45	0.55	205	156	135	446	396	178
1994	320.1	3457	3457	0.66	0.34	237	322	255	483	568	377
1995	357.0	2352	2352	0.86	0.14	250	205	244	413	368	318
1996	136.1	735	735	0.48	0.52	225	66	106	281	122	59
1997	103.4	1201	1201	0.33	0.67	167	119	128	312	264	88
1998	162.6	2954	2954	0.41	0.59	183	301	169	392	510	211
1999	188.4	3182	3182	0.42	0.58	217	307	222	446	536	226
2000	195.9	2288	2288	0.40	0.60	236	212	198	494	470	186
2001	170.1	2142	2142	0.31	0.69	259	200	198	557	498	152
2002		2071	2071	0.31	0.69		198	179		585	181

Sprat catches 2001, 1st Quarter

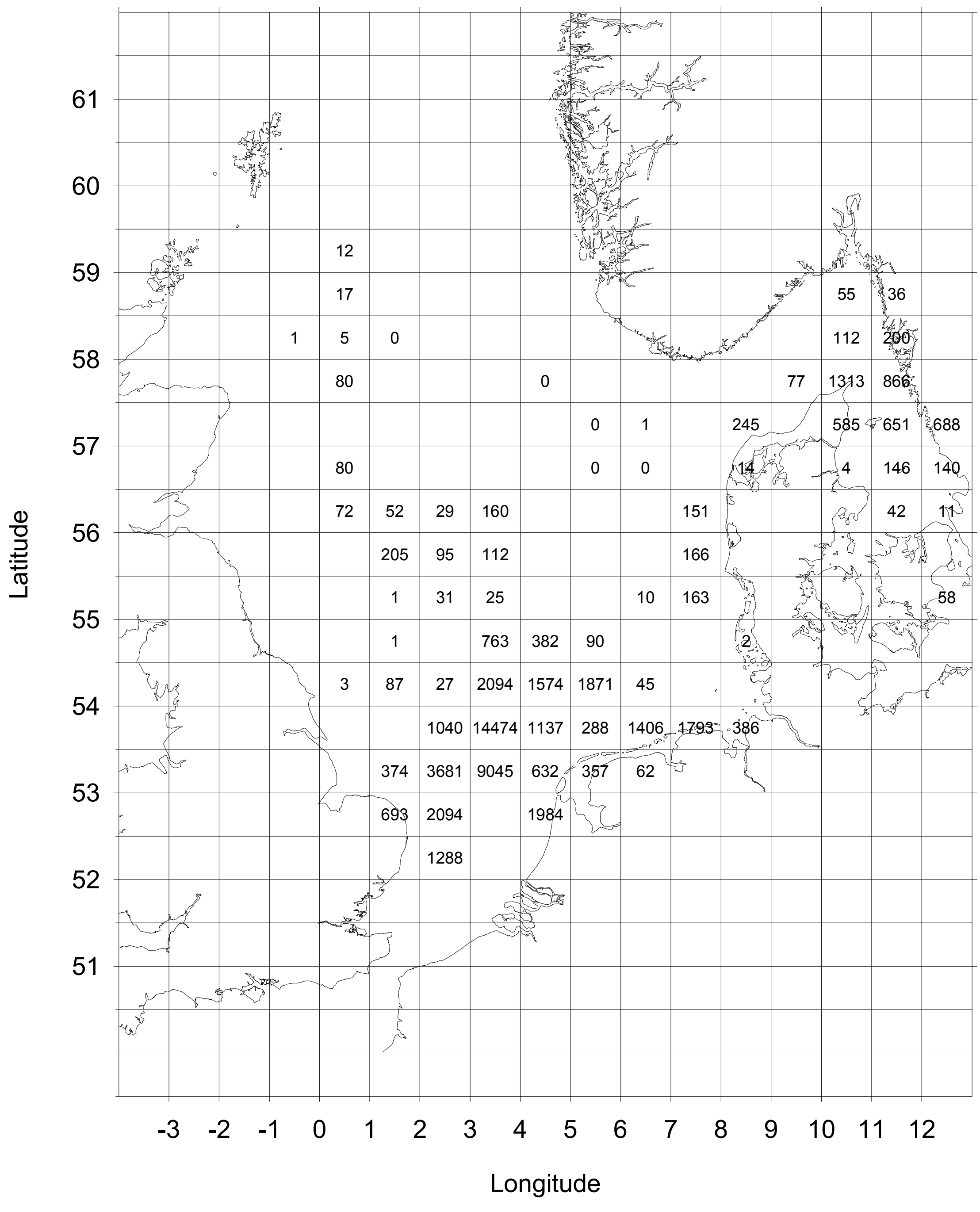


Figure 8.1.1a: Sprat catches (in tonnes) in the North Sea in 2001 by statistical rectangle. Working group estimates (if available). First quarter.

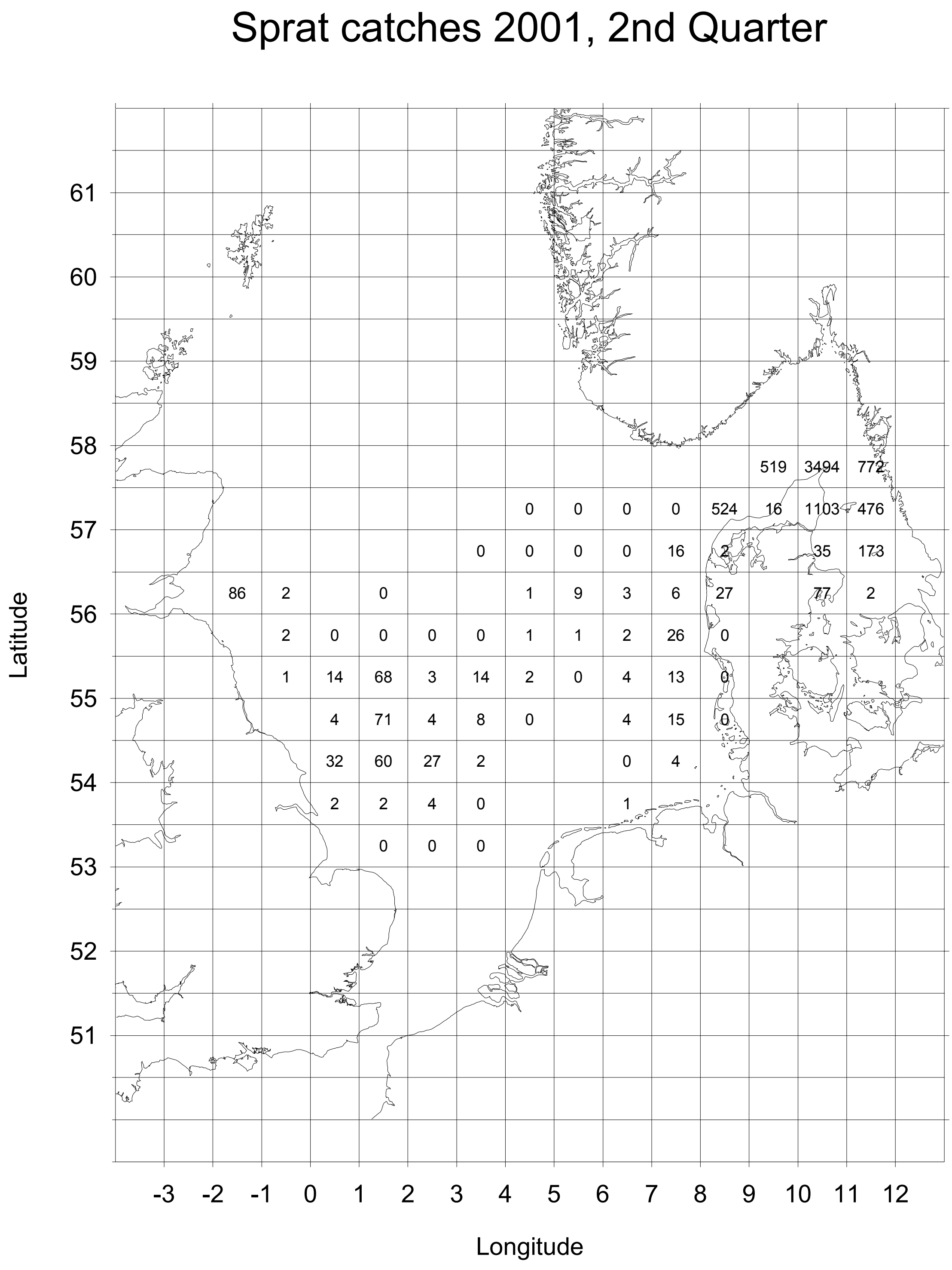


Figure 8.1.1b: Sprat catches (in tonnes) in the North Sea in 2001 by statistical rectangle. Working group estimates (if available). Second quarter.

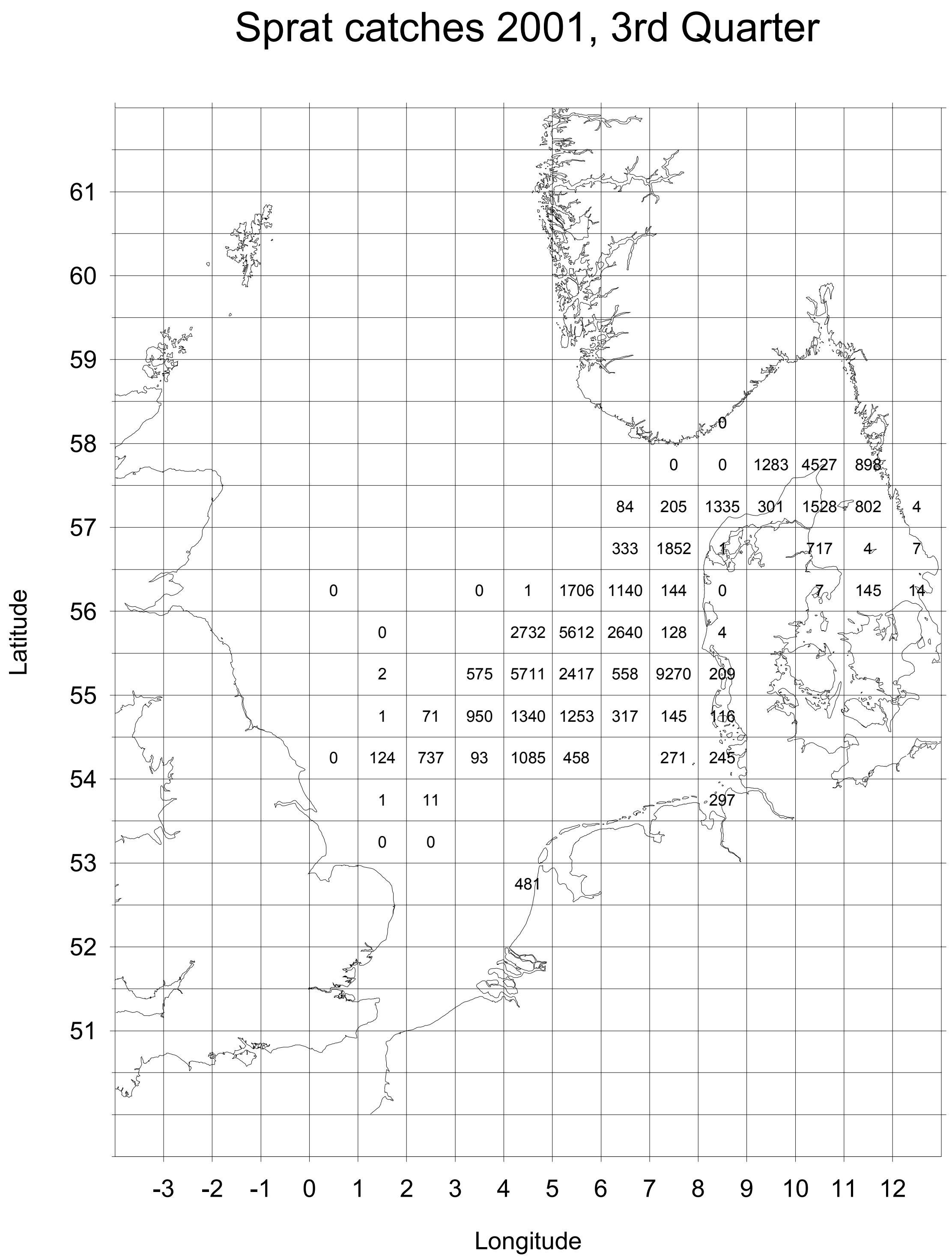


Figure 8.1.1c: Sprat catches (in tonnes) in the North Sea in 2001 by statistical rectangle. Working group estimates (if available). Third quarter.

Sprat catches 2001, 4th Quarter

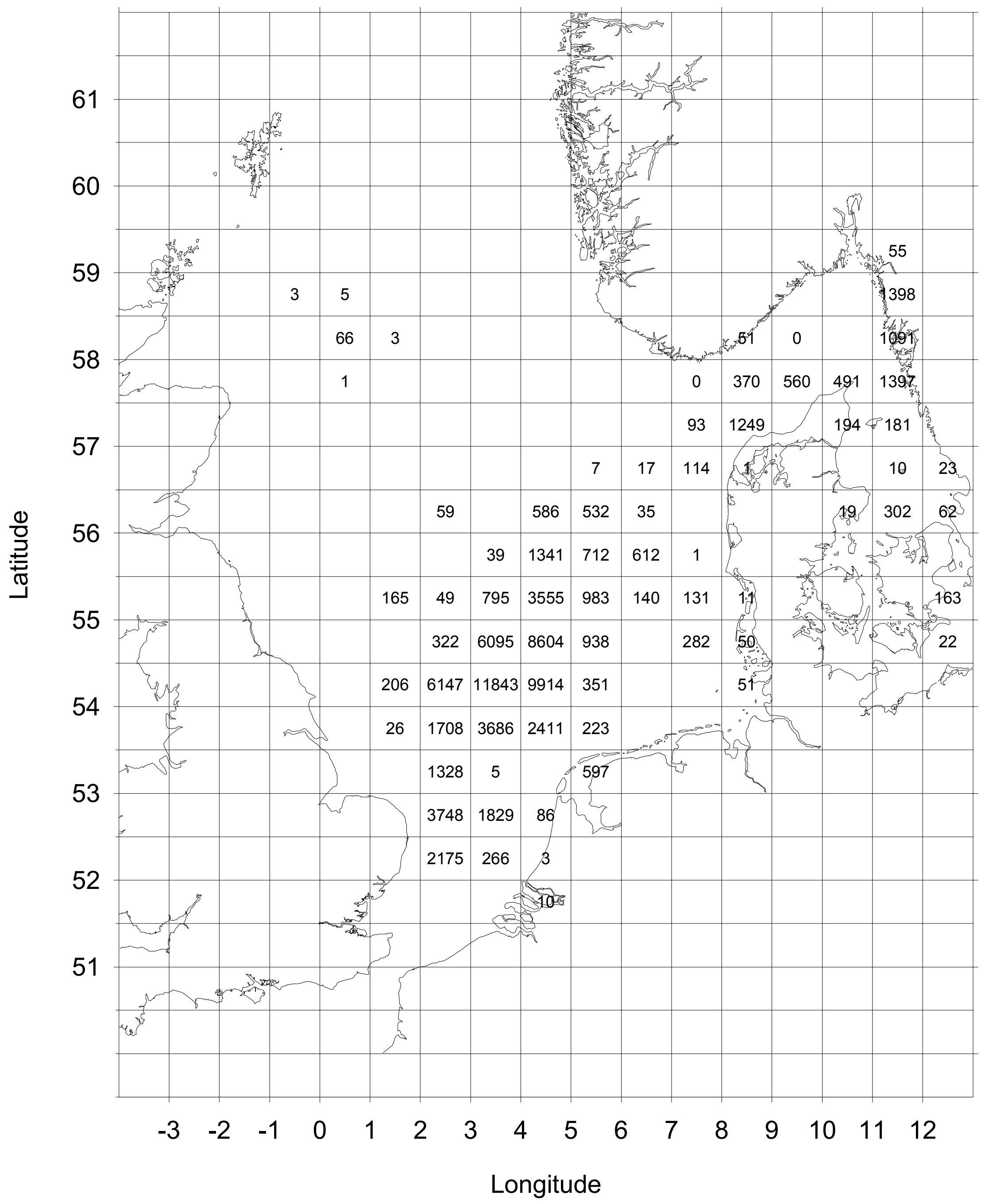


Figure 8.1.1d: Sprat catches (in tonnes) in the North Sea in 2001 by statistical rectangle. Working group estimates (if available). Fourth quarter.

Sprat catches 2001, all quarters

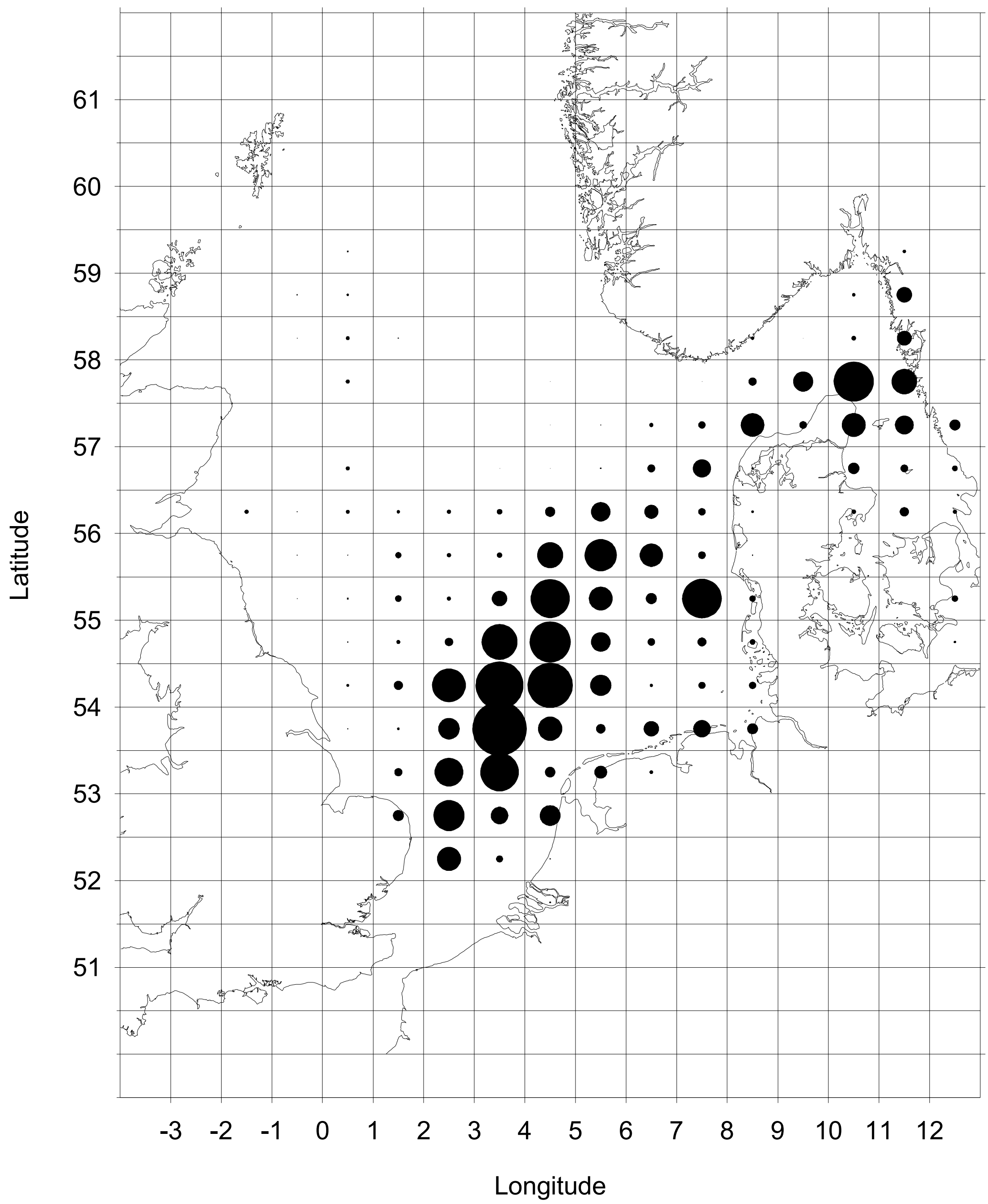


Figure 8.1.2: Total Sprat catches (in tonnes) in the North Sea in 2001 by statistical rectangle. Circle diameter is proportional to catch in tones. Working group estimates (if available).

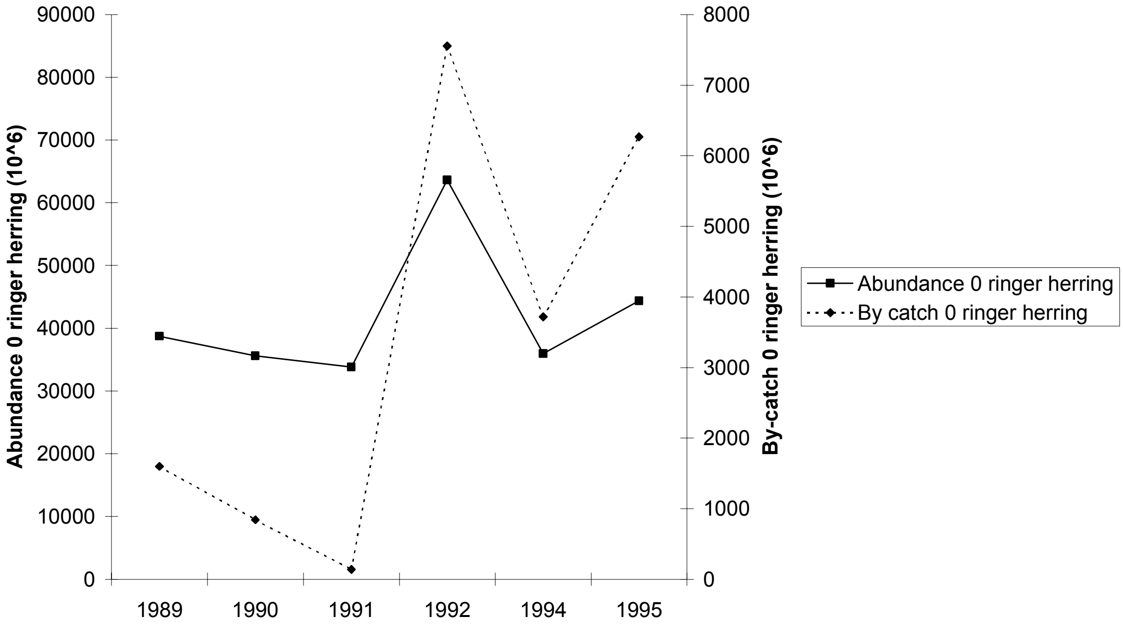


Figure 8.2.1. Number of 0 ringer herring (in millions) at the beginning of the year and 0 ringer herring caught as by-catch by the Danish Sprat Fishery (in millions) over 1989-1995 when data available.

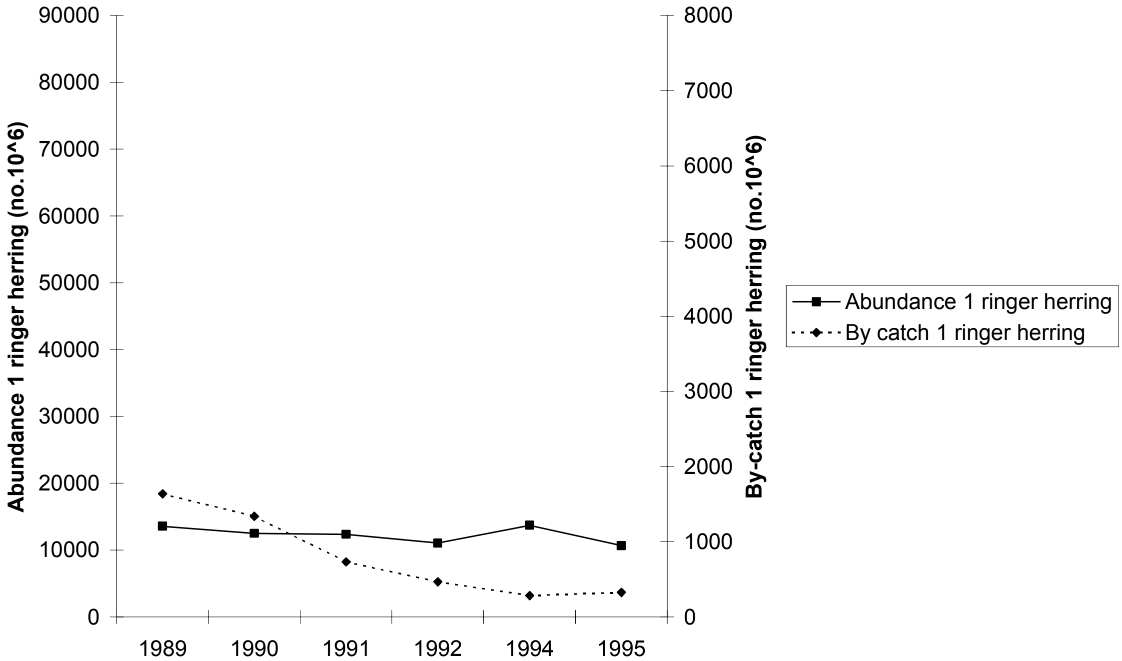


Figure 8.2.2. Number of 1 ringer herring (in millions) at the beginning of the year and 1 ringer herring caught as by-catch by the Danish Sprat Fishery (in millions) over 1989-1995 when data available.

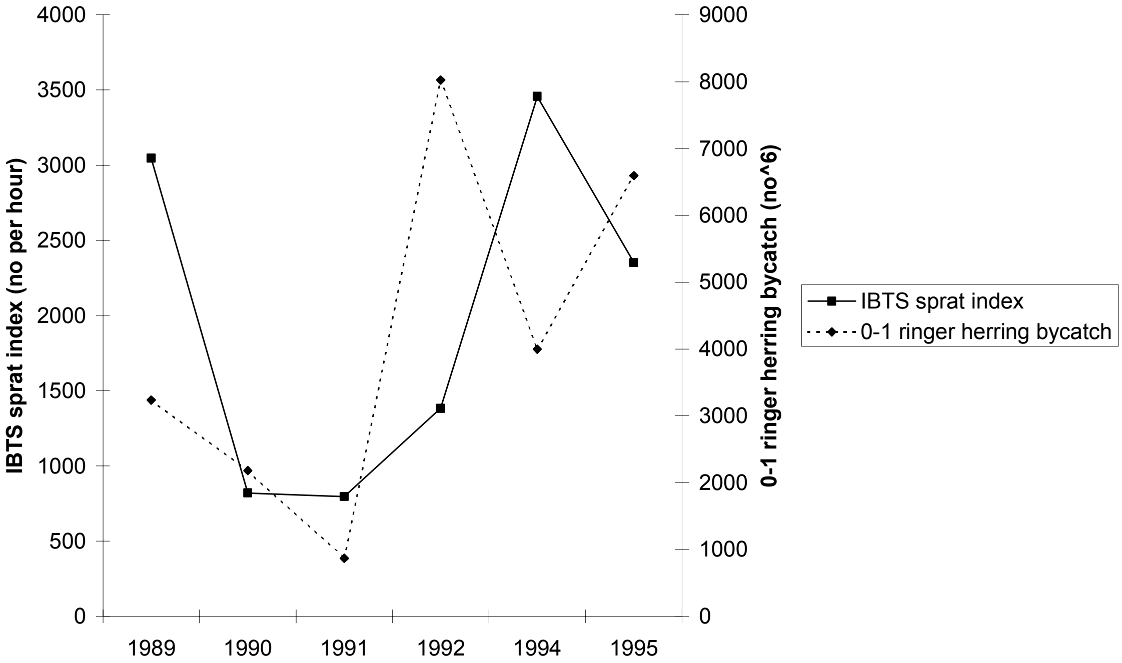


Figure 8.2.3. IBTS sprat index of abundance (no per hour) and number of 0-1 ringer herring by-catch by the Danish Sprat Fishery (in millions) over 1989-1995 when data available.

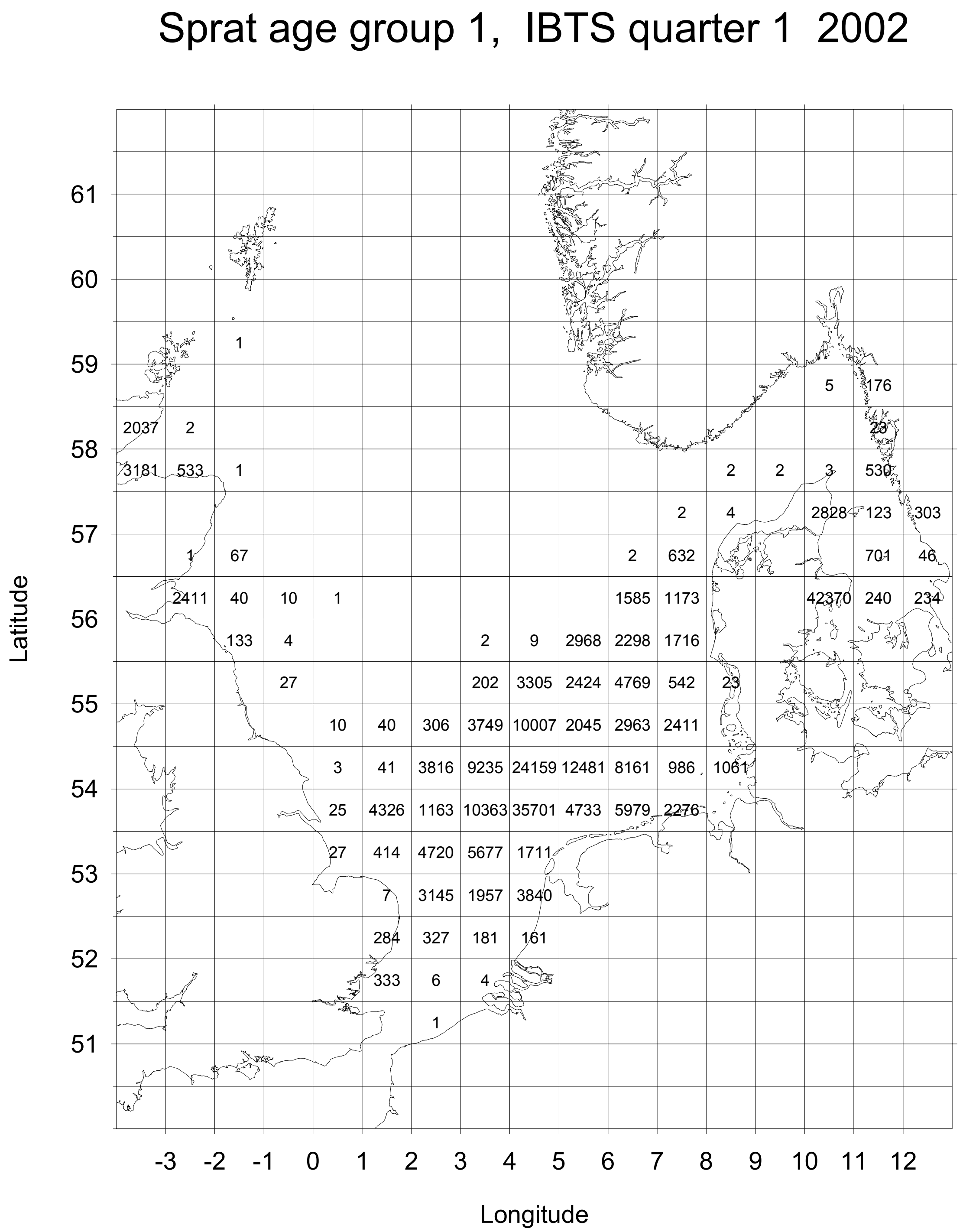


Figure 8.3.1a. Distribution by age groups in the IBTS (February) 2002 in the North Sea and Division IIIa.

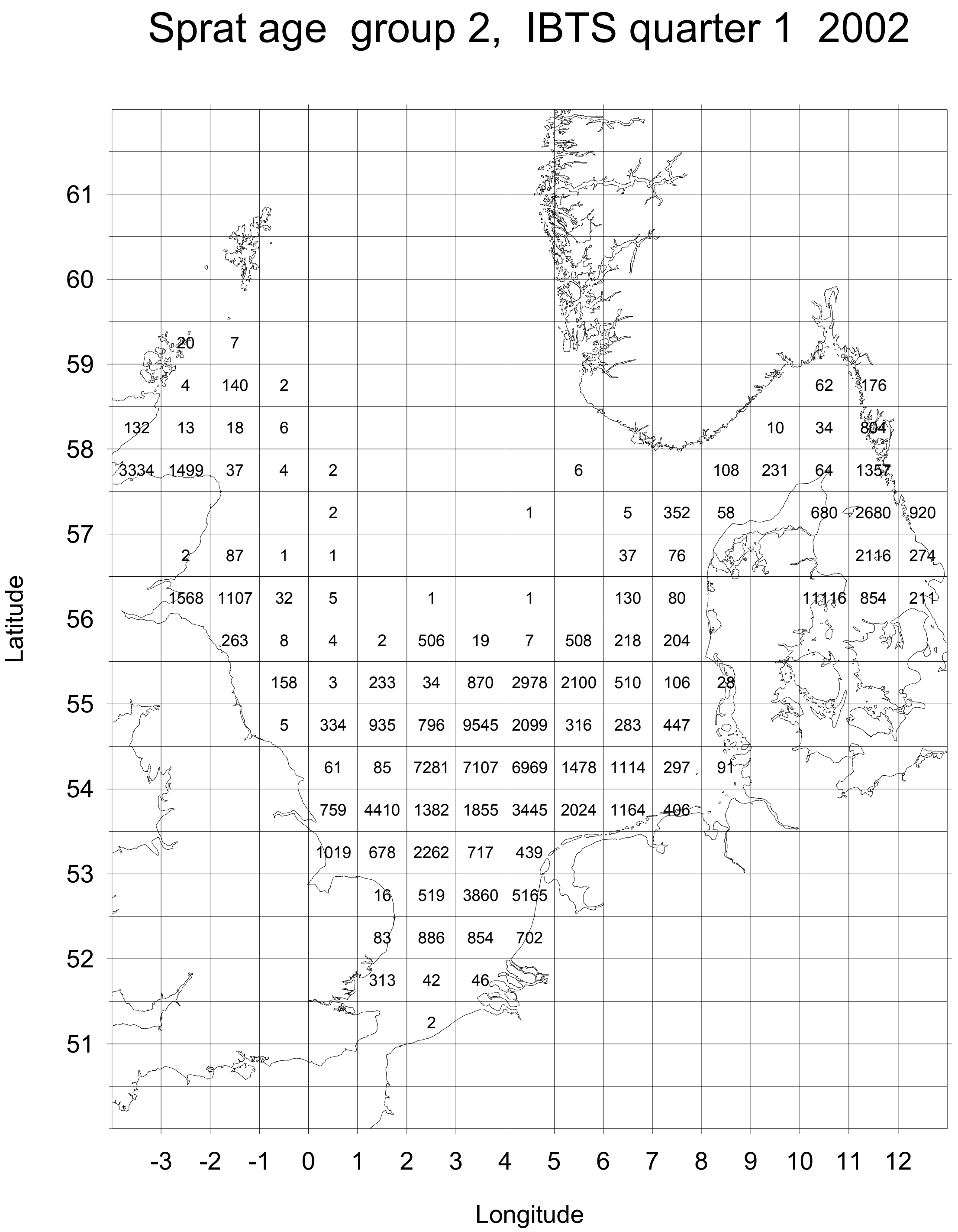


Figure 8.3.1b. Continued. Distribution by age groups in the IBTS (February) 2002 in the North Sea and Division IIIa. Sprat age group 2.

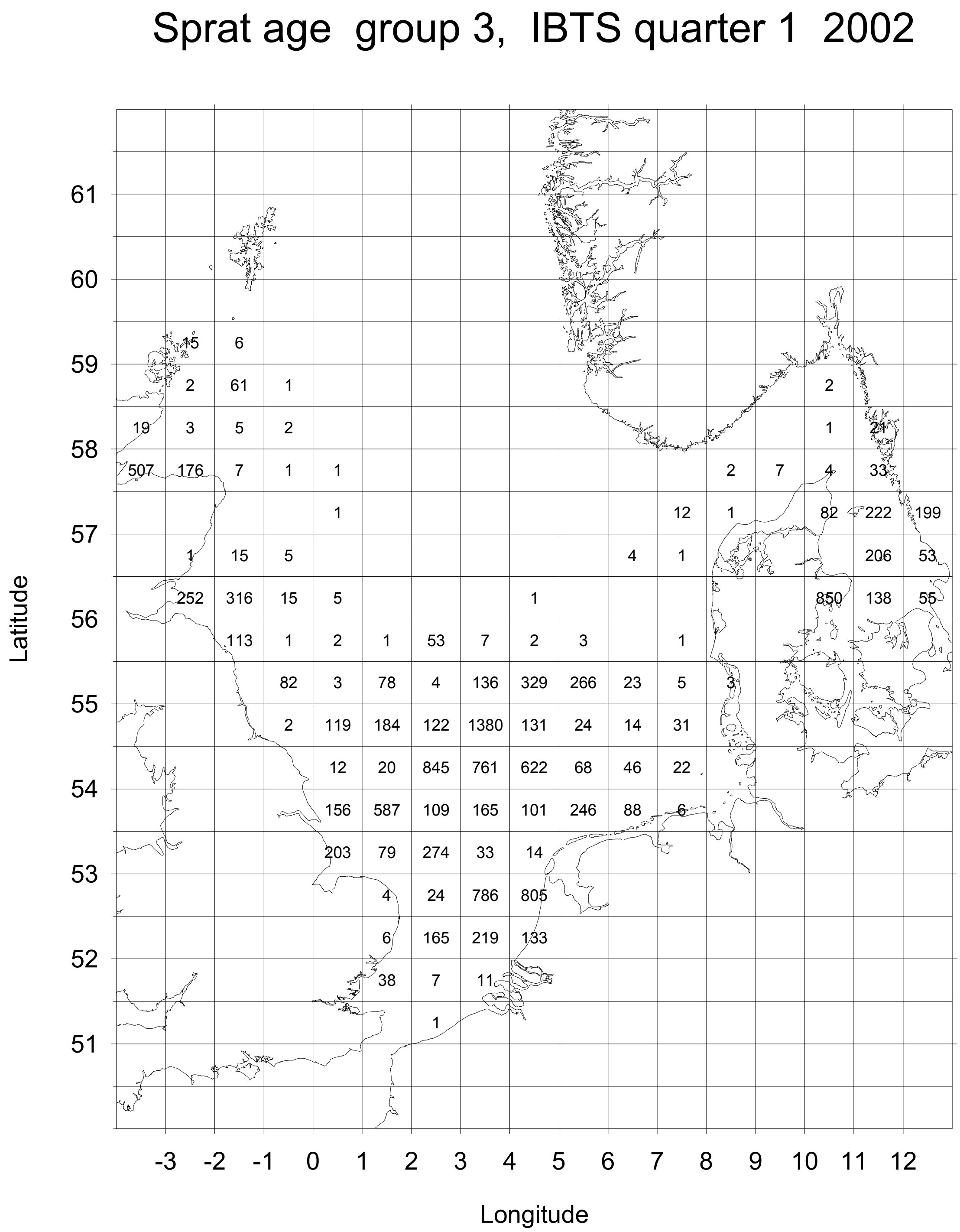


Figure 8.3.1c Continued. Distribution by age groups in the IBTS (February) 2002 in the North Sea and Division IIIa. Sprat age group 3.

Sprat age group 1 mean lengths, IBTS quarter 1 2002

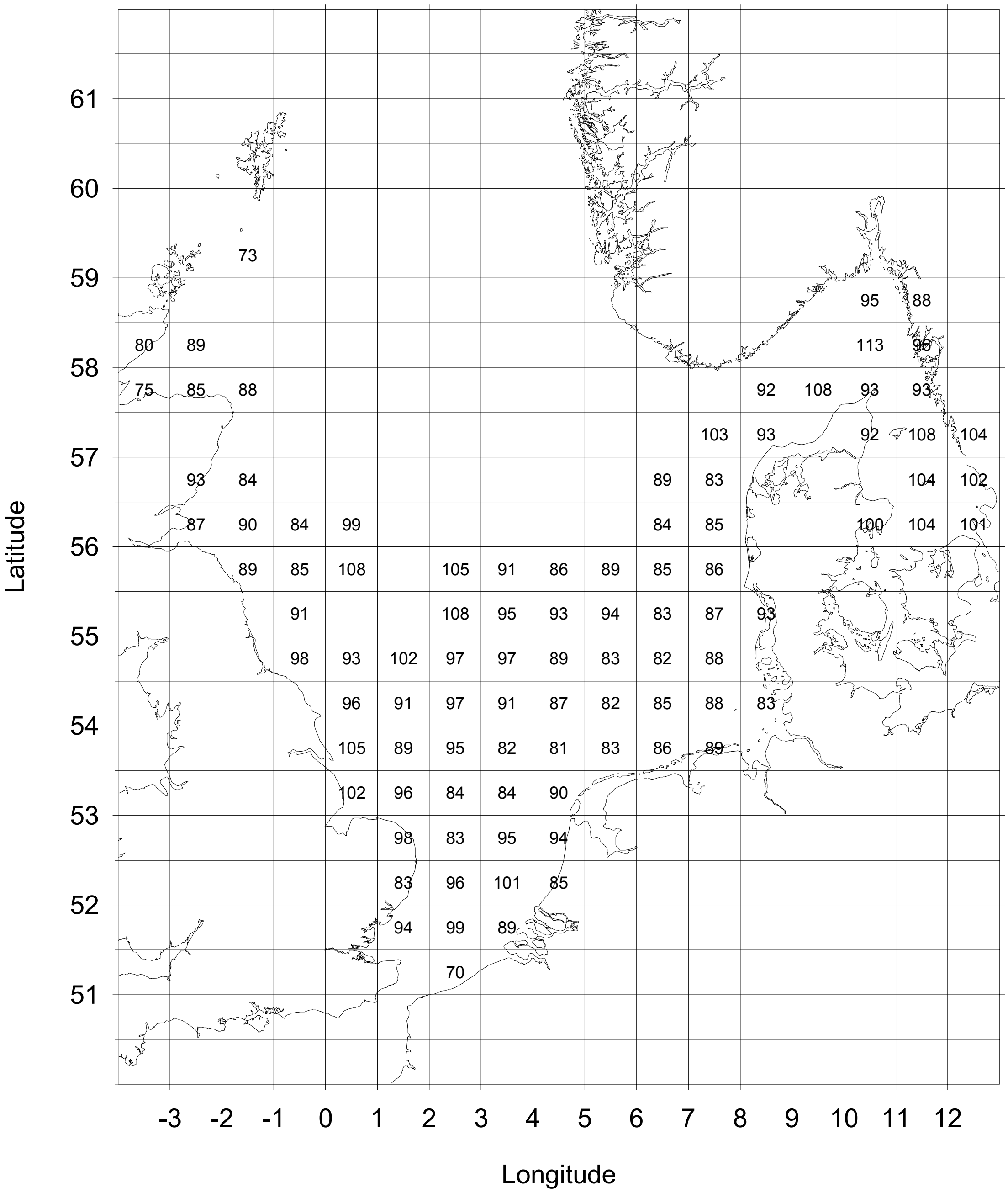


Figure 8.3.2. Mean length (mm) of age group 1sprat in the IBTS (February) 2002 in the North Sea and Division IIIa.

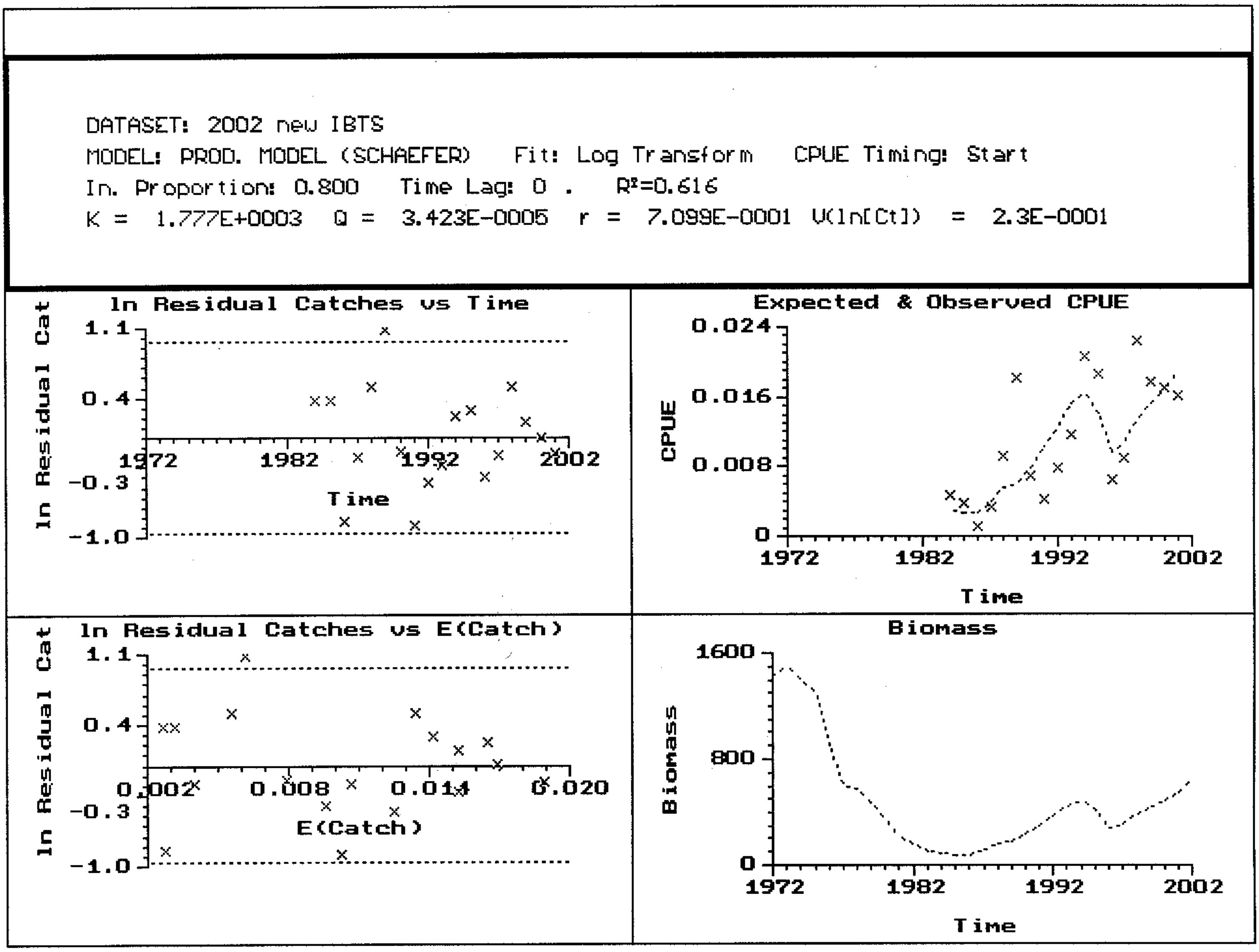


Figure 8.5.1 North Sea sprat. Results from the CEDA (v 1.01) assessment: Schaefer model, initial biomass proportion = 0.8, error model log-normal. Plots correspond to the model fit to the IBTS biomass index (CPUE), residual plots and estimated biomass trajectory (Estimated parameters are *K*: carrying capacity (in thousand tonnes), *r*: intrinsic growth rate, *q*: catchability).

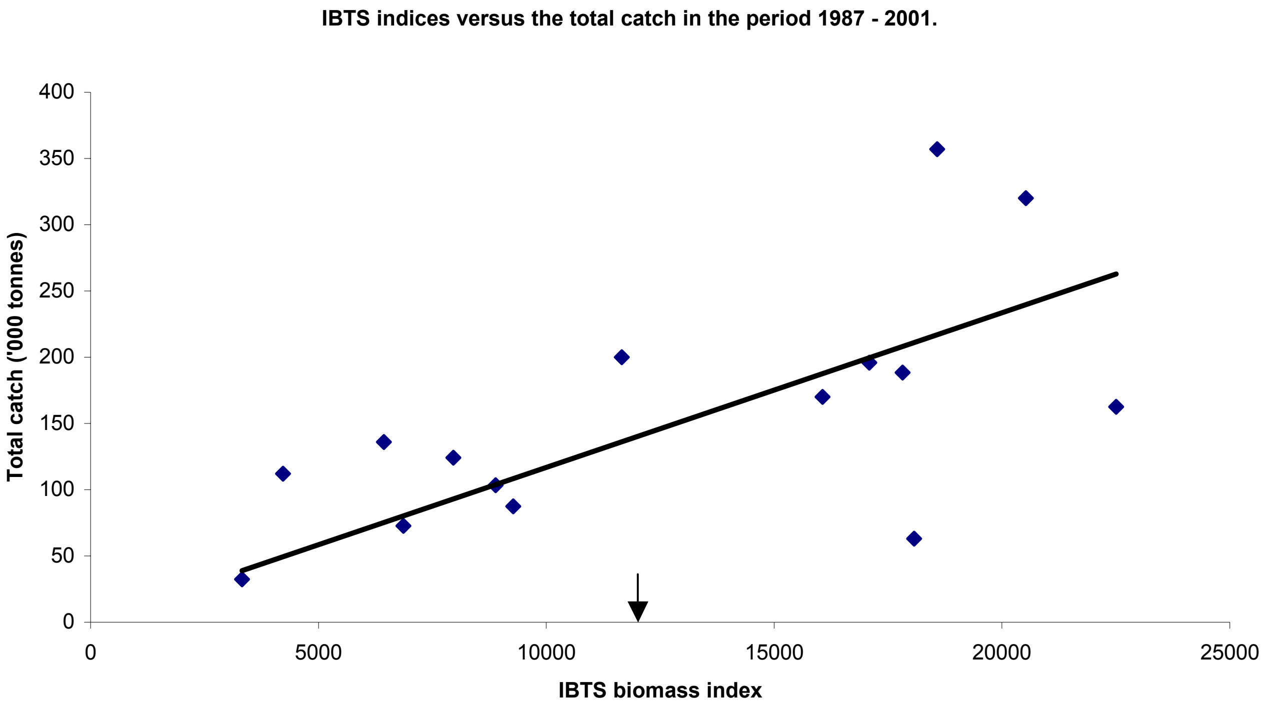


Figure 8.6.1 IBTS indices versus the total catch (1987 – 2001). The regression line is forced through the intercept; R^2 equals 0.368. The arrow indicates the biomass index for 2002 (12731).

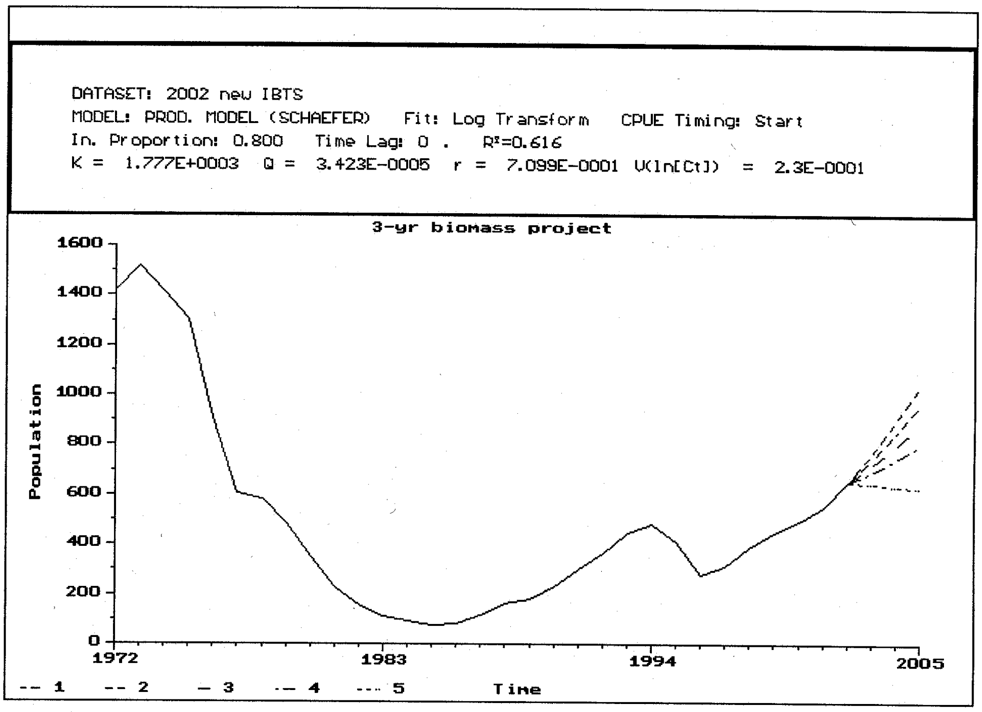


Figure 8.6.2 3-yr forward projection of the biomass of North Sea sprat as predicted by CEDA (v1.01). Constant catch scenarios explored were: 175, 200, 225, 250 and 300 thousand tonnes.

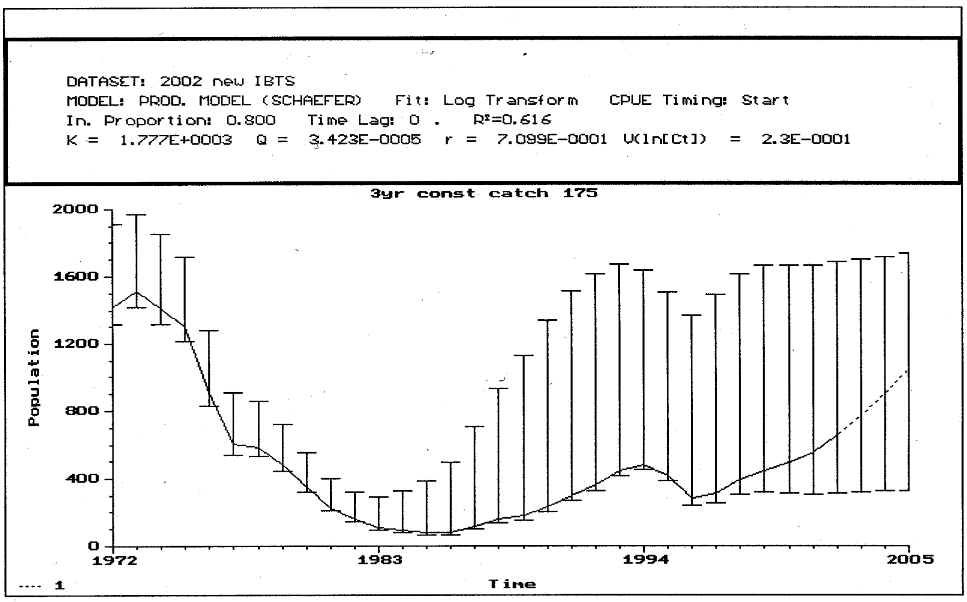


Figure 8.6.3 Historic biomass trajectory for North Sea sprat and 3-yrs forward projection for a constant annual catch of 175 thousand tonnes with associated 95% confidence intervals as estimated by CEDA (v1.01).

9 SPRAT IN DIVISIONS VIID,E

9.1 The Fishery

9.1.1 ACFM advice applicable for 2001

The TAC for this fishery was set to 12 000 t for 2001 and 2002. No ACFM advice has been provided in recent years.

9.1.2 Catches in 2001

Table 9.1.1 shows the nominal landings in 1985–2001. The landings in 2001, as reported by UK (England&Wales), decreased in 2001 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 2002 show that the catches are mainly taken in third and fourth quarter (Table 9.1.2).

9.1.3 Catch composition

Catch compositions and the mean weights for 1991–1998 are given in Tables 9.2.1 and 9.2.2. No samples of commercial catches have been available for 1999, 2000 and 2001.

Table 9.1.1 Nominal catch of sprat (t) in Divisions VIId,e,1985–2001.

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*
Denmark	
France	
Germany	
Netherlands	
UK (Engl.&Wales)	1,349
Total	1,349

* Preliminary

Table 9.1.2 Lyme Bay sprat fishery. Monthly catches (t) 1991-2001. 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	173	541	586	163	114	74	36	0	0	1686
2001/02	0	0	0	458	338	171	50	213					1230

Table 9.2.1 Lyme Bay sprat fishery. Number caught by age group (millions).

Season		0/1	1/2	2/3	3/4	4/5	5/6
1991/92		1.7	56.03	44.69	16.24	0.57	0.03
1992/93[1]		0.22	28.23	48.61	12.94	1.56	0
1993/94[2]		0	0.83	44.81	15.7	1.95	0.58
1994/95			No data				
	0	1	2	3	4	5	6
1995[3]		0.33	5.20	2.31	0.23	0.03	
1996	0.72	12.60	71.35	22.00	1.24	0.20	
1997		8.81	42.88	31.87	5.43	0.10	
1998		4.08	81.16	37.52	5.05	0.39	
1999			No data				
2000			No data				
2001			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)

Table 9.2.2 Lyme Bay area SPRAT. 1991–1998 mean weight (g) at age.

		Age						
Season	Quarter	0/1	1/2	2/3	3/4	4/5	5/6	Overall mean
1991/91	3	4.7	16.6	22.6	25.4	29.2	34.6	20.7
	4	6.6	17.1	23	26.3	30.9		21.0
	1	5.7	13.3	17.5	20.2	24.1		14.4
1992/93	3	4.2	12.1	22.8	24.6	32.4		21.8
	4		15.8	20.0	23.8	24.8		21.0
	1		13.2	17.1	21.2			14.2
1993/94	3			19.1	22.2	20.8		19.8
	4[1]		14.2	18.9	24.5	28.1	25.5	20.6

		Age							
Season	Quarter	0	1	2	3	4	5	6	Overall mean
1995	3[2]	-	-	12.0	17.0	19.0	21.0	29.0	-
1996	1			8.0	11.0	13.0	13.0		-
	4	8.0	15.0	19.0	23.0	28.0			-
1997	1		10.0	15.0	19.0	22.0	28.0		
	3		13.0	17.0	19.0	24.0			
	4		17.0	20.0	22.0	23.0			
1998	1		11.0	13.0	18.0	21.0	28.0		15.0

[1]Based on November samples only.

[2]Based on September sample only.

10 SPRAT IN DIVISION IIIA

10.1 The Fishery

10.1.1 ACFM advice applicable for 2001 and 2002

No ACFM advice on sprat TAC has been given in recent years. The sprat TAC for 2001 was 50,000 t, with a restriction on by-catches of herring not exceeding 21,000 t. For 2002 the same values were set as in 2001.

10.1.2 Landings

Prior to 1998 a mixed-clupeoid fishery management regime existed. In 1997 this fishery management regime was changed and the new agreement between EU and Norway implied that a TAC for sprat was set 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 -2001. The total landings increased from 20,100 t in 2000 to 29,100 t in 2001 and are the highest since 1995.

The Norwegian and Swedish landings include the coastal and fjord fisheries. Though the Swedish coastal sprat fishery increased in 2001, these landings continued to be low.

Landings by countries and by quarter are shown in Table 10.1.2. For 2001 the landings were taken in all quarters with the bulk of the catch in the 1st quarter. In the second quarter only 1,400 t were landed. Denmark has a total ban on the sprat fishery in Division 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 and in the Swedish fjords.

The Norwegian sprat fishery in Division IIIa is an inshore purse seine fishery for human consumption.

10.2 Catch Composition

10.2.1 Catches in number and weight-at-age

The numbers and the mean weight by age in the landings from 1995 to 2001 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 2001 with 45 samples from a total landing of 20,900 tonnes.

Denmark has provided biological samples of all the quarters where there were landings in both the Skagerrak and the Kattegat. Sweden provided no biological samples from the fishery in Kattegat but did provide samples from quarter 1 and 4 from the Skagerrak. No Norwegian samples were collected.

The provided samples were used to estimate the numbers of sprat at age and the mean weight-at-age, in all sprat landings (Table 10.2.1 and Table 10.2.2). The sample size has slightly decreased, but was considered adequate. As in previous years, no samples of sprat were taken from the fisheries for human consumption. Therefore, data from the industrial landings were used for the estimation of numbers of sprat at age and the mean weight-at-age. Detail on the sampling for biological data per country, area and quarter are shown in Table 10.2.3.

10.3 Recruitment

The IBTS (February) sprat indices for 1984-2002 are presented in Table 10.3.1. The IBTS data are provided by rectangle in Figure 8.3.1 for age groups 1,2 and 3+, and the mean length (mm) of 1-gr sprat in Figure 8.3.2. The indices are calculated as mean no./hr (CPUE) weighted by area where water depths are between 10 and 150 m (ICES 1995/Assess:13). The indices were revised in 2002 (ICES 2002/G:02) 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 higher than the 2000-index and is above the average, however the remaining age-groups indices are lower than in 2001.

10.4 Acoustic Survey

Acoustic estimates of sprat were included in the ICES co-ordinated Herring Acoustic surveys in 1996. In 1996 the total estimate was 7.9×10^8 fish or 14,267 tonnes. About 95 % of the biomass was recorded in Kattegat. Since 1997 only individual sprat has been caught and no or low acoustic values allocated to sprat (ICES 2001/G:02). In the Acoustic survey in 2001 sprat were present in the Kattegat, but none were found in the Skagerrak (ICES 2002/G:02). The total biomass in the Kattegat was estimated to 8,000 tonnes.

10.5 State of the Stock

No assessments of the sprat stock in Division IIIa have been presented since 1985 and this year is no exception. From the experiences with the run of the Schaefer model in 1999 (ICES 1999/ACFM:12), the WG decided not to run the model this year, as the data did not fit the model. According to the IBTS (February)-index for 2002, the sprat stock in the area has decreased from last year.

10.6 Projection of Catch and Stock

There is no relationship between the IBTS (February) index (no/h) and the total catch in the same year (r^2=0.01), the data is shown in Figure 10.6.1, and the index was not considered useful for management of sprat at Div. IIIa.

The estimated yield for 2001 using the total IBTS index were 14,000 tonnes (Table 10.6.1) in a SHOT-estimate (Shepherd, 1991). This is considerably lower than the estimated yield for 2001 (32,000 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.

10.7 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 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 SPRAT. Division IIIA. Landings in (1000 tonnes) 1974-2001.
(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.

	Skagerrak				Kattegat			Div. IIIa total
Year	Denmark	Sweden	Norway	Total	Denmark	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

	Skagerrak			Kattegat		Div. IIIa	Division IIIa
Year	Denmark	Sweden	Norway	Denmark	Sweden	Sweden	Total
1982	10.5		1.9	21.4		5.9	39.7
1983	3.4		1.9	9.1		13.0	27.4
1984	13.2		1.8	10.9		10.2	36.1
1985	1.3		2.5	4.6		11.3	19.7
1986	0.4		1.1	0.9		8.4	10.8
1987	1.4		0.4	1.4		11.2	14.4
1988	1.7		0.3	1.3		5.4	8.7
1989	0.9		1.1	3.0		4.8	9.8
1990	1.3		1.3	1.1		6.0	9.7
1991	4.2		1.0	2.2		6.6	14.0
1992	1.1		0.6	2.2		6.6	10.5
1993	0.6	4.7	1.3	0.8	1.7		9.1
1994	47.7	32.2	1.8	11.7	2.6		96.0
1995	29.1	9.7	0.5	11.7	4.6		55.6
1996	7.0	3.5	1.0	3.4	3.1		18.0
1997	7.0	3.1	0.4	4.6	0.7		15.8
1998	3.9	5.2	1.0	7.3	1.0		18.4
1999	6.8	6.4	0.2	10.4	2.9		26.7
2000	5.1	4.3	0.9	7.7	2.1		20.1
2001	5.2	4.5	1.4	14.9	3.0		29.1

Table 10.1.2 Division IIIa Sprat. Landings of sprat ('000 t) by quarter and by countries, 1994-2001.
(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

+ Catch record, but amount not precisely known.

Table 10.2.1 Division IIIA Sprat. Landed numbers (millions) of sprat by age groups in 1995-2001.

	Quarter	Age						Total
		0	1	2	3	4	5+	
1995	1		312.04	784.37	53.50	27.29	9.01	1186.20
	2		1248.72	993.29	61.06	15.24	4.77	2323.08
	3		1724.02	133.56	14.17			1871.74
	4		902.76	139.95	29.95	10.58		1083.25
	Total		4187.54	2051.17	158.68	53.12	13.77	6,464.27
1996	1		288.42	546.53	62.11	15.65	5.07	917.78
	2		0.89	414.10	42.76	0.71	0.06	458.51
	3		0.34	1.81	0.30	0.02		2.47
	4		31.19	165.65	27.34	2.03		226.21
	Total		320.84	1128.08	132.51	18.41	5.13	1,604.97
1997	1			3.43	18.31	20.60	4.59	46.94
	2		1.00	2.76	19.56	1.51	0.25	25.07
	3	4.35	209.25	9.51	1.92	6.24		231.26
	4	32.39	644.28	58.31	7.16	28.02		770.16
	Total	36.74	854.53	74.01	46.95	56.37	4.84	1,073.43
1998	1		14.91	103.38	94.00	76.99	6.34	295.61
	2		3.24	21.49	20.59	16.63	1.33	63.28
	3	53.62	26.03	41.84	5.65	0.74		127.88
	4	192.13	253.98	226.55	53.14	29.80		755.61
	Total	245.75	298.16	393.25	173.38	124.17	7.67	1242.38
1999	1	0.0	560.5	158.0	151.2	77.4	6.8	953.9
	2		32.8	1.6	1.7	1.1	0.3	37.6
	3	9.6	741.7	46.7	6.3	5.9		810.0
	4	8.5	645.4	20.5	6.8	0.6	0.3	682.1
	Total	18.0	1,980.4	226.8	166.0	85.0	7.4	2,483.6
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

Table 10.2.2. Division IIIa Sprat. Quarterly mean weight (g) at age in the landings in 1995-2001. (1994-1995 Danish and Swedish data, 1996-1997 Danish data, 1998-2001 Danish and Swedish data).

Year		Age						**SOP**
	Quarter	0	1	2	3	4	5+	Corrected l 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

Table 10.2.3 Division IIIa Sprat. Sampling commercial landings for biological samples in 2001.

Country Area	**Quarter**	**Landings ('000 t)**	**No. samples**	**No. meas.**	**No. aged**
Denmark	1	0	6	976	200
Skagerrak	2	1	9	1,632	300
	3	3	12	1,672	254
	4	1	1	107	
	Total	5.2	28	4,387	754
Denmark	1	2	2	386	102
Kattegat	2	5	6	1,109	291
	3	7	9	1,369	413
	4	0			
	Total	14.9	17	2,864	806
Norway	1	0.0			
Skagerrak	2	0.0			
	3	0.0			
	4	1.4			
	Total	1.4	0	0	0
Sweden	1	1.5	4	400	400
Skagerrak	2	0.1			
	3	0.1			
	4	4.1	13	1,300	1,290
	Total	5.7	17	1,700	1,690
Sweden	1	1.1			
Kattegat	2	0.0			
	3	0.0			
	4	0.7			
	Total	1.8	0	0	0
Denmark		20.2	45	7,251	1,560
Norway		1.4	0	0	0
Sweden		7.6	17	1,700	1,690
	Total	29.1	62	8,951	3,250

Table 10.3.1. Div. 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). New revised data.

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

Table 10.6.1. Div.IIIa Sprat. SHOT forecast of landings in 2002 using total landings and the total IBTS-indices as input data.

IIIa 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		2242	2242	0,77	0,23		10	14		18	14

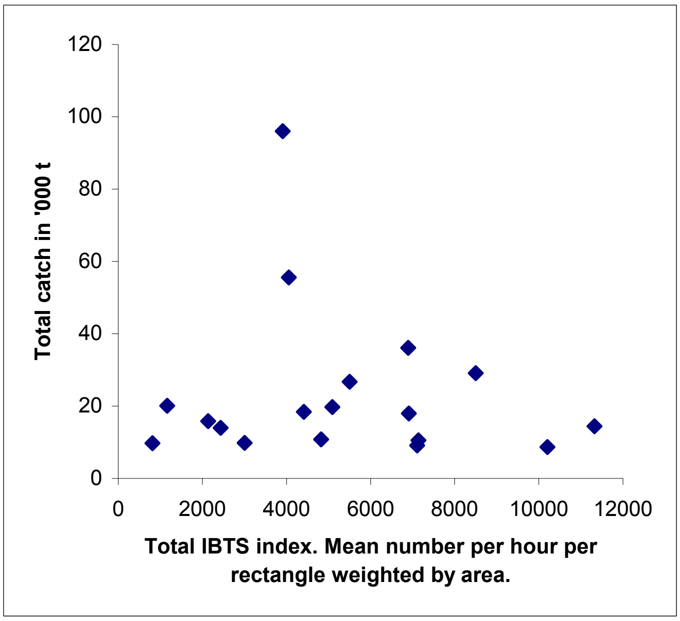


Figure 10.6.1. Division IIIa sprat IBTS indices vs. the total catches in 1984 to 2001. The $R^2 =$ 0.01.

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APPENDIX I

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

12 - 21 March 2002

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Advisory Committee on Fishery Management ICES CM 2002/ACFM:12

ADDENDUM

REPORT OF THE

Herring Larvae Surveys in the North Sea in 2001/2002

International Council for the Exploration of the Sea

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Palægade 2–4 DK–1261 Copenhagen K Denmark

TABLE OF CONTENTS

1 SUMMARY

Results of the international herring larvae surveys in 2001/2002 are presented. Spatial and temporal coverage is described as is the distribution of larvae in the areas sampled. Larval Abundance Index (LAI) for the units sampled and Multiple Larval Abundance Index (MLAI) are shown for the period since 1972.

Compared to 2000, a strong increase in abundance was observed in the Orkney/Shetland area where the abundance was approximately four times higher than last year's estimate. In the Buchan area the LAI increased but was still below the long-term mean. The situation in the Central (CNS) showed continuously rising LAI estimates over the last four years, representing a recovery from very low records to the long-term mean of this unit. In the Southern North Sea (SNS) the abundance did not changed substantially and was comparable to last year's estimate. Both years showed high larvae abundances and indicate a higher SSB for the Downs component.

Both the LAI per unit as well as the MLAI from the larvae surveys in period 2001/2002 indicate that the SSB increased and almost doubled when compared to last years WG estimates.

2 INTRODUCTION

Within the scope of the International Council for the Exploration of the Sea (ICES) since 1972 a continuos research on distribution and abundance of herring larvae has been undertaken in the North Sea and adjacent waters. The results of these surveys are used as an important estimator of herring spawning stock biomass and thus are valuable basic elements of stock assessment.

3 HERRING LARVAE SURVEYS IN 2001/2002

Institutes in the Netherlands and the Federal Republic of Germany participated in the reporting period. The data administration and analysis were compiled by IfM Kiel and BFA-Fi Hamburg and Rostock, Germany.

Six survey units (out of ten) were covered in the 2001/2002 period. The areas and time periods as well as numbers of samples, vessel-days in sampling and area coverage are given in Table 1. Number of samples taken has decreased (Table 2). This is mainly due to the absence of the Norwegian vessel, which participated last year. Norway will take part in the surveys every third year. Also the planned activity in the Buchan area (1st period) by Germany was cancelled. The research vessel had severe engine problems and was replaced by one which had only a few free ship days available. The program was shorten down and only the Orkney/Shetland area was covered (2nd period). The spatial extent of the surveys is shown in Figures 1-4.

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 3.

Compared to 2000 (ICES 2001), a strong increase in abundance was observed in the Orkney/Shetland area where the abundance was approximately four times higher than last year's estimate. In the Buchan area the LAI increased but was still below the long-term mean. The situation in the Central North Sea (CNS) showed continuously rising LAI estimates over the last four years, representing a recovery from very low records to the long-term mean of this unit. In the Southern North Sea (SNS) the total abundance did not changed substantially and was comparable to last year's estimate. Both years showed high larvae abundances and indicate a higher SSB for the Downs component. A comparison of the LAI and the HAWG SSB estimates is given in Figure 5. The spatial distribution of larvae was mainly restricted to the western parts of the Channel (VIId). The amount of larvae caught in IVc was negligible for all three surveys in the SNS. This may be an effect of the relatively low temperatures in the bottom water layers, especially near the Belgian and Dutch coastline.

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:

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

where $\text{MLAI}_{\text{year}}$ is the relative spawning stock size in each year, $\text{MLAI}_{\text{LAI unit}}$ are the relative abundances of larvae in each sampling unit and $u_{\text{year, LAI unit}}$ 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 4. The estimated trend in spawning stock biomass from this model fit is plotted in Figure 6 versus the SSB values obtained from the ICA runs of the Herring Assessment Working Group (ICES 2001).

Both the LAI per unit as well as the MLAI from the larvae surveys in period 2001/2002 indicate that the SSB has increased and almost doubled when compared to last years WG estimates.

4 ACKNOWLEDGEMENTS

This paper reports on surveys undertaken in 2001/2002 by the RIVO, Netherlands (G. Eltink, M. Warmerdam), and the IfM Kiel, Germany (D. Schnack, N. Rohlf).

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6 TABLES AND FIGURES

Table 1: Fortnights, time periods sampled and survey effort in 2001/2002.
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	5	FRG	Total
Buchan	01-15 Sep.	None			
	16-30 Sep.	65	5	NL	Partial
Central North Sea	01-15 Sep.	None			
	16-30 Sep.	76	7	NL	Total
	01-15 Oct.	None			
Southern North Sea	16-31 Dec.	84	4	NL	Total
	01-15 Jan.	117	6	FRG	Total
	16-31 Jan.	99	5	NL	Total

Table 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

Table 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

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

Table 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 < 10mm in length.

a) Analysis of variance of the model fit

	DF	Sum of Squares	Mean Square	F Value	P
Model	39	150.1	3.85	8.006	0.0001
Error	213	102.4	0.4807		
C Total	252	252.5			

b) Estimates of parameters

Reference Mean

Estimate	Standard Error	
6.8194	0.5637	Reference: 1972, Orkney/Shetland 09/01 – 09/15

Year Effects

Year	Estimate	Standard Error	Year	Estimate	Standard Error
1973	0.3787	0.7008	1988	2.7247	0.6057
1974	-0.1388	0.7508	1989	2.6889	0.6198
1975	-1.2079	0.7630	1990	2.9253	0.6429
1976	-1.3127	0.7488	1991	2.2881	0.6967
1977	-0.4007	0.7179	1992	1.5169	0.7363
1978	-0.2094	0.7287	1993	1.2124	0.7128
1979	0.5051	0.7015	1994	0.8032	0.7511
1980	0.1201	0.6983	1995	0.9511	0.7407
1981	0.5343	0.6954	1996	1.6521	0.7802
1982	0.8608	0.6309	1997	1.8596	0.7318
1983	1.1168	0.6469	1998	2.1599	0.6878
1984	1.7169	0.6281	1999	1.9889	0.6918
1985	2.1396	0.6059	2000	1.5673	0.7071
1986	1.4769	0.6259	2001	2.6950	0.7200
1987	2.0307	0.6176			

Sampling Unit Effects

Sampling Unit	Estimate	Standard Error
Or/Shet 16-30 Sep	-0.6515	0.3359
Buchan 01-15 Sep	-1.8225	0.4265
Buchan 16-30 Sep	-2.5583	0.3737
CNS 01-15 Sep	-1.6535	0.4129
CNS 16-30 Sep	-1.4814	0.3687
CNS 01-15 Oct	-2.0955	0.3956
CNS 16-31 Oct	-4.1683	0.5370
SNS 12-31 Dec	-1.8640	0.4001
SNS 01-15 Jan	-2.4991	0.3448
SNS 16-31 Jan	-3.7295	0.3896

Orkney/Shetland 1-15 September 2001: No samples taken in this period.

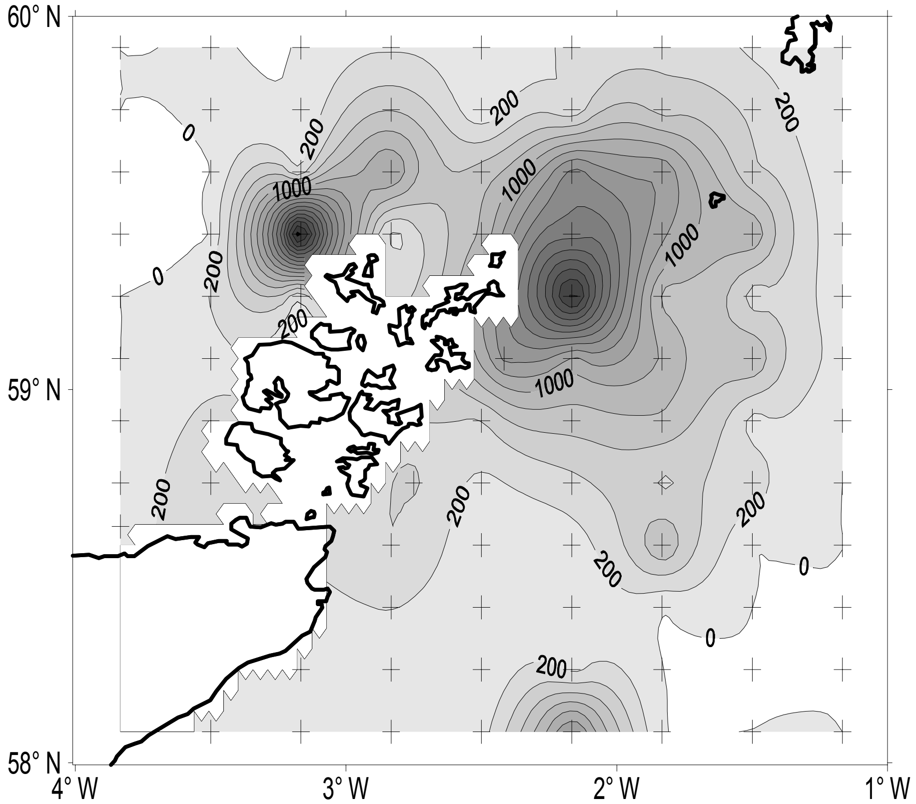

Figure 1: Orkney/Shetlands 16–30 September 2001 (FRG). Abundance of larvae < 10 mm (n/m²)

Buchan 1-15 September 2001: No samples taken in this period.

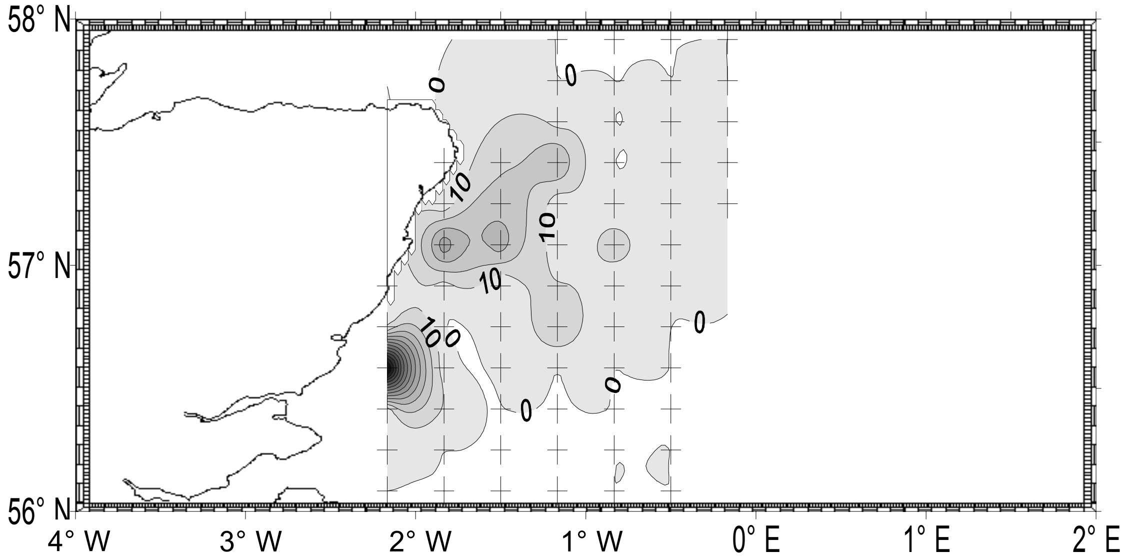

Figure 2: Buchan 16–30 September 2001 (NL). Abundance of larvae < 10 mm (n/m²)

Central North Sea 1-15 September 2001: No samples taken in this period

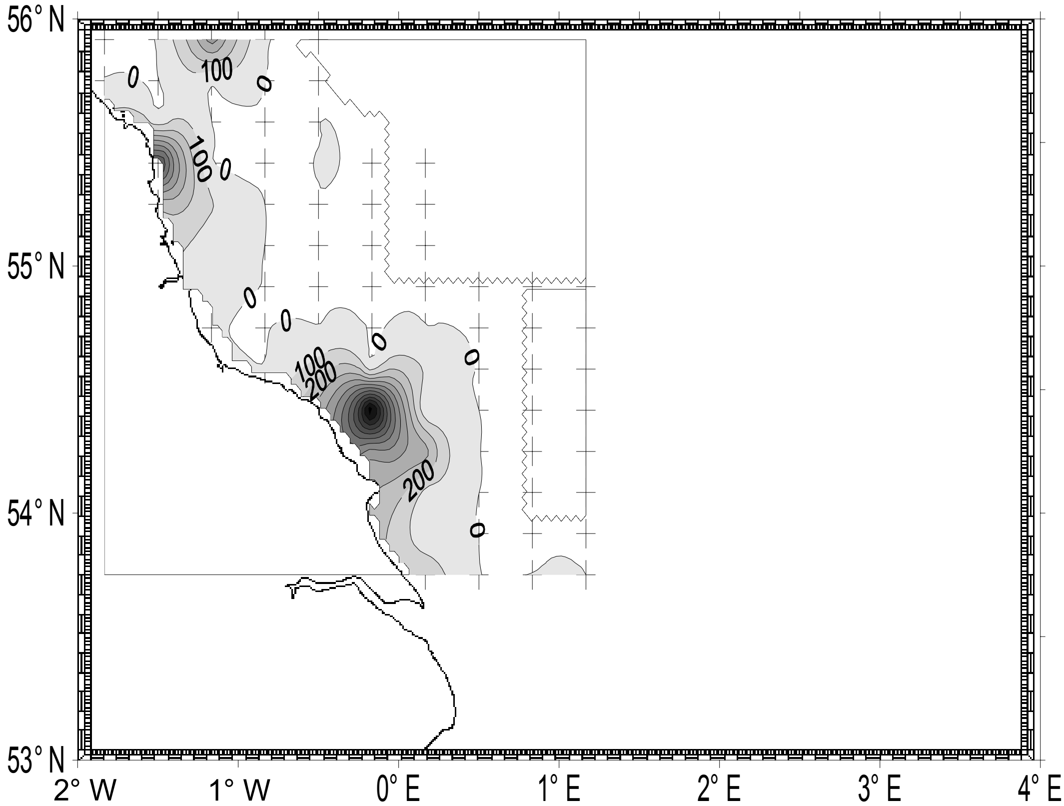

Figure 3: Central North Sea 16-30 September 2001 (NL). Abundance of larvae < 10 mm (n/m²)

Central North Sea 01-15 October 2001: No samples taken in this period

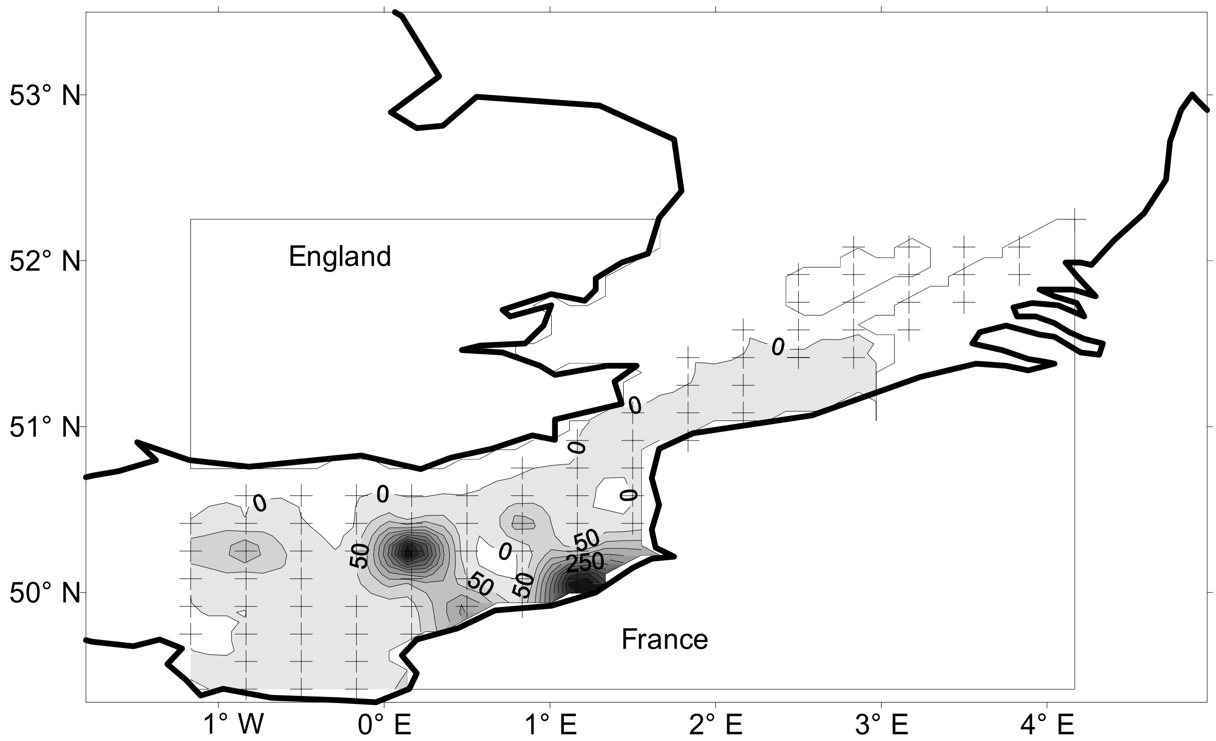

Figure 4a: Southern North Sea 16-31 December 2001 (NL). Abundance of larvae < 11 mm (n/m²)

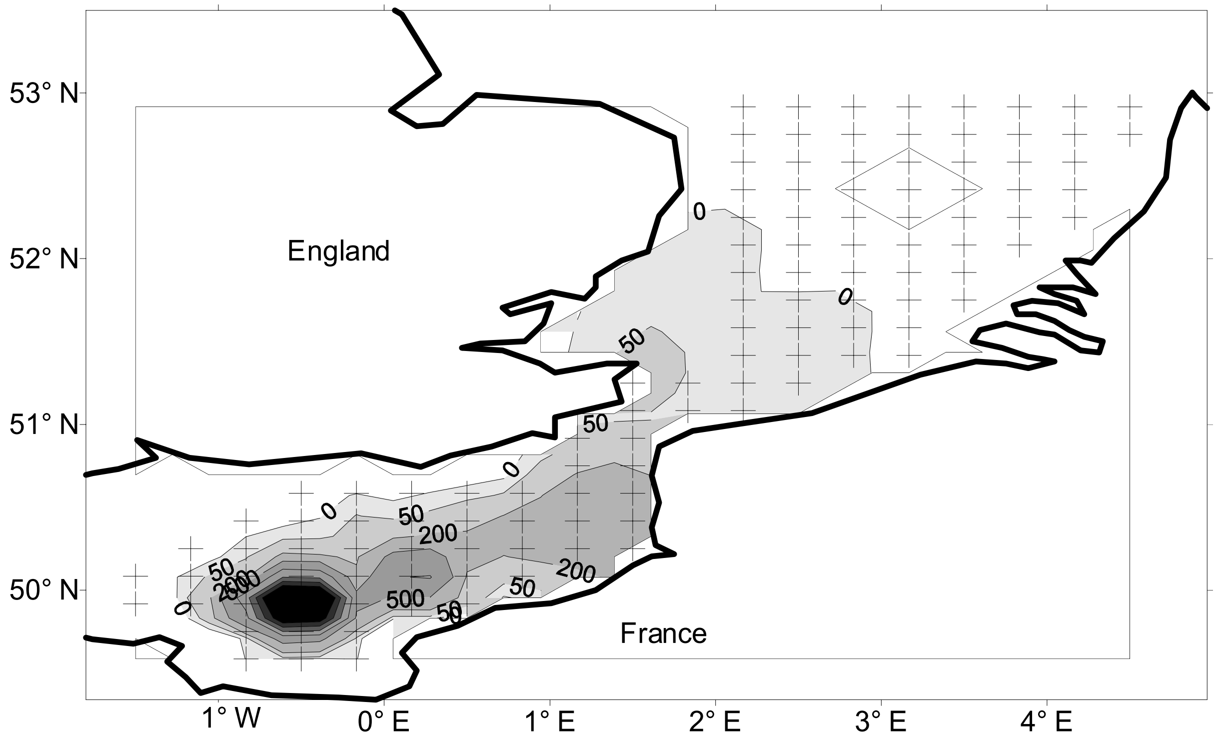

Figure 4b: Southern North Sea 1-15 January 2002 (FRG). Abundance of larvae < 11 mm (n/m²)

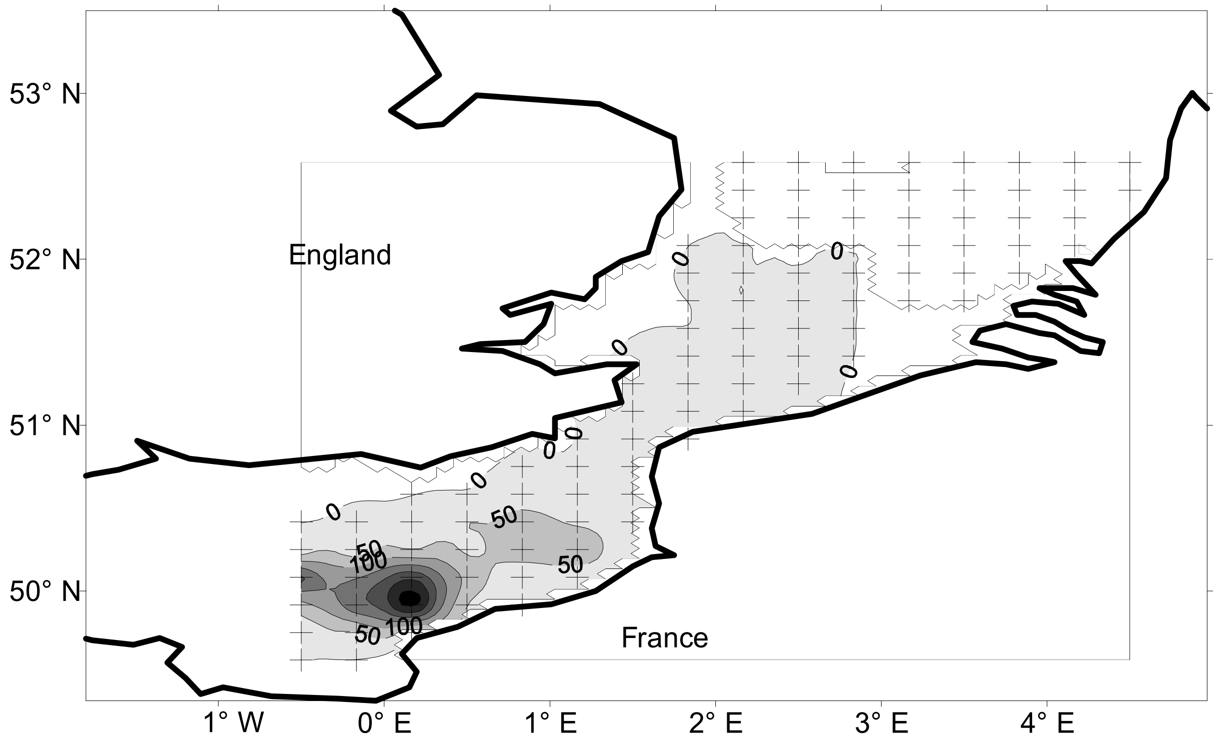

Figure 4c: Southern North Sea 16-31 January 2002 (NL). Abundance of larvae < 11 mm (n/m²)

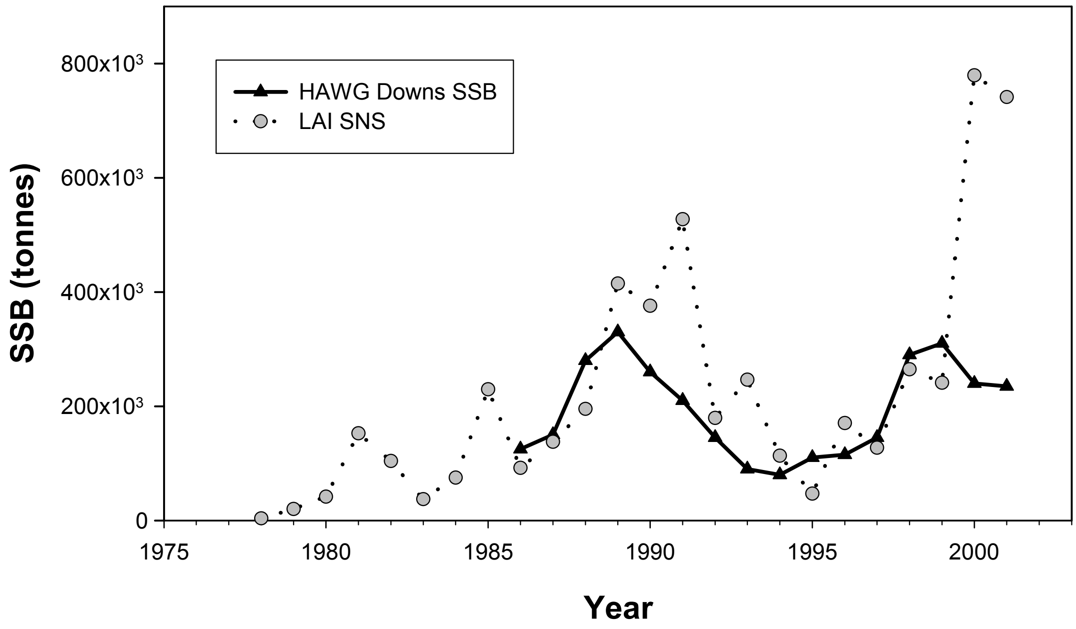

Figure 5: Comparison of spawning stock size HAWG estimates for the Downs herring and the LAI for the Southern North Sea. LAI estimates (Table 3) are multiplied by 100 to fit the same scale.

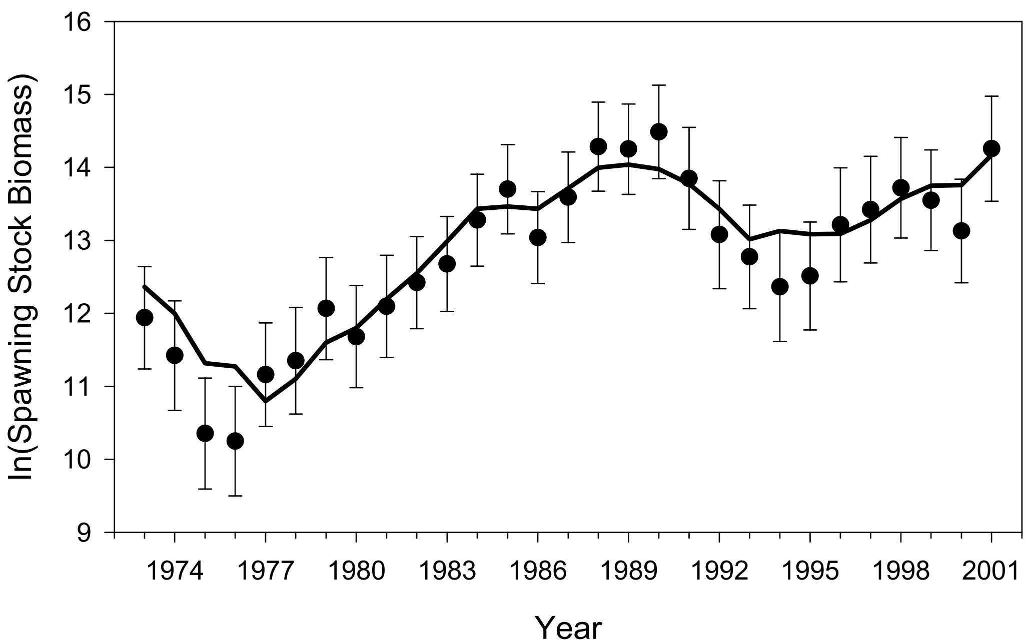

Figure 6: Comparison of spawning stock size estimates from the Herring Working Group (ICES, 2002; bold line) and the year effects fitted to the larval abundances in the multiplicative model (symbols with error bars). The MLAI estimates have been rescaled to the mean of the WG estimates. Error bars indicate +/- one standard error of larval survey abundance estimates.