Advisory Committee on Fisheries Management ICES CM 2001/ACFM:12

REPORT OF THE

Herring Assessment Working Group for the Area South of 62ºN

Hamburg, Germany
13–22 March 2001

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

TABLE OF CONTENTS

Section **Page**

1 INTRODUCTION 1
1.1 Participants 1
1.2 Terms of Reference 1
1.3 Summary of the Report of the Planning Group for Herring Surveys (PGHERS) 2
1.3.1 Review of larvae surveys 2
1.3.2 Coordination of larvae surveys for 2001/2002 2
1.3.3 Review of acoustic surveys in 2000 from the North Sea, west of Scotland, Western Baltic and the Sounds 2
1.3.4 Inter ship calibrations and survey overlaps 3
1.3.5 Biological sampling 3
1.3.6 Clupea.net 4
1.3.7 Sprat 4
1.3.8 Literature review on depth dependence of target strength in herring 4
1.3.9 Variability in herring depth distribution and the impact of TS depth dependence on survey results 4
1.3.10 HERSUR 4
1.3.11 The Planning Group for Herring Surveys recommends that: 5
1.4 HAWG Recommendations 5
1.4.1 The Planning Group for Herring Surveys 5
1.4.2 Recommendation for TORs of the IBTS Working Group 6
1.4.3 Exchange Studies on Sprat and Herring Otoliths 6
1.4.4 Recommendations on landings data collection 7
1.4.5 International co-ordination of data collection 7
1.4.6 Recommendations on SGEHAP 7
1.4.7 Recommendation for preparation of catch data 7
1.5 Commercial Catch Data Input, Quality Control, and Long-term Data Storage 7
1.6 Quality Control 9
1.6.1 Comments on the Quality Control Handbook 9
1.6.2 Comments on ICA and ICP revised 10
1.7 Relevant results from other studies 10
1.7.1 Report on the Workshop on International Analysis of Market Sampling and the Evaluation of Raising Procedures and Data-Storage (software) [WKIMS] 10
1.7.2 Vessel effects in the IBTS catch rates for herring 11
1.7.3 Calculation of mean weights at age and fraction mature for use in the assessments and predictions11
1.8 Study Group on the Evaluation of Current Assessment Procedures for North Sea Herring 13
1.8.1 Terms of reference 13
1.9 Fleet Descriptions 15
1.10 Reference Points 17

TABLE 1.5.1 18

FIGURES 1.5.1–1.7.9 19

2 NORTH SEA HERRING 26
2.1 The Fishery 26
2.1.1 ACFM advice and management applicable to 2000 and 2001 26
2.1.2 Catches in 2000 26
2.2 Biological Composition of the Catch 27
2.2.1 Catch in numbers at age 27
2.2.2 Treatment of Spring Spawning herring in the North Sea 28
2.2.3 Data revisions 28
2.2.4 Quality of catch and biological data 28
2.3 Recruitment 29
2.3.1 The IBTS index of 1-ringer recruitment 29
2.3.2 The MIK index of 0-ringer recruitment 29
2.3.3 Relationship between the MIK 0-ringer and the IBTS 1-ringer indices 29
2.3.4 Trends in recruitment as estimated by the assessment 29
2.3.5 Separate recruitment indices of the Downs herring 30
2.4 Acoustic Surveys in the VIa North and the North Sea July 2000 30
2.5 Larvae Surveys 31
2.6 International Bottom Trawl Survey (IBTS) 32
2.7 Mean Weights-at-Age and Maturity-at-Age 33
2.7.1 Mean weights at age 33

TABLE OF CONTENTS

Section **Page**

2.7.2 Maturity ogive 33
2.8 Stock Assessment 33
2.8.1 Data exploration and preliminary modelling 33
2.8.2 Stock assessment 36
2.9 Herring in Division IVc and VIId 37
2.10 Short Term Projection by Area and Fleet 38
2.11 Medium Term Predictions (Revised 22/3 0900) 42
2.12 Quality of the Assessment 43
2.13 Management Considerations 44

TABLES 2.1.1–2.12.2 45

FIGURES 2.1.1–2.13.1 106

3 HERRING IN DIVISION IIIA AND SUB-DIVISIONS 22–24 149
3.1 The Fishery 149
3.1.1 ACFM advice and management applicable to 2000 and 2001 149
3.1.2 Total landings 149
3.2 Stock Composition 151
3.2.1 Treatment of spring spawning herring in the North Sea 151
3.2.2 Treatment of autumn spawners in Division IIIa 152
3.2.3 Autumn spawners in the fishery in Sub-divisions 22 and 24 152
3.2.4 Accuracy and precision in stock identification 152
3.3 Catch in Numbers and Mean Weights at Age 154
3.4 Quality of Catch Data and Biological Sampling Data 154
3.5 Fishery-Independent Estimates 155
3.5.1 German bottom trawl surveys in Sub-divisions 22 and 24 155
3.5.2 International Bottom Trawl Survey in Division IIIa 155
3.5.3 Summer acoustic survey in Division IIIa 156
3.5.4 October acoustic survey in western Baltic and the southern part of Division IIIa (Kattegat) 156
3.5.5 Larvae surveys 157
3.6 Recruitment Estimates 157
3.7 Data Exploration 157
3.7.1 Input data 157
3.7.2 Exploration by individual survey indices 159
3.7.3 Exploration by combined survey indices 159
3.8 Status of the Stock 160

TABLES 3.1.1–3.7.27 161

FIGURES 3.2.1–3.7.7 201

4 CELTIC SEA AND DIVISION VIIJ HERRING 209
4.1 Introduction 209
4.2 The Fishery in 2000–2001 209
4.2.1 Advice and management applicable to 2000–2001 209
4.2.2 The fishery in 2000/2001 209
4.2.3 The catch data 209
4.2.4 Quality of catch and biological data 210
4.2.5 Catches in numbers at age 210
4.3 Mean Weights and Maturity at Age 210
4.4 Survey Indices 210
4.4.1 Acoustic surveys 210
4.4.2 Bottom trawl surveys 211
4.5 Stock Assessment 211
4.5.1 Preliminary data exploration 211
4.5.2 Results of the assessment 212
4.5.3 Comments on the assessment 212
4.6 Recruitment Estimates 212
4.7 Short Term Projection 213
4.7.1 Biological reference points and management considerations 213
4.7.2 Management considerations 214

TABLE OF CONTENTS

Section **Page**

TABLES 4.2.1–4.7.3 216

FIGURES 4.2.1–4.7.1 242

5 WEST OF SCOTLAND HERRING 253
- 5.1 Division VIa(North) 253
  - 5.1.1 ACFM advice applicable to 2000 and 2001 253
  - 5.1.2 The fishery 253
  - 5.1.3 Landings estimates and allocation of catches to area 253
  - 5.1.4 Age-composition of commercial catches 254
  - 5.1.5 Larvae surveys 254
  - 5.1.6 Acoustic survey 254
  - 5.1.7 Mean weights at age 254
  - 5.1.8 Maturity ogive 254
  - 5.1.9 Data exploration and preliminary modelling 254
  - 5.1.10 Stock assessment 255
  - 5.1.11 Projections 255
  - 5.1.12 Comments on the assessment 256
  - 5.1.13 Management considerations 256
  - 5.1.14 Reference points 257
- 5.2 Clyde herring 257
  - 5.2.1 Advice and management applicable to 2000 and 2001 257
  - 5.2.2 The fishery in 2000 257
  - 5.2.3 Weight at age and stock composition 257
  - 5.2.4 Surveys 258
  - 5.2.5 Stock assessment 258
  - 5.2.6 Stock and catch projections 258
  - 5.2.7 Management considerations 258
- 5.3 Weight in the catch 263

TABLES 5.1.1–5.2.4 259

FIGURES 5.1.1–5.1.15 290

6 HERRING IN DIVISIONS VIA (SOUTH) AND VIIB,C 299
- 6.1 The Fishery 299
  - 6.1.1 Advice and management applicable to 1999 and 2000 299
  - 6.1.2 Catch data 299
  - 6.1.3 The fishery in 2000 299
  - 6.1.4 Catch in numbers at age 299
  - 6.1.5 Quality of the catch and biological data 299
  - 6.1.6 Mean weights at Age 300
- 6.2 Ground Fish Surveys 300
- 6.3 Acoustic Surveys 300
- 6.4 Stock Assessment 300
  - 6.4.1 Date exploration and preliminary assessments 301
  - 6.4.2 Results of the assessment 302
- 6.5 Stock Forecasts and Catch Predictions 302
- 6.6 Management Considerations 302
- 6.7 Medium Term Projections and Management Considerations 303

TABLES 6.1.1–6.6.6 304

FIGURES 6.1.1–6.5.2.1 322

7 IRISH SEA HERRING (DIVISION VIIA, NORTH) 327
- 7.1 The Fishery 327
  - 7.1.1 Advice and management applicable to 2000 and 2001 327
  - 7.1.2 The fishery in 2000 327
  - 7.1.3 Quality of catch and biological data 327
  - 7.1.4 Catch in numbers 327
- 7.2 Mean Length, Weight, Maturity and Natural Mortality at Age 327
- 7.3 Research Surveys 328
  - 7.3.1 Acoustic surveys 328

TABLE OF CONTENTS

Section			Page
	7.3.2	Larvae surveys	328
	7.3.3	Groundfish surveys of Area VIIa(N)	328
7.4	Data Exploration and Preliminary Modelling		329
7.5	Stock Assessment		330
7.6	Stock and Catch Projection		330
7.7	Medium-Term Predictions of Stock Size		331
7.8	Management Considerations		331
	7.8.1	Precision of the assessment	331
	7.8.2	Reference points	331
	7.8.3	Spawning and juvenile fishing area closures	331
TABLES 7.1.1–7.6.5			332
FIGURES 7.2.1–7.5.6			351
8	SPRAT IN THE NORTH SEA		361
8.1	The Fishery		361
	8.1.1	ACFM advice applicable for 1999 and 2000	361
	8.1.2	Total landings in 2000	361
8.2	Catch Composition		361
	8.2.1	By-catches in the North Sea sprat fishery	361
	8.2.2	Catches in number	361
	8.2.3	Mean weight at age	362
	8.2.4	Quality of catch and biological data	362
8.3	Recruitment		362
8.4	Acoustic Survey		362
8.5	State of the Stock		363
	8.5.1	Catch-survey data analysis	363
8.6	Projections of Catch and Stock		363
8.7	Management Considerations		363
TABLES 8.1.1–8.6.1			365
FIGURES 8.1.1–8.6.2			372
9	SPRAT IN DIVISIONS VIID,E		384
9.1	The Fishery		384
	9.1.1	ACFM advice applicable for 2001	384
	9.1.2	Catches in 2000	384
9.2	Catch Composition		384
TABLES 9.1.1–9.2.3			385
10	SPRAT IN DIVISION IIIA		387
10.1	The Fishery		387
	10.1.1	ACFM advice applicable for 2000 and 2001	387
	10.1.2	Landings	387
	10.1.3	Fleets	387
10.2	Catch Composition		387
	10.2.1	Catches in number and weight at age	387
	10.2.2	Quality of catch and biological data	388
10.3	Recruitment		388
10.4	Acoustic Survey		388
10.5	State of the Stock		388
10.6	Projection of Catch and Stock		388
10.7	Management Considerations		388
TABLES 10.1.1–10.6.1			390
FIGURE 10.6.1			397
11	REFERENCES		398
12	WORKING DOCUMENTS		402

1 INTRODUCTION

1.1 Participants

Marinelle Basson (Chair)	UK
Jørgen Dalskov	Denmark
Mark Dickey-Collas	UK
Joachim Gröger	Germany
Tomas Gröhsler	Germany
Emma Hatfield	UK
Soenke Jansen (part time)	Germany
Ciarán Kelly	Ireland
Johan Modin	Sweden
Henrik Mosegaard	Denmark
Peter Munk (part time)	Denmark
Richard Nash	UK
Martin Pastoors	The Netherlands
Gerjan Piet	The Netherlands
Beatriz Roel	UK
Norbert Rohlf (part time)	Germany
John Simmonds	UK
Dankert Skagen	Norway
Else Torstensen	Norway
Lotte Askgaard Worsøe	Denmark
Christopher Zimmermann	Germany

1.2 Terms of Reference

The **Herring Assessment Working Group for the Area South of 62°N** [HAWG] (Chair: Dr M. Basson, UK) will meet in Hamburg, Germany from 13–22 March 2001 to:

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

b) assess the status of and provide catch options for 2002 for the sprat stocks in Sub-area IV and Divisions IIIa and VIId,e;

c) identify major deficiencies in the assessments;

d) review the layout of a Quality Handbook and prepare a Workplan for writing such a document. A draft of the Quality Handbook shall be reviewed by the Working Group in 2002.

HAWG will report by 29 March 2001 for the attention of ACFM.

The Working Group could not meet at ICES in Copenhagen as usual, due to building work, and therefore met in Hamburg. The group was welcomed to the Institut fur Seefischerei by the director, Dr Gerd Hubold. A server and network was set up and last year's Working Group files as well as stand alone software were available. The IFAP system was not, however, available to the group. Henrik Sparholt from ICES attended the first few days of the meeting.

The Working Group would like to thank the institute and Dr Chris Zimmermann in particular, for providing excellent facilities and logistical assistance during the meeting.

The Working Group has some serious concerns regarding continuity between meetings and requests ICES to:

1. Transfer all stock data to the IFAP system. This is a crucial request which, if not done, could seriously affect the work of ACFM in May, as well as the Working Group's work at next year's meeting.

2. Ensure that final runs are correctly transferred into summary sheets for ACFM.

3. Generate graphs and summary tables which the Working Group could not produce since IFAP was not available.

4. Copy the whole archive (from this meeting) into the directory for next year's meeting.

Based on experience of this meeting, the Working Group strongly recommends that ICES provide secretarial support, particularly during the second half of the meeting to other Working Groups which need to take place outside of ICES headquarters.

The Working Group have put in a lot of extra effort to convert the catch tables into EXCEL spreadsheets. This greatly facilitates checking and ensuring that figures add up, and minimises typing errors. The Working Group requests that these tables, or copies of these tables, be kept in the EXCEL format for updating next year. The Working Group will no longer use Word versions to update.

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

PGHERS met at the Netherlands Institute of Marine Research in IJmuiden, the Netherlands, from 11–15 December 2000 to:

a) coordinate 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;

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

c) take into account the findings of WGFAST and examine aspects of the depth dependence of target strength for herring, specifically;

   i. review the available literature on the depth dependence of target strength in herring;

   ii. report on investigations on the depth distribution of herring schools around Shetland for the years 1991-1997;

   iii. determine methods to evaluate the depth distribution of herring in past surveys for the whole of the North Sea.

The report of the meeting was made available to the Working Group (ICES CM 2001/G:02).

1.3.1 Review of larvae surveys

At the time of meeting four of the seven units and time periods planned for the 2000 period had successfully been carried out. Three surveys in the southern North Sea remained to be carried out in December 2000 and January 2001. Final results were presented to the HAWG, see Section 2.5.

The herring larvae survey in the Greifswalder Bodden (Baltic Sea) around the Rugen Island took place in the period from 17 April to 30 June during 10 × 5 day cruises.

1.3.2 Coordination of larvae surveys for 2001/2002

In the 2001/2002 period, only the Netherlands and Germany will participate in the larvae surveys. They will cover the same areas and time periods as in the 2000/2001 period. The herring larvae survey in the Greifswalder Bodden (Baltic Sea) will be conducted from 19 April to 29 June.

1.3.3 Review of acoustic surveys in 2000 from the North Sea, west of Scotland, Western Baltic and the Sounds

Six surveys were carried out during late June and July covering most of the North Sea and west of Scotland to a northern limit of 62ºN. Individual survey reports and final estimates of abundance were presented and, for the first time, combined at the planning group meeting to produce a global estimate. A full report including distribution maps will be prepared as an ICES paper. The data are used as indices 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 survey shows exceptional numbers of 1 ring herring (the 1998 year class) in the North Sea, which is consistent with the observation of an exceptionally large year class observed in the MIK and IBTS surveys. The estimates of Western Baltic spring spawning herring and of herring west of Scotland, were presented to the HAWG.

1.3.4 Inter ship calibrations and survey overlaps

Inter ship calibrations took place during the summer surveys between *Scotia* (Scotland, UK) and *G.O. Sars* (Norway) and between *Tridens* (Netherlands) and *Walther Herwig III* (Germany). The data do not indicate that the systems on board these ships are operating in an inconsistent manner.

The acoustic surveys have been organized with a number of overlapping statistical rectangles covered by two or more vessels on the boundaries of their respective survey areas. Data from different vessels in overlapping areas were compared using the combined survey database for years 1991 to 2000. This provisional analysis suggests that there were some differences in reported biomass between countries: namely in the estimates between Norway and Denmark, Scotland and Norway and The Netherlands and Norway. In these three cases, Denmark, Scotland and The Netherlands all reported higher densities than Norway. The results of the inter-ship calibrations in the last years indicate, however, that these differences are possibly due to differences in scrutinizing procedures. To facilitate further investigation the study group recommends that, where possible, survey overlap should be increased in areas of high fish density (east of Orkney and Shetland) and there should be an exchange of staff among surveys.

1.3.5 Biological sampling

ACFM request

Biological data from the 2000 acoustic survey were examined in detail in response to a technical minute from ACFM in relation to the appearance of very small light 1 and 2 ring herring in the south eastern part of the survey area. It is apparent that there was some ambiguity in the terminology used to report the age of fish. The calculations in the combined estimates are based on fish being aged in winter rings, however, fish are sometimes being reported in age classes in the south eastern part of the area. This problem did not occur prior to 1998 and has now been corrected for 1998 and 1999. A revised time series has been made available to the HAWG (see Sec.2.7). To avoid this problem in future, the acoustic survey manual and data spreadsheets will be revised to ensure that age data is reported as winter rings.

Maturity determination

There is a tendency for the percentage of mature herring for the age-class 3 (2 winter ring) to be higher in the north and west of the survey area. This coincides with a higher weight at age for these areas, but the observed differences are not thought to be completely due to this. Some reasons for the differences include the use of different maturity keys used in the different national sampling schemes and a strong tendency towards counting fish sampled on surveys in the south eastern part of the survey area, as mature (coinciding with a change in personnel and the switch from an 8-point to a 4-point maturity key). The planning group estimated a relationship between mean weight at age and fraction mature to correct for this. The results affected less than 0.1% of 2 ring herring numbers in 2000. A similar correction has been applied to data from 1999 and 1998 in time for the HAWG (see Section 2.7).

In the Danish samples the percentage mature of age-class 3 (2wr) was fixed at 50%. As it is now possible to differentiate between individual Autumn and Spring Spawners (by means of otolith microstructure analysis), data is available to estimate maturity fractions in the two groups. A revised time series will be made available to the next HAWG.

The Planning Group agreed that it would be desirable to standardize the reading and estimation of maturity stages in herring, particularly to separate mature and immature fish. Photographs of herring gonads at different maturity stages will be collected in the 2001 surveys. The pictures will be compiled and standardized for colour. It is anticipated that a workshop similar to the egg or otolith reading workshops will then be held to standardize staging and produce a library of holotypes for each maturity stage.

Age determination

There is no evidence to suggest that there are differences in ageing of herring among participants in the North Sea surveys. However, it is more than 8 years since age estimation procedures were compared and so the group thought that an otolith exchange program should be carried out to in 2001 to examine consistency amongst age readers.

In the light of increasing numbers of mature 1 ring fish appearing in some parts of the survey it was decided that the 1 ring category should be split into an immature (1i) and mature component (1m) in a similar fashion to 2 and 3 ringers. The combined survey report will also include estimates of 0 ring fish.

1.3.6 Clupea.net

Chris Zimmerman (Germany) and colleagues have developed an open access website describing the various aspects of herring population ecology (http://www.clupea.net). Currently the site includes mostly data on European herring stocks, using information readily available from three Working Groups within the ICES environment (HAWG, NPBW-WG and BFAS-WG).

1.3.7 Sprat

Data on sprat were available from *FRV Walther Herwig III*, *FRV Tridens* and *FRV Dana*. In 2000 the survey was extended by 30 n.mile 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 342,000 t in the North Sea and 2,000 t in the Skagerrak/Kattegat.

Members of the group expressed some concern about the ageing of sprat and decided to collect samples in order to conduct an otolith age intercalibration prior to the next meeting. Protocols for intercalibration will be drawn up and distributed later in 2001.

1.3.8 Literature review on depth dependence of target strength in herring

A literature review on depth dependence of target strength in herring was presented. A significant amount of information on the topic is contradictory. While there is evidence from recent investigations for a depth dependence of TS, still too little is known about the exact influence of the different parameters. As a consequence of this uncertainty in the exact depth dependency of TS in herring, and the relatively small impact of the corrections on the perception of spawning stock biomass (see below), the group concluded that there was no rationale for using depth corrections until more reliable data become available.

1.3.9 Variability in herring depth distribution and the impact of TS depth dependence on survey results

Given that the acoustic surveys produce an index of stock size rather than an absolute estimate, the most important consequence of TS depth dependence would be if the depth distributions of herring altered markedly between years. A study of herring depth distribution for the Scottish acoustic survey in July 1991–1997 was carried out. The study showed that there were variations in depth distribution between years, but there was no evidence of a trend in depth distribution over years. Application of a preliminary equation developed for TS depth dependency suggested that depth distribution changes would result in a maximum change of about 4% in the calculated index value. It was thus concluded that, provided the survey estimate was used as a relative index, depth variation between years was not a major source of inaccuracy.

1.3.10 HERSUR

The HERSUR II project is a European Union funded study (contract no. 99/006) aimed at developing an international database for acoustic and biological data for North Sea and west of Scotland herring. The HERSUR database is now operational on a dedicated server at DIFRES. The website for entering and validating data was demonstrated at the meeting. It was decided that all available data back to 1991 should be entered to the HERSUR database. The need for an international abundance estimation system based on all the data stored in the database was discussed. A sub-group was identified to specify the requirements for this abundance estimation system. The sub-group met the day before the HAWG to start work on a requirement specification for an estimation system. No report was available to the HAWG.

1.3.11 The Planning Group for Herring Surveys recommends that:

The Planning Group for Herring Surveys should meet in Hamburg, Germany, from 14 to 18 January 2002 with P.G. Fernandes (UK, Scotland) as Chair to:

a) coordinate 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;

b) combine the survey data 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. Members should prepare a brief statistical evaluation of their acoustic data to present at the next meeting.

PGHS further recommends that:

- additional biological samples be taken from surveys;
- nations should exchange staff between surveys to ensure consistent scrutinising;
- the area overlap between *Scotia* and *Michael Sars* be extended with a spacing of 7.5 n.mile.;
- results from the acoustic survey and the larvae survey be posted on the "Clupea.net" website;
- due consideration be given to sprat and 0 ring herring in the acoustic survey. 1 ring fish should be examined closely for maturity to be reported as immature and mature;
- acoustic survey data from 1991 onwards be archived into the HERSUR database;
- the global abundance estimation method specified within the HERSUR project be developed;
- a database be set up to incorporate existing historical tagging data into an accessible format;
- despite recommendations from this group over the past two years, no efforts were made to cover the whole area of Division IIIa at the same time of the year within the frame of the international Baltic autumn acoustic survey. If there is a need to deliver an index for the western Baltic herring to the HAWG, that group must endorse these recommendations;
- a review be made of existing documentation on larvae survey methods;
- the format of individual acoustic survey reports from the coordinated North Sea herring acoustic survey be rationalised.

Comments by HAWG on these recommendations from the PGHERS are made in Section 1.4.

1.4 HAWG Recommendations

1.4.1 The Planning Group for Herring Surveys

The HAWG recommends that:

The Planning Group for Herring Surveys should meet in Hamburg, Germany, from 14 to 18 January 2002 with P.G. Fernandes (UK, Scotland) as Chair to:

- coordinate 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 and extending the area to cover more of the North Sea sprat population;
- combine the survey data to provide estimates of abundance for the population within the area;
- examine consistency in the measurement of biological parameters, specifically:
  - verification of maturity stage measurements of herring and sprat;
  - age reading of herring and sprat;
- investigate the effect of time of day on the detection of herring during the acoustic survey. Members should prepare a brief statistical evaluation of their acoustic data to present at the next meeting;
- to revise the database to hold an additional maturity-at-age series for 1 ring herring;
- to validate acoustic survey data in the assessment tables used by HAWG by comparison with database used by PGHERS for years before 1995;
- to gain a better knowledge on the total distribution of the Western Baltic spring spawning herring efforts should be made to cover the whole distribution area of this stock (Div. IIIa and Sub-divisions 22-24) and to synchronise the timing with the international Baltic autumn acoustic survey. The new survey should continue over a period of at least 4 years in order to deliver a tuning index for the HAWG. During this period the already existing Danish Acoustic survey in Division IIIa, which is carried out in July within the frame of the North Sea acoustic survey, should be continued. Based on the results of the new autumn survey in Div. IIIa it should be decided by the HAWG after the period of four years, whether the old summer or the new autumn survey should be continued.

1.4.2 Recommendation for TORs of the IBTS Working Group

The Working Group was interested in the possibility of using a vessel effect corrected index but needs a more comprehensive review of the impact of these proposed changes before deciding if this is appropriate. However, to carry out the required studies there is a need to supply data from the ICES database to the Working Group to allow a revised index to be calculated. The data required are the catch rate at age by station including location, depth, date, time, and vessel fields. Current methods of supplying data are slow.

The Working Group Recommends:

- The IBTS WG is requested to organise with ICES a method for providing the necessary database output in the correct form in prompt manner routinely to the HAWG members so that such a method might be tested.

- In addition the IBTS WG should comment on how such a function (to be supplied by HAWG) might be incorporated in the routine index provision of the herring IBTS index to the HAWG.

1.4.3 Exchange Studies on Sprat and Herring Otoliths

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

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

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

There continues to be a need to set up routine otolith exchanges for herring and sprat in order to keep quality control of this important aspect of data collection. This is supported by the work of PGHERS (see Section 1.4.1).

1.4.4 Recommendations on landings data collection

The Working Group recommends:

- 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 Working Group members to compensate misreported or unallocated landings or discards data entry should be possible on the most disaggregated level; the application should produce standard outputs and allow for a splitting of catch and weight at age data; and a data exchange to the evaluation routines already created (i.e. DISFAD) has to be ensured. The detailed information given by the WG MHSA (WD Zimmermann *et al.* 2000) should be observed during the development process.

- again to search for national catch and sampling data from previous years either within ICES or at the national institutes (see Sec. 1.5: official catches and Working Group estimates by rectangle, sampling level and sampling details – catch in numbers at age, mean weights at age – by area as defined in Figure 1.5.1). Files should be send to Chris Zimmermann, Hamburg, intersessionally, or provided to next year's Working Group.

- that national labs provide information of commercial catch and sampling by fishery, especially if by-catches in other than the directed fishery occur, and/or if there are indications that the age structure in the catches differ between these fisheries.

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

1.4.5 International co-ordination of data collection

- Collection of fishery dependent or fishery independent data for stock assessment use, has in the past been carried out and co-ordinated internationally and many of the data collection programmes have been co-financed by EU. With the changes of the EU data collection co-financing from January 2002, the Working Group recognises the importance of continuation of the internationally co-ordination and co-operation and recommends that this international co-ordination should be incorporated in all national data collection programmes for herring and sprat stock assessment data collection.

1.4.6 Recommendations on SGEHAP

- The Working Group recommends that in order to complete its work a meeting should be held 20-21 August 2001 at DIFRES Copenhagen, Denmark.

1.4.7 Recommendation for preparation of catch data

- The Working Group recommends a meeting prior and close to the HAWG 2002. This should be conducted to collate new and revised data on stock separation between Western Baltic spring spawning and North Sea autumn spawning herring in Div. IIIa, in order to provide catch at age data for these two stock for the beginning of the HAWG. (data will be available from the finalised CFP 98/026 study project).

1.5 Commercial Catch Data Input, Quality Control, and Long-term Data Storage

Input spreadsheet

Since 1999 (catch data 1998), the Working Group members are using a spreadsheet to provide all necessary landing and sampling data, which was developed originally for the Mackerel Working Group (MHSA) and further adapted to the special needs of the Herring Assessment Working Group. The current version used for reporting the 2000 catch data was v1.4. The majority of commercial catch data of multinational fleets was again provided on these spreadsheets and further processed with the SALLOCL-application (Patterson 1997). This program gives the needed standard outputs on sampling status and biological parameters. It also clearly documents any decisions made by the species co-ordinators for filling in missing data and raising the catch information of one nation/quarter/area with information from another data set, which allows to recalculate data in the future, choosing the same (subjective) decisions made today. Ideally, all data for the various areas should be provided on the standard spreadsheet and processed similarly, resulting in a single output file for all stocks covered by this Working Group.

The quality of the input data has significantly improved over the last years, the provided input format was used by all but one nation. Problems discussed during last year's Working Group could obviously been solved in this year, and in contrast to last year the deadline for sending the data to the species co-ordinators was met by most nations. It proved to be helpful that - as suggested – most of the time-consuming data verification and procedures relevant to the splitting of North Sea Autumn spawners and Western Baltic spring spawners in Div. IIIa was done during a separate meeting prior to the Working Group meeting. The Working Group suggests to conduct a similar meeting in the next year.

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 which is not reproduced in the report is available in a folder called "archive" under the Working Group and year directory structure. This 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 Working Group-data exchange sheet (MS Excel). However only sampled, official, Working Group 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 IFAP system. 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).

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.

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 Working Group again strongly recommends to develop an input application for the 2002 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 Working Group members to compensate misreported or unallocated landings or discards. The Mackerel, Horse Mackerel, Sardine and Anchovy Working Group addressed during its meeting in 2000 its requirements from a database and standard platform used to submit and store the disaggregated fisheries assessment data and produce outputs for the report. These details are given in a working document (Zimmermann et al. 2000 WD to MHSA Working Group). The compilation of this type of information from each Working Group should expedite the building of the new ICES database. HAWG supports WGMHSA's effort and states that the given information would also meet its requirements.

However, if a database input is still not be available for next year's Working Group, it was decided to use the spreadsheet 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 version 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 Working Group is aware of the problem that this knowledge might be lost if the scientist resigns, 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 aggregated data, particularly with regard to confidentiality.

The Working Group considered the need of a **long-term data storage** for commercial catches and sampling, and the documentation of any primary data processing of these data. From last year on, last (consistency checked) versions of the input files together with standard outputs and a documentation of filling-in decisions made by the co-ordinators, ideally in the SALLOC-formats, 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 Working Group members on request. As there was very little historical information available, Working Group members were asked to provide as much as possible national catch and sampling data delivered to the Working Group in previous years to this year's Working Group, in any available format. National data provided in this year is stored in a "~historic" folder within "Archive"; they will be consistency checked intersessionally. Table 1.5.1 gives an overview over data available so far, and the source of the data. If it is needed to re-enter catch data, members are encouraged to use the latest-version input spreadsheets. Figure 1.5.1 shows the separation of areas as used for the long-term storage of data.

In response to last year's discussion on this topic, the Working Group was informed about the development of an open-access **web-page** (http://www.clupea.net) providing information on (in a final stage) all herring stocks in the world. The page contains scientific (and agreed) information on parameters like catches, biomass, SSB, recruitment, weights/numbers/lengths at age etc, and it should ease an evaluation of possible synchronous changes or fluctuations in these parameters. The web page was initiated by members of the institute for Sea Fisheries in Hamburg during last year, and some members of the HAWG contributed useful data in the meantime. The Planning Group for Herring Surveys (PGHERS) decided to use it as a platform for distributing its survey data. It was noted that stock summaries, including reference point definitions and ACFM standard graphs, maps and texts of documents relevant to the group can be found and downloaded from this page.

1.6 Quality Control

1.6.1 Comments on the Quality Control Handbook

The Working Group was asked to comment on the draft ICES quality control (QC) handbook and stock template. Several general points were raised. The Working Group considered that the stock Annexes should form part of the relevant Working Group's report to facilitate the work of the Working Group (consulting the previous year's work during the meeting) and of ACFM (reviewing the work of the Working Group). The Annexes can, of course, also exist as part of the overall QC Handbook.

The Working Group expressed some concern with the requirements of transparency regarding the processes for deriving Working Group catches, used in the assessments, from National statistics. The problem is that total transparency would be highly detrimental to obtaining any information on misreporting in future. This would lead to further deterioration of total catch statistics. The Working Group proposes to provide only as much information on this process as is possible without jeopardising the chances of getting information on misreporting in future.

It was recognised that some 'stability' in the methods and assessment details over several years would be advantageous. However, the Working Group does not run assessments without scrutinising the diagnostics for problems. This means that in many cases there may be a need for some changes in assessment settings to obtain an acceptable fit. Particularly, in cases where tuning series are short, the assessment may still be relatively unstable, and it may not be possible to stick to all the settings set out in the handbook. Also, it may not be appropriate to change the handbook every year. The existence of a defined assessment procedure should not lead to blindly applying that procedure, and the Working Group assumes that this is not the intention of QC Handbook.

The Working Group also considered that filling in the templates for setting up of the first version of each stock annex would be a substantial task. Although some information is already contained in the Working Group reports, other items would need to be filled in after discussion amongst Working Group members. This needs to be taken into account when specifying how and when first versions of the annexes should be drafted.

It is currently unclear whether the existence of an annex for each stock would really speed up the process of report writing. The current method of writing the Working Group report is, in principle, similar to the proposed process, since the previous year's report is updated and amended rather than rewritten from scratch every year. The proposed process will still require updating the report annually, albeit with reference to the handbook where procedures are unchanged.

1.6.2 Comments on ICA and ICP revised

The following items were found concerning the ICA software (Patterson, 1998):

- In the North Sea herring assessment, there appeared to be an error in the calculation of the weighted sum of squares for the stock-recruitment model, since the unweighted and weighted sum of squares were equal, even though a weight of 0.1 was used. This phenomenon was not observed in earlier years.

- It was found that the results of the analyses by tuning index separately were very dependent on the procedure used: if fleets were simply down weighted the confidence intervals were much more narrow than if fleets were physically removed from the input files. This can probably be explained by the fact that in the down weighted scenario, the degrees of freedom remained the same, thereby reducing the confidence interval.

- The ICA.SEN file was found to contain errors, and did not conform to the standard that was defined for this file type. Notably there were errors in the labelling of the variables, the first age group estimate was wrong, some variables and index values at the end of the file were missing.

- File type identifiers (Lowestoft format) are not implemented on some output files, in particular ICA.F and ICA.N. It would be helpful if this were amended.

- ICP sometimes crashes, apparently depending on the F-multipliers applied.

- ICAVIEW cannot display more than one SSB index.

1.7 Relevant results from other studies

1.7.1 Report on the Workshop on International Analysis of Market Sampling and the Evaluation of Raising Procedures and Data-Storage (software) [WKIMS]

A Workshop on International Analysis of Market Sampling and the Evaluation of Raising Procedures and Data-Storage (software) [WKIMS] was held in Lowestoft from 28-30 November 2000. At the workshop results were presented (among others) on the analysis of the international market sampling data for North Sea herring and the implications of the uncertainty in those data on the assessment of the stock. The analysis were carried out within the framework of an EU study project on the Evaluation of market sampling strategies for a number of commercially exploited stocks in the North Sea and development of procedures for consistent data storage and retrieval (EMAS). Results will be briefly summarized below.

Market sample data from the major fishing countries for these species have been collated at the lowest aggregation level and used to generate 1000 national and then 1000 international catch at age datasets, which were then used in bootstrapped ICA assessments.

The workshop used 1000 replicates of national catch at age data for the period 1991 to 1998 for Denmark, Netherlands and Scotland. This fully sampled component constitutes on average 66% of the North Sea herring landings over this period. In addition to this fraction of the catch, the area misreported data from VIa north, and the English German and French fleets, that are usually raised by these samples in the Working Group, this increases the proportion of the catch covered by the sampling to 75% of the total. The major missing components are the unallocated landings and

Norwegian samples, which were supplied, but full bootstrap replicates could not be generated at the meeting. For North Sea herring the bootstrapped components both underestimate and overestimate numbers at age because landings are both added and subtracted due to area misreporting, discards and catches of Baltic Spring Spawning herring in the North Sea. Figure 1.7.1 shows the bootstrapped catch at age from these samples plotted with Working Group estimates of catch at age (ICES C.M. 2000 / ACFM: 10).

The bootstrapped assessments were carried out to study the effects of the estimates of catch numbers at age, using the models, indices and procedures of the ICES Herring Assessment Working Group (ICES C.M. 2000/ACFM:10). CV on fishing mortality is 4% and 8% for adult and juvenile mortality respectively (Figure 1.7.2). The CV on recruitment is 4% and for SSB 2%. However, it must be remembered that these CVs are conditional on the estimate of total landings.

Conclusions

The international sampling programmes appear to be delivering estimates of catch at age that are rather precise, with CV's of 6% for the best estimated ages rising to about 30% for the older ages. While the precision of the best estimated ages is good, the current scheme is delivering much poorer CVs on older ages.

The results of the analyses performed are also conditional on accurate catch census. The initial studies are suggesting that for the data sets examined the current levels of market sampling cause only small amounts of variability in assessment outputs. The studies reported here are incomplete and work is continuing. It is anticipated that more extensive studies will be presented at the ICES Annual Science Conference in 2001, where a theme session will be devoted to the quality and precision of basic data underlying stock assessments.

1.7.2 Vessel effects in the IBTS catch rates for herring

The Working Group noted a paper at the ICES ASC by Simmonds and Rivoirard (ICES CM 2000/K:32). The paper reported significant vessel effects in catch rates of 1 and 2+ herring, equivalent to the IBTS 1 ring and 2-5+ ring indices used in the assessment. The catch rate factors are illustrated in Figure 1.7.3.

The results reported are from an analysis which removes all spatial effects by assigning all other aspects like fishing regimes, gear differences and working practices to vessel effects. No attempt is made to assign reasons to the causes for the differences. Substantial catch rate differences are shown for vessel replacements by Scotland, France, Netherlands and Norway. A revised assessment (up to 1997) using the correction factors to the IBTS derived from this study was presented at the Working Group (Figure 1.7.4) and it was observed that the persistent different perception of the North Sea herring assessment from the IBTS index was removed.

The Working Group was interested in the possibility of using a corrected index but needed a more comprehensive review of the impact of these proposed changes. However, to carry this out there is a need to supply data from the ICES database to the Working Group to allow a revised index to be calculated easily. The data required are the catch rate at age by station including location depth date time and vessel fields. The IBTS WG is requested to organise with ICES a method for providing the indices in the correct form in prompt manner to the Working Group so that such a method might be tested. In addition the IBTS WG should indicate the possibilities for implementing a vessel based correction factor into the routine index calculations provided to the HAWG.

1.7.3 Calculation of mean weights at age and fraction mature for use in the assessments and predictions

ACFM noted that the North Sea assessment uses point values for maturity at age and 3 year running mean for mean weights at age in the stock. The WG has looked briefly at this problem. The objective is to separate the point observation variability from the general trends in growth. While there may be some evidence for annual variability in the growth that occurs, it is not useful to include such growth changes when they occur only at one age in a single year within an assessment which is looking at the long term view for management purposes. These changes if they are real may be very important for recruitment studies but the added variability may not help in an assessment. In the context of an assessment it is not possible to know if these fluctuations are real or just measurement error and it is thought preferable to model them as error.

Examination of weights at age in the assessment

The data used in this analysis was the mean weights at age for autumn spawning North Sea herring from the acoustic survey of the North Sea (Table 2.7.1) and the acoustic survey data base held for PGHERS in Aberdeen.

A year-independent growth model can be fitted to the data

$$W = W_\infty \{1 - \exp [- k (t - t_o)] \}^\wedge b$$

Where

$W_\infty = 0.335$ kg

$k = 0.396$

$t_o = 1.09$

$b = 3.0$

The residuals around this model are best expressed as multiplicative, as the variability increases with age. A plot of the residuals by year and age as a grey scale representation can be seen in Figure 1.7.5. The essential requirement is to separate the noise from real fluctuations in the data. One method of separating the point variability and trend appropriately is Geostatistics (Rivoirard *et al* 2000). Variogram models can be fitted to the data. The model intercept on the variance axis estimates the point variation and the slope of the model line provides the relative weighting of adjacent values. Figure 1.7.6 shows the experimental (data based) variograms between ages and between years that expresses the variability in these directions. The intercept on both directions must by definition be the same, the between ages variogram (Figure 1.7.6b) provides the best estimate of this intercept and has been used to obtain the estimate for this value. There is no evidence of the shape of any structure in the experimental variograms so a linear function has been used to model the trend. The high first value in the experimental variogram by years is due to the sharp yearly fluctuations in weight at age in the data which are easily visible in the residual plots. There is no particular reason why this observed fluctuation should be real so it has not been modelled but ignored by using a linear model. The resulting models (nugget + linear) are shown in Figure 1.7.6. A kriged estimate of the residuals of weight at age based on the data and these models is shown in Figure 1.7.7 using the same greyscale as Figure 1.7.5.

The resulting estimates of mean weights at age by this method may be compared with the survey observations and the 3 year running mean used in the assessment for ages 1 to 5 (Figure 1.7.8). The older ages 6-9 have been omitted from the diagram as they are more variable and the figure would look confusing.

The acoustic survey data archive 1989 to 2000 have been analysed to obtain estimates of mean weight at age with 5 and 95% intervals obtained by bootstrap used for the estimates of abundance and mean weight by statistical square.

The kriged mean weights at age can be compared to the bootstrap intervals from the survey analysis in Figure 1.7.9 for ages 1 to 5. From this figure it is possible to see that around 20% of the kriged estimates of mean weight at age lie outside the 90% intervals. This suggests that either the bootstrap used is overestimating the precision or that the models fitted are smoothing the data too much. This method provides a more objective method for smoothing than the 3 year running average for dealing with mean weights for use in the assessment. This process needs to be looked at in more detail to check the results before being implemented.

Mean weights at age in projections

The use of mean weight in the projections was checked for one year ahead by using the mean weight data from earlier years and comparing this to the values obtained by kriging. The method employed was to use the mean weights in known years to obtain mean weights in the following year. The constraint was that the best fit was found for weighting factors for the mean of earlier years, and for each year (from the current year backwards) the weights were constrained to be reducing and positive. The input data for this were the raw data, or the kriged estimates up to the current year. The results of this analysis suggested two different options. If kriged estimates were used for projection the current year was the best estimate of the next year and if the observed mean weights were used the best estimate came from the 50% of the long term mean and 25% each of the two previous years. This study needs to be extended over more years of projection before full conclusions can be reached.

Maturity at age

There was insufficient time to carry out a detailed study of the use of maturity data. The method described above for mean weights is not applicable because there are only two age classes available. Variograms along a cohort or between ages are not possible. The auto-correlation between residuals on mean mortality at age is shown below for maturity at 2 ring and maturity at 3 ring in the same year, at year+1 (along a cohort) and year +2.

Correlation coefficients

	Mat 2	Mat3	Mat3 y+1	Mat3 Y+2
Mat 2	1			
Mat 3	0.435595	1		
Mat3 y+1	0.699531	0.022835	1	
Mat3 Y+2	0.282649	-0.33199	0.02893	1

The correlation coefficient of 0.7 along cohorts suggests that the variability observed has a substantial cohort effect. While a much more extensive analysis is required this high correlation clearly indicates some evidence of real fluctuation in fraction maturity at age.

Conclusions on methods for mean weights and fractions mature at age

The studies reported are preliminary but show some promise. The small conflict between the variability in the estimated values for mean weight with confidence intervals and the modelled weights needs to be resolved before a conclusion can be reached.

The strong cohort effect in fraction mature at age may need to be incorporated in a projection for this variable.

Attempts will be made to include these studies within the re-evaluation of North Sea assessment (Section 1.8).

1.8 Study Group on the Evaluation of Current Assessment Procedures for North Sea Herring

1.8.1 Terms of reference

The STGEHAP will be established and work by correspondence in 2001 to:

a) propose and evaluate an assessment procedure that is less restrictive in the separability assumption than methods in current use (ICA);

b) evaluate the usefulness of the so-called "split factor" in predicting abundance of the stock components in Division IIIa and in Sub-area IV;

c) review the procedures used for generating fleet based selection patterns;

d) based on the reviews done under b) and c) propose and evaluate a prediction procedure (both short and medium term) that meets management needs for an area based advice. Implement and verify a new prediction computer program;

e) revisit the basis for the biological reference points implemented in the management plan for North Sea (autumn spawning) herring.

SGEHAP will make its report available to HAWG and will report by 30 April 2001 for the attention of ACFM.

The Study group met at the HAWG on 16 March to define a programme of work to address the TOR presented above. A programme of work was established with tasks aimed specifically at each item in the terms of reference.

Study group work plan

a) Evaluation of assessment procedures

Investigation of performance of ICA and AMCI (and possibly XSA) for assessment of North Sea herring.

Data sets will be provided including variability in:

Catch

- Catch at age from market sampling errors by bootstrap 1991-1998 (simulated errors for other years)

- Weights at age in the catch from market sampling errors by bootstrap 1991-1998 (simulated errors for other years)

Biological parameters

- Mean weights at age in the stock from acoustic surveys 1984-2000

- Fraction of stock mature at age 2 and 3 ring from acoustic surveys 1988-2000

Survey indices

- MIK 0-wr index. Available since 1977 as a recruitment index (errors by bootstrap)

- Acoustic 2-9+ wr index. Available since 1984, used since 1989 (errors by bootstrap)

- IBTS 1-5+ wr index. Available since 1971. Separated into a 1 wr index (used since 1979) and a 2-5+ wr index (used since 1983). Errors by boostrap from 1977-1997 (simulated errors for other years)

- Multiplicative larvae abundance index (MLAI). Available since 1973, used since 1979 as an SSB index (Section 2.5). (Error structure not resolved)

The assessment methods will be evaluated using data sets (with error) for precision in the assessment and retrospective patterns. Optimum use of the data series will also be investigated. An comparison of the different methods will be performed by examining uncertainty and sensitivity by means of automatic differentiation. Structural uncertainty for the models will be determined by examining the effect of model modifications and by computation of model selection criteria.

b) Evaluation of split factor

This will be done within the context of the short term projections to be meaningful. One problem in evaluating the projections is that this cannot be done with regard to predicted and subsequently observed catches because the catches are driven by the TACs which are based on the projections in the first place.

An alternative way of evaluating the utility of the split factor for projections is to consider the population numbers at age, and the age structure in catches by fleet and to evaluate its utility as follows:

1. do n, (n may be 5-10 years, for example) retrospective assessments up to year y

2. start at year y-n and do 2-year ahead population projections based on the results of year y-n assessment with and without the split factor, starting from year y-n, y-n+1 etc. up to y-2

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

    - partial F's with no split factor;

    - LOCAL partial F's (ages 0-1) based on split factor and partial F's for older ages

4. compare how close the projections from the two methods are to the estimates from the most recent assessment (2001) taken as the true scenario , in terms of the numbers at age in the population, and the numbers at age in the catches by FLEET.

This evaluation might be done with the range of split factors, and attempts should be made to include years where split factors (observed and or predicted) are towards the ends of the range, rather than just for years where values are in the middle of the range. In addition the precision of the estimated numbers at age in the population and catches by fleet could be taken into account.

c) Review procedures for generating fleet based patterns

The current 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 which combined earlier fleets D and E which are now managed together with a single quota.

The review will consider if the fleet separation still exists and how the fleet catch at age data are generated. A historic estimate of catch by fleet will be produced for use in testing assessments and projections.

The above studies will be carried out in the period 1 April 2001 to 17 August 2001. Individual studies will be collated to provide a report for ACFM by 20 Sept.

d) based on the reviews done under b) and c) propose and evaluate a prediction procedure (both short and medium term) that meets management needs for an area based advice.

This task will be reviewed following completion of the studies above and the needs of work defined at this point. The feasibility and time required for implementation and verification of a new prediction computer program will be examined at this time

e) revisit the basis for the biological reference points implemented in the management plan for North Sea (autumn spawning) herring.

Following the review of assessment procedures and their accuracy and the evaluation of the current stock parameters (such as stock recruitment relationship) the previous studies will be reviewed and any new studies and a timetable proposed.

The above studies under TOR a-c will be carried out in the period 1 April 2001 to 17 August 2001. Individual studies will be collated to provide a report for ACFM by 20 September 2001. A report will be prepared for ACFM at this point.

If this work is to be carried out to the plan given above, a meeting will be required in August 2001. The study group recommends a meeting 20-21 August 2001 at DIFRES Copenhagen, Denmark.

1.9 Fleet Descriptions

A summary of the main herring fleets is given below, more details are given in the following working documents presented during the present working group (**Basson M. and P. Welsby.** Fleet Description of the UK England and Wales fleet fishing for Herring; **Dalskov J.** The Danish Herring and Sprat fishing fleets; **Dickey-Collas M., J. Molloy and R. D.M. Nash.(a)**: Description of the Northern Ireland Herring Fleet and Herring Fishing Activity in VIIa (N) from 1960 to 2000; **Dornheim H.** Herring fishery during the last decade; **Gröhsler T.** German Fisheries for Herring in the Western Baltic; **Hatfield E.** Scottish Pelagic Fleet description, 1990 – 2000; **Kelly C.** Fleet descriptions and Fisheries for herring in the Celtic Sea and VIaS VIIbc in 2000; **Modin J.** The Swedish fishery for herring in Division IIIa and Sub-divisions 23 and 24; **Pastoors M**. The Netherlands – Fleet Description; **Torstensen E**. Sprat fishery.)

Denmark: Danish herring fishery is carried out in the North Sea, the Skagerrak, the Kattegat and in the Baltic area (Sub-division 22, 23 and 24) by three fishing fleets; trawlers using a minimum mesh size of at least 32 mm, purse seiners using a minimum mesh size of at least 32 mm and the small meshed fleet fishing fleet using meshsizes less than 32 mm. In 2000, 96 vessels participated in the direkted herring fishery in Sub-division 22-24, 79 vessels in Division IIIa and 72 vessels in the North Sea. Many of the vessels participated in the fishery both in Division IIIa and the North Sea.

Germany: The German fishing fleet in the Baltic consists of a coastal fishery with open boats (trap-net fishery) and a trawling fleet of different equipment. In 2000, 1719 vessels used gill nets and trap net, and 106 vessels used pelagic trawls. The German fishing fleet fishing in the North Sea consists of 5 stern trawlers and is targeting herring, mackerel, horse mackerel and blue whiting.

Ireland: The Celtic Sea Herring fleet consists of between 24 and 36 vessels. The fishery is directed towards herring in the season and is conducted almost exclusively by pair trawling. The fleet fishing for herring in divisions VIaS VIIbc consists of about 44 vessels. The number of vessels engaged in the fishery depending on the availability of mackerel or horse mackerel, towards which the larger vessels direct their fishery. As in the Celtic Sea the fishing method is almost exclusively pair trawling.

Netherland: The Dutch pelagic fishery consists of about 22 vessels of which about half is fishing for herring in the North Sea and is seasonally rather variable. The main gear types are pelagic trawl fishery and pair trawling.

Norway: The Norwegian fleet fishing for herring in the North Sea consists of about 100 purse seiners which fish for at broad range of pelagic species in various areas. The North Sea herring fishery is directed towards adult herring. In addition there are small by-catches of adult herring in the industrial fishery on Norway pout and blue whiting. The Norwegian fleet fishing for sprat in the North Sea consists of a few purse seiners and purse seiners <27,5 m perform the fishery for sprat in Div. IIIa.

Sweden: The Swedish fisheries catch herring in the Baltic, Kattegat, Skagerrak, to a small extend Sub-div. IVa and in Sub-div IVb. The fleet consists of a directed fishery for herring by trawlers with 32mm mesh size; a directed sprat fishery by purse seiners with mesh sizes > 16mm; and a directed sprat (mixed clupeoid) fishery carried out by trawlers with mainly 16, 18, or 22mm mesh size. The total fleet consists of about 200 vessels.

UK-England/Wales: The UK England and Wales fleet fishing for herring in the North Sea (and occasionally in VIaN) has been small for at least the past 16 years, dominated by only 2 vessels since 1997. The main gear type is the midwater trawl contributing with up to 97% of the landings, most of which is landed abroad.

UK-Northern Ireland: The Northern Ireland Herring fleet consisted in 2000 of 4 vessels using pelagic trawls. Only Northern Irish boats fished for herring in VIIa in 2000, however the fleet is increasingly taking mackerel, horse mackerel and herring from areas beyond the Irish Sea.

UK-Scotland: The Scottish pelagic fleet, targeting herring and mackerel, comprises purse seine vessels and trawlers of a total of 38 vessels. The trawler fleet fishes either as single boat pelagic or pair trawlers. Herring targeted by the Scottish fleet are caught mostly in areas IVa, IVb and VIIa.

1.10 Reference Points

Reference points for herring and sprat stocks South of 62°N taken from ACFM Report, May 2000, and updated by the WG2001. These are summarised in the text table below.

STOCK	LIMIT	PRECAUTIONARY
North Sea Herring	**B_{lim}** is 800 000 t. Technical basis: Below this value poor recruitment has been experienced. **F_{lim}** is not defined.	**B_{pa}** = 1.3 mill t. Technical basis: Part of a harvest control rule based on simulations. **F_{pa}** be set at $F_{ages\ 0\text{-}1} = 0.12$; at $F_{ages\ 2\text{-}6} = 0.25$. Technical basis: Part of a harvest control rule based on simulations.
Sub-div 22-24 & div IIIa	Not specified	
Celtic Sea	**B_{lim}** is 26 000 t. Technical basis: The lowest stock observed. **F_{lim}** is not defined	**B_{pa}** be set at 44 000 t. Technical basis: Reduced probability of low recruitment.
West of Scotland*	Not specified	**B_{pa}** not specified **F_{pa}** = 0.25 Technical basis: preliminary proposed value based on comparison with North Sea (see Section 5.1.14)
Div ViaS & VIIb,c	**B_{lim}** is 81 000 t. Technical basis: Lowest reliable estimated SSB. **F_{lim}** is 0.33	**B_{pa}** be set at 110 000 t. Technical basis: Approximately 1.4 **B_{lim}**. **F_{pa}** be set at 0.22
Irish Sea	**B_{lim}** is 6 000 t. Technical basis: Lowest observed SSB. **F_{lim}** is not defined	**B_{pa}** = 9 500 t. Technical basis: **B_{lim}*** 1.58; still under consideration. **F_{pa}** under review; 0.36 proposed in 1999, not adopted.
Sprat North Sea	Not specified	Not specified
Sprat in div VIId,e	Not specified	Not specified
Sprat in div IIIa	Not specified	Not specified

*F_{pa} proposed at this Working Group meeting, March 2001.

Table 1.5.1: Available disaggregated data for the HAWG per March 2001
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 revis
	2000	X			provided by Jørgen Dalskov, Mar. 2001,
Celtic Sea and VIIj					
her_irls	1999	X			provided by Ciarán Kelly, Mar. 2000
	2000	X			provided by Ciarán Kelly, Mar. 2001
Clyde					
her_clyd	1999	X			provided by Mark Dickey-Collas, Mar. 2000
	2000	X			included in West of Scotland
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
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
	1999		W	D	provided by Christopher Zimmermann, Mar. 2001
West of Scotland (VIa(N))					
her_vian	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
West of Ireland					
her_irlw	1999	X	(W)		provided by Ciaran Kelly, Mar. 2000
	2000	X	(W)		provided by Ciaran Kelly, Mar. 2001
Sprat in IIIa					
spr_kask	1999	X	(W)		provided by Else Torstensen, Mar. 2000
	2000	X	(W)		provided by Else Torstensen, Mar. 2001
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
Sprat in VIId & e					
spr_ech	1999	X	(W)		provided by Else Torstensen, Mar. 2000
	2000	X	(W)		provided by Else Torstensen, Mar. 2001
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 sampli
UK/Scotland	1994-1998	X			provided by Emma Hatfield, Mar. 2001 (without sampling)

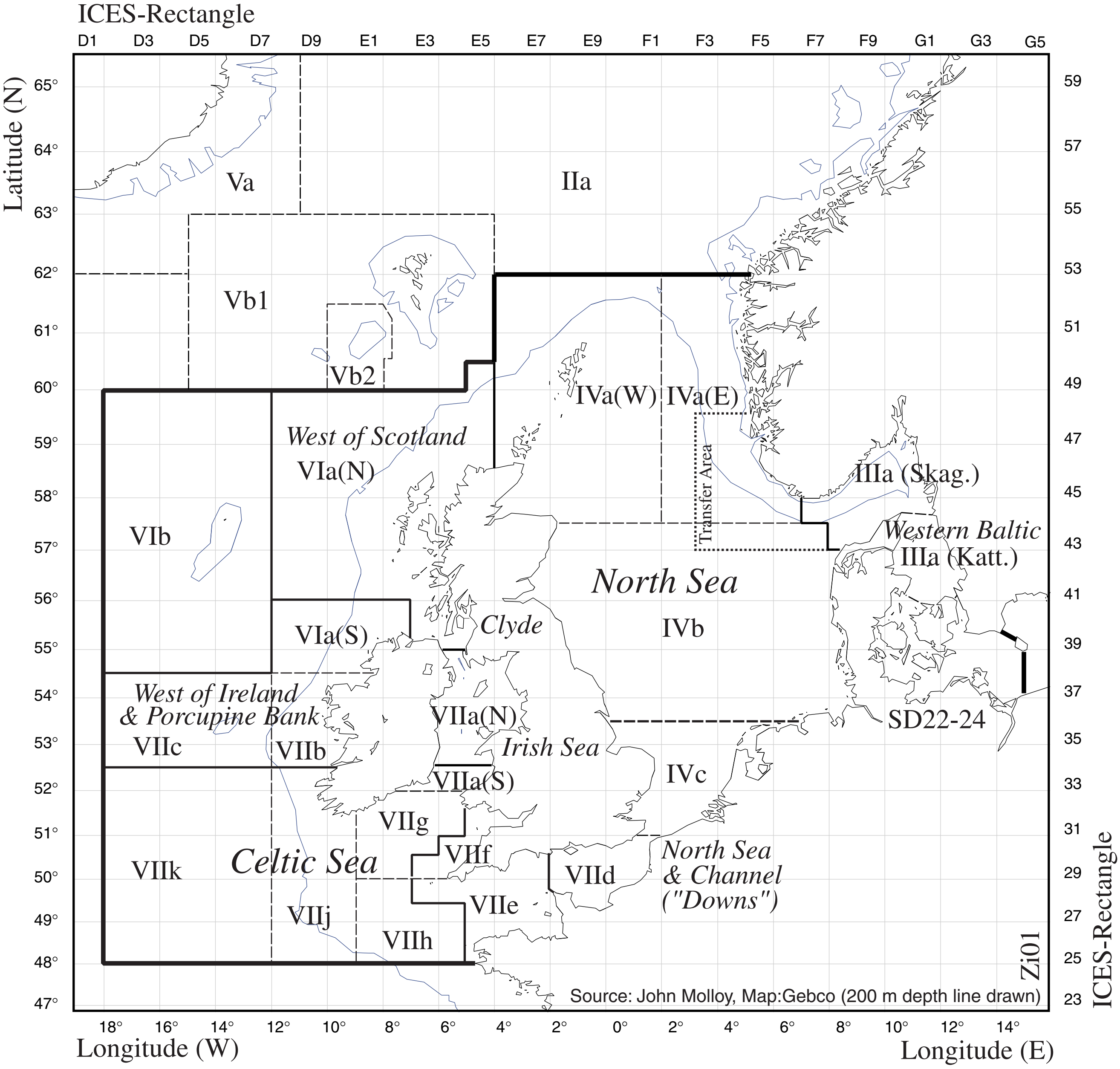


Fig. 1.5.1: ICES areas as used for the assessment of herring stocks south of 62°N. Area names in italics indicate the separation used for long term storage of commercial catch and sampling data. "Transfer area" refers to the transfer of Spring Spawners caught in the North Sea to the Western Baltic Spring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

Figure 1.7.1 **North Sea herring** Estimated numbers of North Sea herring at age for 1997 (top) and 1998 (bottom) showing Working Group catch (line) and 1000 bootstrap estimates (points) from combination of Danish Dutch and Scottish bootstrap estimates. Differences are due to both missing samples from other countries and area misreporting and unallocated catch.

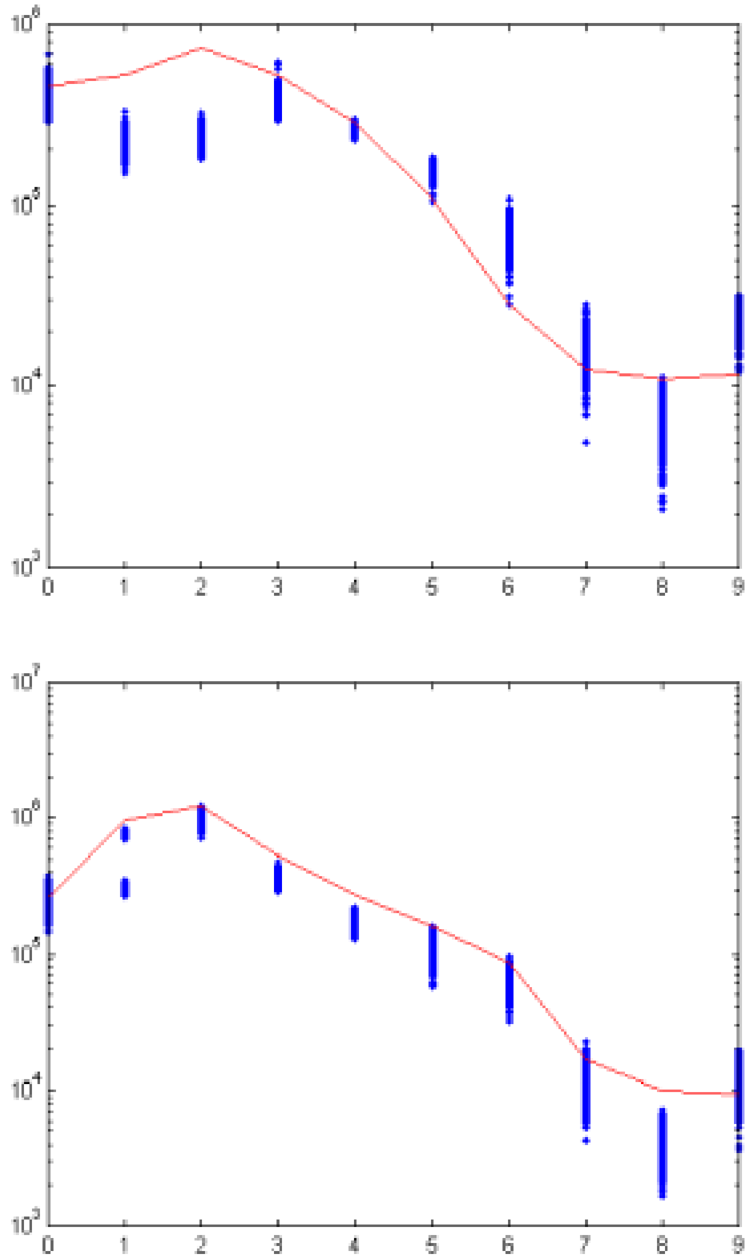
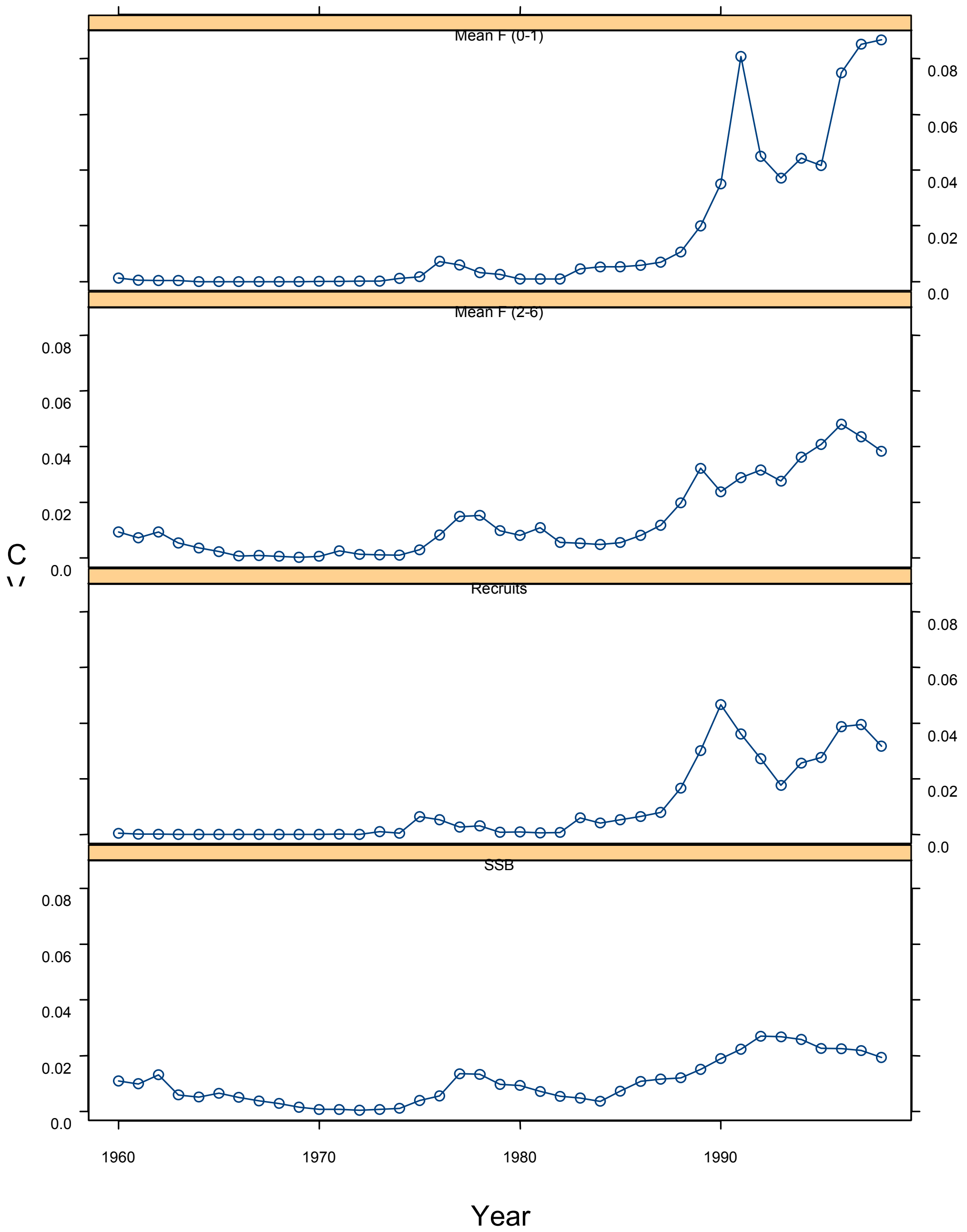
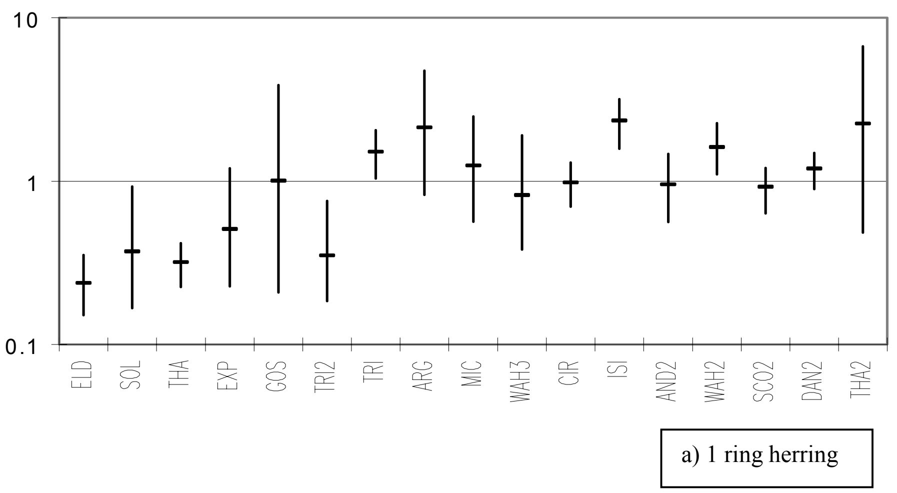


Figure 1.7.2 North Sea herring. CV by year for bootstrapped ICA assessments using numbers at age from 1000 bootstrap replicates for 1991 to 1998 and standard assessment data for all other years and all other indices.





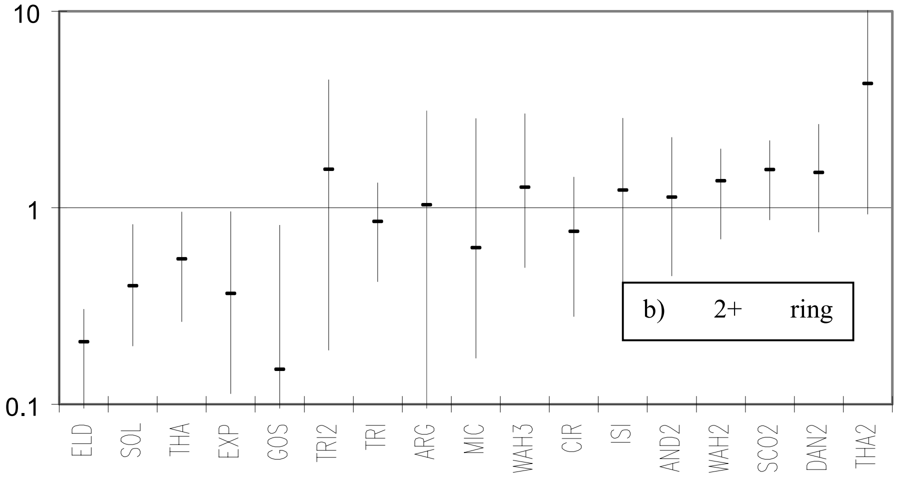


Figure 1.7.3 catch rates by vessel for the period 1983 to 1997 for North Sea herring at a) 1 ring and b) 2+ ring.

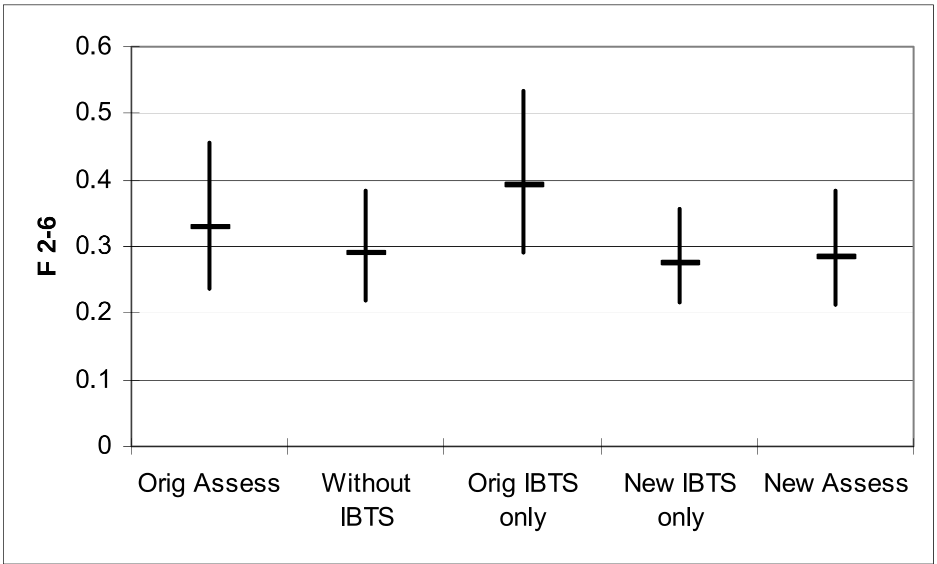


Figure 1.7.4 Effect of correcting for vessel effects in the IBTS survey on the assessment of North Sea herring (in a 1997 assessment). F 2-6 for the original assessment, with the IBTS down weighted (0.01 weight), the IBTS with all other fishery independent data down weighted (weight 0.01) and with a revised IBTS index using all correction factors and all other indices down weighted and a revised assessment

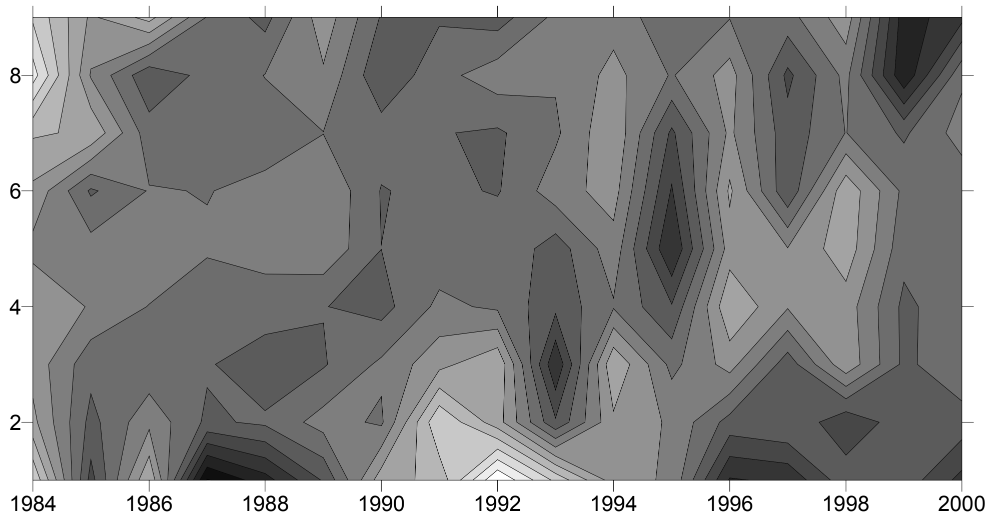


Figure 1.7.5 Greyscale representation of residuals between growth model and observations on mean weight at age for North Sea herring 1984 to 2000 from acoustic surveys. Greyscale 0.65 = white, 1.35 = black

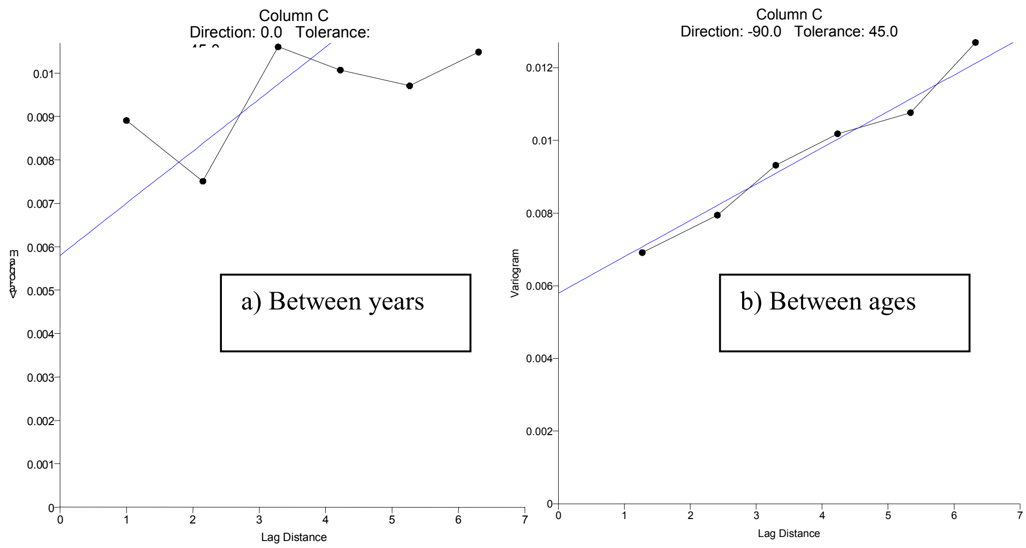


Figure 1.7.6 Variograms of residuals in mean weight at age. Lag refers to either age or year, Variogram is the variance at lag. The dots (joined by lines) are computed values from the data, the model fitted is shown as the straight line. The intercept is (and must be) the same on both axes and derived primarily from fits to the between age variogram.

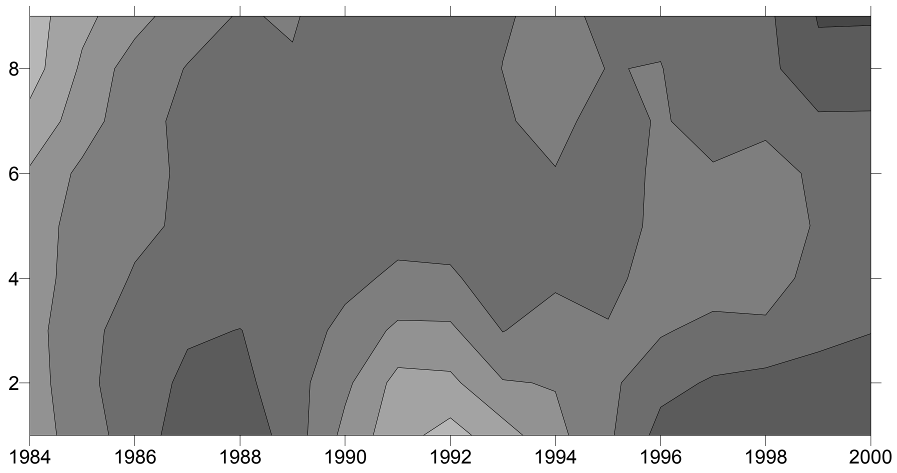


Figure 1.7.7 Modelled residuals between growth model and observations on mean weight at age for North Sea herring 1984 to 2000 from acoustic surveys using kriging with the variograms shown in Figure 1.7.4. Greyscale 0.65 = white, 1.35 = black

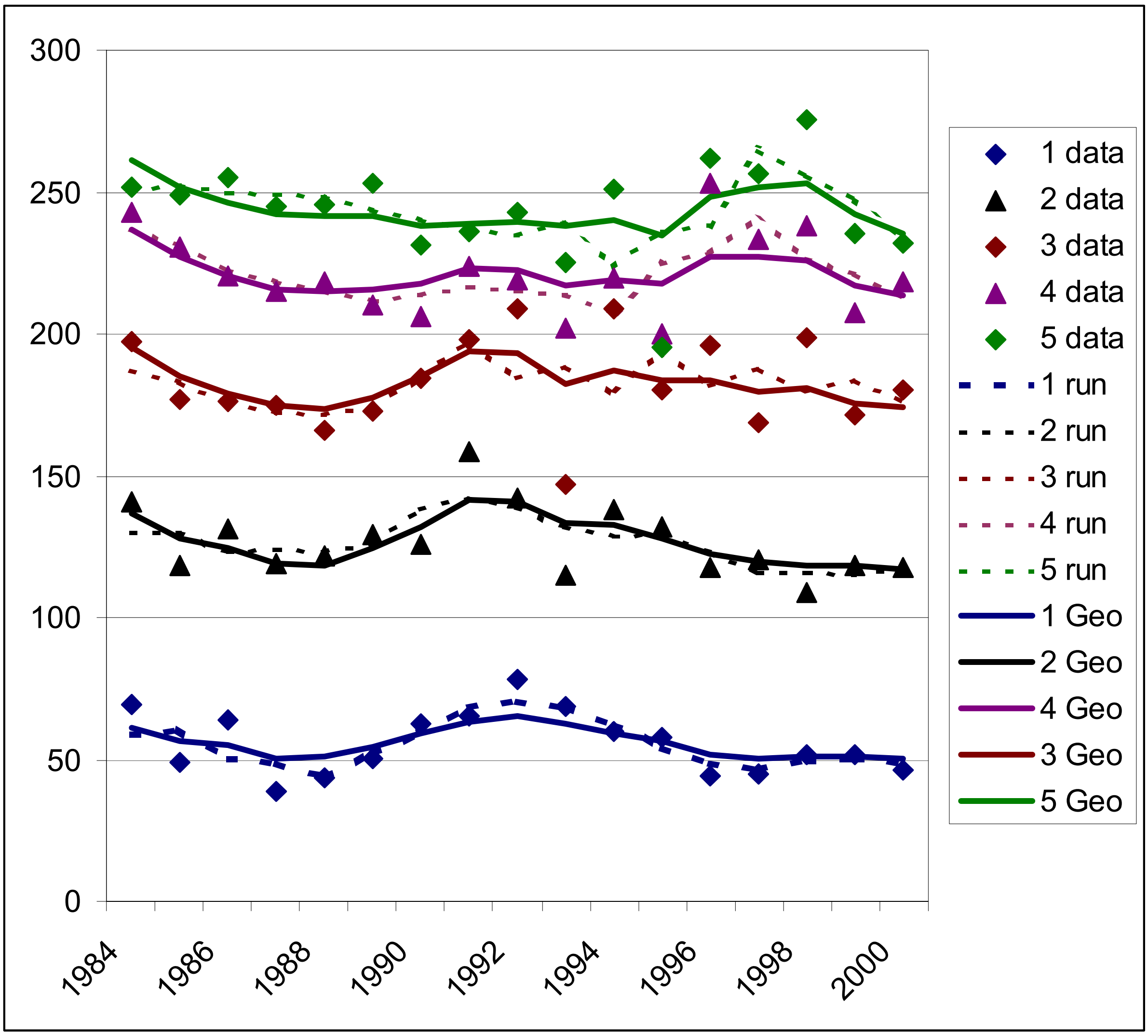


Figure 1.7.8 Comparison between observations on mean weight at age for North Sea herring 1984 to 2000 from acoustic surveys (symbols), the 3 year running mean used in the assessments (dotted) and kriged residuals (solid)

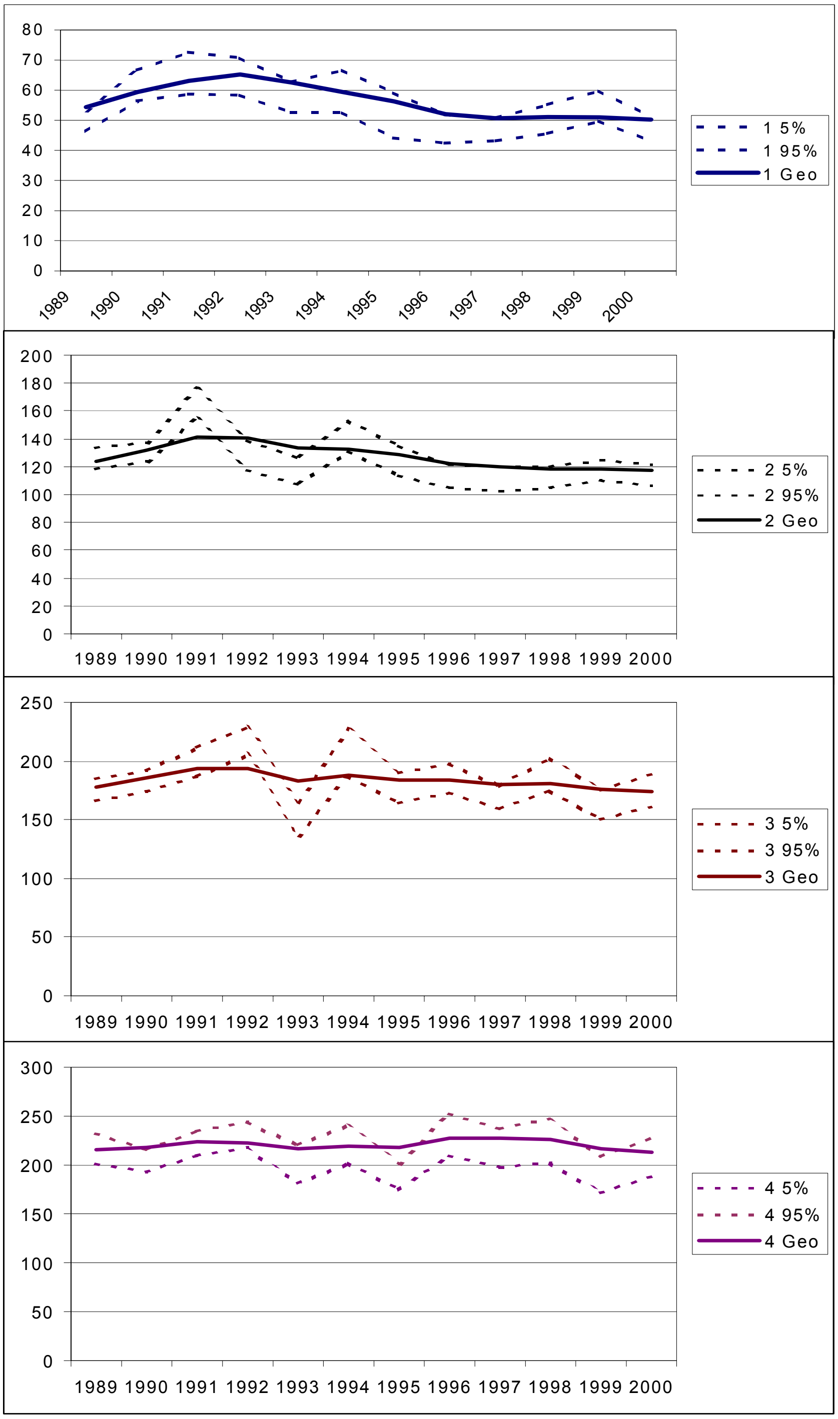


Figure 1.7.9 Comparison of the kriged estimates of mean weight at age and an estimate of 95% confidence intervals on mean weight at age from the acoustic survey.

2 NORTH SEA HERRING

2.1 The Fishery

2.1.1 ACFM advice and management applicable to 2000 and 2001

In 1996, the total allowable catches (TACs) were changed mid-year with the intention to reduce 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 to aim of rebuilding the SSB up to 1.1 million t in 1998.

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

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 2001 that the management for 2000 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 a slight increase of the SSB to 0.9 million t in 2000.

The final TACs adopted by the management bodies for 1999 and 2000 were 265,000 t for Divisions IV and VIId, whereof not more than 25,000 t should be caught in Div. IVc and VIId. This TAC was kept constant for 2001. 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 kept constant for 2001. 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 Section 3).

2.1.2 Catches in 2000

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 Figure 2.1.1 a-e. Most nations provided their catch data (either official landings or working group catch) by statistical rectangle; catches of the Faroes were allocated on advice of the National Institute.

The catch Figures in Table 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. As in previous years, only one EU nation (Denmark) provided information on by-catches of herring (in Fleet B). By-catches in the Norwegian fishery are reported within the official statistics. Catch estimates of herring taken as by-catch in other than the mentioned fisheries in the North Sea may be an underestimate. The total catch in 2000 as used by the Working Group amounted to 329,100 t. It decreased slightly (by about 2%) as compared to last years catch. By area, catches increased in area IVa (West) by about 9 % and decreased in all other areas. The highest decrease in catches was reported from Div. IVc & VIId (Table 2.1.5: -17%). These changes are mostly attributable to differences in the reporting of discards (see below).

Landings of herring taken as by-catch in the Danish small meshed fishery (18,000 t, Table 2.1.6) have increased slightly in 2000, but were again much lower than the by-catch ceiling set for Denmark (34,450 t). In 2000 the Danish sprat fishery was carried out mainly in August and September with minor by-catches of herring, less than 6%.

Misreporting of landings taken in the North Sea but reported to have been taken in other areas such IIa, IIIa and VIa (North) is still substantial, but the estimates of the amount of misreporting out of the area have decreased compared to the previous years. However, the total amount of unallocated and misreported catches (including within-area misreporting) is the same as in last year (about 50,000 t).

TACs (applying for the human consumption fishery only) in Sub-area IV and Division VIId have been significantly exceeded in several years. This excess for the years 1994 to 2000 is shown in the text table below. Since the introduction of yearly by-catch ceilings, implemented in 1996, these ceilings have never been exceeded. In the text table below (adopted 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	1994	1995	1996	1997	1998	1999	2000
TAC HC (‘000 t)	440	440	156	159	254	265	265
“Official” landings HC (‘000 t)[1]	425	436	163	157	250	271	268
Working Group catch HC (‘000 t)	**464**	**501**	**228**	**221[2]**	**314**	**321**	**311**
Excess of landings over TAC HC (‘000 t)	24	61	72	62	60	56	46
By-catch ceiling (‘000 t)			44	24	22	30	36
Reported by-catches (‘000 t) [3]	38	65	38	13	14	15	18
Working Group catch North Sea (‘000 t)	**498**	**566**	**266**	**234[2]**	**329**	**336**	**329**

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 is displayed separately for herring caught in the North Sea (including a minor amount of Western Baltic Spring Spawners taken in IVa East), IVa East (total; Western Baltic Spring Spawners (WBSS) only – see Section 2.2.2; North Sea Autumn Spawners only), 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 Section 3.2. The total catches (SOP Figures), mean weights and numbers at age by fleet are given in Table 2.2.6. Note that fleet D includes the former fleet E from 1999 on.

Data on catch numbers at age and SOP catches are shown for the period 1990–2000 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 the same period (1990–2000) separately for the different Divisions where NSAS are caught (Table 2.2.11).

2.2.1 Catch in numbers at age

North Sea catches in numbers at age over the years 1990–2000 are given in Table 2.2.7. The total number of herring taken in the North Sea in 2000 (2.9 billion) has slightly decreased as compared to the corrected Figure for last year (3.1 billion, see below); the numbers of North Sea Autumn spawners have increased by 4%. Catches of 0-ringer NSAS have decreased by 30%, while those of 1-ringers have increased by factor 3.5 (as compared to the corrected Figures for last year, see below). This was expected and is likely to be caused by high catches of the strong 1998 year class. 0- and 1-ringers contributed more than half of the total catch in numbers of North Sea autumn spawners in 2000. Figure 2.2.1. shows the relative proportions on the total catch numbers for different periods (1960–2000, 1980–2000 for the total area, and 2000 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, the amount of the total catch used for the assessment was 373,000 tonnes, which is almost exactly the Figure used for 1999:

Area	Allocated	Unallocated	Discards	Total
IVa West	124,157	29,581	5,841	159,579
IVa East	52,950	-4	-	52,946
IVb	85,641	-13,769	317	72,189
IVc/VIId	23,262	20,966	196	44,424
	Total catch in the North Sea			329,138
	Autumn Spawners caught in Div. IIIa (SOP)			50,088
	Baltic Spring Spawners caught in the North Sea (SOP)			6,649
	Total Catch NSAS used for the assessment			**372,577**

2.2.2 Treatment of Spring Spawning herring in the North Sea

Norwegian Spring Spawners are taken close to the Norwegian coast under a separate TAC. These catches are not included in the catch tables. Coastal Spring Spawners in the southern North Sea (e.g. Thames estuary) are caught in small quantities regulated by a local TAC. These catches are given in Table 2.1.1 and 2.1.5.

Western Baltic and Division IIIa spring spawners (WBSS) are taken in the eastern North Sea during the summer feeding migration. These catches are included in Table 2.1.1 and listed as IIIa type. Table 2.2.8 specifies the estimated catch numbers of WBSS caught in the North Sea, which are transferred from the North Sea assessment to the assessment of Division IIIa/Western Baltic in 1990–2000.

The method of separating these fish, as described in former reports from this Working Group (ICES 1990/ Assess:14) assumes that for autumn spawners, the mean vertebral count is 56.5 and for spring spawners 55.80. The fractions of spring spawners (fsp) are estimated from the formula (56.50-v)/0.7, where v is the mean vertebral count of the (mixed) sample. The method is quite sensitive to within stock variation (e.g. between year classes) in mean vertebral counts. The same method has been applied to separate the two components in the summer acoustic survey.

To calculate the proportion of spring spawners caught in the transfer area, 17 samples that have been taken in May and June 2000 were used for the second quarter. For the third quarter, 16 samples taken in July and August were used (Figure 2.2.2).

The resulting proportion of spring spawners and the quarterly catches of these in the transfer area in 2000 are as follows:

Quarter	2 wr (%)	3 wr (%)	4+ wr (%)	Catch in the transfer area (t)	Catch of WBSS in the North Sea (t)
Q 2	12	14	17	6,956	929
Q 3	14	17	20	14,527	5,720
total				21,483	**6,649**

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 1999, which made updating of a number of tables for North Sea autumn spawners and Western Baltic spring spawners (see Section 3) necessary. 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. Due to time constraints, it was postponed to next year’s working group.

The catch tables (Tables 2.1.1 to 2.1.6) were transferred from a word processing program into a spreadsheet program to ease crosschecking. Some minor corrections, mostly attributable to rounding errors, were corrected during this process. However, some discrepancies could not be resolved during the working group’s meeting and will be dealt with intersessionally.

2.2.4 Quality of catch and biological data

As in the previous years, it was possible in 2000 to get information on misreportings and unallocated catches from several countries fishing on herring in the North Sea and adjacent areas. Catches made in IVa were mainly misreported to VIa North and IIa, but misreporting also occurred within Area IV, to IIIa and from VIId to IV and IIa.

Only The Netherlands and Scotland provided estimates of discards, but discards are known to occur in the fisheries of most countries and they could represent a significant amount of the total catch, which is so far not included in the assessment. In this respect, there is still a need to improve the quality of the catch data for the North Sea herring. As mentioned earlier, some of the differences in the distribution of catches estimated by the working group are attributable to changed reports of discards in 2000.

In general, sampling of commercial landings for age, length and weight was at the same level as last year (Table 2.2.12) and is below the previously recommended level of one sample per 1,000 t landed, if unallocated and misreported catches are taken into account. 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 to judge whether a country has met the recommended sampling levels or not.

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 90 different *reported* metiers (each combination of fleets/nations/areas/quarters – this is likely to be an underestimate of the possible number of metiers), only 30 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.

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 2001). The index is calculated for the entire survey area, weighting statistical rectangles as described in the WG report of 1995 (ICES CM.1995/ Assess:13).

The indices based on surveys from the period 1979 to 2001 (estimates of the strength of year classes 1977 to 1999) are given in Table 2.3.1. and the temporal trend in indices is illustrated in Figure 2.3.1. The estimate of the 1999 year class (2674) indicates a recruitment of intermediate strength, 20% above the average for the last 20 years.

Figure 2.3.2 illustrates the spatial distribution of 1-ringers as estimated by the trawling in February during 1999, 2000 and 2001. In 2001 the primary concentrations of 1-ringers were found in the German Bight and in the Skagerrak/Kattegat area. (div. IIIa). The enhanced abundance in Division IIIa resembles the findings in 2000, while the present 1-ringer concentration in the German Bight contrasts the more central North Sea distribution pattern found in 2000.

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. Index values are calculated as described in the WG report of 1996 (ICES 1996a). The index value indicating the abundance of 0-ringers in 2001, the 2000 year class, is estimated to 214.8 (Table 2.3.2).

This estimate of the 2000 year class is high, and indicates a recruitment well above average. It is based on extraordinary high concentrations of 0-rings along the coast of UK. The spatial distribution of the 0-ringers follows the trend of a north-westerly displacement which has been observed during the last years (Figure 2.3.3), however, this year the north-westerly distribution is very marked. Unusual high catches were made, for example off Moray Firth and Buchan.

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

The relationship between the two indices is illustrated in Figure 2.3.4 and described by the inserted linear regression. The comparison between the indices for the 1999 year class reveals a relation that is in accordance with the long-term trend. Both indices indicate an intermediate 1999 year class.

2.3.4 Trends in recruitment as estimated by the assessment

The long-term trend in recruitment of 1-ringers to the stock of North Sea autumn spawners is illustrated by Figure 2.3.5. Recruitment estimates are based on the present 2001 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 with ICA estimates of 1-ringer recruitment which are 30.2 and 22.3 billions for year classes 1998 and 1999 respectively, while the estimates for 0-ringers are 84.3, 61.9 and 80.6 for year classes 1998 to 2000 respectively.

2.3.5 Separate recruitment indices of the Downs herring

In last year's report of the working group (ICES CM 2000/ACFM 10) the possibilities of separating the Downs herring from the indices of recruitment were investigated. The Downs herring hatch later than the other autumn spawned herring and generally appears as a smaller sized group during the 1st quarter IBTS.

Polymodal length distributions of the 1-ringers during some years indicate that the group could be separated as 1-ringers smaller than 13 cm. In other years however, as noted in last year's report, a mode of smaller juveniles is less distinct. Table 2.3.3. shows the abundance of 1-ringer herring smaller than 13 cm, estimated from 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. 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 (Table 2.3.3), for example two prominent peaks in the abundance estimates (year classes 1986 and 1991) are due to high relative abundance in IIIa. Some of the variability in small 1-ringers in division IIIa might be due to a variable occurrence of small herring from local stocks of Kattegat winter spawners. This year's estimate of the proportion of small 1-ringer herring (in the 1999 year class) is low, the lowest during the last decade.

The 0-ringed Downs herring are found in the Southern Bight, and due to their later time of hatch they can be distinguished by their smaller mean length. Because of the restricted area of distribution, the previous sampling (until 2000) has not covered the group with sufficient precision, and the sporadic catches of these larvae have not been included (i.e. samples of a mean length of less than 21 mm in the Southern Bight are excluded) in the standard 0-ringer index shown in Table 2.3.2. At the 1999 meeting of the IBTS working group it was decided to increase the intensity of the MIK sampling in the relevant rectangles, and this procedure was implemented in 2000. During the MIK sampling in 2000 only minor densities of small larvae were observed, while the present year's MIK data (2001) showed extraordinary high concentrations of small larvae along the coast of the Netherlands (Figure 2.3.6). The markedly higher value of last year's observation is evident from the comparison of density estimates shown in Table 2.3.4 and Figure 2.3.7.

In contrast to the indices based on MIK 0-ringer and IBTS 1-ringer catches of the whole catch, the indices based on the Downs component in these catches show considerable differences over time which is expressed by a correlation coefficient (R^2) of only 0.002 for the relationship between these indices (Figure 2.3.7). The increased MIK sampling intensity in the southern area may result in an improved index of the Downs component in the MIK catches.

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 54°N in the North Sea and 56°N to the west of Scotland to a northern limit of 62°N. The eastern edge of the survey area is bounded by the Norwegian, Danish and German coasts, and to the west by the shelf edge at approximately 200 m depth. The surveys are reported individually in appendices Ia-f of the report of the planning group for herring surveys (ICES CM2001/G:02). The areas and dates of cruises are given below and in Figure 2.4.1:-

Scotia	4–24 July	58°–62°N 4°W-2°E
Christina S	7–26 July	56°– 60°N 10°-3°W
Tridens	19 July – 14 July	54° 30'–58°N 4°W-3°E
GO Sars	27 June –18 July	57°–62°N 2°W-8°E
Dana	26 June 7 July	56°/57°N 6°E 12°E
W Herwig	23 June 14 July	54° –57°N 3°E 8°E

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 sub-area for North Sea autumn spawning herring. The combined estimate for North Sea herring is given in Table 2.4.4.

Methods

The acoustic surveys were carried out using a Simrad EK500 and EY 500 38 kHz sounder echo-integrator with transducers mounted on the hull, drop keel, and towed bodies. Further data analysis was carried out using BI500, Echoview and Echoann software. The survey track was selected to cover the area giving a basic sampling intensity over the whole area based on the limits of herring densities found in previous years, a transect spacing of 15 nautical miles was used in most parts of the area with the exception of some relatively high density sections east of Orkney, areas both east and west of Shetland and in the Skagerrak where short additional transects were carried out at 7.5 nm spacing.

The following target strength values have been used to analyse the data:

herring TS = 20 log L - 71.2 dB

sprat TS = 20 log L -71.2 dB

gadoids TS = 20 log L - 67.5 dB

mackerel TS = 21.7 log L - 84.9 dB

The TS for gadoids and mackerel are used only for the small proportions of the stock to estimate herring in mixtures and no estimates of these species are obtained.

The survey is conducted with largely opportunistic fishing for trace identification and biological sampling. The trawl data is used to estimate the age structure, the maturity ogive and the mean weights at age in the stock.

Combined Acoustic Survey Results

The estimates of North Sea Autumn herring SSB are 1.7 million tonnes and 8,750 million individuals. (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 over the last 2 years, which is similar to the estimates from the assessment, (0.5). The SSB estimate is rising slightly from 1999 to 2000. The survey also shows the exceptional high numbers of 1 ring herring, 1998 year class, in the North Sea, which is consistent with the observation of an exceptionally large year class observed in the MIK and IBTS surveys (ICES 2000). 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 Figures 2.4.2, the numbers at ages 1 2 and 3+ rings in Figure 2.4.3. The spatial distribution of mean weight at age 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. The contours on these Figures have been set to contain 10% of the abundance within each contour.

Revision of acoustic survey data for 1996 to 1999. ACFM requested that the HAWG and the PGHERS examine the mean weights at age from the acoustic survey for the south eastern North Sea which were seen to be different in 2000. In reviewing this it was found that there were discrepancies in the assignment of herring at age from this area into the combined survey database and some considerable uncertainty in the maturity estimates for these very young herring. Where uncertain the fraction at 2 ring mature has now been estimated from the mean weight at age 2 for the statistical rectangle by fitting an ogive to the observations on fraction mature at weight in the other areas of the North Sea. The details of these revisions are presented in the report of the Planning group for herring surveys (ICES CM2001\G:02). 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. The effect of this on the assessment, which is small is reported in Section 2.8. The revised weights and maturity ogive are reported in Section 2.7 In entering these into the IFAP data some small discrepancies of a few percent were observed between the IFAP data, (and Table 2.4.5 which are in agreement) and some of the database values of numbers at age held in the acoustic survey archive for earlier years. It was not possible to be sure which versions were correct so this should be examined by PGHS before next years WG. As the last 6 years 1995–2000 are in agreement and the differences are small they are not expected to be important.

2.5 Larvae Surveys

Internationally co-ordinated herring larvae surveys have been conducted in the North Sea and adjacent waters since 1972. In last years only The Netherlands and Germany continued to participate in this program, since 2000 together with Norway. Five cruises covering seven survey units were carried out in the 2000/2001 period. The data coordination and analysis were carried out by IfM Kiel and BFA Hamburg/Rostock.

There are no modifications to the methodology used in 1999. Newly hatched larvae less than 10 mm in length (11 mm for the Southern North Sea) were used to calculate larval abundance. Each larvae abundance index (LAI) unit is defined for area and time. To estimate larval abundance, the mean number of larvae per square metre obtained from the ichthyoplankton hauls for each 30x30 nautical mile rectangles was estimated and raised by the corresponding surface area of the rectangle. Within each unit rectangle estimates are summed to give unit abundance. Estimates of larval abundance by sampling unit and time are given in Table 2.5.1.

Compared to 1999, a decrease in abundance is observed in the Orkney/Shetland and Buchan area where the abundance in Orkney/Shetland is approximately 75% of last years estimate. In Buchan area the LAI has decreased almost to 7% of the long term mean. In the Southern North Sea (SNS) the abundance is not comparable to that of last years as the abundance in the December 2000 sampling unit is about ten times higher than that of the year before, while the other two sampling units in January 2001 show a drastic reduction in terms of the corresponding LAIs. The situation in the Central North Sea (CNS) shows a three times higher LAI than in 1999 but can in principle not be compared to former years because of the sparse sampling in this area in the 90s.

The traditional LAI and LPE (Larval Production Estimates) rely on a complete coverage of the survey areas. Due to the substantial decline in ship time and sampling effort since the end of the 80s, these indices have not 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.

The model was fitted to the log difference in abundance of larvae less than 10 mm in length (11 mm for the Southern North Sea). The analysis of variance and the parameter estimates are given in Table 2.5.2, including year effects and standard errors. The updated normalised log MLAI, the re-scaled, un-logged and unlogged/100 MLAI used in the assessment are shown in Table 2.5.3.

Both the LAI per unit as well as the MLAI from the larvae surveys in period 1999/2000 indicate that the SSB has decreased in 2000/2001.

2.6 International Bottom Trawl Survey (IBTS)

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

Table 2.6.1 shows the time series of the abundance at age obtained from the first quarter coverage of the IBTS. The time series is used for two age disaggregated indices, as 1 ringers, discussed in Section 2.3 recruitment and 2–5+ ring, presented here. The IBTS data series is available for years 1971 to 2000, the years used in the 2–5+ series are from 1983 to 2000 inclusive which is consistent with earlier assessments. Standardisation of fishing gear among participating vessels was implemented in 1983 but there were some adjustments following flume tank measurements and standardisation was completed by 1985, the data should be evaluated to indicate which years are the most appropriate. A recent study of vessel effects in this series reported in Section 1.7.2 suggests there may be some benefit in correcting for vessel effects. The WG would like easy access to the data to allow such a study to be evaluated and if necessary incorporated into the provision of the index on a routine basis.

Table 2.6.2 contains the final values for 1999 and the provisional values for 2000 for the IBTS index as received from ICES.

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 2000 (weighted by the numbers caught) are presented by ICES division and by quarter in Table 2.2.11.

Table 2.7.1 presents the mean weights at age in the catch during the 3rd quarter in Divisions IVa and IVb for 1991 to 2000. In this quarter most fish are approaching their peak weights just prior to spawning. For comparison the mean weights in the stock from the last six years of summer acoustic surveys are shown in the same table. (from Table 2.4.4 for the 2000 values). The mean weights in the catch are very close to the long term mean, being only 2% low on average. The mean weights at age in the acoustic survey in 2000 are very similar to the mean for the last 9 years for ages 3+. The weights for 1 and 2 ring are lower than the mean but within the normal observed range. In 2000 ACFM noted that the mean weights of 1 and 2 ring herring in 2000 were unusually low. This was investigated and the problem found to be the result of mis-matching of rings and ages in the combined survey database for one survey in 1998 and 1999. This was disguised in the normal data checks by unusual values reported for maturity at age. In addition a further problem caused by using length stratified sampling but raising as random samples was corrected. The mean weights at age in the acoustic survey have been revised following reworking of acoustic survey data. The percentage revisions from 1995 onwards are given in Table 2.7.2. The details of the revision are reported in the report of the Planning Group Herring Surveys (ICES CM2001/G:02). The estimation of suitable mean weights at age for use in the assessment are discussed in Section 1.7.3.

2.7.2 Maturity ogive

The percentage of North Sea autumn spawning herring (at age) that spawned in 2000 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 2000 was equal to long term mean for 2 ring herring (over the last 12 years). The proportion of 3 ring was one of the highest for the period. The percentages are given in Table 2.7.3.

The recent years 1995 to 1999 were revised following some uncertainties in the correct use of maturity keys. The details of the revision are reported in the report of the Planning Group Herring Surveys (ICES CM 2001 G:02) Only the estimates for 2 ring in 1997 and 1998 required and were modified, both by less than 3%. The PGHERS has instituted a study to improve uniformity in measurement of age and length of maturation. In order to ensure survey results are comparable across the different surveys.

2.8 Stock Assessment

2.8.1 Data exploration and preliminary modelling

Catch-at-age data

Catch-numbers at age (Section 2.2) were available for the period 1947–2000. The year range 1960 to 2000 was chosen for the assessment, because of large discrepancies in the sum of products in earlier years. The catch numbers at age have been changed for 1999 because of a change in the split between autumn spawners and spring spawners in the Skagerrak area (see Section 3.3). The change mostly affected the 0 and 1 ringers. The assessment was carried out early during the working group. Towards the end of the working group it was found that there was a small discrepancy in the total catch used in the assessment (372420 tonnes) and the value generated after compiling the catch tables (372577, see Section 2.2.1). It was decided to update the input dataset for next year's assessment but to leave the value of 372420 t. since it did not have a noticeable effect on the results.

Survey indices available

The following survey indices were available:

- MIK 0-wr index. Available and used since 1977 as a recruitment index (Section 2.3)
- Acoustic 2–9+ wr index. Available since 1984, used since 1989 (Section 2.4). This index is also available as a biomass index but is not used as such in the assessment.

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

Period of separable constraint

The standard ICA model includes the assumption of the exploitation pattern being constant over recent years. The regulations in 1996 and later years affected the various components of the fishery differently. The TACs for 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. The choice for this configuration was based on an XSA analysis (ICES C.M. 1999 / ACFM:12). However, since the change in selection between the two periods was thought to affect the younger ages only, a separate ICA program was compiled whereby the selection at older ages was constrained to be equal in the two periods (ICAHER). At present the number of years after the change in selection is four years. Therefore the WG evaluated the differences between either using a 9 year separable period with the ICAHER program or using a 4 year separable period using the standard ICA program.

Data exploration by abundance index

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-wr and IBTS 1-wr) and indices for ages 4 and higher are fairly consistent. However, the IBTS and Acoustic indices for 2 and 3-wr 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 do show the same dynamics over time, although the absolute level has tended to diverge since 1990. Also the two indices appear to indicate opposite directions in the last year (2000).

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. This procedure was carried out for the model with 2 separable periods (1992–1996, 1997–2000, using the ICAHER program) and with 1 short separable period (1997–2000, using ICA). For each model run the maximum likelihood estimate of the reference fishing mortality (age 4) in 2000 was plotted together with the 95% confidence interval. All model runs were carried with a default weight of 1 for each survey. No stock recruitment model was estimated. Results are shown in Figure 2.8.3 and in the text table below.

index	Fref	low95	up95	cv
2 separable periods				
MLAI, 2 sep	**0.51**	0.30	0.86	27
acoust2-9+,1989-2000, 2 sep	**0.30**	0.21	0.42	17
IBTS2-5+, 1983-2001, 2 sep	**0.50**	0.32	0.80	23
IBTS1, 1979-2001, 2 sep	**0.39**	0.24	0.64	25
MIK0,1977-2001, 2 sep	**0.48**	0.26	0.87	30
1 separable period				
MLAI, 1 sep	**0.52**	0.26	1.04	35
acoust2-9+,1989-2000, 1 sep	**0.35**	0.26	0.47	14
IBTS2-5+, 1983-2001, 1 sep	**0.51**	0.39	0.68	14
IBTS1, 1979-2001, 1 sep	**0.42**	0.24	0.73	28
MIK0,1977-2001, 1 sep	**0.48**	0.22	1.04	39
Full assessment, 2 separable periods	**0.41**	0.30	0.57	16
Full assessment, 1 separable period	**0.43**	0.31	0.61	17

The **multiplicative larvae abundance index (MLAI)** index for larvae smaller than 10 mm was tested using the year range of 1979 to 2000 and assuming a power relationship of index value to stock abundance as in last year's assessment. The indicated reference F in 2000 is higher than in the full assessment. The coefficient of variation (CV) is relatively high, especially when using 1 separable period. The multiplicative larvae abundance index (MLAI) was used in the final assessment.

The age-based **acoustic index** is available from 1984 onwards but has only been used for the period 1989 to 2000 (ICES CM 1996/Assess:10). The estimated fishing mortality was slightly lower than in the full assessment. The CV when using 1 separable period was slightly lower than when using 2 separable periods. The age disaggregated acoustic index (ACOU) was used in the final assessment.

In earlier years, the IBTS indices were always split into two sets: the IBTS 1-ringer indices and the IBTS indices for 2–5+-ringers. By applying the IBTS 1-ringers as a separate index they get the same weight as the combined 2–5+ ringer index. Although the WG has emphasized in the past that the issue of survey weighting deserves more attention, the necessary additional analyses have not been carried out so far. The WG therefore decided to use the separate IBTS 1-wr index as in the past and again stressed the need to revisit the methodological assumptions underlying the survey weighting.

The **IBTS indices** for the 2- to 5+-ringers indicate a fishing mortality in 2000. The confidence intervals are fairly wide when using two separable periods, but less so when using only one separable period. The IBTS2–5+ index was used in the final assessment.

The **IBTS index** for 1 ringers is treated separately from the 2–5+ ringers and using a slightly longer time series. The estimated fishing mortalities are in line with the estimates from the full assessment but the confidence intervals are (as to be expected from a recruitment index) relatively wide. The IBTS 1 wr index was used in the final assessment.

The **MIK 0-wr** index has also been tested in a separate model fit. The index indicates relatively high fishing mortalities but also with high confidence intervals. However, this index thought to be a poor predictor of adult stock size. The MIK index was used in the final assessment.

The spawning stock biomass that is derived by fitting the ICA model to the adult population indices (MLAI, ACOU2–9+, IBTS2–5+) separately is shown in Figure 2.8.4. These estimates are compared to spawning stock biomass of the final assessment. The MLAI and IBTS2–5+ indices are very much in agreement concerning the development in the stock. However, the acoustic index is much more optimistic concerning the recovery of the stock. The full assessment using all (five) tuning indices is intermediate between the acoustic and the other indices. The assessments using the 2 separable periods (using ICAHER) displayed a wider discrepancy between the acoustic index and the other two indices.

Conclusions from explorations

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

- acoustic survey 1989–2000 (2–9+ wr)
- IBTS 1983–2001 (2–5+ wr)
- IBTS 1979–2001 (1-wr)
- MIK 1977–2001(0-wr)
- MLAI<10mm 1979–2000 (biomass index).

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

The choice of the separable period remains to a certain extent arbitrary. However, based on the diagnostics from the model runs with either a nine year separable period using two selection patterns and the ICAHER program or the single, 4 year separable period using ICA, the WG concluded that the arguments in favour of the latter option were most convincing. These arguments were:

- Ockham's razor: if something can be explained by a simpler model equally well, this will always be favoured to the more complex model. The burden of estimating two selection patterns and the longer separable period requires 17 additional parameters, which do not contribute to a distinguishable different perception of the stock.

- The residual patterns look very similar.

- The fishery in 1996 was never compatible with the assumption of constant selection model because of the change in the regulation in the middle of the year.

- Logistic simplicity: the model with the two separable periods requires a specially compiled version of ICA (ICAHER) which is an ad-hoc version. It is preferred to work with the standard software rather than with ad-hoc software.

Therefore the WG presents the assessment with the 4 year separable period as the final assessment of this stock.

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 four-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 2.8.2. Input data are given in Tables 2.8.3–2.8.9. 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: Short selection period

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

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

Weighting

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

Results

The ICA output is presented in Tables 2.8.10–2.8.19 and Figures 2.8.5 – 2.8.13. Uncertainty analysis of the final assessment is presented in Figure 2.8.14 (see below). Long-term trends in yield, fishing mortality, spawning stock biomass and recruitment are given in Figure 2.8.15.

The spawning stock at spawning time 2000 is estimated at 772 thousand tonnes, and decreased slightly compared to 1999 (812,000 tonnes, estimated in the current assessment). The estimate of SSB in 1999 was again downward reduced in the current assessment compared to last years assessment (905,000 tonnes). Fishing mortality on 2–6 wr herring in 2000 is estimated at around 0.41, and on 0–1 wr herring at 0.05. Fishing mortality in 1999 was revised upwards in this years assessment (from 0.38 in last years assessment to 0.47). For further discussion, see also quality of assessment Section 2.12).

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 2.8.14. Estimates of fishing mortality at 2–6 wr and recruitment at 0-wr are highly sensitive to the parameter estimates. The median fishing mortality (2–6 wr) in 2000 estimated from this analysis was 0.41 with 25 and 75 percentiles of 0.34 and 0.51. Median SSB in 2000 was estimated at 784 thousand tonnes with 25 and 75 percentiles of 702 and 877 thousand tonnes. There appears to be a relatively good agreement between the point estimates of the final assessment and the median values of the Monte Carlo evaluations.

2.9 Herring in Division IVc and VIId

The estimation and evaluation of the stock component of herring in the divisions IVc and VIId (Downs component) is based on the assessments results of North Sea herring, an estimation of the mean age and data from various surveys in that area: two recruitment surveys i.e. MIK 0-ringer, IBTS 1-ringer (see Section 2.3) and the herring larvae survey (see Section 2.5).

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

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

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.

In calculating the SSB it was assumed that weight-at-age, maturity-at-age, fishery mortality and natural mortality of Downs herring were similar to that of the entire stock. This approach resulted in a calculated proportion of Downs in the SSB that varied between 18 and 41% (Figure 2.9.1). The validity of the above assumptions should be further explored.

Based on the larvae surveys in the southern North Sea and Eastern Channel (see Table 2.5.1) an abundance index can be calculated (for method see Section 2.5) for this area only (Figure 2.9.2). Figure 2.9.2 also shows the mean age of the herring caught in Division VIId only as there were no catches in IVc. For an evaluation of the estimated SSB of Downs herring in the North Sea stock (Figure 2.9.2) it is compared with the larval abundance index and the mean age of the catch. All graphs show a similar pattern i.e. an increase in the second half of the eighties followed by a decrease until a minimum is reached around 1995 or 1996 and the level increases. Although the observed fluctuations are not exactly in phase the overall impression is that the present level of the stock is near the high level observed in the late eighties/ early nineties.

Age 0 and age 1 have not reached maturity and are therefore not incorporated in the SSB. They are, however, relevant for the recruitment estimation. The proportion of Downs in the 0 group of the last year can not be determined from the

IBTS 1-ring index and therefore the Downs component in that year's recruitment can not be estimated. This, however, does not apply for the SSB. The availability of an additional index for Downs 0-ringers would allow the estimation of the proportion of Downs in the most recent year's recruitment but could also be used as an additional index to validate the Downs component in the IBTS 1-ring index. This additional index might be based on either the MIK 0-ringers or the larvae survey data. Also the possibility of using otolith microstructure might be explored allowing for stock separation of winter and autumn spawners from the entire stock. These methods are presently used for separating Western Baltic spring spawners and North Sea autumn spawners in Div. IIIa (see Section 3.2).

2.10 Short Term Projection by Area and Fleet

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

Fleet Definitions

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

North Sea

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

Division IIIa

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

Input Data for Short Term Projections

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

The starting point for the projection is the stock of North Sea autumn-spawners in the North Sea and Division IIIa combined at 1 January 2001. The ICA estimates of all age groups from 0–9+ are used (Table 2.8.12).

Catches by fleet in reference year: 2000 data from input files Table 2.2.6.

Stock Numbers:

For 2000 the total stock number was taken from ICA (Population Abundance year 2000, Table 2.8.12).
For 2001 the total stock number was taken from ICA (Population Abundance year 2001, Table 2.8.12).

For 2002 0-ringer the stock number was set to 44 000 million as used in the past four years. This value is very close to the estimate of 42 100 million obtained from the Beverton-Holt stock-recruit relationship in ICES 1998 C (Study Group on the stock-recruitment relationship in North Sea Herring), at an SSB of around 900 thousand tonnes.

Fishing Mortalities: fishing mortalities for age classes 2 and older are taken from Table 2.8.11 for 2000. Fishing mortalities for 0 and 1 ringers are calculated (see below).

Mean Weights at age in the stock: the averages of the last 2 years' mean weights (1999 and 2000) 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 1999 and 2000 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., 1999 and 2000 (Table 2.2.6), except for fleet D where the weights in 1999 were exceptionally low.

Natural Mortality: Unchanged from last year. Table 2.8.6.

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

Proportions North Sea autumn spawners in the North Sea and Div. IIIa in 2001–2002 (Split factors)

Projections for North Sea herring were carried out by fleet and area. The proportion of 0- and 1-ringers that occur in Division IIIa is likely to vary between years depending on the size of the year class. The procedure for splitting is as last year, and the results are shown below.

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

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

Year	0-ringer distribution	1-ringer distribution
2000 (last yr in ICA)	This split-factor (0-ringers in 2000) is equal to the split-factor of IBTS 1-ringers in 2001	This split-factor (1-ringers in 2000) is obtained from the proportions estimated for the 1-ringers in the IBTS in 2000
2001 (Assessment	This split-factor is equal to the regressed 1-ringer distribution of 2001, i.e., obtained from the MIK value for 2001 (yr class 2000) and the GLM	This split-factor is obtained from the proportions estimated for the 1-ringers in the IBTS in 2001
2002	This split-factor is equal to that of 1-ringers in 2003, i.e., estimated by taking the average MIK index for the year classes 1981 to 1999 and the GLM to predict the split.	This split-factor is obtained from the MIK value for 2001(yr class 2000), and a general linear model (GLM) to predict the split.
		This split-factor (1-ringers in 2003) is estimated by taking the average MIK index for the yr classes 1981-2000 and the GLM to predict the split-factor.

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

	0-ringers	1-ringers
2000	0.547	0.654
2001	0.58	0.547
2002	0.67	0.58

The value of 1-ringers in 2002 and 0-ringers in 2001 (0.58) was determined by a general linear model between the MIK index and the IBTS 1-ringer proportion in Division IIIa (see comments below). The MIK index of 0-ringers in 2001 is 214.8 which predicts a proportion of 0.42 in Division IIIa (1-0.42=0.58 in the North Sea).

The value of 0-ringers in 2002 (and 1-ringers in 2003, which is not used) of 0.67 was estimated from the general linear model (identity link) and an average MIK index over 1981–2000 (141.5), which gives an estimated proportion of 0.33 in Division IIIa.

Comments on the General Linear Model

The two general linear models relating the proportion of North Sea autumn spawners in Division IIIa to the MIK index of 0-ringers, which have been used over the past two years (ICES CM1998/ACFM:14 and CM1999/ACFM:12), were re-fitted with the new observations for 2000.

Table 2.10.2 shows the observed values and the two models: one with Gamma errors and an inverse link function, and one with Gamma errors and an identity link. The details of these models are discussed in O'Brien and Darby (1997, Working Document to HAWG) and Basson (1997, and 1998 Working Documents to HAWG). The analysis was done in Splus, and summary results are given in Table 2.10.3 for completeness. Results are not very different from those presented last year. For the range of MIK-observations, the two models lead to reasonably similar estimates of the proportion in Division IIIa. Both models are, however, likely to break down when used for prediction with an MIK index that lies outside the range of observed values. Problems are likely to be particularly acute if the predicted value is close to 0 or 1. The MIK index for 2001 is reasonably high (214.8), but not outside the range previously observed. The standard errors of the predicted values based on this MIK index are therefore high compared to predictions based on the mean MIK index (Table 2.10.2). The predicted values from the two models are also very similar. In the absence of any knowledge of a mechanistic relationship, the WG again used the linear model for prediction purposes. Model choice does not make a big difference to the predicted values this year.

Method for the short-term projections

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

The area-specific stock numbers and fishing mortalities apply only to 0- and 1- ringers. Older fish are treated as one uniform stock, and can be found both in the North Sea and in IIIa.

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

- The initial stock number at age N0(a) is divided between the areas according to the assumed split factors.
- Stock numbers N1(a) at the end of the year are computed in each area j using Pope's approximation:

  N1j(a) = N0j(a)*exp(-M(a)) - Cj(a)*exp(-M(a)/2) where Cj(a) is the total catch at age in the area.
- Total local mortality Zj(a) is computed as log(N0j(a)/N1j(a)) and the total fishing mortality as Fj(a) = Zj(a)-M(a).
- Fleet wise partial F's are obtained by dividing the total area F proportional to the catches
- For ages 2 and older, the total F according to the input is divided between the fleets proportional to the catches.

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

- The initial stock number at age N0(a) is divided between the areas according to the assumed split factors.
- The local (area j) partial F's, as adjusted by the f-factors are used to compute the catches at age by fleet using

  Cj(a) = N0j(a)*(1-exp(-Z(j(a)))/Zj(a).
- Stock numbers N1(a) at the end of the year for the whole stock are computed in each area j using Pope's approximation:

  N1(a) = N0(a)*exp(-M(a)) - C(a)*exp(-M(a)/2) where C(a) is the total catch at age by all fleets.
- Total mortality Z (a) for the whole stock is computed as log(N0 (a)/N1(a)) and the total fishing mortality as

  F(a) = Z(a)-M(a).
- Yield is obtained by multiplying catches at age with fleet-specific weights at age.

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

In recent years, fleets C, D took some catches of age 3 and older North Sea autumn spawners. In the present version of the programme (as used in the past 3 years), these catches are included, and treated as being taken from a uniform adult stock. Therefore, the catches by the fleets in Division IIIa and in Subarea IV are not independent of each other. As a consequence, there are multiple solutions as to the share between the fleets even when fishing mortalities for juveniles (as F0-1) and adults (as F2–6) are specified. In order to get a unique solution, additional constraints in terms of catch ratios between fleets have to be specified. This must be done individually for each scenario. The 'Solver' facility in Excel is then used for finding the solution.

Prediction for 2001 and management option tables for 2002

Assumptions and Predictions for 2001

As in recent years, there have been some overshoot of the overall TAC for North Sea autumn spawners. A catch constraint, based on TACs and recent observed overshoots of the set TACs, was therefore used for projections in 2001.

Two kinds of information are needed to calculate the fleet specific catch constraints, the fraction of the TACs in Division IIIa which is assumed to represent autumn spawners, and the expected deviation from the TACs for each fleet. We assumed that the proportion of autumn spawners in the TAC for fleets C and D would be similar to proportions observed in recent catches. The rounded, average proportion based on catches in 1999–2000 are 0.41 for fleet C and 0.72 for fleet D. The years 1999 – 2000 were used because the same regulations applied in those years as in 2001. Furthermore, in recent years, the catches by the A fleet have been above the TAC, while they has been below the TAC or bycatch ceiling for the other fleets. Given that there are no changes in regulations which may change the way in which the fleets operate, the mean deviation in 1999 and 2000 was used for 2001. Thus, a 19% overshoot of the TAC was assumed for the A fleet in the North Sea, while the B fleet was assumed to take 49% of the bycatch ceiling in the North Sea, the C fleet 85% of the North Sea autumn spawner part of the TAC in Division IIIa, and the D fleet 76% of the North Sea autumn spawner part of the bycatch ceiling in Division IIIa. The low catch for fleet C is thought to be partly due to area misreporting, which contributes to the overshoot for fleet A. The resulting expected catches used as catch constraints for 2001 are shown in Table 2.10.4, which also includes the source of the data input to this calculation. The overall overshoot is only about 7%, but it has an impact in the individual catches by fleet because it is not evenly distributed across fleets.

Management Option Tables for 2002

Table 2.10.5 gives management options for 2002. The upper table is based on TACs with overshoot in 2001. The lower table is based on F status quo = F2000. The method for estimating the expected catches by fleet was described above.

As noted above, in addition to constraints on fishing mortalities, some constraints in terms of relative catches between fleets are required to ensure that a unique solution for F-factors by fleet are obtained. The constraint used in the present examples is to keep the ratio of the catches by fleets A and C, and between fleets B and D constant, as noted in Table 2.10.5. It should be noted, however, that other ways of specifying the share of the outtake between fleets are also possible.

Since the adult fishing mortality in recent years has been considerably higher than assumed, a run with status quo F = F2000 for all years, including the intermediate year 2001 was included (Sc. VII). Likewise, a run was made with a fishing mortality in 2002 equal to that corresponding to the TAC constraint in 2001 (Sc. I). Furthermore, runs were made with catches in 2002 equal to either the assumed catches in 2001 (Sc. II), or to the adopted TACs for 2001 (Sc. III). Scenarios with fishing mortalities at the levels adopted for SSB above and below 1.3 million tonnes (Sc. IV – VI) are also included. An overview of the scenarios considered is given in the text table below.

Scenario	**Assumption for 2001**	**Target for 2002**	**Constraints on ratio between catches by fleets**
I	Catch = TAC + overshoot	F by fleet as estimated in 2001	none
II		Catches as estimated in 2001	none
III		Catches as agreed TAC in 2001	none
IV		$F_{juv} = 0.05$; $F_{ad} = 0.20$	Maintain catch ratios for fleets A:C and B:D constant between 2001 and 2002.
V		$F_{juv} = 0.10$; $F_{ad} = 0.20$	
VI		$F_{juv} = 0.12$; $F_{ad} = 0.25$	
VII	$F_{status\ quo} = F_{2000}$	$F_{status\ quo} = F_{2000}$	

All scenarios indicate a rapid increase in spawning biomass and in yield. This is caused mainly by the 1998 year class, which is believed to be strong. The following year classes are also believed to be relatively strong, and contribute further to the expected increase in SSB and yield.

The WG is concerned about the tendency of over-estimating projected SSB (see Figure 2.12.1). As noted in Section 2.8, this is usually because of downward revisions of the stock sizes in recent years in subsequent assessments. This issue is of particular relevance this year given (a) the high estimates of the year classes from 1998 and onwards, and (b) given that current estimated SSB is below $\mathbf{B}_{\text{lim}}$ Taking the uncertainty estimated by ICA forwards, the range (5-percentile to 95 percentile) for SSB estimated by the ICP medium term prediction is 768 – 1634 thousand tonnes for 2001 and there is about 8% probability that it still will be below $\mathbf{B}_{\text{lim}}$ = 800 000 tonnes. For comparison, the probability that SSB was below $\mathbf{B}_{\text{lim}}$ in 2000 was 54%. The medium term prediction with STPR (see Section 2.11) indicates an even wider range (Figure 2.11.1).

Comments on the short-term projections

The need to revise the software for the short term predictions, and to evaluate the usefulness of the split of the stock of young herring was recognised in last years report. A study group has been established and has set up a work plan as described in Section 1.8.

2.11 Medium Term Predictions (Revised 22/3 0900)

An attempt was made to perform medium term predictions with ICP, version 1.4w, but it was impossible to get the program to run under certain circumstances, apparently because of program errors. As an alternative, runs were made with the STPR program (Skagen, 1997, Patterson *et al,* 2000) This program was originally developed for evaluating harvest control rules for North Sea herring (ICES 1997a, Patterson, Skagen, Pastoors, & Lassen, 1997).

Like ICP, it projects the stock forwards with stochastic parameters, and presents statistics of a large number of replicas. The stochastic elements are recruitments, weights, maturities and initial stock numbers, while unlike ICP, STPR takes fishing mortality as fixed inputs. The recruitment is assumed to be log-normally distributed with expectation values according to a stock-recruitment function. For weights and maturities, historical data are used, by drawing a random year each time such data are needed, and using all the data from that year. Initial stock numbers are taken from the ICA assessment, and are regarded as multinormally distributed on the log scale, with variances-covariances taken from the ICA output. The model allows two fleets and allows simulating simple harvest control rules, where fishing mortalities or catch ceilings are stated for each of 3 levels of current SSB.

In the present runs, parameters in the Beverton-Holt stock recruitment function were taken from the ICA assessment. These indicate a better recruitment, in particular at high levels of SSB than previous estimates of these parameters (e.g. ICES CM 1998:D2, Report of the Study Group on Stock-Recruitment Relationships for North Sea Autumn-Spawning Herring). The predicted development of the stock is very sensitive to the assumed recruitment level.

The following scenarios were made, In the simulations, two fleets were considered, both represented by the selection pattern for all ages. One fleet represented fleets B, C and D combined (fleet 1), and was scaled according to F0–1. The other represented fleet A (fleet 2) and was scaled according to F2–6. The following scenarios were made:

- F values as in 2000 (F *status quo*)
- F0–1 = 0.05 for fleet 1, F2–6 = 0.20 for fleet 2
- F0–1 = 0.10 for fleet 1, F2–6 = 0.20 for fleet 2
- F0–1 = 0.12 for fleet 1, F2–6 = 0.25 for fleet 2
- A harvest control rule:

– F0–1 = 0.05 for fleet 1, F2–6 = 0.20 for fleet 2 when SSB < 1.3 million tonnes,

– F0–1 = 0.12 for fleet 1, F2–6 = 0.25 for fleet 2 when SSB > 1.3 million tonnes

The results in terms of percentiles of SSB and recruitment are shown in Figure 2.11.1 and for the catches in Figure 2.11.2.

All scenarios indicate an increase in the stock abundance and in the catches. The catches at the end of the period for both fleets is more dependent on the juvenile mortality than on the adult mortality within the range explored here. The

SSB tends to rise for all scenarios, including the F status quo. Both the level of the catches and the rise in SSB are highly sensitive to the assumed recruitment. The stock-recruitment parameters estimated by ICA indicate recruitments well above the recent geometric mean and may be unrealistically high.

To illustrate the impact of the assumed recruitment function, two additional runs were made, one assuming mean recruitment fixed at 44000, which is the recent geometric mean currently used in short term prediction, the other with the Beverton-Holt function with the parameters obtained by the Study Group on Stock-Recruitment Relationships for North Sea Autumn-spawning herring. The runs were made assuming status quo F, and the percentiles for SSB are shown in Figure 2.11.3 together with the results from the corresponding run described above.

It should also be noted that the STPR gives higher median values for SSB in the initial year than the point estimate by ICA, most likely because of the way the uncertainty in the initial data are handled. The results should therefore be interpreted with considerable caution. In particular, the levels of SSB and catches are highly dependent on model assumptions.

2.12 Quality of the Assessment

There have been some revisions to the catch data, weights at age, maturity at age and the acoustic survey index at age. The results of these changes were found to be small (Table 2.12.1).

In this year's assessment, the different surveys were found to display different trends when used as a single tuning index with the catch at age data (Figure 2.8.4). Notably the acoustic survey gave a positive signal regarding stock development in 2000 whereas the IBTS survey and the larval survey (MLAI) indicated a negative trend (Figures 2.8.1 and 2.8.2).

A comparison of the parameter estimates (and coefficients of variation) in the two recent assessments is shown in Table 2.12.2. The change in the stock recruitment parameter appears to be small but turns out to be quite substantial when used in the medium term simulations.

Comparisons of the perceptions in recent assessments are shown in Figure 2.12.1. There appears to be a pattern of readjustment in both fishing mortality (upwards) and spawning stock biomass (downwards) in recent working groups perceptions of the stock. The estimate of the SSB in 2000 (772 thousand tonnes) is around 16% lower that predicted by last years assessment (908) and the fishing mortality (0.42) is around 32% higher than assumed last year. The estimated recruitment for the 1996 year class (0-wr in 1997) was again lower in the current assessment (34 billion against 39 in last years assessment) and is almost at the long term geometric mean (1960–1997: 29.6 billion). The reasons for the upwards revisions of fishing mortality and downward revisions of SSB are not fully understood but seem to be a general problem in not only this assessment. However, the Study Group on the evaluation of current assessment procedures for North Sea Herring (SGEHAP) is encouraged to further investigate this problem.

In the current assessment, the need to use two selection patterns was no longer necessary, because the second period (1997–2000) was long enough to estimate a selection pattern to. Also this made the use of the dedicated ICA version (ICAHER) superfluous. This is particularly useful since it removes the 1996 year from the separable period. The restrictions on the fishery for juveniles were introduced in the middle of 1996. A large part of the 1-ringer catch was already taken by then, while the catch of 0-ringers, was small.

The catch data for North Sea herring is always a major source of uncertainty, as there is a considerable misreporting of catches and also the splitting between autumn spawners and spring spawners introduces additional uncertainty.

The issue of survey weighting within the ICA model has not been explored in this WG but has been addressed at other occasions (e.g. ICES C.M. 1998/ACFM:14, ICES C.M. 2000/ACFM:5, Kolody and Patterson 1999). However the Working Group recognized that there is a great need to carry out this analysis, and encourages the Study Group on the evaluation of current assessment procedures for North Sea Herring (SGEHAP) to further investigate this problem.

The dependency of the results on the model chosen (ICA) was further investigated by running an XSA model on the assessment data. Default settings were chosen. Catchability was assumed independent of stock size from age 2 (wr) onwards and catchability was assumed independent of age from age 5 onwards. It should be noted that the MLAI SSB index could not be used within the XSA model. Comparisons with the ICA runs are shown in Figure 2.12.2. On the whole, XSA seems to confirm the trends suggested by ICA. The main difference lies in the estimation of recruitment in the recent years. Also XSA is slightly more pessimistic concerning the development in the spawning stock.

New approaches have been presented to improve the knowledge of the Downs component (Section 2.9). However no separate assessment can yet be presented.

With regard to the short- and medium term projections, methodological problems have been identified and discussed in Sections 2.10 and 2.11. Management implications of these points are further discussed in Section 2.13.

2.13 Management Considerations

The current assessment shows that the spawning stock biomass in 2000 was below 800,000 tonnes (772,000) even though the prognoses from last year indicated that the stock would be around 900,000 tonnes. The probability that the SSB is below 800,000 tonnes in 2000 is 54%. The reason for the consistent downward revision of the stock, which is a common problem with many stocks is not fully understood. (van Beek and Pastoors 1999, Patterson *et al*. 2000)

The adopted management regime for protecting the juveniles (0 and 1 wr) have kept the Fs well below the ACFM advice of $F_{0\text{-}1} < 0.1$. On the other hand the estimated level of F on the adult stock (2–6 wr) have consistently been in the order of 0.4, while the ACFM advice has been 0.2. This is due to reduced stock estimates and also to higher catches than the TAC's. Although the stock has not improved as expected with the current recovery regime, it remains clear that the situation would have been far worse without these restrictions.

The survey results indicate consistently that the 1998 year class is large: the acoustic index for 1-ringers in 2000 is the highest observed ever; the IBTS indices for 1-ringers in 2000 and 2-ringers in 2001 are well above average and also the MIK index for 0-ringers in 1999 was the highest observed The year class also shows up in the catches, although with the lower fishing mortality on juveniles it is difficult to compare this to earlier years. This large year class will probably give a rapid rise in SSB from 2001 onwards. The surveys also indicate that the 1999 and 2000 year classes are relatively strong, so that the prospects for the stock are expected to be good. However, given the tendency to overestimate the stock and the uncertainties about the incoming year classes, the agreed Fs on juveniles and adults of 0.12 and 0.25 respectively (EU-Norway agreement) should not be implemented until the spawning stock clearly has exceeded 1.3 mill t. Even though the stock is below $\mathbf{B}_{\mathrm{lim}}$, the Working Group consider that drastic measures are not necessary, given the good recruitment which has been confirmed by several surveys. An increase in the TAC is however not considered appropriate given the tendency to underestimate F (adult).

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. A simulation using an average recruitment at the recent geometric mean of 44 billion recruits, indicated that the current fishing mortality would result in a more or less stable median SSB, although with a large confidence interval around it. The WG considered that the 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 2000 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.

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 1996, the TAC for IVc and VIId was reduced to 25,000 tonnes and has been kept fixed since then. 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. New approaches are being explored to assess the developments in this stock component. Although, at present, 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 developments to estimate the contribution of the Downs component to the total SSB of the North Sea stock and also to estimate the recruitment to the Downs component. Some of the preliminary indices indicate that the stock component is increasing over the last 4 to 5 years and is presently at around the high level of the late 1980s.

Table 2.1.1: HERRING caught in the North Sea (Sub-area IV and Division VIId). Catch in tonnes by country, 1991–2000. These figures do not an all cases correspond to the official statistics and cannot be used for management purposes.

Country	1991	1992	1993	1994	1995
Belgium	163	242	56	144	12
Denmark	194358	193968	164817	121559	153363 [9]
Faroe Islands	334	-	-	-	231 [9]
France	24625	16587	12623	27941	29499 [9]
Germany, Fed.Rep	41791	42665	41619 [9]	38394	43798
Netherlands	75135	75683	79190	76155	78491
Norway [4]	124991	116863	122815	125522	131026
Sweden	5866	4939	5782	5425	5017
USSR/Russia					-
UK (England)	11548	11314	19853 [10]	14216	14676
UK (Scotland)	57572	56171	55532	49919	44813
UK (N.Ireland)	92	-	-	-	-
Unallocated landings	24435	25867	18410	5749	33584 [9]
Misreporting from VIaN	22079	22594	24397	30234	32146
Total landings	582969	566892	545094	495258	566656
Discards	4617	4950	3470	2510	-
Total catch	**587606**	**571842**	**548564** [9]	**497768**	**566656** [9]
Estimates of the parts of the catches which have been allocated to spring spawning stocks					
IIIa type (WBSS)	7894	7854	8928	13228	10315
Thames estuary [5]	252 [5]	202	201	215	203

Country	1996	1997	1998	1999	2000 [1]
Belgium	-	1	1	2	-
Denmark [2,7]	67496	38431	58924	61268	64123
Faroe Islands [2]	-	-	25	1977	915
France [2]	12500	14524	20783	26962	20952
Germany	14215	13381	22259	26764	26687
Netherlands	35276	35129	50654	54318	54382
Norway [4]	43739	38745	68523	70718	72844
Sweden	3090	2253	3221	3241	3046
Russia	-	1619	-	-	-
UK (England)	6881	3421	7635	10598	11179
UK (Scotland)	17473	22914	32403	29911	30033
UK (N.Ireland)	-	-	-	-	915
Unallocated landings	24475	27583	27722	21653	36708
Misreporting from VIaN	38254	29763 [6]	32446	23625	[8]
Total landings	263399	227763	324596	331036	321784
Discards	1469	6005	3918	4769	7354
Total catch	**264868**	**233769** [6]	**328514**	**335805**	**329138**
Estimates of the parts of the catches which have been allocated to spring spawning stocks					
IIIa type (WBSS)	855	979	7833	4732	6649
Thames estuary [5]	168	202	88	88	76

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 This figure is not in accordance with the official catch statistics and should be checked prior to next

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	1991	1992		1993		1994		1995
Denmark	5980	10751		10604		20017		17748
Faroe Islands	334	-		-		-		-
France	3393	4714	4	3362		11658		10427
Germany	20608	21836		17342	4	18364		17095
Netherlands	29563	29845		28616		16944		24696
Norway	37674	39244		33442		56422		56124
Sweden	1130	985		1372		2159		1007
UK (England)	4873	4916		4742		3862		3091
UK (Scotland)	42745	39269		36628	4	44687		40159
UK (N. Ireland)	92	-		-		-		-
Unallocated landings	5492	4855		-8271	5	3214	9	26018
Misreporting from VIa Nc	22079	22593		24397		30234		32146
Total Landings	173963	179008		152234		207561		228511
Discards	883	850		825		550		-
Total catch	**174846**	**179858**		**153059**		**208111**		**228511**

Country	1996	1997		1998	1999	2000	
Denmark 7	3237	2667		4634	15359	25530	
Faroe Islands	-	-		25	1977	205	
France	3177	361		4757	6369	3210	
Germany	2167	-		7752	11206	5811	
Netherlands	2978	6904	9	11851	17038	15117	
Norway	22187	16485		27218	30585	32895	
Sweden	2398	1617		245	859	1479	
Russia	-	1619		-	-	-	
UK (England)	2391	-		4306	7163	8859	
UK (Scotland)	12762	17120		30552	28537	29055	
UK (N. Ireland)	-	-		-	-	996	
Unallocated landings	9959	7574		15952	3889	29581	
Misreporting from VIa Nc	38254	29763	6	32446	23625		8
Total Landings	99510	84110		139738	146607	152738	
Discards	356	1138		730	654	6841	
Total catch	**99866**	**85248**	6	**140468**	**147261**	**159579**	

(2000: 1)

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

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	1991	1992	1993	1994	1995
Denmark [5]	48875	53692	43224	43787	45257
Faroe Islands	-	-	-	-	-
France	-	- [3]	4	14	+
Germany	- [3]	- [3]	- [3]	-	-
Netherlands	-	-	-	-	-
Norway [2]	77465	61379	56215	40658	62224
Sweden	114	508	711	1010	2081
UK (Scotland)	173	196	- [3]	-	-
Unallocated landings	-	-	-	-	-
Total landings	126627	115775	100154	85469	109562
Discards	-	-	-	-	-
Total catch	**126627**	**115775**	**100154**	**85469**	**109562**

Country	1996	1997	1998	1999	2000 [1]
Denmark [5]	19166	22882	25750	18259	11300
Faroe Islands	-	-	-	-	710
France	-	3	-	115	-
Germany	-	4576	-	-	29
Netherlands	-	-	-	1965	38
Norway [1]	18256	18490	41260	37433	39696
Sweden	693	427	1259	772	1177
Unallocated landings	-	-	-	-1965 [4]	-4 [4]
Total landings	38115	46378	68269	56579	52946
Discards	-	-	-	-	-
Total catch	**38115**	**46378**	**68269**	**56579**	**52946**

1 Preliminary
2 Catches of Norwegian spring spawners herring removed (taken under a separate TAC).
3 Included in IVa West.
4 Negative unallocated catches due to misreporting into other areas.
5 Including any bycatches in the industrial fishery

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	**1991**	**1992**	**1993**	**1994**	**1995**	
Belgium	3	13	-	-	-	
Denmark 4	138555	125229	109994	55060	87917	
Faroe Islands	-	-	-	-	231	8
France	4120	2313	2086	5492	7639	
Germany	20479	20005	23628	14796	21707	
Netherlands	26266	26987	31370	39052	30065	
Norway	9852	16240	33158	28442	12678	
Sweden	4622	3446	3699	2256	1929	
UK (England)	2715	3026	3804	7337	9688	
UK (Scotland)	14587	16707	18904	5101	4654	
Unallocated landings 3	3180	-13637	-16415	-26988	-10831	9
Total landings	224376	200329	210228	130548	165677	
Discards 1	1072	1900	245	460	-	
Total catch	**225448**	**202229**	**210473**	**131008**	**165677**	9

Country	**1996** 6	**1997**	**1998**	**1999**	**2000** 1
Belgium	-	-	-	1	-
Denmark 4	43749	11636	26667	26211	26825
Faroe Islands	-	-	1	-	-
France	2373	6069	8944	7634	10863
Germany	11052	7456	13591	13529	18818
Netherlands	18474	14697	27408	22825	26845
Norway	3296	3770	45	2700	253
Sweden	-	209	1717	1610	390
UK (England)	2757	2033	1767	1641	669
UK (Scotland)	4449	5461	1851	1374	978
Unallocated landings 3	-8826	-1615	-11270	-313	-13769
Total landings	77324	49716	70720	77212	71872
Discards 1	592	1855	1188	873	317
Total catch	**77916**	**51571**	**71908**	**78085**	**72189**

1 Preliminary
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	1991	1992	1993	1994	1995
Belgium	163	229	56	144	12
Denmark	948	4296	995	2695	2441
France	17112	9560	7171	10777	11433
Germany	704	824	649	4964	4996
Netherlands	19306	18851	19204	20159	23730
UK (England)	3960	3372	11307 [10]	3016	1896
UK (Scotland)	67	-	-	131	-
Unallocated landings	15763	34649	43096	29792	18397
Total landings	58023	71781	82478	71678	62905
Discards [1]	2662	2200	2400	2400	-
Total catch	**60685**	**73981**	**84878**	**74078**	**62905**
Coastal spring spawners included above [2]	252	202	201	215	203

Country	1996	1997	1998	1999	2000 [1]
Belgium	-	1	1	1	1
Denmark	1344	1246	1873	1439	468
France	6950	8091	7081	12844	6879
Germany	997	1349	916	2029	2029
Netherlands	13824	13528	11395	12490	12348
UK (England)	1733	1388	1562	1794	1537
UK (Scotland)	262	333	-	-	-
Unallocated landings	23934	21624	23040	20042	20966
Total landings	49044	47559	45868	50639	44228
Discards	521	3012	2000	3242	196
Total catch	**49565**	**50571**	**47868**	**53881**	**44424**
Coastal spring spawners included above [2]	168	143	88	88	76

1 Preliminary
2 Landings from the Thames estuary area are included in the North Sea catch figure for UK (England).
9 Figure altered in 2001
10 This figure is not in accordance with the official catch statistics and should be checked prior to next y

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
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
Recommended Divisions IVc, VIId	30	30	50-60 [6]	54	50	50	50	- [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
Agreed Div. IVc, VIId	30	30	50 [6]	50	50	50	50	50;25 [13]	25	25	25	25	25
Bycatch ceiling in the small mesh fishery									24	22	30	36	36
CATCH (IV and VIId)													
National landings Divisions IVa,b [3]	639	499	495	481	463	421	456	176	144	241	255	263	
Unallocated landings Divisions IVa,b	-2	14	30	14	-1	6	47	39	36	37	25	16	
Discard/slipping Divisions IVa,b [4]	3	4	2	3	1	1	0	1	3 [16]	2	2	6	
Total catch Divisions IVa,b [5]	638	516	527	498	463	428	503	216	183 [16]	281	282	285	
National landings Divisions IVc, VIId [3]	30	24	42	37	40	42	45	25	26	23	31	23	
Unallocated landings Divisions IVc,VIId	48	32	16	35	43	30	18	24	22	23	20	21	
Discard/slipping Divisions IVc, VIId	1	5	3	2	2	2	-	1	3	2	3	0.2	
Total catch Divisions IVc, VIId	79	61	61	74	85	74	63	50	51	48	54	44	
Total catch IV and VIId as used by ACFM [5]	**717**	**578**	**588**	**572**	**548**	**498**	**566**	**266**	**234** [16]	**329**	**336**	**329**	
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	
North Sea autumn spawners industrial (Fleet B)	N.a.	N.a.	134	124	101	38	65	38	13	14	15	18	
Baltic-IIIa-type spring spawners	20	8	8	8	9	13	10	0.9	0.9	8	5	7	
Coastal-type spring spawners	2.3	1.1	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	
North Sea autumn spawners in IV and VIId to	**696**	**569**	**580**	**564**	**539**	**485**	**559**	**265**	**233** [16]	**320**	**331**	**322**	
Division IIIa: TAC (IIIa)													
Predicted catch of autumn spawners			96	153	102	77	98	48	35	58	43	53	67
Recommended spring spawners	84	67	91	90	93–113	- [9]	- [12]	- [12]	- [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
Agreed mixed clupeoid TAC	80	65	50	50	45	43	43	43					
Bycatch ceiling in the small mesh fishery									20	17	19	21	21
CATCH (IIIa)													
National landings	192	202	188	227	214	168	157	115	83	120 [16]	86	108	
Catch as used by ACFM	162	195	191	227	214	168	157	115	83	105 [16]	86	108	
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	
Autumn spawners mixed clupeoid (Fleet D)	N.a.	N.a.	13	23	25	12	6	12	4		8 [17]		
Autumn spawners other industrial landings (Fleet E)	N.a.	N.a.	38	82	63	32	43	7	2	5		13	
Autumn spawners in IIIa total	**91**	**77** [8]	**77**	**152**	**132**	**86**	**70**	**42**	**40**	**59**	**39** [17]	**50**	
Spring spawners human consumption (Fleet C)	N.a.	N.a.	68	53	68	59	59	69	34	43	44 [17]	53	
Spring spawners mixed clupeoid (Fleet D)	N.a.	N.a.	5	2	1	1	2	1	1		3 [17]		
Spring spawners other industrial landings (Fleet E)	N.a.	N.a.	40	20	12	24	29	3	1	3		5	
Spring spawners in IIIa total	**71**	**118**	**113**	**75**	**81**	**84**	**90**	**73**	**37**	**46**	**47** [17]	**58**	
North Sea autumn spawners Total as used by ACF	**787**	**646**	**657**	**716**	**671**	**571**	**629**	**307**	**273** [16]	**380**	**370** [17]	**372**	

1 Includes catches in directed fishery and catches of 1-ringers in small mesh fishery up to 1992. 2 IVa,b and EC zone of IIa. 3 Provided by Working Group members. 4 One country only.
5 Includes spring spawners not included in assessment. 6 Revised during 1991. 7 Based on F=0.3 in directed fishery only; TAC advised for IVc, VIId subtracted. 8 Estimated.
9 130-180 for spring spawners in all areas. 10 Based on sum-of-products (number x mean weight at age). 11 Status quo F catch for fleet A. 12 The catch should not exceed recent catch levels.
13 During the middle of 1996 revised to 50% of its original agreed TAC. 14 Included in IVa,b. 15 Managed in accordance with autumn spawners. 16 Figure altered in 2000. 17 Figure altered in 2001.

Table 2.2.1: North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2000. 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	236.2	0.1	0.0	0.1	0.7	857.6	14.2	0.0	858.4	14.2	1108.8	872.6
1	984.3	5.8	0.0	5.8	102.8	66.9	9.0	0.0	175.5	9.0	1168.8	184.5
2	115.6	73.2	8.2	65.0	253.1	90.1	18.3	71.2	408.2	89.4	613.2	505.8
3	21.9	75.2	9.8	65.4	210.4	143.8	9.9	36.1	419.6	46.0	487.5	475.3
4	22.8	92.2	10.2	82.0	319.2	87.8	13.3	77.8	488.9	91.0	602.8	590.2
5	7.5	46.9	5.7	41.3	68.3	16.0	4.9	47.7	125.5	52.6	185.6	183.8
6	3.3	16.1	2.5	13.7	31.2	9.4	2.2	18.8	54.3	21.0	78.5	77.7
7	0.6	5.0	0.6	4.4	13.6	3.0	1.0	5.3	21.0	6.2	27.8	27.8
8	0.1	5.3	0.7	4.6	7.5	4.5	0.0	0.0	16.7	0.0	16.8	17.4
9+	0.0	0.7	0.1	0.6	1.9	0.0	0.0	0.0	2.5	0.0	2.5	2.6
Sum	1392.2	320.5	37.6	282.8	1008.6	1279.1	72.7	256.8	2570.5	329.5	4292.2	2937.7
Quarter: 1												
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	543.0	0.0	0.0	0.0	0.0	7.8	8.9	0.0	7.8	8.9	559.7	16.7
2	43.7	0.3	0.0	0.3	0.0	3.3	16.1	1.4	3.6	17.4	64.7	21.0
3	10.6	4.5	0.0	4.5	5.5	1.8	7.8	0.9	11.8	8.7	31.0	20.4
4	3.1	9.1	0.0	9.1	21.1	3.4	11.4	1.8	33.6	13.1	49.8	46.7
5	1.5	3.9	0.0	3.9	3.3	1.8	3.5	2.5	9.0	5.9	16.4	15.0
6	1.2	0.0	0.0	0.0	1.6	0.0	1.8	0.5	1.6	2.3	5.0	3.9
7	0.2	0.0	0.0	0.0	0.0	0.0	0.9	0.1	0.0	1.0	1.2	1.0
8	0.1	0.4	0.0	0.4	0.2	0.0	0.0	0.0	0.5	0.0	0.6	0.5
9+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	603.3	18.3	0.0	18.3	31.6	18.0	50.3	7.0	67.9	57.3	728.5	125.2
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	77.8	2.6	0.0	2.6	13.3	38.5	0.0	0.0	54.4	0.0	132.3	54.5
2	1.8	48.2	0.9	47.2	60.3	30.2	0.1	0.1	137.7	0.2	139.6	138.7
3	3.7	42.4	2.5	39.9	50.3	3.3	0.0	0.0	93.6	0.1	97.4	96.2
4	0.0	43.2	1.8	41.4	51.7	0.8	0.1	0.1	93.9	0.1	94.0	95.8
5	0.0	16.0	0.7	15.4	14.0	0.2	0.1	0.0	29.6	0.1	29.7	30.4
6	0.0	5.0	0.2	4.8	5.0	0.1	0.0	0.0	9.9	0.0	9.9	10.1
7	0.0	1.0	0.0	0.9	1.1	0.0	0.0	0.0	2.0	0.0	2.0	2.1
8	0.0	0.6	0.0	0.6	0.4	0.0	0.0	0.0	1.1	0.0	1.1	1.1
9+	0.0	0.3	0.0	0.3	0.4	0.0	0.0	0.0	0.8	0.0	0.8	0.8
Sum	83.3	159.3	6.1	153.2	196.6	73.2	0.3	0.2	422.9	0.5	506.8	429.6
Quarter: 3												
0	93.3	0.1	0.0	0.1	0.0	601.3	4.2	0.0	601.4	4.2	698.9	605.6
1	244.2	2.8	0.0	2.8	60.5	19.4	0.1	0.0	82.7	0.1	327.0	82.7
2	59.6	22.7	7.2	15.5	150.8	44.7	0.0	0.1	211.0	0.2	270.7	218.4
3	6.0	25.1	7.3	17.8	109.7	118.8	0.0	0.1	246.3	0.1	252.4	253.7
4	6.9	30.8	8.4	22.3	177.7	67.2	0.0	0.2	267.3	0.2	274.4	275.9
5	2.1	18.2	5.0	13.2	39.3	9.6	0.0	0.1	62.1	0.1	64.3	67.2
6	0.4	8.2	2.3	6.0	20.0	7.3	0.0	0.0	33.3	0.0	33.7	35.6
7	0.1	2.1	0.6	1.5	10.7	2.3	0.0	0.0	14.6	0.0	14.6	15.1
8	0.0	2.3	0.6	1.7	6.1	4.1	0.0	0.0	11.8	0.0	11.8	12.4
9+	0.0	0.4	0.1	0.3	1.4	0.0	0.0	0.0	1.7	0.0	1.7	1.8
Sum	412.5	112.7	31.5	81.2	576.2	874.7	4.4	0.5	1532.0	4.9	1949.4	1568.4
Quarter: 4												
0	142.9	0.0	0.0	0.0	0.7	256.3	10.0	0.0	257.0	10.0	409.9	267.0
1	119.3	0.4	0.0	0.4	28.9	1.2	0.0	0.0	30.6	0.0	149.8	30.6
2	10.6	2.0	0.0	2.0	42.0	12.0	2.1	69.6	56.0	71.7	138.2	127.7
3	1.6	3.2	0.0	3.2	44.9	19.8	2.1	35.1	67.9	37.2	106.7	105.1
4	12.8	9.1	0.0	9.1	68.7	16.4	1.8	75.8	94.3	77.6	184.6	171.8
5	3.9	8.7	0.0	8.7	11.7	4.4	1.3	45.1	24.8	46.4	75.1	71.2
6	1.8	2.8	0.0	2.8	4.7	2.0	0.4	18.3	9.5	18.6	29.9	28.2
7	0.3	2.0	0.0	2.0	1.8	0.6	0.0	5.2	4.4	5.2	9.9	9.6
8	0.0	1.9	0.0	1.9	0.9	0.5	0.0	0.0	3.3	0.0	3.3	3.3
9+	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.1
Sum	293.1	30.2	0.0	30.2	204.3	313.2	17.7	249.0	547.7	266.7	1107.5	814.4

Table 2.2.2: North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2000. Mean weight at age (kg) in the catch (WECA), by quarter and division

WR	IIIa NSAS	IVa(E) all	IVa(E) WBSS	IVa(W)	IVb	IVc	VIId	IVa & IVb all	IVc & VIId	Total IV & IIIa all	Herring caught in the North Sea
Quarters: 1-4											
0	0.021	0.014	0.000	0.014	0.013	0.014	0.000	**0.013**	**0.014**	**0.015**	**0.013**
1	0.028	0.065	0.000	0.074	0.034	0.015	0.000	**0.058**	**0.015**	**0.033**	**0.056**
2	0.076	0.130	0.141	0.129	0.125	0.082	0.115	**0.128**	**0.109**	**0.116**	**0.125**
3	0.109	0.155	0.165	0.157	0.173	0.113	0.143	**0.162**	**0.137**	**0.157**	**0.160**
4	0.163	0.174	0.184	0.186	0.191	0.125	0.159	**0.185**	**0.154**	**0.180**	**0.180**
5	0.190	0.199	0.207	0.208	0.220	0.148	0.189	**0.206**	**0.185**	**0.199**	**0.200**
6	0.184	0.204	0.202	0.234	0.232	0.160	0.207	**0.225**	**0.202**	**0.218**	**0.219**
7	0.190	0.217	0.218	0.268	0.258	0.153	0.220	**0.254**	**0.209**	**0.244**	**0.244**
8	0.198	0.267	0.265	0.294	0.222	0.000	0.000	**0.267**	**-**	**0.267**	**0.267**
9+	0.000	0.256	0.276	0.265	0.268	0.000	0.000	**0.263**	**-**	**0.262**	**0.263**
Quarter: 1											
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	**0.000**	**0.000**
1	0.014	0.064	0.000	0.000	0.029	0.015	0.000	0.029	0.015	**0.014**	**0.022**
2	0.056	0.124	0.000	0.000	0.044	0.075	0.087	0.050	0.076	**0.061**	**0.071**
3	0.099	0.129	0.000	0.121	0.129	0.102	0.098	0.125	0.101	**0.110**	**0.115**
4	0.156	0.141	0.000	0.130	0.141	0.117	0.114	0.134	0.116	**0.131**	**0.129**
5	0.193	0.172	0.000	0.137	0.172	0.128	0.127	0.159	0.128	**0.151**	**0.147**
6	0.188	0.191	0.000	0.166	0.000	0.149	0.151	0.166	0.149	**0.164**	**0.157**
7	0.223	0.227	0.000	0.000	0.000	0.150	0.147	0.227	0.149	**0.164**	**0.150**
8	0.220	0.190	0.000	0.190	0.000	0.000	0.000	0.190	-	**0.193**	**0.190**
9+	0.000	0.227	0.000	0.000	0.000	0.000	0.000	0.227	-	**0.227**	**0.227**
Quarter: 2											
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	**0.000**	**0.000**
1	0.025	0.064	0.000	0.078	0.024	0.015	0.000	0.039	0.015	**0.031**	**0.039**
2	0.042	0.124	0.124	0.124	0.080	0.080	0.086	0.114	0.082	**0.113**	**0.114**
3	0.099	0.144	0.144	0.153	0.134	0.099	0.099	0.148	0.099	**0.147**	**0.148**
4	0.000	0.163	0.163	0.179	0.162	0.115	0.115	0.171	0.115	**0.171**	**0.171**
5	0.000	0.169	0.169	0.178	0.171	0.128	0.128	0.173	0.128	**0.173**	**0.173**
6	0.000	0.191	0.191	0.206	0.193	0.150	0.150	0.198	0.150	**0.198**	**0.198**
7	0.000	0.227	0.227	0.254	0.232	0.147	0.147	0.241	0.147	**0.241**	**0.241**
8	0.000	0.217	0.217	0.251	0.215	0.000	0.000	0.230	-	**0.231**	**0.230**
9+	0.000	0.227	0.227	0.251	0.242	0.000	0.000	0.241	-	**0.241**	**0.241**
Quarter: 3											
0	0.018	0.014	0.000	0.014	0.012	0.012	0.000	0.012	0.012	**0.013**	**0.012**
1	0.049	0.064	0.000	0.076	0.053	0.037	0.000	0.070	0.037	**0.054**	**0.070**
2	0.090	0.143	0.143	0.130	0.156	0.119	0.119	0.136	0.119	**0.126**	**0.136**
3	0.126	0.172	0.172	0.162	0.176	0.146	0.146	0.170	0.146	**0.169**	**0.170**
4	0.151	0.188	0.188	0.203	0.196	0.163	0.163	0.200	0.163	**0.199**	**0.200**
5	0.176	0.212	0.212	0.232	0.234	0.193	0.193	0.227	0.193	**0.226**	**0.227**
6	0.172	0.203	0.203	0.253	0.235	0.208	0.208	0.238	0.208	**0.239**	**0.238**
7	0.142	0.217	0.217	0.276	0.265	0.221	0.221	0.266	0.221	**0.267**	**0.266**
8	0.000	0.267	0.267	0.311	0.222	0.000	0.000	0.274	-	**0.274**	**0.274**
9+	0.000	0.282	0.282	0.268	0.273	0.000	0.000	0.271	-	**0.270**	**0.271**
Quarter: 4											
0	0.023	0.014	0.000	0.014	0.015	0.015	0.000	0.015	0.015	**0.018**	**0.015**
1	0.053	0.076	0.000	0.066	0.089	0.048	0.000	0.067	0.048	**0.056**	**0.067**
2	0.090	0.140	0.000	0.135	0.145	0.135	0.116	0.137	0.116	**0.123**	**0.126**
3	0.133	0.196	0.000	0.153	0.166	0.158	0.144	0.159	0.145	**0.154**	**0.154**
4	0.171	0.216	0.000	0.166	0.183	0.175	0.161	0.174	0.161	**0.168**	**0.168**
5	0.197	0.239	0.000	0.181	0.214	0.201	0.192	0.207	0.192	**0.197**	**0.197**
6	0.184	0.227	0.000	0.205	0.221	0.209	0.208	0.215	0.208	**0.209**	**0.210**
7	0.172	0.213	0.000	0.227	0.231	0.221	0.221	0.221	0.221	**0.220**	**0.221**
8	0.134	0.299	0.000	0.218	0.228	0.000	0.000	0.267	-	**0.266**	**0.267**
9+	0.000	0.000	0.000	0.304	0.000	0.000	0.000	0.304	-	**0.304**	**0.304**

Table 2.2.3: North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2000. 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.**	**11.5**	**n.d.**	**11.5**	**15.1**	**14.2**	**0.0**	**15.1**	**14.2**	**15.1**
1	**n.d.**	**20.5**	**n.d.**	**21.3**	**17.4**	**13.4**	**0.0**	**19.8**	**13.4**	**19.5**
2	**n.d.**	**24.0**	**n.d.**	**24.5**	**24.3**	**22.1**	**24.1**	**24.4**	**23.7**	**24.3**
3	**n.d.**	**25.5**	**n.d.**	**26.2**	**27.1**	**24.6**	**25.6**	**26.4**	**25.4**	**26.3**
4	**n.d.**	**26.8**	**n.d.**	**27.6**	**28.2**	**25.8**	**26.7**	**27.6**	**26.6**	**27.4**
5	**n.d.**	**27.8**	**n.d.**	**28.4**	**29.1**	**26.8**	**27.6**	**28.3**	**27.6**	**28.1**
6	**n.d.**	**28.4**	**n.d.**	**29.7**	**29.9**	**28.0**	**28.2**	**29.4**	**28.1**	**29.0**
7	**n.d.**	**29.8**	**n.d.**	**31.0**	**30.7**	**28.0**	**28.8**	**30.7**	**28.7**	**30.2**
8	**n.d.**	**31.1**	**n.d.**	**31.7**	**32.0**	**0.0**	**0.0**	**31.6**	**-**	**31.6**
9+	**n.d.**	**30.6**	**n.d.**	**31.0**	**31.1**	**0.0**	**0.0**	**30.9**	**-**	**30.9**
Quarter: 1										
0	n.d.	0.0	n.d.	0.0	0.0	0.0	0.0	-	-	**0.0**
1	n.d.	19.2	n.d.	19.2	14.1	15.6	18.3	14.1	15.6	**14.7**
2	n.d.	23.7	n.d.	23.7	19.7	20.3	20.3	20.0	20.3	**21.4**
3	n.d.	26.6	n.d.	26.6	25.3	23.1	23.1	26.4	23.1	**25.4**
4	n.d.	27.4	n.d.	27.4	27.0	24.6	24.6	27.4	24.6	**26.4**
5	n.d.	29.1	n.d.	29.1	29.2	26.3	26.3	29.1	26.3	**27.5**
6	n.d.	27.7	n.d.	27.7	29.0	27.8	27.8	27.7	27.8	**28.2**
7	n.d.	29.1	n.d.	29.1	30.4	0.0	0.0	29.1	0.0	**27.9**
8	n.d.	30.5	n.d.	30.5	0.0	0.0	0.0	30.5	-	**30.5**
9+	n.d.	30.0	n.d.	30.0	0.0	0.0	0.0	30.0	-	**30.0**
Quarter: 2										
0	n.d.	0.0	n.d.	0.0	0.0	0.0	0.0	-	-	**0.0**
1	n.d.	19.2	n.d.	21.1	11.4	13.2	0.0	14.2	13.2	**14.2**
2	n.d.	23.7	n.d.	23.9	21.3	22.4	23.0	23.3	22.7	**23.3**
3	n.d.	25.0	n.d.	25.6	24.8	24.3	24.3	25.3	24.3	**25.3**
4	n.d.	26.1	n.d.	26.8	26.2	25.6	25.6	26.5	25.6	**26.5**
5	n.d.	26.4	n.d.	26.9	26.5	26.5	26.5	26.6	26.5	**26.6**
6	n.d.	27.7	n.d.	28.3	27.8	28.1	28.1	28.0	28.1	**28.0**
7	n.d.	29.1	n.d.	30.3	29.3	28.1	28.1	29.7	28.1	**29.7**
8	n.d.	29.6	n.d.	30.5	29.4	0.0	0.0	30.0	-	**30.0**
9+	n.d.	30.0	n.d.	30.6	30.4	0.0	0.0	30.4	-	**30.4**
Quarter: 3										
0	n.d.	11.5	n.d.	11.5	15.8	15.8	0.0	15.8	15.8	**15.8**
1	n.d.	21.4	n.d.	21.2	29.3	33.5	0.0	23.1	33.5	**23.1**
2	n.d.	24.6	n.d.	24.4	26.3	24.2	24.2	24.8	24.2	**24.8**
3	n.d.	26.0	n.d.	26.1	27.2	25.6	25.6	26.6	25.6	**26.6**
4	n.d.	27.0	n.d.	28.0	28.3	26.7	26.7	27.9	26.7	**27.9**
5	n.d.	28.0	n.d.	29.1	29.3	27.7	27.7	28.8	27.7	**28.8**
6	n.d.	28.2	n.d.	30.2	30.0	28.1	28.1	29.7	28.1	**29.7**
7	n.d.	29.8	n.d.	31.2	30.9	28.8	28.8	31.0	28.8	**31.0**
8	n.d.	30.8	n.d.	31.8	32.0	0.0	0.0	31.7	-	**31.7**
9+	n.d.	31.2	n.d.	31.1	31.2	0.0	0.0	31.1	-	**31.1**
Quarter: 4										
0	n.d.	11.5	n.d.	11.5	13.6	13.6	0.0	13.6	13.6	**13.6**
1	n.d.	22.2	n.d.	21.6	22.5	19.5	0.0	21.6	19.5	**21.6**
2	n.d.	26.2	n.d.	26.0	25.9	24.6	24.1	26.0	24.2	**25.0**
3	n.d.	27.9	n.d.	27.1	27.1	25.5	25.6	27.2	25.6	**26.6**
4	n.d.	28.9	n.d.	27.8	28.0	26.8	26.7	27.9	26.7	**27.4**
5	n.d.	29.7	n.d.	28.6	29.0	27.7	27.7	29.0	27.7	**28.2**
6	n.d.	30.3	n.d.	29.7	29.6	27.7	28.2	29.8	28.1	**28.7**
7	n.d.	30.0	n.d.	30.2	30.0	28.8	28.8	30.1	28.8	**29.4**
8	n.d.	32.1	n.d.	31.5	32.0	0.0	0.0	31.9	-	**31.9**
9+	n.d.	0.0	n.d.	32.7	0.0	0.0	0.0	32.7	-	**32.7**

Table 2.2.4: North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2000. 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	**5.0**	**0.0**	**0.0**	**0.0**	**0.0**	**11.1**	**0.2**	**0.0**	**11.1**	**0.2**	**16.2**	**11.3**
1	**27.9**	**0.4**	**0.0**	**0.4**	**7.6**	**2.3**	**0.1**	**0.0**	**10.2**	**0.1**	**38.2**	**10.4**
2	**8.8**	**9.5**	**1.1**	**8.4**	**32.6**	**11.3**	**1.5**	**8.2**	**52.3**	**9.7**	**70.8**	**64.3**
3	**2.4**	**11.7**	**1.6**	**10.0**	**33.0**	**24.9**	**1.1**	**5.2**	**67.9**	**6.3**	**76.6**	**77.4**
4	**3.7**	**16.1**	**1.9**	**14.2**	**59.5**	**16.8**	**1.7**	**12.4**	**90.4**	**14.0**	**108.2**	**108.2**
5	**1.4**	**9.3**	**1.2**	**8.2**	**14.2**	**3.5**	**0.7**	**9.0**	**25.9**	**9.7**	**37.0**	**37.9**
6	**0.6**	**3.3**	**0.5**	**2.8**	**7.3**	**2.2**	**0.3**	**3.9**	**12.3**	**4.2**	**17.1**	**17.5**
7	**0.1**	**1.1**	**0.1**	**1.0**	**3.6**	**0.8**	**0.1**	**1.2**	**5.4**	**1.3**	**6.8**	**6.9**
8	**0.0**	**1.4**	**0.2**	**1.2**	**2.2**	**1.0**	**0.0**	**0.0**	**4.5**	**0.0**	**4.5**	**4.8**
9+	**0.0**	**0.2**	**0.0**	**0.1**	**0.5**	**0.0**	**0.0**	**0.0**	**0.7**	**0.0**	**0.7**	**0.7**
Sum	**49.9**	**52.9**	**6.6**	**46.3**	**160.5**	**73.8**	**5.8**	**39.8**	**280.6**	**45.6**	**376.1**	**339.5**
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	7.6	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.2	0.1	**8.0**	**0.4**
2	2.4	0.0	0.0	0.0	0.0	0.1	1.2	0.1	0.2	1.3	**3.9**	**1.5**
3	1.0	0.6	0.0	0.6	0.7	0.2	0.8	0.1	1.5	0.9	**3.4**	**2.3**
4	0.5	1.3	0.0	1.3	2.7	0.5	1.3	0.2	4.5	1.5	**6.5**	**6.0**
5	0.3	0.7	0.0	0.7	0.5	0.3	0.4	0.3	1.4	0.8	**2.5**	**2.2**
6	0.2	0.0	0.0	0.0	0.3	0.0	0.3	0.1	0.3	0.3	**0.8**	**0.6**
7	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	**0.2**	**0.2**
8	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	**0.1**	**0.1**
9+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	**0.0**
Sum	**12.1**	**2.7**	**0.0**	**2.7**	**4.2**	**1.4**	**4.3**	**0.8**	**8.2**	**5.1**	**25.4**	**13.3**
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	1.9	0.2	0.0	0.2	1.0	0.9	0.0	0.0	2.1	0.0	**4.1**	**2.1**
2	0.1	6.0	0.1	5.9	7.5	2.4	0.0	0.0	15.7	0.0	**15.8**	**16.0**
3	0.4	6.1	0.4	5.8	7.7	0.4	0.0	0.0	13.9	0.0	**14.3**	**14.6**
4	0.0	7.0	0.3	6.7	9.2	0.1	0.0	0.0	16.1	0.0	**16.1**	**16.7**
5	0.0	2.7	0.1	2.6	2.5	0.0	0.0	0.0	5.1	0.0	**5.2**	**5.4**
6	0.0	1.0	0.0	0.9	1.0	0.0	0.0	0.0	2.0	0.0	**2.0**	**2.0**
7	0.0	0.2	0.0	0.2	0.3	0.0	0.0	0.0	0.5	0.0	**0.5**	**0.5**
8	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.2	0.0	**0.2**	**0.3**
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	**2.4**	**23.4**	**0.9**	**22.4**	**29.4**	**4.0**	**0.0**	**0.0**	**55.9**	**0.1**	**58.3**	**57.8**
Quarter: 3												
0	1.7	0.0	0.0	0.0	0.0	7.2	0.1	0.0	7.2	0.1	**8.9**	**7.3**
1	12.0	0.2	0.0	0.2	4.6	1.0	0.0	0.0	5.8	0.0	**17.8**	**5.8**
2	5.4	3.2	1.0	2.2	19.5	7.0	0.0	0.0	28.7	0.0	**34.1**	**30.8**
3	0.7	4.3	1.3	3.1	17.8	20.9	0.0	0.0	41.8	0.0	**42.5**	**44.3**
4	1.0	5.8	1.6	4.2	36.1	13.2	0.0	0.0	53.5	0.0	**54.5**	**56.7**
5	0.4	3.9	1.1	2.8	9.1	2.2	0.0	0.0	14.2	0.0	**14.6**	**16.3**
6	0.1	1.7	0.5	1.2	5.1	1.7	0.0	0.0	8.0	0.0	**8.1**	**8.9**
7	0.0	0.4	0.1	0.3	2.9	0.6	0.0	0.0	3.9	0.0	**3.9**	**4.1**
8	0.0	0.6	0.2	0.4	1.9	0.9	0.0	0.0	3.2	0.0	**3.2**	**3.6**
9+	0.0	0.1	0.0	0.1	0.4	0.0	0.0	0.0	0.5	0.0	**0.5**	**0.5**
Sum	**21.2**	**20.3**	**5.7**	**14.5**	**97.4**	**54.8**	**0.1**	**0.1**	**166.7**	**0.2**	**188.1**	**178.3**
Quarter: 4												
0	3.3	0.0	0.0	0.0	0.0	3.8	0.2	0.0	3.9	0.2	**7.3**	**4.0**
1	6.3	0.0	0.0	0.0	1.9	0.1	0.0	0.0	2.0	0.0	**8.4**	**2.0**
2	1.0	0.3	0.0	0.3	5.7	1.7	0.3	8.1	7.7	8.3	**17.0**	**16.0**
3	0.2	0.6	0.0	0.6	6.9	3.3	0.3	5.1	10.8	5.4	**16.4**	**16.2**
4	2.2	2.0	0.0	2.0	11.4	3.0	0.3	12.2	16.4	12.5	**31.0**	**28.8**
5	0.8	2.1	0.0	2.1	2.1	0.9	0.3	8.7	5.1	8.9	**14.8**	**14.0**
6	0.3	0.6	0.0	0.6	1.0	0.4	0.1	3.8	2.0	3.9	**6.2**	**5.9**
7	0.1	0.4	0.0	0.4	0.4	0.1	0.0	1.1	1.0	1.2	**2.2**	**2.1**
8	0.0	0.6	0.0	0.6	0.2	0.1	0.0	0.0	0.9	0.0	**0.9**	**0.9**
9+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	**0.0**
Sum	**14.1**	**6.6**	**0.0**	**6.6**	**29.5**	**13.6**	**1.4**	**38.9**	**49.7**	**40.3**	**104.2**	**90.1**

Table 2.2.5: North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2000. 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	17.0%	0.0%	0.0%	0.0%	0.1%	67.1%	19.6%	0.0%	33.4%	4.3%	25.8%	29.7%
1	70.7%	1.8%	0.0%	2.0%	10.2%	5.2%	12.4%	0.0%	6.8%	2.7%	27.2%	6.3%
2	8.3%	22.8%	21.7%	23.0%	25.1%	7.0%	25.2%	27.7%	15.9%	27.1%	14.3%	17.2%
3	1.6%	23.5%	25.9%	23.1%	20.9%	11.2%	13.7%	14.1%	16.3%	14.0%	11.4%	16.2%
4	1.6%	28.8%	27.2%	29.0%	31.6%	6.9%	18.2%	30.3%	19.0%	27.6%	14.0%	20.1%
5	0.5%	14.6%	15.0%	14.6%	6.8%	1.2%	6.7%	18.6%	4.9%	16.0%	4.3%	6.3%
6	0.2%	5.0%	6.6%	4.8%	3.1%	0.7%	3.0%	7.3%	2.1%	6.4%	1.8%	2.6%
7	0.0%	1.6%	1.6%	1.6%	1.3%	0.2%	1.3%	2.1%	0.8%	1.9%	0.6%	0.9%
8	0.0%	1.6%	1.8%	1.6%	0.7%	0.4%	0.0%	0.0%	0.6%	0.0%	0.4%	0.6%
9+	0.0%	0.2%	0.3%	0.2%	0.2%	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%	0.1%
Sum 3+	4.0%	75.3%	78.3%	74.9%	64.6%	20.7%	42.9%	72.3%	43.9%	65.8%	32.7%	46.8%
Quarter: 1												
0	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1	90.0%	0.1%	-	0.1%	0.0%	43.4%	17.6%	0.0%	11.5%	15.5%	76.8%	13.3%
2	7.2%	1.5%	-	1.5%	0.0%	18.3%	31.9%	19.6%	5.3%	30.4%	8.9%	16.8%
3	1.8%	24.6%	-	24.6%	17.4%	9.8%	15.5%	12.4%	17.3%	15.1%	4.3%	16.3%
4	0.5%	49.9%	-	49.9%	66.7%	18.7%	22.6%	25.2%	49.5%	22.9%	6.8%	37.3%
5	0.2%	21.6%	-	21.6%	10.5%	9.7%	6.9%	34.8%	13.3%	10.4%	2.3%	11.9%
6	0.2%	0.2%	-	0.2%	4.9%	0.0%	3.6%	6.8%	2.3%	3.9%	0.7%	3.1%
7	0.0%	0.0%	-	0.0%	0.0%	0.0%	1.8%	1.3%	0.0%	1.7%	0.2%	0.8%
8	0.0%	2.0%	-	2.0%	0.5%	0.0%	0.0%	0.0%	0.8%	0.0%	0.1%	0.4%
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+	2.7%	98.4%	-	98.4%	100.0%	38.3%	50.4%	80.4%	83.2%	54.1%	14.3%	69.9%
Quarter: 2												
0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1	93.4%	1.6%	0.0%	1.7%	6.8%	52.6%	10.7%	0.0%	12.9%	6.3%	26.1%	12.7%
2	2.1%	30.2%	15.1%	30.8%	30.7%	41.2%	27.8%	28.3%	32.5%	28.0%	27.5%	32.3%
3	4.4%	26.6%	40.4%	26.1%	25.6%	4.6%	14.7%	17.1%	22.1%	15.7%	19.2%	22.4%
4	0.0%	27.1%	29.0%	27.0%	26.3%	1.1%	23.8%	27.7%	22.2%	25.4%	18.5%	22.3%
5	0.0%	10.1%	10.8%	10.0%	7.1%	0.3%	16.7%	19.4%	7.0%	17.8%	5.9%	7.1%
6	0.0%	3.1%	3.4%	3.1%	2.5%	0.1%	4.7%	5.5%	2.3%	5.0%	2.0%	2.4%
7	0.0%	0.6%	0.7%	0.6%	0.6%	0.0%	1.6%	1.9%	0.5%	1.8%	0.4%	0.5%
8	0.0%	0.4%	0.4%	0.4%	0.2%	0.0%	0.0%	0.0%	0.3%	0.0%	0.2%	0.3%
9+	0.0%	0.2%	0.2%	0.2%	0.2%	0.0%	0.0%	0.0%	0.2%	0.0%	0.1%	0.2%
Sum 3+	4.4%	68.1%	84.9%	67.5%	62.6%	6.1%	61.5%	71.7%	54.6%	65.7%	46.4%	55.0%
Quarter: 3												
0	22.6%	0.1%	0.0%	0.1%	0.0%	68.7%	95.5%	0.0%	39.3%	85.5%	35.9%	38.6%
1	59.2%	2.5%	0.0%	3.4%	10.5%	2.2%	2.0%	0.0%	5.4%	1.7%	16.8%	5.3%
2	14.4%	20.2%	22.9%	19.1%	26.2%	5.1%	0.7%	27.8%	13.8%	3.6%	13.9%	13.9%
3	1.4%	22.3%	23.1%	22.0%	19.0%	13.6%	0.4%	15.9%	16.1%	2.0%	12.9%	16.2%
4	1.7%	27.3%	26.8%	27.5%	30.8%	7.7%	0.7%	29.4%	17.4%	3.8%	14.1%	17.6%
5	0.5%	16.2%	15.9%	16.3%	6.8%	1.1%	0.5%	18.0%	4.1%	2.3%	3.3%	4.3%
6	0.1%	7.3%	7.2%	7.4%	3.5%	0.8%	0.2%	7.0%	2.2%	0.9%	1.7%	2.3%
7	0.0%	1.8%	1.8%	1.8%	1.9%	0.3%	0.0%	1.9%	0.9%	0.2%	0.7%	1.0%
8	0.0%	2.1%	2.0%	2.1%	1.1%	0.5%	0.0%	0.0%	0.8%	0.0%	0.6%	0.8%
9+	0.0%	0.3%	0.3%	0.3%	0.2%	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%	0.1%
Sum 3+	3.7%	77.3%	77.1%	77.4%	63.3%	23.9%	1.8%	72.2%	41.6%	9.2%	33.5%	42.2%
Quarter: 4												
0	48.7%	0.0%	-	0.0%	0.3%	81.8%	56.7%	0.0%	46.9%	3.8%	37.0%	32.8%
1	40.7%	1.4%	-	1.4%	14.2%	0.4%	0.1%	0.0%	5.6%	0.0%	13.5%	3.8%
2	3.6%	6.6%	-	6.6%	20.6%	3.8%	11.9%	27.9%	10.2%	26.9%	12.5%	15.7%
3	0.6%	10.5%	-	10.5%	22.0%	6.3%	11.6%	14.1%	12.4%	13.9%	9.6%	12.9%
4	4.4%	30.2%	-	30.2%	33.6%	5.2%	10.0%	30.4%	17.2%	29.1%	16.7%	21.1%
5	1.3%	28.8%	-	28.8%	5.7%	1.4%	7.4%	18.1%	4.5%	17.4%	6.8%	8.7%
6	0.6%	9.4%	-	9.4%	2.3%	0.6%	2.1%	7.3%	1.7%	7.0%	2.7%	3.5%
7	0.1%	6.6%	-	6.6%	0.9%	0.2%	0.2%	2.1%	0.8%	2.0%	0.9%	1.2%
8	0.0%	6.4%	-	6.4%	0.4%	0.2%	0.0%	0.0%	0.6%	0.0%	0.3%	0.4%
9+	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Sum 3+	7.0%	92.0%	-	92.0%	64.9%	14.0%	31.4%	72.1%	37.3%	69.4%	37.0%	47.8%

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

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

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

1999	Fleet A		Fleet B		Fleet C		Fleet D		TOTAL	
Total Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	**Numbers**	**Mean Weight**
0	0.9	0.009	968.3	0.009	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 Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	**Numbers**	**Mean Weight**
0	14.3	0.017	858.3	0.013	63.1	0.022	173.1	0.021	**1,108.8**	**0.015**
1	93.5	0.077	91.0	0.035	485.4	0.041	498.9	0.016	**1,168.8**	**0.033**
2	486.7	0.127	19.0	0.074	105.8	0.078	9.8	0.056	**621.4**	**0.116**
3	470.4	0.160	4.9	0.130	21.4	0.108	0.5	0.127	**497.2**	**0.157**
4	587.2	0.180	3.0	0.140	19.8	0.164	3.0	0.158	**613.0**	**0.180**
5	183.0	0.200	0.7	0.112	7.5	0.191	0.1	0.168	**191.3**	**0.200**
6	77.7	0.219			2.9	0.183	0.3	0.189	**81.0**	**0.217**
7	27.8	0.244			0.3	0.212	0.3	0.170	**28.4**	**0.243**
8	16.1	0.272	1.3	0.199	0.1	0.198	0.0	0.177	**17.4**	**0.267**
9+	2.6	0.263							**2.6**	**0.263**
TOTAL	1,959.4		978.2		706.2		686.0		**4,329.9**	
SOP catch	**315.8**		**17.0**		**37.0**		**13.1**		**382.9**	

Table 2.2.7: Catch at age (numbers in millions) of herring caught in the North Sea, 1990-2000.

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**

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, 1990-2000.

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**

Table 2.2.9: Catch at age (numbers in millions) of North Sea Autumn Spawners taken in IIIa, and transfered to the assessement of North Sea Autumn Spawners, 1990 - 2000. Figures for 1999 were altered in 2001.

Year/WR	0	1	2	3	4	5	6	7	8	9+	Total
1990	398	1424	284								**2106**
1991	712	823	330								**1865**
1992	2408	1587	284	27	27	16	12	5	1		**4367**
1993	2911	2404	377								**5692**
1994	542	1240	305								**2087**
1995	1723	1070	126								**2919**
1996	632	870	159	32							**1692**
1997	94	352	211	71	12	6	2	1	1		**749**
1998	50	708	157	26	19	3	3	1	0	0	**967**
1999	596	249	147	52	13	6	1	0	0	0	**1066**
2000	236	984	116	22	23	8	3	1	0	0	**1392**

Table 2.2.10: Catch at age (numbers in millions) of the total North Sea Autumn Spawning stock as used for the assessment, 1990 - 2000. Figures for 1999 were altered in 2001.

Year/WR	0	1	2	3	4	5	6	7	8	9+	Total
1990	1286	2982	888	769	850	383	79	54	29	12	**7331**
1991	2370	2124	1125	553	545	498	204	39	25	13	**7496**
1992	10281	2292	1279	441	360	359	374	152	39	23	**15598**
1993	10165	3789	1165	603	303	214	224	186	86	41	**16776**
1994	4377	1737	1735	476	338	106	89	74	68	45	**9045**
1995	8518	1653	1590	908	245	122	56	41	54	73	**13259**
1996	2428	1608	708	629	196	59	20	11	8	18	**5685**
1997	457	527	680	496	258	94	25	12	10	9	**2568**
1998	258	959	1214	525	276	161	85	16	10	10	**3514**
1999	1565	330	647	1077	298	138	69	27	9	3	**4164**
2000	1109	1169	613	487	603	186	79	28	17	2	**4292**

Table 2.2.11: Comparison of mean weights (kg) at age in the catch of adult herring in the North Sea in 1990 - 2000, and North Sea Autumn Spawners caught in Div IIIa in 1997-2000.

		Age (Winter Rings)							
Div.	**Year**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9+**
IIIa*	1997	0.071	0.129	0.167	0.182	0.191	0.194	0.202	-
	1998	0.080	0.118	0.163	0.179	0.196	0.179	0.226	-
	1999	0.076	0.109	0.163	0.190	0.184	0.189	0.198	-
	2000	0.076	0.109	0.163	0.190	0.184	0.190	0.198	-
IVa	1990	0.123	0.154	0.177	0.194	0.229	0.234	0.251	0.295
	1991	0.146	0.164	0.181	0.198	0.214	0.231	0.263	0.275
	1992	0.149	0.184	0.189	0.208	0.223	0.240	0.243	0.285
	1993	0.133	0.156	0.193	0.210	0.234	0.249	0.268	0.319
	1994	0.135	0.171	0.201	0.223	0.246	0.258	0.278	0.295
	1995	0.142	0.172	0.208	0.220	0.260	0.253	0.284	0.290
	1996	0.133	0.162	0.200	0.213	0.239	0.253	0.254	0.291
	1997	0.126	0.159	0.197	0.234	0.241	0.245	0.232	0.304
	1998	0.125	0.161	0.192	0.226	0.242	0.254	0.274	0.291
	1999	0.125	0.156	0.180	0.212	0.235	0.249	0.253	0.291
	2000	0.129	0.156	0.184	0.204	0.224	0.254	0.283	0.263
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
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
IVb	1990	0.102	0.145	0.194	0.219	0.250	0.272	0.259	0.277
	1991	0.119	0.173	0.196	0.220	0.225	0.277	0.257	0.263
	1992	0.081	0.179	0.198	0.213	0.232	0.255	0.272	0.313
	1993	0.102	0.146	0.199	0.220	0.236	0.261	0.275	0.306
	1994	0.122	0.150	0.177	0.205	0.237	0.251	0.255	0.245
	1995	0.135	0.174	0.197	0.205	0.261	0.266	0.272	0.282
	1996	0.106	0.178	0.213	0.238	0.243	0.268	0.270	0.263
	1997	0.122	0.153	0.201	0.228	0.245	0.227	0.270	0.296
	1998	0.116	0.151	0.182	0.218	0.230	0.220	0.299	0.277
	1999	0.120	0.152	0.154	0.214	0.227	0.205	0.286	0.345
	2000	0.125	0.173	0.191	0.220	0.232	0.258	0.222	0.268
IVa & IVb	1990	0.113	0.152	0.181	0.198	0.232	0.238	0.252	0.290
	1991	0.131	0.167	0.184	0.203	0.217	0.239	0.262	0.272
	1992	0.100	0.183	0.191	0.209	0.224	0.243	0.250	0.290
	1993	0.116	0.152	0.195	0.212	0.234	0.251	0.269	0.317
	1994	0.131	0.164	0.192	0.218	0.245	0.258	0.277	0.292
	1995	0.140	0.173	0.205	0.216	0.260	0.256	0.283	0.289
	1996	0.126	0.165	0.203	0.219	0.240	0.258	0.259	0.281
	1997	0.125	0.157	0.198	0.232	0.243	0.236	0.236	0.302
	1998	0.122	0.159	0.191	0.224	0.241	0.250	0.275	0.290
	1999	0.123	0.155	0.177	0.213	0.233	0.247	0.262	0.291
	2000	0.128	0.162	0.185	0.206	0.225	0.254	0.267	0.263
IVc & VIId	1990	0.118	0.131	0.152	0.171	0.195	0.216	0.208	0.231
	1991	0.123	0.165	0.184	0.200	0.212	0.196	0.237	0.161
	1992	0.100	0.183	0.191	0.209	0.224	0.243	0.250	0.290
	1993	0.113	0.139	0.152	0.174	0.182	0.191	0.211	0.216
	1994	0.117	0.145	0.172	0.191	0.209	0.224	0.229	0.218
	1995	0.114	0.130	0.161	0.177	0.203	0.208	0.184	0.241
	1996	0.118	0.140	0.154	0.178	0.181	0.201	0.186	0.250
	1997	0.099	0.133	0.159	0.180	0.156	0.193	0.165	0.158
	1998	0.125	0.161	0.192	0.226	0.242	0.254	0.274	0.291
	1999	0.113	0.142	0.155	0.188	0.209	0.214	-	-
	2000	0.109	0.137	0.154	0.185	0.202	0.209	-	-
Total North Sea Catch	1990	0.114	0.149	0.177	0.193	0.229	0.236	0.250	0.287
	1991	0.130	0.166	0.184	0.203	0.217	0.235	0.259	0.271
	1992	0.103	0.175	0.189	0.207	0.223	0.237	0.249	0.287
	1993	0.115	0.145	0.189	0.204	0.228	0.244	0.256	0.310
	1994	0.130	0.159	0.181	0.214	0.240	0.255	0.273	0.281
	1995	0.136	0.167	0.196	0.200	0.247	0.249	0.278	0.287
	1996	0.123	0.160	0.192	0.207	0.211	0.252	0.255	0.281
	1997	0.115	0.147	0.192	0.228	0.230	0.228	0.224	0.297
	1998	0.118	0.146	0.183	0.220	0.237	0.250	0.275	0.286
	1999	0.122	0.153	0.169	0.207	0.233	0.243	0.262	0.291
	2000	0.125	0.160	0.180	0.200	0.219	0.244	0.267	0.263

*Figure for 1999 altered in 2001

Table 2.2.12 Sampling of commercial landings of Herring in the North Sea (Div. IV and VIId) in 2000 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)	Quarte	Sampled Catch	Landings (t)	No. of samples	No. of fish measured	No. of fish aged	No. of metiers	lo. of metiers sampled
Denmark (A)	1	86%	7332	2	461	98	3	2
Denmark (A)	2	0%	1467	0	0	0	3	0
Denmark (A)	3	0%	14214	0	0	0	3	0
Denmark (A)	4	59%	23375	4	815	223	3	1
	total	**43%**	**46388**	**6**	**1276**	**321**	**12**	**3**
Denmark (B)	1	47%	1090	7	44	43	4	2
Denmark (B)	2	100%	1350	19	86	55	3	3
Denmark (B)	3	94%	8132	22	1248	702	4	1
Denmark (B)	4	97%	7163	17	216	190	4	2
	total	**93%**	**17735**	**65**	**1594**	**990**	**15**	**8**
Faroe Isl	4	0%	915	0	0	0	2	0
	total	**0%**	**915**	**0**	**0**	**0**	**2**	**0**
France	1	0%	832	0	0	0	2	0
France	2	0%	40	0	0	0	3	0
France	3	0%	11663	0	0	0	4	0
France	4	0%	8417	0	0	0	4	0
	total	**0%**	**20952**	**0**	**0**	**0**	**13**	**0**
Germany	2	0%	1038	0	0	0	2	0
Germany	3	0%	18406	0	0	0	2	0
Germany	4	0%	7243	0	0	0	1	0
	total	**0%**	**26687**	**0**	**0**	**0**	**5**	**0**
Netherlands	1	100%	3723	8	1713	200	2	2
Netherlands	2	100%	2436	12	2570	300	3	3
Netherlands	3	100%	27915	33	4836	825	2	2
Netherlands	4	100%	20268	11	1795	275	2	2
	total	**100%**	**54342**	**64**	**10914**	**1600**	**9**	**9**
Norway	1	0%	137	0	0	0	1	0
Norway	2	99%	37894	26	2589	2547	3	2
Norway	3	100%	22039	6	698	682	2	2
Norway	4	100%	12774	2	200	197	2	2
	total	**99%**	**72844**	**34**	**3487**	**3426**	**8**	**6**
Sweden	2	0%	965	0	0	0	3	0
Sweden	3	0%	879	0	0	0	3	0
Sweden	4	0%	1202	0	0	0	3	0
	total	**0%**	**3046**	**0**	**0**	**0**	**9**	**0**
UK (England and Wa	1	0%	62	0	0	0	2	0
UK (England and Wa	2	0%	14	0	0	0	2	0
UK (England and Wa	3	0%	9532	0	0	0	4	0
UK (England and Wa	4	0%	1571	0	0	0	2	0
	total	**0%**	**11179**	**0**	**0**	**0**	**10**	**0**
UK (Northern Ireland)	3	0%	996	0	0	0	1	0
	total	**0%**	**996**	**0**	**0**	**0**	**1**	**0**
UK (Scotland)	2	96%	2221	14	3096	731	2	1
UK (Scotland)	3	100%	26430	112	20182	4402	2	2
UK (Scotland)	4	100%	1382	4	363	93	1	1
	total	**100%**	**30033**	**130**	**23641**	**5226**	**5**	**4**
Period Total	**1**	**100%**	**13176**	**18**	**2219**	**342**	**14**	**6**
Period Total	**2**	**100%**	**47425**	**82**	**9117**	**3863**	**24**	**9**
Period Total	**3**	**91%**	**140206**	**175**	**26966**	**6613**	**27**	**7**
Period Total	**4**	**86%**	**84310**	**39**	**3390**	**979**	**25**	**8**
Total for Stock	**total**	**97%**	**285117**	**314**	**41692**	**11797**	**90**	**30**
Human cons only	**total**	**98%**	**267382**	**249**	**40098**	**10807**	**79**	**22**

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	1443
1983	1985	2083
1984	1986	2543
1985	1987	3684
1986	1988	4530
1987	1989	2313
1988	1990	1016
1989	1991	1159
1990	1992	1162
1991	1993	2943
1992	1994	1667
1993	1995	1186
1994	1996	1735
1995	1997	4069
1996	1998	2067
1997	1999	715
1998	2000	3632
1999	2001	2674

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

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	1443	330.25	0.23	278.5	0.19	0.21
1983	1985	2083	295.46	0.14	276.2	0.13	0.13
1984	1986	2543	585.93	0.23	372.45	0.15	0.41
1985	1987	3684	640.27	0.17	526.85	0.14	0.23
1986	1988	4530	2365.73	0.52	697.49	0.15	0.72
1987	1989	2313	548.79	0.24	488.36	0.21	0.17
1988	1990	1016	69.01	0.07	60.07	0.06	0.19
1989	1991	1159	299.97	0.26	305.38	0.26	0.05
1990	1992	1162	120.9	0.10	125.44	0.11	0.03
1991	1993	2943	754.89	0.26	163.09	0.06	0.8
1992	1994	1667	266.99	0.16	224.91	0.13	0.21
1993	1995	1186	386.34	0.33	379.98	0.32	0.08
1994	1996	1735	537.1	0.31	408.92	0.24	0.29
1995	1997	4069	1179.9	0.29	932.95	0.23	0.26
1996	1998	2067	1168.12	0.57	1231.57	0.60	0.02
1997	1999	715	141.15	0.20	138.77	0.19	0.08
1998	2000	3632	1062.18	0.29	936.11	0.26	0.18
1999	2001	2674	322.57	0.12	302.19	0.11	0.06

Table 2.3.4. North Sea Herring. Calculated density (no m-2) of Downs herring larvae. Means within rectangles and as mean of all sampled rectangles. Year classes 1990 to 2000.

YC Rectangle	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
31F1			0.8	0.8			0	0.2	0.2		14.1
31F2		1.2	3.4	2				0	1.9	0	20.1
32F1			0	0.6		0	0		0	0.5	44
32F2	3.3	0	0	1.5	5.2	5.7	0	0.1	4.2	0.3	22.5
32F3	1.3	0	0	0.9	9.1	0	0	0	4.5	0	29.1
33F1			0				0	0	0	0	0.2
33F2	0	0	0	0.7	13.5	2.4	0	0	0	0.9	0
33F3	0.8	0		0.6	23.5	2.7	0	0.1	2.3	0	10.9
33F4	0			0	4.7	0.1	0	0.1	0.2	0	0
34F1	0		0		0		0	0	0		
34F2	0	0	0	0	0	0		0	0	0	0.5
34F3	0	0	0	1.7	4.5	0	0	0	1.7	0	1.9
34F4	0.2	0	0	4.9	0.5	0	0	0	0	0	154.1
35F0	0	0		0	0		0	0		0	0
35F1	0	0	0	0	0		0	0		0	0
35F2	0	0	0	0	0	0	0	0	0	0	0
35F3		0	0	0.9	0	0	0	0	0	0	1.1
35F4		0	1.6	0	3.3	0	0	0	3.7	0	24.4
Mean	0.5	0.1	0.4	0.9	4.6	0.9	0.0	0.0	1.2	0.1	19.0

Table 2.4.1 Numbers (millions) of North Sea herring at age and maturity by ICES sub-area.

ICES A	IIIa	IVa	IVb
0	78.96	45.99	7445.61
1	7738.63	6673.01	10102.50
2i	77.34	443.23	434.58
2m	77.34	1505.11	235.73
3i	1.32	14.52	71.33
3m	7.46	1736.32	164.91
4	6.34	2815.74	48.88
5	0.00	867.93	55.60
6	0.00	411.67	31.16
7	0.00	233.47	10.39
8	0.00	92.65	18.84
9+	0.00	55.55	36.38
Immature	7896.25	7176.75	18054.01
Mature	91.15	7718.45	601.90
Total	7987.39	14895.20	18655.91

Table 2.4.2 Biomass (thousands of tonnes) of North Sea herring at age and maturity by ICES sub-area

ICES A	IIIa	IVa	IVb
0	0.83	0.63	37.78
1	340.19	361.71	437.73
2i	6.13	38.88	37.98
2m	6.13	209.57	27.42
3i	0.16	1.51	6.83
3m	0.90	326.71	24.08
4	0.78	618.63	7.23
5	0.00	205.49	8.93
6	0.00	110.12	5.24
7	0.00	69.86	2.08
8	0.00	29.78	3.70
9+	0.00	18.11	7.66
Immature	346.47	402.10	482.53
Mature	7.81	1588.28	86.34
Total	355.11	1991.00	606.65

Table 2.4.3 Mean weight (g) of North Sea herring at age and maturity by ICES sub-area

ICES A	IIIa	IVa	IVb
0	10.5	13.7	5.1
1	44.0	54.2	43.3
2i	79.2	87.7	87.4
2m	79.2	139.2	116.3
3i	120.8	104.1	95.7
3m	120.8	188.2	146.0
4	123.7	219.7	147.8
5		236.8	160.6
6		267.5	168.3
7		299.2	200.3
8		321.4	196.2
9+		326.1	210.6
Mean (i)	81.3	82.0	75.5
Mean (m)	107.9	249.8	168.3
Mean (all)	82.6	188.1	131.5

Table 2.4.4 Total numbers (millions) and biomass (thousands of tonnes) of North Sea autumn spawning herring in the area surveyed in the acoustic surveys July 2000, with mean weights (g) and fraction mature by winter ring.

North Sea	Numbers	Biomass	Maturity	mean weight
	(millions)	Tonnes $*10^3$	(fraction)	(g)
0	7570.6	39.2	0.00	5
1	24514.1	1139.6	0.00	46
2	2773.3	326.1	0.66	118
3	1995.9	360.2	0.96	180
4	2871.0	626.6	1.00	218
5	923.5	214.4	1.00	232
6	442.8	115.4	1.00	261
7	243.9	71.9	1.00	295
8	111.5	33.5	1.00	300
9+	91.9	25.8	1.00	280
Immature	33127.0	1231.1		
Mature	8411.5	1682.4		
Total	41538.5	2952.8		

Table 2.4.5 Estimates of North Sea autumn spawners (millions) at age from acoustic surveys, and SSB (thousands of tonnes) 1984-2000. 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.

							Numbers (millions)										
Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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	6,542	24,514
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	2,945	2,773
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	4,364	1,996
4	394	323	833	657	528	1,612	3,370	2,102	1,397	909	429	656	1,087	1,696	1,625	1,036	2,871
5	158	113	135	368	349	488	1,349	1,984	1,510	795	363	272	311.0	692.1	982.4	470.1	923.5
6	44	41	36	77	174	281	395	748	1,311	788	321	175	98.7	259.2	445.2	289.5	442.8
7	52	17	24	38	43	120	211	262	474	546	238	135	82.8	78.6	170.3	128.9	243.9
8	39	23	6	11	23	44	134	112	155	178	220	110	132.9	78.3	45.2	51.6	111.5
9+	41	19	8	20	14	22	43	56	163	116	132	84	206.0	158.3	121.4	82.7	91.9
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	15,910	35,521
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
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
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	1,501	1,682

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

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

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	38	145.2	3.82	7.923	0.0001
Error	208	100.4	0.4824		
C Total	246	245.6			

b) Estimates of parameters

Reference Mean

Estimate	Standard Error	
6.825288	0.5648	Reference: 1972 Orkney/Shetland 09/01 – 09/15

Year Effects

Year	Estimate	Standard Error	Year	Estimate	Standard Error
1973	0.3722	0.7022	1987	2.0285	0.6188
1974	-0.1398	0.7522	1988	2.7176	0.6069
1975	-1.2162	0.7645	1989	2.6830	0.6210
1976	-1.3219	0.7503	1990	2.9212	0.6441
1977	-0.4166	0.7193	1991	2.2750	0.6981
1978	-0.2249	0.7301	1992	1.5158	0.7377
1979	0.5006	0.7029	1993	1.1915	0.7143
1980	0.1194	0.6997	1994	0.8074	0.7525
1981	0.5309	0.6969	1995	0.9557	0.7525
1982	0.8598	0.6321	1996	1.6460	0.7818
1983	1.1144	0.6482	1997	1.8660	0.7333
1984	1.7082	0.6294	1998	2.1697	0.6893
1985	2.1319	0.6072	1999	1.9953	0.6934
1986	1.4694	0.6072	2000	1.4531	0.7091

Sampling Unit Effects

Sampling Unit	Estimate	Standard Error
Or/Shet 16-30 Sep	-0.6843	0.3390
Buchan 01-15 Sep	-1.8179	0.4274
Buchan 16-30 Sep	-2.5036	0.3772
CNS 01-15 Sep	-1.6537	0.4137
CNS 16-30 Sep	-1.4510	0.3724
CNS 01-15 Oct	-2.0958	0.3964
CNS 16-31 Oct	-4.1678	0.5380
SNS 12-31 Dec	-1.8170	0.4068
SNS 01-15 Jan	-2.5230	0.3462
SNS 16-31 Jan	-3.7836	0.3954

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

Reference: **6.825288** (Orkney/Shetland, 1st-15th September 1972)

Year	**MLAI**	MLAIrefer	un-logged	unlogged/100
1973	0.3722	7.1975	1336.1	13.4
1974	-0.1398	6.6855	800.7	8.0
1975	-1.2162	5.6091	272.9	2.7
1976	-1.3219	5.5034	245.5	2.5
1977	-0.4166	6.4087	607.1	6.1
1978	-0.2249	6.6004	735.4	7.4
1979	0.5006	7.3259	1519.1	15.2
1980	0.1194	6.9447	1037.6	10.4
1981	0.5309	7.3562	1565.9	15.7
1982	0.8598	7.6850	2175.6	21.8
1983	1.1144	7.9397	2806.5	28.1
1984	1.7082	8.5335	5082.0	50.8
1985	2.1319	8.9572	7763.6	77.6
1986	1.4694	8.2947	4002.5	40.0
1987	2.0285	8.8538	7001.0	70.0
1988	2.7176	9.5429	13945.0	139.5
1989	2.6830	9.5083	13471.2	134.7
1990	2.9212	9.7465	17094.2	170.9
1991	2.2750	9.1003	8957.6	89.6
1992	1.5158	8.3411	4192.8	41.9
1993	1.1910	8.0163	3030.1	30.3
1994	0.8074	7.6327	2064.6	20.6
1995	0.9557	7.7810	2394.7	23.9
1996	1.6460	8.4713	4775.6	47.8
1997	1.8659	8.6912	5950.5	59.5
1998	2.1697	8.9950	8062.8	80.6
1999	1.9953	8.8206	6772.0	67.7
2000	1.4531	8.2784	3937.8	39.4

Table 2.6.1 Ist Quarter IBTS index for North Sea herring
All values for 2000 revised from preliminary values provided in 2000
All values for 2001 are preliminary values

	Age (ring)			
Year	2	3	4	5+
1983	128	43	14	27
1984	158	62	28	10
1985	695	280	44	29
1986	762	269	78	27
1987	880	115	59	50
1988	4393	851	61	26
1989	868	373	104	10
1990	448	291	272	72
1991	763	268	240	162
1992	380	181	64	102
1993	782	209	44	64
1994	1094	199	64	40
1995	1174	233	31	6
1996	194	43	13	9
1997	490	190	40	23
1998	743	90	20	19
1999	425	509	101	38
2000*	216	157	61	9
2001	1142	322	98	71

Table 2.6.2.a. IBTS 2000, 1st quarter. North Sea Herring. Final estimates of mean Number per Hour per Haul per Statistical Rectangle by Age Group and Area.

Standard Area and Sampling Area	Number per Hour per Haul	Number per Hour per Haul / Mean per Statistical Rectangle / Age Group						
	TOTAL	1	2	3	4	5	6	Unknown
TOTAL	647982	3638.9	215.9	157.4	60.9	9.0	0.0	0.0
Standard Area	365204	6337.3	270.0	66.6	29.2	5.3	0.0	0.0
Not Standard Area	282777	2230.5	187.6	204.8	77.4	11.0	0.0	0.0
RF1	30771	5.8	261.1	326.6	151.2	15.1	0.0	0.0
RF2	158515	5813.9	458.6	62.4	4.1	1.7	0.0	0.0
RF3	13460	721.0	12.5	4.7	1.8	0.8	0.0	0.0
RF4	15519	745.8	228.8	314.5	152.6	28.0	0.0	0.0
RF5	14765	424.6	370.0	632.1	169.5	42.5	0.0	0.0
RF6	142311	4395.9	146.8	33.8	8.5	2.7	0.0	0.0
RF7	64563	4723.2	127.5	3.4	0.0	0.2	0.0	0.0
RF8	83894	13067.6	0.0	0.0	0.0	0.0	0.0	0.0
RF9	124182	26088.7	0.0	0.0	0.0	0.0	0.0	0.0
Not RF	*	*	*	*	*	*	*	*

Table 2.6.2.b. IBTS 2001, 1st quarter. North Sea Herring. Preliminary estimates Mean Number per Hour per Haul per Statistical Rectangle by Age Group and Area.

Standard Area and Sampling Area	Number per Hour per Haul	Number per Hour per Haul / Mean per Statistical Rectangle / Age Group						
	TOTAL	1	2	3	4	5	6	Unknown
TOTAL	683678	2674.1	1141.9	322.0	98.0	70.9	0.0	0.0
Standard Area	280217	3830.7	1150.7	158.3	4.6	3.1	0.0	0.0
Not Standard Area	403461	2070.4	1137.4	407.4	146.7	106.4	0.0	0.0
RF1	107603	13.2	1865.5	345.1	240.8	192.3	0.0	0.0
RF2	24365	402.6	540.0	23.4	7.7	0.7	0.0	0.0
RF3	33710	429.7	1326.8	46.0	41.5	11.2	0.0	0.0
RF4	8440	688.2	100.2	7.9	2.1	0.9	0.0	0.0
RF5	6008	582.8	18.0	45.7	15.1	5.2	0.0	0.0
RF6	259875	5050.1	1948.1	1125.3	151.3	102.9	0.0	0.0
RF7	45971	2947.7	485.4	23.3	0.0	0.1	0.0	0.0
RF8	82818	12900.0	0.0	0.0	0.0	0.0	0.0	0.0
RF9	114888	24136.2	0.0	0.0	0.0	0.0	0.0	0.0
Not RF	*	*	*	*	*	*	*	*

Table 2.6.2.c. IBTS 2001, 1st quarter. North Sea herring <13cm, Preliminary estimates of mean Number per Hour per Haul per Statistical Rectangle by Age Group and Area.

Standard Area and Sampling Area	Number per Hour per Haul	Number per Hour per Haul – Mean per Statistical Rectangle – Age Group						
	TOTAL	1	2	3	4	5	6	Unknown
TOTAL	51931	384.4	3.9	0.0	0.0	0.0	0.0	0.0
Standard Area	41698	971.7	10.8	0.0	0.0	0.0	0.0	0.0
Not Standard Area	10233	111.4	0.6	0.0	0.0	0.0	0.0	0.0
RF1	2	0.1	0.0	0.0	0.0	0.0	0.0	0.0
RF2	*	*	*	*	*	*	*	*
RF3	1191	65.6	0.0	0.0	0.0	0.0	0.0	0.0
RF4	364	34.4	0.0	0.0	0.0	0.0	0.0	0.0
RF5	403	44.8	0.0	0.0	0.0	0.0	0.0	0.0
RF6	38996	1240.4	16.7	0.0	0.0	0.0	0.0	0.0
RF7	4192	315.2	0.0	0.0	0.0	0.0	0.0	0.0
RF8	3708	577.5	0.0	0.0	0.0	0.0	0.0	0.0
RF9	3075	646.1	0.0	0.0	0.0	0.0	0.0	0.0
Not RF	*	*	*	*	*	*	*	*

Table 2.7.1: Herring in the North Sea: Mean weight at age in the third quarter, in Division IVa and IVb.
(Weight at age in the stock from the July acoustic survey 1995 to 1999 revised see Table 2.7.2)

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)	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	73	51	53	55	52	10	38	42	58	54	65	78	69	60	58	45	45	52	52	46
2	164	127	145	131	151	126	125	132	139	125	158	142	115	138	132	119	120	109	118	118
3	189	200	161	164	190	165	157	172	165	169	198	209	147	209	180	196	168	198	171	180
4	210	215	179	192	221	203	198	208	195	199	224	219	202	220	200	253	233	238	207	218
5	229	235	199	218	231	219	232	240	230	226	236	243	225	251	195	262	256	275	236	232
6	246	252	221	245	277	240	243	262	251	239	260	255	277	289	228	299	245	307	267	261
7	276	276	239	258	276	258	236	270	263	267	275	272	286	315	257	306	265	289	272	295
8	296	286	240	277	316	259	236	288	279	274	298	312	305	323	302	325	269	308	230	300
9+	293	330	283	292	316	281	302	315	292	270	317	311	340	346	324	335	329	363	260	280

Table 2.7.2 North Sea Herring. Percentage correction in mean weight at age follwing revision of acoustic surveys

Age	% change in mean wt				
(WR)	1995	1996	1997	1998	1999
1	0.0%	3.4%	3.9%	9.7%	33.2%
2	0.0%	0.7%	1.5%	12.8%	37.3%
3	0.0%	-0.2%	1.2%	1.1%	0.1%
4	0.0%	-0.1%	2.6%	0.5%	0.0%
5	0.0%	0.0%	8.7%	0.0%	0.0%
6	0.0%	0.1%	2.6%	0.0%	0.0%
7	0.0%	0.3%	7.8%	0.0%	0.0%
8	0.0%	0.3%	0.0%	0.0%	0.0%
9+	0.0%	0.0%	0.0%	0.0%	0.0%

Table 2.7.3 North Sea Herring. Maturity at age 2, 3 and 4+ for Autumn Spawning herring in the North Sea (1996–1999 revised only 2 ring 1997/8 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

Table 2.8.1. North Sea herring. Input parameters of the final ICA assessments for the years 1998-2001.

Assessment year			**2001**	**2000**	**1999**	**1998**
First data year			1960	1960	1960	1960
Last data year			2000	1999	1998	1997
No of years for separable constraint ?			**4**	8	7	6
Reference age for separable constraint			4	4	4	4
Constant selection pattern model (Y/N)			**yes**	s1 (92-96), s2(97-99)-constrained	s1 (92-96), s2(97-98)-constrained	s1 (92-95), s2(96-97)-constrained
S to be fixed on last age			1.0	1 / 1	1 / 1	1 / 1
First age for calculation of reference F			2	2	2	2
Last age for calculation of reference F			6	6	6	6
Shrink the final populations			no	no	no	no
Tuning indices	*survey*	*age*				
Year ranges for survey indices	MLAI		1979-2000	1979-1999	79-98	77-96
	Acoustic survey	2-9+	1989-2000	1989-1999	89-98	89-97
	IBTSA	2-5+	1983-2001	1983-2000	83-99	83-98
	IBTSY	1	1979-2001	1979-2000	79-99	79-98
	MIK	0	1977-2001	1977-2000	77-99	77-98
Catchability models	MLAI		power	power	power	power
	Acoustic survey	2-9+	linear	linear	linear	linear
	IBTSA	2-5+	linear	linear	linear	linear
	IBTSY	1	linear	linear	linear	linear
	MIK	0	linear	linear	linear	linear
Model weighting						
Relative weights in catch at age matrix			all 1	all 1	all 1	all 1
Total weight catch at age matrix			**36**	72	63	54
Survey indices weights	MLAI		1.0	1.0	1.0	1.0
	Acoustic survey	2	0.125	0.125	0.125	0.125
	Acoustic survey	3	0.125	0.125	0.125	0.125
	Acoustic survey	4	0.125	0.125	0.125	0.125
	Acoustic survey	5	0.125	0.125	0.125	0.125
	Acoustic survey	6	0.125	0.125	0.125	0.125
	Acoustic survey	7	0.125	0.125	0.125	0.125
	Acoustic survey	8	0.125	0.125	0.125	0.125
	Acoustic survey	9+	0.125	0.125	0.125	0.125
	IBTSA	2	0.25	0.25	0.25	0.25
	IBTSA	3	0.25	0.25	0.25	0.25
	IBTSA	4	0.25	0.25	0.25	0.25
	IBTSA	5+	0.25	0.25	0.25	0.25
	IBTSY	1	1.0	1.0	1.0	1.0
	MIK	0	1.0	1.0	1.0	1.0
Stock recruitment weight			0.1	0.1	0.1	0.1
Parameters to be estimated			**42**	57	55	53
Number of observations			324	338	313	289

Table 2.8.2 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 2001  used for the year 2000
west
 Natural mortality in 2001  used for the year 2000
natmor
 Maturity ogive in 2001  used for the year 2000
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 ?--> 4
 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) ?-->y
 Is the last age of Acoustic survey 2-9+ wr         Acoustic 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.

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

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

 Model for   MLAI  is to be A/L/P ?-->p
 Model for Acoustic survey 2-9+ wr         Acoustic  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       138.6444803394
    0.10        74.3121264232
    0.15        46.8617695554
    0.20        33.6023596539
    0.25        26.8222586918
    0.30        23.2974541734
    0.35        21.5344828341
    0.40        20.7870061301
    0.45        20.6575795043
    0.50        20.9225708511
    0.55        21.4499424781
    0.60        22.1584187557
    0.65        22.9961640613
    0.70        23.9291713363
    0.75        24.9346993595
    0.80        25.9974078637
    0.85        27.1070692177
    0.90        28.2571390944
    0.95        29.4439671202
    1.00        30.6663446127
Lowest SSQ is for F =     0.439
-------------------------------------------------------------
No of years for separable analysis : 4
Age range in the analysis : 0  . . . 9
Year range in the analysis : 1960  . . . 2000
Number of indices of SSB : 1
Number of age-structured indices : 4
Stock-recruit relationship to be fitted.
Parameters to estimate : 42
Number of observations : 324
Conventional single selection vector model to be fitted.
```

Table 2.8.2 (continued)

```
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for   MLAI-->    1.000000000000000
 Enter weight for Acoustic survey 2-9+ wr         Acoustic  at age 2-->    1.000000000000000
 Enter weight for Acoustic survey 2-9+ wr         Acoustic  at age 3-->    1.000000000000000
 Enter weight for Acoustic survey 2-9+ wr         Acoustic  at age 4-->    1.000000000000000
 Enter weight for Acoustic survey 2-9+ wr         Acoustic  at age 5-->    1.000000000000000
 Enter weight for Acoustic survey 2-9+ wr         Acoustic  at age 6-->    1.000000000000000
 Enter weight for Acoustic survey 2-9+ wr         Acoustic  at age 7-->    1.000000000000000
 Enter weight for Acoustic survey 2-9+ wr         Acoustic  at age 8-->    1.000000000000000
 Enter weight for Acoustic survey 2-9+ wr         Acoustic  at age 9-->    1.000000000000000
 Enter weight for IBTSA: 2-5+ wr  at age 2-->    1.000000000000000
 Enter weight for IBTSA: 2-5+ wr  at age 3-->    1.000000000000000
 Enter weight for IBTSA: 2-5+ wr  at age 4-->    1.000000000000000
 Enter weight for IBTSA: 2-5+ wr  at age 5-->    1.000000000000000
 Enter weight for IBTSY 1-wr  at age 1-->    1.000000000000000
 Enter weight for MIK 0-wr  at age 0-->    1.000000000000000
 Enter weight for stock-recruit model-->    0.100000000000000
Enter estimates of the extent to which errors
in the age-structured indices are correlated
across ages. This can be in the range 0 (independence)
to 1 (correlated errors).
  Enter value for Acoustic survey 2-9+ wr         Acoustic-->    1.000000000000000
  Enter value for IBTSA: 2-5+ wr-->    1.000000000000000
  Enter value for IBTSY 1-wr-->    1.000000000000000
  Enter value for MIK 0-wr-->    1.000000000000000
 Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.
SSB index weights
  1.000
Aged index weights
Acoustic survey 2-9+ wr         Acoustic
 Age   :       2     3     4     5     6     7     8     9
 Wts :     0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125
IBTSA: 2-5+ wr
 Age   :       2     3     4     5
 Wts :     0.250 0.250 0.250 0.250
IBTSY 1-wr
 Age   :       1
 Wts :     1.000
MIK 0-wr
 Age   :       0
 Wts :     1.000
 Stock-recruit weight           0.100
F in 2000  at age 4  is 0.430632  in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->D
 Output page width in characters (e.g. 80..132) ?--> 450
 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 2.8.3 North Sea herring. Catch number at age (millions).

```
Output Generated by ICA Version 1.4
------------------------------------
Herring IV VIId IIIa (run: I02)
----------------------------------------
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.

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

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

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

x 10 ^ 6

Table 2.8.4 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
0	0.01000	0.00600	0.00900	0.01600	0.01600	0.02000	0.00900	0.01500
1	0.03300	0.05600	0.04800	0.01000	0.03200	0.04900	0.04700	0.03300
2	0.11500	0.13000	0.13600	0.12300	0.10400	0.11300	0.11400	0.11600
3	0.14500	0.15900	0.16700	0.16000	0.14600	0.14400	0.15100	0.15700
4	0.18900	0.18100	0.19600	0.19200	0.19400	0.18200	0.16800	0.18000
5	0.20400	0.21400	0.20000	0.20700	0.22800	0.22000	0.20500	0.19900
6	0.22800	0.24000	0.24700	0.21100	0.22900	0.23600	0.23200	0.21800
7	0.24400	0.25500	0.24900	0.25200	0.22800	0.24500	0.24300	0.24400
8	0.25600	0.27300	0.27800	0.25400	0.22600	0.27300	0.26000	0.26700
9	0.31000	0.28100	0.28700	0.28100	0.29600	0.28600	0.29200	0.26200

Table 2.8.5 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	0.01500	0.01300	0.01000	0.00700	0.00600	0.00800	0.01200	0.01500	0.01400	0.01200
1	0.05000	0.05700	0.05600	0.06100	0.05100	0.04900	0.04400	0.05200	0.05900	0.06900	0.07100
2	0.15500	0.15000	0.13800	0.13000	0.12300	0.12400	0.12300	0.12600	0.13800	0.14200	0.13800
3	0.18700	0.19000	0.18700	0.18300	0.17600	0.17200	0.17100	0.17400	0.18500	0.19700	0.18500
4	0.22300	0.23000	0.23200	0.23200	0.22200	0.21800	0.21500	0.21200	0.21300	0.21600	0.21500
5	0.23900	0.24300	0.24700	0.25200	0.25000	0.24900	0.24800	0.24400	0.24000	0.23700	0.23500
6	0.27600	0.28200	0.27500	0.27300	0.26500	0.27100	0.27500	0.27000	0.26600	0.25700	0.26400
7	0.29900	0.31100	0.32100	0.31500	0.29600	0.28100	0.28300	0.28400	0.28100	0.27600	0.27800
8	0.30600	0.33800	0.34100	0.33200	0.29600	0.29100	0.30400	0.29800	0.29700	0.29500	0.30500
9	0.31200	0.34700	0.36500	0.39200	0.36400	0.34700	0.33700	0.33100	0.33200	0.31500	0.32300

AGE	1993	1994	1995	1996	1997	1998	1999	2000
0	0.00900	0.00800	0.00600	0.00400	0.00600	0.00600	0.00600	0.00500
1	0.06900	0.06200	0.05400	0.04900	0.04700	0.05000	0.05000	0.04900
2	0.13200	0.12800	0.12900	0.12300	0.11600	0.11600	0.11500	0.11800
3	0.18800	0.17900	0.19500	0.18100	0.18700	0.17900	0.18300	0.17600
4	0.21400	0.20700	0.22400	0.22900	0.24100	0.22600	0.22100	0.21300
5	0.24000	0.22400	0.23600	0.23800	0.26500	0.25600	0.24800	0.23400
6	0.27400	0.26500	0.27200	0.25800	0.28400	0.27300	0.27800	0.26400
7	0.29100	0.28600	0.29300	0.27600	0.28700	0.27500	0.28500	0.28300
8	0.31300	0.31000	0.31700	0.29900	0.30100	0.26900	0.27900	0.26500
9	0.33200	0.33700	0.33500	0.32900	0.34200	0.31700	0.30100	0.27000

Table 2.8.6 North Sea herring. Natural mortality, proportion F and M before spawning.

Natural Mortality (per year)

AGE	1960	1961	1962	1963	....	1995	1996	1997	1998	1999	2000
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 2.8.7 North Sea herring. Proportion mature.

Proportion of fish spawning

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

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

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

AGE	1993	1994	1995	1996	1997	1998	1999	2000
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.4700	0.7200	0.7300	0.6100	0.6400	0.6700	0.6900	0.6600
3	0.6300	0.8600	0.9500	0.9800	0.9400	0.8900	0.9100	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

Table 2.8.8 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	10.40	15.70	21.80	28.10

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	50.80	77.60	40.00	70.00	139.50	134.70	170.90	89.60	41.90	30.30	20.60

	1995	1996	1997	1998	1999	2000
1	23.90	47.80	59.50	80.60	67.70	39.40

AGE-STRUCTURED INDICES

Acoustic survey 2-9+ wr (x 10 ^ 3)

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	3726.0	2971.0	2834.0	4179.0	3710.0	3280.0	3799.0	4557.0	6363.0	5747.0	2945.0
3	3751.0	3530.0	1501.0	1633.0	1855.0	957.0	2056.0	2824.0	3287.0	2520.0	4364.0
4	1612.0	3370.0	2102.0	1397.0	909.0	429.0	656.0	1087.0	1696.0	1625.0	1036.0
5	488.0	1349.0	1984.0	1510.0	795.0	363.0	272.0	311.0	692.1	982.4	470.1
6	281.0	395.0	748.0	1311.0	788.0	321.0	175.0	98.7	259.2	445.2	289.5
7	120.0	211.0	262.0	474.0	546.0	238.0	135.0	82.8	78.6	170.3	128.9
8	44.0	134.0	112.0	155.0	178.0	220.0	110.0	132.9	78.3	45.2	51.6
9	22.0	43.0	56.0	163.0	116.0	132.0	84.0	206.0	158.3	121.4	82.7

AGE	2000
2	2773.0
3	1996.0
4	2871.0
5	923.5
6	442.8
7	243.9
8	111.5
9	91.9

IBTSA: 2-5+ wr

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

AGE	1994	1995	1996	1997	1998	1999	2000	2001
2	1094.0	1174.0	194.0	490.0	743.0	425.0	216.0	1142.0
3	199.0	233.0	43.0	190.0	90.0	509.0	157.0	322.0
4	64.0	31.0	13.0	40.0	20.0	101.0	61.0	98.0
5	40.0	6.0	9.0	23.0	19.0	38.0	9.0	71.0

Table 2.8.8 North Sea herring. Tuning indices (continued).

IBTSY 1-wr

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

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	1016.0	1159.0	1162.0	2943.0	1667.0	1186.0	1735.0	4069.0	2067.0	715.0	3639.0

AGE	2001
1	2674.0

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
0	244.00	137.10	214.80

Table 2.8.9 North Sea herring. Weighting factors for the catches in number.

AGE	1997	1998	1999	2000
0	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000
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

Table 2.8.10 North Sea herring. Predicted catch in number.

Predicted Catch in Number

AGE	1997	1998	1999	2000
0	500.9	344.9	1340.8	890.8
1	786.8	656.4	319.4	1294.1
2	658.7	1567.0	931.6	479.4
3	435.1	634.7	1057.5	681.1
4	234.3	305.2	307.0	561.7
5	118.1	174.0	156.3	173.4
6	31.2	77.4	78.2	77.8
7	11.9	16.1	27.2	30.3
8	11.0	10.0	9.4	17.3

x 10 ^ 6

Table 2.8.11 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	0.2561	0.1293	0.0897	0.1241	0.3084	0.2461	0.1852	0.2980	0.3002	0.3291	0.2681
2	0.4348	0.6181	0.2500	0.2975	0.3890	0.7753	0.5921	0.4222	1.3272	0.7844	0.9728
3	0.3273	0.3509	0.6289	0.2752	0.4124	0.7389	0.7082	0.8046	1.8722	0.9124	1.2670
4	0.3403	0.4067	0.4188	0.2280	0.3698	0.7767	0.5719	0.9244	1.0716	0.8743	1.3305
5	0.2677	0.4075	0.5305	0.1492	0.3096	0.6585	0.8346	0.8279	1.2340	1.0545	0.8761
6	0.3114	0.3843	0.8368	0.1800	0.2350	0.5245	0.3890	1.0099	1.1760	1.9011	1.0811
7	0.5923	0.2481	0.6443	0.2964	0.2783	0.4491	0.3937	1.5173	1.6003	1.3049	4.1319
8	0.5956	0.5072	0.5730	0.3426	0.5915	0.8413	0.7085	1.1014	1.5775	1.3255	1.7820
9	0.5956	0.5072	0.5730	0.3426	0.5915	0.8413	0.7085	1.1014	1.5775	1.3255	1.7820

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.0340	0.0583	0.0462	0.0749	0.1588	0.1475	0.0979	0.0457	0.0838	0.1260	0.4826
1	0.6022	0.5784	0.6739	0.4526	0.6884	0.2521	0.2992	0.2009	0.1673	0.1134	0.2862
2	0.8826	0.8124	1.0228	1.0285	1.3182	1.3412	0.2286	0.0244	0.0952	0.3657	0.3247
3	1.2147	0.8015	1.3349	0.9748	1.5037	1.4647	1.4202	0.0433	0.0671	0.4221	0.2775
4	1.2268	0.7995	0.9880	0.9966	1.3816	1.7346	0.4515	0.1054	0.0956	0.3005	0.3065
5	1.0849	0.5499	0.9511	1.1868	1.9079	1.6473	1.1944	0.0177	0.0530	0.2715	0.4193
6	2.6251	0.5180	1.3807	1.0776	1.2787	1.1401	0.8080	0.0762	0.0133	0.0682	0.4465
7	2.7350	0.0993	0.8069	0.7771	2.0231	1.5205	0.8659	0.0698	0.4290	0.1090	0.9921
8	2.0208	1.0821	1.6013	1.3406	2.0767	1.6059	0.9970	0.2282	0.2736	0.3513	0.6887
9	2.0208	1.0821	1.6013	1.3406	2.0767	1.6059	0.9970	0.2282	0.2736	0.3513	0.6887

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	0.3348	0.3999	0.2266	0.0854	0.0620	0.1627	0.1262	0.1319	0.0594	0.1176	0.2900
1	0.2254	0.2521	0.2053	0.3834	0.3162	0.3726	0.5867	0.4377	0.4599	0.3114	0.3863
2	0.2615	0.3029	0.3152	0.4048	0.4605	0.4071	0.3561	0.4060	0.3862	0.5897	0.5822
3	0.5098	0.3261	0.4312	0.6739	0.5236	0.5075	0.4021	0.4108	0.3800	0.4718	0.5216
4	0.2497	0.4386	0.5414	0.7426	0.5864	0.5912	0.5859	0.5588	0.4687	0.4777	0.6100
5	0.1563	0.2792	0.6325	0.6735	0.5611	0.6251	0.6686	0.6649	0.5047	0.4855	0.5872
6	0.1481	0.3503	0.3665	0.7419	0.7538	0.6507	0.6930	0.7099	0.5037	0.4852	0.7270
7	0.2409	0.4026	0.7153	0.5735	0.8464	0.6480	0.7239	0.7463	0.6982	0.4382	0.7161
8	0.4504	0.5507	0.6428	0.9146	0.8556	0.8535	1.0378	0.9204	0.8633	0.7449	0.9260
9	0.4504	0.5507	0.6428	0.9146	0.8556	0.8535	1.0378	0.9204	0.8633	0.7449	0.9260

AGE	1993	1994	1995	1996	1997	1998	1999	2000
0	0.3633	0.2311	0.3626	0.0755	0.0236	0.0292	0.0254	0.0230
1	0.4088	0.2348	0.2951	0.2596	0.0716	0.0885	0.0771	0.0697
2	0.6657	0.6466	0.6262	0.3572	0.2809	0.3470	0.3025	0.2734
3	0.6606	0.7102	0.8910	0.5991	0.4154	0.5132	0.4473	0.4043
4	0.8003	0.9760	0.9105	0.4601	0.4424	0.5466	0.4765	0.4306
5	0.8055	0.6617	1.0095	0.5171	0.4930	0.6091	0.5309	0.4798
6	0.8042	0.8726	0.7477	0.3958	0.5004	0.6182	0.5389	0.4870
7	0.8927	0.6201	1.1586	0.2810	0.3759	0.4645	0.4048	0.3659
8	1.0805	0.8995	1.0857	0.6299	0.4424	0.5466	0.4765	0.4306
9	1.0805	0.8995	1.0857	0.6299	0.4424	0.5466	0.4765	0.4306

Table 2.8.12 North Sea herring. Population abundance (1 January, billions).

Population Abundance (1 January, x 10 ^ 9)

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	12.10	108.86	46.27	47.66	62.79	34.89	27.86	40.26	38.70	21.58	41.07
1	16.41	4.34	39.31	16.94	17.27	22.81	12.75	10.03	14.43	13.75	7.87
2	3.71	4.67	1.40	13.22	5.50	4.67	6.56	3.90	2.74	3.93	3.64
3	7.73	1.78	1.87	0.81	7.27	2.76	1.59	2.69	1.89	0.54	1.33
4	0.60	4.56	1.03	0.81	0.50	3.94	1.08	0.64	0.98	0.24	0.18
5	0.75	0.39	2.75	0.61	0.59	0.31	1.64	0.55	0.23	0.31	0.09
6	0.44	0.52	0.23	1.46	0.48	0.39	0.15	0.64	0.22	0.06	0.10
7	0.29	0.29	0.32	0.09	1.11	0.34	0.21	0.09	0.21	0.06	0.01
8	0.30	0.15	0.21	0.15	0.06	0.76	0.20	0.13	0.02	0.04	0.01
9	0.33	0.23	0.21	0.18	0.14	0.14	0.49	0.27	0.12	0.04	0.02

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	32.30	20.86	10.09	21.69	2.81	2.71	4.32	4.59	10.59	16.70	37.84
1	14.59	11.49	7.24	3.55	7.40	0.88	0.86	1.44	1.61	3.58	5.41
2	2.22	2.94	2.37	1.36	0.83	1.37	0.25	0.23	0.43	0.50	1.18
3	1.02	0.68	0.97	0.63	0.36	0.16	0.27	0.15	0.17	0.29	0.26
4	0.31	0.25	0.25	0.21	0.19	0.07	0.03	0.05	0.12	0.13	0.16
5	0.04	0.08	0.10	0.08	0.07	0.04	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	0.01	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	0.01	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	64.70	61.79	53.41	80.85	97.56	85.56	41.79	38.73	35.56	33.70	63.41
1	8.59	17.03	15.24	15.67	27.31	33.73	26.75	13.55	12.49	12.33	11.02
2	1.50	2.52	4.87	4.57	3.93	7.32	8.55	5.47	3.22	2.90	3.32
3	0.63	0.85	1.38	2.63	2.26	1.84	3.61	4.44	2.70	1.62	1.19
4	0.16	0.31	0.50	0.73	1.10	1.09	0.90	1.98	2.41	1.51	0.83
5	0.10	0.11	0.18	0.27	0.32	0.55	0.55	0.46	1.02	1.36	0.85
6	0.05	0.08	0.08	0.09	0.12	0.16	0.27	0.25	0.21	0.56	0.76
7	0.04	0.04	0.05	0.05	0.04	0.05	0.08	0.12	0.11	0.12	0.31
8	0.01	0.03	0.02	0.02	0.02	0.01	0.02	0.03	0.05	0.05	0.07
9	0.00	0.03	0.04	0.03	0.03	0.01	0.01	0.02	0.02	0.03	0.04

AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	51.76	33.85	42.56	52.50	33.89	18.93	84.31	61.91	80.55
1	17.45	13.24	9.88	10.90	17.91	12.18	6.76	30.24	22.26
2	2.76	4.27	3.85	2.71	3.09	6.13	4.10	2.30	10.37
3	1.37	1.05	1.66	1.53	1.40	1.73	3.21	2.24	1.30
4	0.58	0.58	0.42	0.56	0.69	0.76	0.85	1.68	1.23
5	0.41	0.24	0.20	0.15	0.32	0.40	0.40	0.48	0.99
6	0.43	0.16	0.11	0.07	0.08	0.18	0.20	0.21	0.27
7	0.33	0.17	0.06	0.05	0.04	0.05	0.09	0.10	0.12
8	0.14	0.12	0.08	0.02	0.03	0.02	0.03	0.05	0.07
9	0.07	0.08	0.11	0.04	0.03	0.02	0.01	0.01	0.03

Table 2.8.13 North Sea herring. Predicted index values.

Predicted SSB Index Values

MLAI

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	17.50	11.74	5.53	5.24	3.02	4.25	7.40	9.23	14.34	21.13	34.22

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	56.10	57.91	58.23	69.97	93.93	107.33	96.94	78.07	56.77	35.47	37.95

	1995	1996	1997	1998	1999	2000
1	37.39	34.55	42.87	58.38	68.80	64.78

Predicted Age-Structured Index Values

Acoustic survey 2-9+ wr (x 10 ^ 3)

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	6008.8	3571.8	2878.3	3310.0	2622.2	4103.0	3746.5	3052.0	3636.3	6954.9	4765.2
3	5997.4	3714.8	2118.3	1515.5	1620.1	1202.8	1718.7	1859.6	1891.6	2210.3	4255.0
4	2973.2	3805.4	2378.1	1209.9	762.4	695.0	523.1	882.8	1099.9	1147.5	1333.6
5	725.8	1779.8	2397.3	1410.9	599.8	375.5	261.2	265.5	556.0	655.1	680.8
6	429.6	401.5	1068.9	1271.3	685.0	254.2	181.9	131.3	157.2	312.0	364.4
7	204.5	196.1	231.9	534.5	517.4	312.8	83.7	102.6	82.4	89.7	174.4
8	64.8	102.8	107.4	129.3	241.5	238.6	147.2	39.7	80.1	58.2	63.3
9	42.4	62.3	80.1	112.8	169.3	233.1	291.1	133.6	123.4	81.5	33.0

AGE	2000
2	2720.8
3	3045.6
4	2712.0
5	839.8
6	403.6
7	215.7
8	129.6
9	27.5

IBTSA: 2-5+ wr Predicted

AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	360.0	693.7	643.3	549.6	1031.5	1212.1	771.1	454.5	399.4	457.8	375.8
3	90.9	145.1	268.3	234.4	191.2	380.9	467.5	285.8	169.5	123.8	140.4
4	20.2	32.5	46.2	70.4	70.1	58.0	127.2	156.7	98.3	52.9	36.1
5	11.2	14.1	16.7	19.7	29.8	34.5	32.6	53.7	80.4	75.3	49.7

AGE	1994	1995	1996	1997	1998	1999	2000	2001
2	583.2	528.0	383.6	442.5	870.4	585.2	330.0	1486.0
3	106.5	164.3	157.0	147.7	180.0	336.9	236.7	137.0
4	35.5	26.0	36.2	44.8	48.8	55.1	109.9	80.2
5	28.6	20.3	12.3	19.3	25.1	27.1	32.4	56.1

Table 2.8.13 North Sea herring. Predicted index values (continued).

IBTSY 1-wr Predicted

AGE	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	192.1	429.9	635.5	1016.0	2007.2	1806.8	1816.5	3193.1	3916.7	3023.8	1560.7

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	1434.2	1442.5	1277.4	2017.3	1564.1	1158.5	1283.1	2159.0	1464.9	815.0	3646.0

AGE	2001
1	2683.9

MIK 0-wr Predicted

AGE	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	11.41	12.20	28.04	43.95	95.26	165.92	157.18	138.85	213.91	258.88	224.20

AGE	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	110.01	101.88	94.40	88.80	163.52	132.28	87.93	108.78	139.07	90.36	50.45

AGE	1999	2000	2001
0	224.74	165.08	214.80

Table 2.8.14 North Sea herring. Fitted selection pattern.

Fitted Selection Pattern

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	0.0756	0.0457	0.0116	0.0649	0.0340	0.0092	0.0375	0.0277	0.0325	0.0094	0.0264
1	0.7527	0.3179	0.2141	0.5441	0.8340	0.3169	0.3239	0.3224	0.2802	0.3764	0.2015
2	1.2778	1.5198	0.5969	1.3047	1.0518	0.9983	1.0353	0.4567	1.2385	0.8971	0.7312
3	0.9619	0.8627	1.5015	1.2070	1.1151	0.9514	1.2384	0.8704	1.7471	1.0436	0.9523
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.7867	1.0019	1.2666	0.6542	0.8372	0.8479	1.4594	0.8956	1.1516	1.2061	0.6584
6	0.9151	0.9450	1.9979	0.7892	0.6354	0.6752	0.6802	1.0924	1.0975	2.1743	0.8126
7	1.7404	0.6099	1.5382	1.2996	0.7526	0.5782	0.6884	1.6414	1.4933	1.4924	3.1055
8	1.7502	1.2471	1.3680	1.5024	1.5996	1.0832	1.2390	1.1914	1.4721	1.5160	1.3393
9	1.7502	1.2471	1.3680	1.5024	1.5996	1.0832	1.2390	1.1914	1.4721	1.5160	1.3393

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.0277	0.0729	0.0468	0.0752	0.1149	0.0851	0.2168	0.4333	0.8768	0.4195	1.5744
1	0.4909	0.7234	0.6821	0.4541	0.4983	0.1453	0.6627	1.9057	1.7509	0.3773	0.9338
2	0.7195	1.0161	1.0352	1.0320	0.9541	0.7732	0.5063	0.2316	0.9959	1.2172	1.0594
3	0.9901	1.0025	1.3511	0.9781	1.0884	0.8444	3.1454	0.4104	0.7019	1.4046	0.9054
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8844	0.6878	0.9627	1.1909	1.3810	0.9496	2.6453	0.1682	0.5548	0.9036	1.3680
6	2.1398	0.6479	1.3975	1.0813	0.9255	0.6573	1.7895	0.7223	0.1389	0.2269	1.4566
7	2.2294	0.1242	0.8167	0.7798	1.4644	0.8765	1.9178	0.6621	4.4888	0.3629	3.2365
8	1.6473	1.3535	1.6207	1.3452	1.5032	0.9258	2.2080	2.1637	2.8627	1.1691	2.2468
9	1.6473	1.3535	1.6207	1.3452	1.5032	0.9258	2.2080	2.1637	2.8627	1.1691	2.2468

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	1.3410	0.9117	0.4185	0.1150	0.1057	0.2752	0.2154	0.2360	0.1267	0.2462	0.4754
1	0.9030	0.5748	0.3793	0.5162	0.5393	0.6303	1.0013	0.7833	0.9811	0.6519	0.6332
2	1.0475	0.6906	0.5822	0.5451	0.7854	0.6887	0.6077	0.7265	0.8239	1.2344	0.9543
3	2.0421	0.7436	0.7965	0.9074	0.8929	0.8585	0.6863	0.7352	0.8108	0.9876	0.8550
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.6260	0.6366	1.1682	0.9069	0.9569	1.0574	1.1411	1.1899	1.0767	1.0163	0.9626
6	0.5933	0.7988	0.6768	0.9989	1.2856	1.1007	1.1828	1.2705	1.0746	1.0156	1.1917
7	0.9649	0.9180	1.3212	0.7723	1.4434	1.0962	1.2356	1.3356	1.4897	0.9173	1.1739
8	1.8038	1.2557	1.1873	1.2316	1.4592	1.4437	1.7713	1.6472	1.8419	1.5591	1.5179
9	1.8038	1.2557	1.1873	1.2316	1.4592	1.4437	1.7713	1.6472	1.8419	1.5591	1.5179

AGE	1993	1994	1995	1996	1997	1998	1999	2000
0	0.4540	0.2368	0.3982	0.1641	0.0534	0.0534	0.0534	0.0534
1	0.5109	0.2405	0.3241	0.5642	0.1618	0.1618	0.1618	0.1618
2	0.8319	0.6624	0.6877	0.7764	0.6348	0.6348	0.6348	0.6348
3	0.8254	0.7277	0.9785	1.3021	0.9388	0.9388	0.9388	0.9388
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0065	0.6779	1.1087	1.1240	1.1142	1.1142	1.1142	1.1142
6	1.0050	0.8940	0.8212	0.8603	1.1310	1.1310	1.1310	1.1310
7	1.1155	0.6353	1.2725	0.6108	0.8497	0.8497	0.8497	0.8497
8	1.3501	0.9216	1.1924	1.3692	1.0000	1.0000	1.0000	1.0000
9	1.3501	0.9216	1.1924	1.3692	1.0000	1.0000	1.0000	1.0000

Table 2.8.15 North Sea herring. Stock summary.

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 6	SoP (%)
1960	12096130	3740795	1877111	696200	0.3709	0.3363	84
1961	108859390	4364373	1662701	696700	0.4190	0.4335	88
1962	46273490	4399635	1116800	627800	0.5621	0.5330	85
1963	47657560	4625020	2185439	716000	0.3276	0.2260	116
1964	62785270	4794340	2028570	871200	0.4295	0.3432	93
1965	34894950	4344650	1449889	1168800	0.8061	0.6948	86
1966	27858810	3317876	1282053	895500	0.6985	0.6192	93
1967	40255900	2815074	920332	695500	0.7557	0.7978	85
1968	38698960	2521934	413571	717800	1.7356	1.3362	79
1969	21581390	1905403	424167	546700	1.2889	1.1054	103
1970	41069690	1921824	374627	563100	1.5031	1.1055	103
1971	32301770	1849248	265999	520100	1.9553	1.4068	93
1972	20860460	1549319	288255	497500	1.7259	0.6963	108
1973	10092480	1155651	233229	484000	2.0752	1.1355	104
1974	21690030	911526	161859	275100	1.6996	1.0529	103
1975	2805610	679537	81297	312800	3.8476	1.4780	107
1976	2714080	357640	77437	174800	2.2573	1.4656	104
1977	4320960	209320	46845	46000	0.9819	0.8205	83
1978	4587820	223553	63931	11000	0.1721	0.0534	82
1979	10594450	380739	106149	25100	0.2365	0.0648	99
1980	16695760	628833	129979	70764	0.5444	0.2856	91
1981	37837120	1156509	194400	174879	0.8996	0.3549	99
1982	64697790	1840313	277124	275079	0.9926	0.2651	102
1983	61790670	2591631	430552	387202	0.8993	0.3394	92
1984	53414490	2700515	676658	428631	0.6335	0.4574	94
1985	80846800	3133985	696570	613780	0.8811	0.6473	95
1986	97560130	3339375	700145	671488	0.9591	0.5771	87
1987	85560240	3834654	828196	792058	0.9564	0.5563	98
1988	41792750	3618447	1084019	887686	0.8189	0.5411	85
1989	38731050	3279513	1224623	787899	0.6434	0.5501	96
1990	35564460	3083546	1115764	645229	0.5783	0.4487	95
1991	33697600	2902329	915372	658008	0.7188	0.5020	98
1992	63406250	2920312	684053	716799	1.0479	0.6056	100
1993	51762150	2792442	444981	671397	1.5088	0.7473	97
1994	33846110	2157452	473353	568234	1.2004	0.7734	95
1995	42561930	1862842	466975	639146	1.3687	0.8370	98
1996	52498710	1565294	434421	306157	0.7047	0.4659	99
1997	33891070	1971722	529153	272627	0.5152	0.4264	100
1998	18933160	2091480	701800	380178	0.5417	0.5268	99
1999	84306360	2278045	815482	372341	0.4566	0.4592	100
2000	61907350	3028340	771796	372420	0.4825	0.4150	98

```
 -----------------------------------------------------------------
 No of years for separable analysis : 4
 Age range in the analysis : 0  . . . 9
 Year range in the analysis : 1960  . . . 2000
 Number of indices of SSB : 1
 Number of age-structured indices : 4
 Stock-recruit relationship to be fitted.
 Parameters to estimate : 42
 Number of observations : 324

 Conventional single selection vector model to be fitted.
-----------------------------------------------------------------
```

Table 2.8.16 North Sea herring. Parameter estimates.

PARAMETER ESTIMATES

Separable model : F by year

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
1	1997	0.4424	15	0.3278	0.5972	0.3796	0.5156	0.4476
2	1998	0.5466	15	0.4066	0.7348	0.4700	0.6357	0.5529
3	1999	0.4765	15	0.3485	0.6514	0.4062	0.5589	0.4826
4	2000	0.4306	17	0.3060	0.6060	0.3618	0.5126	0.4372

Separable Model: Selection (S) by age

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
5	0	0.0534	20	0.0355	0.0803	0.0433	0.0657	0.0545
6	1	0.1618	20	0.1089	0.2406	0.1322	0.1981	0.1652
7	2	0.6348	19	0.4357	0.9249	0.5239	0.7692	0.6466
8	3	0.9388	18	0.6516	1.3527	0.7792	1.1311	0.9553
	4	1.0000	Fixed : Reference Age					
9	5	1.1142	17	0.7850	1.5815	0.9319	1.3322	1.1322
10	6	1.1310	16	0.8116	1.5760	0.9548	1.3396	1.1473
11	7	0.8497	17	0.6021	1.1991	0.7127	1.0130	0.8629
	8	1.0000	Fixed : Last true age					

Separable model: Populations in year 2000

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
12	0	61907349	17	44031063	87041275	52028423	73662042	62849978
13	1	30235862	15	22460206	40703427	25980685	35187961	30585664
14	2	2303959	13	1776843	2987447	2017951	2630502	2324286
15	3	2244771	12	1754558	2871947	1979602	2545459	2262578
16	4	1680910	13	1282998	2202231	1464495	1929305	1696951
17	5	476298	15	348651	650679	406212	558477	482370
18	6	211297	18	148156	301347	176292	253252	214791
19	7	103615	20	68986	155628	84196	127514	105871
20	8	51665	21	33960	78600	41708	63998	52862

Separable model: Populations at age

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
21	1997	32155	28	18387	56234	24177	42766	33490
22	1998	24735	22	15810	38700	19685	31081	25389
23	1999	25862	21	16925	39519	20832	32108	26475

Recruitment in year 2001

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
24	2000	80554218	28	46101240	140755042	60593666	107090104	83886855

SSB Index catchabilities

MLAI

Power model fitted. Slopes (Q) and exponents (K) at age

Parm. No.			Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
25	1	Q	2.985	17	2.238	4.458	2.650	3.766	3.208
26	1	K	.2358E-04	17	.3448E-04	.6868E-04	.4082E-04	.5802E-04	.5314E-04

Age-structured index catchabilities

Acoustic survey 2-9+ wr

Linear model fitted. Slopes at age :

Parm. No.			Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
27	2	Q	1.619	22	1.300	3.186	1.619	2.558	2.089
28	3	Q	1.892	22	1.518	3.725	1.892	2.990	2.441
29	4	Q	2.160	22	1.733	4.258	2.160	3.417	2.789
30	5	Q	2.426	23	1.945	4.792	2.426	3.842	3.135
31	6	Q	2.638	23	2.113	5.231	2.638	4.189	3.415
32	7	Q	2.689	23	2.150	5.361	2.689	4.286	3.488
33	8	Q	3.359	23	2.679	6.741	3.359	5.377	4.369
34	9	Q	4.929	23	3.943	9.805	4.929	7.845	6.388

IBTSA: 2-5+ wr

Linear model fitted. Slopes at age :

Parm. No.			Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
35	2	Q	.1539E-03	12	.1359E-03	.2255E-03	.1539E-03	.1992E-03	.1766E-03
36	3	Q	.1137E-03	12	.1005E-03	.1667E-03	.1137E-03	.1473E-03	.1305E-03
37	4	Q	.6984E-04	12	.6167E-04	.1025E-03	.6984E-04	.9050E-04	.8017E-04
38	5	Q	.4093E-04	13	.3612E-04	.6020E-04	.4093E-04	.5312E-04	.4703E-04

Table 2.8.16 North Sea herring. Parameter estimates (continued)

```
IBTSY 1-wr
Linear model fitted. Slopes at age :
   39   1  Q  .1378E-03   6 .1301E-03 .1648E-03 .1378E-03 .1555E-03 .1467E-03


MIK 0-wr
Linear model fitted. Slopes at age :
   40   0  Q  .3030E-05   5 .2865E-05 .3604E-05 .3030E-05 .3407E-05 .3219E-05

Parameters of the stock-recruit relationship
   41   1  a  .8342E+08  41 .5591E+08 .2864E+09 .8342E+08 .1920E+09 .1380E+09
   42   1  b  .6604E+06  69 .3376E+06 .5228E+07 .6604E+06 .2672E+07 .1696E+07
```

Table 2.8.17 North Sea herring. Residuals about the model fit.

Separable Model Residuals

Age	1997	1998	1999	2000
0	-0.0914	-0.2904	0.1547	0.2189
1	-0.4009	0.3787	0.0324	-0.1018
2	0.1138	-0.2552	-0.3639	0.2463
3	0.1913	-0.1895	0.0185	-0.3346
4	0.1958	-0.0997	-0.0284	0.0706
5	-0.0993	-0.0771	-0.1237	0.0680
6	-0.1058	0.0946	-0.1299	0.0089
7	0.0250	0.0158	-0.0260	-0.0863
8	-0.0040	0.0042	-0.0470	-0.0298

SPAWNING BIOMASS INDEX RESIDUALS

MLAI

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	-0.2670	-0.3833	-0.7164	-0.7401	0.7015	0.5547	0.7200	0.1190	0.0906	0.0311	-0.1969

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	-0.0992	0.2927	-0.3756	0.0004	0.3955	0.2272	0.5670	0.1378	-0.3037	-0.1576	-0.6110

	1995	1996	1997	1998	1999	2000
1	-0.4476	0.3246	0.3278	0.3225	-0.0161	-0.4972

AGE-STRUCTURED INDEX RESIDUALS

Acoustic survey 2-9+ wr Acousti

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	-0.478	-0.184	-0.016	0.233	0.347	-0.224	0.014	0.401	0.560	-0.191	-0.481
3	-0.469	-0.051	-0.344	0.075	0.135	-0.229	0.179	0.418	0.553	0.131	0.025
4	-0.612	-0.122	-0.123	0.144	0.176	-0.482	0.226	0.208	0.433	0.348	-0.253
5	-0.397	-0.277	-0.189	0.068	0.282	-0.034	0.040	0.158	0.219	0.405	-0.370
6	-0.425	-0.016	-0.357	0.031	0.140	0.233	-0.038	-0.285	0.500	0.356	-0.230
7	-0.533	0.073	0.122	-0.120	0.054	-0.273	0.478	-0.215	-0.047	0.641	-0.302
8	-0.387	0.266	0.042	0.181	-0.305	-0.081	-0.291	1.208	-0.023	-0.253	-0.204
9	-0.656	-0.371	-0.357	0.368	-0.378	-0.568	-1.243	0.433	0.249	0.398	0.918

Age	2000
2	0.019
3	-0.423
4	0.057
5	0.095
6	0.093
7	0.123
8	-0.150
9	1.208

Table 2.8.17 North Sea herring. Residuals about the model fit (continued).

IBTSA: 2-5+ wr

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	-1.034	-1.479	0.077	0.327	-0.159	1.288	0.118	-0.014	0.647	-0.186	0.733
3	-0.748	-0.850	0.043	0.137	-0.508	0.804	-0.226	0.018	0.458	0.380	0.398
4	-0.368	-0.149	-0.048	0.103	-0.172	0.050	-0.201	0.552	0.893	0.191	0.197
5	0.877	-0.342	0.551	0.317	0.519	-0.283	-1.181	0.293	0.700	0.303	0.253

Age	1994	1995	1996	1997	1998	1999	2000	2001
2	0.629	0.799	-0.682	0.102	-0.158	-0.320	-0.424	-0.263
3	0.625	0.349	-1.295	0.252	-0.693	0.413	-0.411	0.855
4	0.589	0.176	-1.024	-0.113	-0.893	0.606	-0.588	0.201
5	0.336	-1.217	-0.316	0.177	-0.277	0.339	-1.282	0.235

IBTSY 1-wr

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	-0.2080	-0.2286	-0.2044	-0.2402	-0.4889	-0.2248	0.1369	-0.2280	-0.0612	0.4042	0.3934

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.3447	-0.2188	-0.0947	0.3777	0.0637	0.0234	0.3018	0.6338	0.3443	-0.1309	-0.0019

Age	2001
1	-0.0037

MIK 0-wr

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	0.404	0.071	0.620	0.833	-0.217	-0.214	-0.538	-0.188	-0.165	-0.378	0.189

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.429	-0.356	-1.293	-0.239	0.205	0.363	0.145	0.155	-0.267	0.494	0.051

Age	1999	2000	2001
0	0.082	-0.186	0.000

Table 2.8.18 North Sea herring. Parameters of distributions.

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1997 to 2000

Variance	0.0827
Skewness test stat.	-1.4146
Kurtosis test statistic	0.1360
Partial chi-square	0.0814
Significance in fit	0.0000
Degrees of freedom	13

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR MLAI

Power catchability relationship assumed
Last age is a plus-group

Variance	0.1808
Skewness test stat.	-0.1174
Kurtosis test statistic	-0.9962
Partial chi-square	2.1619
Significance in fit	0.0000
Number of observations	28
Degrees of freedom	26
Weight in the analysis	1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR Acoustic survey 2-9+ wr Acousti
Linear catchability relationship assumed

Age	2	3	4	5	6	7	8	9
Variance	0.0140	0.0128	0.0132	0.0084	0.0103	0.0135	0.0230	0.0631
Skewness test stat.	0.1762	0.0852	-0.8199	-0.2829	0.1637	0.6252	2.7964	0.0784
Kurtosis test statisti	-0.7069	-0.6317	-0.5123	-0.7725	-0.6662	-0.2136	2.3792	-0.5652
Partial chi-square	0.0101	0.0096	0.0103	0.0068	0.0090	0.0127	0.0234	0.0620
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	12	12	12	12	12	12	12	12
Degrees of freedom	11	11	11	11	11	11	11	11
Weight in the analysis	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250

DISTRIBUTION STATISTICS FOR IBTSA: 2-5+ wr
Linear catchability relationship assumed

Age	2	3	4	5
Variance	0.1104	0.0913	0.0613	0.1025
Skewness test stat.	-0.4175	-0.9278	-0.6045	-1.6058
Kurtosis test statisti	0.0061	-0.6278	-0.1789	-0.2085
Partial chi-square	0.3109	0.3239	0.2766	0.5744
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	19	19	19	19
Degrees of freedom	18	18	18	18
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

Table 2.8.18 North Sea herring. Parameters of distributions (continued).

DISTRIBUTION STATISTICS FOR IBTSY 1-wr
Linear catchability relationship assumed

Age	1
Variance	0.0831
Skewness test stat.	1.0187
Kurtosis test statisti	-0.6211
Partial chi-square	0.2481
Significance in fit	0.0000
Number of observations	23
Degrees of freedom	22
Weight in the analysis	1.0000

DISTRIBUTION STATISTICS FOR MIK 0-wr

Linear catchability relationship assumed

Age	0
Variance	0.1870
Skewness test stat.	-1.4339
Kurtosis test statisti	1.6306
Partial chi-square	1.0582
Significance in fit	0.0000
Number of observations	25
Degrees of freedom	24
Weight in the analysis	1.0000

Table 2.8.19 North Sea herring. Analysis of variance.

ANALYSIS OF VARIANCE

Unweighted Statistics

	SSQ	Data	Parameters	d.f.	Variance
Total for model	67.2090	324	42	282	0.2383
Catches at age	1.0750	36	23	13	0.0827
MLAI	4.6996	28	2	26	0.1808
Acoustic survey 2-9+ wr	13.9298	96	8	88	0.1583
IBTSA: 2-5+ wr	26.3140	76	4	72	0.3655
IBTSY 1-wr	1.8286	23	1	22	0.0831
MIK 0-wr	4.4881	25	1	24	0.1870
Stock-recruit model	14.8739	40	2	38	0.3914

Weighted Statistics

	SSQ	Data	Parameters	d.f.	Variance
Total for model	28.8275	324	42	282	0.1022
Catches at age	1.0750	36	23	13	0.0827
MLAI	4.6996	28	2	26	0.1808
Acoustic survey 2-9+ wr	0.2177	96	8	88	0.0025
IBTSA: 2-5+ wr	1.6446	76	4	72	0.0228
IBTSY 1-wr	1.8286	23	1	22	0.0831
MIK 0-wr	4.4881	25	1	24	0.1870
Stock-recruit model	14.8739	40	2	38	0.3914

	Age class									
Year	0	1	2	3	4	5	6	7	8	9
1977	0.08									
1978	0.33	0.08								
1979	0.11	0.33	0.08							
1980	0.22	0.11	0.33	0.08						
1981	0.16	0.22	0.11	0.33	0.08					
1982	0.22	0.16	0.22	0.11	0.33	0.08				
1983	0.14	0.22	0.16	0.22	0.11	0.33	0.08			
1984	0.22	0.14	0.22	0.16	0.22	0.11	0.33	0.08		
1985	0.17	0.22	0.14	0.22	0.16	0.22	0.11	0.33	0.08	
1986	0.37	0.17	0.22	0.14	0.22	0.16	0.22	0.11	0.33	0.08
1987	0.23	0.37	0.17	0.22	0.14	0.22	0.16	0.22	0.11	0.33
1988	0.07	0.23	0.37	0.17	0.22	0.14	0.22	0.16	0.22	0.11
1989	0.26	0.07	0.23	0.37	0.17	0.22	0.14	0.22	0.16	0.22
1990	0.11	0.26	0.07	0.23	0.37	0.17	0.22	0.14	0.22	0.16
1991	0.23	0.11	0.26	0.07	0.23	0.37	0.17	0.22	0.14	0.22
1992	0.15	0.23	0.11	0.26	0.07	0.23	0.37	0.17	0.22	0.14
1993	0.32	0.15	0.23	0.11	0.26	0.07	0.23	0.37	0.17	0.22
1994	0.29	0.32	0.15	0.23	0.11	0.26	0.07	0.23	0.37	0.17
1995	0.27	0.29	0.32	0.15	0.23	0.11	0.26	0.07	0.23	0.37
1996	0.59	0.27	0.29	0.32	0.15	0.23	0.11	0.26	0.07	0.23
1997	0.19	0.59	0.27	0.29	0.32	0.15	0.23	0.11	0.26	0.07
1998	0.29	0.19	0.59	0.27	0.29	0.32	0.15	0.23	0.11	0.26
1999	0.12	0.29	0.19	0.59	0.27	0.29	0.32	0.15	0.23	0.11
2000		0.12	0.29	0.19	0.59	0.27	0.29	0.32	0.15	0.23

Table 2.9.1 Proportion of Downs in the North Sea stock at age and year based on the proportion of IBTS 1-ringers < 13 cm.

Table 2.10.1 North Sea herring.
Input data for short term prediction

Data for 2000 =Reference year

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

				Catches in numbers by fleet					Fraction of Stock in North sea
	Stock	Fishing		North Sea	IIIa				The remainder is in the IIIa
Age	numbers	mortality	Nat. mort	A	B	C	D	E	Only for 0-1 ringers, the older are treated as one stock
0	61907		1	14.3	858.3	63.1	173.1		0.547
1	30236		1	93.5	91.0	485.4	498.9		0.654
2		0.2734	0.3	486.7	19.0	105.8	9.8		
3		0.4043	0.2	470.4	4.9	21.4	0.5		
4		0.4306	0.1	587.2	3.0	19.8	3.0		
5		0.4798	0.1	183.0	0.7	7.5	0.1		
6		0.487	0.1	77.7	0.0	2.9	0.3		
7		0.3659	0.1	27.8	0.0	0.3	0.3		
8		0.4306	0.1	16.1	1.3	0.1	0.0		
9+		0.4306	0.1	2.6	0.0	0.0	0.0		

Data for 2001

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

	Stock	Nat. mort	Weight	Fraction	Weight in catch by fleet					Fraction of Stock in North sea
Age	numbers		in sp.stocl	mature	A	B	C	D	E	The remainder is in the IIIa
0	80554	1	0.0055	0	16.8	10.6	20.1	21.1		0.58
1	22257	1	0.0495	0	73.5	36.7	44.3	16.5		0.547
2	10374	0.3	0.1165	0.675	125.5	70.2	84.9	55.8		
3	1298	0.2	0.1795	0.935	155.3	128.7	115.0	127.5		**Proportions before spawning**
4	1227	0.1	0.217	1	177.0	145.3	154.1	158.1		**F** 0.67
5	989	0.1	0.241	1	203.4	150.3	176.3	168.2		**M** 0.67
6	267	0.1	0.271	1	225.5	174.4	185.5	188.5		
7	117	0.1	0.284	1	244.2	199.6	205.8	169.9		
8	65	0.1	0.272	1	269.4	199.3	208.6	177.0		
9+	35	0.1	0.2855	1	278.9	0.0	0.0	0.0		

Data for 2002

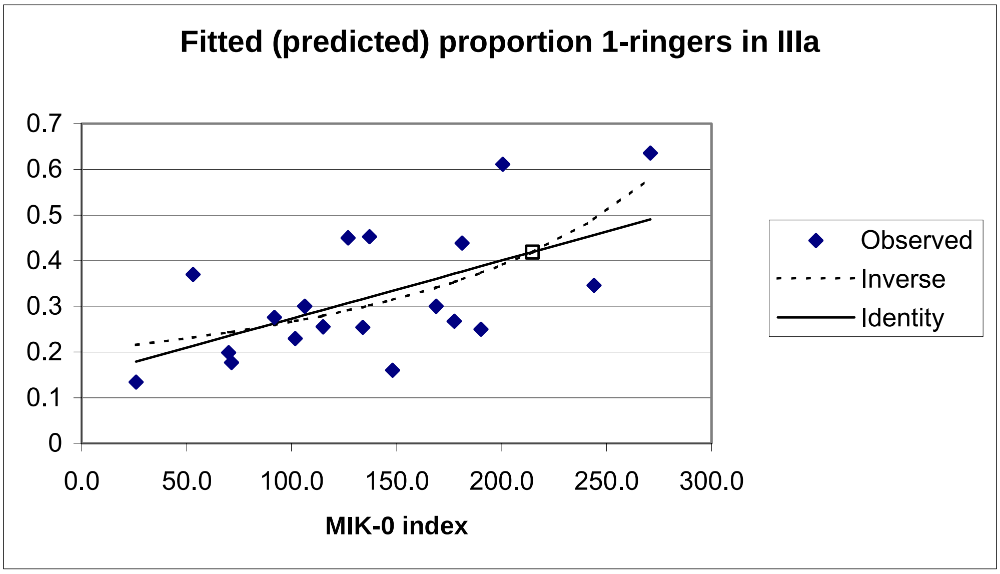
	Recruits	Nat. mort	Weight	Fraction	Weight in catch by fleet					Fraction of Stock in North sea
Age			in sp.stocl	mature	A	B	C	D	E	The remainder is in the IIIa
0	44000	1	0.0055	0	16.8	10.6	20.1	21.1		0.67
1		1	0.0495	0	73.5	36.7	44.3	16.5		0.58
2		0.3	0.1165	0.675	125.5	70.2	84.9	55.8		
3		0.2	0.1795	0.935	155.3	128.7	115.0	127.5		**Proportions before spawning**
4		0.1	0.217	1	177.0	145.3	154.1	158.1		**F** 0.67
5		0.1	0.241	1	203.4	150.3	176.3	168.2		**M** 0.67
6		0.1	0.271	1	225.5	174.4	185.5	188.5		
7		0.1	0.284	1	244.2	199.6	205.8	169.9		
8		0.1	0.272	1	269.4	199.3	208.6	177.0		
9+		0.1	0.2855	1	278.9	0.0	0.0	0.0		

Data for 2003

	Recruits	Nat. mort	Weight	Fraction	Weight in catch by fleet					Fraction of Stock in North sea
Age			in sp.stocl	mature	A	B	C	D	E	The remainder is in the IIIa
0	44000	1	0.0055	0	16.8	10.6	20.1	21.1		0.67
1		1	0.0495	0	73.5	36.7	44.3	16.5		0.67
2		0.3	0.1165	0.675	125.5	70.2	84.9	55.8		
3		0.2	0.1795	0.935	155.3	128.7	115.0	127.5		**Proportions before spawning**
4		0.1	0.217	1	177.0	145.3	154.1	158.1		**F** 0.67
5		0.1	0.241	1	203.4	150.3	176.3	168.2		**M** 0.67
6		0.1	0.271	1	225.5	174.4	185.5	188.5		
7		0.1	0.284	1	244.2	199.6	205.8	169.9		
8		0.1	0.272	1	269.4	199.3	208.6	177.0		
9+		0.1	0.2855	1	278.9	0.0	0.0	0.0		

TABLE 2.10.2 North Sea Herring - Split factors for Short term predictions

			Fitted (Predicted in bold) Proportion 1-ringers in IIIa			
Year-class	MIK-0	IBTS 1-ring Prop.IIIa	Inverse link	(se)	Identity link	(se)
1981	133.9	0.254	0.30	0.025	0.32	0.026
1982	91.8	0.276	0.26	0.026	0.26	0.024
1983	115.0	0.255	0.28	0.025	0.29	0.024
1984	181.3	0.439	0.36	0.031	0.38	0.038
1985	177.4	0.267	0.35	0.030	0.37	0.037
1986	270.9	0.636	0.58	0.145	0.49	0.070
1987	168.9	0.3	0.34	0.028	0.36	0.034
1988	71.4	0.177	0.24	0.026	0.24	0.028
1989	25.9	0.134	0.22	0.027	0.18	0.040
1990	69.9	0.199	0.24	0.026	0.23	0.028
1991	200.7	0.611	0.39	0.040	0.40	0.045
1992	190.1	0.25	0.37	0.035	0.39	0.041
1993	101.7	0.23	0.27	0.025	0.28	0.024
1994	126.9	0.45	0.29	0.025	0.31	0.025
1995	106.2	0.3	0.27	0.025	0.28	0.024
1996	148.1	0.16	0.31	0.025	0.33	0.029
1997	53.1	0.37	0.23	0.027	0.21	0.032
1998	244.0	0.346	0.49	0.085	0.46	0.060
1999	137.1	0.453	0.30	0.025	0.32	0.027
2000	214.8		0.42	0.050	0.42	0.050
Average	141.5		**0.31**	0.025	**0.33**	0.027



(The open symbol shows the predicted value)

Table 2.10.3 North Sea Herring – Split Factor model results.

Data as in Table 2.10.2; models were fitted in Splus.
(Proportion of 1-ringer Autumn spawners in Div. IIIa, based on 1-ringer IBTS, modelled as a function of the MIK 0-ringer index for the same yearclass)

Model: Gamma errors, Inverse link[1]

Coefficients	Value	Std. Error	t value
Intercept	4.94	0.660	7.41
mik0	-0.012	0.003	-3.309

Null Deviance: 3.29 on 18 degrees of freedom
Residual Deviance: 2.04 on 17 degrees of freedom

Correlation of Coefficients:

	(Intercept)
mik0	-0.932

Model: Gamma errors, Identity link[2]

Coefficients	Value	Std. Error	t value
Intercept:	0.146	0.049	2.98
mik0	0.00126	0.0004	3.14

Null Deviance: 3.29 on 18 degrees of freedom
Residual Deviance: 2.04 on 17 degrees of freedom

Correlation of Coefficients:

	(Intercept)
mik0	-0.877

1. Model fitting for Inverse link:
glm(formula = prop3a ~ mik0, family = Gamma(link = inverse), data = splitdat, subset = 1:19)
2. Model fitting for Identity link:
glm(formula = prop3a ~ mik0, family = Gamma(link = identity), data = splitdat, subset = 1:19)

Table 2.10.4
Computation of TAC constrained catch with overshoot for 2001

					Sum	
Yearly catches and TACs						**Source:**
1999 data	A	B	C	D		
TAC	265000	30000	80000	19000		Norway-EU agreement
Exp.prop NSAS	1	1	0.5	0.7		Avg. ratio in 2 prev. years, rounded
Exp catch NSAS	265000	30000	40000	13300		
Catch NSAS	315770	15205	31200	8400	370575	Table 2.2.6
Over/undershoot	**1.19**	**0.51**	**0.78**	**0.63**		
2000 data						
TAC	265000	36000	80000	21000		Norway-EU agreement
Exp.prop NSAS	1	1	0.5	0.7		Avg. ratio in 2 prev. years, rounded
Exp catch NSAS	265000	36000	40000	14700		
Catch NSAS	315800	17000	37000	13100	382900	Table 2.2.6
Over/undershoot	**1.19**	**0.47**	**0.93**	**0.89**		

Compute expected fraction being NSAS of TAC in IIIa for 2001 onwards according to average 1999 - 2000 catches

Fleet		C		D		
		NSAS	BSS	NSAS	BSS	
	1999	31	44	8	3	Table 2.1.6
	2000	37	53	13	5	Table 2.1.6
99-2000		68	97	21	8	
Fraction NSAS		0.4121212		0.7241379		

Overshoot for 1999 - 2000 combined

	A	B	C	D	Sum
Catch NSAS	631570	32205	68200	21500	753475
Exp catch NSAS	530000	66000	80000	28000	704000
Over/undershoot	**1.1916415**	**0.4879545**	**0.8525**	**0.7678571**	**1.070277**

Expected catch in 2001

	A	B	C	D	Sum
TAC 2001	265000	36000	80000	21000	402000
Expect prop 2001	1	1	0.412	0.724	
TAC 2001 NSAS	265000	36000	32969.697	15206.897	349176.6
Expexted catch 2001	**315785**	**17566**	**28107**	**11677**	**373134.8**

Table 2.10.5 North Sea herring. Short-term projections.

Based on TAC+Over/undershoot constraint

	Predictions for 2001, based on TAC+Overshoot Constraint in 2001									(in '000t)
	Fjuv	*Fad*	*Fleet F's*		*Fleet Yields in '000t*				*TOTAL*	*SSB*
	(0-1 ring)	*(2-6 ring)*	*FB-E*	*FA*	*A*	*B*	*C*	*D*	*Yield*	*2001*
	0.04	0.27	0.04	0.25	316	18	27	11	373	1244

	Prediction summary: Yields for 2002									(in '000t)
Scenario	*Fjuv*	*Fad*	*Fleet F's*		*Fleet Yields in '000t*				*TOTAL*	*SSB*
	(0-1 ring)	*(2-6 ring)*	*FB-E*	*FA*	*A*	*B*	*C*	*D*	*Yield*	*2002*
I	0.04	0.27	0.04	0.25	446	15	30	11	501	1738
II	0.04	0.19	0.04	0.17	316	18	28	11	373	1826
III	0.06	0.16	0.06	0.14	265	36	33	15	349	1851
IV	0.05	0.20	0.05	0.18	332	23	30	15	400	1812
V	0.10	0.20	0.10	0.18	318	52	28	34	432	1809
VI	0.12	0.25	0.12	0.22	390	61	35	40	526	1753

	CONSTRAIN F	**Maintain catch ratios**
I	Maintain Fs as estimated for 2001.	
II		Maintain catches as estimated for 2001.
III		Maintain catches as agreed TAC for 2001
IV	Fjuv=0.05, Fad=0.20	Maintain catch ratios for fleets A:C and B:D
V	Fjuv=0.10, Fad=0.20	Maintain catch ratios for fleets A:C and B:D
VI	Fjuv=0.12, Fad=0.25	maintain catch ratios for fleets A:C and B:D

Based on F status quo = F2000

	Predictions for 2001, based on F values from 2000									(in '000t)
	Fjuv	*Fad*	*Fleet F's*		*Fleet Yields in '000t*				*TOTAL*	*SSB*
	(0-1 ring)	*(2-6 ring)*	*FB-D*	*FA*	*A*	*B*	*C*	*D*	*Yield*	*2001*
	0.047	0.415	0.046	0.396	463	20	41	13	537	1145

	Prediction summary: Yields for 2002									(in '000t)
Scenario	*Fjuv*	*Fad*	*Fleet F's*		*Fleet Yields in '000t*				*TOTAL*	*SSB*
	(0-1 ring)	*(2-6 ring)*	*FB-E*	*FA*	*A*	*B*	*C*	*D*	*Yield*	*2002*
VII	0.047	0.415	0.044	0.392	589	16	52	11	668	1453

<u>F-values</u>	<u>Maintain catch ratios</u>
as in 2000	maintain catch ratios for fleets A:C and B:D

Table 2.12.1 North Sea herring. Percentage difference in estimated stock numbers at age between the final WG2000 assessment and an assessment (NEW) with the same settings but using the updated data for catch in numbers, weights at age, maturity at age and the revised acoustic survey index. Formula: perc = NEW/WG2000 –1. Years indicate the years for which the stock numbers are estimated.

	1997	1998	1999	2000
0	0%	2%	-4%	0%
1	-1%	0%	2%	-4%
2	0%	-1%	0%	2%
3	0%	-1%	-1%	0%
4	0%	0%	-1%	-1%
5	0%	-2%	-3%	-2%
6	0%	-5%	0%	0%
7	0%	0%	-8%	-7%
8	0%	0%	0%	0%
9	0%	0%	0%	0%

Table 2.12.2 North Sea herring. Comparison of parameter estimates for the ICA model in the 2000 and 2001 WG.

Parameter	age or year	WG2000 Maximum Likelihood Estimate	WG2000 CV	WG2001 Maximum Likelihood Estimate	WG2001 CV	% diff in estimate
Separable model : F by year	1992	0.6788	11	not estimated		
	1993	0.8532	10	not estimated		
	1994	0.771	10	not estimated		
	1995	0.9406	10	not estimated		
	1996	0.4134	12	not estimated		
	1997	0.4444	13	0.4424	15	0%
	1998	0.5122	14	0.5466	15	7%
	1999	0.4222	16	0.4765	15	13%
	2000	not estimated		0.4306	17	
Separable Model: Selection (S1) by age (1992-1996)	0	0.3241	13	not estimated		
	1	0.4318	13	not estimated		
	2	0.8383	13	not estimated		
	3	0.9913	11	not estimated		
	4	1	Fixed	not estimated		
	5	0.9763	11	not estimated		
	6	0.9393	10	not estimated		
	7	0.8588	10	not estimated		
		1	Fixed	not estimated		
Separable Model: Selection (S) by age (1997 onwards)	0	0.0513	21	0.0534	20	4%
	1	0.1728	21	0.1618	20	-6%
	2	0.546	20	0.6348	19	16%
	3	0.9919	12	0.9388	18	-5%
	4	1	Fixed	1	Fixed	0%
	5	0.9776	11	1.1142	17	14%
	6	0.9412	10	1.131	16	20%
	7	0.8567	10	0.8497	17	-1%
	8	1	Fixed	1	Fixed	0%
Separable model: Populations in year 1999 resp 2000	0	101611333	16	61907349	17	
	1	6479538	14	30235862	15	
	2	4727806	12	2303959	13	
	3	3109968	12	2244771	12	
	4	1062665	12	1680910	13	
	5	386192	15	476298	15	
	6	238566	15	211297	18	
	7	115452	16	103615	20	
	8	31706	17	51665	21	
Separable model: Populations at age	1992	83546	26	not estimated		
	1993	163461	19	not estimated		
	1994	153868	17	not estimated		
	1995	78349	16	not estimated		
	1996	28675	17	not estimated		
	1997	23126	15	32155	28	39%
	1998	27401	15	24735	22	-10%
	1999	not estimated		25862	21	
Recruitment in year 2000 resp 2001	2000/2001	52391691	27	80554218	28	
MLAI : Q	1	2.927	10	2.985	17	2%
MLAI: K	1	0.00003149	10	0.00002358	17	-25%
Acoustic survey Q	2	1.627	22	1.619	22	0%
Acoustic survey Q	3	1.913	22	1.892	22	-1%
Acoustic survey Q	4	2.08	22	2.16	22	4%
Acoustic survey Q	5	2.317	23	2.426	23	5%
Acoustic survey Q	6	2.417	23	2.638	23	9%
Acoustic survey Q	7	2.397	23	2.689	23	12%
Acoustic survey Q	8	2.638	24	3.359	23	27%
Acoustic survey Q	9	3.421	23	4.929	23	44%
IBTSA: 2-5+ wr Q	2	1.51E-04	12	1.54E-04	12	2%
IBTSA: 2-5+ wr Q	3	1.03E-04	12	1.14E-04	12	11%
IBTSA: 2-5+ wr Q	4	6.99E-05	12	6.98E-05	12	0%
IBTSA: 2-5+ wr Q	5	3.77E-05	12	4.09E-05	13	9%
IBTSY 1-wr Q	1	1.33E-04	5	1.38E-04	6	3%
MIK 0-wr Q	0	2.97E-06	5	3.03E-06	5	2%
Beverton: a	1	8.45E+07	40	8.34E+07	41	-1%
Beverton: b	1	6.91E+05	66	6.60E+05	69	-4%

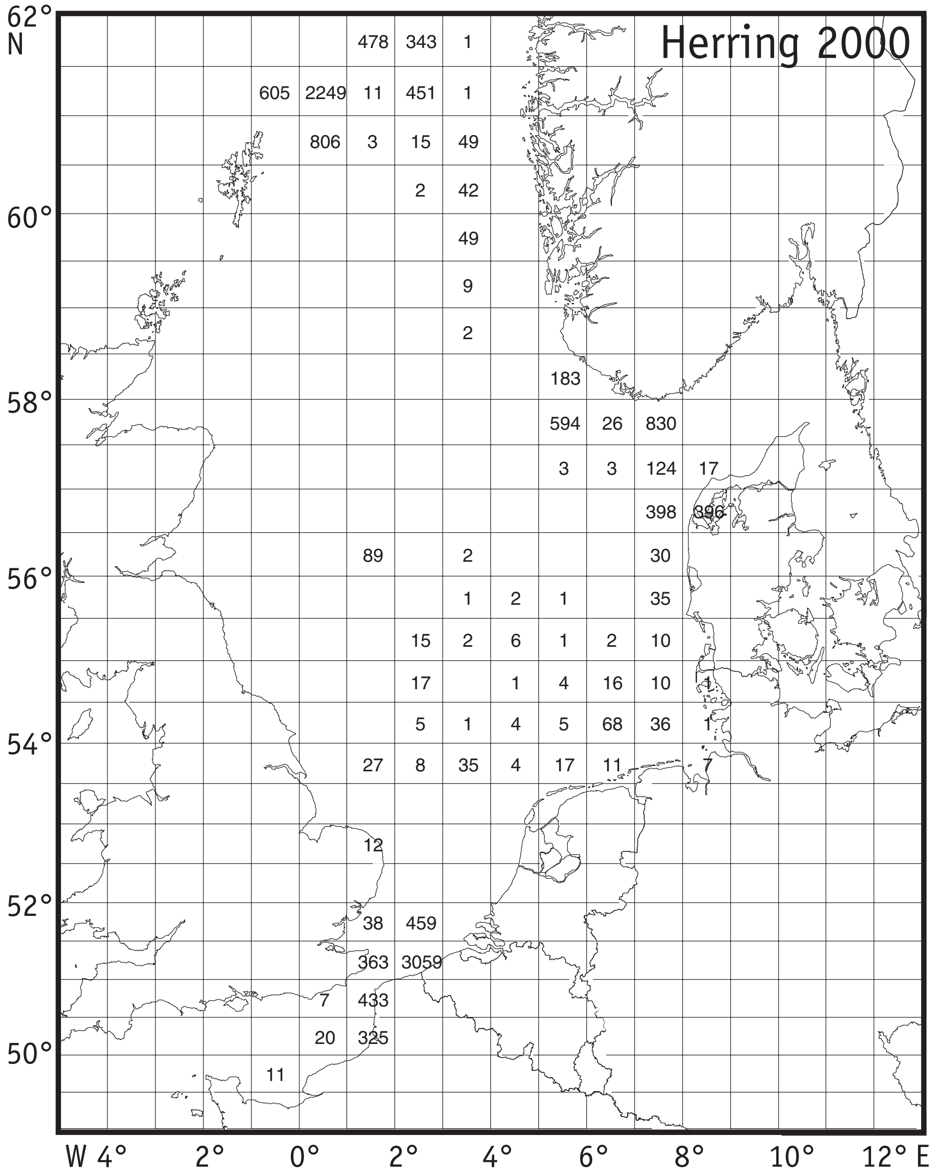


Fig. 2.1.1: Herring catches (in tonnes) in the North Sea in 2000 by statistical rectangle. Working Group estimates (if available). **a.:** 1st quarter

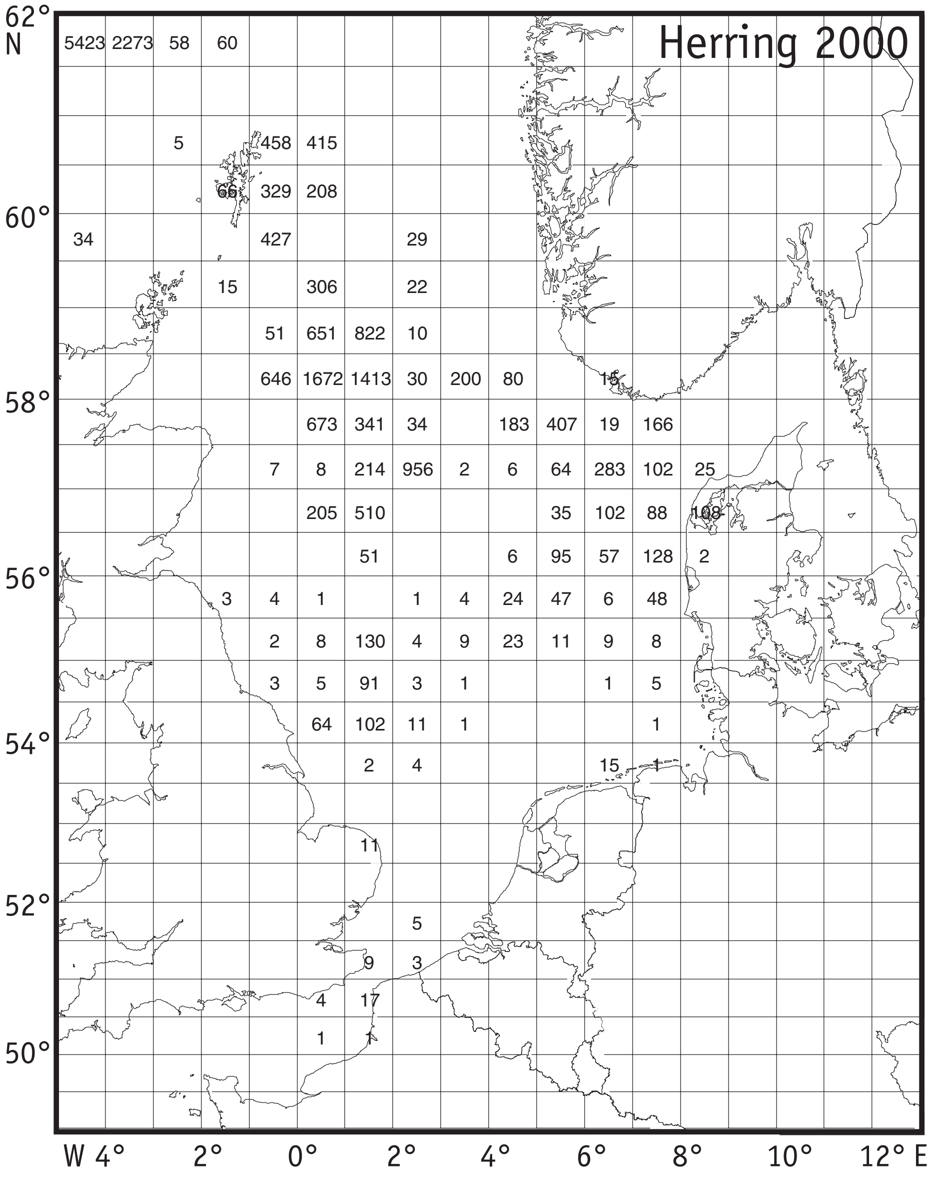


Fig. 2.1.1: Herring catches (in tonnes) in the North Sea in 2000 by statistical rectangle. Working Group estimates (if available). **b.:** 2nd quarter

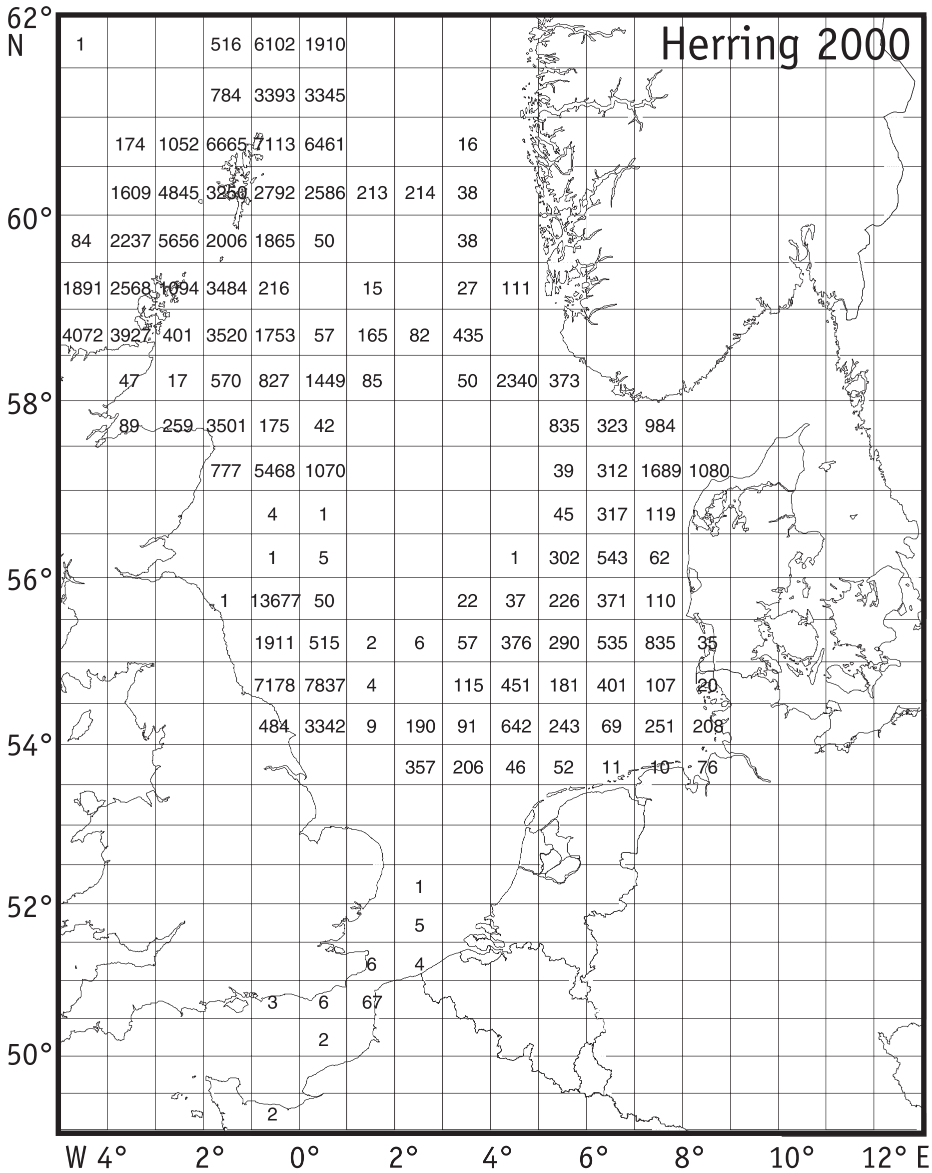


Fig. 2.1.1: Herring catches (in tonnes) in the North Sea in 2000 by statistical rectangle. Working Group estimates (if available). **c.:** 3rd quarter

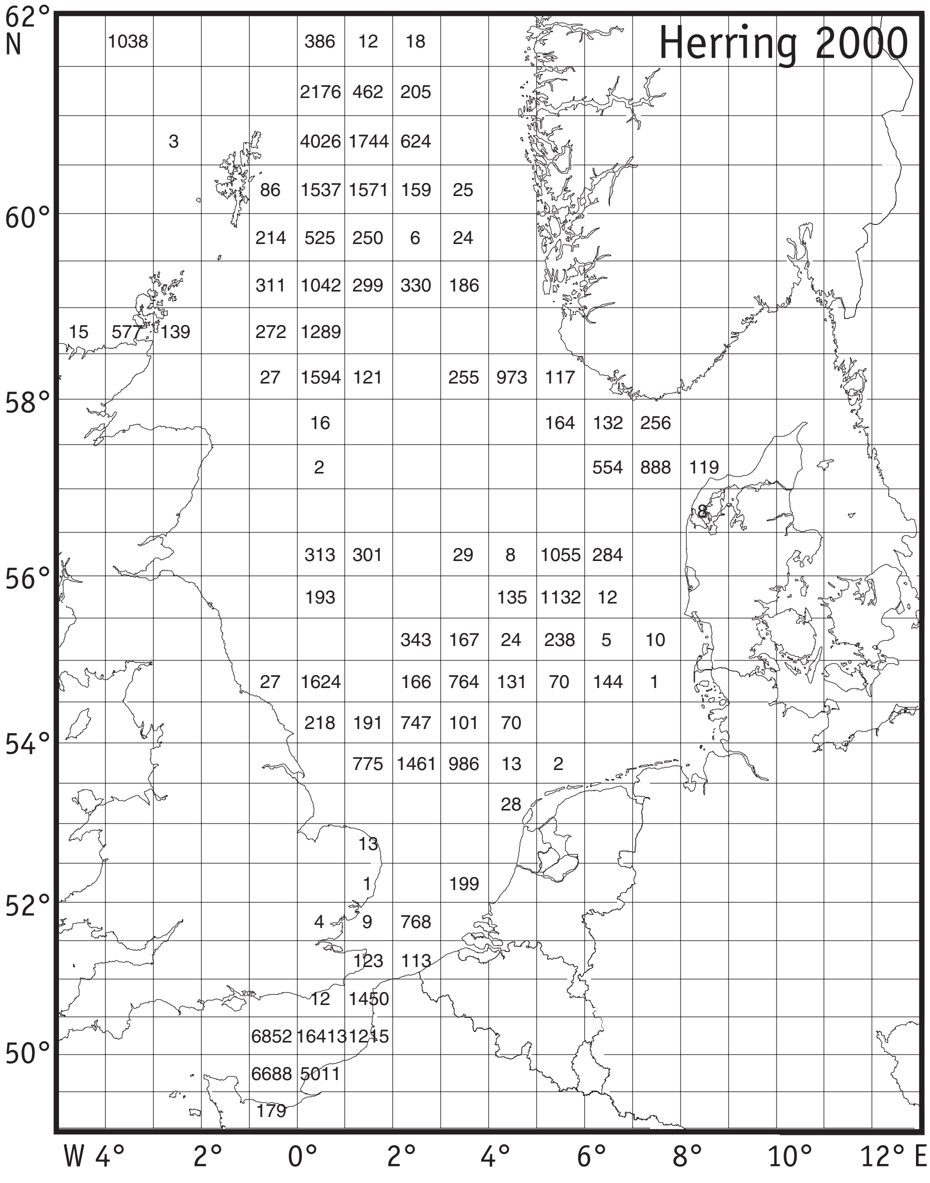


Fig. 2.1.1: Herring catches (in tonnes) in the North Sea in 2000 by statistical rectangle. Working Group estimates (if available). **d.:** 4th quarter

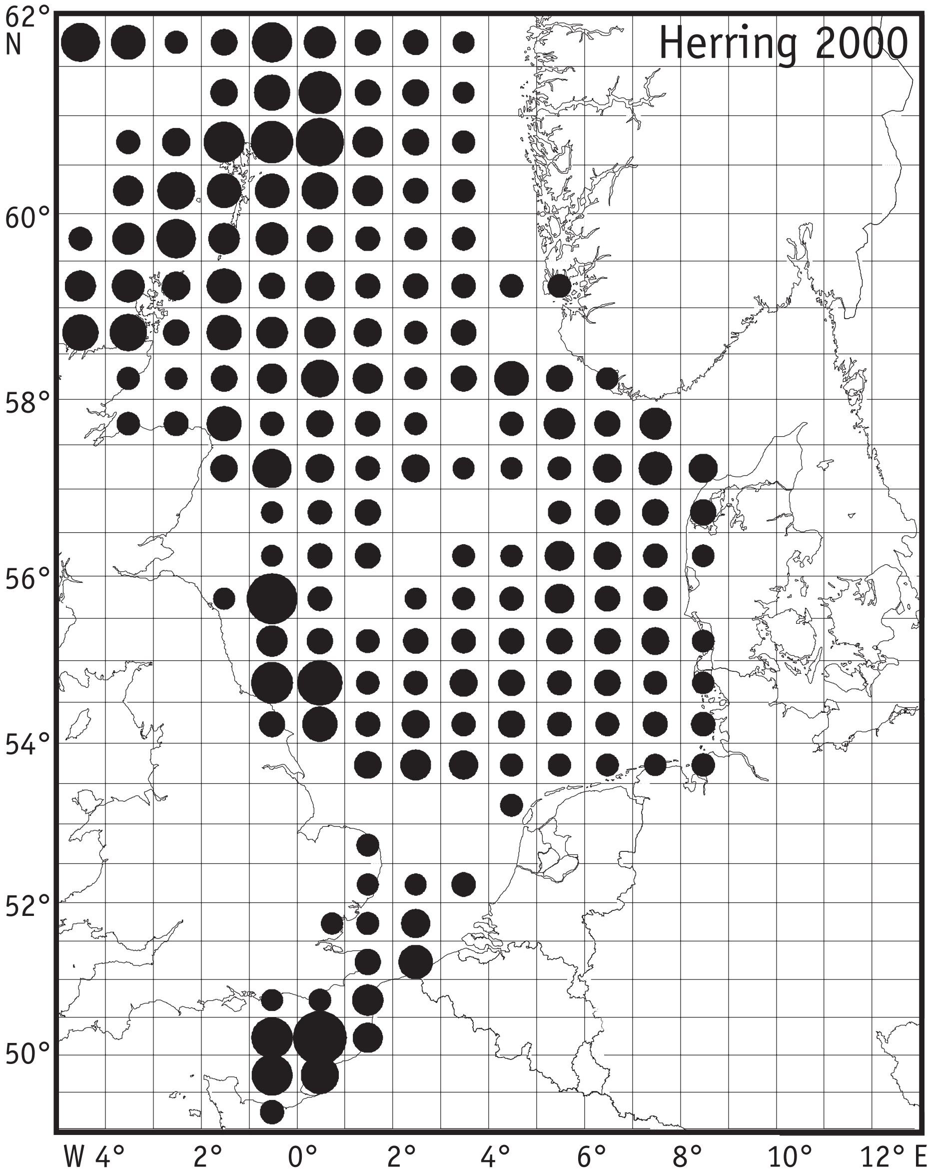


Fig. 2.1.1: Herring catches in the North Sea in 2000 by statistical rectangle. Circle diameter is proportional to catch in tonnes. Working Group estimates (if available). **e.:** all quarters

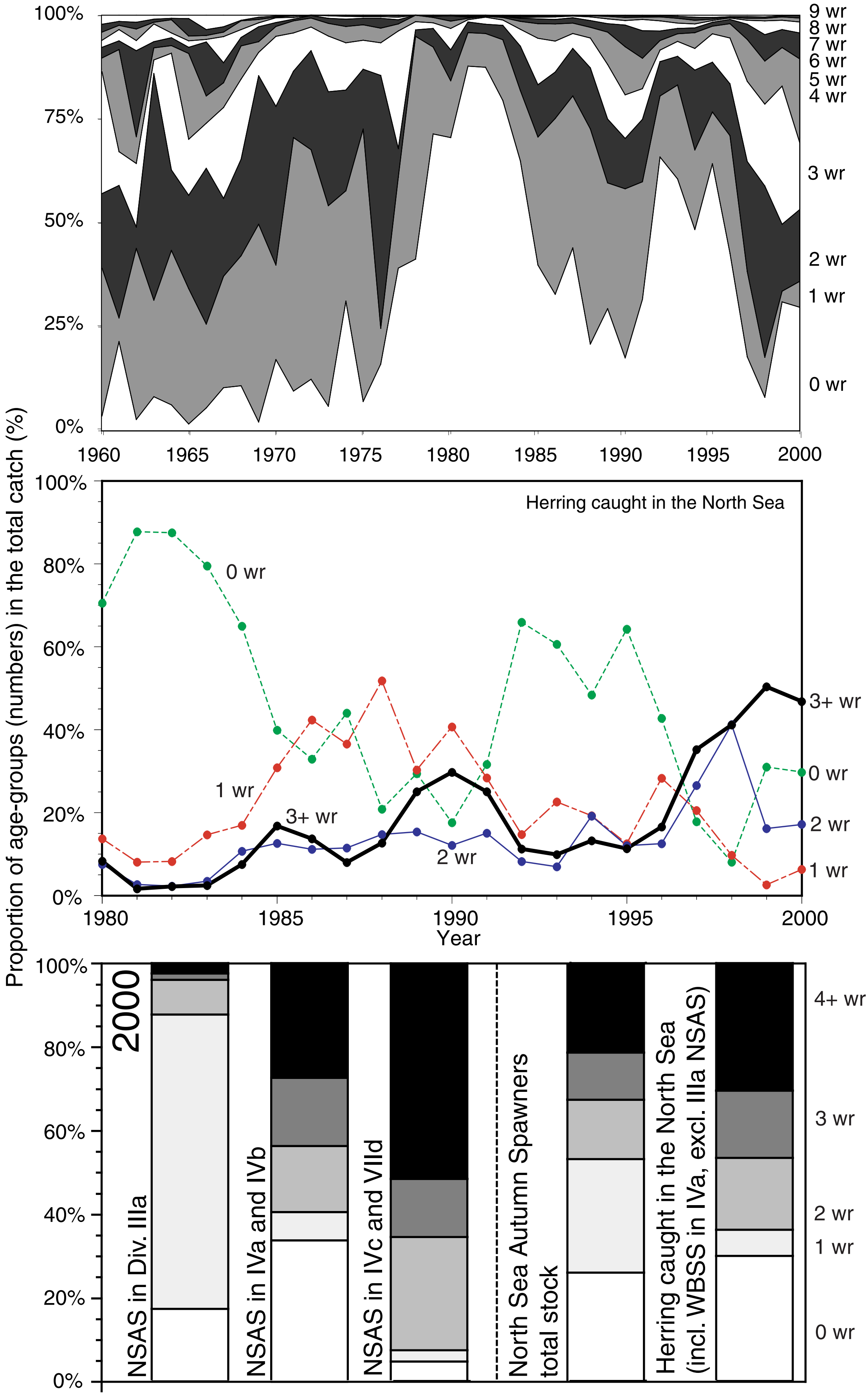


Fig. 2.2.1: Porportions of age groups (numbers) in the total catch of herring in the North Sea (upper, 1960-2000, and middle panel, 1980-2000), and in the total catch of North Sea Autumn Spawners in 2000 (lower panel).

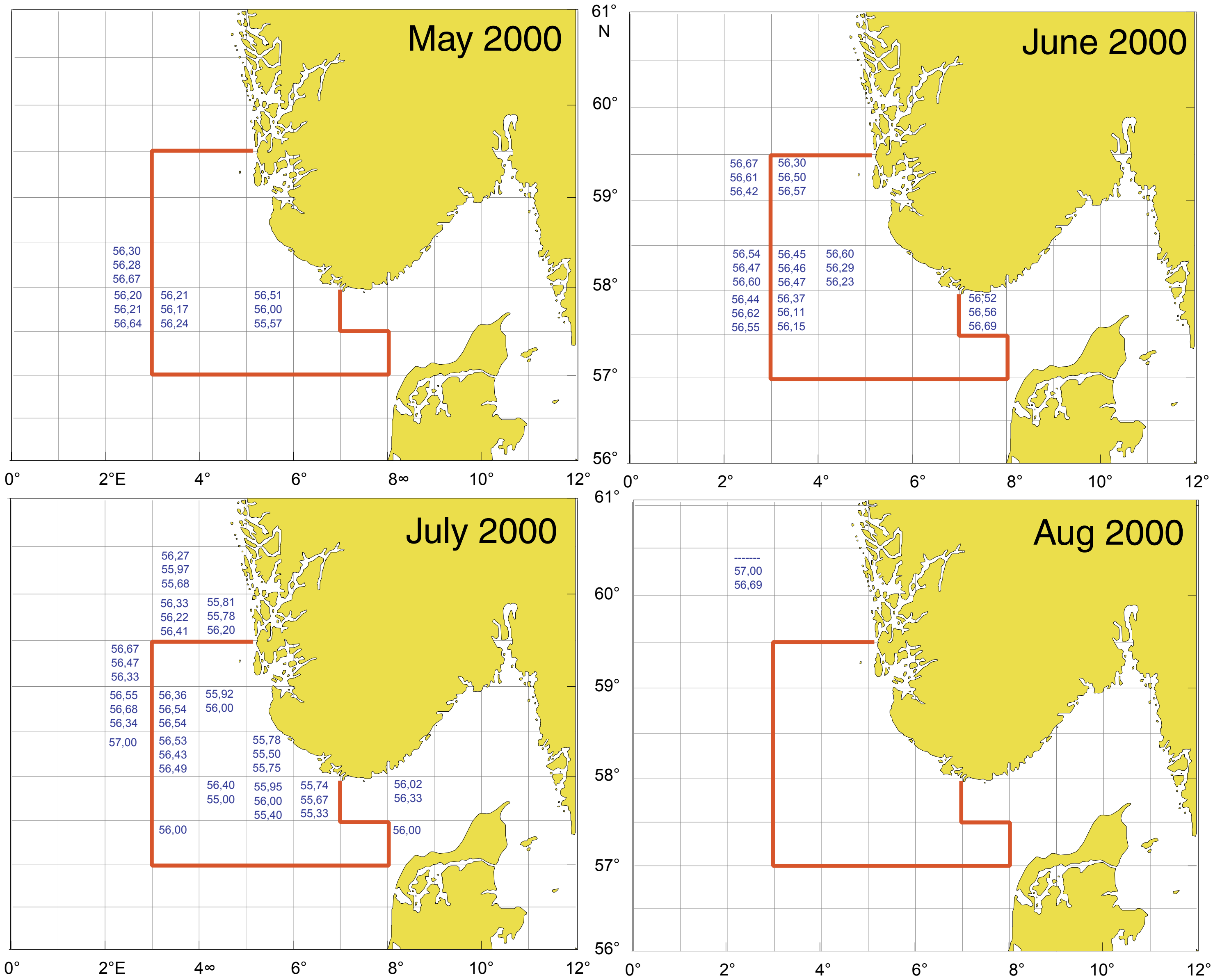


Fig. 2.2.2: Mean vertebrae counts of 2 (upper number), 3 (middle) and 4+ herring (lower) in the North Sea and Div. IIIa as obtained by Norwegian sampling in the 2nd and 3rd quarter 2000. The transfer area (Western Baltic Spring Spawners transfered to the assessment of IIIa herring) is indicated.

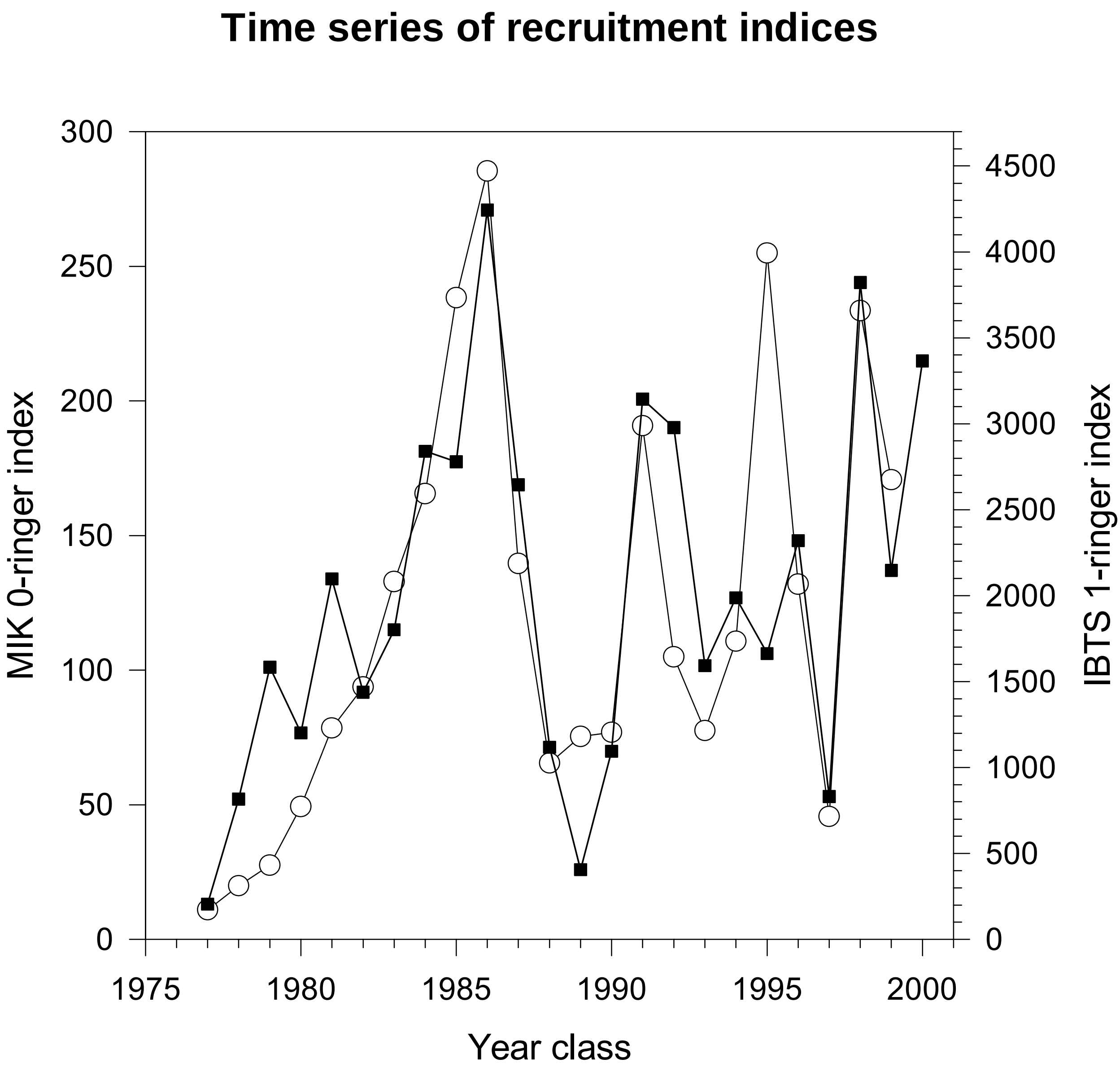


Figure 2.3.1 North Sea herring. Time series of the 0-ringer and the 1-ringer indices, 0-ringers are illustrated by filled squares, 1-ringers by open circles.

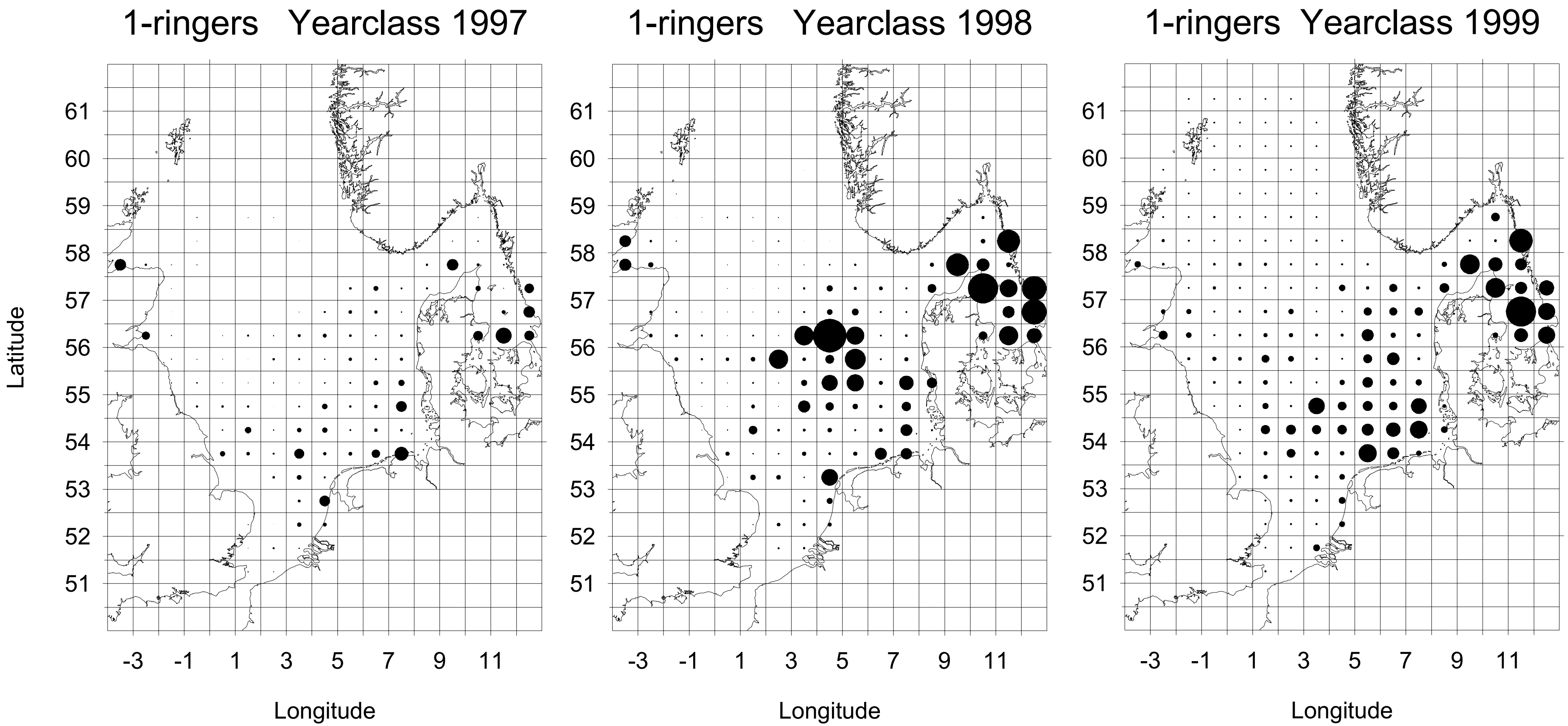


Figure 2.3.2. North Sea herring. Distribution of 1-ringer herring, year classes 1997–1999. Abundance estimates of 1-ringers within each statistical rectangle are based on GOV catches during IBTS in February. Areas of filled circles illustrate numbers per hour, the area of a circle extending to the border of a rectangle represents 45000.

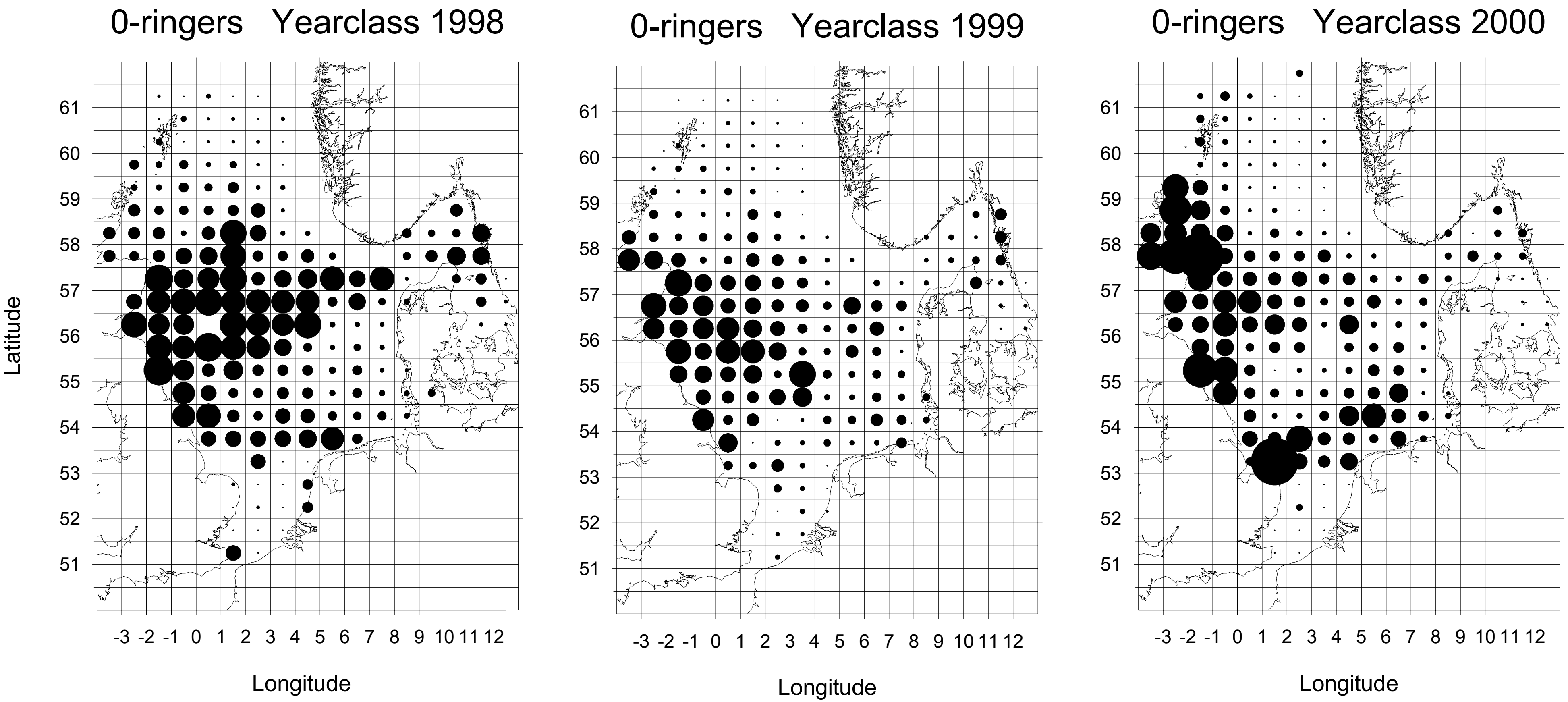


Figure 2.3.3. North Sea herring. Distribution of 0-ringer herring, year classes 1998–2000. Abundance estimates of 0-ringers within each statistical rectangle are based on MIK catches during IBTS in February. Areas of filled circles illustrate densities in no m^{-2}, the area of a circle extending to the border of a rectangle represents 1 m^{-2}

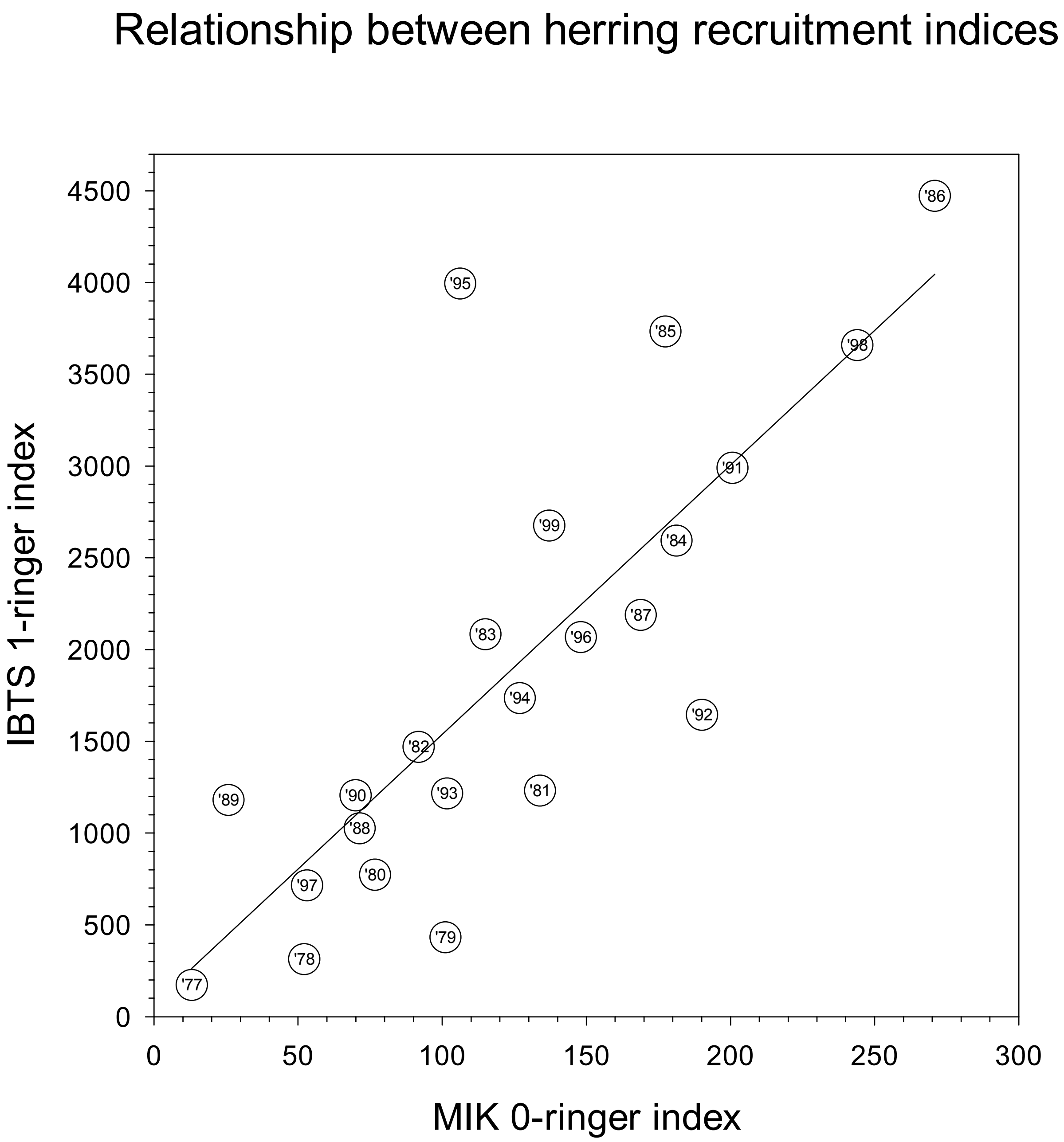


Figure 2.3.4. North Sea herring. Regression between the MIK 0-ringer index and the IBTS 1-ringer indices for year classes 1977 to 1999. Numbers in symbols indicate year class.

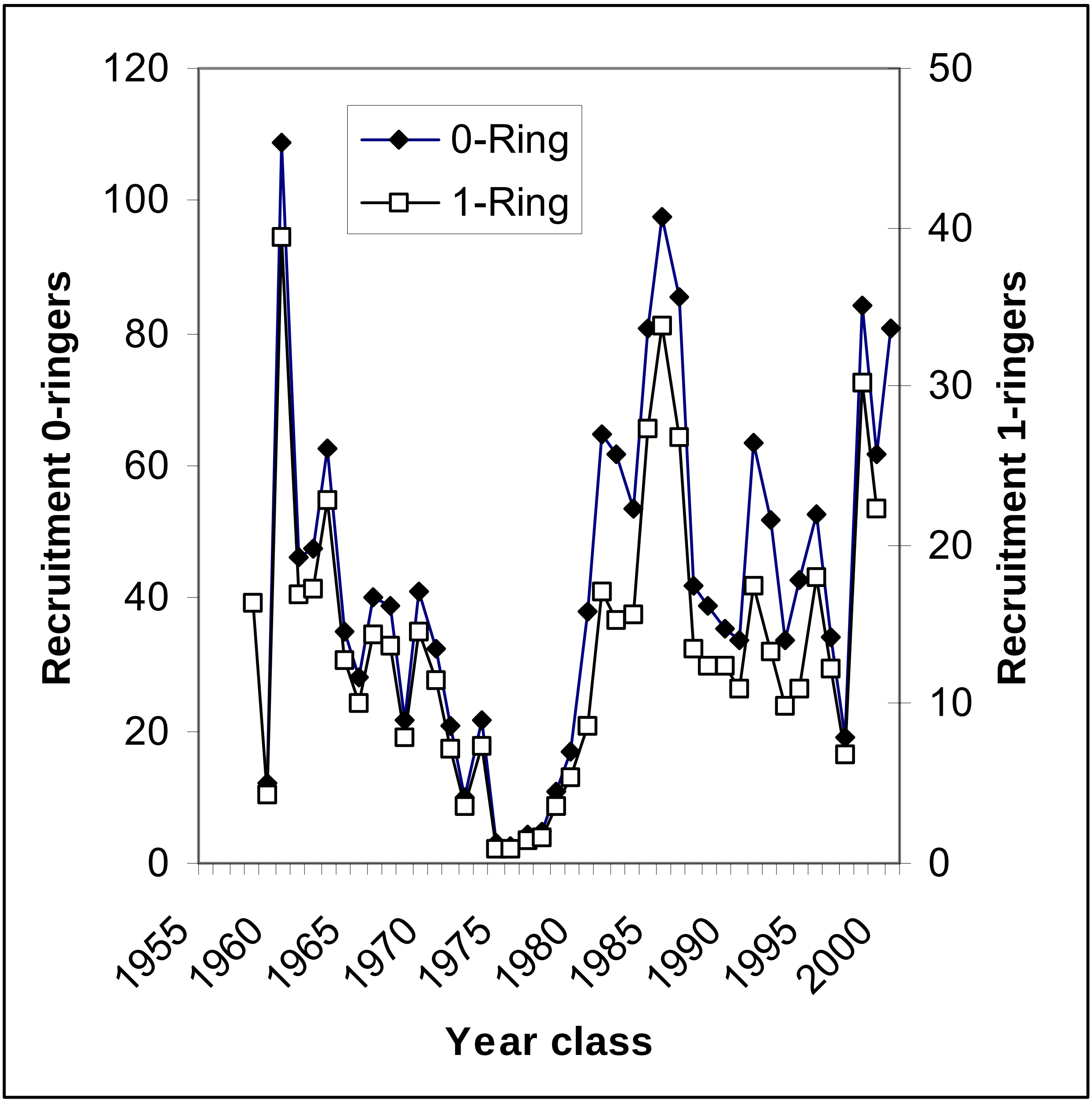


Figure 2.3.5. North Sea herring. Recruitment of 0- and 1-ringer North Sea autumn spawners. Estimates from the ICA assessment in 2001.

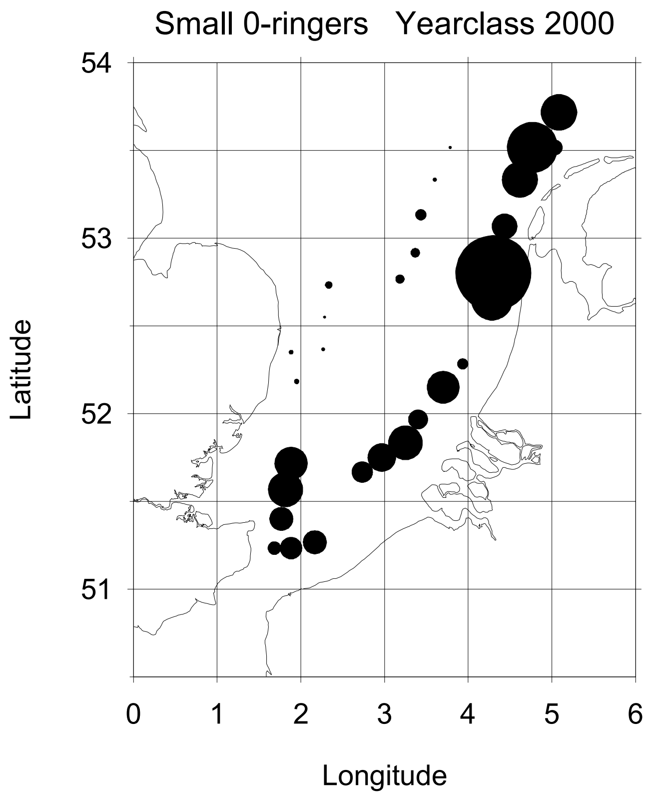


Figure 2.3.6. North Sea herring. Distribution of MIK hauls of small 0-ringers (mean length of catch <21mm). Area of circles indicate larval density, largest circle represent 240 larvae m^{-2}.

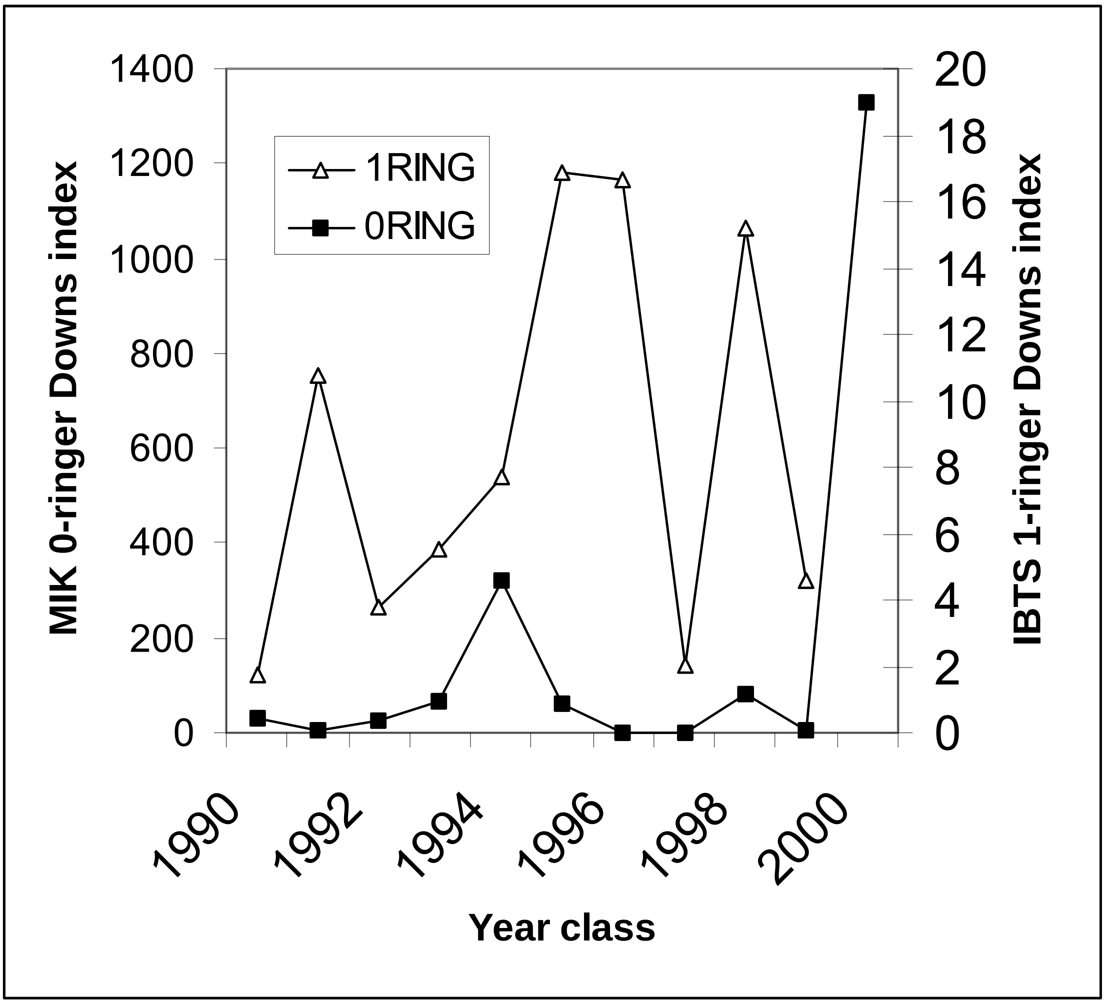


Figure 2.3.7. North Sea herring. Time series of 0-ringer and 1-ringer Downs herring indices.

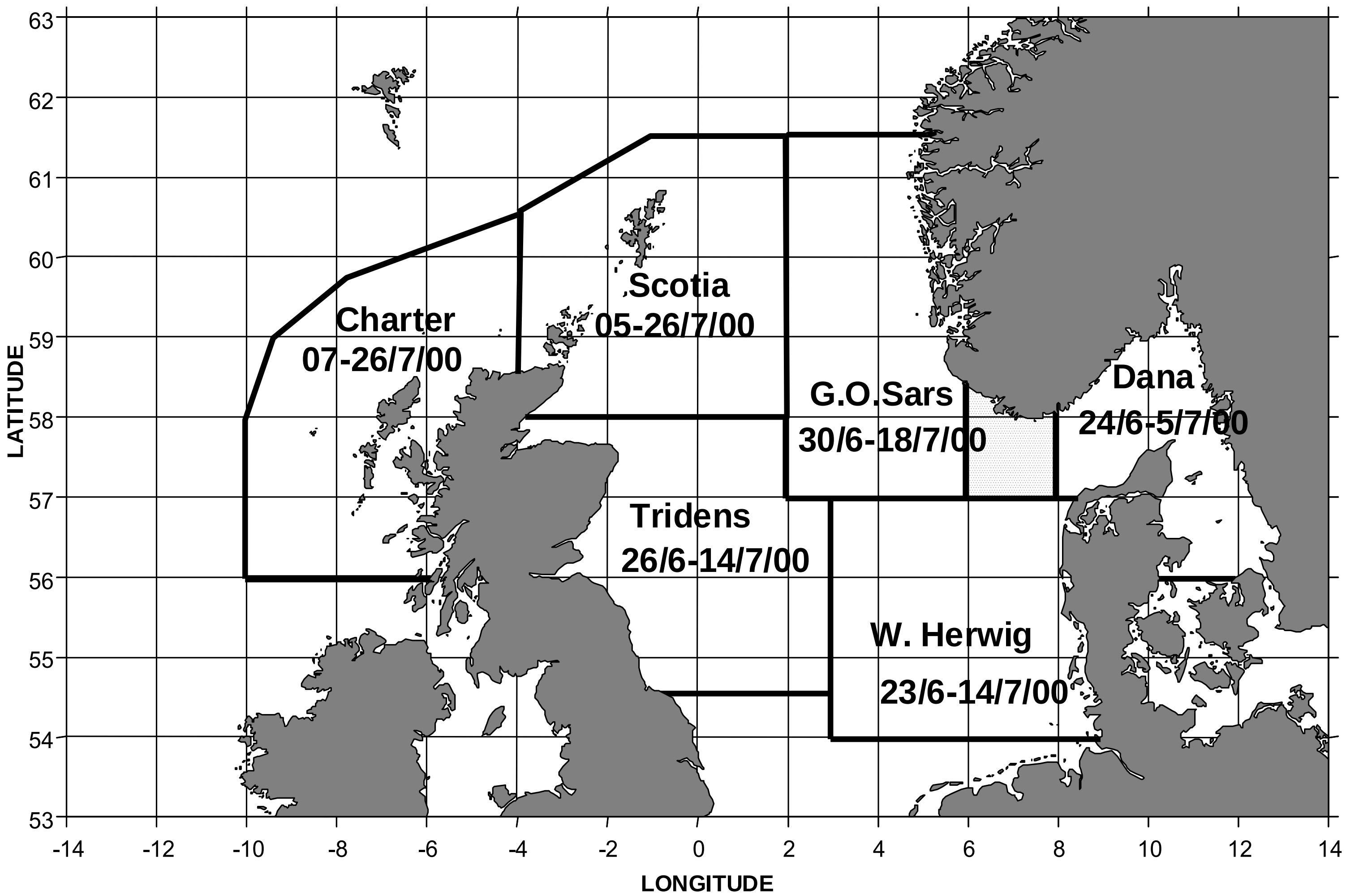


Figure 2.4.1. Survey area layouts and dates for all participating vessels in the 2000 North Sea and west of Scotland herring acoustic survey. Shaded areas indicate areas of overlap.

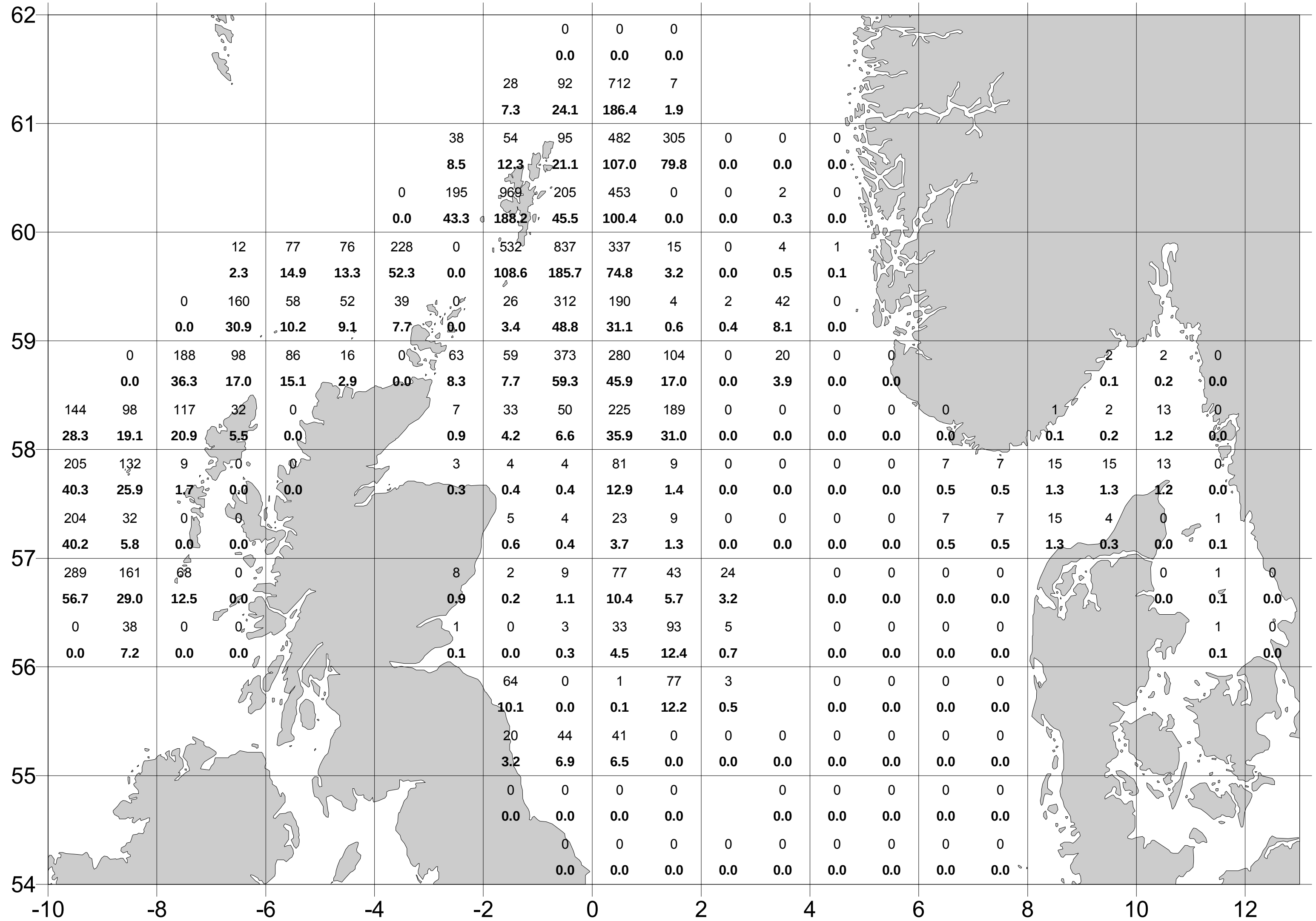


Figure 2.4.2. Numbers (millions) and biomass (thousands of tonnes) (upper and lower value) of mature autumn spawning herring from combined acoustic surveys in June July 2000.

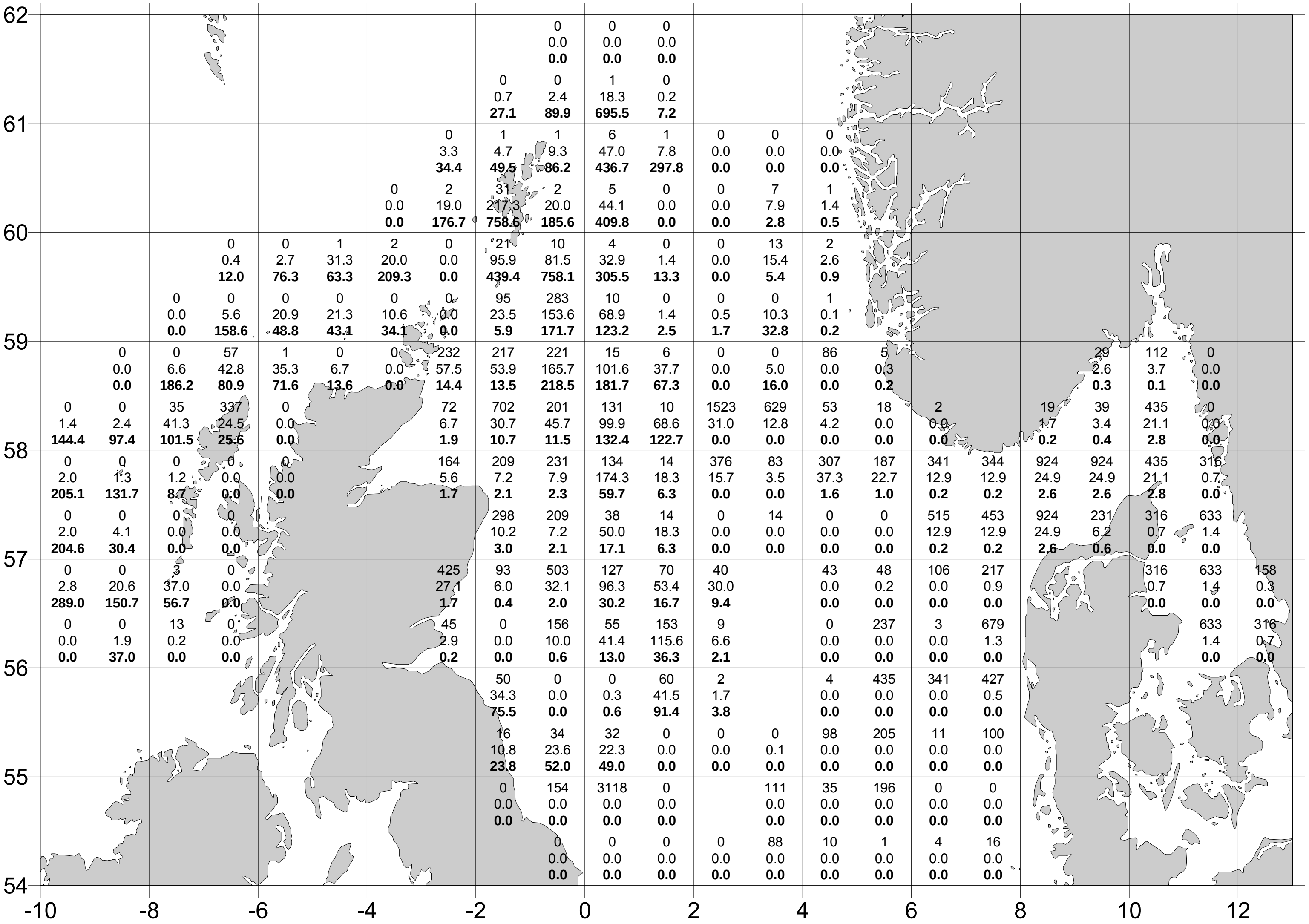


Figure 2.4.3. Numbers (millions) at ages 1, 2 3+ ring (upper middle and lower value) of autumn spawning herring from combined acoustic surveys in June July 2000.

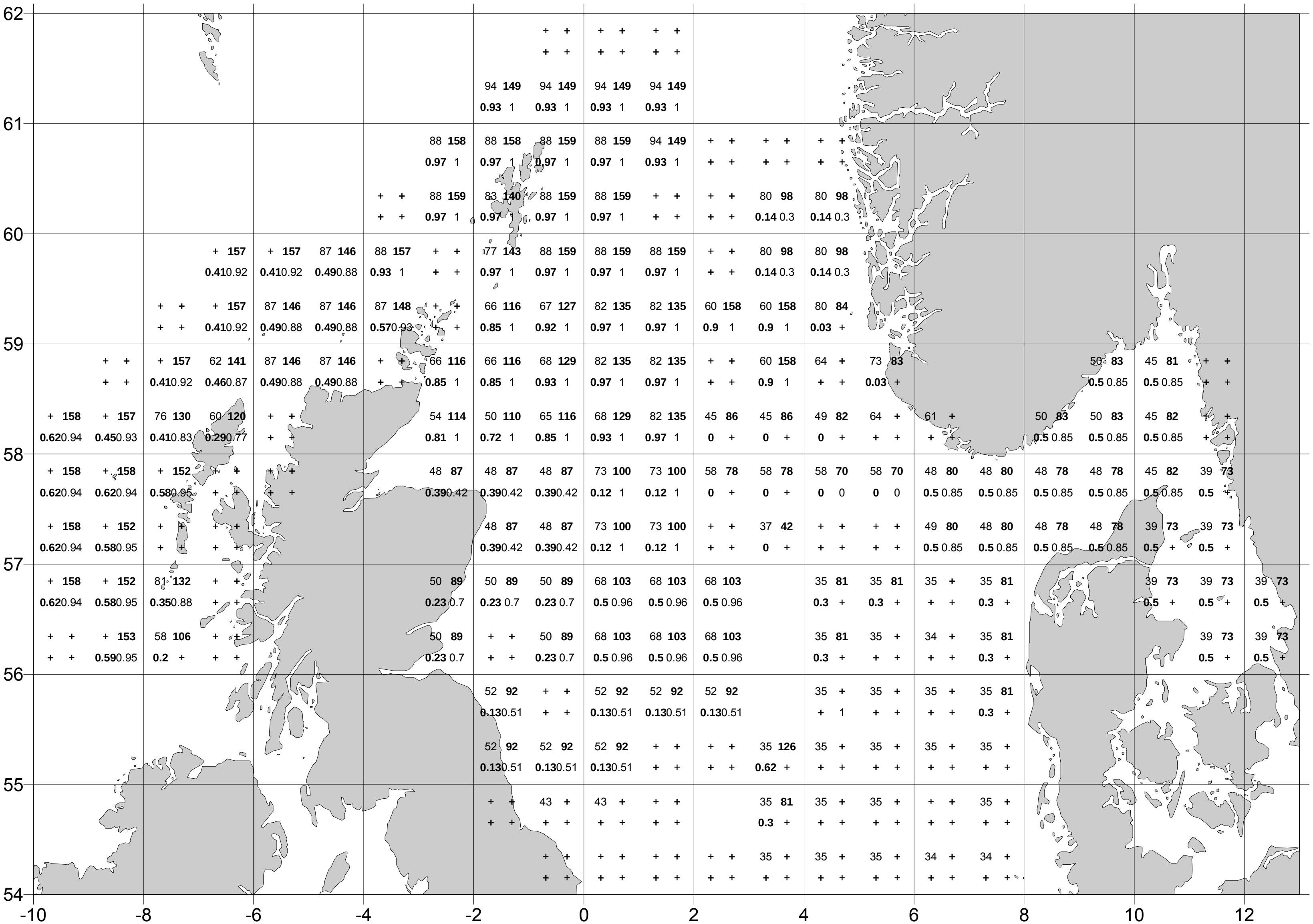


Figure 2.4.4. Mean weight (g) at ages 1, 2 ring (upper left and right value) and fraction mature at ages 2, 3 ring (lower left and right values) of autumn spawning herring from combined acoustic surveys in June July 2000.

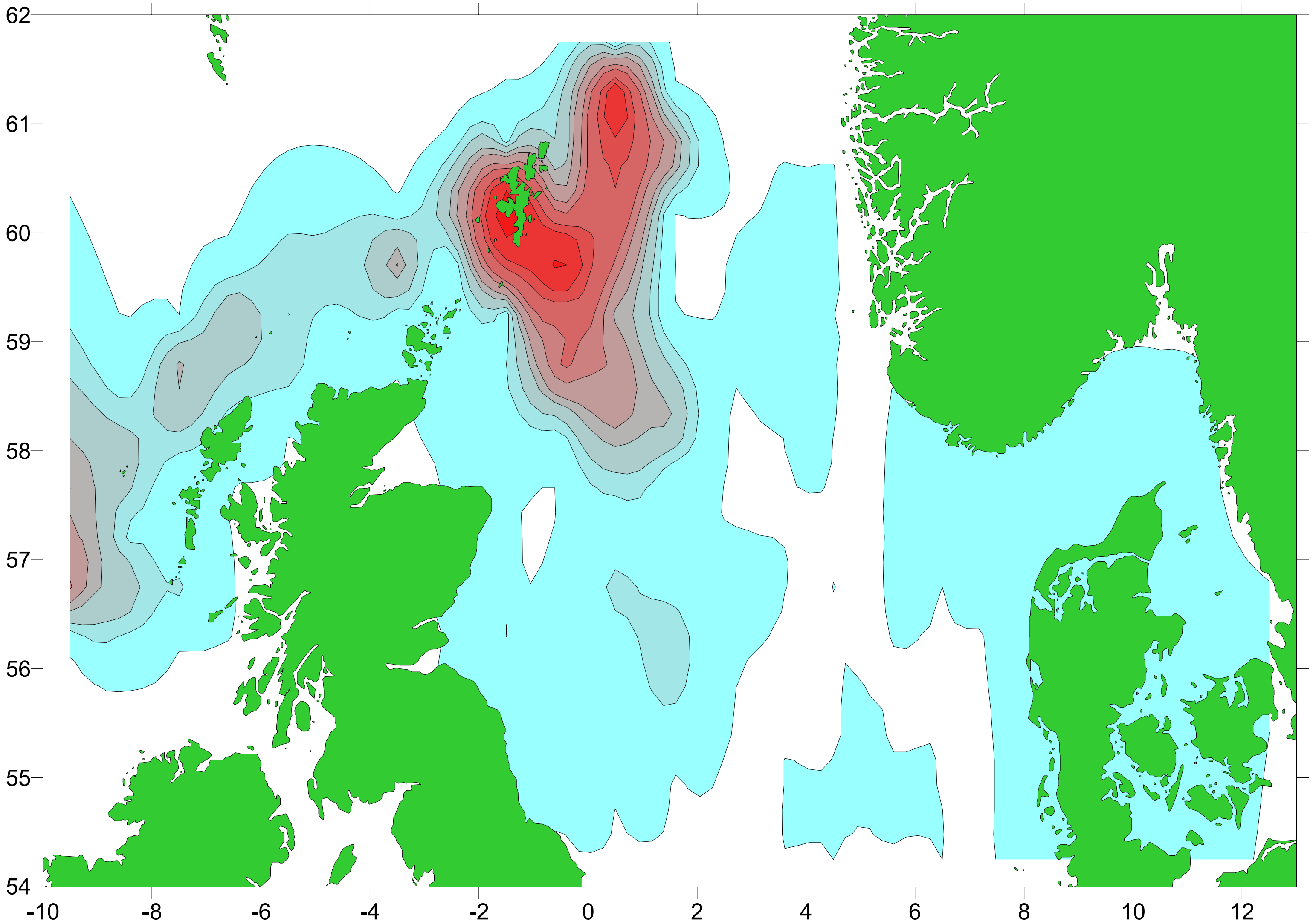


Figure 2.4.5. Relative spatial distribution of mature autumn spawning herring from combined acoustic surveys in June July 2000. 10% of the population is contained within each contour. Contour colour indicated density.

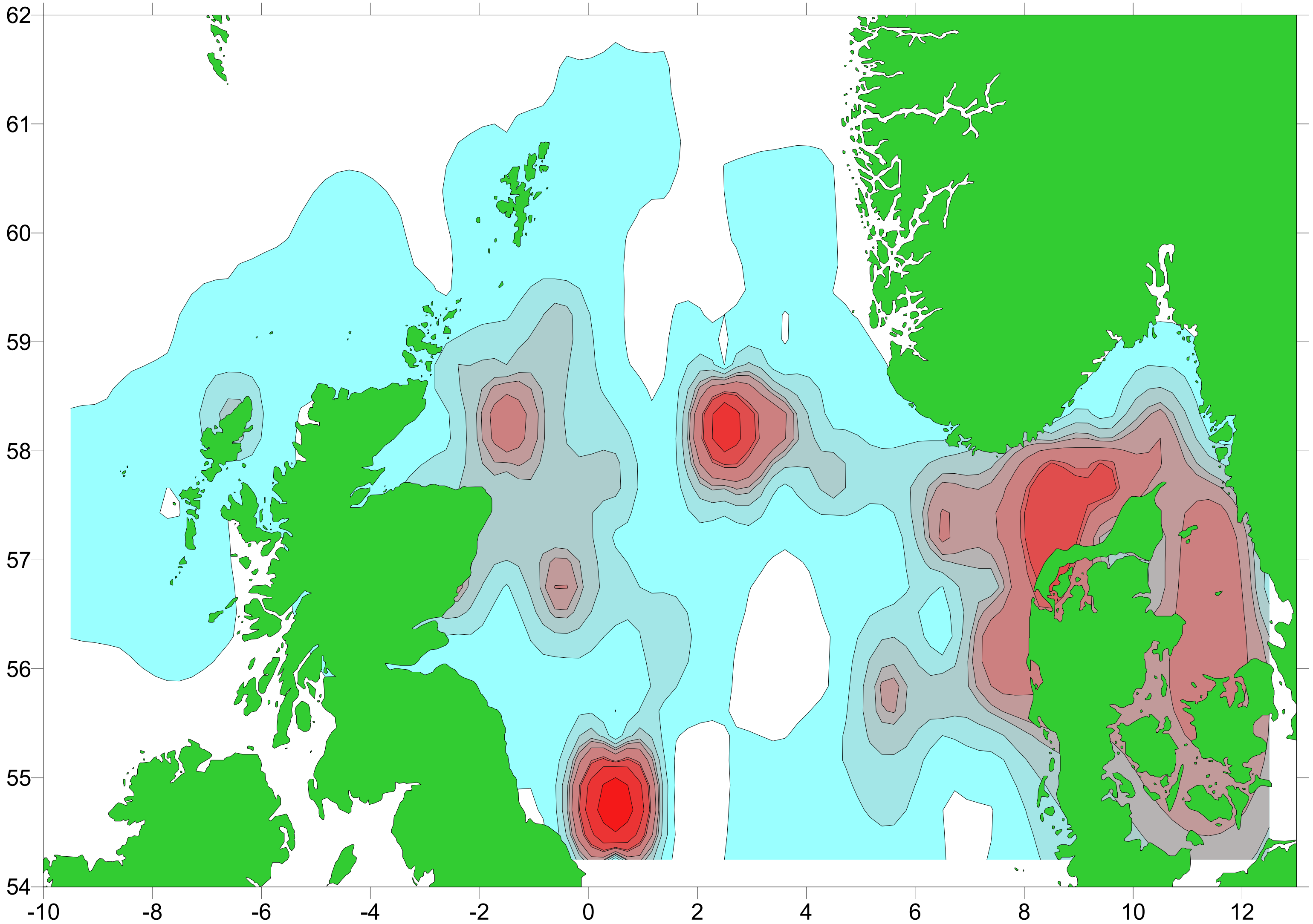


Figure 2.4.6. Relative spatial distribution of juvenile autumn spawning herring from combined acoustic surveys in June July 2000. 10% of the population is contained within each contour. Contour colour indicated density.

Figure 2.8.1. North Sea herring**.** Abundance indices.

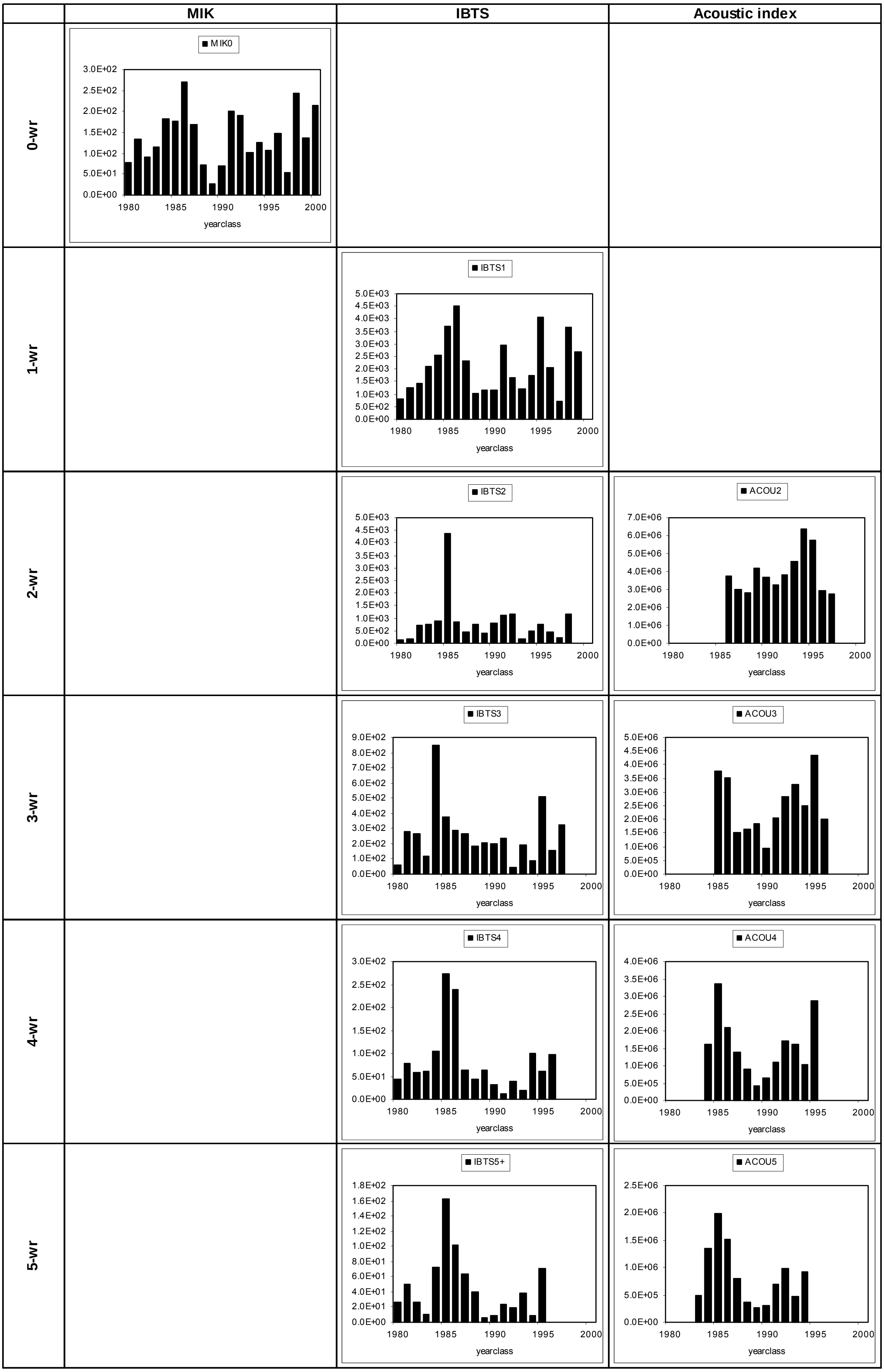


Figure 2.8.2. North Sea herring. Available SSB indices: MLAI and Acoustic index (latter not used as an SSB index in the assessment, but as an age-based index).

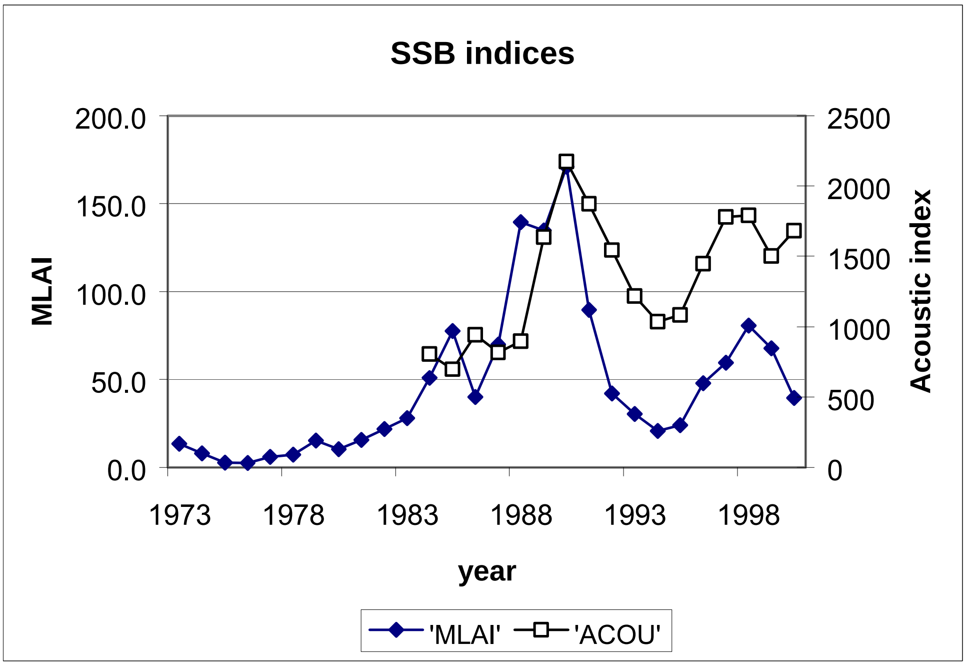
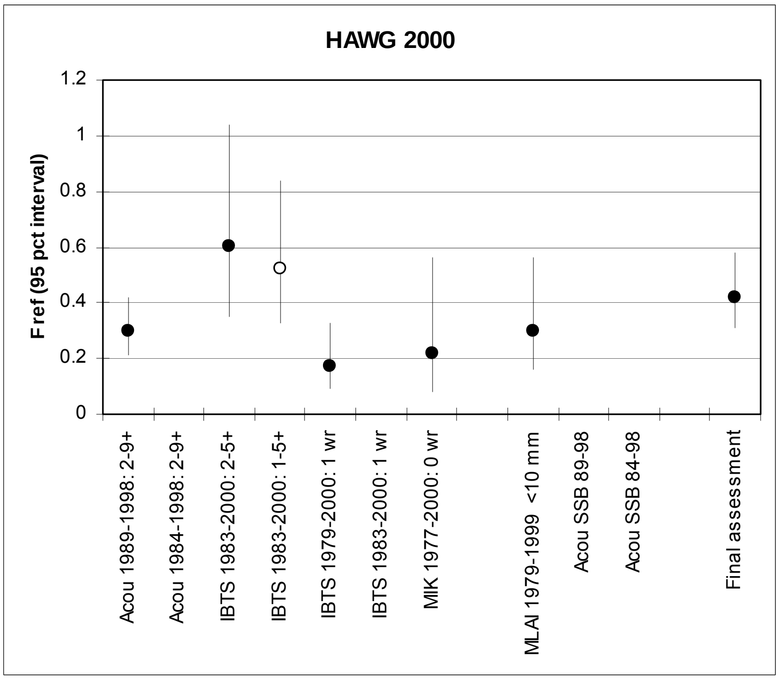


Figure 2.8.3. North Sea herring. Estimates of fishing mortality at reference age (+/- 95 c.l.) in the ICA model fitted to the separate indices and the catch at age matrix. Each index is given an equal weight. The dark circles indicate which indices are used in the final assessment. The upper panel refers to last years assessment (using a 4 year separable period) and the lower panel to this years assessment (left: runs with 2 separable periods (ICAHER), right: runs with 1 separable period of 4 years (ICA))



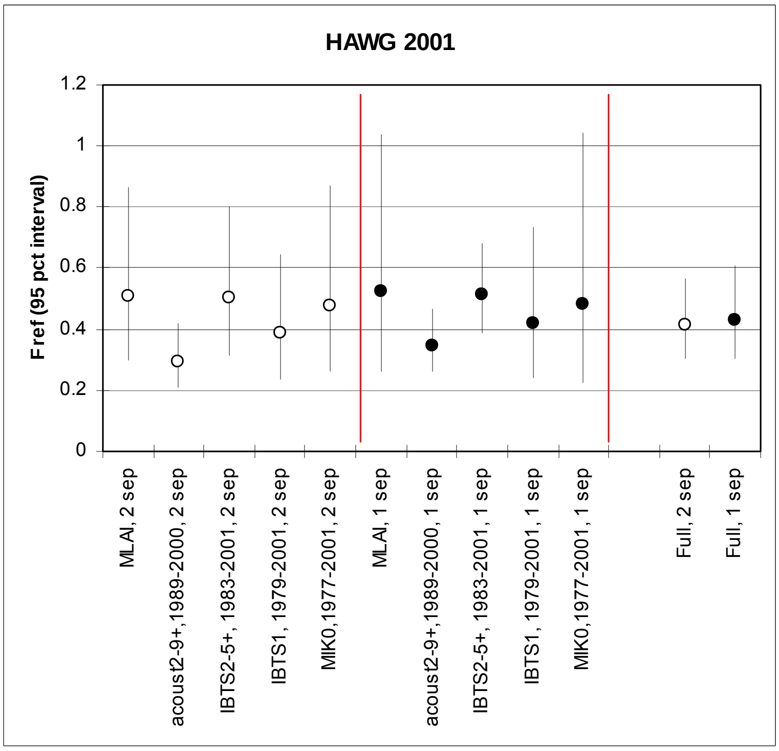
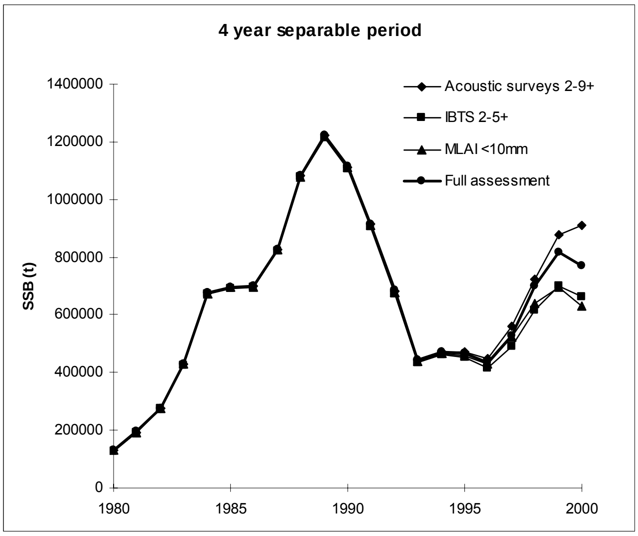


Figure 2.8.4. North Sea herring. SSB estimates from ICA model with separate indices and with all indices combined. Left: 4 year separable period using ICA, right: 2 separable periods using ICAHER.



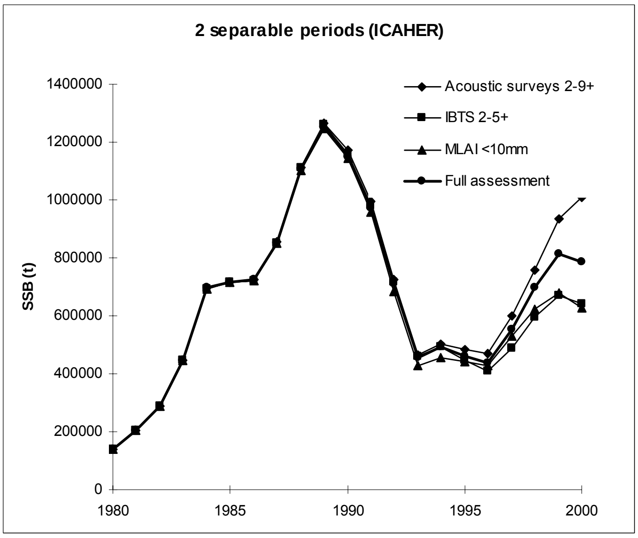


Figure 2.8.5. North Sea herring. **Upper panel**: sum of squares (SSQ) surfaces for the tuning indices from a separable analysis. SSBx1 refers to the MLAI estimate of spawning biomass, the age-indices 1 to 4 refer to the acoustic index (1), the IBTS 2-5+ index (2), the IBTS 1-ringer index (3) and the MIK 0-ringer index (4). **Lower panel**: summary of landings, estimated fishing mortality at reference age 4 (wr), recruitment of 0-ringers and total biomass and spawning stock biomass.

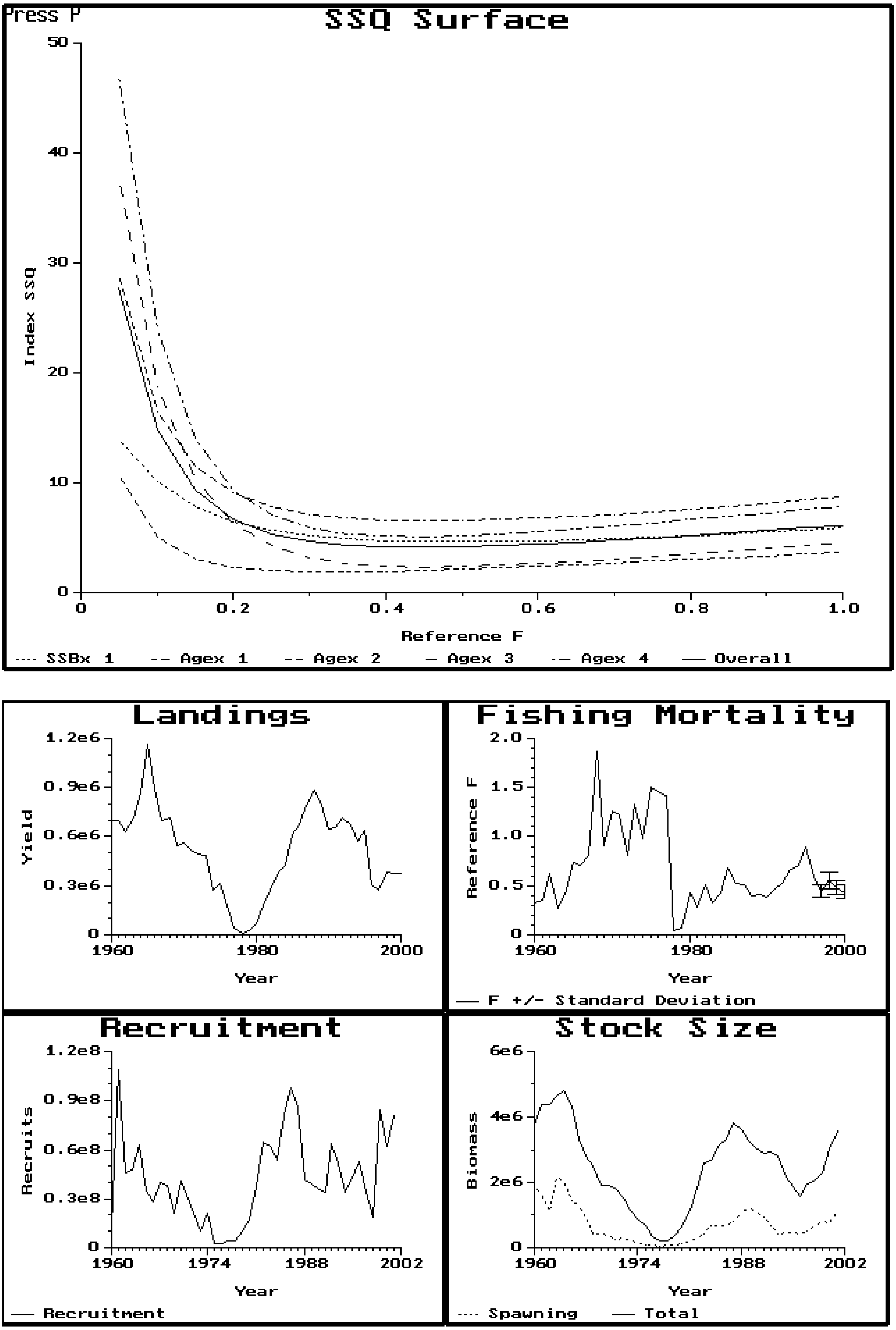


Figure 2.8.6. North Sea herring **Upper panel**: selection patterns diagnostics. Top left: contour plot of selection pattern residuals. Top right: estimated selection pattern. Bottom: marginal totals of residuals by year and age. **Lower panel**: diagnostics of the fit of the **MLAI** spawning stock biomass against the estimated SSB. Top left: spawning biomass from the fitted populations (line) and the predicted spawning biomasses from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of spawning biomass from the fitted populations and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

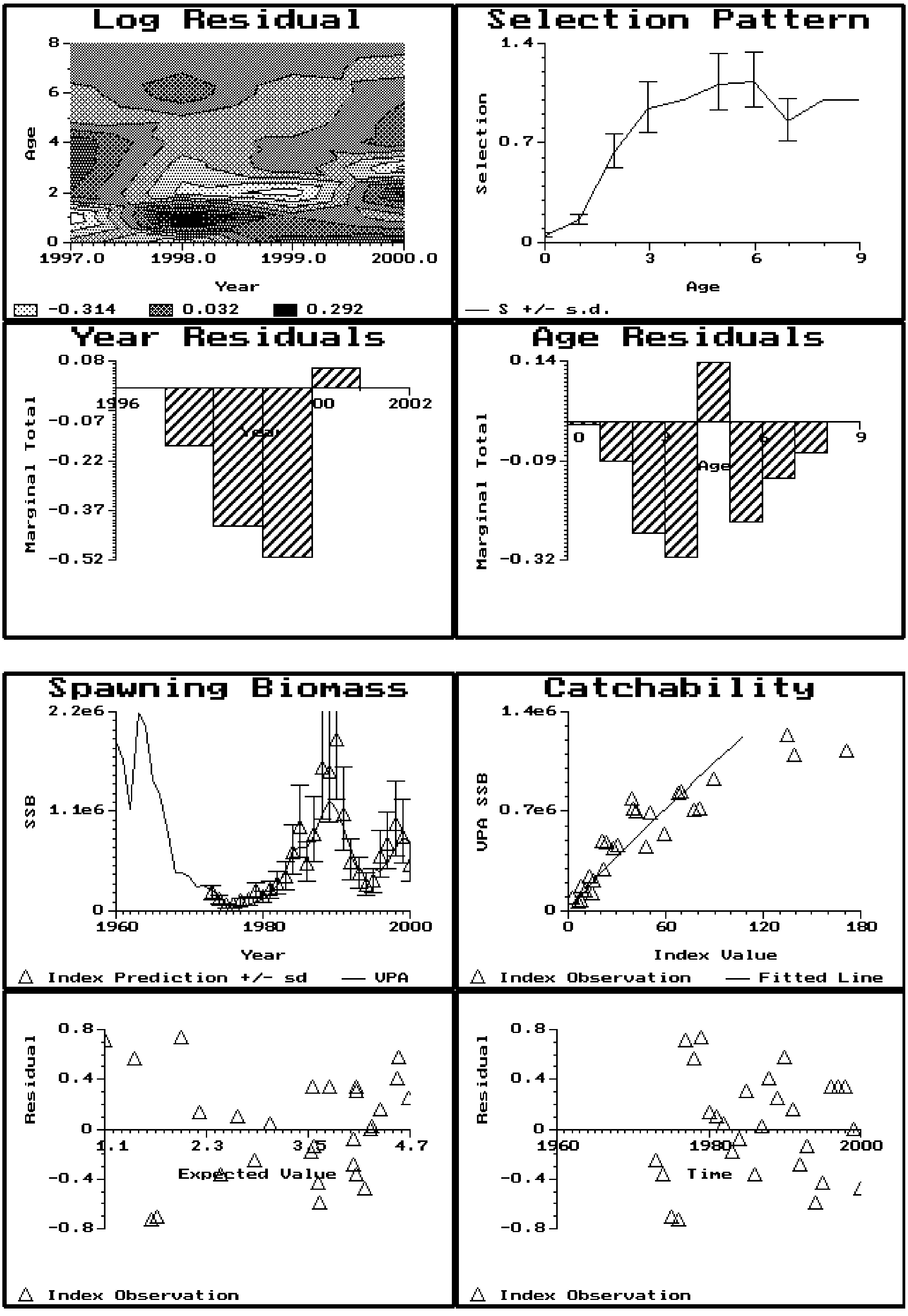


Figure 2.8.7. North Sea herring. **Upper panel**: diagnostics of the fit of the **acoustic 2-ringer index** against the estimated stock numbers at age. **Lower panel**: diagnostics of the fit of the **acoustic 3-ringer index** against the estimated stock numbers at age. Top left: fitted populations at age (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

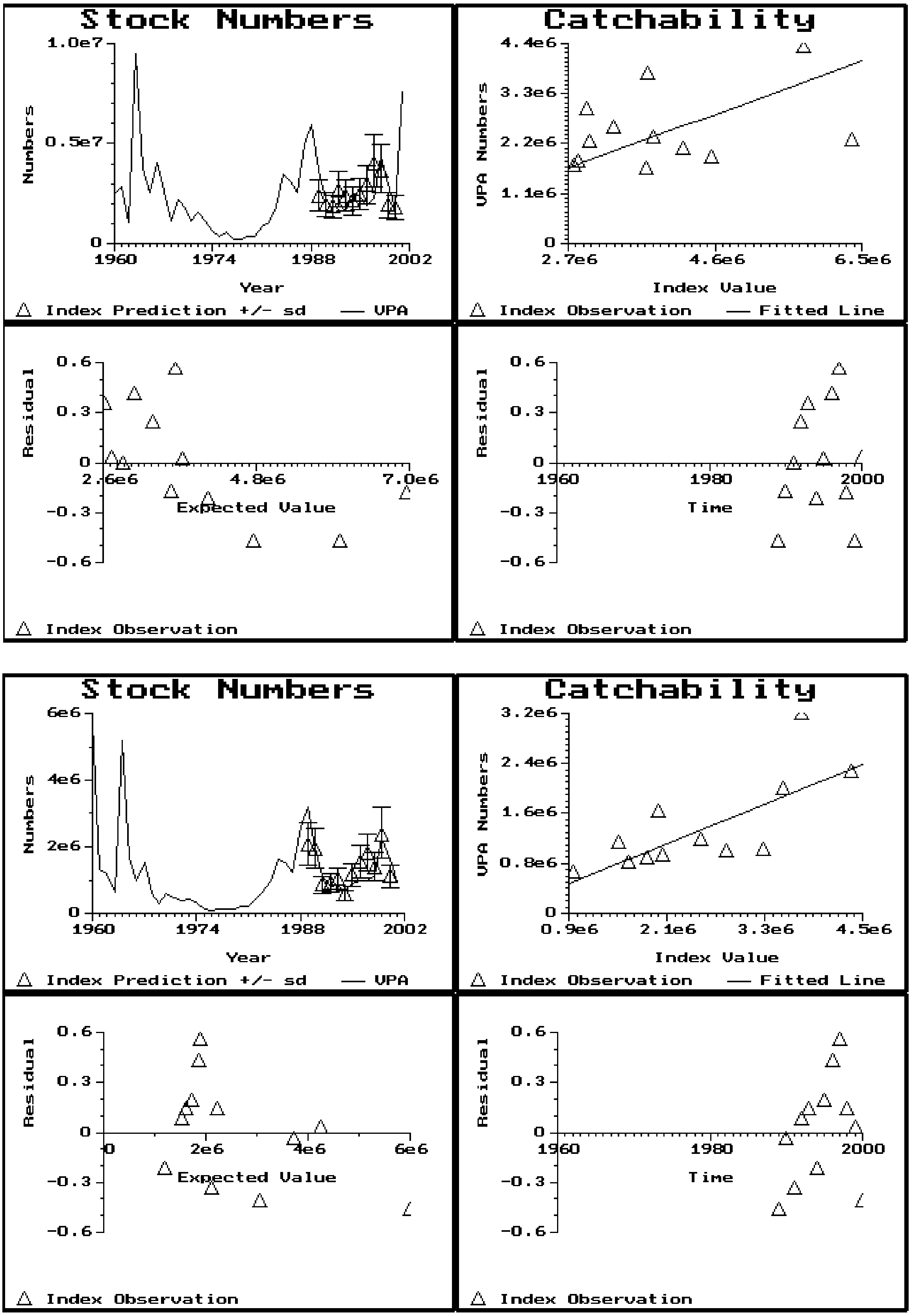


Figure 2.8.8. North Sea herring. **Upper panel**: diagnostics of the fit of the **acoustic 4-ringer index** against the estimated stock numbers at age. **Lower panel**: diagnostics of the fit of the **acoustic 5-ringer index** against the estimated stock numbers at age. Top left: fitted populations at age (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

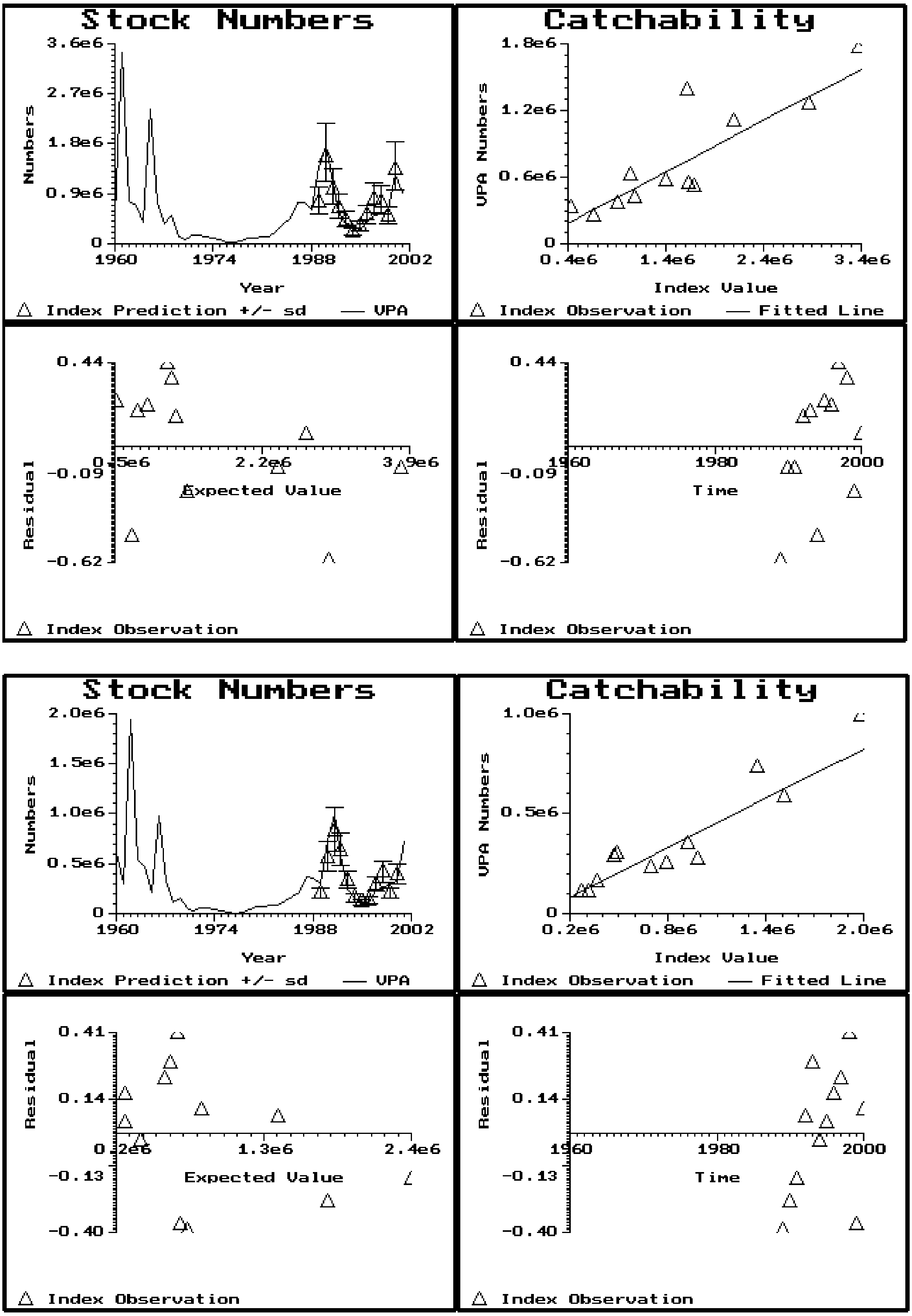


Figure 2.8.9. North Sea herring. **Upper panel**: diagnostics of the fit of the **acoustic 6-ringer index** against the estimated stock numbers at age. **Lower panel**: diagnostics of the fit of the **acoustic 7-ringer index** against the estimated stock numbers at age. Top left: fitted populations at age (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

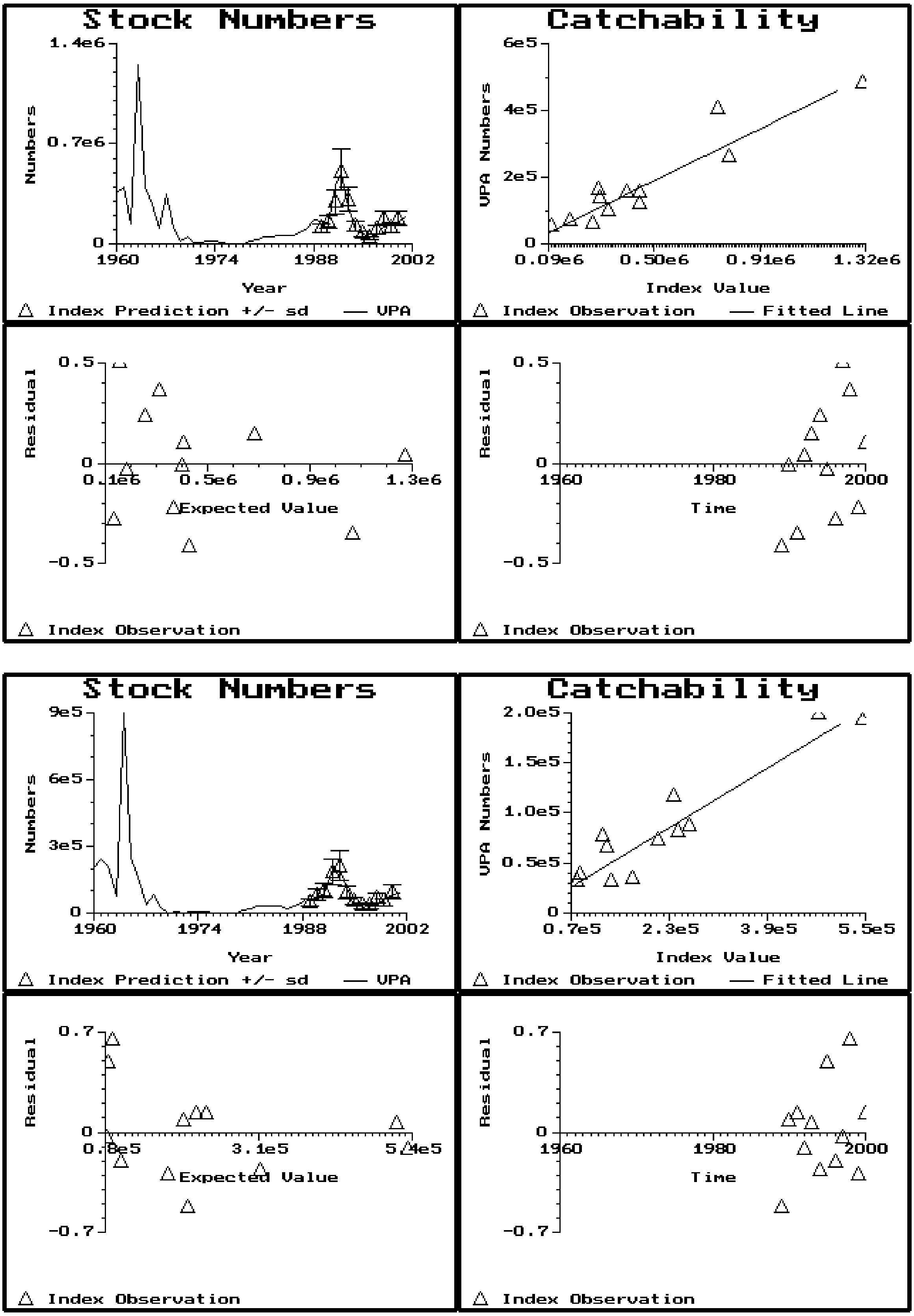


Figure 2.8.10. North Sea herring. **Upper panel**: diagnostics of the fit of the **acoustic 8-ringer index** against the estimated stock numbers at age. **Lower panel**: diagnostics of the fit of the **acoustic 9+ ringer index** against the estimated stock numbers at age. Top left: fitted populations at age (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

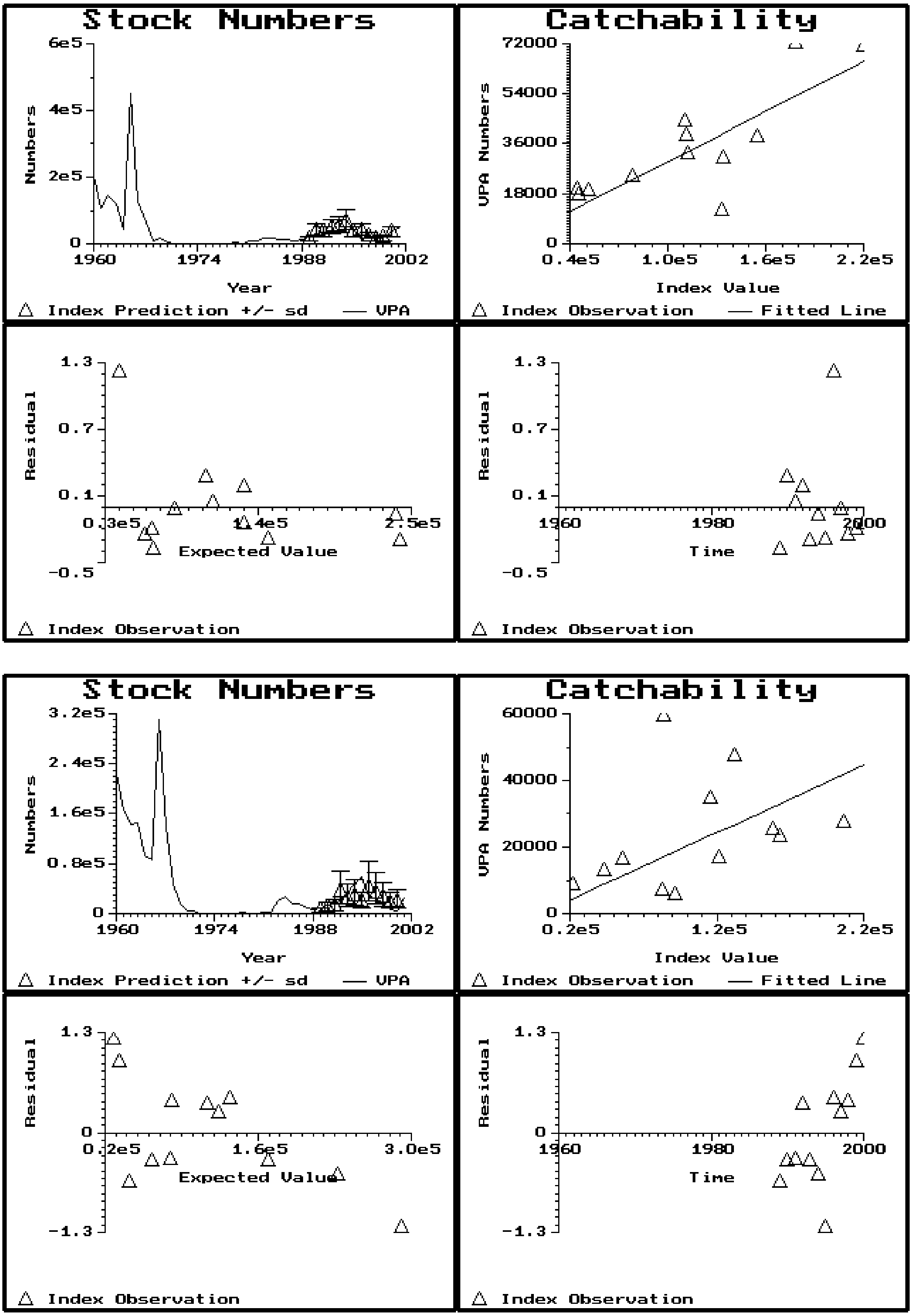


Figure 2.8.11. North Sea herring. **Upper panel**: diagnostics of the fit of the **IBTS 2-ringer index** against the estimated stock numbers at age. **Lower panel**: diagnostics of the fit of the **IBTS 3-ringer index** against the estimated stock numbers at age. Top left: fitted populations at age (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

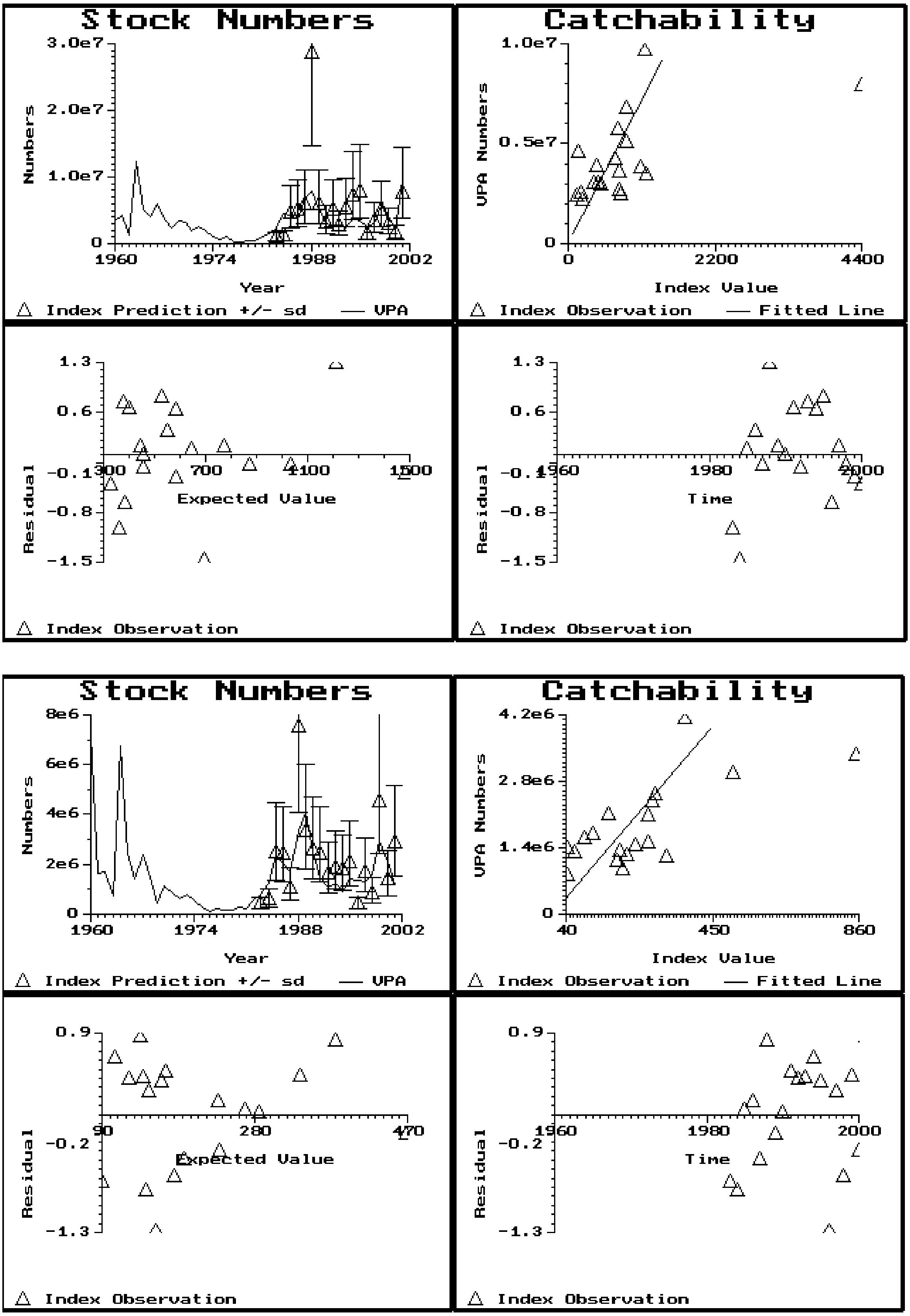


Figure 2.8.12. North Sea herring. **Upper panel**: diagnostics of the fit of the **IBTS 4-ringer index** against the estimated stock numbers at age. **Lower panel**: diagnostics of the fit of the **IBTS 5+ ringer index** against the estimated stock numbers at age. Top left: fitted populations at age (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

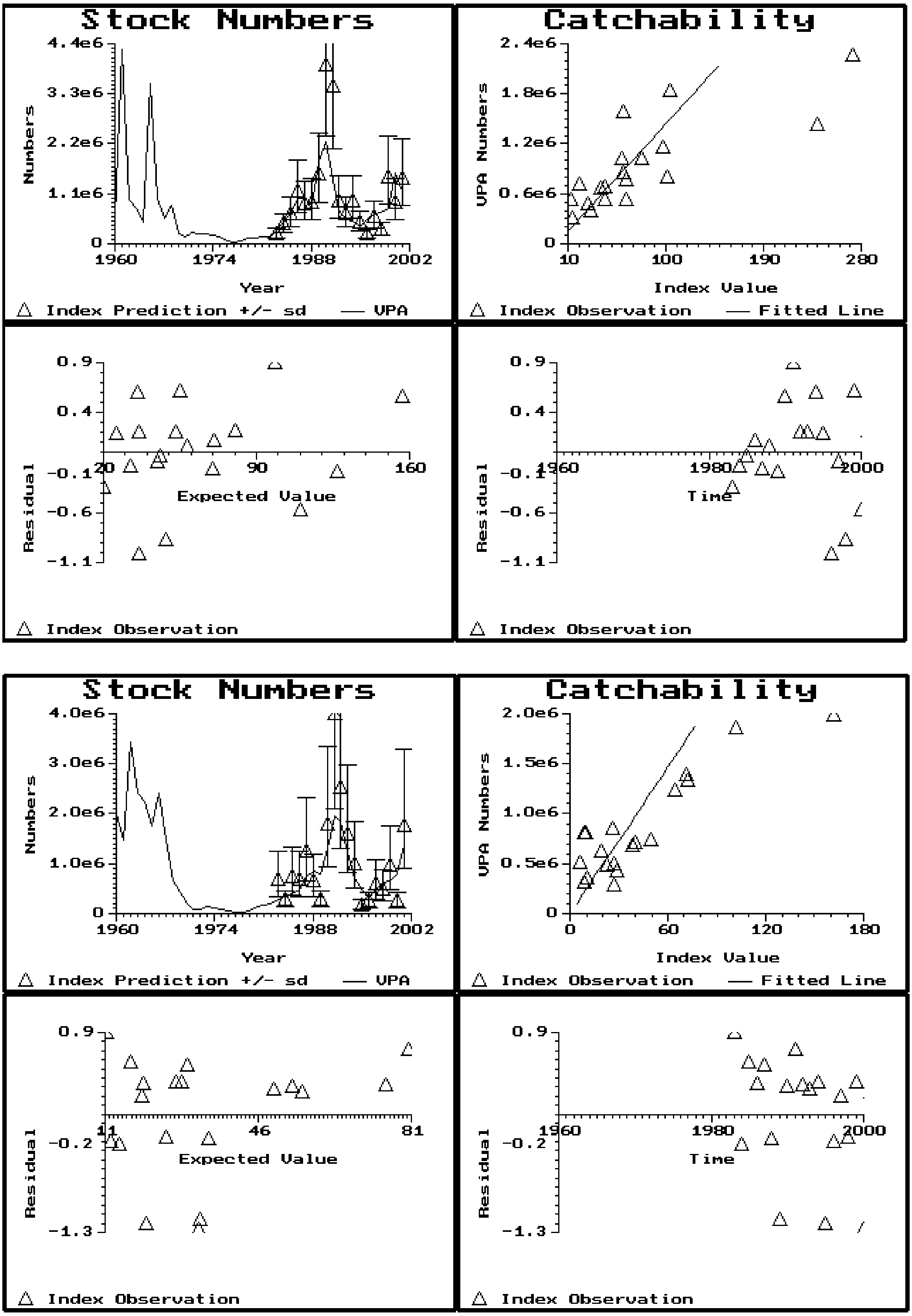


Figure 2.8.13. North Sea herring. **Upper panel**: diagnostics of the fit of the **IBTS 1-ringer index** against the estimated stock numbers at age. **Lower panel**: diagnostics of the fit of the **MIK 0-ringer index** against the estimated stock numbers at age. Top left: fitted populations at age (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

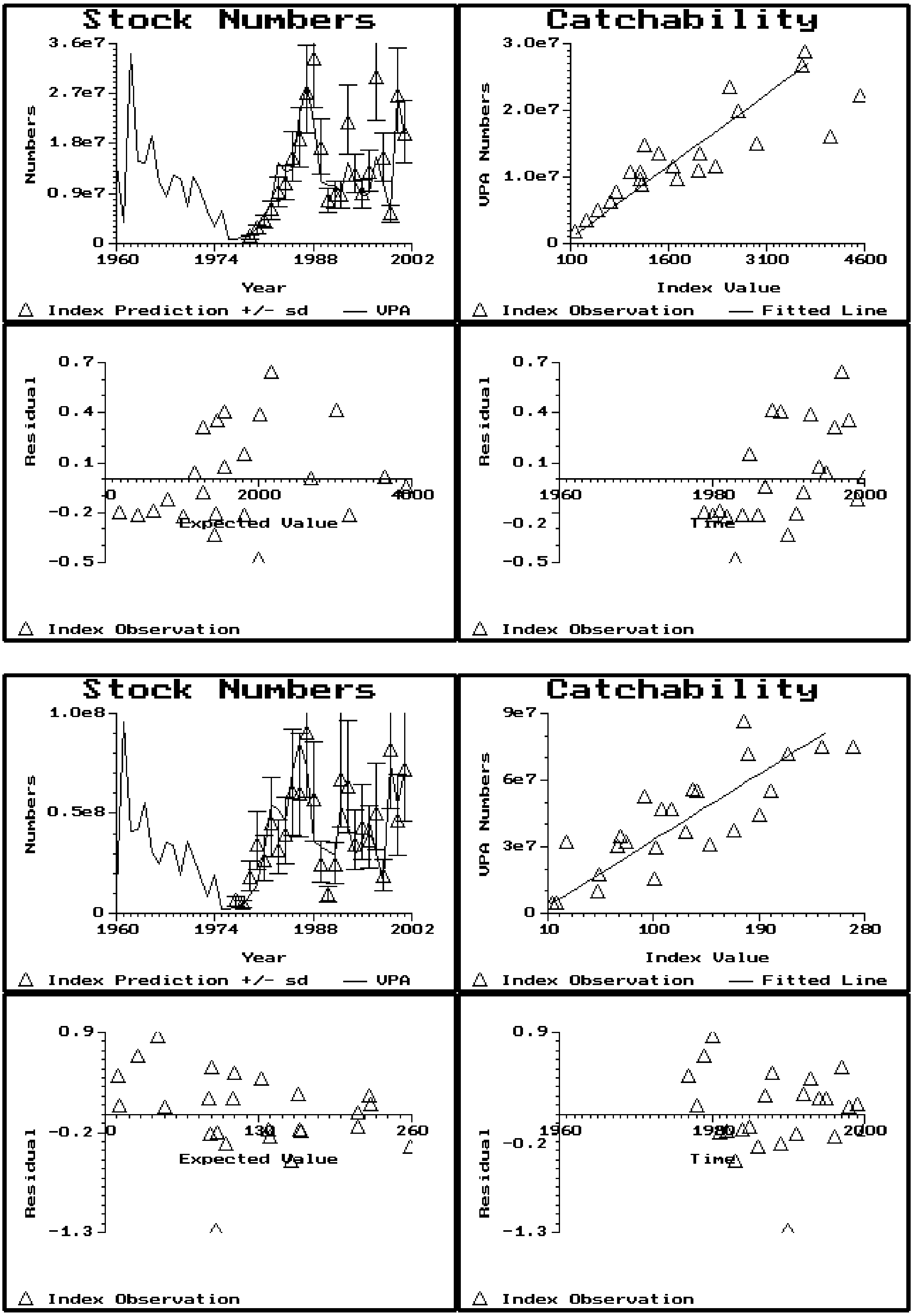


Figure 2.8.14. North Sea herring. Evaluation of assessment uncertainty using a covariance matrix method with 1000 random draws from the estimated parameter distributions **Upper panel**: summary of landings, estimated mean fishing mortality (age 2-6), recruitment of 0-ringers and spawning biomass. Shown are the 5, 25, 50, 75 and 95 percentiles. **Lower panel**: distribution of spawning stock biomass in relation to $\mathbf{B}_{\mathrm{lim}}$ (800.000 tonnes) and the risk of SSB being below $\mathbf{B}_{\mathrm{lim}}$.

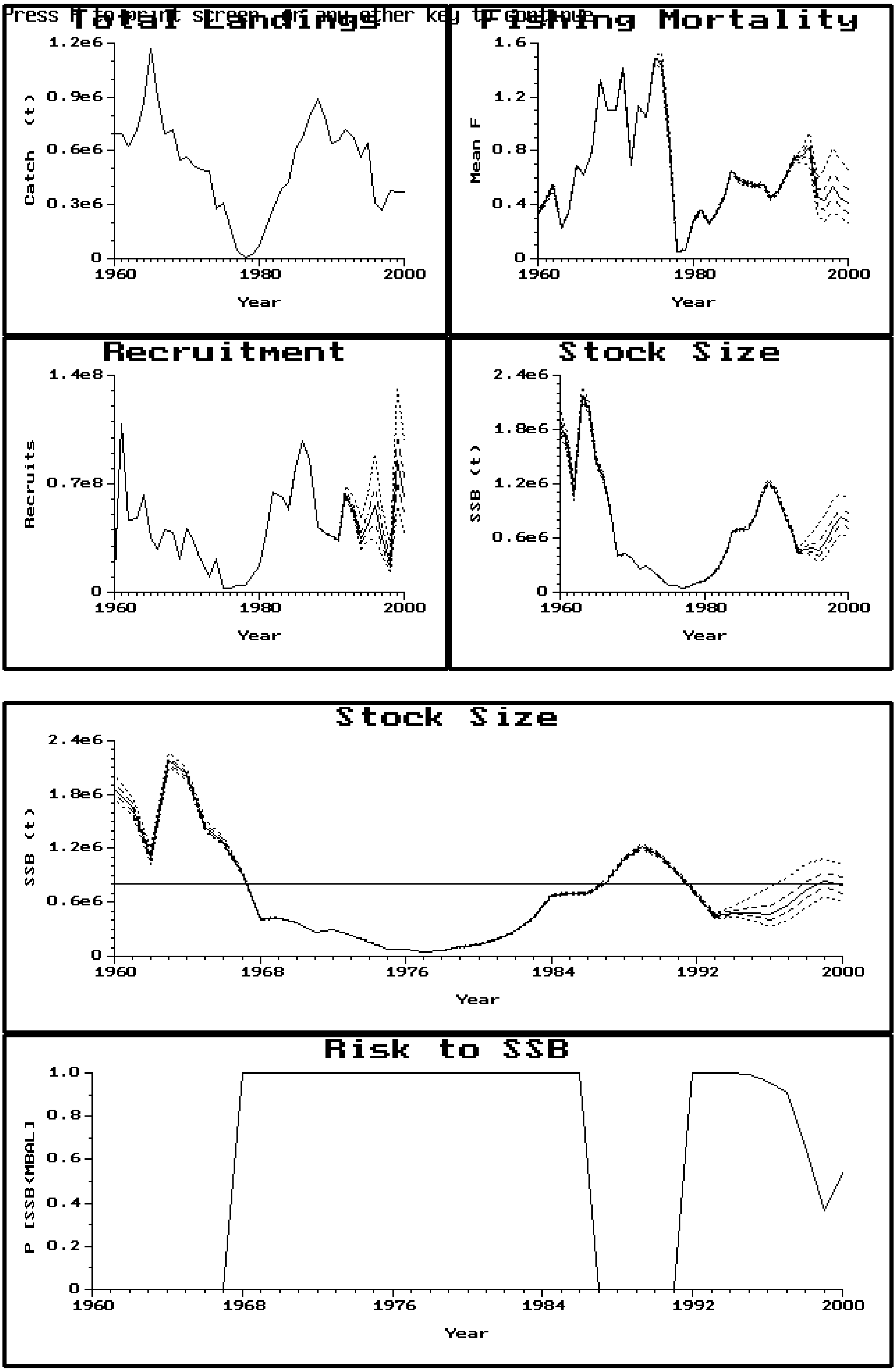
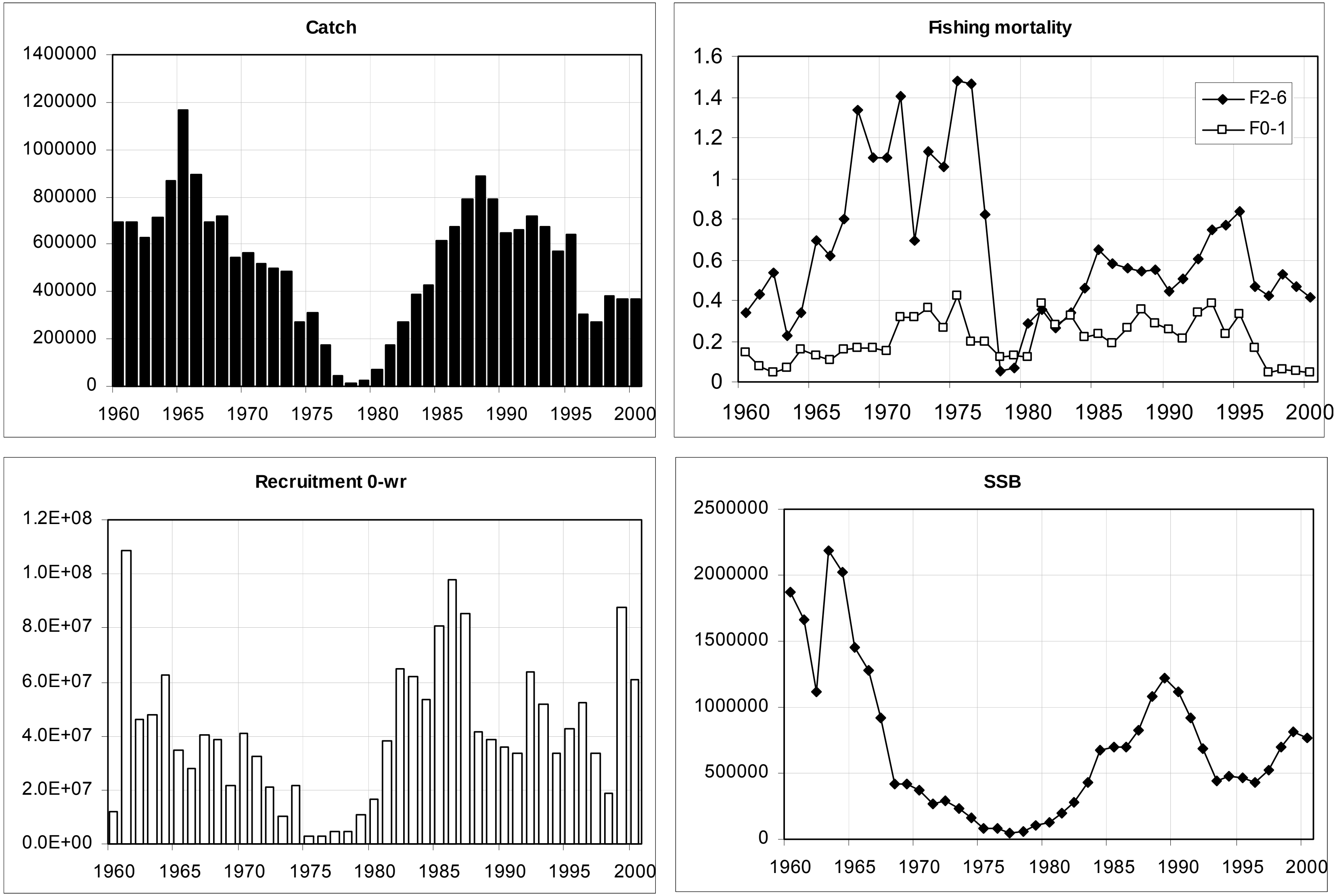


Figure 2.8.15. North Sea autumn spawning herring. Long term trends in catches (top left), fishing mortality on ages 2-6 and 0-1 (top right), spawning stock biomass (bottom right) and recruitment as 0-ringers (bottom left).



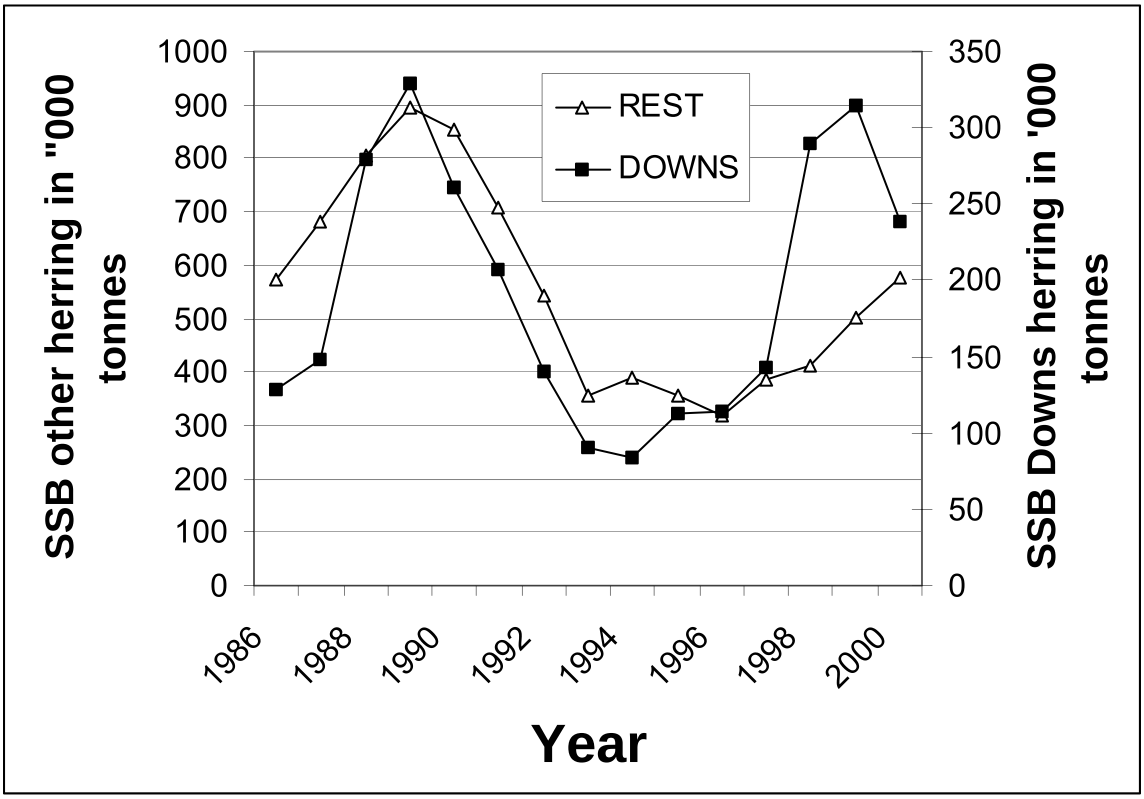


Figure 2.9.1. Estimates of North Sea herring SSB distinguishing a Downs component (division IVc and VIId) and a non-Downs component (Rest). Note the different scales.

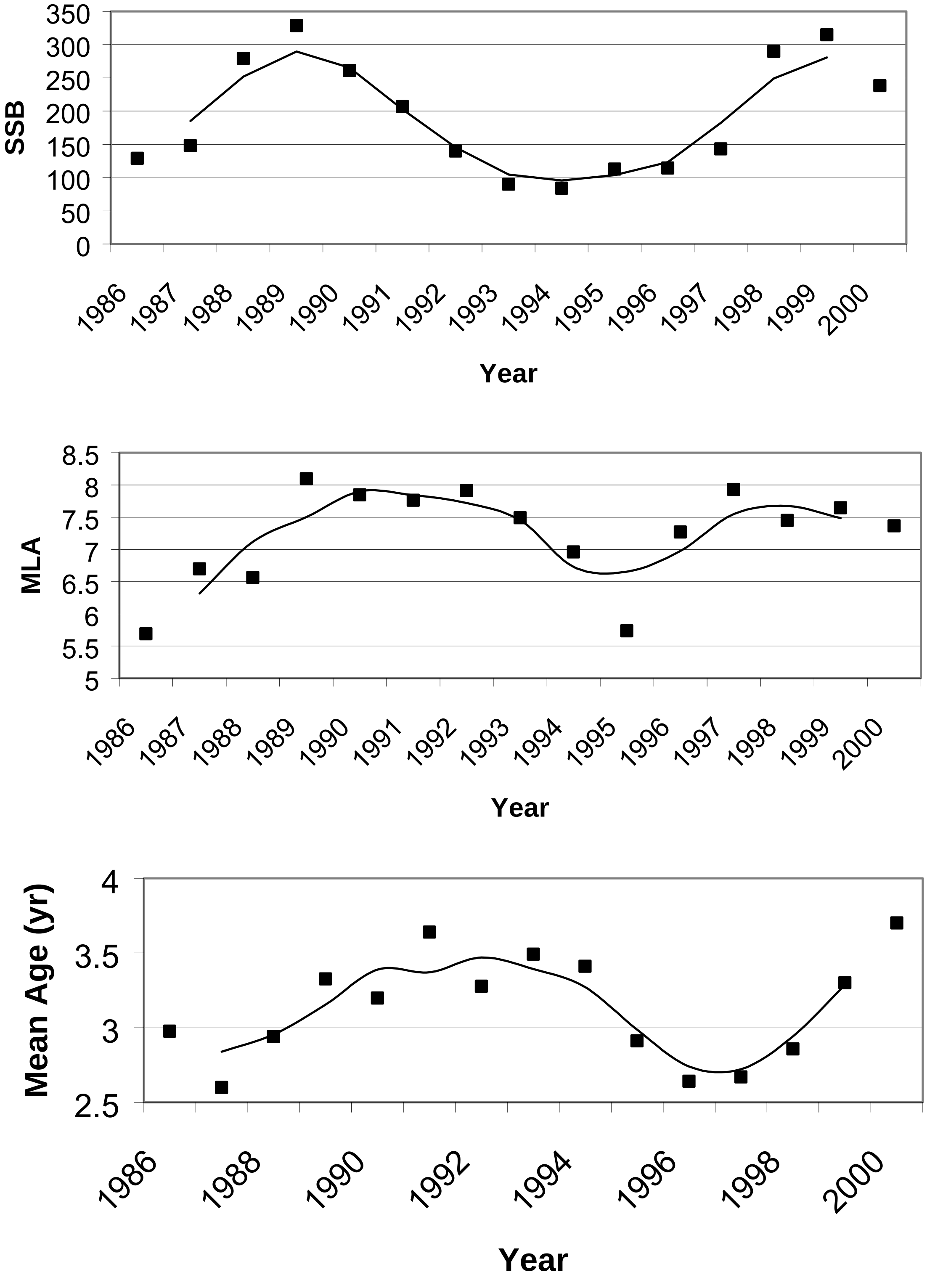


Figure 2.9.2. Estimates for Downs herring of (a) the Spawning Stock Biomass (SSB)(as in Figure 2.9.1), (b) larval abundance (MLA) and (c) Mean age (winter-ring). Points are observations, lines show the three point moving average.

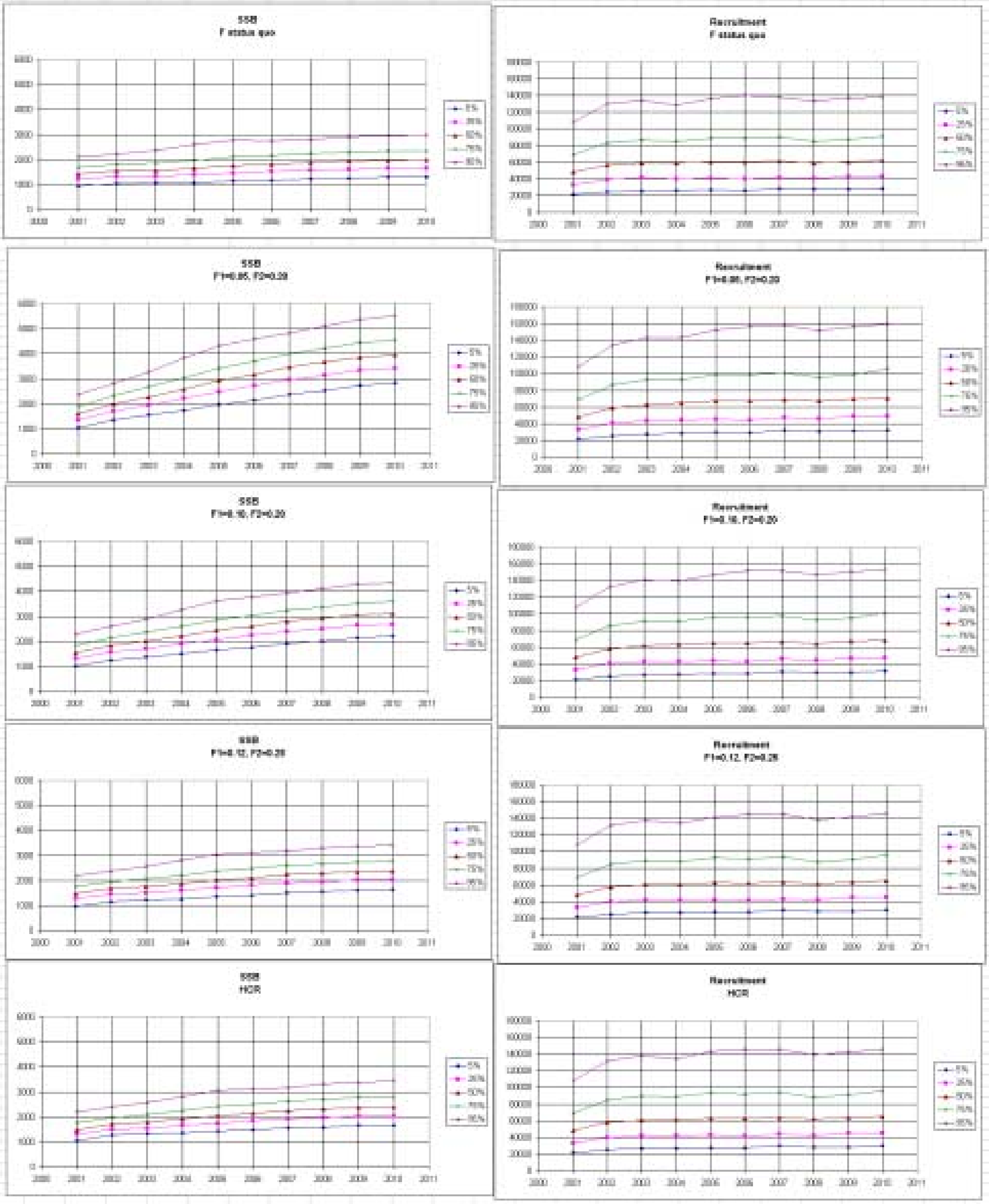


Figure 2.11.1 North Sea Herring
Percentiles for SSB and recruitment by fleet in 10 years medium term predictions using STPR

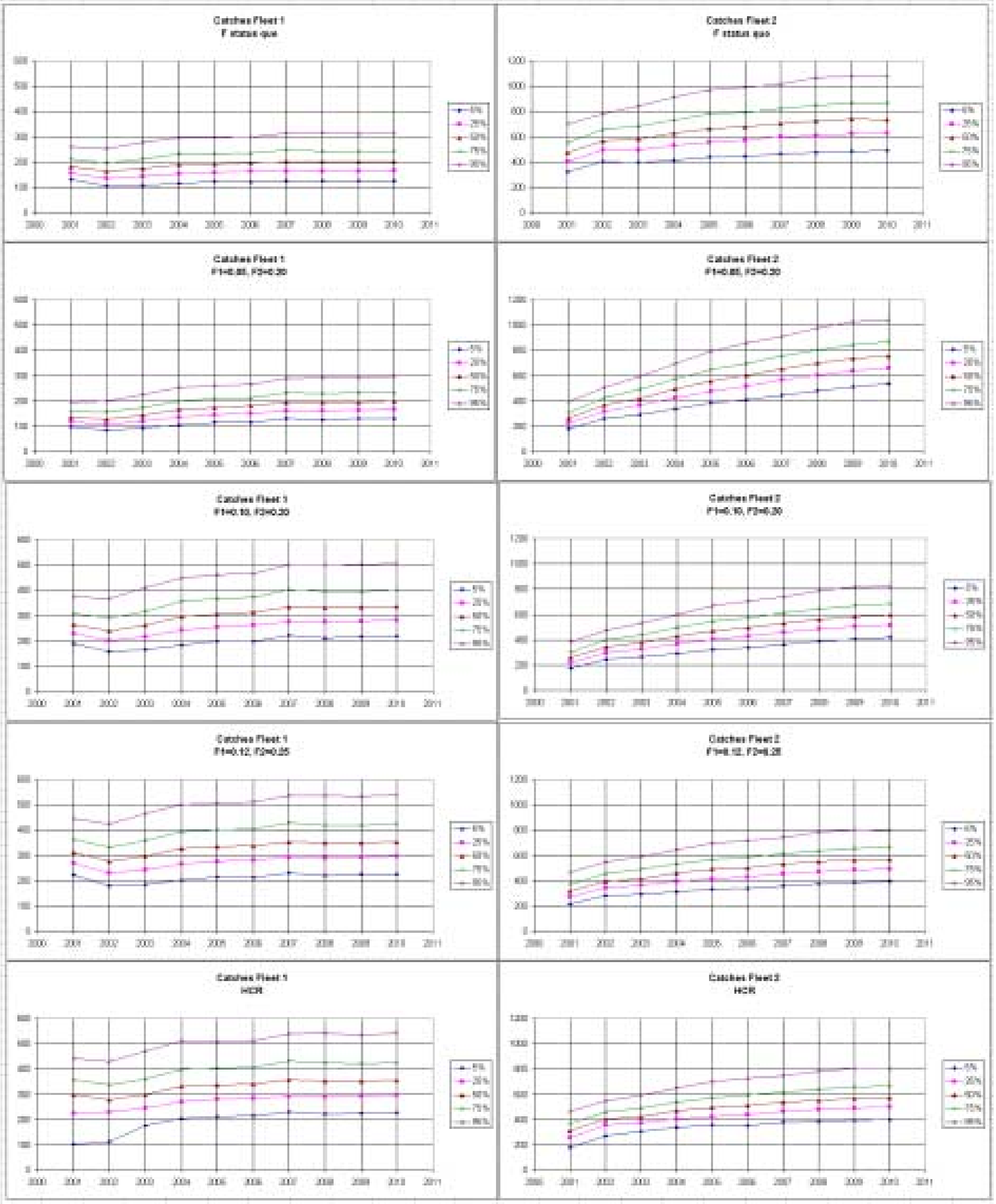


Figure 2.11.2 North Sea Herring

Percentiles for catches by fleet in 10 years medium term predictions using STPR

Fleet 1: Fleets B+C+D

Fleet 2: Fleet A

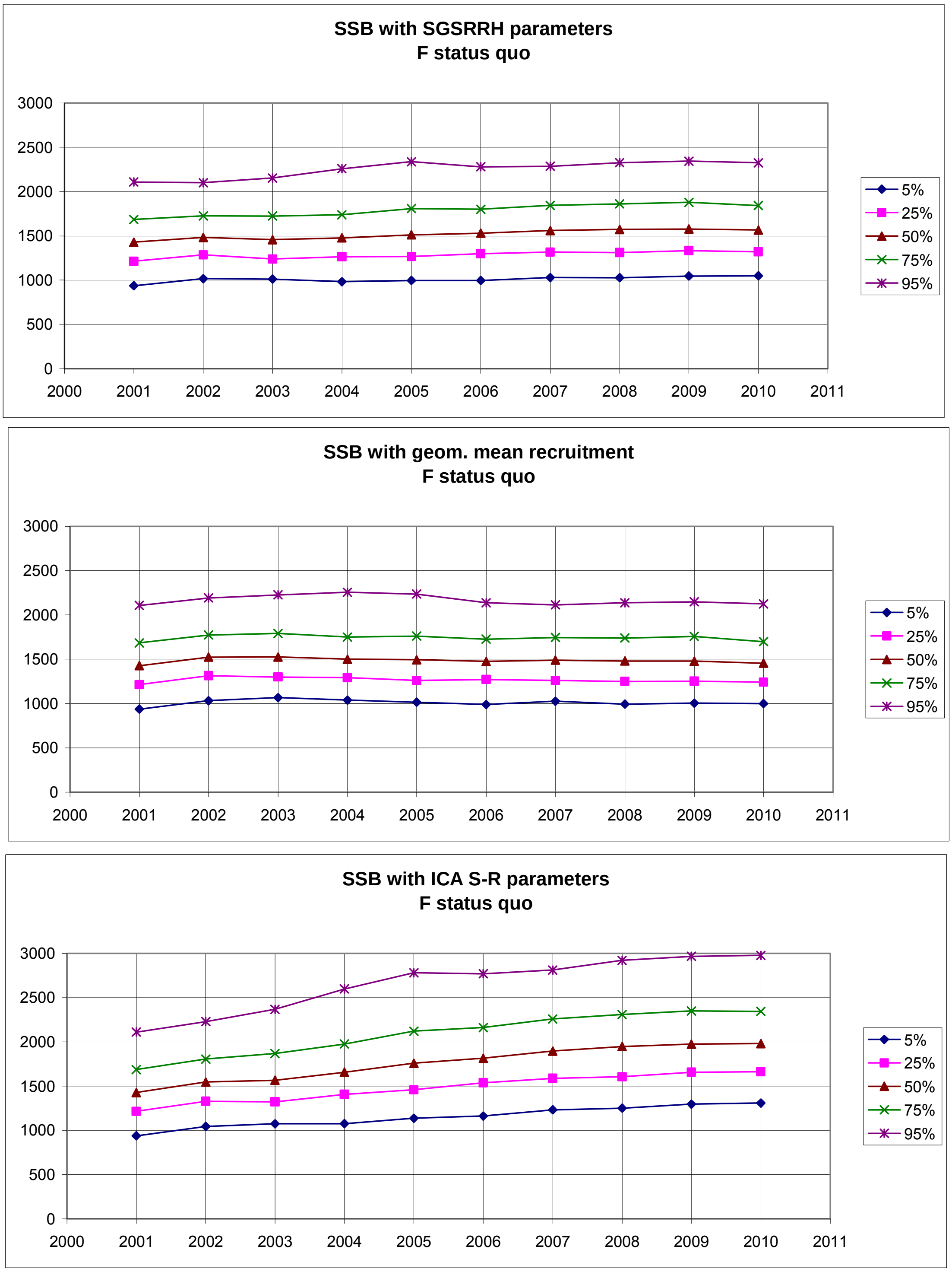


Figure 2.11.3 North Sea Herring
Comparison of medium term predictions of SSB
with different recruitment functions.
F *status quo* assumed.

Figure 2.12.1. North Sea herring. Perception of the stock in subsequent assessment years.

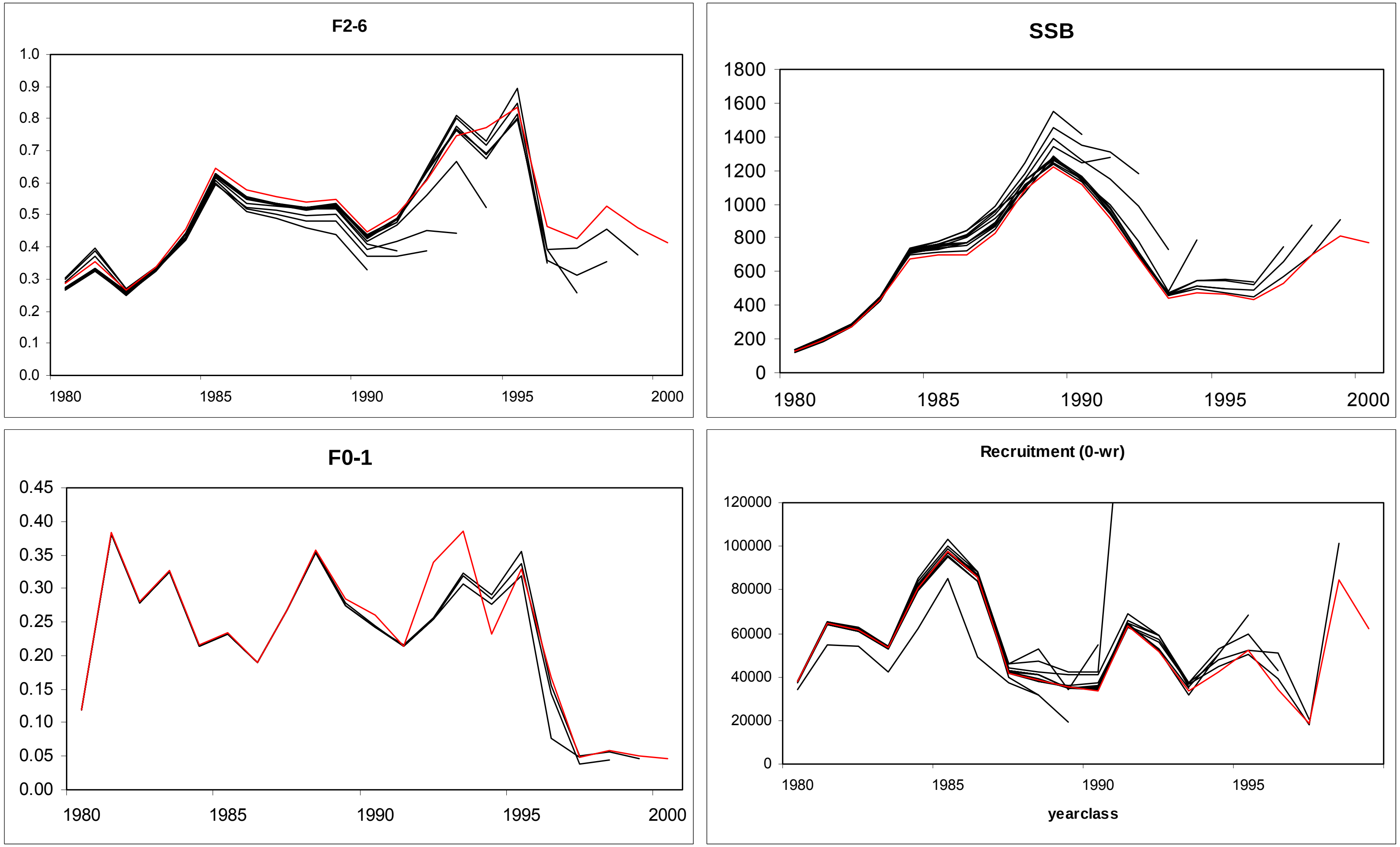
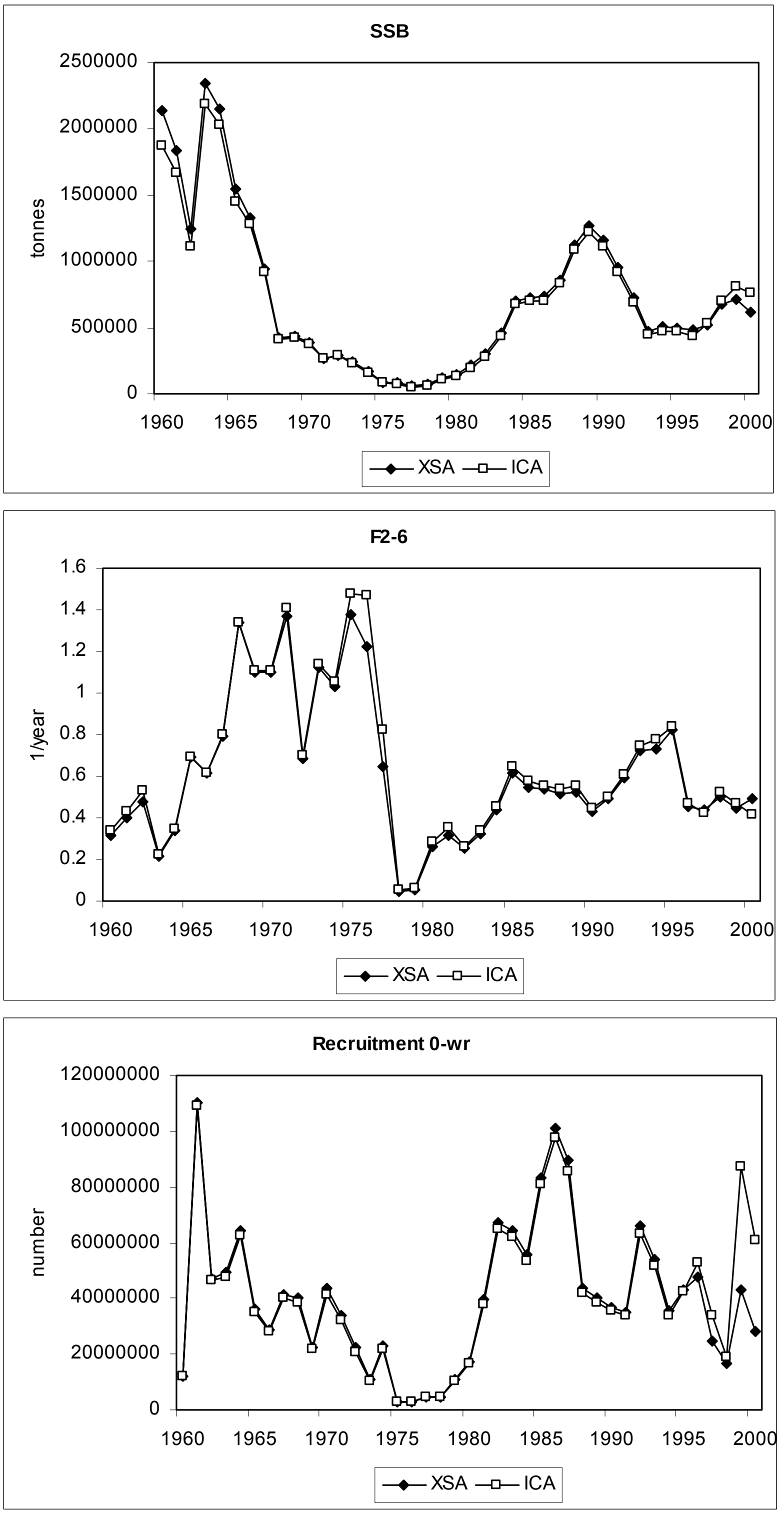


Figure 2.12.2. North Sea herring. Comparison of the final ICA assessment with an XSA assessment using default settings.



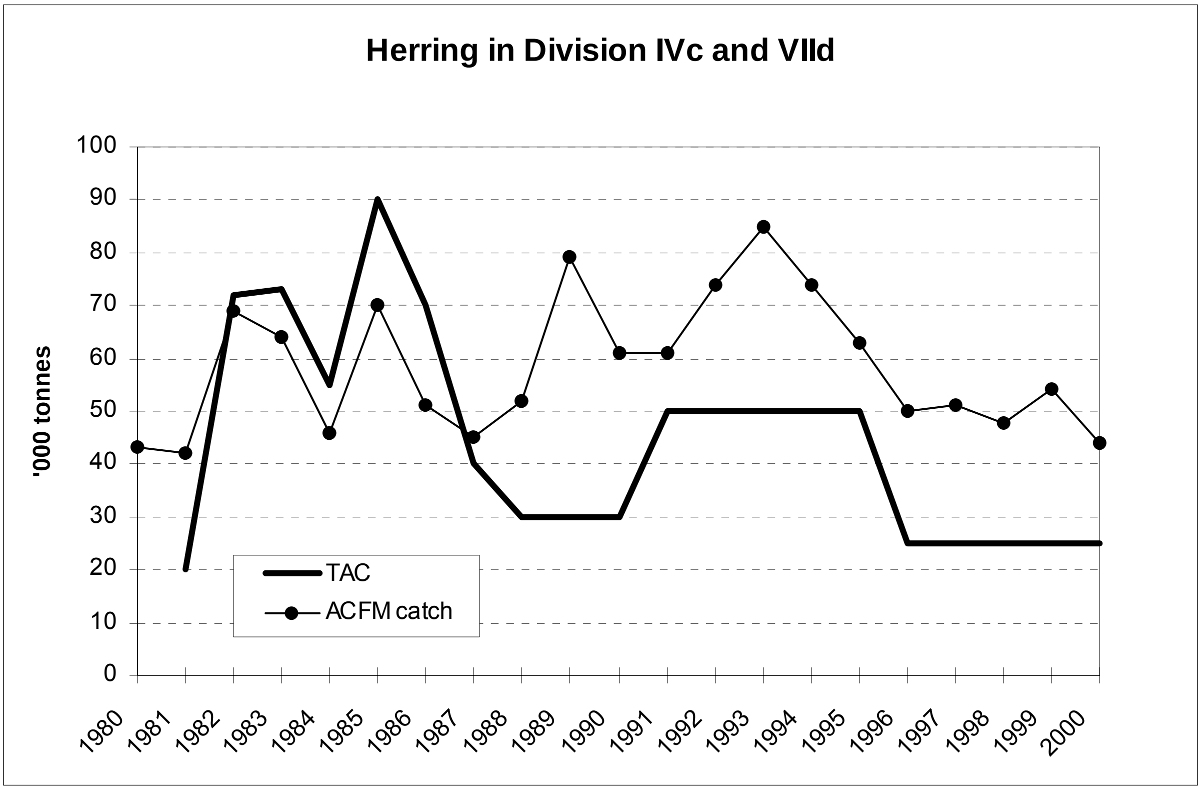


Figure 2.13.1. "Downs herring". Agreed TAC for Divisions IVc and VIId compared to the ACFM catch in that area.

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

3.1 The Fishery

3.1.1 ACFM advice and management applicable to 2000 and 2001

At the ACFM (May) meeting in 2000, it was again stated that the state of the stock is uncertain and that the available data indicates that SSB has been relatively stable over the last few years and that there were no indication of over fishing.

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

The EU and Norway agreement on a herring TAC's set for 2000 was 80,000 t in Division IIIa for the human consumption fleet and a TAC or by-catch ceiling of 21,000 t to be taken in the small meshed fishery.

For 2001 the EU and Norway agreed record on the herring TAC's in Division IIIa is 80,000 t for the human consumption fishery and that by-catches of herring taken in industrial and sprat fisheries was limited to 21,000 t.

As in previous years no special TAC for 2000 was set by the International Baltic Sea Fishery Commission (IBSFC) on the stock component in the Western Baltic area. For the Baltic there was for 2000 a TAC of 405,000 t for the Sub-divisions 22–29 South and 32. The TAC was reduced to 300,000 t for the same area in 2001.

Introduction to landing statistics

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

3.1.2 Total landings

Landings from 1985 to 2000 are given in Table 3.1.1. For the years 1995, 1996, and 1999, the distribution of the Swedish landings into fisheries (fleets) has been revised. The Danish landings in the Kattegat in 1998 have also been revised. In 2000 the total landings increased to 162,000 t in Division IIIa and Sub-divisions 22–24 compared with 1999 where the landings were 137,200 t, resulting in a landing Figure for 2000 at the level of the landing Figure for 1998, which was 169,400 t.

In 2000 36,200 t were taken in the Kattegat, about 71,500 t from the Skagerrak and 54,300 t from Sub-divisions 22–24. These landings represent an increase of 24,800 t compared to 1999.

Misreporting of fishing grounds still occurs. Some of the Danish landings of herring for human consumption reported in Division IIIa may have been taken in the adjacent waters of the North Sea in quarters 1, 2 and 4. These landings are included in the values for the North Sea. A part of Swedish landings have been misreported as caught in the triangle (an area in the southern Kattegat, which is a part of the Baltic area: Gilleleje, DK - Kullen, S - Helsingborg, S - Helsingør, DK). This amount is included in the values for Kattegat and Skagerrak. Some Danish landings, reported as taken in this triangle, may have been taken outside this area. These landings are listed under Kattegat.

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

In 2000 the landing data are calculated by fleet according to the fleet definitions used when setting TACs. In the autumn 1998 the EU and Norway have agreed on setting TACs for only two fleets, and this agreement was also in force for 2000. Therefore, the HAWG in 1998 has decided to merge Fleet D and Fleet E and only present data according to these new fleet definitions for fisheries in Div. IIIa. See (ICES 1999a/ACFM12).

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

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

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

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

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

- C: Fleet using 32 mm mesh size in Division IIIa.

- D: Fleets using mesh size less than 32 mm Division IIIa.

- F: Landings from Sub-divisions 22–24.

In the Table below the landings are given for 1996 to 2000 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 Sub-divisions 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

The landings from fleets C-F are SOP Figures.

3.2 Stock Composition

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

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

The herring stocks in the Kattegat and the Skagerrak have been identified within samples by a number of different methods. Some of them are presented below. In a number of scientific papers the average counts in number of vertebrae in herring samples have been considered (Rosenberg & Palmén, 1982; Gröger & Gröhsler, 1995 and 1996). NSAS have a mean number of 56.5 vertebrae while the WBSS has traditionally been considered to have a mean number of 55.8 vertebrae (ICES 1992b/H:5), a more recent investigation (Gröger & Gröhsler 2000, Gröger & Gröhsler WD 2000) points to a somewhat lower value of 55.63. The most abundant local spring spawning herring, the Skagerrak spring spawners (SSS), are represented by a higher mean number, 57.0 vertebrae.

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

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

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

For the HAWG 2001 the years from 1991 to 1996 have been reworked applying common splitting keys for all years in the series, but two different methods depending on the availability information for different quarters and age groups. For quarters one and three in the years 1991 to 1997 otolith microstructure information was available for all age groups for quarters two and four a least squares' minimisation method fitting to observed frequency distributions of VS counts has been applied (see Section 3.2.4). For 1998 and 1999 the split presented in last years Working Group report (ICES 2000b/ACFM:10) has been adopted, and 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 using the equation:

f(sp) = [56.5-VS(sample)]/[56.5–55.8]

where VS (sample) was the sample mean vertebral count (ICES 1992b/H:5). For commercial landings in May, June and July from the North Sea in 2000, the proportion of spring spawners was calculated using samples from Norwegian commercial landings by age, ICES rectangle and month, and then raised to total number using the overall mean weight at age in Norwegian landings. For the actual split see Section 2.2.2.

3.2.2 Treatment of autumn spawners in Division IIIa

For commercial landings in 2000 the split of the Swedish and Danish landings was conducted using an age-class stratified random subsample of herring where analysis of individual otolith microstructure determined the spawning type (Mosegaard and Popp-Madsen 1996). A total of 1024 otoliths from the year 2000 were analysed for spawning type in Div. IIIa. Samples were taken from Danish and Swedish landings constituting 51% and 49% of the analyses respectively. Data were disaggregated by area (Kattegat and Skagerrak), age group (0–4+ WR) and quarter (1–4).

The available number of individual otolith microstructure analyses by SD, quarter and age group for year 2000 is given in the following text Table:

	Skagerrak						Kattegat						total
Age:	0	1	2	3	4+	Subtot	0	1	2	3	4+	subtot	
Quarter													
1		37				37		1	29	13		43	80
2		10	32	22	18	82		207	154	22	20	403	485
3	90	54	36	34	31	245	3	56	29	8	4	100	345
4	30	28	6			64	2	32	16			50	114
	120	129	74	56	49	428	5	296	228	43	24	596	1024

Despite a reasonable coverage of the fishery, some of the age, area and season combinations had to be estimated as an average of the proportions in adjacent areas, age groups or years. These data are indicated in Table 3.2.1.

For the years 1991 to 1996 average values of proportions by quarter and age–class were applied. The averages were obtained by weighting by sample-size.

For the 1st and 3rd quarters 1991-1995 proportions of WBSS were based on otolith microstructure analyses from Swedish IBTS samples. For the 2nd and 4th quarters proportions were based on VS-counts. Primarily samples from commercial landings were used when available and supplemented by samples from cruises when necessary. In 1996 otolith microstructure analyses were extended with material from Danish cruises in the 3rd quarter.

From 1997 and on otolith microstructure analyses were increasingly available from commercial landings, and from 1998 the proportions were based only on otolith microstructure analyses. Where there was a lack of information averaging over adjacent years, age-classes and quarters were used to estimate proportions.

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

In the western Baltic a small percentage of the herring landings consisted of autumn spawned individuals. Compared to the 1997 years assessment (ICES 1998a/ACFM 14) the magnitude of the problem in later years appears minor. Juvenile autumn spawned herring of the age group 1 was found in landings' samples from Sub-division 22, quarter one, year 2000 comprising about 17% in numbers. The small size at age however, indicated that the herring were local autumn spawners rather than originating from the North Sea stock. Since this problem is of limited influence and since it only affects the younger age classes (0 to 2 WR), the landings were treated as coming from the Western Baltic spring spawning stock. The existence of varying proportions of autumn spawners in sub-divisions 22–24 however, indicates a potential problem for the assessment that should be kept in mind.

3.2.4 Accuracy and precision in stock identification

Stock identification and splitting methods for the years 1991–1996

During the last decade the HAWG has encountered a suite of difficulties in the assessment of the Western Baltic Spring Spawning (WBSS) stock, as it was impossible to separate the WBSS from some North Sea stock component (autumn spawner) in Division IIIa (Skagerrak, Kattegat, Sound), where both stocks are mixing. The introduction of otolith microstructure analysis in 1996/7 enables an accurate and precise split between three groups, autumn, winter and spring spawners, however, different 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 VS as e.g. winter spawning Downs herring: 56.6 (Hulme 1995), and the small local stocks, the Skagerrak winter/spring spawners: 57.0 (Rosenberg & Palmén 1981). Further, the estimated stock specific mean VS count varies somewhat among different studies; North Sea: 56.53, Western Baltic Sea: 55.60 (Gröger & Gröhsler 2000) and North Sea: 56.5, Western Baltic Sea: 55.80 (ICES 1992b/H:5).

For the years 1991 to 1999 individual otolith microstructure information from Swedish IBTS surveys in quarters 1 and 3 has been worked up, categorising individuals into three spawning groups autumn-, winter- and spring- spawners. From these the information from 1991 to 1996 was used in the analysis. VS-counts from the same individuals were used to compare VS-count distributions with identified OM-based spawning type.

From 1640 individuals analysed from the Skagerrak and the Kattegat 1991-2000 where both VS counts and otolith microstructure analyses were available distributions of VS counts were analysed by spawning type and subdivision.

Since no information on pure stock VS counts was available for the time series in question, as a pragmatic solution we estimated each VS-count distribution using the observed counts according to individual spawning type determined from otolith microstructure, assuming a composite but among years constant stock structure of each spawning type.
In the present analysis no difference in VS-count distribution was found between winter and autumn spawners in the Skagerrak, indicating that the Downs herring may be the dominating winter spawning type in this area. In the Kattegat area, however, a different VS distribution was assigned for an apparently composite winter spawning stock.

The split between spawning types was then estimated by the sum of squares minimisation of the following function:

$$\sum_{i=53}^{60}(f_{obs}(i)-p_{AS}\times f_{AS}(i)-p_{WS}\times f_{WS}(i)-p_{SS}\times f_{SS}(i))^2$$

Where p_{AS}, p_{WS} and p_{SS} = 1-(p_{AS}+p_{WS}) are the respective proportions of autumn, winter, and spring spawners to be estimated. f(i) is the relative frequency of the i^{th} VS number, where the subscripts AS, WS, SS refer to the present attributed proportions of autumn, winter, and spring spawners, and obs refer to the observed sample distribution with unknown spawning type proportions.

From landing samples in the period 1991 – 1996 the total number of VS counts available were 12166 for the Skagerrak and 15750 for the Kattegat areas.

For the first and third quarter in the period 1991-1996 an average for each quarter, sub-division and age-class (0-4+), over all years was calculated based on individual otolith microstructure information from the Swedish IBTS samples and in 1996 supplemented with quarter three Danish acoustics samples. A total of 2005 otoliths were analysed for this period with 820 from the Skagerrak and 1185 from the Kattegat.

An effort was made to compare proportions of spring spawners from different sources of information. The estimated proportion of spring spawners from VS counts in surveys and commercial landings were plotted versus the estimated proportion spring spawners using otolith microstructure from surveys (Figures 3.2.1 and 3.2.2). The data were disaggregated by year-group, sub-division, age group, and quarter. The year-groups were 1991-1996 and 1997, sub-divisions were Kattegat and Skagerrak, age-classes were 0,1, 2, 3, and 4+; and quarters 1 and 3. For survey versus survey comparisons the average number otolith microstructure analyses and VS counts per data point were 115 and 887 respectively, for landings versus survey comparisons were based on 118 and 698 analyses respectively. A minimum of 25 and 75 otolith microstructure analyses and VS counts respectively was applied in both comparisons to reduce random errors.

Figure 3.2.1 shows a high degree of correspondence between the two methods when applied to a reasonable number of individuals sampled from the same sources of samples.

Also when using VS counts from landings' samples versus otolith microstructure analyses from surveys a reasonably good correspondence when the two methods were compared (Figure 3.2.2).

The HAWG therefore concluded that no great bias is expected when using a mixture of the two methods to update catch statistics from the period 1991 to 1996.

The applied proportions of spring spawners by sub-division, quarter, and age-class for the period 1991-1996 are given in Table 3.2.2.

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

Based on the proportions of spring- and autumn spawners (see Section 3.2.3) in the landings, number and mean weights by age and spawning stock are calculated (Tables 3.3.3 - 3.3.8). The total catch in numbers of BSS in Division IIIa and the North Sea is shown in Tables 3.3.10, 3.3.11 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 2000 were estimated to be about 64,000 tons (Table 3.3.14) compared to about 54,000 t in 1998 and 50,000 t in 1999. This increase in landings is mainly due to a general increase in total landings in Division IIIa, which increased by 11,000 t compared to 1999. The landings of North Sea autumn spawners in Division IIIa amounted to 50,000 t compared to 59,000 t in 1998 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 Sub-divisions 22–24 for 1991–2000 are given in Tables 3.3.13 and 3.3.14. Mean weights at age in 2000 were, in general, comparable to the mean weights in 1999 for the ages 0 to 6. For the older ages (age 7-8+) the mean weights at age for herrings in the North Sea and Division IIIa were higher in 2000 compared to 1999.

Data for 1991 to 1999 was revised and details can be found in Tables 3.3.11 and 3.3.15.

3.4 Quality of Catch Data and Biological Sampling Data

The sampling intensity of the landings in 2000 was acceptable and above the recommended level. Danish landings were sampled in the most important quarters for the Skagerrak, the Kattegat and for Sub-divisions 22 and 24. In 2000 no sampling was carried out from the limited fishery (640 t) in Sub-division 23.

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 162,000 t from which 255 samples were taken, 70,800 fish measured and 15,100 aged compared to 1999 where the landings were 137,000 t from which 278 samples were taken, 76,700 fish were measured and 13,700 fish were aged. Despite the high sampling level, still the distribution over seasons, areas and fishing fleets needs to be improved. Sampling used to estimate mean weight at age shown in Table 3.4.2.

Swedish landings from the human consumption fishery were sampled in all quarters and in contrast to the Swedish landings for industrial purposes from the Skagerrak and the Kattegat, where samples only were taken in quarter 1, 3 and 4 for Skagerrak and quarter 3 and 4 for Kattegat. During the second quarter 80% of the Norwegian total landings of herring from Skagerrak take place, however, only 5 samples were taken from these landings in the second quarter.

Sampling of the Danish landings for industrial purposes were at the same high level in 2000 as in the three previous years. The number of samples and number of fish investigated were considered to be at adequate level. Again in 2000 there have been difficulties in getting samples from the Danish directed herring human consumption fishery in Skagerrak. There is uncertainty about where the Danish landings for human consumption, reported from Division IIIa (quarters 1, 2 and 4), were actually taken. Some of the landings from quarter 1, 2 and 4 supposed to have been taken in the North Sea and were therefore transferred to the North Sea. A part of Swedish landings have been misreported as caught in the triangle (an area in the southern Kattegat, which is a part of the Baltic area: Gilleleje, DK - Kullen, S - Helsingborg, S - Helsingør, DK). This amount is included in the values for Kattegat and Skagerrak. Some Danish landings, reported as taken in this triangle, may have been taken outside this area. These landings are listed under Kattegat.

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

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

3.5 Fishery-Independent Estimates

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

The following trawl surveys are conducted every year:

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

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

Abundance indices for 0, 1, 2, and 3+ ringed herring obtained by bottom-trawl surveys carried out in November/ December of each year in Sub-divisions 24 and 22 are given in Tables 3.5.1 and 3.5.2. Combined estimates for the total area are calculated by weighting each single survey estimate by the survey areas of each Sub-division. The resulting time index series is shown in Table 3.5.3. In general the 2000 estimates are far below the average of the recorded time period nearly for all age groups. In 2000 only the 2 ringers in Sub-division 24 and the 1 ringers in Sub-division 22 reached higher values above the average.

Abundance indices for 1 to 8+ ringed herring from bottom-trawl surveys conducted each year in January/February in Sub-division 24 are given in Table 3.5.4. In 2000 the mean catch in numbers of the 1 ringer are above and all other age groups are far below the average of the reported time period.

From 2001 onwards a new standardised bottom-trawl will be 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.

3.5.2 International Bottom Trawl Survey in Division IIIa

The IBTS in the ICES Div. IIIa (the Skagerrak and the Kattegat) has been conducted annually in the 1st quarter since 1977. From 1983 and onwards the survey was standardised 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 1996b/H:1, addendum). The survey was intended for and is still used to obtain recruitment estimates for herring stocks in the Div. 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 continued until 1999. Around 45 hauls have been taken within each quarterly survey from 1991 to 2001. Data on catch rates and biological data (size and age compositions, gender and maturity stages) are transferred to and retained within a standard database at the ICES Secretariat.

The IBTS survey in Div. 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 2000 the survey data was revised for the 1st and available 3rd quarters from 1990 to 2001. Historical catch rates are heavily skewed and therefore the survey indices by winter rings 1-5 were calculated as geometric means from observed abundances at trawl stations within each of the Skagerrak and the Kattegat. The survey indices were further decomposed into spring and autumn spawning components by microstructure analysis of otoliths (section 3.2). The new estimates for the relative abundance by age and the spring spawning component only by age are presented in Table 3.3.9 and Table 3.3.10, respectively.

The survey estimates for spring spawners show 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 2000. 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 a depth stratification. The average instantaneous mortality of the year-classes 1990 to 1996 (over 1 to 4 wr) exceeds 1.0 in both areas but increases with years.

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

3.5.3 Summer acoustic survey in Division IIIa

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 24 June to 5 July 2000 covered the area in the Skagerrak, east of 6°E and the Kattegat.

Acoustic data were sampled using a Simrad EY500 38 kHz echo sounder with the transducer in a towed body (Type ES38-29). The hydroacoustic equipment was calibrated just before the survey at the Bornö, Gullmarn Fjord, Sweden. Trawl hauls were carried out during the survey for species identification. Pelagic hauls were carried out using a FOTÖ trawl (16 mm in the codend) while demersal hauls were carried out using an EXPO trawl (16 mm in the codend). Trawling was carried out between 1000 and 1600h, and 2000 and 0400h UTC.

Trawl haul duration was 1 hour. Fish, sorted by species, were measured for length (to nearest 0.5 cm total length) and weight (to nearest 0.1g wet weight). In each trawl haul 10 herring per 0.5 cm length class were sampled for determination of age, race (North Sea autumn spawners or Baltic Sea spring spawners) and maturity. Microstructure formed during the larval period was used for the discrimination of herring race.

For each sub area 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: Age 0 and 1: no mature individuals Age 2: 30% mature individuals Age 3: 58% mature individuals Age 4+: 100% mature individuals.

Approximately 1700 nautical miles were surveyed and 34 trawl hauls were conducted.

Further details of the survey are given in Section 2.4.

The total stock size of Western Baltic spring spawning herring in 2000 was estimated by combining the results from the Danish (Division IIIa) and Norwegian Acoustic Survey (Sub-area IVa and IVb). The result is summarised in Table 3.5.7. The total stock estimate of 351,400 t is about 38 % higher compared to 1999 (254,900 t).

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 29 September–20 October 2000 in the Western Baltic. The survey covered ICES Sub-divisions 22, 23, 24 and the southern part of the Kattegat. All investigations were performed during night as in previous years.

The acoustic equipment used was an EK500 Echo sounder connected to the BI500 Bergen-Integrator. The specific settings of the hydroacoustic equipment were used as described in the 'Manual for the Baltic International Acoustic Surveys (BIAS)' (Annex 4 in the 'Report of the Baltic International Fish Survey Working Group', ICES CM 2000c/H:2). A 38kHz transducer 38-26 was deployed in a towed body. The towed body had a lateral distance of about 30 m to reduce escape reactions of fish. The transducer was calibrated before this survey in Warnemünde and during the cruise in Aabenraa/Denmark.

The cruise track reached in total a length of 996 nautical miles. 50 trawl hauls were carried out.

The result for 2000 is presented in Table 3.5.8. The data series have been recalculated and revised for 1991–1999. The revision followed procedures recommended in the Baltic international acoustic survey manual (ICES CM 2000c/H:2). In 2000 the total estimated stock size of herring in Sub-divisions 22–24 was 160,000 t, which is far below the average for the whole time period of about 249,000 t.

3.5.5 Larvae surveys

The German herring larvae monitoring started in 1977 and takes place every year from March/April to June in the main spawning grounds of the spring spawning herring in the Western Baltic. These are the Greifswalder Bodden (area: 510.2 km^2, volume: 2,960 x 106 m^2, mean depth: 5.8 m, maximum depth: 13.5 m) and adjacent waters. Since 1977 the same sampling method, sampling strategy and station grid have been used. R/V CLUPEA samples usually 35 standard stations during daylight in 10 consecutive cruises. At each station herring larvae samples are taken by means of a MARMAP-Bongo (diameter: 600 mm, mesh size of both nets: 0.315 mm) by parallel double oblique tows at a speed of 3 knots. Since 1996 a HYDROBIOS-Bongo (mesh size: 0.335 mm) was used.

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

Further details concerning the surveys and the treatment of the samples are given in Brielmann (1989), Müller & Klenz (1994) and Klenz (2000). The estimated numbers of larvae for the period 1977 to 2000 are summarised in Table 3.5.9. Compared to the former two years with very high estimates, the 2000 estimate of the larval index dropped to a very low level.

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), and from the German Bottom Trawl Surveys during November-December in Sub-divisions (SD) 22 and 24 GBTS_ND (Table 3.5.3). Indices of 1-ringer abundance were also available from the GBTS_ND, (Table 3.5.3), and from the German Bottom Trawl Surveys during January-February in SD 24 GBTS_JF, (Table 3.5.4). Log transformed indices were compared by year class in Figure 3.6.1 The larval 0-ringer and GBTS_ND 0-ringer indices for the year classes 1977 to 2000 show some similar year-to-year variability (correlation R-square = 0.44). For the year classes 1978 to 1999 the GBTS_ND 0-ringer and the GBTS_JF 1-ringer showed co-variation (correlation R-square = 0.34) whereas the GBTS_ND 0-ringer and the GBTS_ND 1-ringer indices showed no co-variation. The indices illustrated in Figure 3.6.1 show the following general time trends: Poor recruitment of year classes 1980–82 was followed by an increase to a high level of recruitment for year classes 1983–88. From year class 1990 the recruitment declined until 1992 when recruitment was low. An increase in year classes 1993−1994 is indicated. The year class 1996 was below average but the estimates 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_ND and the 1-ringer GBTS_JF 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_ND and the acoustic survey in Subdivisions 22–240-ringer indices are far below average.

3.7 Data Exploration

3.7.1 Input data

Catch in numbers by age for spring spawners in Div. IVe, Div. IIIa and Sub-divisions 22-24 were available for 1991 to 2000 (Table 3.3.13). Landings, catch at age in numbers has been revised (section 3.2 and 3.3). Monitoring of discards has been patchy and discard data are not included. The data demonstrate a decrease in landings from 1991 to 1999 and an increase in 2000.

Mean weights at age in the landings for spring spawning herring are found in Table 3.3.4. Mean weights for adults is conspicuously lower in Sub-division 22-24 compared to Div. IIIa. Mean weights of 2+ ringers in Div. IIIa have decreased since 1995 whereas mean weights in Sub-division 24 lacks an apparent trend between years.

Mean weights at age in the stock by year was derived as the mean weights representing catch in numbers during the 1st quarter.

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 meeting in 2000:

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 16 was added to the 0 and 1 ringers, which resulted in an increase in their natural mortality to 0.3 and 0.46, respectively. The estimates of predation mortality were derived as a mean for the years 1977–1995 from the Baltic MSVPA (ICES 1997 CM/J:2).

Available survey indices were:

- Index 1: Hydroacoustic survey in Division IIIa, July 1989–99, 0–8+ ringers
- Index 2: Hydroacoustic survey in SD 22, 23 and 24, Oct. 1989–99, 0–8+ ringers
- Index 3: Larvae survey in SD 24 (Greifswalder Bodden), March-June 1977-99
- Index 4: German bottom trawl survey (GBTS) in SD 22, Nov. 1979–99, 0–3+ ringers
- Index 5: German bottom trawl survey (GBTS) in SD 24, Nov. 1978–99, 0–3+ ringers
- Index 6: German bottom trawl survey (GBTS) in SD 24, Feb. 1979–99, 1–8+ ringers
- Index 7: IBTS in Div. IIIa, Quarter 1, 1991-00, 1-5 ringers
- Index 8: IBTS in Div. IIIa, Quarter 3, 1991-99, 1–5 ringers

None of the indices covered the total spatial distribution of the WBSS stock and the indices represent different seasonal overlap:

Survey area	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Div. IIIa	Index 7		Index 1,8	
Sub-divisions 22-24	Index 3,6			Index 2,4,5

The observed year-class abundance varied similarly for yearclasses 1990 to 1998 but demonstrated also inconsistencies (negative correlations) between and within indices (between age-groups).

3.7.2 Exploration by individual survey indices

Exploratory runs were done by tuning catches by individual survey time series with ICA software (version 4). Contrary to the 2000 assessment, one separability period from 1997 to 2000 were selected. The period represents a fishery with a different selectivity pattern than before the international regulation in 1996. This period is also consistent with the separable period used for the North Sea assessment this year. The ICA settings were:

- The weighing factor to all indices (lambda = 1).
- A linear catchability model for all indices.
- The range of years for separable constraint (= 4 years from 1997 to 2000).
- The reference F set at age 4 and the selection 1 for oldest age.
- All available age groups were included and not down weighted.
- No shrinkage applied.

Results of these runs are presented in Figure 3.7.1. The hydroacoustic surveys in Div. IIIa, in Sub-div. 22-24 and the IBTS indices suggest high Fs of around 0.6, while the larval and trawl surveys in Sub-divisions 22-24 suggests considerably lower values. The hydroacoustic survey in Div. IIIa generally tracks the VPA estimates in numbers and have comparatively lower age and year residuals than the other indices. However, the survey showed high age residuals for the 0-and 1 ringers. The hydroacoustic survey and the German trawl survey in Sub-div. 24 showed high residuals for older ages. The runs indicated that the year-class strength in both 1998 and 1999 was above the average.

3.7.3 Exploration by combined survey indices

A combined ICA run (no 16) was performed with the following indices:

- Index 1: Hydroacoustic survey in Division IIIa, July 1989–99, 0–8+ ringers
- Index 2: Hydroacoustic survey in SD 22, 23 and 24, Oct. 1989–99, 0–8+ ringers
- Index 5: German bottom trawl survey (GBTS) in SD 24, Nov. 1978–99, 0–3+ ringers
- Index 8: IBTS in Div. IIIa, Quarter 3, 1991-99, 1–5 ringers

The choice of indices was based on the known migration pattern and spatial distribution of the stock between seasons. A second combined run (no 17) was also performed on restricted age ranges of the chosen indices. Indices in the Div. IIIa were truncated to include 2+ ringers only and indices in Sub-div. 22-24 were truncated to contain 0-1 ringers only. The rationale was partly high age residuals for the deleted age groups, and partly an assumption about how well the age groups are represented in the surveys.

Model settings besides the age range were set as in section 3.7.2. Input data are shown in Tables 3.7.1 – 3.7.5.

Results are presented in:

ICA run	Tables	Figures
Combined run 16 (all available ages)	3.7.6 - 3.7.16	3.7.2 - 3.7.4
Combined run 17 (selected age range)	3.7.17 - 3.7.27	3.7.5 - 3.7.7

Both runs demonstrate a shallow SSQ response-curve. The SSB shows a stable level over the recent years. The F (3-6) of the combined run 16 was lower (0.50) than of the combined run 17 (0.58). However, runs indicate irregular catch abilities and high residuals. Moreover, the survey indices did not track the VPA estimates in stock numbers over time for some of the age-classes.

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

- Absence of an operative migration model (ICES 2000/ACFM:10).

- No survey fully covering the stock at any particular time.

- A limited time series of revised catch data (1991–2000).

3.8 Status of the Stock

Despite the failure to contribute a conclusive assessment the survey and catch data provide some information on stock development. These ICA runs and general observations on catch and biological samples indicate that the stock size did not decrease since 1996. It should be noted that the landing data for the period 1991 to 2000 have been revised.

The total landings have decreased until 1999 with a subsequent small increase in 2000. Catch at age data and indices suggest that the recruitment in 1998 and 1999 show an increase compared to the rather stable level 1991-1997. Last year's HAWG report indicated, that the SSB and mean F of the Western Baltic stock had stabilised. However, the estimated mean F from this years assessment indicates a very high fishing pressure which in a pessimistic scenario might only be maintained due to the relatively higher recruitment.

The available information provides reason for concern. Fishing mortalities appear to be stable at a high level during the last 4 years while catches have declined over the same period. A temporary improvement can be expected only if the assumed large year-classes 1998 and 1999 can be confirmed in future catches. The working group therefore stresses that the present level of fishing mortality cannot be expected to 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 can also increase. This is an additional cause for concern.

Table 3.1.1 **HERRING in Division IIIa and Sub. Division 22-24. 1986 - 2000**
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 [2]	1999 [2]	2000 [1]
Skagerrak						
Denmark	43.7	28.7	14.3	10.3	10.1	16.0
Faroe Islands						
Norway	16.7	9.4	8.8	8.0	7.4	9.7
Sweden	48.5	32.7	32.9	46.9	36.4	45.8
Total	108.9	70.8	56.0	65.2	53.9	71.5
Kattegat						
Denmark	16.9	17.2	8.8	23.7	17.9	18.9
Sweden	30.8	27.0	18.0	29.9	14.6	17.3
Total	47.7	44.2	26.8	53.6	32.5	36.2
Sub. Div. 22+24						
Denmark	36.8	34.4	30.5	30.1	32.5	32.6
Germany	13.4	7.3	12.8	9.0	9.8	9.3
Poland	7.3	6.0	6.9	6.5	5.3	6.6
Sweden	15.8	9.0	14.5	4.3	2.6	4.8
Total	73.3	56.7	64.7	49.9	50.2	53.3
Sub. Div. 23						
Denmark	0.9	0.7	2.2	0.4	0.5	0.9
Sweden	0.2	0.3	0.1	0.3	0.1	0.1
Total	1.1	1.0	2.3	0.7	0.6	1.0
Grand Total	231.0	172.7	149.8	169.4	137.2	162.0

[1] Preliminary data.
[2] Revised data for 1998 and 1999

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: 2000

		Skagerrak		Kattegat	
Quarter	W-rings	North Sea autumn SP	Baltic Spring SP	North Sea autumn SP	Baltic Spring SP
1	1	100.00%	0.00%	72.90%	27.10%
	2	66.67%	33.33%	17.24%	82.76%
	3	43.00%	57.00%	15.38%	84.62%
	4	42.86%	57.14%	0.00%	100.00%
	5	**42.86%**	**57.14%**	**0.00%**	**100.00%**
	6	**42.86%**	**57.14%**	**0.00%**	**100.00%**
	7	**42.86%**	**57.14%**	**0.00%**	**100.00%**
	8+	**42.86%**	**57.14%**	**0.00%**	**100.00%**
		Skagerrak		Kattegat	
Quarter	W-rings	North Sea autumn SP	Baltic Spring SP	North Sea autmn SP	Baltic Spring SP
2	1	90.00%	10.00%	79.59%	20.41%
	2	0.00%	100.00%	8.26%	91.74%
	3	8.33%	91.67%	18.18%	81.82%
	4	0.00%	100.00%	0.00%	100.00%
	5	**0.00%**	**100.00%**	**0.00%**	**100.00%**
	6	**0.00%**	**100.00%**	**0.00%**	**100.00%**
	7	**0.00%**	**100.00%**	**0.00%**	**100.00%**
	8+	**0.00%**	**100.00%**	**0.00%**	**100.00%**
		Skagerrak		Kattegat	
Quarter	W-rings	North Sea autumn SP	Baltic Spring SP	North Sea autmn SP	Baltic Spring SP
3	0	98.78%	1.22%	92.00%	8.00%
	1	90.91%	9.09%	28.57%	71.43%
	2	75.00%	25.00%	6.90%	93.10%
	3	23.53%	76.47%	12.50%	87.50%
	4	29.03%	70.97%	0.00%	100.00%
	5	**29.03%**	**70.97%**	**0.00%**	**100.00%**
	6	**29.03%**	**70.97%**	**0.00%**	**100.00%**
	7	**29.03%**	**70.97%**	**0.00%**	**100.00%**
	8+	**29.03%**	**70.97%**	**0.00%**	**100.00%**
		Skagerrak		Kattegat	
Quarter	W-rings	North Sea autumn SP	Baltic Spring SP	North Sea autmn SP	Baltic Spring SP
4	0	50.33%	50.00%	67.00%	33.33%
	1	90.00%	10.00%	25.00%	75.00%
	2	17.68%	81.82%	12.00%	87.50%
	3	7.69%	92.31%	16.00%	84.00%
	4	**99.62%**	**0.00%**	15.00%	84.62%
	5	**99.62%**	**0.00%**	**15.00%**	**84.62%**
	6	**99.62%**	**0.00%**	**15.00%**	**84.62%**
	7	**99.62%**	**0.00%**	**15.00%**	**84.62%**
	8+	**99.62%**	**0.00%**	**15.00%**	**84.62%**

Figures marked with **Bold** are estimated. All other figures are calculated by using otolith microstructure.

Table 3.2.2 Proportion of Baltic spring spawning herring in the Skagerrak and the Kattegat by year, age and quarter for the years 1991-2000. 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

Table 3.3.1 **Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet.**
Division: Skagerrak **Year: 2000** **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	13.61	21	186.35	13	199.95	14
	2	30.50	68	8.93	37	39.43	61
	3	15.55	110			15.55	110
	4	7.22	156			7.22	156
	5	3.41	193			3.41	193
	6	2.70	188			2.70	188
	7	0.55	223			0.55	223
	8+	0.12	220			0.12	220
	Total	73.66		195.28		268.93	
	SOP		6,512		2,751		9,263
2	1	36.71	32	7.27	34	43.98	32
	2	68.54	74	3.34	30	71.88	72
	3	36.29	105			36.29	105
	4	29.59	130			29.59	130
	5	10.72	144			10.72	144
	6	3.84	138			3.84	138
	7	0.52	159			0.52	159
	8+	0.61	152			0.61	152
	Total	186.81		10.62		197.43	
	SOP		16,108		348		16,456
3	0			57.19	18	57.19	18
	1	209.97	53	22.46	26	232.43	51
	2	71.97	90	3.28	80	75.25	90
	3	21.97	125	0.44	112	22.40	125
	4	23.19	151	0.72	154	23.92	151
	5	7.14	176	0.21	168	7.35	176
	6	1.09	170	0.12	193	1.21	172
	7	0.15	152	0.03	80	0.18	142
	8+						
	Total	335.49		84.45		419.94	
	SOP		25,411		2,103		27,514
4	0	112.22	22	58.78	23	171.00	22
	1	70.30	56	38.92	51	109.22	55
	2	30.58	94	7.55	96	38.13	94
	3	8.62	137	5.03	132	13.64	135
	4	9.68	176	2.83	158	12.51	172
	5	3.80	198			3.80	198
	6	1.42	183	0.31	188	1.73	184
	7			0.32	172	0.32	172
	8+						
	Total	236.61		113.73		350.35	
	SOP		13,137		5,263		18,400
Total	0	112.22	22	115.97	20	228.19	21
	1	330.58	50	255.01	21	585.59	37
	2	201.59	82	23.10	61	224.69	80
	3	82.43	115	5.46	130	87.89	116
	4	69.68	146	3.55	157	73.23	146
	5	25.07	168	0.21	168	25.28	168
	6	9.06	164	0.43	189	9.49	165
	7	1.22	187	0.34	165	1.56	182
	8+	0.73	163			0.73	163
	Total	832.58		404.08		1,236.65	
	SOP		61,168		10,465		71,633

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

Division: Kattegat **Year: 2000** **Country: ALL**

		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	141.40	19	329.18	13	470.58	14
	2	101.04	48			101.04	48
	3	25.32	80			25.32	80
	4	0.20	88			0.20	88
	5	0.09	78			0.09	78
	6	0.28	56			0.28	56
	7						
	8+						
	Total	268.32		329.18		597.50	
	SOP		9,515		4,181		13,696
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	40.54	18	7.48	13	48.02	17
	2	21.68	42			21.68	42
	3	3.74	71			3.74	71
	4	1.77	93			1.77	93
	5	0.36	124			0.36	124
	6	0.55	93			0.55	93
	7	0.04	94			0.04	94
	8+						
	Total	68.69		7.48		76.17	
	SOP		2,185		95		2,280
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0	0.58	16	39.43	18	40.01	18
	1	101.47	44	13.70	23	115.17	41
	2	44.96	81	0.46	86	45.42	81
	3	5.41	136	0.02	110	5.43	136
	4	1.71	177	0.01	153	1.73	177
	5	1.33	191	0.01	137	1.34	191
	6	0.17	158			0.17	158
	7						
	8+			0.01	132	0.01	132
	Total	155.64		53.63		209.28	
	SOP		9,416		1,078		10,494
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	9.07	23	75.72	26	84.79	25
	1	80.95	47	2.86	48	83.81	47
	2	31.61	82	0.17	79	31.78	82
	3	3.52	129	0.05	113	3.57	129
	4	2.13	155	0.03	172	2.17	155
	5	0.99	169			0.99	169
	6	0.17	148	0.00	201	0.18	149
	7						
	8+	0.11	132	0.00	177	0.12	134
	Total	128.57		78.84		207.40	
	SOP		7,628		2,108		9,737
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	9.65	23	115.15	23	124.80	23
	1	364.36	32	353.22	13	717.59	23
	2	199.30	60	0.62	84	199.92	60
	3	37.99	92	0.07	112	38.06	92
	4	5.82	140	0.05	167	5.87	141
	5	2.78	170	0.01	137	2.78	170
	6	1.17	102	0.00	201	1.18	102
	7	0.04	94			0.04	94
	8+	0.11	132	0.01	152	0.13	134
	Total	621.22		469.13		1,090.35	
	SOP		28,744		7,462		36,206

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: 2000** **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	13.61	21	186.35	13	199.95	14
	2	20.33	68	5.95	37	26.29	61
	3	6.69	110			6.69	110
	4	3.09	156			3.09	156
	5	1.46	193			1.46	193
	6	1.16	188			1.16	188
	7	0.24	223			0.24	223
	8+	0.05	220			0.05	220
	Total	46.63		192.30		238.93	
	SOP		3,452		2,641		6,094
2	1	33.03	32	6.55	34	39.58	32
	2						
	3	3.02	105			3.02	105
	4						
	5						
	6						
	7						
	8+						
	Total	36.06		6.55		42.61	
	SOP		1,371		223		1,593
3	0			56.49	18	56.49	18
	1	190.88	53	20.42	26	211.30	51
	2	53.98	90	2.46	80	56.44	90
	3	5.17	125	0.10	112	5.27	125
	4	6.73	151	0.21	154	6.94	151
	5	2.07	176	0.06	168	2.14	176
	6	0.32	170	0.03	193	0.35	172
	7	0.04	152	0.01	80	0.05	142
	8+						
	Total	259.20		79.79		338.99	
	SOP		17,134		1,813		18,947
4	0	56.48	22	29.59	23	86.07	22
	1	63.27	56	35.03	51	98.30	55
	2	5.41	94	1.33	96	6.74	94
	3	0.66	137	0.39	132	1.05	135
	4	9.64	176	2.82	158	12.46	172
	5	3.78	198			3.78	198
	6	1.41	183	0.31	188	1.72	184
	7			0.31	172	0.31	172
	8+						
	Total	140.66		69.78		210.44	
	SOP		8,085		3,197		11,282
Total	0	56.48	22	86.08	20	142.56	20
	1	300.79	50	248.35	20	549.14	36
	2	79.72	85	9.75	56	89.47	82
	3	15.54	115	0.49	128	16.03	115
	4	19.47	164	3.03	158	22.49	163
	5	7.32	191	0.06	168	7.38	191
	6	2.89	184	0.35	189	3.23	184
	7	0.28	212	0.32	170	0.60	189
	8+	0.05	220			0.05	220
	Total	482.54		348.42		830.96	
	SOP		30,042		7,874		37,916

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: 2000** **Country: All**

		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	103.07	19	239.96	13	343.04	14
	2	17.42	48			17.42	48
	3	3.89	80			3.89	80
	4						
	5						
	6						
	7						
	8+						
	Total	124.39		239.96		364.35	
	SOP		3,065		3,048		6,113
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	32.27	18	5.96	13	38.22	17
	2	1.79	42			1.79	42
	3	0.68	71			0.68	71
	4						
	5						
	6						
	7						
	8+						
	Total	34.74		5.96		40.69	
	SOP		711		76		787
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0	0.53	16	36.28	18	36.81	18
	1	28.99	44	3.91	23	32.91	41
	2	3.10	81	0.03	86	3.13	81
	3	0.68	136	0.00	110	0.68	136
	4						
	5						
	6						
	7						
	8+						
	Total	33.30		40.22		73.53	
	SOP		1,618		753		2,371
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	6.08	23	50.73	26	56.81	25
	1	20.24	47	0.72	48	20.95	47
	2	3.79	82	0.02	79	3.81	82
	3	0.56	129	0.01	113	0.57	129
	4	0.32	155	0.01	172	0.33	155
	5	0.15	169			0.15	169
	6	0.03	148	0.00	201	0.03	149
	7						
	8+	0.02	132	0.00	177	0.02	134
	Total	31.18		51.48		82.66	
	SOP		1,562		1,340		2,902
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	6.61	22	87.00	23	93.62	23
	1	184.57	26	250.55	13	435.12	18
	2	26.10	56	0.05	83	26.16	56
	3	5.81	90	0.01	112	5.83	90
	4	0.32	155	0.01	172	0.33	155
	5	0.15	169			0.15	169
	6	0.03	148	0.00	201	0.03	149
	7						
	8+	0.02	132	0.00	177	0.02	134
	Total	223.61		337.62		561.24	
	SOP		6,956		5,217		12,173

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: 2000** **Country: All**

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
1	1						
	2	10.17	68	2.98	37	13.14	61
	3	8.86	110			8.86	110
	4	4.12	156			4.12	156
	5	1.95	193			1.95	193
	6	1.55	188			1.55	188
	7	0.31	223			0.31	223
	8+	0.07	220			0.07	220
	Total	27.03		2.98		30.01	
	SOP		3,060		110		3,169

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
2	1	3.67	32	0.73	34	4.40	32
	2	68.54	74	3.34	30	71.88	72
	3	33.27	105			33.27	105
	4	29.59	130			29.59	130
	5	10.72	144			10.72	144
	6	3.84	138			3.84	138
	7	0.52	159			0.52	159
	8+	0.61	152			0.61	152
	Total	150.75		4.07		154.82	
	SOP		14,737		126		14,863

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
3	0			0.70	18	0.70	18
	1	19.09	53	2.04	26	21.13	51
	2	17.99	90	0.82	80	18.81	90
	3	16.80	125	0.33	112	17.13	125
	4	16.46	151	0.51	154	16.97	151
	5	5.07	176	0.15	168	5.22	176
	6	0.78	170	0.08	193	0.86	172
	7	0.11	152	0.02	80	0.13	142
	8+						
	Total	76.29		4.66		80.95	
	SOP		8,277		290		8,567

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
4	0	56.11	22	29.39	23	85.50	22
	1	7.03	56	3.89	51	10.92	55
	2	25.02	94	6.18	96	31.20	94
	3	7.96	137	4.64	132	12.59	135
	4						
	5						
	6						
	7						
	8+						
	Total	96.12		44.10		140.22	
	SOP		5,035		2,065		7,100

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Total Numbers	Total Mean W.
Total	0	56.11	22	30.09	22	86.20	22
	1	29.79	51	6.66	42	36.45	50
	2	121.72	80	13.32	65	135.03	78
	3	66.88	115	4.97	131	71.86	116
	4	50.18	139	0.51	154	50.69	139
	5	17.74	158	0.15	168	17.89	158
	6	6.16	155	0.08	193	6.25	155
	7	0.94	180	0.02	80	0.96	178
	8+	0.68	159			0.68	159
	Total	350.20		55.80		406.00	
	SOP		31,109		2,590		33,699

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: 2000** **Country: All**

		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	38.32	19	89.22	13	127.54	14
	2	83.62	48			83.62	48
	3	21.42	80			21.42	80
	4	0.20	88			0.20	88
	5	0.09	78			0.09	78
	6	0.28	56			0.28	56
	7						
	8+						
	Total	143.93		89.22		233.15	
	SOP		6,450		1,133		7,583
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	8.27	18	1.53	13	9.80	17
	2	19.89	42			19.89	42
	3	3.06	71			3.06	71
	4	1.77	93			1.77	93
	5	0.36	124			0.36	124
	6	0.55	93			0.55	93
	7	0.04	94			0.04	94
	8+						
	Total	33.95		1.53		35.48	
	SOP		1,474		19		1,493
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0	0.05	16	3.15	18	3.20	18
	1	72.48	44	9.78	23	82.27	41
	2	41.86	81	0.43	86	42.29	81
	3	4.73	136	0.02	110	4.75	136
	4	1.71	177	0.01	153	1.73	177
	5	1.33	191	0.01	137	1.34	191
	6	0.17	158			0.17	158
	7						
	8+			0.01	132	0.01	132
	Total	122.34		13.41		135.75	
	SOP		7,798		325		8,123
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	3.02	23	25.24	26	28.26	25
	1	60.71	47	2.15	48	62.86	47
	2	27.66	82	0.15	79	27.81	82
	3	2.96	129	0.04	113	3.00	129
	4	1.81	155	0.03	172	1.83	155
	5	0.84	169			0.84	169
	6	0.14	148	0.00	201	0.15	149
	7						
	8+	0.10	132	0.00	177	0.10	134
	Total	97.24		27.61		124.85	
	SOP		6,052		774		6,827
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	3.07	23	28.39	25	31.46	25
	1	179.79	38	102.67	14	282.46	30
	2	173.03	61	0.57	84	173.60	61
	3	32.17	92	0.06	112	32.24	92
	4	5.49	140	0.04	166	5.53	140
	5	2.62	171	0.01	137	2.63	170
	6	1.15	101	0.00	201	1.15	101
	7	0.04	94			0.04	94
	8+	0.10	132	0.01	150	0.11	134
	Total	397.46		131.76		529.23	
	SOP		21,774		2,251		24,025

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: 2000** **Country: All**

		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	116.68	19	426.31	13	542.99	14
	2	37.75	59	5.95	37	43.71	56
	3	10.58	99			10.58	99
	4	3.09	156			3.09	156
	5	1.46	193			1.46	193
	6	1.16	188			1.16	188
	7	0.24	223			0.24	223
	8+	0.05	220			0.05	220
	Total	171.02		432.26		603.28	
	SOP		6,517		5,689		12,206
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	65.30	25	12.50	24	77.81	25
	2	1.79	42			1.79	42
	3	3.70	99			3.70	99
	4						
	5						
	6						
	7						
	8+						
	Total	70.80		12.50		83.30	
	SOP		2,082		298		2,380
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0	0.53	16	92.77	18	93.30	18
	1	219.88	52	24.34	25	244.21	49
	2	57.08	90	2.50	80	59.57	90
	3	5.84	127	0.11	112	5.95	126
	4	6.73	151	0.21	154	6.94	151
	5	2.07	176	0.06	168	2.14	176
	6	0.32	170	0.03	193	0.35	172
	7	0.04	152	0.01	80	0.05	142
	8+						
	Total	292.50		120.02		412.52	
	SOP		18,752		2,566		21,318
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	62.56	22	80.32	25	142.88	23
	1	83.51	54	35.75	51	119.25	53
	2	9.20	89	1.35	95	10.56	90
	3	1.23	133	0.39	132	1.62	133
	4	9.96	175	2.82	158	12.78	171
	5	3.93	197			3.93	197
	6	1.44	183	0.31	188	1.75	184
	7			0.31	172	0.31	172
	8+	0.02	132	0.00	177	0.02	134
	Total	171.84		121.26		293.10	
	SOP		9,647		4,538		14,184
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	63.10	22	173.08	21	236.18	21
	1	485.36	41	498.90	16	984.26	28
	2	105.82	78	9.80	56	115.63	76
	3	21.36	108	0.50	127	21.86	109
	4	19.79	164	3.03	158	22.82	163
	5	7.47	191	0.06	168	7.53	190
	6	2.91	183	0.35	189	3.26	184
	7	0.28	212	0.32	170	0.60	189
	8+	0.07	198	0.00	177	0.07	198
	Total	706.16		686.04		1,392.20	
	SOP		36,998		13,091		50,089

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: 2000   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	38.32	19	89.22	13	127.54	14
	2	93.78	50	2.98	37	96.76	49
	3	30.28	89			30.28	89
	4	4.32	153			4.32	153
	5	2.04	188			2.04	188
	6	1.82	168			1.82	168
	7	0.31	223			0.31	223
	8+	0.07	220			0.07	220
	Total	170.96		92.19		263.15	
	SOP		9,510		1,243		10,752
2	1	11.94	22	2.25	20	14.20	22
	2	88.43	66	3.34	30	91.77	65
	3	36.33	102			36.33	102
	4	31.36	128			31.36	128
	5	11.08	143			11.08	143
	6	4.40	133			4.40	133
	7	0.56	155			0.56	155
	8+	0.61	152			0.61	152
	Total	184.70		5.60		190.30	
	SOP		16,211		145		16,356
3	0	0.05	16	3.85	18	3.90	18
	1	91.57	46	11.83	23	103.40	43
	2	59.86	84	1.25	82	61.10	84
	3	21.53	128	0.35	112	21.88	127
	4	18.17	154	0.53	154	18.70	154
	5	6.40	179	0.16	167	6.56	179
	6	0.95	168	0.08	193	1.03	170
	7	0.11	152	0.02	80	0.13	142
	8+			0.01	132	0.01	132
	Total	198.63		18.07		216.70	
	SOP		16,075		614		16,689
4	0	59.14	22	54.63	24	113.76	23
	1	67.74	48	6.04	50	73.78	48
	2	52.68	88	6.32	95	59.00	88
	3	10.92	135	4.68	132	15.60	134
	4	1.81	155	0.03	172	1.83	155
	5	0.84	169			0.84	169
	6	0.14	148	0.00	201	0.15	149
	7						
	8+	0.10	132	0.00	177	0.10	134
	Total	193.36		71.71		265.06	
	SOP		11,088		2,839		13,927
Total	0	59.18	22	58.48	24	117.66	23
	1	209.58	40	109.34	16	318.92	32
	2	294.75	69	13.89	66	308.64	68
	3	99.06	107	5.03	130	104.09	108
	4	55.67	139	0.56	155	56.22	139
	5	20.36	160	0.16	167	20.52	160
	6	7.31	146	0.09	194	7.40	147
	7	0.98	177	0.02	80	1.00	175
	8+	0.77	155	0.01	150	0.78	155
	Total	747.66		187.56		935.22	
	SOP		52,883		4,841		57,725

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

Division: 22-24 **Year: 2000** **Country: ALL**

Quarter	W-rings	Sub-division 22		Sub-division 23		Sub-division 24		Total	
		Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	97.91	14	1.21	13	84.23	14	183.36	14
	2	36.03	30	0.72	43	27.02	40	63.77	34
	3	0.99	82	2.35	89	51.80	83	55.14	83
	4	0.25	107	2.36	124	53.47	125	56.08	125
	5	0.17	137	0.81	134	24.37	142	25.36	142
	6	1.29	163	0.26	155	13.60	162	15.15	162
	7	1.17	176	0.19	160	5.77	160	7.12	163
	8+	1.89	182	0.00	138	0.81	184	2.70	183
	Total	139.71		7.90		261.07		408.68	
	SOP		3,291		726		19,912		23,929
Quarter	W-rings	Sub-division 22		Sub-division 23		Sub-division 24		Total	
		Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	243.84	21	0.03	17	19.69	23	263.56	21
	2	24.24	38	0.04	42	16.98	48	41.26	42
	3	0.29	64	0.02	71	20.85	72	21.16	72
	4	1.28	104	0.01	95	12.37	110	13.66	109
	5	1.45	138	0.00	124	15.43	130	16.89	131
	6	1.54	148	0.00	93	12.02	126	13.56	129
	7	1.18	162			3.19	150	4.37	153
	8+	2.69	166			3.18	123	5.87	143
	Total	276.51		0.10		103.71		380.33	
	SOP		7,273		5		8,528		15,806
Quarter	W-rings	Sub-division 22		Sub-division 23		Sub-division 24		Total	
		Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0			0.02	16	2.73	14	2.75	14
	1	16.67	31	0.62	45	17.74	34	35.03	32
	2	37.10	34	1.09	82	5.78	55	43.96	38
	3			0.34	104	2.87	62	3.21	66
	4			0.19	107	1.34	71	1.53	76
	5			0.25	94	1.91	76	2.16	78
	6			0.09	85	0.86	68	0.95	70
	7			0.03	98	0.28	87	0.31	88
	8+			0.00	113	0.12	68	0.12	70
	Total	53.76		2.64		33.62		90.03	
	SOP		1,772		209		1,458		3,440
Quarter	W-rings	Sub-division 22		Sub-division 23		Sub-division 24		Total	
		Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	4.91	13	0.13	25	29.96	17	35.00	17
	1	15.53	36	0.70	47	118.13	33	134.37	33
	2	0.19	157	0.48	76	44.64	60	45.30	60
	3	1.32	139	0.09	102	5.80	82	7.22	93
	4	5.82	162	0.01	126	0.68	99	6.51	156
	5	3.55	172			5.01	95	8.56	127
	6					0.40	94	0.40	94
	7	0.13	224			0.50	94	0.63	120
	8+					0.60	113	0.60	113
	Total	31.45		1.41		205.73		238.58	
	SOP		2,419		83		8,227		10,729
Quarter	W-rings	Sub-division 22		Sub-division 23		Sub-division 24		Total	
		Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	4.91	13	0.15	24	32.70	17	37.75	17
	1	373.95	20	2.57	30	239.80	25	616.32	22
	2	97.56	34	2.33	68	94.41	52	194.30	43
	3	2.60	109	2.81	91	81.32	79	86.73	80
	4	7.35	150	2.57	122	67.87	121	77.78	124
	5	5.17	161	1.07	125	46.72	130	52.96	133
	6	2.83	155	0.35	137	26.88	142	30.06	143
	7	2.48	172	0.22	151	9.73	151	12.43	155
	8+	4.58	173	0.00	118	4.71	131	9.29	151
	Total	501.42		12.06		604.13		1,117.62	
	SOP		14,756		1,023		38,125		53,904

Table 3.3.10 **Landings in numbers (mill.), mean weight (g.) and SOP (t)**
by age and quarter from. **Western Baltic Spring Spawners**
(values from the North Sea, see Table 2.2.1-2.2.5)
Division: **IV + IIIa + 22-24** **Year: 2000**

		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1			127.54	14	183.36	14	310.90	14
	2			96.76	49	63.77	34	160.53	43
	3			30.28	89	55.14	83	85.43	85
	4			4.32	153	56.08	125	60.40	127
	5			2.04	188	25.36	142	27.40	145
	6			1.82	168	15.15	162	16.97	163
	7			0.31	223	7.12	163	7.44	165
	8+			0.07	220	2.70	183	2.77	184
	Total	0.00		263.15		408.68		671.83	
	SOP		0		10,752		23,929		34,681
		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1			14.20	22	263.56	21	277.76	21
	2	0.93	124.00	91.77	65	41.26	42	133.96	58
	3	2.47	144.40	36.33	102	21.16	72	59.96	93
	4	1.77	162.60	31.36	128	13.66	109	46.80	124
	5	0.66	168.70	11.08	143	16.89	131	28.62	136
	6	0.21	191.30	4.40	133	13.56	129	18.17	130
	7	0.04	226.70	0.56	155	4.37	153	4.96	154
	8+	0.04	220.26	0.61	152	5.87	143	6.52	144
	Total	6.12		190.30		380.33		576.75	
	SOP		929		16,356		15,806		33,091
		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0			3.90	18	2.75	14	6.65	17
	1			103.40	43	35.03	32	138.43	40
	2	7.23	142.90	61.10	84	43.96	38	112.30	70
	3	7.28	172.30	21.88	127	3.21	66	32.38	131
	4	8.45	188.40	18.70	154	1.53	76	28.68	160
	5	5.00	212.00	6.56	179	2.16	78	13.72	175
	6	2.26	203.40	1.03	170	0.95	70	4.24	165
	7	0.57	216.90	0.13	142	0.31	88	1.00	167
	8+	0.74	268.80	0.01	132	0.12	70	0.86	240
	Total	31.53		216.70		90.03		338.26	
	SOP		5,720		16,689		3,440		25,849
		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0			113.76	23	35.00	17	148.76	21
	1			73.78	48	134.37	33	208.15	39
	2			59.00	88	45.30	60	104.31	76
	3			15.60	134	7.22	93	22.81	121
	4			1.83	155	6.51	156	8.34	155
	5			0.84	169	8.56	127	9.40	130
	6			0.15	149	0.40	94	0.55	109
	7					0.63	120	0.63	120
	8+			0.10	134	0.60	113	0.70	116
	Total	0.00		265.06		238.58		503.65	
	SOP		0		13,927		10,729		24,656
		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0			117.66	23	37.75	17	155.41	21
	1			318.92	32	616.32	22	935.24	26
	2	8.16	141	308.64	68	194.30	43	511.10	60
	3	9.75	165	104.09	108	86.73	80	200.58	99
	4	10.22	184	56.22	139	77.78	124	144.22	134
	5	5.66	207	20.52	160	52.96	133	79.14	145
	6	2.47	202	7.40	147	30.06	143	39.92	148
	7	0.61	218	1.00	175	12.43	155	14.03	159
	8+	0.78	266	0.78	155	9.29	151	10.85	160
	Total	37.64		935.22		1,117.62		2,090.49	
	SOP		6,649		57,725		53,904		118,278

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 1991-2000

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

All data from 1991 - 1999 revised.

Table 3.3.12 **Transfers of North Sea autumn spawners from Div. IIIa to the North Sea Numbers (mill) and mean weight, SOP in (tonnes) 1991-2000.**

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

Corrections for the years 1991-1998 has been made, but are NOT included in the North Sea assessment.
Data for 1999 is revised and is 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 1991-2000**

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

All data from 1991-1999 revised

Table 3.3.14 **Mean weight (g) and SOP (tons) of spring spawners in Division IIIa + the North Sea and in Sub-Divisions 22-24 in the years 1991 - 2000**

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

All data from 1991-1999 revised

Table 3.3.15 **Landings in numbers (mill.), mean weight (g.) and SOP (t)**
by age and quarter from. **Western Baltic Spring Spawners**
(values from the North Sea, see Table 2.2.1-2.2.5)
Division: **IV + IIIa + 22-24** **Year: 1999** **Revised**

		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	1			45.92	22	162.04	21	207.96	21
	2			56.65	73	82.95	46	139.60	57
	3			42.09	99	67.38	79	109.47	87
	4			16.07	96	27.53	115	43.61	108
1	5			11.95	135	19.43	156	31.38	148
	6			1.20	124	6.74	167	7.93	160
	7			1.29	50	2.47	193	3.76	144
	8+			1.24	94	1.19	210	2.42	150
	Total	0.00		176.41		369.73		546.14	
	SOP		0		12,776		20,587		33,363
		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	1	0.00	77.60	26.03	49	114.17	22	140.21	27
	2	1.24	124.90	48.86	87	69.02	47	119.12	64
	3	5.59	143.90	22.16	99	41.28	73	69.03	87
	4	2.95	159.20	12.04	113	14.37	106	29.35	114
2	5	1.74	190.60	4.38	128	11.95	141	18.07	143
	6	0.67	216.30	1.01	140	4.17	125	5.86	138
	7	0.26	226.90	1.02	141	3.44	166	4.72	164
	8+	0.18	279.05	0.58	182	2.48	137	3.23	153
	Total	12.62		116.08		260.88		389.59	
	SOP		2,014		10,017		13,366		25,397
		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0	0.00	0.00	16.12	9	280.86	8	296.99	8
	1	0.00	76.20	61.72	58	71.59	31	133.31	43
	2	2.08	128.60	42.37	92	6.26	63	50.71	90
	3	8.73	150.70	37.87	121	0.99	93	47.59	126
	4	2.67	173.70	11.77	144	0.85	116	15.29	147
3	5	1.89	196.90	3.18	163	1.51	90	6.57	156
	6	0.77	219.20	1.03	206	0.12	187	1.93	210
	7	0.30	224.90	0.35	231	0.53	62	1.18	154
	8+	0.25	248.26	0.38	212	0.02	221	0.65	226
	Total	16.69		174.80		362.73		554.22	
	SOP		2,718		14,812		5,317		22,847
		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0			25.23	13	247.40	14	272.62	14
	1			57.57	68	78.03	44	135.60	54
	2			19.50	100	20.44	77	39.94	88
	3			17.20	140	14.30	117	31.50	129
	4			2.30	158	4.34	109	6.64	126
4	5			0.86	178	0.82	176	1.68	177
	6			0.18	137	0.03	222	0.21	150
	7			0.05	194	0.02	213	0.07	199
	8+			0.11	224			0.11	224
	Total	0.00		122.99		365.38		488.38	
	SOP		0		9,176		10,790		19,966
		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0			41.35	12	528.26	11	569.61	11
	1			191.24	51	425.84	27	617.08	34
	2	3.32	127	167.38	85	178.67	50	349.37	68
	3	14.32	148	119.32	112	123.95	82	257.59	99
	4	5.61	166	42.18	118	47.10	112	94.89	118
Total	5	3.62	194	20.37	140	33.71	148	57.71	148
	6	1.45	218	3.42	154	11.07	151	15.94	158
	7	0.56	226	2.70	110	6.46	168	9.73	155
	8+	0.43	261	2.31	142	3.68	161	6.42	161
	Total	29.31		590.28		1,358.73		1,978.32	
	SOP		4,732		46,781		50,060		101,573

Table 3.4.1 Herring in Division IIIa, IIIb and IIIc. Samples of commercial landings by quarter and area for 2000

	Country	Quarter	Landings in '000 tons	Numbers of samples	Numbers of fish meas.	Numbers of fish aged
Skagerrak	**Denmark**	**1**	3.8	6	530	431
		2	1.3	10	105	100
		3	6.7	16	1000	328
		4	4.3	8	722	298
	Total		16.0	40	2357	1157
	Norway	**1**	1.3	No data available		
		2	7.7	5	500	495
		3	0.2	No data available		
		4	0.5			
	Total		9.7	5	500	495
	Sweden	**1**	4.1	9	1919	661
		2	7.5	13	3138	1008
		3	20.5	22	9570	1513
		4	13.7	14	1989	882
	Total		45.8	58	16616	4064
Kattegat	**Denmark**	**1**	8.1	4	744	252
		2	0.9	2	714	106
		3	5.7	5	1507	225
		4	4.2	5	1417	327
	Total		18.9	16	4382	910
	Sweden	**1**	5.6	7	2146	677
		2	1.3	4	1336	287
		3	4.8	4	921	641
		4	5.6	16	2943	1464
	Total		17.3	31	7346	3069
Sub-Division 22	**Denmark**	**1**	2.4	4	1510	251
		2	6.1	3	902	159
		3	1.8	3	468	144
		4	2.4	2	378	106
	Total		12.7	12	3258	660
	Germany	**1**	0.9	15	6634	401
		2	1.2	15	7485	640
		3	0.0	No data available		
		4	0.1			
	Total		2.2	30	14119	1041
Sub-Division 23	**Denmark**	**1**	0.7	No data available		
		2	+			
		3	0.2			
		4	+			
	Total		0.9			
	Sweden	**1**	0.0	No data available		
		2				
		3	0.1			
		4	0.0			
	Total		0.1			
Sub-Division 24	**Denmark**	**1**	11.2	4	1037	201
		2	2.2	1	268	53
		3	0.6	1	268	53
		4	5.9	1	397	56
	Total		19.9	7	1970	363
	Germany	**1**	4.1	31	11700	1487
		2	2.9	19	6960	1146
		3	0.0	No data available		
		4	0.1			
	Total		7.2	50	18660	2633
	Poland	**1**	1.8	No data available		
		2	3.4			
		3	0.6			
		4	0.7			
	Total		6.6			
	Sweden	**1**	2.6	1	905	242
		2	0.0	No data available		
		3	0.3	2	352	170
		4	1.8	3	548	308
	Total		4.8	6	1805	720

Table 3.4.2 Herring in Division IIIa.
Samples of landings by quarter and area for 2000 of mean weight at age.

	Country	Quarter	Fleet	Sampling used to estimate mean weight at age.
Skagerrak	**Denmark**	**1**	**C**	Swedish sampling in Q1
		2	**C**	Swedish sampling in Q2
		3	**C**	Danish sampling
		4	**C**	Danish sampling
	Norway	**1**	**C**	Norwegian sampling in Q2
		2	**C**	Norwegian sampling
		3	**C**	Swedish sampling in Q3
		4	**C**	Swedish sampling in Q4
	Sweden	**1**	**C**	Swedish sampling in Q1
		2	**C**	Swedish sampling in Q2
		3	**C**	Swedish sampling in Q3
		4	**C**	Swedish sampling in Q4
Kattegat	**Denmark**	**1**	**C**	Danish sampling
		2	**C**	Danish sampling
		3	**C**	Danish sampling
		4	**C**	Danish sampling
	Sweden	**1**	**C**	Swedish sampling
		2	**C**	Swedish sampling
		3	**C**	Swedish sampling
		4	**C**	Swedish sampling
Skagerrak	**Denmark**	**1**	**D**	Danish sampling
		2	**D**	Danish sampling
		3	**D**	Danish sampling
		4	**D**	Danish sampling
	Sweden	**1**	**D**	Swedish sampling
		2	**D**	Danish sampling in Q2
		3	**D**	Swedish sampling
		4	**D**	Swedish sampling
Kattegat	**Denmark**	**1**	**D**	Danish sampling
		2	**D**	Danish sampling in Q1
		3	**D**	Danish sampling in Q3 in Skagerrak
		4	**D**	Danish sampling
	Sweden	**1**	**D**	Danish sampling in Q1 in Kattegat
		2	**D**	Danish sampling in Q1 in Kattegat
		3	**D**	Danish sampling in Q3 in Skagerrak
		4	**D**	Swedish sampling

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 2000 of mean weight at age.

	Country	Quarter	Fleet	Sampling used to estimate mean weight at age
Sub-Division 22	**Denmark**	**1**	**D**	Danish sampling
		2	**D**	Danish sampling
		3	**D**	Danish sampling
		4	**D**	Danish sampling
	Germany	**1**	**D**	German sampling
		2	**D**	German sampling
		3	**D**	No sampling
		4	**D**	No sampling
Sub-Division 23	**Denmark**	**1**	**D**	Danish sampling in Q1 in Sub.div 24.
		2	**D**	Danish sampling in Q2 in Kattegat
		3	**D**	Danish sampling in Q3 in Kattegat
		4	**D**	Danish sampling in Q4 in Kattegat
	Sweden	**1**	**D**	Swedish sampling in Q1 in Sub.div 24
		2	**D**	Swedish sampling in Q2 in Sub.div 25
		3	**D**	Swedish sampling in Q3 in Sub.div 26
		4	**D**	Swedish sampling in Q4 in Sub.div 27
Sub-Division 24	**Denmark**	**1**	**D**	Danish sampling
		2	**D**	Danish sampling
		3	**D**	Danish sampling
		4	**D**	Danish sampling
	Germany	**1**	**D**	German sampling
		2	**D**	German sampling
		3	**D**	No sampling
		4	**D**	No sampling
	Poland	**1**	**D**	No information on sampling available
		2	**D**	No information on sampling available
		3	**D**	No information on sampling available
		4	**D**	No information on sampling available
	Sweden	**1**	**D**	Swedish sampling
		2	**D**	Danish sampling in Q2
		3	**D**	Swedish sampling
		4	**D**	Swedish sampling

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 sub-division :		
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

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*	-	-	-	-	-

* = 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 1989-2000 (July).

Year	1989	1990	1991	1992*	1993*	1994*	1995*	1996*	1997	1998	1999**	2000
Numbers in millions												
W-rings												
0		31		3,853	372	964						
1		135		277	103	5	2,199	1,091	128	138	1367	1509
2	1,105	1,497	1,864	2,092	2,768	413	1,887	1,005	715	1,682	1143	1891
3	714	549	1,927	1,799	1,274	935	1,022	247	787	901	523	674
4	317	319	866	1,593	598	501	1,270	141	166	282	135	364
5	81	110	350	556	434	239	255	119	67	111	28	186
6	51	24	88	197	154	186	174	37	69	51	3	56
7	16	10	72	122	63	62	39	20	80	31	2	7
8+	4	5	10	20	13	34	21	13	77	53	1	10
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**
3+ group	**1,183**	**1,017**	**3,313**	**4,287**	**2,536**	**1,957**	**2,781**	**577**	**1,245**	**1,428**	**691**	**1,295**
Biomass ('000 tonnnes)												
W-rings												
0	0.0	0.5	0.0	34.3	1	8.7						
1	0.0	6.8	0.0	26.8	7	0.4	77.4	52.9	4.7	7.1	74.8	61.4
2	86.2	122.8	177.1	169.0	139	33.2	108.9	87.0	52.2	136.1	101.6	138.1
3	83.5	59.8	219.7	206.3	112	114.7	102.6	27.6	81.0	84.8	59.5	68.8
4	54.2	41.2	116.0	204.7	69	76.7	145.5	17.9	21.5	35.2	14.7	45.3
5	16.0	15.8	51.1	83.3	65	41.8	33.9	17.8	9.8	13.1	3.4	25.1
6	11.4	3.8	19.0	36.6	26	38.1	27.4	5.8	9.8	6.9	0.5	10.0
7	3.4	1.8	13.0	24.4	16	13.1	6.7	3.3	14.9	4.8	0.3	1.4
8+	0.9	0.8	2.0	5.0	2	7.8	3.8	2.7	13.6	9.0	0.1	1.3
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
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
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
2	78	82	95	80.8	50.1	80.3	57.7	86.6	73.0	80.9	88.9	73.1
3	117	109	114	114.7	87.9	122.7	100.4	111.9	103.0	94.1	113.8	102.2
4	171	129	134	128.5	116.2	153.0	114.6	126.8	129.6	124.7	109.1	124.4
5	198	144	146	149.8	149.9	175.1	132.9	149.4	145.0	118.7	120.0	135.4
6	211	159	216	185.7	169.6	205.0	157.2	157.3	143.1	135.8	179.9	179.2
7	215	176	181	199.7	256.9	212.0	172.9	166.8	185.6	156.4	179.9	208.8
8+	226	156	200	252.0	164.2	230.3	183.1	212.9	178.0	168.0	181.7	135.2
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

* revised in 1997

**the survey only covered the Skagerrak area. 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 Sub-divisions 22-24 in 1989-2000 (September/October).

Year	1989	1990	1991*	1992*	1993*	1994*	1995*	1996*	1997*	1998*	1999*	2000
	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	2,137	1,785	2,864	1,961	345	412	1,163	1,084	1,389	451	1,145	1,208
2	213	892	1,418	1,051	354	823	307	541	492	557	246	477
3	161	146	1,403	588	485	540	332	413	343	364	187	348
4	102	79	472	283	381	433	342	282	151	232	129	206
5	23	19	241	86	121	182	247	283	112	99	44	81
6	4	8	85	40	52	56	124	110	92	51	8	39
7	3	4	13	9	28	22	40	44	32	23	1	5
8+	1	2	28	9	13	2	27	18	46	9	2	4
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
3+ group	294	258	2,243	1,014	1,080	1,235	1,112	1,151	775	778	370	682
	Biomass ('000 tonnnes)											
W-rings												
0	**	287.7	76.3	41.3	11.3	49.3	41.1	12.3	25.6	20.4	54.2	12.8
1	**	65.9	121.4	71.4	12.3	14.3	39.6	32.9	49.4	18.2	42.3	47.5
2	**	56.2	111.1	64.7	15.7	38.1	19.8	26.8	29.2	41.4	18.8	29.7
3	**	12.3	141.3	53.8	29.7	39.2	28.5	29.3	31.9	32.9	22.0	29.0
4	**	7.6	59.6	34.7	23.5	41.3	39.1	20.0	21.0	27.5	13.1	24.1
5	**	1.9	35.5	13.0	12.3	22.9	26.7	33.9	16.0	11.3	5.6	9.2
6	**	0.9	12.7	6.3	6.7	11.5	14.7	14.7	13.2	6.1	0.8	5.6
7	**	0.4	1.7	1.8	2.2	4.9	8.8	5.7	5.1	3.7	0.2	1.1
8+	**	0.2	3.8	2.2	2.3	0.6	6.6	2.7	10.2	2.2	0.4	0.7
Total	**	438.5	563.3	289.3	116.0	222.1	224.9	178.4	201.7	163.5	157.5	159.7
3+ group	**	23.4	254.5	111.8	76.7	120.4	124.5	106.3	97.4	83.5	42.1	69.6
	Mean weight (g)											
W-rings												
0	**	13.6	10.6	14.4	14.7	11.2	10.3	8.7	9.8	9.4	11.2	12.6
1	**	36.9	42.4	36.4	35.7	34.7	34.0	30.4	35.6	40.3	37.0	39.3
2	**	63.0	78.4	61.6	44.3	46.3	64.5	49.6	59.4	74.3	76.4	62.3
3	**	84.5	100.7	91.5	61.3	72.6	85.9	70.8	93.1	90.4	117.6	83.3
4	**	96.6	126.4	122.7	61.6	95.5	114.5	71.1	139.2	118.3	101.8	117.1
5	**	101.4	147.3	151.3	101.3	125.9	108.0	119.7	142.3	114.0	127.5	114.1
6	**	112.2	148.2	159.1	129.6	204.0	118.1	133.5	143.4	120.5	107.2	143.0
7	**	100.6	126.6	205.7	80.2	222.6	222.0	128.5	161.6	158.1	231.1	202.9
8+	**	102.5	132.5	259.2	172.7	269.6	241.1	154.7	222.2	232.9	219.1	180.9
Total	**	18.2	41.1	41.9	45.5	32.4	34.2	42.5	38.3	41.2	23.9	47.1

* 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)
** no data available

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[2+3]
1993	199[2+3]
1994	788[2]
1995	171[2]
1996	31[2]
1997	54[2]
1998	2553[2]
1999	1945[4]
2000	151[4]

[1] Brielmann 1989
[2] Klenz 1999 Inf.Fischwirtsch. Fischereiforsch. 46(2), 1999: 15-17
[3] Müller & Klenz 1994
[4] Klenz 2000 Inf.Fischwirtsch. Fischereiforsch. 47(4), 2000: 191-192

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
0	119.0	145.1	206.1	263.2	541.3	171.1	376.8	549.8	566.8	155.4
1	826.0	456.7	530.7	249.4	1660.7	638.9	668.6	625.5	563.0	935.2
2	541.2	602.6	495.9	365.0	451.8	403.1	298.2	463.2	347.5	511.1
3	564.4	364.9	415.1	382.6	258.5	211.5	289.4	190.7	262.5	200.6
4	279.8	334.0	260.9	267.0	212.9	157.3	87.8	152.5	94.9	144.2
5	177.5	183.2	210.5	168.1	88.9	134.3	47.2	47.1	57.7	79.1
6	46.5	139.8	102.8	118.4	62.6	67.7	41.4	24.3	15.9	39.9
7	13.2	52.7	63.9	49.5	35.5	31.7	21.6	15.5	9.7	14.0
8	4.9	22.6	24.5	33.1	20.9	25.5	25.0	14.3	6.4	10.8

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
0	0.03000	0.01500	0.01500	0.01500	0.01000	0.01100	0.03000	0.01400	0.01100	0.02100
1	0.03500	0.03400	0.02500	0.03700	0.02100	0.02500	0.02700	0.03300	0.03100	0.02600
2	0.06700	0.06700	0.06800	0.08300	0.07100	0.08100	0.07000	0.06800	0.06700	0.06000
3	0.09500	0.09400	0.10200	0.10300	0.10800	0.10200	0.12100	0.09500	0.10000	0.09900
4	0.12300	0.11600	0.11400	0.12200	0.12900	0.12100	0.14600	0.11900	0.11800	0.13400
5	0.13900	0.14200	0.13600	0.14100	0.15500	0.13500	0.16800	0.13800	0.14800	0.14500
6	0.15600	0.16500	0.16800	0.15600	0.17400	0.14000	0.18300	0.16700	0.15800	0.14800
7	0.17100	0.17600	0.18200	0.17000	0.20800	0.15700	0.19800	0.16600	0.15500	0.15900
8	0.18300	0.19200	0.19900	0.18600	0.21800	0.19100	0.20900	0.18800	0.16100	0.16000

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
0	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
2	0.05300	0.04500	0.04000	0.05300	0.04600	0.05500	0.05100	0.05600	0.05700	0.04300
3	0.07900	0.08200	0.09700	0.08400	0.07100	0.09100	0.10600	0.08300	0.08700	0.08500
4	0.10400	0.10800	0.10800	0.10800	0.13300	0.11700	0.13300	0.11300	0.10800	0.12700
5	0.12400	0.13100	0.14100	0.13900	0.16700	0.12000	0.16600	0.13400	0.14800	0.14500
6	0.14500	0.15900	0.16700	0.15700	0.18900	0.15400	0.19400	0.16800	0.16000	0.16300
7	0.15900	0.17100	0.18300	0.17700	0.21000	0.14700	0.20900	0.16800	0.14400	0.16500
8	0.16400	0.18700	0.18900	0.20300	0.23400	0.12800	0.22600	0.18400	0.15000	0.18400

Table 3.7.4 WESTERN BALTIC HERRING. Input to ICA . Natural mortality.

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	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
2	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
4	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
6	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
8	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.
FLT01: German Bottom Trawl Survey in SD 24, Nov./Dec., Ages 0-3+(Catch: Number).

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	117.0	234.0	1116.0	1021.0	635.0	515.0	627.0	4651.0	2630.0	176.0
1	134.0	88.0	25.0	13.0	33.0	36.0	66.0	274.0	311.0	86.0
2	103.0	57.0	50.0	74.0	48.0	49.0	94.0	146.0	62.0	85.0
3	145.0	114.0	476.0	583.0	325.0	349.0	127.0	564.0	43.0	96.0

Table 3.7.5 b WESTERN BALTIC HERRING. Input to ICA. AGE - STRUCTURED INDICES.
FLT04: Acoustic Survey in SD 22-24, Ages 0-8+ (Catch: Number in millions).

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	7180.0	2876.0	768.0	4383.0	4001.0	1418.0	2608.0	2179.0	4821.0	1021.0
1	2864.0	1961.0	345.0	412.0	1163.0	1084.0	1389.0	451.0	1145.0	1208.0
2	1418.0	1051.0	354.0	823.0	307.0	541.0	492.0	557.0	246.0	477.0
3	1403.0	588.0	485.0	540.0	332.0	413.0	343.0	364.0	187.0	348.0
4	472.0	283.0	381.0	433.0	342.0	282.0	151.0	232.0	129.0	206.0
5	241.0	86.0	121.0	182.0	247.0	283.0	112.0	99.0	44.0	81.0
6	85.0	40.0	52.0	56.0	124.0	110.0	92.0	51.0	8.0	39.0
7	13.0	9.0	28.0	22.0	40.0	44.0	32.0	23.0	1.0	5.0
8	28.0	9.0	13.0	2.0	27.0	18.0	46.0	9.0	2.0	4.0

Table 3.7.5 c WESTERN BALTIC HERRING. Input to ICA. AGE - STRUCTURED INDICES.
FLT09: Acoustic Survey in Div. IIIa+IVaE, Ages 0-8+ (Catch: Number in millions).

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	*******	3853.0	372.0	964.0	*******	*******	*******	*******	*******	*******
1	*******	277.0	103.0	5.0	2199.0	1091.0	128.0	138.0	1367.4	1509.2
2	1864.0	2092.0	2768.0	413.0	1887.0	1005.0	715.0	1682.0	1142.9	1891.1
3	1927.0	1799.0	1274.0	935.0	1022.0	247.0	787.0	901.0	522.7	673.6
4	866.0	1593.0	598.0	501.0	1270.0	141.0	166.0	282.0	134.8	363.9
5	350.0	556.0	434.0	239.0	255.0	119.0	67.0	111.0	28.3	185.7
6	88.0	197.0	154.0	186.0	174.0	37.0	69.0	51.0	2.8	55.6
7	72.0	122.0	63.0	62.0	39.0	20.0	80.0	31.0	1.5	6.9
8	10.0	20.0	13.0	34.0	21.0	13.0	77.0	53.0	0.7	9.6

Table 3.7.5 d 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
1	141.21	371.52	403.96	264.55	687.33	631.33	52.37	117.53	292.00	*******
2	83.21	107.60	158.74	229.37	191.54	321.79	122.16	85.82	116.29	*******
3	100.87	69.92	41.93	154.22	113.17	30.78	33.19	22.35	71.17	*******
4	41.17	62.96	36.03	48.96	99.09	17.50	8.36	27.32	33.64	*******
5	23.84	24.69	25.13	35.66	29.36	11.28	13.19	4.96	14.30	*******

Table 3.7.6 WESTERN BALTIC HERRING: Input parameters for ICA Run 16.

```
                         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 2001  used for the year 2000
west
 Natural mortality in 2001  used for the year 2000
natmor
 Maturity ogive in 2001  used for the year 2000
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 ?--> 4
 Reference age for separable constraint ?--> 4
 Constant selection pattern model (Y/N) ?-->y
 S to be fixed on last age ?-->    1.000000000000000
 First age for calculation of reference F ?--> 3
 Last age for calculation of reference F ?--> 6
 Use default weighting (Y/N) ?-->y
 Is the last age of FLT01: German Bott. Trawl S. SD 24 Nov/D a plus-group (Y-->y
 Is the last age of FLT04: Acoustic Survey in Sub div 22-24 a plus-group (Y/-->y
 Is the last age of FLT09: Acoustic Survey in Div IIIa+IVaE a plus-group (Y/-->y
 Is the last age of FLT22: IYFS Katt/Quarter 3/Age groups 1- 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 FLT01: German Bott. Trawl S. SD 24 Nov/D  is to be A/L/P ?-->L
 Model for FLT04: Acoustic Survey in Sub div 22-24  is to be A/L/P ?-->L
 Model for FLT09: Acoustic Survey in Div IIIa+IVaE  is to be A/L/P ?-->L
 Model for FLT22: IYFS Katt/Quarter 3/Age groups 1-  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        45.7999936598
    0.10        33.1024739529
    0.15        27.9932992800
    0.20        25.4923773633
    0.25        24.1305864590
    0.30        23.3514022576
    0.35        22.9085599597
    0.40        22.6787593220
    0.45        22.5937870840
    0.50        22.6124006145
    0.55        22.7082478234
    0.60        22.8634222823
    0.65        23.0655995292
    0.70        23.3056748935
    0.75        23.5773136347
    0.80        23.8756974357
    0.85        24.1976098780
    0.90        24.5408894147
    0.95        24.9041733858
    1.00        25.2871820176
Lowest SSQ is for F =     0.464
-----------------------------------------------------------------
```

Table 3.7.6 continued.

```
No of years for separable analysis : 4
Age range in the analysis : 0  . . . 8
Year range in the analysis : 1991  . . . 2000
Number of indices of SSB : 0
Number of age-structured indices : 4

Parameters to estimate : 48
Number of observations : 289

Conventional single selection vector model to be fitted.



-----------------------------------------------------------------
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for FLT01: German Bott. Trawl S. SD 24 Nov/D  at age 0-->    1.000000000000000
 Enter weight for FLT01: German Bott. Trawl S. SD 24 Nov/D  at age 1-->    1.000000000000000
 Enter weight for FLT01: German Bott. Trawl S. SD 24 Nov/D  at age 2-->    1.000000000000000
 Enter weight for FLT01: German Bott. Trawl S. SD 24 Nov/D  at age 3-->    1.000000000000000
 Enter weight for FLT04: Acoustic Survey in Sub div 22-24  at age 0-->    1.000000000000000
 Enter weight for FLT04: Acoustic Survey in Sub div 22-24  at age 1-->    1.000000000000000
 Enter weight for FLT04: Acoustic Survey in Sub div 22-24  at age 2-->    1.000000000000000
 Enter weight for FLT04: Acoustic Survey in Sub div 22-24  at age 3-->    1.000000000000000
 Enter weight for FLT04: Acoustic Survey in Sub div 22-24  at age 4-->    1.000000000000000
 Enter weight for FLT04: Acoustic Survey in Sub div 22-24  at age 5-->    1.000000000000000
 Enter weight for FLT04: Acoustic Survey in Sub div 22-24  at age 6-->    1.000000000000000
 Enter weight for FLT04: Acoustic Survey in Sub div 22-24  at age 7-->    1.000000000000000
 Enter weight for FLT04: Acoustic Survey in Sub div 22-24  at age 8-->    1.000000000000000
 Enter weight for FLT09: Acoustic Survey in Div IIIa+IVaE  at age 0-->    1.000000000000000
 Enter weight for FLT09: Acoustic Survey in Div IIIa+IVaE  at age 1-->    1.000000000000000
 Enter weight for FLT09: Acoustic Survey in Div IIIa+IVaE  at age 2-->    1.000000000000000
 Enter weight for FLT09: Acoustic Survey in Div IIIa+IVaE  at age 3-->    1.000000000000000
 Enter weight for FLT09: Acoustic Survey in Div IIIa+IVaE  at age 4-->    1.000000000000000
 Enter weight for FLT09: Acoustic Survey in Div IIIa+IVaE  at age 5-->    1.000000000000000
 Enter weight for FLT09: Acoustic Survey in Div IIIa+IVaE  at age 6-->    1.000000000000000
 Enter weight for FLT09: Acoustic Survey in Div IIIa+IVaE  at age 7-->    1.000000000000000
 Enter weight for FLT09: Acoustic Survey in Div IIIa+IVaE  at age 8-->    1.000000000000000
 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 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: German Bott. Trawl S. SD 24 Nov/D-->    1.000000000000000
  Enter value for FLT04: Acoustic Survey in Sub div 22-24-->    1.000000000000000
  Enter value for FLT09: Acoustic Survey in Div IIIa+IVaE-->    1.000000000000000
  Enter value for FLT22: IYFS Katt/Quarter 3/Age groups 1--->    1.000000000000000
 Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.

Aged index weights
FLT01: German Bott. Trawl S. SD 24 Nov/D
 Age   :       0     1     2     3
 Wts :     0.250 0.250 0.250 0.250
FLT04: Acoustic Survey in Sub div 22-24
 Age   :       0     1     2     3     4     5     6     7     8
 Wts :     0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111
FLT09: Acoustic Survey in Div IIIa+IVaE
 Age   :       0     1     2     3     4     5     6     7     8
 Wts :     0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111
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
F in 2000  at age 4  is 0.579341  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 16. FISHING MORTALITY (per year).

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.02699	0.04525	0.07931	0.05161	0.16098	0.04940	0.10069	0.10700	0.09674	0.11364
1	0.25341	0.16801	0.28539	0.15938	0.65917	0.35982	0.26322	0.27970	0.25287	0.29707
2	0.31630	0.36036	0.33517	0.39580	0.59168	0.40177	0.37836	0.40204	0.36348	0.42701
3	0.41615	0.36539	0.45327	0.46906	0.54313	0.61866	0.46490	0.49401	0.44662	0.52469
4	0.39007	0.46634	0.48539	0.59695	0.52152	0.76395	0.51333	0.54547	0.49315	0.57934
5	0.36039	0.47968	0.60936	0.67378	0.40506	0.74521	0.56737	0.60289	0.54506	0.64033
6	0.22798	0.53838	0.54696	0.85423	0.57607	0.62101	0.56082	0.59593	0.53877	0.63293
7	0.38461	0.43553	0.50819	0.55903	0.68388	0.65609	0.51333	0.54547	0.49315	0.57934
8	0.38461	0.43553	0.50819	0.55903	0.68388	0.65609	0.51333	0.54547	0.49315	0.57934

Table. 3.7.8 WESTERN BALTIC HERRING. Output from ICA Run 16. POPULATION ABUNDANCE (millions)- 1 January.

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	5168.1	3791.4	3122.8	6048.6	4197.0	4105.0	4093.3	6620.8	7892.0	1578.1	4027.2
1	4640.1	3726.7	2684.5	2137.0	4255.5	2646.9	2894.5	2741.9	4407.1	5307.4	1043.5
2	2190.8	2184.4	1910.8	1224.0	1105.2	1335.1	1120.3	1349.3	1257.3	2075.8	2391.8
3	1816.8	1307.3	1247.3	1118.9	674.6	500.8	731.4	628.3	739.0	715.7	1108.9
4	949.5	981.1	742.7	649.0	573.1	320.8	220.8	376.2	313.9	387.1	346.7
5	643.3	526.3	503.9	374.3	292.5	278.5	122.4	108.2	178.5	156.9	177.6
6	250.6	367.3	266.7	224.3	156.2	159.7	108.2	56.8	48.5	84.7	67.7
7	45.5	163.4	175.5	126.4	78.2	71.9	70.3	50.6	25.6	23.2	36.8
8	16.9	70.0	67.4	84.5	46.1	57.8	68.2	37.3	18.1	26.9	23.0

Table. 3.7.9 WESTERN BALTIC HERRING. Output from ICA Run 16. STOCK SUMMARY.

Year	Recruits Age 3 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 6	SoP (%)
1991	5168060	628350	317074	191573	0.6042	0.3486	99
1992	3791380	554371	330876	194411	0.5876	0.4625	100
1993	3122770	481029	306225	185010	0.6042	0.5237	100
1994	6048570	396303	244929	172438	0.7040	0.6485	100
1995	4197000	335837	198703	164284	0.8268	0.5114	99
1996	4104960	280172	141257	128243	0.9079	0.6872	99
1997	4093260	273087	151503	123199	0.8132	0.5266	100
1998	6620800	269933	119045	112386	0.9441	0.5596	100
1999	7891960	302978	121217	98040	0.8088	0.5059	100
2000	1578050	318901	137684	118276	0.8590	0.5943	99

Table. 3.7.10 WESTERN BALTIC HERRING. Output from ICA Run 16. 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	0.5133	16	0.3747	0.7032	0.4372	0.6027	0.5200
2	1998	0.5455	15	0.3996	0.7446	0.4654	0.6393	0.5524
3	1999	0.4931	16	0.3553	0.6845	0.4172	0.5830	0.5001
4	2000	0.5793	19	0.3948	0.8502	0.4764	0.7046	0.5905
Separable Model: Selection (S) by age								
5	0	0.1962	23	0.1244	0.3094	0.1555	0.2475	0.2015
6	1	0.5128	20	0.3401	0.7732	0.4158	0.6323	0.5241
7	2	0.7371	20	0.4972	1.0927	0.6029	0.9011	0.7521
8	3	0.9057	19	0.6143	1.3352	0.7429	1.1040	0.9236
	4	1.0000	Fixed : Reference Age					
9	5	1.1053	18	0.7698	1.5869	0.9190	1.3293	1.1243
10	6	1.0925	17	0.7691	1.5518	0.9134	1.3067	1.1102
	7	1.0000	Fixed : Last true age					

Table. 3.7.10 continued

Separable model: Populations in year 2000

11	0	1578050	31	845199	2946337	1147554	2170044	1660186
12	1	5307441	21	3449792	8165399	4260199	6612115	5437201
13	2	2075802	17	1459854	2951635	1734554	2484187	2109552
14	3	715672	16	515900	992802	605605	845744	725721
15	4	387092	17	277384	540191	326566	458836	392728
16	5	156931	17	111617	220639	131889	186726	159320
17	6	84739	19	58283	123203	70009	102567	86298
18	7	23159	21	15156	35389	18654	28753	23708

Separable model: Populations at age

19	1997	70274	29	39732	124293	52534	94005	73312
20	1998	50574	23	31999	79931	40041	63878	51972
21	1999	25626	21	16849	38975	20691	31739	26219

Table. 3.7.11 WESTERN BALTIC HERRING. Output from ICA Run 16. Age-structured index catchabilities.

FLT01: German Bott. Trawl S. SD 24 Nov/D

Linear model fitted. Slopes at age :

22	0	Q	.2177E-03	19	.1800E-03	.3912E-03	.2177E-03	.3235E-03	.2706E-03
23	1	Q	.4266E-04	19	.3536E-04	.7607E-04	.4266E-04	.6306E-04	.5286E-04
24	2	Q	.8326E-04	19	.6906E-04	.1482E-03	.8326E-04	.1229E-03	.1031E-03
25	3	Q	.2106E-03	19	.1748E-03	.3743E-03	.2106E-03	.3106E-03	.2607E-03

FLT04: Acoustic Survey in Sub div 22-24

Linear model fitted. Slopes at age :

26	0	Q	.8018E-03	28	.6071E-03	.1890E-02	.8018E-03	.1431E-02	.1117E-02
27	1	Q	.5489E-03	28	.4164E-03	.1287E-02	.5489E-03	.9762E-03	.7630E-03
28	2	Q	.5789E-03	28	.4393E-03	.1355E-02	.5789E-03	.1028E-02	.8041E-03
29	3	Q	.8526E-03	28	.6470E-03	.1996E-02	.8526E-03	.1515E-02	.1184E-02
30	4	Q	.9840E-03	28	.7467E-03	.2305E-02	.9840E-03	.1749E-02	.1367E-02
31	5	Q	.8840E-03	28	.6700E-03	.2078E-02	.8840E-03	.1575E-02	.1230E-02
32	6	Q	.6961E-03	29	.5261E-03	.1650E-02	.6961E-03	.1247E-02	.9722E-03
33	7	Q	.3919E-03	29	.2953E-03	.9383E-03	.3919E-03	.7069E-03	.5498E-03
34	8	Q	.4198E-03	29	.3172E-03	.9955E-03	.4198E-03	.7523E-03	.5864E-03

FLT09: Acoustic Survey in Div IIIa+IVaE

Linear model fitted. Slopes at age :

35	0	Q	.3356E-03	51	.2040E-03	.1558E-02	.3356E-03	.9468E-03	.6448E-03
36	1	Q	.1433E-03	30	.1071E-03	.3519E-03	.1433E-03	.2630E-03	.2033E-03
37	2	Q	.1303E-02	28	.9890E-03	.3046E-02	.1303E-02	.2313E-02	.1809E-02
38	3	Q	.1522E-02	28	.1156E-02	.3559E-02	.1522E-02	.2702E-02	.2113E-02
39	4	Q	.1351E-02	28	.1025E-02	.3159E-02	.1351E-02	.2398E-02	.1875E-02
40	5	Q	.1038E-02	28	.7875E-03	.2435E-02	.1038E-02	.1847E-02	.1444E-02
41	6	Q	.7567E-03	29	.5726E-03	.1788E-02	.7567E-03	.1353E-02	.1055E-02
42	7	Q	.7146E-03	29	.5390E-03	.1706E-02	.7146E-03	.1286E-02	.1001E-02
43	8	Q	.5583E-03	29	.4224E-03	.1320E-02	.5583E-03	.9983E-03	.7788E-03

FLT22: IYFS Katt/Quarter 3/Age groups 1-

Linear model fitted. Slopes at age :

44	1	Q	.1291E-03	22	.1039E-03	.2516E-03	.1291E-03	.2026E-03	.1659E-03
45	2	Q	.1410E-03	22	.1136E-03	.2746E-03	.1410E-03	.2212E-03	.1811E-03
46	3	Q	.9977E-04	22	.8037E-04	.1944E-03	.9977E-04	.1566E-03	.1282E-03
47	4	Q	.1062E-03	22	.8555E-04	.2070E-03	.1062E-03	.1667E-03	.1365E-03
48	5	Q	.9911E-04	22	.7976E-04	.1936E-03	.9911E-04	.1558E-03	.1275E-03

Table. 3.7.12 WESTERN BALTIC HERRING. Output from ICA Run 16. RESIDUALS ABOUT THE MODEL FIT Separable Model Residuals (log(Observed Catch)-log(Expected Catch)).

Age	1997	1998	1999	2000
0	0.1039	-0.0569	-0.1060	0.0565
1	0.2269	0.1608	-0.3299	-0.1501
2	-0.0765	0.1279	-0.0053	-0.2534
3	0.1527	-0.1601	0.0770	-0.2865
4	0.0802	0.0531	-0.1627	-0.0770
5	-0.0273	0.0498	-0.1729	0.1521
6	-0.0271	0.0402	-0.1474	0.0924
7	-0.1797	-0.2258	0.0648	0.4091

Table. 3.7.13 WESTERN BALTIC HERRING. Output from ICA Run 16. Aged Index Residuals: log (Observed Index) - log(Expected Index).

FLT01: German Bott. Trawl S. SD 24 Nov/D

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	-1.954	-0.934	0.854	0.078	0.072	-0.221	0.027	1.556	0.801	-0.278
1	0.322	0.040	-0.780	-1.325	-0.609	-0.331	0.095	1.588	1.215	-0.215
2	-0.084	-0.631	-0.652	0.243	0.097	-0.250	0.554	0.831	0.009	-0.117
3	-1.134	-1.243	0.376	0.795	0.519	1.007	-0.128	1.442	-1.231	-0.400

LT04: Acoustic Survey in Sub div 22-24

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.811	0.221	-0.878	0.180	0.542	-0.563	0.091	-0.565	0.045	0.116
1	0.720	0.492	-0.824	-0.519	0.230	0.395	0.476	-0.581	-0.146	-0.243
2	0.525	0.263	-0.711	0.626	-0.101	0.125	0.187	0.144	-0.634	-0.422
3	0.394	-0.187	-0.262	-0.034	0.045	0.622	-0.066	0.169	-0.697	0.018
4	-0.211	-0.694	-0.103	0.249	0.077	0.658	0.207	0.129	-0.319	0.009
5	-0.410	-1.144	-0.656	0.101	0.438	0.895	0.649	0.677	-0.681	0.134
6	-0.377	-1.264	-0.675	-0.182	0.752	0.646	0.808	0.891	-0.848	0.253
7	0.152	-1.454	-0.332	-0.204	0.974	1.131	0.721	0.745	-1.753	0.027
8	1.838	-0.675	-0.211	-2.268	1.041	0.386	1.044	0.044	-0.777	-0.415

FLT09: Acoustic Survey in Div IIIa+IVaE

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	*******	1.324	-0.799	-0.525	*******	*******	*******	*******	*******	*******
1	*******	-0.239	-0.827	-3.703	2.007	1.594	-0.699	-0.559	1.243	1.183
2	-0.103	0.043	0.441	-0.978	0.765	-0.172	-0.352	0.332	-0.008	0.034
3	0.024	0.252	0.009	-0.182	0.460	-0.615	0.069	0.374	-0.362	-0.028
4	-0.024	0.601	-0.089	-0.061	0.946	-0.520	-0.140	-0.123	-0.712	0.125
5	-0.296	0.442	0.319	0.060	0.203	-0.297	-0.160	0.490	-1.414	0.656
6	-0.500	0.117	0.196	0.750	0.872	-0.671	0.304	0.668	-2.111	0.378
7	1.161	0.441	-0.246	0.098	0.193	-0.408	0.911	0.312	-2.069	-0.388
8	0.421	-0.273	-0.620	0.147	0.350	-0.375	1.149	1.401	-2.234	0.038

FLT22: IYFS Katt/Quarter 3/Age groups 1-5

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.974	0.159	0.644	0.370	0.949	1.151	-1.488	-0.615	-0.196	*******
2	-0.989	-0.701	-0.194	0.657	0.701	0.912	0.105	-0.420	-0.069	*******
3	-0.201	-0.270	-0.680	0.741	0.984	0.027	-0.372	-0.597	0.369	*******
4	-0.527	-0.087	-0.355	0.156	0.938	-0.064	-0.586	0.086	0.442	*******
5	-0.633	-0.323	-0.181	0.507	0.391	-0.304	0.564	-0.269	0.253	*******

Table. 3.7.14 WESTERN BALTIC HERRING. Output from ICA Run 16. PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE.

```
 Separable model fitted from 1997  to 2000
 Variance                            0.0769
Skewness test stat.                 -0.3084
Kurtosis test statistic             -0.2227
Partial chi-square                   0.0742
Significance in fit                  0.0000
Degrees of freedom                       11
```

Table. 3.7.15 WESTERN BALTIC HERRING. Output from ICA Run 16. PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES.

DISTRIBUTION STATISTICS FOR FLT01: German Bott. Trawl S. SD 24 Nov/D

Linear catchability relationship assumed

Age	0	1	2	3
Variance	0.2395	0.1945	0.0548	0.2406
Skewness test stat.	-0.5490	0.6089	0.3155	-0.0956
Kurtosis test statisti	-0.0121	-0.3365	-0.4139	-0.8854
Partial chi-square	0.3223	0.4273	0.1146	0.4079
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	10	10	10	10
Degrees of freedom	9	9	9	9
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

DISTRIBUTION STATISTICS FOR FLT04: Acoustic Survey in Sub div 22-24

Linear catchability relationship assumed

Age	0	1	2	3	4	5	6	7	8
Variance	0.0304	0.0316	0.0235	0.0144	0.0148	0.0528	0.0672	0.1069	0.1497
Skewness test stat.	-0.3415	-0.2369	-0.4207	-0.1865	-0.2025	-0.3595	-0.3376	-0.8551	-0.3855
Kurtosis test stat.	-0.5326	-0.8972	-0.7159	0.0346	0.0313	-0.8012	-0.8783	-0.4718	-0.1422
Partial chi-square	0.0350	0.0417	0.0332	0.0221	0.0239	0.0976	0.1558	0.4041	0.6237
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
Number of observ.	10	10	10	10	10	10	10	10	10
Degrees of freedom	9	9	9	9	9	9	9	9	9
Weight in the anal.	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111

DISTRIBUTION STATISTICS FOR FLT09: Acoustic Survey in Div IIIa+IVaE

Linear catchability relationship assumed

Age	0	1	2	3	4	5	6	7	8
Variance	0.1481	0.3440	0.0249	0.0119	0.0259	0.0397	0.0891	0.0886	0.1135
Skewness test stat.	0.4688	-1.0777	-0.5940	-0.5195	0.7499	-1.6696	-1.7614	-1.3913	-1.0342
Kurtosis test stat.	-0.5302	0.1021	0.1715	-0.3392	-0.0814	0.7554	0.6993	0.6875	0.4079
Partial chi-square	0.0428	0.5029	0.0321	0.0167	0.0387	0.0742	0.2320	0.2910	0.4638
Significance in fit	0.0212	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observ.	3	9	10	10	10	10	10	10	10
Degrees of freedom	2	8	9	9	9	9	9	9	9
Weight in the anal.	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111

DISTRIBUTION STATISTICS FOR FLT22: IYFS Katt/Quarter 3/Age groups 1-

Linear catchability relationship assumed

Age	1	2	3	4	5
Variance	0.1596	0.0864	0.0681	0.0467	0.0374
Skewness test stat.	-0.3998	-0.0030	0.6568	0.7538	0.0873
Kurtosis test statisti	-0.6595	-0.7514	-0.6312	-0.2162	-0.8969
Partial chi-square	0.2326	0.1377	0.1366	0.1081	0.1073
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	9	9	9	9	9
Degrees of freedom	8	8	8	8	8
Weight in the analysis	0.2000	0.2000	0.2000	0.2000	0.2000

Table. 3.7.16 WESTERN BALTIC HERRING. Output from ICA Run 16. ANALYSIS OF VARIANCE TABLE.

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	142.1389	289	48	241	0.5898
Catches at age	0.8460	32	21	11	0.0769
Aged Indices					
FLT01: German Bott. Trawl S. SD 24 Nov	26.2584	40	4	36	0.7294
FLT04: Acoustic Survey in Sub div 22-2	39.8015	90	9	81	0.4914
FLT09: Acoustic Survey in Div IIIa+IVa	59.3084	82	9	73	0.8124
FLT22: IYFS Katt/Quarter 3/Age groups	15.9247	45	5	40	0.3981

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	4.3477	289	48	241	0.0180
Catches at age	0.8460	32	21	11	0.0769
Aged Indices					
FLT01: German Bott. Trawl S. SD 24 Nov	1.6411	40	4	36	0.0456
FLT04: Acoustic Survey in Sub div 22-2	0.4914	90	9	81	0.0061
FLT09: Acoustic Survey in Div IIIa+IVa	0.7322	82	9	73	0.0100
FLT22: IYFS Katt/Quarter 3/Age groups	0.6370	45	5	40	0.0159

Table 3.7.17 WESTERN BALTIC HERRING: Input parameters for ICA Run 17.

```
                         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 2001  used for the year 2000
west
 Natural mortality in 2001  used for the year 2000
natmor
 Maturity ogive in 2001  used for the year 2000
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 ?--> 4
 Reference age for separable constraint ?--> 4
 Constant selection pattern model (Y/N) ?-->y
 S to be fixed on last age ?-->    1.000000000000000
 First age for calculation of reference F ?--> 3
 Last age for calculation of reference F ?--> 6
 Use default weighting (Y/N) ?-->y
 Is the last age of FLT10: German Bott.Trawl S. SD 24 Nov/De a plus-group (Y-->n
 Is the last age of FLT24: Acoustic Survey in Div IIIa+IVaE a plus-group (Y/-->n
 Is the last age of FLT25: Acoustic Survey in Sub div 22-24 a plus-group (Y/-->n
 Is the last age of FLT26: IYFS Katt/Quarter 3/Age groups 2- 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 FLT10: German Bott.Trawl S. SD 24 Nov/De  is to be A/L/P ?-->L
 Model for FLT24: Acoustic Survey in Div IIIa+IVaE  is to be A/L/P ?-->L
 Model for FLT25: Acoustic Survey in Sub div 22-24  is to be A/L/P ?-->L
 Model for FLT26: IYFS Katt/Quarter 3/Age groups 2-  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        40.0232721037
    0.10        26.3176128230
    0.15        21.0688804693
    0.20        18.7169055919
    0.25        17.5928065356
    0.30        17.0703415476
    0.35        16.8788504467
    0.40        16.8868464638
    0.45        17.0236777750
    0.50        17.2479435141
    0.55        17.5336475621
    0.60        17.8635569768
    0.65        18.2258127355
    0.70        18.6120387900
    0.75        19.0162591122
    0.80        19.4341897878
    0.85        19.8628390229
    0.90        20.3002038516
    0.95        20.7450817645
    1.00        21.1970179024
Lowest SSQ is for F =     0.373
-----------------------------------------------------------------
```

Table 3.7.17 continued.

```
No of years for separable analysis : 4
Age range in the analysis : 0  . . . 8
Year range in the analysis : 1991  . . . 2000
Number of indices of SSB : 0
Number of age-structured indices : 4

Parameters to estimate : 34
Number of observations : 158

Conventional single selection vector model to be fitted.



-----------------------------------------------------------------
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for FLT10: German Bott.Trawl S. SD 24 Nov/De  at age 0-->    1.000000000000000
 Enter weight for FLT10: German Bott.Trawl S. SD 24 Nov/De  at age 1-->    1.000000000000000
 Enter weight for FLT24: Acoustic Survey in Div IIIa+IVaE  at age 2-->    1.000000000000000
 Enter weight for FLT24: Acoustic Survey in Div IIIa+IVaE  at age 3-->    1.000000000000000
 Enter weight for FLT24: Acoustic Survey in Div IIIa+IVaE  at age 4-->    1.000000000000000
 Enter weight for FLT24: Acoustic Survey in Div IIIa+IVaE  at age 5-->    1.000000000000000
 Enter weight for FLT24: Acoustic Survey in Div IIIa+IVaE  at age 6-->    1.000000000000000
 Enter weight for FLT25: Acoustic Survey in Sub div 22-24  at age 0-->    1.000000000000000
 Enter weight for FLT25: Acoustic Survey in Sub div 22-24  at age 1-->    1.000000000000000
 Enter weight for FLT26: IYFS Katt/Quarter 3/Age groups 2-  at age 2-->    1.000000000000000
 Enter weight for FLT26: IYFS Katt/Quarter 3/Age groups 2-  at age 3-->    1.000000000000000
 Enter weight for FLT26: IYFS Katt/Quarter 3/Age groups 2-  at age 4-->    1.000000000000000
 Enter weight for FLT26: IYFS Katt/Quarter 3/Age groups 2-  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 FLT10: German Bott.Trawl S. SD 24 Nov/De-->    1.000000000000000
  Enter value for FLT24: Acoustic Survey in Div IIIa+IVaE-->    1.000000000000000
  Enter value for FLT25: Acoustic Survey in Sub div 22-24-->    1.000000000000000
  Enter value for FLT26: IYFS Katt/Quarter 3/Age groups 2--->    1.000000000000000
 Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.

Aged index weights
FLT10: German Bott.Trawl S. SD 24 Nov/De
 Age   :       0     1
 Wts :     0.500 0.500
FLT24: Acoustic Survey in Div IIIa+IVaE
 Age   :       2     3     4     5     6
 Wts :     0.200 0.200 0.200 0.200 0.200
FLT25: Acoustic Survey in Sub div 22-24
 Age   :       0     1
 Wts :     0.500 0.500
FLT26: IYFS Katt/Quarter 3/Age groups 2-
 Age   :       2     3     4     5
 Wts :     0.250 0.250 0.250 0.250
F in 2000  at age 4  is 0.495160  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 3.7.18 WESTERN BALTIC HERRING. Output from ICA Run 17. FISHING MORTALITY (per year).

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.02723	0.04441	0.07901	0.05140	0.16280	0.04262	0.09997	0.09707	0.07418	0.08862
1	0.25778	0.16969	0.27915	0.15872	0.65545	0.36508	0.25695	0.24951	0.19067	0.22778
2	0.31835	0.36891	0.33952	0.38369	0.58810	0.39793	0.37721	0.36629	0.27990	0.33439
3	0.41912	0.36873	0.46960	0.47820	0.51706	0.61188	0.45864	0.44536	0.34032	0.40657
4	0.39730	0.47153	0.49219	0.63424	0.53836	0.69657	0.55857	0.54240	0.41447	0.49516
5	0.37205	0.49354	0.62105	0.69083	0.44814	0.79200	0.58007	0.56327	0.43042	0.51422
6	0.24275	0.56622	0.57382	0.88911	0.60363	0.74042	0.58087	0.56405	0.43102	0.51493
7	0.42187	0.47591	0.55392	0.60834	0.74596	0.71654	0.55857	0.54240	0.41447	0.49516
8	0.42187	0.47591	0.55392	0.60834	0.74596	0.71654	0.55857	0.54240	0.41447	0.49516

Table 3.7.19 WESTERN BALTIC HERRING. Output from ICA Run 17. POPULATION ABUNDANCE (millions)- 1 January.

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	5121.9	3862.3	3133.9	6072.5	4153.5	4742.8	4757.1	7941.0	8870.9	1810.5	4664.5
1	4570.1	3692.5	2737.0	2145.3	4273.2	2614.7	3367.0	3188.9	5338.6	6101.9	1227.5
2	2178.7	2142.0	1890.1	1255.7	1110.2	1345.7	1100.8	1579.4	1507.1	2675.9	2947.1
3	1806.3	1297.4	1212.7	1102.0	700.5	504.8	740.1	618.1	896.5	932.6	1568.2
4	935.3	972.6	734.7	620.8	559.3	342.0	224.2	383.0	324.2	522.3	508.5
5	626.4	514.7	496.9	367.7	269.5	267.3	139.5	105.0	182.3	175.4	260.6
6	237.0	353.5	257.2	218.6	150.9	141.0	99.1	63.9	48.9	97.1	85.8
7	42.2	152.2	164.3	118.6	73.6	67.5	55.0	45.4	29.8	26.0	47.5
8	15.7	65.3	63.1	79.3	43.4	54.3	64.0	37.4	20.7	30.4	28.1

Table 3.7.20 WESTERN BALTIC HERRING. Output from ICA Run 17. STOCK SUMMARY.

Year	Recruits Age 3 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 6	SoP (%)
1991	5121930	618436	310493	191573	0.6170	0.3578	99
1992	3862280	543536	322860	194411	0.6022	0.4750	100
1993	3133900	471381	297645	185010	0.6216	0.5392	100
1994	6072480	389454	237459	172438	0.7262	0.6731	100
1995	4153500	329863	192271	164284	0.8544	0.5268	99
1996	4742790	277693	138621	128243	0.9251	0.7102	99
1997	4757120	276523	149280	123199	0.8253	0.5445	100
1998	7940950	292505	121704	112386	0.9234	0.5288	100
1999	8870880	353230	136900	98040	0.7161	0.4041	100
2000	1810460	397222	175728	118276	0.6731	0.4827	99

Table 3.7.21 WESTERN BALTIC HERRING. Output from ICA Run 17. 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	0.5586	22	0.3604	0.8656	0.4467	0.6985	0.5727
2	1998	0.5424	22	0.3466	0.8488	0.4316	0.6816	0.5567
3	1999	0.4145	24	0.2568	0.6689	0.3247	0.5291	0.4270
4	2000	0.4952	27	0.2900	0.8456	0.3769	0.6506	0.5140
Separable Model: Selection (S) by age								
5	0	0.1790	29	0.1013	0.3163	0.1338	0.2393	0.1867
6	1	0.4600	27	0.2697	0.7847	0.3503	0.6041	0.4774
7	2	0.6753	26	0.4030	1.1315	0.5190	0.8788	0.6991
8	3	0.8211	25	0.4953	1.3612	0.6344	1.0627	0.8489
	4	1.0000	Fixed : Reference Age					
9	5	1.0385	23	0.6613	1.6308	0.8249	1.3074	1.0664
10	6	1.0399	22	0.6737	1.6052	0.8333	1.2978	1.0657
	7	1.0000	Fixed : Last true age					

Table 3.7.21 continued.

```
Separable model: Populations in year 2000
   11      0    1810461  30    1002077   3270973   1338825   2448242   1894812
   12      1    6101868  21    3994124   9321890   4915461   7574629   6246168
   13      2    2675917  20    1795120   3988889   2182800   3280435   2732005
   14      3     932633  19     634010   1371912    765937   1135609    950891
   15      4     522274  21     344527    791723    422394    645772    534172
   16      5     175349  23     111034    276918    138884    221387    180180
   17      6      97054  25      58659    160579     75066    125482    100310
   18      7      26034  30      14317     47339     19189     35321     27274

Separable model: Populations at age
   19   1997      55046  40      25127    120589     36894     82128     59633
   20   1998      45394  32      24133     85387     32885     62660     47815
   21   1999      29784  30      16502     53754     22037     40254     31166
```

Table 3.7.22 WESTERN BALTIC HERRING. Output from ICA Run 17. Age-structured index catchabilities.

```
Age-structured index catchabilities
FLT10: German Bott.Trawl S. SD 24 Nov/De
 Linear model fitted. Slopes at age :
   22   0  Q  .2001E-03  17 .1696E-03 .3333E-03 .2001E-03 .2824E-03 .2413E-03
   23   1  Q  .3930E-04  17 .3336E-04 .6513E-04 .3930E-04 .5529E-04 .4730E-04
FLT24: Acoustic Survey in Div IIIa+IVaE
 Linear model fitted. Slopes at age :
   24   2  Q  .1209E-02  26 .9411E-03 .2621E-02 .1209E-02 .2039E-02 .1625E-02
   25   3  Q  .1427E-02  26 .1110E-02 .3094E-02 .1427E-02 .2407E-02 .1918E-02
   26   4  Q  .1293E-02  26 .1005E-02 .2816E-02 .1293E-02 .2188E-02 .1741E-02
   27   5  Q  .1023E-02  26 .7927E-03 .2247E-02 .1023E-02 .1741E-02 .1383E-02
   28   6  Q  .7642E-03  27 .5887E-03 .1708E-02 .7642E-03 .1316E-02 .1041E-02
FLT25: Acoustic Survey in Sub div 22-24
 Linear model fitted. Slopes at age :
   29   0  Q  .7377E-03  17 .6253E-03 .1228E-02 .7377E-03 .1041E-02 .8893E-03
   30   1  Q  .5070E-03  17 .4306E-03 .8390E-03 .5070E-03 .7126E-03 .6098E-03
FLT26: IYFS Katt/Quarter 3/Age groups 2-5
 Linear model fitted. Slopes at age :
   31   2  Q  .1344E-03  24 .1062E-03 .2774E-03 .1344E-03 .2193E-03 .1769E-03
   32   3  Q  .9640E-04  24 .7618E-04 .1991E-03 .9640E-04 .1574E-03 .1269E-03
   33   4  Q  .1053E-03  24 .8314E-04 .2180E-03 .1053E-03 .1721E-03 .1387E-03
   34   5  Q  .9958E-04  24 .7850E-04 .2074E-03 .9958E-04 .1635E-03 .1316E-03
```

Table 3.7.23 WESTERN BALTIC HERRING. Output from ICA Run 17. RESIDUALS ABOUT THE MODEL FIT Separable Model Residuals (log(Observed Catch)-log(Expected Catch)).

Age	1997	1998	1999	2000
0	-0.0395	-0.1460	0.0320	0.1562
1	0.0970	0.1107	-0.2667	-0.0543
2	-0.0565	0.0474	0.0366	-0.3047
3	0.1517	-0.0617	0.1077	-0.3488
4	0.0007	0.0394	-0.0562	-0.2565
5	-0.1751	0.1309	-0.0087	0.2055
6	0.0345	-0.0372	0.0187	0.1116
7	0.0000	-0.1134	0.0532	0.4121

Table 3.7.24 WESTERN BALTIC HERRING. Output from ICA Run 17. Aged Index Residuals: log(Observed Index) - log(Expected Index).

FLT10: German Bott.Trawl S. SD 24 Nov/De

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	-1.861	-0.869	0.935	0.158	0.168	-0.287	-0.039	1.449	0.747	-0.355
1	0.423	0.133	-0.723	-1.247	-0.535	-0.231	0.020	1.491	1.046	-0.338

FLT24: Acoustic Survey in Div IIIa+IVaE

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	-0.022	0.142	0.529	-0.937	0.833	-0.108	-0.261	0.227	-0.167	-0.203
3	0.096	0.327	0.112	-0.096	0.471	-0.563	0.118	0.425	-0.557	-0.302
4	0.039	0.656	-0.030	0.050	1.024	-0.583	-0.083	-0.099	-0.751	-0.184
5	-0.247	0.488	0.355	0.103	0.327	-0.212	-0.269	0.510	-1.492	0.481
6	-0.445	0.163	0.239	0.788	0.914	-0.481	0.395	0.520	-2.198	0.159

FLT25: Acoustic Survey in Sub div 22-24

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.9038	0.2849	-0.7988	0.2593	0.6371	-0.6290	0.0232	-0.6712	-0.0062	0.0424
1	0.8181	0.5821	-0.7686	-0.4438	0.3022	0.4907	0.3993	-0.6772	-0.3078	-0.3582

FLT26: IYFS Katt/Quarter 3/Age groups 2-5

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	-0.9341	-0.6284	-0.1328	0.6718	0.7424	0.9500	0.1693	-0.5515	-0.2548	*******
3	-0.1590	-0.2260	-0.6068	0.7967	0.9646	0.0494	-0.3535	-0.5771	0.1436	*******
4	-0.4986	-0.0666	-0.3313	0.2326	0.9820	-0.1610	-0.5636	0.0747	0.3697	*******
5	-0.6044	-0.2969	-0.1644	0.5304	0.4948	-0.2385	0.4357	-0.2685	0.1554	*******

Table 3.7.25 WESTERN BALTIC HERRING. Output from ICA Run 17. PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE.

```
Separable model fitted from 1997  to 2000
 Variance                          0.0696
Skewness test stat.               -0.4644
Kurtosis test statistic            0.7643
Partial chi-square                 0.0670
Significance in fit                0.0000
Degrees of freedom                     11
```

Table 3.7.26 WESTERN BALTIC HERRING. Output from ICA Run 17. PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES.

DISTRIBUTION STATISTICS FOR FLT10: German Bott.Trawl S. SD 24 Nov/De

Linear catchability relationship assumed

Age	0	1
Variance	0.4452	0.3358
Skewness test stat.	-0.5187	0.5533
Kurtosis test statisti	-0.1199	-0.3545
Partial chi-square	0.6041	0.7329
Significance in fit	0.0001	0.0002
Number of observations	10	10
Degrees of freedom	9	9
Weight in the analysis	0.5000	0.5000

DISTRIBUTION STATISTICS FOR FLT24: Acoustic Survey in Div IIIa+IVaE

Linear catchability relationship assumed

Age	2	3	4	5	6
Variance	0.0461	0.0283	0.0542	0.0750	0.1611
Skewness test stat.	-0.1577	-0.4544	0.7808	-1.9234	-1.9523
Kurtosis test statisti	0.0792	-0.7455	-0.0689	0.9898	1.0843
Partial chi-square	0.0596	0.0390	0.0812	0.1383	0.4147
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 FLT25: Acoustic Survey in Sub div 22-24

Linear catchability relationship assumed

Age	0	1
Variance	0.1588	0.1649
Skewness test stat.	-0.0198	0.0217
Kurtosis test statisti	-0.6642	-1.0007
Partial chi-square	0.1822	0.2167
Significance in fit	0.0000	0.0000
Number of observations	10	10
Degrees of freedom	9	9
Weight in the analysis	0.5000	0.5000

DISTRIBUTION STATISTICS FOR FLT26: IYFS Katt/Quarter 3/Age groups 2-

Linear catchability relationship assumed

Age	2	3	4	5
Variance	0.1121	0.0778	0.0583	0.0422
Skewness test stat.	0.1756	0.8700	0.9603	0.1698
Kurtosis test statisti	-0.8365	-0.4741	-0.0551	-0.8504
Partial chi-square	0.1812	0.1567	0.1354	0.1163
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	9	9	9	9
Degrees of freedom	8	8	8	8
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

Table 3.7.27 WESTERN BALTIC HERRING. Output from ICA Run 17. ANALYSIS OF VARIANCE TABLE.

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	46.3555	158	34	124	0.3738
Catches at age	0.7653	32	21	11	0.0696
Aged Indices					
FLT10: German Bott.Trawl S. SD 24 Nov/	14.0585	20	2	18	0.7810
FLT24: Acoustic Survey in Div IIIa+IVa	16.4095	50	5	45	0.3647
FLT25: Acoustic Survey in Sub div 22-2	5.8269	20	2	18	0.3237
FLT26: IYFS Katt/Quarter 3/Age groups	9.2952	36	4	32	0.2905

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	6.9740	158	34	124	0.0562
Catches at age	0.7653	32	21	11	0.0696
Aged Indices					
FLT10: German Bott.Trawl S. SD 24 Nov/	3.5146	20	2	18	0.1953
FLT24: Acoustic Survey in Div IIIa+IVa	0.6564	50	5	45	0.0146
FLT25: Acoustic Survey in Sub div 22-2	1.4567	20	2	18	0.0809
FLT26: IYFS Katt/Quarter 3/Age groups	0.5810	36	4	32	0.0182

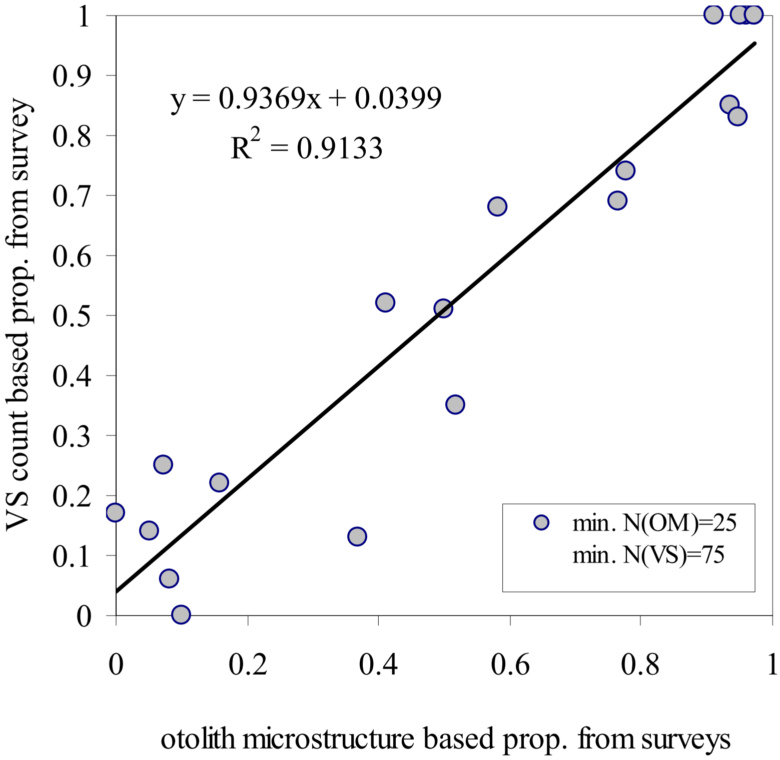


Figure 3.2.1 Comparison of proportions of estimated herring spring spawners in Div. IIIa based on vertebral counts from surveys vs. otolith microstructure from surveys. Data points represent average estimates over the years 1991-1996 and 1997, disaggregated by quarter, subdivision and age-group (0-4+).

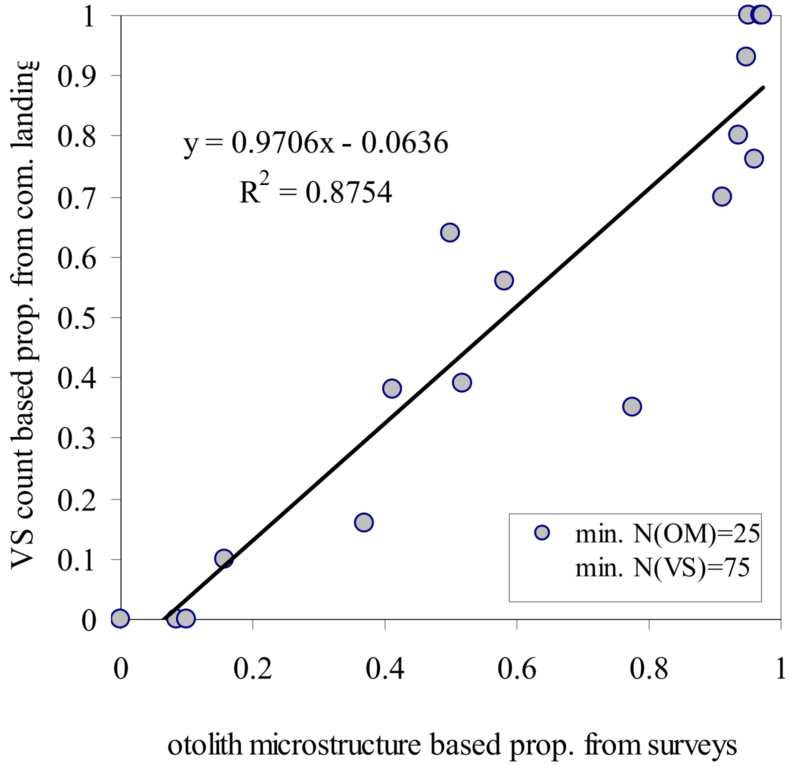


Figure 3.2.2 Comparison of proportions of estimated herring spring spawners in Div. IIIa based on vertebral counts from commercial landings vs. otolith microstructure from surveys. Data points represent average estimates over the years 1991–1996 and 1997, disaggregated by quarter, subdivision and age group (0-4+).

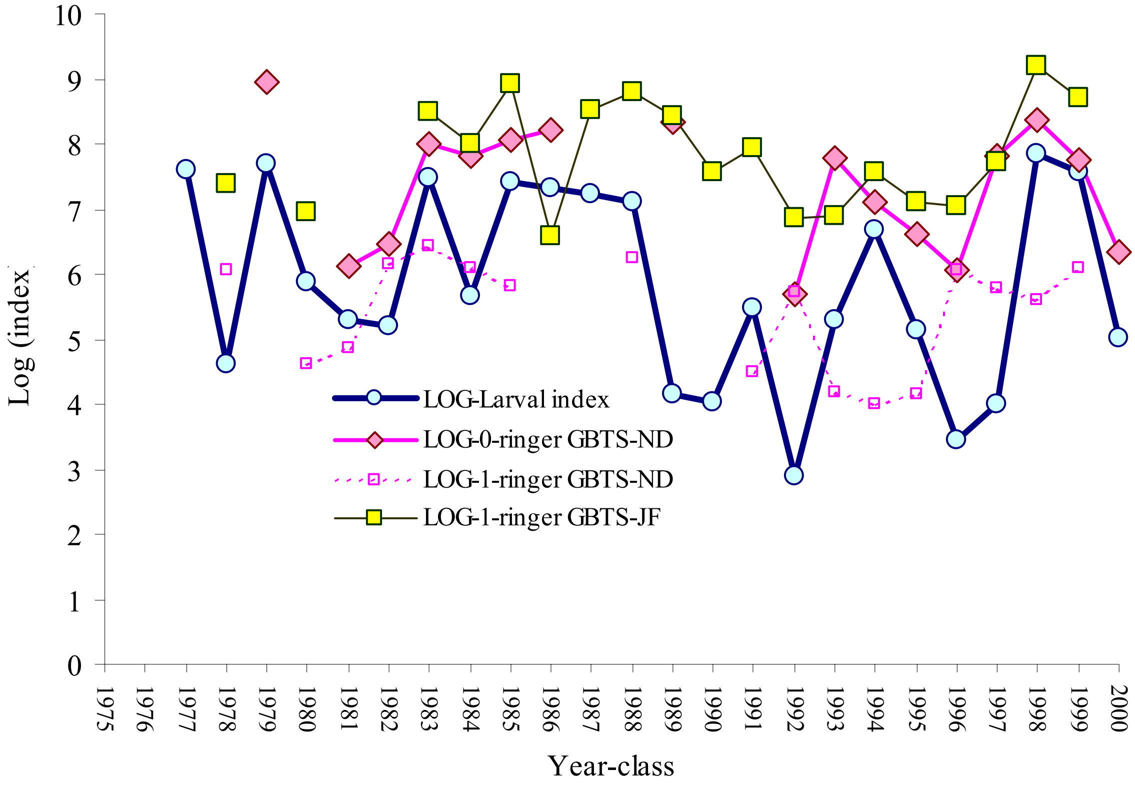


Figure 3.6.1 Recruitment indices (natural log) for the Western Baltic spring spawning herring plotted against year-class. GBTS=German Bottom Trawl Survey, ND=November/December, JF=January/February.

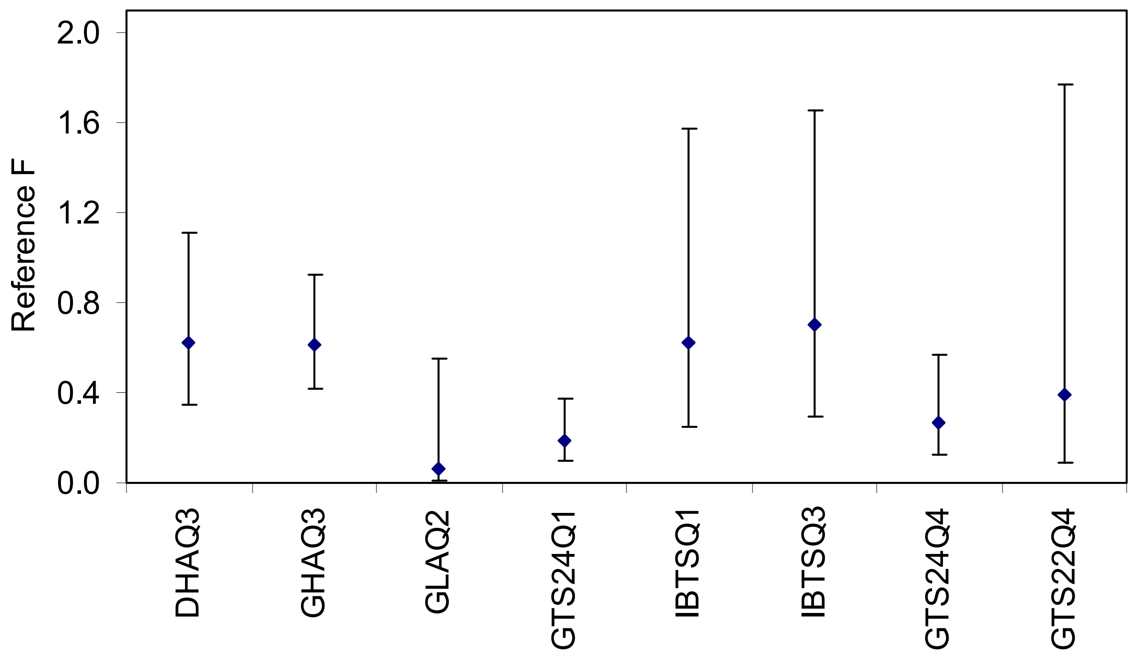


Figure 3.7.1 Western Baltic herring. Estimates of mean F by ICA runs by individual indices and catch at age data 1991 to 2000. The indices are:

Acoustic Survey Division IIIa, quarter 3	DHAQ3
Acoustic Survey Sub-div. 22-24, quarter 4	GHAQ4
Larval survey Greifswalder Bodden, quarter 1-2	GLAQ2
German Bottom Trawl Survey Sub-div 24, quarter 1	GTS24Q1
IBTS Kattegat, quarter 1	IBTSQ1
IBTS Kattegat, quarter 3	IBTSQ3
German Bottom Trawl Survey Sub-div. 24, quarter 4	GTS24Q4
German Bottom Trawl Survey Sub-div. 22, quarter 4	GTS22Q4

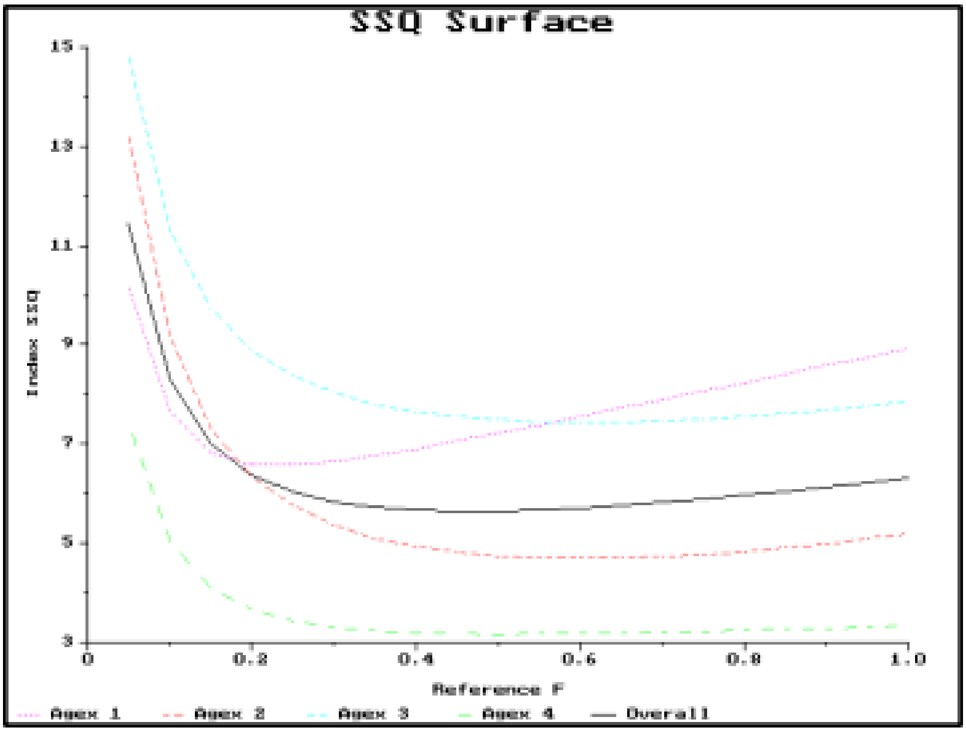


Figure 3.7.2 Western Baltic Herring. Output from ICA Run 16:
Index sum of squares of deviations between model and observations
(survey index) as a function of the reference F in 2000.
INDEX 1: German Bottom Trawl Surv. in Sub-division 24, Nov./Dec., Ages 0-3+
INDEX 2: Acoustic Survey in Sub-divisions 22-24, Sept./Oct., Ages 0-8+
INDEX 3: Acoustic Survey in Div. IIIa+IvaE, July, Ages 0-8+
INDEX 4: IYFS in Kattegat, Quarter 3, Ages 1-5

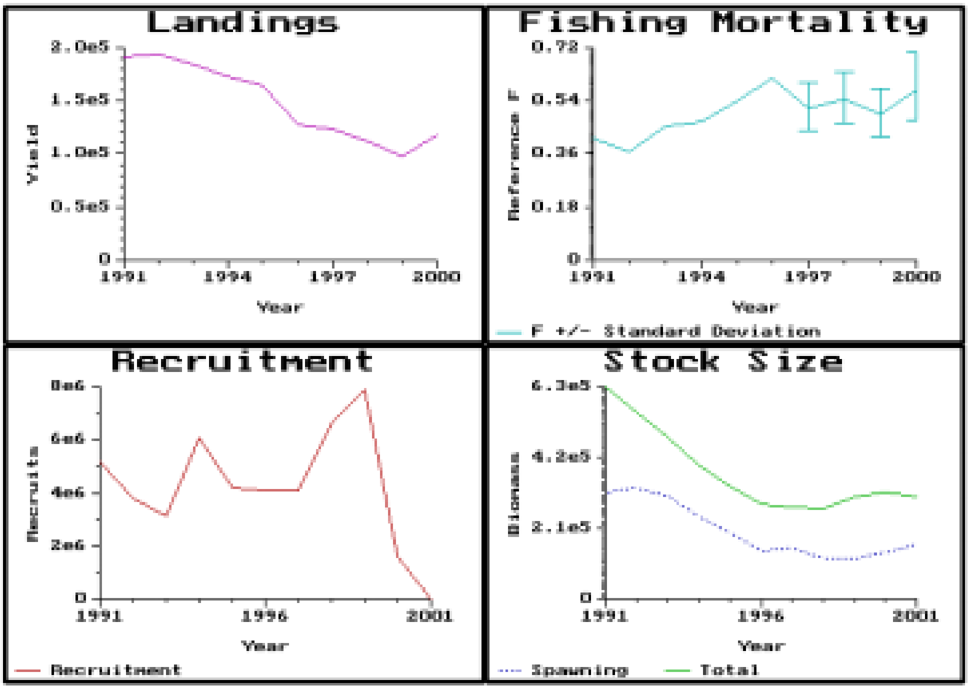


Figure 3.7.3 Western Baltic Herring. Out put from ICA Run 16: Stock Summary.

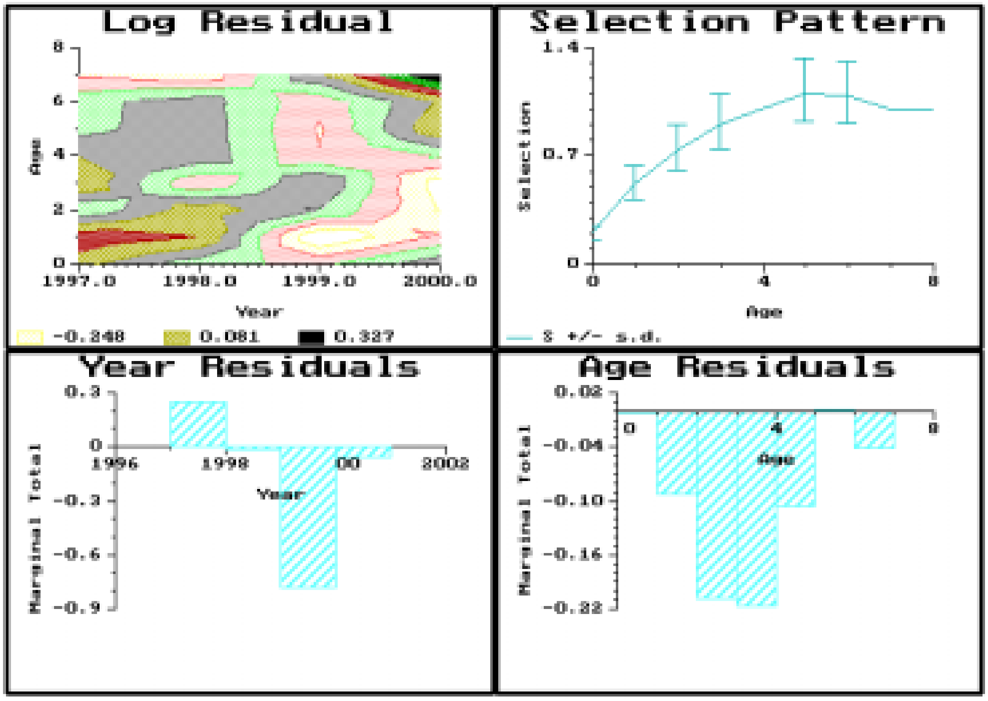


Figure 3.7.4 Western Baltic Herring. Output from ICA Run 16: Separable Model Diagnostics.

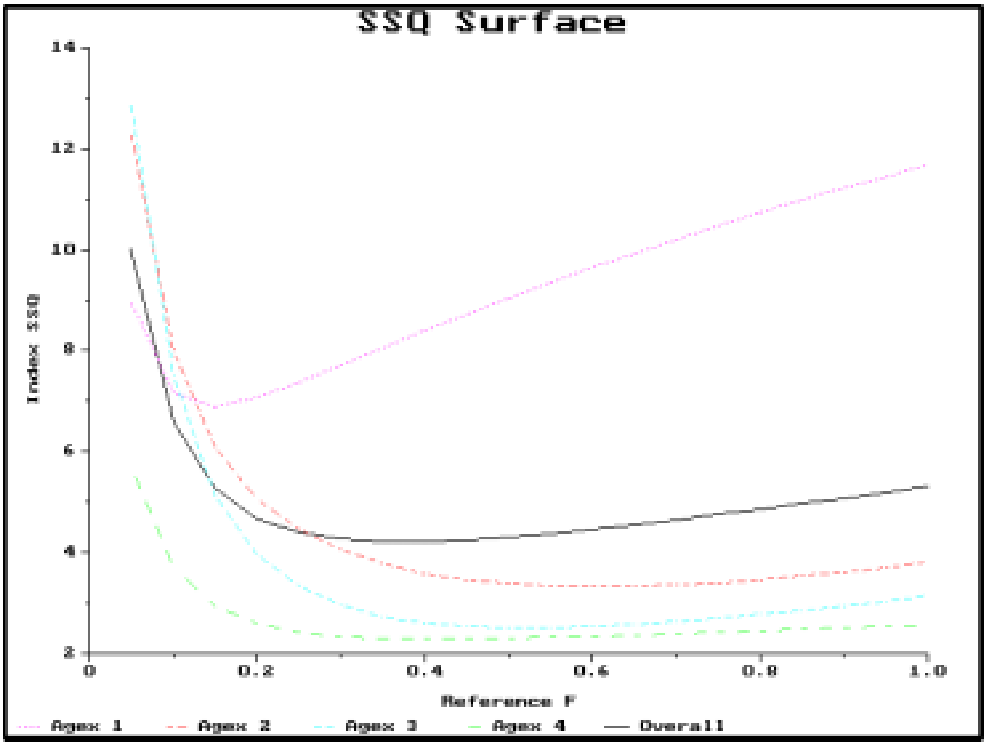


Figure 3.7.5 Western Baltic Herring. Output from ICA Run 17:
Index sum of squares of deviations between model and observations
(survey index) as a function of the reference F in 2000.
INDEX 1: German Bottom Trawl Surv. in Sub-division 24, Nov./Dec., Ages 0-1
INDEX 2: Acoustic Survey in Div. IIIa+IvaE, July, Ages 2-6
INDEX 3: Acoustic Survey in Sub-divisions 22-24, Sept./Oct., Ages 0-1
INDEX 4: IYFS in Kattegat, Quarter 3, Ages 2-5

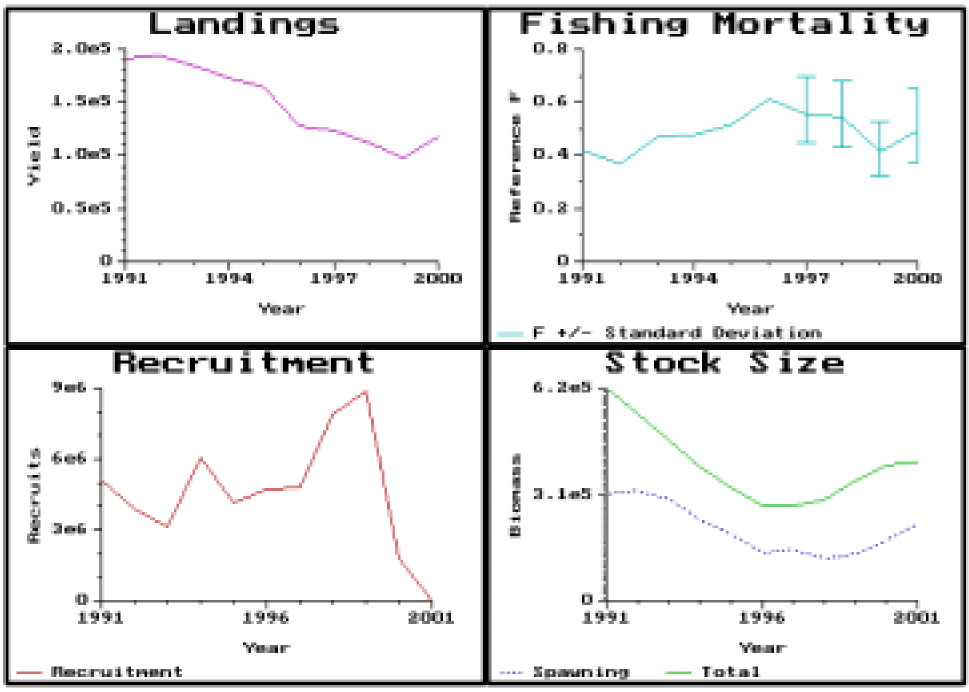


Figure 3.7.6 Western Baltic Herring. Out put from ICA Run 17: Stock Summary.

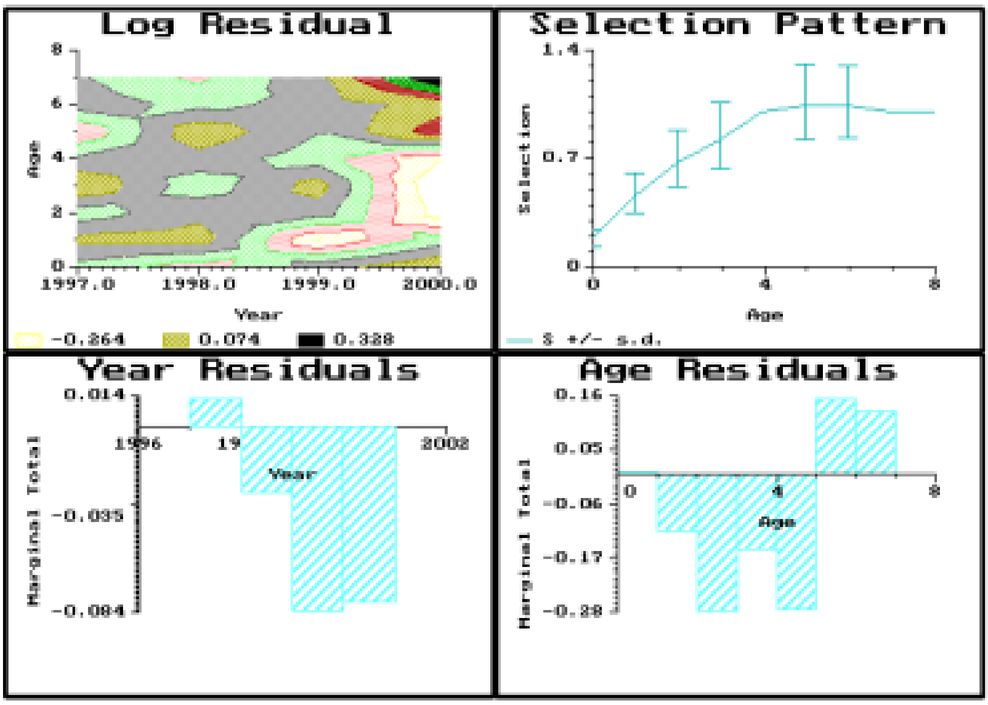


Figure 3.7.7 Western Baltic Herring. Output from ICA Run 17: Separable Model Diagnostics.

4 CELTIC SEA AND DIVISION VIIJ HERRING

4.1 Introduction

The herring fisheries to the south of Ireland in the Celtic Sea and in Division VIIj have been considered to exploit the same stock. For the purpose of stock assessment and management these areas have been combined since 1982. The areas for which the assessments are now made, together with the area for which the TAC is set by the EU are shown in Figure 1.5.1. It should be noted that, although the management unit covers all of Divisions VIIg,h,j and k and the southern part of Division VIIa, the Irish catch which constitutes over 95 % of the total catch is taken from the inshore waters along the Irish coast.

4.2 The Fishery in 2000–2001

4.2.1 Advice and management applicable to 2000–2001

In 2000 ACFM considered that this stock was within safe biological limits that the SSB was well above the proposed $\mathbf{B}_{pa}$. In the absence of a proposed $\mathbf{F}_{pa}$ ACFM advised that the F in 2001 should not exceed that of 1999. This corresponds to catches of no more than 17,900t. The TAC subsequently set by the EU for 2001was 20,000t.

The spawning box closure system, which was first introduced in the late eighties and which is described in ICES (CM 1989/Assess:15) was again continued during the 2000/2001 season - the box closed being that in Division VIIg. This box was closed for a fortnight in the fourth quarter 2000. The entire Irish fishery was again closed from mid-February 2000 through to early October 2000.

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 8,255 t in the January –February (2000) period and the remainder of the national quota (9,813t) in the October to December period.

4.2.2 The fishery in 2000/2001

As has been the case for a number of years the major portion of the catch in this area was taken by the Irish fishery during the spawning season which normally lasts from October to February. There were small catches taken by Germany and UK, and small catches were misreported from outside the Celtic Sea.

In contrast to previous years marketing conditions improved 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 30, compared with an average of 24 in the previous season. Over 100 vessels participated in this fishery during the early sixties.

The fishery was marked by a scarcity of large fish throughout the area particularly in VIIaS and towards the end of the season. Fishermen reported that shoals of large fish which were observed before the fishing season opened had moved from western areas by early October. During January and February good quantities of small fish (21–23cm) were observed in VIIaS and some vessels moved out of the area to search for better quality fish.

4.2.3 The catch data

The estimated national catches from 1988–2000 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 2000 are shown in Figure 4.2.1. The reported catch, including some unallocated landings, taken during the 2000/2001 season was about 17,800 t compared with 18,500 t during the previous season.

<u>Discards</u>

Although 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. There were reports of small levels of discarding from the fishery towards the end of the season in 2001. However there were no estimates of discarding available and no adjustments were made to the catch data.

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 are very good for this period.

Biological sampling of the catches throughout the area continues to be satisfactory and at a high level. Details of the sampling data per quarter are shown in Table 4.2.3, while the length distributions of the catches taken by the Irish fleet per quarter are shown in Table 4.2.4.

4.2.5 Catches in numbers at age

The total catches in numbers at age, including discards, per season from 1958 to 2000 are shown in Table 4.2.5. The age composition in 2000/2001 was dominated by 2 w ring herring (1997/98 year class) which constituted 58% of the catch. 3 w. ring herring (1996/97 year class) and 5 w. ring herring (1995/96 year class) constituted 14% and 9% respectively. In recent years there was a gradual improvement of the age structure of the catches in numbers at age. However this year the numbers of fish in the catch at three years and older have fallen sharply. The numbers of 1 w.ring herring constituted 7% of the catch in numbers which slightly above the average since the fishery was fully re-opened in 1983. These young fish were mainly taken in the catches from Divisions VIIg and VIIaS in Q1 2001 and Q4 2000 respectively.

4.3 Mean Weights and Maturity at Age

As the major portion of the catch from this fishery continues to be taken during the spawning season the mean weights at age in the catches have traditionally been taken as the mean weights in the stock at spawning time (1 October). The mean weights during 2000/2001 were very similar to those in recent seasons with the exception of 2 year old fish, which are lighter this year than any other year in the time series. This low mean weight may be due to the apparent high abundance of this year class in the population (Table 4.2.5).

The maturity at age for this stock has been assumed to be constant throughout the whole time period (50% of fish are assumed to be mature at age 1 and 100% mature at age 2). While this maturity ogive reflects the current rate of maturation of the population, it is apparent that the stock has undergone growth changes and also considerable changes in abundance during this time period. Both these factors may have had effects on the maturity ogive and this needs to be investigated before biological reference points are finalised. The historical data will be examined in 2001 and the results will be presented when available.

4.4 Survey Indices

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. Surveys are carried out during the spawning season which lasts from October to February/March and two surveys are carried out when possible in October and in January. The objective of the surveys is to estimate the size of the spawning stock of the autumn and winter spawning components separately. In most years it has been possible to do this with some confidence and therefore the size of both components has been combined to give the size of the total spawning stock. However, recent surveys were thought to have missed out important parts of either component and have had difficulties in adequately covering the distribution of the stock. This was because of weather conditions or because of the difficulty of timing the surveys to coincide with the arrival of the shoals on the spawning grounds.

During the 1998/99 season two surveys were carried out. However, only the results of the first survey (November, 1998) were available to the Working Group at the time of the meeting in 1999 (ICES 1999 ACFM 12). During the 1999/2000 season two surveys were again carried out. However because of the timing difficulties using in autumn and winter surveys to give one overall estimate of the size of the total Celtic Sea stock it was decided to carry out a survey during the Summer on the off shore feeding grounds. The estimate of adult stock biomass from this survey (22,500t) was very low when compared with catches of 18,000t of adult fish, which were taken over the subsequent season. Over 90% of the herring seen during the July survey were either 0 1 or 2 w.ring fish. The age distribution of these fish was completely different from samples taken from the commercial fishery and it was therefore concluded that this survey did not cover the main adult component of the stock and therefore could not be taken as a realistic estimate of the spawning stock biomass.

A further survey was however carried out in January 2000. Although this survey was carried out at what was considered to the appropriate time and good coverage was obtained, the amount of herring observed was small. Reports from the commercial fishery at the time suggested that shoals were less abundant than in the January to February period during the 98/99 season, and from the commercial samples that some spawning had in fact taken place earlier than usual. The majority of fish sampled during the acoustic survey were spent fish (stage 7) compared with mainly full and spawning fish sampled from the commercial catches during January and February. The total stock estimated was 29,700 t while the spawning stock was estimated at around 26,200 t. This estimate was not considered to be realistic because the main spawning concentrations were not located during the acoustic survey.

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 avoid the problems mentioned above associated with a survey designed 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. These difficulties were compounded by the lack of a suitable vessel. 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, but this is not 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 2001appeared to be consistent with a peak spawning period of the Winter spawning component. There are some indications that the stock was not contained (Figure 4.4.1) but there was no conflict between the age and maturity distributions of fish observed during the survey and in the fishery, as last year. The survey did not cover any ground west of the Old head of Kinsale as there had been no landings of fish from this area since December 2000. As there was ship time left after the initial survey was completed it was decided to conduct a repeat survey concentrating on the inshore ground. This second survey produced a considerably different biomass for the Baginbun area than a survey completed 2 days previously. Information from the fishery suggests that shoals of fish were dispersed during the first part 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 difference between the two surveys was (5,300t as opposed to 14,400t). Such differences in abundance as measured by an acoustic survey, especially over a small area can occur. Therefore it was decided to average the estimate of the Baginbun area between the two surveys. The estimate of SSB from the January survey was 12,385t.

The age distribution of the stock from all acoustic surveys carried out since 1990 is shown in Table 4.4.1.

4.4.2 Bottom trawl surveys

Last year some information from a UK bottom trawl survey in the first quarter was made available to the group. This information was useful in examining for major changes in Z in the last year as indicated by the 1999/2000 acoustic survey index. There was no updated information from this survey series available to the WG in 2001. It would be useful for the WG to have this information in 2002.

4.5 Stock Assessment

4.5.1 Preliminary data exploration

Recent Working Groups have used the results of the acoustic surveys in the ICA programme but stated that the results of the 1996/97 surveys and 1998/99 surveys should be taken as a minimum estimates. In 1998 the Working Group decided to use the age disaggregated data but only over the ages 2–5 as a relative index in the ICA programme. It was clear that the 1996 survey had failed to estimate the older fish in the population because of the small proportion of older fish recorded by the survey relative to the catch. The 1999 WG decided that, even with an incomplete index for the 1998/99 surveys, the same procedure as that adopted in 1998 should again be carried out in 1999, i.e. an ICA run in which the age disaggregated data over the ages 2–5 should be used as a relative index of stock size. The 2000 WG decided that neither acoustic survey carried out in (1999/2000) provided a realistic estimate of the stock size and the assessment was based on an ICA run with no 1999/2000 index. Shrinkage over 4 years was used to stabilise the estimate of F in the final year.

This year the relative distribution of age classes in the population from the combined acoustic survey index closely matches the catches (Figure 4.5.1.1). This is now the second acoustic survey to have produced a low overall estimate of stock size. For the purpose of examining Z from the survey series the 1999 survey was included, this plot shows a pattern of increasing Z which is now reflected in the catch at age data (Figures 4.5.1.2 and 4.5.1.3). Thus the WG decided to use the combined acoustic survey as an index for the 2001 assessment. As in last years assessment the combined acoustic index for 1999 was excluded. The surveys, which are used as a relative index of numbers at ages 2–5, 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. A table is given below showing the options used in the assessment since 1998.

Working Group	Index	Shrinkage
1998	Combined acoustic index ages 2-5 1990-1996	No
1999	Combined acoustic index ages 2-5 1990-1996,November 1998	No
2000	Combined acoustic index ages 2-5 1990-1996,November 1998	Yes
2001	Combined acoustic index ages 2-5 1990-1996,November 1998, Combined index 2000	No

4.5.2 Results of the assessment

The run log of this year's assessment is given in Table 4.5.2.1. The results of the assessment and the diagnostics are shown in are shown in Table 4.5.2.2 and Figures. 4.5.2.1–4.5.2.7. These results indicate that the SSB in 2000 has fallen to 34,800t. Last year the final run produced an estimate of SSB in 1999 of 117,000t. However this high figure was due to the large number of 1 year olds in the population which is poorly estimated by the model. For the purposes of the prediction last year the number of 1 year olds was replaced by a geometric mean from 1982 to 1997, when this figure is substituted for the number of 1 year olds in the population it gives a biomass of 71,800t in 1999. The current perception shows an SSB which has declined from 71,500t in 1995. This view is strongly influenced by the inclusion of the age-structured index from the acoustic surveys which estimate the stock size to be 31,800t in the most recent year. This index has been problematic over the past 2 years (see section 4.4.1) and the 1999/2000 index was omitted from the assessment last year because of this. None the less the relative distribution of age classes in the population from the survey this year closely matches the catches, and this indicates a high mortality on age classes 3 and older. Figure 4.5.2.8 shows the trajectories 5, 50 and 75 percentiles from the uncertainty estimates of SSB, F and recruits produced by ICA.

The value of F estimated for 2000 is 0.94, and for 1999 0.95. Estimates of F estimated by the 2000 WG were 0.34 and 0.34 for 1998 and 1999 respectively.

The number of 1 w.ring herring in the stock, show that recruitment was below average in the period 1996 – 1998 but appears to have improved in the past 2 years.

4.5.3 Comments on the assessment

Figure 4.5.3.1 shows the trajectories of SSB, F, and recruitment according to this years assessment. For comparison the final run from last year is also included. Error bars on SSB relate to the 5 and 95 percentiles from the 2001 assessment. These error bars indicate quite clearly the uncertainty associated with any estimate of SSB in the separable period, it is also notable how skewed the point estimate of SSB is in relation to the range of estimates in the uncertainty analysis. The current point estimate of SSB lies almost on the lower bound of 5 percentile. If the assessment were conducted as last year (i.e. omission of the age structured index in the most recent year and F's shrunk to the mean of the last 4 years) the age distribution of the catches is explained by exceptionally large recruitment in 1999 and 2000. There is no evidence from the surveys or the fishery of recruitment on such a large scale. The only other explanation for the relatively low catches of age group 3 and older fish would be a change in the distribution of this component of the stock whereby these fish were not in the area of the fishery. Such a change in the distribution of the stock would be exceptional and there is no evidence for this. It should be noted that there has been significant temperature changes in the Celtic Sea over the past few years and this may have an affect on the behaviour of this stock which is at the south-western edge of its range. In the absence of alternative information the low abundance of age group 3 or older fish in the stock is explained by very high adult mortalities, and relatively poor recruitment of these age groups over the period 1996 – 1998.

4.6 Recruitment Estimates

At present there are no recruitment estimates for this stock that can be used for predictive purposes. The numbers of 1 w.ring fish estimated from the ICA model suggest that recruitment from the 1995, 1996 and 1997 year classes have been below average but that recruitment may have improved in the two most recent years.

There are some data available from the January 2001 acoustic survey to indicate that the 1998 year class may be good as substantial numbers of them were present in Divisions VIIaSouth and VIIg.

In this stock a proportion of juvenile fish are present in the Irish Sea and do not recruit to the Celtic Sea until they are mature. Therefore neither the numbers of 1 w.ring fish in the stock as estimated from the acoustic surveys nor the numbers in the catches give a reliable indication of year class strength. The relationship between the numbers of 1 w.ring herring taken per hour in the Northern Irish ground fish surveys and the numbers of 1 w.ring herring estimated by ICA for the Celtic Sea was examined in a working document presented to the 1999 WG (Armstrong *et al*.,1999, W.D) and the results suggest that these surveys may become a useful indicator of recruitment when a longer time series is established.

4.7 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 therefore carried out under the following assumptions.

The number of 1 w.ring fish was based on the geometric mean from 1958 to 1998. This value was 403 million fish. In contrast to last year the geometric mean was calculated over the entire time period (1958 – 1998) rather than over the more recent period (1982–1998) because the perception of the stock this year was that it is at a low level. Given the present 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 over 150 million lower than that used by the 2000 WG.

The mean weights used in the catches and in the stock were based on average values over the period 1997 – 2000. The catch in 2001 was assumed to be equal to the TAC of 20,000t. The input data used for the predictions are shown in Table 4.7.1.

Results of Predictions

The calculated SSB for 2001 comes to 33,031t (Table 4.7.2). The overall results of the predictions (Table 4.7.3) indicate that the perception of the development of the stock has changed dramatically to that presented in recent reports. This perception is driven by the inclusion of the acoustic survey index in this years assessment (the reasons for this are discussed in Section 4.5.3). This year, catches of 18,000t – 19,000t in 2002 (which were estimated to be at an appropriate level for the stock by the 2000 WG) produce a decrease in SSB.

If the TAC in 2002 is set at the same level as that for 2001 (20,000t) then the SSB in 2002 will be about 34,348t which is higher than that in 2001. In order for the stock to be above $\mathbf{B}_{pa}$ (44,000t) in 2003 the catch would have to be 3,500t.

If F in 2002 is set to correspond to $\mathbf{F}_{med}$ = 0.30 then the resultant catch in 2003 will be between 5,500t and 6,000t and the SSB will be around 41,000t.

If catches are reduced by 1/3 in 2002 (about 14,000t) then SSB in 2003 will be about 32,000t.

Yield per recruit and short term yield are shown in Figure 4.7.1.

4.7.1 Biological reference points and management considerations

Biological reference points were discussed in detail last year's report (ICES 2000b) and in the report of the previous years (ICES 1999a ICES 1998a). 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 millions in most other years. This recruitment failure apparently was not induced by a low SSB. Rather, it started when the SSB was at a high level and recruitment returned to normal while the SSB was at its lowest. Overall, the recruitment does not appear to be strongly dependent on the SSB.

In the periods with good recruitment, the fishing mortalities have mostly been in the range 0.35 – 0.6, and the stock seems to have tolerated this fishing mortality well. This fishing mortality is higher than that which most herring stocks will tolerate. The background for this may be partly because the recruits per SSB is quite high, except in the period with poor recruitment, and partly because the fishery is almost exclusively on mature fish, which gives a favourable SSB per recruit.

The 1998 Working Group suggested a $\mathbf{B}_{lim}$ 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 2000 Working Group therefore re examined the stock recruit relationship over the 1958 to 1999 period using the new SSB estimated on the revised stock weights for the 1958 to 1983 period. The new stock recruitment plot is shown in Figure 4.6.2 in ICES CM 2000/ACFM:10. The F med value which has been proposed as appropriate for $\mathbf{F}_{pa}$ is calculated as 0.29 which is identical to the previous proposed value. It was therefore concluded that the revised stock weights have had no effect on the stock recruitment relationship.

The present Working Group therefore re examined the stock recruit relationship over the 1958 to 1999 period using the new SSB estimated on the revised stock weights for the 1958 to 1983 period. The new stock recruitment plot is shown in Figure 4.7.2.The F med value which has been proposed as appropriate for $\mathbf{F}_{pa}$ is calculated as 0.29 which is identical to the previous proposed value. It was therefore concluded that the revised stock weights have had no effect on the stock recruitment relationship.

It has also been suggested that the catches of juvenile fish taken in the industrial fishery in the Irish Sea (Division VIIa North) may also have had an effect on the stock recruit relationship. This is because these catches contain an unknown proportion of Celtic Sea recruits and these have never been included in the catch in number at age for the Celtic Sea. The Working Group examined the numbers at age taken in the industrial fishery which were presented in an earlier working group report (ICES 1980 H:4). It was concluded that the numbers, although substantial in some years, were unlikely to have had any major effect on the Celtic Sea recruitment. However, it was decided to examine the stock recruitment relationship over the period after the industrial fishery ceased and when the Celtic Sea stock had recovered after the collapse that cause it's closure from 1977 to 1982. Accordingly a new stock recruitment plot was calculated over the period 1982 to 1999. 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 the biological characteristics of this stock are such that it can withstand higher rates of fishing mortality than other stocks as suggested by earlier working groups. This is partially due to the fact that 50% of the age 1 fish are mature and these spawning fish are not fully selected by the fishery. As the period of low recruitment is strongly correlated with the juvenile fishery in the Irish Sea and appears to be atypical of the 40 years history of the stock the inclusion of this period for the management of the stock in it's current state seems inappropriate. While a $\mathbf{F}_{pa}$=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 the current assessment is unstable, the WG did not propose any change to the reference points suggested by last years WG.

4.7.2 Management considerations

The most recent assessment is very imprecise and is driven by the assumption that the acoustic surveys in 2000 are an accurate reflection of the state of the stock. The current point estimate of SSB in 2000 appears to be at the lower bound of the range of uncertainty (see Figure 4.5.3.1). The trajectory of the stock biomass since 1996 is altered dramatically by this years assessment and this seems to be at odds with acoustic surveys in the period 1996 – 1998 and reports from the fishery up to 1999. This said however fish at age three and older were poorly represented in the catches in 2000 and in population estimates from the acoustic survey index, and when this is explained by fishing mortality, the current perception is the result. Projections based on this perception of the stock show that the stock is heavily reliant on recruitment, and with pessimistic levels of recruitment, that current levels of catch will lead to a further decline in SSB. Following the most recent fishing season the industry is very concerned about the current situation and is involved in a management plan which is being put in place. This will focus on getting more information on the possible distribution of older fish during the summer and increasing the level of sampling. A further acoustic survey will be carried out in November and this will be extended further offshore than in previous years.

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 and extended to cover the entire stock.

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), 1988–2000. (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

[1]Preliminary

Table 4.2.2 Celtic Sea and Division VIIj herring landings (t) by season (1 April–31 March) 1988/1989-1999/2000. (Data provided by Working Group members. 1998/99 figures are preliminary.).
These figures may not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	France	Germany	Ireland	Netherlands	U.K.	Unallocated	Discards	Total
1988/1989	-	-	17,000	-	-	-	3,400	20,400
1989/1990	+	-	15,000	1,900	-	2,600	3,600	23,100
1990/1991	+	-	15,000	1,000	200	700	1,700	18,600
1991/1992	500	100	21,400	1,600	-	-100	2,100	25,600
1992/1993	-	-	18,000	1,300	-	-100	2,000	21,200
1993/1994	-	-	16,600	1,300	+	-1,100	1,800	18,600
1994/1995	+	200	17,400	1,300	+	-1,500	1,900	19,300
1995/1996	200	200	20,000	100	+	-200	3,000	23,300
1996/1997	1,000	-	17,900	1,000	-	-1,800	750	18,800
1997/1998	1,300	-	19,900	1,400	-	-2100	0	20,500
1998/1999	+	-	17,700	1,200	-	-700	-0	18,200
1999/2000		200	18,300	1300	+	-1300	0	18,500
2000/2001	573	228	16,962	44	1	-617	0	17,191

[1] Preliminary

Table 4.2.3. Celtic Sea, Division VIIj (2000–2001). Sampling intensity of commercial catches.

Country		Catch (t)	No. of samples	No. of age readings	No. of fish measured	Aged per 1000 t	Estimates of discards
Ireland	Q 4	9,813	31	942	6518	96	No
	Q 1	7,149	10	320	2134	45	No
Germany	Q4	228	0	0	0	0	No
UK	Q3	1	0	0	0	0	No

Table 4.2.4. Celtic Sea and Division VIIj. Length distribution of Irish catches/quarter (thousands) 2000/2001.

	Q4 2000			Q1 2001		
Length	VIIaS	VIIg	VIIj	VIIaS	VIIg	VIIj
18.5	15					
19	30					
19.5	46					
20	76	25				
20.5	227	12		128		
21	500	162	5	43	168	
21.5	758	349	10	425	273	56
22	1,471	874	80	1,020	1,282	
22.5	2,305	1,123	151	1,275	2,060	56
23	3,458	1,697	196	2,891	3,216	56
23.5	4,231	2,109	347	3,826	4,225	
24	5,202	2,396	317	3,571	3,973	56
24.5	4,489	2,259	347	3,018	3,531	501
25	3,214	1,897	478	2,848	2,922	613
25.5	2,063	1,972	709	1,148	1,766	501
26	1,911	2,421	976	1,105	1,492	278
26.5	1,638	2,047	1,076	808	1,156	
27	1,517	1,797	1,147	893	1,303	390
27.5	1,274	2,209	1,323	765	1,429	167
28	925	1,348	1,177	638	1,408	56
28.5	773	1,073	795	340	778	56
29	364	449	397	128	420	
29.5	121	187	251		42	
30	91	37	96		42	
30.5		12	85		21	
31			10			
31.5			5			
Total	36,700	26,458	9,977	24,869	31,510	2,784

Table 4.2.5(a) Celtic Sea and Division VIIj. Catch at age 1958-2000, predicted catch for the separable period (OUTPUT from ICA).

```
Output Generated by ICA Version 1.4
 ------------------------------------

        Herring Celtic VIIj (run:Final 01 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
1	5.82	14.27	9.95
2	41.51	34.07	77.38
3	27.10	36.09	18.95
4	28.27	14.64	12.06
5	13.18	15.52	5.23
6	3.75	8.88	6.23
7	2.67	1.86	2.32
8	0.60	2.01	0.66
9	0.39	0.55	0.58

x 10 ^ 6

Predicted Catch in Number

AGE	1995	1996	1997	1998	1999	2000
1	11270.	4308.	5297.	3716.	11020.	9953.
2	79195.	70779.	37661.	37721.	37887.	68156.
3	22415.	46136.	58410.	24270.	33529.	17776.
4	26944.	11056.	32373.	31525.	17725.	12284.
5	4235.	12553.	7345.	16428.	21489.	5918.
6	3690.	1910.	8075.	3596.	10733.	6793.
7	2878.	1328.	993.	3186.	1951.	2782.
8	1859.	1388.	915.	527.	2324.	717.

x 10 ^ 3

Table 4.2.5(b) Celtic Sea and Division 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
1	0.09900	0.09000	0.09200
2	0.12100	0.12000	0.11100
3	0.15300	0.14900	0.14800
4	0.16300	0.16700	0.16800
5	0.17300	0.18000	0.18500
6	0.18500	0.18300	0.18700
7	0.19900	0.20200	0.19700
8	0.20400	0.20900	0.21000
9	0.22500	0.20800	0.22000

Table 4.2.5(c) Celtic Sea and Division 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

Weights at age in the stock (Kg)

Table 4.2.5(c) Continued.

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
1	0.09900	0.09000	0.09200
2	0.12100	0.12000	0.11100
3	0.15300	0.14900	0.14800
4	0.16300	0.16700	0.16800
5	0.17300	0.18000	0.18500
6	0.18500	0.18300	0.18700
7	0.19900	0.20200	0.19700
8	0.20400	0.20900	0.21000
9	0.22500	0.20800	0.22400

Table 4.2.5(d) Celtic Sea and Division VIIj. Natural mortality (constant for all years).

Natural Mortality (per year)

AGE	1958	...	2000
1	1.0000	...	1.0000
2	0.3000	...	0.3000
3	0.2000	...	0.2000
4	0.1000	...	0.1000
5	0.1000	...	0.1000
6	0.1000	...	0.1000
7	0.1000	...	0.1000
8	0.1000	...	0.1000
9	0.1000	...	0.1000

Table 4.2.5(e) Celtic Sea and Division VIIj. Maturity at age (constant for all years).

Proportion of fish spawning

AGE	1958	...	2000
1	0.5000	...	0.5000
2	1.0000	...	1.0000
3	1.0000	...	1.0000
4	1.0000	...	1.0000
5	1.0000	...	1.0000
6	1.0000	...	1.0000
7	1.0000	...	1.0000
8	1.0000	...	1.0000
9	1.0000	...	1.0000

Proportion of M before spawning: 0.5
Proportion of F before spawning: 0.2

Table 4.4.1. Total stock numbers at age (10^6) estimated using combined acoustic surveys.

W.Rs	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996*	1998*	July 1999	Jan 2000
0	204.8	213.8	141.8	258.8	41.3	5.1	2.8	-	13.2	-
1	131.6	62.6	426.9	217.1	38.0	279.5	133.6	21.43	397.6	22.87
2	249.0	195.2	117.0	437.9	127.2	550.7	757.0	157.13	207.6	96.6
3	108.6	94.7	87.8	58.7	160.3	138.4	249.9	149.62	48.2	85.13
4	152.5	54.0	49.6	63.4	10.5	93.5	50.6	201.48	8.0	16.25
5	32.4	84.8	22.2	26.0	10.6	7.9	41.9	108.53	0.9	21.37
6	14.9	22.1	24.2	16.3	6.5	9.2	1.1	31.71	1.2	7.65
7	6.1	5.3	9.6	24.6	1.6	8.4	14.2	29.80	0.1	1.61
8	2.5	6.1	1.8	2.3	2.6	9.2	0.5	3.95	0.1	0.86
9+	1.5	-	1.1	1.7	0.5	4.7	1.8	1.28	0.0	0.04
Total	903.9	738.6	882.0	1,106.8	399.1	1106.5	1,253.4	704.9	676.9	252.38
TSB (000't)	103.0	84.4	88.5	104.0	51.8	134.6	151.3	110.9	58.0	29,7
SSB (000't)	91.0	77.0	71.0	90.0	50.6	114.0	145.8	110.5	22.5	26,2

- November survey only, likely to be an underestimate of stock size.

W.R.s	2000/01
0	22.75
1	17.58
2	142.66
3	36.17
4	18.67
5	6.56
6	3.28
7	1.72
8	0.26
9+	0.50
Total	250.17
TSB (000't)	33.34
SSB (000't)	31.79

Table 4.5.2.1 Run log of the assessment in 2001

```
                         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 -->c:\herirls\index
C:\herirls\canum
C:\herirls\weca
 Stock weights in 2001  used for the year 2000
C:\herirls\west
 Natural mortality in 2001  used for the year 2000
C:\herirls\natmor
 Maturity ogive in 2001  used for the year 2000
C:\herirls\matprop
 Name of age-structured index file (Enter if none) : -->c:\herirls\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 1995-->    1.000000000000000
 Weight for year 1996-->    1.000000000000000
 Weight for year 1997-->    1.000000000000000
 Weight for year 1998-->    1.000000000000000
 Weight for year 1999-->    1.000000000000000
 Weight for year 2000-->    1.000000000000000
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 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
```

Table 4.2.5.1 Continued

```
Mapping the F-dimension of the SSQ surface

    F                  SSQ
+--------+------------------
    0.05        10.9292865707
    0.13         6.2399525482
    0.20         4.5157535578
    0.28         3.5701644406
    0.36         2.9657474257
    0.43         2.5503405703
    0.51         2.2551245099
    0.58         2.0437718060
    0.66         1.8951133095
    0.74         1.7959858625
    0.81         1.7378713815
    0.89         1.7151868048
    0.97         1.7243574714
    1.04         1.7633049839
    1.12         1.8311937017
    1.19         1.9283538540
    1.27         2.0563682667
    1.35         2.2183526891
    1.42         2.4195244140
    1.50         2.6683236157
Lowest SSQ is for F =     0.900
-----------------------------------------------------------------
No of years for separable analysis : 6
Age range in the analysis : 1  . . . 9
Year range in the analysis : 1958  . . . 2000
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 29
Number of observations : 84

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
 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 2000  at age 3  is 0.897385  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  ?--> 2000
 Enter SSB reference level (e.g. MBAL, Bpa..) [t]-->   4.0000000000000000E+04
Succesful exit from ICA
```

Table 4.5.2.2 Outputs from the assessment.

Output Generated by ICA Version 1.4

Herring Celtic VIIj (run:Final 01 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
2	157.13	*******	142.66
3	149.62	*******	36.17
4	201.48	*******	18.67
5	108.53	*******	6.56

Fishing Mortality (per year)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	0.0081	0.0018	0.0130	0.0135	0.0025	0.0017	0.0116	0.0002
2	0.1196	0.2902	0.2407	0.1592	0.2682	0.3989	0.1853	0.2416
3	0.3506	0.1048	0.5355	0.1694	0.3216	0.3260	0.2366	0.1781
4	0.5082	0.3358	0.2401	0.2101	0.3885	0.0976	0.2610	0.3341
5	0.3898	0.3761	0.3761	0.1762	0.4618	0.2564	0.0478	0.1844
6	0.4869	0.2809	0.2272	0.2069	0.4689	0.2435	0.1464	0.1539
7	0.7560	0.7233	0.4688	0.1982	0.5615	0.2973	0.1602	0.2773
8	0.4088	0.3447	0.3412	0.1811	0.3941	0.2766	0.1729	0.2265
9	0.4088	0.3447	0.3412	0.1811	0.3941	0.2766	0.1729	0.2265

Table 4.5.2.2 Continued - Celtic Sea and 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	0.0496	0.1239
2	0.1814	0.2139	0.2927	0.4301	0.3041	0.3603	0.6887	0.6031
3	0.3564	0.3043	0.3619	0.5771	0.4658	0.6157	0.5574	0.7327
4	0.2751	0.5260	0.2728	0.5537	0.5783	0.8624	0.5445	0.4198
5	0.4576	0.3928	0.4342	0.4561	0.6208	0.9448	0.7446	0.6670
6	0.4589	0.6121	0.3347	0.6415	0.5282	0.7523	0.5649	0.5944
7	0.1570	0.6014	0.5316	0.5510	0.4377	0.5425	0.4439	0.9257
8	0.2939	0.4160	0.3620	0.5180	0.4641	0.6376	0.5831	0.6489
9	0.2939	0.4160	0.3620	0.5180	0.4641	0.6376	0.5831	0.6489

Fishing Mortality (per year)

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	0.0650	0.1402	0.1061	0.0766	0.0331	0.0780	0.0802	0.1625
2	0.6429	0.4648	0.3031	0.2355	0.3003	0.4012	0.5539	0.6714
3	0.6576	0.6627	0.4478	0.4355	0.3944	0.5394	0.7634	1.1654
4	0.7148	0.6244	0.5689	0.6485	0.5325	0.5233	0.5861	0.9901
5	0.4267	0.6189	0.4713	0.2132	0.3603	0.5144	0.2849	0.8967
6	0.5214	0.6715	0.6988	0.5786	0.2803	0.5088	0.8340	0.5871
7	0.6964	0.4051	0.9013	0.2803	0.2836	0.3718	1.0687	0.7333
8	0.6066	0.5530	0.5394	0.3769	0.3481	0.4609	0.6703	0.8200
9	0.6066	0.5530	0.5394	0.3769	0.3481	0.4609	0.6703	0.8200

Fishing Mortality (per year)

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	0.0372	0.0296	0.0556	0.0493	0.0123	0.0092	0.0086	0.0253
2	0.4802	0.6905	0.5199	0.4012	0.3806	0.4995	0.2889	0.3760
3	0.7080	0.6958	0.7221	0.4223	0.6483	0.6018	0.4893	0.4453
4	0.8498	0.5900	1.1915	0.6603	0.8105	0.8478	0.2372	0.6276
5	0.7123	0.8490	1.1153	0.4561	0.8347	0.9160	0.4833	0.2986
6	1.1462	0.2899	1.9258	0.2388	0.3745	0.5910	0.4368	0.5827
7	0.5606	0.6320	0.5557	0.7176	0.1372	0.7378	0.3362	0.7197
8	0.7012	0.6225	0.9251	0.4751	0.5048	0.6709	0.3650	0.4931
9	0.7012	0.6225	0.9251	0.4751	0.5048	0.6709	0.3650	0.4931

Table 4.5.2.2 Continued - Celtic Sea and Division VIIj

Fishing Mortality (per year)

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0095	0.0163	0.0197	0.0076	0.0249	0.0228	0.0196	0.0242
2	0.2959	0.5869	0.6001	0.4383	0.4080	0.3927	0.3371	0.4166
3	0.4184	0.5215	0.8298	0.4674	0.6251	0.5222	0.4484	0.5540
4	0.4120	0.5379	0.8532	0.5848	0.2804	0.5858	0.5029	0.6215
5	0.5107	0.6038	0.6377	0.2790	0.3018	0.6150	0.5280	0.6525
6	0.1968	0.5828	0.8708	0.3175	0.4739	0.6419	0.5511	0.6810
7	0.4796	0.1784	0.7799	0.7028	0.2925	0.5174	0.4442	0.5489
8	0.3762	0.4914	0.7376	0.4627	0.3925	0.5222	0.4484	0.5540
9	0.3762	0.4914	0.7376	0.4627	0.3925	0.5222	0.4484	0.5540

Fishing Mortality (per year)

AGE	1998	1999	2000
1	0.0245	0.0396	0.0392
2	0.4213	0.6826	0.6748
3	0.5603	0.9079	0.8974
4	0.6285	1.0184	1.0066
5	0.6599	1.0692	1.0569
6	0.6887	1.1159	1.1030
7	0.5551	0.8995	0.8891
8	0.5603	0.9079	0.8974
9	0.5603	0.9079	0.8974

Population Abundance (1 January)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	321.6	1058.0	346.4	250.1	493.1	279.3	1035.7	369.4
2	38.3	117.3	388.5	125.8	90.8	181.0	102.6	376.6
3	122.7	25.2	65.0	226.3	79.5	51.4	90.0	63.1
4	67.6	70.8	18.6	31.2	156.4	47.2	30.4	58.1
5	40.7	36.8	45.8	13.2	22.9	95.9	38.7	21.2
6	65.0	25.0	22.9	28.4	10.0	13.0	67.2	33.4
7	31.7	36.2	17.1	16.5	20.9	5.7	9.2	52.5
8	29.3	13.5	15.9	9.7	12.2	10.8	3.8	7.1
9	17.4	26.4	15.0	31.3	17.1	12.1	14.5	38.8

x 10 ^ 6

Table 4.5.2.2 Continued - Celtic Sea and Division VIIj

Population Abundance (1 January)

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	661.2	686.5	850.0	458.7	242.4	875.7	274.3	316.4
2	135.8	239.1	248.1	305.6	163.3	88.4	314.8	96.0
3	219.1	83.9	143.0	137.2	147.3	89.2	45.7	117.1
4	43.3	125.6	50.7	81.5	63.1	75.7	39.5	21.4
5	37.7	29.7	67.2	34.9	42.4	32.0	28.9	20.7
6	15.9	21.6	18.2	39.4	20.0	20.6	11.3	12.4
7	25.9	9.1	10.6	11.8	18.8	10.7	8.8	5.8
8	36.0	20.0	4.5	5.6	6.1	11.0	5.6	5.1
9	15.8	20.8	17.0	9.0	9.5	5.0	2.4	2.6

x 10 ^ 6

Population Abundance (1 January)

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	137.8	152.7	207.5	174.0	135.6	237.4	146.0	409.8
2	102.8	47.5	48.8	68.6	59.3	48.2	80.8	49.6
3	38.9	40.1	22.1	26.7	40.2	32.5	23.9	34.4
4	46.1	16.5	16.9	11.6	14.1	22.2	15.5	9.1
5	12.7	20.4	8.0	8.7	5.5	7.5	11.9	7.8
6	9.6	7.5	9.9	4.5	6.3	3.5	4.1	8.1
7	6.2	5.2	3.5	4.5	2.3	4.3	1.9	1.6
8	2.1	2.8	3.1	1.3	3.1	1.6	2.7	0.6
9	1.9	2.9	4.4	1.6	1.7	1.8	1.2	1.6

x 10 ^ 6

Population Abundance (1 January)

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	662.3	733.1	568.5	586.9	536.1	1030.6	425.5	522.2
2	128.2	234.7	261.8	197.8	205.5	194.8	375.7	155.2
3	18.8	58.7	87.2	115.3	98.1	104.1	87.6	208.5
4	8.8	7.6	24.0	34.7	61.9	42.0	46.7	44.0
5	3.1	3.4	3.8	6.6	16.2	24.9	16.3	33.3
6	2.9	1.4	1.3	1.1	3.8	6.4	9.0	9.1
7	4.1	0.8	0.9	0.2	0.8	2.4	3.2	5.3
8	0.7	2.1	0.4	0.5	0.1	0.6	1.0	2.1
9	1.2	0.7	0.3	0.4	0.0	1.0	0.3	1.8

x 10 ^ 6

Table 4.5.2.2 Continued - Celtic Sea and Division VIIj

Population Abundance (1 January)

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	450.3	186.8	841.4	335.1	779.0	789.5	351.0	350.0
2	187.3	164.1	67.6	303.5	122.3	279.5	283.9	126.6
3	78.9	103.2	67.6	27.5	145.0	60.3	139.8	150.1
4	109.3	42.5	50.2	24.1	14.1	63.6	29.3	73.1
5	21.2	65.5	22.5	19.3	12.2	9.6	32.0	16.0
6	22.4	11.5	32.4	10.7	13.2	8.1	4.7	17.1
7	4.6	16.6	5.8	12.3	7.1	7.5	3.9	2.5
8	2.3	2.6	12.6	2.4	5.5	4.8	4.0	2.3
9	1.5	1.6	1.4	1.4	1.5	2.2	3.0	1.5

x 10 ^ 6

Population Abundance (1 January)

AGE	1998	1999	2000	2001
1	242.8	447.2	408.5	416.1
2	125.7	87.2	158.1	144.5
3	61.8	61.1	32.6	59.7
4	70.6	28.9	20.2	10.9
5	35.5	34.1	9.4	6.7
6	7.5	16.6	10.6	3.0
7	7.8	3.4	4.9	3.2
8	1.3	4.1	1.3	1.8
9	0.9	1.0	1.0	0.9

x 10 ^ 6

Weighting factors for the catches in number

AGE	1995	1996	1997	1998	1999	2000
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 and Division VIIj

Predicted Age-Structured Index Values

FLT02: celtic combined acc data (Catch: Predicted

AGE	1990	1991	1992	1993	1994	1995	1996	1997
2	315.16	206.42	83.92	442.92	184.05	427.02	458.42	*******
3	141.92	167.35	80.53	47.04	212.05	97.66	243.96	*******
4	186.78	64.08	55.12	34.69	27.48	91.26	45.66	*******
5	27.24	76.60	25.40	31.28	19.24	11.14	40.37	*******

FLT02: celtic combined acc data (Catch: Predicted

AGE	1998	1999	2000
2	186.55	*******	182.16
3	96.47	*******	36.33
4	97.17	*******	19.02
5	39.28	*******	7.02

Fitted Selection Pattern

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	0.0231	0.0172	0.0244	0.0800	0.0077	0.0052	0.0488	0.0014
2	0.3411	2.7693	0.4495	0.9400	0.8340	1.2236	0.7831	1.3560
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.4493	3.2045	0.4484	1.2405	1.2082	0.2996	1.1032	1.8754
5	1.1117	3.5896	0.7023	1.0402	1.4360	0.7866	0.2019	1.0351
6	1.3886	2.6812	0.4243	1.2216	1.4582	0.7471	0.6186	0.8641
7	2.1562	6.9030	0.8754	1.1700	1.7461	0.9120	0.6770	1.5564
8	1.1660	3.2894	0.6371	1.0690	1.2257	0.8484	0.7305	1.2714
9	1.1660	3.2894	0.6371	1.0690	1.2257	0.8484	0.7305	1.2714

Fitted Selection Pattern

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	0.0480	0.0580	0.0633	0.0574	0.0185	0.0375	0.0890	0.1691
2	0.5091	0.7028	0.8087	0.7452	0.6527	0.5851	1.2355	0.8231
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.7721	1.7284	0.7537	0.9594	1.2414	1.4006	0.9768	0.5729
5	1.2840	1.2907	1.1997	0.7903	1.3327	1.5345	1.3358	0.9103
6	1.2877	2.0116	0.9247	1.1115	1.1339	1.2218	1.0134	0.8112
7	0.4406	1.9763	1.4687	0.9547	0.9395	0.8811	0.7965	1.2634
8	0.8247	1.3671	1.0001	0.8976	0.9962	1.0355	1.0461	0.8856
9	0.8247	1.3671	1.0001	0.8976	0.9962	1.0355	1.0461	0.8856

Table 4.5.2.2 Continued - Celtic Sea and Division VIIj

Fitted Selection Pattern

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	0.0988	0.2115	0.2369	0.1759	0.0840	0.1446	0.1051	0.1394
2	0.9776	0.7013	0.6769	0.5407	0.7614	0.7439	0.7256	0.5761
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0869	0.9422	1.2704	1.4889	1.3501	0.9702	0.7677	0.8496
5	0.6489	0.9339	1.0524	0.4895	0.9135	0.9538	0.3732	0.7694
6	0.7929	1.0133	1.5605	1.3285	0.7106	0.9433	1.0925	0.5038
7	1.0589	0.6113	2.0127	0.6436	0.7192	0.6894	1.3998	0.6293
8	0.9223	0.8345	1.2046	0.8654	0.8827	0.8546	0.8780	0.7036
9	0.9223	0.8345	1.2046	0.8654	0.8827	0.8546	0.8780	0.7036

Fitted Selection Pattern

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	0.0526	0.0425	0.0770	0.1167	0.0190	0.0153	0.0176	0.0568
2	0.6783	0.9925	0.7200	0.9501	0.5871	0.8301	0.5905	0.8443
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.2004	0.8480	1.6500	1.5636	1.2502	1.4088	0.4848	1.4095
5	1.0062	1.2202	1.5444	1.0800	1.2876	1.5221	0.9879	0.6706
6	1.6190	0.4166	2.6668	0.5653	0.5777	0.9820	0.8927	1.3085
7	0.7918	0.9084	0.7695	1.6991	0.2116	1.2260	0.6871	1.6162
8	0.9905	0.8947	1.2810	1.1249	0.7787	1.1148	0.7460	1.1074
9	0.9905	0.8947	1.2810	1.1249	0.7787	1.1148	0.7460	1.1074

Fitted Selection Pattern

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0228	0.0313	0.0238	0.0163	0.0398	0.0437	0.0437	0.0437
2	0.7073	1.1253	0.7233	0.9378	0.6526	0.7519	0.7519	0.7519
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.9849	1.0314	1.0283	1.2514	0.4486	1.1217	1.1217	1.1217
5	1.2207	1.1579	0.7686	0.5971	0.4829	1.1777	1.1777	1.1777
6	0.4704	1.1175	1.0494	0.6794	0.7581	1.2292	1.2292	1.2292
7	1.1462	0.3421	0.9399	1.5037	0.4680	0.9907	0.9907	0.9907
8	0.8991	0.9423	0.8889	0.9900	0.6278	1.0000	1.0000	1.0000
9	0.8991	0.9423	0.8889	0.9900	0.6278	1.0000	1.0000	1.0000

Table 4.5.2.2 Continued - Celtic Sea and Division VIIj

Fitted Selection Pattern

AGE	1998	1999	2000
1	0.0437	0.0437	0.0437
2	0.7519	0.7519	0.7519
3	1.0000	1.0000	1.0000
4	1.1217	1.1217	1.1217
5	1.1777	1.1777	1.1777
6	1.2292	1.2292	1.2292
7	0.9907	0.9907	0.9907
8	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000

Table 4.5.2.2 Continued – Celtic Sea and 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	321560	108124	75446	22978	0.3046	0.4352	89
1959	1058040	152934	80430	15086	0.1876	0.3518	88
1960	346360	118339	82284	18283	0.2222	0.3481	88
1961	250050	103562	77026	15372	0.1996	0.1867	128
1962	493140	128687	80718	21552	0.2670	0.4117	98
1963	279290	104407	74035	17349	0.2343	0.2699	99
1964	1035690	176865	93483	10599	0.1134	0.1729	97
1965	369350	153285	110891	19126	0.1725	0.2282	86
1966	661190	184881	113993	27030	0.2371	0.3144	103
1967	686470	187909	114628	27658	0.2413	0.4417	90
1968	849970	209982	122529	30236	0.2468	0.3713	100
1969	458730	176078	114821	44389	0.3866	0.5349	99
1970	242390	125588	88025	31727	0.3604	0.4891	99
1971	875680	172191	87048	31396	0.3607	0.6796	96
1972	274270	121789	77755	38203	0.4913	0.5907	100
1973	316400	96931	57258	26936	0.4704	0.6571	95
1974	137760	64725	41911	19940	0.4758	0.6100	97
1975	152680	52460	31815	15588	0.4899	0.5746	107
1976	207480	53349	29105	9771	0.3357	0.5652	94
1977	173960	49551	28955	7833	0.2705	0.3986	100
1978	135550	45903	29251	7559	0.2584	0.3586	91
1979	237400	55592	30016	10321	0.3438	0.4765	100
1980	145960	45538	27830	13130	0.4718	0.6818	107
1981	409790	70594	31666	17103	0.5401	0.8407	101
1982	662280	104907	45575	13000	0.2852	0.7428	101
1983	733060	130386	62739	24981	0.3982	0.6245	104
1984	568510	112829	62319	26779	0.4297	1.0051	99
1985	586940	117399	64262	20426	0.3179	0.4827	102
1986	536130	125033	70218	25024	0.3564	0.5310	100
1987	1030570	160842	79025	26200	0.3315	0.6990	99
1988	425530	121493	79052	20447	0.2587	0.3786	100
1989	522150	124550	73978	23254	0.3143	0.5083	100
1990	450320	111102	69680	18404	0.2641	0.3856	99
1991	186790	82908	58887	25562	0.4341	0.5019	101
1992	841410	123136	57900	21127	0.3649	0.7619	95
1993	335100	88130	55746	18618	0.3340	0.4650	100
1994	779020	127149	64847	19300	0.2976	0.3970	99
1995	789480	131655	71538	23305	0.3258	0.5458	100
1996	351020	98815	65210	18816	0.2885	0.4686	100
1997	349970	88252	55192	20496	0.3714	0.5791	99
1998	242800	69795	44608	18041	0.4044	0.5856	99
1999	447170	75556	38989	18485	0.4741	0.9489	99
2000	408510	68534	34818	17191	0.4937	0.9380	100

No of years for separable analysis : 6
Age range in the analysis : 1 . . . 9
Year range in the analysis : 1958 . . . 2000
Number of indices of SSB : 0
Number of age-structured indices : 1
Parameters to estimate : 29
Number of observations : 84

Conventional single selection vector model to be fitted.

Table 4.5.2.2 Continued - Celtic Sea and 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	1995	0.5222	14	0.3951	0.6902	0.4530	0.6020	0.5275
2	1996	0.4483	13	0.3412	0.5892	0.3900	0.5154	0.4527
3	1997	0.5540	13	0.4264	0.7199	0.4847	0.6332	0.5590
4	1998	0.5603	13	0.4331	0.7249	0.4913	0.6390	0.5652
5	1999	0.9079	12	0.7040	1.1709	0.7974	1.0337	0.9156
6	2000	0.8974	16	0.6454	1.2478	0.7585	1.0617	0.9102
Separable Model: Selection (S) by age								
7	1	0.0437	40	0.0197	0.0967	0.0291	0.0655	0.0474
8	2	0.7519	15	0.5543	1.0199	0.6436	0.8785	0.7611
	3	1.0000	Fixed : Reference Age					
9	4	1.1217	14	0.8394	1.4990	0.9675	1.3005	1.1341
10	5	1.1777	14	0.8950	1.5497	1.0238	1.3547	1.1893
11	6	1.2291	13	0.9461	1.5968	1.0755	1.4047	1.2402
12	7	0.9907	13	0.7589	1.2934	0.8647	1.1351	0.9999
	8	1.0000	Fixed : Last true age					
Separable model: Populations in year 2000								
13	1	408512	96	61811	2699857	155872	1070635	649806
14	2	158112	21	102851	243062	126964	196900	161963
15	3	32626	18	22670	46954	27095	39285	33194
16	4	20175	16	14619	27842	17117	23778	20449
17	5	9448	16	6892	12952	8044	11098	9572
18	6	10586	17	7523	14897	8893	12602	10748
19	7	4926	19	3387	7165	4069	5964	5017
20	8	1261	21	835	1905	1022	1557	1289
Separable model: Populations at age								
21	1995	4780	29	2674	8544	3554	6428	4994
22	1996	4020	23	2545	6350	3184	5076	4131
23	1997	2249	20	1512	3344	1837	2753	2295
24	1998	1284	18	899	1833	1070	1540	1305
25	1999	4062	17	2894	5701	3417	4829	4123

Age-structured index catchabilities

FLT02: celtic combined acc data (Catch:

Linear model fitted. Slopes at age :

26	2 Q	.3054E-02	12	.2711E-02	.4410E-02	.3054E-02	.3914E-02	.3484E-02
27	3 Q	.3336E-02	12	.2963E-02	.4809E-02	.3336E-02	.4271E-02	.3804E-02
28	4 Q	.2851E-02	12	.2531E-02	.4113E-02	.2851E-02	.3652E-02	.3251E-02
29	5 Q	.2363E-02	12	.2097E-02	.3418E-02	.2363E-02	.3032E-02	.2698E-02

Table 4.5.2.2 Continued - Celtic Sea and Division VIIj

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1995	1996	1997	1998	1999	2000
1	-0.1761	-0.2146	-0.3194	0.4482	0.2587	0.0000
2	-0.0005	-0.1337	-0.0059	0.0957	-0.1061	0.1269
3	0.0078	-0.1876	-0.0964	0.1104	0.0735	0.0640
4	0.3047	-0.3307	-0.0292	-0.1088	-0.1911	-0.0184
5	-0.1388	0.2498	0.1244	-0.2204	-0.3257	-0.1236
6	-0.0760	0.0839	-0.2736	0.0410	-0.1899	-0.0869
7	-0.0823	0.1772	0.1451	-0.1749	-0.0449	-0.1816
8	0.0000	0.0823	-0.1012	0.1247	-0.1443	-0.0797

AGE-STRUCTURED INDEX RESIDUALS

FLT02: celtic combined acc data (Catch:

Age	1990	1991	1992	1993	1994	1995	1996	1997
2	-0.236	-0.056	0.332	-0.011	-0.369	0.254	0.502	*******
3	-0.268	-0.569	0.086	0.221	-0.280	0.349	0.024	*******
4	-0.203	-0.171	-0.106	0.603	-0.962	0.024	0.103	*******
5	0.173	0.102	-0.135	-0.185	-0.596	-0.344	0.037	*******

FLT02: celtic combined acc data (Catch:

Age	1998	1999	2000
2	-0.172	*******	-0.244
3	0.439	*******	-0.004
4	0.729	*******	-0.019
5	1.016	*******	-0.068

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1995 to 2000	
Variance	0.0436
Skewness test stat.	-1.6803
Kurtosis test statistic	-0.5415
Partial chi-square	0.1104
Significance in fit	0.0000
Degrees of freedom	23

Table 4.5.2.2 Continued - Celtic Sea and 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	0.0556	0.0660	0.1495	0.1254
Skewness test stat.	0.5880	-0.4124	-0.4118	1.4346
Kurtosis test statisti	-0.6839	-0.5206	0.0802	0.7497
Partial chi-square	0.0814	0.1097	0.3242	0.3003
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	9	9	9	9
Degrees of freedom	8	8	8	8
Weight in the analysis	0.6250	0.6250	0.6250	0.6250

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	6.4794	84	29	55	0.1178
Catches at age	1.4039	48	25	23	0.0610
Aged Indices					
FLT02: celtic combined acc data (Catch	5.0754	36	4	32	0.1586

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	2.9843	84	29	55	0.0543
Catches at age	1.0017	48	25	23	0.0436
Aged Indices					
FLT02: celtic combined acc data (Catch	1.9826	36	4	32	0.0620

Table 4.7.1 Input data for short term predictions - Celtic Sea and Division VIIj

MFDP version 1a
Run: stp TAC plus F multiplier 1
Time and date: 16:15 21/3/01
Fbar age range: 2-7

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	402741	1	0.5	0.2	0.5	0.094	0.039	0.094
2	144510	0.3	1	0.2	0.5	0.117	0.675	0.117
3	59654	0.2	1	0.2	0.5	0.150	0.897	0.150
4	10889	0.1	1	0.2	0.5	0.166	1.007	0.166
5	6671.8	0.1	1	0.2	0.5	0.179	1.057	0.179
6	2971.7	0.1	1	0.2	0.5	0.185	1.103	0.185
7	3179.3	0.1	1	0.2	0.5	0.199	0.889	0.199
8	1832.7	0.1	1	0.2	0.5	0.208	0.897	0.208
9	863.4	0.1	1	0.2	0.5	0.219	0.897	0.219

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	402741	1	0.5	0.2	0.5	0.094	0.039	0.094
2	.	0.3	1	0.2	0.5	0.117	0.675	0.117
3	.	0.2	1	0.2	0.5	0.150	0.897	0.150
4	.	0.1	1	0.2	0.5	0.166	1.007	0.166
5	.	0.1	1	0.2	0.5	0.179	1.057	0.179
6	.	0.1	1	0.2	0.5	0.185	1.103	0.185
7	.	0.1	1	0.2	0.5	0.199	0.889	0.199
8	.	0.1	1	0.2	0.5	0.208	0.897	0.208
9	.	0.1	1	0.2	0.5	0.219	0.897	0.219

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	402741	1	0.5	0.2	0.5	0.094	0.039	0.094
2	.	0.3	1	0.2	0.5	0.117	0.675	0.117
3	.	0.2	1	0.2	0.5	0.150	0.897	0.150
4	.	0.1	1	0.2	0.5	0.166	1.007	0.166
5	.	0.1	1	0.2	0.5	0.179	1.057	0.179
6	.	0.1	1	0.2	0.5	0.185	1.103	0.185
7	.	0.1	1	0.2	0.5	0.199	0.889	0.199
8	.	0.1	1	0.2	0.5	0.208	0.897	0.208
9	.	0.1	1	0.2	0.5	0.219	0.897	0.219

Input units are thousands and kg - output in tonnes

Table 4.7.2 Single option prediction table with TAC constraint - Celtic Sea and Division VIIj

MFDP version 1a
Run: stp TAC plus F multiplier 1
Time and date: 16:15 21/3/01
Fbar age range: 2-7

Year:	2001	F multiplier	1.4234	Fbar:	1.3351				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0558	13871	1299	402741	37723	201371	18862	120783	11313
2	0.9604	78893	9257	144510	16956	144510	16956	102644	12044
3	1.2773	39805	5971	59654	8948	59654	8948	41808	6271
4	1.4328	7981	1325	10889	1808	10889	1808	7777	1291
5	1.5043	4998	896	6672	1196	6672	1196	4697	842
6	1.57	2268	420	2972	550	2972	550	2065	382
7	1.2655	2194	437	3179	634	3179	634	2348	468
8	1.2773	1271	264	1833	381	1833	381	1350	280
9	1.2773	599	131	863	189	863	189	636	139
Total		151880	20000	633313	68385	431942	49523	284109	33031

Year:	2002	F multiplier	1	Fbar:	0.938				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0392	9812	919	402741	37723	201371	18862	121184	11351
2	0.6748	60402	7087	140124	16441	140124	16441	105381	12365
3	0.8974	22324	3349	40973	6146	40973	6146	30983	4647
4	1.0066	8290	1376	13616	2260	13616	2260	10590	1758
5	1.0569	1473	264	2351	422	2351	422	1810	325
6	1.103	860	159	1341	248	1341	248	1023	189
7	0.8891	316	63	559	112	559	112	445	89
8	0.8974	461	96	812	169	812	169	645	134
9	0.8974	386	85	680	149	680	149	541	118
Total		104324	13397	603198	63670	401828	44808	272603	30976

Year:	2003	F multiplier	1	Fbar:	0.938				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0392	9812	919	402741	37723	201371	18862	121184	11351
2	0.6748	61412	7206	142468	16716	142468	16716	107143	12571
3	0.8974	28803	4321	52867	7930	52867	7930	39977	5997
4	1.0066	8326	1382	13675	2270	13675	2270	10636	1766
5	1.0569	2820	506	4502	807	4502	807	3467	622
6	1.103	474	88	739	137	739	137	564	104
7	0.8891	227	45	403	80	403	80	321	64
8	0.8974	118	25	208	43	208	43	165	34
9	0.8974	312	68	550	120	550	120	437	96
Total		112306	14559	618153	65828	416783	46966	283894	32605

Input units are thousands and kg - output in tonnes

Table 4.7.3 Short term prediction with management options - Celtic Sea and Division VIIj

MFDP version 1a
Run: stp TAC plus F multiplier 1
Celtic Sea 2001Projection index file Wednesday 21st March 2001.
Time and date: 16:15 21/3/01
Fbar age range: 2-7

2001				
Biomass	SSB	FMult	FBar	Landings
68385	33031	1.4234	1.3351	20000

2002					2003	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
63670	34348	0	0	0	79493	48877
.	33986	0.1	0.0938	1807	77620	46552
.	33631	0.2	0.1876	3487	75885	44424
.	33281	0.3	0.2814	5050	74277	42475
.	32936	0.4	0.3752	6506	72785	40687
.	32597	0.5	0.469	7862	71401	39045
.	32262	0.6	0.5628	9126	70116	37537
.	31933	0.7	0.6566	10306	68924	36149
.	31609	0.8	0.7504	11407	67816	34871
.	31290	0.9	0.8442	12436	66786	33692
.	30976	1	0.938	13397	65828	32605
.	30667	1.1	1.0317	14297	64937	31599
.	30362	1.2	1.1255	15139	64107	30669
.	30062	1.3	1.2193	15929	63335	29807
.	29767	1.4	1.3131	16669	62615	29007
.	29476	1.5	1.4069	17363	61943	28264
.	29190	1.6	1.5007	18016	61317	27573
.	28908	1.7	1.5945	18629	60732	26929
.	28630	1.8	1.6883	19207	60186	26328
.	28357	1.9	1.7821	19750	59675	25766
.	28087	2	1.8759	20263	59197	25241

Input units are thousands and kg - output in tonnes

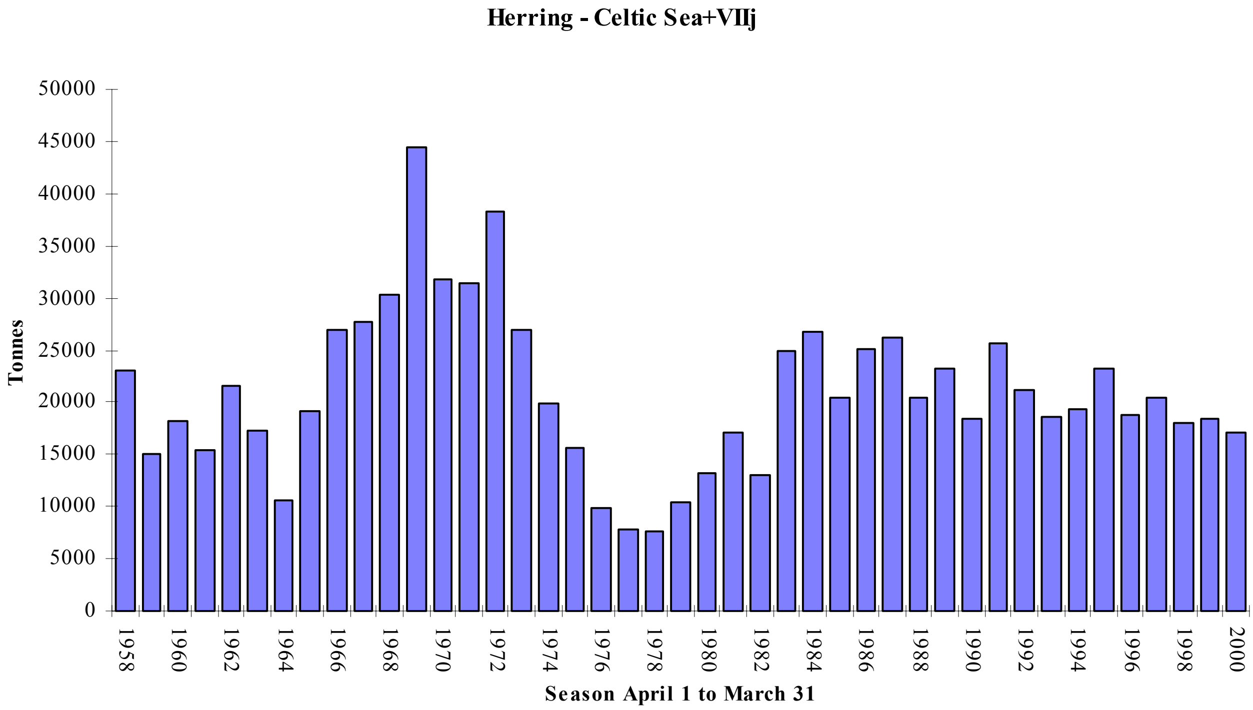
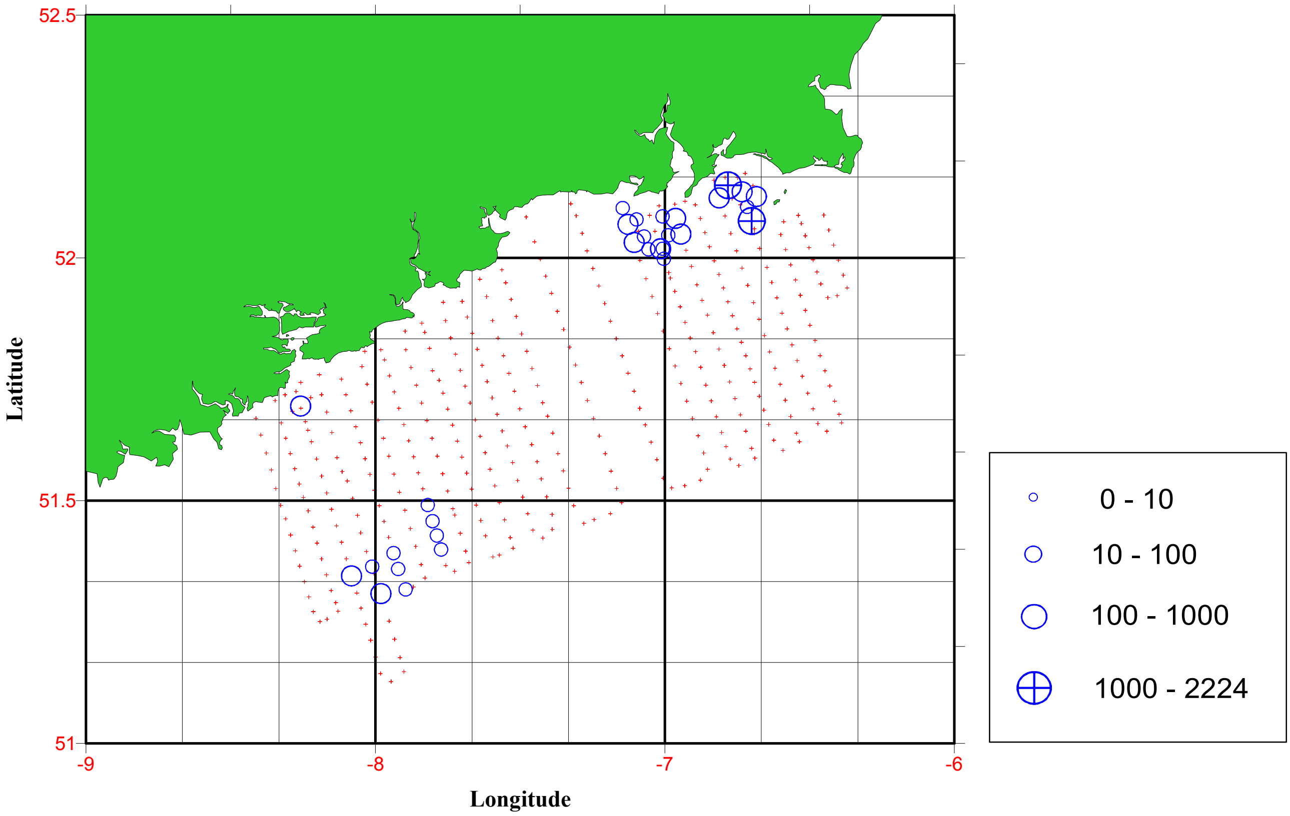


Figure 4.2.1. Herring catches in Celtic Sea and Division VIIj: 1958–2000.

Figure 4.4.1. Post plot showing distribution of herring S_A values observed during January survey in the Celtic Sea.

The distribution of values indicates that the stock may not have been contained at the southwestern edge of the survey area



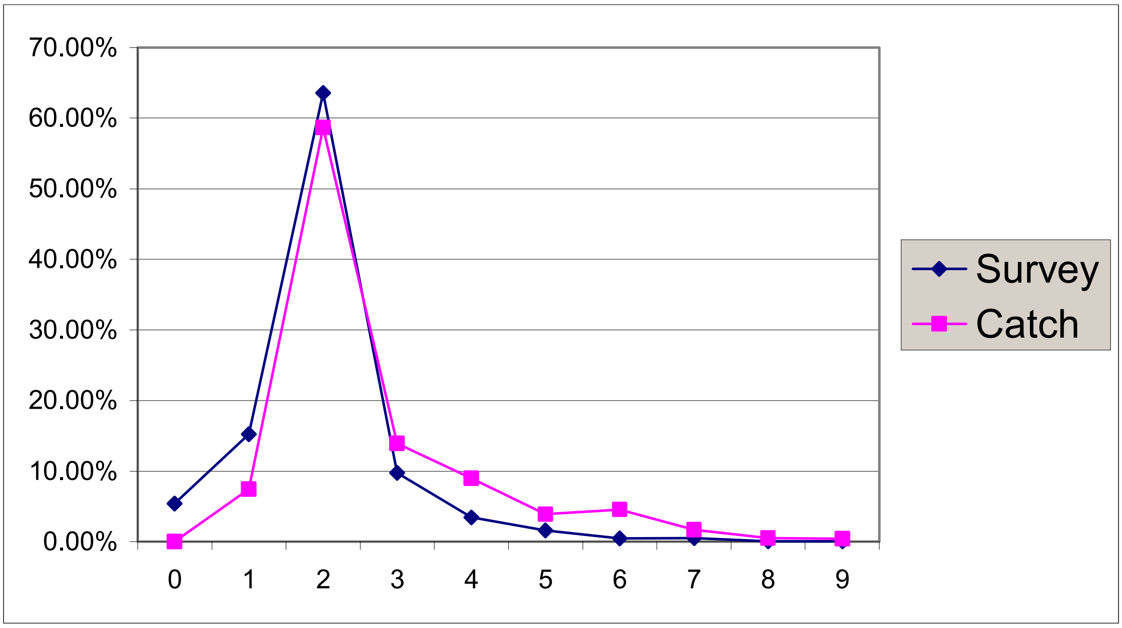


Figure 4.5.1.1. Comparison of age distribution of herring in population from acoustic survey and those from the commercial catch. Celtic Sea and Division VIIj.

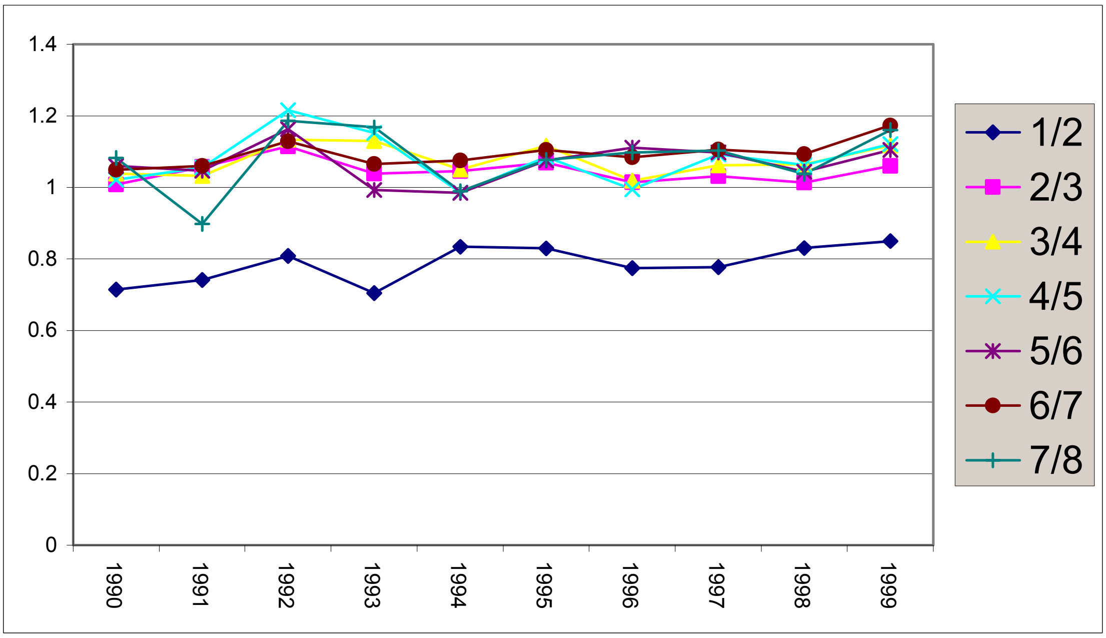


Figure 4.5.1.2. Z at age calculated from the log catch ratios. Celtic Sea and Division VIIj.

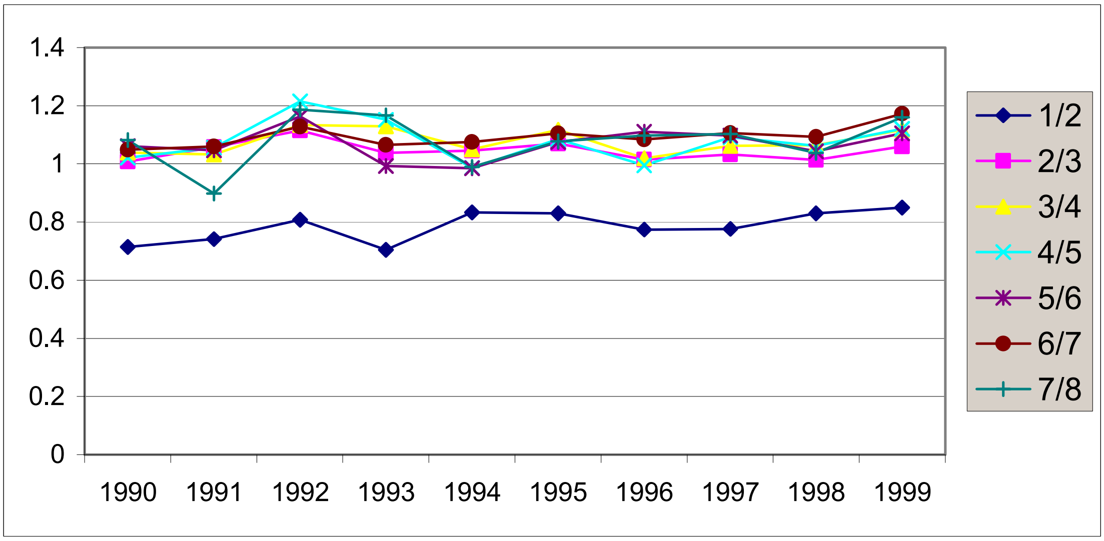


Figure 4.5.1.3. Z at age calculated from log survey population ratios. Celtic Sea and Division VIIj.

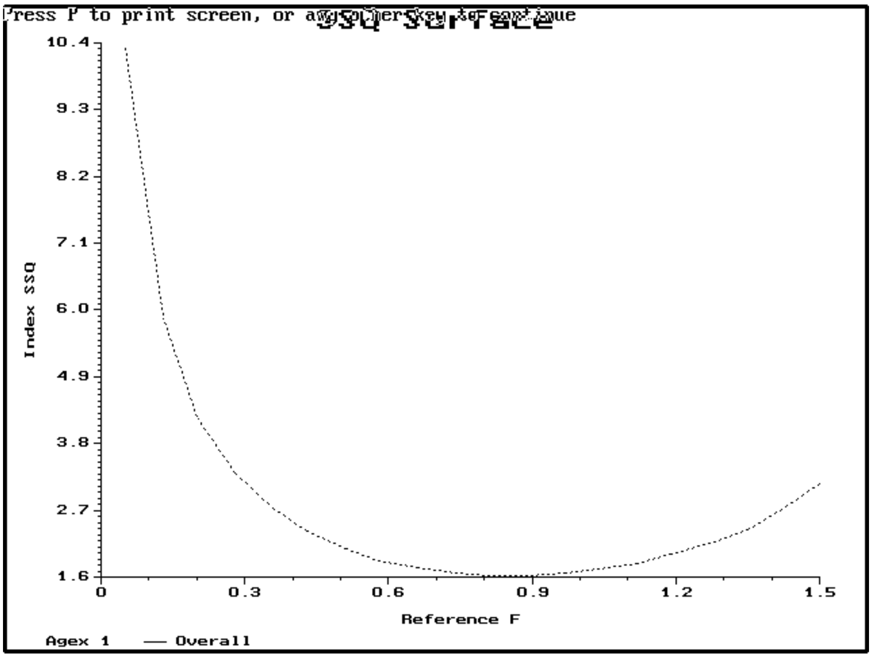


Figure 4.5.2.1 Herring in Celtic Sea and Division VIIj. SSQ surface for the baseline assessment.

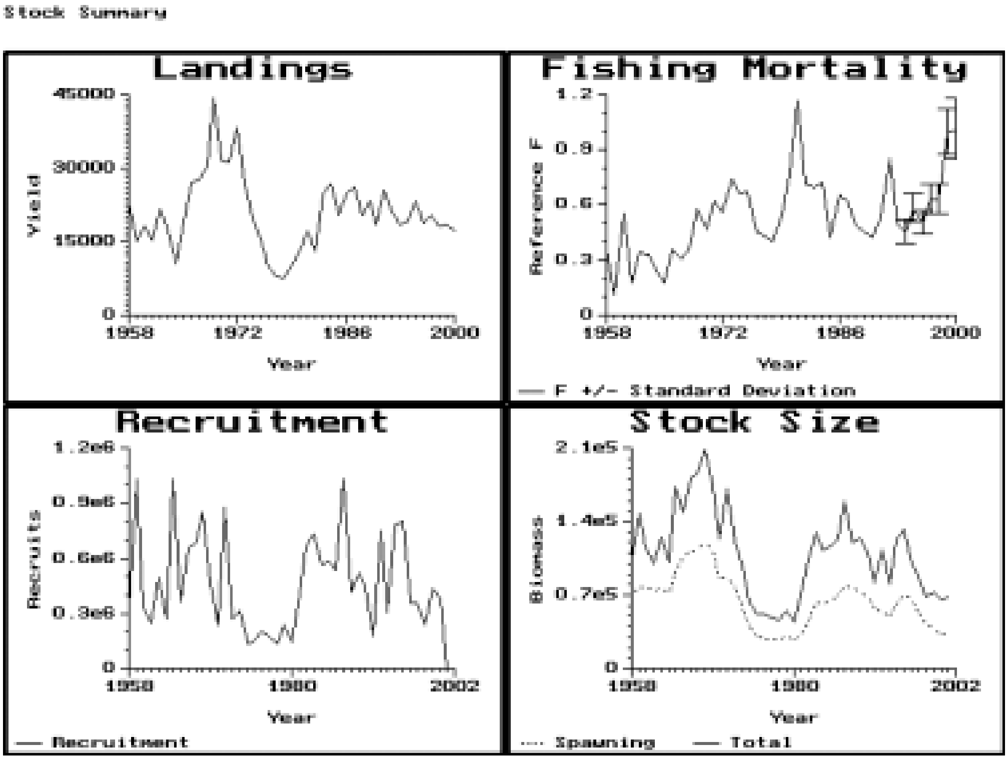


Figure 4.5.2.2 Herring in Celtic Sea and Division VIIj. Results of baseline assessment. Summary of estimates of landings, fishing mortality at age 3, recruitment at age 1, stock size on 1 January and spawning stock size at spawning time.

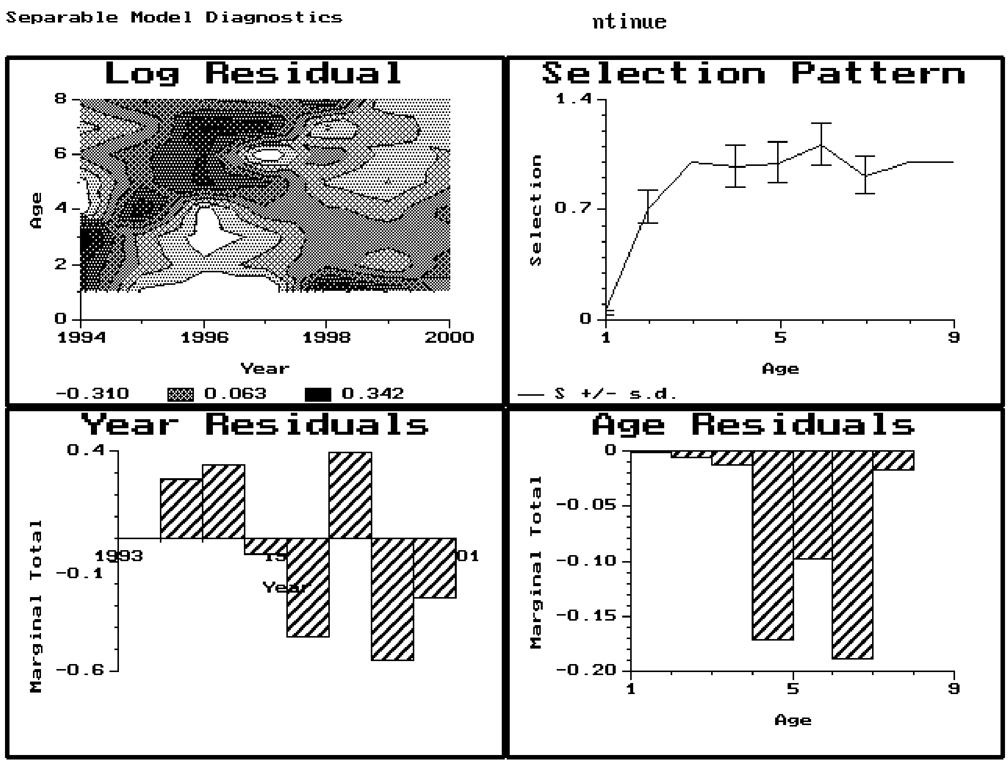


Figure 4.5.2.3. Herring in Celtic Sea and Div.VIIj Results of baseline assessment. Selection pattern diagnostics. Top left, contour plot of selection pattern residuals. Top right, estimated selection (relative to age 3) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

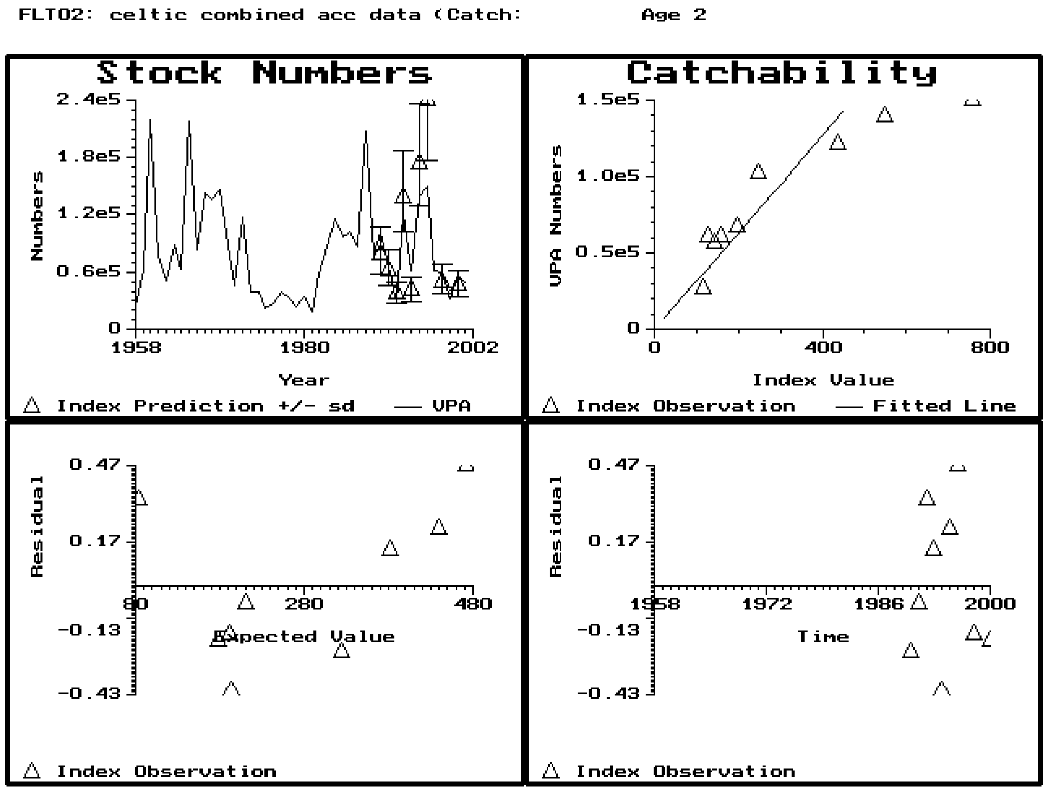


Figure 4.5.2.4. Herring in Celtic Sea and Division VIIj Results of baseline assessment. Diagnostics of the fit of the acoustic survey index at age 2 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

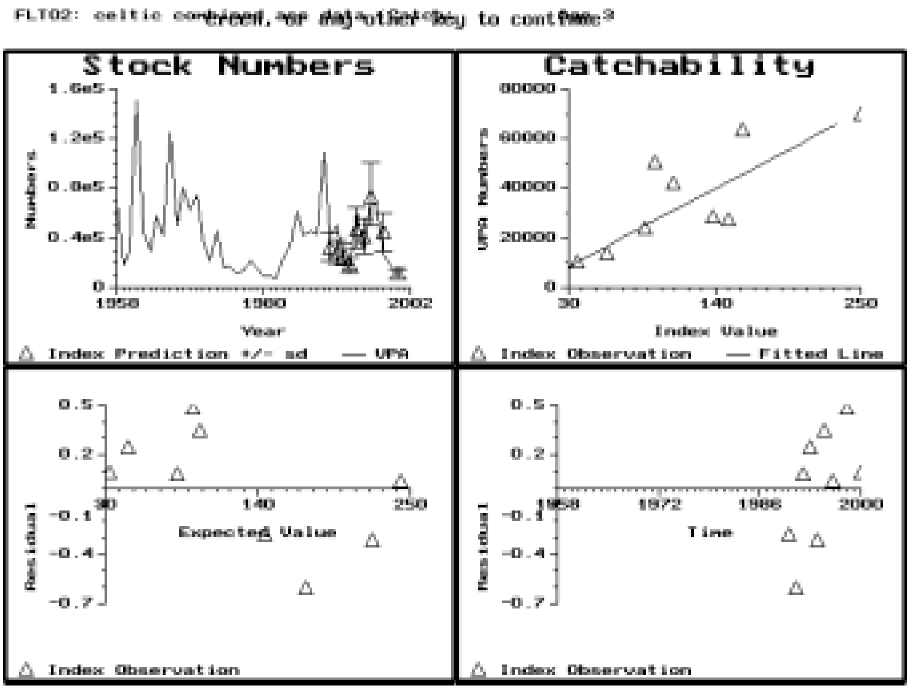


Figure 4.5.2.5. Herring in Celtic Sea and Division VIIj Results of baseline assessment. Diagnostics of the fit of the acoustic index at age 3 against the estimated populations at age 1-ring. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and 1-ringer survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

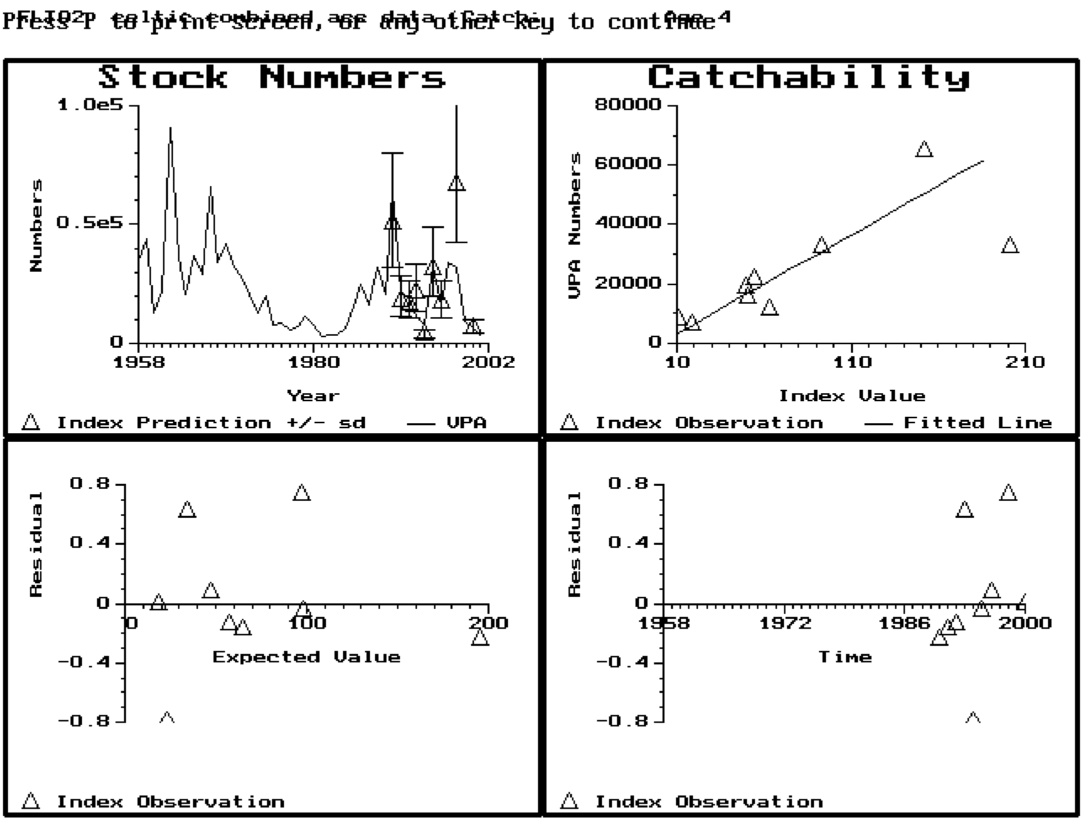


Figure 4.5.2.6. Herring in Celtic Sea and Division VIIj Results of baseline assessment. Diagnostics of the fit of the acoustic survey index at age 4 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

FLT02: celtic combined acc data (Catch: Age 5

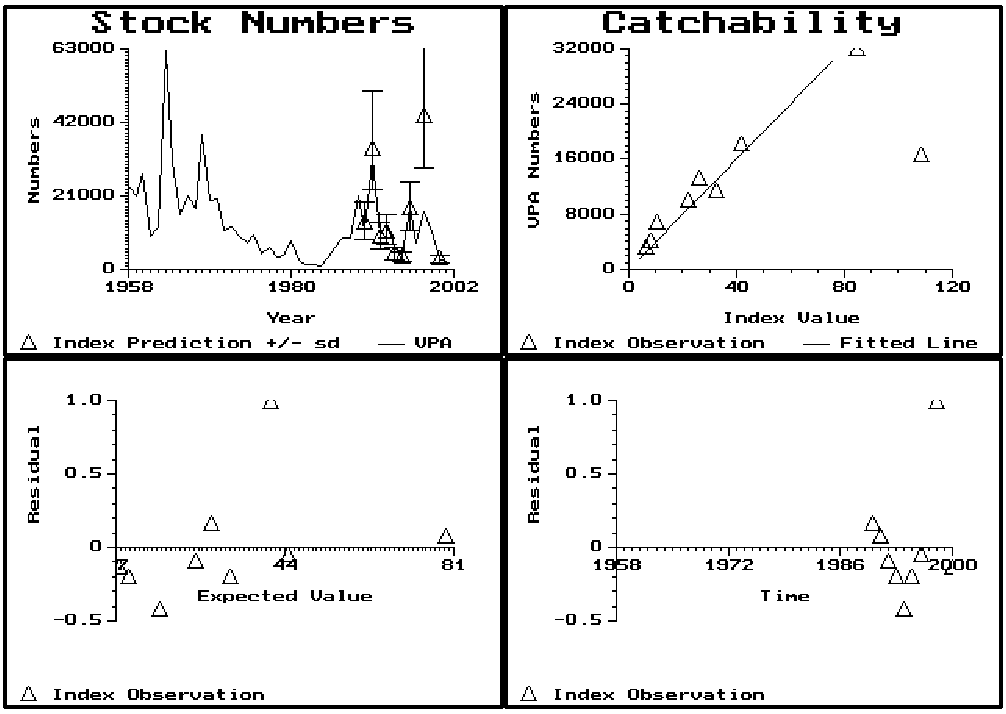
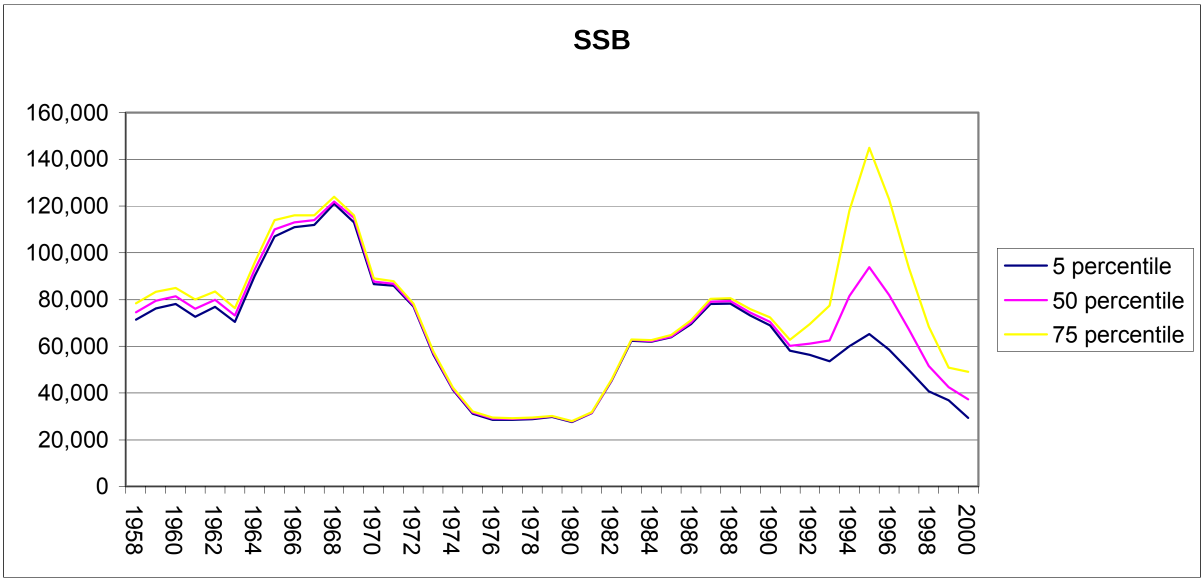
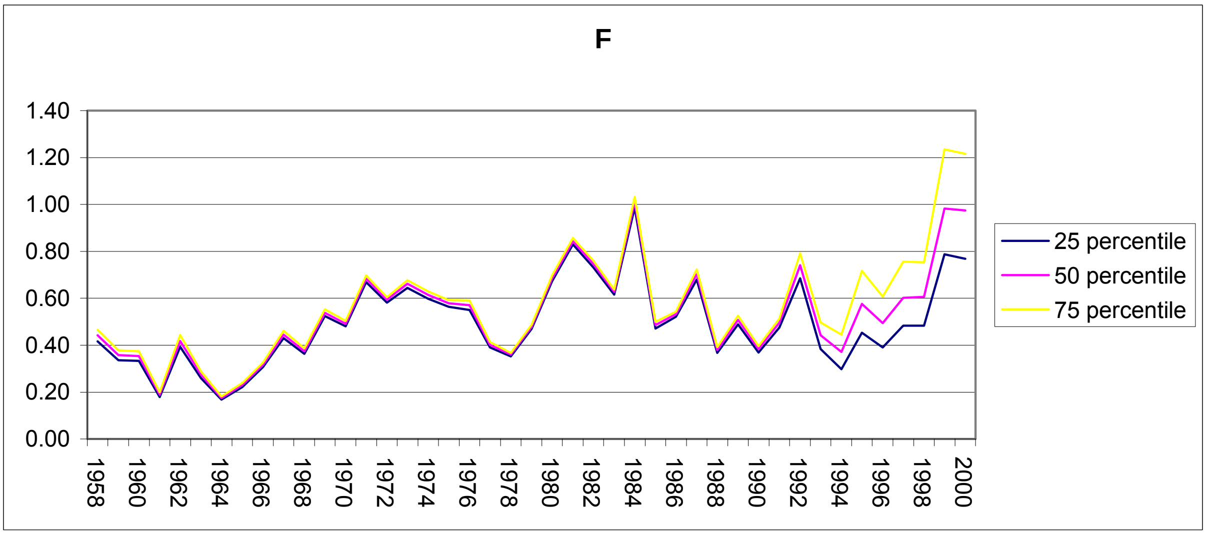


Figure 4.5.2.7. Herring in Celtic Sea and Division VIIj Results of baseline assessment. Diagnostics of the fit of the acoustic survey index at age 5 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles =/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.





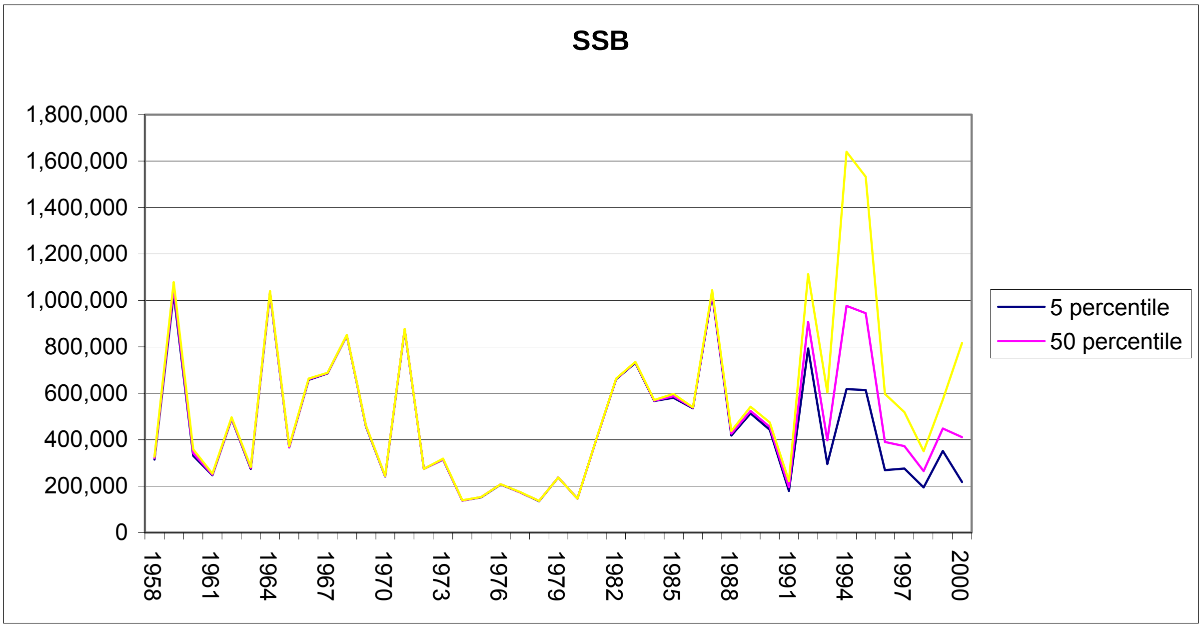


Figure 4.5.2.8 SSB, F and Recruitment stock trajectories with 5 50 & 75 percentiles - Celtic Sea and Division VIIj

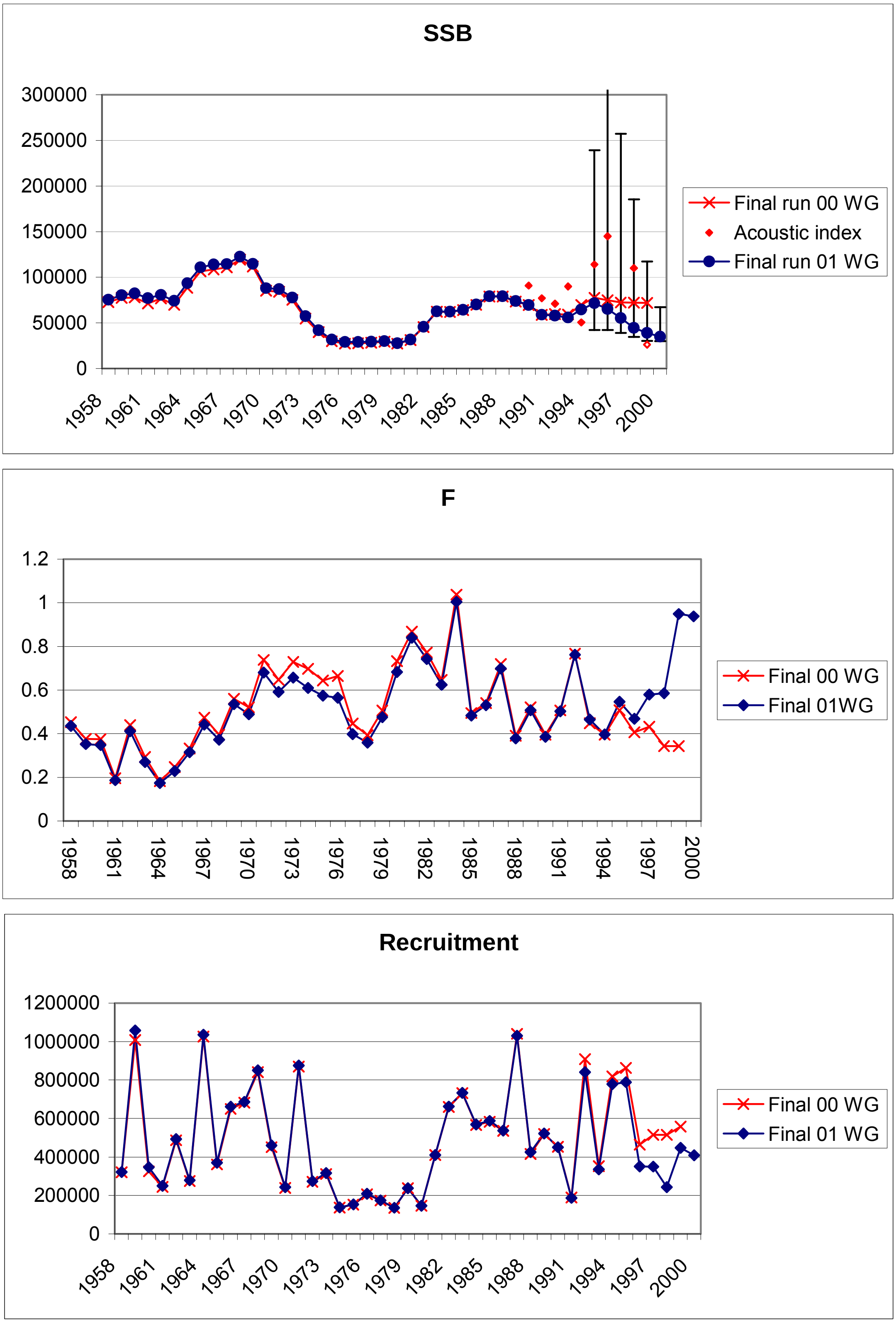
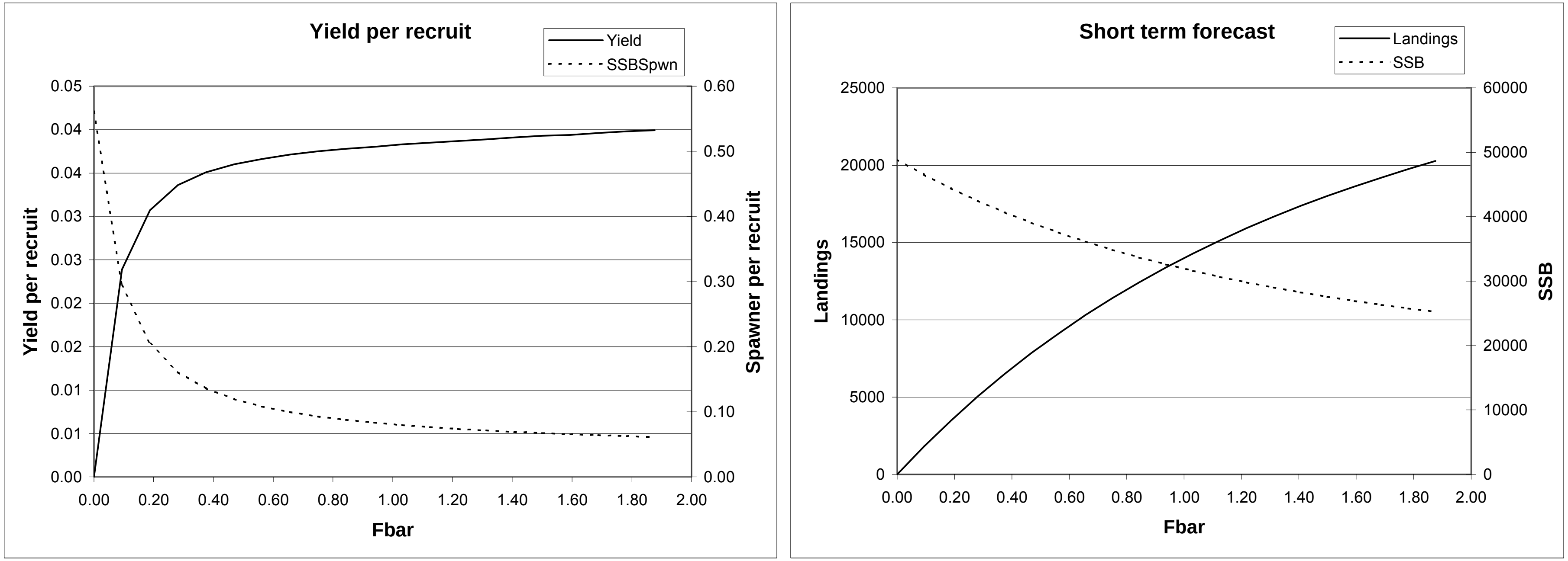


Figure 4.5.3.1 Stock trajectories from this years assessment compared to the final run in the 2000 WG The error bars around SSB estimates relate to 5 and 95 percentiles as calculated from this years assessment. The open diamond in the SSB plot is the SSB estimate from the 1999 survey which is not used in the index. Celtic Sea and Division VIIj.



MFYPR version 2a
Run: irls ypr
Time and date: 17:16 21/3/01

Reference point	F multiplier	Absolute F
Fbar(2-7)	1.0000	0.9380
FMax	>=1000000	
F0.1	0.1807	0.1695
F35%SPR	0.2148	0.2015
Flow	0.0640	0.0600
Fmed	0.3167	0.2970
Fhigh	1.2652	1.1867

Weights in kilograms

Celtic Sea 2001Projection index file Wednesday 21st March 2001.
Run: stp TAC plus F multiplier 1
Celtic Sea 2001Projection index file Wednesday 21st March 2001.
Time and date: 16:15 21/3/01
Fbar age range: 2-7

Input units are thousands and kg - output in tonnes

Figure 4.7.1. 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 2000 and 2001

ACFM reported in 2000 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 2001 should not exceed the average of the 1991–1999 period, which was about 30,000 t.

The agreed TAC for 2001 is 36,360 t compared with a TAC in 2000 of 42,000 t.

There are no explicit management objectives for this stock and because of uncertainties about the historical catch data, the size of the biomass, and about estimates of recruitment and fishing mortality, no biological reference points have been proposed for this stock.

5.1.2 The fishery

Catches are taken from this area by three fisheries. The Scottish domestic pair trawl fleet operates in shallower, coastal areas, principally fishing in the Minches and around the Island of Barra in the south; younger herring are found in these areas. The Scottish and Norwegian purse seine fleets target herring mostly in the northern North Sea, but also operate in the northern part of VIa(N). An international freezer-trawler fishery has historically operated in deeper water near the shelf edge where older fish are distributed; these vessels are mostly registered in the Netherlands, Germany, France and England. 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 with the intention of improving reporting accuracy. Under this regulation, Scottish vessels fishing for herring are required to hold a license either to fish in the North Sea or in the west of Scotland area (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 1999a) 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 - 2000 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 2000, the preliminary reports of official catches corresponding to the VIa(N) herring stock unit total 37,789 t compared with the TAC of 42,000 t. The Working Group's estimates of area misreported catches are 14,626 t. No herring has been reported as discarded.

The Working Group’s best estimate of removals from the stock in 2000 is 23,163 t. Details of estimated national catches from 1980 to 2000 are given in Table 5.1.1.

5.1.4 Age-composition of commercial catches

Age composition data for the commercial catches for 2000 were available from Scotland (quarters 3 and 4) and the Netherlands (quarter 3). The number of samples used to allocate an age-distribution for the Scottish catches increased from 34 in 1999 to 36 in 2000. A single sample was again available from the offshore freezer-trawl fishery comprising 75 fish, an increase of 50 fish from 1999. 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 and Netherlands samples indicated that there was no difference in the age structure of the catch for these fleets in 2000.

Unsampled catches were allocated a mean age-structure (weighted by the sampled catch) of all sampled fleets in the same quarter, or in adjacent quarters if no samples were available in the corresponding quarter. The allocation of age-structures to unsampled catches, and the calculation of total international catch at age and mean weight at age in the catches were made using the 'sallocl' programme (Patterson, 1998).

New and historic catch in number at age information is given in Table 5.1.3.

5.1.5 Larvae surveys

Larvae surveys for this stock have been discontinued since 1994. The historical time-series will however be used in assessment model fitting and has been reproduced for convenience (Table 5.1.4). Documentation of this survey time-series is given in ICES (1994b).

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 2000 acoustic survey was carried out from 7-26 July using a chartered commercial fishing vessel (MFV Christina S.). The total biomass estimate obtained was similar to that of the previous year (500,500 t this year compared to 419,500 t in 1999). 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 2001). Estimates of abundance by age and in aggregate spawning stock biomass for 2000 and for previous years are given in Table 5.1.5.

5.1.7 Mean weights at age

Weights at age in the catches and from acoustic surveys are given in Table 5.1.6. Due to the different timing of the acoustic survey in 1997 the estimates of weight at age in the stock in that year are not consistent with previous estimates (Table 5.1.6). 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 2000 are generally close to the long-term average, except for 8 ring which are high.

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. The 2000 ogive is slightly lower than the mean.

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 1999, 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 acoustic survey (as above) and the larval survey from 1976-1991 and 1993 (Section 5.1.5).

The appropriate usage of catch data and period of separable constraint were investigated in detail as these were found to have a large influence on the assessment. Assessments were run with different periods of separable constraint, from four to ten years. SSB and F estimates from these assessments were consistent for periods of seven years and less, and for eight to ten years. Examination of residuals, using a ten year separable period, indicated that there was a distinct change in the pattern of catch at age from 1993 to 1994. Also, there was evidence of changes after 1993, particularly in the catch of 1 ring herring. ICA provides for a choice of two periods of separable constraint. To allow flexibility of choice in the period 1994 onward a seven year period was selected for investigation using an extensive range of options: 3/4 years, 4/3 years, both with abrupt and gradual change between selection periods. The patterns of residuals for the separable period were the criteria used for judging the usefulness of the fit. Preference was given to the model that gave residuals that were without trend for both the catch and the acoustic survey data.

The influence of the 1 ring catch caused large positive residuals between the stock and the acoustic survey at ages 2 and 3 in the final two years. Down-weighting of 1 ring catch provided more stability in the assessment and reduced these positive residuals. As the SSB estimate is heavily dependent on the values for 2 and 3 ring fish it was considered to be important to avoid a poor fit at these ages. The relative catch of 1 ring herring is thought to be a poor indication of abundance of that group as the fishery is directed at the older ages, and the catch of young herring reflects its abundance poorly. (In addition 1 ring herring in the acoustic survey were down-weighted, as in previous assessments, because the survey does not cover this year class in the population). The use of two periods of separable constraint provided a much better fit to the catch data than one fixed period, suggesting that there might be some changes in the pattern of catch over time. However, the residuals between stock estimates and the acoustic survey of 2 and 3 ring herring in the last years were large, implying that the two-period separable model is inappropriate. Because of the poor quality of the age-structure information from the catch it may be that we cannot differentiate between noise and pattern. A fixed seven year period provided a good pattern of residuals at age and over years for both the catch and the acoustic survey with only a small rise in residuals on the acoustic survey in older age classes (7 and 8 ring) in the last years. Effectively the choice of this model assumes that the variability in the age structure in the catch is due largely to poor sampling, and this seems a reasonable assumption given the poor sampling in some years. This option of a seven year fixed separable constraint with 1 ring down-weighted in the catch and the acoustic survey was used for the final assessment.

5.1.10 Stock assessment

The run log for the assessment is shown in Table 5.1.8. The period for the separable constraint is 7 years. The catch and survey data were down-weighted for 1 ring herring. The input data are given in Tables 5.1.9 to 5.1.15. The output data are given in Tables 5.1.16 to 5.1.25. The assessment results in an SSB for 2000 of 93,064 tonnes and a mean fishing mortality (ages 3-6) of 0.18 (Table 5.1.21). The model diagnostics (Tables 5.1.22 to 5.1.25 and Figs. 5.1.1 to 5.1.13) 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 7 and 8). The acoustic survey residuals are larger than the catch model residuals. The model used was chosen because the residual patterns were relatively free of structure and the fit to the acoustic survey data was better than the model using two selection periods. However, the statistical fit to the chosen model was a little poorer (after accounting for changes in the number of model parameters).

The assessment may be an underestimate of SSB for VIa(N) as the catchability factors from the assessment imply that the VIa(N) acoustic survey is a little more than half as efficient at estimating abundance as the North Sea acoustic survey. There is no obvious reason as to why this should be the case as the two surveys are conducted by the same research group in July each year, the fish are at the same maturity stage, are a similar size and occupy similar water depths. The difference implies that there may be an overall underestimate of SSB (and consequent overestimation of F) for recent years. The reason for this may be due to the difficulty of estimating SSB from a catch at age model when the stock is lightly exploited. Figure 5.1.14 shows the trajectories of 25, 50 and 75 percentiles from the estimates of historical uncertainty of F, SSB and recruits produced in the final assessment. These are based on 1000 samples. In spite of this there is high variability, even of the 75^{th} percentile.

5.1.11 Projections

Deterministic short-term projections

Area misreporting of the current TAC (36,360 t) for VIa(N) is approximately 52%. This proportion is taken in other areas leading to a low F of 0.18 in area VIa(N). ICES advice in 2000 was for a catch of 30,000 t. For deterministic short-term projections two scenarios are presented: status quo F, which is consistent with the current level of misreporting, and a catch constraint of approximately 30,000 t, which is consistent with the ICES advice for 2001.

Scenario	2001	2002	2003
1 – status quo F	$F_{2001} = F_{2000} = 0.18$	$F_{2001} = F_{2000} = 0.18$	$F_{2001} = F_{2000} = 0.18$
2 – ICES advice for 2001	$Catch_{2001}$ = 30,000 t	$F = 1.4 * F_{2000}$ Catch ~ Catch 2001 ~ 30,000 t	$F = 1.4 * F_{2000}$ Catch ~ Catch 2001 ~ 30,000 t

Input data are stock numbers in 2001 from the 2001 ICA assessment (section 5.1.10, Table 5.1.18), with geometric mean replacing recruitment at 1 and 2 ring in 2001 and 1 ring in 2000. 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 large estimate of 1 ring numbers in the final year of the assessment (2000) and consequently a high value in the survivors (January 1st 2001) which are taken forward into the projection. These values were replaced by geometric mean values. The selection pattern used is the fishery in 2000 (Table 5.1.20). 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., 1998 - 2000) (Table 5.1.26).

The results of the short-term predictions can be seen in Tables 5.1.27 – 30. Tables 5.1.27 and 29 show single option predictions for 2002 and 2003 for the two scenarios respectively. Tables 5.1.28 and 30 show the multiple options for 2002. The short-term forecast for landings and SSB at different levels of F under scenario 1 is shown in Figure 5.1.15. Under status quo F (scenario 1) SSB will rise to approximately 127,000 t in 2003. Under scenario 2 (ICES advice) SSB is anticipated to rise from around 100,000 t to 110,000 t in 2003. A catch of 36,000 t (the current TAC) in 2002 is consistent with no change in SSB for 2002 - 2003.

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 0.17 and 0.30 respectively. These may be compared with the current F (2001 assessment) of 0.18. The yield per recruit relationship suggests that at geometric mean recruitment (896 million) a yield of approximately 30,000 t is possible at F = 0.2.

5.1.12 Comments on the assessment

In contrast to the assessment presented last year, the down-weighting of 1 ring herring in the catch data, in addition to the survey data, has allowed the selection of a suitable separable period. The current assessment is less sensitive to this aspect of the model choice than in previous years. However, the assessment provided here is subject to a degree of uncertainty due to the variable quality of the catch data. The age composition of the catch is poorly estimated with very few samples. However, in the most recent year (2000) the samples obtained indicate that the different fleets are currently fishing on similar ages of herring. The survey data are also quite noisy although in the last three years the survey has shown signs of stabilising due to improved knowledge of the spatial distribution of herring. The extent of misreporting is still widespread but information is improving in this respect also, and some satellite data have been used to improve knowledge of the movement of vessels. In addition, recent enquires suggest that the misreporting in 1997, which was previously uncertain, now appears to be similar to that for 1996 and 1998. A comparison between the acoustic survey used to tune this stock and the survey used in the North Sea assessments suggests that the VIa(N) assessment may be an underestimate of SSB for the stock. This is because the catchability factors from the assessment imply that the VIa(N) acoustic survey is a little more than half as efficient at estimating abundance as the North Sea acoustic survey. There is no obvious reason as to why this should be the case as the two surveys are conducted by the same research group in July each year, the fish are at the same maturity stage, are a similar size and occupy similar water depths.

5.1.13 Management considerations

The assessment presented here is subject to a degree of uncertainty due to the highly variable nature of the input data. However, even though the SSB may be uncertain, this assessment provides a basis for assuming that the stock is currently lightly exploited and able to sustain the current fishery. As a result of the apparent survey performance differences, wherein the VIa(N) survey appears to be a little more than half as efficient at estimating herring abundance as the North Sea survey, the assessment is more likely to be an under-estimate than an over-estimate. In the future it is hoped that improvements in satellite monitoring will reduce area misreporting and improve information on the fishery.

In the absence of any agreed management reference points for this stock the short-term predictions provide a basis for management advice. Based on the point estimate of F_{2000} (F = 0.18) the short-term predictions and the yield per recruit results suggest that the ICES advice of 2000 for a catch of 30,000 t should not lead to a decrease in SSB in the short term, i.e., 2002 and 2003. However, the precision of the assessment is poor and the confidence intervals are large.

5.1.14 Reference points

The assessment provided this year is the first for several years. The main reason for a lack of assessment in previous working group meetings has been uncertainty in the catch data, coupled with noise in the acoustic survey data. The current assessment does not provide a basis for the presentation of biological reference points for this stock, calculated directly from the assessment data. The fishery in VIa(N) is on adults with no young herring taken, and is prosecuted by the same fleets as in the north-western area of the North Sea. The markets for the VIa(N) herring are the same, also, as herring in the North Sea. Thus the exploitation pattern is likely to be similar for the two stocks, certainly selection patterns for both fisheries are flat from age 3 to 9+ (Figures 2.8.6 and 5.1.3). It is proposed, therefore, that the $\mathbf{F}_{pa}$ for the North Sea (F = 0.25) could be applied to the herring stock in VIa(N) as a preliminary value until stability in the assessment for VIa(N) allows calculation of reference points. Of the two main reference points used for management ($\mathbf{F}_{pa}$, $\mathbf{B}_{pa}$) only an F reference point, which is less dependent on estimates of stock abundance than the absolute level of SSB, is considered, due to uncertainty in the current assessment results.

5.2 Clyde herring

5.2.1 Advice and management applicable to 2000 and 2001

Management of herring in the Clyde is complicated by the presence of two virtually indistinguishable stocks; a resident spring-spawning population and the immigrant autumn-spawning component. In recent years management strategies have been directed towards rebuilding the highly depleted spring-spawning component to historical levels.

The measures which remain in force in order to protect the indigenous spring-spawning stock are:

- A complete ban on herring fishing from 1 January to 30 April;
- A complete ban on all forms of active fishing from 1 February to 1 April, on the Ballantrae Bank spawning grounds, to protect the demersal spawn and prevent disturbance of the spawning shoals;
- A ban on herring fishing between 00:00 Saturday morning and 24:00 Sunday night;
- The TACs in 2000 and 2001 were maintained at the same level as in recent years (1,000 tonnes).

5.2.2 The fishery in 2000

Annual landings from 1955 to 2000 are presented in Table 5.2.1. Landings in 2000 were 1.3t which were the lowest since before 1955. The one tonne was landed by the local fleet. No fish were taken by the Northern Ireland fleet. The proportions of spring and autumn spawners in these landings could not be estimated. The sampling levels of the local fishery have been reduced in recent years but are still above recommended levels, but should not go any lower (Table 5.2.2).The absence of a fishery might be explained by the low price of herring in 2000 compared to other pelagic species available to the vessels to which the quota is assigned.

5.2.3 Weight at age and stock composition

The catch in numbers at age for the period 1970 to 2000 are given in Table 5.2.3. The numbers are so low that no comparison with previous years can be made. 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.

No attempt has been made to apportion catches between spring and autumn-spawning stocks for 2000 as the catch was so small.

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 2000. Historical estimates from these surveys are tabulated in (ICES 1995 Assess:13).

5.2.5 Stock assessment

The structure of the stock in the Clyde remains uncertain. No survey data are available from recent years therefore no assessment could be attempted.

5.2.6 Stock and catch projections

In the absence of an analytical assessment no stock projections can be provided.

5.2.7 Management considerations

The management of this fishery is made difficult by the presence of a mixture of a severely depleted spring-spawning component and autumn spawners from Division VIa. The management objectives for these two components are necessarily distinct. The absence of fishery independent data from surveys further compounds the problem. Historically the spring spawning stock supported a fishery with catches up to 15,000 tonnes per year in the 1960’s. Landings 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 below 1,000 tonnes. The fishery in 2000 was 0.01% of the catch of the fishery in the early 1950s and 1.3 tonne constitutes 0.1% of the TAC.

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, 1980-2000. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1980	1981	1982	1983	1984	1985	1986
Denmark		1580			96		
Faroes			74	834	954	104	400
France	2	1243	2069	1313		20	18
Germany	256	3029	8453	6283	5564	5937	2188
Ireland							6000
Netherlands		5602	11317	20200	7729	5500	5160
Norway		3850	13018	7336	6669	4690	4799
UK	48	31483	38471	31616	37554	28065	25294
Unallocated		4633	18958	-4059	16588	-502	37840
Discards							
Total	306	51420	92360	63523	75154	43814	81699
Area-Misreported					-19142	-4672	-10935
WG Estimate	**306**	**51420**	**92360**	**63523**	**56012**	**39142**	**70764**
Source (WG)	1982	1983	1984	1985	1986	1987	1988

Country	1987	1988	1989	1990	1991	1992	1993
Denmark							
Faroes				326	482		
France	136	44	1342	1287	1168	119	818
Germany	1711	1860	4290	7096	6450	5640	4693
Ireland	6800	6740	8000	10000	8000	7985	8236
Netherlands	5212	6131	5860	7693	7979	8000	6132
Norway	4300	456		1607	3318	2389	7447
UK	26810	26894	29874	38253	32628	32730	32602
Unallocated	18038	5229	2123	2397	-10597	-5485	-3753
Discards			1550	1300	1180	200	
Total	63007	47354	53039	69959	50608	51578	56175
Area-Misreported	-18647	-11763	-19013	-25266	-22079	-22593	-24397
WG Estimate	**44360**	**35591**	**34026**	**44693**	**28529**	**28985**	**31778**
Source (WG)	1989	1990	1991	1992	1993	1994	1995

Country	1994	1995	1996	1997	1998	1999	2000
Denmark							
Faroes							
France	274	3672	2297	3093	1903	463	870
Germany	5087	3733	7836	8873	8253	6752	4615
Ireland	7938	3548	9721	1875	11199	7915	4841
Netherlands	6093	7808	9396	9873	8483	7244	4647
Norway	8183	4840	6223	4962	5317	2695	
UK	30676	42661	46639	44273	42302	36446	22816
Unallocated	-4287	-4541	-17753	-8015	-11748	-8155	
Discards	700			62	90		
Total	54664	61271	64359	64995	65799	61514	37789
Area-Misreported	-30234	-32146	-38254	-29766	-32446	-23623	-14626
WG Estimate	**24430**	**29575**	**26105**	**35233***	**33353**	**29736**	**23163**
Source (WG)	1996	1997	1997	1998	1999	2000	2001

*WG estimate for 1997 has been revised according to the Bayesian assessment (see text section 5.1.3).

Table 5.1.2. Herring in VIa(N). Catch and sampling effort by nation participating in the fishery. 'Periods 1-4' refer to quarters of the year.

Total over year

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
England & Wales	0.00	2934.00	0	0	0	0.00
France	0.00	870.00	0	0	0	0.00
Germany	0.00	4615.00	0	0	0	0.00
Ireland	0.00	4841.00	0	0	0	0.00
N. Ireland	0.00	2586.00	0	0	0	0.00
Netherlands	3297.00	4647.00	1	75	75	100.00
Scotland	9365.00	17296.00	36	6745	1366	99.99
Total for Stock	12662.00	37789.00	37	6820	1441	99.99
Sum of Offical Catches :		**37789.00**				
Unallocated Catch :		**-14626.00**				
Working Group Catch :		**23163.00**				

PERIOD : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
France	0.00	28.00	0	0	0	0.00
Germany	0.00	366.00	0	0	0	0.00
Ireland	0.00	589.00	0	0	0	0.00
Scotland	0.00	2.00	0	0	0	0.00
Period Total	0.00	985.00	0	0	0	0.00
Sum of Offical Catches :		**985.00**				
Unallocated Catch :		**-589.00**				
Working Group Catch :		**396.00**				

PERIOD : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
England & Wales	0.00	874.00	0	0	0	0.00
Germany	0.00	782.00	0	0	0	0.00
Ireland	0.00	414.00	0	0	0	0.00
N. Ireland	0.00	131.00	0	0	0	0.00
Netherlands	0.00	17.00	0	0	0	0.00
Scotland	0.00	17.00	0	0	0	0.00
Period Total	0.00	2235.00	0	0	0	0.00
Sum of Offical Catches :		**2235.00**				
Unallocated Catch :		**-431.00**				
Working Group Catch :		**1804.00**				

PERIOD : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
England & Wales	0.00	2060.00	0	0	0	0.00
France	0.00	842.00	0	0	0	0.00
Germany	0.00	3024.00	0	0	0	0.00
Ireland	0.00	52.00	0	0	0	0.00
N. Ireland	0.00	2455.00	0	0	0	0.00
Netherlands	3297.00	3294.00	1	75	75	100.00
Scotland	7958.00	15871.00	33	6216	1106	99.98
Period Total	11255.00	27598.00	34	6291	1181	99.99
Sum of Offical Catches :		**27598.00**				
Unallocated Catch :		**-8041.00**				
Working Group Catch :		**19557.00**				

PERIOD : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Germany	0.00	443.00	0	0	0	0.00
Ireland	0.00	3786.00	0	0	0	0.00
Netherlands	0.00	1336.00	0	0	0	0.00
Scotland	1407.00	1406.00	3	529	260	99.99
Period Total	1407.00	6971.00	3	529	260	99.99
Sum of Offical Catches :		**6971.00**				
Unallocated Catch :		**-5565.00**				
Working Group Catch :		**1406.00**				

Table 5.1.3. Herring in VIa(N). Estimated catches at age (numbers, thousands), 1976-2000.

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**
1	9092	7635	4511
2	74167	35252	22960
3	34571	93910	21825
4	31905	25078	51420
5	22872	13364	15505
6	14372	7529	9002
7	8641	3251	3898
8	2825	1257	1836
9	3327	1089	576

Table 5.1.4. Herring in VIa(N). Larvae abundance indices (Numbers in billions), larvae mortality rates (Z/K), fecundity estimate (10^5 eggs/g). LPE Biomass estimate in thousands of tonnes.

Year	LAI	10% Trim LAI	Z/K	LPE		
				Larvae	Fecundity	SSB
1973	2 442	46.49	0.74	318	(1.39)	229
1974	1 186	17.44	0.42	238	(1.39)	171
1975	878	22	0.46	157	1.46	108
1976	189	11.04	-	60	1.23	49
1977	787	25	-	223	1.49	150
1978	332	32.8	-	132	1.37	109
1979	1 071	26.94		118	1.49	79
1980	1 436	26.33	0.39	287	2.04	141
1981	2 154	35.61	0.34	448	2.12	211
1982	1 890	32.58	0.39	267	1.95	137
1983	668	24.55	-	112	1.88	60
1984	2 133	45.99	0.57	253	1.75	145
1985	2 710	50.03	0.37	418	(1.86)	225
1986	3 037	45.36	0.24	907	(1.86)	488
1987	4 119	45.47	0.53	423	(1.86)	227
1988	5 947	75.13	0.47	781	(1.86)	420
1989	4 320	82.68	0.40	752	(1.86)	404
1990	6 525	86.2	0.64	426	(1.86)	229
1991	4 430	63.06	0.60	632	(1.86)	340
1992	12 252	41.79	0.66	463	(1.86)	248
1993	2 941	65.01	0.56	538	(1.86)	289

Table 5.1.5. Herring in 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
1	487 000	447 600
2	293 900	316 200
3	1 265 800	337 100
4	393 800	899 500
5	280 700	393 400
6	126 400	247 600
7	78 900	199 500
8	25 200	95 000
9+	32 300	65 000
SSB:	419 500	500 500

*Biomass of 2+ ringers in November.
The 1997 survey is not on the same basis as the other years, it was conducted in June (all other surveys were carried out in July) and it is not used for assessment purposes.

Table 5.1.6. Herring in VIa(N). Mean weights at age (g).

							5.3	Weight in the catch									
Age, Rings	**1982-1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1	90	69	113	73	80	82	79	84	91	89	83	105	81	89	97	76	83
2	140	103	145	143	112	142	129	118	122	128	142	142	134	136	138	130	137
3	175	134	173	183	157	145	173	160	172	158	167	180	178	177	159	158	164
4	205	161	196	211	177	191	182	203	194	197	190	191	210	205	182	175	183
5	231	182	215	220	203	190	209	211	216	206	195	198	230	222	199	191	201
6	253	199	230	238	194	213	224	229	224	228	201	213	233	223	218	210	215
7	270	213	242	241	240	216	228	236	236	223	244	207	262	219	227	225	239
8	284	223	251	253	213	204	237	261	251	262	234	227	247	238	212	223	281
9+	295	231	258	256	228	243	247	271	258	263	266	277	291	263	199	226	253

Weight in the stock from Acoustic surveys										
(Age, Rings)	**Historical**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997#**	**1998**	**1999**	**2000**
1	90	68	75	52	45	45	57	65	54	62
2	164	152	162	150	144	140	150	138	137	141
3	208	186	196	192	191	180	189	177	166	173
4	233	206	206	220	202	209	209	193	188	183
5	246	232	226	221	225	219	225	214	203	194
6	252	252	234	233	226	222	233	226	219	204
7	258	271	254	241	247	229	248	234	225	211
8	269	296	260	270	260	242	266	225	235	222
9+	292	305	276	296	293	263	287	249	245	230

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.

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

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 run log for the maximum-likelihood ICA calculation for the 7 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 2001  used for the year 2000
west.dat
 Natural mortality in 2001  used for the year 2000
natmor.dat
 Maturity ogive in 2001  used for the year 2000
matprop.dat
 Name of age-structured index file (Enter if none) : -->fleet.dat
 Name of the SSB index file (Enter if none) -->ssb.dat
 No of years for separable constraint ?--> 7
 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 1994-->    1.000000000000000
 Weight for year 1995-->    1.000000000000000
 Weight for year 1996-->    1.000000000000000
 Weight for year 1997-->    1.000000000000000
 Weight for year 1998-->    1.000000000000000
 Weight for year 1999-->    1.000000000000000
 Weight for year 2000-->    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   INDEX1  is to be A/L/P ?-->p
 Model for FLT01: West Scotland Summer Acoustic Sur  is to be A/L/P ?-->L
 Fit a stock-recruit relationship (Y/N) ?-->n
 Enter lowest feasible F-->   2.0000000000000000E-02
 Enter highest feasible F-->    0.500000000000000
```

Table 5.1.8 Continued

```
Mapping the F-dimension of the SSQ surface

    F                 SSQ
+--------+-------------------
    0.02        13.4435181771
    0.05        10.8019739499
    0.07        10.1128789958
    0.10        10.0022850807
    0.12        10.0995117839
    0.15        10.2860625947
    0.17        10.5152977415
    0.20        10.7662322697
    0.22        11.0288079933
    0.25        11.2982691496
    0.27        11.5728071269
    0.30        11.8526227553
    0.32        12.1398174636
    0.35        12.4390798202
    0.37        12.7603004247
    0.40        13.1277614919
    0.42        13.4953186782
    0.45        13.7504634726
    0.47        14.0098926193
    0.50        14.2778154576
Lowest SSQ is for F =     0.093
-----------------------------------------------------------------
No of years for separable analysis : 7
Age range in the analysis : 1  . . . 9
Year range in the analysis : 1976  . . . 2000
Number of indices of SSB : 1
Number of age-structured indices : 1

Parameters to estimate : 38
Number of observations : 163

Conventional single selection vector model to be fitted.



-----------------------------------------------------------------
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for   INDEX1-->    1.000000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 1-->    0.100000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 2-->    1.000000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 3-->    1.000000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 4-->    1.000000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 5-->    1.000000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 6-->    1.000000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 7-->    1.000000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 8-->    1.000000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 9-->    1.000000000000000
Enter estimates of the extent to which errors
in the age-structured indices are correlated
across ages. This can be in the range 0 (independence)
to 1 (correlated errors).
  Enter value for FLT01: West Scotland Summer Acoustic Sur-->    1.000000000000000
 Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.
SSB index weights
  1.000
Aged index weights
FLT01: West Scotland Summer Acoustic Sur
 Age   :       1     2     3     4     5     6     7     8     9
 Wts :     0.011 0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111
F in 2000  at age 4  is 0.180135  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]-->  0.0000000000000000E+000
Successful exit from ICA
```

Table 5.1.9. 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
1	4.51
2	22.96
3	21.83
4	51.42
5	15.50
6	9.00
7	3.90
8	1.84
9	0.58

x 10 ^ 6

Table 5.1.10. 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
1	0.08340
2	0.13730
3	0.16370
4	0.18290
5	0.20140
6	0.21470
7	0.23940
8	0.28120
9	0.25260

Table 5.1.11. 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
1	0.06200
2	0.14100
3	0.17300
4	0.18300
5	0.19400
6	0.20400
7	0.21100
8	0.22200
9	0.23000

Table 5.1.12. Herring in VIa(N). Natural mortality.

Natural Mortality (per year)

AGE	1976	1977	1978	……	1997	1998	1999	2000
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 5.1.13. 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
1	0.0000
2	0.4500
3	0.9200
4	1.0000
5	1.0000
6	1.0000
7	1.0000
8	1.0000
9	1.0000

Table 5.1.14. Herring in VIa(N). Tuning indices

INDICES OF SPAWNING BIOMASS

INDEX1

	1976	1977	1978	1979	1980	1981	1982	1983
1	189.0	787.0	332.0	1071.0	1436.0	2154.0	1890.0	668.0

INDEX1

	1984	1985	1986	1987	1988	1989	1990	1991
1	2133.0	2710.0	3037.0	4119.0	5947.0	4320.0	6525.0	4430.0

INDEX1

	1992	1993
1	*******	2941.0

AGE-STRUCTURED INDICES

FLT01: West Scotland Summer Acoustic Sur

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

x 10 ^ 3

FLT01: West Scotland Summer Acoustic Sur

AGE	1995	1996	1997	1998	1999	2000
1	460.6	41.2	*******	1221.7	487.0	447.6
2	1085.1	576.5	*******	794.6	293.9	316.2
3	472.7	802.5	*******	666.8	1265.8	337.1
4	450.2	329.1	*******	471.1	393.8	899.5
5	153.0	95.4	*******	179.1	280.7	393.4
6	187.1	60.6	*******	79.3	126.4	247.6
7	169.2	77.4	*******	28.1	78.9	199.5
8	236.6	78.2	*******	13.8	25.2	95.0
9	201.5	114.8	*******	36.8	32.3	65.0

x 10 ^ 3

Table 5.1.15. Herring in VIa(N). Weighting factors for the catch in numbers

Weighting factors for the catches in number

AGE	1994	1995	1996	1997	1998	1999	2000
1	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 5.1.16. Herring in VIa(N). Predicted catch in number.

Predicted Catch in Number

AGE	1994	1995	1996	1997	1998	1999	2000
1	1.62	1.73	1.53	6.22	2.28	1.26	4.35
2	27.52	45.11	34.43	75.24	129.49	32.62	26.20
3	22.79	26.72	31.19	58.31	49.81	61.46	24.14
4	8.01	17.28	14.37	41.30	29.20	18.07	35.66
5	8.26	6.69	10.26	20.87	22.72	11.70	11.59
6	11.71	6.08	3.49	13.20	10.07	7.96	6.59
7	12.14	10.46	3.87	5.39	7.73	4.32	5.48
8	11.98	8.06	4.92	4.50	2.32	2.42	2.20

x 10 ^ 6

Table 5.1.17. Herring in VIa(N). Fishing mortality (per year).

Fishing Mortality (per year)

AGE	1976	1977	1978	1979	1980	1981	1982	1983
1	0.1953	0.0923	0.0397	0.0003	0.0048	0.0355	0.0277	0.0446
2	0.7723	0.3549	0.2953	0.0005	0.0007	0.3233	0.6598	0.3915
3	1.2179	0.6041	0.2710	0.0007	0.0004	0.4296	0.6049	0.5958
4	1.0834	0.9423	0.5312	0.0003	0.0006	0.3987	0.8057	0.5012
5	0.8929	0.9523	0.7743	0.0002	0.0003	0.3082	0.7227	0.9712
6	1.0786	1.4658	1.1024	0.0015	0.0002	0.3173	0.5746	0.7922
7	1.1196	0.8940	1.0088	0.0023	0.0017	0.3146	0.4715	0.7645
8	1.0443	0.8612	0.6510	0.0009	0.0006	0.3599	0.6655	0.6675
9	1.0443	0.8612	0.6510	0.0009	0.0006	0.3599	0.6655	0.6675

AGE	1984	1985	1986	1987	1988	1989	1990	1991
1	0.0031	0.0551	0.0616	0.0147	0.0029	0.0135	0.0529	0.1185
2	0.2341	0.2123	0.5520	0.2829	0.1992	0.1327	0.1942	0.1910
3	0.5031	0.3105	0.4771	0.3291	0.3103	0.3012	0.2262	0.1870
4	0.4460	0.3069	0.4153	0.3093	0.3343	0.2138	0.3257	0.2290
5	0.4581	0.3150	0.5682	0.2747	0.2841	0.3278	0.4597	0.2422
6	0.6653	0.3357	0.6595	0.4759	0.2221	0.1503	0.3782	0.3994
7	0.6074	1.0024	0.1882	0.5436	0.3015	0.1562	0.2655	0.3418
8	0.4824	0.4013	0.5032	0.3726	0.2787	0.2158	0.3101	0.2671
9	0.4824	0.4013	0.5032	0.3726	0.2787	0.2158	0.3101	0.2671

AGE	1992	1993	1994	1995	1996	1997	1998	1999
1	0.0113	0.0496	0.0032	0.0036	0.0028	0.0059	0.0051	0.0029
2	0.2647	0.5173	0.1710	0.1920	0.1513	0.3171	0.2775	0.1579
3	0.3468	0.3544	0.2362	0.2652	0.2090	0.4380	0.3833	0.2181
4	0.2552	0.2398	0.2390	0.2683	0.2114	0.4431	0.3878	0.2207
5	0.2483	0.1981	0.2552	0.2866	0.2258	0.4733	0.4142	0.2357
6	0.3191	0.2374	0.2403	0.2698	0.2126	0.4456	0.3899	0.2219
7	0.2942	0.2685	0.2780	0.3122	0.2460	0.5156	0.4512	0.2568
8	0.2964	0.3289	0.2390	0.2683	0.2114	0.4431	0.3878	0.2207
9	0.2964	0.3289	0.2390	0.2683	0.2114	0.4431	0.3878	0.2207

AGE	2000
1	0.0024
2	0.1289
3	0.1780
4	0.1801
5	0.1924
6	0.1811
7	0.2096
8	0.1801
9	0.1801

Table 5.1.18. Herring in VIa(N). Population abundance (1 January, millions).

Population Abundance (1 January)

AGE	1976	1977	1978	1979	1980	1981	1982	1983
1	605.9	620.1	912.0	1216.8	885.0	1660.1	769.5	2958.6
2	674.6	183.4	208.0	322.5	447.5	324.0	589.4	275.3
3	156.0	230.9	95.3	114.7	238.8	331.3	173.7	225.7
4	55.9	37.8	103.3	59.5	93.8	195.4	176.5	77.7
5	44.5	17.1	13.3	55.0	53.8	84.9	118.7	71.4
6	120.4	16.5	6.0	5.6	49.7	48.7	56.4	52.1
7	16.9	37.1	3.4	1.8	5.0	45.0	32.1	28.7
8	6.3	5.0	13.7	1.1	1.6	4.5	29.7	18.1
9	19.3	2.7	3.4	8.1	8.3	4.6	8.7	18.2

AGE	1984	1985	1986	1987	1988	1989	1990	1991
1	1130.1	1198.0	889.4	2100.5	930.5	734.7	436.9	370.2
2	1040.9	414.4	417.1	307.6	761.4	341.3	266.7	152.4
3	137.9	610.2	248.3	177.9	171.7	462.2	221.4	162.7
4	101.8	68.3	366.2	126.2	104.8	103.1	280.0	144.6
5	42.6	59.0	45.4	218.7	83.8	67.9	75.3	182.9
6	24.4	24.4	39.0	23.3	150.4	57.1	44.3	43.0
7	21.4	11.4	15.8	18.2	13.1	109.0	44.4	27.4
8	12.1	10.5	3.8	11.8	9.6	8.8	84.3	30.8
9	5.4	6.9	5.2	20.2	10.2	18.9	21.7	19.9

AGE	1992	1993	1994	1995	1996	1997	1998	1999
1	741.2	576.4	811.0	771.4	866.6	1679.5	703.4	681.2
2	121.0	269.6	201.8	297.4	282.8	317.9	614.2	257.4
3	93.3	68.8	119.1	126.0	181.8	180.1	171.5	344.8
4	110.5	54.0	39.5	77.0	79.1	120.8	95.1	95.7
5	104.1	77.4	38.4	28.1	53.3	57.9	70.2	58.4
6	129.9	73.5	57.5	26.9	19.1	38.4	32.7	42.0
7	26.1	85.4	52.4	40.9	18.6	14.0	22.3	20.0
8	17.6	17.6	59.1	35.9	27.1	13.2	7.6	12.8
9	22.5	14.0	50.4	43.6	171.2	28.9	10.8	5.8

AGE	2000	2001
1	2887.9	1668.0
2	249.9	1059.9
3	162.8	162.7
4	227.0	111.6
5	69.5	171.5
6	41.8	51.8
7	30.4	31.5
8	14.0	22.3
9	3.7	13.4

x 10 ^ 6

Table 5.1.19. Herring in VIa(N). Predicted index values.

Predicted SSB Index Values

INDEX1

	1976	1977	1978	1979	1980	1981	1982	1983
1	825.4	379.5	325.2	852.6	2683.2	3057.0	2016.9	1022.1

INDEX1

	1984	1985	1986	1987	1988	1989	1990	1991
1	2446.5	3882.2	3071.8	2584.6	3901.8	4996.2	4212.9	2582.2

INDEX1

	1992	1993
1	*******	1388.0

Predicted Age-Structured Index Values

FLT01: West Scotland Summer Acoustic Su Predicted

AGE	1987	1988	1989	1990	1991	1992	1993	1994
1	444.4	*******	*******	*******	74.0	157.1	119.7	172.7
2	625.1	*******	*******	*******	325.7	248.2	482.1	435.8
3	617.6	*******	*******	*******	610.2	320.7	235.4	434.8
4	541.3	*******	*******	*******	648.2	488.2	240.6	176.1
5	891.3	*******	*******	*******	758.7	430.1	329.0	158.3
6	89.6	*******	*******	*******	172.6	544.2	321.7	251.3
7	60.6	*******	*******	*******	101.8	99.4	329.8	201.3
8	36.9	*******	*******	*******	101.9	57.4	56.3	198.5
9	59.2	*******	*******	*******	62.0	69.0	42.1	159.1

x 10 ^ 3

FLT01: West Scotland Summer Acoustic Su Predicted

AGE	1995	1996	1997	1998	1999	2000
1	164.2	184.5	*******	149.6	145.1	615.1
2	635.0	617.3	*******	1251.8	559.9	552.2
3	452.8	673.9	*******	578.1	1271.4	613.8
4	337.7	358.1	*******	391.1	431.0	1044.8
5	113.9	222.9	*******	265.0	243.1	296.0
6	116.0	84.9	*******	131.6	185.4	188.6
7	154.2	72.8	*******	77.9	77.8	121.3
8	118.7	92.3	*******	23.4	43.5	48.6
9	135.6	549.4	*******	31.6	18.4	12.0

x 10 ^ 3

Table 5.1.20. Herring in VIa(N). Fitted selection pattern.

Fitted Selection Pattern

AGE	1976	1977	1978	1979	1980	1981	1982	1983
1	0.1803	0.0980	0.0748	0.9565	8.4404	0.0891	0.0343	0.0890
2	0.7129	0.3766	0.5558	1.5185	1.2637	0.8110	0.8190	0.7810
3	1.1242	0.6411	0.5102	2.2066	0.7687	1.0774	0.7508	1.1888
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8242	1.0107	1.4576	0.7405	0.4446	0.7729	0.8970	1.9378
6	0.9956	1.5556	2.0753	4.5070	0.3331	0.7957	0.7132	1.5805
7	1.0335	0.9487	1.8990	6.9797	2.9324	0.7892	0.5853	1.5253
8	0.9639	0.9139	1.2256	2.7547	1.1352	0.9027	0.8260	1.3318
9	0.9639	0.9139	1.2256	2.7547	1.1352	0.9027	0.8260	1.3318

AGE	1984	1985	1986	1987	1988	1989	1990	1991
1	0.0069	0.1796	0.1484	0.0477	0.0087	0.0629	0.1624	0.5174
2	0.5249	0.6917	1.3291	0.9145	0.5958	0.6205	0.5963	0.8344
3	1.1281	1.0118	1.1488	1.0638	0.9282	1.4086	0.6944	0.8168
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0271	1.0264	1.3681	0.8881	0.8498	1.5331	1.4113	1.0577
6	1.4918	1.0937	1.5879	1.5385	0.6644	0.7031	1.1610	1.7445
7	1.3620	3.2659	0.4532	1.7573	0.9019	0.7303	0.8150	1.4929
8	1.0817	1.3076	1.2115	1.2043	0.8338	1.0091	0.9520	1.1667
9	1.0817	1.3076	1.2115	1.2043	0.8338	1.0091	0.9520	1.1667

AGE	1992	1993	1994	1995	1996	1997	1998	1999
1	0.0441	0.2070	0.0133	0.0133	0.0133	0.0133	0.0133	0.0133
2	1.0372	2.1574	0.7157	0.7157	0.7157	0.7157	0.7157	0.7157
3	1.3587	1.4780	0.9884	0.9884	0.9884	0.9884	0.9884	0.9884
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.9727	0.8263	1.0681	1.0681	1.0681	1.0681	1.0681	1.0681
6	1.2503	0.9900	1.0056	1.0056	1.0056	1.0056	1.0056	1.0056
7	1.1526	1.1196	1.1635	1.1635	1.1635	1.1635	1.1635	1.1635
8	1.1614	1.3717	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.1614	1.3717	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	2000
1	0.0133
2	0.7157
3	0.9884
4	1.0000
5	1.0681
6	1.0056
7	1.1635
8	1.0000
9	1.0000

Table 5.1.21. 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	605910	263624	73421	93642	1.2754	1.0682	100
1977	620140	162758	51892	41341	0.7967	0.9911	109
1978	912030	170427	48438	22156	0.4574	0.6697	99
1979	1216840	218156	74491	60	0.0008	0.0007	99
1980	885040	254493	124299	306	0.0025	0.0004	99
1981	1660110	364288	131755	51420	0.3903	0.3634	103
1982	769470	305380	109422	92360	0.8441	0.6769	96
1983	2958640	424775	80773	63523	0.7864	0.7151	97
1984	1130060	351798	119277	56012	0.4696	0.5181	105
1985	1198010	347064	146594	39142	0.2670	0.3170	99
1986	889390	313029	132039	70764	0.5359	0.5301	95
1987	2100510	379346	122239	44360	0.3629	0.3473	102
1988	930480	336193	146925	35591	0.2422	0.2877	97
1989	734720	309350	164077	34026	0.2074	0.2483	98
1990	436890	264530	152044	44693	0.2939	0.3474	101
1991	370170	202882	122188	28529	0.2335	0.2644	93
1992	741160	208087	98978	28985	0.2928	0.2924	99
1993	576420	176341	92603	31778	0.3432	0.2574	100
1994	811030	169376	84980	24430	0.2875	0.2427	100
1995	771420	159506	69872	29575	0.4233	0.2725	99
1996	866620	199616	117127	26105	0.2229	0.2147	95
1997	1679510	239968	82423	35233	0.4275	0.4500	99
1998	703370	211845	104789	33353	0.3183	0.3938	100
1999	681210	177263	95687	29736	0.3108	0.2241	99
2000	2887870	316350	93064	23163	0.2489	0.1829	100

No of years for separable analysis : 7
Age range in the analysis : 1 . . . 9
Year range in the analysis : 1976 . . . 2000
Number of indices of SSB : 1
Number of age-structured indices : 1

Parameters to estimate : 38
Number of observations : 163

Conventional single selection vector model to be fitted.

Table 5.1.22. 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	1994	0.2390	20	0.1612	0.3543	0.1955	0.2921	0.2438
2	1995	0.2683	19	0.1827	0.3941	0.2205	0.3264	0.2735
3	1996	0.2114	19	0.1432	0.3122	0.1733	0.2579	0.2156
4	1997	0.4431	20	0.2960	0.6634	0.3607	0.5444	0.4526
5	1998	0.3878	24	0.2385	0.6305	0.3026	0.4969	0.3999
6	1999	0.2207	29	0.1226	0.3972	0.1635	0.2979	0.2308
7	2000	0.1801	34	0.0908	0.3574	0.1270	0.2555	0.1915
Separable Model: Selection (S) by age								
8	1	0.0133	47	0.0052	0.0335	0.0083	0.0213	0.0148
9	2	0.7157	19	0.4846	1.0569	0.5866	0.8732	0.7300
10	3	0.9884	18	0.6882	1.4195	0.8217	1.1889	1.0054
	4	1.0000		Fixed : Reference Age				
11	5	1.0681	16	0.7702	1.4812	0.9040	1.2620	1.0831
12	6	1.0056	15	0.7366	1.3729	0.8579	1.1787	1.0184
13	7	1.1635	15	0.8525	1.5880	0.9927	1.3636	1.1782
	8	1.0000		Fixed : Last true age				
Separable model: Populations in year 2000								
14	1	2887878	116	293490	28416007	899402	9272641	5702684
15	2	249873	45	102911	606701	158913	392896	276821
16	3	162844	37	78657	337136	112339	236055	174463
17	4	226952	33	116680	441439	161628	318677	240410
18	5	69456	32	36619	131740	50104	96283	73261
19	6	41757	32	22151	78716	30217	57704	44000
20	7	30414	32	16147	57285	22018	42011	32043
21	8	14006	33	7270	26982	10023	19570	14812
Separable model: Populations at age								
22	1994	59103	36	28807	121259	40961	85280	63212
23	1995	35917	28	20391	63264	26907	47945	37447
24	1996	27082	26	16238	45166	20861	35157	28020
25	1997	13171	24	8216	21114	10352	16756	13558
26	1998	7557	27	4409	12950	5741	9947	7847
27	1999	12838	31	6973	23637	9403	17529	13476
SSB Index catchabilities								
INDEX1								
Power model fitted. Slopes (Q) and exponents (K) at age								
28	1 Q	9.385	15	8.668	16.15	10.09	13.87	11.98
29	1 K	.1051E-07	15	.1122E-06	.2090E-06	.1307E-06	.1795E-06	.1658E-06
Age-structured index catchabilities								
FLT01: West Scotland Summer Acoustic Su								
Linear model fitted. Slopes at age :								
30	1 Q	.3678	104	.1355	8.000	.3678	2.947	1.789
31	2 Q	2.792	34	2.007	7.725	2.792	5.553	4.177
32	3 Q	4.632	34	3.338	12.72	4.632	9.166	6.906
33	4 Q	5.363	34	3.867	14.70	5.363	10.60	7.990
34	5 Q	4.998	34	3.600	13.74	4.998	9.898	7.456
35	6 Q	5.264	34	3.784	14.56	5.264	10.47	7.875
36	7 Q	4.719	34	3.378	13.23	4.719	9.470	7.103
37	8 Q	4.040	35	2.872	11.56	4.040	8.220	6.138
38	9 Q	3.802	34	2.725	10.62	3.802	7.610	5.713

Table 5.1.23. Herring in VIa(N). Residuals about the model fit.

Separable Model Residuals

Age	1994	1995	1996	1997	1998	1999	2000
1	0.063	-1.873	0.241	-1.652	1.383	1.803	0.035
2	0.284	0.600	0.095	-0.299	-0.557	0.078	-0.132
3	0.567	0.129	-0.009	-0.511	-0.365	0.424	-0.101
4	-0.287	0.208	-0.444	-0.266	0.089	0.328	0.366
5	-0.105	-0.219	-0.313	0.102	0.006	0.133	0.291
6	-0.368	-0.368	-0.334	0.282	0.356	-0.056	0.311
7	-0.143	-0.173	0.194	0.651	0.112	-0.285	-0.341
8	0.015	-0.011	0.542	0.146	0.197	-0.657	-0.181

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1976	1977	1978	1979	1980	1981	1982	1983
1	-1.474	0.729	0.021	0.228	-0.625	-0.350	-0.065	-0.425

INDEX1

	1984	1985	1986	1987	1988	1989	1990	1991
1	-0.137	-0.359	-0.011	0.466	0.421	-0.145	0.438	0.540

INDEX1

	1992	1993
1	*******	0.751

AGE-STRUCTURED INDEX RESIDUALS

FLT01: West Scotland Summer Acoustic Su

Age	1987	1988	1989	1990	1991	1992	1993	1994
1	-0.579	*******	*******	*******	1.520	-0.749	-3.769	1.051
2	-0.078	*******	*******	*******	-0.101	0.707	0.442	0.218
3	-0.114	*******	*******	*******	-0.621	-0.419	1.062	0.335
4	-0.427	*******	*******	*******	-0.567	-0.637	0.998	0.484
5	-0.169	*******	*******	*******	-0.441	-0.036	0.503	0.662
6	0.220	*******	*******	*******	0.022	-0.818	0.989	0.065
7	-0.231	*******	*******	*******	-0.030	0.061	-0.149	0.704
8	-0.842	*******	*******	*******	-0.126	-0.012	0.991	-0.133
9	-2.209	*******	*******	*******	-0.066	-0.084	1.312	-0.188

Age	1995	1996	1997	1998	1999	2000
1	1.031	-1.499	*******	2.100	1.211	-0.318
2	0.536	-0.068	*******	-0.454	-0.645	-0.557
3	0.043	0.175	*******	0.143	-0.004	-0.599
4	0.288	-0.084	*******	0.186	-0.090	-0.150
5	0.295	-0.849	*******	-0.392	0.144	0.284
6	0.478	-0.337	*******	-0.507	-0.383	0.272
7	0.093	0.062	*******	-1.021	0.015	0.498
8	0.690	-0.166	*******	-0.525	-0.547	0.671
9	0.396	-1.566	*******	0.152	0.562	1.692

Table 5.1.24. Herring in VIa(N). Parameters of distributions.

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

 Separable model fitted from 1994  to 2000
 Variance                           0.2098
Skewness test stat.                 0.0603
Kurtosis test statistic            -1.1993
Partial chi-square                  0.6730
Significance in fit                 0.0000
Degrees of freedom                      29


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


DISTRIBUTION STATISTICS FOR   INDEX1


 Power catchability relationship assumed
 Last age is a plus-group

 Variance                           0.3378
Skewness test stat.                -1.4481
Kurtosis test statistic             0.6767
Partial chi-square                  0.7200
Significance in fit                 0.0000
Number of observations                  17
Degrees of freedom                      15
Weight in the analysis              1.0000

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


DISTRIBUTION STATISTICS FOR FLT01: West Scotland Summer Acoustic Su


 Linear catchability relationship assumed

Age         1       2       3       4        5        6        7        8        9
Variance 0.0343  0.0245  0.0275  0.0283   0.0244   0.0311   0.0232   0.0402   0.1538
Skewness test stat.
       -1.1348  0.0985  0.8785  0.7222  -0.4318   0.3423  -0.9629   0.4803  -0.6768
Kurtosis test statisti
        0.0389 -0.8132  0.1415 -0.2722  -0.5310  -0.3457   0.6195  -0.6781  -0.2263
Partial chi-square
        0.0262  0.0168  0.0194  0.0201   0.0177   0.0225   0.0180   0.0334   0.1275
Significance in fit
        0.0000  0.0000  0.0000  0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
Number of observations
       10      10      10      10       10       10       10       10       10
Degrees of freedom
        9       9       9       9        9        9        9        9        9
Weight in the analysis
        0.0111  0.1111  0.1111  0.1111   0.1111   0.1111   0.1111   0.1111   0.1111
```

Table 5.1.25. Herring in VIa(N). Analysis of variance.

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	77.8684	163	38	125	0.6229
Catches at age	16.4020	56	27	29	0.5656
SSB Indices					
INDEX1	5.0667	17	2	15	0.3378
Aged Indices					
FLT01: West Scotland Summer Acoustic S	56.3997	90	9	81	0.6963

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	11.5072	163	38	125	0.0921
Catches at age	6.0841	56	27	29	0.2098
SSB Indices					
INDEX1	5.0667	17	2	15	0.3378
Aged Indices					
FLT01: West Scotland Summer Acoustic S	0.3564	90	9	81	0.0044

Table 5.1.26. 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).

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	896530.4	1	0	0.67	0.67	6.07E-02	0.002388	8.55E-02
2	328087.6	0.3	0.623333	0.67	0.67	0.138667	0.12892	0.1351
3	162720	0.2	0.956667	0.67	0.67	0.171667	0.17804	0.160233
4	111580	0.1	1	0.67	0.67	0.188333	0.18014	0.179967
5	171500	0.1	1	0.67	0.67	0.203667	0.1924	0.197133
6	51848	0.1	1	0.67	0.67	0.216333	0.18114	0.214233
7	31525	0.1	1	0.67	0.67	0.223333	0.20959	0.230467
8	22317	0.1	1	0.67	0.67	0.227333	0.18014	0.238733
9	13357	0.1	1	0.67	0.67	0.241333	0.18014	0.225867

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	896530.4	1	0	0.67	0.67	6.07E-02	0.002388	8.55E-02
2	.	0.3	0.623333	0.67	0.67	0.138667	0.12892	0.1351
3	.	0.2	0.956667	0.67	0.67	0.171667	0.17804	0.160233
4	.	0.1	1	0.67	0.67	0.188333	0.18014	0.179967
5	.	0.1	1	0.67	0.67	0.203667	0.1924	0.197133
6	.	0.1	1	0.67	0.67	0.216333	0.18114	0.214233
7	.	0.1	1	0.67	0.67	0.223333	0.20959	0.230467
8	.	0.1	1	0.67	0.67	0.227333	0.18014	0.238733
9	.	0.1	1	0.67	0.67	0.241333	0.18014	0.225867

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	896530.4	1	0	0.67	0.67	6.07E-02	0.002388	8.55E-02
2	.	0.3	0.623333	0.67	0.67	0.138667	0.12892	0.1351
3	.	0.2	0.956667	0.67	0.67	0.171667	0.17804	0.160233
4	.	0.1	1	0.67	0.67	0.188333	0.18014	0.179967
5	.	0.1	1	0.67	0.67	0.203667	0.1924	0.197133
6	.	0.1	1	0.67	0.67	0.216333	0.18114	0.214233
7	.	0.1	1	0.67	0.67	0.223333	0.20959	0.230467
8	.	0.1	1	0.67	0.67	0.227333	0.18014	0.238733
9	.	0.1	1	0.67	0.67	0.241333	0.18014	0.225867

Table 5.1.27. Herring in VIa(N). Short-term prediction single option table, scenario 1 - status quo F.

Year:	2001	F multiplier:	1	Fbar:	0.1829				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0024	1352	116	896530	54389	0	0	0	0
2	0.1289	34395	4647	328088	45495	204508	28358	153428	21275
3	0.178	24124	3865	162720	27934	155669	26723	120837	20744
4	0.1801	17530	3155	111580	21014	111580	21014	92485	17418
5	0.1924	28610	5640	171500	34929	171500	34929	140988	28715
6	0.1811	8187	1754	51848	11216	51848	11216	42946	9291
7	0.2096	5682	1310	31525	7041	31525	7041	25620	5722
8	0.1801	3506	837	22317	5073	22317	5073	18498	4205
9	0.1801	2098	474	13357	3223	13357	3223	11071	2672
Total		125485	21797	1789465	210315	762304	137579	605873	110041

Year:	2002	F multiplier:	1	Fbar:	0.1829				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0024	1352	116	896530	54389	0	0	0	0
2	0.1289	34494	4660	329028	45625	205094	28440	153868	21336
3	0.178	31675	5075	213655	36677	204396	35088	158662	27237
4	0.1801	17517	3152	111496	20998	111496	20998	92416	17405
5	0.1924	14066	2773	84319	17173	84319	17173	69317	14118
6	0.1811	20215	4331	128020	27695	128020	27695	106040	22940
7	0.2096	7055	1626	39141	8742	39141	8742	31809	7104
8	0.1801	3634	868	23131	5259	23131	5259	19173	4359
9	0.1801	4235	957	26958	6506	26958	6506	22345	5393
Total		134244	23557	1852278	223064	822556	149900	653629	119891

Year:	2003	F multiplier:	1	Fbar:	0.1829				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0024	1352	116	896530	54389	0	0	0	0
2	0.1289	34494	4660	329028	45625	205094	28440	153868	21336
3	0.178	31766	5090	214267	36783	204982	35189	159117	27315
4	0.1801	23000	4139	146397	27571	146397	27571	121344	22853
5	0.1924	14056	2771	84255	17160	84255	17160	69265	14107
6	0.1811	9939	2129	62941	13616	62941	13616	52135	11279
7	0.2096	17420	4015	96645	21584	96645	21584	78541	17541
8	0.1801	4512	1077	28720	6529	28720	6529	23805	5412
9	0.1801	5947	1343	37851	9135	37851	9135	31374	7572
Total		142486	25340	1896635	232393	866886	159224	689448	127414

Table 5.1.28. Herring in VIa (N). Short-term prediction multiple option table, scenario 1 - status quo F.

2001				
Biomass	SSB	Fmult	Fbar	Landings
210315	110041	1	0.1829	21797

2002					2003	
Biomass	SSB	Fmult	Fbar	Landings	Biomass	SSB
223064	134724	0	0	0	256824	165740
.	133160	0.1	0.0183	2538	254187	161394
.	131615	0.2	0.0366	5033	251596	157171
.	130088	0.3	0.0549	7487	249049	153068
.	128579	0.4	0.0732	9900	246545	149081
.	127088	0.5	0.0915	12273	244084	145206
.	125614	0.6	0.1098	14606	241665	141442
.	124158	0.7	0.1281	16900	239287	137783
.	122719	0.8	0.1463	19157	236949	134227
.	121296	0.9	0.1646	21375	234652	130772
.	119891	1	0.1829	23557	232393	127414
.	118502	1.1	0.2012	25703	230172	124150
.	117130	1.2	0.2195	27814	227990	120978
.	115773	1.3	0.2378	29889	225844	117895
.	114433	1.4	0.2561	31930	223735	114898
.	113108	1.5	0.2744	33937	221662	111985
.	111799	1.6	0.2927	35911	219623	109154
.	110506	1.7	0.311	37853	217620	106401
.	109227	1.8	0.3293	39762	215650	103726
.	107964	1.9	0.3476	41640	213713	101124
.	106715	2	0.3659	43487	211810	98596

Table 5.1.29. Herring in VIa(N). Short-term prediction single option table, scenario 2 – ICES advice for 2001, catch = 30,000 t.

Year:		2001	F multiplier:	1.4246	Fbar:	0.2606				
Age		F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	1	0.0034	1925	165	896530	54389	0	0	0	0
	2	0.1837	47775	6454	328088	45495	204508	28358	147903	20509
	3	0.2536	33179	5316	162720	27934	155669	26723	114869	19719
	4	0.2566	24085	4334	111580	21014	111580	21014	87865	16548
	5	0.2741	39215	7731	171500	34929	171500	34929	133479	27185
	6	0.258	11246	2409	51848	11216	51848	11216	40789	8824
	7	0.2986	7763	1789	31525	7041	31525	7041	24137	5391
	8	0.2566	4817	1150	22317	5073	22317	5073	17574	3995
	9	0.2566	2883	651	13357	3223	13357	3223	10518	2538
Total			172888	30000	1789465	210315	762304	137579	577134	104710

Year:		2002	F multiplier:	1.4	Fbar:	0.2561				
Age		F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	1	0.0033	1892	162	896530	54389	0	0	0	0
	2	0.1805	47106	6364	328695	45579	204886	28411	148492	20591
	3	0.2493	40614	6508	202274	34724	193509	33219	143211	24585
	4	0.2522	21975	3955	103379	19470	103379	19470	81649	15377
	5	0.2694	17591	3468	78110	15908	78110	15908	60986	12421
	6	0.2536	25201	5399	117977	25522	117977	25522	93092	20139
	7	0.2934	8792	2026	36244	8094	36244	8094	27846	6219
	8	0.2522	4498	1074	21162	4811	21162	4811	16714	3800
	9	0.2522	5309	1199	24973	6027	24973	6027	19724	4760
Total			172979	30154	1809343	214525	780240	141462	591712	107891

Year:		2003	F multiplier:	1.4	Fbar:	0.2561				
Age		F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	1	0.0033	1892	162	896530	54389	0	0	0	0
	2	0.1805	47109	6364	328714	45582	204898	28413	148500	20592
	3	0.2493	40818	6540	203292	34898	194482	33386	143932	24708
	4	0.2522	27437	4938	129072	24308	129072	24308	101941	19199
	5	0.2694	16371	3227	72690	14804	72690	14804	56754	11559
	6	0.2536	11532	2471	53988	11679	53988	11679	42600	9216
	7	0.2934	20095	4631	82839	18501	82839	18501	63644	14214
	8	0.2522	5198	1241	24455	5559	24455	5559	19315	4391
	9	0.2522	6896	1557	32439	7829	32439	7829	25621	6183
Total			177348	31132	1824018	217551	794863	144480	602307	110062

Table 5.1.30. Herring in VIa(N). Short-term prediction multiple option table, scenario 2 - ICES advice for 2001, catch = 30,000 t.

2001				
Biomass	SSB	Fmult	Fbar	Landings
210315	104710	1.4246	0.2606	30000

2002					2003	
Biomass	SSB	Fmult	Fbar	Landings	Biomass	SSB
214525	121179	0.4	0.0732	9346	239114	142480
.	119778	0.5	0.0915	11586	236788	138808
.	118394	0.6	0.1098	13790	234502	135239
.	117026	0.7	0.1281	15956	232254	131771
.	115674	0.8	0.1463	18087	230045	128399
.	114339	0.9	0.1646	20183	227873	125122
.	113018	1	0.1829	22244	225737	121937
.	111714	1.1	0.2012	24271	223638	118841
.	110424	1.2	0.2195	26265	221574	115831
.	109150	1.3	0.2378	28226	219545	112906
.	107891	1.4	0.2561	30154	217551	110062
.	106646	1.5	0.2744	32051	215590	107297
.	105416	1.6	0.2927	33916	213662	104609
.	104201	1.7	0.311	35751	211767	101996
.	103000	1.8	0.3293	37556	209904	99455
.	101812	1.9	0.3476	39331	208072	96984
.	100639	2	0.3659	41077	206271	94582
.	99480	2.1	0.3842	42795	204500	92247
.	98334	2.2	0.4024	44484	202759	89975
.	97201	2.3	0.4207	46145	201048	87767
.	96082	2.4	0.439	47780	199365	85619

Table 5.2.1. Catches of HERRING from the Firth of Clyde. Spring and autumn-spawners combined. Catch in tonnes by country, 1955–2000.

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
All Catches																	
Total	4,050	4,848	5,915	4,926	10,530	15,680	10,848	3,989	7,073	14,509	15,096	9,807	7,929	9,433	10,594	7,763	4,088

Year	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
All Catches										
Total	4,226	4,715	4,061	3,664	4,139	4,847	3,862	1,951	2,081	2,135

Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Scotland	2,506	2,530	2,991	3,001	3,395	2,895	1,568	2,135	2,184	713	929	852
Other UK	-	273	247	22	-	-	-	-	-	-	-	-
Unallocated[1]	262	293	224	433	576	278	110	208	75	18	-	-
Discards	1,253	1,265	2,308[3]	1,344[3]	679[3]	439[4]	245[4]	-[2]	-[2]	-[2]	-[2]	-[2]
Agreed TAC			3,000	3,000	3,100	3,500	3,200	3,200	2,600	2,900	2,300	1,000
Total	4,021	4,361	5,770	4,800	4,650	3,612	1,923	2,343	2,259	731	929	852

Year	1994	1995	1996	1997	1998	1999	2000
Scotland	608	392	598	371	779	16	1
Other UK	-	-	283	119	213	240	0
Unallocated[1]	-	-	-	-	-	-	-
Discards	-[2]	-[2]	-	-	-	-	-
Agreed TAC	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Total	608	392	881	490	992	256	1

[1]Calculated from estimates of weight per box and in some years estimated by-catch in the sprat fishery
[2]Reported to be at a low level, assumed to be zero.
[3]Based on sampling.
[4]Estimated assuming the same discarding rate as in 1986.

Table 5.2.2. Sampling levels of Clyde herring 1988–2000.

Year	Reported catch (tonnes)	No. of samples	No. of fish measured	No. of fish aged	Discards
1988	1,568	41	5,955	2,574	Based on local reports
1989	2,135	45	8,368	4,152	" "
1990	2,184	37	5,926	3,803	" "
1991	713	29	4,312	2,992	No information
1992	929	23	4,604	1,579	No information
1993	852	16	3,408	798	No information
1994	608	16	3,903	1,388	No information
1995	392	16	2,727	1,073	No information
1996	881	9	1,915	679	No information
1997	490	3	650	383	No information
1998	992	3	462	196	
1999	256	3	251	126	
2000[1]	1	1	105	96	

[1] One sample collected in first quarter, but not applied to catch, which was taken in third quarter.

Table 5.2.3. Clyde HERRING catch in numbers at age. Spring- and autumn-spawners combined. Thousands of fish.

Age(Rings)	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	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
1	145	3	399	118	494	275	323	123	0
2	411	418	964	1425	1962	2005	2731	418	3
3	493	261	964	186	1189	429	1779	318	2
4	385	268	358	189	273	346	667	393	1
5	1947	1305	534	149	544	18	344	122	1
6	333	327	319	130	183	52	77	36	0
7	91	78	76	66	208	0	55	36	0
8	69	111	57	35	127	5	35	13	0
9	32	38	16	15	52	61	55	19	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	Weight in the catch																
(rings)	1970-81	1982-85	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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
3	270	187	199	194	194	174	186	163	187	174	157	174	184	174	174	169	162
4	290	228	224	203	207	203	202	188	188	198	184	201	203	192	189	184	180
5	310	253	253	217	211	221	216	192	216	213	212	226	233	231	204	197	194
6	328	272	265	225	222	227	237	198	227	216	249	241	255	228	218	202	213
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
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

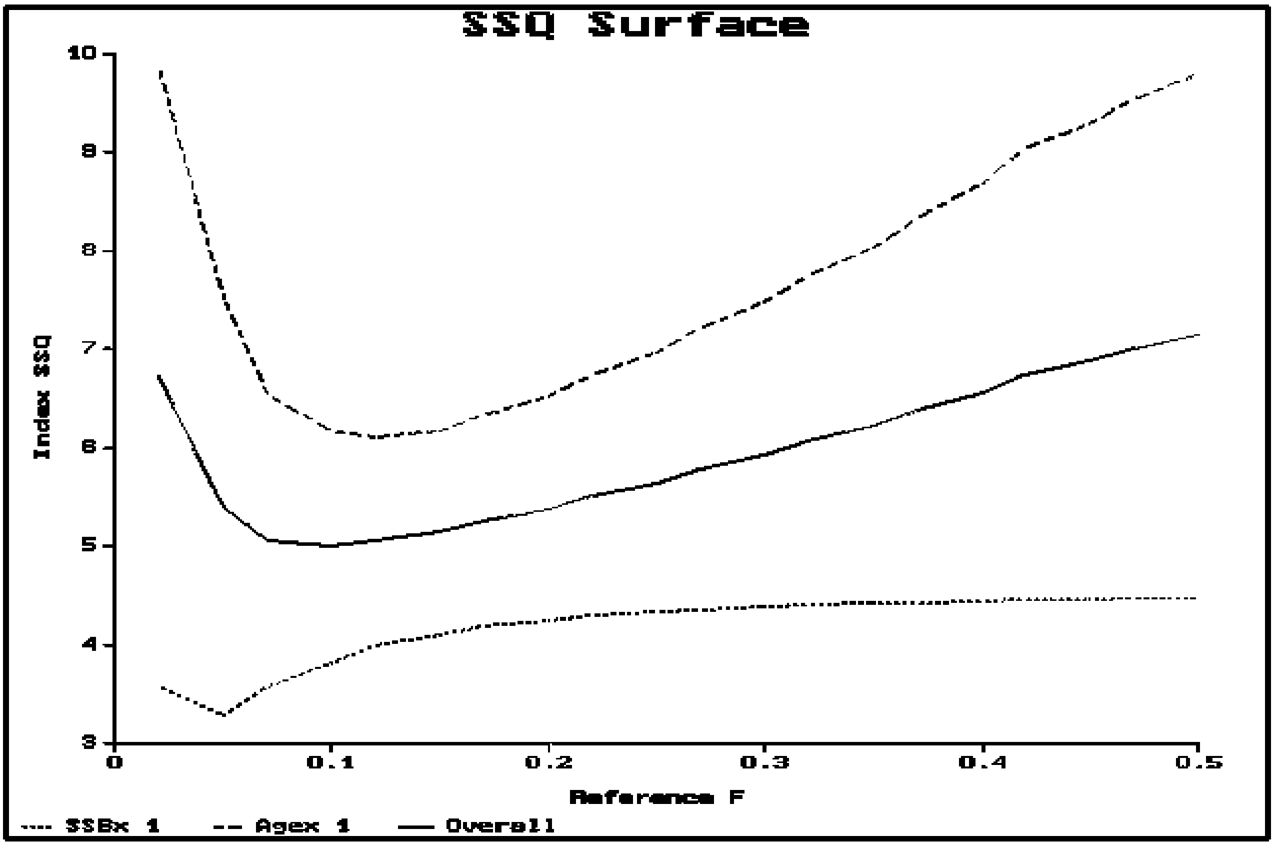


Figure 5.1.1. Herring in VIa(N). SSQ surface for the deterministic calculation of the 7 year separable period. SSBx 1 - larval production estimates from 1973-1993; Agex1- age disaggregated acoustic estimates.

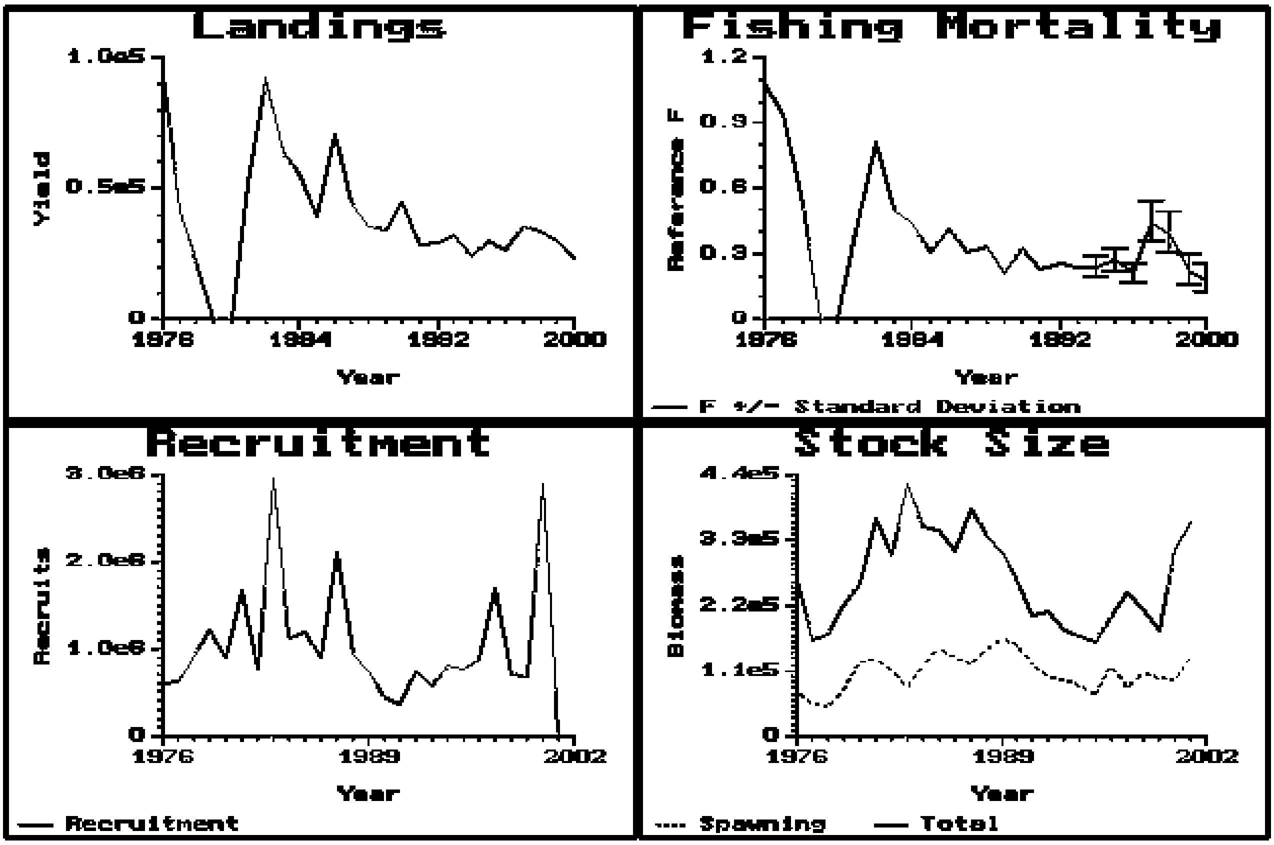


Figure 5.1.2. Herring in VIa(N). Illustration of stock trends from deterministic calculation (7 year separable period). Summary of estimates of landings, fishing mortality at age 4, recruitment at age 1, stock size on 1 January and spawning stock at spawning time.

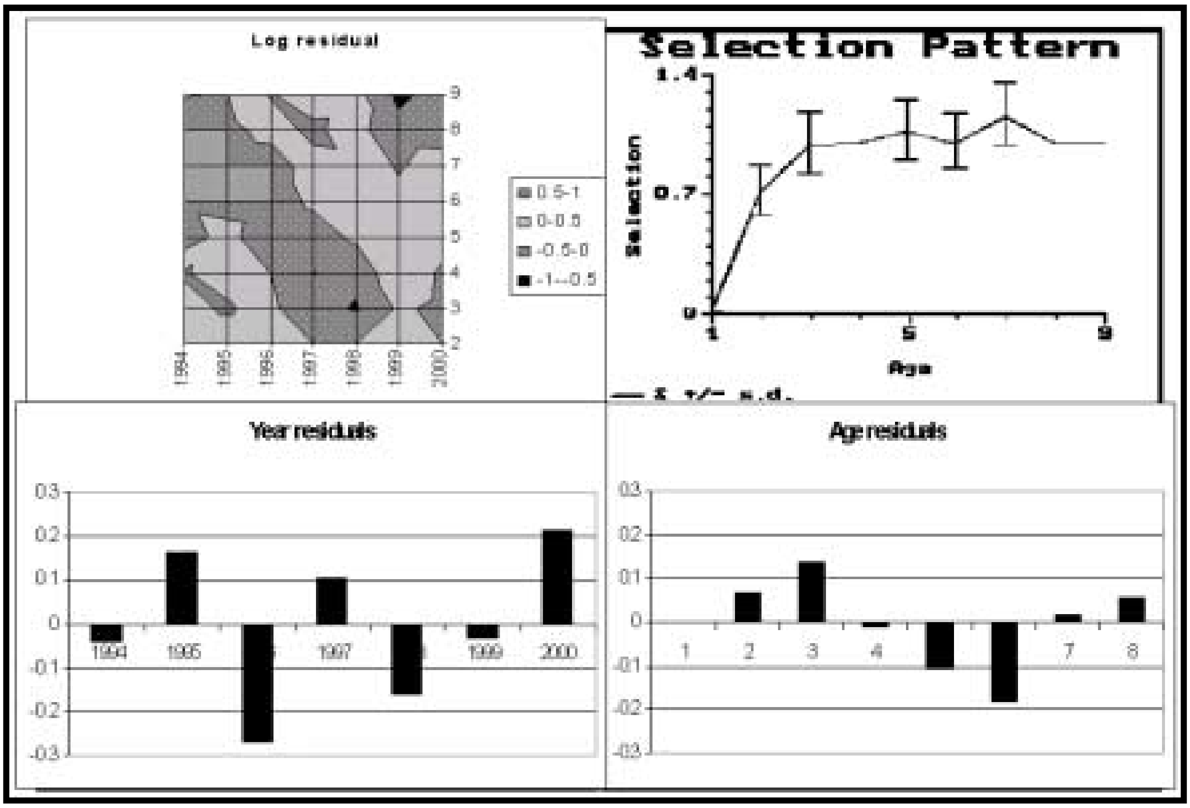


Figure 5.1.3. Herring in VIa(N). Illustration of selection patterns diagnostics, from deterministic calculation (7 year separable period). Top left, a contour plot of selection pattern residuals. Top right, estimated selection (relative to age 4) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

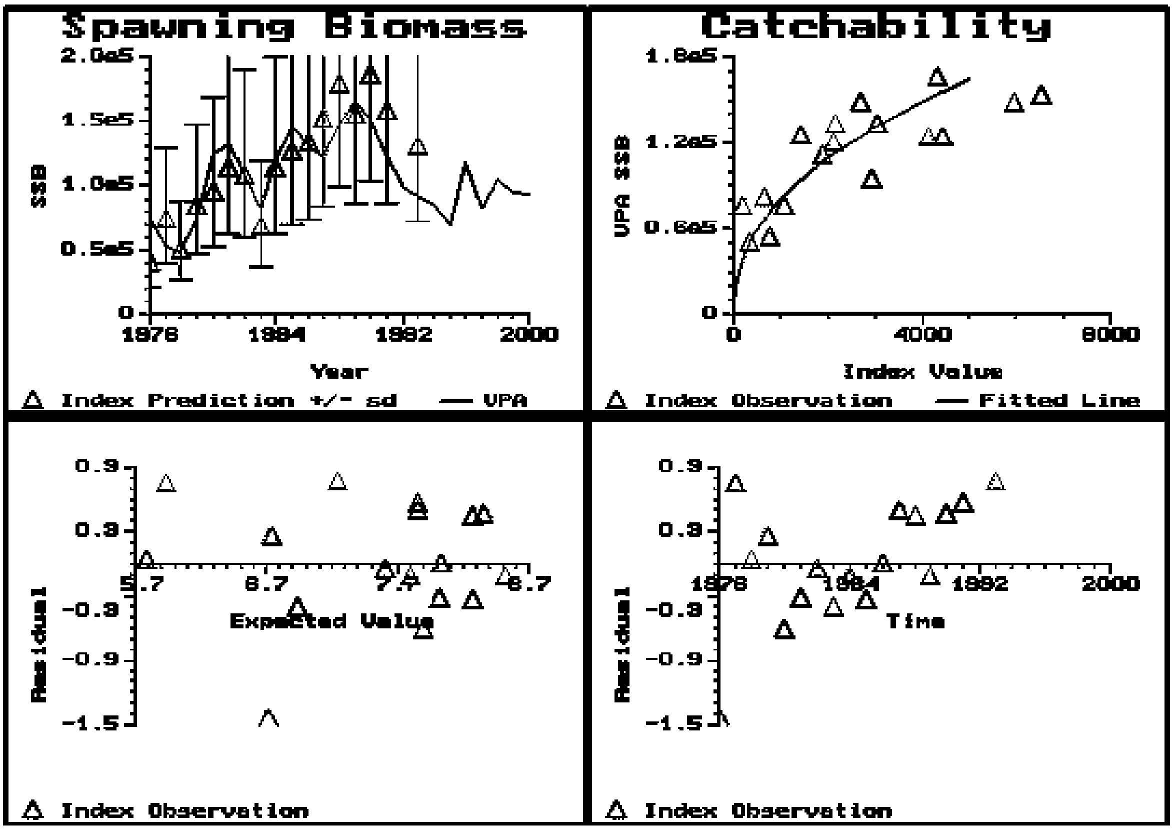


Figure 5.1.4. Herring in VIa(N). Illustration of residuals from deterministic calculation (7 year separable period). Diagnostics of the fit of the larval index against the estimated spawning biomass. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larval index. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

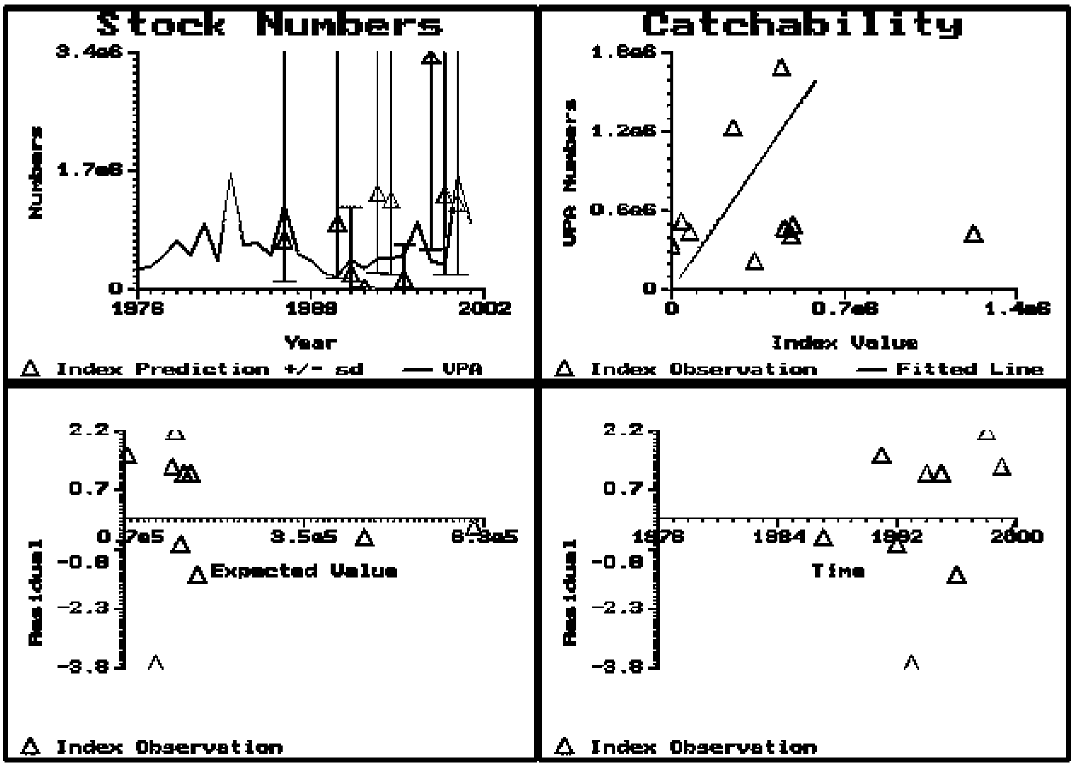


Figure 5.1.5. Herring in VIa(N). Illustration of residuals from deterministic calculation (7 year separable period). Diagnostics of the fit of the age 1 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of age 1 acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

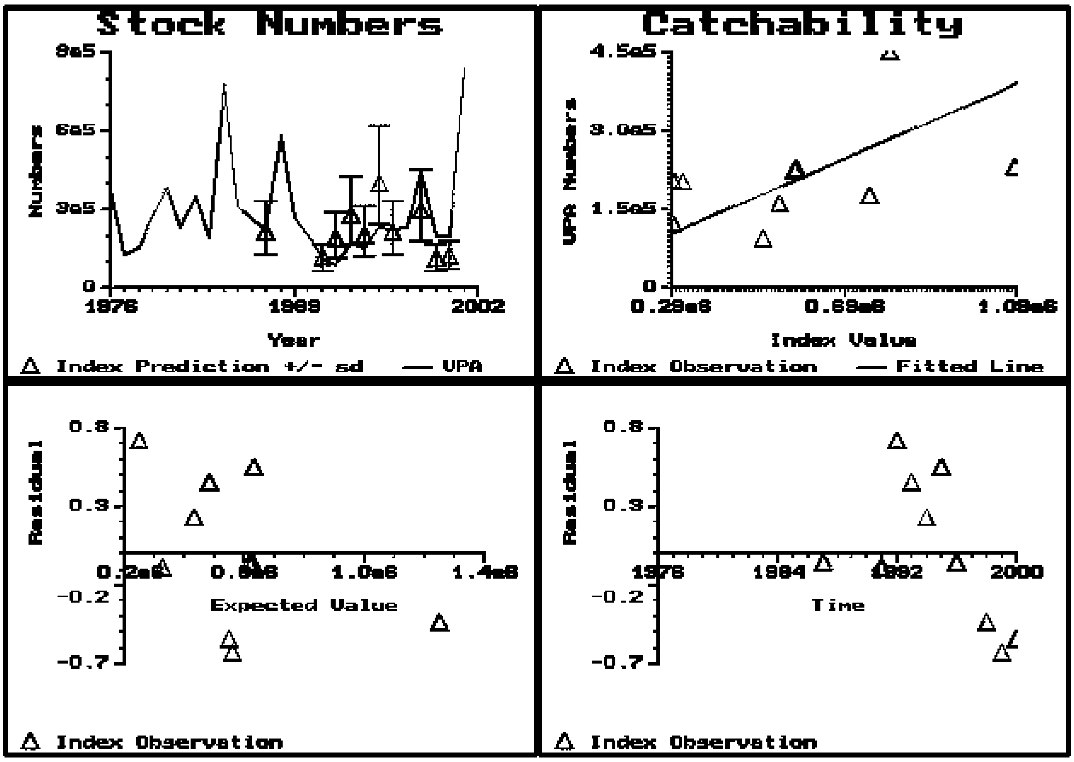


Figure 5.1.6. Herring in VIa(N). Illustration of residuals from deterministic calculation (7 year separable period). Diagnostics of the fit of the age 2 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations 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.

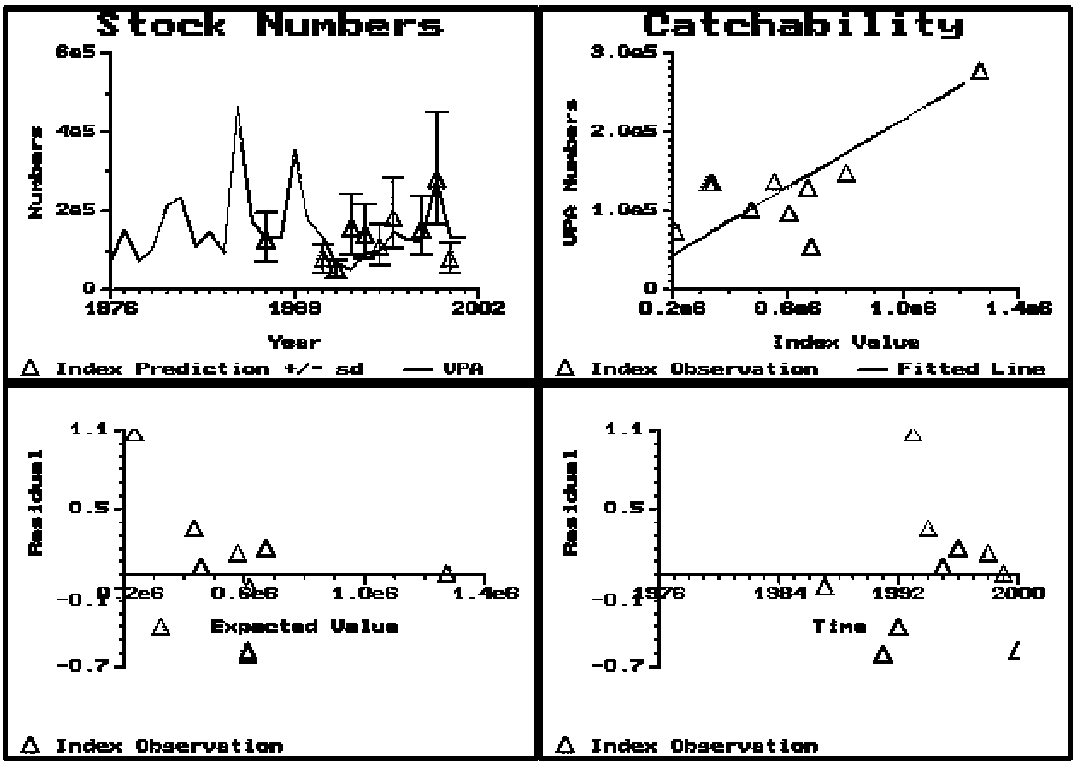


Figure 5.1.7. Herring in VIa(N). Illustration of residuals from deterministic calculation (7 year separable period). Diagnostics of the fit of the age 3 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations 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.

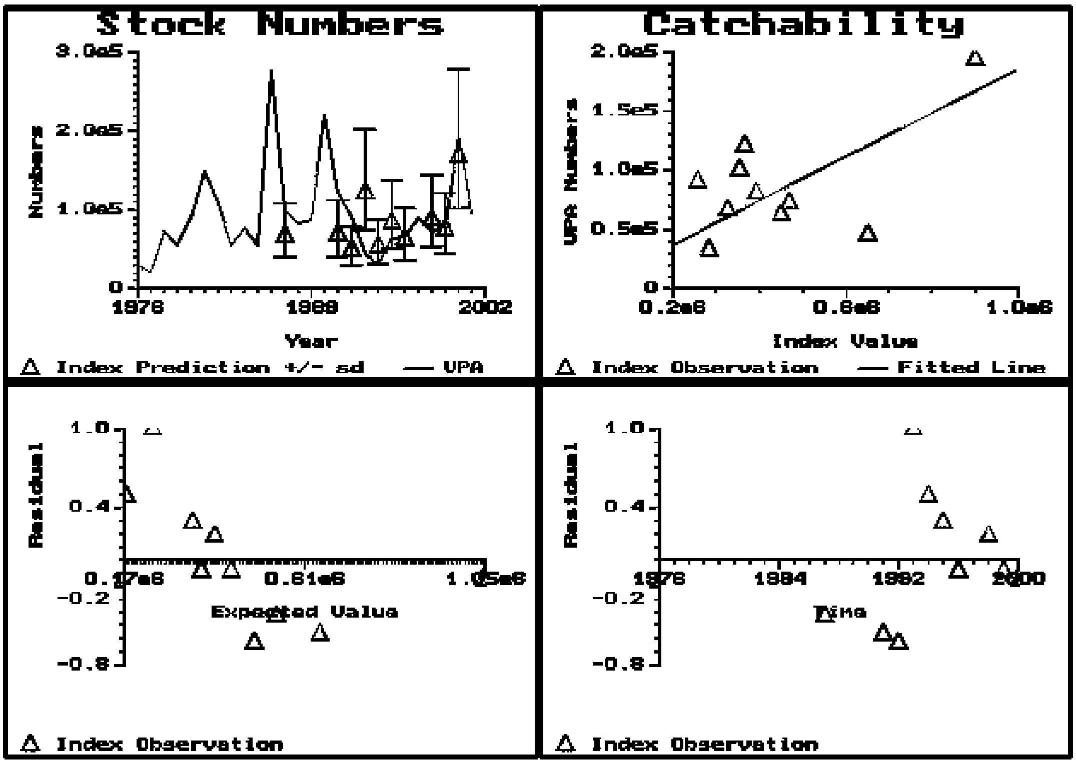


Figure 5.1.8. Herring in VIa(N). Illustration of residuals from deterministic calculation (7 year separable period). Diagnostics of the fit of the age 4 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations 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.

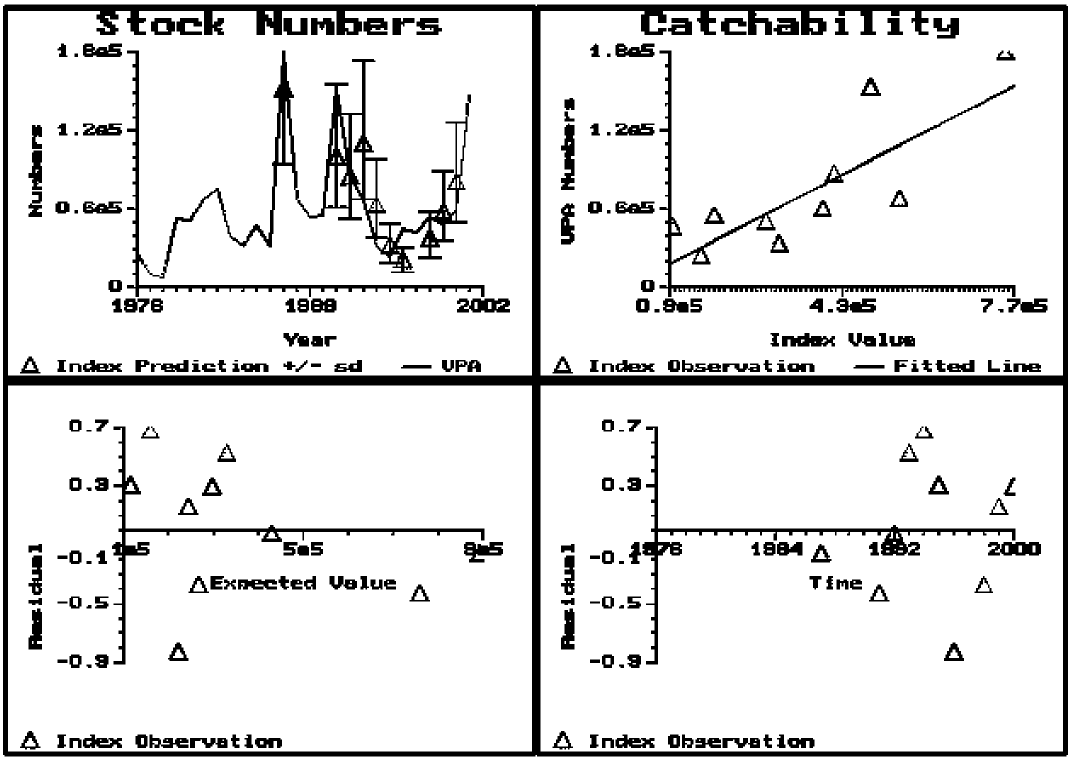


Figure 5.1.9. Herring in VIa(N). Illustration of residuals from deterministic calculation (7 year separable period). Diagnostics of the fit of the age 5 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations 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.

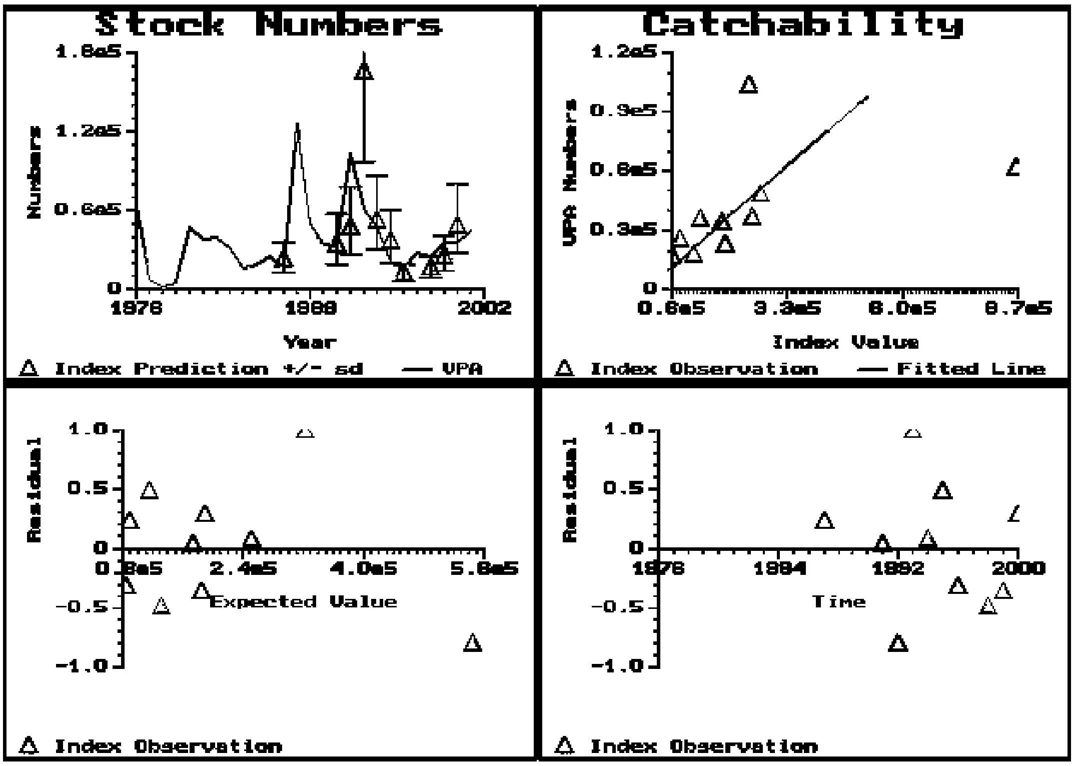


Figure 5.1.10. Herring in VIa(N). Illustration of residuals from deterministic calculation (7 year separable period). Diagnostics of the fit of the age 6 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations 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.

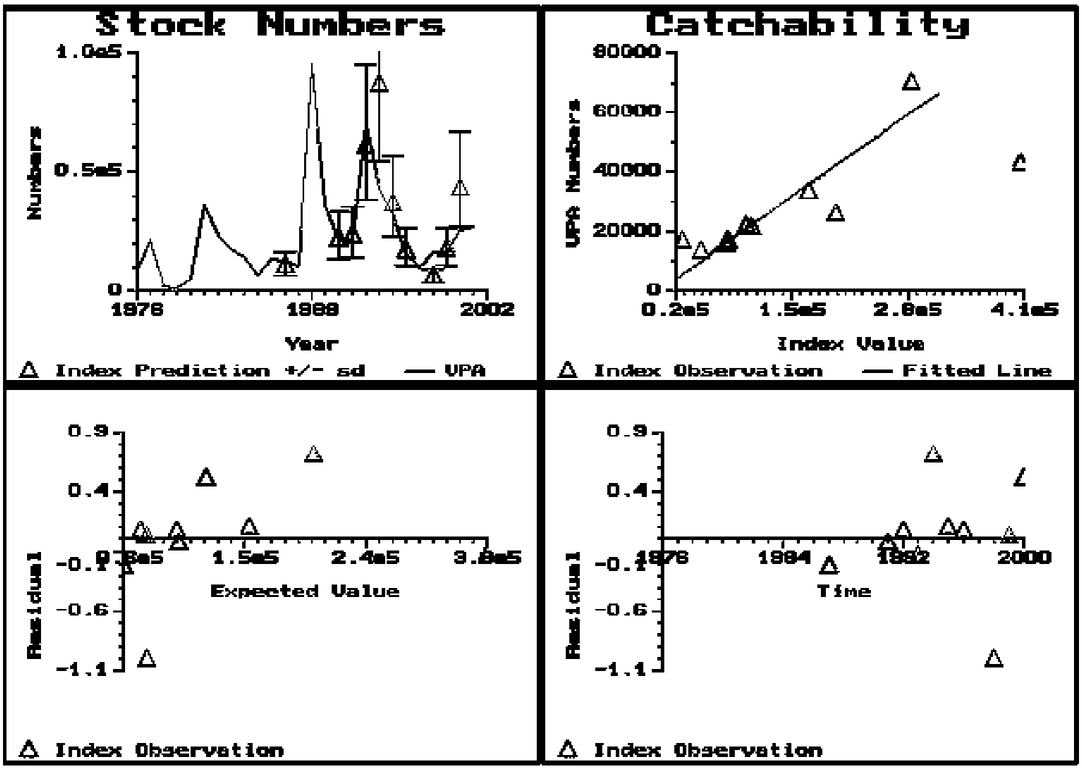


Figure 5.1.11. Herring in VIa(N). Illustration of residuals from deterministic calculation (7 year separable period). Diagnostics of the fit of the age 7 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations 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.

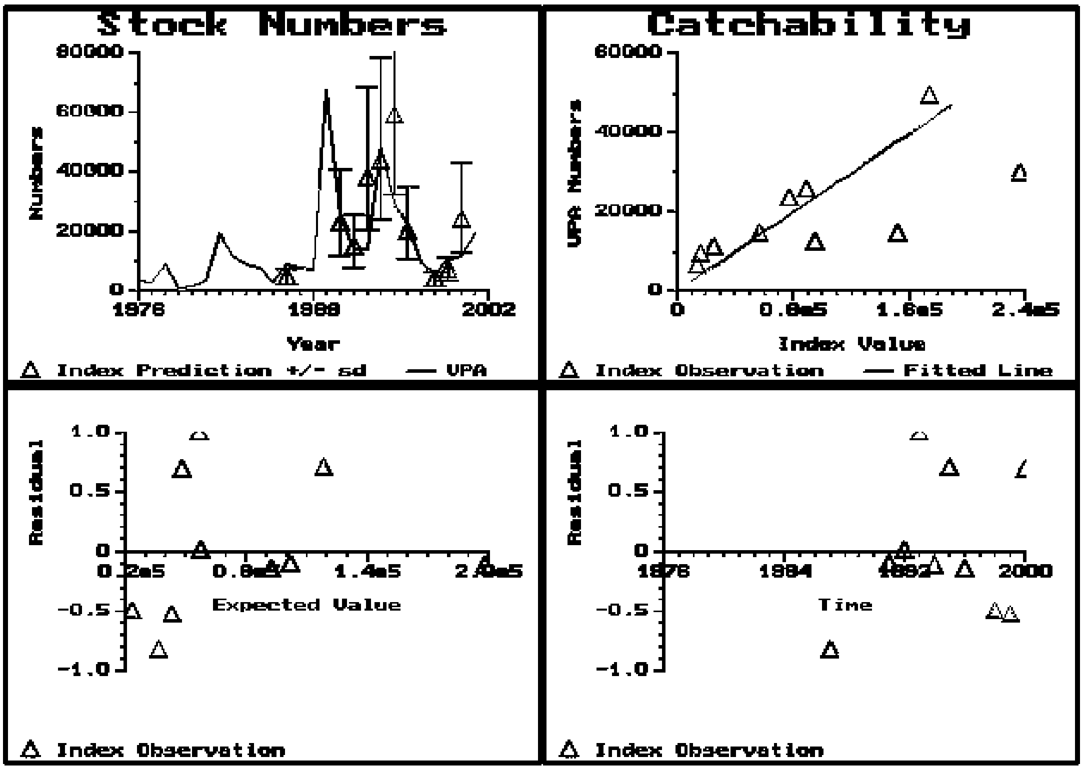


Figure 5.1.12. Herring in VIa(N). Illustration of residuals from deterministic calculation (7 year separable period). Diagnostics of the fit of the age 8 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations 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.

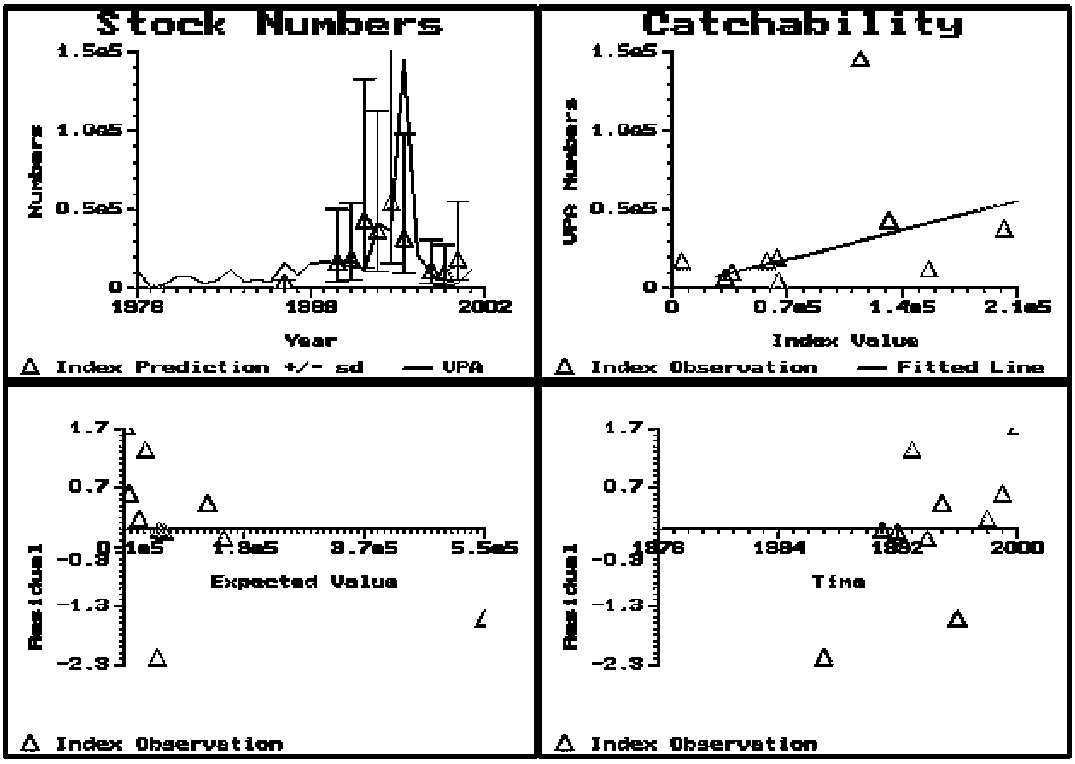


Figure 5.1.13. Herring in VIa(N). Illustration of residuals from deterministic calculation (7 year separable period). Diagnostics of the fit of the age 9 index against from acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations 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.

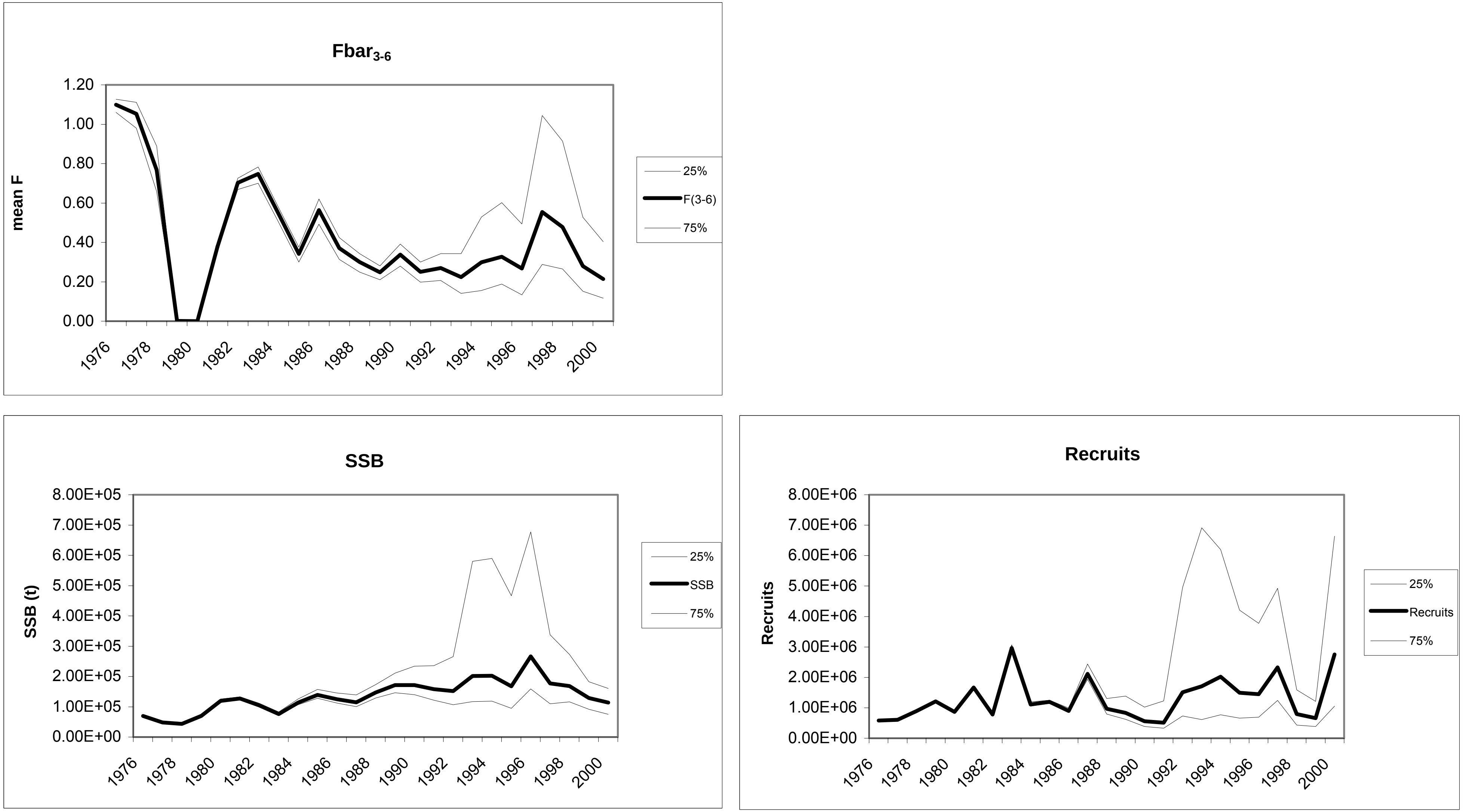
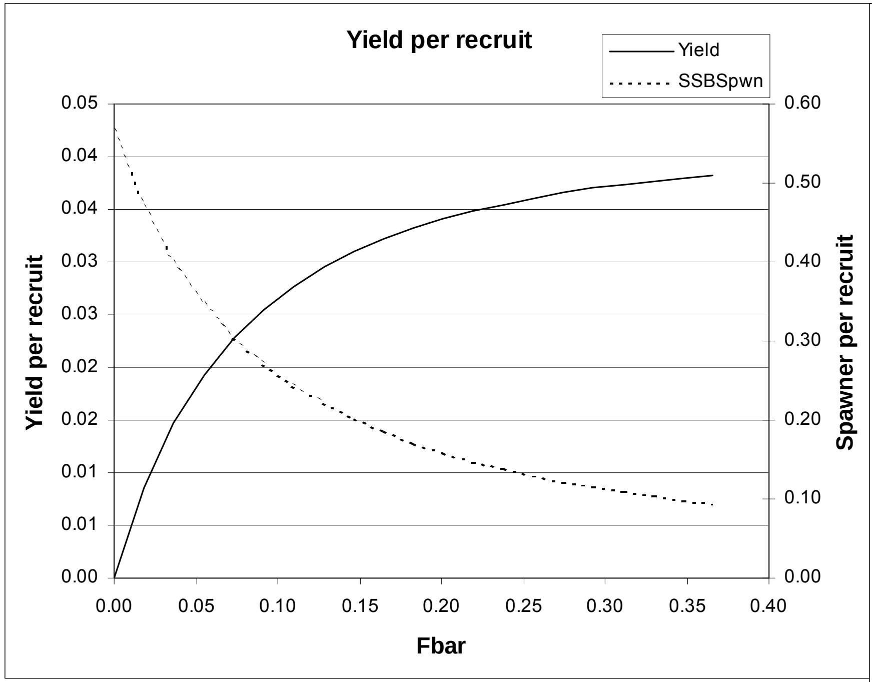
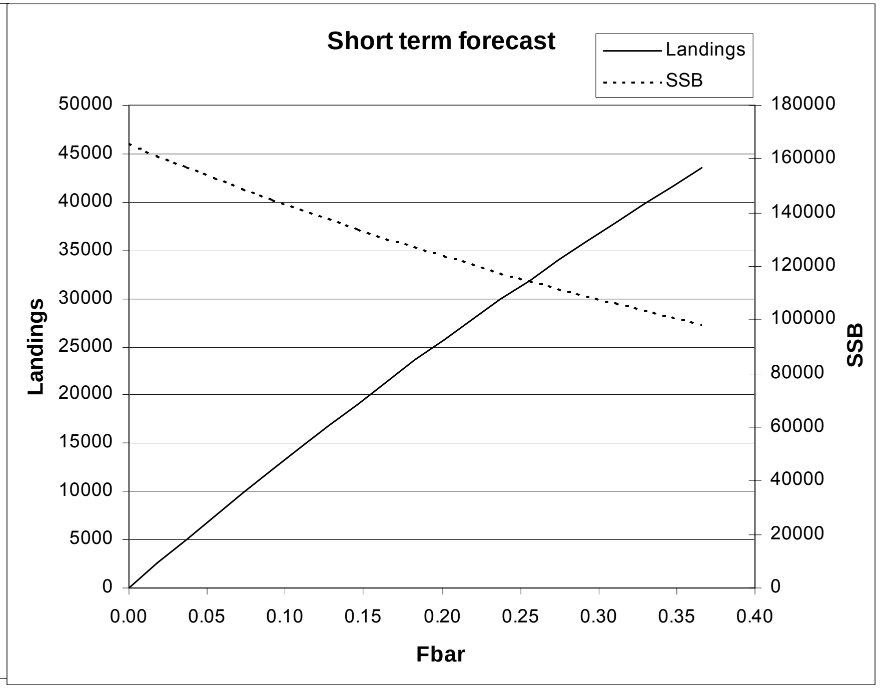


Figure 5.1.14. Herring in VIa(N). Trajectories of 25, 50 and 75 percentiles from the estimates of historical uncertainty of F, SSB and recruits produced in the final assessment. These were based on 1000 samples.





MFYPR version 1
Run: VIAN Final2
Time and date: 20:26 20/03/2001

Reference point	F multiplier	Absolute F
Fbar(3-6)	1.00	0.18
$\mathbf{F}_{max}$	>=1000000	
$\mathbf{F}_{0.1}$	0.95	0.17
F35%SPR	0.82	0.15
$\mathbf{F}_{low}$	0.72	0.13
$\mathbf{F}_{med}$	1.64	0.30
$\mathbf{F}_{high}$	4.04	0.74

Weights in kilograms

MFDP version 1
Run: Via(N) status f
TestYPR index file 15/3/99.
Time and date: 14:49 21/03/2001
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).

6 HERRING IN DIVISIONS VIA (SOUTH) AND VIIB,C

6.1 The Fishery

6.1.1 Advice and management applicable to 1999 and 2000

The TAC for this area for 2000 was 13,900 t. 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 2000 this stock was considered to be outside biological limits, although the exact state of the stock is unknown. ACFM therefore advised that the F in 2000 should be reduced to the proposed $\mathbf{F}_{pa} = 0.22$, corresponding to a catch of 13,900 t in 2000. ACFM further advised that, if it was not possible to achieve this in a single year, then a multi-annual recovery plan to reduce the fishing mortality as rapidly as possible should be agreed. The TAC set by the EU for 2001 was again 13,900 t.

6.1.2 Catch data

The main landings from this fishery in 2000 were again taken by Ireland (Table 6.1.1). Over 1,000t of the official catch was misreported as having been taken in this area. The total catch recorded for 2000 was about 15,005 t which is a decrease of over 6,000 t on the total for 1999.

The total amount of unallocated catches in 2000 was 3,607 t, compared with almost 8,000 t in 1999. The overshoot of the TAC was considerably smaller this year than in previous years.

The main reason for the decrease in the total catch was the decrease in the quota, coupled with the decrease in misreported catches.

The catches and landings recorded by each country fishing in this area from 1988–2000 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 2000 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 2000

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, and in general the fish were very scarce here. Winter/Spring spawning herring were fished off the north coast (Malin Head to Tory Island) and again off the west of Donegal (Rosbeg) during quarter 1 and 4. During 2000 the Irish fishery was again divided into two period with no directed fishing taking place from April to September.

6.1.4 Catch in numbers at age

The catches at age for this fishery since 1970 are shown in Table 6.1.2. In recent years the catches in numbers at age have been derived mainly from Irish sampling data. The age distributions in the catch were very similar to last year with the catch dominated by 2, 3 and 4 age group fish. 2 w.ring fish (1997 year class) constituted 30% of the catches, 3 w.ring fish (1996 year class) constituted 36% of the catches and 4 w.ring fish, (the 1995 year class) which, constituted 21% of the catches.

6.1.5 Quality of the catch and biological data

The management of the Irish fishery in recent years is believed to have tightened considerably and the accuracy of reported catches in recent years is believed to have improved. The numbers of samples and the biological data, together with the length distribution of the catches taken per quarter by the Irish fleet, are shown in Tables 6.1.3 and 6.1.4 respectively. Sampling of catches throughout 2000 was maintained at a satisfactory rate. Although no samples were obtained from small catches in the 3rd quarter.

6.1.6 Mean Weights at Age

The mean weights (kg) at age in the catches in 2000 are based on Irish samples taken throughout the year and are very similar to those of 1999. The mean weights from 1970–2000 are shown in Table 6.2.1.

The mean weights in the stock at spawning time have been calculated from Irish samples taken during the main spawning period that extends from October to February and are also similar to those of the previous season and are shown in Table 6.2.2.

6.2 Ground Fish Surveys

Ground fish surveys have been carried out during November along the west coast of Ireland from 1993 to 2000. More than 60 stations have been sampled each year with a bottom trawl fitted with fine mesh liner. Although these surveys are designed to obtain an abundance index for demersal fish it is hoped that they will also provide recruitment indices for herring. However, the data has not yet been properly evaluated.

6.3 Acoustic Surveys

Acoustic surveys have been carried out on this stock during the period 1994–1996 and the estimates of TSB obtained ranged from 350,000 t in 1994 to less than 35,000 t in 1996. The results from these surveys were always difficult to interpret and have not been used by previous working groups as realistic estimates of stock sizes. The difficulties were mainly due to difficulties in locating shoals at the time at which the surveys were carried out (July) because of lack of information on the distribution of the summer feeding grounds and also difficulties in catching and verifying marks located. There were no surveys in 1997 & 1998.

A herring acoustic survey was carried out throughout Division VIa (South) and VIIb during October 1999, using the Irish research vessel *R.V Celtic Voyager*. The results were presented in a working document to the 2000 WG (Molloy and Kelly, W.D. 2000). The 1999 survey was considerably hampered by bad weather and problems with the fishing gear and the total area was not adequately covered. Very few herring shoals were located during the survey, apart from some small marks located off the spawning grounds around Achill Island where a commercial fishery was taking place. Reports from fishermen engaged in this fishery indicated that the marks were very small and difficult to locate. The total stock biomass estimated from the survey was 23,800 t and the spawning stock biomass was 22,800 t. The survey was not considered to give a realistic estimate of the total stock size because it did not cover the northern part of the area where in recent years most of the important fishery has taken place. In addition the stock size estimated was considered to be unrealistically low in view of the subsequent catch taken from the fishery which was over 20,000 t in the October to February period.

The survey in 2000 was carried out in late November and early December. This survey was carried out on a commercial vessel using the same acoustic and fishing gear as used in the last years survey carried out on the RV Celtic Voyager. The area coverage was improved and unlike the survey in the previous year, the majority of the original survey design was completed and a greater degree of effort was given to surveying the inshore spawning grounds. The fact that fish were located at the offshore end of some of the transects suggests that a proportion of stock was not contained within the area surveyed. It is worth noting that certain herring shoals encountered during the survey were fast moving and as a result were very difficult to catch. Ideally more trawls should have been made which would have reduced the proportion of this biomass estimate which was attributed to the “probably herring” category.

Analysis of the commercial catch data over the past six years would indicate 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

6.4 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 Working Groups have therefore only carried out VPA analyses to study the development of the stock and only tentative stock projections have been made. The results of those analyses have indicated that the stock has decreased in recent years from a high level in 1988. This high level was as the result of recruitment of the exceptionally strong 1985 year class which dominated the catches in this area for a long period. The stock is considered to be composed of two spawning components both of which spawn along the Irish coast. A historical examination of the fishery indicates that the winter/spring spawning component dominated the catches in the early part of the century but the autumn spawners dominated in the sixties and seventies. In recent years both components have been present but increasing catches appeared to have been made on the winter/spring spawners.

In 1998 the Working Group carried out an analysis of the relationship between estimates of recruitment and terminal F on the combined components in order to define a range of consistent F's to be used in the assessment. The analysis indicated that either recruitment had been exceptional in 1997 or that there had been a considerable increase in fishing mortality. Indications from the fishery and the catch in numbers at age suggested that the latter was the more likely conclusion.

In 1999 the Working Group carried out a detailed analysis of the development of the two components that constitute the stock. This analysis was considered necessary because of the possibility of the development of a new winter/spring spawning component and the decline of the traditional autumn spawning component. It was considered important to determine if both components were declining at the same extent. The overall conclusions of the analysis suggested that there may not in fact be two separate stock components because of the similarities in recruitment and age distributions. The increase in the winter/spring spawners may be due to a gradual change in spawning time rather than the emergence of a new spawning component.

In 2000 the Working Group suggested that the value of F (0.60) in 1998, assumed by the 1999 Working Group, was too low compared with that estimated in 2000 for 1998 (range between 0.8 and 1.1). Similarly, that the value assumed for terminal F in 1997 (0.6) was too high and that it may range from 0.46 to 0.55. As these values were more accurately evaluated in 2000 it was suggested that the most appropriate value of terminal F would appear to lie somewhere between 0.4 and 0.5 as this range produced F values for 1997 and 1998 as described above.

6.4.1 Date exploration and preliminary assessments

The assessment of this stock has been problematic because the only available data are catch numbers at age. For some years, the Separable VPA has been used for a range of terminal fishing mortalities to get some indication of the recent development of the stock. There is, however, no objective way of fixing a terminal F. In order to find some more objective estimates of the terminal fishing mortality, the assessment model ISVPA was used. 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 be zero, but other constraints are possible. The objective function which is minimised is the median of the squared log catch residuals. Using the median instead of the sum renders the estimate more robust to outliers in the data (Kizner Z.I. & Vasilyev. D.1997, Vasilyev, D, Belikov, S, Shamray, E 2000).

The model was first run with various possible choices of constraints on the phi matrix, with quite similar results. Therefore, the standard constraint was used for further runs. Then, the model was run with a range of choices for the year range and age range. Some results are shown in Figures 6.5.1.1-2 . There are strong year class dependent residuals in the first years from 1990 onwards, and at age 1. The catch data may be less reliable in the early period, and 1-group fish are poorly selected by the fishery. Since this model relies strongly on the separable hypothesis, using, the shorter period and excluding age 1 was considered to be the most adequate choice. Moreover, when comparing the performance with 1999 as the terminal year (Figure 6.5.1.3), the results using the shorter time period were more consistent with this years assessment up to 2000.

The results indicate a flat selection from age 4 onwards (Figure 6.5.1.4). The fishing mortality (Figure 6.5.1.3) appears to have increased strongly until 1998, and to have decreased strongly after that. F in the final year was determined to be in the range of 0.4 to 0.6 with the latter giving the best model fit to the data. However the objective function profile for

[*] in the original document the nomenclature *phi(a,y)=f(y)*s(a)* is used, but changed here to avoid confusion with fishing mortality f.

f(y) is very flat and it is possible to select a range of values of F in the range of 0.4 to 0.6 which produce only a marginally poorer fit at the minimum (Figure 6.5.1.5).

Because the ISVPA produced the best fit in the range of F_{00} = 0.4 to 0.6 with an optimum at 0.6 it was decided that this value would be the best choice for terminal F and that the SVPA model would be used for the assessment to maintain consistency with previous years.

6.4.2 Results of the assessment

The present Working Group carried out a separable VPA on the total stock using a range of terminal F values from 0.4 to 0.6. 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' assessment the weight of the 1 year-old group was reduced to account for poor selectivity at this age. An example of the assessment output with 0.6 selected for terminal F is given in Table 6.5.2.1. Example outputs with terminal F at 0.6 and F at 0.4 are given in Tables 6.5.2.1 and 6.5.2.2.

The decline in SSB appears to have stopped around 1996 and the most recent trend is dependent on the value of the input F. In the absence of ancillary data it is not possible to make a choice of final F based on the results from the separable VPA. In trying to keep consistency with the results from previous assessments a terminal F = 0.2 which results in F = 0.5 in 1999 could be appropriate. However, results from applying ISVPA, presented above, suggest that a terminal F value of 0.6 would result in a better fit to the catch data. Estimated SSB trajectories and recruitment from 1970 onwards are shown in Figure 6.5.2.1 for a range of terminal Fs from 0.4 to 0.6. Using a terminal F of 0.6 in 2000 suggests that the actual levels of fishing mortality from 1997 onwards may have been higher than those assumed by the Working Group in 2000. In the absence of any fishery independent information this must be considered as the best estimate of the current state of the stock.

6.5 Stock Forecasts and Catch Predictions

Even though there is difficulty in estimating the current size of the stock it was decided to present catch projections based on estimates of F in 2000 of 0.6 and 0.4. The SSB, derived from the SVPA, using terminal F's of 0.6 and 0.4 were projected forward to 2002, assuming a catch of 13,900 t in 2001. This catch correspond to the TAC in 2001. Recruitment was based on the geometric mean of the period (1970 – 1998). This period gives recruitment at 712 at F = 0.6 and 721 million and F=0.4. The input data for F = 0.6 and 0.4 are shown in Tables 6.6.1 and 6.6.2 respectively.

The results, of the predictions derived from using a terminal F's of 0.6 and 0.4, are shown in Tables 6.6.3 - 6.6.6. If F in 2000 is 0.6 and the TAC of 13,900 is taken in 2001and the same fishing effort is applied in 2002 then the SSB will increase slightly from around 50,000t in 2001 to 58,000t in 2003. If 0.4 is taken as the value of F in 2000 and the stock is fished under the same scenario the stock will remain stable at around 88,000t.

If F in 2000 is taken at 0.4 and the current TAC is taken in 2002 the SSB will increase to about 110,000t ($\mathbf{B}_{pa}$) in 2003. If F is assumed to be 0.6 in 2000 the stock will not increase to $\mathbf{B}_{pa}$ by 2003 under this scenario.

Because of the uncertainty that surrounds the current stock size it was decided not to carry out stock and recruitment plots or yield per recruit curves.

6.6 Management Considerations

The results of the non tuned assessment indicate that the spawning stock has declined considerably in recent years and is now at a low level. There has been no substantial recruitment to the stock in recent years although there is some indication that it may have improved slightly. The perceived low stock size may be due to a combination of the decline in stock accentuated by a more northerly distribution of the stock in recent years. It is also interesting to note the increasing importance of winter/spring spawning fish in this area. Traditionally the fisheries in this area, which were extremely important in the early part of the century, were all based on winter/spring spawning herring compared with the situation that prevailed in the 1960s and 1970s when the fisheries mainly exploited an autumn spawning component. There is some indication that the rate of decline in stock size has decreased or may even have stopped. However this perception is dependent on the assumed level of current F. It will not be possible to present a more precise assessment on this stock until a series of acoustic surveys have been carried out. It is also important that an index of recruitment should be made available as soon as possible. In this respect it is important that the ground fish surveys carried out by Ireland should be properly evaluated.

Precautionary reference points.

As this assessment is still quite uncertain there was no revision of the precautionary reference points for this stock. The precautionary reference points in relation to this stock were discussed in the 1999 Working Group Report (ICES 1999a). The 1999 WG showed that recruitment does not show any clear dependence on the SSB and that apart from the very high 1985 year class has been quite stable but at a much lower level. The suggested $\mathbf{F}_{loss}$ value is about 0.33 and the $\mathbf{F}_{pa}$ 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 is well below the $\mathbf{B}_{pa}$ (110,000 t) and the fishing mortality is well above the $\mathbf{F}_{pa.}$ = 0.22.

6.7 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 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. Estimated Herring catches in tonnes in Divisions VIa (South) and VIIb,c, 1988–2000. 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[1]
France	
Germany	
Ireland	10,164
Netherlands	1,234
UK	
Unallocated	3,607
Total landings	15,005
Discards	-
Total catch	15,005

[1]Provisional according to text.

Table 6.1.2. Catch in numbers at age for herring in VIaS and VIIbc from 1970 to 2000.

	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

Table 6.1.3. Divisions VIa (South) and VIIb. Sampling intensity of catches in 2000.

Country	Q	Catch[1]	No. of samples	No. of age readings	No. of fish measured	Aged per 1000 t.	Estimate of discards
Ireland	1	1,923	7	250	1326	130	No
	2	993	3	144	739	145	No
	3	456	0	0	0	0	No
	4	11,633	10	394	2405	33	No

[1]including Division VIa (North).

Table 6.1.4. Divisions VIa and VIIb. Length distributions of Irish catches (pelagic trawlers) per quarter (10^3) in 2000.

Length (cm)	Quarter1 2000	Quarter 2 2000	Quarter 3 2000	Quarter 4 2000
20.5		9		31
21	9	44	20	125
21.5	18	52	15	156
22	18	236	82	688
22.5	27	244	97	938
23	110	236	194	2,219
23.5	192	209	158	2,250
24	192	279	362	5,376
24.5	301	192	362	4,813
25	630	401	229	5,344
25.5	1,086	340	260	5,688
26	1,625	672	372	9,782
26.5	1,862	654	275	8,345
27	2,017	733	316	10,939
27.5	1,488	567	189	7,626
28	1,150	410	148	6,094
28.5	630	436	82	2,719
29	301	262	31	1,531
29.5	146	209		375
30	128	113		125
30.5	91	70		
31	55	44		
31.5	0	17		
32	18	9		
32.5	9	9		
TOTAL numbers	12,104	6,449	3,191	75,165

Table 6.2.1. Mean weight in the catch for herring in VIaS and VIIbc from 1970 to 2000.

	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 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

Table 6.2.2 Mean weight in the stock for herring in VIaS and VIIbc from 1970 to 2000.

	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9
1970	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1971	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1972	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1973	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1974	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1975	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1976	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1977	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1978	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1979	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1980	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1981	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1982	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1983	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1984	0.12	0.169	0.21	0.236	0.26	0.273	0.283	0.29	0.296
1985	0.1	0.15	0.196	0.227	0.238	0.251	0.252	0.269	0.284
1986	0.098	0.169	0.209	0.238	0.256	0.276	0.28	0.287	0.312
1987	0.097	0.164	0.206	0.233	0.252	0.271	0.28	0.296	0.317
1988	0.097	0.164	0.206	0.233	0.252	0.271	0.28	0.296	0.317
1989	0.138	0.157	0.168	0.182	0.2	0.217	0.227	0.238	0.245
1990	0.113	0.152	0.17	0.18	0.2	0.217	0.225	0.233	0.255
1991	0.102	0.149	0.174	0.19	0.195	0.206	0.226	0.236	0.248
1992	0.102	0.144	0.167	0.182	0.194	0.197	0.214	0.218	0.242
1993	0.118	0.166	0.196	0.205	0.214	0.22	0.223	0.242	0.258
1994	0.098	0.156	0.192	0.209	0.216	0.223	0.226	0.23	0.247
1995	0.09	0.144	0.181	0.203	0.217	0.226	0.227	0.239	0.246
1996	0.086	0.137	0.186	0.206	0.219	0.234	0.233	0.249	0.253
1997	0.094	0.135	0.169	0.194	0.21	0.224	0.231	0.23	0.239
1998	0.095	0.136	0.145	0.173	0.191	0.196	0.202	0.222	0.217
1999	0.104	0.145	0.154	0.174	0.2	0.222	0.23	0.24	0.246
2000	0.1	0.134	0.157	0.177	0.197	0.207	0.217	0.23	0.245

Table 6.5.2.1. Herring VIaS, VIIbc. Output from a separable VPA with Terminal F = 0.6

Run title : Herring VIa(S) VIIbc (run: PRE wg 2001) At 21/03/20019:31

Table 8 Fishing mortality (F) at age

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	.0005	.0017	.0022	.0196	.0093	.0297	.0402	.0127	.0160	.0101	.0090
2	.3895	.0499	.1192	.1932	.1984	.2564	.2682	.2456	.2585	.1709	.1461
3	.2491	.1321	.2460	.3112	.3271	.2761	.4176	.2026	.2463	.1996	.3716
4	.1854	.1482	.1562	.3105	.5107	.3861	.4960	.3247	.3007	.2745	.4113
5	.1782	.1626	.1999	.2538	.5537	.4974	.5995	.3956	.3062	.3179	.4879
6	.1591	.2456	.2513	.3166	.4795	.6724	.5979	.4404	.2686	.3739	.4193
7	.2121	.2135	.4022	.3401	.4494	.6014	.7246	.4068	.3058	.4240	.5322
8	.2684	.2234	.3648	.2932	.6909	.7724	.8069	.3681	.4534	.5255	.6255
+gp	.2684	.2234	.3648	.2932	.6909	.7724	.8069	.3681	.4534	.5255	.6255
0FBAR3-6	.1929	.1721	.2134	.2980	.4678	.4580	.5278	.3408	.2805	.2915	.4225

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.0040	.0018	.0011	.0049	.0130	.0016	.0062	.0000	.0050	.0018
2	.1507	.0923	.2286	.1236	.0547	.0760	.1658	.0301	.0422	.1173
3	.2371	.1743	.4131	.2448	.1508	.1261	.3559	.2785	.1123	.1695
4	.2937	.2365	.4000	.2427	.1555	.2067	.3030	.2945	.2377	.3096
5	.3379	.2476	.4028	.1681	.2122	.2400	.4755	.2490	.2211	.3232
6	.5113	.3308	.3724	.2507	.2417	.2054	.3730	.3712	.2239	.2965
7	.2976	.2707	.4414	.1778	.2552	.2553	.5071	.2589	.3161	.3583
8	.3655	.4451	.3279	.2037	.3184	.2104	.4197	.1552	.2209	.1452
+gp	.3655	.4451	.3279	.2037	.3184	.2104	.4197	.1552	.2209	.1452
0FBAR3-6	.3450	.2473	.3971	.2266	.1901	.1945	.3768	.2983	.1988	.2747

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	FBAR98-**
1	.0021	.0100	.0005	.0236	.0010	.0098	.0164	.0224	.0090	.0066	.0127
2	.1476	.1033	.1722	.3380	.1502	.1929	.2612	.3839	.3687	.2186	.3237
3	.1963	.2910	.2286	.4555	.3959	.5400	.3434	.7896	.7061	.4008	.6322
4	.1474	.2794	.4911	.2521	.5133	.6874	.6298	1.2077	.9387	.6067	.9177
5	.3079	.1955	.3712	.4520	.4442	.4976	.7167	1.3880	1.1488	.6899	1.0756
6	.3711	.3435	.2971	.3424	.6270	.6807	.5665	1.2814	1.0505	.6729	1.0016
7	.3301	.2701	.5362	.2779	.2112	.6709	.8838	1.3460	.8998	.4911	.9123
8	.4005	.2726	.3678	.4622	.4356	.8220	.5851	1.0345	1.0421	.5957	.8907
+gp	.4005	.2726	.3678	.4622	.4356	.8220	.5851	1.0345	1.0421	.5957	
0FBAR3-6	.2557	.2774	.3470	.3755	.4951	.6014	.5641	1.1667	.9610	.5926	

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

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	399215	805333	721419	521781	576266	397059	665481	560352	1014922	933319	503357
2	124769	146785	295753	264814	188220	210034	141797	235179	203534	367458	339907
3	129611	62611	103451	194488	161711	114346	120401	80334	136289	116430	229466
4	82106	82721	44918	66225	116646	95458	71033	64924	53712	87223	78073
5	25042	61720	64539	34764	43930	63338	58706	39138	42458	35978	59978
6	286717	18961	47466	47818	24404	22848	34851	29166	23843	28284	23689
7	16366	221277	13420	33407	31525	13670	10554	17343	16989	16493	17609
8	7426	11978	161729	8122	21513	18198	6779	4627	10448	11322	9766
+gp	8513	11318	14757	210287	63980	62153	29601	14118	9546	10470	11992
0TOTAL	1079764	1422703	1467451	1381706	1228196	997104	1139203	1045182	1511742	1606976	1273837

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	648016	669949	2201412	898240	1178334	907259	3110952	526637	711461	787985
2	183514	237449	246026	808973	328819	427900	333229	1137388	193739	260428
3	217584	116930	160391	145011	529648	230627	293794	209151	817633	137599
4	129564	140538	80418	86877	92941	372947	166450	168505	129607	598334
5	46821	87394	100384	48774	61667	71983	274446	111246	113574	92459
6	33318	30217	61732	60713	37306	45130	51237	154357	78474	82378
7	14093	18079	19641	38492	42756	26508	33253	31928	96356	56763
8	9358	9469	12479	11430	29157	29972	18581	18121	22300	63557
+gp	17861	8379	15935	22882	8332	11758	31122	14339	16070	8776
0TOTAL	1300129	1318405	2898420	2121392	2308959	2124084	4313061	2371673	2179214	2088279

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	GMST70-8	AMST70-98
	497132	411423	611186	793038	436301	773668	723191	529963	420286	744772	0	712238	810850
2	289373	182493	149847	224732	284941	160341	281839	261712	190642	153224	272182	255768	293482
3	171575	184952	121921	93453	118735	181641	97941	160803	132067	97682	91224	158673	187535
4	95091	115434	113191	79423	48518	65431	86664	56883	59773	53367	53566	98033	119650
5	397261	74247	78989	62678	55851	26275	29774	41771	15383	21154	26325	63038	79489
6	60559	264195	55254	49311	36089	32411	14455	13156	9433	4413	9601	43604	60287
7	55414	37808	169549	37146	31682	17443	14847	7423	3305	2985	2037	27649	39925
8	35895	36045	26113	89740	25456	23210	8069	5551	1748	1216	1653	17221	25738
+gp	24309	27621	20469	28546	42150	12053	10067	4756	1528	2821	2014		
TOTAL	1626608	1334219	1346518	1458067	1079723	1292473	1266846	1082017	834165	1081634	458602		

Table 6.5.2.1 Herring VIaS, VIIbc. cont.

Traditional VPA Terminal populations from weighted Separable populations

	RECRUITS Age1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR3-6
1970	399215	209676	128049	20306	.1586	.1929
1971	805333	244786	120496	15044	.1249	.1721
1972	721419	253683	127016	23474	.1848	.2134
1973	521781	259986	146713	36719	.2503	.2980
1974	576266	214632	97802	36589	.3741	.4678
1975	397059	179932	88537	38764	.4378	.4580
1976	665481	184362	67412	32767	.4861	.5278
1977	560352	167747	72360	20567	.2842	.3408
1978	1014922	225696	75772	19715	.2602	.2805
1979	933319	247259	100196	22608	.2256	.2915
1980	503357	217887	110812	30124	.2718	.4225
1981	648016	218304	104539	24922	.2384	.3450
1982	669949	219559	108235	19209	.1775	.2473
1983	2201412	415256	106130	32988	.3108	.3971
1984	898240	345697	182813	27450	.1502	.2266
1985	1178334	337089	174296	23343	.1339	.1901
1986	907259	348765	207867	28785	.1385	.1945
1987	3110952	563438	185502	48600	.2620	.3768
1988	526637	408676	279008	29100	.1043	.2983
1989	711461	360410	210460	29210	.1388	.1988
1990	787985	325905	181538	43969	.2422	.2747
1991	497132	258710	157940	37700	.2387	.2557
1992	411423	209224	126704	31856	.2514	.2774
1993	611186	222564	106487	36763	.3452	.3470
1994	793038	207939	90585	33908	.3743	.3755
1995	436301	155559	82052	27792	.3387	.4951
1996	773668	161998	59855	32534	.5435	.6014
1997	723191	156575	58093	27225	.4686	.5641
1998	529963	133417	44215	38895	.8797	1.1667
1999	420286	108818	36990	26109	.7058	.9610
2000	744772	126491	34687	15005	.4326	.5926
Arith. Mean	796120	248066	118489	29421	.3075	.3887
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 6.5.2.2. Output from sVPA with terminal F =0.4

Run title : Herring VIa(S) VIIbc (run: PRE wg 2001)

At 17/03/2001 9:26

Traditional VPA Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR,	1970,
AGE	
1,	.0005,
2,	.3910,
3,	.2506,
4,	.1870,
5,	.1804,
6,	.1618,
7,	.2169,
8,	.2762,
+gp,	.2762,
0 FBAR 3- 6,	.1950,

Table 8 Fishing mortality (F) at age

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
1,	.0017,	.0022,	.0197,	.0093,	.0298,	.0404,	.0128,	.0161,	.0102,	.0091,
2,	.0500,	.1195,	.1939,	.1992,	.2576,	.2698,	.2470,	.2603,	.1722,	.1474,
3,	.1327,	.2468,	.3124,	.3286,	.2775,	.4203,	.2041,	.2482,	.2014,	.3754,
4,	.1493,	.1571,	.3118,	.5135,	.3886,	.4998,	.3277,	.3037,	.2772,	.4162,
5,	.1643,	.2016,	.2556,	.5574,	.5020,	.6059,	.4002,	.3101,	.3223,	.4951,
6,	.2495,	.2545,	.3203,	.4843,	.6808,	.6076,	.4482,	.2729,	.3805,	.4277,
7,	.2179,	.4110,	.3461,	.4571,	.6117,	.7429,	.4176,	.3137,	.4338,	.5473,
8,	.2297,	.3748,	.3024,	.7117,	.7972,	.8355,	.3842,	.4723,	.5464,	.6506,
+gp,	.2297,	.3748,	.3024,	.7117,	.7972,	.8355,	.3842,	.4723,	.5464,	.6506,
0 FBAR 3- 6,	.1740,	.2150,	.3000,	.4710,	.4622,	.5334,	.3451,	.2837,	.2953,	.4286,

1

Run title : Herring VIa(S) VIIbc (run: PRE wg 2001)

At 17/03/2001 9:26

Traditional VPA Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
1,	.0040,	.0018,	.0011,	.0050,	.0130,	.0016,	.0062,	.0000,	.0050,	.0018,
2,	.1520,	.0931,	.2306,	.1245,	.0551,	.0765,	.1666,	.0302,	.0422,	.1172,
3,	.2397,	.1762,	.4173,	.2476,	.1521,	.1271,	.3585,	.2802,	.1127,	.1697,
4,	.2980,	.2398,	.4057,	.2462,	.1577,	.2089,	.3060,	.2975,	.2396,	.3110,
5,	.3437,	.2523,	.4106,	.1712,	.2160,	.2440,	.4826,	.2523,	.2241,	.3265,
6,	.5239,	.3388,	.3821,	.2574,	.2473,	.2099,	.3815,	.3798,	.2277,	.3016,
7,	.3061,	.2805,	.4574,	.1839,	.2641,	.2629,	.5233,	.2671,	.3264,	.3665,
8,	.3820,	.4638,	.3442,	.2140,	.3327,	.2198,	.4374,	.1621,	.2298,	.1512,
+gp,	.3820,	.4638,	.3442,	.2140,	.3327,	.2198,	.4374,	.1621,	.2298,	.1512,
0 FBAR 3- 6,	.3513,	.2518,	.4039,	.2306,	.1933,	.1975,	.3822,	.3025,	.2010,	.2772,

Table 6.5.2.2. Continued

Table 8 Fishing mortality (F) at age

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	FBAR 98-**
AGE											
1	.0021	.0100	.0005	.0233	.0010	.0093	.0146	.0175	.0061	.0040	.0092
2	.1474	.1029	.1714	.3359	.1486	.1885	.2471	.3342	.2760	.1423	.2508
3	.1961	.2905	.2275	.4528	.3923	.5314	.3331	.7198	.5618	.2691	.5169
4	.1476	.2790	.4898	.2506	.5083	.6765	.6121	1.1293	.7633	.4076	.7667
5	.3098	.1957	.3705	.4502	.4404	.4895	.6942	1.2825	.9418	.4595	.8946
6	.3765	.3465	.2976	.3415	.6226	.6704	.5511	1.1756	.8301	.4443	.8167
7	.3379	.2756	.5436	.2786	.2105	.6619	.8549	1.2516	.7158	.3187	.7620
8	.4141	.2814	.3781	.4727	.4371	.8174	.5708	.9508	.8417	.3974	.7299
+gp	.4141	.2814	.3781	.4727	.4371	.8174	.5708	.9508	.8417	.3974	
0 FBAR 3- 6	.2575	.2780	.3464	.3738	.4909	.5919	.5476	1.0768	.7742	.3951	

1

Run title : Herring VIa(S) VIIbc (run: PRE wg 2001)

At 17/03/2001 9:26

Traditional VPA Terminal populations from weighted Separable populations

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

YEAR	1970
AGE	
1	398125
2	124391
3	128918
4	81451
5	24754
6	282312
7	16041
8	7242
+gp	8302
0 TOTAL	1071537

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

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
AGE										
1	803087	719182	519945	574006	395009	662105	557019	1007783	925622	499286
2	146384	294926	263991	187545	209203	141042	233937	202308	364831	337075
3	62332	103154	193877	161102	113846	119786	79776	135370	115523	227522
4	82154	44690	65982	116146	94960	70625	64422	53255	86471	77331
5	61128	64026	34558	43710	62886	58256	38769	42005	35566	59299
6	18701	46930	47354	24218	22650	34443	28760	23510	27874	23316
7	217293	13184	32922	31105	13502	10375	16975	16622	16191	17239
8	11684	158125	7909	21075	17819	6627	4466	10116	10991	9494
+gp	11040	14428	204779	62676	60858	28937	13627	9243	10164	11657
0 TOTAL	1413803	1458646	1371316	1221584	990733	1132196	1037752	1500212	1593233	1262218

1

Run title : Herring VIa(S) VIIbc (run: PRE wg 2001)

At 17/03/2001 9:26

Table 6.5.2.2. Continued

Traditional VPA Terminal populations from weighted Separable populations

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

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
1,	643191,	664716,	2185626,	891788,	1171716,	903279,	3100412,	526163,	712038,	789003,
2,	182016,	235674,	244101,	803166,	326445,	425465,	331765,	1133511,	193564,	260641,
3,	215488,	115821,	159076,	143587,	525347,	228869,	291990,	208067,	814761,	137469,
4,	127976,	138823,	79511,	85803,	91776,	369428,	165011,	167032,	128721,	595983,
5,	46151,	85958,	98833,	47954,	60697,	70929,	271263,	109945,	112242,	91658,
6,	32704,	29612,	60433,	59311,	36564,	44251,	50284,	151482,	77297,	81174,
7,	13756,	17525,	19094,	37318,	41488,	25837,	32458,	31067,	93758,	55698,
8,	9024,	9164,	11978,	10935,	28095,	28826,	17974,	17404,	21521,	61208,
+gp,	17222,	8109,	15296,	21892,	8028,	11308,	30105,	13772,	15508,	8451,
0 TOTAL,	1287526,	1305402,	2873948,	2101754,	2290156,	2108193,	4291262,	2358442,	2169411,	2081285,

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

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	GMST 70-98	AMST 70-98
AGE													
1,	499061,	413094,	614520,	801230,	445678,	812164,	811228,	675814,	622950,	1232204,	0,	720979,	817996,
2,	289748,	183202,	150462,	225958,	287954,	163791,	296001,	294099,	244296,	227779,	451498,	256732,	294248,
3,	171732,	185230,	122446,	93908,	119641,	183872,	100494,	171277,	155984,	137330,	146362,	158630,	187251,
4,	94985,	115563,	113418,	79853,	48890,	66170,	88482,	58969,	68268,	72820,	85907,	97732,	119099,
5,	395135,	74151,	79105,	62883,	56240,	26610,	30441,	43411,	17249,	28795,	43833,	62696,	78916,
6,	59834,	262273,	55167,	49416,	36274,	32762,	14757,	13757,	10894,	6086,	16455,	43207,	59566,
7,	54324,	37153,	167812,	37068,	31777,	17610,	15164,	7696,	3842,	4298,	3531,	27228,	39243,
8,	34933,	35060,	25521,	88172,	25385,	23296,	8220,	5836,	1992,	1699,	2828,	16815,	25107,
+gp,	23657,	26867,	20005,	28048,	42033,	12098,	10254,	5000,	1741,	3903,	3407,		
0 TOTAL,	1623410,	1332593,	1348455,	1466536,	1093872,	1338374,	1375042,	1275859,	1127215,	1714913,	753820,		

1

Run title : Herring VIa(S) VIIbc (run: PRE wg 2001) ,

At 17/03/2001 9:26

Table 6.5.2.2. Continued

Table 16 Summary (without SOP correction)

Traditional VPA Terminal populations from weighted Separable populations

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 3- 6,
1970,	398125,	207697,	126330,	20306,	.1607,	.1950,
1971,	803087,	242736,	118836,	15044,	.1266,	.1740,
1972,	719182,	251670,	125387,	23474,	.1872,	.2150,
1973,	519945,	257431,	144534,	36719,	.2541,	.3000,
1974,	574006,	213261,	96763,	36589,	.3781,	.4710,
1975,	395009,	178611,	87518,	38764,	.4429,	.4622,
1976,	662105,	183084,	66590,	32767,	.4921,	.5334,
1977,	557019,	166399,	71494,	20567,	.2877,	.3451,
1978,	1007783,	223833,	74858,	19715,	.2634,	.2837,
1979,	925622,	245033,	99030,	22608,	.2283,	.2953,
1980,	499286,	215775,	109352,	30124,	.2755,	.4286,
1981,	643191,	215933,	102903,	24922,	.2422,	.3513,
1982,	664716,	217130,	106588,	19209,	.1802,	.2518,
1983,	2185626,	411298,	104230,	32988,	.3165,	.4039,
1984,	891788,	342024,	180225,	27450,	.1523,	.2306,
1985,	1171716,	333856,	171974,	23343,	.1357,	.1933,
1986,	903279,	345589,	205322,	28785,	.1402,	.1975,
1987,	3100412,	559684,	182956,	48600,	.2656,	.3822,
1988,	526163,	405687,	276325,	29100,	.1053,	.3025,
1989,	712038,	358384,	208512,	29210,	.1401,	.2010,
1990,	789003,	324316,	179930,	43969,	.2444,	.2772,
1991,	499061,	257771,	156856,	37700,	.2403,	.2575,
1992,	413094,	208631,	125968,	31856,	.2529,	.2780,
1993,	614520,	222565,	106090,	36763,	.3465,	.3464,
1994,	801230,	208677,	90491,	33908,	.3747,	.3738,
1995,	445678,	157179,	82723,	27792,	.3360,	.4909,
1996,	812164,	166575,	60986,	32534,	.5335,	.5919,
1997,	811228,	167907,	60742,	27225,	.4482,	.5476,
1998,	675814,	154160,	50275,	38895,	.7736,	1.0768,
1999,	622950,	143768,	49169,	26109,	.5310,	.7742,
2000,	1232204,	197405,	54057,	15005,	.2776,	.3951,
Arith. Mean ,	825066,	251099,	118613,	29421,	.2946,	.3751,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

Run title : Herring VIa(S) VIIbc (run: PRE wg 2001) ,

At 17/03/2001 9:26

Table 6.5.2.2. Continued

Table 17 Summary (with SOP correction)

Traditional VPA Terminal populations from weighted Separable populations

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 3- 6,
1970,	398125,	186253,	113287,	20306,	.1792,	.8968,	.1950,
1971,	803087,	211355,	103473,	15044,	.1454,	.8707,	.1740,
1972,	719182,	225866,	112531,	23474,	.2086,	.8975,	.2150,
1973,	519945,	261591,	146870,	36719,	.2500,	1.0162,	.3000,
1974,	574006,	208179,	94457,	36589,	.3874,	.9762,	.4710,
1975,	395009,	200698,	98340,	38764,	.3942,	1.1237,	.4622,
1976,	662105,	191725,	69732,	32767,	.4699,	1.0472,	.5334,
1977,	557019,	179348,	77058,	20567,	.2669,	1.0778,	.3451,
1978,	1007783,	227447,	76066,	19715,	.2592,	1.0161,	.2837,
1979,	925622,	261297,	105603,	22608,	.2141,	1.0664,	.2953,
1980,	499286,	207911,	105366,	30124,	.2859,	.9636,	.4286,
1981,	643191,	222667,	106113,	24922,	.2349,	1.0312,	.3513,
1982,	664716,	223658,	109793,	19209,	.1750,	1.0301,	.2518,
1983,	2185626,	413023,	104667,	32988,	.3152,	1.0042,	.4039,
1984,	891788,	331360,	174606,	27450,	.1572,	.9688,	.2306,
1985,	1171716,	328716,	169326,	23343,	.1379,	.9846,	.1933,
1986,	903279,	345645,	205355,	28785,	.1402,	1.0002,	.1975,
1987,	3100412,	531016,	173585,	48600,	.2800,	.9488,	.3822,
1988,	526163,	405383,	276117,	29100,	.1054,	.9992,	.3025,
1989,	712038,	358734,	208715,	29210,	.1400,	1.0010,	.2010,
1990,	789003,	324517,	180041,	43969,	.2442,	1.0006,	.2772,
1991,	499061,	257035,	156409,	37700,	.2410,	.9971,	.2575,
1992,	413094,	207606,	125349,	31856,	.2541,	.9951,	.2780,
1993,	614520,	223891,	106722,	36763,	.3445,	1.0060,	.3464,
1994,	801230,	208259,	90310,	33908,	.3755,	.9980,	.3738,
1995,	445678,	165430,	87065,	27792,	.3192,	1.0525,	.4909,
1996,	812164,	165826,	60711,	32534,	.5359,	.9955,	.5919,
1997,	811228,	168179,	60840,	27225,	.4475,	1.0016,	.5476,
1998,	675814,	153967,	50212,	38895,	.7746,	.9988,	1.0768,
1999,	622950,	144027,	49258,	26109,	.5300,	1.0018,	.7742,
2000,	1232204,	197007,	53948,	15005,	.2781,	.9980,	.3951,
Arith. Mean ,	825066,	249601,	117804,	29421,	.2933		.3751,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

1

Table 6.6.1. Divisions VIA(S) and VIIb,c. Input data for short-term projections, based on separable VPA run with F=0.6.

MFDP version 1a
Run: shortterm irlw 1
Time and date: 18:05 21/3/01
Fbar age range: 3-6

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	712238	1	0	0.67	0.67	9.97E-02	8.28E-03	0.101
2	272182	0.3	1	0.67	0.67	0.138333	0.211563	0.136333
3	91224	0.2	1	0.67	0.67	0.152	0.413127	0.148
4	53566	0.1	1	0.67	0.67	0.174667	0.599725	0.169333
5	26325	0.1	1	0.67	0.67	0.196	0.702893	0.185667
6	9601	0.1	1	0.67	0.67	0.208333	0.654555	0.191667
7	2037	0.1	1	0.67	0.67	0.216333	0.596197	0.202
8	1653	0.1	1	0.67	0.67	0.230667	0.582124	0.213667
9	2014	0.1	1	0.67	0.67	0.236	0.582124	0.214333

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	712238	1	0	0.67	0.67	9.97E-02	8.28E-03	0.101
2	.	0.3	1	0.67	0.67	0.138333	0.211563	0.136333
3	.	0.2	1	0.67	0.67	0.152	0.413127	0.148
4	.	0.1	1	0.67	0.67	0.174667	0.599725	0.169333
5	.	0.1	1	0.67	0.67	0.196	0.702893	0.185667
6	.	0.1	1	0.67	0.67	0.208333	0.654555	0.191667
7	.	0.1	1	0.67	0.67	0.216333	0.596197	0.202
8	.	0.1	1	0.67	0.67	0.230667	0.582124	0.213667
9	.	0.1	1	0.67	0.67	0.236	0.582124	0.214333

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	712238	1	0	0.67	0.67	9.97E-02	8.28E-03	0.101
2	.	0.3	1	0.67	0.67	0.138333	0.211563	0.136333
3	.	0.2	1	0.67	0.67	0.152	0.413127	0.148
4	.	0.1	1	0.67	0.67	0.174667	0.599725	0.169333
5	.	0.1	1	0.67	0.67	0.196	0.702893	0.185667
6	.	0.1	1	0.67	0.67	0.208333	0.654555	0.191667
7	.	0.1	1	0.67	0.67	0.216333	0.596197	0.202
8	.	0.1	1	0.67	0.67	0.230667	0.582124	0.213667
9	.	0.1	1	0.67	0.67	0.236	0.582124	0.214333

Input units are thousands and kg - output in tonnes

Table 6.6.2. Divisions Via(S) and VIIb,c. Input data for short-term projections, based on separable VPA run with F=0.4.

MFDP version 1a
Run: Short term Run 04 irlw
Time and date: 08:47 22/3/01
Fbar age range: 3-6

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	720979	1	0	0.67	0.67	9.97E-02	4.86E-03	0.101
2	451498	0.3	1	0.67	0.67	0.138333	0.132372	0.136333
3	146362	0.2	1	0.67	0.67	0.152	0.272784	0.148
4	85907	0.1	1	0.67	0.67	0.174667	0.404629	0.169333
5	43833	0.1	1	0.67	0.67	0.196	0.472108	0.185667
6	16455	0.1	1	0.67	0.67	0.208333	0.43098	0.191667
7	3531	0.1	1	0.67	0.67	0.216333	0.402148	0.202
8	2828	0.1	1	0.67	0.67	0.230667	0.385226	0.213667
9	3407	0.1	1	0.67	0.67	0.236	0.385226	0.214333

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	720979	1	0	0.67	0.67	9.97E-02	4.86E-03	0.101
2	.	0.3	1	0.67	0.67	0.138333	0.132372	0.136333
3	.	0.2	1	0.67	0.67	0.152	0.272784	0.148
4	.	0.1	1	0.67	0.67	0.174667	0.404629	0.169333
5	.	0.1	1	0.67	0.67	0.196	0.472108	0.185667
6	.	0.1	1	0.67	0.67	0.208333	0.43098	0.191667
7	.	0.1	1	0.67	0.67	0.216333	0.402148	0.202
8	.	0.1	1	0.67	0.67	0.230667	0.385226	0.213667
9	.	0.1	1	0.67	0.67	0.236	0.385226	0.214333

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	720979	1	0	0.67	0.67	9.97E-02	4.86E-03	0.101
2	.	0.3	1	0.67	0.67	0.138333	0.132372	0.136333
3	.	0.2	1	0.67	0.67	0.152	0.272784	0.148
4	.	0.1	1	0.67	0.67	0.174667	0.404629	0.169333
5	.	0.1	1	0.67	0.67	0.196	0.472108	0.185667
6	.	0.1	1	0.67	0.67	0.208333	0.43098	0.191667
7	.	0.1	1	0.67	0.67	0.216333	0.402148	0.202
8	.	0.1	1	0.67	0.67	0.230667	0.385226	0.213667
9	.	0.1	1	0.67	0.67	0.236	0.385226	0.214333

Input units are thousands and kg - output in tonnes

Table 6.6.3. Divisions Via(S) and VIIb,c. Single option short-term projection based on VPA with F=0.6.
MFDP version 1a
Run: shortterm irlw 1
Time and date: 18:05 21/3/01
Fbar age range: 3-6

Year:		2001	F multiplier	0.7183	Fbar:	0.4256				
Age		F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	1	0.0059	2670	270	712238	70986	0	0	0	0
	2	0.152	33277	4537	272182	37652	272182	37652	201070	27815
	3	0.2967	21335	3158	91224	13866	91224	13866	65398	9941
	4	0.4308	17905	3032	53566	9356	53566	9356	37536	6556
	5	0.5049	9973	1852	26325	5160	26325	5160	17553	3440
	6	0.4702	3441	659	9601	2000	9601	2000	6553	1365
	7	0.4282	678	137	2037	441	2037	441	1430	309
	8	0.4181	539	115	1653	381	1653	381	1168	269
	9	0.4181	657	141	2014	475	2014	475	1423	336
Total			90475	13900	1170840	140318	458602	69331	332132	50032

Year:		2002	F multiplier	1	Fbar:	0.5926				
Age		F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	1	0.0083	3714	375	712238	70986	0	0	0	0
	2	0.2116	43135	5881	260464	36031	260464	36031	184882	25575
	3	0.4131	53493	7917	173210	26328	173210	26328	114860	17459
	4	0.5997	23945	4055	55510	9696	55510	9696	34735	6067
	5	0.7029	15224	2827	31505	6175	31505	6175	18397	3606
	6	0.6546	6607	1266	14377	2995	14377	2995	8672	1807
	7	0.5962	2332	471	5429	1174	5429	1174	3405	737
	8	0.5821	507	108	1201	277	1201	277	760	175
	9	0.5821	922	198	2184	515	2184	515	1383	326
Total			149878	23097	1256119	154178	543881	83192	367095	55752

Year:		2003	F multiplier	1	Fbar:	0.5926				
Age		F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	1	0.0083	3714	375	712238	70986	0	0	0	0
	2	0.2116	43034	5867	259858	35947	259858	35947	184452	25516
	3	0.4131	48229	7138	156163	23737	156163	23737	103556	15740
	4	0.5997	40470	6853	93820	16387	93820	16387	58707	10254
	5	0.7029	13324	2474	27573	5404	27573	5404	16101	3156
	6	0.6546	6487	1243	14115	2941	14115	2941	8514	1774
	7	0.5962	2903	587	6760	1462	6760	1462	4240	917
	8	0.5821	1142	244	2706	624	2706	624	1713	395
	9	0.5821	722	155	1711	404	1711	404	1084	256
Total			160025	24935	1274945	157893	562707	86907	378367	58008

Input units are thousands and kg - output in tonnes

Table 6.6.4. Divisions Via(S) and VIIb,c. Multiple options of short-term projections based on VPA with F=0.6.
Run: shortterm irlw 1
Herring VIa(S) VIIbc (run: PRE wg 2001)
Time and date: 18:05 21/3/01
Fbar age range: 3-6

2001				
Biomass	SSB	FMult	FBar	Landings
140318	50032	0.7183	0.4256	13900

2002					2003	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
154178	71979	0	0	0	181785	97590
.	70121	0.1	0.0593	2786	178878	92154
.	68321	0.2	0.1185	5451	176102	87125
.	66576	0.3	0.1778	8002	173451	82470
.	64884	0.4	0.237	10444	170919	78156
.	63243	0.5	0.2963	12782	168498	74155
.	61652	0.6	0.3555	15023	166185	70441
.	60109	0.7	0.4148	17170	163972	66990
.	58613	0.8	0.4741	19229	161856	63780
.	57161	0.9	0.5333	21203	159831	60793
.	55752	1	0.5926	23097	157893	58008
.	54385	1.1	0.6518	24915	156037	55411
.	53058	1.2	0.7111	26660	154260	52987
.	51771	1.3	0.7703	28337	152557	50720
.	50521	1.4	0.8296	29947	150925	48600
.	49307	1.5	0.8889	31495	149361	46615
.	48128	1.6	0.9481	32984	147861	44754
.	46984	1.7	1.0074	34415	146421	43007
.	45872	1.8	1.0666	35792	145040	41366
.	44792	1.9	1.1259	37118	143715	39823
.	43743	2	1.1852	38394	142442	38371

Input units are thousands and kg - output in tonnes

Table 6.6.5. Divisions Via(S) and VIIb,c. Single option short-term projection based on VPA with F=0.4.
MFDP version 1a
Run: Short term Run 04 irlw
Time and date: 08:47 22/3/01
Fbar age range: 3-6

Year:		2001	F multiplier	0.6363	Fbar:	0.2514				
Age		F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
	1	0.0031	1406	142	720979	71858	0	0	0	0
	2	0.0842	31577	4305	451498	62457	451498	62457	349022	48281
	3	0.1736	21200	3138	146362	22247	146362	22247	113953	17321
	4	0.2575	18597	3149	85907	15005	85907	15005	67610	11809
	5	0.3004	10851	2015	43833	8591	43833	8591	33519	6570
	6	0.2742	3764	722	16455	3428	16455	3428	12806	2668
	7	0.2559	760	154	3531	764	3531	764	2782	602
	8	0.2451	586	125	2828	652	2828	652	2244	518
	9	0.2451	706	151	3407	804	3407	804	2704	638
Total			89448	13900	1474800	185807	753821	113949	584640	88407

Year:		2002	F multiplier	1	Fbar:	0.3951				
Age		F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
	1	0.0049	2208	223	720979	71858	0	0	0	0
	2	0.1324	28417	3874	264415	36577	264415	36577	197914	27378
	3	0.2728	66831	9891	307458	46734	307458	46734	223984	34046
	4	0.4046	32008	5420	100736	17595	100736	17595	71837	12548
	5	0.4721	21602	4011	60087	11777	60087	11777	40955	8027
	6	0.431	9821	1882	29370	6119	29370	6119	20578	4287
	7	0.4021	3578	723	11318	2448	11318	2448	8084	1749
	8	0.3852	755	161	2474	571	2474	571	1787	412
	9	0.3852	1348	289	4415	1042	4415	1042	3190	753
Total			166568	26474	1501252	194721	780273	122863	568329	89199

Year:		2003	F multiplier	1	Fbar:	0.3951				
Age		F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
	1	0.0049	2208	223	720979	71858	0	0	0	0
	2	0.1324	28367	3867	263949	36513	263949	36513	197565	27330
	3	0.2728	37299	5520	171597	26083	171597	26083	125009	19001
	4	0.4046	60888	10310	191628	33471	191628	33471	136654	23869
	5	0.4721	21865	4060	60817	11920	60817	11920	41453	8125
	6	0.431	11339	2173	33909	7064	33909	7064	23758	4950
	7	0.4021	5460	1103	17270	3736	17270	3736	12336	2669
	8	0.3852	2091	447	6850	1580	6850	1580	4949	1142
	9	0.3852	1294	277	4240	1001	4240	1001	3064	723
Total			170811	27981	1471240	193226	750261	121368	544788	87808

Input units are thousands and kg - output in tonnes

Table 6.6.6. Divisions Via(S) and VIIb,c. Multiple options of short-term projections based on VPA with F=0.4.

MFDP version 1a
Run: Short term Run 04 irlw
Herring VIa(S) VIIbc (run: 004)
Time and date: 08:47 22/3/01
Fbar age range: 3-6

2001				
Biomass	SSB	FMult	FBar	Landings
185807	88407	0.6363	0.2514	13900

2002					2003	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
194721	107779	0	0	0	221065	133431
.	105729	0.1	0.0395	3041	217851	127638
.	103725	0.2	0.079	5986	214741	122165
.	101765	0.3	0.1185	8838	211733	116992
.	99849	0.4	0.1581	11601	208823	112101
.	97974	0.5	0.1976	14278	206007	107476
.	96141	0.6	0.2371	16872	203282	103100
.	94348	0.7	0.2766	19386	200644	98959
.	92594	0.8	0.3161	21822	198091	95038
.	90878	0.9	0.3556	24184	195619	91325
.	89199	1	0.3951	26474	193226	87808
.	87557	1.1	0.4346	28695	190908	84474
.	85951	1.2	0.4742	30848	188664	81313
.	84379	1.3	0.5137	32937	186490	78316
.	82841	1.4	0.5532	34963	184384	75472
.	81336	1.5	0.5927	36929	182343	72772
.	79863	1.6	0.6322	38837	180366	70209
.	78422	1.7	0.6717	40689	178450	67774
.	77011	1.8	0.7112	42486	176593	65460
.	75631	1.9	0.7507	44231	174793	63260
.	74279	2	0.7903	45925	173048	61168

Input units are thousands and kg - output in tonnes

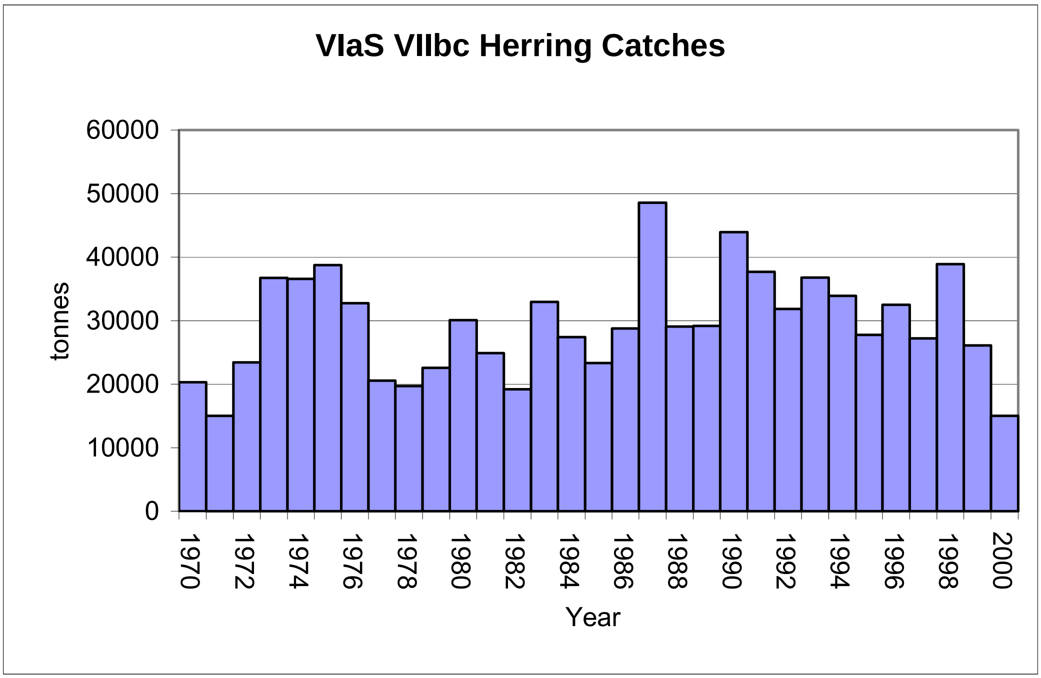


Figure 6.1.1. Total catches from VIaS VIIbc 1970–2000.

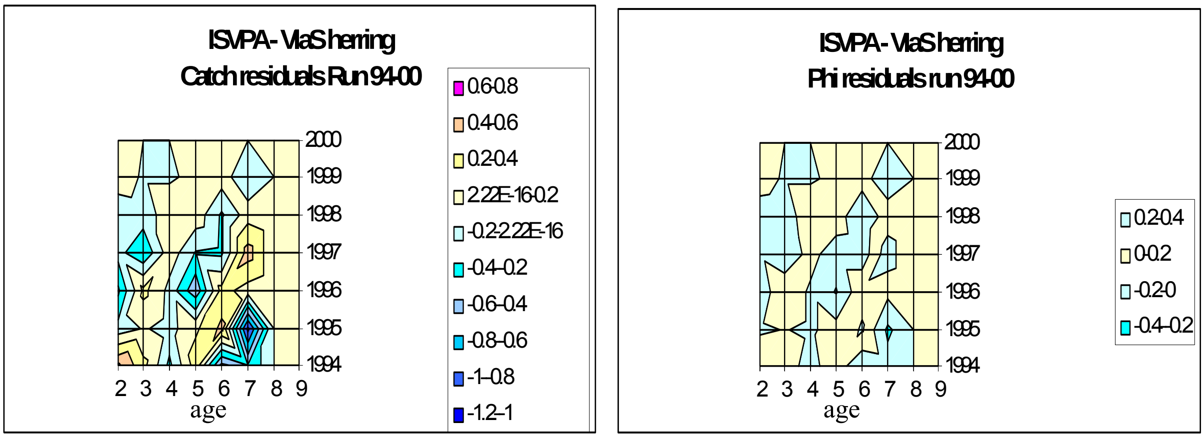


Figure 6.5.1.1. Divisions VIa(S) and VIIb,c. Residuals in catches and instantaneous mortality phi, with ISVPA for the time period 1994 to 2000.

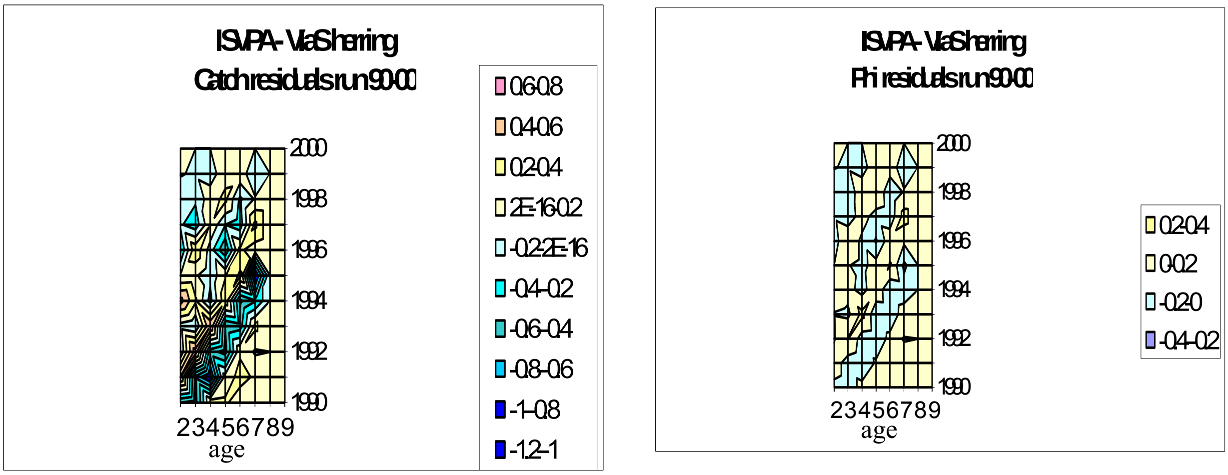
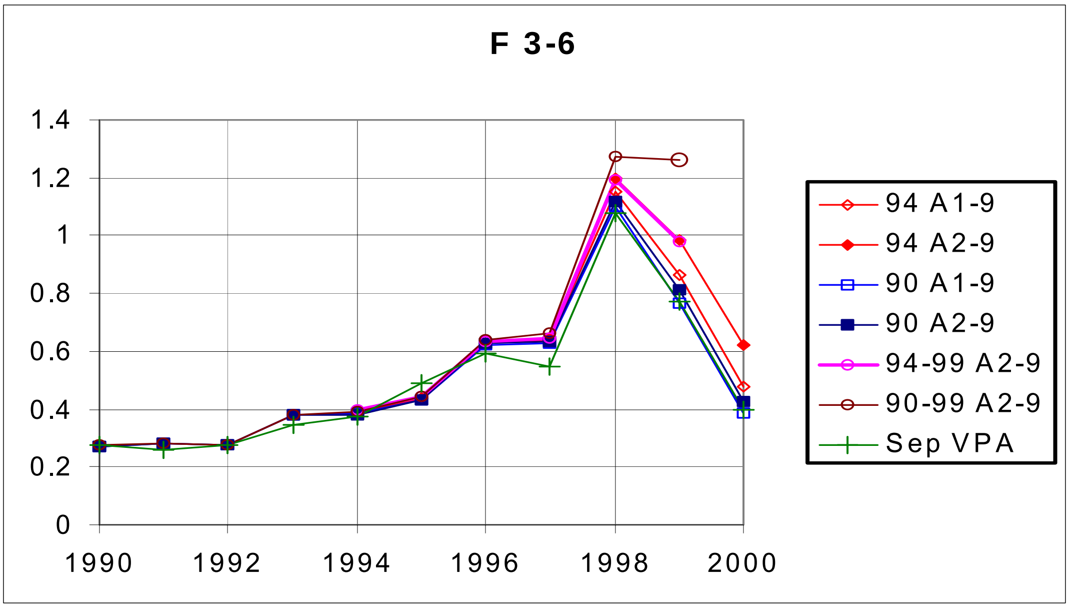


Figure 6.5.1.2. Divisions Via(S) and VIIb,c. Residuals in catches and instantaneous mortality phi, with ISVPA for the time period 1990 to 2000.



6

Figure 6.5.1.3. Divisions Via(S) and VIIb,c. Fishing mortalities (arithmetic mean ages 3-6) as estimated by ISVPA for time periods and age ranges as indicated, and from a separable VPA assessment with terminal F = 0.4. The runs are identified with a two digits denoting the year at the start of the separable period, followed by “A n-n” denoting the range of age groups used in the analysis

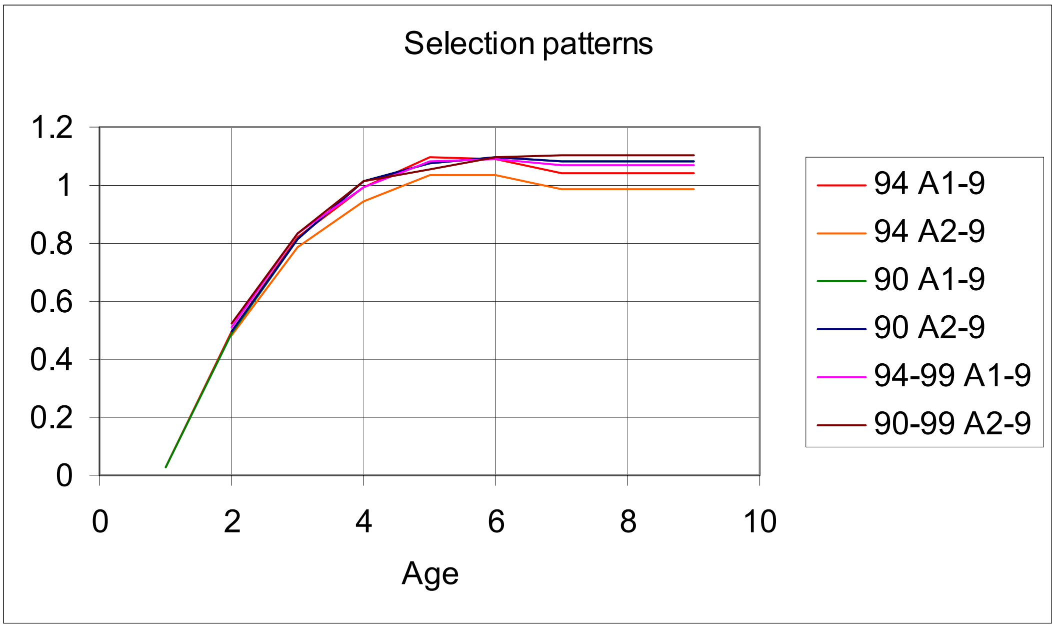


Figure 6.5.1.4. Divisions VIa(S) and VIIb,c. Selection pattern as estimated by ISVPA runs. The runs are identified with two digits denoting the year at the start of the separable period, followed by "A n-n" denoting the range of age groups used in the analysis.

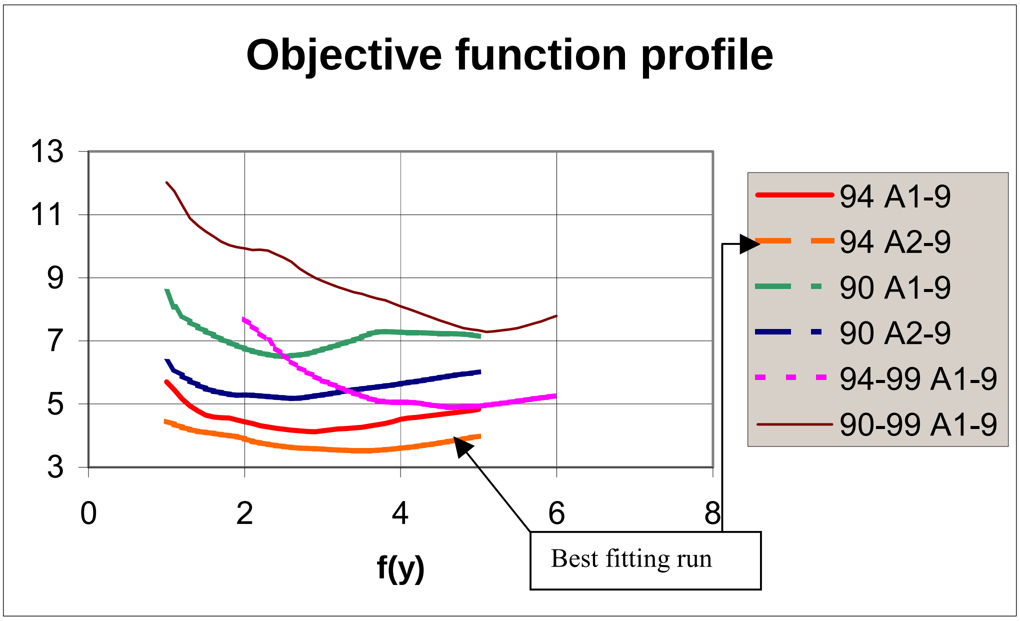


Figure 6.5.1.5. Divisions Via(S) and VIIb,c. Objective function profiles for various runs of ISVPA. f(y) is a fishing mortality year term analogous to from the SVPA. The runs are identified with a two digits denoting the year at the start of the separable period, followed by "A n-n" denoting the range of age groups used in the analysis

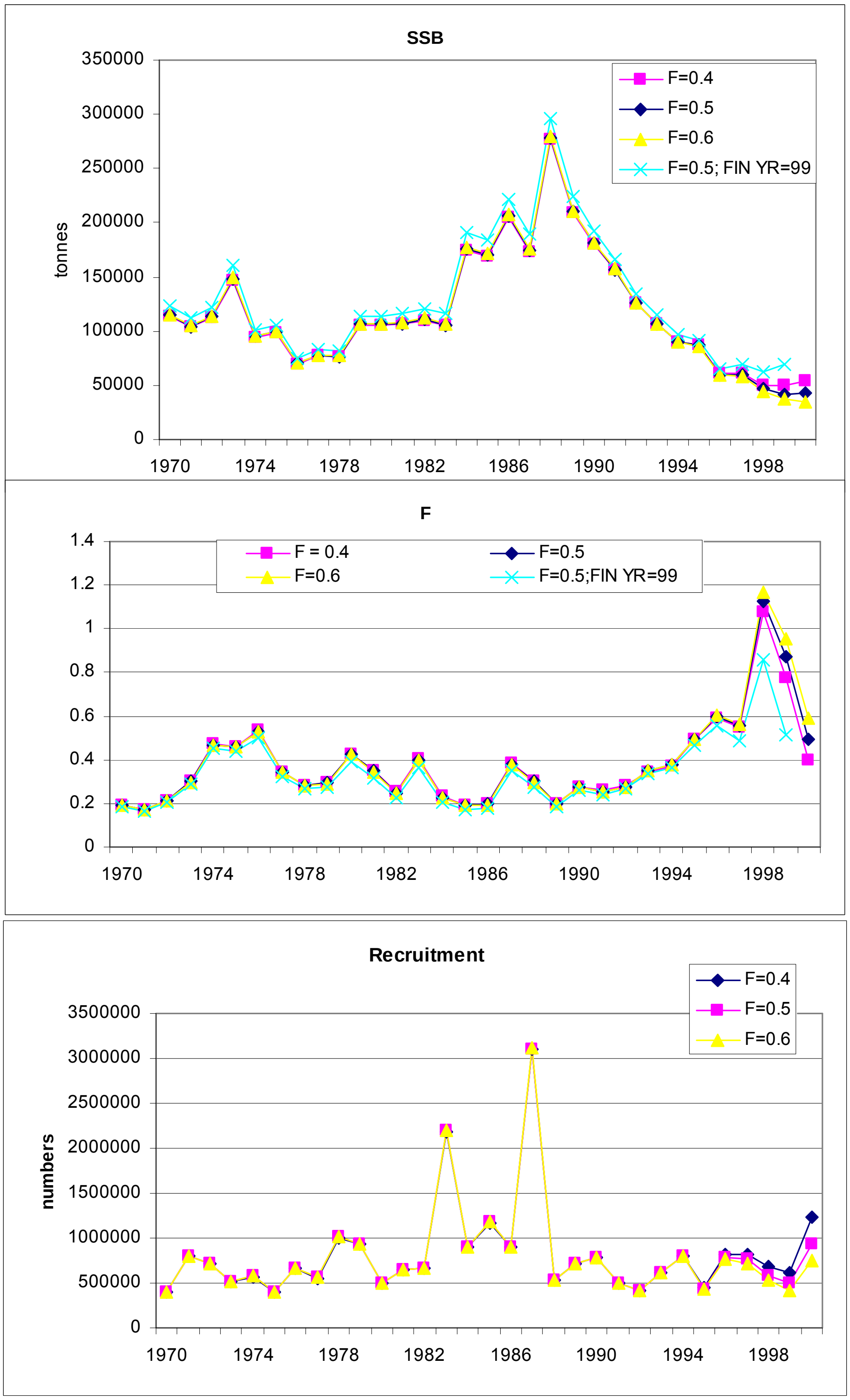


Figure 6.5.2.1. Divisions Via(S) and VIIb,c. Trajectories of SSB F & recruitment for a range of terminal F selections (0.4 – 0.6) from the SVPA.

7 IRISH SEA HERRING (DIVISION VIIA, NORTH)

7.1 The Fishery

7.1.1 Advice and management applicable to 2000 and 2001

In 1998 and 1999, the Working Groups undertook an age-based assessment of the stock. However, due to the instability in the assessment, the shrinkage option in ICA was applied in both years. The model estimate of the F was shrunk to the mean of the ten previous years. 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 the Working Group undertook an age-based assessment. There was uncertainty concerning the actual catches so three scenarios were presented: catches in 1998 and 1999 were 1). as reported in the official landings (4,905 and 4,217t respectively), 2) there was area misreporting (i.e. 3,718 and 1,936t respectively) and 3) the catches were 2000t above the official landings (6,905 and 6,127t respectively). ACFM recommended a catch of 5,000t and hence a TAC of 6,900t was adopted for 2001. This was partitioned as 5,100 to the UK and 1,800 to the Republic of Ireland.

In 2000 the UK fishery opened in August. Closed areas for herring fishing in the Irish Sea along the east coast of Ireland and within 12 nautical miles of the west coast of Britain were maintained throughout the year. The traditional September, gillnet fishery on the Mourne herring, which has a derogation to fish within the Irish closed box, did not take place in 2000. The area to the east of the Isle of Man, encompassing the Douglas Bank spawning ground (described in ICES CM 2000/ACFM:10) was closed from 21 September to 15 November.

7.1.2 The fishery in 2000

The catches reported from each country, for the period 1985 to 2000 are given in Table 7.1.1 and total catches from 1967 to 2000 in Figure 7.1.1. Reported landings for the Irish Sea amounted to 2,002t. The size of the actual catch from the Irish Sea (VIIaN) may still be uncertain. In 1993, the Republic of Ireland ceased taking their quota from Division VIIa(N). The number of vessels that specifically target herring in the Irish Sea has fallen to its lowest level in 30 years (Dickey-Collas *et al.* 2000 WDa). 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.

7.1.3 Quality of catch and biological data

There are still no estimates of discarding or slippage of herring in the Irish Sea fisheries. Working Group landing statistics are assumed to be accurate up to 1997, however there are no reliable estimates of landings from 1998 to 2000. 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 and 1999 should be treated as highly unreliable. Biological sampling in this fishery remains fairly high with every landing into Northern Ireland being sampled (Dickey-Collas *et al.* 2000 WDa) (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 2000. The official catches were used for 1998 to 2000. The predominant year class in 2000 was the 3-ringers (1996 year class), which was prevalent in 1999. The catch in numbers at length is given in Table 7.1.4 for 1988 to 2000. In 2000 the mode moved to slightly larger fish (see Table 7.1.3) reflecting the increased prevalence of 3 and 4-ringers in the catches and in the acoustic estimates (see 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 2000 in Table 7.2.1. In general, mean lengths at age have remained fairly stable since 1988.

Mean weights at age in the catch are given in Table 7.2.2. Mean weights at age in 2000 were, in general, comparable to the mean weights in 1999. There has been a change in mean weight over the time period 1961 to the present (Figure 7.2.1). Mean weights at age increased between the early 1960s and the late 1970s whereupon there has 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, the period 1972 to 1984 is taken as an unchanging mean weight at age. The data for 1961 to 1984, presented in Figure 7.2.1, have not been area and/or catch weighted and so cannot be used at present in the assessment.

Mean weights at age in the third-quarter catches have been used as estimates of stock weights at spawning time.

A preliminary examination of the historical time series of maturity at age suggests that there may have been substantial variations over time (Figure 7.2.2). 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-ringers, 0.85 for 2-ringers and 1.00 for 3+-ringers.

As in previous years, natural mortality per year was assumed to be 1.0 on 1-ringers, 0.3 on 2-ringers, 0.2 on 3-ringers and 0.1 on all older age classes. These are based on the natural mortality rates determined for herring in the North Sea.

7.3 Research Surveys

7.3.1 Acoustic surveys

The information on the time series of acoustic surveys in the Irish Sea is given in Table 7.3.1.

An acoustic survey was undertaken in the northern Irish Sea (Division VIIa(N)) between 11–21 September 2000 by Northern Ireland. It centred on the spawning area for herring and added to the time series that commenced in 1994. It used a similar survey design to previous years (Figure 7.3.1) although effort was increased around the Isle of Man in an attempt to improve precision of the herring biomass estimates. Relatively low effort was employed around the periphery of the Irish Sea where the acoustic targets comprise mainly extended school groups of sprats and 0-group herring. The survey followed the methods described in Armstrong *et al.* (WD 2001) and used a Simrad EK500 echosounder with a towed 38 kHz split-beam transducer. Targets were identified where possible by midwater trawling, and appropriate ALKs constructed from catch samples.

Well-defined schools of herring, comprising mainly 1-ring and older fish of around 18cm and longer, were found in coastal waters around the Isle of Man and the Mull of Galloway (Figure 7.3.1). Herring on the spawning grounds to the east of the Isle of Man comprised mainly of adult fish. Dense schools of herring, with a smaller component of adult fish, were found close inshore along 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 (Dickey-Collas *et al*., WD2001b). The estimated SSB of herring in VIIa(N) was 33,700 t (Table 7.3.1), the highest in the series. Sprats and 0-ring 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 (234 x10^3 t) was similar to recent years. The age structure of herring from the acoustic survey is given in Table 7.3.2.

7.3.2 Larvae surveys

A larvae survey was undertaken by Northern Ireland in 2000. Sampling was carried out on a systematic grid of stations covering the spawning grounds and surrounding regions in the NE and NW Irish Sea. Poor weather prevented any Douglas Bank larval herring surveys being carried out by Port Erin Marine Laboratory. The production estimate for 2000 in the NE Irish Sea was the third highest in the series, the highest since 1994 and had a relatively small CV (Table 7.3.3).

The estimated spawning time of Irish Sea herring in 2000, determined by length distributions of the larvae, was earlier than previously recorded in DARD surveys. The mean spawning date for the survey was around 20 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 immediately after the period of the DARD 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 (Dickey-Collas *et al*., WD2001b; Armstrong *et al*., WD2001).

7.3.3 Groundfish surveys of Area VIIa(N)

Groundfish surveys, carried out by Northern Ireland since 1991 in the Irish Sea, were used by the 1996 to 1999 Herring Assessment Working Groups to obtain indices for 0 and 1-ringer herring in the Irish Sea (Table 7.4.1). 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 ring and 1 ring fish were more suitable as a prospective index of recruitment strength (Table 7.4.1). The standard errors are generally high over the series (coefficients of variation ± 50%). It should be noted that the March groundfish fish 1-ringer index has been reworked since last year.

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 – 2000 (**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 ring and 1 ring fish from October surveys in the northern Irish Sea as a prospective index of recruitment strength, 1993–2002 (**GFS-octtot**).
4) Age-disaggregated acoustic estimates for the SSB of herring in Division VIIa(N) in September 1994 – 2000 (**ACAGE**, table 7.3.2).
5) Age-aggregated acoustic estimates for the SSB of herring in Division VIIa(N) in September 1994 – 2000 (**AC_VIIa(N)**).
6) The arithmetic mean abundance data (within strata) of 1 ring fish from March surveys in the northern Irish Sea as a prospective index of recruitment strength, 1992–2000 (**GFS-martot**).
7) The arithmetic mean abundance data (within strata) of 0 ring and 1 ring fish from October surveys in the north-eastern Irish Sea as a prospective index of recruitment strength, 1993–2002 (**GFS-octeast**).

Initial fits within integrated catch-at-age analysis (ICA) including a separable constraint (Deriso *et al.* 1985), were found in 2001 with all indices except the March groundfish 1-ringer index. The ICA model was fitted using each survey series (1–7). The following input values were used:

- Separable constraint over last 6 years (weighting = 1.0 for each year)
- Reference age = 4
- Constant selection pattern model
- Selectivity on oldest age = 1.0
- First age for calculation of mean F = 2
- Last age for calculation of mean F = 6
- Weighting on 1-ringers = 0.1; all other age classes = 1.0
- Weighting for all years = 1.0
- All indices treated as linear
- No S/R relationship fitted
- Lowest and highest feasible F = 0.05 and 2.0
- All survey weights fitted by hand i.e., 1.0
- Correlated errors assumed i.e., = 1.0
- No shrinkage applied

The indices GFS-octtot and GFS-octeast did not have sums of squares minima above F=0.05. ACAGE, DBL and AC_VIIa(N) gave similar and relatively low F at reference age 4 (0.10, 0.11 and 0.13 respectively) (Figure 7.4.1). The estimate of $F_{(4)}$ from NINEL was slightly higher (0.19) and had a higher variance than the other indices. Overall the precision in the estimation of mean F was much improved, compared to 1997 to 1999. 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 used last year (* in Figure 7.4.1), excluding GFS-octtot since it did not reach a sums of squares minimum above F=0.05 and the exclusion of the DBL, which was not updated in the most recent year. The combinations resulted in a similar perception of the state of the stock (Figure 7.4.1).

It was decided to use the same tuning indices as last year with the exception of the October groundfish survey (GFS-octtot, run $ in Figure 7.4.1). The reason for excluding this survey was because the sums of squares surface was complete at odds with the other indices, also there was no minimum sums of squares for this series. However, when compared to the 2000 assessment the SSBs in the 2001 run were between 10 – 40% lower (Figure 7.4.2). The differences in SSB between the 2000 and 2001 assessments went back beyond the period of convergence. This may be a problem with using a single 6 year separable constraint. There may have been a major shift in the catching power of the fishery and probably a shift in the fishing practices in 1996 with a reduction in the number of vessels prosecuting the fishery (Dickey-Collas *et al.* 2001 WDa). Explorations were made of the effects of changing the duration of separable constraint, using and differing two time periods of separable constraint and changing the values of final S. In all cases the age and year residuals became larger and more skewed. The use of either abrupt or gradual shifts in selection pattern from 1996 onward did not improve the age or year residuals leaving exceptionally high 4-ringer residuals. Using two periods did not suggest a major change in the shape of the selection pattern. Therefore, it was decided to proceed with a single 6 year separable period and it appeared that the difference in SSB was primarily due to a change in the estimated catchabilities of the indices (Table 7.4.2), particularly the aged 2, 3 and 4 fish in the acoustic survey series. The catchability pattern this year is similar to that in the North Sea (Figure 7.4.3). Until the survey series are longer, there will be instability in the catchabilities and this will introduce a source of uncertainty into the assessment.

In 2000 the Working Group pursued scenarios based on different assumptions about actual landings (see 7.1.1). There is still uncertainty concerning the actual landings. However, since the extent of any misreporting is still uncertain it was decided not to investigate the effect of incorrect catch statistics on the assessment any further at this stage. Official landings were used for all runs.

7.5 Stock Assessment

The results of the baseline model fit are shown in Figures 7.5.1–7.5.3 (the plots for the indices are not shown due to problems encountered with using two SSB indices in IcaView, the residuals and fitted values are given in table 7.5.2). The run log is given in Table 7.5.1. The SSQ surface for the index shows a minimum at a low level of fishing mortality (Figure 7.5.1). The estimate for $F_{(2\text{-}6)}$ for 2000 using the official landing data was 0.15 (Table 7.5.2) with a corresponding SSB estimate of approximately 10,296 t. The assessment shows estimated fishing mortality in the last few years to be higher than previously estimated and the SSB was lower. The historical uncertainty in SSB was estimated and the 5 to 95% confidence limits are given in Figure 7.5.4 and takes into account the uncertainty within the parameter estimates of the model. The historical uncertainty does not reflect the uncertainty in the catches (see 7.1.2). The standard fish stock summary plots are shown in Figure 7.5.5 and the stock recruitment plot with $\mathbf{F}_{low}$ (0.18), $\mathbf{F}_{med}$ (0.37) and $\mathbf{F}_{high}$ (0.61) in Figure 7.5.6.

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 2000–2002 were assumed to be a geometric mean of the recruitment over the period 1985–2000 (Table 7.6.1). Mean weights in the catch and in the stock were taken as a mean for the years 1998–2000. The relevant ICA estimates of F at age in 2000 were used for the exploitation pattern.

There is still uncertainty in the actual catches, however, to simplify the short-term predictions the landings are assumed to be the official statistics. Also, the UK did not take its quota in 2000 and there is no evidence whether this situation will continue or the fishery will return to taking quota. As such, two options tables are presented:

1) based on the quota being taken in 2001 (Table 7.6.2)
2) $F_{(2000)}$ being maintained in 2001 (Table 7.6.3)

The Management Option Tables for both catch levels in 2001 are given in Tables 7.6.2 and 7.6.3. The single option tables, giving age-disaggregated information are given in Tables 7.6.4 and 7.6.5. A summary Table is given below:

Year	$F_{(2-6)}$	Landings	SSB (t)	Comment	
2001	0.38	5100	10,095		
2002	0.39	5101	9,691	Stable SSB	Table 7.6.4
2001	0.38	5100	10,095		
2002	$0.15=F_{(2000)}$	2123	12,061	Rising SSB	
2003	$0.15=F_{(2000)}$	2431	14,090	Rising SSB	Table 7.6.5

7.7 Medium-Term Predictions of Stock Size

The assessment is not stable as the perception of the stock changes between years. The level of catches is also uncertain. Therefore, the Working Group decided that there was no real basis for undertaking a meaningful medium term projection of stock size. The current state of herring recruitment to VIIaN is unclear, considering the imprecision in the assessments and the variable mixing of Celtic Sea and western Irish Sea juveniles. Also the historical assessments of recruitment have incorporated both Manx and Mourne components and the contribution of the Mourne component is now thought to be negligible.

7.8 Management Considerations

7.8.1 Precision of the assessment

The current time-series of survey data are short and are prone to providing variable perceptions of stock development (Figure 7.4.2) due to variability in catchabilities of the indices (Figure 7.4.3). The current SSB is similar to that perceived by the Working Group in 2000 and previous assessments lie within the 95% confidence limits of the current SSB estimates (Figure 7.5.4). There have probably been changes in this stock since the early 1990s with the severe reduction in the Mourne component of VIIa(N). The consequence of this is that the SSB in VIIa(N) may be lower than when both components are present. This change in stock dynamics and the variability in the tuning data mean that assessments on this stock should continue to be treated with caution. It is likely, however, that the SSB has declined over recent years and the ecology and behaviour of the stock is in a state of flux.

There is considerable between year variation in SSB indices and the relevant 2000 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 last year (ICES CM2000\ACFM:10). Candidate F reference points are given in Figure 7.5.5.

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/Assess:10) with a change to the closed are 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 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 21 September–15 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)). Catch in tonnes by country, 1985–2000. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993
Ireland	1,000	1,640	1,200	2,579	1,430	1,699	80	406	0
UK	4,077	4,376	3,290	7,593	3,532	4,613	4,318	4,864	4,408
Unallocated	4,110	1,424	1,333	-	-	-	-	-	-
Total	9,187	7,440	5,823	10,172	4,962	6,312	4,398	5,270	4,408

Country	1994	1995	1996	1997	1998	1999	2000
Ireland	0	0	100	0	0	0	0
UK	4,828	5,076	5,180	6,651	4,905	4,127	2002
Unallocated	-	-	22	-	-	-	-
Total	4,828	5,076	5,302	6,651	4,905*	4,127*	2002*

* Reliability uncertain.

Table 7.1.2. Irish Sea HERRING. Sampling intensity of commercial landings for Division VIIa (N) in 2000.

Quarter	Country	Landings (t)	No. samples	No. fish measured	No. fish aged	Estimation of discards
1	Ireland	0	-	-	-	-
	UK (N. Ireland)	0	-	-	-	-
	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
2	Ireland	0	-	-	-	-
	UK (N. Ireland)	0	-	-	-	-
	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
3	Ireland	0	5	932	0	-
	UK (N. Ireland)	1735	19	1563	950	No
	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
4	Ireland	0	-	-	-	-
	UK (N. Ireland)	267	4	352	200	No
	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-

Table 7.1.3. Herring in the North Irish Sea (Manx plus Mourne VIIa(N)). Catch in numbers (thousands) by year.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1972	40640	46660	26950	13180	13750	6760	2660	1670
1973	42150	32740	38240	11490	6920	5070	2590	2600
1974	43250	109550	39750	24510	10650	4990	5150	1630
1975	33330	48240	39410	10840	7870	4210	2090	1640
1976	34740	56160	20780	15220	4580	2810	2420	1270
1977	30280	39040	22690	6750	4520	1460	910	1120
1978	15540	36950	13410	6780	1740	1340	670	350
1979	11770	38270	23490	4250	2200	1050	400	290
1980	5840	25760	19510	8520	1980	910	360	230
1981	5050	15790	3200	2790	2300	330	290	240
1982	5100	16030	5670	2150	330	1110	140	380
1983	1305	12162	5598	2820	445	484	255	59
1984	1168	8424	7237	3841	2221	380	229	479
1985	2429	10050	17336	13287	7206	2651	667	724
1986	4491	15266	7462	8550	4528	3198	1464	877
1987	2225	12981	6146	2998	4180	2777	2328	1671
1988	2607	21250	13343	7159	4610	5084	3232	4213
1989	1156	6385	12039	4708	1876	1255	1559	1956
1990	2313	12835	5726	9697	3598	1661	1042	1615
1991	1999	9754	6743	2833	5068	1493	719	815
1992	12145	6885	6744	6690	3256	5122	1036	392
1993	646	14636	3008	3017	2903	1606	2181	848
1994	1970	7002	12165	1826	2566	2104	1278	1991
1995	3204	21330	3391	5269	1199	1154	926	1452
1996	5335	17529	9761	1160	3603	780	961	1364
1997	9551	21387	7562	7341	1641	2281	840	1432
1998	3069	11879	3875	4450	6674	1030	2049	451
1999	1810	16929	5936	1566	1477	1989	444	622
2000	1221	3743	5873	2065	558	347	251	147

Table 7.1.4. HERRING in Division VIIa (North). Catch at length for 1988-2000. Numbers of fish in thousands.

Length	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
14	1												
	1												
15	1				95								
	10				169							10	
16	13		6		343			21	21	17		19	12
	16		6	2	275			55	51	94		53	49
17	29		50	1	779		84	139	127	281	26	97	67
	44	24	7	4	1,106		59	148	200	525	30	82	97
18	46	44	224	31	1,263		69	300	173	1,022	123	145	115
	85	43	165	56	1,662		89	280	415	1,066	206	135	134
19	247	116	656	168	1,767	39	226	310	554	1,720	317	234	164
	306	214	318	174	1,189	75	241	305	652	1,263	277	82	97
20	385	226	791	454	1,268	75	253	326	749	1,366	427	218	109
	265	244	472	341	705	57	270	404	867	1,029	297	242	85
21	482	320	735	469	705	130	400	468	886	1,510	522	449	115
	530	401	447	296	597	263	308	782	1,258	1,192	549	362	138
22	763	453	935	438	664	610	700	1,509	1,530	2,607	1354	1261	289
	1,205	497	581	782	927	1,224	785	2,541	2,190	2,482	1099	2305	418
23	2,101	612	2,400	1,790	1,653	2,016	1,035	4,198	2,362	3,508	2493	4784	607
	3,573	814	1,908	1,974	1,156	2,368	1,473	4,547	2,917	3,902	2041	4183	951
24	5,046	1,183	3,474	2,842	1,575	2,895	2,126	4,416	3,649	4,714	3695	4165	1436
	5,447	1,656	2,818	2,311	2,412	2,616	2,564	3,391	4,077	4,138	2769	3397	1783
25	5,276	2,206	4,803	2,734	2,792	2,207	3,315	3,100	4,015	5,031	2625	2620	2144
	4,634	2,720	3,688	2,596	3,268	2,198	3,382	2,358	3,668	3,971	2797	1817	1791
26	4,082	3,555	4,845	3,278	3,865	2,216	3,480	2,334	2,480	3,871	3115	1694	1349
	4,570	3,293	3,015	2,862	3,908	2,176	2,617	1,807	2,177	2,455	2641	1547	840
27	4,689	2,847	3,014	2,412	3,389	2,299	2,391	1,622	1,949	1,711	2992	1475	616
	4,124	2,018	1,134	1,449	2,203	2,047	1,777	990	1,267	1,131	1747	867	479
28	3,406	1,947	993	922	1,440	1,538	1,294	834	906	638	1235	276	212
	2,916	1,586	582	423	569	944	900	123	564	440	170	169	58
29	2,659	1,268	302	293	278	473	417	248	210	280	111	61	42
	1,740	997	144	129	96	160	165	56	79	59	92		12
30	1,335	801	146	82	70	83	9	40	32	8	84		6
	685	557	57	36	36	15	27	5	0	5	3		
31	563	238	54	12	2	4		1	2				
	144	128	31	3									
32	80	57	29										
	7	7											
33	2	5											
	1	6											
34		0											
		5											

Table 7.2.1. HERRING in Division VIIa (North). Mean length at age.

Year	Lengths at age (cm)							
	Age (rings)							
	1	2	3	4	5	6	7	8+
1985	22.1	24.3	26.1	27.6	28.3	28.6	29.5	30.1
1986	19.7	24.3	25.8	26.9	28.0	28.8	28.8	29.8
1987	20.0	24.1	26.3	27.3	28.0	29.2	29.4	30.1
1988	20.2	23.5	25.7	26.3	27.2	27.7	28.7	29.6
1989	20.9	23.8	25.8	26.8	27.8	28.2	28.0	29.5
1990	20.1	24.2	25.6	26.2	27.7	28.3	28.3	29.0
1991	20.5	23.8	25.4	26.1	26.8	27.3	27.7	28.7
1992	19.0	23.7	25.3	26.2	26.7	27.2	27.9	29.4
1993	21.6	24.1	25.9	26.7	27.2	27.6	28.0	28.7
1994	20.1	23.9	25.5	26.5	27.0	27.4	27.9	28.4
1995	20.4	23.6	25.2	26.3	26.8	27.0	27.6	28.3
1996	19.8	23.5	25.3	26.0	26.6	27.6	27.6	28.2
1997	19.6	23.6	25.1	26.0	26.5	27.1	27.7	28.2
1998	20.8	23.8	25.2	26.1	27.0	26.8	27.2	28.7
1999	19.8	23.6	25.0	26.1	26.5	27.1	27.2	28.0
2000	19.7	23.8	25.3	26.3	27.1	27.7	27.7	28.1

Table 7.2.2. HERRING in Division VIIa (North). Mean weights at age.

Year	Weights at age (g)							
	Age (rings)							
	1	2	3	4	5	6	7	8+
1985	87	125	157	186	202	209	222	258
1986	68	143	167	188	215	229	239	254
1987	58	130	160	175	194	210	218	229
1988	70	124	160	170	180	198	212	232
1989	81	128	155	174	184	195	205	218
1990	77	135	163	175	188	196	207	217
1991	70	121	153	167	180	189	195	214
1992	61	111	136	151	159	171	179	191
1993	88	126	157	171	183	191	198	214
1994	73	126	154	174	181	190	203	214
1995	72	120	147	168	180	185	197	212
1996	67	116	148	162	177	199	200	214
1997	64	118	146	165	176	188	204	216
1998	80	123	148	163	181	177	188	222
1999	69	120	145	167	176	188	190	210
2000	64	120	148	168	188	204	200	213

Table 7.3.1. Herring: Summary of acoustic survey information for Division VIIa(N) for the period 1989-2000. 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

[1] sprat only

Table 7.3.2. Age structure of herring in Division VIIa(N) from the Northern Ireland Acoustic surveys in September.

Age (rings)	1994	1995	1996	1997	1998	1999	2000
1	66.8	319.1	11.3	134.1	110.4	157.8	78.5
2	68.3	82.3	42.4	50.0	27.3	77.7	103.4
3	73.5	11.9	67.5	14.8	8.1	34.0	105.3
4	11.9	29.2	9.0	11.0	9.3	5.1	27.5
5	9.3	4.6	26.5	7.8	6.5	10.3	8.1
6	7.6	3.5	4.2	4.6	1.8	13.5	5.4
7	3.9	4.9	5.9	0.6	2.3	1.6	4.9
8+	10.1	6.9	5.8	1.9	0.8	6.3	2.4

Table 7.3.3. Irish Sea HERRING larval production (10^{11}) indices for the Manx component of Division VIIa(N).

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

SE = Standard error

Table 7.4.1. Tuning indices used for the Irish Sea (VIIa(N)) herring assessment. Values and approximate CVs are given.

Year	GFS-octeast[1]		GFS-octtot[1]		GFS-martot[2]	DBL[3]	NINEL[3]	AC_VIIa(N)[4]
	Age 1	Age 2	Age 1	Age 2	Age 1	SSB	SSB	SSB
1989						3.39 (1.54)		-
1990						1.92 (0.78)		-
1991						1.56 (0.73)		-
1992					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				

1. Mean abundance of juveniles (within strata) per 3nm trawl, surveyed when aged 0 in September and 1 in the following September and used as indices for the following years, for either the eastern Irish Sea or total northern Irish Sea. These indices are reworked (see Section 7.3.3).
2. Mean abundance of juveniles (within strata) per 3nm trawl, aged 1 in March from the eastern Irish Sea. This index is reworked (see Section 7.3.3).
3. Numbers of larvae at 6mm x 10^{11}, a size weighted index.
4. Biomass of SSB, tonnes from acoustic surveys of the northern Irish Sea.

na- not available. GFS-Ground fish survey. DBL- Douglas Bank Larvae. NINEL- North East Larvae. AC- Acoustic.

Table 7.4.2. Herring VIIa(N). ICA derived catchabilities of indices in the present assessment and the assessment in 2000. Indices are described in Section 7.4.1.

2001	mle	CV	Lower 95 % ci	Upper 95 % ci	-SE	+SE	mean of pd
DBL	0.4156E-01	15	0.35E-01	0.64E-01	0.41E-01	0.56E-01	0.48E-01
NINEL	0.2333E-02	19	0.19E-02	0.42E-02	0.23E-02	0.34E-02	0.29E-02
Acoustic age 1	1.445	52	0.87	6.85	1.44	4.13	2.80
Acoustic age 2	2.391	50	1.47	10.68	2.39	6.57	4.50
Acoustic age 3	2.232	50	1.37	9.91	2.23	6.11	4.19
Acoustic age 4	1.880	50	1.15	8.46	1.88	5.19	3.55
Acoustic age 5	1.889	51	1.15	8.73	1.88	5.31	3.62
Acoustic age 6	1.948	53	1.16	9.47	1.94	5.67	3.83
Acoustic age 7	1.738	55	1.01	9.07	1.73	5.30	3.55
Acoustic age 8	2.063	53	1.23	9.99	2.06	5.99	4.05

2000	mle.	CV	Lower 95% ci	Upper 95% ci	-SE	+SE	mean of pd
DBL	0.29E-01	17	0.25E-01	0.48E-01	0.29E-01	0.41E-01	0.35E-01
NINEL	0.15E-02	23	0.12E-02	0.31E-02	0.15E-02	0.24E-02	0.19E-02
Acoustic age 1	1.29	56	0.75	6.83	1.29	3.98	2.65
Acoustic age 2	2.06	54	1.22	10.26	2.06	6.09	4.10
Acoustic age 3	1.69	54	0.99	8.55	1.69	5.04	3.39
Acoustic age 4	1.14	55	0.67	5.92	1.14	3.47	2.32
Acoustic age 5	1.0	57	0.58	5.49	1.00	3.17	2.10
Acoustic age 6	0.90	59	0.51	5.26	0.90	2.97	1.95
Acoustic age 7	0.66	62	0.36	4.06	0.64	2.23	1.45
Acoustic age 8	1.02	59	0.58	5.86	1.01	3.32	2.19

mle= maximum likelihood estimate, ci= confidence interval, SE= standard error, pd= parameter distribution

Table 7.5.1. Herring in Division VIIa(N). Run log of HAWG 2000, Irish Sea VIIa(N) final run.

Integrated Catch at Age Analysis

```
Enter the name of the index file -->index canum weca
 Stock weights in 2001 used for the year 2000 west
 Natural mortality in 2001 used for the year 2000 natmor
 Maturity ogive in 2001 used for the year 2000 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 ?-->    1.000
 First age for calculation of reference F ?--> 2    Last age for calculation of reference F ?--> 6
 Use default weighting (Y/N) ?-->n
Enter relative weights at age
 Weight for age 1-->    0.10         Weight for age 2-->    1.00
 Weight for age 3-->    1.00         Weight for age 4-->    1.00
 Weight for age 5-->    1.00         Weight for age 6-->    1.00
 Weight for age 7-->    1.00         Weight for age 8-->    1.00
Enter relative weights by year
 Weight for year 1995-->    1.00     Weight for year 1996-->    1.00
 Weight for year 1997-->    1.00     Weight for year 1998-->    1.00
 Weight for year 1999-->    1.00     Weight for year 2000-->    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-->   5.00E-02      Enter highest feasible F-->    2.00
 Mapping the F-dimension of the SSQ surface
     F                  SSQ
+--------+-------------------
    0.05         17.6191775614
    0.15         15.8685836725
    0.26         17.4104480880
    0.36         19.4022562046
    0.46         21.4975337512
    0.56         23.6582660195
    0.67         26.0126926302
    0.77         27.9793278581
    0.87         29.4365722974
    0.97         30.8103586264
    1.08         32.1156828109
    1.18         33.3684636230
    1.28         34.5882725820
    1.38         35.8050640055
    1.49         36.8842883192
    1.59         37.6068546559
    1.69         38.2734706335
    1.79         38.8892367894
    1.90         39.4587470521
    2.00         39.9861645740
Lowest SSQ is for F =     0.117
No of years for separable analysis : 6   Age range in the analysis : 1  . . . 8
Year range in the analysis : 1972-2000   Number of indices of SSB : 2
Number of age-structured indices : 1     Parameters to estimate : 33  Number of observations : 117
Conventional single selection vector model to be fitted.
Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for   INDEX1-->    1.00 Enter weight for   INDEX2-->    1.00
 Enter weight for at age 1-->    1.00   Enter weight for at age 2-->    1.00
 Enter weight for at age 3-->    1.00   Enter weight for at age 4-->    1.00
 Enter weight for at age 5-->    1.00   Enter weight for at age 6-->    1.00
 Enter weight for at age 7-->    1.00   Enter weight for at 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   1.000 1.000
Aged index weights Age   :       1     2     3     4     5     6     7     8
                     Wts :     0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125
F in 2000  at age 4  is 0.149264  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. ICA assessment of Irish Sea herring catches from official landings. Output Generated by ICA Version 1.4 Herring Irish Sea VIIa(N).

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
1	5.33	9.55	3.07	1.81	1.22
2	17.53	21.39	11.88	16.93	3.74
3	9.76	7.56	3.88	5.94	5.87
4	1.16	7.34	4.45	1.57	2.06
5	3.60	1.64	6.67	1.48	0.56
6	0.78	2.28	1.03	1.99	0.35
7	0.96	0.84	2.05	0.44	0.25
8	1.36	1.43	0.45	0.62	0.15

x 10 ^ 6

Predicted Catch in Number

AGE	1995	1996	1997	1998	1999	2000
1	3253.	2407.	4868.	8642.	2704.	1239.
2	19321.	12782.	12579.	19085.	21052.	4661.
3	3174.	9235.	8172.	5538.	5038.	4425.
4	5406.	1917.	7425.	4558.	1870.	1347.
5	1329.	3266.	1541.	4125.	1532.	501.
6	1248.	747.	2456.	801.	1288.	379.
7	921.	812.	647.	1480.	293.	371.

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
1	0.06700	0.06400	0.08000	0.06900	0.06400
2	0.11600	0.11800	0.12300	0.12000	0.12000
3	0.14800	0.14600	0.14800	0.14500	0.14800
4	0.16200	0.16500	0.16300	0.16700	0.16800
5	0.17700	0.17600	0.18100	0.17600	0.18800
6	0.19900	0.18800	0.17700	0.18800	0.20400
7	0.20000	0.20400	0.18800	0.19000	0.20000
8	0.21400	0.21600	0.22200	0.21000	0.21000

Table 7.5.2. continued. Herring VIIa(N)..Final Run.

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
1	0.06700	0.06300	0.07300	0.06800	0.06300
2	0.11500	0.11900	0.12100	0.12100	0.12000
3	0.14800	0.14800	0.15000	0.14500	0.14900
4	0.16200	0.16700	0.16600	0.16800	0.17100
5	0.17700	0.17800	0.17900	0.17800	0.18800
6	0.19500	0.18900	0.19000	0.18900	0.20400
7	0.19900	0.20600	0.20000	0.19900	0.20500
8	0.21200	0.21400	0.23000	0.21400	0.21000

Natural Mortality (per year)

AGE	1972-96	1997	1998	1999	2000
1	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.0000

Proportion of fish spawning

AGE	1972-96	1997	1998	1999	2000
1	0.0800	0.0800	0.0800	0.0800	0.0800
2	0.8500	0.8500	0.8500	0.8500	0.8500
3	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000

INDICES OF SPAWNING BIOMASS

INDEX1	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	339.0	192.0	156.0	1564.0	481.0	730.0	158.0	480.0	559.0	227.0	387.0	none

INDEX2	1993	1994	1995	1996	1997	1998	1999	2000
1	38300.	71200.	15100.	4700.	29100.	5800.	16700.	35500

x 10 ^ -3

AGE-STRUCTURED INDICES FLT01: Northern Ireland acoustic surveys

AGE	1994	1995	1996	1997	1998	1999	2000
1	66.83	319.10	11.34	134.15	110.40	157.80	78.52
2	68.29	82.30	42.37	49.98	27.30	77.70	103.44
3	73.53	11.90	67.47	14.81	8.10	34.00	105.29
4	11.86	29.20	8.95	10.98	9.30	5.10	27.54
5	9.30	4.60	26.47	1.75	6.50	10.30	8.07
6	7.55	3.50	4.17	4.55	1.80	13.50	5.43
7	3.87	4.90	5.91	0.57	2.30	1.60	4.90
8	10.12	6.90	5.82	1.91	0.80	6.30	2.36

x 10 ^ 3

Table 7.5.2. continued. Herring VIIa(N)..Final Run.

Fishing Mortality (per year)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	0.1663	0.1043	0.2140	0.1523	0.2298	0.1584	0.1040	0.1441
2	0.3618	0.3443	0.8249	0.7524	0.7930	0.8584	0.5383	0.7585
3	0.5226	0.6146	1.0134	0.9075	0.9769	0.9972	0.9273	0.8740
4	0.5338	0.4188	1.0057	0.8259	1.1024	0.9962	0.9160	0.8390
5	0.6142	0.5264	0.7580	0.9559	0.9141	1.0797	0.6692	0.7728
6	0.6379	0.4249	0.8007	0.6846	0.9983	0.7491	1.0139	1.0041
7	0.5455	0.4755	0.8968	0.8388	0.9755	0.9508	0.8328	0.8676
8	0.5455	0.4755	0.8968	0.8388	0.9755	0.9508	0.8328	0.8676

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	0.0623	0.0380	0.0365	0.0092	0.0145	0.0267	0.0431	0.0133
2	1.0929	0.4213	0.2794	0.1934	0.1255	0.2860	0.4090	0.2905
3	1.3557	0.3907	0.2790	0.1572	0.1788	0.4349	0.3806	0.3053
4	0.8997	0.6672	0.4693	0.2067	0.1463	0.5404	0.3767	0.2451
5	1.1242	0.5734	0.1330	0.1477	0.2229	0.3944	0.3153	0.2841
6	0.7614	0.4856	0.5329	0.2619	0.1628	0.3989	0.2710	0.2894
7	1.0641	0.5154	0.3474	0.1975	0.1704	0.4189	0.3557	0.2882
8	1.0641	0.5154	0.3474	0.1975	0.1704	0.4189	0.3557	0.2882

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	0.0386	0.0127	0.0333	0.0490	0.1056	0.0163	0.0173	0.0423
2	0.2919	0.2125	0.3278	0.3317	0.4179	0.3107	0.4338	0.4129
3	0.5882	0.2846	0.3191	0.3053	0.4313	0.3466	0.4936	0.3830
4	0.6609	0.4017	0.3697	0.2447	0.5315	0.3311	0.3473	0.4027
5	0.6359	0.3175	0.5396	0.2991	0.4333	0.4106	0.4597	0.4061
6	0.5810	0.3121	0.4545	0.3982	0.4923	0.3507	0.5214	0.3766
7	0.5633	0.3114	0.4093	0.3223	0.4698	0.3562	0.4606	0.4027
8	0.5633	0.3114	0.4093	0.3223	0.4698	0.3562	0.4606	0.4027

AGE	1996	1997	1998	1999	2000
1	0.0419	0.0595	0.0656	0.0406	0.0157
2	0.4090	0.5802	0.6397	0.3958	0.1530
3	0.3793	0.5381	0.5933	0.3671	0.1419
4	0.3989	0.5659	0.6239	0.3861	0.1493
5	0.4022	0.5705	0.6290	0.3892	0.1505
6	0.3730	0.5291	0.5834	0.3610	0.1396
7	0.3989	0.5659	0.6239	0.3861	0.1493
8	0.3989	0.5659	0.6239	0.3861	0.1493

Population Abundance (1 January)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	414.05	667.45	349.02	368.58	262.69	322.89	246.69	137.13
2	176.31	128.99	221.22	103.66	116.43	76.80	101.39	81.78
3	72.43	90.96	67.72	71.83	36.19	39.03	24.11	43.84
4	33.34	35.16	40.28	20.13	23.73	11.15	11.79	7.81
5	31.32	17.69	20.93	13.33	7.97	7.13	3.73	4.27
6	14.98	15.34	9.45	8.87	4.64	2.89	2.19	1.73
7	6.62	7.16	9.07	3.84	4.05	1.55	1.24	0.72
8	4.15	7.19	2.87	3.01	2.13	1.90	0.65	0.52

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	152.21	213.43	224.56	226.06	128.08	145.47	167.93	265.72
2	43.68	52.61	75.59	79.65	82.40	46.44	52.10	59.17
3	28.38	10.85	25.58	42.35	48.63	53.85	25.85	25.64
4	14.98	5.99	6.01	15.84	29.63	33.30	28.54	14.46
5	3.05	5.51	2.78	3.40	11.66	23.16	17.55	17.72
6	1.78	0.90	2.81	2.20	2.65	8.44	14.13	11.59
7	0.57	0.75	0.50	1.49	1.53	2.04	5.13	9.75
8	0.37	0.62	1.36	0.35	3.21	2.22	3.07	7.00

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	108.49	145.13	111.47	65.92	190.14	62.94	180.98	123.73
2	96.46	38.40	52.72	39.66	23.09	62.94	22.78	65.44
3	32.79	53.37	23.00	28.14	21.09	11.26	34.17	10.94
4	15.47	14.91	32.87	13.69	16.98	11.22	6.52	17.08
5	10.24	7.23	9.03	20.55	9.70	9.03	7.29	4.17
6	12.07	4.91	4.76	4.76	13.79	5.69	5.42	4.16
7	7.85	6.11	3.25	2.73	2.89	7.63	3.62	2.91
8	10.23	7.66	5.04	3.10	1.09	2.96	5.65	4.59

AGE	1996	1997	1998	1999	2000	2001
1	92.43	132.75	214.25	107.21	125.80	124.32
2	43.63	32.61	46.02	73.82	37.87	45.56
3	32.08	21.47	13.52	17.98	36.81	24.08
4	6.10	17.97	10.26	6.12	10.20	26.15
5	10.33	3.71	9.23	4.98	3.76	7.95
6	2.51	6.25	1.90	4.45	3.05	2.93
7	2.59	1.57	3.33	0.96	2.81	2.40
8	4.34	3.47	1.02	2.03	1.06	3.10

x 10 ^ 6

Table 7.5.2. continued. Herring VIIa(N)..Final Run.

Weighting factors for the catches in number

AGE	1995	1996	1997	1998	1999	2000
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	1997	1998	1999	2000
1	583.04	533.50	462.86	314.07	413.53	335.97	366.72	355.95	285.19	255.71	347.10	none

INDEX2	1993	1994	1995	1996	1997	1998	1999	2000
1	23212.	18859.	20584.	19980	16008.	14353.	19483.	24022

Predicted Age-Structured Index Values FLT01: Northern Ireland acoustic survey Predicted x 10 ^ 3

AGE	1994	1995	1996	1997	1998	1999	2000
1	121.96	81.83	61.14	86.67	139.24	71.00	84.87
2	31.41	91.66	61.30	40.29	54.38	104.74	64.47
3	45.34	15.76	46.37	27.56	16.65	26.23	63.58
4	8.76	22.02	7.89	20.51	11.21	7.99	15.90
5	9.05	5.39	13.39	4.24	10.10	6.51	5.89
6	6.62	5.68	3.43	7.60	2.21	6.14	4.97
7	4.14	3.47	3.09	1.65	3.37	1.16	4.05
8	7.65	6.49	6.16	4.34	1.22	2.91	1.96

Fitted Selection Pattern

AGE	1972	1973	1974	1975	1976	1977	1978	1979
1	0.3115	0.2491	0.2128	0.1844	0.2085	0.1590	0.1136	0.1717
2	0.6779	0.8221	0.8202	0.9110	0.7194	0.8617	0.5877	0.9040
3	0.9791	1.4675	1.0076	1.0988	0.8861	1.0010	1.0123	1.0416
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.1507	1.2569	0.7537	1.1573	0.8292	1.0838	0.7305	0.9210
6	1.1952	1.0146	0.7961	0.8289	0.9056	0.7520	1.1068	1.1967
7	1.0220	1.1353	0.8917	1.0157	0.8849	0.9544	0.9092	1.0341
8	1.0220	1.1353	0.8917	1.0157	0.8849	0.9544	0.9092	1.0341

AGE	1980	1981	1982	1983	1984	1985	1986	1987
1	0.0692	0.0570	0.0777	0.0444	0.0992	0.0494	0.1144	0.0543
2	1.2148	0.6314	0.5954	0.9359	0.8581	0.5292	1.0859	1.1850
3	1.5068	0.5855	0.5946	0.7606	1.2223	0.8049	1.0104	1.2456
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.2496	0.8594	0.2835	0.7147	1.5241	0.7298	0.8370	1.1592
6	0.8463	0.7279	1.1355	1.2669	1.1130	0.7382	0.7194	1.1804
7	1.1828	0.7725	0.7403	0.9553	1.1648	0.7752	0.9442	1.1756
8	1.1828	0.7725	0.7403	0.9553	1.1648	0.7752	0.9442	1.1756

AGE	1988	1989	1990	1991	1992	1993	1994	1995
1	0.0584	0.0315	0.0900	0.2001	0.1986	0.0494	0.0499	0.1051
2	0.4416	0.5291	0.8868	1.3556	0.7862	0.9385	1.2491	1.0253
3	0.8900	0.7086	0.8632	1.2474	0.8115	1.0469	1.4212	0.9509
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.9621	0.7904	1.4597	1.2222	0.8152	1.2401	1.3237	1.0082
6	0.8790	0.7770	1.2294	1.6271	0.9262	1.0592	1.5013	0.9351
7	0.8522	0.7752	1.1070	1.3172	0.8838	1.0758	1.3263	1.0000
8	0.8522	0.7752	1.1070	1.3172	0.8838	1.0758	1.3263	1.0000

AGE	1996	1997	1998	1999	2000
1	0.1051	0.1051	0.1051	0.1051	0.1051
2	1.0253	1.0253	1.0253	1.0253	1.0253
3	0.9509	0.9509	0.9509	0.9509	0.9509
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0082	1.0082	1.0082	1.0082	1.0082
6	0.9351	0.9351	0.9351	0.9351	0.9351
7	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000

Table 7.5.2. continued. Herring VIIa(N)..Final R un.

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	414040	93282	33644	27350	0.8129	0.5341	112
1973	667440	106622	32467	22600	0.6961	0.4658	100
1974	349020	92510	24405	38640	1.5832	0.8805	99
1975	368570	68905	16838	24500	1.4550	0.8252	102
1976	262690	54389	12730	21250	1.6692	0.9570	99
1977	322880	49158	9398	15410	1.6396	0.9361	95
1978	246680	43167	10868	11080	1.0194	0.8129	92
1979	137130	34838	9542	12338	1.2929	0.8497	92
1980	152200	28252	5418	10613	1.9588	1.0468	97
1981	213430	29247	7371	4377	0.5938	0.5076	90
1982	224560	36494	12211	4855	0.3976	0.3387	98
1983	226050	42624	17929	3933	0.2194	0.1934	98
1984	128070	41304	22715	4066	0.1790	0.1673	96
1985	145470	40574	16803	9187	0.5467	0.4109	102
1986	167920	37564	16436	7440	0.4526	0.3505	97
1987	265710	39335	16038	5823	0.3631	0.2829	103
1988	108490	35701	15060	10172	0.6754	0.5516	105
1989	145120	32745	14027	4949	0.3528	0.3057	100
1990	111460	29596	12835	6312	0.4918	0.4022	101
1991	65920	21799	11135	4398	0.3949	0.3158	100
1992	190130	24219	7556	5270	0.6974	0.4612	101
1993	62940	22038	9949	4409	0.4432	0.3500	101
1994	180980	26772	8083	4828	0.5973	0.4512	102
1995	123730	24304	8822	5076	0.5753	0.3963	99
1996	92420	20700	8563	5301	0.6190	0.3925	100
1997	132750	21328	6861	6651	0.9694	0.5568	100
1998	214250	27854	6152	4905	0.7973	0.6139	100
1999	107210	22210	8350	4127	0.4942	0.3799	99
2000	125790	21826	10296	2002	0.1944	0.1469	100

No of years for separable analysis : 6
Age range in the analysis : 1 . . . 8
Year range in the analysis : 1972 . . . 2000
Number of indices of SSB : 2
Number of age-structured indices : 1
Parameters to estimate : 33
Number of observations : 117

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1995	0.4027	26	0.2404	0.6748	0.3095	0.5241	0.4170
2	1996	0.3989	25	0.2411	0.6600	0.3085	0.5157	0.4123
3	1997	0.5659	25	0.3449	0.9285	0.4395	0.7285	0.5842
4	1998	0.6239	27	0.3608	1.0788	0.4718	0.8250	0.6487
5	1999	0.3861	32	0.2047	0.7281	0.2793	0.5336	0.4068
6	2000	0.1493	35	0.0742	0.3002	0.1045	0.2132	0.1591
Separable Model: Selection (S) by age								
7	1	0.1051	64	0.0299	0.3689	0.0554	0.1994	0.1290
8	2	1.0253	26	0.6051	1.7372	0.7834	1.3418	1.0631
9	3	0.9509	25	0.5722	1.5802	0.7338	1.2322	0.9834
	4	1.0000	Fixed : Reference Age					
10	5	1.0082	22	0.6450	1.5761	0.8027	1.2663	1.0348
11	6	0.9351	22	0.6054	1.4444	0.7491	1.1674	0.9584
	7	1.0000	Fixed : Last true age					
Separable model: Populations in year 2000								
12	1	125795	105	15911	994543	43804	361249	219439
13	2	37872	46	15364	93351	23901	60009	42104
14	3	36808	32	19454	69640	26586	50960	38808
15	4	10197	33	5334	19492	7326	14192	10769
16	5	3761	33	1939	7292	2682	5272	3981
17	6	3050	35	1523	6107	2140	4346	3247
18	7	2808	38	1332	5919	1919	4108	3018
Separable model: Populations at age								
19	1995	2909	47	1144	7397	1807	4683	3258
20	1996	2584	37	1231	5424	1770	3772	2776
21	1997	1565	33	815	3004	1122	2182	1654
22	1998	3331	34	1707	6502	2368	4686	3531
23	1999	956	37	460	1987	658	1388	1025
SSB Index catchabilities								
INDEX1 Linear model fitted. Slopes at age :								
24	1 Q	.4156E-01	15	.3596E-01	.6499E-01	.4156E-01	.5622E-01	.4889E-01
INDEX2 Linear model fitted. Slopes at age :								
25	2 Q	.2333E-02	19	.1928E-02	.4202E-02	.2333E-02	.3472E-02	.2903E-02
Age-structured index catchabilities **FLT01: Northern Ireland acoustic survey**								
Linear model fitted. Slopes at age :								
26	1 Q	1.445	52	.8722	6.856	1.445	4.138	2.808
27	2 Q	2.391	50	1.472	10.68	2.391	6.573	4.505
28	3 Q	2.232	50	1.376	9.914	2.232	6.113	4.194
29	4 Q	1.880	50	1.154	8.465	1.880	5.196	3.556
30	5 Q	1.889	51	1.150	8.735	1.889	5.316	3.623
31	6 Q	1.948	53	1.167	9.475	1.948	5.673	3.835
32	7 Q	1.738	55	1.017	9.075	1.738	5.309	3.550
33	8 Q	2.063	53	1.237	9.994	2.063	5.991	4.052

RESIDUALS ABOUT THE MODEL FIT Separable Model Residuals

Age	1995	1996	1997	1998	1999	2000
1	-0.015	0.796	0.674	-1.035	-0.401	-0.015
2	0.099	0.316	0.531	-0.474	-0.218	-0.219
3	0.066	0.055	-0.078	-0.357	0.164	0.283
4	-0.026	-0.502	-0.011	-0.024	-0.178	0.427
5	-0.103	0.098	0.063	0.481	-0.037	0.108
6	-0.078	0.043	-0.074	0.251	0.434	-0.087
7	0.005	0.168	0.261	0.325	0.417	-0.391

Table 7.5.2. continued. Herring VIIa(N)..Final Run.

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	-0.542	-1.022	-1.088	1.605	0.151	0.776	-0.842	0.299	0.673	-0.119	0.109	

INDEX2	1993	1994	1995	1996	1997	1998	1999	2000
1	0.501	1.329	-0.310	-1.447	0.598	-0.906	-0.154	0.391

AGE-STRUCTURED INDEX RESIDUALS

FLT01: Northern Ireland acoustic survey

Age	1994	1995	1996	1997	1998	1999	2000
1	-0.602	1.361	-1.685	0.437	-0.232	0.799	-0.078
2	0.777	-0.108	-0.369	0.215	-0.689	-0.299	0.473
3	0.483	-0.281	0.375	-0.621	-0.720	0.259	0.504
4	0.302	0.282	0.126	-0.624	-0.187	-0.448	0.549
5	0.027	-0.158	0.681	-0.883	-0.440	0.458	0.315
6	0.131	-0.483	0.194	-0.512	-0.206	0.788	0.089
7	-0.067	0.345	0.648	-1.062	-0.381	0.326	0.191
8	0.280	0.061	-0.058	-0.821	-0.420	0.771	0.188

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1995 to 2000

Variance	0.1437	Skewness test stat.	0.9446
Kurtosis test statistic	-0.6310	Partial chi-square	0.3518
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	0.7001	Skewness test sta	0.4435
Kurtosis test statistic	-0.4663	Partial chi-square	1.1808
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	0.7944	Skewness test stat.	-0.2652
Kurtosis test statistic	-0.4774	Partial chi-square	1.9047
Significance in fit	0.0030	Number of observations	8
Degrees of freedom	7	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	0.1238	0.0330	0.0350	0.0232	0.0369	0.0255	0.0408	0.0326
Skewness test stat.	-0.3751	0.2556	-0.4250	-0.2966	-0.4048	0.5133	-0.9357	-0.2050
Kurtosis test statisti	-0.3279	-0.6151	-0.8593	-0.7085	-0.5188	-0.3241	-0.1463	-0.3150
Partial chi-square	0.0664	0.0184	0.0205	0.0145	0.0252	0.0176	0.0321	0.0242
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	7	7	7	7	7	7	7	7
Degrees of freedom	6	6	6	6	6	6	6	6
Weight in the analysis	0.1250	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	34.2198	117	33	84	0.4074
Catches at age	4.8187	42	23	19	0.2536
SSB INDEX1	7.0009	11	1	10	0.7001
SSB INDEX2	5.5606	8	1	7	0.7944
Aged Indices	16.8396	56	8	48	0.3508

Weighted Statistics

Variance	SSQ	Data	Parameters	d.f.	Variance
Total for model	15.5545	117	33	84	0.1852
Catches at age	2.7299	42	23	19	0.1437
INDEX1	7.0009	11	1	10	0.7001
INDEX2	5.5606	8	1	7	0.7944
FLT01: Northern Ireland acoustic surve	0.2631	56	8	48	0.0055

Table 7.6.1. Herring VIIa(N). Input table for short term predictions.

MFDP version 1a   Run: final nirs   Fbar age range: 2-6

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	130569	1	0.08	0.9	0.75	0.068	0.016	0.071
2	45560	0.3	0.85	0.9	0.75	0.121	0.153	0.121
3	24080	0.2	1	0.9	0.75	0.148	0.142	0.147
4	26150	0.1	1	0.9	0.75	0.168	0.149	0.166
5	7950	0.1	1	0.9	0.75	0.182	0.150	0.182
6	2930	0.1	1	0.9	0.75	0.194	0.140	0.190
7	2400	0.1	1	0.9	0.75	0.201	0.149	0.193
8	3100	0.1	1	0.9	0.75	0.220	0.149	0.215

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	130569	1	0.08	0.9	0.75	0.068	0.016	0.071
2		0.3	0.85	0.9	0.75	0.121	0.153	0.121
3		0.2	1	0.9	0.75	0.148	0.142	0.147
4		0.1	1	0.9	0.75	0.168	0.149	0.166
5		0.1	1	0.9	0.75	0.182	0.150	0.182
6		0.1	1	0.9	0.75	0.194	0.140	0.190
7		0.1	1	0.9	0.75	0.201	0.149	0.193
8		0.1	1	0.9	0.75	0.220	0.149	0.215

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	130569	1	0.08	0.9	0.75	0.068	0.016	0.071
2		0.3	0.85	0.9	0.75	0.121	0.153	0.121
3		0.2	1	0.9	0.75	0.148	0.142	0.147
4		0.1	1	0.9	0.75	0.168	0.149	0.166
5		0.1	1	0.9	0.75	0.182	0.150	0.182
6		0.1	1	0.9	0.75	0.194	0.140	0.190
7		0.1	1	0.9	0.75	0.201	0.149	0.193
8		0.1	1	0.9	0.75	0.220	0.149	0.215

Input units are thousands and kg - output in tonnes

Table 7.6.2. Herring VIIa(N). Management option table for 2002, assuming TAC is taken in 2001.

MFDP version 1a   Run: nirs final 5100mult   Fbar age range: 2-6

Irish Sea 2001Projection index file Saturday, 17 March 2001.

2001

Biomass	SSB	FMult	FBar	Landings
25520	10095	2.6014	0.382	5100

2002					**2003**	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
25065	13742	0	0	0	29840	18000
	13387	0.2	0.0294	448	29377	17134
	13043	0.4	0.0587	885	28928	16312
	12707	0.6	0.0881	1309	28491	15533
	12380	0.8	0.1175	1721	28067	14792
	12061	1	0.1469	2123	27655	14090
	11751	1.2	0.1762	2513	27254	13423
	11450	1.4	0.2056	2893	26864	12789
	11156	1.6	0.235	3263	26486	12188
	10869	1.8	0.2643	3623	26118	11617
	10591	2	0.2937	3972	25761	11074
	10319	2.2	0.3231	4313	25413	10559
	10055	2.4	0.3525	4644	25075	10070
	9798	2.6	0.3818	4967	24747	9605
	9547	2.8	0.4112	5280	24428	9164
	9304	3	0.4406	5586	24117	8744
	9066	3.2	0.47	5883	23816	8346
	8835	3.4	0.4993	6172	23522	7967
	8610	3.6	0.5287	6454	23237	7607
	8390	3.8	0.5581	6728	22960	7265
	8177	4	0.5874	6995	22691	6939

Input units are thousands and kg - output in tonnes

Table 7.6.3. Herring VIIa(N). Management option table for 2002, assuming *status quo* F in 2001.

MFDP version 1a Run: Catch and F for 2000 Fbar age range: 2-6

Irish Sea 2001Projection index file Saturday, 17 March 2001.

2001

Biomass	SSB	FMult	FBar	Landings
25520	12433	1	0.1469	2179

2002					**2003**	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
28061	16424	0	0	0	32684	20630
	16000	0.2	0.0294	529	32139	19622
	15587	0.4	0.0587	1043	31610	18665
	15185	0.6	0.0881	1542	31096	17758
	14793	0.8	0.1175	2029	30596	16897
	14412	1	0.1469	2501	30111	16080
	14041	1.2	0.1762	2961	29639	15305
	13679	1.4	0.2056	3409	29181	14570
	13327	1.6	0.235	3844	28735	13872
	12984	1.8	0.2643	4267	28302	13210
	12651	2	0.2937	4679	27882	12581
	12326	2.2	0.3231	5080	27473	11984
	12009	2.4	0.3525	5470	27075	11418
	11701	2.6	0.3818	5849	26689	10880
	11401	2.8	0.4112	6218	26314	10369
	11109	3	0.4406	6577	25949	9885
	10824	3.2	0.47	6926	25594	9424
	10547	3.4	0.4993	7266	25250	8987
	10277	3.6	0.5287	7597	24915	8572
	10015	3.8	0.5581	7919	24589	8177
	9759	4	0.5874	8233	24272	7802

Input units are thousands and kg - output in tonnes

Table 7.6.4. Herring VIIa(N). Single option table for TAC taken in 2001 and catch remaining at 5100 tonnes in 2002.

MFDP version 1a | Run: F 2000 | Fbar age range: 2-6

Year:	**2001**	F multiplier:	2.6014	Fbar:	0.382				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0408	3313	235	130569	8879	10446	710	4756	323
2	0.3981	13055	1580	45560	5498	38726	4673	21612	2608
3	0.3692	6779	997	24080	3564	24080	3564	14866	2200
4	0.3883	8034	1334	26150	4402	26150	4402	17105	2879
5	0.3915	2459	447	7950	1444	7950	1444	5185	942
6	0.3631	852	162	2930	569	2930	569	1961	381
7	0.3883	737	142	2400	483	2400	483	1570	316
8	0.3883	952	205	3100	681	3100	681	2028	445
Total		36181	5100	242739	25520	115782	16527	69082	10095

Year:	**2002**	F multiplier:	2.685	Fbar:	0.3943				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0421	3418	243	130569	8879	10446	710	4750	323
2	0.4109	13561	1641	46112	5564	39195	4730	21623	2609
3	0.3811	6552	963	22668	3355	22668	3355	13845	2049
4	0.4008	4297	713	13628	2294	13628	2294	8815	1484
5	0.404	5093	925	16047	2915	16047	2915	10349	1880
6	0.3748	1451	275	4863	945	4863	945	3220	626
7	0.4008	581	112	1844	371	1844	371	1193	240
8	0.4008	1064	229	3375	741	3375	741	2183	480
Total		36016	5101	239107	25065	112066	16062	65978	9691

Input units are thousands and kg - output in tonnes

Table 7.6.5. Herring VIIa(N). Single option table for TAC taken in 2001 and following years fishing at F_{2000}=0.147.

MFDP version 1a		Run: final nirs		Fbar age range: 2-6					
Year:	**2001**	F multiplier:	2.6014	Fbar:	0.382				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0408	3313	235	130569	8879	10446	710	4756	323
2	0.3981	13055	1580	45560	5498	38726	4673	21612	2608
3	0.3692	6779	997	24080	3564	24080	3564	14866	2200
4	0.3883	8034	1334	26150	4402	26150	4402	17105	2879
5	0.3915	2459	447	7950	1444	7950	1444	5185	942
6	0.3631	852	162	2930	569	2930	569	1961	381
7	0.3883	737	142	2400	483	2400	483	1570	316
8	0.3883	952	205	3100	681	3100	681	2028	445
Total		36181	5100	242739	25520	115782	16527	69082	10095

Year:	**2002**	F multiplier:	1	Fbar:	0.1469				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0157	1287	91	130569	8879	10446	710	4865	331
2	0.153	5675	687	46112	5564	39195	4730	27271	3291
3	0.1419	2725	401	22668	3355	22668	3355	17171	2541
4	0.1493	1801	299	13628	2294	13628	2294	11054	1861
5	0.1505	2136	388	16047	2915	16047	2915	13002	2362
6	0.1396	604	114	4863	945	4863	945	3979	773
7	0.1493	244	47	1844	371	1844	371	1496	301
8	0.1493	446	96	3375	741	3375	741	2738	601
Total		14916	2123	239107	25065	112066	16062	81575	12061

Year:	**2003**	F multiplier:	1	Fbar:	0.1469				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0157	1287	91	130569	8879	10446	710	4865	331
2	0.153	5819	704	47286	5706	40193	4850	27965	3374
3	0.1419	3524	518	29313	4338	29313	4338	22205	3286
4	0.1493	2128	353	16103	2711	16103	2711	13061	2199
5	0.1505	1414	257	10622	1930	10622	1930	8606	1563
6	0.1396	1550	294	12492	2428	12492	2428	10221	1986
7	0.1493	506	97	3827	771	3827	771	3104	625
8	0.1493	537	116	4068	894	4068	894	3299	725
Total		16765	2431	254279	27655	127062	18630	93326	14090

Input units are thousands and kg - output in tonnes

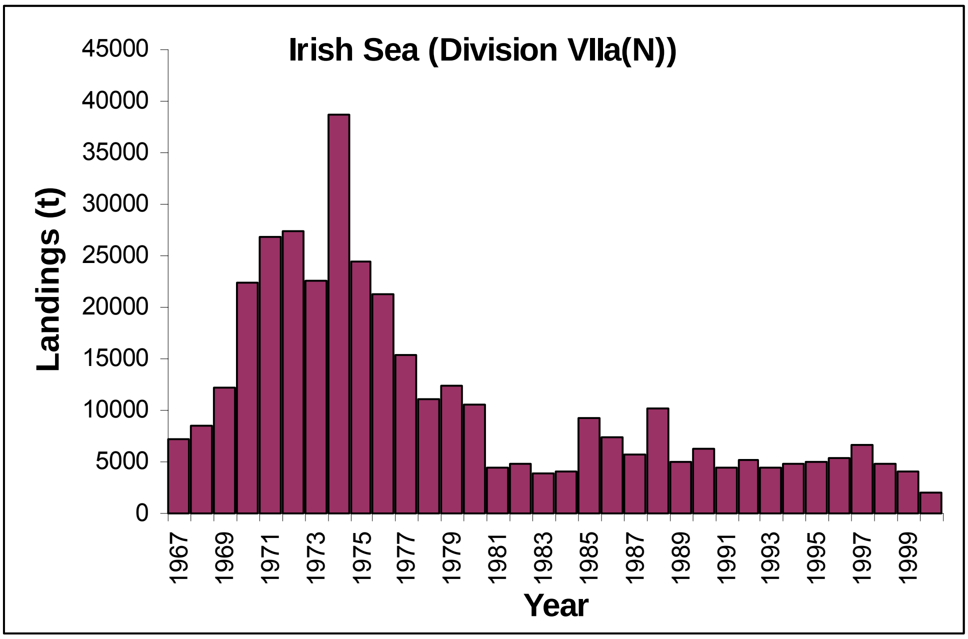


Figure 7.1.1 Herring VIIa(N). Landings of herring from VIIa(n) from 1967 to 2000.

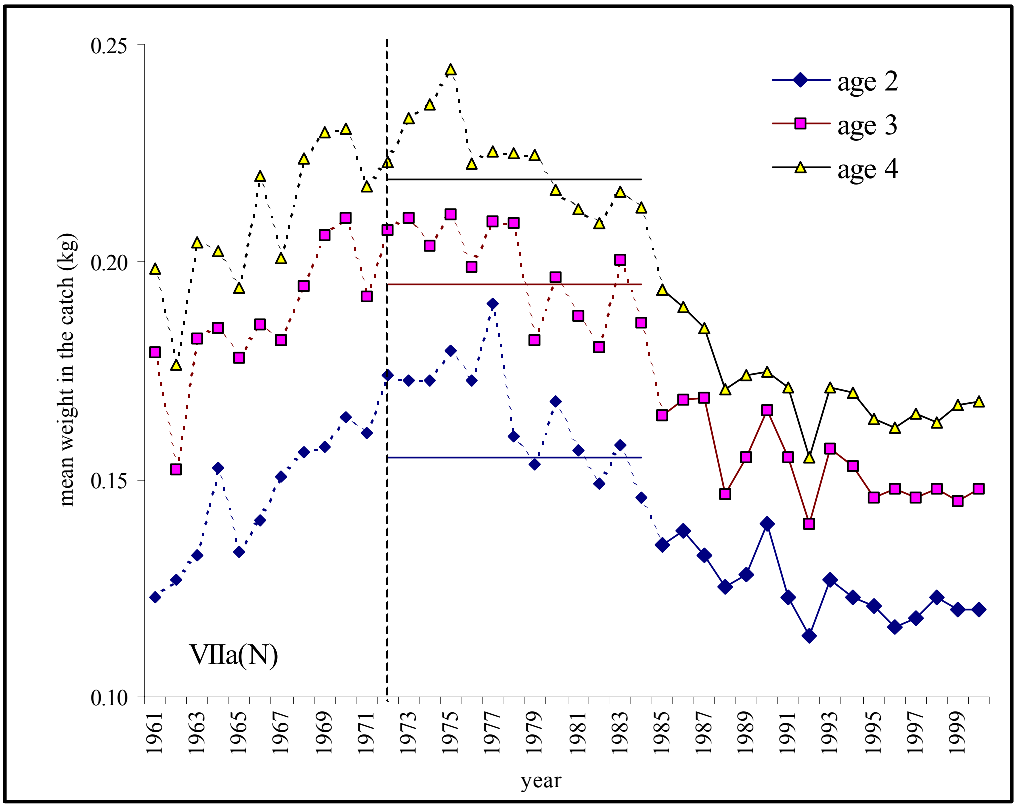


Figure 7.2.1. Herring VIIa(N). Mean weights in the catch for herring in VIIa(N) for 2-4 ringers. The vertical line indicates the start of the assessment period and solid lines are the data currently used in the assessment. Dotted lines are unpublished, simple arithmetic means of data held by the Port Erin Marine Laboratory. These data need to be worked up fully (catch and area weighted) before they can be utilised for assessment purposes.

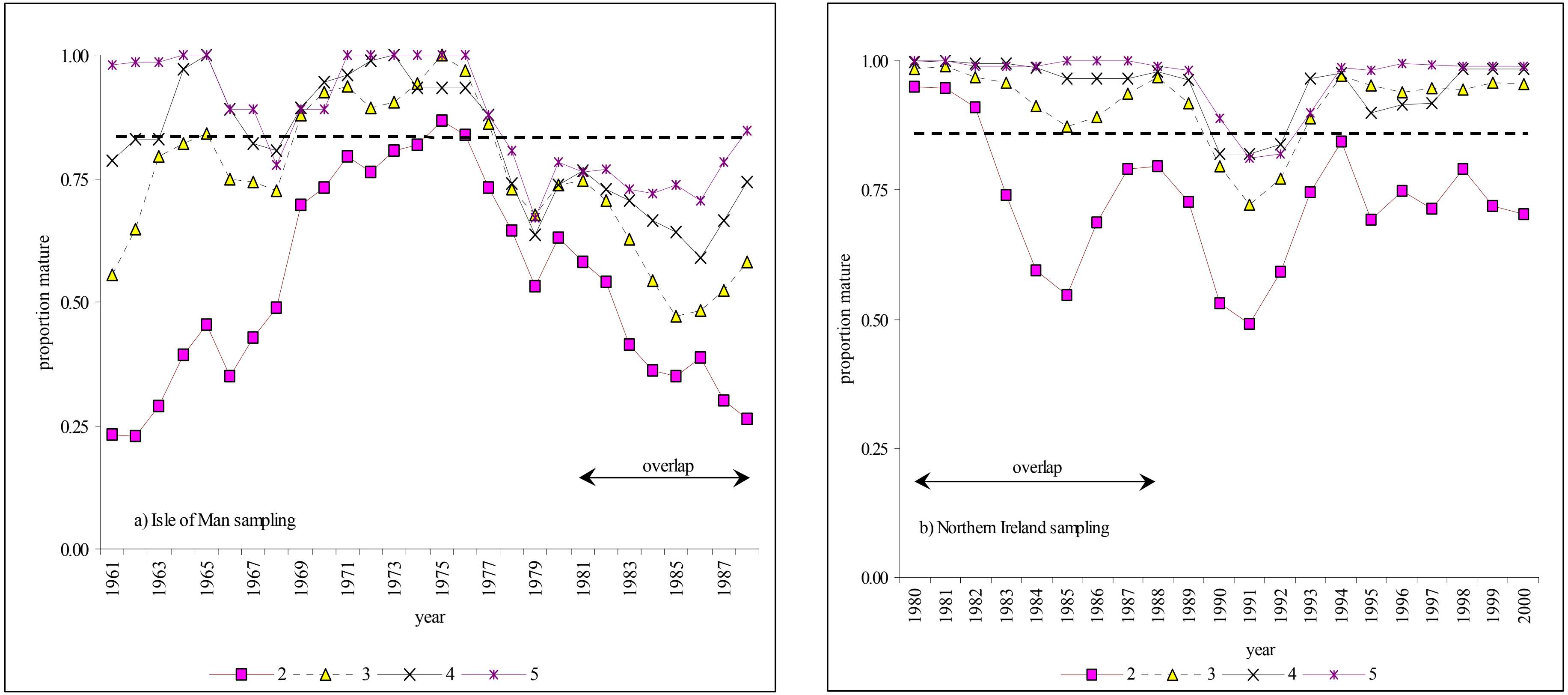


Figure 7.2.2. Herring VIIa(N). Historical time series of maturity at age data for 2 to 5 ringers in the Irish Sea (VIIa(N)). A. Data held by the Isle of Man for the period 1961 to 1988, using random sampling of the catch. B. Data held by Northern Ireland for the period 1980 to 2000, using length stratified sampling. The dashed line is the proportion of 2-ringers that are mature, currently used by the Working Group for all years in the assessment. The period of overlap in the data presented here is indicated. These data are for illustrative purposes only as the landings in to the Isle of Man and Northern Ireland are from fisheries targeting different parts of the population. These data need to be re-worked and consideration of any bias caused by length stratified sampling taken in to account prior to any use in assessments.

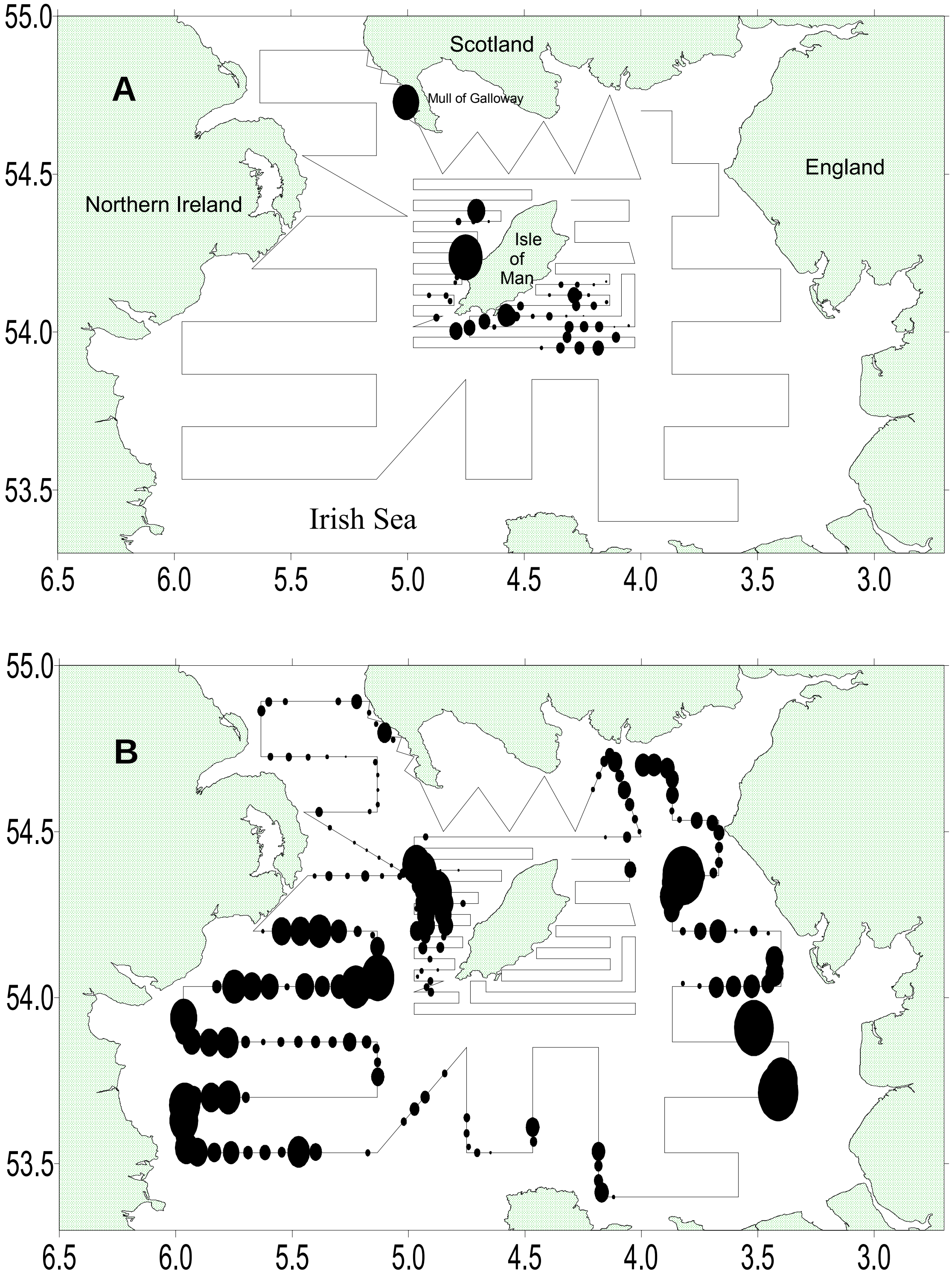


Figure 7.3.1. Herring VIIa(N). Density distribution of (**A**) herring schools (mainly 1-ring and older) and (**B**) sprats and 0-group herring during the September 2000 DARD acoustic survey. Size of ellipses is proportional to square root of the integrated backscatter for each 15-minute interval (same scale for figures A and B).

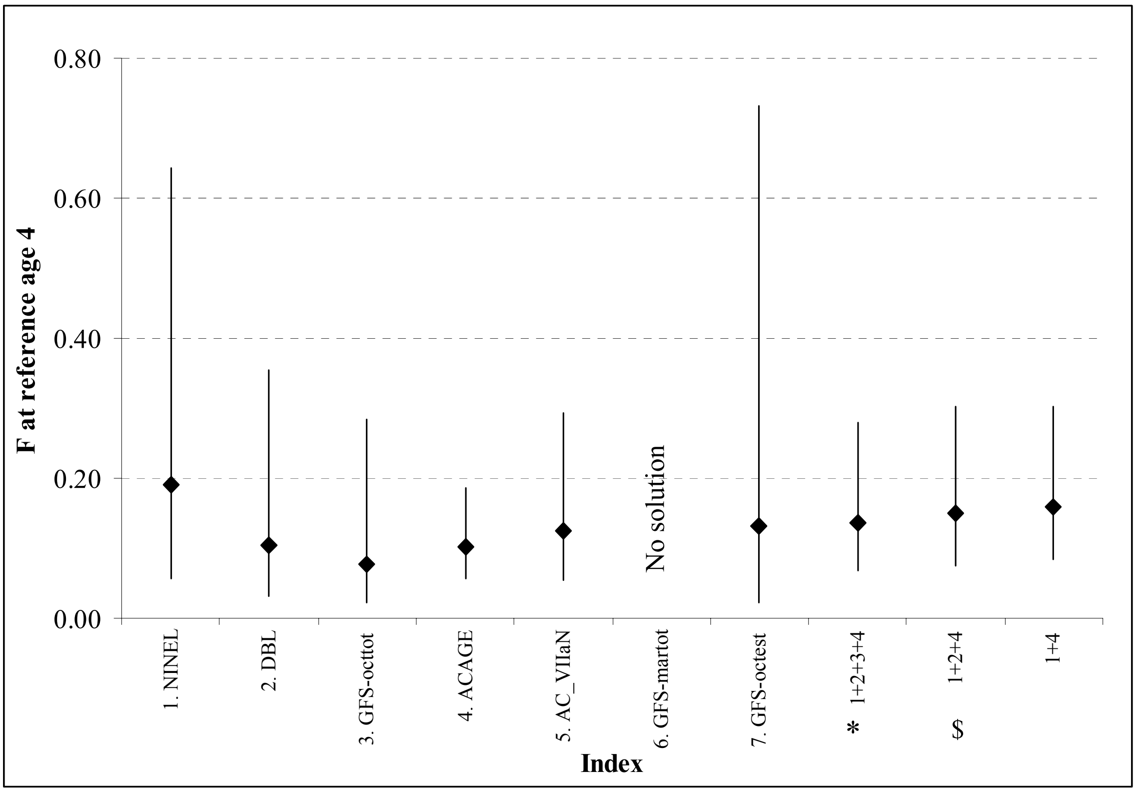


Figure 7.4.1. Herring VIIa(N). Results in terms of F at reference age 4, of preliminary modelling with ICA of survey indices described inn table 7.4.1. Error bars show the upper and lower 95% confidence limits. The combination of indices denoted by * were used for last years assessment, the indices denoted by $ were used in this assessment.

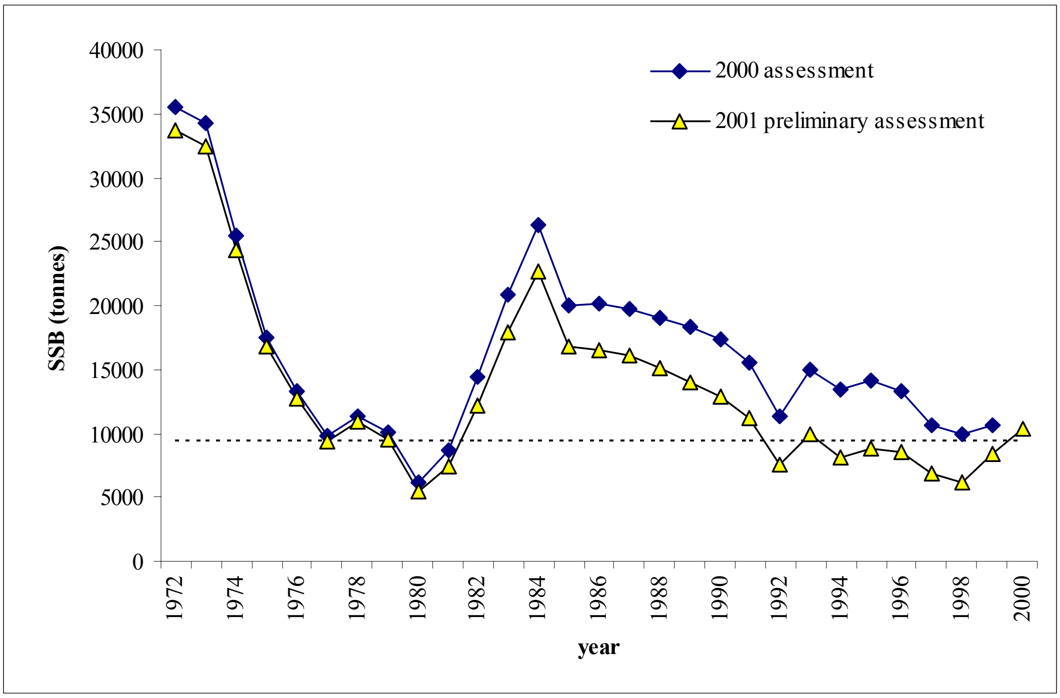


Figure 7.4.2. Herring VIIa(N). Comparison of estimates of SSB derived from assessment in 2000 and the preliminary run of ICA using indices denoted by $ in Figure 7.4.1 in 2001. Dotted line is $\mathbf{B}_{pa}$.

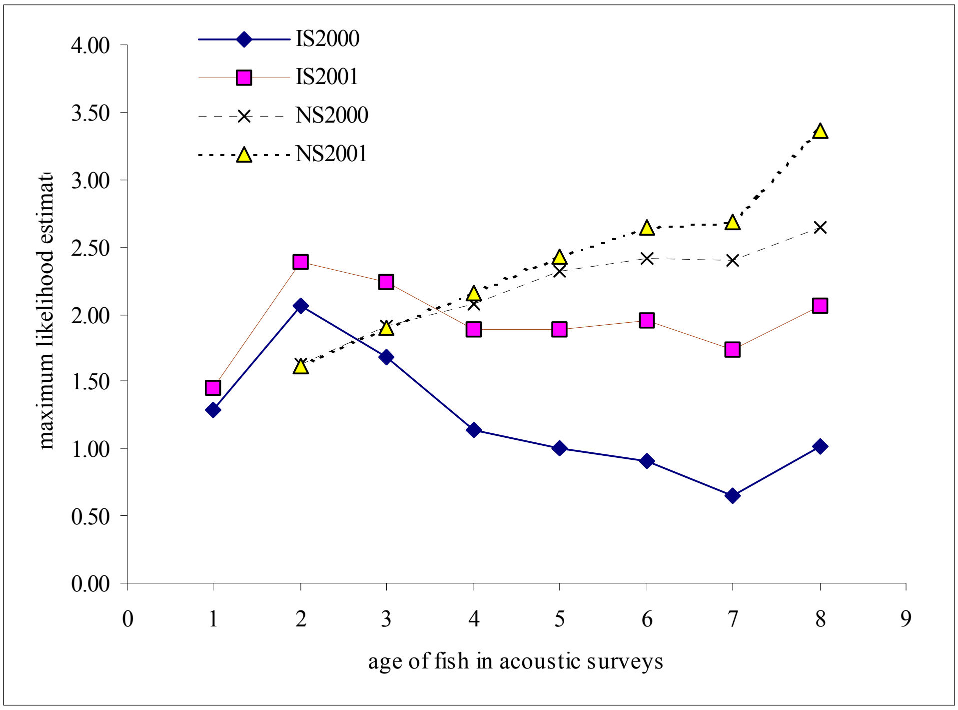


Figure 7.4.3. Herring VIIa(N). Maximum likelihood estimate of catchability of acoustic indices by age from Irish Sea (IS) and the North Sea (NS) herring assessments in 2000 and 2001.

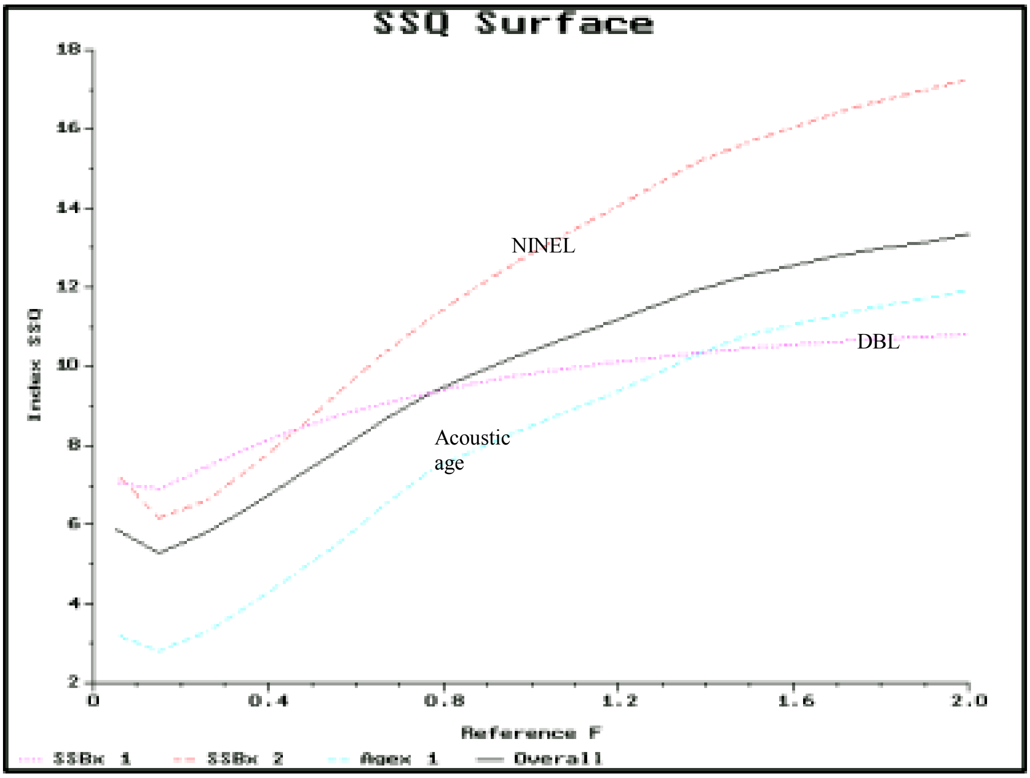


Figure 7.5.1. Herring VIIa(N). SSQ surface for the baseline assessment. Indices described in Table 7.4.1.

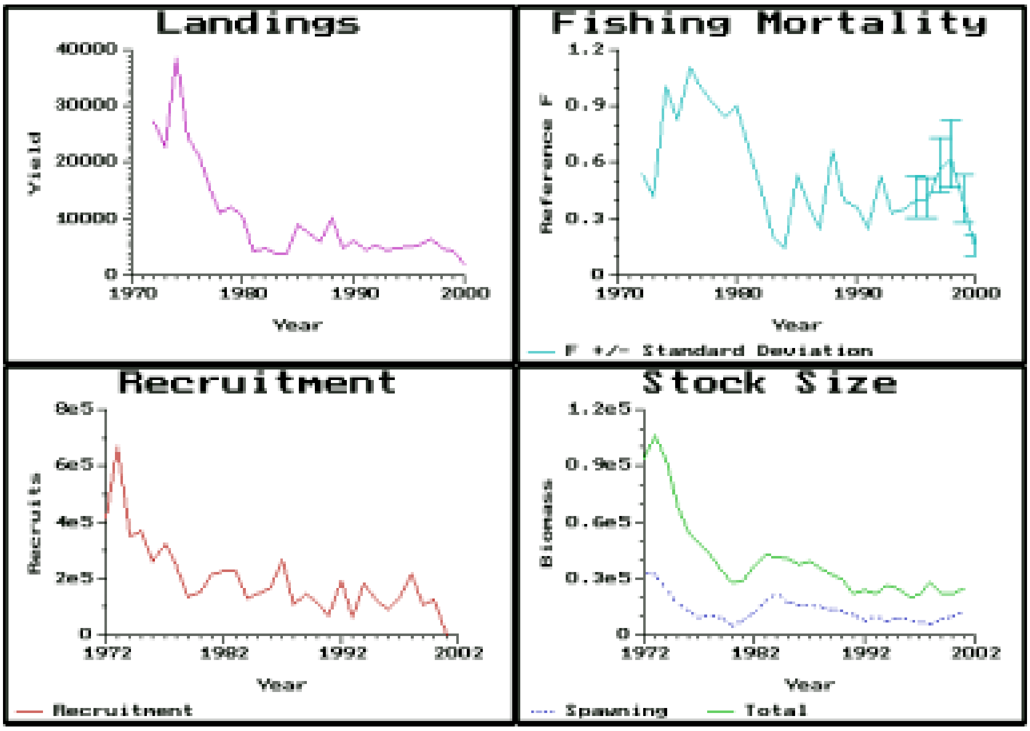


Figure 7.5.2. Herring VIIa(N). Results of baseline assessment. Summary of estimates of landings, fishing mortality at age 4, recruitment at age 1, stock size on January 1 and spawning stock size at spawning time.

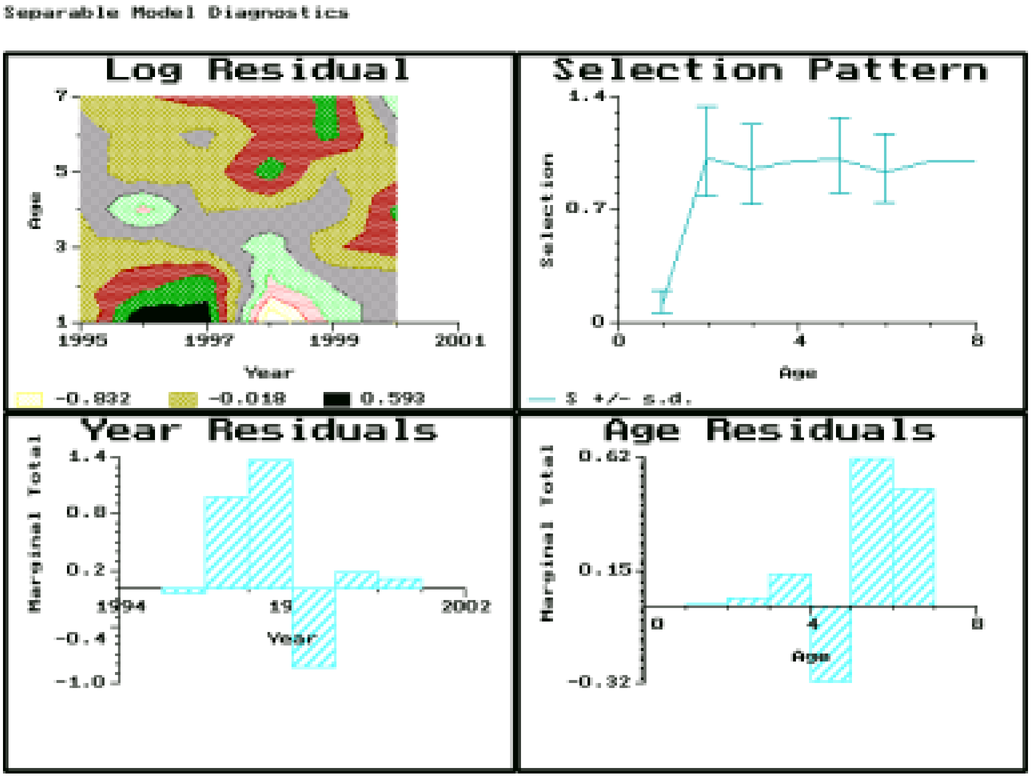


Figure 7.5.3. Herring VIIa(N). Results of baseline assessment. Selection patterns diagnostics. Top left, contour plot of selection pattern residuals. Top right, estimated selection (relative to age 4) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

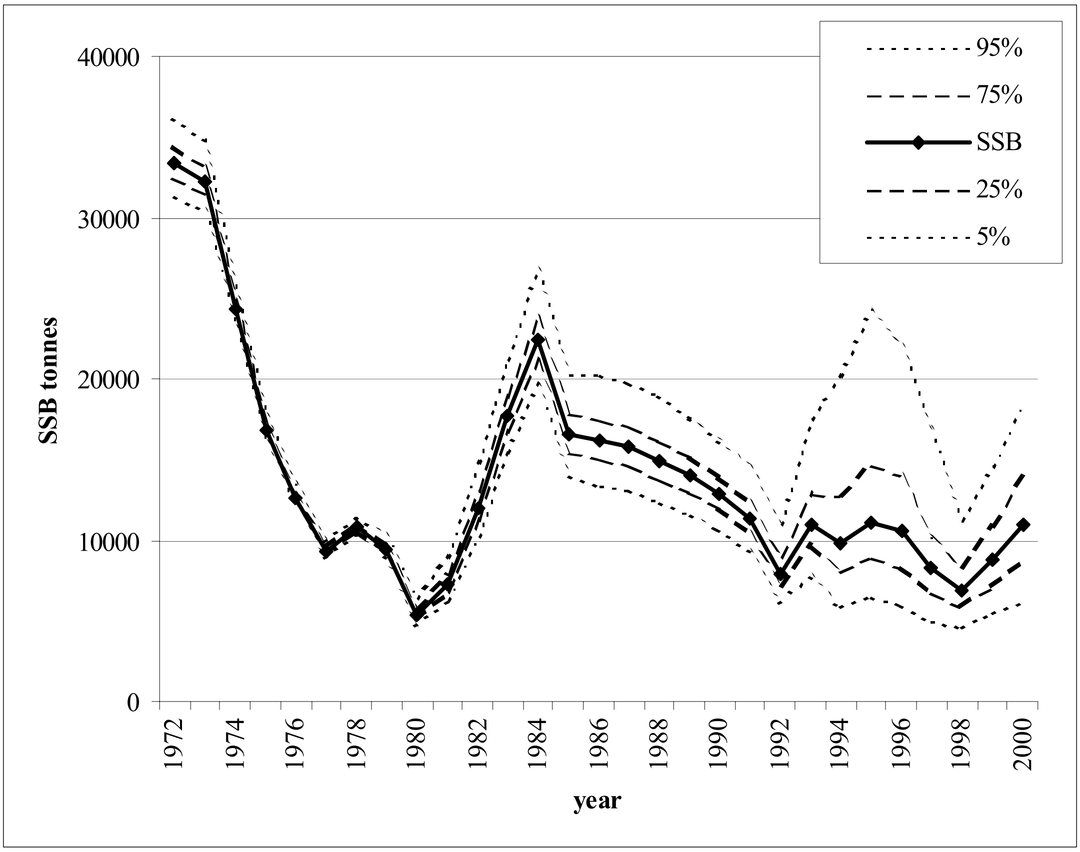
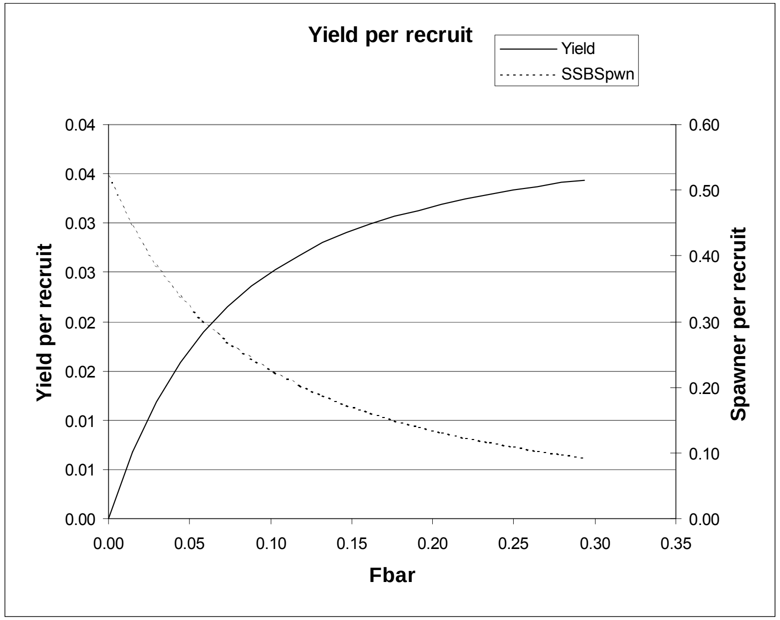
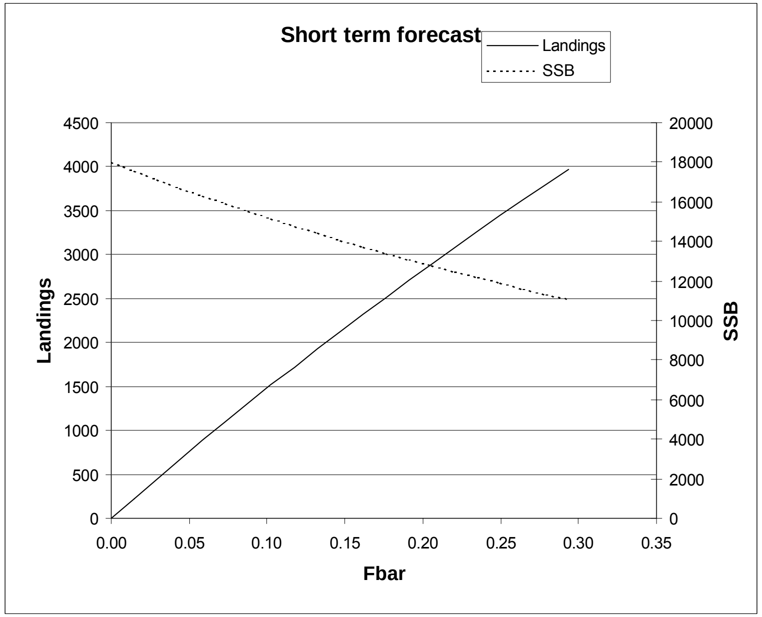


Figure 7.5.4. Herring VIIa(N). Estimates of historical uncertainty of the SSB from 1972 to 2000. Dashed lines denote 25% and 75% confidence intervals and dotted lines denote 5% and 95% confidence intervals.





MFYPR version 2a
Run: Final ypr nirs
Time and date: 13:46 20/3/01

Reference point	**F multiplier**	**Absolute F**
Fbar(2-6)	1.0000	0.1469
$\mathbf{F}_{max}$	>=1000000	
$\mathbf{F}_{0.1}$	1.1316	0.1662
F35%SPR	0.9335	0.1371
$\mathbf{F}_{low}$	1.1952	0.1755
$\mathbf{F}_{med}$	2.5212	0.3703
$\mathbf{F}_{high}$	4.1527	0.6099

Weights in kilograms

MFDP version 1a
Run: final nirs
Irish Sea 2001Projection index file Saturday, 17 March 2001.
Time and date: 10:33 20/3/01
Fbar age range: 2-6

Input units are thousands and kg - output in tonnes

Figure 7.5.5. Herring VIIa(N). Long and short term yield and SSB, derived by MFDP V1a.

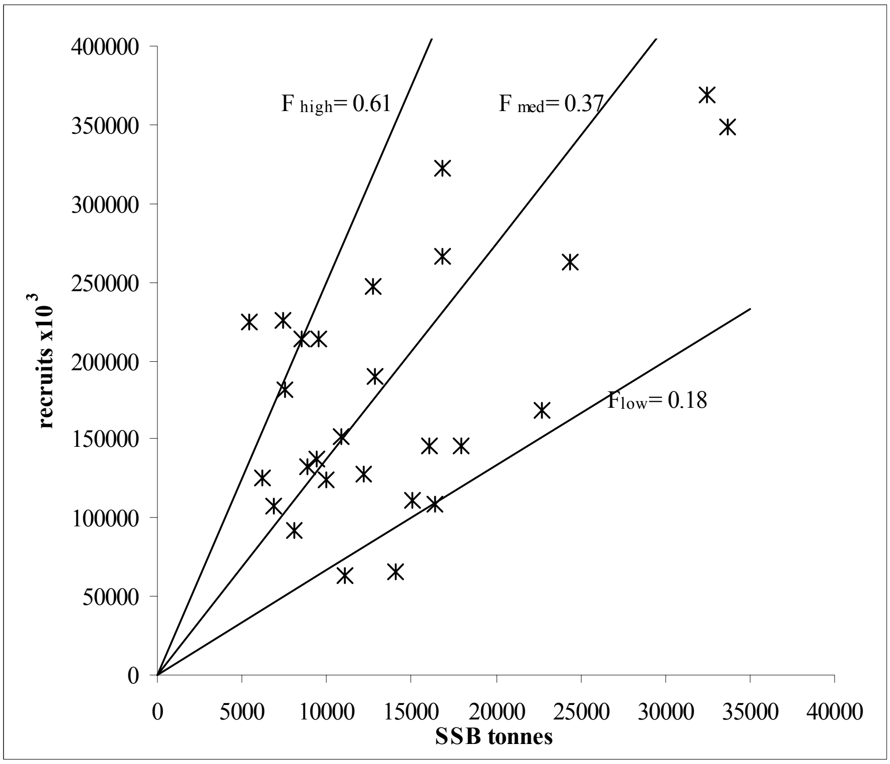


Figure 7.5.6. Herring VIIa(N). Recruitment to SSB plot for herring from 1972 to 1998. Lines denote the locations of $\mathbf{F}_{\mathrm{high}}$, $\mathbf{F}_{\mathrm{med}}$ and $\mathbf{F}_{\mathrm{low}}$.

8 SPRAT IN THE NORTH SEA

8.1 The Fishery

8.1.1 ACFM advice applicable for 1999 and 2000

No ACFM advice has been given on sprat TAC in recent years. The TAC set by management was 225,000 t for 1999 [Sub-area IV (EU zone) + Division IIa (EU zone)] and 225,000 t for 2000. For 2001, a management agreement between the EU and Norway set a TAC of 225,000 t.

8.1.2 Total landings in 2000

Landing statistics for sprat for the North Sea by area and country are presented in Table 8.1.1 for 1987–2000. 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 1994–2000 by year, quarter, and area in the North Sea.

The landings in 2000 were at the same level, 196,000 t, as in 1999 where the landings were 188,000 t. A reduction in the Norwegian sprat fishery from 18,800 t in 1999 to 2,700 t in 2000 was counterbalanced by an increase in the Danish fishery form 164,300 t in 1999 to 191,100 t in 2000. The Danish fishery had high landings in August and September, 71,000 t and 61,000 t respectively and at the same time low by-catches of herring, 4% and 6% respectively. In October and November the sprat stock was more widely spread and therefore the small meshed fishing fleet moved towards Norway pout instead. Neither Denmark nor Norway did take their quota in 2000.

The quarterly and annual distributions of catches by rectangle for Sub-area 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. The Norwegian landings in 2000, the lowest for last 10 years, were mainly taken in first quarter.

8.2 Catch Composition

8.2.1 By-catches in the North Sea sprat fishery

On the request by ACFM the by-catch composition in the sprat fishery has been provided. The species composition in the Danish sprat fishery has changed towards a fishery with low by-catches of other species. On the basis of Danish data sprat fishery can be defined as a fishery where at least 50 percent of the total landings from a fishery in a statistical rectangle in a month are sprat. The text table below shows the Danish data for 2000 from the North Sea.

	Sprat	Herring	Horse-mackerel	Whiting	Haddock	Mackerel	Cod	Other species	Total
Tonnes	188.463	11.662	3.239	2.107	66	766	4	2.334	208.641
Percent	90.3	5.6	1.6	1.0	0.0	0.4	0.0	1.1	

The Norwegian landings by the purse seiners were not sampled in 2000.

8.2.2 Catches in number

The estimated quarterly catch-at-age in numbers by country for the years 1995 to 2000 is presented in Table 8.2.1. Denmark and UK-England/Wales provided age composition data of commercial landings in 2000. The Norwegian landings were raised to landings in numbers using the Danish samples. In 1999 1-group fish dominated (83%) the landings in both the Danish and the Norwegian fleets. In 2000 the 1-group constituted 66 % and the 2-group 25%of the total numbers landed.

Catch at age data from the Danish commercial landings was available from Denmark in quarter 1 and 3 and 91% of the Danish landings were covered by samples. Danish landings in the second quarter are negligible. To estimate landings in numbers for the fourth quarter the samples from the third quarter were used. All the UK-England/Wales fishery has taken place in the first quarter and was sampled

8.2.3 Mean weight at age

The mean weights (g) at age in the catches in 2000, weighted by the numbers caught, are presented by quarter in Table 8.2.2. The table gives the mean weights at age for 1995–1999 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 8.2.3. The total number of samples available in 1997 was low compared to 1996, but increased in 1998 and this sampling level was maintained in 1999. but decreased again in 2000. The recommended level of one sample per 1,000 t landed was not reached, but as the fishery was carried out in a limited area, the sampling level can be regarded as adequate. In 2000, Denmark collected 48 samples from commercial landings and these were analysed for length and age. This gives 0.25 sample per 1,000 t landed. These samples were used to estimate age composition and weight at age of the Danish and Norwegian landings of sprat.

The Danish monitoring schemes for species composition in the Danish small meshed fisheries has again in 2000 worked well and a total of 1209 samples were collected from landings taken in the North Sea. The sampling figure for 1999 was 1085 samples. The total landings from the Danish small mesh fishery in 2000 was 936,000 t (all species) compared to 790,000 t in 1999. The recommended sampling levels for species composition were achieved.

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.

8.3 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 (ICES1995). The fishing method (gear) in the IBTS-survey was standardised in 1983 and the data series from 1984, are comparable. The IBTS-indices for 1984–2000 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 continued the declining trend from last year, and is below the mean of the time series. The abundance of the 1998-year class continues to be high and is as 3-group, well above the average. The total-abundance index shows a small decrease but is still among the highest in the series.

The IBTS data by rectangle are given in Figure 8.3.1 for age groups 1, 2 and 3+. Age 1-group was again found to be concentrated in the south-eastern areas of Division IVb. 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 40,000 t (1998) to 210,000 t (1996). In 1999 the acoustic estimate of sprat was very low. The low value was not thought to be representative mainly due to inappropriate coverage of the south-eastern area (ICES 2000), the area expected to have the highest abundance of sprat in the North Sea. In 2000 the survey was extended by 30 n.mile 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 342,000 t (ICES 2001).

8.5 State of the Stock

8.5.1 Catch-survey data analysis

As has also been demonstrated by previous Working Groups (see ICES 1998a), the IBTS surveys do not fully reflect strong and weak cohorts for sprat. The 1–2group ratios varies and does not adequately reflect the age structure of the stock. This may be due to difficulties in age reading and/or a possible prolonged spawning and recruitment season. However, the IBTS-survey may still be a useful indicator of the level of the stock biomass used as a tuning index in production models.

The Biomass dynamic model (Schaefer model) was fitted using the CEDA program, ver.1.01, (see ICES 1993) and Holden, Kirkwood and Bravington (1995), assuming that the sprat in the North Sea belongs to one stock. The annual landings for 1972–2000 and the IBTS (February) abundance indices for 1984 to 2000 were used as input data. The input data in the model has to be given in the same unit and therefore, the IBTS-indices were given as "IBTS-indices of biomass". Mean weights-at-age for age group 1, 2 and 3+ were calculated from the biological data from commercial landings (weighted by numbers) in 1st quarter of 1995–2000. The total IBTS-biomass was used as the input in the fit (Table 8.5.1). This means that a constant mean weight at ages for ages 1, 2 and 3+ was assumed, while in reality it may be quite variable year to year.

The level of the Initial proportion, i.e. the ratio of stock size at the start of catch data to unexploited stock size, is an essential 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. The sensitivity of the fit and the estimated parameters to ratios of the initial proportion in the range of 0.8 to 0.05, were examined. The fits were made both on a complete set and with the 1989-IBTSdata considered as outlier. The results from the fits seemed to be reasonable stable in the range of 0.8–0.4 (carrying capacity (K): 1.77–2.25E+03 and intrinsic growth rate (r):0.611–0.718). As there is no objective way to determine the size of the initial proportion, the WG decided to do the run with 0.8 as the initial proportion as used last year. The model fits reasonable well, as shown in Figure 8.5.1.

8.6 Projections of Catch and Stock

The regression of the total catches and total the IBTS indices for 1984–2000, excluding the 1989-index, are given in Figure 8.6.1 ($r^2 = 0.73$). From this a predicted a yield for 2001 is of about 180,000 t. The TAC set for 2001 is 225,000 t.

The total IBTS-indices were used in a SHOT-estimate (Shepherd, 1991). Using the various indices as input (combined 1-and 2-group and the total IBTS-indices) the estimated landings for 2001 were in the range of 170–190 000 (Table 8.6.1).

Projections, run in the CEDA package, with annual catches of 200,000 t, 225,000 t, 250,000 t and 300,000 t as input values, are shown in Figure 8.6.2. These catch levels were chosen based on the current catch level and the projections from the regression and the SHOT-estimate.

The biomass dynamic model has some attractions over the SHOT method for stock and catches 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 Management Considerations

Prior to 1993, the sprat was caught with a relative high percentage of herring by-catch. In 1993, 1994 and 1995 the sprat fishery could be conducted with rather low herring by-catch percentages. In some periods in 1997 and 1998 it was stopped with the aim of protecting the juvenile herring and due to high by-catch of herring.

The sprat stock shows signs of being in good condition as both catch and biomass appears to increase and there is indication from the IBTS(February)-2001-survey of a good 2000-year class recruiting to the 2001 fishery. The natural variability in stock abundance is high and the recruitment between years does not appear to be strongly influenced by fishing effort. In 1998–2000 the by-catch of herring is not a limiting factor in the sprat fishery and the main controlling factor was the TAC limits. A TAC for 2002 could be within a range of 200–250 000 tonnes. Because the fishery in certain a given year is very dependent on that year's incoming year class, the Working Group is not able to predict catches for 2002.

Attempts to assess this stock have demonstrated the need for a better survey coverage of the south-south-eastern areas of the North Sea and for the addition of directed sprat sampling for age data. There is also a need for better knowledge of spawning seasons and recruitment from a possible autumn spawning. There are indications that larvae from autumn spawning will over-winter as larvae and metamorphose the year after. As sprat is aged by counting winter-rings with reference to January 1 as the birthday this will result in incorrect allocation to year classes.

Table 8.1.1. Sprat catches in the North Sea (' 000 t) 1986-2000. 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
Division IVa West														
Denmark	0.2	0.1				0.3	0.6						0.7	
Netherlands														
Norway					0.1									
UK(Scotland)								0.1						
Total	0.2	0.1			0.1	0.3	0.6	0.1					0.7	
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
Norway		3.5	0.1	1.2	4.4	18.4	16.8	12.6	21.0	1.9	2.3			
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
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
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
Sweden				+	+				0.2	0.5		1.7	2.1	
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
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
France									+					
Netherlands		0.4	0.4										0.2	
Norway							0.4	4.6	0.4		0.1	16.0	5.7	1.8
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
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
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
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
Sweden					2.5								2.7	
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
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

Table 8.1.2. Sprat catches (' 000 t) in the fjords of western Norway, 1985-2000.

1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000 [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] = 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

Table 8.2.1 North Sea Sprat. Catch in numbers (millions) by quarter and by age 1995-2000.

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

Table 8.2.2 North Sea Sprat. Mean weight (g) by quarter and by age for 1995 - 2000.

Year	Quarter	Age						SOP
		0	1	2	3	4	5+	Tonnes
1995	1		3.0	9.4	12.9	19.4		41,976.3
	2		3.0	8.4	10.3			6,890.8
	3	2.4	7.6	13.9	16.4	20.7		208,897.2
	4		10.5	13.9	16.2			99,578.1
	Total	2.4	24.1	45.6	55.8	40.1		357,342.4
1996	1		3.9	9.3	14.9	15.3	16.1	88,806.9
	2		6.9	8.4	11.6	20.0	15.2	2,735.0
	3		11.6	14.2	18.2	21.5		6,500.9
	4		12.1	15.9	17.2	20.5		37,358.5
	Total	0.0	34.5	47.8	61.9	77.3		135,401.2
1997	1		8.0	10.0	15.0	17.0	19.0	8,160.9
	2		8.0	10.0	15.0	17.0	19.0	1,243.0
	3		14.2					28,284.7
	4	3.7	11.9	16.4	19.1	19.6		63,083.4
	Total	3.7	42.1	36.4	49.1	53.6		100,772.0
1998	1		5.6	6.0	8.7	15.0		7,231.6
	2		5.6	6.0	8.3			743.3
	3	3.7	14.7	15.3				60,149.0
	4	4.1	10.6	13.8	16.3	14.6		94,173.0
	Total	7.8	36.4	41.1	33.2	29.6		162,296.8
1999	1		3.3	8.7	12.5	14.4	16.3	30,167.7
	2		3.1	10.1	13.6	15.4		993.4
	3		10.0	18.3				129,383.2
	4	4.4	11.0	14.4				27,126.2
	Total	4.4	27.4	51.5	26.0	29.8		187,670.4
2000	1		4.2	10.1	10.7	10.2	10.5	46,191.5
	2		3.3	9.0	10.2	12.8	10.5	1,767.1
	3		11.9	11.9	11.0			132,562.7
	4		11.9	11.9	11.0			15,403.3
	Total	0.0	31.3	42.9	42.9	23.0		195,924.6

Table 8.2.3 North Sea Sprat. Sampling commercial landings for biological samples in 1998-2000.

Country	Quarter	Landings 000t	No samples	No fish meas.	No fish aged
1998					
Denmark	1	7.2	6	247	
	2	0.7	11	94	30
	3	60.3	16	1,936	109
	4	62.9	15	2,105	442
	Total	131.1	48	4,382	581
Norway	1	0.2			
	2				
	3				
	4	31.3	16	1,704	1,096
	Total	31.5	16	1,704	1,096
England/Wales	1				
	2				
	3				
	4	0.2	2	657	216
	Total	0.2	2	657	216
Total North Sea		162.8	66	6743	1893
1999					
Denmark	1	14.1	4	724	238
	2	0.1	22	132	
	3	129.4	22	2,413	170
	4	20.7	9	983	129
	Total	164.3	57	4,252	537
Norway	1	13.7	14	649	599
	2				
	3				
	4	5.1			
	Total	18.8	14	649	599
Sweden	1	1.0			
	2	1.0			
	3	0.0			
	4				
	Total	2.1			
UK-England/Wales	1	1.6	4	2,223	460
	2				
	3				
	4				
	Total	1.6	4	2,223	460
UK-Scotland	1				
	2				
	3				
	4	1.4			
	Total	1.4			
Total North Sea		188.1	75	7124	1596
2000					
Denmark	1	41.8	8	2,066	357
	2	1.8	9	19	
	3	132.5	24	2,840	258
	4	15.1	7	336	
	Total	191.2	48	5,261	615
Norway	1	2.4			
	2				
	3				
	4	0.3			
	Total	2.7			
UK-England/Wales	1	2.0	8	3,030	464
	2				
	3				
	4				
	Total	2.0	8	3,030	464
UK-Scotland	1				
	2				
	3				
	4	0.0			
	Total	0.0			
Total North Sea		196.0	56	8291	1079

Table 8.3.1 North Sea Sprat. Abundance indices by age group from IBTS(February), 1984-2001, in the standard sprat area (Div. IVb).

Year	No rect.	No hauls	Age					
			1	2	3	4	5+	Total
1984	80	251	383.63	393.57	47.43	6.66	0.41	831.70
1985	79	289	675.49	305.00	38.22	4.32	0.90	1023.93
1986	78	285	68.22	104.77	29.38	1.31	0.26	203.94
1987	78	299	758.28	74.68	24.80	3.61	0.21	861.58
1988	78	208	152.29	1410.52	109.66	8.78	0.00	1681.25
1989	79	236	4293.66	445.72	318.65	4.10	13.44	5075.57
1990	78	192	115.16	567.46	149.83	30.79	0.59	863.83
1991	78	179	834.45	104.89	27.84	2.63	1.17	970.98
1992	79	185	1562.20	344.08	38.25	5.51	0.45	1950.49
1993	79	181	1732.54	602.01	84.12	4.35	0.06	2423.08
1994	78	173	4084.89	1397.77	129.96	2.79	0.67	5616.08
1995	79	166	1059.30	2643.93	134.01	3.23	1.12	3841.59
1996	78	146	346.37	483.45	141.96	23.64	0.56	995.98
1997	79	159	887.43	389.35	33.80	3.42	0.15	1314.15
1998	79	197	1650.35	1744.60	286.34	12.14	2.32	3695.75
1999	78	177	4045.34	538.13	56.00	3.85	44.75	4688.07
2000	78	177	2227.35	838.61	71.05	1.73	0.01	3138.75
2001	78	171	1316.76	1289.67	257.36	43.49	0.12	2907.40

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 1995-2000.

Year	Age			
	1	2	3+	Total
1984	1688	3660	741	6089
1985	2972	2837	591	6399
1986	300	974	421	1695
1987	3336	695	389	4420
1988	670	13118	1611	15399
1989	18892	4145	4572	27609
1990	507	5277	2464	8249
1991	3672	975	430	5077
1992	6874	3200	601	10675
1993	7623	5599	1204	14426
1994	17974	12999	1815	32787
1995	4661	24589	1882	31131
1996	1524	4496	2260	8280
1997	3905	3621	508	8034
1998	7262	16225	4091	27577
1999	17799	5005	1423	24227
2000	9800	7799	990	18589
2001	5794	11994	4093	21881
Mean W (g)	4.4	9.3	13.6	

Table 8.6.1. North Sea Sprat. SHOT forecast of landings in 2001 using total landings and the total IBTS-indices as input data.

North Sea sprat — SHOT forecast spreadsheet version 6
The total IBTS-indices — March 2001

running recruitment weights

older	0.00		G-M =	0.00
central	1.00		exp(d)	1.00
younger	0.00		ex exp(d/2)	1.00

Year	Land -ings	Recrt Index	W'td Index	Y/B Ratio	Hang -over	Act'l Prodn	Est'd Prodn	Est'd SQC.	Act'l Expl Biom	Est'd Expl Biom	Est'd Land -ings
1984		832		0.77	0.23				0		
1985		1024	1024	0.77	0.23	0			0		
1986	16	204	204	0.77	0.23	21	0	0	21		
1987	32	862	862	0.77	0.23	37	22	21	42		
1988	87	1681	1681	0.77	0.23	103	46	43	113	56	43
1989	63	5076	5076	0.77	0.23	56	217	187	82	243	187
1990	73	864	864	0.77	0.23	76	21	31	95	40	31
1991	112	971	971	0.77	0.23	124	29	39	145	51	39
1992	124	1950	1950	0.77	0.23	128	76	84	161	110	84
1993	200	2423	2423	0.77	0.23	223	104	109	260	141	109
1994	320	5616	5616	0.77	0.23	356	286	266	416	346	266
1995	357	3842	3842	0.77	0.23	368	209	234	464	304	234
1996	136	996	996	0.77	0.23	70	61	129	177	167	129
1997	103	1314	1314	0.77	0.23	93	80	93	134	121	93
1998	163	3696	3696	0.77	0.23	181	228	199	212	259	199
1999	188	4688	4688	0.77	0.23	195	282	255	244	331	255
2000	196	3139	3139	0.77	0.23	198	181	183	255	237	183
2001		2907	2907	0.77	0.23		169	175		228	175

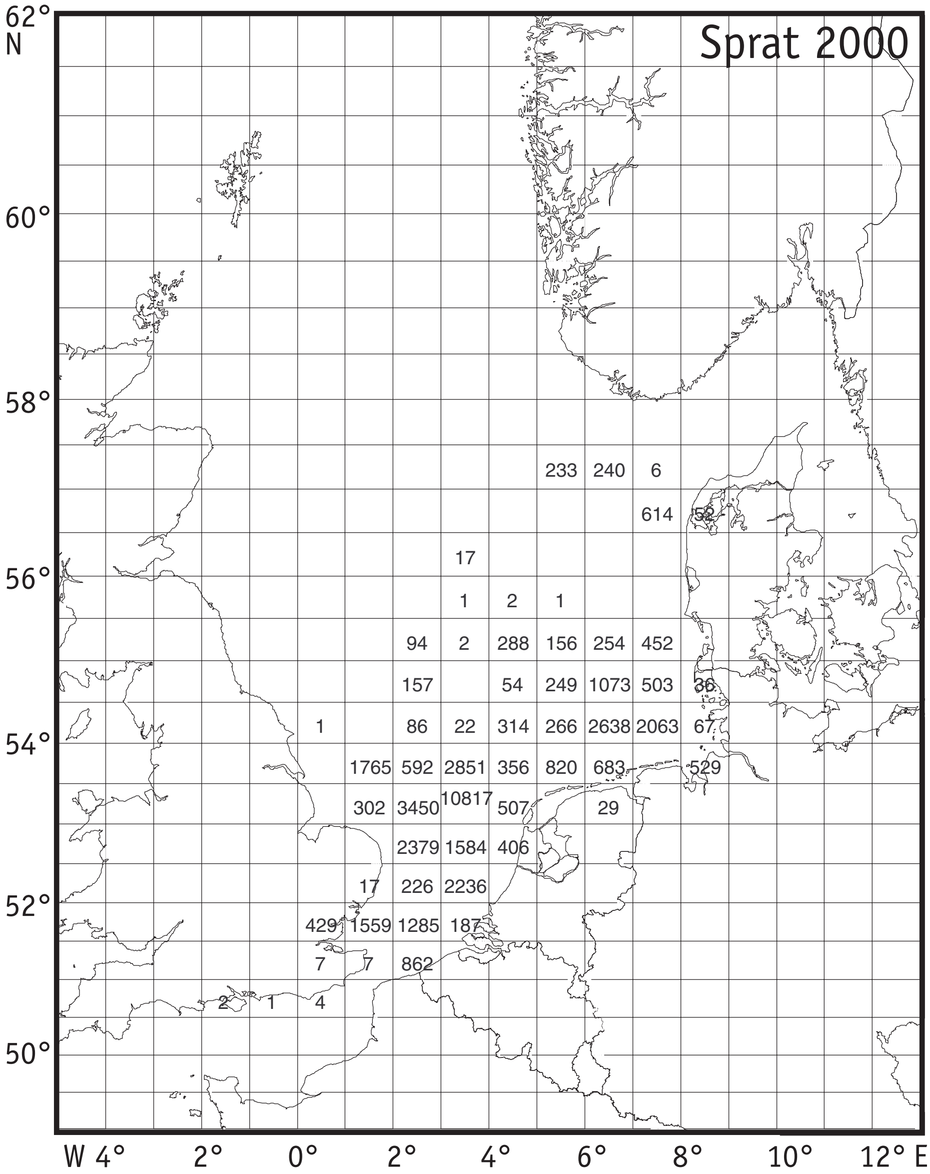


Fig. 8.1.1: Sprat catches (in tonnes) in the North Sea in 2000 by statistical rectangle. Working Group estimates (if available). **a.:** 1st quarter

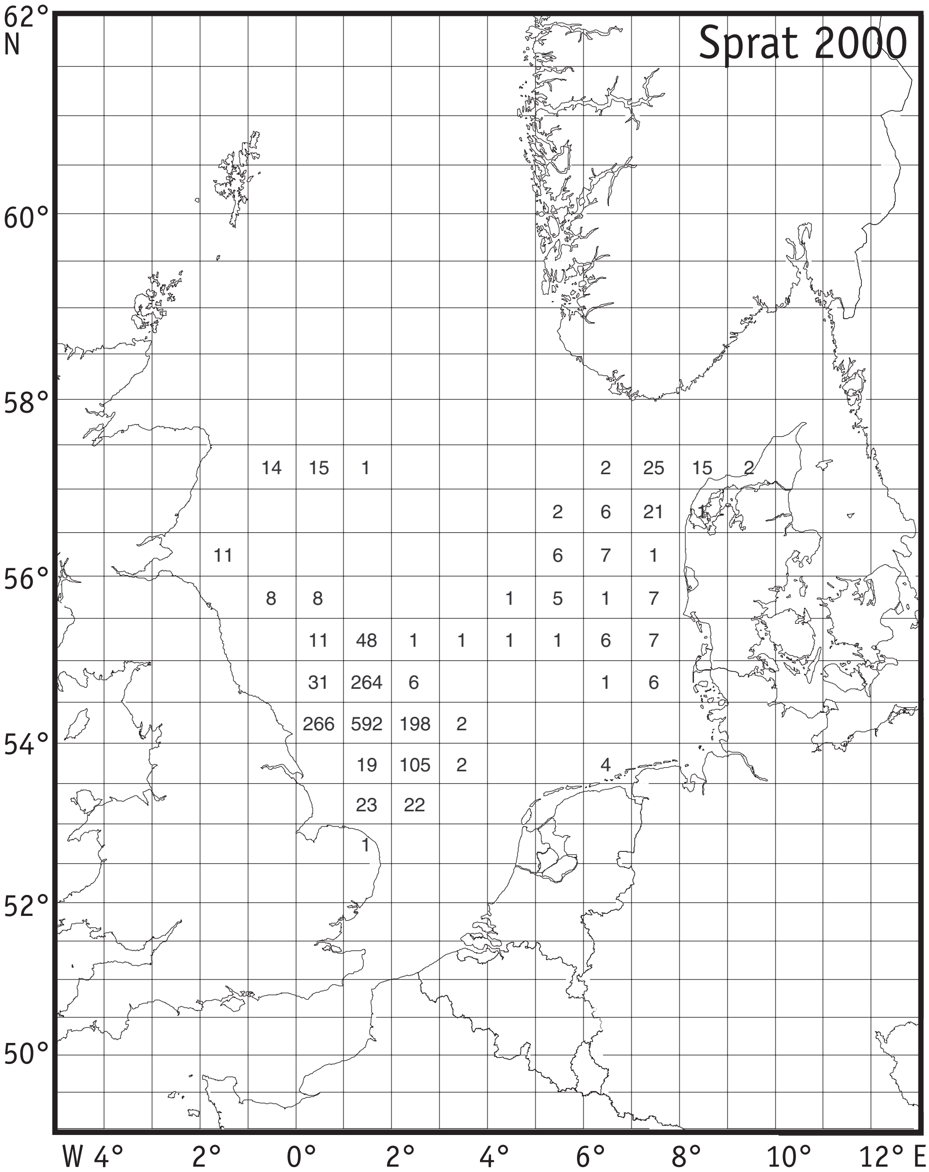


Fig. 8.1.1: Sprat catches (in tonnes) in the North Sea in 2000 by statistical rectangle. Working Group estimates (if available).
b.: 2nd quarter

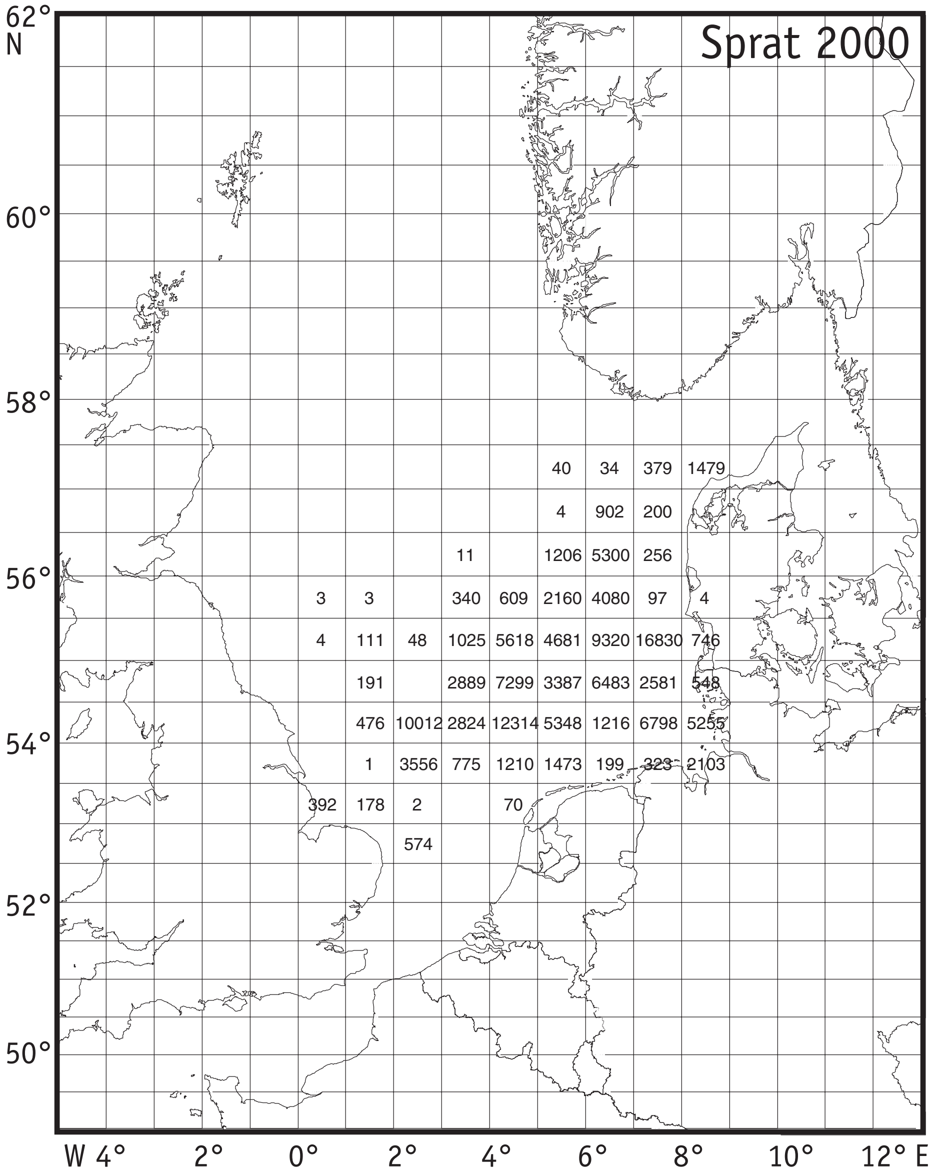


Fig. 8.1.1: Sprat catches (in tonnes) in the North Sea in 2000 by statistical rectangle. Working Group estimates (if available). **c.:** 3rd quarter

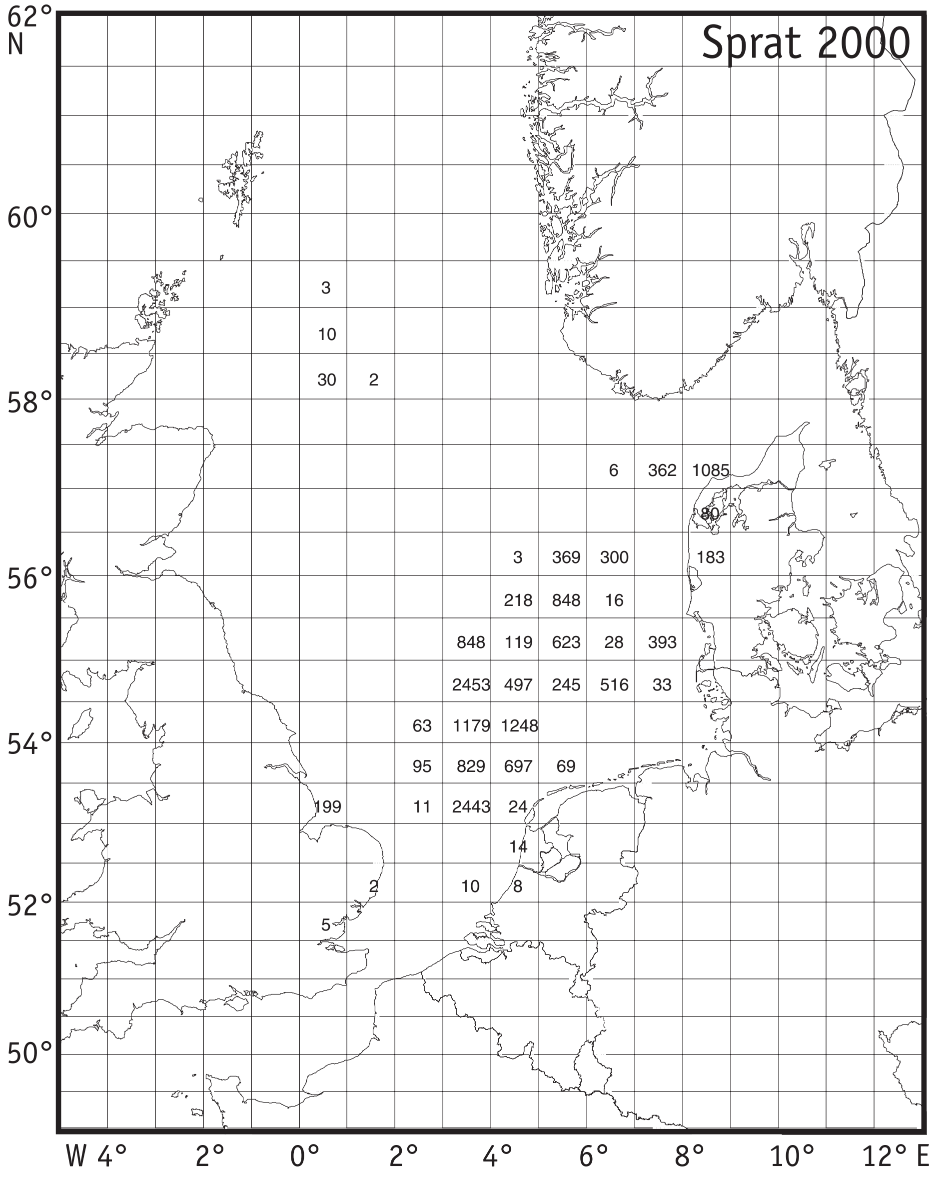


Fig. 8.1.1: Sprat catches (in tonnes) in the North Sea in 2000 by statistical rectangle. Working Group estimates (if available). **d.:** 4th quarter

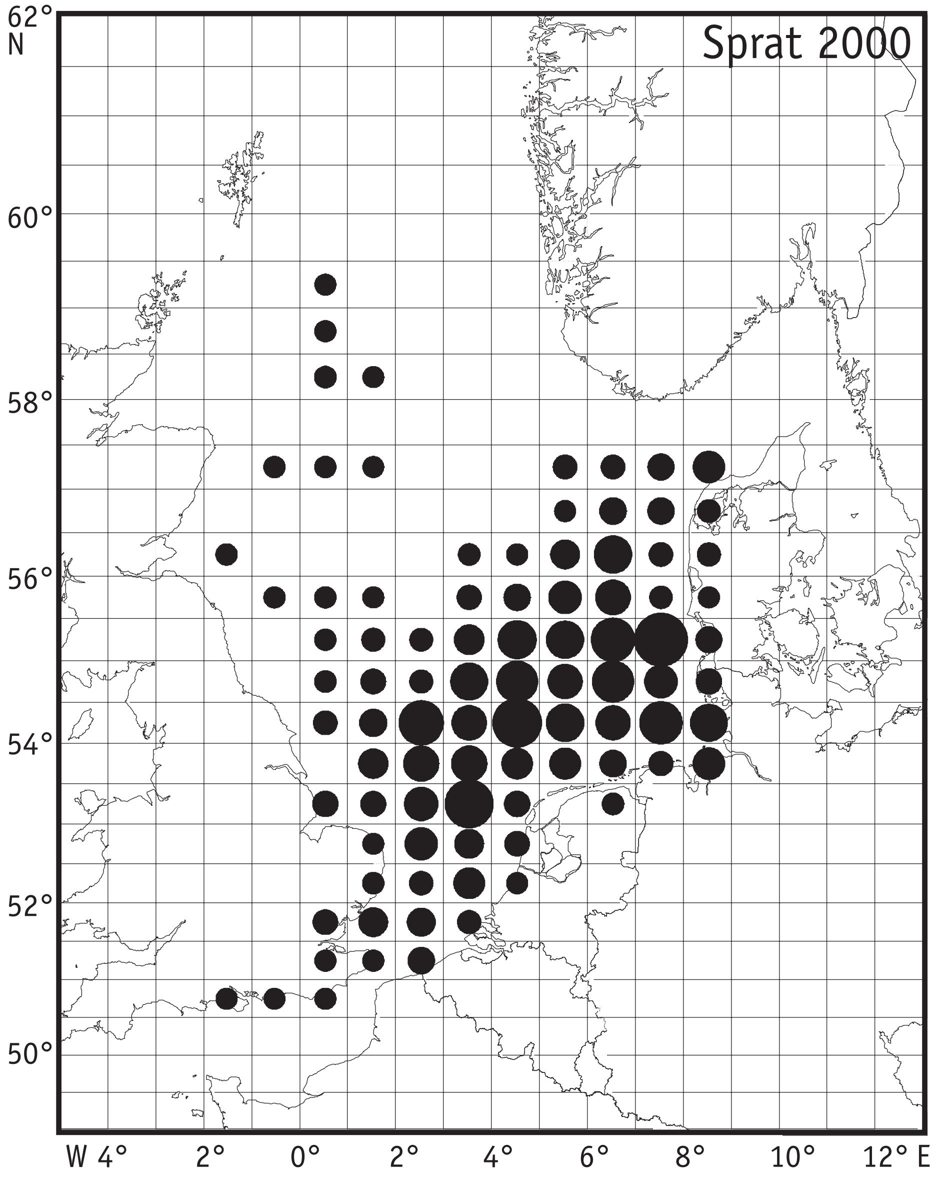


Fig. 8.1.2: Sprat catches in the North Sea in 2000 by statistical rectangle. Circle diameter is proportional to catch in tonnes. Working Group estimates (if available). All quarters.

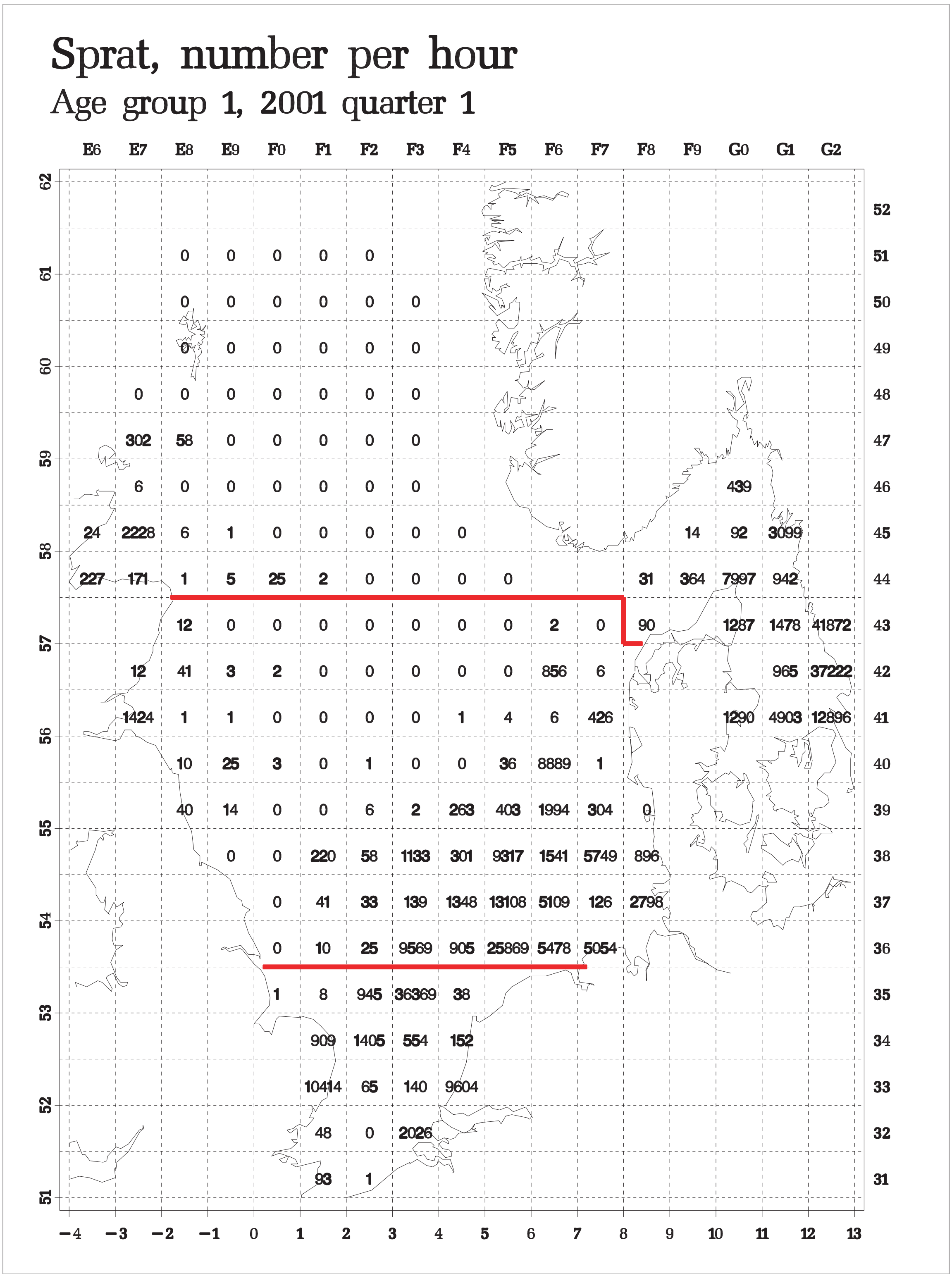


Fig. 8.3.1: Sprat - Distribution by age groups in the IBTS February 2001, in the North Sea and Div. IIIa. **a:** Age group 1.

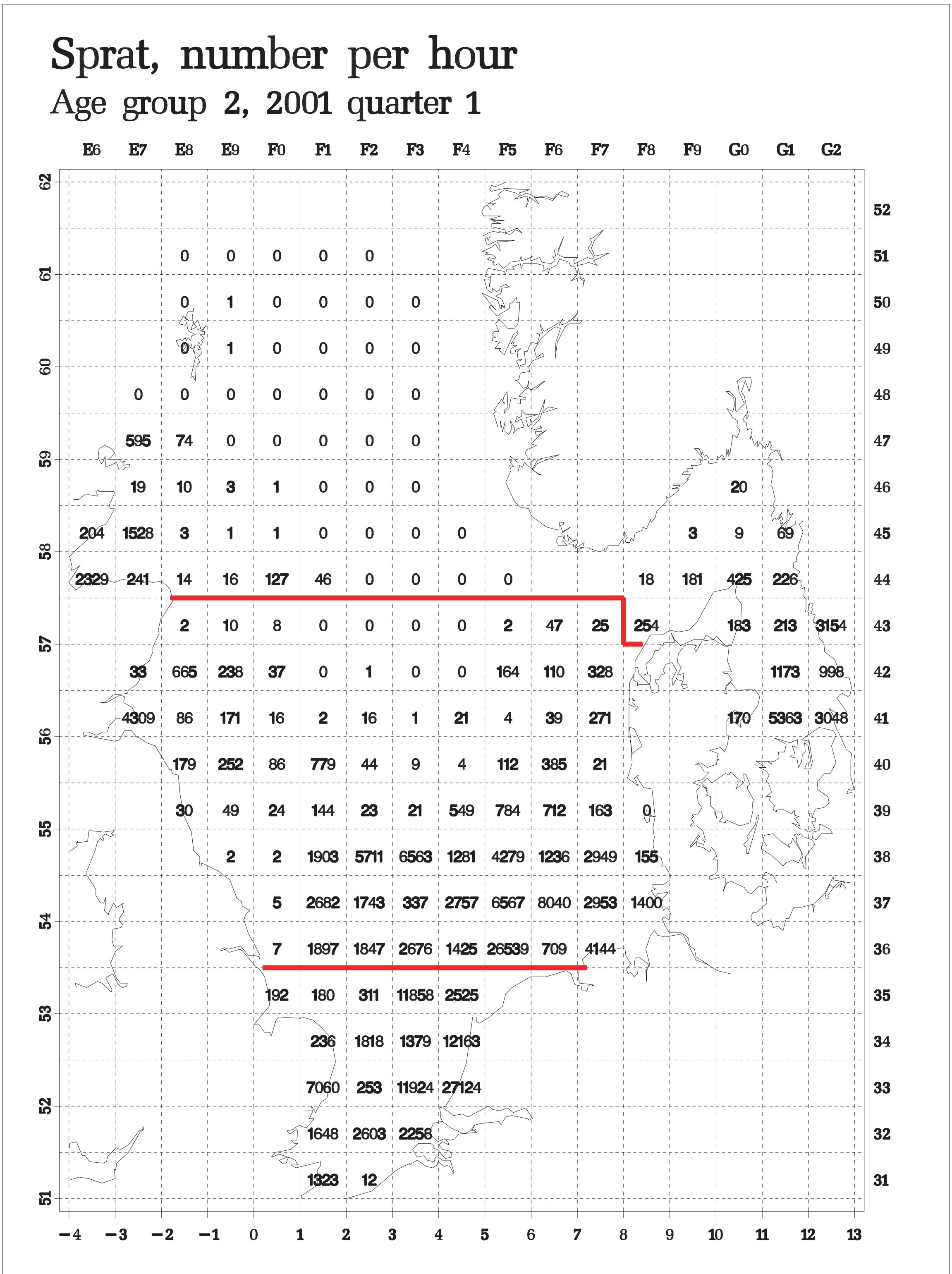


Fig. 8.3.1 (cont'd.): Sprat - Distribution by age groups in the IBTS February 2001, in the North Sea and Div. IIIa. **b:** Age group 2.

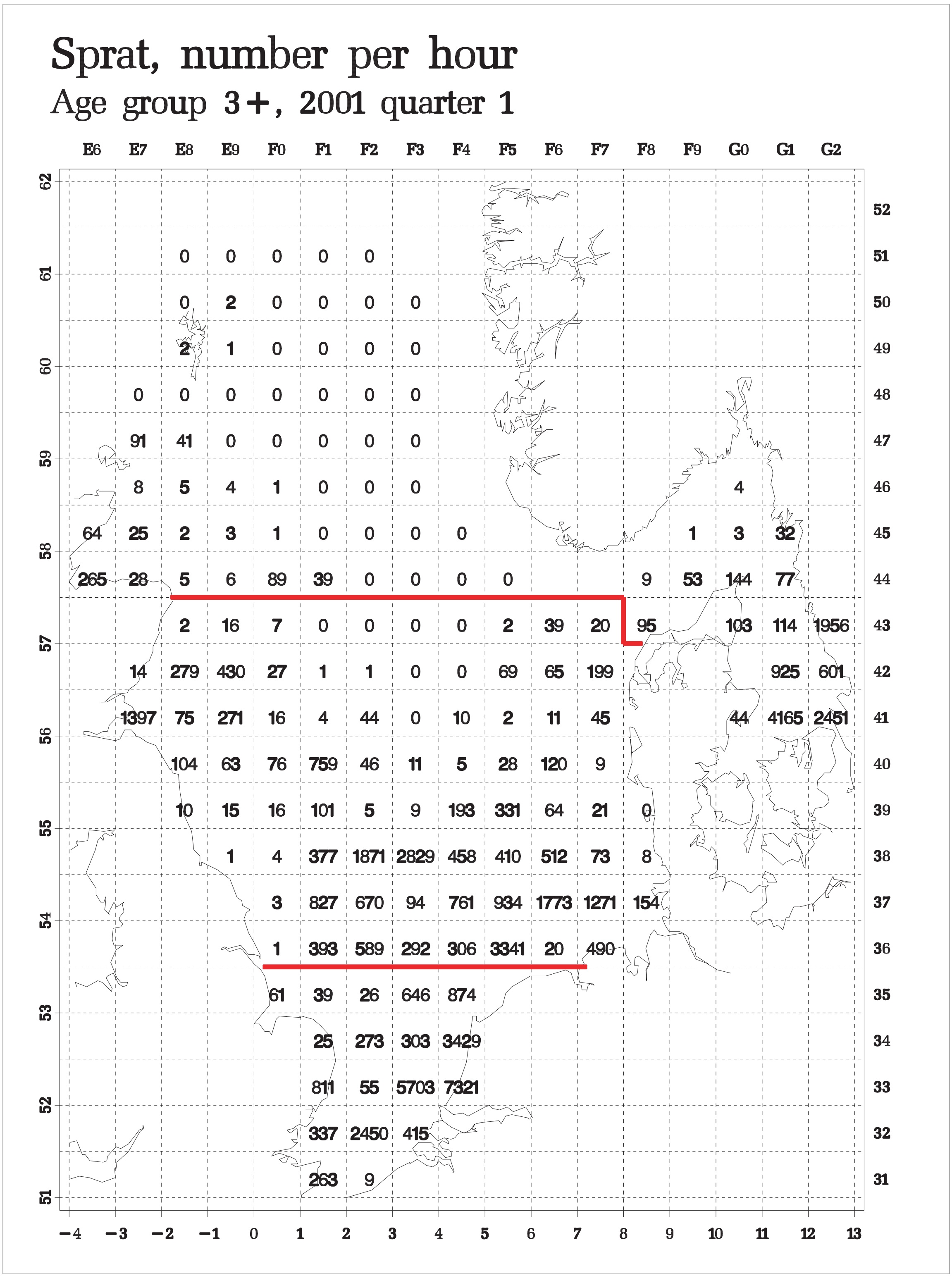


Fig. 8.3.1 (cont'd.): Sprat - Distribution by age groups in the IBTS February 2001, in the North Sea and Div. IIIa. **c:** Age groups 3+.

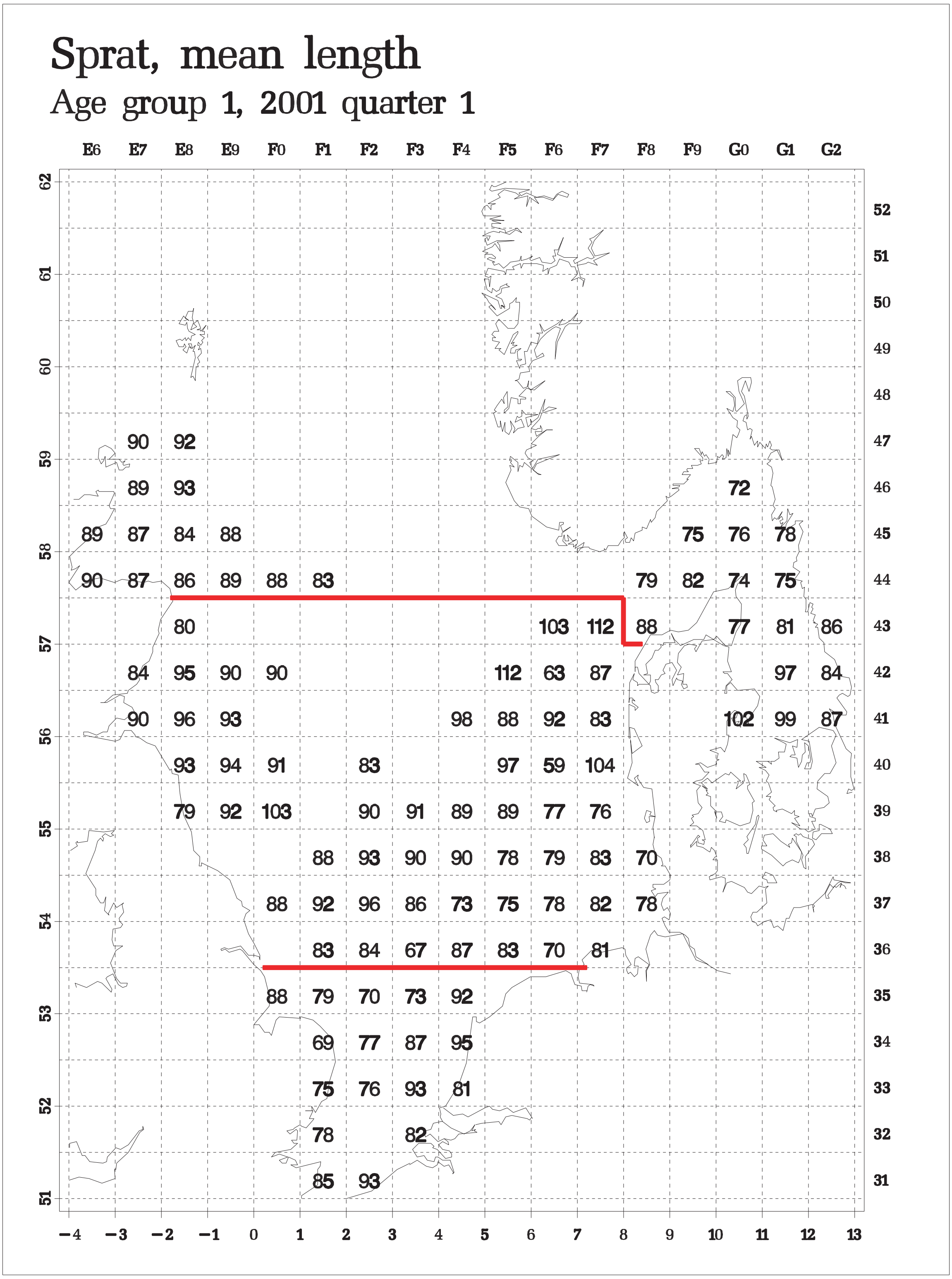


Fig. 8.3.2: Sprat - Mean length (mm) of age group 1 in the IBTS Fbruary 2001, in the North Sea and Div. IIIa

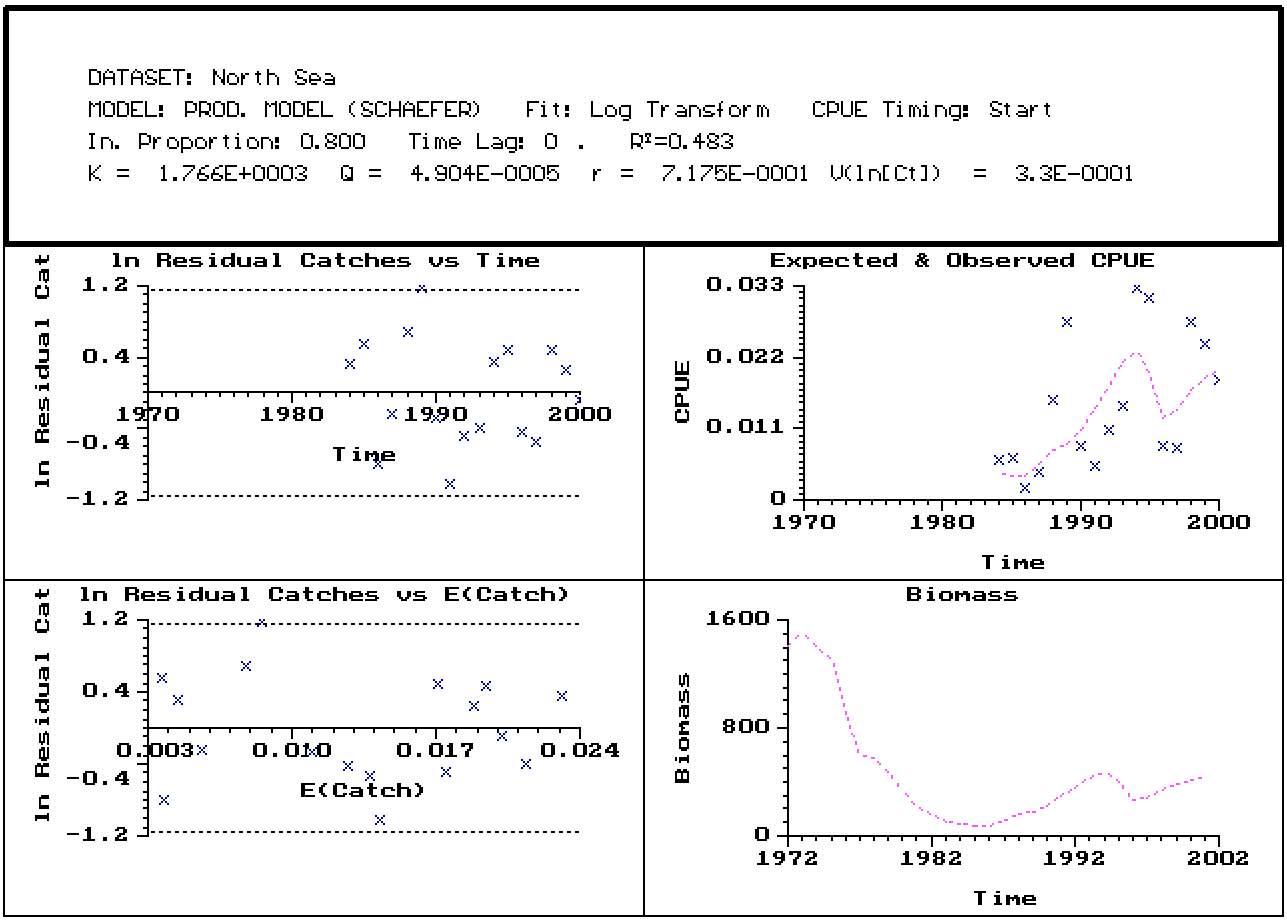
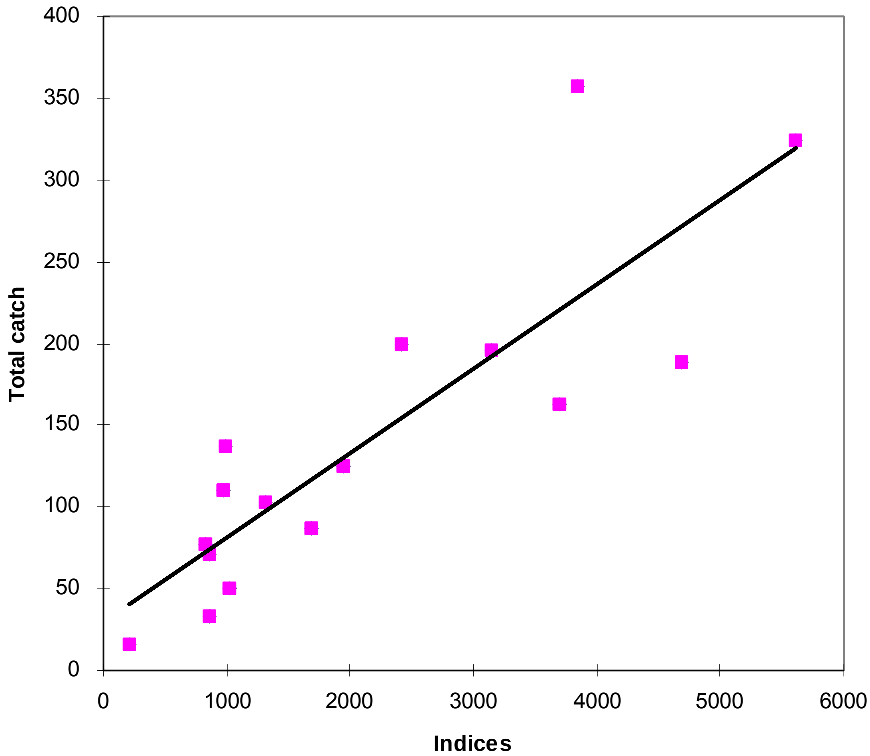


Figure 8.5.1 Schaefer production model output from CEDA Program, fitted for sprat in the North Sea. (K: carrying capacity, r: intrinsic growth rate, R^2: goodnes of fit, Q: catchability)

Fig. 8.6.1. North Sea Sprat. IBTS-indices vs. total catches in 1984-2000, the 1989-index excluded (rsq=0.73).



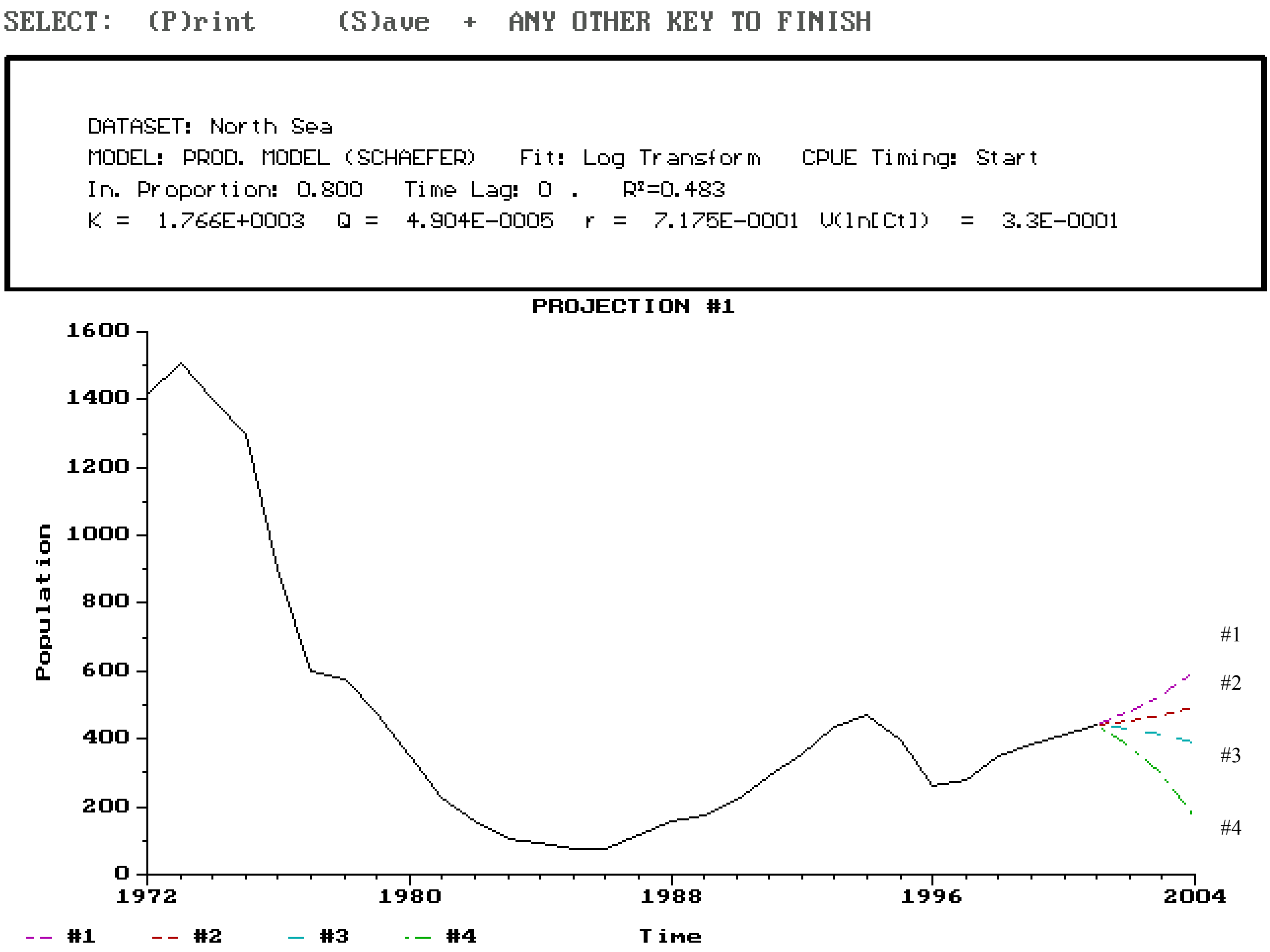


Figure 8.6.2 Projections as output from the CEDA run with the following scenarios in order from top to bottom, i.e. upper line is #1 and lowest line is #4: #1:total catches 200,000 t, #2: total catches 225,000 t, #3: total catches 250,000 t and #4: 300,000 t.

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 2000 and 2001. No ACFM advice has been provided in recent years.

9.1.2 Catches in 2000

Table 9.1.1 shows the nominal landings in 1985–2000. The landings in 2000, as reported by UK (England & Wales), decreased in 2000 and was 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 show that the catches are mainly taken in third and fourth quarter (Table 9.1.2). Quarterly and annual distributions of catches by rectangle are shown in Figures 8.1.1–8.1.2.

9.2 Catch Composition

Catch compositions and the mean weights for 1991–1998 are given in Table 9.2.1 and Table 9.2.2. No samples of commercial catches have been available for 1999 and 2000, but the figures for 1998 have been included in Table 9.2.3.

Table 9.1.1. Nominal catch of sprat (t) in Divisions VIId,e, 1985-1998.

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997*	1998*
Denmark	-	15	250	2,529	2,092	608	-	-	-	-	-	-	-	-
France	14	-	23	2	10	-	-	35	2	1	+			-
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (Engl.&Wales)	3,771	1,163	2,441	2,944	1,319	1,508	2,567	1,790	1,798	3,177	1,515	1,789	1,621	2,024
Total	3,785	1,178	2,714	5,475	3,421	2,116	2,567	1,825	1,800	3,178	1,515	1,789	1,621	2,024

* Preliminary

Table 9.1.2. Lyme Bay sprat fishery. Monthly catches (t). (UK vessels only).

Season	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total
1991/92	0	0	0	205	450	952	60	358	258	109	51	0	2443
1992/93	0	0	0	302	472	189	294	248	284	158	78	0	2025
1993/94	0	8	0	156	82	302	529	208	417	134	53	0	1889
1994/95	0	0	0	299	834	545	608	232	112	68	0	0	2698
1995/96	0	0	0	154	409	301	307	151	15	80	28	4	1449
1996/97	0	0	0	309	452	586	47	243	239	74	30	0	1980
1997/98	2	0	14	259	625	105	255	19	50	184	45	0	1558
1998/99	0	0	0	337	728	206	56	318					1645

Table 9.2.1. Lyme Bay sprat fishery. Number caught by age group (millions).

Season		0/1	1/2	2/3	3/4	4/5	5/6
1991/92		1.7	56.03	44.69	16.24	0.57	0.03
1992/93[1]		0.22	28.23	48.61	12.94	1.56	0
1993/94[2]		0	0.83	44.81	15.7	1.95	0.58
1994/95				No data			
	0	1	2	3	4	5	6
1995[3]		0.33	5.20	2.31	0.23	0.03	
1996	0.72	12.60	71.35	22.00	1.24	0.20	
1997		8.81	42.88	31.87	5.43	0.10	
1998		4.08	81.16	37.52	5.05	0.39	

[1] August to December only (samples in August and December only, so these are best estimates

[2] August to December only (samples in August, September and November only, so these are best estimates

[3] Only September (one sample)

Table 9.2.2. Lyme Bay area SPRAT. 1991–1998 mean weight (g) at age.

Season	Quarter	Age						
		0/1	1/2	2/3	3/4	4/5	5/6	Overall mean
1991/91	3	4.7	16.6	22.6	25.4	29.2	34.6	20.7
	4	6.6	17.1	23	26.3	30.9		21.0
	1	5.7	13.3	17.5	20.2	24.1		14.4
1992/93	3	4.2	12.1	22.8	24.6	32.4		21.8
	4		15.8	20.0	23.8	24.8		21.0
	1		13.2	17.1	21.2			14.2
1993/94	3			19.1	22.2	20.8		19.8
	4[1]		14.2	18.9	24.5	28.1	25.5	20.6

Season	Quarter	Age							
		0	1	2	3	4	5	6	Overall mean
1995	3[2]	-	-	12.0	17.0	19.0	21.0	29.0	-
1996	1			8.0	11.0	13.0	13.0		-
	4	8.0	15.0	19.0	23.0	28.0			-
1997	1		10.0	15.0	19.0	22.0	28.0		
	3		13.0	17.0	19.0	24.0			
	4		17.0	20.0	22.0	23.0			
1998	1		11.0	13.0	18.0	21.0	28.0		15.0

[1]Based on November samples only.
[2]Based on September sample only.

Table 9.2.3. Division VIId,e Sprat. Sampling commercial landings for biological samples in 1998.

Country	Quarter	Landings ('000 t)	No. samples	No. meas.	No. aged
1998					
England/Wales					
	1	0.3	2	326	141
	2	0.0	0	0	0
	3	1.1	0	0	0
	4	0.6	0	0	0
	Total	2.0	2	326	141

10 SPRAT IN DIVISION IIIA

10.1 The Fishery

10.1.1 ACFM advice applicable for 2000 and 2001

No ACFM advice on sprat TAC has been given in recent years. The sprat TAC for 2000 was 50,000 t, with a restriction on by- catches of herring not exceeding 21,000 t. For 2001 the same values were set as in 2000, which were a sprat TAC of 50,000 t and a total by-catch ceiling of herring of 21,000 t from all other fisheries.

10.1.2 Landings

Prior to 1998 a so-called 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.

In 1994 and 1995 a substantial sprat fishery was conducted in Division IIIa. In these years there was, for the first time in several years, a directed sprat fishery for industrial purposes in Skagerrak and the northern part of Kattegat. Such high sprat landings have not been seen since.

The total annual landings for Division IIIa by area and country are given in Table 10.1.1 for 1974–2000. The total landings decreased from 27,000 t in 1999 to 21,100 t in 2000 and are at the same level as in 1996-1998.

The Norwegian and Swedish landings include the coastal and fjord fisheries. Though the Swedish coastal sprat fishery increased in 1999, these landings continued to be low.

Landings by countries and by quarter are shown in Table 10.1.2. For 2000 the landings were taken in all quarters and evenly distributed in the 1st, 3rd and 4th quarter as in 1999. In the second quarter only 1,900 t was 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 fish meal 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.

As mentioned above the fisheries can therefore be listed in three fishery categories:

1) By-catches in a directed herring trawl fishery with minimum mesh size of 32 mm and by purse seiners.
2) Directed sprat fishery for human consumption carried out by purse seiners.
3) A directed sprat fishery carried out by trawlers, using mainly 16, 18 or 22 mm meshes size, for human consumption and for reduction purposes.

10.2 Catch Composition

10.2.1 Catches in number and weight at age

The numbers and the mean weight by age in the landings from 1995 to 2000 are presented in Table 10.2.1 and Table 10.2.2, respectively. Landings, for which samples were collected, were raised using a combination of Swedish and Danish samples, without any differentiation in types of fleets.

10.2.2 Quality of catch and biological data

Denmark reorganised and improved its monitoring system for management and scientific purposes in 1996. The high sampling level has continued since. In 2000 a total of 311 samples compared with a total of 313 samples in 1999 from the small meshed fishery for species composition were collected from a total landing of 58,000 t of all species. This high sampling intensity, 1 sample per 190 t landed, more than meet the required level of one sample per 1,000 t landed.

Denmark has provided biological samples all the quarters where there were landings and from landings in both the two areas (the Skagerrak and the Kattegat). Sweden provided biological samples for quarter 4 from the fishery in Kattegat and from quarter 1 and 4 from the Skagerrak. No Norwegian samples have been collected.

All the provided samples were used, for estimation of numbers of sprat at age and the mean weight at age, in all sprat landings (Table 10.2.1 and Table 10.2.2). The quantity of sampling has improved and was considered adequate. As in previous years, no samples of sprat were taken from the fisheries for human consumption. Therefore, data from the industrial landings were used for the estimation of numbers of sprat at age and the mean weight at age. Details on the sampling for biological data per country, area and quarter are shown in Table 10.2.3.

10.3 Recruitment

The IBTS (February) sprat indices for 1984–2001 are presented in Table 10.3.1. The IBTS data are provided by rectangle in Figure 8.3.1 for age groups 1,2 and 3+, and the mean length (mm) of 1-gr sprat in Figure 8.3.2. The indices are calculated as mean no./hr (CPUE) weighted by area where water depths are between 10 and 150 m (ICES 1995).

The 2001-IBTS indices are higher for all age groups than the 2000-indices. The 1-group as well as the total index are of the highest recorded for the period. The abundance of the 1998-year class sprat (3- group) continued to be relatively good.

10.4 Acoustic Survey

Acoustic estimates of sprat were included in the ICES co-ordinated Herring Acoustic surveys in 1996. In 1996 the total estimates was 7.9×10^8 fish or 14,267 tonnes. About 95 % of the biomass was recorded in Kattegat. Since 1997 only single specimens of sprat have been caught and no or low acoustic values allocated to sprat (ICES 2001).

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 1999a), the WG decided not to run the model this year. According to the IBTS (February)-index from 2001, the sprat stock in the area has increased 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=0.03), the data is shown in Figure 10.6.1, and the index is considered as not useful for management of sprat in Division IIIa at present.

The estimated yields for 2001 using various IBTS-indices; i.e. 1-group, combined 1-and 2-group and total index, in a SHOT-estimate (Shepherd, 1991) were in the range of 30-40,000 tonnes. The estimate run with a combined 1-and 2-group index is shown in Table 10.6.1. This method does not provide any reliable projection under the present management regime.

10.7 Management Considerations

The natural variability in the recruitment is high and the variation in stock abundance between years do not appear to be driven directly 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. 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) 1974–2000.
(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
2001	5.1	4.3	0.9	7.7	2.1		20.1

Table 10.1.2. Div. IIIa Sprat. Landings of sprat ('000 t) by quarter by countries, 1994-2000. (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

+ Catch record, but amount not precisely known.

Table 10.2.1 Division IIIA Sprat. Landed numbers (millions) of sprat by age groups in 1995–2000.

	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

Table 10.2.2. Division IIIa Sprat. Quarterly mean weight (g) at age in the landings in 1995-2000. (1994-1995 Danish and Swedish data, 1996-1997 Danish data, 1998-2000 Danish and Swedish data)

Year	Age							SOP
	Quarter	0	1	2	3	4	5+	
1995	1		2.3	8.9	18.8	22.9	26.1	9,519
	2		2.9	7.3	12.4	23.7	27.0	12,054
	3		10.5	18.4	15.5			20,765
	4		11.5	15.6	15.5	18.2		13,262
	Total		7.8	9.2	15.3	22.2	26.4	55,600.3
1996	1		9.2	10.6	14.2	17.4	17.7	9,724
	2		8.6	12.5	15.1	17.4	17.0	5,847
	3		4.2	10.9	15.5	21.0		26
	4		4.2	10.9	15.5	21.0		2,403
	Total		8.7	7.6	14.8	19.6	17.7	18,000.3
1997	1			17.3	18.6	21.8	26.0	968
	2		8.3	17.6	20.0	22.1	31.0	489
	3	4.1	13.6	17.2	21.1			3,062
	4	4.7	14.7	17.5		19.5		11,176
	Total	4.6	14.4	17.5	19.6	20.4	26.3	15,696.2
1998	1		6.6	14.0	18.0	19.0	21.3	4,828
	2		6.6	13.9	17.8	18.7	21.0	1,027
	3	4.6	17.7	20.7	22.1	24.7		1,718
	4	4.8	17.5	20.4	22.5	27.5		11,998
	Total	4.8	16.9	18.5	19.6	21.2	21.2	19,570.0
1999	1		4.6	6.4	17.3	13.4	13.1	7,319
	2		5.3	17.1	18.6	22.2	17.8	264
	3	3.0	11.4	12.6	16.8	18.3		9,257
	4	4.8	13.9	17.6	20.8	21.2	23.5	9,521
	Total	3.8	10.2	8.8	17.4	13.9	13.7	26,361.0
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
	Total	6.7	14.3	14.3	17.3	21.1	22.7	19,949.3

Table 10.2.3 Division IIIa Sprat. Sampling commercial landings for biological samples in 2000.

Country Area	**Quarter**	**Landings ('000 t)**	**No. samples**	**No. meas.**	**No. aged**
Denmark	1	0.3	6	696	75
Skagerrak	2	0.0			
	3	2.7	20	2128	177
	4	2.0	6	619	98
	Total	5.1	32	3443	350
Denmark	1	3.8	6	648	239
Kattegat	2		4	159	116
	3	2.1	4	160	65
	4	1.8	9	1413	616
	Total	7.7	23	2380	1036
Norway	1	0.1			
Skagerrak	2				
	3	0.1			
	4	0.7			
	Total	0.9	0	0	0
Sweden	1	1.0	1	100	99
Skagerrak	2	1.3			
	3	0.0			
	4	2.1	17	3695	1102
	Total	4.4	18	3795	1201
Sweden	1	1.4			
Kattegat	2	0.6			
	3	0.0			
	4	0.2	1	18	18
	Total	2.2	1	18	18
Denmark		12.7	55	5823	1386
Norway		0.9	0	0	0
Sweden		6.6	19	3813	1219
	Total	20.2	74	9636	2605

Table 10.3.1. Division IIIa Sprat. IBTS (February) indices of sprat per age group 1984-2001. (Mean number per hour per rectangle weighted by area. Only hauls taken in depths of 10-150 m are included).

Year	No Rect	No hauls	Age Group					
			1	2	3	4	5+	Total
1984	15	38	5779.73	854.30	207.60	80.09	61.47	6983.19
1985	14	38	2397.24	2395.15	368.76	128.50	49.11	5338.76
1986	15	38	664.99	1918.53	1786.59	116.20	31.91	4518.22
1987	16	38	2244.33	2501.38	2224.94	1655.66	78.69	8705.00
1988	13	38	939.91	5461.23	1519.15	2130.02	459.41	10509.72
1989	14	38	437.60	994.37	1077.13	603.41	147.86	3260.37
1990	15	38	502.83	237.76	69.90	65.65	49.04	925.18
1991	14	38	636.17	456.74	493.57	86.03	215.58	1888.09
1992	16	38	6016.26	605.99	272.13	215.45	79.26	7189.09
1993	16	38	1789.73	4623.70	996.75	218.97	260.08	7889.23
1994	16	38	1546.88	614.35	961.44	299.48	67.58	3489.73
1995	17	38	2282.92	1828.84	37.24	47.86	4.53	4201.39
1996	15	38	176.15	5800.45	794.23	135.95	228.51	7135.29
1997	16	41	200.80	409.84	1307.35	147.36	144.17	2209.52
1998	15	39	75.09	1742.73	680.95	1793.92	579.34	4872.03
1999	16	42	4273.15	363.18	269.01	47.77	345.85	5298.96
2000	16	41	213.70	643.96	54.68	50.53	24.01	986.88
2001	16	42	5973.89	1196.79	722.44	96.99	48.02	8038.13

Table 10.6.1. DIV. IIIa Sprat. SHOT forecast of landings in 2001 using total landings and the total IBTS-indices as input data**.**

DIV. IIIa sprat SHOT forecast spreadsheet version 6

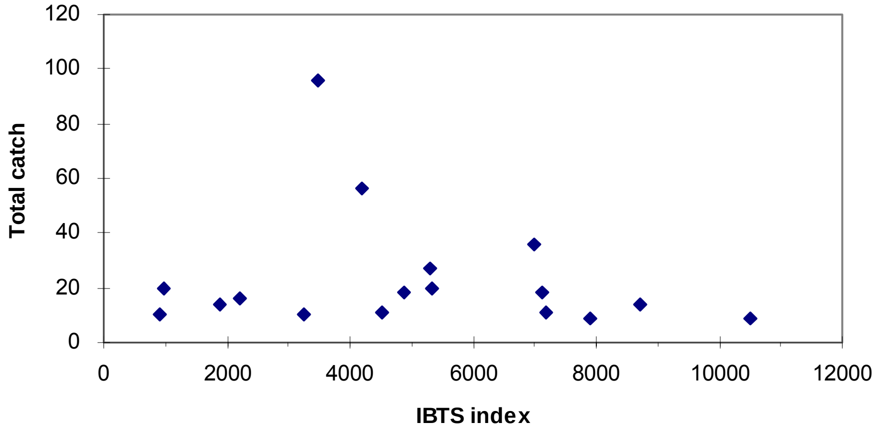
Total index March 2001

running recruitment weights

older	0.00		G-M =	0.00
central	1.00		exp(d)	1.00
younger	0.00	ex	exp(d/2)	1.00

Year	Land -ings	Recrt Index	W'td Index	Y/B Ratio	Hang -over	Act'l Prodn	Est'd Prodn	Est'd SQC.	Act'l Expl Biom	Est'd Expl Biom	Est'd Land -ings
1984	36	6983		0.77	0.23				47		
1985	20	5339	5339	0.77	0.23	15			26		
1986	11	4518	4518	0.77	0.23	8	26	24	14		
1987	14	8705	8705	0.77	0.23	15	31	27	18		
1988	9	10510	10510	0.77	0.23	8	22	20	12	26	20
1989	10	3260	3260	0.77	0.23	10	5	6	13	8	6
1990	10	925	925	0.77	0.23	10	2	4	13	5	4
1991	14	1888	1888	0.77	0.23	15	4	5	18	7	5
1992	11	7189	7189	0.77	0.23	10	17	16	14	21	16
1993	9	7889	7889	0.77	0.23	8	17	16	12	20	16
1994	96	3490	3490	0.77	0.23	122	7	7	125	10	7
1995	56	4201	4201	0.77	0.23	44	17	35	73	46	35
1996	18	7135	7135	0.77	0.23	7	33	38	23	49	38
1997	16	2210	2210	0.77	0.23	15	9	11	21	15	11
1998	18	4872	4872	0.77	0.23	19	21	20	23	26	20
1999	27	5299	5299	0.77	0.23	30	23	21	35	28	21
2000	20	987	987	0.77	0.23	18	4	10	26	12	10
2001		8038	8038	0.77	0.23		36	33		42	33

Fig. 10.6.1. Div.IIIa sprat. IBTS total indices vs total catches in 1984-1998. (rsq=0.03)



11 REFERENCES

Armstrong, M, Dickey- Collas M, Mc Curdy W, Burns C, Peel J, Mc Aliskey M, and Briggs R. 1998a Catch rates of juvenile herring in Irish Sea (Area VIIaN) groundfish surveys: June 1991- Sept.1998.

Armstrong, M, Burns C, Clarke W, Dickey-Collas M, Mc Aliskey M, Mc Curdy W, Peel J, and Snyder R. 1998b Acoustic survey of herring and sprat in the northern Irish Sea (area VIIa N) in September and October 1998, plus corrections to 1995 survey estimates.

Basson, M. 1997. A comparison of two short term projection methods for North Sea herring catches by fleet. Working Document to the Herring Assessment Working Group, Copenhagen, March 1997.

Basson, M. 1998. Some notes on stochastic short term projections, based on split factors, for North Sea herring. Working Document to the Herring Assessment Working Group, Copenhagen, March 1998.

Beek, F.A van, and Pastoors, M.A., 1999. Evaluating ICES catch forecasts: the relationships between implied and realized fishing mortality ICES C.M. 1999/R:4.

Biester, E. 1979. Der Frühjahrshering Rügens. Doctoral Thesis. Wilhelm-Pieck Universität Rostock.

Brielmann, N. 1989. Quantitative analysis of Ruegen spring-spawning herring larvae for estimating 0-group herring in Sub-divisions 22 and 24. Rapp. P.-v. Reun. Cons. int. Explor. Mer, 190: 271–275.

Cook, R.M., Kunzlik, P.A. and Fryer, R. 1991. On the quality of North Sea stock forecasts. ICES J. Mar. Sci., 48: 1–13.

Cook, R.M. 1995. A simple model for the analysis of research vessel data to determine stock trends ICES CM 1995/D:12.

Gröger, J. and Gröhsler, T. 1995. On the discrimination of herring stocks in Division IIIa. ICES CM 1995/J:22.

Gröger, J. and Gröhsler, T. 1996. Information Updated Discrimination of Herring Stocks in Baltic Division IIIa. ICES CM 1996/J:10.

Gröger, J. and Gröhsler, T. 2000a. On the separation of herring stocks in the Western Baltic. Working document HAWG2000. 13 pp.

Gröger, J. and Gröhsler, T. 2000b. Comparative analysis of alternative statistical models for herring stock discrimination based on meristic characters (Applied Ichthyology, accepted in January 2000).

Hammer, C., Reid, D.G., and Greenstreet, S.P.R. 1996. The use of weight length relationships for the analysis of acoustic survey data from herring surveys: a source of variability. ICES CM 1996/ H:6.

Heinke, F. 1898. Naturgeschichte des Herings. Teil 1. Deutscher Seefischerei-Verein. Band II.

Holden, S., Kirkwood, G. and Bravington, M.V. 1995. Catch Effort Data Analysis. The CEDA Package. User Manual for CEDA version 2.01. MRAG Ltd., London, UK.

Hulme, T.J. 1995. The use of vertebral counts to discriminate between North Sea herring stocks. ICES J. mar. Sci., 52: 775–779.

ICES 1980. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1980/H:4, 103 pp.

ICES 1984. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1984/Assess:12.

ICES 1989. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1989/Assess:15.

ICES 1990. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1989/Assess:14.

ICES 1991. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1991/Assess:15.

ICES 1992a. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES 1992/Assess:9, 114 pp.

ICES 1992b. Report of the Workshop on Methods of Forecasting Herring Catches in Div. IIIa and the North Sea. ICES CM 1992/H:5.

ICES 1993. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM1993/Assess:15.

ICES 1994a. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1994/Assess:13.

ICES 1994b. Report of the Planning Group for Herring Surveys. ICES CM 1994/H:3.

ICES 1994c. Report of the Study Group on herring assessment and biology in the Irish Sea and adjacent waters. ICES CM 1994/H:5.

ICES 1995. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1995/Assess:13.

ICES 1996a. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1996/Assess:10.

ICES 1996b. Manual for the International Bottom Trawl Surveys. Revision V. Addendum to ICES CM 1996/H:1 (Ref. Assess+G).

ICES 1997a. Report of the Herring Assessment Working Group for the Area south of 62°N. ICES CM 1997/Assess:8.

ICES 1997b. Study Group on Multispecies Model Implementation in the Baltic. ICES CM 1997/J:2 (Ref.:Assess).

ICES 1998a. Report of the Herring Assessment Working Group for the Area south of 62°N. ICES CM 1998/ACFM:14.

ICES 1998b. Report of the Planning Group for Herring Surveys. ICES CM 1998/G:4 Ref. D.

ICES 1998c Report of the Study Group on Stock-recruitment Relationships for North Sea Autumn Spawning Herring. ICES CM 1998/D:2.

ICES 1998d. Report of the Planning Group for Herring Surveys. ICES CM 1998/G:4 Ref. D.

ICES 1999. Report of the international bottom trawl survey working group. ICES CM 1999/D:2.

ICES 1999a. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1999/ACFM:12.

ICES 1999b. Report of the Planning Group for Herring Surveys. 1999. ICES CM 1999/G:7, Ref. D.

ICES 1999c/H:1 (addendum) Manual for the Baltic International Acoustic Survey. Addendum to ICES CM 1999/H:1 (Ref. Appendix IV).

ICES 2000. Report of the planning group for herring surveys. ICES CM 2000/G:02.

ICES 2000a. Report of the working group on the assessment of mackerel, horse mackerel, sardine and anchovy. ICES CM 2000/ACFM:5.

ICES 2000b. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 2000/ACFM:10.

ICES 2000c. Report of the Baltic International Fish Survey Working Group. ICES CM 2000/H:2.

ICES 2001. Report of the planning group for herring surveys. ICES CM 2001/G:02.

ICES 2001a. Report of the Workshop On International Analysis Of Market Sampling And The Evaluation Of Raising Procedures And Data-Storage (Software). ICES C.M. 2001/D:5.

Jensen, A.J.C. 1957. Danish herring investigations in the Skagerrak, Kattegat, Belts and Baltic. Ann. Biol., 14: 191–194.

Kizner Z.I. and D. Vasilyev 1997. Instantaneous Separable VPA (ISVPA). ICES Journal of Marine Science, 54(3): 399–411.

Klenz, B. 1993. Quantitative Larvenanalyse des Rügenschen Frühjahrsherings in den Laichsaisons 1991 und 1992. Infn. Fischw., 40(3): 118–124.

Klenz, B. 1999. Das deutsche Larvenprogramm im Hauptlaichgebiet des Herings der westlichen Ostsee – Eine Forschungsaufgabe von internationaler Bedeutung. Inf. Fischwirtsch. Fischereiforsch. 46(2), 1999: 15–17.

Klenz, B. 2000. Schwacher Nachwuchsjahrgang 2000 des Herings in der westlichen Ostsee. Inf. Fischwirtsch. Fischereiforsch. 47(4), 2000: 1991–192.

Kolody, D. & K. Patterson, 1999. Evaluation of NE Atlantic Mackerel stock assessment models on the basis of simulated long-term management performance. Working document. ICES Working Group on the Assessment of Mackerel, Horse mackerel, Sardine and Anchovy, Copenhagen, 14–23 September 1999.

Levene, H. 1960. Robust tests for equality of variances. Contributions probability and statistics, Stanford University Press (1960), pp 278–292.

Molloy J and Kelly C. Herring Acoustic Surveys by Ireland 1999/2000. Working Document to the Herring Assessment Working Group, Copenhagen, March 2000.

Moksness, E. and Fossum, P. 1991. Distinguishing spring and autumn spawned herring larvae (*Clupea harengus* L.) by otolith microstructure. ICES J. Mar. Sci., 48: 61–66.

Mosegaard, H. and Popp-Madsen, K. 1996. Racial discrimination of herring stocks, comparing vertebral counts and otolith microstructure analysis. ICES CM 1996/H:17.

Müller, H. and Klenz, B. 1994. Quantitative Analysis of Rügen Spring Spawning Herring Larvae Surveys with Regard to the Recruitment of the Western Baltic and Division IIIa Stock. ICES CM 1994/L:30.

Needle, C.L. 2000. The ins and outs of ICA. Marine Laboratory Aberdeen, Report no. 04/00.

NRC, 1998. Improving fish stock assessments. Committee on fish stock assessment National Academy Press: 177 pp.

Patterson, K.R. and D.S. Beveridge 1995: Report of the Herring Larvae Surveys in the North Sea and Adjacent Waters in 1993/1994. ICES CM 1995/H:22.

Patterson, K.R., Skagen D., Pastoors, M., and Lassen H. 1997. HAWG 1997. Harvest control rules for North Sea herring. Working Document to ACFM 1997.

Patterson, K.R. 1998. Integrated Catch at Age Analysis Version 1.4. Scottish Fisheries Research Report. No. 38.

Patterson, K.R., Cook, R.M., Darby, C.D., Gavaris, S., Mesnil, B., Punt, A.E., Restrepo, V.R, Skagen, D.W., Stefansson, G. and Smith, M. 2000. Validating three methods for making probability statements in fisheries forecasts. ICES CM 2000/V:06.

Patterson, K.R , R.M. Cook, C.D. Darby, S. Gavaris, B. Mesnil , A.E. Punt, V.R. Restrepo, D. W. Skagen , G. Stefánsson, M. Smith. 2000. Validating three methods for making probability statements in fisheries forecasts ICES CM 2000 V:06.

Rivoirard J., Simmonds J., Foot K.G. Fernandes P.G. and Bez N. 2000. Geostatistics for Fish Stock Estimation. Blackwell Science, London.

Rosenberg, R. and Palmén, L.-E. 1982. Composition of herring stocks in the Skagerrak-Kattegat and the relations of these stocks with those of the North Sea and adjacent waters. Fish. Res., 1:83–104.

Schulz, N. and Vaske, B. 1988. Methodik, Ergebnisse und statistische Bewertung der Grundtrawlsurveys in der Mecklenburger Bucht, Arkonasee und des noerdlichen Bornholmbeckens in den Jahren 1978–1985 sowie einige Bemerkungen zu den Jahrgangsstaerken des Dorsches (*Gadus morhua*) und des Herings (*Clupea harengus* L.). Fischerei-Forschung, 26(3): 53–67.

Skagen, D.W. Medium term simulation of management regimes for North Sea herring. Working Document: ICES Herring Assessment Working Group for the Area South of 62°, March 1997.

Shepherd, J.G. 1991. Simple Methods for Short Term Forecasting of Catch and Biomass. ICES J. Mar. Sci., 48: 67–78.

Simmonds, E.J., Bailey, M.C., Toresen, R., Torstensen, E., Pedersen, J., Götze, E., Fernandes, P. and Couperus, A.S. 1999. 1998 ICES Coordinated Acoustic Survey of ICES Division IIIa, IVa, IVb, and VIa(North). ICES CM/1999:J36.

Simmonds E.J. and J. Rivoirard 2000. Vessel and day/night effects in the estimation of herring abundance and distribution from the IBTS surveys in North Sea. ICES CM2000/K:2.

Smith, P.E. and Richardson, S.L. 1977. Standard techniques for pelagic fish egg and larva surveys. FAO Fish. Techn. Pap., 175 pp.

Vasilyev D. 1998. Separable cohort procedures with internal property of unbiasness of the solution. ICES CM 1998/BB:3, 11pp.

Van Beek, F.A. and Pastoors, M.A. 1999. Evaluating ICES catch forecasts: the relationships between implied and realized fishing mortality. ICES CM 1999/R:4.

Vasilyev, D., Belikov, S., S. Shamray, E 2000. Tuning of the natural mortality for North East Atlantic Macerel. Working document for the ICES working group on the assessment of mackerel, horse mackerel, sardine and anchovy 2000.

Zhang, Z. and Moksness, E. 1993. A chemical way of thinning otoliths of adult Atlantic herring (*Clupea harengus*) to expose the microstructure in the nucleus region. ICES Journal of Marine Science, 50(2): 213–217.

Zimmermann C, Kelly C, Abaunza P, Carrera P, Eltink A, Iversen S, Murta A, Reid D, Silva A, Uriarte A, Villamor B (The WG MHSA 2000 quality control subgroup) (2000): Whitelist on the functionality and properties of an input application for the submission of commercial catch and sampling data in the ICES environment. Working Document to the ICES WG on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy 2000.

12 WORKING DOCUMENTS

Armstrong M, M. Dickey-Collas, C. Burns, J. Peel, M. McAliskey, W. McCurdy and R. Briggs. Survey Indicies of Abundances for Herring in the Irish Sea (Area VIIaN): 1992–2000

Basson M. and P. Welsby. Fleet Description of the UK England and Wales fleet fishing for Herring.

Dalskov J. The Danish Herring and Sprat fishing fleets.

Dickey-Collas M. Review of Recent Sampling from Landings of VIIa(N) Herring.

Dickey-Collas M., J. Molloy and R.D.M. Nash. a) Description of the Northern Ireland Herring Fleet and Herring Fishing Activity in VIIa (N) from 1960 to 2000.

Dickey-Collas M., R. D.M. Nash and J. Brown. b) The Location of Spawning of Irish Sea Herring (*Clupea harengus*).

Dornheim H. Germany: Herring fishery during the last decade.

Gröhsler T. German Fisheries for Herring in the Western Baltic.

Hatfield E. Scottish Pelagic Fleet description, 1990–2000.

Kelly C. Fleet descriptions and Fisheries for herring in the Celtic Sea and ViaS VIIbc in 2000.

Modin J. The Swedish fishery for herring in Division IIIa and Subdivisions 23 and 24.

Pastoors M. The Netherlands – Fleet Description.

Torstensen E. Sprat fishery.