ICES HAWG Report 2006

ICES Advisory Committee on Fishery Management

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Report of the Herring Assessment Working Group South of 62° N (HAWG)

14 – 23 March

ICES Headquarters

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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Contents

Executive Summary

The ICES herring assessment working group (HAWG) met for 10 days in March 2006 to assess the state of 7 herring stocks and 3 sprat stocks. New data were only available for 6 herring stocks and 2 sprat stocks. HAWG carried out a benchmark assessment on North Sea herring. The following issues were explored:

- catch data through catch curves
- survey data based assessments using SURBA
- simpler models using CSA
- standard catch at age assessment models (ICA, XSA and FLICA, FLXSA in R)
- time inconsistencies, outliers and time trends in indices.
- retrospective performance of the different models.

The exploration resulted in ICA being chosen again as the principle model for the assessment of North Sea herring. HAWG also truncated the IBTS and MIK time series used in the model and adjusted the weighting factors on the catch and surveys. These changes lead to improved precision in the estimates of F and SSB in the terminal year and reduced retrospective bias in the assessment. The changes did not greatly change the perception of the state of the stock compared to last year's assessment or compared to an assessment with last years model settings.

The recent trends in North Sea autumn spawning herring show a peak in spawning biomass (SSB) of 1.8 million tonnes in 2004 and the SSB is now likely to decline due to serial poor recruitment since 2001. The new recruitment estimate for 2006 is again well below average. This poor recruitment is caused during the larvae phase of North Sea herring.

Update or exploratory assessments were carried out on all the other stocks. Two assessments were offered for herring to the west of Scotland (as a very low acoustic survey estimate had a marked effect on the assessment). Both IVaS and Celtic Sea herring had their time series of acoustic surveys revised. The assessments suggest that both of these stocks are at historic low spawning biomass. The assessment of IIIa was updated, and HAWG then spent much time improving the clarity of the IIIa advice.

HAWG answered one special request from the EU on the TAC for North Sea sprat in 2006. Sprat in the North Sea appears to be at a high biomass in recent years, but the incoming 2006 year class appears to be well below the average.

HAWG also commented on the quality and availability of data, the problems with estimating the amounts of discarded fish, the relevance of ecosystem changes to the stocks considered by the group and recent meetings and reports of relevance to HAWG.

HAWG was concerned about the apparent increase in misreporting of catches in recent years and the growing relaxation of regulations designed to restrict the ability to misreport or catch herring as bycatch.

1 Introduction

1.1 Participants

Steven Beggs	UK/Northern Ireland
Massimiliano Cardinale	Sweden
Maurice Clarke	Ireland
Lotte Worsøe Clausen	Denmark
Jørgen Dalskov	Denmark
Mikael van Deurs	Denmark
Mark Dickey-Collas (Chair)	The Netherlands
Ian Doonan	Ireland
Afra Egan	Ireland
Tomas Gröhsler	Germany
Joachim Gröger	Germany
Olvin van Keeken	The Netherlands
Emma Hatfield	UK/Scotland
Phil Large	UK/England & Wales
Henrik Mosegaard	Denmark
Peter Munk	Denmark
Beatriz Roel	UK/England & Wales
Norbert Rohlf	Germany
John Simmonds	UK/Scotland
Dankert Skagen	Norway
Else Torstensen	Norway
Christopher Zimmermann	Germany

Contact details for each participant are given in Appendix 1.

1.2 Terms of Reference

2005/2/2ACFM03

The Herring Assessment Working Group south of 62° N [HAWG]:

a) assess the status of and provide management options (by fleet where possible) for 2007 for:

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

2) the herring stocks in Division VIa and Sub-area VII;

3) the stock of spring-spawning herring in Division IIIa and Sub-divisions 22–24 (Western Baltic);

b) forecasts for North Sea autumn-spawning herring should be provided by fleet and according to the management plan agreed between the EU and Norway;

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

d) assess the status of the sprat stocks in Subarea IV and Divisions IIIa and VIId,e;

for the stocks mentioned in a) and d) perform the tasks described in C.Res. 2005/2/ACFM01.

1.3 Working Group's response to ad hoc requests

1.3.1 Request by European Commission (10/3/06_ C.3.m) on North Sea sprat.

ICES received one special request from the European Commission to be considered by HAWG 2006.

"The Commission has to propose the establishment of the final catch limits for Sprat in Ila-IV (EC waters) and Norway pout in IIA-IIIA and IV (EC waters) in the first half of 2006.

Following our preliminary contacts, we understand that ICES is in a position to deliver, under the current MOU and without extra charges, an updated assessment for both stocks and provide a mid-year revision of the TAC taking into account the estimates of incoming recruitment."

The response of HAWG to this request is given in section 8.7 of this report, see below.

1.4 Reviews of groups or work important for the WG

HAWG was briefed throughout the meeting about other groups and projects that were of relevance to their work. Some of these briefings and/or groups are described below.

1.4.1 The Annual Meeting of Assessment Working Group Chairs [AMAWGC]

The working group was addressed by the chair of ACFM (Martin Pastoors). Both he and Mark Dickey-Collas informed the group about the AMAWGC meeting in 2006. They described the construction of a roadmap for the working group for the next 3 years. The HAWG road map can be summarised as:

- 2006- Benchmark assessment North Sea herring
- 2007- Benchmark assessment Celtic Sea herring, evaluation of Irish management agreements
- 2008- Benchmark assessment of herring in IIIa (western Baltic spring spawning herring), comprehensive descriptions of the fleets.

The new developments in mixed fisheries, evaluation of management strategies and ecosystem descriptions were also discussed at AMAWGC, and were taken into account when the HAWG 2006 report was put together. The input of WGRED was also discussed in the context of the AMAWGC meeting (see section 1.8).

1.4.2 The Planning Group for Herring Surveys [PGHERS]

PGHERS met in Rostock, Germany, from 24–27 January 2006 (Chair: B. Couperus, Netherlands) to:

Investigate and report on the possible bias introduced by a change in gear for sampling herring larvae during the Dutch herring larvae survey.

a) combine the 2005 survey data to provide indices of abundance for the population within the area;

b) coordinate the timing, area and effort allocation, and methodologies for acoustic and larvae surveys for herring and sprat in the North Sea, around Ireland, Divisions VIa and IIIa and Western Baltic in 2006;

c) review and update the PGHERS manual for acoustic surveys to address standardization of all sampling tools and survey gears;

d) assess the status and future of the HERSUR database and an intermediate database containing aggregated data;

e) review the conclusions of the herring age reading exchange and workshop (Turku, Finland) and report on implications and use;

f) investigate and report on the possible bias introduced by a change in gear for sampling herring larvae during the Dutch herring larvae survey.

Review of larvae surveys in 2005/2006: Five surveys in the North Sea were carried out covering six of the ten units in the North Sea. They were subsequently completed successfully and the results were made ready for this Herring Assessment Working Group (HAWG) meeting.

Coordination of larvae surveys for 2006/2007: In the 2006/2007 period, the Netherlands and Germany will undertake seven larvae surveys in the North Sea from 1 September 2006 to 31 January 2007. Germany will contribute a second vessel to the IHLS to ensure coverage in the Orkney and Buchan area, which has not been covered in recent years; this will also take place in the first half of September. Thus, with the combined effort of Germany and Netherlands an almost complete coverage of the main spawning grounds is achievable. The Baltic Sea Fisheries Institute will continue with the larvae survey in the Greifswalder Bodden area in 2006.

Larvae survey sampler: In the sampling period 2004-2005 the Netherlands changed from a Gulf III to a Gulf VII plankton torpedo. The Gulf VII seems to perform better in that the oblique hauls show a sharp ‘V’-shape. Possible differences between these two sampling devices will be investigated by sampling simultaneously with the Gulf III and Gulf VII during the September 2006 survey. A special set-up will be tested and improved during a survey in May targeting spawning horse mackerel in the southern North Sea. If the tests during the May survey prove successful, the apparatus will be used during the herring larvae survey in September 2006 to obtain a set of intercalibration hauls.

North Sea acoustic surveys in 2005: Six acoustic surveys were carried out during late June and July 2005 covering the North Sea and west of Scotland. The provisional total combined estimate of North Sea spawning stock biomass (SSB) is 1.9 million t, a decrease from 2.6 million t in 2004. The stock is dominated by the 2000 year class. Growth of the 2000 year class seems again to be slower than average: 96% is mature. The west of Scotland SSB estimate is 190 000 t (400 000 t in 2004); this is a substantial reduction from last years estimate.

Western Baltic acoustic survey in 2005: A joint German-Danish acoustic survey was carried out with RV “Solea” from 4 to 21 October in the Western Baltic. The estimate of Western Baltic spring spawning herring SSB is 197 700 t (192 100 t in 2004).

Manuals for acoustic and herring larvae surveys: The *manual for herring acoustic surveys in ICES Divisions III, IV, and VI*A will be reviewed and updated in 2006 by correspondence. Development of the equipment used, has been extensive in recent years: an extensive review is, therefore, required: there was not enough time to carry out this activity at the meeting. The *manual for the International Herring Larvae Surveys south of 62° north* has been reviewed and updated.

Status and future of the FISHFRAME and HERSUR database: The status of the HERSUR database has not changed since 2005. Only Denmark has uploaded new data. Three countries have uploaded aggregated (“stage 3”) data in the Fishframe database. The international data set was completed by extracting national input data from the excel sheet used so far. The calculation, aggregation and reporting procedures on uploaded data of 2003, 2004 and 2005 was tested against the old procedure. The minor differences found were caused by differences in precision. It was decided that the Fishframe stage 3 module will be used to aggregate data from the 2006 surveys at the next meeting in 2007. To ensure that all countries confirm to same methods in stage 2, a group to design the user requirement specifications should be formed and meet during 13–14 June 2006 at DIFRES in Copenhagen.

S**prat:** Data on sprat were available from RV “Solea” III, RV “Tridens” and RV “Dana”. The total sprat biomass was estimated as 562 000 t in the North Sea (up from 360 000 t in 2004) and 59 800 t in the Kattegat (up from 15 000 t in 2004). The present data suggest that sprat abundance is decreasing in the south and the distribution limit might therefore have been reached.

Coordination of acoustic surveys in 2006: Six acoustic surveys will be carried out in the North Sea and west of Scotland in 2006 between 25 June and 30 July. Participants are referred to Figure 4.4.1 for indications of survey boundaries. “Tridens” and “Solea” will cover the area between 52º and 57º together with interlaced transects. A survey of the western Baltic and southern part of Kattegat will be carried out by a German research vessel in October.

Review of the Age Reading Workshop at the Archipelago Research Institute on the Island of Seili, Finland on 6–June 2005: Thirty-five participants from 25 countries attended the Age Reading Workshop to identify present problems in herring age determination, improve the accuracy and precision of age determinations and spread information of the methods and procedures used in different ageing laboratories working with herring. The main conclusion was that it is recommended that regular otolith exchanges take place between institutes in order to detect precision drift in the age estimations.

Evaluating the potential of the Torry Fish Fat Meter for measuring lipid content of herring at sea: Deborah Davidson from the University of Aberdeen gave a presentation of her ongoing PhD study examining the fat content in herring. The overall aim of the field study in 2006 is to determine whether lipids impose a threshold on the onset of maturation in North Sea herring. PGHERS recommends that in the 2006 North Sea acoustic surveys, all participants take a student from Aberdeen University to make measurements of the fat content of herring.

1.4.3 Study Group on Recruitment Variability in North Sea Planktivorous Fish [SGRECVAP]. 2005/2/LRC14

SGRECVAP met in IJmuiden in 2006 and considered the serial poor recruitment in herring, Norway pout and sand eel in the North Sea in recent years. The summary of SGRECVAP is as follows:

“The poor recruitment in recent years (2001-2004) in planktivorous fish in the North Sea has become cause for concern for fishers, managers and scientists alike. It has lead to fishery closures and cuts in total allowable catches in sandeel, Norway pout and herring. SGRECVAP met to investigate and describe the serial poor recruitment, and review probable mechanisms for the recruitment trends.

Time series analysis showed that there was a common trend in the recent recruitment of all three target species. There was a strong negative trend in the stock-recruit residuals for herring and Norway pout, suggesting that the poor recruitment in those stocks is not related to spawning stock biomass size. This was not the case in sandeel, where the situation was more complex. The common pattern of decline in recruitment seen in the planktivorous fish was not common to the major commercially exploited fish species in the North Sea. There was evidence for significant shifts of at least two periods of recruitment for the major commercial fish species exploited in the North Sea (1986 and 1996/97). Specifically for the three target planktivorous species, SGRECVAP considered there was a significant shift in recruitment in 2001.

There was enough evidence to conclude that poor recruitment in herring was caused by a higher mortality of herring larvae before February of each year. The mechanisms for this were most likely poor larval feeding, predation or poor hatching condition and probably a combination of these. There was evidence that higher mortality of herring larvae can co-occur with high larval production.

Whilst herring, Norway pout and sandeel showed a common trend in recruitment, it cannot be assumed that the same mechanism was common for all three species. Due to insufficient information on the production of each life history stage in Norway pout and sandeel it was not possible to determine the mechanisms driving recruitment. It was clear that the poor sandeel recruitment from 2002 occurred at low spawning stock biomass (the stock was below Blim in 2000), this was not the case for Norway pout.

A well documented change in the planktonic community occurred in the North Sea after the mid 1980s. Change has continued to date, on a gradual basis, and is linked to the broader process of climate change/variability. Reponses at other trophic levels to this gradual change in the zooplankton may result in abrupt changes.

More exploration is needed to investigate the hypotheses presented in the report particularly targeting ecosystem interactions, especially in zooplankton (combined with hydrographic variability), predation and quality/condition of adults, eggs and larvae. SGRECVAP acknowledged that many of the proposed hypotheses could not be tested without extensive use of empirical data and individual and ecosystem modelling (biophysical models and spatial trophic modelling)."

HAWG found the descriptions of recent changes in the North Sea as useful. HAWG viewed the synthesis on herring recruitment from SGRECVAP as important and was concerned about the findings of the dynamic factor analysis that suggested that a shift had occurred in the recruitment of the three species in 2001.

1.4.4 Study Group on Regional Scale Ecology of Small Pelagics [SGRESP]

Dave Reid gave a presentation about SGRESP. The study group on small pelagics has considered the life history strategies of small pelagics in the ICES area. The findings of SGRESP will be published in an ICES cooperative research report. The proposed new work and study group following from the conclusions of SGRESP was of interest to some of the members of HAWG.

1.4.5 WESTHER [EU project]

WESTHER: **A multidisciplinary approach to the identification of herring (*Clupea harengus* L.) stock components west of the British Isles using biological tags and genetic markers. Q5RS-2002-01056 (2003-2006).**

WESTHER's overall goal is to describe the population structure of herring stocks distributed from the south-west of Ireland and the Celtic Sea to the northwest of Scotland. To achieve its goal WESTHER has four research objectives: (i) estimation of genetic and phenotypic differentiation between spawning aggregations; (ii) determination of stock origins and life history of juveniles; (iii) determination of composition of feeding aggregations and (iv) improved guidelines for the conservation and management of biodiversity and stock preservation. The Project started officially on January 1st, 2003 and was extended, in 2005, by six months to finish at the end of June 2006.

In 2005 further sampling was carried out resulting overall in a good broad coverage of spawning areas, adult feeding aggregations and nursery areas. In all, 14 samples of spawners from 8 sites were collected; 17 samples of juveniles from 6 areas; 8 samples from feeding aggregations in the four ICES herring management areas (VIa North; VIa South, VIIb,c; Irish Sea and Celtic Sea); 7 samples of 4 different outgroup areas.

Seven of the eight analytical workpackages have produced data now to enable analyses of spawning population differentiation, and the relation of juveniles and non-spawning aggregations to spawners. The research using parasites as biological tags enables the different life-stages to be linked; the other workpackages allow determination of the most important indicators of differentiation between spawners. These indicators will then inform mixed stock analyses of non-spawning adults and juveniles. The use of a number of different methods on the same individual fish results in a broader analysis of different facets of population structure than a single method would allow.

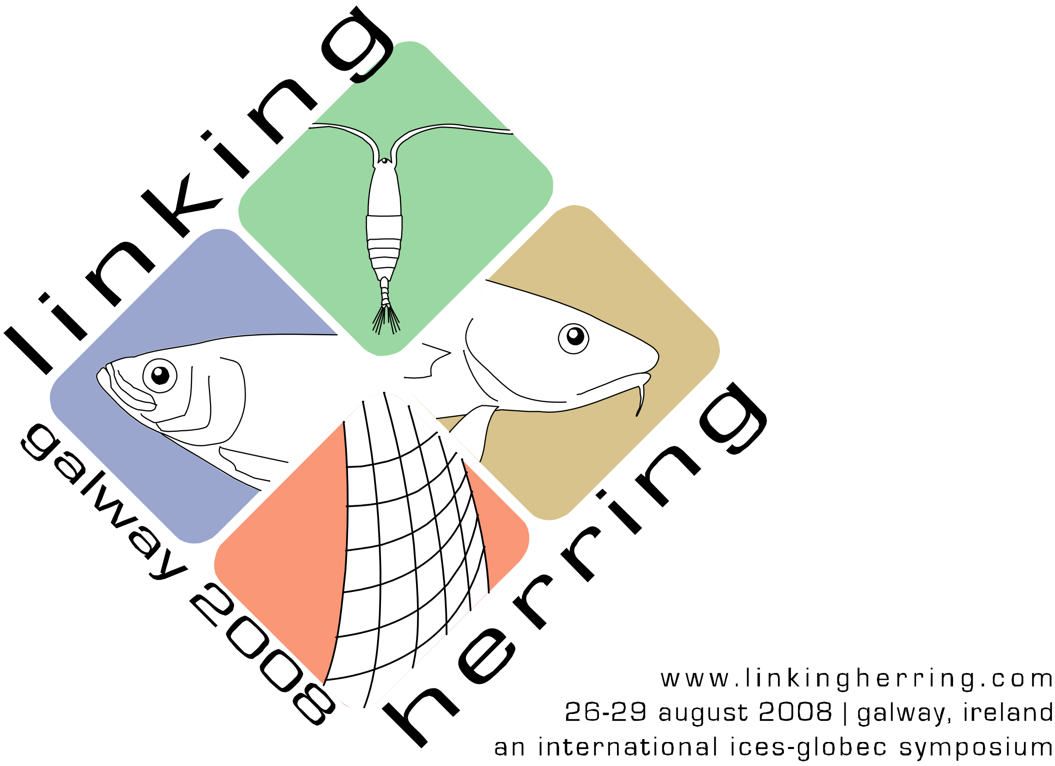
At the time of writing, the chapters for the final report are partially delivered and a full comparison of all of the results is on the way. All workpackages have carried out analyses using the same aggregation levels of data, both on a temporal and spatial basis, to enable comparison of the results. It appears that some of the analyses may be unstable, with different perceptions being produced, depending on the aggregation level of the spawner data used for the classification of the feeding adult aggregations. Some of the methods have a higher success in discriminating between spawning populations (the reference collections) and are thus expected to show a higher success in linking movements of adults between the spawning grounds and their feeding areas.

A meeting will take place in April 2006, of the participants from the different fishery institutes, to discuss the outcomes of each method and their comparisons and to produce a report to fulfil Objective 4: improved guidelines for the conservation and management of biodiversity and stock preservation. This report will then be presented to HAWG in 2007 with any recommendations arising from the project's synthesis.

1.4.6 Linking Herring 2008 [ICES/GLOBEC sponsored symposium]

The ICES/Globec sponsored symposium "Herring: Linking biology, ecology and status of populations in the context of changing environments", with the shortened title "Linking Herring" is planned to take place 26-29th August 2008 in Galway, Ireland. It will take place at the Radisson SAS hotel in Galway city. The conveners are Maurice Clarke, Mark Dickey-Collas and Aril Slotte. A science organising committee has been set up with Maurice Clarke, Mark Dickey-Collas, Aril Slotte, Emma Hatfield, Doug Hay, Richard Nash, Deirdre Brophy, Øyvind Fiksen as members. The symposium web site is www.linkingherring.com.

The proceedings will be published in the ICES Journal of Marine Science. Niels Daan will act as guest editor on the symposium proceedings. Audrey Geffen will be the in house ICES editor.



The Theme Sessions will include:

i) *Herring in the middle*- the trophic and ecological interactions and impacts of herring

ii) *Managing Change*- management and exploitation of herring in a dynamic environment, within the context of long term change

iii) *Variable Production*- particularly the role of reproduction, recruitment and life history strategies.

iv) *Population Integrity*- the integrity of stocks and the drivers of migration

v) *Counting herring*- qualitative and quantitative estimation of herring and its application.

1.4.7 Improved advice for the mixed herring stocks in the Skagerrak and Kattegat [EU project IAMHERSKA]

This is an EU-project under the priority programme for the provision of fisheries scientific advice in the Community (FISH/2004/03). The primary goal of IAMHERSKA is to improve the assessment and advice of the mixed stock in IIIa by elaborating fleet- and stock-based disaggregation on the existing projection method. The advice would so take into account both stocks and all fleet components in IIIa. Temporal and spatial distribution of the different stock components and fleet exploitation patterns will form the basis for the elaboration.

The HAWG used a simple procedure in 2004 to find the highest total catch by fleet in Division IIIa that would be compatible with a precautionary exploitation of WBSS. This procedure used two kinds of information about the fishery, the fraction of WBSS that is caught in IIIa, and the fraction of the catches by the IIIa fleets that consist of WBSS based on recent historic data. This very crude procedure can be refined with more detailed information on how the stocks on one hand and the fisheries on the other hand are distributed geographically and seasonally.

The migration patterns of the different stock components has been evaluated using existing data in the institute databases and other published material. Based on historical material the spatial and temporal distribution of the NSAS and WBSS in IIIa were mapped. The current assumption of equal distribution of all stock components in the area with no differentiation regarding geographical and seasonal information is revised in van Deurs and Clausen, WD 1 to the present report.

The exploitation pattern and fleet behaviour has been modelled to describe the CPUE and catchability on all stock components and preliminary investigations and simulations of how changes in fleet effort affect the various herring stocks has been initiated. The preliminary results are presented in Ulrich-Rescan and Andersen, WD 2 to the present report.

The assumptions in the current approach for advice will be replaced by more consolidated fractions of the stock components based on the above outlined results. The calculations will then be combined with multi-fleet short term prediction programs for each stock, to outline combinations of total quotas by fleet that are compatible with proposed harvest rules and/or precautionary criteria.

1.5 Commercial catch data collation, sampling, and terminology

1.5.1 Commercial catch and sampling: data collation and handling

Input spreadsheet and initial data processing

Since 1999 (catch data 1998), the working group members have used a spreadsheet to provide all necessary landing and sampling data. The current version used for reporting the 2005 catch data was v1.6.4. All but one nation provided commercial catch data on these spreadsheets, which were then further processed with the SALLOCL-application (Patterson et al., 1997). This program gives the needed standard outputs on sampling status and biological parameters. It also clearly documents any decisions made by the species co-ordinators for filling in missing data and raising the catch information of one nation/quarter/area with information from another data set. This allows recalculation of data in the future (as done by SG REDNOSE in 2003, ICES 2003/ACFM:10, and as will have to be done when the new ICES InterCatch database is released, see below), choosing the same (subjective) decisions currently made by the WG. 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. Data submission in 2006 was less smooth than in the year before, as some institutes delivered their data very late. Data was, however, almost error free.

More information on data handling transparency, data archiving and the current methods compiling fisheries assessment data are given in the stock annex 3. To facilitate a long-term data storage, the group stores all relevant catch and sampling data in a separate “archive” folder on the ICES network, which is updated annually. This collection is supposed to be kept confidential as it will contain data on misreporting and unallocated catches, and will be available for WG members on request. Table 1.5.1 gives an overview of data available at present, and the source of the data. Members are encouraged to use the latest-version input spreadsheets if the re-entering of catch data is required. Figure 1.5.1 shows the separation of areas applied to data in the archive.

Future developments: The ICES InterCatch database.

In this section of the report, since 1999, the WG has stated that the handling of catch data is considered as a priority issue for quality control, as the quality of the input data from commercial sampling has proven to be crucial for the quality of the whole assessment procedure. ICES has been asked repeatedly to develop a database application for the proper handling and storage of fisheries catch (-at-age) data. This is also regarded to be a prerequisite for the use of fisheries data for multifleet/multispecies advice. Following generous funding by Norway in 2002, ICES started in early 2005 to develop such a database, called “InterCatch”. HAWG was involved in defining the user specifications, and a first version was presented at the Annual Science Conference, Aberdeen, in September 2005. Since then, some effort has been spent on testing the system (*inter alia* with the validated 2004 North Sea herring data), and progress has continued and the software being debugged. Platform independene required for such systems have yet to be tested. Information requested by the ICES data centre (fleet and stock definitions, specifications for WG specific inputs like data types needed for specific assessments – with dimensions, level of disaggregation, limits for initial validity checks, stock extraction rules etc.) were given in last year’s report. A properly tested beta-release of the software was, however, not available prior to, or during this year’s HAWG meeting, so that the DISFAD/ALLOC system had to be used again to collate international catch and sampling data.

HAWG is eager to start using ICES’ new database and again offers full support in the future. The group reiterated that the database should provide an opportunity to clearly track changes of “official” landings made by WG members to compensate misreported or unallocated landings or discards. This would, however, require means to keep some of the national disaggregated data confidential in order to protect their sources. Further, a transparent and effective handling of information obtained from market sampling in foreign ports should be possible.

1.5.2 Sampling

Quality of sampling for the whole area.

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

The EU sampling regime.

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

AREA	SAMPLING LEVEL PER 1000 t CATCH		
Baltic area (IIIa (S) and IIIb-c)	*1 sample of which*	*100 fish measured and*	*50 aged*
Skagerrak (IIIa (N))	*1 sample*	*100 fish measured*	*100 aged*
North Sea (IV and VIId):	*1 sample*	*50 fish measured*	*25 aged*
NE Atlantic and Western Channel ICES sub-areas II, V, VI, VII (excluding d) VIII, IX, X, XII, XIV	*1 sample*	*50 fish measured*	*25 aged*

There are some exemptions to the above mentioned sampling rules if e.g. landings of a specific EU member states are less than 5 % of the total EU-quota for that particular species.

The process of setting up bilateral agreements for sampling landings into foreign ports has started last year and is beginning to yield results. However, there is scope for improvement, and more of these agreements have to be negotiated, especially between EU and non-EU countries, to reach a sufficient sampling coverage of these landings.

HAWG reviewed the quality of the overall sampling of herring and sprat for the whole area. There is concern that the present sampling regime may lead to a deterioration of sampling quality, because it does not enssure an appropriate sampling of different metiers (each combination of fleet/nation/area and quarter). Given the diversity of the fleets harvesting most stocks assessed by HAWG, an appropriate spread of sampling effort over the different métiers is more important to the quality of catch at age data than a sufficient overall sampling level. The EU data directive appears to not assure this. The WG therefore recommends that all metiers with substantial catch should be sampled (including by-catches in the industrial fisheries), that catches landed abroad should be sampled, and information on these samples should be made available to the national laboratories. Most of the issues raised here have also been addressed by the Planning Group on Commercial Catch, Discard and Biological Sampling (see Section 1.4.8.).

1.5.3 Terminology

The WG noted that the use of “age”, “winter rings” and “rings” still causes confusion outside the group (and sometimes even among WG members). The WG tries to avoid this by consequently using “rings” or “ringers” instead of “age” throughout the report. It should be observed that, for autumn spawning stocks, there is a difference of one year between “age” and “rings”. Further elaboration on the rationale behind this can be found in the stock annex 3.

1.6 Methods Used

1.6.1 ICA

“Integrated Catch-at-age Analysis” (ICA: Patterson, 1998; Needle, 2000) combines a statistical separable model of fishing mortality for recent years with a conventional VPA for the more distant past. Population estimates are tuned by CPUE indices from commercial fisheries or research-vessel surveys, which may be age-structured or not as required. This model appears to behave well on the stocks considered by this WG.

The program ICAVIEW4 produces standard plots for the ICA output. This year there were great problems with getting ICAVIEW4 to work on most computers, probably caused by the incompatibility of the program with windows XP. As a result the standard ICA plots are not presented for all stocks.

1.6.2 CSA

“Catch Survey Analysis” (CSA: Mesnil, 2004) is an assessment method that aims to estimate absolute stock abundance, given a time series of catches and of relative abundance indices, typically from research surveys. It does this by filtering measurement error in the latter through a simple two-stage population dynamics model known in the literature as the Collie-Sissenwine (1983) model. The underlying aim is to reduce the dependence on age-structured data inherent in most VPA-type assessment methods. CSA can be used with only 2 life-history stages (recruits and adults, for example), although simplifying assumptions have to be made. CSA has been used for the final assessment of North Sea sprat and for exploratory analyses for North Sea herring and IIIa sprat.

1.6.3 FLXSA and FLICA [recent developments of XSA and ICA in R]

The complexity of fisheries systems and their management require flexible modelling solutions for evaluations. The FLR (Fisheries Library in R) system (www.flr-project.org) is an attempt to implement a framework for modeling integral fisheries systems including population dynamics, fleet behaviour, stock assessment and management objectives. FLR consists of a number of packages for the open source statistical computer program R, centered around conventions on the representation of stocks, fleets, surveys etc. A broad range of models can be set up, encompassing population dynamics, fleet dynamics and stock assessment models. Moreover, previously developed methods and models developed in standard programming languages can be incorporated in FLR, using interfaces for which documentation is being written. The stock assessment tools in FLR can also be used on their own in the WG context. The combination of the statistical and graphical tools in R with the stock assessment aids the exploration of input data and results. Currently, an effort is being made to incorporate stock assessment models that are used in some of the ICES working groups. Methods for reading in VPA suite files, for investigating the effect of different model input parameters on the stock estimates, and modeling different aspects of uncertainty are also being developed. Currently the assessment methods “Extended Survivors Analysis” (XSA: Darby & Flatman, 1994; Shepherd, 1999) and ICA have been incorporated in a package as FLXSA and FLICA, but the development of other stock assessment methods like ADAPT and SURBA is on-going.

In this working group, FLR has been used for exploratory analyses for North Sea herring, applying both FLICA and FLXSA:

- deterministic analysis using FLXSA and FLICA;
- retrospective analysis using FLXSA (not applicable for FLICA during the WG);
- structural uncertainty using different combinations of basic model assumptions using FLXSA and FLICA (up to last year’s data);
- data uncertainty from bootstrapped tuning indices using FLXSA and FLICA (up to last year’s data);

Bootstrapping of tuning data has been used in the assessment of North Sea plaice and sole during WGNSSK 2005 to estimate uncertainty of the data. However for this exercise survey residuals were resampled. It was found that for North Sea plaice, where a high shrinkage is used in the assessment, the bootstrapped assessments had the tendency to be biased compared to the deterministic assessment. In the exploration phase of this year’s North Sea herring benchmark assessment, the survey data was resampled from station level to estimate data uncertainty. Combining this data uncertainty estimation with the estimation of model uncertainty due to the model settings, which can be done relatively easy in FLR, is a promising step forward towards management, which takes more account of uncertainty than currently.

1.6.4 SURBA

“Survey Based Assessment” (SURBA: Beare, 2005; Needle, 2003, 2004) is based on a simple survey-based separable model of mortality and has been used for exploratory analyses for North Sea herring. SURBA is under continual development. At the moment SURBA is not yet available in FLR, but development towards this is ongoing.

1.6.5 MFSP, MSYPR and MFDP

Short-term predictions for the North Sea used MFSP / MSYPR that was developed three years ago in the HAWG (Skagen; WD to HAWG 2003). Other short-term predictions were carried out using the MFDP v.1a software.

1.6.6 STPR used for medium term projections NS herring

Medium term projections were performed with the STPR3 software, supplemented with a version (S3S) made to ease screening over ranges of model parameter choices. The software documentation is available from ICES or as a report (Skagen, 2003). The simulation framework covers alternative scenarios for future recruitment, weight and maturity at age, assessment error, discarding and other unaccounted mortality. The harvest rules can be examined with respect to error in future assessments by assuming that the stock numbers at age, and hence the SSB on which managers make their decisions, deviates from the real state of the stock. STPR3 does this by a simple stochastic multiplier on the stock numbers as seen by decision makers. Likewise, discrepancy between the decided TAC and the catch actually taken is simulated by a common implementation multiplier. This may account for bias due to misreporting etc. Uncertainty due to measurement (i.e. sampling of the catch derivation of CPUE) estimation within the assessment process, model mis-specification and implementation error were not explicitly modelled but assigned a combined assessment error. However, varying feedback between the assessment process and the management decision making process was not included. Feedback can cause bias in the assessment to affect the management and thus the stock which in turn affects bias in the assessment.

The simple approach in STPR allows for some evaluation of the robustness of a harvest rule to such errors, but does not pretend to foresee how these errors will appear in the future. However, to be feasible, one would assume that the harvest rule still should lead to a precautionary management if these errors have an order of magnitude that has been experienced in the past. It may be noted that previous implementation error that has not been accounted for, although it will have influenced the perception of the stock in the past. Hence, implementation error should only cover cases where it may be different from what it was in the past or already documented and explicitly included in past data.

1.7 Discarding and unaccounted mortality by Pelagic fishing Vessels

In many fisheries, fish, invertebrates and other animals are caught as by-catch and returned to the sea, a practice known as discarding. Most animals do not survive this procedure. Reasons for discarding are various and usually have economic drivers:

- Fish smaller than the minimum landing size
- Quota for this specific species has already been taken
- Fish of undesired quality (high-grading)
- By-caught species of no commercial value

Theoretically, the use of modern fish finding technology used to find schools of fish should result in low by-catch. However, if species mixing occurs in pelagic schools (most notable of herring and mackerel), non-target species might be discarded. Releasing unwanted catch from the net (slipping) or pumping unsorted catch overboard also results in discarding.

Discarding of herring in the pelagic fisheries was considered not to be a large problem, with discards below 5%, estimated by onboard observer programmes. In the area considered by HAWG, only two nations reported discards from their fleets in 2005. For those nations, discard figures were raised to national landings (based on the spatial and temporal distribution of the fleet), and used in the assessment of North Sea autumn spawning herring (UK/Scotland and Germany, see Section 2.3) and VIaN (UK/Scotland, see Section 5.1.3). All other nations did not report notable amounts of discards of herring in the pelagic fisheries, either because they did not occur, catches were not sampled for discards or difficulties with raising procedures. No discard estimates for the total international catch were calculated.

The inclusion of discarded catch is considered to reduce bias of the assessment and thus give more realistic values of fishing mortality and biomass. However, they might also increase the noise in the assessment because the sampling level for discards is usually lower than that for landings (Table 1.7.1. and 1.7.2). This is, as for sampling of landings, caused by the large number of different metiers in the pelagic fishery and the difficulty to predict behaviour of the fisheries (in terms of target species and spatial and temporal distribution). Raising discard estimates to the national landings might result in a higher bias than an area based estimate of discards from the total international fleet, if sampling is insufficient. HAWG therefore recommends that the development of methods for estimating discards be based on a fleet based method, rather than on a national basis.

1.8 Ecosystem considerations, sprat and herring– response to WGRED, SGRECVAP and SGRESP.

HAWG acknowledges the importance of trends and variability in the ecosystem on the dynamics of herring and sprat. This must be considered when giving advice. The reports of SGPRISM (soon to be published as an ICES Cooperative Report) and SGGROMAT have played a role in the determination of current thinking within HAWG. HAWG is also aware of the need to consider the impact of the pelagic fisheries on the ecosystem as a whole. In considering the impact of ecosystem variability and trends on the recent productivity of herring and sprat, HAWG has used the reports of WGRED, SGRECVAP and SGRESP to provide information and input to the current two sections below.

1.8.1 North Sea

The largest stock assessed by HAWG is in the North Sea. Salinity and temperature are known to have a large impact to shape the ecosystem structure in the North Sea and generally their variability reflects the influence of the North Atlantic Oscillation (NAO) on the movement of Atlantic water into the North Sea. The ICES Annual Ocean Climate Status Summary (IAOCSS) for 2003/04 suggests that it may have been negative in the winter of 2004/05 as in the previous winter (Hughes and Lavin 2005). Negative NAO were usually associated with lower temperature than normal but this correlation seems to have been broken down in the latest years (ICES 2006/LRC:03).

The long-term temperature and salinity anomalies in the Atlantic waters flowing into the North Sea with the Faire Isle current provide a broadly similar cyclical behaviour up to the late 1990s (ICES 2006/LRC:03). However, in more recent years the two signals appear to diverge, with relatively high temperatures persisting during years showing a marked decline in salinity (Hughes and Lavin 2005).

In 2005, SST (Sea Surface Temperature) was close to the long term mean for the first eight months of the year, but showed strong positive anomalies in September to December (source http://www.bsh.de/en/index.jsp).

A series of studies on the plankton ecosystem at the herring spawning grounds in the North Sea have shown a strong linkage between frontal hydrography and the prey availability, growth and drift of herring larvae which hatch in these areas (e.g. Richardson and Heath 1986, Kiørboe et al 1988) and other studies propose a strong connection between frontal hydrography and herring recruitment (Iles and Sinclair 1982, Sinclair 1988). Preliminary explorations of the hydrographic variability at the spawning grounds during the period 1975-2005 indicate that two periods of poor herring recruitment (1987-90 and 2001-05) coincide periods of anomalous low water density in nearshore areas. This observed decline in water density is connected to both salinity and temperature fluctuations, and has most likely changed the performance of nearshore fronts. Hence, the preliminary comparisons indicate that the herring recruitment could be affected by oceanographic fluctuations, leading to changes in frontal hydrography at the herring spawning areas, and further investigations of this relationship are recommended.

In concomitance with an increased SST and decreased salinity, the plankton community in the North Sea has shifted to a dominance of more "southerly" species, as shown by CPR data (Reid et al., 2003) after the decline in the abundance of the copepod *Calanus finmarchicus*. Both Calanus species and juvenile sand eels are common prey of herring and recent evidence from the Baltic has shown that herring positively select *Pseudocalanus* and *Temora* and select less *Acartia* (Casini et al., 2004). *Acartia* is associated with summer blooms and warmer temperatures as shown by Gowen et al. (1998). These trends in zooplankton species abundance and species compositions appear to be continuing and those might have causal effect with herring growth and migration patterns (ICES 2006/ACE:03). The CPR data also show a reduction in euphausid availability. Although no changes have been recorded in the total zooplankton biomass and in total copepod abundance (e.g. northern North Sea areas B1 and B2; SAHFOS 2004, Heath 2005), the overall picture is one of a changing zooplankton community structure.

The production of herring has increased (ICES 2005/ACFM:18) since the collapse caused by overfishing in the 1970s (for methods details see Dutil and Brander, 2003). Surplus production has been of the order of 700 k tonnes for the last 25 years and the recent positive net production has lead to an increase in available herring biomass in the system. Also, the biomass of sprat is considered high and fairly stable compared to the last decade (ICES 2005/ACFM:18).

In terms of the impact of a high biomass of herring and sprat on the North Sea ecosystem, some studies are ongoing, but more resources are required to obtain new estimates of stomach contents, prey selectivity, stomach evacuation rates and behavioural interactions by herring and sprat. With low sandeel and *Calanus* abundances, the herring may well be having a stronger impact on the ecosystem than in the previous last 2 decades. However, a high biomass of herring may also provide an alternative prey source to piscivores such as horse mackerel and Minke whales (Olsen and Holst, 2001) reducing the pressure on sandeel. Also, the impact of herring as predator of fish eggs varies with the prey spectra faced by the species (Segers et al., 2006). These last sentences are very speculative and if the quantitative trophic-complexities of the system are to be considered as a priority by ICES, more resources need to be spent on understanding the trophic interactions in the North Sea and developing spatial and temporal trophic dynamics models of the system.

Recent investigations of the decline in larval herring at age (empirical data from the ICES coordinated larval herring surveys, Dickey-Collas in prep.), which used a temperature dependent growth model to estimate larval age, suggest that the daily mortality rate of herring in the North Sea has recently increased to the highest in the time series (ICES 2006/LRC:03). There was evidence that high mortality of herring larvae can co-occur with high larval production (CM 2006/LRC:03). There was a strong negative trend in the residuals from stock-recruits relationship in the latest decade suggesting that the poor recruitment is not just related to high spawning stock biomass level (ICES 2006/LRC:03) but likely caused by an high mortality of herring larvae. The mechanisms for this were most likely poor larval feeding, predation, poor hatching condition and probably a combination of those with possible links to variable hydrographic conditions.

SGRECVAP (ICES 2006/LRC:03), using dynamic factor analysis, highlighted a positive correlation between the time series of SST and herring recruitment anomalies in the North Sea. In addition, a recent analysis (see Cardinale and Hjelm, 2006 for details on methods used) on the effect of spawning stock biomass (SSB) and sea surface temperature (SST) on clupeid recruitment in the North East Atlantic showed significantly more stocks with an SSB effect on recruitment compared to an SST effect on recruitment (Cardinale et al., 2006), although there was not significant difference on the strength of the SSB compared to the SST effect. Variability of recruitment anomalies of clupeid stocks (using all stocks assessed by ICES in the North East Atlantic) was positively strongly correlated with anomalies of SST in the area. A strong positive relationship was found between the first principal component, which explained around 29% of the recruitment anomalies variation, and average temperature deviations in the area. A similar relationship was found also with NAO, but its strength was lower than for SST. Interestingly, 70´and 80´s are clearly separated from 90´ and onwards, plausibly mimicking the different climate regimes (i.e cold against warm period) (Cardinale et al., 2006). This again highlights the link of temperature to recruitment strength of clupeids in the area but it does not provide any clear underlying mechanisms.

In the neighbouring Baltic Sea, the interactions between herring and sprat have been shown to be very dynamic (Mollmann and Koster, 2002). A close association in food items predated upon by those species has been recently shown, together with a clear density-dependent (i.e. food limited) growth for both herring and sprat (Casini et al., 2006). Clupeid condition co-varied with the changes in the weight of zooplankton in the stomachs, which further suggest food competition being the main mechanism behind the changes in clupeid condition in the Baltic Sea during the last two decades. This is the first evidence of food resource mediated density-dependent fish growth in a large marine ecosystem (Casini et al., 2006). The individual fish from the strong 2000 year class of herring in the North Sea have been smaller in size and are less mature at age. This suggests that either slower-growing fish have survived in that year class or that the ecosystem has failed to provide enough food to allow the full potential growth for that cohort i.e. that food has been limiting for that cohort. This cohort grew well up to 1 winter ring of age. However, the less abundant 2001-2004 year classes show again average growth, tending to corroborate food limitation as the likely explaining factor for growth rates variability also in the North Sea herring (ICES 2006/LRC:03). With the decline in sandeel and other planktivorous fish, HAWG would support further studies into the feeding interaction and spatial and temporal associations of herring, sprat, anchovy and pilchard (sardine), especially in the light of the increase of the abundance of the latter southern species in the area during the latest decade (ICES 2006/ACE:03).

The Kattegat and the Skagerrak is also considered an important area for herring by HAWG, it supports both local spawning populations and is the major nursery ground for North Sea herring. The impact of the higher saline inflows through this area into the Baltic Sea in recent years on the resident herring populations is at present unknown. Studies presented to HAWG in 2005 about the HERGEN project suggest that salinity may play a role in the genetic integrity of local spawning components.

Most herring fisheries deploy gear that is deployed clear of the seabed. The impact of gravel extraction on the conservation and productivity of herring is still unclear, and there are virtually no studies to provide evidence at present (ICES 2005/ACFM:18). The limited evidence available at present records no incidences of cetacean mortality due to pelagic trawling (0 catches observed out of 218 pelagic hauls by commercial trawlers from 1999-2004). There are also very few other by-catches of fish, beyond the targeted fisheries of herring, mackerel, horse mackerel and blue whiting.

No specific environmental signals were identified specifically by WGRED (CM 2006/LRC:03) to be considered in assessment or management of herring and sprat in this area in 2006.

1.8.2 Celtic Seas

The western herring stocks assessed by HAWG are found in the Celtic Seas (Celtic Sea, Irish Sea, Malin/Hebridean Shelf). There is less information on the hydrographic variability and ecosystem dynamics in the Celtic Seas. WGRED appeared to concentrate on the Celtic Sea, and this is reflected below:

In the Celtic Sea, in terms of hydrographic variability, the Irish Shelf Front, that occurs to the south and west of Ireland (at about 11°W) around the 150m isobath, and exists year-round, is an important feature for the structure of the marine ecosystem in the area. The turbulence caused by the front may bring nutrients from deeper water to the surface where it promotes the growth of phytoplankton, especially diatoms in spring, but also dinoflagellates where there is increased stratification. These may in-turn be fed on by swarms of zooplankton and associated with these, aggregations of fish, like herring and sprat (Reid et al. 2003).

The WGRED report (ICES 2006/ACE:03) suggests that there are indications of steadily warming in the area over recent years. Similar trends appear for salinity (ICES 2006/ACE:03). Considering that Celtic Sea herring is the second most southerly population of herring exploited in Europe, and this is an area of warming sea surface water, sea warming could affect the recruitment of this pelagic species.

Variation of zooplankton abundance and species composition might affect feeding conditions and mortality of juveniles and adults of both herring and sprat. Zooplankton monitoring data are available from one station in waters about 50 m deep in the English Channel. These data exhibited a decreasing trend from 1988 to 1995 but a recovery thereafter. This recovery was mainly due to two autumn developing small species of copepod, *Euterpina* sp. and *Oncaea* sp. In 1999 there was a decline in the zooplankton population, with the top ten species all below their typical average values (apart from *Temora* and *Corycaeus*, which exhibited very little variation) (ICES 2006/ACE:03). In 2000, 2001 and 2002 zooplankton population abundance experienced a recovery reaching values comparable to those after 1995 (reported in ICES Zooplankton Monitoring Status Summary 2001/2002). Data for 2004 and 2005 were not yet available.

WGRED considered that in the Celtic Sea key pelagic species here is herring as well as sardine, in the southern area, and sprat, in the Celtic Sea proper. The area also accommodates considerable stocks of argentines (two species) and large numbers of small mesopelagic myctophids along the shelf break (ICES 2006/ACE:03).

Despite recent evidence from WESTHER and HERGEN that there is little genetic differentiation between herring stocks, their phenotypic characteristics and population dynamics are different. A comparison of the relative trends in surplus production indicates that after the collapses due to overfishing in the 1970s, the Celtic Sea shows a very different pattern compared to both the west of Scotland and the Irish Sea stock (ICES 2006/ACE:03). The Celtic Sea stock appears to have been more dynamic in terms of surplus production (biomass available to fish) than the stocks further to the north.

No obvious environmental signals were identified by WGRED that should be considered in assessment or management of herring and sprat in this area. However, the major trends in the ecosystem noted above (i.e. the steady warming of the area and the reduction of copepod abundance) could play a major role to shape the dynamic of herring and sprat stocks in the near future (ICES 2006/ACE:03).

1.9 Pelagic Regional Advisory Council [Pelagic RAC]

Members of HAWG have attended meetings of the pelagic RAC since its inauguration in 2005. HAWG considers the views of the Pelagic RAC as important, and welcomes the formation of the forum to give stakeholders a role in the advisory process. HAWG notes that the Pelagic RAC also has special members from outside the EU, notably from Norway.

Prior to HAWG 2006, the chair of HAWG approached the Pelagic RAC to ask if any specific concerns about herring were of great worry to the RAC at present. The emailed response from Mr Rob Banning (RAC secretary) pointed to the poor communication of the advice on IIIa herring and worries in the RAC about the poor recruitment of North Sea herring. HAWG noted these worries, and whilst answering its terms of reference from ACFM, it took the RAC's comments into consideration.

1.10 Stock overview

At HAWG, a total of eight herring stocks and three sprat stocks are considered in the area south of 62°N. Analytical assessment could be carried out for three of these eleven stocks. The stock of the North Sea autumn spawning herring was analysed as a benchmark assessment. Results of the assessments are presented in the subsequent sections of the report and are summarized below and in Figures 1.10.1 - 1.10.3.

North Sea autumn spawning herring is the largest stock assessed by this WG. It has experienced very low spawning stock biomass levels in the late 1970s when the fishery was closed for a number of years. This stock began to recover until the mid-1990s, when it appeared to decrease again rapidly. A management scheme was adopted to halt this decline. Following a period of good recruitment co-occurring with the new management measures, SSB and the proportion of older fish in the stock increased. This gave the opportunity to increase TACs and catch. In recent years, F on the adults has been just below F_{pa} and fishing mortality on the juveniles has been low. Both the 1998 and the 2000 year classes were strong. However the 2004 year class is estimated to be among the weakest in the time-series, as were the 2002 and 2003 year classes. Due to the current unusual circumstances of a clearly identified sequence of four poor recruiting year classes of North Sea herring it is particularly important that the potential decline of this stock is addressed with sufficient determination to ensure the safety of the spawning stock in the next few years.

Western Baltic Spring Spawners (WBSS) is the only spring spawning stock assessed within this WG. It is distributed in the eastern part of the North Sea, the Skagerrak, the Kattegat and the Sub-Divisions 22, 23 and 24. Within the northern area, the stock mixes with North Sea autumn spawners. An analytical assessment demonstrates that SSB has been slightly increasing or stable over a number of years. The age structure in the catch over the last three years consistently reflects that the large 1999 year class is now part of the spawning stock. The 2003 year class seems to be above average.

Celtic Sea herring: The herring fisheries to the south of Ireland in the Celtic Sea and in Division VIIj have been considered to exploit the same stock. For the purpose of stock assessment and management, these areas have been combined since 1982. The fishery in the eastern part of the Celtic Sea was closed in the early eighties due to poor recruitment. Stock assessments have become unstable in the recent past due to fluctuations in recruitment, for which there is no independent measure. In 2006 no final assessment could be produced. SSB and F cannot be precisely estimated, although it is likely that the SSB is between B_{PA} and B_{LIM}. Indications from recruitment in the catch suggests that recruitment in 2003 (year-class 2001) may be the lowest in the series. Current fishing mortality is very uncertain and may be very high.

West of Scotland herring can currently be regarded as lightly exploited and with two good year classes the stock is at a relatively high level compared to last 30 years. Earlier data indicate the possibility of larger stock in the 1960s. The stock experienced a heavy fishery in the mid-70s following closure of the North Sea fishery. The fishery was closed before the stock collapsed. It was opened again along with the North Sea. In the mid 1990s there was substantial area misreporting of catch into this area and sampling of catch deteriorated.

Recently the area misreporting has reduced to a very low level and information on catch has improved, but in 2004 and 2005 misreporting increased again.

In this year's assessment uncertainties surrounding the reduced catch and survey estimates were regarded and it was decided to explore assessment outcomes with the 2005 survey both included and excluded in the assessment runs. The outcome of the assessment this year confirms earlier perceptions of a lightly exploited stock (F<=0.2). However, the assessment of the current biomass is very uncertain. The changes seen here are unusually dramatic for a stock that is still perceived as lightly exploited. The Working Group was unable to choose between the two assessment options with confidence. However, these assessments may be used to conclude that F is low but further investigation is required regarding the current SSB.

Herring in VIa south and VIIbc are considered to consist of a mixture of autumn- and winter/spring-spawning fish. The winter/spring-spawning component is distributed in the northern part of the area. The main decline in the overall stock since 1998 appears to have taken place on the autumn-spawning component, and this is particularly evident on the traditional spawning grounds in VIIb. The current levels of SSB and F are not precisely known, as there is no tuned assessment available for this stock. The results of a tentative assessment suggest that the sharp decline in SSB may have stopped and that the SSB may have stabilised at a low level. The current levels of SSb and F are not precisely known, but F appears to have been reduced due to the reduction in catch.

Irish Sea autumn spawning herring as comprises of two spawning groups (Manx and Mourne). This stock complex experienced a very low biomass level in the late 1970s with an increase in the mid-1980s after the introduction of quotas. The stock then declined from the late 1980s to its present level. During this time period the contribution of the Mourne spawning component has declined. In the past decade there have been problems in assessing the stock. It seems likely that the stock has been relatively stable for the last 10 years, and that the fishing mortality does not appear to be increasing above the recent average.

North Sea Sprat is the only sprat stock on which an assessment is carried out within this WG. Sprat in the North Sea is a short-lived species. The recruits account for a large proportion of the stock, and the fishery in a given year is very dependent on that year's incoming year class. The size of the stock has been variable with a large biomass in the early 90's followed by a sharp decline. The sprat stock now shows signs of being in good condition. The 1st quarter 2006 IBTS estimate of the 2005 year class indicate that this year class is the lowest estimate since the 1995 year class and far below long time mean.

1.11 Structure of the report

The report below, further details in each chapter the available information on the catch, fisheries and biology of the stocks and then the stock assessments, the projections, the quality of the assessments and management considerations for each stock. This information and analysis are given in chapters for each of the seven major stocks considered by HAWG. Despite this structure, it is important to realise that there are many links between the stocks and/or areas (e.g. North Sea and herring caught in IIIa, VIaN herring and the North Sea, Celtic Sea and Irish Sea herring).

HAWG has adopted the ICES recommended procedure of benchmark and update assessments. In 2006 HAWG carried out one benchmark assessment: North Sea autumn spawning herring. VIaN herring, western Baltic spring spawning herring and North Sea sprat were all update assessments in 2006. VIaS, Celtic Sea, Irish Sea herring and IIIa sprat were all exploratory assessments. Two stocks, with very poor data (no catch at age sampling) and no current ongoing research are described in chapter 10. These are Clyde herring and sprat in the English Channel.

1.12 Recommendations

Please see Annex 2.

Table 1.5.1: Available disaggregated data for the HAWG per March 2006. X: Multiple spreadsheets (usually xls); W: WG-data national input spreadsheets (xls); D: Disfad inputs and Alloc-outputs (ascii/txt)

Stock	Catchyear	Format X	W	D	Comments
Baltic Sea: IIIa and SD 22-24					
her_3a22	1991-2000	X			raw data, provided by Jørgen Dalskov, Mar. 2001, splitting revised
	1998	X			provided by Jørgen Dalskov, Mar. 2001, splitting revised
	1999	X			provided by Jørgen Dalskov, Mar. 2001, splitting revised, catch data revise
	2000	X			provided by Jørgen Dalskov, Mar. 2001
	2001	X			provided by Jørgen Dalskov, Mar. 2002
	2002	X			provided by Jørgen Dalskov, Mar. 2003
	2003	X			provided by Jørgen Dalskov, Mar. 2004
	2004	X			provided by Lotte Worsøe Clausen, Mar. 2005
	2005	X			provided by Lotte Worsøe Clausen, Mar. 2006
Celtic Sea and VIIj					
her_irls	1999	X			provided by Ciarán Kelly, Mar. 2000
	2000	X			provided by Ciarán Kelly, Mar. 2001
	2001			D	provided by Ciarán Kelly, Mar. 2002
	2002			D	provided by Ciarán Kelly, Mar. 2003
	2003			D	provided by Maurice Clarke, Mar. 2004
	2004			D	provided by Maurice Clarke, Mar. 2005
	2005			D	provided by Maurice Clarke, Mar. 2006
Clyde					
her_clyd	1999	X			provided by Mark Dickey-Collas, Mar. 2000
	2000-2003				included in VIaN
Irish Sea					
her_nirs	1988-2003	X			updated by SG HICS, March 2004
	1998	X			provided by Mark Dickey-Collas, Mar. 2000
	1999	X			provided by Mark Dickey-Collas, Mar. 2000
	2000	X	W		provided by Mark Dickey-Collas, Mar. 2001
	2001	X			provided by Mark Dickey-Collas, Mar. 2002
	2002	X			provided by Richard Nash, Mar. 2003
	2003	X			provided by Richard Nash, Mar. 2004
	2004	X			provided by Beatriz Roel, Mar. 2005
	2005	X			provided by Steven Beggs, Mar. 2005
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	W	D	provided by Yves Verin, Feb. 2001, updated by SG Rednose, Oct 2003
	1996	(X)	W	D	provided by Yves Verin, Feb. 2001, updated by SG Rednose, Oct 2003
	1997	(X)	W	D	provided by Yves Verin, Feb. 2001, updated by SG Rednose, Oct 2003
	1998	(X)	W	D	provided by Yves Verin, Mar. 2000, updated by SG Rednose, Oct 2003
	1999		W	D	provided by Christopher Zimmermann, Mar. 2000, updated by SG Rednos
	2000		W	D	provided by Christopher Zimmermann, Mar. 2001, updated by SG Rednos
	2001		W	D	provided by Christopher Zimmermann, Mar. 2002
	2002		W	D	provided by Christopher Zimmermann, Mar. 2003
	2003		W	D	provided by Christopher Zimmermann, Mar. 2004
	2004		W	D	provided by Christopher Zimmermann, Mar. 2005
	2005		W	D	provided by Christopher Zimmermann, Mar. 2006
West of Scotland (VIa(N))					
her_vian	1957-1972	x			provided by John Simmonds, Mar. 2004
	1997	X			provided by Ken Patterson, Mar. 2002
	1998	X			provided by Ken Patterson, Mar. 2002
	1999		W	D	provided by Paul Fernandes, Mar. 2000, W included in North Sea
	2000		W	D	provided by Emma Hatfield, Mar. 2001, W included in North Sea
	2001		W	D	provided by Emma Hatfield, Mar. 2002, W included in North Sea
	2002		W	D	provided by Emma Hatfield, Mar. 2003, W included in North Sea
	2003		W	D	provided by Emma Hatfield, Mar. 2004, W included in North Sea
	2004		W	D	provided by John Simmonds, Mar. 2005, W included in North Sea
	2005		W	D	provided by Emma Hatfield, Mar. 2006, W included in North Sea
West of Ireland					
her_irlw	1999	X	(W)		provided by Ciaran Kelly, Mar. 2000
	2000	X	(W)		provided by Ciaran Kelly, Mar. 2001
	2001			D	provided by Ciaran Kelly, Mar. 2002
	2002			D	provided by Ciaran Kelly, Mar. 2003
	2003			D	provided by Maurice Clarke, Mar. 2004
	2004			D	provided by Maurice Clarke, Mar. 2005
	2005			D	provided by Afra Egan, Mar. 2006
Sprat in IIIa					
spr_kask	1999	X	(W)		provided by Else Torstensen, Mar. 2000
	2000	X	(W)		provided by Else Torstensen, Mar. 2001
	2001	X	(W)		provided by Lotte Askgaard Worsøe, Mar. 2002
	2002	X	(W)		provided by Lotte Worsøe Clausen, Mar. 2003
	2003	X	(W)		provided by Lotte Worsøe Clausen, Mar. 2004
	2004	X	(W)		provided by Lotte Worsøe Clausen, Mar. 2005
	2005	X	(W)		provided by Lotte Worsøe Clausen, Mar. 2006
Sprat in the North Sea					
spr_nsea	1999	X	(W)		provided by Else Torstensen, Mar. 2000
	2000	X	(W)		provided by Else Torstensen, Mar. 2001
	2001	X	(W)		provided by Lotte Askgaard Worsøe, Mar. 2002
	2002	X	(W)		provided by Lotte Worsøe Clausen, Mar. 2003
	2003	X	(W)		provided by Lotte Worsøe Clausen, Mar. 2004
	2004	X	(W)		provided by Lotte Worsøe Clausen, Mar. 2005
	2005	X	(W)		provided by Lotte Worsøe Clausen, Mar. 2006
Sprat in VIId & e					
spr_ech	1999	X	(W)		provided by Else Torstensen, Mar. 2000
	2000	X	(W)		provided by Else Torstensen, Mar. 2001
	2001	X	(W)		provided by Lotte Askgaard Worsøe, Mar. 2002
	2002	X	(W)		provided by Lotte Worsøe Clausen, Mar. 2003
	2003	X	(W)		provided by Lotte Worsøe Clausen, Mar. 2004
	2004	X	(W)		provided by Lotte Worsøe Clausen, Mar. 2005
	2005	X	(W)		provided by Lotte Worsøe Clausen, Mar. 2006
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 samplir
UK/Scotland	1990-1998		W		provided by Sandy Robb/Emma Hatfield, Mar. 2002

Table 1.7.1: **Sampling of the pelagic fleet by country, quarter and area for the North Sea (area IV) and area VIId. No. trip = number of trips. Total hauls = total number of hauls sampled. Herring hauls = total number of hauls sampled with herring catches (landings and/or discards) on a discard observer trip.**

COUNTRY	QUARTER	AREA	NO. TRIPS	TOTAL HAULS	HERRING HAULS
Germany	1	IVa	1	18	4
Scotland	1	IVa	9	26	4
Germany	2	IVa	1	10	10
Netherlands	2	IVa	-	52	52
Germany	3	IVa	1	16	16
Netherlands	3	IVa	-	19	19
Scotland	3	IVa	13	33	33
Germany	3	IVb	1	24	24
Germany	4	VIId	1	?	30
Netherlands	4	VIId	-	50	48

*** this table is based on the information available at the HAWG. It should not be regarded as a complete list of all biological samples taken in the pelagic fleet. The samples taken by The Netherlands are obtained from 11 trips.**

Table 1.7.2 **Sampling of the pelagic fleet by country, quarter and area for the remaining areas covered by the national sampling programmes within HAWG. No. trip = number of trips. Total hauls = total number of hauls sampled. Herring hauls = total number of hauls sampled with herring catches (landings and/or discards) on a discard observer trip.**

COUNTRY	QUARTER	AREA	NO. TRIPS	TOTAL HAULS	HERRING HAULS
Germany	1	VIa	1	3	0
Netherlands	2	VIa	-	37	0
Netherlands	4	VIa	-	13	4
Netherlands	1	VIIb	-	17	0
Netherlands	3	VIIb	-	6	1
Netherlands	4	VIIb	-	2	1
Netherlands	1	VIIc	-	44	0
Netherlands	4	VIIe	-	2	0
Netherlands	1	VIIh	-	3	0
Netherlands	4	VIIh	-	34	0
Germany	1	VIIj	1	8	0
Netherlands	1	VIIj	-	25	0
Netherlands	3	VIIj	-	3	0

*** this table is based on the information available at the HAWG. It should not be regarded as a complete list of all biological samples taken in the pelagic fleet. The samples taken by The Netherlands are obtained from 11 trips.**

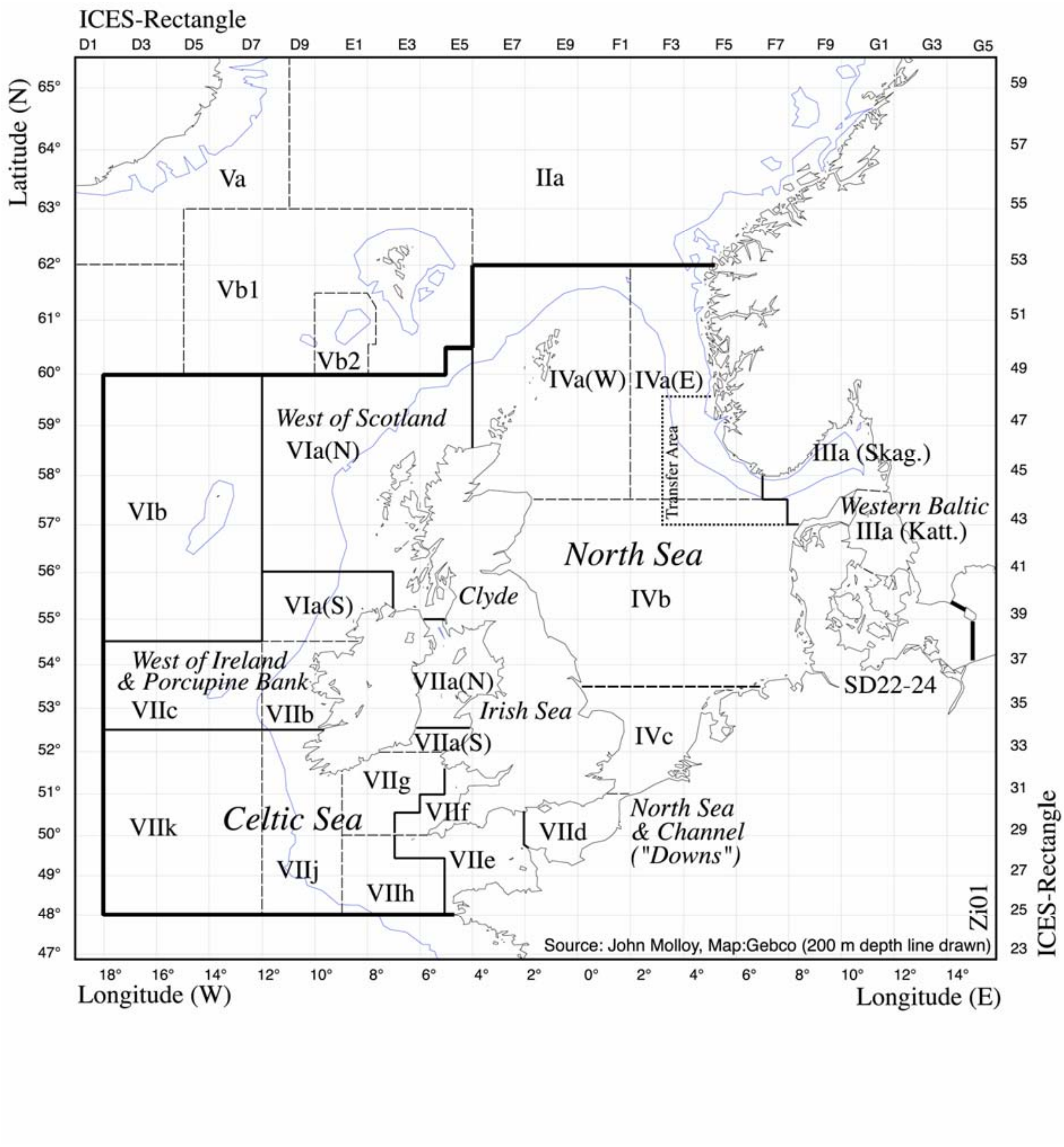


Figure 1.5.1: ICES areas as used for the assessment of herring stocks south of 62°N. Area names in italics indicate the area separation applied to the commercial catch and sampling data kept in long term storage. "Transfer area" refers to the transfer of Western Baltic Spring Spawners caught in the North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

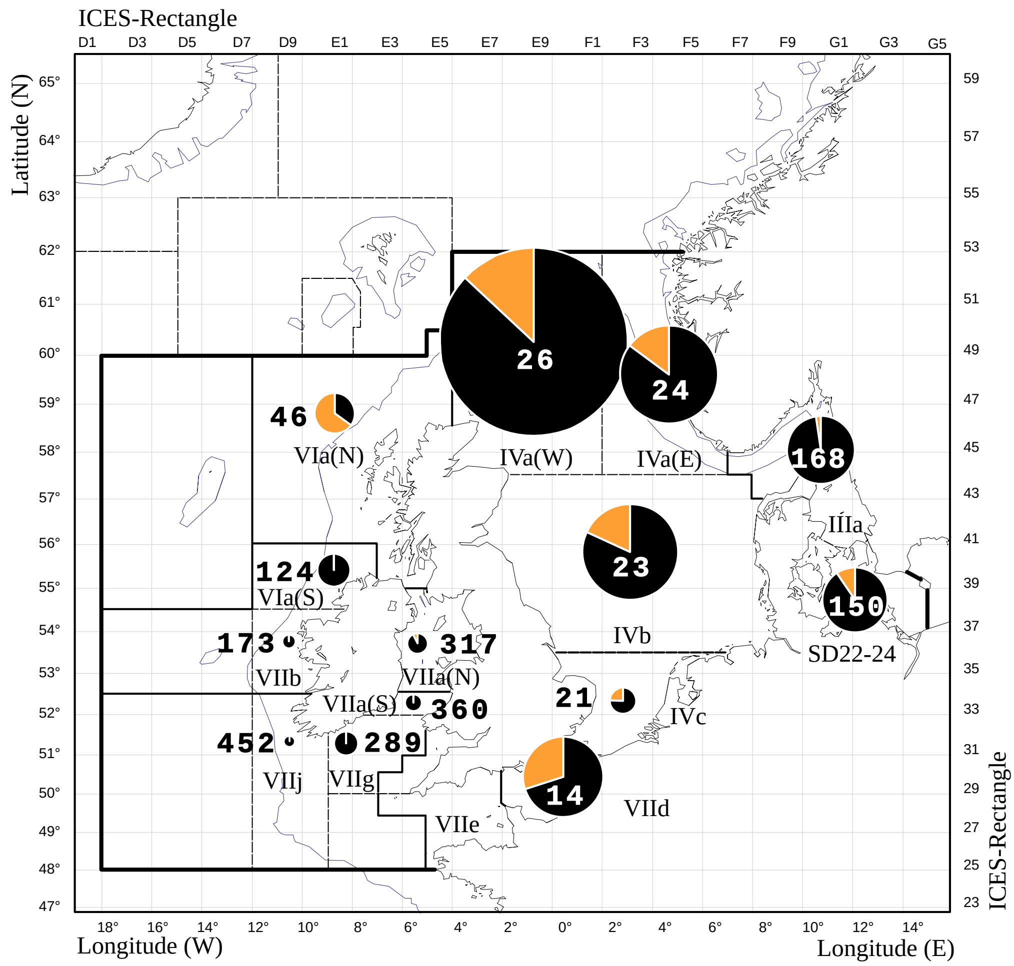


Figure 1.5.2: Herring south of 62°N: Sampling level per ICES areas for the whole year and all fleets in 2005. Circle diameter is proportional to working group catch; share of sampled catch (black) is indicated. Numbers give the numbers of age readings per 1000 t catch. For the allocation of areas to stocks, see Fig. 1.5.1

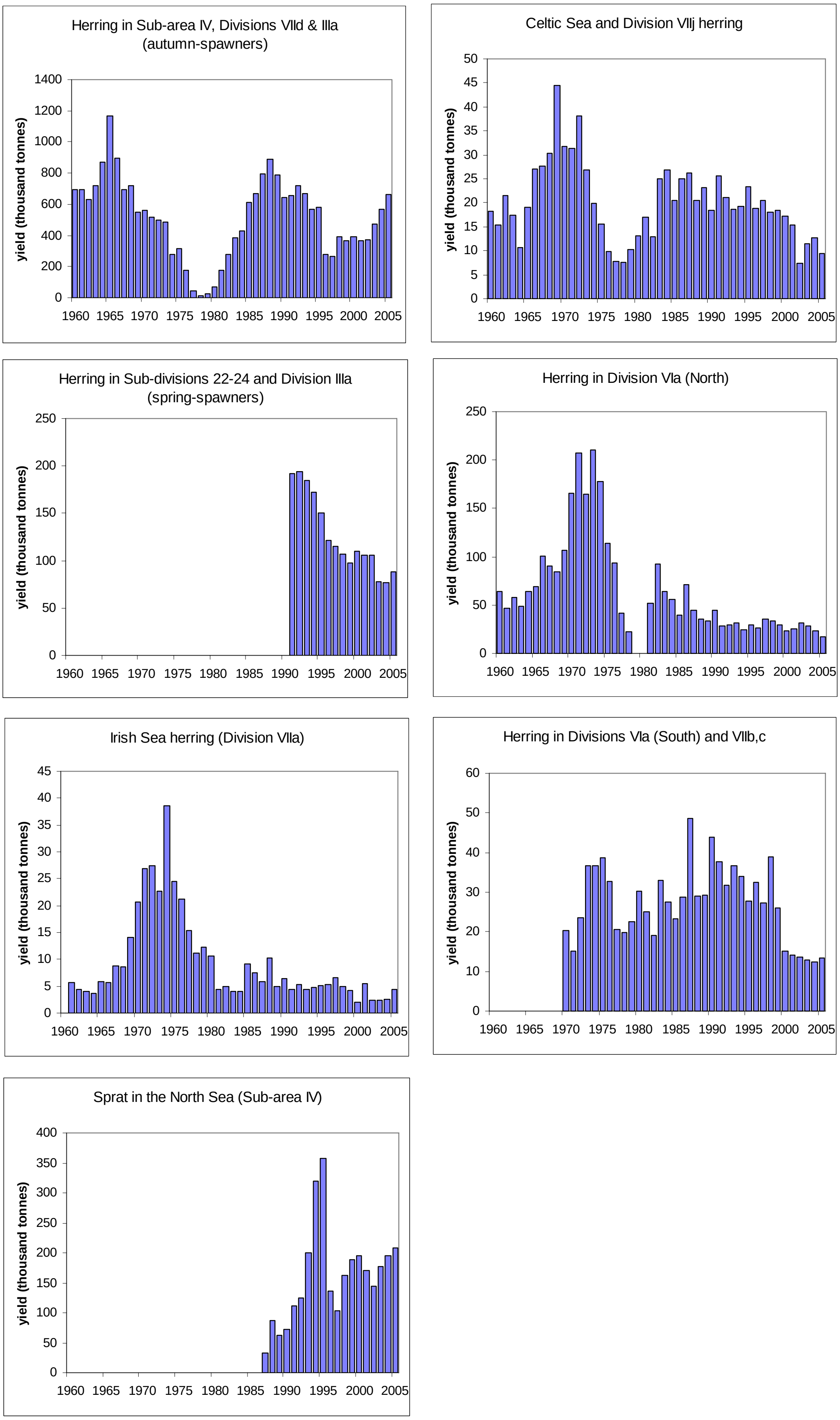


Figure 1.10.1 WG estimates of catch (yield) of the stocks presented in HAWG 2006.

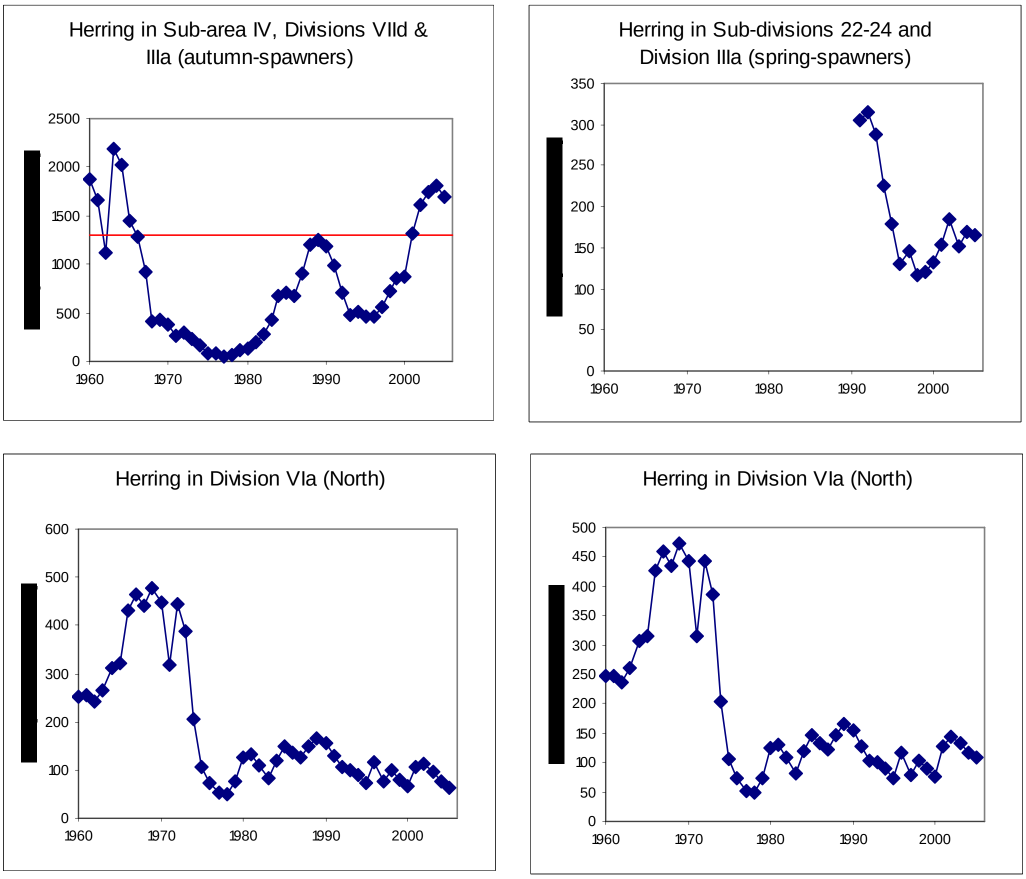


Figure 1.10.2: Spawning stock biomass estimates of the 4 stocks for which analytical assessments were presented in HAWG 2006. The B_{pa} level (if defined) is indicated in the graphs. Note that the SSB of herring Division VIa (North) is given in two different figures: Acoustic survey included (left lower panel) and acoustic survey excluded (right lower panel).

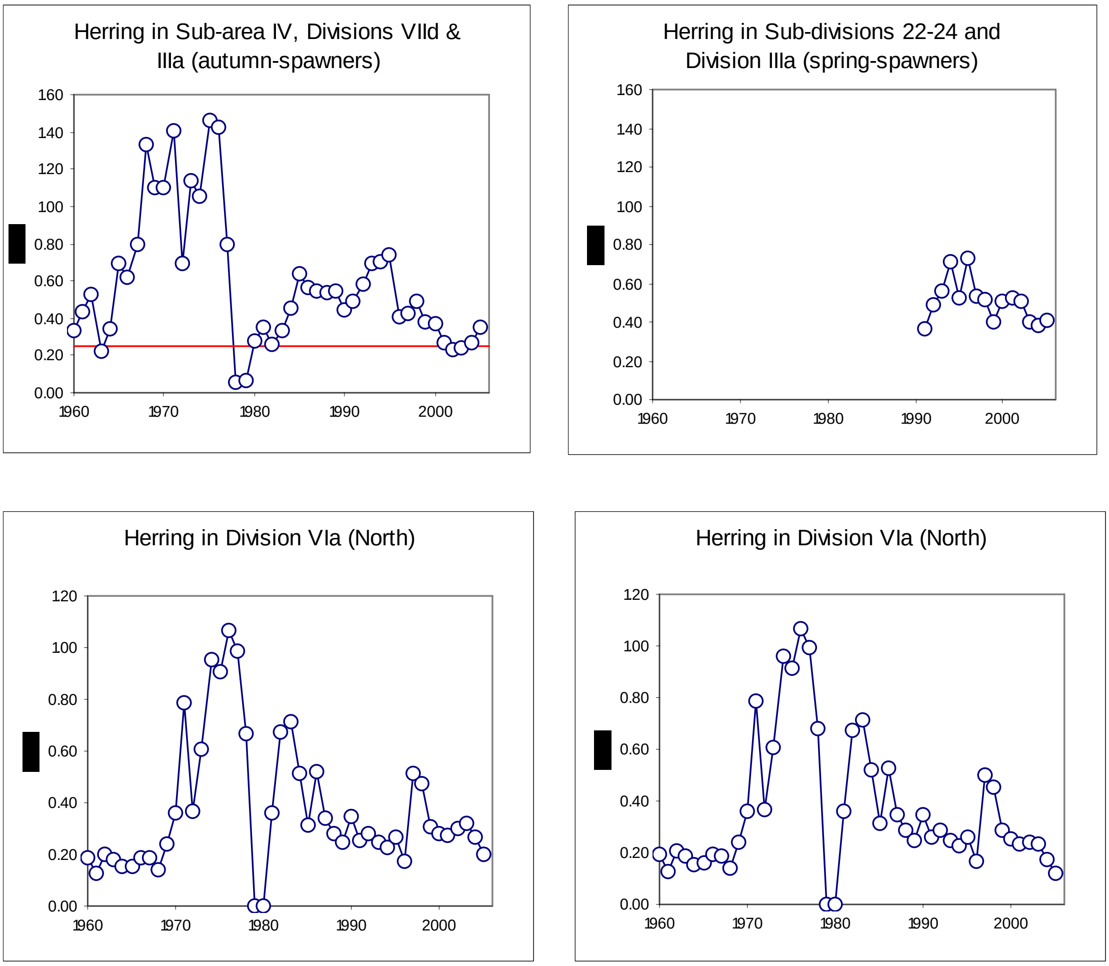


Figure 1.10.3 Estimates of mean F of the 4 stocks for which analytical assessments were presented in HAWG 2006. The F_{pa} level (if defined) is indicated in the graphs. Note that the F for herring in Division VIa (North) is given in two different figures: Acoustic survey included (left lower panel) and acoustic survey excluded (right lower panel)

2 North Sea Herring

2.1 The Fishery

2.1.1 ACFM advice and management applicable to 2005 and 2006

According to the management scheme agreed between the EU and Norway, adopted in December 1997 and last amended in November 2004, efforts should be made to maintain the SSB of North Sea Autumn Spawning herring above 800 000 tonnes. An SSB reference point of 1.3 million has been set (=$\mathbf{B}_{pa}$) 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, the fishing mortality will have to be linearly reduced. A TAC deviation of more than 15% between two subsequent years should be avoided, however, the TAC might be reduced by more than 15% if the parties consider this appropriate. The full management agreement is given in section 2.12 below.

Since 2002, the SSB is considered to have been above $\mathbf{B}_{pa}$. From then on, ACFM gave fleetwise catch option tables for fishing mortalities within the constraints of the EU-Norway management scheme. The advice for a sub-TAC on catches in IVc and VIId for 2004 was that it should not increase faster than the TAC for the North Sea as a whole. ACFM thought that a share of 11% on the total North Sea TAC (average share 1989-2002) would be an appropriate guide to distributing the harvesting of Downs herring.

It was expected that fishing at the recommended level would lead to a further increase in the SSB in the short term, mainly due to large recruiting year classes entering the fishery. ACFM considered in 2005 that there were three recruiting year classes (2002, 2003, and 2004) that were all well below average. This is unusual and ACFM recommended that managers should take this into account when implementing the harvest control rule as there is an increased risk that the stock may fall below the 1.3 mill. tonnes in the medium-term if the rule of 15% constraint on TAC variation is applied.

The final TAC adopted by the management bodies for 2005 was 535 000 t for Area IV and Division VIId, whereof not more than 74 293 t should be caught in Division IVc and VIId. For 2006, the TAC was reduced by 15% (following the constraints of the harvest control rule) to 454 751 t and the sub-TAC set for Division IVc and VIId was reduced to 50 023 t.

Catches of herring in the Thames estuary are not included in the TAC. The by-catch ceiling set for fleet B in the North Sea was 50 000 t for 2005 and was decreased by 15% to 42 500 t for 2006. As North Sea autumn spawners are also caught in Division IIIa, regulations for the fleets operating in this area have to be taken into account for the management of the stock (see Section 3). For a definition of the different fleets harvesting North Sea herring see the stock annex and Section 2.7.2.

Following the apparent recovery of the autumn spawning North Sea herring, some regulatory measures were amended in 2004: The total Norwegian quota and half of the EU quota for Division IIIa could be taken in the North Sea. A licence scheme introduced in 1997 by UK/Scotland to reduce misreporting between the North Sea and VIaN was relaxed. The minimal amount of target species in the EU industrial fisheries in IIIa has been reduced to 60 % (for sprat, blue whiting and Norway pout). In 2005, for Division IIIa, Norway could only take half of its quota in the North Sea, and there is no flexibility for EU vessels. These amendments will be kept for 2006.

2.1.2 Catches in 2005

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

The catch figures in Tables 2.1.1 - 2.1.5 are mostly provided by WG members and may or may not reflect national catch statistics. These figures can therefore **not** be used for legal purposes. For corrections applied to and inconsistencies in previous year's data see Section 2.2.3. Denmark and Norway provided information on by-catches of herring in the industrial fishery. These are taken in the small-meshed fishery (B-fleet) under an EU quota by Denmark and are included in the A-fleet figures for Norway. Catch estimates of herring taken as by-catch by other small-mesh fisheries in the North Sea may be an underestimate. The total catch in 2005 as used by the Working Group amounted to 638 900 t.

In 2004, the catches of herring caught in the human consumption fishery in the North Sea overshot the TAC by 77 000 t. For 2005, the TAC was raised by 16 %. Catches also increased by 16%, so the excess over TAC amounted to 83 000 t in the most recent year. By area, catches decreased in Division IVa (East) by about 16 % and in IVb by 4 %. Catches increased in IVa (West) by 40 % and by 8 % in the southern North Sea (Division IVc and VIId). As the sub-TAC for the latter area was raised by 12 %, the total catch in this area now appears to be in good agreement with the TAC.

Landings of herring taken as by-catch in the Danish small-meshed fishery in the North Sea have increased by 60 % to 21 800 t as compared to last year (Table 2.1.6). This occurred in spite of the reduced numbers of juvenile herring in the area, and was mostly caused by significantly increased sprat catches, and a shift of effort from the sandeel- and Norway pout fisheries to sprat fisheries. However, these industrial herring catches were much lower than the by-catch ceiling set for Denmark (50 000 t). In 2005, the Danish sprat fishery was carried out throughout the year with by-catches of herring of about 9 % (21 035 t; by-catch 2004: 5%). Herring by-catches in the Danish sandeel fishery were less than 0.5 % and 0.8 % in industrial fisheries targeting other fish. In the Norwegian industrial fishery, herring by-catch has decreased from 4 984 t last year by 80 % to 998 t, mostly due to the closure of the Norway pout fishery. The quarterly distribution of herring by-catches in the Norwegian industrial fishery and its relative share on the total industrial landings are given in the text table below. These figures are counted against the human consumption quota.

QUARTER 1	QUARTER 2	QUARTER 3	QUARTER 4	TOTAL
148 t	329 t	96 t	425 t	998 t
7.0 %	0.7 %	0.3 %	2.6 %	1.0 %

Misreporting of landings taken in the North Sea but reported from other areas such IIa and IIIa, and from VIaN has increased by almost 80 % in 2005 compared to 2004 (from 31 000 t to 56 000 t). The estimates of the total amount of misreported (including within-area misreporting) and unallocated catches have increased to about 79 000 t (roughly 13 % of the total landings from the North Sea - 626 100 t). This is also an increase compared to 2004 (57 000 t, 11 % of the total landings of 533 100 t).

Based on WG estimates of total catch, TACs for the human consumption fishery in Subarea IV and Division VIId have been greatly exceeded for several years. This appears to have continued in 2005, when the over catch of TAC amounted to 83 000 t (compared to 77 000 t in 2004). In the past, the largest relative discrepancies between officially reported landings and WG catch occurred in Division IVc and VIId, where TACs were exceeded by almost 100 %

between 1996 and 2001 (when the sub-TAC was set to 25 000 t). This has apparently changed since 2004, when the over-catch of TAC in the southern North Sea and the Eastern Channel was reduced to only 4 %. Following the increase of the sub-TAC, the Downs catch met the TAC in 2005. The excess catch is now taken in IVa and IVb.

The total North Sea TAC excess for the years 1995 to 2005 is shown in the table below (adapted from Table 2.1.6). Since the introduction of yearly by-catch ceilings in 1996, these ceilings have never been exceeded.

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
TAC HC (‘000 t)	440	156	159	254	265	265	265	265	400	460	535
“Official” landings HC (‘000 t)[1]	443	170	162	253	275	267	275	282	414	484	547
Working Group catch HC (‘000 t)	449	196	226	324	318	328	303	331	438	537	617
Excess of landings over TAC HC (‘000 t)	9	40	67	70	53	63	38	66	38	77	83
By-catch ceiling (‘000 t) [3]		44	24	22	30	36	36	36	52	38	50
Reported by-catches (‘000 t) [4]	67	38	13	14	15	18	20	22	12	14	22
Working Group catch North Sea (‘000 t)	516	233	238	338	333	346	323	353	450	550	639

HC = human consumption fishery

[1] “Official” landings might be provided by WG members; they do not in all cases correspond to official catches and cannot be used for management purposes. Norwegian by-catches included in this figure.

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

[3] by-catch ceiling for EU industrial fleets only, Norwegian by-catches included in the HC figure.

[4] provided by Denmark only.

2.2 Biological composition of the catch

Biological information (numbers, weight, length, catch (SOP) at age and relative age composition) on the catch as obtained by sampling of commercial catches is given for the whole year and per quarter in Tables 2.2.1 to 2.2.5. Except in cases where the necessary data are missing, data are displayed separately for herring caught in the North Sea (including a minor amount of Western Baltic spring spawners taken in IVa East), IVa East (total; Western Baltic spring spawners [WBSS] only – see Section 2.2.2; North Sea autumn spawners only), IVa West, IVb, VIId/IVc as well as for North Sea autumn spawners (NSAS) caught in Division IIIa, and the total NSAS stock, including catches in Division IIIa.

Biological information on the NSAS caught in Division IIIa was obtained using splitting procedures described in Sec. 3.2 and in the stock annex 3. Note that splitting was only applied to the working group catch, following the correction of area misreporting.

The total catches of NSAS (SOP figures), mean weights and numbers-at-age by fleet are given in Table 2.2.6. Data on catch numbers-at-age and SOP catches are shown for the period 1991-2005 in Tables 2.2.7 (herring caught in the North Sea), 2.2.8 (WBSS taken in the North Sea, see below), 2.2.9 (NSAS caught in Division IIIa) and 2.2.10 (total numbers of NSAS). Mean weights-at-age are given for 1995-2005 separately for the different Divisions where NSAS are caught (Tab. 2.2.11). Note that SOP catch estimates may deviate in some instances slightly from the working group catch used for the assessment.

2.2.1 Catch in numbers-at-age

The total number of herring taken in the North Sea and the total number of NSAS have increased by 18 % (to 4.7 billion fish) and by 21 % (to 5.2 billion fish), respectively, as compared to last year. 0- and 1-ringers contributed 33 % of the total catch in numbers of NSAS in 2005 (Table 2.2.7). 0- and 1-ringer catch has increased by 50 % and 200 %, respectively, as compared to 2004. Figure 2.2.1 shows the relative proportions of the total catch numbers for different periods (1960-2005 and 1980-2005 for the total area, 2005 for different Divisions). While two thirds of the catch in the southern North Sea consisted of the strong 2000 year-class in 2004, this fraction was reduced to little more than 50% in 2005. Likewise, the share of the strong 1998 year-class in northern and central North Sea catch (2004: 20 %) was reduced to 12 % in 2005. The proportion of the 2000 year-class has now increased to 26 % in the northern catch.

The following table summarises the total catch in tonnes of North Sea autumn spawners. To arrive at the total catch of NSAS, splitting of the catch into NSAS and Western Baltic Spring Spawners has to be done in Divisions IIIa and IVaE. NSAS from IIIa are then added, and WBSS from the North Sea subtracted from the total NSAS catch figure. The final total catch used for the assessment of NSAS in 2005 was 664 000 tonnes:

AREA	ALLOCATED	UNALLOCATED	DISCARDS	TOTAL
IVa West	318 787	39 324	10 861	368 972
IVa East	99 934	-	-	99 934
IVb	83 541	10 233	1 963	95 737
IVc/VIId	66 051	8 231	-	74 282
	Total catch in the North Sea			638 926
	Autumn Spawners caught in Division IIIa (SOP)			31 927
	Baltic Spring Spawners caught in the North Sea (SOP)			-7 039
	Other Spring Spawners			-74
	Total Catch NSAS used for the assessment			**663 740**

"Other spring spawners" are 74 t of Blackwater herring caught under a separate quota and included in the catch figure for England & Wales. This year no spring spawners were reported from the commercial catch taken in other areas of the Western North Sea (see Sect. 2.2. below).

2.2.2 Spring-spawning herring in the North Sea

Norwegian Spring-spawners and local fjord-type spring spawning herring are taken in Division IVa (East) close to the Norwegian coast under a separate TAC. These catches are not included in the Norwegian North Sea catch figures given in Tables 2.1.1 to 2.1.6, but are listed separately in the respective catch tables. The amount of these catches varied significantly between less than 417 t in 2005 and 55 000 t in 1997. Coastal Spring Spawners in the southern North Sea (e.g. Thames estuary) are caught in small quantities (usually less than 100 t) regulated by a local TAC. The Netherlands reported increasing catches of Spring Spawners in the Western Part of the North Sea in recent years, which were included in the national catch figures and subtracted from the total catch used for the assessment of NSAS. This and last year no spring spawners were reported from routine sampling of commercial catch taken in the west.

Western Baltic and local Division IIIa Spring-spawners (WBSS) are taken in the eastern North Sea during the summer feeding migration (see stock annex 3 and section 3.2.2). 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 1991-2005.

The method of separating these fish, using vertebral counts as described in former reports of this Working Group (ICES 1991/ACFM:15) is given in Sec. 3 and in stock annex 3. For herring 2-ringers, 3-ringers, and 4+-ringers caught in the 2nd quarter, mean vertebral counts in the transfer area (see Fig. 1.5.1) were used. Samples from the Norwegian catches that have been taken in May and June 2005 were used for the second quarter (Figure 2.2.2). For 1-ringers in the 2nd quarter it was assumed that all fish were autumn spawners. For the 3rd quarter no Norwegian or Danish samples were available from commercial landings, and instead the proportions from samples taken during the July Danish acoustic survey in this area (based on otolith micro-increment analysis) were applied. The source for the splitting in the 4th quarter were again micro-increment analysis from Danish commercial samples. The resulting proportion of spring spawners and the quarterly catches of these in the transfer area in 2005 were as follows:

QUARTER	1-RINGERS (%)	2-RINGERS (%)	3-RINGERS (%)	4+-RINGERS (%)	CATCH IN THE TRANSFER AREA (T)	CATCH OF WBSS IN THE NORTH SEA (T)
Q 2	0%	9%	52%	12%	13 320	2 752
Q 3	100%	100%	100%	100%	4 282	4 282
Q 4	80%	100%	0%	0%	4 926	4
total					22 528	7 039

The quarterly age distribution and mean weight-at-age in sub-division IVa East was applied to the catches of the second, third, and fourth quarter in the transfer area. The numbers of spring spawners by age were obtained by applying the estimated proportion by age.

2.2.3 Data revisions

The last major data revision to the North Sea herring dataset was applied in 2004, specifically following the work of the Study Group on the Revision of Data for North Sea Herring (SG Rednose, ICES 2003/ACFM:10), and a revision of the splitting between NSAS and WBSS in Division IIIa. Splitting data is still not completely reworked for the earlier period and NSAS assessment data could therefore not be updated for 1991 to 1995.

No data revisions were made this year.

2.2.4 Quality of catch and biological data, discards

As in previous years, some nations provided information on misreported and unallocated catches of herring in the North Sea and adjacent areas. Catches made in Division IVa were mainly misreported to Division VIa, IIIa and IIa, but misreporting also occurred from IIIa to IVa, within Area IV, and from Division VIId to IVb. The **Working Group catch**, which includes estimates of discards and misreported or unallocated catches (see Section 1.5), was estimated to exceed the official catch by more than 12 %. It is likely that this figure is an underestimate as it only includes information from a fraction of the fleets fishing herring in the North Sea, as an analysis conducted in 2002 indicated (ICES 2002/ACFM:12). This corroborates suggestions of the Study Group for Herring Assessment Procedures (ICES 2001/ACFM:22), that a important uncertainty of the total catch figure exists since the re-opening of the fishery in 1980.

Discards. Prior to 1998, there was little information available on herring discards in the pelagic fisheries in the North Sea. Observer sampling programs since 1999 suggested that discarding in these fisheries were less than 5 %. In 2002 for the first time, onboard sampling by two nations observed increased discards of herring in the mackerel fishery in the 3rd and 4th quarter in Division IVa (W). At this time, the quotas for herring were already taken and herring occurred in mixed schools with mackerel. The discard figure finally used for the assessment was 17 000 t. If the same raising scheme would have been used for all fleets involved, discards would have been as high as 50 000 t. However, the behaviour of other than the sampled fleets is uncertain. For 2003, the herring TAC was increased by 50%, and at the same time the mackerel TAC was reduced by more than 5 %. Sampling of the same fleets in 2003 showed a reduced level of discarding, as was anticipated. Discards again occurred mainly in the mackerel fishery in the 1st and 4th quarter, and to less extent as slippage in the directed herring fishery in the 3rd quarter. The discard figure used in the assessment for 2003 was 4 125 t, based on the raised figure for one sampled fleet. In 2004, herring quotas were again increased and mackerel quotas markedly decreased. In spite of this, discarding reported from three fleets increased again to 17 049 t. Reasons for discarding were again the removal of unwanted by-catch in the mackerel fishery in IVa in the 4th quarter (11 000 t), and for the first time there were indications for high-grading in the summer fishery in the central North Sea. The same three fleets have been sampled in 2005: discards occurred again in the mackerel fishery (mostly in the 1st quarter), and in the directed herring fishery in summer in IVa and IVb. In contrast to last year, no high-grading was detected, but the limited processing capacity on smaller vessels was the likely reason for discarding (fish not processed during the day was pumped overboard; WD 4). Again, onboard sampling of other vessels in a similar fleet observed much less discarding (see Section 1.7). The final figure for discards in 2005 as used in the assessment was 12 824 t, based on the raised discards for two fleets. As discards are likely to occur in all nation's fisheries, this figure is certainly an underestimate. Discard data has not been consistently available for the whole time series and was only included in the assessment when reported.

In general, **sampling of commercial landings** for age, length and weight is comparable to last year (Table 2.2.12). The European Union implemented a new sampling regime in 2002, obliging member states to meet specified overall sampling levels. This year, 95 % of the catch was sampled (2004: 94 %), but the number of age readings has decreased by 17 %. It should be observed that "sampled catch" in Table 2.2.12 refers to the proportion of the reported catch to which sampling was applied. This figure is limited to 100 % but might in fact exceed the official landings due to sampling of discards, unallocated and misreported catches.

However, more important than a sufficient overall sampling level is an appropriate spread of sampling effort over the different metiers (each combination of fleet/nation/area and quarter). Of 102 different *reported* metiers, only 39 were sampled in 2005 (39 %; as in 2004). Some of them, however, yielded very little catch. The recommended sampling level of more than 1 sample per 1 000 t catch has been met only for 14 metiers (2004: 29). For age readings (recommended level >25 fish aged per 1 000 t catch) this is also worse: only 17 metiers appear to be sampled sufficiently (2004: 26). The catch of France, UK/England and Wales, Sweden, UK/Northern Ireland, the Faroe Islands, Russia, Poland and Belgium from the North Sea (combined share 14 % of the total North Sea catch) has not been sampled. Information on catches landed abroad was again not available or could not be used. While it is known that by-catches of herring in other than the directed human consumption fisheries occur, most countries have not implemented a sampling scheme for monitoring these fisheries.

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

2.3 Fishery Independent Information

2.3.1 Acoustic Surveys in VIa(N) and the North Sea in July 2004

Five surveys were carried out in the North Sea during late June and July 2005 covering most of the continental shelf north of 51° 30'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, Swedish, German and Dutch coasts. The western edge is bounded by the UK coast and by the shelf edge at approximately 200 m depth. The individual surveys and the survey methods are given in the report of the Planning Group for Herring surveys (ICES 2006/LRC:04). The vessels, areas and dates of cruises are given below and in Figure 2.3.1.1:

VESSEL	PERIOD	AREA	
Johan Hjort(NOR)	04 July – 27 Jul	56°30'- 62° N, 2° - 6° E	
Scotia (SCO)	28 June – 18 July	57° - 62° N, 2/4° W - 2°E	
Tridens (NED)	28 June – 23 July	53°30' – 58°30' N, Eng/ Sco to Den/Ger coasts	
Solea (GER)	28 June – 19 July	52° - 56°30' N, Eng to Den/Ger coasts	
Dana (DEN)	29 June – 12 July	Kattegat north of 56° + Skagerrak and North Sea north of 56°30' N, east of 6° E	

The data has been combined to provide an overall estimate. Estimates of numbers-at-age, maturity ogive 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 have been combined and the estimate of the stock surveyed is shown in Tables 2.3.1.1-3 by ICES subarea for North Sea autumn spawning herring.

Combined Acoustic Survey Results:

The estimates of North Sea autumn spawning herring SSB are reasonably consistent with previous years, at 1.9 million tonnes and 9,600 millions herring (Table 2.3.1.4). The survey again shows two well above average year classes of herring (1998 and 2000). Growth of the 2000 year class seems still to be slower than average, individuals of this year class are smaller and lighter than the 1998 year class at the same age. In 2005, 96% of this year class are mature at age 4 compared to 65% when this year class was age 3wr. Previous year classes were 100% mature at age 4 wr. This reduced maturation is thought to be a year class effect as the fraction mature for younger year classes 2 and 3 wr herring of 76% and 97% respectively is typical for these ages.

The survey again shows two well above average year classes of herring (the 1998 and 2000 year classes) in the North Sea, which is consistent with the observation of these large year classes observed in the MIK and IBTS surveys and the acoustic survey last year (ICES 2005). The 2005 estimate of the 2000 year class in the North Sea suggests it is 1.3 times higher than the 1998 year class at age 4wr, which is comparable with previous estimates. 2001 is observed as close to the long term mean with the 2002 and 2003 year classes estimated as the lowest in the time series. These estimates are comparable with earlier estimates of these year classes in this and other surveys.

The numbers and biomass of adult autumn spawning herring can be seen in Figures 2.3.1.2, the numbers at 1, 2 and 3+ rings in Figure 2.3.1.3. The spatial distribution of mean weight at 1 and 2 ring, and fraction mature at 2 and 3 ring are given in Figure 2.3.1.4. These show a considerable spatial trend which is observed each year, with more larger mature fish found in the North and less smaller mature fish found in the south and particularly the eastern north Sea. The relative spatial distributions of adult and juvenile autumn spawning herring can be seen in Figures 2.3.1.5 and 2.3.1.6 respectively. The distribution of adults fairly is typical but with a small southerly shift. The distribution of juveniles within the North Sea is also typical but the low levels of juvenile Autumn spawners in the Skagerrak and Kattegat is unusual.

2.3.2 Larvae surveys

In 2005/06 The Netherlands and Germany carried out larvae surveys and managed to cover six out of ten areas. The survey effort is comparable to previous years. The areas and time periods (including numbers of samples, vessel-days in sampling and area coverage) are given in Table 2.3.2.1 and Table 2.3.2.2. The spatial extent of the surveys is shown in Figures 2.3.2.1 – 2.3.2.6. The historical background of the larvae surveys and the methods used for abundance calculation are described in the handbook for quality control (Appendix 2). A more detailed description is available in the manual for the international herring larvae surveys in the North Sea (ICES CM 2006/LRC: 04).

In the **Orkney/Shetlands** area a large spatial extension of newly hatched larvae and high larvae aggregations can be observed eastwards and northwards of the Orkneys (Fig. 2.3.2.1). The overall abundance varies greatly between years, and is approximately half of last year's estimate and 25% of the historical high value observed in 2001 (Table 2.3.2.3).

In the **Buchan** area (Fig. 2.3.2.2) larval distribution is concentrating on only a few stations. The abundance estimate for the second half of September is only 1/3 of last years estimate (Tab. 2.3.2.3).

Abundance estimates in the **central North Sea** are comparable to last year and yield relatively high records (Fig. 2.3.2.3, Tab. 2.3.2.3).

Abundance estimates from the three surveys in the **southern North Sea** result in a high index value, but have a negative trend in the two most recent years (Tab. 2.3.2.3). The peak of the spawning activity has shifted towards middle and end of January. Larvae are almost exclusively found in subdivision VIId, while the impact of the part in IVc is nearly negligible this year (Fig. 2.3.2.4-6).

An overview of the historic trends for a collection of sampling areas and periods is given in Figure 2.3.2.7.

The model for the Multiplicative Larval Abundance Index (MLAI) was fitted to abundances of larvae less than 10 mm in length (11 mm for SNS) (Table 2.3.2.3). The analysis of variance and the parameter estimates are given in Table 2.3.2.4. The updated MLAI time-series is shown in Table 2.3.2.5. The estimated trend in spawning stock biomass from this model fit is plotted in Figure 2.3.2.8 along with the SSB values obtained from the ICA runs of the Herring Assessment Working Group (ICES 2005/ACFM:16).

Both the LAI per unit as well as the MLAI from the larvae surveys in period 2005/2006 indicate that the SSB has decreased considerably when compared to last years WG estimate (Tab. 2.3.2.5).

2.3.3 International Bottom Trawl Survey (IBTS)

The International Bottom Trawl Survey (IBTS) started out as a young herring fish survey in 1966 with the objective of obtaining annual recruitment indices (abundance of 1-ringers in 1st quarter) for the combined North Sea herring stock. It has been carried out every year since, and presently the survey provides recruitment indices not only for herring, but for roundfish species as well. Examinations of the catch of adult herring during the 1st quarter IBTS have shown that this catch also indicates abundances of 2-5+ herring. Also during IBTS 1st quarter, herring larvae are sampled during the night by small, fine-meshed nets. From 1977 to 1991 the gear was a small mid-water trawl (IKMT), but due to poor catchability of this gear, the standard gear was changed to a 2 metre ring net (MIK), used since the 1991 sampling. The total abundance of herring larvae in the survey area is used as an estimate of 0-ringer abundance of the stock. Hence, a series of herring abundance indices (0-5+ ringers) are available from the IBTS programme.

2.3.3.1 Indices of 2-5+ ringer herring abundances

Fishing gear and survey practices were standardised from 1983, and the series of 2-5+ ringer abundance estimates from 1983 onwards has shown the most consistent results in assessments of these age groups. This series is subsequently used in North Sea herring assessment. Note that the abundances in Division IIIa are not included in the 2-5+ ringer indices. Table 2.3.3.1 shows the time-series of abundance estimates of 2-5+ ringers from the 1st quarter IBTS for the period 1983-2006, while Table 2.3.3.2 contains area-disaggregated information on the IBTS indices for year 2006.

2.3.3.2 Index of 1-ringer recruitment

The 1-ringer index of recruitment is based on trawl catches in the entire survey area. Indices are available for year classes 1977 to 2004 (Table 2.3.3.3). This years estimate of the 2004 year class strength (920) indicates a very low recruitment, among the lowest on record.

Figure 2.3.3.1 illustrates the spatial distribution of 1-ringers as estimated by the trawling in February 2004, 2005 and 2006. In 2006 the main concentrations of 1-ringers were found in the south-eastern part of the North Sea, as it was also observed during the preceding two years. The 1-ringers are, however, distributed more offshore in 2006. Their mean length in the areas of peak abundance is in the order of 14 cm (Figure 2.3.3.2.).

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

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

About 14% of this years group of 1-ringers is smaller than 13 cm. These are almost exclusively found in the North Sea area (Table 2.3.3.3)

2.3.3.3 The MIK index of 0-ringer recruitment

This years 0-ringer index is based on 636 depth-integrated hauls with a 2 metre ring-net (the MIK). Index values are calculated as described in the WG report of 1996 (ICES 1996/ACFM:10). The series of estimates is shown in Table 2.3.3.4, the new index value of 0-ringer abundance of the 2005 year class is estimated at 83.1.

This estimate is relatively low (63% of average for yea classes 1983-2004) however, it indicates some increase in recruitment compared to the last three year classes, 2002-2004. The 0-ringers were distributed westerly and southerly in the North Sea with highest concentrations in the south-western areas. Compared to the preceding year class, which is also shown in Figure 2.3.3.3, the 0-ringers of this year class are distributed in a more restricted area with outstanding high concentrations along the English coast. This marked westerly distribution is also apparent from Figure 2.3.3.4, which illustrates the changes in absolute and relative abundance of 0-ringers in the western part of the North Sea. The relative abundance is given as the number of 0-ringers in the area west of 2°E relative to the total number of 0-ringers in the given year class. Since the year class 1982, when the relative abundance was 25%, a general increase has been seen for the western part. In the last decade, the majority of 0-ringers has been distributed in this area, and the calculated relative abundance of 70% for the present year class is in accordance with the long term trend.

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

2.4.1 Mean weights-at-age

The mean weights-at-age of fish in the catches in 2005 (weighted by the numbers caught) are presented by ICES Division and by quarter in Table 2.2.2. Table 2.4.1.1 shows the historic mean weights-at-age (wr) in the North Sea stock during the 3rd quarter in Divisions IV and IIIa for the period 1995 to 2005. These values were obtained from the acoustic survey. The data for 2005 are taken from Table 2.3.1.4. In this quarter most fish are approaching their peak weights just prior to spawning. The spatial distribution of mean weight for 1 and 2-ringers is given in Figure 2.3.1.4. The spatial variability of mean weight is considerable but not unusual. For comparison the mean weights-in-the-catch from the last ten years are also shown in Table 2.4.1.1 (from Section 2.2.1 for the 2005 values). For 5-ringers and older the mean weights for 2005 in the catch are close to the long-term mean and for the acoustic survey a little lower. These estimates are typical for this time series. For 4-ring herring the acoustic survey shows mean weights that are the lowest for the last 10 years supporting the view that the exceptional 2000 year class is growing slowly. This year class, possibly the largest in recent years and the first large one competing with an already large herring stock biomass, has grown more slowly than earlier year classes. This slower growth, although evident in catch mean weights up to 2004, is not continued in the catch weights in 2005. The reasons for this are not clear but could include higher selection on faster growing fish and/or high-grading in large catches.

2.4.2 Maturity ogive

The percentages of North Sea autumn-spawning herring (at age) that spawned in 2005 were estimated from the July acoustic survey (Table 2.4.2.1). The values were determined from samples of herring from the research vessel catches examined for maturity stage, and raised by the local abundance. All herring at maturity stage between 3 and 6 inclusive (using an 8-stage scale) in June or July were assumed to spawn in the autumn. The method and justification for the use of values derived from a single year’s data was described fully in ICES (1996/ACFM:10). The values for 2- & 3-ringers are taken from the acoustic survey results which are presented in Table 2.3.1.4. For 2-ringers the proportion mature at 76% was typical for this age group. For 3 ring herring the fraction mature (97%) was also typical and much higher than observed last year (65%), the latter reflecting slow growth and maturation of the large 2000 year class. Fraction mature, mean weight and mean length-at-age and by year are shown in Figure 2.4.2.1. Due to the prior knowledge of slow growth the fraction mature in the 2000 year class at age 4-ringer was monitored in the data from the acoustic survey. The results from this survey in Table 2.3.1.4 show a fraction mature at 95%, which confirms that this year class has now finally fully matured with about 1 year of delay.

2.5 Recruitment

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

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

The 0-ringer MIK index predicts the year class strength one year before the information is available from the IBTS 1-ringer estimates. The relationship between year class estimates from the two indices is illustrated in Figure 2.5.1 and described by the fitted linear regression. Last years prediction of a very small 2004 year class was confirmed by this year's IBTS 1-ringer index of the year class. The good correlation between the indices is also evident when comparing the respective trends in indices during the period (Figure 2.5.2).

2.5.2 Trends in recruitment from the assessment

Recruitment is estimated in the ICA-assessment, and in Figure 2.5.3 the trends in 1-ringer recruitment based on 2006 assessment is illustrated. The recruitment declined during the sixties and the seventies, followed by a marked increase in the early eighties. After the strong 1985 year class recruitment declined again until the strong year classes 1998-2001. However, the 1-ringer recruitments of the recent 2002-2004 year classes are very low, and while MIK index of 0-ringer recruitment for the present year indicates an increasing recruitment size of the 2005 year class, this foreseen to be below average. The present ICA estimates of 1-ringer recruitment are 7.7 and 7.6 no10^9 for year classes 2003 and 2004 respectively, while the estimates for 0-ringers are 21.9, 21.8 and 27.0 no 10^9 for year classes 2003, 2004 and 2005 respectively.

2.6 Assessment of North Sea herring (Benchmark)

2.6.1 Introduction

To carry out a benchmark the WG used the data and expertise available to the group. The evaluation followed six main strands:

- Exploration of catch data through catch curves
- Exploration of survey data based assessments using SURBA
- Exploration of simpler models using CSA
- Exploration of standard catch at age assessment models
- Exploration of time inconsistencies, outliers and time trends in indices.
- Exploration of retrospective performance of the different models.

The HAWG receives three of the four major indices and the catch at age data a few days into the meeting because the surveys are completed in January and February and catch data has to wait until the end of the previous year and takes some time to process and to split between Autumn and Spring spawning populations. In consequence a substantial proportion of the exploration was limited to the 2005 WG data. As this is a benchmark assessment, sensitivity to the last year of data should not be an issue so this is not regarded as a problem for the WG. The updated data are used in the final assessment.

The criteria used to judge the results of these explorations was to select data sets with a model and settings that gave consistent performance when evaluated retrospectively over time and provided low variability in the terminal year estimates of F2-6, SSB and recruitment. Within the current benchmark assessment the WG decided not to investigate the variability or trends in natural mortality, the effects of gross catch misreporting, or year effects in the surveys.

The sections below describe the work carried out under each topic and Section 2.6.11 provides a synthesis of the finding and gives overall conclusions.

2.6.2 Exploration of log catch ratios

Comparing the ratios between consecutive ages within each year class of the log catch numbers (log catch ratios) to the log abundance ratios from the acoustic survey (Figure 2.6.2.1) show a declining trend in the log catch ratio, while the ratios for the acoustic survey are relatively stable. For the IBTS there is a downwards trend in log abundance ratios for ages 2-3, but not for ages 1-2 or 3-4 (Table 2.6.2.1). In the log catch ratios the downwards trend for the younger ages can be caused by a shift in the selection towards lower exploitation. The reason for the discrepancy between the log catch ratios and the acoustic survey ratios for the older ages, and the differences in the trends at different ages in the IBTS survey are less clear. Assuming that the selection in the fishery at older age is independent of age, these discrepancies represent conflicts between the mortality signal in the catch and in the survey data.

2.6.3 Exploration of survey data by correlations and modelling with SURBA

2.6.3.1 Correlations at age in the survey data

The main time-series of survey data were inspected for correlations:-

a) along cohorts within surveys correlation (N_{ya} $N_{y+1,a+1}$)

b) between survey correlation (Acoustic $_{y\,a}$, IBTS $_{y\,a}$)

c) between surveys and assessments (excluding recent years)
(Assess $_{y\,a}$, Acoustic $_{y\,a}$, IBTS $_{y\,a}$)

The results of the along cohort correlation are given in Table 2.6.3.1 for Acoustic and IBTS surveys. The Acoustic survey shows higher correlation reflecting the relatively reliable appearance of yearclasses in subsequent years. Table 2.6.3.2 shows the correlations between surveys and between surveys and the assessment (excluding the last 4 years in the assessment). These results support the general view that the acoustic survey provides the most self consistent view of numbers at age and the best indication of relative yearclass strength in the assessment.

2.6.3.2 Exploration with SURBA

The performance of the survey data was explored using SURBA (ICES CM2003/D:03; Needle 2004). With SURBA, estimates of the stock indicators are derived from the survey data, independently of the catch data. The weightings and catchabilities for each index were maintained the same as last year. The stock summary from SURBA is presented in Figure 2.6.3.1 and Table 2.6.3.3. The uncertainty of Z in the beginning is quite wide, because during the earliest years data are only available from the MLAI biomass index. The SURBA run had a lower SSB and higher mean $F_{2\text{-}6}$ in the terminal year than the ICA run with same procedure as last year (Figure 2.6.3.2). Retrospectives plots (Figure 2.6.3.3) indicate strong retrospective patterns back in time, probably driven by the differing lengths of the survey time-series. More importantly however, retrospective patterns in recent years are relatively small for SSB and recruitment. Retrospective patterns are visible in mean Z, but a constant tendency of over- or underestimation is not apparent.

2.6.4 Simple model stock assessment with CSA

An exercise using Catch Survey Analysis (Mesnil 2003) was undertaken to explore the results of using a comparatively simple model to assess the state of the stock. In essence, CSA is an assessment method that aims to estimate absolute stock abundance give a time series of catches and relative abundance indices, typically from research surveys. This is done by filtering measurement error in the latter through a simple two-stage population dynamics model known as the Collie-Sissenwine (1983) model. The population dynamics are described by the following model:

$$N_{y+1} = (N_y + R_y)e^{-M} - C_y e^{-M(1-\tau)} \qquad [1]$$

where:

y : time step, typically annual. Years may be defined either on a calendar basis or as the interval between regular surveys. The year range is [1, Y].

Ny : population size, in number, of fully recruited animals at start of year y;

Ry : population size, in number, of recruits at start of year y;

Cy : catch in number during year y (known);

M : instantaneous rate of natural mortality (equal for both stages, assumed);

τ : fraction of the year when the catch is taken, e.g. 0 if the fishing season is early in the year, or 0.5 if the catch is taken midway through the year or, by resemblance with Pope's (1972) cohort approximation, evenly over the year.

Estimating the time series of Ny and Ry given the catches is the basic task of any assessment but, as with other methods, this requires additional information in the form of relative indices ny and ry of abundance for each stage, typically from surveys, which are assumed to be proportional to absolute population sizes Ny and Ry. The indices are deemed to be measured with some (log-normal) observation error:

$$n_y = q_n N_y \exp(\eta_y); y = 1, Y \qquad [2]$$

$$r_y = q_r R_y \exp(\delta_y); y = 1, Y - 1 \qquad [3]$$

where:

qn and qr : catchability coefficients of fully-recruited and recruits, respectively, in the survey, supposed to be constant with time;

η and δ : normally distributed random variables.

A constraint must be imposed whereby the survey catchability of the recruits is some fraction s of that of the fully-recruited:

$$s = q_r / q_n \qquad [4]$$

2.6.4.1 Data for CSA

Data used were the total catch numbers from 1984 to date, the stock weights at ages 0 and 1+, the MIK survey series as index of the number of the 0 group and the acoustic numbers at age 1 and older as an index of the fully recruited ages (Table 2.6.4.1). Natural mortality (M) was derived from mean of the M vector used in the ICA assessment weighted by the stock numbers at age for the period of this analysis and is equal to 0.9.

2.6.4.2 Results for CSA

The model was run assuming that catches take place in the middle of the year. In practice it appears that the catchability ratio s cannot be estimated together with other parameters because it is strongly correlated with q_n in the estimation (Mesnil 2005), the model was run iteratively for a set of values of s until a minimum in the sum of squares was found (Figure 2.6.4.1), s = 0.3 was chosen as a result.

The model estimates for total biomass and the number of recruits are shown in Figures 2.6.4.2 and 3 for the period 1984 - 2005. Both trajectories are in agreement with our current perception of the stock although that does not apply to the early years of the series. This could well be the effect of a change of the exploitation of the young fish in the 1980s compared to now. The industrial fishery was more important then but as CSA aggregates all ages in the catch the signal of year-class strength is only based on the MIK index. A similar effect can be observed in total biomass (Figure 2.6.4.3), total stock biomass, where ICA estimates fall within the 95% confidence intervals in the recent period but not in the early years.

Comparison between the estimated numbers at age scaled by their corresponding catchabilities and the survey indices suggests very good fits to the data (Figure. 2.6.4.4 and 5). However, examination of the log-residuals suggests patterns although the individual residuals are relatively low (Figures. 2.6.4.6 and 7). Sensitivity to the value of natural mortality (M) was explored by running the model for a set of values (Figures 2.6.4.8 and 9) and results show that this parameter scales the stock numbers and the biomass.

Results from the retrospective analysis (Figures 2.6.4.10 and 11) suggest that the addition of new data has resulted in upward revisions of the estimates in recent years although small downward revisions were also observed in the past.

2.6.5 Exploratory stock assessment with FLXSA

An exploratory assessment of North Sea herring has been performed using the Fish Lab in R (FLR) version 0.2 of XSA. The FLR system (www.flr-project.org) is an attempt to implement a framework for modelling fisheries systems and consists of a number of packages for the open source statistical computer program R. The combination of the statistical and graphical tools in R with the stock assessment facilitates exploration of input data and results. Currently XSA and ICA have been incorporated in a package, and the development of other assessment methods like SURBA and ADAPT is ongoing. The FLR version of XSA has been used for North Sea plaice and sole for WGNSSK 2005 (ICES 2005).

The model settings for FLXSA were chosen such that they resemble approximately the ICA model using same procedure as last year. The FLXSA settings in this year’s assessment were kept the same as in last year’s XSA exploratory assessment, using weak shrinkage (2.0) and exclusion of the MLAI (XSA cannot use biomass indices). The stock summary of the exploratory FLXSA is presented in Table 2.6.5.1. The FLXSA assessment is consistent with the ICA assessment (Figure 2.6.5.1) except for the last few years. In the last 3 years FLXSA shows higher estimates of mean F_{2-6} and lower estimates of SSB.

Exploration of different model settings of FLXSA (changing plus-group, shrinkage, Q-age and R-age, Figure 2.6.5.2) showed changes in SSB and F in 1973-1979, caused by the choice of plus-group. However, the choice of plus-group does not greatly affect the stock status in recent years. Variability in recent years due to choice of model settings is larger for SSB compared to mean F. The choice of model settings had some effect on the recruitment in recent years, but no effect in historic period.

Changing the number of surveys used to tune the assessment has however much greater effect on the estimate of stock status than changing the model settings (Figure 2.6.5.3). Using only the Acoustic survey, which covers juvenile and adult ages, showed slightly lower SSB and higher mean F ages 2-6 in the final year. The IBTS and MIK however showed opposite signals with estimating a higher SSB and lower mean F ages 2-6. It is important to keep in mind that the IBTS only includes younger age groups and MIK only 0-ringers.

The XSA assessment that uses the three tuning series together gives results closest to the acoustic survey because the dynamic weighting choses higher weights for this survey

2.6.6 Variability in survey and catch data for catch at age model exploration

The exploration above indicated that the tuning data sources were the dominant factor effecting the terminal values in the assessment. Earlier studies reported in SGEHAP (ICES 2001) indicated that sampling of catch data had much smaller influence on the terminal values in the assessment

Due to the availability of data mentioned in the introduction (Section 2.6.1) generation of bootstrap dataset to evaluate the models was limited to data that could be obtained before the WG and consisted of:

Catch at age 0-9+, 1960 – 2004

MLAI index 1973 - 2004 (including January 2005 survey),

MIK index 1977 – 2005 ; see Figure 2.6.6.2

IBTS survey 1-5 indices, 1983 – 2005; see examples Figure 2.6.6.3

Acoustic survey 1-9 indices, 1989 - 2004, including weights and maturities at age (1 group limited to 1996 - 2004); see examples Figure 2.6.6.4

The spatial distributions of stations and examples of data see are give in Figure 2.6.6.1 to 4. Figures 2.6.6.1a and b show two of the ten annual area and seasonal larvae surveys that are used to give the MLAI index. For a description of the survey time periods and areas and which ones are covered each year see Table 2.3.2.3. Figure 2.6.6.2 shows the MIK 0wr surveys. Figures 2.6.6.3a and b and Figures 2.6.6.4a-c show surveys for 2wr and 4wr by the IBTS and acoustic surveys respectively. Figures 2.6.6.4a and b show the mature and immature components of 2wr herring. (Note in particular the high abundance in 2003 distribution of immature 2wr herring which was slow maturing.

For catch in tonnes the WG catch by year was taken as a fixed value. For the catch at age the variance / covariance of estimates of numbers and weights at age of the internationally assembled data from 1991 to 1998 was evaluated by the project EMAS (EU 98/075 Simmonds et al 2001). Since then there have been no further studies. The variance / covariance from these evaluations has been used to simulate data for all other years.

The general analytical approach used to prepare bootstrap data sets for use in multiple assessments was the substantively the same for all the survey index data sets. Evaluations under EVARES indicated that almost all the variance comes from the variability in catch at age among stations because the sampling of station data for length and for age is sufficiently great that the resulting added variance is negligible. The full procedure is fully documented in (Simmonds et al 2003) and is carried out in three stages:

Stage 1: For each year, and survey, the catch at age was bootstrap resampled with replacement treating each station as an identically independently distributed (IID) sample, this preserves the correlation at age within the data. At this first stage the index to be used was taken as the mean of the station values. 100 replicates of each survey were obtained.

Stage 2: None of the surveys are random survey designs. Each has a strong systematic element to the station layout and the interaction between the station location and spatial autocorrelation could give rise to errors in the estimated variance assuming IID. To test for this and account for it where necessary a geostatistical evaluation of the data was used (Rivoirard et al 2000). Individual years of data give very variable measures of spatial autocorrelation and the results can be unstable. To improve the reliability of the estimates of spatial autocorrelation it was decided to average the results over several years, thus the mean spatial autocorrelation at age for each survey was obtained through the calculation of the mean variogram for all years. An index year and age correction factor for the sampling variance was obtained using the modelled variograms and the spatial distribution of stations through the comparision between the variance of the mean assuming IID and the geostatistical estimation variance. In most cases these correction factors are small.

Stage 3. The series were corrected for small difference between the means of the simulated data sets and the standard indices. The resampling method in stage 1 assumed that all the stations are weighted equally when estimating the index. Normally this is only the case when the survey area is sampled fully. Often stations are missed or coverage is reduced and then the abundance is calculated by raising to statistical rectangle, filling in missing rectangles to generate the standard indices used in the assessment. So the small differences are dealt with by realigning the mean value of each simulated index by year and age with the value normally used in the assessment.

This procedure is used for all the survey data, with two minor differences:

For the acoustic survey data station estimates are replaced by ICES stat rectangle estimates combining trawl and acoustic data at that stage.

For the MLAI index the GLM procedure to combine areas and seasons (Patterson and Beveridge 1998 , Gröger et al 1999) and account for missing data was implemented for each set after the above procedure was completed.

The variances and the simulated data sets created by this process capture most of the sampling variability. The resulting variance is dominated by the underlying variability in the sample data, because herring is inherently distributed in a rather patchy way giving rise to high local variability. By treating all the different sources of data in the same way any aspects of the method that affect give differences between estimated and underlying variance do so to each data set in a similar way. The resulting data sets for the surveys are given in Figures 2.6.6.5 to 2.6.6.8 for the MLAI SSB index, MIK 0 group index, the IBTS 1-5+ index and the Acoustic 1-9+ indices respectively. This method captures sampling variability, other variability that can create year effects in the time-series is not included.

The mean weights in the stock, (Figure 2.6.6.9) and fraction at age mature at ages 2 and 3 (Figure 2.6.6.10) are also derived from the Acoustic survey and are bootstrapped in the same way, preserving correlation between weights, numbers and maturities.

2.6.7 Variance and weighting factors for ICA

In recent NS herring assessments the ICA model was used with user defined weighting factors for the input data series. Since 2001 a fixed set of inverse variance weights for surveys and catch at age have been used. These were derived from the survey and catch data by methods similar to those given above in 2.6.6. (ICES 2001). The variance used is the variance of the natural logarithm of the estimates of the index from the bootstrap procedures. The choice matches the use of a maximum log likelihood method with a lognormal error distribution used within the ICA model. The variance by year and age for the indices are given in Figure 2.6.7.1. The MLAI, MIK Acoustic survey 2-4wr and IBTS 1 wr surveys all have similar variances. The variance increase with age for acoustic survey and to an even greater extent for the IBTS survey.

The estimates at age from the IBTS and Acoustic surveys are not independent, the mean correlation at age is given in Tables 2.6.7.1 and 2.6.7.2. Correlation at old ages in the acoustic survey is particularly strong. The correlation in estimates of catch at age has been similarly checked but does not exhibit similar features probably because the international sampling program contains lots of independent components. ICA does not explicitly deal with covariance (in common with many assessment models) but it does allow modification of weights at age to account for this in a general way. The concept is to reduce the inverse variance factor by an amount that accommodates the covariance. The limits are: for zero correlation a factor of unity; for 100% covariance over n ages weights of 1/n. In both surveys the 1 to 2 group estimates are effectively independent and can be given weighting due to the full inverse variance weight, for subsequent ages the weighting has been implemented here for intermediate values of covariance to give the W_{age} weighting factors at age :-

$$W_{age} = \frac{1}{\mathrm{var}_{age}}\{n - \sum \mathrm{cov}_{age,age-1}\}/\{\mathrm{cov}_{age,age-1}/\sum 1/\mathrm{cov}_{age,age-1}\}$$

Where var_{age} is the variance of ln(estimate at age)

cov is covariance (age, age-1)

n is the number of ages in the correlated sequence

The resulting correlation correction factors are given in Tables 2.6.7.3

The resulting weighting factors are given in Table 2.6.7.4 and can be compared with the old weighting factors derived under SGEHAP (ICES 2001). The major difference is a slight general reduction in survey weights relative to the catch. Among the surveys the resulting spread of weights is generally similar to the earlier values, reducing with age, more steeply with the IBTS than the acoustic. The major difference is the MIK weighting which is reduced to about 1/3 of the previous value. The change is caused by the recent extended analysis. The difference between the previous analysis and this one was that in the earlier work the geostatistical analysis of spatial variance was limited to only a few recent years in each series. This resulted quite accidentally and unknowingly in selecting years from the MIK index that were very precise (see years 1997 to 2000 in Figure 2.6.7.1.

2.6.8 Influence of the data and assessment models settings for FLICA and FLXSA

The influence of the variability in the data on the assessment was evaluated by two methods. In the first, 100 bootstrapped data sets were introduced into the assessment models FLXSA and FLICA. In the second the standard dataset was evaluated in FLICA by removing each value one at a time from the data and evaluating the deviation in the assessment. This work was carried out using the FLR framework, with FLICA(preliminary version 0.1) and FLXSA (version 0.2). These were validated for the particular stock and year range by comparison with the standard version. Subsequent changes to data and models were limited to substitution of data points and small ranges of parameter changes and are thought to be stable. The FLR Framework as used in this WG was a source of both considerable increased flexibility and great frustration. At this stage its use must be regarded as preliminary because updates can crash the system and some functionality does not work, some functions still need validation. Nevertheless the view of the WG is that the FLR direction is a considerable beneficial advance which will ultimately (soon) be a considerable addition to the facilities available for assessment work.

2.6.8.1 Using bootstrap data sets to evaluate the influence of data and model settings

The results for the full FLICA and FLXSA assessments with settings from 2004 (Same Procedure as Last Year: SPALY) are given in Figures 2.6.8.1 and 2.6.8.2. All the results in this section have been carried out using a definition for SSB at 1st of January which should not be confused with the SSB at spawning time which includes the in-year fishery and natural mortality. It was realised late on that the calculation of SSB did not take this mortality into account. The variability due to this will affect the precision of SSB but it is likely that the general conclusions will be the same.

For FLXSA the same evaluations given in section 2.6.2 and Figure 2.6.2.4 are repeated here including the variability in the data. Figure 2.6.8.3 summarises the last 4 years and shows that this range of model setting make very little difference.

For FLICA (and FLXSA) Figure 2.6.8.4 summaries the results of data variability due for various model settings. The first run SPALY uses 2005 settings, runs 2 to 5 show the effect on SSB(1st Jan), mean F ages 2-6 and recruitment age 0 using each of the 5 tuning series separately. The next 4 runs numbers 6 to 9 show 4 small changes to the separable model settings, changing the 5 year separable to 4 and 6 years and changing F at oldest age to 0.9 and 1.1 times the F at reference age. These 8 runs together show that the perceptions of the state of the stock depend mostly on the sources of data and not the separable model settings in FLICA. Run 10 and 11 compare FLICA with the same indices as FLXSA (removing the MLAI as FLXSA cannot accommodate SSB series) showing the SSB is largely independent of the choice of model but that FLXSA gives a different more variable perception of F. Finally run 12 is with the new weights given in Table 2.6.7.4 discussed above in Section 2.6.7

The final year variability from these 12 runs is summarised in Figure 2.6.8.5 and Table 2.6.8.1. From this we can see that the dominant feature is the sources of data and not the model choices, at least within a small range of settings. Variability in the FLXSA assessment due to the variability in the input data exceeds that from FLICA assessments particularly for estimation of F. The most precise assessment is obtained using all the input data and the new weighting factors.

2.6.8.2 Evaluation of the influence of individual data values

The section above concludes that the data are the major source of influence on the assessment. While the variability can be best constrained by using inverse variance weights, the influence of individual data points may have undue influence on an assessment. Each of 390 values of numbers at age in the catch in the separable period or at any time in the tuning indices was individually removed from the FLICA assessment and treated as a missing value. The deviation in the assessment was evaluated and the full range of variability can be seen in Figure 2.6.8.6. This shows that the sensitivity to individual values is very small indeed in only a small number of cases do deviations from the central value occur. The five most influential data observations on the numbers and F at age, the SSB and mean F 2-6 were tabulated in Table 2.6.8.2. The influence is expressed in a standardised way. The general variability in a parameter value was estimated as the standard deviation in that parameter resulting from the sampling variability estimated through the bootstraps. The deviation of the most influential points was then expressed in the table as the signed number of these standard deviations from the central parameter values. The most influential value is not surprisingly the N0 (recruitment) in the final year of the assessment, and even this value is only 3.2 standard deviations from the central point.

Overall the clear conclusion is that there are no individual data observations exerting undue influence on the assessment. Therefore looking for individual residuals is not particularly helpful. Nevertheless it is important to remember that there may be groups of values working together causing much greater influence. Some evidence for this can be seen in residual plots (c.f. Section 2.6.9 Figure 2.6.9.1 and 2). This aspect of conflict in the data is illustrated in the most extreme way by the influence of whole data series.

2.6.9 Analysis of trends in survey time-series

The data in the herring assessment come from several time-series of 17 to 33 years, with 45 years of catch data. There are possibilities that there may be long term differences in consistency due to either creep in survey procedures, or changes in catch area misreporting or under/over reporting. Whatever the cause of such inconsistencies the results would be to make retrospective errors more likely. To explore the possibility of long term trends in the data influencing the assessment, the longer time-series data sets (IBTS, MIK and MLAI) were split into two and fitted separately in the assessment. The non-weighted residuals are shown in Figure 2.6.9.1 illustrating the differences between model and data. The weighted residuals are shown in Figure 2.6.9.2 illustrating the influence of these differences on the model fit. The model fit diagnostics provide model parameter estimates with 95% confidence intervals and standard errors (Table 2.6.9.1)

For those series fitted with a linear model (MIK and IBTS) the precision of the catchability (q) can be used to detect significant differences if they are present.

MIK: Examination of survey procedures suggested that there was potential for different catchabilities before and after 1991, when changes in procedures occurred. Standardisation of the series was done at this time following evidence from gear trials. The analysis with this series taken as two periods showed significant differences in catchabilities between older and later series.

IBTS: The series was split arbitrarily in 1990. In this case there was no significant difference in catchability (q) for the all ages except 1wr. Documentation in the IBTS shows that gear standardisation had occurred fully by 1984. The 1wr index had 5 years of data pre standardisation. Truncation of the IBTS at 1984 removed a series of 5 negative residuals on the first 5 years. Following this truncation the significant difference in catchability (q) of 1wr for the split series was removed.

For the MLAI with a power model, two coefficients are estimated and they are strongly inversely correlated so that significant differences in the coefficients cannot be used to detect differences in the series. Figure 2.6.9.3 shows the estimate of the time-series of the MLAI index by the assessment with one series, or with two. The early part fits rather differently to the points because the high values in recent years are not available for the earlier data. However, the fit of the model to the later series is 6% different from the full series fit which is not thought to be significantly different.

The conclusion was to use data from, and base weighting factors for the data on, the following series and years.

IBTS	years	1984 to 2006

MLAI	years	1973 to 2005
MIK	years	1992 to 2006
Acoustic	years	1989 to 2005

2.6.10 Analytical retrospective performance of assessments

Compared to the majority of stocks assessed by ICES, the retrospective patterns for North Sea herring over the last 5 years are considered good, with low bias and variance (EASE project, unpublished).

Retrospective performance of the runs with the new weight applied to the catch and the surveys was better compared to the SPALY runs for SSB and F ages 2-6 (Figure 2.6.10.1). The bias, which is a measure for the direction of the retrospective pattern, increased slightly in recruitment. With the IBTS and MIK time series truncated, the bias decreased for recruitment and mean F ages 2-6, but variance (measured for the spread) increased compared to the SPALY (Table 2.6.10.1). The value of bias for SSB hardly changed, however the direction of the bias changed for SSB and mean F ages 2-6.

Retrospective analyses of single survey assessments (Figure 2.6.10.2) showed that the bias in SSB and mean F ages 2-6 was lowest when using only the MIK survey and highest when using the MLAI survey. Comparison of SSB with the SPALY retrospective (Figure 2.6.10.2) with the single survey retrospectives showed lower bias in SSB and F ages 2-6 only for the MIK survey. This survey showed however a different perception of SSB and mean F ages 2-6 compared to the SPALY run.

For FLXSA, the bias in SSB was in close agreement with the ICA run with new weights applied and truncated survey time series (Table 2.6.10.1). The bias in F ages 2-6 and recruitment was lower for the FLXSA runs, but for both cases the bias is considered low.

2.6.11 Synthesis and conclusions for the benchmark assessment for North Sea herring

The assessment of NS herring has been evaluated through extensive data exploration and model testing. Initial trials with simpler models and survey only based methods look potentially promising. CSA give quite stable results and good retrospective performance. However, the CSA perception of the stock in the mid-1980s differs from ICA. There are two reasons why this is not surprising for a relatively simple model. Firstly it uses only two tuning indices: the MIK for recruits and an aggregated acoustic survey for the exploited component. Secondly as the model subtracts total numbers caught, any signal in the catch-at-age data would not be detected by the model. SURBA give a similar perception of the recent stock trends to other methods but with extensive variability in retrospectives. These models should be kept in mind and may prove useful if data sources deteriorate. However, they would currently be difficult to use to service the current management agreements. SURBA would give greater year on year variability and CSA would be difficult to use to give the required fleet based advice.

While the benchmark carried out in this year’s working group was quite extensive and it is considered that it provides a basis for future assessments, it did not consider variability or trends in natural mortality, the effects of gross catch misreporting, or year effects in the surveys.

The main conclusions from the benchmark assessment are:

- The assessment of NS herring is a relatively stable

- The assessment is not at all sensitive to small changes in the model settings of ICA or XSA
- The choice of plusgroup does not affect the current perception of the stock and only affects a small part of the historic time-series.
- Individual data points are not perturbing the assessment
- There are indications of trend in the very early IBTS years and in the MIK series and truncated series give slightly improved retrospectives.
- Revised inverse variance weighting factors give a more precise assessment.
- The major issue for the assessment is the way the four tuning series are used. If used individually they give different perceptions of the stock.
- Data sensitivity analysis shows that ICA is less sensitive to data variability and gives much more precise estimate of mean F than XSA
- Analytical retrospectives show almost identical mean square error for ICA and XSA.

The current ICA model still seems to deliver the best method for providing an assessment of the current state of the stock and its exploitation rate.

The following changes are made from assessment run for 2005 WG:-

Truncating the IBTS survey time-series to a new starting date of 1984 when the gear was standardised

Truncating the MIK survey time-series to a start date of 1992 when the gears were standardised.

Changing the weighting factors to the new values which include variance estimates from data in recent years.

2.6.12 Final Assessment for NS herring

The final assessment of North Sea herring was carried out by fitting the integrated catch-at-age model (ICA) with a separable constraint over a five-year period, and truncating the IBTS (1984-2006) and the MIK survey (1992-2006) time series. The model settings are shown in Table 2.6.12.1, the ICA output is presented in Table 2.6.12.2, the stock summary in Table 2.6.12.3 and Figure 2.6.12.1, and model fit and parameter estimates in Table 2.6.12.4 and Figures 2.6.12.2 - 2.6.12.19.

The spawning stock at spawning time in 2005 is estimated at approximately 1.70 million tonnes. The abundance of 0wr fish in 2006 (2005 year class) remains low for the fourth consecutive year. A low recruitment was also observed in the three previous year classes. The strong 1998 and 2000 year classes are still evident in the population, with the 2000 year class at 4wr in 2005 and the 1998 year class at 6wr both being the highest in the time series since 1960. Mean fishing mortality on 2-6wr herring in 2005 is estimated at around 0.35, which is above the management agreement F, while mean F on 0-1wr herring is 0.08. The value of mean F ages 2-6 for 2004 in this year’s assessment is 0.27, which is slightly higher than the value of mean F ages 2-6 from last year’s assessment, which was 0.25.

2.7 Short term projection by fleets.

2.7.1 Method

The procedure and program used (MFSP Skagen; WD to HAWG 2003) was the same as has been used since 2003. For the North Sea herring, managers have agreed to constrain the total outtake at levels of fishing mortalities for ages 0-1 and 2-6, and need options to show the trade-off between fleets within those limits. The MFSP program was developed to cover these needs.

2.7.2 Input data

Fleet Definitions

The current fleet definitions are:

North Sea

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

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

Division IIIa

Fleet C: Directed herring fisheries with purse seiners and trawlers

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

The fleet definitions are the same as last year.

Input Data for Short Term Projections

All the input data for the short term projections are shown in Table 2.7.1, which is the input file for the predictions.

Stock Numbers: For the start of 2006 the stock numbers at age were taken from ICA (ica.n – file)

Recruitment: For 2007 and 2008, the recruitment was set to 23169 million which is the mean of the recruitments of the year classes 2001-2005, as estimated in this year's assessment. This (at 50% of the previous value) is far below the mean recruitment used in previous years. All the year classes from 2001 onwards have been poor. The SGRECVAP, which was set up to have a closer look at the recruitment failure in herring (as well as in Sandeel and Norway pout), concluded that the reduced recruitment is caused by an increased mortality in the first winter. Analysis of the time series of SSB and recruitment data clearly indicates a shift in the recruitment success in 2001. The underlying cause for the change in 2001 is not clear, but there is no evidence to justify an assumption of normal recruitment from 2006 onwards. Consequently, the advice is adopted to the current recruitment regime.

Fishing Mortalities: Selection by fleet at age was calculated by splitting the total fishing mortality in 2005 at each age proportional to the catches by fleets at that age. These fishing mortalities were used for all years in the prediction.

Mean weights in the catch by fleet: The mean weights by fleet for the years 2003 – 2005, excluding the 2000 year class, was used for all year classes except the 2000 year class. For the 2000 year class, the weights at age have so far been about 7% below the average of the surrounding year classes. Assuming that this year class will continue to have reduced weights at age, the weights at age for this year class were reduced by 7 % in the prediction years.

Mean Weights at age in the stock: The smoothed weights at age in the stock for 2005 were used. However, the weights at age were reduced by 7% for the 2000 year class, following the procedure for weights in the catch.

Maturity at age: The average maturity at age for 2003 to 2005, calculated without the 2000 year class, was used (Table 2.6.2.2). The 2000 year class is now fully mature.

Natural Mortality: Unchanged from last year, equal to those assumed in the assessment.

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

2.7.3 Prediction for 2006 and management option tables for 2007

2.7.3.1 Assumptions and Predictions for 2006

After the TACs were increased in 2003, the TAC for the A-fleet has been over-fished by 9 – 16 percent, while the other fleets caught less than half their TAC or by-catch ceiling. Catches in 2006 may be predicted with some confidence. The retrospective error has been low in recent years. It therefore seems most reasonable to use assumed catches to account for the removal in 2006. It is assumed that the TAC of 454 000 tonnes of the A-fleet will be overshoot by 13%, which is the average overshoot since 2003. The by-catch by the B-fleet has increased gradually from 23% to 44% in the same period. For the prediction, it is assumed that the catch by the B-fleet will be the same as in 2005, which implies a further increase in the fraction of the by-catch quota utilised, up to 55%. An increased utilisation of the by-catch quota may be expected due to shortage of sandeel, and closure of the fishery for Norway pout. For the C and D fleet, it was assumed that their catch of North Sea autumn spawning herring would be the same as in 2005. The fishing mortalities resulting from these assumed catches were close to the fishing mortalities by fleet for 2005. Thus the difference between a catch constraint and F status quo constraint is small. The catch constraint assumes a very slightly higher catch and has been used.

2.7.3.2 Management Option Tables for 2006

The EU-Norway agreement on management of North Sea herring was updated in 2004. The revised rule specifies fishing mortalities for juveniles (F_{0-1}) and for adults (F_{2-6}) not to be exceeded, at 0.12 and 0.25 respectively, for the situation where the SSB is above 1.3 million tonnes. In addition, it now has a rule specifying reduced fishing mortalities when the SSB is below 1.3 million tonnes. Moreover, the current agreement has a constraint on year-to-year change of 15% in TAC, but allows for a stronger reduction in TAC if necessary.

With four fleets there are innumerable combinations of fleet-wise fishing mortalities and catches that satisfy the agreed rules.

Since the North Sea autumn spawning (NSAS) stock was rebuilt, the advice has been that the primary limiting factor for the fishery in IIIa should be the concern for the Western Baltic spring spawning (WBSS) stock. Using that as a guideline, and in order to reduce the number of possible options, the options for catches by the fleets C and D were derived from the likely recommended outtake of WBSS. The procedure for obtaining these catch limitations are described in detail in Section 3.10. In brief, the historical fractional distribution of the WBSS catches on IIIa and the other areas is used to translate the total recommended TAC for WBSS into outtake of WBSS in IIIa. Then, the mix of WBSS and NSAS in the IIIa catches is used to derive the outtake of NSAS in IIIa. Assuming a total catch of WBSS of 99 000 tonnes (see Section 3.7) led to a catch of 24 000 tonnes of NSAS herring for the C-fleet and 12 900 tonnes of NSAS herring for the D-fleet by this procedure. Options are shown for these catches. In addition, to give an alternative example, options are shown with 2/3 of these values.

It has become increasingly clear that in previous years, large parts of the catches reported for IIIa were actually taken in the North Sea. For 2004, Norway was allowed to transfer all of its quota in IIIa to IV, while the EC could transfer 50% of its quota. For 2005, Norway could transfer 50% its quota in IIIa to IV, while the EC could not. For 2006, Norway can again transfer 50% of its quota, while EU still can not. Furthermore, the last 4 year classes of NSAS have been weak, implying relatively small amounts of NSAS in IIIa. Therefore, it seems likely that the current fleet behaviour, with relatively small catches of NSAS in IIIa will be continued in the coming years.

The following options for 2007 and 2008 are tabulated:

- Catches as assumed for 2006
- F for the A-fleet and B-fleet reduced to get SSB at 1.3 million tonnes in 2007
- F0-1 = 0.12 and F2-6 = 0.25
- F0-1 = 0.05 and F2-6 = 0.25
- F0-1 = 0.05 and F2-6 = 0.20
- Applying the 15% rule in 2007, which gives catches of 388 000 tonnes for the A-fleet in 2007. Due to limitations in the prediction programme, this catch is also assumed for 2008 when calculating the SSB in 2008.

All predictions are for North Sea autumn spawning herring only.

The results are presented in Table 2.7.2.

2.7.4 Comments on the short-term projections

The outlook for this stock is poorer than in previous years, due to the recent reduction in the recruitment. This has been taken into account in the current prediction, both through the stock numbers at the start of 2006 as derived from the assessment, and by assuming a recruitment in line with what has been experienced the last 4 years.

As a result, maintaining the current catches in 2007 and 2008 will lead to a rapid and continuous decline in the spawning biomass. A drastic reduction in catches, in particular for the A-fleet, is needed to maintain the estimated SSB above Bpa (1.3 million tonnes) in 2006. The impact on the SSB of the catches by the other fleets is mainly on the prospect of recovery of the SSB from 2008 onwards, as these fleets to a large extent exploit juvenile herring.

The present agreement includes a rule to reduce the fishing mortality below 0.25 if the SSB drops below Bpa. It is not clear whether that applies to the SSB estimated for the assessment year, for the intermediate year, or for the prediction year. The SSB estimated for the intermediate year is marginally above Bpa, giving F=0.25 from the rule. SSB is expected to drop below 1.3 million tonnes in the prediction year unless the removals from the stock are reduced markedly. The effect of the rule (a linear reduction in F with SSB below Bpa) would result in only a very small reduction in F below F=0.25 for the prediction year. As the reduction was so small such simulations were not done.

The present agreement also includes a rule to constrain reductions in the TAC to 15%, unless a greater reduction is considered appropriate. Applying this rule for 2007 will bring the SSB far below Bpa (the trigger biomass).

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

It is also worth noticing that the realised $F_{2\text{-}6}$ for many years has exceeded that intended when setting the TACs. If managers wish to avoid exceeding the agreed limits, options with lower F-values may be preferable. Maintaining catches at the present level will bring the stock far below B_{pa}.

The predictions presented here account for the slow growth of the large 2000 year class. There are no indications of reduced growth of the subsequent year classes.

The estimated impact of the juvenile fishery depends on the assumed value for natural mortality. It has not been investigated to what extent changes in natural mortality would affect the current advice, or if indeed such changes are taking place. However, some of the important predator stocks are currently in a poor condition.

2.8 Medium term predictions and HCR simulations

Medium term predictions have been made repeatedly for many years for this stock, to first develop and later evaluate the current management agreement. In all these simulations, a recruitment in line with what has been experienced in the 40 years in the past was assumed. This assumption may now be questioned, given the poor recruitment for 4 consecutive years. Such a prolonged sequence of poor recruitments is unusual for this stock, and would appear as very unlikely in the previous simulations. SGRECVAP has considered variability in the timeseries of recruitment and concluded that at least from a statistical point of view the current situation is different from the past. Although the cause of this poor recruitment is unclear and it is uncertain whether it will continue, management may have to adapt to a lower productivity of the North Sea herring stock.

To inform management under these circumstances medium term predictions assuming low recruitment in the future, in line with what has been experienced for the last 4 years are presented here. This is done to give some guidance to management adaptation to a reduced productivity. A run with normal stochastic recruitment is also included for comparison. In both cases an Ockham based recruitment function is used to simulate recruitment in both situations, with the same biomass point of inflection but lower recruitment at high biomass for the reduced recruitment scenario.

The software used was STPR3, the same as used at the evaluation of HCRs for North Sea herring in June 2004. This is a program for performing 10 years stochastic simulations of the stock and fishery, applying some HCRs. A description can be found i.a. the SGMAS report (ICES 2005, ICES CM 2006 /ACFM:09) and a manual in an EU Norway report on medium term management measures (EU 2004).

2.8.1 Input data:

The program was run with 2 fleets, Fleet 1 corresponds to the A-fleet and Fleet 2 corresponds to fleets B, C and D combined.

Stock numbers in the initial year 2006 and their variances were taken from the current ICA output (ica.n and ica.vc). Covariances were not included.

The stock-recruitment function was the same as used in previous simulations, but with a reduced recruitment. It assumed recruitment of 23169 millions independent of SSB at SSB larger than 800 thousand tonnes, and a linear reduction of the recruitment at lower SSB. The recruitment was drawn from a log-normal distribution with $\sigma = 0.572$, which is the variation in the historic data series.

For weights and maturities historical data were used, by drawing years randomly and using data from that year.

Fleetwise selection at age were equal to those used in the short term prediction (Table 2.7.1)

For the intermediate year, catches by fleets were assumed as in the short term prediction.

Assessment and implementation was assumed to deviate from the true values by a random multiplier with mean 1.0 and CV = 0.1. No bias was assumed, except in Run 3.

2.8.2 Simulation options.

Run 1 Standard HCR: The first set of simulations applied the basic harvest rule agreed by Norway and EU from 2004:

At SSB > 1.3 million tonnes: F0-1 = 0.12 and F2-6 = 0.25

At SSB < 1.3 million tonnes and SSB > 800 000 tonnes:

F0-1 = 0.12 – (0.08*(1300 000 – SSB)/500 000)

F2-6 = 0.25 – (0.15*(1300 000 – SSB)/500 000) 800 000 tonnes:

For SSB < 800 000 tonnes: F0-1 = 0.04 and F2-6 = 0.10

The agreement does not state the year which the SSB refers to. The SSB considered by STPR3 is the SSB in the quota year.

Run 2 – 15% rule: The second set applied the rule to not change the TAC by more than 15% per year. The other parameters were as in the first set.

Run 3 - Overfishing: The third set assumed an overfishing of the derived quotas by 15% . The other parameters were as in run 1, i.e. the rule constraining catch variation was not applied.

For comparison, 3 similar runs were also carried out assuming that the recruitment was normal as used in previous years.

2.8.3 Results

Figure 8.3.1a shows the risk of SSB being below Bpa of 1300 000 tonnes in each of the simulation years. In this figure, the effect of recruitment reverting to the normal pattern from 2007 onwards is also shown for comparison. The deterministic short term prediction indicates an SSB slightly above Bpa. Figure 2.8.1b shows the risk of SSB being below Blim of 800 000 tonnes in each of the simulation years. This risk is considerable if the 15% rule for constraining catch variation is applied, but small in the other cases.

Figures 2.8.2 a-c shows the SSB as median and upper and lower percentiles for the three cases. The median for 2006 is slightly above the deterministic estimate, and the variation due to the assessment uncertainty is small. This leads to a low probability of being below Bpa in the intermediate year 2006. These figures show that if the current harvest rule with F01 = 0.12 and F2-6 = 0.25 is implemented exactly, the SSB can be expected to be in equilibrium in the range of 1.0 to 1.6 million tonnes, with a median slightly below1.2 million tonnes, which is somewhat below the current Bpa of 1.3 million tonnes. If the constraint on year to year variation in annual quotas is applied, the SSB will fall for several years ahead, but recover gradually after that. As noted above, there is a considerable risk that it will even be well below Blim in some of the years. Assuming an overfishing of 15% on average leads towards an equilibrium between 0.9 and 1.5 million tonnes. In all cases, the rule to reduce fishing mortality when the SSB is below 1.3 million tonnes leads to an average F2-6 at about 0.25, in accordance with the equilibrium of 1.3 million tonnes with F2-6 at 0.25.

Figure 2.8.3 shows the risk for SSB < 1.3 million tonnes for a range of F2-6, with a low (0.04) and high (0.12) option for F0-1. In order to avoid the present Bpa with a high probability, the F0-1 will have to be kept low and F2-6 will have to be reduced to about 0.17.

2.8.4 In conclusion:

There is high probability (>60%) of the stock going below Bpa in 2007 and 2008 in all situations

There is a high probability (>60%) of staying below Bpa under the current HCR if recruitment continues at the low level.

There is a significant probability (~20%) of the stock going below Blim if the 15% rule continues to be used after SSB falls below Bpa.

Reducing the fishery on either juveniles or adults can reduce the probability of SSB being below Bpa in 10 years (2017)

Under the current regime only if recruitment returns to normal does the risk to SSB reduce substantially.

2.9 Precautionary Reference Points

In 2003, SGPRP (ICES 2003 ACFM:04) suggested to reduce B_{lim} from the current 800 000 tonnes to about 560 000 tonnes, based on the results of the segmented regression analysis of the stock and recruitment data. Fitting an "Ockham Razor" stock-recruit function with non-linear minimisation of the SSQ of log residuals suggests a break point at 537 000 tonnes. Although it is apparent that the recruitment historically has been at about the same level when the SSB was somewhat below 800 000 tonnes as above, HAWG decided not to propose any revision of the B_{lim} reference points at present for the following reasons:

- There is some doubt as to the validity of the calculation procedure used by the SGPRP
- Currently there is concern that the stock dynamics are changing
- HAWG would prefer to consider all reference points together, rather than revising just B_{lim}.

Most importantly, a downward revision of reference points now would not be helpful in precautionary management of the stock. While the harvest control rule in place for this stock has worked well in the recent past, and apart from B_{lim}, the current reference points are derived from this HCR. The target F in the HCR was adopted by ACFM as F_{pa}, while the trigger point at which F should be reduced below the target is adopted as B_{pa}.

2.10 Quality of the Assessment

The details of the assessment have been discussed in great detail in the benchmark analysis presented in Section 2.6. The important issues on sensitivity of the assessment to sampling variability in the data, options for weighting of indices and model settings for ICA have been examined in section 2.6.8. A small range of model settings do not influence the assessment very much. Sampling errors important but the dominate effect is the different signals in the tuning indices, which is discussed below

2.10.1 Sensitivity to measured maturity

In previous years the measured maturity of the 2000 year class has been a source of variability in the estimates. This year class is now thought to be almost fully mature at age 4wr (95%) and the precision of this measure is quite good with 95% intervals at about ±2.5%. Other maturing year classes show typical levels of maturity. The assessment this year is therefore not particularly sensitive to measurement of maturity.

2.10.2 Use of tuning indices in the 2006 assessment

In this year's surveys, the MLAI surveys display an upward trend in SSB, in contrast to the Acoustic index that shows a decline. In single fleet tuning of the ICA assessment these translate into Acoustic Index: 14% decline, IBTS: 1% increase and MLAI: 7% increase in SSB from 2004 to 2005. The MIK can also be used to tune the assessment but as this only provides a recruitment index the results are not that informative as a tuning index for the older parts of the population. The final assessment shows a decline of 6% which compares with a 4% decline if the 2005 procedure had been used. While the change in the last year terminal F and SSB is consistent among indices and with the precision of the combined assessment, the recent longer term trajectories are less so. ICA provides a variance/covariance method to bootstrap parameters estimated in the assessment. The scatter plot from 1000 bootstrap estimates using a the ICA variance covariance resampling method on parameter estimates is shown in Figure 2.10.1. Along with this are plotted the results of assessments with the indices alone. The Acoustic survey suggests a lower SSB and higher F, the MLAI the highest SSB and lowest F. In particular the MLAI gives a much higher overall perception that is outside the range suggested by the combined assessment.

In conclusion the WG recognises that the different signals in the tuning data are currently the major cause of concern in the assessment. The WG has examined the indices through correlation to show they contain useful consistent data, reconciled the different tuning indices through the use of inverse variance weighting in a single assessment. Then checked that errors indicated by the retrospective patterns are small enough to support the utility of the assessment.

2.10.3 Comparison with the 2005 assessment and projection

The 2006 assessment is in good agreement with last years assessment see table below.

Assessment year	SSB in 2004	F2-6 in 2004	SSB in 2005	F in 2005
2006	**1.81 M t**	**0.27**	**Assessed 1.69 Mt**	**Assessed 0.35**
2005	**1.89 M t**	**0.25**	**Projected 1.82 Mt**	**Projected 0.30**

SSB in 2004 is revised down by 5%. SSB projected for 2005 was only a 7% overestimate of the current assessment with a fishing mortality at 0.35 instead of the projected 0.3.

2.10.4 Uncertainty in the 2005 assessment

The ICA plot of historic uncertainty is given in Figure 2.10.2. This shows 10% to 90% spread from -15% to +21%. Figure 2.10.1 provides a scatter plot of 100 terminal values in F against SSB, the spread of SSB is slightly narrower than in 2004 suggesting a slightly more precise assessment than last year. However, this ignores the disparity between the potentially different outcomes obtained when using the indices are used alone.

2.10.5 Comparison with earlier assessments

Cohort retrospectives are shown in Figure 2.10.3. The earliest cohorts shown have some revision over the early years. Latterly with the exception of the 2001 cohort retrospective evaluations suggest the WG is providing a fairly consistent evaluation of each year class. In particular the dominant 2000 year class has been estimated consistently since it was first seen in 2001. The early revisions occurred during the period following management changes in 1996/1997 and are thought to be mostly due to this but also the more equitable index weighting that was used before 2001.

2.10.6 Predictions

The short-term prediction method was substantially modified in 2002. Following the review by SGEHAP (ICES 2001/ACFM:22), which recommended that a simple multi-fleet method would be preferable, the complex split-factor method used for a number of years prior to 2002 has not been used since. The multi-fleet, multi-option, deterministic short-term prediction programme (MFSP) was accepted by ACFM and was developed further in 2004. It is intended to continue to use this programme in the future for as long as multifleet advice in the current form is requested. Last year’s short-term prediction suggested that the North Sea autumn-spawning herring stock SSB in 2006 would be around 1.62 Mt at an F of 0.30. This does not compare so well with this year’s projection of the 2006 SSB which is 1.3 Mt, a reduction of 19%. However, the currently estimated F was higher at F=0.35. This demonstrates that the current prediction procedure may be underestimating the fishing mortality, which for a declining stock may be an additional problem for management.

2.11 Herring in Division IVc and VIId (Downs Herring).

Over many years the working group has attempted to assess the contribution of winter spawning Downs herring to the overall population of North Sea herring. There is a separate TAC for herring in Divisions IVc and VIId as part of the total North Sea TAC.

Historically, the TAC for herring in IVc and VIId has been set as a proportion of the total North Sea TAC and this has varied between 6 and 16% since 1986 and as a proportion has been relatively high in recent years. ACFM in 2005 expressed a range of concerns regarding Downs herring and recommended that the proportion used to determine the TAC should be set to the long term average of the proportions used since 1986 (11%). This resulted in an agreed TAC in 2006 of 50,023 tonnes, a reduction of 33% compared with 2005 (Figure 2.11.1). The TAC in 2006 is 1.18 times the long term mean TAC for Downs (compared with 1.75 in 2005).

ACFM has in the past expressed concern that there is a persistent tendency to overfish the Downs TAC. However, this tendency has been markedly reduced in recent years (Figure 2.11.2), possibly because TACs have been much higher.

A further concern is that recent high catch levels in IVc and VIId have been driven largely by the strong 2000 year class. This year class accounted for 67% and 51% of the catch in numbers in 2004 and 2005, respectively. As has been noted previously these fish are smaller than average for their age and also have a lower proportion mature than average.

Historically, the Downs herring has been considered highly sensitive to overexploitation (Burd, 1985; Cushing 1968; 1992). It is less fecund and expresses different growth dynamics and recruitment patterns to the more northern spawning components. Furthermore, the directed fishery in Q4 and Q1 targets aggregations of spawning herring.

Preliminary studies suggest that the population profile of herring caught in Divisions IVc and VIId is slightly steeper than that for Divisions IVa and IV, particularly on the older ages (Figure 2.11.3)..The profiles were derived taking the log of the average catch numbers at age for Q4 over the period 1996 to 2004. Moreover, time-series estimates of total mortalities from within cohort catch-curves suggest that Z has been significantly higher on the 1998 and 1999 year classes of Downs herring (Figure 2.11.4).

Downs herring is also taken in other herring fisheries in the North Sea. Downs herring mixes with other components of North Sea herring in the summer whilst feeding, but it has not been possible to quantify the complete Downs component in catches. There is also a summer industrial fishery in the eastern North Sea exploiting Downs and North Sea autumn spawning herring juveniles. Tagging experiments (Aasen *et al,* 1962) estimated that around 15% of catches comprised Downs recruits. Recent otolith microstructure studies of Dutch catches in the summer of 2004 and 2005 from the northern North Sea suggest that the proportion of Downs herring may vary considerably from year to year. The percentage contribution was estimated as 60% in 2004 and 26% in 2005 (Dickey-Collas *et al*., 2005).

The proportion of the autumn and winter spawning components in recruiting year classes of North Sea herring has been traditionally monitored through the abundance of different sized fish in the IBTS. 1 wr fish from Downs spawning sites (winter) are thought to be smaller than those from the more northern, autumn spawning sites (<13 cm and >13 cm respectively). Both the total abundance and the proportion of Downs herring have, on average, been higher since the early 1990s, although there is considerable variation between year classes (Figure 2.11.5). These data (Table 2.3.3.3) suggest that around 35% of the strong 2000 year class came from Downs production and that approximately 70% of the 2002 year class originated from Downs production. In contrast, only 15% of the very weak 2004 year class was derived from Downs spawners.

Contribution by recent year classes

2000 year class- The Downs component continues to contribute significantly to the total fishery on the North Sea herring stock. Separate catches of this component are not available for all areas in the North Sea, however where separate data are available this year class in catches in IVc and VIId alone accounted for 8% and 5% of the total North Sea catches by weight in 2004 and 2005, respectively.

2003 and 2004 year classes- It appears probable that the recruitment for the 2003 and 2004 year classes of Downs herring is poor (Figure 2.11.6), based on the MIK index for the southern North Sea and the IBTS 1wr estimates (<13cm) (Table 2.3.3.3).

2005 year class- The preliminary results from the MIK survey (Figure 2.11.6) suggest that the 2005 year class may be the second highest since these data became available (1995). However, this estimate should be treated with extreme caution because it is based on a single large catch.

There remains an expectation of a low recruitment in recent years despite high levels (but with high variance) of larval abundances (Fig. 2.11.6). Hence it is probable that the productivity of the Downs component will reduce over the next few years, when the 2000 and 2002 year classes are fished out.

The Downs herring has returned to its pre-collapse state of being a major component of the stock but is currently dominated by one year class. Hence the management of the fishery on the spawning aggregations of Downs herring should continue to be cautious. More evidence about the dynamics and catches of Downs herring is required. Hence, HAWG continues to recommend that existing surveys of herring in the southern North Sea and English Channel be maintained and that the microincrement analysis of otoliths (to determine spawning type) is expanded to other fleets in the North Sea and also carried out on samples collected during the annual acoustic survey.

Last year the EC set a TAC for herring in IVc and VIId in concordance with the ICES advice. The TAC is specific to the conservation of the spawning aggregation of Downs herring. Evidence from catch-curve studies indicates a higher total mortality (Z) on this component and Downs herring is also caught in large numbers in other areas during the rest of the year. The TAC in 2006 remains 18% above the long-term mean TAC and low recruitment to the component is probable in the next few years. Thus, in the absence of other information HAWG recommends that the IVc-VIId TAC should be maintained in 2007 at 11% of the total North Sea TAC (as recommended by ACFM). This recommendation should be seen as an interim measure prior to the development of a more robust harvest control for setting the TAC of Downs herring, supported by increased research effort into the dynamics of this component in fisheries in the central and northern North Sea. Any new approach should provide an appropriate balance of F across stock components and be similarly conservative until the uncertainty in the Downs contribution to the catch in all fisheries in the North Sea is reduced.

Towards a Harvest Rule to determine IVc and VIId herring TAC allocation

The larval index although noisy seems to be a reliable index of North Sea herring SSB. Comparison between the Downs and the North Sea indices of SSB based on larval production (Dickey-Collas WG D3) suggests differences in the trends corresponding to both stocks (Fig. 2.11.7), particularly in recent years where estimated SSB for the Downs has declined compared with an increasing trend for total North Sea SSB. Given the lack of key information to provide a well-substantiated southern North Sea TAC allocation, an indicator of Downs abundance relative to the total North Sea would be useful. The ratio of the IVc and VIId to the

North Sea index of SSB based on larval production is noisy so a three-year running average was applied to smooth the series. The historic series of the proportion of the catch in IVc – VIId compared to the whole of the North Sea is plotted along with the smoothed larval SSBs ratios in Fig. 2.11.8. The smoothed larval ratios suggest an increasing trend in the proportion of Downs for the period although a persistent decline in the annual ratio was seen from 2000. However, the series of total mortality estimates by cohort presented early in this section (Fig. 2.11.4) suggested that fishing mortality for the component could have been high in recent years compared to the rest of the North Sea. Therefore, although the proportion of the Downs component relative to the total North Sea may on average have increased in the period 1986 to 2004 it is possible that the effective catch exerted on the component is not sustainable particularly if the in-coming year-classes continue to be weak. In recent years, the actual proportion of the southern North Sea component in the catch has substantially exceeded the 11% of the TAC long-term average reaching 22% in 1997 (Fig. 2.11.8). There is no scientific basis for the proposed 11% and given the indications of high mortality it becomes increasingly important that the 11% proposed as a conservative allocation is revised.

A number of rules to set the percentage TAC allocation could be proposed but they will have to be tested on a simulation framework. The SSB ratios should be investigated as a potential index to derive a percentage southern North Sea allocation and indices of in-coming year-class strength such as the proportion of small fish (<13cm) in the IBTS survey and the MIK index for the Channel should also be taken into account when developing rules. Flexibility and perhaps some innovative approaches will be required when setting a framework given uncertainty in the dispersal/migration components and mixing rates of the various components in each area, and their variability. Further, measures of precision associated to the larval SSBs estimates will need to be taken into account. The possibility of bias in the larval SSB ratio and that the bias could have a temporal trend due for example environmental changes should be incorporated into the scenario testing. Needless to say, the actual HCR will have to be conservative given uncertainty and robust to a variety of likely scenarios. Although is must be noted that acting conservatively on one component may result in the opposite effect on the remaining components.

2.12 Management Considerations

Based on the most recent estimates of SSB and fishing mortality, the North Sea autumn spawning herring stock is considered to be at 1.7 million t in 2005 and is expected to decrease to 1.3 million tonnes in 2006, which is at the $\mathbf{B}_{pa}$. Following currently estimated low recruitment SSB is expected to decline further and will be at risk of having reduced reproductive capacity in 2007. The fishing mortality has increased considerably in the last year, and the stock is now clearly at risk of being harvested unsustainably. SSB peaked since the rise from the low stock size in the mid-1990s, in response to reduced catches, strong recruitment and management measures that reduced exploitation both on juveniles and adults. However, in the last 4 years the recruitment has been far below average, and the stock is declining. Landings of adult herring in recent years have consistently exceeded the agreed TAC, mainly due to unallocated catches and catches misreported out of the North Sea (see section 2.1). The fishing mortality is increasing and is now well above what was intended in the management agreement, and what was considered sustainable.

The stock is managed according to the EU-Norway Management agreement which was updated on 26 November 2004, the relevant parts of the text are included here for reference:-

1. *Every effort shall be made to maintain a level of Spawning Stock Biomass (SSB) greater than the 800,000 tonnes (Blim).*
2. *Where the SSB is estimated to be above 1.3 million tonnes the Parties agree to set quotas for the directed fishery and for by-catches in other fisheries , reflecting a fishing mortality rate of no more than 0.25 for 2 ringers and older and no more than 0.12 for 0-1 ringers.*
3. *Where the SSB is estimated to be below 1.3 million tonnes but above 800,000 tonnes, the Parties agree to set quotas for the direct fishery and for by-catches in other fisheries, reflecting a fishing mortality rate equal to:*
4. *0.25 – (0.15*(1,300,000-SSB)/500,000) for 2 ringers and older, and*
5. *0.12 – (0.08*(1,300,000-SSB)/500,000) for 0-1 ringers.*
6. *Where the SSB is estimated to be below 800,000 tonnes the Parties agree to set quotas for the directed fishery and for by-catches in other fisheries, reflecting a fishing mortality rate of less than 0.1 for 2 ringers and older and less than 0.04 for 0-1ringers.*
7. *Where the rules in paragraphs 2 and 3 would lead to a TAC which deviates by more than 15% from the TAC of the preceding year the Parties shall fix a TAC that is no more than 15% greater or 15% less than the TAC of the preceding year.*
8. *Not withstanding paragraph 5 the Parties may, where considered appropriate, reduce the TAC by more than 15% compared to theTAC of the preceding year.*
9. *By-catches of herring may only be landed in ports where adequate sampling schemes to effectively monitor the landings have been set up. All catches landed shall be deducted from the respective quotas set, and the fisheries shall be stopped immediately in the event that the quotas are exhausted*
10. *The allocation of TAC for the directed fishery for herring shall be 29% to Norway and 71% to the Community. The by-catch quota for herring shall be allocated to the Community*
11. *A review of this arrangement shall take place no later than 31 December 2007 .*
12. *This arrangement enters in to force on 1 January 2005.*

ACFM examined the performance of this revised harvest control rule in 2005, and considered "the agreement in terms of target F to be consistent with the Precautionary Approach. However, ACFM also considered that the strict application of the TAC change limit of 15% (rule number 5) is not consistent with the Precautionary Approach in a situation like the present when three consecutive weak year-classes have recruited to the population. The harvest control rule is in accordance with the precautionary approach if paragraph 6 is consistently invoked sufficiently early to prevent or minimise the risk of SSB falling below B_{pa} even in the case of several consecutive weak year-classes. Assuming that paragraph 6 would be invoked when TAC constraints would lead to SSB falling below B_{pa} it is considered that the revised HCR is in accordance with the Precautionary Approach."

The situation now is unusual, with all the four year classes from 2001 onwards being poor. The SGRECVAP, which was set up to have a closer look at the recruitment failure in herring (as well as in Sandeel and Norway pout), concluded that the reduced recruitment is caused by an increased mortality in the first winter. Analysis of the time series of SSB and recruitment data clearly indicates a shift in the recruitment success in 2001. The underlying cause for the change in 2001 is not clear, but there is no evidence to justify an assumption of normal recruitment from 2006 onwards.

Consequently, the WG considers that the advice for 2007 should be adapted to the current recruitment regime. However, managers should also consider adaptation of the management agreement to account for the possibility that this low recruitment is continuing. It still is unclear how long this poor recruitment will last. Nevertheless actions need to be taken.

With the current low recruitment, medium term simulations show that the SSB will be in stochastic equilibrium at SSB ~ 1.2 million tonnes if the realised fishing mortality is at the level that has been intended in the agreed management plan. To reduce the the risk of SSB<1.3 million tonnes to less than 5%, fishing mortality for adults will have to be reduced to about 0.16, provided that the fishing mortality on juveniles can be reduced to the level it had in the rebuilding phase prior to 2003 (F0-1 < 0.05). However, the present Bpa was derived as an element in a harvest rule based on simulations assuming the historic recruitment regime, and may not give adequate guidance for management with a different stock productivity. However, Blim which is has been used to derive the current Bpa is based on a very stable stock and recruit time-series and is unlikely to change in the short term.

With full compliance, the agreed fishing mortality of 0.25 for the adults should be sustainable, provided the fishing mortality on juveniles is maintained at the present low level. However, failure to comply with this fishing mortality is a matter of concern. The consequences of the present mortality around 0.35, has not been examined in detail, but it is clear that it will lead to a substantial reduction in SSB in the near future. Likewise, the rule to constrain year-to-year change in TACs in the present situation inevitably precludes an adequate response to the abrupt change in recruitment. The combination of poor enforcement implementation and insufficient reduction in catch due to the 15% rule will act together to accelerate the decline.

The 1998 and 2000 year classes were both very strong, and will dominate the adult stock in the coming years. Therefore, in order to avoid later drastic reductions in fishing opportunities, these year classes should be exploited carefully. Likewise, as these year classes are depleted, the stock will be dominated by weak year classes. Managers, have an option to reduce the effect of this decline in recruitment by specifically reducing fishing mortality of incoming year classes.

This stock complex also includes Downs herring (herring in Divisions IVc and VIId), which has shown independent trends in exploitation rate and recruitment, but cannot be assessed separately. This year the Working Group concludes that the current state of the component is unknown. The WG's understanding of the component's dynamics is unlikely to improve until further examination of catch and the existing time series of surveys takes place. Both, alternative assessment methods have to be explored, and a greater knowledge the ecology of Downs herring is needed. The Downs fishery is concentrated on the spawning aggregations in a restricted area, which makes this stock component particularly vulnerable to excessive fishing pressure. Catches of the of the Downs component are taken both in the southern area and in the mixed fishery in the central and northern North Sea. The EU splits its share of the total North Sea herring TAC (Subarea IV and Division VIId) into TACs for Divisions IVa+IVb and for Divisions IVc+VIId. In response to ICES advice in May 1996, the IVc+VIId TAC was reduced by 50% in line with reductions for the whole North Sea. The TAC for Downs herring was reduced to 25 000 t and remained there until 2001. The catches for this component have significantly exceeded the sub-TACs in all years from 1989 to 2003. ACFM advised for 2004 and 2005 that the quota should not increase faster than the TAC for the North Sea as a whole. For three years ICES proposed that a share of 11% on the total North Sea TAC (average share 1989-2002) would be appropriate for distributing the harvesting among Downs Herring and other stock components. In accordance with the ICES advice the sub-TAC was reduced from 74.3Kt in 2005 to 50Kt in 2006. The IVc and VIId TAC is specific to the conservation of the spawning aggregation of Downs herring. Downs herring is caught in large numbers in other areas during the rest of the year (see Dickey-Collas et al., 2005). While the WG acknowledges that the basis for this exact 11% figure is weak there are indications that the total mortality on the Downs component, of which fishing is the major component, has recently been significantly higher than for the rest NS components.

Since the North Sea autumn spawning (NSAS) stock was rebuilt, ICES advice for catches of herring in IIIa, has been that the primary limiting factor should be the concern for the Western Baltic spring spawning (WBSS) stock. If as expected NS herring biomass declines, primacy of consideration may not be WBSS in future years. Currently the provision of advice affects the C and D fleets operating in IIIa. The issue of predicted catch in IIIa is dealt with in detail in the discussion of short term predictions in Section 2.7 and Section 3.10. Following the procedure set out in section 3.10 and assuming a total catch of WBSS of 99 000 tonnes (see Section 3.7) leads to a catch of 21 800 tonnes of NSAS herring for the C-fleet and 11 900 tonnes of NSAS herring for the D-fleet.

It has become increasingly clear that in previous years, large parts of the catches reported for IIIa were actually taken in the North Sea. For 2004, Norway was allowed to transfer all of its quota in IIIa to IV, while the EC could transfer 50% of its quota from IIIa to IV. For 2005 and 2006, Norway could again transfer 50% of its quota in IIIa to IV, while the EC now cannot (See Section 3.10). Furthermore, the last 4 year classes of NSAS have been weak, implying relatively smaller amounts of NSAS in IIIa. Therefore, it seems likely that the current fleet behaviour, with relatively small catches of NSAS in IIIa, will continue in the coming year.

Following the derogation for quota transfer from IIIa (described in the above paragraph) the UK relaxed its single area licence restrictions for fishing for herring in sub-area IV and sub-area VI. Since then there has been an increase in area misreporting from the North Sea into subdivision VIa north.

The relaxation of the by-catch limits in the Danish industrial fishery in 2004 along with increased fishing opportunities for sprat and reduced opportunities for other industrial species has resulted in increased fishing mortality on juvenile herring, though the fishing mortality on herring juveniles is still below the management target of F_{01}=0.12. Management of the North Sea sprat fishery must take account the bycatch of herring. Although the bycatch of juvenile herring was much lower than the allowed by-catch ceiling (50 000 t), the poor recruitment of herring warrants that the bycatch be constrained further.

All of the relaxation of area and bycatch rules are now contributing to the increase in exploitation and current over exploitation of North Sea herring. Removal of these derogations and increased compliance would be beneficial, particularly in the current circumstance of a declining North Sea population.

Table 2.1.1: Herring caught in the North Sea (Sub-area IV and Division VIId). Catch in tonnes by country, 1996 – 2005. These figures do not in all cases correspond to the official statistics and cannot be used for legal purposes.

Country	1996 [9]	1997 [9]	1998 [9]	1999 [9]	2000 [9]
Belgium	-	1	-	2	-
Denmark	66733	38324	58924	61268	64123
Faroe Islands	815	1156	1246	1977	915
France	12500	14525	20784	26962	20952
Germany, Fed.Rep	14215	13380	22259	26764	26687
Netherlands	42792	35985	49933	54467	54341
Norway [4]	43739	41606	70981	74071	72072
Sweden	2458	2253	3221	3241	3046
USSR/Russia	-	1619	452	-	-
UK (England)	6880	3470	7635	11434	11179
UK (Scotland)	17212	22582	31313	29911	30033
UK (N.Ireland)	-	-	1015	-	996
Unallocated landings	26069 [12]	63403 [6,12]	70329 [12]	43327 [12]	61673 [12]
Total landings	233413	238304	338092	333424	346017
Discards	-	-	-	-	-
Total catch	**233413**	**238304**	**338092**	**333424**	**346017**
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
Others [11]	-	-	-	-	378
Norw. Spring Spawners [13]	30274	54728	29220	32106	25678

Country	2001 [9]	2002	2003	2004 [1]	2005 [1]
Belgium	-	23	5	8	6
Denmark [7]	67096	70825	78606	99037	128380
Faroe Islands	1082	1413	627	402	738
France	24880 [14]	25422	31544	34521	38829
Germany	29779	27213	43953	41858	46555
Netherlands	51293	55257	81108	96162	81531
Norway [4]	75886 [1]	74974 [1]	112481 [1]	137638	156802
Poland	-	-	-	-	458
Sweden	3695	3418	4781	5692	13464
Russia	-	-	-	-	99
UK (England)	14582	13757	18639	20855	25311
UK (Scotland)	26719	30926	40292	45331	73227
UK (N.Ireland)	1018	944	2010	2656	2912
Unallocated landings	27362 [12]	31552 [12]	31875 [12]	48898 [12]	57788
Total landings	323392 [14]	335724	445921	533058	626101
Discards	-	17093	4125	17059	12824
Total catch	**323392** [14]	**352817**	**450046**	**550117**	**638925**
Estimates of the parts of the catches which have been allocated to spring spawning stocks					
IIIa type (WBSS)	6449	6652	2821	7079	7039
Thames estuary [5]	107	60	84	62	74
Others [11]	1097	0	308	0	0
Norw. Spring Spawners [13]	7108	4069	979	452	417

[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 the UK (England)
[7] Including any by-catches in the industrial fishery
[9] Figures verified and altered if needed in 2003 by SG Rednose (ICES 2003/ACFM:10)
[10] Figure altered in 2001
[11] Caught in the whole North Sea, partly included in the catch figure for The Netherlands
[12] may include misreported catch from IVaN and discards
[13] These catches (including some local fjord-type spring spawners) are taken by Norway under a separate quota south of 62°N and are not included in the Norwegian North Sea catch figure for this area
[14] Figure altered in 2004

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 legal purposes.

Country	1996 [11]	1997 [11]	1998 [11]	1999 [11]	2000 [11]
Denmark	3183	2657	4634	15359	25530
Faroe Islands	815	1156	1246	1977	205
France	3177	362	4758	6369	3210
Germany	2167	4576	7753	11206	5811
Netherlands	7714	6072	10917	21552	15117
Norway	22187	16869	27290	31395	33164
Sweden	769	1617	315	859	1479
Russia	-	1619	452	-	-
UK (England)	2391	49	4306	7999	8859
UK (Scotland)	12763	17121	29462	28537	29055
UK (N. Ireland)	-	-	1015	-	996
Unallocated landings	12681 [8]	40662 [5,8]	56058 [8]	25469 [8]	44334 [8]
Misreporting from VIa North					
Total Landings	67847	92760	148206	150722	167760
Discards					
Total catch	**67847**	**92760**	**148206**	**150722**	**167760**

Country	2001 [11]	2002	2003	2004 [1]	2005
Denmark [7]	17770	26422	48358	48128	80990
Faroe Islands	192	-	95	-	
France	8164	10522	11237	10941	13474
Germany	17753	15189	25796	17559	22278
Netherlands	17503 [10]	18289	25045	43876	36619
Norway	11653 [1]	10836 [1]	34443	36119	66232
Poland	-	-	-	-	458
Sweden	1418	2397	2647	2178	8261
Russia	-	-	-	-	99
UK (England)	12283	10142	12030	13480	15523
UK (Scotland)	25105	30014	39970	43490	71941
UK (N. Ireland)	1018	944	2010	2656	2912
Unallocated landings	24725 [8]	14201 [8]	14115 [8]	28631 [8]	39324 [8]
Misreporting from VIa North					
Total Landings	137584	138956	215746	247058	358111
Discards		17093	4125	15794	10861
Total catch	**137584**	**156049**	**219871**	**262852**	**368972**

[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 m isreporting into IVa (North)
[7] Including any by-catches in the industrial fishery
[8] May include misreported catch from VIaN and discards
[9] Figure altered in 2001
[10] Including 1057 t of local spring spawners
[11] Figures verified and altered if needed in 2003 by SG Rednose (ICES 2003/ACFM:10)

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 legal purposes.

Country	1996 [7]	1997 [7]	1998 [7]	1999 [7]	2000 [7]
Denmark [5]	19166	22862	25750	18259	11300
Faroe Islands	-	-	-	-	710
France	-	3	-	115	-
Germany	-	-	-	-	29
Netherlands	-	756	301	-	38
Norway [2]	18256	20975	43646	39977	38655
Sweden	1119	422	1189	772	1177
Unallocated landings	-	-756 [4]	-292 [4]	-	338
Total landings	38541	44262	70594	59123	52247
Discards	-	-	-	-	-
Total catch	**38541**	**44262**	**70594**	**59123**	**52247**
Norw. Spring Spawners [6]	30274	54728	29220	32106	25678

Country	2001 [7]	2002	2003 [1]	2004 [1]	2005 [1]
Denmark 5	18466	17846	7401	16278	5761
Faroe Islands	890	1365	359	-	738
France	-	-	-	-	-
Germany	-	81	54	888	-
Netherlands	-	-	-	-	-
Norway 2	56904 [1]	63482 [1]	62306	100443	89925
Sweden	517	568	1529	1720	3510
Unallocated landings	o	5961	11991	0	0
Total landings	76777	89303	83640	119329	99934
Discards	-	-	-	-	-
Total catch	**76777**	**89303**	**83640**	**119329**	**99934**
Norw. Spring Spawners [6]	7108	4069	979	452	417

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

Table 2.1.4: Herring. Catch in tonnes in Division IVb. These figures do not in all cases correspond to the official statistics and cannot be used for legal purposes.

Country	**1996** [6]	**1997** [6]	**1998** [6]	**1999** [6]	**2000** [6]
Belgium	-	-	-	1	-
Denmark [4]	43749	11558	26667	26211	26825
Faroe Islands	-	-	-	-	-
France	2373	6069	8945	7634	10863
Germany	11051	7455	13590	13529	18818
Netherlands	21053	14976	27468	22343	26839
Norway	3296	3762	45	2699	253
Sweden	570	214	1717	1610	390
UK (England)	2757	2033	1767	1641	669
UK (Scotland)	4449	5461	1851	1374	978
Unallocated landings	-17313 [5]	-3744 [5]	-12138 [5]	-3794 [5]	-9820 [5]
Total landings	71985	47784	69912	73248	75815
Discards [2]	-	-	-	-	-
Total catch	**71985**	**47784**	**69912**	**73248**	**75815**

Country	**2001** [6]	**2002**	**2003** [1]	**2004** [1]	**2005** [1]
Belgium	-	-	-	-	-
Denmark [4]	30277	26387	22574	33857	41423
Faroe Islands	-	48	173	402	-
France	7796 [14]	4214	7918	10592	10205
Germany	8340	7577	12116	13823	14381
Netherlands	24160	13154	19115	23649	10038
Norway	7329 [1]	656 [1]	15732	1076	645
Sweden	1760	453	605	1794	1694
UK (England)	814	317	2632	2864	3869
UK (Scotland)	1614	289	322	1841	1286
Unallocated landings	-22885 [5]	4052	-2401	8300	10233
Total landings	59205	57147	78786	98198	93774
Discards [2]	-	-	-	1265	1963
Total catch	**59205** [14]	**57147**	**78786**	**99463**	**95737**

[1] Preliminary
[2] Discards partly included in unallocated landings
[3] Negative unallocated catches due to misreporting from other areas
[4] Including any by-catches in the industrial fishery
[5] May include discards. Negative unallocated due to misreporting into other areas
[6] Figures verified and altered if needed in 2003 by SG Rednose (ICES 2003/ACFM:10)
[14] Figure altered in 2004

Table 2.1.5: Herring. Catch in tonnes in Division IVc and VIId. These figures do not in all cases correspond to the official statistics and cannot be used for legal purposes.

Country	1996 [9]	1997 [9]	1998 [9]	1999 [9]	2000 [9]
Belgium	-	1	-	1	1
Denmark	635	1247	1873	1439	468
France	6950	8091	7081	12844	6879
Germany	997	1349	916	2029	2029
Netherlands	14024	14181	11247	10572	12348
UK (England)	1733	1388	1562	1794	1651
UK (Scotland)	-	-	-	-	-
Unallocated landings	30702 [4]	27241 [4]	26701 [4]	21652 [4]	26822 [4]
Total landings	55041	53498	49380	50331	50198
Discards [3]	-	-	-	-	-
Total catch	**55041**	**53498**	**49380**	**50331**	**50198**
Coastal spring spawners included above [2]	168	143	88	88	76

Country	2001 [9]	2002	2003 [1]	2004 [1]	2005 [1]
Belgium	-	23	5	8	6
Denmark	583	170	273	774	206
France	8750	10686	12389	12988	15150
Germany	3686	4366	5987	9588	9896
Netherlands	9630	23814	36948	28637	34874
UK (England)	1485	3298	3977	4511	5919
UK (Scotland)	-	623	-	-	-
Unallocated landings	25522 [4]	7338	8170	11967	8231
Total landings	49656	50318	67749	68473	74282
Discards 3	-	-	-	-	-
Total catch	**49656**	**50318**	**67749**	**68473**	**74282**
Coastal spring spawners included above [2]	147 [11]	60	84	62	74

[1] Preliminary
[2] Landings from the Thames estuary area are included in the North Sea catch figure for UK (England)
[3] Discards partly included in unallocated landings
[4] May include misreported catch and discards
[9] Figures verified and altered if needed in 2003 by SG Rednose (ICES 2003/ACFM:10)
[10] Figure altered in 2002 (was 7851 t higher before)
[11] Thames/Blackwater herring landings: 107 t, others included in the catch figure for The Netherlands
[14] Figure altered in 2004

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 [18]	1997 [18]	1998 [18]	1999 [18]	2000 [18]	2001 [18]	2002	2003	2004	2005	2006
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	- [22]	- [22]	- [22]	- [22]	- [22]	- [22]
Recommended Divisions IVc, VIId	30	30	50-60 [6]	54	50	50	50	- [14]	- [14]	- [14]	- [14]	- [14]	- [14]	- [14]	- [14]	- [14]	- [14]	- [14]
Expected catch of spring spawners				10	8													
Agreed Divisions IVa,b [2]	484	385	370 [6]	380	380	390	390	263;131 [13]	134	229	240	240	240	223	340.5	393.9	460.7	404.7
Agreed Div. IVc, VIId	30	30	50 [6]	50	50	50	50	50; 25 [13]	25	25	25	25	25	42.7	59.5	66.1	74.3	50.0
Bycatch ceiling in the small mesh fishery									24	22	30	36	36	36	52.0	38.0	50.0	42.5
CATCH (IV and VIId)																		
National landings Divisions IVa,b [3]	639	499	495	481	463	421	465	183	149	245	261	261	272	261	354.5	427.7	502.3	
Unallocated landings Divisions IVa,b	-2	14	30	14	-1	6	-15	-5	36	44	22	35	2	24	23.7	36.9	49.6	
Discard/slipping Divisions IVa,b [4]	3	4	2	3	1	1	-	-	-	-	-	-	-	17	4.1	17.1	12.8	
Total catch Divisions IVa,b [5]	638	516	527	498	463	428	450	178	185	289	283	296	273	303	382.3	481.6	564.6	
National landings Divisions IVc, VIId [3]	30	24	42	37	32 [21]	42	45	24	26	23	29	23	24	43	59.5	56.5	66.1	
Unallocated landings Divisions IVc,VIId	48	32	16	35	43	30	22	31	27	27	22	27	26	7	8.2	12.0	8.2	
Discard/slipping Divisions IVc, VIId [4]	1	5	3	2	2	2	-	-	-	-	-	-	-	0	-	-	-	
Total catch Divisions IVc, VIId	79	61	61	74	77 [21]	74	67	55	53	49	50	50	50	50	67.7	68.5	74.3	
Total catch IV and VIId as used by ACFM [5]	**717**	**578**	**588**	**572**	**540** [21]	**498**	**516**	**233**	**238**	**338**	**333**	**346**	**323**	**353**	**450.0**	**550.1**	**638.9**	
CATCH BY FLEET/STOCK (IV and VIId) [10]																		
North Sea autumn spawners directed fisheries (Fleet A	N.a.	N.a.	446	441	438	447	439	195	225	316	313	322	296	323	434.9	529.5	611.7	
North Sea autumn spawners industrial (Fleet B)	N.a.	N.a.	134	124	101	38	67	38	13	14	15	18	20	22	12.3	13.6	21.8	
North Sea autumn spawners in IV and VIId total	**696**	**569**	**580**	**564**	**539**	**485**	**506**	**233**	**237**	**330**	**329**	**339**	**317**	**346**	**447.2**	**543.0**	**631.9**	
Baltic-IIIa-type spring spawners in IV	20	8	8	8	9	13	10	1	1	8	5	7	6	7	2.8	7.1	7.0	
Coastal-type spring spawners	2.3	1.1	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	1.2	0.1	0.1	0.1	0.1	
Norw. Spring Spawners caught under a separate quota	N.a.	4	5	5	9	6	10	30	55	29	32	26	7	4	1.0	0.5	0.4	
Division IIIa: TAC (IIIa)																		
Predicted catch of autumn spawners			96	153	102	77	98	48	35	58	43	53	- [22]	- [22]	- [22]	- [22]	- [22]	- [22]
Recommended spring spawners	84	67	91	90	93–113	- [9]	- [12]	- [12]	- [15]	- [15]	- [15]	- [15]	- [15]	- [15]	- [15]	- [22]	- [22]	- [22]
Recommended mixed clupeoids	80	60	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-
Agreed herring TAC	138	120	104.5	124	165	148	140	120	80	80	80	80	80	80	80.0	70.0	96.0	81.6
Agreed mixed clupeoid TAC	80	65	50	50	45	43	43	43										
Bycatch ceiling in the small mesh fishery									20	17	19	21	21	21	21.0	21.0	24.2	20.5
CATCH (IIIa)																		
National landings	192	202	188	227	214	168	157	115	83	120	86	108	90	79	76.0	61.1	90.8	
Catch as used by ACFM	162	195	191	227	214	168	140	105	74	108	79	99	82	73	68.1	52.7	69.6	
CATCH BY FLEET/STOCK (IIIa) [10]																		
Autumn spawners human consumption (Fleet C)	N.a.	N.a.	26	47	44	42	38	24	21	59	28 [17]	36	34	17	24.1	13.4	22.9	
Autumn spawners mixed clupeoid (Fleet D) [19]	N.a.	N.a.	13	23	25	12	6	9	4	6	8 [17]	13	12	9	8.4	10.8	9.0	
Autumn spawners other industrial landings (Fleet E)	N.a.	N.a.	38	82	63	32	29	8	2									
Autumn spawners in IIIa total	**91**	**77** [8]	**77**	**152**	**132**	**86**	**73**	**43**	**27**	**61**	**34** [17]	**49**	**46**	**26**	**32.5**	**24.2**	**31.9**	
Spring spawners human consumption (Fleet C)	N.a.	N.a.	68	53	68	59	44	58	43	40	40 [17]	45	33	38	31.6	16.8	32.5	
Spring spawners mixed clupeoid (Fleet D) [19]	N.a.	N.a.	5	2	1	1	2	4	3	3	3 [17]	5	3	9	4.0	11.2	5.1	
Spring spawners other industrial landings (Fleet E)	N.a.	N.a.	40	20	12	24	21	2	1									
Spring spawners in IIIa total	**71**	**118**	**113**	**75**	**81**	**84**	**67**	**64**	**47**	**43**	**43** [17]	**50**	**36**	**47**	**35.6**	**28.0**	**37.6**	
North Sea autumn spawners Total as used by ACFM	**787**	**646**	**657**	**716**	**671**	**571**	**579**	**275**	**264**	**392**	**363**	**388**	**363**	**372**	**479.7**	**567.2**	**663.8**	

[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] Incomplete, only some countries providing discard information. Discards might also be included in un. [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. [17] Figure altered in 2001 and again in 2004. [18] Data for 1995-2001 were verified and amended where necessary by SG REDNOSE in 2003. [19] Fleet D and E are merged from 1999 onwards. [20] These catches (including local fjord-type Spring Spawners) are taken by Norway under a separate quota south of 62°N and are not included in the Norwegian North Sea catch figure for this area. [21] figure altered in 2003 to account for earlier summarizing errors. [22] See catch option tables for different fleets.Shaded cells for the catch by fleet in Division IIIa indicate persisting inconsistencies which have to be resolved intersessionally.

Table 2.2.1: North Sea autumn spawning herring (NSAS), and western Baltic spring spawners (WBSS) caught in the North Sea in 2005. Catch in numbers (millions) at age (CANUM), by quarter and division.

Quarters: 1-4

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
0	96.4	0.0	0.0	0.0	0.0	914.8	4.3	0.0	914.8	4.3	1015.6	919.1
1	307.5	1.4	0.0	1.3	2.7	399.2	4.4	0.5	403.2	4.9	715.5	408.1
2	159.2	53.7	6.6	47.1	94.2	16.6	2.1	36.2	157.9	38.3	355.4	202.8
3	16.2	110.9	17.4	93.5	282.2	57.4	5.0	31.4	433.1	36.4	485.7	486.9
4	5.4	204.5	12.7	191.8	736.8	136.4	34.0	213.9	1065.1	247.9	1318.4	1325.7
5	2.4	67.0	2.6	64.4	307.4	59.6	3.7	42.4	431.4	46.2	479.9	480.1
6	2.3	88.0	3.8	84.2	362.9	56.6	3.1	66.8	503.7	69.9	575.9	577.4
7	0.5	19.4	1.1	18.3	53.9	17.9	1.1	23.5	90.1	24.6	115.2	115.8
8	0.2	23.8	0.4	23.4	62.0	13.1	0.2	9.1	98.5	9.3	108.0	108.2
9+	0.0	13.4	0.3	13.1	23.0	2.1	0.0	0.9	38.2	0.9	39.1	39.4
Sum	589.9	582.0	44.8	537.1	1925.1	1673.9	58.1	424.6	4136.1	482.7	5208.7	4663.6

Quarter: 1

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
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	97.2	0.0	0.0	0.0	0.0	32.2	0.5	0.0	32.2	0.5	129.8	32.7
2	125.3	0.8	0.0	0.8	3.4	0.1	0.0	1.1	4.3	1.1	130.8	5.4
3	12.6	10.2	0.0	10.2	39.3	1.1	1.8	7.5	50.6	9.3	72.5	59.9
4	0.9	25.0	0.0	25.0	121.8	3.3	16.3	61.8	150.1	78.1	229.1	228.2
5	0.2	0.5	0.0	0.5	51.9	1.3	1.8	8.6	53.7	10.4	64.3	64.1
6	0.3	5.0	0.0	5.0	55.5	1.3	1.8	4.6	61.8	6.5	68.6	68.3
7	0.2	0.2	0.0	0.2	4.3	0.1	0.9	3.9	4.6	4.8	9.6	9.5
8	0.0	0.1	0.0	0.1	6.1	0.2	0.0	1.8	6.3	1.8	8.1	8.1
9+	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.3	0.3
Sum	236.6	41.9	0.0	41.9	282.7	39.5	23.1	89.3	364.1	112.4	713.1	476.5

Quarter: 2

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
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	46.2	1.3	0.0	1.3	0.9	35.6	0.8	0.0	37.7	0.8	84.7	38.5
2	19.5	42.7	0.9	41.8	48.1	2.2	0.0	0.0	92.0	0.0	111.5	92.9
3	1.1	85.4	10.8	74.5	81.6	3.4	0.0	0.0	159.5	0.0	160.7	170.4
4	0.3	149.5	4.4	145.1	229.9	18.5	0.2	0.2	393.6	0.3	394.2	398.3
5	0.1	29.1	0.8	28.2	53.5	2.5	0.0	0.0	84.2	0.0	84.3	85.0
6	0.1	34.7	1.0	33.7	71.8	1.4	0.0	0.0	106.9	0.0	107.0	107.9
7	0.0	10.0	0.3	9.7	16.4	1.1	0.0	0.0	27.2	0.0	27.3	27.5
8	0.0	5.1	0.1	4.9	8.9	0.1	0.0	0.0	14.0	0.0	14.0	14.1
9+	0.0	1.3	0.0	1.2	2.2	0.0	0.0	0.0	3.5	0.0	3.5	3.5
Sum	67.3	358.9	18.4	340.5	513.3	64.7	1.0	0.3	918.5	1.3	987.1	938.2

Quarter: 3

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
0	62.9	0.0	0.0	0.0	0.0	572.5	0.0	0.0	572.5	0.0	635.4	572.5
1	113.1	0.0	0.0	0.0	0.4	43.9	0.0	0.0	44.3	0.0	157.4	44.3
2	8.8	10.1	5.7	4.4	38.3	11.2	0.0	0.0	54.0	0.0	62.8	59.7
3	1.9	11.7	6.6	5.1	133.6	48.2	0.0	0.0	187.0	0.0	188.9	193.6
4	2.0	14.8	8.3	6.5	327.4	106.6	0.0	0.1	440.4	0.2	442.6	448.9
5	0.8	3.1	1.7	1.3	180.2	52.0	0.0	0.0	233.6	0.0	234.4	235.3
6	0.2	4.9	2.8	2.2	212.6	48.6	0.0	0.0	263.3	0.0	263.6	266.1
7	0.0	1.4	0.8	0.6	31.6	15.9	0.0	0.0	48.2	0.0	48.2	49.0
8	0.0	0.5	0.3	0.2	43.1	11.1	0.0	0.0	54.4	0.0	54.4	54.7
9+	0.0	0.5	0.3	0.2	20.1	2.1	0.0	0.0	22.4	0.0	22.4	22.7
Sum	189.6	46.9	26.4	20.6	987.3	912.2	0.1	0.2	1920.0	0.3	2110.0	1946.7

Quarter: 4

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
0	33.5	0.0	0.0	0.0	0.0	342.4	4.3	0.0	342.4	4.3	380.2	346.6
1	51.0	0.1	0.0	0.1	1.4	287.5	3.2	0.5	289.0	3.6	343.6	292.6
2	5.6	0.2	0.0	0.1	4.3	3.1	2.1	35.1	7.5	37.2	50.4	44.8
3	0.6	3.7	0.0	3.7	27.6	4.7	3.2	23.8	36.0	27.0	63.6	63.0
4	2.2	15.1	0.0	15.1	57.8	8.0	17.5	151.8	81.0	169.3	252.5	250.3
5	1.3	34.3	0.0	34.3	21.8	3.8	1.9	33.8	60.0	35.7	97.0	95.7
6	1.7	43.4	0.0	43.4	23.0	5.3	1.3	62.1	71.7	63.3	136.7	135.1
7	0.3	7.8	0.0	7.8	1.5	0.8	0.2	19.5	10.1	19.7	30.1	29.8
8	0.1	18.2	0.0	18.2	3.9	1.8	0.2	7.3	23.8	7.5	31.5	31.3
9+	0.0	11.6	0.0	11.6	0.4	0.0	0.0	0.9	12.0	0.9	13.0	13.0
Sum	96.3	134.3	0.0	134.2	141.7	657.5	33.9	334.8	933.4	368.7	1398.4	1302.2

Table 2.2.2: North Sea autumn spawning herring (NSAS), and western Baltic spring spawners (WBSS) caught in the North Sea in 2005. Mean weight-at-age (kg) in the catch (WECA), by quarter and division.

WR	IIIa NSAS	IVa(E) all	IVa(E) WBSS	IVa(W)	IVb	IVc	VIId	IVa & IVb all	IVc & VIId	Total NSAS	Herring caught in the North Sea
Quarters: 1-4											
0	0.017	0.000	0.000	0.000	0.011	0.015	0.000	0.011	0.015	0.011	0.011
1	0.051	0.091	0.111	0.102	0.038	0.032	0.092	0.039	0.038	0.044	0.039
2	0.071	0.117	0.107	0.122	0.132	0.122	0.122	0.121	0.122	0.099	0.121
3	0.106	0.146	0.154	0.158	0.172	0.128	0.133	0.157	0.132	0.153	0.155
4	0.155	0.153	0.168	0.174	0.187	0.139	0.139	0.172	0.139	0.166	0.166
5	0.173	0.202	0.179	0.213	0.217	0.156	0.172	0.212	0.170	0.208	0.208
6	0.185	0.209	0.189	0.229	0.220	0.171	0.209	0.225	0.207	0.223	0.223
7	0.200	0.233	0.186	0.245	0.245	0.192	0.230	0.242	0.228	0.240	0.239
8	0.209	0.262	0.216	0.275	0.253	0.250	0.236	0.269	0.237	0.266	0.266
9+	0.000	0.265	0.197	0.267	0.252	0.000	0.245	0.265	0.245	0.265	0.265
Quarter: 1											
0	0.000	0.000		0.000	0.000	0.000	0.000	-	-	0.000	0.000
1	0.035	0.090		0.000	0.016	0.016	0.000	0.016	0.016	0.030	0.016
2	0.067	0.120		0.089	0.089	0.000	0.079	0.095	0.079	0.068	0.092
3	0.102	0.114		0.110	0.110	0.091	0.083	0.111	0.085	0.106	0.107
4	0.131	0.123		0.127	0.126	0.115	0.099	0.126	0.102	0.118	0.118
5	0.141	0.175		0.152	0.149	0.136	0.121	0.152	0.124	0.147	0.147
6	0.156	0.149		0.160	0.155	0.157	0.138	0.159	0.143	0.158	0.158
7	0.171	0.195		0.178	0.165	0.182	0.161	0.179	0.165	0.172	0.172
8	0.000	0.225		0.190	0.189	0.000	0.152	0.191	0.152	0.182	0.182
9+	0.000	0.207		0.215	0.000	0.000	0.000	0.215	-	0.215	0.215
Quarter: 2											
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	0.000	0.000
1	0.028	0.090	0.090	0.092	0.021	0.020	0.000	0.025	0.020	0.026	0.024
2	0.068	0.120	0.120	0.117	0.101	0.000	0.079	0.118	0.079	0.109	0.118
3	0.094	0.144	0.144	0.154	0.125	0.091	0.083	0.148	0.086	0.148	0.148
4	0.128	0.150	0.150	0.164	0.126	0.115	0.099	0.157	0.106	0.157	0.157
5	0.145	0.173	0.173	0.201	0.145	0.136	0.121	0.190	0.127	0.190	0.190
6	0.146	0.185	0.185	0.214	0.153	0.157	0.138	0.204	0.148	0.204	0.204
7	0.150	0.195	0.195	0.216	0.162	0.182	0.161	0.206	0.170	0.206	0.206
8	0.140	0.225	0.225	0.251	0.189	0.000	0.152	0.241	0.152	0.241	0.241
9+	0.000	0.207	0.207	0.213	0.000	0.000	0.000	0.211	-	0.211	0.211
Quarter: 3											
0	0.012	0.000	0.000	0.000	0.008	0.000	0.000	0.008	-	0.008	0.008
1	0.063	0.143	0.143	0.100	0.028	0.000	0.092	0.029	0.092	0.054	0.029
2	0.104	0.105	0.105	0.129	0.142	0.122	0.120	0.127	0.120	0.126	0.127
3	0.127	0.170	0.170	0.177	0.179	0.150	0.139	0.177	0.143	0.177	0.177
4	0.148	0.177	0.177	0.202	0.202	0.161	0.148	0.201	0.152	0.201	0.201
5	0.161	0.182	0.182	0.238	0.225	0.176	0.170	0.235	0.171	0.235	0.235
6	0.183	0.190	0.190	0.256	0.227	0.191	0.191	0.249	0.191	0.250	0.249
7	0.000	0.183	0.183	0.269	0.252	0.235	0.217	0.261	0.218	0.263	0.261
8	0.000	0.212	0.212	0.295	0.258	0.250	0.228	0.287	0.230	0.287	0.287
9+	0.000	0.196	0.196	0.273	0.252	0.000	0.245	0.270	0.245	0.271	0.270
Quarter: 4											
0	0.025	0.000	0.000	0.000	0.015	0.015	0.000	0.015	0.015	0.016	0.015
1	0.074	0.111	0.111	0.109	0.044	0.038	0.092	0.045	0.045	0.049	0.045
2	0.109	0.127	0.127	0.129	0.118	0.122	0.123	0.125	0.123	0.122	0.123
3	0.137	0.206	0.206	0.144	0.148	0.150	0.148	0.151	0.148	0.150	0.150
4	0.174	0.214	0.214	0.156	0.157	0.161	0.156	0.167	0.156	0.160	0.160
5	0.188	0.229	0.229	0.187	0.171	0.176	0.185	0.210	0.184	0.200	0.200
6	0.192	0.238	0.238	0.196	0.193	0.191	0.214	0.221	0.214	0.218	0.218
7	0.227	0.293	0.293	0.236	0.225	0.235	0.244	0.279	0.244	0.255	0.256
8	0.215	0.274	0.274	0.235	0.227	0.250	0.257	0.264	0.257	0.262	0.262
9+	0.000	0.274	0.274	0.277	0.252	0.000	0.245	0.274	0.245	0.272	0.272

Table 2.2.3: North Sea autumn spawning herring (NSAS), and western Baltic spring spawners (WBSS) caught in the North Sea in 2005. Mean length-at-age (cm) in the catch, by quarter and division.

WR	IIIa NSAS	IVa(E) all	IVa(E) WBSS	IVa(W)	IVb	IVc	VIId	IVa & IVb all	IVc & VIId	Herring caught in the North Sea
Quarters: 1-4										
0	n.d.	0.0	n.d.	0.0	12.1	13.5	0.0	12.1	13.5	12.1
1	n.d.	21.6	n.d.	23.5	17.9	17.3	22.5	18.0	17.8	18.0
2	n.d.	23.4	n.d.	23.9	24.9	23.9	24.1	23.8	24.1	23.9
3	n.d.	25.3	n.d.	26.3	26.5	24.0	25.0	26.1	24.9	26.0
4	n.d.	25.8	n.d.	27.0	27.5	24.8	25.3	26.9	25.3	26.6
5	n.d.	28.1	n.d.	29.0	28.7	25.8	26.9	28.8	26.8	28.6
6	n.d.	28.5	n.d.	29.3	28.9	27.1	28.2	29.1	28.1	29.0
7	n.d.	29.1	n.d.	29.7	30.1	29.3	29.0	29.6	29.0	29.5
8	n.d.	30.5	n.d.	30.8	30.7	28.8	29.3	30.7	29.3	30.6
9+	n.d.	31.0	n.d.	30.5	30.1	0.0	29.7	30.6	29.7	30.6
Quarter: 1										
0	n.d.	0.0	n.d.	0.0	0.0	0.0	0.0	-	-	0.0
1	n.d.	21.4	n.d.	0.0	14.7	14.7	0.0	14.7	14.7	14.7
2	n.d.	23.6	n.d.	23.9	23.9	0.0	21.6	23.8	21.6	23.4
3	n.d.	25.2	n.d.	25.6	25.6	22.5	23.1	25.5	23.0	25.1
4	n.d.	25.8	n.d.	26.8	26.8	24.1	23.9	26.7	23.9	25.7
5	n.d.	26.7	n.d.	28.4	28.3	25.5	25.4	28.4	25.4	27.9
6	n.d.	27.7	n.d.	28.8	28.7	27.0	26.6	28.7	26.7	28.5
7	n.d.	27.8	n.d.	29.9	29.4	29.3	28.1	29.8	28.3	29.0
8	n.d.	29.0	n.d.	30.8	30.8	0.0	28.0	30.8	28.0	30.1
9+	n.d.	28.5	n.d.	31.0	0.0	0.0	0.0	30.8	-	30.8
Quarter: 2										
0	n.d.	0.0	n.d.	0.0	0.0	0.0	0.0	-	-	0.0
1	n.d.	21.4	n.d.	22.2	14.6	14.5	0.0	15.0	14.5	15.0
2	n.d.	23.6	n.d.	23.7	22.6	0.0	21.6	23.6	21.6	23.6
3	n.d.	25.1	n.d.	25.6	24.3	22.5	23.1	25.3	22.8	25.3
4	n.d.	25.4	n.d.	26.1	24.5	24.1	23.9	25.8	24.0	25.8
5	n.d.	26.8	n.d.	27.6	26.0	25.5	25.4	27.3	25.4	27.3
6	n.d.	27.2	n.d.	28.2	26.4	27.0	26.6	27.9	26.8	27.9
7	n.d.	27.8	n.d.	28.6	27.2	29.3	28.1	28.3	28.6	28.3
8	n.d.	29.0	n.d.	29.9	30.3	0.0	28.0	29.6	28.0	29.6
9+	n.d.	28.5	n.d.	28.4	0.0	0.0	0.0	28.4	-	28.4
Quarter: 3										
0	n.d.	0.0	n.d.	0.0	11.2	0.0	0.0	11.2	-	11.2
1	n.d.	25.1	n.d.	22.5	16.0	0.0	22.5	16.0	22.5	16.0
2	n.d.	22.3	n.d.	24.0	25.3	23.9	24.1	24.0	24.1	24.0
3	n.d.	25.8	n.d.	26.8	26.7	24.9	25.3	26.7	25.1	26.7
4	n.d.	26.0	n.d.	27.6	28.1	25.4	25.7	27.7	25.6	27.7
5	n.d.	26.5	n.d.	29.5	29.0	26.0	26.8	29.3	26.7	29.3
6	n.d.	27.2	n.d.	29.7	29.1	27.3	27.6	29.5	27.6	29.5
7	n.d.	27.5	n.d.	30.1	30.3	29.3	28.6	30.1	28.6	30.1
8	n.d.	28.0	n.d.	30.9	30.9	28.8	28.9	30.9	28.9	30.9
9+	n.d.	28.0	n.d.	30.7	30.1	0.0	29.7	30.6	29.7	30.6
Quarter: 4										
0	n.d.	0.0	n.d.	0.0	13.5	13.5	0.0	13.5	13.5	13.5
1	n.d.	24.9	n.d.	24.7	19.0	18.4	22.5	19.0	18.9	19.0
2	n.d.	26.2	n.d.	26.1	25.0	23.9	24.2	25.7	24.2	24.5
3	n.d.	28.3	n.d.	27.2	26.1	24.9	25.6	27.1	25.5	26.4
4	n.d.	28.9	n.d.	27.9	26.6	25.4	25.9	27.9	25.9	26.5
5	n.d.	29.3	n.d.	29.5	26.9	26.0	27.3	29.2	27.2	28.5
6	n.d.	29.8	n.d.	29.9	27.8	27.3	28.3	29.7	28.3	29.0
7	n.d.	31.1	n.d.	31.3	30.5	29.3	29.2	31.1	29.2	29.8
8	n.d.	31.0	n.d.	31.3	29.5	28.8	29.6	30.9	29.6	30.6
9+	n.d.	31.4	n.d.	31.3	30.1	0.0	29.7	31.4	29.7	31.3

Table 2.2.4: North Sea autumn spawning herring (NSAS), and western Baltic spring spawners (WBSS) caught in the North Sea in 2005. 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	**1.6**	**0.0**	**0.0**	**0.0**	**0.0**	**9.7**	**0.1**	**0.0**	**9.7**	**0.1**	**11.4**	**9.8**
1	**15.6**	**0.1**	**0.0**	**0.1**	**0.3**	**15.2**	**0.1**	**0.0**	**15.6**	**0.2**	**31.4**	**15.8**
2	**11.2**	**6.3**	**0.7**	**5.6**	**11.5**	**2.2**	**0.3**	**4.4**	**19.2**	**4.7**	**35.1**	**24.6**
3	**1.7**	**16.2**	**2.7**	**13.5**	**44.5**	**9.9**	**0.6**	**4.2**	**67.9**	**4.8**	**74.4**	**75.4**
4	**0.8**	**31.3**	**2.1**	**29.1**	**128.3**	**25.5**	**4.7**	**29.8**	**182.9**	**34.5**	**218.3**	**219.6**
5	**0.4**	**13.5**	**0.5**	**13.1**	**65.6**	**12.9**	**0.6**	**7.3**	**91.6**	**7.9**	**99.9**	**99.9**
6	**0.4**	**18.4**	**0.7**	**17.7**	**83.1**	**12.5**	**0.5**	**14.0**	**113.3**	**14.5**	**128.2**	**128.5**
7	**0.1**	**4.5**	**0.2**	**4.3**	**13.2**	**4.4**	**0.2**	**5.4**	**21.9**	**5.6**	**27.6**	**27.7**
8	**0.0**	**6.2**	**0.1**	**6.1**	**17.0**	**3.3**	**0.1**	**2.1**	**26.5**	**2.2**	**28.7**	**28.8**
9+	**0.0**	**3.5**	**0.1**	**3.5**	**6.1**	**0.5**	**0.0**	**0.2**	**10.2**	**0.2**	**10.4**	**10.4**
Sum	**31.9**	**100.1**	**7.0**	**93.1**	**369.6**	**96.1**	**7.2**	**67.4**	**558.8**	**74.6**	**665.3**	**640.4**
Quarter: 1												
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	**0.0**
1	3.4	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.5	0.0	**3.9**	**0.5**
2	8.4	0.1	0.0	0.1	0.3	0.0	0.0	0.1	0.4	0.1	**8.9**	**0.5**
3	1.3	1.2	0.0	1.2	4.3	0.1	0.2	0.6	5.6	0.8	**7.7**	**6.4**
4	0.1	3.1	0.0	3.1	15.5	0.4	1.9	6.1	19.0	8.0	**27.1**	**27.0**
5	0.0	0.1	0.0	0.1	7.9	0.2	0.2	1.0	8.2	1.3	**9.5**	**9.4**
6	0.0	0.7	0.0	0.7	8.9	0.2	0.3	0.6	9.8	0.9	**10.8**	**10.8**
7	0.0	0.0	0.0	0.0	0.8	0.0	0.2	0.6	0.8	0.8	**1.7**	**1.6**
8	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.3	1.2	0.3	**1.5**	**1.5**
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	**13.3**	**5.2**	**0.0**	**5.2**	**38.9**	**1.5**	**2.7**	**9.4**	**45.6**	**12.1**	**71.0**	**57.7**
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	1.3	0.1	0.0	0.1	0.1	0.7	0.0	0.0	0.9	0.0	**2.2**	**0.9**
2	1.3	5.1	0.1	5.0	5.6	0.2	0.0	0.0	10.9	0.0	**12.2**	**11.0**
3	0.1	12.3	1.6	10.7	12.6	0.4	0.0	0.0	23.7	0.0	**23.8**	**25.3**
4	0.0	22.4	0.7	21.7	37.8	2.3	0.0	0.0	61.8	0.0	**61.9**	**62.5**
5	0.0	5.0	0.1	4.9	10.7	0.4	0.0	0.0	16.0	0.0	**16.0**	**16.1**
6	0.0	6.4	0.2	6.2	15.3	0.2	0.0	0.0	21.8	0.0	**21.8**	**22.0**
7	0.0	1.9	0.1	1.9	3.5	0.2	0.0	0.0	5.6	0.0	**5.6**	**5.7**
8	0.0	1.1	0.0	1.1	2.2	0.0	0.0	0.0	3.4	0.0	**3.4**	**3.4**
9+	0.0	0.3	0.0	0.3	0.5	0.0	0.0	0.0	0.7	0.0	**0.7**	**0.7**
Sum	**2.8**	**54.7**	**2.8**	**51.9**	**88.4**	**4.5**	**0.0**	**0.0**	**144.8**	**0.1**	**147.6**	**147.6**
Quarter: 3												
0	0.8	0.0	0.0	0.0	0.0	4.6	0.0	0.0	4.6	0.0	**5.3**	**4.6**
1	7.1	0.0	0.0	0.0	0.0	1.2	0.0	0.0	1.3	0.0	**8.4**	**1.3**
2	0.9	1.1	0.6	0.5	5.0	1.6	0.0	0.0	7.0	0.0	**7.9**	**7.6**
3	0.2	2.0	1.1	0.9	23.6	8.6	0.0	0.0	33.1	0.0	**33.4**	**34.3**
4	0.3	2.6	1.5	1.1	66.0	21.5	0.0	0.0	88.7	0.0	**89.0**	**90.2**
5	0.1	0.6	0.3	0.2	42.9	11.7	0.0	0.0	54.9	0.0	**55.0**	**55.2**
6	0.0	0.9	0.5	0.4	54.4	11.0	0.0	0.0	65.8	0.0	**65.8**	**66.3**
7	0.0	0.3	0.1	0.1	8.5	4.0	0.0	0.0	12.6	0.0	**12.6**	**12.8**
8	0.0	0.1	0.1	0.0	12.7	2.9	0.0	0.0	15.6	0.0	**15.6**	**15.7**
9+	0.0	0.1	0.1	0.0	5.5	0.5	0.0	0.0	6.1	0.0	**6.1**	**6.1**
Sum	**9.5**	**7.6**	**4.3**	**3.3**	**218.7**	**67.7**	**0.0**	**0.0**	**289.7**	**0.0**	**299.2**	**294.0**
Quarter: 4												
0	0.8	0.0	0.0	0.0	0.0	5.1	0.1	0.0	5.1	0.1	**6.0**	**5.2**
1	3.8	0.0	0.0	0.0	0.2	12.7	0.1	0.0	12.9	0.2	**16.8**	**13.0**
2	0.6	0.0	0.0	0.0	0.6	0.4	0.3	4.3	0.9	4.6	**6.1**	**5.5**
3	0.1	0.8	0.0	0.8	4.0	0.7	0.5	3.5	5.4	4.0	**9.5**	**9.4**
4	0.4	3.2	0.0	3.2	9.0	1.3	2.8	23.7	13.5	26.5	**40.4**	**40.0**
5	0.2	7.9	0.0	7.9	4.1	0.7	0.3	6.2	12.6	6.6	**19.4**	**19.2**
6	0.3	10.3	0.0	10.3	4.5	1.0	0.2	13.3	15.9	13.6	**29.7**	**29.4**
7	0.1	2.3	0.0	2.3	0.4	0.2	0.0	4.8	2.8	4.8	**7.7**	**7.6**
8	0.0	5.0	0.0	5.0	0.9	0.4	0.1	1.9	6.3	1.9	**8.2**	**8.2**
9+	0.0	3.2	0.0	3.2	0.1	0.0	0.0	0.2	3.3	0.2	**3.5**	**3.5**
Sum	**6.3**	**32.6**	**0.0**	**32.6**	**23.7**	**22.4**	**4.4**	**58.0**	**78.7**	**62.4**	**147.5**	**141.1**

Table 2.2.5: North Sea autumn spawning herring (NSAS), and western Baltic spring spawners (WBSS) caught in the North Sea in 2005. 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	**16.3%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**54.7%**	**7.4%**	**0.0%**	**22.1%**	**0.9%**	**19.5%**	**19.7%**
1	**52.1%**	**0.2%**	**0.0%**	**0.3%**	**0.1%**	**23.8%**	**7.7%**	**0.1%**	**9.7%**	**1.0%**	**13.7%**	**8.8%**
2	**27.0%**	**9.2%**	**14.6%**	**8.8%**	**4.9%**	**1.0%**	**3.6%**	**8.5%**	**3.8%**	**7.9%**	**6.8%**	**4.3%**
3	**2.7%**	**19.1%**	**38.9%**	**17.4%**	**14.7%**	**3.4%**	**8.6%**	**7.4%**	**10.5%**	**7.5%**	**9.3%**	**10.4%**
4	**0.9%**	**35.1%**	**28.3%**	**35.7%**	**38.3%**	**8.2%**	**58.6%**	**50.4%**	**25.8%**	**51.4%**	**25.3%**	**28.4%**
5	**0.4%**	**11.5%**	**5.7%**	**12.0%**	**16.0%**	**3.6%**	**6.4%**	**10.0%**	**10.4%**	**9.6%**	**9.2%**	**10.3%**
6	**0.4%**	**15.1%**	**8.4%**	**15.7%**	**18.9%**	**3.4%**	**5.3%**	**15.7%**	**12.2%**	**14.5%**	**11.1%**	**12.4%**
7	**0.1%**	**3.3%**	**2.4%**	**3.4%**	**2.8%**	**1.1%**	**1.9%**	**5.5%**	**2.2%**	**5.1%**	**2.2%**	**2.5%**
8	**0.0%**	**4.1%**	**0.9%**	**4.4%**	**3.2%**	**0.8%**	**0.4%**	**2.1%**	**2.4%**	**1.9%**	**2.1%**	**2.3%**
9+	**0.0%**	**2.3%**	**0.7%**	**2.4%**	**1.2%**	**0.1%**	**0.0%**	**0.2%**	**0.9%**	**0.2%**	**0.8%**	**0.8%**
Sum 3+	**4.5%**	**90.5%**	**85.3%**	**91.0%**	**95.0%**	**20.5%**	**81.3%**	**91.4%**	**64.3%**	**90.2%**	**59.9%**	**67.2%**
Quarter: 1												
0	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**	**0.0%**
1	41.1%	0.1%	-	0.1%	0.0%	81.4%	2.1%	0.0%	8.8%	0.4%	**18.2%**	**6.9%**
2	53.0%	1.9%	-	1.9%	1.2%	0.2%	0.0%	1.2%	1.2%	1.0%	**18.3%**	**1.1%**
3	5.3%	24.3%	-	24.3%	13.9%	2.7%	7.8%	8.4%	13.9%	8.3%	**10.2%**	**12.6%**
4	0.4%	59.8%	-	59.8%	43.1%	8.3%	70.5%	69.2%	41.2%	69.5%	**32.1%**	**47.9%**
5	0.1%	1.2%	-	1.2%	18.4%	3.4%	7.8%	9.6%	14.8%	9.2%	**9.0%**	**13.5%**
6	0.1%	11.9%	-	11.9%	19.6%	3.3%	7.8%	5.2%	17.0%	5.7%	**9.6%**	**14.3%**
7	0.1%	0.5%	-	0.5%	1.5%	0.3%	3.9%	4.4%	1.3%	4.3%	**1.4%**	**2.0%**
8	0.0%	0.2%	-	0.2%	2.1%	0.4%	0.0%	2.0%	1.7%	1.6%	**1.1%**	**1.7%**
9+	0.0%	0.1%	-	0.1%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	**0.0%**	**0.1%**
Sum 3+	**6.0%**	**98.0%**	-	**98.0%**	**98.8%**	**18.4%**	**97.9%**	**98.8%**	**90.0%**	**98.6%**	**63.5%**	**92.0%**
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	68.6%	0.4%	0.0%	0.4%	0.2%	55.0%	78.8%	0.0%	4.1%	62.1%	**8.6%**	**4.1%**
2	28.9%	11.9%	4.8%	12.3%	9.4%	3.3%	0.0%	1.2%	10.0%	0.3%	**11.3%**	**9.9%**
3	1.7%	23.8%	58.9%	21.9%	15.9%	5.3%	1.7%	8.4%	17.4%	3.1%	**16.3%**	**18.2%**
4	0.4%	41.7%	23.7%	42.6%	44.8%	28.6%	15.2%	69.2%	42.8%	26.7%	**39.9%**	**42.4%**
5	0.1%	8.1%	4.6%	8.3%	10.4%	3.8%	1.7%	9.6%	9.2%	3.4%	**8.5%**	**9.1%**
6	0.1%	9.7%	5.5%	9.9%	14.0%	2.2%	1.7%	5.2%	11.6%	2.4%	**10.8%**	**11.5%**
7	0.1%	2.8%	1.6%	2.9%	3.2%	1.7%	0.8%	4.4%	3.0%	1.6%	**2.8%**	**2.9%**
8	0.0%	1.4%	0.8%	1.4%	1.7%	0.2%	0.0%	2.0%	1.5%	0.4%	**1.4%**	**1.5%**
9+	0.0%	0.4%	0.2%	0.4%	0.4%	0.0%	0.0%	0.0%	0.4%	0.0%	**0.4%**	**0.4%**
Sum 3+	**2.4%**	**87.8%**	**95.2%**	**87.4%**	**90.5%**	**41.7%**	**21.2%**	**98.8%**	**85.9%**	**37.7%**	**80.1%**	**86.0%**
Quarter: 3												
0	33.2%	0.0%	0.0%	0.0%	0.0%	62.8%	0.0%	0.0%	29.8%	0.0%	**30.1%**	**29.4%**
1	59.6%	0.0%	0.0%	0.0%	0.0%	4.8%	0.0%	0.2%	2.3%	0.2%	**7.5%**	**2.3%**
2	4.6%	21.4%	21.4%	21.4%	3.9%	1.2%	8.0%	13.8%	2.8%	12.6%	**3.0%**	**3.1%**
3	1.0%	25.0%	25.0%	25.0%	13.5%	5.3%	12.0%	6.5%	9.7%	7.6%	**9.0%**	**9.9%**
4	1.0%	31.5%	31.5%	31.5%	33.2%	11.7%	66.4%	51.1%	22.9%	54.2%	**21.0%**	**23.1%**
5	0.4%	6.5%	6.5%	6.5%	18.2%	5.7%	7.2%	9.9%	12.2%	9.3%	**11.1%**	**12.1%**
6	0.1%	10.5%	10.5%	10.5%	21.5%	5.3%	4.8%	12.2%	13.7%	10.7%	**12.5%**	**13.7%**
7	0.0%	3.0%	3.0%	3.0%	3.2%	1.7%	0.8%	4.4%	2.5%	3.6%	**2.3%**	**2.5%**
8	0.0%	1.0%	1.0%	1.0%	4.4%	1.2%	0.8%	1.5%	2.8%	1.4%	**2.6%**	**2.8%**
9+	0.0%	1.0%	1.0%	1.0%	2.0%	0.2%	0.0%	0.5%	1.2%	0.4%	**1.1%**	**1.2%**
Sum 3+	**2.6%**	**78.6%**	**78.6%**	**78.6%**	**96.1%**	**31.2%**	**92.0%**	**86.0%**	**65.1%**	**87.2%**	**59.5%**	**65.3%**
Quarter: 4												
0	34.8%	0.0%	0.0%	0.0%	0.0%	52.1%	12.6%	0.0%	36.7%	1.2%	**27.2%**	**26.6%**
1	52.9%	0.0%	0.0%	0.0%	1.0%	43.7%	9.3%	0.1%	31.0%	1.0%	**24.6%**	**22.5%**
2	5.8%	0.1%	0.1%	0.1%	3.0%	0.5%	6.2%	10.5%	0.8%	10.1%	**3.6%**	**3.4%**
3	0.6%	2.7%	0.0%	2.7%	19.5%	0.7%	9.4%	7.1%	3.9%	7.3%	**4.5%**	**4.8%**
4	2.3%	11.3%	0.0%	11.3%	40.8%	1.2%	51.8%	45.3%	8.7%	45.9%	**18.1%**	**19.2%**
5	1.3%	25.6%	0.0%	25.6%	15.4%	0.6%	5.6%	10.1%	6.4%	9.7%	**6.9%**	**7.3%**
6	1.8%	32.3%	0.0%	32.3%	16.2%	0.8%	3.7%	18.5%	7.7%	17.2%	**9.8%**	**10.4%**
7	0.3%	5.8%	0.0%	5.8%	1.1%	0.1%	0.6%	5.8%	1.1%	5.4%	**2.2%**	**2.3%**
8	0.2%	13.5%	0.0%	13.5%	2.7%	0.3%	0.6%	2.2%	2.6%	2.0%	**2.3%**	**2.4%**
9+	0.0%	8.6%	0.0%	8.6%	0.3%	0.0%	0.0%	0.3%	1.3%	0.3%	**0.9%**	**1.0%**
Sum 3+	**6.4%**	**99.8%**	**0.0%**	**99.9%**	**96.0%**	**3.7%**	**71.8%**	**89.4%**	**31.6%**	**87.8%**	**44.6%**	**47.5%**

Table 2.2.6: Total catch of herring in the North Sea and Div. IIIa: North Sea autumn spawners (NSAS). Catch in numbers (millions) at mean weight-at-age (kg) by fleet, and SOP catches ('000 t). SOP catch might deviate from reported catch as used for the assessment.

2002	Fleet A		Fleet B		Fleet C		Fleet D		TOTAL	
Total		Mean		Mean		Mean		Mean		**Mean**
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight	**Numbers**	**Weight**
0			318.8	0.013	10.2	0.015	468.3	0.012	**797.3**	**0.013**
1	77.5	0.082	412.9	0.025	201.0	0.054	161.6	0.018	**852.9**	**0.036**
2	427.2	0.129	77.8	0.050	51.5	0.101	5.2	0.096	**561.7**	**0.115**
3	874.3	0.153	23.5	0.114	5.1	0.120	0.5	0.136	**903.4**	**0.151**
4	281.5	0.169	1.7	0.169	0.7	0.143	0.1	0.143	**283.9**	**0.169**
5	131.4	0.199	1.6	0.180	0.2	0.161	0.0	0.170	**133.2**	**0.198**
6	159.7	0.215	1.4	0.193	0.1	0.179	0.0	0.180	**161.2**	**0.214**
7	46.0	0.228	0.2	0.228	0.0	0.177	0.0	0.000	**46.3**	**0.227**
8	33.2	0.250	0.2	0.244	0.0	0.221	0.0	0.179	**33.4**	**0.250**
9+	7.2	0.253							**7.2**	**0.253**
TOTAL	2,038		838.1		268.8		635.7		**3,780**	
SOP catch		**323.4**		**22.1**		**17.1**		**9.1**		**371.7**

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

2003	Fleet A		Fleet B		Fleet C		Fleet D		TOTAL	
Total		Mean		Mean		Mean		Mean		**Mean**
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight	**Numbers**	**Weight**
0	1.7	0.038	345.8	0.013	1.9	0.013	19.7	0.021	**369.1**	**0.014**
1	59.2	0.078	112.8	0.030	167.5	0.054	277.5	0.021	**617.0**	**0.037**
2	952.9	0.115	69.2	0.048	142.1	0.073	40.2	0.048	**1,204.5**	**0.104**
3	502.0	0.158	1.9	0.123	12.4	0.124	0.7	0.099	**516.9**	**0.157**
4	799.1	0.174	4.4	0.133	16.0	0.151	0.2	0.128	**819.7**	**0.173**
5	240.5	0.185	0.4	0.162	1.8	0.163	0.0	0.174	**242.7**	**0.184**
6	104.7	0.204	0.4	0.173	1.1	0.193	0.1	0.152	**106.2**	**0.204**
7	118.8	0.221	0.5	0.178	1.2	0.214	0.0	0.244	**120.5**	**0.221**
8	36.8	0.232	0.1	0.178	0.2	0.187	0.0	0.180	**37.1**	**0.232**
9+	8.3	0.253							**8.3**	**0.253**
TOTAL	2,824		535.5		344.1		338.4		**4,042**	
SOP catch		**434.8**		**12.3**		**24.1**		**8.4**		**479.6**

Figures for A fleet include 3809 t unsampled bycatch in the industrial fishery

2004	Fleet A		Fleet B		Fleet C		Fleet D		TOTAL	
Total		Mean		Mean		Mean		Mean		**Mean**
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight	**Numbers**	**Weight**
0			627.2	0.013	13.2	0.024	75.2	0.022	**715.6**	**0.014**
1	2.7	0.073	133.0	0.025	18.8	0.060	52.1	0.054	**206.7**	**0.036**
2	252.9	0.121	5.9	0.039	114.2	0.069	65.7	0.073	**438.8**	**0.099**
3	1298.6	0.138	6.8	0.096	12.0	0.120	8.7	0.121	**1,326.1**	**0.137**
4	510.6	0.183	2.9	0.137	4.4	0.138	1.6	0.147	**519.5**	**0.182**
5	714.6	0.206	1.9	0.175	8.7	0.149	1.0	0.171	**726.2**	**0.205**
6	168.6	0.221	0.8	0.168	1.6	0.169	0.2	0.185	**171.1**	**0.220**
7	99.1	0.229	0.2	0.217	1.9	0.187	0.1	0.183	**101.2**	**0.228**
8	69.7	0.241	0.5	0.232	0.8	0.178	0.0	0.213	**71.1**	**0.241**
9+	22.0	0.265							**22.0**	**0.265**
TOTAL	3,139		779.1		175.7		204.7		**4,298**	
SOP catch		**532.8**		**13.6**		**13.4**		**10.8**		**570.6**

Figures for A fleet include 4984 t unsampled bycatch in the industrial fishery

2005	Fleet A		Fleet B		Fleet C		Fleet D		TOTAL	
Total		Mean		Mean		Mean		Mean		**Mean**
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight	**Numbers**	**Weight**
0	0.4	0.119	918.7	0.011	11.3	0.027	85.1	0.015	**1,015.6**	**0.011**
1	42.3	0.088	365.8	0.033	174.6	0.065	132.9	0.032	**715.5**	**0.044**
2	196.3	0.122	0.0	0.000	115.9	0.072	43.3	0.068	**355.4**	**0.099**
3	469.5	0.155	0.0	0.000	12.4	0.106	3.7	0.105	**485.7**	**0.153**
4	1313.0	0.166	0.0	0.000	4.7	0.154	0.6	0.158	**1,318.4**	**0.166**
5	477.6	0.208	0.0	0.000	2.1	0.175	0.2	0.157	**479.9**	**0.208**
6	573.6	0.223	0.0	0.000	1.9	0.189	0.3	0.160	**575.9**	**0.223**
7	114.7	0.240	0.0	0.000	0.3	0.216	0.2	0.178	**115.2**	**0.240**
8	107.8	0.266	0.0	0.000	0.2	0.209	0.0	0.000	**108.0**	**0.266**
9+	39.1	0.265	0.0	0.000					**39.1**	**0.265**
TOTAL	3,334		1,284.5		323.5		266.4		**5,209**	
SOP catch		**611.7**		**21.8**		**22.9**		**9.0**		**665.4**

Figures for A fleet include 998 t unsampled bycatch in the industrial fishery

Table 2.2.7: Catch at age (numbers in millions) of herring caught in the North Sea, 1991-2005.
SG Rednose's revisions for 1995-2001 are included (see Sect. 2.2.3).

Year/rings	0	1	2	3	4	5	6	7	8	9+	Numbers
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	6294	484	1319	818	244	122	57	43	69	29	9480
1996	1795	645	488	516	170	57	22	9	17	4	3723
1997	364	174	565	428	285	109	31	12	19	6	1993
1998	208	254	1084	525	267	179	89	14	17	4	2642
1999	968	73	487	1034	289	134	70	28	10	2	3096
2000	873	194	516	453	636	212	82	36	15	3	3019
2001	1025	58	678	473	279	319	92	39	18	2	2982
2002	319	490	513	913	294	136	164	47	34	7	2917
2003	347	172	1022	507	809	244	106	121	37	8	3375
2004	627	136	274	1333	517	721	170	100	70	22	3970
2005	919	408	203	487	1326	480	577	116	108	39	4664

Table 2.2.8: Catch at age (numbers in millions) of Baltic Spring spawning Herring taken in the North Sea, and transfere
to the assessment of the spring spawning stock in IIIa, 1991-2005.

Year/rings	0	1	2	3	4	5	6	7	8	9+	Numbers
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	0.7	0.0	57.8
1996	-	-	0.0	2.8	0.8	0.4	0.1	0.1	0.3	0.0	4.5
1997	-	-	2.2	1.3	1.5	0.4	0.2	0.1	0.2	0.0	5.9
1998	-	5.1	9.5	12.0	10.1	6.0	3.0	0.4	0.9	0.0	47.0
1999	-	-	3.3	14.3	5.6	3.6	1.4	0.6	0.4	0.0	29.3
2000	-	-	8.2	9.8	10.2	5.7	2.5	0.6	0.7	0.1	37.6
2001	-	-	11.3	10.2	6.1	7.2	2.7	1.6	0.4	0.0	39.9
2002	-	-	7.6	14.8	10.6	3.3	2.9	1.0	0.5	0.1	40.8
2003	-	-	0.0	3.1	6.0	3.5	1.2	1.3	0.5	0.1	15.7
2004	-	-	15.1	27.9	3.5	4.1	1.0	0.5	0.1	0.0	52.3
2005	-	-	6.6	17.4	12.7	2.6	3.8	1.1	0.4	0.3	44.8

Table 2.2.9: Catch at age (numbers in millions) of North Sea Autumn Spawners taken in IIIa, and transfered to the ass
ment of NSAS, 1991 - 2005. Figures for 1991-1999 were altered in 2001 and 2002, but for 1991-1995 n
n the assessment. SG Rednose's revisions and the revision of 2002 splitting are included (see Sect. 2.2.3).

Year/rings	0	1	2	3	4	5	6	7	8+	Numbers
1991	677	748	298	52	8	5	1	0	0	1791
1992	2298	1409	220	22	10	7	3	1	0	3971
1993	2795	2033	238	27	8	4	3	2	1	5109
1994	482	1087	201	27	6	3	2	0	0	1807
1995	1145	1181	147	10	3	1	1	0	0	2487
1996	516	961	154	13	3	1	1	0	0	1649
1997	68	305	125	20	1	1	0	0	0	521
1998	51	729	145	25	19	3	3	1	0	977
1999	598	231	133	39	10	5	1	1	0	1017
2000	232	978	115	20	21	7	3	1	0	1377
2001	808	557	140	15	1	0	0	0	0	1521
2002	411	345	48	5	1	0	0	0	0	811
2003	22	445	182	13	16	2	1	1	0	682
2004	88	71	180	21	6	10	2	2	1	380
2005	96	307	159	16	5	2	2	0	0	590

Table 2.2.10: Catch at age (numbers in millions) of the total North Sea Autumn Spawning stock 1991 - 2005. Figures
1991-1999 were altered in 2001 and 2002, but for 1991-1995 not used in the assessment.
SG Rednose's revisions and the revision of 2002 splitting are included (see Sect. 2.2.3).

Year/rings	0	1	2	3	4	5	6	7	8	9+	Numbers
1991	2405	2198	1157	500	537	493	203	39	25	13	7570
1992	10390	2470	1342	445	376	368	383	156	40	23	15994
1993	10280	4160	1305	577	295	210	221	184	86	41	17358
1994	4437	1890	1839	449	332	103	88	74	68	45	9325
1995	7438	1665	1444	817	232	119	55	41	69	29	11909

Table 2.2.11 Comparison of mean weights (kg) at age (rings) in the catch of adult herring in the North Sea (by Div.) and North Sea autumn spawners caught in Div. IIIa in 1995 – 2005. SG Rednose's revisions for 1995 – 2001 are included.

		Age (Rings)							
Div.	Year	2	3	4	5	6	7	8	9+
IIIa*	1995	0.084	0.135	0.159	0.203	0.203	0.239	0.244	-
	1996	0.078	0.110	0.160	0.182	0.215	0.215	0.244	-
	1997	0.066	0.122	0.155	0.176	0.175	0.179	0.185	-
	1998	0.078	0.118	0.163	0.180	0.197	0.179	0.226	-
	1999	0.084	0.113	0.141	0.161	0.181	0.206	0.199	-
	2000	0.076	0.103	0.162	0.190	0.184	0.186	0.177	-
	2001	0.073	0.105	0.128	0.133	0.224	0.170	0.192	-
	2002	0.104	0.126	0.144	0.164	0.180	0.180	0.218	-
	2003	0.067	0.123	0.150	0.163	0.191	0.214	0.187	-
	2004	0.070	0.121	0.141	0.152	0.170	0.187	0.178	-
	2005	0.071	0.106	0.155	0.173	0.185	0.200	0.209	-
IVa(E)	1995	0.134	0.158	0.193	0.215	0.233	0.227	0.245	0.242
	1996	0.131	0.141	0.168	0.196	0.217	0.218	0.242	0.300
	1997	0.122	0.149	0.174	0.204	0.228	0.229	0.221	0.313
	1998	0.114	0.148	0.171	0.199	0.219	0.237	0.269	0.233
	1999	0.125	0.143	0.162	0.191	0.207	0.226	0.232	0.272
	2000	0.130	0.154	0.172	0.195	0.202	0.218	0.261	0.256
	2001	0.121	0.148	0.165	0.177	0.197	0.220	0.262	0.238
	2002	0.130	0.154	0.167	0.189	0.198	0.212	0.229	0.238
	2003	0.122	0.154	0.162	0.177	0.189	0.203	0.213	0.218
	2004	0.119	0.133	0.171	0.185	0.212	0.192	0.218	0.252
	2005	0.117	0.146	0.153	0.202	0.209	0.233	0.262	0.265
IVa(W)	1995	0.144	0.186	0.218	0.221	0.267	0.268	0.307	0.286
	1996	0.131	0.167	0.215	0.218	0.237	0.275	0.301	0.278
	1997	0.127	0.166	0.218	0.248	0.246	0.262	0.294	0.289
	1998	0.130	0.170	0.205	0.244	0.263	0.270	0.308	0.314
	1999	0.129	0.162	0.192	0.227	0.250	0.261	0.272	0.309
	2000	0.127	0.159	0.187	0.214	0.237	0.271	0.293	0.265
	2001	0.138	0.168	0.193	0.222	0.235	0.266	0.285	0.296
	2002	0.144	0.161	0.191	0.211	0.230	0.242	0.261	0.263
	2003	0.130	0.167	0.184	0.202	0.224	0.237	0.259	0.276
	2004	0.131	0.155	0.193	0.220	0.242	0.251	0.246	0.299
	2005	0.122	0.158	0.174	0.213	0.229	0.245	0.275	0.267
IVb	1995	0.136	0.176	0.201	0.214	0.257	0.267	0.271	0.296
	1996	0.111	0.184	0.209	0.230	0.249	0.297	0.282	0.287
	1997	0.124	0.170	0.210	0.230	0.259	0.263	0.286	0.286
	1998	0.117	0.162	0.203	0.216	0.243	0.218	0.311	0.307
	1999	0.118	0.148	0.154	0.207	0.226	0.209	0.287	0.345
	2000	0.118	0.173	0.194	0.224	0.229	0.251	0.240	0.268
	2001	0.105	0.150	0.176	0.188	0.199	0.206	0.244	0.275
	2002	0.086	0.149	0.161	0.206	0.214	0.189	0.270	0.241
	2003	0.098	0.161	0.178	0.195	0.214	0.214	0.222	0.281
	2004	0.118	0.143	0.186	0.214	0.234	0.239	0.297	0.308
	2005	0.132	0.172	0.187	0.217	0.220	0.245	0.253	0.252
IVa & IVb	1995	0.139	0.174	0.206	0.218	0.256	0.255	0.286	0.276
	1996	0.124	0.162	0.199	0.215	0.236	0.267	0.282	0.288
	1997	0.125	0.161	0.202	0.233	0.245	0.254	0.264	0.291
	1998	0.123	0.162	0.194	0.224	0.243	0.253	0.293	0.283
	1999	0.124	0.155	0.179	0.213	0.236	0.250	0.264	0.301
	2000	0.125	0.162	0.185	0.210	0.227	0.258	0.275	0.263
	2001	0.129	0.156	0.180	0.202	0.217	0.242	0.275	0.285
	2002	0.119	0.157	0.177	0.203	0.219	0.228	0.253	0.253
	2003	0.113	0.163	0.178	0.190	0.210	0.225	0.239	0.255
	2004	0.122	0.147	0.187	0.210	0.227	0.233	0.247	0.266
	2005	0.121	0.157	0.172	0.212	0.225	0.242	0.269	0.265
IVc & VIId	1995	0.117	0.140	0.169	0.190	0.207	0.212	0.209	0.245
	1996	0.121	0.143	0.159	0.185	0.194	0.203	0.155	-
	1997	0.101	0.133	0.156	0.168	0.166	0.190	0.163	-
	1998	0.096	0.114	0.146	0.149	0.184	0.000	0.176	-
	1999	0.116	0.139	0.159	0.189	0.198	0.217	-	-
	2000	0.106	0.133	0.150	0.180	0.194	0.203	-	-
	2001	0.113	0.138	0.171	0.167	0.171	0.168	0.180	-
	2002	0.108	0.123	0.153	0.170	0.187	0.219	0.208	-
	2003	0.103	0.127	0.144	0.168	0.176	0.188	0.200	0.227
	2004	0.099	0.113	0.135	0.162	0.184	0.191	0.186	0.224
	2005	0.122	0.132	0.139	0.170	0.207	0.228	0.237	0.245
Total North Sea Catch	1995	0.135	0.169	0.199	0.207	0.244	0.248	0.283	0.276
	1996	0.123	0.157	0.189	0.205	0.212	0.262	0.280	0.288
	1997	0.118	0.149	0.195	0.227	0.227	0.235	0.245	0.291
	1998	0.119	0.146	0.185	0.219	0.239	0.253	0.288	0.283
	1999	0.123	0.152	0.172	0.208	0.233	0.246	0.264	0.301
	2000	0.122	0.159	0.180	0.202	0.217	0.247	0.275	0.263
	2001	0.127	0.150	0.178	0.197	0.212	0.236	0.267	0.285
	2002	0.118	0.152	0.168	0.198	0.214	0.227	0.250	0.253
	2003	0.111	0.157	0.174	0.185	0.204	0.221	0.232	0.254
	2004	0.120	0.137	0.182	0.206	0.221	0.229	0.241	0.265
	2005	0.121	0.155	0.166	0.208	0.223	0.239	0.266	0.265

*** Figures for 1991 – 1999 altered in 2002 but the 1991 – 1995 updated figures were still not included in the assessment**

Table 2.2.12: Sampling of commercial landings of herring in the North Sea (Div. IV and VIId) in 2005 by quarter. Sampled catch means the proportion of the reported catch to which sampling was applied. It is limited by 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 sampled their by-catches in the industrial fishery (Denmark, fleet B). Metiers are each *reported* combination of nation/fleet/area/quarter.

Country (fleet)	Quarter	No of metiers	Metiers sampled	Sampled Catch %	Official Catch	No. of samples	No. fish aged	No. fish measured	>1 sample per 1 kt catch
Belgium	4	1	0	0%	6	0	0	0	n
total		**1**	**0**	**0%**	**6**	**0**	**0**	**0**	**n**
Denmark (A)	1	3	2	97%	39242	25	686	3617	n
	2	3	2	100%	7293	4	104	603	n
	3	3	2	100%	36228	31	792	4136	n
	4	3	2	96%	23956	9	301	1552	n
total		**12**	**8**	**98%**	**106719**	**69**	**1883**	**9908**	**n**
Denmark (B)	1	2	1	98%	534	4	17	17	y
	2	2	1	98%	721	5	7	7	y
	3	1	1	100%	5681	20	302	1447	y
	4	2	1	99%	14727	15	285	426	y
total		**7**	**4**	**99%**	**21662**	**44**	**611**	**1897**	**y**
England & Wa	1	2	0	0%	51	0	0	0	n
	2	4	0	0%	6990	0	0	0	n
	3	3	0	0%	12208	0	0	0	n
	4	3	0	0%	6062	0	0	0	n
total		**12**	**0**	**0%**	**25311**	**0**	**0**	**0**	**n**
Faroe Isl	2	1	0	0%	18	0	0	0	n
	3	1	0	0%	720	0	0	0	n
total		**2**	**0**	**0%**	**738**	**0**	**0**	**0**	**n**
France	1	3	0	0%	783	0	0	0	n
	2	4	0	0%	4770	0	0	0	n
	3	4	0	0%	18983	0	0	0	n
	4	2	0	0%	14292	0	0	0	n
total		**13**	**0**	**0%**	**38828**	**0**	**0**	**0**	**n**
Germany	1	2	1	7%	423	4	117	713	y
	2	2	1	97%	4982	10	239	3018	y
	3	4	4	100%	29372	45	912	25015	y
	4	4	1	80%	11778	30	575	13550	y
total		**12**	**7**	**100%**	**46555**	**89**	**1843**	**42296**	**y**
Netherlands	1	3	2	100%	7463	11	275	2586	y
	2	4	2	100%	13500	51	1275	7541	y
	3	2	2	100%	31288	45	1125	4177	y
	4	4	2	100%	29280	10	250	1582	n
total		**13**	**8**	**100%**	**81531**	**117**	**2925**	**15886**	**y**
Northern Irelan	3	1	0	0%	2888	0	0	0	n
	4	1	0	0%	24	0	0	0	n
total		**2**	**0**	**0%**	**2912**	**0**	**0**	**0**	**n**
Norway	1	2	0	0%	2317	0	0	0	n
	2	3	3	100%	86484	30	2962	2978	n
	3	3	1	77%	34258	3	283	284	n
	4	2	1	92%	33743	1	100	100	n
total		**10**	**5**	**92%**	**156802**	**34**	**3345**	**3362**	**n**
Poland	3	1	0	0%	458	0	0	0	n
total		**1**	**0**	**0%**	**458**	**0**	**0**	**0**	**n**
Russia	3	1	0	0%	99	0	0	0	n
total		**1**	**0**	**0%**	**99**	**0**	**0**	**0**	**n**
Scotland	1	2	1	100%	29	1	26	90	y
	2	2	2	100%	5638	17	662	2993	y
	3	4	4	100%	66098	67	4204	12579	y
	4	1	0	0%	1461	0	0	0	n
total		**9**	**7**	**100%**	**73225**	**85**	**4892**	**15662**	**y**
Sweden	2	3	0	0%	7203	0	0	0	n
	3	2	0	0%	4283	0	0	0	n
	4	2	0	0%	1979	0	0	0	n
total		**7**	**0**	**0%**	**13465**	**0**	**0**	**0**	**n**
grand total		**102**	**39**	**95%**	**568312**	**438**	**15499**	**89011**	**n**
Period total	**1**	19	7	100%	50841	45	1121	7023	n
Period total	**2**	28	11	93%	137600	117	5249	17140	n
Period total	**3**	30	14	100%	242565	211	7618	47638	n
Period total	**4**	25	7	80%	137307	65	1511	17210	n
Total for stock 2005		**102**	**39**	**95%**	**568312**	**438**	**15499**	**89011**	**n**
Human Cons. only		95	35	94%	546650	394	14888	87114	n
Total for stock 2003		108	46	90%	414045	533	14568	95347	y
Total for stock 2004		100	39	94%	484159	519	18643	93311	y
Human Cons. only 2004		85	33	95%	470574	450	17928	92389	n

Table 2.3.1.1 North Sea herring numbers (millions) at age (wr) and maturity by ICES Subarea from July acoustic survey 2005. The suffixes i and m refer to the immature and mature fish respectively.

ICES A	IIIA	IVA	IVB	IVC
0	3.5	0.0	4747.7	264.8
1i	118.5	360.7	2613.5	3.1
1m	0.0	7.4	9.4	0.0
2i	6.0	226.9	220.1	0.0
2m	0.0	1341.8	95.4	0.0
3i	1.7	87.3	24.6	0.0
3m	0.4	3196.9	125.5	0.0
4i	1.2	231.1	9.9	0.0
4m	1.2	5149.3	216.6	0.0
5	0.5	1190.6	20.2	0.0
6	0.0	1166.2	6.1	0.0
7	0.0	137.3	2.6	0.0
8	0.0	125.3	1.2	0.0
9+	0.0	106.7	0.0	0.0
Immature	130.8	906.0	7615.8	267.8
Mature	1.7	9224.7	351.4	0.0

Table 2.3.1.2 North Sea herring biomass (thousands of tonnes) at age (wr) and maturity by ICES subarea from July acoustic survey 2005. The suffixes i and m refer to the immature and mature fish respectively.

ICES A	IIIA	IVA	IVB	IVC
0	0.00	0.00	15.17	0.8
1i	5.81	25.95	101.76	0.1
1m	0.00	0.75	0.35	0.0
2i	0.34	23.39	16.26	0.0
2m	0.00	203.57	11.84	0.0
3i	0.18	10.32	3.06	0.0
3m	0.05	556.56	17.63	0.0
4i	0.14	30.40	1.11	0.0
4m	0.14	953.74	28.84	0.0
5	0.06	274.09	2.66	0.0
6	0.00	289.36	0.91	0.0
7	0.00	34.99	0.35	0.0
9	0.00	34.53	0.19	0.0
9+	0.00	31.50	0.00	0.0
Immature	6.48	90.06	137.35	0.9
Mature	0.20	1822.52	45.14	0.0

Table 2.3.1.3 North Sea herring mean weight (g) at age (wr) and maturity by ICES Subarea from July acoustic survey 2005. The suffixes i and m refer to the immature and mature fish respectively.

ICES A	IIIA	IVA	IVB	IVC
0	1.26		3.19	3.17
1i	49.03	71.94	38.94	35.54
1m		101.22	37.76	
2i	56.58	103.09	73.87	
2m		151.72	124.08	
3i	109.77	118.24	124.19	
3m	109.77	174.09	140.46	
4i	120.36	131.54	111.68	
4m	120.36	185.22	133.13	
5	124.44	230.21	131.47	
6		248.12	149.74	
7		254.73	138.50	
8		275.52	159.08	

Table 2.3.1.4 North Sea autumn-spawning herring in the area surveyed in the acoustic surveys July 2005 Total numbers (millions) and biomass (thousands of tonnes) with mean weights (g) and fraction mature by ring.

North Sea	Numbers	Biomass	Maturity	Mean weight	Mean length
Ring	(millions)	Tonnes $*10^3$	(fraction)	(g)	(cm)
0	5015.9	16.0	0.00	3.2	7.9
1	3112.5	134.7	0.01	43.3	17.5
2	1890.2	255.4	0.76	135.1	24.5
3	3436.4	587.8	0.97	171.0	26.2
4	5609.3	1014.4	0.96	180.8	26.6
5	1211.3	276.8	1.00	228.5	28.5
6	1172.3	290.3	1.00	247.6	29.2
7	139.9	35.3	1.00	252.6	29.5
8	126.5	34.7	1.00	274.4	30.2
9+	106.7	31.5	1.00	295.1	30.7
Immature	8920.4	234.8			
Mature	9577.8	1867.9			
Total	21821.0	2676.9			

Table 2.3.1.5 North Sea autumn spawners, estimates of (millions) at age from acoustic surveys, and SSB (thousands of tonnes) 1984-2005. For 1984-1986 the estimates are the sum of those from the Division IVa summer survey, the Division IVb autumn survey, and the Divisions IVc, VIId winter survey. The 1987 to 2000 estimates are from the summer survey in Divisions IVa,b, and IIIa excluding estimates of Division IIIa/Baltic spring spawners. For 1999 & 2000 the Kattegat was excluded from the results because it was not surveyed. The 1996 to 1999 surveys have been revised due to changes in methods for calculating mean weight and proportion adult. The earlier surveys were revised in March 2002 following recent reorganisation of archive, removal of a 9% calibration error on Scottish survey 1999-2000. In 2003 the area was extended to include part of area IVc and provide better coverage for sprat, the increase in biomass due to this change in area was negligible at 0.05%.

AGE (RINGS)	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	551	726	1639	13736	6431	6333	6249	3182	6351	10399	3646	4202	6198	9416	4449	5087	24735	6837	23055	9829	5183	3113
2	3194	2789	3206	4303	4202	3726	2971	2834	4179	3710	3280	3799	4557	6363	5747	3078	2922	12290	4875	18949	3415	1890
3	1005	1433	1637	955	1732	3751	3530	1501	1633	1855	957	2056	2824	3287	2520	4725	2156	3083	8220	3081	9191	3436
4	394	323	833	657	528	1612	3370	2102	1397	909	429	656	1087	1696	1625	1116	3139	1462	1390	4189	2167	5609
5	158	113	135	368	349	488	1349	1984	1510	795	363	272	311	692.1	982.4	506.4	1006	1676	794.6	675.1	2590	1211
6	44	41	36	77	174	281	395	748	1311	788	321	175	98.7	259.2	445.2	313.6	482.5	449.6	1031	494.8	317.1	1172
7	52	17	24	38	43	120	211	262	474	546	238	135	82.8	78.6	170.3	138.6	266.4	169.6	244.4	568.3	327.6	139.9
8	39	23	6	11	23	44	134	112	155	178	220	110	132.9	78.3	45.2	54.3	120.4	97.7	121	145.5	342.1	126.5
9+	41	19	8	20	14	22	43	56	163	116	132	84	206	158.3	121.4	87.2	97.2	58.9	149.5	177.7	185.6	106.7
Total	5478	5484	7542	20165	13496	16377	18262	12781	17173	19326	13003	11220	18786	22028	16104	15107	34928	26124	39881	38110	23722	16805
$Z_{2+/3+}$	.	0.91	0.57	1.02	0.81	0.11	0.10	0.57	0.36	0.72	1.19	0.51	0.42	0.38	0.75	0.51	0.31	0.37	0.48	0.58	0.62	0.44
Smooth $Z_{2+/3+}$	.	-	0.74	0.79	0.91	0.46	0.11	0.34	0.47	0.54	0.96	0.85	0.46	0.40	0.56	0.63	0.41	0.34	0.42	0.53	0.60	0.53
SSB ('000 t)	807	697	942	817	897	1637	2174	1874	1545	1216	1035	1082	1446	1780	1792	1534	1833	2622	2948	2999	2584	1868

Table 2.3.2.1: North Sea autumn spawners. Fortnightly time periods sampled and survey effort in 2005/2006.

NL – Netherlands, FRG – Federal Republic of Germany

Area	Time period	Samples available	Vessel days	Nation	Coverage
Orkney/Shetland	01-15 Sep.	None			
	16-30 Sep.	93	9	FRG	Total
Buchan	01-15 Sep.	None			
	16-30 Sep.	86	6	NL	Total
Central North	01-15 Sep.	None			
Sea	16-30 Sep.	75	5	NL	Total
	01-15 Oct.	None			
Southern North	16-31 Dec.	76	4	NL	Total
Sea	01-15 Jan.	117	7	FRG	Total
	16-31 Jan.	96	5	NL	Total

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

Year	Samples	Vessel-days (sampling)
1988/89	1355	98
1989/90	1300	96
1990/91	634	49
1991/92	738	51
1992/93	498	31
1993/94	491	34
1994/95	450	33
1995/96	421	26
1996/97	469	32
1997/98	456	29
1998/99	531	37
1999/00	645	38
2000/01	696	53
2001/02	534	32
2002/03	533	35
2003/04	568	35
2004/05	483	33
2005/06	543	36

Table 2.3.2.3: North Sea autumn spawners. Estimated abundances of herring larvae <10 mm long (<11 mm for the SNS), by standard sampling area and time periods. The number of larvae are expressed as mean number per ICES rectangle * 10^9

	Orkney/Shetland		Buchan		Central North Sea			Southern North Sea		
Period	1-15 Sep.	16-30 Sep.	1-15 Sep.	16-30 Sep.	1-15 Sep.	16-30 Sep.	1-15 Oct.	16-31 Dec.	1-15 Jan.	16-31 Jan.
1972	1133	4583	30		165	88	134	2	46	
1973	2029	822	3	4	492	830	1213			1
1974	758	421	101	284	81		1184		10	
1975	371	50	312			90	77	1	2	
1976	545	81		1	64	108			3	
1977	1133	221	124	32	520	262	89	1		
1978	3047	50		162	1406	81	269	33	3	
1979	2882	2362	197	10	662	131	507		111	89
1980	3534	720	21	1	317	188	9	247	129	40
1981	3667	277	3	12	903	235	119	1456		70
1982	2353	1116	340	257	86	64	1077	710	275	54
1983	2579	812	3647	768	1459	281	63	71	243	58
1984	1795	1912	2327	1853	688	2404	824	523	185	39
1985	5632	3432	2521	1812	130	13039	1794	1851	407	38
1986	3529	1842	3278	341	1611	6112	188	780	123	18
1987	7409	1848	2551	670	799	4927	1992	934	297	146
1988	7538	8832	6812	5248	5533	3808	1960	1679	162	112
1989	11477	5725	5879	692	1442	5010	2364	1514	2120	512
1990		10144	4590	2045	19955	1239	975	2552	1204	
1991	1021	2397		2032	4823	2110	1249	4400	873	
1992	189	4917		822	10	165	163	176	1616	
1993		66		174		685	85	1358	1103	
1994	26	1179				1464	44	537	595	
1995		8688					43	74	230	164
1996		809		184		564		337	675	691
1997		3611		23				9374	918	355
1998		8528		1490	205	66		1522	953	170
1999		4064		185		134	181	804	1260	344
2000		3352	28	83		376		7346	338	106
2001		11918		164		1604		971	5531	909
2002		6669		1038			3291	2008	260	925
2003		3199		2263		12018	3277	12048	3109	1116
2004		7055		3884		5545		7055	2052	4175
2005		3380		1364		5614		498	3999	4822

Table 2.3.2.4: North Sea autumn spawners. Parameter estimates obtained on fitting the MLAI 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	43	167.7	3.899	8.4	<0.0001
Error	234	108.6	0.464		
C Total	277	276.3			

b) Estimates of parameters

Reference Mean

Estimate	Standard Error	
6.84203	0.55367	Reference: 1972, Orkney/Shetland 09/01 – 09/15

Year Effects

Year	Estimate	Standard Error	Year	Estimate	Standard Error
1973	0.35580	0.68836	1989	2.67017	0.60877
1974	-0.14271	0.73758	1990	2.93199	0.63166
1975	-1.21357	0.74957	1991	2.28105	0.68435
1976	-1.31916	0.73563	1992	1.52494	0.72348
1977	-0.41293	0.70500	1993	1.19585	0.70005
1978	-0.21939	0.71567	1994	0.82072	0.73799
1979	0.45887	0.68884	1995	0.93639	0.72737
1980	0.08507	0.68590	1996	1.60750	0.76610
1981	0.47529	0.68261	1997	1.84465	0.71857
1982	0.83976	0.61974	1998	2.11886	0.67539
1983	1.08712	0.63543	1999	1.93386	0.67909
1984	1.68328	0.61682	2000	1.52417	0.69434
1985	2.10319	0.59501	2001	2.66741	0.70698
1986	1.44902	0.61478	2002	2.50262	0.68621
1987	2.00990	0.60666	2003	3.40549	0.69858
1988	2.69683	0.59483	2004	3.56590	0.74056
			2005	3.05546	0.68945

Sampling Unit Effects

Sampling Unit	Estimate	Standard Error
Or/Shet 16-30 Sep	-0.76912	0.32313
Buchan 01-15 Sep	-1.82087	0.41918
Buchan 16-30 Sep	-2.53133	0.35378
CNS 01-15 Sep	-1.65436	0.40574
CNS 16-30 Sep	-1.46950	0.35525
CNS 01-15 Oct	-2.08176	0.38265
CNS 16-31 Oct	-4.16573	0.52771
SNS 12-31 Dec	-1.86590	0.38197
SNS 01-15 Jan	-2.52268	0.33205
SNS 16-31 Jan	-3.52261	0.36906

Table 2.3.2.5: North Sea autumn spawners. Time-series of the Multiplicative Larval Abundance Index (MLAI). The original MLAI is given in the second column. $MLAI_{plus}$ is the sum of the MLAI and the value of the reference area (Orkney/Shetlands, 1st-15th September 1972). This estimate is then unlogged (eMLAI) and divided by 100 ($MLAI_{assess}$). The $MLAI_{assess}$ describes the time-series that is used in the assessment.

REFERENCE VALUE:	6.84203

YEAR	MLAI	$MLAI_{PLUS}$	EMLAI	$MLAI_{ASSESS}$
1973	0.3558	7.1978	1336.5	**13.37**
1974	-0.1427	6.6993	811.9	**8.12**
1975	-1.2136	5.6285	278.2	**2.78**
1976	-1.3192	5.5229	250.4	**2.50**
1977	-0.4129	6.4291	619.6	**6.20**
1978	-0.2194	6.6226	751.9	**7.52**
1979	0.4589	7.3009	1481.6	**14.82**
1980	0.0851	6.9271	1019.5	**10.20**
1981	0.4753	7.3173	1506.2	**15.06**
1982	0.8398	7.6818	2168.5	**21.68**
1983	1.0871	7.9292	2777.1	**27.77**
1984	1.6833	8.5253	5040.7	**50.41**
1985	2.1032	8.9452	7671.1	**76.71**
1986	1.4490	8.2911	3988.0	**39.88**
1987	2.0099	8.8519	6987.9	**69.88**
1988	2.6968	9.5389	13889.1	**138.89**
1989	2.6702	9.5122	13523.7	**135.24**
1990	2.9320	9.7740	17571.3	**175.71**
1991	2.2811	9.1231	9164.4	**91.64**
1992	1.5249	8.3670	4302.6	**43.03**
1993	1.1959	8.0379	3096.0	**30.96**
1994	0.8207	7.6628	2127.6	**21.28**
1995	0.9364	7.7784	2388.5	**23.88**
1996	1.6075	8.4495	4672.9	**46.73**
1997	1.8447	8.6867	5923.5	**59.23**
1998	2.1189	8.9609	7792.3	**77.92**
1999	1.9339	8.7759	6476.2	**64.76**
2000	1.5242	8.3662	4299.3	**42.99**
2001	2.6674	9.5094	13486.4	**134.86**
2002	2.5026	9.3447	11437.5	**114.37**
2003	3.4055	10.2475	28212.5	**282.12**
2004	3.5659	10.4079	33121.2	**331.21**
2005	3.0555	9.8975	19880.4	**198.80**

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

YEAR OF SAMPLING	2-RINGER	3-RINGER	4-RINGER	5+ RINGER
1983	137.4	46.4	15.3	28.5
1984	169.9	67.0	30.0	10.8
1985	748.1	301.5	47.6	31.2
1986	820.1	288.9	84.1	28.5
1987	946.3	124.0	63.2	53.6
1988	4725.8	915.0	65.4	28.0
1989	933.9	401.2	111.8	10.5
1990	482.1	312.9	292.7	77.1
1991	821.0	288.4	258.7	174.3
1992	410.1	195.1	68.5	109.4
1993	840.8	225.1	46.9	68.6
1994	1176.5	214.4	68.4	43.0
1995	1263.1	251.0	33.2	6.2
1996	209.0	46.6	13.5	9.1
1997	526.6	204.1	42.8	24.3
1998	799.7	96.4	22.0	20.7
1999	456.8	547.8	109	40.3
2000	232.2	169.3	65.5	9.7
2001	1228.1	337.0	106.8	79.0
2002	666.2	323.9	22.8	19.2
2003	1597.7	452.7	354.8	51.5
2004	456.0	759.9	110.9	141.1
*2005	190.2	325.7	402.2	140.3
2006	1436.4	358.5	251.7	338.8

*** Norwegian survey data not included**

Table 2.3.3.2. North Sea herring. Estimates of mean number per hour per statistical rectangle from 1st quarter IBTS 2006. Means for age groups in "Roundfish areas" (*) and in all areas. In the index 2-5+ for all areas, the findings in RF8 and RF9 are not included.

AREA	TOTAL	MEAN PER STATISTICAL RECTANGLE				
		Age group (wr)				
		1	2	3	4	5+
All areas		919.9	1436.4	358.5	251.7	338.8
RF1	2844.2	0.3	117.1	450.6	884.8	1391.7
RF2	10022.6	65.0	7566.3	1610.1	493.5	352.7
RF3	36.9	975.5	30.9	4.4	1.0	0.6
RF4	1351.1	510.8	1304.5	45.9	0.3	0.3
RF5	27.7	145.9	26.3	0.9	0.4	0.1
RF6	147.9	1611.1	146.6	0.9	0.3	0.2
RF7	128.7	1615.0	108.3	7.8	8.1	4.5
RF8	349.9	2977.9	290.3	46.3	7.3	6.0
RF9	1552.8	8990.6	1048.1	433.8	56.9	14.0

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

Table 2.3.3.3. North Sea herring. Indices of 1-ringers from the IBTS 1st Quarter. Estimation of the small sized component (possibly Downs herring) in different areas. " North Sea" = total area of sampling minus IIIa.

Year class	Year of sampling	All 1-ringers in total area (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	11.1	0.07	11.9	0.08	0
1978	1980	342	112.9	0.33	112.5	0.33	0.07
1979	1981	518	57.6	0.11	48.3	0.09	0.22
1980	1982	799	175.34	0.22	184.0	0.23	0.02
1981	1983	1231	188.6	0.15	180.2	0.15	0.11
1982	1984	1469	330.3	0.23	278.5	0.19	0.21
1983	1985	2082	295.5	0.14	276.2	0.13	0.13
1984	1986	2593	585.9	0.23	372.5	0.15	0.41
1985	1987	3734	640.3	0.17	526.9	0.14	0.23
1986	1988	4470	2365.7	0.52	697.5	0.15	0.72
1987	1989	2187	548.8	0.24	488.4	0.21	0.17
1988	1990	1025	69.0	0.07	60.1	0.06	0.19
1989	1991	1180	300.0	0.26	305.4	0.26	0.05
1990	1992	1204	120.9	0.10	125.4	0.11	0.03
1991	1993	2989	754.9	0.26	163.1	0.06	0.8
1992	1994	1644	267.0	0.16	224.9	0.13	0.21
1993	1995	1215	386.3	0.33	380.0	0.32	0.08
1994	1996	1728	537.1	0.31	408.9	0.24	0.29
1995	1997	3993	1179.9	0.29	933.0	0.23	0.26
1996	1998	2067	1168.1	0.57	1231.6	0.60	0.02
1997	1999	715	141.2	0.20	138.8	0.19	0.08
1998	2000	3639	1062.2	0.29	936.1	0.26	0.18
1999	2001	2696	322.6	0.12	302.2	0.11	0.06
2000	2002	3948	1510.9	0.38	1427.6	0.36	0.12
2001	2003	2926	708.4	0.24	201.6	0.07	0.73
2002	2004	980	649.0	0.66	691.5	0.71	0.004
2003	2005	1033	346.6	0.34	363.9	0.35	0.02
2004	2006	**920**	120.6	0.13	126.6	0.14	0.02

Table 2.3.3.4 North Sea herring. Density and abundance estimates of 0-ringers caught in February during the IBTS. Values given for year classes by areas are density estimates in numbers per square metre. Total abundance is found by multiplying density by area and summing up.

AREA	NORTH WEST	NORTH EAST	CENTRAL WEST	CENTRAL EAST	SOUTH WEST	SOUTH EAST	DIV. IIIA	SOUTH' BIGHT	0-RINGER ABUNDANCE
Area m^2 x 10^9	83	34	86	102	37	93	31	31	
Year class									no. in 10^9
1976	0.054	0.014	0.122	0.005	0.008	0.002	0.002	0.016	17.1
1977	0.024	0.024	0.05	0.015	0.056	0.013	0.006	0.034	13.1
1978	0.176	0.031	0.061	0.02	0.01	0.005	0.074	0	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	0.289	0.199	0.215	0.645	0.109	0.036	133.9
1982	0.025	0.011	0.068	0.248	0.29	0.309	0.47	0.14	91.8
1983	0.019	0.007	0.114	0.268	0.271	0.473	0.339	0.377	115
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	0.73	0.557	0.83	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	0.02	0.095	0.096	0.151	0.411	0.181	0.016	71.4
1989	0.083	0.03	0.04	0.094	0.013	0.035	0.041	0	25.9
1990	0.075	0.053	0.202	0.158	0.121	0.198	0.086	0.196	69.9
1991	0.255	0.39	0.431	0.539	0.5	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	0.26	0.187	0.12	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	0.26	0.086	0.699	0.092	0.266	0.018	0.001	0.02	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	0.1	0.056	1.15	0.592	0.998	0.265	0.28	0.127	244.0
1999	0.045	0.011	0.799	0.2	0.514	0.22	0.107	0.026	137.1
2000	0.284	0.011	1.052	0.197	1.156	0.376	0.063	0.006	214.8
2001	0.08	0.019	0.566	0.473	0.567	0.247	0.209	0.226	161.8
2002	0.141	0.04	0.287	0.028	0.121	0.045	0.003	0.157	54.4
2003	0.045	0.005	0.284	0.074	0.106	0.021	0.022	0.154	47.3
2004	0.017	0.010	0.189	0.089	0.268	0.187	0.027	0.198	61.3
2005	0.013	0.018	0.327	0.081	0.633	0.184	0.007	0.131	**83.1**

Table 2.4.1.1: North Sea Herring: Mean weight-at-age (wr) in the third quarter, in Divisions IVa, IVb and IIIa

Ring	Third quarter mean wts in catch (Divisions IVa, IVb & IIIa)											July acoustic survey										
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	63	75	43	54	62	54	69	50	65	45	53	58	45	45	52	52	46	50	45	46	35	43
2	149.7	135.1	129	131	128	123	136	140	119	125	124	132	119	120	109	118	118	127	138	104	116	135
3	192.5	186.3	175	172	163	172	167	177	177	159	177	180	196	168	198	171	180	162	172	185	139	171
4	221	224.3	220	209	193	201	199	200	198	203	201	200	253	233	238	207	218	204	194	209	206	181
5	232.4	229.3	247	237	228	228	218	224	210	234	234	195	262	256	275	236	232	228	224	214	231	229
6	272	252.6	255	263	252	241	237	244	236	250	249	228	299	245	307	267	261	237	247	243	253	248
7	275.8	291.6	278	269	263	266	262	252	247	264	261	257	306	265	289	272	295	255	261	281	262	253
8	317	300.3	295	313	275	286	288	281	272	262	287	302	325	269	308	230	300	286	280	290	279	274
9+	306	302.3	295	298	306	271	298	298	282	299	270	324	335	329	363	260	280	294	249	307	270	295

Weights-at-age in the catch for 1995 to 2001 were revised by SG Rednose for details of the revision see last years report (ICES ACFM 2003/ACFM:10).

Table 2.4.2.1 North Sea herring. Maturity at 2-, 3- and 4+ ring for Autumn Spawning herring in the North Sea. The values are derived from the acoustic survey for 1988 to 2005.

YEAR \ RING	2	3	>3
1988	65.6	87.7	100
1989	78.7	93.9	100
1990	72.6	97.0	100
1991	63.8	98.0	100
1992	51.3	100	100
1993	47.1	62.9	100
1994	72.1	85.8	100
1995	72.6	95.4	100
1996	60.5	97.5	100
1997	64.0	94.2	100
1998	64.0	89.0	100
1999	81.0	91.0	100
2000	66.0	96.0	100
2001	77.0	92.0	100
2002	86.0	97.0	100
2003	43.0	93.0	100
2004	69.8	64.9	100
2005	76.0	97.0	100

Table 2.6.2.1. North Sea herring. Values for the slope of the regression line fitted through the time trend of log catch ratios for the catch data, and the log abundance ratios of Acoustic 1-9+ ring and IBTS 1-5+ ring indices. Their significance was not tested.

Ages	catch ratio slope	Acoustic abundance ratio slope	IBTS abundance ratio slope
0-1	-0.0895		
1-2	-0.0603	0.0673	0.0137
2-3	-0.0960	-0.0461	-0.1684
3-4	-0.0825	-0.0315	-0.0226
4-5	-0.0910	-0.0068	
5-6	-0.0631	-0.0097	
6-7	-0.0875	-0.0206	
7-8	-0.0166	0.0088	

Table 2.6.3.1. North Sea herring. Correlations within cohorts in the acoustic survey and IBTS, with number of observations used for each correlation.

	Acoustic survey		IBTS	
Ages	Correlation	N obs	Correlation	N obs
1-2	0.92	8	0.51	24
2-3	0.92	16	0.20	24
3-4	0.95	16	0.46	24
4-5	0.94	16		
5-6	0.91	16		
6-7	0.92	16		
7-8	0.84	16		

Table 2.63.2. North Sea herring. Correlations at age between the acoustic survey and stock numbers, the IBTS and stock numbers and the acoustic survey and the IBTS, with number of observations used for each correlation.

	Acoustic with stock N		IBTS with stock N		Acoustic with IBTS	
Age	Correlation	N obs	Correlation	N obs	Correlation	N obs
1	0.95	5	0.83	23	0.76	9
2	0.82	13	0.69	23	0.62	17
3	0.83	13	0.81	23	0.68	17
4	0.87	13	0.82	23	0.85	17
5	0.95	13				
6	0.95	13				
7	0.90	13				
8	0.78	13				

Table 2.6.3.3. North Sea herring. EXPLORATORY SURBA stock summary results. Standard errors are given for recruitment and mean Z age 2-6.

YEAR	RECRUITMENT		SSB	TB	MEAN Z	
	ESTIMATE	S.E.	ESTIMATE	ESTIMATE	ESTIMATE	S.E.
1973	NA	NA	NA	NA	0.117	0.194
1974	NA	NA	NA	NA	0.117	0.176
1975	NA	NA	NA	NA	0.117	0.156
1976	NA	NA	NA	NA	0.117	0.133
1977	0.141	0.109	NA	NA	0.117	0.105
1978	0.114	0.109	NA	NA	0.106	0.067
1979	0.431	0.105	NA	NA	0.014	0.058
1980	0.829	0.104	NA	NA	-0.026	0.057
1981	0.643	0.103	NA	NA	0.032	0.055
1982	0.977	0.102	NA	NA	0.119	0.055
1983	0.746	0.101	NA	NA	0.289	0.06
1984	0.943	0.099	NA	NA	0.256	0.054
1985	1.381	0.098	0.611	0.793	0.309	0.052
1986	1.582	0.097	0.686	0.902	0.363	0.053
1987	1.958	0.095	0.83	1.104	0.217	0.043
1988	1.002	0.093	1.175	1.425	0.308	0.043
1989	0.463	0.092	1.61	1.835	0.486	0.05
1990	0.238	0.092	1.548	1.694	0.561	0.056
1991	0.458	0.091	1.187	1.285	0.404	0.044
1992	1.056	0.091	0.902	1.039	0.389	0.044
1993	0.978	0.092	0.703	1.02	0.478	0.049
1994	0.596	0.092	0.721	1.009	0.534	0.053
1995	0.759	0.093	0.876	1.118	0.583	0.054
1996	0.828	0.092	0.883	1.143	0.575	0.055
1997	0.898	0.092	0.851	1.141	0.423	0.044
1998	0.393	0.092	0.985	1.272	0.562	0.054
1999	2.107	0.09	1.179	1.396	0.479	0.048
2000	1.025	0.091	0.909	1.387	0.458	0.046
2001	2.049	0.091	1.149	1.468	0.457	0.05
2002	1.461	0.09	1.666	2.094	0.276	0.038
2003	0.428	0.092	1.535	2.014	0.421	0.047
2004	0.413	0.093	2.097	2.649	0.41	0.048
2005	0.523	0.103	1.633	1.721	0.435	0.064
2006	0.611	0.103	1.389	1.522	0.422	0.046

Table 2.6.4.1: North Sea herring CSA assessment input data.

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Table 2.6.5.1. North Sea herring. EXPLORATORY FLXSA v0.2 stock summary results with low shrinkage (=2.0).

YEAR	RECRUITMENT	SSB	LANDINGS	MEAN F2-6	MEAN F0-1	Y/SSB
1960	12273704	2393348	696200	0.28	0.15	0.29
1961	110197268	2106771	696700	0.36	0.08	0.33
1962	47010514	1455864	627800	0.42	0.05	0.43
1963	49157192	2563307	716000	0.21	0.07	0.28
1964	64470773	2323578	871200	0.33	0.17	0.37
1965	35926530	1662521	1168800	0.7	0.13	0.7
1966	28993207	1402660	895500	0.62	0.11	0.64
1967	41629336	926397	695500	0.8	0.17	0.75
1968	40167311	421235	717800	1.34	0.17	1.7
1969	22310335	430409	546700	1.1	0.17	1.27
1970	43508211	382261	563100	1.09	0.16	1.47
1971	34221049	273368	520100	1.36	0.33	1.9
1972	22271655	299762	497500	0.68	0.33	1.66
1973	10721340	246352	484000	1.09	0.37	1.96
1974	23502196	176332	275100	0.98	0.27	1.56
1975	3252951	97552	312800	1.2	0.42	3.21
1976	3059790	99641	174800	1.01	0.18	1.75
1977	4655139	72227	46000	0.46	0.19	0.64
1978	5557103	96835	11000	0.03	0.12	0.11
1979	10817424	135630	25100	0.05	0.11	0.19
1980	17322719	170150	70764	0.23	0.12	0.42
1981	39558908	236364	174879	0.28	0.4	0.74
1982	67425793	321606	275079	0.23	0.29	0.86
1983	64471129	477593	387202	0.3	0.34	0.81
1984	55787894	727198	428631	0.41	0.22	0.59
1985	83260131	745017	613780	0.62	0.24	0.82
1986	101500706	732319	671488	0.55	0.2	0.92
1987	90384000	929004	792058	0.54	0.28	0.85
1988	44396582	1236699	887686	0.51	0.37	0.72
1989	40623356	1293764	787899	0.52	0.29	0.61
1990	36716833	1240937	645229	0.42	0.27	0.52
1991	35261432	1029772	658008	0.48	0.22	0.64
1992	65550854	746918	716799	0.56	0.35	0.96
1993	52577790	509941	671397	0.67	0.41	1.32
1994	34458961	565930	568234	0.68	0.25	1
1995	42327680	496416	579371	0.74	0.33	1.17
1996	49981849	486476	275098	0.39	0.18	0.57
1997	26948691	560763	264313	0.39	0.04	0.47
1998	24715351	725803	391628	0.46	0.1	0.54
1999	63105028	830155	363163	0.39	0.05	0.44
2000	36328936	792236	388157	0.42	0.07	0.49
2001	84071657	1153833	363343	0.33	0.06	0.31
2002	36340436	1370293	370941	0.27	0.04	0.27
2003	19123592	1469104	472587	0.3	0.06	0.32
2004	21086591	1545682	567252	0.38	0.05	0.37
2005	24135744	1447985	663813	0.43	0.12	0.46

Table 2.6.7.1. North Sea herring. Correlation at age for estimates from acoustic survey (derived from bootstrap estimates from stat rectangle data)

AGE	1	2	3	4	5	6	7	8	9
1	1.00	0.06	-0.12	-0.13	-0.13	-0.13	-0.15	-0.12	-0.13
2	0.06	1.00	0.66	0.41	0.34	0.28	0.25	0.18	0.23
3	-0.12	0.66	1.00	0.89	0.83	0.77	0.74	0.65	0.68
4	-0.13	0.41	0.89	1.00	0.96	0.92	0.90	0.83	0.83
5	-0.13	0.34	0.83	0.96	1.00	0.97	0.93	0.88	0.87
6	-0.13	0.28	0.77	0.92	0.97	1.00	0.95	0.92	0.90
7	-0.15	0.25	0.74	0.90	0.93	0.95	1.00	0.96	0.92
8	-0.12	0.18	0.65	0.83	0.88	0.92	0.96	1.00	0.94
9	-0.13	0.23	0.68	0.83	0.87	0.90	0.92	0.94	1.00

Table 2.6.7.2. North Sea herring. Correlation at age for estimates from IBTS survey (derived from bootstrap estimates from haul data)

AGE	1	2	3	4	5
1	1.00	0.24	0.03	0.00	-0.01
2	0.24	1.00	0.64	0.42	0.32
3	0.03	0.64	1.00	0.82	0.68
4	0.00	0.42	0.82	1.00	0.85
5	-0.01	0.32	0.68	0.85	1.00

Table 2.6.7.3. North Sea herring. Corrections to inverse variance weights at age due to correlation at age in the survey catch series. Old corrections are included for comparison

	ACOUSTIC		IBTS	
Age	old	new	old	new
3	0.33	0.28	0.30	0.50
4	0.20	0.21	0.20	0.39
5	0.15	0.19	0.20	0.38
6	0.15	0.19		
7	0.15	0.20		
8	0.15	0.19		
9	0.15	0.20		

Table 2.6.7.4. North Sea herring. New weighting factors based bootstrap of survey data. Old weights are included for comparison

	CATCH		ACOUSTIC		IBTS		MIK		MLAI	
AGE	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW
0	0.10	0.10					2.05	0.63		
1	0.10	0.10	0.74	0.63	0.67	0.47				
2	3.17	3.67	0.75	0.62	0.24	0.28				
3	2.65	2.87	0.64	0.17	0.06	0.01				
4	1.94	2.23	0.27	0.10	0.03	0.01				
5	1.31	1.74	0.14	0.09	0.03	0.01				
6	0.97	1.37	0.13	0.08						
7	0.75	1.04	0.12	0.07						
8	0.55	0.94	0.07	0.07						
9	0.54	0.91	0.07	0.05						
SSB									0.65	0.60

Table 2.6.8.1. North Sea herring. Variability in the FLICA/FLXSA assessments due to data variability and a small range of model settings (last year in the assessment SSB 1st Jan, mean F ages 2-6, Recruitment age 0). 2005 settings all data (spaly), individual tuning series (MLAI, MIK, IBTS, Acoustic), separable model settings (4-6 years 0.9 to 1.1 F on oldest age), ICA and XSA compared with same data (MLAI removed) and new weighting factors. (SSB 1st of Jan should not be confused with SSB at spawning time wgich is used for management and includes proportion of F and M in the year prior to spawning)

						Biomass of spawners 1st of January						
Percentile	**spaly**	**MLAI**	**MIK**	**IBTS**	**Acoust**	**6yrsep**	**4yrsep**	**sel1.1**	**sell0.9**	**XSAind**	**XSA**	**newwt**
2.5	2.08E+06	3.21E+06	2.27E+06	2.06E+06	1.58E+06	2.11E+06	1.99E+06	2.06E+06	2.11E+06	1.88E+06	1.63E+06	2.20E+06
25	2.34E+06	3.41E+06	2.84E+06	2.47E+06	1.80E+06	2.35E+06	2.22E+06	2.31E+06	2.38E+06	2.17E+06	1.88E+06	2.42E+06
50	2.42E+06	3.50E+06	3.07E+06	2.66E+06	1.91E+06	2.47E+06	2.33E+06	2.40E+06	2.46E+06	2.25E+06	2.04E+06	2.51E+06
75	2.57E+06	3.56E+06	3.40E+06	2.87E+06	2.08E+06	2.58E+06	2.45E+06	2.54E+06	2.61E+06	2.42E+06	2.22E+06	2.62E+06
97.5	2.87E+06	3.69E+06	4.05E+06	3.27E+06	2.43E+06	2.86E+06	2.71E+06	2.83E+06	2.92E+06	2.78E+06	2.67E+06	2.86E+06
CV(%)	8%	3%	14%	11%	11%	8%	8%	8%	8%	10%	13%	7%
						F ages 2-6						
Percentile	**spaly**	**MLAI**	**MIK**	**IBTS**	**Acoust**	**6yrsep**	**4yrsep**	**sel1.1**	**sell0.9**	**XSAind**	**XSA**	**newwt**
2.5	0.21	0.15	0.13	0.17	0.24	0.21	0.22	0.22	0.21	0.22	0.28	0.21
25	0.24	0.16	0.17	0.21	0.30	0.23	0.25	0.24	0.23	0.26	0.39	0.23
50	0.25	0.17	0.19	0.22	0.33	0.24	0.27	0.25	0.25	0.27	0.43	0.24
75	0.26	0.17	0.21	0.24	0.36	0.25	0.28	0.27	0.26	0.29	0.51	0.25
97.5	0.29	0.18	0.24	0.29	0.40	0.28	0.31	0.29	0.28	0.32	0.58	0.27
CV(%)	7%	4%	15%	12%	12%	8%	8%	7%	7%	9%	18%	6%
						Recruitment age 1						
Percentile	**spaly**	**MLAI**	**MIK**	**IBTS**	**Acoust**	**6yrsep**	**4yrsep**	**sel1.1**	**sell0.9**	**XSAind**	**XSA**	**newwt**
2.5	1.65E+07	5.44E+07	1.56E+07	2.03E+07	3.31E+07	1.65E+07	1.64E+07	1.64E+07	1.65E+07	1.63E+07	1.62E+07	1.85E+07
25	1.88E+07	5.91E+07	1.84E+07	2.38E+07	3.59E+07	1.88E+07	1.86E+07	1.87E+07	1.89E+07	1.87E+07	1.89E+07	2.10E+07
50	1.98E+07	6.21E+07	1.99E+07	2.74E+07	3.92E+07	1.98E+07	1.97E+07	1.97E+07	1.98E+07	1.96E+07	2.01E+07	2.21E+07
75	2.09E+07	6.43E+07	2.11E+07	2.93E+07	4.24E+07	2.10E+07	2.08E+07	2.09E+07	2.10E+07	2.07E+07	2.19E+07	2.34E+07
97.5	2.39E+07	6.90E+07	2.52E+07	3.36E+07	4.67E+07	2.39E+07	2.36E+07	2.38E+07	2.40E+07	2.37E+07	2.48E+07	2.61E+07
CV(%)	9%	6%	12%	12%	9%	9%	9%	9%	9%	9%	11%	9%

Table 2.6.8.2. North Sea herring. The influence of individual data values on the 2005 assessment parameters N0 to N9, F0 to F9, SSB(1st Jan) and Mean F2-6. Source date defined by data type, year and age (MLAI 0 indicates SSB Index). The 5 most influential values are selected. The deviation as a ln(deviation) is given in a standardised format for each variable and is expressed as number of standard deviations deviation from the central value where the standard deviation is derived from the bootstrap data sets.

	Most influential point				2nd Most influential point				3rd Most influential point				4th Most influential point				5th Most influential point			
	Data	year	age	log dev	data	year	age	log dev	data	year	age	log dev	data	year	age	log dev	data	year	age	log dev
N0	MIK	2004	0	3.29	IBTS	2005	1	-0.52	MIK	1990	0	-0.44	MIK	1980	0	0.25	Catch	2004	0	-0.23
N1	IBTS	2005	2	0.42	Acoustic	2004	1	-0.32	MIK	1990	0	-0.30	MIK	2003	0	0.21	MIK	1980	0	0.18
N2	MIK	2002	0	-2.24	Catch	2004	2	1.57	Acoustic	2004	2	1.16	IBTS	2003	1	-0.74	MLAI	2004	0	-0.41
N3	Catch	2004	2	-0.69	MIK	2001	0	0.61	MLAI	2004	0	-0.40	Acoustic	2003	2	-0.35	MIK	2002	0	-0.33
N4	Catch	2004	2	-0.77	MIK	2000	0	-0.76	Catch	2002	2	-0.64	Acoustic	2003	3	0.52	MLAI	2004	0	-0.49
N5	Catch	2001	2	0.93	Catch	2004	2	-0.53	Acoustic	2000	1	-0.43	MLAI	2004	0	-0.40	Catch	2004	5	-0.38
N6	Catch	2000	2	-1.05	Catch	2001	3	-0.49	Catch	2004	2	-0.44	Acoustic	2004	6	0.36	Catch	2004	7	-0.36
N7	Catch	2004	7	-0.79	Catch	2002	8	-0.37	Catch	2000	2	-0.35	Catch	2002	5	0.34	MLAI	2000	0	0.33
N8	Catch	2002	8	-0.51	MLAI	2000	0	0.39	Catch	2002	4	-0.36	Catch	2000	2	-0.29	MLAI	2003	0	-0.22
N9	Catch	2004	9	0.88	Catch	2004	2	-0.56	MIK	2002	0	-0.25	MLAI	2004	0	-0.18	Catch	2002	4	-0.16
F0	Catch	2004	0	-1.67	Catch	2004	2	1.09	Catch	2000	0	0.71	MIK	2002	0	0.71	Acoustic	2004	2	-0.71
F1	Catch	2002	1	1.15	Catch	2004	1	0.97	Catch	2004	2	0.88	Acoustic	2004	2	-0.88	Catch	2000	1	0.85
F2	Catch	2004	2	2.42	MIK	2002	0	1.11	Catch	2001	2	0.64	Acoustic	2004	2	-0.63	MLAI	2004	0	0.51
F3	Catch	2004	2	1.94	MIK	2002	0	0.88	MLAI	2004	0	0.60	Catch	2001	3	-0.59	Catch	2003	3	0.57
F4	Catch	2004	2	1.63	MIK	2002	0	0.73	MLAI	2004	0	0.52	Catch	2002	4	0.47	Catch	2000	2	0.42
F5	Catch	2004	2	1.60	MIK	2002	0	0.72	Catch	2004	5	-0.70	Catch	2002	5	0.55	MLAI	2004	0	0.51
F6	Catch	2004	2	1.28	MIK	2002	0	0.57	Catch	2002	8	0.57	Catch	2000	2	0.50	Catch	2000	6	0.50
F7	Catch	2004	2	1.06	Catch	2004	7	-1.01	Catch	2002	8	0.80	Catch	2000	7	0.49	MIK	2002	0	0.47
F8	Catch	2004	2	1.63	MIK	2002	0	0.73	MLAI	2004	0	0.52	Catch	2002	4	0.47	Catch	2000	2	0.42
F9	Catch	2004	2	1.63	MIK	2002	0	0.73	MLAI	2004	0	0.52	Catch	2002	4	0.47	Catch	2000	2	0.42
SSB	MIK	2002	0	-0.62	MLAI	2004	0	-0.44	MIK	2001	0	0.34	Acoustic	2004	2	0.34	MLAI	2003	0	-0.32
F2-6	Catch	2004	2	1.89	MIK	2002	0	0.85	MLAI	2004	0	0.57	Acoustic	2004	2	-0.46	Catch	2000	2	0.42

Table 2.6.9.1. North Sea herring. Catchability estimates from ICA run with the MLAI survey split into 1973-1989 and 1990-2005, IBTS into 1979-1994 and 1995-2006 and MIK into 1977-1991 and 1992-2006.

```
MLAI1

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

Q  2.930      17 2.247     4.444     2.655     3.760     3.208

K  .2979E-04  17 .5450E-04 .1078E-03 .6440E-04 .9121E-04 .8361E-04

MLAI2

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

Q  5.389      17 4.714     9.324     5.571     7.889     6.731

K  .8332E-08  17 .9831E-07 .1945E-06 .1162E-06 .1645E-06 .1508E-06



IBTS1: 1-5+ wr

Linear model fitted. Slopes at age :

1  Q  .1288E-03   8 .1192E-03 .1632E-03 .1288E-03 .1511E-03 .1400E-03

2  Q  .1788E-03  15 .1541E-03 .2826E-03 .1788E-03 .2436E-03 .2112E-03

3  Q  .1268E-03  30 .9424E-04 .3168E-03 .1268E-03 .2354E-03 .1813E-03

4  Q  .8451E-04  43 .5553E-04 .3085E-03 .8451E-04 .2027E-03 .1440E-03

5  Q  .5169E-04  43 .3397E-04 .1887E-03 .5169E-04 .1240E-03 .8810E-04

IBTS2: 1-5+ wr

Linear model fitted. Slopes at age :

1  Q  .1984E-03   9 .1807E-03 .2645E-03 .1984E-03 .2409E-03 .2197E-03

2  Q  .1553E-03  15 .1335E-03 .2472E-03 .1553E-03 .2126E-03 .1839E-03

3  Q  .1262E-03  31 .9367E-04 .3166E-03 .1262E-03 .2349E-03 .1807E-03

4  Q  .6537E-04  43 .4291E-04 .2395E-03 .6537E-04 .1572E-03 .1116E-03

5  Q  .2852E-04  43 .1870E-04 .1048E-03 .2852E-04 .6873E-04 .4877E-04


MIK1 0-wr

Linear model fitted. Slopes at age :

Q  .2818E-05   4 .2693E-05 .3242E-05 .2818E-05 .3098E-05 .2958E-05

MIK2 0-wr

Linear model fitted. Slopes at age :

Q  .3681E-05   5 .3495E-05 .4318E-05 .3681E-05 .4100E-05 .3891E-05
```

Table 2.6.10.1. North Sea herring. Bias and variance from the retrospective runs over last 5 years for ICA using same procedure as last year, ICA with new weights applied to the catch and IBTS and MIK surveys truncated, and FLXSA.

	ICA SPALY		ICA, new weights & surveys truncated		FLXSA	
	Bias	Variance	Bias	Variance	Bias	Variance
F	-0.111	0.049	0.049	0.054	0.0021	0.0984
SSB	0.08	0.048	-0.077	0.063	0.0757	0.0578
R	0.161	0.215	0.109	0.235	0.0694	0.1976

Table 2.6.12.1 North Sea herring. Final model fit ICA log. Note age=ringer.

```
Enter the name of the index file -->index.txt   canum.txt   weca.txt
Stock weights in 2006  used for the year 2005               west.txt
Natural mortality in 2006  used for the year 2005           natmor.txt
Maturity ogive in 2006  used for the year 2005              matprop.txt
Name of age-structured index file (Enter if none) : -->     fleet.txt
Name of the SSB index file (Enter if none) -->              ssb.txt
No of years for separable constraint ?                      --> 5
Reference age for separable constraint ?                    --> 4
Constant selection pattern model (Y/N) ?                    --> y
S to be fixed on last age ?                                 -->
1.000000000000000
First age for calculation of reference F ?                  --> 2
Last age for calculation of reference F ?                   --> 6
Use default weighting (Y/N) ?                               --> n

Enter relative weights at age
Weight for age 0-->    0.100000000000000
Weight for age 1-->    0.100000000000000
Weight for age 2-->    3.670000000000000
Weight for age 3-->    2.870000000000000
Weight for age 4-->    2.230000000000000
Weight for age 5-->    1.740000000000000
Weight for age 6-->    1.370000000000000
Weight for age 7-->    1.040000000000000
Weight for age 8-->    0.940000000000000
Weight for age 9-->    0.910000000000000

Enter relative weights by year
Weight for year 2001-->    1.000000000000000
Weight for year 2002-->    1.000000000000000
Weight for year 2003-->    1.000000000000000
Weight for year 2004-->    1.000000000000000
Weight for year 2005-->    1.000000000000000

Enter new weights for specified years and ages if needed
Enter year, age, new weight or -1,-1,-1 to end.  -1 -1   -1.000000000000000
Is the last age of Acoustic survey 1-9+ wr a plus-group (Y/N) ?     -->y
Is the last age of IBTS: 1-5+ wr a plus-group (Y/N) ?               -->y
Is the last age of MIK 0-wr a plus-group (Y/N) ?                    -->n
You must choose a catchability model for each index.

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

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

 Model for   MLAI  is to be A/L/P ?                                 -->p
 Model for Acoustic survey 1-9+ wr  is to be A/L/P ?                -->L
 Model for IBTS: 1-5+ wr  is to be A/L/P ?                          -->L
 Model for MIK 0-wr  is to be A/L/P ?                               -->L
 Fit a stock-recruit relationship (Y/N) ?                           -->y
Enter the time lag in years between spawning and the stock size
 of fish aged 0  years on 1 January.
This will probably be 0 unless the stock is an autumn-spawning herring
 in which case it will probably be 1  years.
 Enter the lag in years (rounded up)                                --> 1
 Enter lowest feasible F                                            --> 0.02
 Enter highest feasible F                                           --> 2.00
Mapping the F-dimension of the SSQ surface

    F               SSQ
+--------+-------------------
    0.02       114.2898515193
    0.12        37.0742013872
    0.23        22.9607551584
    0.33        18.6770574976
    0.44        17.6706787397
    0.54        18.0005553785
    0.65        18.9500886015
    0.75        20.2178087607
    0.85        21.6650599371
    0.96        23.2253002660
    1.06        24.8686423026
```

Table 2.6.12.1 North Sea herring. Continued.

```
    1.17         26.5889357314
    1.27         28.4066191669
    1.37         30.2077316068
    1.48         32.0035534900
    1.58         33.8679564328
    1.69         35.8321285804
    1.79         37.6558646215
    1.90         39.4693946176
    2.00         41.2946727268
Lowest SSQ is for F =     0.452
-----------------------------------------------------------------
No of years for separable analysis : 5
Age range in the analysis : 0  . . . 9
Year range in the analysis : 1960  . . . 2005
Number of indices of SSB : 1
Number of age-structured indices : 4
Stock-recruit relationship to be fitted.
Parameters to estimate : 50
Number of observations : 398

Conventional single selection vector model to be fitted.

-----------------------------------------------------------------
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for   MLAI-->                                   0.600000000000000
 Enter weight for Acoustic survey 1-9+ wr  at age 1-->      0.630000000000000
 Enter weight for Acoustic survey 1-9+ wr  at age 2-->      0.620000000000000
 Enter weight for Acoustic survey 1-9+ wr  at age 3-->      0.170000000000000
 Enter weight for Acoustic survey 1-9+ wr  at age 4-->      0.100000000000000
 Enter weight for Acoustic survey 1-9+ wr  at age 5-->      8.9999999999999997E-02
 Enter weight for Acoustic survey 1-9+ wr  at age 6-->      8.0000000000000002E-02
 Enter weight for Acoustic survey 1-9+ wr  at age 7-->      7.0000000000000007E-02
 Enter weight for Acoustic survey 1-9+ wr  at age 8-->      7.0000000000000007E-02
 Enter weight for Acoustic survey 1-9+ wr  at age 9-->      5.0000000000000003E-02
 Enter weight for IBTS: 1-5+ wr  at age 1-->                0.470000000000000
 Enter weight for IBTS: 1-5+ wr  at age 2-->                0.280000000000000
 Enter weight for IBTS: 1-5+ wr  at age 3-->                1.0000000000000000E-02
 Enter weight for IBTS: 1-5+ wr  at age 4-->                1.0000000000000000E-02
 Enter weight for IBTS: 1-5+ wr  at age 5-->                1.0000000000000000E-02
 Enter weight for MIK 0-wr  at age 0-->                     0.630000000000000
 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 1-9+ wr-->                0.0000000000000000E+000
  Enter value for IBTS: 1-5+ wr-->                          0.0000000000000000E+000
  Enter value for MIK 0-wr-->                               0.0000000000000000E+000

Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.

SSB index weights
  0.600
Aged index weights
Acoustic survey 1-9+ wr
 Age   :      1     2     3     4     5     6     7     8     9
 Wts :    0.630 0.620 0.170 0.100 0.090 0.080 0.070 0.070 0.050
IBTS: 1-5+ wr
 Age   :      1     2     3     4     5
 Wts :    0.470 0.280 0.010 0.010 0.010

MIK 0-wr
 Age   :      0
 Wts :    0.630
 Stock-recruit weight          0.100

F in 2005  at age 4  is 0.409115  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 exit from ICA
```

Table 2.6.12.2 North Sea herring. Final model fit ICA output. Note age=ringer

Catch in Number x 10 ^ 6

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

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

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

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

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	10331.	10265.	4499.	7438.	2311.	431.	260.	1566.
1	2303.	3827.	1785.	1665.	1606.	480.	978.	304.
2	1285.	1176.	1783.	1444.	642.	688.	1220.	616.
3	443.	609.	489.	817.	526.	447.	538.	1059.
4	362.	306.	348.	232.	172.	285.	276.	294.
5	361.	216.	109.	119.	58.	109.	176.	136.
6	376.	226.	92.	55.	23.	31.	89.	69.
7	152.	188.	76.	41.	9.	12.	15.	28.
8	39.	87.	70.	69.	17.	19.	17.	10.
9	23.	42.	47.	29.	4.	6.	4.	2.

Table 2.6.12.2 North Sea herring. Continued.

Catch in Number x 10 ^ 6

AGE	2000	2001	2002	2003	2004	2005
0	1105.	1833.	730.	369.	716.	1016.
1	1172.	614.	835.	617.	207.	716.
2	623.	806.	553.	1204.	439.	355.
3	463.	477.	903.	517.	1326.	486.
4	647.	274.	284.	820.	520.	1318.
5	213.	312.	133.	243.	726.	480.
6	82.	89.	161.	106.	171.	576.
7	36.	37.	46.	120.	101.	115.
8	15.	17.	33.	37.	71.	108.
9	2.	2.	7.	8.	22.	39.

Predicted Catch in Number x 10 ^ 6

AGE	2001	2002	2003	2004	2005
0	2400.6	741.2	451.9	595.4	768.4
1	655.9	1291.0	474.9	311.1	470.9
2	950.5	495.2	1162.6	457.4	339.7
3	396.6	867.2	540.4	1349.3	592.4
4	269.8	311.5	818.5	539.3	1478.4
5	287.9	168.0	234.2	649.1	466.3
6	86.4	164.7	116.2	170.9	516.3
7	42.7	47.0	108.3	80.7	130.0
8	17.1	26.9	35.7	87.0	70.9

Weights at age in the catches (Kg)

AGE	1960	1961	1962	1963	1964	1965	1966	1967
0	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
2	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
4	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
6	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
8	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

AGE	1968	1969	1970	1971	1972	1973	1974	1975
0	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
2	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
4	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
6	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
8	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

AGE	1976	1977	1978	1979	1980	1981	1982	1983
0	0.01500	0.01500	0.01500	0.01500	0.01500	0.00700	0.01000	0.01000
1	0.05000	0.05000	0.05000	0.05000	0.05000	0.04900	0.05900	0.05900
2	0.12600	0.12600	0.12600	0.12600	0.12600	0.11800	0.11800	0.11800
3	0.17600	0.17600	0.17600	0.17600	0.17600	0.14200	0.14900	0.14900
4	0.21100	0.21100	0.21100	0.21100	0.21100	0.18900	0.17900	0.17900
5	0.24300	0.24300	0.24300	0.24300	0.24300	0.21100	0.21700	0.21700
6	0.25100	0.25100	0.25100	0.25100	0.25100	0.22200	0.23800	0.23800
7	0.26700	0.26700	0.26700	0.26700	0.26700	0.26700	0.26500	0.26500
8	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27400	0.27400
9	0.27100	0.27100	0.27100	0.27100	0.27100	0.27100	0.27500	0.27500

Table 2.6.12.2 North Sea herring. Continued.

Weights at age in the catches (Kg)

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

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	0.01000	0.01000	0.00600	0.00900	0.01500	0.01500	0.02100	0.00900
1	0.05300	0.03300	0.05600	0.04200	0.01800	0.04400	0.05100	0.04500
2	0.10200	0.11500	0.13000	0.13000	0.11200	0.10800	0.11400	0.11500
3	0.17500	0.14500	0.15900	0.16900	0.15600	0.14800	0.14500	0.15100
4	0.18900	0.18900	0.18100	0.19800	0.18800	0.19500	0.18300	0.17100
5	0.20700	0.20400	0.21400	0.20700	0.20400	0.22700	0.21900	0.20700
6	0.22300	0.22800	0.24000	0.24300	0.21200	0.22600	0.23800	0.23300
7	0.23700	0.24400	0.25500	0.24700	0.26100	0.23500	0.24700	0.24500
8	0.24900	0.25600	0.27300	0.28300	0.28000	0.24400	0.28900	0.26100
9	0.28700	0.31000	0.28100	0.27600	0.28800	0.29100	0.28300	0.30100

AGE	2000	2001	2002	2003	2004	2005
0	0.01500	0.01200	0.01200	0.01400	0.01400	0.01100
1	0.03300	0.04800	0.03700	0.03700	0.03600	0.04400
2	0.11300	0.11700	0.11600	0.10400	0.09900	0.09900
3	0.15700	0.14900	0.15100	0.15700	0.13700	0.15300
4	0.17900	0.17700	0.16900	0.17300	0.18200	0.16600
5	0.20100	0.19700	0.19800	0.18400	0.20500	0.20800
6	0.21600	0.21200	0.21400	0.20400	0.22000	0.22200
7	0.24600	0.23700	0.22800	0.22100	0.22800	0.23900
8	0.27500	0.26700	0.25000	0.23200	0.24100	0.26600
9	0.26200	0.28600	0.25300	0.25300	0.26500	0.26500

Weights at age in the stock (Kg)

AGE	1960	1961	1962	1963	1964	1965	1966	1967
0	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
2	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
4	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
6	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
8	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

AGE	1968	1969	1970	1971	1972	1973	1974	1975
0	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
2	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
4	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
6	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
8	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

Table 2.6.12.2 North Sea herring. Continued.

Weights at age in the stock (Kg)

AGE	1976	1977	1978	1979	1980	1981	1982	1983
0	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01500	0.01700
1	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05000	0.05700
2	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15000
3	0.18700	0.18700	0.18700	0.18700	0.18700	0.18700	0.18700	0.19000
4	0.22300	0.22300	0.22300	0.22300	0.22300	0.22300	0.22300	0.23000
5	0.23900	0.23900	0.23900	0.23900	0.23900	0.23900	0.23900	0.24300
6	0.27600	0.27600	0.27600	0.27600	0.27600	0.27600	0.27600	0.28200
7	0.29900	0.29900	0.29900	0.29900	0.29900	0.29900	0.29900	0.31100
8	0.30600	0.30600	0.30600	0.30600	0.30600	0.30600	0.30600	0.33800
9	0.31200	0.31200	0.31200	0.31200	0.31200	0.31200	0.31200	0.34700

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

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

AGE	2000	2001	2002	2003	2004	2005
0	0.00600	0.00600	0.00700	0.00700	0.00600	0.00600
1	0.05100	0.04700	0.04700	0.04200	0.04100	0.03900
2	0.12200	0.12800	0.12300	0.11900	0.11800	0.12600
3	0.17200	0.17200	0.17300	0.16500	0.16500	0.15500
4	0.21000	0.20500	0.20200	0.20300	0.19800	0.19300
5	0.23300	0.22800	0.22200	0.22300	0.22500	0.23000
6	0.25500	0.24800	0.24200	0.24800	0.24800	0.25000
7	0.27500	0.27000	0.26600	0.26800	0.26500	0.25700
8	0.27400	0.28900	0.28500	0.28300	0.28100	0.27700
9	0.28000	0.27500	0.28300	0.27500	0.29100	0.28300

Natural Mortality (per year)

AGE	1960	1961	1962	1963	1964	1965	1966	1967
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Table 2.6.12.2 North Sea herring. Continued.

Natural Mortality (per year)

AGE	1968	1969	1970	1971	1972	1973	1974	1975
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

AGE	1976	1977	1978	1979	1980	1981	1982	1983
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

AGE	2000	2001	2002	2003	2004	2005
0	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
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Table 2.6.12.2 North Sea herring. Continued.

Proportion of fish spawning

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

AGE	1968	1969	1970	1971	1972	1973	1974	1975
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	1.0000	1.0000	1.0000	1.0000	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
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	1976	1977	1978	1979	1980	1981	1982	1983
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	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
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

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

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.5000	0.4700	0.7300	0.6700	0.6100	0.6400	0.6400	0.6900
3	0.9900	0.6100	0.9300	0.9500	0.9800	0.9400	0.8900	0.9100
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.6.12.2 North Sea herring. Continued.

Proportion of fish spawning

AGE	2000	2001	2002	2003	2004	2005
0	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
2	0.6700	0.7700	0.8700	0.4300	0.7000	0.7600
3	0.9600	0.9200	0.9700	0.9300	0.6500	0.9700
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
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

INDICES OF SPAWNING BIOMASS
MLAI

	1973	1974	1975	1976	1977	1978	1979	1980
1	13.40	8.10	2.80	2.50	6.20	7.50	14.80	10.20

	1981	1982	1983	1984	1985	1986	1987	1988
1	15.10	21.70	27.80	50.40	76.70	39.90	69.90	138.90

	1989	1990	1991	1992	1993	1994	1995	1996
1	135.20	175.70	91.60	43.00	31.00	21.30	23.90	46.70

	1997	1998	1999	2000	2001	2002	2003	2004
1	59.20	77.90	64.80	43.00	134.90	114.40	282.10	331.20

	2005
1	198.80

AGE-STRUCTURED INDICES
Acoustic survey 1-9+ wr x 10 ^ 3

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

AGE	1997	1998	1999	2000	2001	2002	2003	2004
1	9361.	4449.	5087.	24736.	6837.	23055.	9829.	5184.
2	5960.	5747.	3078.	2923.	12290.	4875.	18949.	3416.
3	2935.	2520.	4725.	2156.	3083.	8220.	3081.	9192.
4	1441.	1625.	1116.	3140.	1462.	1390.	4189.	2167.
5	601.	982.	506.	1007.	1676.	795.	675.	2591.
6	215.	445.	314.	483.	450.	1031.	495.	317.
7	46.	170.	139.	266.	170.	244.	568.	328.
8	78.	45.	54.	120.	98.	121.	146.	342.
9	159.	121.	87.	97.	59.	149.	178.	186.

Table 2.6.12.2 North Sea herring. Continued.

Acoustic survey 1-9+ wr x 10 ^ 3

AGE	2005
1	3112.
2	1890.
3	3436.
4	5609.
5	1211.
6	1172.
7	140.
8	126.
9	107.

IBTS: 1-5+ wr

AGE	1984	1985	1986	1987	1988	1989	1990	1991
1	1468.9	2082.4	2593.0	3733.8	4469.6	2187.0	1024.6	1180.3
2	169.9	748.1	820.1	946.3	4725.8	933.9	482.1	821.0
3	67.0	301.5	288.9	124.0	915.0	401.2	312.9	288.4
4	30.0	47.6	84.1	63.2	65.4	111.8	292.7	258.7
5	10.8	31.2	28.5	53.6	28.0	10.5	77.1	174.3

AGE	1992	1993	1994	1995	1996	1997	1998	1999
1	1204.0	2988.5	1644.3	1215.4	1728.3	3992.7	2067.1	714.8
2	410.1	840.8	1176.5	1263.1	209.0	526.6	799.7	456.8
3	195.1	225.1	214.4	251.0	46.6	204.1	96.4	547.8
4	68.5	46.9	68.4	33.2	13.5	42.8	22.0	109.0
5	109.4	68.6	43.0	6.2	9.1	24.3	20.7	40.3

AGE	2000	2001	2002	2003	2004	2005	2006
1	3693.7	2508.8	4071.1	2999.9	979.5	1033.1	919.9
2	217.9	1117.2	654.4	1547.9	456.0	190.2	1436.4
3	159.3	317.4	306.3	475.2	759.0	325.6	385.5
4	61.5	98.0	21.9	345.9	110.9	402.1	251.7
5	8.6	66.2	19.9	43.9	141.1	140.3	338.8

MIK 0-wr

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	200.70	190.10	101.70	127.00	106.50	148.10	53.10	244.00

AGE	2000	2001	2002	2003	2004	2005	2006
0	137.10	214.80	161.80	54.40	47.30	61.30	83.00

Table 2.6.12.2 North Sea herring. Continued.

Fishing Mortality (per year)

AGE	1960	1961	1962	1963	1964	1965	1966	1967
0	0.0257	0.0186	0.0049	0.0148	0.0126	0.0071	0.0215	0.0256
1	0.2559	0.1294	0.0897	0.1241	0.3084	0.2461	0.1852	0.2980
2	0.4363	0.6172	0.2502	0.2975	0.3890	0.7753	0.5921	0.4222
3	0.3284	0.3526	0.6271	0.2755	0.4124	0.7389	0.7082	0.8046
4	0.3365	0.4086	0.4220	0.2271	0.3703	0.7767	0.5719	0.9244
5	0.2663	0.4010	0.5345	0.1507	0.3079	0.6601	0.8347	0.8278
6	0.3156	0.3815	0.8120	0.1819	0.2378	0.5200	0.3905	1.0101
7	0.6101	0.2525	0.6363	0.2815	0.2820	0.4567	0.3885	1.5338
8	0.5640	0.5341	0.5888	0.3358	0.5464	0.8615	0.7306	1.0701
9	0.5640	0.5341	0.5888	0.3358	0.5464	0.8615	0.7306	1.0701

AGE	1968	1969	1970	1971	1972	1973	1974	1975
0	0.0348	0.0082	0.0351	0.0340	0.0583	0.0462	0.0749	0.1568
1	0.3002	0.3291	0.2681	0.6021	0.5781	0.6739	0.4515	0.6878
2	1.3272	0.7844	0.9728	0.8826	0.8120	1.0219	1.0286	1.3107
3	1.8720	0.9124	1.2669	1.2148	0.8013	1.3331	0.9724	1.5042
4	1.0714	0.8741	1.3302	1.2263	0.7996	0.9876	0.9924	1.3704
5	1.2340	1.0539	0.8754	1.0842	0.5494	0.9515	1.1853	1.8719
6	1.1757	1.9009	1.0793	2.6110	0.5173	1.3776	1.0788	1.2731
7	1.6018	1.3034	4.1187	2.6988	0.0978	0.8046	0.7722	2.0348
8	1.6608	1.3308	1.7722	1.9397	1.0113	1.5391	1.3291	2.0177
9	1.6608	1.3308	1.7722	1.9397	1.0113	1.5391	1.3291	2.0177

AGE	1976	1977	1978	1979	1980	1981	1982	1983
0	0.1466	0.0975	0.0455	0.0837	0.1257	0.4818	0.3343	0.3995
1	0.2483	0.2969	0.1999	0.1666	0.1132	0.2853	0.2249	0.2516
2	1.3378	0.2241	0.0242	0.0946	0.3636	0.3241	0.2604	0.3020
3	1.4322	1.4064	0.0423	0.0664	0.4187	0.2753	0.5082	0.3242
4	1.7375	0.4279	0.1034	0.0933	0.2970	0.3031	0.2470	0.4363
5	1.5882	1.2023	0.0166	0.0519	0.2638	0.4124	0.1541	0.2753
6	1.0562	0.7236	0.0771	0.0124	0.0667	0.4284	0.1449	0.3440
7	1.4937	0.7156	0.0593	0.4356	0.1014	0.9546	0.2275	0.3912
8	1.6598	0.9412	0.1681	0.2259	0.3593	0.6190	0.4177	0.5061
9	1.6598	0.9412	0.1681	0.2259	0.3593	0.6190	0.4177	0.5061

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	0.2263	0.0852	0.0619	0.1614	0.1246	0.1304	0.0589	0.1179
1	0.2051	0.3827	0.3157	0.3723	0.5800	0.4306	0.4530	0.3082
2	0.3143	0.4042	0.4592	0.4061	0.3556	0.3983	0.3767	0.5747
3	0.4294	0.6706	0.5223	0.5052	0.4005	0.4100	0.3695	0.4543
4	0.5364	0.7369	0.5810	0.5888	0.5814	0.5553	0.4673	0.4576
5	0.6269	0.6620	0.5529	0.6148	0.6635	0.6553	0.4993	0.4832
6	0.3595	0.7290	0.7280	0.6335	0.6714	0.6993	0.4909	0.4769
7	0.6932	0.5562	0.8145	0.6053	0.6869	0.7001	0.6776	0.4207
8	0.6124	0.8529	0.8041	0.7824	0.8906	0.8198	0.7526	0.7010
9	0.6124	0.8529	0.8041	0.7824	0.8906	0.8198	0.7526	0.7010

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	0.2968	0.3764	0.2304	0.3218	0.0746	0.0245	0.0146	0.0370
1	0.3874	0.4222	0.2463	0.3000	0.2537	0.0448	0.1636	0.0478
2	0.5728	0.6691	0.6839	0.6010	0.3185	0.2867	0.2629	0.2541
3	0.4990	0.6409	0.7174	0.8675	0.4917	0.4100	0.4068	0.4089
4	0.5720	0.7352	0.9119	0.8700	0.4188	0.5143	0.4551	0.3863
5	0.5462	0.7095	0.5600	0.8247	0.4812	0.4535	0.6129	0.3752
6	0.7207	0.6990	0.6661	0.5441	0.3151	0.4658	0.7245	0.4603
7	0.6939	0.8755	0.4759	0.6387	0.1447	0.2422	0.3833	0.4634
8	0.8546	1.0011	0.8585	0.9305	0.5287	0.4275	0.5585	0.4227
9	0.8546	1.0011	0.8585	0.9305	0.5287	0.4275	0.5585	0.4227

Table 2.6.12.2 North Sea herring. Continued.

Fishing Mortality (per year)

AGE	2000	2001	2002	2003	2004	2005
0	0.0442	0.0429	0.0375	0.0390	0.0438	0.0572
1	0.0795	0.0755	0.0660	0.0687	0.0771	0.1007
2	0.2225	0.1437	0.1257	0.1307	0.1467	0.1916
3	0.3284	0.2288	0.2002	0.2082	0.2337	0.3052
4	0.4465	0.3068	0.2684	0.2791	0.3133	0.4091
5	0.4747	0.3245	0.2839	0.2953	0.3314	0.4328
6	0.3653	0.3175	0.2777	0.2889	0.3242	0.4234
7	0.4050	0.2911	0.2547	0.2649	0.2974	0.3883
8	0.4162	0.3068	0.2684	0.2791	0.3133	0.4091
9	0.4162	0.3068	0.2684	0.2791	0.3133	0.4091

Population Abundance (1 January) x 10 ^ 9

AGE	1960	1961	1962	1963	1964	1965	1966	1967
0	12.09	108.86	46.27	47.66	62.79	34.90	27.86	40.26
1	16.42	4.33	39.31	16.94	17.27	22.81	12.75	10.03
2	3.70	4.68	1.40	13.22	5.51	4.67	6.56	3.90
3	7.71	1.77	1.87	0.81	7.27	2.76	1.59	2.69
4	0.61	4.55	1.02	0.82	0.50	3.94	1.08	0.64
5	0.75	0.39	2.73	0.60	0.59	0.31	1.64	0.55
6	0.44	0.52	0.24	1.45	0.47	0.39	0.15	0.64
7	0.29	0.29	0.32	0.10	1.09	0.34	0.21	0.09
8	0.31	0.14	0.20	0.15	0.07	0.75	0.19	0.13
9	0.34	0.22	0.20	0.19	0.14	0.14	0.48	0.27
AGE	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**
0	38.70	21.58	41.08	32.31	20.86	10.11	21.70	2.84
1	14.43	13.75	7.87	14.59	11.49	7.24	3.55	7.41
2	2.74	3.93	3.64	2.22	2.94	2.37	1.36	0.83
3	1.89	0.54	1.33	1.02	0.68	0.97	0.63	0.36
4	0.98	0.24	0.18	0.31	0.25	0.25	0.21	0.20
5	0.23	0.31	0.09	0.04	0.08	0.10	0.08	0.07
6	0.22	0.06	0.10	0.03	0.01	0.04	0.04	0.02
7	0.21	0.06	0.01	0.03	0.00	0.01	0.01	0.01
8	0.02	0.04	0.01	0.00	0.00	0.00	0.00	0.00
9	0.12	0.04	0.02	0.01	0.00	0.00	0.00	0.00
AGE	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**
0	2.73	4.34	4.61	10.61	16.74	37.89	64.79	61.83
1	0.89	0.87	1.45	1.62	3.59	5.43	8.61	17.06
2	1.37	0.26	0.24	0.44	0.50	1.18	1.50	2.53
3	0.17	0.27	0.15	0.17	0.29	0.26	0.63	0.86
4	0.07	0.03	0.05	0.12	0.13	0.16	0.16	0.31
5	0.04	0.01	0.02	0.04	0.10	0.09	0.11	0.11
6	0.01	0.01	0.00	0.02	0.04	0.07	0.05	0.08
7	0.01	0.00	0.00	0.00	0.02	0.03	0.04	0.04
8	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
AGE	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
0	53.48	80.96	97.63	86.22	42.30	39.16	35.87	33.62
1	15.25	15.69	27.35	33.76	26.99	13.74	12.64	12.44
2	4.88	4.57	3.94	7.34	8.56	5.56	3.29	2.96
3	1.39	2.64	2.26	1.84	3.62	4.44	2.77	1.67
4	0.51	0.74	1.11	1.10	0.91	1.99	2.41	1.56
5	0.18	0.27	0.32	0.56	0.55	0.46	1.03	1.37
6	0.08	0.09	0.13	0.17	0.27	0.26	0.22	0.57
7	0.05	0.05	0.04	0.05	0.08	0.13	0.12	0.12
8	0.03	0.02	0.03	0.02	0.03	0.04	0.06	0.05
9	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.03

Table 2.6.12.2 North Sea herring. Continued.

Population Abundance (1 January)

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	62.13	50.21	33.94	41.66	50.54	28.18	28.26	68.01
1	10.99	16.99	12.68	9.92	11.11	17.25	10.12	10.25
2	3.36	2.75	4.10	3.65	2.70	3.17	6.07	3.16
3	1.23	1.41	1.04	1.53	1.48	1.46	1.76	3.46
4	0.87	0.61	0.61	0.42	0.53	0.74	0.79	0.96
5	0.90	0.44	0.27	0.22	0.16	0.31	0.40	0.45
6	0.76	0.47	0.20	0.14	0.09	0.09	0.18	0.20
7	0.32	0.34	0.21	0.09	0.07	0.06	0.05	0.08
8	0.07	0.14	0.13	0.12	0.04	0.06	0.04	0.03
9	0.04	0.07	0.08	0.05	0.01	0.02	0.01	0.01

AGE	2000	2001	2002	2003	2004	2005	2006
0	40.29	90.19	31.76	18.63	21.91	21.78	26.98
1	24.11	14.18	31.79	11.25	6.59	7.71	7.57
2	3.59	8.19	4.84	10.95	3.87	2.24	2.57
3	1.82	2.13	5.26	3.16	7.12	2.47	1.37
4	1.88	1.07	1.39	3.52	2.10	4.61	1.49
5	0.59	1.09	0.71	0.96	2.41	1.39	2.77
6	0.28	0.33	0.71	0.49	0.65	1.57	0.82
7	0.11	0.18	0.22	0.49	0.33	0.42	0.93
8	0.04	0.07	0.12	0.15	0.34	0.22	0.26
9	0.01	0.01	0.03	0.04	0.09	0.12	0.21

Weighting factors for the catches in number

AGE	2001	2002	2003	2004	2005
0	0.1000	0.1000	0.1000	0.1000	0.1000
1	0.1000	0.1000	0.1000	0.1000	0.1000
2	3.6700	3.6700	3.6700	3.6700	3.6700
3	2.8700	2.8700	2.8700	2.8700	2.8700
4	2.2300	2.2300	2.2300	2.2300	2.2300
5	1.7400	1.7400	1.7400	1.7400	1.7400
6	1.3700	1.3700	1.3700	1.3700	1.3700
7	1.0400	1.0400	1.0400	1.0400	1.0400
8	0.9400	0.9400	0.9400	0.9400	0.9400

Predicted SSB Index Values
MLAI

	1973	1974	1975	1976	1977	1978	1979	1980
1	17.19	11.33	5.19	4.93	2.82	4.02	7.11	8.94

	1981	1982	1983	1984	1985	1986	1987	1988
1	14.12	21.12	34.94	58.42	60.43	58.46	80.64	111.28

	1989	1990	1991	1992	1993	1994	1995	1996
1	117.18	110.31	88.77	60.82	38.69	42.16	37.46	37.02

	1997	1998	1999	2000	2001	2002	2003	2004
1	45.84	63.28	75.79	77.26	124.74	157.13	171.13	178.27

	2005
1	165.99

Table 2.6.12.2 North Sea herring. Continued.

Predicted Age-Structured Index Values
Acoustic survey 1-9+ wr Predicted x 10 ^ 3

AGE	1989	1990	1991	1992	1993	1994	1995	1996
1	999990.	999990.	999990.	999990.	999990.	999990.	999990.	999990.
2	5775.	3453.	2788.	3174.	2457.	3637.	3388.	2934.
3	5669.	3609.	2079.	1498.	1579.	1122.	1520.	1806.
4	2513.	3205.	2089.	1088.	702.	630.	443.	718.
5	566.	1382.	1850.	1170.	529.	344.	247.	213.
6	312.	295.	778.	917.	570.	244.	182.	131.
7	143.	132.	158.	360.	345.	270.	107.	111.
8	45.	72.	69.	86.	159.	152.	137.	63.
9	54.	81.	96.	138.	206.	274.	157.	39.

AGE	1997	1998	1999	2000	2001	2002	2003	2004
1	10742.	5899.	6368.	14726.	8681.	19558.	6914.	4031.
2	3503.	6792.	3553.	4112.	9789.	5839.	13173.	4611.
3	1858.	2254.	4414.	2423.	3004.	7528.	4507.	10003.
4	959.	1058.	1334.	2525.	1552.	2055.	5187.	3036.
5	431.	505.	651.	803.	1606.	1075.	1439.	3542.
6	122.	216.	272.	412.	499.	1091.	739.	965.
7	84.	67.	102.	149.	251.	316.	700.	463.
8	86.	58.	47.	69.	110.	199.	253.	548.
9	71.	35.	26.	31.	41.	144.	160.	377.

AGE	2005
1	4657.
2	2612.
3	3342.
4	6321.
5	1931.
6	2214.
7	567.
8	339.
9	508.

IBTS: 1-5+ wr Predicted

AGE	1984	1985	1986	1987	1988	1989	1990	1991
1	2064.3	2076.6	3650.4	4473.9	3485.4	1807.2	1658.9	1662.1
2	782.5	724.6	619.8	1163.0	1365.0	882.0	522.6	458.9
3	161.0	297.8	259.7	212.1	422.5	517.7	323.9	193.5
4	34.2	48.5	74.1	73.5	61.0	133.6	164.2	106.6
5	12.8	15.3	17.9	27.2	31.5	29.8	48.9	72.7

AGE	1992	1993	1994	1995	1996	1997	1998	1999
1	1454.2	2237.3	1706.9	1326.3	1494.4	2382.2	1376.0	1414.1
2	522.0	421.0	627.1	563.9	433.1	510.2	979.3	510.4
3	142.1	159.0	116.8	168.5	170.8	169.7	205.6	402.8
4	58.3	40.3	39.0	26.9	36.0	50.1	53.9	66.0
5	69.8	47.9	29.6	20.3	12.8	18.3	22.8	26.4

AGE	2000	2001	2002	2003	2004	2005	2006
1	3314.3	1950.5	4376.8	1549.1	906.2	1057.7	1037.3
2	582.7	1341.6	794.1	1795.5	632.7	365.4	417.8
3	213.7	254.0	628.7	377.7	847.4	291.9	162.1
4	128.2	74.3	96.8	245.3	145.7	315.9	102.2
5	35.6	58.2	62.8	74.1	132.4	127.7	170.9

Table 2.6.12.2 North Sea herring. Continued.

MIK 0-wr Predicted

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	185.47	148.41	102.17	123.98	155.10	87.02	87.39	209.71

AGE	2000	2001	2002	2003	2004	2005	2006
0	124.14	277.89	97.93	57.42	67.50	66.98	83.00

Fitted Selection Pattern

AGE	1960	1961	1962	1963	1964	1965	1966	1967
0	0.0765	0.0455	0.0115	0.0651	0.0340	0.0092	0.0375	0.0277
1	0.7603	0.3166	0.2125	0.5464	0.8329	0.3169	0.3239	0.3224
2	1.2965	1.5105	0.5929	1.3103	1.0504	0.9982	1.0353	0.4567
3	0.9757	0.8630	1.4861	1.2134	1.1136	0.9513	1.2385	0.8703
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.7912	0.9813	1.2666	0.6635	0.8313	0.8498	1.4596	0.8955
6	0.9378	0.9337	1.9243	0.8009	0.6422	0.6695	0.6829	1.0927
7	1.8128	0.6181	1.5079	1.2399	0.7616	0.5880	0.6793	1.6592
8	1.6758	1.3072	1.3954	1.4789	1.4756	1.1092	1.2775	1.1575
9	1.6758	1.3072	1.3954	1.4789	1.4756	1.1092	1.2775	1.1575

AGE	1968	1969	1970	1971	1972	1973	1974	1975
0	0.0325	0.0094	0.0264	0.0277	0.0729	0.0467	0.0755	0.1144
1	0.2802	0.3765	0.2015	0.4910	0.7230	0.6824	0.4550	0.5019
2	1.2388	0.8974	0.7313	0.7197	1.0155	1.0347	1.0365	0.9564
3	1.7473	1.0438	0.9524	0.9906	1.0021	1.3499	0.9799	1.0976
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.1518	1.2058	0.6581	0.8841	0.6871	0.9635	1.1944	1.3660
6	1.0973	2.1748	0.8114	2.1292	0.6469	1.3949	1.0871	0.9290
7	1.4951	1.4912	3.0962	2.2007	0.1223	0.8148	0.7781	1.4848
8	1.5501	1.5226	1.3323	1.5817	1.2647	1.5585	1.3393	1.4724
9	1.5501	1.5226	1.3323	1.5817	1.2647	1.5585	1.3393	1.4724

AGE	1976	1977	1978	1979	1980	1981	1982	1983
0	0.0844	0.2278	0.4399	0.8968	0.4232	1.5899	1.3532	0.9157
1	0.1429	0.6939	1.9329	1.7855	0.3811	0.9413	0.9107	0.5766
2	0.7700	0.5238	0.2339	1.0140	1.2241	1.0693	1.0540	0.6921
3	0.8243	3.2867	0.4091	0.7121	1.4098	0.9083	2.0575	0.7429
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.9141	2.8098	0.1604	0.5566	0.8881	1.3609	0.6238	0.6310
6	0.6079	1.6910	0.7452	0.1329	0.2245	1.4137	0.5867	0.7883
7	0.8597	1.6723	0.5732	4.6693	0.3415	3.1500	0.9209	0.8965
8	0.9553	2.1995	1.6254	2.4214	1.2098	2.0425	1.6909	1.1600
9	0.9553	2.1995	1.6254	2.4214	1.2098	2.0425	1.6909	1.1600

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	0.4219	0.1157	0.1066	0.2741	0.2144	0.2348	0.1260	0.2576
1	0.3824	0.5193	0.5432	0.6323	0.9976	0.7755	0.9692	0.6736
2	0.5860	0.5485	0.7903	0.6897	0.6117	0.7172	0.8061	1.2560
3	0.8006	0.9101	0.8990	0.8581	0.6890	0.7384	0.7906	0.9927
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.1689	0.8984	0.9516	1.0443	1.1413	1.1801	1.0685	1.0560
6	0.6702	0.9892	1.2530	1.0759	1.1548	1.2594	1.0504	1.0421
7	1.2924	0.7548	1.4018	1.0280	1.1815	1.2608	1.4499	0.9194
8	1.1419	1.1575	1.3839	1.3289	1.5319	1.4762	1.6104	1.5320
9	1.1419	1.1575	1.3839	1.3289	1.5319	1.4762	1.6104	1.5320

Table 2.6.12.2 North Sea herring. Continued.

Fitted Selection Pattern

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	0.5188	0.5120	0.2526	0.3699	0.1782	0.0476	0.0321	0.0958
1	0.6773	0.5743	0.2701	0.3448	0.6057	0.0871	0.3594	0.1238
2	1.0014	0.9101	0.7500	0.6908	0.7605	0.5575	0.5776	0.6578
3	0.8724	0.8718	0.7866	0.9972	1.1740	0.7971	0.8940	1.0587
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.9550	0.9651	0.6141	0.9479	1.1490	0.8818	1.3468	0.9715
6	1.2600	0.9507	0.7304	0.6254	0.7523	0.9057	1.5919	1.1918
7	1.2132	1.1908	0.5218	0.7341	0.3455	0.4708	0.8423	1.1998
8	1.4941	1.3617	0.9414	1.0696	1.2623	0.8311	1.2273	1.0944
9	1.4941	1.3617	0.9414	1.0696	1.2623	0.8311	1.2273	1.0944

AGE	2000	2001	2002	2003	2004	2005
0	0.0990	0.1397	0.1397	0.1397	0.1397	0.1397
1	0.1780	0.2461	0.2461	0.2461	0.2461	0.2461
2	0.4984	0.4683	0.4683	0.4683	0.4683	0.4683
3	0.7355	0.7460	0.7460	0.7460	0.7460	0.7460
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0633	1.0578	1.0578	1.0578	1.0578	1.0578
6	0.8181	1.0349	1.0349	1.0349	1.0349	1.0349
7	0.9071	0.9490	0.9490	0.9490	0.9490	0.9490
8	0.9321	1.0000	1.0000	1.0000	1.0000	1.0000
9	0.9321	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.6.12.3 North Sea herring. 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	12089090	3742767	1878943	696200	0.3705	0.3366	84
1961	108857940	4355991	1654851	696700	0.4210	0.4322	88
1962	46274080	4394678	1112088	627800	0.5645	0.5291	85
1963	47657600	4623391	2183934	716000	0.3278	0.2265	116
1964	62786690	4793448	2027794	871200	0.4296	0.3435	93
1965	34895610	4339714	1444957	1168800	0.8089	0.6942	86
1966	27859050	3314047	1278256	895500	0.7006	0.6195	93
1967	40256630	2817000	922295	695500	0.7541	0.7978	85
1968	38698600	2521070	412563	717800	1.7399	1.3360	79
1969	21582200	1905429	424184	546700	1.2888	1.1051	103
1970	41076490	1922007	374699	563100	1.5028	1.1049	103
1971	32311610	1849647	266156	520100	1.9541	1.4038	93
1972	20859910	1549694	288415	497500	1.7249	0.6959	108
1973	10110780	1156277	233539	484000	2.0725	1.1343	104
1974	21703360	912367	162160	275100	1.6965	1.0515	103
1975	2838870	680953	81920	312800	3.8184	1.4660	107
1976	2730140	359354	78269	174800	2.2333	1.4304	104
1977	4339830	211395	48108	46000	0.9562	0.7969	83
1978	4606470	226049	65555	11000	0.1678	0.0527	82
1979	10610250	383299	107880	25100	0.2327	0.0637	99
1980	16740200	631922	131863	70764	0.5366	0.2819	91
1981	37886010	1160526	196653	174879	0.8893	0.3486	99
1982	64790370	1845630	279729	275079	0.9834	0.2629	102
1983	61831650	2722230	434419	387202	0.8913	0.3364	92
1984	53480290	2867906	681180	428631	0.6292	0.4533	94
1985	80962350	3466041	701654	613780	0.8748	0.6405	95
1986	97629230	3476059	681561	671488	0.9852	0.5687	87
1987	86218840	3939726	903069	792058	0.8771	0.5497	98
1988	42295410	3582175	1197041	887686	0.7416	0.5345	85
1989	39157000	3312890	1252346	787899	0.6291	0.5436	96
1990	35870540	2978928	1187869	645229	0.5432	0.4408	95
1991	33623240	2716427	982216	658008	0.6699	0.4893	98
1992	62131240	2438439	705619	716799	1.0158	0.5821	100
1993	50214890	2521386	474950	671397	1.4136	0.6907	97
1994	33944220	2024386	512037	568234	1.1097	0.7079	95
1995	41664490	1831794	461800	579371	1.2546	0.7414	99
1996	50536400	1618364	457038	275098	0.6019	0.4051	100
1997	28177000	1946148	550909	264313	0.4798	0.4261	99
1998	28262470	2063765	730446	391628	0.5361	0.4924	99
1999	68007550	2346352	855344	363163	0.4246	0.3770	100
2000	40293360	2872004	869867	388157	0.4462	0.3675	99
2001	90186270	3242997	1322733	363343	0.2747	0.2643	100
2002	31759100	3933122	1618810	370941	0.2291	0.2312	100
2003	18626860	3660971	1744290	472587	0.2709	0.2404	98
2004	21909350	3358171	1807780	567252	0.3138	0.2699	99
2005	21775360	2903375	1698377	663813	0.3909	0.3524	99

No of years for separable analysis : 5
Age range in the analysis : 0 . . . 9
Year range in the analysis : 1960 . . . 2005
Number of indices of SSB : 1
Number of age-structured indices : 3
Stock-recruit relationship to be fitted.
Parameters to estimate : 45
Number of observations : 398

Conventional single selection vector model to be fitted.

Table 2.6.12.4 North Sea herring. Model fit parameters, residuals and diagnostics.

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	2001	0.3068	9	0.2557	0.3681	0.2795	0.3367	0.3081
2	2002	0.2684	9	0.2231	0.3228	0.2442	0.2949	0.2696
3	2003	0.2791	9	0.2312	0.3371	0.2535	0.3073	0.2804
4	2004	0.3133	10	0.2575	0.3812	0.2835	0.3463	0.3149
5	2005	0.4091	11	0.3287	0.5091	0.3659	0.4574	0.4117
Separable Model: Selection (S) by age								
6	0	0.1397	29	0.0789	0.2475	0.1044	0.1871	0.1458
7	1	0.2461	28	0.1412	0.4290	0.1853	0.3268	0.2562
8	2	0.4683	8	0.3940	0.5566	0.4288	0.5114	0.4701
9	3	0.7460	8	0.6308	0.8821	0.6848	0.8126	0.7487
	4	1.0000	Fixed : Reference Age					
10	5	1.0578	8	0.8888	1.2589	0.9679	1.1560	1.0619
11	6	1.0349	9	0.8556	1.2517	0.9392	1.1403	1.0398
12	7	0.9490	11	0.7624	1.1814	0.8487	1.0612	0.9550
	8	1.0000	Fixed : Last true age					
Separable model: Populations in year 2005								
13	0	21775360	18	15249348	31094201	18156394	26115665	22138025
14	1	7714736	13	5879361	10123065	6716169	8861771	7789209
15	2	2244528	10	1840842	2736741	2028580	2483465	2256042
16	3	2472563	9	2067927	2956375	2257092	2708603	2482862
17	4	4611338	8	3890334	5465966	4228180	5029217	4628720
18	5	1389958	9	1157811	1668651	1266222	1525786	1396013
19	6	1566343	10	1284314	1910305	1415466	1733303	1574398
20	7	423101	12	331813	539504	373759	478957	426366
21	8	221165	14	167362	292263	191845	254965	223413
Separable model: Populations at age								
22	2001	67764	21	44663	102811	54781	83823	69314
23	2002	119922	17	85876	167466	101136	142198	121675
24	2003	153730	15	114412	206560	132223	178736	155486
25	2004	338862	14	257505	445922	294569	389814	342202
Recruitment in year 2006								
26	2005	26984597	26	16164827	45046476	20776512	35047678	27922770
SSB Index catchabilities								
MLAI								
Power model fitted. Slopes (Q) and exponents (K) at age								
27	1 Q	3.136	11	2.637	4.086	2.935	3.670	3.303
28	1 K	.1256E-04	11	.1826E-04	.2829E-04	.2032E-04	.2541E-04	.2403E-04
Age-structured index catchabilities								
Acoustic survey 1-9+ wr								
Linear model fitted. Slopes at age :								
29	1 Q	1.106	8	1.015	1.441	1.106	1.322	1.214
30	2 Q	1.525	6	1.435	1.841	1.525	1.732	1.628
31	3 Q	1.785	11	1.593	2.535	1.785	2.262	2.024
32	4 Q	1.814	15	1.564	2.863	1.814	2.469	2.141
33	5 Q	1.863	16	1.593	3.016	1.863	2.580	2.221
34	6 Q	1.885	17	1.596	3.148	1.885	2.666	2.276
35	7 Q	1.752	18	1.466	3.037	1.752	2.541	2.147
36	8 Q	2.031	18	1.698	3.528	2.031	2.950	2.491
37	9 Q	5.505	21	4.465	10.50	5.505	8.515	7.011

Table 2.6.12.4 North Sea herring. Continued.

IBTS1: 1-5+ wr
Linear model fitted. Slopes at age :

38	1	Q	.1573E-03	6	.1481E-03	.1894E-03	.1573E-03	.1783E-03	.1678E-03
39	2	Q	.1731E-03	7	.1603E-03	.2193E-03	.1731E-03	.2031E-03	.1881E-03
40	3	Q	.1257E-03	41	.8428E-04	.4317E-03	.1257E-03	.2894E-03	.2080E-03
41	4	Q	.7300E-04	41	.4893E-04	.2507E-03	.7300E-04	.1680E-03	.1208E-03
42	5	Q	.3663E-04	41	.2454E-04	.1258E-03	.3663E-04	.8432E-04	.6062E-04

MIK 0-wr
Linear model fitted. Slopes at age :

43	0	Q	.3510E-05	7	.3279E-05	.4331E-05	.3510E-05	.4045E-05	.3778E-05

Parameters of the stock-recruit relationship

44	1	a	.6321E+08	22	.5101E+08	.1224E+09	.6321E+08	.9880E+08	.8102E+08
45	1	b	.4499E+06	44	.2930E+06	.1689E+07	.4499E+06	.1100E+07	.7772E+06

RESIDUALS ABOUT THE MODEL FIT
Separable Model Residuals

Age	2001	2002	2003	2004	2005
0	-0.2699	-0.0148	-0.2024	0.1839	0.2789
1	-0.0655	-0.4354	0.2617	-0.4090	0.4183
2	-0.1643	0.1105	0.0354	-0.0416	0.0452
3	0.1856	0.0406	-0.0443	-0.0173	-0.1987
4	0.0157	-0.0926	0.0015	-0.0374	-0.1146
5	0.0802	-0.2320	0.0356	0.1123	0.0288
6	0.0335	-0.0215	-0.0902	0.0016	0.1091
7	-0.1309	-0.0154	0.1064	0.2262	-0.1210
8	0.0081	0.2143	0.0374	-0.2014	0.4206

SPAWNING BIOMASS INDEX RESIDUALS
MLAI

	1973	1974	1975	1976	1977	1978	1979	1980
1	-0.2489	-0.3353	-0.6171	-0.6783	0.7862	0.6229	0.7333	0.1316

	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0671	0.0269	-0.2285	-0.1477	0.2384	-0.3819	-0.1429	0.2217

	1989	1990	1991	1992	1993	1994	1995	1996
1	0.1430	0.4655	0.0314	-0.3468	-0.2215	-0.6827	-0.4495	0.2322

	1997	1998	1999	2000	2001	2002	2003	2004
1	0.2558	0.2079	-0.1566	-0.5860	0.0783	-0.3174	0.4998	0.6194

	2005
1	0.1804

Table 2.6.12.4 North Sea herring. Continued.

AGE-STRUCTURED INDEX RESIDUALS

Acoustic survey 1-9+ wr

Age	1989	1990	1991	1992	1993	1994	1995	1996
1	*******	*******	*******	*******	*******	*******	*******	*******
2	-0.345	-0.044	-0.057	0.163	0.194	-0.133	0.128	0.427
3	-0.373	-0.025	-0.201	-0.084	0.036	-0.291	0.295	0.447
4	-0.431	0.063	-0.064	0.053	0.250	-0.457	0.417	0.415
5	-0.140	-0.012	-0.001	-0.031	0.337	0.101	0.192	0.376
6	-0.098	0.285	-0.189	0.307	0.309	0.274	0.110	-0.281
7	-0.174	0.465	0.369	0.092	0.470	0.190	0.254	-0.286
8	-0.013	0.610	0.304	0.287	0.121	0.365	-0.140	0.748
9	-0.896	-0.632	-0.627	-0.281	-0.576	-0.739	-0.525	1.660

Age	1997	1998	1999	2000	2001	2002	2003	2004
1	-0.138	-0.282	-0.225	0.519	-0.239	0.164	0.352	0.252
2	0.531	-0.167	-0.144	-0.341	0.228	-0.180	0.364	-0.300
3	0.457	0.111	0.068	-0.117	0.026	0.088	-0.380	-0.085
4	0.407	0.430	-0.179	0.218	-0.060	-0.391	-0.214	-0.337
5	0.333	0.665	-0.253	0.227	0.043	-0.302	-0.757	-0.313
6	0.568	0.723	0.142	0.159	-0.103	-0.056	-0.401	-1.113
7	-0.599	0.927	0.314	0.579	-0.388	-0.257	-0.208	-0.347
8	-0.096	-0.253	0.137	0.557	-0.116	-0.497	-0.555	-0.472
9	0.811	1.228	1.217	1.128	0.359	0.038	0.106	-0.708

Age	2005
1	-0.403
2	-0.324
3	0.028
4	-0.119
5	-0.467
6	-0.636
7	-1.399
8	-0.987
9	-1.560

IBTS1: 1-5+ wr

Age	1984	1985	1986	1987	1988	1989	1990	1991
1	-0.340	0.003	-0.342	-0.181	0.249	0.191	-0.482	-0.342
2	-1.527	0.032	0.280	-0.206	1.242	0.057	-0.081	0.582
3	-0.877	0.012	0.107	-0.537	0.773	-0.255	-0.034	0.399
4	-0.132	-0.020	0.126	-0.151	0.069	-0.178	0.578	0.887
5	-0.171	0.716	0.463	0.680	-0.117	-1.042	0.455	0.875

Age	1992	1993	1994	1995	1996	1997	1998	1999
1	-0.189	0.290	-0.037	-0.087	0.145	0.516	0.407	-0.682
2	-0.241	0.692	0.629	0.806	-0.729	0.032	-0.203	-0.111
3	0.317	0.347	0.607	0.398	-1.299	0.185	-0.757	0.307
4	0.162	0.151	0.562	0.210	-0.982	-0.158	-0.896	0.501
5	0.450	0.359	0.374	-1.188	-0.341	0.285	-0.097	0.424

Age	2000	2001	2002	2003	2004	2005	2006
1	0.108	0.252	-0.072	0.661	0.078	-0.024	-0.120
2	-0.984	-0.183	-0.193	-0.148	-0.328	-0.653	1.235
3	-0.294	0.223	-0.719	0.230	-0.110	0.109	0.867
4	-0.735	0.277	-1.486	0.344	-0.273	0.241	0.901
5	-1.420	0.128	-1.148	-0.524	0.064	0.094	0.684

Table 2.6.12.4 North Sea herring. Continued.

MIK 0-wr

Age	1992	1993	1994	1995	1996	1997	1998	1999
0	0.0789	0.2476	-0.0046	0.0240	-0.3759	0.5317	-0.4983	0.1515

Age	2000	2001	2002	2003	2004	2005	2006
0	0.0993	-0.2575	0.5021	-0.0541	-0.3557	-0.0886	0.0000

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 2001 to 2005

Variance	0.0514
Skewness test stat.	0.3071
Kurtosis test statistic	0.6286
Partial chi-square	0.0834
Significance in fit	0.0000
Degrees of freedom	20

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES
DISTRIBUTION STATISTICS FOR MLAI

Power catchability relationship assumed
Last age is a plus-group

Variance	0.1027
Skewness test stat.	0.3167
Kurtosis test statistic	-0.9120
Partial chi-square	1.4291
Significance in fit	0.0000
Number of observations	33
Degrees of freedom	31
Weight in the analysis	0.6000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES
DISTRIBUTION STATISTICS FOR Acoustic survey 1-9+ wr
Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8	9
Variance	0.0671	0.0490	0.0102	0.0098	0.0111	0.0160	0.0209	0.0151	0.0424
Skewness test stat	0.4112	0.7032	0.5172	0.0903	-0.4229	-1.2915	-1.2001	-0.5000	0.5704
Kurtosis test ti	-0.8393	-0.8663	-0.3431	-1.1081	-0.1619	0.4846	0.5956	-0.4216	-0.8378
Partial chi-square	0.0338	0.0513	0.0111	0.0113	0.0130	0.0194	0.0272	0.0202	0.0607
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	9	17	17	17	17	17	17	17	17
Degrees of freedom	8	16	16	16	16	16	16	16	16
Weight in the anal	0.6300	0.6200	0.1700	0.1000	0.0900	0.0800	0.0700	0.0700	0.0500

DISTRIBUTION STATISTICS FOR IBTS1: 1-5+ wr
Linear catchability relationship assumed

Age	1	2	3	4	5
Variance	0.0491	0.1226	0.0030	0.0034	0.0044
Skewness test stat.	-0.0086	-0.0445	-1.2835	-1.5175	-1.6315
Kurtosis test statisti	-0.2940	0.0957	-0.1345	0.3488	-0.3940
Partial chi-square	0.1443	0.4182	0.0122	0.0174	0.0274
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	23	23	23	23	23
Degrees of freedom	22	22	22	22	22
Weight in the analysis	0.4700	0.2800	0.0100	0.0100	0.0100

DISTRIBUTION STATISTICS FOR MIK 0-wr
Linear catchability relationship assumed

Age	0
Variance	0.0553
Skewness test stat.	0.2577
Kurtosis test statisti	-0.4088
Partial chi-square	0.1677
Significance in fit	0.0000
Number of observations	15
Degrees of freedom	14
Weight in the analysis	0.6300

Table 2.6.12.4 North Sea herring. Continued.

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	92.7966	398	45	353	0.2629
Catches at age	1.4317	45	25	20	0.0716
SSB Indices					
MLAI	5.3071	33	2	31	0.1712
Aged Indices					
Acoustic survey 1-9+ wr	31.6156	145	9	136	0.2325
IBTS1: 1-5+ wr	35.6595	115	5	110	0.3242
MIK 0-wr	1.2290	15	1	14	0.0878
Stock-recruit model	17.5537	45	2	43	0.4082

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	5.8451	398	45	353	0.0166
Catches at age	1.0282	45	25	20	0.0514
SSB Indices					
MLAI	1.9105	33	2	31	0.0616
Aged Indices					
Acoustic survey 1-9+ wr	0.9778	145	9	136	0.0072
IBTS1: 1-5+ wr	1.2653	115	5	110	0.0115
MIK 0-wr	0.4878	15	1	14	0.0348
Stock-recruit model	0.1755	45	2	43	0.0041

Table 2.7.1 Input file for the short term prediction with MFSP

```
North sea herring 2006
2006
0 9
4
F ref. age for each fleet
1 2 6
2 0 1
3 0 1
4 0 1
Two age ranges for overall F
0 1
2 6
Init numbers
       0       26980
       1        7570
       2        2570
       3        1370
       4        1490
       5        2770
       6         820
       7         930
       8         260
       9         210
recruitments
23169
23169
selection by age and fleet
       0     0.00002   0.05170   0.00064   0.00479
       1     0.00595   0.05147   0.02456   0.01870
       2     0.10579   0.00000   0.06244   0.02335
       3     0.29503   0.00000   0.00781   0.00235
       4     0.40744   0.00000   0.00147   0.00019
       5     0.43060   0.00000   0.00193   0.00021
       6     0.42171   0.00000   0.00143   0.00024
       7     0.38664   0.00000   0.00093   0.00067
       8     0.40849   0.00000   0.00061   0.00000
       9     0.40910   0.00000   0.00000   0.00000
natmor at age
0 1.0
1 1.0
2 0.3
3 0.2
4 0.1
5 0.1
6 0.1
7 0.1
8 0.1
9 0.1
weca2006
       0       0.079     0.012     0.021     0.020
       1       0.080     0.029     0.060     0.036
       2       0.122     0.039     0.071     0.070
       3       0.156     0.123     0.115     0.102
       4       0.178     0.135     0.145     0.138
       5       0.186     0.168     0.163     0.167
       6       0.216     0.171     0.183     0.166
       7       0.230     0.197     0.206     0.201
       8       0.247     0.205     0.191     0.196
       9       0.261         0         0         0
```

Table 2.7.1 Cont: Input file for the short term prediction with MFSP

```
weca 2007
       0       0.079     0.012     0.021     0.020
       1       0.080     0.029     0.060     0.036
       2       0.122     0.039     0.071     0.070
       3       0.156     0.123     0.115     0.102
       4       0.178     0.135     0.145     0.138
       5       0.200     0.168     0.163     0.167
       6       0.201     0.171     0.183     0.166
       7       0.230     0.197     0.206     0.201
       8       0.247     0.205     0.191     0.196
       9       0.261         0         0         0
west 2006
0 0.006
1 0.039
2 0.126
3 0.155
4 0.193
5 0.214
6 0.250
7 0.257
8 0.277
9 0.283
west 2007
0 0.006
1 0.039
2 0.126
3 0.155
4 0.193
5 0.230
6 0.233
7 0.257
8 0.277
9 0.283
west 2008
0 0.006
1 0.039
2 0.126
3 0.155
4 0.193
5 0.230
6 0.250
7 0.239
8 0.277
9 0.283
maturity 2006
0 0
1 0
2 0.73
3 0.95
4 1
5 1
6 1
7 1
8 1
9 1
```

Table 2.7.1 Cont: Input file for the short term prediction with MFSP

```
maturity 2007
0 0
1 0
2 0.73
3 0.95
4 1
5 1
6 1
7 1
8 1
9 1
maturity 2008
0 0
1 0
2 0.76
3 0.97
4 1
5 1
6 1
7 1
8 1
9 1
Proportion of F and M before spawning
0.67 0.67
```

Table 2.7.2. Management options for North Sea herring.

The numbers *in italics are assumed*, the others are derived.

Intermediate year – TAC constraint:

F1	F2	F3	F4	F_{0-1}	F_{2-6}	C1	C2	C3	C4	SSB2006
0.346	*0.066*	*0.016*	*0.013*	0.098	0.371	*513.0*	*21.8*	*22.9*	*9.1*	1327.0

Intermediate year – F- constraint:

F1	F2	F3	F4	F_{0-1}	F_{2-6}	C1	C2	C3	C4	SSB2006
0.332	*0.052*	*0.013*	*0.012*	0.079	0.352	496.3	17.2	18.2	8.5	1343.3

Prediction year (all with TAC constraint)

F-values by fleet and total						Catches by fleet					
F1	**F2**	**F3**	**F4**	**F_{0-1}**	**F_{2-6}**	**C1**	**C2**	**C3**	**C4**	**SSB2007**	**SSB2008**
Catches as in 2006											
0.443	0.066	0.016	0.012	0.098	0.467	*512.9*	*21.8*	*22.9*	*9.1*	1037.3	920.7
Reduce F for A fleet to get SSB in 2007 at 1.3 mill. t											
0.130	0.040	0.010	0.011	0.063	0.147	177.5	13.4	*16.0*	*8.6*	1301.3	1507.9
0.130	0.040	0.016	0.017	0.074	0.156	177.2	13.4	*24.0*	*12.9*	1296.0	1488.2
Harvest control rule: F on adults 0.25, F on juveniles 0.12											
0.232	0.096	0.011	0.012	*0.120*	*0.250*	300.0	31.5	*16.0*	*8.6*	1209.0	1271.2
0.223	0.085	0.016	0.017	*0.120*	*0.250*	289.1	27.8	*24.0*	*12.9*	1211.8	1273.6
Harvest control rule: F on adults 0.25, F on juveniles 0.05											
0.232	0.026	0.010	0.011	*0.050*	*0.250*	300.3	8.9	*16.0*	*8.6*	1208.9	1286.3
0.223	0.015	0.016	0.017	*0.050*	*0.250*	289.6	5.1	*24.0*	*12.9*	1211.7	1288.1
Harvest control rule: F on adults 0.20, F on juveniles 0.05											
0.183	0.027	0.010	0.011	*0.050*	*0.200*	242.2	9.1	*16.0*	*8.6*	1253.0	1390.3
0.174	0.016	0.016	0.017	*0.050*	*0.200*	231.1	5.3	*24.0*	*12.9*	1255.9	1393.3
Applying the 15% TAC constraint rule in 2007											
0.313	*0.040*	0.011	0.011	0.065	0.331	*387.8*	*13.4*	*16.0*	*8.6*	1141.1	1134.1
0.314	*0.100*	0.016	0.01	0.137	0.341	*387.9*	*32.6*	*24.0*	*12.9*	1135.3	1102.4

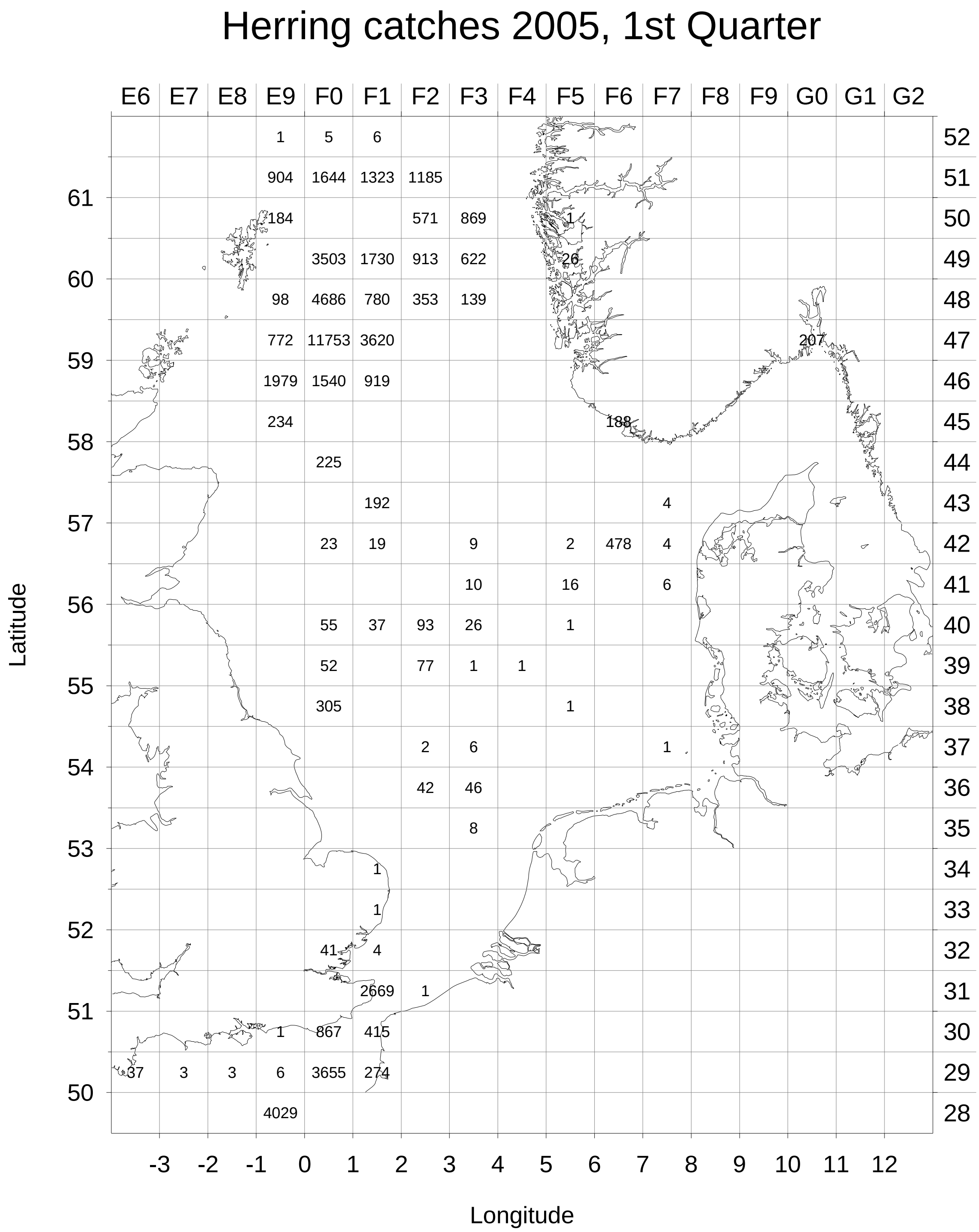


Figure 2.1.1: Herring catches in the North Sea (in tonnes) in 2005 by statistical rectangle. Working group estimates (if available). a.: 1st quarter

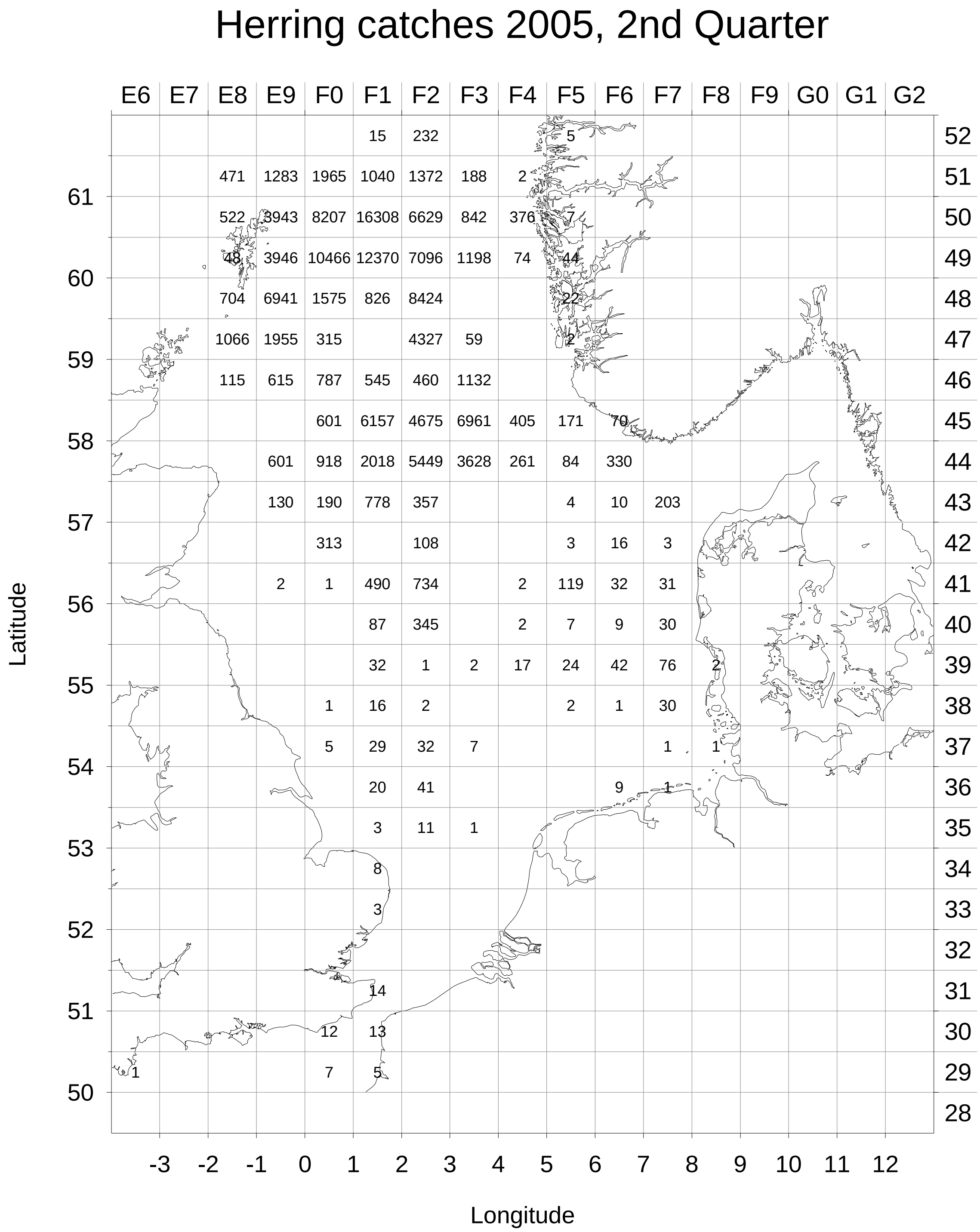


Figure 2.1.1: Herring catches in the North Sea (in tonnes) in 2005 by statistical rectangle. Working group estimates (if available). b.: 2nd quarter

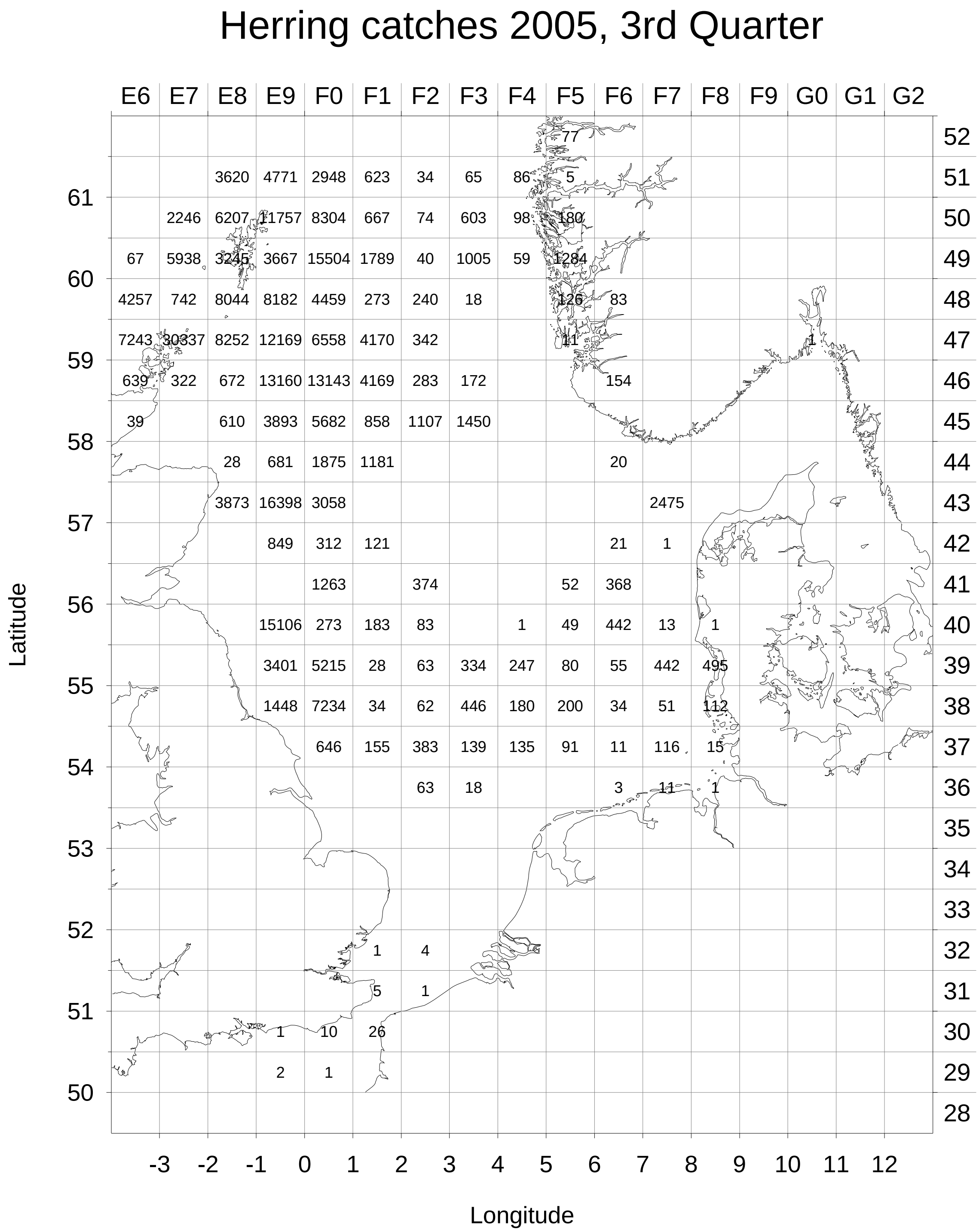


Figure 2.1.1: Herring catches in the North Sea (in tonnes) in 2005 by statistical rectangle. Working group estimates (if available). c.: 3rd quarter

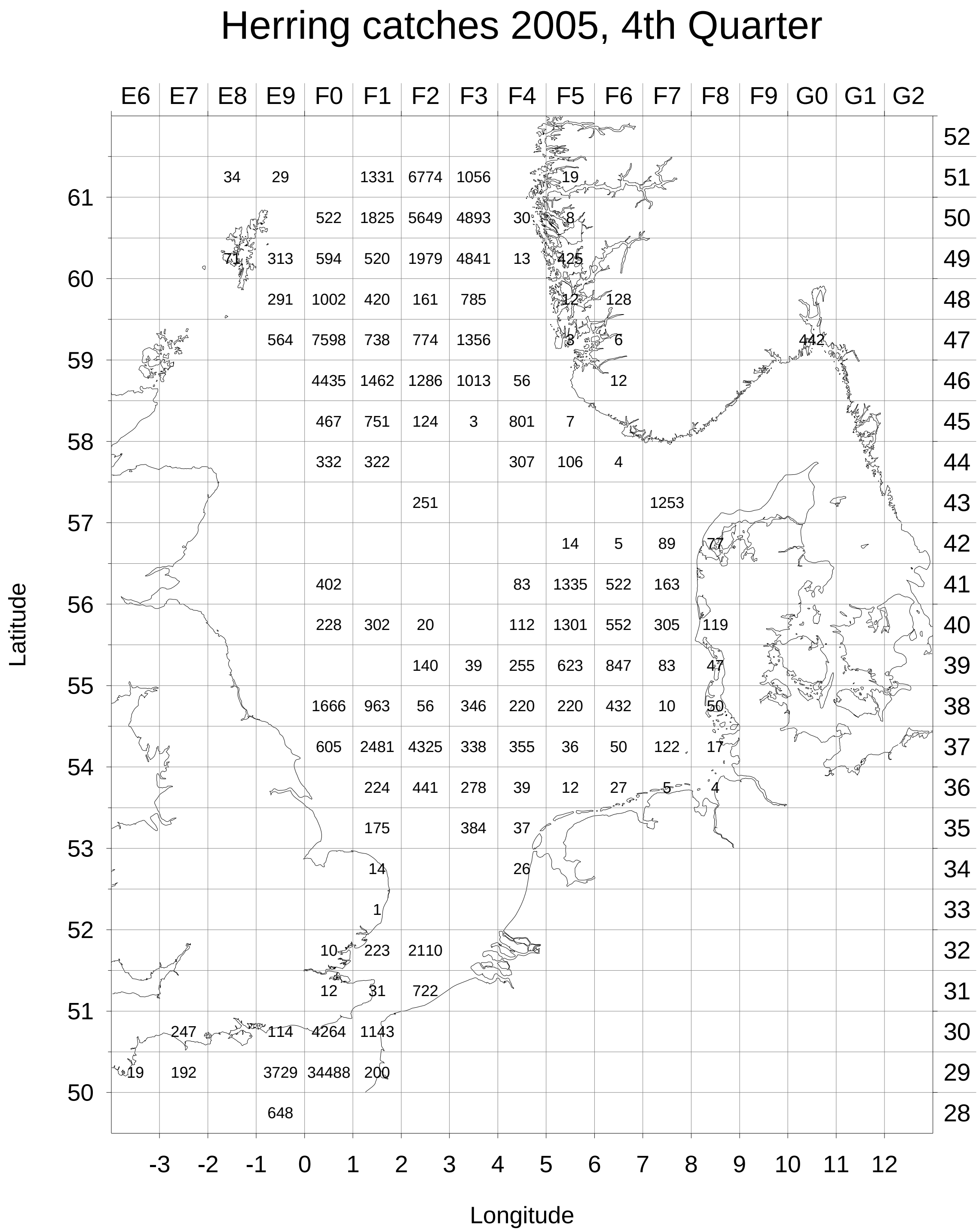


Figure 2.1.1.: Herring catches in the North Sea (in tonnes) in 2005 by statistical rectangle. Working group estimates (if available). d.: 4th quarter

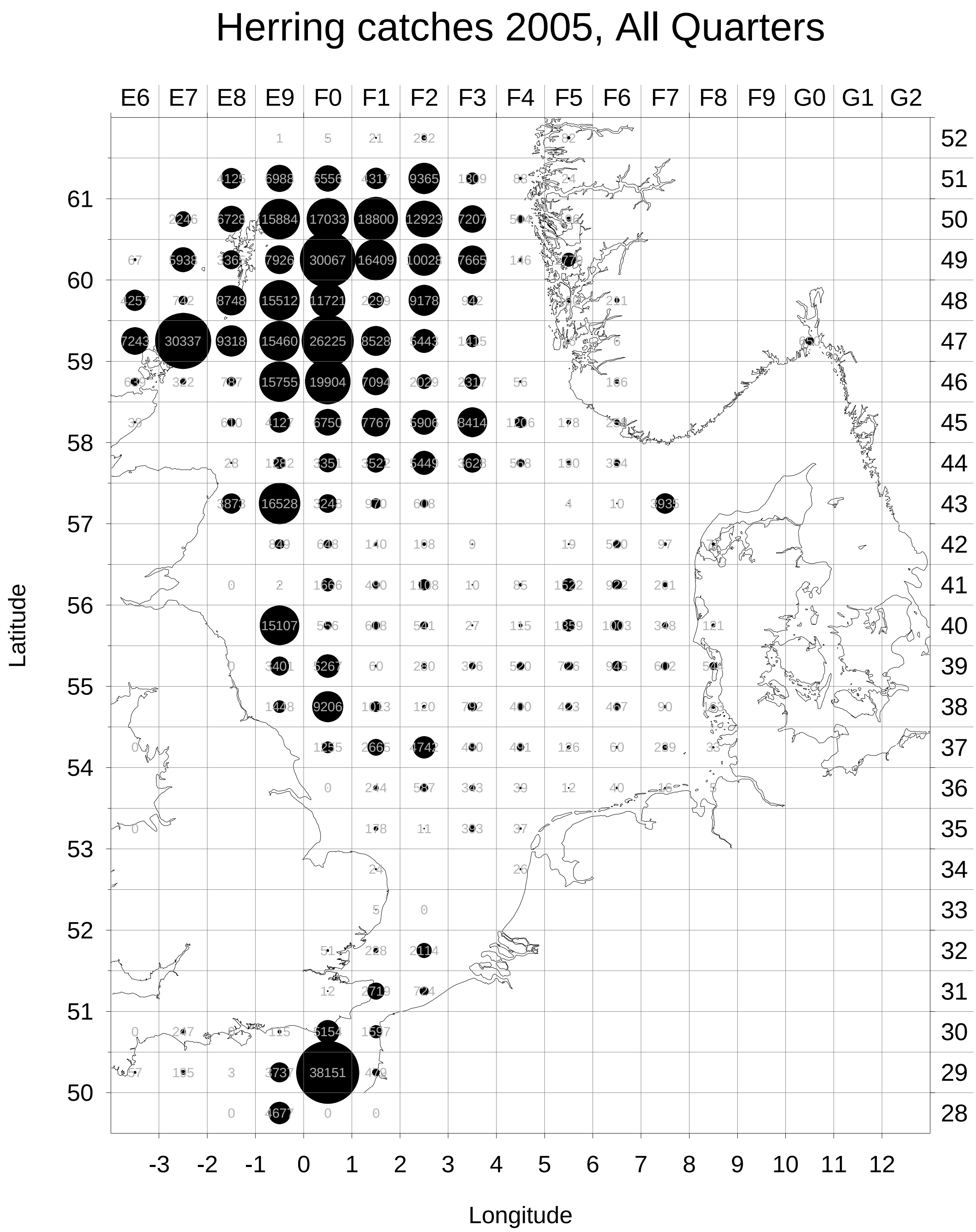


Figure 2.1.1: Herring catches in the North Sea (in tonnes) in 2005 by statistical rectangle. Working group estimates (if available). e: all quarters

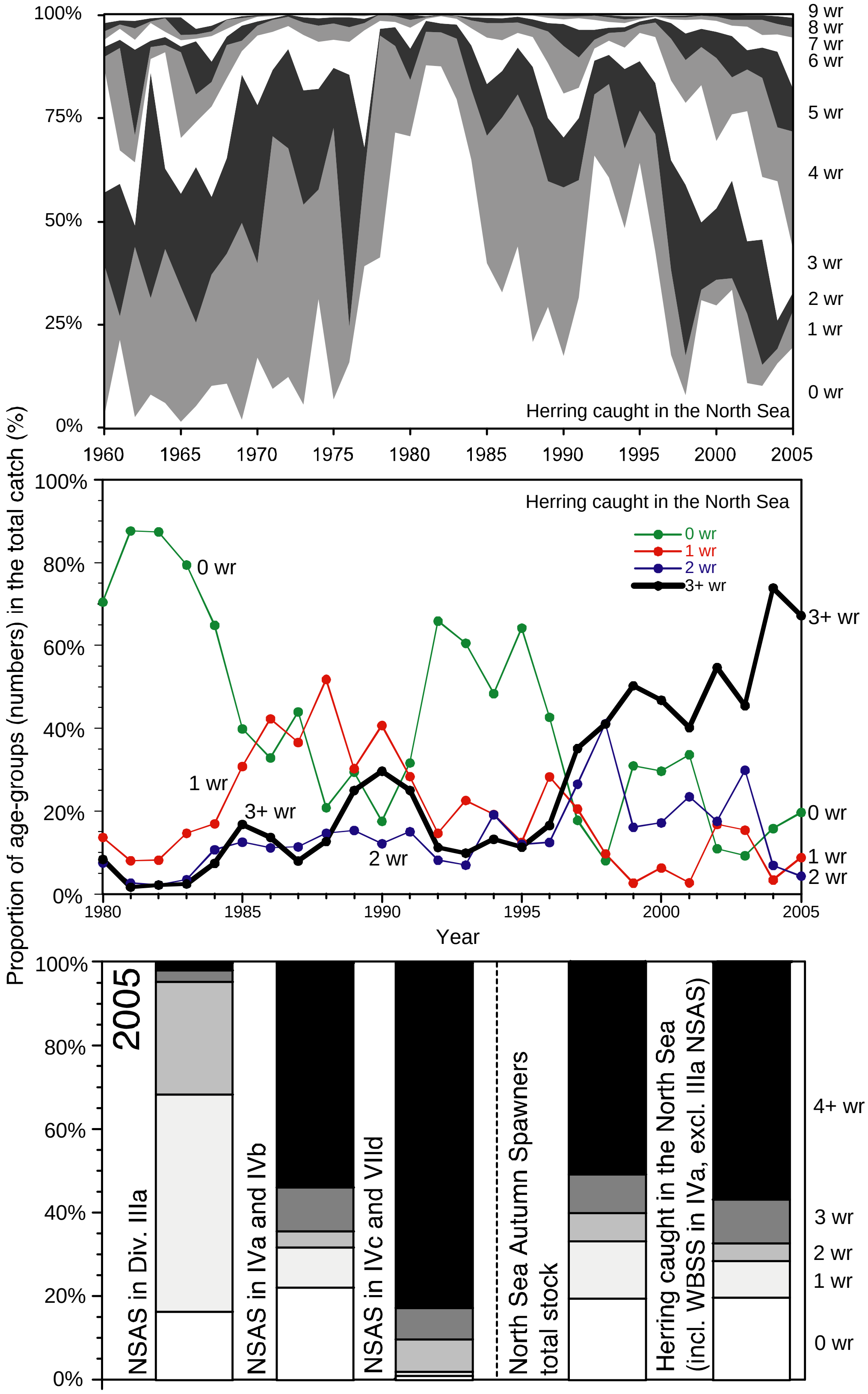


Figure 2.2.1: Proportions of age groups (numbers) in the total catch of herring in the North Sea (upper, 1960 – 2005, and middle panel, 1980 – 2005), and in the total catch of North Sea autumn spawners in 2005 (lower panel).

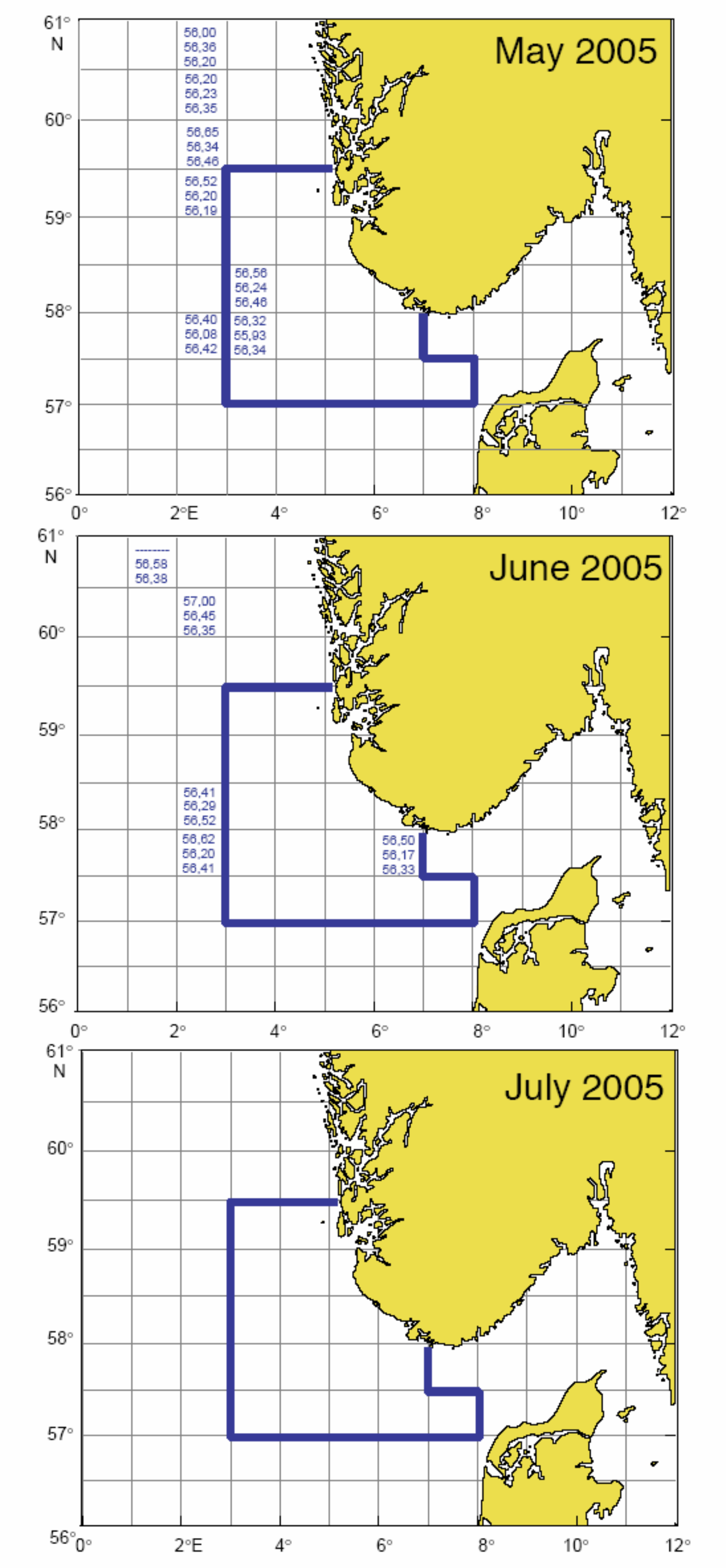


Figure 2.2.2: Mean vertebrae counts of 2 (upper number), 3 (middle) and 4+ herring (lower) in the North Sea and Div. IIIa as obtained by Norwegian sampling in the 2nd and 3rd quarter 2005. The transfer area (Western Baltic spring spawners transferred to the assessment of IIIa herring) is indicated.

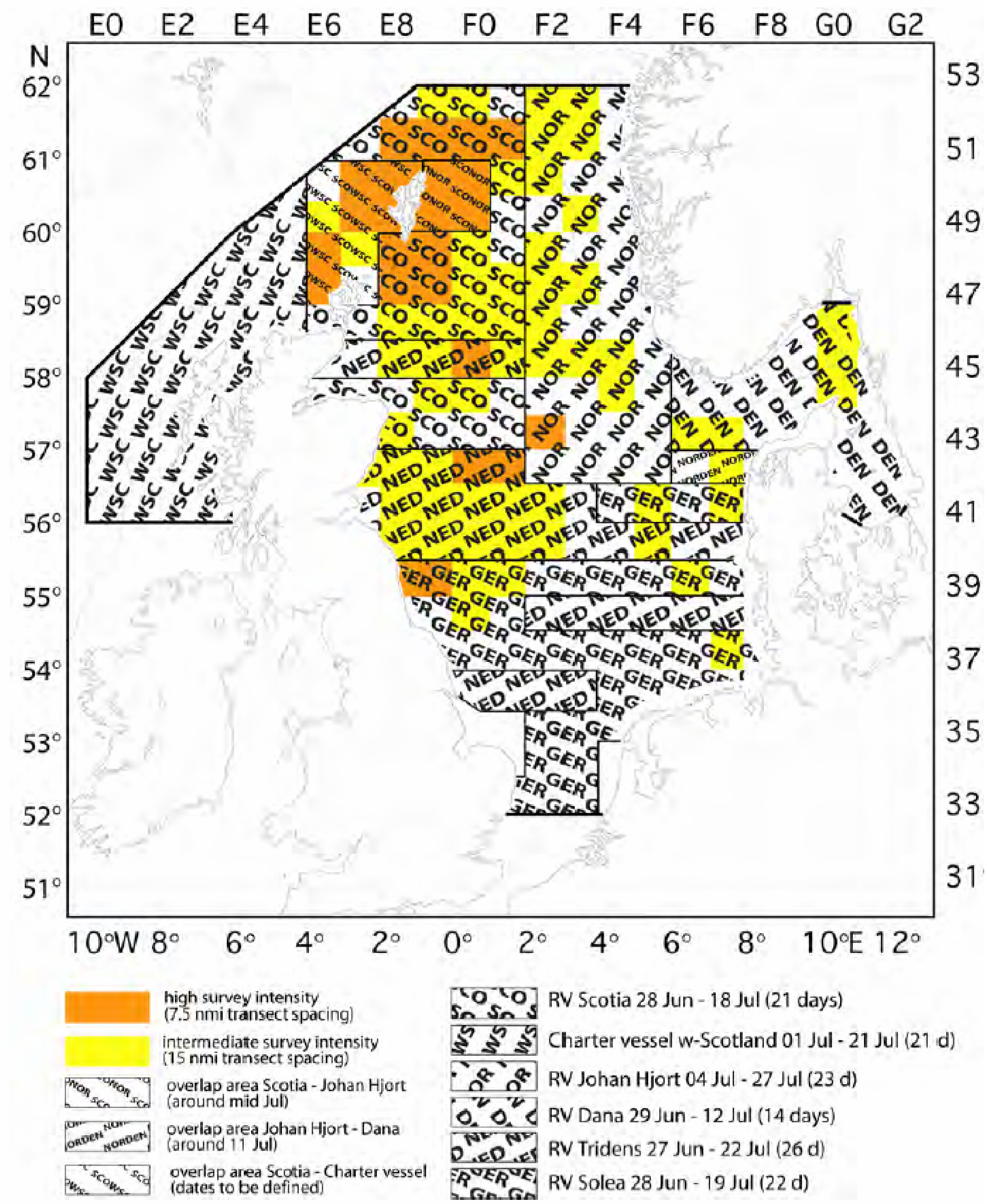


Figure 2.3.1.1 Herring in the North Sea. Herring survey area layouts and dates for all participating vessels in the 2005 acoustic survey of the North Sea and adjacent areas.

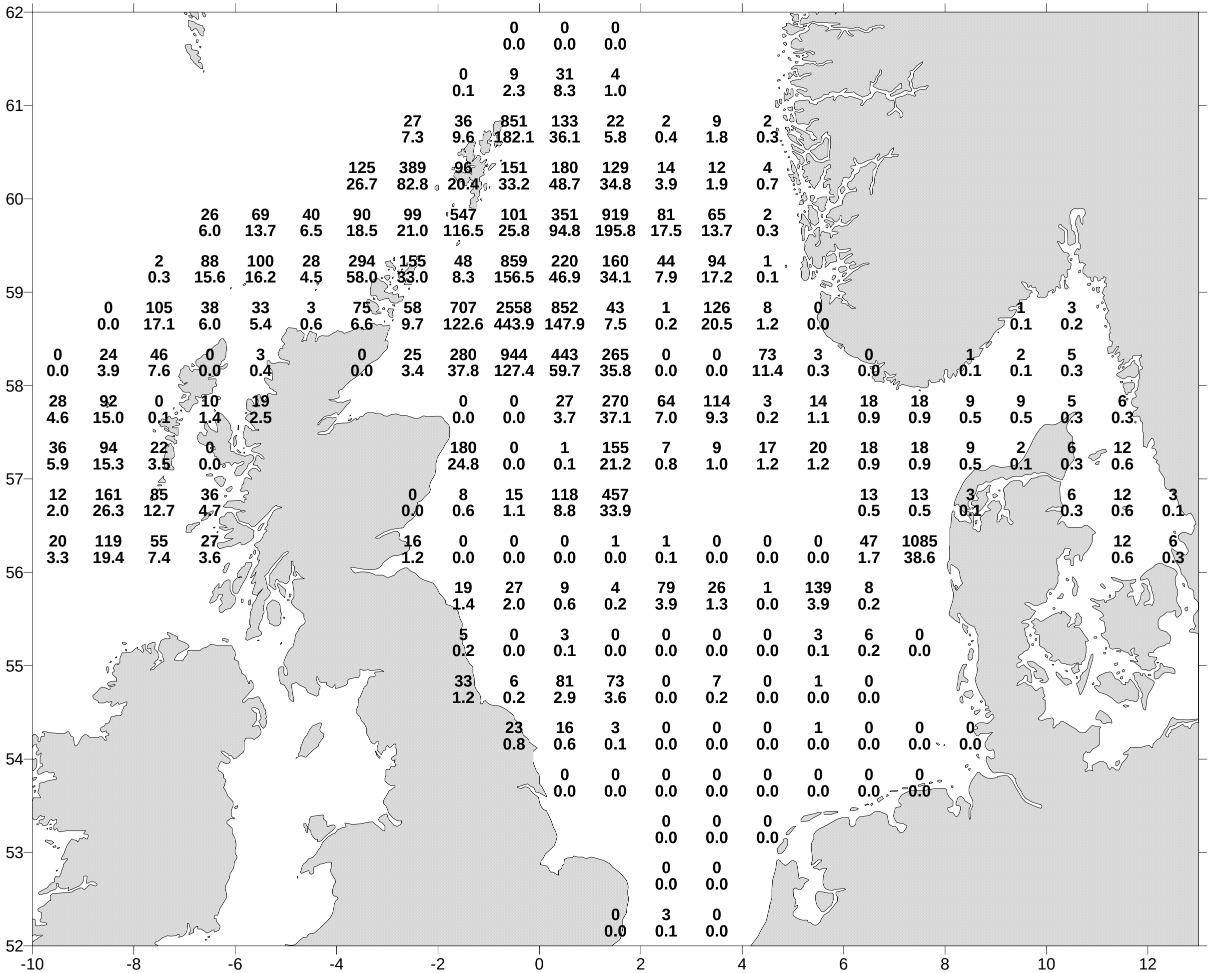


Figure 2.3.1.2 Herring in the North Sea. Autumn spawning herring abundance from combined acoustic survey July 2005. Numbers (millions) (upper figure), and biomass (thousands of tonnes) (lower figure)

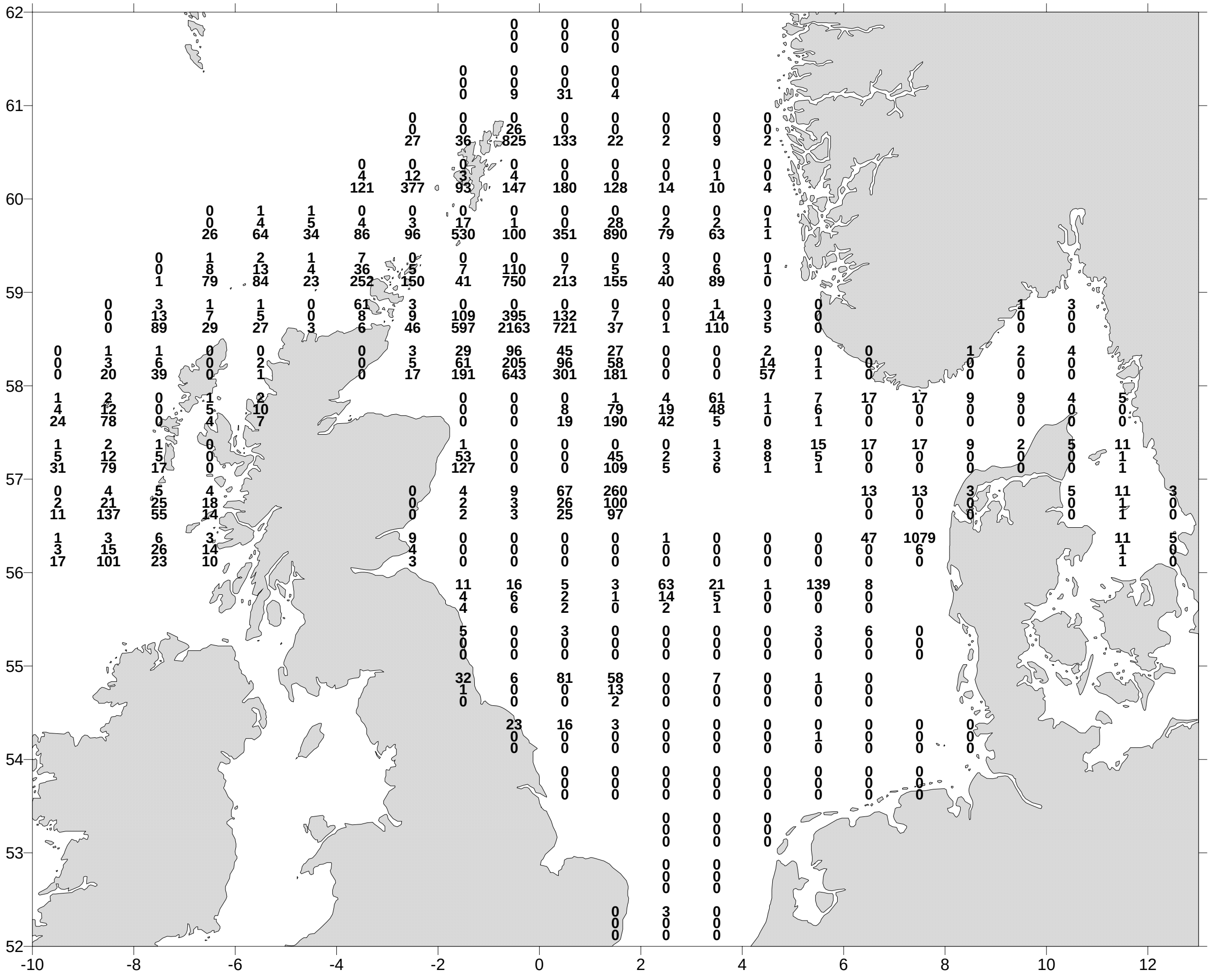


Figure 2.3.1.3 Herring in the North Sea. Autumn spawning herring numbers (millions) from combined acoustic survey July 2005. 1-ring (upper figure), 2-ring (centre figure), 3+ (lower figure)

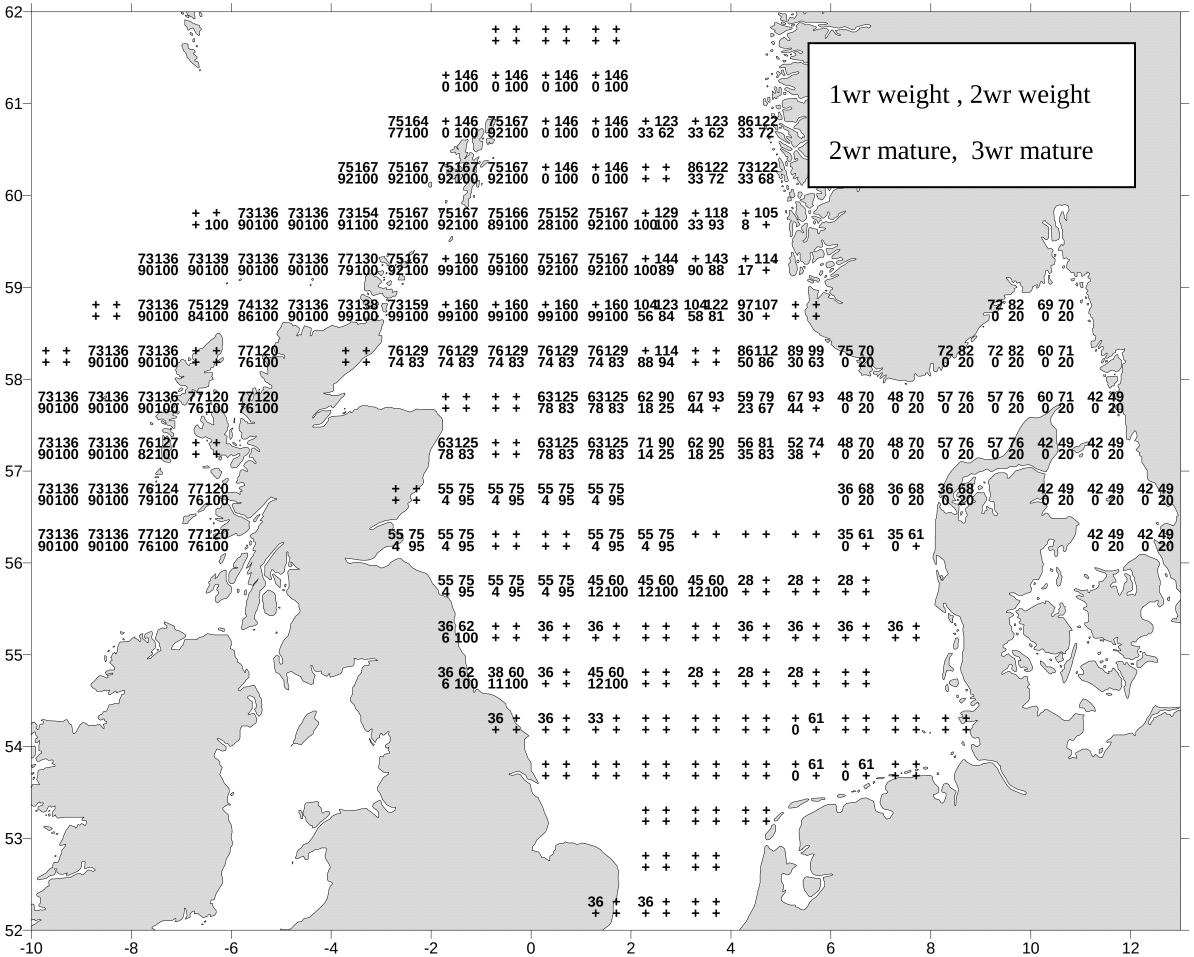


Figure 2.3.1.4 Herring in the North Sea. Mean weight & maturity of Autumn spawning herring from combined acoustic survey June – July 2005. Four values per ICES rectangle, percentage mature (lower), 2 wr (left), 3 wr (right), mean weights gram (upper), 1 wr (left) , 2 wr (right) , 0 indicates measured percentage mature, + indicates surveyed with zero abundance blank indicates an unsurveyed rectangle

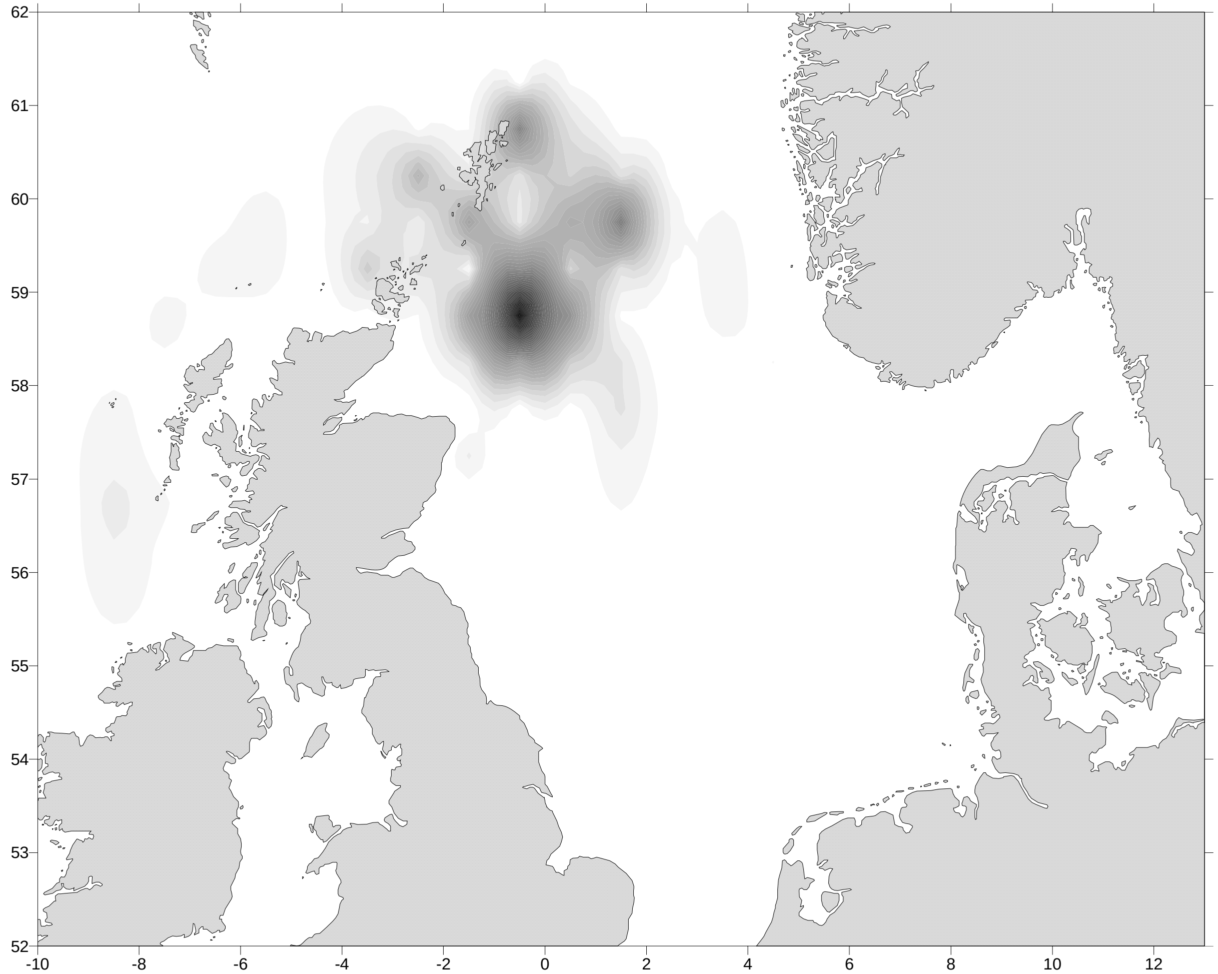


Figure 2.3.1.5 Herring in the North Sea. Abundance of mature autumn-spawning herring from combined acoustic survey July 2005. Numbers of herring, (dark areas indicate higher density).

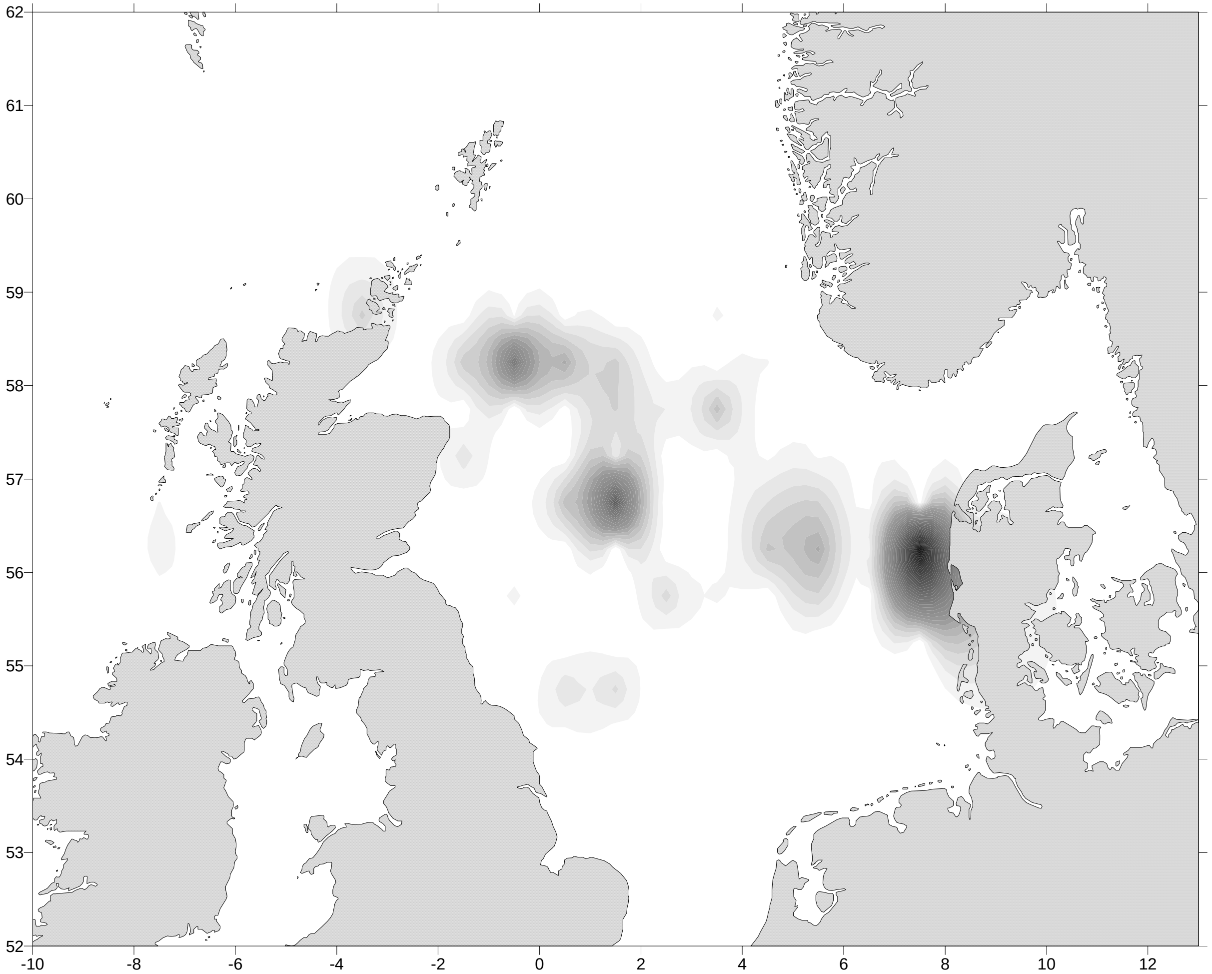


Figure 2.3.1.6 Herring in the North Sea. Abundance of immature autumn spawning herring from combined acoustic survey July 2005. Numbers of herring.(dark areas indicate higher density)

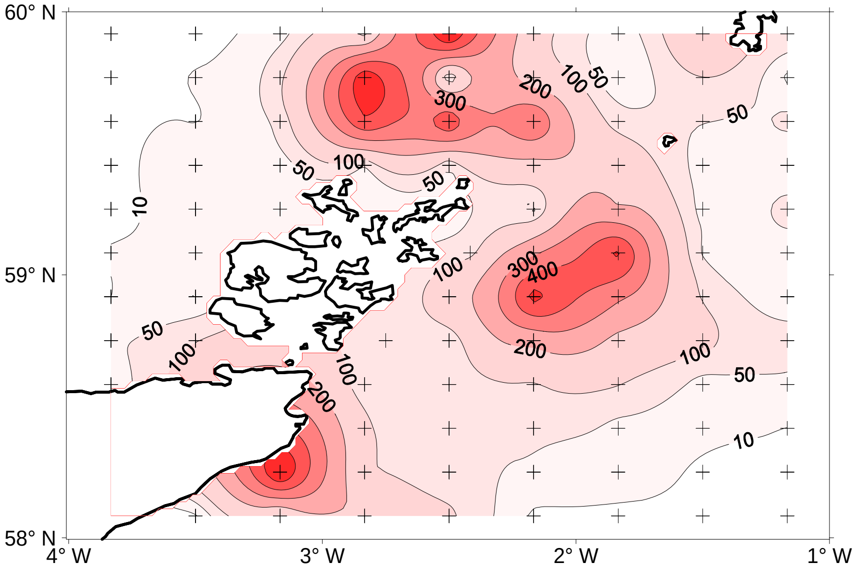


Figure 2.3.2.1: North Sea autumn spawners. Orkney/Shetlands 16–30 September 2005. Abundance of larvae < 10 mm (n/m²)

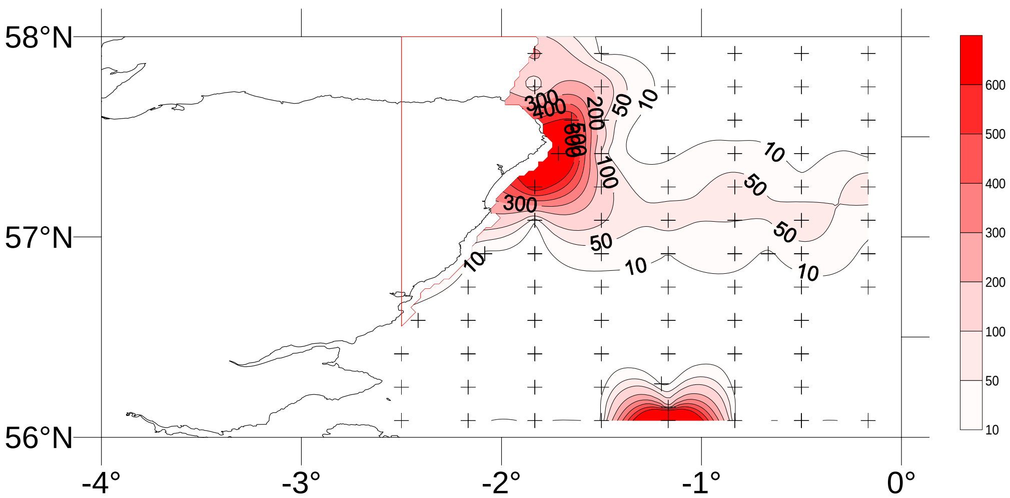


Figure 2.3.2.2: North Sea autumn spawners. Buchan 16–30 September 2005. Abundance of larvae < 10 mm (n/m²)

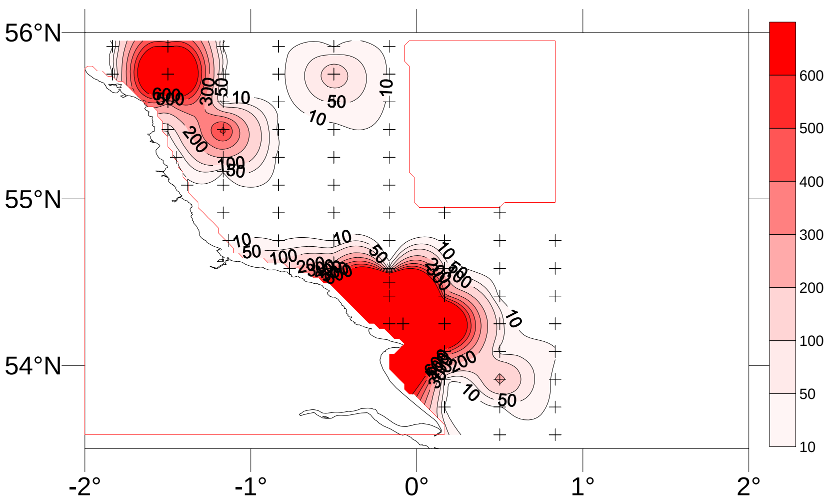


Figure 2.3.2.3: North Sea autumn spawners. Central North Sea 16–30 September 2005. Abundance of larvae < 10 mm (n/m²)

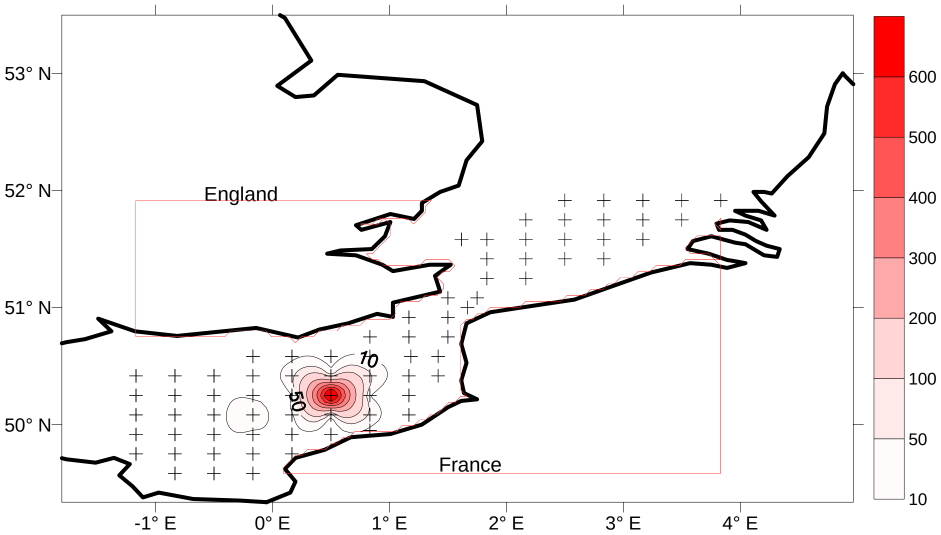


Figure 2.3.2.4: North Sea autumn spawners. Southern North Sea 16–31 December 2005. Abundance of larvae < 11 mm (n/m²)

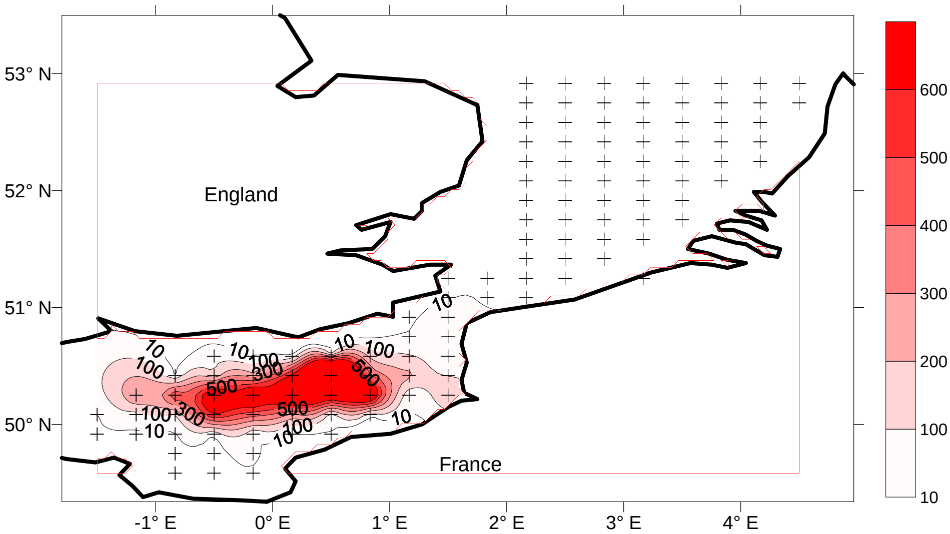


Figure 2.3.2.5: North Sea autumn spawners. Southern North Sea 1–15 January 2006. Abundance of larvae < 11 mm (n/m²)

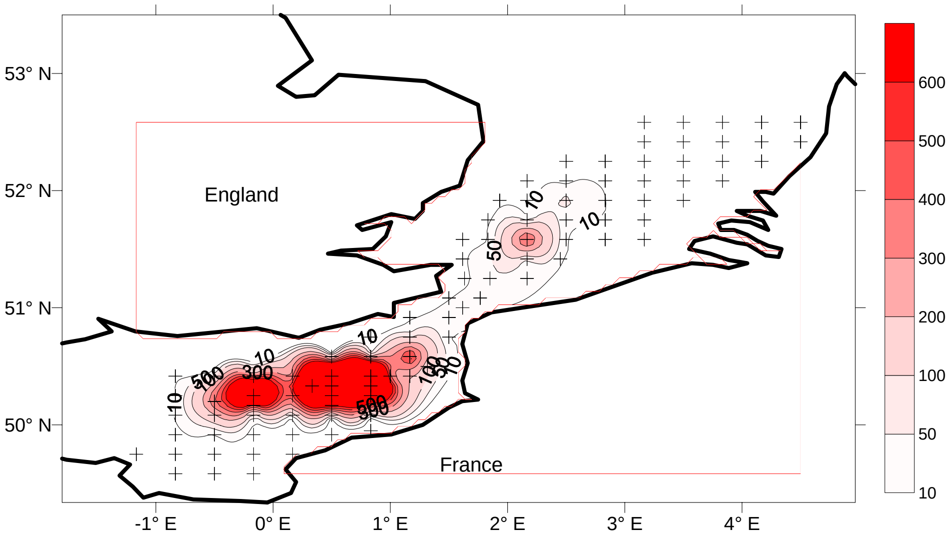


Figure 2.3.2.6: North Sea autumn spawners. Southern North Sea 16–31 January 2006. Abundance of larvae < 11 mm (n/m²)

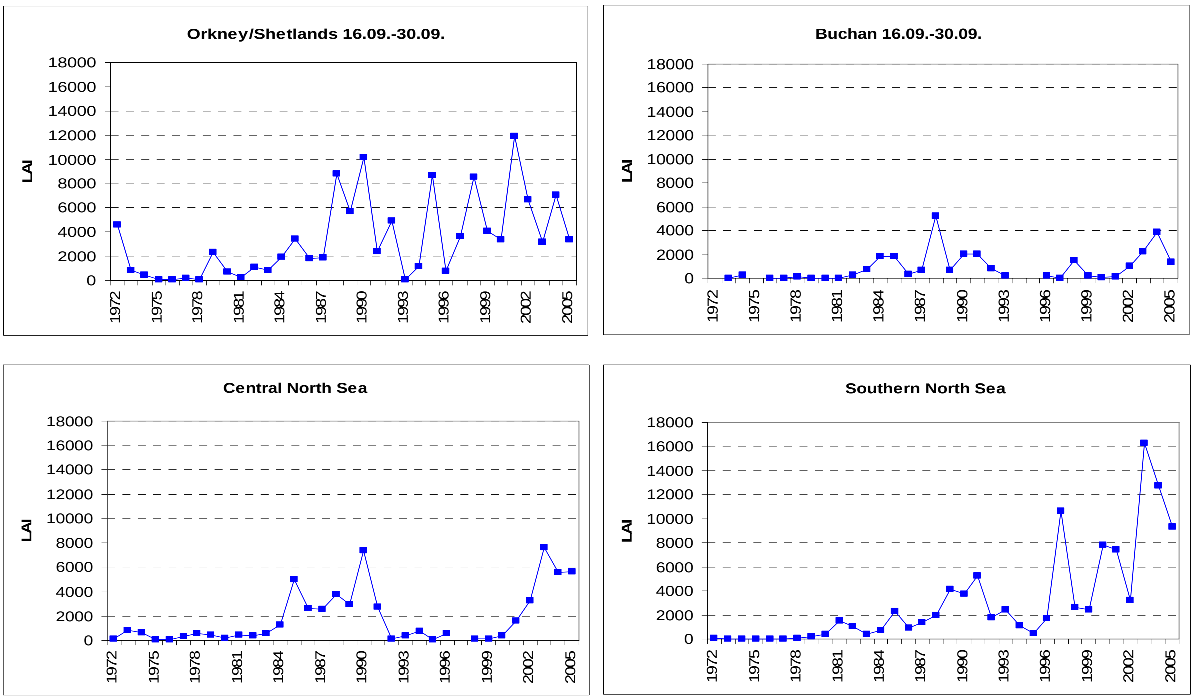


Figure 2.3.2.7: North Sea autumn spawners. Larval Abundance Index time-series for a collection of areas and sampling periods (Orkney/Shetlands 2nd half of September top left panel, Buchan 2nd half of September top right, central North Sea lower left, southern North Sea lower right. Due to historic reasons the abundance in the CNS is given as the mean of three surveys and in the SNS as the sum of three).

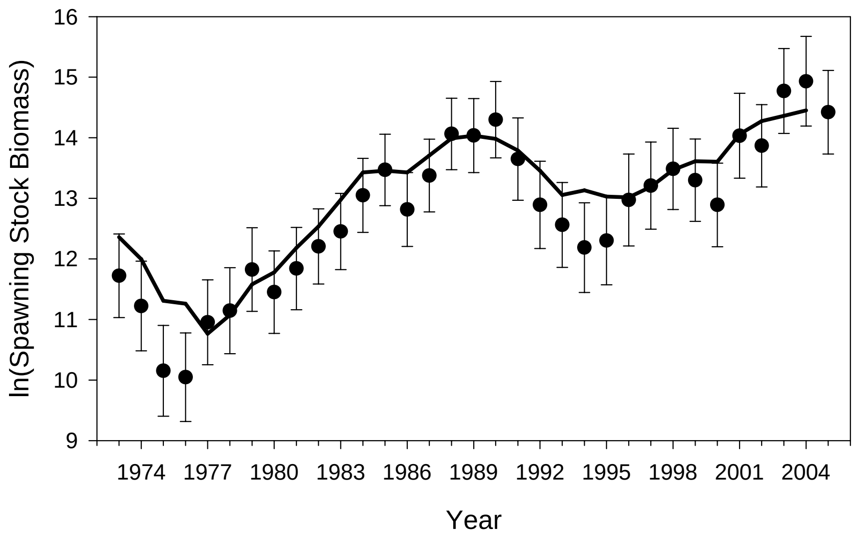


Figure 2.3.2.8: North Sea autumn spawners. Comparison of spawning stock size estimates from the Herring Assessment Working Group (ICES, 2005; bold line) and the year effects fitted to the larval abundances in the multiplicative model (symbols with error bars). The MLAI estimates have been rescaled to the mean of the WG estimates. Error bars indicate +/- one standard error of larval survey abundance estimates. Note the log y axis.

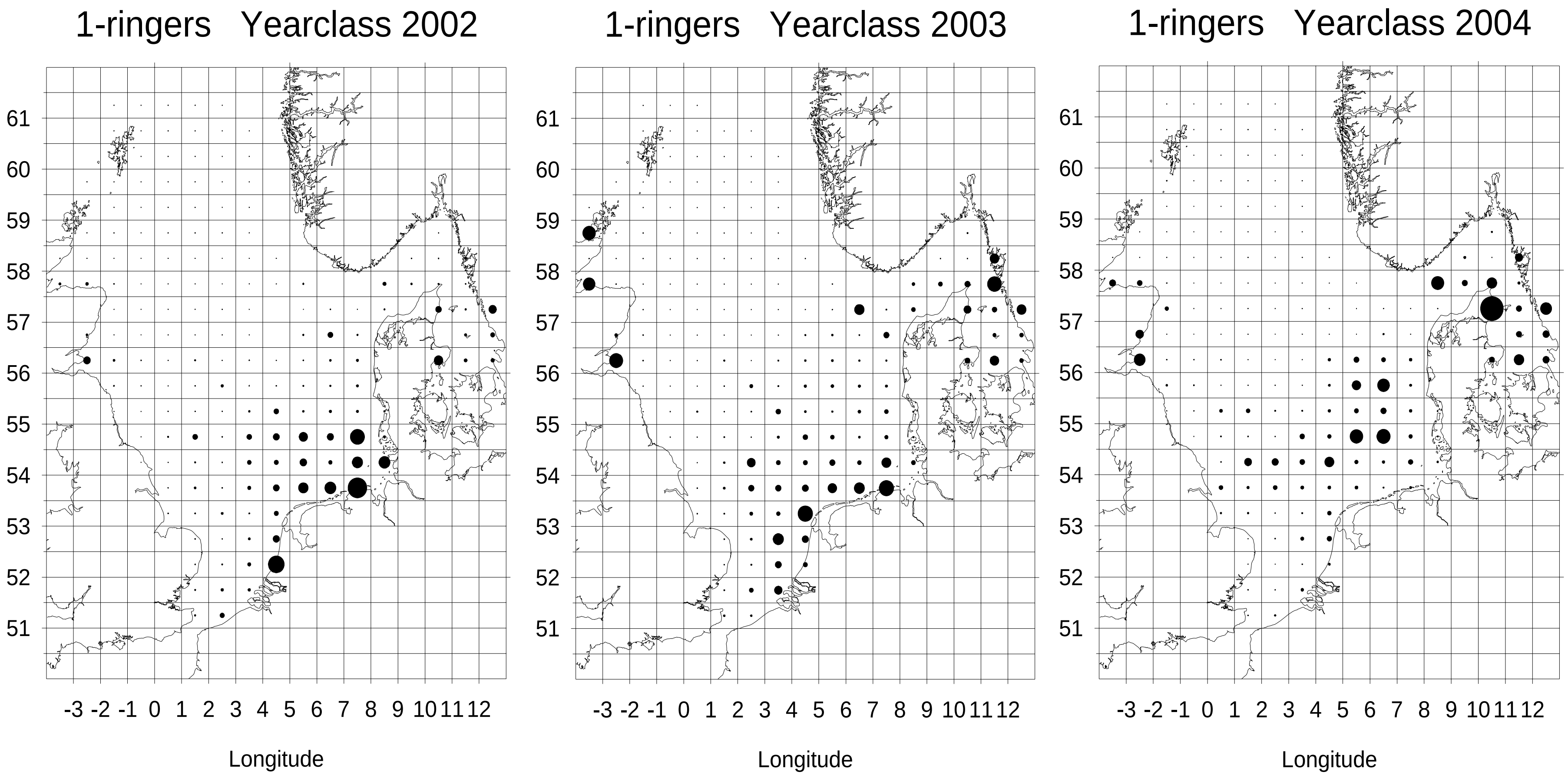


Figure 2.3.3.1. North Sea herring. Distribution of 1-ringer herring, year classes 2002-2004. Abundance estimates of 1-ringers within each statistical rectangle are based on GOV catches during IBTS in February 2004-2006. Areas of filled circles illustrate numbers per hour, the area of a circle extending to the border of a rectangle represents 45000 h^{-1}.

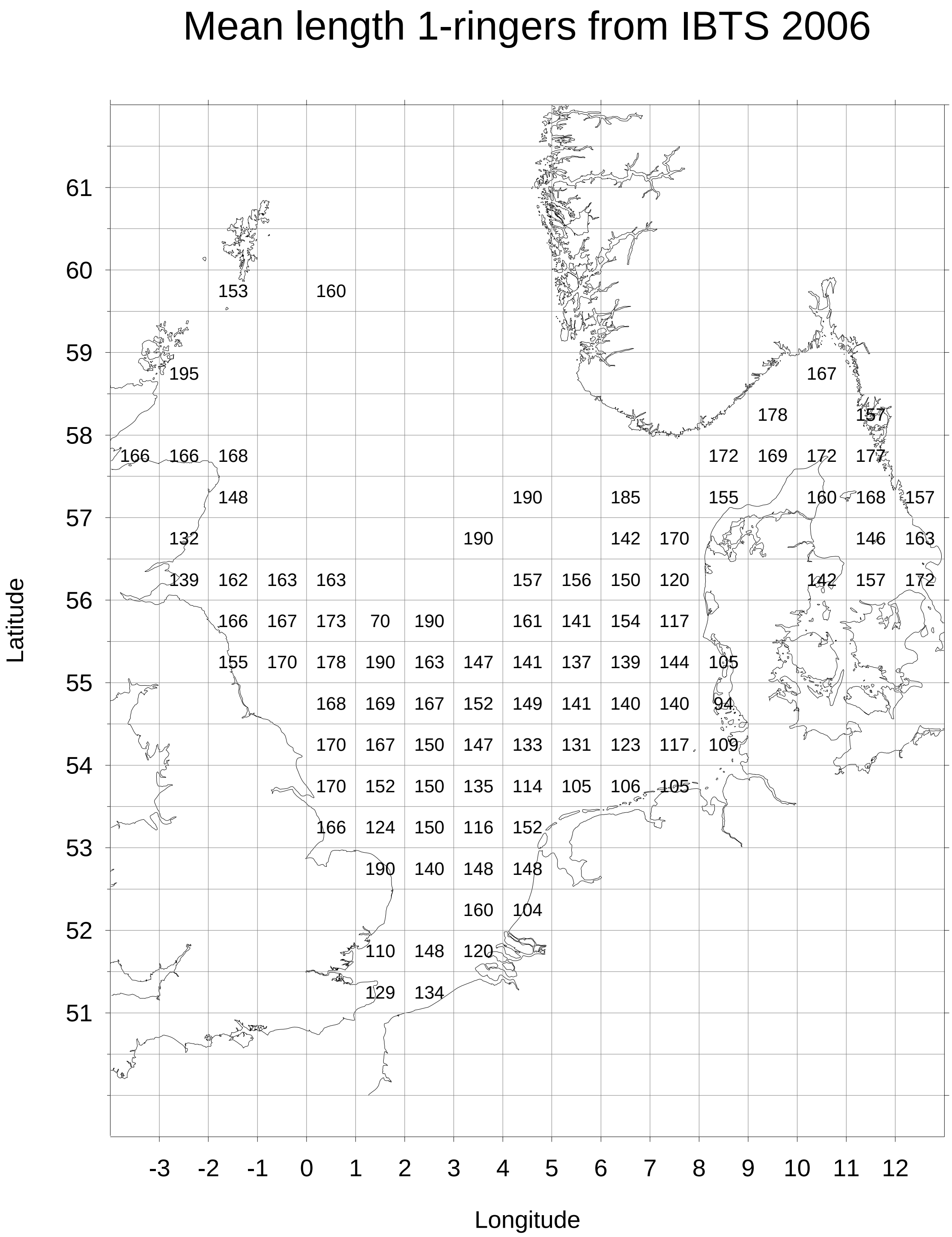


Figure 2.3.3.2. North Sea herring. Mean length (mm) of 1-ringer herring caught during IBTS 1st Quarter

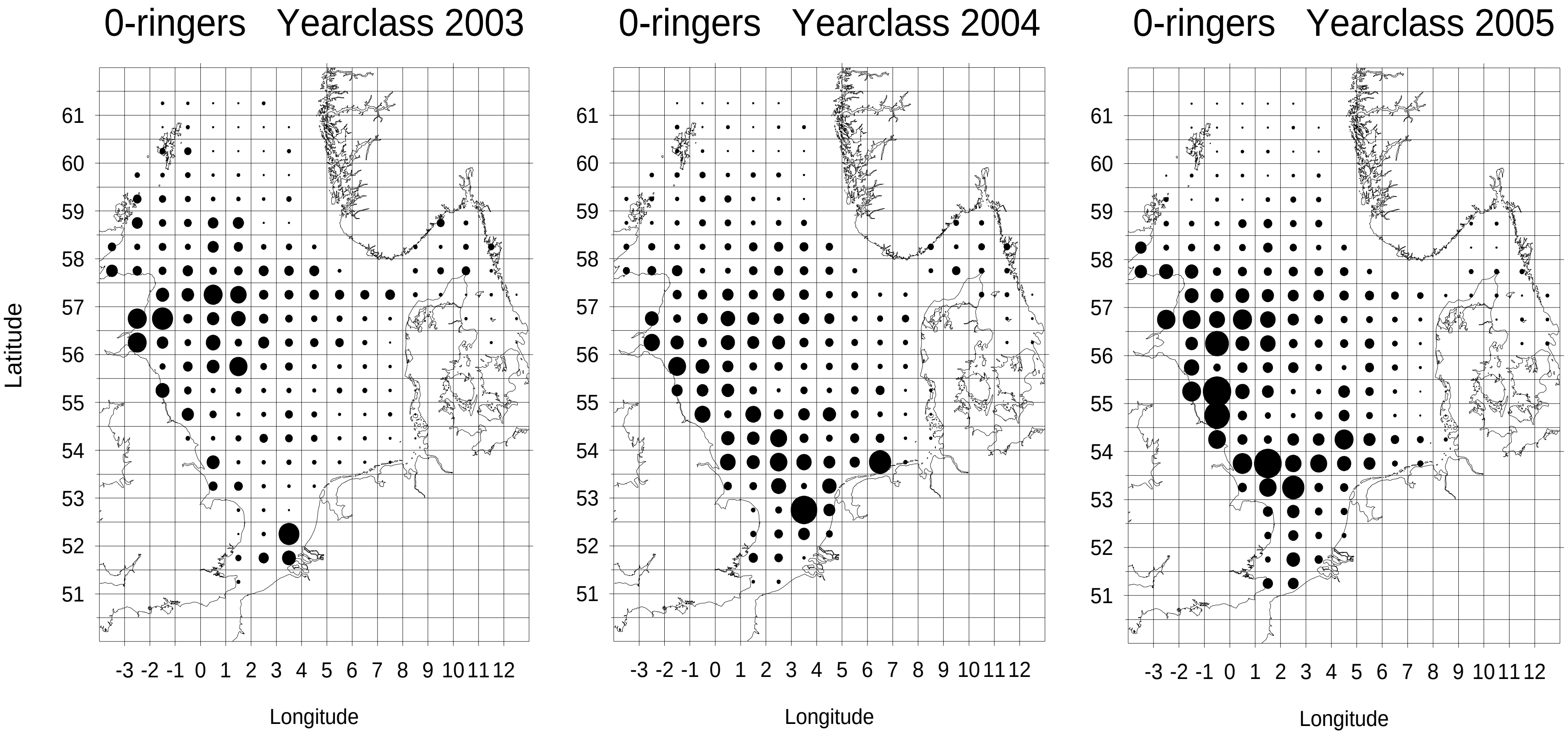


Figure 2.3.3.3. North Sea herring. Distribution of 0-ringer herring, year classes 2003-2005. Abundance estimates of 0-ringers within each statistical rectangle are based on MIK catches during IBTS in February 2004-2006. Areas of filled circles illustrate densities in no m^{-2}, the area of a circle extending to the border of a rectangle represents 1 m^{-2}

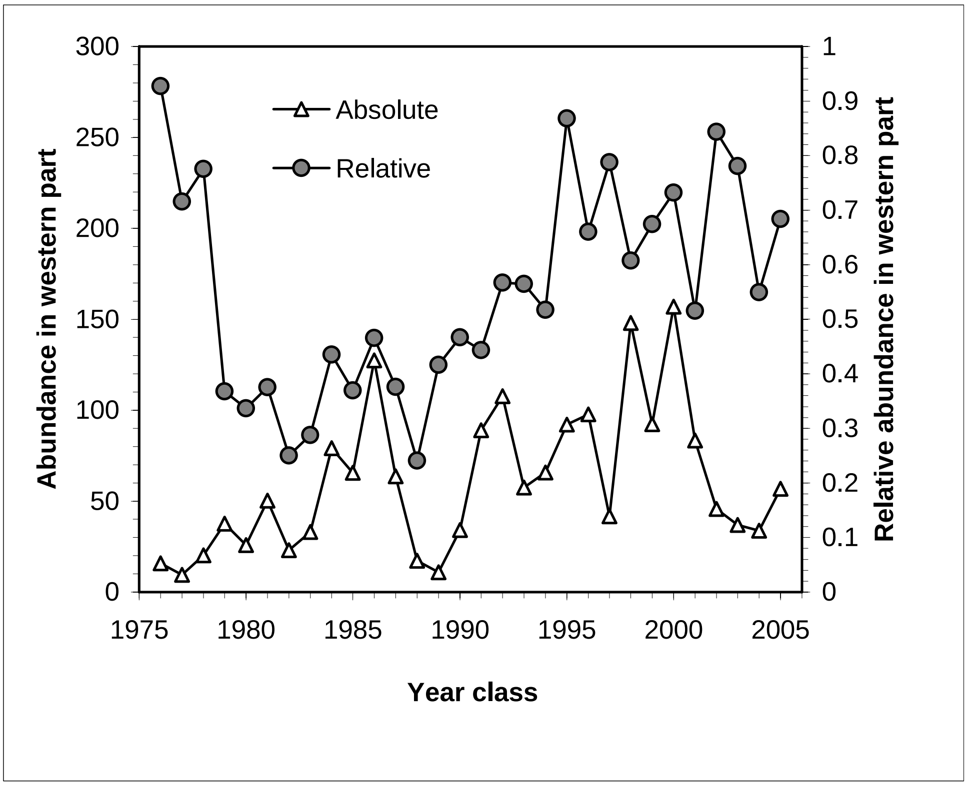


Figure 2.3.3.4 North Sea herring. Absolute (no * 10^9) and relative abundance of 0-ringers in the area west of 2°E in the North Sea. Abundances are based on MIK sampling during IBTS, the relative abundance in the western part is estimated as the number of 0-ringers west of 2°E relative to total number of 0-ringers

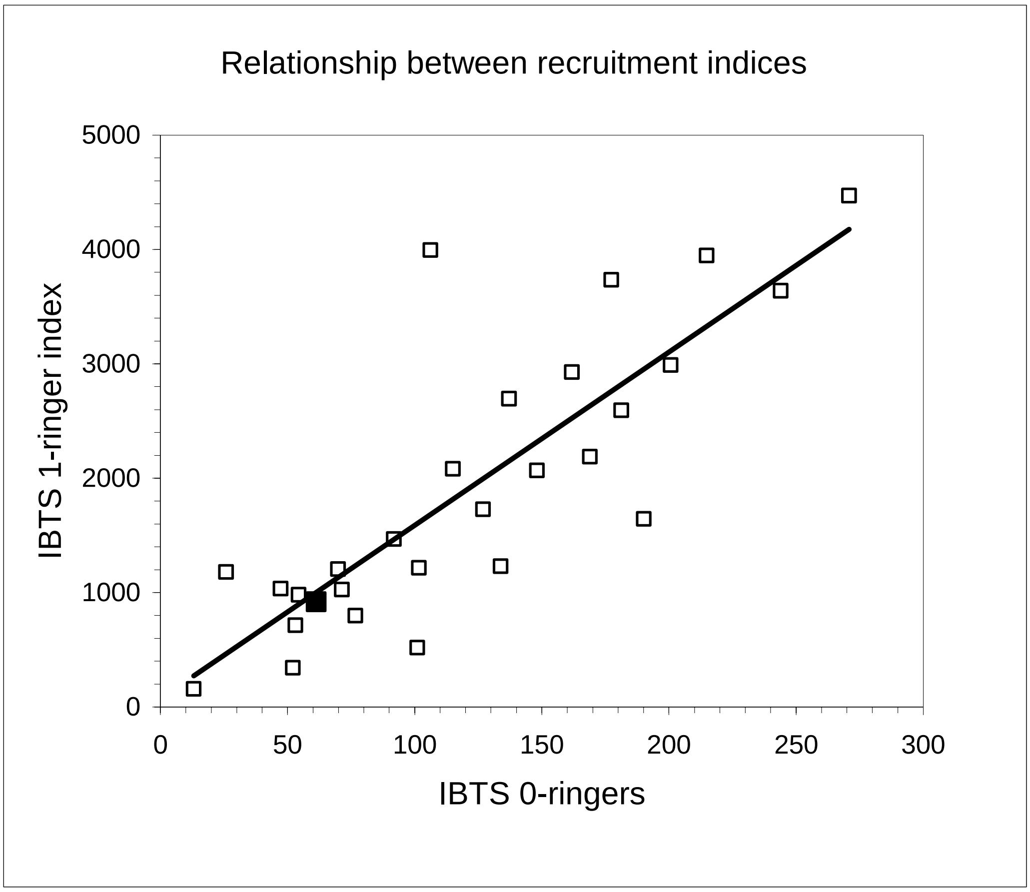


Figure 2.5.1 North Sea herring. Relationship between indices of 0-ringers and 1-ringers for year classes 1977 to 2004. The 2004 relation is indicated by a circle.

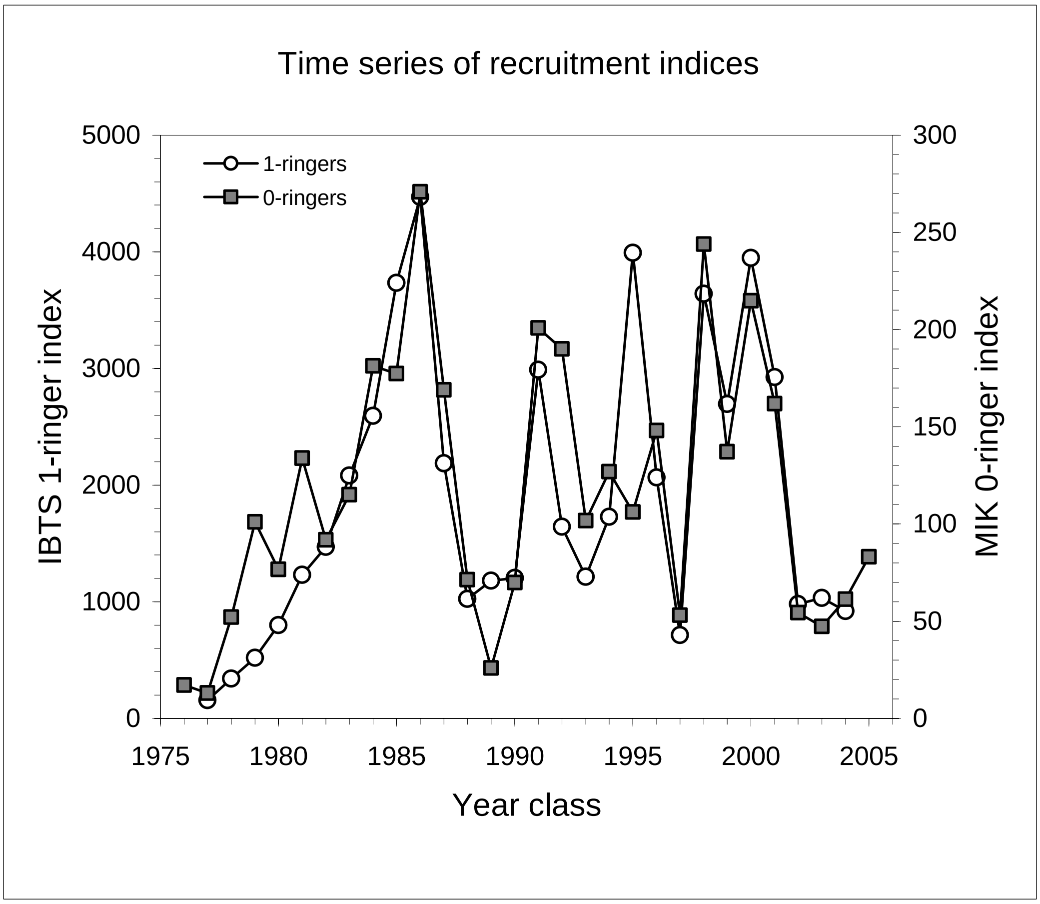


Figure 2.5.2 North Sea herring. Time series of 0-ringer and 1-ringer indices. Year classes 1976 to 2005 for 0-ringers, year classes 1977-2004 for 1-ringers.

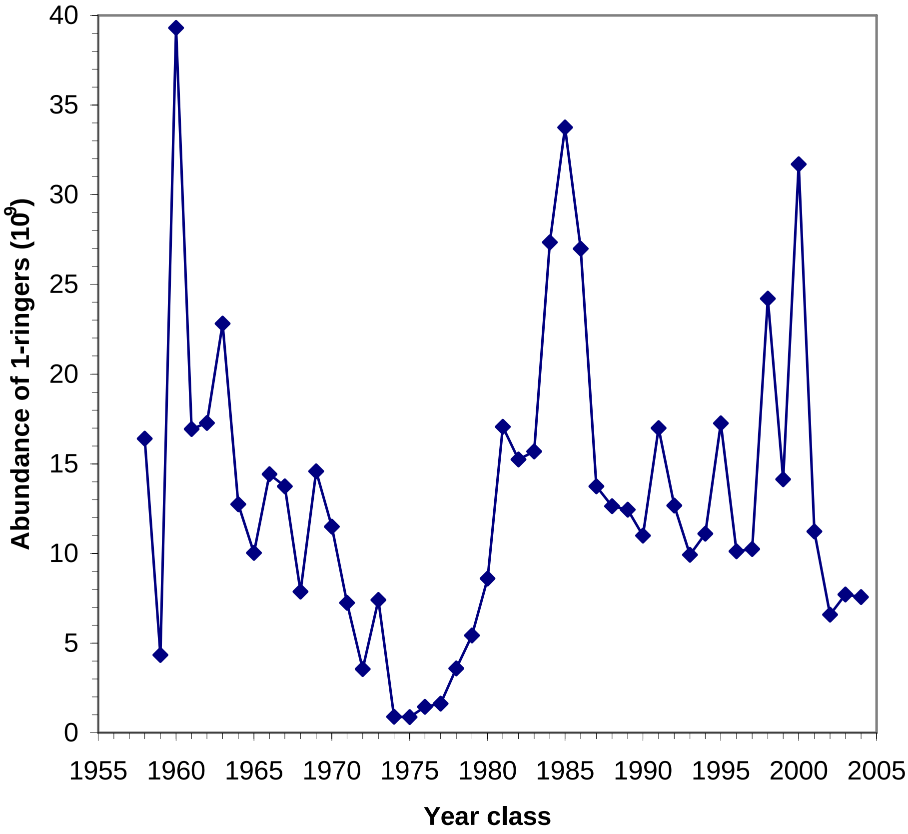


Figure 2.5.3. North Sea herring. Trend in recruitment of 1-ringers from year class 1958 to 2004. Data from the 2006 ICA assessment of the North Sea autumn spawned herring.

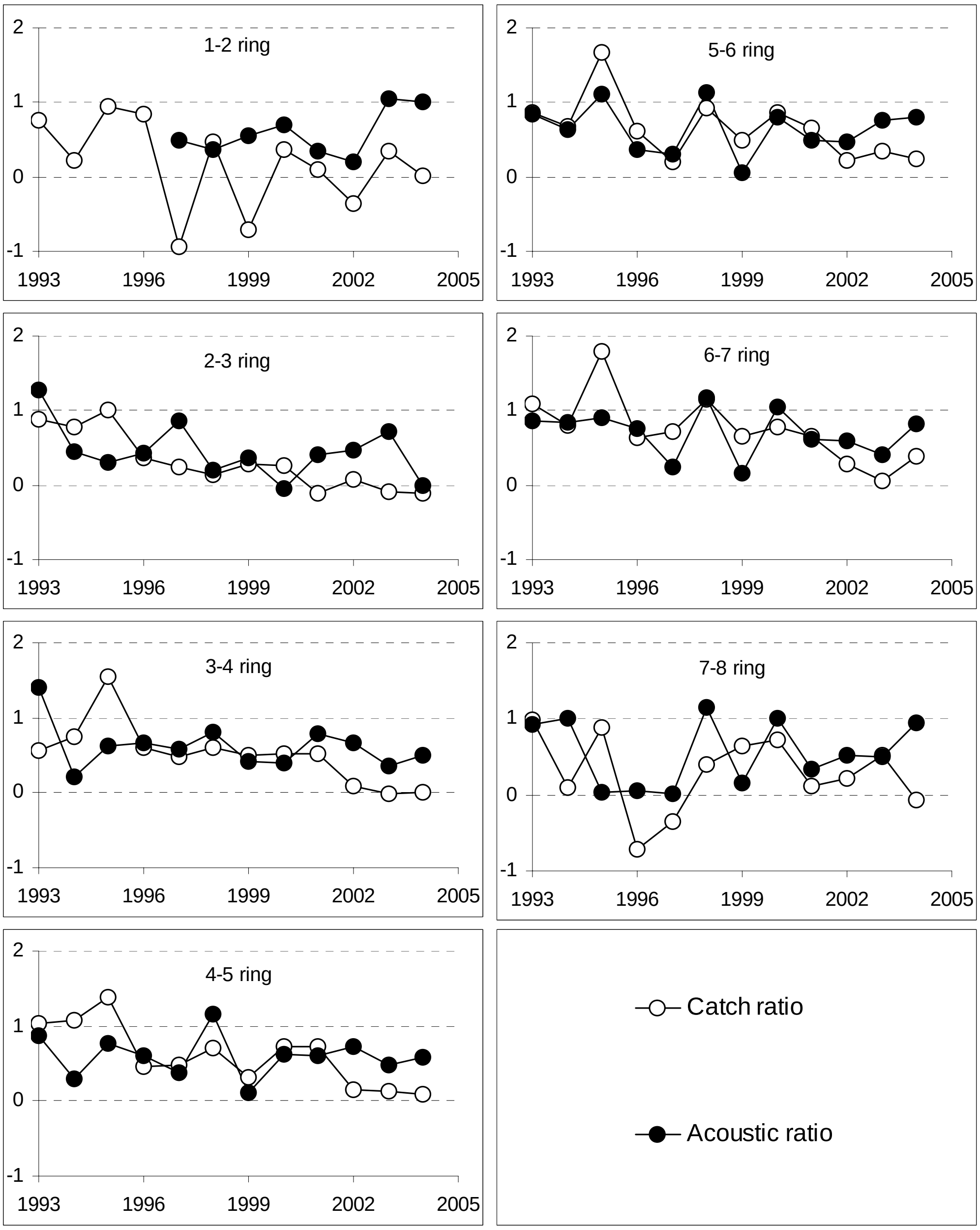


Figure 2.6.2.1. North Sea herring. Log ratios for the catch data and the Acoustic survey indices along cohort.

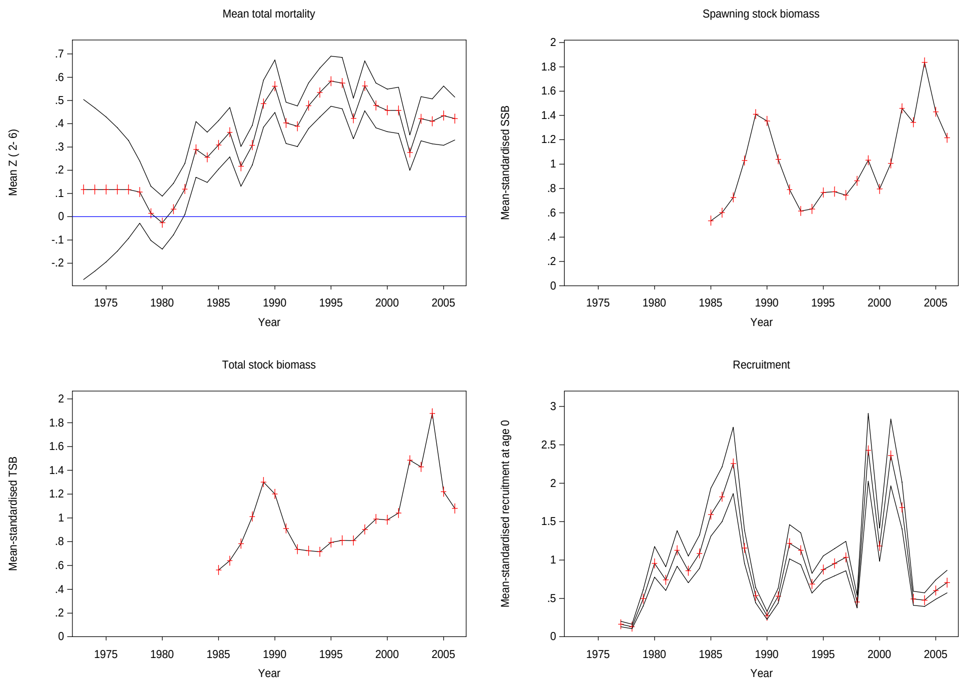


Figure 2.6.3.1. North Sea herring. EXPLORATORY SURBA stock summary. Mean Z ages 2-6, SSB, total stock biomass and recruitment. Confidence limits are +/- 2 standard deviation.

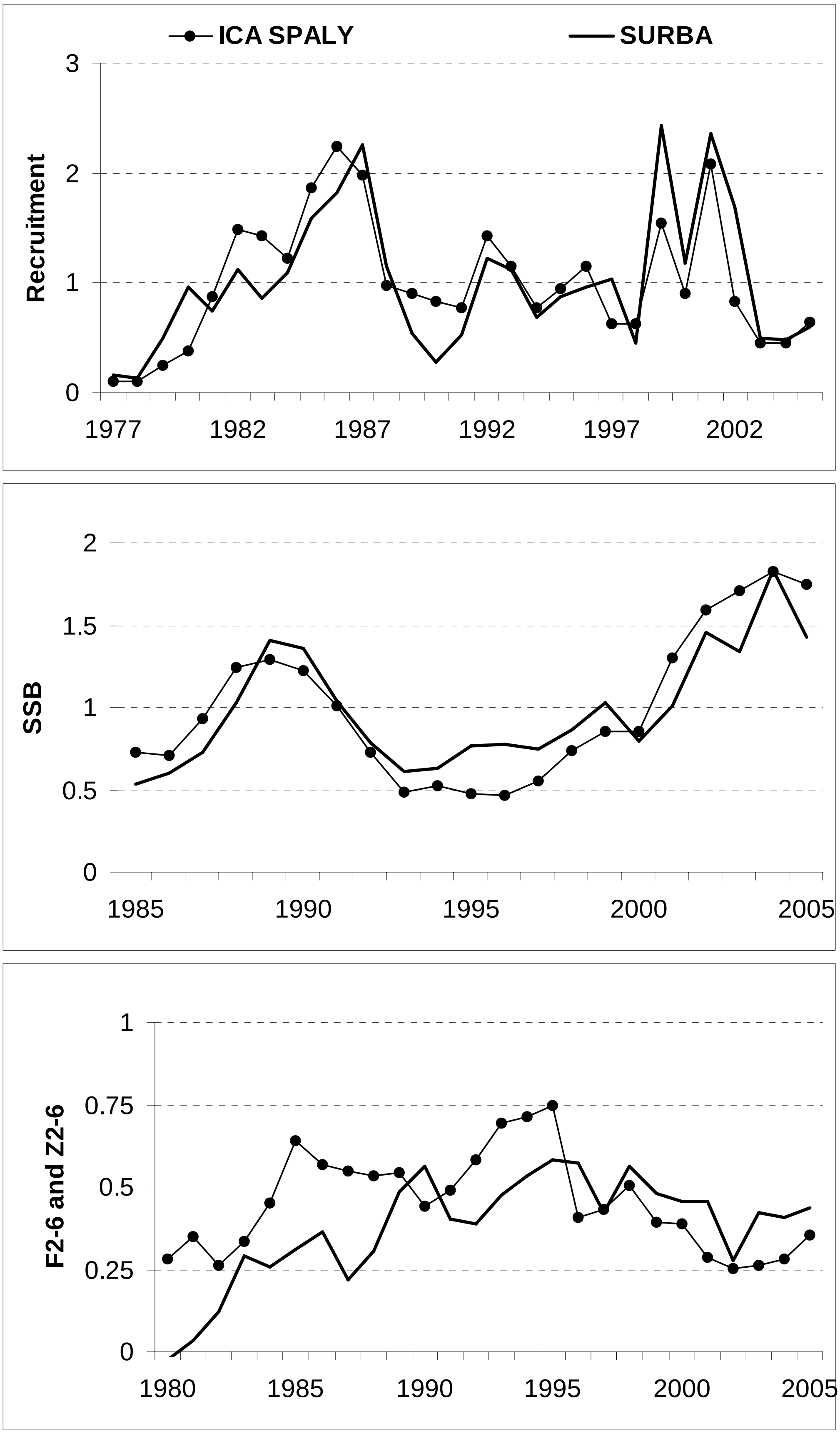


Figure 2.6.3.2. North Sea herring. Comparison of EXPLORATORY SURBA with ICA (using same procedure as last year). Recruitment and SSB are presented as mean standardized for comparison between both models.

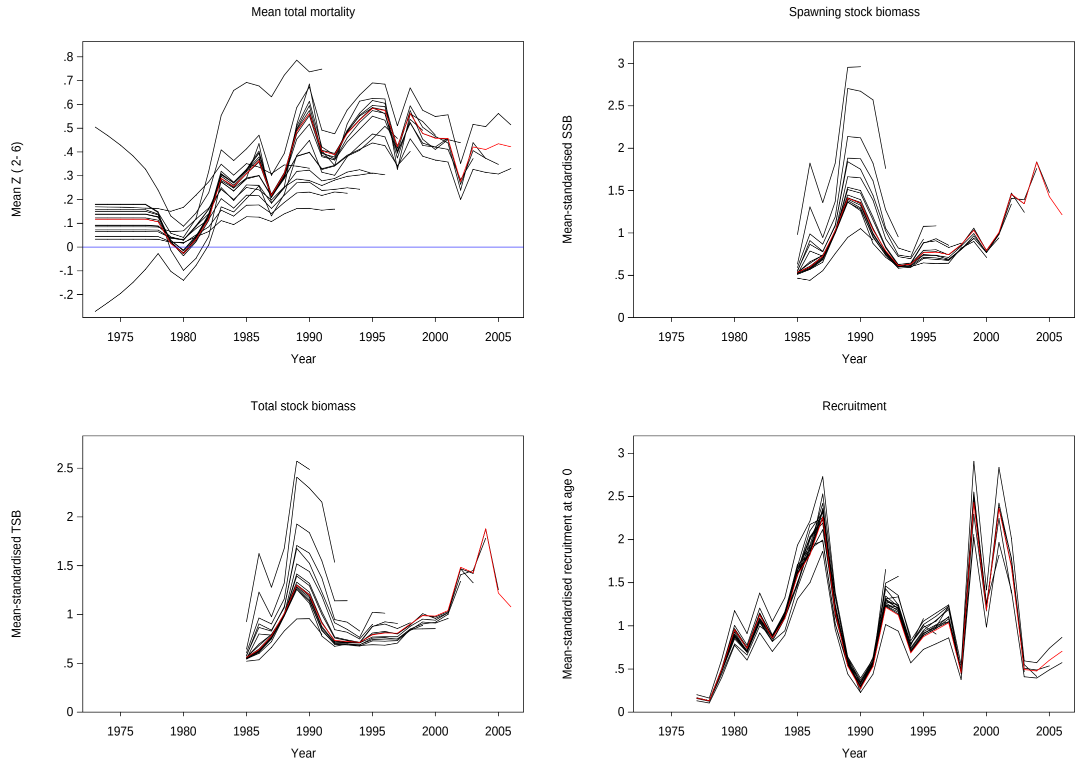


Figure 2.6.3.3. North Sea herring. EXPLORATORY SURBA retrospective analysis. Mean Z at ages 2-6, SSB, total stock biomass and recruitment.

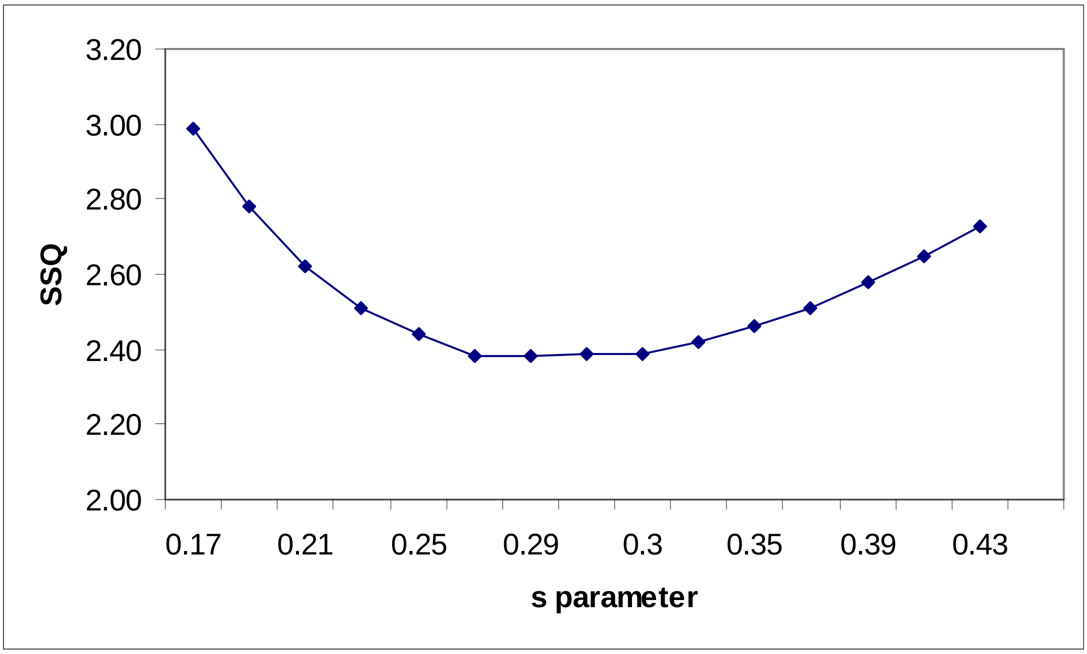


Figure 2.6.4.1. North Sea herring. CSA. Sum of squares profile for the catchabilities ratio $s = q_r / q_f$.

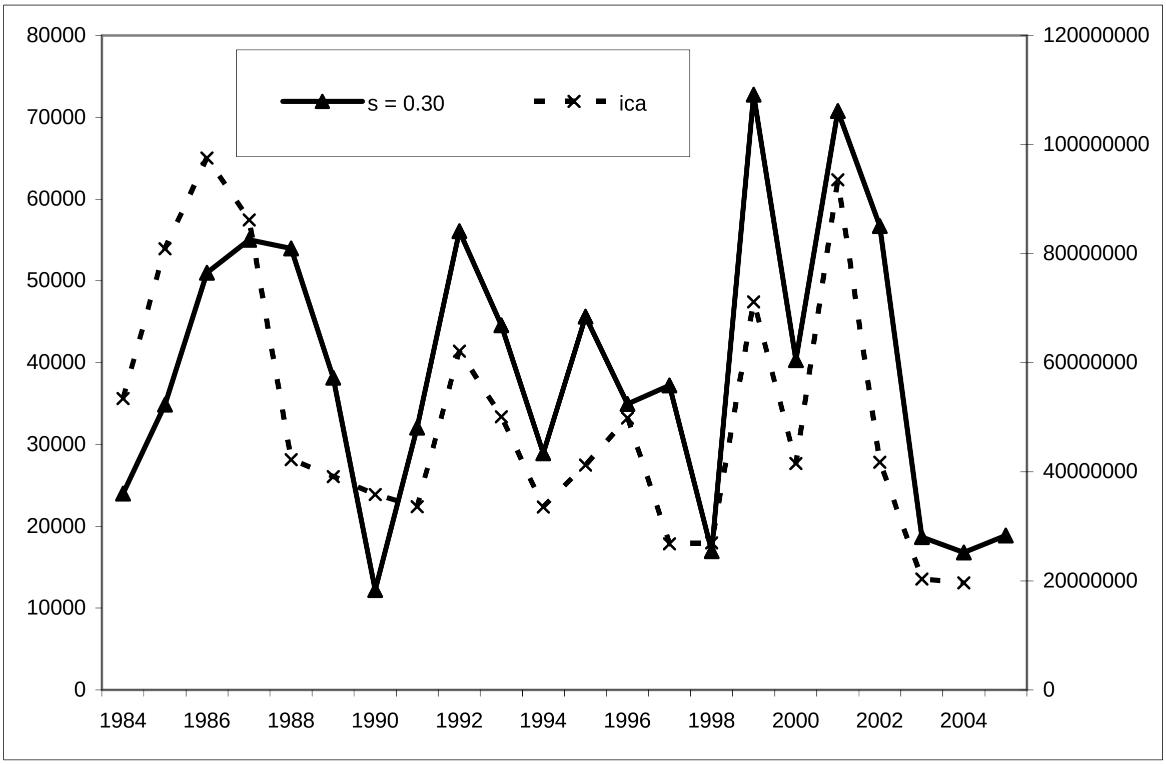


Figure 2.6.4.2. North Sea herring. Recruits as estimated by CSA (solid line) and ICA 2005 WG.

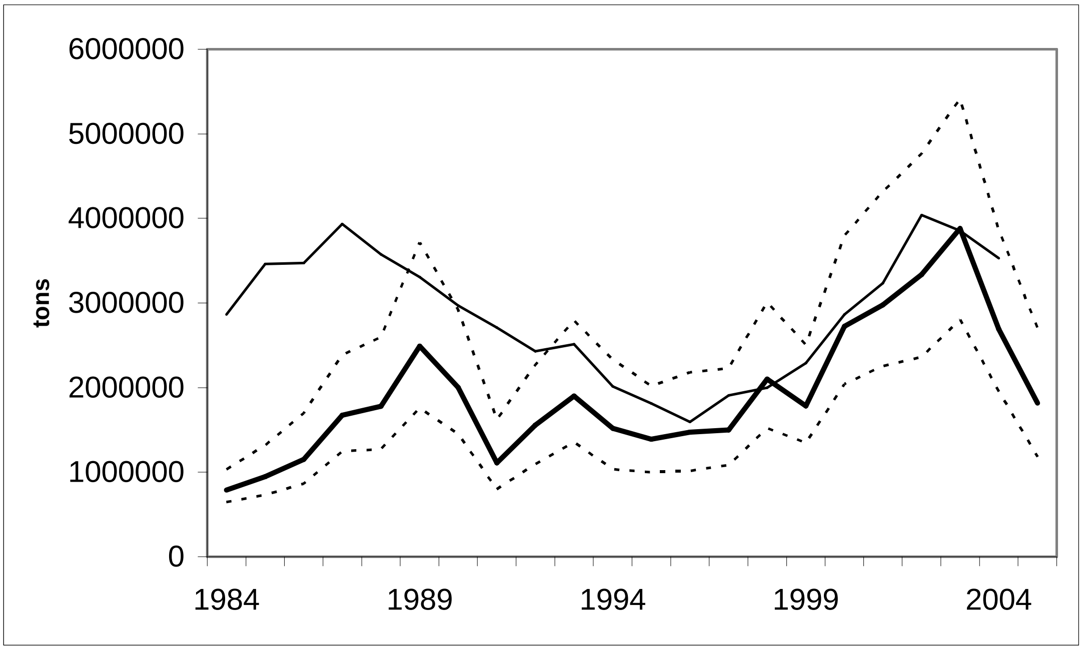


Figure 2.6.4.3. North Sea herring. CSA estimated stock total biomass (thick line), 5th and 95th percentiles (dotted lines) and 2005 ICA WG estimate of total biomass (thin line).

Figure 2.6.4.4. North Sea herring. CSA estimate of recruits multiplied by the estimated survey index catchability and MIK estimates.

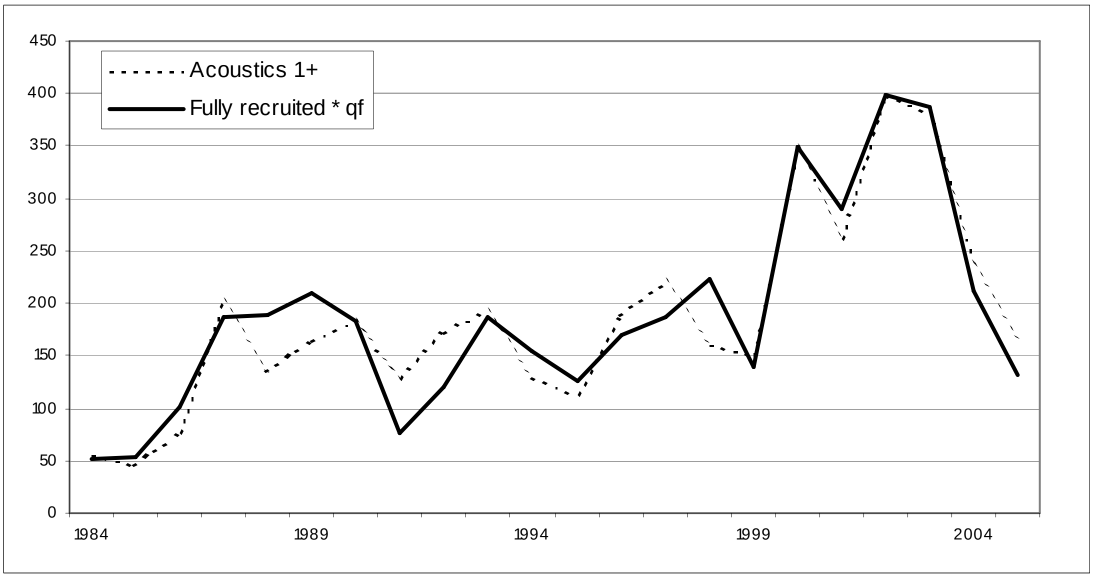


Figure 2.6.4.5. North Sea herring. CSA estimated 1+ multiplied by the model estimated catchability of the fully recruited and Acoustics 1+.

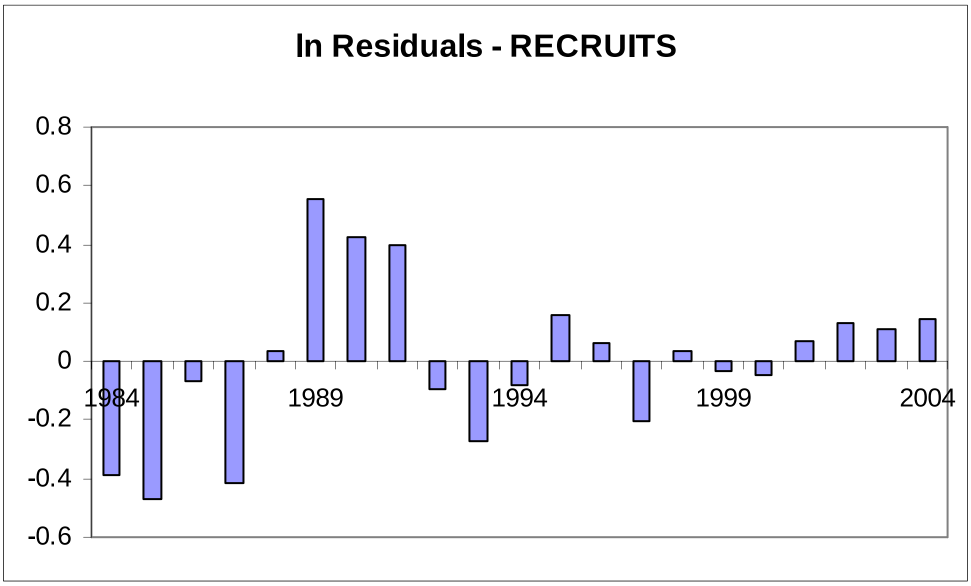


Figure 2.6.4.6. North Sea herring. CSA. Recruits log-residuals from the model fit to the MIK index.

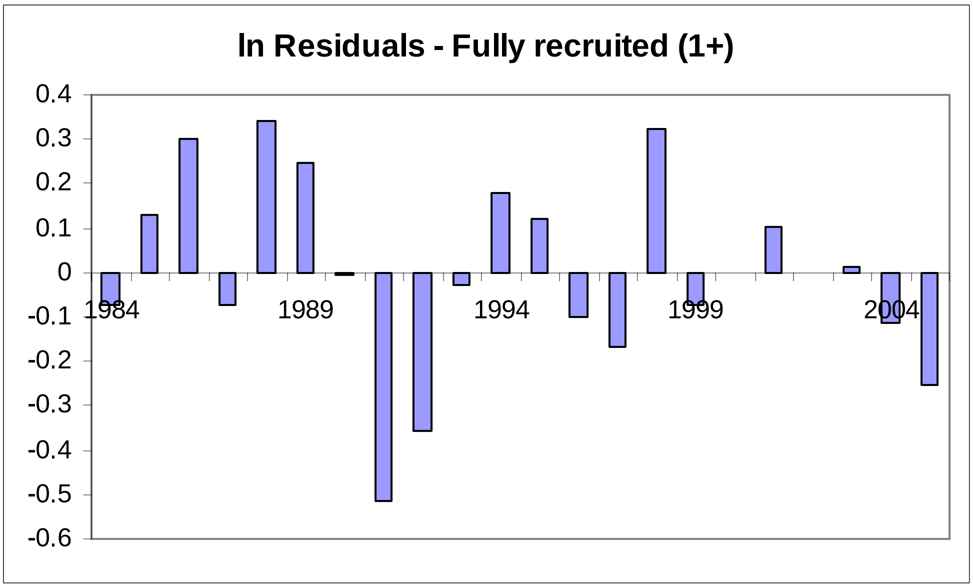


Figure 2.6.4.7. North Sea herring. CSA. Log-residuals from the model fit to the aggregated acoustics index of numbers of fish aged 1 and older.

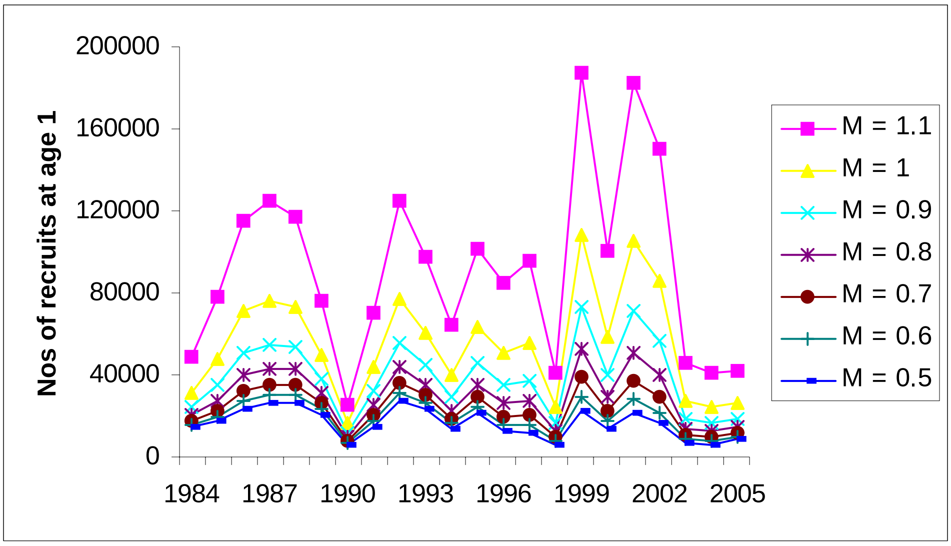


Figure 2.6.4.8. North Sea herring. CSA. Estimated number of recruits for a range of values of natural mortality (M).

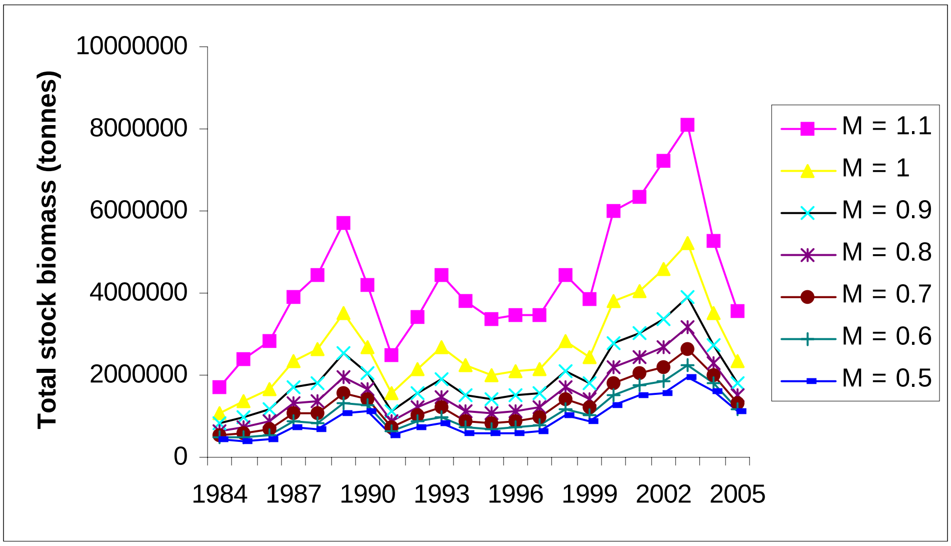


Figure 2.6.4.9. North Sea herring. CSA. Estimated total stock biomass for a range of natural mortality values (M).

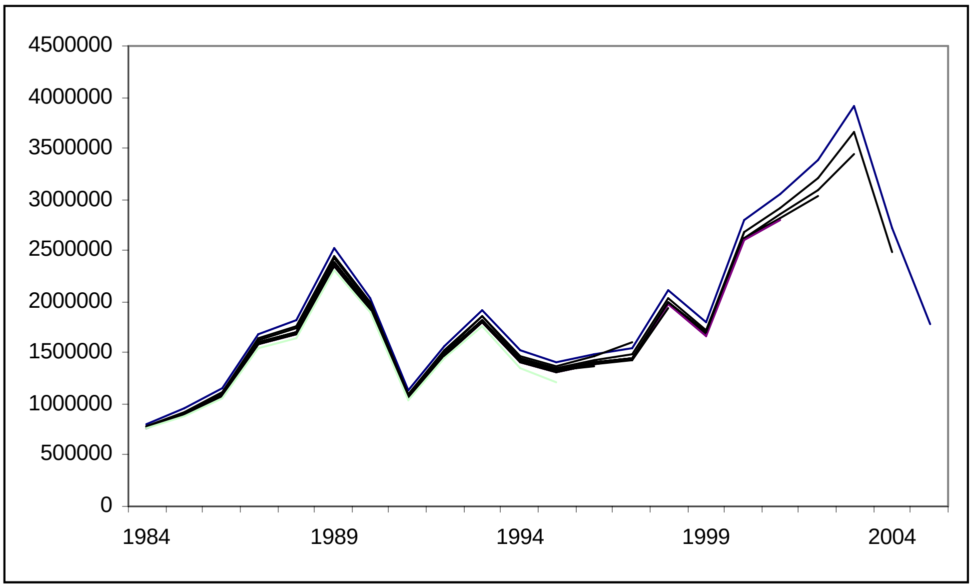


Figure 2.6.4.10. North Sea herring. CSA. Retrospective analysis, total biomass.

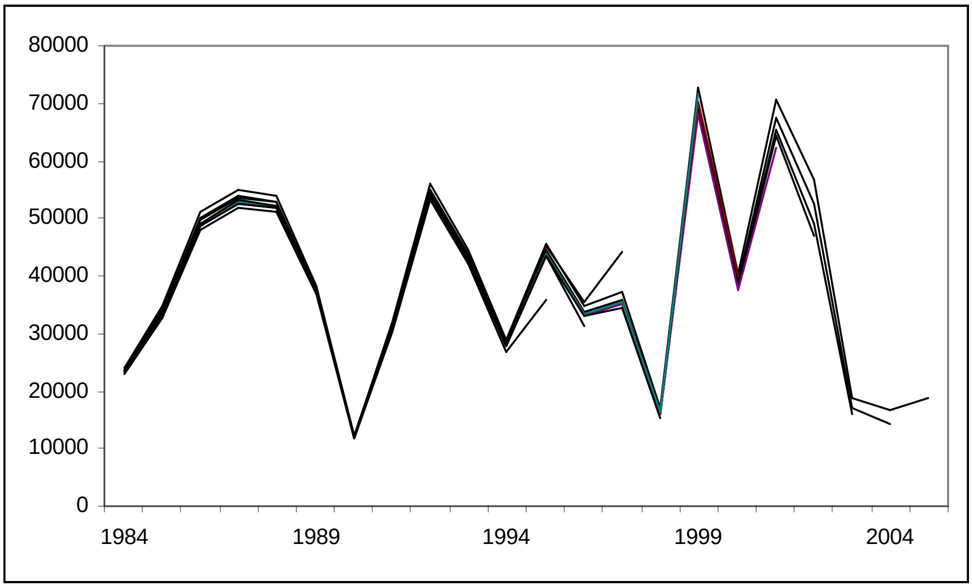


Figure 2.6.4.11. North Sea herring. CSA. Retrospective analysis, recruits numbers.

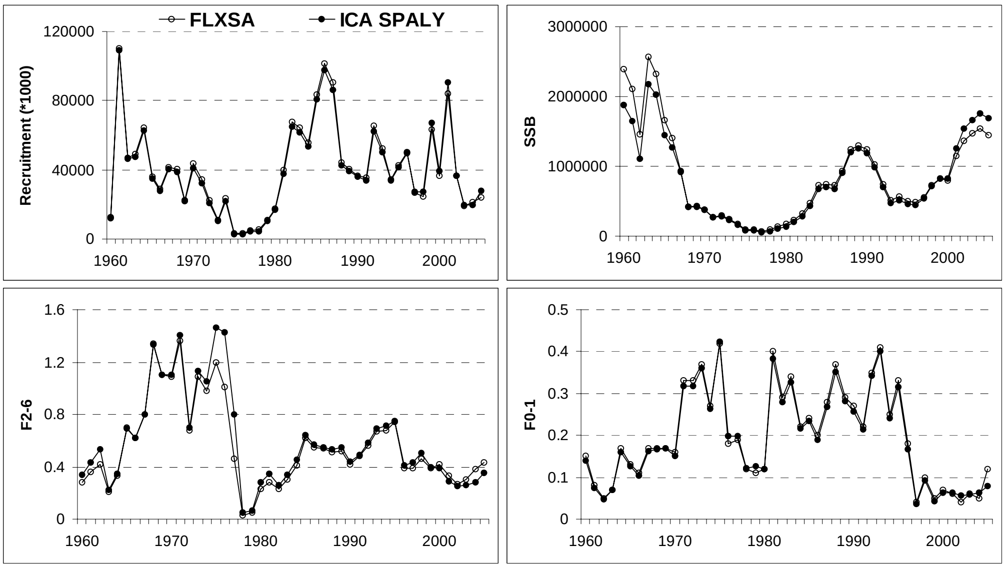


Figure 2.6.5.1. North Sea herring. Comparison of EXPLORATORY FLXSA v0.2 with ICA (using same procedure as last year): recruitment, SSB, mean F ages 2-6 and mean F ages 0-1.

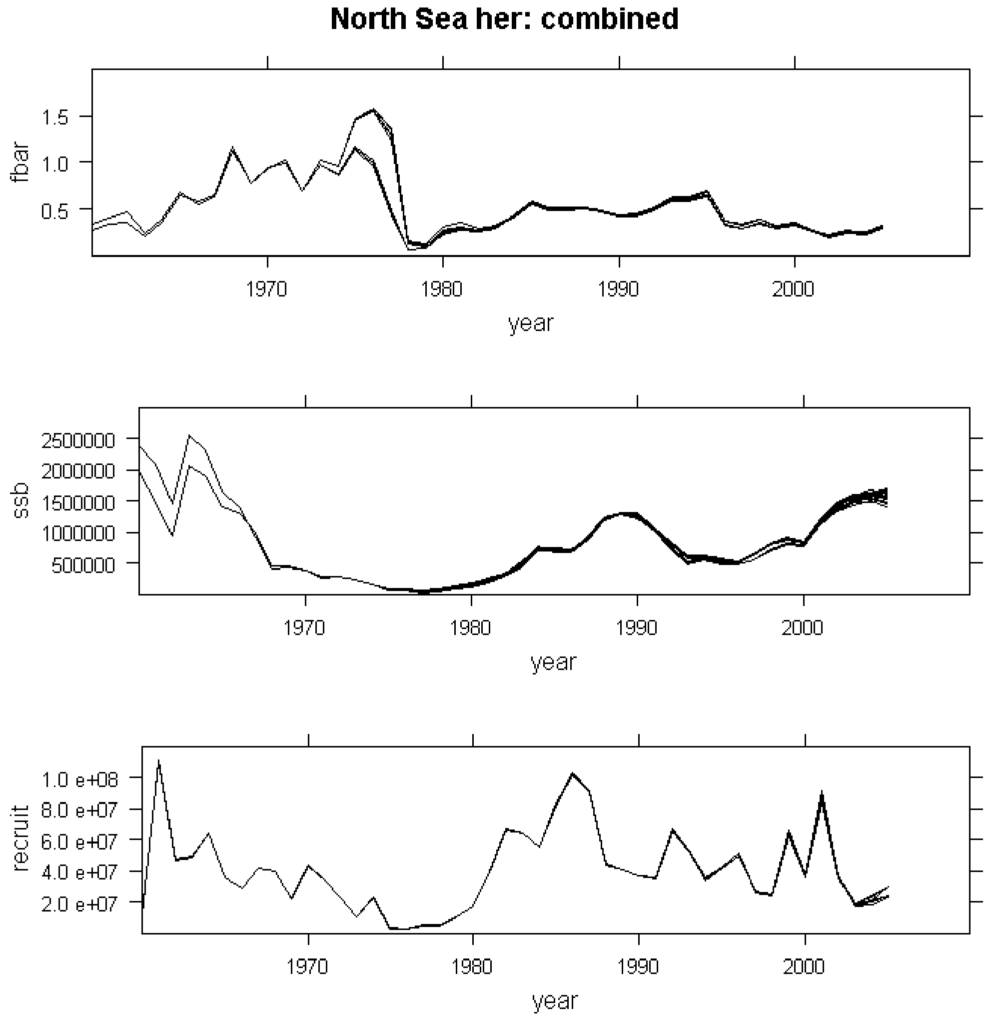


Figure 2.6.5.2. North Sea herring. EXPLORATORY FLXSA v0.2 permutation runs; Mean F ages 2-6, SSB and recruitment. In total 16 assessments have been run with changing the following settings for the XSA model:

Fse- shrinkage set at:	**0.5 (high) and 2.0 (low)**
Plus group set at:	**7 and 9**
Q age, catchability independent of age, for ages >=	**4 and 6**
R age, catchability independent on	
stock size for ages smaller than:	**-1 and 3**

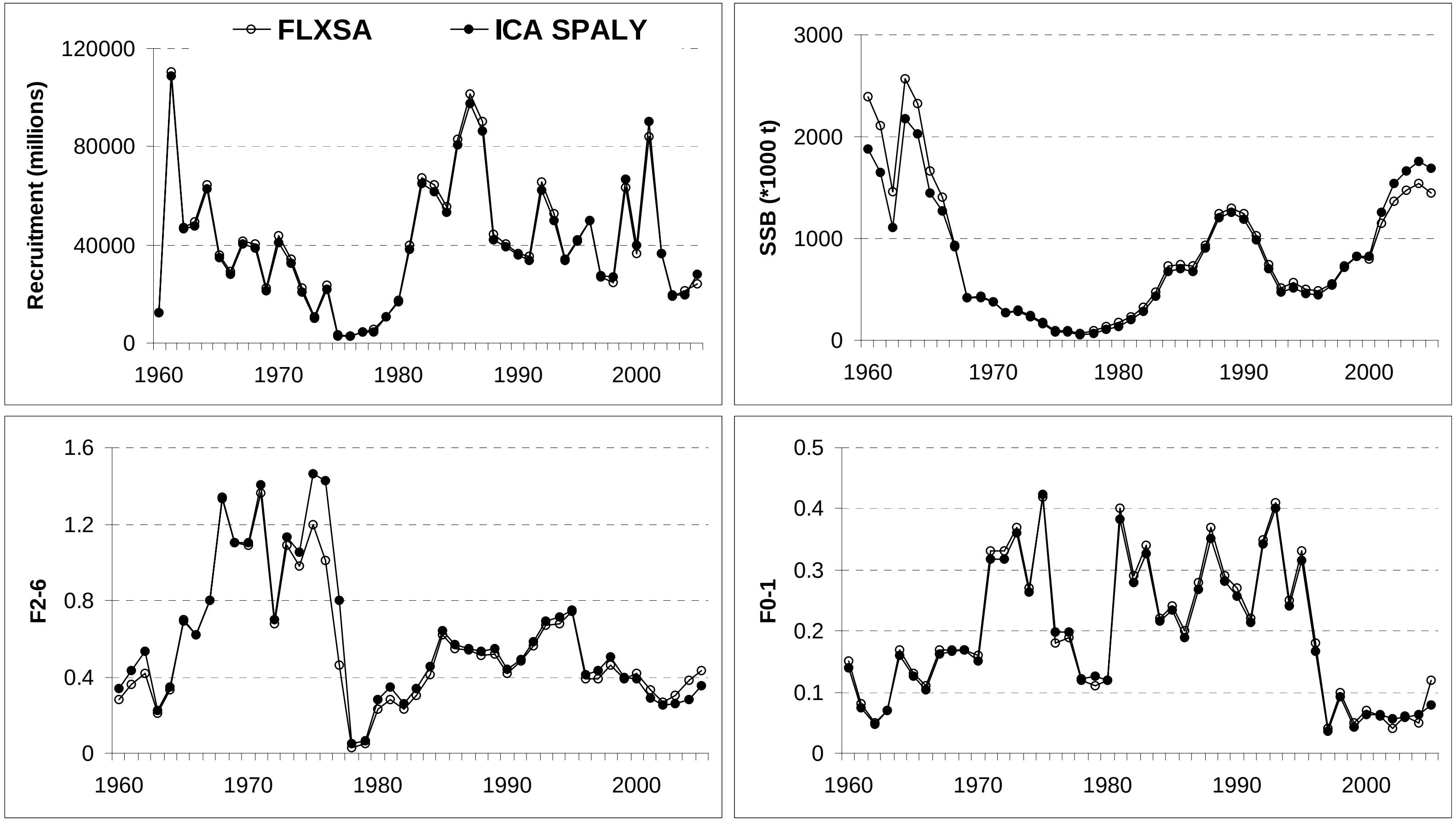


Figure 2.6.5.3. North Sea herring. EXPLORATORY FLXSA v0.2, comparison of the assessment run using all three age structured tuning indices with single survey assessments: recruitment, SSB and mean F ages 2-6. Note that XSA cannot use the MLAI survey.

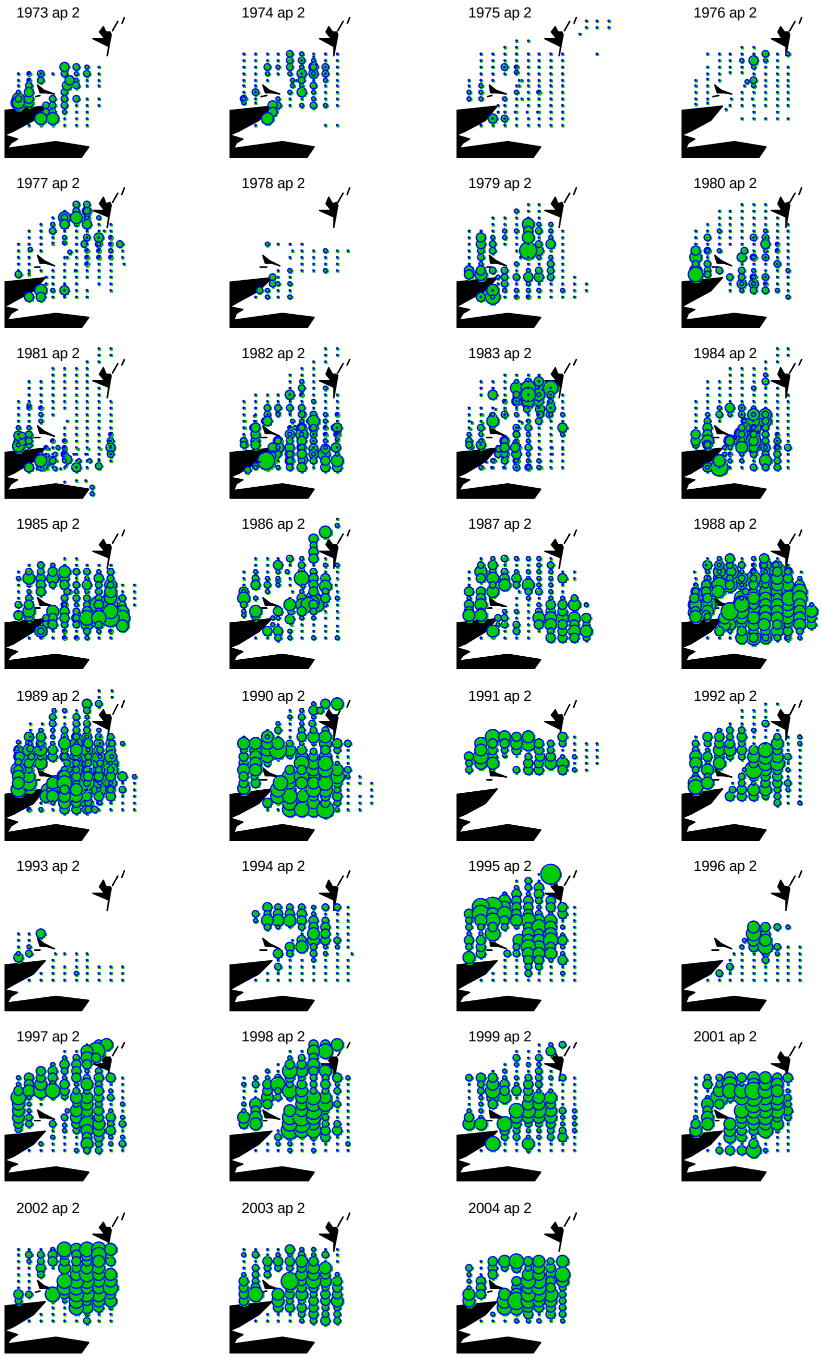


Figure 2.6.6.1a. North Sea herring. An example of the spatial distribution of stations and values for the spatial and seasonal coverage of the Larvae survey. Area / period 2: the second coverage of the Orkney Shetland area (circles are on a log scale) See Table 2.3.2.3 for definitions of periods and areas.

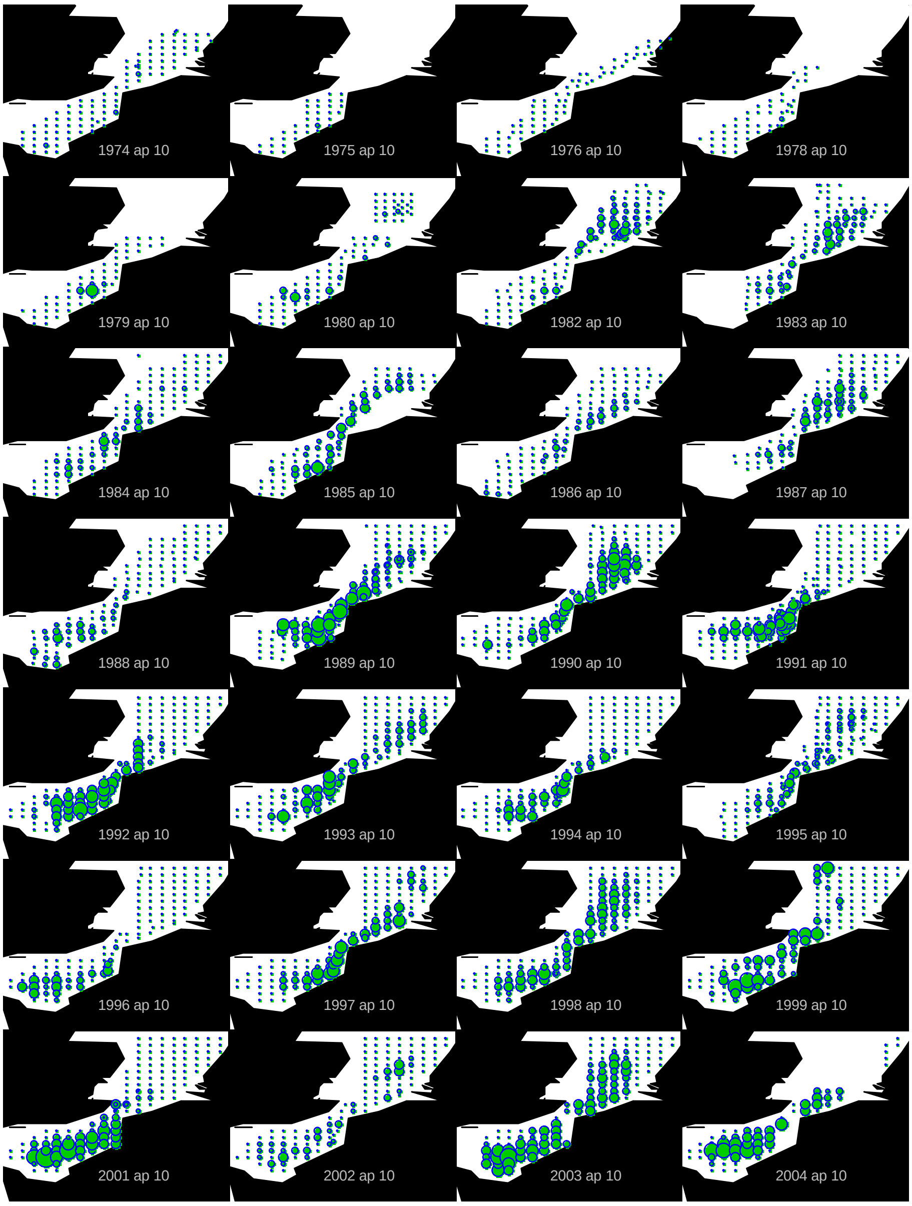


Figure 2.6.6.1b. North Sea herring. An example of the spatial distribution of stations and values for the spatial and seasonal coverage of the Larvae survey. Area / period 10: the second coverage of the area IVc (circles are on a log scale). See Table 2.3.2.3 for definitions of periods and areas.

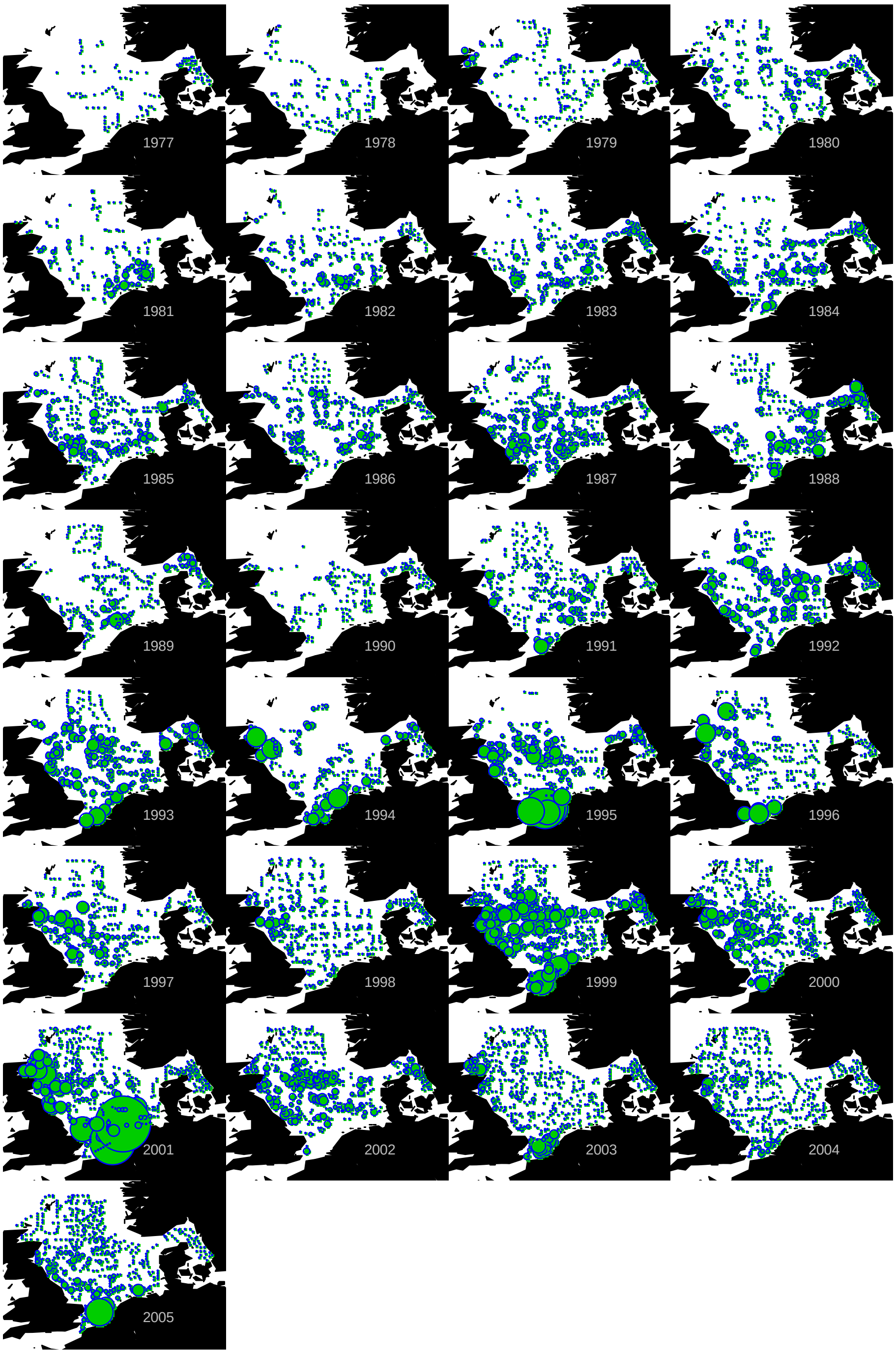


Figure 2.6.6.2. North Sea herring. The spatial distribution of stations and values for the spatial coverage of the MIK 0wr survey. Circles indicate catch rates per unit of surface area and are on a linear scale.

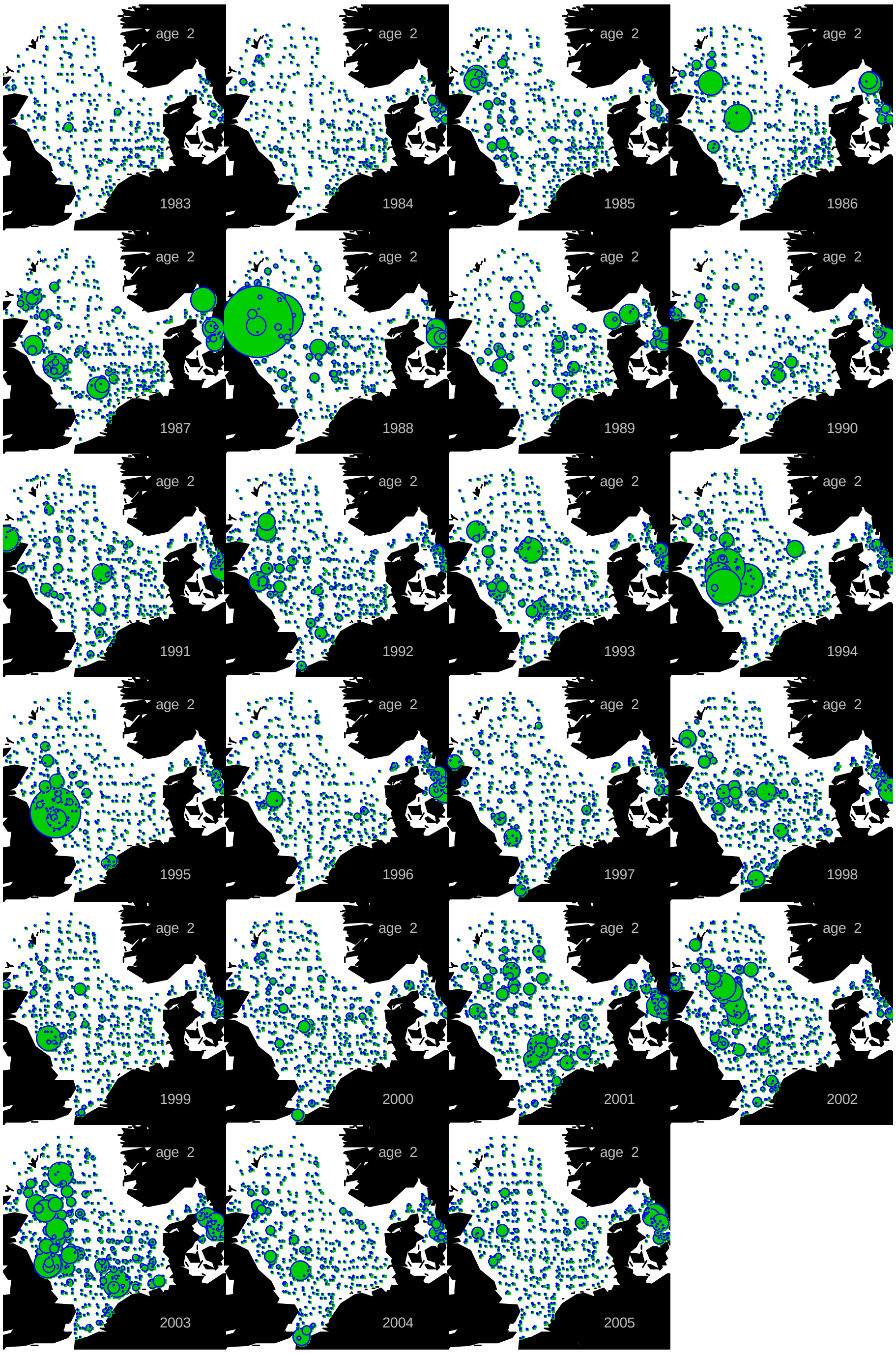


Figure 2.6.6.3a. North Sea herring. The spatial distribution of stations and values for the spatial coverage of the IBTS 2wr survey. Circles indicate catch rates per unit of surface area and are on a linear scale.

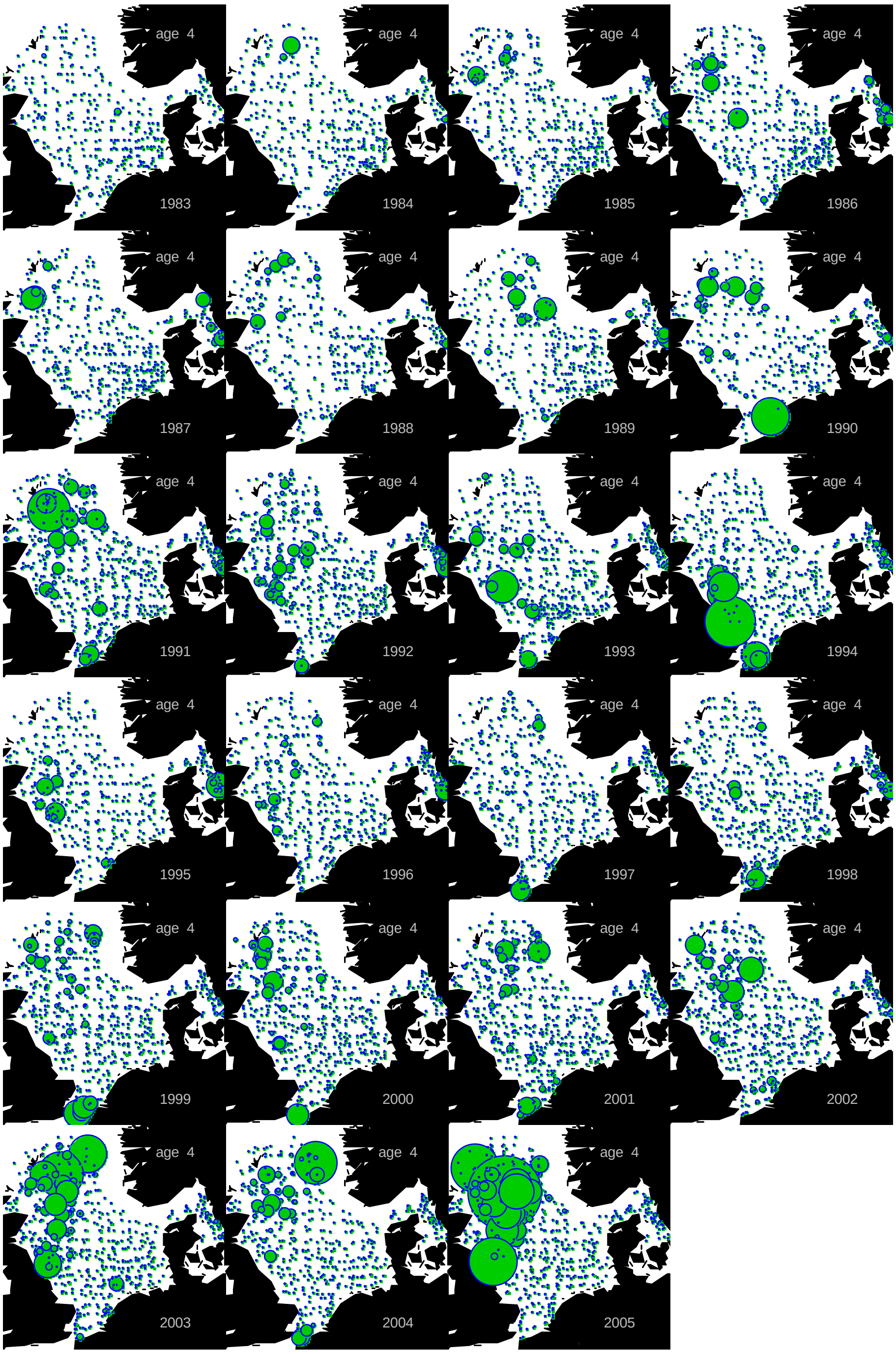


Figure 2.6.6.3b. North Sea herring. The spatial distribution of stations and values for the spatial coverage of the IBTS 4 wr survey. Circles indicate catch rates per unit of surface area and are on a linear scale.

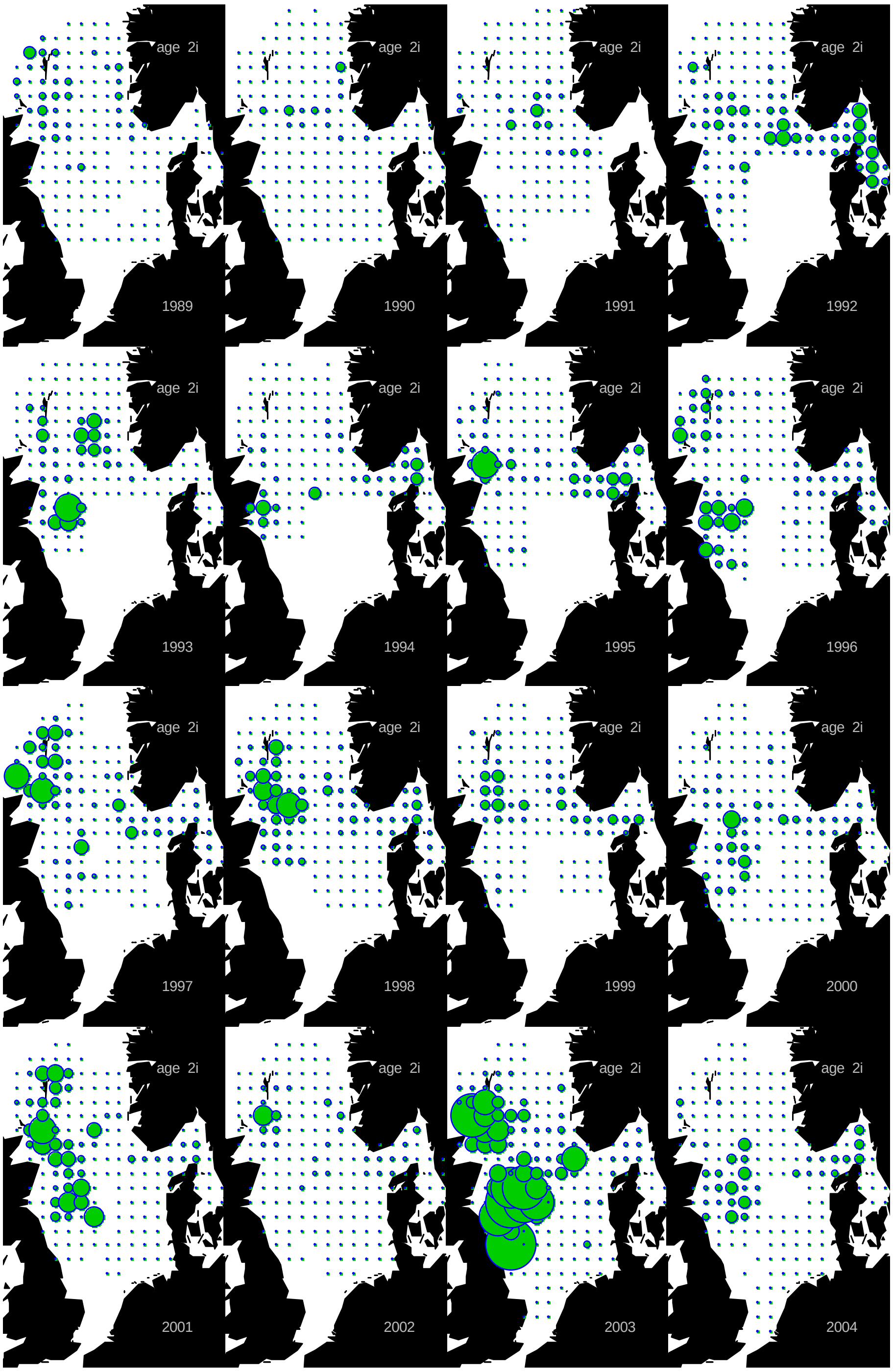


Figure 2.6.6.4a. North Sea herring. The spatial distribution of stations and values for the spatial coverage of the Acoustic 2wr immature group survey, note the high abundance of immature 2wr herring in 2003, the slow growing 2000 yearclass. Circles indicate catch rates per unit of surface area and are on a linear scale. (The immature component is used to estimate the maturity ogive used in the assessment)

Figure 2.6.6.4b. North Sea herring. The spatial distribution of stations and values for the spatial coverage of the Acoustic survey 2wr mature. Circles indicate catch rates per unit of surface area and are on a linear scale. (The mature component is used to estimate the maturity ogive used in the assessment)

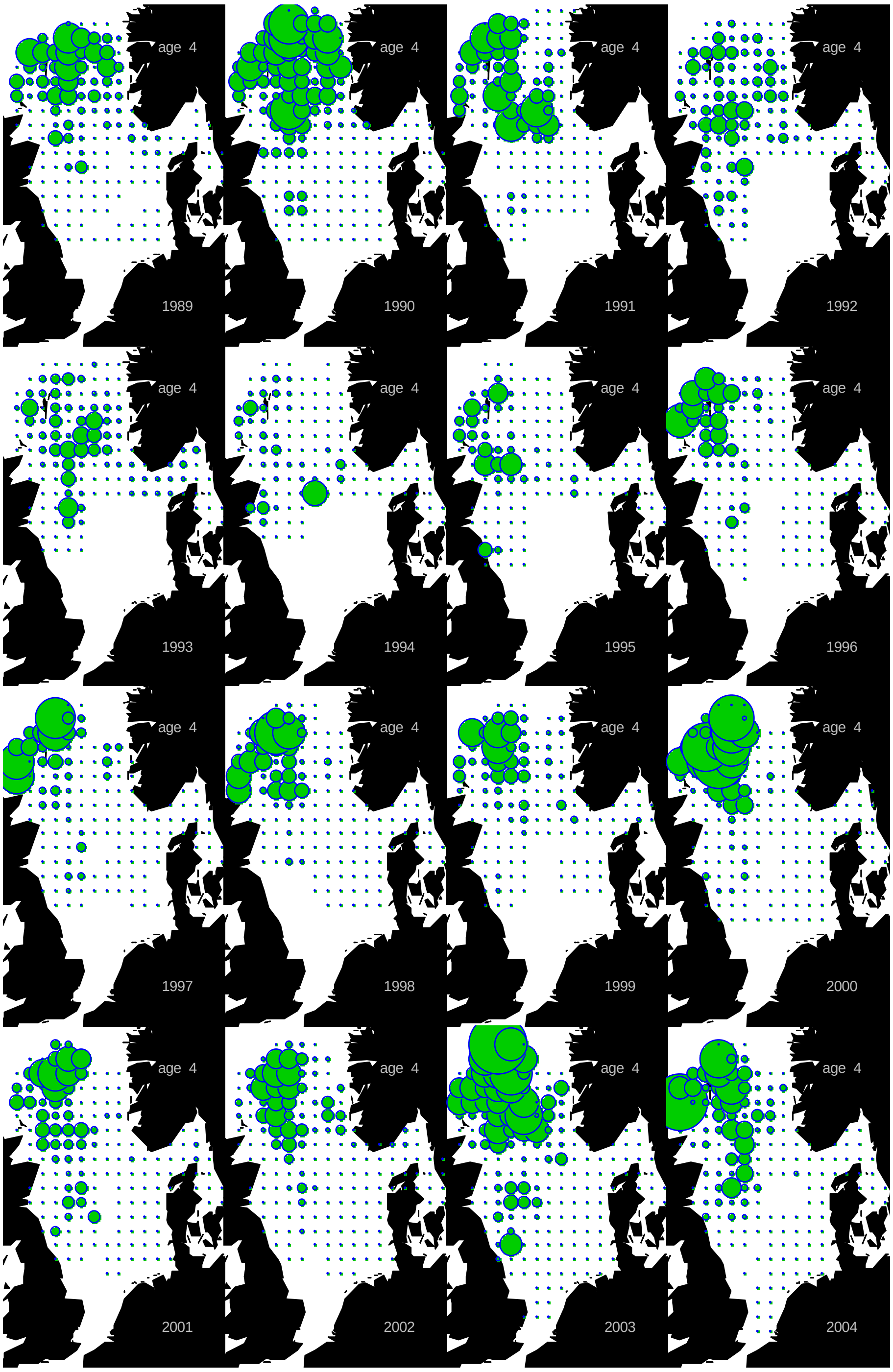


Figure 2.6.6.4c. North Sea herring. The spatial distribution of stations and values for the spatial coverage of the Acoustic 4wr survey. Circles indicate catch rates per unit of surface area and are on a linear scale.

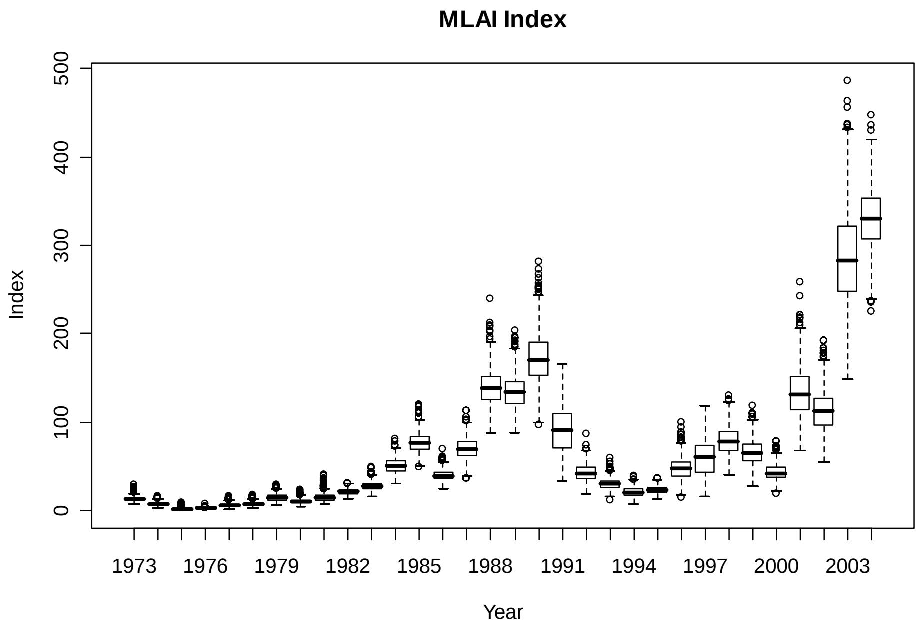


Figure 2.6.6.5 North Sea herring. Multiplicative Larvae Abundance Index (MLAI) used as an SSB index, box and whisker plot derived from bootstrap of station data.

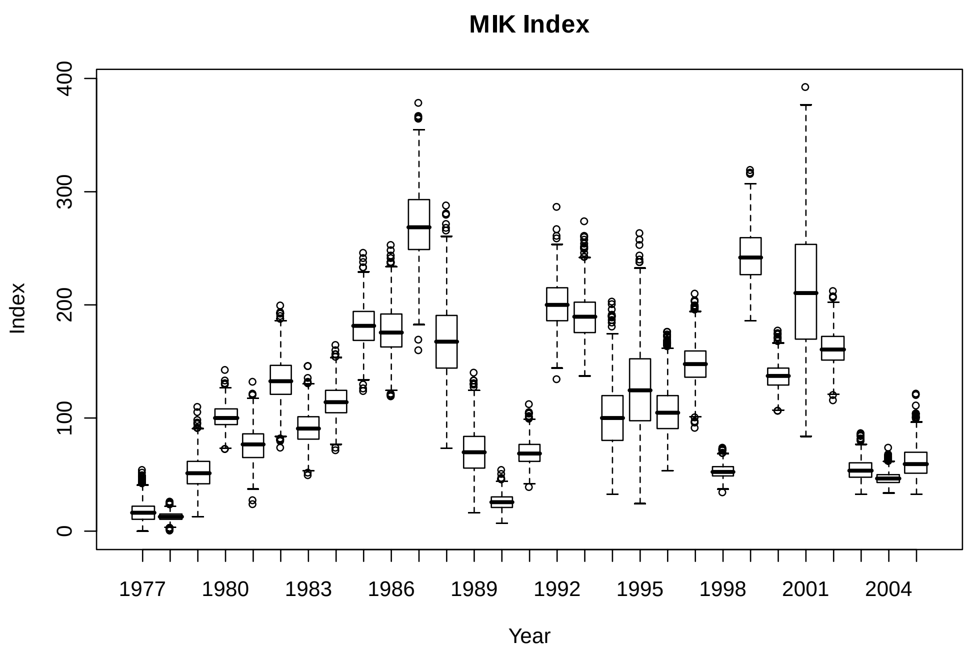


Figure 2.6.6.6. North Sea herring. Methot Issacs Kidd (MIK) 0wr recruitment index, box and whisker plot derived from bootstrap of station data.

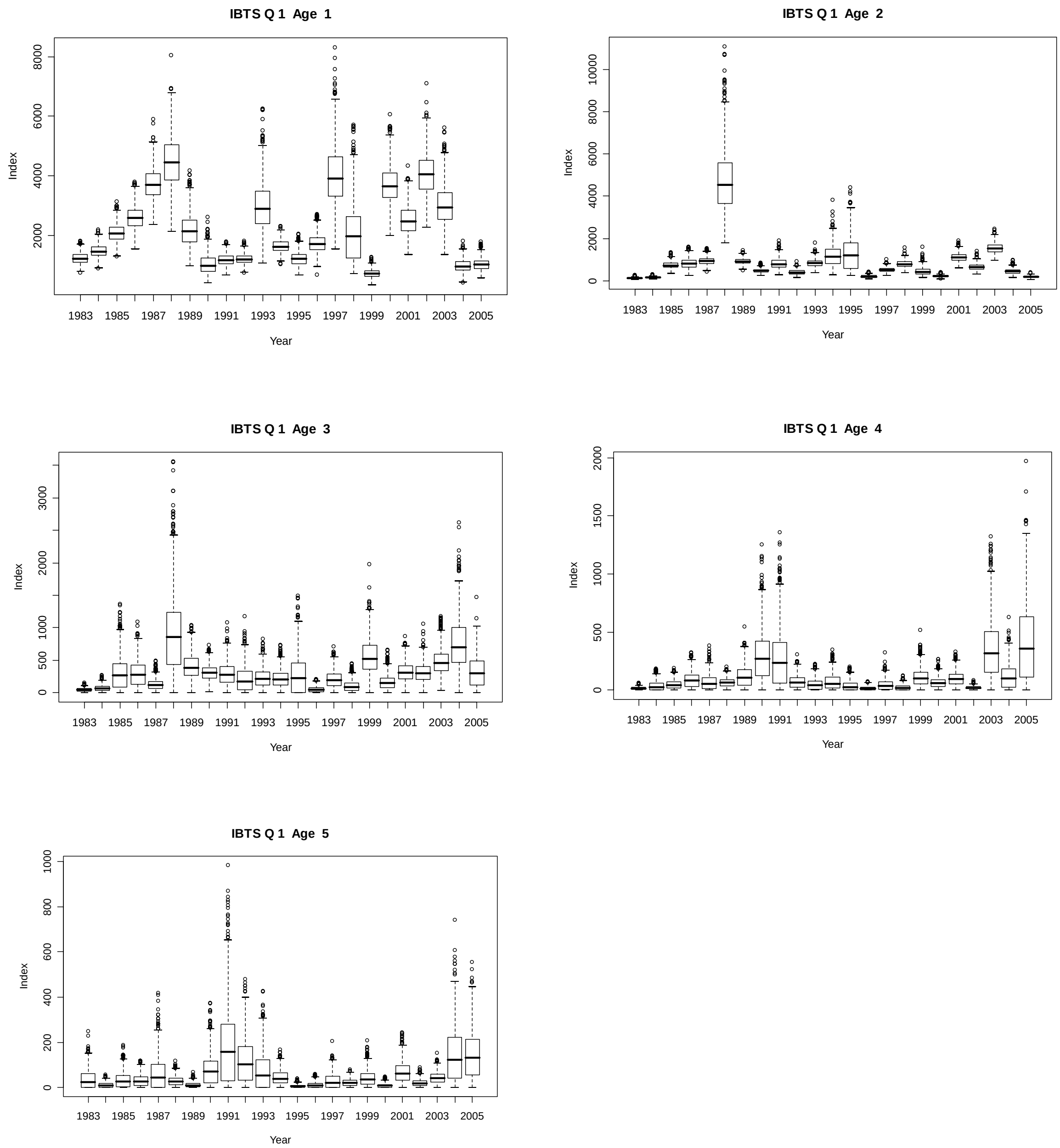


Figure 2.6.6.7. North Sea herring. International Bottom Trawl Survey (IBTS) 1-5 wr indices, box and whisker plot derived from bootstrap of station data.

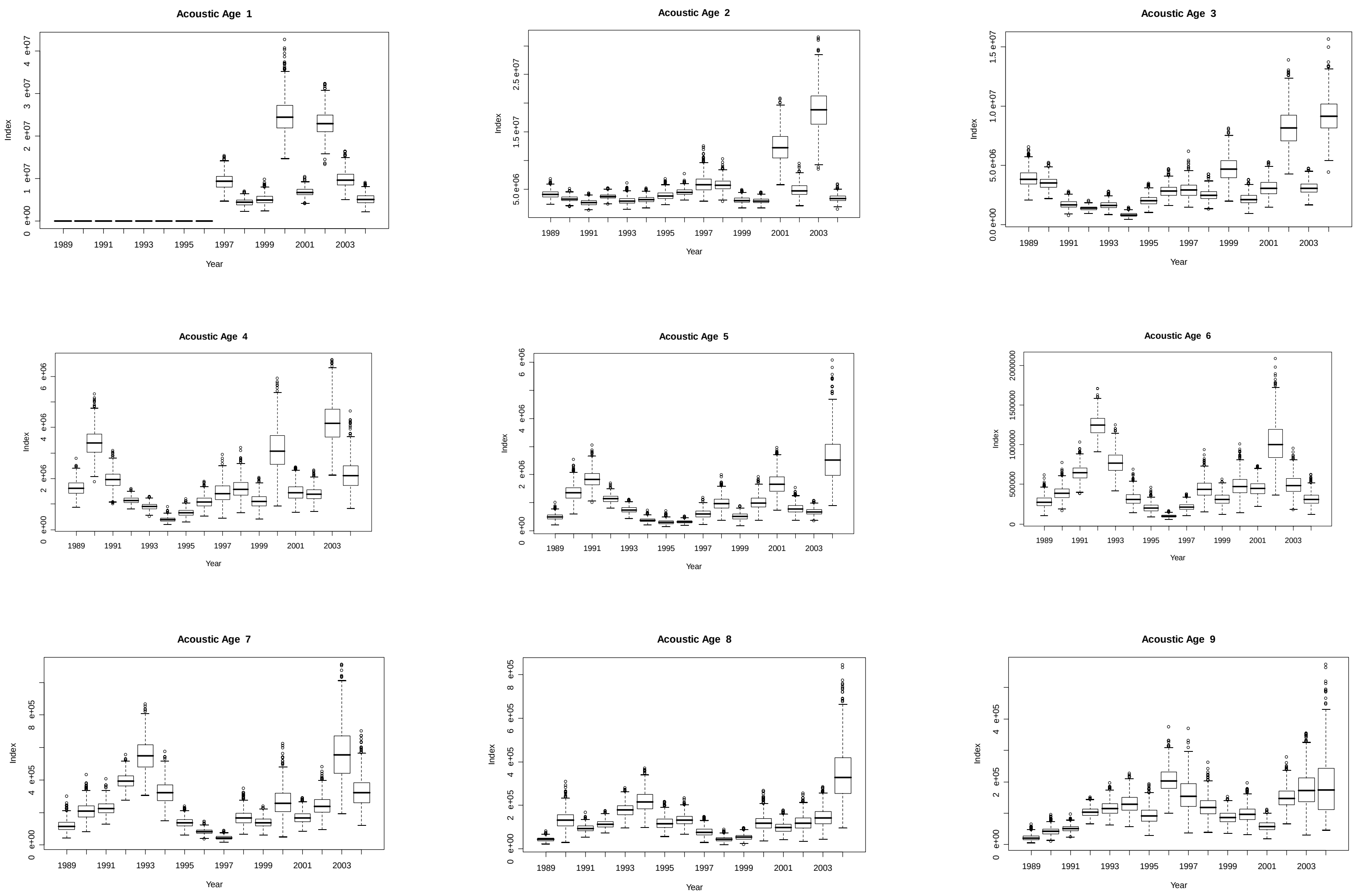


Figure 2.6.6.8. North Sea herring. ICES Coordinated Acoustic Survey 1-9+ wr indices, box and whisker plot derived from bootstrap of estimates at age by stat rectangle data.

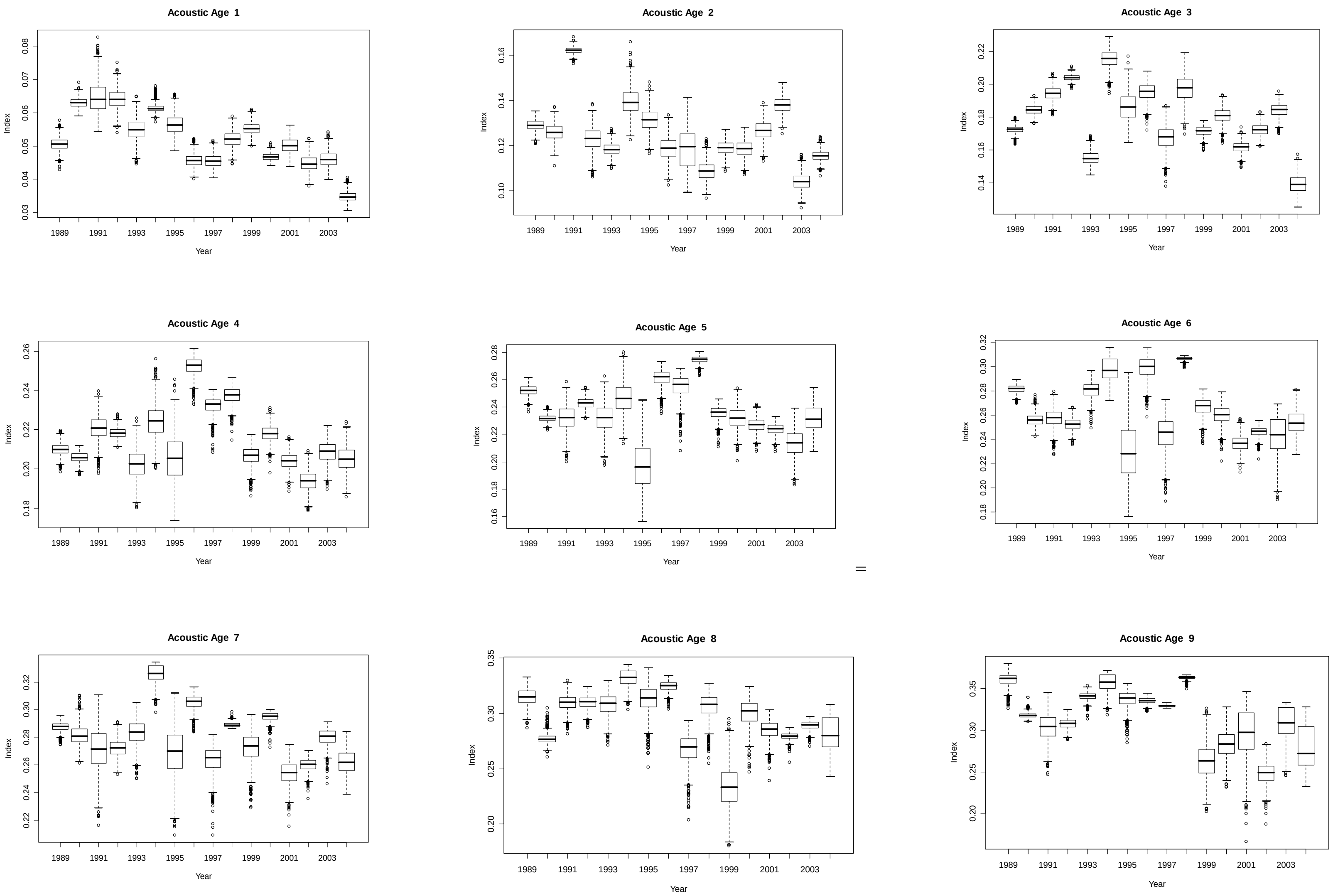
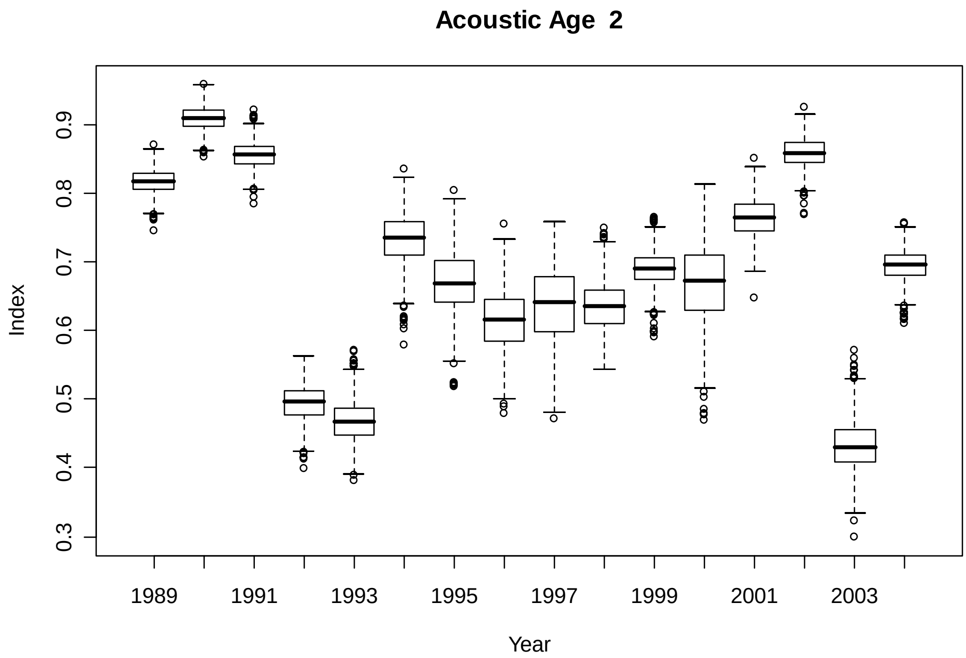


Figure 2.6.6.9. North Sea herring. Acoustic Survey 1-9+ wr mean weights, box and whisker plot derived from bootstrap of estimates at age by stat rectangle data.



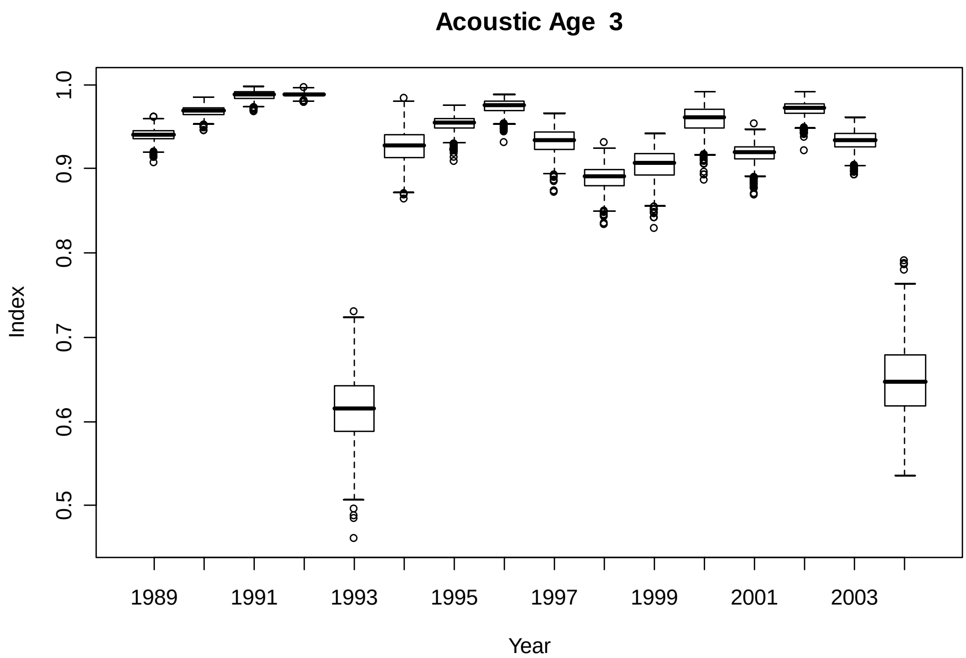


Figure 2.6.6.10 North Sea herring. ICES Coordinated Acoustic Survey 2 and 3 wr fraction mature, box and whisker plot derived from bootstrap of estimates at age by stat rectangle data.

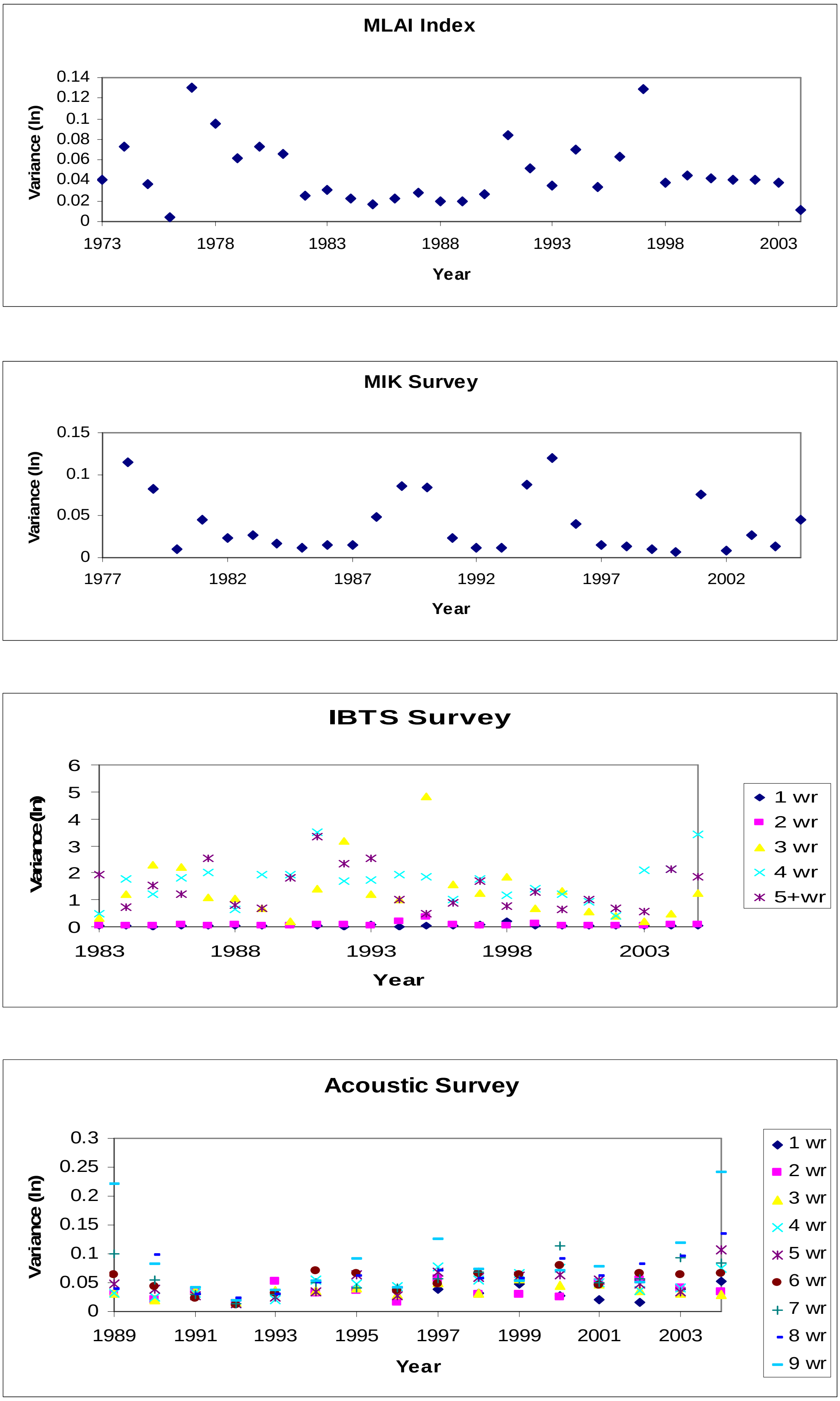


Figure 2.6.7.1. North Sea herring. Variance of log survey abundance at age by year (a) MLAI SSB Index, (b) MIK 0wr survey, (c) IBTS 1-5wr survey (d) Acoustic 1-9wr

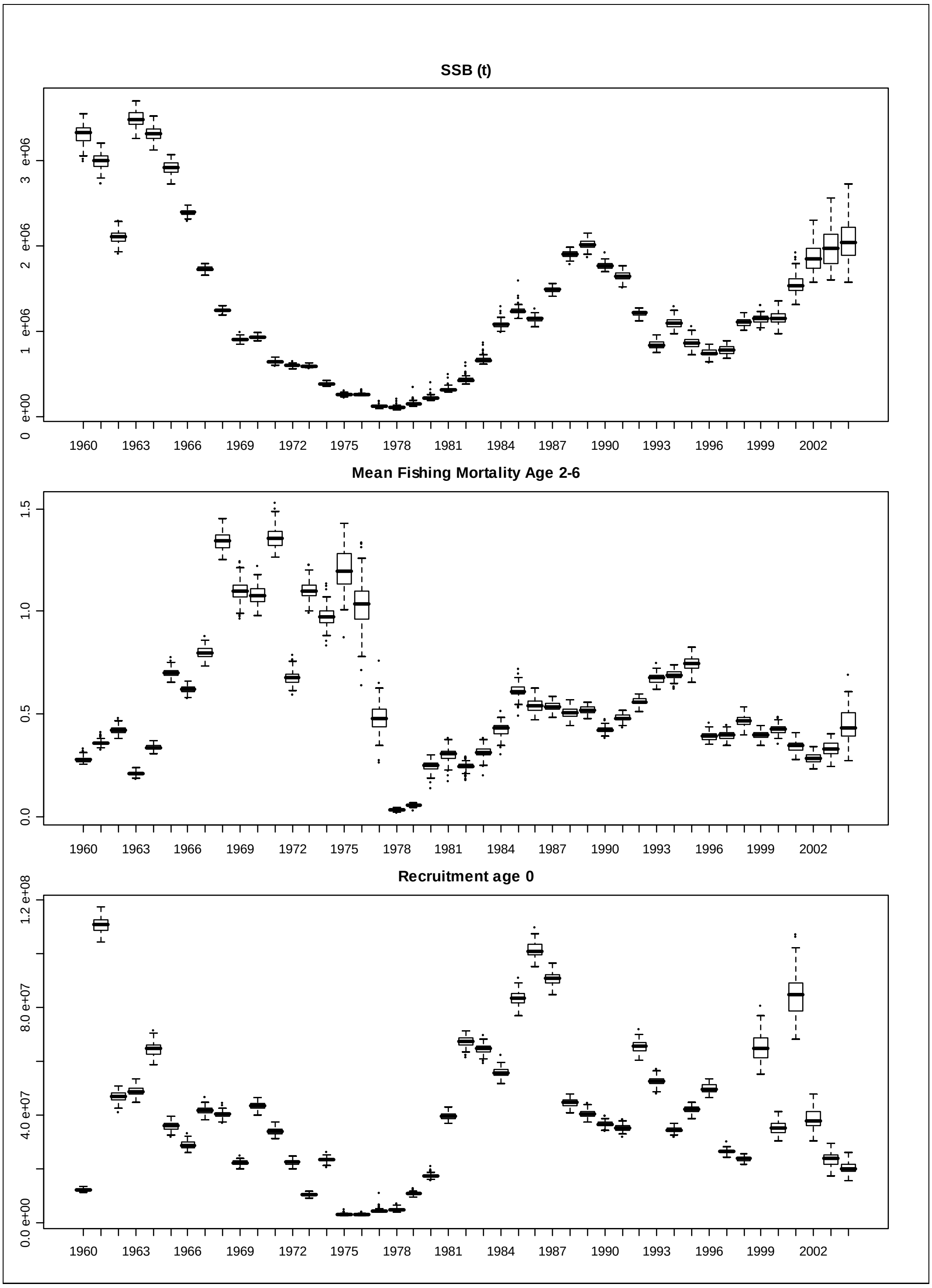


Figure 2.6.8.1. North Sea herring. Results of assessments using FLXSA with 2005 settings using bootstrap data for all surveys, weights at age, maturities at age and catch at age. (SSB refers to SSB at 1st of January and should not be confused with as SSB at spawning time which is used for management and includes the proportion of F and M in the year before spawning.)

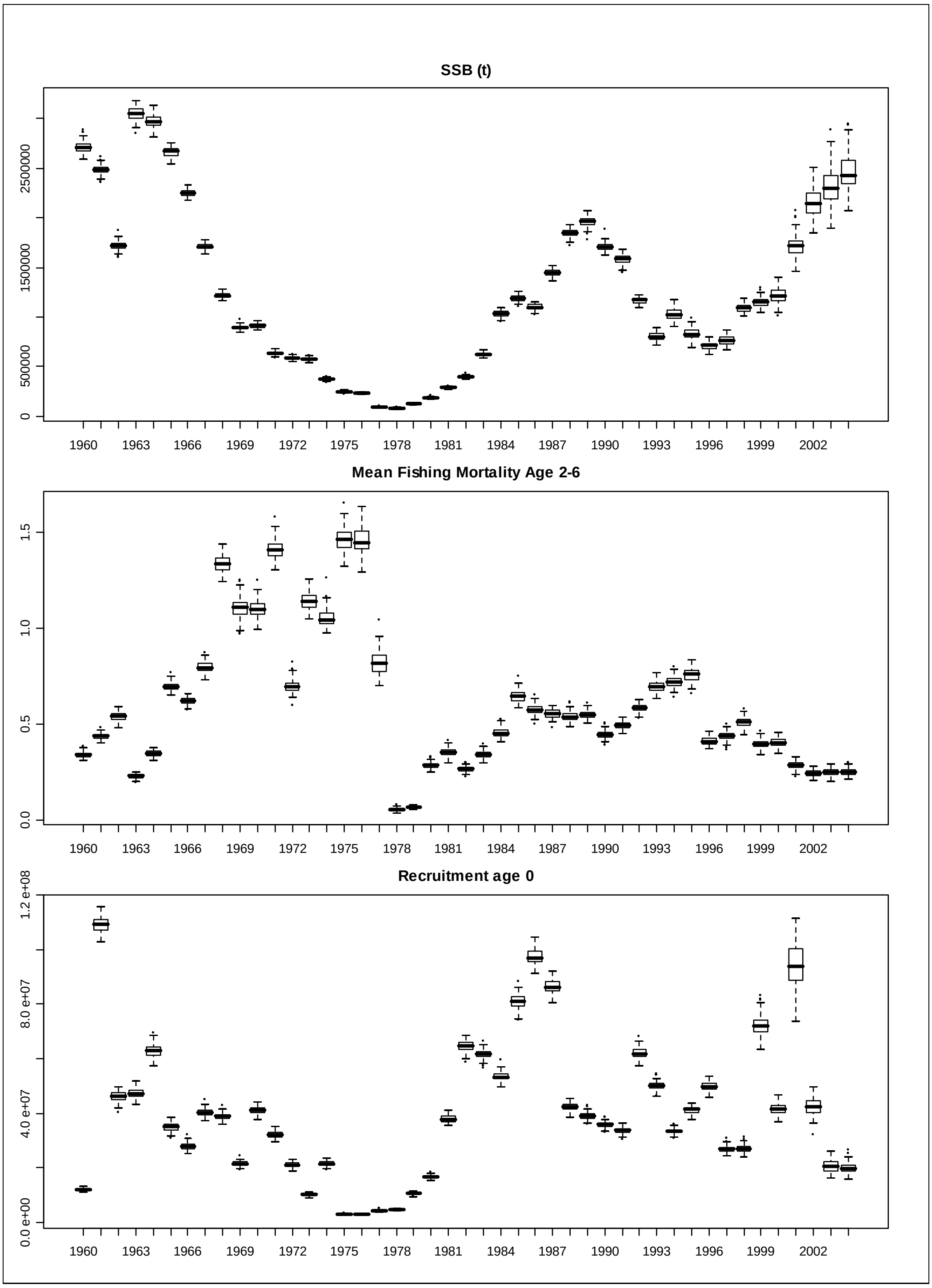


Figure 2.6.8.2. North Sea herring. Results of assessments using FLICA with 2005 settings using bootstrap data for all surveys, weights at age, maturities at age and catch at age. (SSB refers to SSB at 1st of January and should not be confused with as SSB at spawning time which is used for management and includes the proportion of F and M in the year before spawning.)

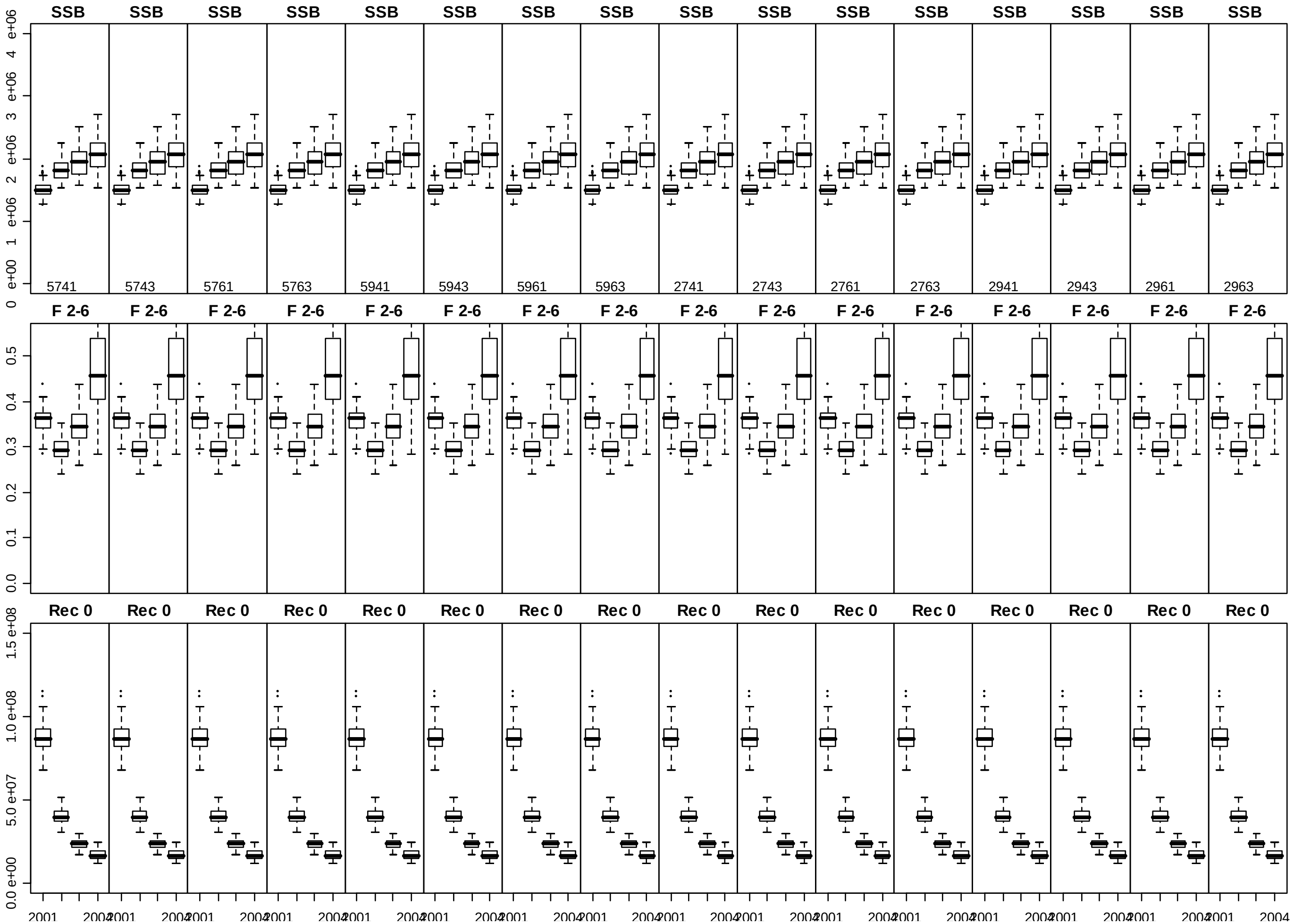


Figure 2.6.8.3. North Sea herring. Variability in the FLXSA assessments (2005 settings) due to data variability and a small range of model settings (see Section 2.6.5), These model changes make no significant difference to the assessment. (SSB refers to SSB at 1^{st} of January and should not be confused with as SSB at spawning time which is used for management and includes the proportion of F and M in the year before spawning.)

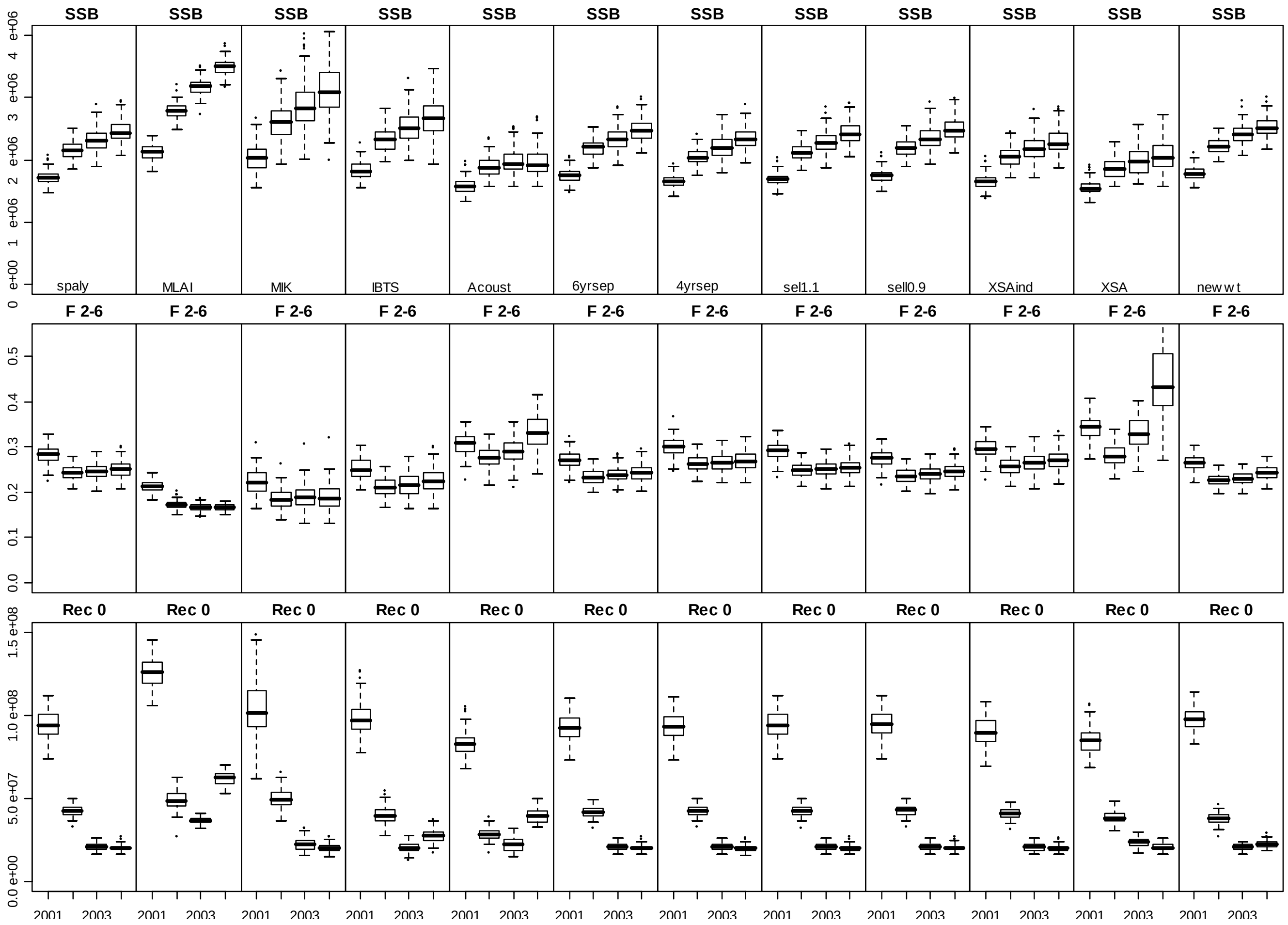


Figure 2.6.8.4. North Sea herring. Variability in the FLICA/FLXSA assessments due to data variability and a small range of model settings (last 4 years in the assessment SSB 1st Jan, mean F ages 2-6, Recruitment age 0). Panel 1 2005 settings all data (spaly) Panel 2-5 individual tuning series (MLAI, MIK, IBTS, Acoustic), Panel 6-9 Separable model settings (4-6 years 0.9 to 1.1 F on oldest age) Panel 10 - 11, ICA and XSA compared with same data (MLAI removed), Panel 12 new weighting factors. (SSB refers to SSB at 1st of January and should not be confused with as SSB at spawning time which is used for management and includes the proportion of F and M in the year before spawning.)

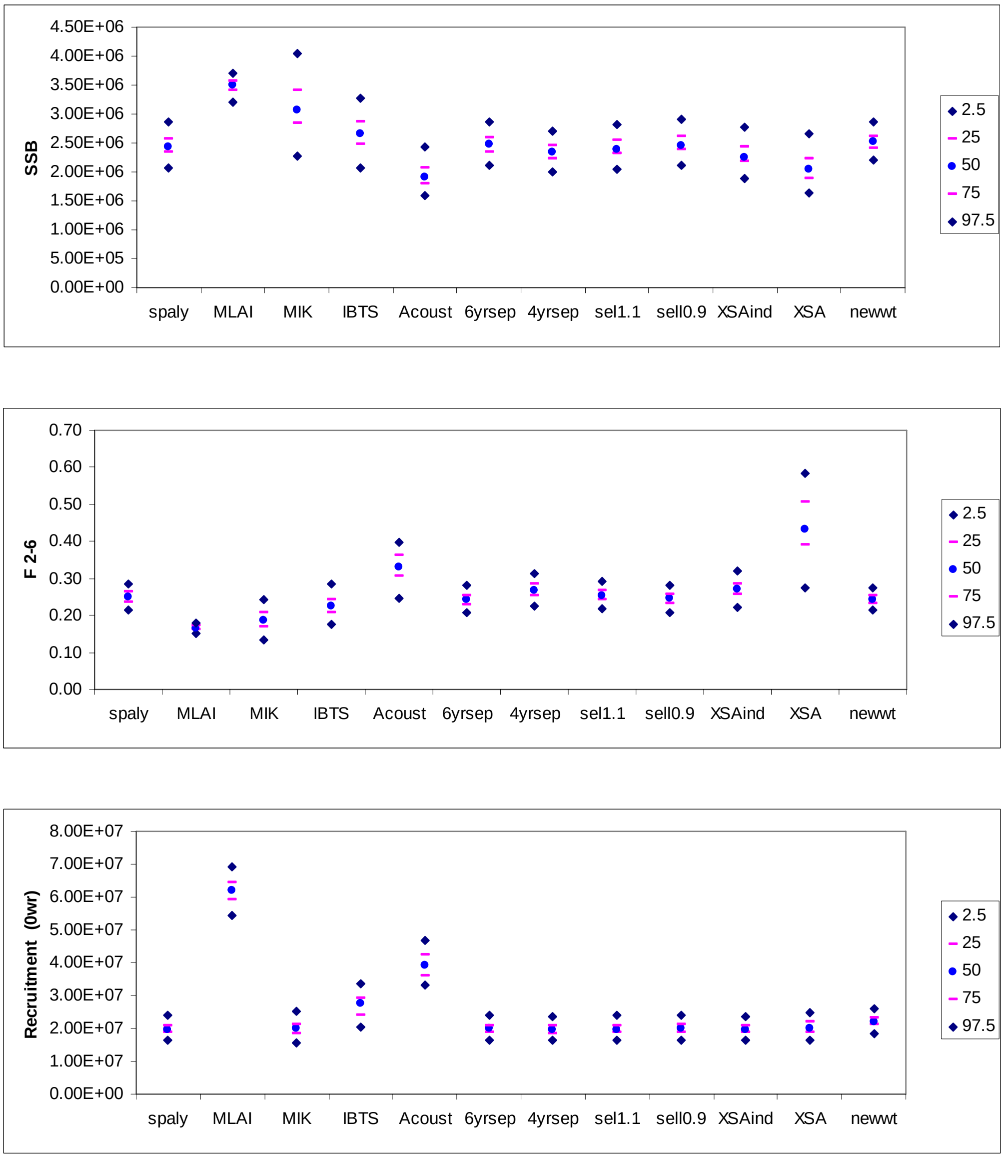


Figure 2.6.8.5 North Sea herring. Variability in the FLICA/FLXSA assessments due to data variability and a small range of model settings (last year in the assessment SSB 1st Jan, mean F ages 2-6, Recruitment age 0). From left to right:- (1) 2005 settings all data (spaly); (2-5) individual tuning series (MLAI, MIK, IBTS, Acoustic); (6-9) Separable model settings (4-6 years 0.9 to 1.1 F on oldest age); (10 – 11) ICA and XSA compared with same data (MLAI removed), (12) new weighting factors. (SSB refers to SSB at 1st of January and should not be confused with as SSB at spawning time which is used for management and includes the proportion of F and M in the year before spawning)

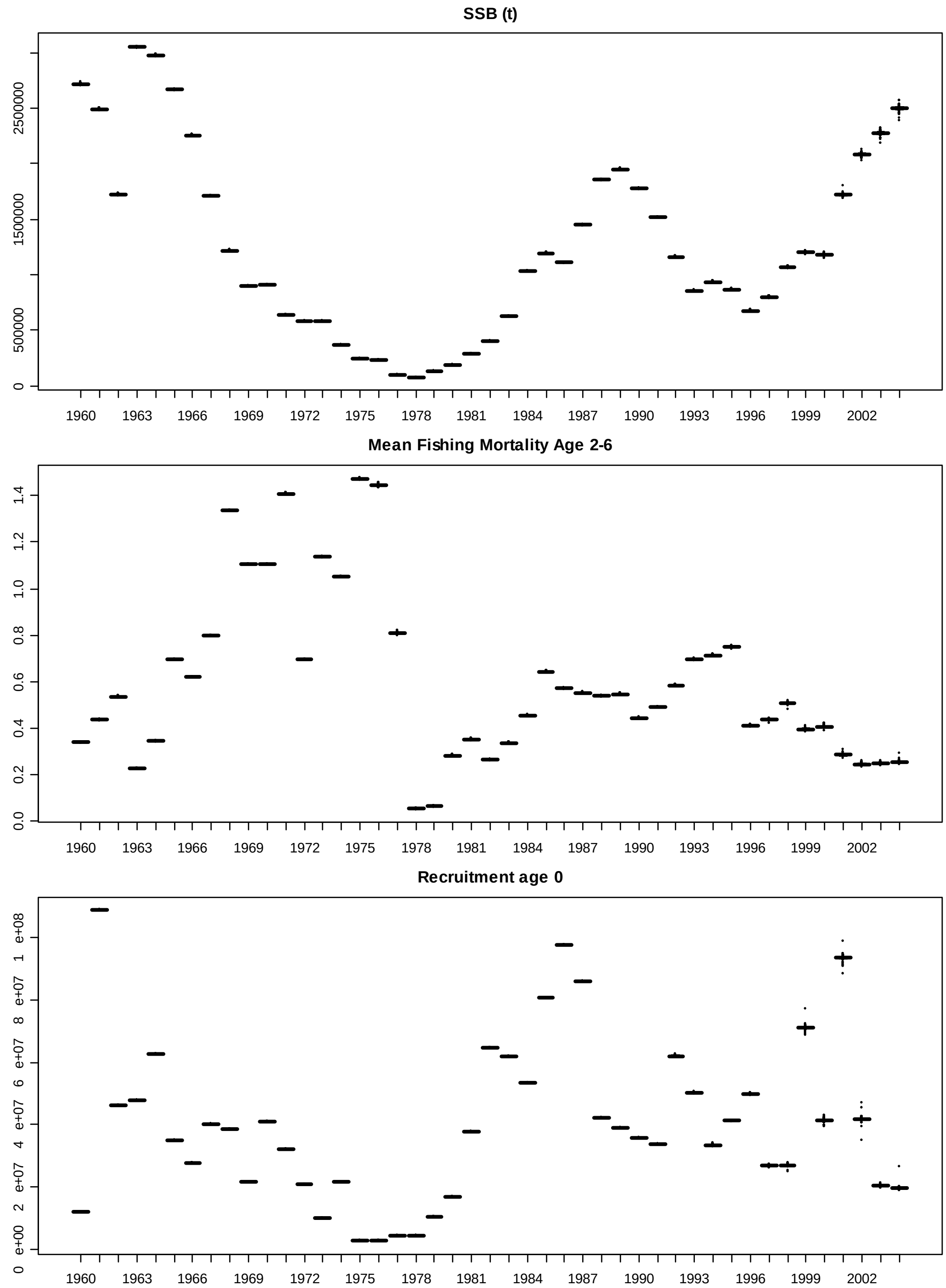


Figure 2.6.8.6 Variability in ICA assessment due to input data. Box and whisker plots of assessments with 390 individual data points removed one at a time from the tuning series and the catch at age in the separable period (last 5 years). (SSB refers to SSB at 1st of January and should not be confused with as SSB at spawning time which is used for management and includes the proportion of F and M in the year before spawning)

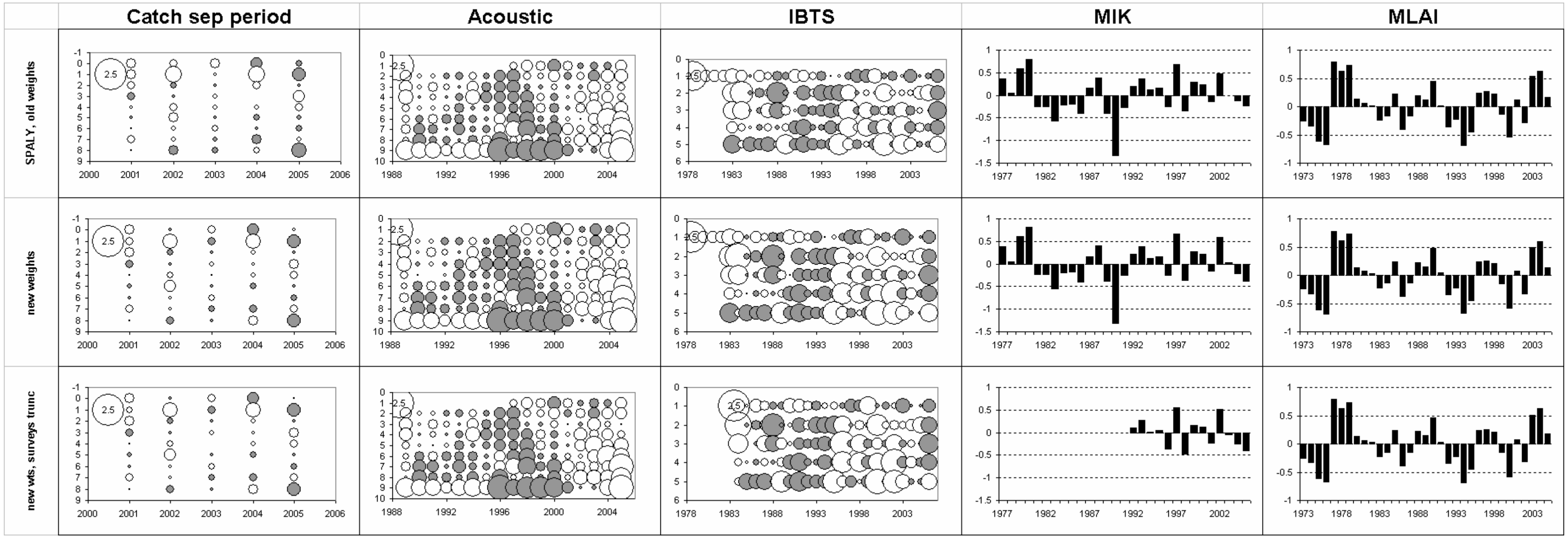


Figure 2.6.9.1 North Sea herring. ICA residuals plots for catch separable period, acoustic survey, IBTS, MIK and MLAI from SPALY (top panels), new weights applied to the catch and surveys (middle panels) and new weights applied in combination with truncation of the IBTS (1984-2006) and the MIK (1992-2006, lower panels).

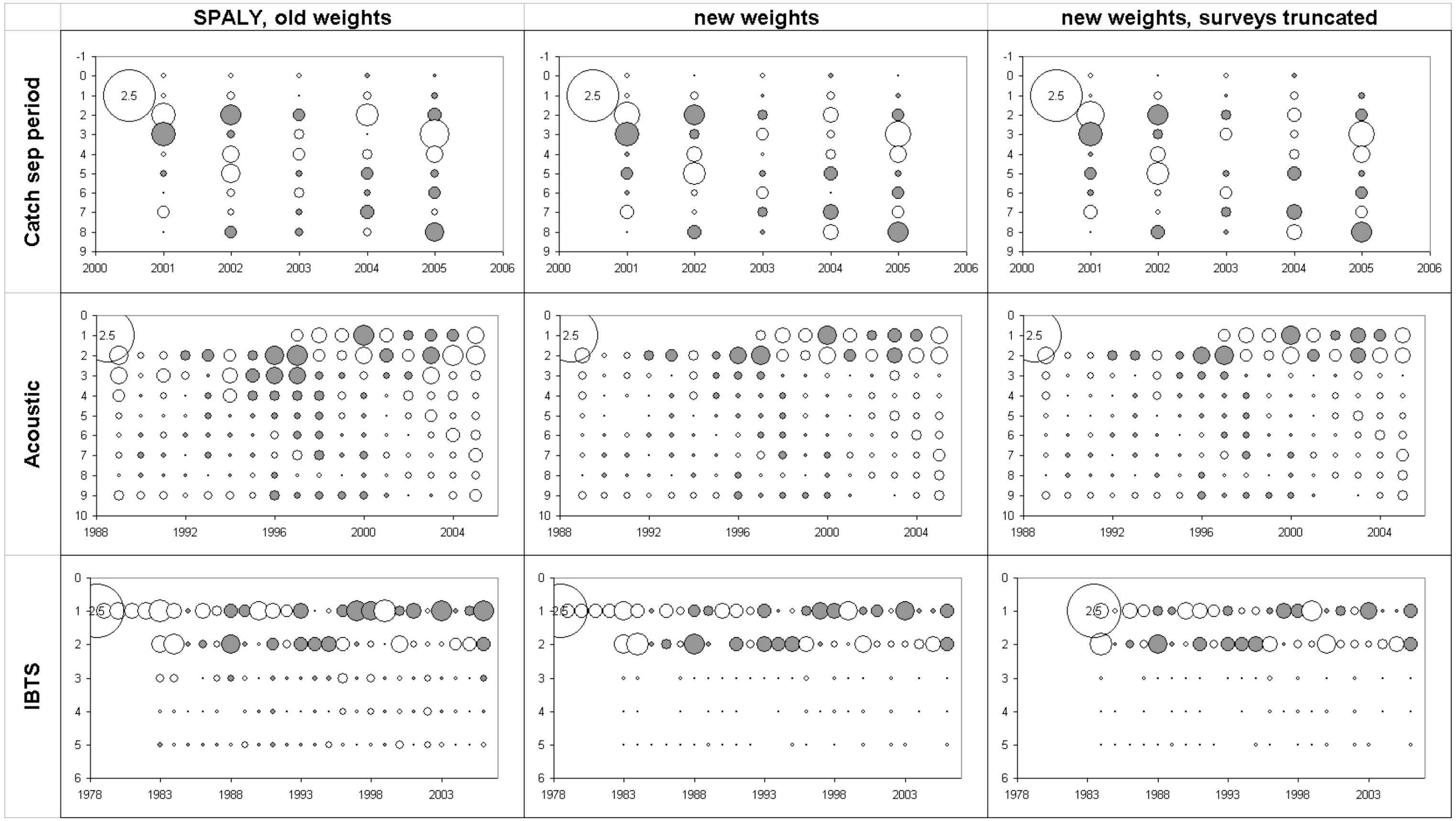


Figure 2.6.9.2 North Sea herring. Weighted ICA residuals plots for catch separable period, acoustic survey and IBTS, from SPALY (left panels), new weights applied to the catch and surveys (middle panels) and new weights applied in combination with truncation of the IBTS (1984-2006) and the MIK (1992-2006, right panels).

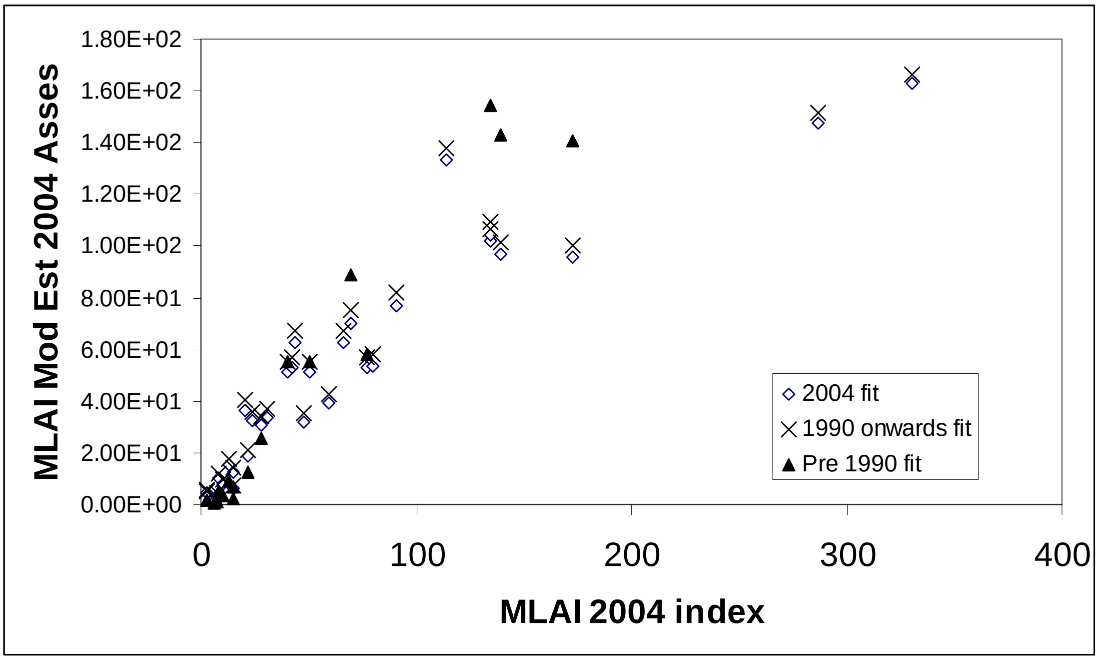


Figure 2.6.9.3. North Sea herring. Plot of the MLAI estimated index using model coefficients from the assessments against measured index for 1) 2005 assessment, and 2) MLAI split into two separate time series 1973-1990 and 1991 to 2005. The earlier series fits differently but this is due to the absence of high values only seen in recent years. The later series differs by 6% from the full series which is not thought to be significant.

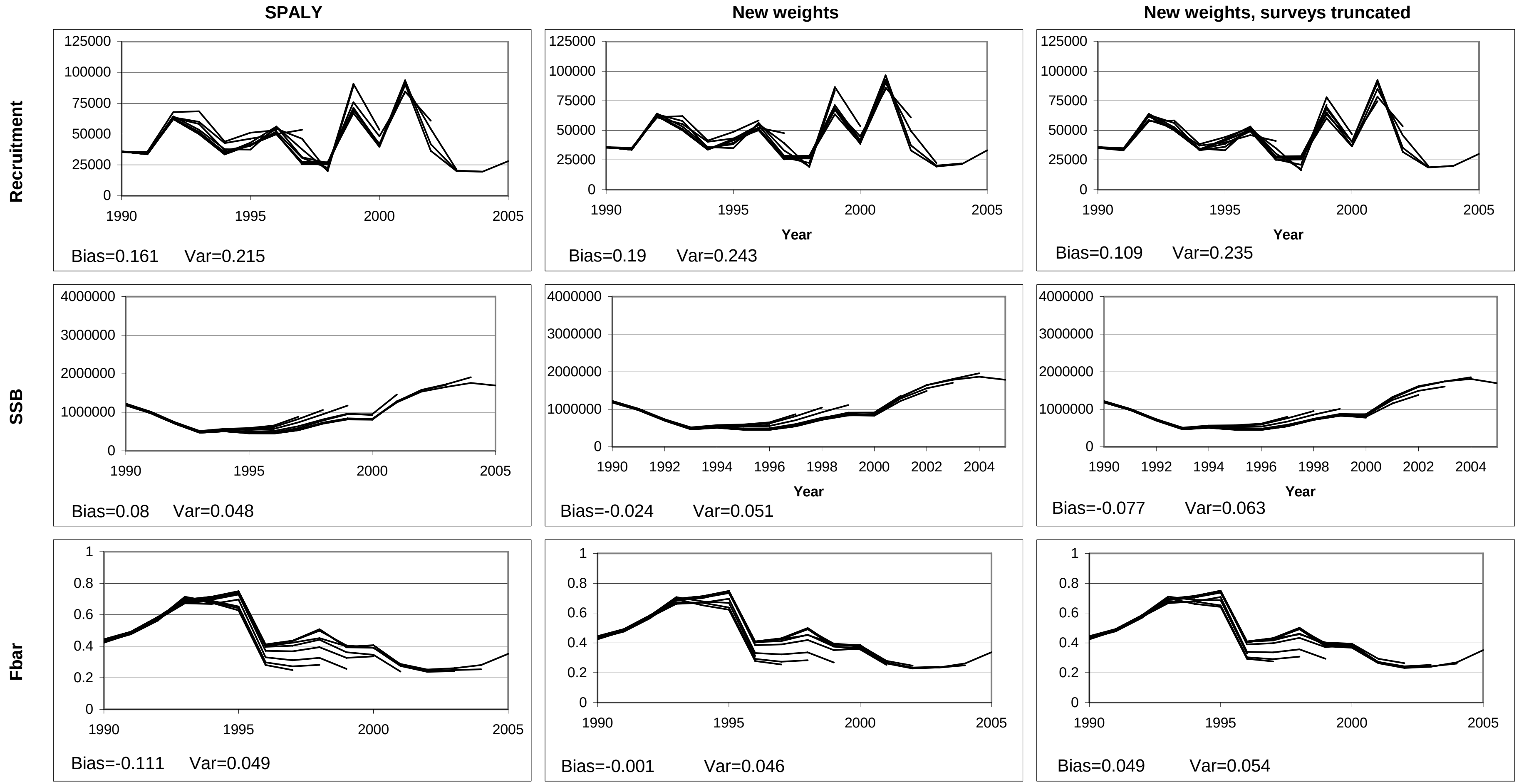


Figure 2.6.10.1. North Sea herring. ICA. Retrospective plots for SPALY (left panels), new weights applied to the catch and surveys (middle panels) and new weights applied in combination with the IBTS truncated to 1984-2006 and the MIK truncated to 1992-2006 (left panels): recruitment, SSB and mean F ages 2-6. Bias and variance are calculated over the last 5 years.

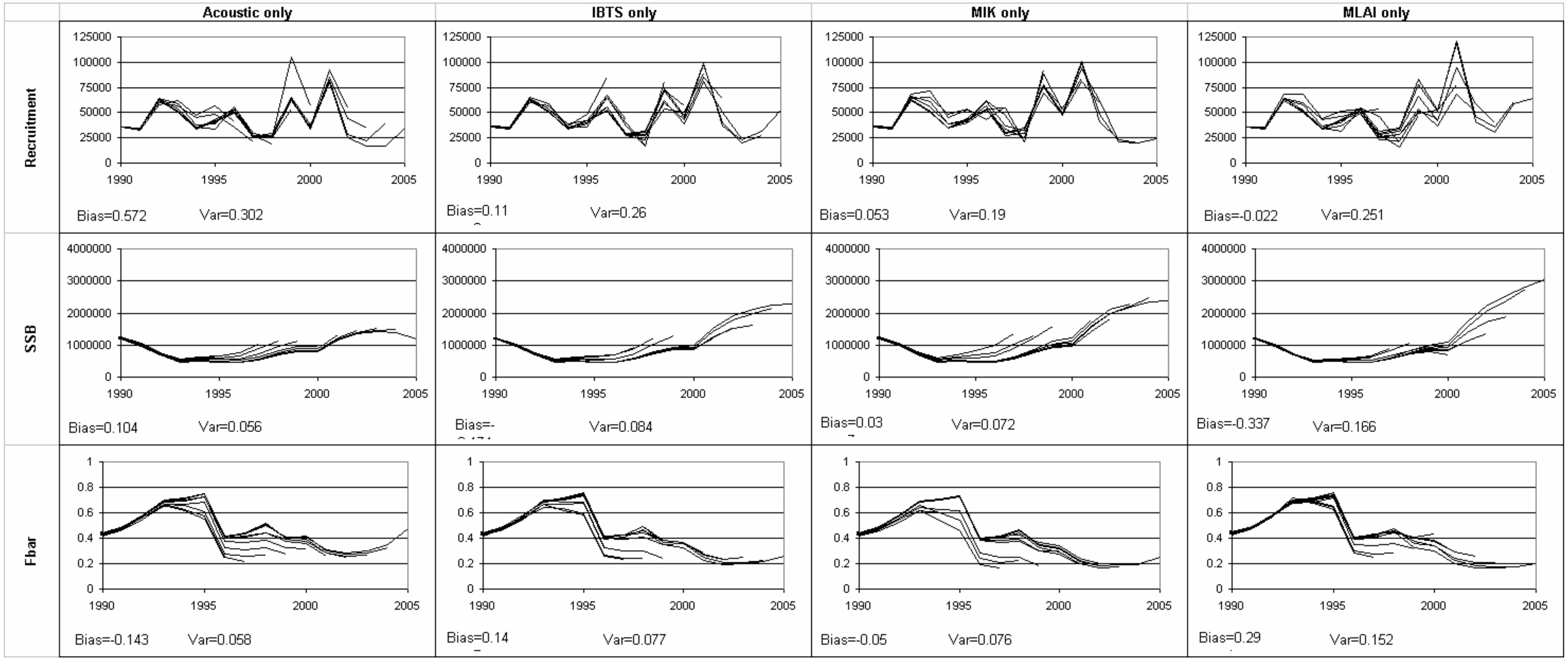


Figure 2.6.10.2. North Sea herring. ICA. Retrospective plots for single survey assessments using same procedure as last year: recruitment, SSB and mean F ages 2-6. Bias and variance are calculated over the last 5 years.

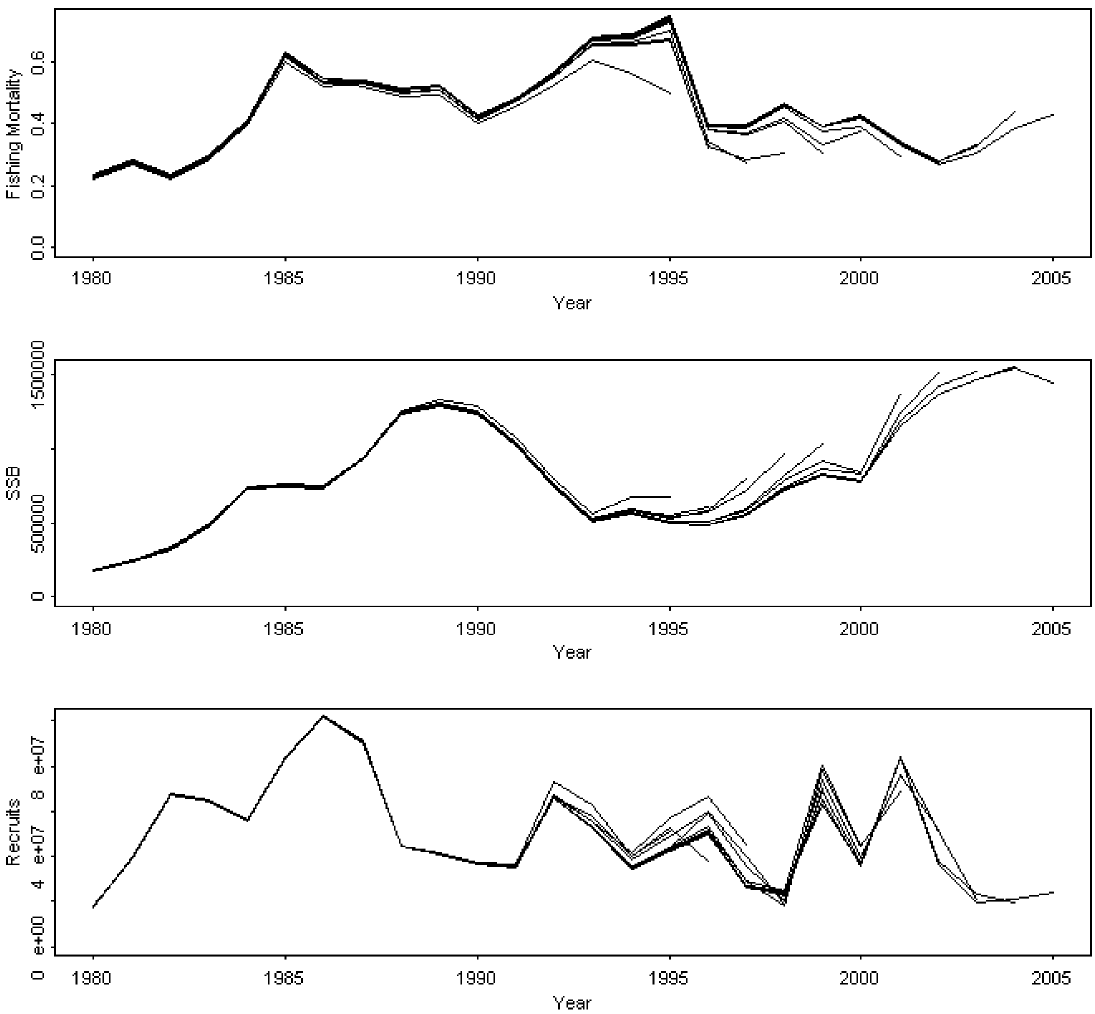


Figure 2.6.10.3. North Sea herring. EXPLORATORY FLXSA v0.2. Retrospective plots for mean F ages 2-6, SSB and recruitment.

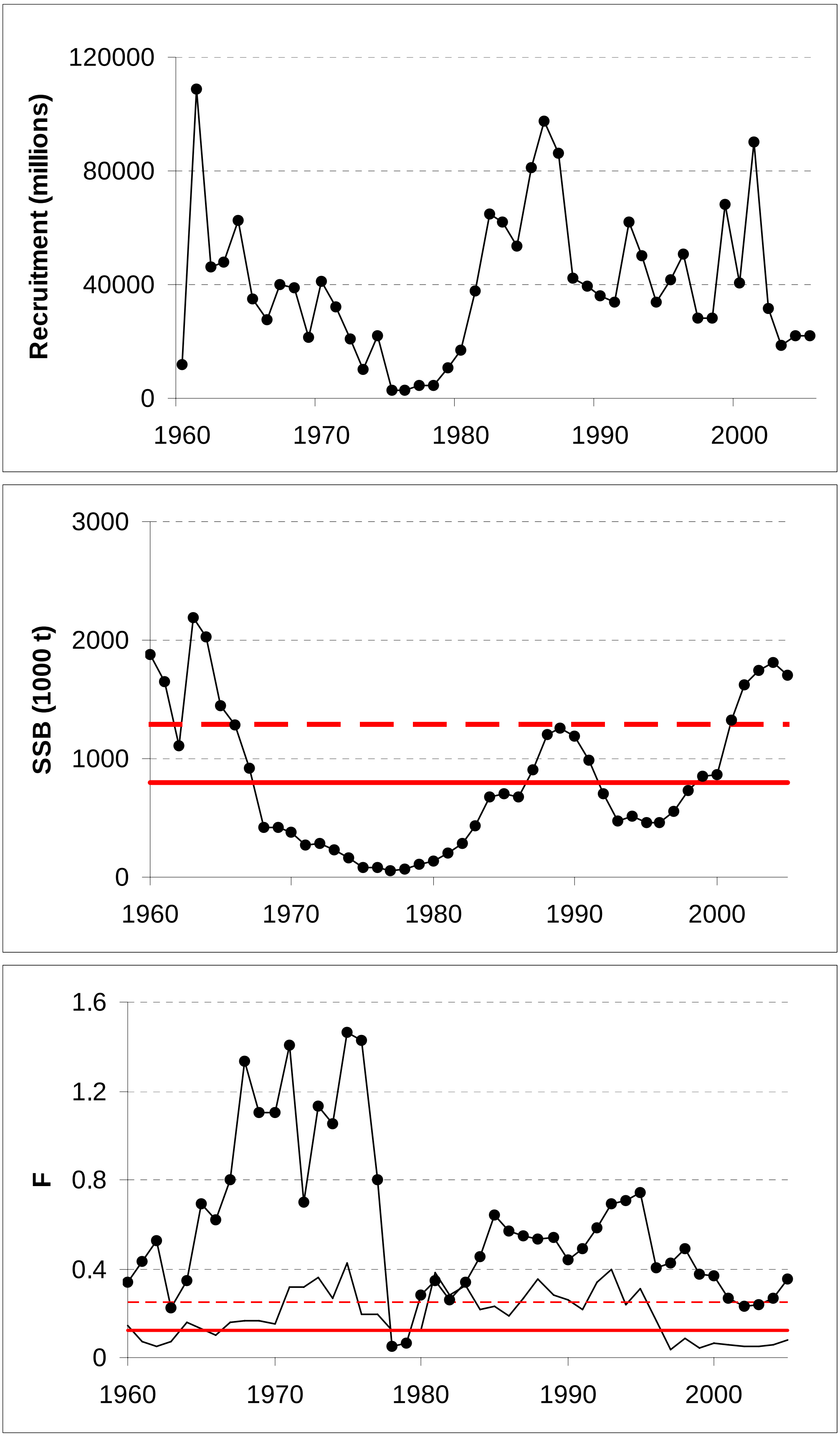


Figure 2.6.12.1. North Sea herring. Stock summary of the FINAL ICA assessment: recruitment, SSB and mean F on ages 2-6 (line with dots) and ages 0-1 (line without dots).

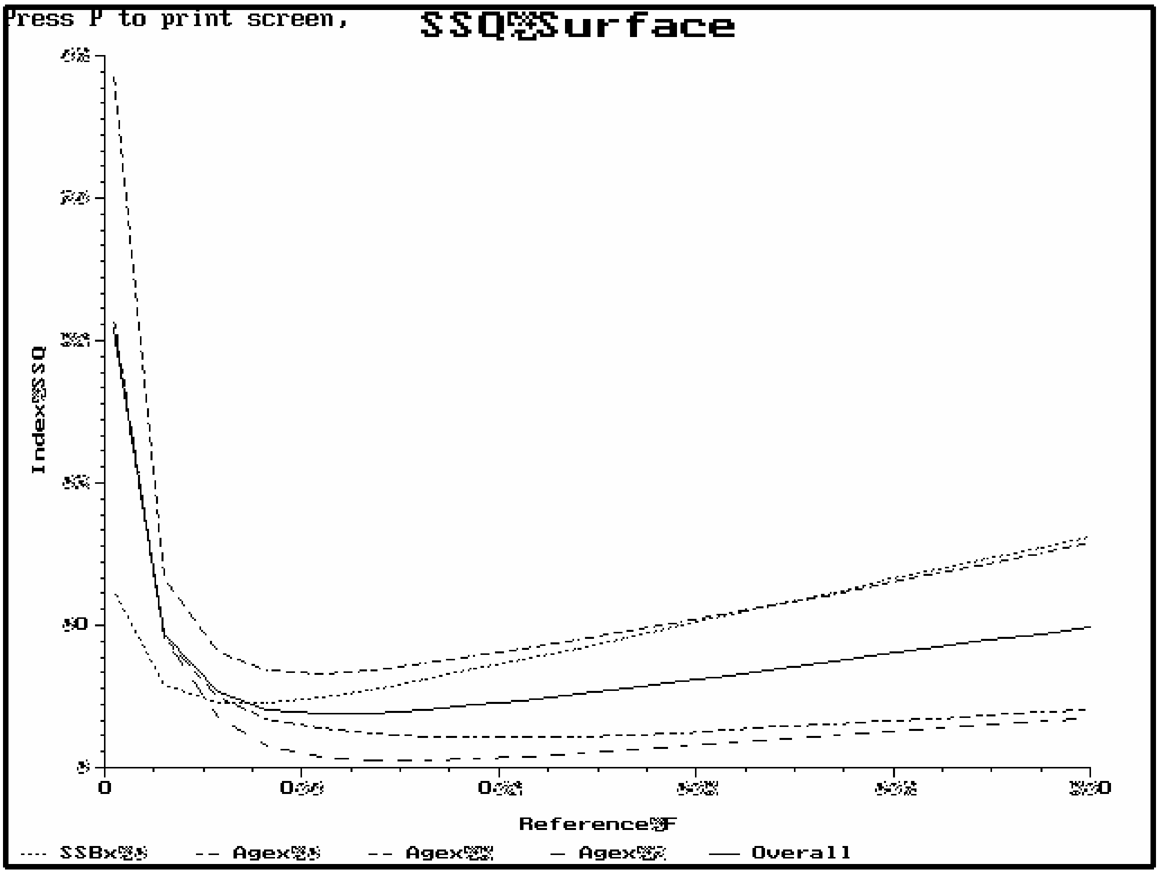


Figure 2.6.12.2. North Sea herring. SSQ surface for the deterministic calculation of the 5-year separable period.

SSBx1 - MLAI larvae survey,

Agex1 - age disaggregated acoustic estimates

Agex2 - age disaggregated IBTS estimates

Agex3 - age disaggregated MIK net estimates

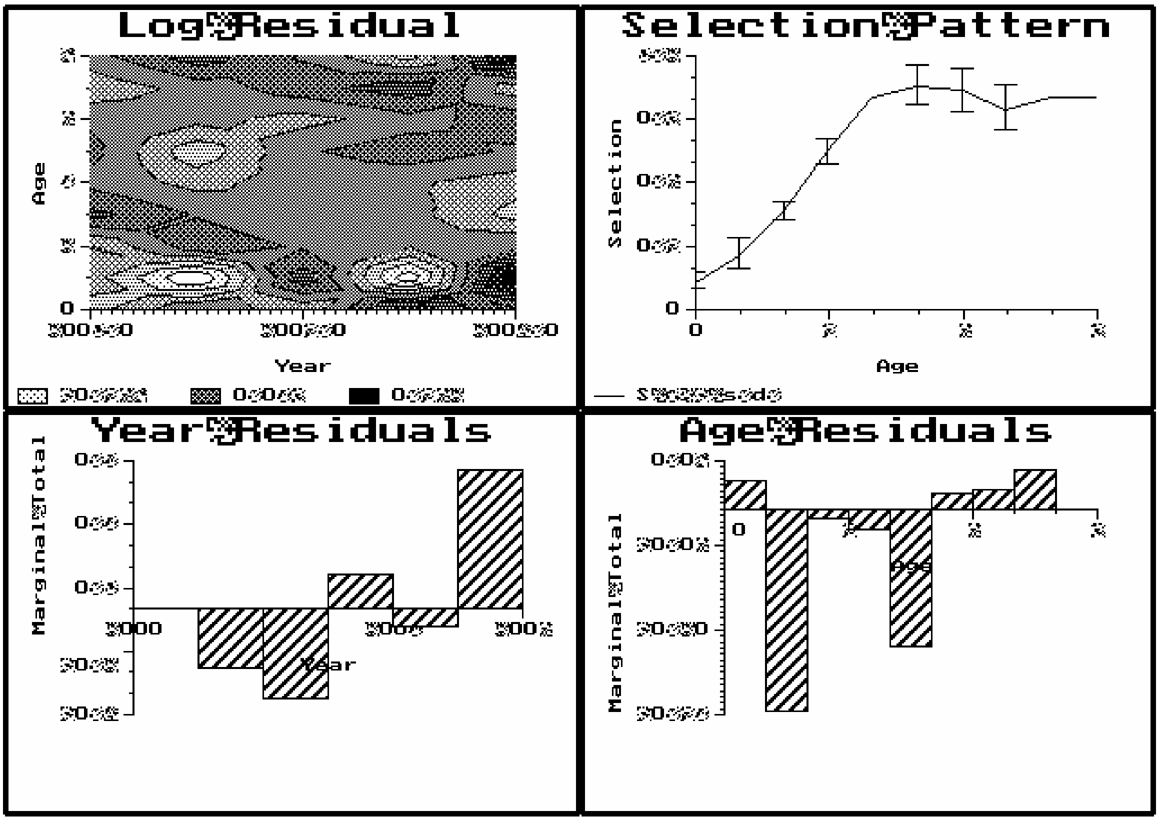


Figure 2.6.12.3. North Sea herring. Illustration of selection patterns diagnostics, from deterministic calculation (5-year separable period). Top left, a contour plot of selection pattern residuals. Top right, estimated selection (relative to 4-ringers) +/- standard deviation. Bottom, marginal totals of residuals by year and ring (with weights applied).

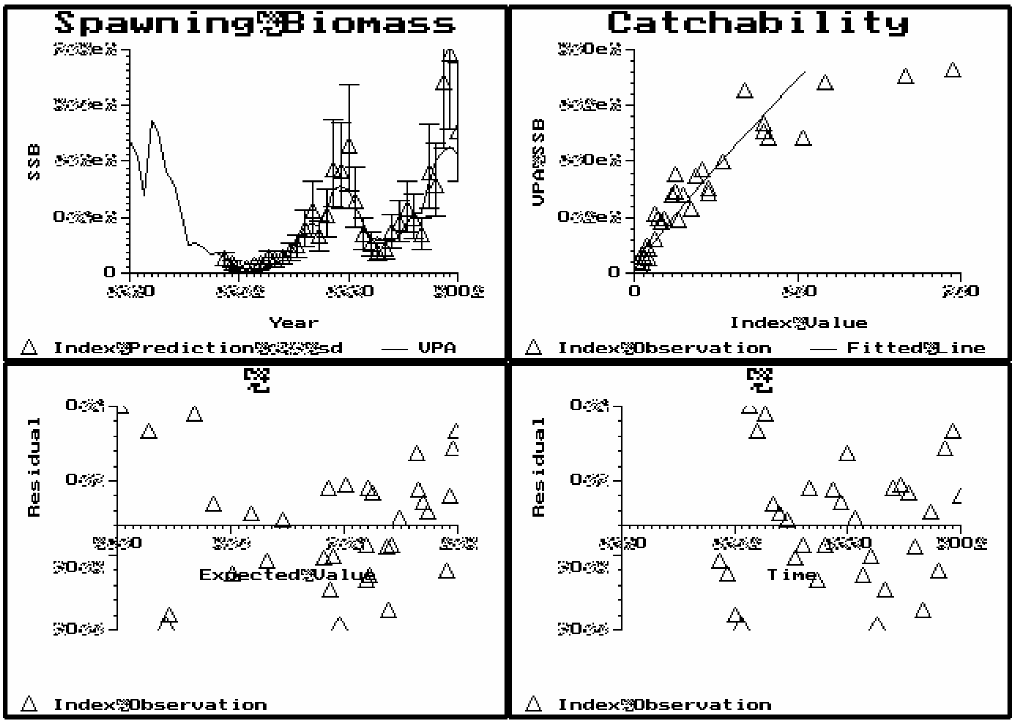


Figure 2.6.12.4. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the predicted SSB against the SSB MLAI survey. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 1-ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

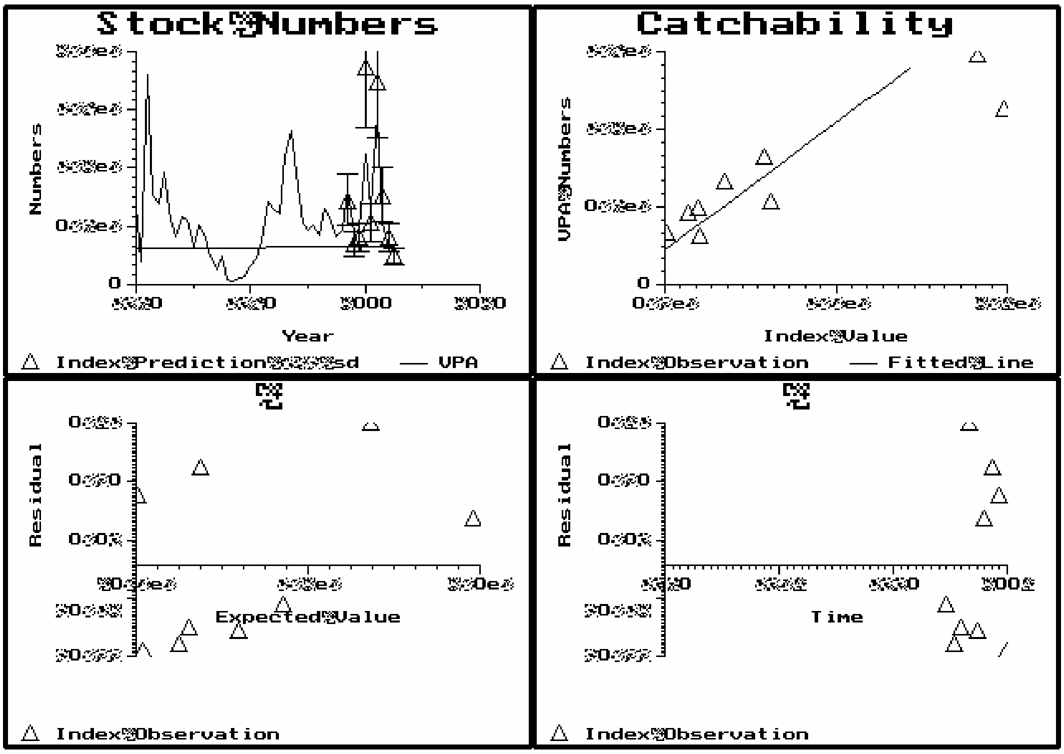


Figure 2.6.12.5. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the 1-ring index against the acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 2-ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

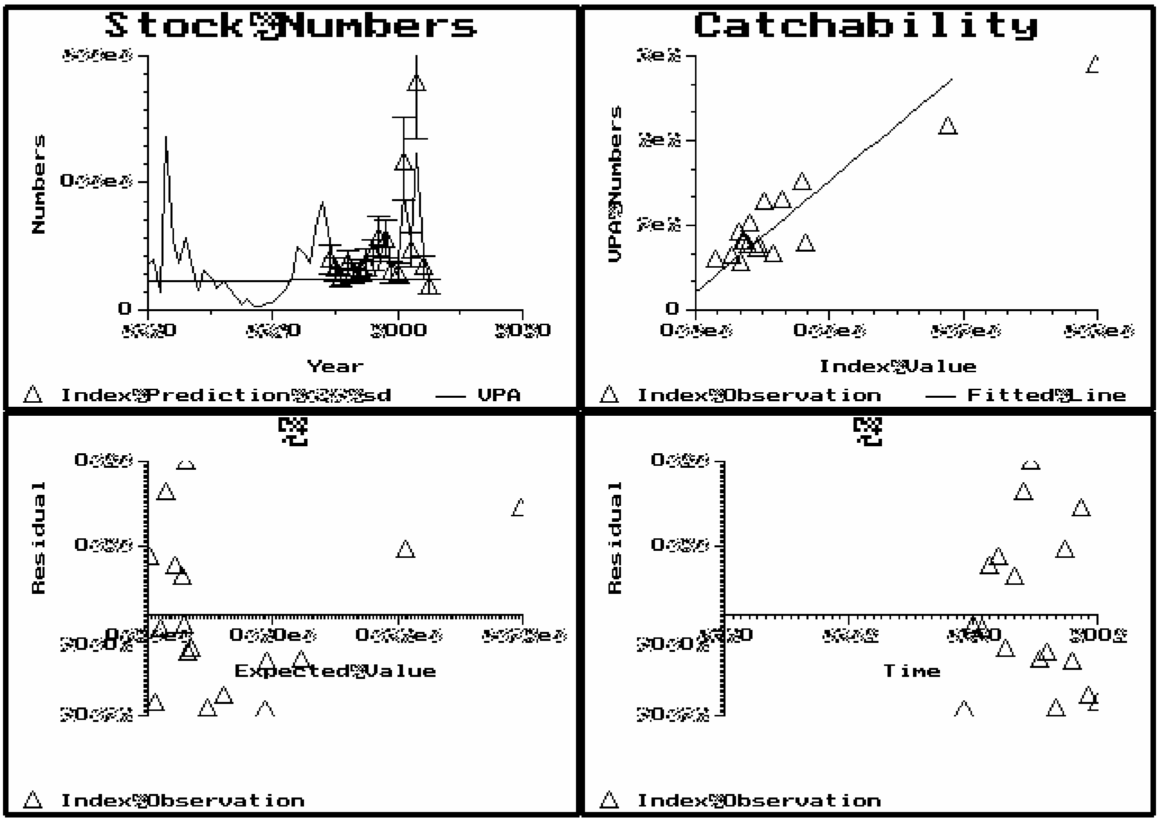


Figure 2.6.12.6. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the 2-ring index against the acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 3-ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

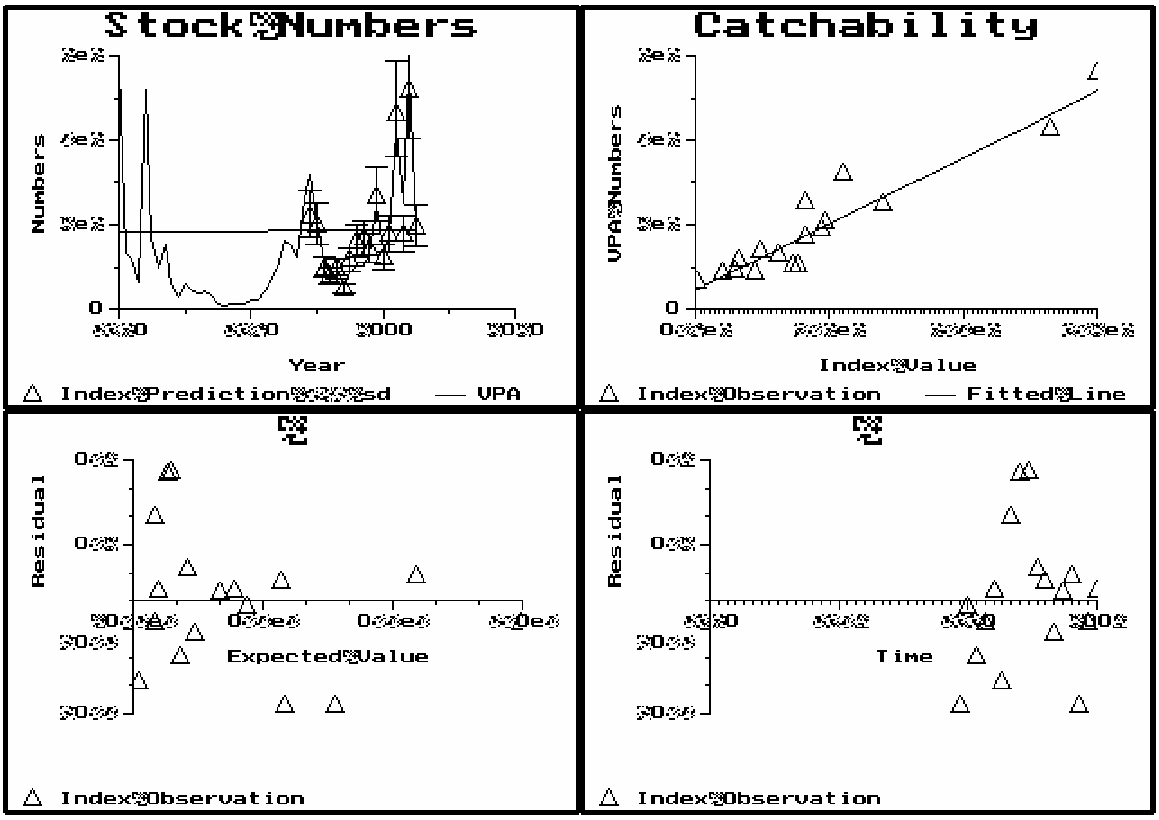


Figure 2.6.12.7. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the 3-ring index against the acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 3-ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

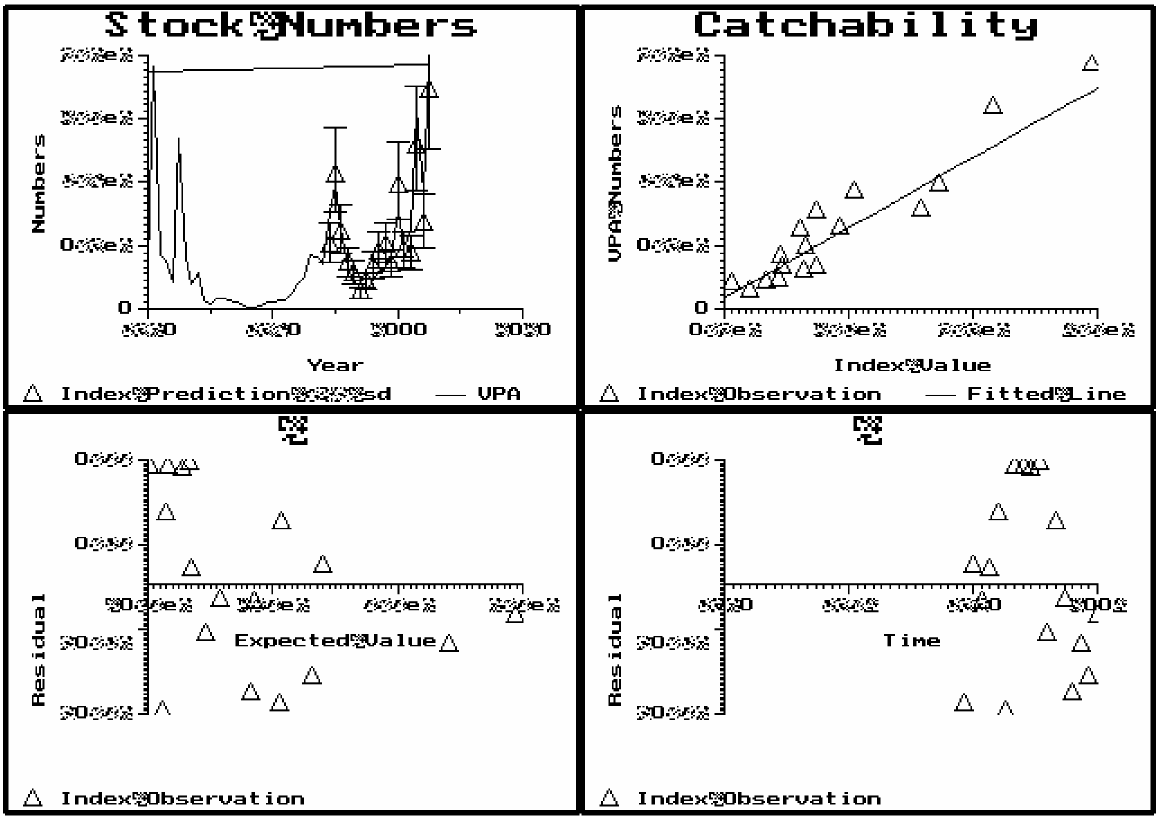


Figure 2.6.12.8. **North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the 4 ring index against the acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 5 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.**

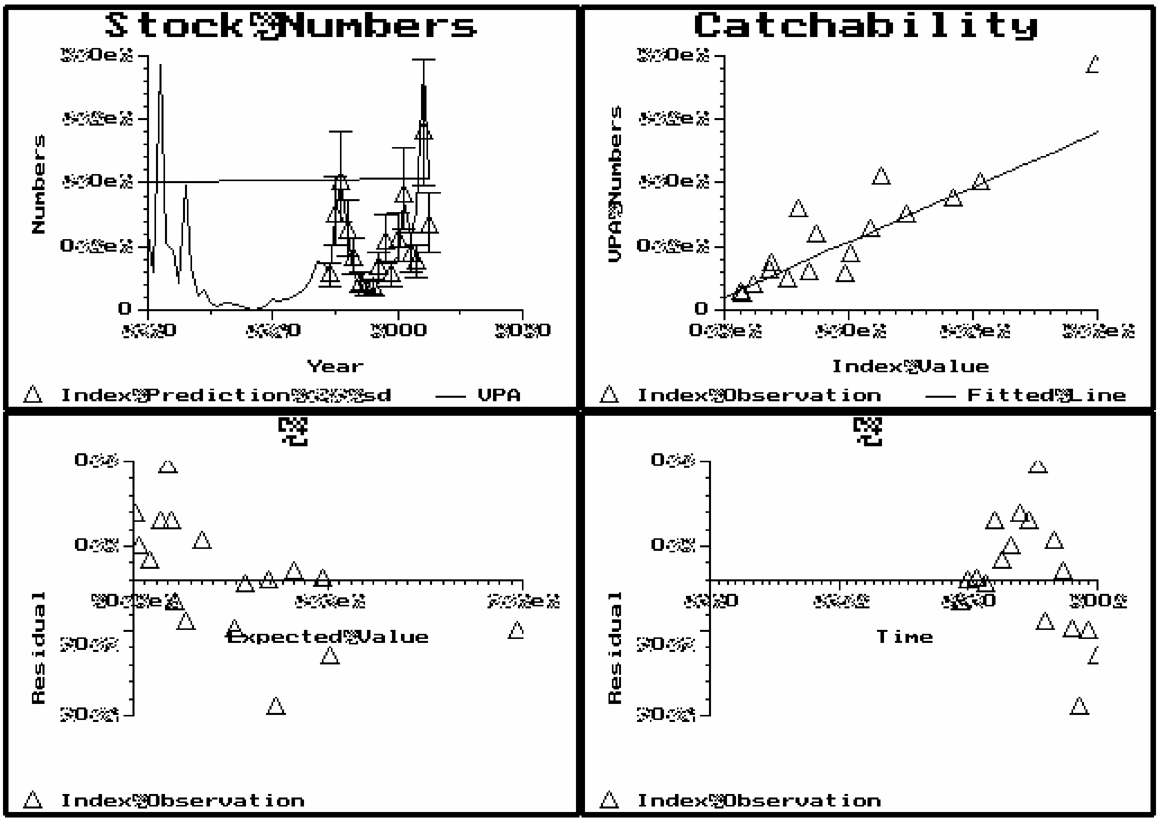


Figure 2.6.12.9. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the 5 ring index against the acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 5 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

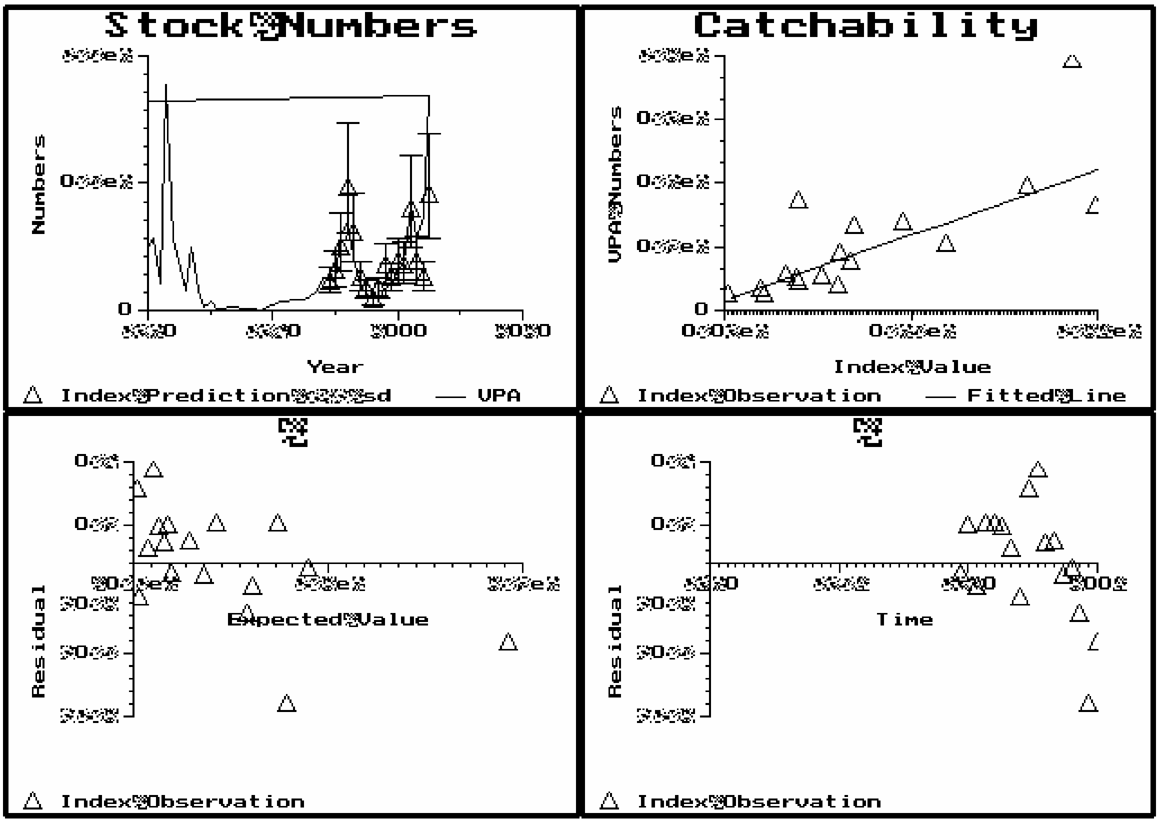


Figure 2.6.12.10. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the 6 ring index against the acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 5 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

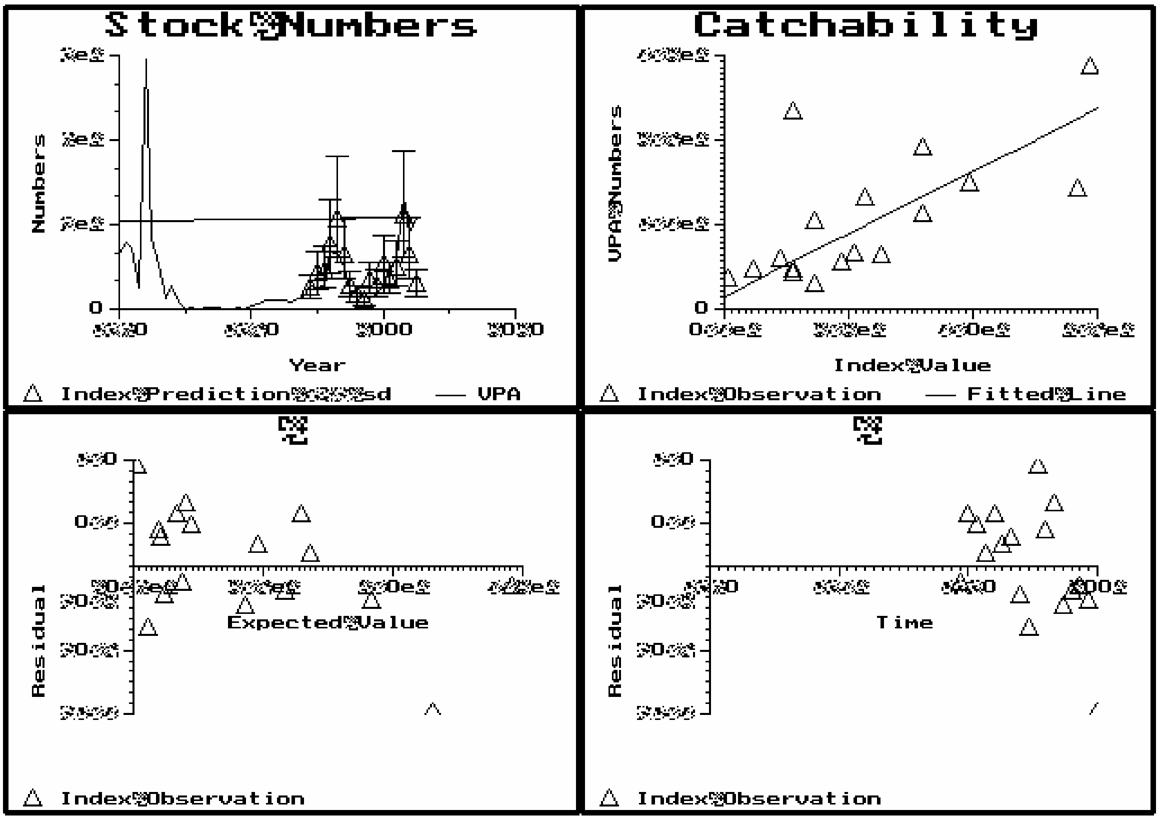


Figure 2.6.12.11. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the 7 ring index against the acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 5 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

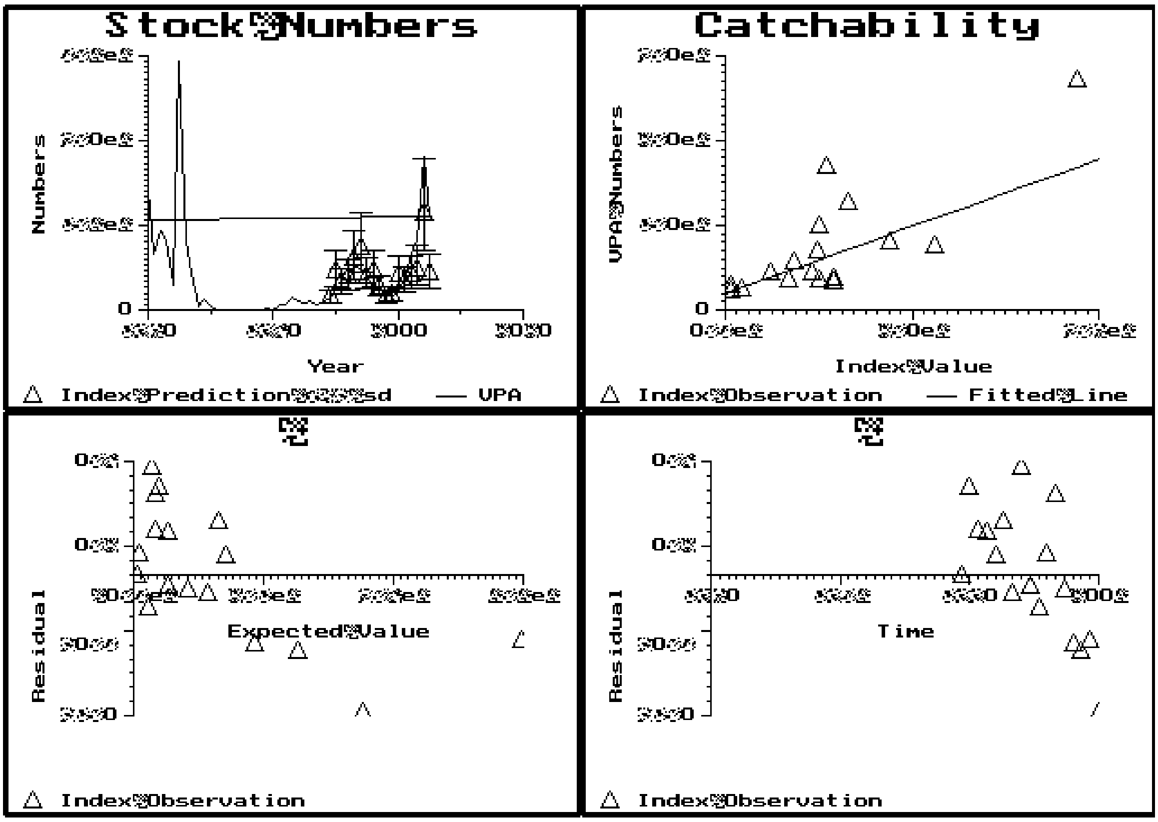


Figure 2.6.12.12. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the 8 ring index against the acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 5 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

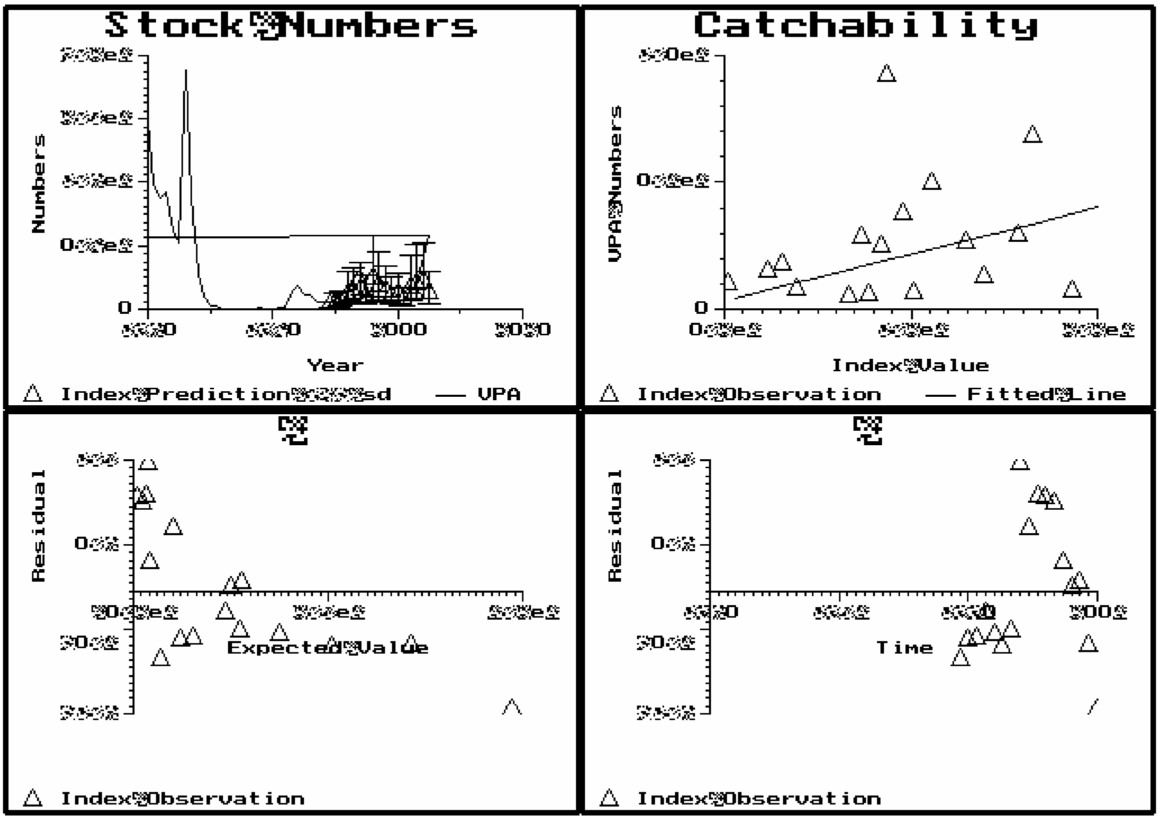


Figure 2.6.12.13. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the 9 ring index against the acoustic surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 5 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

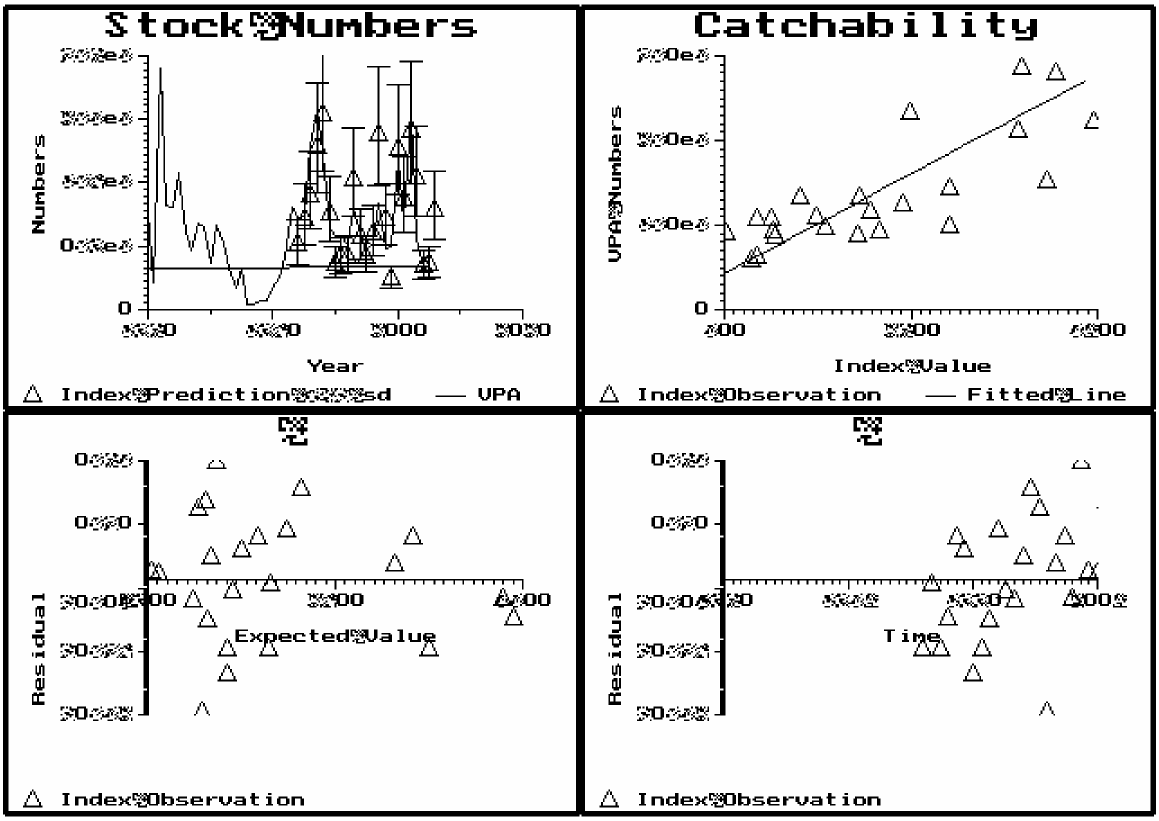


Figure 2.6.12.14. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the 1 ring index against the IBTS survey. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 9 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

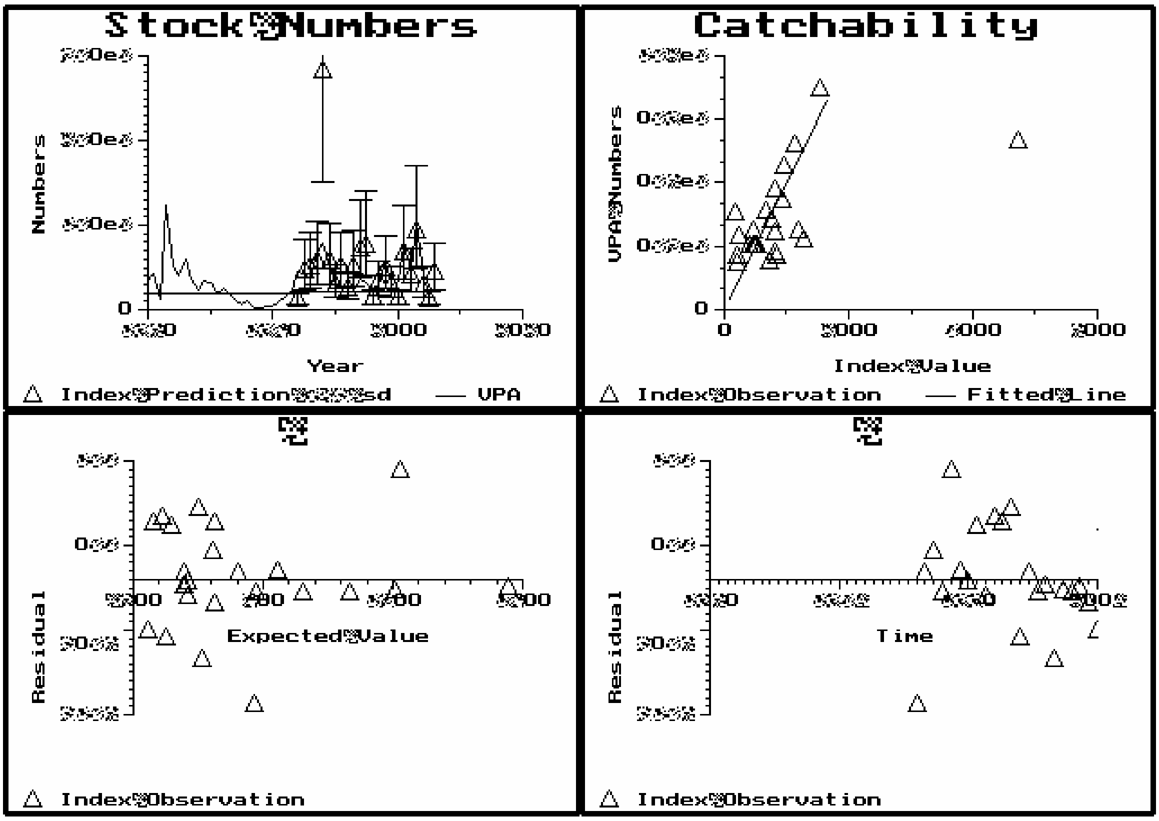


Figure 2.6.12.15. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the 2 ring index against the IBTS survey. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 9 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

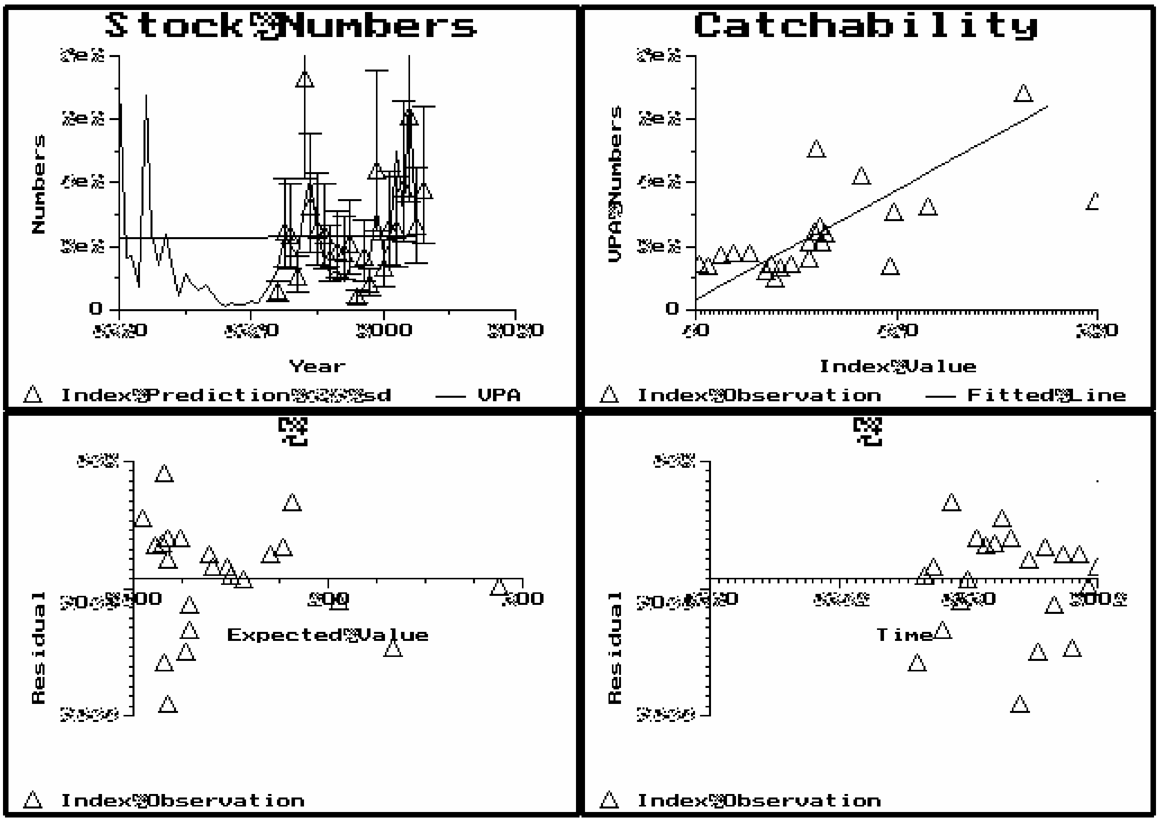


Figure 2.6.12.16. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the 3 ring index against the IBTS survey. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 9 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

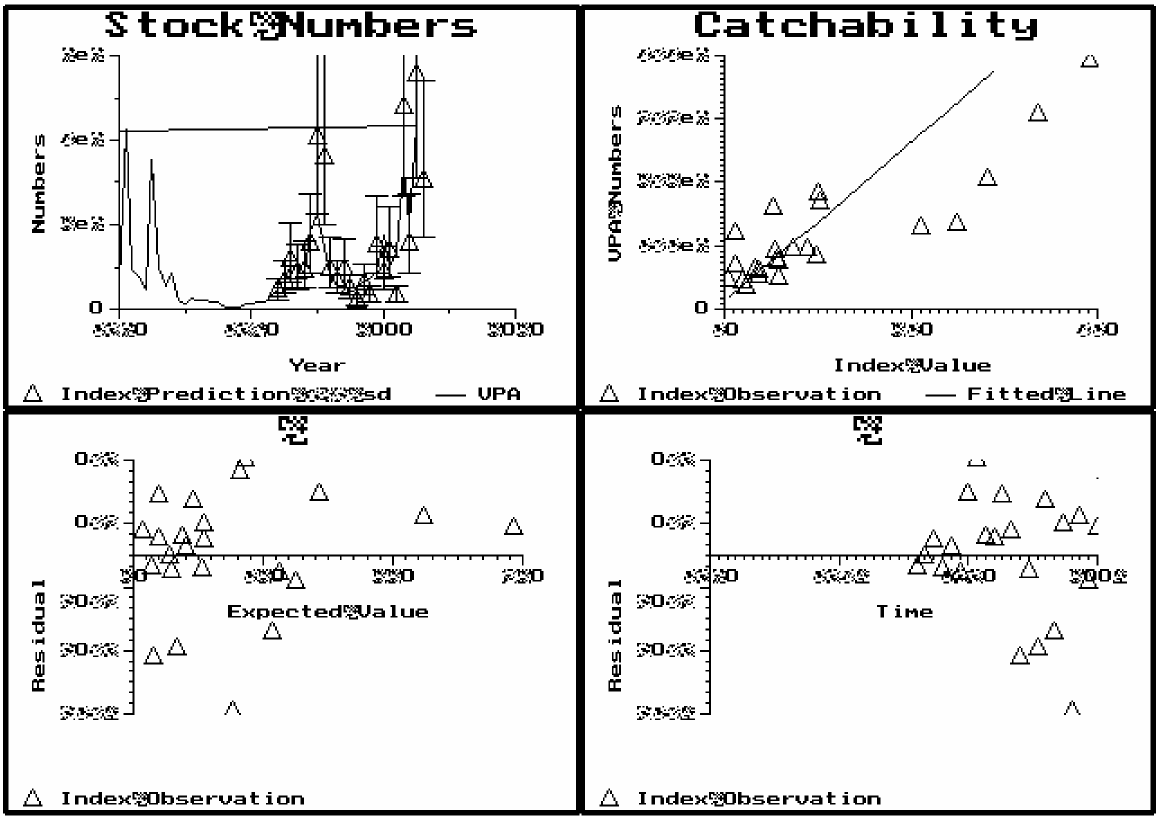


Figure 2.6.12.17. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the 4 ring index against the IBTS survey. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 9 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

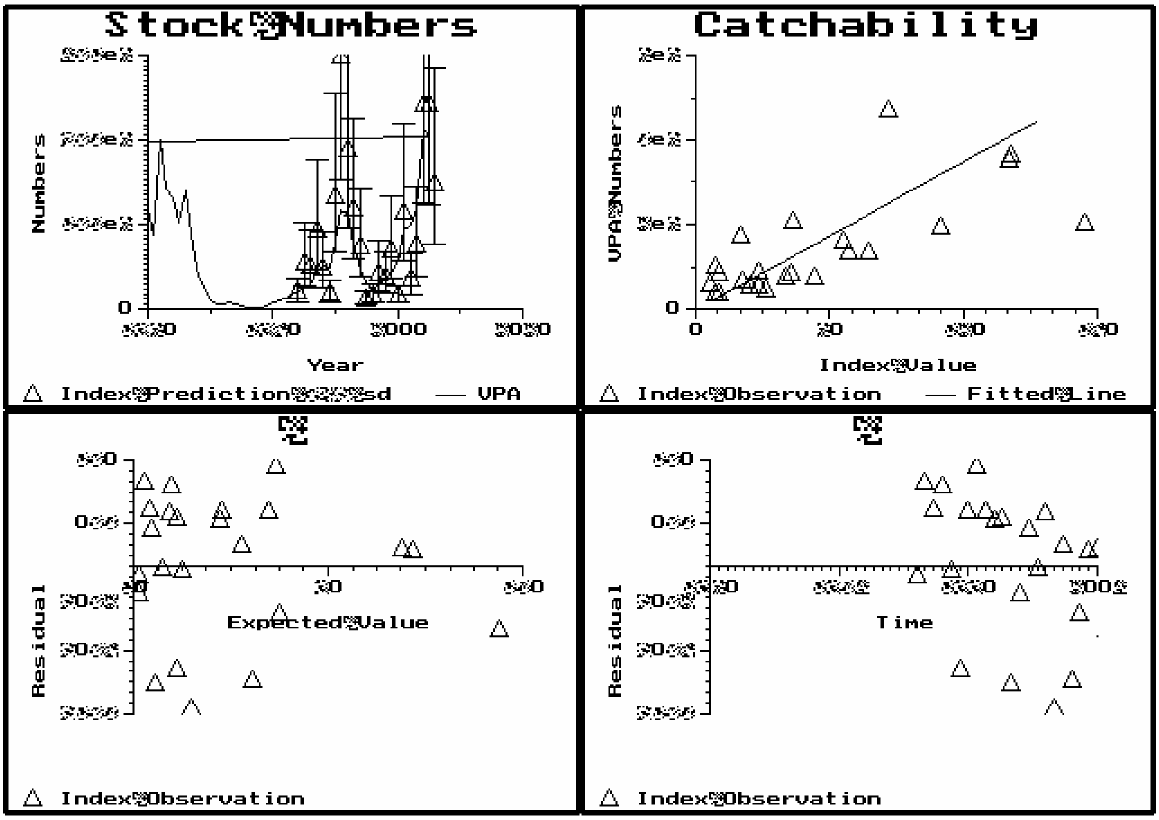


Figure 2.6.12.18. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the 5 ring index against the IBTS survey 1984-1994. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 9 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

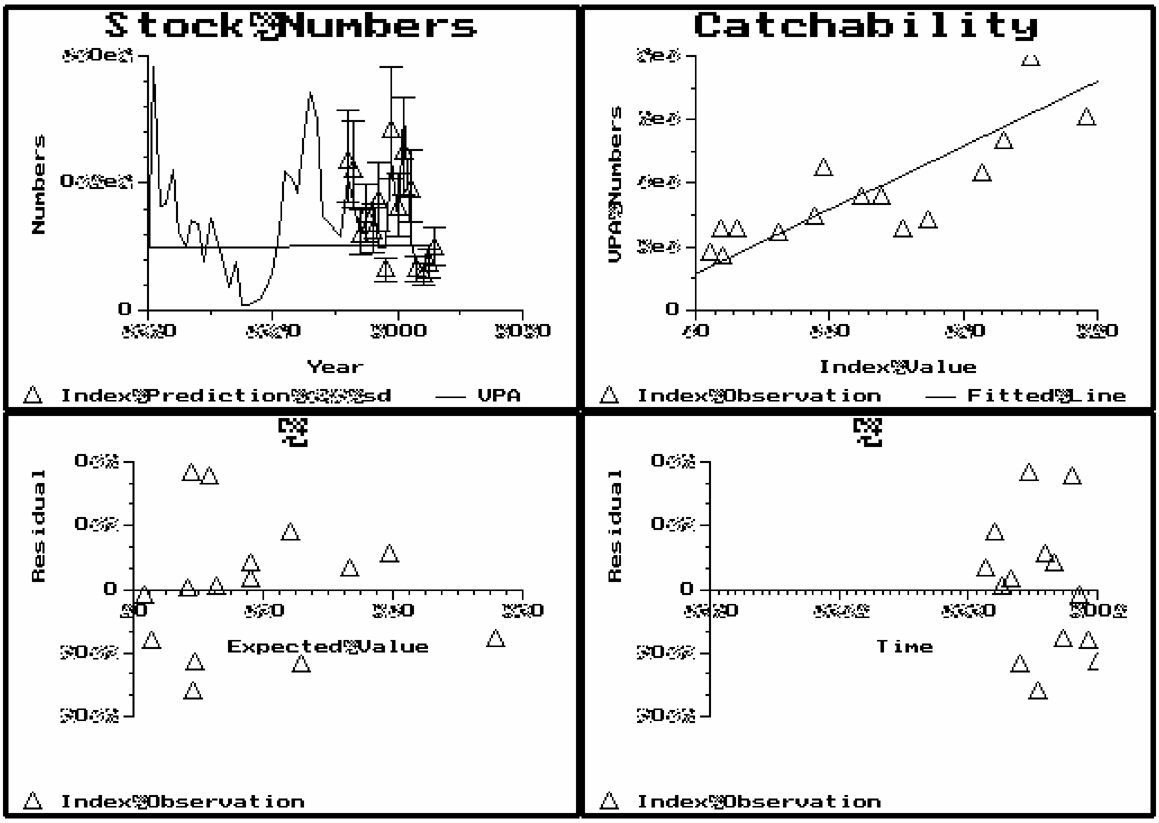
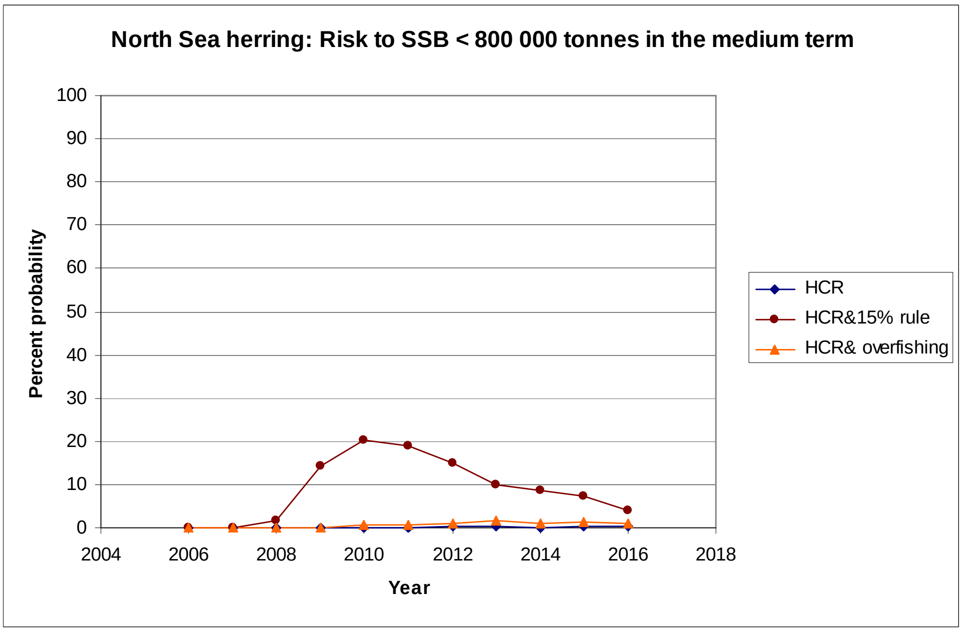


Figure 2.6.12.19. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the 0 ring index against the MIK surveys. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 9 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.



Figure

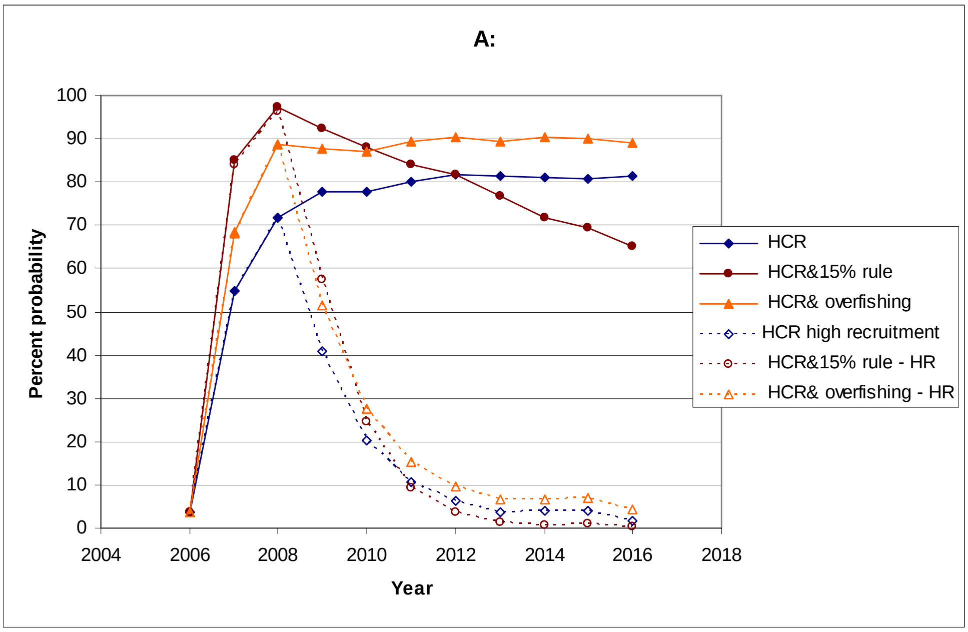
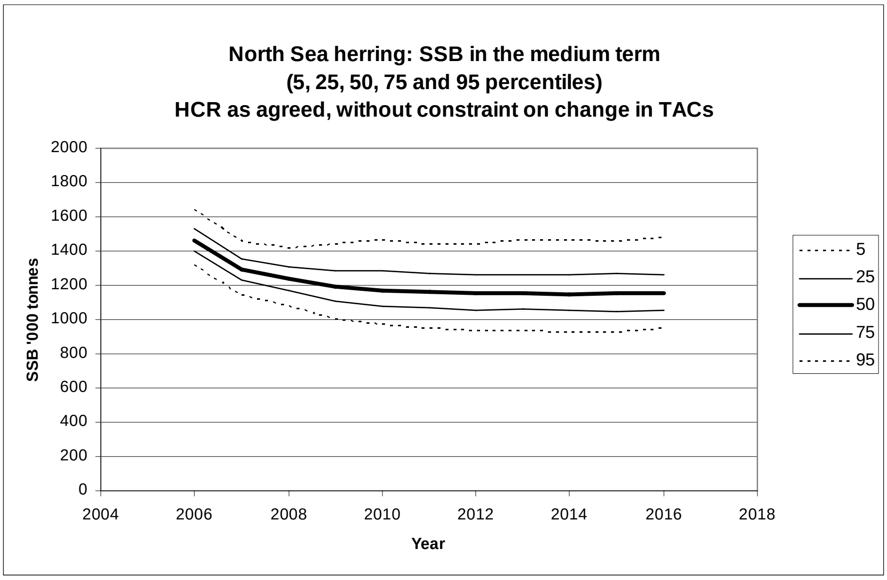
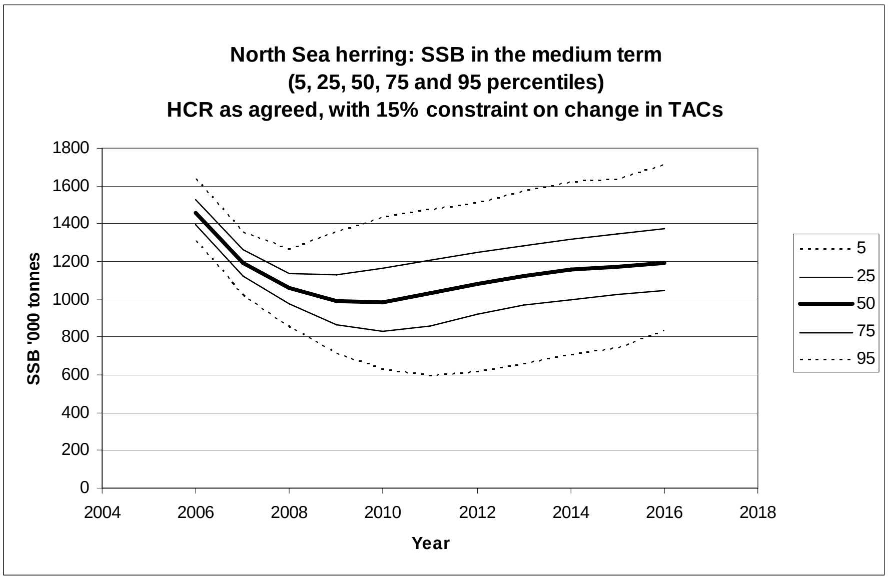


Figure 2.8.1. A) Probability of SSB below Bpa (1300000 t) and B) Probablity of SSB below Blim (800,000 t). The probability is expressed as the percentage probability by year. The three scenarios with low recruitment detailed in section 2.8 are evaluated: Current simple HCR excluding the 15% rule, the HCR including the 15% rule, the HCR with 15% overfishing. In A) a scenario with historic recruitment is included for comparison.





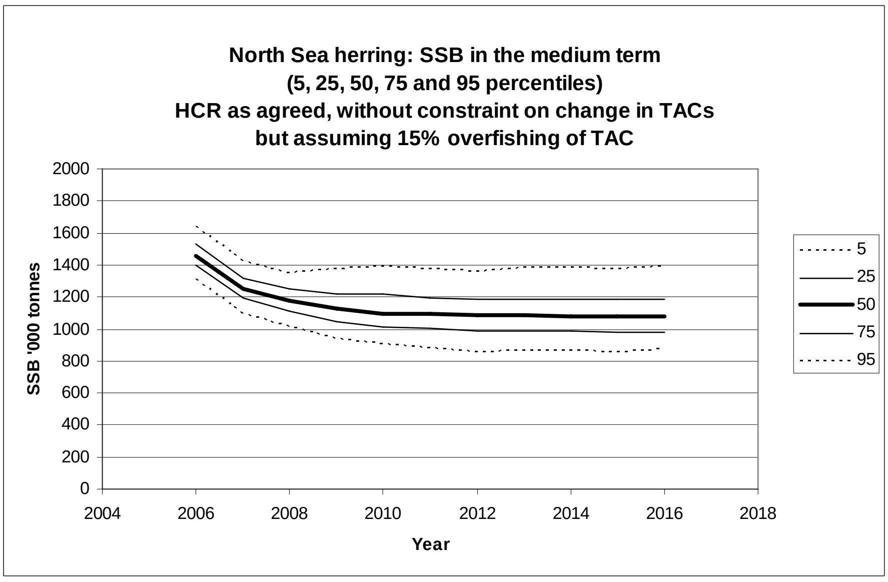
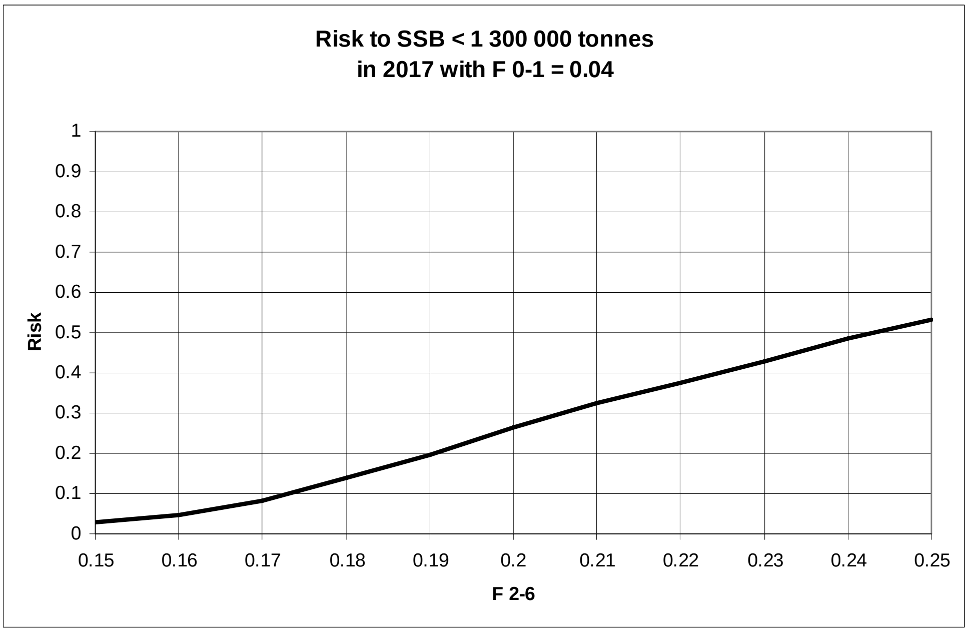


Figure 2.8.2 Spawning Stock Biomass (SSB) median, quartiles, upper and lower intervals for three scenarios. (See section 2.8)



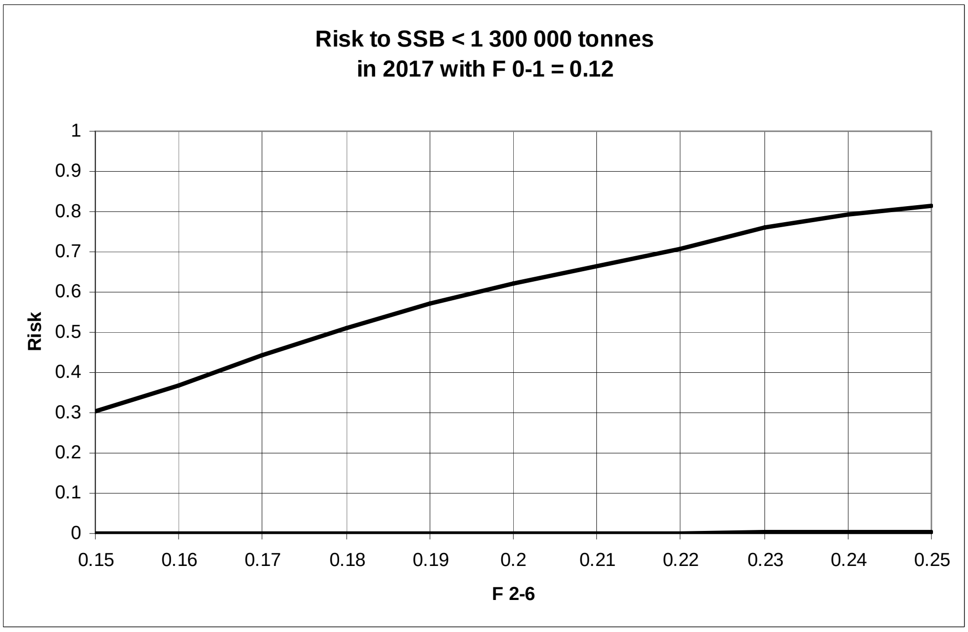


Figure 2.8.3 Risk of SSB being below Bpa in 2017 with recent recruitment for different exploitation rates (F2-6) of the adult fisheries for two levels of juvenile fishery (F0-1) A) at 0.4 and B) at 0.12.

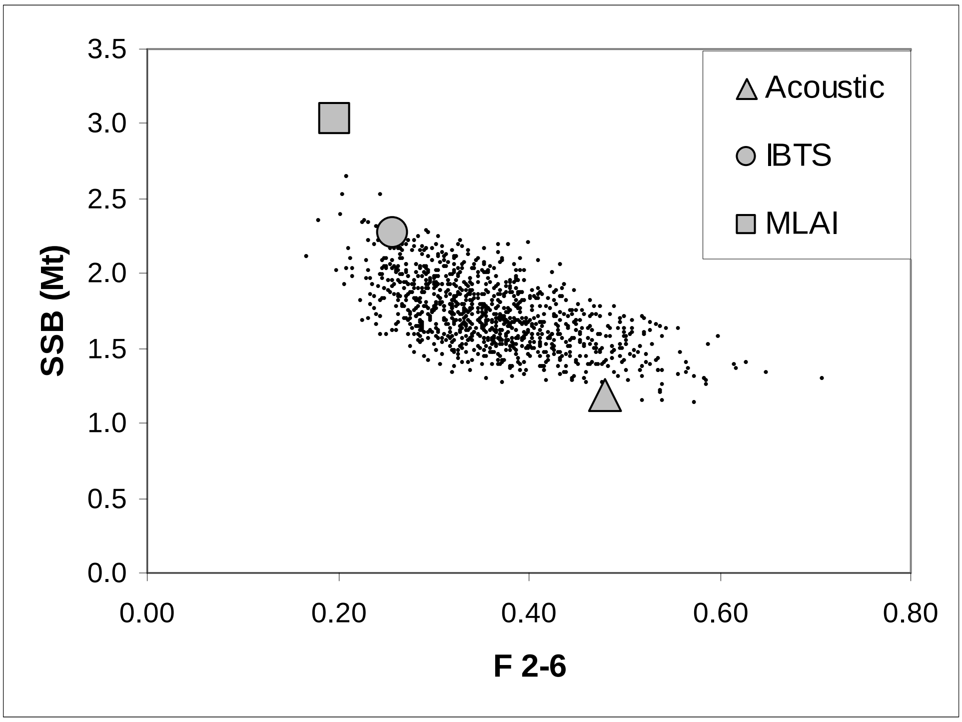


Figure 2.10.1 Uncertainty in the assessment in the terminal year; SSB verses F2-6 from bootstrap of parameter residuals based on variance covariance method in ICA (small points). For comparison the terminal F and SSB values if the three main tuning indices are used alone. Acoustic (triangle) IBTS (circle) MLAI(square).

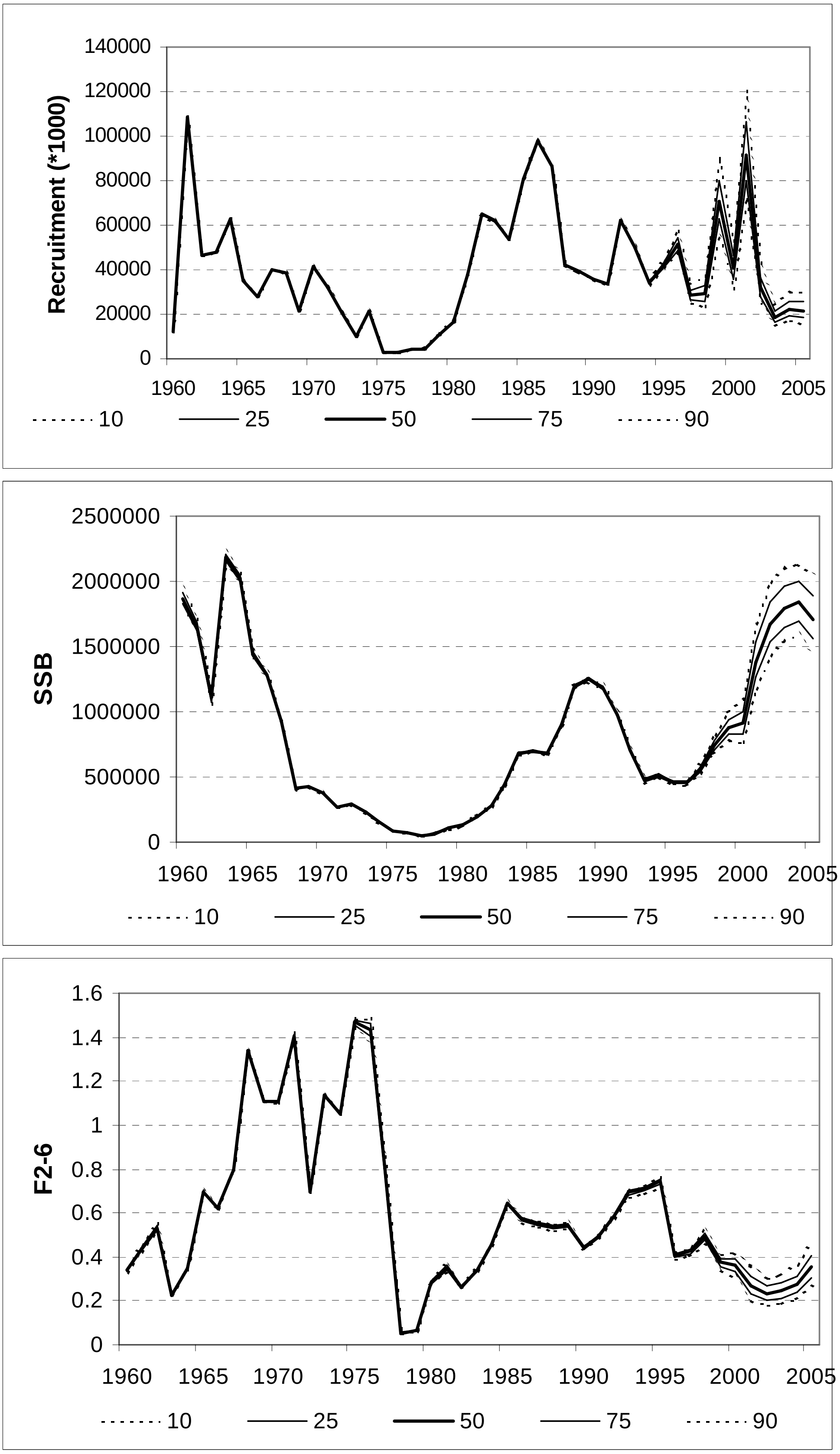


Figure 2.10.2 Historic uncertainty at 10, 25, 50, 75, 90 percentiles estimated by bootstrap of parameter residuals based on variance covariance method in ICA.

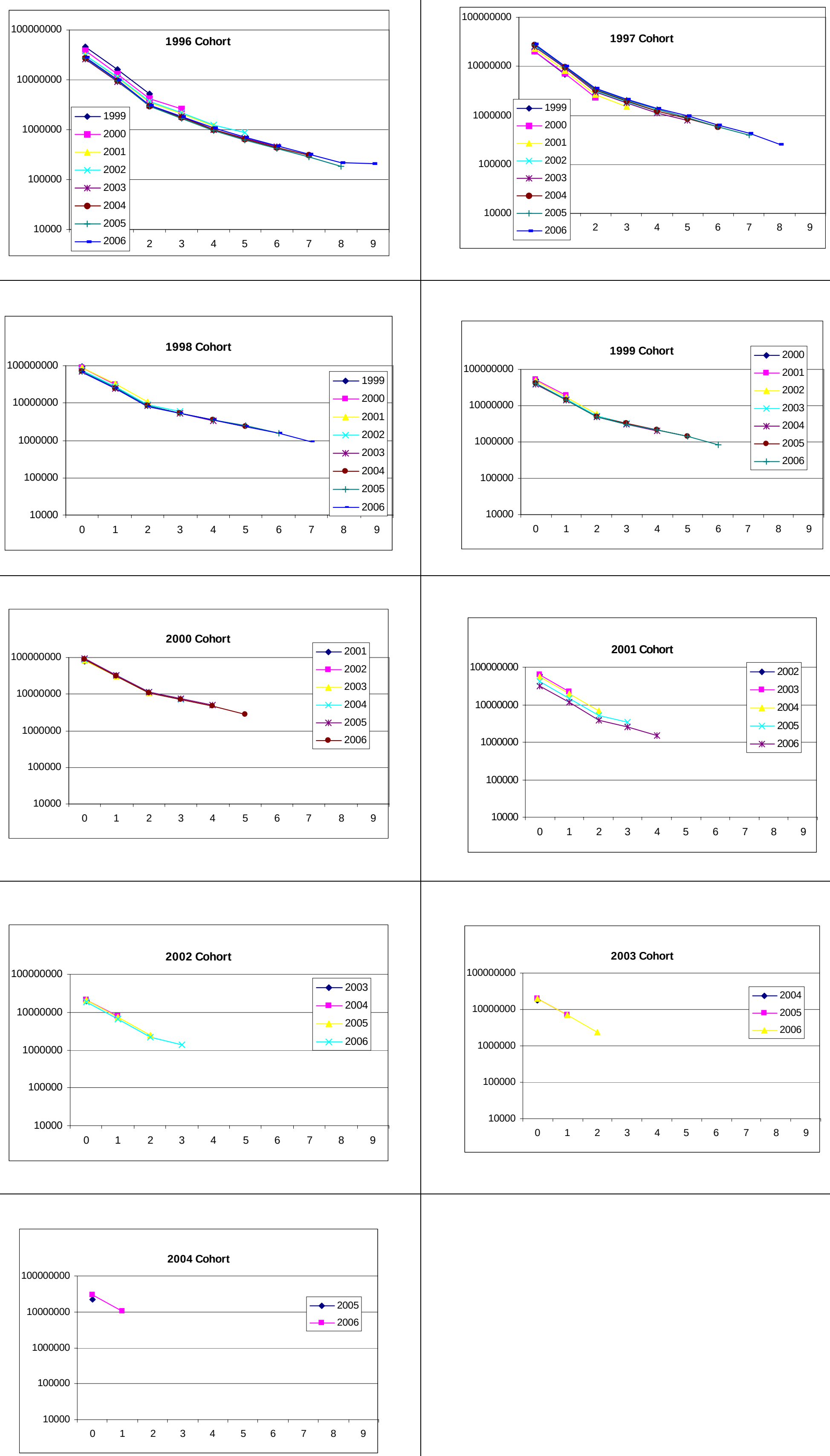


Figure 2.10.3 Cohort historic retrospectives for yearclasses from 1994 to 2004.

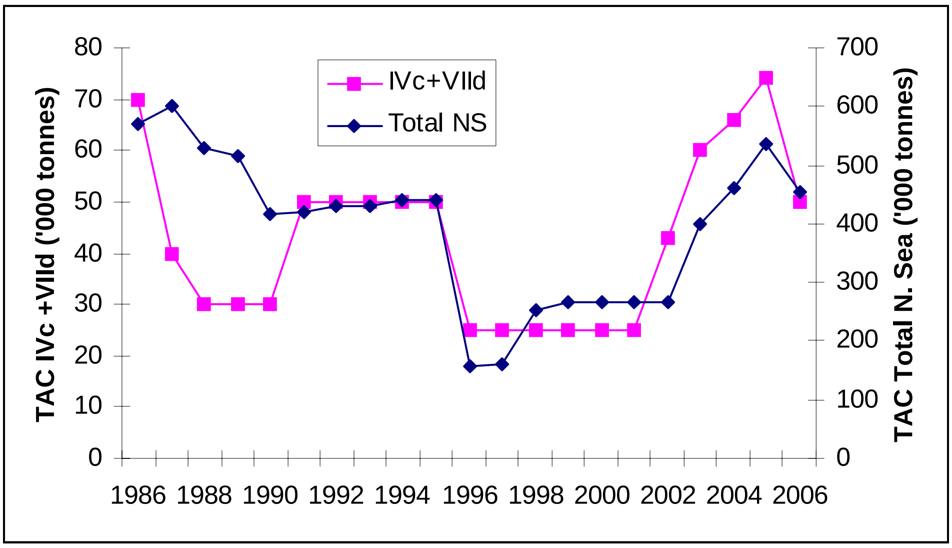


Figure 2.11.1. North Sea herring. Comparison of TACs for total North Sea and IVc and VIId.

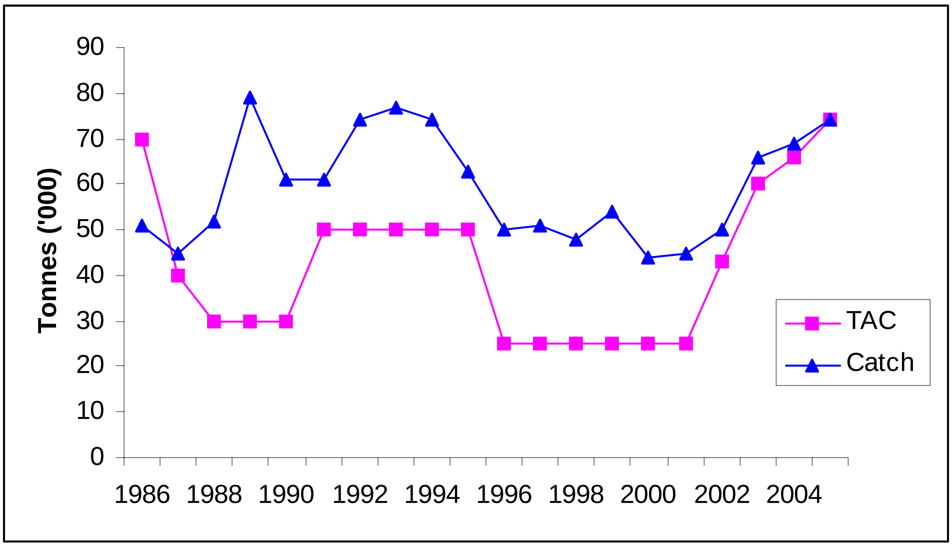


Figure 2.11.2. Herring in IVc and VIId. Comparison of historical catches and TACs.

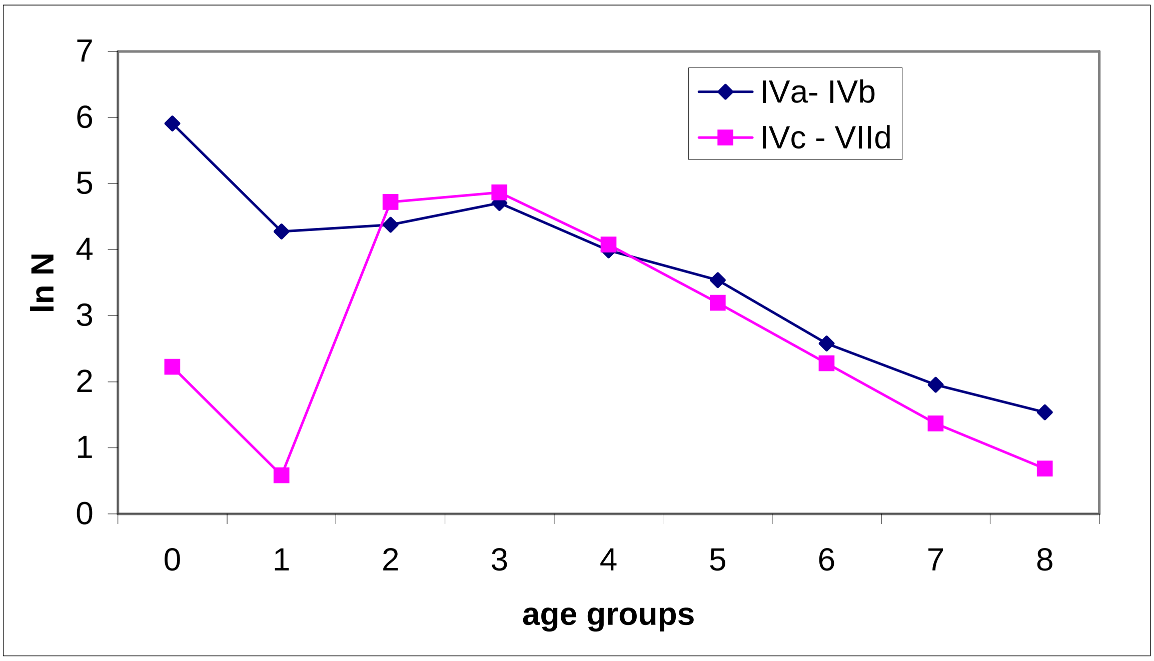


Figure 2.11.3 North Sea herring. Comparison between the population profiles from the log catch numbers at age data (4th quarter, 1996 – 2004) for divisions IVa - IVb and IVc – VIId.

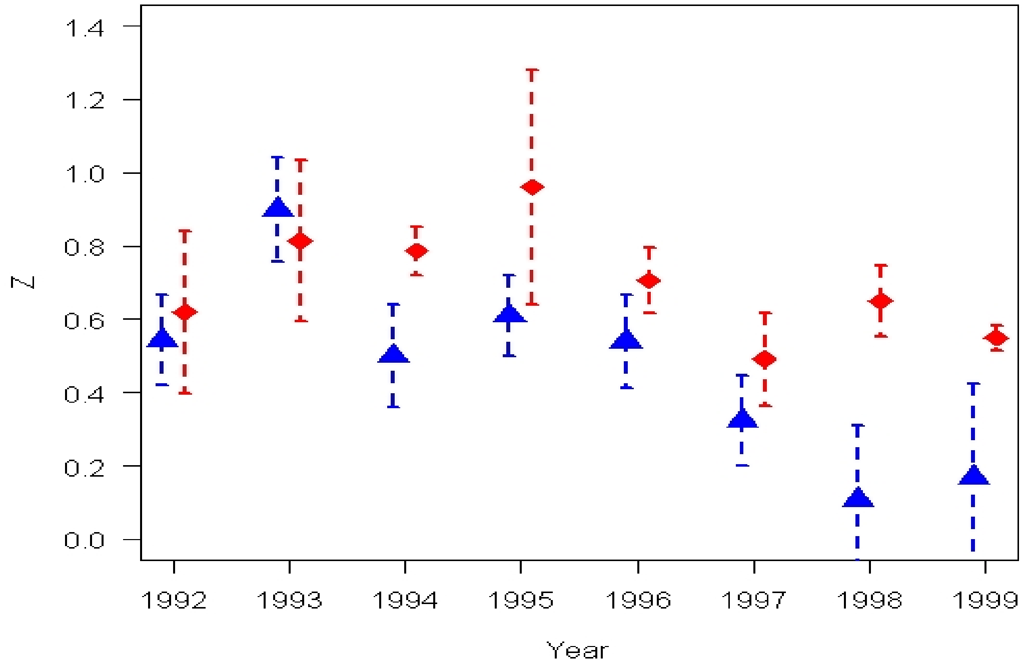


Figure 2.11.4. North Sea herring. Estimated total mortality (Z on the y-axis) for year-classes 1992 to 1999 from the slope of the log-catch numbers for ages 3 to 8 in the 4th quarter. Comparison between the northern (IVa – IVb, triangles) and southern North Sea (IVc – VIId, diamonds). The dash lines correspond to one standard error.

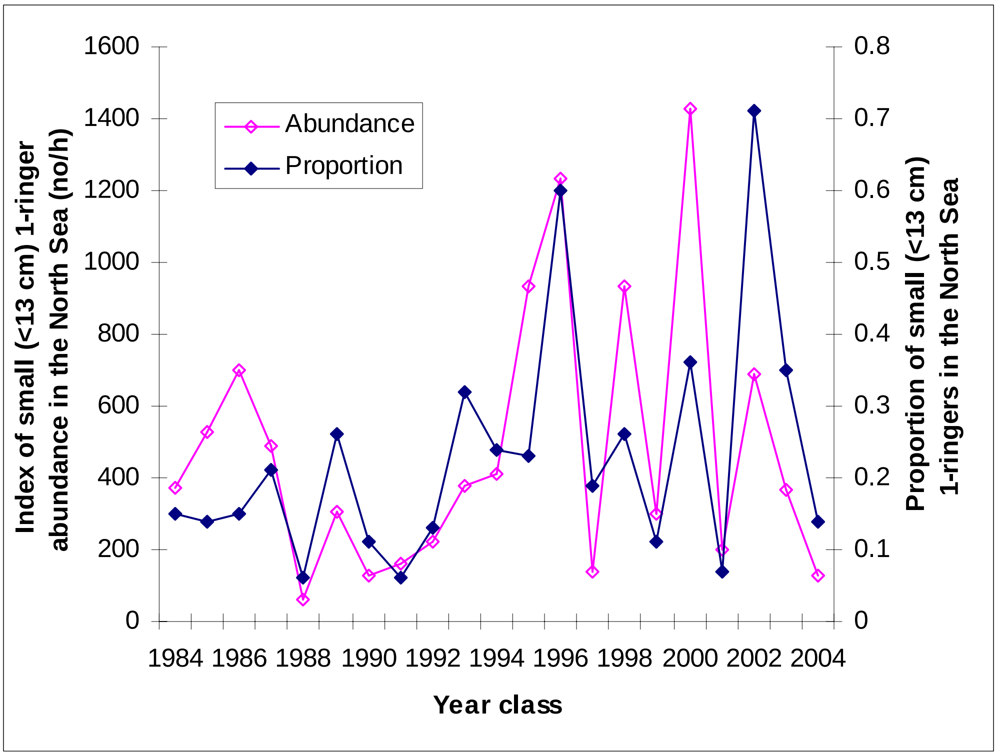


Figure 2.11.5. Downs herring. Index (nos per hr) of small (<13 cm) 1-ringers in the North Sea and proportion of small 1-ringers versus all sizes in the North Sea (from Table 2.3.3.3)

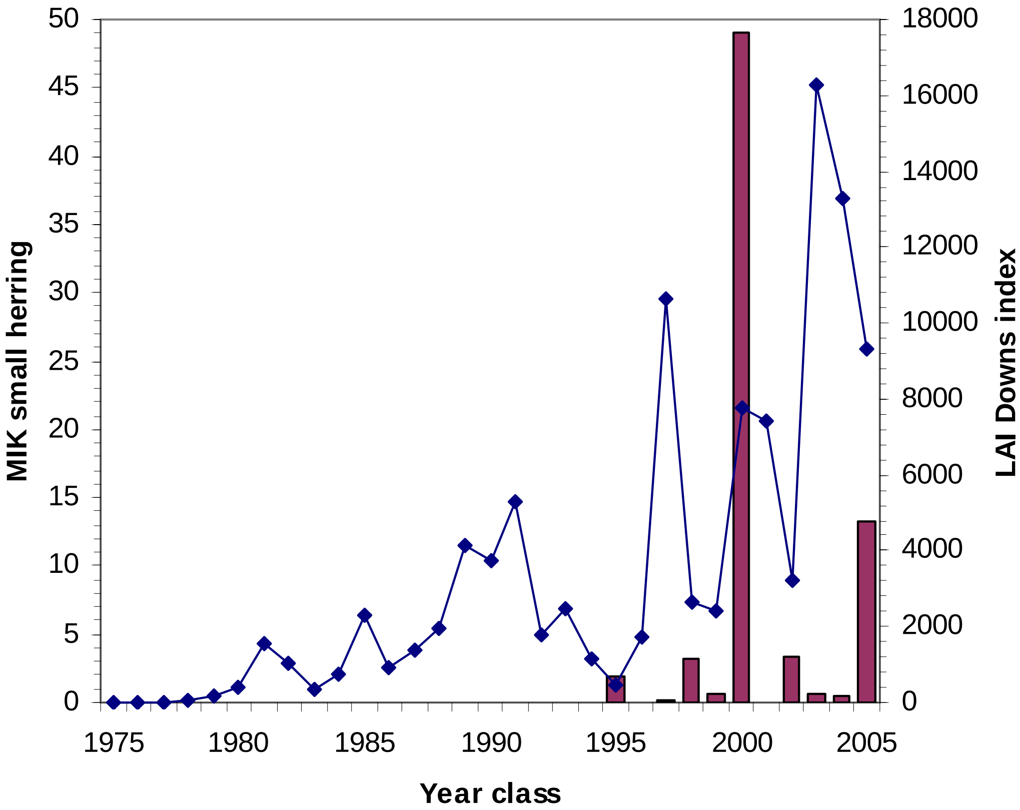


Figure 2.11.6. Downs herring. Larval Abundance Index (LAI) in the Channel area (line), calculated as the sum of surveys per year class 1975-2005, and preliminary MIK survey results in the Channel (bars) (early spring 1995-2005) (there were no data available in 1996 and 2001 and the estimate for 2005 should be treated with extreme caution because it is driven by a single large catch).

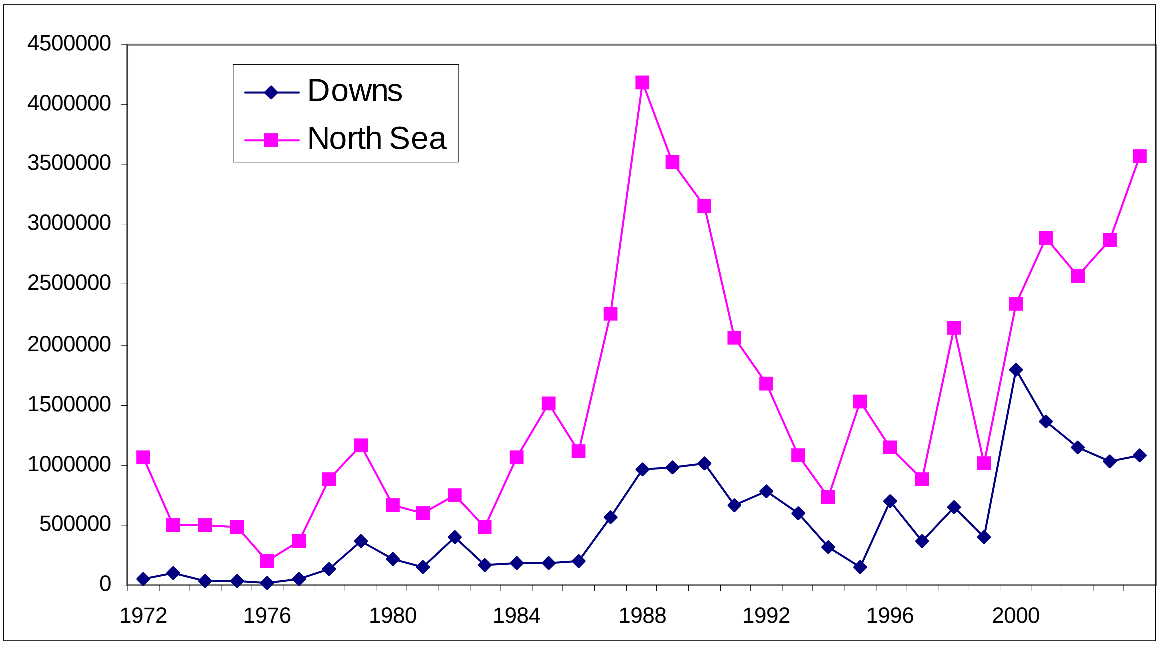


Figure 2.11.7 North Sea herring. North Sea and Downs component SSBs estimated from larval production.

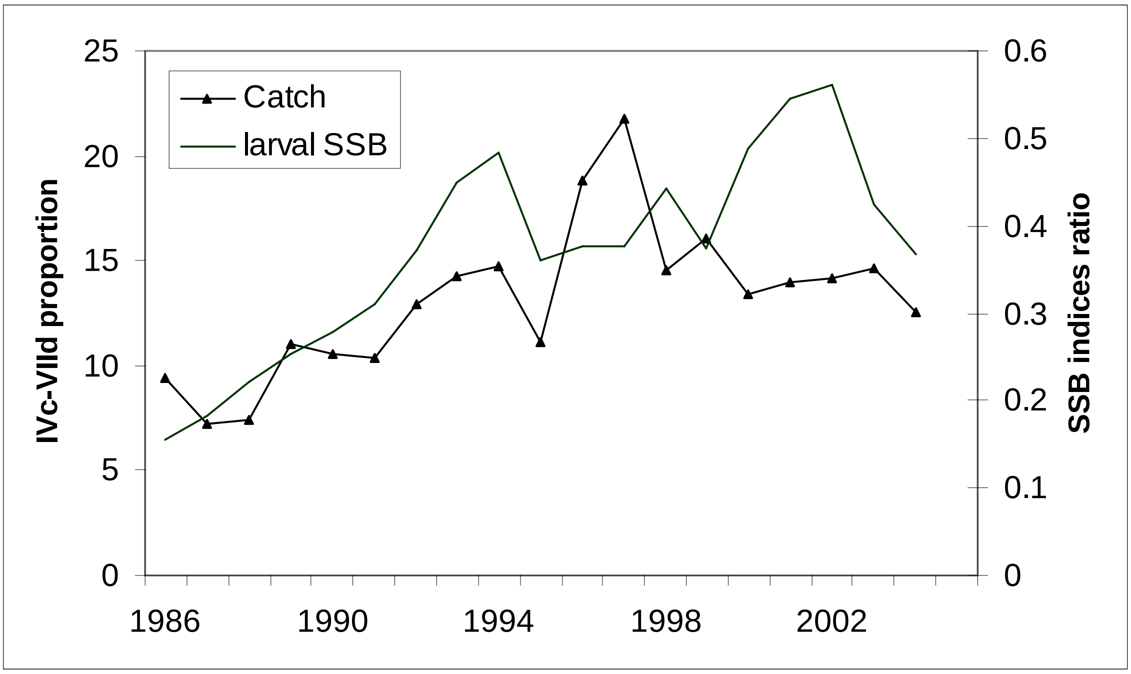


Figure 2.11.8. North Sea herring. Downs to entire North Sea catch proportion (as a percentage, left y-axis) and IVc – VIId to whole of North Sea larval SSBs ratios smoothed by taking a 3-year running average.

3 Herring in Division IIIa and Subdivisions 22–24 [update assessment]

3.1 The Fishery

3.1.1 ACFM advice and management applicable to 2005 and 2006

At the ACFM (May) meeting in 2005, it was stated that the status of the stock is unknown relative to safe biological limits, because reference points have not been determined. Although the assessment is uncertain SSB has been stable over a number of years. Fishing mortality estimates for 2004 are 0.36 for adults and 0.11 for the juveniles (0- and 1-ringers).

ACFM recommended that since the current fishing mortality has lead to a stable or increased SSB, the fishing mortality should not be allowed to increase. This would correspond to catches in 2006 less than 95 000 t. According to the recent geographic distribution of catches, approximately half of the total catches should be taken from Subdivisions 22-24.

In 2005 the EU and Norway agreement on herring TACs were 96 000 t in Division IIIa for the human consumption fleet and a by-catch ceiling of 24 150 t to be taken in the small mesh fishery.

The EU and Norway agreement on a herring TACs set for 2006 was 81 600 t in Division IIIa for the human consumption fleet and a by-catch ceiling of 20 528 t to be taken in the small mesh fishery.

In previous years the International Baltic Sea Fishery Commission (IBSFC) set no special TAC for Subdivisions 22-24. In 2006, a TAC was set for the first time on the Western Baltic area the stock component. The TAC for 2006 was set at 47 500 t.

3.1.2 Catches in 2005

Herring caught in Division IIIa are a mixture of North Sea Autumn Spawners (NSAS) and Western Baltic Spring Spawners (WBSS). This Section gives the landings of both NSAS and WBSS, but the stock assessment applies only to the spring spawners.

Landings from 1985 to 2005 are given in Table 3.1.1. In 2005 the total landings increased to 113 300 t in Division IIIa and Subdivisions 22–24, resulting in a landing figure for 2005 slightly below the average for the recent 5 years, though higher than 2004. In 2005, 21 100 t were taken in the Kattegat, about 48,500 t from the Skagerrak and 43 700 t from Subdivisions 22–24. The Danish national management regime for herring and sprat fishery in Subdivision 22 was changed in 2002. It should be noted that the total landings for fishery in Skagerrak have been updated for 1995-2001 because of Norwegian misreporting of landings taken in the North Sea and reported to Skagerrak.

The German landings in 2005 were slightly higher than observed in 2004. The overall fishing pattern changed in the last few years. Until 2000 the dominant part of herring was caught in the passive fishery by gillnets and trapnets around the Rügen Island. Since 2001 the activities in the trawl fishery increased. Recently the landings by trawl reached a level of more than 50 % of the total landings (2003: 63 %, 2004: 52 % and 2005: 57 %). The change in fishing pattern was caused by new requirements for a new fish factory on Rügen Island. This factory expects to process 50 000 t per year and started during autumn 2003.

In 2005 the landing data are calculated by fleet according to the fleet definitions used when setting TACs.

The fleet definitions used since 1998 are:

- **Fleet C**: directed fishery for herring in which trawlers (with 32 mm minimum mesh size) and purse seiners participate.
- **Fleet D**: All fisheries in which trawlers (with mesh sizes less than 32 mm) and small purse seiners, fishing for sprat along the Swedish coast and in the Swedish fjords, participate. For most of the landings taken by this fleet, herring is landed as by-catch. Danish and Swedish by-catches of herring from the sprat fishery and the Norway pout and blue-whiting fisheries are listed under fleet D.
- **Fleet F**: Landings from Subdivisions 22–24. Most of the catches are taken in a directed fishery for herring and some as by-catch in a directed sprat fishery.

In Table 3.1.2 the landings are given for 2001 to 2004 in thousands of tonnes by fleet (as defined by HAWG) and quarter.

Investigation of new Danish fleet/metier description

A descriptive analysis of the Danish fleet dynamics during the last decade, in terms of the distribution of herring catches over fleets and at the overall activity of the vessels targeting herring in IIIa was performed in the IAMHERSKA (Improved advice for the mixed herring stocks in the Skagerrak and Kattegat (ICES Division IIIa)) project (see also section 1.4.12 and Ulrich-Rescan and Andersen 2006 WD 1 to the present report). The definition of fleet and metier followed the proposed STECF fleet definition which is different than the definition above, where the fleets correspond to metiers according to the STECF definition. For the descriptive analysis of the Danish fleet dynamics during the last decade, the fisheries identified in Ulrich and Andersen (2004) was modified accordingly, to get as much consistency with the previous HAWG work. Fisheries were identified using a 3-steps method using multivariate analysis of landings profile (target species) and trips descriptors (mesh size, season, and area). The data were based on logbook data and though considerable misreporting is suspected to take place between Division IIIa and the North Sea, the geographical patterns described below is believed to illustrate the fishery behaviour in general terms.

Figure 3.1.1 illustrates the distribution of Danish herring landings in Division IIIa by vessel type and homeport (fleet) in 2004. From this 4 fleets were identified and Figure 3.1.2 shows the Distribution of herring landings by fleet over selected years:

1) OTB_NSSK: trawlers from North Sea and Skagerrak harbours (Skagen included). This fleet is referred to as the Northern fleet.
2) PSB_NSSK: purse-seines from North Sea and Skagerrak harbours.
3) OTB_KAWB: trawlers from North Sjælland and Western Baltic (Subdivisions 22-24) harbours. This fleet is referred to as the Southern fleet.
4) OTH: all other vessels recorded for having caught herring in Division IIIa at least once a year. Given its low importance, this fleet is not kept further in the analysis.

Figure 3.1.3 displays the time series of number of vessel by vessel length class, their average catches of herring in Division IIIa, and the proportion of effort they spent in the various metiers.

The general dynamics of the Danish herring activities in Division IIIa can be summed up as the following points:

- During the first half of the nineties, the activity was relatively local. The fleets were mostly fishing in their immediate waters. For some of the vessels mainly participating in the small meshed fisheries the fishery for herring for the human consumption was a minor but stable activity.

- The second half of the nineties was a period of extension. Both the Southern and Northern trawling fleets extended their activity to the Baltic, and decreased meanwhile their industrial activities in the Kattegat and Skagerrak, which induced reduced by-catches of herring. In the same period, the large purse seines (most of the vessels are polyvalent) increased significantly their geographical mobility, with a majority of their effort being spent outside the traditional Danish fishing grounds in the North Sea and Division IIIa as they participated in fishery for blue whiting and Norwegian spring spawning herring.

3.2 Biological composition of the catch

Table 3.2.1 and Table 3.2.2 show the total catch (autumn- and spring-spawners) in numbers and mean weight-at-age in the catch for herring by quarter and fleet landed from Skagerrak and Kattegat, respectively. The total numbers and mean weights-at-age for herring landed from the Kattegat, Skagerrak and Subdivisions 22 - 24 are shown in Table 3.2.3.

The level of sampling of the commercial landings was generally acceptable. One exception is the total lack of Danish samples from the Danish landings of 4 900 t in 1st quarter in the Skagerrak (Table 3.2.4). It is, however, not clear to the working group whether these landings were actual landings or due to miss-reporting. In the remaining cases of missing samples the corresponding landings were minor. 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 (Table 3.2.5).

Based on the proportions of spring- and autumn-spawners in the landings (Table 3.2.6 and see Section 3.2.2 for more details) catches were split between NSAS and WBSS. A common mean weight-at-age was used for both stocks.

The total numbers and mean weight-at-age of the WBSS and NSAS landed from Kattegat, Skagerrak, and IIIa respectively was then estimated by quarter and fleet (Table 3.2.7 - 3.2.12).

The total catch (SOP) of the WBSS taken in the North Sea+IIIa in 2005 were estimated to be 44 645 t, and has thereby increased compared to 35 078 t in 2004 and 37 994 t in 2003 (Table 3.2.13). This increase in catch (SOP) was mainly due to an increase in the estimated number of 2- and 4-ringers. The estimated number of 1-ringers in fact decreased considerably between 2004 and 2005.

Furthermore, the total catches (SOP) of WBSS from the North Sea, IIIa, and Subdivisions 22-24 respectively, by quarter, was estimated for 2005 (Table 3.2.14). Additionally, the total catches of WBSS in numbers and tonnes (SOP), divided between the North Sea+IIIa and Subdivisions 22–24 respectively for 1991–2005, was estimated (Tables 3.2.15 and 3.2.16)

Catches (SOP) of WBSS from Subdivisions 22-24 have remained rather stable for the last three years at about 40 000 t (Table 3.2.16).

The total catch (SOP) of NSAS in IIIa+Subdivisions 22-24 amounted to 31 927 t in 2005, and thereby it has increased compared to 24 214 t in 2004 and 32 498 t in 2003. The increase relative to 2004 was mainly due to an increase in 1-ringers (Table 3.2.17).

3.2.1 Quality of Catch Data and Biological Sampling Data

Misreporting of fishing area still occurs. There is uncertainty about where the Danish landings for human consumption, reported from Division IIIa were actually taken. There is a high probability that these catches have been taken in the North Sea. Therefore, some of these catches have been transferred to the North Sea. The same problem of mis-reporting is likely to have existed also for the Norwegian landings between 1995 and 2005 (except for 2004 where the Norwegian fleet had full area flexibility). Some landings, reported as taken in the Triangle (Gilleleje, DK - Kullen, S - Helsingborg, S - Helsingør, DK), may have been taken outside this area and listed under the Kattegat.

The amount of discards for 2005 is regarded as being insignificant. However, no quantitative estimates of discards were available to the Working Group.

Table 3.2.4 shows the number of fish aged by country, area, fishery and quarter. The total landings from Division IIIa and Subdivisions 22-24 in 2005 were 114 500 t from which 328 samples were taken, 34 866 fish were measured and 14 687 aged. For comparison, 94 200 t were landed in 2004 from which 352 samples were taken, 34 581 fish were measured and 18 611 aged. Although the overall sampling more than meets the recommended level of one sample per 1000 t landed per quarter, there is an unequal coverage of some areas, times of the year and gear (meshsize).

There is an unknown effect of variability in the stock composition in Division IIIa due to uncertainty of the splitting factor between the NSAS and the WBSS. There is at present no information about the relevance of local herring stocks/populations in relation to the fisheries and their possible influence on the stock assessment. Recent evidence from genetic differentiation among spawning aggregations in the Skagerrak suggests a potential high representation of these local spawning stocks (Bekkevold et al., 2005; see also stock annex 3).

3.2.2 Stock composition in the catch

Catches of herring in the Kattegat, the Skagerrak and the Eastern part of the North Sea are taken from a mixture of two main spawning stocks mainly 1+ ringers of the Western Baltic Spring Spawners (WBSS) and 0-2-ringers from the North Sea Autumn Spawners (NSAS). The winter spawning Downs herring are included under NSAS (see stock annex 3). An uncertain amount of spring spawners belonging to local spawning populations in the Skagerrak/Kattegat area are likely also to contribute to the catches, however, due to lack of knowledge concerning these, they are included under WBSS (see also stock annex 3). As in recent years the WG uses the analysis of individual otolith microstructure for determination of spawning type in age-class stratified random sub-samples of herring in Division IIIa (see stock annex 3). The split between WBSS and NSAS in the eastern North Sea is limited to an area also referred to as the transfer area (the transfer area is defined by the following ICES rectangles: 43F3 to 43F7, 44F3 to 44F6, 45F3 to 45F6, 46F3 to 46F6, and 47F3 to 47F6 (see also Figure 2.2.2)), under the assumption that the geographical distribution of WBSS into the North Sea is within the boarders of the transfer area.

For the present year the otolith-based method has been exclusively applied for the Division IIIa split. For Subdivisions 22, 23 and 24 it was assumed that all individuals caught belong to the WBSS stock, even when otolith microstructure indicate occurrence of autumn spawners in the surveys or in samples of commercial catches (see stock annex 3).

In the Division IV and IIIa a common TAC and by-catch ceiling is set for the mixed herring stock of WBSS and NSAS. An on-going research project has been launched to explore ways to regulate the fishing mortality of NSAS and WBSS individually within Division IV and IIIa (IMHERSKA). Preliminary results indicate that a set of proposed métiers, to some degree, were fishing selectively with respect to stock (WBSS and NSAS) and fish sizes, in specific areas and quarters (Working document-2, HAWG 2006; Working document-1, HAWG 2006). In example the metiér, abbreviated OTB_KAWB/MTB_Her, landed almost solely 2+ ringer WBSS in the southern Kattegat during 3rd quarter (time-series explored was 2000-2003). This picture is fairly consistent between years and the proportion of the total yearly Danish landing of 2+ ringer WBSS falls within 10 to 30%. Also worth noticing is that results agreed with the existing knowledge on migration behaviors of the respective stocks.

3.2.2.1 Spring-spawning herring in the North Sea

Catches from the transfer area in the eastern North Sea in 2005 were split by analyses of Norwegian and Danish samples from landings (see Figure 2.2.2 for details about the transfer area). Mean vertebral counts from the Norwegian samples and otolith microstructure readings from the Danish samples were used to estimate the proportion of WBSS. Samples were missing in the 1st quarter for all ages and in 2nd quarter for 1-ringers, and proportions were assumed to 0%. The sources of data for splitting between NSAS and WBSS in the transfer area are:

	1-RINGERS	2-RINGERS	3-RINGERS	4+-RINGERS
1st quarter	Assumed to be 0% WBSS	Assumed to be 0% WBSS	Assumed to be 0% WBSS	Assumed to be 0% WBSS
2nd quarter	Assumed to be 0% WBSS	Norwegian samples (landings)	Norwegian samples (landings)	Norwegian samples (landings)
3rd quarter	Danish samples (acoustic + landings)	Danish samples (acoustic + landings)	Danish samples (acoustic + landings)	Danish samples (acoustic + landings)
4th quarter	Danish samples (landings)	Danish samples (landings)	Danish samples (landings)	Danish samples (landings)

Resulting proportions of WBSS can be found in Section 2.2.2.

3.2.2.2 Autumn spawners in Division IIIa

The proportions and the analysed numbers are presented in Table 3.2.6.

For commercial landings in 2005 the split of the Swedish and Danish landings was conducted using the proportion by age in the combined samples of Swedish and Danish microstructure analyses. The estimation of the proportion of spring- and autumn-spawners in the landings from Division IIIa was performed on the basis of totally 2411 (869 Danish and 1542 Swedish) otolith microstructure analyses in 2005. Data were disaggregated by area (Kattegat and Skagerrak), age group (1-8+ in 1st and 2nd quarter and 0-8+ in 3rd and 4th quarter) and quarter (1–4).

Sampling levels in 2005 were high enough in age groups 1-3 to allow the split to be applied to their respective spatial and temporal origin without reallocating between landings and surveys or between areas or quarters. Sampling of individual older age classes, and age group 0 in the Kattegat in 3rd quarter, was scarce. Individual microstructure estimates were reallocated from the Swedish IBTS surveys, if less than 12 individual microstructure estimates per age group were available. In cases where reallocation of individual microstructure estimates was not enough, then analyses were pooled in combined age groups to achieve at least 12 individual otolith microstructure estimates per age group. Autumn spawners in the fishery in Subdivisions 22 to 24.

All herring found in subdivisions 22-24 are treated as Western Baltic spring spawners (see stock annex 3).

3.2.2.3 Accuracy and precision in stock identification

The stock classification power of otolith microstructure by visual inspection was tested by Danish readers in 2004/2005. Almost all of the Danish routine samples for the stock identification are interpreted by experienced readers. In the test these readers classified the spawning stock affiliation with a high agreement of 95-100% (ICES 2005/ACFM:16). A closer analysis of all test readings indicated that winter spawned individuals were most likely to be misinterpreted by inexperienced readers; the problem has been corrected before this years working group.

Recent work on the precision and accuracy of hatch month determination using both spawning individuals and back-calculation of hatch month in 0-group herring validated the method (Clausen et al. submitted). Otoliths from spawning individuals were classified and compared to the sampling season, with an overall success rate of 91%, but some mix-up between autumn and winter spawners. However, in case of spawning type infidelity this validation method would show false misclassification. Therefore, an objective method of hatch time estimation was employed, enumerating the unbroken series of daily increments in 0-group herring hatched during different seasons. Visual inspection and objective estimation agreed to 89%, and the confusion between autumn and winter spawners was explained by overlapping hatch periods. Older herring may be classified using multiple linear regression of hatch time versus median increment width (Clausen et al. submitted).

Danish and Swedish otolith microstructure analyses are regularly double checked by the same Danish expert reader for consistency in interpretation. The overall impression is a good agreement among readers implying a potential high accuracy in the splits.

Results presented to the WG on mixed stock analysis exploiting genetic variation in herring from Division IIIa in 2002 and 2003, show excellent agreement between assignments based on micro satellites and otolith microstructure (HERGEN QLRT - 2000 – 01370, final report) indicating good accuracy of the split between North Sea and local stocks plus Western Baltic herring. The possibility of combining genetics and otolith analyses (both otolith morphology and microstructure) for a higher resolution of the Skagerrak, Kattegat and Western Baltic stocks is presently being explored (see also stock annex 3).

Otolith microstructure analysis for stock splitting is a relatively time consuming method. Time has therefore been put into developing new, and more time efficient methods, for stock splitting. Under the EU-FP5 project HERGEN (EU project QLRT 200-01370, final report) a promising and time effective method based on otolith morphology are hopefully on its way. So far this work has showed that individual stocks and local populations display significantly different patterns of lobe formation in the otolith (se also stock annex 3).

3.3 Fishery Independent Information

3.3.1 International Bottom Trawl Survey in Division IIIa

The survey indices were split into spring and autumn spawning components by microstructure analysis of otoliths (section 3.2.2) except for 2001 3rd quarter and 2002 1st quarter when vertebrae counting methods were used. The estimates of the abundance by age of the spring spawning component in the Kattegat are presented in Table 3.3.1 and Table 3.3.2. In line with last year, the mean value for 1-ringers in 2006 1st quarter is lower than the average and follows two of the lowest values in 2004 and 2005. The older age classes shows similar values to the prior years except a tendency of a slight increase of the abundance of individuals of age 4 and 5. For 3st quarter survey indices, the mean value for 1-ringers in 2005 is just above the average values in the time-series while there was a decrease of the abundance of fish older than 3 years.

3.3.2 Summer Acoustic Survey in Division IIIa

The acoustic survey from 29 June to 11 July 2005 covered the area in the Skagerrak and the Kattegat. Details of the survey are given in the ‘Report of the Planning Group for Herring Surveys’ (ICES 2006/LRC:04). The estimated spawning biomass (3+) of Western Baltic Spring Spawning herring (WBSS) in 2005 was about 119 000 tonnes, showing a decrease compared to the previous year of about 34 %. The results from this survey are summarised in Table 3.3.3.

3.3.3 Autumn Acoustic Survey in Subdivisions 22-24

A joint German-Danish acoustic survey was carried out with R/V "SOLEA" between 4 and 21 October 2005 in the Western Baltic covering Subdivisions 21, 22, 23 and 24. A full survey report is given in the Report of the Planning Group for Herring Surveys (ICES 2006/LRC:04). The results for 2005 are presented in Table 3.3.4. The herring stock was estimated to be about 191 000 tonnes in Subdivisions 22-24 (Table 3.3.4). This is an increase of 10 % compared to the last year estimate.

3.3.4 Larvae Surveys

Herring larvae surveys in the western Baltic were conducted in weekly intervals during the 2005 spawning season. The estimated numbers of larvae for the period 1977 to 2005 are summarised in Table 3.3.5. For 2005 the estimate has considerably decreased. It is comparable to 1995 and 2000, and indicates weak year-class strength.

3.4 Mean weights-at-age and maturity-at-age

Mean weights at age in the catch in the 1st quarter were used as stock weights (Table 3.2.14). The maturity ogive was assumed constant between years. The same maturity ogive was used as in the HAWG 2005:

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

3.5 Recruitment

Indices of 0-ringer abundance of the Western Baltic Spring Spawning herring (WBSS) in Subdivisions 22-24 for 2005 were available from the larvae surveys during the spawning season on the main spawning area (see also Table 3.3.5) and from the autumn acoustic survey in Subdivisions 22-24. Log transformed indices were compared by year class in Figure 3.5.1. The larvae index and the 0-ringer from the acoustic survey showed very similar trends in the last 5-10 years, except in the most recent year when the larvae index shows a decline in spite of a rather stable trend in the 0-ringer from the acoustic survey. The latest estimate in the time series shows a quite low value of abundance for the 0-group herring (Table 3.3.5).

3.6 Assessment of western Baltic spring spawners in Division IIIa and Subdivisions 22-24

3.6.1 Input data

Catch in numbers at age from 1991 to 2005 were available for Subdivision IVa (East), Division IIIa and Subdivisions 22-24 (Table 3.6.1) and as proportion at age (Figure 3.6.1). Years before 1991 have been excluded due to lack of reliable data for splitting spawning type and to a large change in fishing pattern caused by changes in the German fishing fleets.

Mean weights at age in the landings are found in Table 3.6.2 and in Figure 3.6.2. The proportions of F and M before spawning were assumed constant between years. F-prop was set to be 0.1 and M-prop 0.25 for all age groups. Natural mortality was assumed constant at age and equal to 0.3, 0.5, and 0.2 for 0- ringers, 1- ringers, and 2+ ringers respectively (Table 3.6.4). The estimates of natural mortality were derived as a mean for the years 1977–1995 from the Baltic MSVPA (ICES 1997/J:2).

Available survey indices were:

FLT1: Hydroacoustic survey in Division IIIa & Sub-division IVa East, July 1991–2005, 0–8+ ringers
FLT2: Hydroacoustic survey in Subdivisions 22, 23 and 24, Oct. 1991–2005, 0–8+ ringers
FLT3: IBTS in Division IIIa, Quarter 1, 1991-2006, 1-5 ringers
FLT4: IBTS in Division IIIa, Quarter 3, 1991-2005, 1–5 ringers
FLT5: Larvae survey in Subdivision 24 (Greifswalder Bodden), March-June 1977-2005, 0-ringer

All are age-structured indices with FLT5 used as an index of recruiting 0-ringers. None of the indices covered the total spatial distribution of the WBSS stock and the indices covered the following quarters and areas:

Survey area	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Division IIIa	FLT3		FLT1 and FLT4	
Subdivisions 22-24	FLT5	FLT5		FLT2

Subsets of these data series representing selected age groups were constructed to give a better representation of the stock (see section 3.6.3).

3.6.2 ICA settings

The following settings were used in 2006, similar to 2005:

- The period for the separable constraint: 5 years (2001-2005).
- The weighing factor to all indices (lambda = 1).
- A linear catchability model for indices 1,2,3, and 4, and both linear and power model for index 5.
- The reference F set at age 4 and the selection=1 for the oldest age.
- The catch data were down-weighted to 0.1 for 0-ringer herring.

3.6.3 Exploration by individual survey indices

Given that this is an update assessment only a limited exploration was carried out similar to as last year. Exploratory runs of catch data with single indices were performed using the general ICA-setting mentioned above (Section 3.6.2). A summary of the results from these runs is presented in Figures 3.6.3 and 3.6.4.

The runs with the larval survey index only including all years and using a linear model did not exhibit a realistic F value, whereas the power model was more in line with other individual indices. However, the recent history of exploratory runs for the larval survey has shown large variation in estimated F and it may still be too early to judge their robustness for use in the final assessment.

The IBTS in Kattegat Q1 (FLT3) indicate a high F of 0.7, slightly higher than or similar to the hydroacoustic survey indices in Division IIIa (FLT1a and FLT1b) being 0.5 and 0.7 respectively, whereas the Acoustic survey indices in Subdivisions 22- 24 (FLT2a and FLT2b) and the IBTS index in Kattegat Q3 (FLT4) suggest more intermediate Fs of 0.3, 0.4 and 0.2 respectively. On the other extreme the larval survey in Subdivision 24 (FLT5a and FLT5b) give indications of quite low fishing mortality depending on the chosen model, power- (F~0.08) and linear catchability (F~0.01).

The larvae survey FLT5 (N30) predicts strong and weak year classes very well but does not reflect the actual magnitude of year class strength. This results in a strong correlation, but large residuals when fitted in the ICA model to the catch data. A longer time-series may help resolve these issues, particularly if intermediate N30 values appear in the time-series. Although the larval survey does not add information to the current specification of the ICA model, it appears to function well as an indicator of recruitment. Trends in log transformed values of recruitment indices (larval index total time-series, 0-ringer Acoustic in SD 22-24 and 1-ringer Acoustic in SD 22-24) show good concordance in the recent time series from 1991 (Figure 3.5.1). In the North Sea, the long MIK time-series (on post larvae) works well as an indicator of 0 ring year class strength in the ICA model. The larvae N30 is an abundance index of post-larvae in some ways similar to the MIK index, so potentially it may be of use in the future. The N30 index provides extremely valuable information on the general biology and year class development of the WBSS herring population.

The tuning fleet choice and the settings for the final ICA run for the 2005 assessment were the same as in the last two years assessments with fleets FLT1b, FLT2b, and FLT4. The biological reasoning behind the choice of indices with restricted numbers of age classes is that there is only a partial migration of age 0-1 ringers to the Division IIIa in the summer and that ages older than 5-ringers are poorly represented in the Subdivision 22-24 acoustic surveys and in the IBTS.

3.6.4 Final Assessment

This assessment conforms to an update assessment of WBSS herring, input data (years 1991-2005, Ages 0-8+ ringers) are given in the following tables:

- Catch in number (Table 3.6.1)
- Weight in catch (Table 3.6.2)
- Weight in stock (Table 3.6.3)
- Natural mortality (Table 3.6.4)
- Maturity (see text table in section 3.4)

The following surveys were included (Tables 3.6.5a-c):

- FLT 1b: DK Hydroacoustic survey in Division IIIa+ SD IVaE, July 1991–2005, excl. 1999, 2–8+ ringers
- FLT 2b: GER Hydroacoustic survey in Subdivisions 22, 23 and 24, Oct 1991–2005, 0–5 ringers
- FLT 4: IBTS in Kattegat, Quarter 3, 1991-2005, 1–5 ringers

The final model settings are shown in Table 3.6.6. The output data are given in Tables 3.6.7-3.6.16. The estimated SSB for 2005 is about 164 600 tonnes with a mean fishing mortality (ages 3-6) of 0.41 (Table 3.6.9). The model diagnostics show a rather well defined minimum SSQ response-curve for all age-indices except age-index 1 (Acoustic Survey in Division IIIa+IVaE) that is somewhat flat (Figure 3.6.5). The minimum SSQ for the Acoustic Survey in Subdivisions 22-24 (age-index 2) finds an intermediate compromise between the high F of age-index 1 (Acoustic Survey in Division IIIa+IVaE) and the low F of age-index 3 (IBTS Kattegat Q3). The stock summary is shown in Figure 3.6.6 and Table 3.6.9.

The marginal totals of residuals between the catch and the separable model (scrutinised on screen in ICA-view) are overall small, with almost no residuals for younger ages (1-3) and slightly larger residuals at older ages (4-7) as well as a reasonably trend-free separable period (2001-2005). Year effects repeat the somewhat large positive and negative values for 2001 and 2003 respectively (see Figure 3.6.7), but as already noted in last years assessment most of the year effects are again caused by 0-ringers that are down-weighted in the analysis but still appears with full weight in the residual plot of the ICA diagnostics. For values see Table 3.6.12.

The diagnostics for the three surveys repeat the trend of low acoustic and high IBTS residuals for 2003 seen in last years assessment, whereas values for 2004 are much closer to model predictions although they reflect the same type of balance between acoustic and IBTS surveys. The Acoustic Survey in Division IIIa+IVaE and the Acoustic Survey in Subdivisions 22-24 showed in general negative but relatively small residuals for 2005 (Figure 3.6.8), with the exception of a somewhat marked negative residual for 4-ringers also indicated in the IBTS Kattegat Q3 survey.

The catch-at-age unweighted variance component is of the same magnitude as the individual acoustic survey variance components and smaller than the IBTS survey component (Table 3.6.16), however in the unweighted statistics down-weighting of the 0-ringers is not accounted for, and this age contribute quite some variation with a C.V. of 49% compared to about 14% for the 2+ groups (Table 3.6.10). After a period of fluctuating high fishing mortality in the mid 1990s, the F3-6 values declined; and since 2000 there has been shift from a level of just above 0.5 in the first three years to a level around 0.4 in the recent three years. After a marked decline in the mid 1990s and a slight increase after the late 1990s the SSB is now fluctuating at around 160 000 t.

All surveys had noisy fits to population estimates for the younger age-classes, but improved from age 3, 2 and 4 in the Acoustic Survey in Division IIIa, in the Acoustic Survey in Subdivisions 22-24, and in the IBTS Kattegat Q3 survey, respectively. Model fit declined again for the oldest ages 8 and 5 in the Acoustic Survey in Division IIIa and in the Acoustic Survey in Subdivisions 22-24, respectively. The fits were generally better for the acoustic surveys than for the IBTS and more so in recent years than for earlier years during the period (1991-2005). The reason for the poorer performance of the Kattegat Q3 IBTS survey may be an increased redistribution of immature age-classes into the Kattegat area in the recent years.

Overall trends in the age structured data for the ICA model

Exploring the cohort dynamics by log catch and log survey indices gives an indication of overall mortality and catchability in successive cohorts from year classes 1991-2002 (Figures 3.6.9a-d). Disregarding the last analysed cohort (2002 year-class) which obviously has a poor fit, slopes of log catches indicate a stable slightly decreasing trend in mortality (Figure 3.6.9a). Slopes from the three surveys; Division IIIa acoustic survey (Figure 3.6.9b), the Subdivisions 22-24 acoustic survey (Figure 3.6.9c), and the IBTS in quarter 3 in the Kattegat (Figure 3.6.9d) are somewhat more fluctuating, with a decreasing trend in mortality from the 1994 cohort, but with a change to higher mortalities for the most recent cohorts especially in the two southernmost surveys (Figures 3.6.9c-d). Although these cohorts are still based on few age-classes (3-4), the slopes are well described and except for the 2002 cohort in the Subdivisions 22-24 acoustic survey, all slopes have $R^2>0.9$. The explanation for the discrepancy between recent changes in trends of apparent cohort mortality between southern surveys and catches may be sought in a shift in the geographical distributions of older individuals into the North Sea IVaE area (see figure 8 in ICES CM 2006/LRC:04).

3.7 Short term projections

The assessment was used to provide a yield-per-recruit plot for WBSS herring in Division IIIa and Subdivisions 22-24 (Figure 3.7.1). The values for $\mathbf{F}_{0.1}$ and $\mathbf{F}_{max}$ are 0.22 and 0.46, respectively.

Short-term predictions were carried out using MFDP v.1a software. ICA estimates of population numbers and fishing mortalities were used except for the numbers of 0-ringers in 2005-2008, where the geometric mean of the recruitment over the period 1994–2003 was taken, and for the numbers of 1-ringers in 2006, where the geometric mean over the period 1995-2004 was used. Mean weights-at-age in the catch and in the stock were taken as a mean for the years 2003–2005. A *status quo* fishing mortality for 2006 onwards was assumed, with values rescaled to the last year estimate. Input data for catch predictions are presented in Table 3.7.1.

Short-term predictions were carried out assuming a *status quo* fishing mortality for 2006 onwards. The single option table is available for 2006 to 2008 (Table 3.7.2).

SCENARIO	2006	2007	2008
1) *status quo* F	F_{2006}= F_{2005} = 0.41 *Status quo* F Catch = 94 000 t	F_{2006}= F_{2005} = 0.41 *Status quo* F Catch = 98 700 t	F_{2006}= F_{2005} = 0.41 *Status quo* F Catch = 101 300 t

The results of the short-term predictions are given in Tables 3.7.2 – 3.7.3. Table 3.7.2 shows single option predictions for 2006-2008 and Table 3.7.3 multiple options for 2007 at *status quo* fishing mortality in 2006. The catches for 2007 and 2008 at *status quo* fishing mortality were predicted to be 98 700 t and 101 300 t, respectively, which is an overall increase in relation to the current catch level of 88 400 t. The SSB is predicted to increase to 181 500 t in 2007 and to 189 100 t in 2008.

Based on *Status quo* F and $F_{0.1}$ (0.41 and 0.22 respectively) the predictions of SSB_{2007} (181 500 t and 184 000 t respectively) are well both above the lowest observed in the time series from 1991-2005 (SSB_{1998} 117 000 t).

3.8 Precautionary and yield based reference points

Reference points have neither been defined nor proposed for this stock. The time series is short with revised catch data and reliable splitting factors for only 15 years, the estimated SSB has not been below 117 000 t since 1991 and there is no obvious stock-recruitment relationship.

3.9 Quality of the Assessment

This year’s assessment is an update similar to last year’s assessment. Therefore, the assessment has not been explored beyond examining the standard diagnostics.

Three data series (surveys) are used in addition to the catch numbers at age. None of these surveys cover the whole distribution area of the stock, but each of them covers areas where it is likely that certain ages are well represented at survey time. The acoustic survey in Division IIIa+IVaE covers fish age 2 and older while the two others largely cover the younger part of the population. Hence, these surveys can be regarded as complementary. All surveys are noisy, with strong year effects. The acoustic survey in Division IIIa+IVaE indicates a higher mortality than the others, but its contribution to the total sum of squares does not have a distinct minimum (Figure 3.6.5). The selection pattern is smooth and no age (1+) or year effects (2001-2005) in model residuals are large (Figure 3.6.7).

Altogether, the current procedure for assessing the stock has given consistent results with respect to fishing mortality and spawning biomass for several years (Figure 3.9.1).

The retrospective errors are small, except in the recruitment (Figure 3.9.2). Apparently, the strength of a year class is not firmly estimated before the year class has been followed for 2-3 years. The selection at age in the fishery changes in retrospective runs. This probably reflects a stronger exploitation of younger herring in earlier years, which in the present assessment is reflected in the VPA part. The selection at age in this year’s assessment is virtually equal to that in two last year’s assessment (Figure 3.9.3), and the catch residuals are relatively small. Hence, the separable assumption does not seem to be violated.

For prediction purposes, better indicators of recruitment would be useful. At present, geometric mean recruitment has to be assumed for age 0 in the intermediate year and for later years. The larval survey index has been considered previously as a candidate recruitment indicator, but including it in the assessment as another tuning series has not been successful (Figure 3.9.4). However, it does identify most strong and weak year classes. Using it as a semi-quantitative support for the assumptions about recruitment in the predictions may be considered as an alternative (Figure 3.5.1). This would need further exploration with this purpose in mind. HAWG suggests to investigate procedures that give a better predictive power of the recruitment by reducing the impact of outliers and to analyse within survey variances.

The predictions are made for the Western Baltic Spring Spawning (WBSS) stock, while management is by areas. In Division IIIa, the fishery exploits both WBSS and North Sea autumn spawning herring. The Working Group has attempted to outline the consequences for both stocks in fishery in Division IIIa (Section 3.10). This requires insight to both how the catches of WBSS are distributed by areas, and the proportions of the catches in Division IIIa from each stock. Both these properties change over time, and are influenced both by managers' decisions and the abundance of the respective stocks in the area. So far, the only basis has been historical data of catches in biomass by area and species (cfr. Table 2.1.6). A better basis could be achieved by considering catches at age by different fleets, and investigations of how management decisions influence the fishery. Further a deeper understanding of relationships between stock characteristics and major migration patterns would help predictions of the seasonal stock composition in the mixed areas. These efforts require inter-sessional work; an attempt to resolve parts of the problem is addressed through the IAMHERSKA project (see section 1.4.8).

Compared to last year's assessment, the change in the estimate is +3% and +8% for the fishing mortalities in 2003 and 2004 respectively; and –3% and -6% for the SSB in 2003 and 2004 respectively. The text table below gives an overview of the assumptions made in the 2005 and 2006 assessments and a comparison of the main results with 2003 and 2004 as baselines.

CATEGORY	PARAMETER	ASSESSMENT IN 2005	ASSESSMENT IN 2006	DIFF. 2006-2005 (+/-) %
ICA input	No. of years for separable constraints	5	5	No
	Reference age for separable constraint	4	4	No
	Selection to be fixed on last age	1	1	No
	Weighting factor to all indices	1	1	No
	Catch down-weighted to 0.1 for 0-ringer	Yes	Yes	No
	Tuning data	Acoustic Surv. Div. IIIa 2-8+ ringers	Acoustic Surv. Div. IIIa 2-8+ ringers	No
		Acoustic Surv. SDs 22-24 0-5 ringers	Acoustic Surv. SDs 22-24 0-5 ringers	No
		IBTS Surv. Quarter 3 1-5 ringers	IBTS Surv. Quarter 3 1-5 ringers	No
ICA results	SSB 2003	155,000 t	150,800t	-3%
	F(3-6) 2003	0.389	0.401	+3%
	SSB 2004	180,400 t	168,700 t	-6%
	F(3-6) 2004	0.358	0.386	+8%

3.10 Management Considerations

Catch options for mixed stocks in Division IIIa based on short term predictions for WBSS

The present state of a declining NSAS stock with poor recruitment in the last 4 years and a stable WBSS stock with an above average recruitment in 2003 indicate that management has to consider both stocks in the mixed areas of Division IIIa and Division IVaE.

It should also be noted that the scope for exploitation is not only dependent on the overall population dynamics of the two stocks. Management also has to consider age-class specific stock composition in the mixing zones brought about by unpredictable changes in distribution pattern triggered by environmental as well as population biological and behavioural cues.

The current fleet definitions are:

North Sea

Fleet A: Directed herring fisheries with purse seiners and trawlers. By-catches in industrial fisheries by Norway are included.
Fleet B: Herring taken as by-catch under EU regulations.

Division IIIa

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

Subdivision 22-24

Fleet F: All herring fisheries in Subdivisions 22-24

Quotas in Division IIIa

The quota for the C-fleet and the by-catch quota for the D-fleet are set for both stocks together. Therefore the implication of the quotas for the outtake of WBSS has to be considered. Furthermore the implication for the outtake of NSAS has to be taken into account when setting fleet wise quotas for that stock (see section 2.7).

For ***2005 the agreed TAC*** for the directed fishery in Division IIIa (C-fleet) was 96 000 t. The TAC was divided into quotas, 500 t for the Faeroes, 82 700 t for the EU of which all has to be taken in Divisiion IIIa, and 12 800 t for Norway of which 50% could be taken in the North Sea. A by-catch ceiling for Division IIIa herring in the small meshed fishery (fleet-D) was set at 24 150 t for the EU fleet.

For ***2006 the agreed TAC*** for the directed fishery in Division IIIa (C-fleet) is 81 600 t. The TAC is divided into quotas, 500 t for the Faeroes, 70 217 t for the EU of which all has to be taken in Division IIIa, and 10 883 t for Norway of which 50% can be taken in the North Sea. A by-catch quota for Division IIIa herring in the small meshed fishery (fleet-D) is set at 22 528 t.

It must also be noted that a slightly variable and relatively small amount (around 7 000 t) of WBSS herring is taken in the fishery in Subarea IV (see Section 2.2.2 and Figure 2.2.2 for information about WBSS taken in Divisions IVa and IVb East). This component is accounted for in both the assessments on NSAS and WBSS. The situation is further complicated by misreporting by areas. In recent years, HAWG has calculated a substantial part of the catch reported as taken in Division IIIa in fleet C actually has been taken in Subarea IV. These catches have been allocated to the North Sea stock and accounted under the A-fleet. Regulations allowing quota transfers from Division IIIa to the North Sea were introduced with the incentive to decrease misreporting for the Norwegian part of the fishery. However, working group estimates suggest that out of the official landings for human consumption in the Skagerrak, 46%, 58%, and 46% are misreported in 2003, 2004, and 2005 respectively. These figures are probably underestimating the problem since only a subset of countries supply this information to the HAWG. Misreported catches are moved to the appropriate stock for the assessment.

TAC in Subdivisions 22-24

For ***2006 the agreed TAC*** for the herring fishery in Subdivisions 22-24 (Fleet F) is 47 500 t. The TAC is divided into quotas, 6 658 t for Denmark, 26 207 t for Germany, 3 t for Finland, 6 181 t for Poland and 8 451 t for Sweden.

ICES catch predictions versus management TAC

ICES gives advice on catch options for the entire distribution of the two herring stocks separately, whereas herring is managed by areas cross sectioning the geographical distribution of the stocks (see the following text diagram).

Data used for catch options in 2007

There is no firm basis for predicting the fraction of NSAS in the catches by the C- and D-fleets. The proportions of the two stocks as well as the distribution pattern of the fishery in the Eastern North Sea and the Division IIIa is dynamically changing year by year. This is probably influenced by year-class strength of the two stocks and their relative geographical distributions as well as fleet behaviour reacting on herring availability and management decisions. Directed intersessional work has started to make further progress regarding catch predictions by stock for the different fleets (see Section 1.4.8).

Recent years' shares of the WBSS catches in IIIa and other areas is used to translate the total recommended TAC for WBSS into outtake of WBSS in Division IIIa and Subdivisions 22-24. The mix of the two stocks in the Division IIIa catches is used to derive the outtake of NSAS and total catches in Division IIIa. Predicted catches of WBSS and NSAS by fleet in IIIa is based on recent patterns of 1) ratio of WBSS catches taken by each fleet and 2) proportion of the two stocks in catches of the different fleets.

The catch option for 2007 is based on the share by fleet and stock composition in catches given as a mean for 2004 and 2005. The ratio by fleet and stock composition is given in the following table A and B, respectively:

Text table **A** showing the 2004 and 2005 average **share** of the total catch in t of WBSS by each fleet.

WBSS	FLEET C (IIIA)	FLEET D (IIIA)	FLEET F (SD22-24) *+ FLEET A (IV)**	TOTAL
Mean (2004,2005) catch in t	24,650	8,150	49,800	82,600
Mean (2004,2005) share in %	29.9 %	9.9 %	60.2 %	100%

*A constant catch of 7 100 t of WBSS caught in Subarea IV are accounted for in the calculations.

Text table **B** showing the 2004 and 2005 average proportion of WBSS in catches by fleet.

WBSS	FLEET C	FLEET D	FLEET F (SD22-24) *+ FLEET A (IV)*
Mean (2004,2005) proportion	0.576	0.452	1

Exploring a range of total WBSS catches

Considering the present level of a NSAS stock with low recruitment in recent years, catch options were explored for the two stocks in Division IIIa at total catches set for the WBSS stock. Short-term predictions indicate a catch in 2007 of 99 000 t with status quo fishing mortality (F_{sq}) (Table 3.7.3). Further the projected stock composition was assumed to equal the 2004 and 2005 average of the NSAS and WBSS in each of the C and D fleets (in Division IIIa) and a 2004 and 2005 average catch of 7 100 t of WBSS taken in Subarea IV.

The text table below gives the catch option derived from the HAWG2006 short-term predictions for the Western Baltic spring spawners in Division IIIa, in SDs 22-24 and in Subarea IV (text table below: option 5 in bold corresponding to F_{sq}) along with several other options between 80 000 t and 105 000 t (values rounded to the nearest 100 t).

Management considerations for Division IIIa based on short term predictions (HAWG2006)									
Catch option for the WBSS herring stock	WBSS herring				NSAS herring		Total catches of both stocks in Division IIIa and Sub-division 22-24		
Total catches of WBSS herring*	Fleet A*	Fleet C	Fleet D	Fleet F	Fleet C	Fleet D	Fleet C	Fleet D	Fleet F
80,000	7,100	23,900	7,900	41,100	17,600	9,600	41,500	17,500	41,100
85,000	7,100	25,400	8,400	44,100	18,700	10,200	44,100	18,600	44,100
90,000	7,100	26,900	8,900	47,100	19,800	10,800	46,700	19,700	47,100
95,000	7,100	28,400	9,400	50,100	20,900	11,400	49,300	20,800	50,100
99,000	**7,100**	**29,600**	**9,800**	**52,500**	**21,800**	**11,900**	**51,400**	**21,700**	**52,500**
100,000	7,100	29,900	9,900	53,100	22,000	12,000	51,900	21,900	53,100
105,000	7,100	31,400	10,400	56,100	23,100	12,600	54,500	23,000	56,100

*A catch of 7 100 t of WBSS herring taken in the Eastern North Sea is assumed.

Applying status quo fishing mortality from the HAWG2006 short term predictions (Section 3.7) give a catch option for WBSS of 99 000 t in the entire distribution area including Subdivisions 22-24, Division IIIa and Division IVaE (bold in text table).

The catch option (both stocks combined) for the directed herring fishery in Division IIIa (fleet C) is then found to be 51 400 t; and the by-catch quota is accordingly 21 700 t. A

constant catch of 7 100 t WBSS in Subarea IV is assumed and leaves a catch option of 52 500 t in Subdivisions 22-24 for 2007, which is an 11% increase in relation to the TAC for this area set in 2006.

For a TAC on catch of NSAS and total catch by the fleets in Division IIIa to be compatible with the advice for WBSS, the numbers derived as above, based on the largest advisable catch of WBSS, are upper bounds on the advisable catches of NSAS by the C- and D- fleets. Thus the resulting catch options were also used as constraints for short term predictions for the NSAS herring (section 2.7).

Table 3.1.1 **HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24.**
Landings in 1986 -2005 in thousands of tonnes.
(Data provided by Working Group members 2006).

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

Year	1996	1997	1998 [2]	1999 [2]	2000	2001	2002	2003	2004	2005 [1]
Skagerrak										
Denmark	28.7	14.3	10.3	10.1	16.0	16.2	26.0	15.5	11.8	14.8
Faroe Islands										0.4
Germany								0.7	0.5	0.8
Norway	9.4	8.8	8.0	7.4	9.7					
Sweden	32.7	32.9	46.9	36.4	45.8	30.8	26.4	25.8	21.8	32.5
Total	70.8	56.0	65.2	53.9	71.5	47.0	52.3	42.0	34.1	48.5
Kattegat										
Denmark	17.2	8.8	23.7	17.9	18.9	18.8	18.6	16.0	7.6	11.1
Sweden	27.0	18.0	29.9	14.6	17.3	16.2	7.2	10.2	9.6	10.0
Total	44.2	26.8	53.6	32.5	36.2	35.0	25.9	26.2	17.2	21.1
Sub. Div. 22+24										
Denmark	34.4	30.5	30.1	32.5	32.6	28.3	13.1	6.1	7.3	5.3
Germany	7.3	12.8	9.0	9.8	9.3	**11.4**	22.4	18.8	18.5	21.0
Poland	6.0	6.9	6.5	5.3	6.6	9.3	-	4.4	5.5	6.1
Sweden	9.0	14.5	4.3	2.6	4.8	13.9	10.7	9.4	9.9	9.2
Total	56.7	64.7	49.9	50.2	53.3	62.9	46.2	38.7	41.2	41.5
Sub. Div. 23										
Denmark	0.7	2.2	0.4	0.5	0.9	0.6	4.6	2.3	0.1	1.8
Sweden	0.3	0.1	0.3	0.1	0.1	0.2	-	0.2	0.3	0.4
Total	1.0	2.3	0.7	0.6	1.0	0.8	4.6	2.6	0.4	2.2
Grand Total	172.7	149.8	169.4	137.2	162.0	145.7	128.9	109.5	92.8	113.3

[1] Preliminary data.
2 Revised data for 1998 and 1999
Bold= German revised data for 2001

Table 3.1.2 HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24.
Landings (SOP) in 2001-2005 in thousands of tonnes by fleet and quarter.

Year	Quarter	Division IIIa		SD 22-24	Division IIIa + SD 22-24
		Fleet C	Fleet D	Fleet F	Total
2001	1	19.6	3.8	20.8	44.2
	2	11.1	1.9	20.7	33.7
	3	24.7	7.9	7.5	40.1
	4	11.1	1.7	14.8	27.6
	Total	66.5	15.3	63.8	145.6
2002	1	11.4	6.2	19.6	37.2
	2	6.3	2.1	18.3	26.7
	3	23.2	7	1.5	31.7
	4	14.2	2.5	13.3	30.0
	Total	55.1	17.8	52.7	125.6
2003	1	10.9	7	20.3	38.2
	2	7.9	1.3	12.9	22.1
	3	21.9	0.9	1.5	24.3
	4	15	3.3	5.6	23.9
	Total	55.7	12.5	40.3	108.5
2004	1	13.5	2.8	20.4	36.7
	2	2.8	3.3	10.4	16.5
	3	8.2	10.8	2.4	21.4
	4	5.9	5.0	8.6	19.4
	Total	30.3	22.0	41.7	93.9
2005	1	16.6	6.1	20.4	43.1
	2	3.4	1.9	15.6	20.9
	3	23.4	3.4	1.9	28.7
	4	12.0	2.6	5.8	20.5
	Total	55.4	14.1	43.7	113.3

Table 3.2.1 **HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24. Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet in the Skagerrak.**

Division: **Skagerrak** **Year:** **2005** **Country:** **All**

		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	26.63	40	29.02	34	55.65	37
	2	88.07	69	40.85	68	128.92	69
	3	11.51	105	6.38	105	17.89	105
	4	4.61	132	3.33	135	7.94	134
	5	0.20	138	0.24	144	0.44	141
	6	0.07	201	0.62	151	0.69	156
	7			0.40	171	0.40	171
	8+						
	Total	131.08		80.83		211.91	
	SOP		8,996		5,081		14,076
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	5.37	46	24.80	23	30.17	27
	2	9.93	68	8.08	65	18.01	67
	3	0.57	93	0.27	103	0.84	96
	4	0.20	128	0.05	131	0.24	129
	5						
	6						
	7						
	8+						
	Total	16.07		33.20		49.26	
	SOP		1,006		1,118		2,124
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0	5.53	23	100.36	14	105.89	14
	1	76.57	76	29.48	35	106.05	65
	2	51.99	109	1.18	68	53.17	108
	3	19.06	129			19.06	129
	4	15.04	148			15.04	148
	5	4.15	161			4.15	161
	6	4.37	183			4.37	183
	7	0.97	196			0.97	196
	8+	0.46	210			0.46	210
	Total	178.14		131.01		309.15	
	SOP		18,024		2,486		20,510
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	1.83	34	20.07	23	21.89	24
	1	55.20	80	14.95	68	70.16	78
	2	24.19	110	5.51	111	29.71	110
	3	4.50	138	0.92	135	5.42	137
	4	4.50	173	0.84	178	5.34	174
	5	1.50	190	0.15	170	1.65	188
	6	2.06	191	0.08	198	2.15	192
	7	0.29	229	0.04	212	0.33	227
	8+	0.19	215			0.19	215
	Total	94.27		42.56		136.83	
	SOP		9,335		2,428		11,763
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	7.36	26	120.42	15	127.78	16
	1	163.78	70	98.24	37	262.02	58
	2	174.18	87	55.62	72	229.80	83
	3	35.64	122	7.57	109	43.21	119
	4	24.35	149	4.22	144	28.56	149
	5	5.85	168	0.38	154	6.23	167
	6	6.50	186	0.70	157	7.20	183
	7	1.26	204	0.44	175	1.70	196
	8+	0.64	212			0.64	212
	Total	419.56		287.60		707.15	
	SOP		37,360		11,113		48,473

Table 3.2.2 HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24. Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet in the Kattegat.

Division: Kattegat   Year: 2005   Country: ALL

		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	24.80	43	36.72	24	61.52	32
	2	51.30	62	3.68	43	54.99	60
	3	18.03	93	0.08	88	18.11	93
	4	7.97	126			7.97	126
	5	2.24	148			2.24	148
	6	1.64	151			1.64	151
	7	0.47	152			0.47	152
	8+	0.04	179			0.04	179
	Total	106.49		40.49		146.98	
	SOP		7,565		1,060		8,625
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	7.37	49	20.36	22	27.73	29
	2	18.97	69	4.73	69	23.70	69
	3	2.20	95	0.38	84	2.58	93
	4	1.53	130	0.10	98	1.63	128
	5	0.40	145			0.40	145
	6	1.06	146			1.06	146
	7	0.58	150			0.58	150
	8+	0.17	140			0.17	140
	Total	32.29		25.57		57.87	
	SOP		2,406		818		3,224
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0	1.45	8	50.14	12	51.59	11
	1	21.26	65	11.06	31	32.32	54
	2	34.56	85	0.25	46	34.80	85
	3	7.94	111			7.94	111
	4	0.91	140			0.91	140
	5	0.08	149			0.08	149
	6	0.08	152			0.08	152
	7	0.06	197			0.06	197
	8+						
	Total	66.34		61.44		127.78	
	SOP		5,396		933		6,329
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	7.86	29	4.53	22	12.39	26
	1	19.68	57	1.79	49	21.47	56
	2	12.36	83	0.29	92	12.65	83
	3	2.19	99	0.05	99	2.24	99
	4	0.51	149	0.02	129	0.53	148
	5	0.19	150			0.19	150
	6	0.01	268			0.01	268
	7	0.04	140			0.04	140
	8+						
	Total	42.82		6.69		49.51	
	SOP		2,697		221		2,918
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	9.31	25	54.67	12	63.98	14
	1	73.11	54	69.94	25	143.04	40
	2	117.19	72	8.95	58	126.14	71
	3	30.36	98	0.51	86	30.87	98
	4	10.92	129	0.12	103	11.04	128
	5	2.91	148			2.91	148
	6	2.79	150			2.79	150
	7	1.16	153			1.16	153
	8+	0.21	147			0.21	147
	Total	247.95		134.19		382.14	
	SOP		18,064		3,032		21,096

Table 3.2.3 HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24. Landings in numbers (mill.), mean weight (g.) and SOP (t) by age and quarter in Subdivisions 22-24.

Subdivisions: 22-24 **Year: 2005** **Country: ALL**

Quarter	W-rings	Sub-division 22 Numbers	Sub-division 22 Mean W.	Sub-division 23 Numbers	Sub-division 23 Mean W.	Sub-division 24 Numbers	Sub-division 24 Mean W.	Total Numbers	Total Mean W.
1	1	146.31	9	1.49	29	6.05	19	153.86	10
	2	13.89	31	18.27	50	36.53	41	68.68	41
	3	1.29	52	2.32	62	41.80	72	45.41	71
	4			1.87	121	30.00	94	31.86	96
	5			1.12	94	17.13	133	18.25	130
	6			0.96	137	25.73	159	26.69	158
	7			0.04	150	13.43	168	13.47	168
	8+			0.01	140	4.96	182	4.97	182
	Total	161.49		26.08		175.63		363.20	
	SOP		1,879		1,563		16,974		20,416
2	1	28.37	17	0.46	49	3.86	18	32.68	18
	2	11.76	33	1.18	68	5.80	43	18.74	38
	3	0.69	90	0.14	92	25.93	67	26.77	68
	4			0.10	126	41.64	83	41.74	83
	5			0.03	131	27.32	112	27.35	112
	6			0.07	143	23.08	132	23.14	132
	7			0.04	148	12.85	156	12.89	156
	8+			0.01	139	5.41	160	5.42	160
	Total	40.82		2.02		145.89		188.73	
	SOP		936		149		14,507		15,593
3	0	0.09	13	0.13	12	1.13	13	1.35	13
	1	0.05	32	0.65	45	5.91	35	6.61	36
	2	0.01	34	0.72	73	5.14	59	5.87	60
	3			0.41	91	10.34	52	10.75	54
	4			0.15	93	4.66	60	4.81	61
	5			0.05	116	3.61	53	3.66	54
	6			0.02	153	2.09	60	2.11	61
	7			0.01	134	0.81	63	0.82	64
	8+			0.01	124	0.18	91	0.19	92
	Total	0.14		2.16		33.88		36.18	
	SOP		3		146		1,725		1,875
4	0	7.28	11	0.88	26	2.08	17	10.24	14
	1	0.67	34	1.54	51	12.20	40	14.41	41
	2	0.09	80	1.93	77	20.57	74	22.60	74
	3			0.71	92	18.84	97	19.55	96
	4			0.13	117	4.92	126	5.05	126
	5			0.05	138	1.99	146	2.04	145
	6			0.03	150	2.22	173	2.25	173
	7			0.01	144	0.58	181	0.58	181
	8+			0.01	157	0.63	189	0.64	188
	Total	8.04		5.28		64.04		77.36	
	SOP		112		344		5,386		5,841
Total	0	7.37	11	1.01	24	3.21	16	11.59	14
	1	175.40	11	4.14	42	28.02	31	207.56	14
	2	25.75	32	22.10	54	68.05	53	115.89	48
	3	1.99	65	3.58	73	96.91	74	102.48	73
	4			2.24	119	81.22	89	83.46	89
	5			1.25	97	50.05	116	51.30	116
	6			1.07	138	53.12	144	54.19	144
	7			0.10	147	27.67	160	27.77	160
	8+			0.04	140	11.17	170	11.21	170
	Total	210.50		35.53		419.43		665.46	
	SOP		2,930		2,202		38,593		43,725

Table 3.2.4 HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24. Samples of commercial landings by quarter and area for 2005 available to the Working Group.

	Country	Quarter	Landings in '000 tons	Numbers of samples	Numbers of fish meas.	Numbers of fish aged
Skagerrak	**Denmark**	**1**	4.9	No data available		
		2	0.8	7	59	35
		3	7.2	30	2748	731
		4	1.8	8	842	380
	Total		14.8	45	3,649	1,146
	Germany	**1**	-	No data available		
		2	-			
		3	0.6			
		4	0.2			
	Total		0.8	0	0	0
	Faroe Islands	**1**	-	No data available		
		2	-			
		3	0.1			
		4	0.3			
	Total		0.4	0	0	0
	Sweden	**1**	9.2	25	1,248	1,246
		2	1.3	5	462	462
		3	12.6	10	492	486
		4	9.5	13	710	709
	Total		32.5	53	2,912	2,903
Kattegat	**Denmark**	**1**	4.9	18	1,542	946
		2	1.3	9	231	178
		3	3.2	32	1,786	495
		4	1.7	11	700	547
	Total		11.1	70	4,259	2,166
	Sweden	**1**	3.7	10	500	498
		2	1.9	10	496	495
		3	3.1	6	465	465
		4	1.3	4	421	419
	Total		10.0	30	1,882	1,877
Subdivision 22	**Denmark**	**1**	0.8	18	1,027	286
		2	0.2	4	59	59
		3	0.0	10	232	27
		4	0.0	13	903	386
	Total		1.0	45	2,221	758
	Germany	**1**	1.1	No data available		
		2	0.7			
		3	0.0			
		4	0.1			
	Total		1.9	0	0	0
Subdivision 23	**Denmark**	**1**	1.4	1	158	106
		2	0.1	No data available		
		3	0.1	No data available		
		4	0.2	No data available		
	Total		1.8	1	158	106
	Sweden	**1**	0.2	No data available		
		2	0.0			
		3	0.1			
		4	0.1			
	Total		0.4	0	0	0
Subdivision 24	**Denmark**	**1**	2.8	8	943	372
		2	0.5	1	98	97
		3	0.0	No data available		
		4	1.0	1	101	100
	Total		4.3	10	1,142	569
	Germany	**1**	8.7	17	4,842	1,074
		2	9.5	20	8,331	1,529
		3	-	-	-	-
		4	1.0	4	1,191	479
	Total		19.1	41	14,364	3,082
	Poland	**1**	0.9	4	682	278
		2	4.6	5	696	276
		3	0.8	2	850	146
		4	0.0	2	561	188
	Total		6.3	13	2789	888
	Sweden	**1**	4.7	8	805	560
		2	0.1	4	200	199
		3	0.9	3	185	183
		4	3.5	5	300	250
	Total		9.2	20	1,490	1,192

Table 3.2.5 HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24.
Samples of landings by quarter and area used to
to estimate catch in numbers and mean weight by age for 2005.

	Country	Quarter	Fleet	Sampling
Skagerrak	**Denmark**	**1**	**C**	Swedish sampling in Q1
		2	**C**	Swedish sampling in Q2
		3	**C**	Danish sampling in Q3
		4	**C**	Danish sampling in Q4
	Germany	**1**	**C**	No landings
		2	**C**	No landings
		3	**C**	Danish sampling in Q3
		4	**C**	Danish sampling in Q4
	Sweden	**1**	**C**	Swedish sampling in Q1
		2	**C**	Swedish sampling in Q2
		3	**C**	Swedish sampling in Q3
		4	**C**	Swedish sampling in Q4
	Denmark	**1**	**D**	Swedish sampling in Q1
		2	**D**	Danish sampling in Q2
		3	**D**	Danish sampling in Q3
		4	**D**	Danish sampling in Q4
	Sweden	**1**	**D**	Swedish sampling in Q1
		2	**D**	Swedish sampling in Q2
		3	**D**	Danish sampling in Q3
		4	**D**	Swedish sampling in Q4
	Faroe Islands	**1**	**C**	No landings
		2	**C**	No landings
		3	**C**	Danish sampling in Q3
		4	**C**	Danish sampling in Q4
Kattegat	**Denmark**	**1**	**C**	Danish sampling in Q1
		2	**C**	Swedish sampling in Q2
		3	**C**	Swedish sampling in Q4
		4	**C**	Danish sampling in Q4
	Sweden	**1**	**C**	Swedish sampling in Q1
		2	**C**	Swedish sampling in Q2
		3	**C**	Swedish sampling in Q3
		4	**C**	Swedish sampling in Q4
	Denmark	**1**	**D**	Danish sampling in Q1
		2	**D**	Danish sampling in Q2
		3	**D**	Danish sampling in Q3
		4	**D**	Danish sampling in Q4
	Sweden	**1**	**D**	Danish sampling in Q1
		2	**D**	No landings
		3	**D**	Danish sampling in Q3
		4	**D**	Danish sampling in Q4

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

Table 3.2.5 continued. HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24. Samples of landings by quarter and area used to to estimate catch in numbers and mean weight by age for 2005. 2/2

	Country	Quarter	Fleet	Sampling
Subdivision 22	**Denmark**	**1**	**F**	Danish sampling in Q1
		2	**F**	Danish sampling in Q2
		3	**F**	Danish sampling in Q3
		4	**F**	Danish sampling in Q4
	Germany	**1**	**F**	Danish sampling in Q1
		2	**F**	Danish sampling in Q2
		3	**F**	Danish sampling in Q3
		4	**F**	Danish sampling in Q4
Subdivision 23	**Denmark**	**1**	**F**	Danish sampling in Q1
		2	**F**	Swedish sampling in Q2 in Kattegat (fleet C)
		3	**F**	Swedish sampling in Q3 in Kattegat (fleet C)
		4	**F**	Danish sampling in Q4 in Kattegat (fleet C)
	Sweden	**1**	**F**	Danish sampling in Q1
		2	**F**	Swedish sampling in Q2 in Sub-division 24
		3	**F**	Swedish sampling in Q3 in Sub-division 24
		4	**F**	Swedish sampling in Q4 in Sub-division 24
Subdivision 24	**Denmark**	**1**	**F**	Danish sampling in Q1
		2	**F**	Danish sampling in Q2
		3	**F**	Swedish sampling in Q3
		4	**F**	Danish sampling in Q4
	Germany	**1**	**F**	German sampling in Q1
		2	**F**	German sampling in Q2
		3	**F**	Swedish sampling in Q3
		4	**F**	German sampling in Q4
	Poland	**1**	**F**	Polish sampling in Q1
		2	**F**	Polish sampling in Q2
		3	**F**	Polish sampling in Q3
		4	**F**	Polish sampling in Q4
	Sweden	**1**	**F**	Swedish sampling in Q1
		2	**F**	Swedish sampling in Q2
		3	**F**	Swedish sampling in Q3
		4	**F**	Swedish sampling in Q4

Fleet C= Human consumption, Fleet D= Industrial landings, Fleet F= All landings from Subdiv.22-24.

Table 3.2.6 HERRING IN DIVISION IIIa AND SUBDIVISIONS
Proportion of North Sea autumn spawners and Baltic spring spawners given in % in Skagerrak and Kattegat by age and quarter. Year: 2005

		Skagerrak				Kattegat			
		North Sea	Baltic			North Sea	Baltic		
Quarter	W-rings	autumn SP	Spring SP	n	source	autumn SP	Spring SP	n	source
1	1	97.50%	2.50%	40		69.72%	30.28%	109	
	2	84.78%	15.22%	46		29.19%	70.81%	185	
	3	53.33%	46.67%	45		16.67%	83.33%	72	
	4	7.69%	92.31%	39		3.57%	96.43%	56	
	5	50.00%	50.00%	10		**0.00%**	**100.00%**		
	6	**42.11%**	**57.89%**		IBTS	**0.00%**	**100.00%**		IBTS
	7	**42.11%**	**57.89%**		age5-7	**0.00%**	**100.00%**		age5-7
	8+	**42.11%**	**57.89%**	**19**	(6-8+)	**0.00%**	**100.00%**	**21**	(5-8+)
2	1	97.67%	2.33%	43		60.42%	39.58%	96	
	2	57.14%	42.86%	49		38.78%	61.22%	49	
	3	37.50%	62.50%	24		30.95%	69.05%	42	
	4	**3.33%**	**96.67%**			16.67%	83.33%	18	
	5	**3.33%**	**96.67%**		Acoust	25.00%	75.00%	4	
	6	**3.33%**	**96.67%**		IBTS	**7.69%**	**92.31%**		
	7	**3.33%**	**96.67%**		age4-6	**7.69%**	**92.31%**		
	8+	**3.33%**	**96.67%**	**30**	(4-8+)	**7.69%**	**92.31%**	**26**	(6-8+)
3	0	14.29%	85.71%	35		92.59%	7.41%	54	
	1	88.24%	11.76%	51		60.42%	39.58%	48	
	2	13.89%	86.11%	108		4.00%	96.00%	50	
	3	9.09%	90.91%	99		2.04%	97.96%	49	
	4	13.04%	86.96%	92		2.04%	97.96%	49	Acoust
	5	18.18%	81.82%	22	Acoust	4.00%	96.00%	25	IBTS
	6	4.76%	95.24%	21	IBTS	**0.00%**	**100.00%**		age0&
	7	**0.00%**	**100.00%**		age7-8	**0.00%**	**100.00%**		age4-8
	8+	**0.00%**	**100.00%**	**19**	(7-8+)	**0.00%**	**100.00%**	**32**	(6-8+)
4	0	100%*	0%*	5		94.06%	5.94%	101	
	1	60.77%	39.23%	130		38.89%	61.11%	90	
	2	17.86%	82.14%	56		2.08%	97.92%	96	
	3	11.11%	88.89%	45		0.00%	100.00%	36	
	4	41.18%	58.82%	34		**0.00%**	**100.00%**		
	5	**78.95%**	**21.05%**			**0.00%**	**100.00%**		
	6	**78.95%**	**21.05%**			**0.00%**	**100.00%**		
	7	**78.95%**	**21.05%**			**0.00%**	**100.00%**		
	8+	**78.95%**	**21.05%**	**19**	(5-8+)	**0.00%**	**100.00%**	**22**	(4-8+)

Figures marked with * are based on less than 12 observations.
If data was reallocated from IBTS or acoustic surveys it is noted under `source`.
If age-clases were pooled it is noted under `source` in ( ), and the estimated percentages are in **bold**.

Table 3.2.7 HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24. Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet of North Sea Autumn spawners in Kattegat.

North Sea Autumn spawners

Division: Kattegat **Year:** 2005 **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	17.29	43	25.60	24	42.90	32
	2	14.97	62	1.08	43	16.05	60
	3	3.01	93	0.01	88	3.02	93
	4	0.28	126			0.28	126
	5						
	6						
	7						
	8+						
	Total	35.56		26.69		62.25	
	SOP		1,981		671		2,652
2	1	4.45	49	12.30	22	16.75	29
	2	7.36	69	1.83	69	9.19	69
	3	0.68	95	0.12	84	0.80	93
	4	0.25	130	0.02	98	0.27	128
	5	0.10	145			0.10	145
	6	0.08	146			0.08	146
	7	0.04	150			0.04	150
	8+	0.01	140			0.01	140
	Total	12.98		14.27		27.25	
	SOP		860		410		1,270
3	0	1.34	8	46.42	12	47.77	11
	1	12.85	65	6.68	31	19.53	54
	2	1.38	85	0.01	46	1.39	85
	3	0.16	111			0.16	111
	4	0.02	140			0.02	140
	5	0.00	149			0.00	149
	6						
	7						
	8+						
	Total	15.76		53.11		68.87	
	SOP		991		743		1,734
4	0	7.39	29	4.27	22	11.65	26
	1	7.65	57	0.70	49	8.35	56
	2	0.26	83	0.01	92	0.26	83
	3						
	4						
	5						
	6						
	7						
	8+						
	Total	15.30		4.97		20.27	
	SOP		669		128		797
Total	0	8.73	26	50.69	12	59.42	14
	1	42.24	53	45.29	25	87.53	39
	2	23.97	65	2.92	59	26.90	65
	3	3.85	94	0.13	85	3.98	94
	4	0.56	128	0.02	98	0.58	127
	5	0.10	145			0.10	145
	6	0.08	146			0.08	146
	7	0.04	150			0.04	150
	8+	0.01	140			0.01	140
	Total	79.60		99.05		178.64	
	SOP		4,501		1,953		6,454

Table 3.2.8 HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24. Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet of North Sea Autumn spawners in Skagerrak.

North Sea Autumn spawners

Division: Skagerrak **Year:** 2005 **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	25.96	40	28.29	34	54.26	37
	2	74.67	69	34.63	68	109.30	69
	3	6.14	105	3.40	105	9.54	105
	4	0.35	132	0.26	135	0.61	134
	5	0.10	138	0.12	144	0.22	141
	6	0.03	201	0.26	151	0.29	156
	7			0.17	171	0.17	171
	8+						
	Total	107.25		67.13		174.38	
	SOP		6,898		3,794		10,692
2	1	5.25	46	24.22	23	29.47	27
	2	5.67	68	4.62	65	10.29	67
	3	0.21	93	0.10	103	0.32	96
	4	0.01	128	0.00	131	0.01	129
	5						
	6						
	7						
	8+						
	Total	11.14		28.94		40.08	
	SOP		651		858		1,509
3	0	0.79	23	14.34	14	15.13	14
	1	67.56	76	26.01	35	93.57	65
	2	7.22	109	0.16	68	7.38	108
	3	1.73	129			1.73	129
	4	1.96	148			1.96	148
	5	0.75	161			0.75	161
	6	0.21	183			0.21	183
	7						
	8+						
	Total	80.23		40.51		120.74	
	SOP		6,596		1,124		7,720
4	0	1.83	34	20.07	23	21.89	24
	1	33.55	80	9.09	68	42.63	78
	2	4.32	110	0.98	111	5.30	110
	3	0.50	138	0.10	135	0.60	137
	4	1.85	173	0.35	178	2.20	174
	5	1.18	190	0.12	170	1.30	188
	6	1.63	191	0.07	198	1.69	192
	7	0.23	229	0.03	212	0.26	227
	8+	0.15	215			0.15	215
	Total	45.24		30.80		76.03	
	SOP		4,238		1,313		5,552
Total	0	2.62	31	34.40	19	37.02	20
	1	132.32	69	87.61	35	219.93	55
	2	91.88	74	40.40	68	132.28	72
	3	8.58	111	3.61	106	12.19	110
	4	4.18	158	0.60	160	4.78	158
	5	2.04	177	0.23	157	2.27	175
	6	1.86	190	0.33	160	2.19	186
	7	0.23	229	0.20	178	0.43	205
	8+	0.15	215			0.15	215
	Total	243.86		167.38		411.24	
	SOP		18,383		7,090		25,473

Table 3.2.9 HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24. Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet of Baltic Spring spawners in Kattegat.

Baltic Spring spawners

Division: **Kattegat** **Year:** **2005** **Country:** **All**

		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	7.51	43	11.12	24	18.63	32
	2	36.33	62	2.61	43	38.94	60
	3	15.03	93	0.07	88	15.09	93
	4	7.69	126			7.69	126
	5	2.24	148			2.24	148
	6	1.64	151			1.64	151
	7	0.47	152			0.47	152
	8+	0.04	179			0.04	179
	Total	70.94		13.79		84.73	
	SOP		5,585		389		5,973
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	2.92	49	8.06	22	10.98	29
	2	11.62	69	2.89	69	14.51	69
	3	1.52	95	0.26	84	1.78	93
	4	1.27	130	0.09	98	1.36	128
	5	0.30	145			0.30	145
	6	0.98	146			0.98	146
	7	0.54	150			0.54	150
	8+	0.16	140			0.16	140
	Total	19.31		11.30		30.61	
	SOP		1,546		408		1,954
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0	0.11	8	3.71	12	3.82	11
	1	8.42	65	4.38	31	12.79	54
	2	33.18	85	0.24	46	33.41	85
	3	7.78	111			7.78	111
	4	0.89	140			0.89	140
	5	0.07	149			0.07	149
	6	0.08	152			0.08	152
	7	0.06	197			0.06	197
	8+						
	Total	50.59		8.33		58.91	
	SOP		4,405		189		4,594
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	0.47	29	0.27	22	0.74	26
	1	12.02	57	1.10	49	13.12	56
	2	12.10	83	0.29	92	12.39	83
	3	2.19	99	0.05	99	2.24	99
	4	0.51	149	0.02	129	0.53	148
	5	0.19	150			0.19	150
	6	0.01	268			0.01	268
	7	0.04	140			0.04	140
	8+						
	Total	27.52		1.72		29.24	
	SOP		2,027		93		2,121
		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	0.57	25	3.98	12	4.56	14
	1	30.87	55	24.65	26	55.52	42
	2	93.22	74	6.03	58	99.25	73
	3	26.51	99	0.38	87	26.89	99
	4	10.36	129	0.11	104	10.47	129
	5	2.80	148			2.80	148
	6	2.71	150			2.71	150
	7	1.11	153			1.11	153
	8+	0.20	148			0.20	148
	Total	168.35		35.14		203.50	
	SOP		13,562		1,080		14,642

Table 3.2.10 HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24. Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet of Baltic Spring spawners in Skagerrak.

Baltic Spring spawners

Division: Skagerrak Year: 2005 Country: All

		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	1	0.67	40	0.73	34	1.39	37
	2	13.40	69	6.22	68	19.62	69
	3	5.37	105	2.98	105	8.35	105
	4	4.25	132	3.07	135	7.32	134
1	5	0.10	138	0.12	144	0.22	141
	6	0.04	201	0.36	151	0.40	156
	7			0.23	171	0.23	171
	8+						
	Total	23.83		13.70		37.53	
	SOP		2,098		1,287		3,385
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	1	0.12	46	0.58	23	0.70	27
	2	4.25	68	3.46	65	7.72	67
	3	0.36	93	0.17	103	0.53	96
	4	0.19	128	0.05	131	0.23	129
2	5						
	6						
	7						
	8+						
	Total	4.93		4.25		9.18	
	SOP		354		261		615
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0	4.74	23	86.02	14	90.76	14
	1	9.01	76	3.47	35	12.48	65
	2	44.77	109	1.02	68	45.78	108
	3	17.33	129			17.33	129
	4	13.08	148			13.08	148
3	5	3.39	161			3.39	161
	6	4.16	183			4.16	183
	7	0.97	196			0.97	196
	8+	0.46	210			0.46	210
	Total	97.91		90.50		188.41	
	SOP		11,428		1,361		12,789
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0						
	1	21.66	80	5.87	68	27.52	78
	2	19.87	110	4.53	111	24.40	110
	3	4.00	138	0.82	135	4.82	137
	4	2.65	173	0.49	178	3.14	174
4	5	0.32	190	0.03	170	0.35	188
	6	0.43	191	0.02	198	0.45	192
	7	0.06	229	0.01	212	0.07	227
	8+	0.04	215			0.04	215
	Total	49.03		11.76		60.80	
	SOP		5,097		1,115		6,212
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0	4.74	23	86.02	14	90.76	14
	1	31.46	78	10.64	53	42.09	72
	2	82.30	101	15.22	80	97.52	97
	3	27.06	125	3.96	111	31.02	123
	4	20.17	148	3.61	141	23.78	147
Total	5	3.81	163	0.15	149	3.96	162
	6	4.63	184	0.38	153	5.01	181
	7	1.03	198	0.24	173	1.27	193
	8+	0.50	210			0.50	210
	Total	175.69		120.22		295.91	
	SOP		18,977		4,023		23,001

Table 3.2.11 HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24. Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet of North Sea Autumn spawners in Division IIIa.

North Sea Autumn spawners

Division: IIIa Year: 2005 Country: All

		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	1	43.26	41	53.90	30	97.15	35
	2	89.64	68	35.71	67	125.35	67
	3	9.14	101	3.42	105	12.56	102
	4	0.64	129	0.26	135	0.90	131
1	5	0.10	138	0.12	144	0.22	141
	6	0.03	201	0.26	151	0.29	156
	7			0.17	171	0.17	171
	8+						
	Total	142.81		93.82		236.63	
	SOP		8,878		4,465		13,344

		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	1	9.70	48	36.52	22	46.22	28
	2	13.03	69	6.45	66	19.48	68
	3	0.89	94	0.22	93	1.11	94
	4	0.26	130	0.02	101	0.28	128
2	5	0.10	145			0.10	145
	6	0.08	146			0.08	146
	7	0.04	150			0.04	150
	8+	0.01	140			0.01	140
	Total	24.13		43.21		67.34	
	SOP		1,511		1,268		2,779

		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0	2.13	13	60.76	12	62.89	12
	1	80.41	74	32.69	34	113.10	63
	2	8.60	105	0.17	67	8.78	104
	3	1.89	127			1.89	127
	4	1.98	148			1.98	148
3	5	0.76	161			0.76	161
	6	0.21	183			0.21	183
	7						
	8+						
	Total	95.99		93.62		189.61	
	SOP		7,587		1,868		9,455

		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0	9.21	30	24.33	23	33.54	25
	1	41.20	76	9.78	67	50.98	74
	2	4.58	108	0.99	111	5.57	109
	3	0.50	138	0.10	135	0.60	137
	4	1.85	173	0.35	178	2.20	174
4	5	1.18	190	0.12	170	1.30	188
	6	1.63	191	0.07	198	1.69	192
	7	0.23	229	0.03	212	0.26	227
	8+	0.15	215			0.15	215
	Total	60.53		35.77		96.30	
	SOP		4,908		1,442		6,349

		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0	11.35	27	85.09	15	96.44	17
	1	174.56	65	132.89	32	307.46	51
	2	115.85	72	43.32	68	159.17	71
	3	12.43	106	3.74	105	16.17	106
	4	4.73	154	0.62	158	5.36	155
Total	5	2.14	175	0.23	157	2.38	173
	6	1.95	189	0.33	160	2.27	185
	7	0.28	216	0.20	178	0.48	200
	8+	0.16	209			0.16	209
	Total	323.46		266.42		589.88	
	SOP		22,884		9,042		31,927

Table 3.2.12 HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24.
Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet of Baltic Spring spawners in Division IIIa.

Baltic Spring spawners

Division: IIIa Year: 2005 Country: All

		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	1	8.17	43	11.84	25	20.02	32
	2	49.73	64	8.82	60	58.55	63
	3	20.40	96	3.04	105	23.44	97
	4	11.94	128	3.07	135	15.01	130
1	5	2.34	148	0.12	144	2.46	148
	6	1.68	152	0.36	151	2.03	152
	7	0.47	152	0.23	171	0.70	159
	8+	0.04	179			0.04	179
	Total	94.77		27.49		122.26	
	SOP		7,683		1,675		9,358
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	1	3.04	49	8.64	22	11.68	29
	2	15.87	69	6.36	67	22.23	68
	3	1.88	95	0.43	92	2.31	94
	4	1.46	130	0.13	110	1.59	128
2	5	0.30	145			0.30	145
	6	0.98	146			0.98	146
	7	0.54	150			0.54	150
	8+	0.16	140			0.16	140
	Total	24.23		15.56		39.79	
	SOP		1,900		669		2,569
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0	4.85	22	89.73	14	94.58	14
	1	17.42	71	7.85	33	25.27	59
	2	77.94	99	1.25	64	79.20	98
	3	25.11	123			25.11	123
	4	13.98	147			13.98	147
3	5	3.47	161			3.47	161
	6	4.23	182			4.23	182
	7	1.03	196			1.03	196
	8+	0.46	210			0.46	210
	Total	148.49		98.83		247.32	
	SOP		15,833		1,551		17,384
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0	0.47	29	0.27	22	0.74	26
	1	33.68	72	6.96	65	40.64	71
	2	31.97	100	4.82	110	36.79	101
	3	6.19	124	0.87	133	7.06	125
	4	3.15	169	0.51	176	3.67	170
4	5	0.50	175	0.03	170	0.53	175
	6	0.44	193	0.02	198	0.46	193
	7	0.10	193	0.01	212	0.11	195
	8+	0.04	215			0.04	215
	Total	76.55		13.48		90.04	
	SOP		7,124		1,208		8,332
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0	5.32	23	90.00	14	95.32	14
	1	62.32	67	35.29	34	97.61	55
	2	175.52	86	21.25	74	196.77	85
	3	53.57	112	4.34	109	57.92	112
	4	30.53	141	3.72	140	34.25	141
Total	5	6.61	157	0.15	149	6.76	156
	6	7.34	171	0.38	153	7.71	170
	7	2.14	175	0.24	173	2.38	175
	8+	0.69	193			0.69	193
	Total	344.05		155.37		499.41	
	SOP		32,539		5,103		37,643

Table 3.2.13 HERRING IN DIVISION IIIa AND
Total catch in numbers (millions) and mean weight (g), SOP (tonnes) of
Western Baltic Spring spawners in Division IIIa and the North Sea in the years 1991-2005.

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	204.19	97.93	90.86	30.55	21.28	12.01	7.24	816.86
	Mean W.	17.9	41.5	97.8	138.0	163.1	198.5	207.0	228.8	234.3	
	SOP	902	12,551	19,970	13,517	14,823	6,065	4,404	2,747	1,696	76,674
1996	Numbers	166.23	228.05	317.74	75.60	40.41	30.63	12.58	6.73	5.63	883.60
	Mean W.	10.5	27.6	90.1	134.9	164.9	186.6	204.1	208.5	220.2	
	SOP	1,748	6,296	28,618	10,197	6,665	5,714	2,568	1,402	1,241	64,449
1997	Numbers	25.97	73.43	158.71	180.06	30.15	14.15	4.77	1.75	2.31	491.31
	Mean W.	19.2	49.7	76.7	127.2	154.4	175.8	184.4	192.0	208.0	
	SOP	498	3,648	12,176	22,913	4,656	2,489	879	337	480	48,075
1998	Numbers	36.26	175.14	315.15	94.53	54.72	11.19	8.72	2.19	2.09	699.98
	Mean W.	27.8	51.3	71.5	108.8	142.6	171.7	194.4	184.2	230.0	
	SOP	1,009	8,980	22,542	10,287	7,804	1,922	1,695	403	481	55,121
1999	Numbers	41.34	190.29	155.67	122.26	43.16	22.21	4.42	3.02	2.40	584.77
	Mean W.	11.5	51.0	83.6	114.9	121.2	145.2	169.6	123.8	152.3	
	SOP	477	9,698	13,012	14,048	5,232	3,225	749	373	366	47,179
2000	Numbers	114.83	318.22	302.10	99.88	50.85	18.76	8.21	1.35	1.40	915.60
	Mean W.	22.6	31.9	67.4	107.7	140.2	170.0	157.0	185.0	210.1	
	SOP	2,601	10,145	20,357	10,756	7,131	3,189	1,288	249	294	56,010
2001	Numbers	121.68	36.63	208.10	111.08	32.06	19.67	9.84	4.17	2.42	545.65
	Mean W.	9.0	51.2	76.2	108.9	145.3	171.4	188.2	187.2	203.3	
	SOP	1,096	1,875	15,863	12,093	4,657	3,371	1,852	780	492	42,079
2002	Numbers	69.63	577.69	168.26	134.60	53.09	12.05	7.48	2.43	2.02	1,027.26
	Mean W.	10.2	20.4	78.2	117.7	143.8	169.8	191.9	198.2	215.5	
	SOP	709	11,795	13,162	15,848	7,632	2,046	1,435	481	435	53,544
2003	Numbers	52.11	63.02	182.53	65.45	64.37	21.47	6.26	4.35	1.81	461.38
	Mean W.	13.0	37.4	76.5	113.3	132.7	142.2	153.5	169.9	162.2	
	SOP	678	2,355	13,957	7,416	8,540	3,053	961	740	294	37,994
2004	Numbers	25.7	209.3	96.0	94.0	18.2	16.8	4.5	1.5	0.6	466.71
	Mean W.	27.1	43.2	81.9	117.1	145.4	157.4	170.7	184.4	187.1	
	SOP	695	9,047	7,869	11,005	2,652	2,651	769	279	111	35,078
2005	Numbers	95.3	96.9	203.3	75.4	46.9	9.3	11.5	3.5	1.4	543.51
	Mean W.	14.1	54.9	85.6	121.6	148.3	162.7	176.3	178.3	200.6	
	SOP	1,341	5,319	17,415	9,163	6,961	1,519	2,028	618	282	44,645

Data for 1995 to 2001 was revised in 2003.

Table 3.2.14 HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24.
Landings in numbers (mill.), mean weight (g.) and SOP (t)
by age and quarter from of Western Batic Spring spawners in the North Sea & Division IIIa & Subdivisions 22-24.

(values from the North Sea, see Table 2.2.1-2.2.5) **Western Baltic Spring Spawners**

Division: IV + IIIa + 22-24 **Year: 2005**

Quarter	W-rings	Subarea IV Numbers	Subarea IV Mean W.	Division IIIa Numbers	Division IIIa Mean W.	Subdivisions 22-24 Numbers	Subdivisions 22-24 Mean W.	Total Numbers	Total Mean W.
1	1			20.02	32	153.86	10	173.875	12.60
	2			58.55	63	68.68	41	127.238	51.36
	3			23.44	97	45.41	71	68.852	80.00
	4			15.01	130	31.86	96	46.876	106.57
	5			2.46	148	18.25	130	20.711	132.21
	6			2.03	152	26.69	158	28.722	157.33
	7			0.70	159	13.47	168	14.177	167.66
	8+			0.04	179	4.97	182	5.007	182.05
	Total	0.00		122.26		363.20		485.46	
	SOP		0		9,358		20,416		29,774

Quarter	W-rings	Subarea IV Numbers	Subarea IV Mean W.	Division IIIa Numbers	Division IIIa Mean W.	Subdivisions 22-24 Numbers	Subdivisions 22-24 Mean W.	Total Numbers	Total Mean W.
2	1	0.00	0.00	11.68	29	32.68	18	44.36	21
	2	0.89	120	22.23	68	18.74	38	41.85	56
	3	10.85	144	2.31	94	26.77	68	39.93	90
	4	4.36	150	1.59	128	41.74	83	47.69	91
	5	0.85	173	0.30	145	27.35	112	28.50	114
	6	1.01	185	0.98	146	23.14	132	25.14	135
	7	0.29	195	0.54	150	12.89	156	13.72	157
	8+	0.19	221	0.16	140	5.42	160	5.76	161
	Total	18.43		39.79		188.73		246.95	
	SOP		2,753		2,569		15,593		20,915

Quarter	W-rings	Subarea IV Numbers	Subarea IV Mean W.	Division IIIa Numbers	Division IIIa Mean W.	Subdivisions 22-24 Numbers	Subdivisions 22-24 Mean W.	Total Numbers	Total Mean W.
3	0	0.00	0.00	94.58	14	1.35	13		
	1	0.00	143.00	25.27	59	6.61	36	31.88	54
	2	5.66	105.00	79.20	98	5.87	60	90.73	96
	3	6.59	170	25.11	123	10.75	54	42.45	113
	4	8.32	177	13.98	147	4.81	61	27.11	141
	5	1.72	182	3.47	161	3.66	54	8.85	121
	6	2.78	190	4.23	182	2.11	61	9.12	157
	7	0.79	183	1.03	196	0.82	64	2.65	151
	8+	0.53	204	0.46	210	0.19	92	1.17	188
	Total	26.38		247.32		36.18		213.95	
	SOP		4,282		17,384		1,875		22,201

Quarter	W-rings	Subarea IV Numbers	Subarea IV Mean W.	Division IIIa Numbers	Division IIIa Mean W.	Subdivisions 22-24 Numbers	Subdivisions 22-24 Mean W.	Total Numbers	Total Mean W.
4	0	0.00	0	0.74	26	10.24	14	10.97	15
	1	0.01	111	40.64	71	14.41	41	55.06	63
	2	0.03	127	36.79	101	22.60	74	59.41	91
	3	0.00	206	7.06	125	19.55	96	26.61	104
	4	0.00	214	3.67	170	5.05	126	8.72	145
	5	0.00	229	0.53	175	2.04	145	2.57	152
	6	0.00	238	0.46	193	2.25	173	2.71	176
	7	0.00	293	0.11	195	0.58	181	0.69	183
	8+	0.00	0	0.04	215	0.64	188	0.68	190
	Total	0.03		90.04		77.36		167.43	
	SOP		4		8,332		5,841		14,178

Quarter	W-rings	Subarea IV Numbers	Subarea IV Mean W.	Division IIIa Numbers	Division IIIa Mean W.	Subdivisions 22-24 Numbers	Subdivisions 22-24 Mean W.	Total Numbers	Total Mean W.
Total	0			95.32	14	11.59	14	106.906	14.01
	1			97.61	55	207.56	14	305.171	27.19
	2	6.57	107	196.77	85	115.89	48	319.225	72.08
	3	17.43	154	57.92	112	102.48	73	177.833	93.78
	4	12.68	168	34.25	141	83.46	89	130.394	110.57
	5	2.57	179	6.76	156	51.30	116	60.639	122.80
	6	3.79	189	7.71	170	54.19	144	65.695	149.33
	7	1.08	186	2.38	175	27.77	160	31.231	161.92
	8+	0.71	208	0.69	193	11.21	170	12.620	173.55
	Total	44.84		499.41		665.46		1,209.71	
	SOP		7,038		37,643		43,725		88,406

Table 3.2.15 **HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24.**
Total catch in numbers (millions) of Western Baltic Spring Spawners
in the North Sea & Division IIIa & Subdivisions 22-24 in the years 1991-2005.

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	204.2	97.9	90.9	30.6	21.3	12.0	7.2	816.9
	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	317.7	75.6	40.4	30.6	12.6	6.7	5.6	883.6
	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	158.7	180.1	30.2	14.2	4.8	1.8	2.3	491.3
	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	175.1	315.1	94.5	54.7	11.2	8.7	2.2	2.1	700.0
	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	41.34	190.29	155.67	122.26	43.16	22.21	4.42	3.02	2.40	584.8
	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	114.8	318.2	302.1	99.9	50.8	18.8	8.2	1.3	1.4	915.6
	Sub-div. 22-24	37.7	616.3	194.3	86.7	77.8	53.0	30.1	12.4	9.3	1079.9
2001	Div. IV+Div. IIIa	121.7	36.6	208.1	111.1	32.1	19.7	9.8	4.2	2.4	545.6
	Sub-div. 22-24	634.6	486.5	280.7	146.8	76.0	48.7	29.3	14.1	4.3	1721.0
2002	Div. IV+Div. IIIa	69.6	577.7	168.3	134.6	53.1	12.0	7.5	2.4	2.0	1027.3
	Sub-div. 22-24	80.6	81.4	113.6	186.7	119.2	45.1	31.1	11.4	6.3	675.4
2003	Div. IV+Div. IIIa	52.1	63.0	182.5	64.0	62.2	20.3	5.9	3.8	1.6	455.5
	Sub-div. 22-24	1.4	63.9	82.3	95.8	125.1	82.2	22.9	13.1	7.0	493.6
2004	Div. IV+Div. IIIa	25.7	209.3	96.0	94.0	18.2	16.8	4.5	1.5	0.6	466.7
	Sub-div. 22-24	217.9	248.4	101.8	70.8	75.0	74.4	44.5	13.4	10.4	856.5
2005	Div. IV+Div. IIIa	95.3	96.9	203.3	75.4	46.9	9.3	11.5	3.5	1.4	543.5
	Sub-div. 22-24	11.6	207.6	115.9	102.5	83.5	51.3	54.2	27.8	11.2	665.5

Data for 1995-2001 for the North Sea and Div. IIIa was revised in 2003.

Table 3.2.16 **HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24.**
Mean weight (g) and SOP (tons) of Western Baltic Spring Spawners
in the North Sea & Division IIIa & Subdivisions 22-24 in the years 1991-2005.

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	97.8	138.0	163.1	198.5	207.0	228.8	234.3	76,674
	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	90.1	134.9	164.9	186.6	204.1	208.5	220.2	64,449
	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	76.7	127.2	154.4	175.8	184.4	192.0	208.0	48,075
	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	71.5	108.8	142.6	171.7	194.4	184.2	230.0	55,121
	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	11.5	51.0	83.6	114.9	121.2	145.2	169.6	123.8	152.3	47,179
	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	67.4	107.7	140.2	170.0	157.0	185.0	210.1	56,010
	Sub-div. 22-24	16.5	22.2	42.8	80.4	123.5	133.2	143.4	155.4	151.4	53,904
2001	Div. IV+Div. IIIa	9.0	51.2	76.2	108.9	145.3	171.4	188.2	187.2	203.3	42,079
	Sub-div. 22-24	12.9	22.3	46.8	69.0	93.5	150.8	145.1	146.3	153.1	63,724
2002	Div. IV+Div. IIIa	10.2	20.4	78.2	117.7	143.8	169.8	191.9	198.2	215.5	53,544
	Sub-div. 22-24	10.8	27.3	57.8	81.7	108.8	132.1	186.6	177.8	157.7	52,647
2003	Div. IV+Div. IIIa	13.0	37.4	76.5	112.7	132.1	140.8	151.9	167.4	158.2	37,075
	Sub-div. 22-24	22.4	25.8	46.4	75.3	95.2	117.2	125.9	157.1	162.6	40,315
2004	Div. IV+Div. IIIa	27.1	43.2	81.9	117.1	145.4	157.4	170.7	184.4	187.1	35,078
	Sub-div. 22-24	3.7	14.3	47.4	77.7	96.4	125.5	150.4	165.8	151.0	41,736
2005	Div. IV+Div. IIIa	14.1	54.9	85.6	121.6	148.3	162.7	176.3	178.3	200.6	44,645
	Sub-div. 22-24	13.6	14.2	48.3	73.3	89.3	115.5	143.6	159.9	170.2	43,725

Data for 1995-2001 for the North Sea and Div. IIIa was revised in 2003.

Table 3.2.17 **HERRING IN DIVISION IIIa AND SUBDIVISIONS 22-24.**
Transfers of North Sea autumn spawners from Division IIIa to the North Sea.
Numbers (mill) & mean weight (g) & SOP in (tonnes) in the years 1991-2005.

Year	W-Rings	0	1	2	3	4	5	6	7	8+	Total
1991	Number	677.1	748.3	298.3	52.4	7.7	5.1	1.1	0.4	0.1	1,790.6
	Mean W.	25.6	40.5	72.9	97.2	135.8	149.7	155.7	159.8	176.8	
	SOP	17,314	30,336	21,744	5,098	1,049	771	178	59	26	76,575
1992	Number	2,298.4	1,408.8	220.3	22.1	10.4	6.6	2.9	1.0	0.4	3,970.9
	Mean W.	12.3	51.8	84.2	131.4	162.0	173.4	185.3	198.4	201.2	
	SOP	28,159	72,985	18,557	2,907	1,683	1,143	533	200	84	126,251
1993	Number	2,795.4	2,032.5	237.6	26.5	7.7	3.6	2.7	2.2	0.7	5,109.0
	Mean W.	12.5	28.6	79.7	141.4	132.3	233.4	238.5	180.6	203.1	
	SOP	34,903	58,107	18,939	3,749	1,016	850	647	390	133	118,734
1994	Number	481.6	1,086.5	201.4	26.9	6.0	2.9	1.6	0.4	0.2	1,807.5
	Mean W.	16.0	42.9	83.4	110.7	138.3	158.6	184.6	199.1	213.9	
	SOP	7,723	46,630	16,790	2,980	831	460	287	75	37	75,811
1995	Number	1,144.5	1,189.2	161.5	13.3	3.5	1.1	0.6	0.4	0.3	2,514.4
	Mean W.	11.2	39.1	88.3	145.7	165.5	204.5	212.2	236.4	244.3	
	SOP	12,837	46,555	14,267	1,940	573	225	133	86	65	76,680
1996	Number	516.1	961.1	161.4	17.0	3.4	1.6	0.7	0.4	0.3	1,661.9
	Mean W.	11.0	23.4	80.2	126.6	165.0	186.5	216.1	216.3	239.1	
	SOP	5,697	22,448	12,947	2,151	565	307	145	77	66	44,403
1997	Number	67.6	305.3	131.7	21.2	1.7	0.8	0.2	0.1	0.1	528.7
	Mean W.	19.3	47.7	68.5	124.4	171.5	184.7	188.7	188.7	192.4	
	SOP	1,304	14,571	9,025	2,643	285	146	40	16	25	28,057
1998	Number	51.3	745.1	161.5	26.6	19.2	3.0	3.1	1.2	0.5	1,011.6
	Mean W.	27.4	56.4	79.8	117.8	162.9	179.7	197.2	178.9	226.3	
	SOP	1,409	41,994	12,896	3,137	3,136	547	608	211	108	64,045
1999	Number	598.8	303.0	148.6	47.2	13.4	6.2	1.2	0.5	0.5	1,119.4
	Mean W.	10.4	50.5	87.7	113.7	137.4	156.5	188.1	187.3	198.8	
	SOP	6,255	15,297	13,037	5,369	1,841	974	230	90	92	43,186
2000	Number	235.3	984.3	116.0	21.9	22.9	7.5	3.3	0.6	0.1	1,391.8
	Mean W.	21.3	28.5	76.1	108.8	163.1	190.3	183.9	189.4	200.2	
	SOP	5,005	28,012	8,825	2,377	3,731	1,436	601	114	13	50,115
2001	Number	807.8	563.6	150.0	17.2	1.4	0.3	0.5	0.0	0.0	1,540.8
	Mean W.	8.7	49.4	75.3	108.2	130.1	147.1	219.1	175.8	198.1	
	SOP	7,029	27,849	11,300	1,856	177	43	109	8	5	48,376
2002	Number	478.5	362.6	56.7	5.6	0.7	0.2	0.1	0.0	0.0	904.5
	Mean W.	12.2	38.0	100.6	121.5	142.7	160.9	178.7	177.4	218.6	
	SOP	5,859	13,790	5,705	684	106	26	21	8	5	26,205
2003	Number	21.6	445.0	182.3	13.0	16.2	1.8	1.1	1.2	0.2	682.4
	Mean W.	20.5	33.7	67.0	123.2	150.3	163.5	190.2	214.6	186.8	
	SOP	442	14,992	12,219	1,606	2,436	293	213	264	33	32,498
2004	Number	88.4	70.9	179.9	20.7	6.0	9.7	1.8	2.0	0.9	380.4
	Mean W.	22.5	55.3	70.2	120.6	140.9	151.7	170.6	186.6	178.5	
	SOP	1,993	3,921	12,638	2,498	851	1,479	312	367	154	24,214
2005	Number	96.4	307.5	159.2	16.2	5.4	2.4	2.3	0.5	0.2	589.9
	Mean W.	16.5	50.5	71.0	105.9	154.6	173.5	184.5	200.2	208.9	
	SOP	1,595	15,527	11,304	1,712	828	412	420	95	34	31,927

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

Table 3.3.1 **WESTERN BALTIC HERRING.**
International Bottom Trawl Survey in the Kattegat in quarter 1.
Mean catch of spring-spawning herring at age in number per hour.

Year	Winter rings				
	1	2	3	4	5
1990	416	681	65	43	11
1991	190	206	144	25	20
1992	588	82	33	21	13
1993	3140	554	81	35	50
1994	1380	256	112	22	31
1995	781	132	30	42	24
1996	1312	1405	160	42	22
1997	3267	229	119	15	18
1998	407	853	165	74	8
1999	309	66	43	21	14
2000	1933	219	28	10	7
2001*	-	-	-	-	-
2002	2335	178	222	23	7
2003	1364	1495	41	10	0
2004	147	144	37	6	2
2005	286	257	26	12	5
2006	361	163	48	19	17

* = no data available

Table 3.3.2 **WESTERN BALTIC HERRING.**
International Bottom Trawl Survey in the Kattegat in quarter 3.
Mean catch of spring-spawning herring at age in number per hour.

Year	Winter rings				
	1	2	3	4	5
1991	141	83	101	41	24
1992	372	108	70	63	25
1993	404	159	42	36	25
1994	265	229	154	49	36
1995	687	192	113	99	29
1996	631	322	31	17	11
1997	52	122	33	8	13
1998	118	86	22	27	5
1999	292	116	71	34	14
2000*	-	-	-	-	-
2001	313	190	72	18	2
2002	1568	169	100	16	6
2003	969	550	170	53	29
2004	1225	215	144	30	23
2005	607	255	54	23	13

* = no survey was carried out in 2000

Table 3.3.3 **WESTERN BALTIC HERRING. Acoustic surveys on the Spring Spawning Herring in the North Sea/Division IIIa in 1991-2005 (July).**

Year	1991	1992*	1993*	1994*	1995*	1996*	1997	1998	1999**	2000	2001	2002	2003	2004	2005
Numbers in millions															
W-rings															
0		3,853	372	964											
1		277	103	5	2,199	1,091	128	138	1,367	1,509	66	3,346	1,833	1,669	2,687
2	1,864	2,092	2,768	413	1,887	1,005	715	1,682	1,143	1,891	641	1,577	1,110	930	1,342
3	1,927	1,799	1,274	935	1,022	247	787	901	523	674	452	1,393	395	726	464
4	866	1,593	598	501	1,270	141	166	282	135	364	153	524	323	307	201
5	350	556	434	239	255	119	67	111	28	186	96	88	103	184	103
6	88	197	154	186	174	37	69	51	3	56	38	40	25	72	84
7	72	122	63	62	39	20	80	31	2	7	23	18	12	22	37
8+	10	20	13	34	21	13	77	53	1	10	12	17	5	18	21
Total	**5,177**	**10,509**	**5,779**	**3,339**	**6,867**	**2,673**	**2,088**	**3,248**	**3,201**	**4,696**	**1,481**	**7,002**	**3,807**	**3,926**	**4,939**
3+ group	**3,313**	**4,287**	**2,536**	**1,957**	**2,781**	**577**	**1,245**	**1,428**	**691**	**1,295**	**774**	**2,079**	**864**	**1,328**	**910**
Biomass ('000 tonnnes)															
W-rings															
0		34.3	1	8.7											
1		26.8	7	0.4	77.4	52.9	4.7	7.1	74.8	61.4	3.5	137.2	79.0	63.9	105.9
2	177.1	169.0	139	33.2	108.9	87.0	52.2	136.1	101.6	138.1	55.8	107.2	91.5	75.6	100.1
3	219.7	206.3	112	114.7	102.6	27.6	81.0	84.8	59.5	68.8	51.2	126.9	41.4	89.4	46.6
4	116.0	204.7	69	76.7	145.5	17.9	21.5	35.2	14.7	45.3	21.5	55.9	41.7	41.5	28.9
5	51.1	83.3	65	41.8	33.9	17.8	9.8	13.1	3.4	25.1	17.9	12.8	13.9	29.3	16.5
6	19.0	36.6	26	38.1	27.4	5.8	9.8	6.9	0.5	10.0	6.9	7.4	4.2	11.7	14.9
7	13.0	24.4	16	13.1	6.7	3.3	14.9	4.8	0.3	1.4	4.7	3.5	2.0	4.1	7.5
8+	2.0	5.0	2	7.8	3.8	2.7	13.6	9.0	0.1	1.3	2.7	3.1	0.9	3.2	4.9
Total	597.9	756.1	436.5	325.8	506.2	215.1	207.5	297.0	254.9	351.4	164.2	454.0	274.5	318.8	325.3
3+ group	420.9	560.3	291.0	292.3	319.9	75.2	150.6	153.7	78.5	151.9	104.9	209.6	104.0	179.3	119.3
Mean weight (g)															
W-rings															
0		8.9	4.0	9.0											
1		96.8	66.3	80.0	35.2	48.5	36.9	51.9	54.7	40.7	54.0	41.0	43.1	38.3	39.4
2	95	80.8	50.1	80.3	57.7	86.6	73.0	80.9	88.9	73.1	87.0	68.0	82.5	81.3	74.6
3	114	114.7	87.9	122.7	100.4	111.9	103.0	94.1	113.8	102.2	113.2	91.1	104.9	123.2	100.5
4	134	128.5	116.2	153.0	114.6	126.8	129.6	124.7	109.1	124.4	140.5	106.6	128.8	135.2	143.7
5	146	149.8	149.9	175.1	132.9	149.4	145.0	118.7	120.0	135.4	185.2	145.8	134.2	159.4	160.9
6	216	185.7	169.6	205.0	157.2	157.3	143.1	135.8	179.9	179.2	182.6	186.5	165.4	162.9	177.7
7	181	199.7	256.9	212.0	172.9	166.8	185.6	156.4	179.9	208.8	206.3	198.7	167.2	191.6	202.3
8+	200	252.0	164.2	230.3	183.1	212.9	178.0	168.0	181.7	135.2	226.9	183.4	170.3	178.0	229.2
Total	115.6	123.9	75.8	100.2	73.7	80.5	99.4	91.4	78.5	74.8	110.9	64.8	72.1	81.2	65.9

* revised in 1997

**the survey only covered the Skagerrak area by Norway. Additional estimates for the Kattegat area were added (see ICES 2000/ACFM:10, Table 3.5.8)

Table 3.3.4 **WESTERN BALTIC HERRING. Acoustic survey on the Spring Spawning Herring in Sub-divisions 22-24 in 1991-2005 (September/October).**

Year	1991[3]	1992[3]	1993[1]	1994[1]	1995[1]	1996[1]	1997[1]	1998[1]	1999[1]	2000	2001[2]	2002	2003	2004	2005
Numbers in millions															
W-rings															
0	5,577	3,467	768	4,383	4,001	1,418	2,608	2,179	4,821	1,021	1,831	3,984	3,701	2,401	2,769
1	2,507	2,179	345	412	1,163	1,084	1,389	451	1,145	1,208	1,314	611	781	912	662
2	880	1,015	354	823	307	541	492	557	246	477	1,761	372	200	590	569
3	852	465	485	540	332	413	343	364	187	348	1,013	566	230	352	378
4	259	233	381	433	342	282	151	232	129	206	357	337	276	166	183
5	102	71	122	182	247	283	112	99	44	81	92	61	103	145	102
6	49	32	52	56	124	110	92	51	8	39	55	23	41	81	87
7	6	8	28	22	40	44	32	23	1	5	5	3	9	23	25
8+	27	9	13	2	27	18	46	9	2	4	0	13	11	12	16
Total	10,259	7,480	2,547	6,854	6,583	4,193	5,265	3,966	6,582	3,389	6,428	5,970	5,353	4,682	4,791
3+ group	1,295	818	1,080	1,235	1,112	1,151	775	778	370	682	1,522	1,002	671	780	791
Biomass ('000 tonnnes)															
W-rings															
0	62.0	48.9	11.1	49.3	41.1	12.3	25.6	20.4	54.2	12.8	21.4	33.9	31.5	20.5	28.6
1	97.8	77.8	12.3	14.3	39.6	32.9	49.4	18.2	42.3	47.5	59.1	23.9	24.7	34.2	26.0
2	60.0	57.5	15.7	38.1	19.8	26.8	29.2	41.4	18.8	29.7	118.7	27.1	14.9	34.9	43.6
3	76.9	39.5	29.7	39.2	28.5	29.2	31.9	32.9	22.0	29.0	93.4	56.1	23.3	28.4	34.3
4	29.4	28.5	23.5	41.3	39.1	20.0	21.0	27.5	13.1	24.1	34.2	39.8	36.3	18.9	21.8
5	13.5	10.6	12.3	22.9	26.7	33.9	16.0	11.2	5.6	9.2	11.6	8.6	15.6	17.8	14.0
6	6.4	5.1	6.7	11.5	14.7	14.7	13.2	6.1	0.8	5.6	7.6	3.3	6.2	12.6	14.0
7	0.8	1.6	2.2	4.9	8.8	5.7	5.1	3.7	0.2	1.1	0.9	0.5	1.5	3.5	5.0
8+	3.6	2.1	1.8	0.6	6.6	2.7	10.2	2.2	0.4	0.7	0.0	1.9	1.8	2.1	3.5
Total	350.3	271.6	115.3	222.1	224.8	178.4	201.6	163.5	157.4	159.7	346.9	195.2	155.8	172.8	190.8
3+ group	130.5	87.4	76.2	120.4	124.4	106.3	97.4	83.5	42.1	69.6	147.7	110.3	84.6	83.2	92.6
Mean weight (g)															
W-rings															
0	11.1	14.1	14.4	11.2	10.3	8.7	9.8	9.4	11.2	12.6	11.7	8.5	8.5	8.6	10.3
1	39.0	35.7	35.7	34.7	34.0	30.4	35.6	40.3	37.0	39.3	45.0	39.1	31.7	37.5	39.2
2	68.2	56.7	44.3	46.3	64.5	49.6	59.4	74.3	76.4	62.2	67.4	72.8	74.5	59.1	76.7
3	90.2	84.9	61.3	72.6	85.9	70.7	93.1	90.4	117.6	83.3	92.2	99.2	101.2	80.7	90.8
4	113.5	122.3	61.6	95.5	114.5	71.1	139.2	118.3	101.8	117.1	95.7	118.2	131.2	113.6	118.8
5	132.2	148.7	100.9	125.9	108.0	119.7	142.3	114.0	127.5	114.1	126.0	142.6	151.0	122.6	137.2
6	130.4	161.0	129.6	204.0	118.1	133.5	143.4	120.5	107.2	143.0	137.0	142.8	150.9	154.6	161.8
7	133.0	205.7	80.2	222.6	222.0	128.5	161.6	158.1	232.7	202.9	175.7	205.5	155.7	151.1	202.5
8+	132.5	224.4	137.5	269.6	241.1	154.7	222.2	232.9	219.1	180.9	-	143.5	165.6	169.0	215.3
Total	34.1	36.3	45.3	32.4	34.2	42.5	38.3	41.2	23.9	47.1	54.0	32.7	29.1	36.9	39.8

1) revised in 2001 due to new presented area of strata in the 'Manual for the Baltic International Acoustic Survey'. ICES CM 2000/H:2 Ref.: D: Annex 3 (Table 2.2)

2) incl. estimates for Sub-division 23, which was covered by RV ARGOS (Sweden) in November 2001

3) revised in 2003 due to revised Sa values

Table 3.3.5 WESTERN BALTIC HERRING. Estimation of the herring 0-Group (TL >=30 mm) Greifswalder Bodden and adjacent waters (March/April to June).

Year	Number in Millions
1977	2000[1]
1978	100[1]
1979	2200[1]
1980	360[1]
1981	200[1]
1982	180[1]
1983	1760[1]
1984	290[1]
1985	1670[1]
1986	1500[1]
1987	1370[1]
1988	1223[2]
1989	63[2]
1990	57[2]
1991	236[3]
1992	18[4]
1993	199[4]
1994	788[4]
1995	171[4]
1996	31[4]
1997	54[4]
1998	2553[4]
1999	1945[4]
2000	151[4]
2001	421[4]
2002	2051[4]
2003	2005[4]
2004	860[4]
2005	162[5]

[1] Brielmann 1989
[2] Klenz 1999 Inf. Fischwirtsch. Fischereiforsch. 46(2), 1999: 15-17
[3] Müller & Klenz 1994
[4] Klenz 2005 Inf. Fischwirtsch. Fischereiforsch. 52, 2005: 21-22
[5] unpublished

Table 3.6.1 WESTERN BALTIC HERRING. Input to ICA.

Catch in number (millions)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	119.0	145.1	206.1	263.2	541.3	171.1	376.8	549.8	569.6	152.6	756.3	150.3	53.5	243.6	106.9
1	826.0	456.7	530.7	249.4	1660.7	638.9	668.6	623.1	616.1	934.5	523.2	659.1	126.9	457.8	305.2
2	541.2	602.6	495.9	365.0	438.1	400.6	289.3	430.9	334.3	496.4	488.8	281.8	264.9	197.8	319.2
3	564.4	364.9	415.1	382.6	226.8	199.7	276.9	182.9	246.2	186.6	257.8	321.3	161.3	164.8	177.8
4	279.8	334.0	260.9	267.0	194.9	144.2	75.3	146.7	90.3	128.6	108.1	172.3	189.4	93.2	130.4
5	177.5	183.2	210.5	168.1	84.1	130.1	43.1	45.3	55.9	71.7	68.4	57.2	103.6	91.2	60.6
6	46.5	139.8	102.8	118.4	60.1	65.3	39.9	23.8	15.5	38.3	39.1	38.5	29.1	49.0	65.7
7	13.2	52.7	63.9	49.5	32.9	30.7	21.2	15.4	9.5	13.8	18.3	13.8	17.5	14.9	31.2
8	4.9	22.6	24.5	33.1	20.5	25.1	24.1	14.1	6.1	10.7	6.7	8.3	8.8	11.0	12.6

Table 3.6.2 WESTERN BALTIC HERRING. Input to ICA.

Mean weight in catch (kg)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.02957	0.01519	0.01535	0.01458	0.01010	0.01056	0.02962	0.01426	0.01112	0.02113	0.01229	0.01053	0.01325	0.00618	0.01401
1	0.03476	0.03447	0.02545	0.03704	0.02092	0.02458	0.02748	0.03333	0.03433	0.02550	0.02432	0.02127	0.03152	0.02754	0.02719
2	0.06685	0.06732	0.06797	0.08328	0.06843	0.08090	0.06845	0.06634	0.06583	0.05775	0.05931	0.06998	0.06711	0.06419	0.07208
3	0.09490	0.09435	0.10204	0.10323	0.09841	0.09702	0.11807	0.09423	0.09814	0.09501	0.08618	0.09678	0.09075	0.10017	0.09378
4	0.12342	0.11630	0.11428	0.12213	0.12349	0.11254	0.13420	0.11779	0.11642	0.13013	0.10886	0.11956	0.10792	0.10596	0.11057
5	0.13901	0.14169	0.13615	0.14115	0.15196	0.13283	0.16198	0.13673	0.14713	0.14280	0.15673	0.14003	0.12234	0.13139	0.12280
6	0.15560	0.16511	0.16795	0.15648	0.17041	0.13687	0.18170	0.16628	0.15660	0.14633	0.15597	0.18763	0.13188	0.15228	0.14933
7	0.17091	0.17576	0.18228	0.17046	0.20626	0.15425	0.19671	0.16523	0.15382	0.15829	0.15560	0.18141	0.16029	0.16768	0.16192
8	0.18256	0.19152	0.19890	0.18596	0.21696	0.19100	0.20872	0.18701	0.15756	0.15908	0.17132	0.17170	0.16252	0.15295	0.17355

Table 3.6.3 WESTERN BALTIC HERRING. Input to ICA .

Mean weight in stock (kg)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010
1	0.03085	0.02029	0.01563	0.01855	0.01305	0.01815	0.01310	0.02209	0.02106	0.01398	0.01686	0.01645	0.01444	0.01306	0.01260
2	0.05277	0.04513	0.04020	0.05288	0.04590	0.05456	0.05147	0.05578	0.05668	0.04313	0.05088	0.06368	0.04447	0.04561	0.05136
3	0.07873	0.08176	0.09671	0.08357	0.07081	0.09051	0.10633	0.08293	0.08705	0.08370	0.07829	0.09046	0.07926	0.08106	0.08000
4	0.10412	0.10751	0.10793	0.10767	0.13269	0.11703	0.13334	0.11280	0.10813	0.12504	0.11594	0.12388	0.10509	0.10925	0.10657
5	0.12447	0.13127	0.14087	0.13921	0.16745	0.11974	0.16618	0.13378	0.14801	0.14365	0.16904	0.17365	0.12681	0.14399	0.13221
6	0.14492	0.15934	0.16715	0.15656	0.18923	0.15383	0.19429	0.16779	0.16015	0.16287	0.17627	0.19830	0.15061	0.16285	0.15733
7	0.15943	0.17102	0.18273	0.17676	0.20970	0.14667	0.20895	0.16832	0.14394	0.16503	0.16808	0.19801	0.17287	0.19321	0.16766
8	0.16398	0.18693	0.18906	0.20275	0.23377	0.12803	0.22635	0.18432	0.15043	0.18311	0.18052	0.20363	0.18471	0.20759	0.18200

Table 3.6.4 WESTERN BALTIC HERRING. Input to ICA .

Natural mortality

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.30000	0.30000	0.30000	0.30000	0.30000	0.30000	0.30000	0.30000	0.30000	0.30000	0.30000	0.30000	0.30000	0.30000	0.30000
1	0.50000	0.50000	0.50000	0.50000	0.50000	0.50000	0.50000	0.50000	0.50000	0.50000	0.50000	0.50000	0.50000	0.50000	0.50000
2	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
3	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
4	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
5	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
6	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
7	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
8	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000

Table 3.6.5 a **WESTERN BALTIC HERRING. Input to ICA.**
AGE - STRUCTURED INDICES.
Fleet 1b: Acoustic Survey in Div. IIIa+IVaE, Ages 2-8+ (Catch: Number in millions)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	1864.0	2092.0	2768.0	413.0	1887.0	1005.0	715.0	1682.0	*******	1891.1	641.2	1576.6	1110.0	929.6	1342.1
3	1927.0	1799.0	1274.0	935.0	1022.0	247.0	787.0	901.0	*******	673.6	452.3	1392.8	394.6	726.0	463.5
4	866.0	1593.0	598.0	501.0	1270.0	141.0	166.0	282.0	*******	363.9	153.1	524.3	323.4	306.9	201.3
5	350.0	556.0	434.0	239.0	255.0	119.0	67.0	111.0	*******	185.7	96.4	87.5	103.4	183.7	102.5
6	88.0	197.0	154.0	186.0	174.0	37.0	69.0	51.0	*******	55.6	37.6	39.5	25.2	72.1	83.6
7	72.0	122.0	63.0	62.0	39.0	20.0	80.0	31.0	*******	6.9	23.0	17.8	12.0	21.5	37.2
8	10.0	20.0	13.0	34.0	21.0	13.0	77.0	53.0	*******	9.6	11.9	17.1	5.4	18.0	21.4

Table 3.6.5 b **WESTERN BALTIC HERRING. Input to ICA.**
AGE - STRUCTURED INDICES.
Fleet 2b: Acoustic Survey in SD 22-24, Ages 0-5 (Catch: Number in millions)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	5577.0	3467.0	768.0	4383.0	4001.0	1418.0	2608.0	2179.0	4821.0	1021.0	1831.0	3984.0	3701.0	2401.0	2769.0
1	2507.0	2179.0	345.0	412.0	1163.0	1084.0	1389.0	451.0	1145.0	1208.0	1314.0	611.0	781.0	912.0	662.0
2	880.0	1015.0	354.0	823.0	307.0	541.0	492.0	557.0	246.0	477.0	1761.0	372.0	200.0	590.0	569.0
3	852.0	465.0	485.0	540.0	332.0	413.0	343.0	364.0	187.0	348.0	1013.0	566.0	230.0	352.0	378.0
4	259.0	233.0	381.0	433.0	342.0	282.0	151.0	232.0	129.0	206.0	357.0	337.0	276.0	166.0	183.0
5	102.0	71.0	121.0	182.0	247.0	283.0	112.0	99.0	44.0	81.0	92.0	61.0	103.0	145.0	102.0

Table 3.6.5 c **WESTERN BALTIC HERRING. Input to ICA.**
AGE - STRUCTURED INDICES.
Fleet 4: IBTS in Kattegat, Quarter 3, Ages 1-5 (Catch: Number per hour)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	141.2	371.5	404.0	264.5	687.3	631.3	52.4	117.5	292.0	*******	313.0	1567.8	968.8	1225.2	607.2
2	83.2	107.6	158.7	229.4	191.5	321.8	122.2	85.8	116.3	*******	190.0	169.0	550.2	215.0	255.4
3	100.9	69.9	41.9	154.2	113.2	30.8	33.2	22.4	71.2	*******	72.0	100.2	170.2	143.6	53.7
4	41.2	63.0	36.0	49.0	99.1	17.5	8.4	27.3	33.6	*******	18.0	15.5	52.7	30.0	23.3
5	23.8	24.7	25.1	35.7	29.4	11.3	13.2	5.0	14.3	*******	2.0	5.8	29.4	23.0	12.5

Table 3.6.6 WESTERN BALTIC HERRING:

Input parameters for ICA FINAL Run

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

                            Version 1.4 w

                           K.R.Patterson
                     Fisheries Research Services
                          Marine Laboratory
                              Aberdeen

                            24 August 1999

 Type * to change language
 Enter the name of the index file -->index.dat
canum.low
weca.low
 Stock weights in 2006  used for the year 2005
west.low
 Natural mortality in 2006  used for the year 2005
natmor.low
 Maturity ogive in 2006  used for the year 2005
matprop.low
 Name of age-structured index file (Enter if none) : -->dagaiyfd.dat
 Name of the SSB index file (Enter if none) -->
No indices of spawning biomass to be used.
 No of years for separable constraint ?--> 5
 Reference age for separable constraint ?--> 4
 Constant selection pattern model (Y/N) ?-->y
 S to be fixed on last age ?-->    1.000000000000000
 First age for calculation of reference F ?--> 3
 Last age for calculation of reference F ?--> 6
 Use default weighting (Y/N) ?-->n
Enter relative weights at age
 Weight for age 0-->    0.100000000000000
 Weight for age 1-->    1.000000000000000
 Weight for age 2-->    1.000000000000000
 Weight for age 3-->    1.000000000000000
 Weight for age 4-->    1.000000000000000
 Weight for age 5-->    1.000000000000000
 Weight for age 6-->    1.000000000000000
 Weight for age 7-->    1.000000000000000
 Weight for age 8-->    1.000000000000000
Enter relative weights by year
 Weight for year 2001-->    1.000000000000000
 Weight for year 2002-->    1.000000000000000
 Weight for year 2003-->    1.000000000000000
 Weight for year 2004-->    1.000000000000000
 Weight for year 2005-->    1.000000000000000
Enter new weights for specified years and ages if needed
 Enter year, age, new weight or -1,-1,-1 to end.  -1 -1   -1.000000000000000
 Is the last age of Acoustic  Survey in  Div IIIa+IVaE Ages a plus-group (Y/-->y
 Is the last age of Acoustic Survey in Sub div 22-24 Ages 0- a plus-group (Y-->n
 Is the last age of IYFS Katt Quart3 Age groups 1-5 (Mean Ca a plus-group (Y-->n
You must choose a catchability model for each index.

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

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

 Model for Acoustic  Survey in  Div IIIa+IVaE Ages  is to be A/L/P ?-->L
 Model for Acoustic Survey in Sub div 22-24 Ages 0-  is to be A/L/P ?-->L
 Model for IYFS Katt Quart3 Age groups 1-5 (Mean Ca  is to be A/L/P ?-->L
 Fit a stock-recruit relationship (Y/N) ?-->n
 Enter lowest feasible F-->   5.000000000000003E-02
 Enter highest feasible F-->    1.000000000000000
```

Table 3.6.6 continued

```
Mapping the F-dimension of the SSQ surface
    F                 SSQ
    0.05        44.5753175328
    0.10        26.3162612804
    0.15        19.7427063201
    0.20        16.8820333184
    0.25        15.5451373989
    0.30        14.9375764508
    0.35        14.7222945243
    0.40        14.7388060934
    0.45        14.9030566821
    0.50        15.1673727480
    0.55        15.5028868101
    0.60        15.8912535860
    0.65        16.3203647720
    0.70        16.7820739086
    0.75        17.2710374598
    0.80        17.7837178162
    0.85        18.3181246806
    0.90        18.8733553084
    0.95        19.4497370697
    1.00        20.0484579369
Lowest SSQ is for F =     0.369
No of years for separable analysis : 5
Age range in the analysis : 0  . . . 8
Year range in the analysis : 1991  . . . 2005
Number of indices of SSB : 0
Number of age-structured indices : 3
Parameters to estimate : 41
Number of observations : 298
Conventional single selection vector model to be fitted.
-----------------------------------------------------------------
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for Acoustic  Survey in  Div IIIa+IVaE Ages  at age 2-->    1.000000000000000
 Enter weight for Acoustic  Survey in  Div IIIa+IVaE Ages  at age 3-->    1.000000000000000
 Enter weight for Acoustic  Survey in  Div IIIa+IVaE Ages  at age 4-->    1.000000000000000
 Enter weight for Acoustic  Survey in  Div IIIa+IVaE Ages  at age 5-->    1.000000000000000
 Enter weight for Acoustic  Survey in  Div IIIa+IVaE Ages  at age 6-->    1.000000000000000
 Enter weight for Acoustic  Survey in  Div IIIa+IVaE Ages  at age 7-->    1.000000000000000
 Enter weight for Acoustic  Survey in  Div IIIa+IVaE Ages  at age 8-->    1.000000000000000
 Enter weight for Acoustic Survey in Sub div 22-24 Ages 0-  at age 0-->    1.000000000000000
 Enter weight for Acoustic Survey in Sub div 22-24 Ages 0-  at age 1-->    1.000000000000000
 Enter weight for Acoustic Survey in Sub div 22-24 Ages 0-  at age 2-->    1.000000000000000
 Enter weight for Acoustic Survey in Sub div 22-24 Ages 0-  at age 3-->    1.000000000000000
 Enter weight for Acoustic Survey in Sub div 22-24 Ages 0-  at age 4-->    1.000000000000000
 Enter weight for Acoustic Survey in Sub div 22-24 Ages 0-  at age 5-->    1.000000000000000
 Enter weight for IYFS Katt Quart3 Age groups 1-5 (Mean Ca  at age 1-->    1.000000000000000
 Enter weight for IYFS Katt Quart3 Age groups 1-5 (Mean Ca  at age 2-->    1.000000000000000
 Enter weight for IYFS Katt Quart3 Age groups 1-5 (Mean Ca  at age 3-->    1.000000000000000
 Enter weight for IYFS Katt Quart3 Age groups 1-5 (Mean Ca  at age 4-->    1.000000000000000
 Enter weight for IYFS Katt Quart3 Age groups 1-5 (Mean Ca  at age 5-->    1.000000000000000
Enter estimates of the extent to which errors
in the age-structured indices are correlated
across ages. This can be in the range 0 (independence)
to 1 (correlated errors).
  Enter value for Acoustic  Survey in  Div IIIa+IVaE Ages-->    1.000000000000000
  Enter value for Acoustic Survey in Sub div 22-24 Ages 0--->    1.000000000000000
  Enter value for IYFS Katt Quart3 Age groups 1-5 (Mean Ca-->    1.000000000000000
 Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.
Aged index weights
Acoustic  Survey in  Div IIIa+IVaE Ages
 Age   :       2     3     4     5     6     7     8
 Wts :     0.143 0.143 0.143 0.143 0.143 0.143 0.143
Acoustic Survey in Sub div 22-24 Ages 0-
 Age   :       0     1     2     3     4     5
 Wts :     0.167 0.167 0.167 0.167 0.167 0.167
IYFS Katt Quart3 Age groups 1-5 (Mean Ca
 Age   :       1     2     3     4     5
 Wts :     0.200 0.200 0.200 0.200 0.200
F in 2005  at age 4  is 0.428587  in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->D
 Output page width in characters (e.g. 80..132) ?--> 132
 Estimate historical assessment uncertainty ?-->n
Succesful exit from ICA
```

Table. 3.6.7WESTERN BALTIC HERRING. Output from ICA Final Run
FISHING MORTALITY (per year)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.02800	0.04724	0.08023	0.05075	0.16851	0.04705	0.11680	0.11957	0.10883	0.05384	0.06753	0.06473	0.05162	0.04961	0.05247
1	0.26044	0.17497	0.30018	0.16146	0.64393	0.38175	0.32234	0.35675	0.23511	0.32378	0.23979	0.22983	0.18330	0.17616	0.18631
2	0.32164	0.37417	0.35331	0.42543	0.57876	0.38336	0.36284	0.43548	0.40337	0.36645	0.34620	0.33182	0.26465	0.25433	0.26898
3	0.42385	0.37413	0.47985	0.50806	0.51397	0.57333	0.50042	0.41155	0.47896	0.41351	0.40950	0.39250	0.31304	0.30084	0.31817
4	0.40478	0.47988	0.50336	0.65866	0.53046	0.73346	0.44202	0.54448	0.36699	0.49744	0.55162	0.52871	0.42168	0.40525	0.42859
5	0.38330	0.50817	0.64028	0.71972	0.44618	0.83858	0.50561	0.52453	0.41204	0.56037	0.52097	0.49933	0.39825	0.38273	0.40478
6	0.25411	0.59414	0.60337	0.95008	0.61770	0.75559	0.67997	0.58388	0.34053	0.55365	0.61777	0.59211	0.47225	0.45385	0.47999
7	0.45335	0.50852	0.60332	0.66712	0.77505	0.75956	0.59638	0.61503	0.48935	0.57848	0.55162	0.52871	0.42168	0.40525	0.42859
8	0.45335	0.50852	0.60332	0.66712	0.77505	0.75956	0.59638	0.61503	0.48935	0.57848	0.55162	0.52871	0.42168	0.40525	0.42859

Table. 3.6.8WESTERN BALTIC HERRING. Output from ICA Final Run
POPULATION ABUNDANCE (millions)- 1 January

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	4983.0	3635.1	3088.2	6148.3	4023.4	4305.1	3944.8	5629.9	6376.3	3365.0	4030.7	2777.9	4687.0	3611.3	3473.5
1	4528.6	3589.5	2568.7	2111.4	4329.4	2518.4	3042.7	2600.2	3700.7	4236.6	2362.2	2791.0	1929.0	3297.5	2545.8
2	2159.6	2117.0	1827.7	1154.0	1089.7	1379.2	1042.8	1337.0	1103.9	1774.3	1858.9	1127.3	1345.3	974.0	1677.0
3	1790.0	1281.8	1192.2	1051.0	617.4	500.1	769.6	593.9	708.2	603.8	1007.0	1076.6	662.3	845.3	618.4
4	921.1	959.2	721.9	604.1	517.7	302.3	230.8	382.0	322.2	359.1	326.9	547.4	595.3	396.5	512.3
5	611.1	503.1	486.0	357.3	256.0	249.4	118.9	121.5	181.5	182.8	178.8	154.2	264.1	319.7	216.5
6	227.6	341.0	247.8	209.8	142.4	134.1	88.3	58.7	58.8	98.4	85.4	86.9	76.6	145.2	178.5
7	39.8	144.5	154.1	111.0	66.4	62.9	51.6	36.6	26.8	34.3	46.3	37.7	39.4	39.1	75.5
8	14.8	62.0	59.2	74.2	41.3	51.4	58.7	33.6	17.2	26.6	17.2	22.2	28.1	36.2	39.7

AGE	2006
0	3086.4
1	2441.7
2	1281.7
3	1049.2
4	368.3
5	273.2
6	118.2
7	90.4
8	61.4

Table. 3.6.9WESTERN BALTIC HERRING. Output from ICA Final Run
STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 6	SoP (%)
1991	4982970	608826	304411	191573	0.6293	0.3665	99
1992	3635070	533346	314917	194411	0.6173	0.4891	100
1993	3088150	456382	288746	185010	0.6407	0.5567	100
1994	6148290	370909	226086	172438	0.7627	0.7091	99
1995	4023410	312733	178238	150831	0.8462	0.5271	100
1996	4305070	268338	130676	121266	0.9280	0.7252	100
1997	3944820	267503	145258	115588	0.7957	0.5320	100
1998	5629850	263370	116790	107032	0.9164	0.5161	99
1999	6376320	280358	121128	97240	0.8028	0.3996	100
2000	3364990	284340	132694	109914	0.8283	0.5062	100
2001	4030720	307730	152643	105803	0.6931	0.5250	99
2002	2777930	339175	185578	106191	0.5722	0.5032	99
2003	4686970	260229	150752	78309	0.5195	0.4013	99
2004	3611310	284449	168700	76815	0.4553	0.3857	100
2005	3473460	299203	164639	88406	0.5370	0.4079	100

Table. 3.6.10 WESTERN BALTIC HERRING. Output from ICA Final Run
PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	2001	0.5516	12	0.4304	0.7070	0.4860	0.6261	0.5561
2	2002	0.5287	12	0.4116	0.6792	0.4653	0.6008	0.5330
3	2003	0.4217	13	0.3254	0.5465	0.3694	0.4813	0.4254
4	2004	0.4052	13	0.3082	0.5328	0.3524	0.4660	0.4092
5	2005	0.4286	15	0.3145	0.5840	0.3660	0.5019	0.4340
Separable Model: Selection (S) by age								
6	0	0.1224	36	0.0600	0.2499	0.0851	0.1762	0.1308
7	1	0.4347	15	0.3206	0.5894	0.3721	0.5078	0.4400
8	2	0.6276	14	0.4697	0.8386	0.5413	0.7276	0.6345
9	3	0.7424	14	0.5582	0.9874	0.6418	0.8586	0.7503
	4	1.0000		Fixed : Reference Age				
10	5	0.9444	13	0.7300	1.2219	0.8281	1.0771	0.9526
11	6	1.1199	12	0.8740	1.4350	0.9869	1.2709	1.1289
	7	1.0000		Fixed : Last true age				
Separable model: Populations in year 2005								
12	0	3473460	49	1319850	9141133	2120095	5690747	3923626
13	1	2545840	22	1654073	3918389	2043064	3172344	2608207
14	2	1676995	16	1216372	2312049	1423561	1975548	1699656
15	3	618376	14	469255	814885	537166	711865	624536
16	4	512270	12	398704	658183	450780	582148	516475
17	5	216469	12	169045	277197	190811	245577	218199
18	6	178506	13	135970	234348	155361	205099	180236
19	7	75519	16	54826	104020	64136	88921	76533
Separable model: Populations at age								
20	2001	46306	23	28959	74043	36444	58835	47653
21	2002	37715	19	25848	55030	31103	45733	38422
22	2003	39376	17	28124	55128	33164	46751	39960
23	2004	39114	16	28284	54092	33151	46150	39653

Table. 3.6.11 WESTERN BALTIC HERRING. Output from ICA Final Run
AGE-STRUCTURED INDEX OF CATCHABILITIES

```
 Acoustic Survey in Div IIIa+IVaE WR 2-8+
 Linear model fitted. Slopes at age :
   24   2  Q  1.248      17 1.059     2.071     1.248     1.758     1.503
   25   3  Q  1.395      17 1.184     2.315     1.395     1.964     1.680
   26   4  Q  1.256      17 1.065     2.084     1.256     1.768     1.512
   27   5  Q  1.040      17 .8814     1.729     1.040     1.466     1.253
   28   6  Q  .9019      17 .7633     1.509     .9019     1.277     1.089
   29   7  Q  .9093      17 .7673     1.535     .9093     1.295     1.102
   30   8  Q  .8023      17 .6788     1.343     .8023     1.137     .9695

 Acoustic Survey in Subdiv 22-24 WR 0-5
 Linear model fitted. Slopes at age :
   31   0  Q  .8503      15 .7311     1.355     .8503     1.165     1.008
   32   1  Q  .5806      15 .5007     .9161     .5806     .7901     .6854
   33   2  Q  .5815      15 .5018     .9158     .5815     .7903     .6859
   34   3  Q  .8270      15 .7139     1.302     .8270     1.124     .9753
   35   4  Q  .9228      15 .7964     1.453     .9228     1.254     1.089
   36   5  Q  .7813      15 .6738     1.233     .7813     1.064     .9225

 IYFS Katt Quart3 WR 1-5
 Linear model fitted. Slopes at age :
   37   1  Q  .2151E-03  14 .1869E-03 .3315E-03 .2151E-03 .2881E-03 .2516E-03
   38   2  Q  .1781E-03  14 .1549E-03 .2738E-03 .1781E-03 .2382E-03 .2082E-03
   39   3  Q  .1229E-03  14 .1069E-03 .1889E-03 .1229E-03 .1643E-03 .1436E-03
   40   4  Q  .9817E-04  14 .8540E-04 .1509E-03 .9817E-04 .1313E-03 .1147E-03
   41   5  Q  .8860E-04  14 .7701E-04 .1366E-03 .8860E-04 .1187E-03 .1036E-03
```

Table. 3.6.12 WESTERN BALTIC HERRING. Output from ICA Final Run
RESIDUALS ABOUT THE MODEL FIT Separable Model Residuals
(log(Observed Catch)-log(Expected Catch))

Age	2001	2002	2003	2004	2005
0	1.200	-0.003	-1.339	0.477	-0.362
1	0.268	0.370	-0.703	0.081	-0.117
2	-0.014	-0.029	-0.072	-0.006	-0.120
3	-0.180	0.008	-0.006	-0.194	0.147
4	-0.159	-0.176	0.013	-0.257	-0.223
5	0.030	0.032	0.269	-0.016	-0.081
6	0.081	0.080	0.100	0.012	0.055
7	0.019	-0.023	0.345	0.224	0.262

Table. 3.6.13 WESTERN BALTIC HERRING. Output from ICA Final Run
AGED INDEX RESIDUALS: LOG(OBSERVED INDEX) - LOG(EXPECTED INDEX)

Acoustic Survey in Div IIIa+IVaE WR 2-8+

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	-0.043	0.125	0.539	-0.858	0.814	-0.174	-0.247	0.405	*******	0.196	-0.945	0.446	-0.123	0.016	-0.151
3	0.131	0.365	0.158	-0.008	0.617	-0.555	0.127	0.466	*******	0.160	-0.753	0.295	-0.530	-0.172	-0.298
4	0.089	0.705	0.024	0.122	1.126	-0.407	-0.156	-0.066	*******	0.221	-0.517	0.185	-0.449	-0.106	-0.769
5	-0.232	0.504	0.373	0.134	0.361	-0.130	-0.171	0.324	*******	0.452	-0.206	-0.168	-0.603	-0.229	-0.408
6	-0.563	0.051	0.130	0.702	0.815	-0.587	0.407	0.453	*******	0.004	-0.207	-0.191	-0.589	-0.188	-0.230
7	1.097	0.368	-0.298	0.055	0.172	-0.451	1.032	0.438	*******	-1.021	-0.135	-0.200	-0.705	-0.125	-0.220
8	0.235	-0.468	-0.793	-0.018	0.153	-0.555	0.989	1.187	*******	-0.312	0.319	0.415	-1.040	-0.101	-0.004

Acoustic Survey in Sub div 22-24 WR 0-5

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.537	0.393	-0.925	0.104	0.531	-0.671	0.082	-0.451	0.210	-0.747	-0.333	0.814	0.207	0.034	0.217
1	0.561	0.585	-0.824	-0.561	0.144	0.406	0.417	-0.523	-0.041	-0.052	0.549	-0.391	0.186	-0.201	-0.254
2	0.062	0.266	-0.657	0.705	-0.102	0.073	0.241	0.175	-0.476	-0.318	0.925	-0.141	-0.992	0.404	-0.164
3	-0.053	-0.365	-0.166	0.090	0.141	0.617	-0.058	0.190	-0.598	0.130	0.684	0.021	-0.457	-0.285	0.112
4	-0.705	-0.791	0.004	0.434	0.250	0.757	0.170	0.177	-0.381	0.082	0.770	0.178	-0.191	-0.306	-0.446
5	-1.077	-1.145	-0.471	0.308	0.728	1.204	0.752	0.622	-0.680	0.041	0.159	-0.121	-0.216	-0.078	-0.022

IYFS Kattegat Quarter 3 WR 1-5

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-1.456	-0.310	0.187	-0.127	0.411	0.704	-2.012	-1.025	-0.543	*******	-0.022	1.416	1.275	0.969	0.532
2	-1.205	-0.895	-0.372	0.501	0.474	0.635	-0.067	-0.623	-0.148	*******	-0.214	0.160	1.122	0.499	0.137
3	-0.390	-0.454	-0.826	0.620	0.846	-0.208	-0.610	-0.801	0.223	*******	-0.161	0.092	1.058	0.637	-0.024
4	-0.409	0.022	-0.237	0.345	1.124	0.055	-0.596	0.148	0.416	*******	-0.109	-0.785	0.285	0.117	-0.376
5	-0.456	-0.148	-0.013	0.694	0.662	-0.023	0.666	-0.322	0.265	*******	-1.619	-0.414	0.602	0.156	-0.047

Table. 3.6.14 WESTERN BALTIC HERRING. Output from ICA Final Run PARAMETERS OF THE DISTRIBUTION OF Ln CATCHES AT AGE

```
PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)
 -----------------------------------------------------
Separable model fitted from 2001  to 2005
 Variance                            0.1008
Skewness test stat.                 -1.8630
Kurtosis test statistic              2.4610
Partial chi-square                   0.1448
Significance in fit                  0.0000
Degrees of freedom                       17
```

Table. 3.6.15 **WESTERN BALTIC HERRING. Output from ICA Final Run. PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES**

DISTRIBUTION STATISTICS FOR **Acoustic Survey in Div IIIa+IVaE WR 2-8+**

Linear catchability relationship assumed

Age	2	3	4	5	6	7	8
Variance	0.0344	0.0239	0.0345	0.0176	0.0299	0.0503	0.0559
Skewness test stat.	-0.6593	-0.6340	1.0725	0.0675	0.5454	0.5833	0.4147
Kurtosis test statisti	-0.1797	-0.6582	0.2616	-0.9478	-0.7048	-0.2410	-0.3467
Partial chi-square	0.0320	0.0231	0.0346	0.0189	0.0348	0.0645	0.0737
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	14	14	14	14	14	14	14
Degrees of freedom	13	13	13	13	13	13	13
Weight in the analysis	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429

DISTRIBUTION STATISTICS FOR **Acoustic Survey in Subdiv 22-24 WR 0-5**

Linear catchability relationship assumed

Age	0	1	2	3	4	5
Variance	0.0443	0.0343	0.0415	0.0209	0.0371	0.0747
Skewness test stat.	-0.6013	-0.3411	-0.1527	0.4779	-0.0219	-0.1367
Kurtosis test statisti	-0.7147	-0.9018	-0.1922	-0.2110	-0.6203	-0.5087
Partial chi-square	0.0424	0.0351	0.0439	0.0228	0.0416	0.0890
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	15	15	15	15	15	15
Degrees of freedom	14	14	14	14	14	14
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

DISTRIBUTION STATISTICS FOR **IYFS Kattegat Quarter 3 WR 1-5**

Linear catchability relationship assumed

Age	1	2	3	4	5
Variance	0.2027	0.0813	0.0740	0.0465	0.0761
Skewness test stat.	-0.7281	-0.3503	0.4483	0.7929	-1.7051
Kurtosis test statisti	-0.4459	-0.4342	-0.8269	0.2869	1.0742
Partial chi-square	0.4409	0.1992	0.2300	0.1785	0.4119
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	14	14	14	14	14
Degrees of freedom	13	13	13	13	13
Weight in the analysis	0.2000	0.2000	0.2000	0.2000	0.2000

Table. 3.6.16 WESTERN BALTIC HERRING. Output from ICA Final Run ANALYSIS OF VARIANCE TABLE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	79.8559	298	41	257	0.3107
Catches at age	4.9444	40	23	17	0.2908
Aged Indices					
Acoustic Survey Div IIIa+IVaE WR 2-8+	22.4361	98	7	91	0.2466
Acoustic Survey Subdiv 22-24 WR 0-5	21.2345	90	6	84	0.2528
IYFS Kattegat Quarter 3 WR 1-5	31.2409	70	5	65	0.4806

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	4.0102	298	41	257	0.0156
Catches at age	1.7129	40	23	17	0.1008
Aged Indices					
Acoustic Survey Div IIIa+IVaE WR 2-8+	0.4579	98	7	91	0.0050
Acoustic Survey Subdiv 22-24 WR 0-5	0.5898	90	6	84	0.0070
IYFS Kattegat Quarter 3 WR 1-5	1.2496	70	5	65	0.0192

Table 3.7.1 WESTERN BALTIC HERRING. Input table for short term predictions

MFDP version 1a
Run: WBSS_2006_Final
Time and date: 10:18 20/03/2006
Fbar age range: 3-6

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	4390766	0.3	0.00	0.1	0.25	0.000	0.052	0.011
1	2987936	0.5	0.00	0.1	0.25	0.013	0.186	0.029
2	1281700	0.2	0.20	0.1	0.25	0.047	0.269	0.068
3	1049200	0.2	0.75	0.1	0.25	0.080	0.318	0.095
4	368300	0.2	0.90	0.1	0.25	0.107	0.429	0.108
5	273200	0.2	1.00	0.1	0.25	0.134	0.405	0.126
6	118200	0.2	1.00	0.1	0.25	0.157	0.480	0.144
7	90400	0.2	1.00	0.1	0.25	0.178	0.429	0.163
8	61400	0.2	1.00	0.1	0.25	0.191	0.429	0.163

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	4390766	0.3	0.00	0.1	0.25	0.000	0.052	0.011
1		0.5	0.00	0.1	0.25	0.013	0.186	0.029
2		0.2	0.20	0.1	0.25	0.047	0.269	0.068
3		0.2	0.75	0.1	0.25	0.080	0.318	0.095
4		0.2	0.90	0.1	0.25	0.107	0.429	0.108
5		0.2	1.00	0.1	0.25	0.134	0.405	0.126
6		0.2	1.00	0.1	0.25	0.157	0.480	0.144
7		0.2	1.00	0.1	0.25	0.178	0.429	0.163
8		0.2	1.00	0.1	0.25	0.191	0.429	0.163

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	4390766	0.3	0.00	0.1	0.25	0.000	0.052	0.011
1		0.5	0.00	0.1	0.25	0.013	0.186	0.029
2		0.2	0.20	0.1	0.25	0.047	0.269	0.068
3		0.2	0.75	0.1	0.25	0.080	0.318	0.095
4		0.2	0.90	0.1	0.25	0.107	0.429	0.108
5		0.2	1.00	0.1	0.25	0.134	0.405	0.126
6		0.2	1.00	0.1	0.25	0.157	0.480	0.144
7		0.2	1.00	0.1	0.25	0.178	0.429	0.163
8		0.2	1.00	0.1	0.25	0.191	0.429	0.163

Input units are thousands and kg - output in tonnes

M =	Natural mortality
MAT =	Maturity ogive
PF =	Proportion of F before spawning
PM =	Proportion of M before spawning
SWT =	Weight in stock (kg)
Sel =	Exploit. Pattern
CWT =	Weight in catch (kg)

N_{2006} Age 1:	Geometric Mean from ICA of age 1 (Table 3.6.8) for the years 1995-2004
N_{2006} Age 2-8+:	Output from ICA (Table 3.6.8)
$N_{2005/2006/2007/2008}$ Age 0:	Geometric Mean from ICA of age 0 (Table 3.6.8) for the years 1994-2003
Natural Mortality (M):	Average for 2003-2005
Weight in the Catch/Stock (CWt/SWt):	Average for 2003-2005
Expoitation pattern (Sel):	Average for 2003-2005 rescaled to the last year

Table 3.7.2 WESTERN BALTIC HERRING. Short term prediction single option table, status quo F.

MFDP version 1a
Run: WBSS_2006_Final
Time and date: 10:18 20/03/2006
Fbar age range: 3-6

Year:	2006	F multiplier: 1		Fbar:	0.4079				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0525	194152	2164	4390766	439	0	0	0	0
1	0.1863	402774	11580	2987936	39939	0	0	0	0
2	0.269	275198	18657	1281700	60428	256340	12086	237367	11191
3	0.3182	260523	24724	1049200	84048	786900	63036	725082	58084
4	0.4286	117186	12674	368300	39397	331470	35457	302076	32313
5	0.4048	82979	10415	273200	36701	273200	36701	249567	33526
6	0.48	41165	5948	118200	18549	118200	18549	107166	16818
7	0.4286	28763	4697	90400	16083	90400	16083	82383	14657
8	0.4286	19536	3185	61400	11755	61400	11755	55955	10713
Total		1422277	94042	10621102	307339	1917910	193667	1759596	177301

Year:	2007	F multiplier: 1		Fbar:	0.4079				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0525	194152	2164	4390766	439	0	0	0	0
1	0.1863	416059	11962	3086494	41256	0	0	0	0
2	0.269	322976	21896	1504222	70919	300844	14184	278577	13134
3	0.3182	199112	18896	801881	64236	601411	48177	554164	44392
4	0.4286	198835	21504	624914	66847	562422	60162	512548	54827
5	0.4048	59662	7488	196430	26388	196430	26388	179438	24105
6	0.48	51968	7509	149221	23417	149221	23417	135291	21231
7	0.4286	19053	3111	59883	10654	59883	10654	54572	9709
8	0.4286	25760	4199	80961	15500	80961	15500	73782	14126
Total		1487579	98729	10894771	319656	1951172	198482	1788372	181524

Year:	2008	F multiplier: 1		Fbar:	0.4079				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0525	194152	2164	4390766	439	0	0	0	0
1	0.1863	416059	11962	3086494	41256	0	0	0	0
2	0.269	333630	22618	1553839	73258	310768	14652	287766	13567
3	0.3182	233681	22176	941099	75388	705824	56541	650375	52099
4	0.4286	151965	16435	477608	51090	429847	45981	391729	41903
5	0.4048	101231	12706	333293	44773	333293	44773	304461	40900
6	0.48	37365	5399	107289	16837	107289	16837	97274	15265
7	0.4286	24054	3928	75598	13450	75598	13450	68894	12257
8	0.4286	23901	3896	75118	14381	75118	14381	68457	13106
Total		1516039	101284	11041105	330873	2037738	206615	1868957	189099

Input units are thousands and kg - output in tonnes

Table 3.7.3 WESTERN BALTIC HERRING.
Short-term prediction multiple option table, Status quo F.

MFDP version 1a
Run: WBSS_2006_Final
Western Baltic Herring (combined sex; plus group)
Time and date: 10:18 20/03/2006
Fbar age range: 3-6

2006				
Biomass	SSB	FMult	FBar	Landings
307339	177301	1.0000	0.4079	94042

2007					2008	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
319656	188802	0.0000	0.0000	0	438845	278360
.	188061	0.1000	0.0408	11376	426341	267709
.	187323	0.2000	0.0816	22385	414254	257486
.	186588	0.3000	0.1224	33041	402569	247672
.	185856	0.4000	0.1632	43356	391271	238251
.	185127	0.5000	0.2039	53342	380347	229206
.	184400	0.6000	0.2447	63010	369782	220521
.	183677	0.7000	0.2855	72373	359565	212182
.	182957	0.8000	0.3263	81440	349682	204174
.	182239	0.9000	0.3671	90222	340122	196484
.	181524	1.0000	0.4079	98729	330873	189099
.	180813	1.1000	0.4487	106971	321924	182005
.	180104	1.2000	0.4895	114957	313265	175191
.	179398	1.3000	0.5302	122695	304885	168645
.	178695	1.4000	0.5710	130195	296774	162357
.	177994	1.5000	0.6118	137465	288923	156316
.	177297	1.6000	0.6526	144512	281323	150511
.	176602	1.7000	0.6934	151344	273964	144933
.	175910	1.8000	0.7342	157969	266839	139573
.	175221	1.9000	0.7750	164394	259940	134422
.	174534	2.0000	0.8158	170626	253257	129471

Input units are thousands and kg - output in tonnes

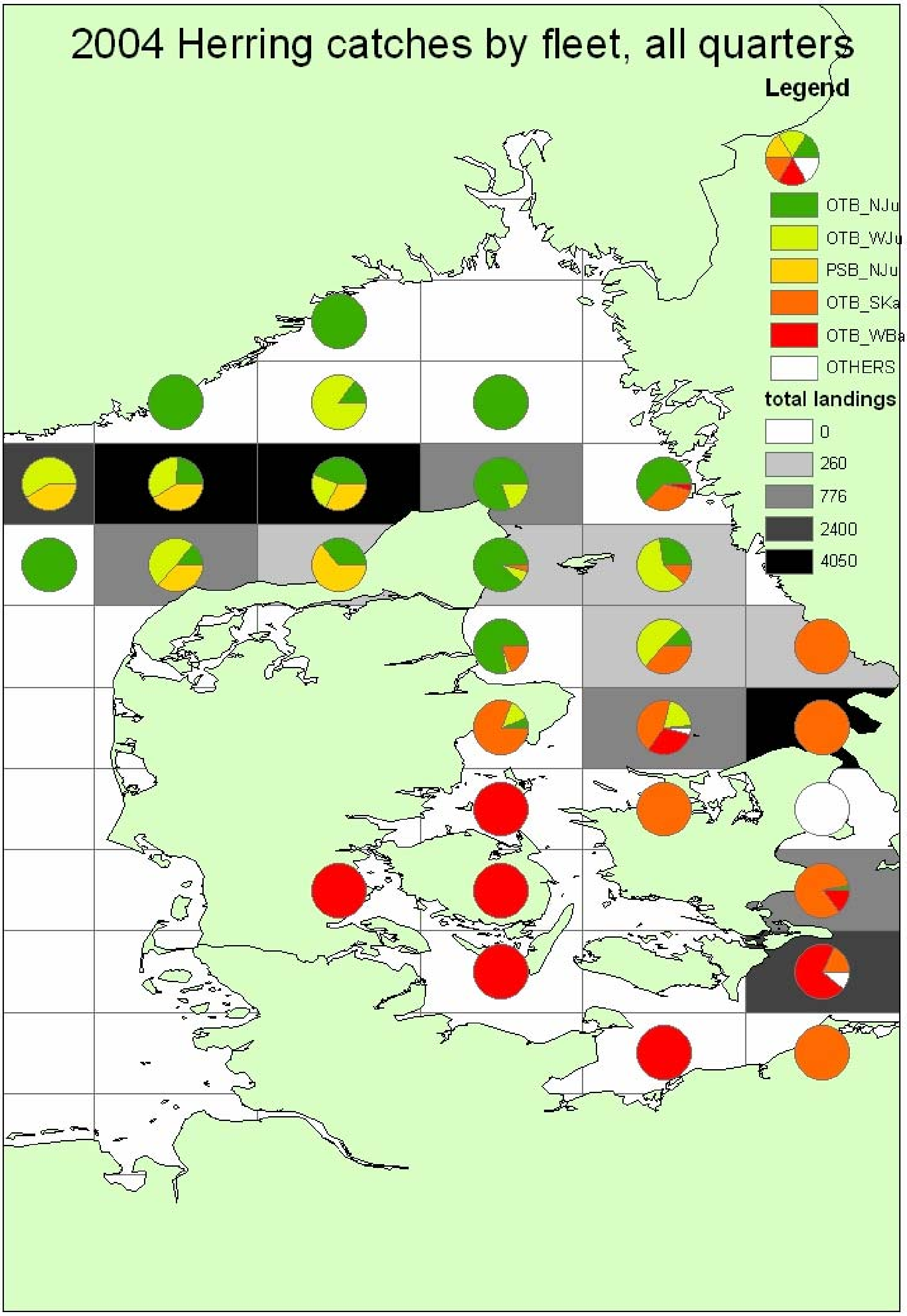


Figure 3.1.1 Western Baltic Herring. Danish herring landings in Division IIIa and Subdivisions 22-24 by vessel type and homeport (fleet) in 2004. Legend: OTB : trawler, PSB: purse seiner, OTH: other; NJu: Northern Jutland, WJu; Western Jutland, SKa: Skagen, WBa: Western Baltic. For further details refer to Ulrich-Rescan and Andersen 2006, WD 1 to the present report.

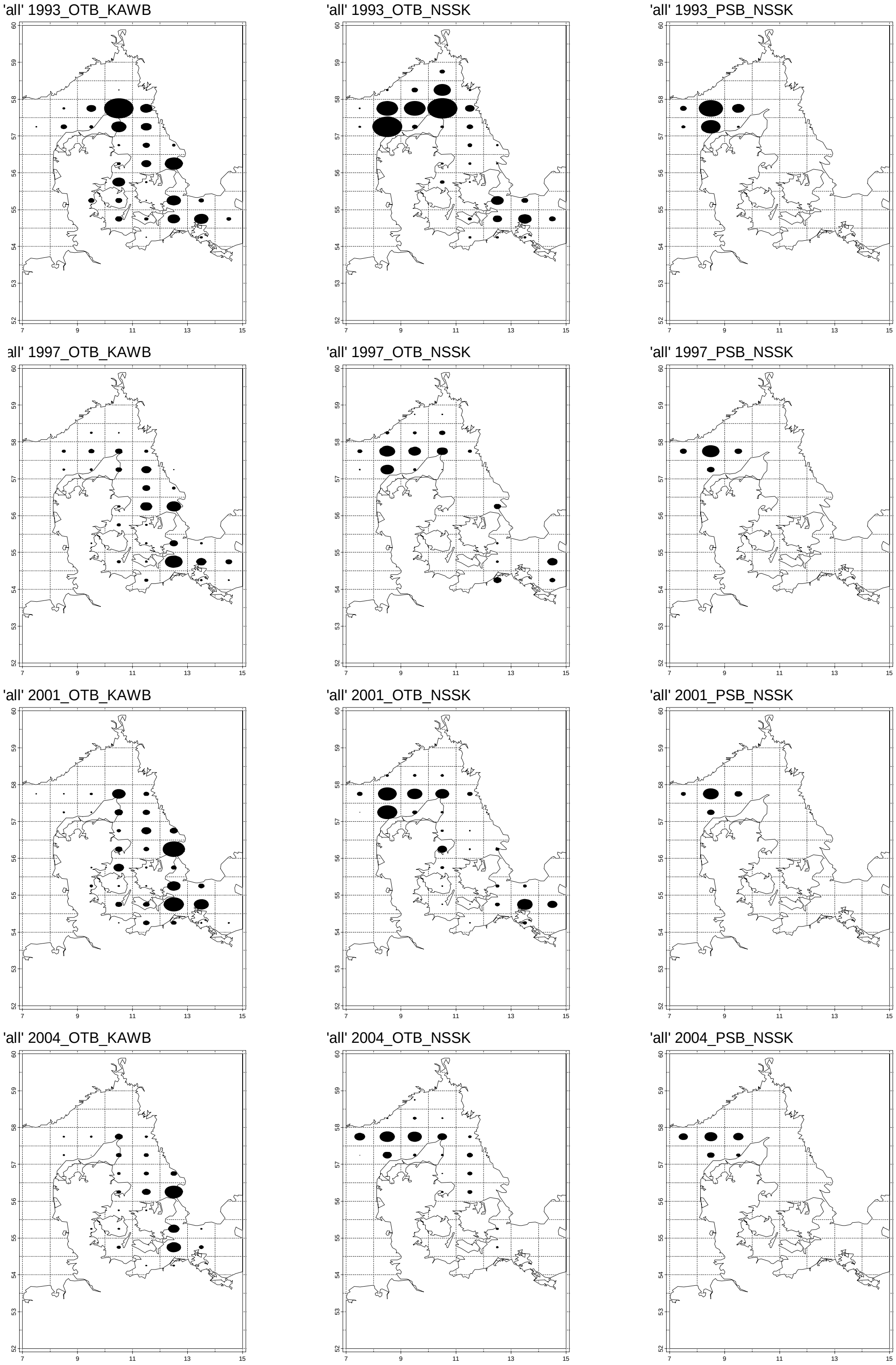


Figure 3.1.2 Western Baltic Herring. Distribution of Danish herring landings by fleet over selected years. For further details refer to Ulrich-Rescan and Andersen 2006, WD 1 to the present report.

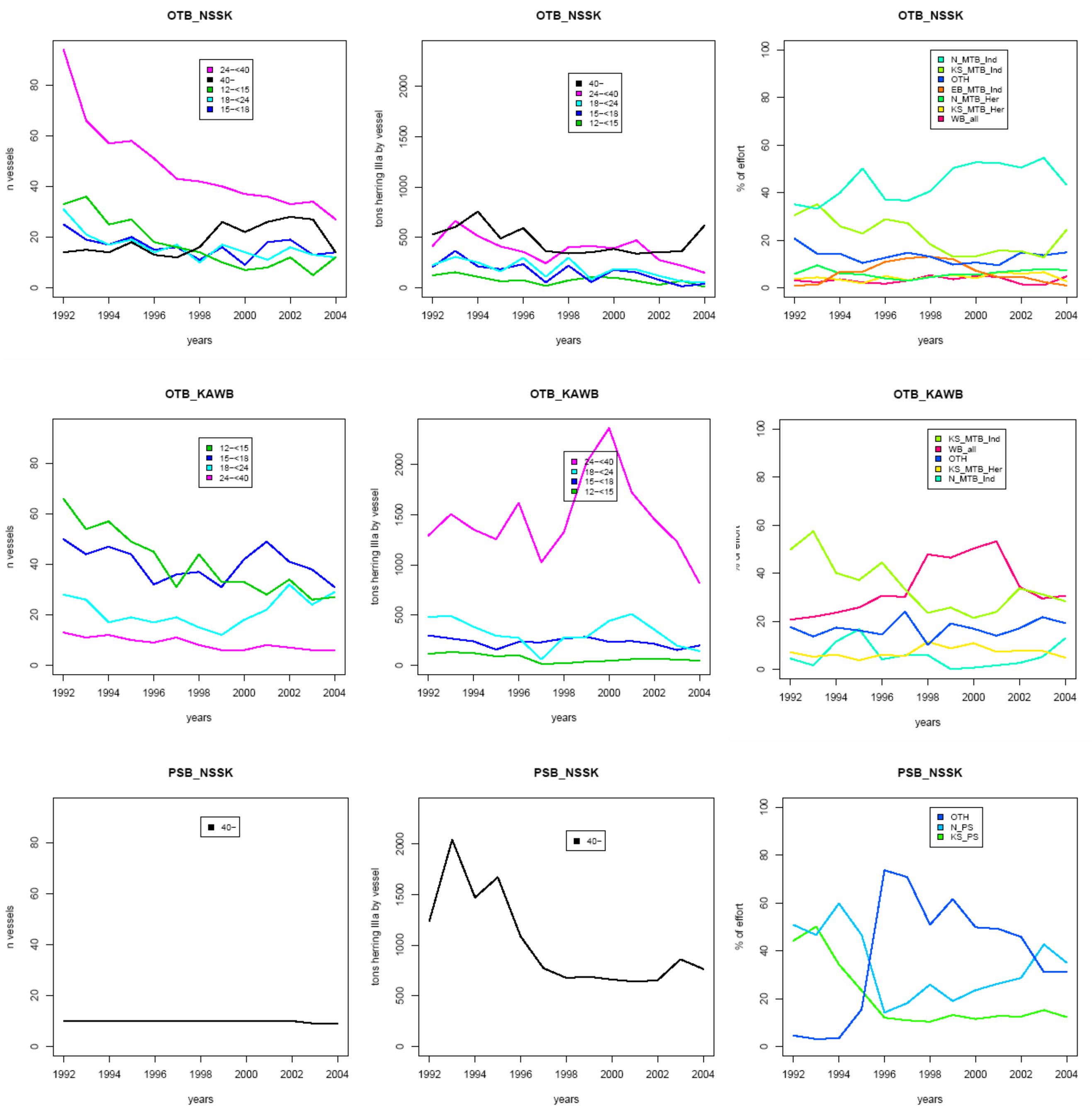


Figure 3.1.3 Western Baltic Herring. Number of vessels, average landings of Division IIIa herring by vessel and effort distribution by metier, by fleet between 1992 and 2004. For further details refer to Ulrich-Rescan and Andersen 2006, WD 1 to the present report.

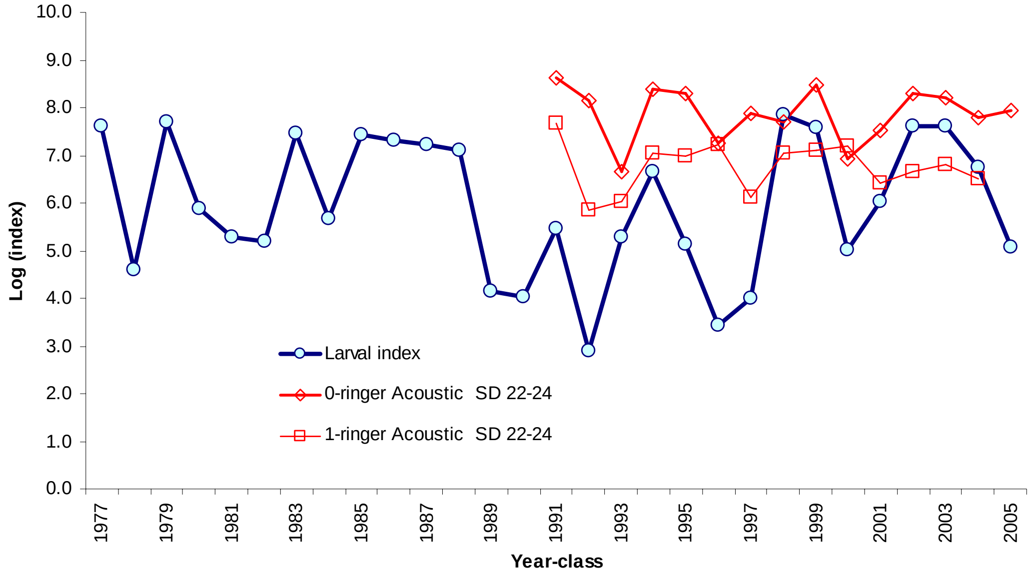


Figure 3.5.1 **WESTERN BALTIC HERRING. Recruitment indices (natural log) adjusted to year-class, versus time.**

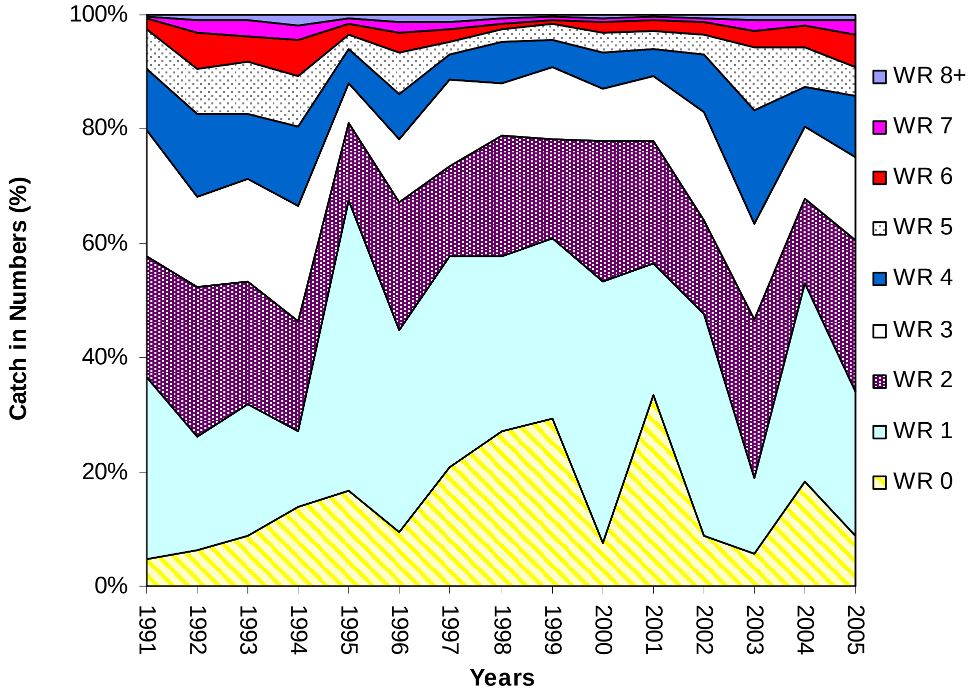


Figure 3.6.1 **WESTERN BALTIC HERRING.**
Proportions of age groups (numbers) in the total catch.

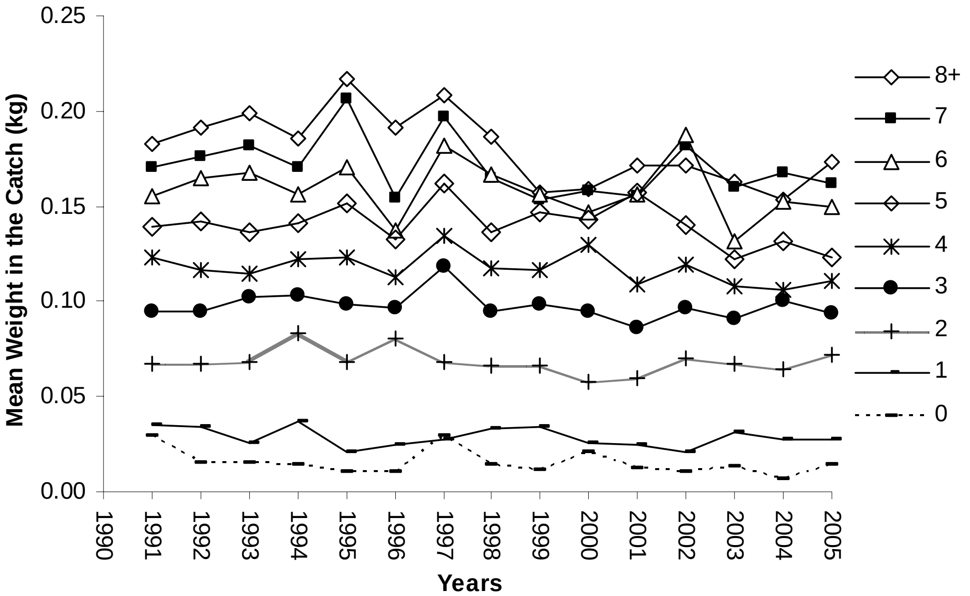
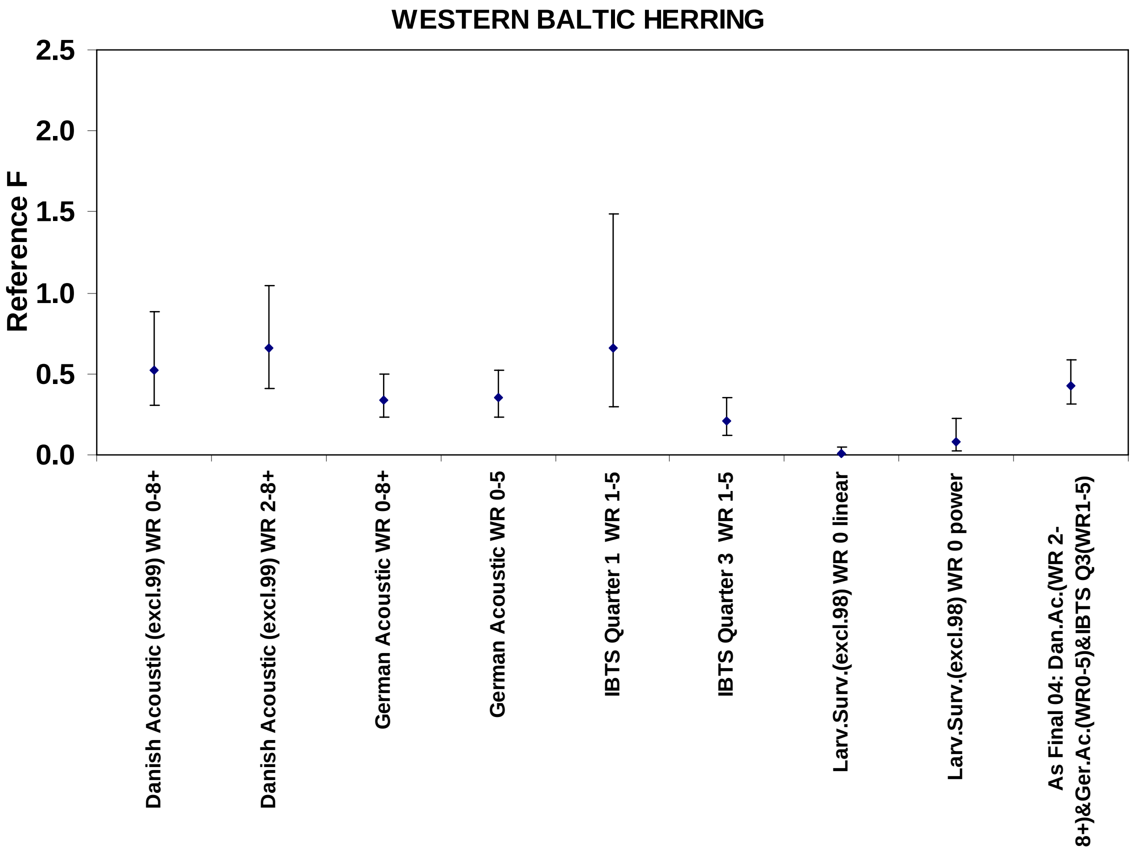


Figure 3.6.2 **WESTERN BALTIC HERRING.**
Mean weight in the catch (kg).



Fleet No.	Survey	Area	Quarter	WR	Mean F 2005	Lower)5% CL	Upper)5% CL	SSB (t) 2005
1a	Danish Acoustic (excl.99) WR 0-8+	Div. IIIa incl. Katt.	3	0-8+	0.522	0.308	0.884	135,897
1b	Danish Acoustic (excl.99) WR 2-8+	Div. IIIa incl. Katt.	3	2-8+	0.656	0.412	1.044	110,173
2a	German Acoustic WR 0-8+	SD 22, 23, 24	4	0-8+	0.340	0.232	0.498	181,276
2b	German Acoustic WR 0-5	SD 22, 23, 24	4	0-5	0.351	0.236	0.523	175,945
3	IBTS Quarter 1 WR 1-5	Kattegat	1	1-5	0.661	0.294	1.484	107,341
4	IBTS Quarter 3 WR 1-5	Kattegat	3	1-5	0.209	0.123	0.356	300,542
5a	Larv.Surv.(excl.98) WR 0 linear	SD 24	1-2	0	0.010	0.002	0.048	5,940,583
5b	Larv.Surv.(excl.98) WR 0 power	SD 24	1-2	0	0.078	0.027	0.224	791,086
1b+2b+4	\s Final 04: Dan.Ac.(WR 2-8+)&Ger.Ac.(WR0-5)&IBTS Q3(WR1-5)	SD 24	1-2	0-8+	0.429	0.315	0.584	164,639

Figure 3.6.3 WESTERN BALTIC HERRING. Estimates of mean F and SSB by ICA runs by individual fleets and catch at age data for 1991-2005.

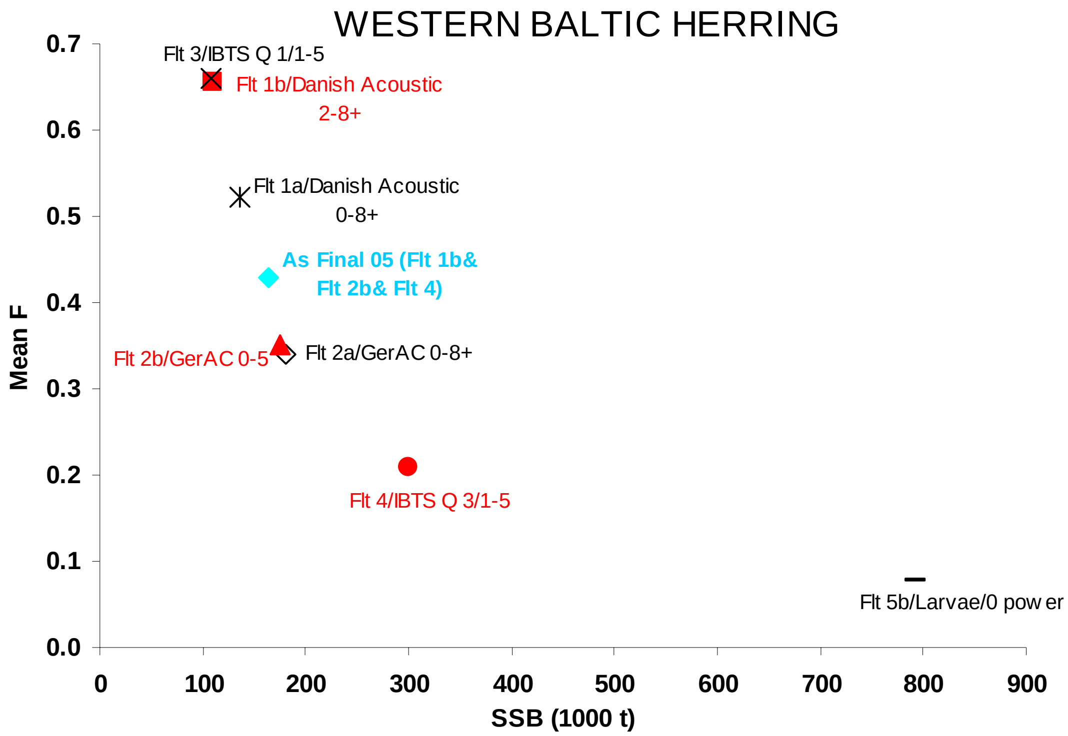


Figure 3.6.4 **WESTERN BALTIC HERRING.**
Estimates of mean F and SSB in terminal year by ICA runs by individual fleets and catch at age data for 1991-2005.

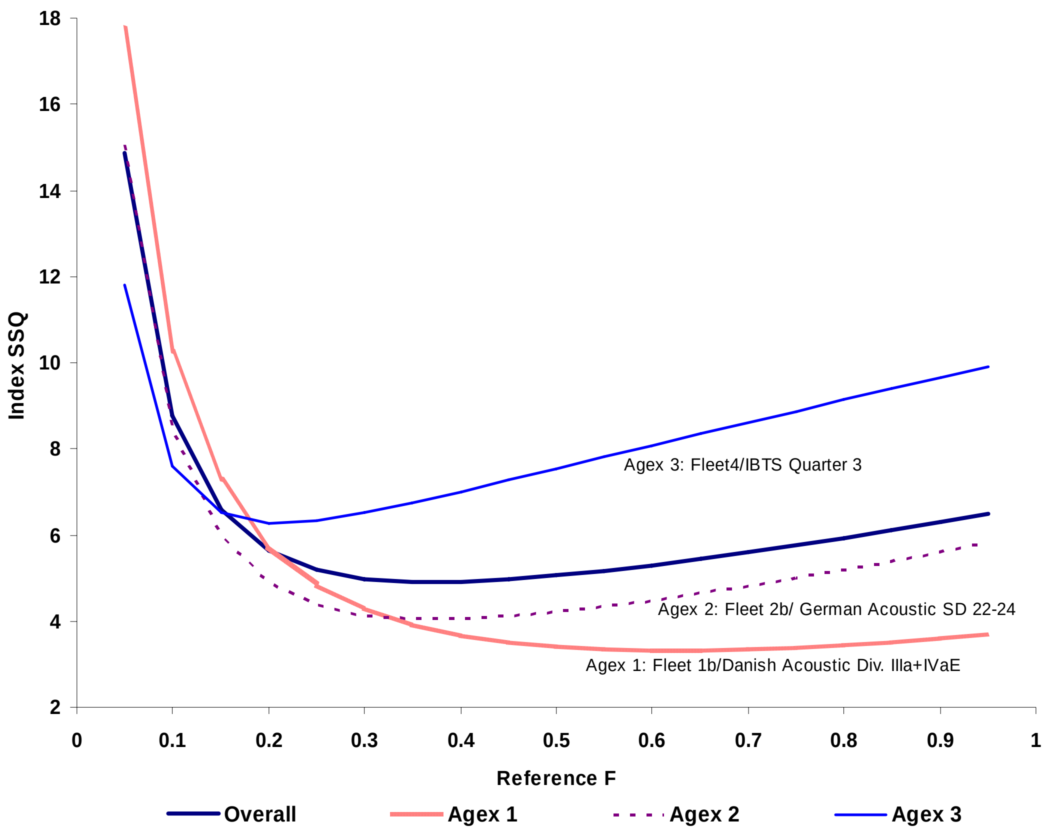


Figure 3.6.5 WESTERN BALTIC HERRING. Output from ICA Final run 2006.

Index sum of squares of deviations between model and observations

(survey index) as a function of the reference F in 2005.

Agex 1: Fleet 1b/Danish Acoustic in Division IIIa+IVaE, ages 0-8+

Agex 2: Fleet 2b/German Acoustic in SD 22-24, ages 0-5

Agex 3: Fleet 4/IBTS Quarter 3, ages 1-5

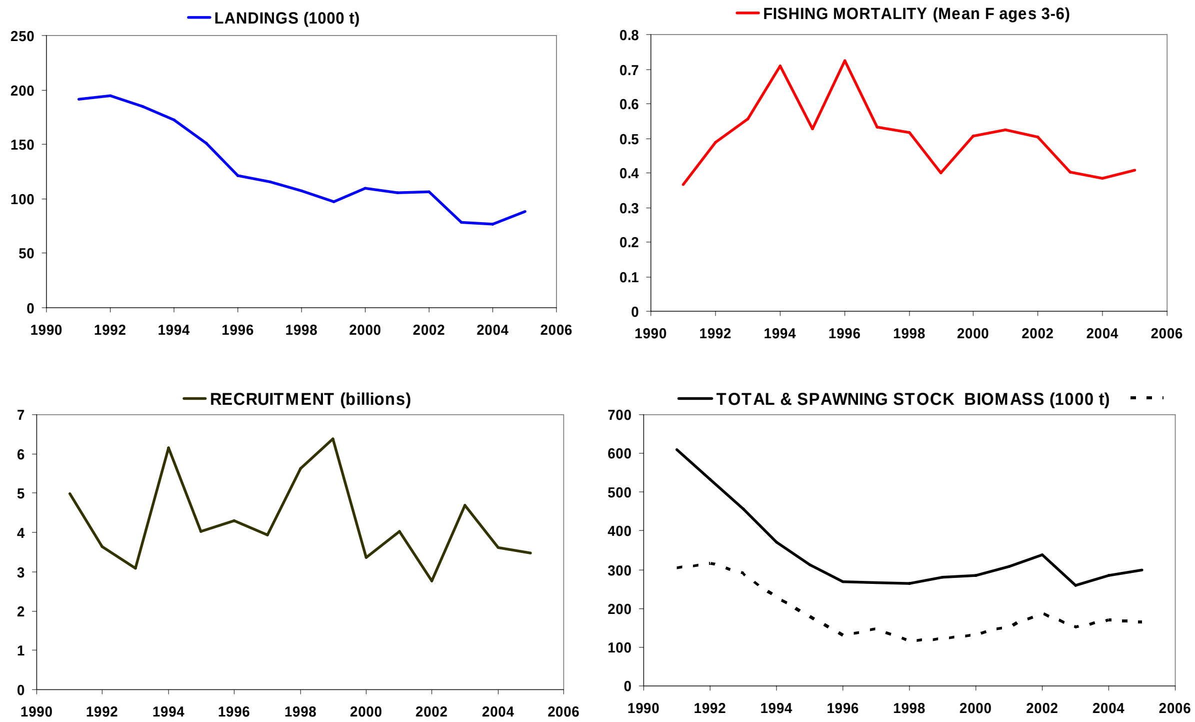


Figure 3.6.6 **WESTERN BALTIC HERRING. Output from ICA Final Run 2006. Stock summary.**

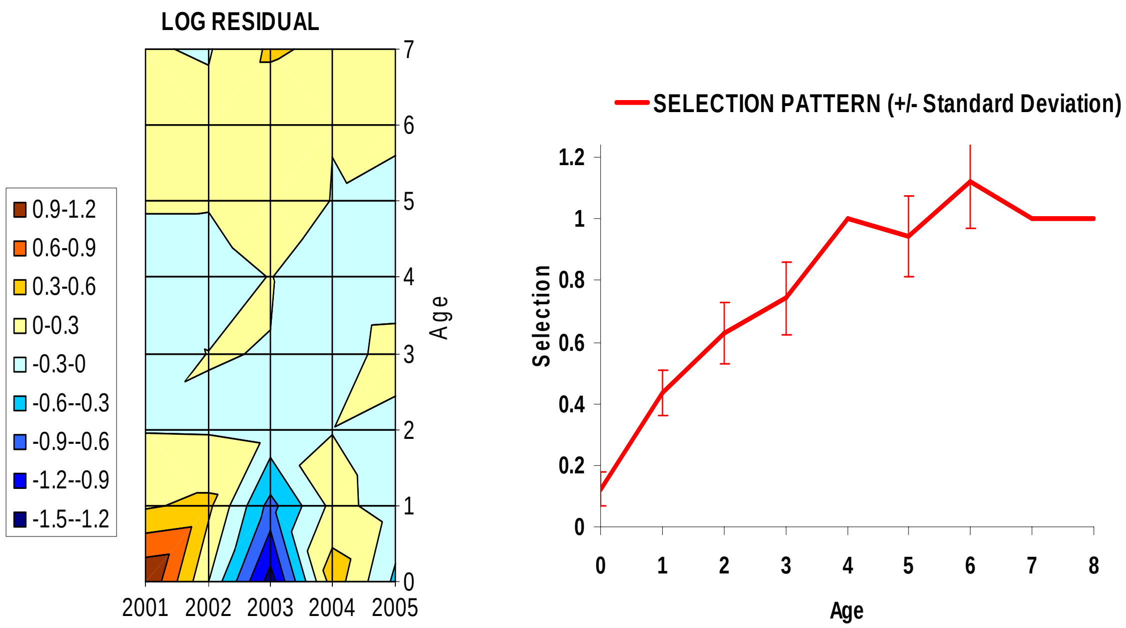


Figure 3.6.7 **WESTERN BALTIC HERRING. Output from ICA Final Run 2006.**
Separable Model Diagnostics: Log Residual & Selection pattern.
Age 0 is still included in the log residual and year residuals although age 0 was down-weighted (0.1) in the catch.

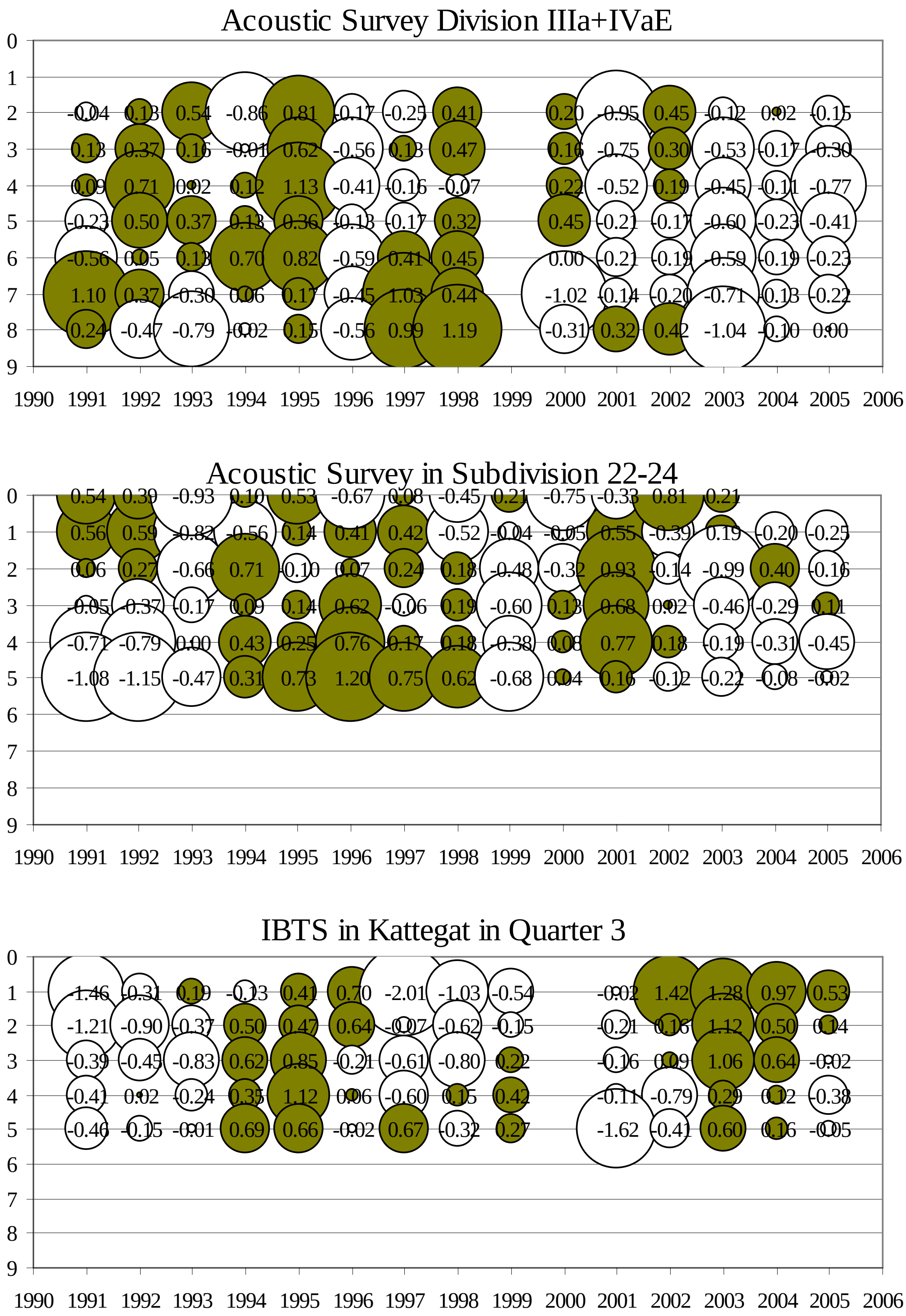


Figure 3.6.8 **WESTERN BALTIC HERRING. ICA Final Run 2006. Log catchability residuals plots.**

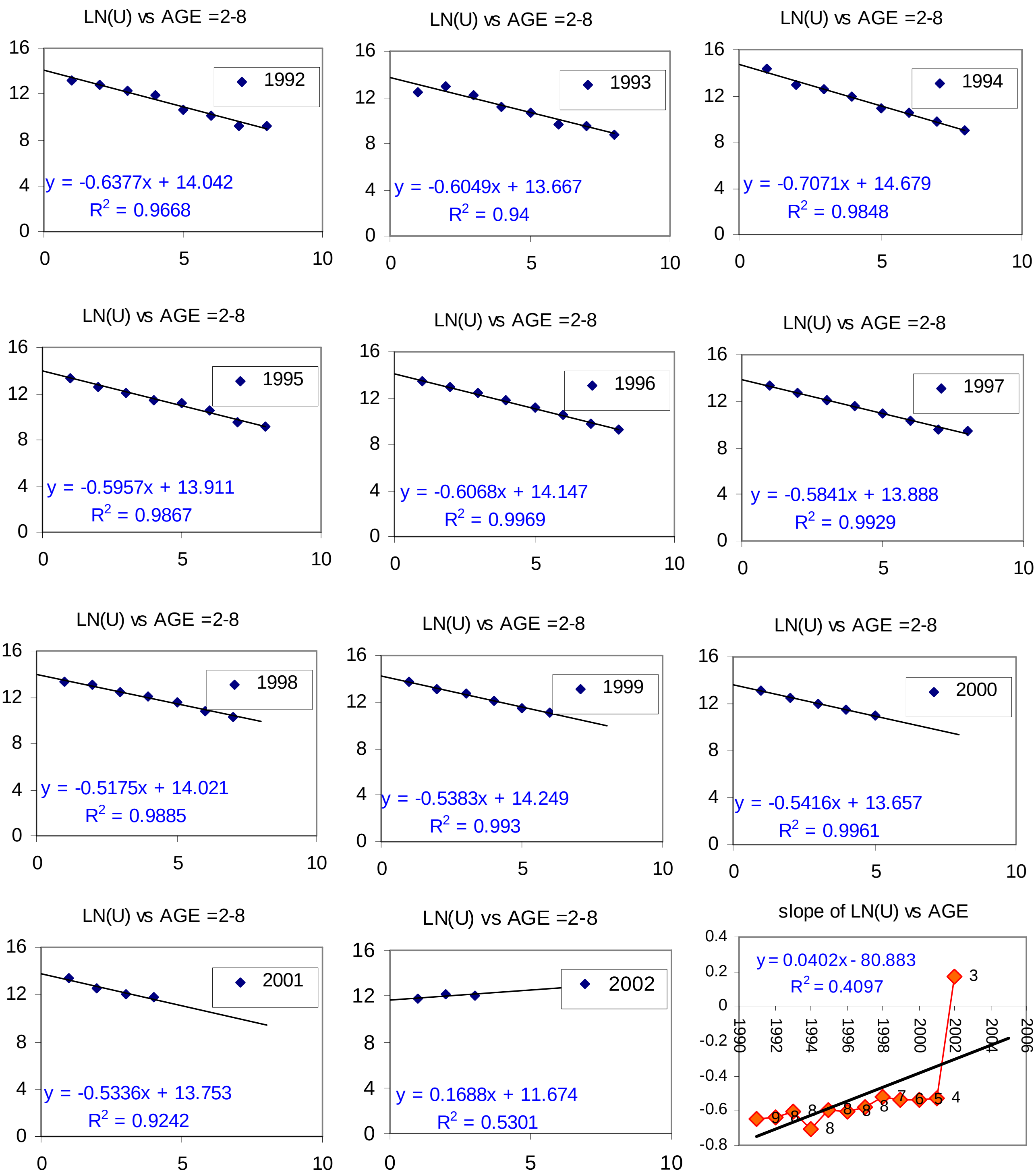


Figure 3.6.9a **WESTERN BALTIC HERRING. Log Catch vs Age for successive cohorts and their resulting slope estimates.**
CATCH IN NUMBER, Ages=1-8

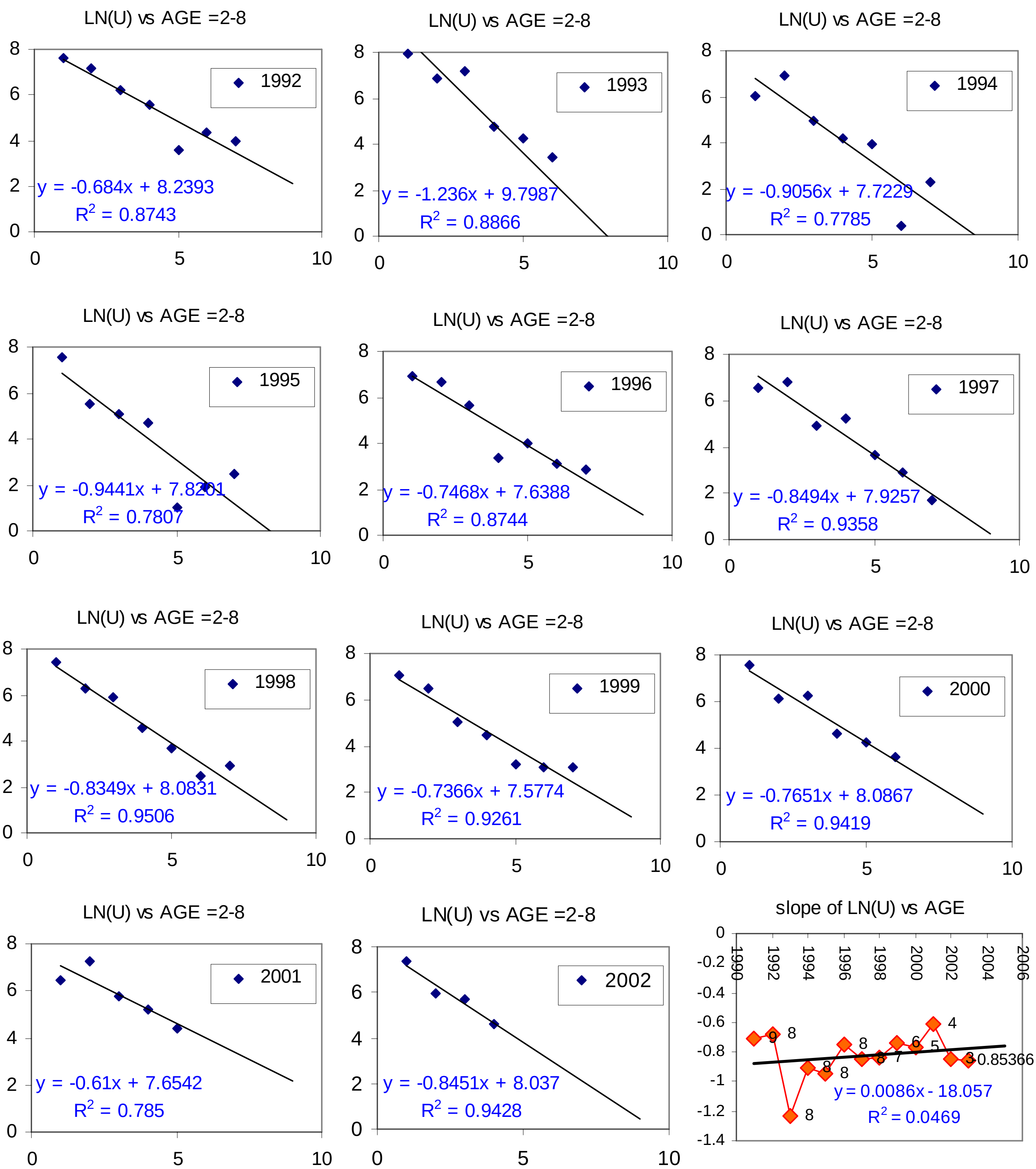


Figure 3.6.9b **WESTERN BALTIC HERRING. Log Catch vs Age for successive cohorts and their resulting slope estimates.**
ACOUSTIC SURVEY IN DIV IIIA+IVAE, AGES=2-8

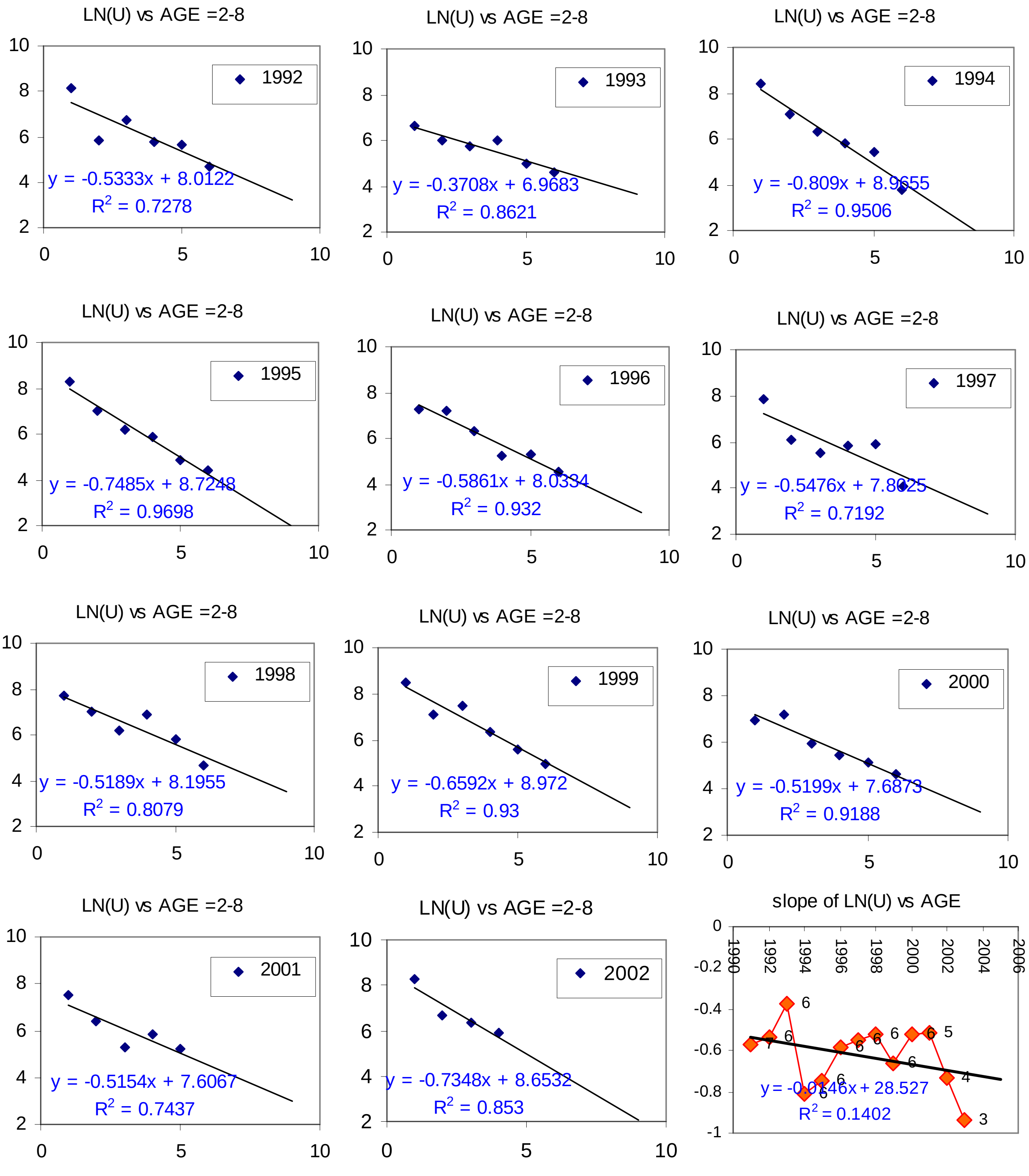


Figure 3.6.9c **WESTERN BALTIC HERRING. Log Catch vs Age for successive cohorts and their resulting slope estimates.**
ACOUSTIC SURVEY IN SD 22-24, Ages=0-5

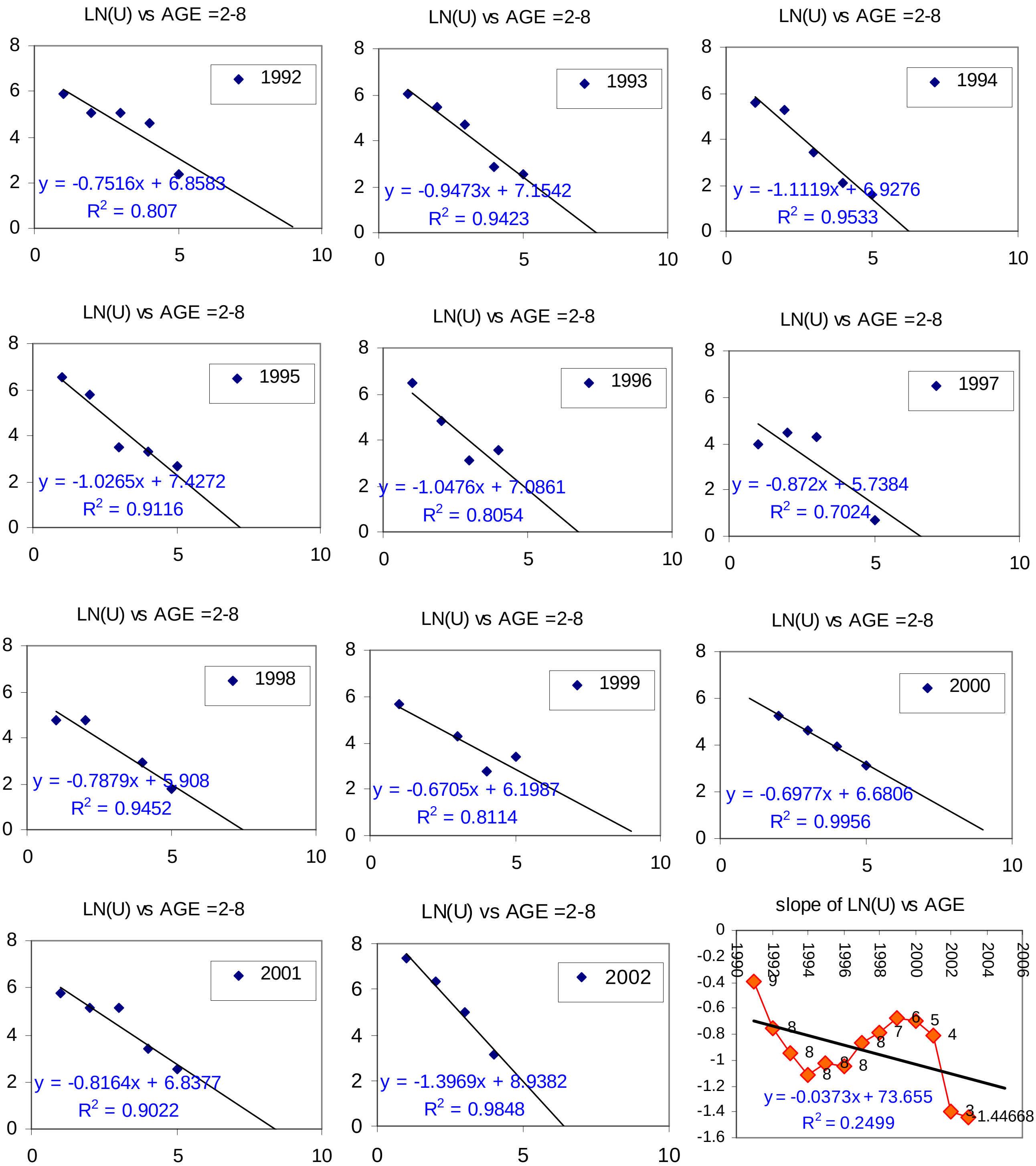
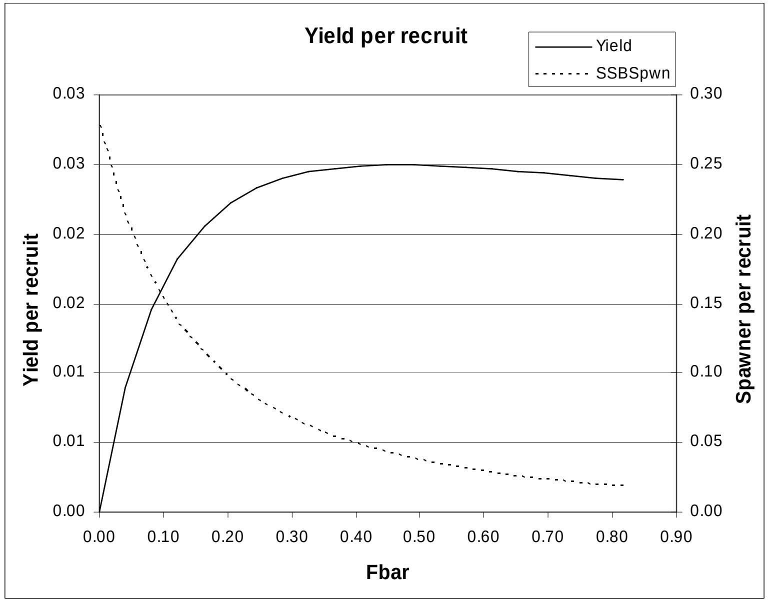
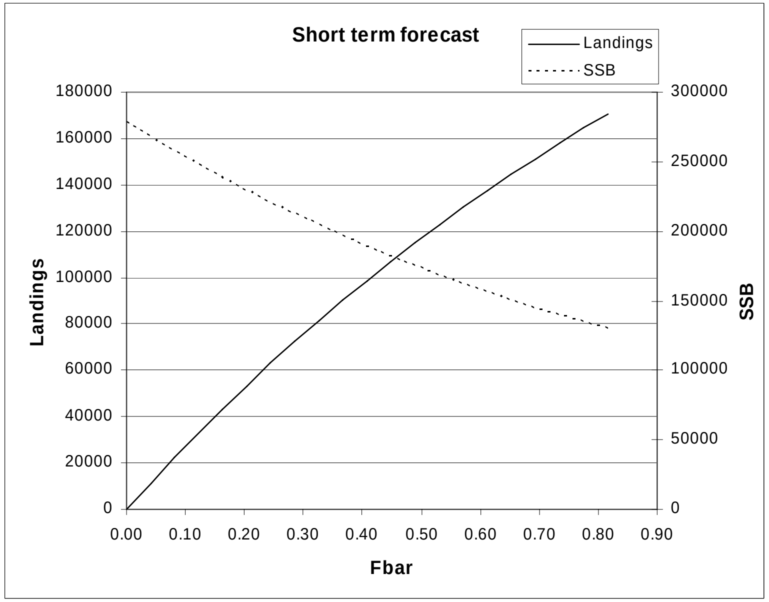


Figure 3.6.9d WESTERN BALTIC HERRING. Log Catch vs Age for successive cohorts and their resulting slope estimates.
IBTS IN KATTEGAT QUARTER 3, Ages=1-5





MFYPR version 2a
Run: WBSS_2006_Final
Time and date: 10:19 20/03/2006

Reference point	F multiplier	Absolute F
Fbar(3-6)	1.0000	0.4079
FMax	1.1389	0.4645
F0.1	0.5299	0.2161
F35%SPR	0.4904	0.2000

Weights in kilograms

MFDP version 1a
Run: WBSS_2006_Final
Western Baltic Herring (combined sex; plus group)
Time and date: 10:18 20/03/2006
Fbar age range: 3-6

Input units are thousands and kg - output in tonnes

Figure 3.7.1 **WESTERN BALTIC HERRING. Long and short term yield and SSB, derived by MFYPR v2a**

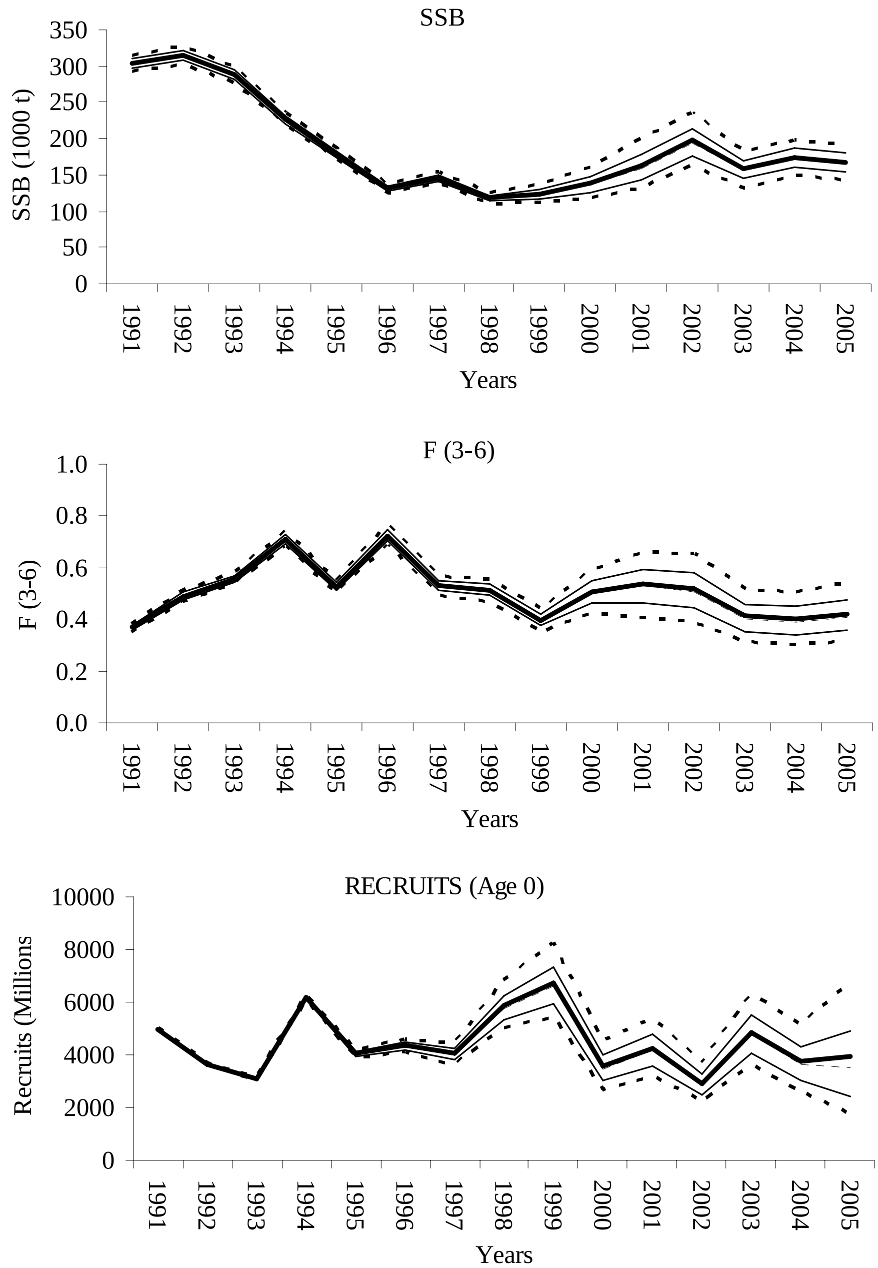


Figure 3.9.1 **WESTERN BALTIC HERRING.**
Historic uncertainty in the Final model fit (ICA assessment).
Percentiles 10, 25, 50, 75 and 90 %.

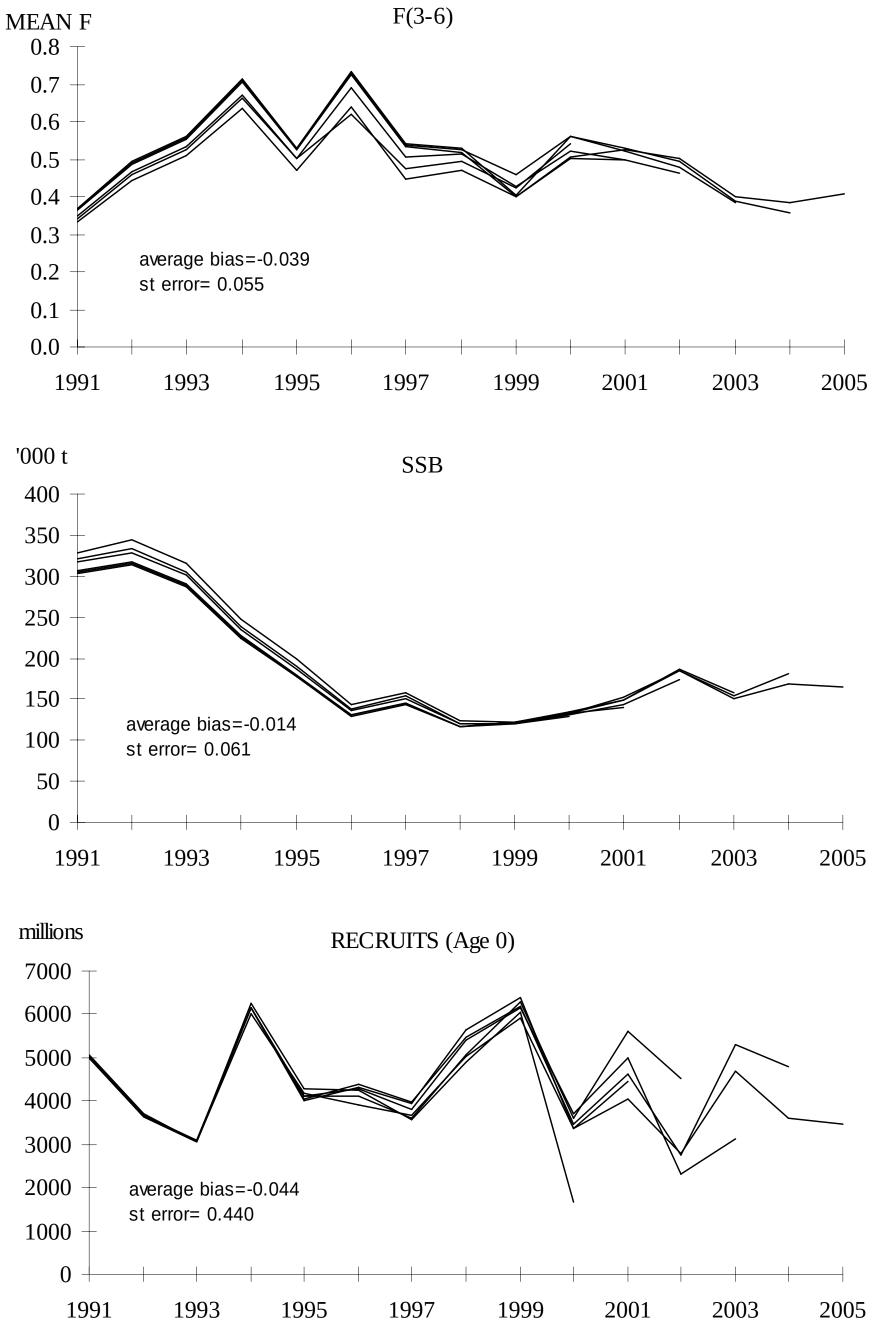


Figure 3.9.2 WESTERN BALTIC HERRING: Restrospective Analysis (ICA)

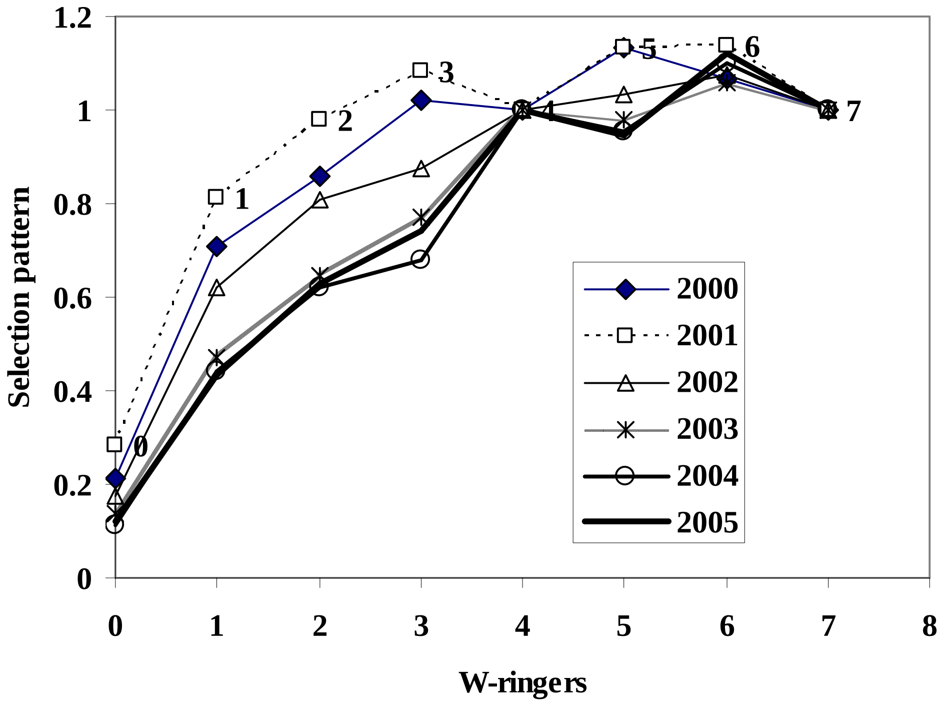


Figure 3.9.3 **WESTERN BALTIC HERRING. Restrospective selection pattern.**

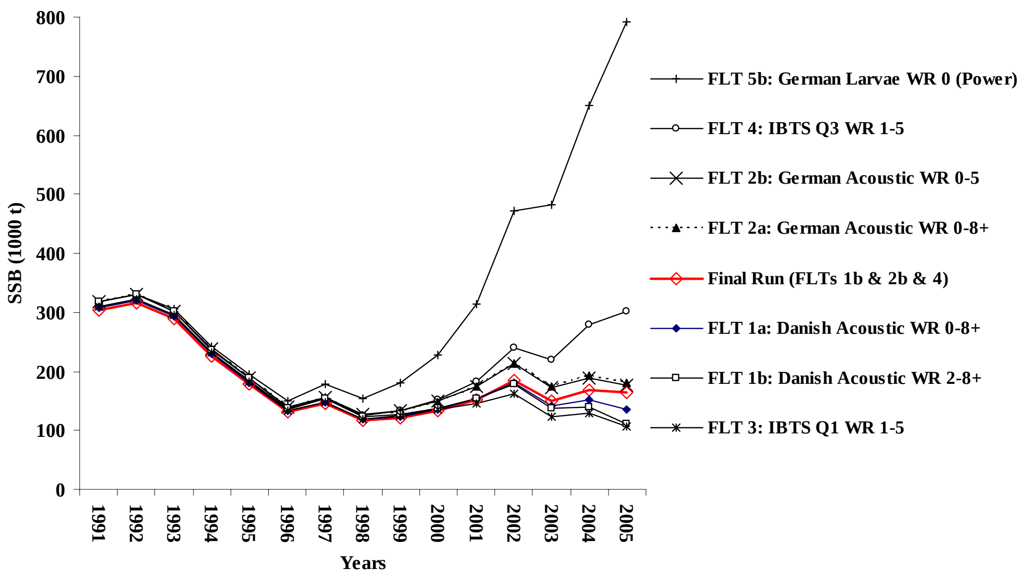


Figure 3.9.4 **WESTERN BALTIC HERRING. SSB estimates from ICA model with separate indices and with indices combined (Final Run 2006).**

4 Celtic Sea and Division VIIj Herring

4.1 The Fishery

The herring fisheries to the south of Ireland in the Celtic Sea and in Division VIIj exploit autumn and winter spawning components. For the purpose of stock assessment and management, these areas have been combined since 1982. The management unit covers all of Divisions VIIg,h,j and k and the southern part of Division VIIa (Figure 1.5.1).

4.1.1 Advice and management applicable to 2005 - 2006

The TAC in 2005 was 13 000 t, and in 2006 is 11 050. In 2005, ACFM considered the current level of SSB to be uncertain, but maybe below B_{pa} and possibly even below B_{lim}. Though there was no short term forecast, ACFM advised that, given the risk to the stock indicated by the poor recruitment of the 2001 year class, exploitation should be significantly reduced in 2006. ACFM suggested that such a reduction should result in catches of 6 700 t corresponding to 60% of the average catch in 2002-2004. In addition, ACFM recommended supplementary measures such as the re-closure of the eastern section of the Celtic Sea (Spawning Box C), see Figure 4.1.1.1a.. ICES considered that this would be an effective measure to reduce exploitation as most of the herring catches have been taken in this area since the voluntary closure was removed in December 2003.

Ad hoc requests

In October 2005, ICES was asked by Ireland to answer the following requests on this stock:

1) Comment on the benefit to the stock of an indefinite closure of Spawning Box C in Division VIIa as an alternative to reduction of the advised catches by 40% in 2006.

2) Since this stock is characterised by variable recruitment, to comment on whether the advised reduction of 40% in catches for 2006 was too severe, given that it is driven by recent low recruitments and bearing in mind that similarly low recruitments have been recorded in the past, most recently in 1991.

ICES' response to point one was that the box closure was intended as a supplementary measure intended to support the main advice to reduce catch in 2006. The closure of Box C is not an alternative to the reduction in TAC. ICES' response to point 2 was that in 1991 the SSB was larger ($>B_{pa}$) than in 2005. Although current SSB is uncertain, it seems low, below B_{pa} and maybe even below B_{lim}. Hence, the more conservative advice was based on the current perception of SSB being low.

The TAC is set by calendar year, whilst the assessment of the stock is conducted on a seasonal basis (1st April to 31st March).

In the past three seasons, a fishery was permitted during the summer months. In 2003 it opened in July, and in subsequent years in August. This was to allow vessels to target fish outside the spawning seasons when the fish are of better quality, marketability and constituting less fish per tonne landed.

Spawning Box Closures

The spawning box closures implemented under EU legislation continued. In the 2005/2006 season, Spawning Box C was closed in the second two weeks of January (Fig 4.1.1.1a). In 2006/2007, Box A will be closed. However, Spawning Box C was not closed entirely in 2006.

In addition to these, Box A was voluntarily closed in the recent seasons, being finally reopened in December 2003. This initiative was put in place by the Irish Celtic Sea Herring Management Advisory Committee to afford extra protection to first time spawners. Areas mentioned in the text are shown in Figure 4.1.1.1b.

Management Plan

The Irish "Celtic Sea Herring Management Advisory Committee" was established to manage the Irish fishery for this herring stock, having been constituted in law in 2005. This committee, therefore, has responsibility for management of the entire fishery for this stock at present. The committee has the following objectives:

- To build the stock to a level whereby it can sustain annual catches of around 20,000 t.
- In the event of the stock falling below the level at which these catches can be sustained the Committee will take appropriate rebuilding measures.
- To introduce measures to prevent landings of small and juvenile herring including closed areas, and or appropriate time closures.
- To ensure that all landings of herring should contain at least 50% of individual fish above 23 cm.
- To maintain and if necessary expand, the spawning box closures in time and area.
- To ensure that adequate scientific resources are available to assess the state of the stock.
- To participate in the collection of data and to play an active part in the stock assessment procedure.

Local management of the fishery

In 2005 the Irish quota was 11 236 t and in 2006, is 9 549 t. The Irish quota is managed by allocating individual quotas to vessels on a weekly basis. Participation in the fishery is restricted to licensed vessels. The licensing requirements have been changed. Previously, vessels had to participate in the fishery each year to maintain their licence. Now this requirement has been lifted. This has been one of the contributing factors to the reduction in number of vessels participating in the fishery in recent seasons. The efficiency of these vessels has improved, however. Fishing is restricted to the period Monday to Friday each week, and vessels must apply a week in advance before they are allowed to fish in the following week.

4.1.2 The fishery in 2004/2005

The landings in this fishery since 1958 are shown in Figure 4.1.2.1. Prices for Celtic Sea herring were better in the current season.

In 2005/2006, 34 vessels participated in the fishery, as follows:

- 12 RSW trawlers of 23-40m, using pair trawls
- 6 dry hold trawlers of 20-24m, using pair trawls
- 16 dry hold trawlers < 20m.

Most vessels under 20 m reported landings of less than 100 t for the assessment period while a number of RSW vessels reported landings greater than 1 000 t. In addition small incidental landings, typically less than a tonne were reported by a number of other vessels. Gillnets are a minor component of the fishery in recent years.

The fishing season is divided into three periods. In quarter 3, 2005 about 3 000 t were landed. These fish were targeted in offshore feeding aggregations to the north of the Labadie Bank and around the Kinsale Gas Field. This fishery opened on the 7th August and closed on 1st September. These catches consisted of about 7 000 fish per tonne. These catches were taken by pair trawl vessels using RSW or modified RSW fish storage. Vessels without RSW storage cannot participate in the summer fishery.

In quarter 4, 2005 about 3 000 t were landed. The fishery opened on the 13th November and closed on the 2nd December 2006. Most of the catch came from the traditional fishing grounds in Division VIIaS. About 200 t were taken from within Waterford Estuary, using single trawls by small inshore vessels. Small catches were taken from VIIj in quarter 4 only.

In quarter 1, 2006, about 3 500 t were landed. The fishery was opened in the beginning of January 2006 and was closed on the 20th January. From the 15th January, Spawning Box C was closed, and effort was diverted to the inshore grounds of VIIg, around Ballycotton and off the Daunt Rock (Figure 4.1.1.1b). Again, about 200 t were taken from within Waterford Estuary, using single trawls by small inshore vessels. These small vessels also fished outside Waterford Estuary.

4.1.3 The catches in 2005/2006

The estimated national catches from 1988–2004 for the combined areas by year and by season (1 April–31 March) are given in Table 4.1.3.1 and Table 4.1.3.2 respectively. The total catches for the fishery over the longer period from 1958 to 2004 are shown in Figure 4.1.2.1 The catch, taken during the 2005/2006 season was under 10 000 t having declined from almost 13 000 t during the previous season.

There are no estimates of discards for this fishery. Anecdotal reports from fishermen suggest that discarding is not a feature of this fishery at present.

4.2 Biological composition of the catch

4.2.1 Catches in numbers-at-age

Catch numbers at age are available for the period 1958/1959 to 2004/2005. These data include discards, when estimates were produced (until 1997). In 2005/2006, the 1-ringers were a higher proportion of the catch than at any season since 1982/1983 (Figure 4.2.1.1 and Table 4.2.1.1). The absolute numbers of 1-ringers were among the highest in recent years, along with those in 1999/2000 and 2001/2002. The proportion of 2-ringers (38%) was about average for recent seasons. The 3-ringers were very low (7%) confirming the weakness of the 2-ringers last season. It is important to note that the weakness of 3-ringers tends to inflate the proportions of the other important age groups in the catches.

The overall proportions at age were largely similar in the 4th and 1st quarter in VIIg and VIIaS. However, the catches in VIIaS (Waterford Harbour) in the 1st quarter were very different, being over 70% 1-ringer. This large proportion of 1-ringers contributed to their overall high contribution in the catches. In VIIj, the proportion at age did not differ from elsewhere, in contrast to last season.

4.2.2 Movements of fish

Juveniles

It is known that fish spawned in the Celtic Sea are present as juveniles in the Irish Sea along with native fish, especially the western part (Brophy and Danilowicz, 2002). Their results show that fish spawned in the eastern Celtic Sea are present as juveniles in the Irish Sea, where fish of local origin are also found. The fish of Celtic Sea origin then return as 1- and 2-ringers (Molloy et al. 1993).

Small fish (1-ringer) predominated in quarter 1, 2006 though not in quarter 4, 2005, in Waterford Estuary. As these fish were smaller, it seems likely that these fish migrated to the Celtic Sea from the Irish Sea.

Further work, redrawing historic larval survey data from the 1980s shows that autumn and winter spawning was taking place in the eastern Celtic Sea (Figure 4.2.2.1). Thus juveniles of Celtic Sea origin present in the Irish Sea cannot be distinguished on the basis of spawner type alone. Therefore further work is required to allow for splitting Irish and Celtic Sea origin fish.

Adults

The quarter 3 fishery targets offshore feeding aggregations of herring in VIIg. It is not known where these fish spawn. However a combination of positional data from the commercial fishery (August) and acoustic surveys (September to December) in this area displays a seasonally progressive movement towards the traditional spawning grounds inshore (Figure 4.2.2.2).

Spatial data from all groundfish surveys using the Portuguese high headline net and the GOV trawl were presented by WGFISHECO (ICES, 2006) show that herring display a continuous distribution throughout the Celtic Sea and Division VIIf. However abundance is very low in the middle area between VIIf and VIIg. However there appears to be a hiatus between VIIe and VIId, though there is little survey effort in that area. It seems possible that the summer feeding aggregations are a mixture of VIIg, VIIaS, and VIIe fish, though information is scarce.

4.2.3 Quality of catch and biological data

Since 1997 there has been a major increase in the monitoring of landings from this fishery and the management measures were again tightly enforced throughout the season. There is no information on misreporting in this fishery in recent years, but it is thought to have decreased.

Biological sampling of the catches throughout the region was comprehensive, except in VIIj. The spasmodic nature of the fishery in that area makes sample acquisition difficult, (Table 4.2.3.1). Under the Data Collection Programme the sampling of this stock is well above that required by the Minimum Programme (Section 1.5).

4.3 Fishery Independent Information

4.3.1 Acoustic Surveys

Acoustic surveys of this stock have been carried out since 1990, with the exception of 1997. Up until 1996, two acoustic surveys were carried out annually. In 1997 there was no research vessel available to do the survey. Since 1998, usually only one winter survey was conducted (Table 4.3.1.1). The survey conducted in 2005/2006, was conducted on the Celtic Explorer, for the second time.

Revision of acoustic time series

The problems with the acoustic survey have been documented in previous reports. In order to improve the series a review was conducted and the series has been revised (Clarke et al. in prep.). This review had two main aims with these being to check the internal consistency of the previous surveys and produce a new refined series for tuning the assessment.

The surveys were divided into two series, early and late, based on how far from the south coast they went. The early group, 1990-91 to 1994-95, extended to about 15 nautical miles offshore with two surveys, one in autumn (before Christmas) and another in winter (after Christmas). This design aimed to survey spawning fish close inshore with two surveys, the results of which could be added, the two legs covering the two main spawning seasons. The off shore limits were extended in 1995 and some of these surveys had more fish off shore than close inshore. This changed the catchability, suggesting the later series should be separated from the earlier one. Consequently the years before 1995 were removed. This is not considered to be a problem because the earlier series would contribute little to the ICA anyway. Winter surveys were not always conducted in the later series, not being done in 1998 and not at all after 2000 so these were dropped too.

The autumn surveys did not cover the southwest Irish coast of VIIj in all years (3 years missing). In order to correct for this, the missing values were substituted with the mean of the available western bays SSB estimates, 7 800 t (11 values, range from 0 to 16 000 t). Numbers-at-age in these surveys were adjusted upwards by the ratio of the adjusted SSB in the SW to the south coast SSB. The abundance estimates produced are presented in Table 4.3.1.2.

Analysis errors were found in the surveys from 1998 onwards. The 2003 biomass (SSB, 85 500 t) was re-analysed after the discovery of errors in the spreadsheets used to estimate biomass. The errors affected the calculation of the weighted mean of the integrated backscatter when positive samples had lengths shorter than the base one (here, 15 minutes) and the partitioning of the backscatter for a mixture of species. Also, no account was taken of different sampling frequencies within a 10x20 minute cell (the analysis unit). The 2003 SSB came mainly from two cells that included an intensive survey in Waterford Harbour and these cells had a SSB of about 68 000 t, which was reduced to 7 300 t when all errors were corrected. There were some minor corrections in three other cells. The revised total biomass was 24 000 t and the revised spawning biomass was 22 700 t.

In addition, the cell means took no account of the implicit sampling area of transects so that the biomass coming from a large sample value depended on the number of transects passing through the cell. The data were re-analysed using mean herring density by transect as the sample unit and dividing the area into strata based on transect spacing. Areas with no positive samples were excluded from the analysis (since they have zero estimates). Zigzags in bays were analysed as before. For each stratum, a mean density was obtained from the transect data (weighted by transect length) and this was multiplied by the stratum area to obtain a biomass and numbers-at-age. The overall total was the sum of the strata estimates. The same haul assignments as in the original analysis were used. At the same time, a CV was obtained based on the transect mean densities, i.e. a survey sample error. For surveys before 1998 and the western part survey in 2002, a cv was estimated using;

$$\sqrt{\log(1.3^2)/n}$$

where n is the number of positive sample values (15 minute of survey track) from Definite and Probably Herring categories. This was based on the data from the autumn surveys in 1998, 2000, 2001, 2002, and 2005. Results are shown in Table 4.3.1.2.

2005 Survey

The acoustic survey of the 2005/2006 season was carried in October 2005 (Doonan, presentation to HAWG). The survey track was begun at the northern boundary of VIIj, covering the SW bays in zig-zags and parallel transects. The main traditional grounds on the south Irish coast (VIIg and VIIaS) were covered using transects of 2nmi spacing, extending 67 nmi offshore (Figure 4.3.1.1a). In total the combined survey transect length was in the order of 2 789 nmi.

To check that the research vessel was adequate in shallower waters, another localised survey was done along parts of the south coast during October by a smaller commercial fishing vessel. This main survey was aimed at pre-spawners as they moved inshore to spawn. The main survey area was based on an analysis of results from previous autumn surveys to make sure that it covered the likely extent of the stock at this time. The survey started at the northern boundary of VIIj, moving through it in a southerly direction, before moving eastwards through the Celtic Sea (Figure 4.3.1.1a). No substantial echo traces of adult herring were encountered in the bays and inlets of VIIj, but there were some from juveniles (Figure 4.3.1.1b). In VIIg, most herring shoals were encountered offshore, but one or two were seen inshore. Nearly all large schools were successfully fished on. The localised inshore survey also found very few herring schools indicating that the research vessel was adequate in shallower waters. It was concluded from this information that the survey estimated the stock size in these areas in 2005/2006. The age structured index of biomass and catch numbers from acoustic surveys in this area, is shown in Table 4.3.1.2, and the revised series in Table 4.3.1.3. In 2005/2006 the SSB estimate was 30 000 t.

The percentage age composition in the survey and the commercial fishery are compared in Figure 4.31.2. The survey displayed the same age distribution as the commercial fishery, both showing a strong predominance of 2-ringers and the very low abundance of 3-ringers. However the survey picked up somewhat lower numbers of 4-ringers and older.

4.3.2 Other surveys

The working group has sought alternative tuning series for this stock.

In 2005, an investigation of the utility of the Irish segment of the western IBTS survey was made (Johnston and Clarke, WD 2005). This survey displayed strong year effects and only those surveys from 2003 onwards are directly comparable because they use the same research vessel. Herring distribution in quarter 4 is very contagious, with fish being caught in large aggregations, or not at all. Consequently the signal from the survey is noisy, but when a longer time series is developed, it will at least provide qualitative information. This survey did highlight the absence of the 2001 year-class in 2004.

In 2006, the working group had access to data from the French EVHOE quarter 4 western IBTS survey (GOV trawl) and the CEFAS UK (E&W) quarter 1 survey (Portuguese high headline trawl) (Johnston et al. WD 2006). The French survey series is from 1997 to 2005 and displayed very variable observed numbers at age between years. Consequently, further exploration of the series was not perfomed.

The UK quarter 1 survey was explored further (Figure 4.3.2.1). There are strong year and age effects in the survey, particularly at 2- and 5-ringer. Total numbers per year vary widely. Because of strong year and age effects and because it was discontinued in 2002 this survey is considered unsuitable as a recruit index. However the survey does display a truncation of older age groups throughout the series, but particularly in the 1990’s (Figure 4.3.2.1). This trend is displayed in the catch numbers at age, the acoustic series and the UK quarter 1 survey. In all three cases, this trend seems progressive with time.

Other surveys that may have utility for tuning the assessment are the DARDNI Groundfish Survey of the Irish Sea, Northern Ireland and the UK quarter 4 western GFS. It is known that juveniles from the Celtic Sea are present in the Irish Sea. If it is possible to distinguish these fish from native Irish Sea herring, in the DARDNI survey then this survey could offer potential for a recruit index for Celtic Sea herring.

4.4 Mean weights-at-age and maturity-at-age

The mean weights in the catch over time are presented in Figure 4.4.1, with stock weights displayed in Figure 4.4.2. There has been an overall downward trend in mean weights at age since the mid-1980’s. The values for 2005/2006 for the important age groups are among the lowest in the series. This trend in mean weights at age is similar to those seen in VI aN, the Irish Sea and to a lesser extent, the North Sea.

For the past three seasons substantial catches were taken outside the spawning season. For 2005/2006, the mean weights in the spawning stock were calculated from samples taken in VIIg, VIIj and VIIaS from October 2005 to February 2006. Samples from quarter 3 were not used in these calculations. No data for 8- or 9-ringers were available this year to calculate stock weights. Therefore values were calculated by linear extrapolation of the 1- to 7-ringer mean weights for these year classes.

While the maturity-at-age for this stock has been assumed to be constant throughout the whole time period (50% of 1 ring fish are assumed to be mature at age 1 and 100% mature at 2 ring), it may not be stable. A new project to develop maturity ogives for this stock from catch and survey data is being started in 2006. This project will also examine long term changes in biological parameters.

4.5 Recruitment

At present there are no recruitment estimates for this stock that can be used for predictive purposes. The 2003 recruitment was estimated as weak in the 2004 assessments, and appears to be the weakest in the series. There is little information in the assessment on the strength of recruitment in 2005, because these 1-ringers are poorly represented in the catches, though they were high.

In this stock a proportion of juvenile fish are present in the Irish Sea and do not recruit to the Celtic Sea and Division VIIj until they are mature. Therefore neither the numbers of 1-ringers in the stock as estimated from the acoustic surveys nor the numbers in the catches give a reliable indication of year class strength. The relationship between the numbers of 1-ringers taken per hour in the ground fish surveys in the Irish Sea and the numbers of 1- ringers estimated by ICA for the Celtic Sea and Division VIIj was examined in a working document presented to the 1999 WG (Armstrong et al., WD 1999) and the results suggest that these surveys may become a useful indicator of recruitment to the Celtic Sea and Division VIIj when a longer time-series is established.

4.6 Assessment

This stock is scheduled for benchmark assessment in 2007. The last time the assessment of this stock was accepted by ACFM as a basis for management advice was 2001. In 2005, the working group did not present a final assessment, but rather presented two exploratory assessments. These assessments were based on the inclusion or exclusion of the acoustic survey conducted in 2004. This survey produced the lowest abundance estimate in the series, and was not considered by the group to have measured the stock. The most important information considered by the 2005 working group was weakness of the 2001 year class. In 2006, the working group continued to conduct exploratory assessments and no final assessment was put forward by the group in 2006.

4.6.1 Data exploration

Considerable data exploration was conducted in 2005. In 2006, only exploration of the revised acoustic series was conducted. The revised acoustic series displays the same age structure as the old one over comparable years. Therefore the series was considered only to be used for tuning over 2- to 5-ringer. The series displays the same truncation of older age groups as seen in the catch at age data (Figure 4.6.1.1 and Figure 4.6.1.2). The revised acoustic series and the catch at age data display similar proportions at age (Figure 4.6.1.3).

Both acoustic series and the catch at age data displayed similar mortality signals (Figure 4.6.1.4).

4.6.2 Exploratory Assessments

In 2006, exploratory assessments were conducted to investigate:

- Behaviour of the revised acoustic series
- Inclusion of 2000 and 2001 surveys which had very high CVs.
- Change of the separable period to accommodate the new quarter 3 fishery.
- Shape of the exploitation pattern

In each case, the same procedure as previous years was used to deal with the assumption that 50% of 1-ringers are mature. Therefore recruitment at 1-ring was replaced with geometric mean (1958-2004), 390 million fish, and the SSB was recalculated based on the stock weights and population numbers in the final year.

In order to compare the old and revised series, two runs of ICA were conducted using the same procedure as last year's assessment (SPALY), which did not use the 2004 survey estimates. The separable period was 6 years and no shrinkage was used. The results of this analysis are presented in Figure 4.6.2.1. Patterns of SSB and recruitment were the same, but slight differences in F were observed, with the old series scaling F up slightly in the final two years. Residual patterns in the tuning series are presented for these runs in Figure 4.6.2.2. The revised series does not represent an appreciable better model fit. Strong age year effects are still present. However, because CVs are available for this series, it is possible to identify years were the survey is particularly noisy. Further diagnostics for comparing these runs are presented in Figures 4.6.2.3 and Figure 4.6.2.4 for the old and revised series respectively. Figure 4.6.2.5 shows q-q plots for the runs with the old and revised surveys. These plots show ranked percentiles of the residuals, and provide a quantitative means to compare residual patterns. This analysis shows that catch numbers-at-age distributions are similar, but with about 20% larger standard deviation (slope of the line fit) when using the new series. The distributions of the survey residuals are not quite the same and the new series' standard deviation is much higher.

Surveys with particularly high CVs were those in 2000 and 2001. Exploration of their exclusion was performed in ICA using SPALY. Summary plots for these runs are shown in Figure 4.6.2.6 and residual patterns in the survey series in Figure 4.6.2.7, and q-q plots in Figure 4.6.2.8. Their exclusion did not change the perception of stock dynamics. However, the q q plot shows that both distributions are similar, but there is a reduction in the standard deviation when dropping the two surveys.

A priori assumptions that the new quarter 3 fishery in the last three years changed the exploitation pattern were tested by running exploratory assessments with 6 year (both using the new survey series with the 2000 and 2001 surveys excluded) and a 4 year separable period. Summary plots are presented in Figure 4.6.2.9, residuals in Table 4.6.2.1 and q-q plots in Figure 4.6.2.10. Stock perception did not change substantially, but the residual pattern did improve. When a 4 year separable period is used (both using the new survey series with the 2000 and 2001 surveys excluded), the qq plots show the same distribution, with no change in standard deviation for the survey.

In order to investigate the shape of the selection pattern, selection on at oldest age relative to reference age (3-ring) was set at 1.5 in comparison to the base case run using the revised acoustic series (Figure 4.6.2.1.). Comparative runs are shown in Figure 4.6.2.11 and residual patterns in Figure 4.6.2.12. Clearly the model fit is somewhat better when selection at the oldest age is set at 1.5 and the model seems to behave better with an increase in selection at the oldest age, compared to setting oldest age selection = 1.0. It is also clear that using a higher S at oldest age applies a scaling factor to the SSB throughout the time series. Figure 4.6.2.13 shows the q-q plot of comparison of these exploitation patterns. The choice of 1.5 appears to improve the residual pattern.

4.7 Short term projections

There was no final assessment and consequently no short term projections.

4.8 Medium term projections

No medium term projections were conducted in 2006.

4.9 Precautionary and yield based reference points

Biological reference points were discussed in detail in the 2000 WG report (ICES 2000/ACFM:10) and in the report of the previous years (ICES 1999/ACFM:12, ICES 1998/ACFM:14). A summary of this discussion was presented in the 2003 HAWG report. $\mathbf{B}_{pa}$ is currently at 44,000t and $\mathbf{B}_{lim}$ at 26,000 t for this stock $\mathbf{F}_{pa}$ and $\mathbf{F}_{lim}$ are not defined. The SGPRP (ICES 2003 ACFM 15) has reviewed the methodology for the calculation of biological reference points, and applying a segmented regression to the stock and recruit data from the 2002 HAWG assessment gave a breakpoint at 61,306 t. This change point appears to be very high with respect to the historical exploitation of the stock. Given that there is a cluster of observations just above this value the sensitivity of the method to these data needs to be further investigated. The HAWG decided that the first priority for this stock should be to achieve a stable assessment and that once this was done the reference points would be reinvestigated. There is still considerable instability in the assessment, so there is no basis for a revision of reference points at this point.

4.10 Quality of the Assessment

No assessment was conducted.

4.11 Management Considerations

There is no new assessment in 2006 upon which to base management advice. However preparations are being made for benchmark assessment next year.

There are certain pieces of information that can be obtained from the available data. The revision of the acoustic survey, though not substantially improving the model fit does show the noise in the individual survey estimates. The revision of the series shows evidence of declining stock abundance. A period of high abundance is evident with reasonable CVs, a period of very fluctuating abundance with high CVs and then a period of low stock abundance with lower CVs.

In 2005, ICES based advice on the poor recruitment of the 2001 year class. In 2006, this year class weakness was further confirmed. The 2002 year class appears stronger in the catches. Although the 2003 year class (1-ringers) are considered to contribute to SSB there is insufficient information in the data available to state if this cohort is stronger than average.

In recent years the fishery has been tightly managed and it is now restricted in time and area. In 2005/2006 fishing was concentrated in the feeding area and also in a few of the traditional inshore areas. Little fishing took place in VIIj.

Though the data available are not informative as to stock status at present., and the exploratory assessments are uncertain The weak 2001-year class means that the stock is more dependent on subsequent cohorts and also 4-ringers. The truncation of age groups in the catches in recent years along with the spatially small area of the fishery are causes for concern. The stock is probably at as low a level as when it previously collapsed. It would seem prudent to proceed with caution.

Table 4.1.3.1. **Celtic Sea and Division VIIh, j and k herring landings by quota year (t), 1988–2005. (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
1989	+	-	16,000	1,900	-	1,300	3,500	22,700
1990	+	-	15,800	1,000	200	700	2,500	20,200
1991	+	100	19,400	1,600	-	600	1,900	23,600
1992	500	-	18,000	100	+	2,300	2,100	23,000
1993	-	-	19,000	1,300	+	-1,100	1,900	21,100
1994	+	200	17,400	1,300	+	-1,500	1,700	19,100
1995	200	200	18,000	100	+	-200	700	19,000
1996	1,000	0	18,600	1,000	-	-1,800	3,000	21,800
1997	1,300	0	18,000	1,400	-	-2,600	700	18,800
1998	+	-	19,300	1,200	-	-200	-	20,300
1999		200	17,900	1300	+	-1300	-	18,100
2000	573	228	18,038	44	1	-617	-	18,267
2001	1,359	219	17,729	-	-	-1578	-	17,729
2002	734	-	10,550	257	-	-991	-	10,550
2003	800	-	10,875	692	14	-1,506	-	10,875
2004	801	41	11,024	-	-	-801	-	11,065
2005	821	150	8452	799	-	-1770	-	8,452

Table 4.1.3.2. Celtic Sea & Division VIIj herring landings (t) by assessment year (1st April–31st March) 1988/1989-2004/2005. (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
1989/1990	+	-	15,000	1,900	-	2,600	3,600	23,100
1990/1991	+	-	15,000	1,000	200	700	1,700	18,600
1991/1992	500	100	21,400	1,600	-	-100	2,100	25,600
1992/1993	-	-	18,000	1,300	-	-100	2,000	21,200
1993/1994	-	-	16,600	1,300	+	-1,100	1,800	18,600
1994/1995	+	200	17,400	1,300	+	-1,500	1,900	19,300
1995/1996	200	200	20,000	100	+	-200	3,000	23,300
1996/1997	1,000	-	17,900	1,000	-	-1,800	750	18,800
1997/1998	1,300	-	19,900	1,400	-	-2100	-	20,500
1998/1999	+	-	17,700	1,200	-	-700	-	18,200
1999/2000		200	18,300	1300	+	-1300	-	18,500
2000/2001	573	228	16,962	44	1	-617	-	17,191
2001/2002	-	-	15,236	-	-	-	-	15,236
2002/2003	734	-	7,465	257	-	-991	-	7,465
2003/2004	800	-	11,536	610	14	-1,424	-	11,536
2004/2005	801	41	12,702	-	-	-801	-	12,743
2005/2006	821	150	9,494	799	-	-1770	-	9,494

Table 4.2.1.1. Celtic Sea & Division VIIj herring. Comparison of age distributions (percentages) in the catches of Celtic Sea and VIIj herring over recent seasons.

Rings	1	2	3	4	5	6	7	8	9
1969	4	40	24	14	5	8	2	1	1
1970	1	24	33	17	12	5	4	1	2
1971	8	15	24	27	12	7	3	3	1
1972	4	67	9	8	7	2	1	1	0
1973	16	26	38	5	7	4	2	2	1
1974	5	43	17	22	4	4	3	1	1
1975	18	22	25	11	13	5	2	2	2
1976	26	22	14	14	6	9	4	2	3
1977	20	31	22	13	4	5	3	1	1
1978	7	35	31	14	4	4	1	2	1
1979	21	26	23	16	5	2	2	1	1
1980	11	47	18	10	4	3	2	2	1
1981	40	22	22	6	5	4	1	0	1
1982	20	55	11	6	2	2	2	0	1
1983	9	68	18	2	1	0	0	1	0
1984	11	53	24	9	1	1	0	0	0
1985	14	44	28	12	2	0	0	0	0
1986	3	39	29	22	6	1	0	0	0
1987	4	42	27	15	9	2	1	0	0
1988	2	61	23	7	4	2	1	0	0
1989	5	27	44	13	5	2	2	0	0
1990	2	35	21	30	7	3	1	1	0
1991	1	40	24	11	18	3	2	1	0
1992	8	19	25	20	7	13	2	5	0
1993	1	72	7	8	3	2	5	1	0
1994	10	29	50	3	2	4	1	1	0
1995	6	49	14	23	2	2	2	1	1
1996	3	46	29	6	12	2	1	1	1
1997	3	26	37	22	6	4	1	1	0
1998	5	34	22	23	11	3	2	0	0
1999	11	27	28	11	12	7	1	2	0
2000	7	58	14	9	4	5	2	0	0
2001	12	49	28	5	3	1	1	0	0
2002	6	46	32	9	2	2	1	0	0
2003	3	41	27	16	6	4	3	0	1
2004	5	10	50	24	9	2	1	0	0
2005	19	38	7	23	9	2	1	0	0
Mean (58-05)	8	37	24	14	7	4	3	2	2

Table 4.2.1.2. Celtic Sea & Division VIIj herring. Length frequency distributions of the Irish catches (raised numbers in '000s) in the 2004/2005 season in the Celtic Sea and VIIj fishery.

Length cm	Quarter 3 2005 VIIg	Quarter 4 2005 VIIaS River	Quarter 4 VIIaS C.S.	Quarter 4 2005 VIIg	Quarter 4 2005 VIIj	Quarter 1 2006 VIIg	Quarter 1 2006 VIIaS River	Quarter 1 2006 VIIaS C.S.	Total Celtic Sea and VIIj
17									0
17.5									0
18							9		9
18.5			19		5	22	28		74
19		11	117	22	20	0	93		262
19.5	13	65	545	91	25	44	139		922
20	60	65	720	125	64	22	390	43	1489
20.5	128	57	1109	216	39	155	325	43	2072
21	322	65	1323	221	39	618	288	143	3020
21.5	477	72	2082	329	113	596	186	122	3976
22	779	133	1907	298	132	906	242	294	4691
22.5	1228	137	2374	471	162	1612	195	373	6553
23	1329	186	2335	497	157	2408	204	337	7454
23.5	1551	95	1751	437	103	1944	93	380	6354
24	1430	91	1051	333	123	1723	46	366	5163
24.5	1356	126	973	272	64	1237	56	208	4291
25	1584	133	1031	251	103	1767	139	237	5245
25.5	2155	179	934	277	118	2098	121	380	6261
26	2725	167	1226	389	137	3004	130	395	8174
26.5	2611	179	856	234	216	2606	37	330	7069
27	1477	46	272	134	270	1789	0	251	4239
27.5	779	11	136	65	260	508	19	79	1856
28	275	4	19	22	113	398		43	873
28.5	94		19		74	88		14	290
29	27			9	10	44			89
29.5	13				10				23
30	7								7
30.5	7					22			29
31	0								
31.5	7								7
32									
32.5									
33									
33.5					5				5
Nos./t	7030	8718	9826	9459	7138	8563	12458	8808	8515

Table 4.2.3.1 Celtic Sea & Division VIIj (2004/2005). Sampling intensity of commercial catches.

ICES area	Year	Quarter	Landings (t)	No. Samples	No. aged	No. Measured	Aged/1000 t
VIIa south	2005	4	2326	16	712	1548	306
	2006	1	678	7	370	858	546
					1082		
VIIg	2005	3	2907	12	749	3044	258
	2005	4	496	6	457	1085	921
	2006	1	2758	8	575	1069	209
					1781		
VIIj	2005	4	330	2	149	481	451
Overall			9494	51	5875	8085	

Table 4.3.1.1. Celtic Sea & Division VIIj herring. Acoustic surveys of Celtic Sea and VIIj herring, by season. Number of surveys per season and type indicated along with biomass and SSB estimates. Shaded sections show surveys not used in tuning.

			Old	Revised	
Season	No.	Type	SSB	Abundance 10^6	SSB
1990/1991	2	Autumn and winter spawners	91	-	-
1991/1992	2	Autumn and winter spawners	77	-	-
1992/1993	2	Autumn and winter spawners	71	-	-
1993/1994	2	Autumn and winter spawners	90	-	-
1994/1995	2	Autumn and winter spawners	51	-	-
1995/1996	2	Autumn and winter spawners	114	469	36
1996/1997	1	Autumn spawners	146	1338	151
1997/1998	-	No survey	-	-	-
1998/1999	1	Autumn spawners	111	656	100
1999/2000	1	Feeding phase	23	-	-
1999/2000	1	Winter-spawners	26	-	-
2000/2001	2	Autumn and winter spawners	32	256	20
2001/2002	2	Pre-spawning	74	681	95
2002/2003	1	Pre-spawning	39	423	41
2003/2004	1	Pre-spawning	86	183	20
2004/2005	1	Pre-spawning	10	-	-
2005/2006	1	Pre-spawning	30	312	33

Table 4.3.1.2. Celtic Sea & Division VIIj herring. Total stock numbers-at-age (10^6) estimated using combined acoustic surveys (age refers in winter rings, biomass and SSB in 000's tonnes). Bold text denotes the years used as inputs to assessment input files.

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1998**	**1999**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
	1991	1992	1993	1994	1995	1996	1997	1999	2000	2000	2001	2002	2003	2004	2005	2006
0	205	214	142	259	41	5	3	-	13	-	23	19	0	25	26	13
1	132	63	427	217	38	280	134	21	398	23	18	30	41	73	13	54
2	249	195	117	438	127	551	757	157	208	97	143	160	176	323	29	125
3	109	95	88	59	160	138	250	150	48	85	36	176	142	253	32	26
4	153	54	50	63	11	94	51	201	8	16	19	40	27	61	16	50
5	32	85	22	26	11	8	42	109	1	21	7	44	6	16	3	20
6	15	22	24	16	7	9	1	32	1	8	3	23	8	5	1	5
7	6	5	10	25	2	8	14	30		2	2	17	3	2		1
8	3	6	2	2	3	9	1	4		1		11				
9+	2	-	1	2	1	5	2	1			1	23				
Total	904	739	882	1107	399	1107	1253	705	677	252	250	542	404	758	119	292
Biomass (000't)	103	84	89	104	52	135	151	111	58	30	33	80	49	89	13	33
SSB (000't)	91	77	71	90	51	114	146	111	23	26	32	74	39	86	10	30

Table 4.3.1.3. Celtic Sea & Division VIIj herring. Revised acoustic index of abundance. Total stock numbers-at-age (10^6) estimated using combined acoustic surveys (age refers in winter rings, biomass and SSB in 000's tonnes).

	1995	1996	1998	2000	2001	2002	2003	2005
	1996	1997	1999	2001	2002	2003	2004	2006
0	202	3	0	25	40	0	24	2
1	25	164	30	102	28	42	13	65
2	157	795	186	112	187	185	62	137
3	38	262	133	13	213	151	60	28
4	34	53	165	2	42	30	17	54
5	5	43	87	1	47	7	5	22
6	3	1	25		33	7	1	5
7	1	15	24		24	3		1
8	2		4		15			
9	2	2	2		52			
Abundance	469	1338	656	256	681	423	183	312
SSB (000 t)	36	151	100	20	95	41	20	33
CV (%)	53	26	36	100	88	49	34	48

Table 4.6.2.1. Celtic Sea and VIIj herring. Separable model residuals from exploratory ICA runs for 4 year and 6 year separable periods. High residuals indicated.

4 year	2000	2001	2002	2003	2004	2005
1			-0.01	0.37	-0.36	0.00
2			0.31	-0.32	0.00	0.06
3			0.34	-0.51	0.34	-0.05
4			0.14	-0.38	0.14	0.16
5			-0.31	-0.02	0.19	0.09
6			-0.21	0.46	-0.11	-0.09
7			-0.19	0.34	-0.12	-0.02
8			0.00	0.19	-0.13	0.02
6 year						
1	0.03	0.55	-0.34	0.22	-0.47	0.00
2	0.54	0.24	-0.03	-0.62	-0.12	-0.01
3	-0.07	0.42	0.11	-0.65	0.28	0.05
4	-0.24	-0.11	0.02	-0.30	0.38	0.48
5	-0.23	-0.25	-0.14	-0.17	0.22	0.29
6	0.17	-0.16	0.01	0.53	-0.41	-0.20
7	-0.10	-0.16	0.09	0.58	-0.05	-0.31
8	0.00	0.10	-0.01	0.30	-0.10	-0.13

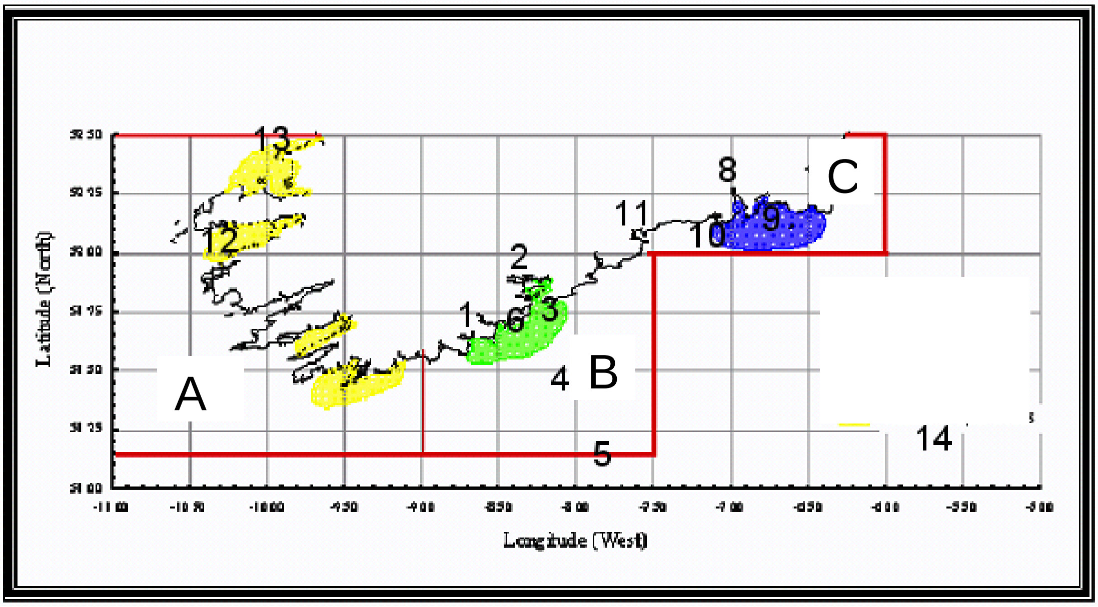


Figure 4.1.1.1a. Celtic Sea and VIIj herring, areas mentioned in the text and spawning boxes A, B and C, south of Ireland. One of these boxes is closed each season, under EU legislation. 1 Courtmacsherry, 2 Cork Harbour, 3 Daunt Rock, 4 Kinsale Gas Field (Rigs), 5 Labadie Bank, 6 Kinsale, 8 Waterford Harbour, 9, Baginbun Bay, 10, Tramore Bay/ Dunmore East, 11, Ballycotton Bay, 12, Valentia Island, 13 Kerry Head to Loop Head, 14, The Smalls.

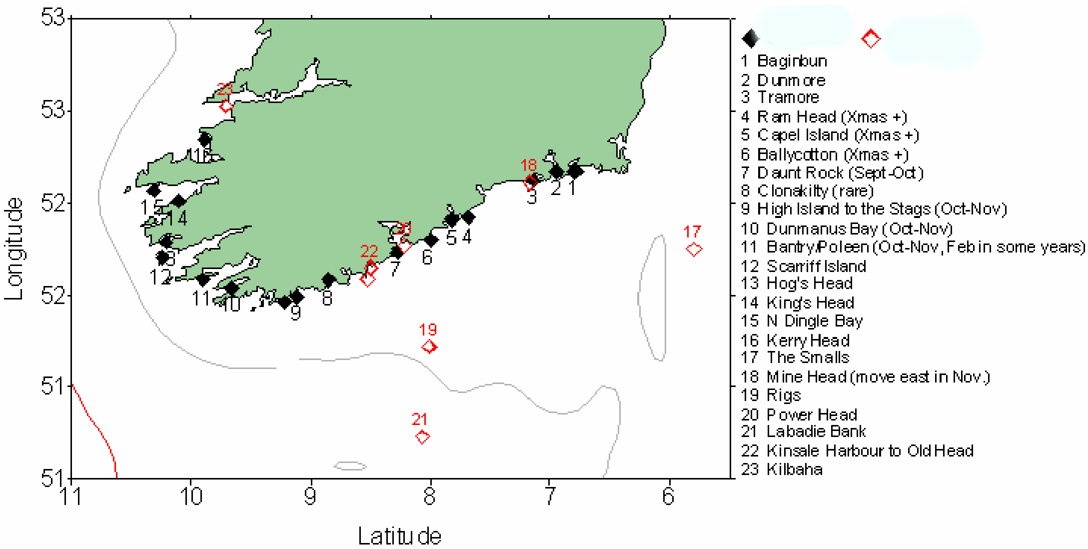


Figure 4.1.1.1b. Celtic Sea and VIIj herring, Location of non-spawning (open symbol) and spawning (closed symbol) herring in the Celtic Sea and SW of Ireland. Based on expert fishermens' personal information.

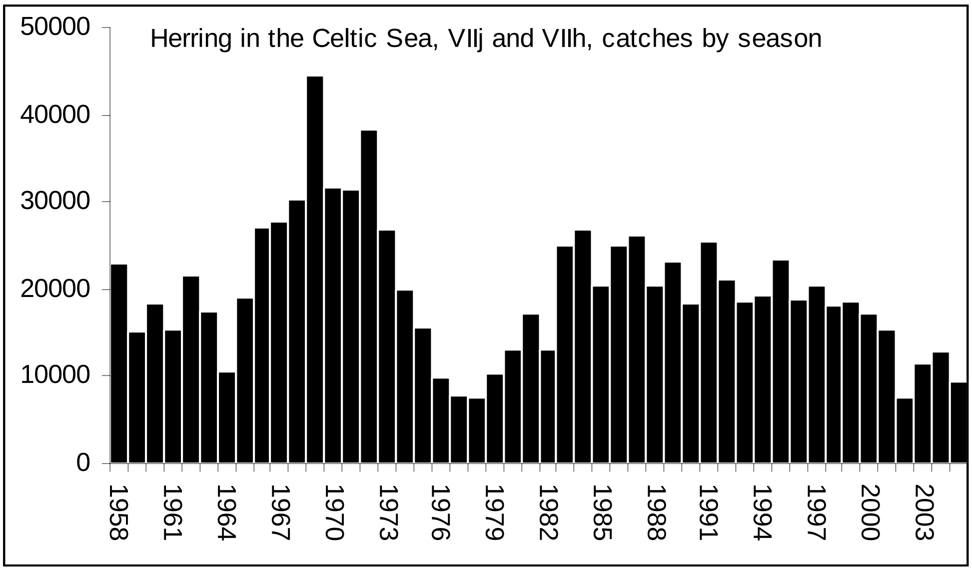


Figure 4.1.2.1 Celtic Sea and Division VIIj – working group estimates of herring landings per season.

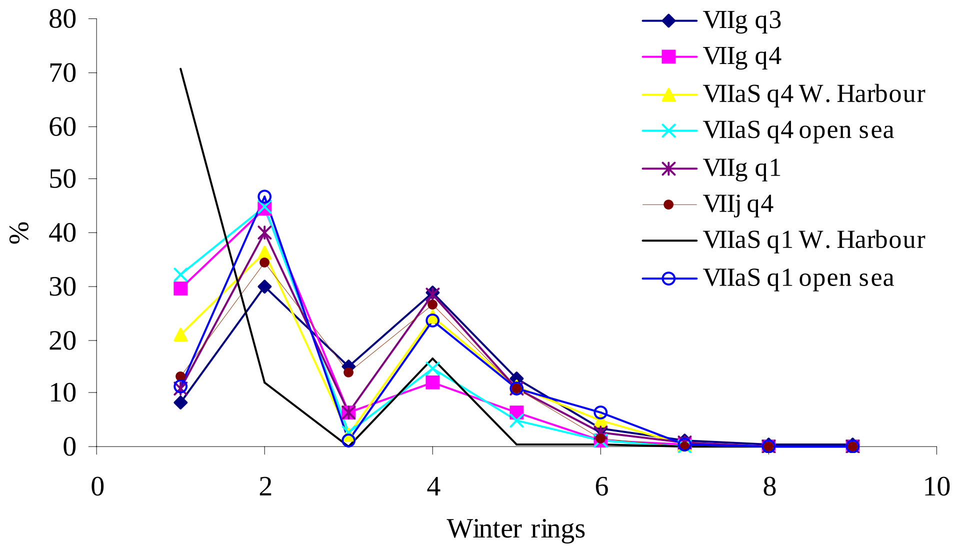


Figure 4.2.1.1 Celtic Sea and Division VIIj – percentage age composition by metier (ICES Division and quarter).

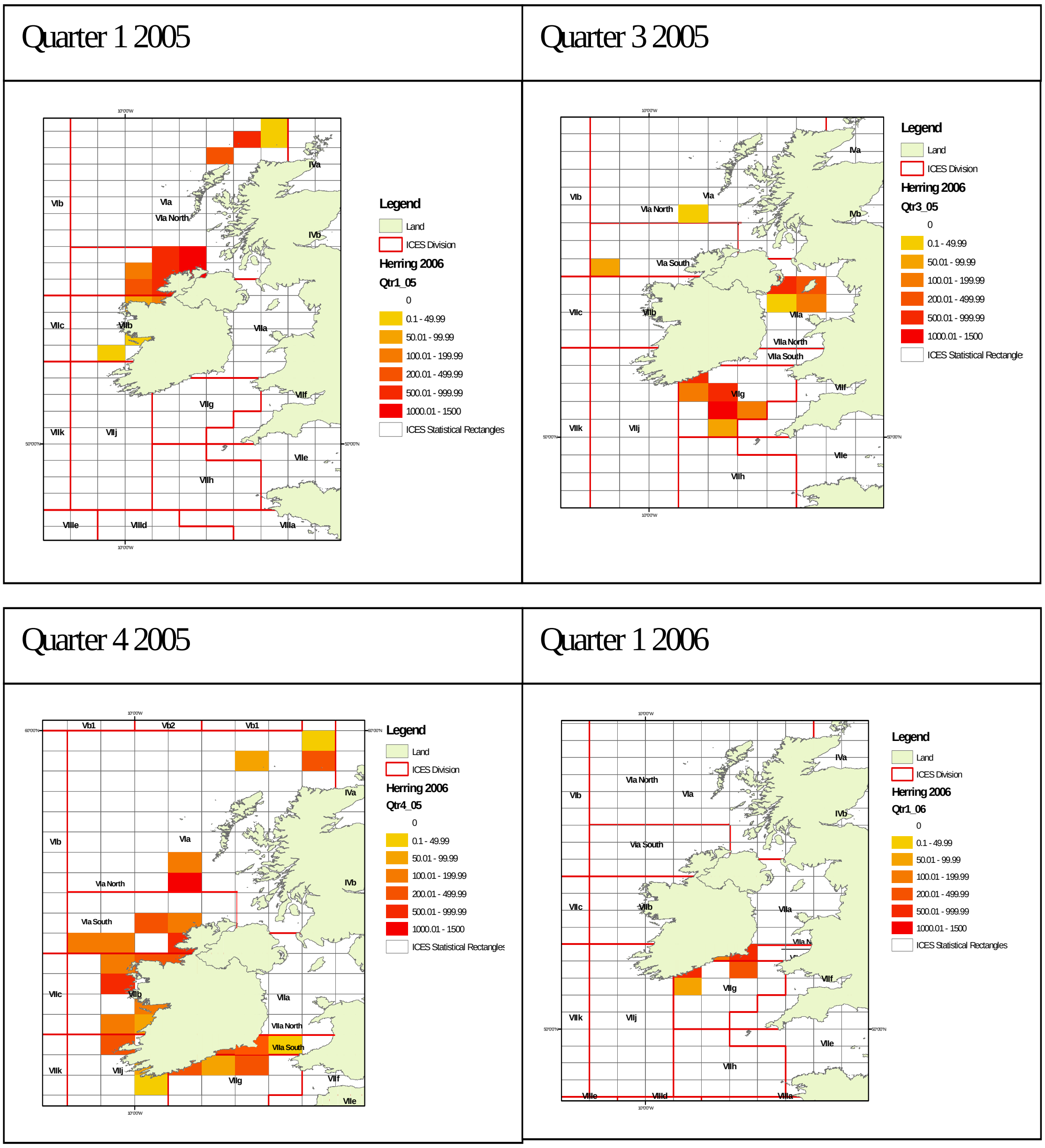


Figure 4.1.3.2 Herring catches by statistical rectangle in the first, third and fourth quarters of 2005 and the first quarter of 2005. Catches in ICES division V11a south, VIIg and VIIj are those in the 33 series of statistical rectangles and lower. Quarter 1 catches for VIaS only are indicated.

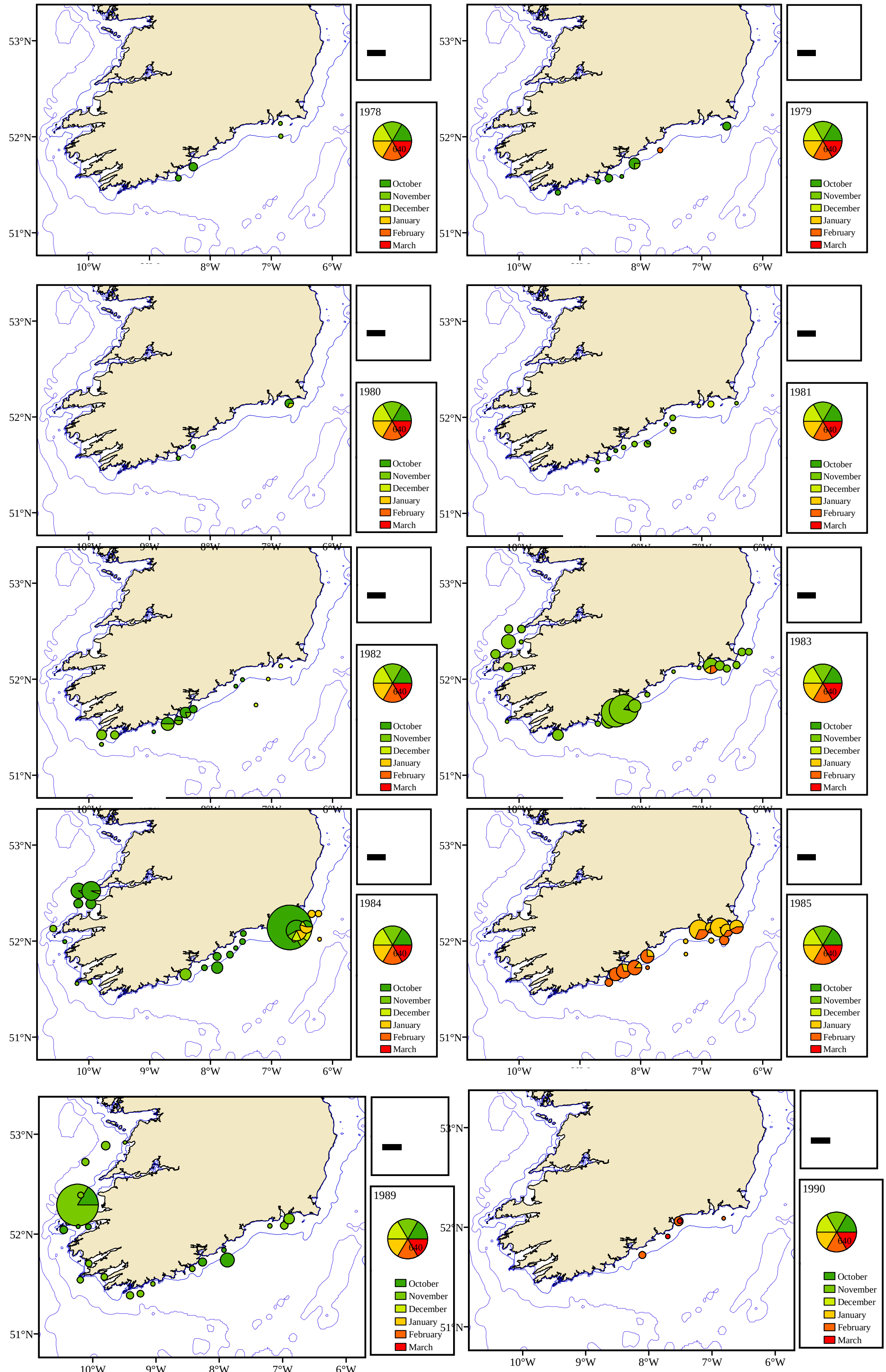


Figure 4.2.2.1 Celtic Sea and Division VIIj. Summary of larval distributions by month in 1980's from Irish surveys.

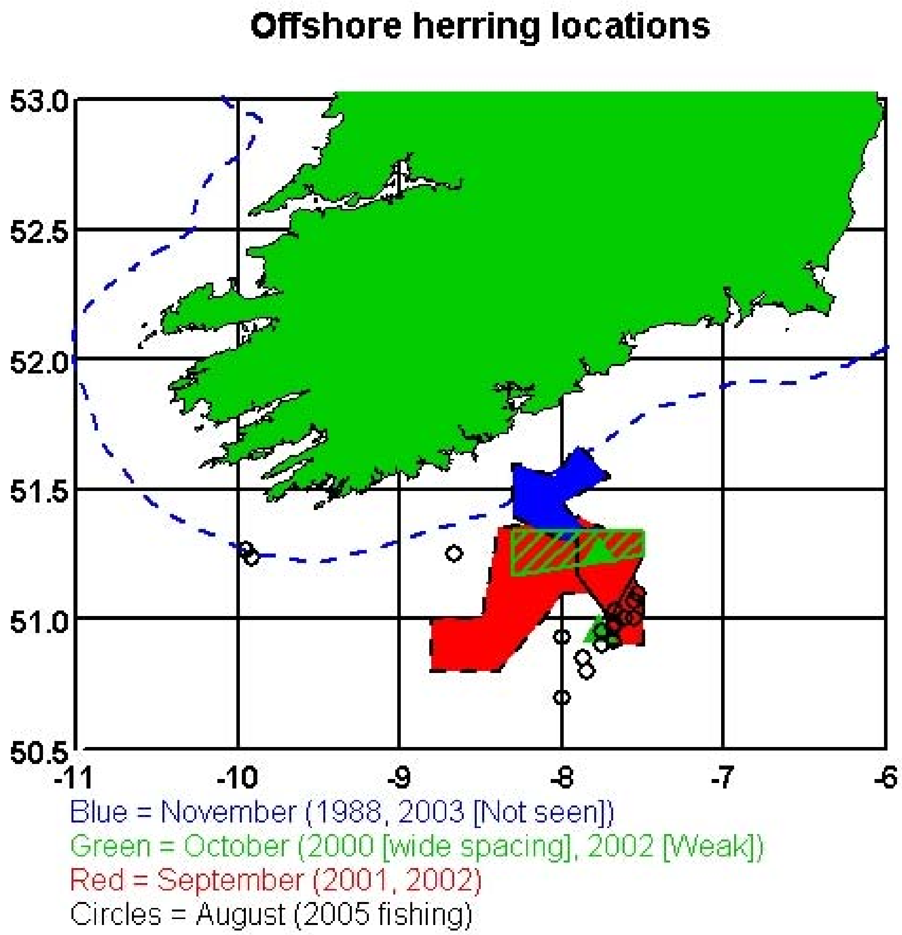


Figure 4.2.2.2 Celtic Sea and Division VIIj. Progressive movement of main aggregations of herring inshore in quarter 3 and 4. Data are from acoustic surveys 1998 to 2005 and the summer fishery in 2005.

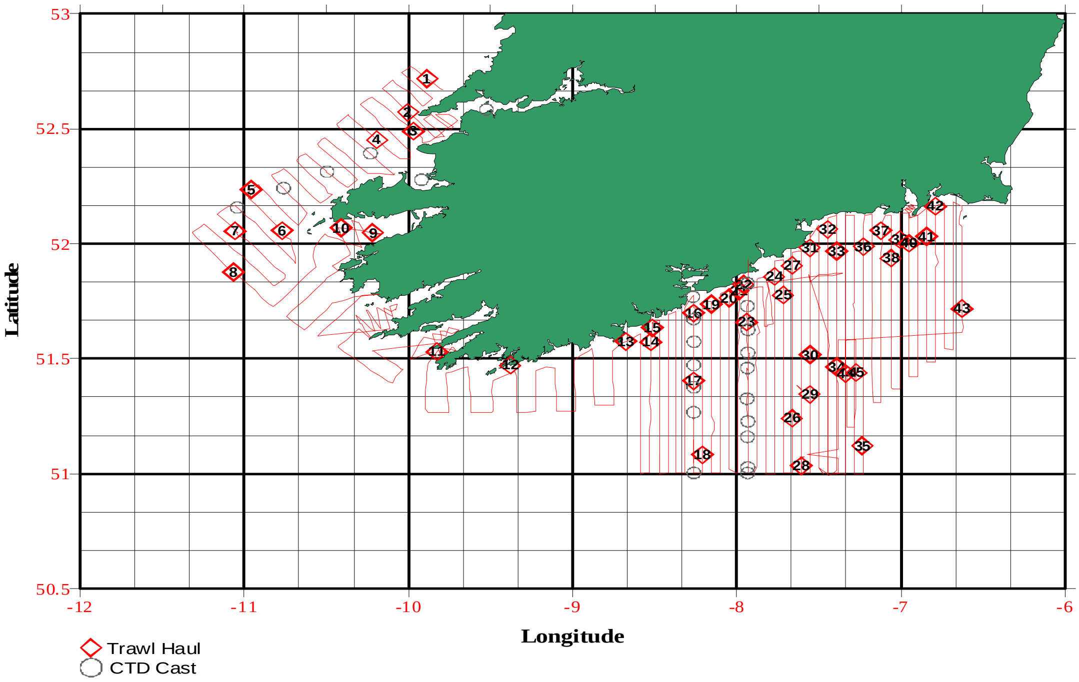


Figure 4.3.1.1a Celtic Sea and Division VIIj acoustic survey track and haul positions from acoustic survey, October 2005.

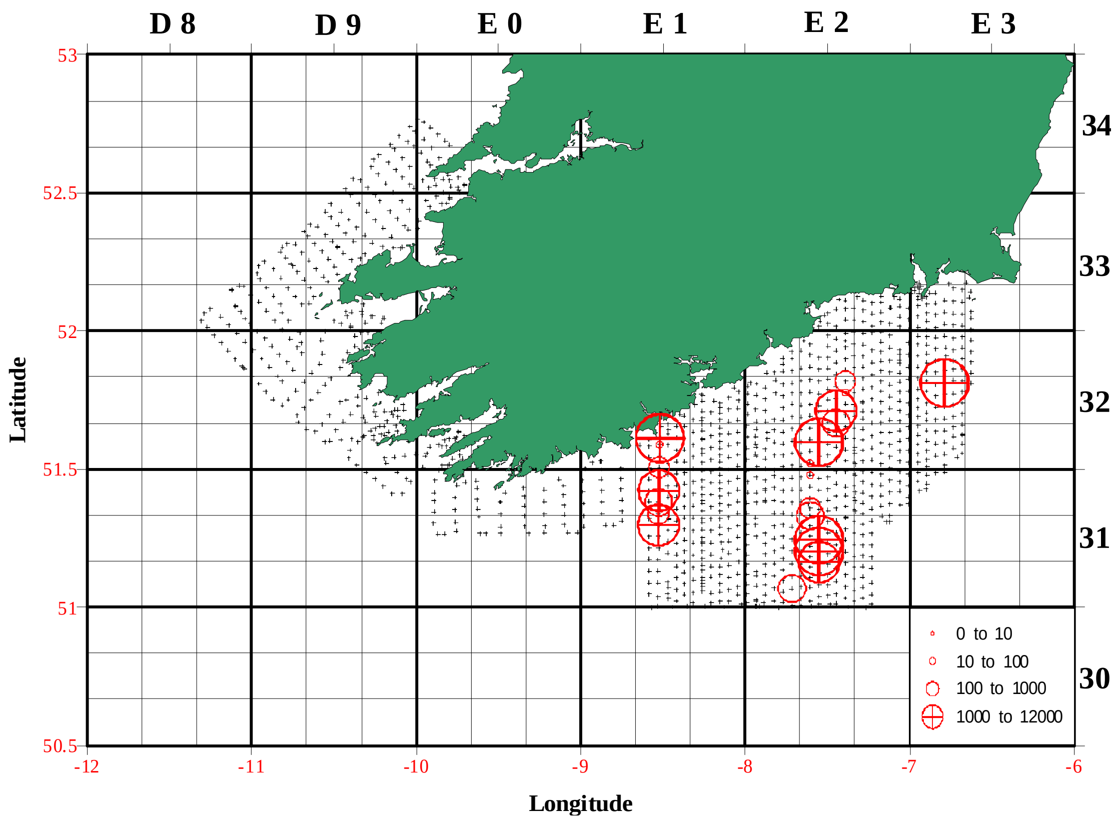


Figure 4.3.1.1b Celtic Sea and Division VIIj acoustic survey, total Sa values for herring obtained in October 2005.

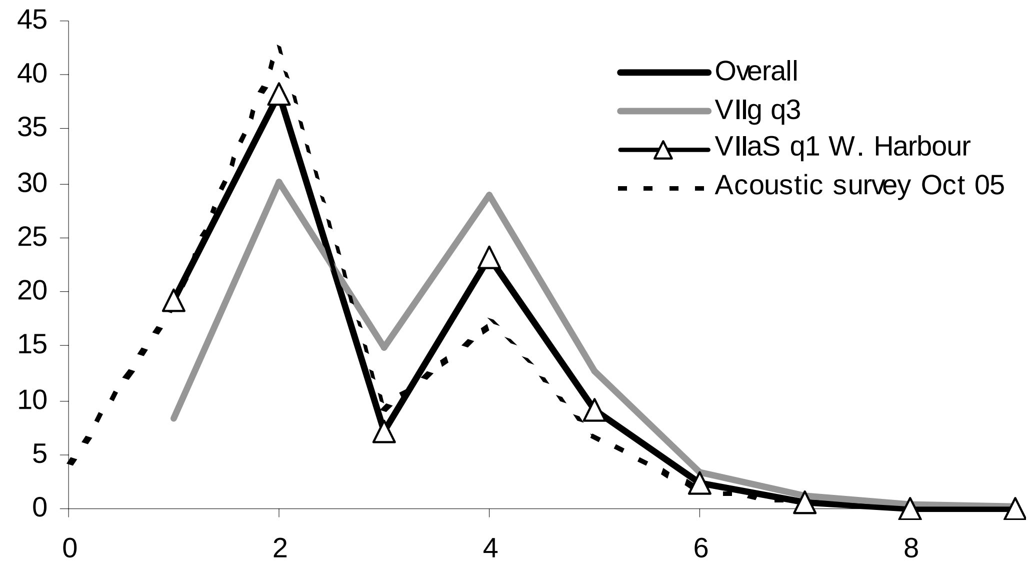


Figure 4.3.1.2 Celtic Sea & Division VIIj herring, comparison of percentage catches-at-age from the commercial fishery and from the acoustic survey.

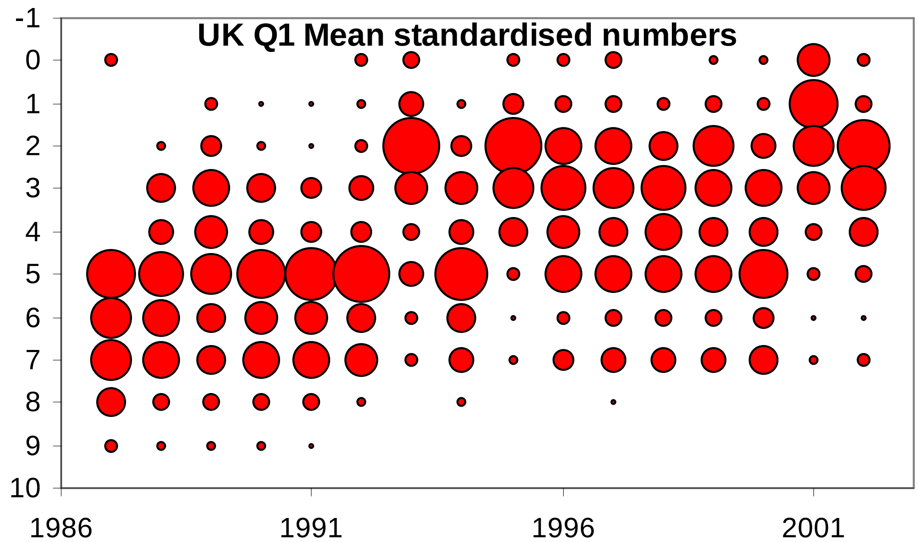


Figure 4.3.2.1 Celtic Sea & Division VIIj herring, mean standardised abundance estimate from UK quarter 1 groundfish survey 1987 to 2002.

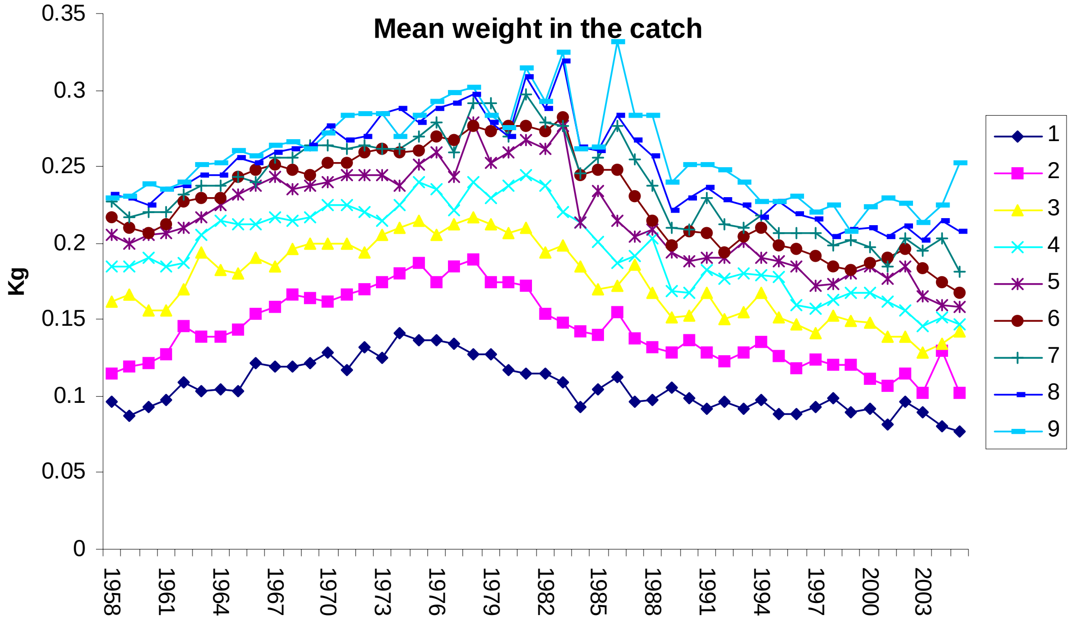


Figure 4.4.1. **Celtic Sea and VIIj herring, trends over time in mean weights in the catch.**

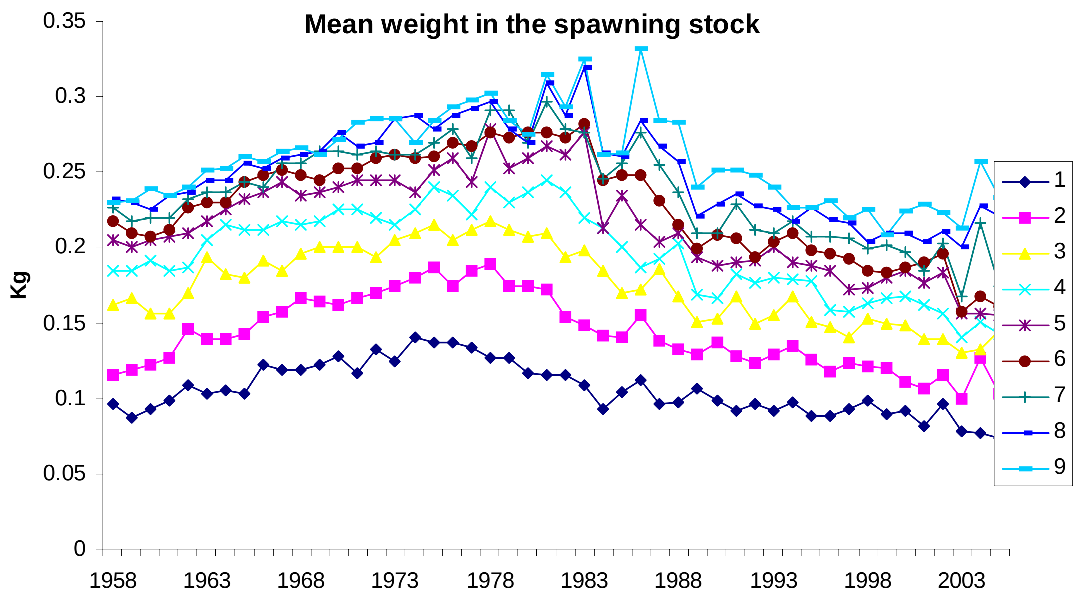


Figure 4.4.2. **Celtic Sea and VIIj herring, trends over time in mean weights in the stock at spawning time.**

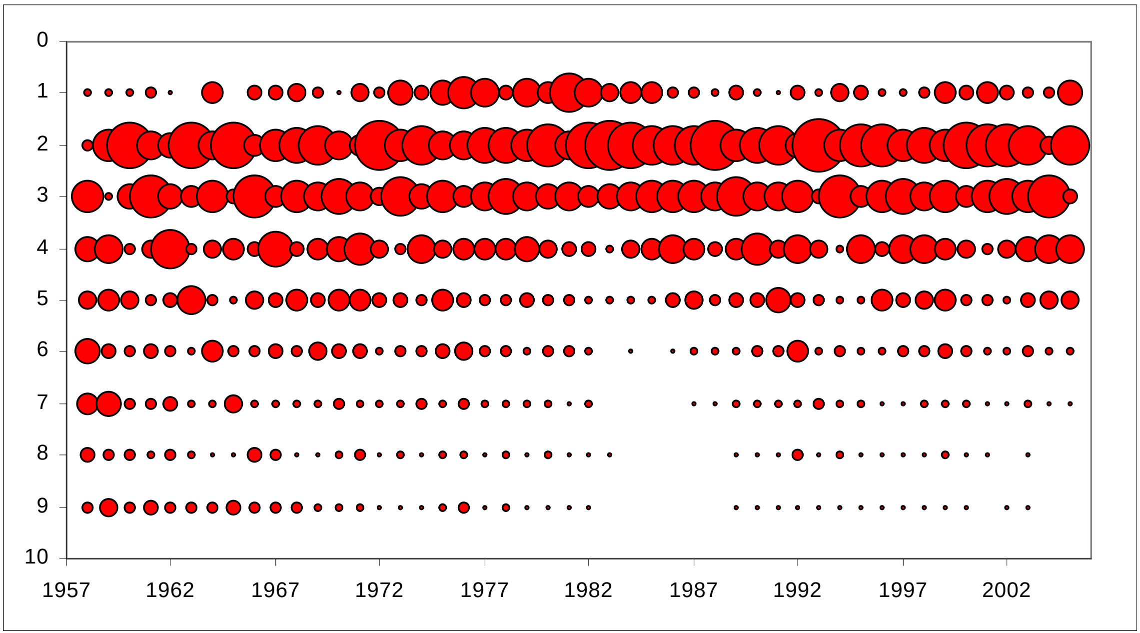


Figure 4.6.1.1. Celtic Sea and VIIj herring. Catch numbers at age in the time series, standardised by year mean.

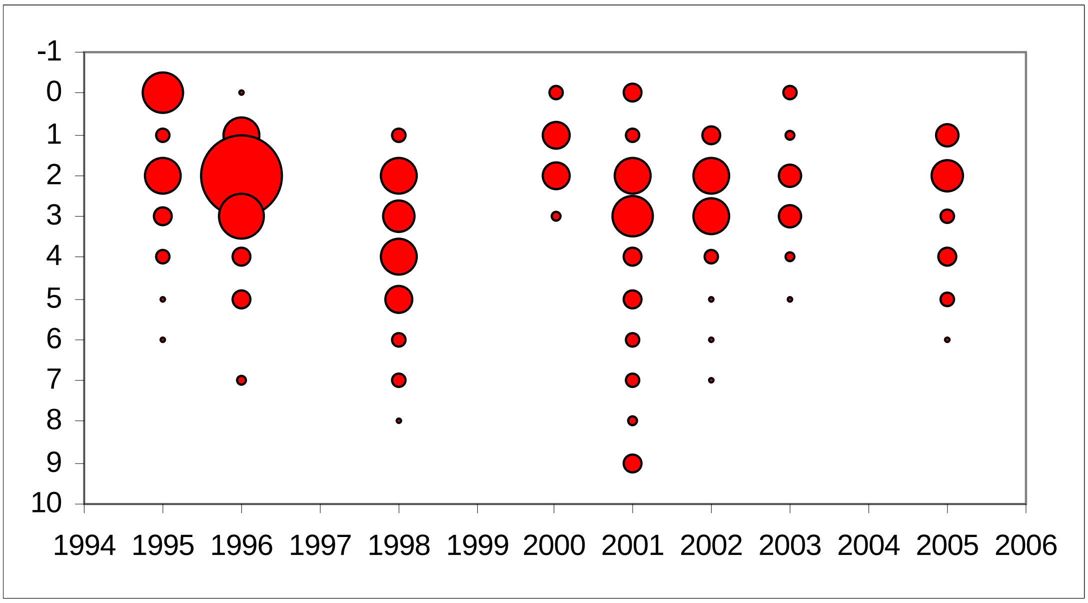


Figure 4.6.1.2. Celtic Sea and VIIj herring. Acoustic estimates of abundance at age in the revised time series, standardised by year mean.

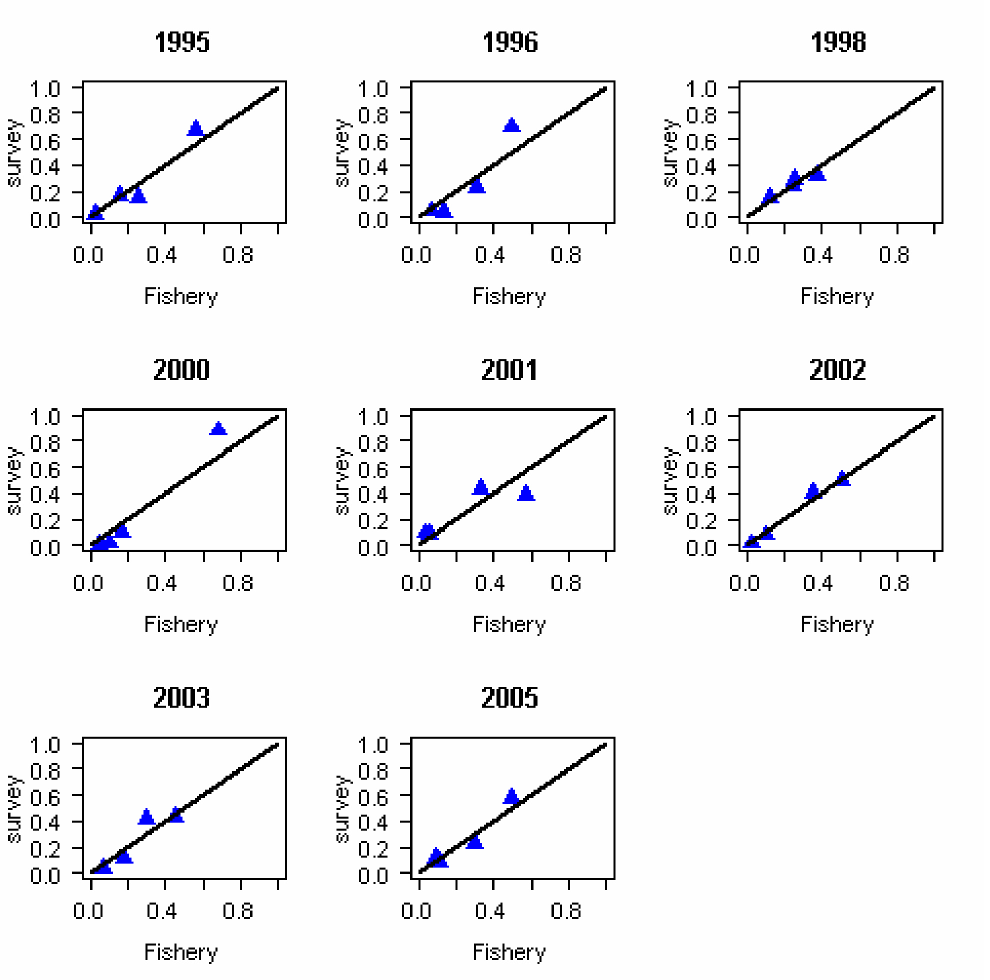


Figure 4.6.1.3. Celtic Sea and VIIj herring. Comparison of proportions at age in the commercial catch and in the revised acoustic survey abundance estimates.

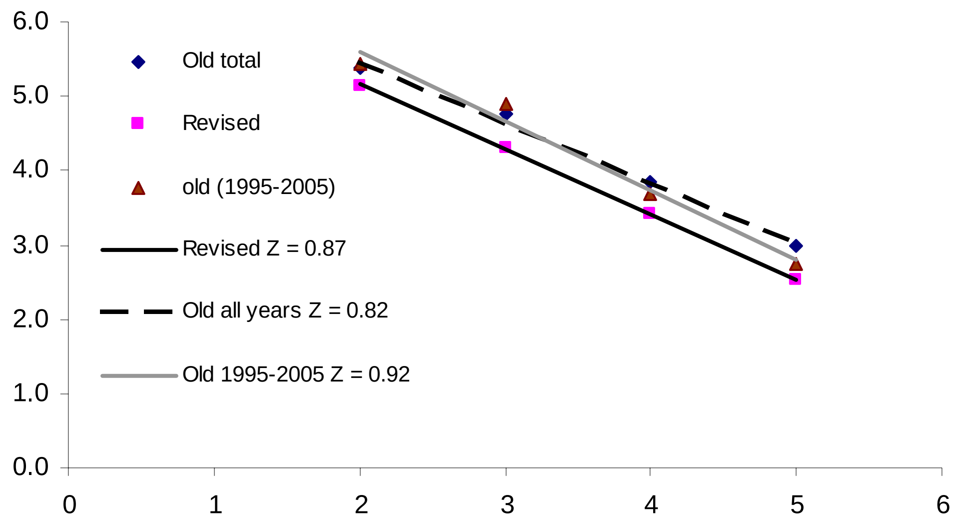


Figure 4.6.1.4. Celtic Sea and VIIj herring. Catch curves based on acoustic abundance estimates from revised and old acoustic survey series.

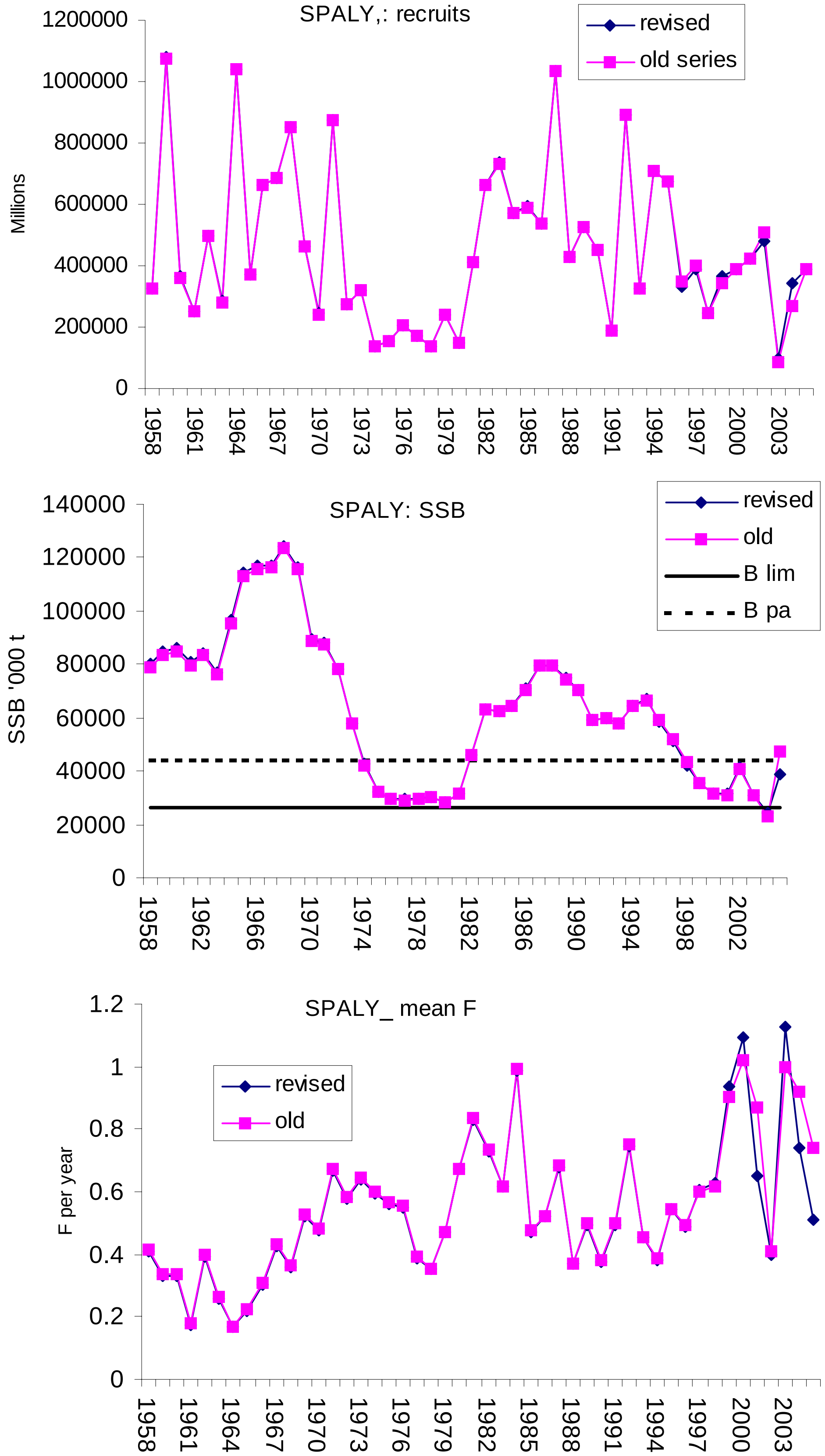


Figure 4.6.2.1. Celtic Sea and VIIj herring. Results of exploratory ICA assessments using SPALY and comparing the revised and the old acoustic sureys.

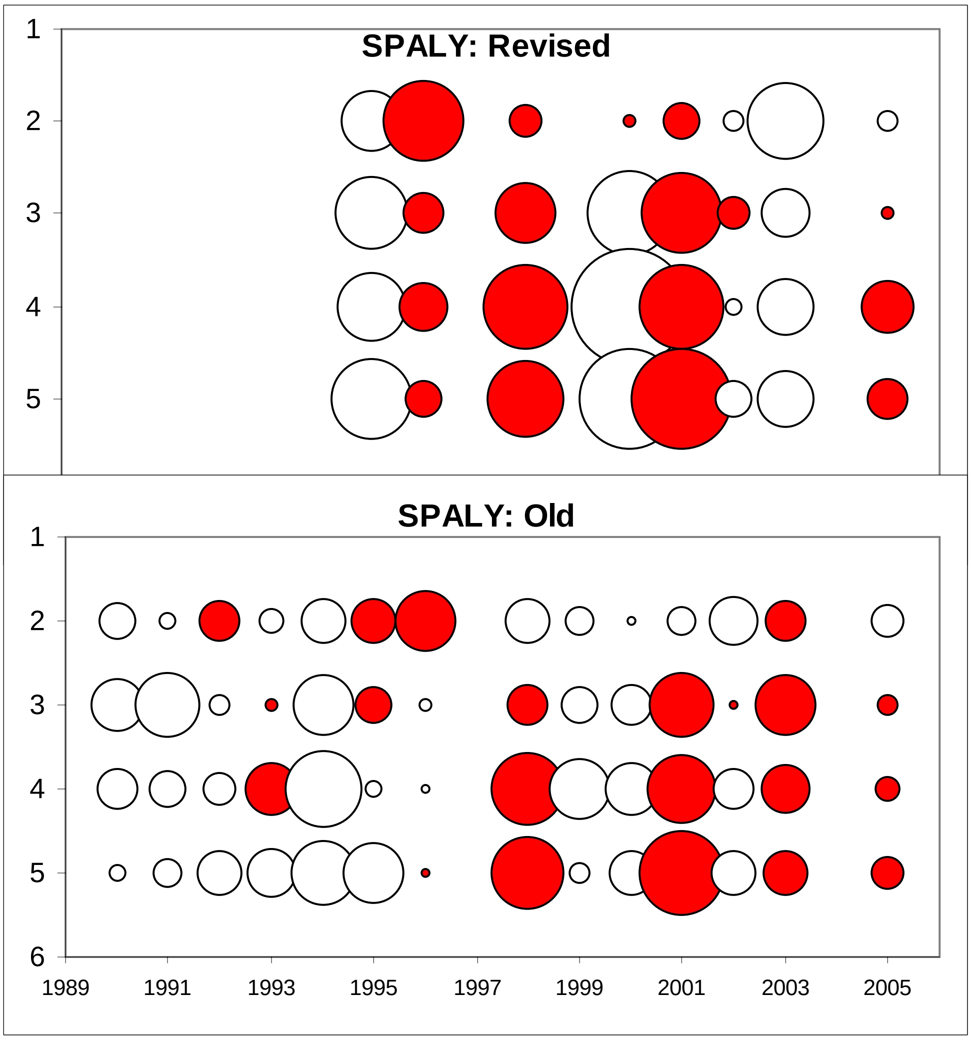


Figure 4.6.2.2. Celtic Sea and VIIj herring. Survey series residuals of exploratory ICA assessments using SPALY and comparing the revised and the old acoustic surveys.

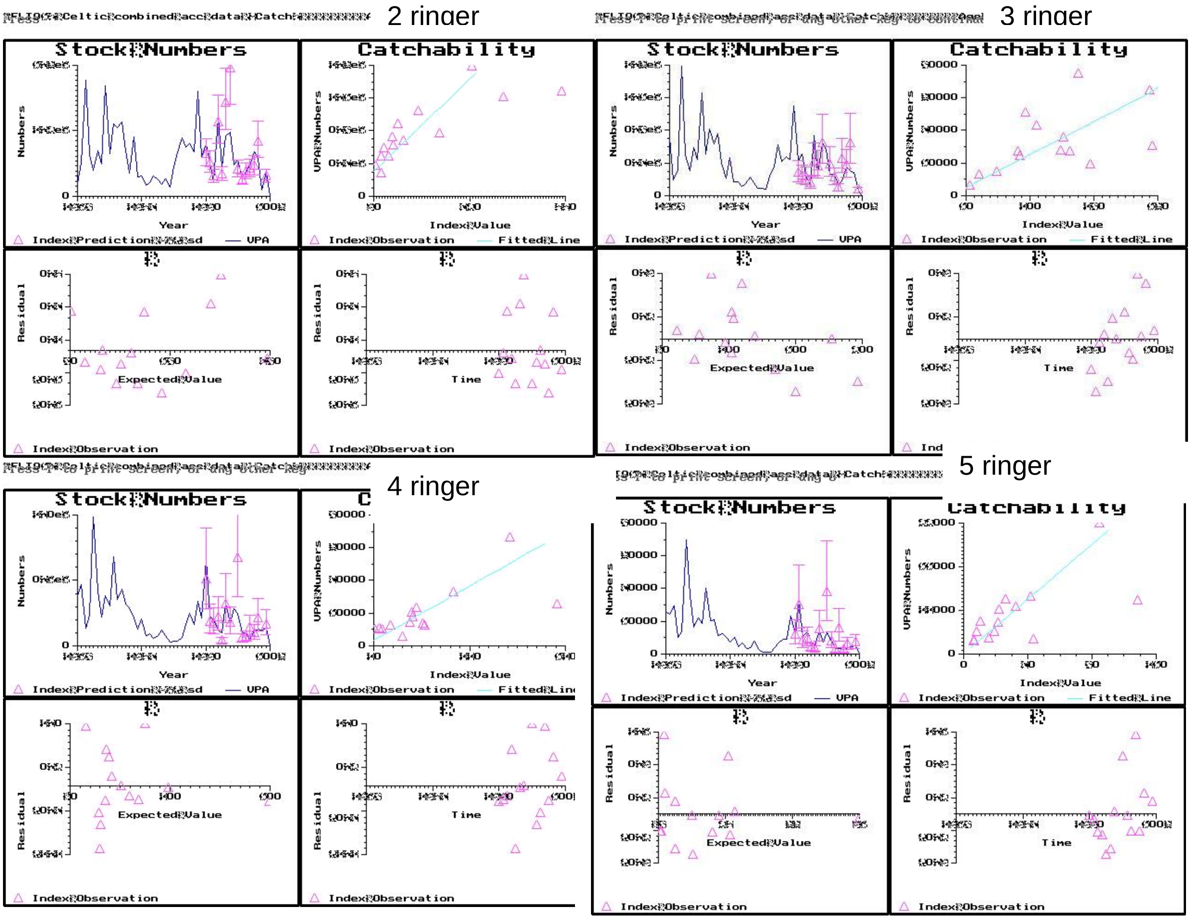


Figure 4.6.2.3 Herring in the Celtic Sea and Division VIIj. Exploratory assessment using updated catch data, <u>excluding</u> the 2004 survey data. Diagnostics of the fit of the <u>old</u> acoustic survey index at age 5 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) – ln(expected index) plotted against expected values and time.

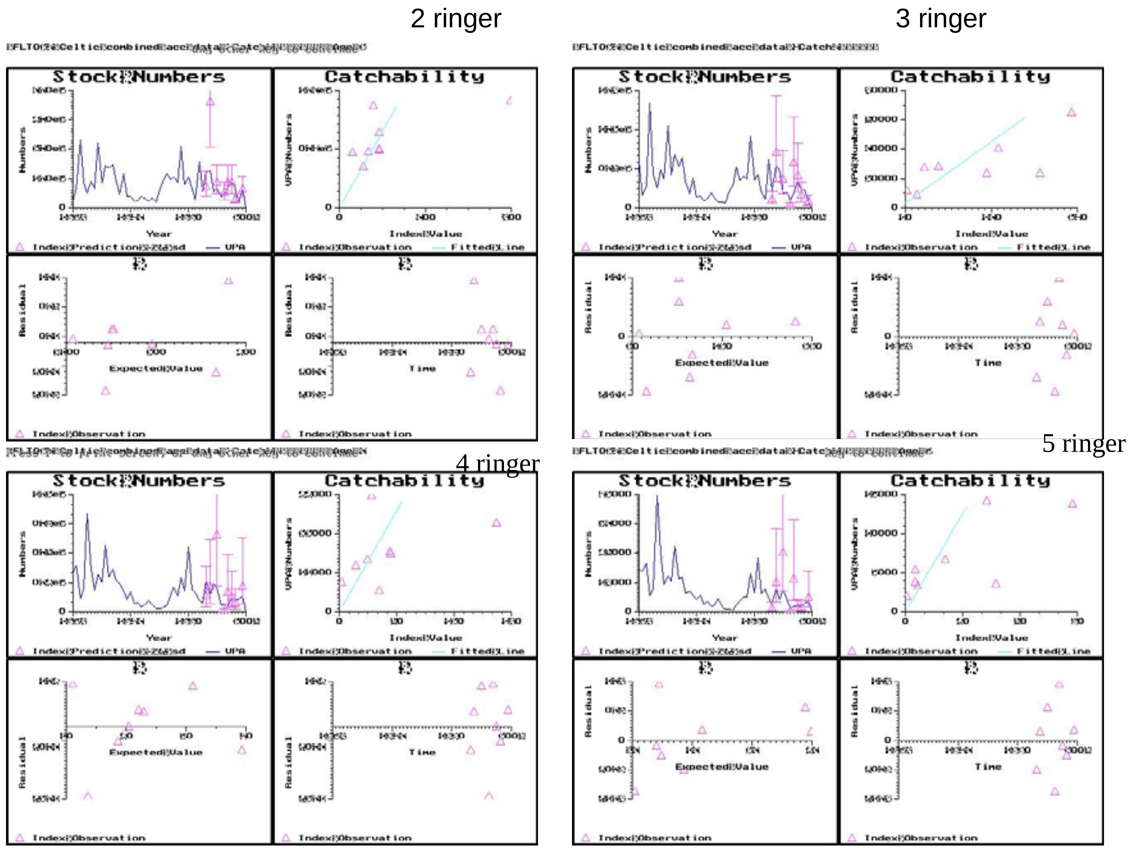


Figure 4.6.2.4. Herring in the Celtic Sea and Division VIIj. Exploratory assessment using updated catch data, <u>excluding</u> the 2004 survey data. Diagnostics of the fit of the <u>revised</u> acoustic survey index at age 5 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) – ln(expected index) plotted against expected values and time.

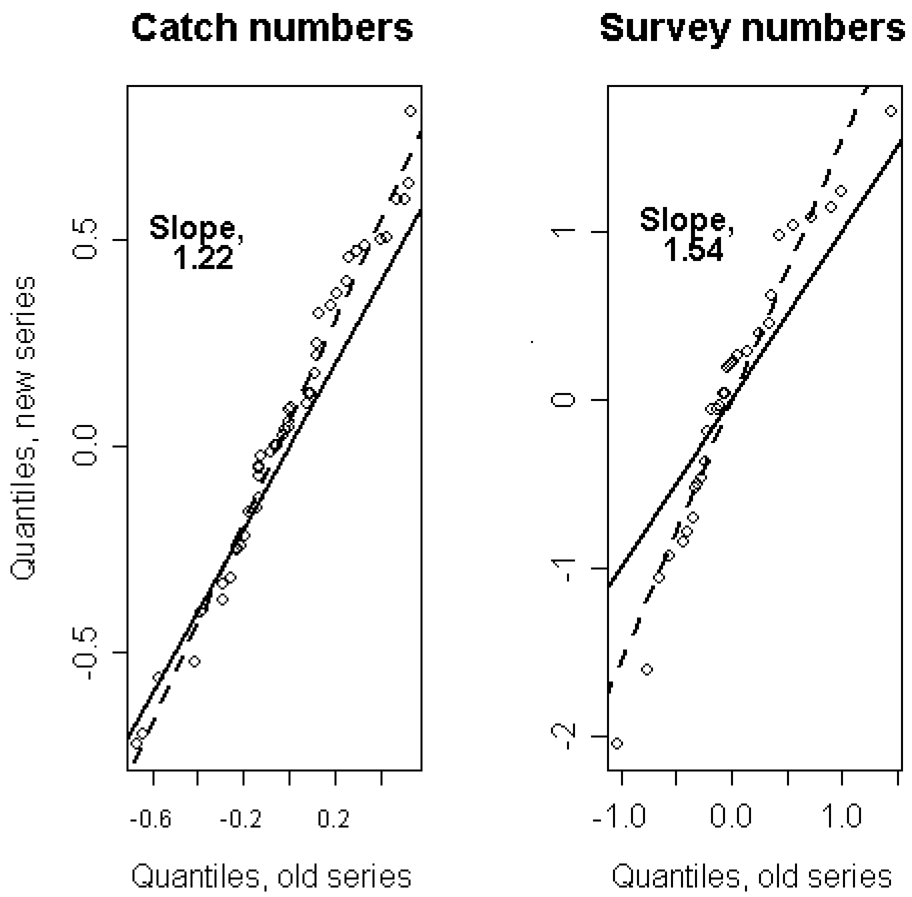
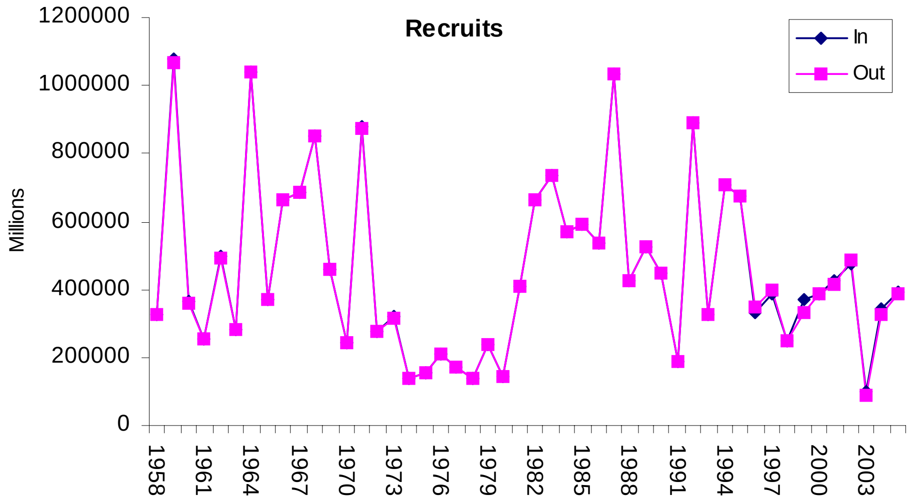
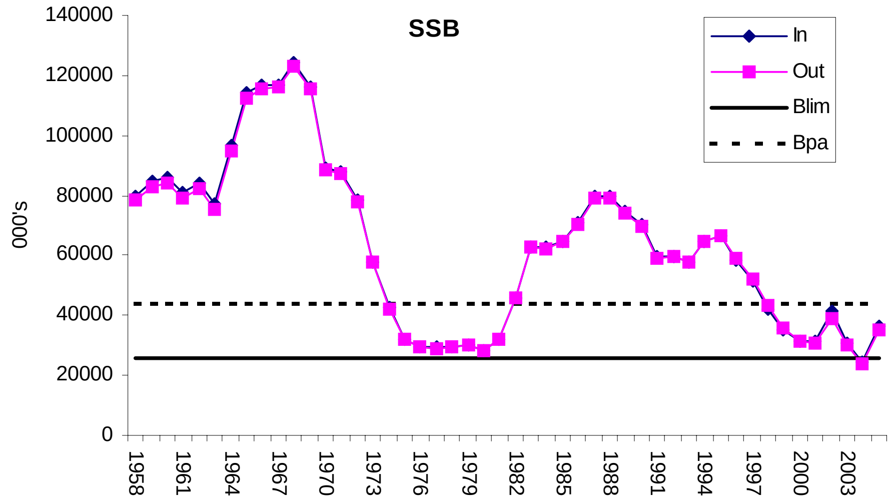


Figure 4.6.2.5. Celtic Sea and VIIj herring. Q-q plots of exploratory ICA assessments using SPALY and comparing the revised and the old acoustic surveys.





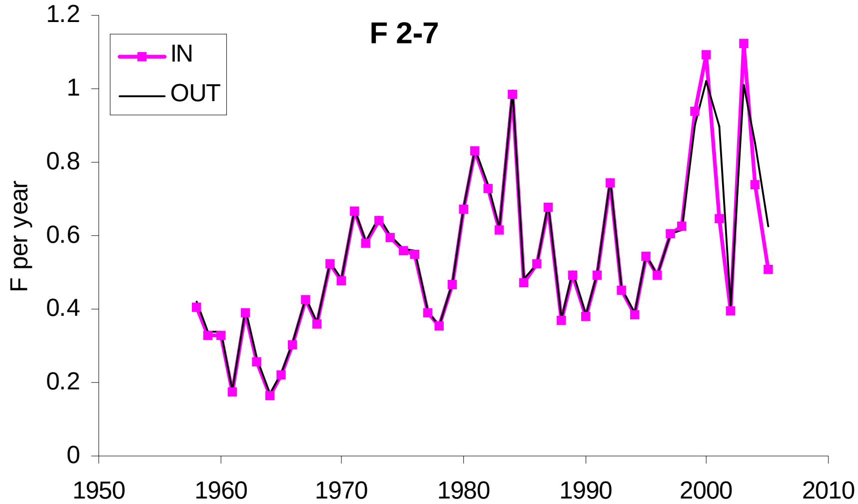


Figure 4.6.2.6. Celtic Sea and VIIj herring. Comparison of performance of revised acoustic series including and excluding surveys with high CVs (2000 and 2001).

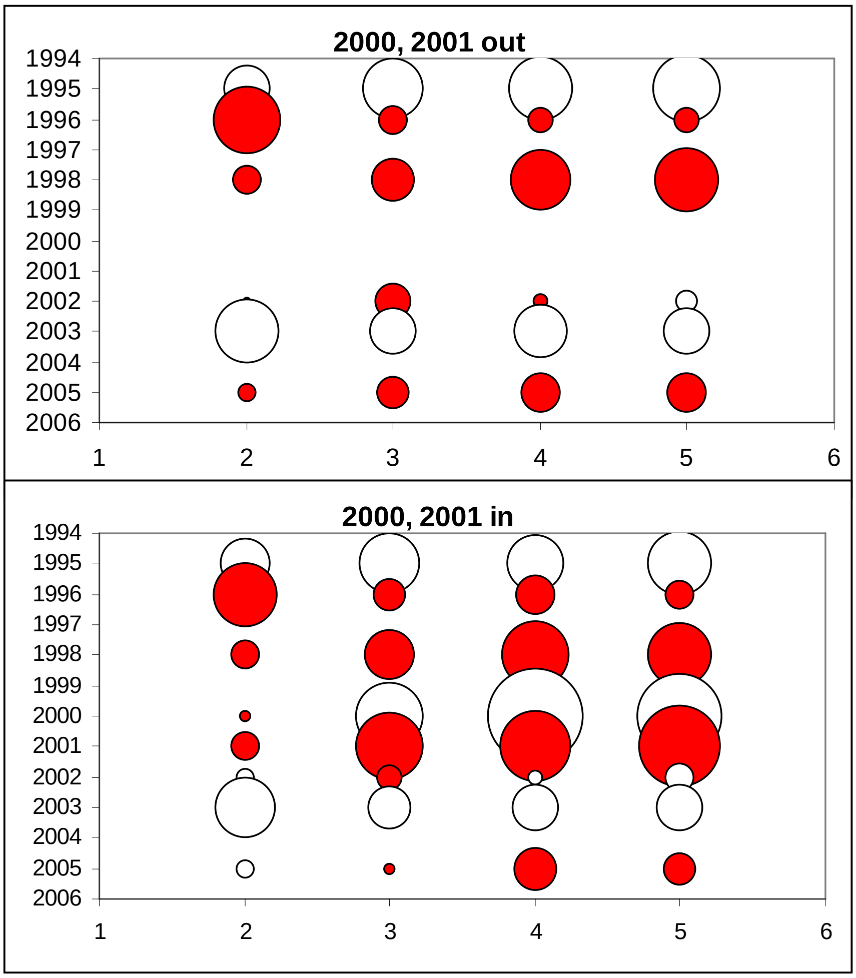


Figure 4.6.2.7. Celtic Sea and VIIj herring. Survey series residuals of exploratory ICA assessments including or excluding the 2000 and 2001 points.

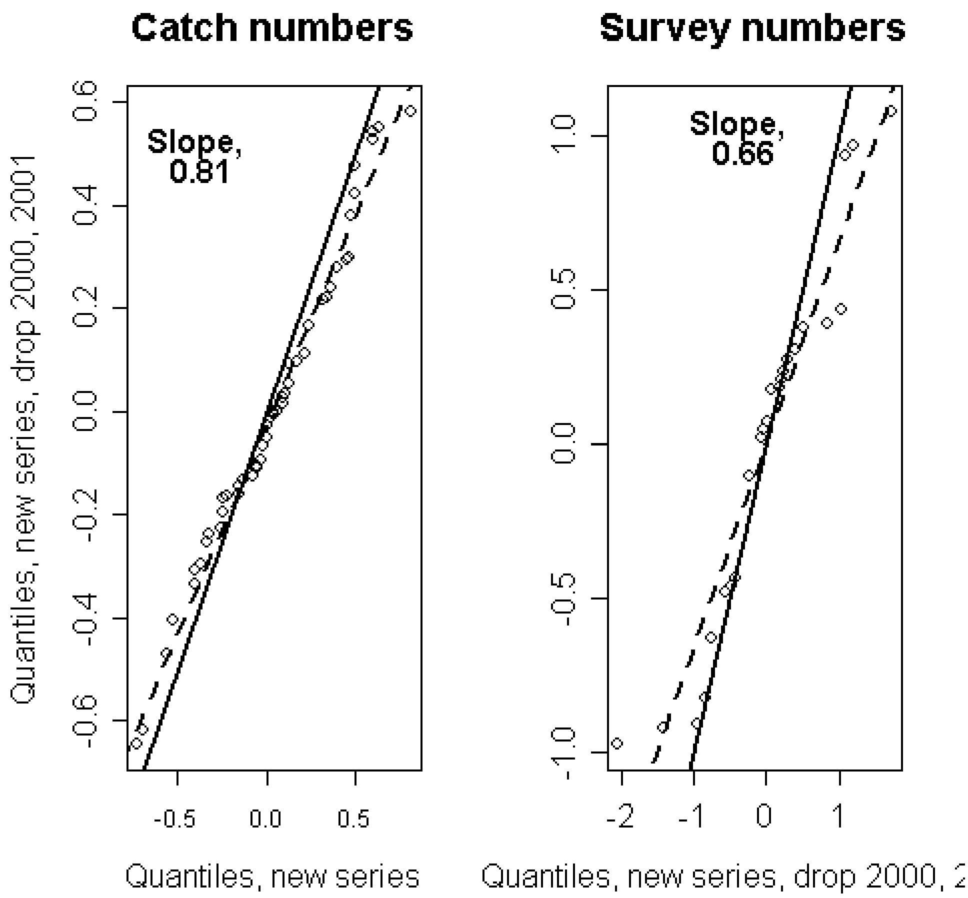


Figure 4.6.2.8. Celtic Sea and VIIj herring. Q-q plots of exploratory ICA assessments including or excluding the 2000 and 2001 points.

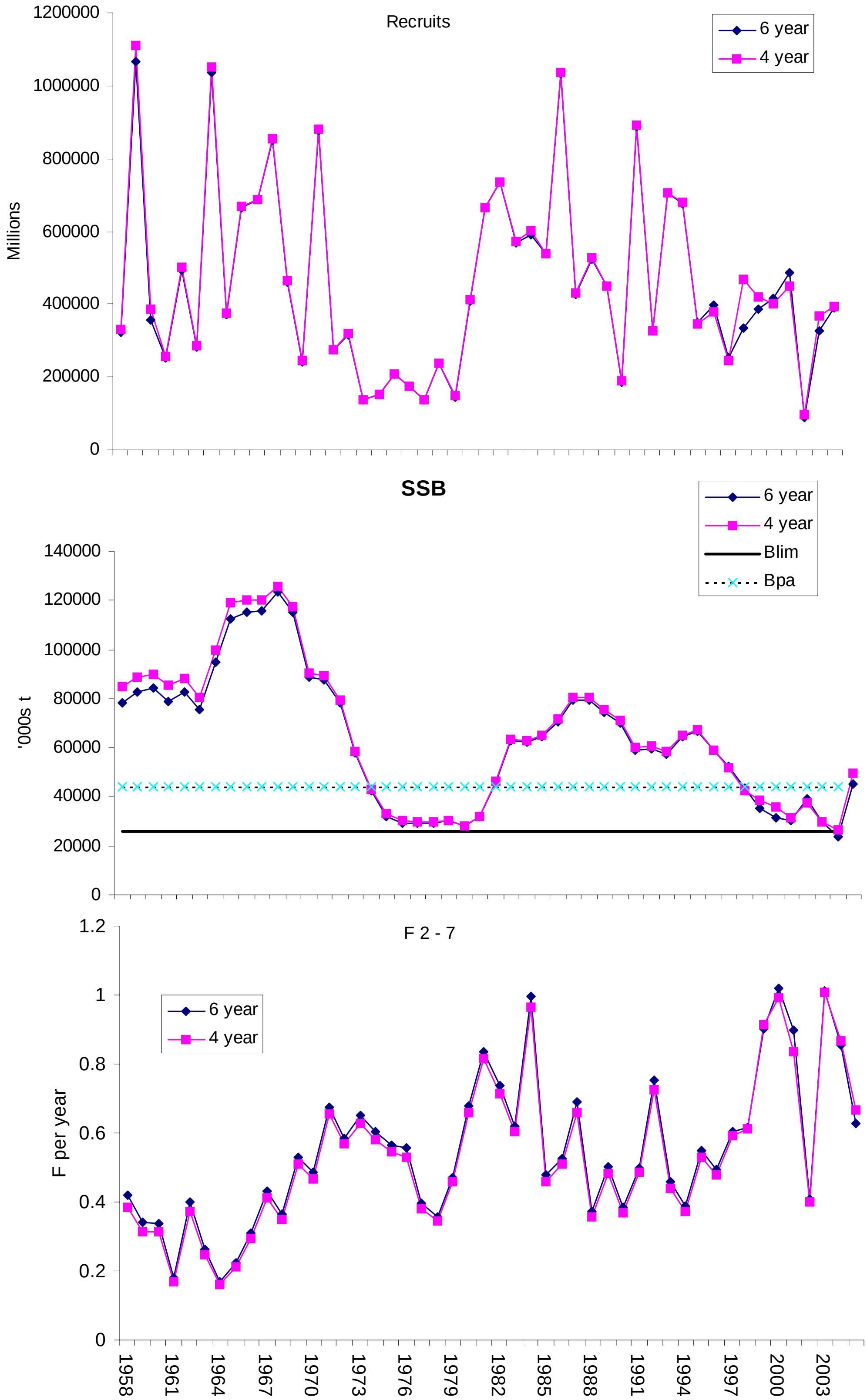


Figure 4.6.2.9. Celtic Sea and VIIj herring. Exploratory runs with 4 and 8 year separable period.

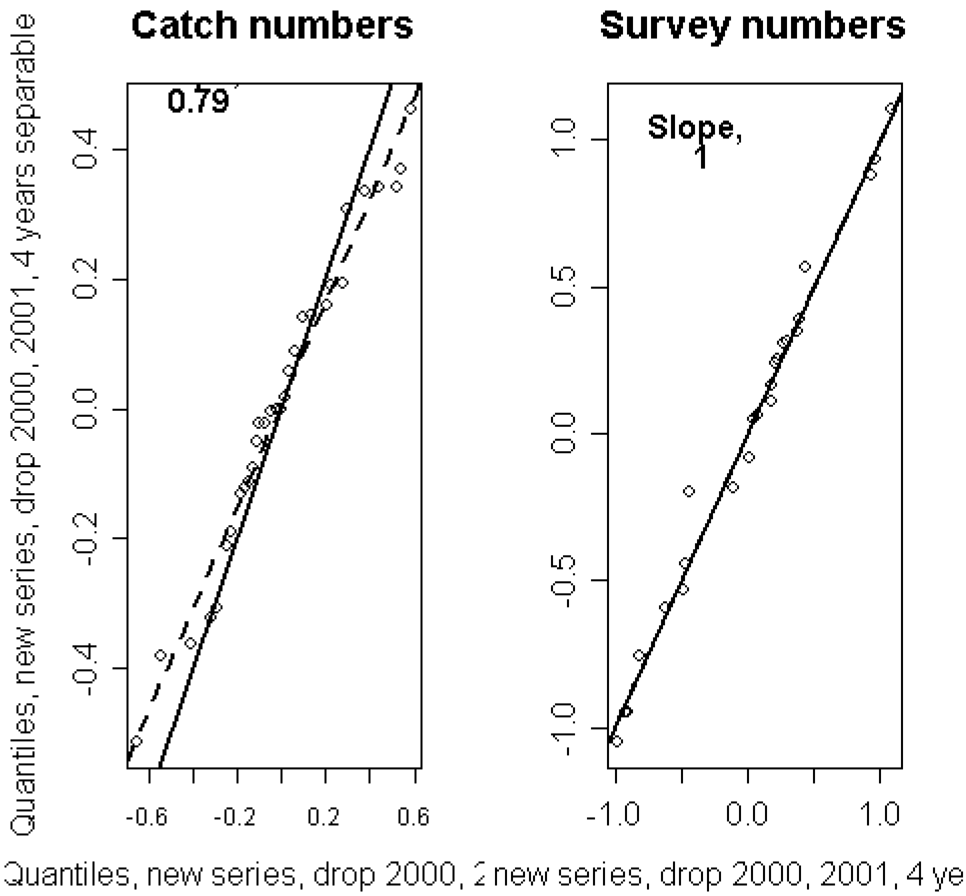
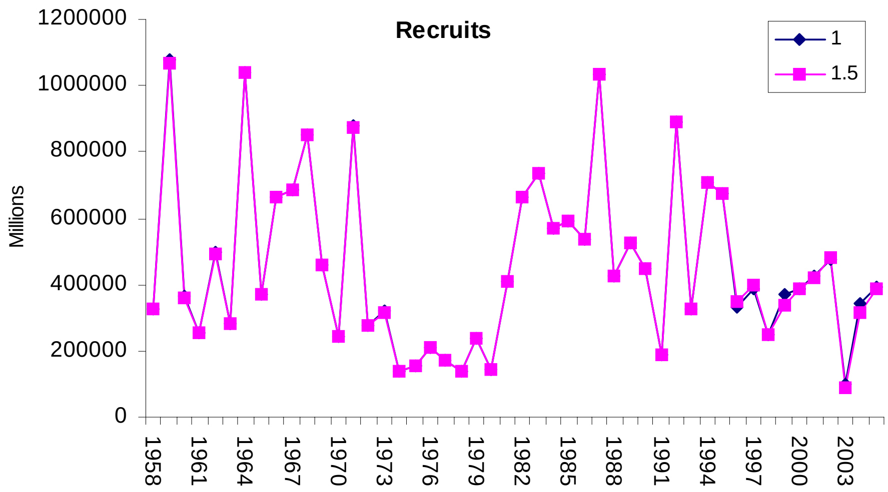
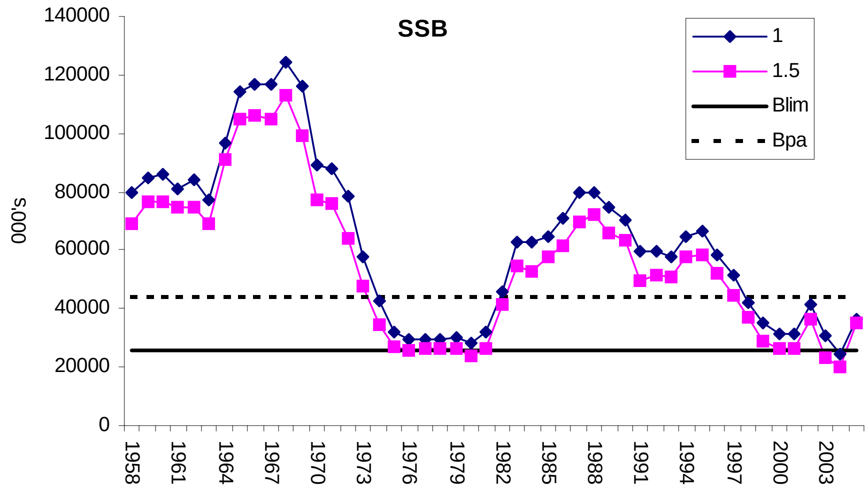


Figure 4.6.2.10. Celtic Sea and VIIj herring. Q-q plots of exploratory ICA assessment comparing 6 year and 4 year separable periods.





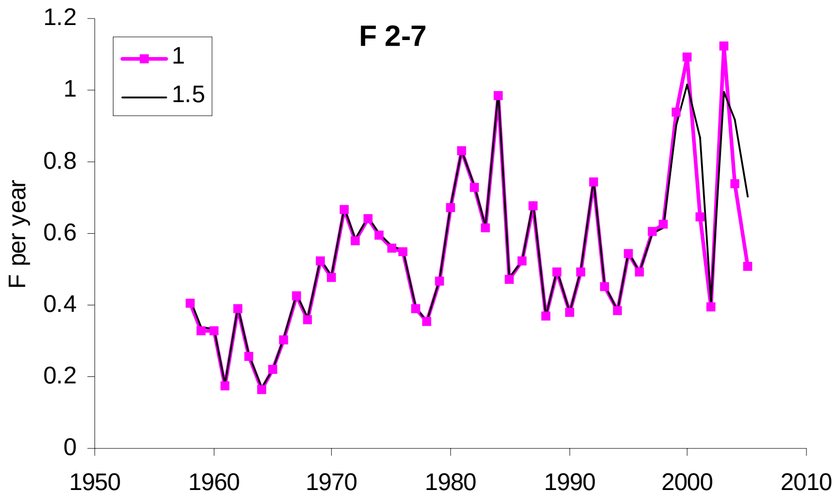


Figure 4.6.2.11. Celtic Sea and VIIj herring. Exploratory runs with terminal S = 1.0 and = 1.5.

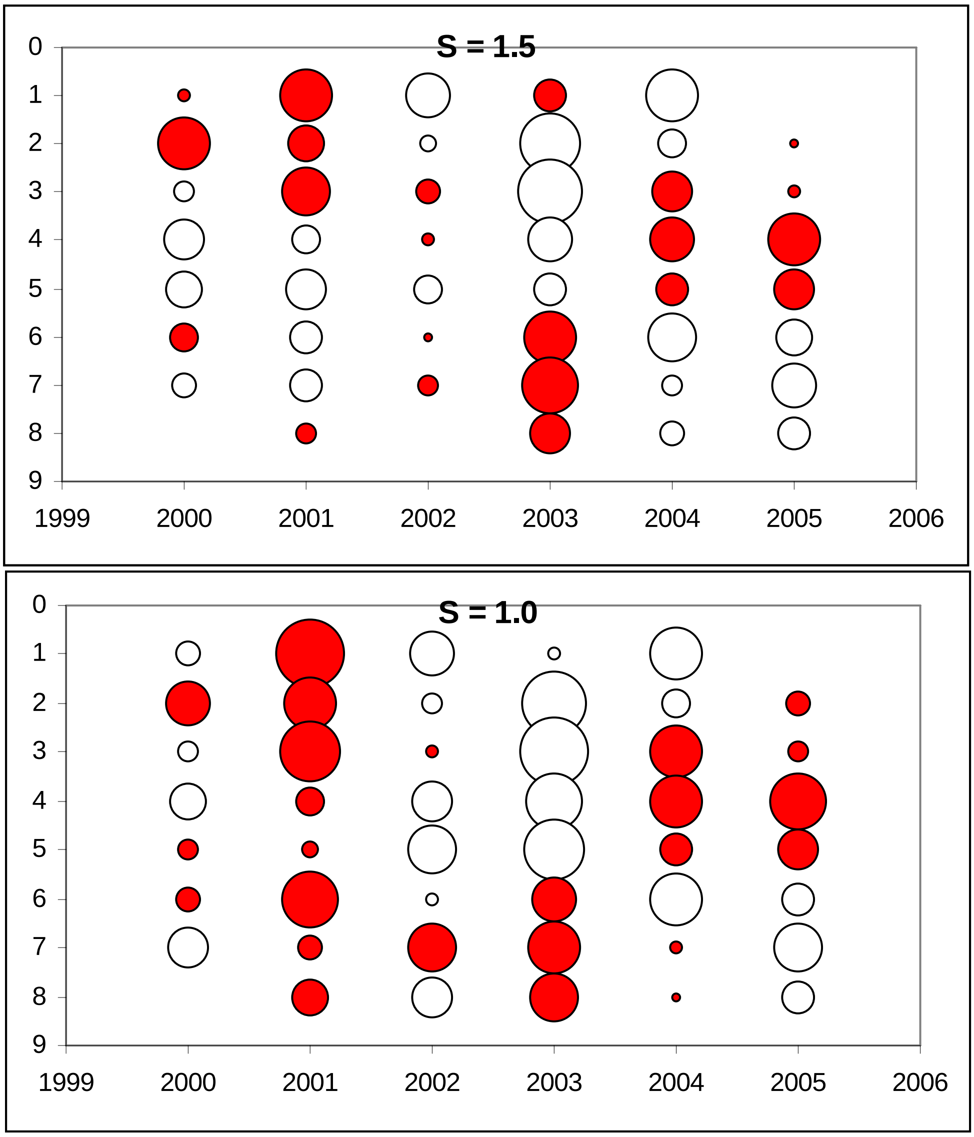


Figure 4.6.2.12. Celtic Sea and VIIj herring. Survey series residuals of exploratory ICA assessments including or excluding the 2000 and 2001 points.

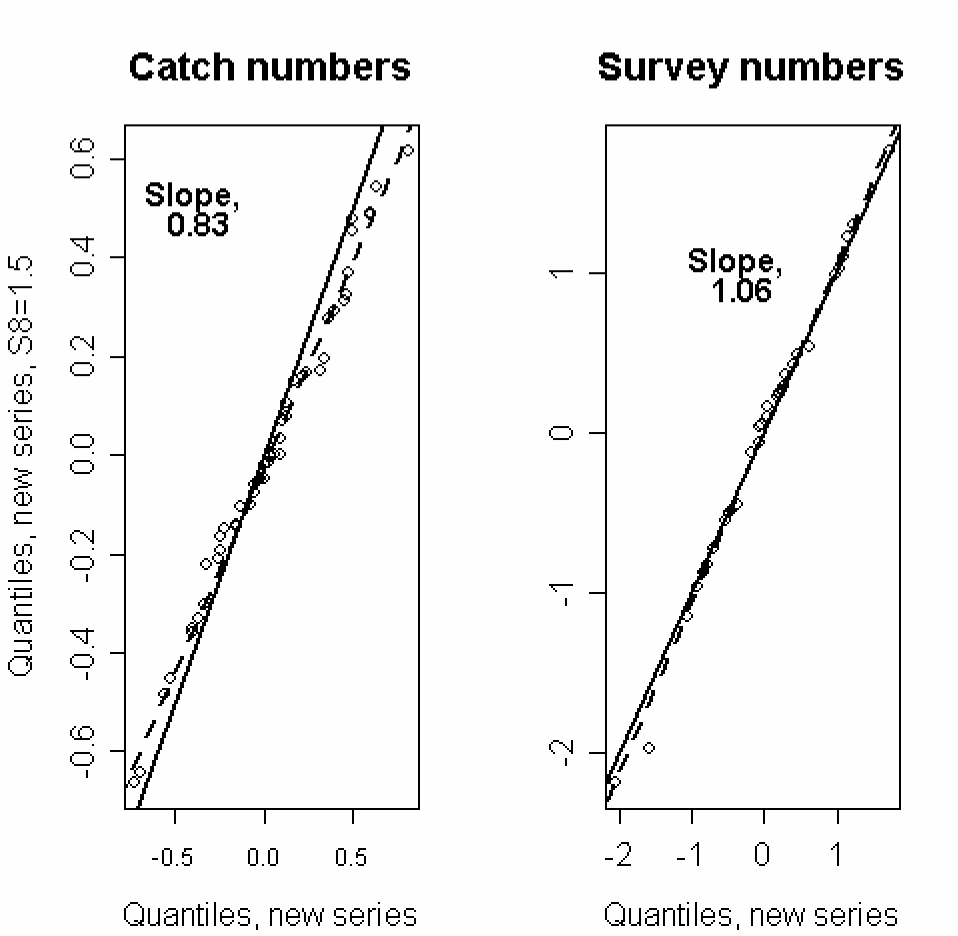


Figure 4.6.2.13. Celtic Sea and VIIj herring. Q-q plots of exploratory ICA assessment comparing choice of S at oldest age = 1 and 1.5.

5 West of Scotland Herring

5.1 The Fishery

5.1.1 ACFM Advice Applicable to 2005 and 2006

ACFM reported in 2005 that based on the most recent estimates of SSB, ICES classified the stock as having full reproductive capacity. The assessment showed a relatively stable SSB over the last three years, substantially higher than the previous ten years. Fishing mortality has stabilised at a low level. The 1998, 1999, and 2000 year classes are all present in reasonable numbers. Current fishing mortality is at a level where the stock remains within PA bounds. Consequently, ACFM recommended that fishing mortality be maintained at *status quo* (=0.19), corresponding to catches in 2006 of 26 400 t.

There are no explicit management objectives for this stock. A $\mathbf{B}_{lim}$ of 50 000 t has been agreed by ACFM for this stock. A candidate HCR (see below) was presented by ACFM in 2005 with the statement that it "seems to maintain the stock inside precautionary limits" and ACFM agreed that it might be adopted subject to an evaluation of a year-on-year TAC constraint.

F=0.25	if SSB > 75 000 t	Optional year on year TAC constraint.
F=0.2	if SSB < 75 000 t	No constraint on TAC.
F = 0	if SSB falls below B_{lim}.	

The agreed TAC for 2005 is 34 000 t, which is in accordance with the HCR above. The TAC in 2004 was 30 100 t.

5.1.2 The VIa (North) Fishery

Historically, catches have been taken from this area by three fisheries.

i) A Scottish domestic pair trawl fleet and the Northern Irish fleet operated 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. This fleet has reduced in recent years.

ii) The Scottish single boat trawl and purse seine fleets, with refrigerated seawater tanks, targeting herring mostly in the northern North Sea, but also operated in the northern part of VIa (N). This fleet now operates mostly with trawls but many vessels can deploy either gear.

iii) 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 but most are Dutch owned.

In recent years the catch of these last two fleets has become more similar and has been dominated by younger adults resulting from increased recruitment into the stock of the stronger 2000 and 2001 year classes.

In 2005, the Scottish trawl fleet fished in areas similar to the freezer trawler fishery, and not in the coastal areas in the southern part of VIa (N). The Northern Irish fleet fished in both the north and the south of VIa (N).

As a result of perceived problems of area misreporting of catch from IVa into VIa (N), Scotland introduced a fishery regulation in 1997 with the aim to improve reporting accuracy. Under this regulation, Scottish vessels fishing for herring were required to hold a license either to fish in the North Sea or in the west of Scotland area (VIa (N)). Only one licensed option could be held at any one time. However in 2004, the requirement to carry only a single licence was rescinded. Area misreporting of catch taken in area IVa into area VIa (N) then increased in 2004 and continued in 2005. It is possible, therefore, that the relaxation of this single area licence has contributed to a resurgence in area misreporting. Reinstating this single area licence requirement should be considered as it appears to be helpful to management for this area. It is also important that all nations with reported official catch in VIa (North) investigate the accuracy of the catch area reported.

5.1.3 Catches in 2005 and Allocation of Catches to Area for VIa (North)

In the past, 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 WG considered that the serious problems with misreporting of catches from this stock, with many examples of vessels operating and landing herring catches distant from VIa (N) but reporting catches from that area, had been reducing in recent years. Levels reduced from some 30 000 t in 1998 and 1999 to around 5 000 t in 2002 with none reported in 2003. However, there was an increase in 2004 (with over 6 000 t being area misreported) that has continued in 2005 (with over 14 000 t being area misreported). The problem was detailed in the Herring Assessment WG report in 2002 (ICES 2002/ACFM:12). In 2004, 3rd quarter misreporting of catch taken in area IVa into area VIa (N) was offset by quantities of herring caught during the 4th quarter mackerel fishery in VIa (N) that were area misreported as IIa herring, presumably because the VIa (N) quota had been exhausted. In 2005, however, the 4th quarter mackerel fishery was curtailed for some fleets and no area misreporting occurred. The basis on which catch tonnages are arrived at have been consistent over the last few years. The process involves observers, location information and contacts with individual skippers and appears to be reasonably dependable.

For 2005, the preliminary report of official catches corresponding to the VIa (N) herring stock unit total 31 392 t, compared with the TAC of 30 100 t. The Working Group's estimates of area misreported catches are 14 383 t. An additional 722 t of herring has been reported as discarded. At such a low level currently, discarding is not perceived to be a problem.

The Working Group’s best estimate of removals from the stock in 2005 is 17 009 t. Details of estimated national catches from 1983 to 2005 are given in Table 5.1.1.

5.2 Biological composition of the catch

Age composition data, by country and by quarter, are detailed in Table 5.2.1. The number of samples used to allocate an age-distribution for the VIa (N) catches steadily decreased from 52 in 2002, 37 in 2003 down to 10 in 2004. This is due to two problems;

i) the difficulty of targeting sampling on vessels that fish in this area because these vessels fish in other herring areas and there may be no prior knowledge of the fishing intentions of the vessel before departure from port.

ii) the area misreporting recorded of catch taken in other in other areas and reported as VIa (N) can result in successfully collected samples being subsequently reallocated correctly to their true area, thus losing numbers of samples from the sampling program, see sections 5.1.2 and 5.1.3.

The number of samples increased to 17 in 2005. Samples were obtained from the Irish, Scottish and Northern Irish fleets, these were used to allocate a mean age-structure (weighted by the sampled catch) to unsampled catches, in the same quarter, or in adjacent quarters if no samples were available in the corresponding quarter. If no sampling data were available for a quarter, a mean age-structure of all samples from adjacent quarters was used. The allocation of age structures to unsampled catches, and the calculation of total international catch-at-age and mean weight-at-age in the catches were made using the ‘sallocl’ programme (Patterson, 1998). While only a limited number of samples were obtained, these did come from the major fisheries by fleet area and season and are thought to be representative of the catches.

Catch in number-at-age information is given in Table 5.2.2. Two reasonable year classes can be seen clearly at 2-ring and older in the catch-at-age table; the 2000 year class at 4-ring in 2005 and the 2001 year class at 3-ring in 2005. The previously abundant 1998 year class is not apparent in the catch numbers-at-age in 2005. 1-ring herring in the catch are variable and are rarely representative of year class strength and are down-weighted in the assessment, see section 5.6.

In the past concern has been raised over the quality of sampling of commercial catch. It was suggested in the 2001 ACFM technical minutes that an analysis of catch by quarter and country might shed some light on the variability in the catch information. In practice the fishery is often dominated by a single quarter catch, and a single country dominates sampling. Thus such an analysis is impossible. In 2002 the Working Group conducted an extensive analysis of the sensitivity of the assessment to missing catch information (Section 5.1.12 in ICES 2002/ACFM:12). Although sampling is relatively poor the analysis indicated that sampling for age information was not the major source of variability in the assessment at that stage.

5.3 Fishery Independent Information

5.3.1 Acoustic Survey

The 2005 acoustic survey was carried out from 28 June-15 July using a chartered commercial fishing vessel (MFV *Enterprise*). The total biomass estimate obtained, 187 500 t, was again lower than in the previous year (396 000 t in 2004 and 739 200 t in 2003), and is comparable only to the 1997 value (which is not used in the assessment due to the earlier than usual prosecution of the survey in that year). The survey ran for approximately 20% less time in 2005 than in previous years due to a shorter number of planned days than usual (due to the effect of increased fuel costs on a limited charter budget) and time lost to bad weather. As a result, wider transect spacing had to be chosen for those areas that had less historical high density. Biomass estimated from the acoustic survey tends to be noisy and fluctuations at a slightly lower level have been observed in previous years. The observed spatial distribution was generally more diffuse than in previous years and while herring were found in areas similar to those in 2004, namely south of the Hebrides off Barra Head, west of the Hebrides and along the shelf edge, the greater abundance was found off Barra Head. Further details are available in the Report of the Planning Group for Herring Surveys (ICES 2006/LRC:04). Estimates of abundance-at-age and aggregate spawning stock biomass for 2005 and for previous years are given in Table 5.3.1. The same year classes seen in the catch can be seen clearly at 2-ring and older in the acoustic survey table, however the 2000 year class at 4-ring in 2005 is more dominant in the survey than in the catch.

5.4 Mean weights-at-age and maturity-at-age

5.4.1 Mean Weight-at-age

Weights-at-age in the catches and weights-at-age in the stock from acoustic surveys are given in Table 5.4.1 and are used in the assessment. The weights-at-age in the stock, for 3 to 8-ringers, appear to be at the long term low. There appears to be a decreasing trend across the time-series. This is not unusual for HAWG stocks. The only increases are seen in the 1-ringers and the plus group.

5.4.2 Maturity Ogive

The maturity ogive is obtained from the acoustic survey and collated in Table 5.4.2 for the period 1992 to 2005.

In 2005, maturity for 2-ring herring is similar to the 2004 value and 3-ring and above are all mature. Weights-at-age in the stock are generally lower than in 2004. Weights-at-age in the catch show no consistent trend.

5.5 Recruitment

There are no specific recruitment indices for this stock. Although both catch and acoustic survey have catches at 1-ring both the fishery and survey encounter this age group only incidentally. The first reliable appearance of a cohort appears at 2-ring in both the catch and the stock. Thus in predictions, estimates of both 1- and 2-ring herring numbers from the assessment need to be replaced for prediction years.

5.6 Assessment of VIa (North) herring

5.6.1 Data Exploration and Preliminary Modelling

In the 2006 HAWG, the VIa (North) assessment is a scheduled update assessment and there is no evidence that there are any specific modelling issues. This model has been explored in much detail in recent years and is perceived to be reasonably well behaved with the settings used. Therefore the model and the model settings used below are the same as last year's assessment and these will not be explored in detail this year.

In 2005 there is reduced catch (the lowest Working Group catch on record) – see Table 5.1.1 and the 2005 acoustic survey SSB is also the lowest on record – see Table 5.3.1. Both these factors have required a detailed analysis of both the catch and survey data to examine patterns and to determine if the signals in the data are real, artefacts, or noise.

Examination of the age classes in both the catch and the survey shows that the age range present in the survey is also present in the catch (Figure 5.6.1). The same pattern of strong and weak cohorts can be seen in both catch and survey data (see, for example, the strong 1998 year class and the weak 1997 year class) and there has been no truncation of catch in older ages in the most recent years suggesting that there has been no major change in mortality in the survey or catch. The survey data often suffer from strong year effects as a primary feature of error – see the changes between 1992 and 1993 as an example.

Patterns of mortality can also be inferred from the catch curves, plotted by year class, of both catch and survey data (Figure 5.6.2). The raw catch data (not standardised for catch) in particular show a sharp increase in "mortality" from 2004 to 2005 in the older ages, but this is primarily a reflection of the reduced catch in 2005. To determine if this apparent increase in mortality in the catch was real, or an artefact of reduced catch in 2005 the catch data were "standardised" by dividing by the catch in each year; these standardised catch curves are given in Figure 5.6.3. In this plot the apparent increase in total mortality in the last years is not seen and mortality rates are similar between the earlier and later periods. This suggests that the total mortalities are unchanged in 2005 and that the impression of increased mortality is not due to a reduced population (i.e., the disappearance of fish from the population) but to reduced catch which is due to other reasons entirely (see section 5.1.3).

To extract the most informative signals on mortality, data are averaged over several ages; Figure 5.6.4 shows the log ratios in the catch and the survey averaged across the 3- to 6-ring age groups (3 to 6 being analogous to the use of the same age grouping as Fbar in the assessment (i.e., the most heavily exploited age groups in the population)). Again there is no apparent increase in the mortality signal in either the catch or the survey in recent years and total mortality fluctuates around the same level (Z~0.3) from 1999 to 2005. What this figure does highlight, however, is the conflicting signal shown by the catch and survey data in the three most recent years. The assessment is particularly sensitive to data in the last years. The high mortality derived from the low survey value is not in agreement with the catch data. This disparity may lead to problems in the assessment.

Given the uncertainties surrounding the reduced catch and survey estimates it was decided to explore assessment outcomes with the 2005 survey both included and excluded in the assessment runs. The acoustic survey index is the only tuning index available for this stock. These exploratory assessments of the stock were carried out by fitting an integrated catch-at-age model (ICA version 1.4w described in the methods section in the 2003 Working Group report (ICES 2003/ACFM:17, Section 1.6.1)). An age-structured index was available from the acoustic survey from 1987, 1991-1996 and 1998-2005 (Section 5.3.1).

In 2006 a selection pattern of 8 years 1998-2005 was used, this length of period was found to be sufficiently long to smooth out noise in the data. ICA was then run for the available time-series, 1957-2005, to compare the exploratory model fits for this year with the 2005 working Group assessment.

The separable model residual patterns for the three runs (with the 2005 survey, without the 2005 survey, agreed assessment from HAWG 2005) are very similar (Figure 5.6.5). The magnitude and location of residuals shown in the bubble plots are consistent and the year residuals follow the same pattern shifted by one year. The age residuals are more different, with a relatively larger value for 4-ringers this year and a larger value for the assessment run with the survey included. However, the age residuals values are all small and there are no trends with age.

The survey residuals patterns for all three runs are mostly similar (Figure 5.6.6). The magnitude and location of residuals shown in the bubble plots are mostly consistent but there is a strong switch from a strongly positive pattern in 2003 to some large negative values in 2005 in the assessment run including the 2005 acoustic survey. This pattern is reflected in the year residuals and most likely caused by the conflicting signals seen in the catch and survey data in the log catch-ratio plots in Figure 5.6.4.

A plot to compare the reference F (from the parameter estimates) in the terminal year (Figure 5.6.7) shows small differences when the survey is either included or excluded in the assessment. The run including the survey has a marginally wider confidence interval, and although the value of F is lower excluding the survey the two values are essentially the same. The conclusion is therefore unequivocal, exploitation is still low. The scatter plot of uncertainty estimates of F and SSB in the terminal year (Figure 5.6.8) gives another way of presenting the estimate of the model precision of the two assessment runs. F varies very slightly less with the exclusion of the 2005 survey whereas SSB varies substantially less when the survey is included. Q-q plots (plots of paired ranked estimates) of F and SSB for the terminal year from the parameter estimate variance-covariance matrix estimates are given in Figure 5.6.9. The almost straight-line plots show that the distribution of estimates have similar properties. However, although F estimates differ only by a factor of around 1.3 the estimates of SSB differ by a factor of almost 2. These differences are reflected in the comparative plots of the F and SSB time series produced in the assessment runs (Figure 5.6.10) showing a substantial difference in the perception of SSB in the final year depending on the assessment run used. A much lower SSB estimate is derived when the 2005 survey is included (64 000 t compared to 110 000 t without the survey). In addition to the reduction caused by the low estimate of numbers-at-age, the 2005 survey also estimated low mean weights-at-age in the stock in 2005; this also contributes to the low SSB value in both assessments.

5.6.2 Stock Assessment

This is an update assessment using the same settings as in 2005, with the 8 year separable period moved forward one year from 1997 - 2004 to 1998 - 2005.

Assessment of the stock was carried out by fitting an integrated catch-at-age model (ICA version 1.4w). The model settings are the same as in 2004 and 2005. Two assessment runs were carried out in 2006: including the 2005 acoustic survey (run A) and excluding the 2005 acoustic survey (run B). The run log for the two assessment runs is shown in Table 5.6.1 – it is the same for both except for the exclusion of the 2005 acoustic survey from the “fleet.dat” file in run B. The catch and survey data were down-weighted for 1-ring herring (see the 2001 Working Group assessment report (ICES 2001/ACFM:12)). The input data are given in Tables 5.6.2 to 5.6.8. The input data are the same for both assessment runs, except that the 2005 survey (values in Table 5.6.7) is excluded in run B. The output data are given in Tables 5.6.9 to 5.6.28 and Figures 5.6.11 and 5.6.12. The output data for the assessment run A are given in the set of tables Table 5.6.9 to 5.6.18; the output data for the assessment run B are given in the set of tables Table 5.6.19 to 5.6.28.

The selection pattern (Figure 5.6.12) is essentially the same in both runs. The assessment including the survey (run A) results in an SSB for 2005 of 64 110 t and a mean fishing mortality (3 to 6-ringers) of 0.20. The assessment excluding the survey (run B) results in an SSB for 2005 of 109 276 t and a mean fishing mortality (3 to 6-ringers) of 0.12. The model diagnostics (Tables 5.6.13 to 5.6.18 and Tables 5.6.23 to 5.6.28) show that the total residuals by age and year between the catch and separable model are reasonably trend-free. The year residuals especially are very similar to the 2005 agreed assessment in both pattern and magnitude. The acoustic survey residuals are of a higher magnitude than the catch residuals and show more evidence of year effects. There is also a switch from a strongly positive pattern in 2003 to some large negative values in 2005 in the assessment run including the 2005 acoustic survey, discussed above in Section 5.6.1. The large 1998 year class is no longer abundant in the catch and survey data in 2005. The 2000 and 2001 year classes are most prevalent in the catch data (4- and 3-ringers respectively). The 2000 year class is most abundant in the acoustic survey. The scale of this year’s estimate of SSB in 2004 is entirely dependent on whether the 2005 acoustic survey is included or not. The estimate for 2004 including the 2005 acoustic survey (run A) is 75 839 t; and without the survey (run B) is 116 526 t, compared with 124 145 t in last year’s estimate. Including the 2005 acoustic survey therefore gives a very different perception of the stock trajectory, with the third lowest SSB estimate seen across the whole time series. Both assessment runs show a decreased recruitment in the last four years.

Undetected under- or overestimation of the catches due to area misreporting implies bias on the estimation of stock status, since the stock size is estimated using these catches. Considerable efforts have been made to detect misreporting. Detected misreporting decreased from 30 000t in the mid 1990s to 5 000t in 2002, while in 2003 it was estimated to be effectively zero. However, during 2004 area misreporting increased to 6 000t and in 2005 it increased again to over 14 000 t, possibly due to relaxation in the area licence requirements, increasing uncertainty.

Retrospective analyses of the assessment from 2005 to 2001 were carried out, and are compared with the two runs including (run A) and excluding (run B) the 2005 acoustic survey. Figure 5.6.13 shows the SSB, mean F_{3-6} and recruitment from ICA assessments, with an 8 year separable period. In the year of assessment recruitment is very poorly estimated. There is broad agreement in the patterns of recruitment. The retrospective patterns of SSB converge around 2000. There is a downward revision for both 2005 assessment runs with a much greater downward revision for run B. The commensurate increase in F and decrease in recruitment complements the decrease in SSB described above.

Historically there was concern about the retrospective error in the assessment, in particular sensitivity to poor sampling of catch. Although sampling has increased in 2005, it has only increased to 17 samples from 10 in 2004 (see Section 5.1.3) and this is still a rather small number of samples. However, they came from the major fisheries by fleet area and season and are thought to be representative of the catches. This is supported by the similarity in selection pattern and residual pattern seen in this year's two assessment runs and compared with last years (see section 5.6.1).

Conclusion to the assessment

The outcome of the assessment this year confirms earlier perceptions of a lightly exploited stock (F<=0.2). However, the assessment of the current biomass is very uncertain. The two different assessment runs presented, along with the evaluation of retrospective patterns in the assessment, show that both the reduced catch and the very low survey index are the key influential factors in the assessment. The reduced catch is thought to be due to changes in fishing practices and not due to changes in the availability of fish. The extent of the retrospective revision is considerable and much larger than any seen for a number of years. While the survey has been previously recognised as noisy, the changes seen here are unusually dramatic for a stock that is still perceived as lightly exploited. While the survey was conducted under less than optimal conditions (reduced resources and unusually bad weather) there is no particular reason to reject the use of it out of hand. Therefore the Working Group was unable to choose between the two assessment options with confidence.

These assessments may be used to conclude that F is low but further investigation is required regarding the current SSB.

5.7 Short term projections

5.7.1 Deterministic short-term projections

In 2005 the Working Group tested a management agreement applicable to VIa (North). To date this proposed agreement has not been implemented. However, the Working Group still recommends that the management agreement be applied to the VIa (North) stock. Two scenarios for deterministic short-term projections are presented, based on the proposed management agreement.

> The projection carried forward from assessment run A (described in Section 5.6.2 above - including the 2005 acoustic survey) corresponds to a *status quo* F projection which also conforms to the proposed management rule of F=0.2 (see Section 5.1.1) for a stock below 75 000 t
>
> The projection carried forward from assessment run B (described in Section 5.6.2 above - excluding the 2005 acoustic survey) uses *status quo* F in the intermediate year and the proposed management rule F=0.25, for a stock below 75 000 t (see Section 5.1.1), for 2007 and 2008.

Short-term projections were carried out using MFDP. Input data are stock numbers on 1st January in 2006 from the 2005 ICA assessments (Section 5.6.2, Tables 5.6.10 and 5.6.20 for the two separate assessment runs), with geometric mean replacing recruitment both 1- and 2-ring in 2006. The retrospective assessment of recruitment in the 2003 Working Group (ICES 2003/ACFM:17) showed the substantial revision of 1- and 2-ring herring abundance in subsequent assessments, justifying the use of geometric means for these ages. The selection pattern used is as estimated by ICA (Tables 5.6.13 and 5.6.23). 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., 2003 - 2005) (Table 5.7.1.1). Two examples are presented, both using *status quo* F in the intermediate year as the basis for projection, based on input data from the two assessment runs A and B. The results of short-term projections are shown in the text table below, illustrating that catches can be expected to be very different depending on the perception of the stock, and hence the options used.

SCENARIO	2006	2007	2008
status quo F / Proposed management rule – from assessment run A	$F_{2006}= F_{2005} = 0.20$ *Status quo* F Catch = 16 101 t	$F_{2007}= F_{2005} = 0.20$ *Status quo* F Catch = 17 933 t	$F_{2008}= F_{2005} = 0.20$ *Status quo* F Catch = 19 859 t SSB = 96 829 t
Proposed management rule – from assessment run B	$F_{2006}= F_{2005} = 0.12$ *Status quo* F Catch = 15 600 t	$F_{2007} = 0.25$ Proposed management rule Catch = 32 950 t	$F_{2008} = 0.25$ Proposed management rule Catch = 32 959 t SSB = 126 263 t

The results of the two short-term projections can be seen in Tables 5.7.1.2 – 5.7.1.5. Tables 5.7.1.2 and 5.7.1.4 show single option predictions for 2007 and 2008 for assessment runs A and B respectively. Tables 5.7.1.3 and 5.7.1.5 show the multiple options for 2007 for assessment runs A and B respectively. For the projection including the 2005 acoustic survey (run A) SSB rises from approximately 79 000 t in 2006 to 97 000 t in 2008. For the run excluding the 2005 acoustic survey (run B) SSB drops slightly from approximately 128 000 t in 2006 to 126 000 t in 2008.

As with the stock assessment outcomes (see Section 5.6.2), the perceptions of the catch opportunities and stock are very different depending on the input data used in the projection. Including the 2005 acoustic survey gives a starting position of SSB being below 75 000 t (B_{trig} in the proposed management rule). The projection shows the stock rebuilding to an SSB around 97 000 t in 2008 with a corresponding catch of 20 000 t. However, if the 2005 acoustic survey is excluded the starting position is a higher SSB with a much lower F. The SSB rebuilds to 129 000 t in 2007 and then drops slightly in 2008, to 126 000 t corresponding to a catch of 33 000 t.

5.7.2 Yield-per-recruit

Two yield-per-recruit analyses were carried out using MFYPR to provide yield-per-recruit plots for the data produced in the two assessment runs described above (Figures 5.7.2.1 and 5.7.2.2) The values for $\mathbf{F}_{0.1}$ and $\mathbf{F}_{med}$ are 0.16 and 0.26 regardless of the input data used (i.e., the inclusion or exclusion of the 2005 acoustic survey has no effect on the perception of these reference points).

5.8 Medium term projections and HCR performance

Medium term projections were used extensively last year to evaluate HCRs for this area. There is no evidence that the stock diagnostics have changed, so the proposed rule should be adequate.

5.9 Precautionary and yield based reference points

There are no agreed precautionary reference points for this stock, The proposed management rule has a B_{trig} at 75 000 t.

5.10 Quality of the Assessment

The estimate of F is relatively stable showing that the stock is lightly exploited. The assessment of SSB is unstable (partly because F is so low) and particularly sensitive to the value of the acoustic survey in the terminal year. While the assessment gives the perception that exploitation of the stock is at a low level it provides a poor basis for selecting catch options.

The Working Group considers that there will be a new survey value available in August this year and the use of this survey in the intermediate year may help to provide a more stable assessment. The additional data will effectively provide two points to estimate the current state of the stock rather than the single noisy value we currently have available.

5.11 Management Considerations

The stock is lightly exploited. The SSB is very uncertain. The assessment is sensitive to the final year in the survey leading to substantial uncertainty in the catch options.

It is recommended to repeat the assessment when the next survey data become available.

Table 5.1.1 Herring in VIa (N). Catch in tonnes by country, 1983-2005. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

COUNTRY	1983	1984	1985	1986	1987	1988	1989	1990
Denmark		96						
Faroes	834	954	104	400				326
France	1313		20	18	136	44	1342	1287
Germany	6283	5564	5937	2188	1711	1860	4290	7096
Ireland				6000	6800	6740	8000	10000
Netherlands	20200	7729	5500	5160	5212	6131	5860	7693
Norway	7336	6669	4690	4799	4300	456		1607
UK	31616	37554	28065	25294	26810	26894	29874	38253
Unallocated	-4059	16588	-502	37840	18038	5229	2123	2397
Discards							1550	1300
Total	63523	75154	43814	81699	63007	47354	53039	69959
Area-Misreported		-19142	-4672	-10935	-18647	-11763	-19013	-25266
WG Estimate	63523	56012	39142	70764	44360	35591	34026	44693
Source (WG)	1985	1986	1987	1988	1989	1990	1991	1992

Country	1991	1992	1993	1994	1995	1996	1997	1998
Denmark								
Faroes	482							
France	1168	119	818	274	3672	2297	3093	1903
Germany	6450	5640	4693	5087	3733	7836	8873	8253
Ireland	8000	7985	8236	7938	3548	9721	1875	11199
Netherlands	7979	8000	6132	6093	7808	9396	9873	8483
Norway	3318	2389	7447	8183	4840	6223	4962	5317
UK	32628	32730	32602	30676	42661	46639	44273	42302
Unallocated	-10597	-5485	-3753	-4287	-4541	-17753	-8015	-11748
Discards	1180	200		700			62	90
Total	50608	51578	56175	54664	61271	64359	64995	65799
Area-Misreported	-22079	-22593	-24397	-30234	-32146	-38254	-29766	-32446
WG Estimate	28529	28985	31778	24430	29575	26105	35233*	33353
Source (WG)	1993	1994	1995	1996	1997	1997	1998	1999

Country	1999	2000	2001	2002	2003	2004	2005
Denmark							
Faroes				800	400	228	1810
France	463	870	760	1340	1370	625	613
Germany	6752	4615	3944	3810	2935	1046	2691
Ireland	7915	4841	4311	4239	3581	1894	2880
Netherlands	7244	4647	4534	4612	3609	8232	5132
Norway	2695						
UK	36446	22816	21862	20604	16947	17706	17494
Unallocated	-8155			878	-7		
Discards						123	772
Total	61514	37789	35411	36283	28835	29854	31392
Area-Misreported	-23623	-14626	-10437	-4496		-6762	-14383
WG Estimate	29736	23163	24974	31787	28835	22969**	17009
Source (WG)	2000	2001	2002	2003	2004	2005	2006

***WG estimate for 1997 has been revised according to the Bayesian assessment (see text Section 5.1.3 of 2000 report). **Revised at HAWG 2006.**

Table 5.2.1 Herring in VIa (N). Catch and sampling effort by nations participating in the fishery in 2005.

PERIOD : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Ireland	0.00	1019.00	0	0	0	0.00
N. Ireland	0.00	539.00	0	0	0	0.00
Netherlands	0.00	20.00	0	0	0	0.00
Scotland	0.00	323.00	0	0	0	0.00
Scotland discard	772.00	772.00	2	90	34	99.64
Period Total	772.00	2673.00	2	90	34	99.64

Sum of Offical Catches :	2673.00
Unallocated Catch :	-20.00
Working Group Catch :	2653.00

PERIOD : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
England & Wales	0.00	1535.00	0	0	0	0.00
France	0.00	149.00	0	0	0	0.00
Germany	0.00	1.00	0	0	0	0.00
Period Total	0.00	1685.00	0	0	0	0.00

Sum of Offical Catches :	1685.00
Unallocated Catch :	0.00
Working Group Catch :	1685.00

PERIOD : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
England & Wales	0.00	748.00	0	0	0	0.00
France	0.00	464.00	0	0	0	0.00
Germany	0.00	2650.00	0	0	0	0.00
N. Ireland	488.00	488.00	2	315	143	100.00
Netherlands	0.00	5112.00	0	0	0	0.00
Scotland	2862.00	13835.00	10	1708	410	100.00
Period Total	3350.00	23297.00	12	2023	553	100.00

Sum of Offical Catches :	23297.00
Unallocated Catch :	-14363.00
Working Group Catch :	8934.00

PERIOD : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroes	0.00	1810.00	0	0	0	0.00
Germany	0.00	40.00	0	0	0	0.00
Ireland	1861.00	1861.00	3	793	191	100.18
Scotland	0.00	26.00	0	0	0	0.00
Period Total	1861.00	3737.00	3	793	191	100.18

Sum of Offical Catches :	3737.00
Unallocated Catch :	0.00
Working Group Catch :	3737.00

Table 5.2.2 Herring in VIa (N). Estimated catch numbers-at-age (thousands), 1976-2005. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	69053	34836	22525	247	2692	36740	13304	81923	2207	40794	33768
2	319604	47739	46284	142	279	77961	250010	77810	188778	68845	154963
3	101548	95834	20587	77	95	105600	72179	92743	49828	148399	86072
4	35502	22117	40692	19	51	61341	93544	29262	35001	17214	118860
5	25195	10083	6879	13	13	21473	58452	42535	14948	15211	18836
6	76289	12211	3833	8	9	12623	23580	27318	11366	6631	18000
7	10918	20992	2100	4	8	11583	11516	14709	9300	6907	2578
8	3914	2758	6278	1	1	1309	13814	8437	4427	3323	1427
9	12014	1486	1544	0	0	1326	4027	8484	1959	2189	1971
	1987	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
1	19463	1708	6216	14294	26396	5253	17719	1728	266	1952	1193
2	65954	119376	36763	40867	23013	24469	95288	36554	82176	37854	55810
3	45463	41735	109501	40779	25229	24922	18710	40193	30398	30899	34966
4	32025	28421	18923	74279	28212	23733	10978	6007	21272	9219	31657
5	50119	19761	18109	26520	37517	21817	13269	7433	5376	7508	23118
6	8429	28555	7589	13305	13533	33869	14801	8101	4205	2501	17500
7	7307	3252	15012	9878	7581	6351	19186	10515	8805	4700	10331
8	3508	2222	1622	21456	6892	4317	4711	12158	7971	8458	5213
9	5983	2360	3505	5522	4456	5511	3740	10206	9787	31108	9883
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**			
1	9092	7635	4511	147	1145	53	0	220			
2	74167	35252	22960	82214	35410	32709	6259	11596			
3	34571	93910	21825	15295	90204	48449	20185	27973			
4	31905	25078	51420	9490	9506	56629	25822	24801			
5	22872	13364	15505	24896	19916	7987	41945	12325			
6	14372	7529	9002	9493	29288	4667	3824	11777			
7	8641	3251	3898	6785	9628	13527	7448	1222			
8	2825	1257	1836	4271	1290	10376	12419	1439			
9	3327	1089	576	1015	1203	1330	689	1722			

Table 5.3.1 Herring in VIa (N). Estimates of abundance from Scottish acoustic surveys. Thousands of fish at age and spawning biomass (SSB, tonnes). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

AGE	1987	1991	1992	1993	1994	1995	1996	1997#	1998
1	249 100	338 312	74 310	2 760	494 150	441 240	41 220	792 320	1 221 700
2	578 400	294 484	503 430	750 270	542 080	1103 400	576 460	641 860	794 630
3	551 100	327 902	210 980	681 170	607 720	473 220	802 530	286 170	666 780
4	353 100	367 830	258 090	653 050	285 610	450 270	329 110	167 040	471 070
5	752 600	488 288	414 750	544 000	306 760	152 970	95 360	66 100	179 050
6	111 600	176 348	240 110	865 150	268 130	187 100	60 600	49 520	79 270
7	48 100	98 741	105 670	284 110	406 840	169 080	77 380	16 280	28 050
8	15 900	89 830	56 710	151 730	173 740	236 540	78 190	28 990	13 850
9+	6 500	58 043	63 440	156 180	131 880	201 500	114 810	24 440	36 770
SSB:	273 000*	452 000	351 460	866 190	533 740	452 120	370300	140 910	375 890

AGE	1999	2000	2001	2002	2003	2004	2005
1	534 200	447 600	313 100	424 700	438 800	564 000	50 200
2	322 400	316 200	1 062 000	436 000	1 039 400	274 500	243 400
3	1 388 800	337 100	217 700	1 436 900	932 500	760 200	230 300
4	432 000	899 500	172 800	199 800	1 471 800	442 300	423 100
5	308 000	393 400	437 500	161 700	181 300	577 200	245 100
6	138 700	247 600	132 600	424 300	129 200	55 700	152 800
7	86 500	199 500	102 800	152 300	346 700	61 800	12 600
8	27 600	95 000	52 400	67 500	114 300	82.200	39 000
9+	35 400	65 000	34 700	59 500	75 200	76.300	26 800
SSB:	460 200	500 500	359 200	548 800	739 200	395 900	187 500

***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 5.4.1 Herring in VIa (N). Mean weights-at-age (g). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

WEIGHTS IN THE CATCH																		
Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	80	82	79	84	91	89	83	105	81	89	97	76	83	49	107	72		108
2	112	142	129	118	122	128	142	142	134	136	138	130	137	140	146	143	155	133
3	157	145	173	160	172	158	167	180	178	177	159	158	164	163	159	158	172	163
4	177	191	182	203	194	197	190	191	210	205	182	175	183	183	171	167	194	185
5	203	190	209	211	216	206	195	198	230	222	199	191	201	192	156	183	213	211
6	194	213	224	229	224	228	201	213	233	223	218	210	215	196	173	196	217	226
7	240	216	228	236	236	223	244	207	262	219	227	225	239	205	182	193	193	234
8	213	204	237	261	251	262	234	227	247	238	212	223	281	224	245	185	185	256
9+	228	243	247	271	258	263	266	277	291	263	199	226	253	271	277	290	313	250

WEIGHT IN THE STOCK FROM ACOUSTIC SURVEYS														
Age	Historical	1993	1994	1995	1996	1997#	1998	1999	2000	2001	2002	2003	2004	2005
1	90	75	52	45	45	57	65	54	62	62	62	64	54	75
2	164	162	150	144	140	150	138	137	141	132	153	138	136	130
3	208	196	192	191	180	189	177	166	173	170	177	176	157	154
4	233	206	220	202	209	209	193	188	183	190	198	190	180	167
5	246	226	221	225	219	225	214	203	194	198	212	204	189	180
6	252	234	233	226	222	233	226	219	204	212	215	213	202	191
7	258	254	241	247	229	248	234	225	211	220	225	217	213	213
8	269	260	270	260	242	266	225	235	222	236	243	223	214	203
9+	292	276	296	293	263	287	249	245	230	254	259	228	206	228

 # The 1997 survey is not on the same basis as the other years, it was conducted in June (all other surveys were carried out in July) and it is not used for assessment purposes.

Table 5.4.2 Herring in VIa (N). Maturity ogive used in estimates of spawning stock biomass taken from acoustic surveys. Values measured in 1997 were measured in June whilst other values are measured in July. The mean value 92-96 is used in the assessment for the years 1976-1991 and 1997.

YEAR \AGE (WINTER RING)	2	3	>3
Mean 92-96	0.57	0.96	1.00
1992	0.47	1.00	1.00
1993	0.93	0.96	1.00
1994	0.48	0.92	1.00
1995	0.19	0.98	1.00
1996	0.76	0.94	1.00
1997[#]	0.41	0.88	1.00
1998	0.85	0.97	1.00
1999	0.57	0.98	1.00
2000	0.45	0.92	1.00
2001	0.93	0.99	1.00
2002	0.92	1.00	1.00
2003	0.76	1.00	1.00
2004	0.83	0.97	1.00
2005	0.84	1.00	1.00

[#] The 1997 survey is not on the same basis as the other years, it was conducted in June (all other surveys were carried out in July) and it is not used for assessment purposes

Table 5.6.1. Herring in VIa (N). ICA run log for the maximum-likelihood ICA calculation for the 8 year separable period. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

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

                                 Version 1.4 w

                                 K.R.Patterson
                          Fisheries Research Services
                               Marine Laboratory
                                    Aberdeen

 Enter the name of the index file -->index.dat
canum.dat
weca.dat
 Stock weights in 2006  used for the year 2005
west.dat
 Natural mortality in 2006  used for the year 2005
natmor.dat
 Maturity ogive in 2006  used for the year 2005
matprop.dat
 Name of age-structured index file (Enter if none) : -->fleet2005.dat
 Name of the SSB index file (Enter if none) -->
No indices of spawning biomass to be used.
 No of years for separable constraint ?--> 8
 Reference age for separable constraint ?--> 4
 Constant selection pattern model (Y/N) ?-->y
 S to be fixed on last age ?-->    1.000000000000000
 First age for calculation of reference F ?--> 3
 Last age for calculation of reference F ?--> 6
 Use default weighting (Y/N) ?-->n
Enter relative weights at age
 Weight for age 1-->    0.100000000000000
 Weight for age 2-->    1.000000000000000
 Weight for age 3-->    1.000000000000000
 Weight for age 4-->    1.000000000000000
 Weight for age 5-->    1.000000000000000
 Weight for age 6-->    1.000000000000000
 Weight for age 7-->    1.000000000000000
 Weight for age 8-->    1.000000000000000
 Weight for age 9-->    1.000000000000000
Enter relative weights by year
 Weight for year 1998-->    1.000000000000000
 Weight for year 1999-->    1.000000000000000
 Weight for year 2000-->    1.000000000000000
 Weight for year 2001-->    1.000000000000000
 Weight for year 2002-->    1.000000000000000
 Weight for year 2003-->    1.000000000000000
 Weight for year 2004-->    1.000000000000000
 Weight for year 2005-->    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","Aco a plus-group (Y--
>y
You must choose a catchability model for each index.

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

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

 Model for "FLT01:","West","Scotland","Summer","Aco  is to be A/L/P ?-->L
There are     1  missing observations for fitting the separable model.

 Fit a stock-recruit relationship (Y/N) ?-->n
 Enter lowest feasible F-->   2.000000000000000E-02
 Enter highest feasible F-->    0.500000000000000
```

Table 5.6.1. continued.

```
Mapping the F-dimension of the SSQ surface
    F                 SSQ
+--------+------------------
    0.05        17.0646939766
    0.06        15.9654567142
    0.07        15.0968911084
    0.07        14.4028680744
    0.08        13.8431581998
    0.09        13.3883199094
    0.10        13.0164511643
    0.11        12.7109733682
    0.11        12.4590887297
    0.12        12.2510005244
    0.13        12.0789357445
    0.14        11.9367695228
    0.14        11.8194942552
    0.15        11.7231833232
    0.16        11.6445907115
    0.17        11.5810401450
    0.18        11.5303824386
    0.18        11.4907661653
    0.19        11.4606937912
    0.20        11.4389197023
Lowest SSQ is for F =     0.205
-----------------------------------------------------------------
No of years for separable analysis : 8
Age range in the analysis : 1  . . . 9
Year range in the analysis : 1957  . . . 2005
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 38
Number of observations : 198

Conventional single selection vector model to be fitted.
-----------------------------------------------------------------
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for "FLT01:","West","Scotland","Summer","Aco  at age 1-->  0.100000000000000
 Enter weight for "FLT01:","West","Scotland","Summer","Aco  at age 2-->  1.000000000000000
 Enter weight for "FLT01:","West","Scotland","Summer","Aco  at age 3-->  1.000000000000000
 Enter weight for "FLT01:","West","Scotland","Summer","Aco  at age 4-->  1.000000000000000
 Enter weight for "FLT01:","West","Scotland","Summer","Aco  at age 5-->  1.000000000000000
 Enter weight for "FLT01:","West","Scotland","Summer","Aco  at age 6-->  1.000000000000000
 Enter weight for "FLT01:","West","Scotland","Summer","Aco  at age 7-->  1.000000000000000
 Enter weight for "FLT01:","West","Scotland","Summer","Aco  at age 8-->  1.000000000000000
 Enter weight for "FLT01:","West","Scotland","Summer","Aco  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","Aco-->          1.000000000000000
 Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.

Aged index weights
"FLT01:","West","Scotland","Summer","Aco
 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 2005  at age 4  is 0.182862  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]-->   5.0000000000000000E+04
Succesful exit from ICA
```

Table 5.6.2. Herring in VIa (N). Run A. Catch number at age (millions). N.B. In this table “age” refers to number of rings (winter rings in the otolith).

Output Generated by ICA Version 1.4

Herring VIa (north) (run: ICAPGF08/I08)

Catch in Number

AGE	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	6.50	15.62	53.09	3.56	13.08	55.05	11.80	26.55	299.48	211.68	207.95	220.25	37.71	238.23	207.71
2	74.62	30.98	67.97	102.12	45.20	92.81	78.25	82.61	19.77	500.85	27.42	94.44	92.56	99.01	335.08
3	58.09	145.39	35.26	60.29	61.62	22.28	53.45	70.08	62.64	33.46	218.69	21.00	71.91	253.72	412.82
4	25.76	39.07	116.39	22.78	33.13	67.45	11.86	26.68	59.38	60.50	37.07	159.12	23.31	111.90	302.21
5	33.98	24.91	24.95	48.88	22.50	44.36	40.52	7.28	22.27	40.91	39.25	13.99	211.24	27.74	101.96
6	19.89	27.63	17.33	11.63	12.41	19.76	26.17	24.23	5.12	19.34	29.79	23.58	21.01	142.40	25.56
7	8.88	17.41	17.00	10.35	5.34	24.14	8.69	18.64	22.89	5.56	11.77	15.68	42.76	21.61	154.42
8	1.43	9.86	7.37	6.35	4.81	6.15	13.66	8.80	18.93	17.81	5.53	6.38	26.03	27.07	16.82
9	4.42	7.16	8.60	4.62	2.58	7.08	6.09	15.10	19.53	27.08	25.80	10.81	26.21	24.08	32.00

Catch in Number

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	534.96	51.17	309.02	172.88	69.05	34.84	22.52	0.25	2.69	36.74	13.30	81.92	2.21	40.79	33.77
2	621.50	235.63	124.94	202.09	319.60	47.74	46.28	0.14	0.28	77.96	250.01	77.81	188.78	68.84	154.96
3	175.14	808.27	151.03	89.07	101.55	95.83	20.59	0.08	0.10	105.60	72.18	92.74	49.83	148.40	86.07
4	54.20	131.48	519.18	63.70	35.50	22.12	40.69	0.02	0.05	61.34	93.54	29.26	35.00	17.21	118.86
5	66.71	63.07	82.47	188.20	25.20	10.08	6.88	0.01	0.01	21.47	58.45	42.53	14.95	15.21	18.84
6	25.72	54.64	49.68	30.60	76.29	12.21	3.83	0.01	0.01	12.62	23.58	27.32	11.37	6.63	18.00
7	10.34	18.24	34.63	12.30	10.92	20.99	2.10	0.00	0.01	11.58	11.52	14.71	9.30	6.91	2.58
8	55.76	6.51	22.47	13.12	3.91	2.76	6.28	0.00	0.00	1.31	13.81	8.44	4.43	3.32	1.43
9	16.63	32.22	21.04	13.70	12.01	1.49	1.54	0.00	0.00	1.33	4.03	8.48	1.96	2.19	1.97

Catch in Number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	19.46	1.71	6.22	14.29	26.40	5.25	17.72	1.73	0.27	1.95	1.19	9.09	7.63	4.51	0.15
2	65.95	119.38	36.76	40.87	23.01	24.47	95.29	36.55	82.18	37.85	55.81	74.17	35.25	22.96	82.21
3	45.46	41.73	109.50	40.78	25.23	24.92	18.71	40.19	30.40	30.90	34.97	34.57	93.91	21.83	15.30
4	32.02	28.42	18.92	74.28	28.21	23.73	10.98	6.01	21.27	9.22	31.66	31.91	25.08	51.42	9.49
5	50.12	19.76	18.11	26.52	37.52	21.82	13.27	7.43	5.38	7.51	23.12	22.87	13.36	15.50	24.90
6	8.43	28.55	7.59	13.30	13.53	33.87	14.80	8.10	4.21	2.50	17.50	14.37	7.53	9.00	9.49
7	7.31	3.25	15.01	9.88	7.58	6.35	19.19	10.52	8.80	4.70	10.33	8.64	3.25	3.90	6.78
8	3.51	2.22	1.62	21.46	6.89	4.32	4.71	12.16	7.97	8.46	5.21	2.83	1.26	1.84	4.72
9	5.98	2.36	3.50	5.52	4.46	5.51	3.74	10.21	9.79	31.11	9.88	3.33	1.09	0.58	1.02

Table 5.6.2. Herring in VIa (N). Run A. Catch number at age (millions). Continued

Catch in Number

AGE	2002	2003	2004	2005
1	1.14	0.05	0.00	0.22
2	35.41	32.71	6.26	11.60
3	90.20	48.45	20.13	27.97
4	9.51	56.63	25.66	24.80
5	19.92	7.99	41.72	12.32
6	29.29	4.67	3.77	11.78
7	9.63	13.53	7.33	1.22
8	1.29	10.38	12.10	1.44
9	1.20	1.33	0.69	1.72

Table 5.6.3. Herring in VIa (N). Run A. Weight in the catch (kg). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Weights at age in the catches (Kg)

AGE	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	0.07900	0.07900	0.07900	0.07900	0.07900	0.07900	0.07900	0.07900	0.07900	0.07900	0.07900	0.07900	0.07900	0.07900	0.07900
2	0.10400	0.10400	0.10400	0.10400	0.10400	0.10400	0.10400	0.10400	0.10400	0.10400	0.10400	0.10400	0.10400	0.10400	0.10400
3	0.13000	0.13000	0.13000	0.13000	0.13000	0.13000	0.13000	0.13000	0.13000	0.13000	0.13000	0.13000	0.13000	0.13000	0.13000
4	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800
5	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400
6	0.17000	0.17000	0.17000	0.17000	0.17000	0.17000	0.17000	0.17000	0.17000	0.17000	0.17000	0.17000	0.17000	0.17000	0.17000
7	0.18000	0.18000	0.18000	0.18000	0.18000	0.18000	0.18000	0.18000	0.18000	0.18000	0.18000	0.18000	0.18000	0.18000	0.18000
8	0.18300	0.18300	0.18300	0.18300	0.18300	0.18300	0.18300	0.18300	0.18300	0.18300	0.18300	0.18300	0.18300	0.18300	0.18300
9	0.18500	0.18500	0.18500	0.18500	0.18500	0.18500	0.18500	0.18500	0.18500	0.18500	0.18500	0.18500	0.18500	0.18500	0.18500

Weights at age in the catches (Kg)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.07900	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.08000	0.08000	0.08000	0.06900	0.11300
2	0.10400	0.12100	0.12100	0.12100	0.12100	0.12100	0.12100	0.12100	0.12100	0.12100	0.14000	0.14000	0.14000	0.10300	0.14500
3	0.13000	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.15800	0.17500	0.17500	0.17500	0.13400	0.17300
4	0.15800	0.17500	0.17500	0.17500	0.17500	0.17500	0.17500	0.17500	0.17500	0.17500	0.20500	0.20500	0.20500	0.16100	0.19600
5	0.16400	0.18600	0.18600	0.18600	0.18600	0.18600	0.18600	0.18600	0.18600	0.18600	0.23100	0.23100	0.23100	0.18200	0.21500
6	0.17000	0.20600	0.20600	0.20600	0.20600	0.20600	0.20600	0.20600	0.20600	0.20600	0.25300	0.25300	0.25300	0.19900	0.23000
7	0.18000	0.21800	0.21800	0.21800	0.21800	0.21800	0.21800	0.21800	0.21800	0.21800	0.27000	0.27000	0.27000	0.21300	0.24200
8	0.18300	0.22400	0.22400	0.22400	0.22400	0.22400	0.22400	0.22400	0.22400	0.22400	0.28400	0.28400	0.28400	0.22300	0.25100
9	0.18500	0.22400	0.22400	0.22400	0.22400	0.22400	0.22400	0.22400	0.22400	0.22400	0.29500	0.29500	0.29500	0.23100	0.25800

Table 5.6.3. Herring in VIa (N). Run A. Weight in the catch (kg). Continued

Weights at age in the catches (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.07300	0.08000	0.08200	0.07900	0.08400	0.09100	0.08900	0.08300	0.10600	0.08100	0.08900	0.09700	0.07600	0.08340	0.04900
2	0.14300	0.11200	0.14200	0.12900	0.11800	0.11900	0.12800	0.14200	0.14200	0.13400	0.13600	0.13800	0.13000	0.13730	0.13960
3	0.18300	0.15700	0.14500	0.17300	0.16000	0.18300	0.15800	0.16700	0.18100	0.17800	0.17700	0.15900	0.15800	0.16370	0.16270
4	0.21100	0.17700	0.19100	0.18200	0.20300	0.19600	0.19700	0.19000	0.19100	0.21000	0.20500	0.18200	0.17500	0.18290	0.18260
5	0.22000	0.20300	0.19000	0.20900	0.21100	0.22700	0.20600	0.19500	0.19800	0.23000	0.22200	0.19900	0.19100	0.20140	0.19200
6	0.23800	0.19400	0.21300	0.22400	0.22900	0.21900	0.22800	0.20100	0.21400	0.23300	0.22300	0.21800	0.21000	0.21470	0.19570
7	0.24100	0.24000	0.21600	0.22800	0.23600	0.24400	0.22300	0.24400	0.20800	0.26200	0.21900	0.22700	0.22500	0.23940	0.20450
8	0.25300	0.21300	0.20400	0.23700	0.26100	0.25600	0.26200	0.23400	0.22700	0.24700	0.23800	0.21200	0.22300	0.28120	0.22440
9	0.25600	0.22800	0.24300	0.24700	0.27100	0.25600	0.26300	0.26600	0.27700	0.29100	0.26300	0.19900	0.22600	0.25260	0.27130

Weights at age in the catches (Kg)

AGE	2002	2003	2004	2005
1	0.10660	0.07200	0.00000	0.10840
2	0.14620	0.14290	0.15510	0.13270
3	0.15940	0.15780	0.17250	0.16320
4	0.17090	0.16650	0.19440	0.18450
5	0.15640	0.18300	0.21350	0.21080
6	0.17250	0.19580	0.21790	0.22580
7	0.18200	0.19270	0.19360	0.23410
8	0.24510	0.18450	0.18610	0.25560
9	0.27710	0.29010	0.31320	0.24960

Table 5.6.4. Herring in VIa (N). Run A. Weight in the stock (kg). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Weights at age in the stock (Kg)

AGE	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000
2	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400
3	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800
4	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300
5	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600
6	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200
7	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800
8	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900
9	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200

Table 5.6.4. Herring in VIa (N). Run A. Continued.

Weights at age in the stock (Kg)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000
2	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400
3	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800
4	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300
5	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600
6	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200
7	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800
8	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900
9	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200

Weights at age in the stock (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.09000	0.09000	0.09000	0.09000	0.09000	0.09000	0.07500	0.05200	0.04200	0.04500	0.05700	0.06600	0.05400	0.06200	0.06200
2	0.16400	0.16400	0.16400	0.16400	0.16400	0.16400	0.16200	0.15000	0.14400	0.14000	0.15000	0.13800	0.13700	0.14100	0.13200
3	0.20800	0.20800	0.20800	0.20800	0.20800	0.20800	0.19600	0.19200	0.19100	0.18000	0.18900	0.17600	0.16600	0.17300	0.17000
4	0.23300	0.23300	0.23300	0.23300	0.23300	0.23300	0.20600	0.22000	0.20200	0.20900	0.20900	0.19400	0.18800	0.18300	0.19000
5	0.24600	0.24600	0.24600	0.24600	0.24600	0.24600	0.22600	0.22100	0.22500	0.21900	0.22500	0.21400	0.20300	0.19400	0.19800
6	0.25200	0.25200	0.25200	0.25200	0.25200	0.25200	0.23400	0.23300	0.22700	0.22200	0.23300	0.22600	0.21900	0.20400	0.21200
7	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25400	0.24100	0.24700	0.22900	0.24800	0.23400	0.22500	0.21100	0.22000
8	0.26900	0.26900	0.26900	0.26900	0.26900	0.26900	0.26000	0.27000	0.26000	0.24200	0.26600	0.22500	0.23500	0.22200	0.23600
9	0.29200	0.29200	0.29200	0.29200	0.29200	0.29200	0.27600	0.29600	0.29300	0.26300	0.28700	0.24900	0.24500	0.23000	0.25400

Weights at age in the stock (Kg)

AGE	2002	2003	2004	2005
1	0.06200	0.06400	0.05900	0.07510
2	0.15300	0.13800	0.13800	0.12960
3	0.17700	0.17600	0.15900	0.15380
4	0.19800	0.19000	0.18000	0.16650
5	0.21200	0.20400	0.18900	0.18020
6	0.21500	0.21300	0.20200	0.19110
7	0.22500	0.21700	0.21300	0.21250
8	0.24300	0.22300	0.21400	0.20300
9	0.25900	0.22800	0.20600	0.22840

Table 5.6.5. Herring in VIa (N). Run A. Natural mortality. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Natural Mortality (per year)

AGE	1957	1958	1959	1960	1961	----	2001	2002	2003	2004	2005
1	1.0000	1.0000	1.0000	1.0000	1.0000	----	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	----	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	----	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	----	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	----	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	----	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	----	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	----	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	----	0.1000	0.1000	0.1000	0.1000	0.1000

Table 5.6.6. Herring in VIa (N). Run A. Proportion mature. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Proportion of fish spawning

AGE	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700
3	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700	0.5700
3	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 5.6.6. Herring in VIa (N). Run A. Proportion mature. Continued

Proportion of fish spawning

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.5700	0.5700	0.5700	0.5700	0.5700	0.4700	0.9300	0.4800	0.1900	0.7600	0.5700	0.8500	0.5700	0.4500	0.9300
3	0.9600	0.9600	0.9600	0.9600	0.9600	1.0000	0.9600	0.9200	0.9800	0.9400	0.9600	0.9700	0.9800	0.9200	0.9900
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	2002	2003	2004	2005
1	0.0000	0.0000	0.0000	0.0000
2	0.9200	0.7600	0.8300	0.8400
3	1.0000	1.0000	0.9700	1.0000
4	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000

Table 5.6.7. Herring in VIa (N). Run A. Tuning indices. N.B. In this table “age” refers to number of rings (winter rings in the otolith).

AGE-STRUCTURED INDICES

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	249.1	*******	*******	*******	338.3	74.3	2.8	494.2	460.6	41.2	*******	1221.7	534.2	447.6	313.1
2	578.4	*******	*******	*******	294.5	503.4	750.3	542.1	1085.1	576.5	*******	794.6	322.4	316.2	1062.0
3	551.1	*******	*******	*******	327.9	211.0	681.2	607.7	472.7	802.5	*******	666.8	1388.0	337.1	217.7
4	353.1	*******	*******	*******	367.8	258.1	653.0	285.6	450.2	329.1	*******	471.1	432.0	899.5	172.8
5	752.6	*******	*******	*******	488.3	414.8	544.0	306.8	153.0	95.4	*******	179.1	308.0	393.4	437.5
6	111.6	*******	*******	*******	176.3	240.1	865.2	268.1	187.1	60.6	*******	79.3	138.7	247.6	132.6
7	48.1	*******	*******	*******	98.7	105.7	284.1	406.8	169.2	77.4	*******	28.1	86.5	199.5	102.8
8	15.9	*******	*******	*******	89.8	56.7	151.7	173.7	236.6	78.2	*******	13.8	27.6	95.0	52.4
9	6.5	*******	*******	*******	58.0	63.4	156.2	131.9	201.5	114.8	*******	36.8	35.4	65.0	34.7

x 10 ^ 3

Table 5.6.7. Herring in VIa (N). Run A. Tuning indices. Continued

AGE	2002	2003	2004	2005
1	424.7	438.8	564.0	50.2
2	436.0	1039.4	274.5	243.4
3	1436.9	932.5	760.2	230.3
4	199.8	1471.8	442.3	423.1
5	161.7	181.3	577.2	245.1
6	424.3	129.2	55.7	152.8
7	152.3	346.7	61.8	12.6
8	67.5	114.3	82.2	39.0
9	59.5	75.2	76.3	26.8

x 10 ^ 3

Table 5.6.8. Herring in VIa (N). Run A. Weighting factors for the catch in numbers. N.B. In this table “age” refers to number of rings (winter rings in the otolith).

Weighting factors for the catches in number

AGE	1998	1999	2000	2001	2002	2003	2004	2005
1	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 5.6.9. Herring in VIa (N). Run A. Fishing mortality (per year). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Fishing Mortality (per year)

AGE	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	0.0094	0.0115	0.0397	0.0089	0.0161	0.0380	0.0088	0.0435	0.0617	0.3630	0.1392	0.0881	0.0201	0.1149	0.0348
2	0.0980	0.0933	0.1057	0.1682	0.2546	0.2586	0.1159	0.1307	0.0682	0.2377	0.1230	0.1461	0.0805	0.1117	0.4158
3	0.3165	0.2979	0.1545	0.1362	0.1537	0.2039	0.2475	0.1527	0.1465	0.1667	0.1640	0.1382	0.1676	0.3491	0.9823
4	0.2113	0.3454	0.3911	0.1344	0.0980	0.2378	0.1513	0.1785	0.1777	0.1954	0.2666	0.1637	0.2127	0.4006	0.8630
5	0.2946	0.2893	0.3441	0.2516	0.1707	0.1652	0.1963	0.1175	0.1987	0.1603	0.1681	0.1364	0.3020	0.3729	0.6832
6	0.2932	0.3676	0.2984	0.2380	0.0838	0.1992	0.1246	0.1548	0.1019	0.2370	0.1507	0.1296	0.2776	0.3047	0.6147
7	0.1824	0.3993	0.3597	0.2606	0.1469	0.2078	0.1134	0.1104	0.1921	0.1379	0.1983	0.0994	0.3242	0.4512	0.5553
8	0.2208	0.2812	0.2614	0.1971	0.1663	0.2243	0.1561	0.1443	0.1403	0.2010	0.1773	0.1409	0.2128	0.3119	0.6725
9	0.2208	0.2812	0.2614	0.1971	0.1663	0.2243	0.1561	0.1443	0.1403	0.2010	0.1773	0.1409	0.2128	0.3119	0.6725

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.3667	0.0778	0.3346	0.1374	0.1939	0.0919	0.0396	0.0003	0.0048	0.0355	0.0276	0.0441	0.0031	0.0549	0.0614
2	0.2361	0.5023	0.4954	0.7371	0.7710	0.3514	0.2935	0.0005	0.0007	0.3224	0.6584	0.3896	0.2309	0.2107	0.5485
3	0.4276	0.5867	0.7722	0.8836	1.2160	0.6021	0.2675	0.0007	0.0004	0.4293	0.6021	0.5935	0.4995	0.3050	0.4721
4	0.2993	0.6289	0.9104	0.8548	1.0848	0.9381	0.5281	0.0003	0.0006	0.3977	0.8049	0.4972	0.4431	0.3036	0.4047
5	0.4088	0.5935	0.9298	0.9041	0.8923	0.9557	0.7664	0.0002	0.0003	0.3057	0.7196	0.9690	0.4522	0.3121	0.5588
6	0.3202	0.6094	1.2104	0.9911	1.0715	1.4624	1.1133	0.0015	0.0002	0.3117	0.5675	0.7850	0.6619	0.3293	0.6494
7	0.4783	0.3508	0.8833	1.0357	1.1010	0.8788	1.0011	0.0024	0.0017	0.3118	0.4593	0.7461	0.5966	0.9904	0.1837
8	0.3521	0.5554	0.8431	0.9015	1.0197	0.8245	0.6280	0.0009	0.0007	0.3536	0.6557	0.6375	0.4615	0.3897	0.4910
9	0.3521	0.5554	0.8431	0.9015	1.0197	0.8245	0.6280	0.0009	0.0007	0.3536	0.6557	0.6375	0.4615	0.3897	0.4910

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.0147	0.0030	0.0116	0.0532	0.1145	0.0105	0.0491	0.0032	0.0007	0.0034	0.0012	0.0050	0.0033	0.0030	0.0029
2	0.2816	0.1981	0.1367	0.1654	0.1922	0.2541	0.4736	0.2307	0.3640	0.2099	0.2108	0.2592	0.1686	0.1550	0.1502
3	0.3258	0.3084	0.2993	0.2343	0.1544	0.3495	0.3353	0.4011	0.3254	0.2402	0.3251	0.4719	0.3070	0.2822	0.2735
4	0.3045	0.3297	0.2122	0.3228	0.2394	0.2020	0.2423	0.1618	0.3637	0.1465	0.3913	0.4274	0.2780	0.2556	0.2477
5	0.2649	0.2781	0.3217	0.4546	0.2393	0.2629	0.1489	0.2297	0.1908	0.1880	0.5721	0.5378	0.3498	0.3216	0.3117
6	0.4628	0.2120	0.1465	0.3681	0.3927	0.3142	0.2555	0.1147	0.1761	0.1144	0.7556	0.4576	0.2977	0.2737	0.2652
7	0.5287	0.2894	0.1477	0.2571	0.3289	0.2873	0.2629	0.2595	0.1578	0.2714	0.7992	0.4948	0.3219	0.2959	0.2868
8	0.3606	0.2675	0.2048	0.2892	0.2562	0.2813	0.3185	0.2365	0.2852	0.2001	0.4807	0.4274	0.2780	0.2556	0.2477
9	0.3606	0.2675	0.2048	0.2892	0.2562	0.2813	0.3185	0.2365	0.2852	0.2001	0.4807	0.4274	0.2780	0.2556	0.2477

Table 5.6.9. Herring in VIa (N). Run A. Fishing mortality (per year). Continued.

Fishing Mortality (per year)

AGE	2002	2003	2004	2005
1	0.0032	0.0034	0.0028	0.0021
2	0.1643	0.1743	0.1465	0.1109
3	0.2992	0.3173	0.2668	0.2019
4	0.2710	0.2874	0.2416	0.1829
5	0.3410	0.3616	0.3040	0.2301
6	0.2902	0.3077	0.2587	0.1958
7	0.3137	0.3327	0.2797	0.2117
8	0.2710	0.2874	0.2416	0.1829
9	0.2710	0.2874	0.2416	0.1829

Table 5.6.10. Herring in VIa (N). Run A. Population abundance (1 January, millions). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Population Abundance (1 January)

AGE	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	1102.2	2151.1	2150.6	634.2	1293.8	2330.5	2133.8	983.4	7876.3	1068.0	2502.9	4102.4	2999.4	3440.5	9573.1
2	922.6	401.7	782.3	760.4	231.2	468.4	825.4	778.1	346.4	2724.1	273.3	801.1	1381.9	1081.5	1128.3
3	235.0	619.6	271.1	521.4	476.1	132.8	267.9	544.6	505.8	239.7	1591.1	179.0	512.8	944.5	716.5
4	141.9	140.2	376.6	190.2	372.5	334.3	88.7	171.2	382.7	357.7	166.1	1105.7	127.6	355.1	545.5
5	139.6	103.9	89.8	230.5	150.4	305.6	238.4	69.0	129.6	289.9	266.2	115.1	849.4	93.4	215.2
6	82.0	94.1	70.4	57.6	162.2	114.8	234.4	177.3	55.5	96.1	223.5	203.6	90.9	568.2	58.2
7	55.9	55.4	58.9	47.3	41.1	134.9	85.1	187.3	137.4	45.3	68.6	173.9	161.8	62.3	379.1
8	7.6	42.2	33.6	37.2	33.0	32.1	99.2	68.7	151.7	102.6	35.7	50.9	142.5	105.9	35.9
9	23.4	30.6	39.2	27.1	17.7	37.0	44.2	118.0	156.6	156.0	166.6	86.4	143.4	94.2	68.3

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	2675.9	1074.5	1673.1	2106.4	610.0	623.1	913.8	1217.3	887.2	1662.5	772.3	2993.8	1137.8	1203.6	892.7
2	3401.2	682.2	365.7	440.5	675.4	184.9	209.1	323.1	447.7	324.8	590.3	276.4	1053.8	417.3	419.1
3	551.5	1989.9	305.8	165.1	156.1	231.4	96.4	115.5	239.2	331.4	174.3	226.4	138.7	619.8	250.4
4	219.7	294.5	906.1	115.7	55.9	37.9	103.8	60.4	94.5	195.8	176.6	78.2	102.4	68.9	374.0
5	208.2	147.4	142.1	329.9	44.5	17.1	13.4	55.4	54.6	85.4	119.0	71.5	43.0	59.5	46.0
6	98.4	125.2	73.7	50.7	120.9	16.5	5.9	5.6	50.1	49.4	57.0	52.4	24.5	24.8	39.4
7	28.5	64.6	61.6	19.9	17.0	37.5	3.5	1.8	5.1	45.3	32.7	29.2	21.6	11.5	16.1
8	196.8	16.0	41.2	23.0	6.4	5.1	14.1	1.2	1.6	4.6	30.0	18.7	12.5	10.8	3.8
9	58.7	79.1	38.5	24.1	19.6	2.8	3.5	8.5	8.7	4.7	8.8	18.8	5.5	7.1	5.3

x 10 ^ 6

Table 5.6.10. Herring in VIa (N). Run A. Population abundance (1 January, millions). Continued.

Population Abundance (1 January)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	2110.1	905.2	849.8	434.7	382.3	793.8	582.9	842.5	626.2	922.2	1556.6	466.7	289.8	1552.1	731.0
2	308.8	764.9	332.0	309.0	151.6	125.4	289.0	204.2	308.9	230.2	338.1	571.9	170.8	106.3	569.3
3	179.4	172.6	464.8	214.5	194.0	92.7	72.1	133.3	120.1	159.0	138.3	202.9	327.0	106.9	67.4
4	127.9	106.0	103.8	282.1	139.0	136.1	53.5	42.2	73.1	71.0	102.4	81.8	103.6	196.9	66.0
5	225.8	85.3	69.0	76.0	184.9	99.0	100.6	38.0	32.5	46.0	55.5	62.7	48.3	71.0	138.0
6	23.8	156.8	58.5	45.3	43.6	131.7	68.8	78.5	27.3	24.3	34.5	28.3	33.1	30.8	46.6
7	18.6	13.6	114.8	45.7	28.3	26.7	87.0	48.2	63.3	20.7	19.6	14.6	16.2	22.2	21.2
8	12.1	9.9	9.2	89.6	32.0	18.5	18.1	60.5	33.7	48.9	14.3	8.0	8.1	10.6	15.0
9	20.7	10.5	19.9	23.1	20.7	23.6	14.4	50.8	41.4	179.9	27.1	10.0	4.7	2.7	4.9

Population Abundance (1 January)

AGE	2002	2003	2004	2005	2006
1	676.6	285.5	343.1	159.5	571.1
2	268.1	248.1	104.7	125.9	58.6
3	362.9	168.5	154.4	67.0	83.4
4	42.0	220.3	100.5	96.8	44.8
5	46.6	29.0	149.5	71.4	73.0
6	91.4	30.0	18.3	99.8	51.3
7	32.3	61.9	20.0	12.8	74.3
8	14.4	21.4	40.2	13.7	9.3
9	5.3	5.6	3.4	10.8	18.4

x 10 ^ 6

Table 5.6.11. Herring in VIa (N). Run A. Predicted catch in number. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Predicted Catch in Number

AGE	1998	1999	2000	2001	2002	2003	2004	2005
1	1.48	0.60	2.94	1.34	1.36	0.61	0.61	0.22
2	113.54	22.99	13.24	68.86	35.25	34.43	12.37	11.44
3	69.71	78.73	23.94	14.69	85.48	41.75	32.91	11.14
4	27.16	23.99	42.36	13.81	9.51	52.48	20.56	15.42
5	24.91	13.60	18.63	35.26	12.86	8.39	37.40	13.99
6	9.94	8.13	7.03	10.35	21.97	7.58	3.97	16.92
7	5.46	4.26	5.44	5.04	8.30	16.71	4.64	2.32
8	2.65	1.87	2.29	3.13	3.26	5.09	8.22	2.17

x 10 ^ 6

Table 5.6.12. Herring in VIa (N). Run A. Predicted index values. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Predicted Age-Structured Index Values

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	769.1	*******	*******	*******	132.0	290.0	208.5	309.0	230.0	338.2	*******	171.0	106.3	569.4	268.2
2	711.8	*******	*******	*******	366.9	293.4	599.8	483.8	680.7	551.7	*******	1334.3	418.7	262.4	1409.3
3	676.7	*******	*******	*******	803.5	345.1	270.4	482.6	453.1	628.5	*******	706.6	1246.0	413.0	261.7
4	557.4	*******	*******	*******	627.6	627.5	241.2	198.8	308.5	337.4	*******	333.4	458.2	881.6	296.8
5	932.1	*******	*******	*******	773.8	408.9	442.6	159.9	139.6	197.9	*******	222.9	190.2	284.2	555.3
6	83.2	*******	*******	*******	158.4	498.8	269.3	331.4	111.6	102.6	*******	99.3	126.6	119.2	181.2
7	61.3	*******	*******	*******	104.1	100.2	331.4	184.1	255.3	78.6	*******	49.2	59.8	83.2	79.6
8	39.1	*******	*******	*******	109.0	62.1	59.7	208.6	113.0	172.0	*******	24.8	27.2	36.3	51.3
9	90.8	*******	*******	*******	95.9	107.8	64.5	238.3	188.9	860.8	*******	42.3	21.6	12.4	22.6

AGE	2002	2003	2004	2005
1	248.2	104.7	125.9	58.5
2	658.7	606.2	259.7	318.3
3	1388.8	638.6	601.5	270.3
4	186.4	969.3	453.2	451.0
5	184.6	113.5	604.3	300.4
6	351.0	114.1	71.3	403.5
7	119.7	226.9	75.3	50.0
8	48.7	71.6	138.0	48.4
9	24.5	25.5	15.7	52.2

x 10 ^ 3

Table 5.6.13. Herring in VIa (N). Run A. Fitted selection pattern. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Fitted Selection Pattern

AGE	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	0.0443	0.0334	0.1015	0.0664	0.1643	0.1596	0.0580	0.2436	0.3473	1.8584	0.5222	0.5381	0.0943	0.2868	0.0404
2	0.4641	0.2701	0.2703	1.2517	2.5982	1.0876	0.7661	0.7320	0.3839	1.2168	0.4615	0.8925	0.3786	0.2788	0.4819
3	1.4984	0.8624	0.3950	1.0132	1.5678	0.8576	1.6362	0.8555	0.8247	0.8536	0.6151	0.8444	0.7879	0.8714	1.1383
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.3942	0.8375	0.8797	1.8720	1.7420	0.6949	1.2980	0.6583	1.1183	0.8204	0.6304	0.8334	1.4201	0.9308	0.7916
6	1.3878	1.0644	0.7628	1.7712	0.8549	0.8378	0.8240	0.8672	0.5736	1.2131	0.5654	0.7917	1.3052	0.7608	0.7123
7	0.8633	1.1560	0.9197	1.9395	1.4984	0.8740	0.7496	0.6183	1.0811	0.7058	0.7439	0.6073	1.5243	1.1264	0.6435
8	1.0454	0.8141	0.6682	1.4665	1.6969	0.9433	1.0323	0.8082	0.7897	1.0290	0.6649	0.8605	1.0003	0.7787	0.7793
9	1.0454	0.8141	0.6682	1.4665	1.6969	0.9433	1.0323	0.8082	0.7897	1.0290	0.6649	0.8605	1.0003	0.7787	0.7793

Table 5.6.13. Herring in VIa (N). Run A. Fitted selection pattern. Continued.

Fitted Selection Pattern

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	1.2253	0.1237	0.3675	0.1608	0.1788	0.0979	0.0751	0.9707	8.4775	0.0892	0.0342	0.0887	0.0069	0.1807	0.1517
2	0.7887	0.7987	0.5441	0.8623	0.7107	0.3746	0.5558	1.5386	1.2719	0.8106	0.8181	0.7837	0.5210	0.6939	1.3554
3	1.4285	0.9329	0.8482	1.0338	1.1210	0.6418	0.5065	2.2249	0.7724	1.0795	0.7480	1.1938	1.1272	1.0045	1.1665
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.3658	0.9437	1.0214	1.0577	0.8226	1.0187	1.4513	0.7460	0.4409	0.7686	0.8940	1.9489	1.0205	1.0278	1.3808
6	1.0700	0.9691	1.3295	1.1595	0.9878	1.5588	2.1082	4.5085	0.3328	0.7837	0.7050	1.5789	1.4937	1.0846	1.6048
7	1.5981	0.5578	0.9702	1.2117	1.0149	0.9368	1.8958	7.2025	2.9092	0.7840	0.5707	1.5006	1.3464	3.2621	0.4538
8	1.1766	0.8831	0.9261	1.0547	0.9400	0.8789	1.1892	2.7628	1.1618	0.8890	0.8147	1.2822	1.0415	1.2836	1.2133
9	1.1766	0.8831	0.9261	1.0547	0.9400	0.8789	1.1892	2.7628	1.1618	0.8890	0.8147	1.2822	1.0415	1.2836	1.2133

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.0482	0.0091	0.0548	0.1648	0.4783	0.0521	0.2025	0.0201	0.0018	0.0229	0.0031	0.0117	0.0117	0.0117	0.0117
2	0.9249	0.6009	0.6442	0.5123	0.8027	1.2580	1.9543	1.4260	1.0008	1.4329	0.5388	0.6064	0.6064	0.6064	0.6064
3	1.0701	0.9353	1.4105	0.7259	0.6449	1.7303	1.3835	2.4791	0.8946	1.6397	0.8308	1.1042	1.1042	1.1042	1.1042
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8700	0.8435	1.5161	1.4083	0.9995	1.3015	0.6146	1.4195	0.5244	1.2834	1.4621	1.2583	1.2583	1.2583	1.2583
6	1.5199	0.6431	0.6903	1.1402	1.6402	1.5554	1.0543	0.7090	0.4842	0.7812	1.9312	1.0708	1.0708	1.0708	1.0708
7	1.7364	0.8778	0.6962	0.7963	1.3738	1.4222	1.0850	1.6036	0.4338	1.8532	2.0427	1.1577	1.1577	1.1577	1.1577
8	1.1842	0.8112	0.9651	0.8957	1.0701	1.3928	1.3143	1.4620	0.7840	1.3663	1.2285	1.0000	1.0000	1.0000	1.0000
9	1.1842	0.8112	0.9651	0.8957	1.0701	1.3928	1.3143	1.4620	0.7840	1.3663	1.2285	1.0000	1.0000	1.0000	1.0000

AGE	2002	2003	2004	2005
1	0.0117	0.0117	0.0117	0.0117
2	0.6064	0.6064	0.6064	0.6064
3	1.1042	1.1042	1.1042	1.1042
4	1.0000	1.0000	1.0000	1.0000
5	1.2583	1.2583	1.2583	1.2583
6	1.0708	1.0708	1.0708	1.0708
7	1.1577	1.1577	1.1577	1.1577
8	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000

Table 5.6.14. Herring in VIa (N). Run A. Stock summary. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 6	SoP (%)
1957	1102190	410748	187429	43438	0.2318	0.2789	137
1958	2151130	504873	204686	59669	0.2915	0.3251	133
1959	2150600	541512	218804	65221	0.2981	0.2970	137
1960	634170	435864	253565	63759	0.2515	0.1900	176
1961	1293780	442691	253652	46353	0.1827	0.1265	171
1962	2330450	550396	243014	58195	0.2395	0.2015	129
1963	2133770	583051	266769	49030	0.1838	0.1799	143
1964	983370	532182	312710	64234	0.2054	0.1509	173
1965	7876290	1127915	320545	68669	0.2142	0.1562	116
1966	1068020	856478	432440	100619	0.2327	0.1898	98
1967	2502900	837528	463706	90400	0.1950	0.1873	123
1968	4102390	958890	440487	84614	0.1921	0.1420	125
1969	2999390	986800	478136	107170	0.2241	0.2400	132
1970	3440480	1004425	445944	165930	0.3721	0.3568	136
1971	9573140	1517775	317858	207167	0.6518	0.7858	98
1972	2675850	1117974	445395	164756	0.3699	0.3640	97
1973	1074490	802943	386285	210270	0.5443	0.6046	95
1974	1673100	577008	204515	178160	0.8711	0.9557	88
1975	2106370	435381	107436	114001	1.0611	0.9084	98
1976	610000	264399	73768	93642	1.2694	1.0662	100
1977	623050	163568	52296	41341	0.7905	0.9896	109
1978	913770	171240	48957	22156	0.4526	0.6688	99
1979	1217340	218921	75099	60	0.0008	0.0007	99
1980	887240	255391	124930	306	0.0024	0.0004	99
1981	1662510	365214	132360	51420	0.3885	0.3611	103
1982	772340	306437	110112	92360	0.8388	0.6735	96
1983	2993790	428928	81638	63523	0.7781	0.7112	97
1984	1137800	355276	120887	56012	0.4633	0.5142	105
1985	1203550	350523	148977	39142	0.2627	0.3125	99
1986	892690	316311	134683	70764	0.5254	0.5212	95
1987	2110090	383337	125070	44360	0.3547	0.3395	102
1988	905160	337280	149801	35591	0.2376	0.2821	97
1989	849840	321395	166328	34026	0.2046	0.2449	98
1990	434650	272878	156952	44693	0.2848	0.3450	101
1991	382310	210430	127684	28529	0.2234	0.2565	93
1992	793800	219255	104627	28985	0.2770	0.2821	99
1993	582930	185309	99993	31778	0.3178	0.2455	100
1994	842500	179007	90586	24430	0.2697	0.2268	100
1995	626240	158508	72495	29575	0.4080	0.2640	99
1996	922150	196559	115078	26105	0.2268	0.1723	95
1997	1556550	223934	76573	35233	0.4601	0.5110	99
1998	466690	188829	97816	33353	0.3410	0.4737	100
1999	289840	136563	80663	29736	0.3686	0.3081	99
2000	1552100	193478	66909	23163	0.3462	0.2833	100
2001	730950	191093	105725	24974	0.2362	0.2745	99
2002	676580	197207	111913	31787	0.2840	0.3003	99
2003	285540	155801	96109	28835	0.3000	0.3185	99
2004	343070	122813	75839	22969	0.3029	0.2678	99
2005	159510	94611	64110	17009	0.2653	0.2027	99

```
No of years for separable analysis : 8
Age range in the analysis : 1  . . . 9
Year range in the analysis : 1957  . . . 2005
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 38
Number of observations : 198

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

Table 5.6.15. Herring in VIa (N). Run A. Parameter estimates. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1998	0.4274	16	0.3121	0.5852	0.3640	0.5017	0.4329
2	1999	0.2780	16	0.2007	0.3852	0.2354	0.3283	0.2819
3	2000	0.2556	16	0.1838	0.3554	0.2161	0.3024	0.2593
4	2001	0.2477	17	0.1767	0.3473	0.2085	0.2943	0.2514
5	2002	0.2710	18	0.1894	0.3878	0.2257	0.3254	0.2755
6	2003	0.2874	20	0.1922	0.4296	0.2341	0.3528	0.2935
7	2004	0.2416	24	0.1502	0.3884	0.1896	0.3078	0.2488
8	2005	0.1829	28	0.1040	0.3216	0.1371	0.2439	0.1906
Separable Model: Selection (S) by age								
9	1	0.0117	41	0.0052	0.0264	0.0077	0.0177	0.0128
10	2	0.6064	16	0.4394	0.8370	0.5145	0.7148	0.6147
11	3	1.1042	15	0.8225	1.4824	0.9501	1.2832	1.1167
	4	1.0000	Fixed : Reference Age					
12	5	1.2583	13	0.9607	1.6480	1.0965	1.4440	1.2703
13	6	1.0708	13	0.8269	1.3867	0.9385	1.2218	1.0801
14	7	1.1577	13	0.8935	1.5000	1.0144	1.3213	1.1679
	8	1.0000	Fixed : Last true age					
Separable model: Populations in year 2004								
15	1	159510	103	21178	1201393	56936	446873	271166
16	2	125852	40	57293	276449	84236	188029	136415
17	3	66988	31	36352	123443	49041	91504	70327
18	4	96820	28	55326	169434	72773	128814	100848
19	5	71394	26	42239	120671	54621	93316	74000
20	6	99841	26	58954	169083	76309	130629	103513
21	7	12758	26	7574	21490	9778	16646	13218
22	8	13649	27	8027	23206	10411	17894	14159
Separable model: Populations at age								
23	1998	7973	31	4308	14752	5824	10913	8375
24	1999	8080	25	4907	13306	6264	10422	8346
25	2000	10641	22	6826	16588	8484	13346	10917
26	2001	14972	21	9895	22655	12120	18495	15310
27	2002	14387	21	9494	21802	11638	17786	14714
28	2003	21370	21	13983	32660	17212	26533	21876
29	2004	40153	23	25233	63893	31680	50891	41296

Age-structured index catchabilities

Linear model fitted. Slopes at age :

30	1	Q	.6337	75	.3067	5.935	.6337	2.873	1.795
31	2	Q	3.164	24	2.494	6.589	3.164	5.194	4.180
32	3	Q	5.023	24	3.966	10.41	5.023	8.220	6.624
33	4	Q	5.434	24	4.291	11.25	5.434	8.887	7.163
34	5	Q	5.036	24	3.974	10.45	5.036	8.249	6.645
35	6	Q	4.748	24	3.740	9.908	4.748	7.805	6.278
36	7	Q	4.641	25	3.645	9.778	4.641	7.679	6.162
37	8	Q	4.140	25	3.238	8.832	4.140	6.908	5.526
38	9	Q	5.634	25	4.429	11.83	5.634	9.301	7.470

Table 5.6.16. Herring in VIa (N). Run A. Residuals about the model fit. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1998	1999	2000	2001	2002	2003	2004	2005
1	1.819	2.550	0.429	-2.210	-0.170	-2.438	*******	0.017
2	-0.426	0.427	0.551	0.177	0.005	-0.051	-0.681	0.013
3	-0.701	0.176	-0.093	0.040	0.054	0.149	-0.492	0.921
4	0.161	0.044	0.194	-0.375	0.000	0.076	0.222	0.475
5	-0.085	-0.017	-0.184	-0.348	0.438	-0.050	0.109	-0.127
6	0.369	-0.077	0.247	-0.086	0.288	-0.485	-0.052	-0.363
7	0.459	-0.271	-0.333	0.298	0.148	-0.212	0.456	-0.642
8	0.065	-0.398	-0.221	0.410	-0.926	0.712	0.387	-0.413

AGE-STRUCTURED INDEX RESIDUALS

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-1.127	*******	*******	*******	0.941	-1.362	-4.325	0.469	0.694	-2.105	*******	1.966	1.614	-0.241	0.155
2	-0.207	*******	*******	*******	-0.220	0.540	0.224	0.114	0.466	0.044	*******	-0.518	-0.261	0.186	-0.283
3	-0.205	*******	*******	*******	-0.896	-0.492	0.924	0.230	0.042	0.244	*******	-0.058	0.108	-0.203	-0.184
4	-0.457	*******	*******	*******	-0.534	-0.888	0.996	0.362	0.378	-0.025	*******	0.346	-0.059	0.020	-0.541
5	-0.214	*******	*******	*******	-0.460	0.014	0.206	0.652	0.092	-0.730	*******	-0.219	0.482	0.325	-0.238
6	0.294	*******	*******	*******	0.107	-0.731	1.167	-0.212	0.517	-0.526	*******	-0.225	0.091	0.731	-0.312
7	-0.243	*******	*******	*******	-0.053	0.053	-0.154	0.793	-0.412	-0.015	*******	-0.561	0.368	0.874	0.255
8	-0.900	*******	*******	*******	-0.194	-0.090	0.933	-0.183	0.739	-0.788	*******	-0.581	0.014	0.962	0.021
9	-2.636	*******	*******	*******	-0.502	-0.531	0.885	-0.592	0.065	-2.015	*******	-0.141	0.495	1.654	0.428

Age	2002	2003	2004	2005
1	0.537	1.433	1.500	-0.154
2	-0.413	0.539	0.055	-0.268
3	0.034	0.379	0.234	-0.160
4	0.069	0.418	-0.024	-0.064
5	-0.133	0.469	-0.046	-0.203
6	0.190	0.125	-0.247	-0.971
7	0.241	0.424	-0.198	-1.378
8	0.327	0.467	-0.518	-0.217
9	0.889	1.083	1.579	-0.667

Table 5.6.17. Herring in VIa (N). Run A. Parameters of distributions. N.B. In this table “age” refers to number of rings (winter rings in the otolith).

```
PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)
 -----------------------------------------------------
Separable model fitted from 1998  to 2005
 Variance                            0.2843
Skewness test stat.                 -0.3629
Kurtosis test statistic             -0.3429
Partial chi-square                   1.1477
Significance in fit                  0.0000
Degrees of freedom                       34
 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               0.0310    0.0131    0.0188    0.0250    0.0158    0.0344    0.0345    0.0383    0.1648
Skewness test stat.    -1.8754    0.4207    0.0285    0.1051    0.0097    0.4318   -1.0584    0.3843   -1.0332
Kurtosis test statisti  0.7964   -0.8865    0.7248   -0.1010   -0.4728   -0.1636    0.6317   -0.7434   -0.1260
Partial chi-square      0.0355    0.0138    0.0202    0.0272    0.0180    0.0389    0.0429    0.0488    0.2088
Significance in fit     0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
Number of observations      15        15        15        15        15        15        15        15        15
Degrees of freedom          14        14        14        14        14        14        14        14        14
Weight in the analysis  0.0111    0.1111    0.1111    0.1111    0.1111    0.1111    0.1111    0.1111    0.1111
```

Table 5.6.18. Herring in VIa (N). Run A. Analysis of variance. N.B. In this table “age” refers to number of rings (winter rings in the otolith).

```
 ANALYSIS OF VARIANCE
--------------------------
Unweighted Statistics
Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                      110.8796     198          38  160   0.6930
Catches at age                        28.4322      63          29   34   0.8362

 Aged Indices
"FLT01:","West","Scotland","Summer","A 82.4474     135           9  126   0.6543
Weighted Statistics
Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                       10.2073     198          38  160   0.0638
Catches at age                         9.6663      63          29   34   0.2843

 Aged Indices
"FLT01:","West","Scotland","Summer","A  0.5410     135           9  126   0.0043
```

Table 5.6.19. Herring in VIa (N). Run B. Fishing mortality (per year). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Fishing Mortality (per year)

AGE	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	0.0095	0.0117	0.0402	0.0090	0.0162	0.0383	0.0088	0.0437	0.0619	0.3639	0.1394	0.0881	0.0201	0.1149	0.0348
2	0.0991	0.0948	0.1075	0.1703	0.2578	0.2610	0.1171	0.1316	0.0685	0.2388	0.1234	0.1464	0.0806	0.1117	0.4159
3	0.3202	0.3019	0.1574	0.1387	0.1559	0.2071	0.2505	0.1546	0.1477	0.1677	0.1649	0.1387	0.1680	0.3494	0.9827
4	0.2150	0.3510	0.3986	0.1373	0.1001	0.2421	0.1541	0.1811	0.1802	0.1973	0.2684	0.1648	0.2136	0.4018	0.8643
5	0.2999	0.2960	0.3520	0.2582	0.1751	0.1693	0.2008	0.1200	0.2023	0.1630	0.1700	0.1376	0.3045	0.3750	0.6869
6	0.2994	0.3771	0.3077	0.2454	0.0864	0.2053	0.1282	0.1590	0.1043	0.2423	0.1537	0.1314	0.2804	0.3081	0.6205
7	0.1879	0.4113	0.3731	0.2715	0.1524	0.2155	0.1175	0.1139	0.1983	0.1416	0.2039	0.1017	0.3298	0.4579	0.5648
8	0.2297	0.2921	0.2724	0.2068	0.1750	0.2346	0.1631	0.1502	0.1455	0.2090	0.1829	0.1456	0.2184	0.3193	0.6903
9	0.2297	0.2921	0.2724	0.2068	0.1750	0.2346	0.1631	0.1502	0.1455	0.2090	0.1829	0.1456	0.2184	0.3193	0.6903

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.3668	0.0778	0.3348	0.1377	0.1948	0.0922	0.0397	0.0003	0.0048	0.0355	0.0276	0.0443	0.0031	0.0550	0.0616
2	0.2361	0.5024	0.4956	0.7378	0.7736	0.3536	0.2946	0.0005	0.0007	0.3234	0.6596	0.3908	0.2324	0.2119	0.5505
3	0.4277	0.5869	0.7725	0.8844	1.2191	0.6062	0.2697	0.0007	0.0004	0.4297	0.6050	0.5954	0.5019	0.3075	0.4758
4	0.2995	0.6293	0.9112	0.8555	1.0873	0.9451	0.5344	0.0003	0.0006	0.3987	0.8061	0.5014	0.4455	0.3058	0.4096
5	0.4100	0.5942	0.9311	0.9061	0.8941	0.9618	0.7796	0.0003	0.0003	0.3073	0.7226	0.9725	0.4584	0.3145	0.5650
6	0.3231	0.6124	1.2142	0.9947	1.0781	1.4723	1.1338	0.0015	0.0002	0.3152	0.5721	0.7920	0.6671	0.3360	0.6577
7	0.4860	0.3552	0.8926	1.0456	1.1125	0.8929	1.0235	0.0025	0.0017	0.3175	0.4671	0.7580	0.6071	1.0089	0.1885
8	0.3616	0.5706	0.8630	0.9249	1.0470	0.8469	0.6493	0.0009	0.0007	0.3642	0.6756	0.6563	0.4749	0.4010	0.5099
9	0.3616	0.5706	0.8630	0.9249	1.0470	0.8469	0.6493	0.0009	0.0007	0.3642	0.6756	0.6563	0.4749	0.4010	0.5099

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.0147	0.0030	0.0117	0.0531	0.1141	0.0105	0.0486	0.0032	0.0007	0.0032	0.0011	0.0044	0.0028	0.0025	0.0023
2	0.2828	0.1990	0.1372	0.1658	0.1919	0.2529	0.4717	0.2284	0.3585	0.2033	0.2018	0.2394	0.1511	0.1336	0.1229
3	0.3277	0.3101	0.3009	0.2354	0.1549	0.3488	0.3332	0.3987	0.3210	0.2353	0.3119	0.4459	0.2815	0.2489	0.2290
4	0.3081	0.3323	0.2137	0.3253	0.2409	0.2027	0.2416	0.1605	0.3606	0.1440	0.3803	0.4154	0.2622	0.2318	0.2133
5	0.2694	0.2825	0.3252	0.4593	0.2417	0.2649	0.1495	0.2288	0.1890	0.1858	0.5582	0.5060	0.3194	0.2824	0.2599
6	0.4714	0.2166	0.1493	0.3739	0.3989	0.3184	0.2580	0.1153	0.1754	0.1132	0.7417	0.4369	0.2758	0.2438	0.2244
7	0.5410	0.2973	0.1515	0.2632	0.3363	0.2937	0.2676	0.2628	0.1586	0.2699	0.7855	0.4825	0.3047	0.2693	0.2478
8	0.3732	0.2767	0.2119	0.2986	0.2642	0.2899	0.3282	0.2420	0.2900	0.2014	0.4768	0.4154	0.2622	0.2318	0.2133
9	0.3732	0.2767	0.2119	0.2986	0.2642	0.2899	0.3282	0.2420	0.2900	0.2014	0.4768	0.4154	0.2622	0.2318	0.2133

Table 5.6.19. Herring in VIa (N). Run B. Fishing mortality (per year). Continued.

Fishing Mortality (per year)

AGE	2002	2003	2004	2005
1	0.0023	0.0023	0.0017	0.0012
2	0.1263	0.1223	0.0929	0.0631
3	0.2353	0.2279	0.1731	0.1175
4	0.2192	0.2123	0.1612	0.1094
5	0.2670	0.2585	0.1964	0.1333
6	0.2305	0.2233	0.1696	0.1151
7	0.2546	0.2466	0.1873	0.1271
8	0.2192	0.2123	0.1612	0.1094
9	0.2192	0.2123	0.1612	0.1094

Table 5.6.20. Herring in VIa (N). Run B. Population abundance (1 January, millions). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Population Abundance (1 January)

AGE	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	1085.3	2117.7	2127.0	627.4	1283.5	2308.3	2119.7	979.0	7847.2	1065.8	2498.8	4099.9	2998.7	3439.9	9570.8
2	913.0	395.5	770.0	751.7	228.7	464.6	817.3	772.9	344.8	2713.4	272.5	799.6	1381.0	1081.3	1128.1
3	232.7	612.5	266.5	512.3	469.6	131.0	265.1	538.5	502.0	238.5	1583.2	178.4	511.7	943.9	716.3
4	139.7	138.3	370.8	186.4	365.1	329.0	87.2	169.0	377.8	354.6	165.1	1099.2	127.2	354.2	544.9
5	137.4	101.9	88.1	225.2	147.0	298.9	233.7	67.6	127.5	285.5	263.4	114.2	843.5	92.9	214.4
6	80.6	92.1	68.6	56.1	157.4	111.7	228.3	173.0	54.3	94.3	219.4	201.1	90.1	562.9	57.8
7	54.4	54.1	57.2	45.6	39.7	130.6	82.3	181.7	133.5	44.2	66.9	170.3	159.5	61.6	374.3
8	7.3	40.8	32.4	35.6	31.5	30.8	95.3	66.2	146.7	99.1	34.7	49.4	139.2	103.8	35.2
9	22.6	29.6	37.8	25.9	16.9	35.5	42.5	113.7	151.4	150.7	162.0	83.8	140.1	92.3	67.1

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	2675.6	1074.2	1672.3	2102.1	607.4	621.2	912.1	1216.6	884.9	1660.5	770.4	2977.4	1132.1	1200.3	889.6
2	3400.4	682.1	365.6	440.2	673.8	183.9	208.4	322.5	447.4	324.0	589.6	275.7	1047.8	415.2	417.9
3	551.3	1989.3	305.7	165.0	155.9	230.3	95.7	115.0	238.8	331.2	173.7	225.8	138.2	615.3	248.9
4	219.5	294.3	905.6	115.6	55.8	37.7	102.8	59.8	94.1	195.4	176.5	77.7	101.9	68.5	370.4
5	207.7	147.2	141.9	329.4	44.5	17.0	13.3	54.5	54.1	85.1	118.7	71.3	42.6	59.1	45.6
6	97.6	124.8	73.5	50.6	120.4	16.5	5.9	5.5	49.3	48.9	56.6	52.1	24.4	24.3	39.0
7	28.1	63.9	61.2	19.8	16.9	37.1	3.4	1.7	5.0	44.6	32.3	28.9	21.4	11.3	15.7
8	192.5	15.6	40.6	22.7	6.3	5.0	13.7	1.1	1.5	4.5	29.4	18.3	12.3	10.5	3.7
9	57.4	77.5	38.0	23.7	19.3	2.7	3.4	8.1	8.3	4.6	8.6	18.4	5.4	6.9	5.2

x 10 ^ 6

Table 5.6.20. Herring in VIa (N). Run B. Population abundance (1 January, millions). Continued.

Population Abundance (1 January)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	2102.0	901.9	848.0	435.3	383.7	796.2	588.1	853.4	644.5	959.3	1652.2	515.5	338.3	1894.3	931.3
2	307.7	762.0	330.8	308.3	151.8	125.9	289.9	206.1	312.9	236.9	351.8	607.1	188.8	124.1	695.2
3	178.5	171.8	462.6	213.6	193.5	92.8	72.4	134.0	121.5	162.0	143.2	213.0	354.0	120.3	80.4
4	126.6	105.3	103.2	280.3	138.2	135.7	53.6	42.5	73.6	72.2	104.8	85.8	111.6	218.7	76.8
5	222.5	84.2	68.4	75.4	183.2	98.3	100.3	38.1	32.8	46.5	56.5	64.8	51.3	77.7	157.0
6	23.5	153.8	57.4	44.7	43.1	130.2	68.2	78.1	27.4	24.5	34.9	29.3	35.4	33.7	53.0
7	18.3	13.3	112.1	44.8	27.8	26.2	85.7	47.7	63.0	20.8	19.8	15.0	17.1	24.3	23.9
8	11.8	9.6	8.9	87.1	31.1	18.0	17.6	59.3	33.2	48.6	14.4	8.2	8.4	11.4	16.8
9	20.1	10.2	19.3	22.4	20.1	23.0	14.0	49.8	40.8	178.9	27.3	10.3	5.0	2.9	5.5

Population Abundance (1 January)

AGE	2002	2003	2004	2005	2006
1	925.5	436.7	604.2	299.7	810.5
2	341.8	339.7	160.3	221.9	110.1
3	455.4	223.2	222.7	108.2	154.3
4	52.4	294.7	145.5	153.3	78.8
5	56.1	38.1	215.6	112.1	124.4
6	109.5	38.9	26.6	160.3	88.7
7	38.3	78.7	28.1	20.3	129.3
8	16.9	26.9	55.6	21.1	16.2
9	6.4	7.3	4.9	17.4	31.3

x 10 ^ 6

Table 5.6.21. Herring in VIa (N). Run B. Predicted catch in number. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Predicted Catch in Number

AGE	1998	1999	2000	2001	2002	2003	2004	2005
1	1.43	0.59	2.94	1.33	1.36	0.62	0.65	0.22
2	112.33	22.97	13.45	69.69	35.15	33.89	12.31	11.74
3	69.97	79.10	24.11	14.98	86.88	41.38	32.17	10.89
4	27.86	24.56	43.15	14.06	9.83	53.72	20.64	15.14
5	24.60	13.38	18.24	34.26	12.54	8.27	36.65	13.32
6	9.90	8.13	6.95	10.16	21.50	7.42	3.95	16.61
7	5.50	4.29	5.47	5.00	8.22	16.40	4.58	2.31
8	2.65	1.85	2.25	3.07	3.17	4.90	7.89	2.08

x 10 ^ 6

Table 5.6.22. Herring in VIa (N). Run B. Predicted index values. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Predicted Age-Structured Index Values

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	666.9	*******	*******	*******	115.3	253.2	183.2	272.5	206.1	306.3	*******	164.5	108.0	605.1	297.5
2	640.4	*******	*******	*******	332.1	266.4	544.2	441.7	624.9	514.9	*******	1293.7	422.2	280.2	1578.4
3	609.5	*******	*******	*******	725.9	313.3	246.6	440.0	416.2	581.5	*******	681.7	1239.3	428.5	289.8
4	499.3	*******	*******	*******	565.5	566.9	219.4	181.7	282.2	311.2	*******	319.3	451.5	899.3	318.8
5	843.4	*******	*******	*******	705.1	373.5	405.7	147.7	129.7	184.3	*******	216.0	189.1	292.5	598.1
6	79.9	*******	*******	*******	152.5	481.5	260.9	322.8	109.7	101.5	*******	101.5	133.9	129.8	206.4
7	61.0	*******	*******	*******	103.6	99.8	331.4	185.0	258.6	80.5	*******	51.8	64.9	93.9	93.4
8	35.8	*******	*******	*******	100.3	57.1	54.9	193.4	105.4	162.1	*******	24.3	27.1	37.4	55.6
9	84.9	*******	*******	*******	90.1	101.4	60.6	225.8	180.0	829.1	*******	42.3	22.2	13.3	25.5

AGE	2002	2003	2004
1	295.7	139.5	193.1
2	774.7	771.5	370.0
3	1634.9	804.5	827.0
4	216.9	1224.6	621.7
5	213.0	145.2	850.6
6	425.0	151.4	106.7
7	149.3	307.9	113.7
8	55.7	89.1	189.6
9	29.4	33.6	23.0

x 10 ^ 3

Table 5.6.23. Herring in VIa (N). Run B. Fitted selection pattern. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Fitted Selection Pattern

AGE	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	0.0442	0.0334	0.1007	0.0656	0.1621	0.1583	0.0573	0.2411	0.3438	1.8448	0.5196	0.5350	0.0939	0.2859	0.0403
2	0.4610	0.2701	0.2696	1.2405	2.5748	1.0782	0.7600	0.7265	0.3804	1.2103	0.4598	0.8887	0.3773	0.2780	0.4812
3	1.4891	0.8601	0.3948	1.0106	1.5576	0.8554	1.6256	0.8532	0.8198	0.8499	0.6143	0.8420	0.7864	0.8694	1.1370
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.3948	0.8432	0.8831	1.8809	1.7486	0.6993	1.3030	0.6625	1.1224	0.8262	0.6335	0.8349	1.4256	0.9332	0.7947
6	1.3922	1.0742	0.7718	1.7874	0.8634	0.8482	0.8321	0.8776	0.5790	1.2283	0.5727	0.7974	1.3129	0.7667	0.7178
7	0.8739	1.1718	0.9360	1.9774	1.5224	0.8900	0.7624	0.6288	1.1003	0.7178	0.7596	0.6170	1.5440	1.1395	0.6535
8	1.0680	0.8320	0.6834	1.5066	1.7476	0.9691	1.0583	0.8291	0.8071	1.0593	0.6814	0.8835	1.0225	0.7947	0.7986
9	1.0680	0.8320	0.6834	1.5066	1.7476	0.9691	1.0583	0.8291	0.8071	1.0593	0.6814	0.8835	1.0225	0.7947	0.7986

Table 5.6.23. Herring in VIa (N). Run B. Fitted selection pattern. Continued.

Fitted Selection Pattern

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	1.2245	0.1237	0.3674	0.1610	0.1792	0.0975	0.0743	0.9620	8.4619	0.0891	0.0343	0.0884	0.0069	0.1799	0.1504
2	0.7883	0.7984	0.5438	0.8624	0.7115	0.3742	0.5513	1.5267	1.2670	0.8112	0.8183	0.7795	0.5216	0.6928	1.3441
3	1.4279	0.9327	0.8477	1.0338	1.1212	0.6414	0.5047	2.2135	0.7705	1.0778	0.7506	1.1875	1.1266	1.0057	1.1617
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.3687	0.9443	1.0218	1.0592	0.8223	1.0177	1.4588	0.7503	0.4432	0.7708	0.8964	1.9394	1.0290	1.0285	1.3794
6	1.0787	0.9732	1.3325	1.1627	0.9915	1.5579	2.1215	4.5768	0.3365	0.7907	0.7097	1.5795	1.4976	1.0988	1.6059
7	1.6226	0.5644	0.9795	1.2222	1.0231	0.9448	1.9152	7.3546	2.9687	0.7964	0.5794	1.5116	1.3628	3.2992	0.4602
8	1.2073	0.9068	0.9470	1.0811	0.9629	0.8961	1.2150	2.8349	1.1926	0.9136	0.8381	1.3090	1.0660	1.3113	1.2450
9	1.2073	0.9068	0.9470	1.0811	0.9629	0.8961	1.2150	2.8349	1.1926	0.9136	0.8381	1.3090	1.0660	1.3113	1.2450

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.0478	0.0090	0.0545	0.1633	0.4737	0.0517	0.2013	0.0200	0.0018	0.0224	0.0030	0.0106	0.0106	0.0106	0.0106
2	0.9180	0.5988	0.6419	0.5097	0.7966	1.2480	1.9524	1.4225	0.9942	1.4121	0.5305	0.5763	0.5763	0.5763	0.5763
3	1.0637	0.9331	1.4080	0.7238	0.6430	1.7207	1.3791	2.4837	0.8904	1.6339	0.8201	1.0736	1.0736	1.0736	1.0736
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8745	0.8500	1.5217	1.4121	1.0036	1.3069	0.6189	1.4255	0.5241	1.2906	1.4676	1.2181	1.2181	1.2181	1.2181
6	1.5302	0.6518	0.6987	1.1494	1.6563	1.5707	1.0678	0.7179	0.4863	0.7861	1.9500	1.0518	1.0518	1.0518	1.0518
7	1.7561	0.8945	0.7090	0.8092	1.3962	1.4490	1.1075	1.6370	0.4400	1.8746	2.0651	1.1617	1.1617	1.1617	1.1617
8	1.2114	0.8326	0.9916	0.9179	1.0970	1.4303	1.3582	1.5073	0.8043	1.3988	1.2535	1.0000	1.0000	1.0000	1.0000
9	1.2114	0.8326	0.9916	0.9179	1.0970	1.4303	1.3582	1.5073	0.8043	1.3988	1.2535	1.0000	1.0000	1.0000	1.0000

AGE	2002	2003	2004	2005
1	0.0106	0.0106	0.0106	0.0106
2	0.5763	0.5763	0.5763	0.5763
3	1.0736	1.0736	1.0736	1.0736
4	1.0000	1.0000	1.0000	1.0000
5	1.2181	1.2181	1.2181	1.2181
6	1.0518	1.0518	1.0518	1.0518
7	1.1617	1.1617	1.1617	1.1617
8	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000

Table 5.6.24. Herring in VIa (N). Run B. Stock summary. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 6	SoP (%)
1957	1085250	405051	184295	43438	0.2357	0.2836	137
1958	2117670	496931	200660	59669	0.2974	0.3315	133
1959	2126950	532983	213815	65221	0.3050	0.3039	137
1960	627420	428176	247770	63759	0.2573	0.1949	176
1961	1283490	435243	247860	46353	0.1870	0.1294	171
1962	2308340	541863	237197	58195	0.2453	0.2060	129
1963	2119690	574530	260651	49030	0.1881	0.1834	143
1964	978990	524357	306265	64234	0.2097	0.1537	173
1965	7847180	1118408	314288	68669	0.2185	0.1586	116
1966	1065840	849175	426618	100619	0.2359	0.1925	98
1967	2498790	831361	458486	90400	0.1972	0.1892	123
1968	4099930	953811	436064	84614	0.1940	0.1431	125
1969	2998710	982144	473902	107170	0.2261	0.2416	132
1970	3439870	1001236	443015	165930	0.3745	0.3586	136
1971	9570820	1515287	315666	207167	0.6563	0.7886	98
1972	2675570	1115799	443429	164756	0.3715	0.3651	97
1973	1074150	801864	385297	210270	0.5457	0.6057	95
1974	1672310	576286	203873	178160	0.8739	0.9573	88
1975	2102070	434536	107001	114001	1.0654	0.9102	98
1976	607390	263587	73318	93642	1.2772	1.0697	100
1977	621160	162799	51809	41341	0.7979	0.9963	109
1978	912080	170430	48394	22156	0.4578	0.6794	99
1979	1216570	218131	74483	60	0.0008	0.0007	99
1980	884920	254466	124291	306	0.0025	0.0004	99
1981	1660520	364309	131744	51420	0.3903	0.3627	103
1982	770440	305473	109413	92360	0.8441	0.6764	96
1983	2977370	426692	80967	63523	0.7845	0.7153	97
1984	1132070	353230	119916	56012	0.4671	0.5182	105
1985	1200340	348512	147602	39142	0.2652	0.3160	99
1986	889620	314311	133162	70764	0.5314	0.5270	95
1987	2101980	380702	123374	44360	0.3596	0.3441	102
1988	901900	334875	148062	35591	0.2404	0.2854	97
1989	847950	319042	164414	34026	0.2070	0.2473	98
1990	435260	270833	155040	44693	0.2883	0.3485	101
1991	383690	209248	126447	28529	0.2256	0.2591	93
1992	796220	218525	103685	28985	0.2795	0.2837	99
1993	588050	185157	99457	31778	0.3195	0.2456	100
1994	853350	179240	90104	24430	0.2711	0.2258	100
1995	644460	159932	72645	29575	0.4071	0.2615	99
1996	959330	199784	116179	26105	0.2247	0.1696	95
1997	1652220	233346	79257	35233	0.4445	0.4980	99
1998	515510	200349	104350	33353	0.3196	0.4510	100
1999	338310	149085	88391	29736	0.3364	0.2848	99
2000	1894270	226061	75806	23163	0.3056	0.2517	100
2001	931310	230710	128243	24974	0.1947	0.2317	99
2002	925520	250494	144379	31787	0.2202	0.2380	99
2003	436710	210881	134285	28835	0.2147	0.2305	99
2004	604220	184397	116526	22969	0.1971	0.1750	99
2005	299670	156857	109276	17009	0.1557	0.1188	99

No of years for separable analysis : 8
Age range in the analysis : 1 . . . 9
Year range in the analysis : 1957 . . . 2005
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 38
Number of observations : 189

Conventional single selection vector model to be fitted.

Table 5.6.25. Herring in VIa (N). Run B. Parameter estimates. N.B. In this table “age” refers to number of rings (winter rings in the otolith).

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1998	0.4154	16	0.2999	0.5752	0.3518	0.4904	0.4211
2	1999	0.2622	17	0.1859	0.3700	0.2200	0.3126	0.2663
3	2000	0.2318	18	0.1622	0.3312	0.1932	0.2781	0.2357
4	2001	0.2133	19	0.1462	0.3113	0.1759	0.2587	0.2173
5	2002	0.2192	21	0.1446	0.3322	0.1773	0.2710	0.2242
6	2003	0.2123	24	0.1317	0.3420	0.1664	0.2708	0.2186
7	2004	0.1612	28	0.0923	0.2814	0.1213	0.2142	0.1679
8	2005	0.1094	33	0.0572	0.2093	0.0786	0.1523	0.1156
Separable Model: Selection (S) by age								
9	1	0.0106	42	0.0046	0.0244	0.0069	0.0162	0.0116
10	2	0.5763	17	0.4113	0.8075	0.4852	0.6845	0.5849
11	3	1.0736	15	0.7940	1.4515	0.9204	1.2522	1.0863
	4	1.0000	Fixed : Reference Age					
12	5	1.2181	13	0.9291	1.5969	1.0609	1.3986	1.2297
13	6	1.0518	13	0.8107	1.3646	0.9210	1.2012	1.0611
14	7	1.1617	13	0.8940	1.5096	1.0164	1.3278	1.1721
	8	1.0000	Fixed : Last true age					
Separable model: Populations in year 2004								
15	1	299673	112	33181	2706497	97502	921044	562870
16	2	221901	48	86564	568825	137271	358708	249028
17	3	108214	37	52191	224374	74595	156986	115968
18	4	153339	33	79601	295382	109744	214251	162162
19	5	112050	31	60624	207099	81904	153291	117690
20	6	160335	30	87710	293093	117860	218117	168111
21	7	20312	30	11268	36616	15038	27436	21251
22	8	21112	30	11717	38038	15634	28509	22086
Separable model: Populations at age								
23	1998	8176	31	4386	15244	5950	11236	8600
24	1999	8399	26	5038	14005	6471	10903	8690
25	2000	11415	23	7188	18126	9016	14452	11737
26	2001	16788	22	10803	26089	13407	21022	17218
27	2002	16877	22	10761	26469	13414	21233	17327
28	2003	26887	24	16794	43045	21147	34183	27673
29	2004	55645	26	33097	93555	42688	72536	57635

Age-structured index catchabilities

Linear model fitted. Slopes at age :

30	1	Q	.5516	78	.2595	5.641	.5516	2.654	1.647
31	2	Q	2.859	25	2.229	6.158	2.859	4.801	3.832
32	3	Q	4.551	25	3.554	9.752	4.551	7.617	6.086
33	4	Q	4.927	25	3.850	10.54	4.927	8.236	6.584
34	5	Q	4.636	25	3.621	9.932	4.636	7.757	6.199
35	6	Q	4.646	25	3.624	9.992	4.646	7.794	6.222
36	7	Q	4.726	26	3.678	10.24	4.726	7.970	6.350
37	8	Q	3.928	26	3.046	8.608	3.928	6.674	5.303
38	9	Q	5.462	26	4.253	11.82	5.462	9.199	7.334

Table 5.6.26. Herring in VIa (N). Run B. Residuals about the model fit. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1998	1999	2000	2001	2002	2003	2004	2005
1	1.848	2.554	0.428	-2.202	-0.171	-2.460	*******	0.000
2	-0.415	0.428	0.535	0.165	0.007	-0.036	-0.677	-0.012
3	-0.705	0.172	-0.100	0.021	0.038	0.158	-0.469	0.943
4	0.135	0.021	0.175	-0.393	-0.033	0.053	0.218	0.494
5	-0.073	-0.001	-0.162	-0.319	0.463	-0.035	0.130	-0.078
6	0.373	-0.077	0.258	-0.068	0.309	-0.463	-0.048	-0.344
7	0.451	-0.277	-0.339	0.305	0.158	-0.193	0.470	-0.637
8	0.062	-0.385	-0.205	0.429	-0.898	0.750	0.427	-0.371

AGE-STRUCTURED INDEX RESIDUALS

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-0.985	*******	*******	*******	1.076	-1.226	-4.195	0.595	0.804	-2.006	*******	2.005	1.598	-0.301	0.051
2	-0.102	*******	*******	*******	-0.120	0.637	0.321	0.205	0.552	0.113	*******	-0.487	-0.270	0.121	-0.396
3	-0.101	*******	*******	*******	-0.795	-0.396	1.016	0.323	0.127	0.322	*******	-0.022	0.113	-0.240	-0.286
4	-0.347	*******	*******	*******	-0.430	-0.787	1.091	0.452	0.467	0.056	*******	0.389	-0.044	0.000	-0.612
5	-0.114	*******	*******	*******	-0.367	0.105	0.293	0.731	0.165	-0.659	*******	-0.188	0.488	0.296	-0.313
6	0.335	*******	*******	*******	0.145	-0.696	1.199	-0.185	0.534	-0.516	*******	-0.247	0.035	0.646	-0.443
7	-0.237	*******	*******	*******	-0.049	0.058	-0.154	0.788	-0.424	-0.039	*******	-0.613	0.288	0.754	0.095
8	-0.812	*******	*******	*******	-0.110	-0.007	1.017	-0.107	0.808	-0.729	*******	-0.561	0.019	0.931	-0.059
9	-2.570	*******	*******	*******	-0.440	-0.469	0.947	-0.538	0.113	-1.977	*******	-0.140	0.467	1.585	0.307

Age	2002	2003	2004
1	0.362	1.146	1.072
2	-0.575	0.298	-0.298
3	-0.129	0.148	-0.084
4	-0.082	0.184	-0.340
5	-0.275	0.222	-0.388
6	-0.002	-0.159	-0.650
7	0.020	0.119	-0.610
8	0.192	0.249	-0.836
9	0.704	0.805	1.200

Table 5.6.27. Herring in VIa (N). Run B. Parameters of distributions. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

```
PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)
 -------------------------------------------------
Separable model fitted from 1998  to 2005
 Variance                            0.2843
Skewness test stat.                 -0.0805
Kurtosis test statistic             -0.2883
Partial chi-square                   1.1498
Significance in fit                  0.0000
Degrees of freedom                       34
 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	0.0304	0.0161	0.0193	0.0276	0.0169	0.0322	0.0197	0.0417	0.1500
Skewness test stat.	-1.8313	0.1777	0.8763	0.6709	0.2491	1.0372	0.6418	0.3831	-1.3591
Kurtosis test statisti	0.7329	-0.8388	0.9153	-0.1157	-0.6290	-0.1297	-0.2253	-0.6970	0.1028
Partial chi-square	0.0325	0.0157	0.0195	0.0283	0.0177	0.0344	0.0221	0.0490	0.1735
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	14	14	14	14	14	14	14	14	14
Degrees of freedom	13	13	13	13	13	13	13	13	13
Weight in the analysis	0.0111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111

Table 5.6.28. Herring in VIa (N). Run B. Analysis of variance. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

```
 ANALYSIS OF VARIANCE
-------------------------
Unweighted Statistics
Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                      101.9758     189           38  151   0.6753
Catches at age                        28.6138      63           29   34   0.8416

 Aged Indices
FLT01: West Scotland Summer Acoustic S 73.3621     126            9  117   0.6270
Weighted Statistics
Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                       10.1383     189           38  151   0.0671
Catches at age                         9.6667      63           29   34   0.2843

 Aged Indices
FLT01: West Scotland Summer Acoustic S  0.4716     126            9  117   0.0040
```

Table 5.7.1.1. Herring in VIa (N). Input data for short-term predictions, numbers at age from the assessment with ages 1 and 2 replaced by geometric mean values - natural mortality (M), proportion mature (Mat), proportion of fishing mortality prior to spawning (PF), proportion of natural mortality prior to spawning (PM), mean weights at age in the stock (SWt), selection pattern (Sel), mean weights at age in the catch (CWt). All biological data are taken as mean of the last 3 years. VIa (N) herring appears to have considerable annual variability in mean weights and in fraction mature. Last years values are not applicable. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	748700	1	0	0.67	0.67	0.0660	0.0021	0.0601
2	288925	0.3	0.81	0.67	0.67	0.1352	0.1108903	0.1435667
3	83448	0.2	0.99	0.67	0.67	0.1629333	0.2019121	0.1645
4	44819	0.1	1	0.67	0.67	0.1788333	0.1828605	0.1818
5	72967	0.1	1	0.67	0.67	0.1910667	0.2300991	0.2024333
6	51323	0.1	1	0.67	0.67	0.2020333	0.1958082	0.2131667
7	74276	0.1	1	0.67	0.67	0.2141667	0.2116974	0.2068
8	9342.6	0.1	1	0.67	0.67	0.2133333	0.1828605	0.2087333
9	18437	0.1	1	0.67	0.67	0.2208	0.1828605	0.2843

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	748700	1	0	0.67	0.67	0.0660	0.0021	0.0601
2	.	0.3	0.81	0.67	0.67	0.1352	0.1108903	0.1435667
3	.	0.2	0.99	0.67	0.67	0.1629333	0.2019121	0.1645
4	.	0.1	1	0.67	0.67	0.1788333	0.1828605	0.1818
5	.	0.1	1	0.67	0.67	0.1910667	0.2300991	0.2024333
6	.	0.1	1	0.67	0.67	0.2020333	0.1958082	0.2131667
7	.	0.1	1	0.67	0.67	0.2141667	0.2116974	0.2068
8	.	0.1	1	0.67	0.67	0.2133333	0.1828605	0.2087333
9	.	0.1	1	0.67	0.67	0.2208	0.1828605	0.2843

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	748700	1	0	0.67	0.67	0.0660	0.0021	0.0601
2	.	0.3	0.81	0.67	0.67	0.1352	0.1108903	0.1435667
3	.	0.2	0.99	0.67	0.67	0.1629333	0.2019121	0.1645
4	.	0.1	1	0.67	0.67	0.1788333	0.1828605	0.1818
5	.	0.1	1	0.67	0.67	0.1910667	0.2300991	0.2024333
6	.	0.1	1	0.67	0.67	0.2020333	0.1958082	0.2131667
7	.	0.1	1	0.67	0.67	0.2141667	0.2116974	0.2068
8	.	0.1	1	0.67	0.67	0.2133333	0.1828605	0.2087333
9	.	0.1	1	0.67	0.67	0.2208	0.1828605	0.2843

Table 5.7.1.2. Herring in VIa (N). Short-term prediction single option table, *status quo* F with the 2005 acoustic survey included in the assessment. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Year:	2006	F multiplier:	1	Fbar:	0.2027				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0021	1014	61	748700	49439	0	0	0	0
2	0.1109	26273	3772	288925	39063	234029	31641	177709	24026
3	0.2019	13875	2282	83448	13596	82614	13460	63111	10283
4	0.1829	7138	1298	44819	8015	44819	8015	37081	6631
5	0.2301	14300	2895	72967	13942	72967	13942	58489	11175
6	0.1958	8699	1854	51323	10369	51323	10369	42096	8505
7	0.2117	13509	2794	74276	15907	74276	15907	60277	12909
8	0.1829	1488	311	9343	1993	9343	1993	7730	1649
9	0.1829	2937	835	18437	4071	18437	4071	15254	3368
Total		89233	16101	1392238	156395	587807	99398	461747	78547
Year:	2007	F multiplier:	1	Fbar:	0.2027				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0021	1014	61	748700	49439	0	0	0	0
2	0.1109	24992	3588	274841	37159	222622	30098	169047	22855
3	0.2019	31853	5240	191575	31214	189659	30902	144886	23607
4	0.1829	8892	1617	55830	9984	55830	9984	46191	8261
5	0.2301	6619	1340	33777	6454	33777	6454	27075	5173
6	0.1958	8891	1895	52453	10597	52453	10597	43022	8692
7	0.2117	6944	1436	38181	8177	38181	8177	30985	6636
8	0.1829	8662	1808	54385	11602	54385	11602	44996	9599
9	0.1829	3334	948	20935	4623	20935	4623	17321	3824
Total		101202	17933	1470676	169248	667841	112437	523523	88647
Year:	2008	F multiplier:	1	Fbar:	0.2027				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0021	1014	61	748700	49439	0	0	0	0
2	0.1109	24992	3588	274841	37159	222622	30098	169047	22855
3	0.2019	30300	4984	182236	29692	180414	29395	137823	22456
4	0.1829	20414	3711	128171	22921	128171	22921	106043	18964
5	0.2301	8246	1669	42075	8039	42075	8039	33727	6444
6	0.1958	4116	877	24280	4905	24280	4905	19915	4024
7	0.2117	7097	1468	39021	8357	39021	8357	31667	6782
8	0.1829	4453	929	27956	5964	27956	5964	23130	4934
9	0.1829	9041	2570	56763	12533	56763	12533	46964	10370
Total		109672	19859	1524044	179010	721302	122214	568315	96829

Table 5.7.1.3. Herring in VIa (N). Short-term prediction multiple option table,. *status quo* F with the 2005 acoustic survey included in the assessment.

2006						
Biomass	SSB	FMult	FBar	Landings		
156395	78547	1	0.2027	16101		
2007					2008	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
169248	99748	0	0	0	196311	124899
.	98575	0.1	0.0203	1939	194437	121706
.	97416	0.2	0.0405	3843	192597	118606
.	96272	0.3	0.0608	5715	190789	115595
.	95142	0.4	0.0811	7553	189014	112673
.	94025	0.5	0.1013	9360	187271	109835
.	92923	0.6	0.1216	11135	185559	107079
.	91834	0.7	0.1419	12879	183877	104403
.	90758	0.8	0.1621	14593	182226	101804
.	89696	0.9	0.1824	16278	180603	99280
.	88647	1	0.2027	17933	179010	96829
.	87611	1.1	0.2229	19559	177445	94448
.	86587	1.2	0.2432	21157	175908	92135
.	85576	1.3	0.2635	22728	174398	89888
.	84578	1.4	0.2837	24272	172915	87706
.	83591	1.5	0.304	25789	171459	85586
.	82617	1.6	0.3243	27279	170028	83526
.	81655	1.7	0.3445	28745	168622	81525
.	80704	1.8	0.3648	30185	167242	79580
.	79765	1.9	0.3851	31600	165885	77691
.	78838	2	0.4053	32991	164553	75855

Table 5.7.1.4. Herring in VIa (N). Short-term prediction single option table, *status quo* F with the 2005 acoustic survey excluded from the assessment. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Year:	2006	F multiplier:	1	Fbar:	0.1188				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0012	613	37	836018	55205	0	0	0	0
2	0.0631	16639	2389	314623	42537	254845	34455	199817	27015
3	0.1175	15536	2556	154340	25147	152797	24896	123519	20125
4	0.1094	7778	1414	78779	14088	78779	14088	68465	12244
5	0.1333	14786	2993	124370	23763	124370	23763	106373	20324
6	0.1151	9190	1959	88735	17927	88735	17927	76825	15521
7	0.1271	14705	3041	129300	27692	129300	27692	111048	23783
8	0.1094	1598	334	16186	3453	16186	3453	14067	3001
9	0.1094	3088	878	31273	6905	31273	6905	27179	6001
Total		83932	15600	1773624	216718	876284	153179	727293	128015

Year:	2007	F multiplier:	2.1	Fbar:	0.2495				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0024	1286	77	836018	55205	0	0	0	0
2	0.1324	33029	4742	307197	41533	248830	33642	186240	25180
3	0.2467	43541	7163	218834	35655	216645	35299	160608	26168
4	0.2298	21994	3999	112357	20093	112357	20093	90081	16109
5	0.2799	14880	3012	63893	12208	63893	12208	49534	9464
6	0.2417	20165	4299	98491	19898	98491	19898	78337	15827
7	0.267	15992	3307	71561	15326	71561	15326	55962	11985
8	0.2298	20168	4210	103028	21979	103028	21979	82602	17622
9	0.2298	7535	2142	38491	8499	38491	8499	30860	6814
Total		178591	32950	1849871	230397	953297	166944	734225	129170

Year:	2008	F multiplier:	2.1	Fbar:	0.2495				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0024	1286	77	836018	55205	0	0	0	0
2	0.1324	32987	4736	306805	41480	248512	33599	186003	25148
3	0.2467	39665	6525	199349	32481	197355	32156	146307	23838
4	0.2298	27404	4982	139994	25036	139994	25036	112239	20072
5	0.2799	18815	3809	80791	15437	80791	15437	62635	11967
6	0.2417	8947	1907	43698	8828	43698	8828	34756	7022
7	0.267	15639	3234	69983	14988	69983	14988	54728	11721
8	0.2298	9705	2026	49580	10577	49580	10577	39750	8480
9	0.2298	19920	5663	101762	22469	101762	22469	81587	18014
Total		174369	32959	1827980	226500	931675	163089	718005	126263

Table 5.7.1.5. Herring in VIa (N). Short-term prediction multiple option table,. *status quo* F with the 2005 acoustic survey excluded from the assessment.

2006				
Biomass	SSB	FMult	FBar	Landings
216718	128015	1	0.1188	15600

2007					2008	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
230397	150041	0	0	0	258186	175916
.	147804	0.21	0.025	3636	254681	170070
.	145601	0.42	0.0499	7192	251256	164440
.	143433	0.63	0.0749	10668	247908	159018
.	141299	0.84	0.0998	14068	244637	153797
.	139198	1.05	0.1248	17393	241439	148768
.	137129	1.26	0.1497	20645	238313	143924
.	135092	1.47	0.1747	23824	235258	139258
.	133087	1.68	0.1996	26934	232272	134764
.	131113	1.89	0.2246	29976	229353	130434
.	129170	2.1	0.2495	32950	226500	126263
.	127256	2.31	0.2745	35859	223711	122243
.	125372	2.52	0.2994	38705	220985	118371
.	123517	2.73	0.3244	41488	218320	114639
.	121691	2.94	0.3494	44211	215715	111043
.	119893	3.15	0.3743	46874	213168	107577
.	118123	3.36	0.3993	49479	210678	104237
.	116380	3.57	0.4242	52027	208244	101017
.	114664	3.78	0.4492	54520	205864	97913
.	112974	3.99	0.4741	56959	203537	94921
	111311	4.2	0.4991	59345	201262	92036

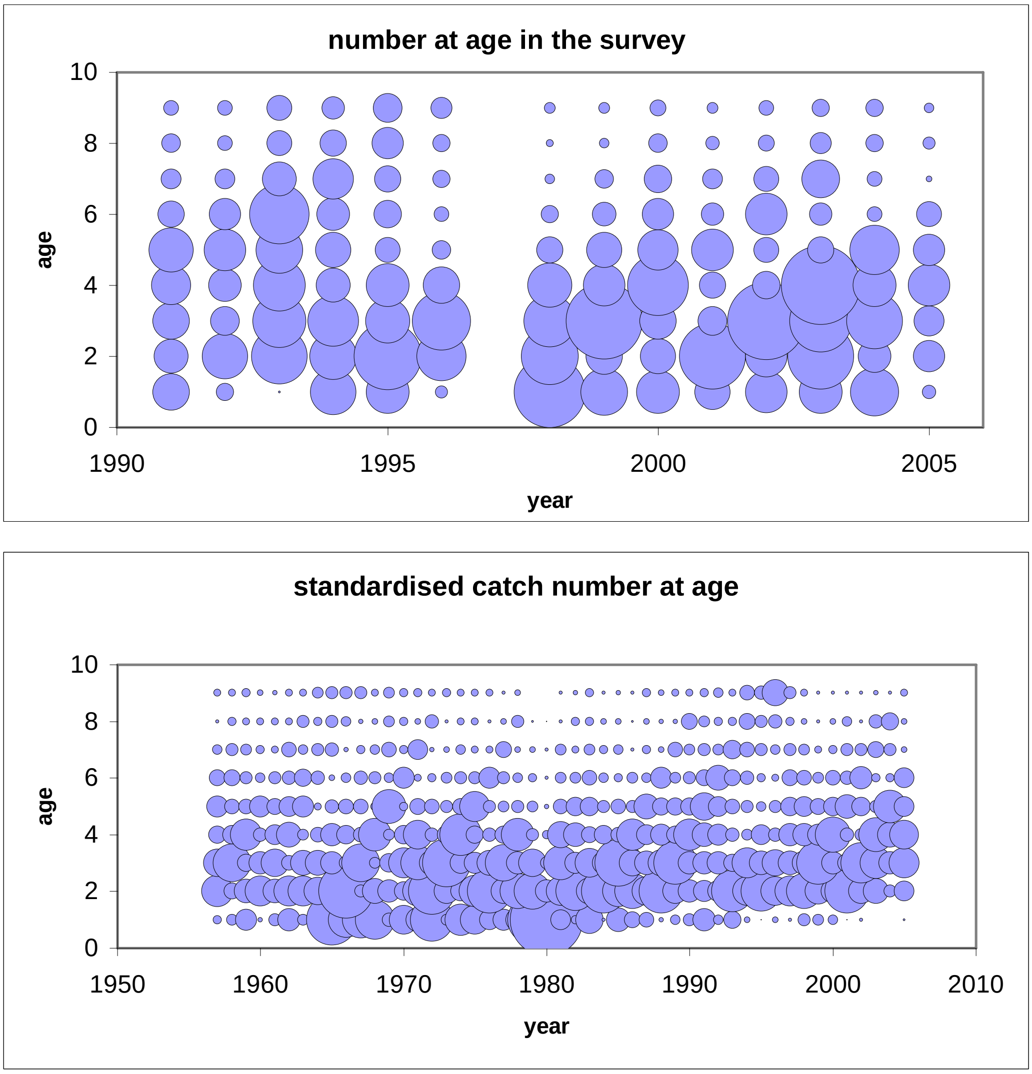
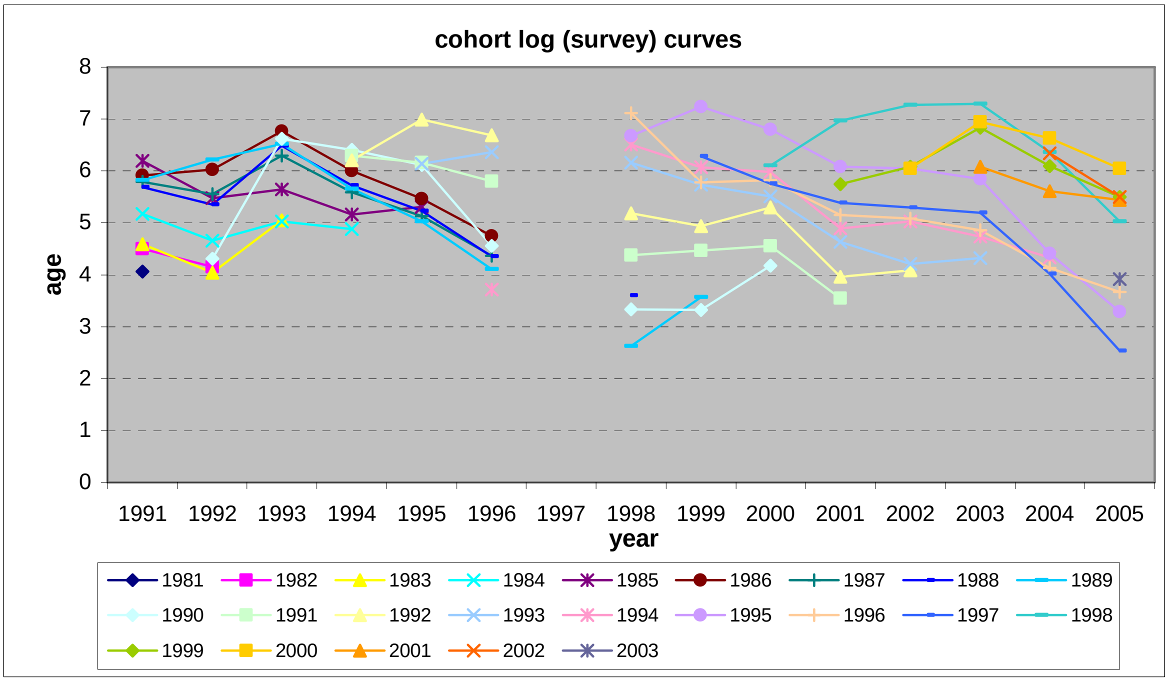


Figure 5.6.1. Herring in VIa (North). Bubble-plots of number-at-age in the survey (upper panel) and catch (lower panel) to show patterns present in the population and in the catch. N.B. catch numbers are standardised to the catch in each year. The actual values for the circles are given in Table 5.2.2 (survey) and Table 5.3.1 (catch).



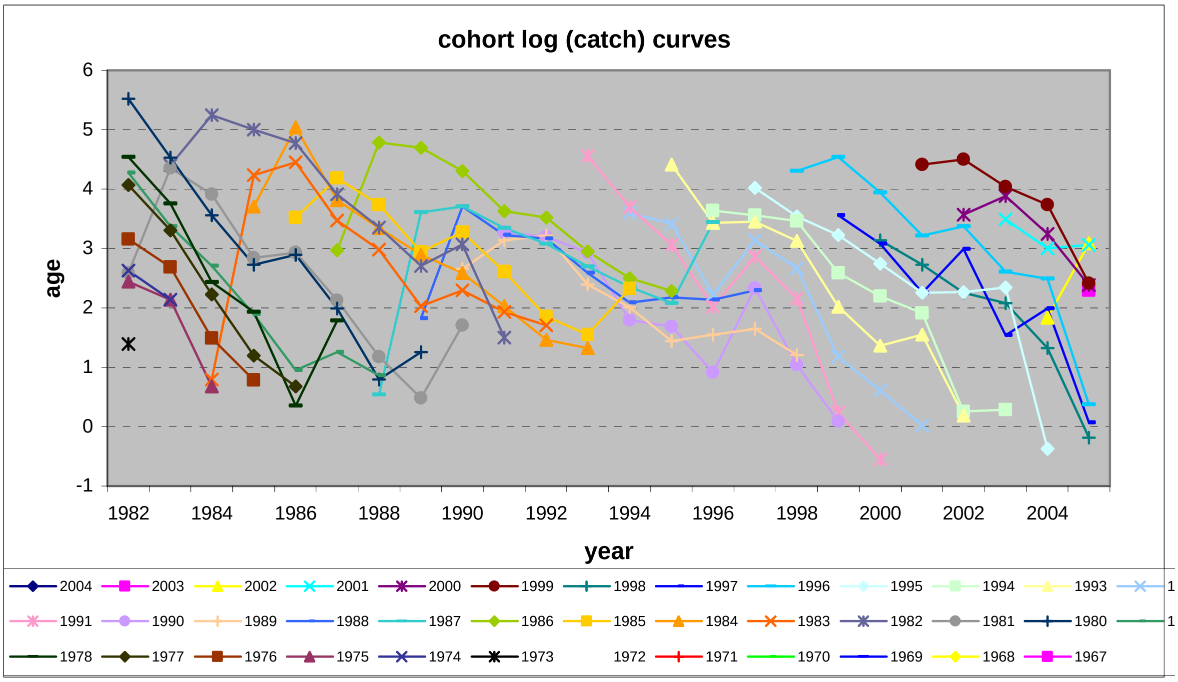


Figure 5.6.2. Herring in VIa (North). Log (catch) curves from the survey (upper panel) and in the catch (lower panel) for cohorts to give an impression of total mortality.

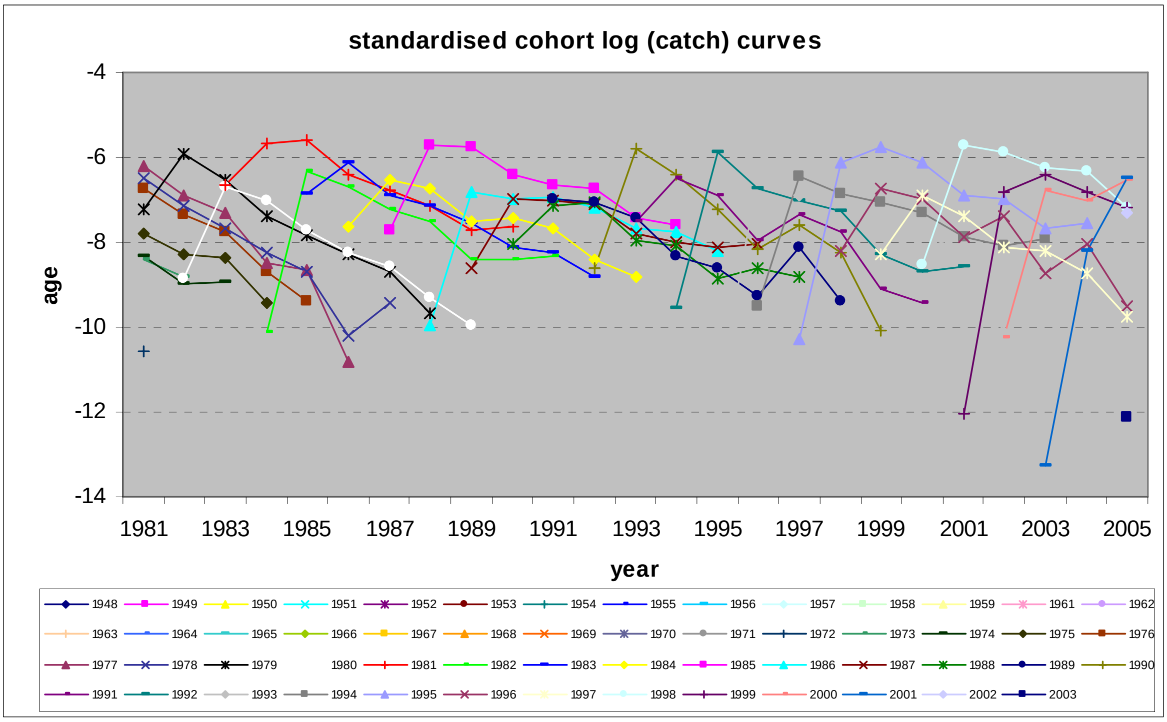


Figure 5.6.3. Herring in VIa (North). Standardised log (catch) curves in the catch for cohorts to show the different impression of total mortality given when compared to the similar plot using raw data (Figure 5.6.2 lower panel).

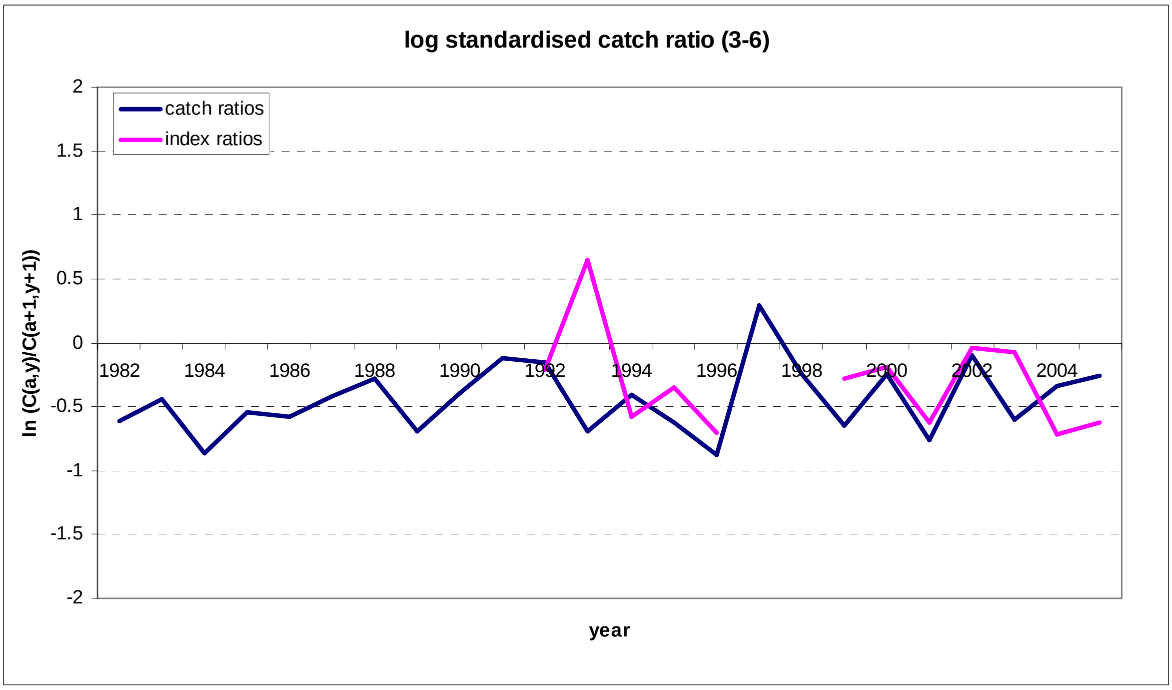


Figure 5.6.4. Herring in VIa (North). Standardised average log (catch) ratios, by year, in the catch and survey for 3- to 6-ringers to show patterns of total mortality in the catch and survey data.

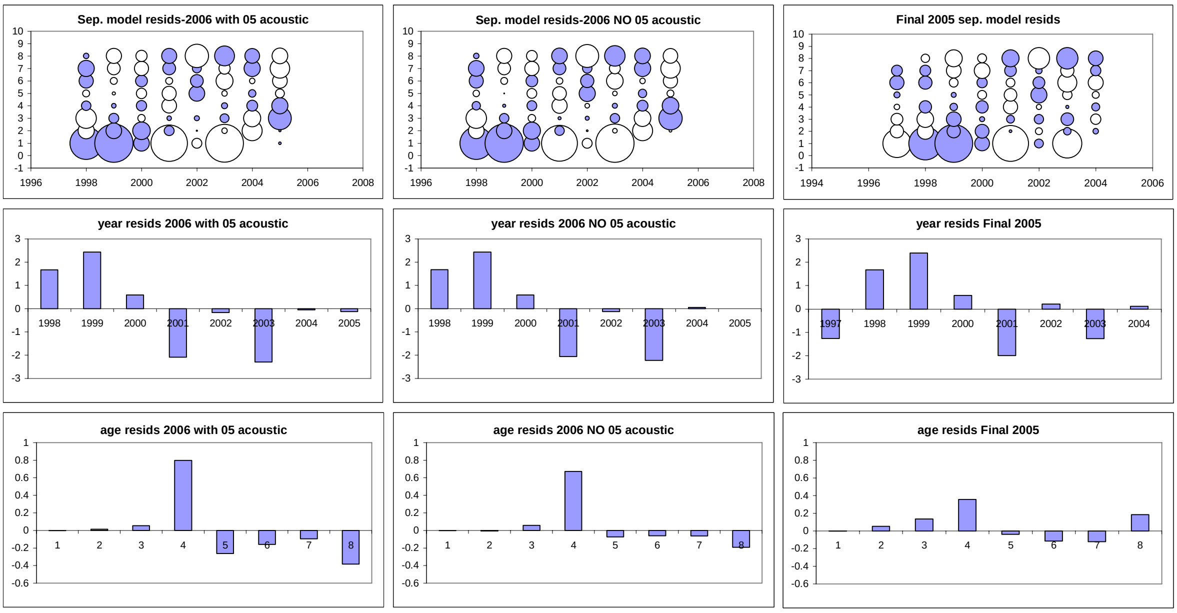


Figure 5.6.5. Herring in VIa (North). Separable model residual plots for two exploratory assessments and the HAWG 2005 final run with data from 1957-2005 (to 2004 for the previous year's final run). Left panels have the 2005 acoustic survey included; middle panels exclude the 2005 survey; right panels are from the HAWG 2005 final run.

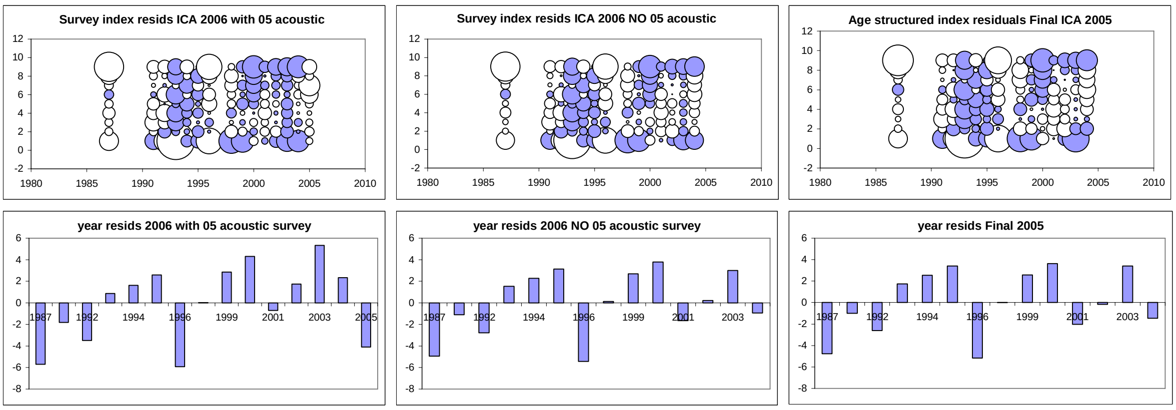


Figure 5.6.6. Herring in VIa (North). Survey residual plots for two exploratory assessments and the HAWG 2005 final run with data from 1957-2005 (to 2004 for the previous year's final run). Left panels have the 2005 acoustic survey included; middle panels exclude the 2005 survey; right panels are from the HAWG 2005 final run.

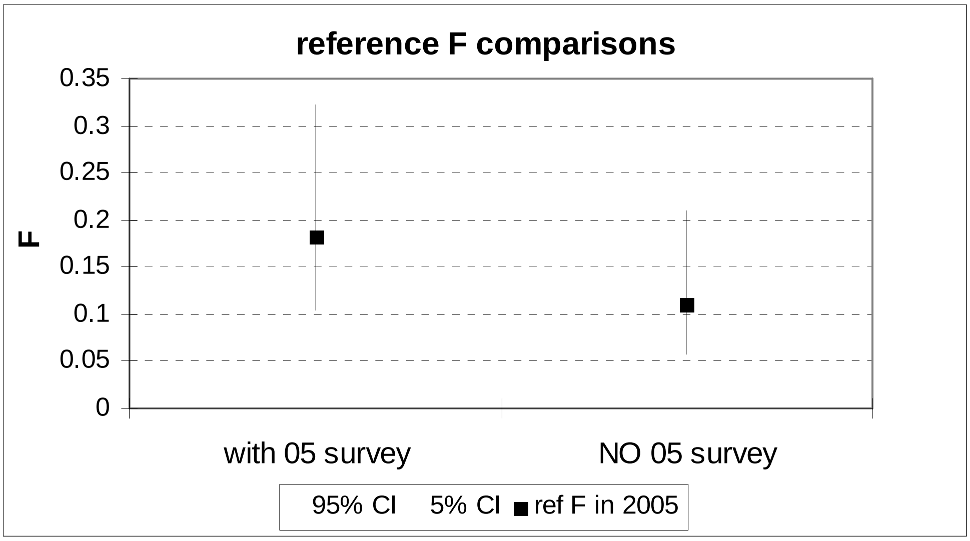


Figure 5.6.7. Herring in VIa (North). Plot to show the value of reference F (and 95% confidence intervals) obtained from the two ICA assessment runs with the 2005 acoustic survey both included and excluded.

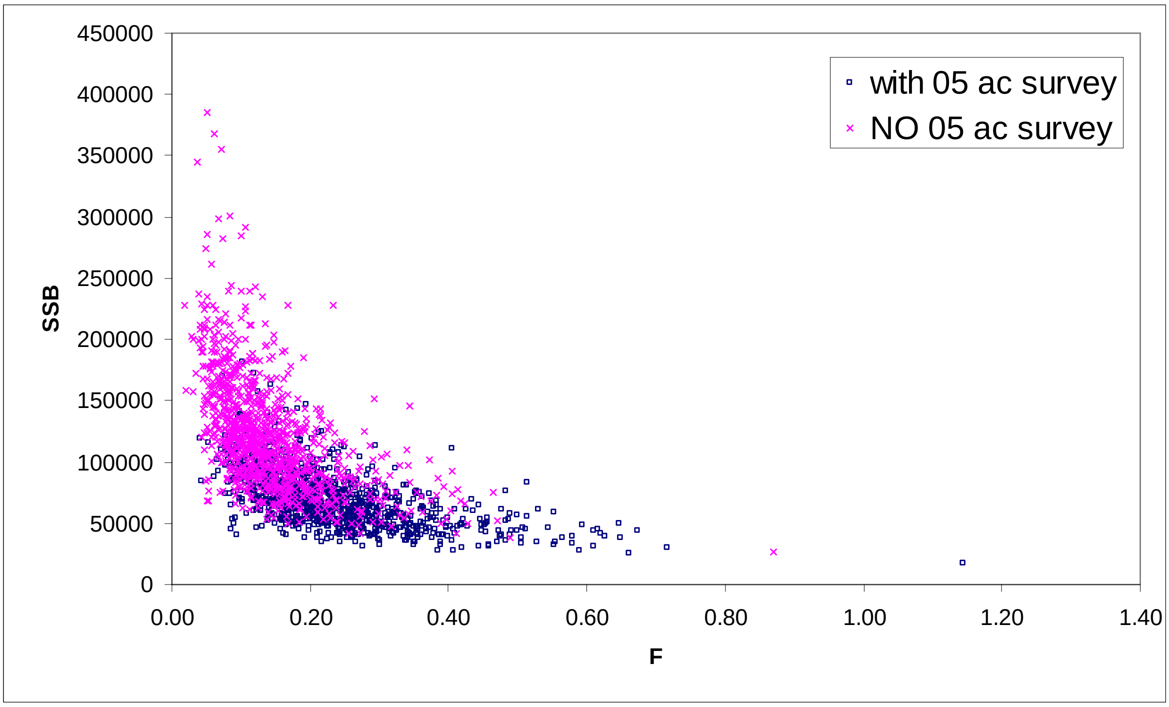
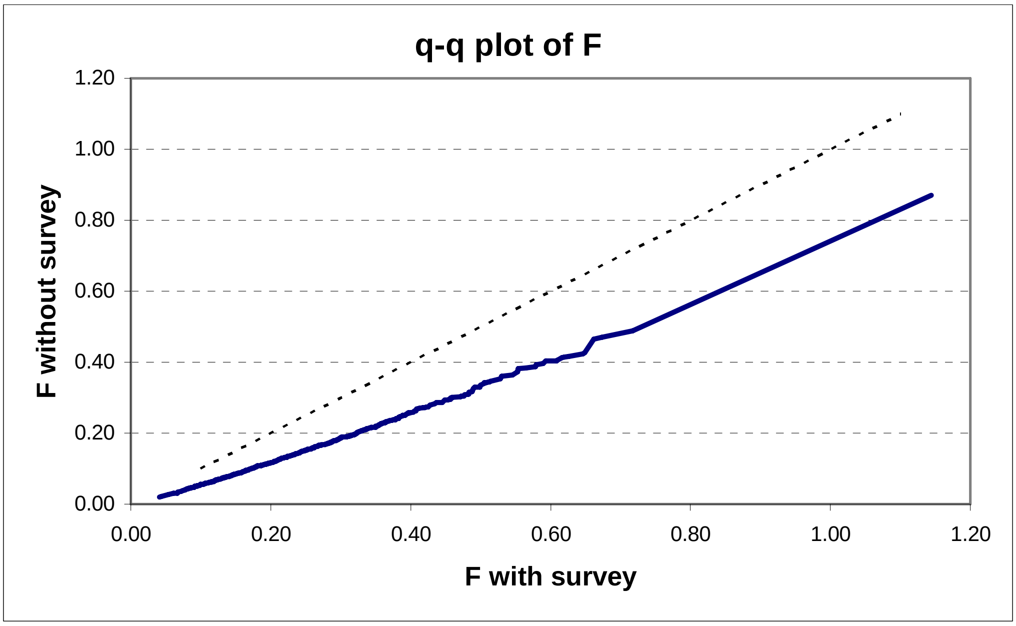


Figure 5.6.8. Herring in VIa (North). Scatter plot of estimates of F and SSB for the terminal year using parameter estimate variance-covariance matrix estimates in a bootstrap evaluation of the precision of the assessment both including and excluding the 2005 acoustic survey.



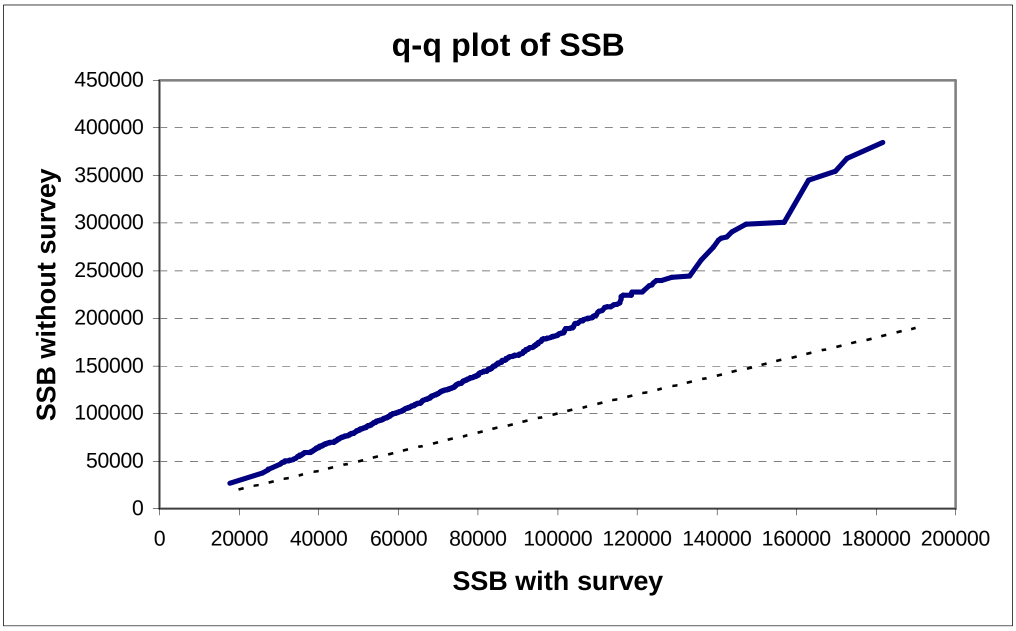


Figure 5.6.9. Herring in VIa (North). Q-q plots of estimates of F and SSB for the terminal year using parameter estimate variance-covariance matrix estimates in a bootstrap evaluation of the precision of the assessment both including and excluding the 2005 acoustic survey. The dashed line denotes a 1:1 ratio.

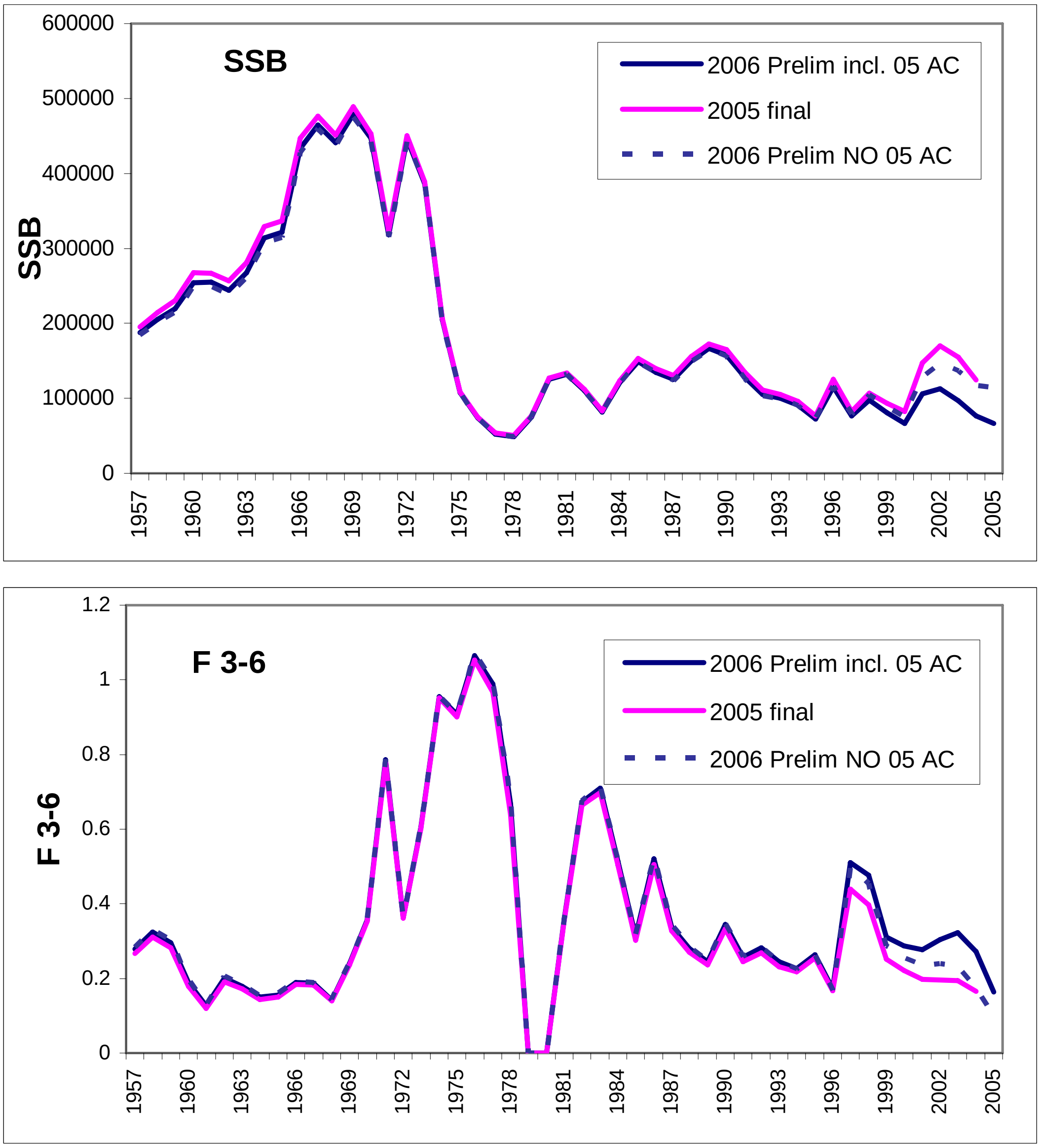


Figure 5.6.10. Herring in VIa (North). F and SSB from the assessment both including and excluding the 2005 acoustic survey and a comparison with the 2005 HAWG final run.

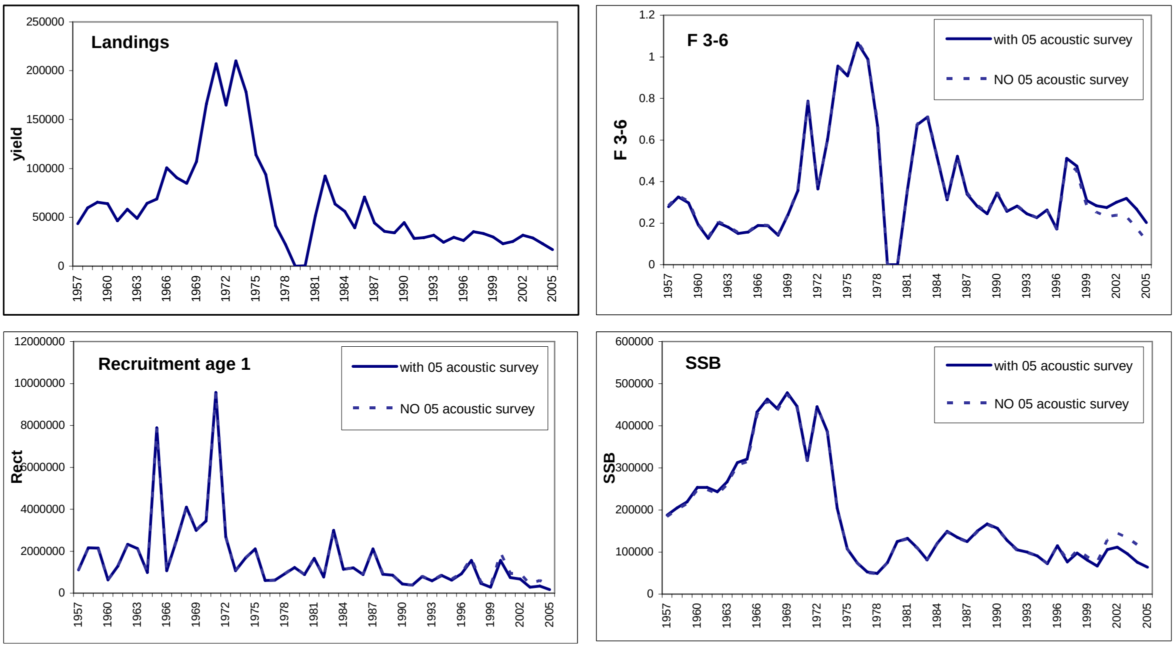


Figure 5.6.11. Herring in VIa (North). Illustration of stock trends from deterministic calculation (8 year separable period). Summary of estimates of landings, fishing mortality at $F_{3\text{-}6}$, recruitment at 1-ring, spawning stock biomass at spawning time in the two assessment runs both including and excluding the 2005 acoustic survey.

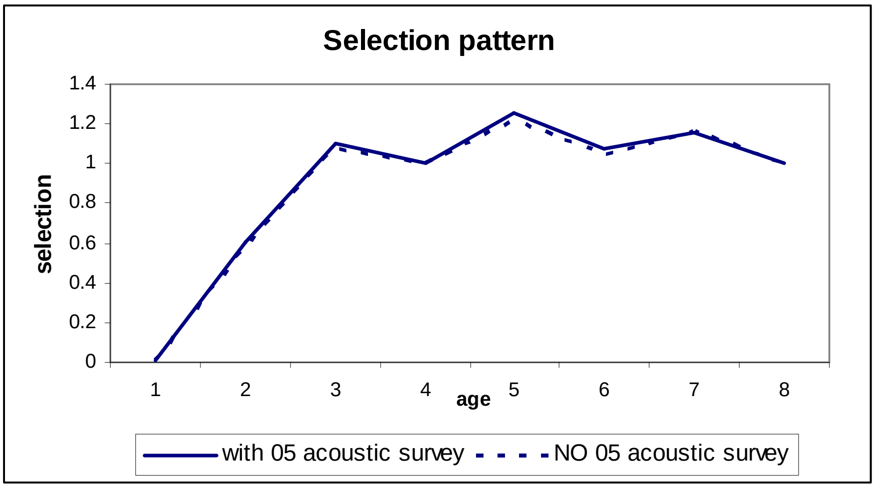


Figure 5.6.12. Herring in VIa (North). Plot to show the selection pattern in the two assessment runs both including and excluding the 2005 acoustic survey.

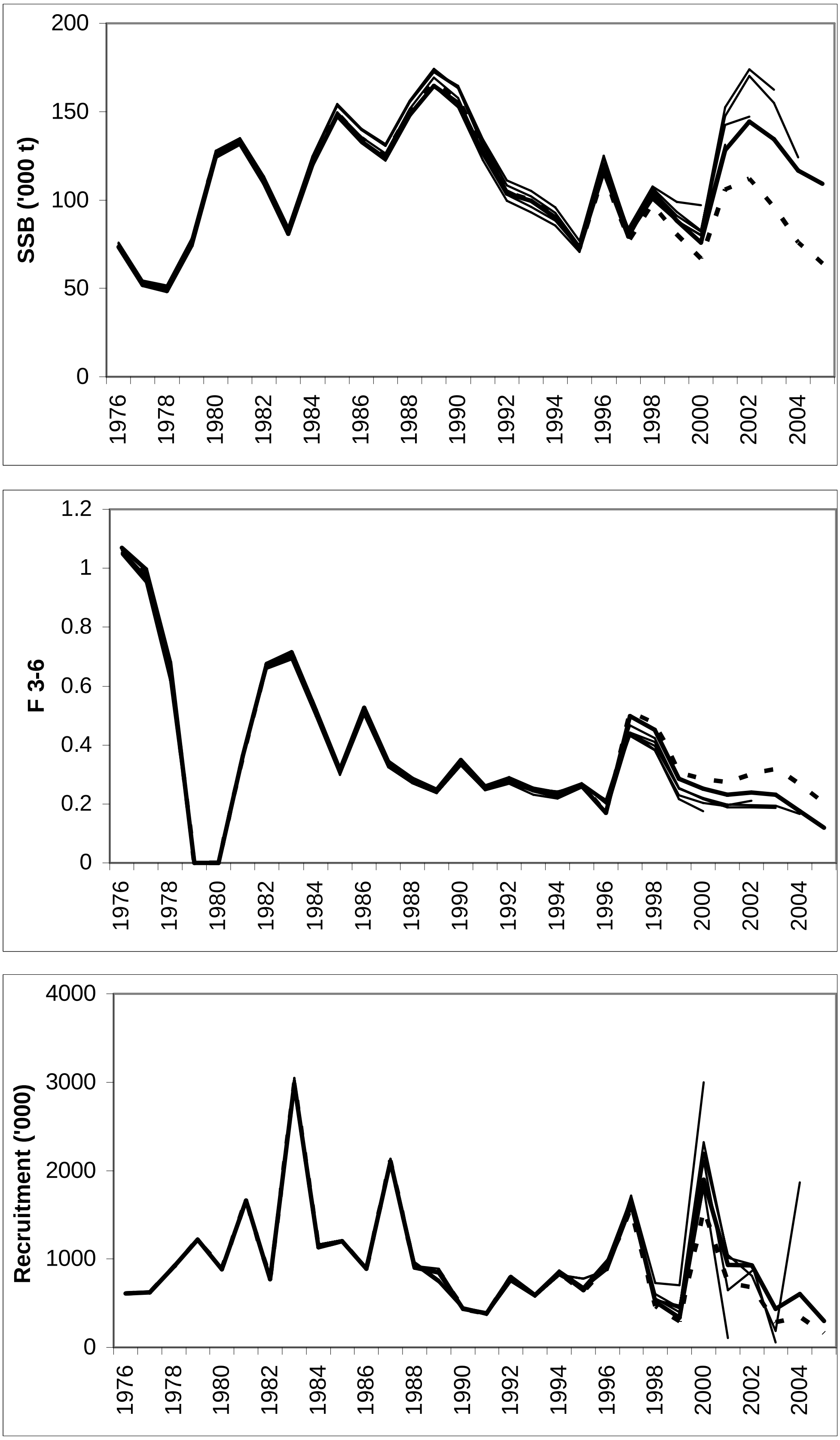
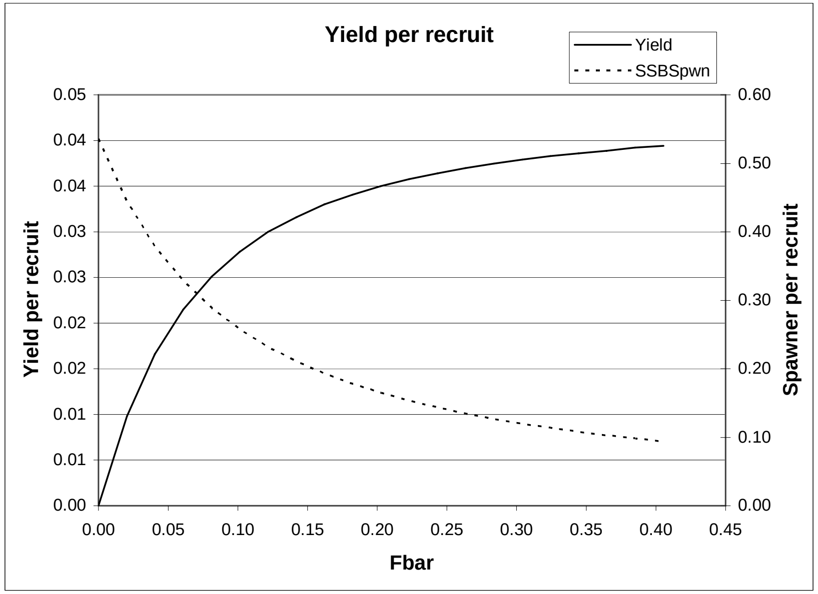
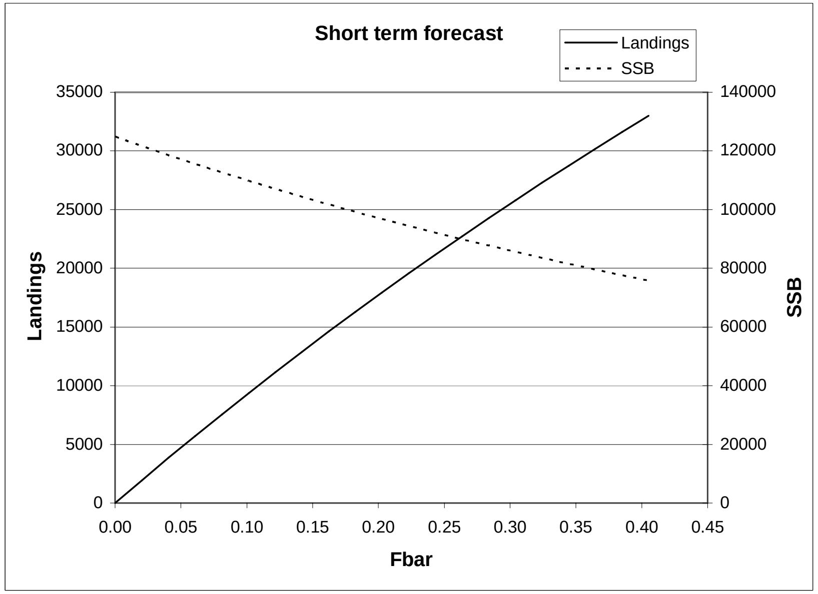


Figure 5.6.13. Herring in VIa (North). Analytical retrospective patterns of SSB, mean $F_{3\text{-}6}$ and recruitment from the assessments both including (dashed thicker line) and excluding (solid thicker line) the 2005 acoustic survey in the most recent year.





MFYPR version 2a
Run: Run1stquFwith05
Time and date: 14:56 21/03/2006

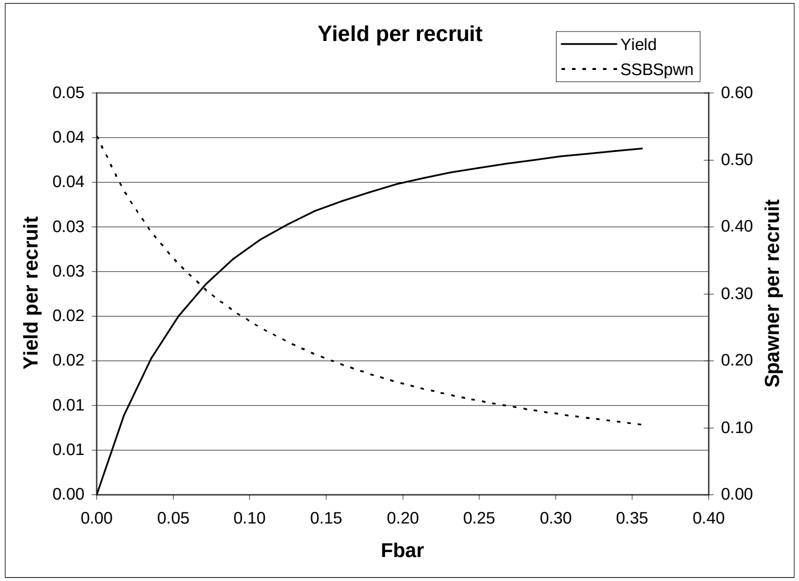
Reference point	F multiplier	Absolute F
Fbar(3-6)	1.0000	0.2027
FMax		
F0.1	0.8118	0.1645
F35%SPR	0.8342	0.1691
Flow	0.3429	0.0695
Fmed	1.2897	0.2614
Fhigh	4.1371	0.8385

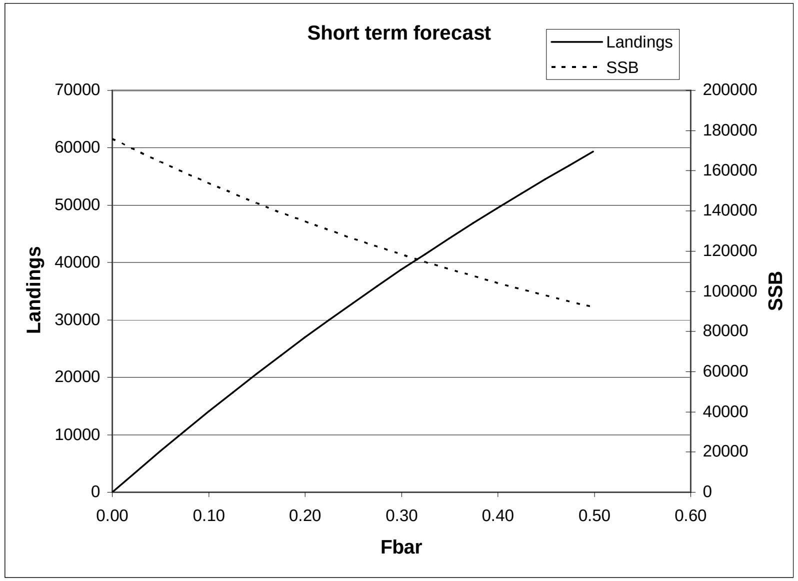
Weights in kilograms

MFDP version 1a
Run: Run1stquFwith05
Herring VIa (north) (run: ICAPGF08/I08)
Time and date: 11:16 21/03/2006
Fbar age range: 3-6

Input units are thousands and kg - output in tonnes

Figure 5.8.1.1. Herring in VIa (North). Yield-per-recruit and short-term forecast from the assessment including the 2005 acoustic survey.





MFYPR version 2a
Run: Run2AstquFNO05
Time and date: 15:01 21/03/2006

Reference point	F multiplier	Absolute F
Fbar(3-6)	1.0000	0.1188
FMax		
F0.1	1.3634	0.1620
F35%SPR	1.4190	0.1686
Flow	0.5806	0.0690
Fmed	2.2012	0.2616
Fhigh	7.1489	0.8495

Weights in kilograms

MFDP version 1a
Run: Run2AstquFNO05
Herring VIa (north) (run: ICAPGF08/I08)
Time and date: 10:50 22/03/2006
Fbar age range: 3-6

Input units are thousands and kg - output in tonnes

Figure 5.8.1.2. Herring in VIa (North). Yield-per-recruit and short-term forecast from the assessment excluding the 2005 acoustic survey

6 Herring in Divisions VIa (South) and VIIb,c

6.1 The Fishery

6.1.1 Advice and management applicable to 2005 - 2006

The TAC for this area for 2005 was 14 000 t with an increase to 15 400 t in 2006. For 2005, ICES advised that catches should not exceed 14 000 t. In 2005 ACFM considered the state of the stock to be unknown with respect to safe biological limits. Results from assessments suggest that the sharp decline in SSB may have stopped. The current SSB was unknown but thought likely to be below B_{pa} (110 000 t). For SSB to be above B_{lim} (81 000 t) there would have to have been very strong recruitment in recent years but no evidence has been found for such year classes. The recent TACs (14 000 t) are approximately 50% of the average catches taken in the 1970s when the productivity of the stock was comparable to the present. ACFM considered that if SSB is not reliably found to be increasing, further increases in catch will not be permitted, and that in the meantime, the fishery should be exploited with caution.

In 2000, the Irish North West Pelagic Management Committee was established to deal with the management of this stock. The committee has the following objectives:

- To rebuild this stock to above the B_{pa} level of 110 000 t.
- In the event of the stock remaining below this level, additional conservation measures will need to be implemented.
- In the longer term it is the policy of the committee to further rebuild the stock to the level at which it can sustain annual catches of around 25 000 t.
- Implement a closed season from March to October.
- Regulate effort further through boat quotas allocated on a weekly basis in the open season.

This committee manages the whole fishery for this stock at present, given that Ireland currently accounts for the entire catch.

6.1.2 Catches in 2005

The working group estimates of landings recorded by each country from this fishery from 1988 – 2005 are given in Table 6.1.1 Ireland is the dominant country in this fishery. Irish catch estimates for this WG have been based on the preliminary official reported data from the EU Logbook Scheme. The total catch recorded from logbooks for 2005 was almost 13 500 t, compared with about 11 000 t in 2004. The Irish catches in these areas from 1970 –2005 are shown in Figure 6.1.1. There were no estimates of discards reported for 2005 and anecdotal reports from the industry are that discarding is not a major problem in this fishery.

In September 2004 a new procedure was adopted for weighing landings and the allowance for water content was reduced from 14% to 2% therefore the catch data for 2004 are lower that previous years. It is thought that the data from 2003 and previously are directly comparable because the same water content was being adopted.

6.1.3 The fishery in 2005

The assessment period runs concurrently with the annual quota. Quotas are allocated on a fortnightly basis and there is some capacity to carry unused allocation into the following fortnight with overruns being deducted.

In 2005 the majority of catches were reported from quarters 1 and 4 in VIa S and quarter 4 in VIIbc. Catches from the third quarter were minimal and reported only from VIa south. Within VIIbc fishing took place on the coastal spawning grounds around the Mayo coast. Fishing in VIa south took place along the west and north Donegal coast and further north near the boundary with VIa north (figure 6.1.2). The majority of landings are into Killybegs. Figure 4.1.3.2 shows the distribution of Irish catches by statistical rectangle and quarter.

Approximately forty vessels participated in the fishery in 2005.

- 20 pelagic RSW tank trawlers of between 40 and 70 m in length
- 10 Polyvalent trawlers of between 22 and 40m in length
- 10 Polyvalent trawlers of less than 25m in length

The term polyvalent refers to vessels that are licensed to catch pelagic and demersal fish.

All fishing is by pair trawl. The dry hold vessels concentrate effort inshore with the larger RSW vessels also fishing further offshore. In the case of larger boats there may also be a tendency to prioritise effort for mackerel and horse mackerel and take their herring allocations opportunistically.

In quarter 1, 2005, about 5 800 t were landed. Fish caught in this quarter had a wider length distribution (20.5cm – 35.5cm) than those caught in quarter 4 (21.5cm – 31.5cm). A particular aspect of the first quarter fishery in VIa S has been the appearance of large spring spawning fish off the north coast in February. These fish are usually over 31 cm in total length (Table 6.1.1.2). Peak landings in 2005 of 7 500 t were reported in quarter 4 from VIa S and VIIb. These are the autumn spawning component of the stock.

6.2 Biological composition of the catch

6.2.1 Catch in numbers-at-age

Catch-at-age data for this fishery are available since 1970 and are shown in Table 6.2.1.1 with percentages since 1994 shown in Table 6.2.1.2. In 2005 the fishery has been dominated by 2, 3 and 4 ringers, accounting for 27%, 29% and 26% respectively. One ringers are never well represented in the catch but 2005 was the lowest in recent years. Generally it is found that 1 ringers do not show up in the catch until quarter 3. The proportions of 2, 3, and 4 ringers in 2004 accounted for 18% and 38% and 23% respectively. Overall 2005 shows a more even distribution amongst the dominant age groups.

Two winter ring fish dominated in quarter 4 while in quarter 1, dominance is shared between 3 and 4 ringers fish. Sampling data indicates that herring are fully recruited to the fishery at 3 ringers and there is little evidence for 1 ringer fish being an important component of landings in fisheries in this area.

6.2.2 Quality of the catch and biological data

The management of the Irish fishery in recent years has tightened considerably and the accuracy of reported catches is also believed to have improved. The numbers of samples and the associated biological data are shown in Table 6.2.2.1. The length distributions of the catches taken per quarter by the Irish fleet are shown in Table 6.1.1.2. Along with the need to obtain more samples from the larger RSW vessels there is also a requirement to sample the opportunistic catches that occur in VIIb. In 2004 a total of 5 samples were collected in VIIb and in 2005, 6 samples. Sampling in this fishery relies heavily on the vessels that concentrate their effort on the inshore grounds. There have been difficulties in getting samples from the larger RSW boats targeting herring opportunistically and whose landings are erratic and this might lead to the proportion of older ages being underestimated in the sample data.

6.3 Fishery Independent Information

6.3.1 Ground Fish Surveys

There are currently no recruitment indices available for this stock. However an Irish ground fish survey conducted in the area since the early 1990s regularly catches herring. This survey is of little utility as a herring recruit index, because gear, timing and survey vessel changed throughout. Prior to 2003 this survey was carried out on a number of commercial vessels. Surveys undertaken after this time were on the *RV Celtic Explorer* and may be useful, when a time series becomes available. We will also investigate the possibility of utilising data from the Scottish groundfish survey, which has some coverage of VIaS.

6.3.2 Acoustic Surveys

Results from the 2005 survey were not available for the 2005 working group and are presented here as a special case. The current series of winter spawning ground surveys began in 1999. A problem associated with the winter acoustic survey series has been synchronising the survey with the peak spawning event to ensure containment of the stock. The January 2005 survey track and SA values attributed to herring are shown in Figures 6.3.2.1 and 6.3.2.2. In the mid 1990s, surveys were carried out in summer. Details of the acoustic surveys, since 1994, in this area are presented in Table 6.3.2.1.

The 2005 survey covered an area extending from Malin Head to west of Donegal Bay, from close inshore to up to 50 nmi (nautical miles) offshore. The survey started in the south and moved in a northerly direction. There were severe storms for the first week of this survey and in addition, a breakdown kept the vessel in port for part of the survey. However this allowed for a high degree of consultation with the fishermen and the survey track was then adapted to obtain the best coverage of fish distribution.

The majority of fish recorded during the survey were mature, accounting for 73% of the biomass and 67% of the abundance. Spent fish accounted for 19% of the total biomass and of the total abundance. The fish encountered off the north Mayo coast were mostly spent with the fish further north ripe or running. This indicates that timing of the survey was good, having covered the western fish before they dispersed and the northern fish before they spawned. The proportions of older fish encountered were not as high as during the previous years survey. Older fish are considered to be the first to spawn and the lower numbers recorded could be an indication that the older fish had already spawned prior to this survey. Overall the fishing success was high with the majority (96%) of the estimate attributed to “definitely herring” traces. The greatest concentrations of herring were found on the main spawning grounds of Tory and Glen Bay (Figure 6.3.2.1 and Figure 6.3.2.2.).

In 2006, the winter acoustic survey was conducted on the same vessel at the same time of the year as 2005. The January 2006 survey track and SA values attributed to herring are shown in Figure 6.3.2.3 and Figure 6.3.2.4. The survey was started in the south and worked in a northerly direction to encompass the migrations of the spawning components contained within the survey confines. As in 2005 the majority of the herring traces (75%) were assigned as “definitely herring”. Fishing success was reasonably high with several hauls containing mostly herring. On the Mayo coast the fish were still spawning and further north the fish were spawning or pre spawning with small proportions of spent fish. The timing of the survey was the same as in 2005 but the maturity stages encountered are slightly different. A greater proportion of mature fish were found in 2005 (67%) than in 2006 (58%). This indicates that the main spawning event in 2006 was later than in 2005. This is consistent with anecdotal evidence from the demersal and shellfish sectors, which reported herring marks in the northwest area up until the end of February.

The age distribution of the abundance estimate from the acoustic survey and from the commercial fishery in 2005 is presented in Figure 6.3.2.5. The dominant ages in the acoustic survey were the 3, 4 and 5 ringers compared to 2, 3 and 4 ringers for the fishery over the whole season. When the survey age distribution is compared with that portion of the fishery that took place in the same quarter the proportions of 3 and 4 ringers is more pronounced with a lesser amount of 5 ringers. The total biomass estimate for the area surveyed in 2006 was 27 750 t with an SSB of 27 200 t. This is lower than the 2005 biomass estimate of 71 253 t and an SSB estimate of 66 138 t.

6.4 Mean weights-at-age and maturity-at-age

The mean weights (kg) at age in the catches in 2005 are based on Irish catches and are very similar to 2004 for ringers 1-6 (Table 6.4.1). These mean weights display quite a stable pattern over the time series. Data for this time series are available from 1982 onwards. Though there appears to be a slight increase in mean weights of the older ages in the past three years. The time series since 1982 is shown in Figure 6.4.4.1.

The mean weights in the stock at spawning time have been calculated from Irish samples taken during the main spawning period that extends from October to February (Table 6.4.2). As in the mean weights at age there appears to be a slight increase in older ages over the last three years. The time series since 1985 is shown in Figure 6.4.4.2.

6.5 Recruitment

There is little information on recruitment in the catch at age data and there are as yet no recruitment indices from the surveys. One ringers are considered to be immature and they do not contribute to the SSB.

6.6 Stock Assessment

6.6.1 Trends and patterns in basic data

The numbers at age from the catch and the survey have been mean standardised by year and are presented in Figure 6.6.1.1. From 1999 – 2002, in the survey time series, the dominant ages were 1-3 ringers. These surveys were undertaken in quarter four while later in the series 2003 – 2006 the surveys were carried out in quarter one. With the exception of the 2003 survey, the quarter one surveys show a different age profile with higher proportions of older fish. The 2003 survey was conducted later in the quarter after the main spawning had taken place. The surveys undertaken in the early part of quarter one target the larger spring spawners as they move inshore to spawn.

Since the mid nineties there has been a pronounced shift in the age composition of the catches from old fish to younger fish and this has been maintained in 2005, with 2, 3 and 4 ringers making up the bulk of the catch. The catch numbers at age do not suggest strong recruitment in recent years and there is no information in the survey abundance to refute this. Catch curves show the log of the catch numbers and display signals of untransformed mortality in Figure 6.6.1.2. There is a marked trend for greater mortality on cohorts from mid eighties onwards. It seems that there is greater mortality on older ages.

The log catch ratios (ln $C_{a,y}$/ $C_{a+1,y+1}$) are presented in Figure 6.6.1.2 and are smoothed with a 4-year running average to show the main trends. Data for 1-ringers are noisy because this group is not fully selected by the fishery. The data for older fish are also noisy, particularly in later years, reflecting their relative paucity in the catches and the high variability in the exploitation rates of these age groups. These show an upward trend for all fully recruited year classes since the mid nineties. Overall, the catch data show a diminishing range of ages in the catches and older fish are at their lowest levels in the time series.

Figure 6.6.1.3 shows the catch curves from fishery and the survey age data averaged over a number of years. Total mortality has displayed an upward trend since the early 1980s. Increasing mortality in recent years is clearly evident. In the late seventies mortality was at its lowest (0.3). Since 1993 mortality has shown an increase to 0.7. The survey displays a very similar mortality signal to the catch.

Following the procedure of recent years, a separable VPA was used to screen over three terminal fishing mortalities, 0.2, 0.4 and 0.6. This was achieved using the Lowestoft VPA software (Darby and Flatman, 1994). Reference age for calculation of fishing mortality was 3-6 and terminal selection was fixed at 1, relative to age 4 (winter rings).

ICA was also used with the new tuning series. Details of exploratory runs are presented in Table 6.6.1.1. This assessment is still exploratory, and no assessment has been accepted by ACFM in recent years.

Three assessments using the separable VPA are presented, based on the three choices of terminal F. The general development of the stock is presented in Figure 6.6.1.4. Last year's results are included in this figure, for comparative purposes. This figure is more informative for earlier years, but in most recent years has little information on the current stock dynamics. Outputs from separable VPAs with terminal Fs of 0.2, 0.4 and 0.6 are presented in Tables 6.6.1.2, 6.6.1.3 and 6.6.1.4 respectively. Residual plots for the three trial assessments are presented in Figure 6.6.1.5. A strong negative residual pattern can be seen in 6 ringers.

Under the two more optimistic scenarios of terminal F, the current assessment suggests declining fishing mortality since 2001. However, using a terminal F of 0.6 suggests an increase in fishing mortality in 2005. This is consistent with the results from this assessment last year. The landings have been declining slightly since 2000, and this may provide evidence that terminal Fs in the range 0.2 to 0.4 are more realistic.

Recruitment appears to have remained stable at a low level, under the more pessimistic scenarios, or increased very slightly. Recruitment in the final year is calculated using the geometric mean of the recruitment index over the entire time series and these explorations are only useful as indicators of historic trends. These results are consistent with the preliminary data screening that shows no stronger year classes in the fishery in recent years. However these 1-ringer fish are poorly selected in the fishery and thus there is little information in the catch at age matrix on their strength in the final year.

SSB is either stable at a low level or declining slightly, assuming terminal F of 0.6 and possibly increasing at F values of 0.2 or 0.4. If SSB is stable, it is stable at the lowest level in the series. It is considerably lower than the current levels of Bpa and Blim.

In 2006 the survey series was used to tune the data in ICA for the first time. The data were screened using a range of terminal selection values (0.9, 1.0, and 1.1) and also including and excluding age classes and years. Splitting of the survey time series was also investigated. This involved using the 1999-2003 surveys in one series and the remaining 2004 – 2006 surveys in another. The number of ages used to tune the assessment was also reduced to 3 and 4 ringers only.

Results of recruitment, SSB and mean F from the initial ICA runs are presented in Figures 6.6.1.6. The pattern of recruitment is very similar using each terminal selection value. However a more pronounced peak in recruitment in 2004 is evident using selection values of 0.9 and 1.1. This peak is not evident in the results of the separable VPA. The plots of SSB and mean F do not show any distinct differences.

The 95% confidence intervals around F are presented for these ICA runs in Figure 6.6.1.7. Using terminal selection values of 1.0, 0.9 and 1.1, there are no difference in F and selection. When the number of ages used to tune the data is reduced to 3 and 4 ringers there is a shift upwards in F but no change in selectivity. Splitting the surveys produces poor parameter fit to F in later series because of the lack of points with only three surveys included.

The selection patterns using different terminal selection values and using the survey series as one or splitting it are shown in Figure 6.6.1.8. Under each scenario the selection pattern remained the same. Screening over a range of terminal selection values suggests that there may be a dome shaped pattern. All of the values are with the 95% confidence intervals but the possibility that there could be a plateau cannot be discounted.

The residual patterns from the separable period using a range of terminal selection values shows some slight variation in the magnitude of the residuals but the pattern of positives and negatives remains constant (Figure 6.6.1.9). Changing the terminal selection in each case does not have a significant impact.

Comparisons were made between using the survey as one series, splitting it in two and the sVPA using the median value of terminal F =0.4 (Figure 6.6.1.10). The recruitment shows a sharp rise in 2004 when the survey time series is kept as one. When the time series is split in two, the recruitment values are more similar to those indicated by the sVPA. It is considered to be more meaningful to split the series because the selection in the survey changed in 2003. The geometric mean of recruitment replaces estimated recruitment in the terminal year.

Varying levels of SSB can be seen using the three scenarios. SSB appears to be remaining stable at a low level using the series split and the separable VPA. An upward trend is evident when the series remains as one (Figure 6.6.1.10). In each case declining trends in F are visible but the trend is most pronounced when the survey series are treated as one. The use of the separable VPA suggests a slight levelling off of F in the terminal year.

Age structured index residuals from the split survey series are shown in Table 6.6.1.5. Strong year effects are evident. This is as expected given that there are only two age classes present.

Scatter plots were produced, plotting F and SSB in the terminal year to present the precision of the different sets of assessment runs. Figure 6.6.1.11 shows the assessment run with different values for terminal selection. The plot illustrates very poor precision between the data and the model. Figure 6.6.1.12 displays the assessments using the survey as one series or split into two. This plot shows that splitting the survey series gives a greater range of F values and a slightly lower SSB range which is more noisy that with one survey series.

6.7 Short term projections

In the absence of an agreed assessment, it was not considered informative to carry out any predictions.

6.8 Medium term projections

Yield-per-recruit analysis were carried out using MFYPR to provide yield-per-recruit plots for the data produced in the assessment run where the survey series was split and only 3 and 4 ringers were included. This run was considered to be closest to the sVPA runs. Results of this analysis are presented in Figure 6.8.1.The values for $\mathbf{F}_{0.1}$ and $\mathbf{F}_{med}$ are 0.17 and 0.31 respectively. F_{max} is undefined and this is consistent with many other pelagic species.

6.9 Precautionary and yield based reference points

As this assessment is still uncertain there was no revision of the precautionary reference points. The precautionary reference points for this stock were discussed in the 1999 Working Group Report (ICES 1999 ACFM:12). The present analysis, although uncertain, presents a similar picture of the stock as that shown in recent years. The SGPRP (ICES 2003/ACFM: 15) has reviewed the methodology for the calculation of biological reference points, and applying a segmented regression to the stock and recruit data from the 2002 HAWG assessment showed that the fit to the stock and recruit data for this stock was not significant. The stock is still likely below Bpa (110 000 t) but the fishing mortality has been reduced, since 1998

6.10 Quality of the Assessment

No assessment was conducted.

6.11 Management Considerations

The results of the non-tuned assessment suggest that the sharp decline in SSB may have stopped but the current level of SSB is uncertain. Tuning the assessment using the survey series split in two, 1999 – 2003 and 2004 – 2006 agrees with this. There is no evidence that large year classes have recruited to the stock in recent years and F appears to have been reduced due to the decrease in catch. The management of the Irish fishery (which takes most of the catch) has improved in recent years and catches have been considerably reduced since 1999. The reduced catches over this period have resulted in a reduction in fishing mortality, although it is not possible to be precise about the current levels.

SSB may be stable at an historic low level or declining slightly. Though the peak in SSB in the 1980s may have been an isolated event the HAWG suggests that this stock should be exploited with great caution. F appears to have been substantially reduced since 1998. Though little information on recruitment is available, it is unlikely that it is above average. Certainly every effort should be taken to maintain catches at or below the current level. In particular the HAWG commends the tight enforcement of catch quotas, and this should be continued and if necessary intensified.

The opportunistic nature of the fishery means that there is a lack of information in the data and this impedes the provision of more accurate perceptions of stock status. There are essentially two fleets exploiting this stock, the smaller dry hold vessels tend to target the stock more than the larger boats. The HAWG notes that increased accuracy in the catch data over the past 3 years gives a greater confidence in the perception of stock development. It will be necessary to collect biological data from each fleet separately, in order to refine the information from catch at age data.

Table 6.1.1 VIa(S) and VIIb,c. Estimated Herring catches in tonnes, 1988–2005. 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	1994	1995	1996	1997
France		-	-	+	-	-	-	-	-	-	-
Germany, Fed.Rep.		-	-	-	-	250	-	-	11	-	-
Ireland		15,000	18,200	25,000	22,500	26,000	27,600	24,400	25,450	23,800	24,400
Netherlands		300	2,900	2,533	600	900	2,500	2,500	1,207	1,800	3,400
UK (N.Ireland)		-	-	80	-	-	-	-	-	-	-
UK (England + Wales)		-	-	-	-	-	-	50	24	-	-
UK Scotland		-	+	-	+	-	200	-	-	-	-
Unallocated/ misreported	area	13,800	7,100	13,826	11,200	4,600	6,250	6,250	1,100	6,900	-700
Total landings		29,100	28,200	41,439	34,300	31,750	36,550	33,200	27,792	32,500	27,100
Discards		-	1,000	2,530	3,400	100	250	700	-	-	50
Total catch		29,100	29,200	43,969	37,700	31,850	36,800	33,900	27,792	32,500	27,150

Country		1998	1999	2000	2001	2002	2003	2004	2005
France		-	-	-	-	515	-	-	-
Germany, Fed.Rep.		-	-	-	-	-	-	-	-
Ireland		25,200	16,325	10,164	11,278	13,072	12,921	10,950	13,351
Netherlands		2,500	1,868	1,234	2,088	366	-	64	-
UK (N.Ireland)		-	-	-	-	-	-	-	-
UK (England + Wales)		-	-	-	-	-	-	-	-
UK Scotland		-	-	-	-	-	-	-	-
Unallocated/ misreported	area	11,200	7,916	3,607	695	366	-	+1375	-
Total landings		38,900	26,109	15,005	14,060	13,587	12,921	12,289	13,351
Discards		-	-	-	-	-	-	-	-
Total catch		38,900	26,109	15,005	14,060	13,587	12,921	12,289	13,351

Table 6.1.1.2. VIa(S) and VIIb,c herring. Length distribution of Irish catches/quarter (thousands) 2005.

Length cm	Quarter 1	Quarter 1	Quarter 4	Quarter 4
	VIa South	VIIbc	VIa South	VIIbc
19.5				
20				
20.5	19	13		
21	56	26		
21.5	150	13		23
22	356		37	0
22.5	318	13	99	69
23	374	13	198	104
23.5	206	0	754	289
24	599	53	2002	681
24.5	1011	171	3212	1108
25	1872	237	4485	1316
25.5	3070	264	4386	1166
26	6084	356	4819	1258
26.5	5466	198	4473	1247
27	5092	119	4967	1224
27.5	3800	26	3484	1212
28	2939		2125	727
28.5	2153	13	655	427
29	1273	13	334	185
29.5	468		235	58
30	337		99	12
30.5	225		49	12
31	56			12
31.5	112			
32	56		12	
32.5	94			
33	37			
33.5	94			
34	75			
34.5	56			
35	37			
35.5	19			
36				
Nos./t	6623	6451	6275	6547

Table 6.2.1.1 VIa(S) & VIIb,c herring. Catch in numbers-at-age (winter rings) from 1970 to 2005.

	1	2	3	4	5	6	7	8	9+
1970	135	35114	26007	13243	3895	40181	2982	1667	1911
1971	883	6177	7038	10856	8826	3938	40553	2286	2160
1972	1001	28786	20534	6191	11145	10057	4243	47182	4305
1973	6423	40390	47389	16863	7432	12383	9191	1969	50980
1974	3374	29406	41116	44579	17857	8882	10901	10272	30549
1975	7360	41308	25117	29192	23718	10703	5909	9378	32029
1976	16613	29011	37512	26544	25317	15000	5208	3596	15703
1977	4485	44512	13396	17176	12209	9924	5534	1360	4150
1978	10170	40320	27079	13308	10685	5356	4270	3638	3324
1979	5919	50071	19161	19969	9349	8422	5443	4423	4090
1980	2856	40058	64946	25140	22126	7748	6946	4344	5334
1981	1620	22265	41794	31460	12812	12746	3461	2735	5220
1982	748	18136	17004	28220	18280	8121	4089	3249	2875
1983	1517	43688	49534	25316	31782	18320	6695	3329	4251
1984	2794	81481	28660	17854	7190	12836	5974	2008	4020
1985	9606	15143	67355	12756	11241	7638	9185	7587	2168
1986	918	27110	24818	66383	14644	7988	5696	5422	2127
1987	12149	44160	80213	41504	99222	15226	12639	6082	10187
1988	0	29135	46300	41008	23381	45692	6946	2482	1964
1989	2241	6919	78842	26149	21481	15008	24917	4213	3036
1990	878	24977	19500	151978	24362	20164	16314	8184	1130
1991	675	34437	27810	12420	100444	17921	14865	11311	7660
1992	2592	15519	42532	26839	12565	73307	8535	8203	6286
1993	191	20562	22666	41967	23379	13547	67265	7671	6013
1994	11709	56156	31225	16877	21772	13644	8597	31729	10093
1995	284	34471	35414	18617	19133	16081	5749	8585	14215
1996	4776	24424	69307	31128	9842	15314	8158	12463	6472
1997	7458	56329	25946	38742	14583	5977	8351	3418	4264
1998	7437	72777	80612	38326	30165	9138	5282	3434	2942
1999	2392	51254	61329	34901	10092	5887	1880	1086	949
2000	3101	26133	29430	23216	10090	2068	1107	522	1211
2001	2207	20694	20754	16707	17581	9484	1659	979	484
2002	3093	24878	28772	14392	8859	7786	2094	1223	491
2003	1364	25916	22624	19006	7410	4069	1983	726	238
2004	1254	13538	29536	17654	8063	4408	1385	873	289
2005	172	23133	25414	22116	8862	4485	1109	706	200

Table 6.2.1.2 VIa(S) & VIIb,c herring. Percentage age composition (winter rings).

	1	2	3	4	5	6	7	8	9
1994	6	28	15	8	11	7	4	16	5
1995	0	23	23	12	13	11	4	6	9
1996	3	13	38	17	5	8	4	7	4
1997	5	34	16	23	9	4	5	2	3
1998	3	29	32	15	12	4	2	1	1
1999	1	30	36	21	6	3	1	1	1
2000	3	27	30	24	10	2	1	1	1
2001	2	23	23	18	19	10	2	1	1
2002	3	27	31	16	10	9	2	1	1
2003	2	31	27	23	9	5	2	1	0
2004	2	18	38	23	10	6	2	1	0
2005	0	27	29	26	10	5	1	1	0

Table 6.2.2.1 VIa(S) and VIIb,c herring sampling intensity of catches in 2005.

ICES area	Year	Quarter	Landings (t)	No. Samples	No. aged	No. Measured	Aged/1000 t
VIIbc	2005	1	237	1	45	116	190
VIIbc	2005	4	1700	5	290	964	171
VIa south	2005	1	5512	11	698	1950	127
	2005	3	97	0	0	0	0
	2005	4	5805	15	816	2948	141
Total overall			13350	32	1849	5978	138

Table 6.3.2.1. VIa(S) & VIIb,c herring. Details of acoustic surveys of herring in VIaS and VIIbc, 1994– 2006.

Year	Type	Biomass	SSB
1994	Feeding phase	-	353,772
1995	Feeding phase	137,670	125,800
1996	Feeding phase	34,290	12,550
1997	-	-	-
1998	-	-	-
1999	Autumn spawners	23,762	22,788
2000	Autumn spawners	21,000	20,500
2001	Autumn spawners	11,100	9,800
2002	Winter spawners	8,900	7,200
2003	Winter spawners	10,300	9,500
2004	Winter spawners	41,700	41,399
2005	Winter spawners	71,253	66,138
2006	Winter spawners	27,770	27,200

Table 6.3.2.2. VIa(S) & VIIb,c herring. Time series of acoustic surveys since 1999.

Winter rings	1999	2000	2001	2002	2003	2004	2005	2006
0	-	-	5	0	-	0.09	1.28	0
1	18.99	10.71	22.69	35.7	10.28		7.83	1.6
2	104.77	60.88	52.33	14.05	26.26	3.9	56.91	6.9
3	32.53	48.96	6.41	24.23	30.02	62.35	93.51	86.7
4	11.34	25.57	6.47	14	11.08	54.93	109.87	57.5
5	1.65	9.43	2.63	5.79	2.94	80.07	100.8	27.9
6	0.94	2.35	1.94	5.7	0.64	47.14	56.54	16
7	0.3	1.28	0.12	5.06	0.94	13.81	21.16	4.8
8	0.17	0.43	0.24	2.73	0.3	11.77	24.64	4.8
9+	0.11	0.75	0.07	4.07	0.14	-	12.74	1.3
Abundance (millions)	170.8	160.36	97.9	111.33	82.6	274.06	485.29	202.9
Total Biomass (t)	23,762	21,048	11,062	8,867	10,300	41,700	71,253	27,770
SSB (t)	22,788	20,500	9,800	6,978	9,500	41,300	66,138	27,200

Table 6.4.1 VIa(S) & VIIb,c herring. Mean weight-at-age (winter rings) in the catch, 1970 to 2005.

	1	2	3	4	5	6	7	8	9+
1970	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1971	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1972	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1973	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1974	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1975	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1976	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1977	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1978	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1979	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1980	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1981	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1982	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1983	0.090	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1984	0.106	0.141	0.181	0.210	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	0.230
1986	0.095	0.138	0.164	0.194	0.212	0.225	0.239	0.208	0.288
1987	0.085	0.102	0.150	0.169	0.177	0.193	0.205	0.215	0.220
1988	-	0.098	0.133	0.153	0.166	0.171	0.183	0.191	0.201
1989	0.080	0.130	0.141	0.164	0.174	0.183	0.192	0.193	0.203
1990	0.094	0.138	0.148	0.160	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	0.230
1992	0.095	0.141	0.147	0.157	0.165	0.171	0.180	0.194	0.219
1993	0.112	0.138	0.153	0.170	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	0.220
1995	0.080	0.140	0.161	0.173	0.182	0.198	0.194	0.206	0.217
1996	0.085	0.135	0.172	0.182	0.199	0.209	0.220	0.233	0.237
1997	0.093	0.135	0.155	0.181	0.201	0.217	0.217	0.231	0.239
1998	0.095	0.136	0.145	0.173	0.191	0.196	0.202	0.222	0.217
1999	0.106	0.144	0.145	0.163	0.186	0.195	0.200	0.216	0.222
2000	0.102	0.129	0.154	0.172	0.180	0.184	0.204	0.203	0.204
2001	0.086	0.122	0.139	0.167	0.183	0.188	0.222	0.222	0.213
2002	0.097	0.127	0.140	0.155	0.175	0.196	0.204	0.218	0.226
2003	0.102	0.134	0.150	0.167	0.183	0.196	0.216	0.210	0.228
2004	0.085	0.140	0.150	0.167	0.182	0.193	0.222	0.221	0.285
2005	0.105	0.135	0.150	0.162	0.174	0.188	0.200	0.237	0.296

Table 6.4.2 VIa(S) & VIIb,c herring. Mean weight at age (winter rings) in the stock 1970 to 2005.

	1	2	3	4	5	6	7	8	9+
1970	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1971	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1972	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1973	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1974	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1975	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1976	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1977	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1978	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1979	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1980	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1981	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1982	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1983	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1984	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1985	0.100	0.150	0.196	0.227	0.238	0.251	0.252	0.269	0.284
1986	0.098	0.169	0.209	0.238	0.256	0.276	0.280	0.287	0.312
1987	0.097	0.164	0.206	0.233	0.252	0.271	0.280	0.296	0.317
1988	0.097	0.164	0.206	0.233	0.252	0.271	0.280	0.296	0.317
1989	0.138	0.157	0.168	0.182	0.200	0.217	0.227	0.238	0.245
1990	0.113	0.152	0.170	0.180	0.200	0.217	0.225	0.233	0.255
1991	0.102	0.149	0.174	0.190	0.195	0.206	0.226	0.236	0.248
1992	0.102	0.144	0.167	0.182	0.194	0.197	0.214	0.218	0.242
1993	0.118	0.166	0.196	0.205	0.214	0.220	0.223	0.242	0.258
1994	0.098	0.156	0.192	0.209	0.216	0.223	0.226	0.230	0.247
1995	0.090	0.144	0.181	0.203	0.217	0.226	0.227	0.239	0.246
1996	0.086	0.137	0.186	0.206	0.219	0.234	0.233	0.249	0.253
1997	0.094	0.135	0.169	0.194	0.210	0.224	0.231	0.230	0.239
1998	0.095	0.136	0.145	0.173	0.191	0.196	0.202	0.222	0.217
1999	0.104	0.145	0.154	0.174	0.200	0.222	0.230	0.240	0.246
2000	0.100	0.134	0.157	0.177	0.197	0.207	0.217	0.230	0.245
2001	0.091	0.125	0.150	0.172	0.191	0.200	0.203	0.203	0.216
2002	0.092	0.127	0.146	0.170	0.190	0.201	0.210	0.227	0.229
2003	0.094	0.131	0.155	0.175	0.192	0.203	0.232	0.222	0.243
2004	0.081	0.133	0.151	0.175	0.194	0.207	0.238	0.233	0.276
2005	0.095	0.127	0.15	0.172	0.185	0.196	0.223	0.234	0.274

Table 6.6.1.1. VIa(S) and VIIb,c herring assessment runs preformed

Run	Model	Terminal F	Terminal S	2005 survey	Ages Included
1	Separable VPA	0.2	1	-	-
2	Separable VPA	0.4	1	-	-
3	Separable VPA	0.6	1	-	-
4	Separable VPA	0.2	1	-	-
7	Separable VPA	0.2	0.9	-	-
8	Separable VPA	0.4	0.9	-	-
9	Separable VPA	0.6	0.9	-	-
10	ICA	-	1	Yes	All ages
11	ICA	-	0.9	Yes	All ages
12	ICA	-	1.1	Yes	All ages
13	ICA	-	1	Yes	Ages 2 -8
14	ICA	-	1	No	Ages 2 -8
15	ICA	-	0.9	yes	All ages
16	ICA	-	0.9	Yes	Ages 3 and 4
17	ICA	-	0.9	Yes	Ages 3 and 4

Table 6.6.1.2. VIa(S) and VIIb,c herring VPA run with a terminal F value of 0.2

Traditional vpa Terminal populations from weighted Separable populations

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 3- 6
1970	417284	220147	142899	20306	0.1421	0.8968	0.1643
1971	833995	243361	130297	15044	0.1155	0.8707	0.1456
1972	751358	256099	137501	23474	0.1707	0.8975	0.1897
1973	550599	311106	189592	36719	0.1937	1.0162	0.2714
1974	609927	230504	111472	36589	0.3282	0.9762	0.4252
1975	424785	224093	116542	38764	0.3326	1.1237	0.4041
1976	719600	213220	83087	32767	0.3944	1.0472	0.4625
1977	607093	202179	91924	20567	0.2237	1.0778	0.2905
1978	1090619	253218	90257	19715	0.2184	1.0161	0.2394
1979	1028416	294166	123355	22608	0.1833	1.0664	0.2452
1980	556290	236561	125257	30124	0.2405	0.9636	0.3542
1981	714361	257449	129795	24922	0.192	1.0312	0.2769
1982	729107	257400	133289	19209	0.1441	1.0301	0.2028
1983	2447463	473310	131099	32988	0.2516	1.0042	0.3306
1984	1003027	385199	210899	27450	0.1302	0.9688	0.1866
1985	1293462	378095	202855	23343	0.1151	0.9846	0.1564
1986	981854	396953	244982	28785	0.1175	1.0002	0.1625
1987	3377298	598391	212333	48600	0.2289	0.9488	0.3151
1988	484074	456037	325329	29100	0.0894	0.9992	0.2453
1989	723295	396830	242545	29210	0.1204	1.001	0.1666
1990	817407	360116	210570	43969	0.2088	1.0006	0.2411
1991	504138	282862	180081	37700	0.2094	0.9971	0.2289
1992	416287	228233	144372	31856	0.2207	0.9951	0.2639
1993	615766	240073	121946	36763	0.3015	1.006	0.3487
1994	800559	221488	102907	33908	0.3295	0.998	0.3559
1995	454458	164075	84959	27792	0.3271	1.0525	0.4603
1996	814011	168518	63111	32534	0.5155	0.9955	0.581
1997	774602	167797	63733	27225	0.4272	1.0016	0.5369
1998	473591	133789	49553	38895	0.7849	0.9988	1.0533
1999	342787	103150	39593	26109	0.6594	1.0018	0.7558
2000	416919	92635	34291	15005	0.4376	1.0011	0.4373
2001	446619	89273	32529	14061	0.4323	0.9988	0.6326
2002	634799	109032	34561	13587	0.3931	0.9991	0.5367
2003	509618	112154	46570	12921	0.2775	1.002	0.4265
2004	648901	122004	52189	12289	0.2355	1.0006	0.3537
2005	**695364***	86049	60362	13351	0.2212	0.9986	0.2737
Arith.	* **geometric mean**						
Mean	780158	249044	124907	27174	.2754		.3534
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

Table 6.6.1.3. VIa(S) and VIIbc herring VPA run using a terminal F or 0.4

Traditional vpa Terminal populations from weighted Separable populations

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 3- 6
1970	418057	221093	143697	20306	0.1413	0.8968	0.1633
1971	835788	244306	130999	15044	0.1148	0.8707	0.1446
1972	753314	257140	138267	23474	0.1698	0.8975	0.1888
1973	552276	313145	191294	36719	0.192	1.0162	0.2702
1974	611809	231617	112302	36589	0.3258	0.9762	0.4232
1975	426498	225318	117468	38764	0.33	1.1237	0.4017
1976	722957	214400	83790	32767	0.3911	1.0472	0.4591
1977	610121	203444	92713	20567	0.2218	1.0778	0.2879
1978	1097005	254903	91075	19715	0.2165	1.0161	0.2374
1979	1035977	296382	124469	22608	0.1816	1.0664	0.2429
1980	560380	238485	126552	30124	0.238	0.9636	0.3505
1981	718951	259736	131353	24922	0.1897	1.0312	0.2733
1982	733789	259728	134883	19209	0.1424	1.0301	0.2002
1983	2462987	477146	132902	32988	0.2482	1.0042	0.3263
1984	1008621	388523	213280	27450	0.1287	0.9688	0.1842
1985	1298992	381031	205011	23343	0.1139	0.9846	0.1545
1986	984923	399864	247369	28785	0.1164	1.0002	0.1607
1987	3384194	601420	214555	48600	0.2265	0.9488	0.3119
1988	484601	458603	327631	29100	0.0888	0.9992	0.243
1989	723760	398681	244199	29210	0.1196	1.001	0.1654
1990	817455	361621	211973	43969	0.2074	1.0006	0.2398
1991	503875	283809	180996	37700	0.2083	0.9971	0.228
1992	415928	228909	145044	31856	0.2196	0.9951	0.2634
1993	615151	240467	122392	36763	0.3004	1.006	0.3484
1994	799092	221636	103187	33908	0.3286	0.998	0.356
1995	452152	163787	84907	27792	0.3273	1.0525	0.4609
1996	807872	167776	62924	32534	0.517	0.9955	0.5826
1997	763009	166184	63280	27225	0.4302	1.0016	0.54
1998	460883	131568	48649	38895	0.7995	0.9988	1.0686
1999	322190	99406	38160	26109	0.6842	1.0018	0.7822
2000	372123	85689	32107	15005	0.4673	1.0011	0.4625
2001	363976	77579	28837	14061	0.4876	0.9988	0.7005
2002	453089	84702	27879	13587	0.4874	0.9991	0.6425
2003	313786	77731	32727	12921	0.3948	1.002	0.5728
2004	341909	73280	31277	12289	0.3929	1.0006	0.565
2005	**660137***	46982	29279	13351	0.456	0.9986	0.5417
Arith.	***Geometric mean**						
Mean	757182	245447	123540	27174	.2946		.3762
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

Table 6.6.1.4 VIa(S) and VIIb,c herring VPA run using a terminal F or 0.6

Traditional vpa Terminal populations from weighted Separable populations

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 3- 6
1970	418576	221711	144217	20306	0.1408	0.8968	0.1627
1971	836989	244932	131464	15044	0.1144	0.8707	0.144
1972	754596	257831	138777	23474	0.1691	0.8975	0.1881
1973	553373	314453	192383	36719	0.1909	1.0162	0.2694
1974	613047	232337	112837	36589	0.3243	0.9762	0.4219
1975	427632	226120	118071	38764	0.3283	1.1237	0.4001
1976	725138	215174	84254	32767	0.3889	1.0472	0.4568
1977	612103	204276	93234	20567	0.2206	1.0778	0.2863
1978	1101216	256012	91612	19715	0.2152	1.0161	0.2361
1979	1040930	297836	125200	22608	0.1806	1.0664	0.2414
1980	563056	239746	127401	30124	0.2364	0.9636	0.3482
1981	721999	261240	132375	24922	0.1883	1.0312	0.2711
1982	736893	261262	135930	19209	0.1413	1.0301	0.1985
1983	2473102	479657	134086	32988	0.246	1.0042	0.3236
1984	1012286	390702	214841	27450	0.1278	0.9688	0.1826
1985	1302689	382964	206426	23343	0.1131	0.9846	0.1532
1986	986975	401780	248937	28785	0.1156	1.0002	0.1595
1987	3388922	603430	216017	48600	0.225	0.9488	0.3098
1988	484984	460308	329158	29100	0.0884	0.9992	0.2415
1989	724165	399924	245297	29210	0.1191	1.001	0.1646
1990	817629	362641	212909	43969	0.2065	1.0006	0.2389
1991	503830	284469	181619	37700	0.2076	0.9971	0.2273
1992	415825	229398	145513	31856	0.2189	0.9951	0.263
1993	614952	240788	122718	36763	0.2996	1.006	0.3481
1994	798598	221824	103412	33908	0.3279	0.998	0.3558
1995	451378	163731	84928	27792	0.3272	1.0525	0.4609
1996	805826	167551	62884	32534	0.5174	0.9955	0.5831
1997	759175	165663	63144	27225	0.4312	1.0016	0.541
1998	456684	130836	48352	38895	0.8044	0.9988	1.0737
1999	315587	98189	37685	26109	0.6928	1.0018	0.7915
2000	357902	83461	31392	15005	0.478	1.0011	0.4715
2001	336869	73767	27641	14061	0.5087	0.9988	0.7265
2002	392660	76666	25696	13587	0.5288	0.9991	0.6872
2003	248562	66329	28152	12921	0.459	1.002	0.6453
2004	243469	57426	24314	12289	0.5054	1.0006	0.7033
2005	**644892***	34359	18968	13351	0.7039	0.9986	0.8057
Arith.	***Geometric mean**						
Mean	750467	244689	123384	27174	.3081		.3912

Table 6.6.1.5: VIa(S) and VIIb,c herring – age structured index residuals from the split survey series, with q, cv and standard error.

Series one

	1999	2000	2001	2002	2003	q	cv	- se	+ se
3	-0.023	0.761	-1.057	0.125	0.194	0.00048	21	0.0005	0.0007
4	-0.209	0.352	-0.523	0.451	-0.071	0.00048	21	0.0005	0.0007

Series two

	2004	2005	2006	q	cv	- se	+ se
3	-0.2992	0.3527	-0.0535	0.00077	50	0.0008	0.0021
4	-0.0619	0.2479	-0.1859	0.00131	50	0.0013	0.0036

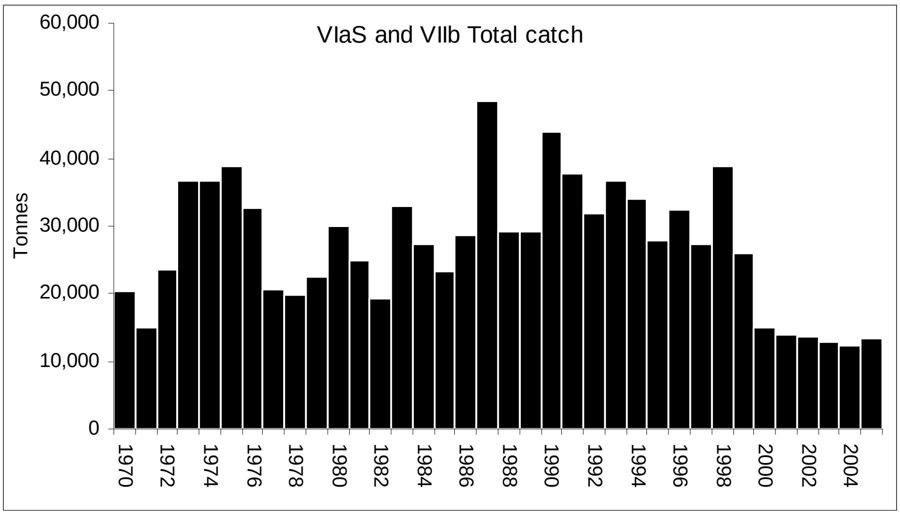


Figure 6.1.1 VIa(S) & VIIb,c herring catches from 1970-2005

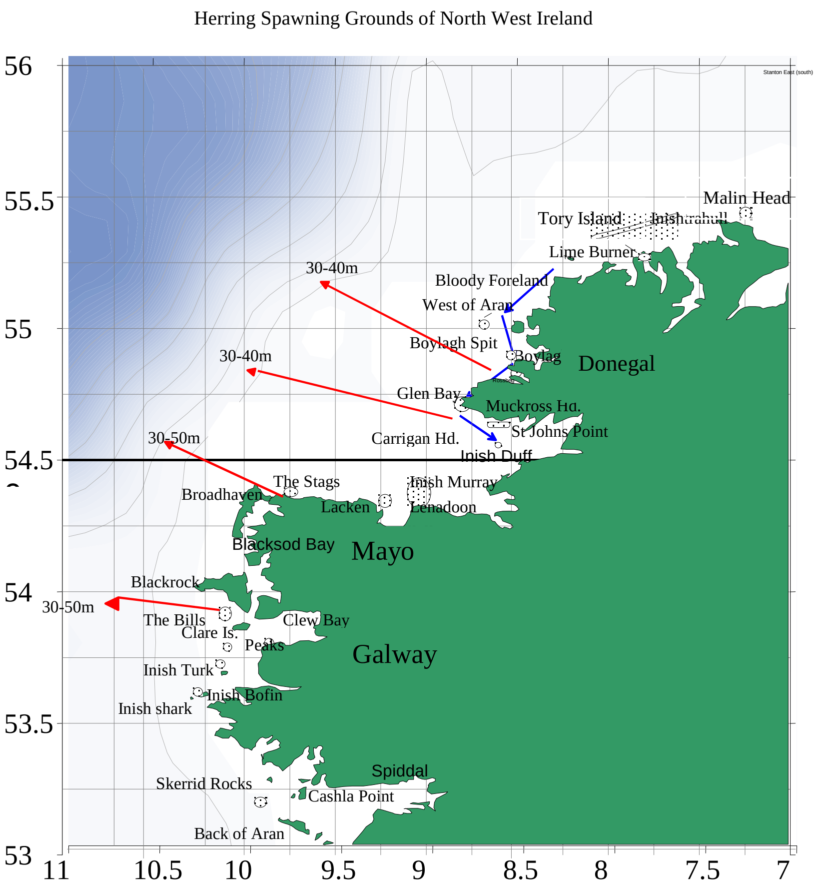


Figure 6.1.2. Northwest coast herring spawning grounds with arrows showing industry perceptions of herring movements.

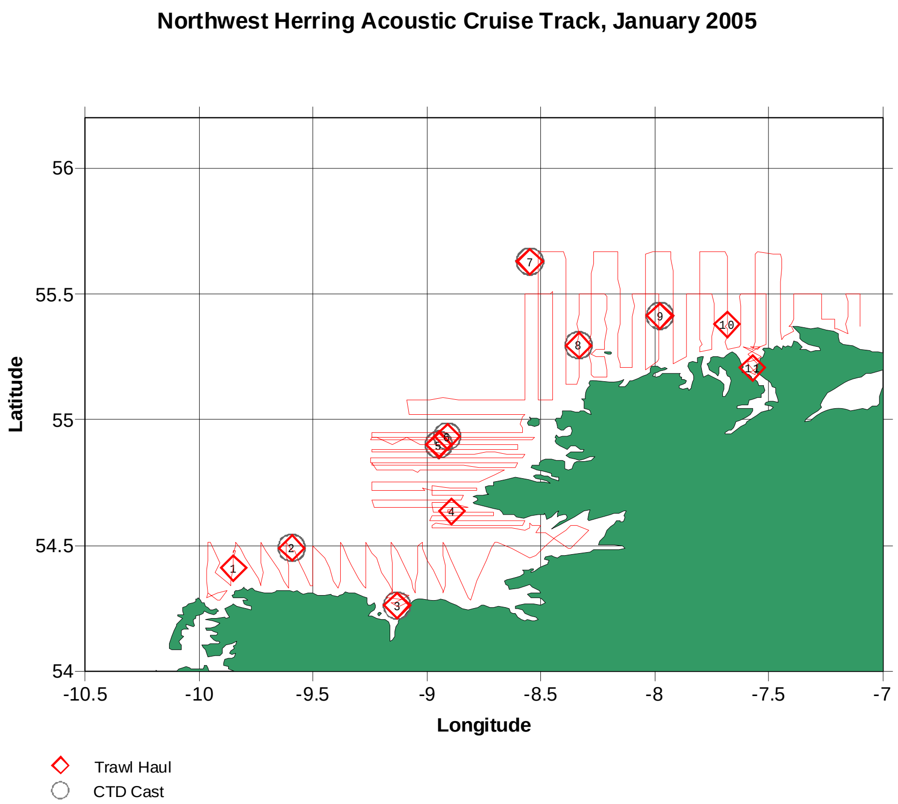


Figure 6.3.2.1 VIa(S) & Division VIIb,c herring. Cruise track and trawl positions during the 2005 northwest herring survey.

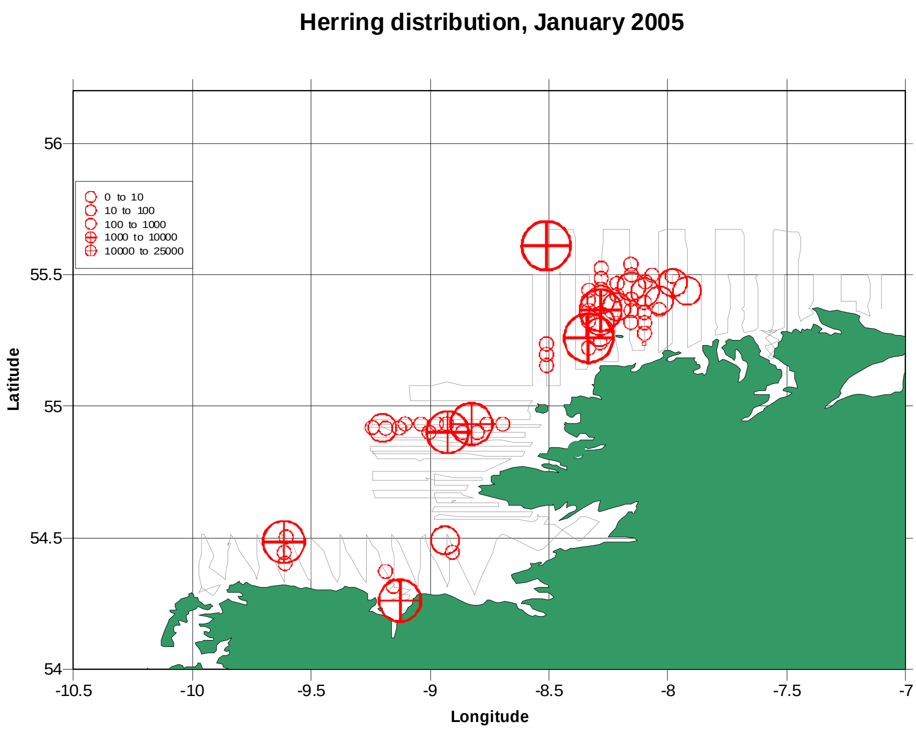


Figure 6.3.2.2 VIa(S) & Division VIIb,c herring. Post plot showing the distribution of total herring SA values obtained during the 2005 northwest herring acoustic survey.

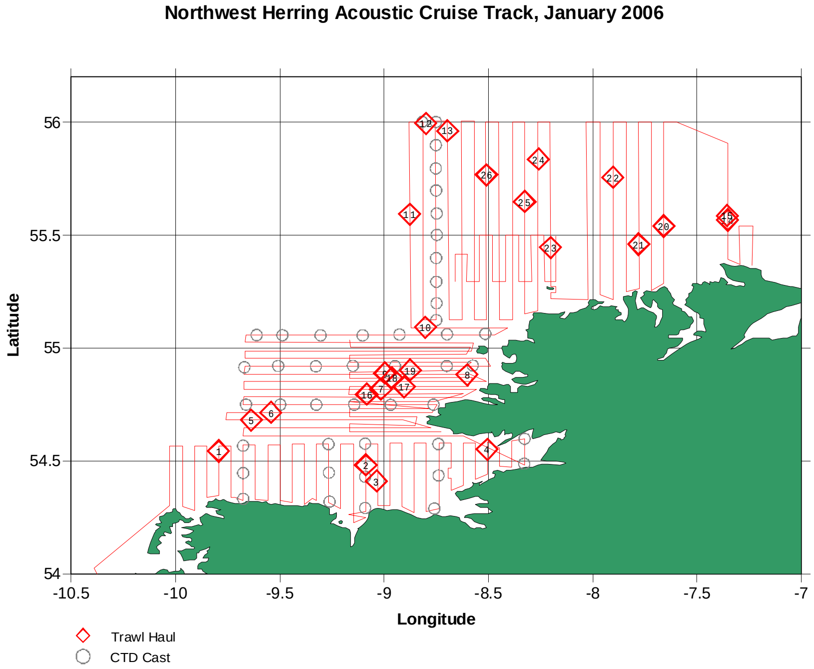


Figure 6.3.2.3 VIa(S) & Division VIIb,c herring. Cruise track and trawl positions during the 2006 northwest herring survey.

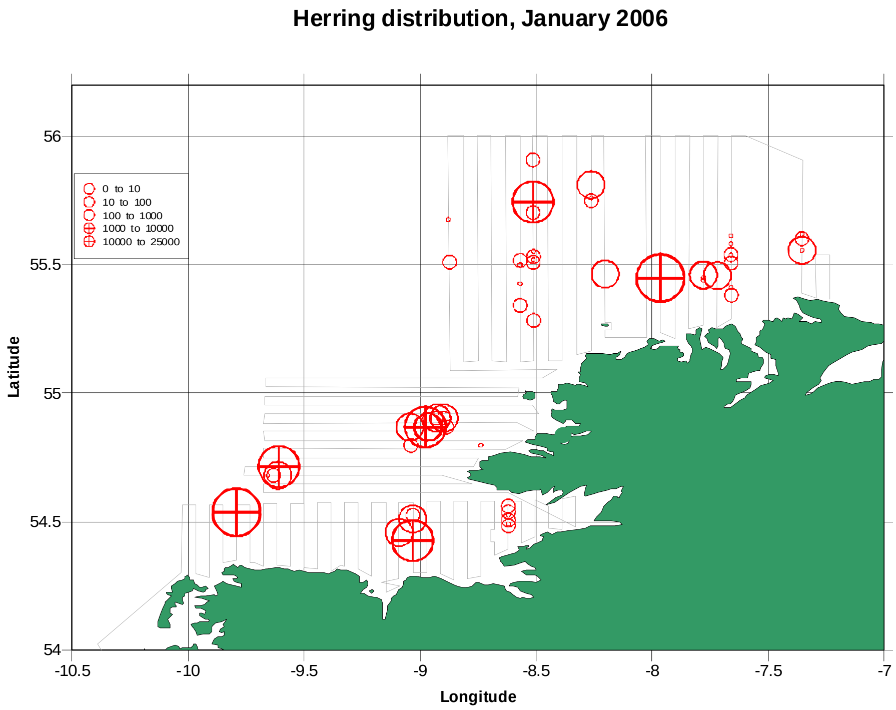
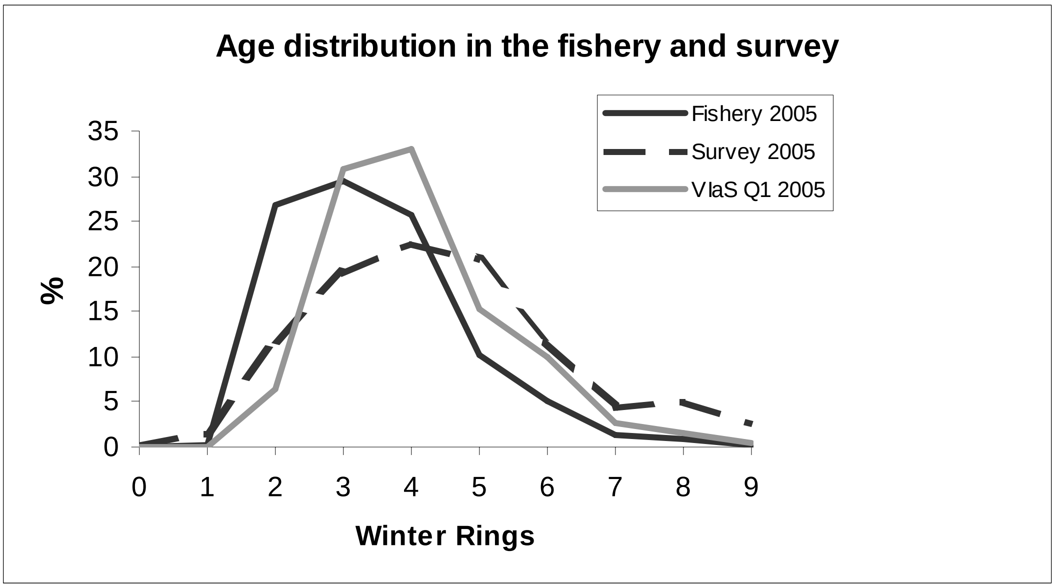


Figure 6.3.2.4 VIa(S) & Division VIIb,c herring. Post plot showing the distribution of total herring SA values obtained during the 2006 Irish northwest herring acoustic survey.



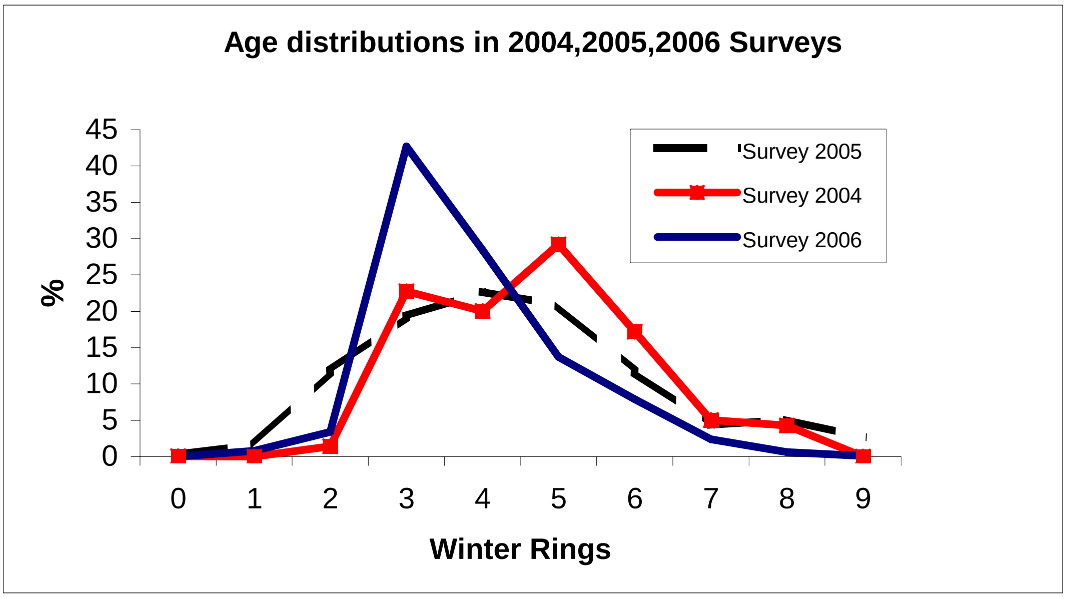


Figure 6.3.2.5. VIa(S) & Division VIIb,c herring. Age (winter rings) distributions of the abundance estimate from the 2005 acoustic survey and of the fishery in 2005 (Above). Age distribution of the abundance estimates from 3 acoustic surveys; 2004, 2005, and 2006 (Below).

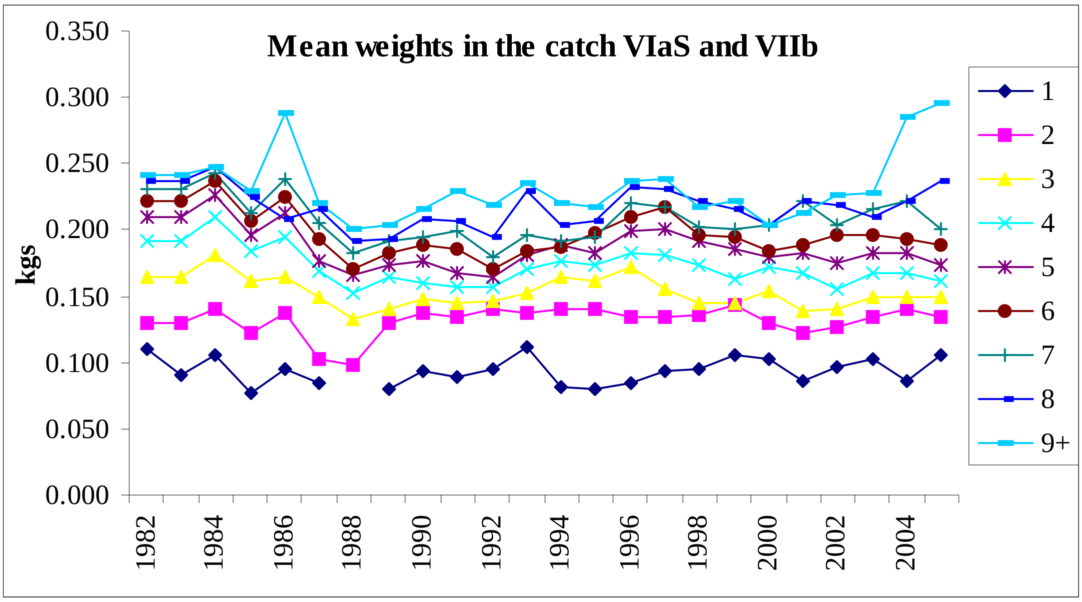


Figure 6.4.4.1. VIa(S) & Division VIIb,c herring. Mean weight in the catch 1970 – 2005.

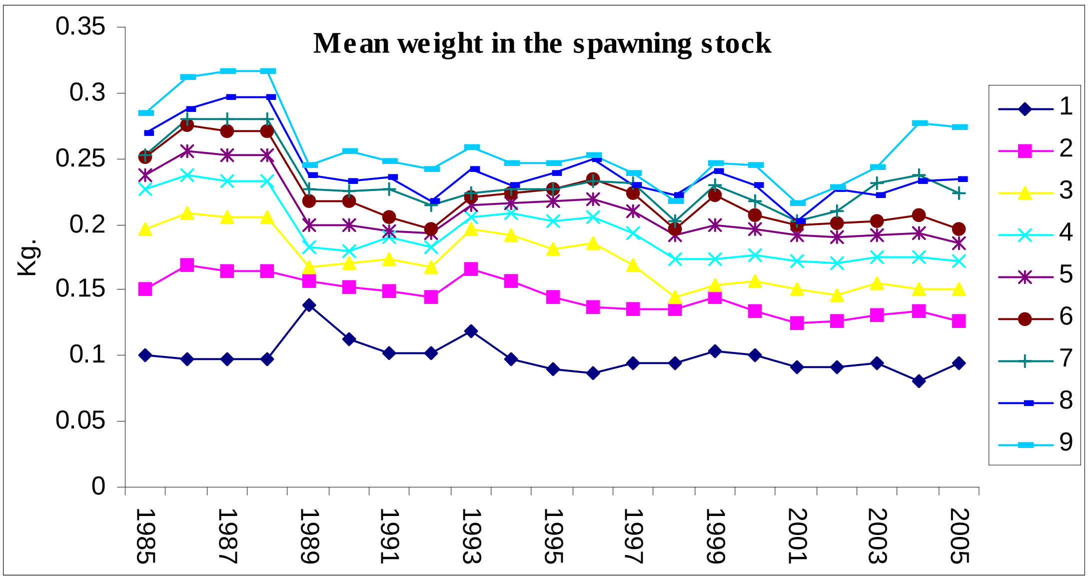
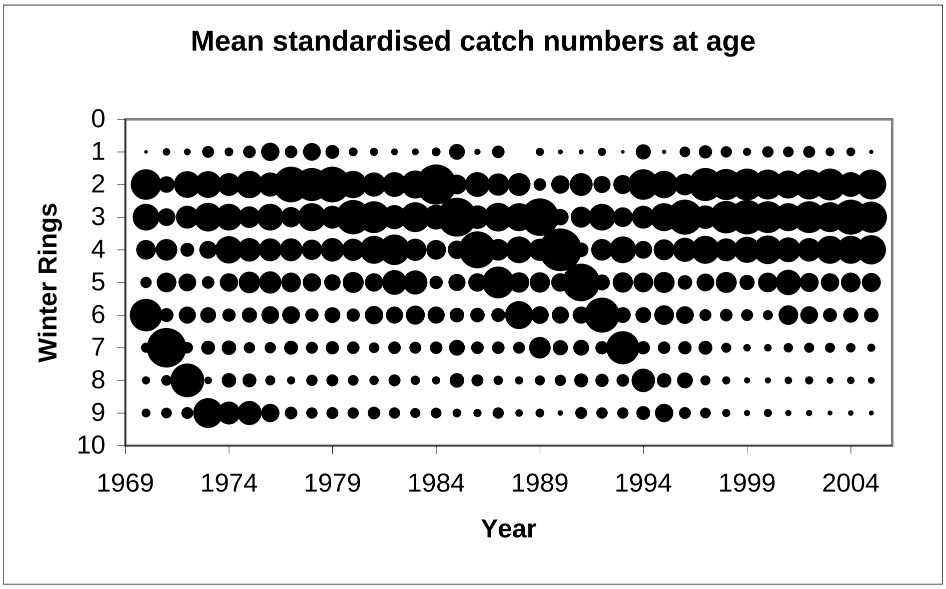


Figure 6.4.4.2. VIa(S) & Division VIIb,c herring. Mean weight in the catch 1970 – 2005.



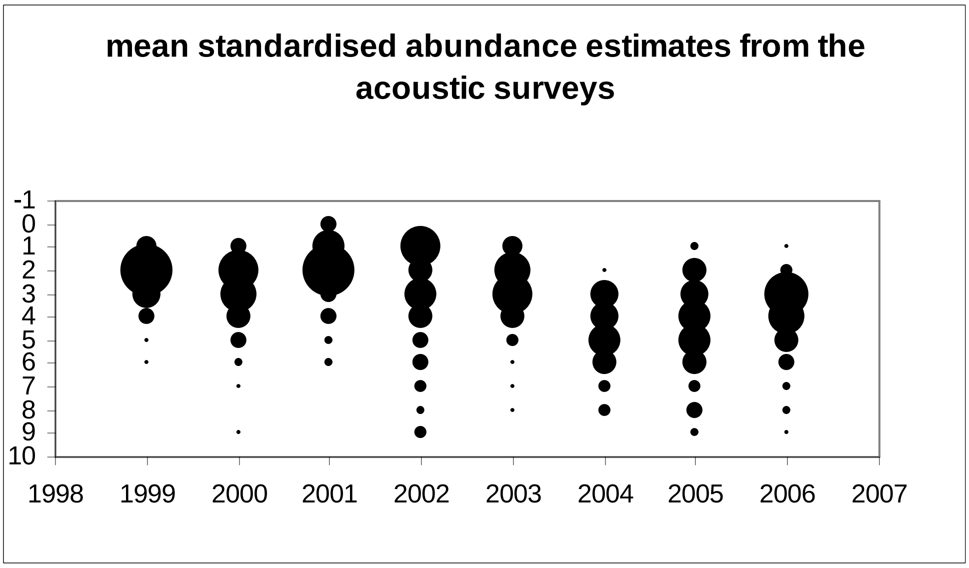


Figure 6.6.1.1 VIa(S) & Division VIIb,c herring mean standardised catch numbers at age standardised by year for the fishery (above) and the survey (below)

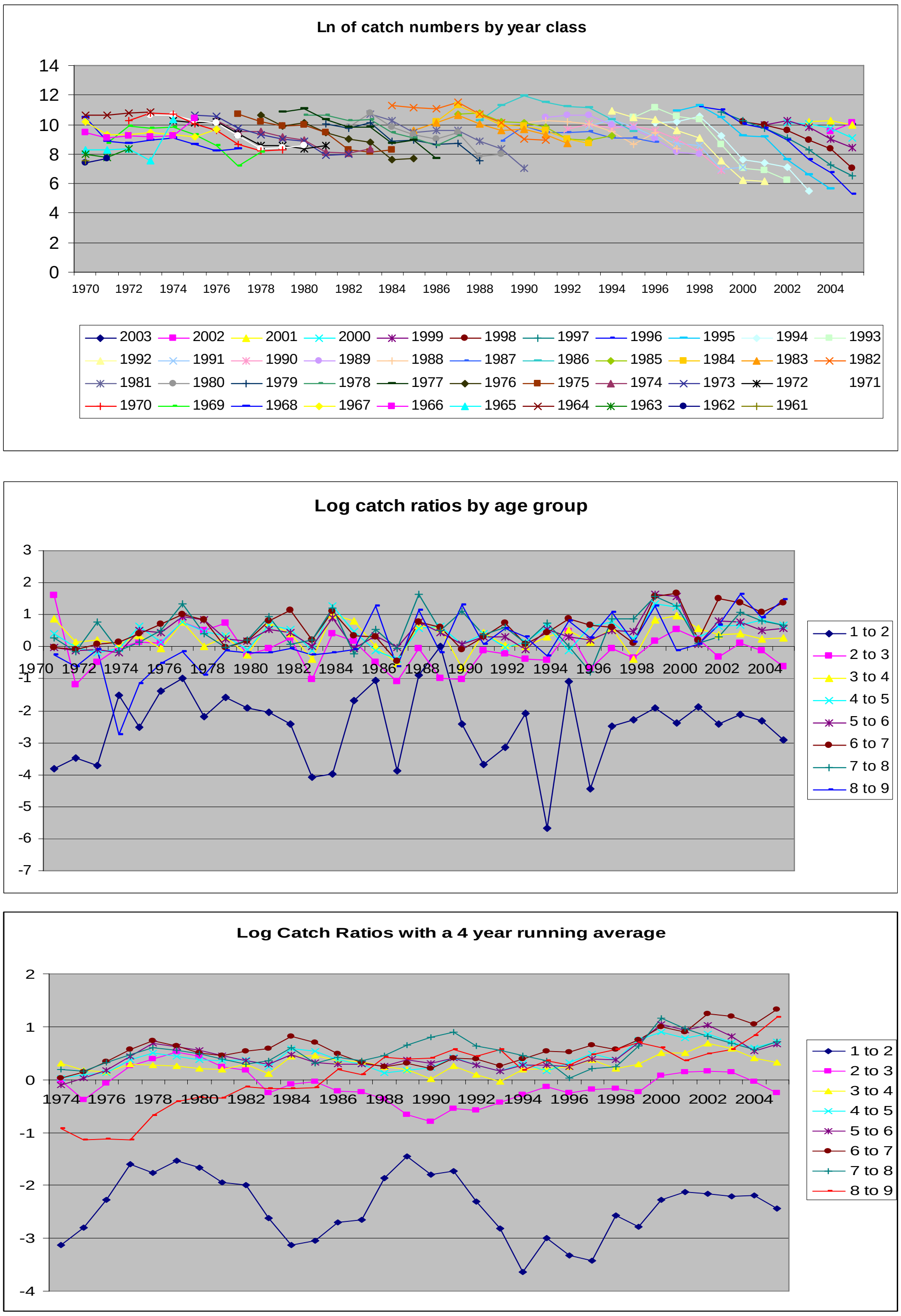


Figure 6.6.1.2: VIa (S) and VIIb,c herring. Catch curves (upper), Log catch ratios (middle) and log catch ratios (lower).

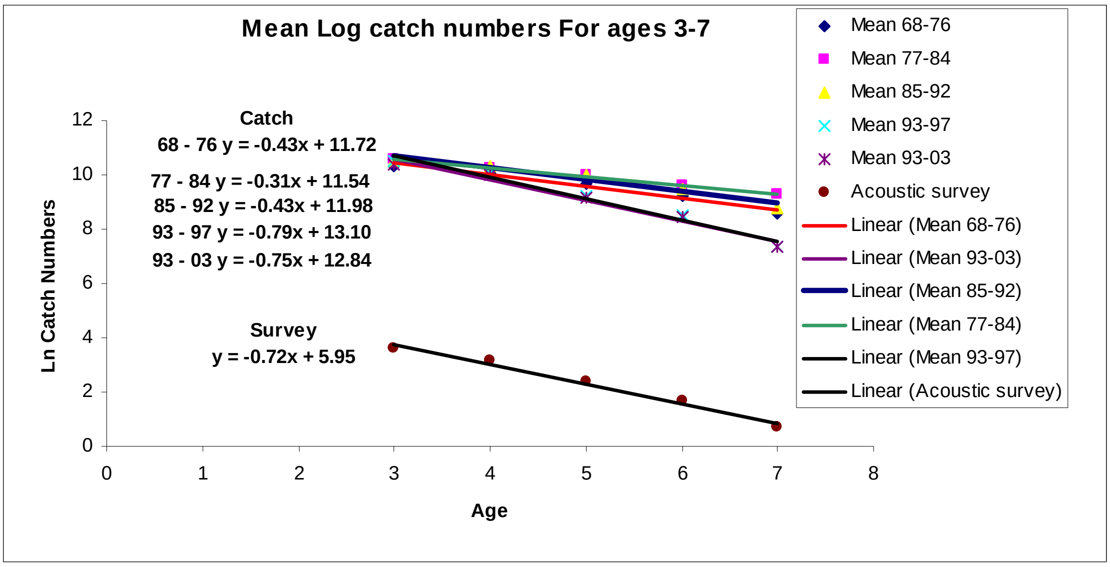


Figure 6.6.1.3: VIa(S) and VIIb,c herring. Mean log catch numbers at age for ages 3 –7 from the fishery and mean abundance estimates at age from the acoustic survey.

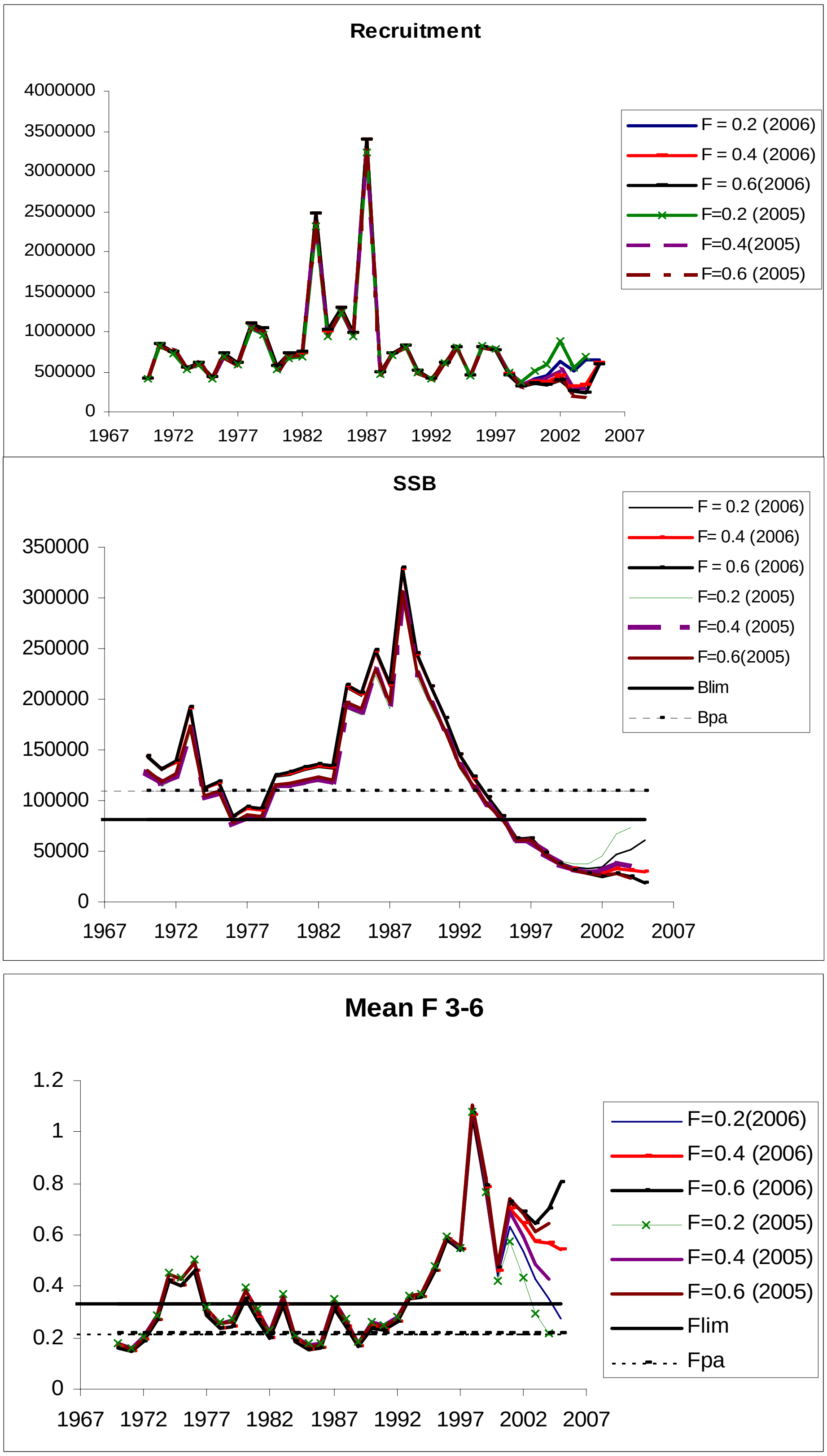


Figure 6.6.1.4 VIa(S) and VIIb,c herring comparison of three separable VPA runs of the current working group and the 2005 working group, using values of 0.2, 0.4 and 0.6 for terminal F.

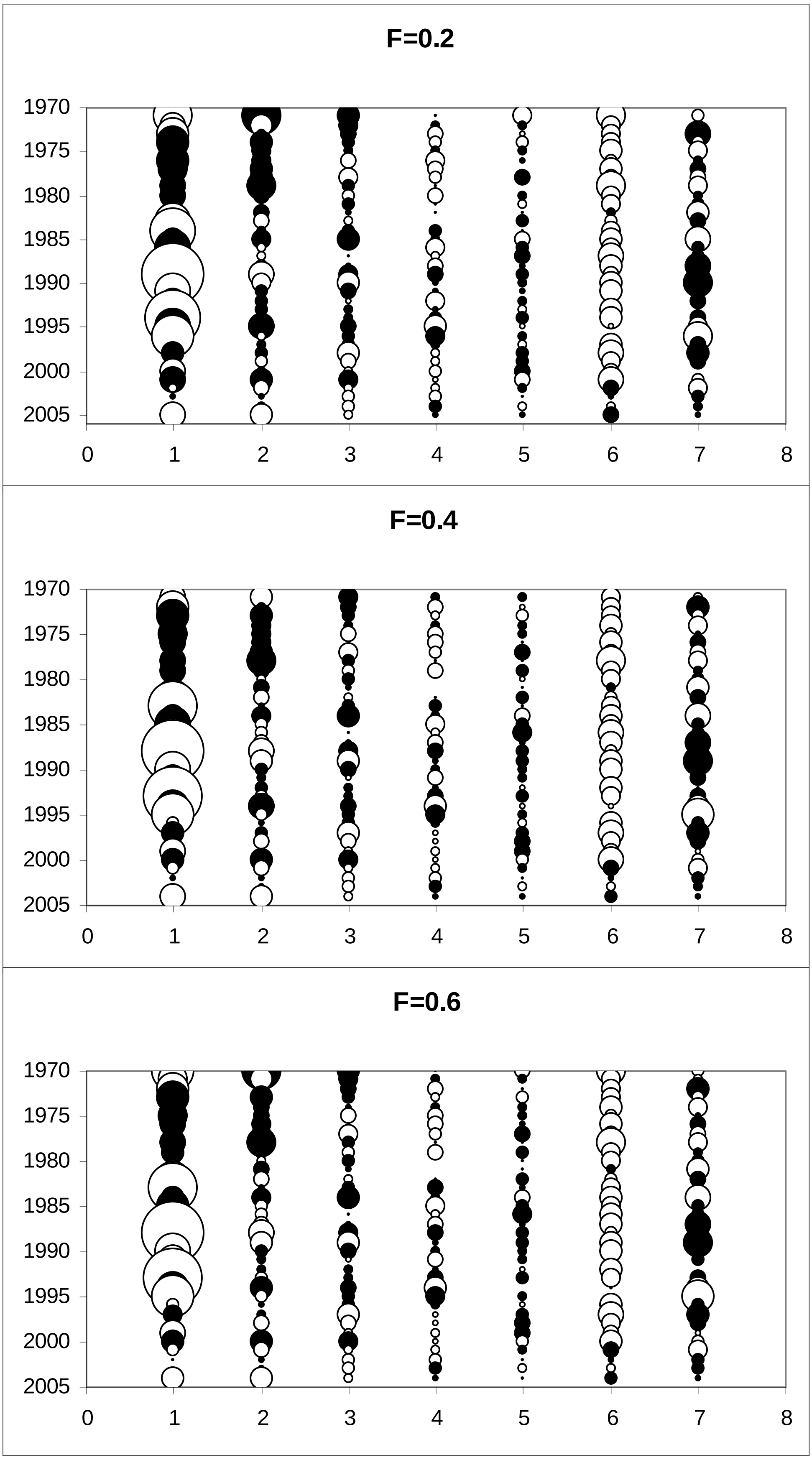


Figure 6.6.1.5. VIa(S) and VIIb,c herring – Residuals from three separable VPA runs using terminal F values of 0.2 (upper), 0.4 (middle) and 0.6 (lower). Black indicates positive residuals and white indicates negative.

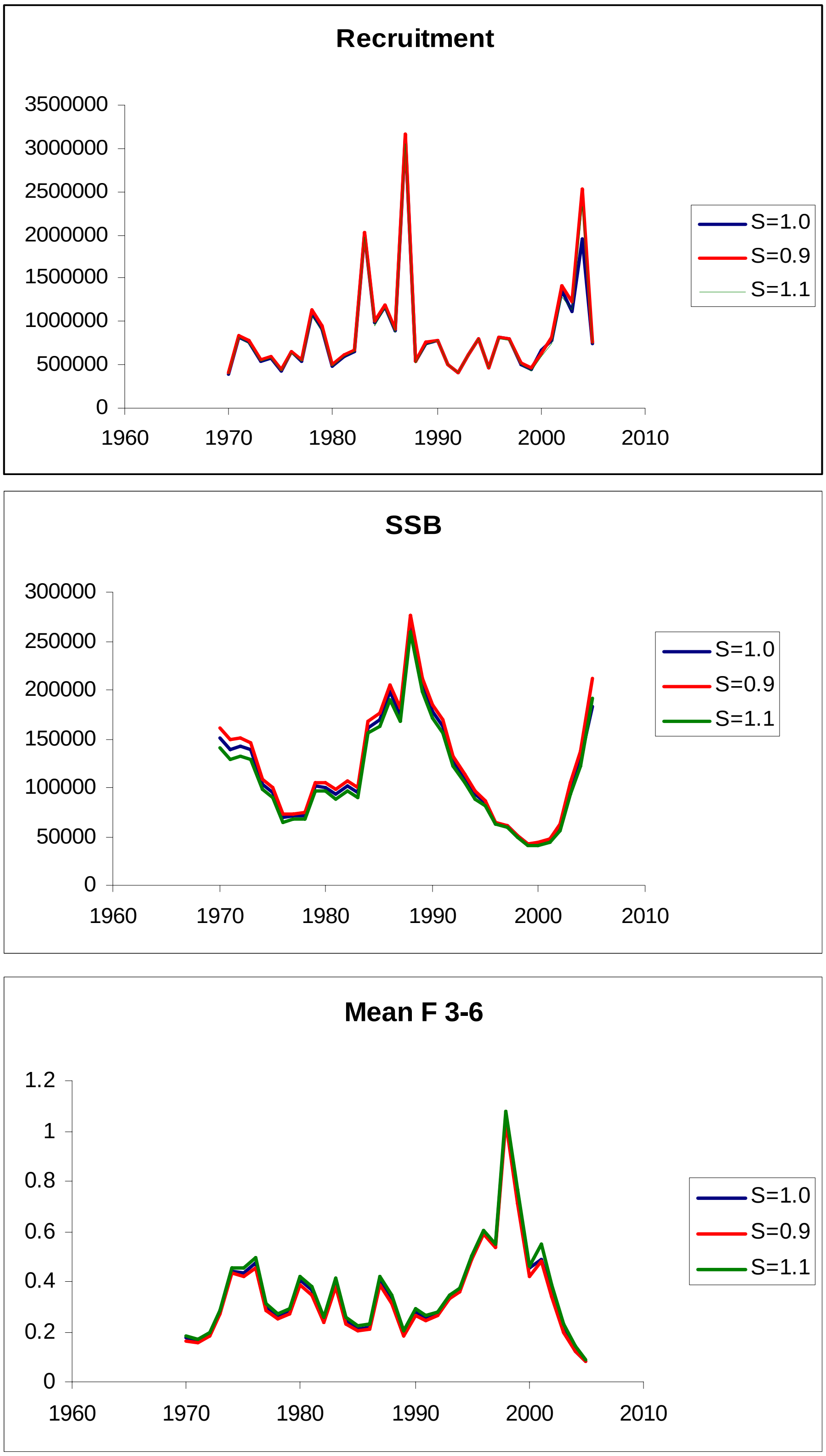


Figure 6.6.1.6. VIa(S) and VIIb,c herring – Results from three separable ICA runs using terminal selection values of 1.0, 0.9 and 1.1.

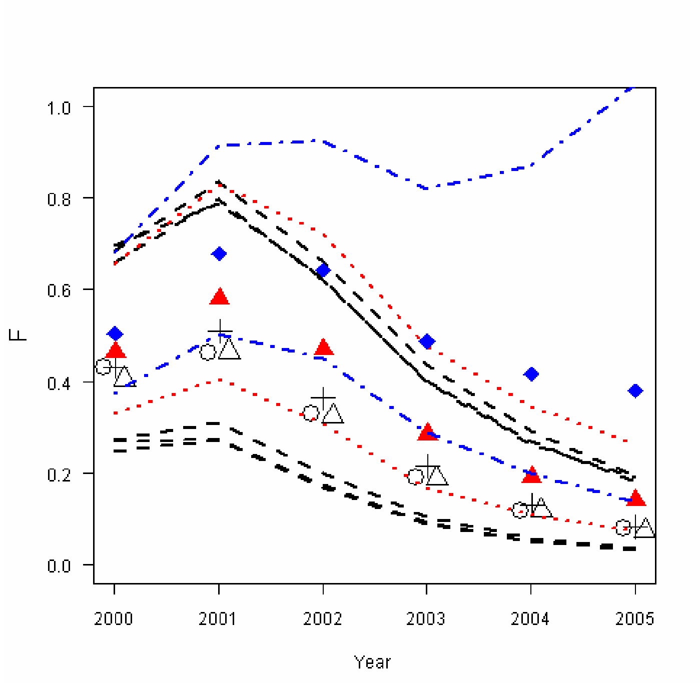


Figure 6.6.1.7. VIa(S) and VIIb,c herring – plot of the 95% confidence intervals around F for five ICA runs. Circles: Terminal selection=1.0, Triangles: Terminal Selection=0.9, Crosses: Terminal Selection=1.1, Red Triangle: Surveys as one series, using 3 and 4 ringers , Blue diamonds: Survey split into two series, with 3 and 4 ringers only.

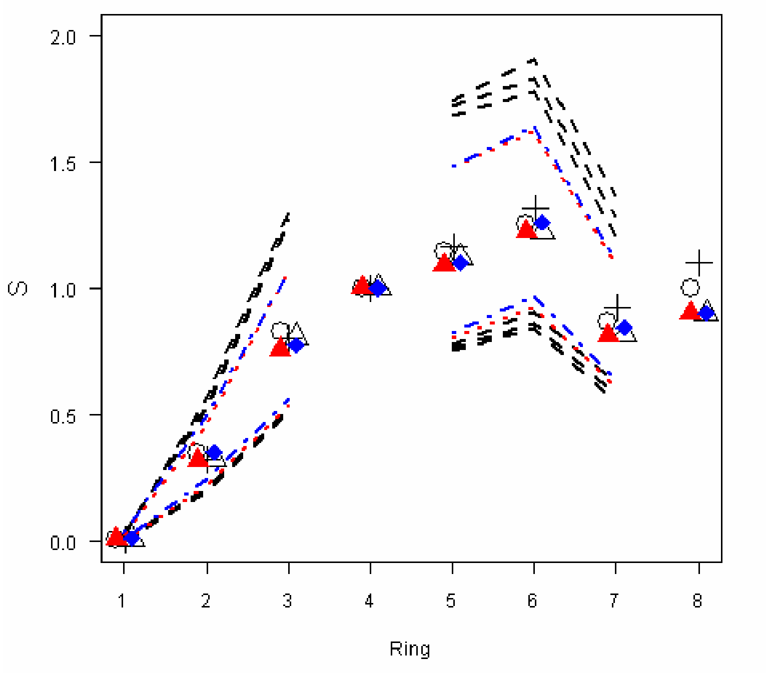


Figure 6.6.1.8. VIa(S) and VIIb,c herring – plot of the selection pattern for five ICA runs. Circles: Terminal Selection =1.0, Triangles: Terminal Selection =0.9, Crosses: Terminal Selection =1.1, Red Triangle: Surveys as one series using 3 and 4 ringers only, Blue diamonds: Survey split into two series with 3 and 4 ringers only.

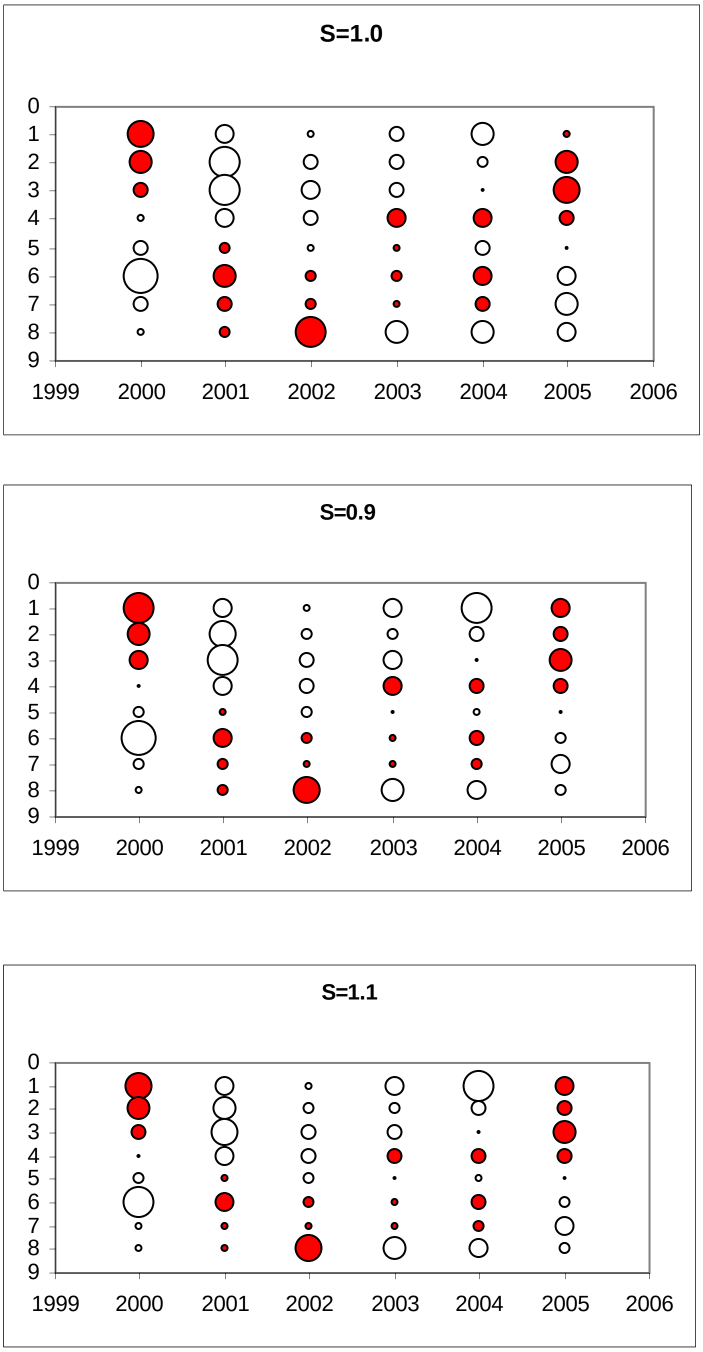


Figure 6.6.1.9. VIa(S) and VIIb,c herring residual patterns with Terminal Selection=1.0 (upper), Terminal Selection=0.9(middle) and Terminal Selection=1.1 (lower)

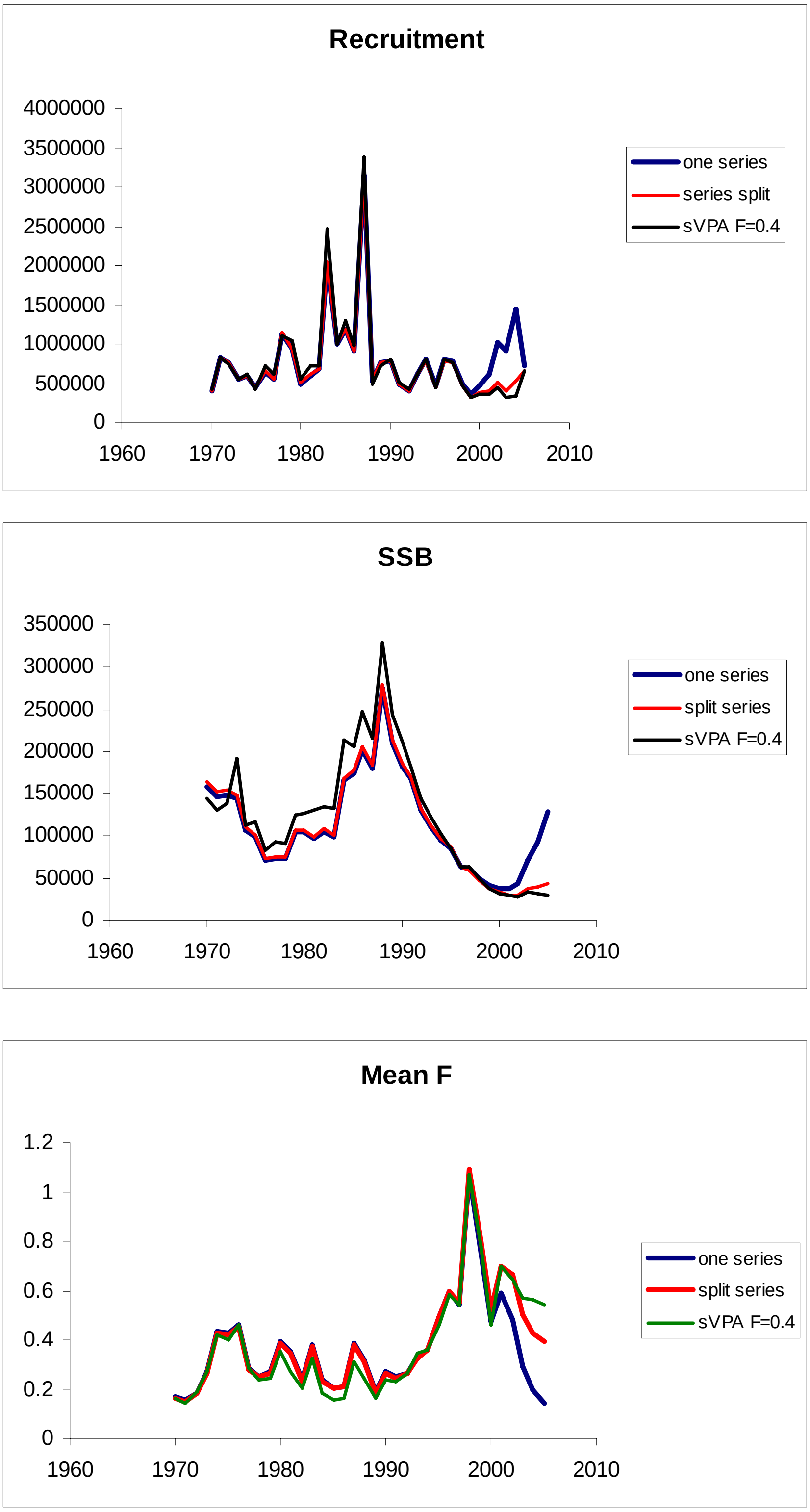


Figure 6.6.1.10. VIa(S) and VIIb,c herring – Recruitment (upper), SSB (middle) and mean F (lower) with the survey as one series, split and the sVPA with F=0.4

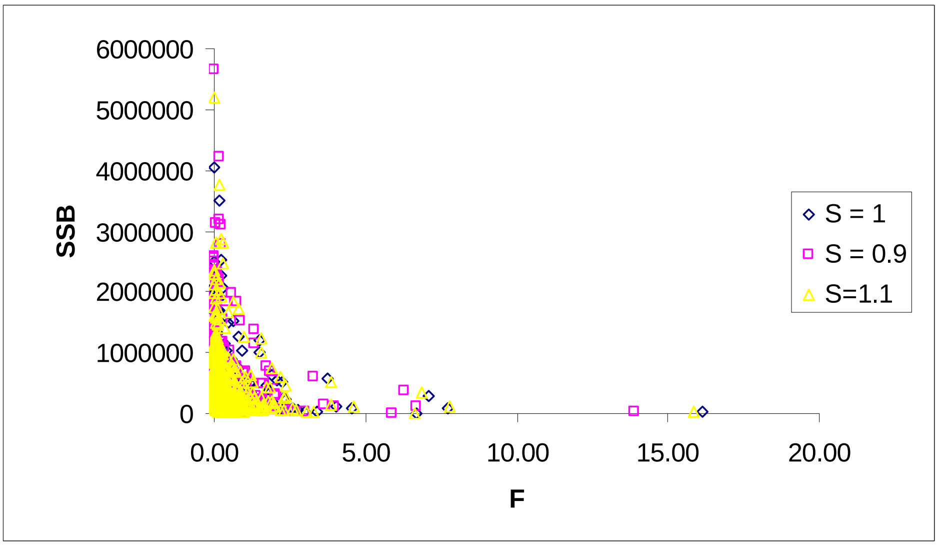


Figure 6.6.1.11. VIa(S) and VIIb,c herring scatter plot of estimates of F and SSB for the terminal year using three different terminal selection values.

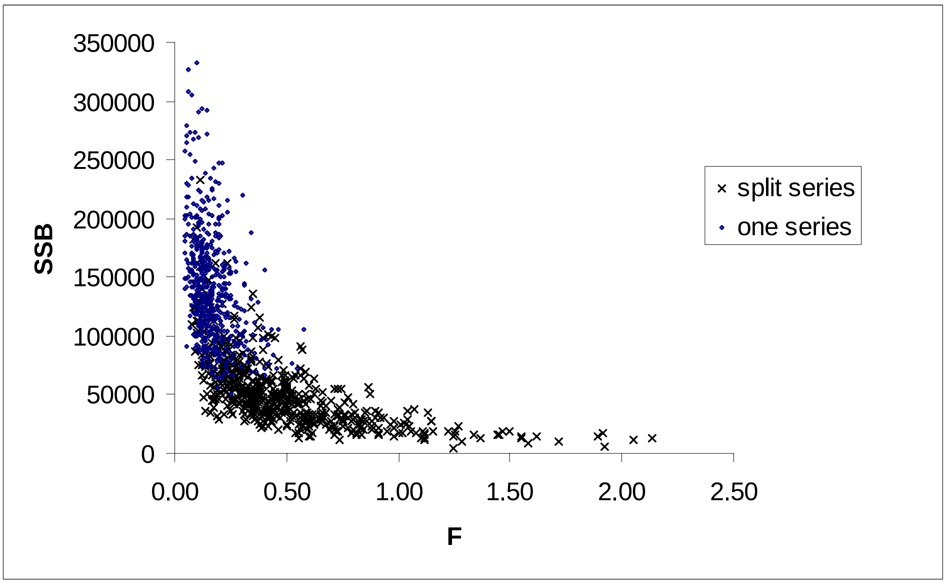
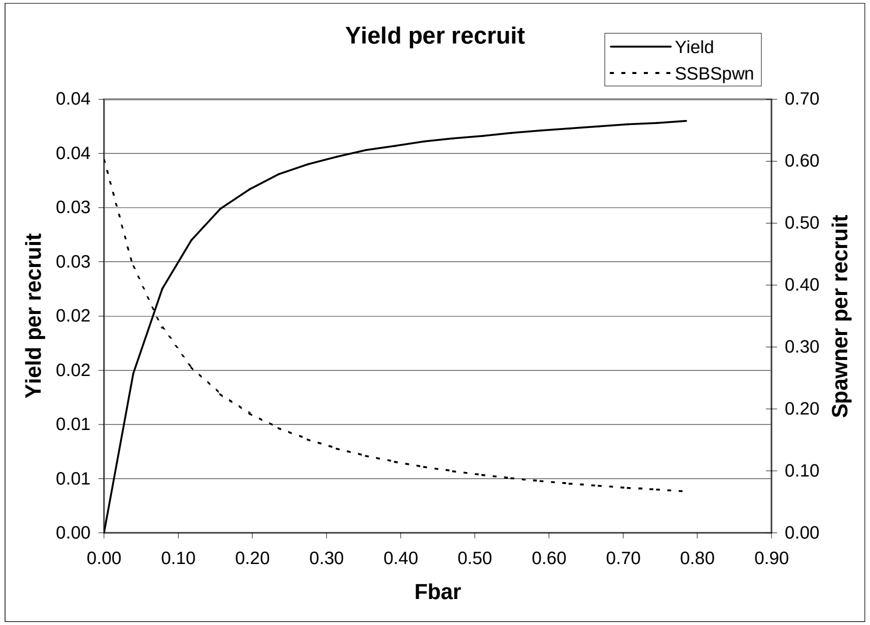
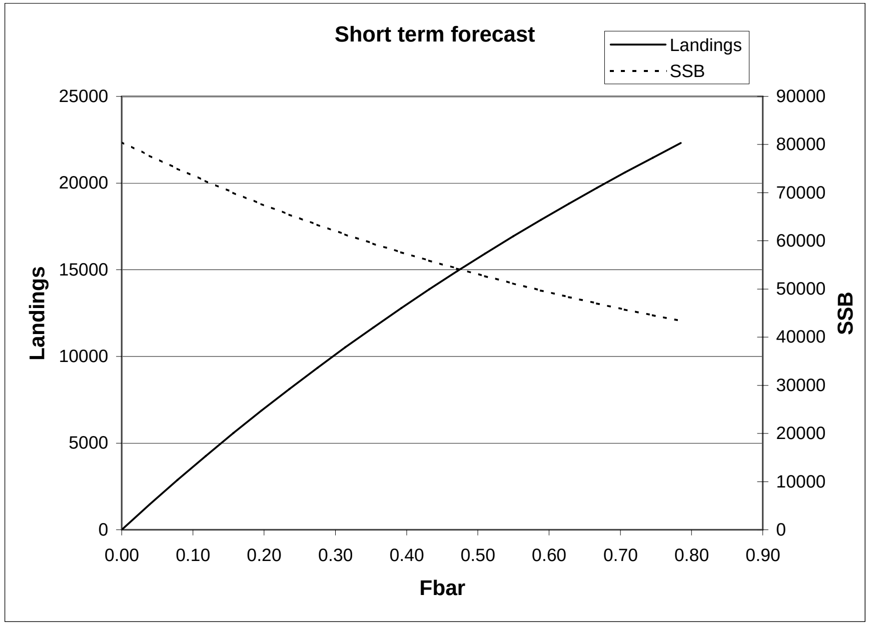


Figure 6.6.1.12. VIa(S) and VIIb,c herring scatter plot of estimates of F and SSB for the terminal year using the survey as one series or as two.





MFYPR version 2a
Run: Run 18
Time and date: 18:19 22/03/2006

Reference point	F multiplier	Absolute F
Fbar(3-6)	1.0000	0.3925
FMax		
F0.1	0.4248	0.1667
F35%SPR	0.4403	0.1728
Flow	0.2293	0.0900
Fmed	0.8059	0.3163
Fhigh	3.0912	1.2133

Weights in kilograms

MFDP version 1a
Run: Herring Run17
Herring VIa (south) (run:)
Time and date: 17:52 22/03/2006
Fbar age range: 3-6

Input units are thousands and kg - output in tonnes

Figure 6.8.1: VIa (S) and VIIb,c herring yield per recruit plots

7 Irish Sea Herring [Division VIIA(North)]

7.1 The Fishery

7.1.1 Advice and Management Applicable to 2004 and 2005

ACFM did not accept the HAWG 2004 assessment because the results were still too imprecise as suggested by the presence of retrospective patterns. ACFM commented that current exploitation levels appeared to give a relatively stable stock and therefore continuation of the 4 800 t TAC was considered sustainable.

In 2005 the WG decided to present short-term forecasts for Irish Sea herring. All management options including a catch equivalent to the 4 800 t TAC resulted in 2007 SSB above Bpa (9 500 t). A TAC of 4 800 t was adopted for 2005, partitioned as 3 550 t to the UK and 1 250 t to the Republic of Ireland.

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 gillnet fishery on the Mourne herring, which has a derogation to fish within the Irish closed box, operated in 2006. The area to the east of the Isle of Man, encompassing the Douglas Bank spawning ground (described in ICES 2001, ACFM:10), was closed from 21st September to 15th November. Boats from the Republic of Ireland are not permitted to fish east of the Isle of Man.

7.1.2 The Fishery in 2005

The catches reported from each country for the period 1986 to 2005 are given in Table 7.1.1, and total catches from 1961 to 2005 in Figure 7.1.1. Reported international landings in 2005 for the Irish Sea amounted to 4 387 t.

As in recent years, in 2005 the majority of the catch of herring in the Irish Sea was taken during the 3rd and 4th quarters. The main fishery commenced fishing in August and made the final landing of herring at the end of November. A total of 93% of the international catch was taken during the 3rd quarter, the majority of which was taken by two pair trawlers. In the 3rd quarter 4 Irish pair trawlers accounted for 1 153 t of total international herring landings. These catches were taken in the mid-channel between the Irish coast and the Isle of Man.

During the 4th quarter the catch accounted for 7% of total international herring landings. During this quarter an additional smaller fishery of 11 vessels registered herring landings. The effort from these vessels was centred off the Northern Irish coastline, in the area of the traditional Mourne fishery.

7.2 Biological composition of the Catch

7.2.1 Catch in numbers

Catches in numbers-at-age are given in Table 7.2.1 for the years 1972 to 2005 and a graphical representation is given in Figure 7.2.1. The predominant year class in 2005 was the 2-ringers (2002-year class), with the highest catch in 3-ringers seen since 1994. The catch in numbers at length is given in Table 7.2.2 for 1990 to 2005.

7.2.2 Quality of catch and biological data

There are no estimates of discarding or slippage in the Irish Sea fisheries that target herring. Discarding however is not thought to be a feature of this fishery. Biological sampling was carried out on 19 out of the 27 landings made by the Northern Ireland pair-trawlers. From a total of 1 153 t landed in the Republic of Ireland, 5 samples were taken. No biological samples were available from landings made during the 4th quarter (Table 7.2.3).

7.2.3 Acoustic surveys

The information on the time-series of acoustic surveys in the Irish Sea is given in Table 7.2.4. As in last year's assessment, the SSB estimates from the survey are calculated using the same (annually varying) maturity ogives that are input to ICA (see Table 7.3.3 estimated from the commercial catch data).

The acoustic survey in 2005 was carried out over 14 days in the period 29th August to 14th September. A survey design of stratified, systematic transects was employed, as in previous years (Figure 7.2.2.A). Very few trawl catches of adult herring have been made off the Irish and English coasts over the time-series of the surveys. Therefore a more intensive survey of these regions, at the expense of time spent around the Isle of Man, remains unwarranted at present. In general, there are few samples on the age composition of the herring in the acoustic survey data. The survey followed the methods described in Armstrong et al., 2005 WD 23; (see Annex 2).

The bulk of the acoustic scatter attributed to pelagic fish was identified as sprat, which were abundant around the periphery of the Irish Sea and to the west of the Isle of Man (Figure 7.2.2.B). As observed in 2004 mixed herring targets were detected in 2005 at a number of locations off the west and south coasts of the Isle of Man (Figure 7.2.3.A).

As in previous years, no herring schools were detected in the area immediately north of the Isle of Man, despite an abundance of early-stage larvae in this area in November (Figure 7.2.4). It is possible that spawning in this area only commences after the date of the acoustic survey.

The estimate of herring SSB of 31 445 t for 2005 was well above the average for the series up to 2004 (19 kt) (Table 7.2.4). The approximate coefficient of variation of 0.42 was close to the average for the series of surveys and similar to the value last year. The biomass estimate of 36 866 t for 1+ ringers was also above the average for the series up to 2004 (33 kt), whilst the approximate CV of 0.37 for the stratified mean estimate was similar to the average for the series. Given the approximate CVs of the estimates, it is not possible to discern any trend in 1+ biomass or SSB since 1999.

The estimate of the herring population, excluding 0-ring fish, is given in Table 7.2.5. The age composition from the acoustic survey was similar to the catch-at-age data with high catches of 2 and 3-ringers.

7.2.4 Larvae surveys

A herring larvae survey was undertaken by Northern Ireland over the period 6th to 15th November. The survey followed the methods and designs of previous surveys in the time-series (see Annex 2). The production estimate for 2005 in the NE Irish Sea was 33 100 t and was slightly above the average up to 2004 (Table 7.2.6). As in recent years, herring larvae were found to be most abundant to the east and north of the Isle of Man and less abundant in the western Irish Sea (Figure 7.2.4).

7.2.5 Groundfish surveys of Area VIIa(N)

Groundfish surveys (Annex 2), carried out by Northern Ireland since 1991 in the Irish Sea, were used by the 1996 to 1999 Herring Assessment Working Groups to obtain indices for 0- and 1-ring herring in the Irish Sea. These indices have performed poorly in the assessment and have not been used since 1999. Indices for 1991 to 2005 are shown in Table 7.2.7.

7.3 Mean length, weight, maturity and natural mortality-at-age

Mean lengths-at-age were calculated using the catch data and are given for the years 1985 to 2005 in Table 7.3.1. In general, mean lengths have been relatively stable over the last few years and this trend has continued in 2005.

Mean weights-at-age in the catch are given in Table 7.3.2. Mean weights-at-age of all ages remained low. There has been a change in mean weight over the time period 1961 to the present (ICES 2003 ACFM:17). Mean weights-at-age increased between the early 1960s and the late 1970s whereupon there was been a steady decline to the early 1990s, were they remained low. In the assessment, mean weights-at-age for the period 1972 to 1984 are taken as unchanging. In extending the data series back from 1971 to 1961, mean weights-at-age in the catch were taken from samples recorded by the Port Erin Marine Laboratory (ICES 2003 ACFM:17).

Mean weights-at-age in the third-quarter catches (for the whole time-series 1961 to present) have been used as estimates of stock weights at spawning time. There was some uncertainty in the mean weights-at-age for 2003 presented to the WG, and consequently the WG replaced these with the average mean stock weights-at-age for the preceding five years (1998 to 2002). There was no further information this year to improve the 2003 values, and these remain as the 5-year mean.

Maturity-at-age (in the catches) for each year (1961 to 2005) are given in Table 7.3.3. Due to inconsistencies in the maturity data collected in 2003, the WG used a mean maturity ogive for the preceding nine years for 2003. The rationale for the 9 years was that there appeared to be a shift in the maturity ogive around 1993. After 2003 all weights and maturity-at-age data were based on corresponding annual biological samples.

As in previous years, natural mortality per year was assumed to be 1.0 on 1-ringers, 0.3 for 2-ringers, 0.2 for 3-ringers and 0.1 for all older age classes. These are based on the natural mortality rates estimated for herring in the North Sea using MSVPA.

7.4 Recruitment

An estimate of total abundance of 1-ringers is provided by the Northern Ireland acoustic survey. However, there is evidence that a fraction of those is of Celtic Sea origin. Separation of the trawl catches of juveniles into autumn and winter spawning components, based on otolith microstructure and/or length composition, could result in a survey index of recruitment for the Irish Sea stock that could be used directly in the assessment.

7.5 Stock Assessment

7.5.1 Data exploration and preliminary modelling

In 2004 examination of the sum of squares surface from integrated catch-at-age analysis (ICA) indicated that the Douglas Bank larvae index (DBL) was having no influence in the current perception of the stock. Therefore, the WG agreed on removing DBL from the analysis. In 2005 two fishery independent survey indices were used as tuning indices to run ICA: Northern

Irish larvae production (NINEL) and the age dis-aggregated abundance index from the acoustic survey (ACAGE). Also, the preliminary modelling used catch-at-age data derived from the landings, extending back to 1961.

This year 2005 data were added to the Northern Irish larvae series (NINEL) and to the Northern Irish acoustic survey (total biomass, SSB and age-structured indices). Due to the continuing problems associated with mixing of Irish Sea and Celtic Sea juveniles the groundfish surveys were considered unsuitable tuning fleets. The survey series available for inclusion in an assessment using the ICA package are documented in Appendix 2.

Initial fits within integrated catch-at-age analysis (ICA), were performed with NINEL and ACAGE. The following model settings were used:

- Separable constraint over the last 6-years (weighting = 1.0 for each year)
- Reference age = 4
- Constant selection pattern model
- Selectivity on oldest age = 1.0
- First age for calculation of mean F = 2
- Last age for calculation of mean F = 6
- Weighting on 1-rings = 0.1; all other age classes = 1.0
- Weighting for all years = 1.0
- All indices treated as linear
- No S/R relationship fitted
- Lowest and highest feasible F = 0.05 and 2.0
- All survey weights fitted by hand i.e., 1.0 with the 1-rings in the acoustic survey weighted to 0.1.
- Correlated errors assumed i.e., = 1.0
- No shrinkage applied

The initial fit corresponds to the same procedure as last year (SPALY).

Examination of the SSQ surface (Figure 7.5.1) showed that although there was a clear overall minimum, the minimum for each individual index did not coincide. Comparison of mean reference Fs estimated in the SPALY run and the runs using one index at a time (NINEL, ACAGE) highlighted the variation in mean F and associated deviation (Figure 7.5.2). Estimates of uncertainty from the ICA bootstrapped mean F and SSB from SPALY were plotted for 2005 and 2006 data (Figure 7.5.3). Comparison of 2005 and 2006 suggests a reduction in precision in the current year. This may also be reflected by the large residuals about the model fit to the acoustic index older ages.

An examination of the exploitation rate estimated as the ratio of the catch to the acoustic estimated 1+ biomass was repeated this year (not shown). A relatively lower exploitation rate over the period 1999 to 2005 was suggested, evidence perhaps that the fishing mortality had probably been relatively stable over this time period. Full quota (4,800 t) in 2005 was not taken.

An exploration of the separable period was carried out. The separable period was increased from 6 to 8 years in an attempt to reduce the noise in the SPALY retrospective series (Figure 7.5.4). It was hoped that this would result in a gain in precision in the model estimates of key population parameters and improve the estimated selection pattern. Adopting an 8-year separable period was considered acceptable as the fishery has evolved little in this time, and changes in fishing practices and their effects on the catch data were assumed to be minimal. Comparison of the residuals from the exploratory ICA runs for the period 2000 - 2005 and age groups 1 to 8 showed very little improvement (Figure 7.5.5). The resulting SSB and F_{2-6} estimates from the SPALY 6-year and 8-year separable period runs were also very similar (Figure 7.5.6). This suggests that the model is not sensitive to assumptions regarding the separable period.

Finally, the influence of the last year estimate of recruitment in the predicted SSB was investigated through retrospective analysis. Retrospective plots of SSB and F were constructed from an ICA run assuming an 8-year separable period with the 1-group for the last year of data excluded from the calculation of SSB by fixing their maturity equal to 0 %. This run resulted in a reduction of retrospective patterns in both SSB and recruitment. The comparison highlighted the role of 1-group in contributing to retrospective variance in SSB (Figure 7.5.7).

7.5.2 Two-stage biomass model

In 2005 a Two-Stage Biomass model for the assessment of Irish Sea VIIa herring given additional variance in the recruitment index was presented by Roel and De Oliveira (2005 WD10). In 2006 due to reduced resources the model was not attempted in the assessment.

7.5.3 Conclusion to explorations

The results from the exploratory runs carried out with ICA using NINEL and ACAGE as tuning indices indicate a decrease in precision compared with 2005. Moreover, the range of F minima in the SSQ surface graph suggests less consistency between the catch data and the indices in the separable period. Increasing the separable period from 6 to 8 years did not improve the residual values. Estimates in SSB and F were not greatly influenced by adopting 0% 1-group maturity. The large recruitment estimate for 2001 was however reduced through this manipulation of 1-group maturity. This could be the result of smaller residuals from fitting other pieces of information that the model did not need to balance out by generating a large residual for the recruits in the last year of data. Overall, the WG considered the improvements from using an 8-year separable period small therefore decided to present results from running SPALY.

7.5.4 Stock Assessment

The results presented correspond to ICA runs using the acoustics data as an age-structured index (ACAGE) and the Northern Ireland larval survey (NINEL) as an index of biomass. The model settings are the same as for 2005. The run log for the assessment is shown in Table 7.5.1. The output from ICA assessment, the residuals and fitted values are given in Tables 7.5.2 –7.5.19. The SSQ for the index shows a variation in minimum between indices but at a relatively low level of fishing mortality (Figure 7.5.1). The model diagnostics (Figure 7.5.8) show that the total residuals by age between the catch and the separable model are reasonably trend-free. The year residuals show influences from 2002 and 2003. The estimate for $F_{(2-6)}$ was 0.34 (Table 7.5.15) with a corresponding SSB estimate of 11 813 t, above Bpa = 9 500 t. The significance of the current SSB estimate for this stock must be viewed in light of the retrospective analysis which shows a general downward revision of SSB values the following year.

However the 2006 assessment results suggest that the stock has been relatively stable in recent years with an apparent increase in SSB in the last year (Table 7.5.15). This apparent increase may be influenced by a similar trend in the larvae index which was fitted by the model, (Figure 7.5.10). The increase may also be driven by the large estimate of numbers of 2 and 3 year-olds in the landing data. These strong year groups were also mirrored in the acoustic survey. These year-classes are mature (Table 7.3.3) and will therefore be contributing substantially to the SSB.

7.6 Stock and Catch Projection

7.6.1 Deterministic short-term predictions

No short-term predictions were included in the 2006 assessment.

7.6.2 Yield-per-recruit

For a yield-per-recruit analysis refer to last years report.

7.7 Medium-term predictions of stock size

The Working Group decided that there was no basis for undertaking medium-term projections of stock size until there is agreement that advice based on the assessment can be provided.

7.8 Reference points

The estimation of $\mathbf{B}_{pa}$ (9 500 t) and $\mathbf{B}_{lim}$ (6 000 t) were not revisited this year. There were no new points to add to the discussions and deliberations presented in 2000 (ICES 2000/ACFM:12). There is no precautionary F value for this stock.

7.9 Quality of the Assessment

The different survey series for Irish Sea herring are characterized by generally poor precision caused by the very patchy distribution of the fish as well as assumptions inherent in the methods (e.g. target strength, larval growth and mortality; relationship between larval production and SSB). Nonetheless, there is evidence of some coherence between the longer-term signals in the different survey series. The acoustic survey provides estimates of abundance at age but the juveniles in the area are a mixture of at least two adjacent stocks (Celtic Sea and VIIa(N)). Separation of trawl catches of juveniles into autumn and winter spawning components, based on otolith microstructure and/or length composition, could result in acoustic and trawl survey indices of juveniles appropriate for the Irish Sea assessment. However information from historical herring larval surveys in the Celtic Sea suggest that a considerable autumn spawning component existed in certain years. This may undermine attempts to separate the Celtic and Irish Sea juvenile components.

Retrospective analysis of the assessment with data from 2000 to 2005 was carried out (Figure 7.5.4). The retrospectives for SSB and $F_{2\text{-}6}$ from the ICA assessment (NINEL + ACAGE) with a 6-year separable period (SPALY) show rather stable estimation of SSB at a level just below B_{pa} (9 500 t). The tendency to over-estimate SSB in the last assessment year was shown to be a continuing trend. The retrospective pattern of $F_{2\text{-}6}$ is relatively stable, however the addition of another year's data results in an upward revision in F.

The very large deviation seen in the recruitment retrospective results from the extremely high estimate of recruitment in 2002 (Figure 7.5.4). As information on recruitment is down-weighted in both the catch at age and the survey, the model is free to use the last year recruitment estimate to balance out high residuals from the model fit to previous years data. Therefore high values of recruitment can be estimated in the last year as there is little constraint placed by the model.

For some years, the assessment for this stock has not been accepted by ACFM. Both the catches and survey data are noisy. In recent years the assessment seems to have improved as more years are added to the acoustic survey series, and the conflicting signals in survey data seen in previous assessments are not observed in this assessment. Given the noise in the data it is difficult to detect abrupt changes in the stock dynamics. Nevertheless some inferences can be made that are quite robust, even though the absolute estimates of SSB and fishing mortality may be less reliable. In particular, it seems likely that the stock is relatively stable at a level close to Bpa, and that the fishing mortality has been low since the late 1990's. Therefore, an advice to maintain catches at the current level is supported by the assessment.

7.10 Spawning and Juvenile Fishing Area Closures

The arrangement of closed areas in Division VIIa(N) prior to 1999 are discussed in detail in ICES (1996/ACFM:10) with a change to the closed area to the east of the Isle of Man being altered in 1999 (ICES 2001/ACFM:10). The closed areas consist of: all year juvenile closures along part of the east coast of Ireland, and the west coast of Scotland, England and Wales; spawning closures along the east coast of the Isle of Man from 21st September- 15th November, and along the east coast of Ireland all year round. The Working Group recommends that any alterations to the present closures are considered carefully, in the context of this report, to ensure protection for all components of this stock.

7.11 Management considerations

The catches have been low in recent years and there are no indications of problems in the catch-at-age for this stock. A slight reduction in precision was noted in the 2006 assessment however the SSB is estimated to be above B_{pa} and continues to show an upward trend. However, analytical retrospectives show that considerable downward revision of SSB took place in subsequent assessments in recent years, placing SSB below the B_{pa}. The current assessment however indicates that SSB remains relatively stable for this stock. Further, a broad range of year classes is present in the stock indicating relatively low mortality. Therefore, the maintenance of recommended catch levels of approximately 5 000 t, in the short-term, should not be detrimental to the stock.

Table 7.1.1 Irish Sea Herring Division VIIa(N). Working group catch estimates in tonnes by country, 1987-2005. The total catch does 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**
Ireland	1 200	2 579	1 430	1 699	80	406	0	0	0
UK	3 290	7 593	3 532	4 613	4 318	4 864	4 408	4 828	5 076
Unallocated	1 333	-	-	-	-	-	-	-	-
Total	5 823	10 172	4 962	6 312	4 398	5 270	4 408	4 828	5 076

Country	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Ireland	100	0	0	0	0	862	286	0	749
UK	5 180	6 651	4 905	4 127	2 002	4 599	2 107	2 399	1 782
Unallocated	22	-	-	-	-	-		-	-
Total	5 302	6 651	4 905	4 127	2 002	5 461	2 393	2 399	2 531

Country	**2005**
Ireland	1 153
UK	3 234
Unallocated	-
Total	4 387

Table 7.2.1 Irish Sea Herring Division VIIa(N). Catch in numbers (thousands) by year.

	Age (rings)							
Year	1	2	3	4	5	6	7	8+
1972	40640	46660	26950	13180	13750	6760	2660	1670
1973	42150	32740	38240	11490	6920	5070	2590	2600
1974	43250	109550	39750	24510	10650	4990	5150	1630
1975	33330	48240	39410	10840	7870	4210	2090	1640
1976	34740	56160	20780	15220	4580	2810	2420	1270
1977	30280	39040	22690	6750	4520	1460	910	1120
1978	15540	36950	13410	6780	1740	1340	670	350
1979	11770	38270	23490	4250	2200	1050	400	290
1980	5840	25760	19510	8520	1980	910	360	230
1981	5050	15790	3200	2790	2300	330	290	240
1982	5100	16030	5670	2150	330	1110	140	380
1983	1305	12162	5598	2820	445	484	255	59
1984	1168	8424	7237	3841	2221	380	229	479
1985	2429	10050	17336	13287	7206	2651	667	724
1986	4491	15266	7462	8550	4528	3198	1464	877
1987	2225	12981	6146	2998	4180	2777	2328	1671
1988	2607	21250	13343	7159	4610	5084	3232	4213
1989	1156	6385	12039	4708	1876	1255	1559	1956
1990	2313	12835	5726	9697	3598	1661	1042	1615
1991	1999	9754	6743	2833	5068	1493	719	815
1992	12145	6885	6744	6690	3256	5122	1036	392
1993	646	14636	3008	3017	2903	1606	2181	848
1994	1970	7002	12165	1826	2566	2104	1278	1991
1995	3204	21330	3391	5269	1199	1154	926	1452
1996	5335	17529	9761	1160	3603	780	961	1364
1997	9551	21387	7562	7341	1641	2281	840	1432
1998	3069	11879	3875	4450	6674	1030	2049	451
1999	1810	16929	5936	1566	1477	1989	444	622
2000	1221	3743	5873	2065	558	347	251	147
2001	2713	11473	7151	13050	3386	936	650	803
2002	179	9021	1894	1866	2395	953	474	343
2003	694	4694	3345	2559	882	2945	872	605
2004	3225	8833	5405	2161	623	213	673	127
2005	8692	13980	10555	3287	1422	415	292	367

Table 7.2.2 Irish Sea Herring Division VIIa(N). Catch-at-length for 1990-2005. Numbers of fish in thousands.

LENGTH	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
14																
14.5																
15			95													
15.5			169							10						
16	6		343			21	21	17		19	12	9				
16.5	6	2	275			55	51	94		53	49	27			13	1
17	50	1	779		84	139	127	281	26	97	67	53			25	39
17.5	7	4	1106		59	148	200	525	30	82	97	105			84	117
18	224	31	1263		69	300	173	1022	123	145	115	229			102	291
18.5	165	56	1662		89	280	415	1066	206	135	134	240	36		114	521
19	656	168	1767	39	226	310	554	1720	317	234	164	385	18		203	758
19.5	318	174	1189	75	241	305	652	1263	277	82	97	439	0	29	269	933
20	791	454	1268	75	253	326	749	1366	427	218	109	523	0	73	368	943
20.5	472	341	705	57	270	404	867	1029	297	242	85	608	18	215	444	923
21	735	469	705	130	400	468	886	1510	522	449	115	1086	307	272	862	1 256
21.5	447	296	597	263	308	782	1258	1192	549	362	138	1201	433	290	1007	1 380
22	935	438	664	610	700	1509	1530	2607	1354	1261	289	1748	1750	463	1495	1 361
22.5	581	782	927	1224	785	2541	2190	2482	1099	2305	418	1763	1949	600	2140	1 448
23	2400	1790	1653	2016	1035	4198	2362	3508	2493	4784	607	2670	2490	1158	2089	1 035
23.5	1908	1974	1156	2368	1473	4547	2917	3902	2041	4183	951	2254	1552	1380	2214	1 256
24	3474	2842	1575	2895	2126	4416	3649	4714	3695	4165	1436	3489	1029	1273	2054	1 276
24.5	2818	2311	2412	2616	2564	3391	4077	4138	2769	3397	1783	4098	758	1249	2269	1 083
25	4803	2734	2792	2207	3315	3100	4015	5031	2625	2620	2144	5566	776	1163	1749	1 086
25.5	3688	2596	3268	2198	3382	2358	3668	3971	2797	1817	1791	4785	1335	1211	1206	584
26	4845	3278	3865	2216	3480	2334	2480	3871	3115	1694	1349	3814	1570	1140	823	438
26.5	3015	2862	3908	2176	2617	1807	2177	2455	2641	1547	840	2243	1552	1573	587	203
27	3014	2412	3389	2299	2391	1622	1949	1711	2992	1475	616	1489	776	1607	510	165
27.5	1134	1449	2203	2047	1777	990	1267	1131	1747	867	479	644	433	1189	383	60
28	993	922	1440	1538	1294	834	906	638	1235	276	212	496	162	726	198	45
28.5	582	423	569	944	900	123	564	440	170	169	58	179	108	569	51	18
29	302	293	278	473	417	248	210	280	111	61	42	10	36	163		12
29.5	144	129	96	160	165	56	79	59	92		12	0	36	129		
30	146	82	70	83	9	40	32	8	84		6	9		43		
30.5	57	36	36	15	27	5	0	5	3					43		
31	54	12	2	4		1	2							43		
31.5	31	3														
32	29															
32.5																
33																
33.5																
34																

Table 7.2.3 Irish Sea Herring Division VIIa(N). Sampling intensity of commercial landings in 2005.

Quarter	Country	Landings (t)	No. samples	No. fish measured	No. fish aged	Estimation of discards
	Ireland	0	-	-	-	-
	UK (N. Ireland)	0	-	-	-	-
1	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
	Ireland	0	-	-	-	-
	UK (N. Ireland)	0	-	-	-	-
2	UK (Isle of Man)	*	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
	Ireland	1153	5	1312	372	No
	UK (N. Ireland)	2927	21	4135	1018	No
3	UK (Isle of Man)	*	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
	Ireland	0	-	-	-	-
	UK (N. Ireland)	308	0	0	0	No
4	UK (Isle of Man)	*	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-

*** no information, but catch is likely to be negligible**

Table 7.2.4 Irish Sea Herring Division VIIa(N). Summary of acoustic survey information for the period 1989-2005. 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	25,133	-	68,600	0.10
	Douglas Bank	22-26 Sept			28,200	-	-	-
1995	Area VIIa(N)	11-22 Sept	38,400	0.29	20,167	-	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	0.25	21426	0.25	-[2]	-
1997	Area VIIa(N)-reduced	8-12 Sept	20,100	0.28	10,702	0.35	46,600	0.20
1998	Area VIIa(N)	8-14 Sept	14,500	0.20	9,157	0.18	228,000	0.11
1999	Area VIIa(N)	6-17 Sept	31,600	0.59	21,040	0.75	272,200	0.10
2000	Area VIIa(N)	11-21 Sept	40,200	0.26	33,144	0.32	234,700	0.11
2001	Area VIIa(N)	10-18 Sept	35,400	0.40	13,647	0.42	299,700	0.08
2002	Area VIIa(N)	9-20 Sept	41,400	0.56	25,102	0.83	413,900	0.09
2003	Area VIIa(N)	7-20 Sept	49,500	0.22	24,390	0.24	265,900	0.10
2004	Area VIIa(N)	6-10, 15/16, 28/29 Sept	34,437	0.41	21,593	0.41	281,000	0.07
2005	Area VIIa(N)	29 Aug – 14 Sept	36,866	0.37	31,445	0.42	141,900	0.10

[1] sprat only; [2]Data can be made available for the IoM waters only

Table 7.2.5 Irish Sea Herring Division VIIa(N). Age-disaggregated acoustic estimates of herring abundance from the Northern Ireland surveys in September (ACAGE).

Age (rings)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	66.8	319.1	11.3	134.1	110.4	157.8	78.5	387.6	391.0	349.2	241.0	94.3
2	68.3	82.3	42.4	50.0	27.3	77.7	103.4	93.4	71.9	220.0	115.5	109.9
3	73.5	11.9	67.5	14.8	8.1	34.0	105.3	10.1	31.7	32.0	29.6	97.1
4	11.9	29.2	9.0	11.0	9.3	5.1	27.5	17.5	24.8	4.7	15.4	17.0
5	9.3	4.6	26.5	7.8	6.5	10.3	8.1	7.7	31.3	3.9	2.1	8.0
6	7.6	3.5	4.2	4.6	1.8	13.5	5.4	1.4	14.8	4.1	2.3	0.8
7	3.9	4.9	5.9	0.6	2.3	1.6	4.9	0.6	2.8	1.0	0.2	0.6
8+	10.1	6.9	5.8	1.9	0.8	6.3	2.4	2.2	4.5	0.9	0.2	5.8

Table 7.2.6 Irish Sea Herring Division VIIa(N). Larval production (10^{11}) indices for the Manx component.

YEAR	DOUGLAS BANK			NORTHEAST IRISH SEA					
	Isle of Man			Isle of Man			Northern Ireland		
	Date	Production	SE	Date	Production	SE	Date	Production	CV
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	0.48
1994	13 Oct	7.26	2.26	24 Nov	12.5	-	16 Nov	71.2	0.12
1995	19 Oct	1.58	1.68	-	-	-	28 Nov	15.1	0.62
1996	-	-	-	26 Nov	0.3	-	19 Nov	4.7	0.30
1997	15 Oct	5.59	1.25	1 Dec	35.9	-	4 Nov	29.1	0.11
1998	6 Nov	2.27	1.43	1 Dec	3.5	-	3 Nov	5.8	1.02
1999	25 Oct	3.87	0.88	-	-	-	9 Nov	16.7	0.57
2000	-	-	-	-	-	-	11 Nov	35.5	0.12
2001	-	-	-	11 Dec	198.6	-	7 Nov	55.3	0.55
2002	-	-	-	6 Dec	19.8	-	4 Nov	31.5	0.47
2003	-	-	-	-	-	-	9 Nov	15.8	0.58
2004	-	-	-	-	-	-	30 Oct	22.7	0.48
2005	-	-	-	-	-	-	6 Nov	33.1	

SE = Standard Error

Table 7.2.7 Irish Sea herring Division VIIa(N). Northern Ireland groundfish survey indices for herring (Nos. per 3 miles.)

(a) 0-ring herring: October survey

	Western Irish Sea			Eastern Irish Sea			Total Irish Sea		
Survey	Mean	N.obs	SE	Mean	N.obs.	SE	Mean	N. obs	SE
1991	54	34	22						
1992	210	31	99	240	8	149	177	46	68
1993	633	26	331	498	10	270	412	44	155
1994	548	26	159	8	7	5	194	41	55
1995	67	22	23	35	9	18	37	35	11
1996	90	26	58	131	9	79	117	42	50
1997	281	26	192	68	9	42	138	43	70
1998	980	26	417	12	9	10	347	43	144
1999	389	26	271	90	9	29	186	43	96
2000	202	24	144	367	9	190	212	38	89
2001	553	26	244	236	11	104	284	45	93
2002	132	26	84	18	11	10	63	45	31
2003	1203	26	855	75	11	47	446	45	296
2004	838	26	292	447	11	191	469	45	125
2005	1516	26	1036	256	11	152	627	45	363

(b) 1-ring herring: March Surveys.

	Western Irish Sea			Eastern Irish Sea			Total Irish Sea		
Survey	Mean	N.obs	SE	Mean	N.obs.	SE	Mean	N.obs	SE
1992	392	20	198	115	10	73	190	34	77
1993	1755	27	620	175	10	66	681	45	216
1994	2472	25	1852	106	9	51	923	39	641
1995	1299	26	679	73	8	32	480	42	235
1996	1055	22	638	285	9	164	487	39	230
1997	1473	26	382	260	9	96	612	43	137
1998	3953	26	1331	250	9	184	1472	43	466
1999	5845	26	1860	736	9	321	2308	42	655
2000	2303	26	853	546	10	217	1009	44	306
2001	3518	26	916	1265	11	531	1763	45	381
2002[a]	2255	25	845	185	11	84	852	44	294
2002[b]	7870	26	5667	185	11	84	2794	45	1960
2003	2103	26	876	896	11	604	1079	45	382
2004	6611	25	2726	491	11	163	2486	44	945
2005	7274	26	3097	1240	8	375	3001	42	1121

a. Unusually large catch removed, b. unusually large catch retained.

Table 7.2.7 Irish Sea herring Division VIIa(N). Northern Ireland groundfish survey indices for herring (Nos. per 3 miles.). Continued.

(c) 1-ring herring: October Surveys

	Western Irish Sea			Eastern Irish Sea			Total Irish Sea		
Survey	Mean	N.obs	SE	Mean	N.obs.	SE	Mean	N.obs	SE
1991	102	34	34	n/a	n/a	n/a	n/a	n/a	n/a
1992	36	31	18	20	8	11	21	46	8
1993	122	26	66	4	10	2	44	44	23
1994	490	26	137	17	6	10	176	40	47
1995	153	22	61	3	9	1	55	35	21
1996	30	26	13	2	9	1	11	42	5
1997	612	26	369	0.2	9	0.2	302	43	156
1998	39	26	15	13	9	10	53	43	35
1999	81	26	41	104	9	95	74	43	40
2000	455	24	250	74	9	52	579	38	403
2001	1412	26	641	5	11	3	513	45	223
2002	370	26	111	4	11	2	291	45	158
2003	314	26	143	410	11	350	267	45	144
2004	710	26	298	103	11	74	299	45	108
2005	3217	25	1467	18	11	12	1121	44	507

Table 7.3.1 Irish Sea Herring Division VIIa(N). Mean length-at-age in the catch.

Year	Lengths-at-age (cm)							
	Age (rings)							
	1	2	3	4	5	6	7	8+
1985	22.1	24.3	26.1	27.6	28.3	28.6	29.5	30.1
1986	19.7	24.3	25.8	26.9	28.0	28.8	28.8	29.8
1987	20.0	24.1	26.3	27.3	28.0	29.2	29.4	30.1
1988	20.2	23.5	25.7	26.3	27.2	27.7	28.7	29.6
1989	20.9	23.8	25.8	26.8	27.8	28.2	28.0	29.5
1990	20.1	24.2	25.6	26.2	27.7	28.3	28.3	29.0
1991	20.5	23.8	25.4	26.1	26.8	27.3	27.7	28.7
1992	19.0	23.7	25.3	26.2	26.7	27.2	27.9	29.4
1993	21.6	24.1	25.9	26.7	27.2	27.6	28.0	28.7
1994	20.1	23.9	25.5	26.5	27.0	27.4	27.9	28.4
1995	20.4	23.6	25.2	26.3	26.8	27.0	27.6	28.3
1996	19.8	23.5	25.3	26.0	26.6	27.6	27.6	28.2
1997	19.6	23.6	25.1	26.0	26.5	27.1	27.7	28.2
1998	20.8	23.8	25.2	26.1	27.0	26.8	27.2	28.7
1999	19.8	23.6	25.0	26.1	26.5	27.1	27.2	28.0
2000	19.7	23.8	25.3	26.3	27.1	27.7	27.7	28.1
2001	20.0	22.9	24.8	25.7	26.2	26.9	27.5	27.8
2002	21.1	23.1	24.8	26.0	26.6	26.7	27.0	28.1
2003	21.1	23.7	25.0	26.5	26.9	27.1	27.8	28.5
2004	20.7	23.1	24.6	25.8	26.1	27.1	27.6	28.3
2005	20.0	22.6	24.5	25.5	26.0	26.6	27.1	27.8

Table 7.3.2 Irish Sea Herring Division VIIa(N). Mean weights-at-age in the catch.

Year	Weights-at-age (g)							
	Age (rings)							
	1	2	3	4	5	6	7	8+
1985	87	125	157	186	202	209	222	258
1986	68	143	167	188	215	229	239	254
1987	58	130	160	175	194	210	218	229
1988	70	124	160	170	180	198	212	232
1989	81	128	155	174	184	195	205	218
1990	77	135	163	175	188	196	207	217
1991	70	121	153	167	180	189	195	214
1992	61	111	136	151	159	171	179	191
1993	88	126	157	171	183	191	198	214
1994	73	126	154	174	181	190	203	214
1995	72	120	147	168	180	185	197	212
1996	67	116	148	162	177	199	200	214
1997	64	118	146	165	176	188	204	216
1998	80	123	148	163	181	177	188	222
1999	69	120	145	167	176	188	190	210
2000	64	120	148	168	188	204	200	213
2001	67	106	139	156	168	185	198	205
2002	85	113	144	167	180	184	191	217
2003*	81	116	136	160	167	172	186	199
2004	73	107	130	157	165	187	200	205
2005	67	103	136	156	166	180	191	209

*** Average for the preceding five years**

Table 7.3.3 Irish Sea Herring Division VIIa(N). Maturity ogive (maturity in the catch).

YEAR				AGE (RINGS)				
	1	2	3	4	5	6	7	8+
1961	0.00	0.22	0.63	1.00	1.00	1.00	1.00	1.00
1962	0.00	0.24	0.83	0.92	1.00	1.00	1.00	1.00
1963	0.00	0.34	0.88	0.89	1.00	1.00	1.00	1.00
1964	0.00	0.53	0.81	1.00	1.00	1.00	1.00	1.00
1965	0.00	0.61	0.90	1.00	1.00	1.00	1.00	1.00
1966	0.00	0.47	0.91	1.00	1.00	1.00	1.00	1.00
1967	0.02	0.37	0.75	0.83	1.00	1.00	1.00	1.00
1968	0.00	0.88	0.94	0.94	1.00	1.00	1.00	1.00
1969	0.00	0.71	0.92	0.94	1.00	1.00	1.00	1.00
1970	0.02	0.92	0.94	0.96	1.00	1.00	1.00	1.00
1971	0.15	0.87	0.97	0.98	1.00	1.00	1.00	1.00
1972	0.11	0.88	0.90	1.00	1.00	1.00	1.00	1.00
1973	0.12	0.77	0.89	0.97	1.00	1.00	1.00	1.00
1974	0.36	0.99	0.96	1.00	1.00	1.00	1.00	1.00
1975	0.40	0.99	1.00	0.94	1.00	1.00	1.00	1.00
1976	0.07	0.96	0.98	1.00	1.00	1.00	1.00	1.00
1977	0.03	0.92	0.96	1.00	1.00	1.00	1.00	1.00
1978	0.04	0.81	0.88	0.91	1.00	1.00	1.00	1.00
1979	0.00	0.84	0.81	0.78	1.00	1.00	1.00	1.00
1980	0.20	0.88	0.95	0.95	1.00	1.00	1.00	1.00
1981	0.19	0.89	0.90	0.94	1.00	1.00	1.00	1.00
1982	0.10	0.80	0.89	0.91	1.00	1.00	1.00	1.00
1983	0.02	0.73	0.88	0.90	1.00	1.00	1.00	1.00
1984	0.00	0.69	0.83	0.93	1.00	1.00	1.00	1.00
1985	0.14	0.62	0.71	0.88	1.00	1.00	1.00	1.00
1986	0.31	0.73	0.66	0.81	1.00	1.00	1.00	1.00
1987	0.00	0.85	0.91	0.87	1.00	1.00	1.00	1.00
1988	0.00	0.90	0.96	0.99	1.00	1.00	1.00	1.00
1989	0.07	0.63	0.93	0.95	1.00	1.00	1.00	1.00
1990	0.06	0.66	0.90	0.95	1.00	1.00	1.00	1.00
1991	0.04	0.30	0.74	0.82	1.00	1.00	1.00	1.00
1992	0.28	0.48	0.72	0.81	1.00	1.00	1.00	1.00
1993	0.00	0.46	0.99	1.00	1.00	1.00	1.00	1.00
1994	0.19	0.68	0.99	0.97	1.00	1.00	1.00	1.00
1995	0.10	0.86	0.94	0.99	1.00	1.00	1.00	1.00
1996	0.02	0.60	0.96	0.83	1.00	1.00	1.00	1.00
1997	0.04	0.82	0.95	1.00	1.00	1.00	1.00	1.00
1998	0.30	0.83	0.97	0.99	1.00	1.00	1.00	1.00
1999	0.02	0.84	0.95	0.97	1.00	1.00	1.00	1.00
2000	0.14	0.79	0.99	1.00	1.00	1.00	1.00	1.00
2001	0.15	0.54	0.88	0.97	1.00	1.00	1.00	1.00
2002	0.02	0.92	0.95	0.98	1.00	1.00	1.00	1.00
*2003	0.11	0.76	0.95	0.97	1.00	1.00	1.00	1.00
2004	0.11	1.00	0.97	1.00	1.00	1.00	1.00	1.00
2005	0.20	0.97	0.99	1.00	1.00	1.00	1.00	1.00

* Average for the preceding nine years

Table 7.5.1 Irish Sea herring VIIa(N). ICA run log for the maximun-likelihood ICA calculation for the 6 year separable period. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

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

                                 Version 1.4 w

                                 K.R.Patterson
                           Fisheries Research Services
                                Marine Laboratory
                                    Aberdeen

                                  8 March 1998

 Enter the name of the index file -->index.txt
canum.txt
weca.txt
 Stock weights in 2006  used for the year 2005
west.txt
 Natural mortality in 2006  used for the year 2005
natmor.txt
 Maturity ogive in 2006  used for the year 2005
matprop.txt
 Name of age-structured index file (Enter if none) : -->fleet.txt
 Name of the SSB index file (Enter if none) -->ssb.txt
 No of years for separable constraint ?--> 6
 Reference age for separable constraint ?--> 4
 Constant selection pattern model (Y/N) ?-->y
 S to be fixed on last age ?-->    1.000000000000000
 First age for calculation of reference F ?--> 2
 Last age for calculation of reference F ?--> 6
 Use default weighting (Y/N) ?-->n
Enter relative weights at age
 Weight for age 1-->    0.100000000000000
 Weight for age 2-->    1.000000000000000
 Weight for age 3-->    1.000000000000000
 Weight for age 4-->    1.000000000000000
 Weight for age 5-->    1.000000000000000
 Weight for age 6-->    1.000000000000000
 Weight for age 7-->    1.000000000000000
 Weight for age 8-->    1.000000000000000
Enter relative weights by year
 Weight for year 2000-->    1.000000000000000
 Weight for year 2001-->    1.000000000000000
 Weight for year 2002-->    1.000000000000000
 Weight for year 2003-->    1.000000000000000
 Weight for year 2004-->    1.000000000000000
 Weight for year 2005-->    1.000000000000000
Enter new weights for specified years and ages if needed
Enter year, age, new weight or -1,-1,-1 to end.  -1 -1   -1.000000000000000
Is the last age of FLT01: Northern Ireland acoustic surveys a plus-group (Y-->y
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.
```

Table 7.5.1 Irish Sea herring VIIa(N). ICA run log. Continued.

```
Model for   NINEL  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-->   5.0000000000000003E-02
Enter highest feasible F-->    2.000000000000000
Mapping the F-dimension of the SSQ surface

    F                 SSQ
+--------+------------------
    0.05        35.3895130929
    0.15        21.2555150480
    0.26        18.4734517107
    0.36        17.5258116407
    0.46        17.2019672374
    0.56        17.1788897908
    0.67        17.3365330547
    0.77        17.6269343828
    0.87        18.0427114103
    0.97        18.6260747316
    1.08        19.3455773597
    1.18        19.9492333753
    1.28        20.2107748791
    1.38        20.4680243281
    1.49        20.7195787812
    1.59        20.9645945940
    1.69        21.2025938681
    1.79        21.4333405545
    1.90        21.6567600715
    2.00        21.8729083158
Lowest SSQ is for F =     0.519
-----------------------------------------------------------------
No of years for separable analysis : 6
Age range in the analysis : 1  . . . 8
Year range in the analysis : 1961  . . . 2005
Number of indices of SSB : 1
Number of age-structured indices : 1

Parameters to estimate : 32
Number of observations : 151

Conventional single selection vector model to be fitted.
-----------------------------------------------------------------
Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
Enter weight for   NINEL-->    1.000000000000000
Enter weight for FLT01: Northern Ireland acoustic surveys at age 1-->    0.10
 Enter weight for FLT01: Northern Ireland acoustic surveys  at age 2-->    1.00
 Enter weight for FLT01: Northern Ireland acoustic surveys  at age 3-->    1.00
 Enter weight for FLT01: Northern Ireland acoustic surveys  at age 4-->    1.00
 Enter weight for FLT01: Northern Ireland acoustic surveys  at age 5-->    1.00
 Enter weight for FLT01: Northern Ireland acoustic surveys  at age 6-->    1.00
 Enter weight for FLT01: Northern Ireland acoustic surveys  at age 7-->    1.00
 Enter weight for FLT01: Northern Ireland acoustic surveys  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
Seeking solution. Please wait.
SSB index weights
  1.000
Aged index weights
FLT01: Northern Ireland acoustic surveys
 Age   :       1     2     3     4     5     6     7     8
 Wts :     0.012 0.125 0.125 0.125 0.125 0.125 0.125 0.125
F in 2005  at age 4  is 0.399402  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  ?--> 100
 Enter SSB reference level (e.g. MBAL, Bpa..) [t]-->   1.0000000000000000E+04
Succesful exit
```

Table 7.5.2 Irish Sea herring VIIa(N). Catch number-at-age (millions). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Output Generated by ICA Version 1.4

Herring Irish Sea

Catch in Number

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	4.54	0.38	4.84	1.51	0.85	0.94	4.44	1.02
2	11.47	12.30	9.44	18.10	27.08	15.05	40.92	30.18
3	2.63	7.34	2.34	4.35	8.18	15.64	5.60	13.46
4	12.43	1.81	2.89	0.71	0.99	2.00	4.63	4.08
5	0.24	5.43	2.26	0.53	0.71	0.12	1.35	0.82
6	0.48	0.19	2.26	0.71	0.99	0.35	0.00	0.61
7	1.20	0.19	0.55	0.00	0.42	0.12	0.00	0.00
8	2.15	0.67	0.62	0.18	0.71	0.00	0.00	0.00

x 10 ^ 6

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	1.32	5.61	12.17	40.64	42.15	43.25	33.33	34.74
2	42.80	31.18	66.92	46.66	32.74	109.55	48.24	56.16
3	16.91	33.63	31.94	26.95	38.24	39.75	39.41	20.78
4	12.68	16.47	29.41	13.18	11.49	24.51	10.84	15.22
5	1.32	12.61	5.07	13.75	6.92	10.65	7.87	4.58
6	2.64	1.75	3.55	6.76	5.07	4.99	4.21	2.81
7	0.53	2.10	1.01	2.66	2.59	5.15	2.09	2.42
8	0.00	1.05	1.01	1.67	2.60	1.63	1.64	1.27

x 10 ^ 6

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	30.28	15.54	11.77	5.84	5.05	5.10	1.31	1.17
2	39.04	36.95	38.27	25.76	15.79	16.03	12.16	8.42
3	22.69	13.41	23.49	19.51	3.20	5.67	5.60	7.24
4	6.75	6.78	4.25	8.52	2.79	2.15	2.82	3.84
5	4.52	1.74	2.20	1.98	2.30	0.33	0.45	2.22
6	1.46	1.34	1.05	0.91	0.33	1.11	0.48	0.38
7	0.91	0.67	0.40	0.36	0.29	0.14	0.26	0.23
8	1.12	0.35	0.29	0.23	0.24	0.38	0.06	0.48

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	2.43	4.49	2.23	2.61	1.16	2.31	2.00	12.15
2	10.05	15.27	12.98	21.25	6.39	12.84	9.75	6.89
3	17.34	7.46	6.15	13.34	12.04	5.73	6.74	6.74
4	13.29	8.55	3.00	7.16	4.71	9.70	2.83	6.69
5	7.21	4.53	4.18	4.61	1.88	3.60	5.07	3.26
6	2.65	3.20	2.78	5.08	1.25	1.66	1.49	5.12
7	0.67	1.46	2.33	3.23	1.56	1.04	0.72	1.04
8	0.72	0.88	1.67	4.21	1.96	1.62	0.81	0.39

x 10 ^ 6

Table 7.5.2 Irish Sea herring VIIa(N). Catch number-at-age (millions). Continued.

Catch in Number

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.65	1.97	3.20	5.34	9.55	3.07	1.81	1.22
2	14.64	7.00	21.33	17.53	21.39	11.88	16.93	3.74
3	3.01	12.17	3.39	9.76	7.56	3.88	5.94	5.87
4	3.02	1.83	5.27	1.16	7.34	4.45	1.57	2.07
5	2.90	2.57	1.20	3.60	1.64	6.67	1.48	0.56
6	1.61	2.10	1.15	0.78	2.28	1.03	1.99	0.35
7	2.18	1.28	0.93	0.96	0.84	2.05	0.44	0.25
8	0.85	1.99	1.45	1.36	1.43	0.45	0.62	0.15

x 10 ^ 6

Catch in Number

AGE	2001	2002	2003	2004	2005
1	2.71	0.18	0.69	3.23	8.69
2	11.47	9.02	4.69	8.83	13.98
3	7.15	1.89	3.35	5.41	10.56
4	13.05	1.87	2.56	2.16	3.29
5	3.39	2.40	0.88	0.62	1.42
6	0.94	0.95	2.95	0.21	0.41
7	0.65	0.47	0.87	0.67	0.29
8	0.80	0.34	0.61	0.06	0.32

x 10 ^

Table 7.5.3 Irish Sea herring VIIa(N). Weight in the catch (kg). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Weights at age in the catches (Kg)

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	0.08200	0.06700	0.06700	0.07800	0.06500	0.09200	0.09300	0.09100
2	0.12300	0.12500	0.13100	0.12900	0.13200	0.14000	0.14900	0.15300
3	0.17800	0.15200	0.18400	0.15600	0.17600	0.18500	0.18000	0.19600
4	0.19800	0.17700	0.20800	0.17100	0.19200	0.21800	0.19900	0.23100
5	0.23200	0.19900	0.22800	0.22600	0.21000	0.25800	0.22300	0.24600
6	0.22600	0.21400	0.23400	0.24000	0.23000	0.25300	0.24300	0.26900
7	0.25300	0.27500	0.26600	0.00000	0.27200	0.22500	0.22700	0.23400
8	0.24800	0.25100	0.25800	0.29600	0.26500	0.26400	0.27500	0.26400

Table 7.5.3 Irish Sea herring VIIa(N). Weight in the catch (kg). Continued.

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	0.07400	0.10100	0.10800	0.07400	0.07400	0.07400	0.07400	0.07400
2	0.15200	0.16200	0.15800	0.15500	0.15500	0.15500	0.15500	0.15500
3	0.20400	0.20600	0.18900	0.19500	0.19500	0.19500	0.19500	0.19500
4	0.23100	0.22500	0.21400	0.21900	0.21900	0.21900	0.21900	0.21900
5	0.25400	0.24500	0.22500	0.23200	0.23200	0.23200	0.23200	0.23200
6	0.26600	0.25100	0.26600	0.25100	0.25100	0.25100	0.25100	0.25100
7	0.23900	0.26900	0.24100	0.25800	0.25800	0.25800	0.25800	0.25800
8	0.27000	0.25800	0.24100	0.27800	0.27800	0.27800	0.27800	0.27800

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07600
2	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.14200
3	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.18700
4	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21300
5	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.22100
6	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.24300
7	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.24000
8	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27300

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	0.08700	0.06800	0.05800	0.07000	0.08100	0.09600	0.07300	0.06200
2	0.12500	0.14300	0.13000	0.12400	0.12800	0.14000	0.12300	0.11400
3	0.15700	0.16700	0.16000	0.16000	0.15500	0.16600	0.15500	0.14000
4	0.18600	0.18800	0.17500	0.17000	0.17400	0.17500	0.17100	0.15500
5	0.20200	0.21500	0.19400	0.18000	0.18400	0.18700	0.18100	0.16500
6	0.20900	0.22800	0.21000	0.19800	0.19500	0.19500	0.19000	0.17400
7	0.22200	0.23900	0.21800	0.21200	0.20500	0.20700	0.19800	0.18100
8	0.25800	0.25400	0.22900	0.23200	0.21800	0.21800	0.21700	0.19700

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.08900	0.07000	0.07500	0.06700	0.06400	0.08000	0.06900	0.06400
2	0.12700	0.12300	0.12100	0.11600	0.11800	0.12300	0.12000	0.12000
3	0.15700	0.15300	0.14600	0.14800	0.14600	0.14800	0.14500	0.14800
4	0.17100	0.17000	0.16400	0.16200	0.16500	0.16300	0.16700	0.16800
5	0.18200	0.18000	0.17600	0.17700	0.17600	0.18100	0.17600	0.18800
6	0.19100	0.18900	0.18100	0.19900	0.18800	0.17700	0.18800	0.20400
7	0.19800	0.20200	0.19300	0.20000	0.20400	0.18800	0.19000	0.20000
8	0.21200	0.21200	0.20700	0.21400	0.21600	0.22200	0.21000	0.21300

AGE	2001	2002	2003	2004	2005
1	0.06700	0.08500	0.08100	0.07300	0.06700
2	0.10600	0.11300	0.11600	0.10700	0.10300
3	0.13900	0.14400	0.13600	0.13000	0.13600
4	0.15600	0.16700	0.16000	0.15700	0.15600
5	0.16800	0.18000	0.16700	0.16500	0.16600
6	0.18500	0.18400	0.17200	0.18700	0.18000
7	0.19800	0.19100	0.18600	0.20000	0.19100
8	0.20500	0.21700	0.19900	0.20500	0.21900

Table 7.5.4 Irish Sea herring VIIa(N). Weight in the stock (kg). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Weights at age in the stock (Kg)

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	0.08200	0.06700	0.06700	0.07800	0.06500	0.09200	0.09300	0.09100
2	0.12300	0.12500	0.13100	0.12900	0.13200	0.14000	0.14900	0.15300
3	0.17800	0.15200	0.18400	0.15600	0.17600	0.18500	0.18000	0.19600
4	0.19800	0.17700	0.20800	0.17100	0.19200	0.21800	0.19900	0.23100
5	0.23200	0.19900	0.22800	0.22600	0.21000	0.25800	0.22300	0.24600
6	0.22600	0.21400	0.23400	0.24000	0.23000	0.25300	0.24300	0.26900
7	0.25300	0.27500	0.26600	0.00000	0.27200	0.22500	0.22700	0.23400
8	0.24800	0.25100	0.25800	0.29600	0.26500	0.26400	0.27500	0.26400

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	0.07400	0.10100	0.10800	0.07400	0.07400	0.07400	0.07400	0.07400
2	0.15200	0.16200	0.15800	0.15500	0.15500	0.15500	0.15500	0.15500
3	0.20400	0.20600	0.18900	0.19500	0.19500	0.19500	0.19500	0.19500
4	0.23100	0.22500	0.21400	0.21900	0.21900	0.21900	0.21900	0.21900
5	0.25400	0.24500	0.22500	0.23200	0.23200	0.23200	0.23200	0.23200
6	0.26600	0.25100	0.26600	0.25100	0.25100	0.25100	0.25100	0.25100
7	0.23900	0.26900	0.24100	0.25800	0.25800	0.25800	0.25800	0.25800
8	0.27000	0.25800	0.24100	0.27800	0.27800	0.27800	0.27800	0.27800

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07600
2	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.14200
3	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.18700
4	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21300
5	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.22100
6	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.24300
7	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.24000
8	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27300

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	0.08700	0.06800	0.05800	0.07000	0.08100	0.07700	0.07000	0.06100
2	0.12500	0.14300	0.13000	0.12400	0.12800	0.13500	0.12100	0.11100
3	0.15700	0.16700	0.16000	0.16000	0.15500	0.16300	0.15300	0.13600
4	0.18600	0.18800	0.17500	0.17000	0.17400	0.17500	0.16700	0.15100
5	0.20200	0.21500	0.19400	0.18000	0.18400	0.18800	0.18000	0.15900
6	0.20900	0.22900	0.21000	0.19800	0.19500	0.19600	0.18900	0.17100
7	0.22200	0.23900	0.21800	0.21200	0.20500	0.20700	0.19500	0.17900
8	0.25800	0.25400	0.22900	0.23200	0.21800	0.21700	0.21400	0.19100

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.08800	0.07300	0.07200	0.06700	0.06300	0.07300	0.06800	0.06300
2	0.12600	0.12600	0.12000	0.11500	0.11900	0.12100	0.12100	0.12000
3	0.15700	0.15400	0.14700	0.14800	0.14800	0.15000	0.14500	0.14900
4	0.17100	0.17400	0.16800	0.16200	0.16700	0.16600	0.16800	0.17100
5	0.18300	0.18100	0.18000	0.17700	0.17800	0.17900	0.17800	0.18800
6	0.19100	0.19000	0.18500	0.19500	0.18900	0.19000	0.18900	0.20400
7	0.19800	0.20300	0.19700	0.19900	0.20600	0.20000	0.19900	0.20500
8	0.21400	0.21400	0.21200	0.21200	0.21400	0.23000	0.21400	0.21500

Table 7.5.4 Irish Sea herring VIIa(N). Weight in the stock (kg). Continued.

Weights at age in the stock (Kg)

AGE	2001	2002	2003	2004	2005
1	0.06600	0.08500	0.08100	0.06700	0.06700
2	0.10500	0.11300	0.11600	0.11400	0.10300
3	0.13900	0.14400	0.13600	0.14400	0.13600
4	0.15600	0.16700	0.16000	0.16100	0.15600
5	0.16700	0.18000	0.16700	0.17000	0.16600
6	0.18300	0.18400	0.17200	0.19200	0.18000
7	0.19900	0.19100	0.18600	0.20200	0.19100
8	0.20500	0.21700	0.19900	0.20500	0.20700

Table 7.5.5 Irish Sea herring VIIa(N). Natural mortality. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Natural Mortality (per year)

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Table 7.5.5 Irish Sea herring VIIa(N). Natural mortality. Continued.

Natural Mortality (per year)

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

AGE	2001	2002	2003	2004	2005
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

Table 7.5.6 Irish Sea herring VIIa(N). Proportion mature. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Proportion of fish spawning

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0200	0.0000
2	0.2200	0.2400	0.3400	0.5300	0.6100	0.4700	0.3700	0.8800
3	0.6300	0.8300	0.8800	0.8100	0.9000	0.9100	0.7500	0.9400
4	1.0000	0.9200	0.8900	1.0000	1.0000	1.0000	0.8300	0.9400
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 7.5.6 Irish Sea herring VIIa(N). Proportion mature. Continued.

Proportion of fish spawning

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	0.0000	0.0200	0.1500	0.1100	0.1200	0.3600	0.4000	0.0700
2	0.7100	0.9200	0.8700	0.8800	0.7700	0.9900	0.9900	0.9600
3	0.9200	0.9400	0.9700	0.9000	0.8900	0.9600	1.0000	0.9800
4	0.9400	0.9600	0.9800	1.0000	0.9700	1.0000	0.9400	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	0.0300	0.0400	0.0000	0.2000	0.1900	0.1000	0.0200	0.0000
2	0.9200	0.8100	0.8400	0.8800	0.8900	0.8000	0.7300	0.6900
3	0.9600	0.8800	0.8100	0.9500	0.9000	0.8900	0.8800	0.8300
4	1.0000	0.9100	0.7800	0.9500	0.9400	0.9100	0.9000	0.9300
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	0.1400	0.3100	0.0000	0.0000	0.0700	0.0600	0.0400	0.2800
2	0.6200	0.7300	0.8500	0.9000	0.6300	0.6600	0.3000	0.4800
3	0.7100	0.6600	0.9100	0.9600	0.9300	0.9000	0.7400	0.7200
4	0.8800	0.8100	0.8700	0.9900	0.9500	0.9500	0.8200	0.8100
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.0000	0.1900	0.1000	0.0200	0.0400	0.3000	0.0200	0.1400
2	0.4600	0.6800	0.8600	0.6000	0.8200	0.8300	0.8400	0.7900
3	0.9900	0.9900	0.9400	0.9600	0.9500	0.9700	0.9500	0.9900
4	1.0000	0.9700	0.9900	0.8300	1.0000	0.9900	0.9700	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	2001	2002	2003	2004	2005
1	0.1500	0.0200	0.1100	0.1140	0.2000
2	0.5400	0.9200	0.7600	1.0000	0.9700
3	0.8800	0.9500	0.9500	0.9700	0.9900
4	0.9700	0.9800	0.9700	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

Table 7.5.7 Irish Sea herring VIIa(N). Indices of spawning biomass.

INDICES OF SPAWNING BIOMASS

NINEL

	1989	1990	1991	1992	1993	1994	1995	1996
1	999990.	999990.	999990.	999990.	38300.	71200.	15100.	4700.

x 10 ^ -3

NINEL

	1997	1998	1999	2000	2001	2002	2003	2004
1	29100.	5800.	16700.	35500.	55300.	31500.	15800.	22700.

x 10 ^ -3

NINEL

	2005
1	33000.

x 10 ^ -3

Table 7.5.8 Irish Sea herring VIIa(N). Tuning indices. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

AGE-STRUCTURED INDICES

FLT01: Northern Ireland acoustic surveys

AGE	1994	1995	1996	1997	1998	1999	2000	2001
1	66.83	319.12	11.34	134.15	110.44	157.76	78.52	387.56
2	68.29	82.26	42.37	49.98	27.31	77.72	103.44	93.40
3	73.53	11.94	67.47	14.81	8.08	34.02	105.29	10.19
4	11.86	29.25	8.95	10.98	9.27	5.11	27.54	17.49
5	9.30	4.57	26.47	1.75	6.48	10.26	8.07	7.70
6	7.55	3.50	4.17	4.55	1.78	13.52	5.43	1.37
7	3.87	4.89	5.91	0.57	2.25	1.59	4.90	0.63
8	10.12	6.89	5.82	1.91	0.78	6.29	2.36	2.26

x 10 ^ 3

FLT01: Northern Ireland acoustic surveys

AGE	2002	2003	2004	2005
1	390.98	349.22	241.01	94.33
2	71.94	220.01	115.53	109.94
3	31.70	31.98	29.59	97.11
4	24.80	4.74	15.40	17.02
5	31.28	3.92	2.07	8.03
6	14.83	4.09	2.30	0.81
7	2.76	0.98	0.24	0.61
8	4.46	0.91	0.24	0.58

x 10 ^ 3

Table 7.5.9 Irish Sea herring VIIa(N). Fishing mortality (per year). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Fishing Mortality (per year)

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	0.1156	0.0115	0.0620	0.0109	0.0111	0.0041	0.0203	0.0029
2	0.5167	1.0475	0.8176	0.6372	0.4904	0.4976	0.4345	0.3217
3	0.3196	0.8134	0.6168	1.3774	0.7346	0.6369	0.3718	0.2637
4	0.7896	0.3603	0.8631	0.3611	1.5646	0.3727	0.3701	0.4823
5	0.1748	0.8690	0.9071	0.3289	0.6467	0.6990	0.4113	0.0914
6	0.8028	0.1847	1.0122	0.7195	1.5646	0.6990	0.2775	0.2944
7	0.6209	0.7854	1.0122	0.3611	1.1746	0.6990	0.3701	0.4823
8	0.6209	0.7854	1.0122	0.3611	1.1746	0.6990	0.3701	0.4823

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	0.0056	0.0186	0.0393	0.1666	0.1044	0.2143	0.1527	0.2304
2	0.2748	0.3031	0.5810	0.3626	0.3452	0.8260	0.7539	0.7961
3	0.3206	0.3855	0.6261	0.5285	0.6169	1.0189	0.9102	0.9816
4	0.4020	0.5593	0.6518	0.5451	0.4265	1.0144	0.8370	1.1117
5	0.2513	0.7811	0.2951	0.6442	0.5456	0.7836	0.9780	0.9440
6	0.4180	0.5410	0.4607	0.7016	0.4606	0.8601	0.7336	1.0622
7	0.3946	0.6081	0.6139	0.6616	0.5641	1.0603	0.9954	1.1564
8	0.3946	0.6081	0.6139	0.6616	0.5641	1.0603	0.9954	1.1564

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	0.1594	0.1049	0.1464	0.0646	0.0400	0.0376	0.0094	0.0149
2	0.8624	0.5435	0.7682	1.1264	0.4414	0.2966	0.2004	0.1294
3	1.0066	0.9379	0.8915	1.4084	0.4156	0.2983	0.1695	0.1866
4	1.0091	0.9386	0.8624	0.9449	0.7392	0.5172	0.2253	0.1597
5	1.1070	0.6889	0.8180	1.2136	0.6355	0.1552	0.1689	0.2483
6	0.8071	1.0897	1.0764	0.8638	0.5762	0.6417	0.3170	0.1907
7	1.1302	0.9906	1.0532	1.3149	0.6618	0.4552	0.2602	0.2172
8	1.1302	0.9906	1.0532	1.3149	0.6618	0.4552	0.2602	0.2172

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	0.0273	0.0437	0.0137	0.0396	0.0128	0.0333	0.0487	0.1033
2	0.2951	0.4195	0.2958	0.3005	0.2188	0.3318	0.3318	0.4147
3	0.4528	0.3978	0.3166	0.6051	0.2959	0.3316	0.3103	0.4315
4	0.5750	0.4004	0.2605	0.7020	0.4208	0.3904	0.2576	0.5451
5	0.4435	0.3471	0.3096	0.7009	0.3504	0.5821	0.3230	0.4661
6	0.4638	0.3202	0.3303	0.6663	0.3659	0.5277	0.4503	0.5534
7	0.5215	0.4466	0.3618	0.6970	0.3881	0.5190	0.4047	0.5723
8	0.5215	0.4466	0.3618	0.6970	0.3881	0.5190	0.4047	0.5723

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.0164	0.0158	0.0399	0.0759	0.1246	0.0243	0.0483	0.0096
2	0.3024	0.4359	0.4162	0.5765	0.9626	0.3982	0.3127	0.1705
3	0.3428	0.4741	0.4183	0.3642	0.5708	0.4833	0.3792	0.2137
4	0.3313	0.3418	0.3668	0.2328	0.4863	0.7521	0.3476	0.2284
5	0.4276	0.4602	0.3506	0.4077	0.5257	0.9855	0.5312	0.1895
6	0.3914	0.5567	0.3435	0.3593	0.4340	0.6526	0.8071	0.1713
7	0.4280	0.5460	0.4504	0.4730	0.7197	0.7721	0.5777	0.2284
8	0.4280	0.5460	0.4504	0.4730	0.7197	0.7721	0.5777	0.2284

Table 7.5.9 Irish Sea herring VIIa(N). Fishing mortality (per year). Continued.

AGE	2001	2002	2003	2004	2005
1	0.0347	0.0179	0.0222	0.0128	0.0168
2	0.6146	0.3182	0.3943	0.2268	0.2982
3	0.7703	0.3988	0.4941	0.2842	0.3737
4	0.8233	0.4262	0.5281	0.3038	0.3994
5	0.6829	0.3536	0.4381	0.2520	0.3313
6	0.6173	0.3196	0.3960	0.2278	0.2995
7	0.8233	0.4262	0.5281	0.3038	0.3994
8	0.8233	0.4262	0.5281	0.3038	0.3994

Table 7.5.10 Irish Sea herring VIIa(N). Population abundance (1 January, millions). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Population Abundance (1 January)

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	65.21	52.73	126.54	219.51	120.64	362.94	349.49	558.27
2	32.49	21.37	19.18	43.75	79.88	43.89	132.97	125.99
3	10.55	14.36	5.55	6.27	17.14	36.24	19.77	63.79
4	23.76	6.27	5.21	2.45	1.30	6.73	15.69	11.16
5	1.56	9.76	3.96	1.99	1.55	0.25	4.20	9.81
6	0.90	1.19	3.70	1.45	1.30	0.73	0.11	2.52
7	2.70	0.37	0.89	1.22	0.64	0.25	0.33	0.08
8	4.86	1.28	1.02	0.61	1.06	0.47	0.32	0.41

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	374.48	479.87	497.53	413.25	666.94	348.64	367.76	262.06
2	204.78	136.99	173.28	175.97	128.69	221.03	103.52	116.14
3	67.66	115.26	74.95	71.80	90.71	67.50	71.69	36.08
4	40.12	40.20	64.18	32.81	34.65	40.07	19.95	23.62
5	6.23	24.29	20.79	30.26	17.21	20.47	13.15	7.82
6	8.10	4.39	10.06	14.01	14.38	9.03	8.46	4.47
7	1.70	4.82	2.31	5.74	6.28	8.21	3.46	3.68
8	0.27	2.41	2.31	3.61	6.31	2.60	2.71	1.93

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	320.84	244.75	135.10	146.90	203.02	217.74	219.77	124.68
2	76.56	100.64	81.07	42.93	50.66	71.76	77.14	80.09
3	38.81	23.94	43.29	27.86	10.31	24.14	39.51	46.77
4	11.07	11.61	7.67	14.53	5.58	5.57	14.67	27.31
5	7.03	3.65	4.11	2.93	5.11	2.41	3.01	10.59
6	2.75	2.10	1.66	1.64	0.79	2.45	1.87	2.30
7	1.40	1.11	0.64	0.51	0.63	0.40	1.17	1.23
8	1.72	0.58	0.46	0.33	0.52	1.09	0.27	2.57

Table 7.5.10 Irish Sea herring VIIa(N). Population abundance (1 January, millions). Continued.

Population Abundance (1 January)

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	142.58	165.43	259.21	105.77	143.68	111.44	66.32	194.18
2	45.19	51.04	58.26	94.06	37.40	52.18	39.65	23.24
3	52.13	24.92	24.86	32.11	51.60	22.26	27.74	21.08
4	31.78	27.14	13.71	14.83	14.35	31.42	13.08	16.65
5	21.06	16.18	16.45	9.56	6.65	8.53	19.24	9.15
6	7.48	12.23	10.35	10.92	4.29	4.24	4.31	12.61
7	1.72	4.26	8.03	6.73	5.08	2.69	2.26	2.49
8	1.86	2.55	5.77	8.77	6.37	4.17	2.56	0.94

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	62.70	198.23	129.15	114.72	127.63	201.67	60.54	67.50
2	64.43	22.69	71.78	45.65	39.12	41.45	72.41	21.22
3	11.37	35.27	10.87	35.07	19.00	11.07	20.62	39.24
4	11.21	6.61	17.98	5.86	19.95	8.79	5.59	11.56
5	8.74	7.28	4.25	11.27	4.20	11.10	3.75	3.57
6	5.19	5.16	4.16	2.71	6.78	2.25	3.75	1.99
7	6.56	3.18	2.67	2.67	1.71	3.98	1.06	1.51
8	2.55	4.95	4.19	3.79	2.92	0.88	1.48	0.76

AGE	2001	2002	2003	2004	2005	2006
1	88.24	83.77	148.18	174.90	512.31	138.46
2	24.59	31.36	30.27	53.32	63.52	185.33
3	13.26	9.85	16.90	15.12	31.48	34.93
4	25.94	5.02	5.41	8.44	9.31	17.74
5	8.32	10.30	2.97	2.89	5.64	5.65
6	2.67	3.80	6.55	1.73	2.03	3.66
7	1.52	1.31	2.50	3.99	1.25	1.36
8	1.49	1.02	1.54	0.24	0.97	1.41

x 10 ^ 6

Table 7.5.11 Irish Sea herring VIIa(N). Weighting factors in number. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Weighting factors for the catches in number

AGE	2000	2001	2002	2003	2004	2005
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

Table 7.5.12 Irish Sea herring VIIa(N). Predicted SSB Index values. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Predicted SSB Index Values

	1993	1994	1995	1996	1997	1998	1999	2000
1	23116.	25902.	28518.	23620.	19954.	22667.	24012.	25989.

	2001	2002	2003	2004	2005
1	14433.	16538.	16215.	25067.	36270.

x 10 ^ -3

Table 7.5.13 Irish Sea herring VIIa(N). Predicted age-structured Index values. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Predicted Age-Structured Index Values

AGE	1994	1995	1996	1997	1998	1999	2000	2001
1	211.14	135.10	116.81	125.29	213.44	62.94	72.23	92.67
2	44.34	142.35	80.28	51.49	83.32	155.18	50.60	42.03
3	55.33	17.78	59.75	27.72	17.24	34.74	74.82	16.65
4	9.91	26.44	9.53	26.83	9.69	8.34	18.86	27.10
5	9.28	5.88	14.93	5.09	9.54	4.53	5.57	8.97
6	5.49	5.20	3.35	7.93	2.23	3.31	2.84	2.72
7	2.41	2.18	2.14	1.14	2.54	0.78	1.45	0.94
8	7.06	6.42	5.71	3.65	1.05	2.06	1.37	1.73

AGE	2002	2003	2004	2005
1	89.08	157.08	186.71	545.27
2	66.93	61.02	121.87	137.63
3	16.36	26.11	27.34	53.25
4	7.07	7.06	13.02	13.37
5	14.22	3.84	4.30	7.91
6	4.84	7.87	2.36	2.63
7	1.08	1.92	3.62	1.06
8	1.59	2.23	0.40	1.66

x 10 ^ 3

Table 7.5.14 Irish Sea herring VIIa(N). Fitted selection pattern. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Fitted Selection Pattern

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	0.1464	0.0319	0.0719	0.0302	0.0071	0.0110	0.0548	0.0060
2	0.6544	2.9076	0.9473	1.7645	0.3135	1.3351	1.1741	0.6670
3	0.4048	2.2578	0.7147	3.8141	0.4695	1.7090	1.0048	0.5467
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.2213	2.4119	1.0511	0.9108	0.4133	1.8755	1.1115	0.1896
6	1.0168	0.5127	1.1728	1.9922	1.0000	1.8755	0.7498	0.6104
7	0.7864	2.1798	1.1728	1.0000	0.7507	1.8755	1.0000	1.0000
8	0.7864	2.1798	1.1728	1.0000	0.7507	1.8755	1.0000	1.0000

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	0.0139	0.0333	0.0603	0.3057	0.2448	0.2112	0.1824	0.2073
2	0.6836	0.5419	0.8914	0.6653	0.8095	0.8142	0.9007	0.7160
3	0.7974	0.6893	0.9606	0.9696	1.4466	1.0044	1.0875	0.8829
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.6252	1.3967	0.4528	1.1818	1.2794	0.7725	1.1685	0.8491
6	1.0399	0.9673	0.7069	1.2872	1.0801	0.8479	0.8764	0.9554
7	0.9817	1.0873	0.9419	1.2138	1.3227	1.0452	1.1892	1.0401
8	0.9817	1.0873	0.9419	1.2138	1.3227	1.0452	1.1892	1.0401

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	0.1580	0.1118	0.1698	0.0684	0.0541	0.0728	0.0419	0.0934
2	0.8547	0.5791	0.8908	1.1921	0.5971	0.5735	0.8896	0.8101
3	0.9975	0.9992	1.0338	1.4906	0.5623	0.5767	0.7523	1.1681
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0971	0.7339	0.9484	1.2844	0.8597	0.3000	0.7497	1.5546
6	0.7998	1.1610	1.2481	0.9142	0.7795	1.2406	1.4075	1.1939
7	1.1201	1.0554	1.2212	1.3915	0.8954	0.8802	1.1553	1.3600
8	1.1201	1.0554	1.2212	1.3915	0.8954	0.8802	1.1553	1.3600

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	0.0474	0.1092	0.0524	0.0565	0.0304	0.0853	0.1889	0.1894
2	0.5132	1.0476	1.1353	0.4280	0.5200	0.8498	1.2882	0.7607
3	0.7874	0.9934	1.2153	0.8619	0.7033	0.8494	1.2047	0.7916
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.7712	0.8668	1.1886	0.9985	0.8328	1.4910	1.2539	0.8551
6	0.8065	0.7997	1.2680	0.9491	0.8695	1.3517	1.7483	1.0153
7	0.9069	1.1153	1.3887	0.9928	0.9224	1.3293	1.5713	1.0500
8	0.9069	1.1153	1.3887	0.9928	0.9224	1.3293	1.5713	1.0500

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.0495	0.0463	0.1088	0.3261	0.2563	0.0323	0.1388	0.0421
2	0.9128	1.2753	1.1345	2.4761	1.9795	0.5294	0.8996	0.7466
3	1.0345	1.3869	1.1402	1.5641	1.1738	0.6426	1.0910	0.9356
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.2905	1.3463	0.9557	1.7510	1.0811	1.3104	1.5282	0.8295
6	1.1812	1.6286	0.9365	1.5434	0.8924	0.8677	2.3219	0.7498
7	1.2919	1.5971	1.2279	2.0315	1.4799	1.0266	1.6620	1.0000
8	1.2919	1.5971	1.2279	2.0315	1.4799	1.0266	1.6620	1.0000

Table 7.5.14 Irish Sea herring VIIa(N). Fitted selection pattern. Continued.

Fitted Selection Pattern

AGE	2001	2002	2003	2004	2005
1	0.0421	0.0421	0.0421	0.0421	0.0421
2	0.7466	0.7466	0.7466	0.7466	0.7466
3	0.9356	0.9356	0.9356	0.9356	0.9356
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8295	0.8295	0.8295	0.8295	0.8295
6	0.7498	0.7498	0.7498	0.7498	0.7498
7	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000

Table 7.5.15 Irish Sea herring VIIa(N). Stock summary. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 6	SoP (%)
1961	65200	18381	4731	5710	1.2069	0.5207	99
1962	52730	12115	2851	4343	1.5230	0.6550	100
1963	126540	15367	2063	3947	1.9131	0.8434	100
1964	219500	25141	2424	3593	1.4818	0.6848	99
1965	120630	22727	4948	5923	1.1970	1.0002	99
1966	362930	48134	5618	5666	1.0084	0.5810	99
1967	349480	60121	8355	8721	1.0438	0.3730	99
1968	558270	88374	22194	8660	0.3902	0.2907	100
1969	374470	86125	30455	14141	0.4643	0.3333	99
1970	479860	112420	35702	20622	0.5776	0.5140	100
1971	497520	117481	34191	26807	0.7840	0.5229	100
1972	413250	92064	32672	27350	0.8371	0.5564	112
1973	666930	105555	30328	22600	0.7452	0.4790	100
1974	348630	91852	28271	38640	1.3667	0.9006	99
1975	367760	68428	20829	24500	1.1762	0.8426	102
1976	262050	54023	13086	21250	1.6239	0.9791	99
1977	320840	48764	8888	15410	1.7338	0.9584	95
1978	244750	42745	9717	11080	1.1402	0.8397	92
1979	135090	34350	8095	12338	1.5240	0.8833	92
1980	146890	27454	5565	10613	1.9070	1.1114	97
1981	203010	27796	7557	4377	0.5792	0.5616	90
1982	217730	34741	10600	4855	0.4580	0.3818	98
1983	219760	40678	14330	3933	0.2744	0.2162	98
1984	124670	39308	18141	4066	0.2241	0.1829	96
1985	142570	38827	13251	9187	0.6933	0.4460	102
1986	165430	35755	14169	7440	0.5251	0.3770	97
1987	259210	37420	13609	5823	0.4279	0.3026	103
1988	105770	34070	13755	10172	0.7395	0.5950	105
1989	143670	31409	11746	4949	0.4213	0.3304	100
1990	111430	28649	10697	6312	0.5900	0.4327	101
1991	66310	21137	7844	4398	0.5607	0.3346	100
1992	194180	24041	6919	5270	0.7617	0.4822	101
1993	62690	21772	7529	4409	0.5856	0.3591	101
1994	198220	27913	8436	4828	0.5722	0.4538	102
1995	129150	25479	9288	5076	0.5465	0.3791	99
1996	114720	22933	7693	5301	0.6890	0.3881	100
1997	127630	21845	6499	6651	1.0233	0.5959	100
1998	201660	26266	7383	4905	0.6643	0.6543	100
1999	60540	18710	7821	4127	0.5277	0.4756	99
2000	67490	16172	8465	2002	0.2365	0.1947	100
2001	88240	16783	4701	5461	1.1617	0.7017	99
2002	83760	15946	5386	2393	0.4442	0.3633	100
2003	148180	21072	5281	2399	0.4542	0.4501	99
2004	174890	23009	8164	2531	0.3100	0.2589	100
2005	512300	48342	11813	4387	0.3713	0.3404	99

```
No of years for separable analysis : 6
Age range in the analysis : 1  . . . 8
Year range in the analysis : 1961  . . . 2005
Number of indices of SSB : 1
Number of age-structured indices : 1

Parameters to estimate : 32
Number of observations : 151

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

Table 7.5.16 Irish Sea herring VIIa(N). Parameter estimates. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

PARAMETER ESTIMATES

Parm. No.			Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year									
1	2000		0.2284	22	0.1484	0.3516	0.1833	0.2846	0.2340
2	2001		0.8233	18	0.5674	1.1947	0.6809	0.9955	0.8383
3	2002		0.4262	21	0.2791	0.6509	0.3434	0.5290	0.4363
4	2003		0.5281	22	0.3373	0.8268	0.4202	0.6638	0.5421
5	2004		0.3038	25	0.1848	0.4994	0.2358	0.3915	0.3137
6	2005		0.3994	28	0.2274	0.7014	0.2997	0.5323	0.4162
Separable Model: Selection (S) by age									
7	1		0.0421	53	0.0148	0.1199	0.0247	0.0718	0.0485
8	2		0.7466	22	0.4850	1.1491	0.5991	0.9303	0.7649
9	3		0.9356	21	0.6185	1.4153	0.7575	1.1556	0.9567
	4		1.0000	Fixed : Reference Age					
10	5		0.8295	19	0.5714	1.2041	0.6859	1.0032	0.8446
11	6		0.7498	18	0.5180	1.0853	0.6208	0.9055	0.7632
	7		1.0000	Fixed : Last true age					
Separable model: Populations in year 2005									
12	1		512307	95	79526	3300273	198045	1325242	804788
13	2		63521	38	30003	134486	43323	93137	68348
14	3		31481	28	17889	55399	23594	42003	32817
15	4		9313	27	5461	15882	7093	12228	9665
16	5		5635	26	3364	9441	4331	7332	5834
17	6		2030	26	1204	3423	1555	2650	2104
18	7		1247	26	735	2116	952	1633	1293
Separable model: Populations at age									
19	2000		1512	39	691	3306	1014	2254	1637
20	2001		1519	29	857	2694	1134	2035	1586
21	2002		1304	28	751	2263	984	1727	1356
22	2003		2498	26	1481	4213	1914	3261	2589
23	2004		3985	27	2333	6808	3033	5237	4137
SSB Index catchabilities									
NINEL									
Linear model fitted. Slopes at age :									
24	1	Q	.3070E-02	11	.2736E-02	.4377E-02	.3070E-02	.3902E-02	.3486E-02
Age-structured index catchabilities									
FLT01: Northern Ireland acoustic survey									
Linear model fitted. Slopes at age :									
25	1	Q	2.282	97	.8925	41.24	2.282	16.13	9.786
26	2	Q	3.393	31	2.506	8.641	3.393	6.381	4.891
27	3	Q	2.601	31	1.922	6.613	2.601	4.886	3.746
28	4	Q	2.088	31	1.541	5.324	2.088	3.930	3.011
29	5	Q	1.939	31	1.429	4.976	1.939	3.665	2.805
30	6	Q	1.744	32	1.279	4.531	1.744	3.324	2.536
31	7	Q	1.230	33	.8958	3.269	1.230	2.381	1.807
32	8	Q	2.315	32	1.697	6.030	2.315	4.421	3.371

Table 7.5.17 Irish Sea herring VIIa(N). Residuals about the model fit. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	2000	2001	2002	2003	2004	2005
1	1.095	0.353	-1.662	-1.090	0.830	0.475
2	0.260	0.147	0.192	-0.606	-0.062	-0.019
3	-0.156	0.090	-0.445	-0.588	0.462	0.165
4	-0.086	-0.066	0.114	0.187	0.024	0.115
5	-0.052	-0.152	-0.201	-0.131	0.015	-0.065
6	0.148	-0.230	-0.041	0.365	-0.458	-0.190
7	-0.160	-0.229	0.091	-0.117	-0.393	-0.296

SPAWNING BIOMASS INDEX RESIDUALS

NINEL

	1989	1990	1991	1992	1993	1994	1995	1996
1	*******	*******	*******	*******	0.505	1.011	-0.636	-1.615

NINEL

	1997	1998	1999	2000	2001	2002	2003	2004
1	0.377	-1.363	-0.363	0.312	1.343	0.644	-0.026	-0.099

NINEL

	2005
1	-0.094

AGE-STRUCTURED INDEX RESIDUALS

Age	1994	1995	1996	1997	1998	1999	2000	2001
1	-1.150	0.860	-2.332	0.068	-0.659	0.919	0.084	1.431
2	0.432	-0.548	-0.639	-0.030	-1.115	-0.691	0.715	0.799
3	0.284	-0.399	0.122	-0.627	-0.758	-0.021	0.342	-0.491
4	0.180	0.101	-0.062	-0.893	-0.045	-0.490	0.379	-0.438
5	0.002	-0.250	0.572	-1.068	-0.386	0.818	0.370	-0.152
6	0.318	-0.396	0.221	-0.554	-0.225	1.407	0.649	-0.685
7	0.474	0.809	1.018	-0.689	-0.121	0.706	1.214	-0.402
8	0.360	0.071	0.019	-0.648	-0.301	1.114	0.546	0.268

Age	2002	2003	2004	2005
1	1.479	0.799	0.255	-1.754
2	0.072	1.282	-0.053	-0.225
3	0.662	0.203	0.079	0.601
4	1.255	-0.399	0.168	0.241
5	0.788	0.020	-0.733	0.015
6	1.119	-0.655	-0.028	-1.176
7	0.935	-0.675	-2.723	-0.554
8	1.034	-0.901	-0.520	-1.050

Table 7.5.18 Irish Sea herring VIIa(N). Residuals about the model fit. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

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

 Separable model fitted from 2000  to 2005
 Variance                            0.1522
Skewness test stat.                 -2.3721
Kurtosis test statistic             -0.2312
Partial chi-square                   0.3873
Significance in fit                  0.0000
Degrees of freedom                       19


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


   DISTRIBUTION STATISTICS FOR   NINEL


 Linear catchability relationship assumed
 Last age is a plus-group

 Variance                            0.7297
Skewness test stat.                 -0.6370
Kurtosis test statistic             -0.3368
Partial chi-square                   2.8843
Significance in fit                  0.0037
Number of observations                   13
Degrees of freedom                       12
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 0.0191		0.0622	0.0276	0.0369	0.0417	0.0750	0.1544	0.0626
Skewness test stat.	-0.8383	0.3482	-0.3662	0.9055	-0.2881	0.5867	-1.6043	0.1473
Kurtosis test statisti	-0.5701	-0.5780	-0.8072	0.5126	-0.4976	-0.5405	0.6468	-0.7446
Partial chi-square	0.0177	0.0613	0.0301	0.0435	0.0523	0.1006	0.2192	0.0921
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	0.0125	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250

Table 7.5.19 Irish Sea herring VIIa(N). Analyses of variance. N.B. In this table “age” refers to number of rings (winter rings in the otolith).

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	74.5300	151	32	119	0.6263
Catches at age	8.4585	42	23	19	0.4452
SSB Indices					
NINEL	8.7568	13	1	12	0.7297
Aged Indices					
FLT01: Northern Ireland acoustic surve	57.3147	96	8	88	0.6513

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	12.2837	151	32	119	0.1032
Catches at age	2.8914	42	23	19	0.1522
SSB Indices					
NINEL	8.7568	13	1	12	0.7297
Aged Indices					
FLT01: Northern Ireland acoustic surve	0.6355	96	8	88	0.0072

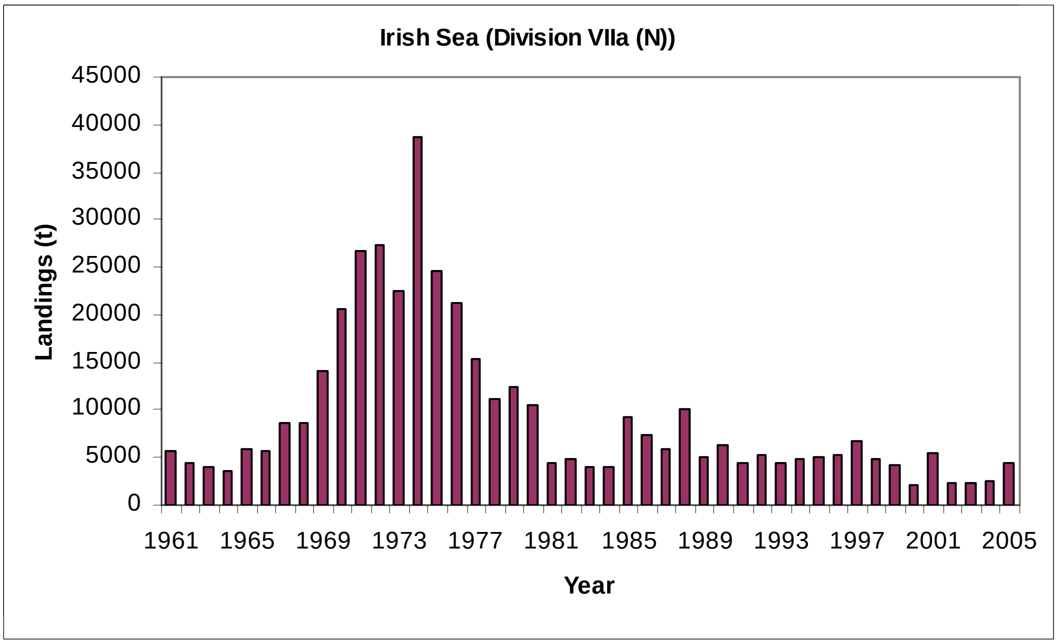


Figure 7.1.1 **Irish Sea herring VIIa(N). Landings of herring from VIIa(N) from 1961 to 2005.**

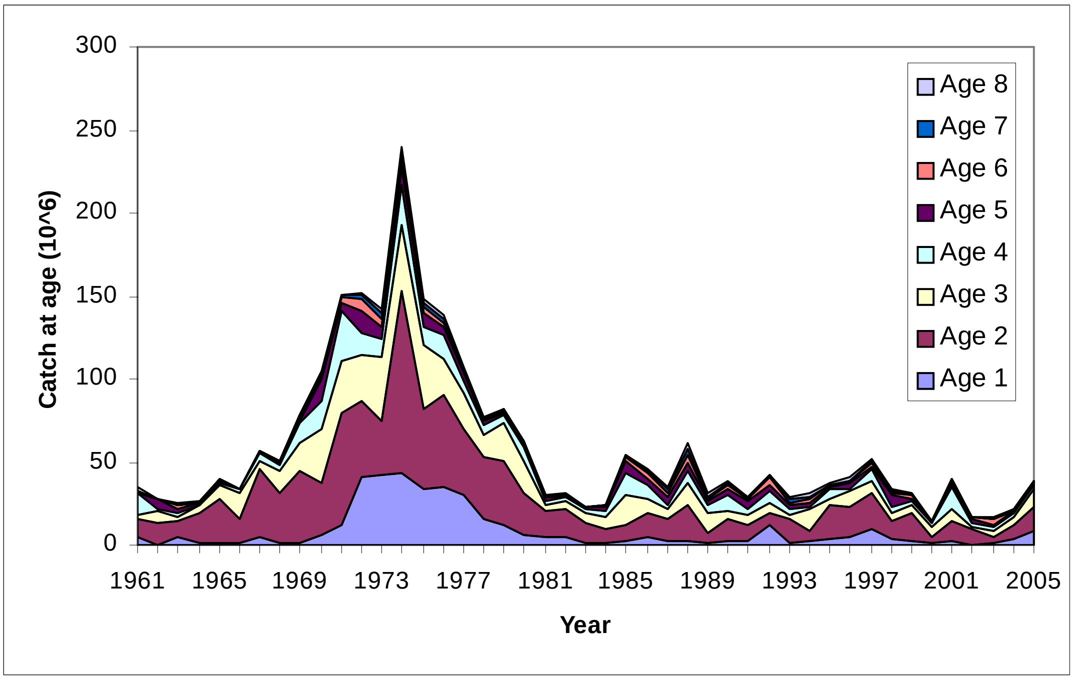


Figure 7.2.1 **Irish Sea herring VIIa(N). Landings (catch-at-age) of herring from VIIa(N) from 1961 to 2005.**

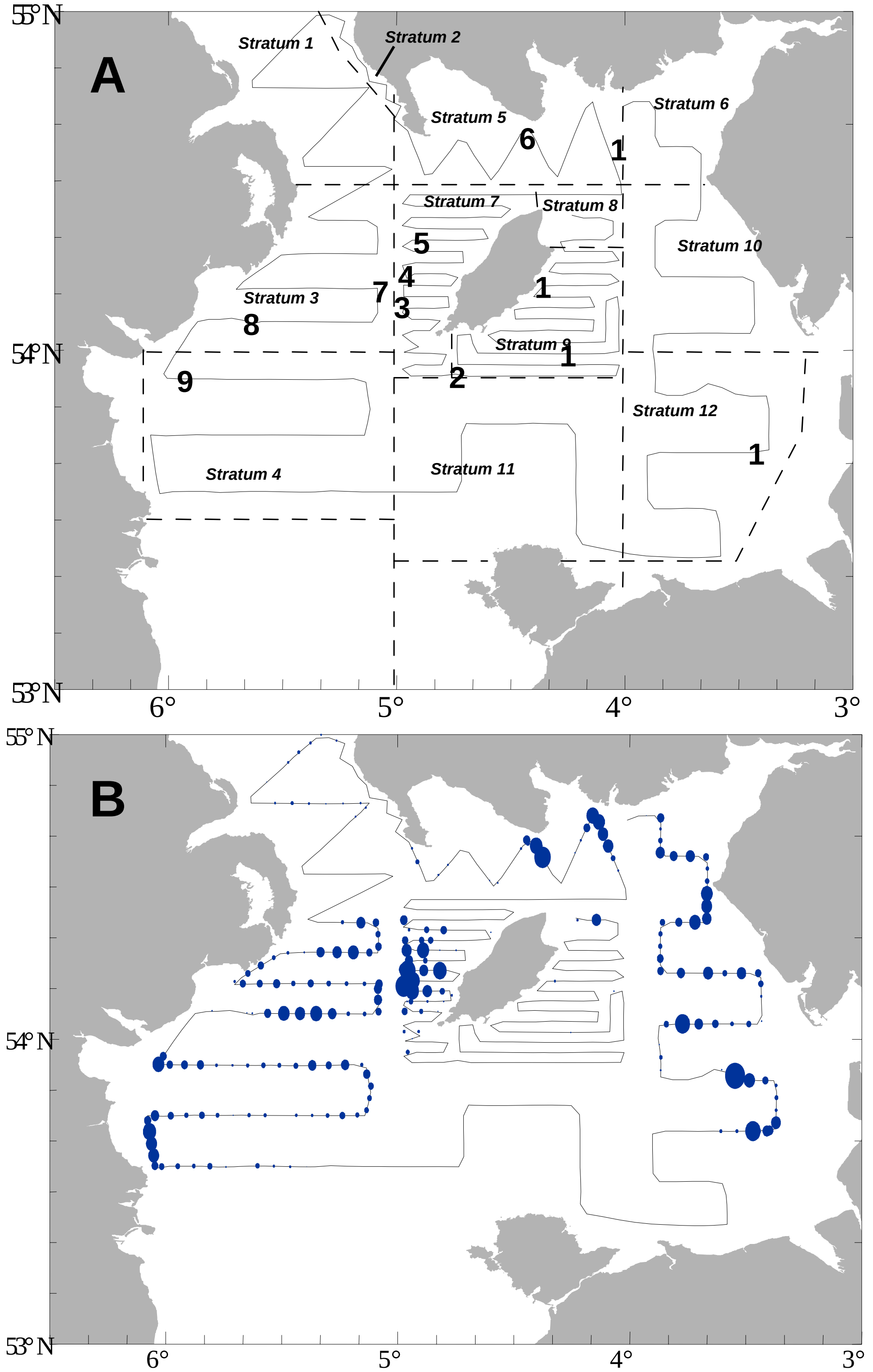


Figure 7.2.2 Irish Sea herring VIIa(N). (A) Transects, stratum boundaries and trawl positions for the September 2004 acoustic survey; (B) Density distribution of sprats (size of elipses is proportional to square root of the fish density (t n.mile^{-2}) per 15-minute interval). Maximum density was 660 t n.mile^{-2}.

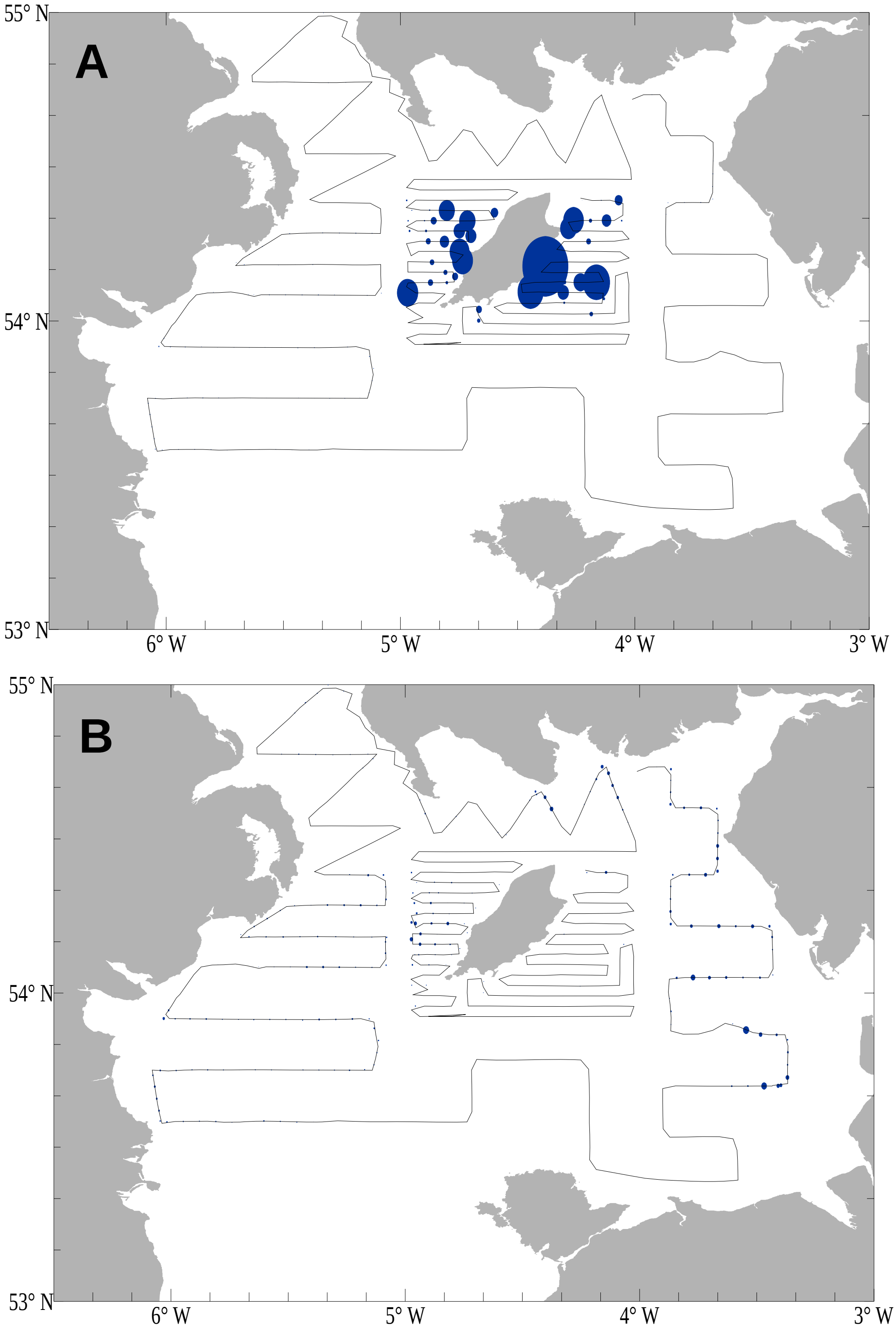


Figure 7.2.3 Irish Sea herring VIIa(N). (A) Density distribution of 1-ring and older herring (size of elipses is proportional to square root of the fish density (t n.mile^{-2}) per 15-minute interval). Maximum density was 1180 t n.mile^{-2}. (B) Density distribution of 0-ring herring. Maximum density was 137 t n.mile^{-2}. Note: same scaling of elipse sizes on Fig. 1 B and Figs 2 A and B.

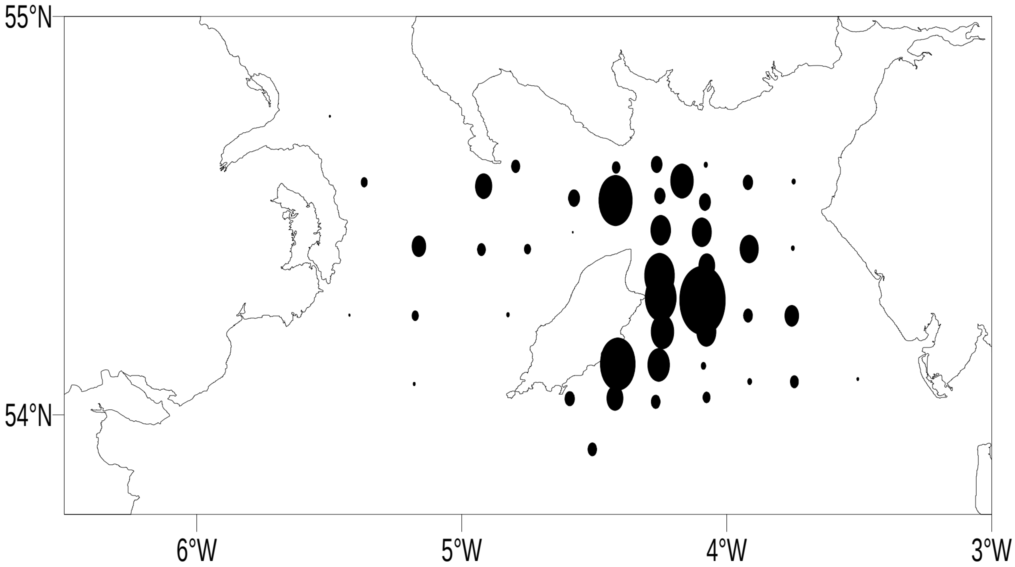


Figure 7.2.4 **Irish Sea herring in VIIa(N). Estimates of larval herring abundance in the Northern Irish Sea, 6th November to 15th November 2005. Areas of the circles are proportional to herring abundance (maximum abundance = 355 per m²).**

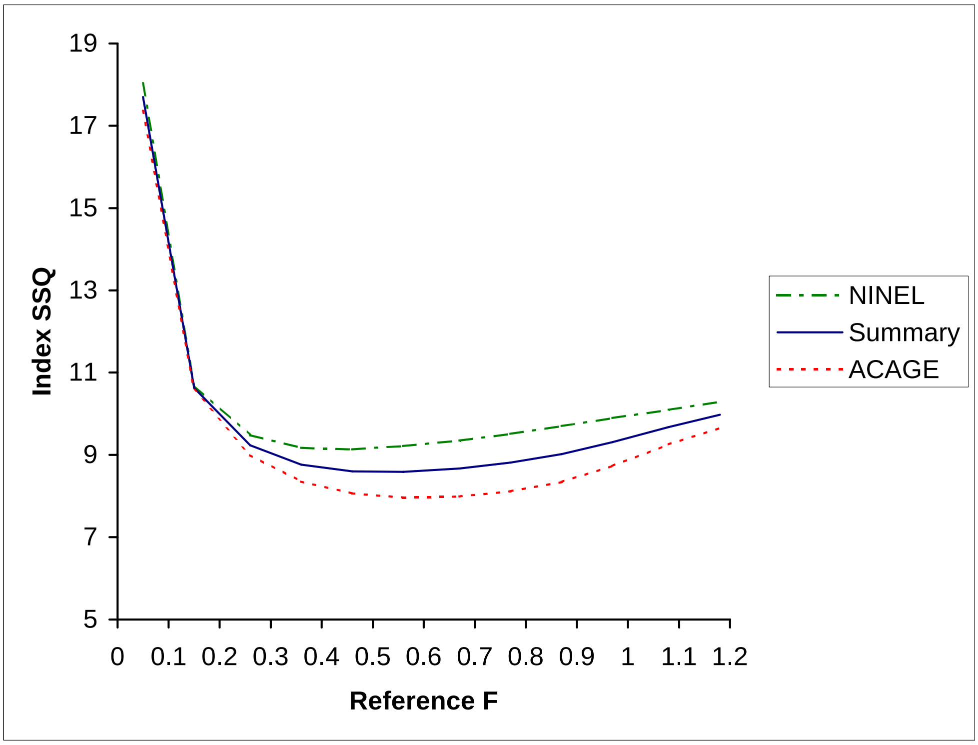


Figure 7.5.1 **Irish Sea herring in VIIa(N). SSQ surface for the deterministic calculation of the 6-year separable period. NINEL is the Northern Ireland larvae SSB index and ACAGE is the age-disaggregated acoustic index.**

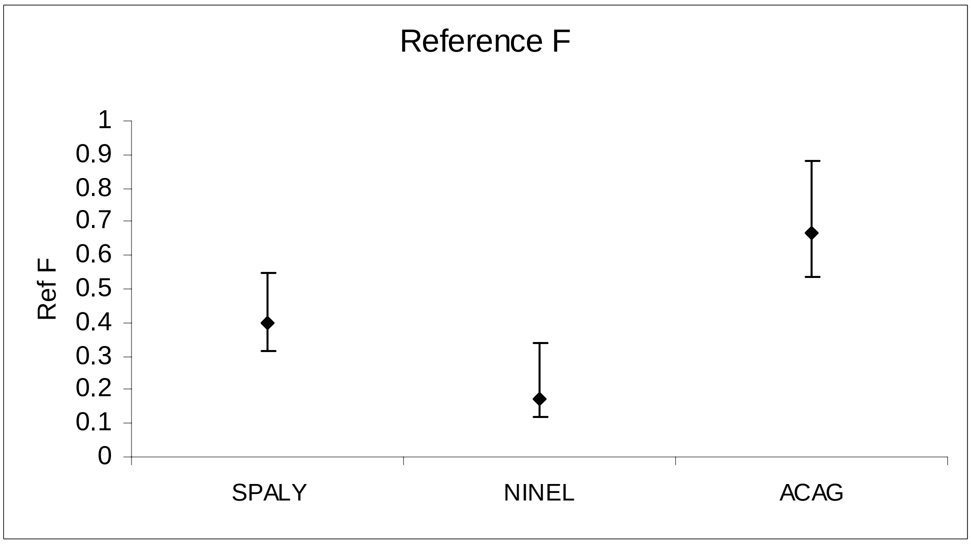


Figure 7.5.2 Irish Sea herring in VIIa(N). Comparison of mean reference F_{2-6} for SPALY run, NINEL tuning index and ACAGE tuning index.

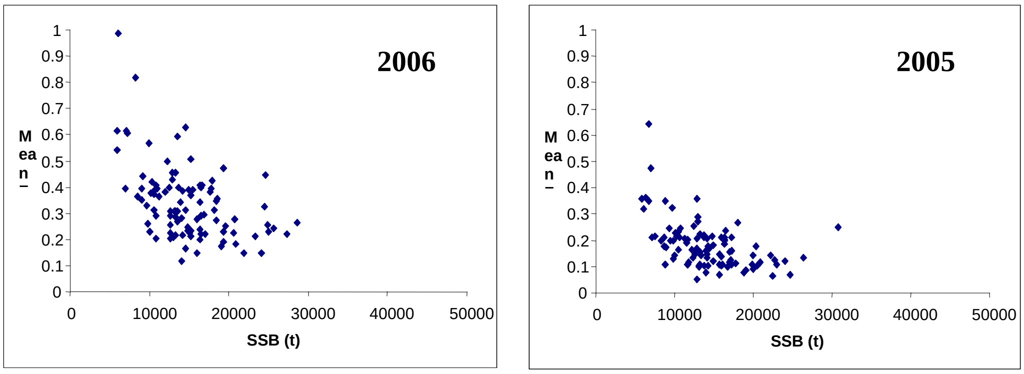


Figure 7.5.3 Irish Sea herring in VIIa(N). Estimates of uncertainty from the ICA bootstrapped mean F_{2-6} and SSB for the 2006 SPALY run and 2005 SPALY run.

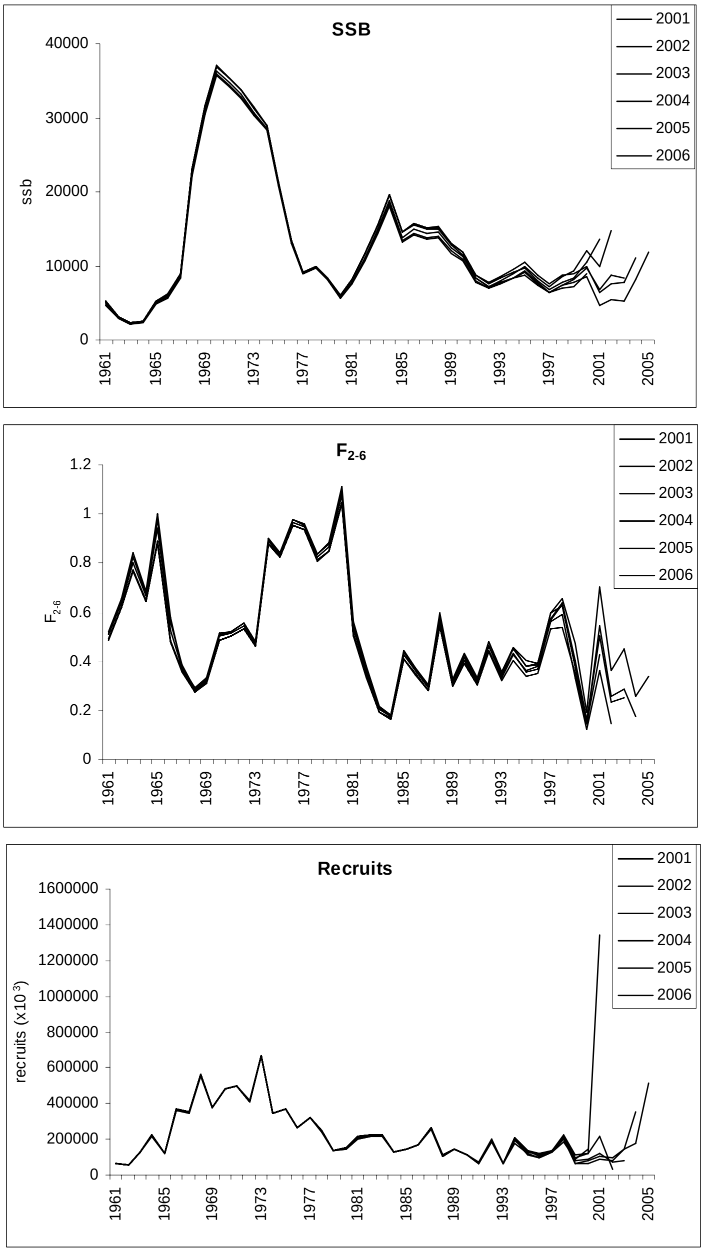
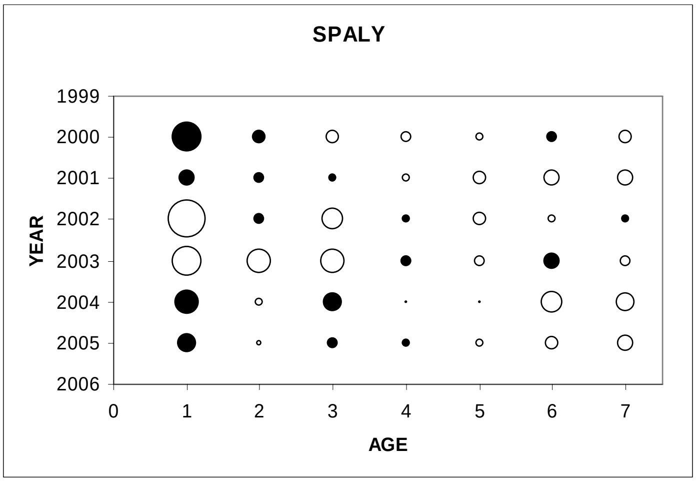


Figure 7.5.4 Irish Sea herring in VIIa(N). Retrospective trends in SSB, $F_{2\text{-}6}$ and recruitment from SPALY ICA run.



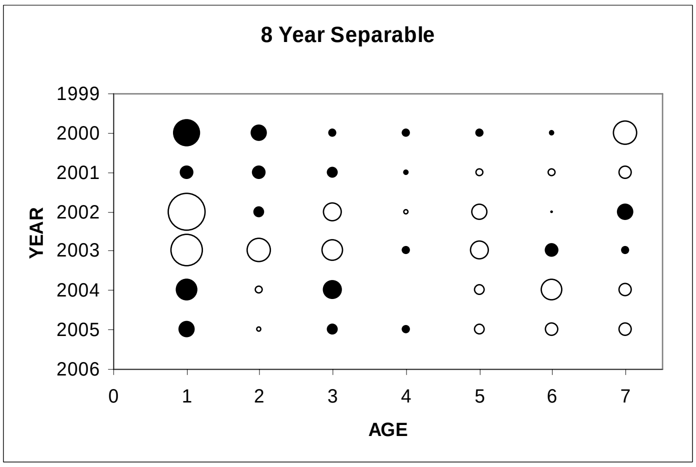
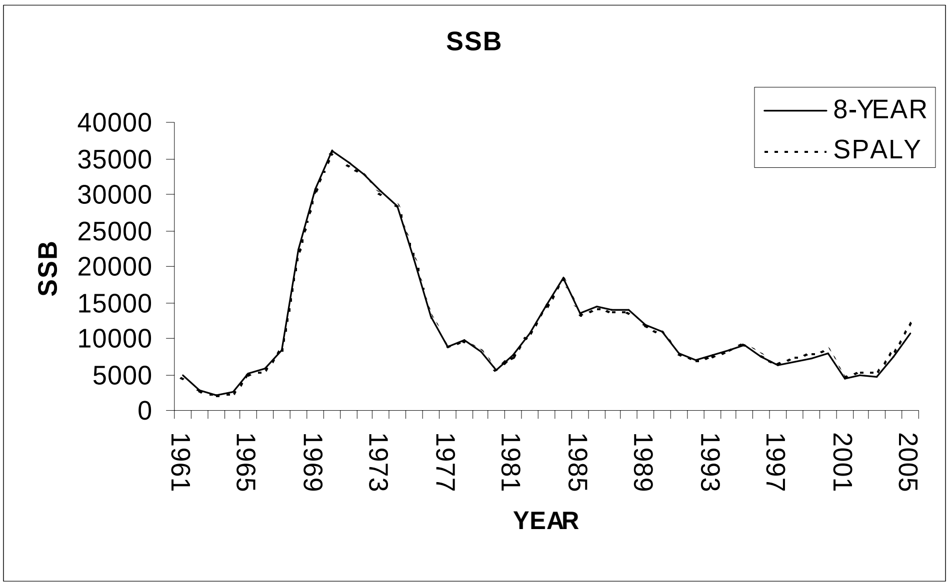


Figure 7.5.5 Irish Sea herring VIIa(N). Separable model residualsfrom ICA fits: SPALY 6-year separable period (above) and 8-year separable period (below). Residuals shown correspond to years 2000 to 2005.



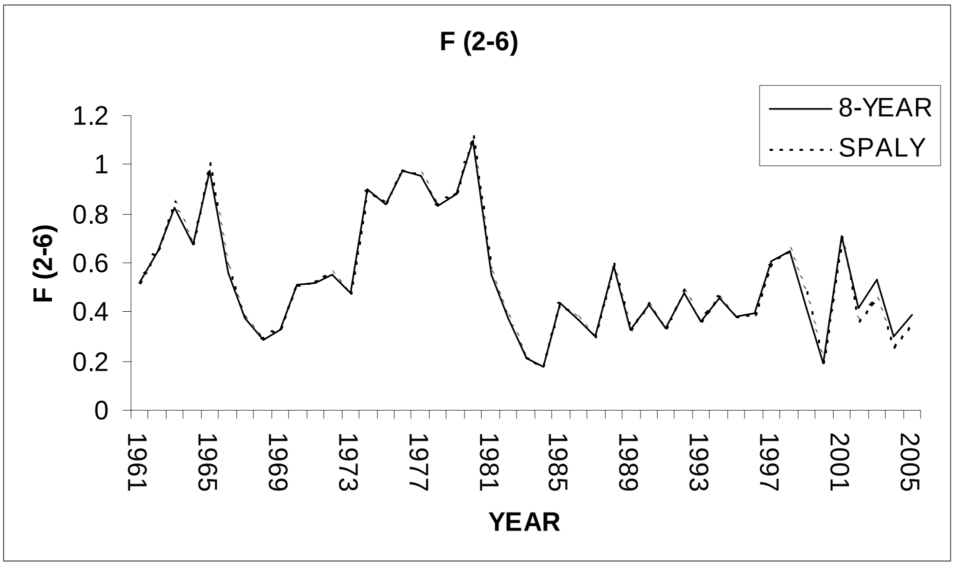


Figure 7.5.6 Irish Sea herring VIIa(N). Comparsion of SSB and F_{2-6} estimates arising from SPALY ICA run (6-year separable period) and ICA run using 8-year separable period.

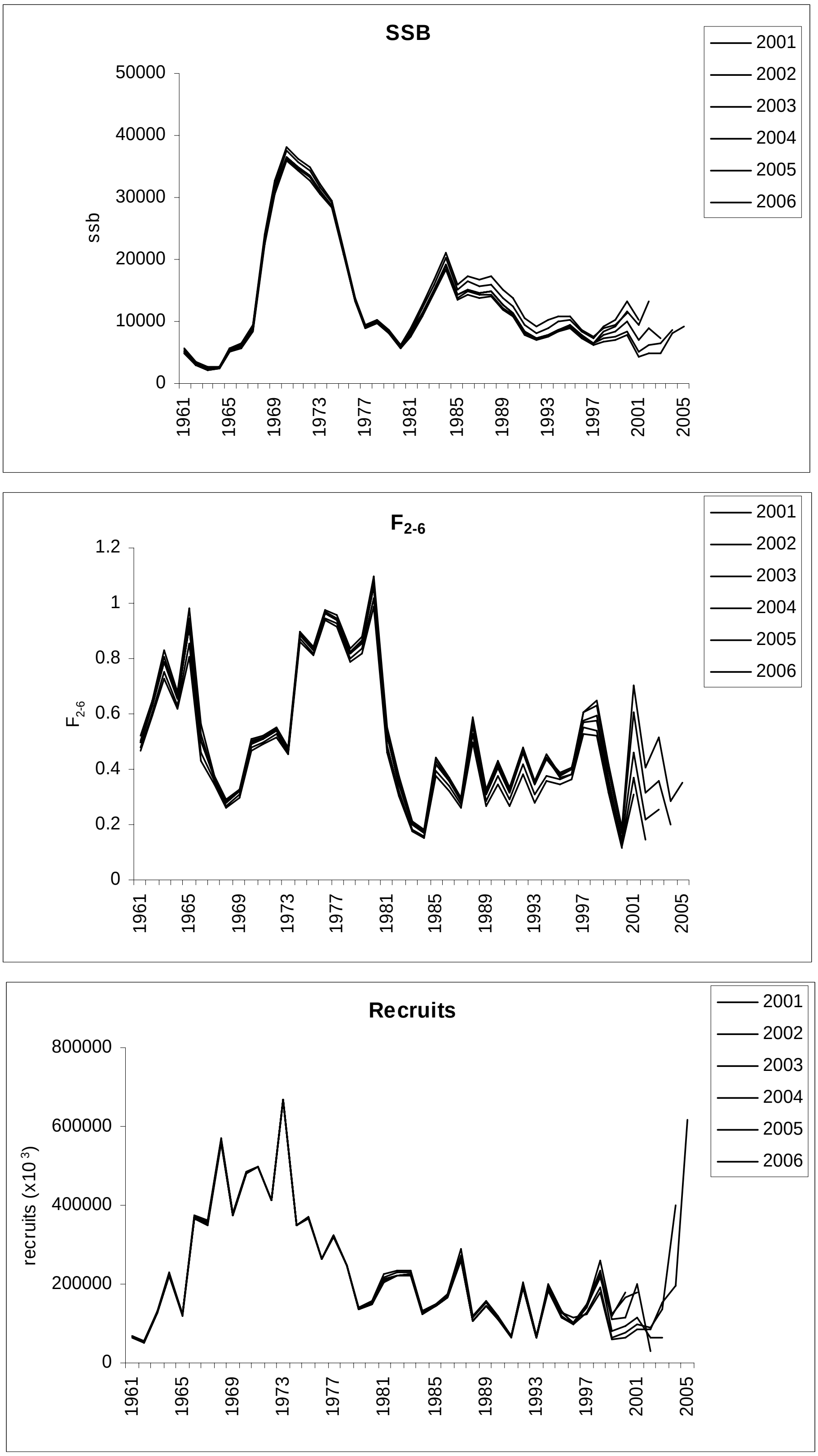


Figure 7.5.7 **Irish Sea herring VIIa(N). Analytical retrospective plots of SSB, F_{2-6} and recruitment assuming 0% maturity of 1-group using 8-year separable period.**

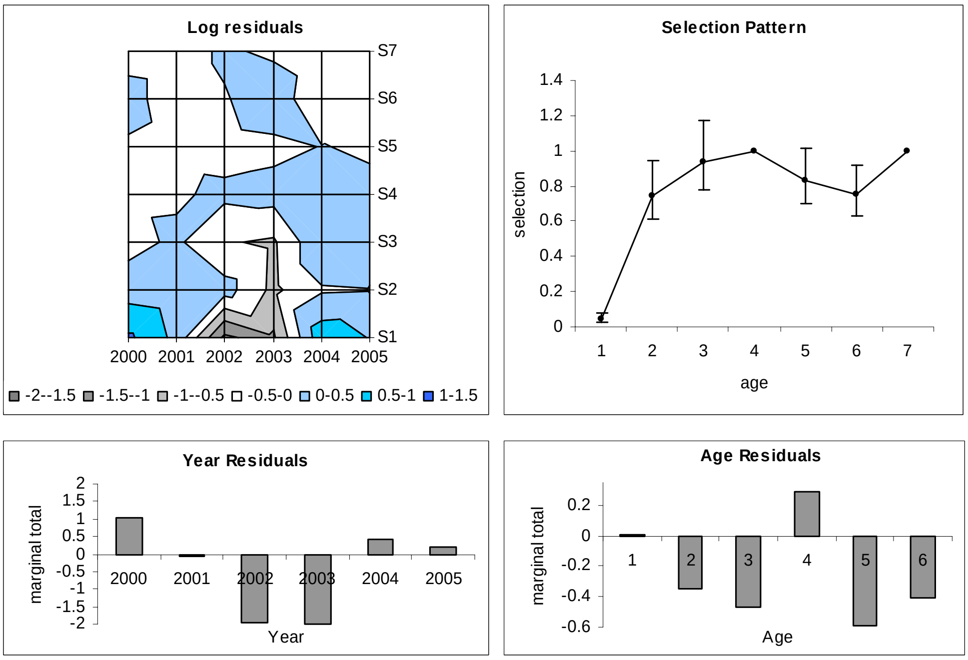


Figure 7.5.8 Irish Sea herring VIIa(N). Selection pattern diagnostics from deterministic calculations (6-year separable period). Top left, a contour plot of selection pattern residuals. Top right, estimated selection (relative to 4-wr)+/- standard deviation. Bottom, marginal totals of residuals by year and ring (ages 2-7 only).

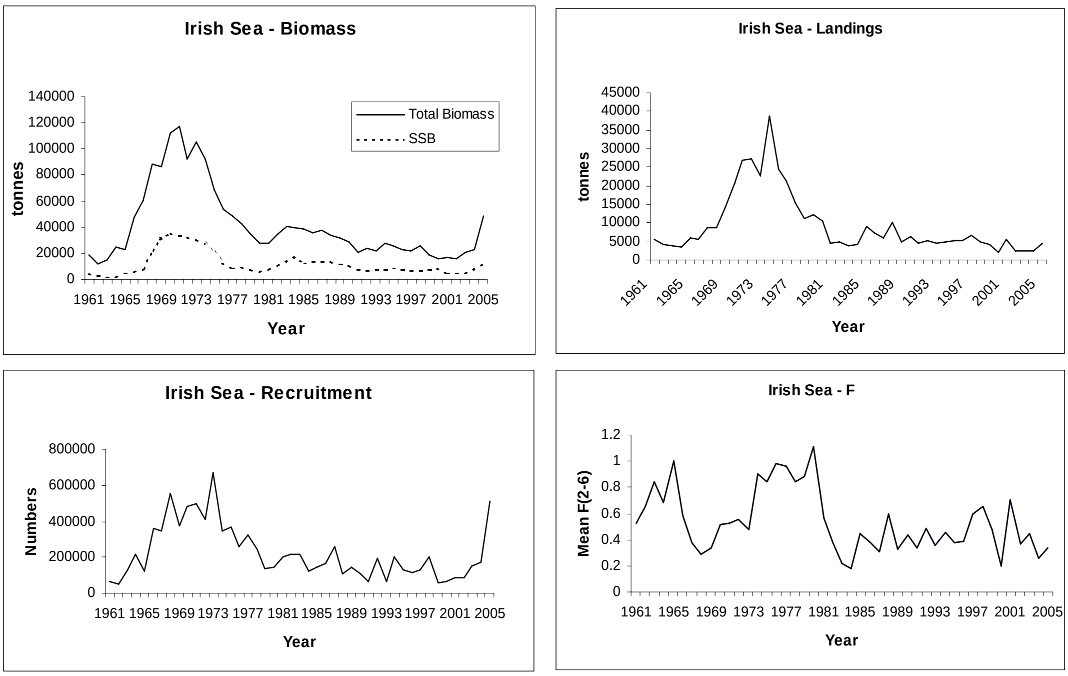


Figure 7.5.9 Irish Sea herring VIIa(N). Illustration of stock trends from deterministic calculation (6-year separable period). Summary of estimates of landings, $F_{2\text{-}6}$, recruitment at 1-ring, stock size on 1st January and spawning stock at spawning time.

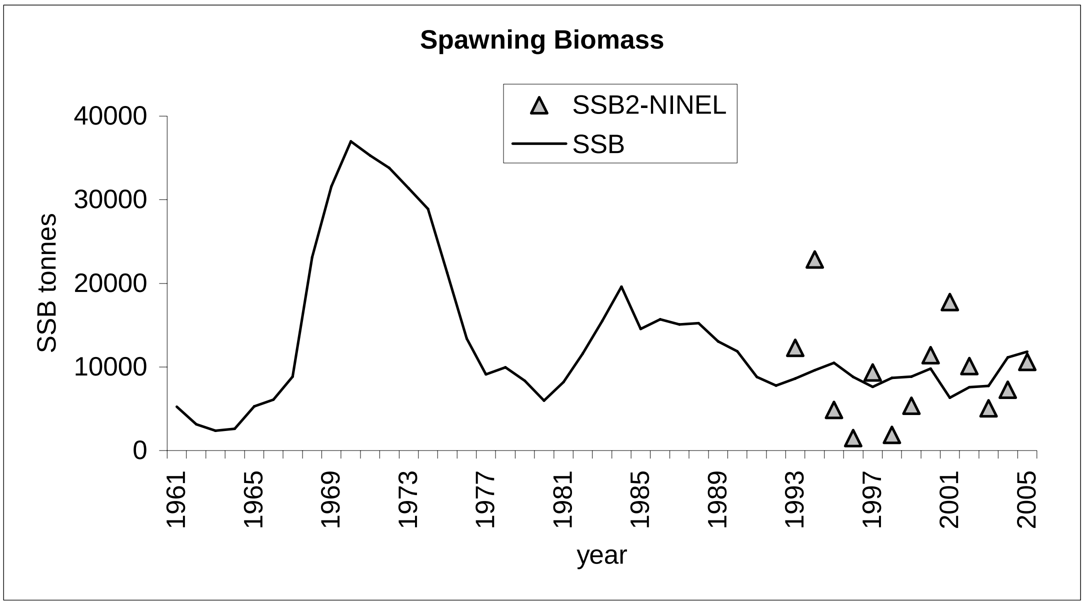


Figure 7.5.10 **Irish Sea Herring VIIa(N). ICA predicted SSB and re-scaled larvae index (NINEL).**

8 Sprat in the North Sea

8.1 The Fishery

8.1.1 ACFM advice applicable for 2005 and 2006

ACFM advised that a catch of 257,000 t in 2004 would allow the SSB to remain near or above the long-term average. This was based on the historic relationship between survey and catch. From 2002 to 2005 the TAC set by management for Subarea IV (EU zone) and Division IIa (EU zone) has been 257 000 t.

ACFM in 2005 considered the absolute stock size as unknown. However, with a biomass that seemed to have increased in recent years and with signals of a good 2004 year class recruiting to the 2005 fishery, the stock was considered to be in good condition.

There have been no explicit management objectives for this stock.

For 2006 TAC is set at 282 700 t. The WG has considered a request from EU to provide a mid-year revision of the TAC taking into account the estimates of incoming recruitment.

8.1.2 Total landings in 2005

Landing statistics for sprat for the North Sea by area and country are presented in Table 8.1.1 for 1988–2005. 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 1995–2005 by year, quarter, and area in the North Sea. In general, most of the landings by tonnes are taken in the second half of the year. The Norwegian vessels are not allowed to fish in the 2nd and 3rd quarters in the EU and the Norwegian zone and not allowed to fish in the Norwegian zone until the quota has been taken in the EU-zone.

The landings in 2005 were 208 000 t, mainly taken by the Danish fleets. This was an increase compared to the landings in the previous three years (144 000 t –194 000 t) and the highest since mid 1990s. This increase was mainly due to an increase in landings in Div.IVbE. There was no Norwegian sprat fishery in the North Sea in 2005. Neither Denmark nor UK (England and Wales) took their quota in 2004. More than 90% of the catches were taken in the third and fourth quarter.

No sprat by-catches were reported in the landings from the Norwegian industrial trawl fishery in 2005.

The quarterly and annual distributions of catches by rectangle for Subarea IV are shown in Figures 8.1.1–8.1.2.

8.2 Biological composition of the catch

8.2.1 By-catches in the North Sea sprat fishery

Data on the species composition of the by-catch is given in Table 8.2.1. Only data on by-catch from the Danish fishery were available to the Working Group. The Danish sprat fishery has in general been conducted with minor by-catches of herring except for about 14 landings where by-catches exceeded the allowed by-catch percentages. The Danish authorities immediately took necessary steps to stop the fishing behaviour of these vessels. The total amount of herring caught as by-catch in the sprat fishery in 2005 is less than 10% of the total catch. This herring by-catch increased in 2005 compared to 2003 and 2004.

8.2.2 Catches in number

The estimated quarterly catch-at-age in numbers for the years 1996 to 2005 is presented in Table 8.2.2. Denmark provided age composition data of commercial landings in 2005 for all quarters and these data were used to raise all catches from the North Sea, as the landings from Sweden and UK (England) were minor and unsampled. In 1996-2005 1-ringer sprat dominates the catches (54-96%). Some years, however, 0-ringers are taken in the fourth quarter but makes normally only a relatively low number (<5%) except for 2004 where they made 60% of the total annual catch by number. In 2005 the 2004 year class (1-ringer) was again the dominating year-class representing 96% of the total number landed. The majority of the total sprat catches are normally taken in the second part of the year.

8.2.3 Quality of catch and biological data

The sampling intensity for biological samples, i.e., age and weight-at-age, is given in Table 8.2.4. The sampling level in 2005 is at the same level as in 2004. In Denmark the provisions in the EU regulation 1639/2001 have been implemented. This provision requires 1 sample per 2000 tonnes landed. This sampling level is lower than the guidelines (1 sample per 1000 tonnes) previously used by the HAWG, but as the fishery was carried out in a limited area and a limited season, the recommended sampling level can be regarded as adequate.

In 2005 a total of 680 samples were collected from all industrial fisheries taken in the North Sea by Danish vessels. The sampling figure for 2004 was 834 samples. The decrease in sampling is caused by the decrease in total landing. The total landings from the Danish small mesh fishery in 2005 were 408 000 t (all species) compared to 532 000 t in 2004. This decrease is mainly due to changes in the sandeel fishery. The recommended sampling levels for species composition were achieved.

8.3 Fishery Independent Information

The IBTS (February) sprat indices (no. per hour) in Div. IVb were previously used as an index of abundance of sprat in the North sea. The historical data were revised in 1995 (ICES 1995/Assess:13) and 1999 (ICES 1999/ACFM:12). The IBTS Working Group redefined the sprat index to be calculated as an area weighted mean by rectangles for the entire North Sea sprat stock. New calculations were carried out in 2001 (ICES 2000/D:07). A revision of the data was made in 2006. The fishing gear used in the IBTS-survey was standardised in 1983 and the data series from 1984 onwards, are considered as comparable. The IBTS-indices for 1984–2006 are shown in Table 8.3.1 for age groups 1–5+ and total.

The IBTS data by rectangle are given in Figure 8.3.1a-c for age groups 1, 2 and 3+. Age 1-group was found to be concentrated in the south, in the more central area of Division IVb and Division IVc. The mean lengths (mm) of age group 1 by rectangle are presented in Figure 8.3.2.

The acoustic surveys for the North Sea Herring in June-July have estimated sprat abundance since 1996 (ICES 2006/LRC:04). The south-eastern area of the North Sea is expected to have the highest abundance of sprat in the North Sea. Due to inappropriate coverage of this area during the first period of the survey, the acoustic estimates are not thought to be representative for the years prior to 2003. In 2004 0-group sprat (<5-6 cm) were for the first time recorded by this survey contributing to 34% of the total abundance It is, however, not clear whether the component of 0-ringer was recruiting from autumn spawning sprat or from an early spring spawning component (ICES 2004/AFM:18). The length distribution indicates that only the largest of this age group have been sampled and the abundance of 0-group sprat is thus considered an underestimate. In this period no sprat has been reported in the northern areas.

In 2005 no 0-group sprat was detected during the survey. The abundance of sprat was calculated to be 76 814 million individuals and the biomass 564 thousand tonnes, which is a significant increase compared to last year. The estimates for 2003-2005 are considered comparable with regards to area covered and are given in the text table below. There was an increase in numbers and biomass from 2003 to 2005 with the 2004-year class as the strongest in this period.

	NUMBERS (mill)						BIOMASS (thousand tonnes)				
year	0	1	2	3+	Sum		0	1	2	3+	Sum
2003	0	25 292	3 984	339	29 616		0	198.8	61.3	6	266.1
2004	17 400	28 940	5 180	99	51 620		19.4	266.6	71.5	2.1	359.6
2005	0	70 175	5 533	1 106	76 814		0	479.6	67.4	16.8	563.8

8.4 Mean weights-at-age and maturity-at-age

Mean weights (g) at age in the catches in 2005 are presented by quarter in Table 8.2.3. The table includes mean weights-at-age for 1996-2004 for comparison.

During the Working Group in 2002, data on maturity and age were compiled from the Danish commercial catches during quarters 1, 3 and 4 in 2001. Data on maturity were provided from the German Acoustic surveys in June-July during 1996-2001. No other countries contributed with data on maturity. This year data on maturity by age, mean weight and length by age during the 2005 summer acoustic survey are presented by the PGHERS for the North Sea (ICES 2006/LRC:04) and given in the following text table:

8.5 Recruitment

The 2005 - index of 1-group (2004 year class) was the highest for the whole time-series (see Table 8.3.1), both absolute and relative. The high level of the 1-group in 2005 was seen in most samples and not only confined to few single hauls. In 2006 the IBTS-index of the 2004-yearclass (2-group) is still abundant and represents nearly 70 % of the total-abundance index. The 1-group index from February 2006 was one of the lowest for the period and the lowest since 1996. The total index was about 50% of the total in 2005 and among the lowest for the last years 10 years.

8.6 Data Exploration and Assessment

Sprat in the North Sea is a short-living species. The catches are dominated by 1 and 2 year-olds. There are difficulties in age reading resulting in unreliable estimates of numbers-at-age both from the surveys and the commercial catches. Given those limitations a data exploration using Catch-Survey Analysis (CSA) has been carried out by the Working Group since 2003 and the model and its inputs have been described (see ICES 2005/ACFM:16). A short description of the model is presented in Section 2.6.4 in the present report. The model assumes that the population consists of two stages: the recruits (preferably a single year class which here corresponds to the 1 year-old) and the fully recruited ages (the 2+ group).

Model input data this year is given in Table 8.6.1. The data used are the time-series 1984-2005 of catch numbers for each stage, the 1st quarter IBTS index of abundance for the 1 year-old sprat and the 2+, mean weights for each stage in the stock at the start of the year. Given low sampling levels in years previous to 1995 and low inter-annual fluctuations in weight-at-age, a constant weight-at-age based on commercial data from the 1st quarter of the period 1984-2004 (CM 2004/ACFM:18) was considered representative of the stock in the first quarter. Reliable stock data were searched for in the IBTS-data base. As stock data were available only for

2005 and 2006 the working group decided to use the same mean weights values as in previous years, fixed for all years. CSA requires a value for the instantaneous rate of natural mortality (M) and a parameter *s* corresponding to the ratio of the survey catchability of the recruits to the fully recruited ages which are fixed externally.

The value of natural mortality used is based on predation mortality estimates from a multispecies VPA (ICES 2002 /D:04). Estimates of predation mortality at-age and 90% confidence intervals representing the variation over time were presented in ICES 2004/ACFM:18. No new estimate of M was available to the working group and M=0.7 was again used in the model fits. In previous years the s-values were set to 1 but this year s was estimated by determining the minimum for a range of fixed s values. The SSQ profile is shown in Figure 8.6.1 and suggests that *s* =1.0 is the “best” estimate. With no other information available, a fixed s-value of 1.0 was used for all years. This results in an assumption of constant catchability in the surveys. The model is sensitive to the choice of the M and *s* parameters. Given the constraints of the model which in its present form does not allow variations of M over time the model was run for M = 0.7. Model output is presented in Table 8.6.2 for M = 0.7.

The model fits to the IBTS indices are shown in Figure 8.6.2. The model does not fit well the high IBTS 1-year indices in 1989 and 1999 and the high IBTS 2+ index in 1998 given low recruitment indices the following year. The model also seems to have problem fitting both groups in the last three years. This could be an example of a late recruitment scenario where IBTS underestimated total recruitment. Estimated numbers of recruits and fully recruited and total biomass are shown in Figure 8.6.3.

The total stock biomass estimated depends very much on the size of the incoming year class. Examination of the residuals suggests patterns in the fit to the recruits index from the last three years (Fig. 8.6.4). The data used to group the catches and survey indices into two stages are based on separation by ages that have little confidence, especially in the earlier years of the time series. A first and rough examination of length composition data by age in IBTS (Figure 8.6.5), suggests that the overlapping of lengths for ages 1 and 2 might result in conflicting signals when s is fixed across years. The length data from the surveys should be analysed to see if there are distinct thresholds in the length frequency data that could be used to split the recruits from the fully recruited.

Confidence intervals for the parameters were estimated by means of non-parametric bootstrapping. Biomass point estimates, 5 and 95 percentiles are given in Figure 8.6.6. The estimates are sensitive to the value of M and run using M=0.8 was made to test sensitivity to the value of this parameter. The estimated biomass is included for comparison. The results show that the setting of M=0.8 scales the biomass upwards.

Retrospective analysis of estimated biomass was carried out to check for consistency of past estimates as new data is included. The retrospective pattern, shown in Figure 8.6.7 indicates that there might be violations of some model assumptions. Vital parameters here are *s* and M, which are both fixed for all the years. Mesnil (2005) suggests that s may have to be re-estimated if retrospective patterns have to be investigated. Hence two new time series were run, 1984-1997 and 1984-2000. A specific s-ratio for each series were estimated and used in the respective runs, 0.8 for 1984-1997 and 0.85 for 1984-2000. A comparison of the retrospective analyses of estimated biomass is presented in Figure 8.6.8, indicating violation in the assumption of fixed s. The model version available to the working group (CSA_0, modified 13/02/2003) does not allow for annual variation in s.

The confidence intervals for biomass in 2006 are wide, indicating that the total biomass is between 700 000 and 2.3 million tonnes. As the stock is dominated by one year class, the working group concluded that the absolute biomass is not known but assumes that the results give indications of general stock trends. However, as constant weights at age are assumed changes in biomass over time due to changes in growth are not reflected in the estimates. Similar trends in biomass have also been seen in the acoustic data on sprat.

8.7 Predicted biomass at the start of 2007 given a range of 2006 catches

A spread sheet was set up for prediction of biomass based on number at age in the catch from the outcome of the CSA, the catches and the quota. Calculations for estimating numbers at age in the catch for the set of catches used in the prediction follow:

$$C_{a,y} = \bar{s}_{y-3,y-1,a} h_y N_{y,a} (TAC)_y / (TAC)^*_y$$

where $C_{a,y}$ corresponds to the catch numbers at age in year y,

$\bar{s}_{y-3,y-1,a}$ is the average selectivity at age for the 3 years prior to y,

h_y is the harvest rate in year y computed as the catch/stock biomass ratio,

$N_{y,a}$ are the numbers at age in the stock in year y,

TAC_y is the TAC for sprat in year y and

TAC^*_y is the calculated catch in year y given $h_{y,a}$, $N_{y,a}$ and weight at age (w_a). [Note that w_a is constant across years and is the same for both the stock and catch. The TACs ratio was introduced in the calculation as a correction factor.]

The biomass at the start of 2006 was estimated of the order of 1.2 million tonnes while the TAC for 2006 was 283 thousand tons. Biomass predictions at the start of 2007 are plotted in Figure 8.7.1 for status quo catch, catches exceeding the TAC by 10 and 25 percent and catches for TAC undershot by 10 and 25 percent; the stock biomass being in the range of

554 -659 thousand tonnes. The same exploitation rate as in the last year is assumed.The reduction in biomass in 2007 results mainly from low recruitment in 2006 which was based on the IBTS index. Recruitment in 2007 is equal to the geometric mean recruitment for the period 1984 – 2006.

A catch prediction for assessment year was provided in the past on the basis of a linear regression of catch versus IBTS estimated biomass. The results for 2006 are given in Figure 8.7.2 and indicate a catch for 2006 of 130 000 t (agreed TAC for 2006 is 282 700 t).

8.8 Quality of the Assessment

Trends in the mean weights-at -age during the first quarter used to compute the biomass index from the IBTS was revised in 2004. No trend was observed in the mean weights-at-age over time, therefore an average over all the years was used to compute stock biomass using the Catch Survey Analysis (CSA). The model fits time-series of abundance for 2 stages in the stock: the recruits and the fully recruited to the fishery. The IBTS indices for the 1st quarter were used as indicators. The Working Group is aware of problems associated with sprat in the IBTS, some sprat hatch in autumn and may not be fully recruited by February next year. Examination of the residuals from the model fit suggests that the problem results in additional noise in the datal.The results are sensitive to the value assumed for the catchability ratio *s*, the estimated biomass being scaled accordingly. The results from the retrospective analyses indicate that there might be violations of some model assumptions and the assumption of a constant s over years was tested. A value of s = 1 for the IBTS-data is compatible with perceptions that catchability of recruits is no different from the one of the fully recruited. The comparison of different retrospective analysis from different time series and s, gives strong indications of year effects in the survey which could not be considered in the model. The stock trend from the estimate as seen in the last three years is also indicated in the acoustic estimates from the summer acoustic survey.

Given the dynamics of this short-living species recent estimates of biomass are likely to correspond to the trajectories derived from M = 0.7. Likewise, The Working Group agreed that an approach like CSA seemed a promising tool to assess sprat in the North Sea. Further, the method, although not specifically designed for short-lived species, does show potential for assessment in that context and therefore **it is recommended that the Working Group of Methods again considers assessment methods for short-lived species in the light of recent developments.**

8.9 Management Considerations

The size of the North Sea sprat stock is mostly driven by the recruiting year class. Thus fishery in a given year will be dependent on that year's incoming year class and only in-year catch forecasts are available. The sprat stock at the beginning of 2005 seemed to be substantial higher compared to the previous years and the biomass was dominated by the very strong 2004 year class. In the beginning of 2006 there is indication of a small incoming 2005 year class (IBTS (February) index), one of the smallest for the time series. The low recruitment in 2006 is expected to have a negative effect on both the stock size and catch level this year. The relatively high biomass estimated for 2006 is dominated by the strong 2004 year class still seen as strong 2-gr index in the 2006 IBTS data.

There are indications that larvae from autumn spawning will over-winter as larvae and metamorphose the year after. A better understanding of the stock structure of sprat in the North Sea, the spawning seasons and recruitment from a possible autumn spawning is required.

The proportion of herring by-catch in the sprat fishery has been in the range of 5-10% the last years. Change in the regulation of by-catches in 2005 (up to 40% of herring allowed compared to 20% previously) increased the level of by-catches compared to 2004 but was within the range seen for the last years but though only half of the total by-catch ceiling.

Table 8.1.1. Sprat in the North Sea. Catches (' 000 t) 1988-2005. 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	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Division IVa West (North Sea) stock																		
Denmark	0.1				0.3	0.6						0.7		0.1	1.1		0.0	
Netherlands																		
Norway				0.1														
Sweden														0.1				
UK(Scotland)							0.1											
Total	0.1			0.1	0.3	0.6	0.1					0.7		0.2	1.1		0.0	
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	1.4	2.0	10.0	9.4	19.9	13.0	19.0	26.0	1.8	82.2	21.1	13.2	18.8	11.1	16.3	22.0	53.8	53.3
Norway	3.5	0.1	1.2	4.4	18.4	16.8	12.6	21.0	1.9	2.3				0.9	0.0			
UK(Engl.&Wales)					0.5	0.5												
UK(Scotland)						0.5						0.8						
Total	4.9	2.1	11.2	13.8	38.8	30.8	31.6	47.0	3.7	84.5	21.1	14.0	18.8	12.0	16.3	22.0	53.8	53.3
Division IVb East																		
Denmark	80.7	59.2	59.2	67.0	66.6	136.2	251.7	283.2	74.7	10.9	98.2	147.1	144.1	132.9	109.8	130.9	122.2	150.7
Germany																		
Norway	0.6		0.6	25.1	9.5	24.1	19.1	14.7	50.9	0.8	15.3	13.1	0.9	5.0			0.1	
Sweden			+	+				0.2	0.5		1.7	2.1		1.4				0.0
UK(Scotland)												0.6						
Total	81.3	59.2	59.8	92.1	76.1	160.3	270.8	298.1	126.1	11.7	115.2	162.9	145.0	139.3	109.8	131.0	122.2	150.7
Division IVc																		
Denmark	0.1	0.5	1.5	1.7	2.5	3.5	10.1	11.4	3.9	5.7	11.8	3.3	28.2	13.1	14.8	22.3	16.8	2.0
France								+										
Netherlands	0.4	0.4										0.2						
Norway						0.4	4.6	0.4		0.1	16.0	5.7	1.8	3.6				
UK(Engl.&Wales)	0.6	0.9	0.2	1.8	6.1	2.0	2.9	0.2	2.6	1.4	0.2	1.6	2.0	2.0	1.6	1.3	1.5	1.6
Total	1.1	1.8	1.7	3.5	8.6	5.9	17.6	12.0	6.5	7.2	28.0	10.8	32.0	18.7	16.4	23.6	18.3	3.6
Total North Sea																		
Denmark	82.3	61.7	70.7	78.1	89.2	153.3	280.8	320.6	80.7	98.8	131.1	164.3	191.1	157.2	142.0	175.2	192.7	206.0
France								+										
Germany																		
Netherlands	0.4	0.4										0.2						
Norway	4.1	0.1	1.8	29.6	28.4	43.8	36.3	36.2	52.8	3.2	31.3	18.8	2.7	9.5	0.0		0.1	
Sweden				2.5								2.7		1.4				
UK(Engl.&Wales)	0.6	0.9	0.2	1.8	6.6	2.5	2.9	0.2	2.6	1.4	0.2	1.6	2.0	2.0	1.6	1.3	1.5	1.6
UK(Scotland)						0.5	0.1					0.8						
Total	87.4	63.1	72.7	112.0	124.3	200.1	320.1	357.0	136.1	103.4	162.6	188.4	195.9	170.1	143.6	176.5	194.3	207.7

Table 8.1.2. Sprat catches ('000 t) in the fjords of western Norway, 1985-2005.

1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005 [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	2.6	1.4	1.1	2.2	0.4	1.2

[1] = preliminary

Table 8.1.3. Sprat in the North Sea. Catches (tonnes) by quarter*. Catches in fjords of Western Norway excluded.

Year	Quarter	Area					Total
		IVaW	IVaE	IVbW	IVbE	IVc	
1995	1			17,752	16,900	7,324	41,976
	2			1,138	5,752	1	6,891
	3		86	25,305	183,500	6	208,897
	4		5	2,826	92,054	4,693	99,578
Total			91	47,021	298,206	12,024	357,342
1996	1		459	2,471	81,020	6,103	90,053
	2			615	2,102	18	2,735
	3			242	6,259		6,501
	4		353	411	36,273	386	37,423
Total			812	3,739	125,654	6,507	136,712
1997	1			1,025	147	7,089	8,261
	2			189	1,054		1,243
	3		3	27,487	569		28,059
	4		81	55,814	9,878		65,773
Total			84	84,515	11,648	7,089	103,336
1998	1			1,917	3,726	1,616	7,259
	2		4	529	206	4	743
	3			4,926	55,155	215	60,296
	4			13,712	54,433	25,984	94,129
Total			4	21,084	113,520	27,819	162,427
1999	1			450	20,862	9,071	30,383
	2			108	1,048		1,156
	3	1	17	7,840	121,186	415	129,459
	4	679	31	5,550	19,731	1,167	27,158
Total		680	48	13,948	162,827	10,653	188,156
2000	1			2,686	15,440	28,063	46,189
	2			1,599	123	45	1,767
	3			14,405	116,901	1,216	132,522
	4			158	12,522	2,718	15,398
Total				18,848	144,986	32,042	195,876
2001	1	115		1,643	39,260	9,716	50,734
	2	0		699	372		1,071
	3	0		947	43,226	481	44,655
	4	79		8,681	56,421	8,538	73,719
Total		194		11,970	139,279	18,735	170,177
2002	1	1,136		222	1,960	2,790	6,108
	2			122	313	93	528
	3			9,131	61,373	647	71,151
	4			6,809	46,133	12,911	65,853
Total		1,136		16,284	109,779	16,441	143,640
2003	1			6,008	5,451	7,727	19,185
	2			57	568	26	652
	3			3,593	52,614	165	56,372
	4			12,389	72,240	15,651	100,280
Total				22,047	130,873	23,570	176,489
2004	1			76	751	1,831	2,657
	2	7		125	135	16	283
	3			627	53,533	496	54,657
	4			52,927	67,757	15,937	136,622
Total		7	0	53,755	122,177	18,280	194,219
2005	1			5,776	5,762	2,457	13,995
	2			145	2,370	123	2,638
	3			39,783	67,747		107,530
	4			7,630	74,844	1,033	83,507
Total		0	0	53,334	150,723	3,613	207,670

Table 8.2.1. North Sea sprat. Species composition in the Danish sprat fishery in tonnes and percentage of the total catch. Data is reported for 1998-2005.

	Year	Sprat	Herring	Horse-mackerel	Whiting	Haddock	Mackerel	Cod	Sandeel	Other species	Total
Tonnes	1998	129,315	11,817	573	673	6	220	11	2,174	1,188	145,978
Tonnes	1999	157,003	7,256	413	1,088	62	321	7	4,972	635	171,757
Tonnes	2000	188,463	11,662	3,239	2,107	66	766	4	423	1,911	208,641
Tonnes	2001	136,443	13,953	67	1,700	223	312	4	17,020	1,142	170,862
Tonnes	2002	140,568	16,644	2,078	2,537	27	715	0	4,102	800	167,471
Tonnes	2003	172,456	10,244	718	1,106	15	799	11	5,357	3,509	194,214
Tonnes	2004	179,944	10,144	474	334		4,351	3	3,836	1,821	200,906
Tonnes	2005	201,331	21,035	2,477	545	4	1,009	16	6,859	974	234,250
Percent	1998	88.6	8.1	0.4	0.5	0.0	0.2	0.0	1.5	0.8	100.0
Percent	1999	91.4	4.2	0.2	0.6	0.0	0.2	0.0	2.9	0.4	100.0
Percent	2000	90.3	5.6	1.6	1.0	0.0	0.4	0.0	0.2	0.9	100.0
Percent	2001	79.9	8.2	0.0	1.0	0.1	0.2	0.0	10.0	0.7	100.0
Percent	2002	83.9	9.9	1.2	1.5	0.0	0.4	0.0	2.4	0.5	100.0
Percent	2003	88.8	5.3	0.4	0.6	0.0	0.4	0.0	2.8	1.8	100.0
Percent	2004	89.6	5.0	0.2	0.2	0.0	2.2	0.0	1.9	0.9	100.0
Percent	2005	85.9	9.0	1.1	0.2	0.0	0.4	0.0	2.9	0.4	100.0

Table 8.2.2 North Sea Sprat. Catch in numbers (millions) by quarter and by age 1996-2005.

Year	Quarter	Age						
		0	1	2	3	4	5+	Total
1996	1		524.7	4,615.4	2,621.9	316.4	11.3	8,089.7
	2		1.9	241.5	32.7	15.5	0.3	291.9
	3		400.5	100.7	22.9	0.3		524.5
	4		1,190.7	1,069.0	339.6	5.6		2,604.8
	Total		2,117.9	6,026.6	3,017.0	337.8	11.5	11,510.8
1997	1		74.4	314.0	229.2	55.3	2.5	675.4
	2		11.3	47.8	34.9	8.4	0.4	102.9
	3		1,991.9					1,991.9
	4	127.6	3,597.2	996.2	117.8	58.1	0.0	4,896.9
	Total	127.6	5,674.8	1,358.1	381.9	121.8	2.8	7,667.1
1998	1		683.2	537.2	18.3	0.1		1,238.8
	2		70.9	55.3	1.8			127.9
	3	74.2	3,356.6	693.3				4,124.2
	4	772.4	4,822.4	2,295.1	483.5	39.5		8,412.8
	Total	846.6	8,933.1	3,580.9	503.6	39.6		13,903.7
1999	1		728.1	2,226.0	554.2	86.6	9.2	3,604.2
	2		38.6	58.4	18.1	2.6		117.7
	3		12,919.0	38.9				12,957.8
	4	105.0	2,143.2	211.5				2,459.7
	Total	105.0	15,828.9	2,534.8	572.3	89.2	9.2	19,139.5
2000	1		559.2	3,177.3	797.5	247.5	72.0	4,853.7
	2		6.8	107.4	60.1	12.8	0.5	187.6
	3		9,928.9	1,111.9	77.8			11,118.6
	4		1,153.7	129.2	9.0			1,291.9
	Total		11,648.7	4,525.8	944.4	260.3	72.6	17,451.8
2001	1		746.3	3,197.7	1,321.9	22.2		5,023.1
	2		15.9	66.2	26.1			108.2
	3	0.4	3,338.8	299.9				3,559.1
	4	1,205.0	4,178.7	1,224.6	261.9			6,651.4
	Total	1,205.4	8,279.8	4,788.4	1,609.9	22.2		15,341.7
2002	1	0.0	104.7	400.3	30.2	11.2		546.4
	2	0.0	13.7	27.9	2.4	0.6		44.6
	3	40.9	5,745.6	582.1	42.3	4.1		6,415.0
	4	415.0	4,578.0	626.2	119.8	3.1		5,742.1
	Total	455.9	10,441.9	1,636.5	194.8	19.0		12,748.1
2003	1	0.0	1,953.9	1,218.9	85.3	11.3	0.0	3,269.3
	2	0.0	41.8	46.3	4.7	0.6	0.0	93.3
	3	1.1	3,481.3	772.0	42.9	0.0	0.0	4,297.2
	4	539.3	7,051.8	1,115.1	93.8	36.5	21.9	8,858.4
	Total	540.4	12,528.7	3,152.3	226.6	48.4	21.9	16,518.2
2004	1	0.0	16.5	214.0	26.3	1.6	0.6	259.0
	2	0.0	22.1	14.9	3.0	0.1	0.0	40.1
	3	210.0	3,661.9	558.2	31.4	0.0	0.0	4,461.5
	4	15,674.4	5,582.8	632.1	59.2	0.0	0.0	21,948.5
	Total	15,884.4	9,283.2	1,419.2	119.8	1.8	0.6	26,709.1
2005	1	0.0	2,476.5	268.5	13.8	2.2	0.0	2,761.1
	2	0.0	499.6	23.4	4.3	4.9	0.0	532.1
	3	0.0	11,920.2	192.3	7.6	0.0	0.0	12,120.0
	4	302.5	7,467.9	191.1	0.0	0.0	0.0	7,961.6
	Total	302.5	22,364.3	675.3	25.7	7.0	0.0	23,374.8

Table 8.2.3. North Sea Sprat. Sampling for biological samples in 2005.

Country	Quarter	Landings ('000 tonnes)	No. samples	No. measured	No. aged
Denmark	1	12.40	15	1266	760
	2	2.60	12	138	4
	3	107.53	22	2369	735
	4	83.50	33	4158	1155
	Total	206.03	82	7931	2654
UK(England)	1				
	2				
	3				
	4	0.01	0	0	0
	Total	0.01	0	0	0
Sweden	1				
	2	0.04	0	0	0
	3				
	4				
	Total	0.04	0	0	0
Total North Sea		206.07	82	7931	2654

Table 8.3.1 North Sea sprat. Abundance indices by age from IBTS (February) from 1984-2006. Revised 2006.

Year	Age					
	1	2	3	4	5+	Total
1983	142,997	453,265	127,595	7,061	0,832	731,750
1984	233,758	329,003	39,608	6,200	0,292	608,861
1985	376,098	195,479	26,726	3,834	0,354	602,491
1986	44,188	73,538	22,010	1,233	0,243	141,212
1987	542,236	66,279	19,144	1,924	0,240	629,823
1988	98,606	884,062	61,803	6,991	0,000	1051,462
1989	2314,218	476,292	271,849	5,570	1,647	3069,576
1990	234,942	451,979	102,164	28,063	2,219	819,367
1991	676,784	93,381	23,313	2,647	0,118	796,243
1992	1060,780	297,691	43,284	7,207	0,522	1409,484
1993	1066,829	568,530	118,416	6,074	0,338	1760,187
1994	2428,357	938,047	92,204	3,662	0,504	3462,774
1995	1224,777	1036,518	87,329	2,516	0,764	2351,904
1996	186,131	383,534	146,839	18,284	0,744	735,532
1997	591,862	411,953	179,551	15,522	2,239	1201,127
1998	1171,050	1456,513	305,903	15,753	3,381	2952,600
1999	2534,528	562,098	80,347	4,828	0,445	3182,246
2000	1069,528	840,237	274,577	44,040	0,885	2229,267
2001	883,058	1057,001	185,466	17,548	0,345	2143,418
2002	1152,328	812,450	91,631	11,931	0,375	2068,715
2003	1842,261	309,918	44,472	2,194	0,076	2198,921
2004	1638,869	397,339	33,718	4,837	0,000	2074,763
2005	3017,097	310,469	37,870	0,773	0,000	3366,209
2006	414,243	1186,017	115,331	10,559	0,071	1726,221

Table 8.4.1 North Sea Sprat. Mean weight (g) by quarter and by age for 1996 - 2005.

Year	Quarter	Age						SOP
		0	1	2	3	4	5+	Tonnes
1996	1		3.9	9.3	14.9	15.3	16.1	88,807.0
	2		6.9	8.4	11.6	20.0	15.2	2,735.0
	3		11.6	14.2	18.2	21.5		6,501.0
	4		12.1	15.9	17.2	20.5		37,359.0
Weighted mean			9.97	10.49	15.12	15.58	16.03	135,401.0
1997	1		8.0	10.0	15.0	17.0	19.0	8,161.0
	2		8.0	10.0	15.0	17.0	19.0	1,243.0
	3		14.2					28,285.0
	4	3.7	11.9	16.4	19.1	19.6		63,083.0
Weighted mean		3.73	12.67	14.66	16.26	18.24	19.00	100,772.0
1998	1		5.6	6.0	8.7	15.0		7,232.0
	2		5.6	6.0	8.3			743.0
	3	3.7	14.7	15.3				60,149.0
	4	4.1	10.6	13.8	16.3	14.6		94,173.0
Weighted mean		4.03	11.69	12.80	15.98	14.65		162,297.0
1999	1		3.3	8.7	12.5	14.4	16.3	30,168.0
	2		3.1	10.1	13.6	15.4		993.0
	3		10.0	18.3				129,383.0
	4	4.4	11.0	14.4				27,126.0
Weighted mean		4.42	9.78	9.39	12.49	14.43	16.34	187,670.0
2000	1		4.2	10.1	10.7	10.2	10.5	46,192.0
	2		3.3	9.0	10.2	12.8	10.5	1,767.0
	3		11.9	11.9	11.0			132,563.0
	4		11.9	11.9	11.0			15,403.0
Weighted mean			11.55	10.56	10.68	10.33	10.52	195,925.0
2001	1		3.3	9.7	12.9	16.5		50,794.0
	2		3.3	10.3	12.9			1,071.0
	3	4.0	12.0	15.3				44,656.0
	4	3.8	11.6	12.6	19.1			73,444.0
Weighted mean		3.75	10.99	10.80	13.91	16.53		169,967.0
2002	1		7.0	12.0	14.0	13.0		61,057
	2		5.3	11.2	12.5	12.4		4,231
	3	2.0	10.9	15.0	15.0	24.0		721,732
	4	3.9	12.0	15.0	15.7	24.0		679,018
Weighted mean		3.73	11.24	13.43	14.93	14.80		1,466,038
2003	1		3.6	9.4	11.0	15.0		19,598.6
	2		3.1	9.9	11.0	15.0		648.0
	3	3.0	13.0	16.0	13.0			58,168.6
	4	4.6	10.8	14.8	16.9	15.0	18.0	97,670.1
Weighted mean		4.60	10.26	12.93	13.82	15.00	18.00	176,085.3
2004	1		3.6	10.3	13.8	16.6	16.1	2,663
	2		6.0	8.5	7.3	10.2		282
	3	4.5	11.9	17.0	20.0			54,639
	4	4.0	11.4	14.6	18.3			136,653
Weighted mean		4.00	11.00	10.90	14.50	16.80	16.12	194,238.4
2005	1		4.6	8.9	12.1	16.0		13,995
	2		4.8	6.5	9.8	10.0		2,641
	3		8.9	9.9	18.6			107,531
	4	4.1	10.7	12.0				83,515
Weighted mean		4.10	8.91	9.98	13.65	11.85		207,681.61

Table 8.4.2. North Sea sprat. Abundance, biomass, mean weight and length by age, maturity (i: immature, m: mature) for the area east and west of 3°E and for the total North Sea.

(Here, the “,” is a decimal point)

	1i	1m	2i	2m	3i	3m	4m	5m	total
	Abundance (mill.)								
w of 3°E	6658,80	4345,10	536,20	4054,80	0,00	1065,50	17,90		**16678,30**
e of 3°E	23406,00	35765,30	282,30	659,30	5,30	16,60	0,90	0,20	**60135,90**
total North Sea	30064,80	40110,40	818,50	4714,10	5,30	1082,10	18,80	0,20	**76814,20**
immature total									***30888,60***
mature total									***45925,60***
	Biomass ('000 tonnes)								
w of 3°E	30,8	42.0	4,6	52.4	0.0	16,2	0.3	0.0	**146.3**
e of 3°E	103.9	302.9	2,6	7,8	0.1	0.2	0.0	0.0	**417.6**
total North Sea	134.7	344.9	7,2	60.2	0.1	16,3	0.3	0.0	**563.8**
immature total									***141.9***
mature total									***421.9***
	mean weight (g)								
w of 3°E	7,9	11,5	8,4	12,9		15,4	16,9		
e of 3°E	5,1	8,7	10,6	14,7	14,7	16,0	22,7	23,7	
total North Sea	7,1	10,8	8,7	13,2	14,7	15,7	17,2	23,7	
	mean length (cm)								
w of 3°E	10,3	11,3	10,5	11,8		12,4	13,0		
e of 3°E	8,9	10,5	10,9	12,2	12,3	12,9	14,2	14,5	
total North Sea	9,9	11,2	10,5	11,9	12,3	12,6	13,1	14,5	

Table 8.6.1. North Sea sprat. CSA Input data. Catch in numbers (CatRec and CatFull), abundance indices (Urec and Ufull), recruits and fully recruited mean weights in the stock, and catchability ratio (Srat). M=0.7.

Year	CatRec	CatFull	Urec	Ufull	Wrec	Wfull	Srat
1984	6455.20	1432.40	233.758	375.103	4.5	9.67	1
1985	23616.00	1680.36	376.098	226.393	4.5	9.67	1
1986	917.33	385.20	44.188	97.024	4.5	9.67	1
1987	2102.31	464.56	542.236	87.587	4.5	9.67	1
1988	529.28	5460.05	98.606	952.856	4.5	9.67	1
1989	2658.36	3431.79	2314.218	755.358	4.5	9.67	1
1990	1415.95	14213.00	234.942	584.425	4.5	9.67	1
1991	2653.30	1890.71	676.784	119.459	4.5	9.67	1
1992	88013.00	25913.00	1060.78	348.704	4.5	9.67	1
1993	4992.73	4069.87	1066.829	693.358	4.5	9.67	1
1994	36190.20	5173.00	2428.357	1034.417	4.5	9.67	1
1995	16646.70	16756.90	1224.777	1127.127	4.5	9.67	1
1996	2117.90	9392.90	186.131	549.401	4.5	9.67	1
1997	5674.80	1864.70	591.862	609.265	4.5	9.67	1
1998	8933.10	4124.10	1171.05	1781.55	4.5	9.67	1
1999	15828.90	3205.60	2534.528	647.718	4.5	9.67	1
2000	11648.70	5803.10	1069.528	1159.739	4.5	9.67	1
2001	8279.80	6420.40	883.058	1260.36	4.5	9.67	1
2002	10442.00	1850.30	1152.328	916.387	4.5	9.67	1
2003	12528.70	3449.10	1842.261	356.66	4.5	9.67	1
2004	9283.20	1541.50	1638.869	435.894	4.5	9.67	1
2005	22364.30	708.00	3017.097	349.112	4.5	9.67	1

Table 8.6.2. North Sea sprat. CSA output.Estimated 1-year old (RecN) and 2+(FullN) numbers in stock, total stock biomass, fishing mortality and harvest rates for the 1-year old and the 2+.

Year	RecN	FullN	TSBiom	F*	HRrec	HRfull	CatRec	CatFull	Sratio	M
1984	14250.8	22211.6	278914.3	0.244	0.453	0.064	6455.2	1432.4	1	0.7
1985	24852.8	14189.8	249053.1	1.044	0.950	0.118	23616.0	1680.4	1	0.7
1986	2960.4	6826.2	79331.3	0.143	0.310	0.056	917.3	385.2	1	0.7
1987	78536.0	4213.1	394152.3	0.032	0.027	0.110	2102.3	464.6	1	0.7
1988	6580.7	39817.3	414646.1	0.138	0.080	0.137	529.3	5460.1	1	0.7
1989	61086.5	20066.3	468930.7	0.078	0.044	0.171	2658.4	3431.8	1	0.7
1990	10867.1	37275.0	409351.4	0.393	0.130	0.381	1416.0	14213.0	1	0.7
1991	39547.5	16145.6	334091.4	0.085	0.067	0.117	2653.3	1890.7	1	0.7
1992	151100.1	25399.9	925567.1	1.037	0.582	1.020	88013.0	25913.0	1	0.7
1993	76407.9	31073.3	644314.3	0.088	0.065	0.131	4992.7	4069.9	1	0.7
1994	136945.1	48873.2	1088857.0	0.252	0.264	0.106	36190.2	5173.0	1	0.7
1995	73460.7	71734.3	1024243.5	0.261	0.227	0.234	16646.7	16756.9	1	0.7
1996	12772.8	55513.9	594297.5	0.185	0.166	0.169	2117.9	9392.9	1	0.7
1997	66390.1	28194.1	571392.3	0.083	0.085	0.066	5674.8	1864.7	1	0.7
1998	61760.0	43225.1	695906.9	0.133	0.145	0.095	8933.1	4124.1	1	0.7
1999	133095.7	45650.1	1040366.6	0.113	0.119	0.070	15828.9	3205.6	1	0.7
2000	63138.5	79310.3	1051053.3	0.131	0.184	0.073	11648.7	5803.1	1	0.7
2001	44796.7	62071.6	801818.0	0.148	0.185	0.103	8279.8	6420.4	1	0.7
2002	41778.9	45769.4	630594.5	0.151	0.250	0.040	10442.0	1850.3	1	0.7
2003	61631.2	37371.0	638718.0	0.176	0.203	0.092	12528.7	3449.1	1	0.7
2004	60108.6	41228.7	669170.3	0.113	0.154	0.037	9283.2	1541.5	1	0.7
2005	183816.1	44947.2	1261812.1	0	0.122	0.016	22364.3	708.0	1	0.7

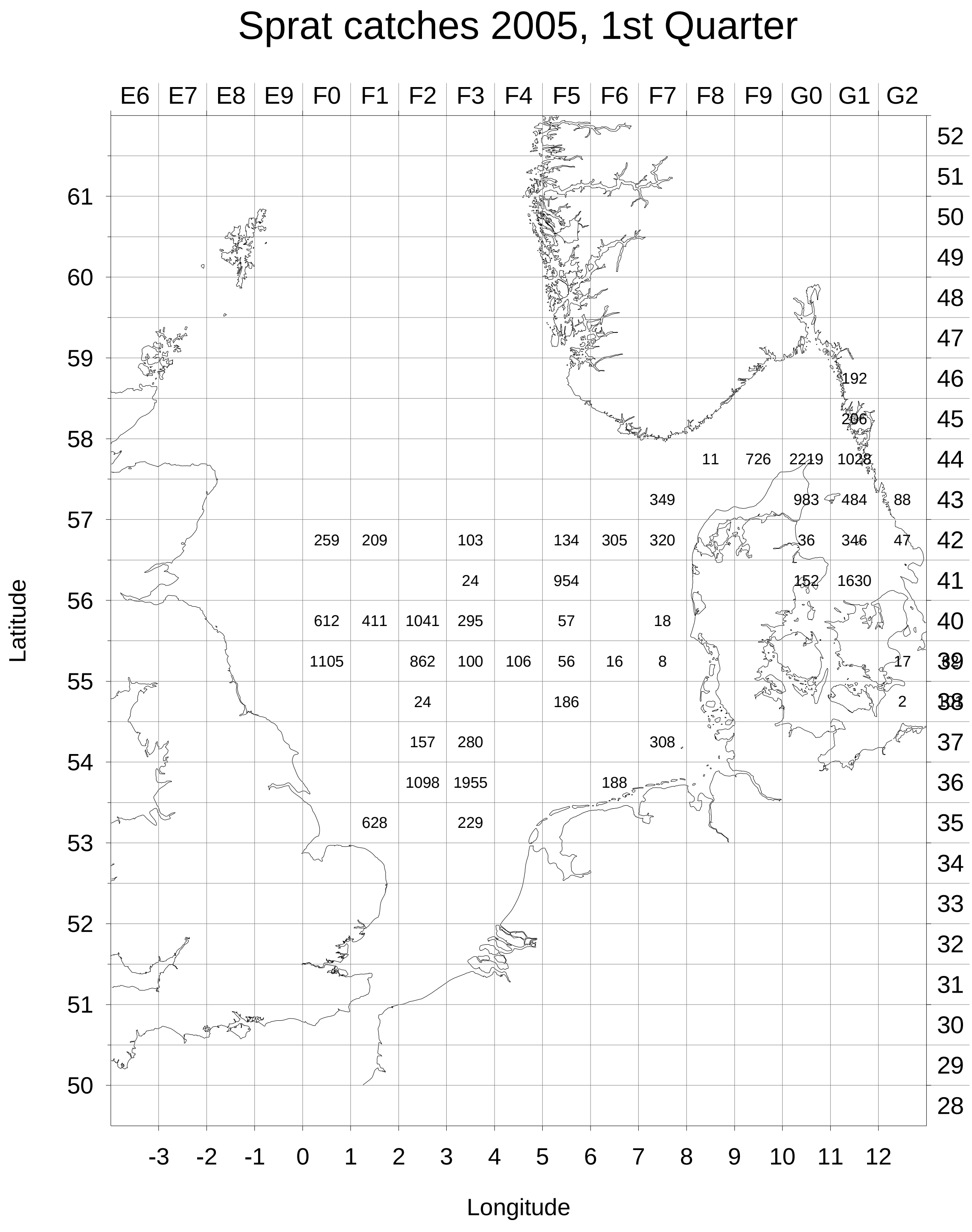


Figure 8.1.1a. Sprat catches (in tonnes) in the North Sea and Div. IIIa in 2005 by statistical rectangle. Working group estimates. First quarter.

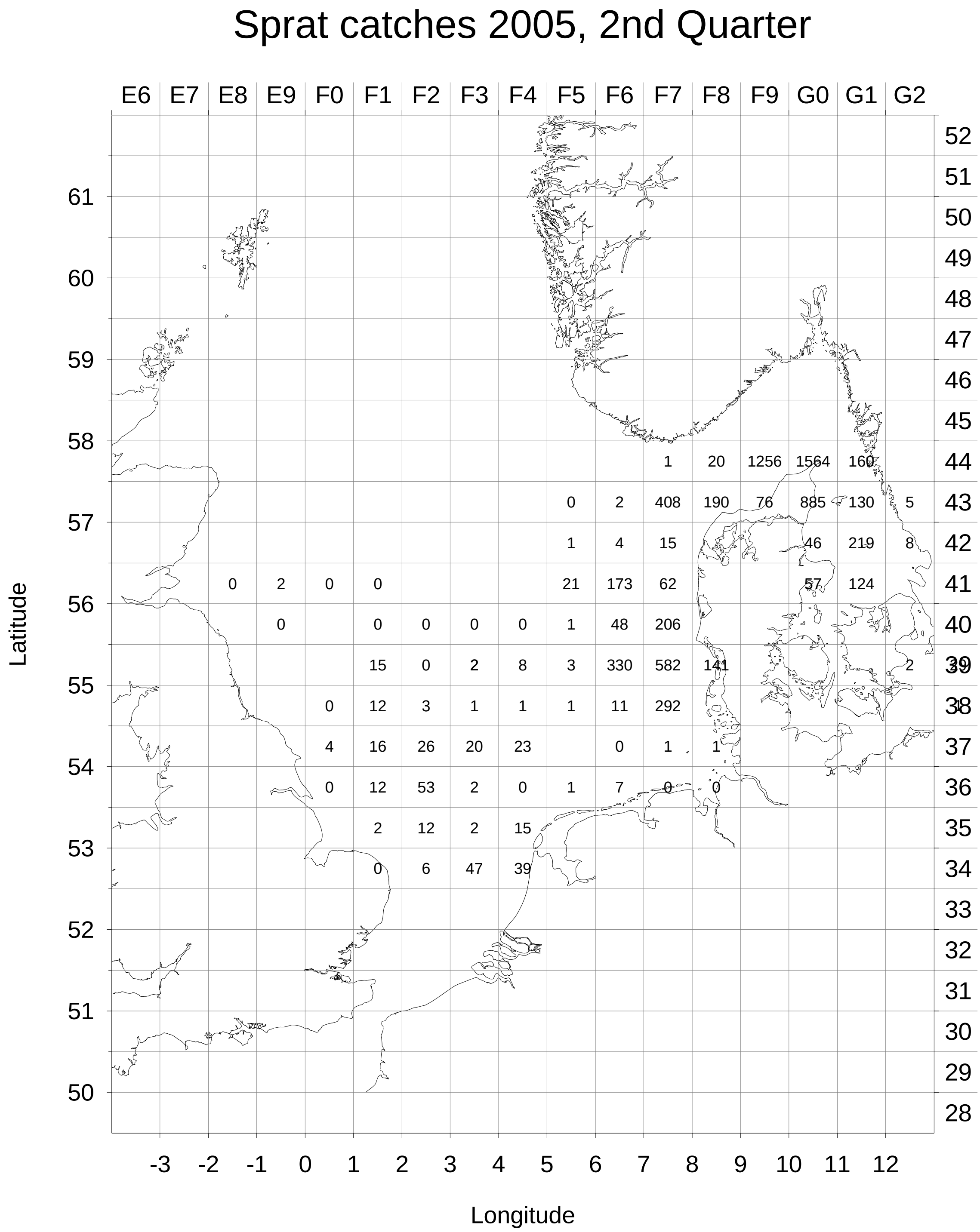


Figure 8.1.1b. Sprat catches (in tonnes) in the North Sea and Div. IIIa in 2005 by statistical rectangle. Working group estimates. Second quarter.

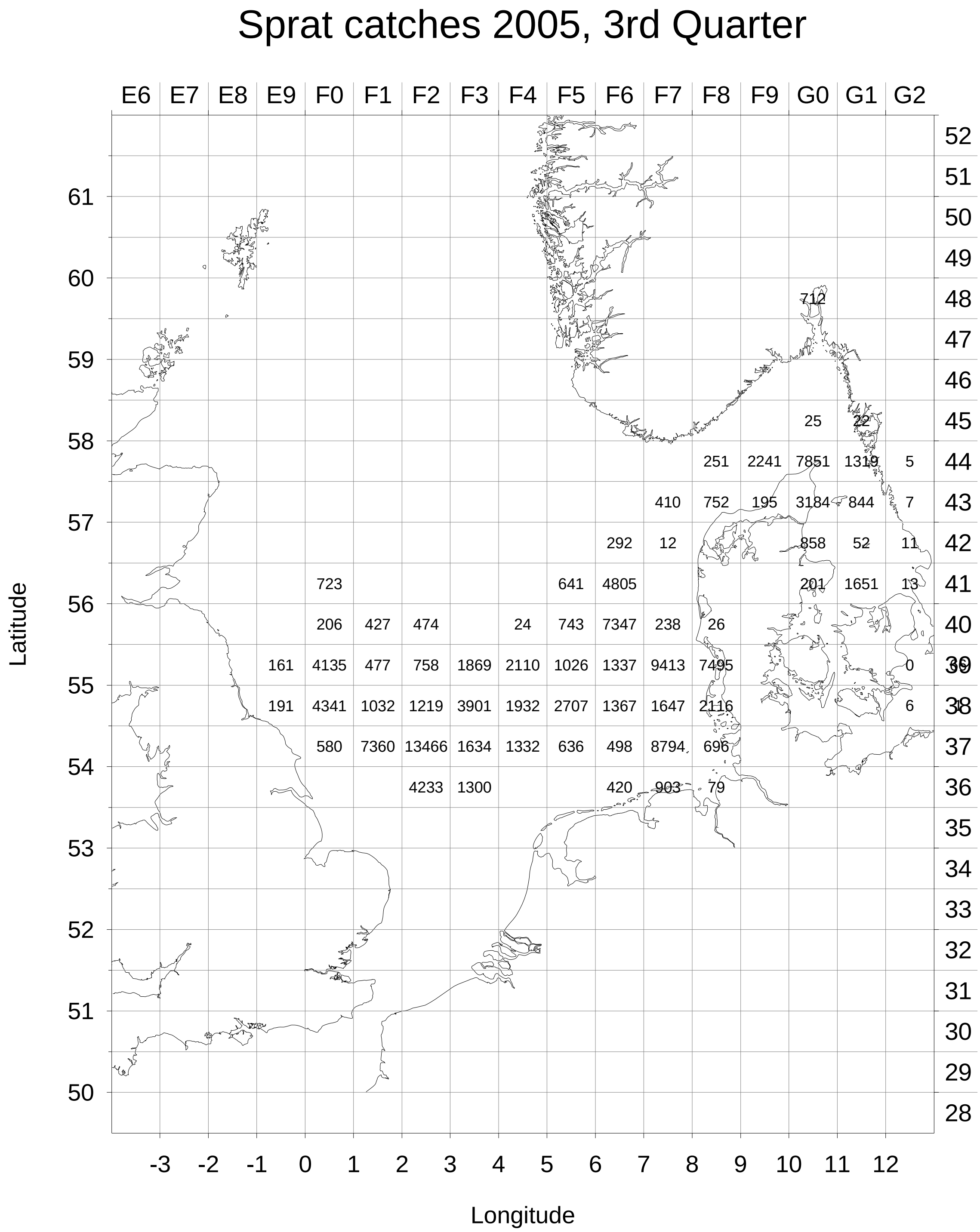


Figure 8.1.1c. Sprat catches (in tonnes) in the North Sea and Div. IIIa in 2005 by statistical rectangle. Working group estimates. Third quarter.

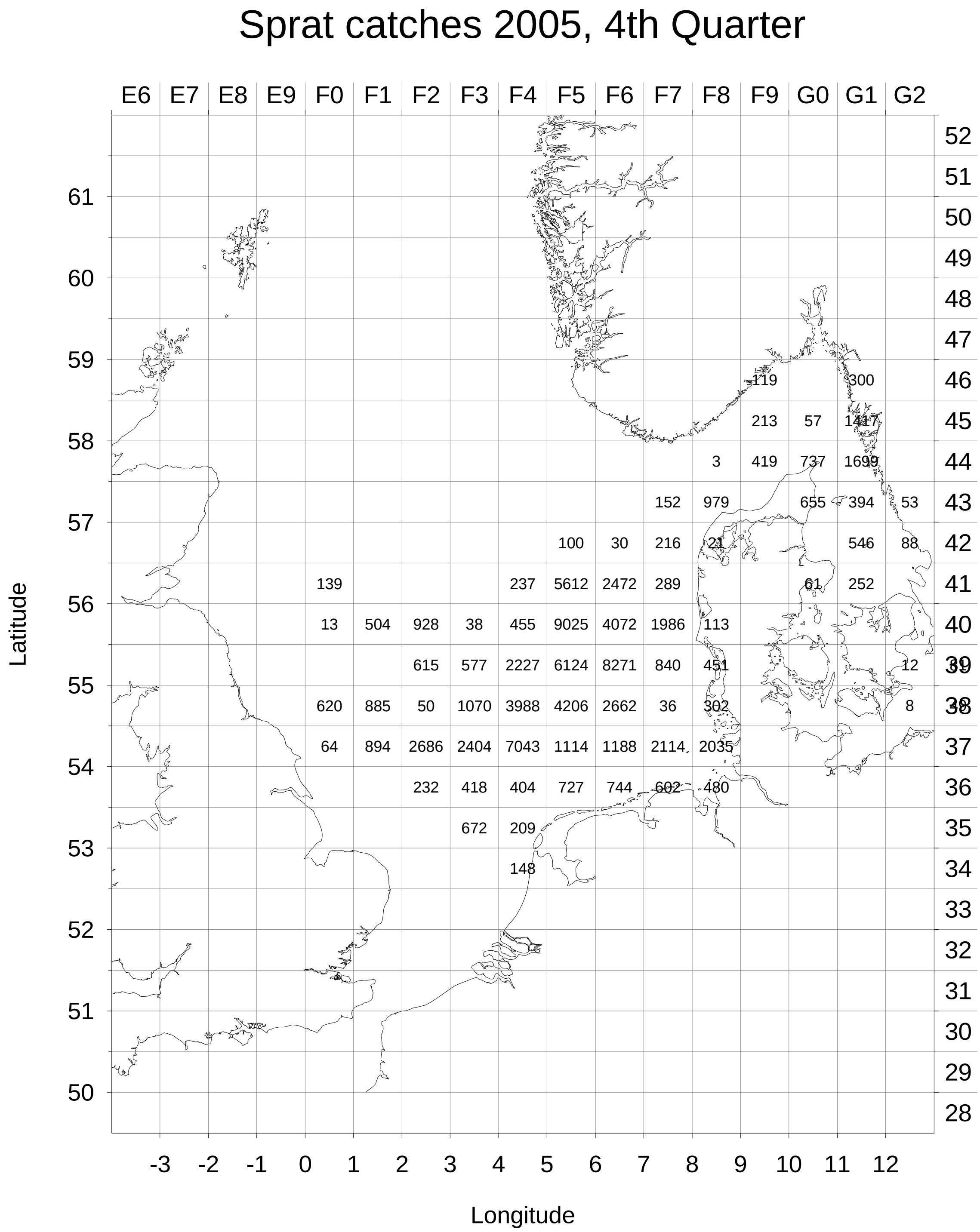


Figure 8.1.1d. Sprat catches (in tonnes) in the North Sea and Div. IIIa in 2005 by statistical rectangle. Working group estimates. Fourth quarter.

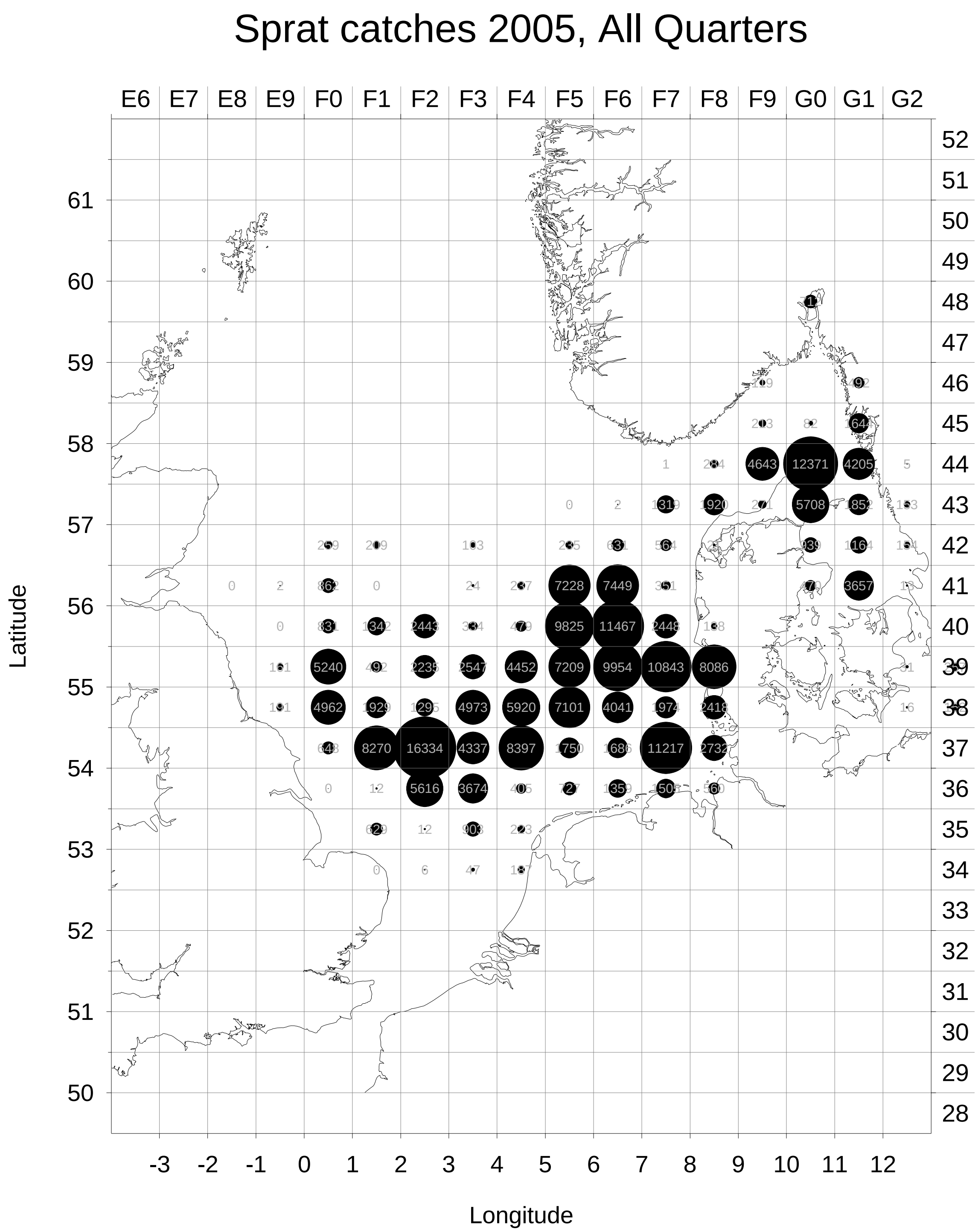


Figure 8.1.2.. Sprat catches (in tonnes) in the North Sea and Div. IIIa in 2005 by statistical rectangle. Working group estimates. All quarters.

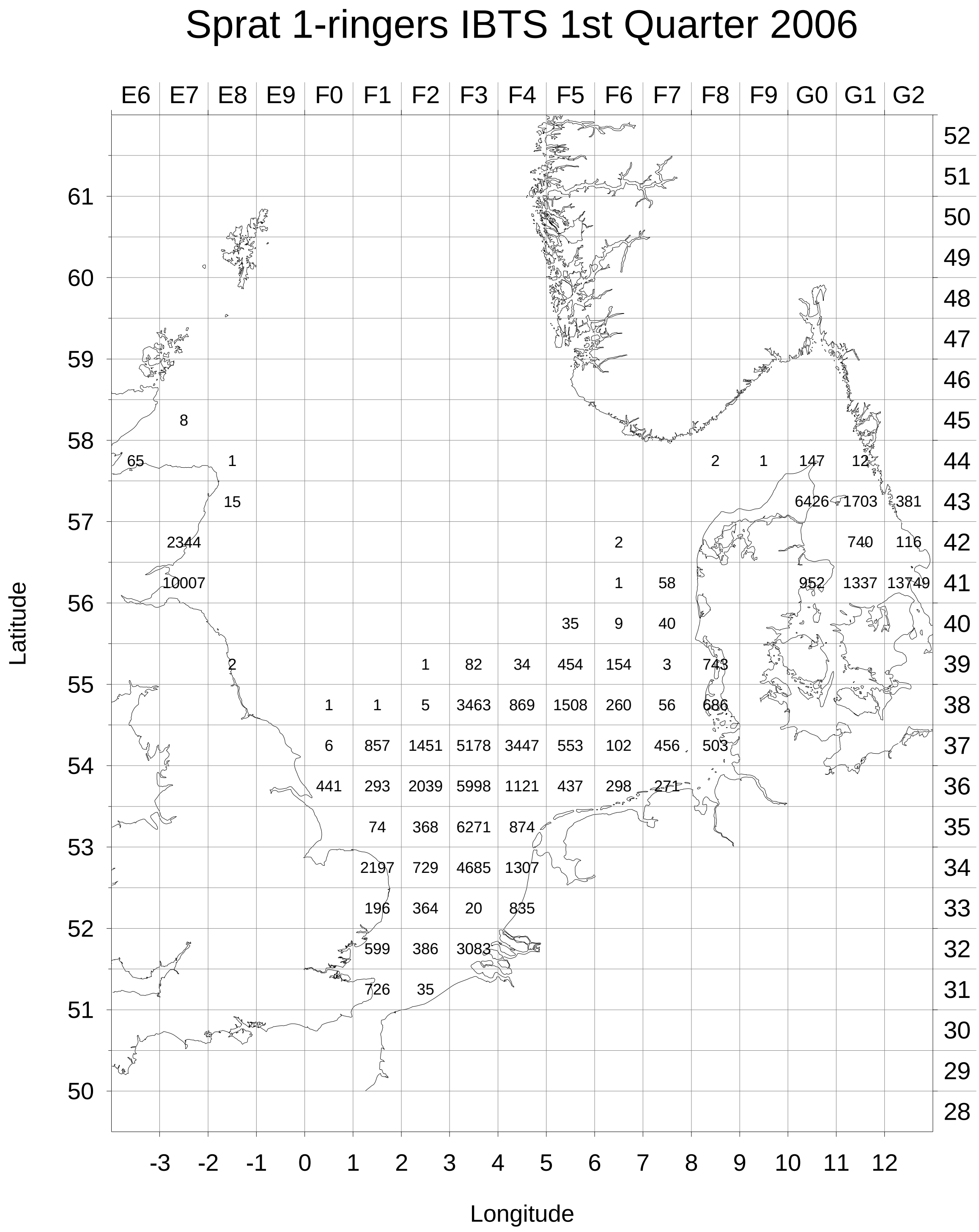


Figure 8.3.1a. Sprat. Distribution of age group 1 in the IBTS (February) 2006 in the North Sea and Division IIIa (Mean number per hour per rectangle).

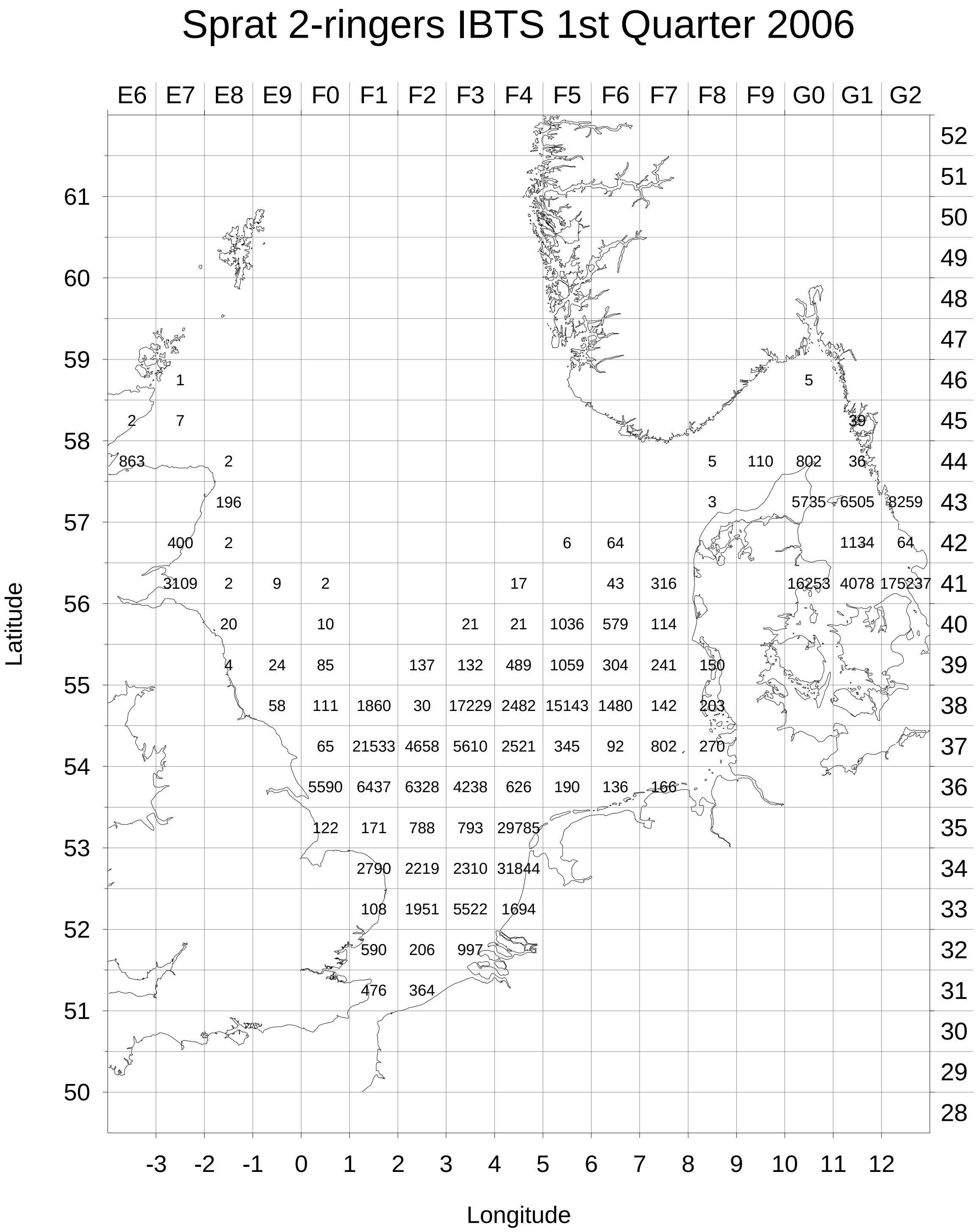


Figure 8.3.1b. Sprat. Distribution of age group 2 in the IBTS (February) 2006 in the North Sea and Division IIIa (Mean number per hour per rectangle).

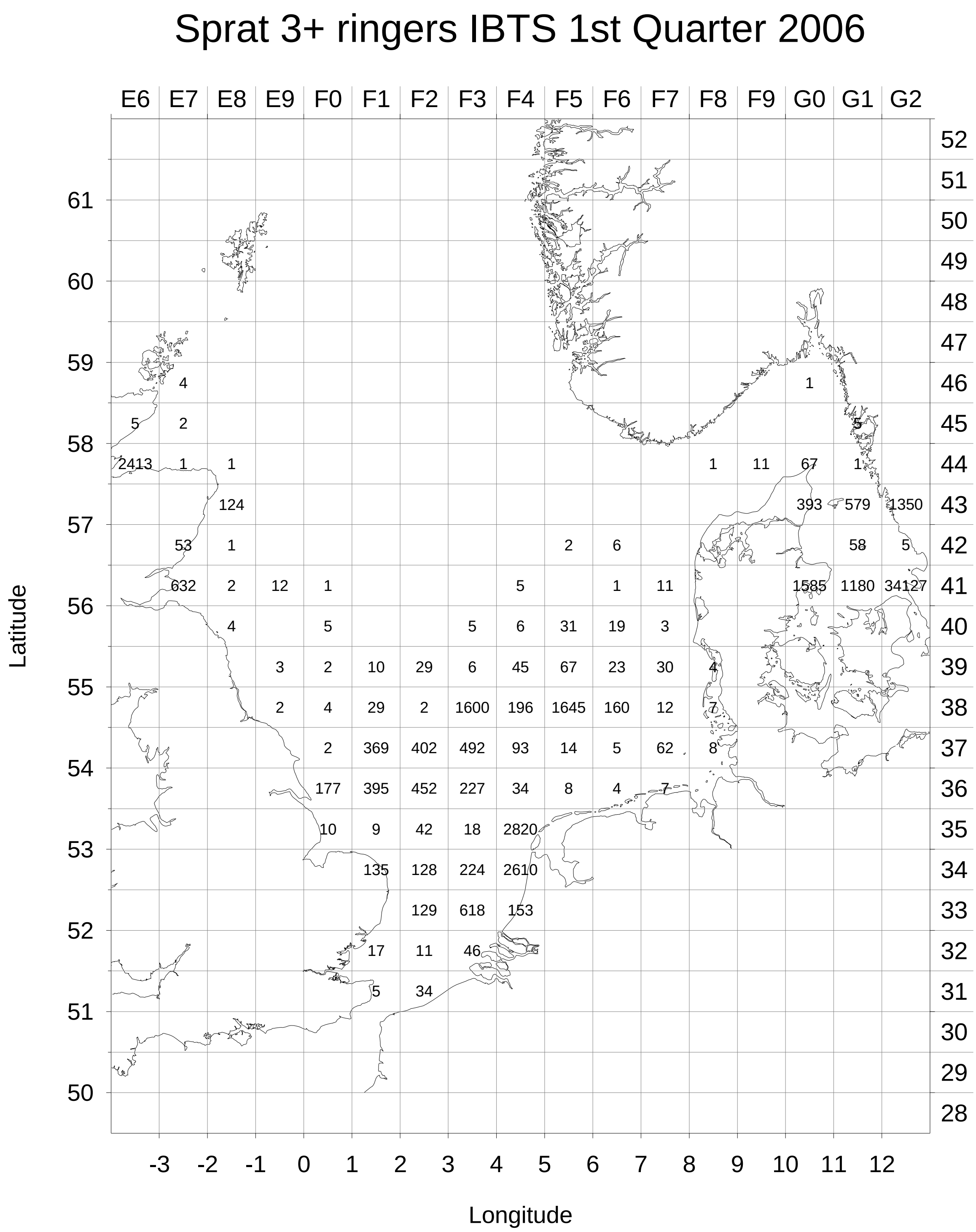


Figure 8.3.1c. Distribution of age group 3+ in the IBTS (February) 2006 in the North Sea and Division IIIa (Mean number per hour per rectangle).

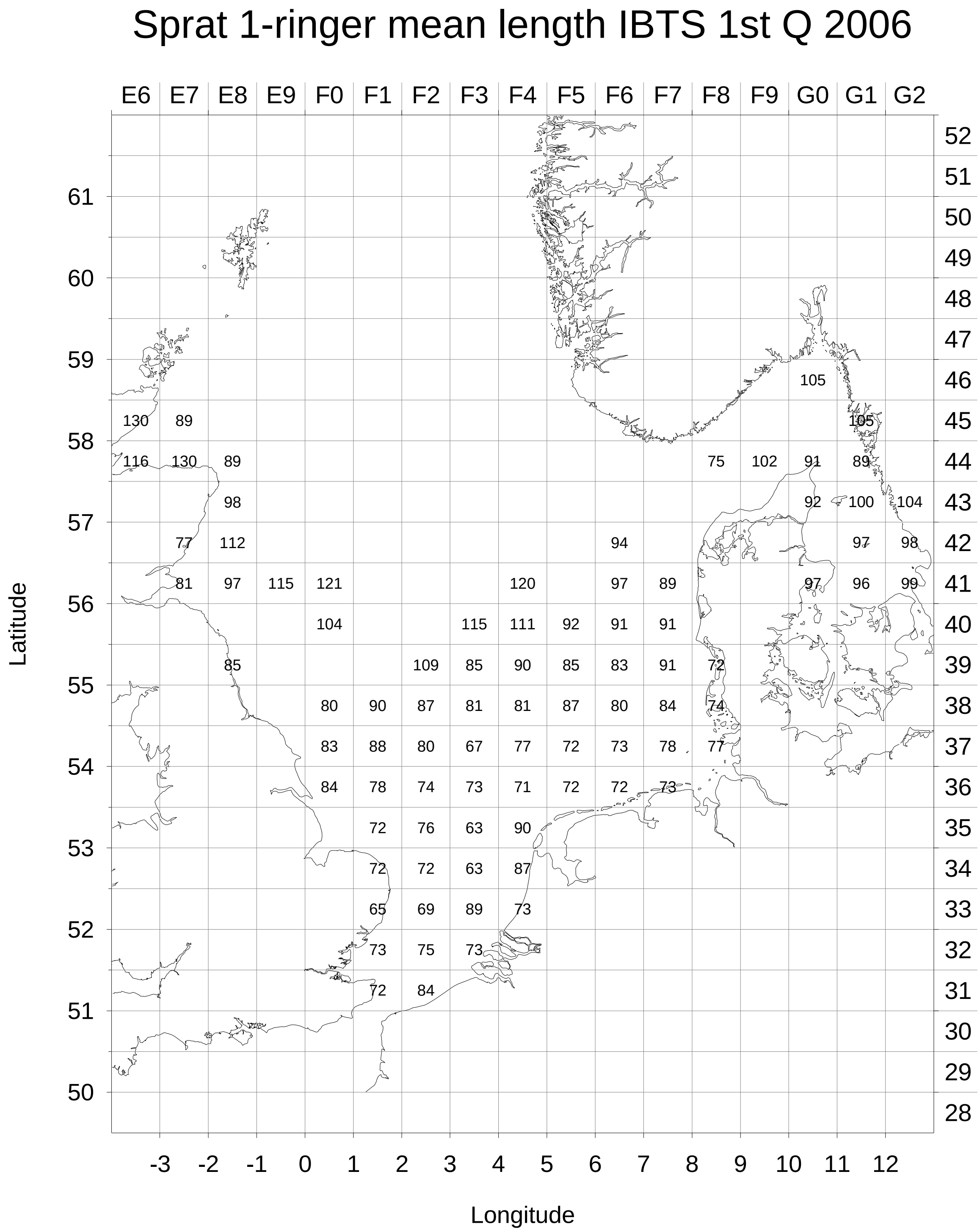


Figure 8.3.2. Sprat. Mean length (mm) of age group 1 in the IBTS (February) 2006 in the North Sea and Division IIIa.

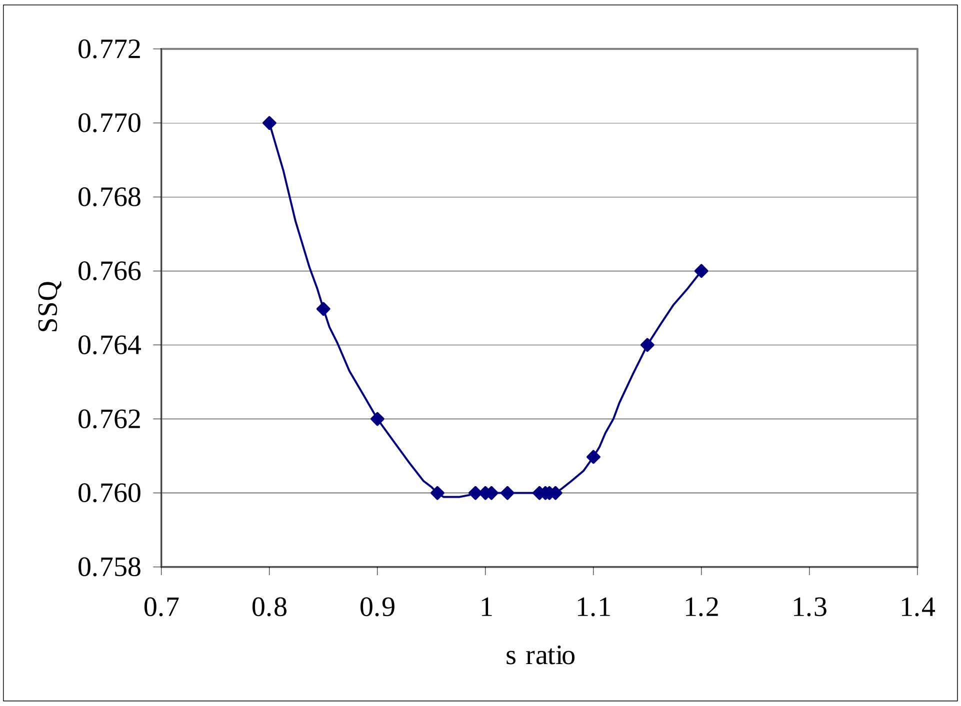
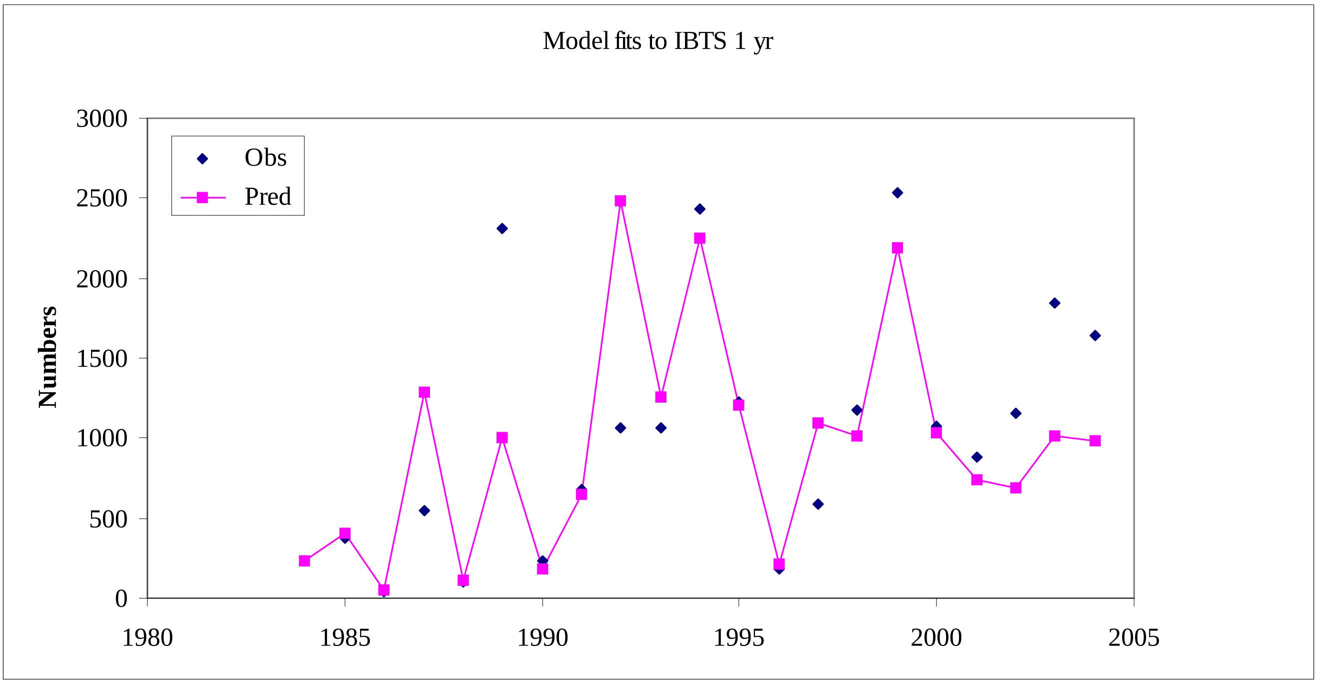


Figure 8.6.1. North Sea sprat. Estimation of the s ratio by SSQ profiling



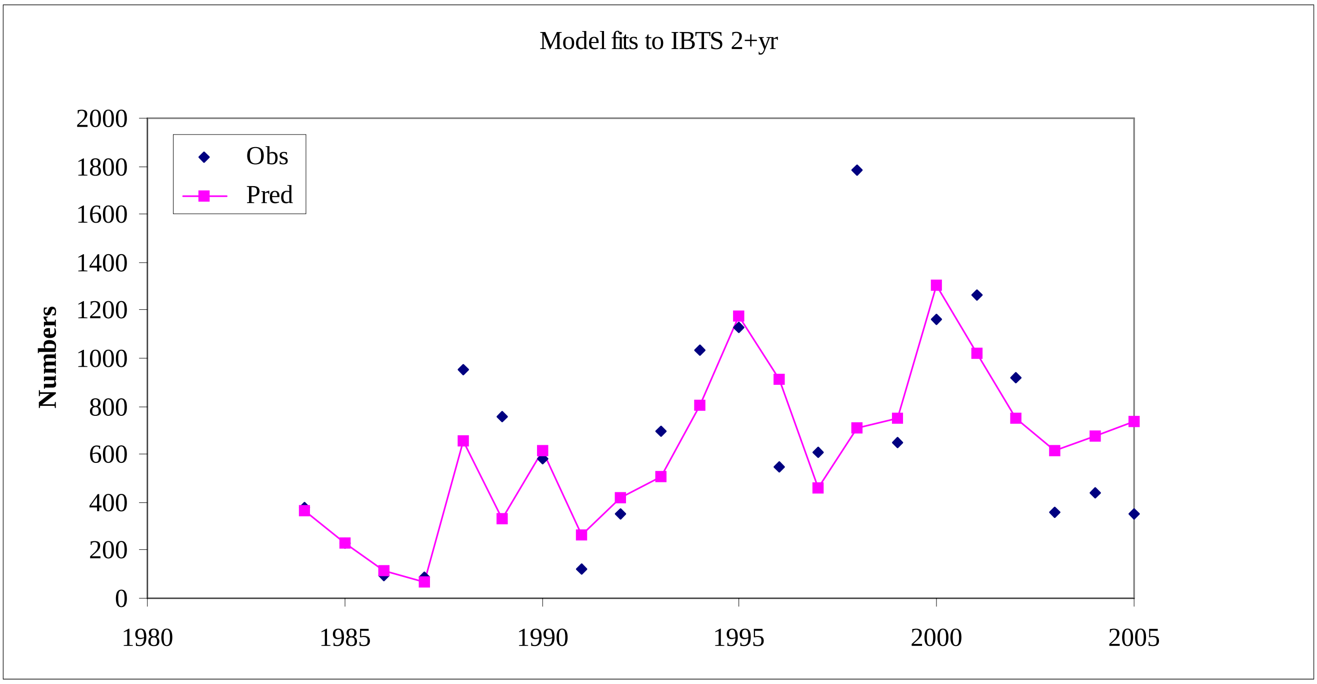


Figure 8.6.2. North Sea sprat. CSA model fits to the IBTS indices of recruits (1yr) and fully recruited (2+yr). M=0.7.

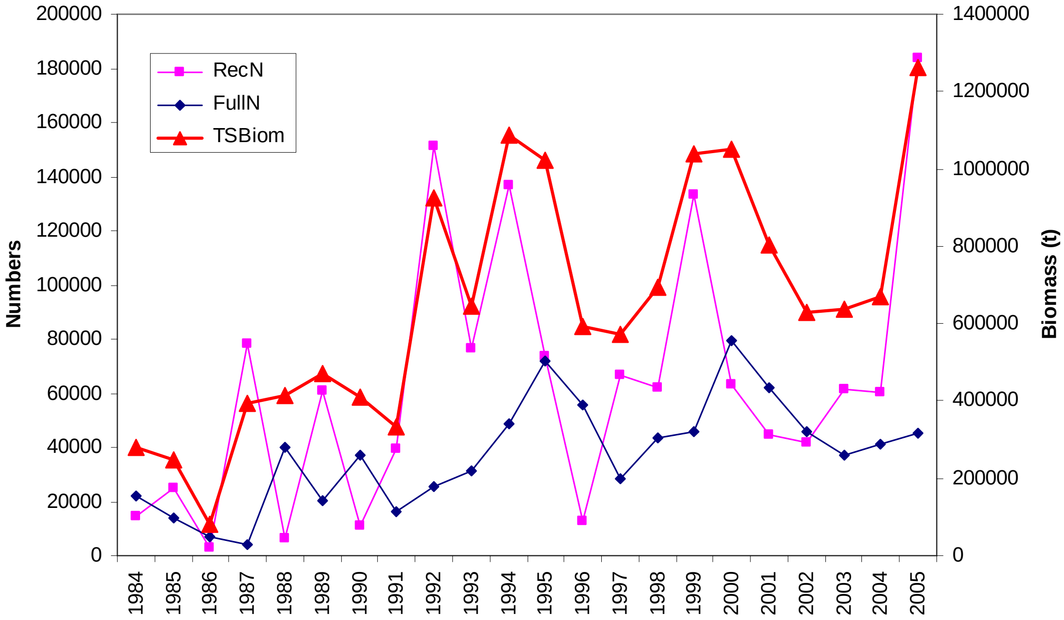
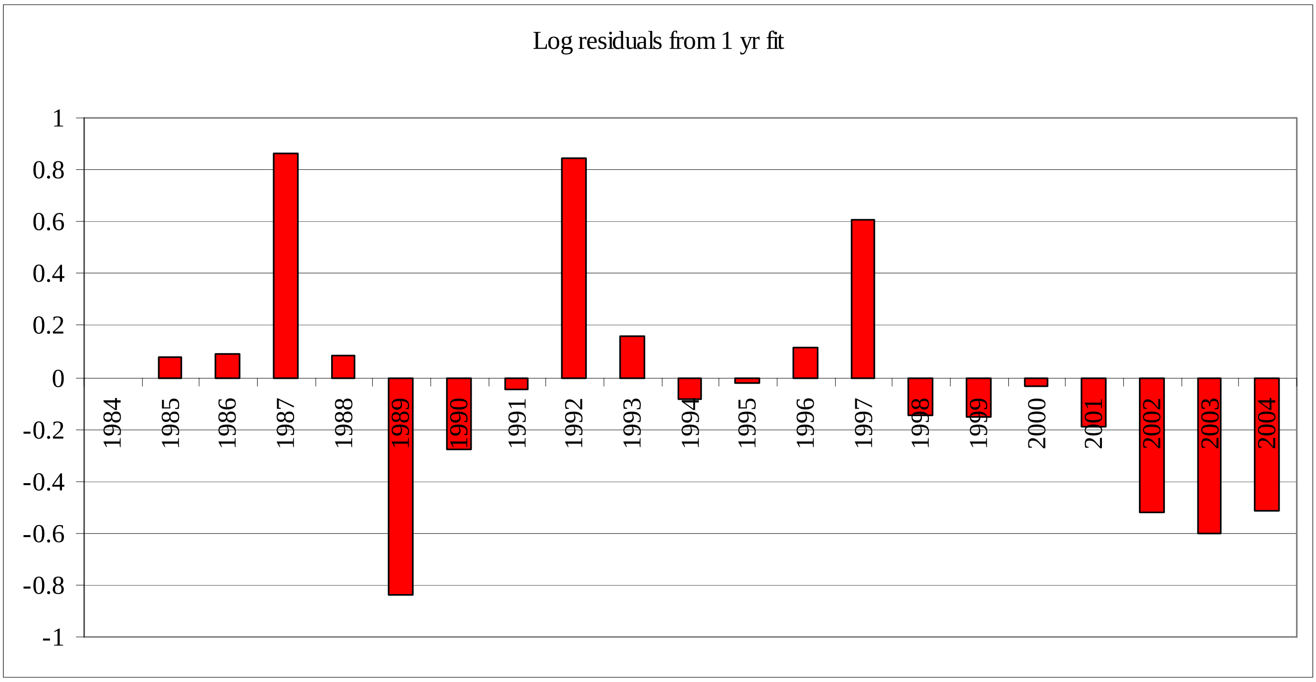


Figure 8.6.3. North Sea sprat. Biomass (t) and numbers (mill) at age estimated by CSA. M=0.7



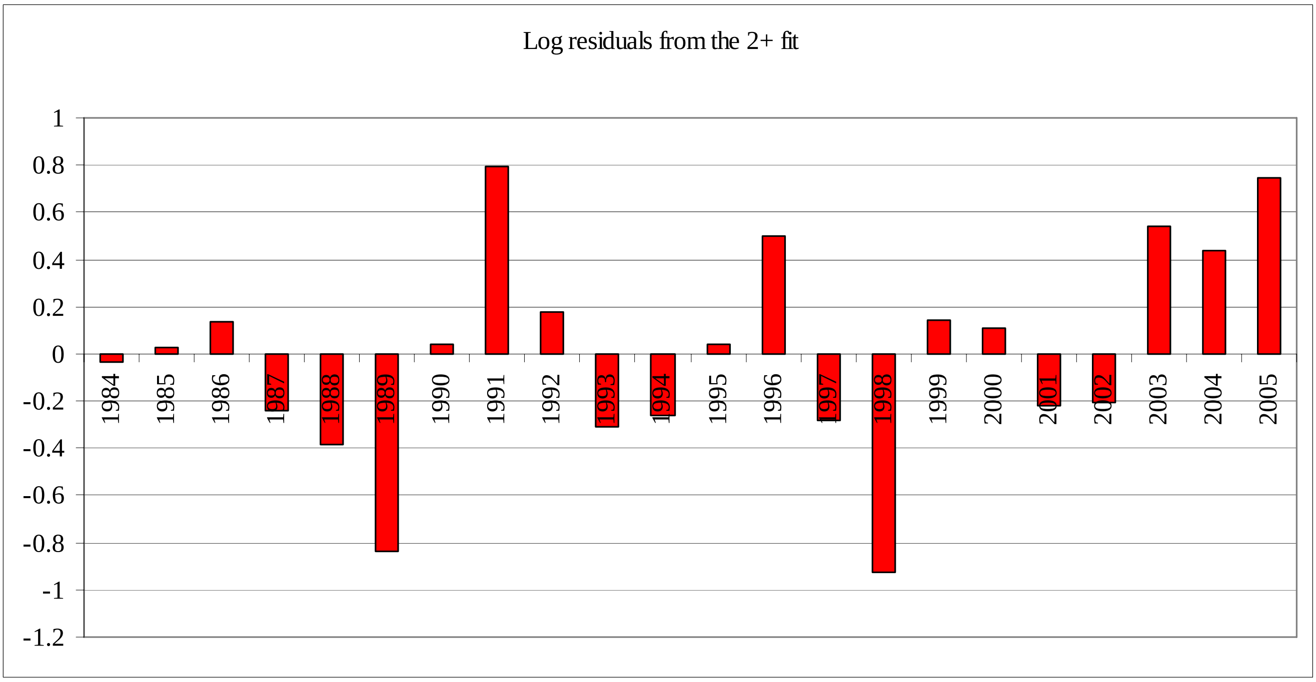
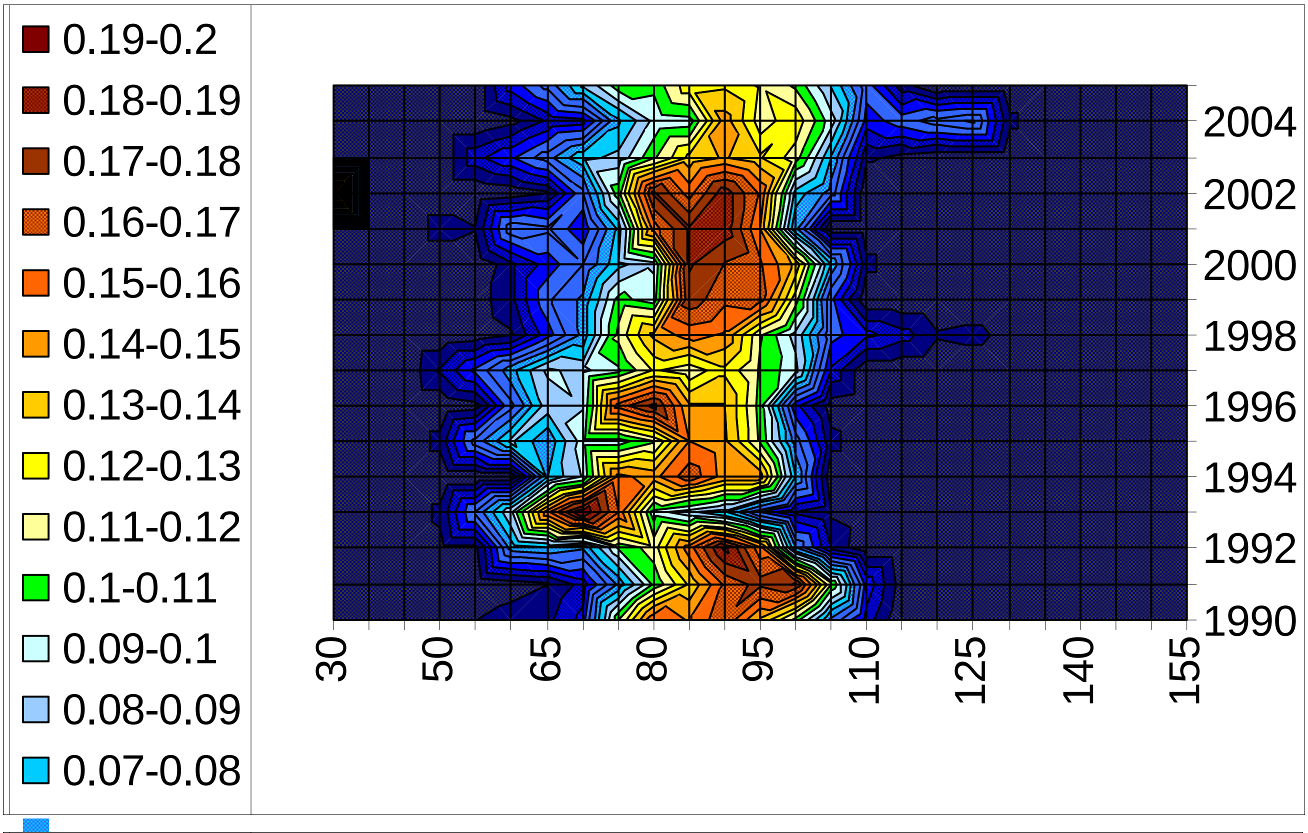


Figure 8.6.4. North Sea sprat. Log residuals from the CSA model fit to the two stages 1yr and 2+year.M=0.7.



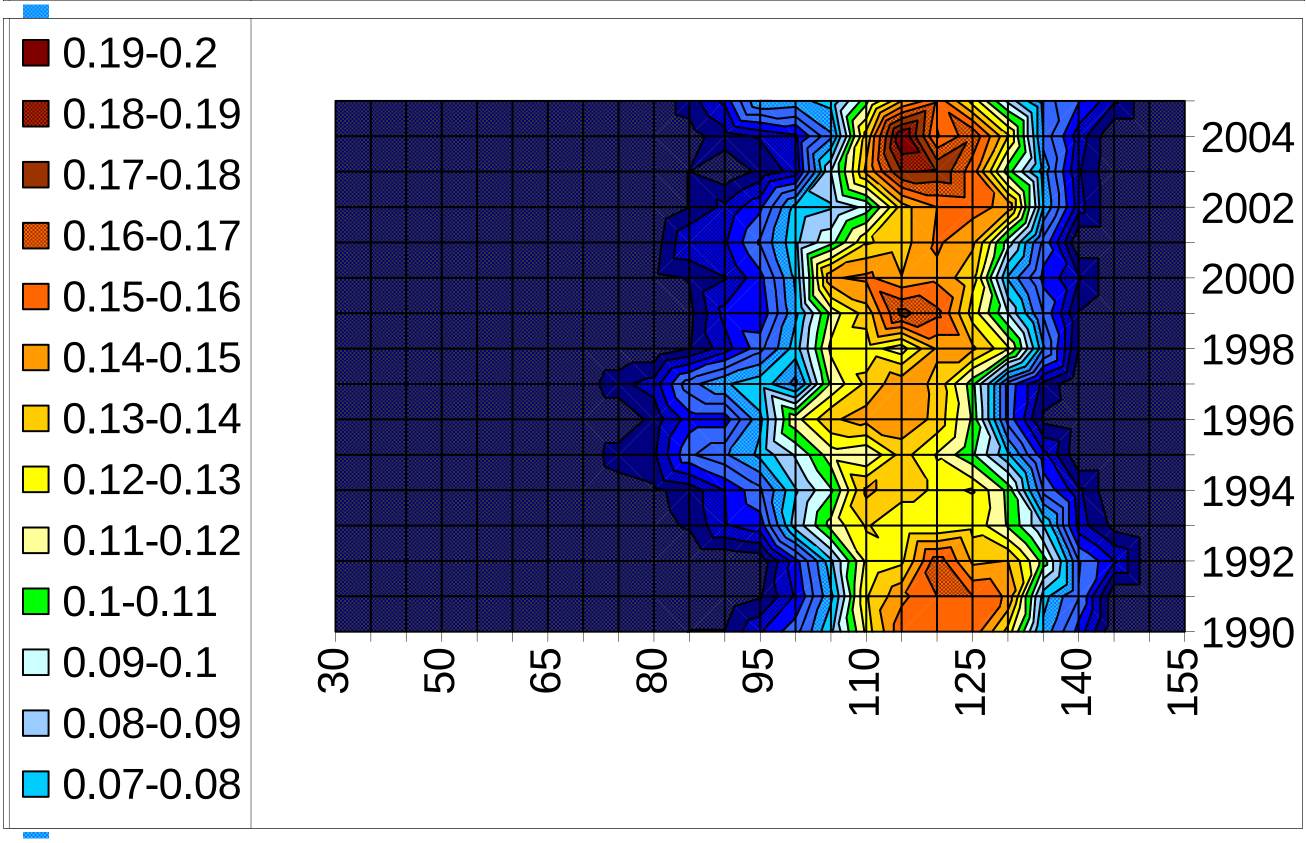


Figure 8.6.5. North Sea sprat. Length composition (%) in the age groups 1 (upper) and 2 (lower) by year in the IBTS surveys, 1st quarter 1990-2006.

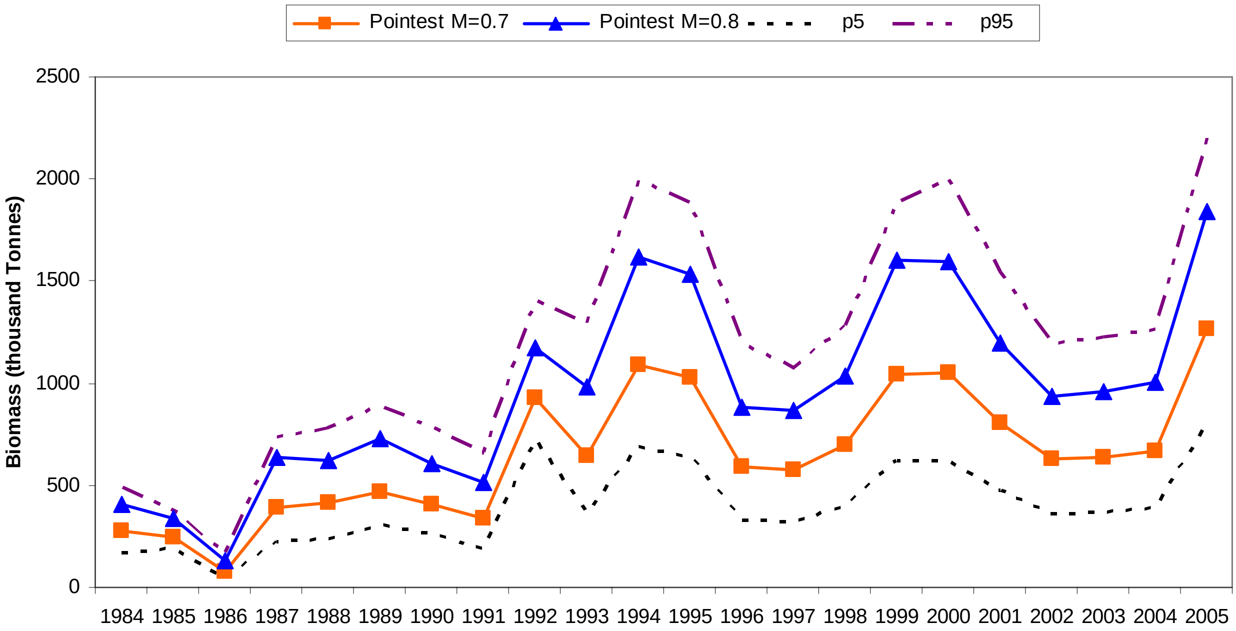


Figure 8.6.6. North Sea sprat. CSA estimated stock biomass, median, 5 and 95% C.I. for M=0.7. Stock biomass estimates for M=0.8 is shown for comparison.

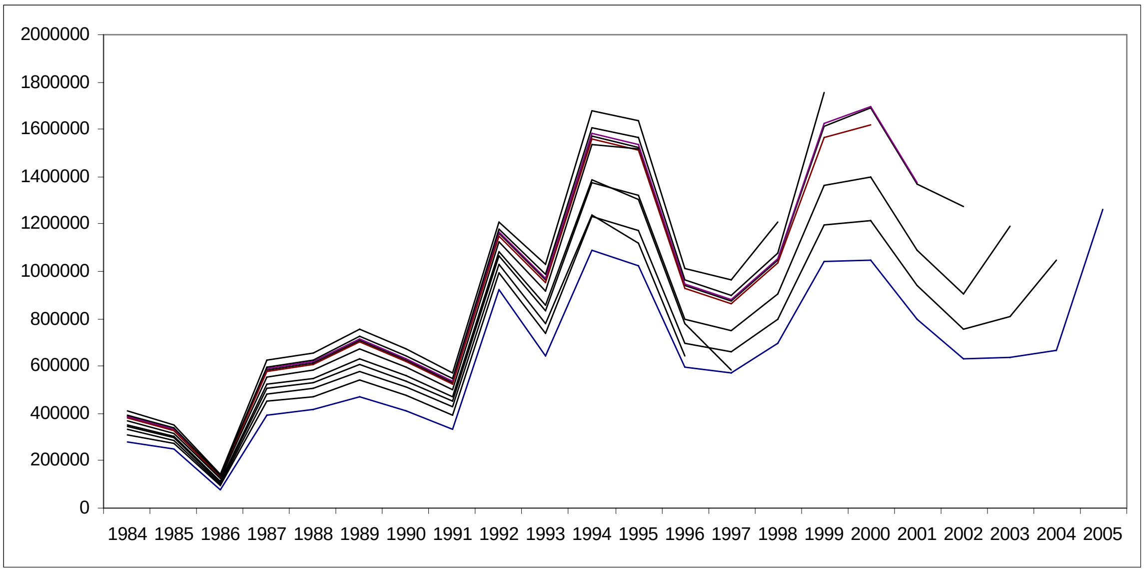


Figure 8.6.7. North Sea sprat. CSA estimated biomass, retrospective plot (M=0.7).

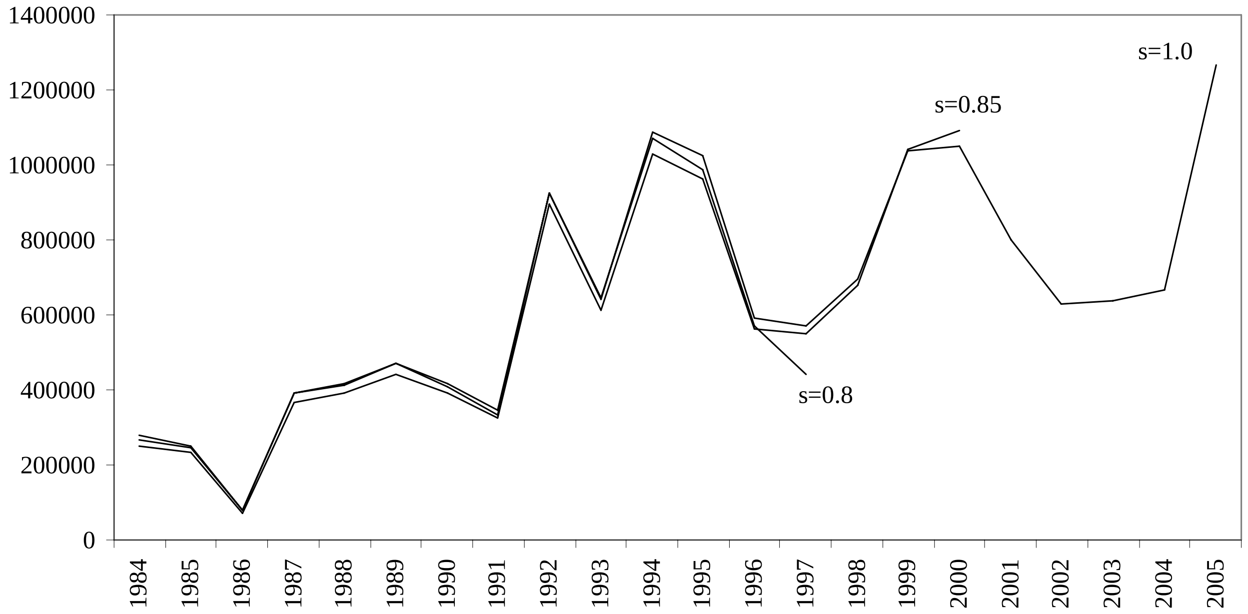


Figure 8.6.8. North Sea sprat. CSA retrospective plots of estimated biomass from different time series using different s. M=0.7.

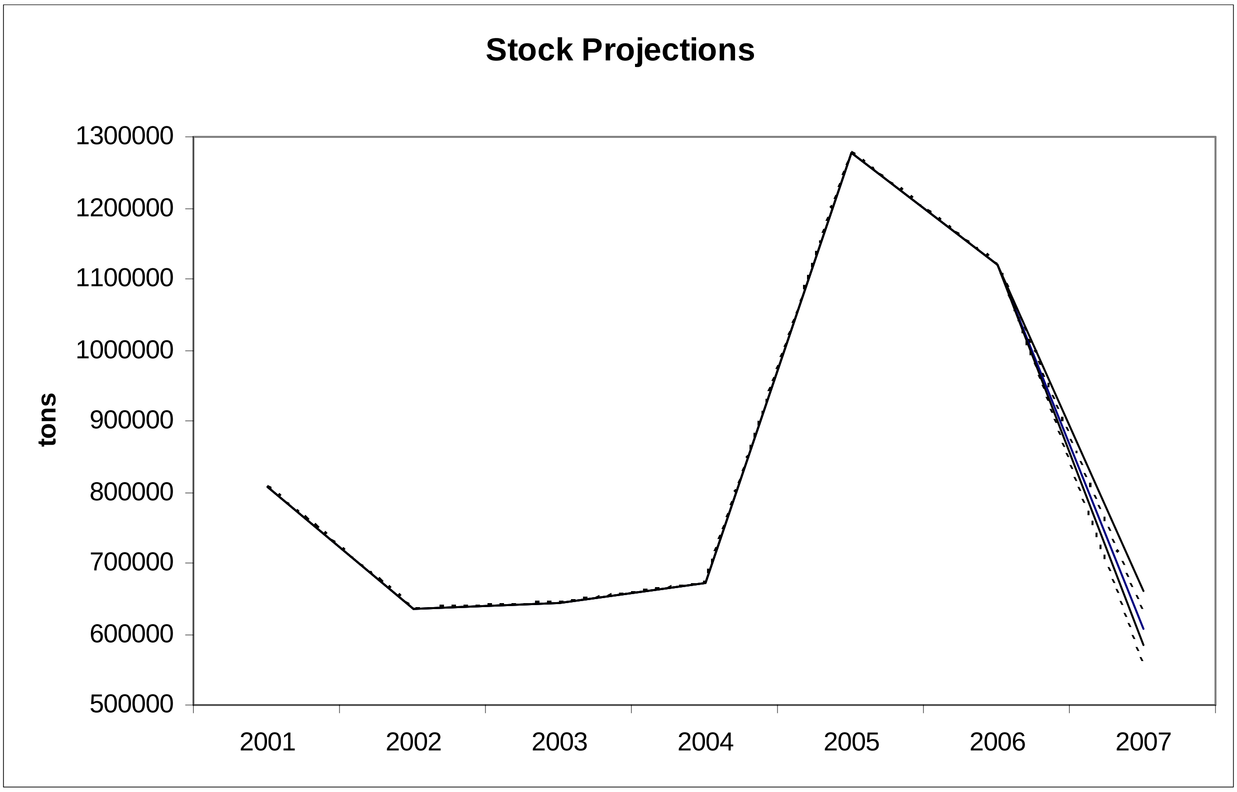


Fig. 8.7.1. Sprat biomass prediction in 2007 for a range of catches in 2006 equal to the agreed TAC and +/-10 and 25%.

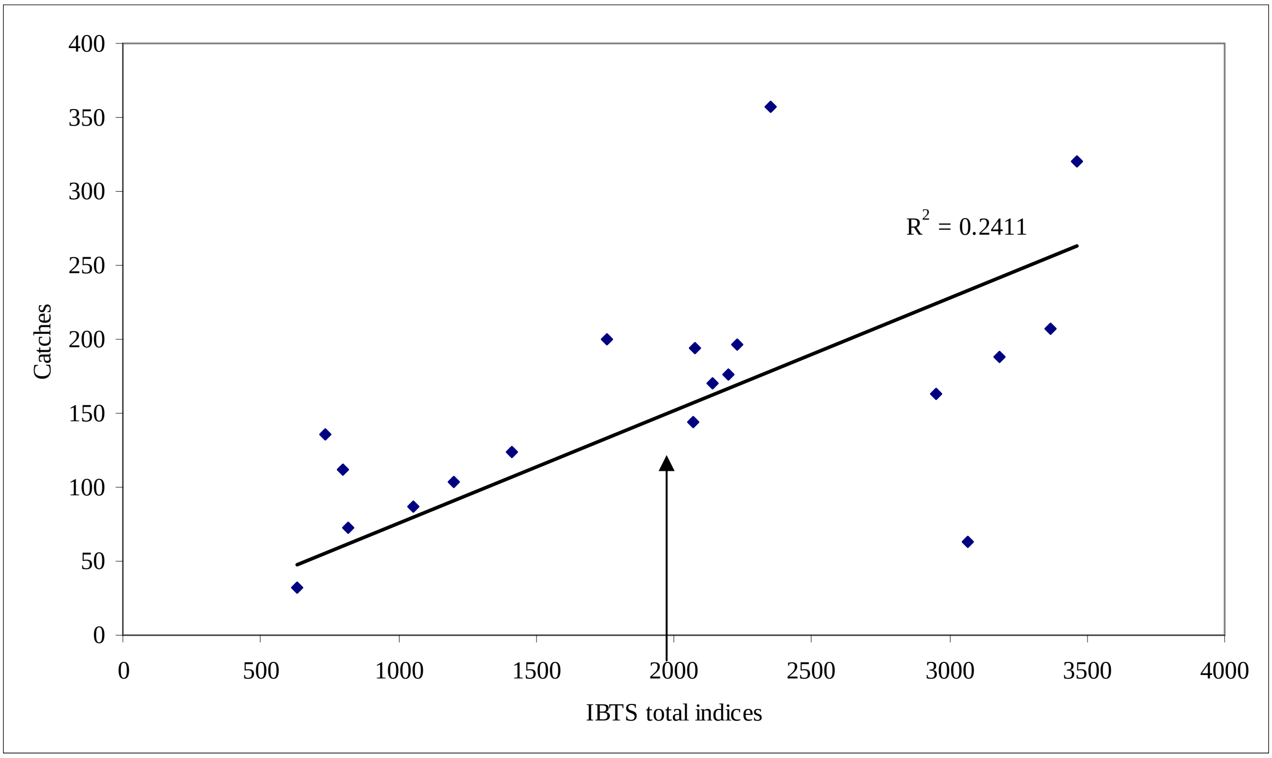


Figure 8.7.2. North Sea sprat. IBTS indices vs total catch (1987-2005). A fitted regression line results in a R-sq of 0.24. Arrow indicates the total IBTS index in 2006 1st quarter.

9 Sprat in Division IIIa

9.1 The Fishery

9.1.1 ACFM advice applicable for 2005 and 2006

The ACFM advice on sprat management is that exploitation of sprat will be limited by the restrictions imposed on fisheries for juvenile herring. This is a result of sprat being fished mainly together with juvenile herring. The sprat fishery is controlled by by-catch ceilings of herring as well as by-catch percentage limits. No ACFM advice on sprat TAC has been given in recent years. The sprat TAC for 2005 was 50,000 t, with a restriction on by-catches of herring not exceeding 21,000 t. For 2006 the TAC was set to 52,000 t, with a restriction of a by-catch ceiling of herring of 20,528 t for the EU fleet.

9.1.2 Landings

The total landings for Division IIIa by area and country are given in Table 9.1.1 for 1974 - 2005. The total landings almost doubled from 2004 to 2005. This increase in landings was mostly in the Kattegat where the total landings were doubled from 10,200 t to 21,800 t. In the Skagerrak, the landings were slightly higher than the level in 2004. The Norwegian and Swedish landings include the coastal and fjord fisheries.

Landings by countries and by quarter are shown in Table 9.1.2. There were landings taken in all quarters. Approximately 50% of the total catch was taken in the 3rd quarter. Only minor landings were taken in the 2nd quarter. Denmark has a total ban on the sprat fishery in Division IIIa from May to September.

The Danish monitoring scheme for management purposes for species composition in the Danish small-meshed fisheries has worked well in 2005. A total of 315 samples were collected from landings taken in Division IIIa by Danish vessels. The sampling figure for 2004 was 293 samples. The total landings from the Danish small mesh fishery in 2005 were 56,800 t (all species) compared to 52,100 t in 2004.

9.1.3 Fleets

Fleets from Denmark, Norway and Sweden carry out the sprat fishery in Division IIIa.

The Danish sprat fishery consists of trawlers using a 16 mm-mesh size codend and all landings are used for fishmeal and oil production. Some of the sprat landings from Denmark and Sweden are by-catches in the herring fishery using 32 mm mesh-size cod ends.

There is a Swedish fishery directed at sprat with by-catches of herring. There is also a fishery carried out with small purse seiners at the West Coast of Sweden for human consumption.

The Norwegian sprat fishery in Division IIIa is a coastal purse seine fishery for human consumption.

9.2 Biological Composition of the Catch

9.2.1 Catches in number and weight-at-age

The numbers and the mean weight-at-age in the landings from 1995 to 2005 are presented in Table 9.2.1 and Table 9.2.2, respectively. Landings, for which samples were collected, were raised using a combination of Swedish and Danish samples, without any differentiation in types of fleets. Quarterly and annual distributions of catches by rectangle are shown in Figures 8.1.1–8.1.2.

9.2.2 Quality of catch and biological data

In 2005 Denmark has provided biological samples from all the quarters where there were landings except quarter 1 in Skagerrak. Sweden provided biological samples from the majority of quarters with landings. No Norwegian samples were collected. The required level of one sample per 1,000 t landed was more than met in 2005 with 128 samples from a total landing of 40,296 tonnes.

The samples were used to estimate the numbers of sprat-at-age and the mean weight-at-age, in all sprat landings (Tables 9.2.1 and Table 9.2.2 respectively). The sample size (128 samples) has increased compared to the level in 2004 (71 samples). 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 9.2.3.

9.3 Fishery-independent information

Acoustic estimates of sprat have been available from the ICES co-ordinated Herring Acoustic surveys in Div. IIIa since 1996. In 1996 the total estimate was 7.9 x 10^8 fish or 14,267 tonnes. About 95 % of the biomass was recorded in Kattegat. There were very low estimates of sprat from 1997 to 2002, but the estimates increased to 15,000 tonnes in 2004. In Division IIIa, in the south-eastern the Kattegat, the abundance and total biomass was estimated to have increased to about 4570 million individuals, equivalent to 54,000 tonnes, and in the south western part of the Skagerrak about 490 million individuals, equivalent to 5,800 tonnes (ICES CM 2006/LRC:04).

The IBTS (February) sprat indices for 1984-2006 are presented in Table 9.3.1. 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-ringer sprat in Figure 8.3.2. The indices are calculated as mean no./hr (CPUE) weighted by area where water depths are between 10 and 150 m (ICES 1995/Assess:13). The indices were revised in 2002 (ICES 2002/ACFM:12) based on an agreement in the IBTS WG in 1999, where it was decided to calculate the sprat index as an area weighted mean over means by rectangles for the IIIa (ICES 1999/D:2). The old time-series of IBTS indices (from 1984-2001) is shown in ICES 2001/ACFM:10.

The total IBTS index for 2006 is much higher than the total index in 2005, and the highest in the whole time-series. This extraordinarily high value is due to a very high index for 2-group sprat, which is based on one single haul, which gives rise to doubts over the validity of this index-value.

9.4 Mean weight-at-age

Mean weights-at-age (g) in the catches during 2005 are presented, by quarter, in Table 9.2.2. The table includes mean weights-at-age for 1995-2004 for comparison. These have been very variable over time, but whether this is due to actual variation in mean weight or difficulties in ageing of sprat is uncertain.

9.5 Recruitment

For this stock the IBTS index for 1-group sprat in the first quarter is considered the most suitable recruitment index. The 1-group index for 2006 is at the level of the average for the time-series (1984-2006). The procedure for the 2005 survey did not differ from previous years. However, the index does not fully reflect strong and weak cohorts in sprat seen in the catch. This was also expressed in previous working group report (ICES 1998 ACFM :14). This can still be linked to difficulties in age determination

9.6 State of the Stock

No assessments of the sprat stock in Division IIIa have been presented since 1985 and this year is no exception. A Schaefer model was fit to the data in 1999 (ICES 1999/ACFM:12) but that attempt was not successful and was subsequently abandoned. In 2003 and 2004 the Working Group agreed to explore the data for sprat in Division IIIa by means of Catch-Survey Analysis (CSA) as performed for sprat in the North Sea (ICES 2003/ACFM:17). This was re-done this year with the time series 1994-2005. The mean weights used for recruitment and fully recruited, were the same as used for the North Sea, except for the three most recent years, where mean weight at age was available from the IBTS database. The attempt was not successful, suggesting scaling problems and input-data problems, which have not yet been solved by the working group.

Although the signal in the IBTS (February)-index for 2006 suggests an increase in the sprat stock from last year and appears to be the highest for the time-series 1984-2006, however as this is due to just one haul the full state of the stock is unknown.

9.7 Projection of Catch and Stock

There is no relationship between the IBTS (February) index (no./h) and the total catch in the same year and the index is not considered useful for management of sprat in Division IIIa.

If the IBTS was to be used, the estimated yield for 2006 would be at the level of 66 000 tonnes (Table 9.6.1) in a SHOT-estimate (Shepherd, 1991). This would be the highest estimated yield for the period; however, this method is not considered to provide any reliable or robust projection under the present management regime and as mentioned above the IBTS index is poor for this particular stock (Figure 9.7.1).

9.8 Reference Points

There are no reference points defined for this stock.

9.9 Management Considerations

Sprat in Division IIIa is short-lived with large inter-annual fluctuations in stock biomass. The natural inter-annual variability in stock abundance, mainly driven by recruitment variability, is high and does not appear to be strongly influenced by the observed levels of fishing effort.

The sprat has mainly been fished together with herring, except for 1994 and 1995 when a directed sprat fishery was carried out with low by-catches of herring. The human consumption fishery takes only a minor proportion of the total catch. With the current management regime, where there is a by-catch ceiling limitation of herring as well as by-catch percentage limits, the sprat fishery is controlled by these factors. However, in 2005 the fishery of sprat was limited by quota restriction on sprat and not by by-catch restrictions on herring. The same situation may occur in 2006.

Attempts to assess this stock have demonstrated the need for:

- Development of a suitable biomass index
- Improvement of the ageing techniques

Effort should be allocated into the development of a more suitable method for projection of catch and stock. There is also a need for better knowledge of spawning seasons and possible recruitment from the North Sea stock.

Table 9.1.1 Division IIIa sprat. Landings in ('000 t) 1974-2005.
(Data provided by Working Group members). These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.
In the period from 1982 to 1992 Sweden only reported total catches from division IIIa.

	Skagerrak				Kattegat			Div. IIIa	**Div. IIIa**
Year	Denmark	Sweden	Norway	**Total**	Denmark	Sweden	**Total**	Sweden	**total**
1974	17.9	2	1.2	21.1	31.6	18.6	50.2		71.3
1975	15	2.1	1.9	19	60.7	20.9	81.6		100.6
1976	12.8	2.6	2	17.4	27.9	13.5	41.4		58.8
1977	7.1	2.2	1.2	10.5	47.1	9.8	56.9		67.4
1978	26.6	2.2	2.7	31.5	37	9.4	46.4		77.9
1979	33.5	8.1	1.8	43.4	45.8	6.4	52.2		95.6
1980	31.7	4	3.4	39.1	35.8	9	44.8		83.9
1981	26.4	6.3	4.6	37.3	23	16	39		76.3
1982	10.5		1.9	12.4	21.4		21.4	5.9	39.7
1983	3.4		1.9	5.3	9.1		9.1	13.0	27.4
1984	13.2		1.8	15	10.9		10.9	10.2	36.1
1985	1.3		2.5	3.8	4.6		4.6	11.3	19.7
1986	0.4		1.1	1.5	0.9		0.9	8.4	10.8
1987	1.4		0.4	1.8	1.4		1.4	11.2	14.4
1988	1.7		0.3	2	1.3		1.3	5.4	8.7
1989	0.9		1.1	2	3.0		3	4.8	9.8
1990	1.3		1.3	2.6	1.1		1.1	6.0	9.7
1991	4.2		1.0	5.2	2.2		2.2	6.6	14.0
1992	1.1		0.6	1.7	2.2		2.2	6.6	10.5
1993	0.6	4.7	1.3	6.6	0.8	1.7	2.5		9.1
1994	47.7	32.2	1.8	81.7	11.7	2.6	14.3		96.0
1995	29.1	9.7	0.5	39.3	11.7	4.6	16.3		55.6
1996	7.0	3.5	1.0	11.5	3.4	3.1	6.5		18.0
1997	7.0	3.1	0.4	10.5	4.6	0.7	5.3		15.8
1998	3.9	5.2	1.0	10.1	7.3	1.0	8.3		18.4
1999	6.8	6.4	0.2	13.4	10.4	2.9	13.3		26.7
2000	5.1	4.3	0.9	10.3	7.7	2.1	9.8		20.1
2001	5.2	4.5	1.4	11.2	14.9	3.0	18.0		29.1
2002	3.5	2.8	0.0	6.3	9.9	1.4	11.4		17.7
2003	2.3	2.4	0.8	5.6	7.9	3.1	10.9		16.5
2004	6.2	4.5	1.1	11.8	8.2	2.0	10.2		22.0
2005	12.1	5.7	0.7	18.5	19.8	2.1	21.8		40.3

Table 9.1.2. Division IIIa sprat. Landings of sprat ('000 t) by quarter by countries, 1995-2005.
(Data provided by the Working Group members)

	Quarter	Denmark	Norway	Sweden	Total
1995	1	4.8	0.1	4.8	9.7
	2	10.4	0.0	0.9	11.3
	3	19.3	0.0	2.3	21.6
	4	6.3	0.4	6.3	13.0
	Total	40.8	0.5	14.3	55.6
1996	1	5.6	+	4.2	9.8
	2	3.4		0.2	3.6
	3	+	0.4	+	0.4
	4	1.4	0.6	2.2	4.2
	Total	10.4	1.0	6.6	18.0
1997	1	0.7	-	0.3	1.0
	2	0.4	-	1.2	1.6
	3	2.3	-	0.1	2.4
	4	8.2	0.4	2.2	10.8
	Total	11.6	0.4	3.8	15.8
1998	1	4.0	0.1	0.1	4.2
	2	0.9		+	0.9
	3	1.1	0.3	0.4	1.8
	4	5.4	0.7	5.7	11.7
	Total	11.4	1.1	6.1	18.6
1999	1	3.5	0.0	4.0	7.5
	2	0.1		0.2	0.3
	3	7.4	0.1	1.9	9.4
	4	6.2	0.1	3.3	9.6
	Total	17.2	0.2	9.3	26.7
2000	1	4.1	0.1	2.3	6.5
	2	0.0		1.9	1.9
	3	4.8	0.1	0.0	4.9
	4	3.8	0.7	2.3	6.8
	Total	12.7	0.9	6.4	20.0
2001	1	2.5		2.6	5.2
	2	6.6		0.1	6.7
	3	10.2		0.1	10.2
	4	0.9	1.4	4.8	7.1
	Total	20.2	1.4	7.6	29.1
2002	1	3.8	0.0	1.4	5.2
	2	2.1		0.4	2.4
	3	5.9	0.0	0.1	6.0
	4	1.7	0.0	2.4	4.1
	Total	13.4	0.0	4.3	17.7
2003	1	3.5	0.1	1.7	5.3
	2	0.6		0.8	1.4
	3	1.0		0.7	1.7
	4	5.0	0.8	2.3	8.1
	Total	10.2	0.8	5.5	16.5
2004	1	3.1	0.0	1.4	4.5
	2	0.6		0.9	1.5
	3	3.7		0.4	4.1
	4	6.9	1.1	3.8	11.9
	Total	14.4	1.1	6.5	22.0
2005	1	6.5		1.7	8.1
	2	4.6		0.1	4.7
	3	18.6	0.7	0.8	20.1
	4	2.1		5.2	7.3
	Total	31.9	0.7	7.7	40.3

+ Catch record, but amount not precisely known.

[1] Preliminary figures

Table 9.2.1 **Division IIIa sprat**. Landed numbers (millions) of sprat by age groups in 1996-2005.

	Quarter	Age						Total
		0	1	2	3	4	5+	
1996	1		288.42	546.53	62.11	15.65	5.07	917.78
	2		0.89	414.10	42.76	0.71	0.06	458.51
	3		0.34	1.81	0.30	0.02		2.47
	4		31.19	165.65	27.34	2.03		226.21
	Total		320.84	1128.08	132.51	18.41	5.13	1,604.97
1997	1			3.43	18.31	20.60	4.59	46.94
	2		1.00	2.76	19.56	1.51	0.25	25.07
	3	4.35	209.25	9.51	1.92	6.24		231.26
	4	32.39	644.28	58.31	7.16	28.02		770.16
	Total	36.74	854.53	74.01	46.95	56.37	4.84	1,073.43
1998	1		14.91	103.38	94.00	76.99	6.34	295.61
	2		3.24	21.49	20.59	16.63	1.33	63.28
	3	53.62	26.03	41.84	5.65	0.74		127.88
	4	192.13	253.98	226.55	53.14	29.80		755.61
	Total	245.75	298.16	393.25	173.38	124.17	7.67	1,242.38
1999	1	0.0	560.5	158.0	151.2	77.4	6.8	953.9
	2		32.8	1.6	1.7	1.1	0.3	37.6
	3	9.6	741.7	46.7	6.3	5.9		810.0
	4	8.5	645.4	20.5	6.8	0.6	0.3	682.1
	Total	18.0	1,980.4	226.8	166.0	85.0	7.4	2,483.6
2000	1		116.6	384.3	40.3	7.3	1.6	550.0
	2		17.3	127.4	11.2			155.9
	3	2.1	223.3	51.4	12.2			289.1
	4	18.0	277.6	81.4	13.1	0.8		390.9
	Total	20.2	634.8	644.6	76.8	8.1	1.6	1,386.0
2001	1	0.0	342.6	173.0	73.3	10.0	1.6	600.4
	2	0.0	1746.4	13.4	0.4	0.0	0.0	1,760.2
	3	5.7	924.1	31.7	0.0	0.0	0.0	961.5
	4	22.9	488.1	39.1	18.5	1.5	0.5	570.6
	Total	28.6	3,501.2	257.2	92.2	11.5	2.1	3,892.8
2002	1	0.0	63.8	323.2	38.5	24.7	2.4	452.6
	2	0.0	185.5	63.2	4.8	1.0	0.0	254.5
	3	1.3	326.2	102.0	23.9	6.6	0.6	460.5
	4	21.3	205.4	45.9	10.6	5.9	0.4	289.6
	Total	22.5	780.9	534.3	77.9	38.2	3.4	1,457.2
2003	1	0.0	17.5	221.4	100.7	17.6	4.3	361.5
	2	0.0	2.6	49.8	24.0	5.5	2.1	84.1
	3	192.7	10.9	31.6	5.4	2.7	0.0	243.3
	4	321.6	131.7	100.6	42.5	3.4	2.3	602.2
	Total	514.3	162.7	403.4	172.6	29.2	8.8	1,291.1
2004	1		539.6	39.3	47.2	20.7	8.0	654.8
	2		36.7	22.3	44.9	11.8	1.1	116.8
	3	10.0	254.4	19.4	4.1	2.4		290.3
	4	874.0	366.8	33.0	24.9	3.4	0.3	1,302.3
	Total	883.9	1,197.5	113.9	121.1	38.3	9.3	2,364.2
2005	1	0.0	1609.1	185.6	25.5	17.4	5.1	1,842.7
	2	0.0	827.1	19.2	0.6	0.0	0.0	846.9
	3	1.8	1557.0	91.3	9.9	12.9	0.0	1,672.9
	4	11.5	447.4	60.5	7.3	4.0	0.7	531.3
	Total	13.4	4,440.6	356.6	43.3	34.2	5.8	4,893.9

Table 9.2.2. **Division IIIa Sprat.** Quarterly mean weight-at-age (g) in the landings. (1998-2005 Danish and Swedish data, 1996-1997 Danish data)

Year	Age							SOP
	Quarter	0	1	2	3	4	5+	Corrected landings
1996	1		9.2	10.6	14.2	17.4	17.7	9,724
	2		8.6	12.5	15.1	17.4	17.0	5,847
	3		4.2	10.9	15.5	21.0		26
	4		4.2	10.9	15.5	21.0		2,403
Weighted mean			8.7	7.6	14.8	19.6	17.7	18,000.3
1997	1			17.3	18.6	21.8	26.0	968
	2		8.3	17.6	20.0	22.1	31.0	489
	3	4.1	13.6	17.2	21.1			3,062
	4	4.7	14.7	17.5		19.5		11,176
Weighted mean		4.6	14.4	17.5	19.6	20.4	26.3	15,696.2
1998	1		6.6	14.0	18.0	19.0	21.3	4,828
	2		6.6	13.9	17.8	18.7	21.0	1,027
	3	4.6	17.7	20.7	22.1	24.7		1,718
	4	4.8	17.5	20.4	22.5	27.5		11,998
Weighted mean		4.8	16.9	18.5	19.6	21.2	21.2	19,570.0
1999	1		4.6	6.4	17.3	13.4	13.1	7,319
	2		5.3	17.1	18.6	22.2	17.8	264
	3	3.0	11.4	12.6	16.8	18.3		9,257
	4	4.8	13.9	17.6	20.8	21.2	23.5	9,521
Weighted mean		3.8	10.2	8.8	17.4	13.9	13.7	26,361.0
2000	1		5.3	13.1	15.3	20.7	22.7	6,438
	2		5.2	12.8	14.1			1,873
	3	4.3	16.6	18.0	21.9			4,897
	4	7.0	16.9	19.9	22.1	24.6		6,742
Weighted mean		6.7	14.3	14.3	17.3	21.1	22.7	19,949.3
2001	1		3.8	14.3	16.2	17.8	17.3	5,168
	2		3.7	6.5	21.0			6,598
	3	5.3	10.5	12.1		13.0		10,114
	4	5.1	12.0	19.7	22.6	19.3	25.6	7,200
Weighted mean		5.1	6.7	14.5	17.5	18.0	19.2	29,078.5
2002	1		5.7	12.7	17.3	19.3	20.6	5,411
	2		7.9	13.7	16.0	17.0		2,175
	3	8.0	12.4	15.1	18.1	17.0	17.0	5,900
	4	5.7	15.6	18.2	21.6	21.5	22.0	4,278
Weighted mean		5.8	11.6	13.7	18.1	19.2	20.1	17,763.2
2003	1		6.0	14.1	16.2	18.9	23.8	5,293
	2		5.0	16.0	17.6	21.6	22.8	1,401
	3	4.0	12.0	19.0	19.0	21.0		1,661
	4	8.9	16.4	21.1	21.7	25.2	24.3	8,211
Weighted mean		7.1	14.8	16.5	17.8	20.3	23.7	16,565.3
2004	1		4.6	14.6	17.8	17.3	17.3	4,392
	2		7.0	13.6	16.7	17.0	19.5	1,532
	3	3.0	14.1	16.7	20.0	21.4		4,075
	4	3.5	16.8	19.9	22.2	20.9	28.0	10,508
Weighted mean		3.5	10.4	16.3	18.4	17.8	17.9	20,507.7
2005	1		3.0	14.6	16.3	20.3	21.1	8,149
	2		5.4	11.7	26.8	0.0		4,723
	3	2.9	11.9	14.6	15.4	11.0		20,130
	4	3.3	13.1	19.1	20.1	21.1	23.1	7,300
Weighted mean		5.0	7.6	15.4	17.1	17.2	21.5	40,301.4

Table 9.2.3 **Division IIIa sprat.** Sampling commercial landings for biological samples in 2005.

Country Area	**Quarter**	**Landings (tonnes)**	**No. samples**	**No. meas.**	**No. aged**
Denmark	1	1072	0	0	0
Skagerrak	2	1746	7	223	107
	3	8041	20	2,451	752
	4	1214	7	1,216	302
	Total	12074	34	3,890	1,161
Denmark	1	5398	13	2,502	798
Kattegat	2	2903	8	1,049	356
	3	10566	34	3,737	886
	4	915	11	1,130	349
	Total	19782	66	8,418	2,389
Norway	1	-			
Skagerrak	2	-			
	3	-			
	4	712	0	0	0
	Total	712	0	0	0
Sweden	1	1428	10	456	453
Skagerrak	2	10	0	0	0
	3	501	0	0	0
	4	3735	10	500	499
	Total	5674	20	956	952
Sweden	1	250	1	104	104
Kattegat	2	63	0	0	0
	3	309	3	151	150
	4	1433	4	364	363
	Total	2054	8	619	617
Denmark		31856	100	12,308	3,550
Norway		712	0	0	0
Sweden		7728	28	1,575	1,569
	Total	40296	128	13,883	5,119

Table 9.5.1. Division IIIa sprat. IBTS(February) indices of sprat per age group 1984-2006. (Mean number per hour per rectangle weighted by area. Only hauls taken in depth of 10-150 m are included).

Year	No Rect	No hauls	Age Group					
			1	2	3	4	5+	Total
1984	15	38	5,676	869	205	79	64	6,892
1985	14	38	2,158	2,347	393	140	51	5,089
1986	15	38	629	1,979	2,035	144	38	4,825
1987	16	38	2,736	2,846	3,003	2,582	157	11,324
1988	13	38	915	5,263	1,485	2,088	453	10,203
1989	14	38	414	911	989	555	136	3,004
1990	15	38	418	224	65	61	46	814
1991	14	38	496	732	700	128	376	2,433
1992	16	38	5,994	599	264	204	75	7,135
1993	16	38	1,590	4,169	907	199	240	7,105
1994	16	38	1,789	716	1,021	313	70	3,908
1995	17	38	2,204	1,770	35	45	4	4,058
1996	15	38	186	5,627	751	128	218	6,909
1997	16	41	233	391	1,239	139	135	2,137
1998	15	39	72	1,585	620	1,618	522	4,416
1999	16	42	4,535	355	250	44	314	5,498
2000	16	41	292	738	60	51	24	1,165
2001	16	42	6,540	1,144	677	92	46	8,499
2002	16	42	1,119	966	87	58	13	2,242
2003	17	46	463	1,247	1,172	381	125	3,388
2004	16	41	403	49	157	87	24	719
2005	17	50	3,314	1,563	471	837	538	6,723
2006	17	48	1,324	11,856	1,754	299	159	15,392

Table 9.6.1. Division IIIa Sprat. SHOT forecast of landings in 2006 using total landings and the total IBTS-indices as input data.

IIIa SHOT forecast spreadsheet version 4

Total Index 15 March 2006

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	36.1	6892		0.77	0.23				47		
1985	19.7	5089	5089	0.77	0.23	15			26		
1986	10.8	4825	4825	0.77	0.23	8	14	15	14	20	15
1987	14.4	11324	11324	0.77	0.23	15	26	23	19	29	23
1988	8.7	10203	10203	0.77	0.23	7	18	18	11	23	18
1989	9.8	3004	3004	0.77	0.23	10	4	5	13	7	5
1990	9.7	814	814	0.77	0.23	10	1	3	13	4	3
1991	14	2433	2433	0.77	0.23	15	4	6	18	7	6
1992	10.5	7135	7135	0.77	0.23	9	15	15	14	19	15
1993	9.1	7105	7105	0.77	0.23	9	14	13	12	17	13
1994	96	3908	3908	0.77	0.23	122	7	8	125	10	8
1995	55.6	4058	4058	0.77	0.23	44	16	34	72	45	34
1996	18	6909	6909	0.77	0.23	7	30	36	23	47	36
1997	15.8	2137	2137	0.77	0.23	15	9	11	21	14	11
1998	18.4	4416	4416	0.77	0.23	19	18	18	24	23	18
1999	26.7	5498	5498	0.77	0.23	29	23	22	35	28	22
2000	20.1	1165	1165	0.77	0.23	18	5	10	26	13	10
2001	29.1	8499	8499	0.77	0.23	32	37	33	38	43	33
2002	17.7	2242	2242	0.77	0.23	14	10	14	23	18	14
2003	16.5	3388	3388	0.77	0.23	16	15	16	21	20	16
2004	22	719	719	0.77	0.23	24	3	6	29	8	6
2005	40.3	6723	6723	0.77	0.23	46	31	29	52	38	29
2006		15392	15392	0.77	0.23		73	66		85	66

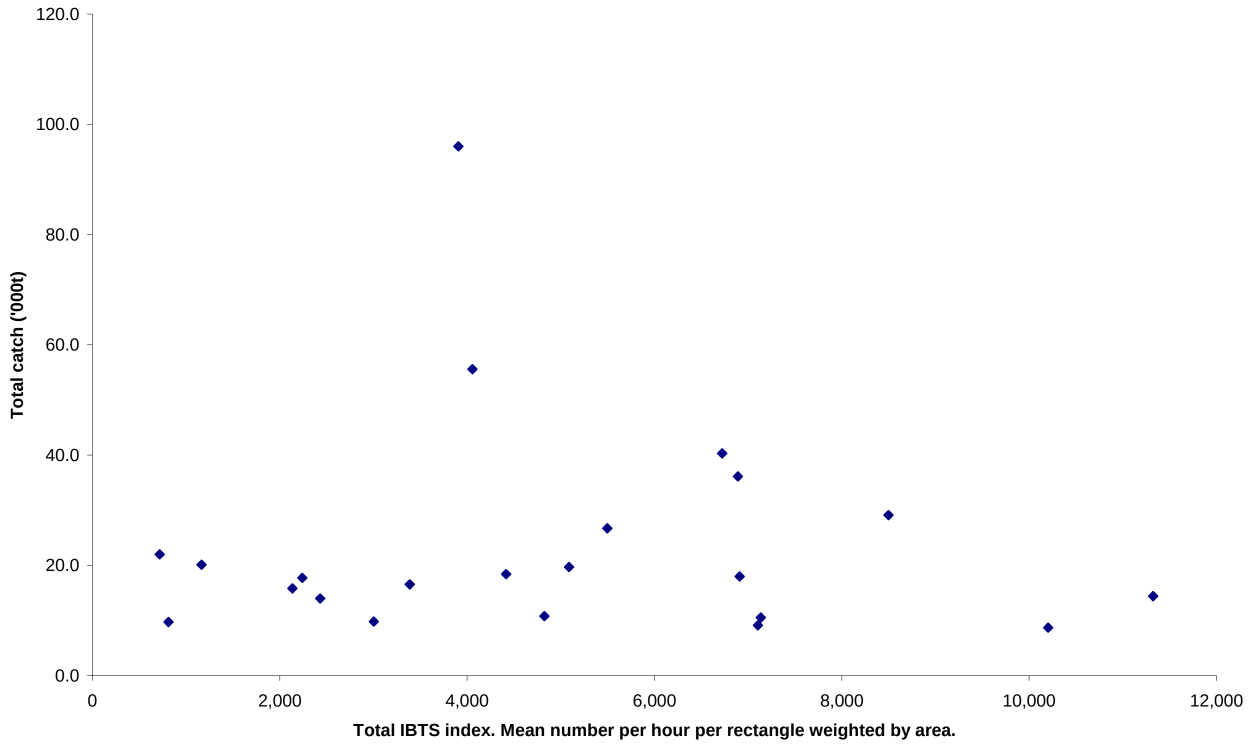


Figure 9.7.1. Division IIIa sprat IBTS indices vs the total catches in 1984-2005.

10 Stocks with insufficient data

Two stocks with very low research intensity were poorly described in previous reports in devoted sections or chapters. These were Clyde herring (section 5.11 in ICES 2005a) and sprat in VIId,e (section 9, in ICES 2005a). The advice on these stocks cannot be improved at present. In this section only the times series are maintained. For most recent advice refer to the appropriate sections in last year's HAWG report (ICES 2005a).

There was zero sampling of the catch in 2005 for both Clyde herring and sprat in VIId,e. The catch of Clyde herring in 2005 was low (Table 10.1) as was the catch of sprat in VIId,e (Table 10.2).

Table 10.1 **Herring from the Firth of Clyde. Catch in tonnes by country, 1955–2005. Spring and autumn-spawners combined.**

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
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

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
All Catches													
Total	10 594	7 763	4 088	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	1994	1995
Scotland	2 506	2 530	2 991	3 001	3 395	2 895	1 568	2 135	2 184	713	929	852	608	392
Other UK	-	273	247	22	-	-	-	-	-	-	-	1	-	194
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]	-[2]	-[2]
Agreed TAC			3 000	3 000	3 100	3 500	3 200	3 200	2 600	2 900	2 300	1 000	1 000	1 000
Total	4 021	4 361	5 770	4 800	4 650	3 612	1 923	2 343	2 259	731	929	853	608	586

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Scotland	598	371	779	16	1	78	46	88	-	-
Other UK	127	475	310	240	0	392	335	240	-	318
Unallocated[1]	-	-	-	-	-	-	-	-	-	-
Discards	-	-	-	-	-	-	-	-	-	-
Agreed TAC	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000
Total	725	846	1089	256	1	480	381	328	0	318

[1]Calculated from estimates of weight per box and in some years estimated by-catch in the sprat fishery

[2]Reported to be at a low level, assumed to be zero, for 1989-1995.

[3]Based on sampling.

[4]Estimated assuming the same discarding rate as in 1986

Table 10.2. Sprat VIId,e. Nominal catches of sprat in VIId,e from 1985-2005

COUNTRY	1985	1986	1987	1988	1989	1990	1991	1992
Denmark		15	250	2,529	2,092	608		
France	14		23	2	10			35
Netherlands								
UK (Engl.&Wales)	3 771	1 163	2 441	2 944	1 319	1 508	2 567	1 790
Total	3 785	1 178	2 714	5 475	3 421	2 116	2 567	1 825
Country	1993	1994	1995	1996	1997	1998*	1999*	2000*
Denmark								
France	2	1	0					18
Netherlands							1	1
UK (Engl.&Wales)	1 798	3 177	1 515	1 789	1 621	2 024	3 559	1 692
Total	1 800	3 178	1 515	1 789	1 621	2 024	3 560	1 711
Country	2001	2002	2003	2004	2005			
Denmark								
France								
Netherlands								
UK (Engl.&Wales)	1 349	1 196	1 377	836	1635			
Total	1 349	1 196	1 377	836	1635			
* Preliminary								

11 Working Documents

WD 1. C., Ulrich-Rescan and Bo, Sølgaard Andersen. Identification and description of the Danish herring fleets in IIIa.

WD 2. M., van Deurs and L.W., Clausen. Catches of Spring- and Autumn spawners in Division IIIa distributed by metier, sub region, and length group - Perspectives for metier and area specific management..

WD 3. S.M.M., Fässler and M Dickey-Collas. Empirical estimates of annual variability in mortality of larval herring (*Clupea harengus*) in the North Sea between 1972 – 2004.

WD 4. J., Ulleweit, K., Panten and C., Zimmermann. Update on herring discards in the 2005 German pelagic fishery..

WD 5. N., Rohlf and J., Gröger. Report of the Herring Larvae Surveys in the North Sea in 2005/2006.

WD 7. T. Gröhsler. German herring fisheries and stock assessment data in the western Baltic in 2005.

WD 8. J.P. Gröger and R.A. Rountree. A mathematical framework for an optimal control of multispecies, multistock, multiarea fisheries adopted from operations research.

WD 9. B.A., Roel, M., Armstrong and P., Large. Towards a Harvest Rule to determine IVc and VIId herring TAC allocation..

WD 10. E.J., Simmonds, E., Torstensen, C., Zimmermann, Bo, Lundgren, P., Fernandes, F., Armstrong and S., Ybema. ICES Co-ordinated acoustic survey offices divisions, IVa, Ivb, IVc AND VIa (NORTH) 2005 results.

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Annex 1: List of participants

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

14 - 23 March 2006

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Annex 2: Recommendations

We suggest that each Expert Group collate and list their recommendations (if any) in a separate annex to the report. It has not always been clear to whom recommendations are addressed. Most often, we have seen that recommendations are addressed to:

- Another Expert Group under the Advisory or the Science Programme;
- The ICES Data Centre;
- Generally addressed to ICES;
- One or more members of the Expert Group itself.

RECOMMENDATION	ACTION
HAWG recommends that the new ICES InterCatch database should provide an opportunity to clearly track changes or allocations of “official” landings made by WG members and to compensate for misreported or unallocated landings or discards. This would, however, require means to keep some of the national disaggregated data confidential in order to protect their sources. Further, a transparent and effective handling of information obtained from market sampling in foreign ports should be possible (from Sec 1.5)	ICES Data Centre SGMID
HAWG recommends that all metiers with substantial catch should be sampled (including by-catches in the small meshed fishery). HAWG recommends that similar arrangements, as the obligation implemented by the EU Member States on sampling of landings outside the flag country, to be implemented between all countries. Furthermore, agreements on when and how the sampling country provides sampled data to the flag country should be made in order to make data available for the HAWG	National labs
HAWG recommends that the development of methods for estimating discards be based on a fleet based method, rather than on a national basis. The inclusion of discarded catch is considered to give more realistic values of fishing mortality and biomass.	PGCCDBS
To ensure the continuity of the North Sea herring larvae surveys they should be considered for priority 1 EU funding. This survey is providing value for money that is equivalent to the other sources of information used to assess North Sea herring. It should therefore be given the same priority of funding as the other surveys and market sampling data collection schemes.	EU STECF
HAWG recommends that the existing surveys of herring in the southern North Sea and English Channel be maintained, and that the micro-increment analysis of otoliths (to determine spawning type) is carried out on samples collected during the annual acoustic survey and on the commercial catches.	National Labs
HAWG recommends that effort should be allocated into the development of a more suitable method for projection of catch and stock for sprat in all areas. A length-based model is currently under development and should be tested on sprat in both areas. For this, data on length and weight in the stock and catch should be made available from national laboratories.	National labs and ICES data centre
HAWG recommends that resources be made available to improve knowledge of spawning seasons and stock structures for sprat is made available.	National laboratories and EU
HAWG recommends the development of a harvest rule to determine the IVc – VIId sub-TAC on a scientific basis.	National labs, ACFM, SGMAS
HAWG recommends further work to identify the causes and dynamics of the serial poor recruitment of North Sea herring.	ICES WGRP, SGRECVAP

After submission of the report, the ICES Secretariat will follow up on the recommendations, which will also include communication of proposed terms of reference to other ICES Expert Group Chairs. The "Action" column is optional, but in some cases, it would be helpful for ICES if you would specify to whom the recommendation is addressed.

Annex 3: Stock Annexes

Quality Handbook ANNEX: hawg-her47d3

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	North Sea Autumn Spawning Herring (NSAS)
Working Group:	Herring Assessment WG for the Area south of 62°N
Date:	17 March 2005
Authors:	C. Zimmermann (ed.), J. Dalskov, M. Dickey-Collas, H. Mosegaard, P. Munk, J. Nichols, M. Pastoors, N. Rohlf, E.J. Simmonds, D. Skagen

A. General

A.1. Stock definition: Autumn spawning herring distributed in ICES area IV, Division IIIa and VIId. Mixing with other stocks occurs especially in Division IIIa (with Western Baltic Spring Spawning herring).

A.2. Fishery

North Sea Autumn Spawners are exploited by a variety of fleets, ranging from small purse seiners to large freezer trawlers, of different nations (Norway, Denmark, Sweden, Germany, The Netherlands, Belgium, France, UK, Faroe Islands). The majority of the fishery takes place in the Shetland-Orkney area in the 2nd and 3rd quarter, and in the English Channel (Division VIId) in the 4th quarter. Juveniles are caught in Division IIIa and as by-catch in the industrial fishery in the central North Sea. For management purposes, 4 fleets are currently defined: Fleet A is harvesting herring for human consumption in IV and VIId, but includes herring by-catches in the Norwegian industrial fishery; fleet B is the industrial (small mesh, <32 mm mesh size) fleet of EU nations operating in IV and VIId. North Sea Autumn spawners are also caught in IIIa in fleets C (human consumption) and D (small mesh).

A.3. Ecosystem aspects:

Herring is the key pelagic species in the North Sea and is thus considered to have major impact as prey and predator to most other fish stocks in that area.

The North Sea is semi-enclosed and situated on the continental shelf of North-western Europe and is bounded by England, Scotland, Norway, Sweden, Denmark, Germany, the Netherlands, Belgium and France. It covers an area of 745,950 km^2 of which the greater part is shallower than 200 m. It is one of the most diverse coastal regions in the world, with a variety of coastal habitats (fjords, estuaries, deltas, banks, beaches, sandbanks and mudflats, marshes, rocks and islands), and four ecological seasons. It is a highly productive (>300 gC m^{-2} yr^{-1}) ecosystem but with primary productivity varying considerably across the sea. The highest values of primary productivity occur in the coastal regions, influenced by terrestrial inputs of nutrients, and in areas such as the Dogger Bank and tidal fronts. Changes observed in trophic structure are indicative of a trend towards a decreasing resilience of this ecosystem. This trend is partially a response to inter-annual changes in the physical oceanography of the North Atlantic.

Herring are an integral and important part of the pelagic ecosystem in the North Sea. As plankton feeders they form an important part of the food chain up to the higher trophic levels. Both as juveniles and as adults they are an important source of food for some demersal fish and for sea mammals. Over the past century the top predator, man, has exerted the greatest influence on the abundance and distribution of herring in the North Sea. Spawning stock biomass has fluctuated from estimated highs of around 4.5 million tonnes in the late 1940s to a lows of less than 100,000 tonnes in the late 1970s. The species has demonstrated a robustness in relation to recovery from such low levels once fishing mortality is curtailed in spite of recruitment levels being adversely affected.

Their spawning and nursery areas, being near the coasts, are particularly sensitive and vulnerable to anthropogenic influences. The most serious of these is the ever increasing pressure for marine sand and gravel extraction. This has the potential to seriously damage and destroy the spawning habitat and disturb spawning shoals and destroy spawn if carried out during the spawning season. Similarly, trawling at or close to the bottom in known spawning areas can have the same detrimental effects. It is possible that the disappearance of spawning on the western edge of the Dogger bank could well be attributable to such anthropogenic influences.

In more recent years the oil and gas exploration in the North Sea has represented a potential threat to herring spawning although great care has been taken by the industry to restrict their activities in areas and at times of known herring spawning activity.

By-catch and Discard

By-catch consists of the retained ‘incidental’ catch of non-target species and discard is a deliberately (or accidentally) abandoned part of the catch returned to the sea as a result of economic, legal, or personal considerations. This section therefore deals with these two elements of the fishery, looking specifically at fishery-related issues. Cetacean, seabird and other threatened, rare and iconic species which may form part of a by-catch are considered separately in the next section.

Incidental Catch: The incidental catch of non-target species in the North Sea pelagic herring fishery in general is considered to be low. A recent study (Pierce et al, 2002) investigated incidental catch from commercial pelagic trawlers over the period January to August 2001. The target species, herring, accounted for 98% by weight of the overall catch with an overall incidental catch of 2.3%. Mackerel, which are known to occur in mixed schools with herring in division IVa was the main by-catch species, accounting for 69% of by-catch by weight. Haddock (25.7% of by-catch by weight), horse mackerel *Trachurus trachurus* (4.8%) and whiting *Merlangius merlangus* (0.4%) were all present in samples. However, onboard sampling over 2002 by Scottish and German observers found substantial discards of herring, taken as by-catch in the mackerel fishery over the 3 rd and 4th quarters, after herring quotas had been exhausted.

Discards and slipping: The indications are that large-scale discarding is not widespread in the directed North Sea herring fishery. A number of direct-observer surveys have recently been conducted on Scottish and Norwegian pelagic trawlers, based on observation of 222 hauls catching 9,889 tonnes fish (Napier et al, 2002) over 2000 - 2002. The overall discard rate was 4.2%, although that from pelagic trawlers of 6.6% was substantially higher than that from pursers (0.6%). These discard rates were higher than the overall figure of 2.8% recorded in an earlier study (Napier et al, 1999) which were evenly distributed between pursers and trawlers. This indicates that the different discard rates between the different fishing types in the later study were more a function of fishing location and stock size compositions rather than any gear-specific size selectivity. Some discarding, in the form of wastage (i.e. fish left meshed in the net or in the cod-end of trawls), was associated with almost all pelagic catches but the actual quantities of fish involved were low (2% of total discarded fish). In both studies by Napier et al., most of the observed discarding occurred through slipping, i.e. opening the net and releasing the fish before they were pumped on-board. This occurred when catch volumes were too small, or the size of fish was too small or the fish were poor in quality. For both pursers and trawlers ‘poor’ fish quality was a significant cause of discarding. The size of the catch was also a significant cause of discarding from trawlers, either because the catch was too small or too large, with boats either discarding a small proportion or all of the catch. The recent influence of strong herring year classes was apparent in the composition of discards with smaller, younger fish accounting for a high proportion of the fish discarded in 2001. However surveys on the reasons why vessels discarded fish showed that larger discarding events (i.e. those >500 kg) were equally likely to the fish being of poor quality (trawlers) or the catch exceeded the vessel’s capacity or market requirements (pursers). No data on survival of discarded fish has been collected but it is considered likely that mortality rates will be significant.

Ecosystem Considerations. The incidental non-target fish catch by directed North Sea herring fisheries appears to be low (ca. 2%), mainly consisting of mackerel when fishing mixed shoals. This infers that the ecosystem level implications of incidental fish catches are negligible. The discard of unwanted herring, mostly in the form of high-grading to improve catch quality and grade sizes of fish between 2-4 years of age (see Section above) is also low, being around 3,250 tonnes (2000) and 750 tonnes (2001) for the Scottish and Norwegian and Scottish pursers and refrigerated seawater tank (RSW) pelagic trawlers operating in ICES division IVa. For both years, this was equivalent to about 10.4% by weight of the total landings. Of more concern are discards of herring from other pelagic fisheries, especially that for mackerel, where more substantial discarding of herring occurs when quotas for herring are exhausted. National reports to ICES over 1996 to 2002 suggest that total herring discards have varied between 1,500 tonnes to an unprecedented 17,000 tonnes in 2002 (reflecting onboard sampling by Scotland and Germany that observed substantial discards of herring in the mackerel fishery in the 3rd and 4th quarter in Division IVa (W)). Assuming a distribution and yield of the international mackerel fishery in IVa in 2002 to be similar to that in 2001, herring discards of all fleets could be as high as 50,000 t. This would increase the total catch in the North Sea by almost 15% and would certainly have an influence on the North Sea autumn spawning stock assessment and the perception of stock size. Discarding behaviour appears to have changed again in 2003, when herring TAC has been increased by 50%, and at the same time the mackerel TAC has been reduced by more than 5%.

Interactions with Rare, Protected or Icon Species: Interactions between the directed North Sea herring fishery with rare, protected or icon species are, in general, considered to be exceptional. Species which may interact with the fishery are considered below.

Cetacean by-catch: Since 2000, the Sea Mammal Research Unit (SMRU) of St. Andrew’s University in Scotland, under contract to DEFRA, has carried out a number of surveys to estimate the level of by-catch in UK pelagic fisheries. SMRU, in collaboration with the Scottish Pelagic Fishermen’s Association, placed observers on board thirteen UK vessels for a total of 190 days at sea, covering 206 trawling operations around the UK. To date, no cetacean by-catch has been observed in the herring pelagic fishery in the North Sea. There is currently an ongoing observer programme in the UK monitoring cetacean by-catch rates in pelagic trawl fisheries with results due at the end of September 2003 and it is understood that this confirms that cetacean by-catch by the pelagic trawl fishery is negligible (Northridge, pers. comm.). Pierce (2002) also reports that no by-catches of marine mammals were observed over 69 studies hauls and considers that the underlying rate for marine mammals in the pelagic fisheries studies (pelagic trawls in IVa and VIa) is no more than 0.05 (i.e. five events per 100 hauls) and may well be considerably lower than this.

Other than the above, there are no reliable estimates of by-catch for pelagic trawl fisheries, though observations have been made and by-catch rates have been established for several fisheries. Kuklik and Skóra (2003) refer to a single record of a harbour porpoise (*Phocoena phocoena*) bycaught in a herring trawl in the Baltic. Observations in several other pelagic trawl fisheries were reported by Morizur et al. (1999) and Couperus (1997). All appear to agree that incidental catches of cetaceans in the Dutch pelagic trawl fishery are largely restricted to late-winter/early-spring in an area along the continental slope southwest of Ireland.

On 24 July 2003 the European Commission issued a proposal for a Council Regulation to address the problem of cetacean by-catch in various fisheries. For the North Sea (ICES IV) 5% of pelagic trawl fisheries would have to be monitored by observers. In the eastern channel 5% of pelagic trips would have to be monitored from April to November but 10% from December to March. The Commission has asked the Council to adopt this proposal by 1 July 2004.

Seal by-catch: The by-catch of seals in directed pelagic herring fishery in the North Sea is reported to be “very rare” (Aad Jonker, pers. comm.). Independent verification also confirms this to be so, with perhaps one animal being caught by the whole North Sea fleet a year (Bram Couperus (RIVO), pers. comm.). Northridge (2003) observed 49 seals taken in 312 pelagic trawl tows throughout UK waters and reports that the fishery in North-western Scotland has the highest observed seal by-catch levels of UK pelagic trawl fisheries, possible amounting to dozens per year. Although not confirmed, it was assumed that the majority were grey seal *Halichoerus grypus*. This species is mainly distributed around the Orkneys and Outer Hebrides – out of a UK population of 129,000, only around 7,000 and 5,900 are distributed off the Scottish and English North Sea coasts respectively (SCOS, 2002), and so by-catch rates in the North Sea are likely to be substantially less than off the NW Scottish coast. The eastern Atlantic population of the Grey seal is not considered to be threatened.

Other by-catch: Sharks are occasionally caught by pelagic trawlers in the North Sea, although this is rare with a maximum of two fish per trip (Aad Jonker, pers. comm.). Survival rates are apparently high, with sharks being released during or after the cod-end is being emptied. The species are unknown, although blue shark *Prionace glauca*, which preys primarily upon schooling fishes such as anchovies, sardines, herring, are known to have been caught by pelagic trawls off the SW English coast (Bram Couperus (RIVO), pers. comm.). Gannets (*Morus bassanus*), which frequently dive at and around nets, were observed by Napier et al. (2002) entangled in the nets but were not present in samples. Actual mortality rates of caught gannets have not been assessed in detail, and some have been observed alive after release from the gear. An extrapolation from observed mortalities corresponds to around 560 gannet deaths per year, although this is based on a relatively low sample frame. Seabird by-catch in the North Sea is considered to be comparatively rare compared to the NW Scotland where 1-3 birds may be caught, esp. in grounds off St. Kilda (Aad Jonker (former freezer trawler skipper), pers. comm.). RIVO observers in the North Sea only recorded one incident of seabird by-catch over 10 trips (Bram Couperus (RIVO), pers. comm.).

B. Data

B.1. Commercial catch:

Commercial catch is obtained from national laboratories of nations exploiting herring in the North Sea. Since 1999 (catch data 1998), these labs have used a spreadsheet to provide all necessary landing and sampling data, which was developed originally for the Mackerel

Working Group (WGMHSA) and further adapted to the special needs of the Herring Assessment Working Group. The current version used for reporting the 2003 catch data was v1.6.4. The majority of commercial catch data of multinational fleets was provided on these spreadsheets and further processed with the SALLOCL-application (Patterson, 1998). This program gives the needed standard outputs on sampling status and biological parameters. It also clearly documents any decisions made by the species co-ordinators for filling in missing data and raising the catch information of one nation/quarter/area with information from another data set.

Transparency of data handling by the Working Group. The current practice of data handling by the Working Group is that the data received by the co-ordinators is available in a folder called "archive". These high-resolution data are not reproduced in the report. The archived data contains the disaggregated dataset (disfad), the allocations of samples to unsampled catches (alloc), the aggregated dataset (sam.out) and (in some cases) a document describing any problems with the data in that year.

Current methods of compiling fisheries assessment data. The species co-ordinator is responsible for compiling the national data to produce the input data for the assessments. In addition to checking the major task involved is to allocate samples of catch numbers, mean length and mean weight-at-age to unsampled catches. There are at present no defined criteria on how this should be done, but the following general process is implemented by the species co-ordinators. Searches are made for appropriate samples by gear (fleet) area quarter, if an exact match is not available the search will move to a neighbouring area if the fishery extends to this area in the same quarter. More than one sample may be allocated to an unsampled catch, in this case a straight mean or weighted mean of the observations may be used. If there are no samples available the search will move to the closest non-adjacent area by gear (fleet) and quarter, but not in all cases.

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

The WG considered the need of a **long-term data storage** for commercial catches and sampling, and the documentation of any primary data processing of these data. From 2000 on (catch data for 1999), the latest (consistency checked) versions of the input files together with standard outputs and a documentation of filling-in decisions made by the co-ordinators, ideally in the SALLOC-formats, are stored in a separate "archive" folder. This is updated annually, and the complete collection (which is supposed to be kept confidential as it will contain data on misreporting and unallocated catches) will be available for WG members on request. As there was very little historical information available, WG members were asked to provide as much as possible national catch and historical data sets in any available format which is then stored in a "~historic" folder within "Archive". They will be consistency checked and transferred into a database system as soon as this is available.

B.2. Biological

Catch-at-age data (catch numbers-at-age, mean weights-at-age in the catch, mean length-at-age) is derived from the raised national figures received from the national laboratories. The data is obtained either by market sampling or by onboard observers, and processed as described above. For information on recent sampling levels and nations providing samples, see Sec. 2.2. of the most recent HAWG report.

Mean weights-at-age in the stock and proportions mature (maturity ogive) are derived from the June/July international acoustic survey (see next paragraph).

B.3. Surveys

B.3.1 Acoustic: ICES Co-ordinated Acoustic Surveys for herring in North Sea, Skagerrak and Kattegat

The ICES Coordinated acoustic surveys started in 1979 around Orkney and Shetland with first major coverage in 1984. An index derived from that survey has been used in assessments since 1994 with the time-series data extending back to 1989. The survey was extended to IIIa to include the overlapping Western Baltic spring spawning stock in 1989, and the index has been used with a number of other tuning indices since 1991. The early survey had occasionally covered VIa (North) during the 1980s and was extended westwards in 1991 to cover the whole of VIa (North) annually since 1991, and provides the only tuning index for VIa (North) herring, By carrying out the co-ordinated survey at the same time from the Kattegat to South of the Hebrides all herring in these areas are covered simultaneously, reducing uncertainly due to area boundaries as well as providing input indices to three distinct stocks. The surveys are co-ordinated under ICES Planning Group for Herring Surveys ICES PGHERS.

At present, six surveys are carried out during late June and July covering most of the continental shelf north of 52°N in the North Sea and to the west of Scotland to a northern limit of 62°N. The eastern edge of the survey area is bounded by the Norwegian and Danish, Swedish and German coasts, and to the west by the shelf edge between 200 and 400 m depth. The surveys are reported individually in the report of the planning group for herring surveys, and a combined report is prepared from the data from all surveys. The combined survey results provide spatial distributions of herring abundance by number and biomass at age by statistical rectangle; and distributions of mean weight and fraction mature at age.

The acoustic recordings are carried out using Simrad EK60, EK500 and EY500 38 kHz sounder echo-integrator with transducers mounted on the hull, drop keel or towed bodies. Further data analysis is carried out using either BI500, Echoview or Echoann software. The survey track is 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 is used in most parts of the area with the exception of some relatively high density sections, east and west of Shetland, in the Skagerrak where short additional transects were carried out at 7.5 nmi spacing, and in the southern area where a 30 nmi transect spacing is used.

The following target strength to fish length relationships 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

Data is reported through standardised data exchange format and combined at FRS Marine Lab Aberdeen. The exchange format currently holds information on the ICES statistical rectangle level, with at least one entry for each rectangle covered, but more flexible strata are accommodated by allowing multiple entries for abundance belonging to different strata. Data submitted consists of the ICES rectangle definition, biological stratum, herring abundance by proportion of Autumn spawners (North Sea and VIa North) and Spring spawners (Western Baltic, age and maturity, and survey weight (survey track length). Data are be presented according to the following age/maturity classes: 1 immature (maturity stage 1 or 2), 1 mature (maturity stage 3+), 2 immature, 2 mature, 3 immature, 3 mature, 4, 5, 6, 7, 8, 9+. In addition to proportions at age data on mean weights and mean length are reported at age/maturity by biological strata. Data is combined using an effort weighted mean based on survey effort reported as number of nautical miles of cruise track per statistical rectangle. A combined survey report is produced annually. Apart from the Biomass index for 1-9+-ringers,mean weights at age in the catch and proportions mature are derived from the survey to be used in the NSAS assessment.

B.3.2 International Bottom Trawl Survey:

The International Bottom Trawl Survey (IBTS) started out as a Young Herring Survey (IYHS) 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 realized that the survey could provide recruitment indices not only for herring, but for roundfish species as well. Examination of the catch data from the 1st quarter IBTS showed that these surveys also gave indications of the abundances of the adult stages of herring, and subsequently the catches have been used for estimating 2-5+ ringer abundances. The surveys are carried out in 1st quarter (February) and in 3rd quarter (August-September) using standardized procedures among all participants. The standard gear is a GOV trawl, and at least two hauls are made in each statistical rectangle.

In 1977 sampling for late stage herring larvae was introduced at the IBTS 1st quarter, using Isaccs-Kidd Midwater trawls. These catches appeared as a good indicator of herring recruitment, however examination of IKMT performance showed deficiencies in its catchability for herring larvae, and a more applicable gear, a ring net (MIK) was suggested as an alternative gear. Hence, gear type was changed in the mid 90'ies, and the MIK has been the standard gear of the program since. This ring net is of 2 meter in diameter, has a long two-legged bridle, and is equipped with a black netting of 1.5 mm mesh size. Oblique hauls are made during night in at least two statistical rectangles.

Indices of 2-5+ ringer herring abundances in the North Sea (1st quarter). Fishing gear and survey practices were standardised from 1983, and herring abundance estimates of 2-5+ ringers from 1983 onwards has shown the most consistent results in assessments of these age groups. This series is used in North Sea herring assessment. The catches in DivisionIIIa is not included in this index. Table 2.3.3.1 in the HAWG report shows the time series of abundance estimates of 2-5+ ringers from the 1st quarter IBTS for the whole period.

Index of 1-ringer recruitment in the North Sea (1st quarter). The 1-ringer index of recruitment is based on trawl catches in the entire survey area, hence, all 1-ringer herring caught in Div IIIa is included in this index. Indices are calculated as an area weighted mean over means by ICES statistical rectangle, and are available for year classes 1977 to recent (Table 2.3.3.3 of HAWG report). The Downs herring hatch later than the other autumn spawned herring and generally appears as a smaller sized group during the 1st quarter IBTS. A recruitment index of smaller sized 1-ringers is calculated using the standard procedure, but solely based on abundance estimates of herring <13 cm (see discussion of procedures in earlier reports (ICES CM 2000/ ACFM:10, and ICES CM 2001/ ACFM:12).

MIK index of 0-ringer recruitment in the North Sea (1st quarter). The MIK catches of late stage herring larvae is used to calculate and 0-ringer index of autumn spawned herring in the North Sea. A flowmeter at the gear opening is used for estimation of volume filtered by the gear, and using this information together with information on bottom depth, the density of herring larvae per square meter is estimated. A mean herring density in statistical rectangles is raised to mean within subareas, and based on areas of these subareas an index of total abundance is estimated (see also ICES 1996/Asses:10). The series of estimates for subareas as well as the total index are shown in the actual report's Table 2.3.3.4.

B.3.3. Larvae:

Surveys of larval herring have a long tradition in the North Sea. Sporadic surveys started around 1880, and available scientific data goes back to the middle of the 20th century. The co-ordination of the International Herring Larvae Surveys in the North Sea and adjacent waters (IHLS) by ICES started in 1967, and from 1972 onwards all relevant data are achieved in a data base. The surveys are carried out annually to map larval distribution and abundance. Larval abundance estimates are of value as relative indicators of the herring spawning biomass in the assessment.

Nearly all countries surrounding the North Sea have participated in the history of the IHLS. Most effort was undertaken by the Netherlands, Germany, Scotland, England, Denmark and Norway. A number of other nations have contributed occasionally. A sharp reduction in ship time and number of participating nations occurred in the end of the 1980s. Since 1994 only the Netherlands and Germany contribute to the larvae surveys, with one exception in 2000 when also Norway participated.

Larvae Abundance Index (LAI): The total area covered by the surveys is divided into 4 sub areas corresponding to the main spawning grounds. These sub areas have to be sampled in different given time intervals. The sampling grid is standardized and stations are approximately 10 nautical miles apart. The standard gear is a GULF III sampler or one of its national modifications. Newly hatched larvae less than 10 mm total length (11 mm for the Southern North Sea) are used in the index calculation. To estimate larval abundance, the mean number of larvae per square meter obtained from the Ichthyoplankton hauls is raised to rectangles of 30x30 nautical miles and the corresponding surface area. These values are summed up within the given unit and provide the larval abundance per unit and time interval.

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

Calculation of the linearised multiplicative model was done using the equation:

$$\ln(\text{Indexyear,LAI unit}) = \text{MLAIyear} + \text{MLAI}_{\text{LAI}}\ \text{unit} + \text{uyear, LAI unit}$$

where MLAIyear is the relative spawning stock size in each year, MLAI_{LAI} unit are the relative abundances of larvae in each sampling unit and year, LAI unit are the corresponding residuals. The unit effects are converted such that the first sampling unit is used as a reference (Orkney/Shetland 01-15.09.72) and the parameters for the other sampling units are redefined as differences from this reference unit. The model is fitted to abundances of larvae less than

10 mm in length (11 mm for SNS). The MLAI is updated annually and represent all larval data since 1972. The time series is used as a biomass index in the herring assessment.

B.4. Commercial CPUE

Not used for pelagic stocks.

B.5. Other relevant data

B.5.1 Separation of North Sea Autumn Spawners and IIIa-type Spring Spawners

North Sea Autumn Spawners and IIIa-type Spring Spawners occur in mixtures in fisheries operating in Divisions IIIa and IVaE (ICES, 1991/Assess:15): mainly 2+ ringers of the Western Baltic spring-spawners and 0-2-ringers from the North Sea autumn-spawners, including winter-spawning Downs herring. In addition, several local spawning stocks have been identified with a minor importance for the herring fisheries (ICES, 2001/ACFM 12).

The method of separating herring in Norwegian samples, using vertebral counts as described in former reports of this Working Group (ICES 1990/ Assess:14) assumes that for autumn spawners, the mean vertebral count is 56.5 and for Spring spawners 55.80. The fractions of spring spawners (fsp) are estimated from the formula (56.50-v)/(56.5-55.8), where v is the mean vertebral count of the (mixed) sample with the restriction that the proportion should be one if fsp>=1 and zero if fsp<=0. The method is quite sensitive to within-stock variation (e.g. between year classes) in mean vertebral counts.

Experience within the Herring Assessment Working Group has shown that separation procedures based on size distributions often will fail. The introduction of otolith microstructure analysis in 1996-97 (Mosegaard and Popp-Madsen, 1996) 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 that are not easily distinguished by their otolith microstructure (OM), are considered to have different mean vertebral counts (vs) as, e.g., winter-spawning Downs herring: 56.6 (Hulme, 1995), and the small local stocks, the Skagerrak winter/spring-spawners: 57 (Rosenberg and Palmén, 1982). Further, the estimated stock specific mean vs count varies somewhat among different studies; North Sea: 56.5, Western Baltic Sea: 55.6 (Gröger and Gröhsler, 2001) and North Sea: 56.5, Western Baltic Sea: 55.8 (ICES 1992/H:5). Comparison between separation methods using frequency distributions of vertebral counts and otolith microstructure showed reasonable correspondence. Using this information the years from 1991 to 1996 was reworked in 2001, applying common splitting keys for all years by using a combination of the vertebral count and otolith microstructure methods (ICES, 2001/ACFM:12). From 2001 and onwards, the otolith-based method only has been used for the Division IIIa.

Different methods of identifying herring stocks in the Division IIIa and Subdivisions 22-24 were recently evaluated in a EU CFP study project (EC study 98/026). The study involved several inter-calibration sessions between microstructure readers in the different laboratories involved with the WBSS herring. After the study was finished a close collaboration concerning reader interpretations has been kept between the Danish and Swedish laboratories. Sub-samples of the 2002 and 2003 Danish, Swedish, and German microstructure analyses were double-checked by the same Danish expert reader for consistency in interpretation. The overall impression is an increasingly good agreement among readers.

New molecular genetic approaches for stock separation are being developed within the EU-FP5 project HERGEN (EU project QLRT 200-01370). Sampling of spawning aggregations during spring, autumn and winter has been carried out in 2002 and in 2003 in Division IIIa and in the Western Baltic at more than 10 different locations. Preliminary results point at a substantial genetic variation between North Sea and Western Baltic herring.

After the introduction of otolith microstructure analysis in 1996 it was discovered that in the western Baltic a small percentage of the herring landings might consist of autumn-spawners individuals. Before molecular genetic methods became available for Atlantic herring the existence of varying proportions of autumn spawners in Subdivisions 22–24 in different years was considered a potential problem for the assessment.

C. Historical Stock Development

Model used:

Details on input parameters and model setup for the final ICA assessment are presented in Table 2.6.2.1. of the most recent HAWG report. The assessment has the same set-up and basic assumption as the assessment that was carried out last year. Input data are given in Tables 2.6.2.2. 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:

$$\sum_{a=0,y=1997}^{a=8,y=2002} \lambda_a \left(\ln(\hat{C}_{a,y}) - \ln(C_{a,y}) \right)^2 +$$
$$\sum_{y=1979}^{y=2002} \lambda_{mlai} \left(\ln(q_{mlai} \cdot S\hat{S}B_y^K) - \ln(MLAI_y) \right)^2 +$$
$$\sum_{a=1,y=1983}^{a=5+,y=2003} \lambda_{a,ibtsa} \left(\ln(q_{a,ibtsa} \cdot \hat{N}_{a,y}) - \ln(IBTS_{a,y}) \right)^2 +$$
$$\sum_{a=1,y=1989}^{a=9+,y=2002} \lambda_{a,acoust} \left(\ln(q_{a,acoust} \cdot \hat{N}_{a,y}) - \ln(ACOUST_{a,y}) \right)^2 +$$
$$\sum_{y=1977}^{y=2003} \lambda_{mik} \left(\ln(q_{mik} \cdot \hat{N}_{0,y}) - \ln(MIK_y) \right)^2 +$$
$$\sum_{y=1960}^{y=2002} \lambda_{ssr} \left(\ln(\hat{N}_{0,y+1}) - \ln\left(\frac{\alpha\, S\hat{S}B_y}{\beta + S\hat{S}B_y} \right) \right)^2$$

** except for 1 ring IBTS which runs from 1979 to 2002

with the following variables:

a,y	age (rings) and year
C	Catch at age (rings)
$\hat{C}$	Estimated catch at age (rings) 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)
IBTS	IBTS index (1-5+ 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

Software used: ICA (Patterson, 1998; Needle, 2000)

Model Options chosen:

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes			
Canum	Catch at age in numbers	1960-2002	1-9+	Yes
Weca	Weight at age in the commercial catch	1960-2002	1-9+	Yes (smoothed)
West	Weight at age of the spawning stock at spawning time.	1960-2002	1-9+	Yes (smoothed)
Mprop	Proportion of natural mortality before spawning	1960-2002	1-9+	No
Fprop	Proportion of fishing mortality before spawning	1960-2002	1-9+	No
Matprop	Proportion mature at age	1960-2002	1-9+	Yes (smoothed)
Natmor	Natural mortality	1960-2002	1-9+	No

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE (WR)
Tuning fleet 1	IBTS Q1	1979-2003	1
Tuning fleet 1	IBTS Q1	1983-2003	2-5
Tuning fleet 2	MIK	1977-2002	0
Tuning fleet 3	Acoustic	1984-2002	1
Tuning fleet 3	Acoustic	1095-2002	2-9+
Tuning fleet 4	MLAI	1972-2002	SSB

D. Short-Term Projection

The short-term prediction method was substantially modified in 2002. Following the review by SGEHAP (ICES 2001/ACFM:22), which recommended that a simple multi-fleet method would be preferable, the complex split-factor method used for a number of years prior to 2002 has not been used since. The multi-fleet, multi-option, deterministic short-term prediction programme (MFSP) was accepted by ACFM and was developed further last year. It is intended to continue to use this programme in the future. The good agreement between predicted biomass for the actual year and SSB taken from the assessment for the most recent year one year after demonstrates that the current prediction procedure for stock numbers is working well. In 2004, the Working Group has included prediction of low maturation into projections for 2005 and expects to monitor growth and maturation of North Sea herring carefully in the future and when deemed necessary will include these changes in predictions in the future.

Model used: Age-structured model, by fleet and area fished

Software used: MFSP

Initial stock size: output from ICA

Maturity: average of the two most recent years used

F and M before spawning: 0.67 for both (assumes spawning starts around September)

Weight at age in the stock: from last year in assessment (already smoothed, see assessment data description)

Weight at age in the catch: average of last two years BY FLEET

Exploitation pattern:

Intermediate year assumptions: Status quo F

Stock recruitment model used: Recent average recruitment (arithmetic, recent 10 years) is used, (unless there is some strong reason for using something else, e.g. if SSB is very low, we may use a prediction from the stock-recruit relationship)

Procedures used for splitting projected catches:

There are 4 values input for this parameter:

a) IBTS 1-ringer proportion in last assessment year (y) is used for 1-ringers in y

b) IBTS 1-ringer proportion in y+1 is used for 1-ringers in y+1, AND for 0-ringers in y.

c) GLM (between MIK index and IBTS 1-ringer proportion) is applied to MIK index in y+1 to predict proportion for 1-ringers in y+2, AND for 0-ringers in y+1

GLM, as in (c), is applied to the Average MIK index for 1981 to year y to predict proportion for 1-ringers in y+3 (not relevant), AND for 0-ringers in y+2 (relevant)

E. Medium-Term Projections – *still to be filled in* -

Model used:

Software used:

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Uncertainty models used:

Initial stock size:
Natural mortality:
Maturity:
F and M before spawning:
Weight at age in the stock:
Weight at age in the catch:
Exploitation pattern:
Intermediate year assumptions:
Stock recruitment model used:

F. Long-Term Projections – *still to be filled in* -

Model used:

Software used:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

G. Biological Reference Points

There is a well functioning harvest control rule in place for this stock, and apart from B_{lim}, the current reference points are derived from this HCR. The target F in the HCR was adopted by ACFM as the F_{pa}, while the trigger point at which F should be reduced below the target is adopted as B_{pa}. The HCR was briefly revisited in 2004, and the results support the initial definitions of limits.

Reference points currently in use are: B_{lim} is 800 000 t (below this value poor recruitment has been experienced); B_{pa} be set at 1.3 mill. T (as part of a harvest control rule based on simulations); F_{lim} is not defined, F_{pa} be set at $F_{ages\ 0\text{-}1}$= 0.12, $F_{ages\ 2\text{-}6}$= 0.25 (as part of a harvest control rule).

H. Other Issues

H.1 Biology of the species in the distribution area

The herring (*Clupea harengus*) is a pelagic species which is widespread in its distribution throughout the North Sea. The herring's unique habit is that it produces benthic eggs which are attached to a gravely substrate on the seabed. This points strongly to an evolutionary history in which herring spawned in rivers and at some later date re-adapted to the marine environment. The spawning grounds in the southern North Sea are in fact located in the beds of rivers which existed in geological times and some groups of spring spawning herring still spawn in very shallow inshore waters and estuaries. Spawning typically occurs on coarse gravel (0.5-5 cm) to stone (8-15 cm) substrates and often on the crest of a ridge rather than hollows. For example, in a spawning area in the English Channel, eggs were found attached to flints 2.5-25 cm in length, where these occurred in gravel, over a 3.5 km by 400m wide strip.

As a consequence of the requirement for a very specific substrate, spawning occurs in small discrete areas in the near coastal waters of the western North Sea. They extend from the Shetland Isles in the north through into the English Channel in the south. Within these specific areas actual patches of spawn can be extremely difficult to find.

The fecundity of herring is length related and varies between approximately 10,000 and 60,000 eggs per female. This is a relatively low fecundity for teleosts, probably because, in evolutionary terms, the benthic egg is a potentially less hazardous phase of development compared with the planktonic egg of most other teleosts. The age of first maturity is 3 years old (2 ringers) but the proportion mature at age may vary from year to year dependent on feeding conditions. Over the past 15 years the proportion mature at age 3 years (2 ringers) has ranged from 47% to 86% and for 4 year old fish (3 winter ringers) from 63% to 100%. Above that age, all are considered to be mature.

The benthic eggs take about three weeks to hatch dependant on the temperature. The larvae on hatching are 6mm to 9mm long and are immediately planktonic. Their yolk sac lasts for a few days during which time they will begin to feed on phytoplankton and small planktonic animals. Their planktonic development lasts around three to four months during which time they are passively subjected to the residual drift which takes them to various coastal nursery areas on both sides of the North Sea and into the Skagerrak and Kattegat.

Herring continue to be mainly planktonic feeders throughout their life history although there are numerous records of them taking small fish, such as sprat and sandeels, on an opportunistic basis. Calanoid copepods, such as *Calanus*, *Pseudocalanus* and *Temora* and the Euphausids, *Meganyctiphanes* and *Thysanoessa* still form the major part of their diet during the spring and summer and are responsible for the very high fat content of the fish at this time.

In the past, herring age has been determined by using the annual rings on the scales. In more recent years the growth rings on the otolith have proved more reliable for age determination. Herring age is expressed as number of winter rings on the otolith rather than age in years as for most other teleost species where a nominal 1 January birthdate is applied. Autumn spawning herring do not lay down a winter ring during their first winter and therefore remain as ‘0’ winter ringers until the following winter. When looking at year classes, or year of hatching, it must be remembered that they were spawned in the year prior to their classification as ‘0’ winter ringers.

North Sea herring comprise both spring and autumn spawning groups but the major fisheries are carried out on the offshore autumn spawning fish. The spring spawners are found mainly as small discrete coastal groups in areas such as The Wash and the Thames estuary. Juveniles of the spring spawning stocks found in the Baltic, Skagerrak and Kattegat may also be found in the North Sea as well as Norwegian coastal spring spawners.

The main autumn spawning begins in the northern North Sea in August and progresses steadily southwards through September and October in the central North Sea to November and as late as January in the southern North Sea and eastern English Channel. The widespread but discrete location of the herring spawning grounds throughout the western North Sea has been well known and described since the early part of the 20 th Century. This led to considerable scientific debate and eventually to investigation and research on stock identity. The controversy centred on whether or not the separate spawning grounds represented discrete stocks or ‘races’ within the North Sea autumn spawning herring complex. Resolution of this issue became more urgent as the need for the introduction of management measures increased during the 1950’s. The International Council for the Exploration of the Sea (ICES) encouraged tagging and other racial studies and a review of all the historic evidence to resolve this problem. The conclusions were the basis for establishing the working hypothesis that the North Sea autumn spawning herring comprise a complex of three separate stocks each with separate spawning grounds, migration routes and nursery areas, illustrated in the figure below.

The three stock units are:

- • The Buchan or Scottish group which spawn from July to early September in the Orkney Shetland area and off the Scottish east coast. Nursery areas for fish up to two years old are found along the east coast of Scotland and also across the North Sea and into the Skagerrak and Kattegat.
- • The Banks or central North Sea group, which derive their name from their former spawning grounds around the western edge of the Dogger Bank. These spawning grounds have now all but disappeared and spawning is confined to small areas along the English east coast, from the Farne Islands to the Dowsing area, from August to October. The juveniles are found along the east coast of England, down to the Wash, and also off the west coast of Denmark.

- • The Downs group which spawns in very late Autumn through to February in the southern Bight of the North Sea and in the eastern English Channel. The drift of their larvae takes them north-eastwards to nursery areas along the Dutch coast and into the German Bight (Burd 1985).

At certain times of the year, individuals from the three stock units may mix and are caught together as juveniles and adults but they cannot be readily separated in the commercial catches. As a consequence, North Sea autumn spawning herring have to be managed as a single unit.

A further complication is that juveniles of the North Sea stocks are found, outside the North Sea, in the Skagerrak and Kattegat areas and are caught in various fisheries there. The proportions of juveniles of North Sea origin, found in these areas varies with the strength of the year class, with higher proportions in the Skagerrak and Kattegat when the year class is good.

H.2 Historic stock development and history of the fishery

Over many centuries the North Sea herring fishery has been a cause of international conflict sometimes resulting in war, but in more recent times in bitter political argument. There have also been fundamental changes in the nature of the fisheries. These have been driven both by changes in catching power and in response to changes in market requirements, particularly the demand for fish meal and oil. Most of these changes have resulted in greater exploitation pressures that increasingly led to the urgent need to ensure a more rational exploitation of North Sea herring. Such pressures really began to exert themselves for the first time during the 1950's when the spawning stock biomass of North Sea autumn spawning herring fell from 5 million tonnes in 1947 to 1.4 million tonnes by 1957. That period also witnessed the decline and eventual disappearance of a traditional autumn drift net fishery in the southern North Sea.

The annual landings from 1947 through to the early 1960's were high, but stable, averaging around 650,000t. Over the period 1952-62 the high fishing mortality (F 0.4 ages 2-6) resulted in a rapid decline in the spawning stock biomass from around 5 million tonnes to 1.5 million tonnes. Recruitment over this period was reasonable, but there were fewer and fewer year classes present in the adult stock, a clear indication that the stocks were being over-fished and that they were also being impacted by the developing industrial fishery in the eastern North Sea.

This period witnessed the complete collapse of the historic East Anglian autumn drift net fishery, which was based entirely on the Downs stock moving south to the Southern Bight and eastern English Channel to spawn. The reasons for that failure have been attributed both to high mortality of the juveniles in the North Sea industrial fisheries, and to heavy fishing by bottom trawlers on the spawning concentrations, in the English Channel, during the 1950's. Such intensive trawling, on vulnerable spawning fish, not only generated a high mortality but also disturbed spawning aggregations, destroyed the spawn and damaged the substrate on which successful spawning depends.

Fishing mortality on the herring in the central and northern North Sea began to increase rapidly in the late 1960's and had increased to F1.3 ages 2-6, or over 70% per year of those age classes, by 1968. Landings peaked at over 1 million tonnes in 1965, around 80% of which were juvenile fish. This was followed by a very rapid decline in the SSB and the total landings. By 1975 the SSB had fallen to 83,500t although the total landings were still over 300,000t. At the same time, spawning in the central North Sea had contracted to the grounds off the east coast of England whilst spawning grounds around the edge of the Dogger Bank were no longer used. This heralded the serious decline and near collapse of the North Sea autumn spawning herring stock which led to the moratorium on directed herring fishing in the North Sea from 1977 to 1981.

International larvae surveys and acoustic surveys were used to monitor the state of the stocks during the moratorium. By 1980 these surveys were indicating a modest recovery in the SSB from its 1977 low point of 52,000t. By 1981 the SSB had increased to over 200,000t. Prior to the moratorium there had been no control, other than market forces, on catches in the North Sea directed herring fishery. Once the fishery re-opened in 1981 the North Sea autumn spawning herring stock was managed by a Total Allowable Catch (TAC) constraint. It should be noted that the TAC was only applied to the directed herring fishery in the North Sea which exploited mainly adult fish for human consumption. Targeted fishing for herring for industrial purposes was banned in the North Sea in 1976 but there was a 10% by-catch allowance in the fisheries for other species, including the small meshed fisheries for industrial purposes, mainly for sprat. Following the re-opening of the now controlled fishery the SSB steadily increased, peaking at 1.3 million tonnes in 1989. Annual recruitment, measured as '0'group fish, was well above the longterm average over this period. The 1985 year class was the biggest recorded since 1960 and the third highest in the records dating back to 1946. Landings also steadily increased over this period reaching a peak of 876,000 tonnes in 1988. This resulted from a steady increase in fishing mortality to $F_{ages\ 2\text{-}6}$ = 0.6 (ca. 45%) in 1985 and a high by-catch of juveniles in the industrial fisheries for sprat. Following a period of four years of below average recruitment (year classes 1987-91) SSB fell rapidly to below 500,000 tonnes in 1993. Fishing mortality increased rapidly averaging $F_{ages\ 2\text{-}6}$=0.75 (ca. 52%) over the period 1992–95 and recorded landings regularly exceeded the TAC. The North Sea industrial fishery for sprat developed rapidly over this period with the annual catch increasing from 33,000 tonnes in 1987 to 357,000 tonnes by 1995. With the 10% by-catch limit as the only control on the catch of immature herring, there was a consequent high mortality on juvenile herring which averaged 76% of the total catch in numbers of North Sea autumn spawners over this period.

During the summer of 1991 the presence of the parasitic fungus *Ichthyophonus* spp was noted in the North Sea herring stock. All the evidence suggested that the parasite was lethal to herring and that its occurrence could have a significant effect on natural mortality in the stock and ultimately on spawning stock biomass. High levels of infection were recorded in the northern North Sea north of latitude 60°N whilst infection rates in the southern North Sea and English Channel were very low. Efforts were made to estimate the prevalence of the disease in the stock through a programme of research vessel and commercial catch sampling. This led to estimates of annual mortality up to 16% (Anon., 1993) which was of the same order as the estimate of fishing mortality at the time. It was recognised that the behavioural changes and catchability of infected fish affected the reliability of the estimate of prevalence of the disease in the population. The uncertainty about the effect on stock size varied between estimates of 5% to 10% and 20%. Continued monitoring of the progress of the disease showed that by 1994 the prevalence in the northern North Sea had fallen from 5% in 1992 to below 1% and confirmed that the infection did not appear to be spreading to younger fish. Ultimately it was concluded that the disease had caused high mortality in the northern North Sea during 1991 and subsequently declined to the point where by 1995 the disease induced increase in natural mortality was insignificant.

The increased fishing pressure during the first half of the 1990's and the disease induced increase in natural mortality led to serious concerns about the possibilities of a stock collapse similar to that in the late 1970's. Reported landings continued at around 650,000 tonnes per year whilst the spawning stock began to decline again from over 1 million tonnes in 1990. The assessments at that time were providing an over optimistic perception of the size of the spawning stock and, for example, it was not until 1995 that it was realised that the SSB in 1993 had already fallen below 500,000 tonnes. This was well below the minimum biologically accepted level of 800,000 tonnes (MBAL) which had been set for this stock at that time.

H.3 Management and ACFM advice

In 1996, the total allowable catches (TACs) for Herring caught in the North Sea (ICES areas IV and Division VIId) were changed mid-year with the intention of reducing the fishing mortality by 50% for the adult part of the stock and by 75% for the juveniles. For 1997, the regulations were altered again to reduce the fishing mortality on the adult stock to 0.25 and for juveniles to less than 0.1 with the aim of rebuilding the SSB up to 1.1 million t in 1998.

According to the EU and Norway agreement adopted in December 1997, efforts should be made to maintain the SSB above the MBAL (Minimum Biologically Acceptable Level) of 800,000 tonnes. An SSB reference point of 1.3 million has been set above which the TACs will be based on an F= 0.25 for adult herring and F= 0.12 for juveniles. If the SSB falls below 1.3 million tonnes, other measures will be agreed and implemented taking account of scientific advice. Relevant parts of the agreement (last amended Dec. 2001) read:

1) Every effort shall be made to maintain a level of Spawning Stock Biomass (SSB) greater than the Minimum Biological Acceptable Level (MBAL) of 800,000 tonnes.
2) A medium-term management strategy, by which annual quotas shall be set for the directed fishery and for by-catches in other fisheries as defined by ICES, reflecting a fishing mortality rate of 0.25 for 2-ringers and older and 0.12 for 0-1-ringers, shall be implemented.
3) Should the SSB fall below a reference point of 1.3 million tonnes, the fishing mortality rates referred under paragraph 2, will be adapted in the light of scientific estimates of the precise conditions then prevailing, to ensure rapid recovery of SSB to levels in excess of 1.3 million tonnes.
4) The recovery plan referred to above may, inter alia, include additional limitations on effort in the form of special licensing of vessels, restrictions on fishing days, closing of areas and/or seasons, special reporting requirements or other appropriate control measures.
5) By-catches of herring may only be landed in ports where adequate sampling schemes to effectively monitor the landings have been set up. All catches landed shall be deducted from the respective quotas set, and the fisheries shall be stopped immediately in the event that the quotas are exhausted.
6) The allocation of the TAC for the directed fishery for herring shall be 29% to Norway and 71% to the Community. The by-catch quota for herring shall be allocated to the Community.
7) The parties shall, if appropriate, consult and adjust management measures and strategies on the basis of any new advice provided by ICES including that from the assessment of the abundance of the most recent year class.
8) A review of this arrangement shall take place no later than 31 December 2004.
9) This arrangement entered into force on 1 January 2002.

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

Since 2002, the SSB is considered to have been above $\mathbf{B}_{pa}$. From then on, ACFM gave fleetwise catch option tables for fishing mortalities within the constraints the EU-Norway management scheme.

H.4 Sampling of commercial catch

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

AREA	SAMPLING LEVEL PER 1000 T CATCH		
Baltic area (IIIa (S) and IIIb-c)	*1 sample of which*	*100 fish measured and*	*50 aged*
Skagerrak (IIIa (N))	*1 sample*	*100 fish measured*	*100 aged*
North Sea (IV and VId):	*1 sample*	*50 fish measured*	*25 aged*
NE Atlantic and Western Channel ICES areas II, V, VI, VII (excluding d) VIII, IX, X, XII, XIV	*1 sample*	*50 fish measured*	*25 aged*

Exemptions to the above mentioned sampling rules are:

Concerning lengths:

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

(i) the relevant quotas must correspond to less than 5 % of the Community share of the TAC or

to less than 100 tonnes on average during the previous three years;

(ii) the sum of all quotas of Member States whose allocation is less than 5 %, must account for

less than 15 % of the Community share of the TAC.

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

Concerning ages:

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

(i) the relevant quotas correspond to less than 10 % of the Community share of the TAC or to

less than 200 tonnes on average during the previous three years;

(ii) the sum of all quotas of Member States whose allocation is less than 10 %, accounts for less than 25 % of the Community share of the TAC.

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

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

The HAWG reviewed the implementation of the new sampling regime for the EU countries in 2003. It was expected that the overall sampling level might be improved, and this was demonstrated e.g. for North Sea herring in 2002 and 2003. However, there is concern that the new regime may lead to a deterioration of sampling quality, because it does not assure an appropriate sampling of different métiers (each combination of fleet/nation/area and quarter). Given the diversity of the fleets harvesting most stocks assessed by HAWG, an appropriate spread of sampling effort over the different métiers is more important to the quality of catch at age data than a sufficient overall sampling level. The EU data directive appears to not assure this. The WG therefore recommends that all metiers with substantial catch should be sampled (including by-catches in the industrial fisheries), that catches landed abroad should be sampled and information on these samples should be made available to the national laboratories.

H.5 Terminology

The WG uses “rings” rather than “age” or “winter rings” throughout the report to denominate the age of herring, with the intention to avoid confusion It should be observed that, for autumn spawning stocks, there is a difference of one year between “age” and “rings”. HAWG in 1992 (ICES 1992/Assess:11) stated that

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

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

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

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

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

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

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Quality Handbook ANNEX: HAWG-Herring wbss

Stock specific documentation of standard assessment procedures used by ICES.

Stock Western Baltic Spring spawning herring (WBSS)

Working Group: Herring Assessment Working Group for the Area South of 62º N

Date: 18.03.2004

Authors: M. Cardinale, J. Dalskov, T. Gröhsler, H. Mosegaard,

A. General

A.1. Stock definition

Herring caught in Division IIIa are a mixture of North Sea autumn spawners and Baltic spring spawners. Spring-spawning herring in the eastern part of the North Sea, Skagerrak, Kattegat and SDs 22, 23 and 24 are considered to be one stock.

Catches of herring in the Kattegat, the Skagerrak and the Eastern part of the North Sea are taken from a mixture of two main spawning stocks (ICES, 1991/Assess:15): mainly 2+ ringers of the Western Baltic spring-spawners and 0-2-ringers from the North Sea autumn-spawners, including winter-spawning Downs herring. In addition, several local spawning stocks have been identified with a minor importance for the herring fisheries (ICES, 2001/ACFM 12).

The method of separating herring in Norwegian samples, using vertebral counts as described in former reports of this Working Group (ICES 1991/ Assess:15) assumes that for autumn spawners, the mean vertebral count is 56.5 and for Spring spawners 55.80. The fractions of spring spawners (fsp) are estimated from the formula (56.50-v)/(56.5-55.8), where v is the mean vertebral count of the (mixed) sample with the restriction that the proportion should be one if fsp>=1 and zero if fsp<=0. The method is quite sensitive to within-stock variation (e.g. between year classes) in mean vertebral counts.

Experience within the Herring Assessment Working Group has shown that separation procedures based on size distributions often will fail. The introduction of otolith microstructure analysis in 1996-97 (Mosegaard and Popp-Madsen, 1996) 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 that are not easily distinguished by their otolith microstructure (OM), are considered to have different mean vertebral counts (vs) as, e.g., winter-spawning Downs herring: 56.6 (Hulme, 1995), and the small local stocks, the Skagerrak winter/spring-spawners: 57 (Rosenberg and Palmén, 1982). Further, the estimated stock specific mean vs count varies somewhat among different studies; North Sea: 56.5, Western Baltic Sea: 55.6 (Gröger and Gröhsler, 2001) and North Sea: 56.5, Western Baltic Sea: 55.8 (ICES 1992/H:5). Comparison between separation methods using frequency distributions of vertebral counts and otolith microstructure showed reasonable correspondence. Using this information the years from 1991 to 1996 was reworked in 2001, applying common splitting keys for all years by using a combination of the vertebral count and otolith microstructure methods (ICES, 2001/ACFM:12). From 2001 and onwards, the otolith-based method only has been used for the Div. IIIa.

Different methods of identifying herring stocks in the Division IIIa and Subdivisions 22-24 were recently evaluated in a EU CFP study project (EC study 98/026). The study involved several inter-calibration sessions between microstructure readers in the different laboratories involved with the WBSS herring. After the study was finished a close collaboration concerning reader interpretations has been kept between the Danish and Swedish laboratories. Sub-samples of the 2002 and 2003 Danish, Swedish, and German microstructure analyses were double-checked by the same Danish expert reader for consistency in interpretation. The overall impression is an increasingly good agreement among readers.

New molecular genetic approaches for stock separation are being developed within the EU-FP5 project HERGEN (EU project QLRT 200-01370). Sampling of spawning aggregations during spring, autumn and winter has been carried out in 2002 and in 2003 in Div. IIIa and in the Western Baltic at more than 10 different locations. Preliminary results point at a substantial genetic variation between North Sea and Western Baltic herring, but significant variation has also been found among spawning populations in DivIIIa and subdiv. 22-24.

For Subdivisions 22, 23 and 24 it is assumed that all individuals caught belong to the Western Baltic spring spawning stock.

After the introduction of otolith microstructure analysis in 1996 it was discovered that in the western Baltic a small percentage of the herring landings might consist of autumn-spawners individuals. Before molecular genetic methods became available for Atlantic herring the existence of varying proportions of autumn spawners in Subdivisions 22–24 in different years was considered a potential problem for the assessment.

Although local aggregations of winter and autumn spawning herring are found in the Western Baltic area these aggregations are genetically more closely related to the Western Baltic spring spawners than to the North Sea autumn spawners (HERGEN, EU project QLRT 200-01370). Therefore, with the present genetic perception in mind, when herring with otolith microstructure indicating autumn hatch are found in subdivisions 22-24 these are treated as belonging to the WBSS stock.

A.2. Fishery

The fleet definitions used since 1998 for the fishery in Div. IIIa are:

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

Danish and Swedish by-catches of herring from the sprat fishery and the Norway pout and blue-whiting fisheries are listed under fleet D.

In SDs 22–24 most of the catches are taken in a directed fishery for herring and some as by-catch in a directed sprat fishery. All landings from SDs22–24 are treated as one fleet.

A.3. Ecosystem aspects

Applying new molecular genetic methods and results emerging from ongoing research projects on herring (HERGEN and WESTHER) the possibility of considering genetic diversity is within reach. Preliminary results indicate an increase in genetic distance between herring populations in the Baltic and successive populations in subdivisions 24, 22, 21, and 20 and finally the North Sea where genetic distance reach a maximum constant difference to the

Baltic. Further, genetic differences are larger among populations within the Divisions IIIa and Western Baltic than among populations in the North Sea.

B. Data

B.1. Commercial catch

The level of sampling of the landings for the human consumption fishery and the small-meshed fishery landings was generally acceptable in the Skagerrak, the Kattegat and SDs 22-24 during the last years. 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.

Based on the proportions of spring- and autumn spawners in the landings, number and mean weights by age and spawning stock are calculated.

The text table below the shows different input data provided by country:

	DATA		
Country	Caton (catch in weight)	Canum (catch-at-age in numbers)	Weca (weight-at-age in the catch)
Denmark	x	x	x
Germany	x	x	x
Norway	x		
Poland	x	x	x
Sweden	x	x	x

B.2. Biological

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

The proportions of F and M before spawning was assumed constant between years. F-prop was set to be 0.1 and M-prop 0.25 for all age groups.

Natural mortality was assumed constant at 0.2 for all years and 2+ ringers. A predation mortality of 0.1 and 0.2 was added to the 0 and 1 ringers, which resulted in an increase in their natural mortality to 0.3 and 0.5, respectively (Table 3.6.4). The estimates of predation mortality were derived as a mean for the years 1977–1995 from the Baltic MSVPA (ICES 1997/J:2).

The maturity ogive was assumed constant between years:

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

B.3. Surveys

The summer Danish acoustic survey in Division IIIa 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. 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 2002/G:02). Used in the final assessment.

The first joint acoustic survey was carried out with R/V 'Solea' in Subdivisions 22-24 in October 1987. Since 1989 the survey was repeated every year as a part of an international hydracoustic survey in the Baltic. Used in the final assessment.

The IBTS 3rd quarter survey in Div. IIIa, which is a part of the North Sea and Div. IIIa bottom trawl survey that is carried out in the 1st and 3rd quarter. The IBTS has been conducted annually in the 1st quarter since 1977 and 3rd quarters from 1991. From 1983 and onwards the survey was standardised according to the IBTS manual (ICES 2002/D:03). During the HAWG 2002 the IBTS survey data (both quarter) were revised from 1991 to 2002. Historical catch rates are heavily skewed and therefore the survey indices by winter rings 1-5 were calculated as geometric means from observed abundances ($n \cdot h^{-1}$) at age at trawl stations. Used in the final assessment.

The German herring larvae monitoring started in 1977 and takes place every year from March/April to June in the main spawning grounds of the spring spawning herring in the Western Baltic. These are the Greifswalder Bodden and adjacent waters. For the calculation of the number of larvae per station and area unit, the methods of Smith and Richardson (1977) and Klenz (1993) were used and projected to length-classes. Further details concerning the surveys and the treatment of the samples are given in Brielmann (1989), Müller and Klenz (1994) and Klenz (2002). Used in the final assessment.

B.4. Commercial CPUE

B.5. Other relevant data

C. Historical Stock Development

Model used: ICA
Software used: ICA Vs 1.4

Model Options chosen:
No of years for separable constraint: 5
Reference age for separable constraint: 4
Constant selection pattern model : yes
S to be fixed on last age: 1.0
First age for calculation of reference F: 3
Last age for calculation of reference F: 6
Relative weights-at-age: 0.1 for 0-group, all others 1
Relative weights by year: all 1
Catchability model used: for all indices linear
Survey weighting: Manual all 1
Estimates of the extent to which errors in the age-structured indices are correlated across ages: all 1
No shrinkage applied

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1991- last data year	0-8+	Yes
Canum	Catch-at-age in numbers	1991- last data year	0-8+	Yes
Weca	Weight-at-age in the commercial catch	1991- last data year	0-8+	Yes
West	Weight-at-age of the spawning stock at spawning time.	1991- last data year	0-8+	Yes, assumed as the Mw in the catch first quarter
Mprop	Proportion of natural mortality before spawning	1991- last data year	0-8+	No, set to 0.25 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1991- last data year	0-8+	No, set to 0.1 for all ages in all years
Matprop	Proportion mature at age	1991- last data year	0-8+	No, constant for all years
Natmor	Natural mortality	1991- last data year	0-8+	No, constant for all years

Presently used Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	Danish Acoustic Survey Div. IIIa	1989 – last year data	2-8+
Tuning fleet 2	German Acoustic Survey SDs 22-24	1989 – last year data	0-5
Tuning fleet 3	IBTS Quarter 3	1991 – last years data	1-5
….			

D. Short-Term Projection

Model used: Age structured

Software used: MFDP Vs 1a

Initial stock size: ICA estimates of population numbers were used except for

- the numbers of 0-ringers in the last two years and the start year of the projection, where a geometric mean of the recruitment over the period of ten years was taken
- the numbers of 1-ringers in the start of the projection, where the geometric mean over the period of ten years excluding the last year was used

Maturity: The same values as in the assessment is used for all years

F and M before spawning: The same ogive as in the assessment is used for all years

Weight-at-age in the stock: Average weight of the three last years

Weight-at-age in the catch: Average weight of the three last years
Exploitation pattern: Average weight of the three last years

Intermediate year assumptions: Status quo fishing mortality

Stock recruitment model used: None

Procedures used for splitting projected catches: Not relevant

E. Medium-Term Projections

Model used: none

Software used:

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:
Uncertainty models used: none

Initial stock size:
Natural mortality:
Maturity:
F and M before spawning:
Weight-at-age in the stock:
Weight-at-age in the catch:
Exploitation pattern:
Intermediate year assumptions:
Stock recruitment model used:

F. Long-Term Projections

Model used: none

Software used:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

G. Biological Reference Points

Reference points have neither been defined nor proposed for this stock.

H. Other Issues

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Quality Handbook ANNEX: Herring in Celtic Sea and VIIj

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Herring in the Celtic Sea and VIIj
Working Group:	Herring Assessment Working Group for the area south of 62^0 N.
Date:	19th April 2004

A. General

A.1. Stock definition

The herring to the south of Ireland in the Celtic Sea and in Division VIIj comprise both autumn and winter spawning components. For the purpose of stock assessment and management, these areas have been combined since 1982. Spawning in VIIj has traditionally taken place in the autumn and in VIIg and VIIaS, later in the autumn and in the winter.

A.2. Fishery

In recent years, this fishery has been prosecuted entirely by Ireland. The fishing season is the same as the assessment period, 1st April to the 31st March the following year. The TAC is set on an annual basis, however.

In the past season season, the fishery was allowed to remain open throughout. This was to allow vessels to target fish outside the spawning seasons when the fish are of better quality and marketability. The spawning grounds are protected by rotating box closures implemented under EU legislation. In addition to these, one box was voluntarily closed in the recent seasons. This initiative was initiated by the Irish Southwest Pelagic Management Committee to afford extra protection to first time spawners. The Irish Southwest Pelagic Management Committee was established to manage the Irish fishery for this herring stock. This committee, therefore, has responsibility for management of the entire fishery for this stock at present.

Landings have decreased markedly in recent years from around 20,000 t in the 1997/1998 season to around 11,000 t in the 2003/2004 season. The fishery is currently prosecuted by Irish RSW pelagic trawlers and by Irish polyvalent trawlers using pelagic gear.

A.3. Ecosystem aspects

B. Data

B.1. Commercial catch

The commercial catches are provided by national laboratories belonging toe the nations that have quota for this stock. In recent years, only Ireland has caught herring in this area, so catch-at-age, mean weights and stock weights are derived entirely from Irish sampling. Sampling is performed as part of commitments under the EU Council Regulation 1639/2001.

Commercial catch at age data are submitted in Exchange sheet v 1.6.4. These data are usually processed using SALLOCL. This program (Patterson, 1998). This program gives outputs on sampling status and available biological parameters and documents actions taken to raise unsampled metiers using other data sets. The species co-ordinator allocates samples of catch numbers, mean length and mean weight-at-age to unsampled catches using appropriate samples by gear (fleet) area quarter and if an exact match is not available then a neighbouring area if the fishery extends to this area in the same quarter.

B.2. Biological

Mean weights at age in the catch in the 4^{th} and 1^{st} quarter are used as stock weights. This is a new procedure first used in 2004, because much of the catch was taken in the summer, before the spawning period.

The natural mortality is based on the results of the MSVPA for North Sea herring.

B.3. Surveys

A series of acoustic surveys have been carried out on this stock from 1990-1996. The series was interrupted in 1997 due to the lack of the survey vessel, it was resumed in 1998. For the 2002/2003 season one acoustic survey was carried out to determine stock abundance. It was decided that a single survey carried out on fish approaching the grounds would be sufficient to contain the stock. A review of this survey series is in preparation (O'Donnell et al. in prep.).

B.4. Commercial CPUE

Not used for this stock.

B.5. Other relevant data

C. Historical Stock Development

Model used:

Recent WG's have used the results of the acoustic surveys in the ICA programme but stated that the results should be taken as minimum estimates.

Software used: The ICA package is used.

Model Options chosen:

The period of separable constraint is 6 years, with areference age of 3-ring. Terminal selection is fixed at 1.0. Reference F is calculated for 2-ring to 7-ring fish. Fish of 1-ring are down weighted by 0.1, all other ages are not down weighted.

The acoustic abundance estimates are included for ages 2-5 only (winter rings). The acoustic estimates are treated as a relative index, using a linear model.

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1958-2003	1-9	Yes
Canum	Catch at age in numbers	1958-2003	1-9	Yes
Weca	Weight at age in the commercial catch	1958-2003	1-9	Yes
West	Weight at age of the spawning stock at spawning time.	1958-2003	1-9	Yes
Mprop	Proportion of natural mortality before spawning	1958-2003	1-9	No
Fprop	Proportion of fishing mortality before spawning	1958-2003	1-9	No
Matprop	Proportion mature at age	1958-2003	1-9	No
Natmor	Natural mortality	1958-2003	1-9	No

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	CSHAS	1990-2003	2-5
Tuning fleet 2			
Tuning fleet 3			
….			

D. Short-Term Projection

Model used: Multi fleet Deterministic Projection (Smith, 2000).

Software used: MFDP Software

A short-term projection is carried out under the following assumptions. The number of 1 ringers was based on the geometric mean from 1958 to 2001. . This was followed to allow for the inclusion of the period of recruitment failure. This value was 406 million fish. Mean weights in the catch and in the stock were calculated as means over the period 1998-2003. Population numbers of 2-ringers in the 2004/2005 season was calculated by the degradation of geometric mean recruitment (1958-2001) using the equation, following the same procedure as last year.

$N_{t+1} = N_t * e^{-F+M}$

Following the same procedure as last year, two scenarios are presented, one based on $\mathbf{F}_{sq}$ (=F_{2003}), the other on a catch constraint of 13,000 (the TAC for 2004).

E. Medium-Term Projections

Not performed

F. Long-Term Projections

Not performed

G. Biological Reference Points

$\mathbf{B}_{pa}$ is set at 44,000 t and $\mathbf{B}_{lim}$ at 26,000 t. F reference points are not defined for this stock.

H. Other Issues

I. References

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Quality Handbook ANNEX: Her VIaN

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Herring in VIa (North)
Working Group:	Herring Assessment WG for the Area south of 62°N
Date:	18 March 2005
Authors:	E.M.C. Hatfield and E.J. Simmonds

A. General

A.1. Stock definition

The stock is distributed over ICES Division VIa (N). Some of the larger adults typically found close to the shelf break may be caught in division Vb.

A.2. Fishery

The dominant fleet fishing in VIa (N) since 1957 has been the Scottish fleet. In the early years the Scottish fishery was prosecuted using a mixture of vessel size and gear, including gill nets, ring-nets and trawls. The boats were small, and targeted the coastal stock, primarily fishing in the winter. Until 1970 the only other nations fishing in this area on a regular basis were the former German Federal Republic, and to a much lesser extend the Netherlands. These fleets operated in deeper water near the shelf edge.

In 1970 a large increase in exploitation occurred with the entry of fleets from Norway and the Faroes, and an increased Netherlands catch. In addition, considerably smaller catches were taken by France and Iceland.

Throughout this period juvenile herring catches from the Moray Firth, in the north-east of Scotland, were included in the VIa catch figures, as tagging programs showed there to be some links between herring spawning to the west of Scotland and the Moray Firth juveniles.

Prior to 1982 herring stocks in ICES Area VIa were assessed as one stock, along with the herring by-catch from the sprat fishery in the Moray Firth. In the 1982 herring assessment working group report, and in subsequent years, Area VIa was split into a northern and a southern area at 56°N (ICES, 1982).

In 1979 and 1981 the fishery was closed. After re-opening the nature of the fishery changed to an extent, with fewer Scottish boats targeting the coastal stock than before the closure. The Scottish domestic pair trawl fleet and the Northern Irish fleet operated 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. Since 1986 Irish trawlers have operated in the south of the area, from the VIa (S) line up to the south-western Hebrides. The Scottish and Norwegian purse seine fleets targeted herring mostly in the northern North Sea, but also operated in the northern part of VIa (N). An international freezer-trawler fishery 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 younger adults resulting from increased recruitment into the stock.

In recent years the Scottish fleet has changed to a predominantly purse-seine fleet to a trawl fleet. Norwegian vessels fish less in the area than in the past. Scottish catches still comprise around half of the total, the rest is dominated by the offshore, international fishery.

A recent EU-funded programme WESTHER aims to elucidate stock structures of herring throughout the western seaboard of the British Isles using a combination of morphometric measurements, otolith structure, genetics and parasite loads. The results of this should provide the best-available information on mixing of stocks within and beyond VIa (N).

A.3. Ecosystem aspects

Herring in this area is an important food source for sea birds, sea mammals and many piscivorous fish.

Adult herring in VIa (N) can consume eggs of other fish species in the area. However, it has not been possible to demonstrate a relationship between herring abundance and recruitment to other stocks, and stomach investigations of herring do not indicate that the predation effect on eggs has significant impact on egg survival for other stocks.

B. Data

B.1. Commercial catch

Commercial catch is obtained from national laboratories of nations exploiting herring in VIa (N). Since 1999 (catch data 1998), these labs have used a spreadsheet to provide all necessary landing and sampling data, which was developed originally for the Mackerel Working Group (WGMHSA) and further adapted to the special needs of the Herring Assessment Working Group. The current version used for reporting the 2002 catch data was v1.6.4. The majority of commercial catch data of multinational fleets was provided on these spreadsheets and further processed with the SALLOCL-application (Patterson, 1998a). 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.

Transparency of data handling by the Working Group. The current practice of data handling by the Working Group is that the data received by the co-ordinators is available in a folder called “archive”. These high-resolution data are not reproduced in the report. The archived data contains the disaggregated dataset (disfad), the allocations of samples to unsampled catches (alloc), the aggregated dataset (sam.out) and (in some cases) a document describing any problems with the data in that year.

Current methods of compiling fisheries assessment data. The species co-ordinator is responsible for compiling the national data to produce the input data for the assessments. In addition to checking the major task involved is to allocate samples of catch numbers, mean length and mean weight-at-age to unsampled catches. There are at present no defined criteria on how this should be done, but the following general process is implemented by the species co-ordinators. Searches are made for appropriate samples by gear (fleet) area quarter, if an exact match is not available the search will move to a neighbouring area if the fishery extends to this area in the same quarter. More than one sample may be allocated to an unsampled catch, in this case a straight mean or weighted mean of the observations may be used. If there are no samples available the search will move to the closest non-adjacent area by gear (fleet) and quarter, but not in all cases.

Until 2003 the VIa(N) catch data extended back to the early 1970s; since 1986 the series has run from 1976 to present. In 2004 the data set was extended back to 1957. Details are given below.

Historic Catches from 1957 to 1975

The working group has obtained preliminary estimates of catch and catch-at-age for the period 1957 to 1975. These have been estimated from records of catch presented in HAWG reports from 1973, 1974, 1981 and 1982. Intervening reports were also consulted to check for changes or updates during the period. Catch-at-age data were available from 1970 to 1975 from the 1982 Working Group report, and catches-at-age for the period 1957 to 1972 were estimated from paper records of catch-at-age by national fleets for 1957 to 1972, held at FRS Marine Laboratory Aberdeen. The fishing practices of national fleets were established for the period 1970 to 1980 from catches in VIa and VIa (N) recorded in the 1981 and 1982 Working Group reports respectively. This procedure suggested that, on average, more than 90% of catch by national fleet could be fully assigned to either VIa (N) or VIa (S). The remaining catch was assigned assuming historic proportions. During this period catches were split into autumn and spring spawning components; anecdotal information on trials to verify this separation suggests it was not a robust procedure. Currently about 5% of herring in VIa (N) is found to be spent at the time of the acoustic surveys in July, and thought to be spring spawning herring. However, at present the Working Group assesses VIa (N) herring as one stock, regardless of spawning stock affiliation. In the earlier period higher proportions were allocated as spring spawners. The Working Group considered that it was preferable to combine all catch in the earlier period as VIa (N) catch, as the spawning components are currently mixed and the historic separation was uncertain. Similarly, a small Moray Firth juvenile fishery was also included in VIa (N) catch in earlier years because it was thought that these juveniles were part of the VIa (N) stock. Separating this component in the historic data was difficult, and as the fishery ceased in the very early 70s this has no implications for current allocation of these fish. The Moray Firth is, geographically, part of IVa (ICES stat. rectangles 44E6, 44E7, 45E6) and is now managed as part of that area. Currently there are no juvenile herring catches from the Moray Firth. Full details of the analysis carried out is provided as an appendix (Appendix 11) to the 2004 Working Group report.

Allocation of catch and misreporting

This fishery had a strong tradition of misreporting. It is believed that the shortfall between the TAC and the catch was used to misreport catches from other areas (from IVa to the east and from VIa (S) to the south). In the past, 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 detailed in the Working Group report in 2002 (ICES 2002/ACFM:12). Improved information from the fishery in 1998 - 2002 allowed for re-allocation of many catches due to area misreporting (principally from VIa (N) to IVa (W)). This information was obtained from only some of the fleets

As a result of perceived problems of area misreporting of catch from IVa into VIa (N), Scotland introduced a new fishery regulation in 1997 aiming to improve reporting accuracy. Under this regulation, Scottish vessels fishing for herring are required to hold a license either to fish in the North Sea or in the west of Scotland area (VIa (N)). Only one of these options can be held at any one time.

The Working Group considers that the serious problems with misreporting of catches from this stock, with many examples of vessels operating and landing herring catches distant from VIa (N) but reporting catches from that area, have been reduced in recent years from some 30,000 t in the mid 1990s to around 5,000 t in 2002. In 2003, for the first time since 1983, observer data indicated there was no misreported catch..

Catches are included in the assessment. Biases and sampling designs are not documented. Discards are not included. Slippage and high grading are not recorded.

B.2. Biological

Catch-at-age data (catch numbers-at-age, mean weights-at-age in the catch, mean length-at-age) are derived from the raised national figures received from the national laboratories. The data are obtained either by market sampling or by onboard observers, and processed as described in Section B.1 above. For information on recent sampling levels and nations providing samples, see Section 2.2. in the most recent HAWG report.

Proportions mature (maturity ogive) and mean weights-at-age in the stock derived from the acoustic survey (see next section) have been used since 1992 and 1993, respectively. Prior to these years, time-invariant values derived from ??? were used.

Biological sampling of the catches was extremely poor in recent history (particularly in 1999). This was particularly the case for the freezer trawler fishery that takes the larger component of the stock based around the shelf break. The lack of samples was due in part to the fact that national vessels tend to land in foreign ports, avoiding national sampling programs. The same fleet is thought to high grade. The long length of fishing trips makes observer programs difficult. Even when samples are taken, age determination is limited for most nations.

Sampling has improved over the last few years. The number of age readings per 1,000 t of catch increased from the low in 1999 of 52 to a high in 2001 of 93. Numbers have decreased again since then to 57 per 1,000 t in 2003. From 1999 to 2003 the sampling has been dominated by Scotland (ranging between 70 and 98% of the age readings), except in 2001, when only 43% of the age determination was on Scottish landings in VIa (N).

Natural mortality (M) varies with age (expressed in number of winter rings) according to the following:

Rings	M
1	1
2	0.3
3	0.2
4+	0.1

Those values have been held constant from 1957 to date. Those values correspond to estimates for North Sea herring based on recommendations by the Multi-species WG (Anon. 1987a) that were applied to adjacent areas (Anon. 1987b).

B.3. Surveys

B.3.1 Acoustic survey

An acoustic survey has been carried out for VIa (N) herring in the years 1987, 1991-2003. The 1997 survey was invalidated due to its unusual timing (June as oppose to July).

Biomass estimated from the acoustic survey tends to be variable. Herring are found in similar area each year, namely south of the Hebrides off Barra Head, west of the Hebrides and along the shelf edge.

The stock is highly contagious in its spatial distribution, which explains some of the high variability in the time series. Effort stratification has improved with knowledge of the distribution and this may be less of a problem in more recent years. The survey uses the same target strength as for the North Sea surveys and there is no reason to suppose why this should be any different. Species identification is generally not a great problem.

B.3.2 Larvae survey

Larvae surveys for this stock were carried out from 1973 to 1993. Larval production estimates (LPE) and a larval abundance index (LAI) were produced for the time series. These values were used in the assessment, the LPE until 2001. However, in 2002 it was decided that the LAI had no influence on the assessment and has not been used since. Documentation of this survey time-series is given in ICES CM 1990/H:40.

B.4. Commercial CPUE Not used for pelagic stocks

B.5. Other relevant data

C. Historical Stock Development

An experimental survey-data-at-age model was formulated at the 2000 HAWG. In 1999 and 1998 a Bayesian modification to ICA was used to account for the uncertainty in misreporting.

Model used: ICA

Software used: ICA (Patterson 1998b)

Model Options chosen:

- Separable constraint over last 8 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 = 3
- Last age for calculation of mean F = 6
- Weighting on 1-rings = 0.1; all other age classes = 1.0
- Weighting for all years = 1.0
- All indices treated as linear
- No S/R relationship fitted
- Lowest and highest feasible F = 0.02 and 0.5
- All survey weights fitted by hand i.e., 1.0 with the 1 ringers in the acoustic survey weighted to 0.1.
- Correlated errors assumed i.e., = 1.0

No shrinkage applied

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1957 - 2003	NA	Yes
Canum	Catch at age in numbers	1957 – 2003	1-9+	Yes
Weca	Weight at age in the commercial catch	1957 –1972 1973-1981 1982-1984 1985-last data year	1-9+ 1-9+ 1-9+ 1-9+	No No No Yes
West	Weight at age of the spawning stock at spawning time.	1957 – 1992 1993-last data year	1-9+ 1-9+	No Yes
Mprop	Proportion of natural mortality before spawning	1957–last data year	NA	No
Fprop	Proportion of fishing mortality before spawning	1957–last data year	NA	No
Matprop	Proportion mature at age	1957 – 1991 1992-last data year	1-9+ 1-9+	No Yes
Natmor	Natural mortality	1957-last data year	1-9+	No

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	VIa (N) Acoustic Survey	1987, 1991-1996 1998-2003	1-9+ 1-9+ 1-9+

D. Short-Term Projection

Model used: Age structured

Software used: MFDP ver 1a

Initial stock size: Taken from the last year of the assessment. 1- and 2-ring recruits taken from a geometric mean for the years 1976 to one year prior to the last year.

Maturity: Mean of the last three years of the maturity ogive used in the assessment.

F and M before spawning: Set to 0.67 for all years.

Weight at age in the stock: Mean of the last three years in the assessment.

Weight at age in the catch: Mean of the last three years in the assessment.

Exploitation pattern: Mean of the previous three years, scaled by the Fbar (3-6) to the level of the last year.

Intermediate year assumptions: *status quo* F constraint.

Stock recruitment model used:

None used

Procedures used for splitting projected catches: Not relevant

E. Medium-Term Projections

Model used: ICP as described in ICES 1996/ACFM:10

Software used: ICP (Patterson 1999)?

Initial stock size: Population parameters (vector of abundance at age in 2003, fishing mortality at reference age in 2003, selection at age) are drawn from a multivariate normal distribution with mean equal to the values estimated in the stock assessment model, and with covariance as estimated in the same model fit. Geometric mean recruitment for 1- and 2-ringers is used to replace the values in the assessment for the first projected year, however, the covariance values produced by ICA are retained.

Natural mortality: Mean of the last three years in the assessment.

Maturity: Mean of the last three years of the maturity ogive used in the assessment.

F and M before spawning: Set to 0.67 for all years.

Weight at age in the stock: Mean of the last three years in the assessment.

Weight at age in the catch: Mean of the last three years in the assessment.

Exploitation pattern: ???

Intermediate year assumptions: F or TAC constraint

Stock recruitment model used: Ockham option using the converged VPA 1972 to three years prior to last year in the assessment.

Uncertainty models used:

Initial stock size:
Natural mortality:
Maturity:
F and M before spawning:
Weight at age in the stock:
Weight at age in the catch:
Exploitation pattern:
Intermediate year assumptions:
Stock recruitment model used:

F. Long-Term Projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

G. Biological Reference Points

The report of SGPRP (ICES 2003/ACFM:15) proposed a $\mathbf{B}_{lim}$ of 50,000 t for VIa (N) herring. This is calculated from the values in the converged part of the VPA (1976-1999) and the Working Group endorsed this value in 2003 (ICES 2003/ACFM:17).

In 2003 the Working Group estimated retrospective error in terminal SSB from 4 years and gave a mean of the absolute values of 20% and a maximum of 38%. Since there are so few data points and they are close in time to the current year the maximum value might be an underestimate of the range of values. The Working Group felt that the 90th percentile on a normal distribution that had a mean error of 20% might be a more appropriate measure; this would give a factor close to 50%.

$\mathbf{B}_{pa} = \mathbf{B}_{lim} * 1.50$ and gives $\mathbf{B}_{pa} = 75{,}000$ t

The Working Group had considerable trouble developing F reference points but proposed a value based on rather limited data on errors of estimation. $\mathbf{F}_{\mathbf{lim}}$ was derived directly from the equilibrium exploitation rate for an SSB for $\mathbf{B}_{\mathbf{lim}}$. $\mathbf{F}_{\mathbf{pa}}$ was obtained in a similar manner to $\mathbf{B}_{\mathbf{pa}}$ with a factor of 50%. Full details of the method are given in last year's Working Group report.

The Working Group did not repeat the extensive analysis carried out in 2003 (ICES 2003/ACFM:17) but suggests that, at the very least, a $\mathbf{B}_{\mathbf{lim}}$ of 50,000 and a $\mathbf{B}_{\mathbf{pa}}$ of 75,000 are suitable as Biomass limit and reference points for VIa (N). Reference points are urgently needed for the management of this stock and these values are as well founded as many others currently in use.

Suggested Precautionary Approach reference points:

$\mathbf{B}_{LIM}$ IS 50,000 T	$\mathbf{B}_{PA}$ BE SET AT 75,000 T
$\mathbf{F}_{lim}$ is 0.75	$\mathbf{F}_{pa}$ = 0.35

Technical basis:

$\mathbf{B}_{LIM}$: $\mathbf{B}_{LOSS}$ ESTIMATED SSB FOR SUSTAINED RECRUITMENT	$\mathbf{B}_{PA}$: = 1.5 * $\mathbf{B}_{LIM}$
$\mathbf{F}_{lim}$ corresponding to $\mathbf{B}_{lim}$ from the yield-per-recruit $\mathbf{F}_{lim}$= 0.75	$\mathbf{F}_{pa}$ = 0.5 * $\mathbf{B}_{lim}$

H. Other Issues

H.1 Terminology

The WG uses “rings” rather than “age” or “winter rings” throughout the report to denominate the age of herring, with the intention to avoid confusion. It should be observed that, for autumn spawning stocks, there is a difference of one year between “age” and “rings”. HAWG in 1992 (ICES 1992/Assess:11) stated that

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

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

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

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

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

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

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Quality Handbook ANNEX: Herring in VIaS and VIIb

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Herring in VIaS and VIIb

Working Group: Herring Assessment Working Group for the area south of 62^0 N

Date: 19th April 2004

A. General

A.1. Stock definition

The herring to the northwest of Ireland comprise both autumn and winter spawning components. For the purpose of stock assessment and management, these areas have been separated from VIaN since 1982. Spawning in VIIb has traditionally taken place in the autumn and in VIaS, later in the autumn and in the winter.

A.2. Fishery

The TAC is taken mainly by Ireland, which has over 90% of the quota. In recent years, only Ireland has exploited herring in this area. In 2000 the Irish North West Pelagic Management Committee was established to deal with the management of this stock.

Landings have decreased markedly from about 44,000 t in 1990 to around 13,000 t in 2003.

A.3. Ecosystem aspects

B. Data

B.1. Commercial catch

The commercial catches are provided by national laboratories belonging toe the nations that have quota for this stock. In recent years, only Ireland has caught herring in this area, so catch-at-age, mean weights and stock weights are derived entirely from Irish sampling. Sampling is performed as part of commitments under the EU Council Regulation 1639/2001.

Commercial catch at age data are submitted in Exchange sheet v 1.6.4. These data are usually processed using SALLOCL. This program (Patterson, 1998) gives outputs on sampling status and available biological parameters and documents actions taken to raise unsampled metiers using other data sets. The species co-ordinator allocates samples of catch numbers, mean length and mean weight-at-age to unsampled catches using appropriate samples by gear (fleet) area quarter and if an exact match is not available then a neighbouring area if the fishery extends to this area in the same quarter.

B.2. Biological

Mean weights at age in the catch in the 4th and 1st quarter are used as stock weights.

B.3. Surveys

Not used in assessment

B.4. Commercial CPUE

Not used in assessment

B.5. Other relevant data

C. Historical Stock Development

Model used:

A separable VPA is used to track the historic development of this stock.

Software used:

Lowestoft VPA Package (Darby and Flatman , 1994). No final assessment has been accepted by the working group. However several scenarios are run, screening over a range of terminal F's and each is presented in the report.

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1970-2003	1-9	Yes
Canum	Catch at age in numbers	1970-2003	1-9	Yes
Weca	Weight at age in the commercial catch	1970-2003	1-9	Yes
West	Weight at age of the spawning stock at spawning time.	1970-2003	1-9	Yes
Mprop	Proportion of natural mortality before spawning	1970-2003	1-9	No
Fprop	Proportion of fishing mortality before spawning	1970-2003	1-9	No
Matprop	Proportion mature at age	1970-2003	1-9	No
Natmor	Natural mortality	1970-2003	1-9	No

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1			
Tuning fleet 2			
Tuning fleet 3			
….			

D. Short-Term Projection

Not conducted

E. Medium-Term Projections

Not conducted

F. Long-Term Projections

Not conducted

G. Biological Reference Points

$\mathbf{B}_{pa} =$ 110,000 t and $\mathbf{B}_{lim}$ = 81,000 t. $\mathbf{F}_{pa}$ = 0.22 and F lim = 0.33.

H. Other Issues

I. References

Darby, C.D. and Flatman, S. 1994. Virtual Population Analysis version 3.1 (Windows/DOS) user guide. Lowestoft: MAFF Information Technology Series No. 1.

Quality Handbook ANNEX:_hawg-nirs_

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Irish Sea herring
Working Group	Herring Assessment Working Group (HAWG)
Date:	17 March 2004

A. General

A.1. Stock definition

Herring spawning grounds in the Irish Sea are found in coastal waters to the west and north of the Isle of Man and on the Irish Coast at around 54^{o}N (ICES 1994, Dickey-Collas *et al*. 2001). Spawning takes place from September to November in both areas, occurring slightly later on average on the Irish Coast than off the Isle of Man. ICES Herring Assessment Working Groups from 19XX to 1983 used v ertebral counts to separate catches into Manx and Mourne stocks associated with these spawning grounds. However, taking account of inaccuracies in this method and the results of biochemical analyses, the 1984 WG combined the data from the two components to provide a "more meaningful and accurate estimate of the total stock biomass in the N.Irish Sea." All subsequent assessments have treated the VIIa(N) data as coming from a single stock. During the 1970s, catches from the Manx component were about three times larger than those from the Mourne component. By the early 1980s, following the collapse of the stock, the catches were of similar magnitude. The fishery off the Mourne coast declined substantially in the 1990s then ceased, whilst acoustic and larva surveys in this period indicate that the spawning population in this area has been very small compared to the biomass off the Isle of Man.

The occurrence in the Irish Sea of juvenile herring from a winter-spring spawning stock has been recognized since the 1960s based on vertebral counts (ICES 1994). More recently, Brophy and Danilowicz (2002) used otolith microstructure to show that nursery grounds in the western Irish Sea were generally dominated by winter-spawned fish. Samples from the eastern Irish Sea were mainly autumn-spawned fish. Recaptures from 10,000 herring tagged off the SW of the Isle of Man in July 1991 occurred both on the Manx spawning grounds and along the Irish Coast with increasing proportions from the Celtic Sea in subsequent years (Molloy *et al.*, 1993). The pattern of recaptures indicated a movement towards spawning grounds in the Celtic Sea as the fish matured.

A proportion of the Irish Sea herring stocks may occur to the north of the Irish Sea outside of the spawning period. This was indicated by the recapture on the Manx spawning grounds of 3-6 ring herring tagged during summer in the Firth of Clyde (Morrison and Bruce 1981). Aggregations of post-spawning adult herring were detected along the west coast of England during an acoustic survey in December 1996 (Department of Agriculture and Rural Development for Northern Ireland, unpublished data), showing that a component of the stock may remain within the Irish Sea.

A recent EU-funded programme WESTHER aims to elucidate stock structures of herring throughout the western seaboard of the British Isles using a combination of morphometric measurements, otolith structure, genetics and parasite loads. The results of this should provide the best-available information on mixing of stocks within and beyond the Irish Sea.

A.2. Fishery

There have been three types of fishery on herring in the Irish Sea in the last 40 years:

i) Isle of Man- aimed at adult fish that spawn around the Isle of Man.

ii) Mourne- aimed at adult fish that spawn off the Northern Irish eastern coast.

iii) Mornington- a mixed industrial fishery that caught juveniles in the western Irish Sea.

The Mornington fishery started in 1969 and at its peak it caught 10,000 tonnes per year. It took place throughout the year. The fishery was closed due to management concerns in 1978 (ICES, 1994). In the 1970s the catch of fish from the Mourne fishery made up over a third of the total Irish Sea catch. The fishery was carried out by UK and Republic of Ireland vessels using trawls, seines and drift nets in the autumn. However the fishery declined and ceased in the early 1990s (ICES, 1994). The biomass of Mourne herring, determined from larval production estimates is now 2-4% of the total Irish Sea stock (Dickey-Collas *et al*., 2001).

The main herring fishery in the Irish Sea has been on the fish that spawn in the vicinity of the Isle of Man. The fish are caught as they enter the North Channel, down the Scottish coast, and around the Isle of Man. Traditionally this fishery supplied the Manx Kipper Industry, which requires fish in June and July. However the fish appeared to spawn slightly later in the year in the 1990s and this lead to problems of supply for the Manx Kipper Industry. In 1998 the Kipper companies decided to buy in fish from other areas. Generally the fishery has occurred from June to November, but is highly dependent on the migratory behaviour of the herring.

The fishery has been prosecuted mainly by UK and Irish vessels. TACs were first introduced in 1972, and vessels from France, Netherlands and the USSR also reported catches from the Irish Sea during the 1970s before the closure of the fisheries from 1978 to 1981. By the 1990s only the fishery on the Manx fish remained, and by the late 1990s this was dominated by Northern Irish boats. The number of Northern Irish vessels landing herring declined from 24 in 1995-96 to 6-10 in 1997-99 and to 4 in 2000. Only two vessels operated in 2002 and 2003. However, total landings have remained relatively stable since the 1980s whilst the mean amount of fish landed per fishing trip has increased, reflecting the increase in average vessel size

A.3. Ecosystem aspects

The main fish predators on herring in the Irish Sea include whiting (*Merlangius merlangus*), hake (*Merluccius merluccius*) and spurdogfish (*Squalus acanthias*). The size composition of herring in the stomach contents indicates that predation by whiting is mainly on 0-ring and 1-ring herring whilst adult hake and spurdogfish also eat older herring (Armstrong, 1979; Newton, 2000; Patterson, 1983). Sampling since the 1980s has shown cod (*Gadus morhua*), taken by both pelagic and demersal trawls in the Irish Sea, to be minor predators on herring. Small clupeids are an important source of food for piscivorous seabirds including gannets, guillemots and razorbills (ref…) which nest at several locations in and around the Irish Sea. Marine mammal predators include grey and harbour seals (ref.) and possibly pilot whales, which occur seasonally in areas where herring aggregate.

Whilst small juvenile herring occur throughout the coastal waters of the western and eastern Irish Sea, their distribution overlaps extensively with sprats (*Sprattus sprattus*). The biomass of small herring has typically been less than 5% of the combined biomass of small clupeids estimated by acoustics (ICES HAWG reports).

B. Data

B.1. Commercial catch

National landings estimates

The current ICES assessment of Irish Sea herring extends back to 1961, and is based on landings only. ICES WG reports (ICES 1981, 1986 and 1991) highlight the occurrence of discarding and slippage of catches, which can occur in areas where adult and juvenile herring co-occur. Discarding has been practised on an increasing scale since 1980 (ICES 1986). This increase is primarily related to the onset of slippage of catches that coincided with the cessation of the industrial fishery in early 1979 (ICES 1980). As a result of sorting practices, slippage has led to marked changes in the age composition of the catch since 1979 and considerable change in the mean weights at age in the catch of the three youngest age groups (ICES 1981). Estimates of discarding were sporadically performed in the 1980s (ICES 1981, 1982, 1985 and 1986), but there are no estimates of discarding or slippage of herring in the Irish Sea fisheries since 1986. Highly variable annual discard rates are evident from the 1980s surveys. For example, discards estimates of juvenile herring (0-group) for the Mourne stock taken in the 1981 *Nephrops* fishery was estimated at $1.9x10^6$ of vessels landing in Northern Ireland, which amounts to approximately 20% of the Mourne fishery (ICES 1982). In 1982, at least 50% of 1-group herring caught were discarded at sea by vessels participating in the Isle of Man fishery (ICES 1983). A more comprehensive survey programme to determine the rate of discarding in 1985 revealed discard estimates of 82% by numbers of 1-ring fish, 30% of 2-ring and 6% of 3-ring fish, with the dominant age group in the landed catch being 3 ring (ICES 1986). A similar survey in 1986, however, found the discarding of young fish fell to a very low level (ICES 1987). The 1991 WG discussed the discard problem in herring fisheries in general and suggested possible measures to reduce discarding. No quantitative estimates were given, but reports of fishermen suggesting discards of up to 50% of catch as a result of sorting practices by using sorting machines (ICES 1991). The variation in discard rates since 1980, as a result of changes in discard practices, can probably be attributed to several changes in the management of the fishery. These include the availability of different fishing areas, the change to fortnightly catch quotas per boat (ICES 1987) and level of TAC, where lower discard rates are observed with a higher TAC (ICES 1989). The level of slippage is also related to the fishing season, since slippage is often at a high level in the early months (ICES 1987). Due to the variable nature of discard estimates and the lack of a continuous data series, it has not been included in the annual catch at age estimates (with the exception of the 1983 assessment when the catch in numbers of 1-ringers was doubled based on a 50% discard estimate of this age group).

Landings data for herring in Division VIIa(N) are generally collated from all participating countries providing official statistics to ICES, namely UK (England & Wales, Northern Ireland, Scotland and the Isle of Man), Ireland, France, the Netherlands and what was formally the USSR. The data for the period 1971 to present are reported in the various Herring Assessment Working Group Reports and are reproduced in Table 1. The official Statistics for Irish landings from VIIa have been processed to remove data from the Dunmore East fishery in area VIIa(S), and represent landings from VIIa(N) only.

Over the past three decades, the WG highlighted the under- or misreporting of catches as the major problem with regards to the accuracy of the landing data. Related to this are the problems of illegal landings during closed periods and paper landings. Area misreporting was also recognised (ICES 1999), although a less prominent problem that is mostly corrected for.

The 1980 WG first identified the problem of misreporting of landings based on the results of a 3-year sampling programme, which was initiated after 1975 when herring were being landed in metric units at ports bordering the Irish Sea (1 unit = 100 kg nominal weight). The study showed the weight of a unit to be very variable, but was usually well in excess of 100 kg. An initial attempt to allow for misreporting using adjusted catches made very little difference to any of the values of fishing mortality (ICES 1980). Subsequently, despite serious concerns about considerable under-reporting being raised (ICES 1990, 1994, 2000 and 2001), the WG made no attempts to examination the extent of the problem. This uncertainty signifies no estimates of under-reporting and consequently no allowance for under-reporting of landings has been made. Considerable doubt was raised as to the accuracy of landing data over the period 1981-87 (ICES 1994). However, after apparent re-examination all WG landing statistics are assumed to be accurate up to 1997 (ICES 2000), but with no reliable estimates of landings from 1998-2000 (ICES 2001). The WG acknowledged that poor quality landing data bring the catch in numbers at age data into question and hence the accuracy of any assessment using data from such periods (ICES 1994).

In 2002 the ICES assessment was extended back to include data for 1961-1970 with the intention of showing the stock development prior to the large expansion in fishing effort and stock size in the early 1970s. This has now been extended further back to 1955. Landings data for this period were extracted from the UK fisheries data bases (England & Wales, Scotland and Northern Ireland: Table 1, columns8-10) and publications by Bowers and Brand (1973) for Isle of Man landings (column 11). Landings data for Ireland and France were not available.

To estimate the VIIa(N) herring landings for Ireland and France during 1955-1970, the NE Atlantic herring catches for each country were obtained from the FAO database (column 16). Using the ICES landings data for each country (column 17) the mean proportion of the VIIa(N) catch to the NE Atlantic catch during 1971 to 1981 was estimated (column 18). This was applied to the NE Atlantic catches from each country, for the period 1955 to 1970, to give an estimated landing for both France and Ireland (column 19). These landings were added to the known catches from the CEFAS database to give the total landings. The landings data (tonnes) used in the assessment are given in Table 1, column 14. It is anticipated that landings data for VIIa(N) for years prior to 1971 can be extracted from the Irish databases. However, the French landings will remain as estimates.

[Need discussion on magnitude of errors in the old data]

[Need discussion on errors due to misreporting]

Catch at age data

Age classes in the ICES Canum file refer to numbers of winter rings in otoliths. As the Irish Sea stock comprises autumn spawners, *i*-ring fish taken in year *y* will comprise fish in their i_{th} year of life if caught prior to the spawning season and $(i+1)_{th}$ year if caught after the spawning period. An *i*-ring fish will belong to year-class *y*-2. As spawning stock is estimated at spawning time (autumn), spawning stock and recruitment relationships require estimates of recruitment of *i*-ring fish in year *y* and estimates of SSB in year *i*-2. The current assessment estimates recruitment as numbers of 1-ring fish.

The most recent description of sampling and raising methods for estimating catch at age of herring stocks is in ICES (1996). This includes sampling by UK(E&W) and Ireland, but not UK(NI) and Isle of Man

UK(NI): A random sample of 10-20kg of herring is taken from each landing into the main landing port (Ardglass) by the NI Department of Agriculture and Rural Development. Samples are also collected from any catches landed into Londonderry. Prior to the 1990s, the samples were mostly processed fresh. During the 1990s, there was an increasing tendency for samples to be frozen for a period of weeks before processing. No corrections have been applied to weight measurements to allow for changes due to freezing and defrosting. The length frequency (total length) of each sample is recorded to the nearest 0.5cm below. A sample of herring is then taken for biological analysis as follows: one fish per 0.5 cm length class, followed by a random sample to make the sample up to 50 fish.

Otoliths are removed from each fish, mounted in resin on a black slide and read by reflected light. Ages are assigned according to number of winter rings.

Length frequencies (LFDs) for VIIa(N) catches are aggregated by quarter. The weight of the aggregate LFD is calculated using a length-weight relationship derived from the biological samples. The LFD is then raised to the total quarterly landings of herring by the NI fleets. A quarterly age-length key, derived from commercial catch samples only, is applied to the raised LFD to give numbers at age and mean weight at age.

IOM: IOM sampling covers the period 1923 – 1997. Samples are collected from any landings into Peel, by staff of the Port Erin Marine Laboratory (Liverpool University). The sampling and raising procedures are the same as described for UK(NI) with the following exceptions: i) the weight of the aggregate quarterly LFD is obtained from the original sample weights rather than using a length-weight relationship, and ii) the biological samples are random rather than stratified by length. The 1993 ICES herring assessment WGs noted a potential under-estimation by one ring, of herring sampled in the IOM. This was caused by a change in materials used for mounting otoliths and appears to have been a problem for ageing older herring in 1990-92. This was since rectified. However, the bias for the 1990-92 period has not yet been quantified and will be examined in the near future.

Ireland: Irish sampling of VIIa(N) herring covers the period 19xx – 2001. Some samples are from landings into NI but transported to factories in southern Ireland. Irish sampling schemes for herring in Div. VIa(S), VIIb, Celtic Sea and VIIj are described in ICES (1996). Methods for sampling catches in VIIa(N) are similar. The procedure is the same as described above for UK(NI) except that the biological samples are random rather than length stratified. ICES (1996) notes that a length-stratified scheme should be adopted to ensure proper coverage at the extremes of the LFDs.

Quality control of herring ageing has fallen under the remit of EU funded programmes EFAN and TACADAR, to which the laboratories sampling VIIa(N) herring contribute. An otolith exchange exercise was initiated in 2002 and is currently being completed.

B.2. Biological

Natural mortality (M) varies with age (expressed in number of winter rings) according to the following:

Rings	M
1	1
2	0.3
3	0.2
4+	0.1

Those values have been held constant from 1972 to date. Those values correspond to estimates for North Sea herring based on recommendations by the Multi-species WG (Anon. 1987a). which were applied to adjacent areas (Anon. 1987b).

Maturity at age. Combined, year-specific maturity ogives were used in the 2003 Assessment (ICES 2003). The way those values were derived is documented on Dickey-Collas *et al.* (2003). Prior to 2003 annually invariant estimates of the proportion of fish mature by age were used. Those were based on estimates from the 1970s (ICES, 1994). The use of the variable maturity ogive in 2003 did not change greatly the perception of the stock state (Dickey-Collas *et al., op cit*).

SSB in September is estimated in the assessment. The survey larvae estimate is used as a relative index of SSB. The proportions of M and F before spawning are held constant over time in the assessment.

Stock weights at age have been derived from the age samples of the 3rd quarter landings since 1984 (R. Nash *pers comm.*). The stock mean weights for 1975-83 are time invariant and were re-examined in 1985 (Anon. 1985). They result from combining Manx and Mourne data sets. The weight at age of those stocks were considered relatively stable over time.

B.3. Surveys

The following surveys provide data for the VIIa(N) assessment:

SURVEY ACRONYM	TYPE	ABUNDANCE DATA	AREA AND MONTH	PERIOD
AC(VIIaN)	Acoustic survey	Numbers at age (1-ring and older); SSB	VIIa(N) from 53^0 20'N – 55^oN; September	1994 – present
NINEL	Larva survey	Production of larvae at 6mm TL	VIIa(N) from 53^o 50'N – 54^o 50'N; November	1993 – present
DBL	Larva survey	Production of larvae at 6mm TL	East coast of Isle of Man; October	1989 – 1999 (1996 missing)
GFS-oct	Groundfish survey	Mean nos. caught per 3 n.miles (1&2 ringers), by region	VIIa(N) from 53^0 20'N – 54^o 50'N (stratified); October	1993 - present
GFS-mar	Groundfish survey	Mean nos. caught per 3 n.miles (1&2 ringers), by region	VIIa(N) from 53^0 20'N – 54^o 50'N (stratified); March	1993 - present

Data from a number of earlier surveys have been documented in the ICES WG reports. These include:

NW Irish Sea young herring surveys (Irish otter trawl survey using commercial trawler; 1980 – 1988)

Douglas Bank (East Isle of Man) larva surveys (ring net surveys; 1974 – 1988) (Port Erin Marine Lab)

Douglas Bank spawning aggregation acoustic surveys (1989, 1990, 1994, 1995) (Port Erin Marine Lab)

Western Irish Sea acoustic survey (July 1991, 1992) (UK(NI))

Eastern Irish Sea acoustic survey (December 1996)

Surveys used in recent assessments are described below.

AC(VIIaN) acoustic survey

This survey uses a stratified design with systematic transects, during the first two weeks of September. Vessel used is the R.V. *Lough Foyle* (UK(NI)). Starting positions are randomized each year (see recent HAWG reports for transect design and survey results). The survey is most intense around the Isle of Man (2 to 4 n.mile transect spacing) where highest densities of adult herring are expected based on previous surveys and fishery data. Transect spacing of 6 to 10 n.miles are used elsewhere. A sphere-calibrated EK-500 38kHz sounder is employed, and data are archived and analysed using Echoview (SonarData, Tasmania). Targets are identified by midwater trawling. Acoustic records are manually partitioned to species by scrutinising the echograms and using trawl compositions where appropriate. ICES-recommended target strengths are used for herring, sprat, mackerel, horse mackerel and gadoids. The survey design and implementation follows, where possible, the guidelines for ICES herring acoustic surveys in the North Sea and West of Scotland. The survey data are analysed in 15-minute elementary distance sampling units (approx. 2.5 n.miles). An estimate of density by age class, and spawning stock biomass, is obtained for each EDSU and a distance-weighted average calculated for each stratum. These are raised by stratum area to give population numbers and SSB by stratum.

NINEL larva survey

The DARD herring larva survey has been carried out in November each year since 1993 . Sampling is carried out on a systematic grid of stations covering the spawning grounds and surrounding regions in the NE and NW Irish Sea (Figure 1). Larvae are sampled using a Gulf-VII high-speed plankton sampler with 280 μm net. Double-oblique tows are made to within 2m of the seabed at each station. Internal and external flow rates, and temperature and salinity profiles, were recorded during each tow. Lengths of all herring larva captured are recorded.

Mean catch-rates (nos.m^{-2}) are calculated over stations to give separate indices of abundance for the NE and NW Irish Sea. Larval production rates (standardised to a larva of 6mm), and birth-date distributions, are computed based on the mean density of larvae by length class. A growth rate of 0.35mm day^{-1} and instantaneous mortality of 0.14 day^{-1} are assumed based on estimates made in 1993 - 1997. More recent studies have indicated a mortality rate of 0.09, and this value is also applied to examine the effect on trends in estimates of larval production

DBL larva survey

Herring larvae were sampled on the east side of the Isle of Man in September or October each year. Double oblique tows with a 60 cm Gulf VII/PRO-NET high-speed plankton sampler with a 40cm aperture nose cone were undertaken on a 5 Nm square grid. The tow profile was followed with a FURUNO net sonde attached to the top of the equipment. The volume of water filtered was calculated from the nose cone mouth flow meter. The samples were preserved in 4% seawater buffered formalin and stored in 70% alcohol.

All herring larvae were sorted from the samples. The numbers of larvae per m^3 were calculated from the volume of water filtered and the number of larvae per tow. Up to 100 larvae from each tow were measured with an ocular graticule in a stereo microscope. Each sample was assigned to a sampling square and the total number of larvae per 0.5mm size class calculated from the average depth of the square and the surface area.

The total production and time of larvae hatch was calculated using an instantaneous mortality coefficient (k) of 0.14 and a growth rate of 0.35 mm d^{-1} in the formula:

$$N_t = N_o e^{-(kt)}$$

Production was calculated as the sum of all size classes/hatching dates. Spawning dates were taken as 10 days prior to the hatching date (Bowers 1952).

GFS-oct and –mar groundfish surveys

The DARD groundfish survey of ICES Division VIIaN are carried out in March and October 2003 at standard stations between 53° 20’N and 54° 45’N (Figure 2). Data from additional stations fished in the St George's Channel since October 2001 have not been used in calculating herring indices of abundance. As in previous surveys, the area was divided into strata according to depth contour and sediment type, with fixed station positions (note that the strata in Fig. 2 differ from those in the September acoustic survey shown in Fig. 1). The sampling gear was a Rockhopper otter trawl fitted with non-rotating rubber discs of approximately 15 cm diameter on the footrope. The trawl fishes with an average headline height of 3.0 m and door spread of 30 - 40 m depending on depth and tide. A 20mm stretched-mesh codend liner was fitted. During March, trawling was carried out at an average speed of 3 knots across the ground, over a standard distance of 3 nautical miles at standard stations and 1 nautical mile in the St. George's Channel. Since 2002, all survey stations in the October survey have been of 1-mile distance. Comparative trawling exercises during the October surveys and during an independent exercise in February 2003 indicate roughly similar catch-rates per mile between 1-mile and 3-mile tows. It is planned to continue with some comparative trawling experiments during future surveys to improve the statistical power of significance tests between the 1-mile and 3-mile tows.

As the surveys are targeted at gadoids, ages were not recorded for herring. The length frequencies in each survey were sliced into length ranges corresponding to 0-ring and 1-ring herring according to the appearance of modes in the overall weighted mean length frequency for each survey. Some imprecision will have resulted because of the overlap in length-at-age distributions of 1-ring and 2-ring herring. The error is considered to be comparatively small for most of the surveys where clear modes are apparent. There was no clear division between 1-ring and 2-ring herring in the March 2003 groundfish survey, and the estimate for 1-ringers may include a significant component of small 2-ringers. The arithmetic mean catch-rate and approximate variance of the mean was computed for each age-class in each survey stratum, and averaged over strata using the areas of the strata as weighting factors.

B.4. Commercial CPUE

Commercial CPUE’s are not used for this stock.

B.5. Other relevant data

C. Historical Stock Development

Model used: ICA
Software used: ICA (Patterson 1998)

Model Options chosen:

- Separable constraint over last 6 years (weighting = 1.0 for each year)
- Reference age = 4
- Constant selection pattern model
- Selectivity on oldest age = 1.0
- First age for calculation of mean F = 2
- Last age for calculation of mean F = 6
- Weighting on 1-rings = 0.1; all other age classes = 1.0
- Weighting for all years = 1.0
- All indices treated as linear
- No S/R relationship fitted
- Lowest and highest feasible F = 0.05 and 2.0
- All survey weights fitted by hand i.e., 1.0 with the 1 ringers in the acoustic survey weighted to 0.1.
- Correlated errors assumed i.e., = 1.0
- No shrinkage applied

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1961-last data year	NA	Yes
Canum	Catch at age in numbers	1961-last data year	1-8+	Yes
Weca	Weight at age in the commercial catch	1961-1971 1972-1983 1984-last data year	1-8+ 1-8+ 1-8+	Yes No Yes
West	Weight at age of the spawning stock at spawning time.	1961-1971 1972-1983 1984-last data year	1-8+ 1-8+ 1-8+	Yes No Yes
Mprop	Proportion of natural mortality before spawning	1961-last data year	NA	No
Fprop	Proportion of fishing mortality before spawning	11961-last data year	NA	No
Matprop	Proportion mature at age	1961-last data year	1-8+	Yes
Natmor	Natural mortality	1961-last data year	1-8+	No

Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	NINEL	1993-2003	SSB
Tuning fleet 2	DBL	1989-1999	SSB
Tuning fleet 3	GFS-octtot	1993-2005	1 & 2
Tuning fleet 4	GFS-martot	1992-2003	1
Tuning fleet 5	ACAGE	1994-2003	1-8+
Tuning fleet 6	AC_VIIa(N)	1994-2003	SSB
Tuning fleet 7	AC_1+	1994-2003	SSB/Total biomass

D. Short-Term Projection

NOT USED IN 2004

Model used: Age structured

Software used: MFDP ver 1a

Initial stock size: Taken from the last year of the assessment. 1-ring recruits taken from a geometric mean for the years 1983 to two years prior to the current year. Where 1-ringers are absurdly estimated in the assessment 2-ringers are estimated as a geometric mean of the previous 10 year period.

Maturity: Mean of the previous three years of the maturity ogive used in the assessment.

F and M before spawning: Set to 0.9 and 0.75 respectively for all years.

Weight at age in the stock: Mean of the previous three years in the assessment.

Weight at age in the catch: Mean of the previous three years in the assessment.

Exploitation pattern: Mean of the previous three years, scaled by the Fbar (2-6) to the level of the last year.

Intermediate year assumptions: TAC constraint.

Stock recruitment model used: None used

Procedures used for splitting projected catches: Not relevant

E. Medium-Term Projections

F. Long-Term Projections

Not done

G. Biological Reference Points

Until there is confidence in the assessment the Working Group decided not to revisit the estimation of $\mathbf{B}_{pa}$ (9,500 t) and $\mathbf{B}_{lim}$ (6,000 t). There were no new points to add to the discussions and deliberations presented in 2000 (ICES 2000/ACFM:10).

H. Other Issues

I. References

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Table 1. Biological sampling of Irish Sea (VIIa(N)) landings. Country denotes sampling nation.

	COVERAGE	% OF LANDINGS SAMPLED	NO OF SAMPLES	TOTAL LANDINGS	LANDINGS BY Q?	IRELAND				NORTHERN IRELAND				ISLE OF MAN				OTHERR UK/UK OFFSHORE				TOTAL			
Year						Landings	Samples	Lengths	Ages	Landings	Samples	Lengths	Ages	Landings	Samples	Lengths	Ages	Landings	Samples	Lengths	Ages	Landings	Samples	Lengths	Ages
1988	(4)					**2579																	0	0	0
1989	(3) temp spread good		88	4962	NO	1430	21	1843	555		45	11464	2249		21	5173	1057		1	96	0	4962	88	18576	3861
1990	p(1,2)	68%	100	6312	YES	1699	44	5176	1022	2322	38	9310	1900	542	18	5276	897	179/1570	0	0	0	6312	100	19762	3819
1991	g	90%	138	4398	YES	80	5	1255	247	3298	105	16724	2484	629	28	8280	1392	0/391	0	0	0	4398	138	26259	4123
1992	g	98%	32	5270	YES	406	3	593	99	4120	16	1588	770	741	13	3488	680	3	0	0	0	5270	32	5669	1549
1993	p (1)	65%	48	4408	YES	0	5	1378	245	3632	34	3744	832	776	9	1560	448	0	0	0	0	4408	48	6682	1525
1994	v.g	95%	59	4828	YES	0	2[1]	569	100	3956	43	3691	1175	716	14	3724	614	156	0	0	0	4828	59	7984	1889
1995	g (1)	87%	85	5076	YES	0	2[1]	569	100	3860	75	8282	2545	615	8	2182	400	601	0	0	0	5076	85	11033	3045
1996	g (1,5)	70%	51	5301	YES	100	1	537	55	4335	45	4813	1050	537	5	997	228	329	0	0	0	5301	51	6347	1333
1997	g (1,2)	91%	34	6649	YES	0	2	473	50	5679	25	2900	1199	765	7	2246	340	205	0	234	76	6649	34	5853	1665
1998	g (2)	84%	31	4904	YES	0	2	150	50	4131	29	2979	1450	0	0	0	0	773[2]	0	0	0	4904	31	3129	1500
1999	g (2)	72%	32	4127	YES	0	4	0	200	2967	28	2518	1400	0	0	0	0	1160[2]	0	0	0	4127	32	2518	1600
2000	v.g	97%	28	2002	YES	0	5	932	0	2002	23	1915	1150	0	0	0	0	0	0	0	0	2002	28	2847	1150
2001	p (2)	70%	31	5461	YES	862	8	1031	222	3786	23	2915	1149	86	0	0	0	727[2]	0	0	0	5461	31	3946	1371
2002	p (1)	62%	9	2392	YES	286	0	0	0	2051	9	949	450	4	0	0	0	51	0	0	0	2392	9	949	450
2003																									

COVERAGE: Sum of the landings (by Q and Nation(UK disaggregated))/total landings. From 1993 (possibly from 1990) to date landings and sampling levels are presented by quarter so coverage is related to this level of detail:

VERY GOOD (v.g) : all landings which individually are >10% of the total were sampled, all Q for which there were landings were sampled

GOOD (g) : landings that constitute the majority of the catch (adding to approx 70% or more of total) were sampled

POOR (p) : some of the large landings not sampled

(1): unsampled quarters

(2): large landings with few samples or unsampled. High level of sampling corresponds to 1 sample per 100t landed (WG rep 1997)

(3): Comment from WG rep. From 1990 going back, Report landings and sampling levels are shown aggregated for the whole year. UK landings lumped in one figure.

(4): no information in the WGrep of level of sampling prior to 1988. Sampling levels believed to be good. Actual figures to be provided by R. Nash, M Armstrong and CEFAS after going back to their labs.

(5): NO samples for NI landings in 4th Q, there is a suspicion that the figures correspond to 'paper landings'.

[1]Samples applied to NI landings: [2]Large unsampled landings.

Table ??: Data and method used to estimate landings from Division VIIa(N) herring.

																Estimates of maximum likely catch for VIIa(N) incl. of French and ROI catches							
Column No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	**16**		**17**		**18**		**19**	
	ICES table							British Isles catches						**CATCH IN ASSESS-MENT**		NE Atlantic catch		ICES 7a catch		% of NE atlantic		max likely catch	
	Ireland	UK	France	Netherlands	USSR / Russia	Unallocated	Total	England	Northern Ireland	Wales	Manx	Irish	Total			France	Ireland	France	Ireland	France	Ireland	France	Ireland
1955								0	0	72	3815		3887	**8056**		60500	4900					3630	539
1956								5	0	20	4762		4787	**8743**		52000	7600					3120	836
1957								21	0	1638	2832		4491	**7966**		36100	11900					2166	1309
1958								31	0	12	2482		2525	**6261**		38800	12800					2328	1408
1959								20	0	96	3577		3693	**7833**		40400	15600					2424	1716
1960								1	0	9	2093		2103	**6607**		36200	21200					2172	2332
1961								32	0	144	1941		2117	**5710**		36600	12700					2196	1397
1962								4	0	21	1528		1552	**4343**		29100	9500					1746	1045
1963								5	0	34	974		1013	**3947**		33500	8400					2010	924
1964								2	0	0	556		558	**3593**		35000	8500					2100	935
1965								1629	0	398	1135		3162	**5923**		26400	10700					1584	1177
1966								2041	0	46	596		2683	**5666**		22400	14900					1344	1639
1967								2911	0	8	1959		4878	**8721**		20600	23700					1236	2607

1968								1504	0	5	3253		4762	**8660**		22800	23000					1368	2530
1969								3591	0	63	5044		8698	**14141**		27100	34700					1626	3817
1970								4662	0	16	9782		14461	**20622**		24400	42700					1464	4697
1971	3131	21861	1815				26807							**26807**		23500	31200	1815	3131	0.08	0.10		
1972	2529	23337	1224	260			27350							**27350**		29900	47800	1224	2529	0.04	0.05		
1973	3614	18587	254	143			22598							**22598**		30800	38900	254	3614	0.01	0.09		
1974	5894	27489	3194	1116	945		38638							**38638**		21199	39608	3194	5894	0.15	0.15		
1975	4790	18244	813	630	26		24503							**24503**		25645	29752	813	4790	0.03	0.16		
1976	3205	16401	651	989			21246							**21246**		20466	22227	651	3205	0.03	0.14		
1977	3331	11498	85	500			15414							**15414**		4164	23436	85	3331	0.02	0.14		
1978	2371	8432	174	98			11075							**11075**		4201	27717	174	2371	0.04	0.09		
1979	1805	10078	455				12338							**12338**		3596	27454	455	1805	0.13	0.07		
1980	1340	9272	1				10613							**10613**		6126	36917	1	1340	0.00	0.04		
1981	283	4094					4377							**4377**		6952	29926			0.00	0.00		
1982	300	3375				1180	4855							**4855**									
1983	860	3025	48				3933							**3933**						0.06	0.11		
1984	1084	2982					4066							**4066**									
1985	1000	4077				4110	9187							**9187**									
1986	1640	4376				1424	7440							**7440**									
1987	1200	3290				1333	5823							**5823**									
1988	2579	7593					10172							**10172**									

1989	1430	3532					4962							**4962**									
1990	1699	4613					6312							**6312**									
1991	80	4318					4398							**4398**									
1992	406	4864					5270							**5270**									
1993	0	4408					4408							**4408**									
1994	0	4828					4828							**4828**									
1995	0	5076					5076							**5076**									
1996	100	5180				22	5302							**5302**									
1997	0	6651					6651							**6651**									
1998	0	4905					4905							**4905**									
1999	0	4127					4127							**4127**									
2000	0	2002					2002							**2002**									
2001	862	4599					5461							**5461**									
2002	286	2107					2393							**2393**									

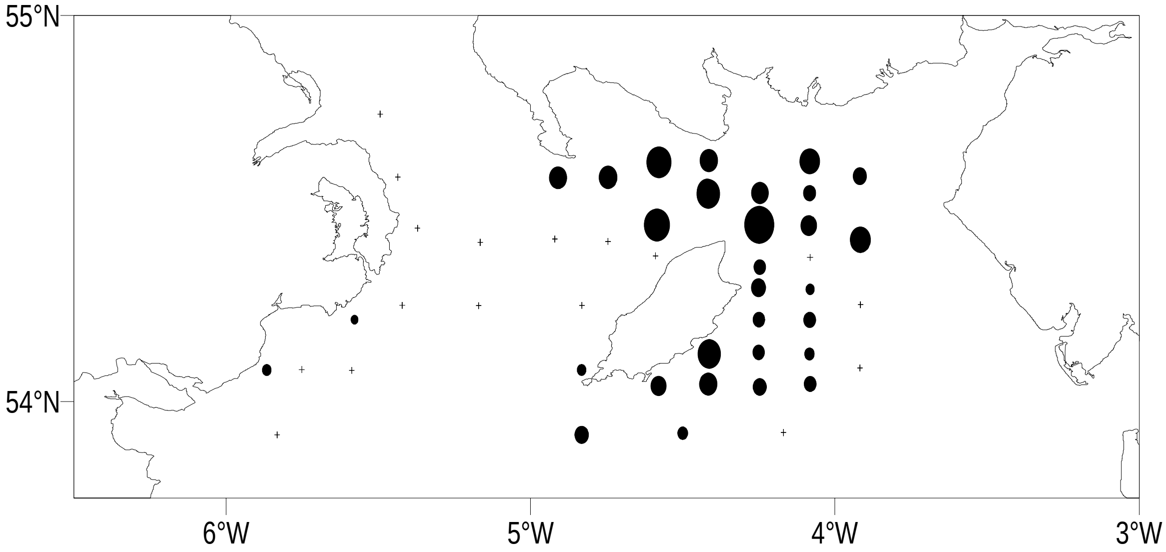
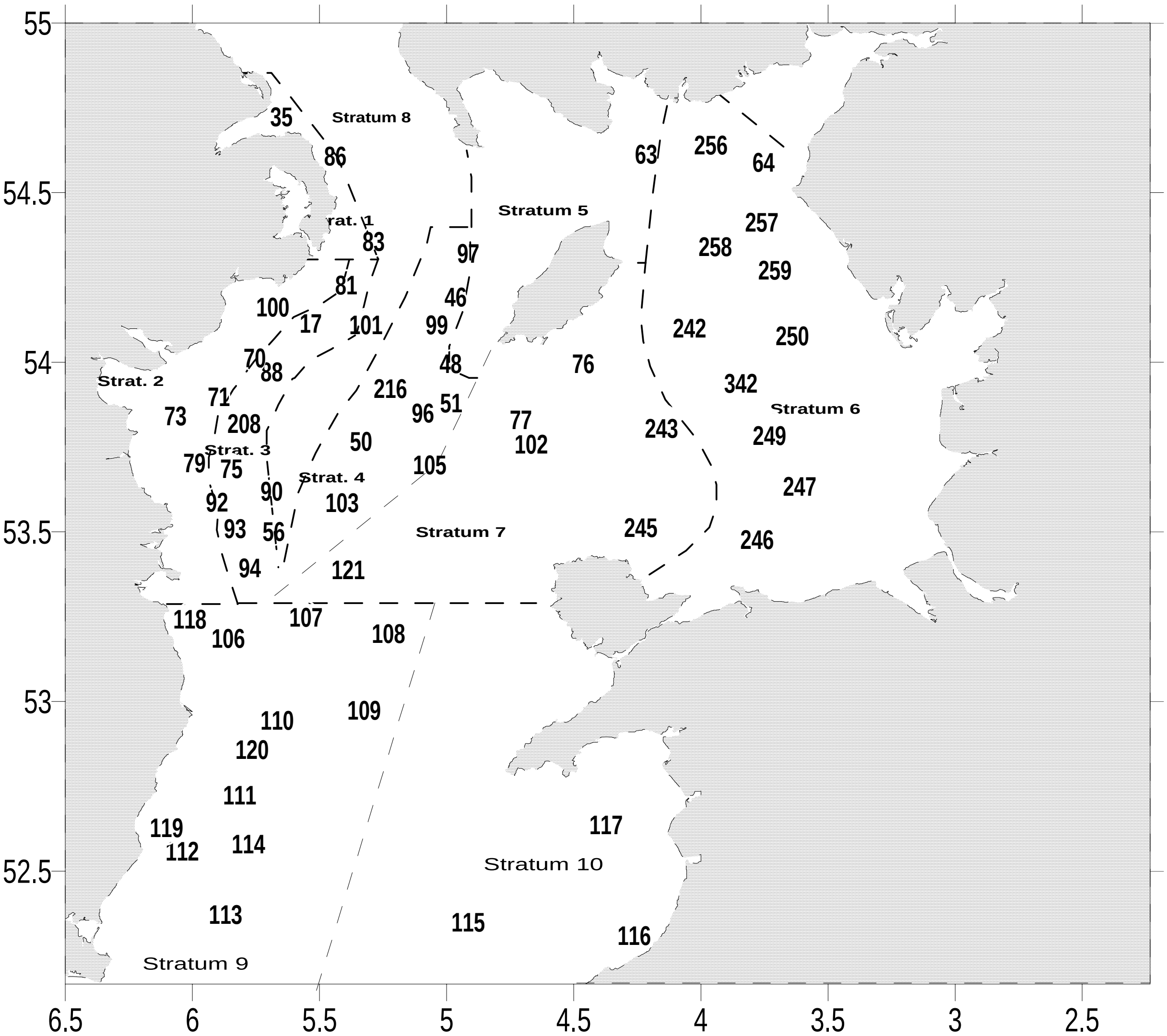


Figure 1. Sampling stations for larvae in the North Irish Sea (NINEL). Sampling is undertaken in November each year.



Key to strata:
1. Irish Coast (N), <100m, Mixed sediments
2. Irish Coast, < 50m, sand and finer sediments
3. Irish Coast, 50 - 100m, Muddy sediments
4. W and SW Isle of Man, 50 - 100m, mud and muddy sand
5. N Isle of Man, <50m, gravel sediments
6. Eastern Irish Sea, <50m, sand and finer sediments
7. S. Isle of Man, <100m, gravel sediments
8. Deep western channel and North Channel >100m
9. St George's Channel west; sandy/mixed sediments; <100m
10. St George's Channel east; sandy/mixed sediments; <100m

Figure 2. Standard station positions for DARD groundfish survey of the Irish Sea in March and October. Boundaries of survey strata are shown. Indices for the "Western Irish Sea" use data from strata 2 - 4. Indices for the "Eastern Irish Sea" use data from stratum 6 only (few juvenile herring are found in stratum 7). (Note different stratification to Fig. 1.). New stations fished in the St Georges Channel (strata 9 and 10) since October 2001 are not included in the survey indices. Stratum 5 (1 station only in recent years) is also excluded from the index. There are no stations in stratum 8 due to difficult trawling conditions for the gear used in the survey. Station 121 in stratum 7 has been fished only once and is excluded from the index.

Quality Handbook ANNEX: Sprat in the North Sea

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Sprat in the North Sea
Working Group (HAWG)	Herring Assessment Working Group
Date:	4TH March 2004

A. General

A.1. Stock definition

Sprat in ICES area IV.

A.2. Fishery

The Danish small meshed fishery is responsible for the majority of the landings. A study undertaken in 2000 showed that the species composition in the Danish sprat fishery has changed towards a fishery with low by-catches of other species (ICES CM 2001/ACFM:12). The Norwegian sprat fishery is carried out by purse- seiners. A closure of the Norwegian fishery was introduced for the second and third quarter in 1999 and this management regime is still in force. On top of this management regime, a maximum quota (900 t) per vessel is set for the Norwegian vessels; and they are not allowed to fish in Norwegian waters until the Norwegian quota in EU waters has been taken. The majority of the catches in both fisheries is taken in the 4th quarter, though some fishery takes place during January and February.

There was a considerable increase in landings from about 10,000 t in 1986 to a peak of 320,000 t in 1995. From 2000 the landings have been relatively stable around 150,000 to 170,000 t.

A.3. Ecosystem aspects

B. Data

B.1. Commercial catch

The commercial catch is provided by the national laboratories belonging to nations exploiting the sprat in the North Sea. The sampling intensity for biological samples, i.e., age and weight-at-age is mainly performed following the EU regulation 1639/2001 as the country landing most of the catches follows this regulation. This provision requires 1 sample per 2000 tonnes landed. This sampling level is lower than the guidelines (1 sample per 1000 tonnes) previously used by the HAWG, but as the fishery is carried out in a limited area, the recommended sampling level can be regarded as adequate.

The majority of commercial catch and sampling data are submitted in the Exchange sheet v. 1.6.4 and further processed with the SALLOCL-application (Patterson 1998). This program gives outputs on sampling status and available biological parameters and documents actions taken to raise unsampled metiers using other data sets. The species co-ordinator allocates samples of catch numbers, mean length and mean weight-at-age to unsampled catches using appropriate samples by gear (fleet) area quarter and if an exact match is not available then a neighbouring area if the fishery extends to this area in the same quarter.

B.2. Biological

Mean weights at age in the catch in the 1st quarter are used as stock weights.

Natural mortality. Results from the multi-species VPA (.Report from the ICES Workshop on Multi-species VPA in the North Sea, Charlottenlund, Denmark 8th-12th April 2002: ICES CM 2002/D:04) are used as a basis to fix the value of M in the CSA model. The estimated values presented in table XX correspond to predation mortality. To estimate total natural mortality a value of 0.2 to account for other sources of natural mortality should be added to the predation mortality.

B.3. Surveys

The acoustic surveys for the North Sea Herring in June-July have estimated sprat abundance since 1996. In the initial years low sprat biomass was estimated but those were not thought to be representative mainly due to inappropriate coverage of the south-eastern area (ICES CM 2000/D:07), the area expected to have the highest abundance of sprat in the North Sea. In 2000 the survey was extended by 30 n.mi to the south and covered for the first time the south-eastern area considered to have the highest abundance of sprat in the North Sea. By doing so, the estimate of sprat increased significantly. The distribution pattern in 2002 demonstrates, however, that the southern distribution border was still not reached by the survey. Further, the inshore areas were sprat is expected to be abundant are not covered so, the survey can only be seen as indicative of trends in biomass.

The IBTS (February) sprat indices (no per hour) in IVb (sprat standard area) are used as an index of abundance. The historical data were revised in 1995 (ICES 1995/Assess:13) and 1999 (ICES 1999/ACFM:12). The IBTS Working Group redefined the sprat index to be calculated as an area weighted mean over means by rectangles for the entire North Sea sprat stock. Based on this, the IBTS WG asked ICES Secretariat to carry out new calculations in 2001 (ICES 2000/D:07), which are the ones used at present. The fishing method (gear) in the IBTS-survey was standardised in 1983 and the data series from 1984, are comparable. The old IBTS-indices are available in ICES 2001/ACFM:12.

B.4. Commercial CPUE

Not used for this stock.

B.5. Other relevant data

C. Historical Stock Development

Model used:

Sprat is a relatively short-lived species, the stock and the catches, consisting mostly of 1 and 2 year-olds. In addition, there are difficulties in age reading resulting in unreliable estimates of numbers at age both from the surveys and the commercial catch. Given those limitations a data exploration using Catch-Survey Analysis (CSA), an assessment method designed for cases where full age-structured data are missing, was undertaken by the WG in 2003. The method is based on the "modified DeLury" two-stage model (Conser 1995) and on an implementation tested on simulated data presented to the Methods Working Group in 2003 (Mesnil 2003). The model assumes that the population consists of two stages: the recruits (preferably a single year-class) and the fully recruited ages.

Software used:
CSA executable version made available by B. Mesnil (IFREMER).

Model Options chosen:

Input data types and characteristics:

Model input data consisting of the time-series of catch numbers for each stage, mean weight for each stage in the stock at the start of the year and the 1st quarter IBTS index of abundance for the 1 year-old sprat (age = number of winter rings) and older than 2 years-old. Given low sampling levels in years previous to 1995, constant weight at age based on commercial data from the 1st quarter was assumed for the whole period. Reservations regarding the ability of the IBTS 1-year-old index to fully reflect strong and weak cohorts for sprat were expressed in previous WG reports (see ICES 1998 ACFM:14). Those were linked to difficulties in age reading and/or a possible prolonged spawning and recruitment season. Another problem identified in some surveys was related to large catches in small areas which could have been very influential on the results. Examination of the biomass and the 1 year-old index trajectories by the WG in 2003, suggested that the observed fluctuations in overall biomass are related to a large extent to observed fluctuations in the 1 year-old index. This is to be expected in a population where the recruits account for a large proportion of the stock. A unique value for the instantaneous rate of natural mortality ($M = 0.4$) and a parameter corresponding to the ratio of the survey catchability of the recruits to the fully recruited ages ($s = 1$) were fixed externally.

D. Short-Term Projection

Model used:

The SHOT- approach (Shepherd, 1991) was used in the past by the WG to estimate the landings in the assessment year. The 2003 WG considered that approach inappropriate for a short-lived stock like sprat therefore the projection was based on the results from CSA.

A catch prediction for the assessment year is based on a linear regression of annual catch versus IBTS estimated biomass for the period starting in 1987.

Software used:

Initial stock size:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Procedures used for splitting projected catches:

E. Medium-Term Projections

Not performed

F. Long-Term Projections

Not performed

G. Biological Reference Points

Not set.

H. Other Issues

Only in-year catch forecasts are available. The stock consists of only a few year classes, with a predominance of 1-year-old fish in the catch.

I. References

Conser, R.J. 1995. A modified DeLury modelling framework for data-limited assessments : bridging the gap between surplus production models and age-structured models. Working document to the ICES Working Group on Methods of Fish Stock Assessment, Copenhagen, February 1995, 85 pp.

Mesnil, B. 2003. Catch-Survey Analysis (CSA): A very promising method for stock assessment, particularly when age data are missing or uncertain. WD at WGMFSA, ICES CM 2003/D:03

Quality Handbook ANNEX:_Sprat VIIde

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Sprat in Division VIId,e

Working Group: Herring Assessment Working Group (HAWG)

Date: 16TH March 2004

A. General

A.1. Stock definition

Sprat in ICES area VIId, VIIe,f.

A.2. Fishery

Vessels from UK (England and Wales) are responsible for the vast majority of the catches. The majority of the catches are taken in the 3rd and 4th quarter.

The landings in this area are very small and have never been above 6,000 t since 1985. Since 2000 the landings have been stable around 1,500 t.

A.3. Ecosystem aspects

B. Data

B.1. Commercial catch

The commercial catch is provided by the national laboratories belonging to nations exploiting the sprat in the Division VIId and VIIe,f. The sampling intensity for biological samples, i.e., age and weight-at-age has not been performed since 1999, but as the fishery is so small, this is not considered to be a problem.

B.2. Biological

B.3. Surveys

There are no surveys targeting sprat in this area.

B.4. Commercial CPUE

Not used for this stock.

B.5. Other relevant data

C. Historical Stock Development

Not performed for this stock.

D. Short-Term Projection

Not performed for this stock.

E. Medium-Term Projections

Not performed

F. Long-Term Projections

Not performed

G. Biological Reference Points

Not set.

H. Other Issues

I. References

Quality Handbook ANNEX: Sprat IIIa

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Sprat in Division IIIa
Working Group:	Herring Assessment Working Group (HAWG)
Date:	16th March 2004

A. General

A.1. Stock definition

Sprat in ICES area IIIa

A.2. Fishery

Fleets from Denmark, Norway and Sweden carry out the sprat fishery in Division IIIa. The Danish sprat fishery consists of trawlers using a 16 mm-mesh size codend and all landings are used for fishmeal and oil production. Some of the sprat landings from Denmark and Sweden are by-catches in the herring fishery using 32 mm mesh-size cod ends. The Swedish fishery is directed at sprat with by-catches of herring but also includes a fishery carried out with small purse seiners at the West Coast of Sweden for human consumption. The Norwegian sprat fishery in Division IIIa is an inshore purse seine fishery for human consumption.

The majority of the landings are made by the Danish fleet. In 1997 a mixed-clupeoid fishery management regime was changed to a new agreement between the EU and Norway that resulted in a TAC for sprat as well as a by-catch ceiling for herring. Catches are taken in all quarters, though with the bulk of catches in the first and fourth quarter. Denmark has a total ban on the sprat fishery in Division IIIa from May to September.

There was a considerable increase in landings from about 10,000 t in 1993 to a peak of 96,000 t in 1994. From 1996 the landings has been stabilising around 20,000 t.

A.3. Ecosystem aspects

B. Data

B.1. Commercial catch

The commercial catch is provided by the national laboratories belonging to nations exploiting the sprat in Division IIIa. The sampling intensity for biological samples, i.e., age and weight-at-age is mainly performed following the EU regulation 1639/2001 as Denmark landing most of the catches follows this regulation. This provision requires 1 sample per 2000 tonnes landed.

The majority of commercial catch and sampling data are submitted in the Exchange sheet v. 1.6.4 and further processed with the SALLOCL-application (Patterson 1998). This program gives outputs on sampling status and available biological parameters and documents actions taken to raise unsampled metiers using other data sets. The species co-ordinator allocates samples of catch numbers, mean length and mean weight-at-age to unsampled catches using appropriate samples by gear (fleet) area quarter and if an exact match is not available then a neighbouring area if the fishery extends to this area in the same quarter.

B.2. Biological

Mean weights-at-age (g) in the catches have been very variable over time, but whether this is due to actual variation in mean weight or difficulties in ageing of sprat is uncertain.

No estimation of natural mortality is made for this stock.

B.3. Surveys

Acoustic estimates of sprat have been available from the ICES co-ordinated Herring Acoustic surveys since 1996. The estimated biomass of sprat has been very variable with low values in the period from 1997 to 2002, but recently the biomass has increased. The majority of the biomass during the acoustic survey is recorded in the Kattegat area.

The IBTS (February) sprat indices (no per hour) in Division IIIa are used as an index of abundance, however, the index has not been considered useful for management of sprat in Division IIIa. The indices are calculated as mean no./hr (CPUE) weighted by area where water depths are between 10 and 150 m (ICES 1995/Assess:13). The indices were revised in 2002 (ICES 2002/ACFM:12) based on an agreement in the IBTS WG in 1999, where it was decided to calculate the sprat index as an area weighted mean over means by rectangles for the IIIa (ICES 1999/D:2). The old time-series of IBTS indices (from 1984-2001) is shown in ICES 2001/ACFM:10.

B.4. Commercial CPUE

Not used for this stock.

B.5. Other relevant data

C. Historical Stock Development

Not performed

D. Short-Term Projection

Not perfomed

E. Medium-Term Projections

Not performed

F. Long-Term Projections

Not performed

G. Biological Reference Points

Not set.

H. Other Issues

I. References

Patterson, K.R. 1998: A programme for calculating total international catch-at-age and weight-at-age. Working Document to Herring Assessment Working Group South of 62_oN. ICES CM 1998/ACFM:14.

Annex 4: Technical Minutes

Review of ICES HAWG Report 2006

(ICES CM 2006/ACFM:20)

May 4, 2006

Reviewers: Gary Shepherd, United States (chair)
Heikki Auvinen, Finland
Olavi Kaljuste, Estonia

Chair HAWG: Mark Dickey-Collas, Netherlands

General

The review of the ICES Herring Assessment Working Group South of 62º N (HAWG) was conducted via correspondence. The Working Group provided a report of the HAWG for 2006 which contained: 1) a benchmark assessment of North Sea herring, update assessments of 2) herring in Division IIIa and Subdivisions 22-24, 3) West of Scotland herring, 4) North Sea sprat, and exploratory assessments of 5) Celtic Sea and Division VIIj herring, 6) herring in Division VIIa (S) and VIIb,c, 7) Irish Sea herring, 8) Sprat in Division IIIa. No new data were available for Clyde herring and English Channel sprat stocks. These two stocks with very low research intensity were poorly described already in previous reports. As result no advice for these stocks were presented. A review of the North Sea Sprat was conducted earlier as a special request to ICES and therefore will not be addressed in these technical minutes.

The reviewers commend the HAWG for providing a very thorough and quality assessment report. Given the volume of information provided in the report, it would be suggested that future reports include supplemental list of tables and figures with the associated page. It may also be helpful to include tables and figures within the text, adjacent to the text reference, for easier use within electronic versions of the document.

Assessment of North Sea autumn spawning herring (benchmark)

In the official catch statistics, all the discards, misreported and unallocated catches of North Sea herring are not reflected. The Working Group instead used the “corrected” data, which in some cases differ significantly from the officially reported catches. The Working Group catch, which includes estimates of discards and misreported or unallocated catches, is assumed to represent removals from the stock.

The national catch data are correctly summed in the catch tables to get international catch. In addition to catch data - IBTS, acoustic and larval survey data are used in North Sea herring assessment. For evaluation of the quality of the survey data an analysis of trends in survey time series has been done. No fishery dependent tuning data is used in North Sea herring assessment. The sampling level of commercial catches is estimated as 95%.

The sensitivity of stock assessment to different model formulations has been explored. It was considered, that the assessment was not sensitive to model setting changes. It gives a very solid basis to present a final assessment. Additionally the residuals in the fitted model were inspected and showed that acoustic survey results were fitting the best with the stock development. Also several retrospective analyses were presented and the ICA model gave good retrospective performance. No consistent biases in spawning stock biomass or fishing mortality were noticed. The sensitivity of parameter estimates to data was evaluated using the analysis of bootstrap datasets.

Although the WG made adjustments to the catch data to account for error in the catch, it does not capture all the uncertainty related to discard levels, area misreporting, under-reporting of catch and stock partitioning within a catch. Future work may look to address the sensitivity of the assessment model results to incorrect catch data. The total catch estimates are likely under- rather than over-estimates, as noted by the WG and this uncertainty is not completely addressed by the bootstrapping approach. A probablisitic assessment approach should be developed which better reflect the uncertainty associated with the input data.

The correlation is poor among cohorts within the IBTS survey but high within the acoustic survey. Yet correlations of cohort strength between the two surveys are reasonably high, which does not seem logical. This should be further explored. Also, the high correlation with the survey and n maybe artificial if n is the result of a model tuned using the same survey indices.

The *Surba* model produces Z estimates but are compared with Fs in the figure 2.6.3.2, which could be misleading. Subtracting an average M (from ICA) might improve the comparison. The mortality correspondence prior to 1997 is quite poor although as noted by the WG, the recruitment and biomass estimates are comparable.

The CSA model assumes equal M for pre- and post-recruits. Consideration should be given to use of age varying M similar to ICA. The model also uses constant q ratio. Is there any evidence that survey changes over that period have affected q? The ratio between the q for pre-recruits compared to acoustic survey biomass was established as 30% using the minimal model sum of square. Does this make biological sense that the larval survey catchability of pre-recruits was 30% of the acoustic survey of 1+ fish? There may be q estimates from other models that could be examined to confirm the 30% ratio. Several mentions were made of increased M in the larval stage for last several years leading to poor recruitment. It might be prudent to examine a possible increase in M at age 1 during those years and examine the sensitivity to this change in final recruitment estimates.

In short term forecast the recruitment has been set as arithmetic mean of recent five (2001-2005) year classes. This is about 50% less than the mean recruitment used in previous years. All the year classes from 2001 onwards have been poor. At the same time in annex 3 (in the quality handbook of North Sea autumn spawning herring) in the short-term projection part, the stock recruitment model is defined as arithmetic average recent 10 years recruitment. The initial stock numbers, fishing mortality and weights at age are taken from ICA final run output and the forecast options have been discussed.

The medium term forecast is fitting with ICA and short-term projection. No alternative plausible stock recruitment models have been explored. The basis for the forecast options has been discussed in the report.

Historical performance of stock assessment has been presented. Comparison with the 2005 assessment and projection shows that the 2006 assessment is in good agreement with last year assessment. Also the historical performance of short-term forecast has been evaluated. The historical performance of recruitment estimates has not been evaluated.

The WG reports on the increasing knowledge of herring in the North Sea ecosystem as well as the influence of environment on herring population dynamics. The use of this information within the stock assessment should be strengthened in future work.

The reviewers agreed that the overall assessment gives a valid basis for advice.

Assessment of western Baltic spring spawning herring in Division IIIa and Subdivisions 22-24 (update)

The national catch data are correctly summed in the catch tables to get international catch. All the data have been used as specified in the stock annex. ICA assessment model has been applied as specified in the stock annex. Partitioning of catch based on samples from different quarters could increase error but there is no major reason to deviate from the standard

procedure for this stock. The final assessment output was used to provide a yield-per-recruit plot. Short-term predictions were carried out using MFDP v.1a software as specified in the stock annex. Historical performance of stock assessment has been presented. Compared to last year's assessment, the change in the estimate is +3% and +8% for the fishing mortalities in 2003 and 2004 respectively; and –3% and -6% for the SSB in 2003 and 2004 respectively.
The reviewers agreed that the overall assessment gives a valid basis for advice.

Assessment of West of Scotland herring (update)

The national catch data are correctly summed in the catch tables to get international catch. All the data have been used as specified in the stock annex. Two assessment runs were carried out in 2006 using ICA assessment model: including the 2005 acoustic survey (run A) and excluding the 2005 acoustic survey (run B) as specified in the stock annex. The Working Group was unable to choose between the two assessment options with confidence. Both assessment outputs were used to provide short-term predictions using MFDP v.1a software as specified in the stock annex.

The reviewers agreed with the WG conclusion that although exploitation appears to be low, the SSB estimate is very uncertain and consequently the basis for catch advice is limited to overall trends in the data.

Assessment of Celtic Sea and Division VIIj herring (exploratory)

The national catch data are correctly summed in the catch tables to get international catch. All the data have been used as specified in the stock annex. ICA assessment model has been applied as specified in the stock annex. The working group continued to conduct exploratory assessments and put no final assessment forward in 2006. No short-term predictions were carried out, although Multi fleet Deterministic Projection (MFDP) model usage is specified in the stock annex.

The reviewers agreed with the WG conclusion that as there is no agreed final assessment, the basis for catch advice is limited to overall trends qualatative assessment results rather than year specific estimates of mortality or biomass.

Assessment of herring in Divisions VIa (South) and VIIb,c (exploratory)

The national catch data are correctly summed in the catch tables to get international catch. All the data have been used as specified in the stock annex. A separable VPA assessment model was used to screen over three terminal fishing mortalities, 0.2, 0.4 and 0.6 as specified in the stock annex. ICA assessment model was also used with the new tuning series, but it was not specified in the stock annex. The acoustic survey produced erratic annual results and may not be particularly useful for absolute abundance but may provide some insight into relative longer term trends

In the absence of an agreed assessment, it was not considered informative to carry out any predictions. Generally as there is no final assessment agreed by the working group, then there is no year specific estimates of mortality or biomass. Therefore the basis for catch advice is limited to trends and qualitative assessment results.

Assessment of Irish Sea herring (exploratory)

The national catch data are correctly summed in the catch tables to get international catch. All the data have been used as specified in the stock annex. ICA assessment model has been applied as specified in the stock annex. The working group continued to conduct exploratory assessments and put no final assessment forward in 2006. In the exploratory assessment the WG may want to consider a geometric mean maturity for previous 9 years rather than an arithmetic mean, in order to prevent influence from the high proportion mature of the 1998 age 1s.

No short-term predictions were included in the 2006 assessment.

The reviewers agreed with the WG conclusion that as there is no agreed final assessment, the basis for catch advice is limited to overall trends qualatative assessment results rather than year specific estimates of mortality or biomass.

Assessment of sprat in Division IIIa (exploratory)

The national catch data are correctly summed in the catch tables to get international catch. All the data have been used as specified in the stock annex. No assessments of the sprat stock in Division IIIa have been presented since 1985 and this year was no exception.

Generally as there was no assessment presented by the working group, then there is also no quantitative basis for advice. Catch advice is limited to evaluation of overall trends in the available data.

Appendix 1: North Sea Sprat review

Review comments regarding North Sea Sprat- April 2006

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11/4/2006

General

The overall impression of the updated assessment is that the working group has done as well as could be expected with the available data. As was noted in the text, there are some major sources of error that should be explored prior to future assessments. The major sources of data are the catch and the IBTS survey.

Fishery data

There was limited background information about the fishery practices, so I will assume that sprat catch equals landings. There was information provided regarding by-catch species in the sprat fisheries, but the level of sprat by-catch in other fisheries appears to be unknown. There appears to be considerable inter-annual variation in 1st Q catch weights at age.

Catch at age information should be provided for the whole time-series instead of from 1996 onwards. Perhaps in separate tables for annual and quarterly data (do we make use of the quarterly data at all?).

Catches of sprat fleet should be given for the whole time series. We make the assertion that the bycatch is much smaller in recent years but we don’t show the years we make the comparison to.

IBTS data

The relative abundance at age from the IBTS survey identifies significant recruitment events, but does not track cohorts well over time. For instance, there are large age-1 indices in 1999 that do not appear as age 2 and there was a modest 2000 age-1 index that resulted in a significant age 2 index. There could be annual catchability issues, variable M, unaccounted F, age error, etc. The point is that since there is only one index that drives the subsequent models, further work should be considered to explore the sources of variability. The IBTS index could yield better fishery independent information, by:

a) splitting on length base into recruits and post recruits rather than relying on uncertain age estimates and

b) a statistical examination of the index to attempt to improve internal consistency and tackle outliers that may cause the year effects.

Could the Q3 IBTS survey be used also as an index for this stock?

CSA

The CSA model fits reasonably well despite the time invariant parameters. The persistent retrospective problem of over-estimating biomass in recent years may be a result of variable s or M. The other issue to consider is possibly the under-estimation of catch. Further simulations with time varying parameters should be explored to analyze the magnitude and direction of the retrospective pattern before the model is used for management decisions.

Advice

The justification for an increase TAC in 2006 is the large 2004 cohort contributing to the catch as age 2. The regression in figure 8.7.2 for predicting catch has a very low r^2 value and I question if it constitutes a significant regression. There are several outliers that should be evaluated to determine the influence of those values in the regression. If the regression is not statistically significant, can it be used to predict catch?