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Report of the Herring Assessment Working Group for the Area South of 62ºN (HAWG)

9–18 March 2004
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International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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EXECUTIVE SUMMARY

The Herring Assessment Working Group (HAWG) met in ICES headquarters from 9 to 18 March 2004. The main terms of reference were to assess the status of and to provide catch options for the North Sea autumn-spawning herring stock in ICES Division IIIa, Sub-area IV and Division VIId, the herring stocks in Division VIa and Subarea VII, the stock of spring-spawning herring in Division IIIa and Subdivisions 22-24 (Western Baltic), and the sprat stocks in Sub-area IV and Divisions IIIa and VIId,e.

The WG reports on the status of all of the stocks (8 herring and 3 sprat stocks). Analytical assessments were only carried out on 4 out of the 11 stocks the WG was requested to examine and of these four analytical assessments of only three of the herring stocks were accepted last year. This year the working group adopted the proposed ACFM methodology of allocating assessments to categories (The Benchmark - Update assessment system). Of the different stocks to be considered by the HAWG, the NSAS-stock was on the Observation list, the WBSS was to have a benchmark assessment and herring in VIa, VIIa, Celtic and sprat update assessments. During the progress of the work, the WG agreed to redefine the assessment of WBSS stock into an update assessment as no new relevant information was available and the assessments on Irish Sea herring, herring in VIaS, VIIb and sprat in the North Sea, as experimental assessments. The other stocks were considered as update assessments. For Irish Sea herring, an additional two-stage biomass model was used to assist exploration of the stock dynamics.

The assessments of the autumn spawners in the North Sea, VIaN and the Western Baltic spring spawners (WBSS), are consistent with those presented last year, resulting in little changes in the perception of the stocks. With regard to the model used for the assessment of all herring stocks, namely ICA, concern has been raised about the instability in the selection patterns at older ages which would affect the stock estimates in the early part of the time series. The WG examined the performance of ICA on North Sea herring and Western Baltic Spring Spawners with another regularly used assessment model, XSA. The two models gave very similar perceptions of the state of the stock and the WG felt that the use of the ICA model is still appropriate. This also maintains consistency with assessments in previous years.

Most of the stocks assessed are considered within safe biological limits. Corresponding catch predictions are provided in options tables for 2005, where possible by fleet.

A number of data revisions have been applied to the assessment input data set for North Sea and WBSS at this year's WG, as total catch and catch-at-age have been updated for the catch years 1995-2002. The catch series for West of Scotland (ViaN) herring were extended back to 1957, with no changes in the perception of the status of the stock compared to the 2003-assessment for the years 1976-2002. There is still a need for better input/sampling data for some stocks, and in other stocks there is a lack of fishery independent data. Though few estimates of discards were available, the amount of discards for most fisheries was regarded as insignificant.

The Stock Annexes of the Quality Control Handbook have been drafted and are attached to the HAWG report. In many cases these are incomplete as there is a large amount of information needed for each and they take a considerable amount of time to compile. For stocks without an accepted assessment, general elements (stock definitions, fisheries and ecosystem aspects) are presented.

For VIaN herring, the inclusion of the longer time-series of catches including a period with higher stock productivity and higher biomass, resulted in the WG reviewing the support for the proposed reference points for that stock. The WG considered that the proposed $B_{\mathbf{lim}}$ of 50,000t and a $B_{\mathbf{pa}}$ of 75,000t are suitable limits and reference points.

The management arrangement for North Sea herring, adopted in 1998 by EU and Norway, was largely based on medium-term simulations made in 1997. Since this is 7 years ago, and the management regime only became effective recently, the WG found it appropriate to reinvestigate the harvest control rules with new simulations. The simulations and the results are presented in the report.

Two formal requests from the EU-Commission to advise on TACs for herring in the Skagerrak/Kattegat-area, were considered by the HAWG

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1 Introduction

1.1 Participants

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John Simmonds	UK/Scotland
Dankert Skagen	Norway
Else Torstensen (Chair)	Norway
Olvin van Keeken	The Netherlands
Christopher Zimmermann	Germany

Contact details for each participant are given in Appendix 1.

1.2 Terms of Reference

The **Herring Assessment Working Group for the Area South of 62°N** [HAWG] (Chair: E. Torstensen, Norway) will meet at ICES Headquarters from 9-18 March 2004 to:

a) assess the status of and provide catch options (by fleet where possible) for 2005 for:

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

   ii) the herring stocks in Division VIa and Subarea VII;

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

b) forecasts for North Sea autumn-spawning herring should be provided by fleet for a range of fishing mortalities that have a high probability of rebuilding or maintaining the stock above 1.3 mill tonnes by spawning time in 2004.

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;

e) provide specific information on possible deficiencies in the 2004 assessments including, at least, any major inadequacies in the data on catches, effort or discards; any major inadequacies in research vessel surveys data, and any major difficulties in model formulation; including inadequacies in available software. The consequences of these deficiencies for both the assessment of the status of the stocks and the projection should be clarified;

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

g) document fully the methods to be applied in subsequent update assessments and list factors that would warrant reconsideration of doing an update, and consider doing a benchmark ahead of schedule, for stocks for which benchmark assessments are done.

HAWG will report by 19 March 2004 for the attention of ACFM.

In addition, HAWG was asked to consider the following requests from the EU Commission:

- to advise whether a TAC of 80 000t for herring in the ICES Division IIIa for 2004 is consistent with the precautionary approach
- to advice on consequences of allowing part of the TAC for herring in the Skagerrak and the Kattegat to be fished in the North Sea.

The group has evaluated relevant information and the requests are dealt with in Sections 1.3.1 and 1.3.2, respectively.

1.3 Working Group's response to ad hoc requests

1.3.1 Mixed stocks in Division IIIa (Response to letter from the EU-commission).

In previous years, the main constraint on the fishery in Division IIIa was the concern for the North Sea autumn spawning herring. This situation has changed since the North Sea autumn spawning herring by now is in a good state. Hence, quotas in Division IIIa, which include both stocks, may have to be constrained by the need to restrict the exploitation of Western Baltic spring spawners (WBSS), which are taken together with North Sea autumn spawners (NSAS) in this area.

The fleets fishing herring in Division IIIa are defined as:

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

The WBSS are exploited by other fleets as well, in Subdivision 22-24. The advise by ICES on WBSS is on total catches for the stock, covering all areas, but including only WBSS herring in these areas. Hence, to compute the catch of NSAS by fleet corresponding to a given total catch option for WBSS, the first step will be to estimate the amount this will correspond to for the C- and D- fleets. Lacking other information, this is based on the historical share of the total catch by these fleets.

The text table below shows the historical share of the total catch in tonnes of WBSS by fleet.

	Fleet C (IIIa)	**Fleet D (IIIa)**	**Subdiv. 22-24**	**Total**
2001	33429 (34%)	3101 (3%)	61832 (63%)	98362
2002	38161 (38%)	8731 (9%)	53647 (53%)	100539
2003	34382 (42%)	5287 (5%)	51931 (53%)	91601
Average	38%	6%	57%	

Next, this share has to be translated to total catch of herring of both stocks (NSAS and WBSS) for each fleet by accounting for the fraction of NSAS in the catches by these fleets. Again, this has to be based on historic experience.

The text table below shows the percent NSAS in the catches by fleet in Division IIIa

	Fleet C	Fleet D
2001	51%	80%
2002	31%	51%
2003	43%	68%
Average	42%	65%

From this, it also follows the amount of NSAS by each fleet corresponding to a certain catch option for the total catch of the WBSS stock. The algorithm can be outlined as follows:

1. Start with a total catch of WBSS
2. Allocate this WBSS catch to fleets based on historical shares to get the WBSS catch by the C- and D- fleets.
3. Translate these fleetwise WBSS catches to catches of both stocks together by the C- and D- fleets, using historical data for the fraction of each stock in the C- and D- fleet catches, and further, derive the corresponding catches of NSAS by these fleets.

The text table below gives some examples (values rounded to the nearest 100 tonnes).

Catch option for WBSS stock	WBSS by C-fleet (38% of TAC)	WBSS by D-fleet (6% of TAC)	**Both stocks by C-fleet** (WBBS/0.58)	**Both stocks by D-fleet** (WBBS/0.35)	**NSAS by C-fleet** (Both *0.42)	NSAS by D-fleet (Both *0.65)
60 000	22 800	3600	39 300	10 300	16 500	6 700
80 000	30 400	4800	52 400	13 700	22 000	8 900
96 000	36 500	5700	62 900	16 500	26 400	10 700

For a TAC on catch of NSAS and total catch by the fleets in Division IIIa to be compatible with the advise for WBSS, the numbers derived as above, based on with the largest advisable catch of WBSS, are upper bounds on the advisable catches of NSAS by the C- and D- fleets.

For 2004, ICES advised that catches for WBSS should not exceed 92 000 tonnes. That translates into a total catch (both stocks) by the C-fleet of 60 000 tonnes. Likewise, it translates into a total catch by the D-fleet of 16000 tonnes. ICES was requested to advise whether a TAC of 80 000 tonnes for Division IIIa for 2004 would be in accordance with the precautionary approach. This TAC, whether it includes by-catches (D-fleet) or not, would lead to a larger catch of WBSS than the upper bound of the ICES advice for that stock, and therefore is considered not to be in accordance with the precautionary approach.

It may also be noted that a variable, but relatively small amount (up to about 8000 tonnes) of WBSS herring is taken in the fishery in Division IVa. This is accounted for in both the assessments on NSAS and WBSS.

1.3.2 Consequence of transfer of quota from C-fleet to A-fleet (Allowance of 50% of TAC for herring in Skagerrak and Kattegat to be fished in the North Sea, Special request from the Euorpean Commission)

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 working group has treated this request as effectively a partial transfer between fleets, but also to some extent a transfer between stocks, since the C-fleet exploits both North Sea autumn spawners (NSAS) and Western Baltic spring spawners (WBSS).

There is no firm basis for predicting the fraction of NSAS in the catches by the C-fleet in future years. It will to some extent depend on the abundance of each stock in the area, which for NSAS is related to the strength of incoming year classes, but also to where and when the fishery is conducted. Hence, the assumption was made that the fraction would be an average over the last 3 years. The text table below shows the percentage of NSAS in the catches in recent years, and the average over the last 3 years.

	Fleet C	Fleet D
2001	51%	80%
2002	31%	51%
2003	43%	68%
Average	42%	65%

Thus, one ton of C-fleet total quota can be assumed to represent 0.42 tonnes of catch of NSAS. A transfer of one ton would then imply that the catch of NSAS by the C-fleet is reduced by this amount, while the catch by the A-fleet is increased by one ton.

For 2004 the agreed TAC for the directed fishery in Division IIIa (C-fleet) is 70 000 tonnes. of which 50% can be taken in the North Sea. This implies a transfer of 35 000 tonnes from the C-fleet to the A-fleet. Assuming that 42% of the catch by the C-fleet is NSAS, a transfer of 35 000 tonnes leads to a reduction in the outtake of NSAS by the C-fleet of approximately 15 000 tonnes, and an increase in the outtake by the A-fleet of 35 000 tonnes.

The situation is complicated by misreporting by areas. In recent years, the HAWG in its calculations has assumed that a substantial part of the catch reported as taken in Division IIIa actually has been taken in Subarea IV. These catches have been allocated to the North Sea stock and accounted under the A-fleet. Thus, the very low partial fishing mortality by the C-fleet represents an estimate, to the best of the Working Groups ability, of the real outtake of NSAS in Division IIIa.

Given this background, there is no obvious way of foreseeing how the agreed transfer will affect current practice. In particular, it is not clear to what extent this will lead to an increase in the real outtake of NSAS in the North Sea, or a real reduction in Division IIIa.

The effect of the transfer on the NSAS stock will be modest in the short-term irrespective of historic fishing practices. Adding 35 000 tonnes of catch to the A-fleet (where the F_{sq} already accounts for the estimated misreporting from Division IIIa), leads to an increase in F2-6 from 0.24 to 0.26, resulting in the SSB in 2004 being reduced by about 1%. The effect of the transfer on the exploitation of WBSS will at the most be a reduction of a similar modest magnitude.

1.4 Reviews of groups or work important for the WG

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

SG Rednose met in Copenhagen in January and March 2003 and on correspondence thereafter to verify and correct data used for the North Sea Autumn Spawner assessment (ICES 2003/ACFM:10). The Study group was expected to deliver a reference data set to HAWG by:

- Resolving discrepancies between official databases and data used by the WG, which could not be attributed to misreported/unallocated landings or discards,
- Applying the revised splitting factors for Div. IIIa catch to the assessment input data for 1991-1998,
- Analysing changes of mean weights and numbers-at-age in the catch showing a significant variability, caused by the current procedure for raising national catch data.

Updated national catch and sampling information was obtained for 1995-2001. This was fed into the system used for reallocating samples by the WG since 1999 (see Section 1.5) and a revised reallocation scheme was applied. The majority of discrepancies in historic catch data information were resolved. The revision of national raising schemes reduced the variability in mean weights-at-age as expected. The removal of all Norwegian catch from Div. IIIa, which is now believed to have been taken in the eastern North Sea, required another revision of the split of catches in IIIa. This became apparent only during the SG meeting immediately prior to the 2003 HAWG. The recalculation was conducted after the 2003 WG and the dataset was available for the 2004 HAWG meeting. All relevant report tables and the HAWG archive have subsequently been updated.

The expected transfer of validated historic data into a new ICES database for catch-at-age data collation and handling was not possible, because no such database was operational at the time of the meeting (and still isn't).

1.4.2 The Planning Group for Herring Surveys [PGHERS]

The PGHERS met in Flødevigen, Norway, on 27–23 January 2004 under the chair of Bram Couperus. Its terms of reference were to:

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

Larvae surveys. The larvae surveys were still being carried out at the time of the planning group. The results were presented to the Herring Assessment Working Group (HAWG, section 2.3.2). The utility of the surveys was examined by the group and in light of historic and recent studies, the survey was found to be vital to the assessment of North Sea herring. The group also reviewed the use of a larvae index for herring in IIIa and 22–24. This index uses a novel technique of larvae production at 30mm length as recruitment index. The process study was strong, but the group suggested closer analysis was required prior to incorporation into the assessment. In the 2004/2005 period, the Netherlands and Germany will undertake 7 larvae surveys in the North Sea from 1 September 2004 to 31 January 2005. The Baltic Sea Fisheries Institute will continue with the larvae survey in the Greifswalder Bodden area in 2004.

North Sea acoustic survey. Six acoustic surveys were carried out during late June and July 2003 covering the North Sea and west of Scotland (section 2.3.1). The provisional total combined estimate of North Sea spawning stock biomass (SSB) was 3.1 million t, an increase from 2.9 million t in 2002. The survey showed high numbers of 2-ring and 4-ring herring (the 2000 and 1998 year classes) confirming last year's expectation that the 2000 year class would be strong. The estimate of Western Baltic spring spawning herring SSB was 106,000 t, a decrease since 2002 (255,000 t).

The west of Scotland SSB estimate was 739,000 t (up from 548,000 t). Six acoustic surveys will be carried out in the North Sea and west of Scotland in 2004 between 28 June and 30 July. Scotia and Tridens will survey an overlapping area to the east of Scotland. Scotia and Johan Hjort will survey an overlapping area to the east of Shetland. Dana, Walther Herwig III and Johan Hjort will survey an overlapping area off north west Denmark. A survey of the western Baltic and southern part of Kattegat, will be carried out by a German research vessel from 29 September to 19 October.

Western Baltic acoustic survey. A joint German-Danish acoustic survey was carried out with R/V Solea from 30 September to 18 October in the Western Baltic. The total number of herring was 5,400 million (down from last years 6,000 million).

Acoustic surveys comparison. A provisional analysis of a spatial overlap of acoustic and trawl catch data was made between FRV Scotia, FRV G.O. Sars and Tridens. Length, age compositions and total abundance estimates were compared. The results for Scotia and Tridens demonstrated agreement, while there were larger differences between Scotia and Sarsen. The group discussed these differences and concluded that differences in timing, sampling strategy and in the interpretation of echograms would be the most likely causes. To solve these problems, it was proposed to conduct both another survey overlap in 2004 (between the Norwegian and two other vessels) and an echogram scrutiny workshop in early 2005.

Methods for acoustic and herring larvae surveys. The manual for herring acoustic surveys in ICES Divisions III, IV, and VIA was reviewed and updated. The new version is 3.2. A completely new manual (version 1.0) has been prepared for the International Herring Larvae Survey. A series of photographs of different herring maturity stages was examined as part of the process to harmonise the herring maturity definitions. It was agreed to make an exchange series of photographs covering the whole spectrum of maturity stages. The status and future of the HERSUR database was discussed. The participants agreed to upload new acoustic data no later than 30 April. During 2004, a meta-database, holding national aggregated data with survey results will be set up by Denmark. This new database will be used to develop further an automated system for delivering output for the combined survey report to the HAWG.

Sprat. Data on sprat were available from RV Walther Herwig III, RV Tridens and RV Dana. The total sprat biomass estimated was 270,000 t in the North Sea (up from 241,000 t in 2001) and 13,000 t in the Kattegat (up from 10,000 t in 2002). The southern summer distribution limit of sprat in the North Sea was still not reached, in spite of the extension of the survey area to 52ºN.

Recommendations of PGHERS 2004.

PGHERS will meet at the Institute for Marine Research Bergen, Norway, from 24 to 28 January 2005 (chair: B. Couperus, The Netherlands) to:

a) combine the 2004 survey data to provide indices of abundance for the population within the area;
b) co-ordinate the timing, area and effort allocation and methodologies for acoustic and larvae surveys for herring and sprat in the North Sea, Division VIa and IIIa and Western Baltic in 2005;
c) review and update the PGHERS manual for acoustic surveys to address standardization of all sampling tools and survey gears;
d) review the results of an exchange exercise on herring maturity staging, and comment on the implications of the conclusions of the sprat age reading exchange and workshop for the acoustic surveys;
e) evaluate the results of the investigations of survey overlaps between vessels in the North Sea acoustic survey;
f) to conduct an echogram scrutiny workshop aiming at further harmonisation of scrutiny procedures.

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

The ICES Planning Group on Commercial Catch, Discards and Biological Sampling [PGCCDBS] met in Palma de Mallorca, 2-5 March to:

a) further regional coordination and co-operation in collecting biological data of landings of fish and shellfish;
b) develop a framework and methodology to ensure spatial / temporal coverage of sampling of biological data from the landings, taking into account the report from the Workshop on sampling and calculation methodology, the report from the Workshop on discard sampling methodology and raising procedures / techniques, the report from the age-reading workshop held in 2003 and from the various otolith exchanges;
c) identify on a regional basis the candidate stocks and species requiring improved ageing;
d) consider data delivered by fisheries' inspectors and how these can be compiled in a consistent way to be used by Assessment Working Groups;
e) compare and standardise protocols for raising national catch and discard data to the international level.

The meeting was attended by 40 participants from 18 countries and representatives from the EU Commission, DG FISH.

ToR a: During the meeting an agreement on establishing regional data collection coordination groups was made.

- Baltic. Originator of the first meeting: Henrik Degel, DIFRES
- North Sea. Originator of the first meeting: Richard Milner, CEFAS
- Western and Southern waters (North east Artic). Originator of the first meeting: Ireland
- Mediterranean. Originator of the first meeting: (not decided yet)

It was also considered whether the North East Artic area should be included in the Western and southern group. No final decision was made concerning this issue.

Some of the tasks of the regional groups are:

- Regional coordination and co-operation in collecting biological data of landings of fish and shellfish
- Report on the main deficiencies in data collection and recommend on how these can be improved.
- Establish bilateral agreements between countries on arrangements of the biological sampling (length and age) of landings by foreign flag vessels.
- Explore the possibilities of (i) task sharing between countries and (ii) setting up joint programmes for the collection of growth, sexual maturity and fecundity data for all analytically assessed fish and shellfish stocks in their region.
- Compare existing manuals for biological sampling to report on inconsistencies and to advice on best practice.

ToR b: Two workshops have been held in the last year. They were the "Discard workshop" and "Workshop on sampling and calculation methodology". The main aim for these workshops was to set up guidelines for data collection concerning discards and port-sampling. The main element can be described as:

- National data collection programmes should be analysed in term of precision of the estimates before going to another step.
- There is no recipe and no simple guideline to estimate the precision for all stocks and all areas.
- Precision should be estimated at a stock level.
- A tool needs to be developed at the international level to produce estimates of precision.

And at the discard workshop it was decided to set up a "Discard Sampling Review Form" and further progress should be:

- The Discard Sampling Review Form should be tested and refined
- The Discard Sampling Review Form should be completed for as many discard sampling programmes as possible
- The information in the Discard Sampling Review Forms should be collated and used to:
    - assess current levels of precision of discard estimates
    - compare alternative raising procedures, particularly the effect of number of trips and total landings
    - identify logistic and methodological problems associated with current sampling strategies
    - explore the effect of alternative stratifications, sampling levels, etc on the precision of discard estimates and the corresponding cost of obtaining them
    - produce guidelines for sampling and raising that might be generally applicable across a wide range of programmes.

It has been recommended that a workshop devoted exclusively to sampling design should be organised in the beginning of 2005 and the terms of reference should be:

a) analyse the results of precision obtained by each country
b) advise on sampling strategies including stratification and sampling effort

ToR c): It has been agreed that the following otolith exchanges and workshops should be conducted in 2004 and 2005:

2004 Age reading workshops:

- Anglerfish Workshop at IPIMAR, Lisbon, Portugal in November 2004.
- Hake Workshop at IEO, Vigo, Spain in Q4 2004.
- Sprat Workshop at IMR, Flødevigen, Norway September 2004 or January 2005.
- Megrim Workshop at AZTI, Sukarrieta, Spain, date not decided.

2004 and 2005 otolith exchange programmes:

- Roundnose Grenadier (France)
- Sandeel (Denmark)
- Anchovy (Spain)
- Blue whiting (Denmark)
- Saithe (France)
- Turbot and brill (Netherlands)
- Sardine (Portugal)
- Redfishes (Spain)
- Sole (England)
- Horse mackerel (Netherlands)

2005 Age reading workshops:

- Herring Workshop in Finland
- Whiting Workshop in England
- Blue whiting Workshop in Denmark
- Sardine Workshop in Cassablanca

ToR d): The group was informed on the data collection and inspection made by the EU Commission fishing inspectors. Since the recovery plans for cod and southern hake have been implemented in 2004 a more intensive data collection will be carried out. The EU Commission has for the present year planned a random sampling of 100 landings. Inspectors will collect logbook pages from the same vessels fishing with the same gear in the same area and season and will then compare the differences in the landing patterns of inspected and non-inspected trips. These data are not considered relevant to the ICES, HAWG.

ToR e): The current raising procedures used in the different countries were presented at the PGCCDBS meeting and they may be summarized by two different approaches:

a. Directly raising procedure, which means direct raising from sample to estimation in numbers.
b. Raising to total numbers by application of length and age/length keys.

It was agreed that attempts to standardise raising procedures should be made.

Recommendations for the PGCCDBS in 2005.

PGCCDBS will meet in Belgium or in Greece in the beginning of March 2005 (nominated chair: G. Eltink, The Netherlands) to:

a) review the reports from the Regional Planning Groups and address common issues and propose further actions to be taken;
b) b) propose sampling methodology for fleet/fishery based data collection;
c) review existing information and propose sampling strategies for recreational fisheries;
d) review national descriptions of small scale fleets by country and evaluate the strategies used by different countries to obtain basic information for management purposes;
e) review the report of the WKSCMFD;
f) review the possibilities of using shared ALKs;
g) review the progress of the common regional sampling manuals;
h) review the reports from the age-reading exchanges and workshops and identify on a regional basis the candidate stocks and species requiring improved ageing;

1.4.4 Methods WG

The HAWG discussed the draft report of the Methods WG, which met in February 2004. The Methods WG considered 3 main items: Management strategies, performance of several methods on artificial data and generation of artificial data. On management strategies, the HAWG noted the recent development towards harvest control rules, as elements of well tested management strategies, to substitute the current framework of reference points, and recognised that future reference points may be defined primarily as parameters in Harvest Control Rules (HCRs).

Methods WG listed some stocks where development of HCRs could be started already this year, without awaiting further model development to handle e.g. mixed fisheries interactions. This included several stocks covered by the HAWG. In the subsequent meeting of the SGLTA, it was decided to restrict such work to a re-evaluation of the existing HCR for North Sea herring, in order not to increase the work-load of the HAWG.

The other items covered by Methods WG were found useful, in particular, experience with diagnostics, but were not considered to have implications for which tasks the HAWG will have to cover.

1.4.5 EU-Projects: HERGEN and WESTHER

HERGEN: Conservation of diversity in an exploited species: spatio-temporal variation in the genetics of herring (*Clupea harengus*) in the North Sea and adjacent areas. QLRT-2000-01370. (2002-2004).

HERGEN's overall goal is to provide guidelines for the conservation and management of biodiversity of Atlantic herring in the North Sea and adjoining waters by identifying its genetic population structure, and by quantifying relative stock contributions to the fishery. The project incorporates both morphological, otolith and genetic information from 40 sampling sites and has four major scientific objectives:

1. **Estimation of genetic differentiation among spawning aggregations**. The outcome will enable identification of spatial genetic structure of Atlantic herring in the West of Scotland, North Sea, Kattegat, Skagerrak and Western Baltic. The results obtained are preliminary, but indicate significant genetic substructure, most notably among samples from Subdivision 22-24 and samples from Skagerrak/Kattegat and the North Sea. This corresponds with the possible existence of a hybrid zone in the western Baltic, as is also found in other marine fishes in the same areas (e.g. Turbot: Nielsen *et al.* (2004) *Molecular Ecology*, 13, 585-595; Atlantic cod: Nielsen et al. (2003) *Molecular Ecology*, 12, 1497-1508). Spawning aggregations in the North Sea generally show low levels of genetic differentiation.
2. **Determination of temporal stability of population differentiation, based on three types of genetic markers (microsatellites, allozymes, mtDNA)**. This provides estimates of the temporal variation in genetic structure both on short-term (based on samples from 2002 and 2003) and over 20 years (based on 2002/2003 samples and samples taken in the 1980s). This part of the project is still ongoing.
3. **Determination of composition of mixed feeding aggregations using genetic Mixed Stock Analysis.** The objective is to quantify the proportions of fish from the various regional spawning components that contribute to mixed aggregations found on common feeding grounds in areas targeted by major fisheries in the North Sea and the Skagerrak/ Kattegat. Microsatellite, allozyme, mtDNA and otolith microstructure data are used separately as well as combined. Preliminary results based on three mixed-stock samples from Skagerrak July 2002 indicate mixing of individuals originating from the three regions North Sea, Skagerrak and Western Baltic (Rügen), with pronounced variation in the contribution of different age components from each of the three regions. Point estimates indicated that 3-ringer fish mainly originated from the Western Baltic (Rügen), 2-ringer fish originated from all three regions, whereas 1-ringer fish mainly originated from the North Sea. The analyses also showed that hatching month estimated from otoliths corresponded well with genetic grouping, such that fish hatched in September and December generally grouped to the North Sea, whereas fish hatched in April grouped to Rügen and to some extent Skagerrak.
4. **Determination of temporal (seasonal and annual) variability in contributions to mixed aggregations**. The objective is to examine seasonal and annual variation in stock contributions to mixed fisheries by comparing contribution estimates from repeat samples in respectively, the North Sea and Skagerrak/Kattegat. These analyses are ongoing.

Based on the result obtained the most appropriate management units and data collection requirements to monitor selected populations will be explored, taking into account genetic diversity and practical management issues. The information will be disseminated as annual and final reports to the EU, as scientific papers at conferences and in peer-reviewed journals and as contributions to ICES annual meetings and working groups (HAWG).

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

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. Three meetings were organised during the course of the year. There were two plenary meeting, both held in Aberdeen, Scotland, the first in January, the second in December. All partners were present at these meeting. The first meeting was a workshop and co-ordination meeting to provide an organisation plan for the project (specifically the first year), to discuss the structure of the project and to determine working arrangements within and among all partners. At the December meeting progress during the first year, procedures and protocols for revision and the second year's sampling were discussed. The third meeting was between partners 1 and 6, to standardise techniques for workpackage 03, parasites as biological tags, and train the new scientists in the techniques.

Two of the major deliverables in the workpackage "Parasites as biological tags" were to produce a list of indicator parasite species that could be used for herring stock discrimination, and to try to isolate genetic markers from selected indicator parasite species to aid in the study of parasites as biological tags. Already in the first year we can report differences in the parasite fauna between herring stocks, indicating their potential for use as biotags in these populations and, in addition, a parasite species new to herring. We also report on the isolation of novel genetic markers from *Ani-*

sakis and two digenean parasites. The isolation of these new markers will allow a more exhaustive study of these candidate indicator species to be carried out, revealing morphologically cryptic species if present, and allowing differences in populations of the same species to be identified, thus increasing the discriminatory value of these parasites as biotags, beyond the species level.

The genetics work in 2003 concentrated on developing a suite of microsatellite markers that will be used to screen all the samples. Currently we have a panel of 16 candidate markers that will be further developed early in 2004 and used as the standard markers against which all herring will be compared. Our initial aim was to have 12-15 markers. Contamination of the tissue of spawning individuals with eggs and milt seemed to be a problem initially. However, this is no longer deemed to be an issue and screening is proceeding according to plan now.

The second major push to acquire samples is already underway, with two 2004 samples already collected and three more samples due in the first three months. The genetics group will continue to refine their methods to limit contamination problems and will meet, in the second half of 2004, for an inter-calibration meeting.

1.4.6 New projects on Downs herring

Members of the Working Group from various Institutes have developed an informal agreement to carry out research into Downs herring. This has been instigated to move the management of the separate quota for Downs herring within the North Sea herring TAC to a more scientific basis. The proposed informal programme takes two main approaches to address the trends in the population; firstly a re-analysis of the larvae surveys of the English Channel and southern North Sea and secondly an investigation of the proportion of winter spawners in the summer catches from the North Sea (the spawning-origin of herring).

The analysis of the larvae surveys is being carried out in the Netherlands and Germany and will apply current methods for determining annually variable larval growth to estimate mortality and hence total larval production. This will hopefully provide a robust estimate of trends in SSB in the English Channel and southern North Sea. The investigation of the spawning-origin of summer catches will use methods developed at DIFRES (in otolith micro-increments) and within HERGEN and apply them to the landings from the feeding aggregations in the North Sea. This should allow the total catch of Downs herring to be estimated. Both these studies are preliminary in nature and will be used in conjunction with the IBTS data on small herring (the <13cm index) and the ongoing and improved MIK series in the southern North Sea (see section 2.11). Discussions between CEFAS and RIVO are already ongoing on the development of management tools that will incorporate these additional data.

It is hoped that within two years, it will be possible to describe an approach to improve the scientific advice on the dynamics of Downs herring and thus underpin with science the advice on the management of the separate quota for Downs herring.

1.4.7 Study Group on Herring in the Irish and Celtic Seas (SGHICS)

A small national level study group (participants from Northern Ireland, Republic of Ireland, England & Wales and the Isle of Man) was convened in Galway (Ireland) on the 15-17th October 2003 to consider aspects of the Irish and Celtic Seas herring stocks. The original terms of reference for this study group were relatively broad, however, it was agreed at the meeting that the group would only consider; 1. Examining the catch-at-age matrix for both stocks and 2. Work on the Quality Handbook for Irish Sea herring.

In regard to the Irish Sea, the number of samples taken and the methods used to combine catches and estimate the catch-at-age matrix were described and documented in the Quality handbook. The study group also compiled a table stating the location and number of samples used for raising catches and the sources of biological information for the stock for the period 1989 – 2002. Time constraints prevented the group from taking the table back to 1961.

In regard to the Celtic Sea, catch data from the working groups between 1969 and 2003 was reviewed. For each year the catch was recorded so that errors and updates could be tracked and documented. Catch data for this stock was recorded in two series by year (January to December) from 1951 to 2003 and by fishing season (March to February) from 1974 to 2003. For the annual (Jan to December) catch data the source of the final updates are given in text table below:

Catch data for the Celtic Sea and VIIj; sources of information.

Dates catch data finalised	Year presented	Source of information	Data set
1951-1960	1969 WG	Bulletin Statistique	1951-1960
1961-1968	1973 WG	WG estimates	1961-1972
1973-1976	1983 WG	WG estimates including VIIj	1973-1982
1983-1989	1990 WG	WG estimates adjusted upwards by 20% of Irish catches in VIIg for discards From 1983 to 1989	1977-1989
Temporarily adjusted	1991 WG	WG estimates adjust Irish catches upwards based on roe yield	1977-1990
1983-1991	1992 WG	WG estimates adjusted back to 1990 WG values but inconsistently rounded	1977-1991
1992-2002	2003 WG	Most recent WG estimates update to dataset. Catch data after 1997 does not include any discard estimates. Discard estimates from 1990 to 1997 are less than 20%	1988-2002

An examination of past HAWG Reports and the 2003 WG Report (ICES 2003: ACFM 17) indicated that some of the catch data in the tables are incorrect. The totals in the tables do not precisely agree with the data used in the assessment. This is mostly due to rounding error (the nearest 100 t) and in other cases typographical errors. The definitive landings data are to be found in the CATON (catch in tonnes) files, currently used for assessment.

1.5 Commercial catch data collation, sampling, terminology and data requirements

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 2003 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, 1998b). 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, see Section 1.4.1), choosing the same (subjective) decisions made today. Ideally, all data for the various areas should be provided on the standard spreadsheet and processed similarly, resulting in a single output file for all stocks covered by this working group.

More information on data handling transparency, data archiving and the current methods compiling fisheries assessment data are given in the stock annex 2. 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. This year, North Sea data was updated from 1995 onwards with information gathered by SG Rednose (see Sec. 1.4.1), and VIaN data was added for the period 1957-1975. Table 1.5.1 gives an overview over data available at present, and the source of the data. Members are encouraged to use the latest-version input spreadsheets if it is needed to re-enter catch data. Figure 1.5.1 shows the separation of areas as used for the long-term storage of data.

Future developments. In this section of the report, the WG has stated since 1999 that the handling of catch data is considered as a priority issue for quality control. 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. In 2000 ICES indicated that the development of such a database would start in the near future, and HAWG offered support wherever needed.

To facilitate the development, Norway generously provided funding to ICES in 2002, and it was expected that such a database would be operational for all WGs in 2004. The working group last year expressed its satisfaction about this progress. This year, however, it has become apparent that there has been little significant progress. After four years of promises, the WG is more than discontent with the obvious lack of attention that is paid to this issue by ICES. Also, recommendations for the adaptation of assessment software to operating systems currently in use, for interim solutions and to ease access to relevant software and documentation have been constantly ignored. *The WG feels that its advice has been as good as useless and its time on these discussions wasted.*

If a database application is ever developed, it should be usable by all working groups, and any future format should provide an opportunity to clearly track changes of official landings made by WG members to compensate misreported or unallocated landings or discards. Further, a transparent and effective handling of sampling information obtained from market sampling in foreign ports should be possible. Reference is made here again to a number of documents addressing this issue (e.g. Pastoors, 1999 WD to HAWG; Zimmermann *et al*. 2000 WD to WGMHSA, EMAS Project report 2001).

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).

Given the diversity of the fleets harvesting most stocks assessed by HAWG, an appropriate spread of sampling effort over the different fisheries/métiers is important to the quality ensure the estimates of catch-at-age data The EU data directive (Commission Regulation 1639/2001) appears not ensure this. The WG therefore recommends that all fisheries/métiers with substantial catch should be sampled (including by-catches in the industrial fisheries) and 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 her have also been addressed by the Planning Group on Commercial Catch, Discard and Biological Sampling (see Section 1.4.3.).

1.5.3 Data requirements

As described in section 1.4.3 the PGCCBDS has agreed to establish regional fisheries data collection coordination and co-operation groups. Furthermore, as the advice on exploitation of the marine fish and shell- fish stocks gradually changes from single-species advice to multi fisheries advice, it is necessary to have data by fishery/metier. As a first step the HAWG has defined the fisheries that exploit the herring stocks which are assessed by the WG. The fishery definition is given in Table 1.5.2.

The regional fisheries data collection coordination and co-operation groups as well as the national laboratories are recommended to take the WG suggestion for fishery definition into account when setting up sampling schemes for 2005.

It should be noticed that this fishery/metier definition is on a lower level of aggregation than prescribed in the EU data directive. In order to be able to give multi fisheries advice it is necessary to harmonize the data directive accordingly.

1.5.4 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 2.

1.6 Stock overview

In this WG, a total of 8 herring stocks and 3 sprat stocks are considered. Analytical assessments could be carried out for the 4 largest of these 11 stocks. Results of the assessments are presented in the subsequent sections of the report and are summarized below and in Figures 1.6.1 - 1.6.3.

North Sea autumn spawning herring is the largest stock assessed by this WG. It has experienced very low spawning stock biomass levels in the late 1970s when the fishery was closed for a number of years. In the mid-1990s, the stock again appeared to decrease rapidly after which corrective measures were taken. The stock has expanded again due to the combination of strong recruitments and relatively low fishing mortality on both juvenile and adult herring. Projections indicate a further rise in 2004 followed by a reduction in 2005 due to small incoming year classes. The North Sea Herring stock is well within precautionary limits and harvested sustainably.

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 Subdivisions 22, 23 and 24. In Division IIIa, they mix with North Sea Autumn Spawners. The WBSS herring stock is slowly recovering from the historic low SSB level in 1998. Yield and fishing mortality on the adults are considered to have been reduced in the last years. However, fishing mortality on adults still appears to be high as compared to other herring stocks in European waters.

Celtic Sea herring: The herring fisheries to the south of Ireland in the Celtic Sea and in Division VIIj have been considered to exploit the same stock. For the purpose of stock assessment and management, these areas have been combined since 1982. The fishery in the eastern part of the Celtic Sea was closed in the early eighties due to poor recruitment. Stock assessments have become unstable in the recent past due to fluctuations in recruitment, for which there is no independent measure. F has reduced sharply since 2000; currently SSB cannot be precisely estimated.

West of Scotland herring is one of the medium-sized stocks covered by the WG. It is currently lightly exploited and with two recent good year classes the stock is at a relatively high level 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. Instability in the assessment has reduced considerably and the assessment shows a relatively stable SSB and a low F over the last 3 years.

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

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

North Sea Sprat is the only sprat stock on which an assessment is carried out within this WG. The recruits account for a large proportion of the stock, and the fishery in a given year is very dependent on that year’s incoming year class. The size of the stock has been variable with a large biomass in the early 90’s followed by a sharp decline in biomass. The sprat stock now shows signs of being in good condition with an increasing biomass.

The main assessment tools used by this WG is ICA (Patterson, 1998, Needle 2000) which is a separable model over a recent number of years and a conventional VPA over the earlier part of the time-series. This model appears to behave well on the stocks considered by this WG. However, for some stocks additional methods need to be used, e.g. for herring caught in Divisions VIaS and VIIbc where no reliable tuning data are available. For North Sea sprat ageing is considered to be problematic. ACFM in May 2003 has accepted the assessment of North Sea autumn-spawning herring, West of Scotland herring and Baltic spring-spawning herring as full analytical assessments. The other assessments were only considered to be indicative of stock trends.

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

1.7 Biological reference points

Reference points for herring and sprat stocks south of 62°N were taken from the ACFM Report, May 2000, and updated by the HAWGR2002. They are summarised in the text table below. The limit reference points for herring West of Scotland (VIa North) was suggested by HAWG 2002.

STOCK	LIMIT	PRECAUTIONARY
North Sea autumn spawning herring	$\mathbf{B}_{lim}$ is 800 000 t. Technical basis: Below this value impaired recruitment has been experienced. $\mathbf{F}_{lim}$ is not defined.	$\mathbf{B}_{pa}$ = 1.3 mill t. Technical basis: Part of a harvest control rule based on simulations. $\mathbf{F}_{pa}$ be set at $F_{ages\ 0\text{-}1} = 0.12$; at $F_{ages\ 2\text{-}6} = 0.25$. Technical basis: Part of a harvest control rule based on simulations.
Western Baltic spring spawning herring	Not specified	
Celtic Sea	$\mathbf{B}_{lim}$ is 26 000 t. Technical basis: The lowest stock observed. $\mathbf{F}_{lim}$ is not defined	$\mathbf{B}_{pa}$ be set at 44 000 t. Technical basis: Reduced probability of low recruitment.
West of Scotland	$\mathbf{B}_{lim}$ **proposed** = 50 000 t Technical basis: $\mathbf{B}_{loss}$ $\mathbf{F}_{lim}$ is not defined	$\mathbf{B}_{pa}$ **proposed** = 75 000 t $\mathbf{F}_{pa}$ is not defined
Div. VIaS & VIIb,c	$\mathbf{B}_{lim}$ is 81 000 t. Technical basis: Lowest reliably estimated SSB. $\mathbf{F}_{lim}$ is 0.33	$\mathbf{B}_{pa}$ be set at 110 000 t. Technical basis: Approximately 1.4 $\mathbf{B}_{lim.}$ $\mathbf{F}_{pa}$ be set at 0.22
Irish Sea	$\mathbf{B}_{lim}$ is 6 000 t. Technical basis: Lowest observed SSB. $\mathbf{F}_{lim}$ is not defined	$\mathbf{B}_{pa}$ = 9 500 t. Technical basis: $\mathbf{B}_{lim}$* 1.58; still under consideration. $\mathbf{F}_{pa}$ under review; 0.36 proposed in 1999, not adopted.
Sprat North Sea	Not specified	Not specified
Sprat in div VIId,e	Not specified	Not specified
Sprat in div IIIa	Not specified	Not specified

1.8 Working Documents provided

ICES coordinated acoustic survey of ICES divisions IIIa, IVa, IVb and VIa (North) 2003 results (E. J. Simmonds, C. Zimmermann, E. Götze, S. Jansen, E. Torstensen, B. Lundgren, D. G. Reid, S. Ybema and A. S. Couperus)

Six surveys were 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 was bounded by the Norwegian and Danish, Swedish and German coastline and to the west by the shelf edge between 200 and 400 m depth. 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 estimates of North Sea autumn spawning herring are consistent with previous years at 3.1 million tonnes and 18,400 million herring. The survey also shows two exceptional year classes of herring (the 1998 and 2000 year classes) in the North Sea, which is consistent with the observation of exceptionally large year classes observed in the MIK and IBTS surveys. The estimates of Western Baltic spring spawning herring SSB are 106,000 tonnes and 823,000 herring and show a substantial decrease compared with the previous year. The West of Scotland survey estimates of 739,000 tonnes and 4,000 million herring shows the high 1995-year class again this year. The 1998-year class (4 ring) is now confirmed being a large one. Indications are found that the 2000- year class is also good. Total adult mortality shows low mortality again (0.1) but the mean mortality over the last 4 years has been around 0.3. This is consistent with the 2003 assessment that the stock is lightly exploited.

Report of the herring larvae surveys in the North Sea in 2003/2004 (N. Rohlf & J. Gröger)

The WD describes spatial and temporal coverage of the larvae surveys and the distribution and abundance of larvae in the areas sampled. Larval Abundance Index (LAI) for separate areas and Multiple Larval Abundance Index (MLAI) for the whole North Sea are shown for the period since 1972. Both the LAI per area as well as the MLAI indicate that the SSB has increase substantially when compared to last years WG estimate.

Herring Spawning Ground in the Eastern English Channel (C. Mills, P.D. Eastwood & S.I. Rogers)

The report of ACME 2003/14/1 confirmed that the eastern English Channel is a well known spawning site for the Downs herring stock, and non-spawning herring also feed in the area. It also showed that high densities of herring larvae and substantial herring catches coincided with the area proposed for gravel extraction in ICES rectangle 29F0. There is some concern that removal of gravel, resulting in a sandier seabed, will reduce the quality of the structural habitat for herring spawning, and that such changes are likely to be permanent.

In order to provide more detailed information on individual licence sites, abundance data for herring larvae in the eastern Channel and southern North Sea were reanalysed in GIS, and superimposed on licence boundaries. The attached report describes the methodology used, and shows the extent of overlap between possible aggregate extraction and herring larvae.

German Herring Fisheries & Stock assessment data in the Western Baltic in 2003 (T.Gröhsler)

The WD gives a description of the German fishery, fishing fleet, landings (tons) and sampling effort in 2003 for fleets targeting herring in the Baltic Sea. Assessment input data for 2003 is provided as catch in numbers and mean weight in the catch, they are further presented split by fishing fleet, quarter and subdivision.

Updated Information on Maturity Ogives for Western Baltic Herring (T. Gröhsler & H. Müller)

The maturity ogives of the Western Baltic herring stock, which is distributed in ICES Division IIIa and Subdivisions 22 – 24, have so far been used as constant over time. A mean maturity-at-age was applied at least since 1991 starting at the age of 1 and reaching 100 % at the age of 5. The basis for using these values could not be verified by reviewing the recent corresponding working group reports.

The aim of this working document is to provide the HAWG with an accurate set of estimated maturity ogives for recent years, which are based on German bottom trawl survey and commercial fishery in Subdivision 24 in the years 1996 till 2000 & 2002 & 2003. The first results on maturity ogives were already presented as a WD during the 2002 meeting of HAWG.

Relation between the spawning stock biomass of the western Baltic herring (ICES SD 22-24 and DIV. IIIa) and estimates of the larvae surveys in the main spawning area (B. Klenz & R. Oeberst)

Series of larvae surveys are carried out in the Greifswalder Bodden, the main spawning area of the spring spawning herring in the western Baltic Sea, for estimating the size of the year class of this herring stock, N30, yearly. The relation between N30 and other estimates of the year class was studied by Oeberst and Klenz (2003).

The aim of this study was to estimate the number of hatched larvae using the results of the larvae surveys and to check whether this index is correlated with estimates of the spawning stock. The studies have shown that the indices based on the larvae surveys cannot be used for assessing the spawning stock due to the variable mortality of spawned eggs.

Herring acoustic Survey in the Celtic Sea and ICES Division VIIj, g & VIIaS (C. O'Donnell)

The WD describes the 2003 Celtic Sea herring acoustic survey. This was conducted on a commercial vessel using an EK60 echosounder and towed body-mounted transducer. The survey track started at the northern boundary of VIIj and extended to the southeast coast of Ireland in VIIaS. The biomass obtained was considerably higher than in the previous season. The very high proportion of the mature fish observed, and the fact that the traces were inshore puts reasonable confidence in the estimate of abundance obtained. The presence of older fish in the abundance estimate agrees well with the predominance of pre-spawning fish, as it is the older fish that are usually first to migrate inshore to spawn. This may suggest that the younger fish had yet to migrate inshore. Therefore the entire stock may not have been contained in the survey area. The large aggregations observed in Waterford Harbour and near Dunmore East contributed about 50% to the abundance and biomass estimate. The closure of this area in recent years has obviously been an important factor in replenishing the stock.

Survey indices of abundance for herring in the Irish Sea (Area VIIaN): 1992 – 2003 (M. Armstrong, W.Clarke, J. Peel, M. McAliskey, W. McCurdy, P. McCorriston, R. Briggs, P-J. Schön, S. Bloomfield, M. Allen and P.Toland)

The WD describes results of acoustic, groundfish and larva surveys undertaken in the northern Irish Sea between 1992 and 2003 to provide abundance indices for herring. Updated survey time-series are shown including spawning stock biomass estimate and larval abundance and production estimates. Annual trends in the three surveys are compared. It is concluded that the Irish Sea herring stock remains difficult to survey because of stock mixing problems, as well as aspects of herring behaviour that strongly influence detection and catchability during surveys. Nonetheless, there is evidence for some coherence in the longer-term signals in the different survey series. The trends in spawning stock biomass from the ICES assessment most closely follow the 1+ biomass estimates from the acoustic survey, including the 2003 survey estimate which was not included in the most recent ICES assessment.

Assessment of Irish Sea VIIa herring using a Two-Stage Biomass model (B. Roel & J. de Oliveira)

This WD presents the results of applying a two-stage biomass model to assess the Irish Sea herring stock. The model was fitted to the biomass of 1-ringers and 2+ ringers of the Northern Ireland acoustic survey for the period 1994 – 2003. The dynamics takes into account only two stages in the population: the recruits (1-ringer fish) and the fully recruited that comprise 2-ringer and older fish. Maximum likelihood estimation is used, assuming survey indices are log-normally distributed about their expected values. Standard errors of the log-distributions are approximated by the sampling CVs. The two-stage biomass model fits the acoustic index generally well with the exception of year 2000 where it suggests the opposite trend. In spite of the high CV associated with the 1999 survey, the poor recruitment estimated by the survey forces a relatively low model estimated 2+ biomass in 2000. The results are sensitive to the choice of the g parameter which is fixed externally. A comparison is made between the total biomass estimates from the survey, the two-stage biomass model and ICA (using the acoustic 1+ index). Both the acoustics index and the two-stage model suggest an increasing trend in the stock biomass starting in 1998. Given the number of "independent" data vs number of estimable parameters the two-stage biomass model is likely to be over-parameterised. A more constrained model (e.g. not allowing the recruitments to vary so freely) could be attempted to address that concern.

Acoustic surveys of Irish Sea herring (Area VIIaN): do the age structure data contain useful information for ICA tuning? (M. Armstrong & B. Roel)

Previous Herring Assessment Working Groups have used age-structured abundance indices from an acoustic survey to tune the Irish Sea ICA assessment, but the age compositions are estimated from relatively few midwater trawl hauls only. The object of the present exercise was to see if poor quality age composition data from the acoustic survey could be a contributing factor to annual revisions in the perceived state of the stock.

Comparison of retrospective patterns in estimates of fishing mortality and SSB from ICA shows that using only the aggregate 1+ biomass index as an SSB tuning series provides more stable assessment results over the 1998 – 2003 period than are given by the age structured indices. Both survey series will be affected by sampling errors. However the use of age structured data introduces an additional source of error associated with the paucity of representative trawling samples, and in the present case the errors may be sufficiently large to degrade rather than enhance the assessment. A drawback of calibrating ICA estimates of SSB against a 1+ aggregated survey estimates is that interannual changes in maturity ogives will degrade the calibration. A better solution may be to calibrate an ICA 1+ biomass estimate against the acoustic estimates to maintain comparability through the series but that requires modifying the ICA structure, which is beyond the scope of this study

1.9 Recommendations

The HAWG recommends:

1.9.1 Data provision and storage

- Due to uncertainties about standardisation of the English trawl catches in 2004 IBTS, these catches are not included in the calculations of 1-5+ ringer indices for 1st Quarter 2004 (North Sea herring). The WG recommends that the IBTS WG evaluates the inclusion of the English 2004 catches in future calculations of IBTS indices. (from section 2.3.3).
- During the HAWG 2002 the Div IIIa 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. However, the 0-values were omitted and the index is not weighted by rectangle and rectangle area. These indices have been developed by the WG. For HAWG 2005, The WG requests the ICES secretary to provide mean abundances ($n \cdot h^{-1}$) (CPUE) at age for herring in Div. IIIa from IBTS survey (quarter 1st and 3th) as an area weighted mean over means by ICES statistical rectangle in accordance to the IBTS WG held in 1999 and as usually

applied for other stocks in the area (ICES 1999/D:2).The contribution of autumn spawned 2-5+ ringers in Division IIIa should be evaluated in the calculation of (from section 3.3.1.).

- If data on sprat from the IBTS survey during the third quarter were available prior to W.G. in 2005 a comparison between the February and the third quarter IBTS indices could be performed with the aim of obtaining an index of abundance of age 1 sprat. Further examination on maturity at length and at age, available from the IBTS conducted in the 3rd quarter and commercial catches could provide important insight into the maturity dynamics during the autumn resulting in a better understanding of the spawning and recruitment processes. Therefore, the WG recommends that countries involved in IBTS analyze data on maturity-at-age of sprat and make available the results prior to the 2005 WG meeting. (from section 8)
- The WG recommends that all fisheries/métiers with substantial catch should be sampled (including by-catches in the industrial fisheries) and that catches landed abroad should be sampled and information on these samples should be made available to the national laboratories. (from section 2.2.4).

1.9.2 Surveys

- The North Sea herring larvae surveys should be considered for priority 1 EU funding, as it is international, covers more than 1 species (herring larvae, cod and plaice eggs) and is incorporated into the stock assessment. Efforts should be made to cover the Orkney/Shetland, Buchan and central North Sea area also in the first half of September (from section 2.3.2.)
- In order to avoid bias due to catch-ability differences between gears used in the IBTS-MIK sampling, the WG recommends a full standardisation of the sampling programme, hence, that Scotland changes gear to the 2-metre ring version with standard netting. (from section 2.3.3.)

1.9.3 Assessment methods

- The WG recommends that the Working Group of Methods again considers assessment methods of short-lived species in the light of recent developments (from section 8.8)

1.9.4 Planning Groups

- PGHERS will meet at the Institute for Marine Research Bergen, Norway, from 24 to 28 January 2005 (chair: B. Couperus, The Netherlands) to:

a) combine the 2004 survey data to provide indices of abundance for the population within the area;

b) co-ordinate the timing, area and effort allocation and methodologies for acoustic and larvae surveys for herring and sprat in the North Sea, Division VIa and IIIa and Western Baltic in 2005;

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

d) review the results of an exchange exercise on herring maturity staging, and comment on the implications of the conclusions of the sprat age reading exchange and workshop for the acoustic surveys;

e) evaluate the results of the investigations of survey overlaps between vessels in the North Sea acoustic survey;

f) to conduct an echogram scrutiny workshop aiming at further harmonisation of scrutiny procedures.

Table 1.5.1: Available disaggregated data for the HAWG per March 2004
X: Multiple spreadsheets (usually xls); W: WG-data national input spreadsheets (xls);
D: Disfad inputs and Alloc-outputs (ascii/txt)

Stock	Catchyear	Format			Comments
		X	W	D	
Baltic Sea: IIIa and SD 22-24					
her_3a22	1991-2000	X			raw data, provided by Jørgen Dalskov, Mar. 2001, splitting revised
	1998	X			provided by Jørgen Dalskov, Mar. 2001, splitting revised
	1999	X			provided by Jørgen Dalskov, Mar. 2001, splitting revised, catch data revised
	2000	X			provided by Jørgen Dalskov, Mar. 2001
	2001	X			provided by Jørgen Dalskov, Mar. 2002
	2002	X			provided by Jørgen Dalskov, Mar. 2003
	2003	X			provided by Jørgen Dalskov, Mar. 2004
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	X			provided by Maurice Clarke, Mar. 2004
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
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 Rednose, Oct 2003
	2000		W	D	provided by Christopher Zimmermann, Mar. 2001, updated by SG Rednose, Oct 2003
	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
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

Table 1.5.1 (Cont'd)

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	X			provided by Maurice Clarke, Mar. 2004
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
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
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
National Data					
Germany: Western Baltic	1991-2000	X			provided by Tomas Gröhsler, Mar. 2001 (with sampling)
Germany: North Sea	1995-1998		W		provided by Christopher Zimmermann, Mar 2001 (without sampling)
Norway: Sprat	1995-1998		W		provided by Else Torstensen, Mar 2001 (without sampling)
Sweden	1990-2000		W		provided by Johan Modin, Mar 2001 (without sampling)
UK/England & Wales	1985-2000	X			database output provided by Marinelle Basson, Mar. 2001 (without sampling)
UK/Scotland	1990-1998		W		provided by Sandy Robb/Emma Hatfield, Mar. 2002

Table. 1.5.2 Fishery definitions for herring landings to be used for sampling schemes.

	Directed fishery				By-catches in					Others
					Sandeel fishery	Sprat fishery	Norway pout and blue whiting fishery	Mackerel fishery	Mackerel fishery	
Gear	Trawlers and RSW trawlers	RSW sein-ers	Freezer trawlers	Gill/trapnets	Trawlers	Trawlers	Trawlers	Purse sein-ers	Trawlers	
Mesh size Area/Subarea/Div./Sub-div.	32-44	32-45	32-46	All	8-31	16-31	16-44	32-50	32-50	
Sub-div. 24	**X**			**X**		**X**				
Sub-div. 23				**X**						
Sub-div. 22	**X**					**X**				
Sub-div. IIIaS Kattegat	**X**				**X**	**X**				
Sub-div. IIIaN Skager-rak	**X**	**X**			**X**	**X**	**X**		**X**	
Subarea IV+VIId	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	
Sub-Div. VIaN	**X**								**X**	
Sub-Div. VIaS + VIIb,c	**X**								**X**	
VIa (Clyde)	**X**									
Celtic Sea + Div.VIIj	**X**									
Div.VIIa	**X**									

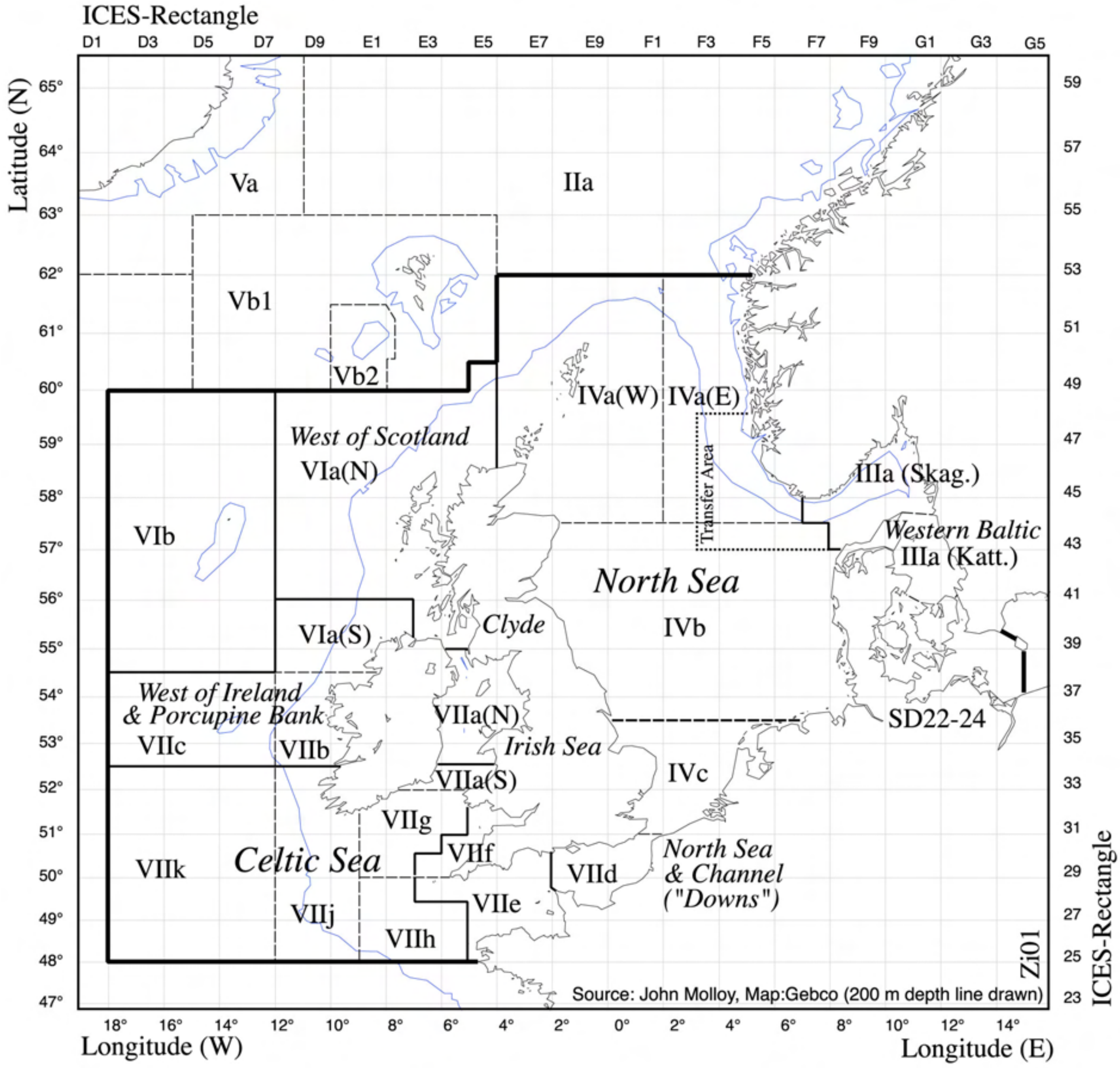

Figure 1.5.1 ICES AREAS as used for the assessment of herring stocks south of 62ºN. Area names in italics indicate the separation used for long-term storage of commercial catch and sampling data. “Transfer area” refers to the transfer of Western Baltic Spring Spawners caught in the North Sea to the Baltic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

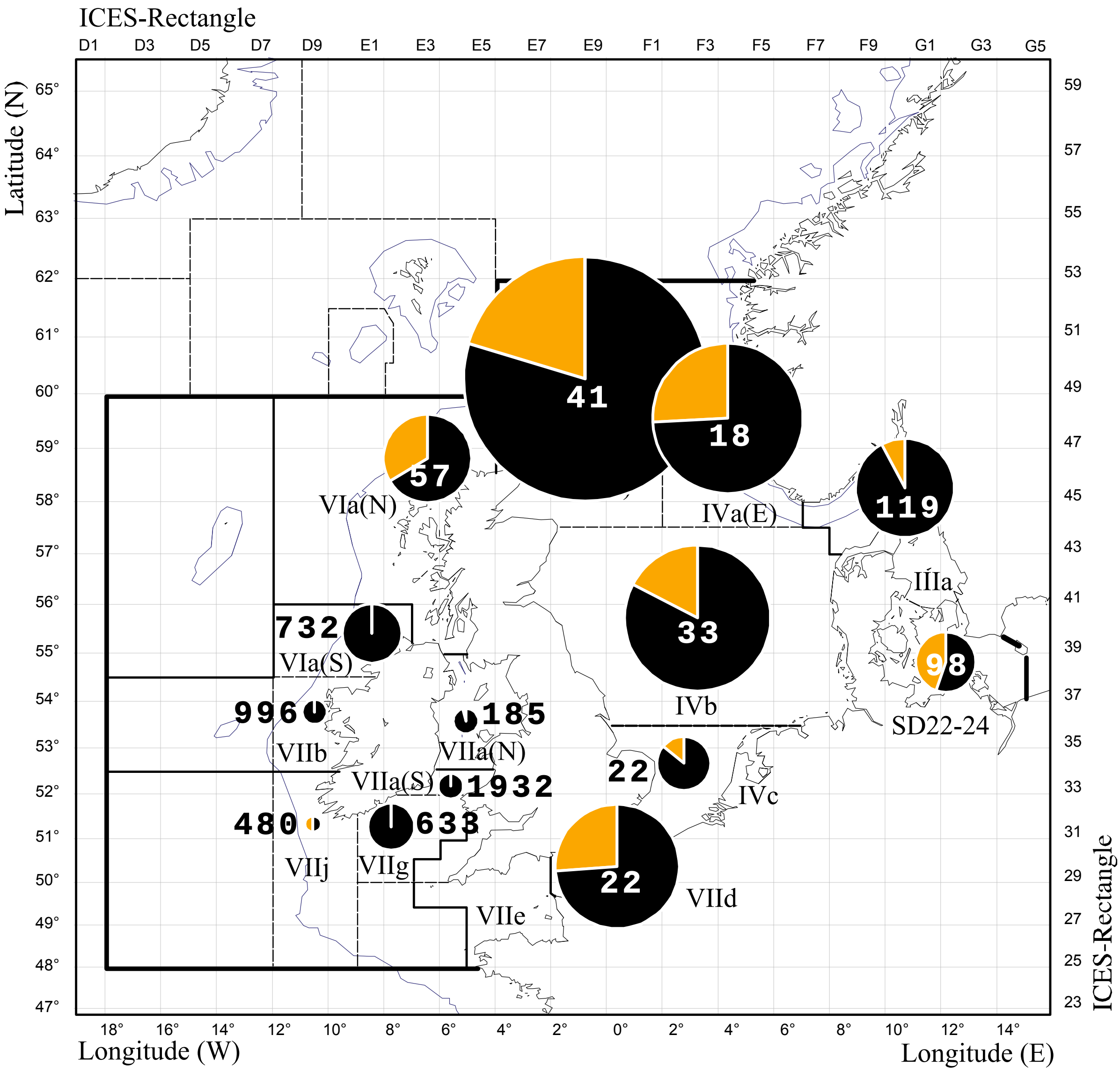

Figure 1.5.2 Herring south of 62°N: Sampling level per ICES areas for the whole year and all fleets. Circle diameter is proportional to working group catch; share of sampled catch (black) is indicated. Numbers give the numbers of age readings per 1000 t catch. For the allocation of areas to stocks, see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

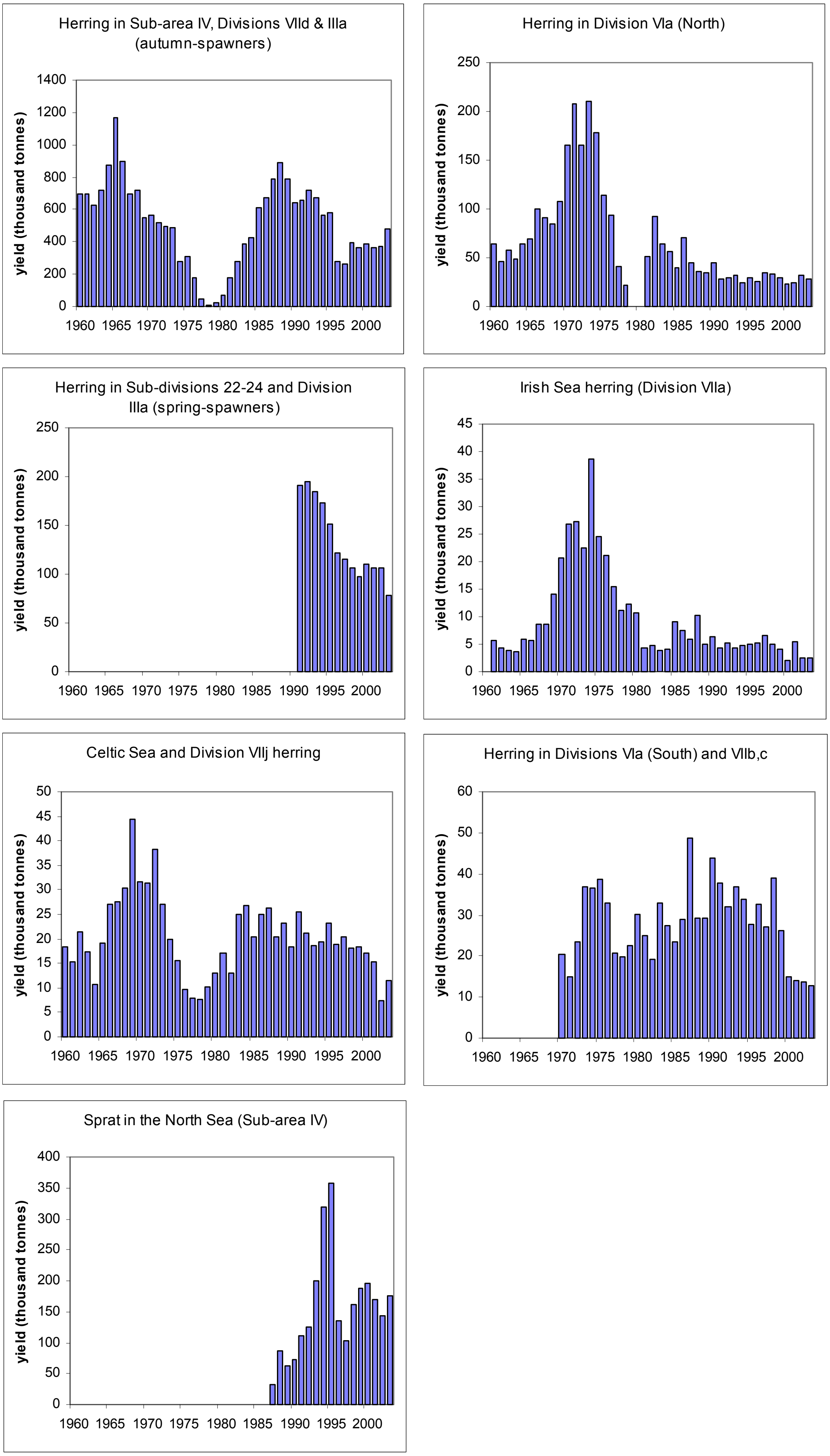

Figure 1.6.1 WG estimates of yield of the stocks presented in HAWG 2004.

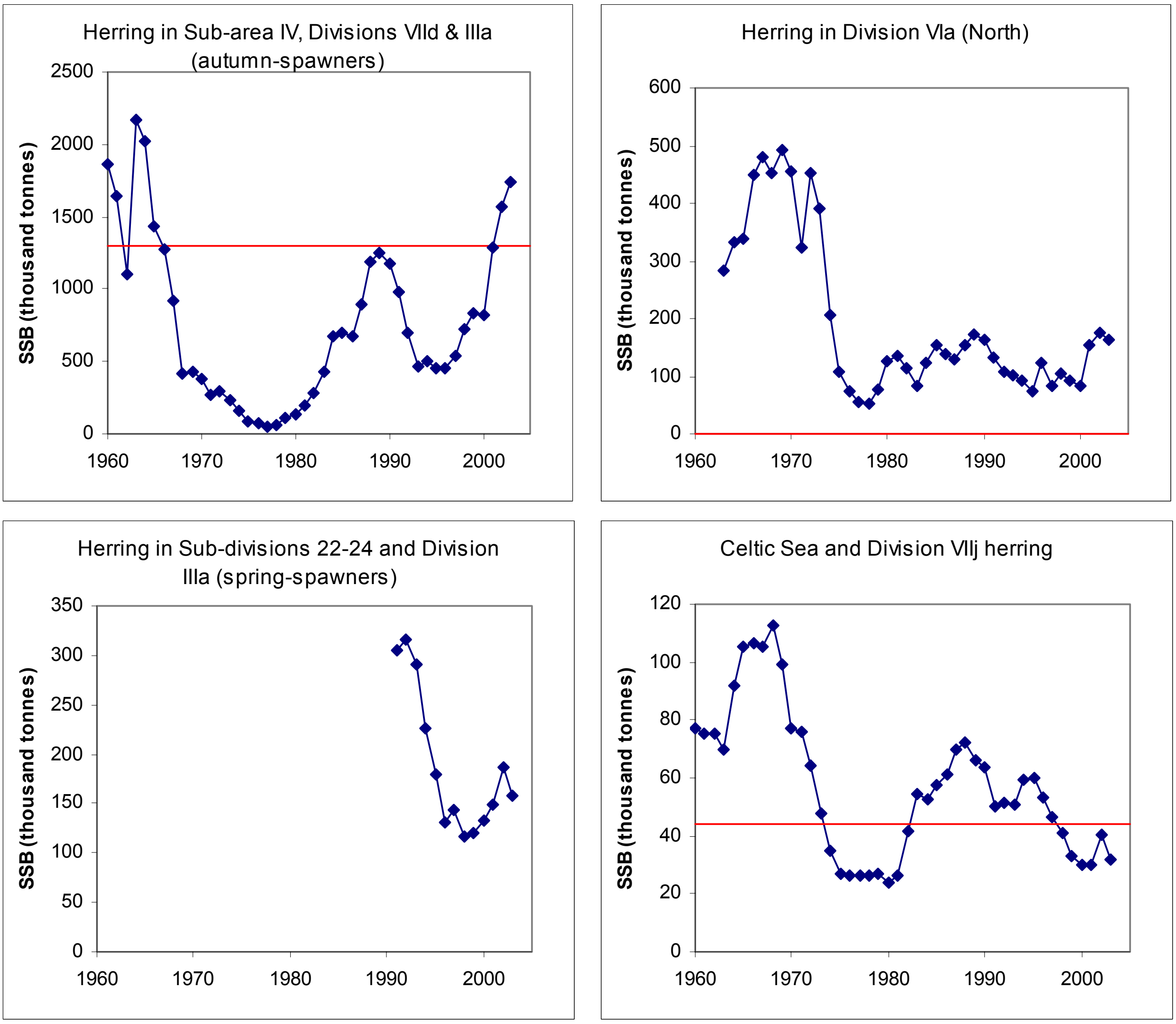

Figure 1.6.2 Spawning stock biomass estimates of the 4 stocks for which analytical assessments were presented in HAWG 2004. The $\mathbf{B}_{pa}$ level (if available) is indicated in the graphs.

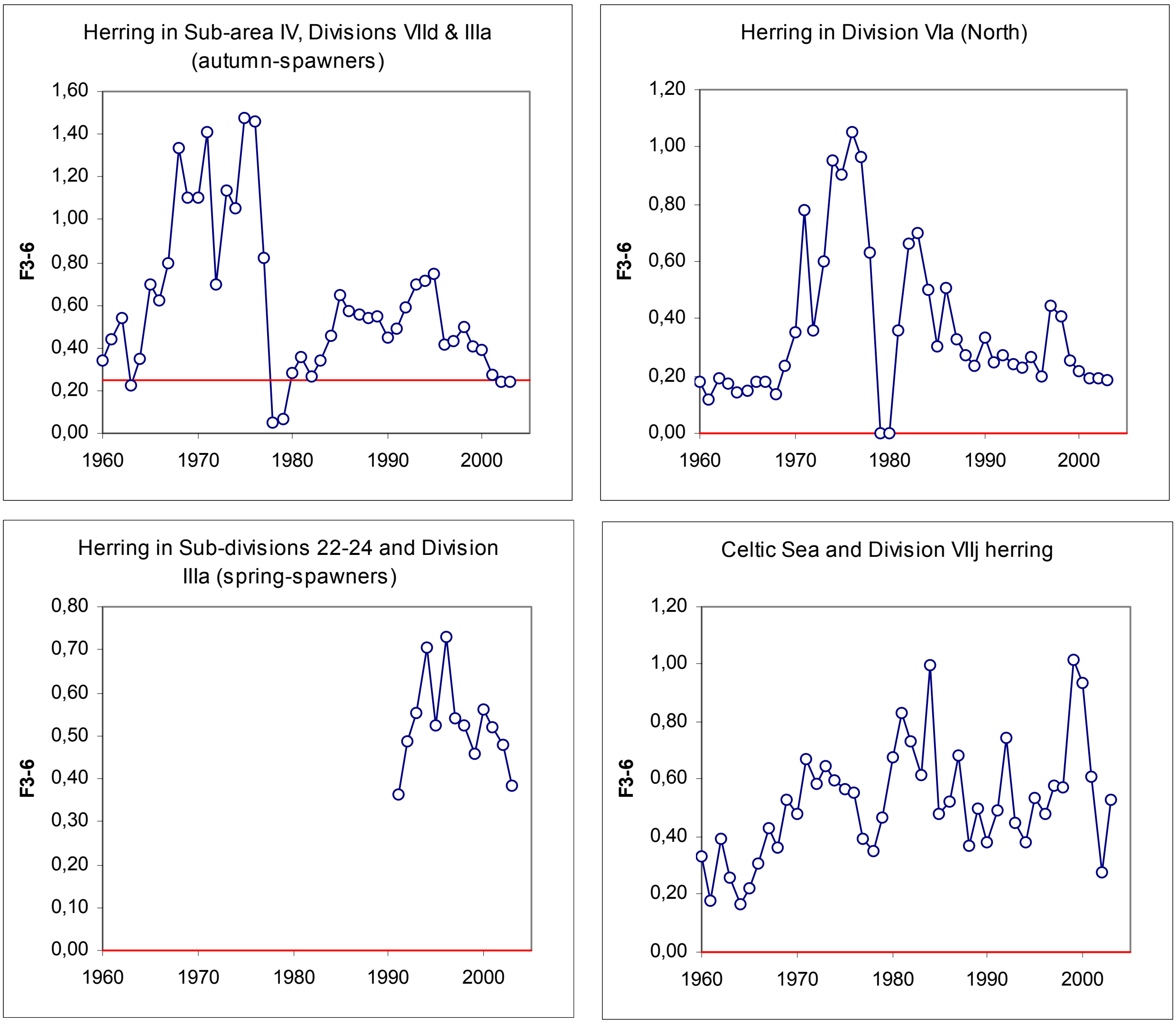

Figure 1.6.3 Estimates of mean F of the 4 stocks for which analytical assessments were presented in HAWG 2004. The $\mathbf{F}_{pa}$ level (if available) is indicated in the graphs.

2 North Sea Herring

2.1 The Fishery

2.1.1 ACFM advice and management applicable to 2003 and 2004

According to the management scheme agreed between the EU and Norway, adopted in December 1997, efforts should be made to maintain the SSB of North Sea Autumn Spawning herring above the MBAL (Minimum Biologically Acceptable Level) of 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, other measures will be agreed and implemented taking account of scientific advice.

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. The advice for a sub-TAC on catches in IVc and VIId for 2003 was that it should not exceed the 2002 sub-TAC, and for 2004 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 among Downs herring and other stock components. It was expected that fishing at the recommended level would lead to a further increase in the SSB, mainly due to large recruiting year classes entering the fishery.

The final TAC adopted by the management bodies for 2003 was 400,000 t for Area IV and Division VIId, whereof not more than 59,542 t should be caught in Division IVc and VIId. For 2004, the TAC was raised to 460,000 t (by 15%) and the sub-TAC set for Division IVc and VIId was raised to 66,098 t (by 11%, representing a share of more than 14% on the total TAC). 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 52,000 t for 2003 and was reduced to 38,000 t for 2004 (by 27%). 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 Appendix 3 and Section 2.7.2.

2.1.2 Catches in 2003

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 official landings, but for some nations catch estimates are given by Working Group members, including unallocated or misreported catches. These figures can therefore **not** be used for management purposes. For corrections applied to and inconsistencies in previous year’s data see Sections 1.4.1, 2.2.3 and 2.2.4. Only Denmark and Norway provided information on by-catches of herring in the industrial fishery. These are taken in the small-meshed fishery (B-fleet) under a EU quota by Denmark and are included in the A-fleet figures for Norway. Catch estimates of herring taken as by-catch in other small-mesh fisheries in the North Sea may be an underestimate. The total catch in 2003 as used by the Working Group amounted to 450,100 t. Following the raising of the TAC for herring caught in the North Sea by more than 50%, the total catch increased by 28% compared to last year. By area, catches increased in Division IVa (West) and IVb by roughly 40%, decreased in Division IVa (East) by about 6 %, and increased by 35 % in the southern North Sea (Division IVc and VIId), while the sub-TAC for the latter area was raised by almost 40%.

Landings of herring taken as by-catch in the Danish small-meshed fishery in the North Sea were much lower than the by-catch ceiling set for Denmark (52,000 t), and have significantly decreased to 12,300 t after a continuous increase between 1997 and 2002 (Table 2.1.6). In 2003, the Danish sprat fishery was carried out mainly in the second half of the year with by-catches of herring of about 6% (10,000 t). Herring by-catches in the Danish Norway pout fishery were estimated to be less than 4% (300 t), less than 0.5 % in the sandeel fishery (900 t) and 8 % in other industrial fisheries (500 t). In the Norwegian industrial fishery, herring by-catch has decreased from 4,457 t last year to 3,809 t. The quarterly distribution of herring by-catches in this 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
379 t	1148 t	1,793 t	489 t	3,809 t
3.2 %	1.9 %	2.6 %	1.5 %	2.1 %

Misreporting of landings taken in the North Sea but reported from other areas such IIa and IIIa is still substantial, and the estimates of the total amount of misreported (including within-area misreporting) and unallocated catches have again increased compared to last year (to about 42,000 t, roughly 10% of the total catch in the North Sea).

Based on WG estimates of total catch, TACs for the human consumption fishery in Subarea IV and Division VIId have been significantly exceeded in several years. This appears to have continued in 2003: The total amount of unallocated and misreported catch remained constant last year. 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). An over catch of TAC of almost 14% still occurs in these two divisions, and absolute amount of unallocated/misreported catch has increased in 2003.

The total North Sea TAC excess for the years 1995 to 2003 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**
TAC HC ('000 t)	440	156	159	254	265	265	265	265	400
"Official" landings HC ('000 t)[1]	443	170	162	253	275	267	275	282	414
Working Group catch HC ('000 t)	**449**	**196**	**226**	**324**	**318**	**328**	**303**	**331**	**438**
Excess of landings over TAC HC ('000 t)	9	40	67	70	53	63	38	66	38
By-catch ceiling ('000 t) [3]		44	24	22	30	36	36	36	52
Reported by-catches ('000 t) [4]	67	38	13	14	15	18	20	22	12
Working Group catch North Sea ('000 t)	**516**	**233**	**238**	**338**	**333**	**346**	**323**	**353**	**450**

HC = human consumption fishery

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

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

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

[4] *provided by Denmark only.*

2.2 Biological composition of the catch

Biological information (numbers, weight, length, catch (SOP) at age and relative age composition) on the catch as obtained by sampling of commercial catches is given for the whole year and per quarter in Tables 2.2.1 to 2.2.5. Where available, data are displayed separately for herring caught in the North Sea (including a minor amount of Western Baltic Spring-spawners taken in IVa East), IVa East (total; Western Baltic Spring spawners [WBSS] only – see Section 2.2.2; North Sea Autumn-spawners only), IVa West, IVb, VIId/IVc as well as for North Sea Autumn-spawners (NSAS) caught in Division IIIa, and the total NSAS stock, including catches 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 Appendix 2. The total catches of NSAS (SOP figures), mean weights and numbers-at-age by fleet are given in Table 2.2.6. Data on catch numbers-at-age and SOP catches are shown for the period 1995-2003 in Tables 2.2.7 (herring caught in the North Sea), 2.2.8 (WBSS taken in the North Sea, see below), 2.2.9 (NSAS caught in Division IIIa) and 2.2.10 (total numbers of NSAS). Mean weights-at-age are given for 1991-2003 separately for the different Divisions where NSAS are caught (Tab. 2.2.11).

Note that Tables 2.2.6 to 2.2.11 (and subsequently the assessment input data) have been updated this year

- for catch year 1995 –2002 following the revisions made by SG Rednose last year (see Section 1.4.1),
- the recalculation of the catch of NSAS in Division IIIa as a result of the removal of all Norwegian catch in that area,
- and to account for the changes in Swedish 2002 catch in Division IIIa distribution data, which was made available only very late during last year's WG meeting (see Section 2.2.3).

2.2.1 Catch in numbers-at-age

North Sea catches in numbers-at-age over the years 1990-2003 are given in Table 2.2.7. The total number of herring taken in the North Sea and the total number of NSAS have increased by 15 % (to 3.3 billion fish) and by 10% (to 4 billion fish), respectively, as compared to last year. 0- and 1-ringers contributed 25% of the total catch in numbers of NSAS in 2003. Fig. 2.2.1. shows the relative proportions of the total catch numbers for different periods (1960-2003, 1980-2003 for the total area, and 2003 for different Divisions).

The following table summarises the total catch in tonnes of North Sea autumn spawners. After the splitting of NSAS in Division IIIa and Western Baltic Spring Spawners caught in the North Sea, and the removal of local Spring-spawners in the Western part of the North Sea, the amount of the total catch used for the assessment of NSAS was 480,000 tonnes:

Area	Allocated	Unallocated	Discards	Total
IVa West	201,631	14,115	4,125	219,871
IVa East	71,649	11,991	-	83,640
IVb	81,187	-2,401	-	78,786
IVc/VIId	59,579	8,170	-	67,749
	Total catch in the North Sea			450,064
	Autumn Spawners caught in Division IIIa (SOP)			32,497
	Baltic Spring Spawners caught in the North Sea (SOP)			-2821
	Other Spring Spawners			-135
	Total Catch NSAS used for the assessment			**479,587**

Summaries 84 t of Thames Blackwater herring caught under a separate quota and included in the catch figure for England & Wales, and 50.8 t spring spawners caught in the Western North Sea (IVb 2nd quarter and IVc 4th quarter) reported by the Netherlands and included in the catch-at-age figures. Germany reported 257 t of spring spawners caught in the 2nd and 3rd quarter in IVaW, but these were removed from the catch-at-age figures (deducted from the official catch figures as negative unallocated catch).

2.2.2 Spring-spawning herring in the North Sea

Norwegian Spring-spawners and local fjord-type 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 now listed separately in the respective catch tables. The amount of these catches varied significantly between less than 1,000 t in 2003 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 year spring spawners reported by the Netherlands and by Germany were treated differently (see paragraph above).

Western Baltic and Division IIIa Spring-spawners (WBSS) are taken in the eastern North Sea during the summer feeding migration. These catches are included in Table 2.1.1 and listed as IIIa type. Table 2.2.8 specifies the estimated catch numbers of WBSS caught in the North Sea, which are transferred from the North Sea assessment to the assessment of Division IIIa/Western Baltic in 1991-2003.

The method of separating these fish, using vertebral counts as described in former reports of this Working Group (ICES 1991/ Assess:15) is given in Sec. 3 and in Stock Appendix 2. 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 2003 were used for the second quarter (Figure 2.2.2). For the 3rd quarter no Norwegian samples were available for landings from the transfer area and instead the otolith-based proportions from samples of Danish commercial landings from this area were applied to the age distributions. For 1-ringers it was assumed that all fish were autumn spawners. The resulting proportion of spring spawners and the quarterly catches of these in the transfer area in 2003 are as follows:

Quarter	1-ringers (%)	2-ringers (%)	3-ringers (%)	4+-ringers (%)	Catch in the transfer area (t)	Catch of WBSS in the North Sea (t)
Q 2	0%	0%	8%	14%	11,732	1,319
Q 3	0%	0%	25%	16%	9,545	1,502
total					21,277	2,821

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

2.2.3 Data revisions

A number of data revisions have been applied to the assessment input data set at this year's WG meeting. The Study Group on the Revision of Data for North Sea Herring (SG Rednose, see Sec. 1.4.1) delivered its report in autumn 2003 (ICES 2003/ACFM:10). SG Rednose reworked catch and catch-at-age data for 1995-2001, the results affected the catch tables (Tables 2.1.1 to 2.1.6) and historical catch-at-age information (Tables 2.2.6 to 2.2.11). These have been updated this year along with the assessment input files. An error was obtained in one of the tables delivered by SG Rednose: mean weights for total North Sea Autumn Spawners in 1995 were not calculated properly. This has been corrected also in the SG Rednose-report.

A second major revision of the splitting between NSAS and WBSS in Division IIIa, based on new information of the distribution of Norwegian catches in Divisions IIIa and IVa(E), has been included in this year's NSAS assessment for the period from 1995 onwards. Since last year, it is assumed that all Norwegian catch in Division IIIa is actually taken in the North Sea. This affected the numbers and mean weights of NSAS in Division IIIa, as most of the older and heavier fish appeared to have been taken by the Norwegian fleet. Splitting data is still not completely reworked for the earlier period and NSAS assessment data could therefore not be updated for 1991 to 1995.

Sweden reported amendments to their catch figures for Division IIIa very late during last year's WG meeting. Corrections to the splitting between NSAS and WBSS in that area had an effect on the data for NSAS and while corrected data was only partly displayed and used in last year's report, all tables have now been updated.

Minor corrections and amendments have again been applied to the catch tables. France revised its catch figures for 2001 (adding 195 t in Division IVb and 170 t in IVc/VIId). Norway delivered final catch figures for 1999 and 2000 to ICES, however, the WG felt that data delivered by WG members to SG Rednose last year would be more suitable to use. The summary ("The Wonderful") table (Tab. 2.1.6) has been updated with information on the distribution of NSAS and WBSS catch on the different fleets operating in Division IIIa for 1995-2001. This information was not available before SG Rednose concluded.

Exploratory assessment runs demonstrated that none of the corrections applied had significant impact on the historic perception of the NSAS stock (see Sec. 2.10.). However, it had an influence on the predictions and removed some variability of the catch-at-age information, which was attributed to arbitrary raising procedures used in the past.

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 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 significantly (by about 10%). An analysis conducted in 2002 (ICES 2002/ACFM:12) indicated that this figure could be much higher if the mean rate of misreporting and unallocated catch for nations reporting this would be applied to the whole North Sea catch. This corroborates suggestions of the Study Group for Herring Assessment Procedures (ICES 2001/ACFM:22), that a significant uncertainty of the total catch figure exists since the reopening of the fishery in 1980.

Discards were so far considered to be unproblematic in the North Sea herring fishery (less than 5% of the total catch, based on observer sampling programs). In 2002 for the first time, onboard sampling by two nations observed substantial 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, but herring discards of all fleets in 2002 could have been as high as 50,000 t. For 2003, the herring TAC has been increased by 50%, and at the same time the mackerel TAC has been reduced by more than 5%. Sampling of the same fleets in 2003 demonstrated that – as anticipated – the total amount of discards may have been reduced to about 5% of the total herring catch. Discards 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. While most of the herring was discarded in the 4th quarter due to a lack of herring quota, there is concern that herring is also discarded earlier in the year when the quota is still not taken and fish could have been landed legally. The final discard figure used for the assessment in 2003 is 4125 t, based on the raised figure for one sampled fleet. As discards are likely to occur in all nation's fisheries, this figure is certainly an underestimate and could be more than 20,000 t.

In general, **sampling of commercial landings** for age, length and weight has again improved as compared 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, 85% of the catch was sampled (2002: 81%), and the number of age readings has again been increased by 34%. 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 108 different *reported* metiers, only 43 were sampled in 2003 (40%; 2002: 47%). 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 34 metiers (2002: 29). For age readings (recommended level >25 ageings per 1000 t catch) this is only slightly worse: only 29 metiers appear to be sampled sufficiently (2002: 21). The catch of France, UK/England and Wales, Sweden, and the Faroe Islands from the North Sea (combined share 13% of the total North Sea catch) has not been sampled. Information on catches landed abroad was also not available or could not be used. While it is known that by-catches of herring in other than the directed human consumption fisheries occur, most countries have not implemented a sampling scheme for monitoring these fisheries.

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

2.3 Fishery Independent Information

2.3.1 Acoustic Surveys in VIa(N) and the North Sea in July 2003

Six surveys were carried out during late June and July 2003 covering most of the continental shelf north of 52°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, and to the west by the shelf edge at approximately 200 m depth. The individual surveys and the survey methods are given in the report of the Planning Group for Herring surveys (ICES 2004/G:05). The vessels, areas and dates of cruises are given below and in Figure 2.3.1.1:

Vessel	Period	Area
FV Enterprise	01 July – 21 July	56°- 60°N, 3° - 7° W
R.V Sarsen	1 – 22 July	56°30’- 61° N, 2° - 6° E
Scotia	27 June – 20 July	58°- 62° N, 4° W - 2° E
Tridens	23 June – 18 July	54°30 – 58° N, west of 3° E
Walther Herwig III	26 June – 13 July	52° - 57° N, east England / 3° E
Dana	27 June – 8 July	North of 57°NS & 56° N, Kattegat east of 6° E

The data has been combined to provide an overall estimate. The areas covered and dates of surveys are shown in Figure 2.3.1.1. Estimates of numbers-at-age, maturity 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 has been combined and the estimate of the stock surveyed is shown in Tables 2.3.1.1-3 by ICES subarea for North Sea autumn spawning herring. This year the area has been extended south to provide better coverage of sprat. A very small amount of herring was also found in this area, the contribution was less than 0.05% of the total biomass.

Combined Acoustic Survey Results:

The estimate of North Sea autumn spawning herring SSB is 3.0 million tonnes which is 17,300 millions herring (Table 2.3.1.4). This data series is used as a relative index in the assessment of North Sea herring because the absolute abundance cannot be used directly due to uncertainties in target strength. The North Sea survey is consistent with previous years, giving a total adult mortality of about 0.45 over the last 3 years, which is similar to the estimates from the assessment. The North Sea herring SSB rose from 2.4 million tonnes in 2001 (Table 2.3.1.5) to 2.9 million tonnes in 2002 and again to 3.0 million tonnes in 2003. However, growth of the 2000 year class seems to be slower than for previously observed year classes. The herring are 1.5 cm smaller, and 20g lighter than the similarly abundant 1998 year class at the same age (2-rings). Only 43% of this year class are mature at 2-ring compared to 66%, 77% and 86% for 1997, 1998 and 1999 year classes. If this year class had grown and matured as previous years, to 76% mature, the spawning stock biomass would have been 27% higher at 3.8 million tonnes. The survey shows again the two exceptional year classes of herring (the 1998 and 2000 year classes) in the North Sea, which is consistent with the observation of exceptionally large year classes observed in the MIK and IBTS surveys (ICES 2001a). The 2003 estimate of the 2000 year class suggests that it may be higher than the 1998 year class at 1.5 times at age 2-ring.

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 larger more mature fish found in the North and smaller less mature fish found in the south and particularly the eastern north Sea. The relative spatial distributions of adult and juvenile autumn spawning herring can be seen in Figures 2.3.1.5 and 2.3.1.6 respectively. The mean weights-at-age and the fraction mature are used in the assessment, the influence of the precision of this data were discussed in detail in section 2.10 last year.

2.3.2 Larvae surveys

In 2003/04 The Netherlands and Germany participated in the surveys and managed to cover seven 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 – 2.3.2.7. The historical background of the larvae surveys and the methods used for abundance calculation are described in the handbook for quality control. A more detailed description is available in the manual for the international herring larvae surveys in the North Sea (ICES 2004 CM/G:05).

Results from the survey around the Orkney/Shetlands show the common pattern of a large spatial extension of newly hatched larvae and high abundance estimates to the east of the Orkneys (Fig. 2.3.2.1). The overall abundance is 50% less than 2002 and a quarter of 2001 (which was the highest record ever observed in that period). Unfortunately no information is available about larval abundance in the first half of September. Peak spawning may have shifted towards the beginning of September during the past two years. This is supported by a certain amount of larger larvae found in the samples.

In the Buchan area larval distribution is more restricted (Fig. 2.3.2.2), but the Larval Abundance Index (LAI) increased substantially and is twice as high as in 2002.

Two periods were covered in the Central North Sea (CNS, Fig. 2.3.2.3 and 2.3.2.4). Both yielded strong abundance estimates. The LAI estimates for this area have risen continuously over the last six years.

Abundance estimates from the three surveys in the Southern North Sea (SNS) have increased substantially in comparison to former years. Spawning started in the second half of December in a restricted area in VIId and then spread out into VIc during January (Fig. 2.3.2.5 – 2.3.2.7). As usual, an area from the French coastline to the middle of the Channel contributed most to the abundance index in the Southern North Sea.

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 versus the SSB values obtained from the ICA runs of the Herring Assessment Working Group (ICES 2003 ACFM:17).

The results of two surveys (CNS, 2nd period, and SNS, 1st period) are influenced by large catches at single stations. More than 12,000 larvae per m² were caught at these two stations. They contributed roughly 50% to the respective LAI values. When excluded, the remaining LAI is 5,207 instead of 12,018 for the CNS and 5,560 instead of 12,048 in case of the SNS (Numbers $*10^9$). These still represent high LAI estimates. As a general rule, additional stations should be inserted in areas with high larval concentrations to enable average calculation. Unfortunately this wasn't done here. However, there are some routines in the MLAI calculation to make it robust against patchiness effect. Exclusion of the two very high abundance catches leads to a difference of 13% on the MLAI estimate. With comparison to the general noise in survey data this figure is minimum. Thus no data were excluded from the MLAI calculation. Both the LAI per area as well as the MLAI from the larvae surveys in 2003/2004 indicate that the SSB has increased when compared to last years WG estimate.

2.3.3 International Bottom Trawl Survey (IBTS)

The International Bottom Trawl Survey (IBTS) started out as a young herring fish survey in 1966 with the objective of obtaining annual recruitment indices (1-ringers) for the combined North Sea herring stocks. It has been carried out every year since, and presently the survey provides recruitment indices not only for herring, but also for roundfish species as well. Examinations of the catch data from the 1st quarter IBTS have shown that catch during the surveys also indicates abundances of the adult stages of herring. From 1977 sampling at night with fine-meshed nets (MIK) was implemented, and the catch of large herring larvae was used for estimation of 0-ringer abundance in the survey area. Hence, a series of herring abundance indices are available from this survey programme.

Due to uncertainties about standardisation of the English trawl catches in 2004, these catches are not included in the calculations of 1-5+ ringer indices for 1st Quarter 2004. The WG recommends that the IBTS WG evaluates the inclusion of the English 2004 catches in future calculations of IBTS indices. The standard sampling gear in the sampling programme for 0-ringers is a fine-meshed ring net. However, the Scottish sampling is carried out using a modified frame version of a larger opening. In the calculation of 0-ringer indices, the differences in gear size is taken into account, but in order to avoid potential catch-ability differences, the WG recommends a full standardisation of the sampling programme, hence, that Scotland changes gear to the 2-metre ring version with standard netting.

2.3.3.1 Indices of 2-5+ ringer herring abundances

Fishing gear and survey practices were standardised from 1983, and herring abundance estimates of 2-5+ ringers from 1983 onwards has shown the most consistent results in assessments of these age groups. This series is then used in North Sea herring assessment. Table 2.3.3.1 shows the time-series of abundance estimates of 2-5+ ringers from the 1st quarter IBTS for the period 1983-2004, when Table 2.3.3.2 contains area-disaggregated information on the IBTS indices for year 2004.

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 2002 (Table 2.3.3.3). This years estimate of the 2002 year class strength (979.5) 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 during 2002, 2003 and 2004. In 2004 the main concentrations of 1-ringers were found in the south- eastern part of the North Sea. The mean length of the 1-ringers in this area is relatively small, between 10 and 14 cm (Figure 2.3.3.2.).

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

This years group of 1-ringers has a high proportion of herring <13 cm (41% of all 1-ringers in total area). 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

The 0-ringer index is based on 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/Assess:10). The series of estimates is shown in Table 2.3.3.4, the new index value of 0-ringer abundance in 2004 is estimated at 47.3.

This estimate of the 2003 year class indicates a very low recruitment, of the same size as last years recruitment estimate. The 0-ringers were concentrated in north-western areas of the North Sea, with highest concentrations off the Scottish coast into the north/central part of the North Sea (Figure 2.3.3.3). This distribution pattern differs from the distribution of the preceding two year classes of 0-ringers, also shown in Figure 2.3.3.3.

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 2003 (weighted by the numbers caught) are presented by ICES Division and by quarter in Table 2.2.11.

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 1993 to 2003. These values were obtained from the acoustic survey. The data for 2003 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 are given in Figure 2.3.1.4. The spatial variability of mean weight is considerable. For comparison the mean weights-in-the-catch from the last ten years are also shown in Table 2.4.1.1 (from Section 2.2.1 for the 2003 values). For 3-ringers and older the mean weights in both the catch and the acoustic survey are generally close to the long-term mean. For 2-ring herring both the catch and the acoustic survey show mean weights that are the lowest for the last 10 years supporting the view that the exceptional 2000 year class is growing slowly. The influence of this low mean weight on the state of the stock is discussed in section 2.10, Quality of the assessment. The weight of 1-ring herring is rather variable, particularly in the catch, which this year shows a high value, the acoustic survey shows a value about 10% below the mean.

2.4.2 Maturity Ogive

The percentages of North Sea autumn-spawning herring (at age) that spawned in 2003 were estimated from the July acoustic survey. 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 years data was described fully in ICES (1996/Assess:10). The values for 2- & 3-ringers taken from the acoustic survey results (Table 2.3.1.4.) For 2-ringers the proportion mature was much lower than last year, and is the lowest in the time-series, though low values have been observed in 1992 and 1993. The data were examined carefully for errors and it was concluded that the 2000 year class has developed slowly since July 2002. Fraction mature, mean weight and mean length-at-age and by year are shown in Figure 2.4.2.1. 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. Slow growing and immature herring were found mostly in the eastern central North Sea. The spatial distribution of fraction mature is shown in Figure 2.4.2.2. The proportion of mature 3-ringers was also above the long-term mean for the period. The percentages are given in Table 2.4.2.1. The influence on the assessment of the low fraction mature at 2-ring is discussed in Section 2.10, Quality of the assessment.

2.5 Recruitment

Information on the development in North Sea herring recruitment is available from the two IBTS indices, the 1-ringer and the 0-ringer index. Further, the ICA assessment provides estimates of the recruitment of herring 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 2002 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 2004 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 recruitment of the recent 2002 year class is very low, and the 0-ringer recruitment based on the MIK index indicates that this year class will be followed by another low year class 2003. The present ICA estimates of 1-ringer recruitment are 19.4 and 7.6 no109 for year classes 2001 and 2002 respectively, while the estimates for 0-ringers are 54.0, 21.2 and 17.4 no 109 for year classes 2001, 2002 and 2003 respectively.

2.6 Assessment of North Sea herring

2.6.1 Data exploration and preliminary results

2.6.1.1 Choice, properties and effect of indices for North Sea herring

Acoustic, Bottom trawl (IBTS), MIK and Larvae (MLAI) surveys are available for the assessment of herring. The surveys and the years for which they are available are given in Table 2.6.1.1 (and appendix 2). A series of basic analyses was conducted last year to check the basic utility of the surveys available (ICES 2003/ACFM: 17). The analysis showed that the surveys had self-consistency in the abundance estimates of successive cohorts. There was also agreement between the different indices in the same year. The 1st and 3rd quarter IBTS surveys indicate good agreement for the 0-ring herring and the 1st quarter IBTS and acoustic survey show agreement on 1-ring. However, in general the different surveys seem to contain different information for older rings.

An analysis of the sampling error by ring by survey (using bootstrap re-sampling as the method, ICES CM 2001/ACFM:22) showed that sampling error is lowest for Acoustic survey at 3 and 4-ring and the MIK survey (IBTS 1Q 0-ring). The sampling error is higher but still reasonable for the IBTS 1st Quarter 1-ring, the Acoustic 2-ring and 5-8 ring and the MLAI SSB index. The IBTS 3rd Quarter index and the IBTS 1st Quarter 3-5 ring index have relatively high sampling errors. Generally, the analysis of variance and correlation indicates that the MLAI provides a good SSB index, the acoustic survey provides good information from 1-8 ring and the IBTS 1st Quarter from 0 and 1-ring. The IBTS 1st Quarter 2-5 ring is useful but noisy, as is the IBTS 3rd Quarter 0-ring index although the latter is still considered too noisy to be included in the assessment. The IBTS 3rd Quarter 1-5 ring index is not consistent. Currently, the MLAI, Acoustic and IBTS 1st Quarter indices are used in the assessment.

The usual assessment tool for the assessment of North Sea herring is ICA. The 4 tuning indices used last year were run separately with the updated catch data, to determine the signal from the individual tuning indices (Figure 2.6.1.1a). The settings were the same as last year (see section 2.6.2). The acoustic survey (1-9 rings), the IBTS (1-5 rings), and the MLAI (as an SSB index) gave very similar perceptions of fishing mortality on the reference age of the separable model (4-rings) with all estimates within the 90% confidence intervals of the others. The MIK index gave a slightly lower estimate, which was below the confidence interval of the acoustic survey. This index contains information for only the youngest age class and such good agreement by tuning with only the 0-group must be viewed as supporting the utility of these datasets. The assessment combining all the indices was within the 90% confidence intervals of all of the individual assessments from the indices (Figure 2.6.1.1a).

The acoustic, IBTS and MLAI series suggest a mean $F_{(2-6)}$ between 2.0 and 2.4 (Figure 2.6.1.1b). All of these are close to the assessment combining all the series. The scatter of 100 estimates of SSB and mean $F_{(2-6)}$ from bootstrapping the residuals of the model with all the tuning indices combined, show that the individual estimates from each tuning series are within that scatter of the estimates (Figure 2.6.1.1c).

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

The HAWG in 2002 moved from arbitrary index weighting as used for the previous 6 years (1996-2001) to a more objective method. This new method was developed from the work of the ACFM study group SGEHAP (ICES CM 2001/ACFM:22) which had one of its objectives to try to rationalise the survey index weighting in the assessment. The analysis carried out is described in last year's report (ICES 2003/ ACFM:17) and in section 2.10. The weighting values are given in Table 2.6.1.2. The weightings applied account for sampling error of the surveys. The WG in 2002 selected index weighting which both minimised the variability in the assessment output but also reduced the retrospective revision of management parameters (F, SSB and recruitment). However, they could not find a method that minimised the revision of all of these parameters but selected the one that performed best for two out of three. This was done by down-weighting the influence of catch of 0 and 1-ring catch in the assessment (Table 2.6.1.2).

The previous WG made an extensive review covering both inverse variance and structural errors, and it considered that the inverse variance method provided the better method. This process meant that the weighting of surveys and catch is fixed and as the sensitivity of the assessment to these weighting values has been greatly studied in recent years, this WG further discusses the implication of these assumptions in section 2.10. The weights express the WG view that the young herring are best estimated with MIK and IBTS surveys, the older herring are best evaluated through the acoustic survey and the SSB should be estimated through the MLAI.

2.6.1.3 Period of separable constraint

Changes in the regulations in 1996 have affected the various components of the fishery differently. Recent meetings of this WG split the separable period into two different periods: 1992-1996 and 1997 onwards. In the WG 2001 it was considered that the number of years after the change in selection was long enough to use only a single separable period of four years. In the 2002 and 2003 WGs a separable period of 5 years was used. An exploration of a 4, 5 or 6 year separable period with current data (2004 WG) showed no important differences in the model fit or outputs. The estimation of F at reference age (4-rings) was not significantly different (Figure 2.6.1.2a), although the confidence interval of the 4 year separable period estimate was slightly broader. There was negligible difference in mean $F_{2\text{-}6}$ and SSB when using a 4, 5 or 6 year separable period (Figure 2.6.1.2 b & c). So the 5 year separable period was maintained in the current assessment.

2.6.1.4 Comparison of assessment models

ICA has been used for at least the last eight years for the assessment of North Sea herring. It was felt that after the findings of the recent WGMG (ICES CM2003/D:03), the performance of ICA should be compared with another regularly used assessment model, XSA. Concern at WGMG was raised about the instability in the selection patterns at older ages impacting on the earlier part of the time-series. The approach used was to choose XSA settings that reflect as many of the assumptions of the ICA model of North Sea herring. The model settings are given in Table 2.6.1.3 and the summary of the results in Table 2.6.1.4.

In a situation of a trend in F, or highly variable F in recent years, XSA is very sensitive to the number of ages used for F shrinkage. Dependency on the actual level of shrinkage, compared to number of ages used was much smaller. The XSA assessment is very consistent with the ICA assessment (Figure 2.6.1.3). The slightly higher estimate of F and lower estimate of SSB in the terminal year by XSA can be explained by the exclusion of the MLAI in the XSA (which cannot use biomass indices) and the effect of shrinkage during a period of declining F, increasing it towards the mean of recent values.

2.6.1.5 Model fit and residuals.

Examination of the residuals of the catch and surveys shows similar patterns as last year. The weighted residuals of the separable model fit show a random distribution by ring and year of small residuals (Figure 2.6.1.4). The residuals of the acoustic survey show a random pattern in the most heavily weighted ages (1-3 rings, Figure 2.6.1.5) with a group of negative residuals at older ages in recent years. The residuals are small but clearly non-random. As mentioned above this is similar to last year's assessment and reflects a different signal in the surveys compared to the catch. The surveys are suggesting a slightly higher fishing mortality than given by the catch information (section 2.3.1). Whilst these differences are very small, they are explored here to maintain the quality of the assessment.

A difference between the surveys and the catch has been crudely compared by using the change in the ratio between the survey estimates of total abundance against the catch in numbers (Figure 2.6.1.6). The relationship changed in 1996, as the management of the stock changed. The increase after 1996, suggests that proportionately more fish were being caught in the surveys compared to the catch. This crude method of analysis, which reflects changes in the exploitation pattern, is based on a ratio, and thus it is difficult to explain which of the two variables has the causal link to any properties seen.

Plotting the log catch ratios from 1993 in the catch and comparing them to the log abundance ratios from the acoustic survey (Figure 2.6.1.7) shows a declining trend in the total mortality experienced by the stock, this is particularly marked in the 2 and 4-ring fish. This suggests that total mortality is declining (table 2.6.1.5). The slopes through the catch ratios (declining rate of total mortality, table 2.6.1.5) are steeper for the catch than in the acoustic survey, suggesting that the estimate of total mortality from the acoustic survey is reducing slower than in the catch. However it is probable that these declining slopes are not significantly different and testing the slopes of data with these properties is very difficult. But again, this supports the concept that the acoustic survey does have a different trend in catchabilities compared to the landings and slightly different impressions of F are coming from different sources. This can occur for at least two reasons. Firstly the catchabilities of the surveys may be decreasing, secondly that there has been a change in the reporting of the true catch. As the North Sea herring quota increases, it has been anecdotally reported that the catches are not actually increasing as fast, but the level of misreporting is declining. An increase in actual landings would have a negative impact on the market price of herring. Hence, the increase in quota is being used to increase the proportion of catch being officially reported. This may result in the real catch remaining relatively stable, whilst scientists assume an increase in catch. A simulation exercise showed that this pattern of negative residuals in the surveys (seen in Figure 2.6.1.5) could be created by assuming that a prolonged period of misreporting was being brought to an end.

As stated earlier the negative block in the weighted residuals of the acoustic survey is very small. A possible mechanism for their appearance has been proposed and found to be practical. However these weak, but not random blocks of residuals, do not have a major or detrimental effect on the other diagnostics of the stock assessment.

2.6.1.6 Conclusions of exploration of the assessment.

In terms of the assumptions about the separable period, the utility of the tuning indices and the weighting of the indices and catch, this assessment appears robust. Preliminary analysis suggests that the recent decline in mortality shown by the acoustic survey is less than the decline shown by the catch. The different mortality signals should be monitored in the future. However as the rest of the assessment appears relatively stable and comparable with another assessment technique (XSA, section 2.6.1.4), and the model residuals were small, it was concluded that the assessment method would be maintained as last year, with comparable settings, tuning indices and weightings. The consistency of the assessment is further discussed in section 2.10.

This formulation of the assessment is also supported by the recent external and independent review of the North Sea herring assessment carried out for the North Sea Commission, where the consistency, precision and quality of the assessment were judged as credible and fully acceptable as a tool for management advice.

2.6.2 The stock assessment

2.6.2.1 The model used

This stock remains on the ACFM observation list, however following a full examination of the settings of the model, the assessment conforms to an update assessment. The assessment of the stock was carried out by fitting the integrated catch-at-age model (ICA) including a separable constraint over a five-year period as explained above (Patterson, 1998, Needle 2000), see section 1.6 and the quality handbook. The input data are shown in table 2.6.2.1.

2.6.2.2 Results

The ICA output is presented in Tables 2.6.2.2 and 2.6.2.3, with model fit and parameter estimates in Table 2.6.2.4, and Figures 2.6.2.1 - 2.6.2.19. Uncertainty analysis of the final assessment is presented in Figure 2.6.2.20, although this only reflects the uncertainty in fitting the model and does not include uncertainty in the model specification. Estimates of fishing mortality at 2-6 ringer in 2003 vary in a similar way to last year, between 0.21 and 0.28 (25 and 75 percentile respectively) and SSB in 2003 between 1.59 and 1.92 million tonnes. There appears to be a relatively good agreement between the point estimates of the final assessment and the median values of the ICA bootstrap realisations. Long-term trends in yield, fishing mortality, spawning stock biomass and recruitment are given in Figure 2.6.2.21.

The spawning stock at spawning time 2003 is estimated at approximately 1.74 million tonnes. The abundance of 0-ring fish in 2003 and 2004 are low (the 2002 and 2003 year classes) with the estimate for 0-rings in 2004 being the lowest since 1980. The strong 1998 and 2000 year classes are still evident in the population, with the 2000 year class at 3 ring in 2004 being the highest in the series since 1964.

Fishing mortality on 2-6 ringer herring in 2003 is estimated at around 0.24, and on 0-1 ringer herring at 0.04. The value of F for 2002 agrees with last year's assessment and is also 0.24.

Analytic retrospective analysis of the assessment (Figure 2.6.2.22) shows that the perception of the state of the stock in 2002 does not change with the addition of 1 years extra data. Assessments in 1994 and 1995 agree with the current perception, and the bias in the intervening years may be due to the use of a 5 year separable period through the management change in 1996. The retrospective selection patterns show a marked change in 2001 (Figure 2.6.2.23), this is probably due to separable period moving back into the time of the change in the catching behaviour and management of the fishery in 1996. The perception of F at reference age of the separable model (4-ring) in 1999 has been very similar (Figure 6.2.2.24).

2.7 Short-term projection by fleets.

2.7.1 2.7.1 Method

The program used (MFSP) was developed two years ago in the HAWG and was used in a slightly amended form at last years meeting (Skagen; WD to HAWG 2003). This year, it was decided that the slow growth and maturation of the large 200 year class needed to be taken into account. The program was therefore amended to use different weights and maturities in each of the prediction years. The standard tool that currently is available for short-term predictions (the MFDP program) has some limitations with regard to management options that can be covered. In particular, when varying the fishing mortality for one fleet, the fishing mortalities for the other fleets are assumed constant at *status quo* F. For the North Sea herring, managers have agreed to constrain the total outtake at levels of fishing mortalities for ages 0-1 and 2-6, and need options to show the trade-off between fleets within those limits. 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 2004 the total stock number was taken from ICA (ica.n – file)

For 2005 and 2006, the recruitment was set to 50 443 million which is the geometric mean of the recruitments of the year classes 1981 – 2000.

Fishing Mortalities: Selection by fleet at age was calculated by splitting the total fishing mortality in 2003 for each age proportional to the catches by fleets at that age. These fishing mortalities were used for all years in the prediction.

Mean Weights-at-age in the stock: Since the weights used in the assessment are already smoothed, the values for 2003 (Table 2.6.2.2) were used in the prediction.

Maturity-at-age: The average maturity-at-age for 2000 to 2002 was used (Table 2.6.2.2), except for the 2000 year class. For this year class, which so far has matured more slowly than usual, the maturity of 3-ringers in 2004 was taken to be the maturity-at-age 2 in 2003 (0.43) raised by a factor of 1.31, which is the mean relative increase in maturity from age 2 to age 3 in the period 1991-2002. For 2005 and 2006, this year class was assumed to be fully mature.

Mean weights in the catch by fleet: The mean weights by fleet for the years 2000 – 2002 were used, except for the 2000 year class, which appears to have been slower growing than usual. For this year class, the ratio between the weight-at-age 2 in 2003 and the average weight-at-age 2 was maintained for 2004 and 2005.

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 2004 and management option tables for 2005

Assumptions and Predictions for 2004

Due to the recent change in the fishery, and the low level of retrospective error in the most recent assessment, only options assuming Fstatus quo (F2004 = F2003) are presented. The partial fishing mortalities at $F_{status\ quo}$ appear in tables 2.7.1.

Management Option Tables for 2005

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

In each set, a range of fixed catches were assumed for fleets C and D (10 000-50 000 t in steps of 5 000 t for fleet C and 2 000 – 22 000 t in steps of 2 000 t for fleet D). For each combination of these, the catches by the fleets A and B were adjusted to give an F0-1 and an F_{2-6} at specified values (0.10 or 0.12 for F_{0-1} and 0.20 or 0.25 for F_{2-6}).

The text table below is an overview of the options tables (Tables 2.7.2 a-c)

Assumption for 2004	F_{0-1} 2005	F_{2-6} 2005	Catch fleet C 2005	Catch fleet D 2005	Table
$F_{status\ quo}$	0.10	0.20	10 – 50 000 t	2 – 20 000 t	2.7.3a
	0.10	0.25	10 – 50 000 t	2 – 20 000 t	2.7.3b
	0.12	0.25	10 – 50 000 t	2 – 20 000 t	2.7.3c

All predictions are for North Sea autumn spawning herring only

In addition, an extract of Tables 2.7.2a-c containing a limited number of management options is presented as Table 2.7.3. This table also includes the option that $F_{status\ quo}$ is continued in 2005.

All scenarios presented (Tables 2.7.2. a-c) indicate a continued increase in spawning biomass and in yield. This is mainly caused by the 1998 and 2000 year classes. The weak 2002 and 2003 year classes leads to comparatively low catches in the fleets exploiting mainly juveniles. The catches by the A fleet are estimated close to 500 000 tonnes at $F_{2-6} = 0.25$, while the catches by the B, C and D fleets is a trade-off between these fleets, the sum of which will be approximately 60 – 100 000 tonnes with an $F_{0-1} = 0.12$.

2.7.4 Comments on the short-term projections

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

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

In a longer term perspective, the small year classes 2002 and 2003 will lead to reduced catches and SSB in the coming years (see Section 2.12).

The predictions presented here account for the delayed maturation of the large 2000 year class. To what extent the increased stock size will lead to slower growth and maturation in the future remains to be seen. There are some indications that this was the case when the stock was large prior to 1960. (ICES 1998)

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 advise, or if indeed such changes are taking place. However, some of the important predator stocks are currently in a poor condition.

2.8 The harvest rule for North Sea herring revisited

The management arrangement that was adopted in 1998 by EU and Norway has now been in effect for 6 years. The agreement is to set quotas according to a fishing mortality for adults (F2-6) at 0.25 and a fishing mortality for juveniles (F0-1) at 0.12, as long as the SSB is estimated to be above 1.3 million tonnes. At SSB below 1.3 million tonnes, the agreement was just to adapt *'the fishing mortality 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.'*

Most of the time since then, the stock was in a rebuilding phase, the SSB being estimated below the trigger value of 1.3 million tonnes. In the rebuilding period, the parties decided on a year to year basis to have a fishing mortality on adults (F2-6) at 0.2 as a target, and to keep the fishing mortality for juveniles as low as at all possible. Thanks to strong regulations, the F0-1 was about 0.05 most of the time.

The agreement was to a large extent based on medium-term simulations made in 1997 (Patterson & al 1997). Since this is 7 years ago, and the management regime as agreed only became effective recently, the WG found it appropriate to revisit the harvest rules with new simulations. Another incentive was the suggestion by the Methods WG

(ICES CM 2004/D:03) and the SGLTA (ICES CM 2004/ACFM:16) that the North Sea herring would be a good candidate for evaluation of harvest rules with software already existing.

The HCR was evaluated by applying it to a simulated population in a 10 years time perspective. This was done as a forward projection of the stock with given fishing mortalities and assumed natural mortalities, where the fishing mortalities were derived from the removal decided by the HCR. The HCR decides on either a fishing mortality or a catch according to the SSB resulting form the application of the rule. Errors in future assessments and in future implementation of the decided quotas were included as distributions.

The software used was STPR (Skagen, 1997a) for simulation of harvest rules in the medium-term and LTEQ (Skagen, 1997b) for long-term stochastic equilibria.

The model was run for two fleets, each characterised by its partial fishing mortalities at age. The first fleet ('Adult') corresponds to fleet A, while the other ('Juvenile') fleet corresponds to fleets B, C and D.

Recruitment: The stock-recruitment function to be used was scrutinised, since this is the most critical element for the risk associated with the management regime. The recruitments were modelled as R(y) = R'(SSB(y))*exp(ε(y)) where R'(SSB(y)) is a deterministic stock-recruit function and ε(y) is a random number with a normal distribution.

Both a Beverton-Holt function and the 'Ockhams razor' – with a constant recruitment at SSB above a break point and a linear reduction below that level, were explored.

A spreadsheet was used to minimise the sum of squared log residuals of historical recruitments. With the Beverton-Holt function: *R = a*SSB/(b + SSB)*, the *a*-parameter became quite large: $83*10^9$, indicating that the recruitment would continue to increase with increasing SSB well beyond the range in the current set of stock-recruit pairs. The Study Group on Stock-Recruitment relationships for North Sea herring (ICES 1998) investigated stock and recruitment back to 1947. In the period prior to 1960, when the spawning biomass at time was estimated at up to 5.3 million tonnes, most year classes were in the order of $30\text{-}60*10^9$**,** the exceptions being the 1956 and 1960 year classes, that were above $100*10^9$. From this experience, it does not seem likely that the shape of the Beverton-Holt curve gives a realistic representation of the recruitment at large SSB.

Estimating the level parameter in the Ockhams razor function:

$$R = a; \quad SSB \geq b$$
$$R = a*SSB/b; \quad SSB < b$$

at various values for the break-point *b* gave slightly increased estimates at increasing values for the break-point. The best fit was obtained with a break point of *b* = 609 000 tonnes, giving a plateau level of *a* = $52.6 * 10^9$. This fit is clearly better than with the Beverton-Holt function

When using the stock-recruitment relation in a prediction, it is mandatory that the error is independent of the SSB. In the model fits described above there were moderate correlations between residuals and SSB. Adding the constraint that the correlation be zero, increased the SSQ slightly, and reduced the level parameter in both models.

The text table below gives an overview of the explorations.

Model	*a*-parameter*10^{-9}	*b*-parameter	SSQ	Correlation
B-H as (ICES 1998)	61.99	$428*10^6$	15.34	0.05
B-H: no constraints	82.96	$6594*10^6$	14.74	-0.08
B-H: Corr = 0	72.23	$506*10^6$	14.88	0
Ockham: no constraints	52.47	608	13.55	-0.09
Ockham: Corr = 0	49.34	537	13.70	0

Based on these explorations, the Ockhams razor function as derived with constraints on correlation (i.e. the last line in the table above) was used in the simulations.

Figure 2.8.1. shows a plot of cumulated probabilities of log recruitment residuals according to the distribution model used for medium and long-term simulations, versus cumulated probabilities of historic recruitment residuals (Q-Q-plot).

The STPR software assumes a log-normal distribution of the recruitments. The distribution was truncated to avoid values outside the range that has been recorded historically. Figure 2.8.2. shows the cumulated distribution of recruitments generated for year 10 by the STPR simulation programme, together with the cumulated distribution of historic recruitments. The shape of the two distributions diverge to some extent, but the arithmetic means are virtually identical.

Initial numbers: These were drawn randomly from a multivariate normal distribution of the logarithm of the numbers. The mean values and the variance-covariance matrix were obtained from the most recent ICA assessment.

Weights-at-age and maturities at age were drawn from historical values, by drawing years and use all weights and maturities at age for that year. For practical reasons, the same weights in the catch were used for both fleets.

The selection at age was as estimated by ICA for 2003, split on fleets according to the catches in 2003.

Long-term equilibria

In the long-term, the 5-percentile of the SSB seems to follow a near linear relation between the fishing mortality as juveniles and as adults. This is shown for some SSB-levels in Figure 2.8.3. At a given level of the 5-percentile, the sum of F for the juvenile fleet, expressed as F0-1, and the F of the adult fleet, expressed as F2-6, is nearly constant, as shown in Figure 2.8.4. Some examples of this relation is shown in the text table below.

Sum of F0-1 and F2-6	5 percentile of long-term distribution of SSB
0.55	800 000
0.47	1 000 000
0.40	1 300 000

These results are in accordance with what has been found previously (Patterson & al, 1997).

Medium-term simulations with no error in assessment and implementation.

For these simulations, the fishing mortality for juveniles was kept at 0.12 and for adults at 0.25. If this led to a predicted SSB for the next year below 1.3 million tonnes, the F on juveniles was reduced to 0.05 and for adults to 0.2. The effect of deviating from these standards was explored briefly, and the results are presented in Table 2.8.1

Medium-term simulations with error in assessment and implementation.

As an example of the effect of overestimation of the stock abundance and overfishing of quotas, a similar set of simulations were made with the assumption that the assessment overestimated the stock with a factor of 10% ± 20% (SD), assuming a normal distribution of the error. Likewise, a 20% ± 20% (SD) overfishing of the quotas was assumed. The results of these runs are shown in Table 2.8.2.

The perceived SSB will be larger than the true SSB because of the overestimation of the stock.

Both a lower action level than 1.3 million tonnes, and a higher fishing mortality on either adults or juveniles leads to a risk that the stock in reality will be below 800 000 tonnes higher than 5% in this example.

Conclusions

The results from this study are quite in line with those that formed the background for the current regime (Patterson & al, 1997). The current regime implies a low risk of undue reduction of the biomass. The impact of the level of juvenile fishing mortality is mostly to reduce the subsequent catch opportunities on the adults, although a high (e.g. 0.2) juvenile fishing mortality leads to some rise in the risk that SSB falls below the action point of 1.3 million tonnes. A modest increase in adult F is tolerable, but gives a relatively small gain in yield, while a larger increase leads to increased risk.

The performance of the management rule is strongly dependent on the precision of the assessment and the adherence to the quotas. In the example here, which may be realistic, there is a substantial risk that the action point is exceeded, and even the risk to the limit biomass of 800 000 tonnes is noticeable. Reducing the target Fs has a beneficial effect. Hence, unless the assessments are very precise and the quotas are strictly adhered to, one should hesitate to increase the F-levels in the current rule.

2.9 Precautionary reference points

In 2003, SGPRP (ICES 2003 ACFM:15) suggested to reduce the $\mathbf{B}_{\text{lim}}$ 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 (section 2.8) 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, the HAWG decided not to propose any revision of the reference points at present for the following reasons:

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

Moreover, there is a well functioning harvest control rule in place for this stock, and apart from $\mathbf{B}_{\text{lim}}$, the current reference points are derived from this HCR. The target F in the HCR was adopted by ACFM as the $\mathbf{F}_{\text{pa}}$, while the trigger point at which F should be reduced below the target is adopted as $\mathbf{B}_{pa}$. Future revisions of the reference points should not trigger alterations in this HCR (see section 2.8).

2.10 Quality of the Assessment

2.10.1 Sensitivity of the assessment to sampling variability in the input data

The influence of sampling variability in the input data on the output of the assessment has been explored through the bootstrap analysis, documented in SGEHAP report. This was reported in detail in the 2003 Working Group report. All the analyses carried out by this method are conditional on the total catch in tonnes, the Working Group choice of fixed natural mortality and the choice of assessment method ICA (Patterson 1998, and Needle 2000) with predefined inverse variance weighting of the data. The model formulation and index weighting are described in Section 2.6.1. For this study eight different terminal years from 1994 to 2001 were tested and the addition of two years is not expected to alter the broad conclusions. It is intended to re-evaluate this work when a benchmark assessment is carried out. Figure 2.10.1 taken from the 2003 WG report shows the influence of sampling variability on each data source in the assessment. The results for the eight years are combined by expressing the output as the relative deviation from the mean of the set obtained from the assessments based on fixed value input data. This figure shows that the estimates of terminal SSB and F_{adult} are the most sensitive to the precision of the Acoustic survey. The MIK, Larvae and IBTS surveys form a second group with precision influencing the results to a lesser extent. The variability due to sampling for estimates of catch in numbers-at-age, the weights-at-age in the stock and the fraction mature form a third group of factors, and these have the least influence. SSB does vary a little due to sampling errors in mean weights and maturity but F is almost independent of these parameters. The results show that the estimates of TAC were almost equal dependent on MIK, IBTS and Acoustic surveys, with some influence from catch-at-age and MLAI but almost no influence from maturity or mean weights in the stock.

All the data combined suggest that the precision of the input data contributes to a range of outputs between 0.75 to 1.21 times the TAC, although there are about 1% of outlying values with greater deviation.

2.10.2 Weighing of indices in the assessment

The index weighting in the ICA assessment is given in section 2.6 As can be seen in Figure 2.10.1 the relatively high weights on catch (3.1 & 2.6 for 2 & 3-ring herring respectively) do not make the assessment overly dependent on measurement variability in the catch. While the spatial variability of growth and fraction mature for North Sea herring is considerable (Figure 2.3.1.4), the influence of the sampling variability in the main management criteria for the stock is small and its influence on the TAC is minimal.

Two XSA assessments are presented in section 2.6. The weighting of indices in the current assessment is compared to weighting in these two XSA assessments and an adaptive assessment using inverse residual weighting within ICA in Table 2.10.1. Both XSA assessments and the ICA adaptive assessment change weighting within the model. The weighting is taken directly from the model output tables. It is difficult to compare these values directly. In order to make comparison easier the weighting in each assessment have been normalised to give the total weight to the acoustic survey a value of five, which is close to the value for the three adaptive assessments.

The common features to weighting for these assessments are:

- The current assessment (ICA fixed weight) and both XSA assessment give a weighting to the Acoustic survey at about three times the IBTS index.
- All the assessments give declining weight with age on the IBTS survey

The differences between the assessments are:

- Adaptive weighting gives much lower weight to the MIK index
- Adaptive weighting gives more weight to the older ages in the acoustic survey. (ICA adaptive has a flat profile of weighting by age, XSA weights rise with age.)

These specific weighting issues were addressed in SGEHAP.

- The high weighting on the MIK was examined; although the survey is known to be rather precise there was concern that the use of uniform mortality through the year at age 0-ring might be inappropriate in the model and thus reduced weighing might be a better solution. Nevertheless following tests it was found that reduced weighting gave more variable results and high weighting on the MIK gave a more stable assessment.
- For the older ages in the acoustic survey it was found that allowing flexibility in weighting gave more weight to more variable data at older ages in the acoustic survey and by forcing reduced weights here the assessment became

less sensitive to known increased variability at these ages. It was thought that the model fit was too flexible at these ages and that this flexibility allowed 'over fitting' resulting in variable output.

2.10.3 Update of catch numbers and mean weights-at-age in the catch

SGREDNOSE worked in 2003 to provide updated catch (see Section 1.4.1) and delivered a completely revised data set for HAWG in 2004. There have now been revisions to the catch data and weights-at-age in the catch covering the year 1995 to 2001. Only in 1995 and 1996 did these changes in catch exceed 10% and the influence of the changes on the assessment was found to be negligible. The change in terminal year was very small (<0.1 %) The biggest change was in 1993 (1.5% in SSB and -2% in F) and 1995(-3% in SSB and +3% in F).

2.10.4 Sensitivity to measured maturity

The 2003 acoustic survey estimate of the fraction of 2-ring herring that spawned in 2003 was 43% of the year class. This is the lowest fraction mature in the recent history of the stock (84-2002) and compares with values of 77% and 86% for the years 2001 and 2002 respectively. The source of the data and comparison with growth parameters for the year class are discussed in section 2.4.2. The precision of this measure was investigated through a simple bootstrap of the acoustic survey data. The 5 and 95 percentiles on measured fraction mature were 39% and 61% respectively, these percentiles ignore spatial autocorrelation in the data and the true intervals are probably closer to the mean. The data therefore support the view that there is a significant decrease in fraction mature which is probably due to slow growth of the very large 2000 year class. The implications for the assessment is that the SSB is estimated as lower than would otherwise be the case. The effect was evaluated by comparing of growth and maturity data from the acoustic survey in previous years. This shows that had all the 2-ring herring both grown and matured at a rate equal to the average of the previous 3 years (76% mature) this would have resulted in an increase in SSB of 27% or 2.2 Mt.

2.10.5 Use of tuning indices in the 2004 assessment

In this year's surveys, Acoustic, IBTS and MLAI surveys display a substantial upward trend in SSB, from 2002 to 2003, the MLAI gives the highest value. All three indices lead to an unequivocal indication of rising biomass when used in the assessment on their own along with the catch data. The IBTS indicates a reduction in SSB in 2004 as the low 2001 year class fails to replenish the stock. ICA provides a variance/covariance method to bootstrap parameters estimated in the assessment. Five scenarios have been examined, the four main indices (Acoustic survey, IBTS, MIK and MLAI) and the final assessment. Figure 2.10.3 shows 100 bootstrap estimates for each scenario. The spread of terminal F and SSB is consistent among indices and with the combined assessment, with the exception of the assessment using the 0-ring MIK index which gives most of the high estimates of biomass. As this index provides estimates of only 0-ring recruits it is not particularly informative for the current state of the stock. From Figure 2.10.3 it can be seen that there is little difference in perception of SSB when using each index separately (excepting the MIK) or when they are combined in the final assessment.

2.10.6 Comparison with 2003 assessment and projection

The 2004 assessment is in extremely good agreement with last years assessment with the exception of reduced fraction mature of the 2000 year class. See table below.

Assessment year	SSB in 2002	F2-6 in 2002	SSB in 2003	F in 2003
2003	**1.59 M t**	**0.24**	Projected **2.17 Mt**	**Projected 0.25**
2004	**1.58 M t**	**0.24**	Assessed 1.74 Mt ***Corrected for low maturity **2.22 Mt**	**Assessed 0.24**

***As shown in the above table and discussed in detail in Section 2.4 due to the slow growth and late maturing the SSB of the 2000 year class has been estimates as lower. If the 2000 year class had developed in the same manner as the previous 3 year classes (as assumed in the projections) the current SSB would have been 2.22 Mt.

2.10.7 Uncertainty in the 2004 assessment

The current estimate of SSB is dominated by the highly abundant 2 and 3-ringers in 2003 and results from a compromise between the various sources of information.

The 2000 year class (90,000 million) is thought to be third highest in the history of the stock, at 84% above geometric mean recruitment (1983-2000), and larger that the 1998 year class (71,000 million) which has provided the recent large rise in the SSB. Estimates of incoming year classes are still uncertain, the 2001 year class (2-ring herring in 2004) have been estimated by the MIK at 0-ring, IBTS at 2&1 and Acoustic at 1-ring; these four estimates are all in good agreement (54,000 million 12% above geometric mean) with log residuals less than ±0.30. The 2002 year class (1-ring in 2004) is estimated by the MIK and the IBTS which are in very good agreement and is thought to be low at about

43% of geometric mean recruitment (this was estimated at 40% of geometric mean recruitment in 2003). The 2003 year class is estimated only by the MIK and is even lower at 38% of geometric mean recruitment.

2.10.8 Comparison of ICA with XSA

For comparison two XSA runs are presented in Section 2.6.1.4. To have similar assumptions to ICA XSA is run with weak shrinkage, and the full data set for all the age based surveys used to obtain the survey catchability (Q). A second higher shrinkage XSA run has also been carried out for comparison. There are only small differences in the results for these three assessment methods (Figure 2.10.2). Compared to this years final assessment the weakly shrunk XSA assessment shows less than 6% reduction in SSB. When shrinkage is increased in XSA there is a slightly larger reduction in SSB in the terminal year and a small rise in terminal F. The perception from all these assessments is of a lightly exploited stock with SSB rising from around 800,000 t in year 1999 to between 1.55 to 1.75 Million tonnes (Mt) in 2004.

2.10.9 Comparison with earlier assessments

As indicated above the current assessment agrees very closely with the 2003 assessment, except for the fraction mature in the 2000 year class.

An historic retrospective of assessments by sequential working groups is presented in Figure 2.10.4. Values for retrospective bias and standard error (Jónsson and Hjörleifsson 2000) are presented in the figures. This analysis suggests an average bias of about 0.18 for SSB and –0.19 for $F_{2\text{-}6}$ for the period 1992 to 2003. The magnitude of the revision seems to be different in different periods, it is less in the last four years (2000-2003) than for the years 1998 and 1999, and then improves again in 1996 and 1997. Comparison with the retrospective of this years assessment (analytic retrospective), presented in section 2.6, shows a similar pattern. Assessments in 1996 and 1997 are more similar to the current assessment than those in 1998 and 1999. It is thought this period of the assessment has been made more difficult due to the difficulties in modelling the change in the fishery from 1996 and 1997, following the changes in management advice. The even earlier retrospective revision seen at the beginning of the time-series from 1992 to 1995 is the poorest and is probably due to changing data series and methods through this period. It is hoped that currently the assessments can be more stable, because the WG has currently adopted consistent use of a single model (ICA) and has available data of a consistent quality. However, for the future it remains to be seen if this improvement is sustained. For example if fishing practices change again in response to stock size and management changes the assessment may again become more unstable.

2.10.10 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 last year. It is intended to continue to use this programme in the future. Last year's short-term prediction suggested that the North Sea autumn-spawning herring stock SSB in 2003 would be around 2.1 Mt. This compares well with this year's estimate of the 2003 SSB which is 2.2 Mt, once the low maturation was taken into account. This demonstrates that the current prediction procedure for stock numbers is working well. 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.

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

Over many years the working group has attempted to assess the contribution of winter spawning Downs herring to the overall population of North Sea herring. There is a separate TAC for herring in areas IVc and VIId as part of the total North Sea TAC. The TAC for IVc and VIId in 2004 was increased from 59,542 tonnes to 66,098 tonnes, the highest TAC since 1986 (Table 2.11.1). This was despite the ACFM advice in 2002:

> *"..TACs for this component have been significantly exceeded in all years. The TAC for this component was increased in 2002 (to 42,000 t) following the advice of ICES in 2001. However, the strong increase in SSB in the North Sea stock in 2001 is not mirrored in the Downs component, and therefore the TAC for Downs herring should not increase."*

The 2003 ACFM advice was:

> *"that it should not increase faster than the TAC for the North Sea as a whole. ... a share of 11% on the total North Sea TAC (average share 1989-2002) would be an appropriate guide to distributing the harvesting among Downs herring"*

A range of methods have been used by the WG in recent years to determine the proportion of Downs herring (relative to the total North Sea) and trend in population size of Downs herring. These are the proportion of 1-ringer juveniles that are less than 13cm in length in the IBTS 1Q survey, the Larvae Abundance Index (LAI) for the IVc and VIId area and the short time-series of MIK surveys in the region. In addition, this year the larvae data were used to construct a primitive Larvae Production Estimate (LPE) with assumed growth of 0.25 mm per day and a daily mortality rate of 0.1. None of these methods address what proportion of F occurs outside VIId, during the summer fishery on mixed feeding aggregations in the North Sea.

All of the indices show relatively high estimates for the current year except for the MIK index. The larvae are generally considered to reflect the spawning potential in the area (i.e. the component's SSB) while the IBTS and MIK indices reflect year class strengths (Figures 2.11.1-3). The recent value in the index of small (<13cm) 1-ringer fish from the IBTS Q1 survey is high, suggesting a good recruitment coming from the 2002-2003 year class (Figure 2.11.1). The proportion in the catch is also high suggesting that the year class strength relative to the other North Sea herring components is relatively higher than last year (Figure 2.11.1). The MIK survey suggests that the 2003 year class will be poor (Figure 2.11.2). Both the larvae abundance and larvae production index suggest that the spawning potential of the component has been increasing since 1994 (Figure 2.11.3). However none of these indices provide information on the exploitation of the component.

New information from the HERGEN project (genetics and otolith microstructure analysis) supports the previous hypothesis that the juveniles of Downs herring are found in IIIa..

There is a vital need for a reassessment of the methods used to investigate the size of the Downs herring stock component. Section 1.4.6 of this report documents new projects that are aimed at addressing the provision of management advice specifically for the Downs herring. To conclude, the current state of the component is unknown. The WG's understanding of the substock dynamics is unlikely to improve until further examination of the existing time-series of surveys takes place, in light of both alternative assessment methods, and a greater knowledge the ecology of Downs herring.

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 within precautionary limits and harvested sustainably. SSB in 2003 was estimated at 1.74 million t and is expected to increase to 2.1 million tonnes in 2004, which is above the $\mathbf{B}_{pa}$ of 1.3 million t. SSB has increased gradually since the low stock size in the mid-1990s, in response to reduced catches, strong recruitment and management measures that reduced exploitation both on juveniles and adults. In 1996 the fishing mortality for the adult part of the stock was reduced to 0.4. It has further decreased in subsequent years, being close to 0.25 in 2002 and 2003. For juveniles the fishing mortality remained below 0.1 since 1996.

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

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

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

4. *By-catches of herring may only be landed in ports where adequate sampling schemes to effectively monitor the landings have been set up. All catches landed shall be deducted from the respective quotas set, and the fisheries shall be stopped immediately in the event that the quotas are exhausted.*

5. *The allocation of the TAC for the directed fishery for herring shall be 29% to Norway and 71% to the Community. The by-catch quota for herring shall be allocated to the Community.*

6. *The parties shall, if appropriate, consult and adjust management measures and strategies on the basis of any new advice provided by ICES including that from the assessment of the abundance of the most recent year class.*

7. *A review of this arrangement shall take place no later than 31 December 2004.*

8. *This arrangement entered into force on 1 January 2002.*

Landings of adult herring in recent years have consistently exceeded the agreed TAC, mainly due to unallocated catches and catches misreported into and out of the North Sea (see section 2.1).

The 1998 year class and the 2000 year class appear to be very strong in all the surveys and in the catches. They will comprise 39% and 17% of SSB in 2004 respectively. In the past large year classes have tended to have a lower maturation rate than the long-term average. These signals have not been detected for the 1998 year class as the proportion mature appears to be above average. However, the 2000 year class has been seen to exhibit a reduced growth and maturation in 2003. As this is expected to continue in 2004, the reduction has been taken into account for the short-term projections.

The ICES advice for 2004 is based on the projected SSB in 2005 being above 1.3 million t. SSB in 2005 depends on the fisheries in 2004 and that part in 2005 that takes place before spawning. About 2/3 of the total mortality is expected to be realised before spawning each year. The increase in SSB projected for 2004 depends on the incoming 2000 and 2001 year classes. Observations from different surveys indicate that the first of these is very strong and the second near average. Generally, the surveys provide more reliable indications of year class strength than catches of juveniles do. Initial estimates of the 2002 and 2003 year classes suggest that they are both the lowest observed in the last 23 years. This is expected to reduce the catch of juvenile herring in the B- C -and D-fleets in 2004. Medium-term projections maintaining F*status quo* (which is very close to EU Norway agreement of F adult = 0.25 but with lower exploitation on juveniles) demonstrate that it will be necessary to reduce catches for the A-fleet in 2006 and 2007. This reduction will be about 12 % by 2007. Increase in exploitation of juveniles (to F=0.12) or adults above this level may require greater reduction

Discards were so far considered to be relatively unproblematic in the North Sea herring fishery (less than 5% of the total catch, based on observer sampling programs). In 2002 for the first time, onboard sampling observed substantial discards of herring in the mackerel fishery in the 3rd and 4th quarter in Div. IVa(W). The discard figure used for the assessment was 17,000 t. For 2003, discarding was estimated at 4,100 t. These estimates come from rather limited reports from discard programs.

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.

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 (Downs herring). 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 since 1989. The sub-TAC was increased in 2003 (to 42,673 t) following the advice of ICES in 2001. In 2003 and 2004, it was increased first to 59,542 t and then to 66,098 t against the advice of ICES. The 2003 ACFM advice was *"that it should not increase faster than the TAC for the North Sea as a whole. … [A] share of 11% on the total North Sea TAC (average share 1989-2002) would be an appropriate guide to distributing the harvesting among Downs herring"* The current sub-TAC for Downs herring is 1.6 times the long-term annual TAC of the component, whereas the North Sea TAC is 1.2 times the long-term TAC. It has long been argued that due to the different characteristics of the Down component (Cushing and Bridger, 1966; Burd, 1985) it is more susceptible to recruitment over fishing. Hence the working group is concerned that until better evidence is available, relative exploitation on this component should not rise above the long-term mean proportion for the area.

Table 2.1.1 HERRING caught in the North Sea (Subarea IV and Division VIId).
Catch in tonnes by country, 1994–2003. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1994	1995 [9]	1996 [9]	1997 [9]	1998 [9]
Belgium	144	-	-	1	-
Denmark	121559	153361	66733	38324	58924
Faroe Islands	-	2018	815	1156	1246
France	27941	29503	12500	14525	20784
Germany, Fed.Rep	38394	43299	14215	13380	22259
Netherlands	76155	82286	42792	35985	49933
Norway [4]	125522	131026	43739	41606	70981
Sweden	5425	5147	2458	2253	3221
USSR/Russia		-	-	1619	452
UK (England)	14216	14899	6880	3470	7635
UK (Scotland)	49919	47944	17212	22582	31313
UK (N.Ireland)	-	-	-	-	1015
Unallocated landings	5749	6599 [12]	26069 [12]	63403 [6,12]	70329 [12]
Misreporting from VIaN	30234		-	-	
Total landings	495258	516082	233413	238304	338092
Discards	2510	-	-	-	
Total catch	**497768**	**516082**	**233413**	**238304**	**338092**
Estimates of the parts of the catches which have been allocated to spring spawning stocks					
IIIa type (WBSS)	13228	10315	855	979	7833
Thames estuary [5]	215	203	168	202	88
Norw. Spring Spawners [13]	5902	9501	30274	54728	29220

Country	1999 [9]	2000 [9]	2001 [9]	2002	2003 [1]
Belgium	2	-	-	23	5
Denmark [7]	61268	64123	67096	70825	78606
Faroe Islands	1977	915	1082	1413	627
France	26962	20952	24880 [14]	25422	31544
Germany	26764	26687	29779	27213	43953
Netherlands	54467	54341	51293	55257	81108
Norway [4]	74071	72072	75886 [1]	74974 [1]	112481
Sweden	3241	3046	3695	3418	4781
USSR/Russia	-	-	-	-	-
UK (England)	11434	11179	14582	13757	18639
UK (Scotland)	29911	30033	26719	30926	40292
UK (N.Ireland)	-	996	1018	944	2010
Unallocated landings	43327 [12]	61673 [12]	27362 [12]	31552 [12]	31875 [12]
Misreporting from VIaN					
Total landings	333424	346017	323392 [14]	335724	445921
Discards				17093	4125
Total catch	**333424**	**346017**	**323392** [14]	**352817**	**450046**
Estimates of the parts of the catches which have been allocated to spring spawning stocks					
IIIa type (WBSS)	4732	6649	6449	6652	2821
Thames estuary [5]	88	76	107	60	84
Others [11]		378	1097	0	308
Norw. Spring Spawners [13]	32106	25678	7108	4069	979

1 Preliminary.
4 Catches of Norwegian spring spawners removed (taken under a separate TAC).
5 Landings from the Thames estuary area are included in the North Sea catch figure for UK (England).
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 VIaN 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 management purposes.

Country	1994	1995 [#]	1996 [#]	1997 [#]	1998 [11]
Denmark	20017	17748	3183	2657	4634
Faroe Islands	-	2018	815	1156	1246
France	11658	10427	3177	362	4758
Germany	18364	17095	2167	4576	7753
Netherlands	16944	27205	7714	6072	10917
Norway	56422	56124	22187	16869	27290
Sweden	2159	1007	769	1617	315
Russia	-	-	-	1619	452
UK (England)	3862	3315	2391	49	4306
UK (Scotland)	44687	43204	12763	17121	29462
UK (N. Ireland)	-	-	-	-	1015
Unallocated landings	3214 [9]	-2556 [8]	12681 [8]	40662 [6,8]	56058 [8]
Misreporting from VIa North	30234				
Total Landings	207561	175587	67847	92760	148206
Discards	550				
Total catch	**208111**	**175587**	**67847**	**92760**	**148206**

Country	1999 [#]	2000 [#]	2001 [#]	2002	2003 [1]
Denmark [7]	15359	25530	17770	26422	48358
Faroe Islands	1977	205	192	-	95
France	6369	3210	8164	10522	11237
Germany	11206	5811	17753	15189	25796
Netherlands	21552	15117	17503 [10]	18289	25045
Norway	31395	33164	11653 [1]	10836 [1]	34443
Sweden	859	1479	1418	2397	2647
Russia	-	-	-	-	-
UK (England)	7999	8859	12283	10142	12030
UK (Scotland)	28537	29055	25105	30014	39970
UK (N. Ireland)	-	996	1018	944	2010
Unallocated landings	25469 [8]	44334 [8]	24725 [8]	14201 [8]	14115 [8]
Misreporting from VIa North					
Total Landings	150722	167760	137584	138956	215746
Discards				17093	4125
Total catch	**150722**	**167760**	**137584**	**156049**	**219871**

1 Preliminary.
4 Including IVa East.
5 Negative unallocated catches due to misreporting from other areas.
6 Altered in 2000 on the basis of a Bayesian assessment on misreporting into VIa (North)
7 Including any 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 management purposes.

Country	1994	1995 [7]	1996 [7]	1997 [7]	1998 [7]
Denmark [5]	43787	45257	19166	22862	25750
Faroe Islands	-	-	-	-	-
France	14	4	-	3	-
Germany	-	-	-	-	-
Netherlands	-	167	-	756	301
Norway [2]	40658	62224	18256	20975	43646
Sweden	1010	2211	1119	422	1189
UK (Scotland)	-	-	-	-	
Unallocated landings	-	-132 [4]	-	-756 [4]	-292 [4]
Total landings	85469	109731	38541	44262	70594
Discards	-	-	-	-	-
Total catch	**85469**	**109731**	**38541**	**44262**	**70594**
Norw. Spring Spawners [6]	5902	9501	30274	54728	29220

Country	1999 [7]	2000 [7]	2001 [7]	2002	2003 [1]
Denmark [5]	18259	11300	18466	17846	7401
Faroe Islands	-	710	890	1365	359
France	115	-	-	-	-
Germany	-	29	-	81	54
Netherlands	-	38	-	-	-
Norway [2]	39977	38655	56904 [1]	63482 [1]	62306
Sweden	772	1177	517	568	1529
Unallocated landings	-	338	0	5961	11991
Total landings	59123	52247	76777	89303	83640
Discards	-	-	-	-	-
Total catch	**59123**	**52247**	**76777**	**89303**	**83640**
Norw. Spring Spawners [6]	32106	25678	7108	4069	979

1 Preliminary
2 Catches of Norwegian spring spawners herring removed (taken under a separate TAC).
3 Included in IVa West.
4 Negative unallocated catches due to misreporting into other areas.
5 Including any by-catches in the industrial fishery
6 These catches (including some local fjord-type Spring Spawners) are taken by Norway under a separate quota south of 62°N and are not included in the Norwegian North Sea catch figure for this area.
7 Figures verified and altered if needed in 2003 by SG Rednose (ICES 2003/ACFM:10)

Table 2.1.4 HERRING, catch in tonnes in Division IVb. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1994	1995 [6]	1996 [6]	1997 [6]	1998 [6]
Belgium	-	-	-	-	-
Denmark [4]	55060	87917	43749	11558	26667
Faroe Islands	-	-	-	-	-
France	5492	7639	2373	6069	8945
Germany	14796	21209	11051	7455	13590
Netherlands	39052	31025	21053	14976	27468
Norway	28442	12678	3296	3762	45
Sweden	2256	1929	570	214	1717
UK (England)	7337	9688	2757	2033	1767
UK (Scotland)	5101	4700	4449	5461	1851
Unallocated landings	-26988 [3]	-12552 [3]	-17313 [5]	-3744 [5]	-12138 [5]
Total landings	130548	164233	71985	47784	69912
Discards [2]	460	-			
Total catch	**131008**	**164233**	**71985**	**47784**	**69912**

Country	1999 [6]	2000 [6]	2001 [6]	2002	2003 [1]
Belgium	1	-	-	-	-
Denmark [4]	26211	26825	30277	26387	22574
Faroe Islands	-	-	-	48	173
France	7634	10863	7796 [14]	4214	7918
Germany	13529	18818	8340	7577	12116
Netherlands	22343	26839	24160	13154	19115
Norway	2699	253	7329 [1]	656 [1]	15732
Sweden	1610	390	1760	453	605
UK (England)	1641	669	814	317	2632
UK (Scotland)	1374	978	1614	289	322
Unallocated landings	-3794 [5]	-9820 [5]	-22885 [5]	4052	-2401
Total landings	73248	75815	59205	57147	78786
Discards [2]					
Total catch	**73248**	**75815**	**59205** [14]	**57147**	**78786**

1 Preliminary
2 Discards partly included in unallocated
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 Divisions IVc and VIId. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1994	1995 [9]	1996 [9]	1997 [9]	1998 [9]
Belgium	144	-	-	1	-
Denmark	2695	2439	635	1247	1873
France	10777	11433	6950	8091	7081
Germany	4964	4996	997	1349	916
Netherlands	20159	23889	14024	14181	11247
UK (England)	3016	1895	1733	1388	1562
UK (Scotland)	131	40	-	-	-
Unallocated landings	29792	21840 [4]	30702 [4]	27241 [4]	26701 [4]
Total landings	71678	66532	55041	53498	49380
Discards [3]	2400				
Total catch	**74078**	**66532**	**55041**	**53498**	**49380**
Coastal spring spawners included above [2]	215	203	168	143	88

Country	1999 [9]	2000 [9]	2001 [9]	2002	2003 [1]	
Belgium	1	1	-	23	5	
Denmark	1439	468	583	170	273	
France	12844	6879	8750	10686	12389	
Germany	2029	2029	3686	4366	5987	
Netherlands	10572	12348	9630	23814	36948	
UK (England)	1794	1651	1485	3298	3977	
UK (Scotland)	-	-	-	623	-	
Unallocated landings	21652 [4]	26822 [4]	25522 [4]	7338	8170	
Total landings	50331	50198	49656	50318	67749	
Discards [3]				-	-	
Total catch	**50331**	**50198**	**49656**	**50318**	**67749**	
Coastal spring spawners included above [2]	88	76	147 [11]	60	84	60

1 Preliminary

2 Landings from the Thames estuary area are included in the North Sea catch figure for UK (England).

3 Discards partly included in unallocated

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
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]
Recommended Divisions IVc, VIId	30	30	50-60 [6]	54	50	50	50	- [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
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
Bycatch ceiling in the small mesh fishery									24	22	30	36	36	36	52.0	38.0
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	
Unallocated landings Divisions IVa,b	-2	14	30	14	-1	6	-15	-5	36	44	22	35	2	24	23.7	
Discard/slipping Divisions IVa,b [4]	3	4	2	3	1	1	-	-	-	-	-	-	-	17	4.1	
Total catch Divisions IVa,b [5]	638	516	527	498	463	428	450	178	185	289	283	296	273	303	382.3	
National landings Divisions IVc, VIId [3]	30	24	42	37	32 [21]	42	45	24	26	23	29	23	24	43	59.5	
Unallocated landings Divisions IVc,VIId	48	32	16	35	43	30	22	31	27	27	22	27	26	7	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	
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**	
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	
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	
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**	
Baltic-IIIa-type spring spawners in IV	20	8	8	8	9	13	10	1	1	8	5	7	6	7	2.8	
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	
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	
Division IIIa: TAC (IIIa)																
Predicted catch of autumn spawners			96	153	102	77	98	48	35	58	43	53	- [22]	- [22]	- [22]	- [22]
Recommended spring spawners	84	67	91	90	93–113	- [9]	- [12]	- [12]	- [15]	- [15]	- [15]	- [15]	- [15]	- [15]	- [15]	- [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
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
CATCH (IIIa)																
National landings	192	202	188	227	214	168	157	115	83	120	86	108	90	79	76.0	
Catch as used by ACFM	162	195	191	227	214	168	140	105	74	108	79	99	82	73	68.1	
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	
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	
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**	
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	
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	
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**	
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**	

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 in earlier years). 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 2003. Catch in numbers (millions) at age (CANUM), by quarter and division

WR	IIIa NSAS	IVa(E) all	IVa(E) WBBS	IVa(E) NSAS only	IVa(W)	IVb	IVc	VIId	IVa & IVb NSAS	IVc & VIId	Total NSAS	Herring caught in the North Sea
Quarters: 1-4												
0	**21.6**	**0.0**	**0.0**	**0.0**	**0.0**	**347.5**	**0.0**	**0.0**	**347.5**	**0.0**	**369.1**	**347.5**
1	**445.0**	**0.4**	**0.0**	**0.4**	**0.1**	**165.0**	**5.6**	**0.8**	**165.6**	**6.4**	**617.0**	**172.0**
2	**182.3**	**70.5**	**0.0**	**70.5**	**308.6**	**394.2**	**32.9**	**216.0**	**773.3**	**248.8**	**1204.5**	**1022.2**
3	**13.0**	**85.4**	**3.1**	**82.3**	**279.1**	**58.4**	**15.3**	**68.7**	**419.9**	**84.0**	**516.9**	**507.0**
4	**16.2**	**181.1**	**6.0**	**175.1**	**451.5**	**76.2**	**14.0**	**86.7**	**702.9**	**100.6**	**819.7**	**809.5**
5	**1.8**	**89.6**	**3.5**	**86.1**	**83.5**	**14.5**	**6.9**	**49.9**	**184.0**	**56.8**	**242.7**	**244.4**
6	**1.1**	**32.5**	**1.2**	**31.3**	**48.1**	**6.7**	**2.8**	**16.2**	**86.0**	**19.0**	**106.2**	**106.2**
7	**1.2**	**35.6**	**1.3**	**34.3**	**68.4**	**3.2**	**4.6**	**8.8**	**105.9**	**13.4**	**120.5**	**120.6**
8	**0.2**	**12.6**	**0.5**	**12.1**	**17.4**	**0.9**	**2.0**	**4.5**	**30.4**	**6.5**	**37.1**	**37.4**
9+	**0.0**	**2.9**	**0.1**	**2.8**	**5.1**	**0.1**	**0.0**	**0.3**	**8.0**	**0.3**	**8.3**	**8.4**
Sum	**682.4**	**510.6**	**15.7**	**494.9**	**1261.9**	**1066.7**	**84.1**	**451.9**	**2823.5**	**536.0**	**4041.9**	**3375.2**
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**	**0.0**
1	247.8	0.1	0.0	0.1	0.0	0.4	0.8	0.0	0.5	0.8	**249.0**	**1.2**
2	84.1	2.9	0.0	2.9	0.7	3.2	0.6	0.0	6.8	0.6	**91.4**	**7.4**
3	2.0	14.9	0.0	14.9	25.3	0.8	4.1	7.7	40.9	11.7	**54.7**	**52.7**
4	1.1	36.7	0.0	36.7	60.2	1.8	5.5	17.2	98.6	22.7	**122.4**	**121.3**
5	0.3	7.0	0.0	7.0	7.4	0.3	3.2	17.2	14.6	20.4	**35.2**	**35.0**
6	0.1	3.9	0.0	3.9	6.2	0.2	0.3	5.6	10.4	5.9	**16.3**	**16.2**
7	0.1	4.8	0.0	4.8	8.1	0.2	0.3	6.5	13.2	6.8	**20.1**	**20.0**
8	0.0	1.3	0.0	1.3	2.0	0.0	0.6	3.9	3.4	4.5	**7.9**	**7.9**
9+	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	**0.1**	**0.1**
Sum	**335.5**	**71.8**	**0.0**	**71.8**	**109.9**	**6.8**	**15.2**	**58.0**	**188.5**	**73.2**	**597.2**	**261.7**
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	48.4	0.2	0.0	0.2	0.0	3.8	3.7	0.0	4.1	3.7	**56.2**	**7.8**
2	53.6	41.2	0.0	41.1	60.1	38.8	0.0	0.0	140.0	0.0	**193.6**	**140.1**
3	1.2	38.8	1.0	37.8	32.7	3.4	0.2	0.3	74.0	0.5	**75.6**	**75.4**
4	0.3	81.0	3.3	77.7	58.6	6.5	0.2	0.2	142.8	0.4	**143.5**	**146.5**
5	0.0	51.8	2.1	49.7	16.0	3.5	0.1	0.1	69.2	0.2	**69.5**	**71.5**
6	0.1	17.4	0.7	16.7	6.8	1.0	0.0	0.0	24.5	0.0	**24.6**	**25.2**
7	0.0	15.2	0.6	14.6	12.0	1.0	0.0	0.0	27.5	0.0	**27.6**	**28.2**
8	0.0	6.9	0.3	6.6	2.9	0.4	0.0	0.0	10.0	0.0	**10.0**	**10.3**
9+	0.0	2.4	0.1	2.3	1.1	0.0	0.0	0.0	3.4	0.0	**3.4**	**3.5**
Sum	**103.6**	**255.0**	**8.1**	**246.9**	**190.2**	**58.4**	**4.4**	**0.5**	**495.5**	**4.9**	**604.0**	**508.5**
Quarter: 3												
0	1.7	0.0	0.0	0.0	0.0	122.5	0.0	0.0	122.5	0.0	**124.2**	**122.5**
1	48.7	0.1	0.0	0.1	0.1	41.8	0.0	0.0	42.0	0.0	**90.8**	**42.0**
2	24.5	14.9	0.0	14.9	195.4	273.7	0.1	0.1	484.0	0.3	**508.8**	**484.2**
3	4.1	18.9	2.2	16.7	169.8	52.4	0.0	0.0	238.9	0.1	**243.1**	**241.2**
4	6.5	37.1	2.7	34.4	245.1	65.9	0.0	0.0	345.3	0.1	**351.9**	**348.1**
5	0.9	19.3	1.4	17.9	50.2	10.4	0.0	0.0	78.5	0.0	**79.5**	**80.0**
6	0.4	6.5	0.5	6.0	27.8	4.6	0.0	0.0	38.5	0.0	**38.9**	**38.9**
7	0.9	9.5	0.7	8.9	40.6	1.8	0.0	0.0	51.3	0.0	**52.2**	**52.0**
8	0.1	2.8	0.2	2.6	11.4	0.3	0.0	0.0	14.3	0.0	**14.5**	**14.5**
9+	0.0	0.2	0.0	0.2	3.4	0.1	0.0	0.0	3.7	0.0	**3.7**	**3.7**
Sum	**87.9**	**109.5**	**7.7**	**101.8**	**743.6**	**573.5**	**0.3**	**0.3**	**1418.9**	**0.5**	**1507.4**	**1427.1**
Quarter: 4												
0	19.9	0.0	0.0	0.0	0.0	225.0	0.0	0.0	225.0	0.0	**244.9**	**225.0**
1	100.0	0.0	0.0	0.0	0.0	119.1	1.1	0.8	119.1	1.9	**221.0**	**121.0**
2	20.1	11.6	0.0	11.6	52.4	78.6	32.1	215.8	142.5	248.0	**410.7**	**390.5**
3	5.8	12.8	0.0	12.8	51.3	1.9	11.0	60.7	66.0	71.8	**143.6**	**137.8**
4	8.3	26.3	0.0	26.3	87.8	2.1	8.2	69.3	116.2	77.5	**202.0**	**193.7**
5	0.6	11.4	0.0	11.4	9.9	0.3	3.6	32.7	21.6	36.3	**58.4**	**57.9**
6	0.5	4.6	0.0	4.6	7.3	0.8	2.5	10.6	12.7	13.1	**26.4**	**25.8**
7	0.2	6.0	0.0	6.0	7.8	0.2	4.3	2.3	13.9	6.6	**20.7**	**20.5**
8	0.0	1.6	0.0	1.6	1.1	0.0	1.4	0.5	2.7	2.0	**4.7**	**4.7**
9+	0.0	0.1	0.0	0.1	0.6	0.0	0.0	0.3	0.8	0.3	**1.1**	**1.1**
Sum	**155.5**	**74.4**	**0.0**	**74.4**	**218.1**	**428.0**	**64.2**	**393.1**	**720.6**	**457.3**	**1333.4**	**1177.9**

Table 2.2.2 North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2003. 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	0.020	0.000	0.000	0.000	0.013	0.000	0.000	0.013	-	0.014	0.013
1	0.034	0.063	0.063	0.144	0.047	0.033	0.082	0.047	0.040	0.037	0.046
2	0.067	0.122	0.122	0.130	0.098	0.101	0.103	0.113	0.103	0.104	0.111
3	0.123	0.154	0.154	0.167	0.161	0.125	0.127	0.163	0.127	0.157	0.157
4	0.150	0.162	0.162	0.184	0.178	0.138	0.145	0.178	0.144	0.173	0.174
5	0.163	0.177	0.177	0.202	0.195	0.161	0.169	0.190	0.168	0.184	0.185
6	0.191	0.189	0.189	0.224	0.214	0.190	0.173	0.210	0.176	0.204	0.204
7	0.214	0.203	0.203	0.237	0.214	0.214	0.175	0.225	0.188	0.221	0.221
8	0.187	0.213	0.213	0.259	0.222	0.241	0.181	0.239	0.200	0.232	0.232
9+	0.000	0.218	0.218	0.276	0.281	0.000	0.227	0.255	0.227	0.253	0.254
Quarter: 1											
0	0.000	0.000		0.000	0.000	0.000	0.000	-	-	0.000	0.000
1	0.016	0.058		0.000	0.027	0.038	0.000	0.032	0.038	0.016	0.036
2	0.050	0.101		0.102	0.086	0.084	0.000	0.094	0.084	0.054	0.093
3	0.089	0.120		0.117	0.122	0.085	0.089	0.118	0.088	0.111	0.111
4	0.114	0.131		0.131	0.132	0.109	0.111	0.131	0.111	0.127	0.127
5	0.132	0.160		0.155	0.166	0.132	0.135	0.158	0.135	0.144	0.144
6	0.141	0.171		0.171	0.170	0.138	0.151	0.171	0.150	0.163	0.163
7	0.150	0.177		0.180	0.175	0.135	0.166	0.179	0.165	0.174	0.174
8	0.164	0.177		0.185	0.178	0.221	0.176	0.182	0.182	0.182	0.182
9+	0.000	0.212		0.275	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	0.022	0.058	0.058	0.000	0.031	0.024	0.000	0.032	0.024	0.023	0.028
2	0.061	0.112	0.112	0.122	0.087	0.084	0.000	0.110	0.084	0.096	0.110
3	0.085	0.143	0.143	0.155	0.139	0.085	0.097	0.148	0.092	0.146	0.147
4	0.105	0.154	0.154	0.175	0.146	0.109	0.111	0.162	0.110	0.161	0.162
5	0.125	0.167	0.167	0.182	0.161	0.132	0.126	0.170	0.130	0.170	0.170
6	0.140	0.181	0.181	0.213	0.169	0.138	0.000	0.189	0.138	0.189	0.189
7	0.126	0.192	0.192	0.238	0.169	0.135	0.000	0.211	0.135	0.210	0.211
8	0.133	0.203	0.203	0.229	0.200	0.221	0.000	0.210	0.221	0.210	0.210
9+	0.000	0.217	0.217	0.246	0.000	0.000	0.000	0.226	-	0.226	0.226
Quarter: 3											
0	0.012	0.000	0.000	0.000	0.014	0.000	0.000	0.014	-	0.014	0.014
1	0.069	0.078	0.078	0.144	0.061	0.059	0.082	0.061	0.063	0.066	0.062
2	0.108	0.141	0.141	0.135	0.107	0.101	0.095	0.120	0.098	0.119	0.120
3	0.136	0.185	0.185	0.181	0.164	0.140	0.126	0.177	0.133	0.177	0.177
4	0.159	0.192	0.192	0.204	0.182	0.159	0.146	0.199	0.152	0.198	0.199
5	0.168	0.198	0.198	0.216	0.206	0.187	0.176	0.211	0.181	0.210	0.211
6	0.200	0.207	0.207	0.245	0.232	0.196	0.184	0.237	0.191	0.236	0.237
7	0.235	0.223	0.223	0.253	0.242	0.220	0.200	0.247	0.217	0.246	0.247
8	0.194	0.240	0.240	0.281	0.254	0.250	0.218	0.273	0.247	0.271	0.273
9+	0.000	0.226	0.226	0.286	0.283	0.000	0.227	0.282	0.227	0.281	0.282
Quarter: 4											
0	0.021	0.000		0.000	0.013	0.000	0.000	0.013	-	0.014	0.013
1	0.065	0.000		0.000	0.042	0.061	0.082	0.042	0.070	0.053	0.042
2	0.105	0.138		0.123	0.070	0.101	0.103	0.095	0.103	0.100	0.100
3	0.134	0.182		0.153	0.150	0.140	0.132	0.159	0.133	0.145	0.146
4	0.150	0.186		0.170	0.169	0.159	0.153	0.174	0.154	0.165	0.166
5	0.174	0.198		0.199	0.199	0.187	0.187	0.199	0.187	0.191	0.191
6	0.199	0.207		0.204	0.180	0.196	0.185	0.203	0.187	0.195	0.195
7	0.164	0.219		0.210	0.223	0.220	0.200	0.214	0.213	0.213	0.214
8	0.000	0.239		0.242	0.240	0.250	0.218	0.240	0.241	0.241	0.241
9+	0.000	0.226		0.274	0.232	0.000	0.227	0.265	0.227	0.255	0.255

Table 2.2.3 North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2003. 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	12.5	0.0	0.0	12.5	-	12.5
1	n.d.	19.1	n.d.	25.0	17.9	14.7	21.8	17.9	15.6	17.8
2	n.d.	23.8	n.d.	24.5	22.2	23.6	22.8	23.3	22.9	23.2
3	n.d.	25.7	n.d.	26.5	26.2	24.4	24.7	26.3	24.7	26.0
4	n.d.	26.4	n.d.	27.5	27.0	25.7	25.7	27.2	25.7	27.0
5	n.d.	27.0	n.d.	28.0	28.0	26.9	27.1	27.5	27.1	27.4
6	n.d.	27.6	n.d.	29.2	28.8	28.0	27.2	28.6	27.3	28.4
7	n.d.	28.3	n.d.	29.7	28.8	29.0	28.1	29.2	28.4	29.1
8	n.d.	28.6	n.d.	30.3	29.7	30.4	28.9	29.6	29.3	29.5
9+	n.d.	29.1	n.d.	31.2	31.4	0.0	29.6	30.4	29.6	30.4
Quarter: 1										
0	n.d.	0.0	n.d.	0.0	0.0	0.0	0.0	-	-	0.0
1	n.d.	18.2	n.d.	0.0	15.5	16.5	0.0	15.9	16.5	16.3
2	n.d.	22.7	n.d.	24.4	21.0	23.3	0.0	22.1	23.3	22.2
3	n.d.	25.9	n.d.	25.8	25.7	23.3	23.7	25.8	23.6	25.3
4	n.d.	26.7	n.d.	26.9	26.7	25.2	25.1	26.8	25.1	26.5
5	n.d.	27.7	n.d.	28.3	27.7	26.4	26.5	28.0	26.5	27.1
6	n.d.	28.9	n.d.	29.1	28.7	27.3	27.3	29.0	27.3	28.4
7	n.d.	29.3	n.d.	29.5	29.0	26.8	27.9	29.4	27.9	28.9
8	n.d.	29.2	n.d.	29.7	29.6	31.0	28.8	29.5	29.1	29.3
9+	n.d.	29.0	n.d.	33.8	0.0	0.0	0.0	29.2	-	29.2
Quarter: 2										
0	n.d.	0.0	n.d.	0.0	0.0	0.0	0.0	-	-	0.0
1	n.d.	18.2	n.d.	0.0	15.9	12.5	0.0	16.0	12.5	14.3
2	n.d.	23.4	n.d.	23.9	21.2	23.3	0.0	23.0	23.3	23.0
3	n.d.	25.3	n.d.	25.7	24.9	23.3	23.5	25.4	23.4	25.4
4	n.d.	25.9	n.d.	26.6	25.6	25.2	24.6	26.2	24.9	26.2
5	n.d.	26.8	n.d.	27.1	26.6	26.4	26.1	26.9	26.3	26.9
6	n.d.	27.3	n.d.	28.5	27.3	27.3	0.0	27.6	27.3	27.6
7	n.d.	28.0	n.d.	29.5	27.2	26.8	0.0	28.6	26.8	28.6
8	n.d.	28.4	n.d.	29.1	29.2	31.0	0.0	28.6	31.0	28.6
9+	n.d.	29.2	n.d.	30.2	0.0	0.0	0.0	29.5	-	29.5
Quarter: 3										
0	n.d.	0.0	n.d.	0.0	12.6	0.0	0.0	12.6	-	12.6
1	n.d.	21.5	n.d.	25.0	19.2	20.8	21.8	19.2	21.0	19.2
2	n.d.	24.4	n.d.	24.5	23.0	23.6	22.6	23.7	23.1	23.7
3	n.d.	26.1	n.d.	26.6	26.3	24.8	24.8	26.5	24.8	26.5
4	n.d.	26.6	n.d.	27.7	27.2	26.1	25.8	27.5	25.9	27.5
5	n.d.	27.0	n.d.	28.1	28.4	27.4	27.3	27.9	27.3	27.9
6	n.d.	27.5	n.d.	29.4	29.4	28.1	27.4	29.1	27.8	29.1
7	n.d.	28.2	n.d.	29.7	29.7	29.2	28.5	29.5	29.1	29.5
8	n.d.	28.9	n.d.	30.8	30.5	30.1	29.3	30.4	30.0	30.4
9+	n.d.	28.2	n.d.	31.4	31.5	0.0	29.6	31.2	29.6	31.2
Quarter: 4										
0	n.d.	0.0	n.d.	0.0	12.5	0.0	0.0	12.5	-	12.5
1	n.d.	0.0	n.d.	0.0	17.5	20.9	21.8	17.5	21.3	17.6
2	n.d.	24.7	n.d.	25.3	20.1	23.6	22.8	22.4	22.9	22.7
3	n.d.	26.3	n.d.	27.1	25.7	24.8	24.9	26.9	24.9	25.8
4	n.d.	26.8	n.d.	28.0	26.6	26.1	25.9	27.7	25.9	27.0
5	n.d.	27.1	n.d.	28.7	27.2	27.4	27.4	27.8	27.4	27.6
6	n.d.	27.8	n.d.	29.5	27.5	28.1	27.1	28.8	27.3	28.0
7	n.d.	28.2	n.d.	29.7	28.3	29.2	28.5	29.0	29.0	29.0
8	n.d.	28.8	n.d.	29.2	28.9	30.1	29.3	28.9	29.9	29.3
9+	n.d.	28.2	n.d.	31.4	28.5	0.0	29.6	30.8	29.6	30.5

Table 2.2.4 North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2003. 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	0.4	0.0	0.0	0.0	0.0	4.7	0.0	0.0	4.7	0.0	5.1	4.7
1	14.9	0.0	0.0	0.0	0.0	7.7	0.2	0.1	7.7	0.3	22.9	8.0
2	12.2	8.6	0.0	8.6	40.2	38.5	3.3	22.2	87.4	25.5	125.1	112.9
3	1.6	13.2	0.5	12.7	46.6	9.4	1.9	8.7	68.7	10.7	80.9	79.8
4	2.4	29.3	1.0	28.3	83.1	13.5	1.9	12.5	125.0	14.5	141.9	140.4
5	0.3	15.9	0.6	15.3	16.9	2.8	1.1	8.4	35.0	9.5	44.8	45.1
6	0.2	6.1	0.2	5.9	10.8	1.4	0.5	2.8	18.1	3.3	21.7	21.7
7	0.3	7.2	0.3	6.9	16.2	0.7	1.0	1.5	23.8	2.5	26.6	26.6
8	0.0	2.7	0.1	2.6	4.5	0.2	0.5	0.8	7.3	1.3	8.6	8.7
9+	0.0	0.6	0.0	0.6	1.4	0.0	0.0	0.1	2.1	0.1	2.1	2.1
Sum	**32.4**	**83.6**	**2.7**	**80.9**	**219.7**	**78.9**	**10.5**	**57.2**	**379.6**	**67.7**	**479.7**	**450.0**
Quarter: 1												
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0
2	4.2	0.3	0.0	0.3	0.1	0.3	0.0	0.0	0.6	0.0	4.9	0.7
3	0.2	1.8	0.0	1.8	3.0	0.1	0.3	0.7	4.8	1.0	6.0	5.9
4	0.1	4.8	0.0	4.8	7.9	0.2	0.6	1.9	12.9	2.5	15.6	15.5
5	0.0	1.1	0.0	1.1	1.1	0.0	0.4	2.3	2.3	2.7	5.1	5.0
6	0.0	0.7	0.0	0.7	1.1	0.0	0.0	0.8	1.8	0.9	2.7	2.6
7	0.0	0.9	0.0	0.9	1.5	0.0	0.0	1.1	2.4	1.1	3.5	3.5
8	0.0	0.2	0.0	0.2	0.4	0.0	0.1	0.7	0.6	0.8	1.4	1.4
9+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	**8.5**	**9.8**	**0.0**	**9.8**	**15.0**	**0.7**	**1.6**	**7.5**	**25.5**	**9.2**	**43.2**	**34.7**
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	1.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.1	1.3	0.2
2	3.3	4.6	0.0	4.6	7.4	3.4	0.0	0.0	15.4	0.0	18.6	15.4
3	0.1	5.5	0.1	5.4	5.1	0.5	0.0	0.0	10.9	0.0	11.1	11.1
4	0.0	12.4	0.5	11.9	10.3	0.9	0.0	0.0	23.1	0.0	23.2	23.7
5	0.0	8.7	0.4	8.3	2.9	0.6	0.0	0.0	11.8	0.0	11.8	12.2
6	0.0	3.2	0.1	3.0	1.4	0.2	0.0	0.0	4.6	0.0	4.7	4.8
7	0.0	2.9	0.1	2.8	2.8	0.2	0.0	0.0	5.8	0.0	5.8	5.9
8	0.0	1.4	0.1	1.3	0.7	0.1	0.0	0.0	2.1	0.0	2.1	2.2
9+	0.0	0.5	0.0	0.5	0.3	0.0	0.0	0.0	0.8	0.0	0.8	0.8
Sum	**4.5**	**39.3**	**1.3**	**38.0**	**30.8**	**5.9**	**0.2**	**0.1**	**74.7**	**0.2**	**79.4**	**76.2**
Quarter: 3												
0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	1.7	0.0	1.7	1.7
1	3.4	0.0	0.0	0.0	0.0	2.6	0.0	0.0	2.6	0.0	5.9	2.6
2	2.6	2.1	0.0	2.1	26.4	29.4	0.0	0.0	57.9	0.0	60.6	57.9
3	0.6	3.5	0.4	3.1	30.7	8.6	0.0	0.0	42.4	0.0	42.9	42.8
4	1.0	7.1	0.5	6.6	50.1	12.0	0.0	0.0	68.7	0.0	69.7	69.2
5	0.2	3.8	0.3	3.5	10.9	2.1	0.0	0.0	16.6	0.0	16.7	16.8
6	0.1	1.3	0.1	1.2	6.8	1.1	0.0	0.0	9.1	0.0	9.2	9.2
7	0.2	2.1	0.2	2.0	10.3	0.4	0.0	0.0	12.7	0.0	12.9	12.8
8	0.0	0.7	0.1	0.6	3.2	0.1	0.0	0.0	3.9	0.0	3.9	4.0
9+	0.0	0.1	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.0	1.0	1.0
Sum	**8.1**	**20.8**	**1.5**	**19.3**	**139.2**	**58.0**	**0.0**	**0.0**	**216.5**	**0.1**	**224.7**	**218.1**
Quarter: 4												
0	0.4	0.0	0.0	0.0	0.0	2.9	0.0	0.0	2.9	0.0	3.3	2.9
1	6.5	0.0	0.0	0.0	0.0	5.0	0.1	0.1	5.0	0.1	11.6	5.1
2	2.1	1.6	0.0	1.6	6.5	5.5	3.2	22.2	13.5	25.4	41.1	39.0
3	0.8	2.3	0.0	2.3	7.8	0.3	1.5	8.0	10.5	9.6	20.8	20.0
4	1.2	4.9	0.0	4.9	14.9	0.4	1.3	10.6	20.2	11.9	33.3	32.1
5	0.1	2.3	0.0	2.3	2.0	0.1	0.7	6.1	4.3	6.8	11.2	11.1
6	0.1	1.0	0.0	1.0	1.5	0.1	0.5	2.0	2.6	2.5	5.1	5.0
7	0.0	1.3	0.0	1.3	1.6	0.0	0.9	0.5	3.0	1.4	4.4	4.4
8	0.0	0.4	0.0	0.4	0.3	0.0	0.4	0.1	0.6	0.5	1.1	1.1
9+	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.1	0.2	0.1	0.3	0.3
Sum	**11.3**	**13.8**	**0.0**	**13.8**	**34.7**	**14.3**	**8.6**	**49.6**	**62.8**	**58.2**	**132.3**	**121.0**

Table 2.2.5 North Sea Autumn Spawning Herring (NSAS), and Western Baltic Spring Spawners (WBSS) caught in the North Sea 2003. 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	**3.2%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**32.6%**	**0.0%**	**0.0%**	**12.3%**	**0.0%**	**9.1%**	**10.3%**
1	**65.2%**	**0.1%**	**0.0%**	**0.1%**	**0.0%**	**15.5%**	**6.6%**	**0.2%**	**5.9%**	**1.2%**	**15.3%**	**5.1%**
2	**26.7%**	**13.8%**	**0.2%**	**14.2%**	**24.5%**	**37.0%**	**39.1%**	**47.8%**	**27.4%**	**46.4%**	**29.8%**	**30.3%**
3	**1.9%**	**16.7%**	**19.9%**	**16.6%**	**22.1%**	**5.5%**	**18.2%**	**15.2%**	**14.9%**	**15.7%**	**12.8%**	**15.0%**
4	**2.4%**	**35.5%**	**38.1%**	**35.4%**	**35.8%**	**7.1%**	**16.6%**	**19.2%**	**24.9%**	**18.8%**	**20.3%**	**24.0%**
5	**0.3%**	**17.5%**	**22.3%**	**17.4%**	**6.6%**	**1.4%**	**8.2%**	**11.1%**	**6.5%**	**10.6%**	**6.0%**	**7.2%**
6	**0.2%**	**6.4%**	**7.4%**	**6.3%**	**3.8%**	**0.6%**	**3.3%**	**3.6%**	**3.0%**	**3.5%**	**2.6%**	**3.1%**
7	**0.2%**	**7.0%**	**8.3%**	**6.9%**	**5.4%**	**0.3%**	**5.5%**	**1.9%**	**3.7%**	**2.5%**	**3.0%**	**3.6%**
8	**0.0%**	**2.5%**	**3.1%**	**2.5%**	**1.4%**	**0.1%**	**2.4%**	**1.0%**	**1.1%**	**1.2%**	**0.9%**	**1.1%**
9+	**0.0%**	**0.6%**	**0.7%**	**0.6%**	**0.4%**	**0.0%**	**0.0%**	**0.1%**	**0.3%**	**0.1%**	**0.2%**	**0.2%**
Sum 3+	**4.9%**	**86.1%**	**99.8%**	**85.7%**	**75.5%**	**15.0%**	**54.3%**	**52.0%**	**54.4%**	**52.4%**	**45.8%**	**54.3%**
Quarter: 1												
0	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**	**0.0%**
1	73.9%	0.1%	-	0.1%	0.0%	5.7%	4.9%	0.0%	0.2%	1.0%	**41.7%**	**0.5%**
2	25.1%	4.0%	-	4.0%	0.7%	46.4%	3.8%	0.0%	3.6%	0.8%	**15.3%**	**2.8%**
3	0.6%	20.8%	-	20.8%	23.0%	11.1%	26.6%	13.2%	21.7%	16.0%	**9.2%**	**20.1%**
4	0.3%	51.2%	-	51.2%	54.7%	25.8%	36.1%	29.6%	52.3%	31.0%	**20.5%**	**46.3%**
5	0.1%	9.7%	-	9.7%	6.7%	4.3%	20.9%	29.6%	7.8%	27.8%	**5.9%**	**13.4%**
6	0.0%	5.5%	-	5.5%	5.7%	2.8%	1.9%	9.6%	5.5%	8.0%	**2.7%**	**6.2%**
7	0.0%	6.7%	-	6.7%	7.4%	3.3%	1.9%	11.2%	7.0%	9.3%	**3.4%**	**7.6%**
8	0.0%	1.8%	-	1.8%	1.8%	0.7%	3.8%	6.8%	1.8%	6.2%	**1.3%**	**3.0%**
9+	0.0%	0.2%	-	0.2%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	**0.0%**	**0.1%**
Sum 3+	**1.1%**	**95.9%**	-	**95.9%**	**99.3%**	**47.9%**	**91.3%**	**100.0%**	**96.2%**	**98.2%**	**43.0%**	**96.7%**
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	46.7%	0.1%	0.0%	0.1%	0.0%	6.5%	85.0%	0.0%	0.8%	75.7%	**9.3%**	**1.5%**
2	51.7%	16.1%	0.4%	16.7%	31.6%	66.4%	0.6%	0.0%	28.3%	0.5%	**32.1%**	**27.5%**
3	1.1%	15.2%	12.0%	15.3%	17.2%	5.8%	4.2%	55.6%	14.9%	9.8%	**12.5%**	**14.8%**
4	0.3%	31.8%	40.6%	31.5%	30.8%	11.1%	5.7%	33.3%	28.8%	8.7%	**23.8%**	**28.8%**
5	0.0%	20.3%	26.0%	20.1%	8.4%	5.9%	3.3%	11.1%	14.0%	4.2%	**11.5%**	**14.1%**
6	0.1%	6.8%	8.7%	6.8%	3.6%	1.8%	0.3%	0.0%	4.9%	0.3%	**4.1%**	**5.0%**
7	0.0%	6.0%	7.6%	5.9%	6.3%	1.6%	0.3%	0.0%	5.6%	0.3%	**4.6%**	**5.5%**
8	0.0%	2.7%	3.5%	2.7%	1.5%	0.8%	0.6%	0.0%	2.0%	0.5%	**1.7%**	**2.0%**
9+	0.0%	1.0%	1.2%	0.9%	0.6%	0.0%	0.0%	0.0%	0.7%	0.0%	**0.6%**	**0.7%**
Sum 3+	**1.5%**	**83.8%**	**99.6%**	**83.2%**	**68.4%**	**27.1%**	**14.4%**	**100.0%**	**70.9%**	**23.8%**	**58.6%**	**70.9%**
Quarter: 3												
0	1.9%	0.0%	0.0%	0.0%	0.0%	21.4%	0.0%	0.0%	8.6%	0.0%	**8.2%**	**8.6%**
1	55.4%	0.1%	0.0%	0.1%	0.0%	7.3%	2.2%	0.4%	3.0%	1.4%	**6.0%**	**2.9%**
2	27.9%	13.6%	0.0%	14.6%	26.3%	47.7%	50.3%	54.4%	34.1%	52.3%	**33.8%**	**33.9%**
3	4.7%	17.3%	28.2%	16.4%	22.8%	9.1%	16.9%	17.0%	16.8%	17.0%	**16.1%**	**16.9%**
4	7.4%	33.9%	35.5%	33.8%	33.0%	11.5%	12.6%	15.8%	24.3%	14.1%	**23.3%**	**24.4%**
5	1.0%	17.7%	18.4%	17.6%	6.8%	1.8%	5.5%	7.2%	5.5%	6.3%	**5.3%**	**5.6%**
6	0.5%	5.9%	6.1%	5.9%	3.7%	0.8%	3.8%	3.5%	2.7%	3.7%	**2.6%**	**2.7%**
7	1.0%	8.7%	9.0%	8.7%	5.5%	0.3%	6.6%	1.2%	3.6%	4.0%	**3.5%**	**3.6%**
8	0.2%	2.6%	2.7%	2.6%	1.5%	0.1%	2.2%	0.3%	1.0%	1.3%	**1.0%**	**1.0%**
9+	0.0%	0.2%	0.2%	0.2%	0.5%	0.0%	0.0%	0.1%	0.3%	0.1%	**0.2%**	**0.3%**
Sum 3+	**14.7%**	**86.3%**	**100.0%**	**85.2%**	**73.7%**	**23.6%**	**47.5%**	**45.1%**	**54.3%**	**46.4%**	**52.0%**	**54.5%**
Quarter: 4												
0	12.8%	0.0%	-	0.0%	0.0%	52.6%	0.0%	0.0%	31.2%	0.0%	**18.4%**	**19.1%**
1	64.3%	0.0%	-	0.0%	0.0%	27.8%	1.7%	0.2%	16.5%	0.4%	**16.6%**	**10.3%**
2	13.0%	15.5%	-	15.5%	24.0%	18.4%	50.0%	54.9%	19.8%	54.2%	**30.8%**	**33.2%**
3	3.7%	17.3%	-	17.3%	23.5%	0.4%	17.2%	15.4%	9.2%	15.7%	**10.8%**	**11.7%**
4	5.4%	35.4%	-	35.4%	40.2%	0.5%	12.8%	17.6%	16.1%	16.9%	**15.1%**	**16.4%**
5	0.4%	15.4%	-	15.4%	4.5%	0.1%	5.6%	8.3%	3.0%	7.9%	**4.4%**	**4.9%**
6	0.3%	6.2%	-	6.2%	3.3%	0.2%	3.9%	2.7%	1.8%	2.9%	**2.0%**	**2.2%**
7	0.1%	8.0%	-	8.0%	3.6%	0.0%	6.7%	0.6%	1.9%	1.4%	**1.6%**	**1.7%**
8	0.0%	2.1%	-	2.1%	0.5%	0.0%	2.2%	0.1%	0.4%	0.4%	**0.3%**	**0.4%**
9+	0.0%	0.2%	-	0.2%	0.3%	0.0%	0.0%	0.1%	0.1%	0.1%	**0.1%**	**0.1%**
Sum 3+	**9.9%**	**84.5%**	-	**84.5%**	**76.0%**	**1.2%**	**48.3%**	**44.9%**	**32.5%**	**45.4%**	**34.3%**	**37.5%**

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

1999	**Fleet A**		**Fleet B**		**Fleet C**		**Fleet D**		**TOTAL**	
Total Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	**Numbers**	**Mean Weight**
0	0.9	0.009	968.3	0.009	42.0	0.018	554.0	0.010	**1,565.2**	**0.009**
1	36.9	0.066	44.1	0.039	180.6	0.054	68.4	0.023	**329.9**	**0.047**
2	479.7	0.124	21.0	0.067	129.3	0.091	17.4	0.065	**647.4**	**0.114**
3	1004.7	0.153	20.4	0.128	50.2	0.118	2.0	0.080	**1,077.2**	**0.151**
4	280.7	0.170	4.3	0.149	13.0	0.139	0.4	0.073	**298.4**	**0.168**
5	130.9	0.208	1.0	0.178	6.0	0.159	0.2	0.088	**138.2**	**0.205**
6	66.6	0.233	0.8	0.174	1.2	0.191	0.0	0.026	**68.6**	**0.232**
7	25.8	0.244	0.2	0.200	0.4	0.202	0.1	0.095	**26.5**	**0.243**
8	8.5	0.264			0.4	0.210	0.0	0.066	**8.9**	**0.260**
9+	3.3	0.292							**3.3**	**0.292**
TOTAL	2,038.0		1,060.1		423.2		642.5		**4,163.7**	
SOP catch		**315.8**		**15.2**		**31.2**		**8.4**		**370.6**

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

2000	**Fleet A**		**Fleet B**		**Fleet C**		**Fleet D**		**TOTAL**	
Total Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	**Numbers**	**Mean Weight**
0			872.6	0.013	63.1	0.022	173.1	0.021	**1,108.8**	**0.015**
1	89.2	0.077	95.3	0.037	485.4	0.041	498.9	0.016	**1,168.8**	**0.033**
2	475.2	0.127	22.4	0.065	105.8	0.078	9.8	0.056	**613.2**	**0.115**
3	460.1	0.160	5.5	0.130	21.4	0.108	0.5	0.127	**487.5**	**0.157**
4	576.8	0.180	3.2	0.140	19.8	0.164	3.0	0.158	**602.8**	**0.180**
5	177.3	0.200	0.8	0.112	7.5	0.191	0.1	0.168	**185.6**	**0.199**
6	75.3	0.219			2.9	0.183	0.3	0.189	**78.5**	**0.218**
7	27.2	0.245			0.3	0.212	0.3	0.170	**27.8**	**0.244**
8	15.3	0.273	1.4	0.200	0.1	0.198	0.0	0.177	**16.8**	**0.267**
9+	2.5	0.262							**2.5**	**0.262**
TOTAL	1,898.8		1,001.3		706.2		686.0		**4,292.2**	
SOP catch		**308.4**		**17.8**		**37.0**		**13.1**		**376.3**

Figures for A and B fleets have been revised in 2002

2001	**Fleet A**		**Fleet B**		**Fleet C**		**Fleet D**		**TOTAL**	
Total Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	**Numbers**	**Mean Weight**
0			1,024.9	0.015	16.1	0.025	791.7	0.008	**1,832.7**	**0.012**
1	35.6	0.104	47.0	0.029	344.0	0.066	219.7	0.023	**646.3**	**0.051**
2	682.4	0.126	21.9	0.050	140.9	0.076	9.1	0.058	**854.4**	**0.116**
3	469.2	0.149	8.6	0.096	16.6	0.108	0.5	0.099	**494.9**	**0.147**
4	258.2	0.175	10.7	0.126	1.4	0.130	0.0	0.133	**270.2**	**0.173**
5	293.0	0.194	1.1	0.121	0.3	0.147	0.0	0.149	**294.4**	**0.194**
6	70.2	0.216	4.8	0.122	0.5	0.221	0.0	0.155	**75.5**	**0.210**
7	39.7	0.229	0.5	0.154	0.0	0.179	0.0	0.166	**40.3**	**0.228**
8	38.6	0.218	0.1	0.251	0.0	0.211	0.0	0.184	**38.6**	**0.218**
9+	2.4	0.285							**2.4**	**0.285**
TOTAL	1,889.3		1,119.6		519.8		1,021.0		**4,549.7**	
SOP catch		**295.3**		**20.4**		**36.1**		**12.3**		**364.0**

2002	**Fleet A**		**Fleet B**		**Fleet C**		**Fleet D**		**TOTAL**	
Total Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	**Numbers**	**Mean Weight**
0			318.8	0.013	10.2	0.015	468.3	0.012	**797.3**	**0.013**
1	77.5	0.082	412.9	0.025	201.0	0.054	161.6	0.018	**852.9**	**0.036**
2	427.2	0.129	77.8	0.050	51.5	0.101	5.2	0.096	**561.7**	**0.115**
3	874.3	0.153	23.5	0.114	5.1	0.120	0.5	0.136	**903.4**	**0.151**
4	281.5	0.169	1.7	0.169	0.7	0.143	0.1	0.143	**283.9**	**0.169**
5	131.4	0.199	1.6	0.180	0.2	0.161	0.0	0.170	**133.2**	**0.198**
6	159.7	0.215	1.4	0.193	0.1	0.179	0.0	0.180	**161.2**	**0.214**
7	46.0	0.228	0.2	0.228	0.0	0.177	0.0	0.000	**46.3**	**0.227**
8	33.2	0.250	0.2	0.244	0.0	0.221	0.0	0.179	**33.4**	**0.250**
9+	7.2	0.253	0.0						**7.2**	**0.253**
TOTAL	2,037.9		838.1		268.8		635.7		**3,780.5**	
SOP catch		**323.4**		**22.1**		**17.1**		**9.1**		**371.7**

Figures for A fleet include 4457 t unsampled by-catch in the industrial fishery

Table 2.2.6 (Cont'd)

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	2,824.0		535.5		344.1		338.4		**4,041.9**	
SOP catch		**434.8**		**12.3**		**24.1**		**8.4**		**479.6**

Figures for A fleet include 3809 t unsampled by-catch in the industrial fishery

Table 2.2.7 Catch-at-age (numbers in millions) of herring caught in the North Sea, 1991-2003.
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+	Total
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

Table 2.2.8 Catch-at-age (numbers in millions) of Baltic Spring spawning Herring taken in the North Sea, and transfered to the assessment of the spring spawning stock in IIIa, 1991-2003.

Year/rings	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9+**	**Total**
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	10	6	7	3	2	0	0	40
2002			8	15	11	3	3	1	1	0	41
2003			0.0	3.1	6.0	3.5	1.2	1.3	0.5	0.1	15.7

Table 2.2.9 Catch-at-age (numbers in millions) of North Sea Autumn Spawners taken in IIIa, and transfered to the assessment of NSAS, 1991 - 2003. Figures for 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+**	**Total**
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

Table 2.2.10 Catch-at-age (numbers in millions) of the total North Sea Autumn Spawning stock 1991 - 2003. Figures for 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+**	**Total**
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
1996	2311	1606	642	526	172	58	23	9	17	4	5368
1997	431	480	688	447	285	109	31	12	19	6	2507
1998	260	978	1220	538	276	176	89	15	17	4	3572
1999	1566	304	616	1059	294	136	69	28	10	2	4084
2000	1105	1172	623	463	647	213	82	36	15	2	4358
2001	1833	614	806	477	274	312	89	37	17	2	4463
2002	730	835	553	903	284	133	161	46	33	7	3687
2003	369	617	1204	517	820	243	106	120	37	8	4042

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 1995-2003. SG Rednose's revisions for 1995-2001 are included. 1991-1994 data can be found in the HAWG 2003-report.

		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	
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
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
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
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
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
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

Table 2.2.12 Sampling of commercial landings of Herring in the North Sea (Div. IV and VIId) in 2003 by quarter. Sampled catch means the proportion of the reported catch to which sampling was applied. It is limited to 100% but might exceed the official landings due to sampling of discards, unallocated and misreported catches. It is not possible to judge the quality of the sampling by this figure alone. Note that only one nation 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%	5	0	0	0	n
total		**1**	**0**	**0%**	**5**	**0**	**0**	**0**	**n**
Denmark (A)	1	3	1	77%	16370	8	209	1228	n
	2	3	2	77%	3686	4	219	505	y
	3	3	3	100%	11980	13	400	1619	y
	4	3	3	100%	34285	13	396	1670	n
total		**12**	**9**	**93%**	**66321**	**38**	**1224**	**5022**	**n**
Denmark (B)	1	4	1	3%	867	4	3	15	y
	2	4	2	97%	590	28	62	112	y
	3	4	1	93%	2269	12	79	121	y
	4	3	2	97%	8560	24	282	496	y
total		**15**	**6**	**90%**	**12286**	**68**	**426**	**744**	**y**
England & Wales	1	3	0	0%	62	0	0	0	n
	2	3	0	0%	1488	0	0	0	n
	3	3	0	0%	13176	0	0	0	n
	4	2	0	0%	3912	0	0	0	n
total		**11**	**0**	**0%**	**18638**	**0**	**0**	**0**	**n**
Faroe Isl	1	1	0	0%	95	0	0	0	n
	2	1	0	0%	25	0	0	0	n
	3	2	0	0%	144	0	0	0	n
	4	2	0	0%	363	0	0	0	n
total		**6**	**0**	**0%**	**627**	**0**	**0**	**0**	**n**
France	1	3	0	0%	644	0	0	0	n
	2	3	0	0%	1538	0	0	0	n
	3	4	0	0%	17758	0	0	0	n
	4	2	0	0%	11603	0	0	0	n
total		**12**	**0**	**0%**	**31544**	**0**	**0**	**0**	**n**
Germany	1	1	0	0%	95	0	0	0	n
	2	2	1	92%	7474	43	379	10715	y
	3	3	2	99%	30004	74	1029	19461	y
	4	4	1	94%	6380	30	442	15868	y
total		**10**	**4**	**97%**	**43952**	**147**	**1850**	**46044**	**y**
Netherlands	1	4	3	100%	8636	14	350	2878	y
	2	3	3	100%	5444	54	1350	10045	y
	3	3	2	100%	37831	58	1450	8242	y
	4	4	3	100%	29197	16	400	2769	n
total		**14**	**11**	**100%**	**81108**	**142**	**3550**	**23934**	**y**
Northern Ireland	3	1	1	100%	2010	1	50	89	n
total		**1**	**1**	**100%**	**2010**	**1**	**50**	**89**	**n**
Norway	1	3	2	95%	3205	1	100	100	n
	2	3	3	100%	47846	20	1988	2000	n
	3	3	3	100%	47423	11	994	1056	n
	4	3	1	17%	14007	0	0	0	n
total		**12**	**9**	**96%**	**112481**	**32**	**3082**	**3156**	**n**
Scotland	1	1	2	100%	143	2	172	238	y
	2	1	1	100%	2438	11	600	2369	y
	3	2	2	100%	37696	89	3472	13529	y
	4	1	1	100%	15	3	142	222	y
total		**5**	**3**	**100%**	**40291**	**105**	**4386**	**16358**	**y**
Sweden	2	3	0	0%	2212	0	0	0	n
	3	3	0	0%	252	0	0	0	n
	4	3	0	0%	2317	0	0	0	n
total		**9**	**0**	**0%**	**4781**	**0**	**0**	**0**	**n**
grand total		**108**	**46**	**90%**	**414045**	**533**	**14568**	**95347**	**y**
Period total	**1**	23	9	82%	30117	29	834	4459	n
Period total	**2**	26	12	96%	72741	160	4598	25746	y
Period total	**3**	31	14	93%	200543	258	7474	44117	y
Period total	**4**	28	11	82%	110644	56	1220	5157	n
Total for stock 2002	**2003**	**108**	**46**	**90%**	**414045**	**503**	**14126**	**79479**	**y**
Human Cons. only		93	40	90%	401759	435	13700	78735	y
Total for stock 2001		98 (93)	26	71%	294865	230	9477	38976	n
Total for stock 2002		91	41	81%	304170	351	10932	53637	y
Human Cons. only 2002		78	31	81%	282081	271	10932	52293	n

Table 2.3.1.1 North Sea herring numbers (millions) at ring and maturity by ICES Subarea from July acoustic survey 2003

ICES A	IIIa	IVa	IVb	IVc
0	2.8	0.0	2347.2	239.9
1i	3376.7	995.3	5446.9	7.9
1m	0.0	2.6	0.0	0.0
2i	107.5	3566.8	7126.6	0.0
2m	6.7	5112.4	3028.6	0.8
3i	8.5	171.4	23.4	0.0
3m	0.8	2662.7	214.1	0.0
4	3.9	3923.3	261.6	0.1
5	1.0	572.1	102.0	0.0
6	0.0	396.4	98.4	0.0
7	0.0	545.2	23.2	0.0
8	0.0	140.4	5.2	0.0
9+	0.0	152.5	25.2	0.0
Immature	3495.6	4733.5	14944.0	247.9
Mature	12.5	13507.4	3758.3	1.0
Total	3508.0	18240.9	18702.3	248.8

Table 2.3.1.2 North Sea herring biomass (thousands of tonnes) at ring and maturity by ICES subarea from July acoustic survey 2003

ICES A	IIIa	IVa	IVb	IVc
0	0.01	0.00	13.64	2.0
1i	127.25	53.63	271.67	0.3
1m	0.00	0.24	0.00	0.0
2i	6.95	363.03	537.99	0.0
2m	0.43	710.74	348.32	0.0
3i	0.79	23.81	2.21	0.0
3m	0.08	512.73	29.10	0.0
4	0.52	834.17	41.64	0.0
5	0.16	128.46	15.55	0.0
6	0.00	105.52	14.70	0.0
7	0.00	156.08	3.58	0.0
8	0.00	41.24	0.94	0.0
9+	0.00	50.04	4.58	0.0
Immature	135.00	440.46	825.51	2.3
Mature	1.19	2539.21	458.41	0.1
Total	136.19	2979.68	1283.92	2.4

Table 2.3.1.3 North Sea herring mean weight (g) at ring and maturity by ICES Subarea from July acoustic survey 2003

ICES A	IIIa	IVa	IVb	IVc
0	5.2		5.8	8.4
1i	37.7	53.9	49.9	36.9
1m		90.0		
2i	64.7	101.8	75.5	42.4
2m	64.7	139.0	115.0	52.7
3i	92.6	138.9	94.2	
3m	92.6	192.6	135.9	101.3
4	131.5	212.6	159.1	116.6
5	164.5	224.5	152.4	124.8
6		266.2	149.4	
7		286.3	154.7	
8		293.8	182.0	
9+		328.2	181.5	

Table 2.3.1.4 North Sea autumn-spawning herring in the area surveyed in the acoustic surveys July 2003 Total numbers (millions) and biomass (thousands of tonnes) with mean weights (g), mean lengths (cm) and fraction mature by ring.

North Sea ring	Numbers (millions)	Biomass Tonnes $*10^3$	Maturity (fraction)	Mean weight (g)	Mean length (cm)
0	2589.9	15.7	0.00	6	9.3
1	9829.4	453.1	0.00	46	18.0
2	18949.4	1967.5	0.43	104	22.5
3	3081.0	568.7	0.93	185	26.3
4	4188.9	876.3	1.00	209	27.5
5	675.1	144.2	1.00	214	28.0
6	494.8	120.2	1.00	243	28.9
7	568.3	159.7	1.00	281	30.0
8	145.5	42.2	1.00	290	30.3
9+	177.7	54.6	1.00	307	31.0
Immature	23420.9	1403.3			
Mature	17279.2	2998.9			
Total	40700.1	4402.1			

Table 2.3.1.5 North Sea autumn spawners, estimates of (millions) at age from acoustic surveys, and SSB (thousands of tonnes) 1984-2003. 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%.

Year/ring	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	551	726	1,639	13,736	6,431	6,333	6,249	3,182	6,351	10,399	3,646	4,202	6,198	9,416	4,449	5,087	24,735	6,837	23,055	9,829
2	3,194	2,789	3,206	4,303	4,202	3,726	2,971	2,834	4,179	3,710	3,280	3,799	4,557	6,363	5,747	3,078	2,922	12,290	4,875	18,949
3	1,005	1,433	1,637	955	1,732	3,751	3,530	1,501	1,633	1,855	957	2,056	2,824	3,287	2,520	4,725	2,156	3,083	8,220	3,081
4	394	323	833	657	528	1,612	3,370	2,102	1,397	909	429	656	1,087	1,696	1,625	1,116	3,139	1,462	1,390	4,189
5	158	113	135	368	349	488	1,349	1,984	1,510	795	363	272	311	692.1	982.4	506.4	1,006	1,676	794.6	675.1
6	44	41	36	77	174	281	395	748	1,311	788	321	175	98.7	259.2	445.2	313.6	482.5	449.6	1,031	494.8
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
8	39	23	6	11	23	44	134	112	155	178	220	110	132.9	78.3	45.2	54.3	120.4	97.7	121.0	145.5
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
Total	5,478	5,484	7,542	20,165	13,496	16,377	18,262	12,781	17,173	19,326	13,003	11,220	18,786	22,028	16,104	15,107	34,928	26,124	39,881	38,110
$Z_{2+/3+}$	.	0.92	0.57	1.02	0.81	0.11	0.11	0.57	0.37	0.74	1.21	0.53	0.43	0.40	0.76	0.52	0.32	0.38	0.47	0.59
Smooth $Z_{2+/3+}$	.	.	0.73	0.76	0.91	0.30	0.11	0.25	0.46	0.52	0.94	0.80	0.48	0.41	0.55	0.63	0.41	0.35	0.42	0.53
SSB (‘000 t)	807	697	942	817	897	1,637	2,174	1,874	1,545	1,216	1,035	1,082	1446.2	1,780	1,792	1,534	1,833	2,622	2,948	2,999

Table 2.3.2.1 Fortnightly time periods sampled and survey effort in 2003/2004.
NL – Netherlands, FRG – Federal Republic of Germany

Area	Time period	Samples available	Vessel days	Nation	Coverage
Orkney/Shetland	01-15 Sep.	None			
	16-30 Sep.	93	6	FRG	Total
Buchan	01-15 Sep.	None			
	16-30 Sep.	76	5	NL	Total
Central North Sea	01-15 Sep.	None			
	16-30 Sep.	64	4	NL	Partial
	01-15 Oct.	58	5	FRG	Partial
Southern North Sea	16-31 Dec.	77	4	NL	Total
	01-15 Jan.	108	8	FRG	Total
	16-31 Jan.	92	5	NL	Total

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

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

Table 2.3.2.3 Estimated abundances of herring larvae <10 mm long, by standard sampling area and time periods. The number of larvae are expressed as mean number per ICES rectangle * 10^9

	Orkney/Shetland		Buchan		Central North Sea			Southern North Sea		
Period	1-15 Sep.	16-30 Sep.	1-15 Sep.	16-30 Sep.	1-15 Sep.	16-30 Sep.	1-15 Oct.	16-31 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

Table 2.3.2.4: 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	41	159.4	3.88	8.31	<0.0001
Error	224	104.7	0.467		
C Total	265	264.1			

b) Estimates of parameters

Reference Mean

Estimate	Standard Error	
6.8335	0.5559	Reference: 1972, Orkney/Shetland 09/01 – 09/15

Year Effects

Year	Estimate	Standard Error	Year	Estimate	Standard Error
1973	0.3615	0.6911	1989	2.6754	0.6112
1974	-0.1421	0.7405	1990	2.9235	0.6341
1975	-1.2197	0.7525	1991	2.2802	0.6871
1976	-1.3204	0.7385	1992	1.5209	0.7263
1977	-0.4157	0.7079	1993	1.1963	0.7029
1978	-0.2221	0.7185	1994	0.8077	0.7408
1979	0.4825	0.6916	1995	0.9432	0.7304
1980	0.1015	0.6886	1996	1.6321	0.7692
1981	0.5014	0.6855	1997	1.8549	0.7215
1982	0.8492	0.6222	1998	2.1489	0.6782
1983	1.1047	0.6380	1999	1.9637	0.6820
1984	1.6986	0.6193	2000	1.5456	0.6972
1985	2.1203	0.5974	2001	2.6749	0.7099
1986	1.4622	0.6172	2002	2.5051	0.6891
1987	2.0192	0.6091	2003	3.4293	0.7015
1988	2.7083	0.5972			

Sampling Unit Effects

Sampling Unit	Estimate	Standard Error
Or/Shet 16-30 Sep	-0.6909	0.3276
Buchan 01-15 Sep	-1.8223	0.4208
Buchan 16-30 Sep	-2.5476	0.3609
CNS 01-15 Sep	-1.6544	0.4073
CNS 16-30 Sep	-1.4676	0.3617
CNS 01-15 Oct	-2.0805	0.3841
CNS 16-31 Oct	-4.1676	0.5297
SNS 12-31 Dec	-1.8262	0.3883
SNS 01-15 Jan	-2.5445	0.3360
SNS 16-31 Jan	-3.6594	0.3761

Table 2.3.2.5 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, 1^{st}-15^{th} 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: 6.83349

Year	MLAI	$MLAI_{plus}$	eMLAI	$MLAI_{assess}$
1973	0.3615	7.1950	1,332.7	13.3
1974	-0.4210	6.6914	805.4	8.1
1975	-1.2197	5.6138	274.2	2.7
1976	-1.3294	5.5041	245.7	2.5
1977	-0.4157	6.4178	612.6	6.1
1978	-0.2221	6.6114	743.5	7.4
1979	0.4825	7.3160	1,504.2	15.0
1980	0.1015	6.9350	1,027.6	10.3
1981	0.5014	7.3349	1,532.9	15.3
1982	0.8492	7.6827	2,170.5	21.7
1983	1.1047	7.9382	2,802.3	28.0
1984	1.6986	8.5321	5,075.0	50.8
1985	2.1203	8.9538	7,737.2	77.4
1986	1.4622	8.2957	4,006.6	40.1
1987	2.0192	8.8527	6,993.2	69.9
1988	2.7083	9.5418	13,929.9	139.3
1989	2.6754	9.5089	13,479.0	134.8
1990	2.9235	9.7570	17,274.6	172.7
1991	2.2802	9.1137	9,078.7	90.8
1992	1.5209	8.3544	4,248.8	42.5
1993	1.1963	8.0298	3,071.1	30.7
1994	0.8077	7.6412	2,082.2	20.8
1995	0.9430	7.7765	2,383.9	23.8
1996	1.6321	8.4656	4,748.5	47.5
1997	1.8549	8.6884	5,933.6	59.3
1998	2.1489	8.9824	7,961.6	79.6
1999	1.9637	8.7972	6,615.6	66.2
2000	1.5456	8.3791	4,355.0	43.6
2001	2.6749	9.5084	13,472.3	134.7
2002	2.5051	9.3386	11,368.4	113.7
2003	3.4293	10.2628	28,646.6	286.5

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

- English 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 2004. 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	2446.5	979.5	456.0	759.0	110.9	141.1
RF1	3112.3	0.1	55.0	1760.3	567.2	729.7
RF2	1097.0	23.6	445.3	578.1	25.7	24.2
RF3	316.2	292.1	16.8	5.7	1.2	0.5
RF4	3221.5	194.0	1559.0	1451.0	10.7	6.7
RF5	1335.6	80.4	125.6	621.4	172.7	335.5
RF6	7054.0	4987.5	948.0	1021.7	72.5	24.4
RF7	1238.9	280.6	703.4	254.9	0.0	0.0
RF8	174.6	174.6	0.0	0.0	0.0	0.0
RF9	2474.9	2474.9	0.0	0.0	0.0	0.0

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

Table 2.3.3.3 North Sea herring. Indices of 1-ringers form the IBTS 1st Quarter, estimation of the small sized component (possibly Downs herring).” North Sea” = total area of sampling minus IIIa.

Year class	Year of sampling	All 1-ringers (no/hour)	Small<13cm 1-ringers in total area (no/hour)	Proportion of small in total area vs. all sizes	Small<13cm 1-ringers in North Sea (no/hour)	Proportion of small in North Sea vs. all sizes	Proportion of small in IIIa vs small in total area
1977	1979	156	11.07	0.07	11.87	0.08	0
1978	1980	342	112.85	0.33	112.47	0.33	0.07
1979	1981	518	57.57	0.11	48.34	0.09	0.22
1980	1982	799	175.36	0.22	184.03	0.23	0.02
1981	1983	1231	188.6	0.15	180.2	0.15	0.11
1982	1984	1469	330.25	0.23	278.5	0.19	0.21
1983	1985	2082	295.46	0.14	276.2	0.13	0.13
1984	1986	2593	585.93	0.23	372.45	0.15	0.41
1985	1987	3734	640.27	0.17	526.85	0.14	0.23
1986	1988	4470	2365.73	0.52	697.49	0.15	0.72
1987	1989	2187	548.79	0.24	488.36	0.21	0.17
1988	1990	1025	69.01	0.07	60.07	0.06	0.19
1989	1991	1180	299.97	0.26	305.38	0.26	0.05
1990	1992	1204	120.9	0.10	125.44	0.11	0.03
1991	1993	2989	754.89	0.26	163.09	0.06	0.8
1992	1994	1644	266.99	0.16	224.91	0.13	0.21
1993	1995	1215	386.34	0.33	379.98	0.32	0.08
1994	1996	1728	537.1	0.31	408.92	0.24	0.29
1995	1997	3993	1179.9	0.29	932.95	0.23	0.26
1996	1998	2067	1168.12	0.57	1231.57	0.60	0.02
1997	1999	715	141.15	0.20	138.77	0.19	0.08
1998	2000	3639	1062.18	0.29	936.11	0.26	0.18
1999	2001	2696	322.57	0.12	302.19	0.11	0.06
2000	2002	3948	1510.9	0.38	1427.64	0.36	0.12
2001	2003	2926	708.4	0.24	201.6	0.07	0.73
2002	2004	**980**	649.0	0.41	691.5	0.43	0.004

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	Division IIIa	South-ern Bight	0-ringer abundance
Area $m^2 \times 10^9$	83	34	86	102	37	93	31	31	no. in 10^9
Year class									
1976	0.054	0.014	0.122	0.005	0.008	0.002	0.002	0.016	17.1
1977	0.024	0.024	0.050	0.015	0.056	0.013	0.006	0.034	13.1
1978	0.176	0.031	0.061	0.020	0.010	0.005	0.074	0.000	52.1
1979	0.061	0.195	0.262	0.408	0.226	0.143	0.099	0.053	101.1
1980	0.052	0.001	0.145	0.115	0.089	0.339	0.248	0.187	76.7
1981	0.197	0.000	0.289	0.199	0.215	0.645	0.109	0.036	133.9
1982	0.025	0.011	0.068	0.248	0.290	0.309	0.470	0.140	91.8
1983	0.019	0.007	0.114	0.268	0.271	0.473	0.339	0.377	115.0
1984	0.083	0.019	0.303	0.259	0.996	0.718	0.277	0.298	181.3
1985	0.116	0.057	0.421	0.344	0.464	0.777	0.085	0.084	177.4
1986	0.317	0.029	0.730	0.557	0.830	0.933	0.048	0.244	270.9
1987	0.078	0.031	0.417	0.314	0.159	0.618	0.483	0.495	168.9
1988	0.036	0.020	0.095	0.096	0.151	0.411	0.181	0.016	71.4
1989	0.083	0.030	0.040	0.094	0.013	0.035	0.041	0.000	25.9
1990	0.075	0.053	0.202	0.158	0.121	0.198	0.086	0.196	69.9
1991	0.255	0.390	0.431	0.539	0.500	0.369	0.298	0.395	200.7
1992	0.168	0.039	0.672	0.444	0.734	0.268	0.345	0.285	190.1
1993	0.358	0.212	0.260	0.187	0.120	0.119	0.223	0.028	101.7
1994	0.148	0.024	0.417	0.381	0.332	0.148	0.252	0.169	126.9
1995	0.260	0.086	0.699	0.092	0.266	0.018	0.001	0.020	106.2
1996	0.003	0.004	0.935	0.135	0.436	0.379	0.039	0.032	148.1
1997	0.042	0.021	0.338	0.064	0.178	0.035	0.023	0.083	53.1
1998	0.100	0.056	1.150	0.592	0.998	0.265	0.280	0.127	244.0
1999	0.045	0.011	0.799	0.200	0.514	0.220	0.107	0.026	137.1
2000	0.284	0.011	1.052	0.197	1.156	0.376	0.063	0.006	214.8
2001	0.080	0.019	0.566	0.473	0.567	0.247	0.209	0.226	161.8
2002	0.141	0.040	0.287	0.028	0.121	0.045	0.003	0.157	54.4
2003	0.045	0.005	0.284	0.074	0.106	0.021	0.022	0.154	47.3

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

Ring	Mean weights-at-age (g)																			
	Third quarter mean weights in catch (Divisions IVa, IVb and IIIa)										July acoustic Survey									
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	55	63	75	43	54	62	54	69	50	65	60	58	45	45	52	52	46	50	45	46
2	131	149.7	135.1	129	131	128	123	136	140	119	138	132	119	120	109	118	118	127	138	104
3	164	192.5	186.3	175	172	163	172	167	177	177	209	180	196	168	198	171	180	162	172	185
4	192	221	224.3	220	209	193	201	199	200	198	220	200	253	233	238	207	218	204	194	209
5	218	232.4	229.3	247	237	228	228	218	224	210	251	195	262	256	275	236	232	228	224	214
6	245	272	252.6	255	263	252	241	237	244	236	289	228	299	245	307	267	261	237	247	243
7	258	275.8	291.6	278	269	263	266	262	252	247	315	257	306	265	289	272	295	255	261	281
8	277	317	300.3	295	313	275	286	288	281	272	323	302	325	269	308	230	300	286	280	290
9+	292	306	302.3	295	298	306	271	298	298	282	346	324	335	329	363	260	280	294	249	307

Weights-at-age in the catch for 1995 to 2001 were revised by SG Rednose,
data for 1994 does not include North Sea Autumn Spawners caught in Div. IIIa.

Table 2.4.2.1 Maturity at 2-, 3- and 4+ring for Autumn Spawning herring in the North Sea. The values are derived from the acoustic survey for 1989 to 2003.

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	1.00
2003	43.0	93.0	1.00

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

Survey	Years survey has been running	Years used in assessment
MLAI (Larvae survey) SSB	1972-2003	1973-2003
IBTS 1st Quarter (Trawl survey) 1wr 2-5wr	 1971-2004 1971-2004	 1979-2004 1983-2004
IBTS 3rd Quarter (Trawl survey)	1991-2003	------------
Acoustic (+trawl) 2-9+ 1wr	 1984-2003 1995-2003	 1989-2003 1997-2003
MIK net 0wr	1977-2004	1977-2004

Table 2.6.1.2 North Sea Herring. The weights used in the ICA assessment in 2002 and 2003.

	Weights for the catch	Weights for the surveys			
Rings		MLAI	Acoustic	IBTS 1-5	MIK
0	0.10				2.050
1	0.10			0.674	
2	3.17		0.746	0.241	
3	2.65		0.639	0.063	
4	1.94		0.274	0.031	
5	1.31		0.140	0.027	
6	0.97		0.133		
7	0.75		0.115		
8	0.55		0.074		
9	0.54		0.075		
SSB		0.645			
St/R rel*	0.1				

* St/R rel= stock recruitment relationship weight

Table 2.6.1.3 North Sea herring. Model settings for XSA with low shrinkage of F (=2.0). Age=ringer.

```
Catch data for  44 years. 1960 to 2003. Ages  0 to   9.

      Fleet                 First   Last   First  Last   Alpha
Beta
                             year   year    age    age
Acoustic survey 2-9+ 1989   2003       1      8   .54     .56
IBTS: 1-5+ wr        1979   2003       1      5   .08     .17
MIK 0-wr             1977   2003       0      0   .08     .17

Time-series weights :
      Tapered time weighting not applied

Catchability analysis :
   Catchability dependent on stock size for ages <    2

         Regression type = C
         Minimum of   5 points used for regression

         Survivor estimates shrunk to the population mean for ages <
2
     Catchability independent of age for ages >=    4

Terminal population estimation :
      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   1 oldest ages.
      S.E. of the mean to which the estimates  are shrunk =   2.000

      Minimum standard error for population
      estimates derived from each fleet =    .300
      Prior weighting not applied

Tuning converged after   25 iterations
```

Table 2.6.1.4 North Sea herring. **EXPLORATORY** stock summary results from **XSA model** with low shrinkage (=2.0). Model settings given in Table 2.6.1.3.

Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 6
1961	110236984	5118709	2345005	696700	.2971	.3459
1962	46997732	4962379	1617116	627800	.3882	.4058
1963	49158448	5205647	2690566	716000	.2661	.2085
1964	64750648	5276351	2422004	871200	.3597	.3376
1965	35941008	4715125	1742672	1168800	.6707	.7056
1966	28998322	3464802	1377219	895500	.6502	.6187
1967	41615512	2868228	920465	695500	.7556	.7952
1968	40153152	2600266	424906	717800	1.6893	1.3351
1969	22292606	1963410	436858	546700	1.2514	1.0724
1970	43384804	1994848	386609	563100	1.4565	1.0333
1971	34074996	1939484	281336	520100	1.8487	1.3067
1972	22221482	1625334	303494	497500	1.6392	.6790
1973	10660823	1206167	241289	484000	2.0059	1.1206
1974	23452732	961892	169938	275100	1.6188	1.0127
1975	3294411	730620	89261	312800	3.5043	1.3250
1976	3084519	392847	91091	174800	1.9190	1.2014
1977	5094526	249440	65043	46000	.7072	.5660
1978	5635589	280933	87743	11000	.1254	.0326
1979	10851826	441826	137514	25100	.1825	.0500
1980	17332150	699068	176803	70764	.4002	.2183
1981	39553212	1247832	244827	174879	.7143	.2680
1982	67403800	1950153	331084	275079	.8308	.2250
1983	64452956	2854713	489445	387202	.7911	.2829
1984	55758660	2992010	738360	428631	.5805	.4087
1985	83219320	3609191	765186	613780	.8021	.6197
1986	101434672	3608318	734592	671488	.9141	.5462
1987	90175736	4067168	928599	792058	.8530	.5376
1988	44367356	3700669	1234375	887686	.7191	.5104
1989	40604500	3410443	1288351	787899	.6116	.5208
1990	36747548	3068941	1234121	645229	.5228	.4248
1991	35367576	2800212	1022870	658008	.6433	.4810
1992	66413884	2539365	740280	716799	.9683	.5636
1993	53708748	2657567	504163	671397	1.3317	.6780
1994	34382832	2155080	571352	568234	.9945	.6738
1995	44049628	1962772	522972	639146	1.2221	.7657
1996	50557228	1647094	484438	276923	.5716	.3940
1997	26584044	1939584	558714	265424	.4751	.3901
1998	23310496	2000335	728033	394308	.5416	.4623
1999	70252744	2229574	827878	368346	.4449	.3941
2000	37715664	2757222	772698	389457	.5040	.4247
2001	93459480	3095247	1203639	364953	.3032	.3388
2002	51988176	3972142	1461037	370941	.2539	.2735
2003	21025278	4027544	1655780	472938	.2856	.3229

Results of Exploratory XSA assessment

Arith. Mean	42364134	2626662	856429	509847	.8609	.5712
	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 2.6.1.5 North Sea herring. Values for the slope of the regression line fitted through the 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.

Age	catch ratio slope	Acoustic abundance ratio slope	IBTS abundance ratio slope
0	-0.0784		
1	-0.0862	-0.0401	-0.0300
2	-0.1013	-0.0623	-0.1684
3	-0.0656	-0.0266	-0.0694
4	-0.0816	-0.0025	
5	-0.0544	-0.0358	
6	-0.0751	-0.0256	
7	-0.0266	-0.0129	

Table 2.6.2.1 North Sea herring (autumn spawners). Final model fit ICA log. Note age=ringer.

```
                         Integrated Catch-at-age Analysis
                         Version 1.4 w K.R.Patterson
Enter the name of the index file -->index.txt   canum.txt   weca.txt
Stock weights in 2004 used for the year 2003               west.txt
Natural mortality in 2004  used for the year 2003         natmor.txt
Maturity ogive in 2004  used for the year 2003          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-->    3.170000000000000
 Weight for age 3-->    2.650000000000000
 Weight for age 4-->    1.940000000000000
 Weight for age 5-->    1.310000000000000
 Weight for age 6-->    0.970000000000000
 Weight for age 7-->    0.750000000000000
 Weight for age 8-->    0.550000000000000
 Weight for age 9-->    0.540000000000000
Enter relative weights by year
 Weight for year 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
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 2-9+ wr a plus-group (Y/N) ?-->y
 Is the last age of IBTS: 1-5+ wr a plus-group (Y/N) ?-->y
 Is the last age of MIK 0-wr a plus-group (Y/N) ?-->n
You must choose a catchability model for each index.
Models:   A  Absolute:  Index = Abundance . e
          L  Linear:    Index = Q. Abundance . e
          P  Power:     Index = Q. Abundance^ K .e
   where Q and K are parameters to be estimated, and
   e is a lognormally-distributed error.
 Model for   MLAI  is to be A/L/P ?-->p
 Model for Acoustic survey 2-9+ wr  is to be A/L/P ?-->L
 Model for IBTS: 1-5+ wr  is to be A/L/P ?-->L
 Model for MIK 0-wr  is to be A/L/P ?-->L
 Fit a stock-recruit relationship (Y/N) ?-->y
Enter the time lag in years between spawning and the stock size
 of fish aged 0  years on 1 January.
This will probably be 0 unless the stock is an autumn-spawning herring
 in which case it will probably be 1  years.
 Enter the lag in years (rounded up)--> 1
 Enter lowest feasible F-->   2.0000000000000000E-02
 Enter highest feasible F-->    2.000000000000000
Mapping the F-dimension of the SSQ surface

    F                  SSQ
+--------+------------------
    0.02       157.5334564310
    0.12        39.9610562393
    0.23        22.7793496941
    0.33        20.1867367780
    0.44        21.1971929916
    0.54        23.2857508933
    0.65        25.7261884494
    0.75        28.2741633207
    0.85        30.8400900775
    0.96        33.3927251641
    1.06        35.9271529515
    1.17        38.4539417123
    1.27        40.9974691031
    1.37        43.6027084160
    1.48        46.1561453068
```

Table 2.6.2.1. cont**.** North Sea herring.

```
    1.58         48.6674430398
    1.69         50.5087994449
    1.79         52.2172316179
    1.90         53.8565161210
    2.00         55.4323322840
Lowest SSQ is for F =     0.333

No of years for separable analysis : 5
Age range in the analysis : 0  . . . 9
Year range in the analysis : 1960  . . . 2003
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 : 388
Conventional single selection vector model to be fitted.

 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for   MLAI-->    0.650000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 1-->    0.740000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 2-->    0.750000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 3-->    0.640000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 4-->    0.270000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 5-->    0.140000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 6-->    0.130000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 7-->    0.120000000000000
 Enter weight for Acoustic survey 2-9+ wr  at age 8-->   7.0000000000000007E-02
 Enter weight for Acoustic survey 2-9+ wr  at age 9-->   7.0000000000000007E-02
 Enter weight for IBTS: 1-5+ wr  at age 1-->   0.670000000000000
 Enter weight for IBTS: 1-5+ wr  at age 2-->   0.240000000000000
 Enter weight for IBTS: 1-5+ wr  at age 3-->   5.9999999999999998E-02
 Enter weight for IBTS: 1-5+ wr  at age 4-->   2.9999999999999999E-02
 Enter weight for IBTS: 1-5+ wr  at age 5-->   2.9999999999999999E-02
 Enter weight for MIK 0-wr  at age 0 -->       2.050000000000000
 Enter weight for stock-recruit model-->       0.100000000000000
Enter estimates of the extent to which errors in the age-structured indices are corre-
lated across ages. This can be in the range 0 (independence) 1 (correlated errors).
  Enter value for Acoustic survey 2-9+ 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 0.650
Aged index weights
Acoustic survey 2-9+ wr
 Age   :       1     2     3     4     5     6     7     8     9
 Wts :     0.740 0.750 0.640 0.270 0.140 0.130 0.120 0.070 0.070
IBTS: 1-5+ wr
 Age   :       1     2     3     4     5
 Wts :     0.670 0.240 0.060 0.030 0.030
MIK 0-wr
 Age   :       0
 Wts :     2.050
 Stock-recruit weight           0.100
F in 2003 at age 4 is 0.278790 in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->D
 Output page width in characters (e.g. 8-..132) ? --> 80
Estimate historical assessment uncertainty ? -->n

Succesful exit from ICA
```

Table 2.6.2.2 North Sea herring, autumn spawners. 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.

AGE	2000	2001	2002	2003
0	1105.	1833.	730.	369.
1	1172.	614.	835.	617.
2	623.	806.	553.	1204.
3	463.	477.	903.	517.
4	647.	274.	284.	820.
5	213.	312.	133.	243.
6	82.	89.	161.	106.
7	36.	37.	46.	120.
8	15.	17.	33.	37.
9	2.	2.	7.	8.

Table 2.6.2.2. cont. North Sea herring.

Predicted Catch in Number x 10 ^ 6

AGE	1999	2000	2001	2002	2003
0	1975.0	1070.6	1710.1	897.3	356.5
1	512.0	1272.5	511.0	1014.7	624.1
2	528.6	562.7	1057.7	535.2	1247.8
3	1004.0	489.2	402.8	980.3	585.8
4	332.7	667.2	255.1	279.4	808.6
5	156.8	187.8	296.5	152.8	199.7
6	69.4	83.2	78.4	167.0	102.8
7	27.8	37.6	35.4	44.8	114.1
8	10.2	15.8	16.8	21.2	32.1

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

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

Table 2.6.2.2. cont**.** North Sea herring.

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

AGE	2000	2001	2002	2003
0	0.01500	0.01200	0.01200	0.01400
1	0.03300	0.04800	0.03700	0.03700
2	0.11300	0.11700	0.11600	0.10400
3	0.15700	0.14900	0.15100	0.15700
4	0.17900	0.17700	0.16900	0.17300
5	0.20100	0.19700	0.19800	0.18400
6	0.21600	0.21200	0.21400	0.20400
7	0.24600	0.23700	0.22800	0.22100
8	0.27500	0.26700	0.25000	0.23200
9	0.26200	0.28600	0.25300	0.25300

Weights-at-age in the stock (Kg). NOTE: The recent estimates are 3 year running averages from the raw weights-at-age in the stock.

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

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

Table 2.6.2.2. cont**.** North Sea herring.

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

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

AGE	2000	2001	2002	2003
0	0.00600	0.00600	0.00700	0.00600
1	0.05100	0.04700	0.04700	0.04600
2	0.12200	0.12800	0.12300	0.12100
3	0.17200	0.17200	0.17300	0.17900
4	0.21000	0.20500	0.20200	0.20200
5	0.23300	0.22800	0.22200	0.21900
6	0.25500	0.24800	0.24200	0.24500
7	0.27500	0.27000	0.26600	0.27100
8	0.27400	0.28900	0.28500	0.28500
9	0.28000	0.27500	0.28300	0.27800

Natural Mortality (per year)

AGE	1960	1970	1980	1990	2000
0	1.0000	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000

Proportion of fish spawning

AGE	1960	1965	1970	1975	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	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

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

Table 2.6.2.2. cont**.** North Sea herring.

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

AGE	2000	2001	2002	2003
0	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000
2	0.6700	0.7700	0.8700	0.4300
3	0.9600	0.9200	0.9700	0.9300
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

INDICES OF SPAWNING BIOMASS

MLAI

	1973	1974	1975	1976	1977	1978	1979	1980
1	13.30	8.10	2.70	2.50	6.10	7.40	15.00	10.30

	1981	1982	1983	1984	1985	1986	1987	1988
1	15.30	21.70	28.00	50.80	77.40	40.10	69.90	139.30

	1989	1990	1991	1992	1993	1994	1995	1996
1	134.80	172.70	90.80	42.50	30.70	20.80	23.80	47.50

	1997	1998	1999	2000	2001	2002	2003
1	59.30	79.60	66.20	43.60	134.70	113.70	286.50

AGE-STRUCTURED INDICES

Acoustic survey 2-9+ 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
1	9361.	4449.	5087.	24736.	6837.	23055.	9829.
2	5960.	5747.	3078.	2923.	12290.	4875.	18949.
3	2935.	2520.	4725.	2156.	3083.	8220.	3081.
4	1441.	1625.	1116.	3140.	1462.	1390.	4189.
5	601.	982.	506.	1007.	1676.	795.	675.
6	215.	445.	314.	483.	450.	1031.	495.
7	46.	170.	139.	266.	170.	244.	568.
8	78.	45.	54.	120.	98.	121.	146.
9	159.	121.	87.	97.	59.	149.	178.

Table 2.6.2.2. cont**.** North Sea herring.

IBTS: 1-5+ wr

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

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

AGE	1995	1996	1997	1998	1999	2000	2001	2002
1	1215.4	1728.3	3992.7	2067.1	714.8	3693.7	2508.8	4071.1
2	1263.1	209.0	526.6	799.7	456.8	217.9	1117.2	654.4
3	251.0	46.6	204.1	96.4	547.8	159.3	317.4	306.3
4	33.2	13.5	42.8	22.0	109.0	61.5	98.0	21.9
5	6.2	9.1	24.3	20.7	40.3	8.6	66.2	19.9

AGE	2003	2004
1	2999.9	979.5
2	1547.9	456.0
3	475.2	759.0
4	345.9	110.9
5	43.9	141.1

MIK 0-wr

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

MIK 0-wr cont.

AGE	1985	1986	1987	1988	1989	1990	1991	1992
0	181.30	177.40	270.90	168.90	71.40	25.90	69.90	200.70

AGE	1993	1994	1995	1996	1997	1998	1999	2000
0	190.10	101.70	127.00	106.50	148.10	53.10	244.00	137.10

AGE	2001	2002	2003	2004
0	214.80	161.80	54.40	47.30

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	0.2562	0.1294	0.0897	0.1241	0.3084	0.2461	0.1852	0.2981
2	0.4374	0.6182	0.2502	0.2976	0.3890	0.7753	0.5921	0.4222
3	0.3296	0.3539	0.6291	0.2755	0.4125	0.7389	0.7082	0.8046
4	0.3403	0.4108	0.4242	0.2282	0.3704	0.7770	0.5719	0.9244
5	0.2696	0.4075	0.5390	0.1517	0.3098	0.6602	0.8353	0.8279
6	0.3188	0.3882	0.8370	0.1841	0.2398	0.5251	0.3906	1.0120
7	0.6184	0.2559	0.6551	0.2965	0.2864	0.4622	0.3944	1.5349
8	0.6015	0.5471	0.6010	0.3520	0.5920	0.8858	0.7468	1.1057
9	0.6015	0.5471	0.6010	0.3520	0.5920	0.8858	0.7468	1.1057

Table 2.6.2.2. cont**.** North Sea herring.

AGE	1968	1969	1970	1971	1972	1973	1974	1975
0	0.0348	0.0082	0.0351	0.0340	0.0583	0.0462	0.0749	0.1586
1	0.3003	0.3291	0.2681	0.6022	0.5783	0.6739	0.4523	0.6884
2	1.3273	0.7844	0.9728	0.8826	0.8123	1.0225	1.0287	1.3165
3	1.8723	0.9127	1.2671	1.2148	0.8015	1.3344	0.9740	1.5049
4	1.0716	0.8745	1.3316	1.2270	0.7997	0.9881	0.9953	1.3777
5	1.2340	1.0546	0.8764	1.0878	0.5501	0.9517	1.1870	1.8972
6	1.1759	1.9011	1.0815	2.6318	0.5210	1.3824	1.0794	1.2793
7	1.6131	1.3041	4.1333	2.7415	0.1001	0.8161	0.7797	2.0409
8	1.6666	1.3705	1.7770	2.0298	1.0959	1.6328	1.3875	2.1095
9	1.6666	1.3705	1.7770	2.0298	1.0959	1.6328	1.3875	2.1095

AGE	1976	1977	1978	1979	1980	1981	1982	1983
0	0.1476	0.0979	0.0457	0.0838	0.1259	0.4824	0.3347	0.3999
1	0.2518	0.2994	0.2010	0.1673	0.1134	0.2860	0.2253	0.2520
2	1.3411	0.2283	0.0244	0.0952	0.3658	0.3247	0.2612	0.3027
3	1.4571	1.4200	0.0432	0.0671	0.4221	0.2776	0.5097	0.3256
4	1.7417	0.4459	0.1054	0.0954	0.3007	0.3066	0.2497	0.4384
5	1.6265	1.2140	0.0175	0.0530	0.2709	0.4198	0.1563	0.2793
6	1.1141	0.7769	0.0784	0.0131	0.0682	0.4451	0.1483	0.3505
7	1.5237	0.8155	0.0658	0.4456	0.1072	0.9917	0.2399	0.4034
8	1.6896	1.0040	0.2066	0.2552	0.3717	0.6714	0.4500	0.5472
9	1.6896	1.0040	0.2066	0.2552	0.3717	0.6714	0.4500	0.5472

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	0.2265	0.0853	0.0620	0.1615	0.1248	0.1304	0.0589	0.1180
1	0.2054	0.3833	0.3161	0.3725	0.5806	0.4313	0.4532	0.3086
2	0.3150	0.4048	0.4603	0.4069	0.3560	0.3990	0.3776	0.5752
3	0.4308	0.6730	0.5236	0.5072	0.4018	0.4106	0.3705	0.4559
4	0.5401	0.7414	0.5849	0.5913	0.5853	0.5581	0.4684	0.4595
5	0.6320	0.6705	0.5593	0.6224	0.6688	0.6636	0.5036	0.4850
6	0.3666	0.7407	0.7471	0.6470	0.6871	0.7105	0.5019	0.4836
7	0.7157	0.5740	0.8436	0.6367	0.7158	0.7335	0.6993	0.4358
8	0.6448	0.9158	0.8570	0.8469	0.9960	0.8970	0.8308	0.7471
9	0.6448	0.9158	0.8570	0.8469	0.9960	0.8970	0.8308	0.7471

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	0.2967	0.3766	0.2328	0.3246	0.0746	0.0258	0.0155	0.0450
1	0.3880	0.4221	0.2465	0.3041	0.2567	0.0448	0.1737	0.0870
2	0.5739	0.6709	0.6835	0.6016	0.3246	0.2912	0.2626	0.2303
3	0.4997	0.6432	0.7212	0.8665	0.4926	0.4213	0.4160	0.3827
4	0.5754	0.7370	0.9192	0.8805	0.4179	0.5158	0.4749	0.4656
5	0.5499	0.7175	0.5626	0.8403	0.4926	0.4520	0.6160	0.4797
6	0.7254	0.7078	0.6811	0.5485	0.3255	0.4836	0.7199	0.4655
7	0.7118	0.8884	0.4867	0.6668	0.1464	0.2529	0.4061	0.4548
8	0.9156	1.0643	0.8892	0.9752	0.5716	0.4340	0.5965	0.4656
9	0.9156	1.0643	0.8892	0.9752	0.5716	0.4340	0.5965	0.4656

Fishing Mortality (per year) cont.

AGE	2000	2001	2002	2003
0	0.0433	0.0306	0.0265	0.0269
1	0.0838	0.0591	0.0513	0.0521
2	0.2218	0.1565	0.1358	0.1379
3	0.3686	0.2601	0.2257	0.2291
4	0.4485	0.3164	0.2746	0.2788
5	0.4620	0.3260	0.2829	0.2872
6	0.4483	0.3163	0.2745	0.2787
7	0.4381	0.3091	0.2682	0.2723
8	0.4485	0.3164	0.2746	0.2788
9	0.4485	0.3164	0.2746	0.2788

Table 2.6.2.2. cont**.** North Sea herring.

Population Abundance (1 January) x 10 ^ 9

AGE	1960	1961	1962	1963	1964	1965	1966	1967
0	12.09	108.85	46.27	47.66	62.79	34.89	27.86	40.26
1	16.40	4.33	39.31	16.94	17.27	22.81	12.75	10.03
2	3.69	4.67	1.40	13.22	5.50	4.67	6.56	3.90
3	7.69	1.77	1.86	0.81	7.27	2.76	1.59	2.69
4	0.60	4.53	1.02	0.81	0.50	3.94	1.08	0.64
5	0.74	0.39	2.72	0.60	0.59	0.31	1.64	0.55
6	0.43	0.51	0.23	1.43	0.47	0.39	0.15	0.64
7	0.29	0.29	0.32	0.09	1.08	0.33	0.21	0.09
8	0.30	0.14	0.20	0.15	0.06	0.73	0.19	0.13
9	0.33	0.22	0.20	0.18	0.14	0.14	0.47	0.27

AGE	1968	1969	1970	1971	1972	1973	1974	1975
0	38.70	21.58	41.07	32.31	20.86	10.10	21.69	2.81
1	14.43	13.75	7.87	14.59	11.49	7.24	3.55	7.40
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	0.03	0.02	0.01	0.00	0.00	0.00	0.00

AGE	1976	1977	1978	1979	1980	1981	1982	1983
0	2.71	4.32	4.59	10.60	16.71	37.85	64.72	61.79
1	0.88	0.86	1.44	1.61	3.58	5.42	8.59	17.04
2	1.37	0.25	0.23	0.43	0.50	1.18	1.50	2.52
3	0.16	0.27	0.15	0.17	0.29	0.26	0.63	0.85
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	0.10	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	0.01	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	53.42	80.87	97.58	86.16	42.25	39.14	35.83	33.58
1	15.24	15.67	27.32	33.74	26.97	13.72	12.64	12.43
2	4.87	4.57	3.93	7.33	8.55	5.55	3.28	2.96
3	1.38	2.63	2.26	1.84	3.61	4.44	2.76	1.67
4	0.51	0.74	1.10	1.09	0.91	1.98	2.41	1.56
5	0.18	0.27	0.32	0.55	0.55	0.46	1.02	1.37
6	0.08	0.09	0.12	0.16	0.27	0.25	0.21	0.56
7	0.05	0.05	0.04	0.05	0.08	0.12	0.11	0.12
8	0.02	0.02	0.02	0.01	0.03	0.03	0.05	0.05
9	0.04	0.03	0.03	0.01	0.01	0.02	0.02	0.03

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	62.14	50.19	33.62	41.34	50.58	26.68	26.66	70.75
1	10.98	16.99	12.67	9.80	10.99	17.27	9.56	9.66
2	3.36	2.74	4.10	3.64	2.66	3.13	6.08	2.96
3	1.23	1.40	1.04	1.53	1.48	1.42	1.73	3.46
4	0.86	0.61	0.60	0.41	0.53	0.74	0.77	0.94
5	0.89	0.44	0.26	0.22	0.15	0.31	0.40	0.43
6	0.76	0.47	0.19	0.14	0.08	0.09	0.18	0.20
7	0.31	0.33	0.21	0.09	0.07	0.06	0.05	0.08
8	0.07	0.14	0.12	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

Table 2.6.2.2. cont. North Sea herring.

Population Abundance (1 January) cont.

AGE	2000	2001	2002	2003	2004
0	39.80	89.62	54.09	21.17	17.37
1	24.88	14.02	31.98	19.38	7.58
2	3.26	8.42	4.86	11.17	6.77
3	1.74	1.93	5.33	3.14	7.21
4	1.93	0.99	1.22	3.48	2.05
5	0.53	1.12	0.65	0.84	2.39
6	0.24	0.30	0.73	0.44	0.57
7	0.11	0.14	0.20	0.50	0.30
8	0.05	0.06	0.09	0.14	0.35
9	0.01	0.01	0.03	0.04	0.12

Weighting factors for the catches in number

AGE	1999	2000	2001	2002	2003
0	0.1000	0.1000	0.1000	0.1000	0.1000
1	0.1000	0.1000	0.1000	0.1000	0.1000
2	3.1700	3.1700	3.1700	3.1700	3.1700
3	2.6500	2.6500	2.6500	2.6500	2.6500
4	1.9400	1.9400	1.9400	1.9400	1.9400
5	1.3100	1.3100	1.3100	1.3100	1.3100
6	0.9700	0.9700	0.9700	0.9700	0.9700
7	0.7500	0.7500	0.7500	0.7500	0.7500
8	0.5500	0.5500	0.5500	0.5500	0.5500

Predicted SSB Index Values
MLAI

	1973	1974	1975	1976	1977	1978	1979	1980
1	17.31	11.54	5.38	5.10	2.92	4.12	7.23	9.04
	1981	1982	1983	1984	1985	1986	1987	1988
1	14.14	20.97	34.23	56.55	58.41	56.54	77.34	105.86
	1989	1990	1991	1992	1993	1994	1995	1996
1	111.25	104.83	84.85	58.61	37.58	41.03	36.60	36.08
	1997	1998	1999	2000	2001	2002	2003	
1	44.11	60.46	71.06	70.30	114.83	143.97	161.52	

Predicted Age-Structured Index Values
Acoustic survey 2-9+ wr Predicted x 10 ^ 3

AGE	1989	1990	1991	1992	1993	1994	1995	1996
1	999990.	999990.	999990.	999990.	999990.	999990.	999990.	999990.
2	6074.	3630.	2935.	3337.	2582.	3835.	3566.	3031.
3	5779.	3673.	2115.	1527.	1606.	1139.	1553.	1841.
4	2640.	3378.	2197.	1142.	740.	660.	462.	760.
5	609.	1492.	2008.	1265.	569.	373.	263.	227.
6	357.	335.	893.	1061.	656.	278.	210.	148.
7	160.	150.	179.	413.	399.	310.	120.	129.
8	48.	77.	77.	95.	177.	174.	155.	69.
9	60.	90.	110.	158.	238.	326.	184.	45.

AGE	1997	1998	1999	2000	2001	2002	2003
1	10302.	5314.	5627.	14528.	8296.	19004.	11512.
2	3632.	7166.	3550.	3927.	10525.	6147.	14115.
3	1844.	2249.	4577.	2319.	2733.	7688.	4524.
4	1010.	1068.	1313.	2739.	1502.	1902.	5420.
5	471.	547.	635.	792.	1793.	1068.	1375.
6	137.	253.	314.	392.	529.	1304.	790.
7	94.	75.	121.	170.	229.	336.	843.
8	101.	65.	51.	82.	125.	183.	272.
9	86.	41.	29.	36.	49.	174.	198.

Table 2.6.2.2. cont**.** North Sea herring.

IBTS: 1-5+ wr Predicted

AGE	1979	1980	1981	1982	1983	1984	1985	1986
1	199.5	446.6	660.7	1055.9	2086.1	1876.8	1887.3	3317.9
2	*******	*******	*******	*******	368.9	711.0	658.8	563.1
3	*******	*******	*******	*******	93.8	149.6	276.7	241.5
4	*******	*******	*******	*******	20.1	32.4	45.9	70.1
5	*******	*******	*******	*******	10.4	13.1	15.6	18.3

IBTS: 1-5+ wr Predicted cont.

AGE	1987	1988	1989	1990	1991	1992	1993	1994
1	4069.4	3169.2	1642.5	1509.2	1511.0	1321.6	2036.7	1552.5
2	1056.9	1241.7	801.7	474.8	417.5	474.5	382.5	571.2
3	197.0	392.7	481.8	301.1	179.8	132.3	147.8	108.4
4	69.6	57.7	126.5	155.8	100.9	55.1	38.2	36.8
5	27.8	32.2	30.4	50.1	74.8	71.7	49.0	30.2

AGE	1995	1996	1997	1998	1999	2000	2001	2002
1	1192.0	1345.3	2170.3	1182.6	1206.8	3111.6	1758.4	4014.5
2	512.9	387.7	458.0	892.5	436.2	480.8	1253.2	725.5
3	157.2	158.9	154.4	187.9	377.2	189.9	213.8	592.6
4	25.4	34.3	47.5	49.4	60.5	125.2	64.9	80.8
5	20.7	12.9	18.8	23.5	26.2	33.2	58.9	61.8

AGE	2003	2004
1	2432.6	951.7
2	1667.3	1009.6
3	349.2	801.0
4	230.6	135.5
5	71.0	134.9

MIK 0-wr Predicted

AGE	1977	1978	1979	1980	1981	1982	1983	1984
0	11.66	12.46	28.65	44.93	97.35	169.59	160.58	141.88

AGE	1985	1986	1987	1988	1989	1990	1991	1992
0	218.60	264.54	230.68	113.64	105.22	97.18	90.41	163.60

AGE	1993	1994	1995	1996	1997	1998	1999	2000
0	130.83	89.22	108.47	136.92	72.65	72.69	192.23	108.14

AGE	2001	2002	2003	2004
0	243.91	147.29	57.65	47.30

Fitted Selection Pattern

AGE	1960	1961	1962	1963	1964	1965	1966	1967
0	0.0756	0.0453	0.0115	0.0648	0.0340	0.0092	0.0375	0.0277
1	0.7527	0.3150	0.2114	0.5438	0.8328	0.3168	0.3239	0.3224
2	1.2851	1.5051	0.5899	1.3041	1.0503	0.9979	1.0353	0.4567
3	0.9684	0.8615	1.4831	1.2076	1.1137	0.9510	1.2385	0.8704
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.7922	0.9921	1.2708	0.6649	0.8366	0.8497	1.4606	0.8955
6	0.9367	0.9450	1.9733	0.8068	0.6476	0.6758	0.6830	1.0947
7	1.8172	0.6230	1.5444	1.2995	0.7732	0.5949	0.6897	1.6604
8	1.7676	1.3320	1.4168	1.5429	1.5984	1.1401	1.3059	1.1961
9	1.7676	1.3320	1.4168	1.5429	1.5984	1.1401	1.3059	1.1961

Table 2.6.2.2. cont**.** North Sea herring.

AGE	1968	1969	1970	1971	1972	1973	1974	1975
0	0.0325	0.0094	0.0264	0.0277	0.0729	0.0468	0.0753	0.1152
1	0.2802	0.3763	0.2013	0.4908	0.7231	0.6821	0.4545	0.4996
2	1.2386	0.8970	0.7306	0.7193	1.0157	1.0349	1.0335	0.9555
3	1.7471	1.0437	0.9516	0.9901	1.0022	1.3505	0.9785	1.0923
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.1515	1.2060	0.6581	0.8866	0.6879	0.9632	1.1926	1.3770
6	1.0972	2.1740	0.8121	2.1449	0.6515	1.3991	1.0845	0.9286
7	1.5053	1.4913	3.1040	2.2343	0.1252	0.8259	0.7834	1.4814
8	1.5552	1.5672	1.3345	1.6543	1.3703	1.6525	1.3940	1.5311
9	1.5552	1.5672	1.3345	1.6543	1.3703	1.6525	1.3940	1.5311

AGE	1976	1977	1978	1979	1980	1981	1982	1983
0	0.0847	0.2196	0.4334	0.8783	0.4189	1.5735	1.3401	0.9121
1	0.1446	0.6714	1.9062	1.7542	0.3770	0.9328	0.9023	0.5748
2	0.7700	0.5119	0.2318	0.9978	1.2165	1.0590	1.0461	0.6905
3	0.8366	3.1847	0.4097	0.7036	1.4038	0.9054	2.0410	0.7428
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.9339	2.7226	0.1656	0.5557	0.9010	1.3692	0.6260	0.6371
6	0.6397	1.7423	0.7439	0.1369	0.2267	1.4518	0.5940	0.7994
7	0.8749	1.8290	0.6243	4.6709	0.3565	3.2347	0.9605	0.9201
8	0.9701	2.2518	1.9596	2.6748	1.2361	2.1900	1.8021	1.2481
9	0.9701	2.2518	1.9596	2.6748	1.2361	2.1900	1.8021	1.2481

Fitted Selection Pattern cont.

AGE	1984	1985	1986	1987	1988	1989	1990	1991
0	0.4194	0.1151	0.1059	0.2731	0.2132	0.2337	0.1258	0.2569
1	0.3802	0.5170	0.5404	0.6300	0.9920	0.7727	0.9675	0.6717
2	0.5832	0.5460	0.7870	0.6882	0.6082	0.7149	0.8062	1.2518
3	0.7977	0.9078	0.8952	0.8578	0.6865	0.7357	0.7910	0.9922
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.1701	0.9044	0.9562	1.0526	1.1427	1.1890	1.0753	1.0555
6	0.6788	0.9991	1.2773	1.0942	1.1740	1.2730	1.0716	1.0525
7	1.3251	0.7742	1.4421	1.0768	1.2229	1.3142	1.4930	0.9484
8	1.1938	1.2352	1.4651	1.4324	1.7016	1.6072	1.7738	1.6261
9	1.1938	1.2352	1.4651	1.4324	1.7016	1.6072	1.7738	1.6261

AGE	1992	1993	1994	1995	1996	1997	1998	1999
0	0.5157	0.5110	0.2533	0.3687	0.1784	0.0501	0.0326	0.0966
1	0.6744	0.5727	0.2682	0.3454	0.6142	0.0868	0.3657	0.1868
2	0.9974	0.9103	0.7436	0.6832	0.7768	0.5647	0.5529	0.4946
3	0.8684	0.8728	0.7846	0.9841	1.1787	0.8169	0.8759	0.8219
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.9558	0.9736	0.6121	0.9543	1.1787	0.8762	1.2973	1.0303
6	1.2609	0.9604	0.7410	0.6230	0.7790	0.9377	1.5160	0.9997
7	1.2371	1.2055	0.5295	0.7573	0.3502	0.4902	0.8552	0.9768
8	1.5913	1.4441	0.9673	1.1075	1.3679	0.8415	1.2561	1.0000
9	1.5913	1.4441	0.9673	1.1075	1.3679	0.8415	1.2561	1.0000

AGE	2000	2001	2002	2003
0	0.0966	0.0966	0.0966	0.0966
1	0.1868	0.1868	0.1868	0.1868
2	0.4946	0.4946	0.4946	0.4946
3	0.8219	0.8219	0.8219	0.8219
4	1.0000	1.0000	1.0000	1.0000
5	1.0303	1.0303	1.0303	1.0303
6	0.9997	0.9997	0.9997	0.9997
7	0.9768	0.9768	0.9768	0.9768
8	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000

Table 2.6.2.3 North Sea herring. STOCK SUMMARY

STOCK SUMMARY NORTH SEA HERRING

Year	Recruits 0-rings Thousands	Total Biomass Tonnes	Spawning Biomass Tonnes	Landings Tonnes	Yield /SSB ratio	Mean F Ages 0-1	Mean F Ages 2-6	SoP (%)
1960	12088630	3721810	1860094	696200	0.3743	0.1410	0.3391	84
1961	08847550	4343276	1643072	696700	0.4240	0.0740	0.4357	88
1962	46273790	4383336	1101348	627800	0.5700	0.0473	0.5359	85
1963	47657560	4611690	2172945	716000	0.3295	0.0695	0.2274	116
1964	62785020	4783422	2018295	871200	0.4317	0.1605	0.3443	93
1965	34894650	4332967	1438321	1168800	0.8126	0.1266	0.6953	86
1966	27857890	3309912	1274252	895500	0.7028	0.1034	0.6196	93
1967	40255510	2814427	919677	695500	0.7562	0.1619	0.7982	85
1968	38698420	2520726	412204	717800	1.7414	0.1676	1.3362	79
1969	21581300	1904995	423741	546700	1.2902	0.1687	1.1055	103
1970	41071680	1921818	374594	563100	1.5032	0.1516	1.1059	103
1971	32305130	1849285	265943	520100	1.9557	0.3181	1.4088	93
1972	20859100	1549358	288242	497500	1.7260	0.3183	0.6969	108
1973	10096650	1155754	233274	484000	2.0748	0.3601	1.1358	104
1974	21690150	911631	161888	275100	1.6993	0.2636	1.0529	103
1975	2808050	679709	81416	312800	3.8420	0.4235	1.4751	107
1976	2713090	357798	77571	174800	2.2534	0.1997	1.4561	104
1977	4320630	209474	47006	46000	0.9786	0.1987	0.8170	83
1978	4587350	223741	64122	11000	0.1715	0.1234	0.0538	82
1979	10595790	380879	106272	25100	0.2362	0.1256	0.0648	99
1980	16706970	629081	130033	70764	0.5442	0.1197	0.2855	91
1981	37847450	1156989	194509	174879	0.8991	0.3842	0.3547	99
1982	64722290	1841140	277317	275079	0.9919	0.2800	0.2651	102
1983	61788690	2716192	430962	387202	0.8985	0.3260	0.3393	92
1984	53423420	2861670	677294	428631	0.6329	0.2160	0.4569	94
1985	80868840	3458687	697344	613780	0.8802	0.2343	0.6461	95
1986	97576970	3468998	677185	671488	0.9916	0.1891	0.5751	87
1987	86155670	3932388	897868	792058	0.8822	0.2670	0.5549	98
1988	42248150	3574240	1191101	887686	0.7453	0.3527	0.5398	85
1989	39143980	3304480	1245600	787899	0.6325	0.2809	0.5484	96
1990	35833650	2970453	1180636	645229	0.5465	0.2561	0.4444	95
1991	33583490	2708572	976015	658008	0.6742	0.2133	0.4918	98
1992	62143430	2430945	699463	716799	1.0248	0.3424	0.5848	100
1993	50194370	2514709	468841	671397	1.4320	0.3994	0.6953	97
1994	33620280	2017237	507351	568234	1.1200	0.2397	0.7135	95
1995	41344670	1819375	457844	579371	1.2654	0.3144	0.7475	99
1996	50583440	1604952	451901	275098	0.6088	0.1657	0.4106	100
1997	26678480	1925234	541588	264313	0.4880	0.0353	0.4328	99
1998	26655460	2013715	719313	391628	0.5444	0.0946	0.4979	99
1999	70754260	2297626	831926	363163	0.4365	0.0660	0.4048	100
2000	39795710	2840699	823943	388157	0.4711	0.0636	0.3898	99
2001	89616040	3197244	1281565	363343	0.2835	0.0449	0.2751	100
2002	54089290	4057687	1571036	370941	0.2361	0.0389	0.2387	100
2003	21170590	4114710	1742436	479587	0.2752	0.0395	0.2424	99

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

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-----------------------------------------------------------------
No of years for separable analysis : 5
Age range in the analysis : 0  . . . 9    age=rings
Year range in the analysis : 1960  . . . 2003
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 : 388

Conventional single selection vector model to be fitted.
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Table 2.6.2.4 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	1999		0.4656	11	0.3689	0.5878	0.4134	0.5244	0.4689
2	2000		0.4485	12	0.3517	0.5718	0.3962	0.5076	0.4519
3	2001		0.3164	13	0.2449	0.4089	0.2776	0.3606	0.3191
4	2002		0.2746	13	0.2114	0.3567	0.2403	0.3138	0.2770
5	2003		0.2788	13	0.2126	0.3655	0.2428	0.3201	0.2815
Separable Model: Selection (S) by age									
6	0		0.0966	38	0.0454	0.2056	0.0657	0.1420	0.1041
7	1		0.1868	37	0.0899	0.3880	0.1286	0.2712	0.2002
8	2		0.4946	11	0.3932	0.6221	0.4399	0.5560	0.4980
9	3		0.8219	11	0.6558	1.0301	0.7325	0.9223	0.8274
	4		1.0000		Fixed : Reference Age				
10	5		1.0303	12	0.7988	1.3289	0.9048	1.1731	1.0390
11	6		0.9997	14	0.7528	1.3276	0.8650	1.1554	1.0102
12	7		0.9768	17	0.6995	1.3642	0.8238	1.1583	0.9911
	8		1.0000		Fixed : Last true age				
Separable model: Populations in year 2003									
13	0		21170593	15	15504164	28907976	18059688	24817373	21439663
14	1		19377294	13	14770075	25421639	16870764	22256225	19564091
15	2		11174927	11	8985049	13898531	9998066	12490315	11244334
16	3		3144084	10	2577525	3835178	2840979	3479528	3160281
17	4		3484351	10	2858960	4246544	3149839	3854388	3502144
18	5		838685	11	667099	1054405	746243	942578	844424
19	6		443140	13	342794	572859	388731	505164	446958
20	7		501610	16	366455	686612	427368	588749	508086
21	8		138236	19	93741	203850	113385	168534	140977
Separable model: Populations at age									
22	1999		28810	34	14555	57025	20336	40816	30612
23	2000		45774	26	27374	76543	35213	59503	47377
24	2001		64780	23	40873	102670	51215	81938	66593
25	2002		92570	21	61095	140261	74885	114432	94674
Recruitment in year 2004									
26	2003		17370873	18	11992898	25160493	14379079	20985156	17683981
SSB Index catchabilities									
MLAI									
Power model fitted. Slopes (Q) and exponents (K) at age									
27	1	Q	3.036	17	2.309	4.504	2.720	3.824	3.272
28	1	K	.1889E-04	17	.2956E-04	.5765E-04	.3481E-04	.4895E-04	.4495E-04
Age-structured index catchabilities									
Acoustic survey 2-9+ wr									
Linear model fitted. Slopes at age :									
29	1	Q	1.060	12	.9413	1.527	1.060	1.356	1.208
30	2	Q	1.607	8	1.486	2.044	1.607	1.891	1.749
31	3	Q	1.822	8	1.674	2.363	1.822	2.172	1.997
32	4	Q	1.916	13	1.685	2.848	1.916	2.504	2.210
33	5	Q	2.029	18	1.698	3.513	2.029	2.941	2.485
34	6	Q	2.196	19	1.824	3.896	2.196	3.235	2.716
35	7	Q	2.062	20	1.696	3.768	2.062	3.099	2.581
36	8	Q	2.425	26	1.879	5.321	2.425	4.124	3.276
37	9	Q	6.808	26	5.297	14.76	6.808	11.48	9.150
IBTS: 1-5+ wr									
Linear model fitted. Slopes at age :									
38	1	Q	.1432E-03	6	.1345E-03	.1735E-03	.1432E-03	.1630E-03	.1531E-03
39	2	Q	.1576E-03	11	.1409E-03	.2224E-03	.1576E-03	.1989E-03	.1783E-03
40	3	Q	.1172E-03	23	.9384E-04	.2325E-03	.1172E-03	.1862E-03	.1517E-03
41	4	Q	.6939E-04	32	.5069E-04	.1827E-03	.6939E-04	.1335E-03	.1015E-03
42	5	Q	.3802E-04	32	.2776E-04	.1002E-03	.3802E-04	.7318E-04	.5565E-04
MIK 0-wr									
Linear model fitted. Slopes at age :									
43	0	Q	.3096E-05	3	.2987E-05	.3458E-05	.3096E-05	.3336E-05	.3216E-05
Parameters of the stock-recruit relationship									
44	1	a	.7585E+08	34	.5421E+08	.2137E+09	.7585E+08	.1527E+09	.1144E+09
45	1	b	.5821E+06	62	.3188E+06	.3727E+07	.5821E+06	.2041E+07	.1327E+07

Table 2.6.2.4. cont. North Sea herring.

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1999	2000	2001	2002	2003
0	-0.2318	0.0317	0.0692	-0.2059	0.0347
1	-0.5228	-0.0826	0.1842	-0.1946	-0.0115
2	0.1536	0.1016	-0.2712	0.0329	-0.0353
3	0.0531	-0.0548	0.1700	-0.0819	-0.1250
4	-0.1235	-0.0311	0.0718	0.0165	0.0136
5	-0.1446	0.1279	0.0506	-0.1369	0.1947
6	-0.0020	-0.0089	0.1304	-0.0356	0.0321
7	0.0060	-0.0514	0.0586	0.0319	0.0549
8	-0.0070	-0.0774	0.0266	0.4531	0.1447

SPAWNING BIOMASS INDEX RESIDUALS

MLAI

	1973	1974	1975	1976	1977	1978	1979	1980
1	-0.2634	-0.3536	-0.6888	-0.7120	0.7363	0.5846	0.7301	0.1301

	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0785	0.0340	-0.2008	-0.1072	0.2815	-0.3435	-0.1011	0.2745

	1989	1990	1991	1992	1993	1994	1995	1996
1	0.1920	0.4993	0.0678	-0.3214	-0.2023	-0.6792	-0.4305	0.2751

	1997	1998	1999	2000	2001	2002	2003
1	0.2959	0.2751	-0.0708	-0.4777	0.1596	-0.2360	0.5731

AGE-STRUCTURED INDEX RESIDUALS

Acoustic survey 2-9+ wr

Age	1989	1990	1991	1992	1993	1994	1995	1996
1	*******	*******	*******	*******	*******	*******	*******	*******
2	-0.395	-0.093	-0.108	0.112	0.145	-0.186	0.076	0.394
3	-0.392	-0.042	-0.218	-0.103	0.019	-0.306	0.273	0.428
4	-0.480	0.011	-0.115	0.004	0.198	-0.503	0.376	0.357
5	-0.213	-0.088	-0.083	-0.110	0.264	0.020	0.127	0.315
6	-0.233	0.156	-0.327	0.161	0.170	0.145	-0.034	-0.400
7	-0.286	0.336	0.243	-0.043	0.323	0.051	0.138	-0.438
8	-0.090	0.541	0.195	0.187	0.014	0.227	-0.264	0.653
9	-1.008	-0.736	-0.771	-0.417	-0.719	-0.912	-0.685	1.530

Age	1997	1998	1999	2000	2001	2002	2003
1	-0.096	-0.178	-0.101	0.532	-0.193	0.193	-0.158
2	0.495	-0.221	-0.143	-0.295	0.155	-0.232	0.295
3	0.465	0.114	0.032	-0.073	0.120	0.067	-0.384
4	0.355	0.419	-0.163	0.137	-0.027	-0.314	-0.258
5	0.244	0.585	-0.227	0.241	-0.068	-0.296	-0.712
6	0.454	0.564	-0.001	0.209	-0.162	-0.235	-0.468
7	-0.718	0.824	0.137	0.447	-0.300	-0.319	-0.394
8	-0.257	-0.360	0.053	0.380	-0.243	-0.412	-0.626
9	0.615	1.085	1.105	0.993	0.178	-0.151	-0.108

IBTS: 1-5+ wr

Age	1979	1980	1981	1982	1983	1984	1985	1986
1	-0.244	-0.264	-0.244	-0.278	-0.528	-0.245	0.098	-0.247
2	*******	*******	*******	*******	-0.988	-1.431	0.127	0.376
3	*******	*******	*******	*******	-0.703	-0.803	0.086	0.179
4	*******	*******	*******	*******	-0.274	-0.076	0.036	0.182
5	*******	*******	*******	*******	1.004	-0.191	0.696	0.442

Table 2.6.2.4. cont. North Sea herring.

Age	1987	1988	1989	1990	1991	1992	1993	1994
1	-0.086	0.344	0.286	-0.387	-0.247	-0.093	0.383	0.057
2	-0.111	1.337	0.153	0.015	0.676	-0.146	0.788	0.723
3	-0.463	0.846	-0.183	0.038	0.473	0.389	0.421	0.682
4	-0.097	0.126	-0.123	0.631	0.941	0.217	0.204	0.619
5	0.658	-0.139	-1.062	0.432	0.846	0.423	0.336	0.352

Age	1995	1996	1997	1998	1999	2000	2001	2002
1	0.019	0.251	0.610	0.558	-0.524	0.172	0.355	0.014
2	0.901	-0.618	0.140	-0.110	0.046	-0.791	-0.115	-0.103
3	0.468	-1.227	0.279	-0.668	0.373	-0.176	0.395	-0.660
4	0.270	-0.933	-0.105	-0.809	0.589	-0.711	0.412	-1.305
5	-1.205	-0.352	0.257	-0.126	0.431	-1.351	0.117	-1.133

Age	2003	2004
1	0.210	0.029
2	-0.074	-0.795
3	0.308	-0.054
4	0.405	-0.200
5	-0.480	0.045

MIK 0-wr

Age	1977	1978	1979	1980	1981	1982	1983	1984
0	0.383	0.050	0.598	0.811	-0.238	-0.236	-0.559	-0.210

MIK 0-wr cont.

Age	1985	1986	1987	1988	1989	1990	1991	1992
0	-0.187	-0.400	0.161	0.396	-0.388	-1.322	-0.257	0.204

Age	1993	1994	1995	1996	1997	1998	1999	2000
0	0.374	0.131	0.158	-0.251	0.712	-0.314	0.238	0.237

Age	2001	2002	2003	2004
0	-0.127	0.094	-0.058	0.000

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

Separable model fitted from 1999 to 2003

Variance	0.0434
Skewness test stat.	-0.8612
Kurtosis test statistic	3.1136
Partial chi-square	0.0694
Significance in fit	0.0000
Degrees of freedom	20

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR MLAI

Power catchability relationship assumed

Variance	0.1102
Skewness test stat.	0.0782
Kurtosis test statistic	-0.8844
Partial chi-square	1.4630
Significance in fit	0.0000
Number of observations	31
Degrees of freedom	29
Weight in the analysis	0.6500

Table 2.6.2.4. cont. North Sea herring.

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR Acoustic survey 2-9+ wr

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8	9
Variance	0.0535	0.0521	0.0442	0.0254	0.0137	0.0120	0.0200	0.0094	0.0516
Skewness test stat.	1.3923	0.6052	0.2909	-0.2594	-0.4994	0.2770	0.2423	0.2477	0.7420
Kurtosis test stat.	0.0831	-0.7134	-0.5619	-0.8891	0.2182	-0.6661	-0.4549	-0.6845	-0.9938
Partial chi-square	0.0196	0.0475	0.0422	0.0255	0.0141	0.0132	0.0237	0.0114	0.0653
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of obs.	7	15	15	15	15	15	15	15	15
Degrees of freedom	6	14	14	14	14	14	14	14	14
Weight in the analysis	0.7400	0.7500	0.6400	0.2700	0.1400	0.1300	0.1200	0.0700	0.0700

DISTRIBUTION STATISTICS FOR IBTS: 1-5+ wr

Linear catchability relationship assumed

Age	1	2	3	4	5
Variance	0.0663	0.1045	0.0179	0.0092	0.0140
Skewness test stat.	0.3632	-0.2543	-1.1295	-1.2325	-1.2757
Kurtosis test statisti	-0.8913	-0.1425	-0.5657	-0.0231	-0.5676
Partial chi-square	0.2270	0.3408	0.0722	0.0462	0.0893
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	26	22	22	22	22
Degrees of freedom	25	21	21	21	21
Weight in the analysis	0.6700	0.2400	0.0600	0.0300	0.0300

DISTRIBUTION STATISTICS FOR MIK 0-wr

Linear catchability relationship assumed

Age	0
Variance	0.3804
Skewness test stat.	-1.4190
Kurtosis test statisti	1.7286
Partial chi-square	2.3872
Significance in fit	0.0000
Number of observations	28
Degrees of freedom	27
Weight in the analysis	2.0500

ANALYSIS OF VARIANCE

Unweighted Statistics Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	81.6732	388	45	343	0.2381
Catches-at-age	1.0030	45	25	20	0.0501
SSB Indices MLAI	4.9151	31	2	29	0.1695
Aged Indices					
Acoustic survey 2-9+ wr	20.8817	127	9	118	0.1770
IBTS: 1-5+ wr	34.1514	114	5	109	0.3133
MIK 0-wr	5.0104	28	1	27	0.1856
Stock-recruit model	15.7116	43	2	41	0.3832

Weighted Statistics Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	27.2517	388	45	343	0.0795
Catches-at-age	0.8681	45	25	20	0.0434
SSB Indices MLAI	2.0766	31	2	29	0.0716
Aged Indices					
Acoustic survey 2-9+ wr	1.4190	127	9	118	0.0120
IBTS: 1-5+ wr	1.6746	114	5	109	0.0154
MIK 0-wr	21.0563	28	1	27	0.7799
Stock-recruit model	0.1571	43	2	41	0.0038

Table 2.7.1.
Input to short-term prediction

```
North sea herring 2004
2004   Intermediate year
0 9    Age range
4      Number of fleets
F reference 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
Initial numbers (by 1/1 - 2004)
0 17371
1  7581
2  6767
3  7212
4  2047
5  2386
6   569
7   303
8   346
9   119
Recruitments
50443   In 2005
50443   In 2006
Selection by age and fleet
0 0.00013 0.02524 0.00014 0.00143
1 0.00499 0.00952 0.01413 0.02342
2 0.10909 0.00792 0.01626 0.00461
3 0.22251 0.00086 0.00548 0.00030
4 0.27178 0.00150 0.00544 0.00008
5 0.28464 0.00048 0.00210 0.00002
6 0.27477 0.00100 0.00277 0.00017
7 0.26850 0.00105 0.00277 0.00001
8 0.27668 0.00076 0.00133 0.00003
9 0.27879 0       0       0
Natural mortality-at-age
0 1.0
1 1.0
2 0.3
3 0.2
4 0.1
5 0.1
6 0.1
7 0.1
8 0.1
9 0.1
```

Table 2.7.1.cont

Weight-at-age in the catch in 2004

0	0.038	0.014	0.020	0.014
1	0.088	0.030	0.054	0.019
2	0.128	0.055	0.085	0.070
3	0.138	0.098	0.096	0.082
4	0.175	0.145	0.146	0.145
5	0.198	0.138	0.166	0.162
6	0.216	0.105	0.194	0.174
7	0.234	0.127	0.189	0.112
8	0.247	0.232	0.210	0.180
9	0.267	0.000	0.000	0.000

Weight-at-age in the catch in 2005

0	0.038	0.014	0.020	0.014
1	0.088	0.030	0.054	0.019
2	0.128	0.055	0.085	0.070
3	0.154	0.113	0.112	0.121
4	0.157	0.126	0.124	0.098
5	0.198	0.138	0.166	0.162
6	0.216	0.105	0.194	0.174
7	0.234	0.127	0.189	0.112
8	0.247	0.232	0.210	0.180
9	0.267	0	0	0

Weight-at-age in the stock in 2004

0	0.006
1	0.046
2	0.121
3	0.179
4	0.202
5	0.219
6	0.245
7	0.271
8	0.285
9	0.278

Weight-at-age in the stock in 2005

0	0.006
1	0.046
2	0.121
3	0.179
4	0.202
5	0.219
6	0.245
7	0.271
8	0.285
9	0.278

Weight-at-age in the stock in 2006

0	0.006
1	0.046
2	0.121
3	0.179
4	0.202
5	0.219
6	0.245
7	0.271
8	0.285
9	0.278

Table 2.7.1.cont

```
Maturity-at-age in 2004
0 0
1 0
2 0.77
3 0.56
4 1
5 1
6 1
7 1
8 1
9 1
Maturity-at-age in 2005
0 0
1 0
2 0.77
3 0.95
4 1
5 1
6 1
7 1
8 1
9 1
Maturity-at-age in 2006
0 0
1 0
2 0.77
3 0.95
4 1
5 1
6 1
7 1
8 1
9 1
Proportion of F and M before spawning
0.67 0.67
```

Table 2.7.2.a

Short-term prediction with F0-1 = 0.10 and F2-6 = 0.20
North sea herring 2004
Input data from: input

Results for the intermediate year 2004
with the folllowing constraints:
Fleet 1 F constraint: 0.2326
Fleet 2 F constraint: 0.0174
Fleet 3 F constraint: 0.0071
Fleet 4 F constraint: 0.0124

F-values by fleet and total						Catches by fleet				
F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2004
0.233	0.017	0.007	0.012	0.039	0.242	522.4	8.7	16.7	4.3	2010.7

Results for the prediction year 2005
with the following types of constraints:
Fleet 1 Screen for total Fs
Fleet 2 Screen for total Fs
Fleet 3 Catch constraint
Fleet 4 Catch constraint

F-values by fleet and total						Catches by fleet					
F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2005	SSB2006
0.183	0.085	0.006	0.008	0.100	0.200	427.2	68.9	10.0	2.0	2346.1	2171.0
0.183	0.077	0.006	0.016	0.100	0.200	428.0	62.8	10.0	4.0	2346.1	2169.4
0.183	0.069	0.006	0.023	0.100	0.200	429.0	56.5	10.0	6.0	2346.0	2167.7
0.184	0.061	0.006	0.031	0.100	0.200	429.9	50.3	10.0	8.0	2346.0	2166.1
0.184	0.053	0.006	0.039	0.100	0.200	430.9	43.9	10.0	10.0	2345.9	2164.3
0.185	0.045	0.006	0.047	0.100	0.200	431.8	37.5	10.0	12.0	2345.8	2162.7
0.185	0.037	0.006	0.055	0.100	0.200	432.7	31.1	10.0	14.0	2345.8	2161.1
0.185	0.030	0.006	0.063	0.100	0.200	433.6	24.6	10.0	16.0	2345.8	2159.5
0.186	0.022	0.006	0.071	0.100	0.200	434.6	18.0	10.0	18.0	2345.7	2157.8
0.186	0.014	0.006	0.079	0.100	0.200	435.5	11.4	10.0	20.0	2345.6	2156.2
0.180	0.082	0.009	0.008	0.100	0.200	422.1	66.6	15.0	2.0	2347.0	2172.8
0.181	0.074	0.009	0.016	0.100	0.200	423.0	60.4	15.0	4.0	2346.9	2171.0
0.181	0.066	0.009	0.023	0.100	0.200	423.9	54.2	15.0	6.0	2346.9	2169.4
0.182	0.058	0.009	0.031	0.100	0.200	424.8	47.9	15.0	8.0	2346.8	2167.8
0.182	0.050	0.009	0.039	0.100	0.200	425.8	41.5	15.0	10.0	2346.7	2166.1
0.182	0.042	0.009	0.047	0.100	0.200	426.7	35.2	15.0	12.0	2346.7	2164.5
0.183	0.035	0.009	0.055	0.100	0.200	427.6	28.7	15.0	14.0	2346.7	2162.9
0.183	0.027	0.009	0.063	0.100	0.200	428.6	22.2	15.0	16.0	2346.6	2161.1
0.184	0.019	0.009	0.071	0.100	0.200	429.6	15.6	15.0	18.0	2346.5	2159.6
0.184	0.011	0.009	0.079	0.100	0.200	430.5	9.0	15.0	20.0	2346.5	2158.0
0.178	0.079	0.012	0.008	0.100	0.200	417.0	64.3	20.0	2.0	2347.8	2174.6
0.179	0.071	0.012	0.016	0.100	0.200	418.0	58.1	20.0	4.0	2347.7	2172.8
0.179	0.063	0.012	0.023	0.100	0.200	418.9	51.9	20.0	6.0	2347.7	2171.2
0.179	0.055	0.012	0.031	0.100	0.200	419.8	45.6	20.0	8.0	2347.6	2169.4
0.180	0.047	0.012	0.039	0.100	0.200	420.7	39.2	20.0	10.0	2347.6	2167.9
0.180	0.039	0.012	0.047	0.100	0.200	421.6	32.7	20.0	12.0	2347.6	2166.3
0.181	0.032	0.012	0.055	0.100	0.200	422.5	26.2	20.0	14.0	2347.6	2164.7
0.181	0.024	0.012	0.063	0.100	0.200	423.5	19.7	20.0	16.0	2347.4	2162.9
0.181	0.016	0.012	0.071	0.100	0.200	424.5	13.1	20.0	18.0	2347.4	2161.4
0.182	0.008	0.012	0.079	0.100	0.200	425.4	6.5	20.0	20.0	2347.4	2159.9
0.176	0.076	0.015	0.008	0.100	0.200	412.0	62.0	25.0	2.0	2348.7	2176.2
0.176	0.068	0.015	0.016	0.100	0.200	412.9	55.8	25.0	4.0	2348.6	2174.6
0.177	0.060	0.015	0.023	0.100	0.200	413.8	49.5	25.0	6.0	2348.6	2173.0
0.177	0.052	0.015	0.031	0.100	0.200	414.8	43.2	25.0	8.0	2348.5	2171.2
0.178	0.044	0.015	0.039	0.100	0.200	415.6	36.8	25.0	10.0	2348.5	2169.7
0.178	0.037	0.015	0.047	0.100	0.200	416.6	30.3	25.0	12.0	2348.4	2168.1
0.178	0.029	0.015	0.055	0.100	0.200	417.6	23.8	25.0	14.0	2348.3	2166.3
0.179	0.021	0.015	0.063	0.100	0.200	418.5	17.3	25.0	16.0	2348.3	2164.8
0.179	0.013	0.015	0.071	0.100	0.200	419.4	10.7	25.0	18.0	2348.3	2163.2
0.180	0.005	0.015	0.079	0.100	0.200	420.2	4.0	25.0	20.0	2348.3	2161.7
0.174	0.073	0.017	0.008	0.100	0.200	406.9	59.7	30.0	2.0	2349.5	2178.0
0.174	0.065	0.017	0.016	0.100	0.200	407.8	53.5	30.0	4.0	2349.5	2176.4
0.175	0.057	0.017	0.023	0.100	0.200	408.8	47.2	30.0	6.0	2349.4	2174.6
0.175	0.049	0.017	0.031	0.100	0.200	409.7	40.8	30.0	8.0	2349.4	2173.0
0.175	0.042	0.017	0.039	0.100	0.200	410.6	34.4	30.0	10.0	2349.4	2171.5
0.176	0.034	0.017	0.047	0.100	0.200	411.4	27.9	30.0	12.0	2349.3	2170.0
0.176	0.026	0.018	0.055	0.100	0.200	412.4	21.4	30.0	14.0	2349.2	2168.2
0.177	0.018	0.018	0.063	0.100	0.200	413.4	14.8	30.0	16.0	2349.2	2166.6
0.177	0.010	0.018	0.071	0.100	0.200	414.3	8.1	30.0	18.0	2349.2	2165.1
0.177	0.002	0.018	0.079	0.100	0.200	415.1	1.5	30.0	20.0	2349.2	2163.6
0.172	0.070	0.020	0.008	0.100	0.200	401.8	57.4	35.0	2.0	2350.4	2179.8
0.172	0.062	0.020	0.016	0.100	0.200	402.7	51.2	35.0	4.0	2350.4	2178.3
0.172	0.054	0.020	0.023	0.100	0.200	403.7	44.8	35.0	6.0	2350.3	2176.5
0.173	0.046	0.020	0.031	0.100	0.200	404.5	38.4	35.0	8.0	2350.3	2175.0
0.173	0.039	0.020	0.039	0.100	0.200	405.4	32.0	35.0	10.0	2350.2	2173.4
0.173	0.031	0.020	0.047	0.100	0.200	406.4	25.5	35.0	12.0	2350.2	2171.8
0.174	0.023	0.020	0.055	0.100	0.200	407.3	18.9	35.0	14.0	2350.1	2170.1

Table 2.7.2.a cont

0.174	0.015	0.020	0.063	0.100	0.200	408.3	12.4	35.0	16.0	2350.1	2168.5
0.175	0.007	0.020	0.071	0.100	0.200	409.2	5.6	35.0	18.0	2350.0	2167.0
Not achievable								35.0	20.0		
0.169	0.067	0.023	0.008	0.100	0.200	396.7	55.1	40.0	2.0	2351.3	2181.7
0.170	0.059	0.023	0.016	0.100	0.200	397.6	48.8	40.0	4.0	2351.3	2180.1
0.170	0.051	0.023	0.023	0.100	0.200	398.6	42.4	40.0	6.0	2351.2	2178.4
0.170	0.044	0.023	0.031	0.100	0.200	399.5	36.0	40.0	8.0	2351.2	2176.8
0.171	0.036	0.023	0.039	0.100	0.200	400.3	29.6	40.0	10.0	2351.1	2175.3
0.171	0.028	0.023	0.047	0.100	0.200	401.3	23.1	40.0	12.0	2351.0	2173.5
0.172	0.020	0.023	0.055	0.100	0.200	402.2	16.5	40.0	14.0	2351.0	2171.9
0.172	0.012	0.023	0.063	0.100	0.200	403.1	9.9	40.0	16.0	2351.0	2170.4
0.172	0.004	0.023	0.071	0.100	0.200	404.0	3.1	40.0	18.0	2350.9	2168.9
Not achievable								40.0	20.0		
0.167	0.064	0.026	0.008	0.100	0.200	391.6	52.8	45.0	2.0	2352.2	2183.5
0.167	0.056	0.026	0.016	0.100	0.200	392.5	46.5	45.0	4.0	2352.2	2182.0
0.168	0.048	0.026	0.023	0.100	0.200	393.5	40.1	45.0	6.0	2352.1	2180.3
0.168	0.041	0.026	0.031	0.100	0.200	394.3	33.6	45.0	8.0	2352.1	2178.7
0.169	0.033	0.026	0.039	0.100	0.200	395.2	27.2	45.0	10.0	2352.0	2177.2
0.169	0.025	0.026	0.047	0.100	0.200	396.2	20.6	45.0	12.0	2351.9	2175.4
0.169	0.017	0.026	0.055	0.100	0.200	397.1	14.0	45.0	14.0	2351.9	2173.9
0.170	0.009	0.026	0.063	0.100	0.200	398.0	7.3	45.0	16.0	2351.8	2172.3
0.170	0.001	0.026	0.071	0.100	0.200	399.0	0.6	45.0	18.0	2351.8	2170.7
Not achievable								45.0	20.0		
0.165	0.061	0.029	0.008	0.100	0.200	386.5	50.5	50.0	2.0	2353.1	2185.5
0.165	0.053	0.029	0.016	0.100	0.200	387.5	44.1	50.0	4.0	2353.0	2183.7
0.166	0.046	0.029	0.024	0.100	0.200	388.3	37.7	50.0	6.0	2353.0	2182.2
0.166	0.038	0.029	0.031	0.100	0.200	389.3	31.2	50.0	8.0	2352.9	2180.4
0.166	0.030	0.029	0.039	0.100	0.200	390.2	24.7	50.0	10.0	2352.8	2178.9
0.167	0.022	0.029	0.047	0.100	0.200	391.1	18.2	50.0	12.0	2352.8	2177.4
0.167	0.014	0.029	0.055	0.100	0.200	392.0	11.6	50.0	14.0	2352.8	2175.8
0.168	0.006	0.029	0.063	0.100	0.200	392.9	4.9	50.0	16.0	2352.7	2174.3
Not achievable								50.0	18.0		
Not achievable								50.0	20.0		

Table 2.7.2.b
Short-term prediction with F0-1 = 0.10 and F2-6 = 0.25

North sea herring 2004
Input data from: input

Results for the intermediate year 2004
with the folllowing constraints:
Fleet 1 F constraint: 0.2326
Fleet 2 F constraint: 0.0174
Fleet 3 F constraint: 0.0071
Fleet 4 F constraint: 0.0124

F-values by fleet and total / Catches by fleet

F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2004
0.233	0.017	0.007	0.012	0.039	0.242	522.4	8.7	16.7	4.3	2010.7

Results for the prediction year 2005
with the following types of constraints:
Fleet 1 Screen for total Fs
Fleet 2 Screen for total Fs
Fleet 3 Catch constraint
Fleet 4 Catch constraint

F-values by fleet and total / Catches by fleet

F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2005	SSB2006
0.233	0.084	0.006	0.008	0.100	0.250	530.4	68.2	10.0	2.0	2263.4	1991.8
0.233	0.076	0.006	0.016	0.100	0.250	531.3	62.0	10.0	4.0	2263.4	1990.1
0.233	0.068	0.006	0.023	0.100	0.250	532.2	55.7	10.0	6.0	2263.4	1988.5
0.234	0.060	0.006	0.031	0.100	0.250	533.0	49.5	10.0	8.0	2263.3	1987.0
0.234	0.052	0.006	0.039	0.100	0.250	534.0	43.1	10.0	10.0	2263.2	1985.3
0.235	0.045	0.006	0.047	0.100	0.250	534.9	36.7	10.0	12.0	2263.2	1983.7
0.235	0.037	0.006	0.055	0.100	0.250	535.8	30.3	10.0	14.0	2263.2	1982.1
0.236	0.029	0.006	0.063	0.100	0.250	536.7	23.8	10.0	16.0	2263.1	1980.4
0.236	0.021	0.006	0.071	0.100	0.250	537.6	17.2	10.0	18.0	2263.0	1978.9
0.236	0.013	0.006	0.079	0.100	0.250	538.5	10.6	10.0	20.0	2263.0	1977.3
0.230	0.081	0.009	0.008	0.100	0.250	525.4	65.8	15.0	2.0	2264.3	1993.3
0.231	0.073	0.009	0.016	0.100	0.250	526.3	59.6	15.0	4.0	2264.2	1991.6
0.231	0.065	0.009	0.023	0.100	0.250	527.2	53.4	15.0	6.0	2264.2	1990.0
0.232	0.057	0.009	0.031	0.100	0.250	528.0	47.1	15.0	8.0	2264.2	1988.5
0.232	0.049	0.009	0.039	0.100	0.250	529.0	40.8	15.0	10.0	2264.1	1986.8
0.232	0.042	0.009	0.047	0.100	0.250	529.9	34.3	15.0	12.0	2264.1	1985.2
0.233	0.034	0.009	0.055	0.100	0.250	530.8	27.8	15.0	14.0	2264.0	1983.7
0.233	0.026	0.009	0.063	0.100	0.250	531.7	21.3	15.0	16.0	2264.0	1982.1
0.234	0.018	0.009	0.071	0.100	0.250	532.7	14.7	15.0	18.0	2263.9	1980.4
0.234	0.010	0.009	0.079	0.100	0.250	533.6	8.1	15.0	20.0	2263.8	1978.9
0.228	0.078	0.012	0.008	0.100	0.250	520.4	63.5	20.0	2.0	2265.1	1994.8
0.229	0.070	0.012	0.016	0.100	0.250	521.3	57.3	20.0	4.0	2265.0	1993.1
0.229	0.062	0.012	0.023	0.100	0.250	522.2	51.0	20.0	6.0	2265.0	1991.6
0.229	0.054	0.012	0.031	0.100	0.250	523.1	44.7	20.0	8.0	2264.9	1989.8
0.230	0.046	0.012	0.039	0.100	0.250	524.0	38.3	20.0	10.0	2264.9	1988.3
0.230	0.039	0.012	0.047	0.100	0.250	524.9	31.9	20.0	12.0	2264.9	1986.7
0.231	0.031	0.012	0.055	0.100	0.250	525.8	25.4	20.0	14.0	2264.9	1985.2
0.231	0.023	0.012	0.063	0.100	0.250	526.7	18.9	20.0	16.0	2264.8	1983.7
0.231	0.015	0.012	0.071	0.100	0.250	527.7	12.2	20.0	18.0	2264.7	1982.0
0.232	0.007	0.012	0.079	0.100	0.250	528.5	5.5	20.0	20.0	2264.7	1980.5
0.226	0.075	0.015	0.008	0.100	0.250	515.5	61.2	25.0	2.0	2265.9	1996.2
0.226	0.067	0.015	0.016	0.100	0.250	516.3	54.9	25.0	4.0	2265.9	1994.7
0.227	0.059	0.015	0.023	0.100	0.250	517.2	48.7	25.0	6.0	2265.9	1993.1
0.227	0.051	0.015	0.031	0.100	0.250	518.2	42.3	25.0	8.0	2265.8	1991.4
0.227	0.044	0.015	0.039	0.100	0.250	519.0	35.9	25.0	10.0	2265.8	1989.9
0.228	0.036	0.015	0.047	0.100	0.250	519.9	29.4	25.0	12.0	2265.7	1988.3
0.228	0.028	0.015	0.055	0.100	0.250	520.9	22.9	25.0	14.0	2265.6	1986.6
0.229	0.020	0.015	0.063	0.100	0.250	521.8	16.4	25.0	16.0	2265.6	1985.1
0.229	0.012	0.015	0.071	0.100	0.250	522.7	9.7	25.0	18.0	2265.6	1983.6
0.229	0.004	0.015	0.079	0.100	0.250	523.5	3.0	25.0	20.0	2265.5	1982.1
0.224	0.072	0.018	0.008	0.100	0.250	510.5	58.8	30.0	2.0	2266.8	1997.8
0.224	0.064	0.018	0.016	0.100	0.250	511.3	52.6	30.0	4.0	2266.7	1996.2
0.224	0.056	0.018	0.024	0.100	0.250	512.3	46.3	30.0	6.0	2266.7	1994.5
0.225	0.048	0.018	0.031	0.100	0.250	513.1	39.9	30.0	8.0	2266.6	1993.0
0.225	0.041	0.018	0.039	0.100	0.250	514.0	33.5	30.0	10.0	2266.6	1991.4
0.226	0.033	0.018	0.047	0.100	0.250	514.9	27.0	30.0	12.0	2266.6	1989.9
0.226	0.025	0.018	0.055	0.100	0.250	515.9	20.4	30.0	14.0	2266.5	1988.2
0.226	0.017	0.018	0.063	0.100	0.250	516.7	13.9	30.0	16.0	2266.4	1986.7
0.227	0.009	0.018	0.071	0.100	0.250	517.6	7.2	30.0	18.0	2266.4	1985.2
0.227	0.001	0.018	0.079	0.100	0.250	518.5	0.5	30.0	20.0	2266.4	1983.7
0.221	0.069	0.021	0.008	0.100	0.250	505.5	56.5	35.0	2.0	2267.6	1999.3
0.222	0.061	0.021	0.016	0.100	0.250	506.3	50.2	35.0	4.0	2267.6	1997.8
0.222	0.053	0.021	0.024	0.100	0.250	507.3	43.9	35.0	6.0	2267.5	1996.1
0.223	0.045	0.021	0.031	0.100	0.250	508.1	37.5	35.0	8.0	2267.5	1994.6

Table 2.7.2.b cont

0.223	0.038	0.021	0.039	0.100	0.250	509.0	31.0	35.0	10.0	2267.5	1993.1
0.223	0.030	0.021	0.047	0.100	0.250	510.0	24.5	35.0	12.0	2267.4	1991.3
0.224	0.022	0.021	0.055	0.100	0.250	510.8	18.0	35.0	14.0	2267.3	1989.8
0.224	0.014	0.021	0.063	0.100	0.250	511.7	11.3	35.0	16.0	2267.3	1988.3
0.225	0.006	0.021	0.071	0.100	0.250	512.6	4.7	35.0	18.0	2267.2	1986.8
Not achievable								35.0	20.0	2267.2	1985.4
0.219	0.066	0.024	0.008	0.100	0.250	500.5	54.2	40.0	2.0	2268.5	2000.9
0.219	0.058	0.024	0.016	0.100	0.250	501.4	47.8	40.0	4.0	2268.4	1999.2
0.220	0.050	0.024	0.024	0.100	0.250	502.2	41.5	40.0	6.0	2268.4	1997.7
0.220	0.042	0.024	0.031	0.100	0.250	503.1	35.1	40.0	8.0	2268.3	1996.2
0.221	0.035	0.024	0.039	0.100	0.250	504.0	28.6	40.0	10.0	2268.3	1994.7
0.221	0.027	0.024	0.047	0.100	0.250	504.8	22.1	40.0	12.0	2268.3	1993.1
0.221	0.019	0.024	0.055	0.100	0.250	505.8	15.5	40.0	14.0	2268.2	1991.5
0.222	0.011	0.024	0.063	0.100	0.250	506.7	8.8	40.0	16.0	2268.1	1989.9
0.222	0.003	0.024	0.071	0.100	0.250	507.6	2.1	40.0	18.0	2268.1	1988.4
Not achievable								40.0	20.0		
0.217	0.063	0.027	0.008	0.100	0.250	495.4	51.8	45.0	2.0	2269.3	2002.5
0.217	0.055	0.027	0.016	0.100	0.250	496.4	45.5	45.0	4.0	2269.2	2000.9
0.218	0.047	0.027	0.024	0.100	0.250	497.2	39.1	45.0	6.0	2269.2	1999.4
0.218	0.039	0.027	0.031	0.100	0.250	498.1	32.6	45.0	8.0	2269.2	1997.8
0.218	0.032	0.027	0.039	0.100	0.250	499.0	26.1	45.0	10.0	2269.1	1996.1
0.219	0.023	0.027	0.047	0.100	0.250	499.9	19.5	45.0	12.0	2269.1	1994.6
0.219	0.016	0.027	0.055	0.100	0.250	500.8	13.0	45.0	14.0	2269.0	1993.1
0.220	0.008	0.027	0.063	0.100	0.250	501.6	6.3	45.0	16.0	2269.0	1991.6
Not achievable								45.0	18.0		
Not achievable								45.0	20.0		
0.215	0.060	0.030	0.008	0.100	0.250	490.4	49.4	50.0	2.0	2270.2	2004.2
0.215	0.052	0.030	0.016	0.100	0.250	491.3	43.1	50.0	4.0	2270.1	2002.5
0.215	0.044	0.030	0.024	0.100	0.250	492.2	36.7	50.0	6.0	2270.1	2001.0
0.216	0.036	0.030	0.032	0.100	0.250	493.0	30.2	50.0	8.0	2270.1	1999.5
0.216	0.029	0.030	0.039	0.100	0.250	494.0	23.7	50.0	10.0	2270.0	1997.8
0.217	0.021	0.030	0.047	0.100	0.250	494.8	17.1	50.0	12.0	2269.9	1996.3
0.217	0.012	0.030	0.055	0.100	0.250	495.7	10.4	50.0	14.0	2269.9	1994.8
0.217	0.005	0.030	0.063	0.100	0.250	496.6	3.8	50.0	16.0	2269.9	1993.3
Not achievable								50.0	18.0		
Not achievable								50.0	20.0		

Table 2.7.2.c
Short-term prediction with F0-1 = 0.12 and F2-6 = 0.25

North sea herring 2004
Input data from: input

Results for the intermediate year 2004
with the folllowing constraints:
Fleet 1 F constraint: 0.2326
Fleet 2 F constraint: 0.0174
Fleet 3 F constraint: 0.0071
Fleet 4 F constraint: 0.0124

F-values by fleet and total						Catches by fleet				
F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2004
0.233	0.017	0.007	0.012	0.039	0.242	522.4	8.7	16.7	4.3	2010.7

Results for the prediction year 2005
with the following types of constraints:
Fleet 1 Screen for total Fs
Fleet 2 Screen for total Fs
Fleet 3 Catch constraint
Fleet 4 Catch constraint

F-values by fleet and total						Catches by fleet					
F1	F2	F3	F4	F 0- 1	F 2- 6	C1	C2	C3	C4	SSB2005	SSB2006
0.230	0.104	0.006	0.008	0.120	0.250	524.5	83.6	10.0	2.0	2265.1	1993.5
0.230	0.096	0.006	0.016	0.120	0.250	525.4	77.5	10.0	4.0	2265.0	1991.8
0.231	0.088	0.006	0.024	0.120	0.250	526.3	71.3	10.0	6.0	2265.0	1990.3
0.231	0.080	0.006	0.031	0.120	0.250	527.2	65.1	10.0	8.0	2265.0	1988.7
0.232	0.072	0.006	0.039	0.120	0.250	528.1	58.9	10.0	10.0	2264.9	1987.0
0.232	0.064	0.006	0.047	0.120	0.250	529.0	52.5	10.0	12.0	2264.8	1985.5
0.232	0.056	0.006	0.055	0.120	0.250	529.9	46.1	10.0	14.0	2264.8	1983.9
0.233	0.048	0.006	0.063	0.120	0.250	530.8	39.8	10.0	16.0	2264.8	1982.4
0.233	0.040	0.006	0.071	0.120	0.250	531.8	33.2	10.0	18.0	2264.7	1980.7
0.234	0.032	0.006	0.079	0.120	0.250	532.7	26.7	10.0	20.0	2264.6	1979.2
0.228	0.101	0.009	0.008	0.120	0.250	519.5	81.3	15.0	2.0	2265.9	1995.1
0.228	0.093	0.009	0.016	0.120	0.250	520.4	75.2	15.0	4.0	2265.8	1993.4
0.228	0.085	0.009	0.024	0.120	0.250	521.3	69.0	15.0	6.0	2265.8	1991.8
0.229	0.077	0.009	0.031	0.120	0.250	522.2	62.8	15.0	8.0	2265.8	1990.3
0.229	0.069	0.009	0.039	0.120	0.250	523.1	56.5	15.0	10.0	2265.7	1988.6
0.230	0.061	0.009	0.047	0.120	0.250	524.0	50.1	15.0	12.0	2265.7	1987.1
0.230	0.053	0.009	0.055	0.120	0.250	524.9	43.8	15.0	14.0	2265.6	1985.5
0.231	0.045	0.009	0.063	0.120	0.250	525.9	37.3	15.0	16.0	2265.5	1983.8
0.231	0.037	0.009	0.071	0.120	0.250	526.8	30.8	15.0	18.0	2265.5	1982.3
0.231	0.029	0.009	0.079	0.120	0.250	527.7	24.2	15.0	20.0	2265.5	1980.7
0.225	0.098	0.012	0.008	0.120	0.250	514.6	79.0	20.0	2.0	2266.7	1996.4
0.226	0.090	0.012	0.016	0.120	0.250	515.4	72.9	20.0	4.0	2266.7	1994.9
0.226	0.082	0.012	0.024	0.120	0.250	516.3	66.7	20.0	6.0	2266.7	1993.4
0.227	0.074	0.012	0.032	0.120	0.250	517.3	60.4	20.0	8.0	2266.6	1991.7
0.227	0.066	0.012	0.039	0.120	0.250	518.2	54.1	20.0	10.0	2266.6	1990.2
0.227	0.058	0.012	0.047	0.120	0.250	519.0	47.7	20.0	12.0	2266.5	1988.6
0.228	0.050	0.012	0.055	0.120	0.250	519.9	41.3	20.0	14.0	2266.5	1987.1
0.228	0.042	0.012	0.063	0.120	0.250	520.9	34.9	20.0	16.0	2266.4	1985.4
0.229	0.034	0.012	0.071	0.120	0.250	521.8	28.3	20.0	18.0	2266.3	1983.9
0.229	0.026	0.012	0.079	0.120	0.250	522.7	21.7	20.0	20.0	2266.3	1982.4
0.223	0.095	0.015	0.008	0.120	0.250	509.6	76.7	25.0	2.0	2267.6	1998.0
0.224	0.087	0.015	0.016	0.120	0.250	510.5	70.6	25.0	4.0	2267.5	1996.5
0.224	0.079	0.015	0.024	0.120	0.250	511.3	64.4	25.0	6.0	2267.5	1995.0
0.224	0.071	0.015	0.032	0.120	0.250	512.3	58.1	25.0	8.0	2267.4	1993.3
0.225	0.063	0.015	0.040	0.120	0.250	513.1	51.7	25.0	10.0	2267.4	1991.8
0.225	0.055	0.015	0.047	0.120	0.250	514.0	45.3	25.0	12.0	2267.4	1990.2
0.226	0.047	0.015	0.055	0.120	0.250	514.9	38.9	25.0	14.0	2267.3	1988.7
0.226	0.039	0.015	0.063	0.120	0.250	515.9	32.4	25.0	16.0	2267.2	1987.0
0.226	0.031	0.015	0.072	0.120	0.250	516.8	25.8	25.0	18.0	2267.2	1985.5
0.227	0.023	0.015	0.080	0.120	0.250	517.7	19.3	25.0	20.0	2267.2	1984.1
0.221	0.092	0.018	0.008	0.120	0.250	504.6	74.4	30.0	2.0	2268.4	1999.6
0.221	0.084	0.018	0.016	0.120	0.250	505.4	68.3	30.0	4.0	2268.4	1998.1
0.222	0.076	0.018	0.024	0.120	0.250	506.3	62.0	30.0	6.0	2268.4	1996.5
0.222	0.068	0.018	0.032	0.120	0.250	507.2	55.7	30.0	8.0	2268.3	1994.9
0.222	0.060	0.018	0.040	0.120	0.250	508.1	49.3	30.0	10.0	2268.3	1993.3
0.223	0.052	0.018	0.048	0.120	0.250	509.0	42.9	30.0	12.0	2268.2	1991.8
0.223	0.044	0.018	0.055	0.120	0.250	510.0	36.5	30.0	14.0	2268.1	1990.2
0.224	0.036	0.018	0.063	0.120	0.250	510.9	30.0	30.0	16.0	2268.1	1988.6
0.224	0.028	0.018	0.072	0.120	0.250	511.8	23.4	30.0	18.0	2268.0	1987.1
0.225	0.020	0.018	0.080	0.120	0.250	512.7	16.7	30.0	20.0	2268.0	1985.6
0.219	0.089	0.021	0.008	0.120	0.250	499.6	72.1	35.0	2.0	2269.3	2001.2
0.219	0.081	0.021	0.016	0.120	0.250	500.4	65.9	35.0	4.0	2269.3	1999.7
0.219	0.073	0.021	0.024	0.120	0.250	501.3	59.7	35.0	6.0	2269.2	1998.0
0.220	0.065	0.021	0.032	0.120	0.250	502.2	53.3	35.0	8.0	2269.2	1996.5

Table 2.7.2.c cont.

0.220	0.057	0.021	0.040	0.120	0.250	503.1	46.9	35.0	10.0	2269.1	1995.0
0.221	0.049	0.021	0.048	0.120	0.250	503.9	40.5	35.0	12.0	2269.1	1993.5
0.221	0.041	0.021	0.056	0.120	0.250	504.9	34.0	35.0	14.0	2269.0	1991.8
0.221	0.033	0.021	0.064	0.120	0.250	505.8	27.4	35.0	16.0	2268.9	1990.3
0.222	0.025	0.021	0.072	0.120	0.250	506.7	20.9	35.0	18.0	2268.9	1988.8
0.222	0.017	0.021	0.080	0.120	0.250	507.6	14.2	35.0	20.0	2268.9	1987.4
0.216	0.086	0.024	0.008	0.120	0.250	494.5	69.8	40.0	2.0	2270.1	2002.9
0.217	0.078	0.024	0.016	0.120	0.250	495.5	63.6	40.0	4.0	2270.0	2001.2
0.217	0.070	0.024	0.024	0.120	0.250	496.3	57.3	40.0	6.0	2270.0	1999.7
0.218	0.062	0.024	0.032	0.120	0.250	497.2	50.9	40.0	8.0	2270.0	1998.2
0.218	0.054	0.024	0.040	0.120	0.250	498.0	44.5	40.0	10.0	2270.0	1996.7
0.218	0.046	0.024	0.048	0.120	0.250	499.0	38.1	40.0	12.0	2269.9	1995.0
0.219	0.038	0.024	0.056	0.120	0.250	499.9	31.6	40.0	14.0	2269.8	1993.5
0.219	0.030	0.024	0.064	0.120	0.250	500.8	25.0	40.0	16.0	2269.8	1992.0
0.220	0.022	0.024	0.072	0.120	0.250	501.7	18.3	40.0	18.0	2269.7	1990.4
0.220	0.014	0.024	0.080	0.120	0.250	502.6	11.7	40.0	20.0	2269.7	1988.9
0.214	0.083	0.027	0.008	0.120	0.250	489.5	67.5	45.0	2.0	2271.0	2004.5
0.214	0.075	0.027	0.016	0.120	0.250	490.4	61.3	45.0	4.0	2270.9	2002.8
0.215	0.067	0.027	0.024	0.120	0.250	491.2	54.9	45.0	6.0	2270.9	2001.4
0.215	0.059	0.027	0.032	0.120	0.250	492.1	48.5	45.0	8.0	2270.9	1999.8
0.216	0.051	0.027	0.040	0.120	0.250	493.0	42.1	45.0	10.0	2270.8	1998.3
0.216	0.043	0.027	0.048	0.120	0.250	493.9	35.6	45.0	12.0	2270.7	1996.7
0.216	0.035	0.027	0.056	0.120	0.250	494.8	29.1	45.0	14.0	2270.7	1995.2
0.217	0.027	0.027	0.064	0.120	0.250	495.7	22.5	45.0	16.0	2270.7	1993.7
0.217	0.019	0.027	0.072	0.120	0.250	496.7	15.9	45.0	18.0	2270.6	1992.1
0.218	0.011	0.027	0.080	0.120	0.250	497.5	9.1	45.0	20.0	2270.6	1990.6
0.212	0.080	0.030	0.008	0.120	0.250	484.4	65.1	50.0	2.0	2271.9	2006.2
0.212	0.072	0.030	0.016	0.120	0.250	485.4	58.9	50.0	4.0	2271.8	2004.5
0.213	0.064	0.030	0.024	0.120	0.250	486.2	52.5	50.0	6.0	2271.8	2003.0
0.213	0.056	0.030	0.032	0.120	0.250	487.1	46.1	50.0	8.0	2271.8	2001.5
0.213	0.048	0.030	0.040	0.120	0.250	488.0	39.7	50.0	10.0	2271.6	1999.9
0.214	0.040	0.030	0.048	0.120	0.250	488.9	33.2	50.0	12.0	2271.6	1998.4
0.214	0.032	0.030	0.056	0.120	0.250	489.8	26.7	50.0	14.0	2271.6	1996.9
0.215	0.024	0.030	0.064	0.120	0.250	490.7	20.0	50.0	16.0	2271.5	1995.4
0.215	0.016	0.030	0.072	0.120	0.250	491.6	13.3	50.0	18.0	2271.5	1993.8
0.215	0.008	0.030	0.080	0.120	0.250	492.5	6.6	50.0	20.0	2271.4	1992.4

Table 2.7.3 North Sea herring. Short term projection – selected examples.

Results for the **intermediate year** 2004 with the following constraints:

Fleet 1 F constraint: 0.2326
Fleet 2 F constraint: 0.0174
Fleet 3 F constraint: 0.0071
Fleet 4 F constraint: 0.0124

F-values by fleet and total Catches by fleet

F1	F2	F3	F4	F0-1	F2-6	C1	C2	C3	C4	SSB2004
0.233	0.017	0.007	0.012	0.039	0.242	522.4	8.7	16.7	4.3	2010.7

Results for the **prediction year 2005** with F_{0-1} = 0.10 and F_{2-6} = 0.20:

F1	F2	F3	F4	F0-1	F2-6	C1	C2	C3	C4	SSB2005	SSB2006
0.183	0.077	0.006	0.016	0.1	0.2	428	63	10	4	2346	2169
0.184	0.061	0.006	0.031	0.1	0.2	430	50	10	8	2346	2166
0.185	0.045	0.006	0.047	0.1	0.2	432	38	10	12	2346	2163
0.179	0.071	0.012	0.016	0.1	0.2	418	58	20	4	2348	2173
0.179	0.055	0.012	0.031	0.1	0.2	420	46	20	8	2348	2169
0.180	0.039	0.012	0.047	0.1	0.2	422	33	20	12	2348	2166
0.174	0.065	0.017	0.016	0.1	0.2	408	54	30	4	2350	2176
0.175	0.049	0.017	0.031	0.1	0.2	410	41	30	8	2349	2173
0.176	0.034	0.017	0.047	0.1	0.2	411	28	30	12	2349	2170

Results for the **prediction year 2005** with F_{0-1} = 0.10 and F_{2-6} = 0.25:

F1	F2	F3	F4	F0-1	F2-6	C1	C2	C3	C4	SSB2005	SSB2006
0.233	0.076	0.006	0.016	0.1	0.25	531	62	10	4	2263	1990
0.234	0.060	0.006	0.031	0.1	0.25	533	50	10	8	2263	1987
0.235	0.045	0.006	0.047	0.1	0.25	535	37	10	12	2263	1984
0.229	0.070	0.012	0.016	0.1	0.25	521	57	20	4	2265	1993
0.229	0.054	0.012	0.031	0.1	0.25	523	45	20	8	2265	1990
0.230	0.039	0.012	0.047	0.1	0.25	525	32	20	12	2265	1987
0.224	0.064	0.018	0.016	0.1	0.25	511	53	30	4	2267	1996
0.225	0.048	0.018	0.031	0.1	0.25	513	40	30	8	2267	1993
0.226	0.033	0.018	0.047	0.1	0.25	515	27	30	12	2267	1990

Results for the **prediction year 2005** with F_{0-1} = 0.12 and F_{2-6} = 0.25:

F1	F2	F3	F4	F0-1	F2-6	C1	C2	C3	C4	SSB2005	SSB2006
0.230	0.096	0.006	0.016	0.12	0.25	525	78	10	4	2265	1992
0.231	0.080	0.006	0.031	0.12	0.25	527	65	10	8	2265	1989
0.232	0.064	0.006	0.047	0.12	0.25	529	53	10	12	2265	1986
0.226	0.090	0.012	0.016	0.12	0.25	515	73	20	4	2267	1995
0.227	0.074	0.012	0.032	0.12	0.25	517	60	20	8	2267	1992
0.227	0.058	0.012	0.047	0.12	0.25	519	48	20	12	2267	1989
0.221	0.084	0.018	0.016	0.12	0.25	505	68	30	4	2268	1998
0.222	0.068	0.018	0.032	0.12	0.25	507	56	30	8	2268	1995
0.223	0.052	0.018	0.048	0.12	0.25	509	43	30	12	2268	1992

Table 2.8.1 Effect of deviations from the current harvest rule for North Sea herring, when no error in assessment and implementation is assumed.

	Prob SSB < Action point	Prob SSB < 800 000 tonnes	Median catch A- fleet	Median catch B-C-D- fleets
Current rule	1	0	526	179
Action at 1000 000 tonnes	0	0	525	179
Action at 1500 000 tonnes	3	0	532	179
F 2-6 = 0.2	0	0	500	184
F 2-6 = 0.30	3	0	551	174
F 0-1 = 0.075	0	0	594	120
F 0-1 = 0.15	2	0	486	213
F 0-1 = 0.20	5	0	440	267

Table 2.8.2 Effect of deviations from the current harvest rule for North Sea herring when assuming that assessment overestimates the stock by 10% ± 20% (SD) and that quotas are overfished by 20 ± 20 % (SD)

	Prob (%) True SSB < Action point	Prob (%) True SSB < 800 000 tonnes	Prob (%) Percieved SSB < Action point	Prob (%) Percieved SSB < 800 000 tonnes	Median catch A- fleet	Median catch B-C-D- fleets
Current rule	47	4	30	3	489	204
Action at 1000 000 tonnes	25	9	14	5	472	210
Action at 1500 000 tonnes	62	3	39	3	492	189
F 2-6 = 0.20	28	2	16	1	458	217
F 2-6 = 0.30	60	9	29	5	509	182
F 0-1 = 0.075	31	2	17	1	558	142
F 0-1 = 0.15	55	7	35	4	451	230
F 0-1 = 0.20	66	11	45	7	408	249

Table 2.10.1 Comparison of index weighting for ICA and XSA assessments for North Sea herring in 2004

A) Weighting taken directly from assessment outputs

	Current Assessment (ICA Inv Var Wts)			ICA addaptive weights			XSA with weak shrinkage					XSA with high shrinkage				
Age	Acoustic survey 2-9+	IBTS: 1-5+ wr	MIK 0-wr	Acoustic survey 2-9+	IBTS: 1-5+ wr	MIK 0-wr	Acoustic survey 2-9+	IBTS: 1-5+ wr	MIK 0-wr	P shrinkage mean	F shrinkage mean	Acoustic survey 2-9+	IBTS: 1-5+ wr	MIK 0-wr	P shrinkage mean	F shrinkage mean
0			2.05			0.30			0.69	0.26	0.05			0.39	0.15	0.46
1	0.74	0.67		0.73	0.53		0.40	0.40	0.13	0.05	0.01	0.36	0.36	0.11	0.04	0.14
2	0.75	0.24		0.81	0.14		0.57	0.34	0.09		0.01	0.51	0.31	0.07		0.11
3	0.64	0.06		0.83	0.19		0.64	0.30	0.06		0.01	0.58	0.27	0.05		0.10
4	0.27	0.03		0.68	0.19		0.67	0.28	0.04		0.01	0.62	0.26	0.04		0.09
5	0.14	0.03		0.85	0.13		0.72	0.24	0.03		0.01	0.63	0.21	0.02		0.15
6	0.13			0.78			0.80	0.18	0.02		0.01	0.71	0.15	0.02		0.12
7	0.12			0.38			0.86	0.12	0.01		0.01	0.75	0.11	0.01		0.13
8	0.07			0.65			0.91	0.07	0.01		0.01	0.78	0.07	0.00		0.15
Total	2.86	1.03	2.05	5.69	1.18	0.30	5.56	1.93	1.07	0.32	0.12	4.92	1.72	0.71	0.20	1.45

B) Weighting for each assessment method normalised to give a standard weight of five to the acoustic survey in each assessment, in order to facilitate comparison

0			3.58			0.26			0.62	0.24	0.04			0.39	0.15	0.47
1	1.29	1.17		0.64	0.46		0.36	0.36	0.12	0.05	0.01	0.36	0.36	0.11	0.04	0.14
2	1.31	0.42		0.71	0.12		0.51	0.30	0.08		0.01	0.52	0.31	0.08		0.11
3	1.12	0.10		0.72	0.17		0.57	0.27	0.05		0.01	0.59	0.27	0.05		0.10
4	0.47	0.05		0.59	0.17		0.60	0.25	0.04		0.01	0.62	0.26	0.04		0.09
5	0.24	0.05		0.74	0.11		0.65	0.22	0.02		0.01	0.64	0.21	0.02		0.15
6	0.23			0.68			0.72	0.16	0.02		0.01	0.72	0.15	0.02		0.12
7	0.21			0.34			0.77	0.11	0.01		0.01	0.76	0.12	0.01		0.13
8	0.12			0.57			0.82	0.07	0.00		0.01	0.79	0.07	0.00		0.15
Total	5.00	1.80	3.58	5.00	1.04	0.26	5.00	1.73	0.96	0.28	0.11	5.00	1.75	0.72	0.20	1.47

Table 2.11.1 Downs herring (IVc+VIId). TAC and ACFM catch from 1986 to 2004. Weights in 1000 tonnes.

	TAC			Catch		
	IVa+IVb	IVc+VIId	Total	IVa+IVb	IVc+VIId	Total
1986	500	70	570	493	51	544
1987	560	40	600	577	45	622
1988	500	30	530	646	52	698
1989	484	30	514	638	79	717
1990	385	30	415	516	61	577
1991	370	50	420	527	61	588
1992	380	50	430	498	74	572
1993	380	50	430	463	77	540
1994	390	50	440	428	74	502
1995	264	50	440	503	63	566
1996	86	25	156	216	50	266
1997	88	25	159	183	51	234
1998	156	25	254	281	48	329
1999	164	25	265	282	54	336
2000	164	25	265	285	44	329
2001	164	25	265	278	45	323
2002	146	43	265	303	50	353
2003	340	60	400	382	68	450
2004	394	66	460			

Herring catches 2003, 1st Quarter

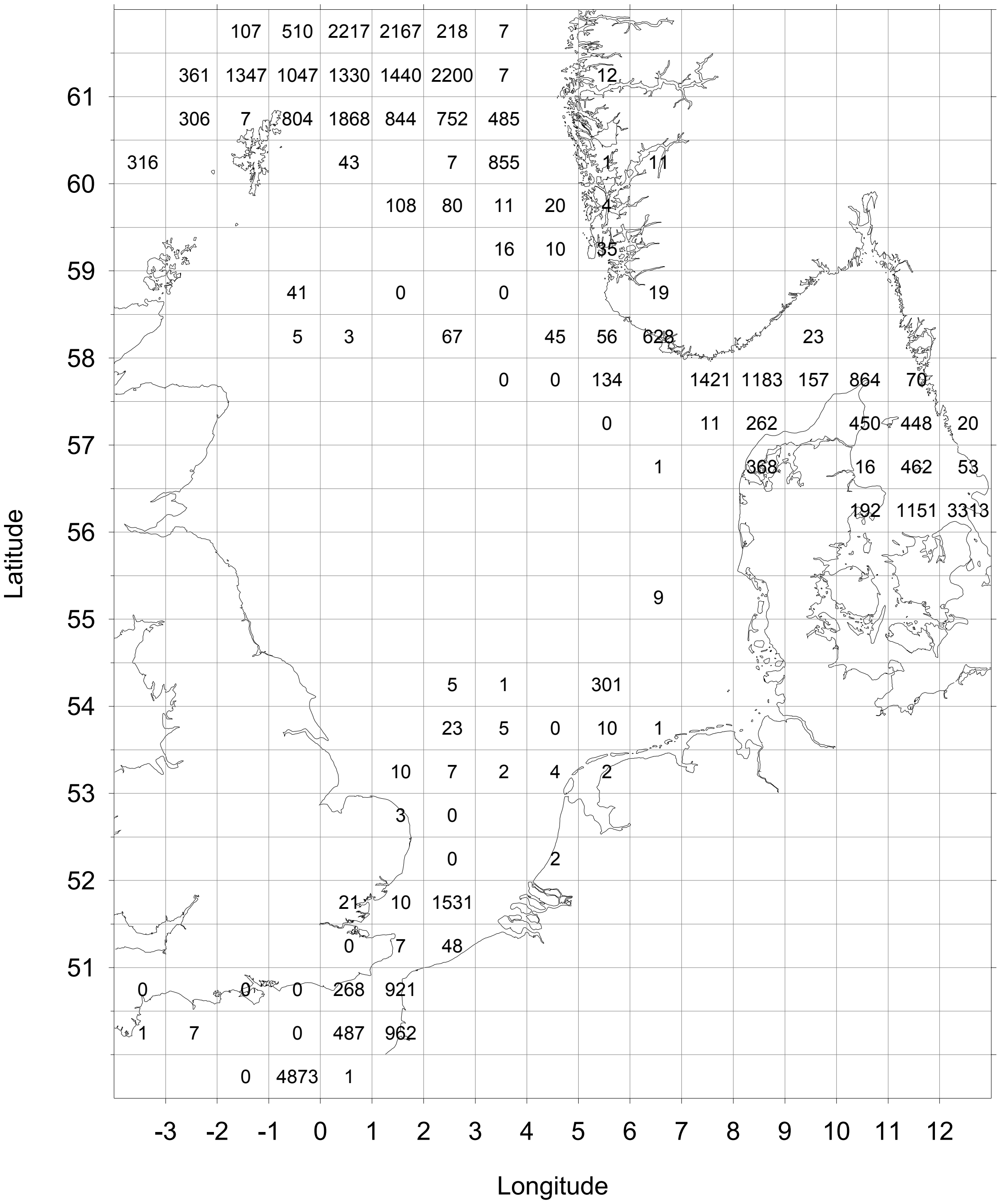


Figure 2.1.1 Herring catches in the North Sea (in tonnes) in 2003 by statistical rectangle. Working group estimates (if available). **a.:** 1st quarter

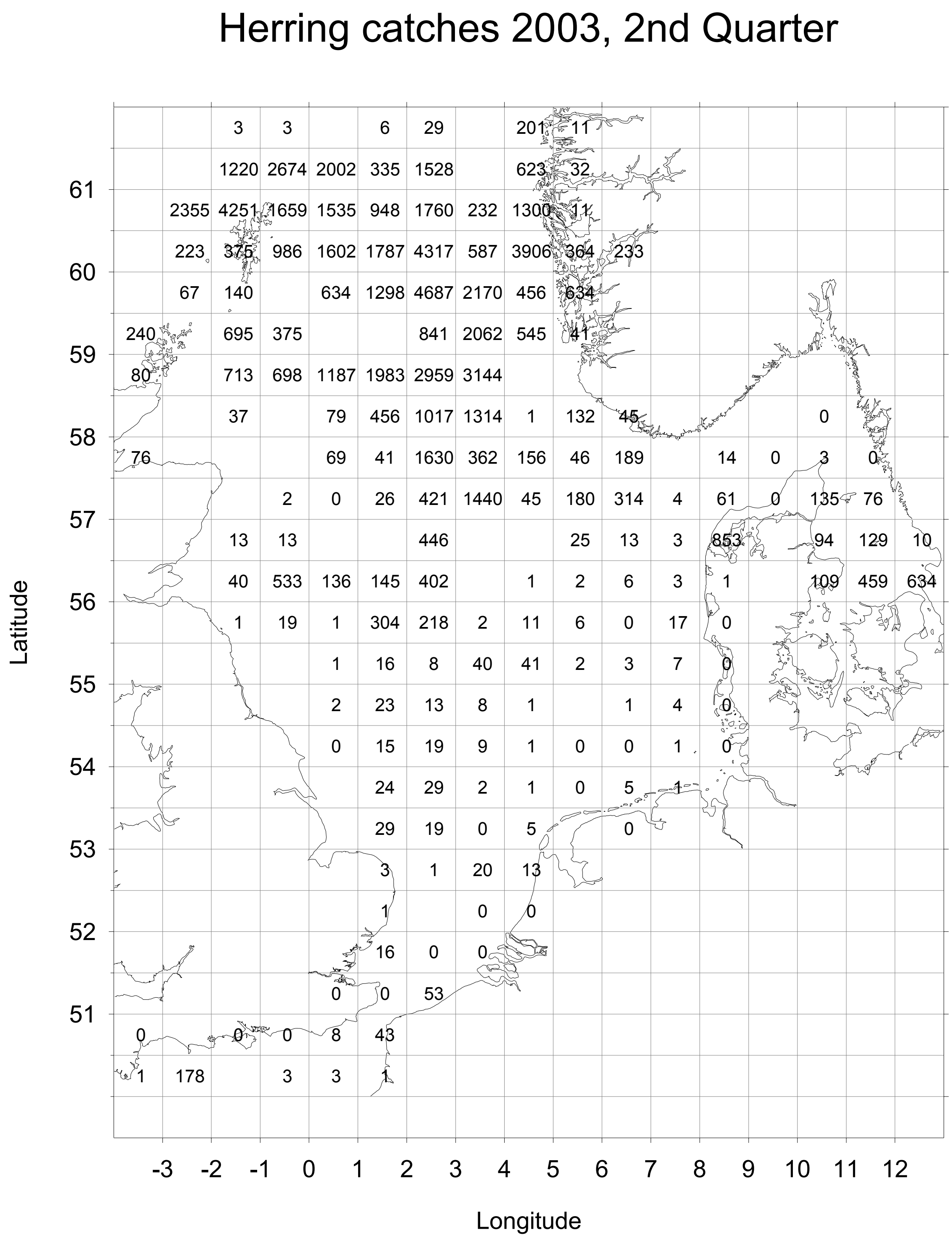


Figure 2.1.1(Cont'd) Herring catches in the North Sea (in tonnes) in 2003 by statistical rectangle. Working group estimates (if available). **b.:** 2nd quarter

Herring catches 2003, 3rd Quarter

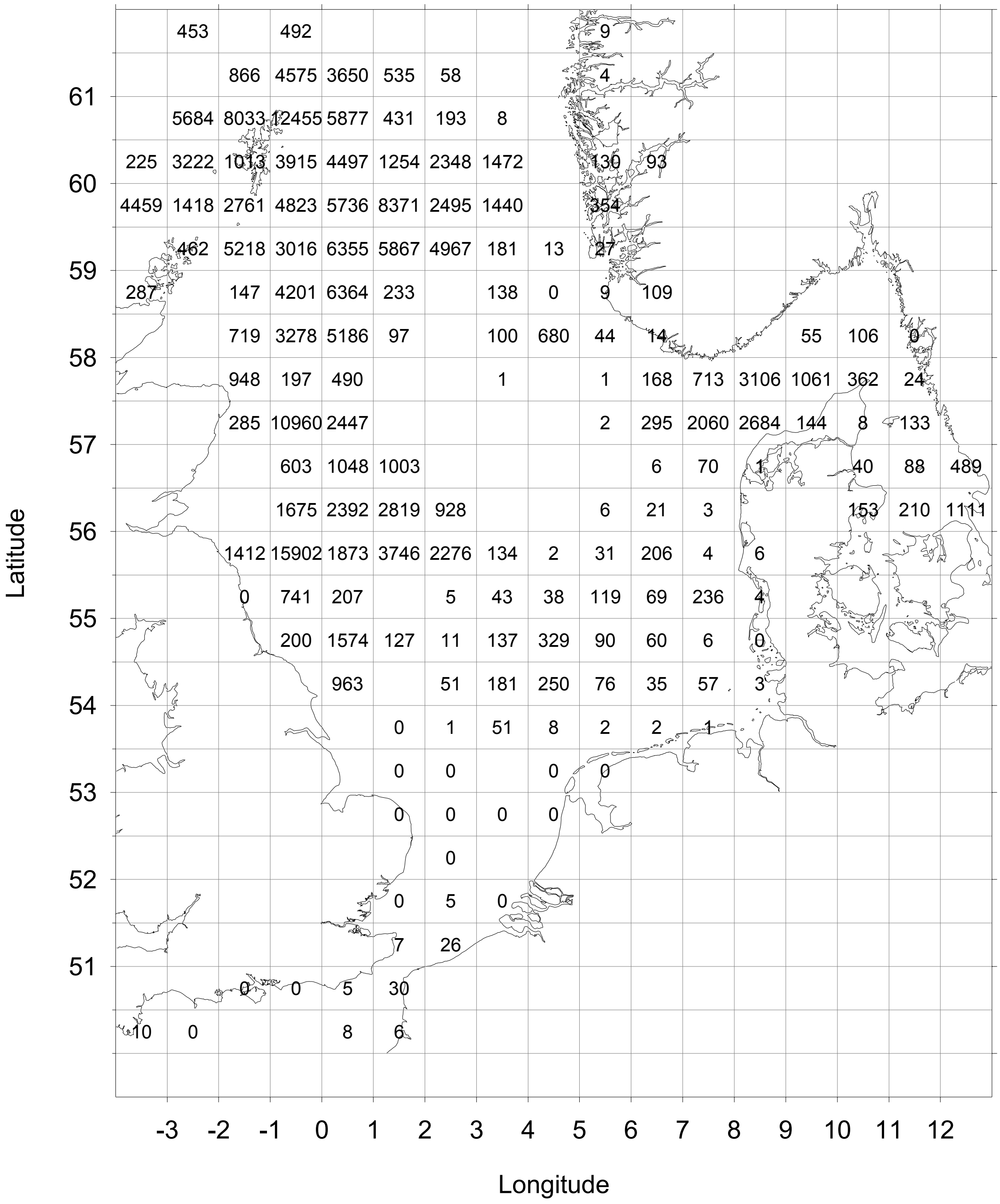


Figure 2.1.1 (Cont'd) Herring catches in the North Sea (in tonnes) in 2003 by statistical rectangle. Working group estimates (if available). **c.:** 3rd quarter

Herring catches 2003, 4th Quarter

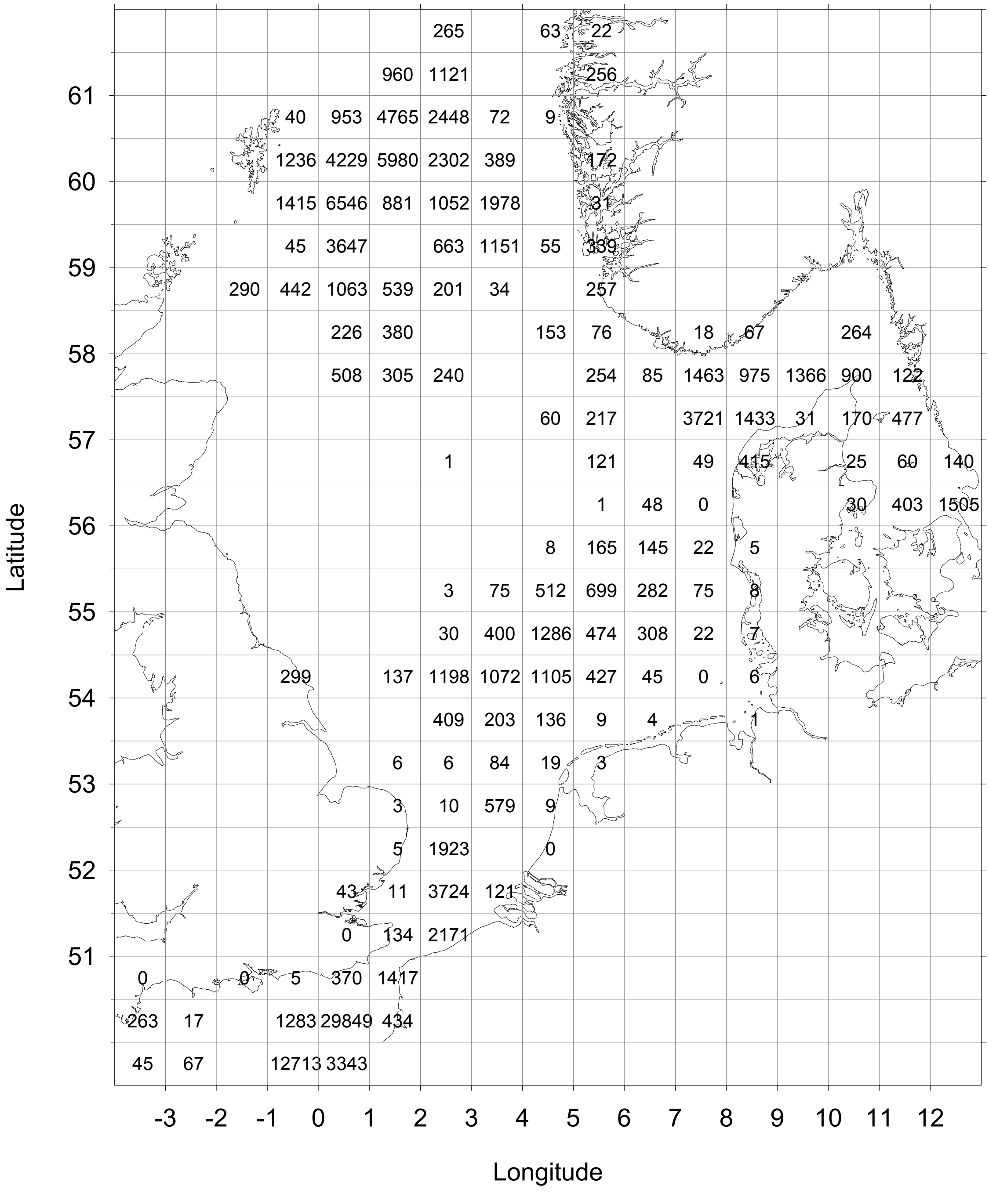


Figure 2.1.1 (Cont'd) Herring catches in the North Sea (in tonnes) in 2003 by statistical rectangle. Working group estimates (if available). **d.:** 4th quarter

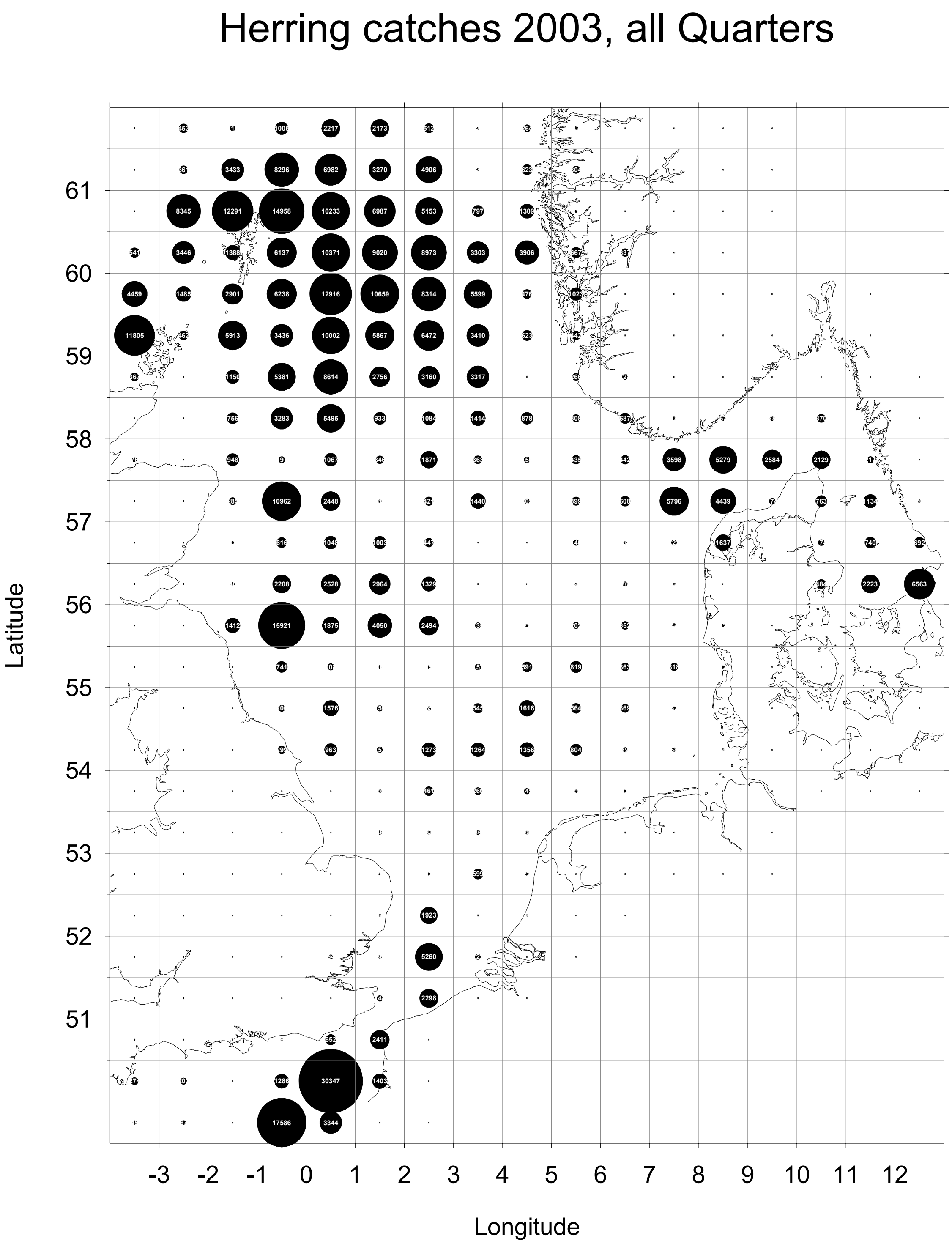


Figure 2.1.1 (Cont'd) Herring catches in the North Sea (in tonnes) in 2003 by statistical rectangle. Working group estimates (if available). **e.:** all quarters

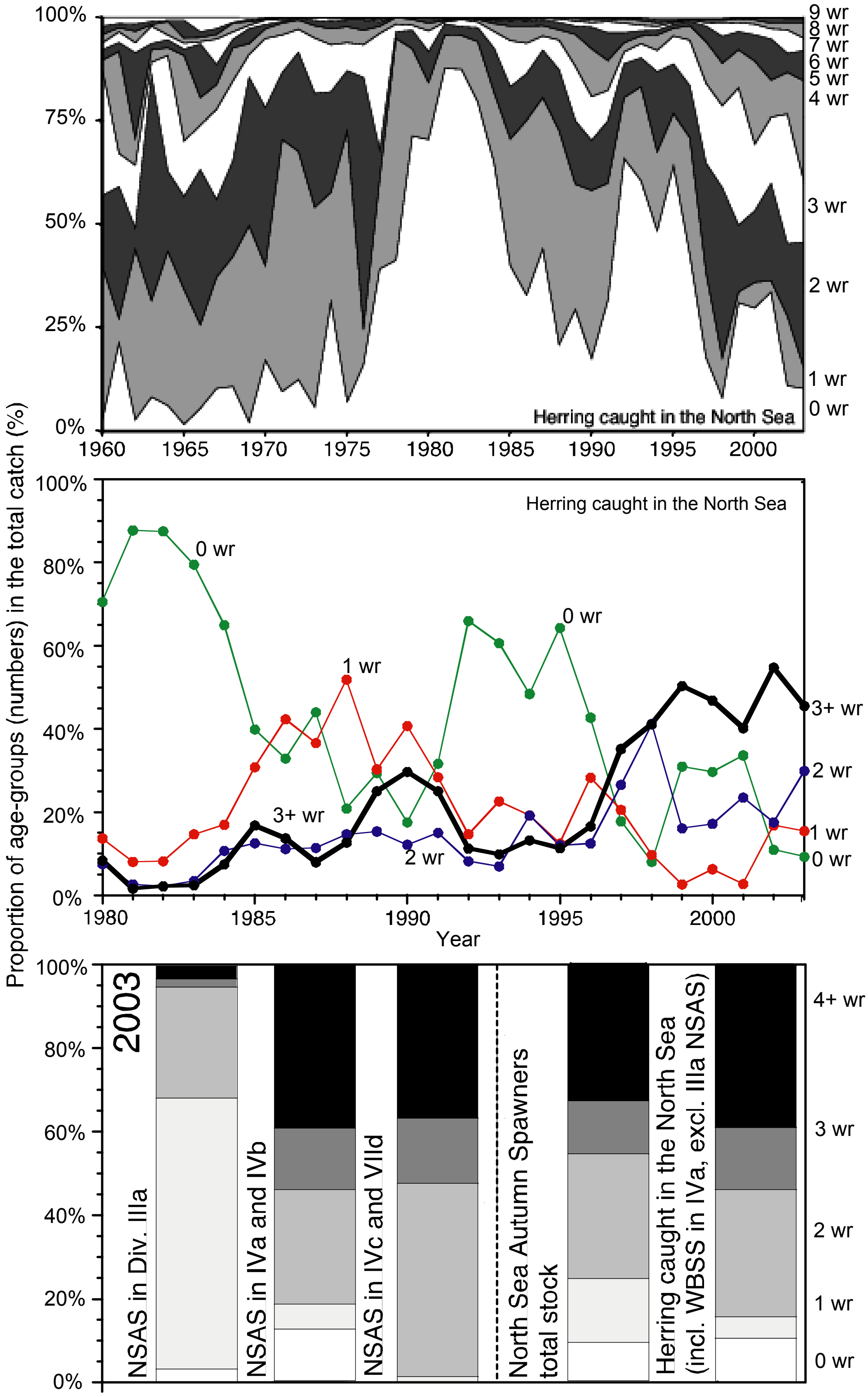


Figure 2.2.1 Proportions of age groups (numbers) in the total catch of herring in the North Sea (upper, 1960-2003, and middle panel, 1980-2003), and in the total catch of North Sea Autumn Spawners in 2003 (lower panel).

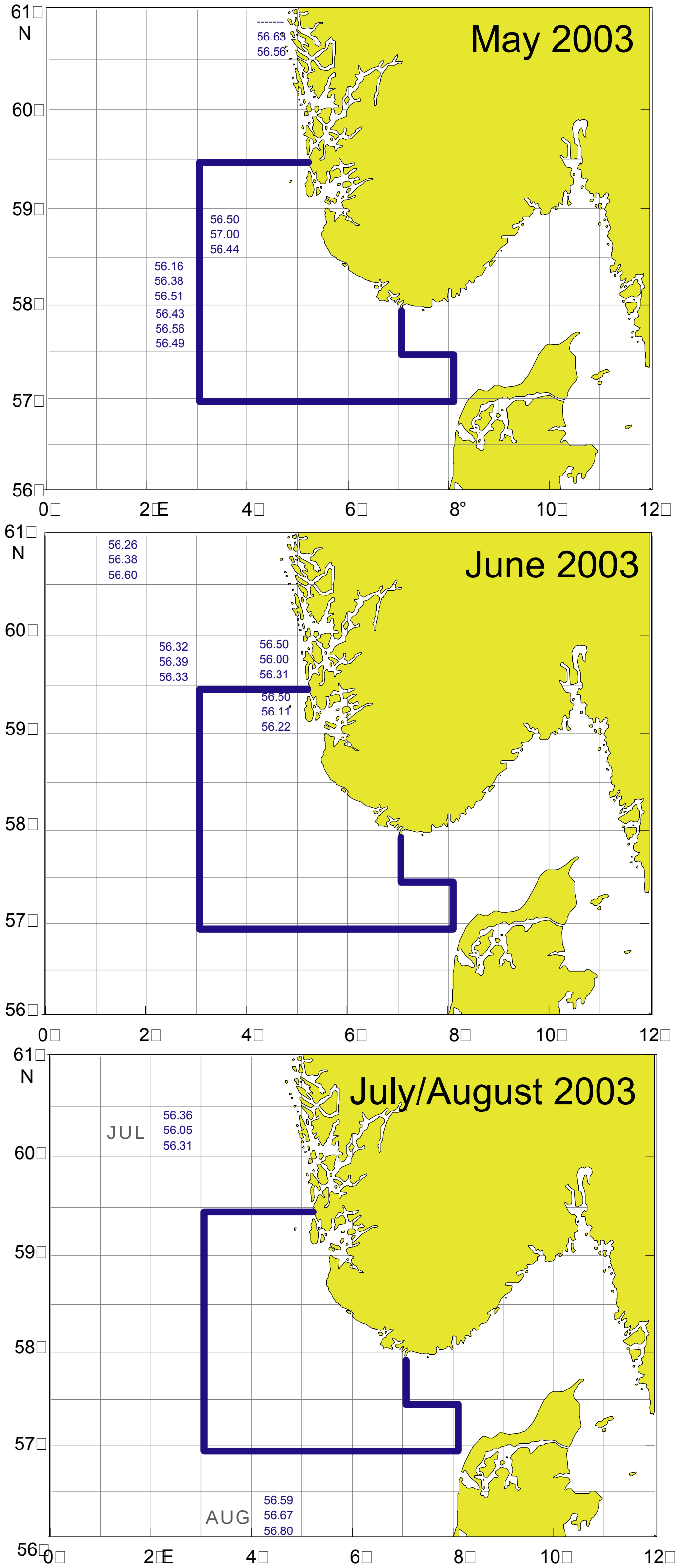


Figure 2.2.2 Mean vertebrae counts of 2 (upper number), 3 (middle) and 4+ herring (lower) in the North Sea and Div. IIIa as obtained by Norwegian sampling in the 2nd and 3rd quarter 2003. The transfer area (Western Baltic Spring Spawners transfered to the assessment of IIIa herring) is indicated.

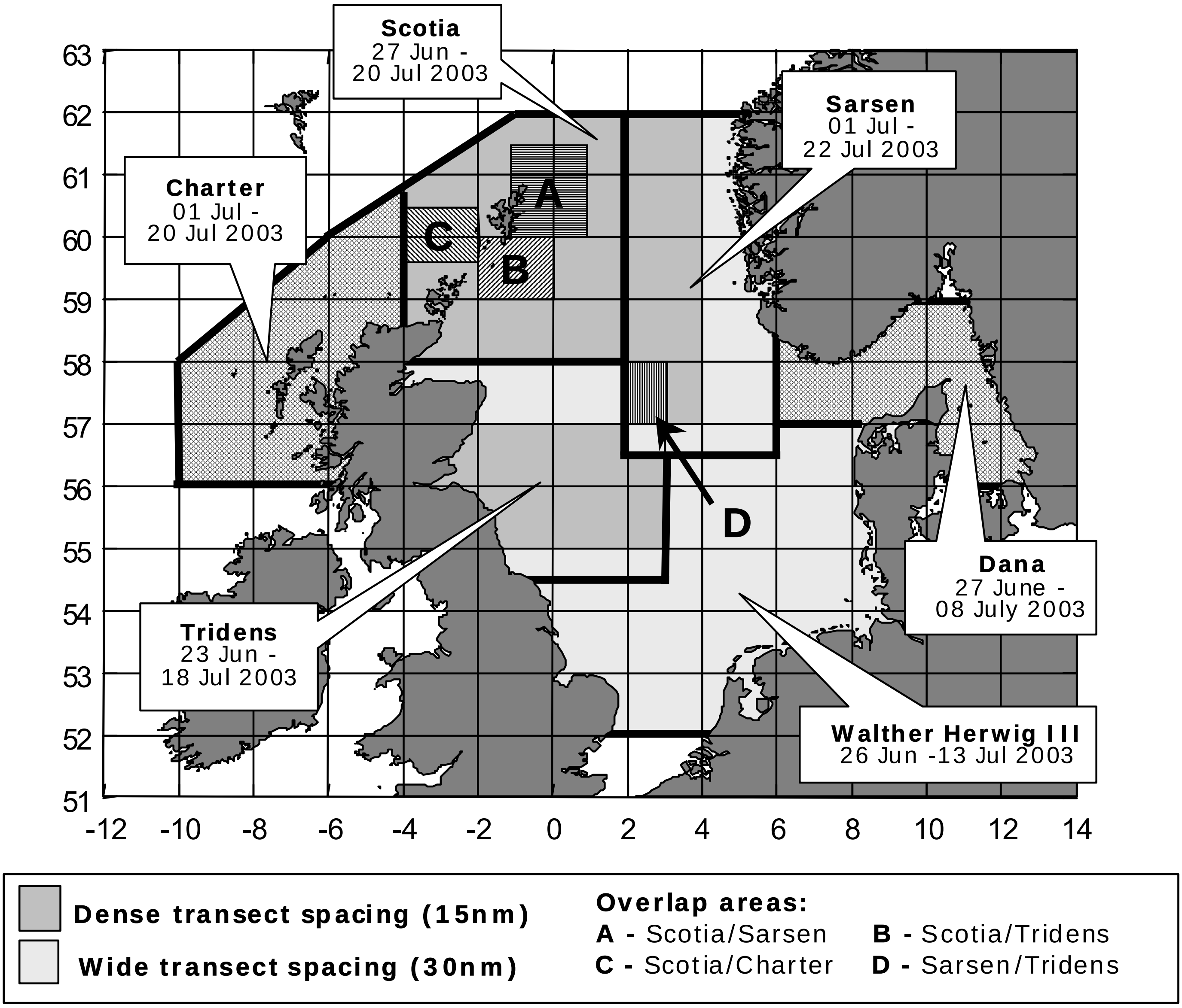


Figure 2.3.1.1 Herring survey area layouts and dates for all participating vessels in the 2003 acoustic survey of the North Sea and adjacent areas. Shaded areas indicate areas of overlap.

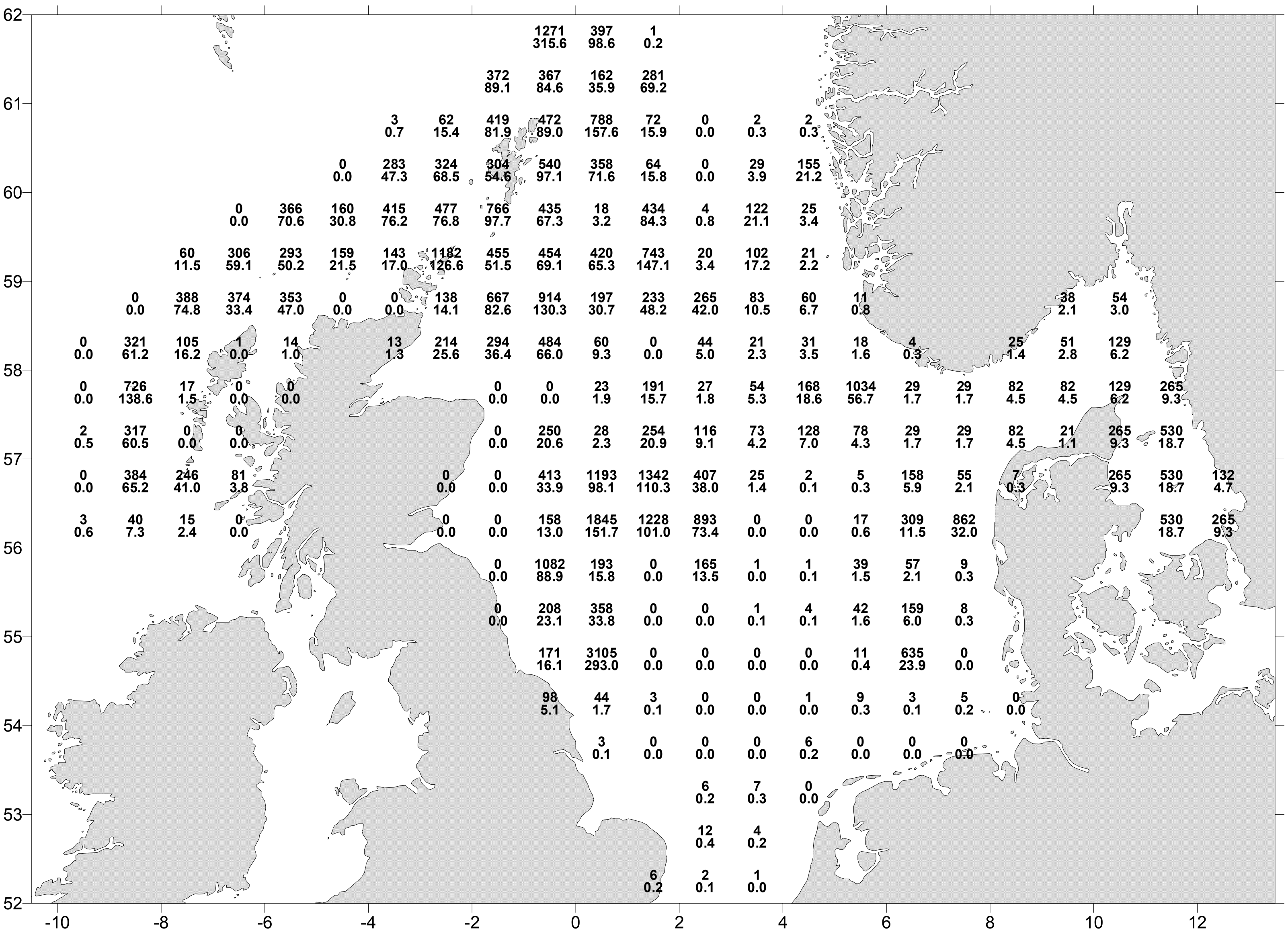


Figure 2.3.1.2 Autumn spawning herring abundance from combined acoustic survey July 2003. Numbers (millions) (upper figure), and biomass (thousands of tonnes) (lower figure)

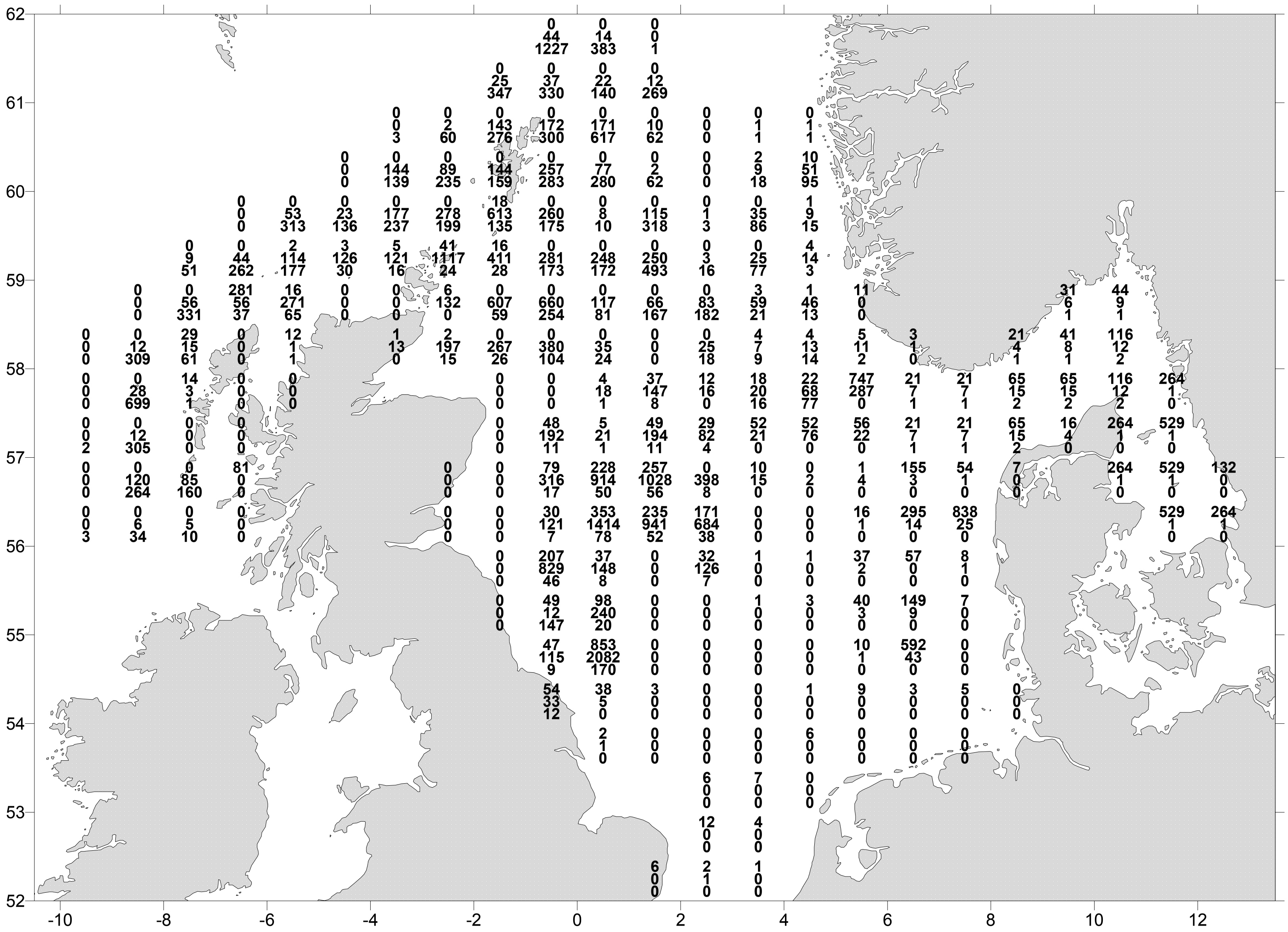


Figure 2.3.1.3 Autumn spawning herring numbers (millions) from combined acoustic survey July 2003. 1-ring (upper figure), 2-ring (centre figure), 3+ (lower figure)

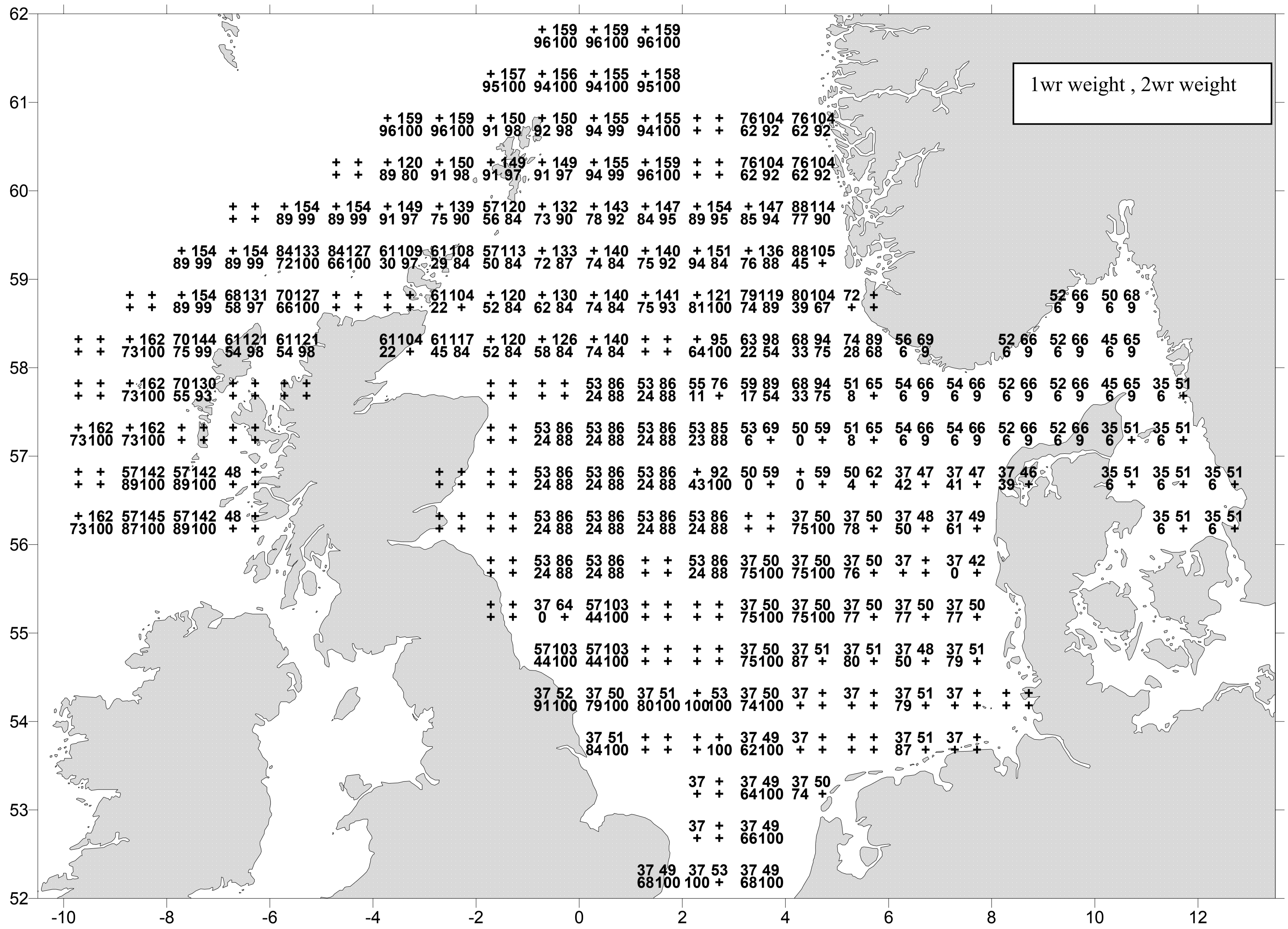


Figure 2.3.1.4 Mean weight & maturity of Autumn spawning herring from combined acoustic survey June - July 2003. Four values per ICES rectangle, percentage mature (lower),2 ring (left), 3 ring (right), mean weights gram (upper),1 ring (left) ,2 ring (right) ,0 indicates measured percentage mature, + indicates surveyed with zero abundance blank indicates an unsurveyed rectangle

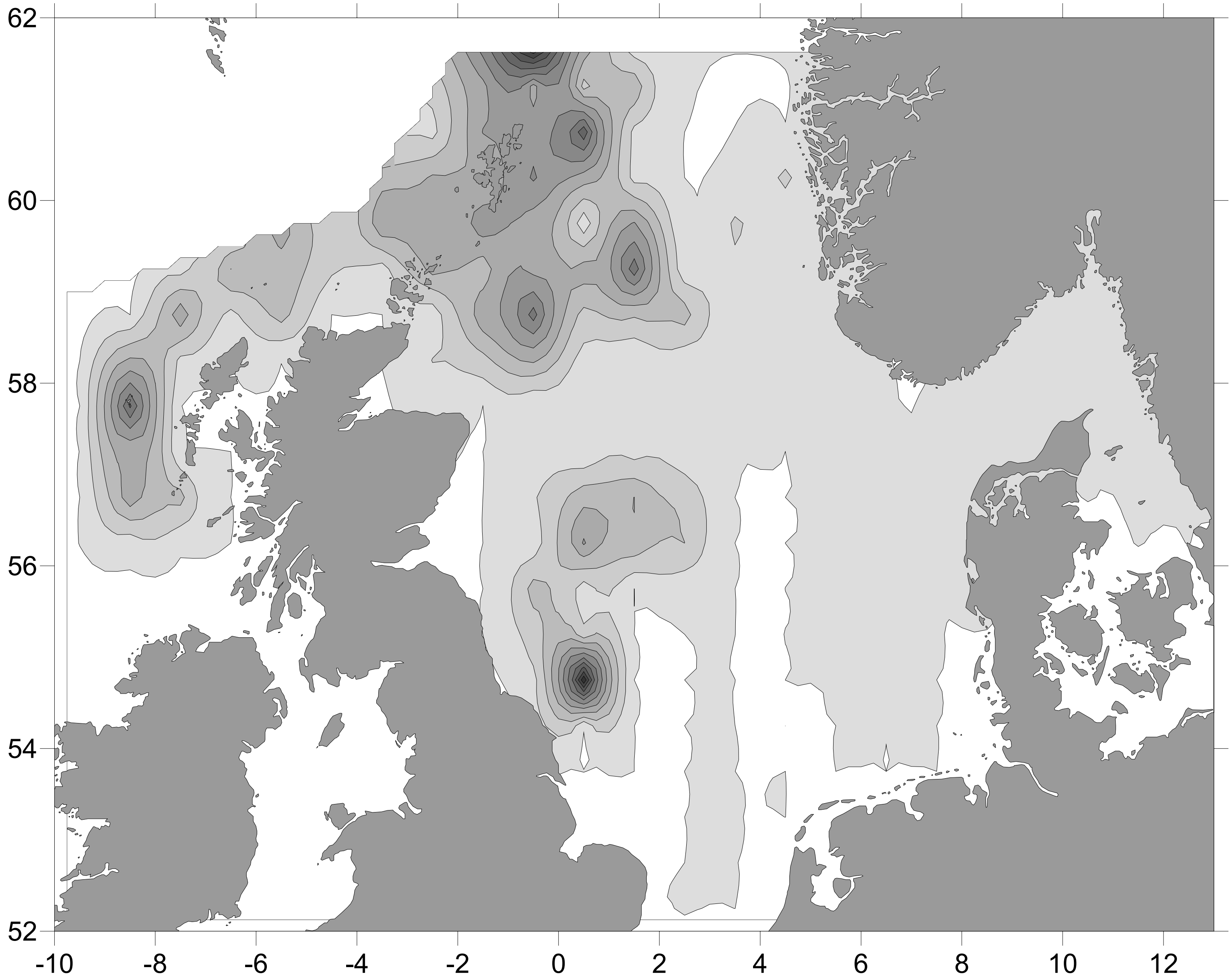


Figure 2.3.1.5 **A**bundance of mature autumn-spawning herring from combined acoustic survey July 2003. Numbers of herring, (dark areas indicate higher density).

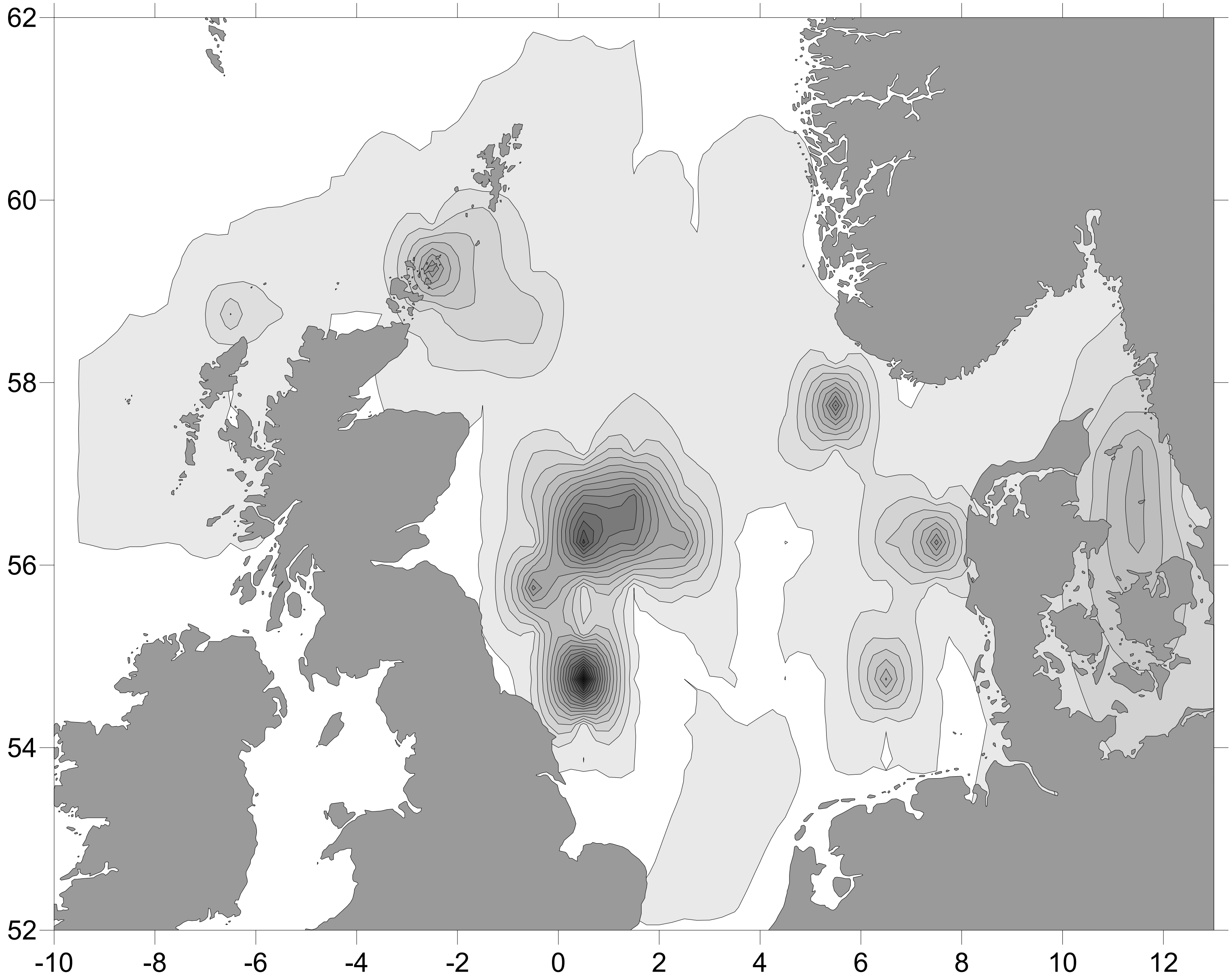


Figure 2.3.1.6 Abundance of immature autumn spawning herring from combined acoustic survey July 2003. Numbers of herring.(dark areas indicate higher density)

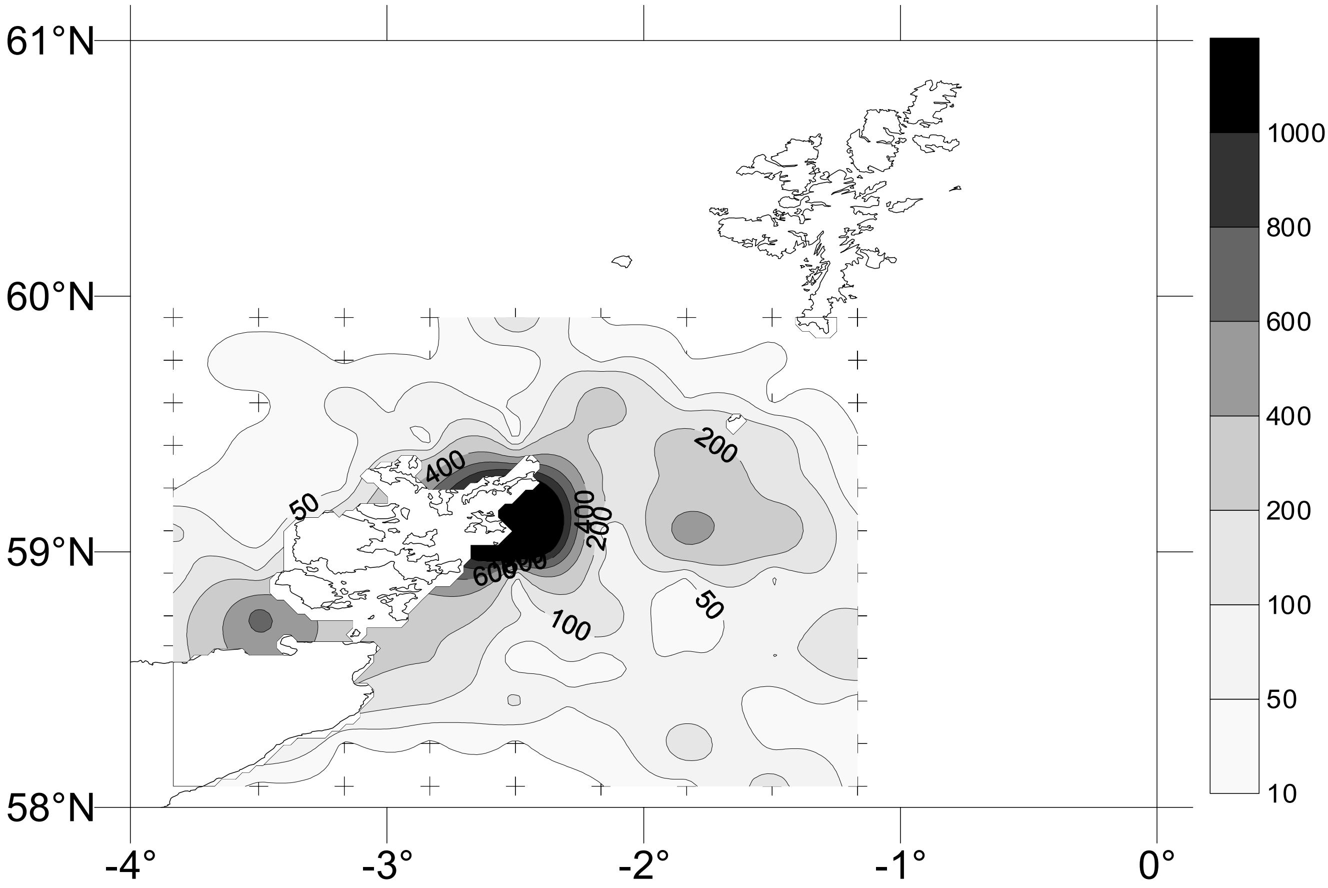


Figure 2.3.2.1 Orkney/Shetlands 16–30 September 2003. Abundance of larvae < 10 mm (n/m²)

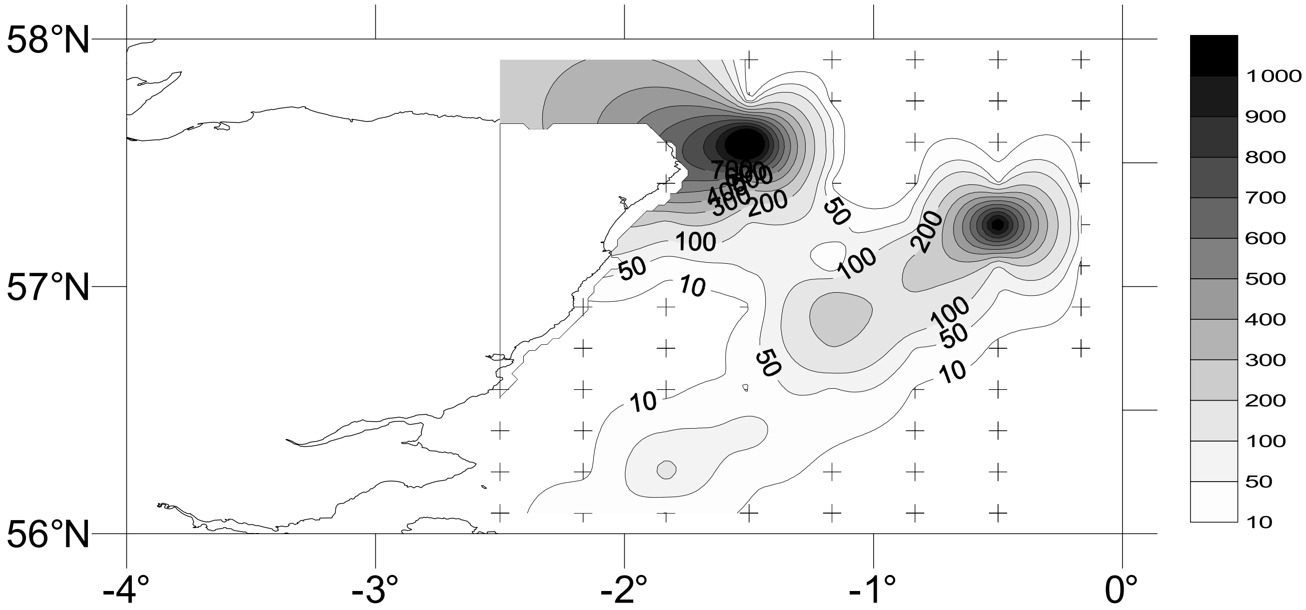


Figure 2.3.2.2 Buchan 16–30 September 2003. Abundance of larvae < 10 mm (n/m²)

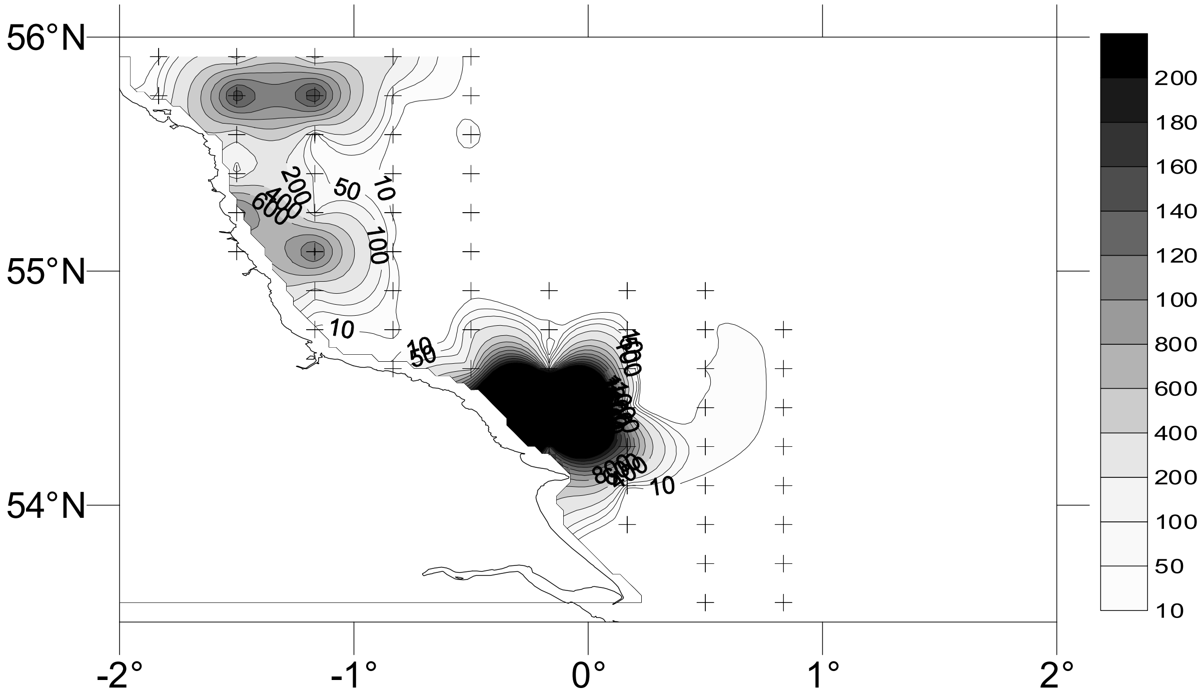


Figure 2.3.2.3 Central North Sea 16-30 September. Abundance of larvae < 10 mm (n/m²)

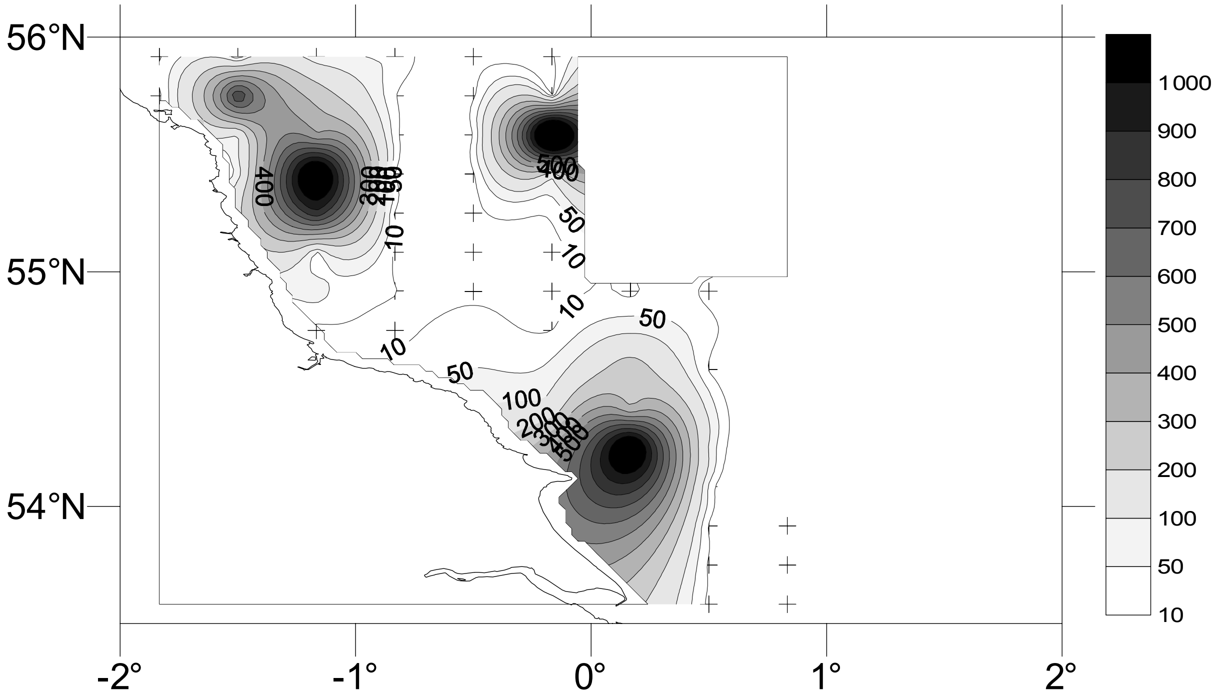


Figure 2.3.2.4 Central North Sea 01-15 October 2003. Abundance of larvae < 10 mm (n/m²)

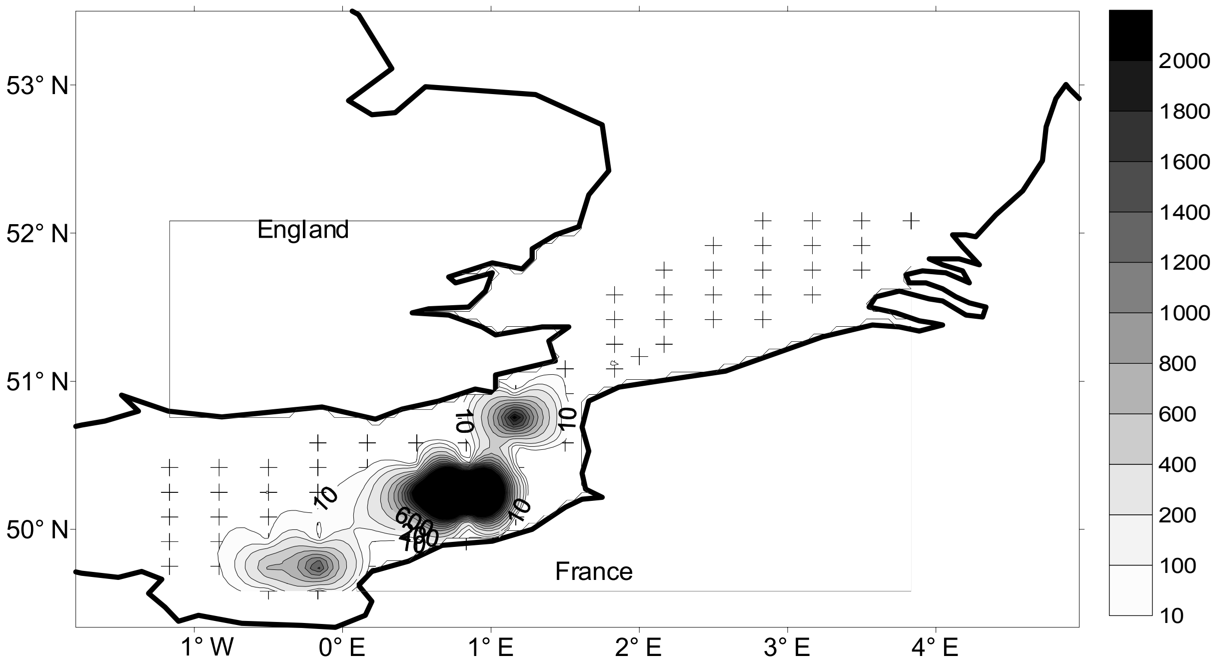


Figure 2.3.2.5 Southern North Sea 16-31 December 2003. Abundance of larvae < 11 mm (n/m²)

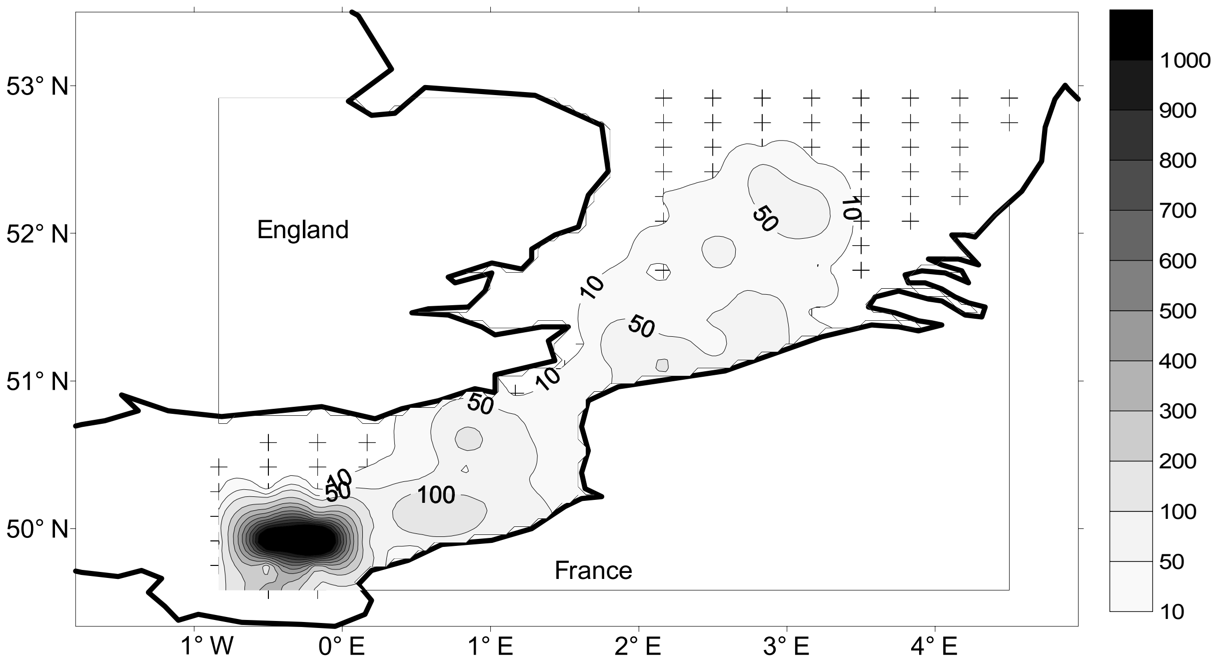


Figure 2.3.2.6 Southern North Sea 1-15 January 2004. Abundance of larvae < 11 mm (n/m²)

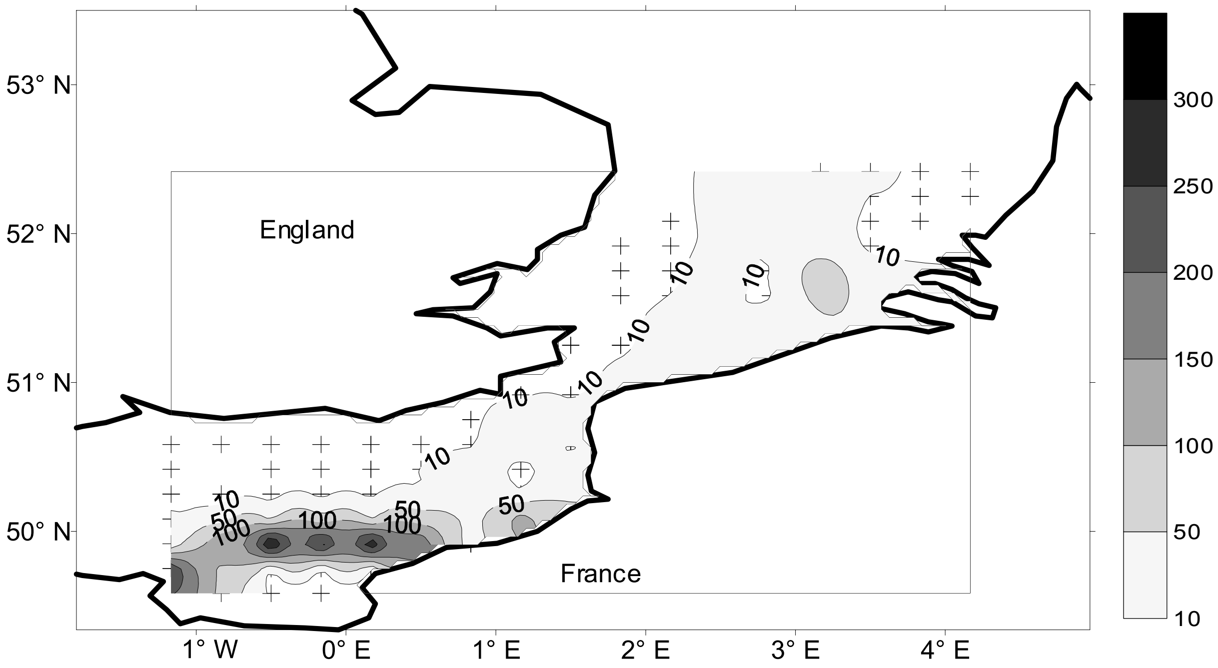


Figure 2.3.2.7 Southern North Sea 16-31 January 2004. Abundance of larvae < 11 mm (n/m²)

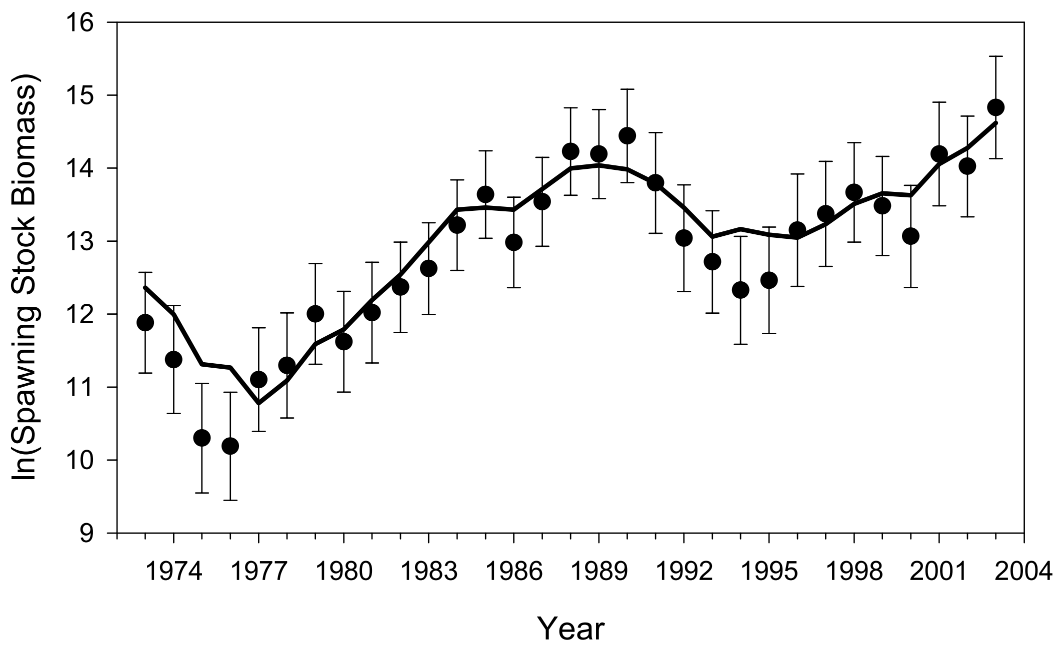


Figure 2.3.2.8 Comparison of spawning stock size estimates from the Herring Assessment Working Group (ICES, 2003; bold line) and the year effects fitted to the larval abundances in the multiplicative model (symbols with error bars). The MLAI estimates have been rescaled to the mean of the WG estimates. Error bars indicate +/- one standard error of larval survey abundance estimates.

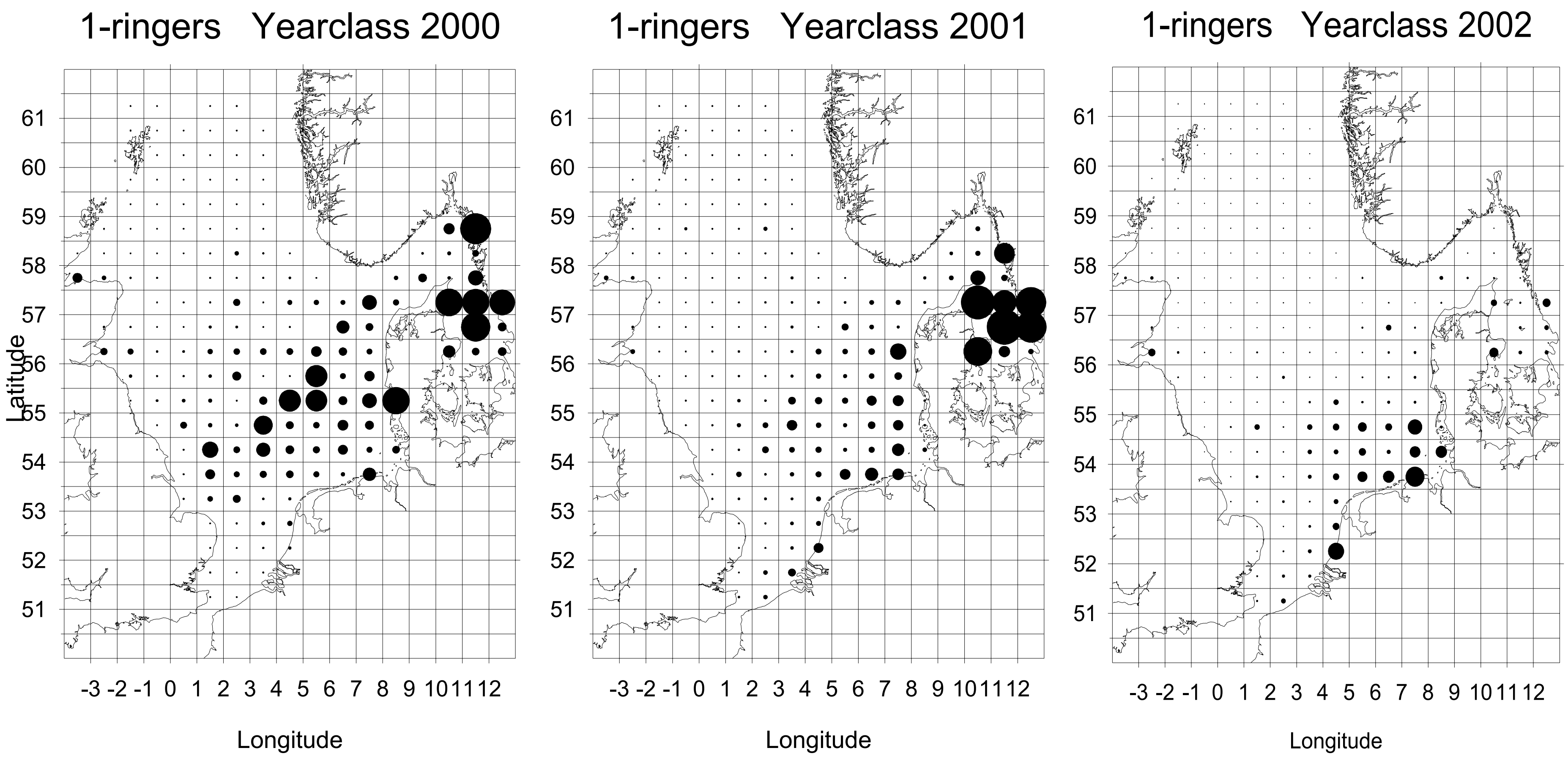


Figure 2.3.3.1 North Sea herring. Distribution of 1-ringer herring, year classes 2000-2002. Abundance estimates of 1-ringers within each statistical rectangle are based on GOV catches during IBTS in February 2002-2004. Areas of filled circles illustrate numbers per hour, the area of a circle extending to the border of a rectangle represents 45000 h^{-1}.

Mean length 1-ringers from IBTS 2004

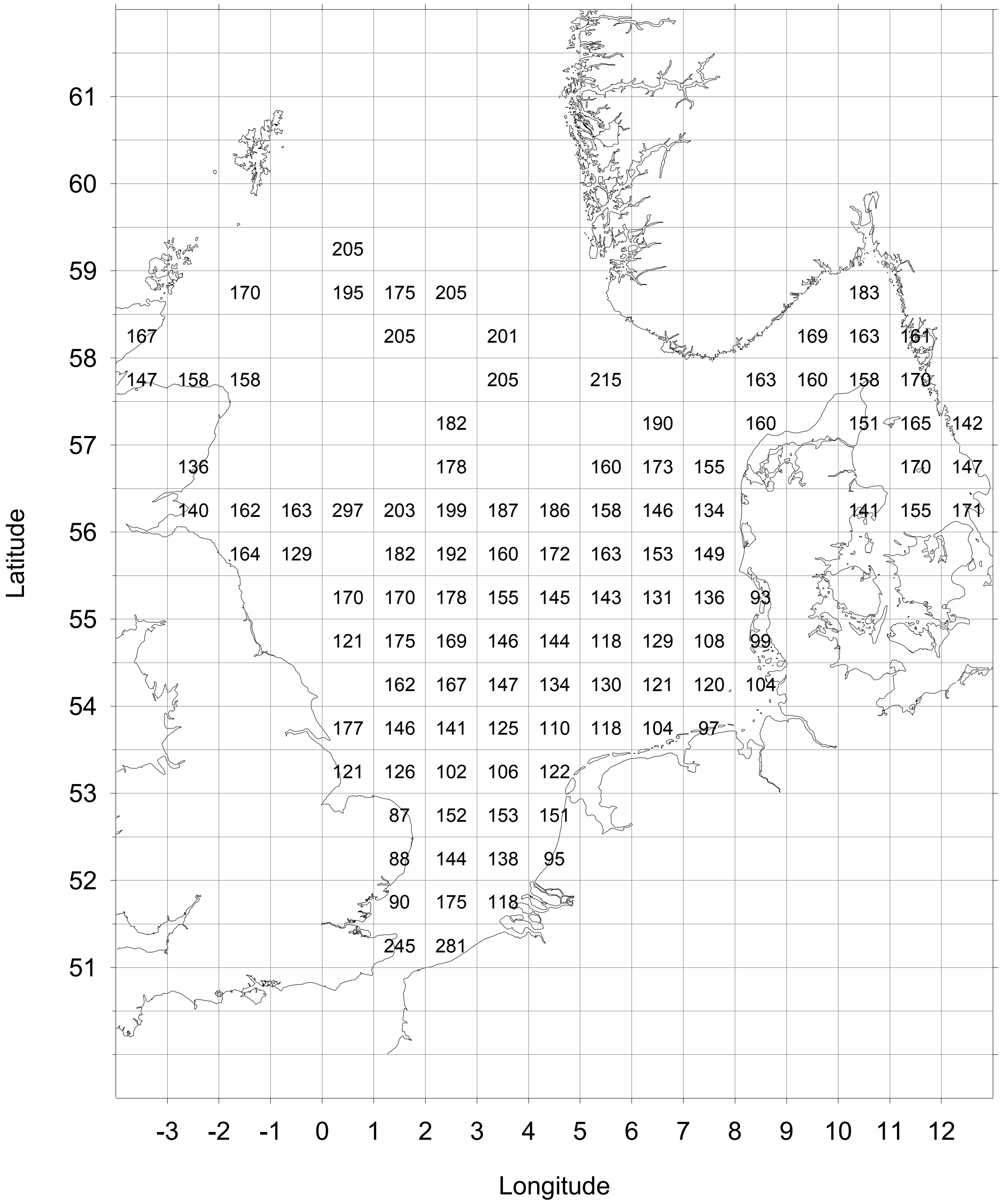


Figure 2.3.3.2 North Sea herring. Mean length (mm) within rectangle of 1-ringer herring caught during the IBTS 1st Quarter 2004.

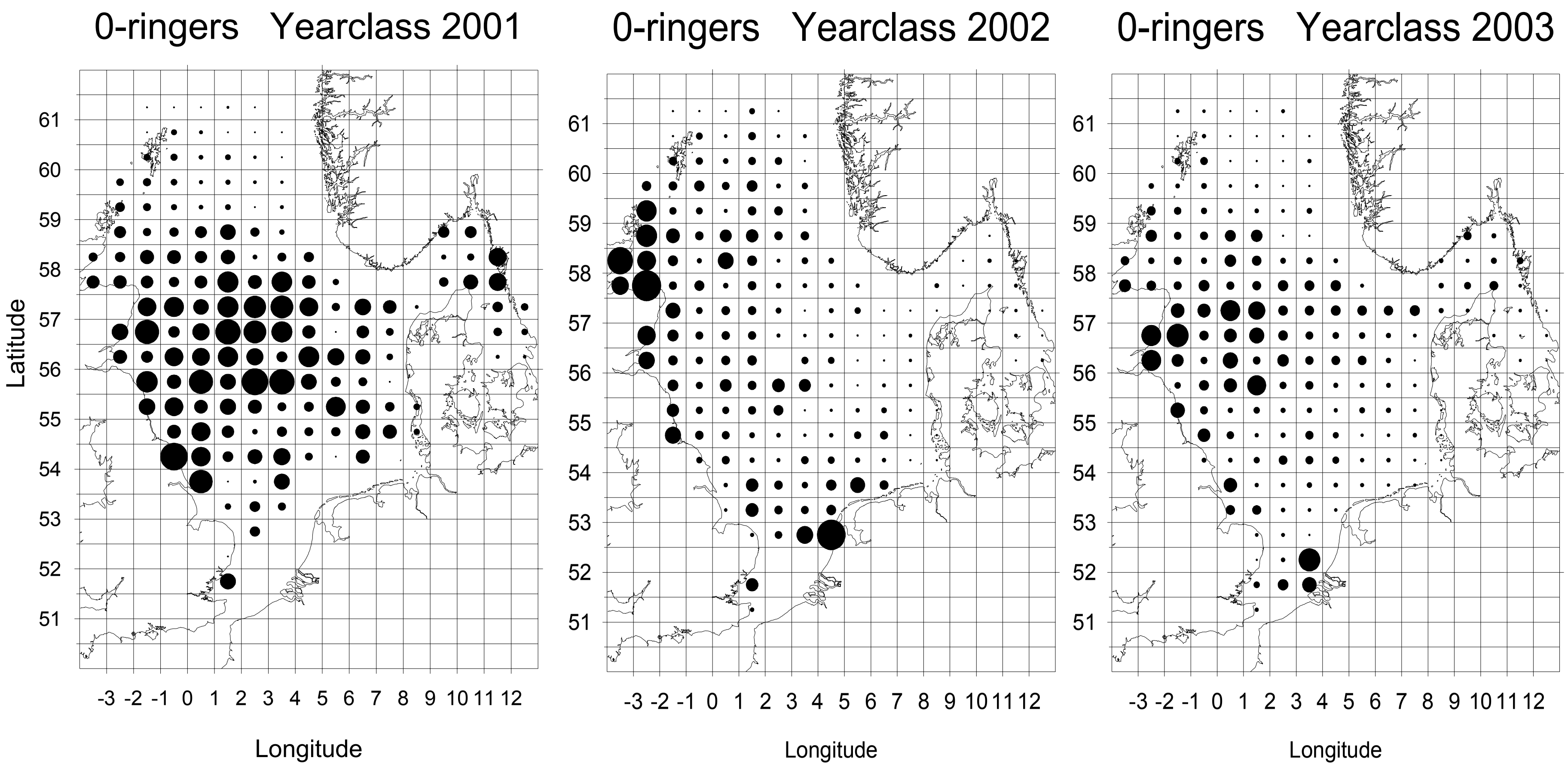


Figure 2.3.3.3 North Sea herring. Distribution of 0-ringer herring, year classes 2001-2003. Abundance estimates of 0-ringers within each statistical rectangle are based on MIK catches during IBTS in February 2002-2004. Areas of filled circles illustrate densities in no m^{-2}, the area of a circle extending to the border of a rectangle represents 1 m^{-2}

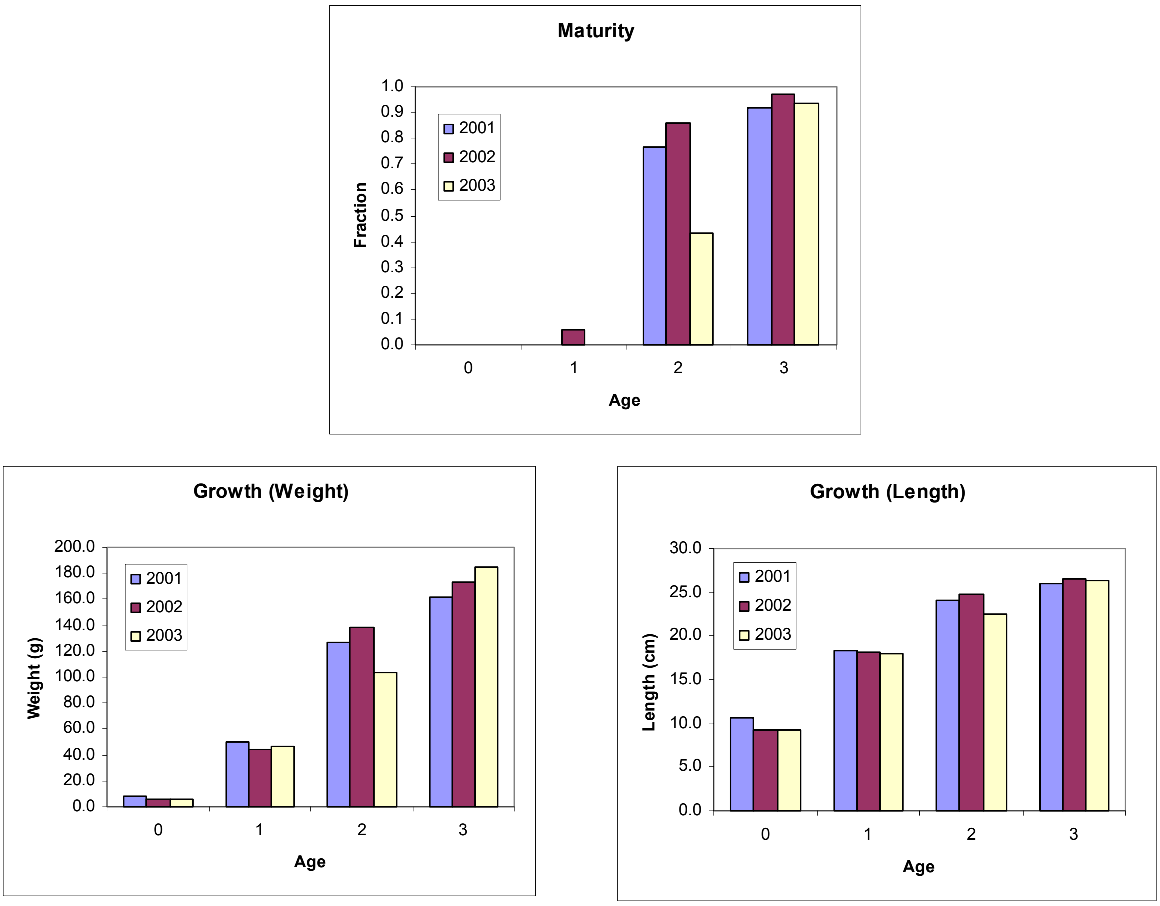


Figure 2.4.2.1 Development of North Sea herring. Mean length and weight and fraction mature at age from the acoustic survey. The 2000 year class (age 2-ringer in 2003) has lower mean length, mean weight and fraction mature.

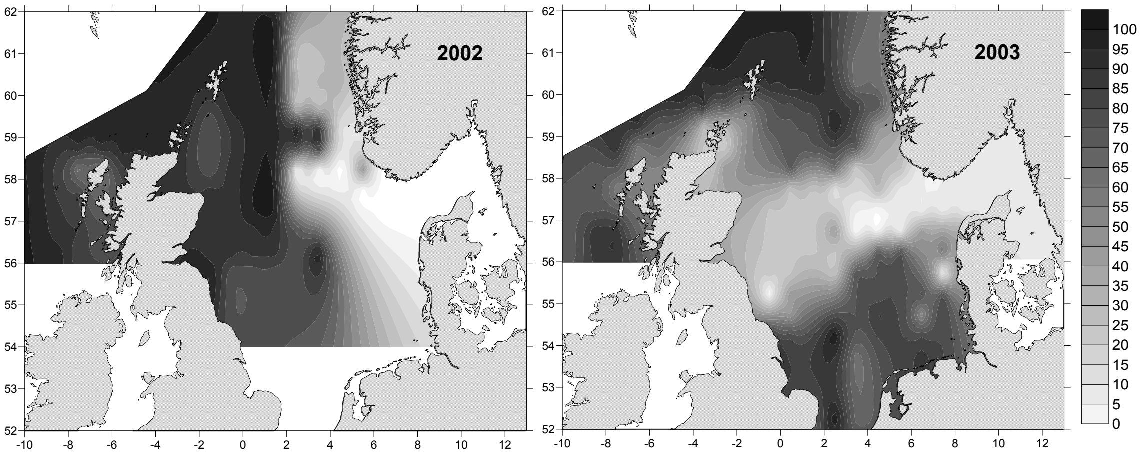


Figure 2.4.2.2 Fraction mature 2-ring North Sea herring in 2003 (left) and 2002 (right). Both low maturity in the Skagerrak and Kattegat with higher proportions North and west of Scotland. In 2003 there is a large area with low fractions mature in the east central North Sea. The low maturity area is covered by 3 vessels.

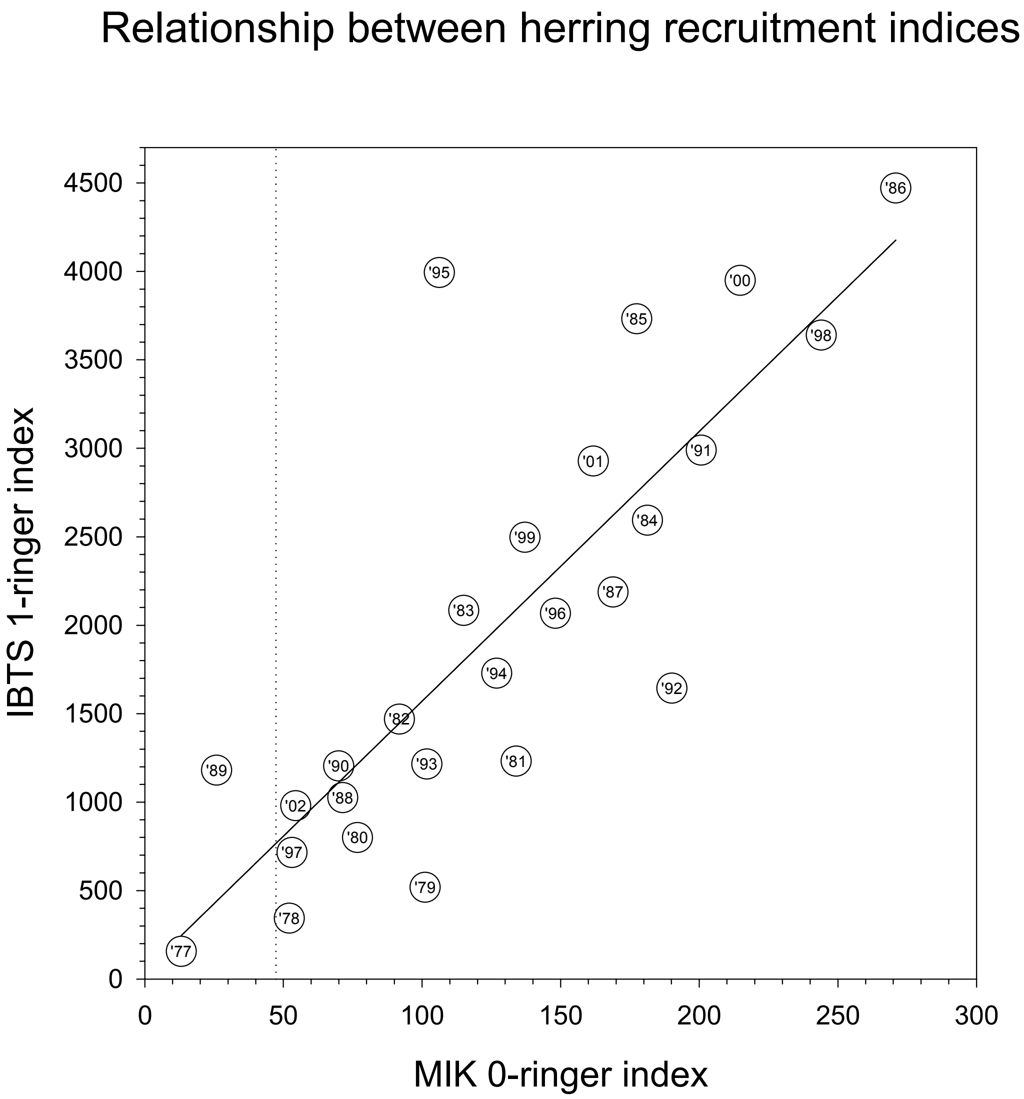


Figure 2.5.1 North Sea herring. Regression between the MIK 0-ringer index and the IBTS 1-ringer indices for year classes 1977 to 2002. Numbers in symbols indicate year class. Dotted vertical line indicates the position of the present MIK index of the 2003 year class.

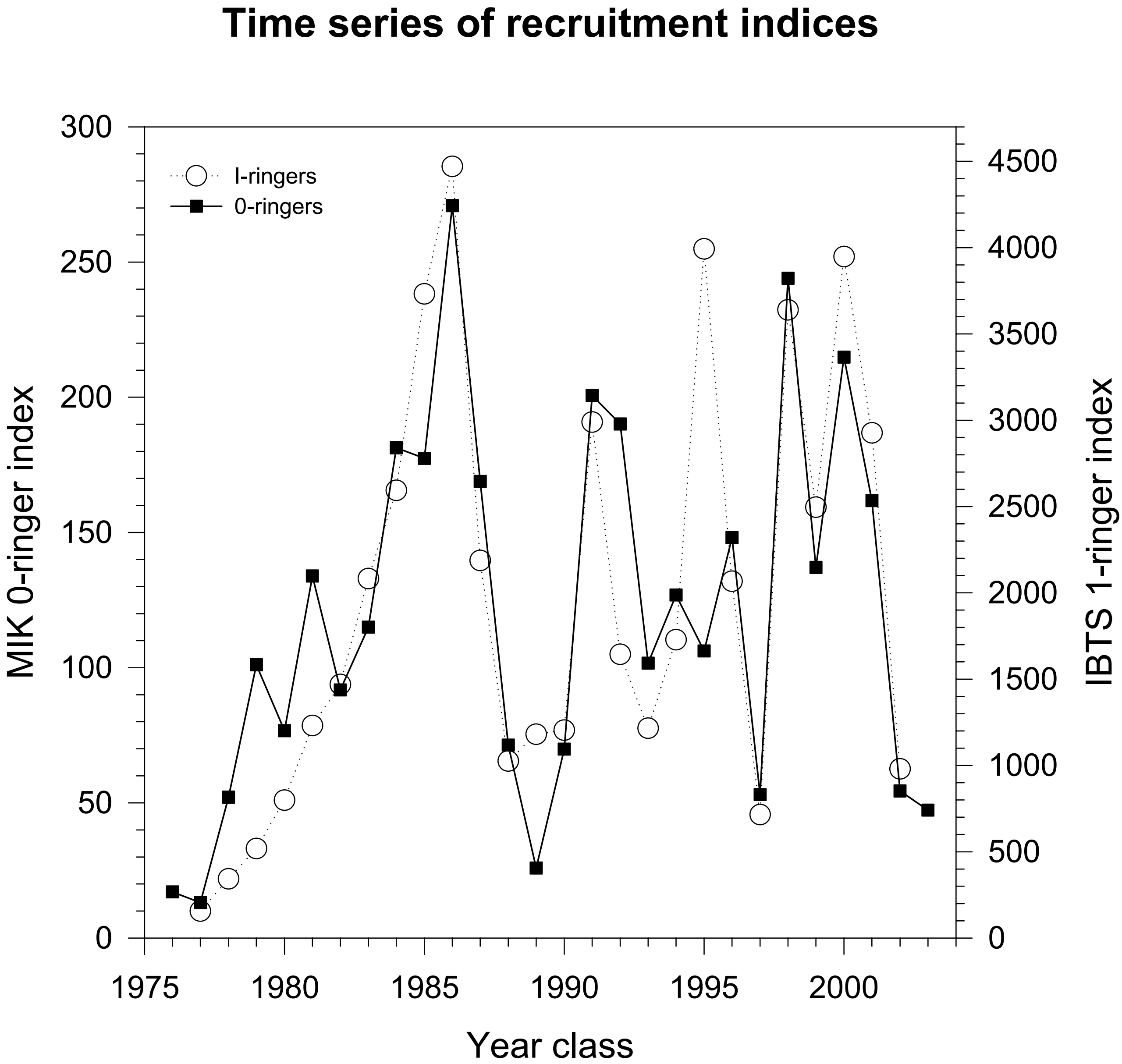


Figure 2.5.2 North Sea herring. Time-series of recruitment indices based on catches of either 0-ringers or 1-ringers during the IBTS. Year class 1976 to 2003 (0-ringers) or 1977 to 2002 (1-ringers).

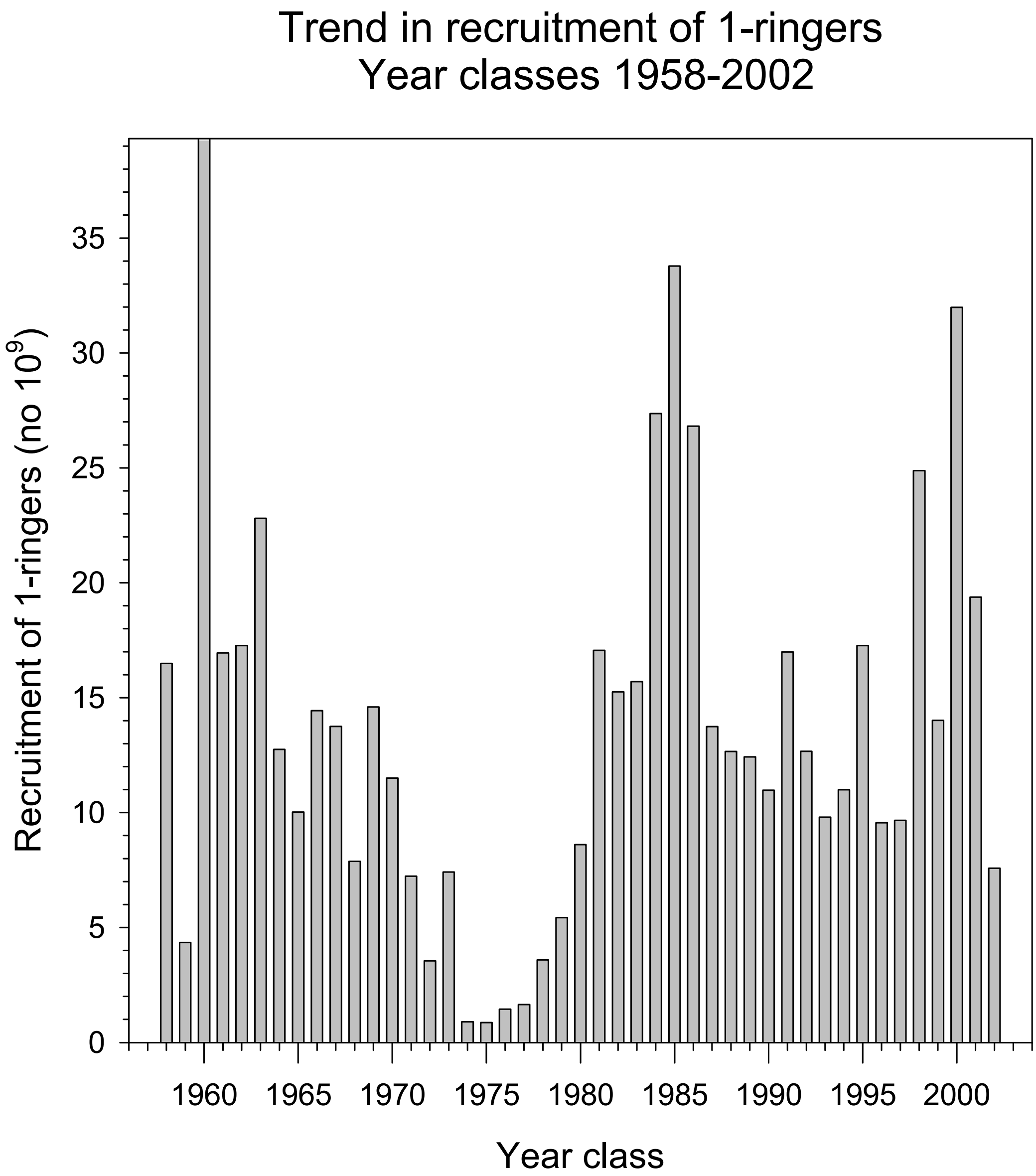
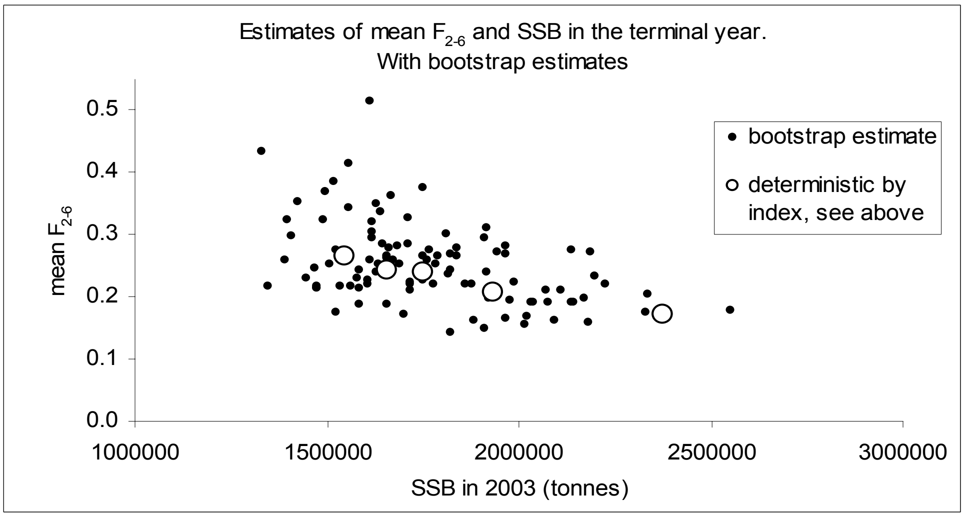
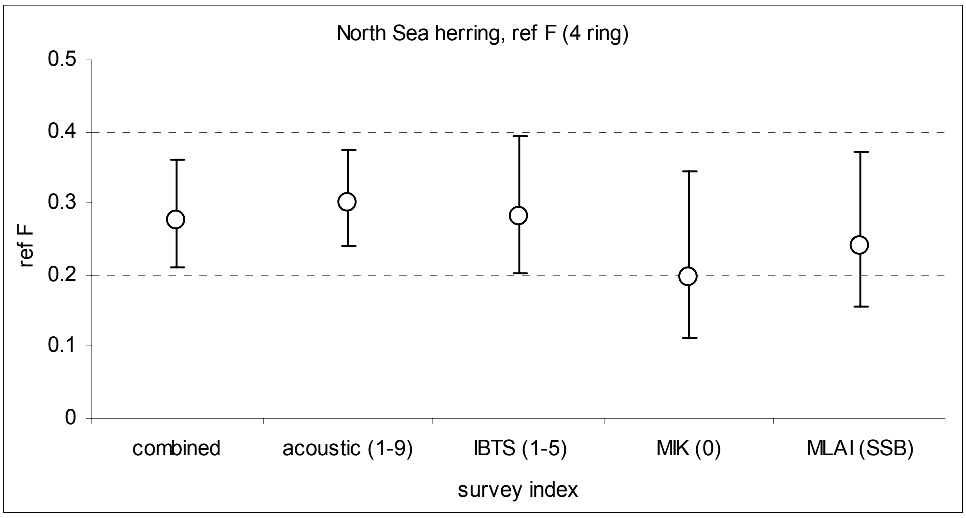


Figure 2.5.3 North Sea herring. Trend in recruitment of 1-ringers from year class 1958 to 2002. Data from the 2004 ICA assessment of the North Sea autumn spawned herring.

a



b



c

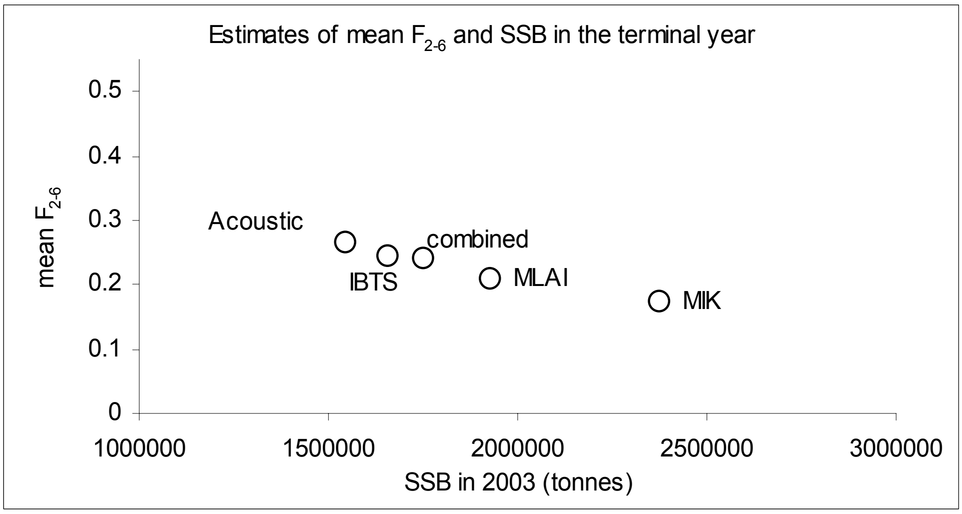
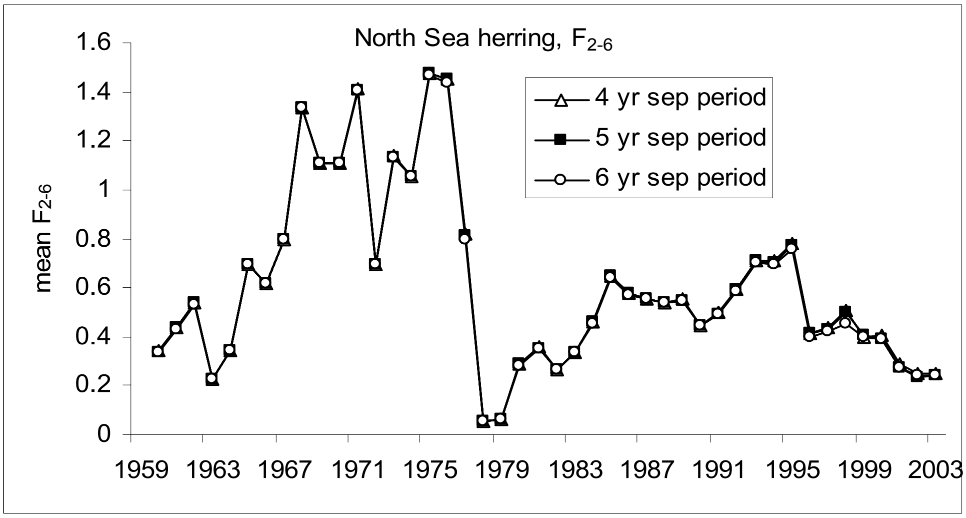
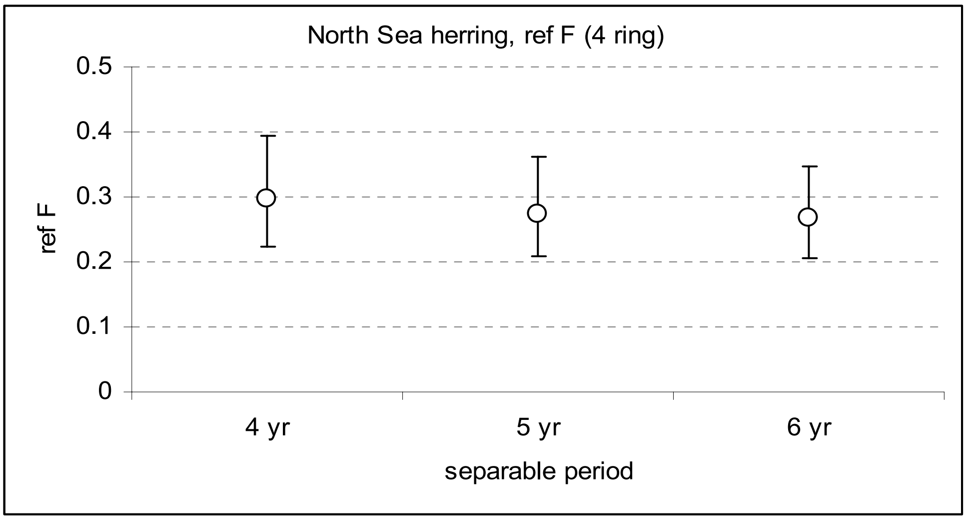


Figure 2.6.1.1 North Sea herring. Comparison of reference F (4 ring) and the relation between mean F and SSB using herring tuning indices (Acoustic 1-9+ ring indices, IBTS 1-5+ ring indices, MIK index and MLAI SSB index) one at the time in the ICA assessment model. The assessment using all indices combined is included for comparison. All other data and model settings used in the same manner as in last year's final assessment. Error bars in the top figure show 90% confidence limits. For the bootstrap estimates 100 bootstrap runs were used.

b



a



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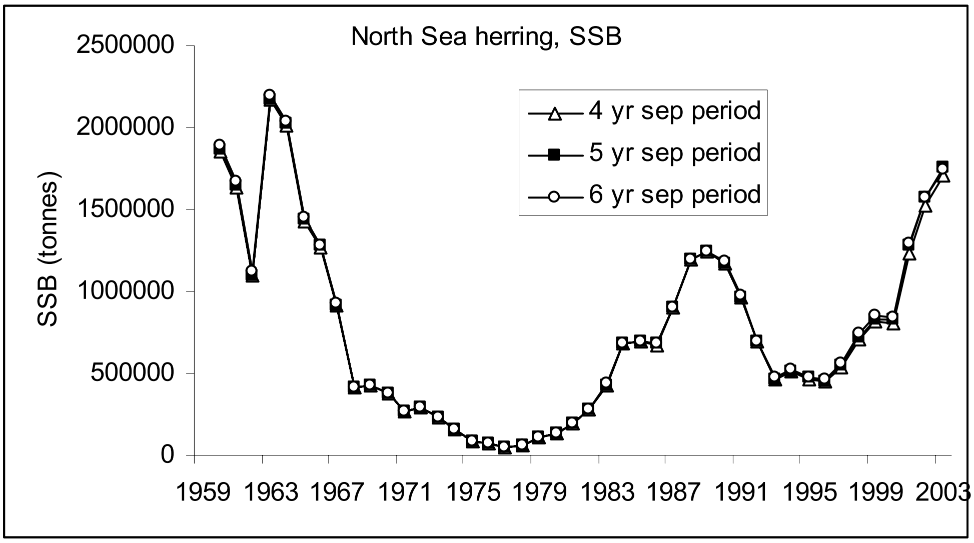
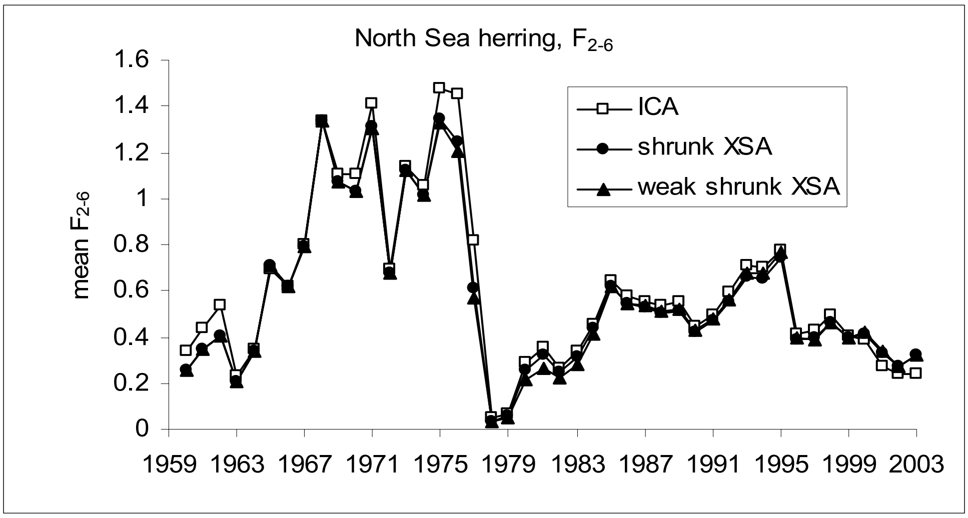


c

Figure 2.6.1.2 North Sea herring. Comparison of results of ICA model fits of North Sea herring, using a separable period over 4, 5 and 6 years. Error bars in the top figure show 90% confidence limits.

a



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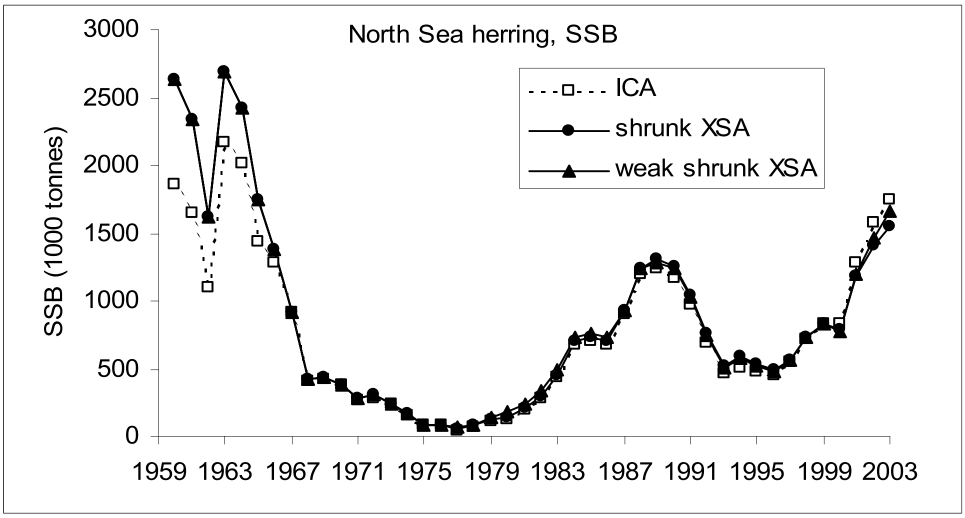


Figure 2.6.1.3 North Sea herring. Comparison of results of ICA and XSA model for North Sea herring, 1960-2003. ICA settings of last years assessment (Section 2.6.2), shrunk XSA=0.5, weak shrunk XSA=2.0 (Table 2.6.1.3).

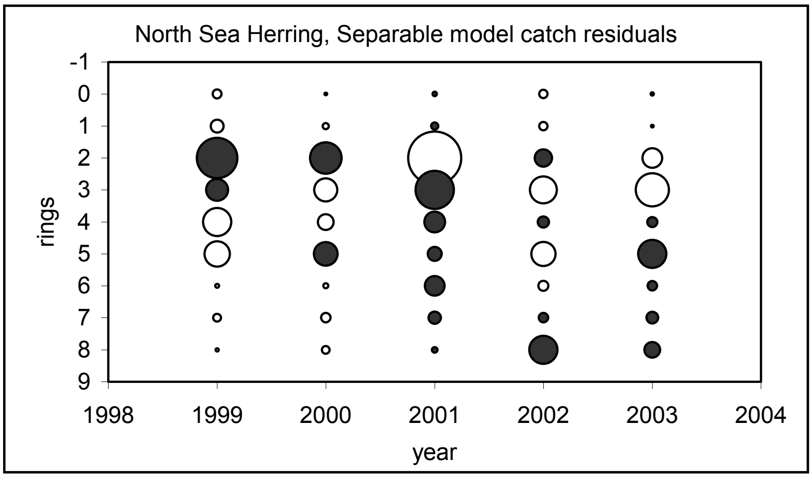


Figure 2.6.1.4 North Sea herring. Bubble plot of catch residuals of ICA separable model (corrected by weights for each age 1999-2003). Maximum bubble = 0.8, scale is linear. Dark bubbles represent values greater than 0, white bubbles less then 0.

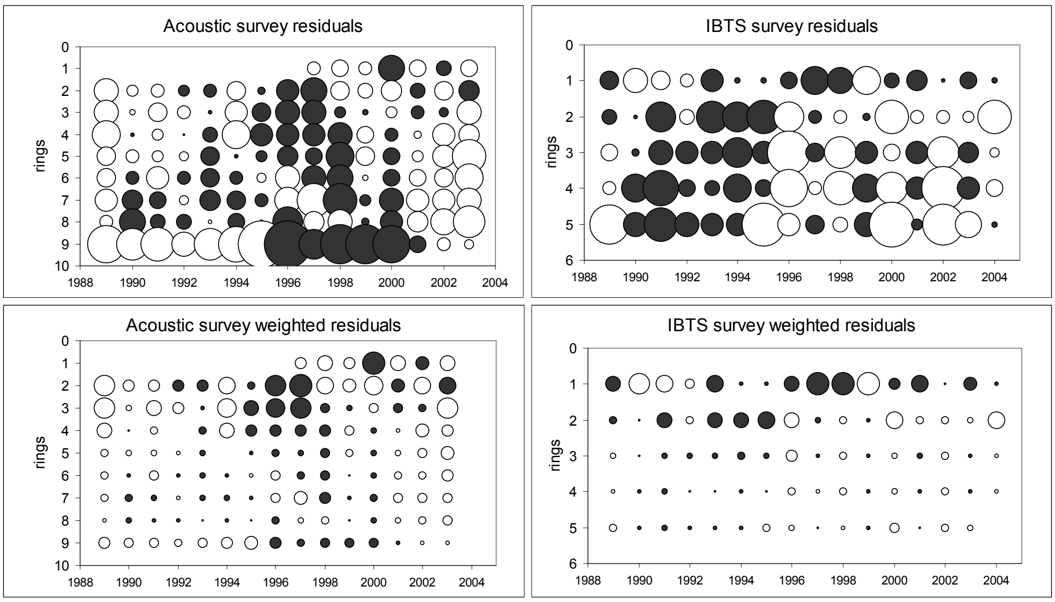


Figure 2.6.1.5 North Sea herring. Bubble plot of survey residuals of ICA separable model (corrected by weights for each age 1989-2003), acoustic survey and IBTS. Unweighted and weighted values are shown. Maximum bubble = 1.5, scale is linear. Dark bubbles represent values greater than 0, white bubbles less then 0.

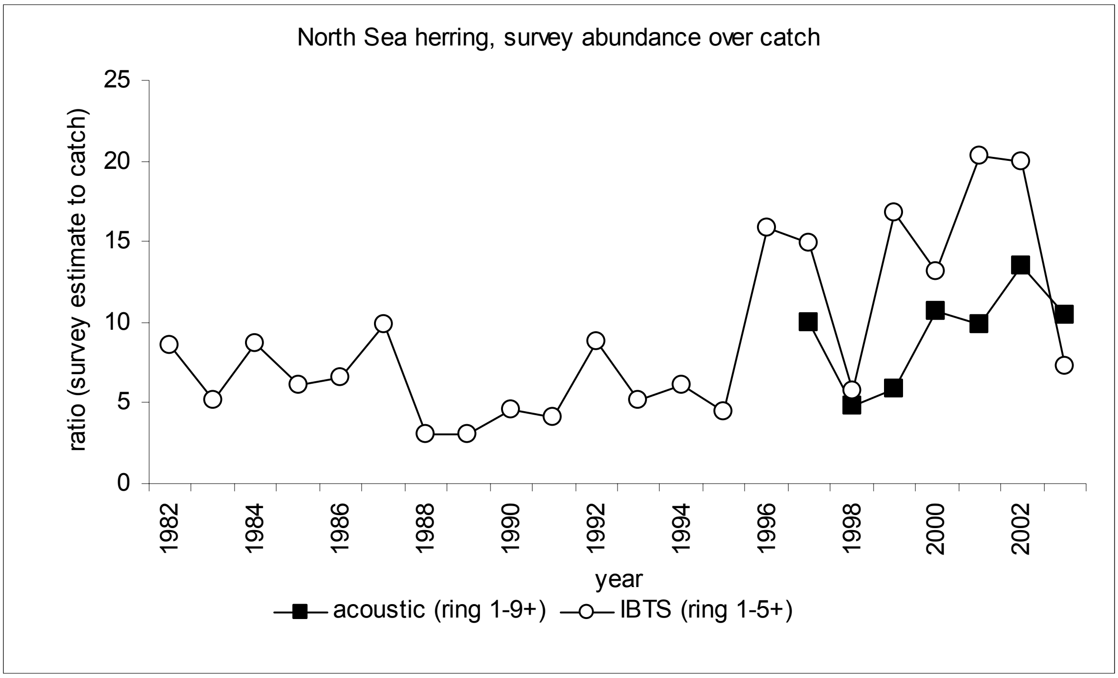


Figure 2.6.1.6 North Sea herring. Ratio of the yield in the Acoustic (1-9+ ring) and the IBTS (1-5+ ring) indices to the total catch.

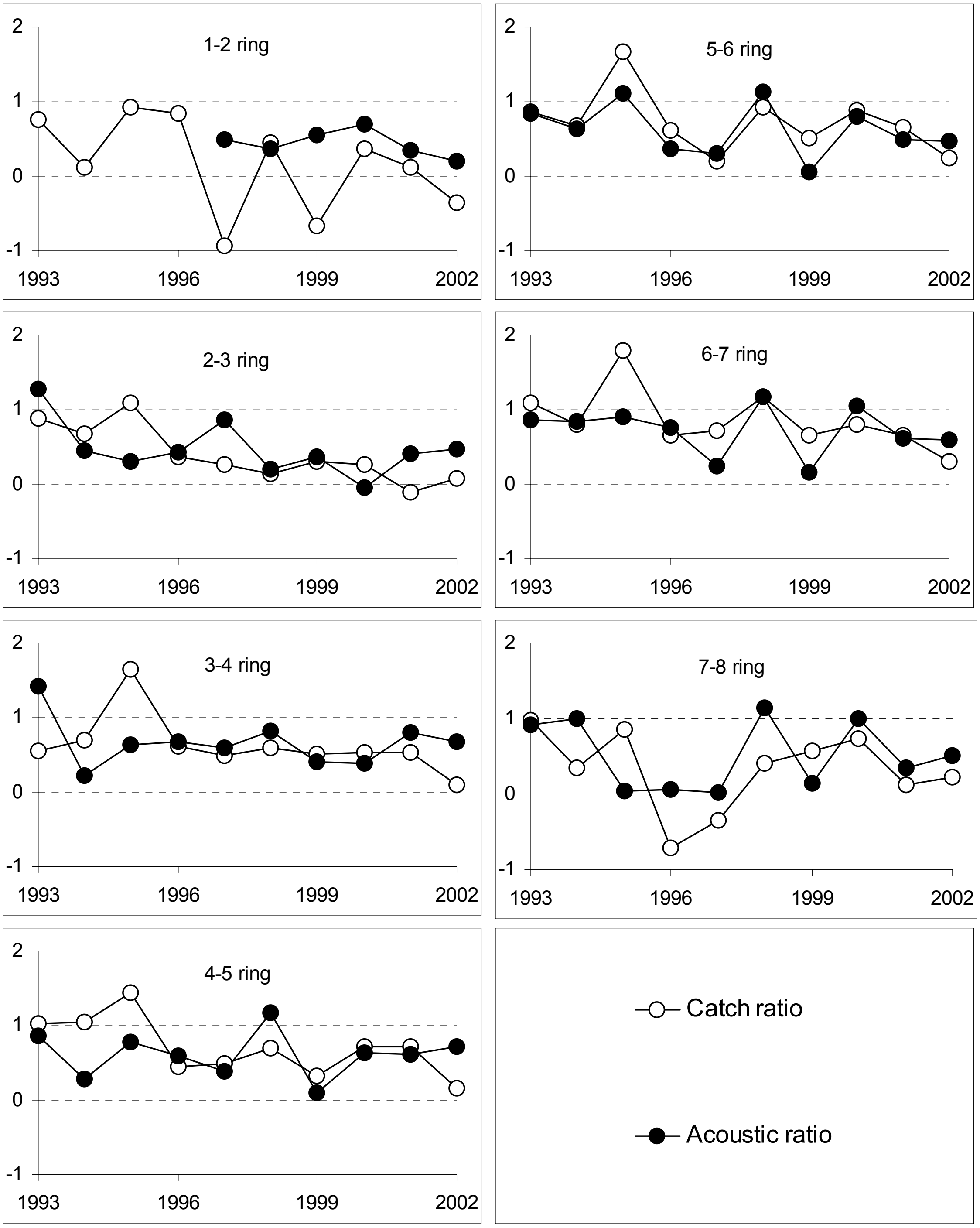


Figure 2.6.1.7 North Sea herring. Log ratios for the catch data and the Acoustic survey indices along cohort.

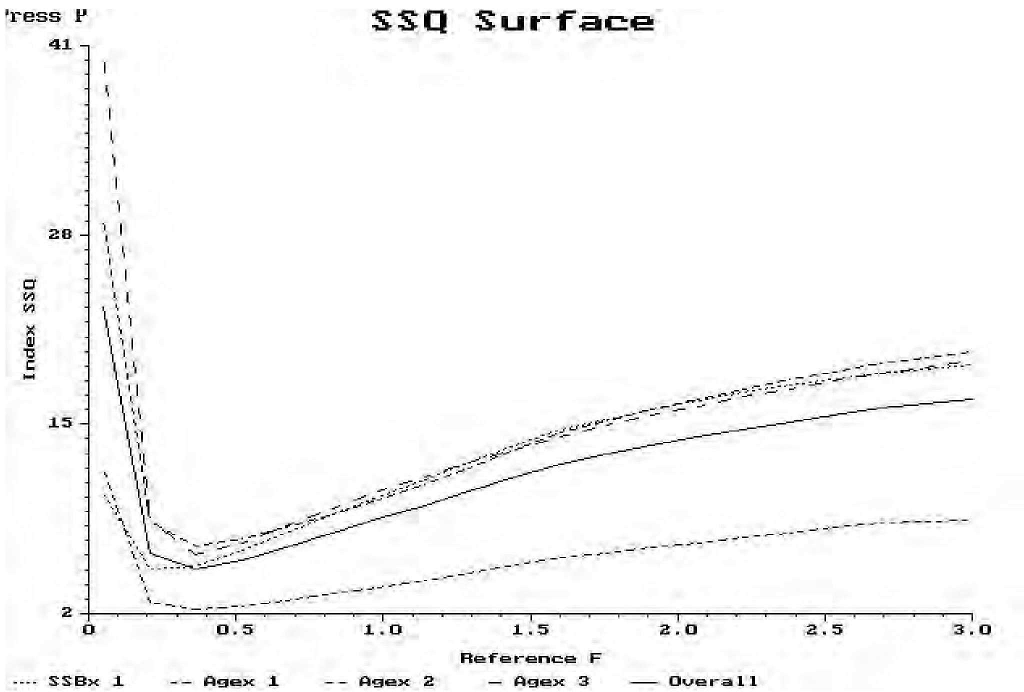


Figure 2.6.2.1 North Sea herring. SSQ surface for the deterministic calculation of the 5-year separable period. SSBx1 – MLAI larvae survey, Agex1- age disaggregated acoustic estimates, Agex2 – age disaggregated IBTS estimates, Agex3 – age disaggregated MIK net estimates

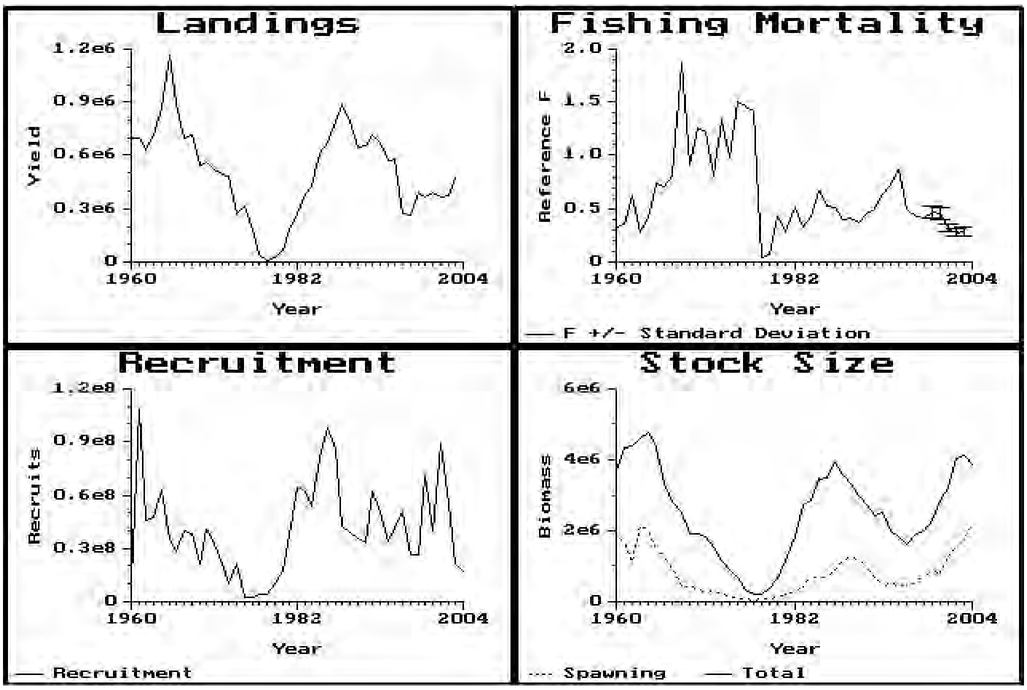


Figure 2.6.2.2 North Sea herring. Illustration of stock trends from deterministic calculation (5-year separable period). Summary of estimates of landings, fishing mortality at 4-ring, recruitment at 1-ring, stock size on 1 January and spawning stock at spawning time (solid line=total biomass, dotted line=SSB).

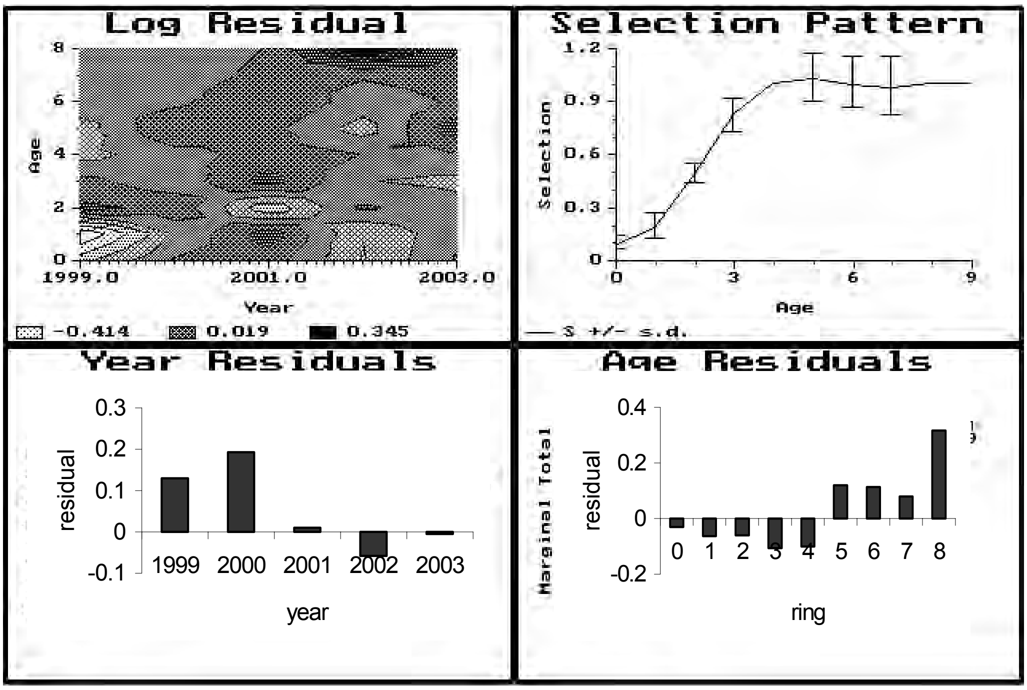


Figure 2.6.2.3. North Sea herring. Illustration of selection patterns diagnostics, from deterministic calculation (5-year separable period). Top left, a contour plot of selection pattern residuals. Top right, estimated selection (relative to 4-ringers) +/- standard deviation. Bottom, marginal totals of residuals by year and ring (with weights applied).

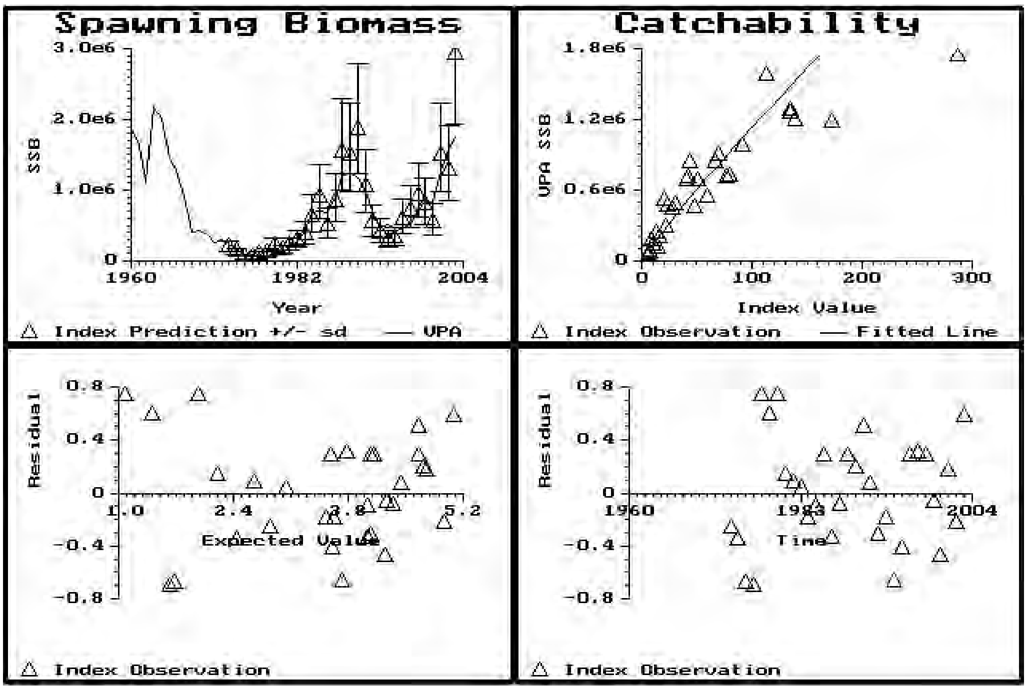


Figure 2.6.2.4. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the **predicted SSB** against the **SSB MLAI survey**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations 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.

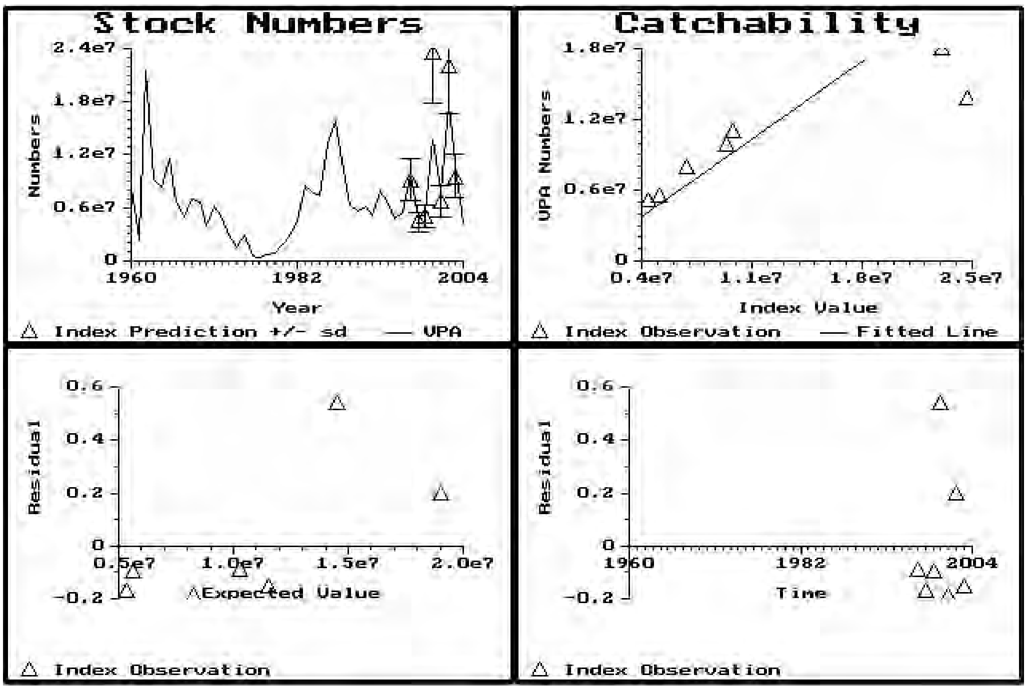


Figure 2.6.2.5**.** North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the **1-ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index 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.

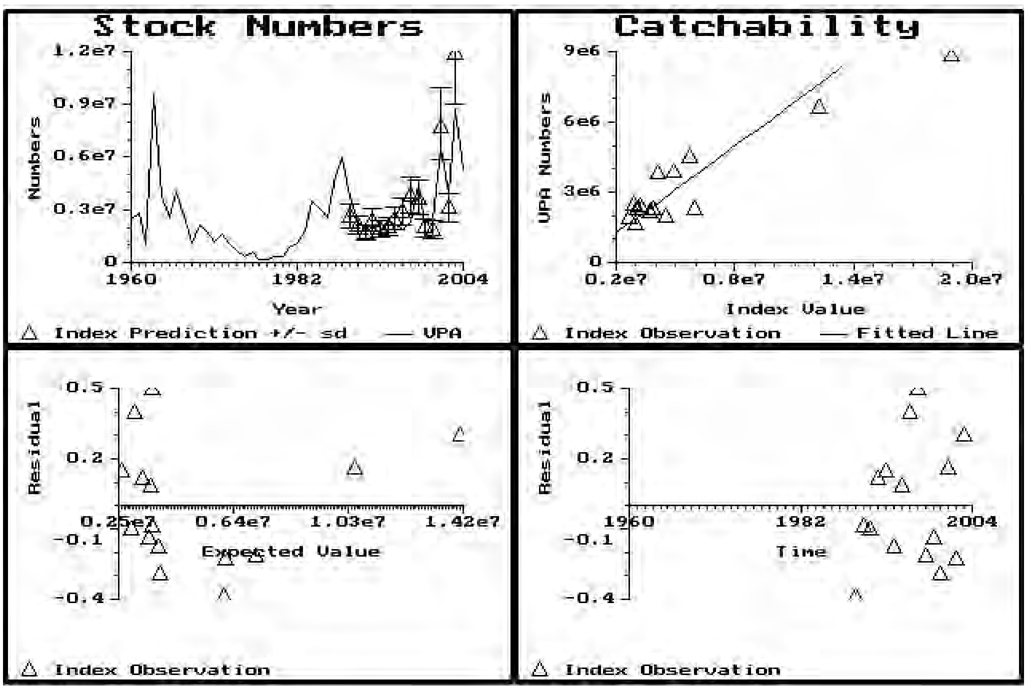


Figure 2.6.2.6**.** North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the **2-ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index 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.

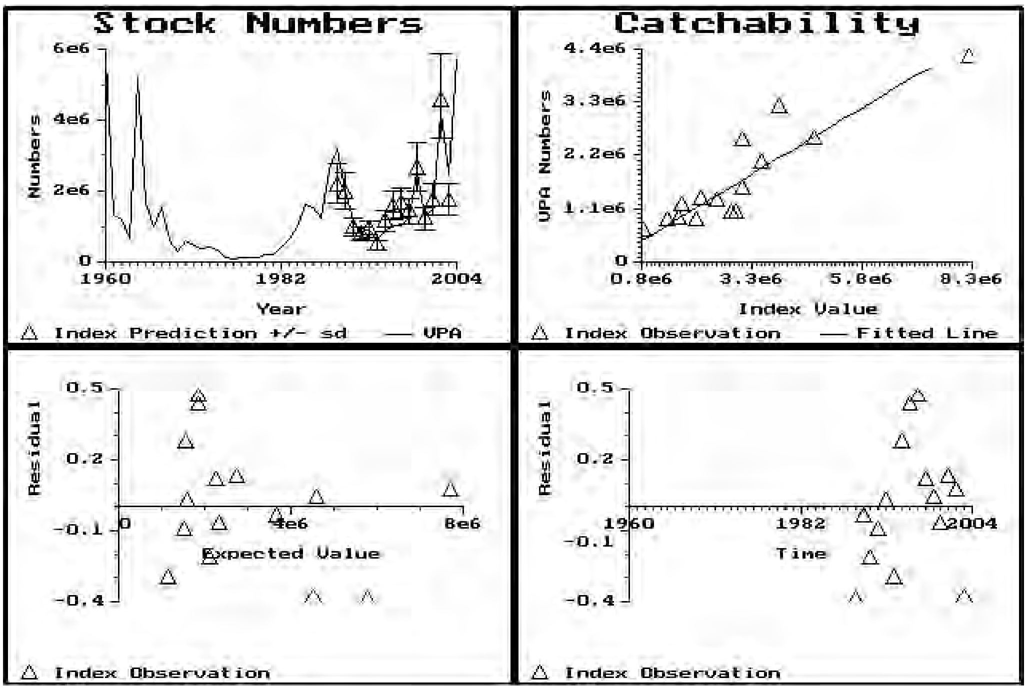


Figure 2.6.2.7 North Sea herring.. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the **3-ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 4-ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

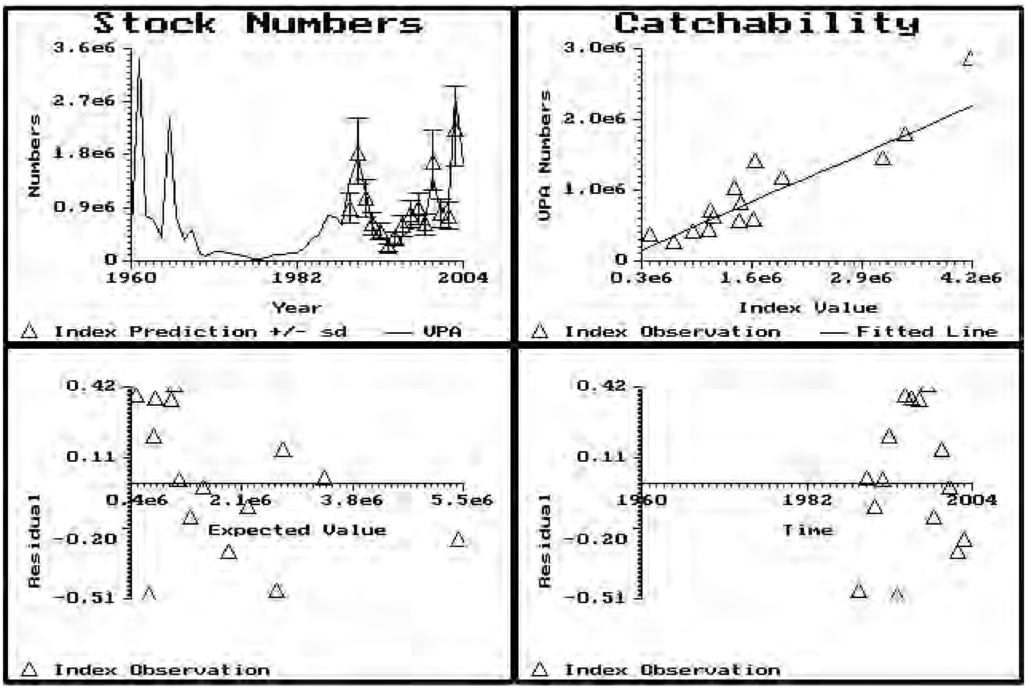


Figure 2.6.2.8 North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the **4 ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations 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.

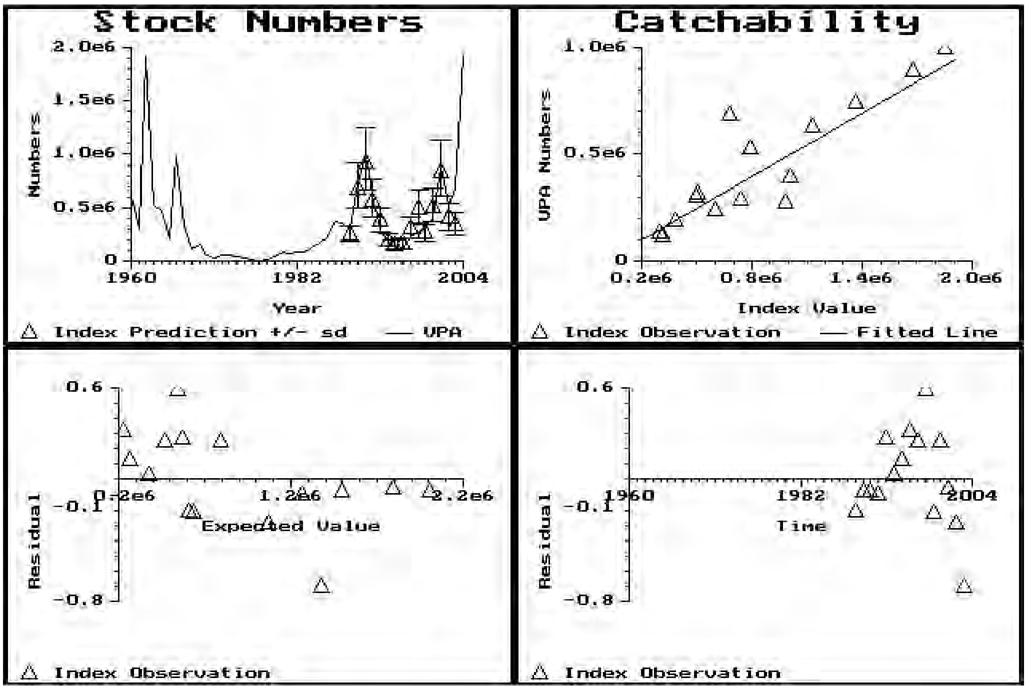


Figure 2.6.2.9 North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the **5 ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 6 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

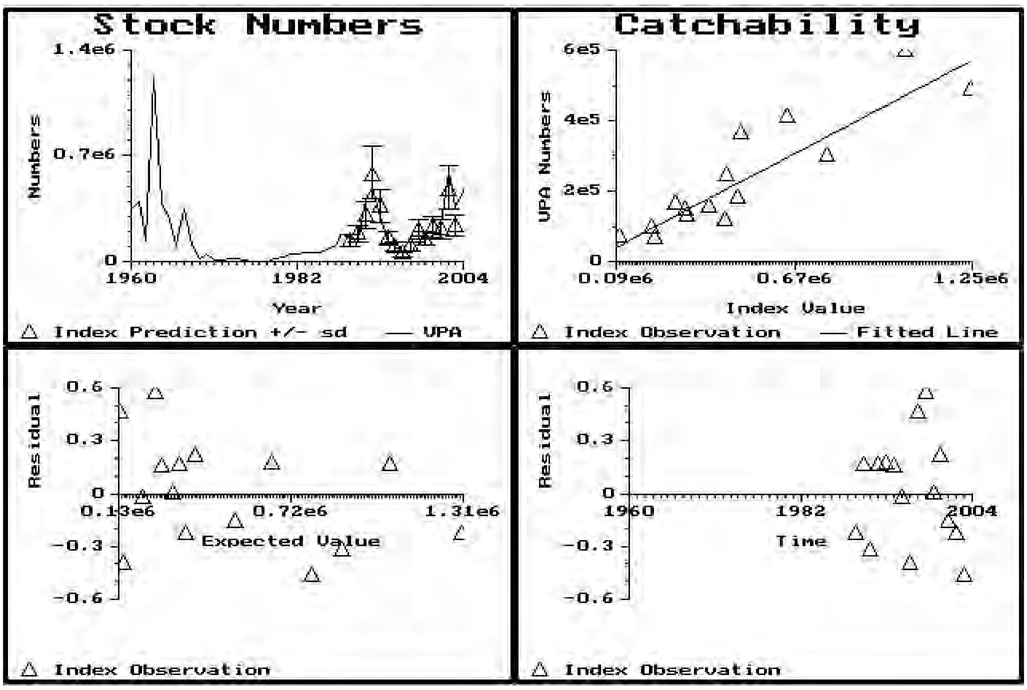


Figure 2.6.2.10 North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the **6 ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 7 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

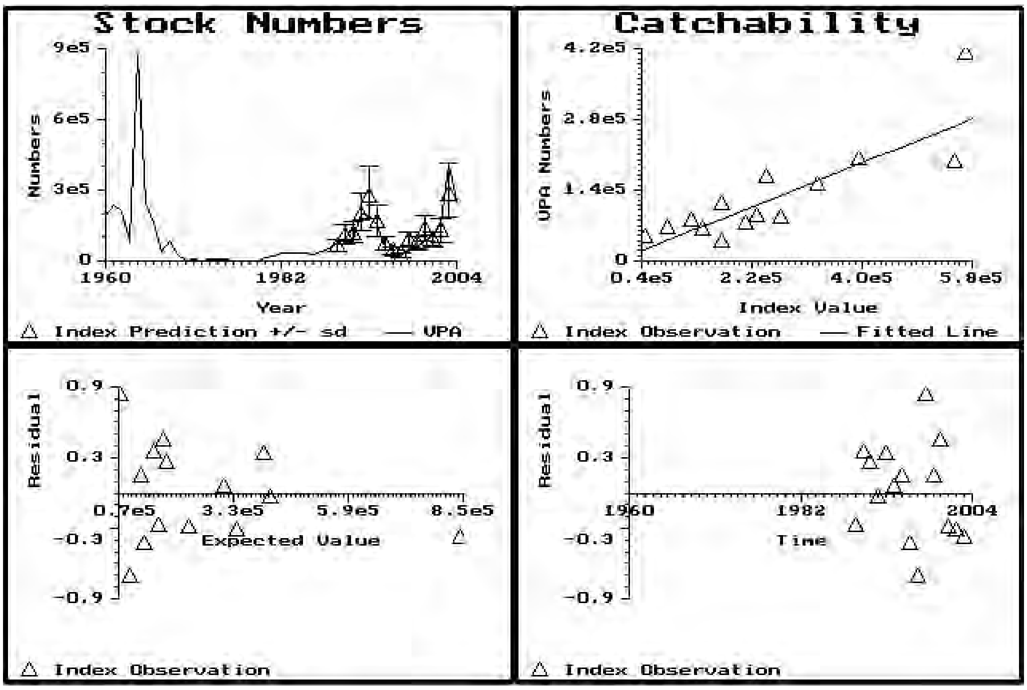


Figure 2.6.2.11 North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the **7 ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 8 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

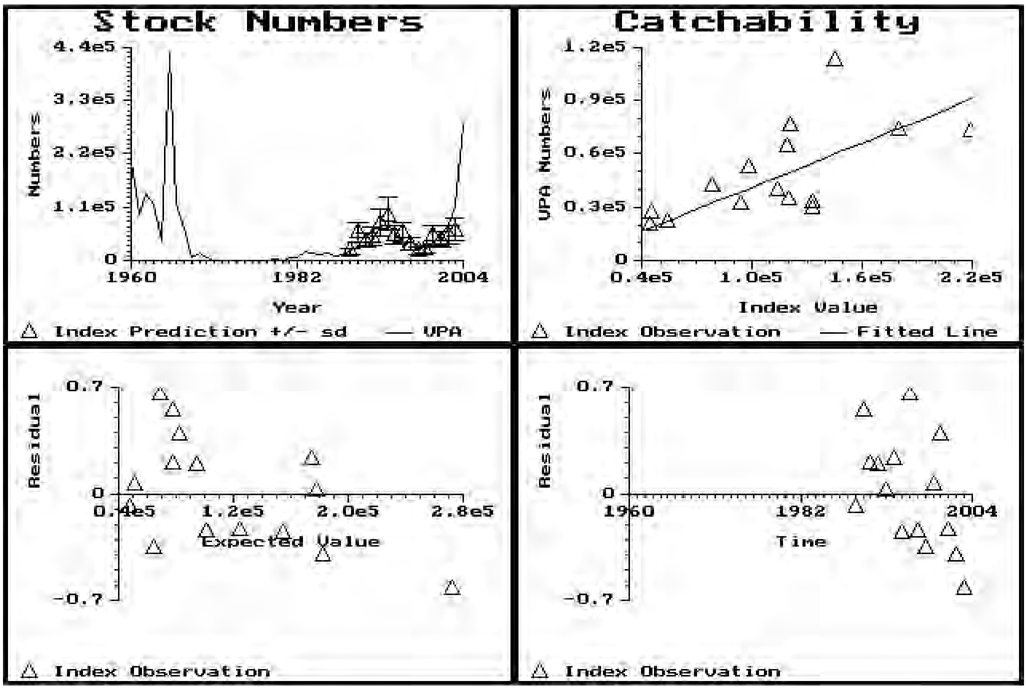


Figure 2.6.2.12 North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the **8 ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 9 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

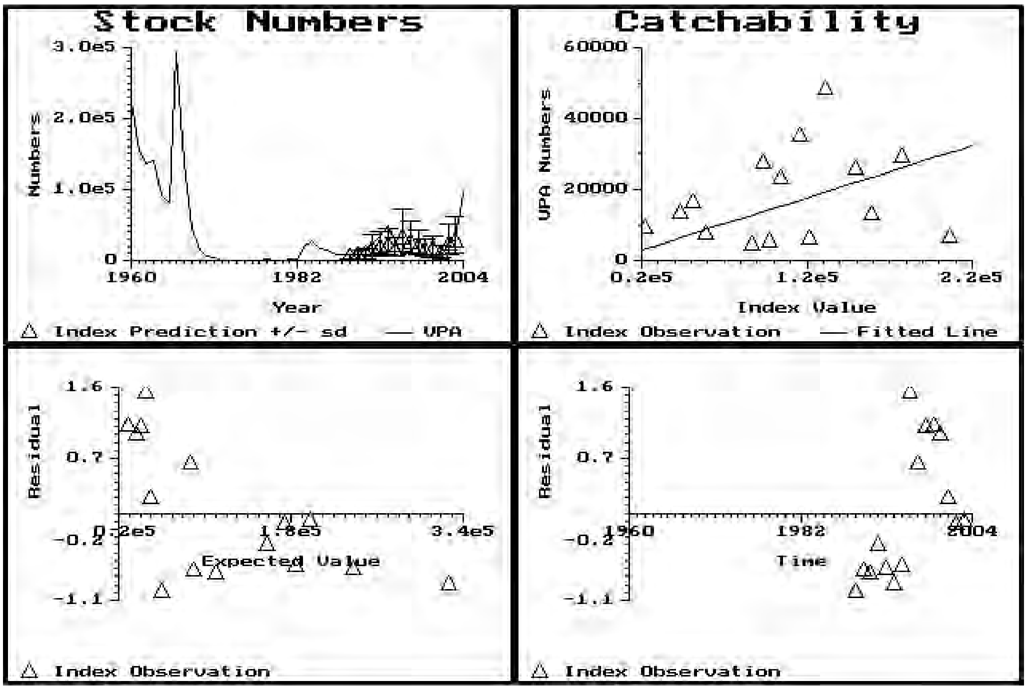


Figure 2.6.2.13 North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the **9 ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 9 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

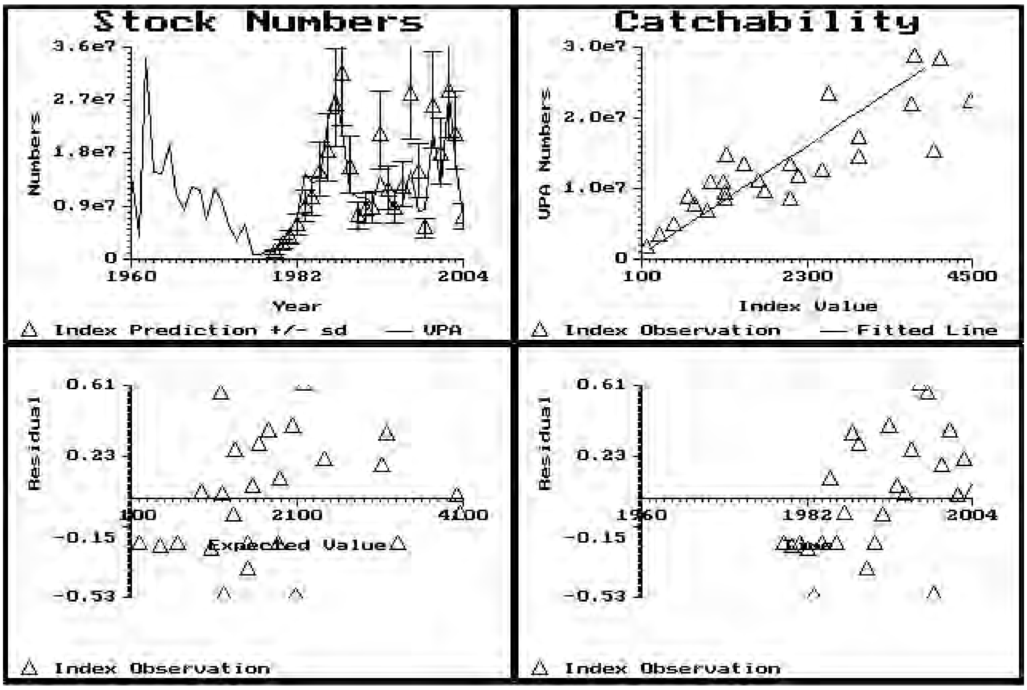


Figure 2.6.2.14 North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the **1 ring** index against the **IBTS surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations 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.

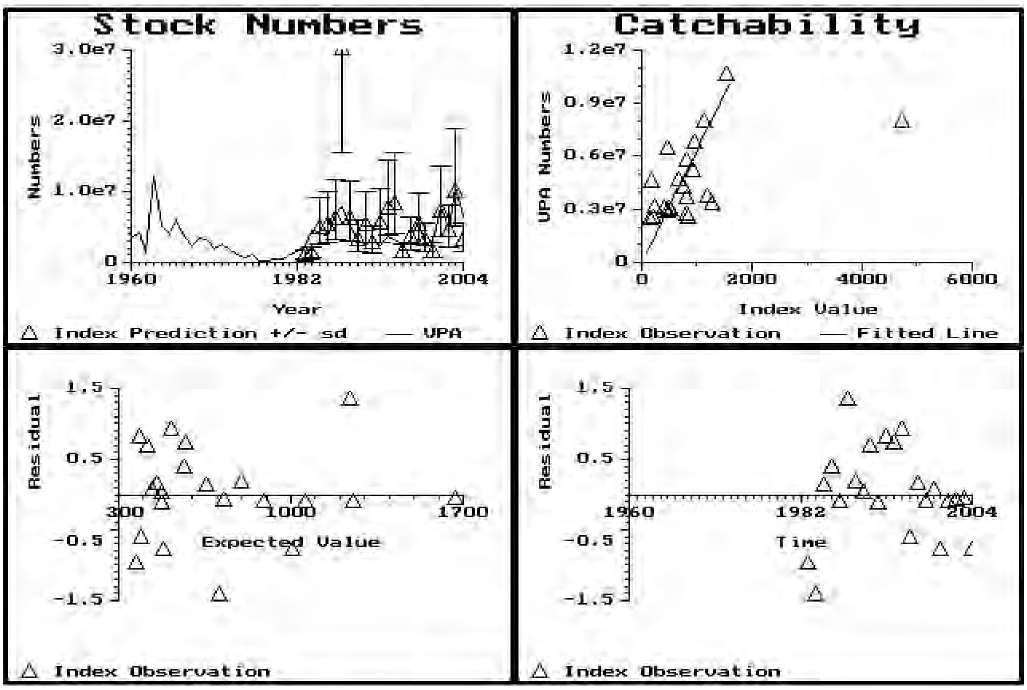


Figure 2.6.2.15 North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the **2 ring** index against the **IBTS surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations 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.

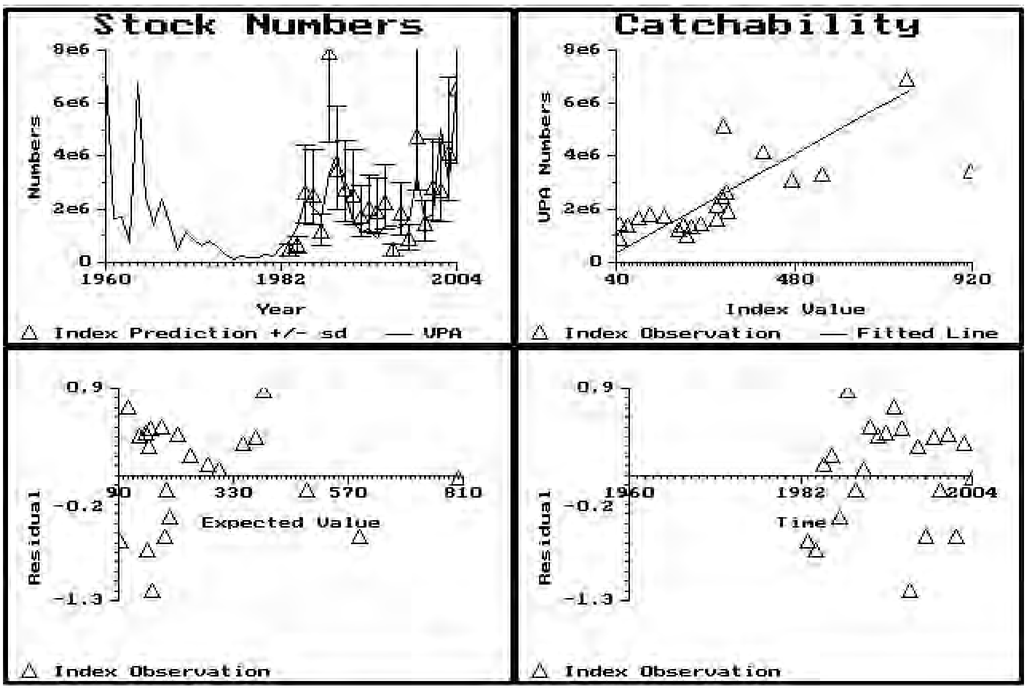


Figure 2.6.2.16. North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the **3 ring** index against the **IBTS surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations 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.

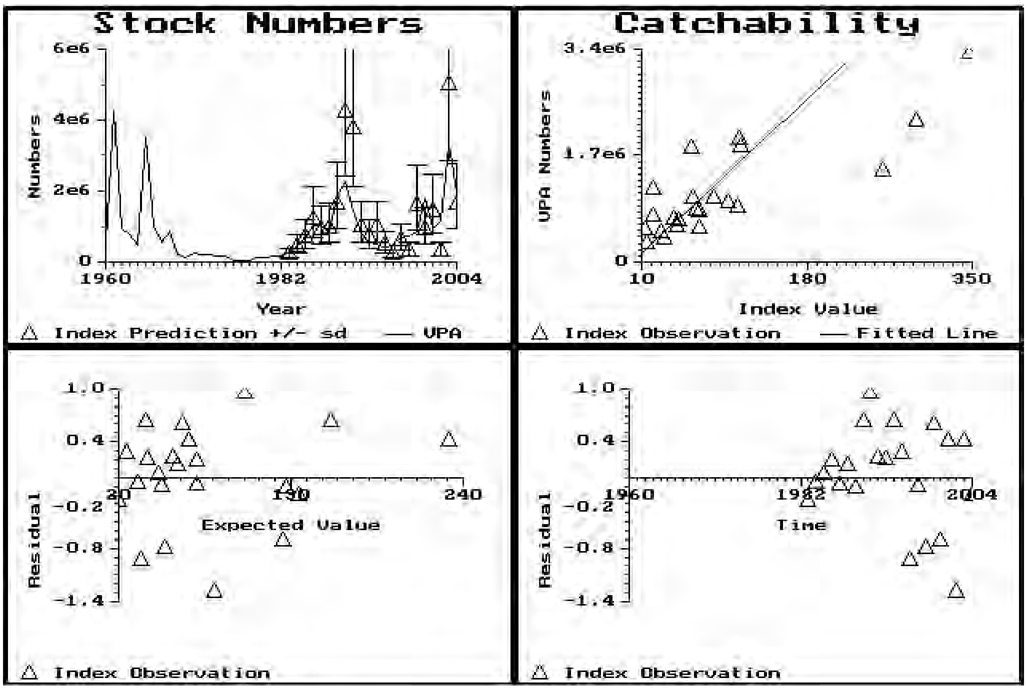


Figure 2.6.2.17 North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the **4 ring** index against the **IBTS surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations 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.

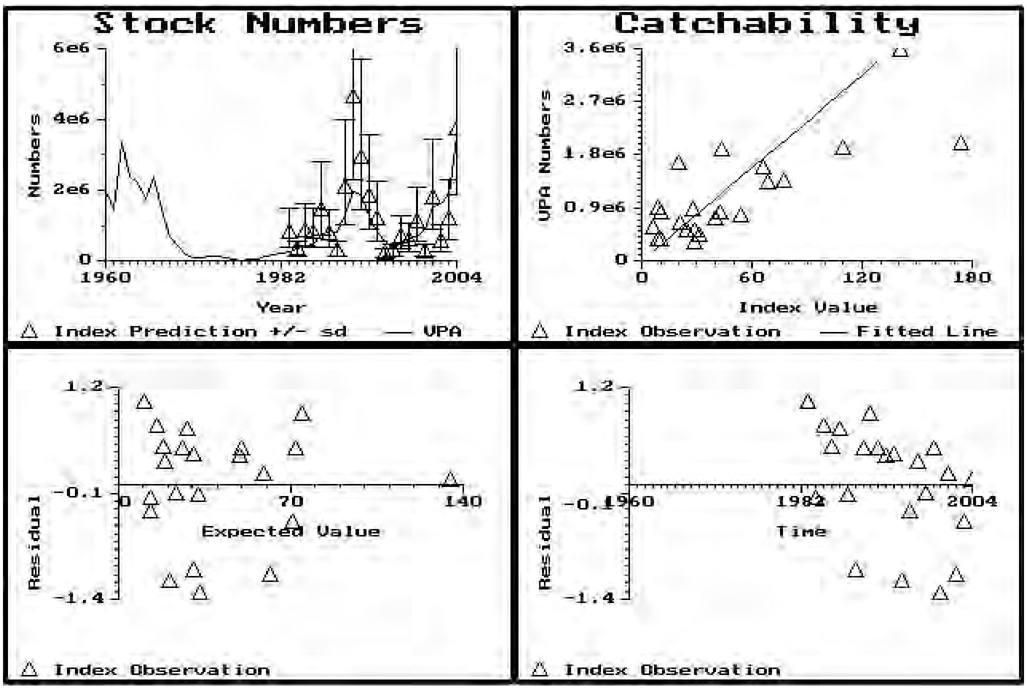


Figure 2.6.2.18 North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the **5 ring** index against the **IBTS surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations 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.

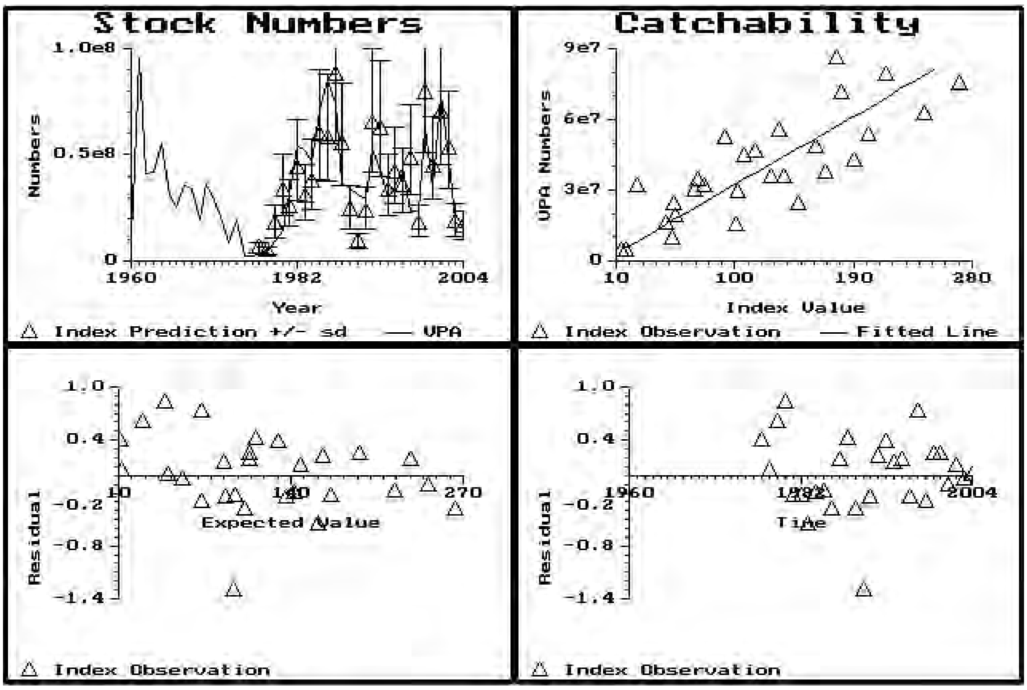


Figure 2.6.2.19 North Sea herring. Illustration of residuals from deterministic calculation (5-year separable period). Diagnostics of the fit of the **0 ring** index against the **MIK surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations 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.

a

b

c

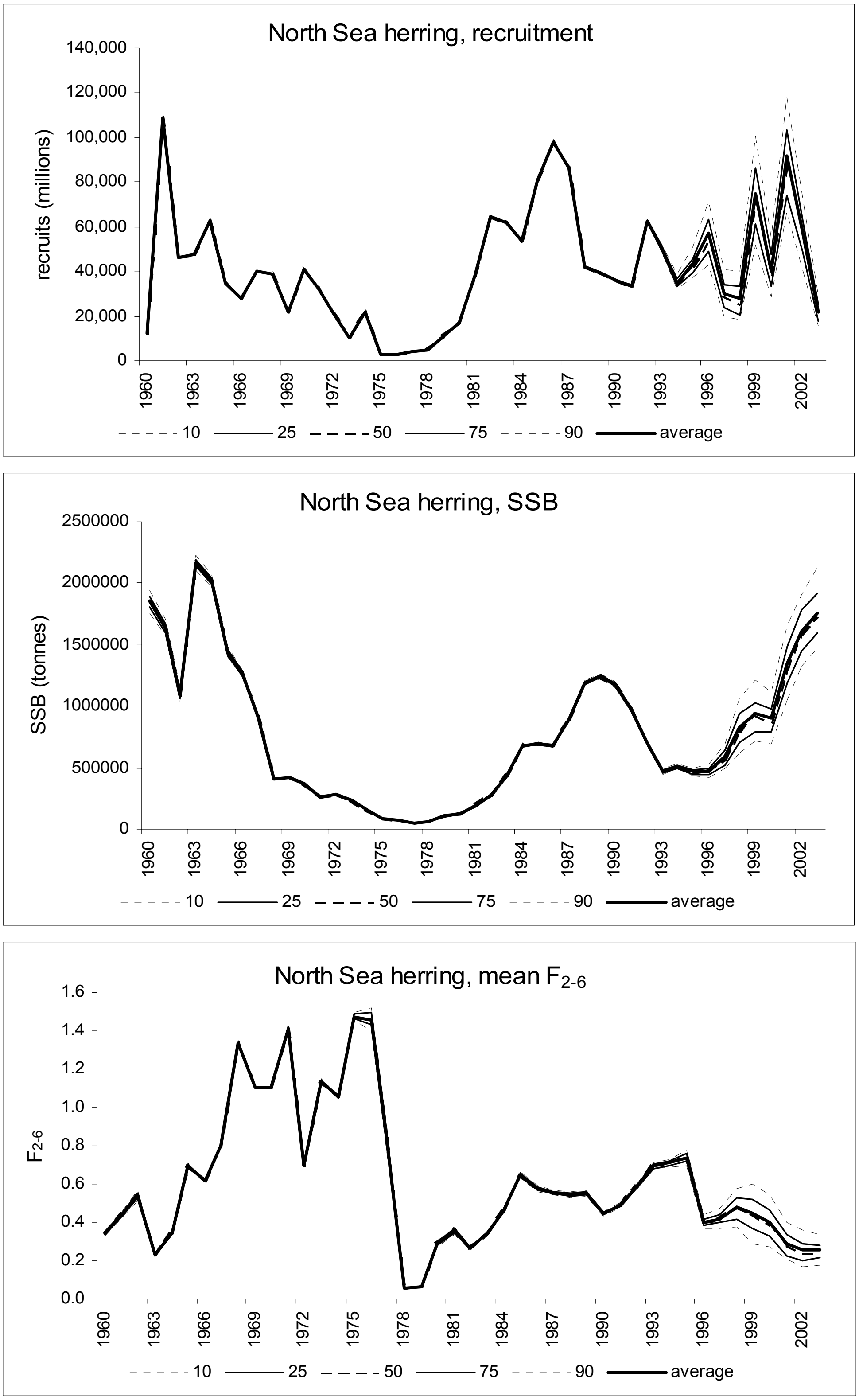


Figure 2.6.2.20 North Sea herring. Historic uncertainty in the final model fit (ICA assssment). Percentiles 10, 25, 50, 75 and 90%.

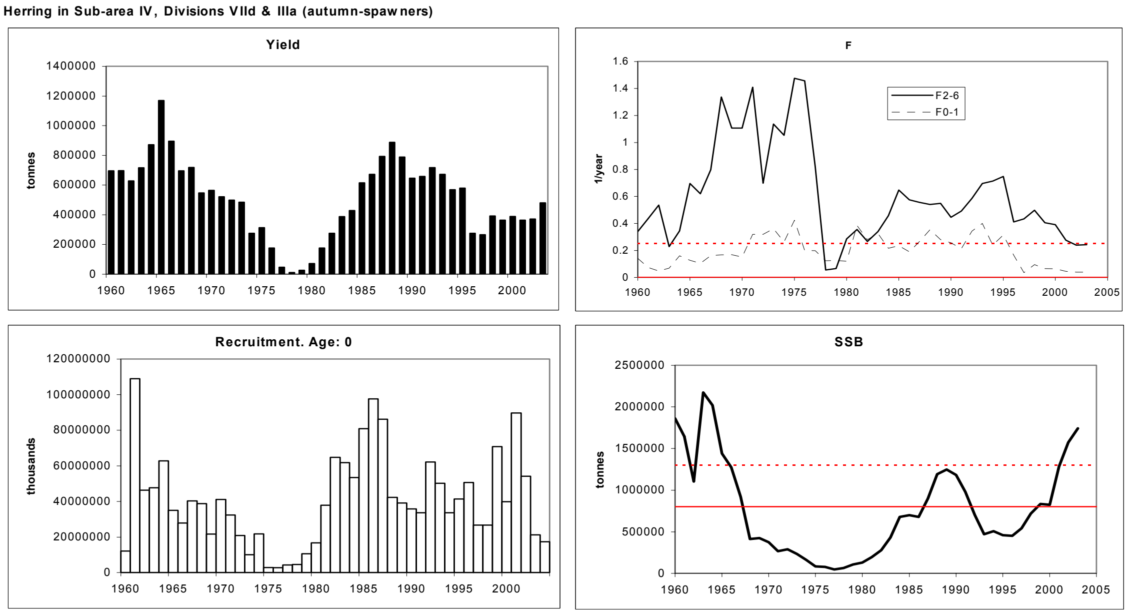
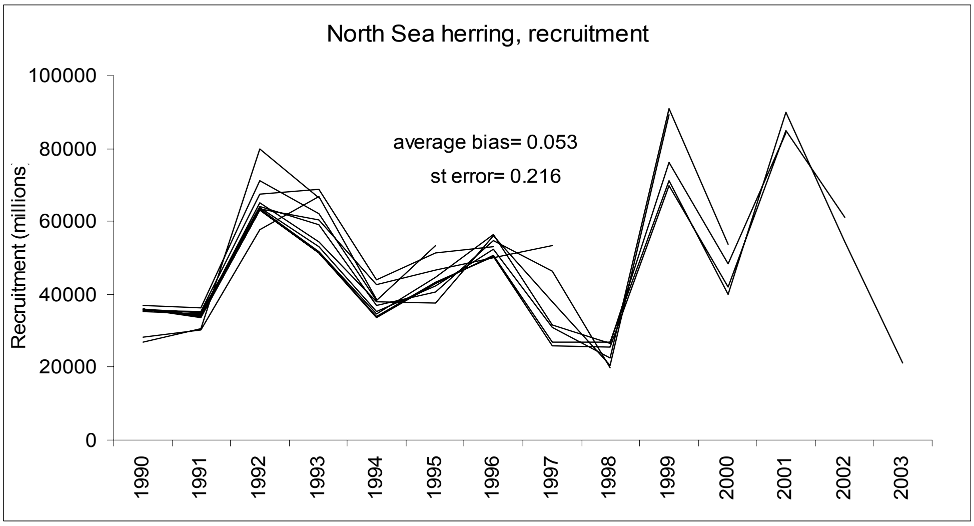
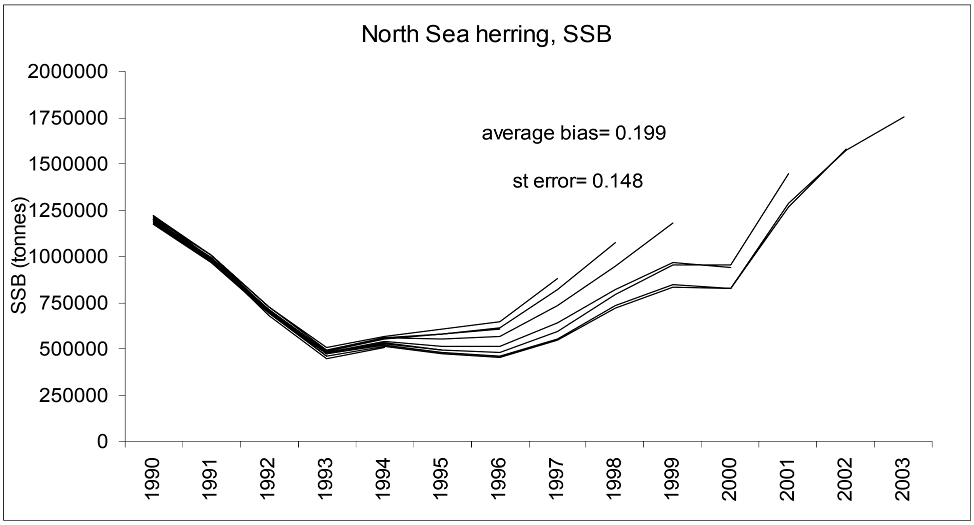


Figure 2.6.2.21 North Sea herring. Stock summary. Yield, F, recruitment and SSB from current assessment.

a



b



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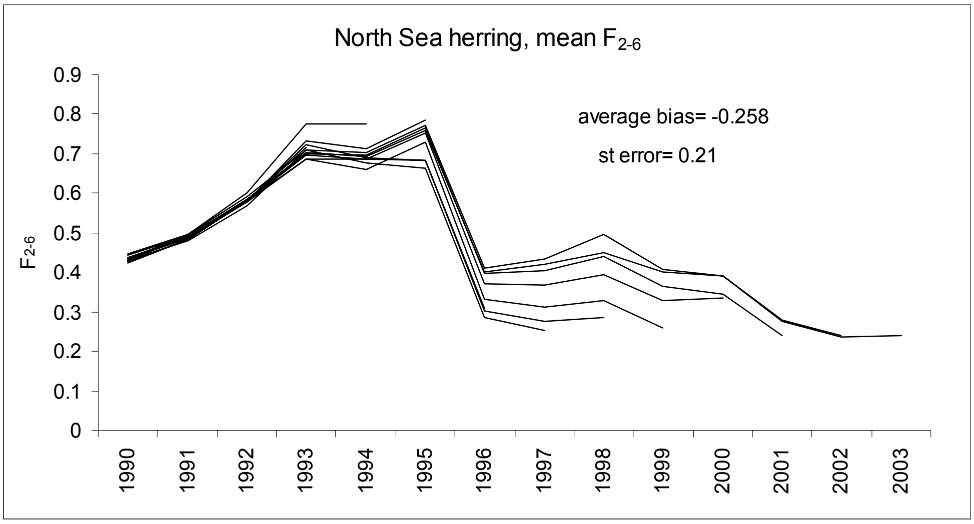


Figure 2.6.2.22 North Sea herring. Analytical retrospective analysis of final model fit (ICA) from 2003 to 1993.

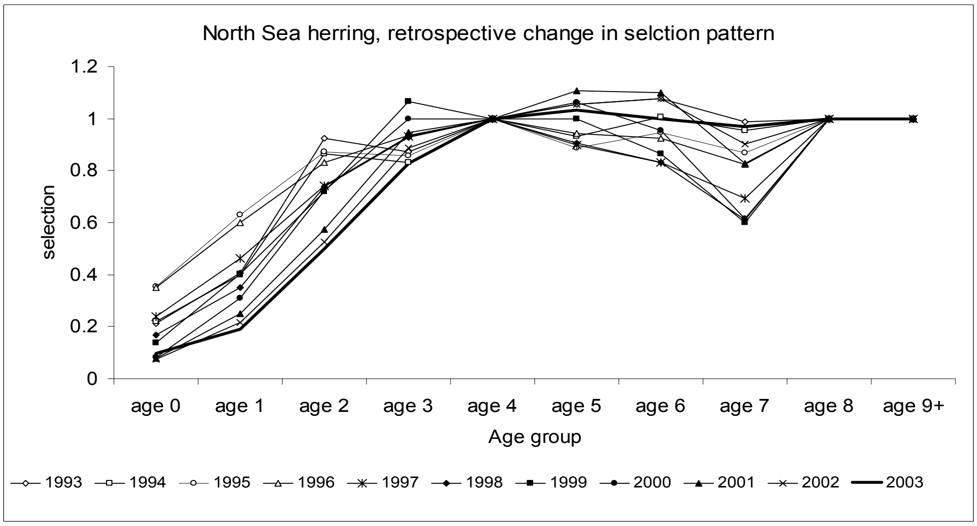


Figure 2.6.2.23 North Sea herring. Analytical retrospective analysis of selection pattern of final model fit (ICA) from 2003 to 1993.

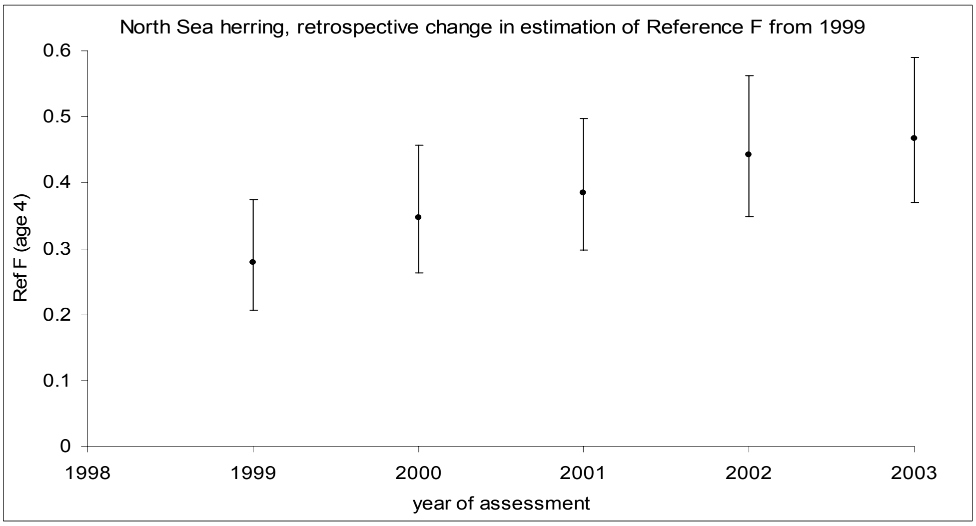


Figure 2.6.2.24 North Sea herring. Analytical retrospective change in estimation of reference F (4-ring) of final model of final model fit (ICA) from 2003-1999.

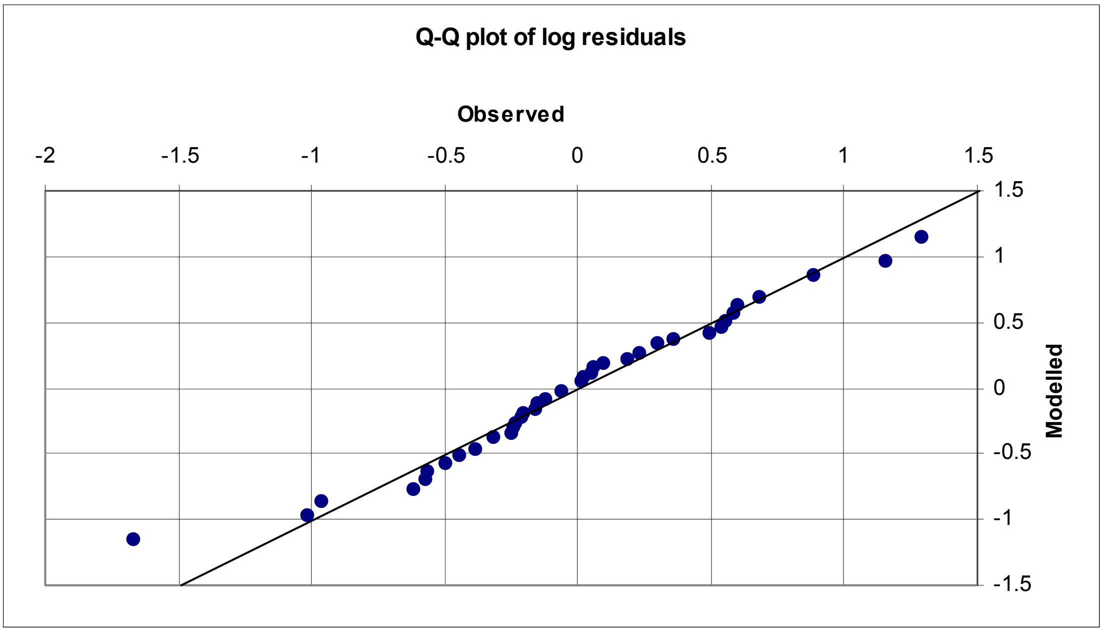


Figure 2.8.1. Cumulated probabilities of log recruitment resiudals according to the distribution model used for medium and long-term simulations, versus cumulated probabilities of historic recruitment recruitment residuals.

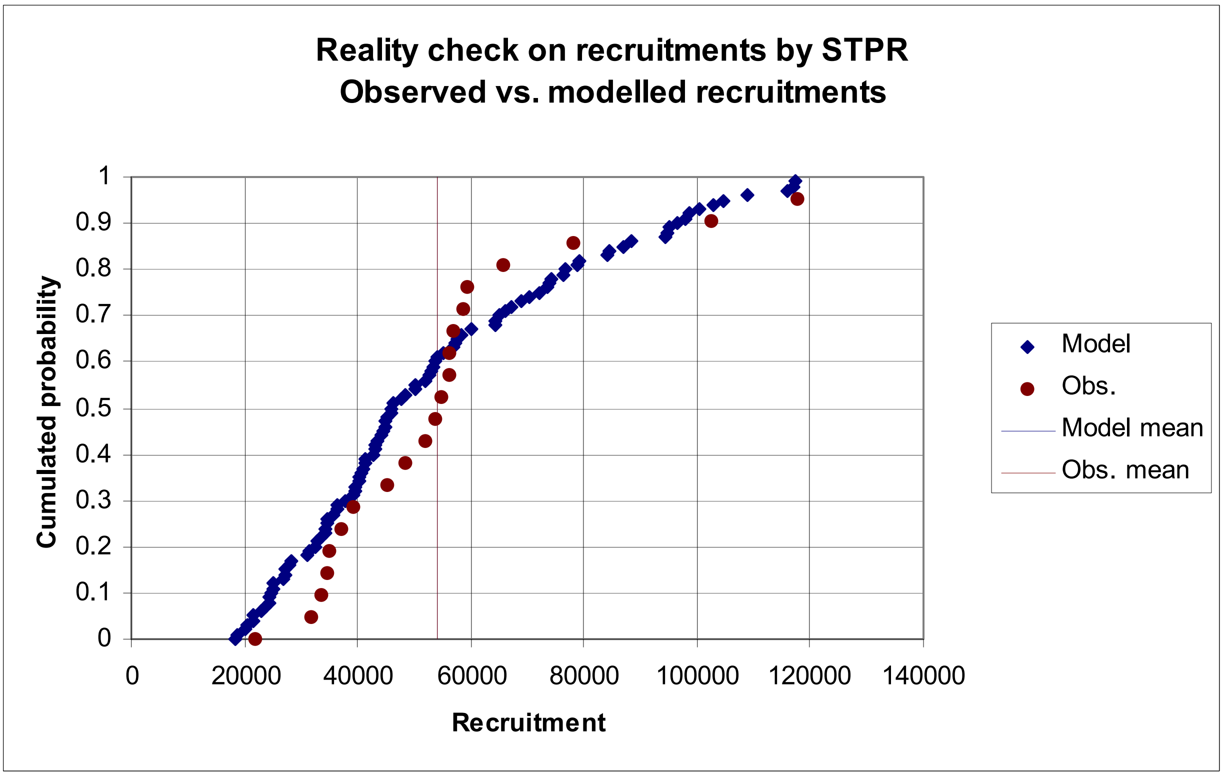


Figure 2.8.2 Cumulated distribution of historic recruitments (only those generated by SSB > 600 000 tonnes), and the cumulated distribution of recruitments in year 10 generated by STPR (only the first 100 bootstrap replicas are shown)

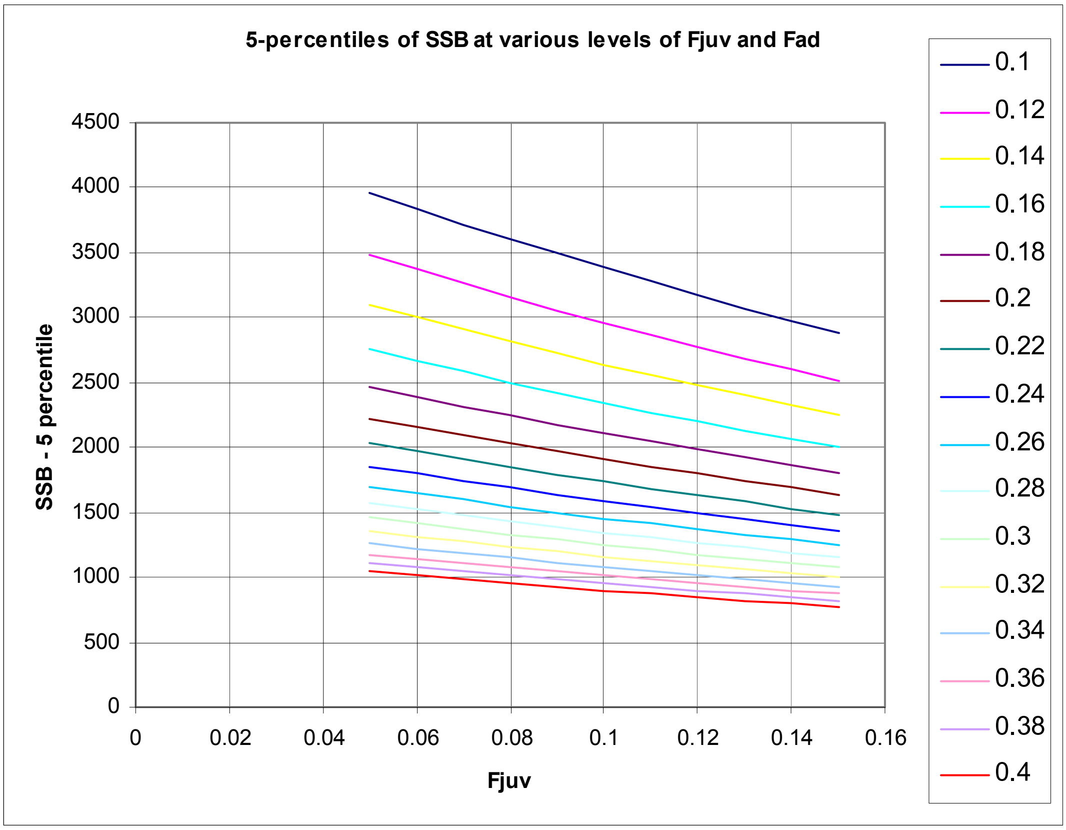


Figure 2.8.3. 5-percentiles of SSB as function of F for the juvenile and adult fleet, in a long-term stochastic equilibrium.

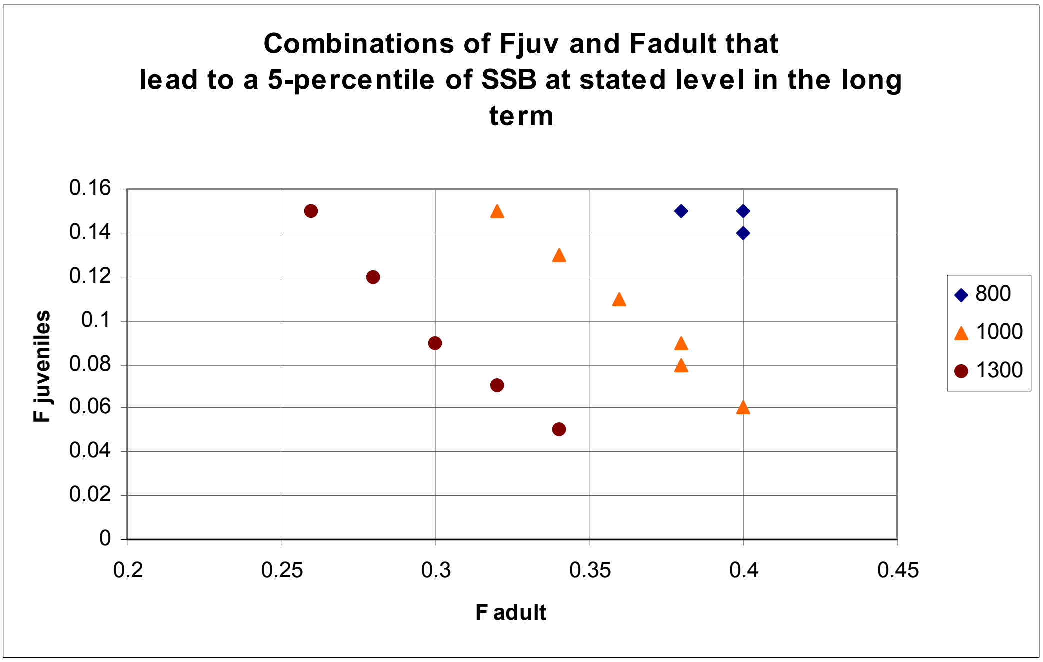


Figure 2.8.4 Combinaltions of F for the juvenile and adult fleets that correspond to some levels of the 5-percentile of SSB in long-term stochastic equilibrium.

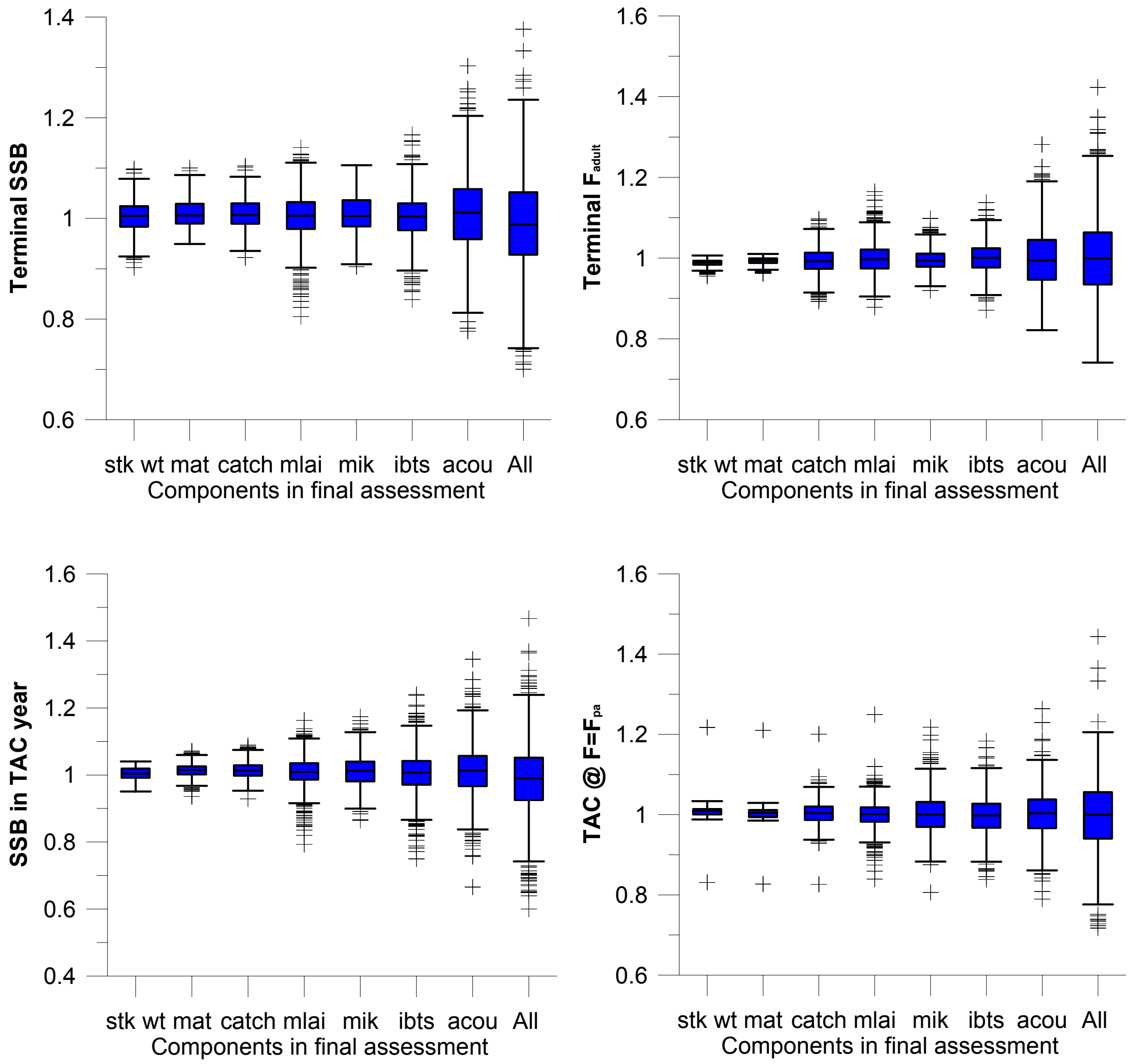
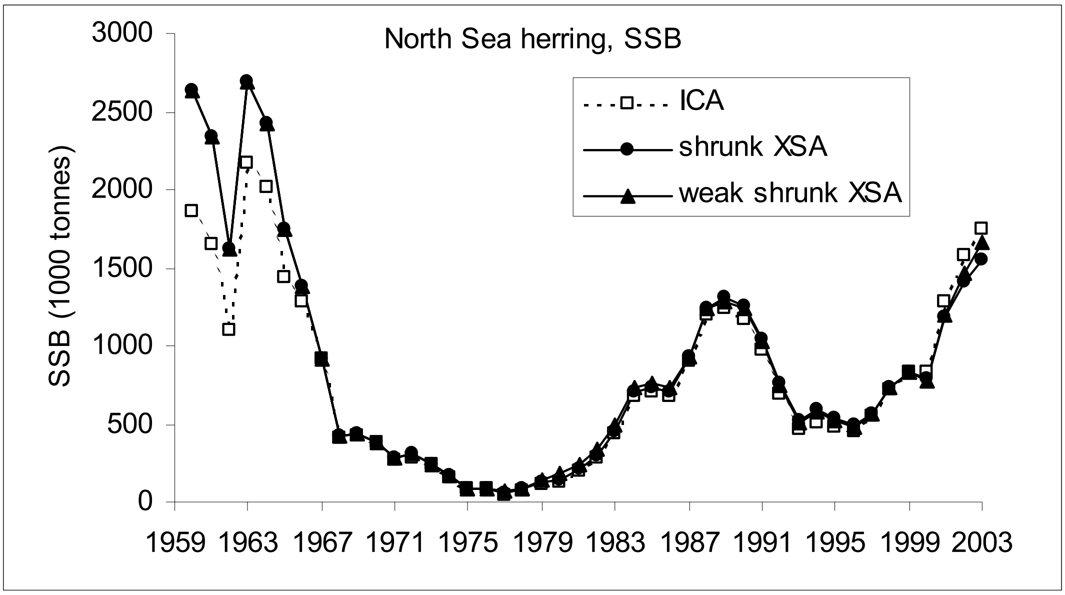


Figure 2.10.1 **V**ariability in terminal North Sea herring SSB, Fadult, SSB in TAC year and TAC at F=$\mathbf{F}_{pa}$ due to the different sources of data in the assessment. Conditional on the catch in tonnes, the ICA model specification, preselected inverse variance weighting and fixed natural mortality.



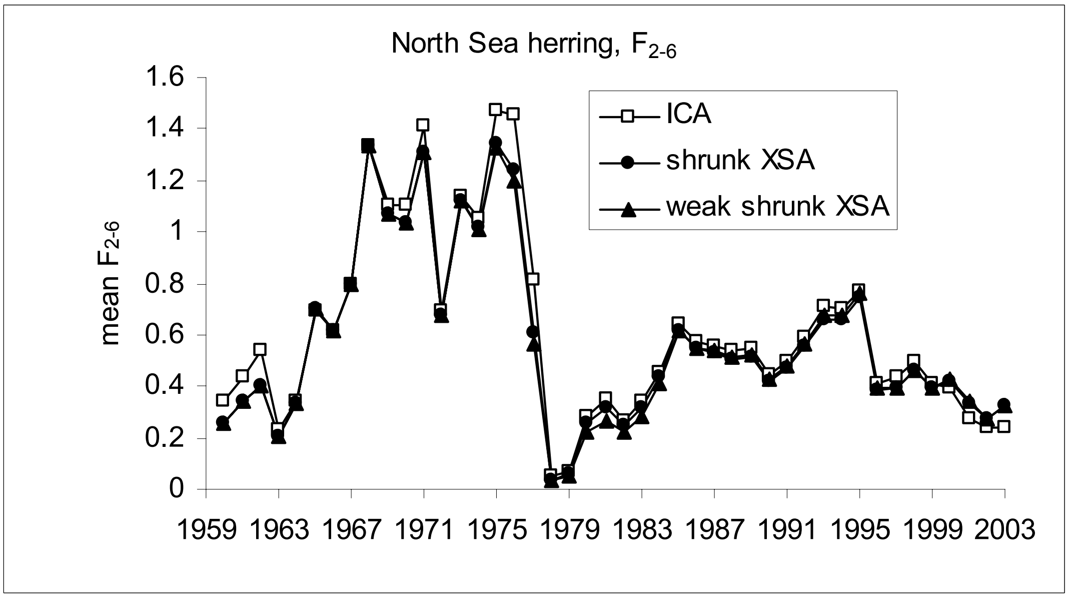


Figure 2.10.2 Assessment of North Sea herring in 2004 using ICA compared with XSA with two settings of shrinkage. All these indices give a similar perception of a rising SSB and a fishing mortality close to 0.2.

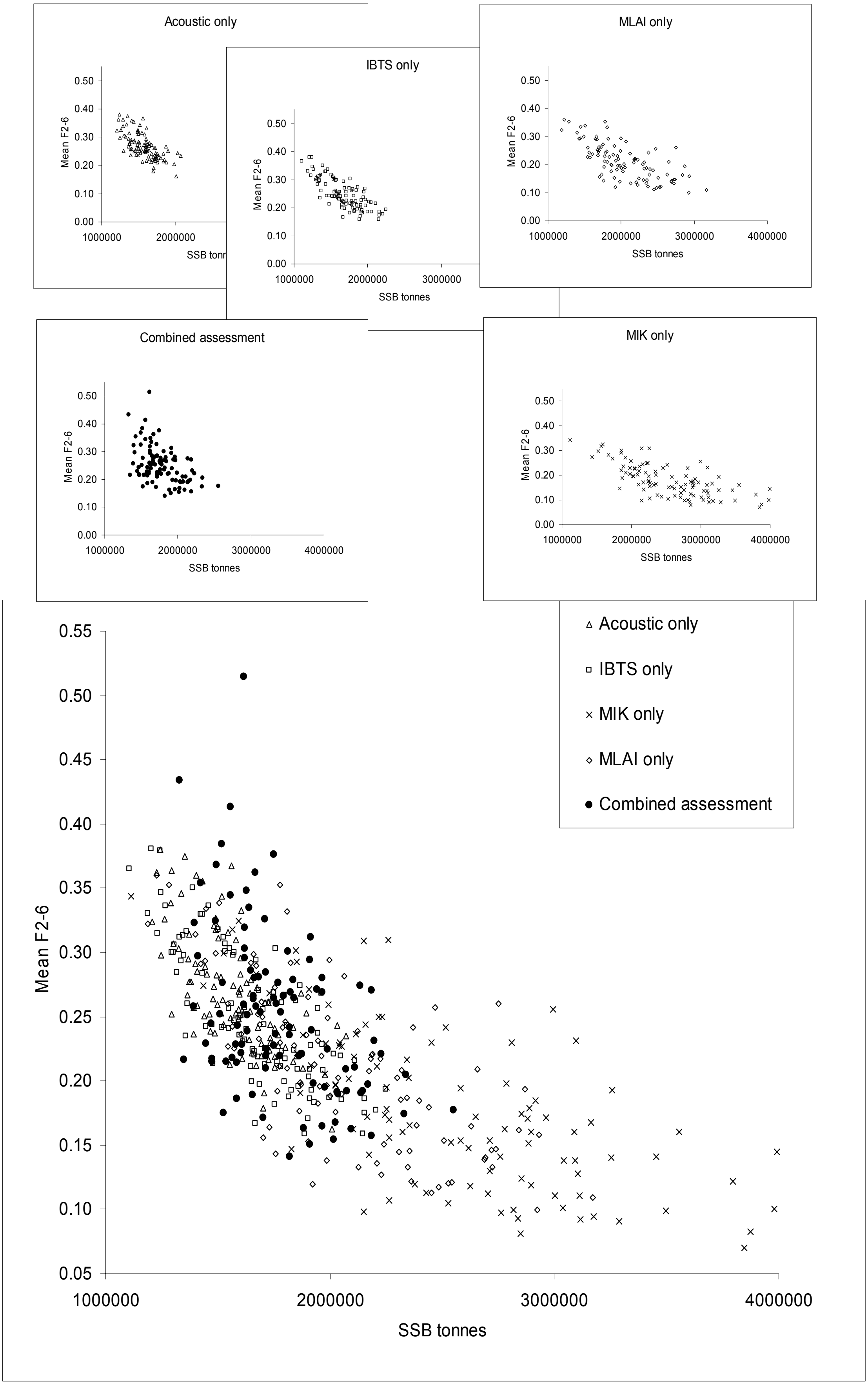


Figure 2.10.3 North Sea herring Bootstrap estimates of F and SSB from ICA variance/covariance resampling of historic errors in the assessment for each of the indices separately and the combined assessment. The data is shown twice, each assessment separately in the upper panels and plotted together in the lower large panel

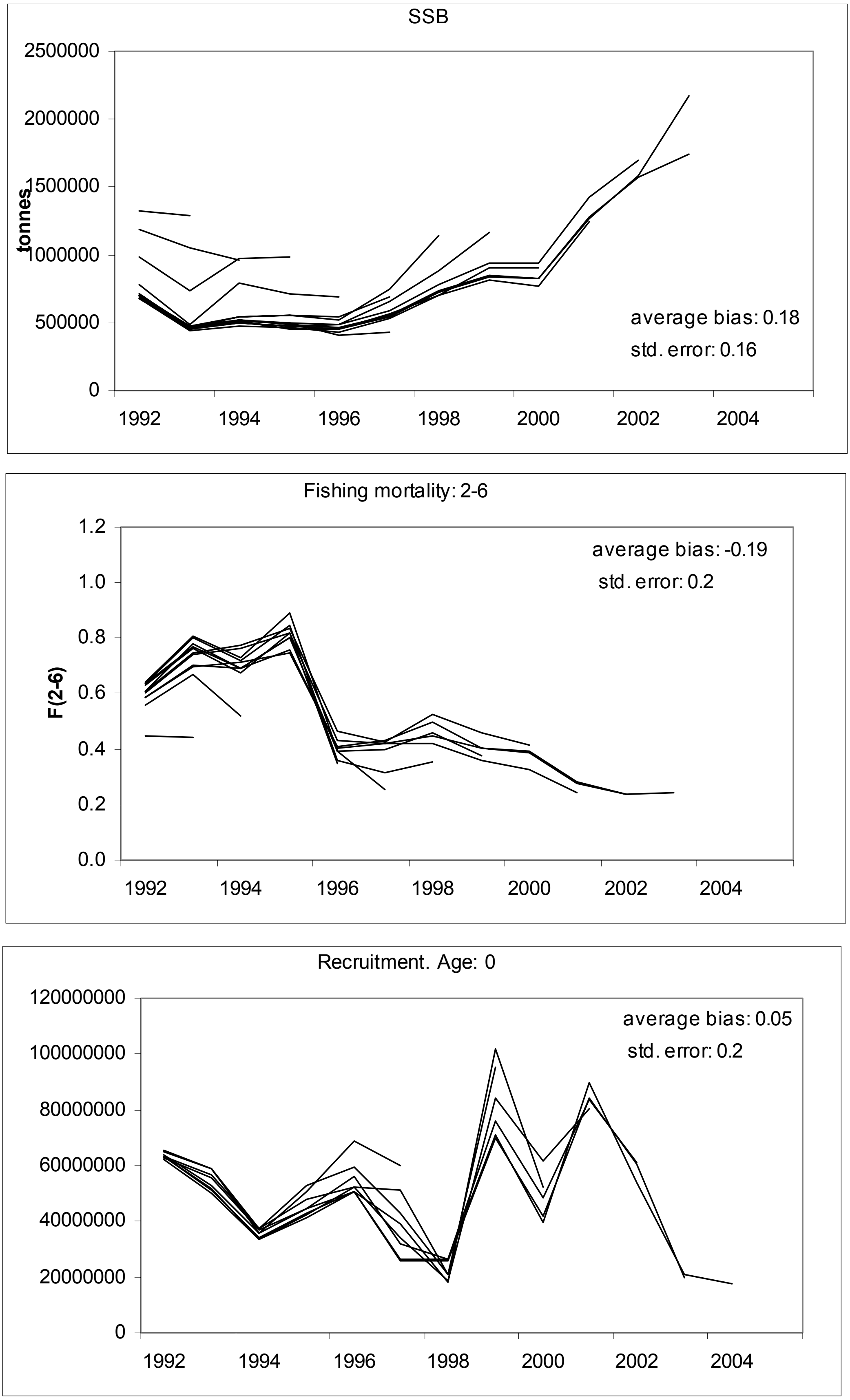


Figure 2.10.4 North Sea herring (Autumn spawning herring in IV, VIId and IIIa.) Historic retrospective of assessments by sequential working groups 1992 to 2004

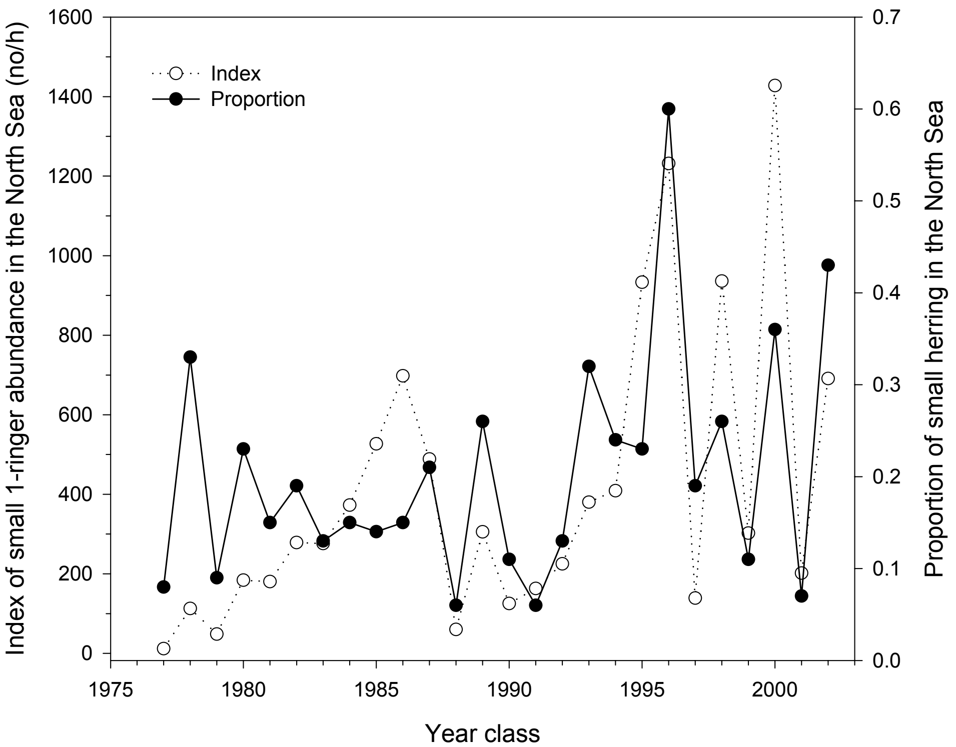


Figure 2.11.1 Downs Herring. Index (numbers per hour) of small (<13 cm) 1-ringers in the North Sea area, and proportion of small 1-ringers versus all sizes in the North Sea area. From Table 2.3.3.3.

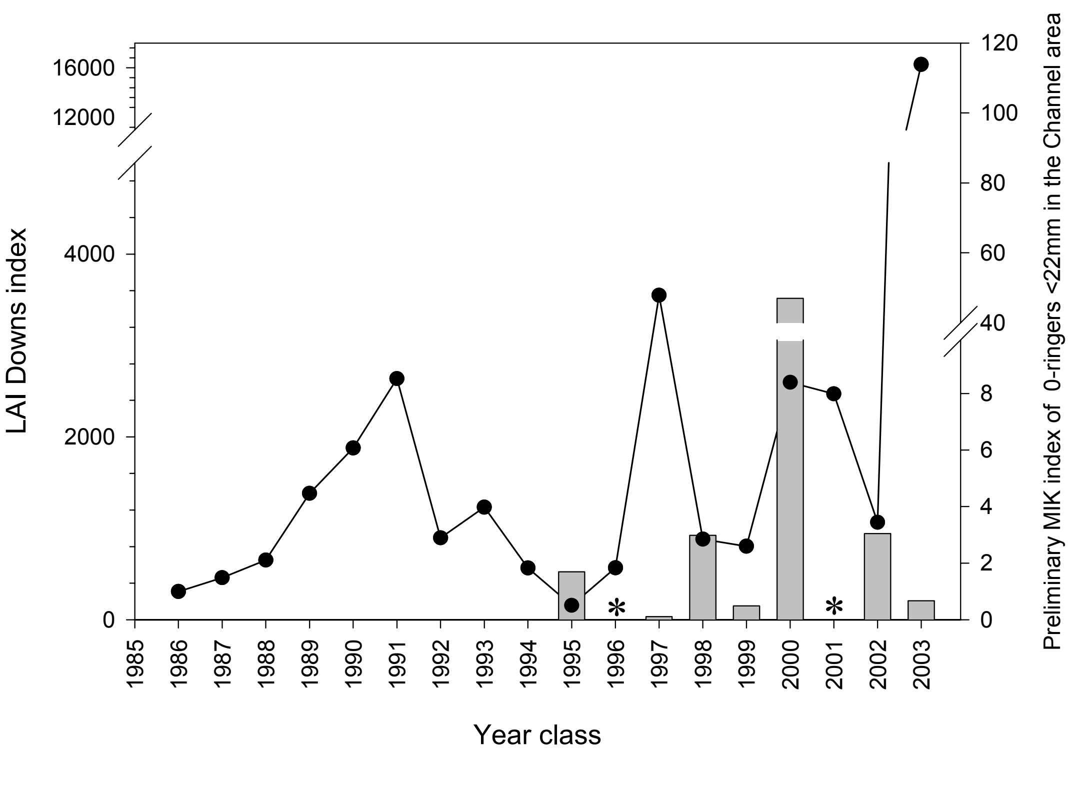


Figure 2.11.2 Downs herring. Larval Abundance Index (LAI) in the Channel area (line), calculated as mean of surveys per year class 1986-2003, and preliminary MIK survey results in the Channel (bars) (early spring 1995-2003). Asterisks denote no data.

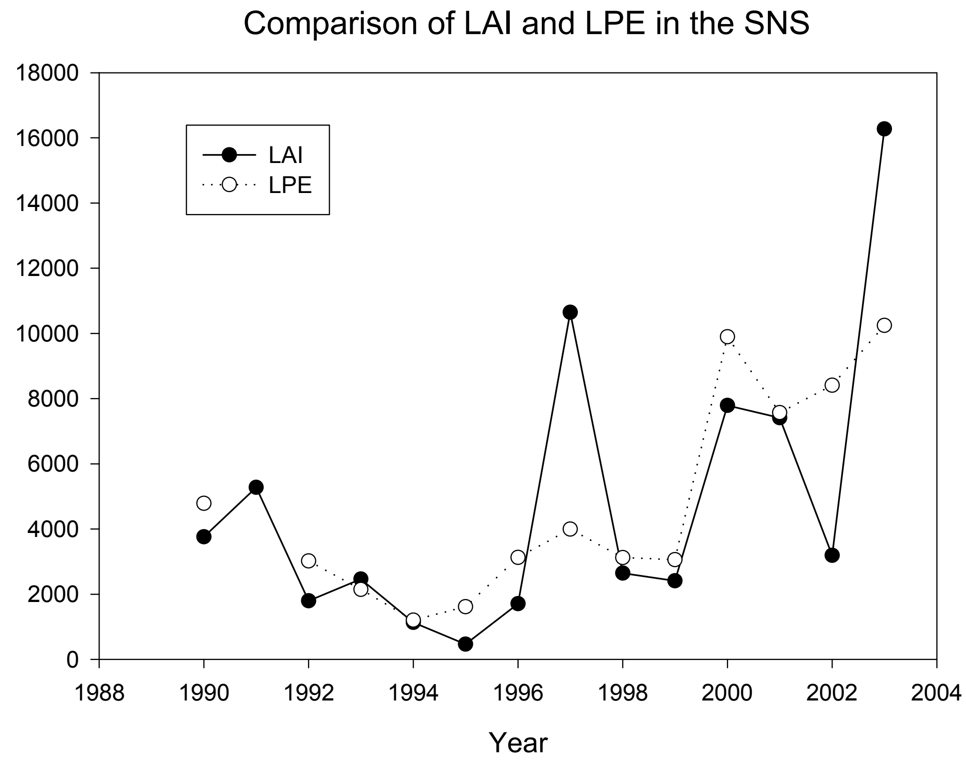


Figure 2.11.3 Downs herring. Comparison of the relative Larvae abundance index (LAI) and larvae production estimate (LPE) from the southern North Sea. The LPE estimates are rescaled by the ratio of meanLAI/meanLPE to fit the same scale.

3 Herring in Division IIIa and Subdivisions 22–24

3.1 The Fishery

3.1.1 ACFM advice and management applicable to 2003 and 2004

At the ACFM (May) meeting in 2003, 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 slightly increasing over the last four years. Fishing mortality is uncertain, but estimates for 2002 are 0.45 for adults and 0.17 for juveniles (0- and 1- ringers), which is greater than $\mathbf{F}_{max}$. The incoming 2002 year class seems to be above average.

ACFM recommended that the fishing mortality should be reduced to less than $\mathbf{F}_{max}$ (0.37) corresponding to catches in 2004 less than 92,000 t. According to the recent geographic distribution of catches, approximately half of the total catches should be taken from Subdivisions 22-24.

The EU and Norway agreement on a herring TACs set for 2004 was 70,000 t in Division IIIa for the human consumption fleet and a by-catch ceiling of 21,000 t to be taken in the small mesh fishery.

As in previous years the International Baltic Sea Fishery Commission (IBSFC) no special TAC for 2003 was set on the Western Baltic area the stock component. For the Baltic there was for 2002 a TAC of 200,000 t for the SDs 22–29 South and 32. The TAC for 2004 increased to 171,350 t compared to 143,349 t for the same area in 2003.

3.1.2 Catches in 2003

Herring caught in Division IIIa are a mixture of North Sea autumn spawners (NSAS) and Baltic spring spawning herring (WBSS) in the eastern part of the North Sea, Skagerrak, Kattegat and Subdivisions 22, 23 and 24 are considered to be one stock. This Section gives the landings of both North Sea autumn spawners and Baltic spring spawners, but the stock assessment applies only to the spring spawners.

Landings from 1985 to 2003 are given in Table 3.1.1. In 2003 the total landings decreased to 109,600 t in Division IIIa and Subdivisions 22–24 compared with 2002 where the landings were 125,600 t, resulting in a landing figure for 2003 at the lowest level for the whole time-series. In 2003, 24,200 t were taken in the Kattegat, about 43,900 t from the Skagerrak and 38,900 t from Subdivisions 22–24. These landings represent a decrease of 16,000 t compared to 2002 and 39,200 t compared to 2001. The Danish national management regime for herring and sprat fishery in Subdivision 22 was changed in 2002. It should be noticed 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 2003 were at the same level as in 2002. The overall change in the German fishing pattern was implemented in 2001. In former years the dominant part of herring was caught in the passive gears, gillnets and trapnets. The share of herring, which was caught by trawlers in the area off the Rügen Island coast up to the Arcona Sea (Subdivision 24), increased from 26% in 2001 to 63% in 2003. This significant change in fishing pattern was caused by the perspective of a new fish factory on Rügen Island. This factory expects to process 50,000 t per year and started during autumn 2003.

In 2003 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 the table below the landings are given for 2000 to 2003 in thousands of tonnes by fleet and quarter. The landings figures in the text table below are SOP figures. The 2000 and 2001 figures for fleet C were updated.

Herring landings by fleet ('000 t)		Div. IIIa		SD 22-24	Div. IIIa+ SD 22-24
Year	**Quarter**	**Fleet C**	**Fleet D**	**Fleet F**	**Total**
2000	1	14.7	6.9	23.9	45.5
	2	10.6	0.4	15.8	26.8
	3	34.6	3.2	3.4	41.2
	4	20.3	7.4	10.7	38.4
	Total	80.2	17.9	53.8	151.9
2001	1	19.7	3.8	20.8	44.3
	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	66.6	15.3	63.8	145.7
2002	1	11.4	6.2	19.6	37.2
	2	6.3	2.1	18.3	26.7
	3	23.2	7.0	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	7.0	20.3	38.2
	2	7.9	1.3	12.9	22.1
	3	21.9	0.9	1.5	24.3
	4	15.0	3.3	5.6	23.9
	Total	55.7	12.5	40.3	108.5

The landings from fleets C-F are SOP figures.

3.1.3 Catch in Numbers and Mean Weights-at-age

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

Table 3.2.2 and Table 3.2.3 show the total catch (autumn and spring spawners) in numbers and mean weight-at-age for herring by quarter and fleet landed from Skagerrak and Kattegat, respectively. The total numbers and mean weights-at-age for herring landed from the Kattegat, Skagerrak and Subdivisions 22 - 24 by fleets are shown in Table 3.2.10. Catch in numbers and mean weight has been updated/revised for 1995-2001 because of misreporting (see section 3.1.5)

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

The total numbers and mean weight of the NSAS by quarter and fleet landed from Division IIIa are shown in Table 3.2.8 and the WBSS in Table 3.2.9.

The total catch in numbers of WBSS in Division IIIa and the North Sea are shown in Tables 3.2.11 and 3.2.12 (see also Tables 2.2.1 – 2.2.5) The landings (SOP) of the WBSS taken in Division IIIa and the North Sea in 2003 were estimated to be about 37,000 t (Table 3.2.15) compared to about 54,000 t in 2002 and 48,000 t in 2001. This decrease in landings (SOP) was mainly due to a decrease in the estimated number of spring spawners in Kattegat. Furthermore, there has been a decrease in total landings from fishery in Subdivisions 22-24 of 11,000 tonnes from 2002 to 2003. The landings (SOP) of NSAS in Division IIIa amounted to 26,000 t compared to 48,000 t in 2001 and 50,000 t in 2000 (Table 3.2.13). The total catch in number and mean weight-at-age of WBSS in the North Sea, Division IIIa and in Subdivisions 22–24 for 1991–2003 are given in Tables 3.2.14 and 3.2.15.

3.1.4 Quality of Catch Data and Biological Sampling Data

Misreporting of fishing area still occurs. Some of the Danish landings of herring for human consumption reported in Division IIIa may have been taken in the adjacent waters of the North Sea. 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, these catches have been transferred to the North Sea. The Norwegian landings reported as having been taken in Skagerrak for the period 1995 to 2003 may have been caught in the North Sea and have been transferred to the North Sea. Some landings, reported as taken in this triangle, (an area in the southern Kattegat, which is a part of the Baltic area: Gilleleje, DK - Kullen, S - Helsingborg, S - Helsingør, DK), may have been taken outside this area. These landings are listed under Kattegat.

No estimates of discards were available to the Working Group. The amount of discards for 2003 is regarded as being insignificant.

Sampling for species composition in the small-meshed fishery has been carried out as in previous years. Sampling in this section only refers to sampling for length, weight and age information.

The sampling intensity of the landings in 2003 was acceptable, the highest level ever and above the recommended level. Danish landings were sampled in the most important quarters for the Skagerrak, the Kattegat and for Subdivisions 22 and 24.

Tables 3.2.16 and 3.2.17 show the number of fish aged by country, area, fishery and quarter. The total landings from Division IIIa and Subdivisions 22-24 were 109,600 t from which 292 samples (1 sample per 370 t landed) were taken, 30,500 fish were measured and 14,800 aged. For comparison, for 2002 where 125,600 t were landed from which 292 samples (1 sample per 450 t landed) were taken, 31,000 fish measured and 15,000 fish 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 and times of the year. In most cases quarter and fisheries have been sampled adequately, but still some quarters and fisheries have not been sampled. Comprehensive spatial and temporal sampling must be implemented in order to improve the overall sampling of landings.

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 importance of local herring stocks in relation to the fisheries (i.e. the Kattegat autumn spawners and the Skagerrak winter spawners) and their possible influence on the stock assessment.

3.1.5 Revision of historical data

At the SGREDNOSE (ICES 2003/ACFM:10) revision of all herring landings figures for the period 1991 to 2002 were revised. New information indicated that the reported Norwegian landings from fishery in Subdivision IIIaN (Skagerrak) with a high probability have been taken in the North Sea. Therefore, all reported Norwegian landings from Subdivision IIIaN were transferred to the North Sea and the respectively catch figures, catch in numbers etc. have been updated for the period 1995-2001.

3.2 Biological Composition of the Catch

Catches of herring in the Kattegat, the Skagerrak and the Eastern part of the North Sea are taken from a mixture of two main spawning stocks mainly 2+ ringers of the Western Baltic spring spawners and 0-2-ringers from the North Sea autumn spawners, including winter-spawning Downs herring (see stock annex). As in recent years the WG expanded the use of 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).

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 landings (see Appendix 3).

For the first time sampling levels in 2003 were high enough to allow the split to be applied to their respective spatial and temporal origin without reallocating between the landings and the surveys or between areas or quarters.

3.2.1 Spring-spawning herring in the North Sea

Catches from the transfer area within Subdivision IVa East and Division IVb are usually split by analyses of Norwegian samples (see Figure 2.2.2). For 1-ringers it was assumed that all fish were autumn spawners. For herring caught in the 2nd quarter 2-ringers, 3-ringers, and 4+-ringers, mean vertebral counts in the transfer area were used (see stock annex). For the 3rd quarter no Norwegian samples were available for landings from the transfer area and instead the otolith-based proportions from samples of Danish commercial landings from the same area were applied to the age distributions. The quarterly age distribution and mean weight-at-age in Subdivision IVa East was applied to the catches of the second and third quarters in the transfer area. The numbers of spring spawners by age were obtained by applying the estimated proportion by age. For the actual split see Section 2.2.2.

3.2.2 Autumn spawners in Division IIIa

For commercial landings in 2003 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 spring and autumn spawners in the landings from Division IIIa was performed on the basis of totally 5847 (4857 Danish and 990 Swedish) otolith microstructure analyses in 2003. Data were disaggregated by area (Kattegat and Skagerrak), age group and quarter (1–4). The proportions and the analysed numbers are presented in Table 3.2.1.

In the acoustic survey in quarter 2 and 3 in Division IIIa 930 otoliths were analysed and applied for the split of this survey only. In the 2003 Division IIIa IBTS survey in the 3rd quarter 375 otoliths were analysed and in the 2004 Division IIIa IBTS survey in the 1st quarter 322 otoliths were analysed.

3.2.3 Autumn spawners in the fishery in Subdivisions 22 and 24

All herring found in subdivisions 22-24 are treated as Western Baltic spring spawners independent of spawning type from otolith micro-structure analysis (see Appendix 3).

3.2.4 Accuracy and precision in stock identification

Sub-samples of the 2003 Danish, Swedish and German otolith microstructure analyses were double checked by the same Danish expert reader for consistency in interpretation. An overall impression of excellent agreement among readers implies a potential high precision in the splits.

Preliminary results presented to the WG on mixed stock analysis exploiting genetic variation in herring from Division IIIa in 2003, show excellent agreement between assignments based on micro satellites and otolith microstructure (Bekkevold pers. commun. HERGEN QLRT - 2000 – 01370) indicating good accuracy of the split between North Sea and Western Baltic herring. The possibility of combining genetics and otolith analyses for a higher resolution will be explored in the near future.

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) except for 2001 3rd quarter and 2002 1st quarter when vertebrae counting methods was used. The estimates of the abundance by age of the spring spawning component are presented in Table 3.3.1 and Table 3.3.2. The mean value for 1-ringers in 2004 1st quarter is the lowest observed in the time-series.

3.3.2 Summer acoustic survey in Division IIIa

The echo integration survey from 30 June to 10 July 2003 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 2004/G:05). The estimate spawning biomass of Western Baltic spring spawning herring in 2003 was about 104,000 tonnes, showing a substantial decrease compared with the previous year but similar to the 2001 estimate. The results from this survey are summarised in Table 3.3.3.

3.3.3 Autumn acoustic survey in western Baltic and the southern part of Division IIIa (Kattegat)

A joint German-Danish acoustic survey was carried out with R/V "SOLEA" between 30 September and 18 October 2003 in the Western Baltic. In 2003, it was planned to cover Subdivisions 21, 22, 23 and 24. A full survey report is given in the Report of the Planning Group for Herring Surveys (ICES CM 2004/G:05). The results for 2003 are presented in Table 3.3.4. The herring stock was estimated to be about 156,000 tonnes in Subdivisions 22-24 (Table 3.3.4). This is comparable to the last year estimates. Young herring dominated the abundance estimates.

3.3.4 Larvae surveys

The series from 1992 to 2003, shows strong correlations between the index derived from the larvae surveys and the abundance of recruits in the acoustic survey of Subdivisions 22-24 (Klenz, 2004). The old bottom trawl series using herring gear, which ended in 2001, also showed a significant correlation with 0 group abundance in Subdivision 24. There is a highly significant correlation with the index derived from the larvae surveys and the estimate of 0 group abundance in the current stock assessment. The estimated numbers of larvae for the period 1977 to 2003 are summarised in Table 3.3.5. The 2003 estimate of the larvae index is very similar to the previous year estimate and close to the 1998-1999 values.

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

Mean weights-at-age in the catch in the 1st quarter were used as stock weights (Table 3.2.11). Ongoing work on updating maturity-at-age data was presented (WD Gröhsler & Müller). The data coverage is still too sparse to allow using annual values, however international collaboration in this area may result in a different perception of SSB in the future, once new estimates replace the current mean values. The maturity ogive was assumed constant between years. The same maturity ogive was used as in the HAWG 2003:

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

3.5 Recruitment estimates

Indices of 0-ringer abundance on the spring Spawning herring in Subdivisions 22-24 for 2003 were available from the larval surveys during the spawning season on the main spawning area (Table 3.3.5) and from the Acoustic survey (September/October). Log transformed indices were compared by year class in Figure 3.5.1. From 1990, the recruitment declined until 1992 when recruitment was the lowest observed in the time-series. From 1992, recruitment year classes, as estimated by the larval index, showed an increase with three large year classes in 1998, 1999 and 2002. Historical high recruitment of the 1998 and 1999 year classes were supported by 0-ringer and 1-ringer indices in the acoustic survey in Subdivisions 22–24 (Table 3.3.4). After 1998-1999, there was a significant drop in recruitment in 2000 while the 2002 and 2003 year classes have some of the largest values observed in the time-series. The larval index and the 0-ringer from the acoustic survey showed very similar trends in the last 5 years.

3.6 Stock Assessment

3.6.1 Data Exploration and preliminary Modelling

3.6.1.1 Input data

Catch in numbers by age in Subdivision IVa (East), Division IIIa and Subdivisions 22-24 were available for 1991 to 2003 (Table 3.6.1) and as proportion at age (Figure 3.6.1). Catches were updated for 1995-2001 (see section 3.1.5). Years before 1991 have been excluded due to lack of reliable data for splitting spawning type and a large change in fishing pattern caused by changes to 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 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 0.3 was added to the 0 and 1 ringers, which resulted in an increase in their natural mortality to 0.3 and 0.5, respectively (Table 3.6.4). The estimates of predation mortality were derived as a mean for the years 1977–1995 from the Baltic MSVPA (ICES 1997/J:2).

Available survey indices were:

FLT1: Hydroacoustic survey in Division IIIa and Subdivision IVa East, July 1989–2003, 0–8+ ringers

FLT2: Hydroacoustic survey in Subdivisions 22, 23 and 24, Oct. 1989–2003, 0–8+ ringers

FLT3: IBTS in Division IIIa, Quarter 1, 1991-2004, 1-5 ringers

FLT4: IBTS in Division IIIa, Quarter 3, 1991-2003, 1–5 ringers

FLT5: Larvae survey in Subdivision 24 (Greifswalder Bodden), March-June 1977-2003

All are age-structured indices with Flt 5 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 3.6.1.3).

3.6.1.2 ICA settings

A variety of ICA settings were explored in 2003, and the most indicative of these were again looked at in 2004. The following settings were used for the Final run in 2003 and used again in 2004:

- The period for the separable constraint: 5 years (1999-2003).
- 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.

3.6.1.3 Exploration by individual survey indices

For the assessment in 2004, the following individual survey time-series were used to tune catches in the different exploratory runs.

- **FLT 1a**: DK Hydroacoustic survey in Division IIIa + SD IVaE, July 1991–2003, excl. 1999, 0–8+ ringers
- **FLT 1b**: DK Hydroacoustic survey in Division IIIa+ SD IVaE, July 1991–2003, excl. 1999, 2–8+ ringers

FLT 1a, and 1b are different subsets of the hydroacoustic suvey in Division IIIa in July leaving out the 1999 cruise due to only partial coverage of the area, a different method (vs count) of stock identification, a different research vessel (the Norwegian R/V GO Sars), and a different acoustic set up. FLT 1a was the total 1991-2003 time-series with all age groups 0-8+ ringers. In FLT 1b the 0 and 1-ringers were excluded since only a small fraction of the WBSS have migrated to the Division IIIa at these ages.

- **FLT 2a**: GER Hydroacoustic survey in Subdivisions 22, 23 and 24, Oct. 1991–2003, 0–8+ ringers
- **FLT 2b**: GER Hydroacoustic survey in Subdivisions 22, 23 and 24, Oct. 1991–2003, 0–5 ringers

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

- **FLT 3**: IBTS in Kattegat, Quarter 1, 1991-2004, 1-5 ringers

FLT3 is referring to the Swedish IBTS survey covering the Kattegat in quarter 1. No data are available for 2001 due to the lack of data for separation of stock components.

- **FLT 4**: IBTS in Kattegat, Quarter 3, 1991-2003, 1–5 ringers

FLT4 is referring to the Swedish IBTS survey covering the Kattegat in quarter 3. No survey was carried out in 2000. Old age-classes (6-8+ ringers) are very poorly represented in these IBTS surveys and therefore excluded from the selected indices.

- **FLT 5a**: Larval survey in Subdivision 24 (Greifswalder Bodden), March-June 1991-2003 excluding 1998, linear model
- **FLT 5b:** Larval survey in Subdivision 24 (Greifswalder Bodden), March-June 1991-2003, excluding 1998, power model

FLT5 is the German larval survey conducted in Subdivision 24 on estimating the abundance 30 mm larvae to give an estimate of the recruitment from the Rügen spawning grounds. FLT5a using linear catchability assumption and FLT5 b using a power model are subsets of FLT5 excluding 1998 due to hydrographical anomalies.

Exploratory runs of catch data with single indices were performed using the general ICA-setting mentioned earlier (Section 3.6.1.2). 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 power model did not exhibit a realistic F value. The hydroacoustic survey indices in Division IIIa (FLT1a and FLT1b), the IBTS in Kattegat Q3 (FLT4) and the Acoustic survey in Subdivisions 22- 24 (FLT2a and FLT2b) suggest intermediate F of between 0.4-0.5. On the other hand, the IBTS in Kattegat Q1 (FLT3) indicate a very high F of 0.8 while the larval survey in Subdivision 24 (FLT5a and FLT5b) give extreme opposite indications of fishing mortality depending on the chosen model the data; power- ($F<0.15$) and linear catchability ($F>3.7$).

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 concordance in recent years (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 maybe 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.

Conclusion

After exploring combinations of settings it was decided for the 2004 final run to choose:

- FLT1b (hydroacoustic survey in Division IIIa+ SD IVaE, 2-8+ ringers, excluding 1999),
- FLT2b (hydroacoustic survey in Subdivisions 22-24, 0-5 ringers) and
- FLT4 (IBTS 3rd quarter survey in the Kattegat, 1-5 ringers).

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 poor represented in the Subdivision 22-24 acoustic surveys and in the IBTS. The settings for the final ICA run for the 2004 assessment were the same as in the last year assessment.

This choice of final run is similar to the 2003 final run.

3.6.2 Final Assessment

This assessment conforms to an update assessment of WBSS herring, input data (years 1991-2003, 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 1991–2003, excl. 1999, 2–8+ ringers
- FLT 2b: GER Hydroacoustic survey in Subdivisions 22, 23 and 24, Oct 1991–2003, 0–5 ringers
- FLT 4: IBTS in Kattegat, Quarter 3, 1991-2003, 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 2003 is 158,000 tonnes with a mean fishing mortality (ages 3-6) of 0.38 (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 SD 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 are overall small, with almost no residuals for younger ages and a small increasing trend at older ages 4-7 as well as a reasonably trend-free separable period (1999-2003) but a somewhat large year effect in the final year (2003) (see Figure 3.6.7 but note that the apparent high 2001 year effect is caused by 0-ringers that are down-weighted in the analysis but still appears with full weight in the residual plots of the ICA diagnostics). For values see Table 3.6.12.

The Acoustic Survey in Division IIIa+IVaE and the Acoustic Survey in SD22-24, showed high negative residuals for 2003 (Figure 3.6.11). This pattern was similar for all ages in both surveys except for age 0 and 1 in the Acoustic Survey in SD22-24. This was contrasted by large positive residuals for all ages in the IBTS Kattegat Q3 survey.

The catch-at-age variance component is smaller than each the individual survey variance components and also smaller than the value in Table 3.6.16, unweighted statistics, where down-weighting of the 0-ringers is not accounted for. Among the survey indices, the IBTS has the largest variance component with the two acoustic indices showing variances of about half to two thirds of the IBTS survey (Table 3.6.16).

After a decrease from a period of high fishing mortality in the mid 1990s, the F values in the recent 5 years have been fluctuating between 0.38 and 0.45. The SSB shows a slight increasing trend over the recent years after a marked decline in the mid 1990s.

The fit of the surveys to the population number by age class is similar between the Division IIIa acoustic survey (Figures 3.6.8a-g) and Subdivisions 22-24 acoustic survey (Figures 3.6.9a-g) (FLT1b and FLT2b respectively). both surveys exhibit the best fit for intermediate ages 3-5 ringers, and neither survey has an annual trend in residuals although Subdivisions 22-24 acoustic survey has lower catchability values than the Division IIIa survey (Table 3.6.11). On the other hand, the Kattegat Q3 IBTS-index (FLT4) shows quite poor fit of catchabilities for the age classes 1-3 ringers but improving for the two oldest ages 4 and 5 ringers in the index (Figures 3.6.10a-e). 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 one or two 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 1991-2000 (Figures 3.6.8a-d). Slopes of log catches do not indicate any increasing trend in mortality (Figure 3.6.12a). Slopes from the Subdivision 22-24 acoustic survey are relatively stable (Figure 3.6.12c) whereas for IBTS in Kattegat it shows fluctuation with initially increasing negative values followed by decreasing negative slopes from the 1994 cohort (Figure 3.6.12d). An opposite increasingly negative trend in slopes is found in the log Division IIIa acoustic survey (Figure 3.6.12b). Generally, the trends may be interpreted as an overall stable to decreasing fishing mortality from 1994.

The signal from the catches is relatively stable whereas the survey indices are more scattered and somewhat conflicting, but together provide a compromise in line with the catch information.

3.7 Short-term Projection

The assessment was used to provide a yield-per-recruit plot for herring in Division IIIa and Subdivisions 22-24 (Figure 3.7.1). The values for $\mathbf{F}_{0.1}$ and $\mathbf{F}_{max}$ are 0.20 and 0.40, respectively.

Short-term predictions were carried out using MFDP v.1a software. ICA estimates of population numbers and fishing mortalities were used except for the numbers of 0-ringers in 2003-2006, where the geometric mean of the recruitment over the period 1992–2001 was taken, and for the numbers of 1-ringers in 2003, where the geometric mean over the period 1993-2002 was used. Mean weights-at-age in the catch and in the stock were taken as a mean for the years 2001–2003. A status quo exploitation pattern for 2004 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 2003. For 2004 onwards either status quo F or $\mathbf{F}_{max}$ were used for the predictions. Single options tables are available for 2004 and 2005 (Tables 3.7.2 and 3.7.4).

Scenario	2004	2005	2006
1) *status quo* F	F_{2004}= F_{2003} = 0.385 *Status quo* F Catch = 86,700 t	F_{2004}= F_{2003} = 0.385 *Status quo* F Catch = 91,500 t	F_{2004}= F_{2003} = 0.385 *Status quo* F Catch = 95,000 t
2) *status quo* F followed by $\mathbf{F}_{max}$	F_{2004}= F_{2003} = 0.385 *Status quo* F Catch = 86,700 t	F = 0.74 * F_{2003} = 0.40 $\mathbf{F}_{max}$ = 0.40 Catch = 95,800 t	F = 0.74 * F_{2003} = 0.40 $\mathbf{F}_{max}$ = 0.40 Catch = 98,000 t

The results of the short-term predictions are given in Tables 3.7.2 – 3.7.4. Table 3.7.2 shows single option predictions for 2004-2006 and Table 3.7.3 multiple options for 2005 at status quo fishing mortality. The catches for 2005 and 2006 at status quo fishing mortality were predicted to be 91,000 t and 95,000 t, respectively, which is an overall increase in relation to the current catch level of 78,000 t. The SSB is predicted to increase to 185,000 t in 2005 and to 194,000 t in 2006.

Table 3.7.4 shows single option predictions for 2005 and 2006 at status quo fishing mortality for 2004 and $\mathbf{F}_{max}$ in 2005 and 2006, respectively. The catches for 2005 and 2006 at $\mathbf{F}_{max}$ were predicted to be 96,000 t and 98,000 t, respectively, which is an overall increase in relation to the current catch level. The SSB in 2005 and 2006 is predicted to increase to 184,000 t and 190,000 t, respectively.

3.8 Reference Points

Reference points have neither been defined nor proposed for this stock (see Section 1.7). The time-series is short with revised catch data and reliable splitting factors for only 13 years, the estimated SSB has not been below 116,000 t since 1991 and there is no obvious stock-recruitment relationship.

3.9 Quality of the Assessment

3.9.1 Sensitivity of the assessment to variability in the input data

Prior to this year's assessment a revision of the catch-at-age data was performed, however, the changes do not seem to influence the results and the ICA assessment model appears to perform generally well under a five-years-separable assumption. Western Baltic spring spawners dominate 2003 catches of 0-group herring taken in Division IIIa. However, since representation of WBSS 0-ringers is varying and this component is generally not well represented in the catch, the numbers are highly influenced by split-data for separation of the two stocks and 0-group herring in catches are subsequently down-weighted.

The influence of different surveys was investigated by repeating key exploratory runs from last year's assessment. Generally surveys behaved quite similarly this year compared to last year. The larval survey was found to be heavily influenced by noisy years and no solution was found when 1998 was included. Opposite and extreme results from the larval survey depending on a linear or a power catchability model indicate this to be unreliable at present. The 1st quarter IBTS estimates a quite low SSB and a high F with high residual values. These results were quite in line with the 2003 year's assessment, and lead to the subsequent exclusion of these indices from the final model run.

A comparison of the estimates of SSB based on the information from the individual surveys and the combination of all three is illustrated in Figure 3.9.1.1. A similar signal in relation to SSB is picked up from all indices. Estimates of annual F for the separable period appear to be quite precise (CVs in the order of 12-15%), and reinforce the perception of high fishing pressure on this stock, which was suggested by previous year's analyses.

Bootstrap analyses were performed using the variance-covariance matrix output from the ICA under the assumption of multinomial distributed errors. These estimates give an indication of the minimum uncertainty in the trends of the stock dynamics with the assumed error distribution (Figure 3.9.1.2). The results indicate that fishing mortalities probably have declined from historic high values in the mid 1990s whereas it is difficult to ascertain if SSB has increased since the lowest value in 1998. Recruitment pattern indicate a high year class in 1999 and a distinctively low one in 2002.

3.9.2 Comparison of ICA with XSA

For comparison an XSA run was investigated the settings with a shrinkage of 0.5 are presented in Table 3.9.2.1 and the stock summary in Table 3.9.2.2. The results of the two assessment methods show the same trends in SSB and are differing with no more than 25% in the final year (Figure 3.9.2.1). When the XSA assumptions are similar to those used in ICA (XSA with no shrinkage, the full data set for all the survey used to obtain the survey catchability (Q)), differences are larger than when shrinkage is included. However, the perception of a stock with a slightly increasing SSB to around 150 thousand tonnes in recent years and a slight drop in the final year of 2003 is apparent in all cases.

3.9.3 Comparison with earlier assessments

For the ICA model five years of retrospective patterns were investigated in accordance with a fixed separable period five years. No evident pattern in SSB is apparent whereas there is some bias in the retrospective F-pattern evident as a repeated underestimation of fishing mortality in the final year (Figure 3.9.3.1). As for last year's assessment, the recruitment estimates are noisy for the most recent years (Figure 3.9.3.1). The selection pattern over ages exhibited a reasonable smooth increasing pattern for all retrospective runs, however a similar bias, as found for the F-pattern, appears as a decreasing selection over the 5 year period for all non reference ages (Figure 3.9.3.2).

A retrospective analysis was also performed using the XSA (with shrinkage 0.5). Compared to the ICA patterns the XSA retrospective SSB, fishing mortality and recruitment was less noisy (Figure 3.9.3.3).

The comparison between the results of the HAWG-2003 and HAWG-2004 assessments shows a high similarity with 2-5 percent difference in the SSB and fishing mortality for 2002 (see the following text table).

Category	**Parameter**	**Assessment 2003**	**Assessment 2004**	**Diff. (+/-) %**
ICA input	No. of years for separable constraints	5	5	No
	Reference age for separable constraint	4	4	No
	Selection to be fixed on last age	1	1	No
	Weighting factor to all indices	1	1	No
	Catch down-weighted to 0.1 for 0-ringer	Yes	Yes	No
	Tuning data	Acoust. Surv. Div. IIIa	Acoust. Surv. Div. IIIa	No
		Acoust. Surv. SDs 22-24 (revised for 1991 & 1992)	Acoust. Surv. SDs 22-24	No
		IBTS Surv. Quarter 3	IBTS Surv. Quarter 3	No
ICA results	SSB 2002	177,000 t	185,970 t	+5%
	F(3-6) 2002	0.47	0.48	+2%

3.10 Management Considerations

The stock in Division IIIa is at present managed in accordance with the North Sea herring stock because a considerable proportion of the juveniles of that stock are present in Division IIIa. The herring fishery in Subdivisions 22-24 is managed in accordance with the whole Baltic area as only one TAC is set for that area.

This year's assessment corroborates the perception that the Western Baltic Spring-spawning herring stock is slowly increasing from the low SSB level in 1998. However, $F_{3\text{-}6}$ still appears to be high compared to other herring stocks in European waters, but still below $\mathbf{F}_{max}$.

Increasing German landings from Subdivisions 22 and 24 have counterbalanced decreasing Danish landings in 2002 and 2003. An increasing fishing pressure in the coming years may be expected due to the opening of a new herring processing plant at Rügen.

Short-term predictions demonstrate that a status quo fishing mortality and geometric mean recruitment would lead to an increase of both yield and SSB in 2004. Different scenarios for 2005 and 2006 show an increase of yield and SSB for the two years for both $\mathbf{F}_{sq}$ and $\mathbf{F}_{max}$. Considering that SSB in recent years (1998) has been historically low and that fishing mortality is still relatively high, the WG recommends to limit the fishing mortality effectively to no more than $\mathbf{F}_{max}$ for 2005. This would equal a yield of about 96,000 t.

Following the rebuilding of the North Sea stock to levels around 2 million t, the TACs for NSAS herring have increased. The two stocks are exploited simultaneously in Division IIIa. However, due to asynchronous population dynamics of herring in the North Sea, the Central Baltic and the Western Baltic/Division IIIa, the WG repeats that a proper management of the Western Baltic Spring-spawning herring stock requires a management regime that is separated both from herring in the Central Baltic and in the North Sea. The need for a separate TAC set for the area where WBSS herring is distributed, i.e. Division IIIa and Subdivisions 22-24 should be considered with urgency.

Table 3.1.1 **HERRING in Division IIIa and Subdivisions 22-24. 1985 - 2003**
Landings in thousands of tonnes.
(Data provided by Working Group members 2004).

Year	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
Skagerrak										
Denmark	88.2	94.0	105.0	144.4	47.4	62.3	58.7	64.7	87.8	44.9
Faroe Islands	0.5	0.5								
Norway	4.5	1.6	1.2	5.7	1.6	5.6	8.1	13.9	24.2	17.7
Sweden	40.3	43.0	51.2	57.2	47.9	56.5	54.7	88.0	56.4	66.4
Total	133.5	139.1	157.4	207.3	96.9	124.4	121.5	166.6	168.4	129.0
Kattegat										
Denmark	69.2	37.4	46.6	76.2	57.1	32.2	29.7	33.5	28.7	23.6
Sweden	39.8	35.9	29.8	49.7	37.9	45.2	36.7	26.4	16.7	15.4
Total	109.0	73.3	76.4	125.9	95.0	77.4	66.4	59.9	45.4	39.0
Subdiv. 22+24										
Denmark	15.9	14.0	32.5	33.1	21.7	13.6	25.2	26.9	38.0	39.5
Germany	54.6	60.0	53.1	54.7	56.4	45.5	15.8	15.6	11.1	11.4
Poland	16.7	12.3	8.0	6.6	8.5	9.7	5.6	15.5	11.8	6.3
Sweden	11.4	5.9	7.8	4.6	6.3	8.1	19.3	22.3	16.2	7.4
Total	98.6	92.2	101.4	99.0	92.9	76.9	65.9	80.3	77.1	64.6
Subdiv. 23										
Denmark	6.8	1.5	0.8	0.1	1.5	1.1	1.7	2.9	3.3	1.5
Sweden	1.1	1.4	0.2	0.1	0.1	0.1	2.3	1.7	0.7	0.3
Total	**7.9**	**2.9**	**1.0**	**0.2**	**1.6**	**1.2**	**4.0**	**4.6**	**4.0**	**1.8**
Grand Total	349.0	307.5	336.2	432.4	286.4	279.9	257.8	311.4	294.9	234.4

Year	**1995**	**1996**	**1997**	**1998** [2]	**1999** [2]	**2000**	**2001**	**2002**	**2003** [1]
Skagerrak									
Denmark	43.7	28.7	14.3	10.3	10.1	16.0	16.2	17.0	17.3
Faroe Islands									
Germany									0.7
Norway	[3]	[3]	[3]	[3]	[3]	[3]	[3]		
Sweden	48.5	32.7	32.9	46.9	36.4	45.8	30.8	26.4	25.8
Total	95.2	64.4	50.2	60.2	49.5	64.8	50.0	43.4	43.9
Kattegat									
Denmark	16.9	17.2	8.8	23.7	17.9	18.9	18.8	22.5	14.0
Sweden	30.8	27.0	18.0	29.9	14.6	17.3	16.2	7.2	10.2
Total	47.7	44.2	26.8	53.6	32.5	36.2	35.0	29.7	24.2
Subdiv. 22+24									
Denmark	36.8	34.4	30.5	30.1	32.5	32.6	28.3	11.0	6.1
Germany	13.4	7.3	12.8	9.0	9.8	9.3	**11.4**	22.4	18.8
Poland	7.3	6.0	6.9	6.5	5.3	6.6	9.3	7.0	4.4
Sweden	15.8	9.0	14.5	4.3	2.6	4.8	13.9	10.7	9.6
Total	73.3	56.7	64.7	49.9	50.2	53.3	62.9	51.1	38.9
Subdiv. 23									
Denmark	0.9	0.7	2.2	0.4	0.5	0.9	0.6	0.4	2.3
Sweden	0.2	0.3	0.1	0.3	0.1	0.1	0.2	1.0	0.2
Total	1.1	1.0	2.3	0.7	0.6	1.0	0.8	1.4	2.6
Grand Total	**217.3**	**166.3**	**144.0**	**164.4**	**132.8**	**155.3**	**148.7**	**125.6**	**109.6**

[1]Preliminary data.
[2]Revised data for 1998 and 1999
[3]Revised data for Norway.
Bold= German revised data for 2001

Table 3.2.1 Proportion of North Sea autumn spawners and Western Baltic spring spawners given as % in Skagarrak and Kattegat by age and quarter.
Year: 2003

		Skagerrak				Kattegat			
Quarter	**W-rings**	North Sea autumn SP	W-Baltic Spring SP	**n**	**source**	North Sea autumn SP	W-Baltic Spring SP	**n**	**source**
1	1	99.2%	0.8%	238		87.3%	12.7%	1358	
	2	68.6%	31.4%	51		51.9%	48.1%	335	
	3	*5.6%*	*94.4%*			10.0%	90.0%	150	
	4	*5.6%*	*94.4%*			4.6%	95.4%	153	
	5	*5.6%*	*94.4%*	*18*	(3-8+)	0.0%	100.0%	35	
	6	*5.6%*	*94.4%*			*0.0%*	*100.0%*		
	7	*5.6%*	*94.4%*			*0.0%*	*100.0%*	*19*	(6-8+)
	8+	*5.6%*	*94.4%*			*0.0%*	*100.0%*		
2	1	100.0%	0.0%	49		91.6%	8.4%	298	
	2	58.1%	41.9%	155		42.7%	57.3%	75	
	3	15.7%	84.3%	70		8.3%	91.7%	12	
	4	1.9%	98.1%	107		*5.3%*	*94.7%*		
	5	0.0%	100.0%	59		*5.3%*	*94.7%*		
	6	14.3%	85.7%	14		*5.3%*	*94.7%*	*19*	(4-8+)
	7	*0.0%*	*100.0%*	*16*	(7-8+)	*5.3%*	*94.7%*		
	8+	*0.0%*	*100.0%*			*5.3%*	*94.7%*		
3	0	100.0%	0.0%	*0*	Acoust	100.0%	0.0%	4	
	1	92.9%	7.1%	98		64.5%	35.5%	110	
	2	39.0%	61.0%	182		8.1%	91.9%	297	
	3	15.6%	84.4%	160		0.0%	100.0%	69	
	4	24.9%	75.1%	181		0.0%	100.0%	32	
	5	14.6%	85.4%	41		*0.0%*	*100.0%*		
	6	30.0%	70.0%	10		*0.0%*	*100.0%*	*12*	(5-8+)
	7	*61.5%*	*38.5%*	*13*	(7-8+)	*0.0%*	*100.0%*		
	8+	*61.5%*	*38.5%*			*0.0%*	*100.0%*		
4	0	88.2%	11.8%	51		8.1%	91.9%	296	
	1	91.3%	8.7%	149		72.9%	27.1%	414	
	2	55.3%	44.7%	94		18.3%	81.7%	186	
	3	59.3%	40.7%	54		1.6%	98.4%	62	
	4	*77.8%*	*22.2%*			*10.7%*	*89.3%*		
	5	*77.8%*	*22.2%*			*10.7%*	*89.3%*		
	6	*77.8%*	*22.2%*	*45*	(4-8+)	*10.7%*	*89.3%*	*56*	(4-8+)
	7	*77.8%*	*22.2%*			*10.7%*	*89.3%*		
	8+	*77.8%*	*22.2%*			*10.7%*	*89.3%*		

Proportions as % are calculated using combined otolith microstructure data from Danish and Swedish catches in 2003

Age-classes with few analyses were joined into plus-groups with more than 11 individuals and *indicated by numbers in italics.* In the source column the constructed plus groups are indicated. For 0-ringers in Q3 the proportion from the Acoustic survey in Skagerrak was used.

Table3.2.2 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet

Division: **Skagerrak** **Year:** **2003** **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	4.54	23	42.82	21	47.36	21
	2	24.44	58	39.89	45	64.33	50
	3	2.36	102	0.99	99	3.35	101
	4	7.61	120	0.42	134	8.03	121
	5	4.81	131	0.16	180	4.96	132
	6	1.65	141			1.65	141
	7	1.82	150			1.82	150
	8+	0.60	164			0.60	164
	Total	47.83		84.28		132.11	
	SOP		3,914		2,887		6,800
Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet D+E** Numbers	Mean W.	**Total** Numbers	Mean W.
2	1	11.17	35	0.22	20	11.39	35
	2	79.29	63	1.30	68	80.59	63
	3	5.00	85	0.23	107	5.23	86
	4	3.64	106	0.87	120	4.51	109
	5	1.86	118	0.55	131	2.41	121
	6	0.29	143	0.18	141	0.48	142
	7	0.13	156	0.21	150	0.34	152
	8+	0.06	147	0.07	164	0.13	156
	Total	101.46		3.63		105.08	
	SOP		6,501		362		6,863
Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet D+E** Numbers	Mean W.	**Total** Numbers	Mean W.
3	0						
	1	33.83	72	1.66	72	35.49	72
	2	57.79	109	1.18	89	58.97	108
	3	25.75	136	0.49	121	26.24	136
	4	25.96	159	0.14	166	26.10	159
	5	6.14	168	0.03	169	6.16	168
	6	1.29	204	0.13	160	1.42	200
	7	1.45	235	0.01	246	1.46	235
	8+	0.23	194	0.00	194	0.23	194
	Total	152.44		3.64		156.08	
	SOP		18,041		335		18,377
Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet D+E** Numbers	Mean W.	**Total** Numbers	Mean W.
4	0	0.19	29	17.35	24	17.54	24
	1	54.72	71	18.49	69	73.21	71
	2	26.87	107	3.21	101	30.08	106
	3	9.26	135	0.39	111	9.65	134
	4	9.99	151	0.07	136	10.06	150
	5	0.57	185			0.57	185
	6	0.62	197			0.62	197
	7	0.30	164			0.30	164
	8+						
	Total	102.51		39.51		142.02	
	SOP		9,787		2,059		11,846
Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet D+E** Numbers	Mean W.	**Total** Numbers	Mean W.
Total	0	0.19	29	17.35	24	17.54	24
	1	104.27	66	63.19	36	167.45	55
	2	188.39	83	45.58	51	233.98	77
	3	42.36	128	2.10	107	44.46	127
	4	47.21	147	1.50	129	48.70	146
	5	13.37	148	0.73	143	14.10	148
	6	3.86	171	0.32	149	4.17	170
	7	3.70	185	0.22	154	3.92	183
	8+	0.89	170	0.07	164	0.96	170
	Total	404.24		131.05		535.29	
	SOP		38,242		5,643		43,885

Table 3.2.3 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet.

Division:	Kattegat	Year:	2003	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	30.13	15	200.04	15	230.17	15
	2	63.40	52	13.44	39	76.85	50
	3	16.17	88	1.97	86	18.14	88
	4	12.37	109	1.89	111	14.26	110
	5	2.51	124	0.81	82	3.32	113
	6	0.62	121	0.31	63	0.93	102
	7	0.26	126	0.05	126	0.31	126
	8+	0.28	108	0.05	103	0.33	108
	Total	125.74		218.56		344.31	
	SOP		6,965		4,075		11,040

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
2	1	6.89	17	33.51	18	40.40	17
	2	9.80	49	6.06	41	15.86	46
	3	3.21	88	0.90	69	4.12	83
	4	3.80	103	0.14	102	3.94	103
	5	0.87	125	0.01	125	0.88	125
	6	0.22	126	0.00	123	0.22	126
	7	0.06	126	0.00	126	0.06	126
	8+	0.06	103	0.04	172	0.10	133
	Total	24.90		40.67		65.58	
	SOP		1,415		923		2,338

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
3	0	1.34	12	0.34	12	1.68	12
	1	20.12	62	4.32	62	24.45	62
	2	17.55	94	1.38	104	18.93	95
	3	4.70	116	0.45	134	5.15	118
	4	2.54	123	0.44	125	2.98	123
	5	0.29	136			0.29	136
	6	0.45	119	0.11	119	0.55	119
	7						
	8+						
	Total	47.00		7.04		54.04	
	SOP		3,862		544		4,406

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
4	0	5.09	13	49.37	13	54.47	13
	1	34.08	58	11.46	45	45.54	54
	2	18.09	102	1.10	80	19.19	101
	3	3.43	120	0.06	125	3.49	120
	4	4.70	143			4.70	143
	5	1.15	136			1.15	136
	6	0.34	217			0.34	217
	7						
	8+						
	Total	66.89		61.99		128.89	
	SOP		5,190		1,227		6,417

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
Total	0	6.43	13	49.72	13	56.15	13
	1	91.22	41	249.34	18	340.56	24
	2	108.84	67	21.98	46	130.83	63
	3	27.51	97	3.38	88	30.90	96
	4	23.42	117	2.47	113	25.88	116
	5	4.83	128	0.82	82	5.66	121
	6	1.63	141	0.41	78	2.04	128
	7	0.31	126	0.05	126	0.36	126
	8+	0.34	107	0.09	135	0.43	113
	Total	264.53		328.27		592.80	
	SOP		17,431		6,769		24,199

Table 3.2.4 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet.

North Sea Autumn spawners

Division: **Kattegat** **Year:** **2003** **Country:** **All**

		Fleet C		Fleet D		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	26.29	15	174.56	15	200.85	15
	2	32.93	52	6.98	39	39.91	50
	3	1.62	88	0.20	86	1.81	88
	4	0.57	109	0.09	111	0.65	110
	5						
	6						
	7						
	8+						
	Total	61.41		181.82		243.23	
	SOP		2,308		2,983		5,291
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	6.31	17	30.70	18	37.01	17
	2	4.18	49	2.58	41	6.77	46
	3	0.27	88	0.08	69	0.34	83
	4	0.20	103	0.01	102	0.21	103
	5	0.05	125	0.00	125	0.05	125
	6	0.01	126	0.00	123	0.01	126
	7	0.00	126	0.00	126	0.00	126
	8+	0.00	103	0.00	172	0.01	133
	Total	11.02		33.37		44.40	
	SOP		360		652		1,012
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0	1.34	12	0.34	12	1.68	12
	1	12.99	62	2.79	62	15.78	62
	2	1.42	94	0.11	104	1.53	95
	3						
	4						
	5						
	6						
	7						
	8+						
	Total	15.75		3.25		18.99	
	SOP		950		189		1,139
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	0.41	13	4.00	13	4.42	13
	1	24.86	58	8.36	45	33.22	54
	2	3.31	102	0.20	80	3.51	101
	3	0.06	120	0.00	125	0.06	120
	4	0.50	143			0.50	143
	5	0.12	136			0.12	136
	6	0.04	217			0.04	217
	7						
	8+						
	Total	29.30		12.57		41.86	
	SOP		1,876		440		2,316
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	1.75	12	4.35	12	6.10	12
	1	70.45	39	216.41	17	286.86	23
	2	41.84	57	9.88	41	51.72	54
	3	1.94	89	0.27	81	2.21	88
	4	1.27	122	0.09	110	1.36	121
	5	0.17	133	0.00	125	0.17	133
	6	0.05	195	0.00	123	0.05	195
	7	0.00	126	0.00	126	0.00	126
	8+	0.00	103	0.00	172	0.01	133
	Total	117.47		231.01		348.48	
	SOP		5,495		4,264		9,759

Table 3.2.5 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet.

Baltic Spring spawners

Division: **Kattegat** **Year:** **2003** **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	3.84	15	25.48	15	29.32	15
	2	30.47	52	6.46	39	36.93	50
	3	14.55	88	1.77	86	16.32	88
	4	11.81	109	1.81	111	13.61	110
	5	2.51	124	0.81	82	3.32	113
	6	0.62	121	0.31	63	0.93	102
	7	0.26	126	0.05	126	0.31	126
	8+	0.28	108	0.05	103	0.33	108
	Total	64.34		36.74		101.08	
	SOP		4,657		1,092		5,749
Quarter	**W-rings**	**Fleet C Numbers**	**Fleet C Mean W.**	**Fleet D+E Numbers**	**Fleet D+E Mean W.**	**Total Numbers**	**Total Mean W.**
2	1	0.58	17	2.81	18	3.39	17
	2	5.62	49	3.47	41	9.09	46
	3	2.95	88	0.83	69	3.78	83
	4	3.60	103	0.13	102	3.73	103
	5	0.83	125	0.01	125	0.84	125
	6	0.20	126	0.00	123	0.21	126
	7	0.05	126	0.00	126	0.05	126
	8+	0.05	103	0.04	172	0.09	133
	Total	13.88		7.30		21.18	
	SOP		1,054		271		1,326
Quarter	**W-rings**	**Fleet C Numbers**	**Fleet C Mean W.**	**Fleet D+E Numbers**	**Fleet D+E Mean W.**	**Total Numbers**	**Total Mean W.**
3	0						
	1	7.14	62	1.53	62	8.67	62
	2	16.13	94	1.27	104	17.40	95
	3	4.70	116	0.45	134	5.15	118
	4	2.54	123	0.44	125	2.98	123
	5	0.29	136			0.29	136
	6	0.45	119	0.11	119	0.55	119
	7						
	8+						
	Total	31.25		3.79		35.04	
	SOP		2,912		355		3,266
Quarter	**W-rings**	**Fleet C Numbers**	**Fleet C Mean W.**	**Fleet D+E Numbers**	**Fleet D+E Mean W.**	**Total Numbers**	**Total Mean W.**
4	0	4.68	13	45.37	13	50.05	13
	1	9.22	58	3.10	45	12.32	54
	2	14.79	102	0.90	80	15.69	101
	3	3.38	120	0.06	125	3.44	120
	4	4.20	143			4.20	143
	5	1.03	136			1.03	136
	6	0.30	217			0.30	217
	7						
	8+						
	Total	37.60		49.43		87.02	
	SOP		3,314		786		4,100
Quarter	**W-rings**	**Fleet C Numbers**	**Fleet C Mean W.**	**Fleet D+E Numbers**	**Fleet D+E Mean W.**	**Total Numbers**	**Total Mean W.**
Total	0	4.68	13	45.37	13	50.05	13
	1	20.77	50	32.93	21	53.70	32
	2	67.01	73	12.10	49	79.11	69
	3	25.57	97	3.11	89	28.68	96
	4	22.15	116	2.37	113	24.52	116
	5	4.66	127	0.82	82	5.48	121
	6	1.58	140	0.41	78	1.99	127
	7	0.31	126	0.05	126	0.36	126
	8+	0.33	108	0.09	134	0.42	113
	Total	147.06		97.26		244.32	
	SOP		11,936		2,504		14,440

Table 3.2.6 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet.

North Sea Autumn spawners

Division: **Skagerrak** **Year:** **2003** **Country:** **All**

		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	4.50	23	42.46	21	46.97	21
	2	16.78	58	27.38	45	44.15	50
	3	0.13	102	0.06	99	0.19	101
	4	0.42	120	0.02	134	0.45	121
	5	0.27	131	0.01	180	0.28	132
	6	0.09	141			0.09	141
	7	0.10	150			0.10	150
	8+	0.03	164			0.03	164
	Total	22.33		69.92		92.25	
	SOP		1,211		2,141		3,352
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	11.17	35	0.22	20	11.39	35
	2	46.04	63	0.75	68	46.79	63
	3	0.79	85	0.04	107	0.82	86
	4	0.07	106	0.02	120	0.08	109
	5						
	6	0.04	143	0.03	141	0.07	142
	7						
	8+						
	Total	58.11		1.05		59.16	
	SOP		3,379		65		3,444
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0						
	1	31.41	72	1.54	72	32.95	72
	2	22.55	109	0.46	89	23.01	108
	3	4.02	136	0.08	121	4.10	136
	4	6.45	159	0.03	166	6.49	159
	5	0.90	168	0.00	169	0.90	168
	6	0.39	204	0.04	160	0.43	200
	7	0.89	235	0.01	246	0.90	235
	8+	0.14	194	0.00	194	0.14	194
	Total	66.75		2.16		68.92	
	SOP		6,768		176		6,944
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	0.17	29	15.31	24	15.48	24
	1	49.94	71	16.88	69	66.82	71
	2	14.86	107	1.78	101	16.64	106
	3	5.49	135	0.23	111	5.72	134
	4	7.77	151	0.06	136	7.82	150
	5	0.44	185			0.44	185
	6	0.49	197			0.49	197
	7	0.23	164			0.23	164
	8+						
	Total	79.39		34.25		113.64	
	SOP		7,263		1,736		8,999
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	0.17	29	15.31	24	15.48	24
	1	97.04	65	61.10	36	158.13	54
	2	100.22	79	30.37	50	130.59	72
	3	10.43	131	0.40	111	10.82	130
	4	14.71	153	0.13	142	14.84	153
	5	1.61	167	0.01	177	1.62	167
	6	1.01	192	0.07	152	1.07	190
	7	1.22	215	0.01	246	1.23	215
	8+	0.17	188	0.00	194	0.17	188
	Total	226.58		107.38		333.96	
	SOP		18,622		4,117		22,739

Table 3.2.7 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet.

Baltic Spring spawners

Division: **Skagerrak** **Year:** **2003** **Country:** **All**

Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet D** Numbers	Mean W.	**Total** Numbers	Mean W.
1	1	0.04	23	0.36	21	0.40	21
	2	7.67	58	12.51	45	20.18	50
	3	2.23	102	0.94	99	3.16	101
	4	7.19	120	0.39	134	7.58	121
	5	4.54	131	0.15	180	4.69	132
	6	1.56	141			1.56	141
	7	1.72	150			1.72	150
	8+	0.56	164			0.56	164
	Total	25.50		14.35		39.85	
	SOP		2,702		746		3,448

Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet D+E** Numbers	Mean W.	**Total** Numbers	Mean W.
2	1						
	2	33.25	63	0.54	68	33.80	63
	3	4.21	85	0.19	107	4.41	86
	4	3.58	106	0.85	120	4.43	109
	5	1.86	118	0.55	131	2.41	121
	6	0.25	143	0.16	141	0.41	142
	7	0.13	156	0.21	150	0.34	152
	8+	0.06	147	0.07	164	0.13	156
	Total	43.35		2.58		45.93	
	SOP		3,121		297		3,419

Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet D+E** Numbers	Mean W.	**Total** Numbers	Mean W.
3	0						
	1	2.42	72	0.12	72	2.53	72
	2	35.25	109	0.72	89	35.97	108
	3	21.73	136	0.41	121	22.14	136
	4	19.51	159	0.10	166	19.61	159
	5	5.24	168	0.02	169	5.26	168
	6	0.90	204	0.09	160	1.00	200
	7	0.56	235	0.00	246	0.56	235
	8+	0.09	194	0.00	194	0.09	194
	Total	85.68		1.48		87.16	
	SOP		11,273		160		11,433

Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet D+E** Numbers	Mean W.	**Total** Numbers	Mean W.
4	0	0.02	29	2.04	24	2.06	24
	1	4.77	71	1.61	69	6.39	71
	2	12.00	107	1.44	101	13.44	106
	3	3.77	135	0.16	111	3.93	134
	4	2.22	151	0.02	136	2.24	150
	5	0.13	185			0.13	185
	6	0.14	197			0.14	197
	7	0.07	164			0.07	164
	8+						
	Total	23.12		5.26		28.39	
	SOP		2,523		324		2,847

Quarter	W-rings	**Fleet C** Numbers	Mean W.	**Fleet D+E** Numbers	Mean W.	**Total** Numbers	Mean W.
Total	0	0.02	29	2.04	24	2.06	24
	1	7.23	71	2.09	61	9.32	69
	2	88.17	87	15.22	53	103.39	82
	3	31.94	127	1.70	106	33.64	126
	4	32.49	144	1.37	128	33.86	143
	5	11.76	146	0.72	142	12.48	146
	6	2.85	164	0.25	148	3.10	163
	7	2.48	170	0.21	152	2.69	169
	8+	0.72	166	0.07	164	0.79	166
	Total	177.66		23.67		201.33	
	SOP		19,620		1,526		21,146

Table 3.2.8 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet.

				North Sea Autumn spawners			
	Division:		**IIIa**	**Year:**	**2003**	**Country:**	**All**
		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	1	30.80	16	217.02	16	247.82	16
	2	49.71	54	34.36	44	84.06	50
	3	1.75	89	0.25	89	2.00	89
	4	0.99	114	0.11	116	1.10	114
1	5	0.27	131	0.01	180	0.28	132
	6	0.09	141			0.09	141
	7	0.10	150			0.10	150
	8+	0.03	164			0.03	164
	Total	83.73		251.75		335.48	
	SOP		3,519		5,124		8,643
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	1	17.48	28	30.92	18	48.40	22
	2	50.22	62	3.34	47	53.56	61
	3	1.05	86	0.11	81	1.16	85
	4	0.27	104	0.02	115	0.29	105
2	5	0.05	125	0.00	125	0.05	125
	6	0.05	139	0.03	141	0.08	140
	7	0.00	126	0.00	126	0.00	126
	8+	0.00	103	0.00	172	0.01	133
	Total	69.13		34.42		103.55	
	SOP		3,740		716		4,456
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0	1.34	12	0.34	12	1.68	12
	1	44.40	69	4.33	66	48.73	69
	2	23.96	108	0.57	92	24.54	108
	3	4.02	136	0.08	121	4.10	136
	4	6.45	159	0.03	166	6.49	159
3	5	0.90	168	0.00	169	0.90	168
	6	0.39	204	0.04	160	0.43	200
	7	0.89	235	0.01	246	0.90	235
	8+	0.14	194	0.00	194	0.14	194
	Total	82.50		5.41		87.91	
	SOP		7,718		365		8,083
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0	0.58	17	19.31	21	19.89	21
	1	74.80	67	25.24	61	100.04	65
	2	18.17	106	1.98	99	20.15	105
	3	5.54	135	0.23	111	5.77	134
	4	8.27	150	0.06	136	8.33	150
4	5	0.57	174			0.57	174
	6	0.52	199			0.52	199
	7	0.23	164			0.23	164
	8+						
	Total	108.69		46.81		155.50	
	SOP		9,139		2,176		11,315
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
	0	1.92	13	19.65	21	21.58	20
	1	167.48	54	277.51	21	444.99	34
	2	142.06	73	40.25	48	182.31	67
	3	12.37	124	0.67	99	13.04	123
	4	15.98	151	0.22	128	16.21	150
Total	5	1.78	163	0.01	174	1.79	163
	6	1.05	193	0.07	152	1.12	190
	7	1.23	214	0.01	244	1.23	215
	8+	0.18	187	0.00	180	0.18	187
	Total	344.05		338.39		682.44	
	SOP		24,116		8,381		32,498

Table 3.2.9 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age, quarter and fleet.

Baltic Spring spawners

Division: **IIIa** **Year:** **2003** **Country:** **All**

		Fleet C		**Fleet D**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	3.88	15	25.84	15	29.72	15
	2	38.14	53	18.98	43	57.12	50
	3	16.78	90	2.71	90	19.49	90
	4	18.99	113	2.20	115	21.20	114
	5	7.05	128	0.96	97	8.01	124
	6	2.18	136	0.31	63	2.49	127
	7	1.98	147	0.05	126	2.03	147
	8+	0.85	145	0.05	103	0.90	143
	Total	89.84		51.09		140.93	
	SOP		7,359		1,837		9,197
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	0.58	17	2.81	18	3.39	17
	2	38.87	61	4.02	45	42.89	60
	3	7.16	86	1.02	76	8.18	85
	4	7.18	105	0.98	118	8.16	106
	5	2.68	120	0.56	131	3.25	122
	6	0.45	135	0.16	141	0.61	137
	7	0.19	148	0.21	150	0.40	149
	8+	0.12	128	0.11	167	0.23	146
	Total	57.23		9.88		67.11	
	SOP		4,176		569		4,744
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0						
	1	9.55	64	1.65	63	11.20	64
	2	51.38	104	1.99	99	53.37	104
	3	26.43	132	0.86	128	27.29	132
	4	22.05	155	0.54	132	22.59	154
	5	5.53	167	0.02	169	5.56	167
	6	1.35	176	0.20	138	1.55	171
	7	0.56	235	0.00	246	0.56	235
	8+	0.09	194	0.00	194	0.09	194
	Total	116.93		5.27		122.20	
	SOP		14,185		514		14,699
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	4.70	13	47.41	13	52.11	13
	1	13.99	62	4.71	53	18.71	60
	2	26.79	104	2.34	93	29.12	103
	3	7.15	128	0.21	115	7.37	128
	4	6.42	146	0.02	136	6.43	146
	5	1.16	142			1.16	142
	6	0.44	211			0.44	211
	7	0.07	164			0.07	164
	8+						
	Total	60.72		54.69		115.41	
	SOP		5,837		1,110		6,947
		Fleet C		**Fleet D+E**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	4.70	13	47.41	13	52.11	13
	1	28.00	55	35.02	23	63.02	37
	2	155.18	81	27.32	52	182.49	76
	3	57.51	114	4.81	95	62.32	112
	4	54.64	133	3.74	118	58.38	132
	5	16.42	141	1.54	110	17.97	138
	6	4.43	155	0.67	104	5.09	149
	7	2.79	165	0.26	147	3.05	164
	8+	1.05	147	0.16	147	1.21	147
	Total	324.72		120.93		445.65	
	SOP		31,557		4,030		35,587

Table 3.2.10 Landings in numbers (mill.), mean weight (g.) and SOP (t) by age and quarter.

Division: 22-24 **Year:** 2003 **Country:** ALL

Quarter	W-rings	Sub-division 22		Sub-division 23		Sub-division 24		Total	
		Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	2.29	14	2.68	14	19.30	13	24.27	13
	2	12.81	41	1.73	48	44.74	38	59.28	39
	3	11.78	86	1.09	86	39.41	72	52.27	75
	4	9.92	93	1.05	111	49.09	104	60.06	102
	5	4.87	109	0.22	125	27.66	131	32.75	127
	6	0.47	144	0.06	123	7.61	159	8.14	158
	7	0.99	120	0.03	126	7.35	187	8.37	179
	8+			0.03	103	3.09	198	3.12	197
	Total	43.14		6.88		198.25		248.26	
	SOP		3,205		371		16,717		20,293

Quarter	W-rings	Sub-division 22		Sub-division 23		Sub-division 24		Total	
		Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1					1.74	12	1.74	12
	2	0.07	44			3.67	43	3.74	43
	3	4.51	84			21.56	67	26.08	70
	4	2.81	98			45.17	85	47.98	85
	5	0.73	110			41.17	109	41.90	109
	6	0.29	117			10.39	118	10.67	118
	7					3.73	131	3.73	131
	8+					3.42	138	3.42	138
	Total	8.40				130.85		139.25	
	SOP		773				12,118		12,890

Quarter	W-rings	Sub-division 22		Sub-division 23		Sub-division 24		Total	
		Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0								
	1	12.89	29			0.97	33	13.86	29
	2	0.66	40	0.36	150	2.39	52	3.41	60
	3			0.30	172	2.48	59	2.79	71
	4			1.34	187	2.86	51	4.20	94
	5			0.76	209	0.69	78	1.45	147
	6			0.05	233	0.55	58	0.60	72
	7					0.41	52	0.41	52
	8+			0.03	201			0.03	201
	Total	13.56		2.85		10.35		26.75	
	SOP		399		534		553		1,486

Quarter	W-rings	Sub-division 22		Sub-division 23		Sub-division 24		Total	
		Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	0.11	23			1.26	22	1.37	22
	1	2.04	37			21.95	37	23.99	37
	2	1.27	67	0.56	150	14.06	68	15.89	70
	3	1.14	82	0.47	172	13.05	83	14.67	86
	4	0.82	79	2.09	187	9.92	83	12.82	99
	5	0.38	81	1.18	209	4.52	88	6.07	111
	6	0.27	81	0.08	233	3.10	82	3.45	86
	7	0.04	60			0.54	84	0.58	82
	8+	0.02	107	0.04	201	0.37	97	0.44	108
	Total	6.10		4.43		68.77		79.30	
	SOP		380		830		4,436		5,646

Quarter	W-rings	Sub-division 22		Sub-division 23		Sub-division 24		Total	
		Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	0.11	23			1.26	22	1.37	22
	1	17.22	28	2.68	14	43.96	26	63.86	26
	2	14.82	43	2.66	84	64.86	46	82.33	46
	3	17.43	85	1.87	122	76.50	72	95.80	75
	4	13.55	93	4.48	169	107.03	92	125.06	95
	5	5.98	107	2.16	200	74.03	116	82.18	117
	6	1.03	120	0.18	199	21.64	126	22.86	126
	7	1.03	118	0.03	126	12.04	161	13.10	157
	8+	0.02	107	0.10	174	6.88	163	7.01	163
	Total	71.20		14.15		408.21		493.56	
	SOP		4,757		1,734		33,823		40,315

Table 3.2.11 Landings in numbers (mill.), mean weight (g.) and SOP (t)
by age and quarter from. Western Baltic Spring Spawners
(values from the North Sea, see Table 2.2.1-2.2.5)
Division: IV + IIIa + 22-24 **Year: 2003**

		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1			29.72	15	24.27	13	53.99	14
	2			57.12	50	59.28	39	116.40	44
	3			19.49	90	52.27	75	71.75	79
	4			21.20	114	60.06	102	81.25	105
	5			8.01	124	32.75	127	40.76	127
	6			2.49	127	8.14	158	10.63	151
	7			2.03	147	8.37	179	10.39	173
	8+			0.90	143	3.12	197	4.02	185
	Total	0.00		140.93		248.26		389.19	
	SOP		0		9,197		20,293		29,490
		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1			3.39	17	1.74	12	5.13	15
	2	0.03	101	42.89	60	3.74	43	46.66	58
	3	0.97	120	8.18	85	26.08	70	35.23	75
	4	3.27	131	8.16	106	47.98	85	59.41	91
	5	2.10	160	3.25	122	41.90	109	47.25	112
	6	0.70	171	0.61	137	10.67	118	11.99	122
	7	0.62	177	0.40	149	3.73	131	4.74	138
	8+	0.38	188	0.23	146	3.42	138	4.02	143
	Total	8.07		67.11		139.25		214.43	
	SOP		1,186		4,744		12,890		18,820
		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0								
	1			11.20	64	13.86	29	25.07	45
	2			53.37	104	3.41	60	56.78	101
	3	2.16	143	27.29	132	2.79	71	32.23	128
	4	2.72	154	22.59	154	4.20	94	29.51	146
	5	1.41	167	5.56	167	1.45	147	8.41	163
	6	0.46	181	1.55	171	0.60	72	2.61	150
	7	0.69	192	0.56	235	0.41	52	1.66	172
	8+	0.23	199	0.09	194	0.03	201	0.34	198
	Total	7.66		122.20		26.75		156.62	
	SOP		1,222		14,699		1,486		17,407
		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0			52.11	13	1.37	22	53.49	13
	1			18.71	60	23.99	37	42.70	47
	2			29.12	103	15.89	70	45.02	92
	3			7.37	128	14.67	86	22.03	100
	4			6.43	146	12.82	99	19.26	115
	5			1.16	142	6.07	111	7.23	116
	6			0.44	211	3.45	86	3.89	100
	7			0.07	164	0.58	82	0.65	90
	8+					0.44	108	0.44	108
	Total	0.00		115.41		79.30		194.71	
	SOP		0		6,947		5,646		12,593
		Division IV		Division IIIa		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0			52.11	13	1.37	22	53.49	13
	1			63.02	37	63.86	26	126.88	32
	2	0.03	101	182.49	76	82.33	46	264.86	67
	3	3.13	136	62.32	112	95.80	75	161.25	91
	4	5.99	141	58.38	132	125.06	95	189.43	108
	5	3.50	163	17.97	138	82.18	117	103.65	122
	6	1.17	175	5.09	149	22.86	126	29.12	132
	7	1.31	185	3.05	164	13.10	157	17.45	160
	8+	0.60	192	1.21	147	7.01	163	8.82	163
	Total	15.73		445.65		493.56		954.94	
	SOP		2,408		35,587		40,315		78,309

Table 3.2.12 Total catch in numbers (mill) and mean weight (g), SOP (tonnes) of Western Baltic Spring spawners in Division IIIa and the North Sea in the years 1991-2003.

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

Data for 1995 to 2001 is revised.

Table 3.2.13 Transfers of North Sea autumn spawners from Div. IIIa to the North Sea
Numbers (mill) and mean weight, SOP in (tonnes) 1991-2003.

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

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

Table 3.2.14 Total catch in numbers (mill) of spring spawners in Division IIIa and the North Sea + in Sub-Divisions 22-24 in the years 1991-2003

	W-rings	0	1	2	3	4	5	6	7	8+	Total
Year	**Area**										
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

Data for 1995-2001 for the North Sea and Div. IIIa is revised.

Table 3.2.15 Mean weight (g) and SOP (tons) of spring spawners in Division IIIa + the North Sea and in Sub-Divisions 22-24 in the years 1991 - 2003

	W-rings	0	1	2	3	4	5	6	7	8+	SOP
Year	**Area**										
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

Data for 1995-2001 for the North Sea and Div. IIIa is revised.

Table 3.2.16 Herring in Division IIIa, IIIb and IIIc.
Samples of commercial landings by quarter and area for 2003 available to the Working Group.

	Country	Quarter	Landings in '000 tons	Numbers of samples	Numbers of fish meas.	Numbers of fish aged
Skagerrak	**Denmark**	**1**	3.2	3	220	196
		2	+	4	587	290
		3	7.9	24	651	466
		4	6.1	18	674	432
	Total		17.2	49	2,132	1,384
	Germany	**1**	0.0			
		2	0.0		No data available	
		3	0.5			
		4	0.2			
	Total		0.7	0	0	0
	Sweden	**1**	3.6	7	350	350
		2	6.8	18	884	884
		3	10.0	7	316	316
		4	5.5	35	1,723	1,723
	Total		25.9	67	3,273	3,273
Kattegat	**Denmark**	**1**	6.9	21	2,671	1,928
		2	1.6	8	872	410
		3	2.3	15	777	495
		4	3.2	29	1,742	1,058
	Total		14.0	73	6,062	3,891
	Sweden	**1**	4.2	17	850	850
		2	0.7	1	50	50
		3	2.1	0		
		4	3.3	3	138	138
	Total		10.3	21	1,038	1,038
Sub-Division 22	**Denmark**	**1**	0.5	1	1	1
		2	0.3	1	20	
		3	0.1	4	209	78
		4	0.1	1	6	
	Total		1.0	7	236	79
	Germany	**1**	2.7			
		2	0.4		No data available	
		3	0.3			
		4	0.3			
	Total		3.7	0	0	0
Sub-Division 23	**Denmark**	**1**	0.3		No data available	
		2	0.0			
		3	0.5		No data available	
		4	0.7	1	195	105
	Total		1.5	1	195	105
	Sweden	**1**	0.1			
		2	0.0		No data available	
		3	0.1			
		4	0.1			
	Total		0.3	0	0	0
Sub-Division 24	**Denmark**	**1**	3.8	3	364	94
		2	+	1	136	49
		3	+			
		4	1.2			
	Total		5.0	4	500	143
	Germany	**1**	7.2	14	4,824	1,178
		2	7.4	17	7,033	1,297
		3	+		No data available	
		4	0.5	2	702	251
	Total		15.1	33	12,559	2,726
	Poland	**1**	0.7	2	993	250
		2	3.6	6	1,301	340
		3	+	1	441	114
		4	0.1	1	483	122
	Total		4.4	10	3218	826
	Sweden	**1**	5.1	12	584	584
		2	1.0	5	231	231
		3	0.5	1	50	50
		4	2.8	9	448	448
	Total		9.4	27	1,313	1,313

Table 3.2.17 Herring in Division IIIa.

Samples of landings by quarter and area, used to estimate catch in numbers and mean weight by age for 2003

	Country	Quarter	Fleet	Sampling
Skagerrak	**Denmark**	**1**	**C**	Danish sampling in Q1
		2	**C**	Danish sampling in Q1
		3	**C**	Danish sampling in Q3
		4	**C**	Danish sampling in Q4
	Germany	**1**	**C**	No catch
		2	**C**	
		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
Kattegat	**Denmark**	**1**	**C**	Danish sampling in Q1
		2	**C**	Danish sampling in Q1
		3	**C**	Danish sampling in Q3
		4	**C**	Danish sampling in Q4
	Sweden	**1**	**C**	Swedish sampling in Q1
		2	**C**	Swedish sampling in Q2
		3	**C**	Swedish sampling in Q3
		4	**C**	Swedish sampling in Q4
Skagerrak	**Denmark**	**1**	**D**	Danish sampling in Q1
		2	**D**	Danish sampling in Q1
		3	**D**	Danish sampling in Q3
		4	**D**	Danish sampling in Q4
	Sweden	**1**	**D**	Swedish sampling in Q1
		2	**D**	Danish sampling in Q2
		3	**D**	Danish sampling in Q3
		4	**D**	Swedish sampling in Q4
Kattegat	**Denmark**	**1**	**D**	Danish sampling in Q1
		2	**D**	Danish sampling in Q2
		3	**D**	Danish sampling in Q3
		4	**D**	Danish sampling in Q4
	Sweden	**1**	**D**	Danish sampling in Q1
		2	**D**	Danish sampling in Q2
		3	**D**	No catch
		4	**D**	Swedish sampling in Q4

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

Table 3.2.17 continued. Herring in Division IIIb and IIIc.
Samples of landings by quarter, and area used to estimate catch in numbers and mean weight by age for 2003

	Country	Quarter	Fleet	Sampling
Sub-Division 22	**Denmark**	**1**	**F**	Danish sampling in Q1
		2	**F**	Danish sampling in Q2
		3	**F**	Danish sampling in Q3
		4	**F**	Danish sampling in Q4
	Germany	**1**	**F**	German sampling in Q1 in Sub-div 24
		2	**F**	German sampling in Q2 in Sub-div 24
		3	**F**	German sampling in Q4 in Sub-div 24
		4	**F**	German sampling in Q4 in Sub-div 24
Sub-Division 23	**Denmark**	**1**	**F**	Danish sampling in Q1 in Kattegat
		2	**F**	Danish sampling in Q2 in Kattegat
		3	**F**	Danish sampling in Q3
		4	**F**	Danish sampling in Q4
	Sweden	**1**	**F**	Danish sampling in Q1 in Kattegat
		2	**F**	Danish sampling in Q2 in Kattegat
		3	**F**	Danish sampling in Q3
		4	**F**	Danish sampling in Q4
Sub-Division 24	**Denmark**	**1**	**F**	Danish sampling in Q1
		2	**F**	Danish sampling in Q2
		3	**F**	Danish sampling in Q4
		4	**F**	Danish sampling in Q4
	Germany	**1**	**F**	German sampling in Q1
		2	**F**	German sampling in Q2
		3	**F**	No landings
		4	**F**	German sampling in Q4
	Poland	**1**	**F**	Polish sampling in Q1
		2	**F**	Polish sampling in Q2
		3	**F**	German sampling in Q3
		4	**F**	German sampling in Q4
	Sweden	**1**	**F**	Swedish sampling in Q1
		2	**F**	Danish sampling in Q2
		3	**F**	Swedish sampling in Q3
		4	**F**	Swedish sampling in Q4

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

Table 3.3.1 International Bottom Trawl Survey in the Kattegat in quarter 1. Mean catch of spring-spawning herring at age in number per haul.

Year	Winter rings				
	1	2	3	4	5
1990	416	681	65	43	11
1991	190	206	144	25	20
1992	588	82	33	21	13
1993	3140	554	81	35	50
1994	1380	256	112	22	31
1995	781	132	30	42	24
1996	1312	1405	160	42	22
1997	3267	229	119	15	18
1998	407	853	165	74	8
1999	309	66	43	21	14
2000	1933	219	28	10	7
2001*	-	-	-	-	-
2002	2335	178	222	23	7
2003	1364	1495	41	10	0
2004	147	144	37	6	2

* = no data available

Table 3.3.2 International Bottom Trawl Survey in the Kattegat in quarter 3. Mean catch of spring-spawning herring at age in number per haul.

Year	Winter rings				
	1	2	3	4	5
1991	141	83	101	41	24
1992	372	108	70	63	25
1993	404	159	42	36	25
1994	265	229	154	49	36
1995	687	192	113	99	29
1996	631	322	31	17	11
1997	52	122	33	8	13
1998	118	86	22	27	5
1999	292	116	71	34	14
2000*	-	-	-	-	-
2001	313	190	72	18	2
2002	1568	169	100	16	6
2003	969	550	170	53	29

* = no survey was carried out in 2000

Table 3.3.3 Acoustic surveys on the Spring Spawning HERRING in the North Sea / Division IIIa in 1991-2003 (July).

Year	**1991**	**1992***	**1993***	**1994***	**1995***	**1996***	**1997**	**1998**	**1999****	**2000**	**2001**	**2002**	**2003**
	Numbers in millions												
W-rings													
0		3,853	372	964									
1		277	103	5	2,199	1,091	128	138	1367	1509	66	3346	1833
2	1,864	2,092	2,768	413	1,887	1,005	715	1,682	1143	1891	641	1577	1110
3	1,927	1,799	1,274	935	1,022	247	787	901	523	674	452	1393	395
4	866	1,593	598	501	1,270	141	166	282	135	364	153	524	323
5	350	556	434	239	255	119	67	111	28	186	96	88	103
6	88	197	154	186	174	37	69	51	3	56	38	40	25
7	72	122	63	62	39	20	80	31	2	7	23	18	12
8+	10	20	13	34	21	13	77	53	1	10	12	17	5
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+ group	**3,313**	**4,287**	**2,536**	**1,957**	**2,781**	**577**	**1,245**	**1,428**	**691**	**1,295**	**774**	**2,079**	**864**
	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
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
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
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
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
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
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
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
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
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
	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
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
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
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
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
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
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
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
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

* 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 Acoustic survey on the Spring Spawning Herring in Sub-divisions 22-24 in 1991-2003 (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
	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
1	2,507	2,179	345	412	1,163	1,084	1,389	451	1,145	1,208	1,314	611	781
2	880	1,015	354	823	307	541	492	557	246	477	1,761	372	200
3	852	465	485	540	332	413	343	364	187	348	1,013	566	230
4	259	233	381	433	342	282	151	232	129	206	357	337	276
5	102	71	122	182	247	283	112	99	44	81	92	61	103
6	49	32	52	56	124	110	92	51	8	39	55	23	41
7	6	8	28	22	40	44	32	23	1	5	5	3	9
8+	27	9	13	2	27	18	46	9	2	4	0	13	11
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
3+ group	1,295	818	1,080	1,235	1,112	1,151	775	778	370	682	1,522	1,002	671
	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
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
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
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
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
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
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
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
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
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
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
	Mean weight (g)												
W-rings													
0	11.11	14.10	14.42	11.24	10.26	8.66	9.82	9.36	11.24	12.57	11.69	8.50	8.52
1	39.03	35.72	35.65	34.74	34.00	30.39	35.57	40.25	36.97	39.33	45.00	39.14	31.66
2	68.19	56.66	44.28	46.31	64.48	49.59	59.41	74.26	76.41	62.25	67.39	72.79	74.45
3	90.20	84.89	61.32	72.60	85.87	70.75	93.11	90.40	117.57	83.35	92.25	99.19	101.22
4	113.47	122.29	61.64	95.46	114.53	71.05	139.16	118.27	101.76	117.13	95.74	118.22	131.24
5	132.20	148.66	100.90	125.90	108.02	119.68	142.28	113.98	127.52	114.13	125.98	142.63	151.01
6	130.36	161.01	129.59	203.98	118.13	133.54	143.37	120.50	107.15	142.99	137.01	142.84	150.92
7	133.03	205.68	80.16	222.60	222.04	128.46	161.65	158.10	232.70	202.91	175.65	205.51	155.68
8+	132.53	224.36	137.54	269.56	241.09	154.73	222.18	232.86	219.08	180.94	-	143.51	165.62
Total	34.15	36.32	45.26	32.41	34.15	42.54	38.30	41.22	23.92	47.13	53.96	32.71	29.10

[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: Appendix 3 (Table 2.2)
[2)] incl. estimates for Sub-division 23, which was covered by RV ARGOS (Sweden) in November 2001
[3)] revised in 2003 due to revised Sa values

Table 3.3.5 Estimation of the herring 0-Group (TL >=30 mm) Greifswalder Bodden and adjacent waters (March/April to June)

Year	Number in Millions
1977	2000[1]
1978	100[1]
1979	2200[1]
1980	360[1]
1981	200[1]
1982	180[1]
1983	1760[1]
1984	290[1]
1985	1670[1]
1986	1500[1]
1987	1370[1]
1988	1223[2]
1989	63[2]
1990	57[2]
1991	236[3]
1992	18[4]
1993	199[4]
1994	788[4]
1995	171[4]
1996	31[4]
1997	54[4]
1998	2553[4]
1999	1945[4]
2000	151[4]
2001	421[4]
2002	2051[4]
2003	2005[5]

[1] Brielmann 1989
[2] Klenz 1999 Inf.Fischwirtsch. Fischereiforsch. 46(2), 1999: 15-17
[3] Müller & Klenz 1994
[4] Klenz 2002 Inf.Fischwirtsch. Fischereiforsch. 49(4), 2002: 143-144
[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
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
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
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
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
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
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
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
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
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

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
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
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
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
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
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
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
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
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
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

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
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
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
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
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
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
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
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
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
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

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
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
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
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
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
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
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
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
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
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

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
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
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
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
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
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
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
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

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
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
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
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
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
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
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

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
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
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
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
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
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

Table 3.6.6 WESTERN BALTIC HERRING:
Input parameters for ICA FINAL Run

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                         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 2004  used for the year 2003
west.low
 Natural mortality in 2004  used for the year 2003
natmor.low
 Maturity ogive in 2004  used for the year 2003
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 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
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-->   5.0000000000000003E-02
 Enter highest feasible F-->    1.000000000000000
```

Table 3.6.6 continued

```
Mapping the F-dimension of the SSQ surface
    F              SSQ
+--------+------------------
    0.05        30.6511972634
    0.10        19.5119137844
    0.15        16.2674747282
    0.20        15.1619367652
    0.25        14.8548163498
    0.30        14.9238308574
    0.35        15.2029734950
    0.40        15.6142106609
    0.45        16.1154390250
    0.50        16.6818866190
    0.55        17.2983347644
    0.60        17.9555488927
    0.65        18.6483795796
    0.70        19.3748296956
    0.75        20.1355880470
    0.80        20.9339489733
    0.85        21.7761862147
    0.90        22.6722656646
    0.95        23.6375888570
    1.00        24.6962198192
Lowest SSQ is for F =     0.262
-----------------------------------------------------------------
No of years for separable analysis : 5
Age range in the analysis : 0  . . . 8
Year range in the analysis : 1991  . . . 2003
Number of indices of SSB : 0
Number of age-structured indices : 3
Parameters to estimate : 41
Number of observations : 262
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 2003  at age 4  is 0.404547  in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->n
 Output page width in characters (e.g. 80..132) ?--> 132
 Estimate historical assessment uncertainty ?-->n
Succesful exit from ICA
```

Table. 3.6.7 WESTERN BALTIC HERRING. Output from ICA Final Run
FISHING MORTALITY (per year)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	0.02800	0.04722	0.08129	0.05081	0.16525	0.04748	0.12184	0.12491	0.06659	0.08110	0.07541	0.06950	0.05580
1	0.26024	0.17496	0.30000	0.16386	0.64487	0.37219	0.32582	0.37629	0.22637	0.27570	0.25636	0.23624	0.18968
2	0.32119	0.37377	0.35329	0.42507	0.59136	0.38430	0.34973	0.44242	0.31282	0.38099	0.35426	0.32646	0.26212
3	0.42298	0.37338	0.47908	0.50801	0.51328	0.59580	0.50232	0.39005	0.37127	0.45218	0.42045	0.38746	0.31110
4	0.40360	0.47833	0.50181	0.65679	0.53038	0.73160	0.47133	0.54796	0.48279	0.58800	0.54675	0.50384	0.40455
5	0.37995	0.50584	0.63668	0.71564	0.44402	0.83832	0.50327	0.58328	0.47180	0.57462	0.53430	0.49237	0.39534
6	0.25038	0.58571	0.59858	0.93829	0.61098	0.74891	0.67954	0.57925	0.50998	0.62112	0.57754	0.53222	0.42733
7	0.43837	0.49766	0.58801	0.65725	0.75310	0.74335	0.58625	0.61429	0.48279	0.58800	0.54675	0.50384	0.40455
8	0.43837	0.49766	0.58801	0.65725	0.75310	0.74335	0.58625	0.61429	0.48279	0.58800	0.54675	0.50384	0.40455

Table. 3.6.8 WESTERN BALTIC HERRING. Output from ICA Final Run
POPULATION ABUNDANCE (millions)- 1 January

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	4983.2	3636.9	3049.5	6142.0	4096.6	4267.3	3790.5	5402.3	6149.7	3716.0	4987.0	2320.9	3122.3	2651.5
1	4531.7	3589.7	2570.0	2082.7	4324.7	2572.6	3014.7	2486.0	3532.2	4262.3	2538.4	3426.1	1603.9	2187.6
2	2162.2	2118.8	1827.8	1154.8	1072.3	1376.4	1075.4	1320.1	1035.0	1708.4	1962.3	1191.5	1640.8	804.7
3	1792.9	1284.0	1193.7	1051.1	618.1	486.0	767.3	620.6	694.4	619.7	955.6	1127.3	703.8	1033.6
4	923.3	961.6	723.7	605.3	517.8	302.9	219.3	380.2	344.0	392.2	322.8	513.8	626.5	422.2
5	615.6	504.9	488.0	358.7	257.0	249.4	119.3	112.1	179.9	173.8	178.4	153.0	254.2	342.3
6	230.6	344.7	249.3	211.4	143.6	135.0	88.3	59.1	51.2	91.9	80.1	85.6	76.6	140.1
7	40.9	147.0	157.1	112.2	67.7	63.8	52.2	36.6	27.1	25.2	40.4	36.8	41.2	40.9
8	15.2	63.0	60.3	75.0	42.1	52.2	59.4	33.6	17.4	26.3	17.4	23.0	29.0	38.4

Table. 3.6.9 WESTERN BALTIC HERRING. Output from ICA Final Run
STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 6	SoP (%)
1991	4983170	610749	305979	191573	0.6261	0.3642	99
1992	3636850	535298	316665	194411	0.6139	0.4858	100
1993	3049470	458018	290257	185010	0.6374	0.5540	100
1994	6142000	371379	227022	172438	0.7596	0.7047	99
1995	4096610	312785	178950	150831	0.8429	0.5247	100
1996	4267330	268315	130132	121266	0.9319	0.7287	100
1997	3790500	267415	144454	115588	0.8002	0.5391	100
1998	5402280	260700	116874	107032	0.9158	0.5251	99
1999	6149710	272658	120198	97240	0.8090	0.4590	100
2000	3715980	283454	132296	109914	0.8308	0.5590	100
2001	4987010	309575	148652	105803	0.7117	0.5198	99
2002	2320900	353607	185970	106191	0.5710	0.4790	99
2003	3122340	274301	157610	78309	0.4969	0.3846	99

Table. 3.6.10 WESTERN BALTIC HERRING. Output from ICA Final Run
PARAMETER ESTIMATES

Separable model : F by year

1	1999	0.4828	13	0.3692	0.6314	0.4210	0.5536	0.4873
2	2000	0.5880	12	0.4558	0.7585	0.5164	0.6696	0.5930
3	2001	0.5467	13	0.4209	0.7102	0.4784	0.6248	0.5516
4	2002	0.5038	14	0.3792	0.6695	0.4358	0.5825	0.5092
5	2003	0.4045	16	0.2913	0.5619	0.3421	0.4784	0.4103

Separable Model: Selection (S) by age

6	0	0.1379	37	0.0659	0.2887	0.0946	0.2011	0.1481
7	1	0.4689	16	0.3425	0.6418	0.3995	0.5503	0.4749
8	2	0.6479	15	0.4793	0.8759	0.5556	0.7556	0.6556
9	3	0.7690	15	0.5703	1.0369	0.6602	0.8957	0.7780
	4	1.0000		Fixed : Reference Age				
10	5	0.9772	13	0.7462	1.2799	0.8516	1.1214	0.9865
11	6	1.0563	13	0.8159	1.3675	0.9259	1.2051	1.0655
	7	1.0000		Fixed : Last true age				

Separable model: Populations in year 2003

12	0	3122339	51	1134847	8590586	1863046	5232830	3567629
13	1	1603935	23	1021828	2517653	1274337	2018782	1646938
14	2	1640797	17	1170171	2300703	1380874	1949646	1665382
15	3	703787	14	525024	943415	606054	817280	711696
16	4	626500	13	477216	822483	545270	719830	632570
17	5	254170	13	193982	333033	221434	291745	256597
18	6	76554	15	56580	103579	65610	89322	77470
19	7	41149	18	28912	58565	34368	49268	41821

Separable model: Populations at age

20	1999	27089	27	15908	46129	20647	35542	28107
21	2000	25173	20	16879	37541	20529	30867	25702
22	2001	40435	17	28551	57266	33857	48291	41077
23	2002	36808	17	25963	52182	30804	43982	37396

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	1.235	19	1.027	2.186	1.235	1.816	1.526
25	3	Q	1.443	19	1.199	2.551	1.443	2.120	1.782
26	4	Q	1.353	19	1.125	2.394	1.353	1.990	1.672
27	5	Q	1.114	19	.9252	1.974	1.114	1.640	1.377
28	6	Q	.9353	19	.7756	1.666	.9353	1.382	1.159
29	7	Q	.9534	19	.7884	1.713	.9534	1.417	1.185
30	8	Q	.7916	19	.6564	1.410	.7916	1.169	.9806

Acoustic Survey in Sub div 22-24 WR 0-5

Linear model fitted. Slopes at age :

31	0	Q	.8605	17	.7258	1.454	.8605	1.227	1.044
32	1	Q	.6006	17	.5087	1.002	.6006	.8489	.7248
33	2	Q	.5594	17	.4741	.9313	.5594	.7894	.6744
34	3	Q	.8298	17	.7035	1.381	.8298	1.170	1.000
35	4	Q	.9827	17	.8329	1.636	.9827	1.387	1.185
36	5	Q	.8032	17	.6800	1.342	.8032	1.136	.9697

IYFS Katt Quart3 WR 1-5

Linear model fitted. Slopes at age :

37	1	Q	.1902E-03	16	.1624E-03	.3095E-03	.1902E-03	.2643E-03	.2272E-03
38	2	Q	.1648E-03	16	.1408E-03	.2674E-03	.1648E-03	.2285E-03	.1967E-03
39	3	Q	.1157E-03	16	.9889E-04	.1876E-03	.1157E-03	.1603E-03	.1380E-03
40	4	Q	.1009E-03	16	.8621E-04	.1636E-03	.1009E-03	.1398E-03	.1204E-03
41	5	Q	.8912E-04	16	.7612E-04	.1449E-03	.8912E-04	.1238E-03	.1064E-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	1999	2000	2001	2002	2003
0	0.508	-0.496	0.880	0.108	-1.008
1	0.081	0.134	0.136	0.140	-0.550
2	0.278	0.006	-0.088	-0.070	-0.263
3	0.226	-0.098	-0.149	-0.028	-0.061
4	-0.288	-0.216	-0.140	-0.076	-0.004
5	-0.100	0.031	0.013	0.050	0.314
6	-0.189	-0.018	0.195	0.177	0.181
7	0.000	0.296	0.162	0.039	0.334

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
2	-0.034	0.135	0.550	-0.849	0.848	-0.161	-0.276	0.432	*******	0.253	-0.983	0.398	-0.313
3	0.095	0.329	0.123	-0.041	0.582	-0.546	0.098	0.375	*******	0.125	-0.727	0.212	-0.626
4	0.010	0.626	-0.055	0.044	1.051	-0.485	-0.162	-0.134	*******	0.115	-0.582	0.157	-0.586
5	-0.310	0.430	0.298	0.058	0.287	-0.199	-0.245	0.372	*******	0.443	-0.264	-0.234	-0.635
6	-0.615	-0.001	0.084	0.650	0.766	-0.634	0.370	0.407	*******	0.077	-0.203	-0.249	-0.652
7	1.013	0.297	-0.374	-0.009	0.092	-0.523	0.965	0.389	*******	-0.754	-0.050	-0.239	-0.807
8	0.212	-0.478	-0.808	-0.021	0.133	-0.567	0.984	1.199	*******	-0.281	0.323	0.376	-1.071

Acoustic Survey in Sub div 22-24 WR 0-5

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	0.525	0.380	-0.924	0.094	0.499	-0.673	0.114	-0.418	0.200	-0.837	-0.551	0.986	0.605
1	0.526	0.551	-0.858	-0.580	0.112	0.343	0.395	-0.496	-0.036	-0.131	0.456	-0.625	0.342
2	0.099	0.304	-0.618	0.742	-0.037	0.115	0.239	0.232	-0.446	-0.230	0.916	-0.162	-1.154
3	-0.059	-0.370	-0.171	0.087	0.136	0.660	-0.057	0.125	-0.668	0.131	0.741	-0.032	-0.523
4	-0.771	-0.858	-0.063	0.368	0.187	0.691	0.181	0.122	-0.417	0.004	0.715	0.159	-0.319
5	-1.114	-1.178	-0.506	0.273	0.695	1.176	0.719	0.722	-0.652	0.075	0.145	-0.146	-0.208

IYFS Katt Quart3 WR 1-5

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-1.334	-0.187	0.309	0.011	0.536	0.800	-1.877	-0.844	-0.379	*******	0.039	1.338	1.587
2	-1.129	-0.818	-0.295	0.578	0.575	0.715	-0.028	-0.528	-0.062	*******	-0.185	0.179	0.999
3	-0.331	-0.395	-0.767	0.680	0.905	-0.105	-0.545	-0.798	0.236	*******	-0.041	0.104	1.057
4	-0.439	-0.008	-0.267	0.315	1.097	0.025	-0.553	0.129	0.396	*******	-0.126	-0.764	0.197
5	-0.471	-0.159	-0.026	0.682	0.651	-0.029	0.655	-0.210	0.305	*******	-1.614	-0.417	0.633

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 1999 to 2003	
Variance	0.0867
Skewness test stat.	-0.7854
Kurtosis test statistic	0.1401
Partial chi-square	0.1287
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	0.0434	0.0247	0.0325	0.0184	0.0342	0.0506	0.0668
Skewness test stat.	-0.5456	-0.9158	1.1055	-0.2091	0.0631	0.5485	0.2958
Kurtosis test statisti	-0.4886	-0.5491	0.1355	-0.8906	-0.8245	-0.5600	-0.5362
Partial chi-square	0.0341	0.0202	0.0275	0.0168	0.0336	0.0546	0.0744
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	12	12	12	12	12	12	12
Degrees of freedom	11	11	11	11	11	11	11
Weight in the analysis	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429

DISTRIBUTION STATISTICS FOR Acoustic Survey in Sub div 22-24 WR 0-5

Linear catchability relationship assumed

Age	0	1	2	3	4	5
Variance	0.0633	0.0406	0.0501	0.0269	0.0395	0.0886
Skewness test stat.	-0.2209	-0.6860	-0.4980	0.4035	-0.4756	-0.2317
Kurtosis test statisti	-0.9226	-0.9360	-0.0152	-0.2043	-0.4948	-0.7019
Partial chi-square	0.0520	0.0354	0.0453	0.0252	0.0375	0.0903
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	13	13	13	13	13	13
Degrees of freedom	12	12	12	12	12	12
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

DISTRIBUTION STATISTICS FOR IYFS Katt Quart3 WR 1-5

Linear catchability relationship assumed

Age	1	2	3	4	5
Variance	0.2096	0.0828	0.0776	0.0488	0.0888
Skewness test stat.	-0.3207	-0.2080	0.5729	0.7810	-1.4700
Kurtosis test statisti	-0.4510	-0.6334	-0.7166	0.1872	0.5887
Partial chi-square	0.3990	0.1732	0.2074	0.1577	0.4053
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	12	12	12	12	12
Degrees of freedom	11	11	11	11	11
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	74.5453	262	41	221	0.3373
Catches at age	3.5505	40	23	17	0.2089
Aged Indices					
Acoustic Survey in Div IIIa+IVaE WR 2-8+	20.8332	84	7	77	0.2706
Acoustic Survey in Sub div 22-24 WR 0-5	22.2443	78	6	72	0.3089
IYFS Katt Quart3 WR 1-5	27.9173	60	5	55	0.5076

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	3.6336	262	41	221	0.0164
Catches at age	1.4739	40	23	17	0.0867
Aged Indices					
Acoustic Survey in Div IIIa+IVaE WR 2-8+	0.4252	84	7	77	0.0055
Acoustic Survey in Sub div 22-24 Wr 0-5 s	0.6179	78	6	72	0.0086
IYFS Katt Quart3 WR 1-5	1.1167	60	5	55	0.0203

Table 3.7.1 WESTERN BALTIC HERRING. Input table for short term predictions

MFDP version 1a
Run: WBSS_1
Time and date: 20:37 15/03/2004
Fbar age range: 3-6

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	4409497	0.3	0.00	0.1	0.25	0.000	0.056	0.012
1	2996873	0.5	0.00	0.1	0.25	0.016	0.190	0.026
2	804700	0.2	0.20	0.1	0.25	0.053	0.262	0.065
3	1033600	0.2	0.75	0.1	0.25	0.083	0.311	0.091
4	422200	0.2	0.90	0.1	0.25	0.115	0.405	0.112
5	342300	0.2	1.00	0.1	0.25	0.157	0.395	0.140
6	140100	0.2	1.00	0.1	0.25	0.175	0.427	0.158
7	40900	0.2	1.00	0.1	0.25	0.180	0.405	0.166
8	38400	0.2	1.00	0.1	0.25	0.190	0.405	0.169

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	4409497	0.3	0.00	0.1	0.25	0.000	0.056	0.012
1		0.5	0.00	0.1	0.25	0.016	0.190	0.026
2		0.2	0.20	0.1	0.25	0.053	0.262	0.065
3		0.2	0.75	0.1	0.25	0.083	0.311	0.091
4		0.2	0.90	0.1	0.25	0.115	0.405	0.112
5		0.2	1.00	0.1	0.25	0.157	0.395	0.140
6		0.2	1.00	0.1	0.25	0.175	0.427	0.158
7		0.2	1.00	0.1	0.25	0.180	0.405	0.166
8		0.2	1.00	0.1	0.25	0.190	0.405	0.169

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	4409497	0.3	0.00	0.1	0.25	0.000	0.056	0.012
1		0.5	0.00	0.1	0.25	0.016	0.190	0.026
2		0.2	0.20	0.1	0.25	0.053	0.262	0.065
3		0.2	0.75	0.1	0.25	0.083	0.311	0.091
4		0.2	0.90	0.1	0.25	0.115	0.405	0.112
5		0.2	1.00	0.1	0.25	0.157	0.395	0.140
6		0.2	1.00	0.1	0.25	0.175	0.427	0.158
7		0.2	1.00	0.1	0.25	0.180	0.405	0.166
8		0.2	1.00	0.1	0.25	0.190	0.405	0.169

Input units are thousands and kg - output in tonnes

N = Stock size (thousands)
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_{2004} Age 1:	Geometric Mean from ICA of age 1 (Table 3.6.8) for the years 1993-2002
N_{2004} Age 2-8+:	Output from ICA (Table 3.6.8)
$N_{2003/2004/2005/2006}$ Age 0:	Geometric Mean from ICA of age 0 (Table 3.6.8) for the years 1992-2001
Natural Mortality (M):	Constant
Weight in the Catch/Stock (CWt/SWt):	Average for 2001-2003
Expoitation pattern (Sel):	Rescaled to F in the last year

Table 3.7.2 WESTERN BALTIC HERRING.
Short term prediction single option table, status quo F.

MFDP version 1a
Run: WBSS_1
Time and date: 20:37 15/03/2004
Fbar age range: 3-6

Year:	**2004**	**F multiplier:**	**1**	**Fbar:**	**0.3846**				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0558	207039	2489	4409497	441	0	0	0	0
1	0.1897	410684	10556	2996873	47700	0	0	0	0
2	0.2621	168907	11058	804700	42657	160940	8531	149130	7905
3	0.3111	251759	22970	1033600	85448	775200	64086	714806	59093
4	0.4045	128176	14370	422200	48540	379980	43686	347118	39908
5	0.3953	101975	14246	342300	53570	342300	53570	312985	48982
6	0.4273	44471	7048	140100	24526	140100	24526	127692	22354
7	0.4045	12417	2058	40900	7348	40900	7348	37363	6712
8	0.4045	11658	1965	38400	7281	38400	7281	35079	6652
Total		1337087	86760	10228570	317511	1877820	209029	1724172	191606

Year:	**2005**	**F multiplier:**	**1**	**Fbar:**	**0.3846**				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0558	207039	2489	4409497	441	0	0	0	0
1	0.1897	423357	10882	3089349	49172	0	0	0	0
2	0.2621	315614	20662	1503636	79708	300727	15942	278660	14772
3	0.3111	123472	11265	506917	41907	380188	31430	350568	28981
4	0.4045	188223	21102	619990	71280	557991	64152	509733	58604
5	0.3953	68715	9600	230657	36098	230657	36098	210903	33006
6	0.4273	59909	9495	188736	33040	188736	33040	172021	30114
7	0.4045	22713	3765	74815	13441	74815	13441	68345	12278
8	0.4045	13153	2216	43323	8215	43323	8215	39576	7504
Total		1422196	91477	10666920	333302	1776437	202318	1629806	185260

Year:	**2006**	**F multiplier:**	**1**	**Fbar:**	**0.3846**				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0558	207039	2489	4409497	441	0	0	0	0
1	0.1897	423357	10882	3089349	49172	0	0	0	0
2	0.2621	325353	21300	1550035	82167	310007	16433	287258	15228
3	0.3111	230716	21050	947208	78306	710406	58729	655060	54154
4	0.4045	92312	10349	304067	34959	273660	31463	249993	28742
5	0.3953	100907	14097	338713	53009	338713	53009	309705	48469
6	0.4273	40370	6398	127179	22264	127179	22264	115915	20292
7	0.4045	30598	5072	100788	18107	100788	18107	92071	16541
8	0.4045	19594	3302	64542	12238	64542	12238	58960	11180
Total		1470246	94939	10931377	350662	1925294	212243	1768962	194605

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_1
Western Baltic Herring (combined sex; plus group)
Time and date: 20:37 15/03/2004
Fbar age range: 3-6

2004 Biomass	SSB	FMult	FBar	Landings
317511	191606	1.0000	0.3846	86760

2005 Biomass	SSB	FMult	FBar	Landings	2006 Biomass	SSB
333302	192450	0.0000	0.0000	0	459854	283220
.	191719	0.1000	0.0385	10500	447284	272710
.	190990	0.2000	0.0769	20670	435116	262608
.	190264	0.3000	0.1154	30524	423335	252895
.	189541	0.4000	0.1538	40071	411929	243558
.	188821	0.5000	0.1923	49322	400884	234580
.	188103	0.6000	0.2307	58287	390188	225947
.	187388	0.7000	0.2692	66976	379829	217646
.	186676	0.8000	0.3077	75398	369796	209664
.	185967	0.9000	0.3461	83562	360077	201988
.	185260	1.0000	0.3846	91477	350662	194605
.	184557	1.1000	0.4230	99152	341541	187504
.	183855	1.2000	0.4615	106594	332703	180674
.	183157	1.3000	0.5000	113811	324138	174105
.	182461	1.4000	0.5384	120812	315839	167785
.	181768	1.5000	0.5769	127602	307795	161706
.	181078	1.6000	0.6153	134190	299998	155857
.	180390	1.7000	0.6538	140582	292439	150230
.	179705	1.8000	0.6922	146784	285112	144815
.	179023	1.9000	0.7307	152803	278007	139605
.	178343	2.0000	0.7692	158645	271118	134592

Input units are thousands and kg - output in tonnes

Table 3.7.4 WESTERN BALTIC HERRING.
Short term prediction single option table, status quo F, Fmax=0.4062.

MFDP version 1a
Run: WBSS_Fmax
Time and date: 10:29 16/03/2004
Fbar age range: 3-6

Year:	**2004**	**F multiplier:**	**1**	**Fbar:**	**0.3846**				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0558	207039	2489	4409497	441	0	0	0	0
1	0.1897	410684	10556	2996873	47700	0	0	0	0
2	0.2621	168907	11058	804700	42657	160940	8531	149130	7905
3	0.3111	251759	22970	1033600	85448	775200	64086	714806	59093
4	0.4045	128176	14370	422200	48540	379980	43686	347118	39908
5	0.3953	101975	14246	342300	53570	342300	53570	312985	48982
6	0.4273	44471	7048	140100	24526	140100	24526	127692	22354
7	0.4045	12417	2058	40900	7348	40900	7348	37363	6712
8	0.4045	11658	1965	38400	7281	38400	7281	35079	6652
Total		1337087	86760	10228570	317511	1877820	209029	1724172	191606

Year:	**2005**	**F multiplier:**	**1.0563**	**Fbar:**	**0.4062**				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0589	218372	2626	4409497	441	0	0	0	0
1	0.2004	445084	11440	3089349	49172	0	0	0	0
2	0.2769	331122	21677	1503636	79708	300727	15942	278249	14750
3	0.3286	129384	11805	506917	41907	380188	31430	349955	28931
4	0.4273	196797	22064	619990	71280	557991	64152	508574	58471
5	0.4176	71861	10039	230657	36098	230657	36098	210434	32933
6	0.4514	62605	9923	188736	33040	188736	33040	171608	30042
7	0.4273	23748	3937	74815	13441	74815	13441	68190	12250
8	0.4273	13752	2317	43323	8215	43323	8215	39486	7487
Total		1492726	95827	10666920	333302	1776437	202318	1626494	184864

Year:	**2006**	**F multiplier:**	**1.0563**	**Fbar:**	**0.4062**				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0589	218372	2626	4409497	441	0	0	0	0
1	0.2004	443688	11404	3079659	49018	0	0	0	0
2	0.2769	337714	22109	1533570	81295	306714	16259	283788	15044
3	0.3286	238222	21735	933332	77159	699999	57869	644334	53267
4	0.4273	94841	10633	298787	34352	268909	30916	245093	28178
5	0.4176	103150	14410	331086	51815	331086	51815	302058	47272
6	0.4514	41258	6539	124379	21774	124379	21774	113091	19798
7	0.4273	31232	5177	98392	17676	98392	17676	89678	16111
8	0.4273	20025	3375	63088	11963	63088	11963	57501	10903
Total		1528501	98007	10871790	345491	1892567	208272	1735543	190573

Input units are thousands and kg - output in tonnes

Table 3.9.2.1 WESTERN BALTIC HERRING. Model settings for XSA with shrinkage = 0.5 (age = ringer)

CPUE data from file dagaiYFd.dat

Catch data for 13 years. 1991 to 2003. Ages 0 to 8.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
FLT 1b: Acoustic Survey in Div. IIIa+IVaE,	1991,	2003,	2,	7,	.580,	.670
FLT 2b: Acoustic Survey in SD 22-24,	1991,	2003,	0,	5,	.770,	.830
FLT 4: IBFS Katt Quart3,	1991,	2003,	1,	5,	.500,	.750

Time series weights :
- Tapered time weighting applied
- Power = 3 over 20 years

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

Terminal population estimation :
- Survivor estimates shrunk towards the mean F of the final 5 years or the 5 oldest ages.
- S.E. of the mean to which the estimates are shrunk = **.500**
- Minimum standard error for population estimates derived from each fleet = .300
- Prior weighting not applied

Tuning converged after 23 iterations

Table 3.9.2.2 WESTERN BALTIC HERRING. Exploratory stock summary results from XSA Model (shrinkage = 0.5).

```
Run title : Herring IIIa & SD 22-24(WBSS) (run: XSATOM)
At 14/03/2004  17:35
Terminal Fs derived using XSA (With F shrinkage)
```

Table 16 Summary (without SOP correction)

	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 3- 6,
1991,	5100626,	623819,	312337,	191573,	.6134,	.3637,
1992,	3715070,	545777,	321913,	194411,	.6039,	.4839,
1993,	3109444,	470590,	298679,	185010,	.6194,	.5367,
1994,	6271659,	385555,	237731,	172438,	.7253,	.6558,
1995,	4082945,	331191,	193977,	150831,	.7776,	.4973,
1996,	4367409,	277770,	138520,	121266,	.8754,	.6726,
1997,	3871274,	279703,	155840,	115588,	.7417,	.4977,
1998,	5290709,	267989,	121592,	107032,	.8803,	.5038,
1999,	6288304,	274488,	122371,	97240,	.7946,	.4048,
2000,	3321155,	273246,	129062,	109914,	.8516,	.5191,
2001,	4016672,	289897,	141848,	105803,	.7459,	.5351,
2002,	2477746,	308523,	171621,	106191,	.6188,	.5477,
2003,	2315001,	217215,	129473,	78309,	.6048,	.5531,
Results of Exploratory XSA Assessment						
Arith. Mean ,	4171386,	349674,	190382,	133508,	.7271,	.5209,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

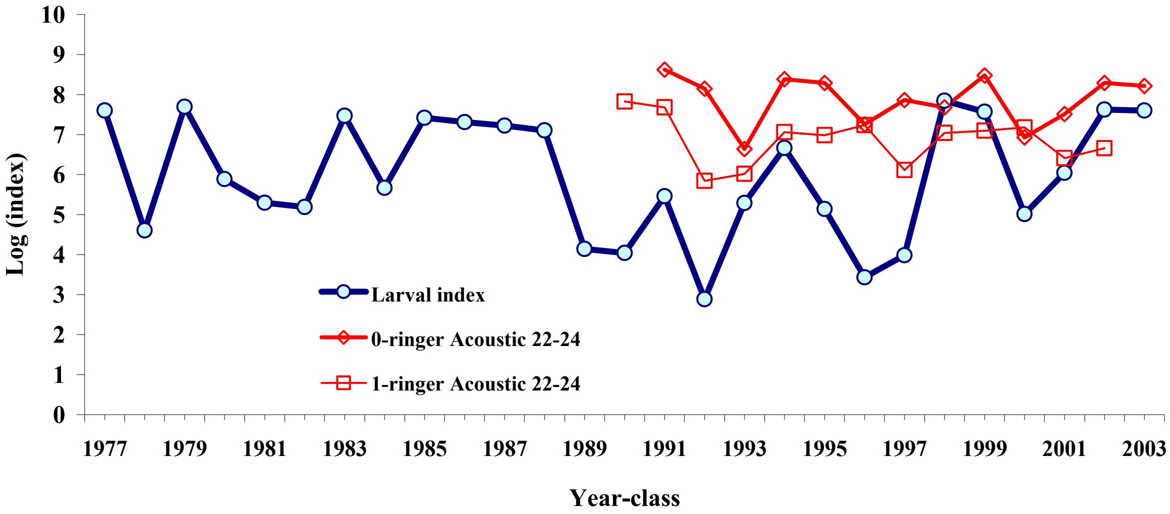


Figure 3.5.1 WESTERN BALTIC HERRING. Recruitment indices (natural log) adjusted to year-class, versus time.

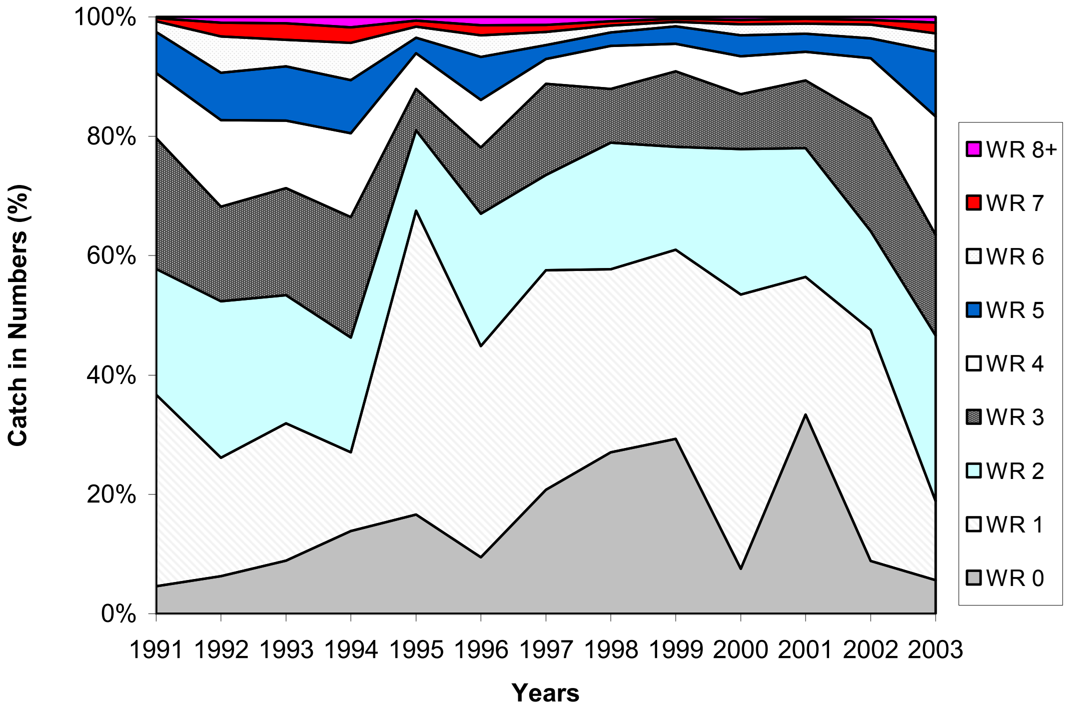


Figure 3.6.1 WESTERN BALTIC HERRING.
Proportions of age groups (numbers) in the total catch.

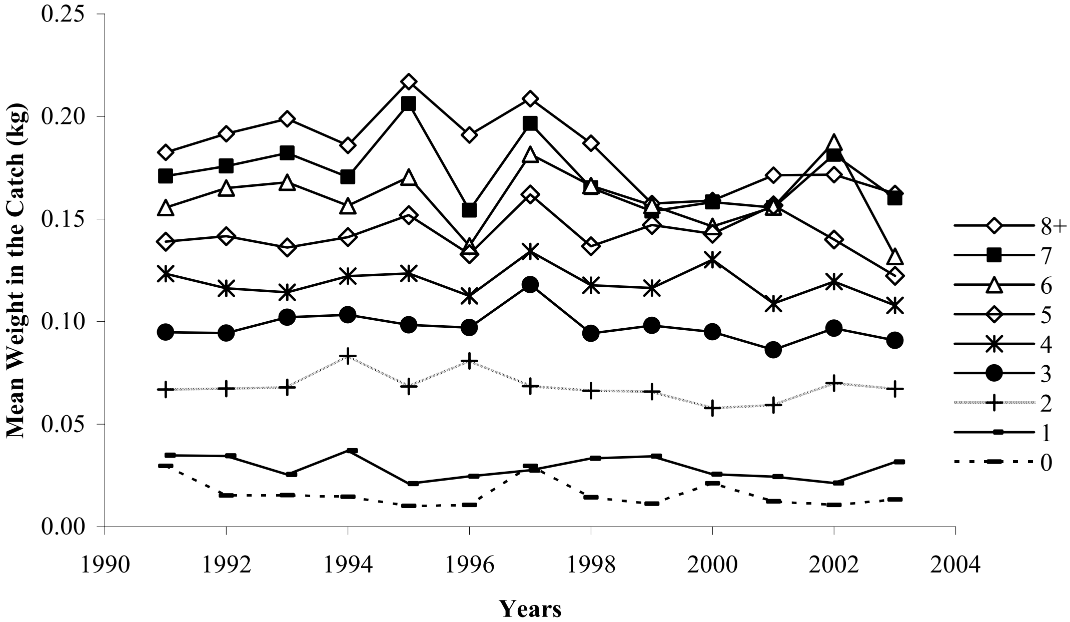
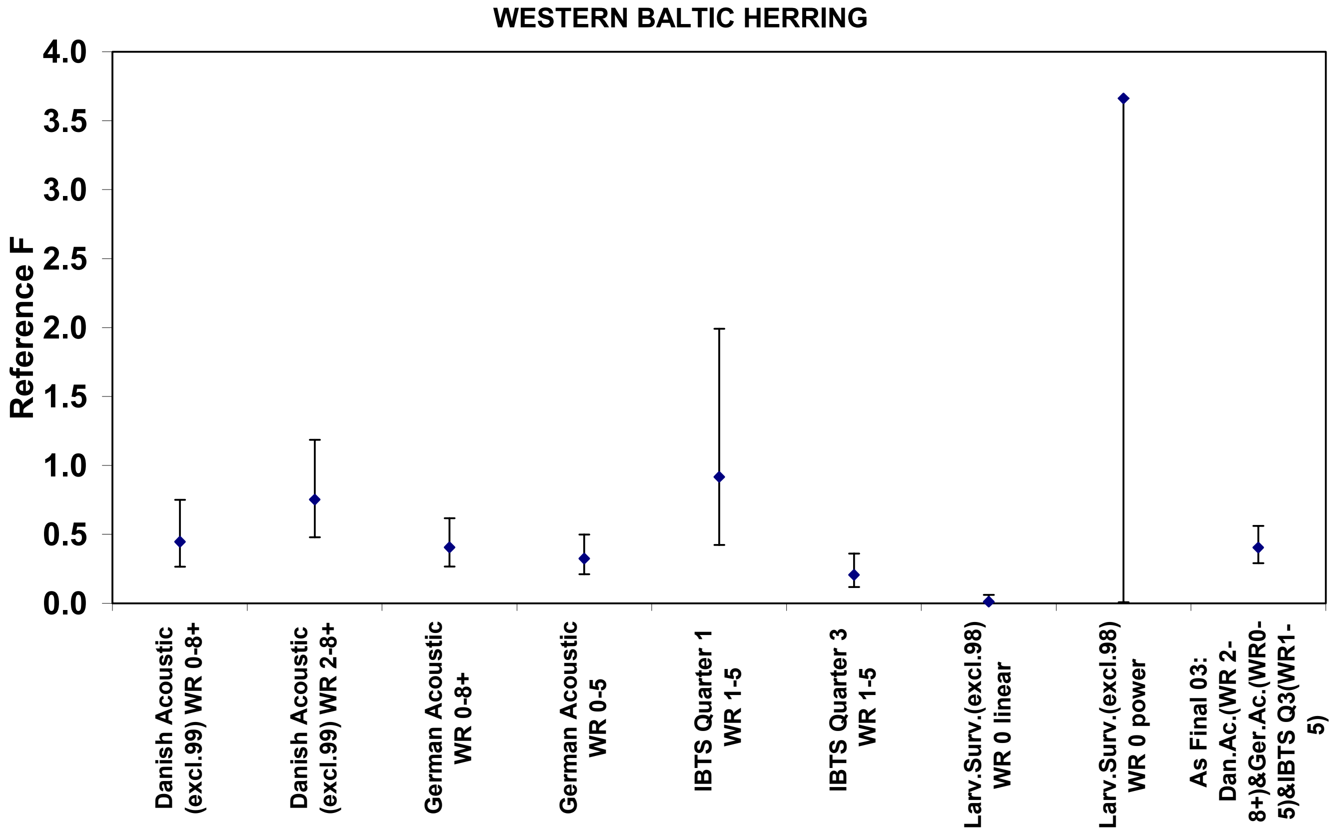


Figure 3.6.2 WESTERN BALTIC HERRING.
Mean weight in the catch (kg).



Fleet No.	Survey	Area	Quarter	WR	Mean F 2002	Lower 95% CL	Upper 95% CL	SSB 2003
1a	Danish Acoustic (excl.99) WR 0-8+	Div. IIIa incl. Katt.	3	0-8+	0.447	0.266	0.750	139,518
1b	Danish Acoustic (excl.99) WR 2-8+	Div. IIIa incl. Katt.	3	2-8+	0.753	0.478	1.185	99,609
2a	German Acoustic WR 0-8+	SD 22, 23, 24	4	0-8+	0.406	0.267	0.617	153,348
2b	German Acoustic WR 0-5	SD 22, 23, 24	4	0-5	0.325	0.212	0.499	172,826
3	IBTS Quarter 1 WR 1-5	Kattegat	1	1-5	0.917	0.422	1.990	74,863
4	IBTS Quarter 3 WR 1-5	Kattegat	3	1-5	0.207	0.119	0.361	275,849
5a	Larv.Surv.(excl.98) WR 0 linear	SD 24	1-2	1-5	0.013	0.003	0.061	3,753,659
5b	Larv.Surv.(excl.98) WR 0 power	SD 24	1-2	0-3+	3.662	0.008	?	31,972
1b+2b+4	As Final 03: Dan.Ac.(WR 2-8+)&Ger.Ac.(WR0-5)&IBTS Q3(WR1-5)	SD 24	1-2	0-3+	0.405	0.291	0.562	157,610

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 1991-2003.

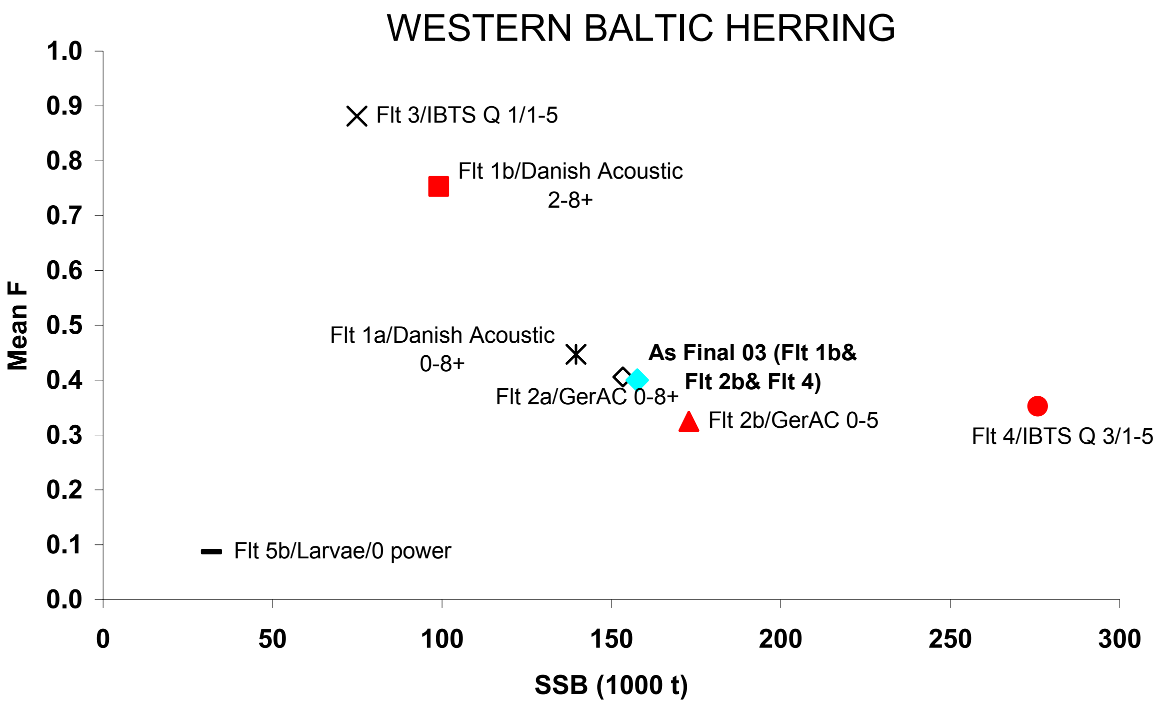


Figure 3.6.4 WESTERN BALTIC HERRING.
Estimates of mean F and SSB in terminal year by ICA runs by individual fleets and catch at age data for 1991-2003.

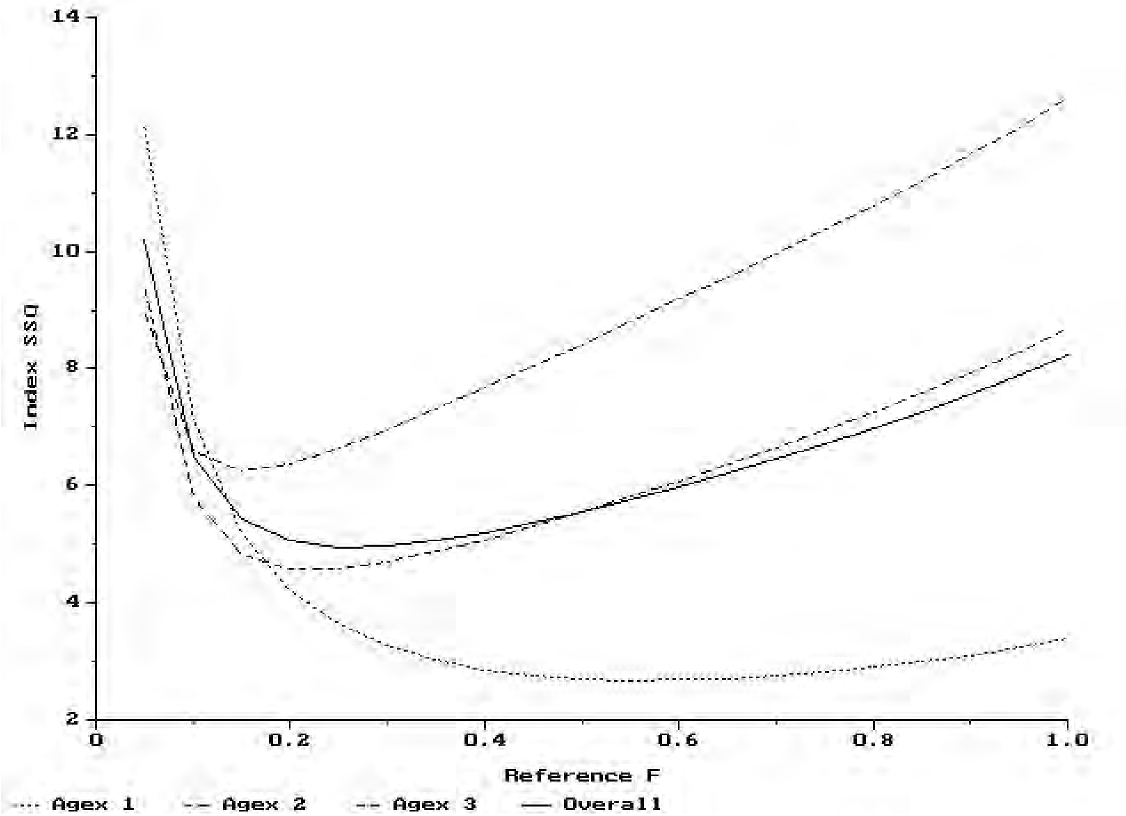


Figure 3.6.5 WESTERN BALTIC HERRING. Output from ICA Final run 2004.
Index sum of squares of deviations between model and observations (survey index) as a function of the reference F in 2003.
Agex 1: Fleet 1b/Danish Acoustic in Division IIIa+IVaE, ages 0-8+
Agex 2: Fleet 2b/German Acoustic in SD 22-24, ages 0-5
Agex 3: Fleet 4/IBTS Quarter 3, ages 1-5

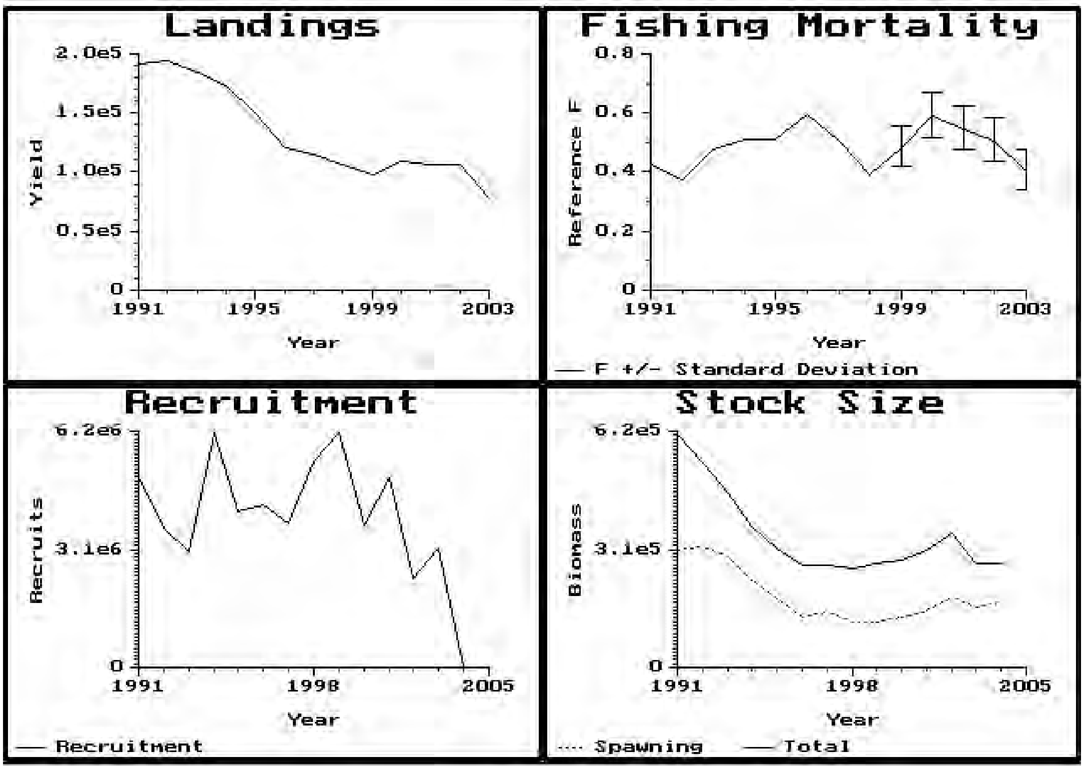


Figure 3.6.6 WESTERN BALTIC HERRING. Output from ICA Final Run 2004. Stock summary.

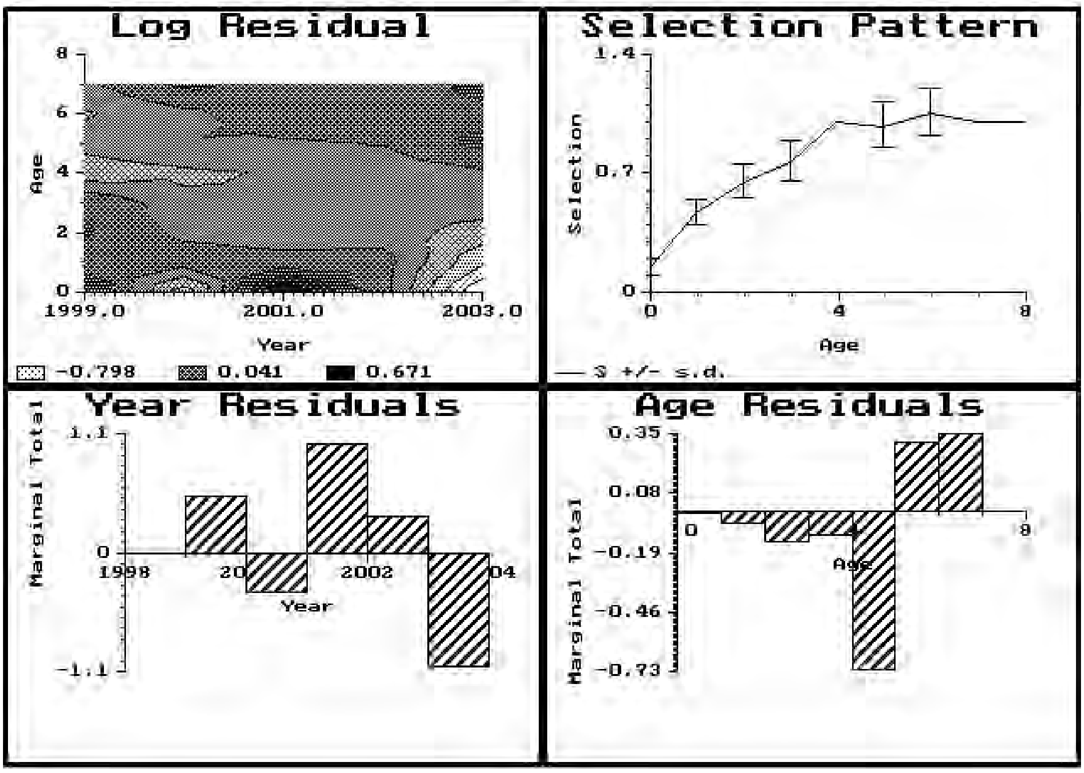


Figure 3.6.7 WESTERN BALTIC HERRING. Output from ICA Final Run 2004. Separable Model Diagnostics.
Age 0 is still included in the log residual and year residuals although age 0 was downweighted (0.1) in the catch.

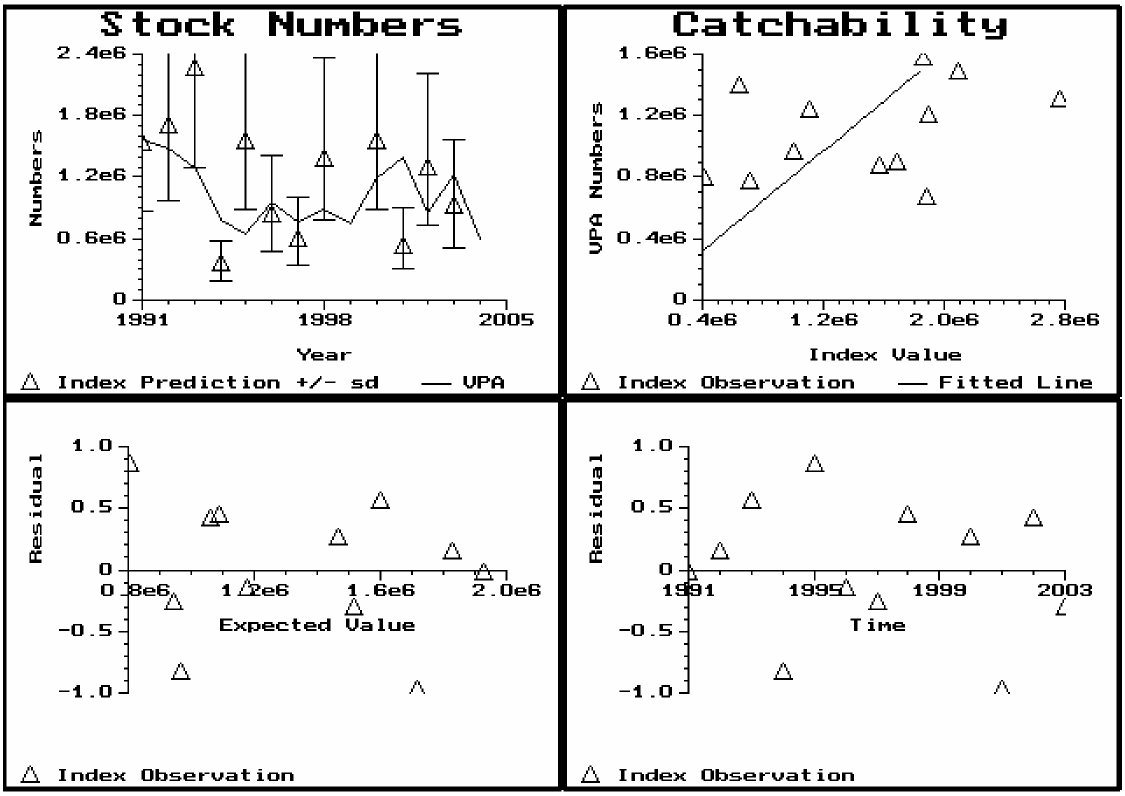


Figure 3.6.8a Western Baltic Herring. Output from ICA Final Run: Tuning Diagnostics.
Acoustic Survey, Division IIIa+IVaE, July, Age group 2

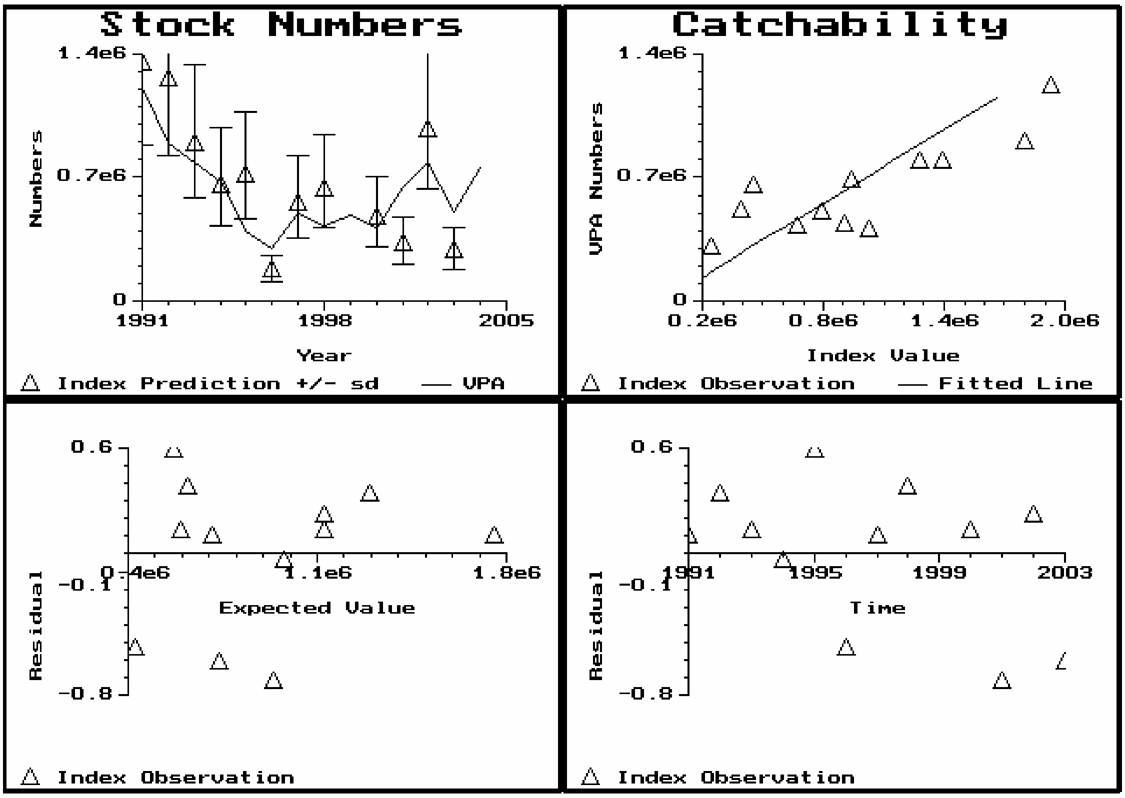


Figure 3.6.8b Western Baltic Herring. Output from ICA FinaL Run: Tuning Diagnostics.
Acoustic Survey, Division IIIa+IVaE, July, Age group 3

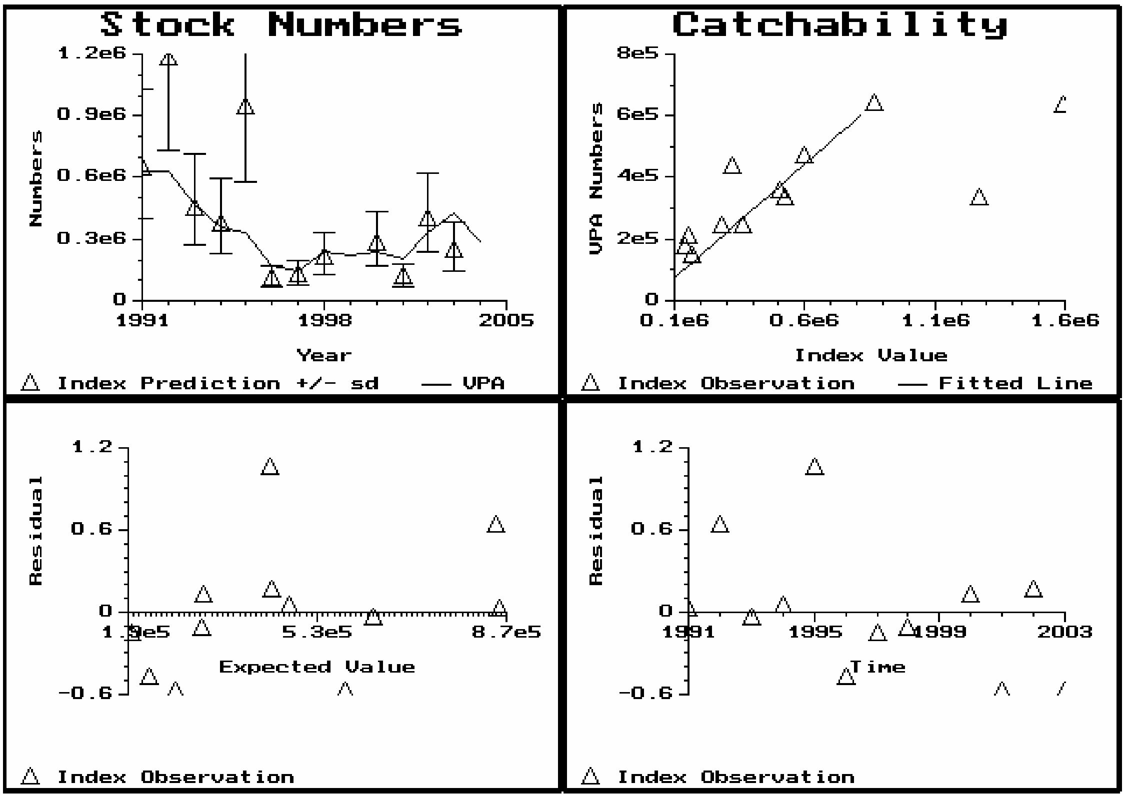


Figure 3.6.8c Western Baltic Herring. Output from ICA Final Run: Tuning Diagnostics. Acoustic Survey, Division IIIa+IvaE, July, Age group 4

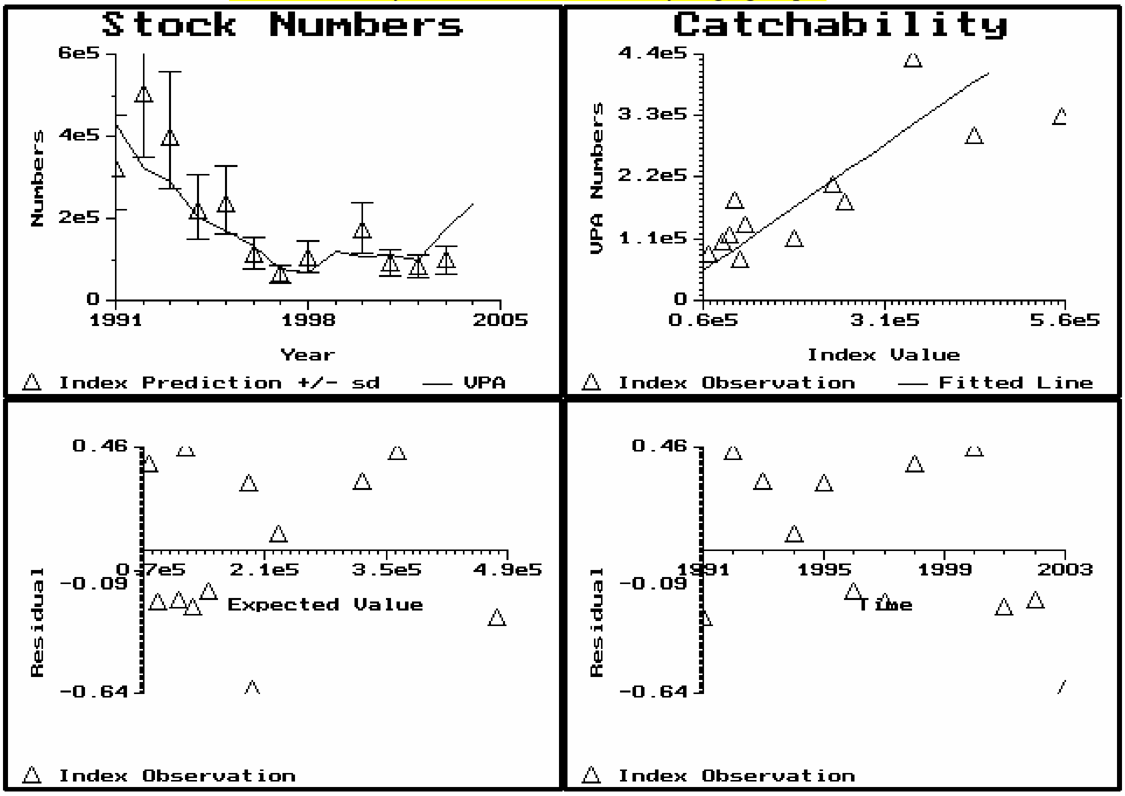


Figure 3.6.8d Western Baltic Herring. Output from ICA Final Run: Tuning Diagnostics. Acoustic Survey, Division IIIa+IvaE, July, Age group 5

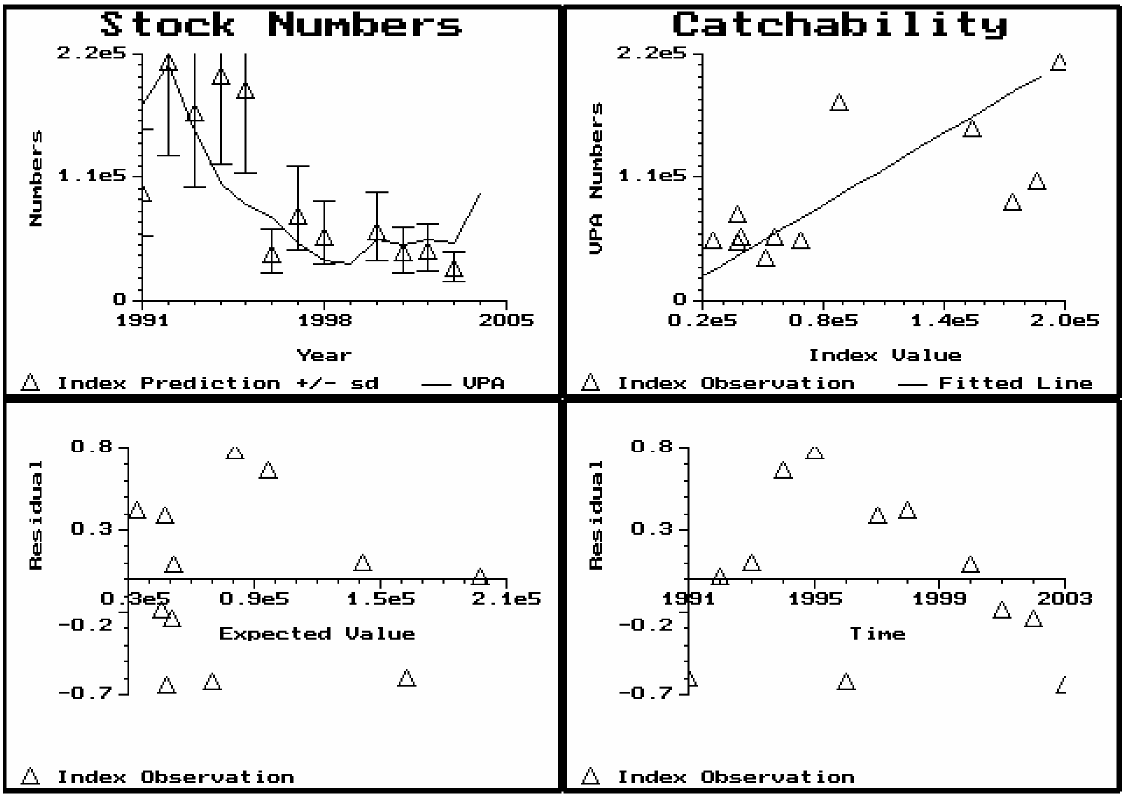


Figure 3.6.8e Western Baltic Herring. Output from ICA Final Run: Tuning Diagnostics.
Acoustic Survey, Division IIIa+IVaE, July, Age group 6

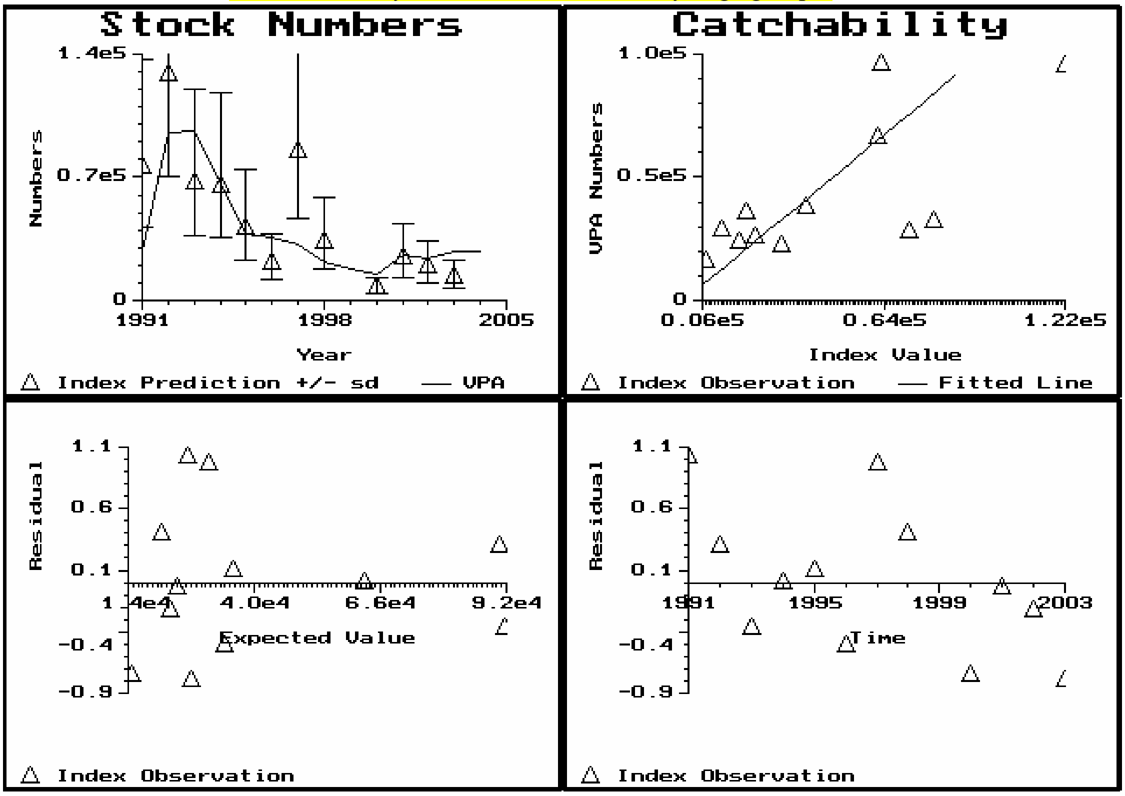


Figure 3.6.8f Western Baltic Herring. Output from ICA Final Run: Tuning Diagnostics.
Acoustic Survey, Division IIIa+IVaE, July, Age group 7

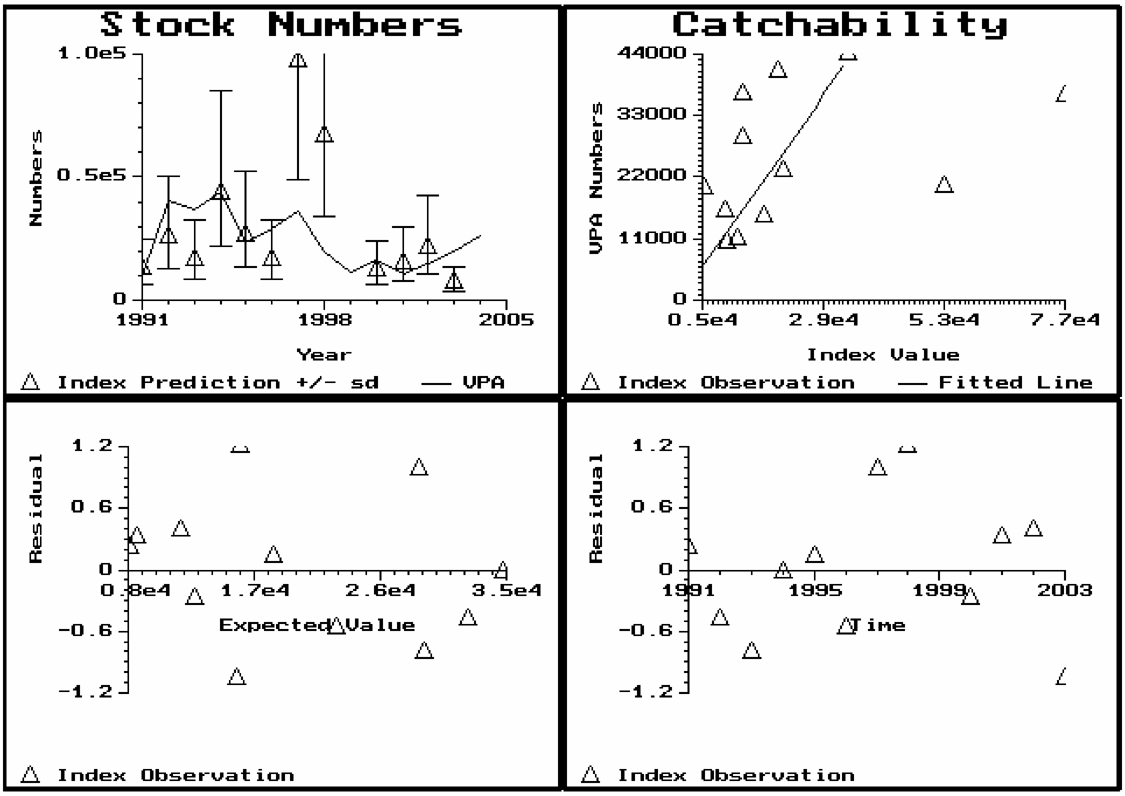


Figure 3.6.8g Western Baltic Herring. Output from ICA Final Run:
Tuning Diagnostics.
Acoustic Survey, Division IIIa+IVaE July, Age group 8+

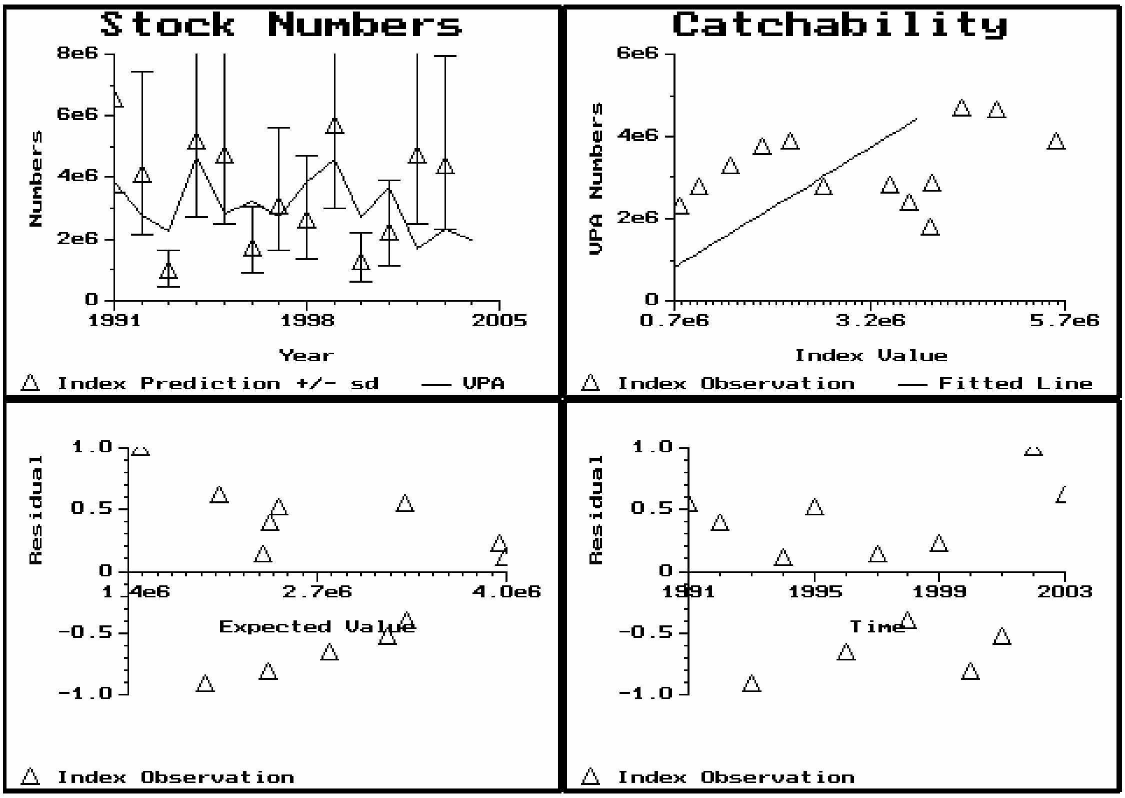


Figure 3.6.9a Western Baltic Herring. Output from ICA Final Run: Tuning Diagnostics. Acoustic Survey, SD 22-24, Sep./Oct., Age group 0

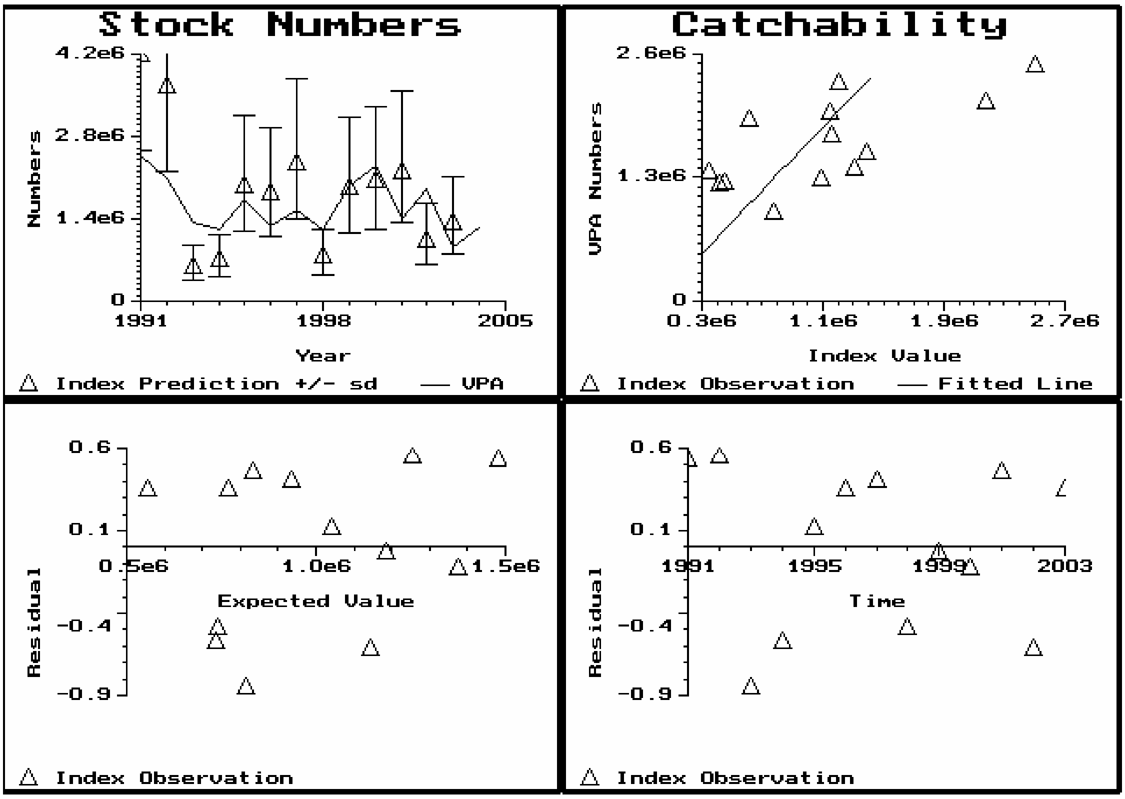


Figure 3.6.9b Western Baltic Herring. Output from ICA Final Run: Tuning Diagnostics. Acoustic Survey, SD 22-24, Sep./Oct., Age group 1

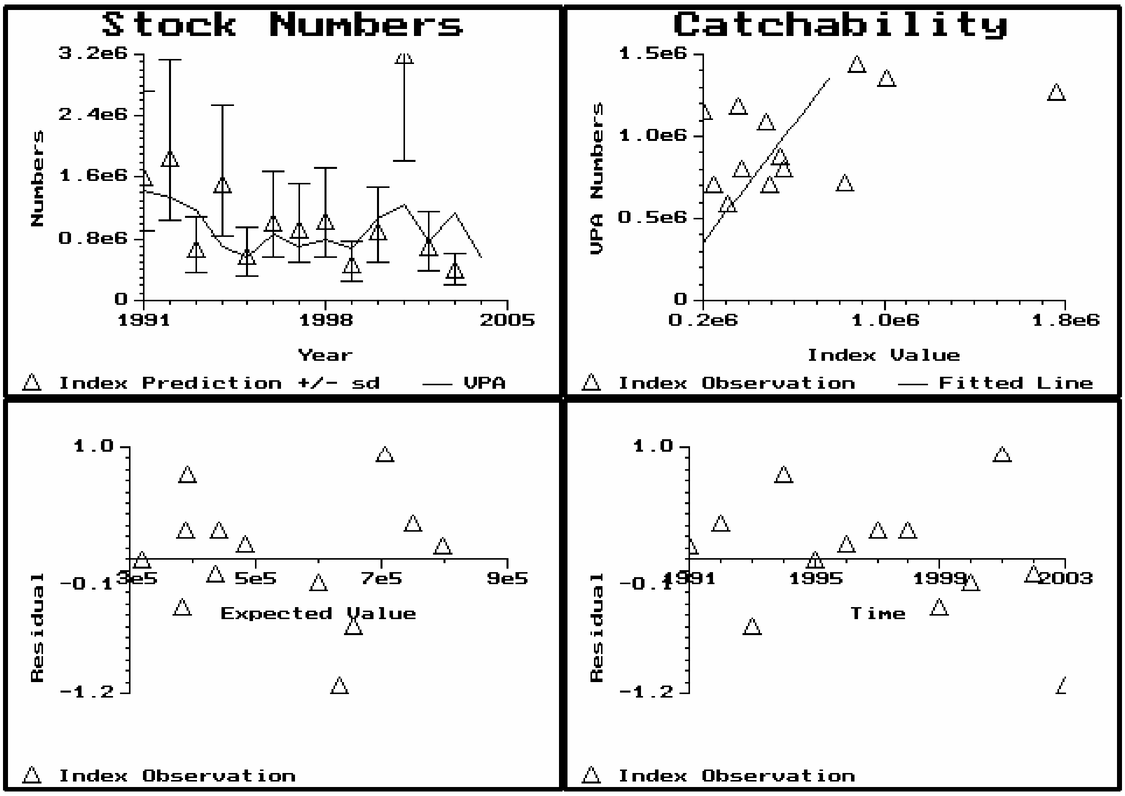


Figure 3.6.9c Western Baltic Herring. Output from ICA Final Run: Tuning Diagnostics.
Acoustic Survey, SD 22-24, Sep./Oct., Age group 2

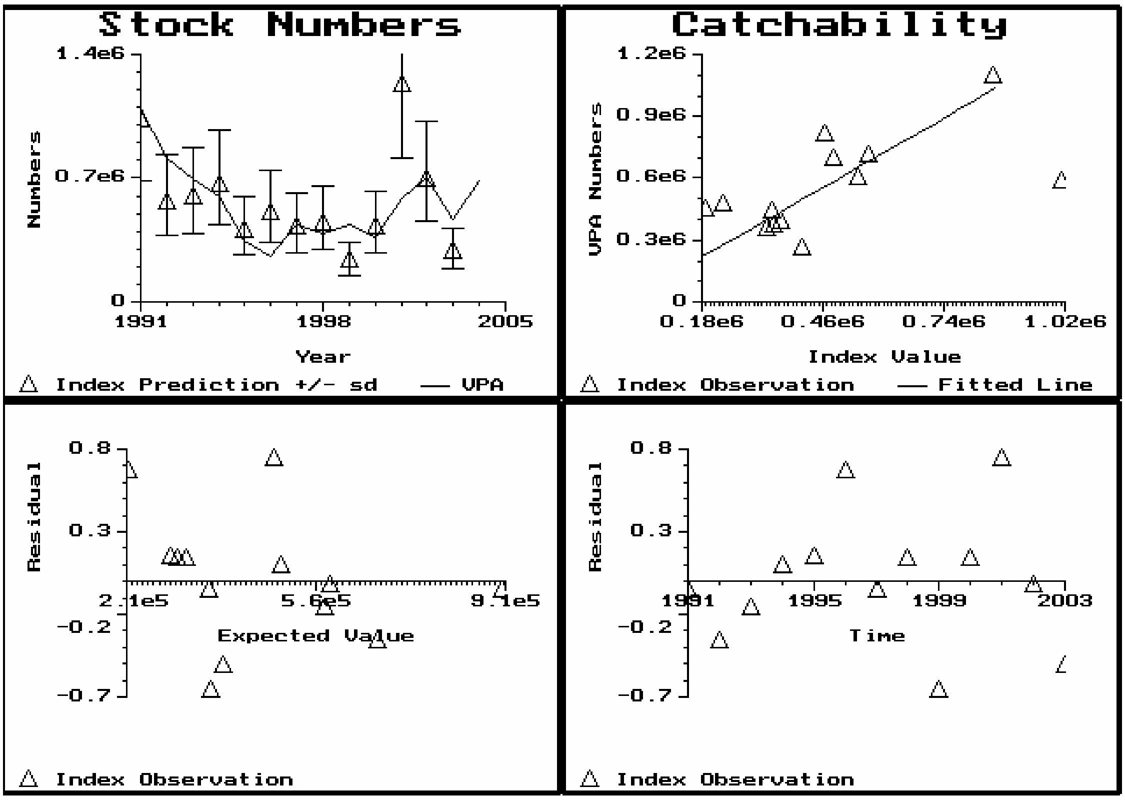


Figure 3.6.9d Western Baltic Herring. Output from ICA Final Run: Tuning Diagnostics.
Acoustic Survey, SD 22-24, Sep./Oct., Age group 3

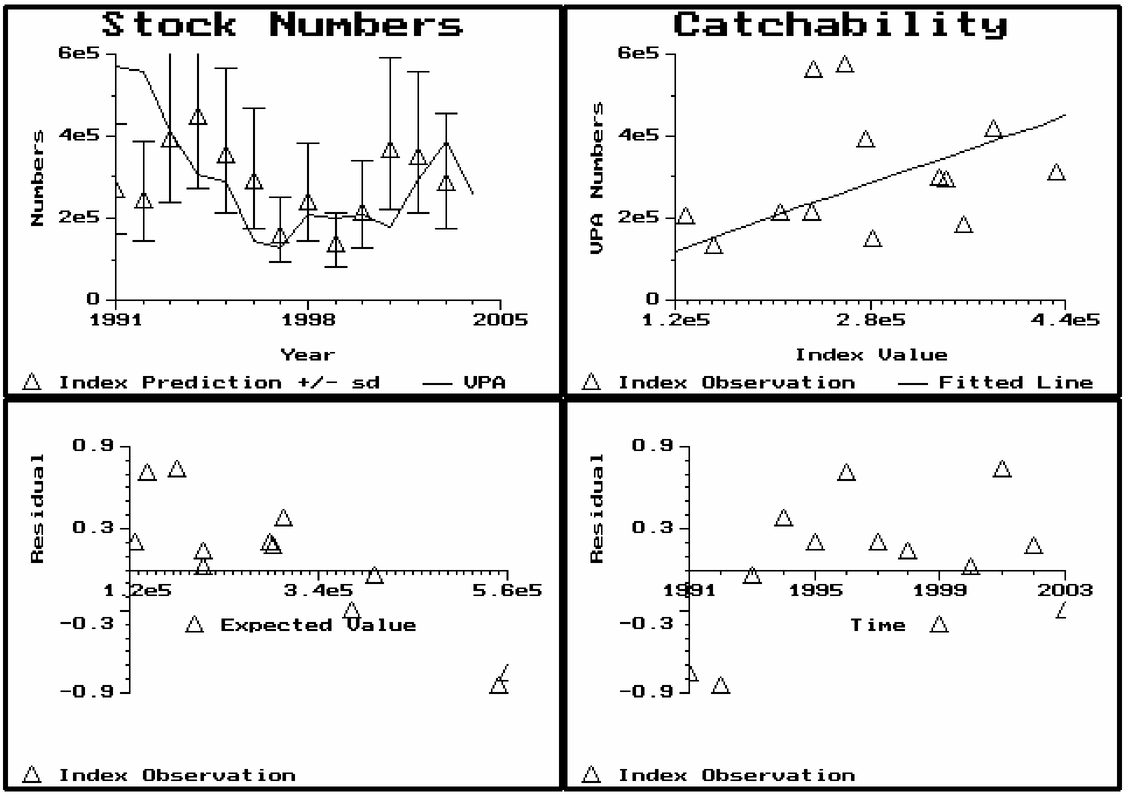


Figure 3.6.9e Western Baltic Herring. Output from ICA Final Run:
Tuning Diagnostics.
Acoustic Survey, SD 22-24, Sep./Oct., Age group 4

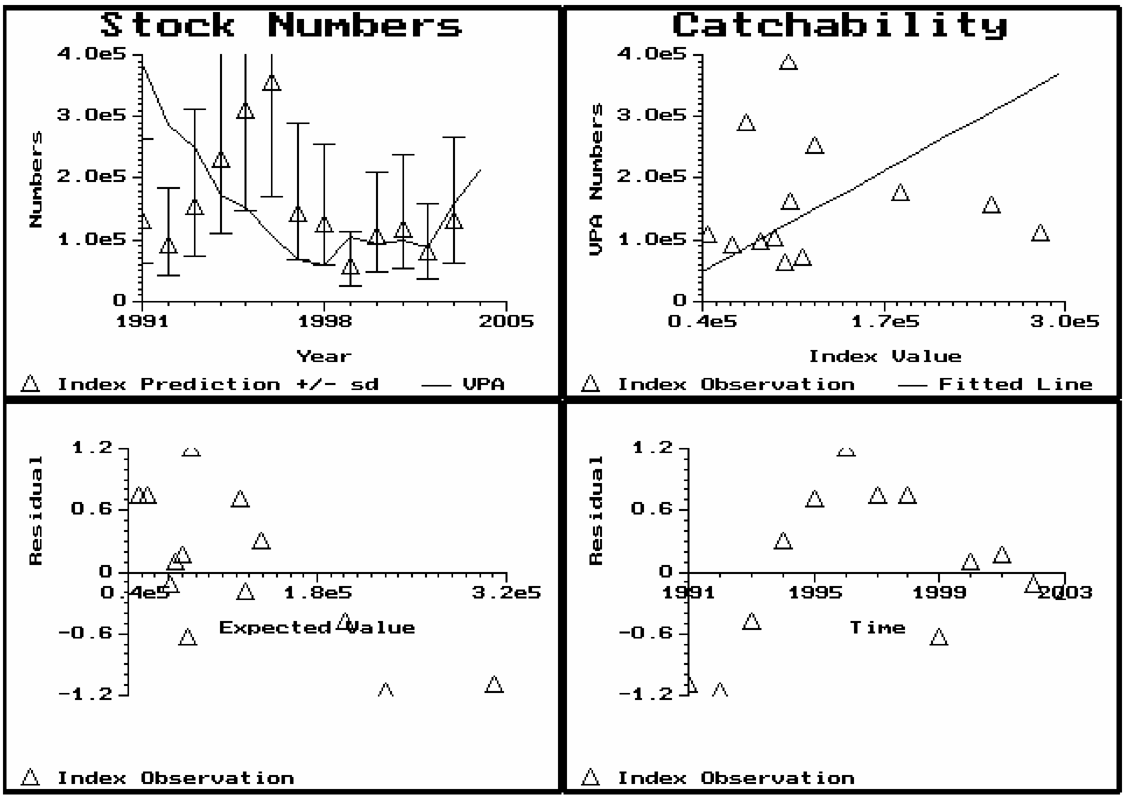


Figure 3.6.9f Western Baltic Herring. Output from ICA Final Run:
Tuning Diagnostics.
Acoustic Survey, SD 22-24, Sep./Oct., Age group 5

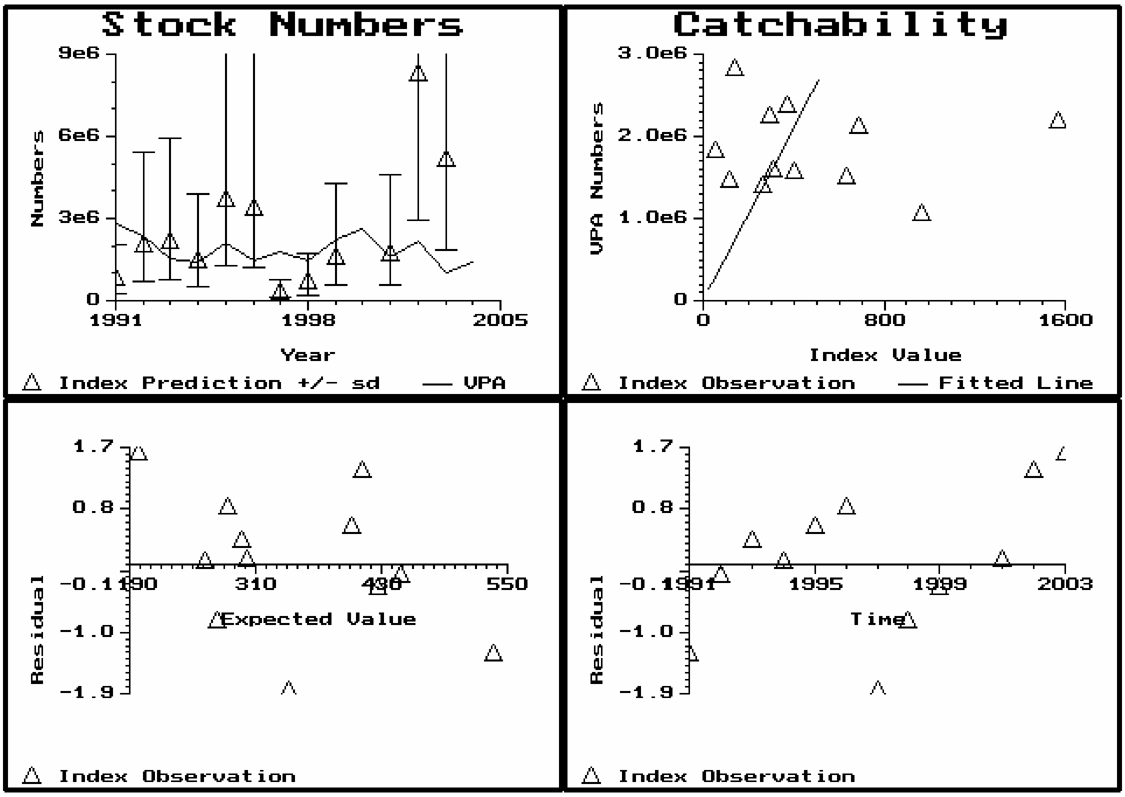


Figure 3.6.10a Western Baltic Herring. Output from ICA Final Run: Tuning Diagnostics.
IBTS, Kattegat, Quarter 3, Age group 1

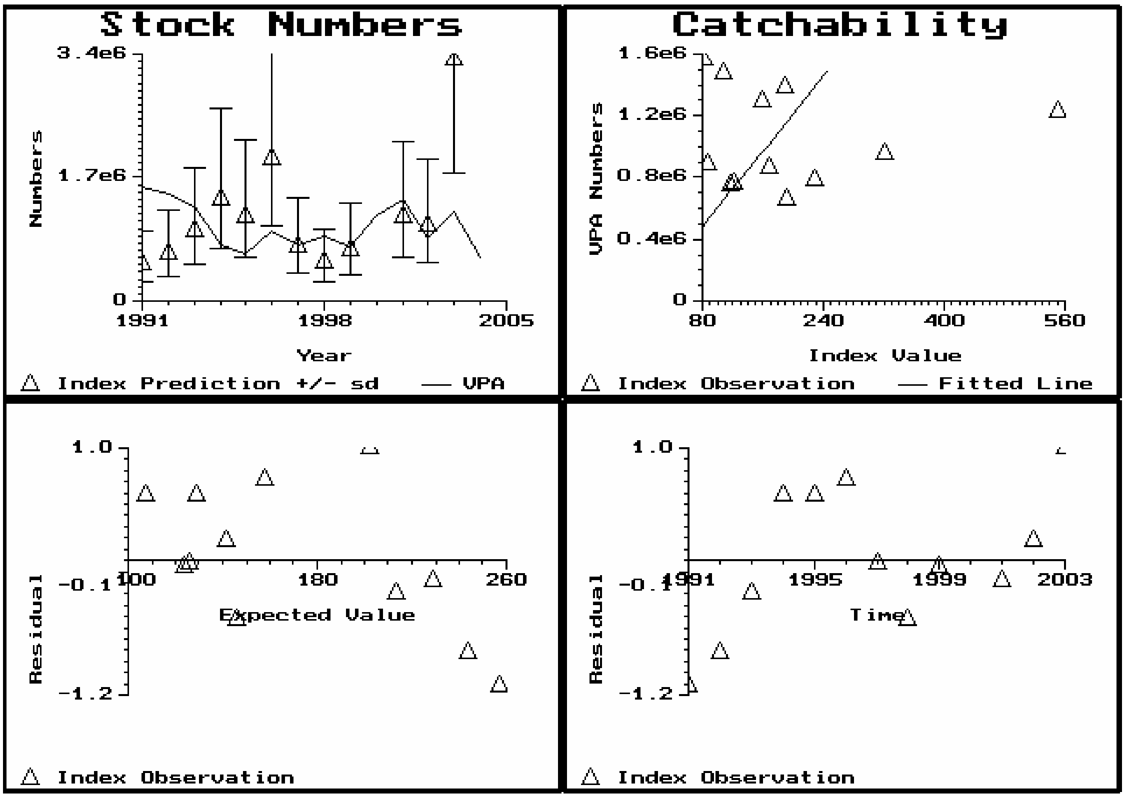


Figure 3.6.10b Western Baltic Herring. Output from ICA FinaL Run: Tuning Diagnostics.
IBTS, Kattegat, Quarter 3, Age group 2

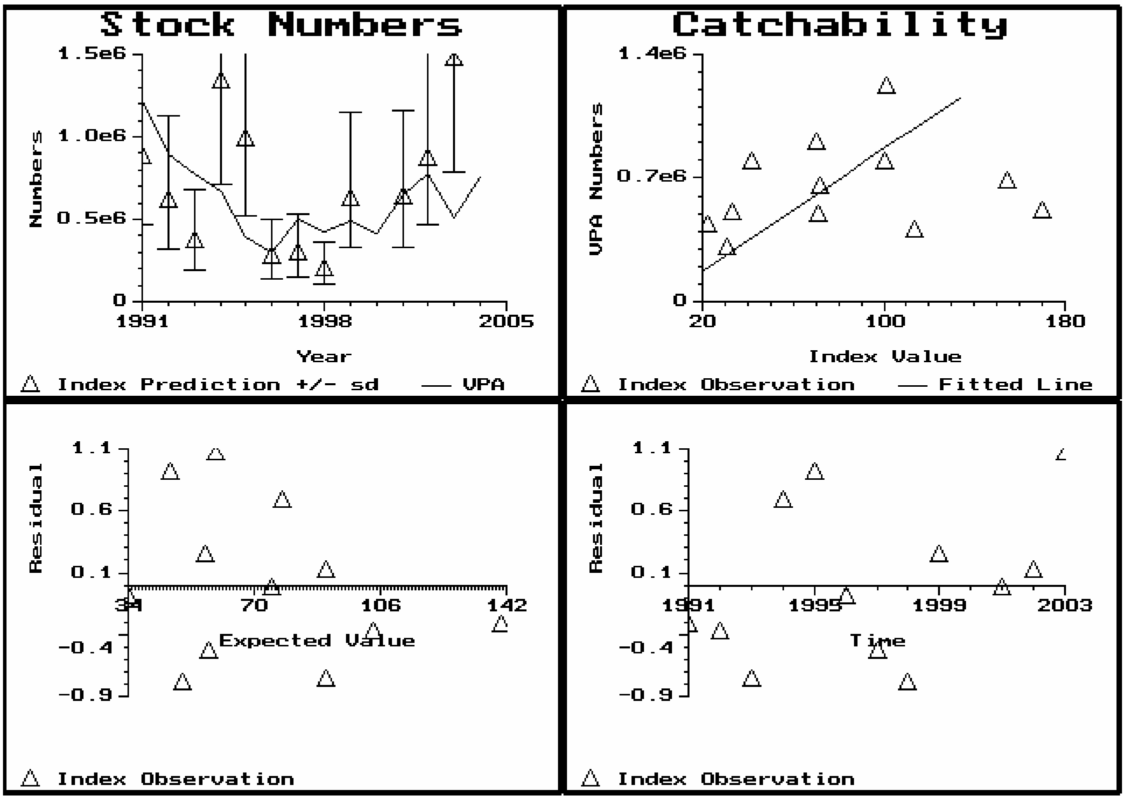


Figure 3.6.10c Western Baltic Herring. Output from ICA Final Run:
Tuning Diagnostics.
IBTS, Kattegat, Quarter 3, Age group 3

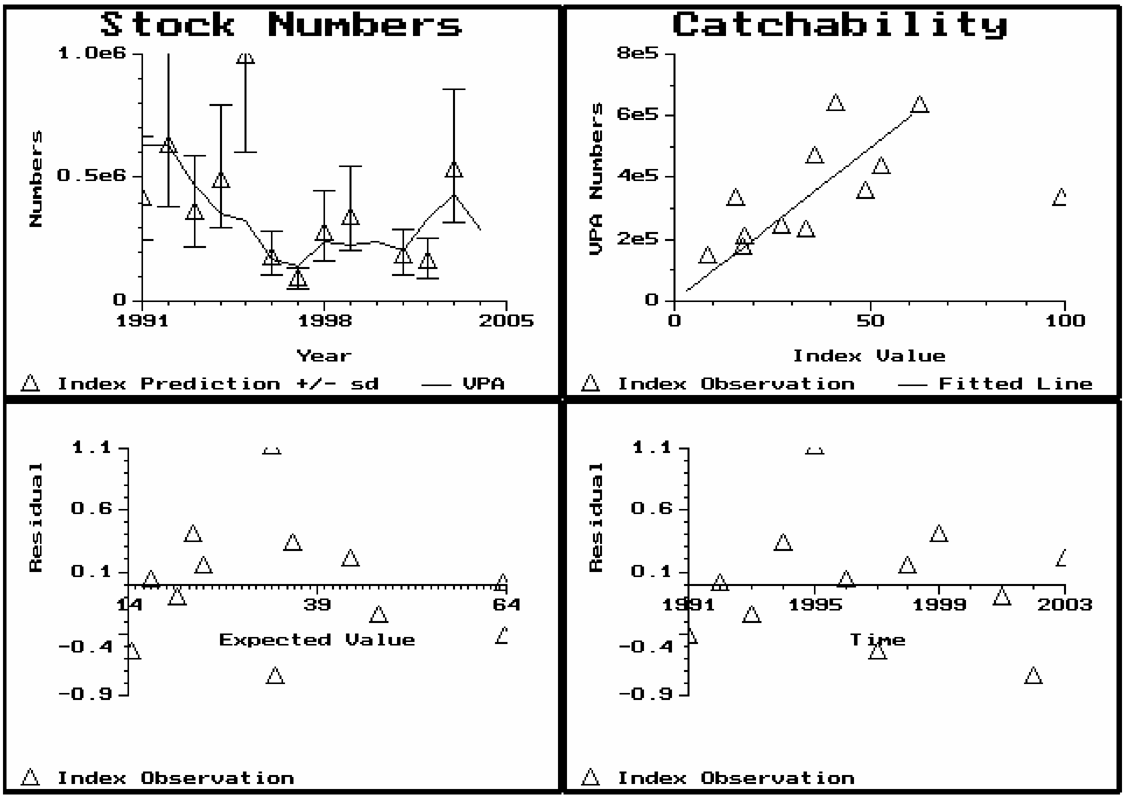


Figure 3.6.10d Western Baltic Herring. Output from ICA Final Run:
Tuning Diagnostics.
IBTS, Kattegat, Quarter 3, Age group 4

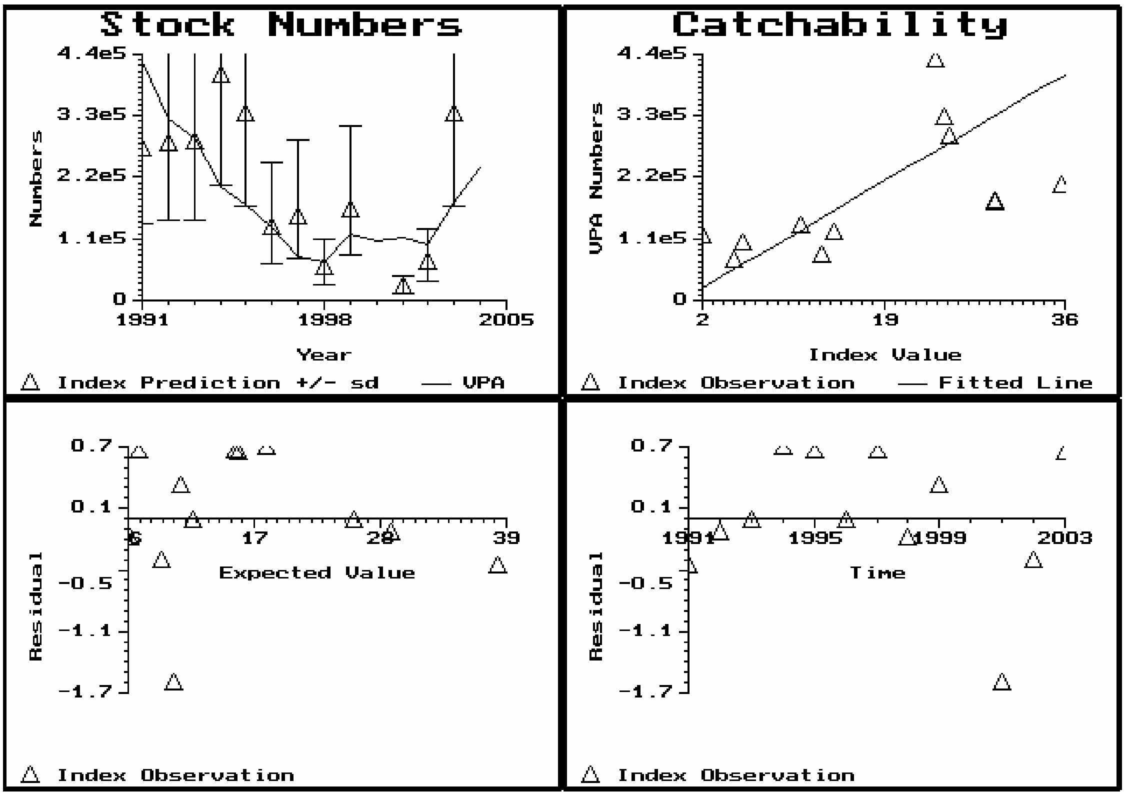


Figure 3.6.10e Western Baltic Herring. Output from ICA Final Run:
Tuning Diagnostics.
IBTS, Kattegat, Quarter 3, Age group 5

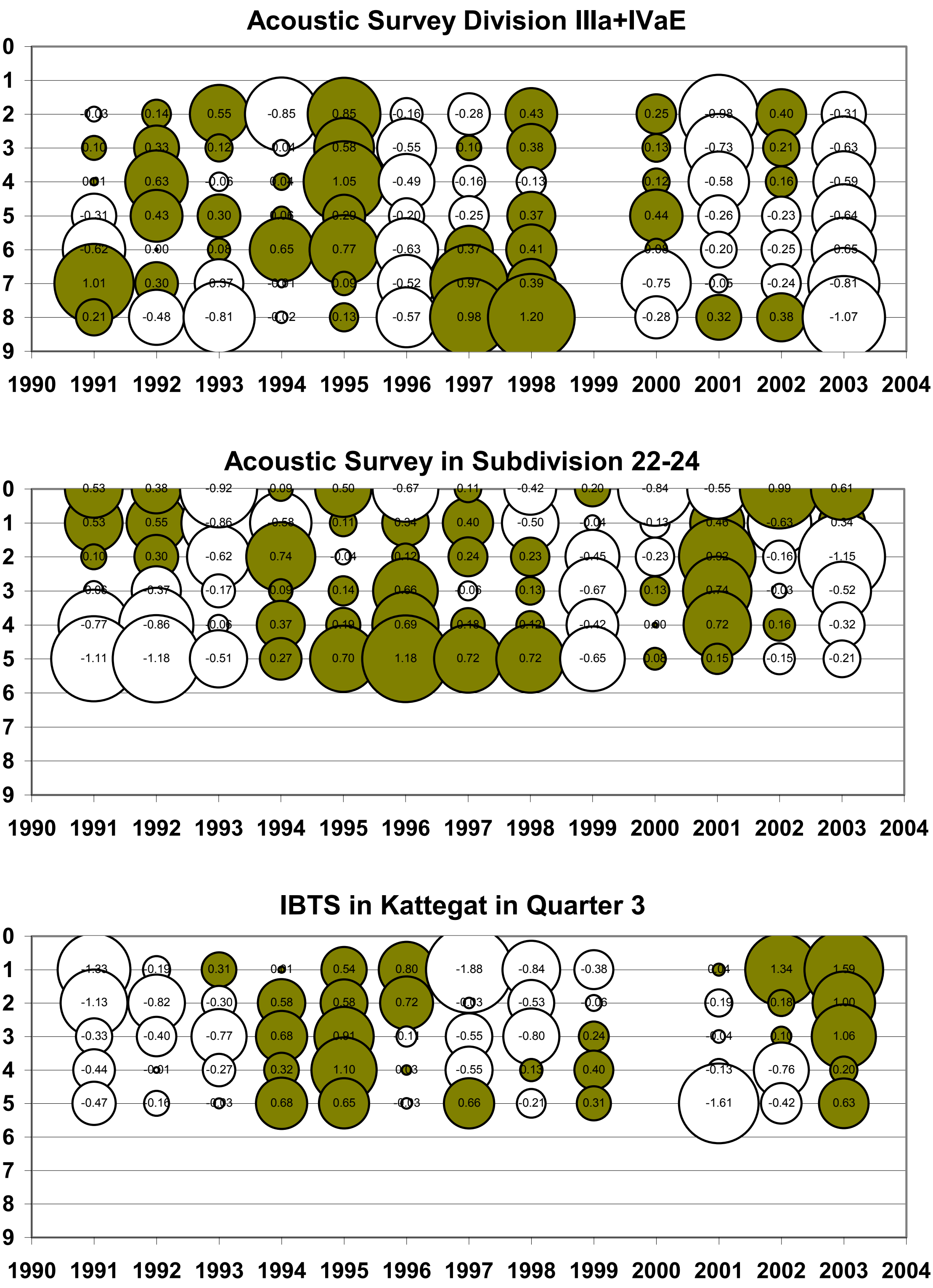


Figure 3.6.11 WESTERN BALTIC HERRING. ICA Final Run 2004.
Log catchability residuals plots.

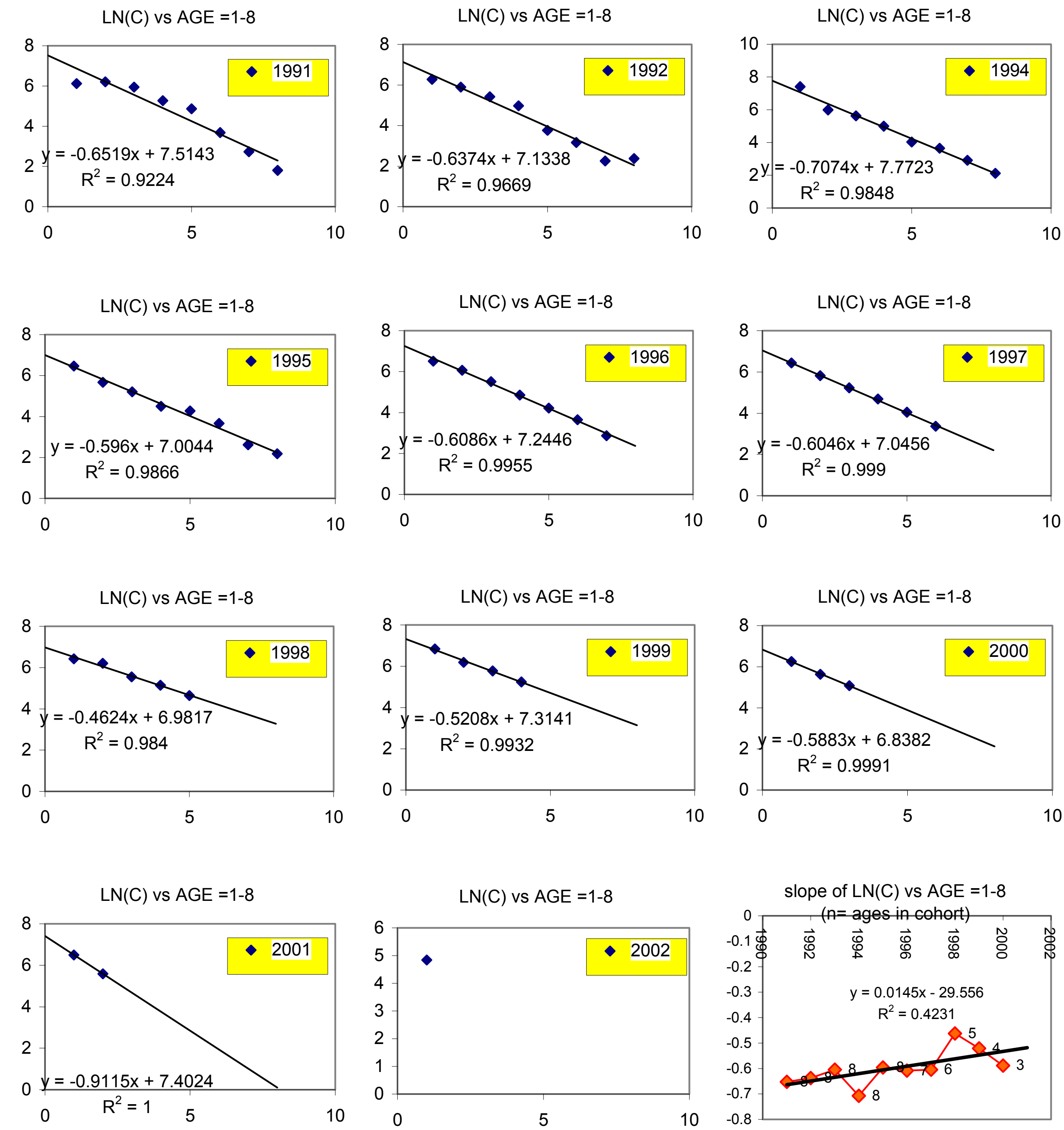


Figure 3.6.12a WESTERN BALTIC HERRING.
Log catch vs age for successive cohorts and their resulting slope estimates.
Catch in number (ages 1-8).

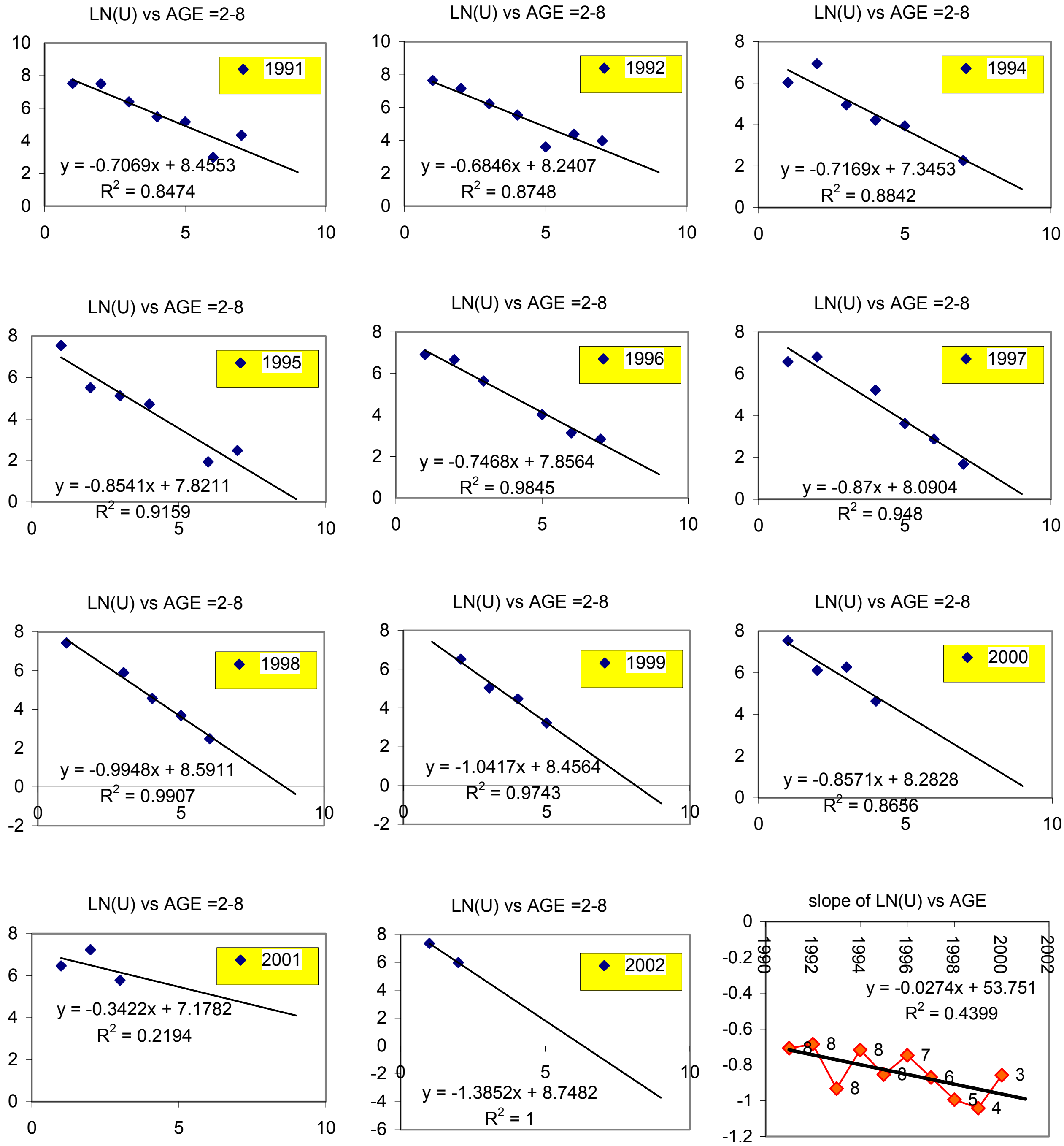


Figure 3.6.12b WESTERN BALTIC HERRING.
Log catch vs age for successive cohorts and their resulting slope estimates.
Acoustic Survey in Div. IIIa+IVaE (ages 2-8+)

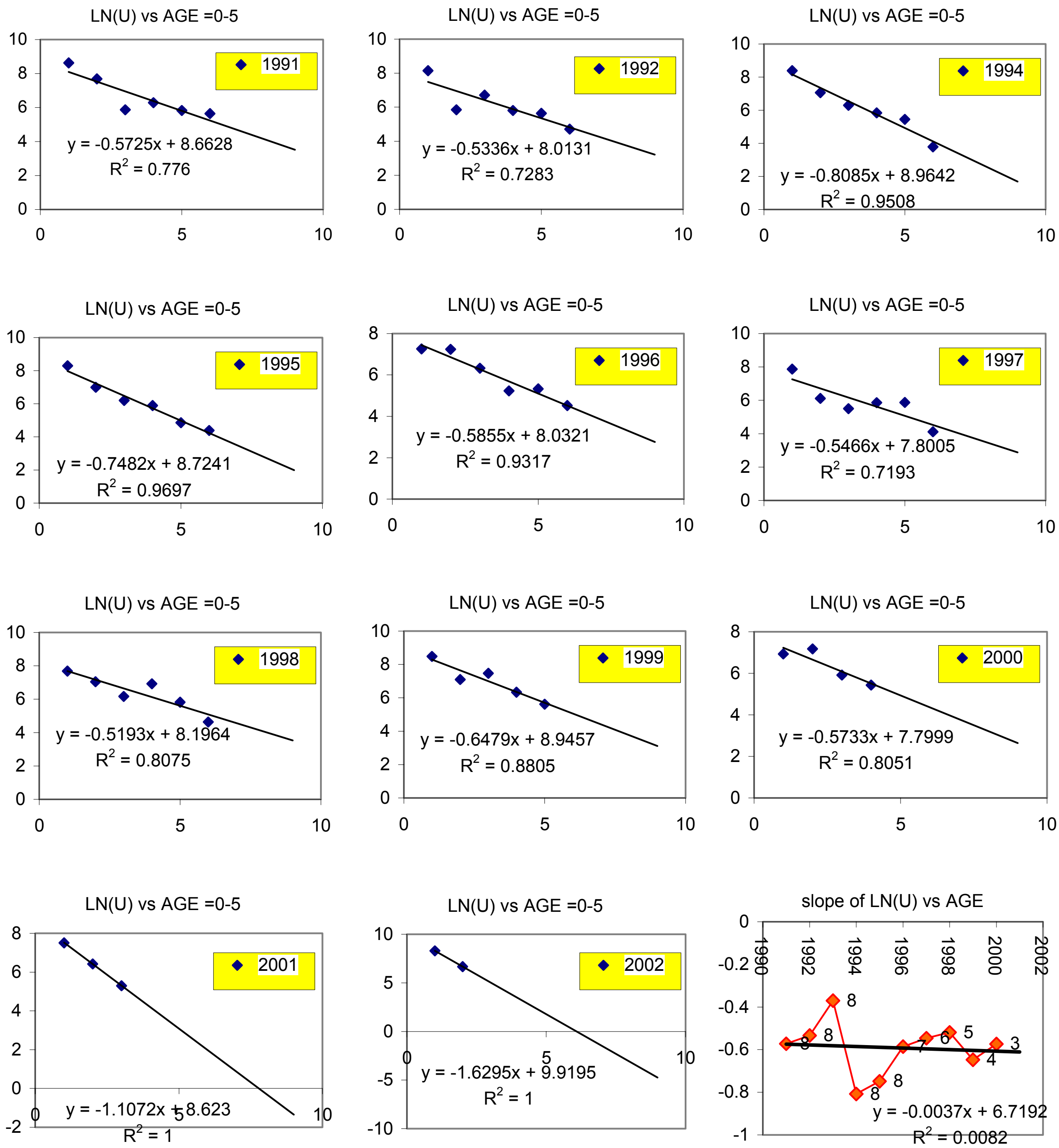


Figure 3.6.12c WESTERN BALTIC HERRING.
Log catch vs age for successive cohorts and their resulting slope estimates.
Acoustic Survey in Subdiv. 22-24 (ages 0-5)

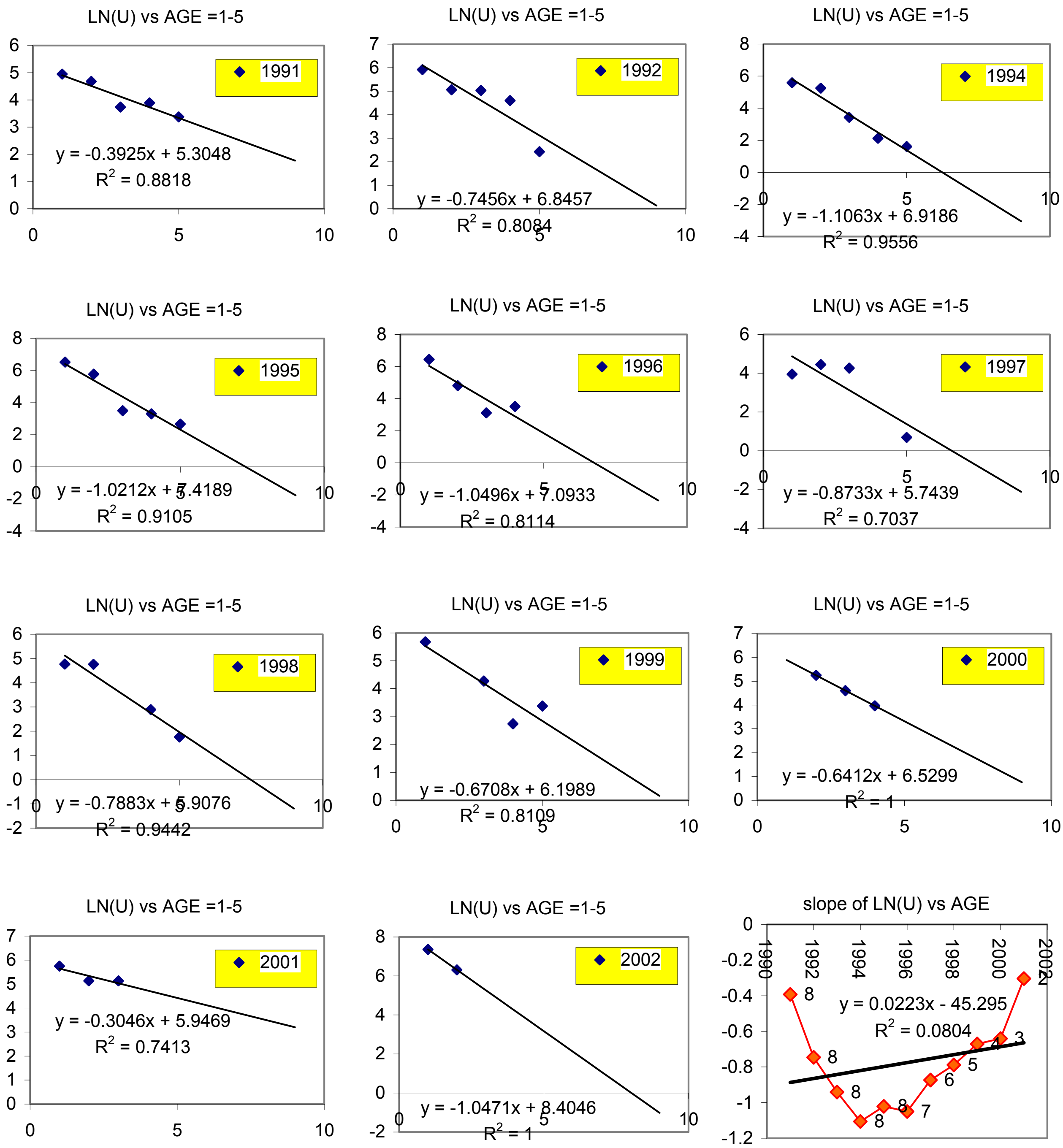
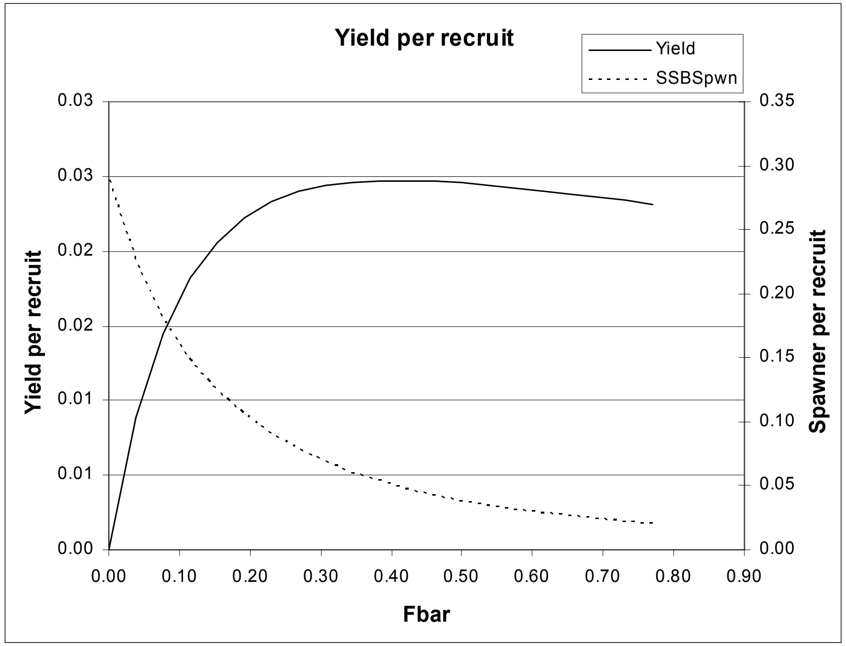
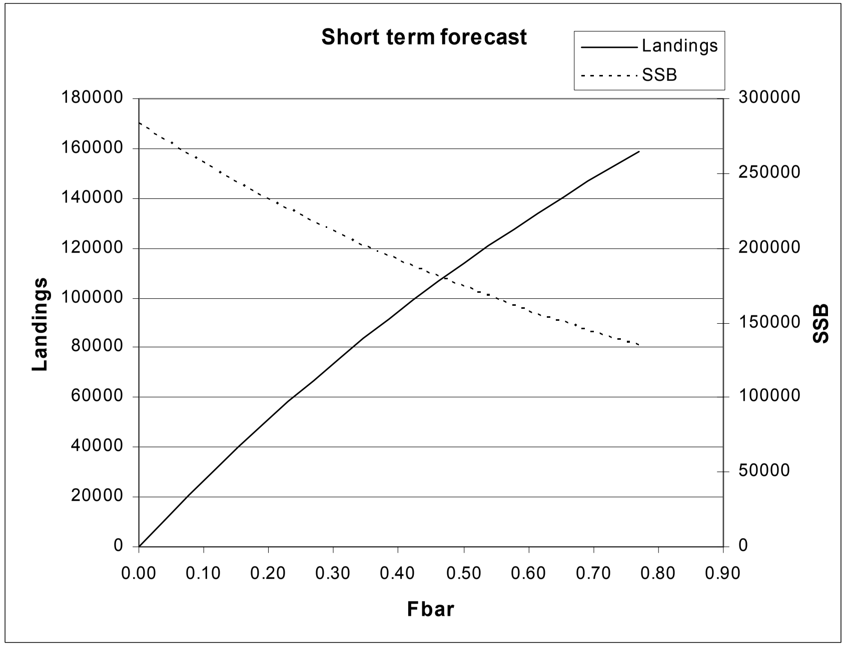


Figure 3.6.12d WESTERN BALTIC HERRING.
Log catch vs age for successive cohorts and their resulting slope estimates.
IBTS in Kattegat Quarter 3 (ages 1-5)





MFYPR version 2a
Run: WBBS_1multi
Time and date: 10:38 16/03/2004

Reference point	F multiplier	Absolute F
Fbar(3-6)	1.0000	0.3846
FMax	1.0563	0.4062
F0.1	0.5339	0.2053
F35%SPR	0.5245	0.2017

Weights in kilograms

MFDP version 1a
Run: WBSS_1
Western Baltic Herring (combined sex; plus group)
Time and date: 10:37 16/03/2004
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

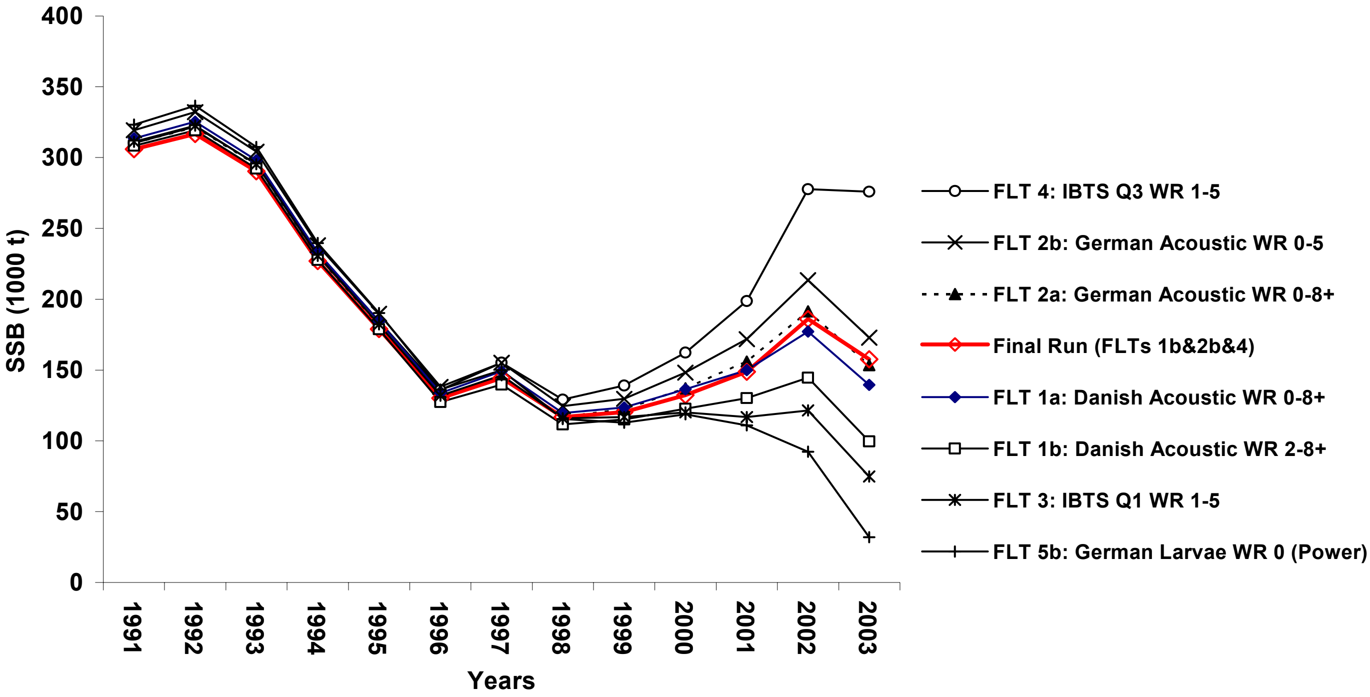


Figure 3.9.1.1 WESTERN BALTIC HERRING. SSB estimates from ICA model with separate indices and with indices combined (Final Run 2004).

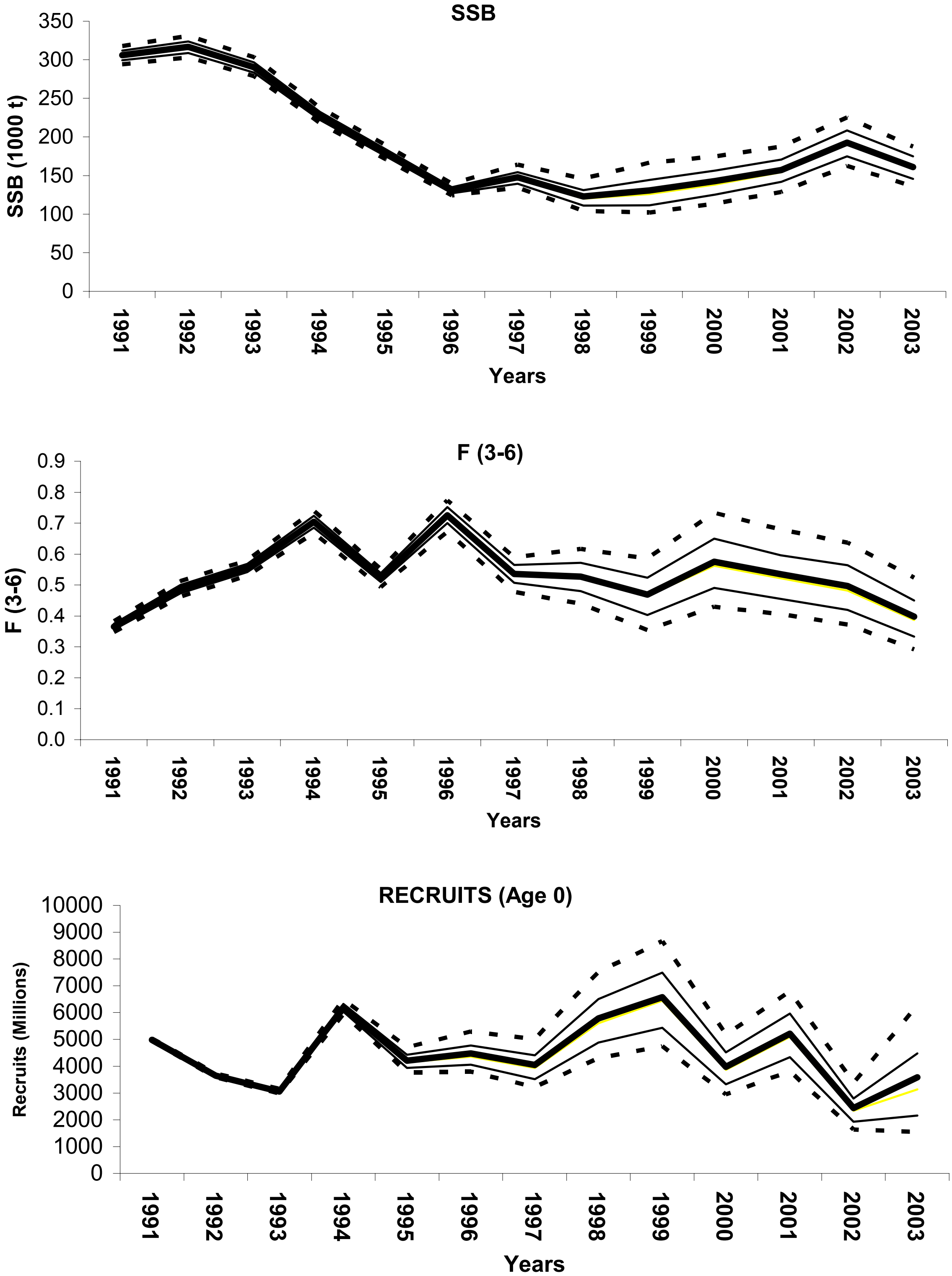


Figure 3.9.1.2 WESTERN BALTIC HERRING.
Historic uncertainty in the Final model fit (ICA assessment).
Percentiles 10, 25, 50, 75 and 90 %.

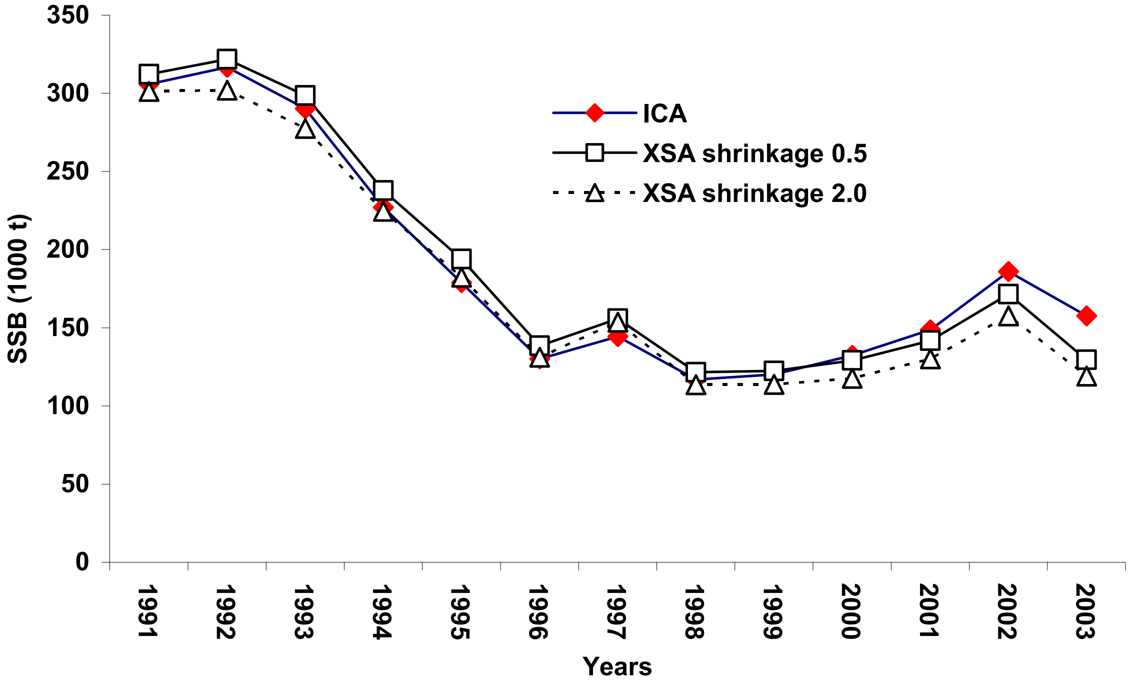


Figure 3.9.2.1 WESTERN BALTIC HERRING.
Comparison of results of ICA and XSA models fits.
Shrunk XSA = 0.5 and non shrunk = 2.0.
ICA settings of Final Run.

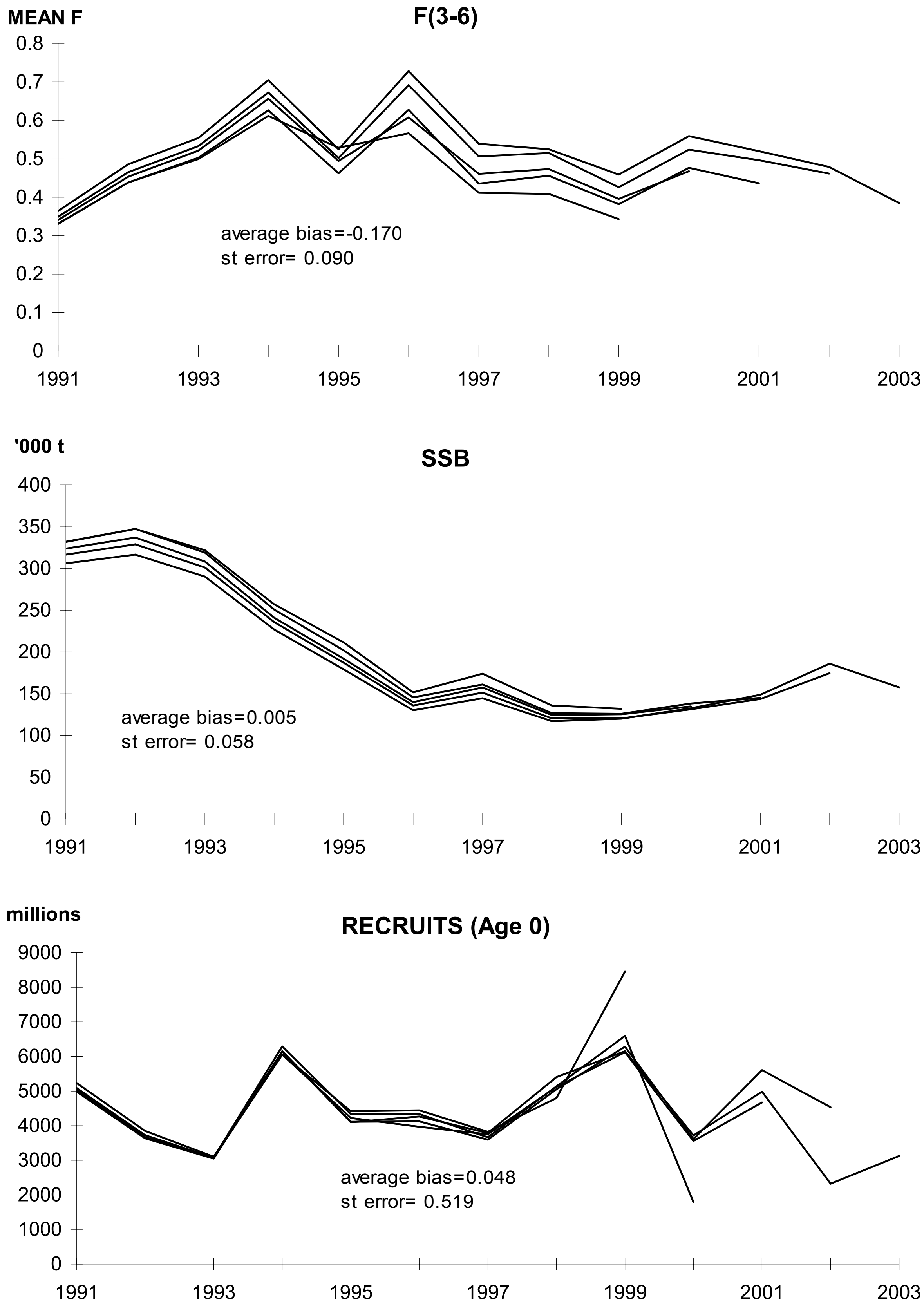


Figure 3.9.3.1 WESTERN BALTIC HERRING: Restrospective Analysis (ICA)

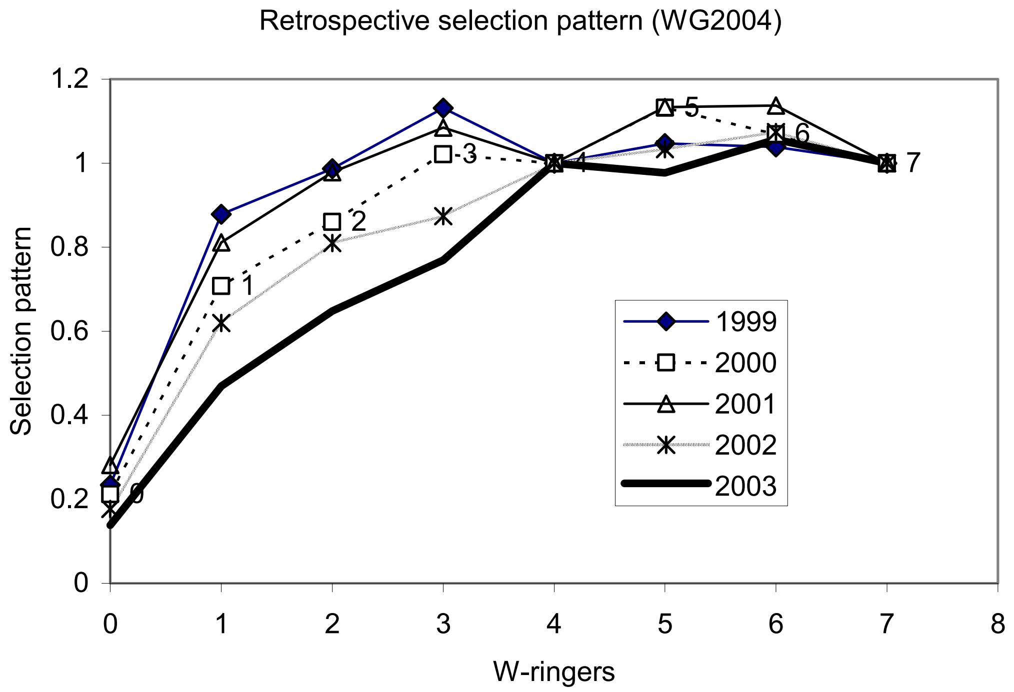


Figure 3.9.3.2 WESTERN BALTIC HERRING.
Restrospective selection pattern

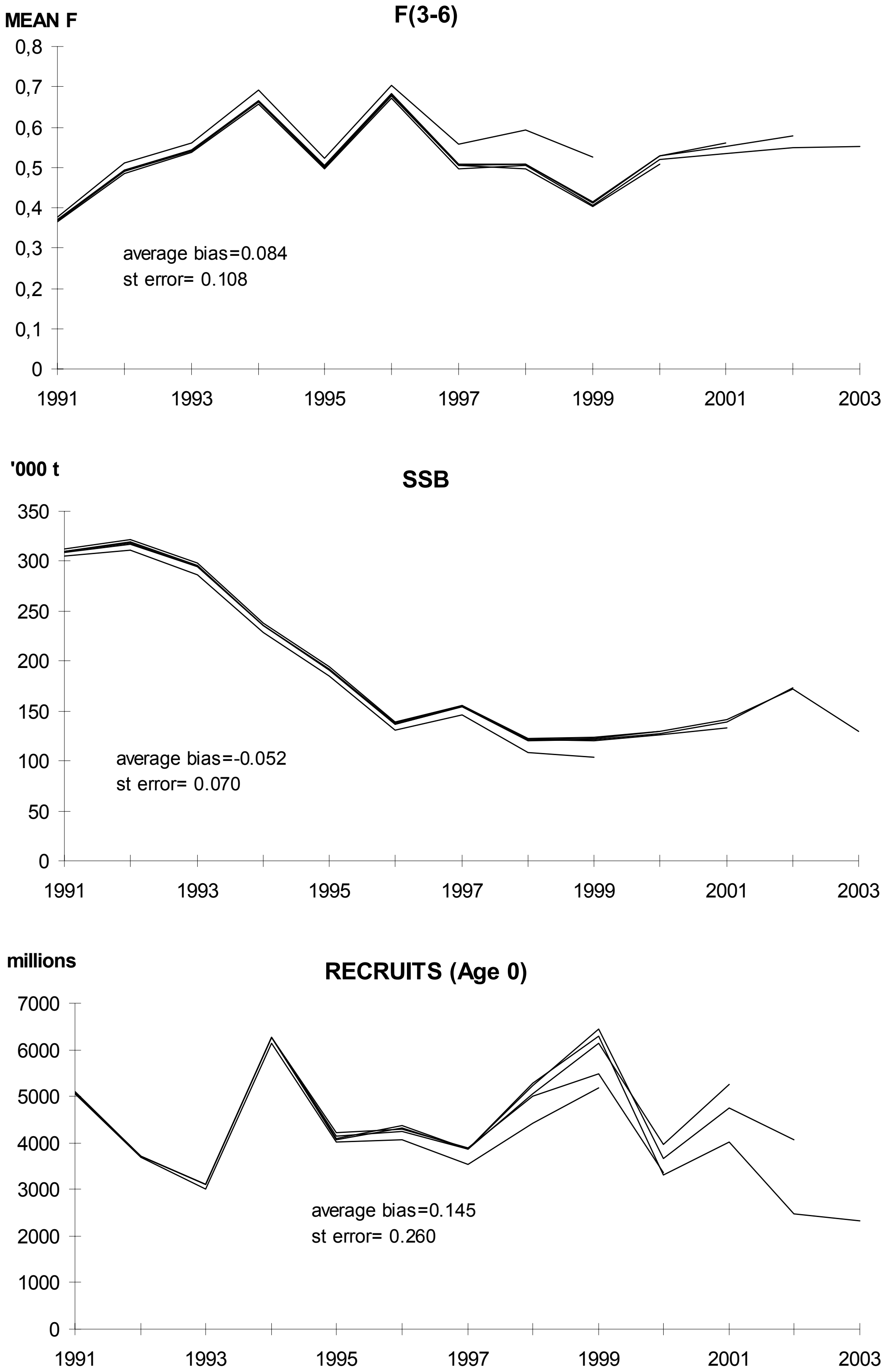


Figure 3.9.3.3 WESTERN BALTIC HERRING. Retrospective Analysis (XSA) (shrinkage = 0.5)

4 Celtic Sea and Division VIIj Herring

Introduction

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 areas for which the assessments are made, together with the area for which the TAC is set by the EU are shown in Figure 1.5.1. The management unit covers all of Divisions VIIg,h,j and k and the southern part of Division VIIa. In the past season, Ireland was the sole participant in the fishery which takes place in VIIg, VIIj and VIIa(S). This has been the case for several recent years.

4.1 The Fishery in 2003-2004

4.1.1 Advice and management applicable to 2003 - 2004

The TAC in 2003, was 13,000 t. In 2003 ICES considered the status of this stock to be unknown. ACFM advised that catches in 2004 should not exceed 40% of the average catches in 1997 –2000 corresponding to catches of less than 11,000 t. This was expected to allow SSB to increase. $\mathbf{B}_{pa}$ is set at 44,000 t and $\mathbf{B}_{lim}$ at 26,000 t. F reference points are not defined for this stock. The TAC is set on a calendar year basis.

The fishing season runs from the 1st April 2003 to the 31st March 2004, though the fishery was traditionally only opened on the 1st October. In the current 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 box closures implemented under EU legislation continued. Box A was closed in the 2003-2004 season and Box B will be closed in November 2004 (Fig 4.1.1.1). In addition to these, Box A 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. This box was re-opened from December 2003, for the remainder of the season. Areas mentioned in the text are shown in Figure 4.1.1.2.

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. 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.

The TAC is set by calendar year, whilst the assessment of this stock is conducted on a seasonal basis (1st April to 31st March). The TAC in 2003 was 13,000 t. Ireland has 86.4% of the quota with, France and the Netherlands having most of the remainder. The Irish quota in 2003 was 11,235 t. This is managed by allocating individual quotas to vessels. 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 contributory factors in the considerable reduction in number of vessels participating in the fishery in recent seasons.

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 2003/2004

In recent years, this fishery has been prosecuted entirely by Ireland. The landings in this fishery since 1958 are shown in Figure 4.1.2.1. The fishing season is the same as the assessment period, 1st April to the 31st March the following year. Traditionally, the fishery was closed in February each year. In the current season, however, the fishery remains open at present.

The main fishery was during the late summer and early autumn at the Kinsale Head Gas Field and the Labadie Bank. The fish at this time were much bigger and of better marketability than the inshore catches. The area off Dunmore East, which had been voluntarily closed for at least two years, was reopened in December 2003. Between July and the start of the traditional spawning season fishery in October, approximately 4,500 t were landed.

Landings were 10,875 t. The total Irish quota was subdivided into boat quotas on a week-by-week basis. In addition to the spawning aggregations fished along the south coast between Waterford and Cork, the off-shore feeding aggregations on the Labadie bank and the Kinsale gas platforms, intermittent landings were also made from the coastal waters of ICES division VIIj. A map of the locations mentioned in the text is given in Figure 4.1.1.2. In this season a total of 10 vessels participated, though only 6 were involved on a regular basis. In 2002-2003, 8 vessels were involved as compared with 33 vessels for 2001/2002 season and 30 for the 2000/2001 season (Figure 4.1.2.2). The markets throughout the season were very poor because of the large catches of herring from the North Sea fishery. The profitability of this Irish fishery was considerably hampered, and led to reduced effort.

The fishery in the third quarter caught larger fish than those caught in the winter fishery (Table 4.2.3.2). See also Figure 4.3.1.2 for comparisons of length distributions.

4.1.3 The catches in 2003/2004

The estimated national catches from 1988–2003 for the combined areas by year and by season (1 April–31 March) are given in Table 4.1.3.1 and Table 4.1.3.2 respectively. The total catches for the fishery over the longer period from 1958 to 2002 are shown in Figure 4.1.2.1 The catch, taken during the 2003/2004 season was about 11,000 t having increased from around 7,500 t during the previous season.

Discards

The level of discards in this fishery is believed to have decreased considerably in recent years with the decline in the demand for "roe" fish for the Japanese market. However there are no estimates of discarding in this fishery.

4.2 Biological Composition of the Catch

4.2.1 Catches in numbers-at-age

Catch numbers-at-age are available for the period 1958-2003. These data include discards, when estimates are available. In 2003/2004, 41% of the catch was composed of 2-ringers (2001/2002 year class) and 27% of the catch was composed of 3-ringers (2000-2001). The percentage of older fish in the current season (30%) was higher than in 2002/2003, having been just 15% (Table 4.2.2.1). The greater proportion of older fish may be explained by the summer fishery, that took these large fish in VIIg and VIIj. The percentage of 1-ringers was 3% in 2003/2004, having been 6% in 2002/2003 (Table 4.2.2.1).

VIIaS was voluntarily closed in 2001 and reopened in early December 2003. Since reopening, catches from this area were dominated by 2-ringers (2001/2002 year class), accounting for 62%.

The Irish authorities, in conjunction with the Irish Southwest Pelagic Management Committee, kept the fishery open all throughout the season in 2003/2004. This initiative was based on the aim to catch the quota when the fish had a better condition factor and consequently less fish would be caught per tonne of quota than in winter time. The summer fishery accounted for most of the catches in this area, and the fish achieved a better price, in difficult marketing conditions for Irish herring. These fish were larger than the winter-caught herring (Table 4.2.2.2). In addition the proportions of 4- to 8-ringer fish was considerably higher than for the entire catches in the 2003/2004 season (Figure 4.3.1.2).

The numbers of herring per tonne (as live fish equivalents) was estimated as 6,554 in the third quarter in VIIg in contrast to 9,405 per tonne in the first quarter of 2004. These data were calculated from mean weights-at-age.

In 2001, the Irish Southwest Pelagic Management Committee, initiated a voluntary closure of spawning box C. This was in addition to the rotating closure of the other boxes in the region (Figure 4.1.1.1). This box was finally reopened in early December 2003. This opening was accompanied by sampling of the catches. The catches since then, were dominated by 2-ringers (62%) and 3-ringers (24%). This age distribution agrees well with the composition of the large aggregations identified in this area during the acoustic survey (Figure 4.3.1.2).

4.2.2 Movements of Juvenile fish

A recent study on herring otolith microstructure has elucidated several points with respect to the natal origin of juvenile herring in the Irish and Celtic Seas (Brophy and Danilowicz, 2002). The results show that fish spawned in the eastern Celtic Sea are present as larvae in the Irish Sea, where fish of local origin are also found. The fish of Celtic Sea origin then return to that area as 1- and 2-ringers. These results show that juvenile distribution affects length-at-age for 0 ring fish and subsequently influences age at recruitment.

4.2.3 Quality of catch and biological data

Since 1997 there has been a major increase in the monitoring of landings from this fishery and the management measures were again tightly enforced throughout the season. As a result the accuracy of the landing figures is considerably better for this period.

Biological sampling of the catches throughout the area increased, relative to last season. This was achieved by co-operation between members of the Irish Southwest Pelagic Management Committee, including fisheries officers, fishermen, skippers and processors. Length distributions of the catches taken by the Irish fleet per quarter are shown in Table 4.2.3.2. Details of the sampling data per quarter are shown in Table 4.2.3.3. A particular difficulty was the paucity of samples from VIIj. However, steps have been taken to rectify this problem.

4.3 Fishery Independent Information

4.3.1 Acoustic Surveys

A series of acoustic surveys have been carried out on this stock from 1990-1996. The series was interrupted in 1997 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 (Table 4.3.1.1). The references cited are dealt with by O'Donnell et al. (in prep.).

In 2003, one acoustic survey was carried out in October and November (O'Donnell WD, 2004). This single survey was aimed at pre-spawners as they move inshore to spawn. The survey track was begun at the northern boundary of VIIj, and moved south and then eastwards, ending in VIIaS (Figure 4.3.1.1a). The largest concentrations of herring were located at the eastern part of the area, in the Waterford Harbour and immediately east of Dunmore East. This area had been voluntarily closed since 2001. NASC values, assigned to herring ,from this area contribute to over 75% of the total values obtained (Figure 4.3.1.1b).

Concentrations of small isolated herring traces were observed in the northern part of VIIj. Offshore occurrence of NASC values attributed to herring was extremely low in comparison to previous surveys in the Celtic Sea. The geographical positioning of the NASC values obtained along the southwest and south coasts closely mirror that of the pattern of fleet activity.

The composition of the aggregations in the Waterford Harbour/Dunmore East (VIIaS) was dominated by 2-ringers, but this age distribution was not observed elsewhere in the survey area. Fish of three winter rings predominated in VIIj. In the south western part of VIIg, 0- and 1-ring fish predominated. Because the aggregations in VIIaS accounted for around 75% of the biomass and numbers, the age structure of the overall biomass estimate is dominated by 2-ringers. Figure 4.3.1.2 compares the age distribution of commercial catches with the acoustic abundance estimate. The 2-ringers are dominant in both, but the percentage of 3-ringers is proportionately greater in the survey. These fish were located in VIIj, though they accounted for only 19% of the overall acoustic estimate.

The majority of the fish were mature, accounting for 87% of the biomass estimate and 85% of the total numbers, indicating that the survey timing was good and major spawning had not taken place. A small proportion of spent fish were also present indicating that some of the stock had just spawned. The majority of the traces were recorded close inshore, and this would suggest that the stock had migrated towards the spawning grounds. Fishing success was reasonably good. Around 50% of the biomass was generated by the VIIaS aggregations, that were positively identified as herring, based on fishing. Elsewhere the estimate is less certain, as the majority of the traces were not identified with confidence.

The age structured index of biomass and numbers from acoustic surveys in this area, is shown in Table 4.3.1.2. The overall biomass estimate (89,000 t) is considerably higher than in the previous season (49,000 t). However, most of the biomass in the present survey was recorded from aggregation, described above, in VIIaS. The strong 3-ringer group in the 2003 survey was not well represented as 2-ring fish in 2002 survey. In addition, 3-ringers were less strongly represented in the commercial fishery. In VIIj in the fourth quarter of 2003, 3-ringers accounted for their greatest proportion of the catch (39%), and this agrees well with the strength in that Division estimated by the acoustic survey. The relatively weak appearance of this year class in the previous year's survey may be explained by the poor coverage, particularly of VIIj, due to adverse weather conditions in autumn 2002.

4.3.2 Other surveys

In 2000 some information from a UK bottom trawl survey in the first quarter was made available to the HAWG. This information was useful in examining for major changes in Z in the previous year as indicated by the 1999/2000 acoustic survey index. While there was no updated information from this survey series available to the WG in 2004, the Irish Marine Institute will initiate a study of the western IBTS survey as a recruitment index for the 2005 WG.

In 2004, an initiative by the Irish Southwest Pelagic Management Committee led to an acoustic survey being conducted on a commercial vessel whilst actively fishing herring in VIIg. A pair team of vessels were actively targeting fish and had located several large aggregations. An ad hoc survey track was developed and echo integration was carried out using the EK60, by Seabed Surveys International Ltd. The estimate was based on tightly spaced tracks in an area where herring were aggregating at the time Biological data were collected for the catches associated with this work, by the Irish Marine Institue. The preliminary results were available to HAWG. Though not age stratified, as yet, the overall biomass of the herring in this area was 42,800 t. This estimate is smaller than that obtained by the acoustic survey, but the area of coverage was much smaller.

4.4 Mean weights and maturity-at-age

The mean weights in the catch for this stock over time are presented in Figure 4.4.1. There has been an overall downward trend in mean weights-at-age since the mid-1980's, with current values among the lowest in the series.

In the past season, and for the first time in many years, a substantial catch was taken, outside the spawning season. The spawning season is considered to begin on the 1st October and progresses through to mid February, in a generally west to east direction. Therefore the mean weights in the stock were calculated from samples taken in VIIg, VIIj and VIIaS from October 2003to February 2004. Summer samples were not used in these calculations. The mean weights were lower than previous years for all ages. This may reflect higher abundances of these year classes in the population.

The maturity-at-age for this stock has been assumed to be constant throughout the whole time period (50% of 1 ring fish are assumed to be mature at age 1 and 100% mature at 2 ring).

4.5 Recruitment

At present there are no recruitment estimates for this stock that can be used for predictive purposes. The modelled catch numbers-at-age from ICA, suggest that the recruitment of 1- ringers in 1999 and 2001 was above average, but that it was weaker in 1998, 2002 and 2003.

In this stock a proportion of juvenile fish are present in the Irish Sea and do not recruit to the Celtic Sea and Division VIIj until they are mature. Therefore neither the numbers of 1-ringers in the stock as estimated from the acoustic surveys nor the numbers in the catches give a reliable indication of year class strength. The relationship between the numbers of 1-ringers taken per hour in the Northern Irish ground fish surveys in the Irish Sea and the numbers of 1-ringers estimated by ICA for the Celtic Sea and Division VIIj was examined in a working document presented to the 1999 WG (Armstrong et al., 1999) and the results suggest that these surveys may become a useful indicator of recruitment to the Celtic Sea and Division VIIj when a longer time-series is established. Recent information on mean length of 0 group herring (measured in October) in the eastern and western Irish Sea suggests that the proportion of juvenile herring from the Celtic Sea and Division VIIj stock in the Irish Sea may be relatively low in recent years.

4.6 Stock Assessment

4.6.1 Preliminary data exploration

Recent WG's have used the results of the acoustic surveys in the ICA programme but stated that the results should be taken as minimum estimates. In 1998 the WG decided to use the age-disaggregated data but only over the 2 to 5-ringers as a relative index in the ICA programme, and this has been continued. The main difference between this year's assessment and that of 2003 was the change in the proportion of F before spawning (=0.551 in 2004) and the different procedure for estimating stock weights (see 4.4.4). In 2004, an examination of the log ratio of abundances in the survey index was carried out. This showed that there was both high frequency and low frequency noise in the acoustic survey abundances by age. The high frequency noise was associated with 0- and 1-ringers and fish older than 5-ringer. This finding confirms the decision to restrict the acoustic index to 2- to 5- ringers. In addition, this analysis confirms the strong year effects in the survey too (Figure 4.6.1.1).

Exploratory runs were made by including the acoustic index as an SSB index also. This was achieved by using a power model in ICA. The results of this exploratory run, produced much higher estimates of recruitment than those where this series was not used. This is because the total SSB index includes all age groups, including 1-ringers. The model attempts to match the SSB proportion contributed by recruits, by inflating the modelled catch numbers-at-age. ICA could not adequately model the inconsistency between the catch-at-age and the non-age stratified SSB index. However it is clear from the acoustic survey that there is a predominance of young fish, particularly in VIIaS, and this signal may indicate increased numbers of younger fish in the population. The working group decided not to include the SSB as a separate index, due to this inconsistency.

In 2004, the working group considered a range of selections at oldest age. This was because there was concern that the pattern of exploitation has changed in recent years. There is a marked trend in log catch ratios (Figure 4.6.1.2). Since 1998/1999 the values have displayed an increasing trend. This may reflect increased F, though this seems unlikely given the decrease in landings in that time. It may also indicate a change in fishing pattern.

The mean of log transformed abundances of 2-5 ringers in the acoustic survey index is relatively stable over the time-series (Figure 4.6.1.3). However, the slopes of the survey curves are much higher than the signal that is received from the catch numbers-at-age data in the commercial fishery (Figure 4.6.1.4). This may be explained by different catchabilities of the older ages in the fishery, over the time period. It most likely also reflects the discarding of fish in the past. There is less information in the most recent years in these figures.

The update assessment run was taken as for last year with the new survey and catch-at-age data. In order to investigate the effects of changing fishing pattern and the sensitivity of the ICA model to different input values of selection on the oldest age. ICA was run for a range of terminal S values from 0.7 to 1.5. The outputs from this analysis showed that SSB and recruitment were not sensitive to differing proportions of terminal selection to the reference age. However higher terminal S inputs (0.7-1.5) produced higher F's (0.48-0.67). Then, the effect of changing the extent of the separable period was examined by using 8 and 4 year periods. These changes did not effect the model outputs to any large extent.

The changes noted above, in separable period and terminal S did not improve the model fit. The update run was chosen as the final run. However, the inability of the assessment model to track changes in the exploitation pattern and the inconsistencies between the survey and the fishery should be noted. A table is given below showing the options used in the assessment since 1998.

Working Group	**Age structured acoustic Index (ages 2-5 rings)**	**Shrinkage**	**Separable period**
1998	1990-1996	No	1992-1997
1999	1990-1996, 1998	No	1993-1998
2000	1990-1996, 1998	Yes (5yr)	1994-1999
2001	1990-1996, 1998, 2000	No	1995-2000
2002	1990-1996, 1998, 2000-2001	No	1996-2001
2003	1990-1996, 1998-2002	No	1998-2003
2004	1990-1996, 1998-2003	No	1997-2003

4.6.2 Results of the assessment

The run log of this years assessment is shown in Table 4.6.2.1. The results of the assessment and the diagnostics are shown in Table 4.6.2.2 and Figures 4.6.2.1 – 4.6.2.8. The model suggests a downward trend in SSB throughout the 1990's, with a slight increase in 2002 and then a decline again. This downward trend accompanies a decline in the mean weights in the catch (Figure 4.4.1). However the estimate of SSB in the final year should be treated with caution because of the inherent uncertainty in the assessment and the higher estimate obtained from the acoustic survey, which there is reasonable confidence attached to. The increase in F in the final year can be explained by a higher catch in the current season. F declined since the early 1980's but showed a marked rise again in the late 1990's, before declining again. The long-term average F for this stock has been about 0.54, and current F is close to this value. However recent landings have been well below the historical average.

The value of F in 2002 from the current assessment is 0.275, lower than that estimated in the 2003 assessment (0.304). The estimate of SSB for 2002 from the current assessment is very similar to that estimated for that year in the previous assessment. Recruitment in 2002 estimated from the current assessment is higher than that estimated from the previous assessment. Overall the estimates F and SSB in the final year in the 2003 assessment and in the current assessment are in the same range. However the value of recruitment last year now appears to have been an underestimate (Figure 4.6.2.1).

Historical uncertainty was evaluated in the current assessment. The results of this analysis, based on 100 bootstrapped samples of residuals, are presented in Figure 4.6.2.9. There is a large uncertainty in the estimate of SSB and recruitment between 1993 and 2000. The uncertainty around the recruitment in 2003 increased markedly again, and this was found to a lesser extent for SSB too. The uncertainty around estimates of mean F also increased in this time period, though the 2002 estimate was low. This may be explained by the low landings in that year. The reasons for these uncertainties are difficult to elucidate. However it is clear that the uncertainty has reduced somewhat in recent years, and this may reflect the improved reporting of catches that has taken place in this period.

4.6.3 Comments on the assessment

The working group has now tracked the historical uncertainty in this assessment for two years in a row. There clearly has been some changes in the fishery in the recent past and this may have affected the assessment. A cause for concern is the inability of the model to match the inconsistencies between the survey and the commercial catch-at-age data. The estimate of SSB from the survey is considerably higher for 2003/2004 than that obtained from ICA. This is reflected in Figure 4.6.2.9. However ICA has produced relatively consistent outputs in the past two years. In the absence of a fisheries-independent estimate, the current estimates of recruitment from the assessment should be treated with caution, though they suggest improved recruitment in 1999 and 2001. The strong year effects in the survey and the especially 1998 survey need to be evaluated. A re-examination of the raw data files and echograms from the survey time-series should be carried out.

4.7 0Short-term projection

A short-term projection was carried out under the following assumptions. The number of 1 ringers was based on the geometric mean from 1958 to 2001. This is the same procedure as last year and was followed to allow for the inclusion of the period of recruitment failure. This value was 406 million fish, somewhat lower than the value of 504 million fish used last year. 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) 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 2004/2005). The input data for the prediction based on $\mathbf{F}_{sq}$ is provided in Table 4.7.1. A single option management table based on $\mathbf{F}_{sq}$=F_{2003} is given in Table 4.7.2. A management option table based on $\mathbf{F}_{sq}$ in 2003 with options for 2004 is given in Table 4.7.3. Fishing at $\mathbf{F}_{sq}$ in the 2004/2005 season will produce landings of 15,000 t and an SSB of 41,000 t. Continued fishing at this level of F will result in landings of 15,000 t in the 2005/2006 season and the 2006/2007 season. Based on this prediction, SSB is estimated to be about 41,000 t in 2004/2005 and again in 2005/2006, falling slightly to 40,000 t in 2006/2007.

The input data for the prediction based on the TAC constraint (=13,000 t) is provided in Table 4.7.4. A single option management table based on TAC constraint (=13,000 t) is given in Table 4.7.5. A management option table based on TAC constraint (=13,000 t) with options for 2004 is given in Table 4.7.6.

If fishing is constrained by a TAC of 13,000 t in 2004/2005, then this will result in an SSB of 43,000 t, and fishing mortality will be 0.44. If this TAC is caught again in 2005/2006, then SSB will reach 45,000 t, with a slight reduction in F to about 0.43.

Plots of yield-per-recruit and short-term yield are given in Figure 4.7.1. $\mathbf{F}_{max}$ is undefined. $\mathbf{F}_{0.1}$ is defined as 0.1674, and $F_{35\%SPR}$ is defined as 0.1807, lower than current mean F2-7 that is estimated as 0.4708. $\mathbf{F}_{sq}$ is concomitant with SSB that is close to $\mathbf{B}_{pa}$. Landings of 13,707 t in 2004/2005 are close to the current TAC and are concomitant with an F of 0.519, a 10% increase in $\mathbf{F}_{sq}$. TAC's in the range 15,000 to 17,000 would require 30% to 50% increases in current estimated F.

4.8 Quality of the assessment

The landings in this fishery have been monitored rigorously and management measures tightly enforced, resulting in considerably better accuracy in landings figures. Allied to this there is a comprehensive sampling programme of the landings that has been enhanced through co-operation with the industry. Apart from a low sampling rate in VIIj, this provides a relatively sound basis for the catch data in the assessment.

Fishery independent data are provided by the autumn acoustic survey, of which the principle index is the age disaggregated numbers. These data are noisy therefore the index only uses the mid range of the year cases. There are no estimates of recruitment.

The present assessment is essentially an update on the previous year's assessment. In recent years, the assessment has become unstable due to problems with acoustic survey numbers-at-age data and an apparent change in the recruitment levels between 1996 and 1998, which was not detected by the assessments in those years. The uncertainty in the assessment around the mid to late 1990s (partially due to differences in the trends in the acoustic survey and catch data) is reflected in the historical uncertainties (see Figure 4.6.2.9).

4.9 Biological 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 last years 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 Management considerations

The current management of this fishery has been described above. The management in place is the best that has ever been implemented for this stock. The working group encourages these initiatives to continue and be intensified. The most important aspects of the suite of management measures have been the shift away from targeting spawners and the closure of box C for two seasons.

The uncertainty in the assessment has been evaluated, but it is still not possible to use this information to produce an analytical TAC. Fishing at current estimated F is expected to lead to an increase in SSB over the coming 3 years. Annual catches of around 13,000 t are concomittitant with $\mathbf{F}_{sq}$. These estimates of F are uncertain, however. The working group considers that this stock could be a candidate for alternative management strategies, other than TAC. This would imply a change in the type of assessment and advice that are currently produced. An investigation of harvest control rules should be carried out for this stock.

The SSB estimate in the past two years is less uncertain than in previous assessments, however the SSB estimate in the final year is still strongly influenced by recruitment at age and without a recruitment index it is not possible to estimate the current SSB more precisely. For this reason the assessment will remain unstable if recruitment continues to fluctuate. Consequently without a recruitment index, the assessment will stabilise only if recruitment returns to geometric mean values for a number of years. The decrease in uncertainty this year may be an indication that this is beginning to happen. It is too early to evaluate if the effects of closing box C. However it is considered that this must have had advantageous effects on the stock. The fact that so much of the biomass in the acoustic survey was recorded in this area, and the predominance of younger fish, suggests that this area should be afforded as much protection as possible.

The changing pattern of the fishery has presented difficulties for the assessment model. The working group notes that these management measures are likely reduce fishing mortality and improve the age profile of the stock. In addition, the increased proportions of older fish in the summer fishery indicates that smaller, first time spawners are being less targeted. In a stock where 1-ringers contribute so much to SSB, this is a good development.

The main Irish fishery takes place on the spawning grounds along the Irish coast. The spawning grounds are well known and are mainly located in shallow inshore waters. In recent years a number of these spawning grounds have come under threat from possible extraction of gravel, dumping of harbour silt and dredge spoil and from the location of fish farms. All relevant information on seabed classification, position of spawning beds and hydrography should be collated so that informed decisions can be made about future proposals for dumping of spoil or gravel extraction.

Table 4.1.3.1 Celtic Sea and Division VIIh, j and k herring landings by calendar year (t), 1988–2003. (Data provided by Working Group members.) These figures may not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	France	Germany	Ireland	Netherlands	U.K.	Unallocated	Discards	Total
1988	-	-	16,800	-	-	-	2,400	19,200
1989	+	-	16,000	1,900	-	1,300	3,500	22,700
1990	+	-	15,800	1,000	200	700	2,500	20,200
1991	+	100	19,400	1,600	-	600	1,900	23,600
1992	500	-	18,000	100	+	2,300	2,100	23,000
1993	-	--	19,000	1,300	+	-1,100	1,900	21,100
1994	+	200	17,400	1,300	+	-1,500	1,700	19,100
1995	200	200	18,000	100	+	-200	700	19,000
1996	1,000	0	18,600	1,000	-	-1,800	3,000	21,800
1997	1,300	0	18,000	1,400	-	-2,600	700	18,800
1998	+	-	19,300	1,200	-	-200	-	20,300
1999		200	17,900	1300	+	-1300	-	18,100
2000	573	228	18,038	44	1	-617	-	18,267
2001	1,359	219	17,729	-	-	-1578	-	17,729
2002	734	-	10,550	257	-	-991	-	10,550
2003	800	-	10,875	692	14	-1,506	-	10,875

Table 4.1.3.2**.** Celtic Sea & Division VIIj herring landings (t) by season (1 April–31 March) 1988/1989-2003/2004. (Data provided by Working Group members.) These figures may not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	France	Germany	Ireland	Netherlands	U.K.	Unallocated	Discards	Total
1988/1989	-	-	17,000	-	-	-	3,400	20,400
1989/1990	+	-	15,000	1,900	-	2,600	3,600	23,100
1990/1991	+	-	15,000	1,000	200	700	1,700	18,600
1991/1992	500	100	21,400	1,600	-	-100	2,100	25,600
1992/1993	-	-	18,000	1,300	-	-100	2,000	21,200
1993/1994	-	-	16,600	1,300	+	-1,100	1,800	18,600
1994/1995	+	200	17,400	1,300	+	-1,500	1,900	19,300
1995/1996	200	200	20,000	100	+	-200	3,000	23,300
1996/1997	1,000	-	17,900	1,000	-	-1,800	750	18,800
1997/1998	1,300	-	19,900	1,400	-	-2100	-	20,500
1998/1999	+	-	17,700	1,200	-	-700	-	18,200
1999/2000		200	18,300	1300	+	-1300	-	18,500
2000/2001	573	228	16,962	44	1	-617	-	17,191
2001/2002	-	-	15,236	-	-	-	-	15,236
2002/2003	734	-	7,465	257	-	-991	-	7,465
2003/2004	800	-	11,536	610	14	-1,424		11,536

Table 4.2.2.1 Comparison of age distributions (percentages) in the catches of Celtic Sea and VIIj herring over recent seasons.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2000/2001	7	58	14	9	4	5	2	0	0
2001/2002	12	49	28	5	3	1	1	0	0
2002/2003	6	46	32	9	2	2	1	0	0
2003/2004	3	41	27	16	6	4	3	0	1

Table 4.2.2.2.. Length frequency distributions of the Irish catches (raised numbers in '000s) in the 2003/2004 season in the Celtic Sea and VIIj fishery.

Length	VIIg Quarter 3 2003	VIIj Quarter 3 2003	VIIaS Quarter 4 2003	VIIg Quarter 4 2003	VIIj Quarter 4 2003	VIIaS Quarter 1 2004	VIIg Quarter 1 2004
(cm)							
19							
19.5				13			
20			25	40		28	62
20.5	55	7	67	159		74	149
21	210	25	277	344		204	286
21.5	574	68	653	530	7	555	509
22	662	78	1050	1483	20	722	920
22.5	949	112	1569	1814	41	1277	957
23	1213	144	1558	1907	81	1379	1069
23.5	1522	180	1299	1509	115	1286	1268
24	1864	221	1204	1920	223	1037	1056
24.5	2581	306	1372	2450	372	1231	1367
25	3629	430	1316	2529	636	1037	1354
25.5	3739	443	797	2066	609	861	1131
26	3651	432	646	1602	426	648	559
26.5	3199	379	298	715	338	342	485
27	2482	294	147	477	203	194	261
27.5	1346	159	67	146	122	148	162
28	993	118	21	66	20	9	50
28.5	695	82	4	26	14	9	
29	199	24		13	7		
29.5	77	9			7		
30	33	4					
30.5							

Table 4.2.3.3 Celtic Sea & Division VIIj (2003–2004). Sampling intensity of commercial catches

Country	Quarter	Year	Catch (t)	No. samples	No ages	No measured	Aged per 1,000 t	Estimate of discards
Ireland	1	2003	1,733	19	724	2122	418	No
Ireland	2	2003	-	-	-	-	-	-
Ireland	3	2003	5,084	20	2,690	963	529	No
Ireland	4	2003	4,059	25	1511	5499	372	No
Ireland	1	2004	2,394	15	966	2130	404	No

Table 4.3.1.1. Acoustic surveys of Celtic Sea and VIIj herring, by season. Number of surveys per season and type indicated along with biomass and SSB estimates. The references cited are dealt with by O'Donnell et al. (in prep.).

Season	**No.**	**Type**	**Biomass**	**SSB**	**Reference**
1990/1991	2	Autumn and winter spawners	103	91	Nash, 1990
1991/1992	2	Autumn and winter spawners	84	77	Reid & Simmonds, 1992
1992/1993	2	Autumn and winter spawners	89	71	Reid & Simmonds, 1993
1993/1994	2	Autumn and winter spawners	104	90	Reid & Simmonds, 1994
1994/1995	2	Autumn and winter spawners	52	51	Fernandes, 1995a
1995/1996	2	Autumn and winter spawners	135	114	Fernandes & Reid 1995
1996/1997	1	Autumn spawners	151	146	Fernandes, 1996a
1997/1998	-		-	-	-
1998/1999	1	Autumn spawners	111	111	Breslin, 1998
1999/2000	1	Feeding phase	58	23	Breslin, 1999a
1999/2000	1	Winter-spawners	30	26	Breslin, 1999b
2000/2001	2	Autumn and winter spawners	33	32	Breslin, 2001a,b
2001/2002	2	Pre-spawning	80	74	Breslin & Griffin, 2002a
2002/2003	1	Pre-spawning	49	39	Breslin and Griffn, 2003a
2003/2004	1	Pre-spawning	89	86	Griffin, 2004

Table 4.3.1.2 Celtic Sea & Division VIIj. 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***	**1997**	**1998***	**1999****	**1999**	**2000**	**2001**	**2002**	**2003**
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2000	2001	2002	2003	2004
0	205	214	142	259	41	5	3	-	-	13	-	23	19	0	25
1	132	63	427	217	38	280	134	-	21	398	23	18	30	41	73
2	249	195	117	438	127	551	757	-	157	208	97	143	160	176	323
3	109	95	88	59	160	138	250	-	150	48	85	36	176	142	253
4	153	54	50	63	11	94	51	-	201	8	16	19	40	27	61
5	32	85	22	26	11	8	42	-	109	1	21	7	44	6	16
6	15	22	24	16	7	9	1	-	32	1	8	3	23	8	5
7	6	5	10	25	2	8	14	-	30	0	2	2	17	3	2
8	3	6	2	2	3	9	1	-	4	0	1	0	11	0	0
9+	2	-	1	2	1	5	2	-	1	0	0	1	23	0	0
Total	904	739	882	1107	399	1107	1253		705	677	252	250	542	404	758
Biomass	103	84	89	104	52	135	151		111	58	30	33	80	49	89
SSB	91	77	71	90	51	114	146		111	23	26	32	74	39	86

*November survey only, likely to be an underestimate of stock size.

** Poor survey coverage due to bad weather, likely to be an underestimate. This survey is not included in assessment.

Table 4.6.2.1 Herring in Celtic Sea and Division VIIj. ICA run for the maximum-likelihood ICA calculation for the 6 year separable period.

```
                    Integrated Catch at Age Analysis
                    -------------------------------
                           Version 1.4 w

                           K.R.Patterson
                     Fisheries Research Services
                         Marine Laboratory
                             Aberdeen

                           24 August 1999

 Type * to change language
 Enter the name of the index file -->index.dat
canum.dat
weca.dat
 Stock weights in 2004  used for the year 2003
west.dat
 Natural mortality in 2004  used for the year 2003
natmor.dat
 Maturity ogive in 2004  used for the year 2003
matprop.dat
 Name of age-structured index file (Enter if none) : -->fleet.dat
 Name of the SSB index file (Enter if none) -->
No indices of spawning biomass to be used.
 No of years for separable constraint ?--> 6
 Reference age for separable constraint ?--> 3
 Constant selection pattern model (Y/N) ?-->y
 S to be fixed on last age ?-->    1.000000000000000
 First age for calculation of reference F ?--> 2
 Last age for calculation of reference F ?--> 7
 Use default weighting (Y/N) ?-->n
Enter relative weights at age
 Weight for age 1-->    0.100000000000000
 Weight for age 2-->    1.000000000000000
 Weight for age 3-->    1.000000000000000
 Weight for age 4-->    1.000000000000000
 Weight for age 5-->    1.000000000000000
 Weight for age 6-->    1.000000000000000
 Weight for age 7-->    1.000000000000000
 Weight for age 8-->    1.000000000000000
 Weight for age 9-->    1.000000000000000
Enter relative weights by year
 Weight for year 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
Enter new weights for specified years and ages if needed
 Enter year, age, new weight or -1,-1,-1 to end.  -1 -1   -1.000000000000000
 Is the last age of FLT02: Celtic combined acc data (Catch: a plus-group (Y/-->n
You must choose a catchability model for each index.

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

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

 Model for FLT02: Celtic combined acc data (Catch:  is to be A/L/P ?-->L
```

Table 4.6.2.1 (Cont'd)
Fit a stock-recruit relationship (Y/N) ?-->n
Enter lowest feasible F--> 5.0000000000000003E-02
Enter highest feasible F--> 1.500000000000000
Mapping the F-dimension of the SSQ surface

F	SSQ
0.05	13.4394507523
0.13	6.6091889336
0.20	4.5469694974
0.28	3.6319136010
0.36	3.1814437316
0.43	2.9646456368
0.51	2.8806673274
0.58	2.8783978916
0.66	2.9292803950
0.74	3.0161708843
0.81	3.1282341071
0.89	3.2583275700
0.97	3.4015772282
1.04	3.5545704242
1.12	3.7148576649
1.19	3.8806453891
1.27	4.0505960934
1.35	4.2236980005
1.42	4.3991721890
1.50	4.5764135308

Lowest SSQ is for F = 0.550

No of years for separable analysis : 6
Age range in the analysis : 1 . . . 9
Year range in the analysis : 1958 . . . 2003
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 29
Number of observations : 100

Conventional single selection vector model to be fitted.

Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
Enter weight for FLT02: Celtic combined acc data (Catch: at age 2--> 1.000000000000000
Enter weight for FLT02: Celtic combined acc data (Catch: at age 3--> 1.000000000000000
Enter weight for FLT02: Celtic combined acc data (Catch: at age 4--> 1.000000000000000
Enter weight for FLT02: Celtic combined acc data (Catch: at age 5--> 1.000000000000000
Enter estimates of the extent to which errors
in the age-structured indices are correlated
across ages. This can be in the range 0 (independence)
to 1 (correlated errors).
Enter value for FLT02: Celtic combined acc data (Catch:--> 5.0000000000000003E-02
Do you want to shrink the final fishing mortality (Y/N) ?-->n
Seeking solution. Please wait.

Aged index weights
FLT02: Celtic combined acc data (Catch:

Age :	2	3	4	5
Wts :	0.962	0.962	0.962	0.962

F in 2003 at age 3 is 0.464859 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
Successful exit from ICA

Table 4.6.2.2 Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Output Generated by ICA Version 1.4

Herring VIIg, VIIj, VIIaS(run: 1 2004)

Catch in Number

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	1.64	1.20	2.84	2.13	0.77	0.30	7.53	0.06
2	3.74	25.72	72.25	16.06	18.57	51.94	15.06	70.25
3	33.09	2.27	24.66	32.04	19.91	13.03	17.25	9.37
4	25.75	19.26	3.78	5.63	48.06	4.18	6.66	15.76
5	12.55	11.02	13.70	2.03	8.07	20.69	1.72	3.40
6	23.95	5.83	4.43	5.07	3.58	2.69	8.72	4.54
7	16.09	17.82	6.10	2.83	8.59	1.39	1.30	12.13
8	9.38	3.75	4.38	1.52	3.81	2.49	0.58	1.38
9	5.58	7.35	4.15	4.95	5.32	2.79	2.19	7.49

x 10 ^ 6

Catch in Number

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	7.09	7.60	12.20	9.47	1.32	12.66	8.42	23.55
2	19.56	39.99	54.79	93.28	37.26	23.31	137.69	38.13
3	59.89	20.06	39.60	55.04	50.09	37.56	17.86	55.80
4	9.92	49.11	11.54	33.15	26.48	41.90	15.84	7.01
5	13.21	9.22	22.60	12.22	18.76	18.76	14.53	9.65
6	5.60	9.44	4.93	17.84	7.85	10.44	4.64	5.32
7	3.59	3.94	4.17	4.76	6.35	4.28	3.01	3.35
8	8.75	6.51	1.31	2.17	2.17	4.94	2.37	2.33
9	3.84	6.76	4.94	3.47	3.37	2.24	1.02	1.21

x 10 ^ 6

Catch in Number

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	5.51	12.77	13.32	8.16	2.80	11.34	7.16	39.36
2	42.81	15.43	11.11	12.52	13.38	13.91	30.09	21.29
3	17.18	17.78	7.29	8.61	11.95	12.40	11.73	21.86
4	22.53	7.33	7.01	5.28	5.58	8.64	6.58	5.50
5	4.22	9.01	2.87	1.58	1.58	2.89	2.81	4.44
6	3.74	3.52	4.79	1.90	1.48	1.32	2.20	3.44
7	2.98	1.64	1.98	1.04	0.54	1.28	1.18	0.80
8	0.90	1.14	1.24	0.38	0.86	0.55	1.26	0.31
9	0.83	1.19	1.77	0.47	0.48	0.64	0.56	0.87

x 10 ^ 6

Table 4.6.2.2 continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Catch in Number

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	15.34	13.54	19.52	17.92	4.16	5.98	2.31	8.26
2	42.73	102.87	92.89	57.05	56.75	67.00	82.03	42.41
3	8.73	26.99	41.12	36.26	42.88	43.08	30.96	68.40
4	4.82	3.23	16.04	16.03	32.93	23.01	9.40	19.60
5	1.50	1.86	2.45	2.31	8.79	14.32	5.96	8.21
6	1.89	0.33	1.08	0.23	1.13	2.72	3.05	3.84
7	1.67	0.37	0.38	0.09	0.10	1.18	0.87	2.59
8	0.34	0.93	0.23	0.17	0.03	0.30	0.30	0.77
9	0.60	0.31	0.18	0.13	0.01	0.46	0.09	0.68

x 10 ^ 6

Catch in Number

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	2.70	1.91	10.41	1.61	12.13	9.45	3.48	3.85
2	41.76	63.85	26.75	94.06	35.77	79.16	61.92	37.44
3	24.63	38.34	35.02	9.37	61.74	22.59	38.24	53.04
4	35.26	16.92	27.59	10.22	3.29	36.54	7.94	31.44
5	8.12	28.41	10.14	4.49	3.02	3.69	16.11	8.32
6	3.81	4.87	18.06	2.79	4.77	3.42	2.08	6.14
7	1.67	2.59	3.02	5.93	1.71	2.65	1.59	1.15
8	0.69	0.95	6.29	0.85	1.71	1.86	1.51	0.83
9	0.46	0.59	0.69	0.51	0.47	0.84	1.02	0.60

x 10 ^ 6

Catch in Number

AGE	1998	1999	2000	2001	2002	2003
1	5.82	14.27	9.95	15.72	3.50	2.71
2	41.51	34.07	77.38	62.15	26.47	37.01
3	27.10	36.09	18.95	35.82	18.53	24.44
4	28.27	14.64	12.06	5.95	5.31	14.76
5	13.18	15.52	5.23	4.25	1.42	5.72
6	3.75	8.88	6.23	1.77	1.27	3.36
7	2.67	1.86	2.32	1.15	0.44	2.33
8	0.60	2.01	0.66	0.47	0.15	0.39
9	0.39	0.55	0.58	0.39	0.20	0.54

x 10 ^ 6

Table 4.6.2.2. continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Predicted Catch in Number

AGE	1998	1999	2000	2001	2002	2003
1	5651.	14668.	13687.	8860.	4515.	2711.
2	47198.	45581.	62192.	45453.	22883.	46260.
3	19903.	43483.	18838.	21232.	13975.	30828.
4	21958.	15493.	14537.	5263.	5539.	16432.
5	14690.	18366.	5577.	4395.	1494.	7047.
6	4354.	14521.	7816.	2111.	1684.	2456.
7	3100.	2186.	2707.	1296.	380.	1472.
8	597.	1736.	486.	510.	241.	337.

x 10 ^ 3

Weights at age in the catches (Kg)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	0.09600	0.08700	0.09300	0.09800	0.10900	0.10300	0.10500	0.10300
2	0.11500	0.11900	0.12200	0.12700	0.14600	0.13900	0.13900	0.14300
3	0.16200	0.16600	0.15600	0.15600	0.17000	0.19400	0.18200	0.18000
4	0.18500	0.18500	0.19100	0.18500	0.18700	0.20500	0.21500	0.21200
5	0.20500	0.20000	0.20500	0.20700	0.21000	0.21700	0.22500	0.23200
6	0.21700	0.21000	0.20700	0.21200	0.22700	0.23000	0.23000	0.24300
7	0.22700	0.21700	0.22000	0.22000	0.23200	0.23700	0.23700	0.24300
8	0.23200	0.23000	0.22500	0.23500	0.23700	0.24500	0.24500	0.25600
9	0.23000	0.23100	0.23900	0.23500	0.24000	0.25100	0.25300	0.26000

Weights at age in the catches (Kg)

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	0.12200	0.11900	0.11900	0.12200	0.12800	0.11700	0.13200	0.12500
2	0.15400	0.15800	0.16600	0.16400	0.16200	0.16600	0.17000	0.17400
3	0.19100	0.18500	0.19600	0.20000	0.20000	0.20000	0.19400	0.20500
4	0.21200	0.21700	0.21500	0.21700	0.22500	0.22500	0.22000	0.21500
5	0.23700	0.24300	0.23500	0.23700	0.24000	0.24500	0.24500	0.24500
6	0.24800	0.25100	0.24800	0.24500	0.25300	0.25300	0.25900	0.26200
7	0.24000	0.25600	0.25600	0.26400	0.26400	0.26200	0.26400	0.26200
8	0.25300	0.25900	0.26200	0.26400	0.27600	0.26700	0.27000	0.28500
9	0.25700	0.26400	0.26600	0.26200	0.27200	0.28300	0.28500	0.28500

Table 4.6.2.2 continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Weights at age in the catches (Kg)

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	0.14100	0.13700	0.13700	0.13400	0.12700	0.12700	0.11700	0.11500
2	0.18000	0.18700	0.17400	0.18500	0.18900	0.17400	0.17400	0.17200
3	0.21000	0.21500	0.20500	0.21200	0.21700	0.21200	0.20700	0.21000
4	0.22500	0.24000	0.23500	0.22200	0.24000	0.23000	0.23700	0.24500
5	0.23700	0.25100	0.25900	0.24300	0.27900	0.25300	0.25900	0.26700
6	0.25900	0.26000	0.27000	0.26700	0.27600	0.27300	0.27600	0.27600
7	0.26200	0.27000	0.27900	0.25900	0.29100	0.29100	0.27000	0.29700
8	0.28800	0.27900	0.28800	0.29200	0.29700	0.27900	0.27000	0.30900
9	0.27000	0.28400	0.29300	0.29800	0.30200	0.28400	0.27500	0.31500

Weights at age in the catches (Kg)

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	0.11500	0.10900	0.09300	0.10400	0.11200	0.09600	0.09700	0.10600
2	0.15400	0.14800	0.14200	0.14000	0.15500	0.13800	0.13200	0.12900
3	0.19400	0.19800	0.18500	0.17000	0.17200	0.18600	0.16800	0.15100
4	0.23700	0.22000	0.21300	0.20100	0.18700	0.19200	0.20300	0.16900
5	0.26200	0.27600	0.21300	0.23400	0.21500	0.20400	0.20900	0.19400
6	0.27300	0.28200	0.24500	0.24800	0.24800	0.23100	0.21500	0.19900
7	0.27900	0.27600	0.24600	0.25600	0.27600	0.25500	0.23700	0.21000
8	0.28800	0.31900	0.26300	0.26000	0.28400	0.26700	0.25700	0.22100
9	0.29300	0.32500	0.26200	0.26300	0.33200	0.28400	0.28300	0.24000

Weights at age in the catches (Kg)

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	0.09900	0.09200	0.09600	0.09200	0.09700	0.08800	0.08800	0.09300
2	0.13700	0.12800	0.12300	0.12900	0.13500	0.12600	0.11800	0.12400
3	0.15300	0.16800	0.15000	0.15500	0.16800	0.15100	0.14700	0.14100
4	0.16700	0.18200	0.17700	0.18000	0.17900	0.17800	0.15900	0.15700
5	0.18800	0.19000	0.19100	0.20100	0.19000	0.18800	0.18500	0.17200
6	0.20800	0.20600	0.19400	0.20400	0.21000	0.19800	0.19600	0.19200
7	0.20900	0.22900	0.21200	0.21000	0.21800	0.20700	0.20700	0.20600
8	0.22900	0.23600	0.22800	0.22500	0.21700	0.22700	0.21900	0.21600
9	0.25100	0.25100	0.24800	0.24000	0.22700	0.22700	0.23100	0.22000

Table 4.6.2.2. continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Weights at age in the catches (Kg)

AGE	1998	1999	2000	2001	2002	2003
1	0.09900	0.09000	0.09200	0.08200	0.09600	0.08900
2	0.12100	0.12000	0.11100	0.10700	0.11500	0.10200
3	0.15300	0.14900	0.14800	0.13900	0.13900	0.12800
4	0.16300	0.16700	0.16800	0.16200	0.15600	0.14600
5	0.17300	0.18000	0.18500	0.17700	0.18500	0.16500
6	0.18500	0.18300	0.18700	0.19000	0.19600	0.18400
7	0.19900	0.20200	0.19700	0.18500	0.20300	0.19500
8	0.20400	0.20900	0.21000	0.20400	0.21100	0.20200
9	0.22500	0.20800	0.22400	0.22900	0.22600	0.21000

Weights at age in the stock (Kg)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	0.09600	0.08700	0.09300	0.09800	0.10900	0.10300	0.10500	0.10300
2	0.11500	0.11900	0.12200	0.12700	0.14600	0.13900	0.13900	0.14300
3	0.16200	0.16600	0.15600	0.15600	0.17000	0.19400	0.18200	0.18000
4	0.18500	0.18500	0.19100	0.18500	0.18700	0.20500	0.21500	0.21200
5	0.20500	0.20000	0.20500	0.20700	0.21000	0.21700	0.22500	0.23200
6	0.21700	0.21000	0.20700	0.21200	0.22700	0.23000	0.23000	0.24300
7	0.22700	0.21700	0.22000	0.22000	0.23200	0.23700	0.23700	0.24300
8	0.23200	0.23000	0.22500	0.23500	0.23700	0.24500	0.24500	0.25600
9	0.23000	0.23100	0.23900	0.23500	0.24000	0.25100	0.25300	0.26000

Weights at age in the stock (Kg)

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	0.12200	0.11900	0.11900	0.12200	0.12800	0.11700	0.13200	0.12500
2	0.15400	0.15800	0.16600	0.16400	0.16200	0.16600	0.17000	0.17400
3	0.19100	0.18500	0.19600	0.20000	0.20000	0.20000	0.19400	0.20500
4	0.21200	0.21700	0.21500	0.21700	0.22500	0.22500	0.22000	0.21500
5	0.23700	0.24300	0.23500	0.23700	0.24000	0.24500	0.24500	0.24500
6	0.24800	0.25100	0.24800	0.24500	0.25300	0.25300	0.25900	0.26200
7	0.24000	0.25600	0.25600	0.26400	0.26400	0.26200	0.26400	0.26200
8	0.25300	0.25900	0.26200	0.26400	0.27600	0.26700	0.27000	0.28500
9	0.25700	0.26400	0.26600	0.26200	0.27200	0.28300	0.28500	0.28500

Table 4.6.2.2. continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Weights at age in the stock (Kg)

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	0.14100	0.13700	0.13700	0.13400	0.12700	0.12700	0.11700	0.11500
2	0.18000	0.18700	0.17400	0.18500	0.18900	0.17400	0.17400	0.17200
3	0.21000	0.21500	0.20500	0.21200	0.21700	0.21200	0.20700	0.21000
4	0.22500	0.24000	0.23500	0.22200	0.24000	0.23000	0.23700	0.24500
5	0.23700	0.25100	0.25900	0.24300	0.27900	0.25300	0.25900	0.26700
6	0.25900	0.26000	0.27000	0.26700	0.27600	0.27300	0.27600	0.27600
7	0.26200	0.27000	0.27900	0.25900	0.29100	0.29100	0.27000	0.29700
8	0.28800	0.27900	0.28800	0.29200	0.29700	0.27900	0.27000	0.30900
9	0.27000	0.28400	0.29300	0.29800	0.30200	0.28400	0.27500	0.31500

Weights at age in the stock (Kg)

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	0.11500	0.10900	0.09300	0.10400	0.11200	0.09600	0.09700	0.10600
2	0.15400	0.14800	0.14200	0.14000	0.15500	0.13800	0.13200	0.12900
3	0.19400	0.19800	0.18500	0.17000	0.17200	0.18600	0.16800	0.15100
4	0.23700	0.22000	0.21300	0.20100	0.18700	0.19200	0.20300	0.16900
5	0.26200	0.27600	0.21300	0.23400	0.21500	0.20400	0.20900	0.19400
6	0.27300	0.28200	0.24500	0.24800	0.24800	0.23100	0.21500	0.19900
7	0.27900	0.27600	0.24600	0.25600	0.27600	0.25500	0.23700	0.21000
8	0.28800	0.31900	0.26300	0.26000	0.28400	0.26700	0.25700	0.22100
9	0.29300	0.32500	0.26200	0.26300	0.33200	0.28400	0.28300	0.24000

Weights at age in the stock (Kg)

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	0.09900	0.09200	0.09600	0.09200	0.09700	0.08800	0.08800	0.09300
2	0.13700	0.12800	0.12300	0.12900	0.13500	0.12600	0.11800	0.12400
3	0.15300	0.16800	0.15000	0.15500	0.16800	0.15100	0.14700	0.14100
4	0.16700	0.18200	0.17700	0.18000	0.17900	0.17800	0.15900	0.15700
5	0.18800	0.19000	0.19100	0.20100	0.19000	0.18800	0.18500	0.17200
6	0.20800	0.20600	0.19400	0.20400	0.21000	0.19800	0.19600	0.19200
7	0.20900	0.22900	0.21200	0.21000	0.21800	0.20700	0.20700	0.20600
8	0.22900	0.23600	0.22800	0.22500	0.21700	0.22700	0.21900	0.21600
9	0.25100	0.25100	0.24800	0.24000	0.22700	0.22700	0.23100	0.22000

Table 4.6.2.2. continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Weights at age in the stock (Kg)

AGE	1998	1999	2000	2001	2002	2003
1	0.09900	0.09000	0.09200	0.08200	0.09600	0.07800
2	0.12100	0.12000	0.11100	0.10700	0.11500	0.10000
3	0.15300	0.14900	0.14800	0.13900	0.13900	0.13000
4	0.16300	0.16700	0.16800	0.16200	0.15600	0.14100
5	0.17300	0.18000	0.18500	0.17700	0.18400	0.15600
6	0.18500	0.18300	0.18700	0.19000	0.19600	0.15800
7	0.19900	0.20200	0.19700	0.18500	0.20300	0.16800
8	0.20400	0.20900	0.21000	0.20400	0.21100	0.20000
9	0.22500	0.20800	0.22400	0.22900	0.22300	0.21300

Natural Mortality (per year)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Natural Mortality (per year)

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Table 4.6.2.2. continued   Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Natural Mortality (per year)

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Natural Mortality (per year)

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Natural Mortality (per year)

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Table 4.6.2.2. continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Natural Mortality (per year)

AGE	1998	1999	2000	2001	2002	2003
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

Proportion of fish spawning

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 4.6.2.2. continued   Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Proportion of fish spawning

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 4.6.2.2 continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Proportion of fish spawning

AGE	1998	1999	2000	2001	2002	2003
1	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE-STRUCTURED INDICES

FLT02: Celtic combined acc data (Catch:

AGE	1990	1991	1992	1993	1994	1995	1996	1997
2	249.00	195.20	117.00	437.90	127.20	550.70	757.00	*******
3	108.60	94.70	87.80	58.70	160.30	138.40	249.90	*******
4	152.50	54.00	49.60	63.40	10.50	93.50	50.60	*******
5	32.40	84.80	22.20	26.00	10.60	7.90	41.90	*******

FLT02: Celtic combined acc data (Catch:

AGE	1998	1999	2000	2001	2002	2003
2	157.13	96.60	142.66	160.37	176.11	322.71
3	149.62	85.13	36.17	175.72	141.99	252.57
4	201.48	16.25	18.67	39.83	27.46	61.37
5	108.53	21.37	6.56	43.54	6.31	15.74

Table 4.6.2.2. continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Fishing Mortality (per year)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	0.0080	0.0018	0.0126	0.0134	0.0025	0.0017	0.0115	0.0002
2	0.1173	0.2867	0.2374	0.1533	0.2652	0.3965	0.1839	0.2408
3	0.3442	0.1026	0.5259	0.1665	0.3066	0.3210	0.2347	0.1765
4	0.4907	0.3271	0.2341	0.2047	0.3797	0.0921	0.2558	0.3304
5	0.3752	0.3564	0.3625	0.1708	0.4452	0.2485	0.0449	0.1798
6	0.4709	0.2664	0.2115	0.1971	0.4491	0.2314	0.1409	0.1436
7	0.6945	0.6807	0.4344	0.1815	0.5228	0.2793	0.1505	0.2646
8	0.3573	0.2994	0.3088	0.1633	0.3507	0.2488	0.1599	0.2101
9	0.3573	0.2994	0.3088	0.1633	0.3507	0.2488	0.1599	0.2101

Fishing Mortality (per year)

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	0.0170	0.0176	0.0229	0.0330	0.0086	0.0231	0.0495	0.1233
2	0.1805	0.2130	0.2923	0.4295	0.3025	0.3594	0.6878	0.6015
3	0.3549	0.3023	0.3599	0.5758	0.4648	0.6107	0.5552	0.7308
4	0.2720	0.5226	0.2705	0.5487	0.5760	0.8586	0.5367	0.4171
5	0.4502	0.3866	0.4298	0.4505	0.6108	0.9365	0.7374	0.6497
6	0.4432	0.5954	0.3271	0.6303	0.5176	0.7286	0.5548	0.5835
7	0.1449	0.5672	0.5065	0.5319	0.4249	0.5242	0.4195	0.8910
8	0.2762	0.3742	0.3301	0.4781	0.4381	0.6064	0.5495	0.5894
9	0.2762	0.3742	0.3301	0.4781	0.4381	0.6064	0.5495	0.5894

Fishing Mortality (per year)

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	0.0649	0.1399	0.1058	0.0765	0.0331	0.0780	0.0801	0.1623
2	0.6380	0.4642	0.3025	0.2348	0.3000	0.4006	0.5539	0.6700
3	0.6544	0.6531	0.4470	0.4342	0.3928	0.5386	0.7612	1.1653
4	0.7109	0.6185	0.5538	0.6464	0.5298	0.5200	0.5846	0.9831
5	0.4225	0.6124	0.4638	0.2050	0.3584	0.5101	0.2822	0.8920
6	0.4976	0.6601	0.6848	0.5631	0.2667	0.5047	0.8201	0.5785
7	0.6724	0.3766	0.8681	0.2714	0.2723	0.3473	1.0495	0.7074
8	0.5607	0.5189	0.4810	0.3521	0.3331	0.4345	0.5986	0.7841
9	0.5607	0.5189	0.4810	0.3521	0.3331	0.4345	0.5986	0.7841

Table 4.6.2.2. continued   Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Fishing Mortality (per year)

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	0.0371	0.0295	0.0555	0.0489	0.0123	0.0092	0.0086	0.0252
2	0.4794	0.6887	0.5191	0.4006	0.3766	0.4978	0.2879	0.3743
3	0.7051	0.6936	0.7183	0.4213	0.6467	0.5914	0.4865	0.4430
4	0.8498	0.5854	1.1818	0.6534	0.8070	0.8434	0.2311	0.6215
5	0.7009	0.8488	1.0948	0.4482	0.8165	0.9067	0.4786	0.2886
6	1.1296	0.2824	1.9238	0.2306	0.3647	0.5657	0.4283	0.5730
7	0.5462	0.6111	0.5341	0.7152	0.1316	0.7046	0.3141	0.6950
8	0.6525	0.5943	0.8603	0.4450	0.5018	0.6304	0.3378	0.4456
9	0.6525	0.5943	0.8603	0.4450	0.5018	0.6304	0.3378	0.4456

Fishing Mortality (per year)

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0095	0.0162	0.0187	0.0077	0.0258	0.0222	0.0171	0.0137
2	0.2947	0.5884	0.5954	0.4104	0.4164	0.4106	0.3437	0.4554
3	0.4157	0.5182	0.8343	0.4611	0.5603	0.5451	0.3811	0.6004
4	0.4088	0.5322	0.8424	0.5912	0.2750	0.7316	0.3542	0.5875
5	0.5020	0.5960	0.6258	0.2730	0.3069	0.4964	0.7455	0.6746
6	0.1884	0.5658	0.8472	0.3081	0.4591	0.5939	0.5113	0.6291
7	0.4662	0.1693	0.7361	0.6629	0.2809	0.4427	0.5376	0.5237
8	0.3547	0.4696	0.6796	0.4173	0.3559	0.4916	0.4307	0.5281
9	0.3547	0.4696	0.6796	0.4173	0.3559	0.4916	0.4307	0.5281

Fishing Mortality (per year)

AGE	1998	1999	2000	2001	2002	2003
1	0.0319	0.0564	0.0520	0.0339	0.0153	0.0294
2	0.4054	0.7175	0.6615	0.4316	0.1948	0.3742
3	0.5036	0.8914	0.8218	0.5362	0.2420	0.4649
4	0.5084	0.8999	0.8297	0.5413	0.2443	0.4693
5	0.5326	0.9427	0.8692	0.5671	0.2560	0.4916
6	0.8134	1.4397	1.3273	0.8660	0.3909	0.7508
7	0.6703	1.1864	1.0938	0.7136	0.3221	0.6187
8	0.5036	0.8914	0.8218	0.5362	0.2420	0.4649
9	0.5036	0.8914	0.8218	0.5362	0.2420	0.4649

Table 4.6.2.2. continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Population Abundance (1 January)

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	324.9	1071.4	358.5	252.5	495.6	281.2	1038.4	371.1
2	39.0	118.6	393.4	130.3	91.7	181.9	103.3	377.6
3	124.7	25.7	65.9	229.9	82.8	52.1	90.6	63.7
4	69.5	72.3	19.0	31.9	159.3	49.9	30.9	58.7
5	42.0	38.5	47.2	13.6	23.5	98.6	41.2	21.7
6	66.8	26.1	24.4	29.7	10.4	13.6	69.6	35.6
7	33.6	37.7	18.1	17.9	22.1	6.0	9.8	54.7
8	32.7	15.2	17.3	10.6	13.5	11.8	4.1	7.6
9	19.5	29.8	16.4	34.5	18.9	13.3	15.6	41.5

x 10 ^ 6

Population Abundance (1 January)

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	663.7	687.3	850.9	460.7	242.9	876.5	274.8	318.0
2	136.5	240.0	248.4	306.0	164.0	88.6	315.1	96.2
3	219.9	84.4	143.7	137.4	147.5	89.8	45.8	117.3
4	43.7	126.2	51.1	82.1	63.3	75.9	39.9	21.5
5	38.2	30.1	67.7	35.3	42.9	32.2	29.1	21.1
6	16.4	22.0	18.5	39.9	20.3	21.1	11.4	12.6
7	27.9	9.5	11.0	12.1	19.2	11.0	9.2	5.9
8	38.0	21.8	4.9	6.0	6.4	11.4	5.9	5.5
9	16.7	22.7	18.4	9.6	9.9	5.1	2.5	2.8

x 10 ^ 6

Population Abundance (1 January)

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	137.9	152.9	208.0	174.1	135.7	237.4	146.2	410.3
2	103.4	47.5	48.9	68.8	59.3	48.3	80.8	49.6
3	39.1	40.5	22.1	26.8	40.3	32.6	24.0	34.4
4	46.3	16.6	17.2	11.6	14.2	22.3	15.6	9.2
5	12.8	20.6	8.1	9.0	5.5	7.6	12.0	7.8
6	10.0	7.6	10.1	4.6	6.6	3.5	4.1	8.2
7	6.4	5.5	3.6	4.6	2.4	4.6	1.9	1.6
8	2.2	2.9	3.4	1.4	3.2	1.6	2.9	0.6
9	2.0	3.1	4.8	1.7	1.8	1.9	1.3	1.7

x 10 ^ 6

Table 4.6.2.2. continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Population Abundance (1 January)

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	663.5	733.9	569.1	591.9	537.6	1033.7	427.1	524.0
2	128.3	235.2	262.1	198.1	207.4	195.3	376.8	155.8
3	18.8	58.9	87.5	115.5	98.3	105.4	88.0	209.3
4	8.8	7.6	24.1	34.9	62.1	42.2	47.8	44.3
5	3.1	3.4	3.8	6.7	16.4	25.1	16.4	34.3
6	2.9	1.4	1.3	1.2	3.9	6.6	9.2	9.2
7	4.2	0.9	1.0	0.2	0.8	2.4	3.4	5.4
8	0.7	2.2	0.4	0.5	0.1	0.7	1.1	2.2
9	1.3	0.7	0.3	0.4	0.0	1.0	0.3	2.0

x 10 ^ 6

Population Abundance (1 January)

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	449.4	187.9	886.7	329.6	751.2	679.1	323.9	447.2
2	188.0	163.8	68.0	320.2	120.3	269.3	244.3	117.1
3	79.4	103.7	67.4	27.8	157.3	58.8	132.3	128.4
4	110.0	42.9	50.6	23.9	14.3	73.6	27.9	74.0
5	21.5	66.2	22.8	19.7	12.0	9.9	32.0	17.7
6	23.3	11.8	33.0	11.0	13.6	8.0	5.4	13.8
7	4.7	17.4	6.1	12.8	7.3	7.8	4.0	2.9
8	2.4	2.7	13.3	2.6	6.0	5.0	4.5	2.1
9	1.6	1.7	1.5	1.6	1.7	2.3	3.1	1.5

x 10 ^ 6

Population Abundance (1 January)

AGE	1998	1999	2000	2001	2002	2003	2004
1	284.1	420.9	425.2	418.8	469.1	147.5	339.7
2	162.3	101.2	146.3	148.5	148.9	169.9	52.7
3	55.0	80.1	36.6	55.9	71.4	90.8	86.6
4	57.7	27.2	26.9	13.2	26.8	45.9	46.7
5	37.2	31.4	10.0	10.6	6.9	19.0	26.0
6	8.2	19.8	11.1	3.8	5.5	4.9	10.5
7	6.6	3.3	4.2	2.7	1.4	3.3	2.1
8	1.6	3.1	0.9	1.3	1.2	0.9	1.6
9	1.0	1.0	1.1	1.0	1.0	1.5	1.4

x 10 ^ 6

Table 4.6.2.2. continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Weighting factors for the catches in number

AGE	1998	1999	2000	2001	2002	2003
1	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Predicted Age-Structured Index Values

FLT02: Celtic combined acc data (Catch: Predicted

AGE	1990	1991	1992	1993	1994	1995	1996	1997
2	298.45	193.84	79.94	452.76	169.15	380.79	369.37	*******
3	151.70	178.92	84.72	50.74	260.25	98.71	261.83	*******
4	171.11	58.94	50.97	31.03	25.50	82.83	45.82	*******
5	26.90	75.29	25.17	30.98	18.23	12.39	31.39	*******

FLT02: Celtic combined acc data (Catch: Predicted

AGE	1998	1999	2000	2001	2002	2003
2	230.64	105.30	160.99	205.59	261.25	249.20
3	96.35	95.20	46.60	94.80	162.45	165.20
4	81.14	25.91	27.47	17.94	49.11	67.21
5	45.12	25.24	8.68	12.44	11.09	23.99

Table 4.6.2.2. continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Fitted Selection Pattern

AGE	1958	1959	1960	1961	1962	1963	1964	1965
1	0.0233	0.0173	0.0240	0.0806	0.0080	0.0052	0.0491	0.0014
2	0.3409	2.7957	0.4513	0.9209	0.8650	1.2349	0.7836	1.3642
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.4255	3.1901	0.4451	1.2296	1.2387	0.2868	1.0899	1.8718
5	1.0899	3.4755	0.6893	1.0257	1.4524	0.7741	0.1912	1.0185
6	1.3680	2.5981	0.4021	1.1836	1.4650	0.7206	0.6005	0.8136
7	2.0177	6.6378	0.8259	1.0900	1.7055	0.8700	0.6415	1.4986
8	1.0382	2.9192	0.5871	0.9806	1.1439	0.7750	0.6813	1.1903
9	1.0382	2.9192	0.5871	0.9806	1.1439	0.7750	0.6813	1.1903

Fitted Selection Pattern

AGE	1966	1967	1968	1969	1970	1971	1972	1973
1	0.0480	0.0583	0.0636	0.0573	0.0185	0.0378	0.0892	0.1687
2	0.5086	0.7044	0.8121	0.7459	0.6508	0.5884	1.2389	0.8231
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.7665	1.7286	0.7515	0.9529	1.2392	1.4059	0.9667	0.5707
5	1.2684	1.2786	1.1943	0.7824	1.3141	1.5335	1.3283	0.8891
6	1.2487	1.9693	0.9091	1.0947	1.1136	1.1930	0.9992	0.7985
7	0.4081	1.8760	1.4074	0.9237	0.9142	0.8584	0.7556	1.2193
8	0.7784	1.2375	0.9171	0.8303	0.9425	0.9928	0.9898	0.8065
9	0.7784	1.2375	0.9171	0.8303	0.9425	0.9928	0.9898	0.8065

Fitted Selection Pattern

AGE	1974	1975	1976	1977	1978	1979	1980	1981
1	0.0992	0.2143	0.2368	0.1763	0.0842	0.1448	0.1053	0.1392
2	0.9750	0.7108	0.6767	0.5408	0.7638	0.7437	0.7277	0.5749
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0864	0.9471	1.2389	1.4888	1.3487	0.9654	0.7680	0.8436
5	0.6457	0.9377	1.0376	0.4722	0.9124	0.9470	0.3707	0.7654
6	0.7605	1.0108	1.5321	1.2971	0.6789	0.9370	1.0774	0.4964
7	1.0276	0.5767	1.9423	0.6251	0.6931	0.6447	1.3787	0.6070
8	0.8568	0.7945	1.0761	0.8110	0.8481	0.8067	0.7864	0.6728
9	0.8568	0.7945	1.0761	0.8110	0.8481	0.8067	0.7864	0.6728

Table 4.6.2.2. continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

Fitted Selection Pattern

AGE	1982	1983	1984	1985	1986	1987	1988	1989
1	0.0527	0.0426	0.0773	0.1160	0.0190	0.0155	0.0176	0.0569
2	0.6799	0.9930	0.7227	0.9509	0.5823	0.8417	0.5918	0.8449
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.2052	0.8440	1.6452	1.5509	1.2479	1.4261	0.4749	1.4028
5	0.9941	1.2237	1.5241	1.0637	1.2626	1.5330	0.9836	0.6515
6	1.6021	0.4071	2.6781	0.5474	0.5640	0.9565	0.8803	1.2933
7	0.7747	0.8810	0.7435	1.6974	0.2035	1.1914	0.6455	1.5689
8	0.9254	0.8568	1.1976	1.0562	0.7759	1.0659	0.6943	1.0058
9	0.9254	0.8568	1.1976	1.0562	0.7759	1.0659	0.6943	1.0058

Fitted Selection Pattern

AGE	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0230	0.0313	0.0224	0.0168	0.0461	0.0408	0.0449	0.0228
2	0.7090	1.1355	0.7136	0.8901	0.7431	0.7532	0.9019	0.7584
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.9835	1.0271	1.0098	1.2823	0.4908	1.3420	0.9295	0.9784
5	1.2078	1.1501	0.7501	0.5922	0.5479	0.9107	1.9563	1.1236
6	0.4534	1.0919	1.0155	0.6683	0.8195	1.0895	1.3418	1.0478
7	1.1216	0.3268	0.8824	1.4377	0.5014	0.8122	1.4109	0.8723
8	0.8534	0.9062	0.8146	0.9050	0.6353	0.9018	1.1303	0.8796
9	0.8534	0.9062	0.8146	0.9050	0.6353	0.9018	1.1303	0.8796

Fitted Selection Pattern

AGE	1998	1999	2000	2001	2002	2003
1	0.0633	0.0633	0.0633	0.0633	0.0633	0.0633
2	0.8050	0.8050	0.8050	0.8050	0.8050	0.8050
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0096	1.0096	1.0096	1.0096	1.0096	1.0096
5	1.0576	1.0576	1.0576	1.0576	1.0576	1.0576
6	1.6151	1.6151	1.6151	1.6151	1.6151	1.6151
7	1.3309	1.3309	1.3309	1.3309	1.3309	1.3309
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

Table 4.6.2.2. continued   Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 7	SoP (%)
1958	324900	111522	69155	22978	0.3323	0.4155	89
1959	1071350	156709	77128	15086	0.1956	0.3367	88
1960	358540	121767	77344	18283	0.2364	0.3343	88
1961	252510	106690	75559	15372	0.2034	0.1790	128
1962	495580	131406	75189	21552	0.2866	0.3948	98
1963	281220	106765	69875	17349	0.2483	0.2615	99
1964	1038440	179074	91656	10599	0.1156	0.1684	97
1965	371070	155832	105220	19126	0.1818	0.2226	86
1966	663700	186955	106518	27030	0.2538	0.3076	103
1967	687330	189655	105215	27658	0.2629	0.4312	90
1968	850920	211144	112958	30236	0.2677	0.3643	100
1969	460690	177078	99471	44389	0.4462	0.5278	99
1970	242900	126384	77097	31727	0.4115	0.4828	99
1971	876470	172862	75790	31396	0.4142	0.6697	96
1972	274780	122324	64443	38203	0.5928	0.5819	100
1973	317980	97566	47905	26936	0.5623	0.6456	95
1974	137880	65137	34906	19940	0.5712	0.5993	97
1975	152930	52850	27169	15588	0.5737	0.5642	107
1976	207970	53811	26064	9771	0.3749	0.5533	94
1977	174090	49803	26553	7833	0.2950	0.3925	100
1978	135730	46139	26545	7559	0.2848	0.3533	91
1979	237410	55774	26712	10321	0.3864	0.4702	100
1980	146160	45711	23648	13130	0.5552	0.6753	107
1981	410260	70735	26378	17103	0.6484	0.8327	101
1982	663460	105148	41348	13000	0.3144	0.7352	101
1983	733860	130618	54387	24981	0.4593	0.6183	104
1984	569140	113035	52850	26779	0.5067	0.9953	99
1985	591910	118080	57666	20426	0.3542	0.4782	102
1986	537550	125618	61523	25024	0.4067	0.5238	100
1987	1033730	161617	69949	26200	0.3746	0.6849	99
1988	427080	122210	72301	20447	0.2828	0.3711	100
1989	524010	125320	66271	23254	0.3509	0.4992	100
1990	449440	111597	63503	18404	0.2898	0.3793	99
1991	187890	83511	50155	25562	0.5096	0.4950	101
1992	886710	127979	51649	21127	0.4090	0.7469	95
1993	329600	90102	51042	18618	0.3648	0.4511	100
1994	751230	126512	59109	19300	0.3265	0.3831	99
1995	679080	122356	60287	23305	0.3866	0.5367	100
1996	323930	90736	53194	18816	0.3537	0.4789	100
1997	447180	92921	46777	20496	0.4382	0.5784	99
1998	284080	75399	41176	18041	0.4381	0.5723	99
1999	420890	77289	32995	18485	0.5602	1.0129	99
2000	425190	70486	29811	17191	0.5767	0.9339	99
2001	418750	63714	30137	15269	0.5066	0.6093	99
2002	469090	79373	40616	7465	0.1838	0.2750	100
2003	147500	51582	31747	11536	0.3634	0.5282	100

No of years for separable analysis : 6
Age range in the analysis : 1 . . . 9
Year range in the analysis : 1958 . . . 2003
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 29
Number of observations : 100

Conventional single selection vector model to be fitted.

Table 4.6.2.2. continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

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	0.5036	20	0.3396	0.7468	0.4119	0.6158	0.5139
2	1999	0.8914	17	0.6356	1.2501	0.7501	1.0593	0.9048
3	2000	0.8218	17	0.5814	1.1617	0.6888	0.9806	0.8347
4	2001	0.5362	20	0.3617	0.7947	0.4386	0.6554	0.5471
5	2002	0.2420	22	0.1546	0.3788	0.1926	0.3042	0.2484
6	2003	0.4649	25	0.2843	0.7602	0.3617	0.5975	0.4797
Separable Model: Selection (S) by age								
7	1	0.0633	60	0.0195	0.2059	0.0347	0.1156	0.0759
8	2	0.8050	22	0.5170	1.2535	0.6422	1.0090	0.8258
	3	1.0000		Fixed : Reference Age				
9	4	1.0096	21	0.6659	1.5305	0.8165	1.2483	1.0326
10	5	1.0576	19	0.7221	1.5490	0.8705	1.2849	1.0778
11	6	1.6151	17	1.1526	2.2632	1.3597	1.9185	1.6392
12	7	1.3309	18	0.9268	1.9113	1.1065	1.6008	1.3538
	8	1.0000		Fixed : Last true age				
Separable model: Populations in year 2003								
13	1	147507	144	8630	2521213	34660	627756	420997
14	2	169945	30	93369	309325	125199	230683	178067
15	3	90787	22	58156	141725	72333	113949	93161
16	4	45919	19	31283	67401	37753	55851	46807
17	5	18988	18	13284	27141	15824	22784	19306
18	6	4857	19	3330	7085	4006	5889	4948
19	7	3335	22	2159	5151	2671	4163	3418
20	8	947	27	556	1613	722	1243	983
Separable model: Populations at age								
21	1998	1577	44	662	3756	1013	2456	1740
22	1999	3069	33	1589	5925	2193	4293	3247
23	2000	903	31	483	1688	657	1243	951
24	2001	1283	31	695	2369	939	1755	1348
25	2002	1175	30	651	2120	869	1588	1229

Age-structured index catchabilities

FLT02: Celtic combined acc data (Catch:

Linear model fitted. Slopes at age :

26	2	Q	.2878E-02	12	.2545E-02	.4205E-02	.2878E-02	.3718E-02	.3298E-02
27	3	Q	.3538E-02	12	.3131E-02	.5155E-02	.3538E-02	.4563E-02	.4050E-02
28	4	Q	.2586E-02	12	.2288E-02	.3776E-02	.2586E-02	.3340E-02	.2963E-02
29	5	Q	.2282E-02	13	.2015E-02	.3355E-02	.2282E-02	.2961E-02	.2622E-02

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1998	1999	2000	2001	2002	2003
1	0.0292	-0.0272	-0.3185	0.5736	-0.2560	0.0000
2	-0.1284	-0.2910	0.2185	0.3129	0.1457	-0.2232
3	0.3087	-0.1865	0.0061	0.5229	0.2822	-0.2320
4	0.2528	-0.0565	-0.1868	0.1232	-0.0424	-0.1071
5	-0.1086	-0.1687	-0.0642	-0.0338	-0.0534	-0.2088
6	-0.1505	-0.4921	-0.2273	-0.1738	-0.2827	0.3141
7	-0.1475	-0.1589	-0.1543	-0.1237	0.1393	0.4612
8	0.0000	0.1475	0.3094	-0.0897	-0.4482	0.1411

Table 4.6.2.2. continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

AGE-STRUCTURED INDEX RESIDUALS

FLT02: Celtic combined acc data (Catch:

Age	1990	1991	1992	1993	1994	1995	1996	1997
2	-0.181	0.007	0.381	-0.033	-0.285	0.369	0.718	*******
3	-0.334	-0.636	0.036	0.146	-0.485	0.338	-0.047	*******
4	-0.115	-0.087	-0.027	0.715	-0.887	0.121	0.099	*******
5	0.186	0.119	-0.126	-0.175	-0.542	-0.450	0.289	*******

FLT02: Celtic combined acc data (Catch:

Age	1998	1999	2000	2001	2002	2003
2	-0.384	-0.086	-0.121	-0.248	-0.394	0.259
3	0.440	-0.112	-0.253	0.617	-0.135	0.425
4	0.909	-0.467	-0.386	0.798	-0.581	-0.091
5	0.878	-0.167	-0.280	1.253	-0.564	-0.421

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1998 to 2003

Variance	0.1007
Skewness test stat.	0.4593
Kurtosis test statistic	-0.4088
Partial chi-square	0.2770
Significance in fit	0.0000
Degrees of freedom	23

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR FLT02: Celtic combined acc data (Catch:

Linear catchability relationship assumed

Age	2	3	4	5
Variance	0.1095	0.1396	0.2824	0.2900
Skewness test stat.	1.0902	0.0225	0.4583	1.6481
Kurtosis test statisti	-0.3236	-0.7393	-0.5453	0.2302
Partial chi-square	0.2388	0.3444	0.9735	1.2426
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	13	13	13	13
Degrees of freedom	12	12	12	12
Weight in the analysis	0.9625	0.9625	0.9625	0.9625

Table 4.6.2.2. continued Herring in Celtic Sea and VIIj. Final run of ICA, using 6-year separable period.

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	13.0059	100	29	71	0.1832
Catches at age	2.7648	48	25	23	0.1202
Aged Indices					
FLT02: Celtic combined acc data (Catch	10.2411	52	4	48	0.2134

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	11.8044	100	29	71	0.1663
Catches at age	2.3169	48	25	23	0.1007
Aged Indices					
FLT02: Celtic combined acc data (Catch	9.4874	52	4	48	0.1977

Table 4.7.1 Celtic Sea and Division VIIj herring. Input data for short-term predictions with $\mathbf{F}_{sq}$ (= F_{2003}). Age in winter rings.

MFDP version 1a

Run: Run5FINAL_Fcon_new

Time and date: 17:40 25/03/2004

Fbar age range: 2-7

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	406912	1	0.5	0.551	0.5	0.0895	0.029434	9.13E-02
2	145358	0.3	1	0.551	0.5	0.11233333	0.3742	0.11266667
3	86599	0.2	1	0.551	0.5	0.143	0.46486	0.14266667
4	46697	0.1	1	0.551	0.5	0.1595	0.46931	0.16033333
5	25987	0.1	1	0.551	0.5	0.17583333	0.49164	0.1775
6	10509	0.1	1	0.551	0.5	0.18316667	0.75079	0.1875
7	2075	0.1	1	0.551	0.5	0.19233333	0.61869	0.19683333
8	1626.1	0.1	1	0.551	0.5	0.20633333	0.46486	0.20666667
9	1406.7	0.1	1	0.551	0.5	0.22033333	0.46486	0.221

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	406912	1	0.5	0.551	0.5	0.0895	0.029434	9.13E-02
2	.	0.3	1	0.551	0.5	0.11233333	0.3742	0.11266667
3	.	0.2	1	0.551	0.5	0.143	0.46486	0.14266667
4	.	0.1	1	0.551	0.5	0.1595	0.46931	0.16033333
5	.	0.1	1	0.551	0.5	0.17583333	0.49164	0.1775
6	.	0.1	1	0.551	0.5	0.18316667	0.75079	0.1875
7	.	0.1	1	0.551	0.5	0.19233333	0.61869	0.19683333
8	.	0.1	1	0.551	0.5	0.20633333	0.46486	0.20666667
9	.	0.1	1	0.551	0.5	0.22033333	0.46486	0.221

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	406912	1	0.5	0.551	0.5	0.0895	0.029434	9.13E-02
2	.	0.3	1	0.551	0.5	0.11233333	0.3742	0.11266667
3	.	0.2	1	0.551	0.5	0.143	0.46486	0.14266667
4	.	0.1	1	0.551	0.5	0.1595	0.46931	0.16033333
5	.	0.1	1	0.551	0.5	0.17583333	0.49164	0.1775
6	.	0.1	1	0.551	0.5	0.18316667	0.75079	0.1875
7	.	0.1	1	0.551	0.5	0.19233333	0.61869	0.19683333
8	.	0.1	1	0.551	0.5	0.20633333	0.46486	0.20666667
9	.	0.1	1	0.551	0.5	0.22033333	0.46486	0.221

Input units are thousands and kg - output in tonnes

Table 4.7.2. Celtic Sea and Division VIIj. Single option prediction table with $\mathbf{F}_{sq}$. Age in winter rings.

MFDP version 1a
Run: Celti Sea F statquo
Time and date: 08:57 17/03/2004
Fbar age range: 2-7

Year:	2004	F multiplier:	1	Fbar:	0.4708				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0262	8272	736	504284	43032	252142	21516	150737	12863
2	0.3335	13018	1406	52691	5656	52691	5656	37738	4051
3	0.4143	26809	3628	86599	11777	86599	11777	62364	8481
4	0.4183	15244	2358	46697	7145	46697	7145	35276	5397
5	0.4382	8806	1547	25987	4478	25987	4478	19417	3346
6	0.6692	4906	932	10509	1906	10509	1906	6914	1254
7	0.5515	841	163	2075	385	2075	385	1457	270
8	0.4143	527	108	1626	333	1626	333	1231	252
9	0.4143	456	102	1407	312	1407	312	1065	236
Total		78879	10981	731875	75024	479733	53508	316197	36150

Year:	2005	F multiplier:	1	Fbar:	0.4708				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0262	8272	736	504284	43032	252142	21516	150737	12863
2	0.3335	44648	4822	180712	19396	180712	19396	129428	13892
3	0.4143	8657	1172	27964	3803	27964	3803	20138	2739
4	0.4183	15294	2365	46850	7168	46850	7168	35391	5415
5	0.4382	9424	1655	27809	4792	27809	4792	20778	3581
6	0.6692	7083	1346	15171	2751	15171	2751	9981	1810
7	0.5515	1973	383	4870	903	4870	903	3418	634
8	0.4143	350	72	1082	222	1082	222	819	168
9	0.4143	587	131	1813	402	1813	402	1373	304
Total		96288	12683	810554	82469	558412	60953	372063	41405

Year:	2006	F multiplier:	1	Fbar:	0.4708				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0262	8272	736	504284	43032	252142	21516	150737	12863
2	0.3335	44648	4822	180712	19396	180712	19396	129428	13892
3	0.4143	29690	4018	95906	13043	95906	13043	69066	9393
4	0.4183	4938	764	15128	2315	15128	2315	11428	1748
5	0.4382	9455	1661	27900	4808	27900	4808	20846	3592
6	0.6692	7579	1440	16235	2944	16235	2944	10680	1937
7	0.5515	2849	554	7030	1303	7030	1303	4935	915
8	0.4143	822	169	2538	520	2538	520	1922	394
9	0.4143	561	125	1731	384	1731	384	1310	290
Total		108814	14289	851464	87745	599322	66229	400353	45025

Input units are thousands and kg - output in tonnes

Table 4.7.3. Celtic Sea and Division VIIj. Short-term predictions with management options based on $\mathbf{F}_{sq}$ = F2003.

MFDP version 1a
Run: Celti Sea F statquo
Herring VII; VIIj VIIaS(run: 1 2004)
Time and date: 08:57 17/03/2004
Fbar age range: 2-7

2004				
Biomass	SSB	FMult	FBar	Landings
75024	36150	1	0.4708	10981

2005					2006	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
82469	48632	0	0	0	100550	65116
.	47833	0.1	0.0471	1499	99027	62529
.	47053	0.2	0.0942	2941	97564	60095
.	46290	0.3	0.1413	4328	96159	57802
.	45544	0.4	0.1883	5663	94809	55642
.	44815	0.5	0.2354	6947	93512	53605
.	44102	0.6	0.2825	8182	92266	51685
.	43404	0.7	0.3296	9372	91068	49874
.	42723	0.8	0.3767	10517	89917	48164
.	42056	0.9	0.4238	11620	88810	46550
.	41405	1	0.4708	12683	87745	45025
.	40767	1.1	0.5179	13707	86722	43583
.	40144	1.2	0.565	14693	85737	42220
.	39535	1.3	0.6121	15644	84790	40930
.	38938	1.4	0.6592	16561	83879	39709
.	38355	1.5	0.7063	17445	83002	38553
.	37785	1.6	0.7534	18297	82158	37457
.	37227	1.7	0.8004	19120	81345	36419
.	36682	1.8	0.8475	19914	80563	35434
.	36148	1.9	0.8946	20680	79810	34499
.	35626	2	0.9417	21419	79084	33612

Input units are thousands and kg - output in tonnes

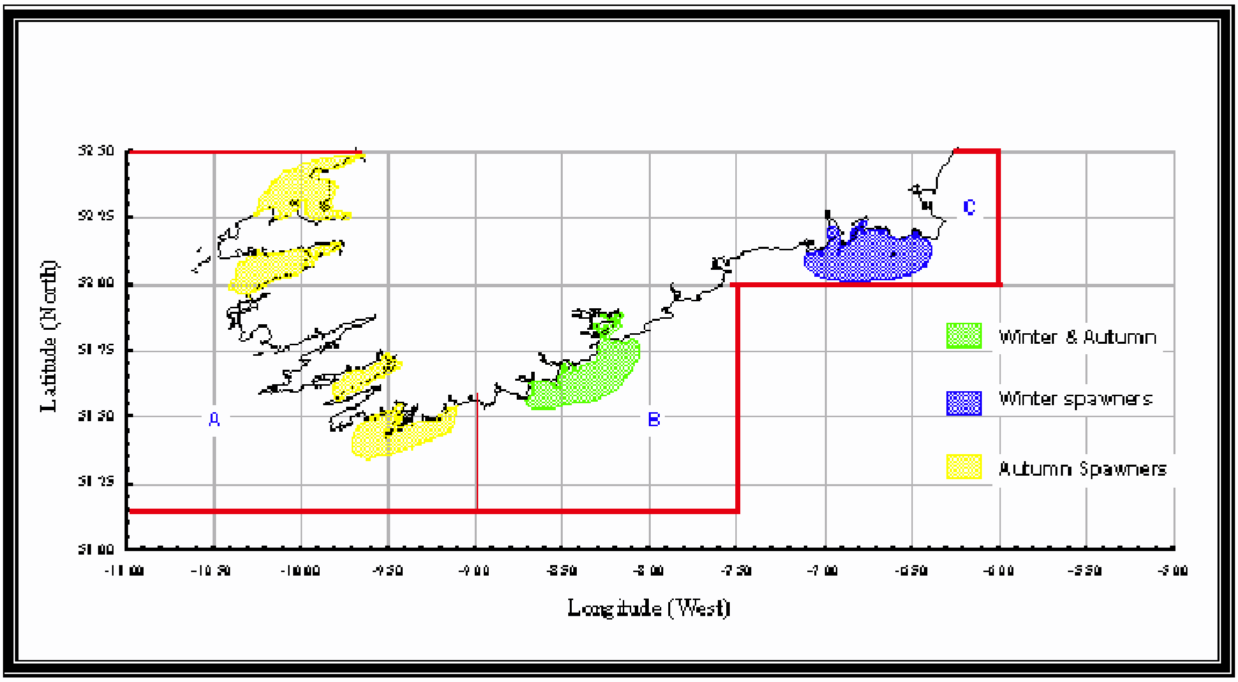


Figure 4.1.1.1 Celtic Sea and VIIj herring, spawning box closures. One of these boxes is closed each season, under EU legislation. In 2003-2004 spawning box A was closed. In the 2004-2005 season, spawning box B will be closed. Additionally, the Irish South and West Pelagic Management Committee initiated a voluntary closure of Box C in the past two seasons, to afford extra protection to first time spawners.

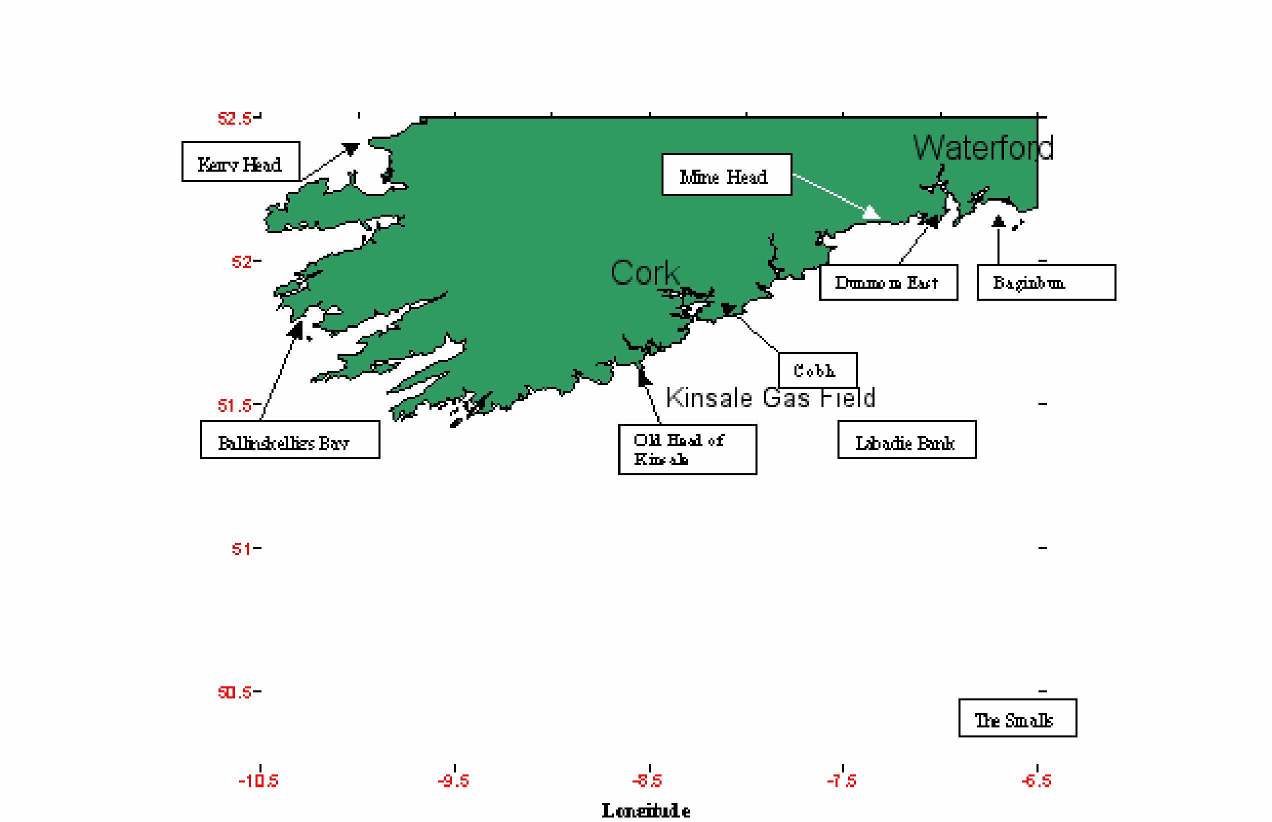


Figure 4.1.1.2 Celtic Sea and Division VIIj, map of locations mentioned in text.

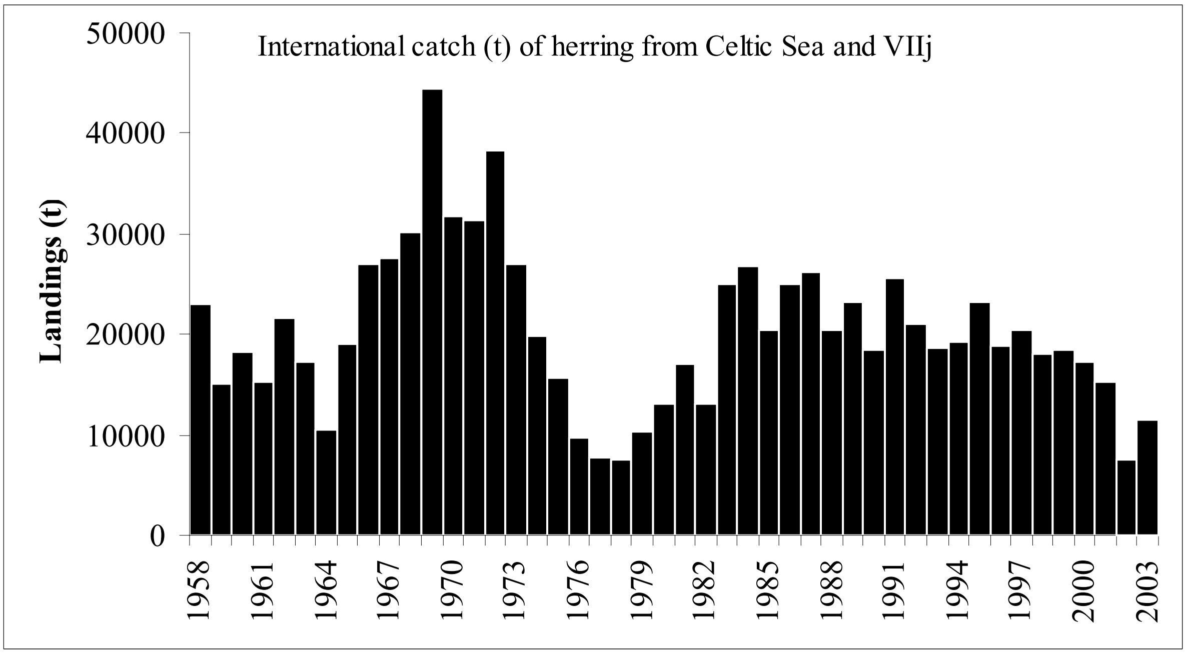


Figure 4.1.2.1 Celtic Sea and Division VIIj – working group estimates of herring landings per season.

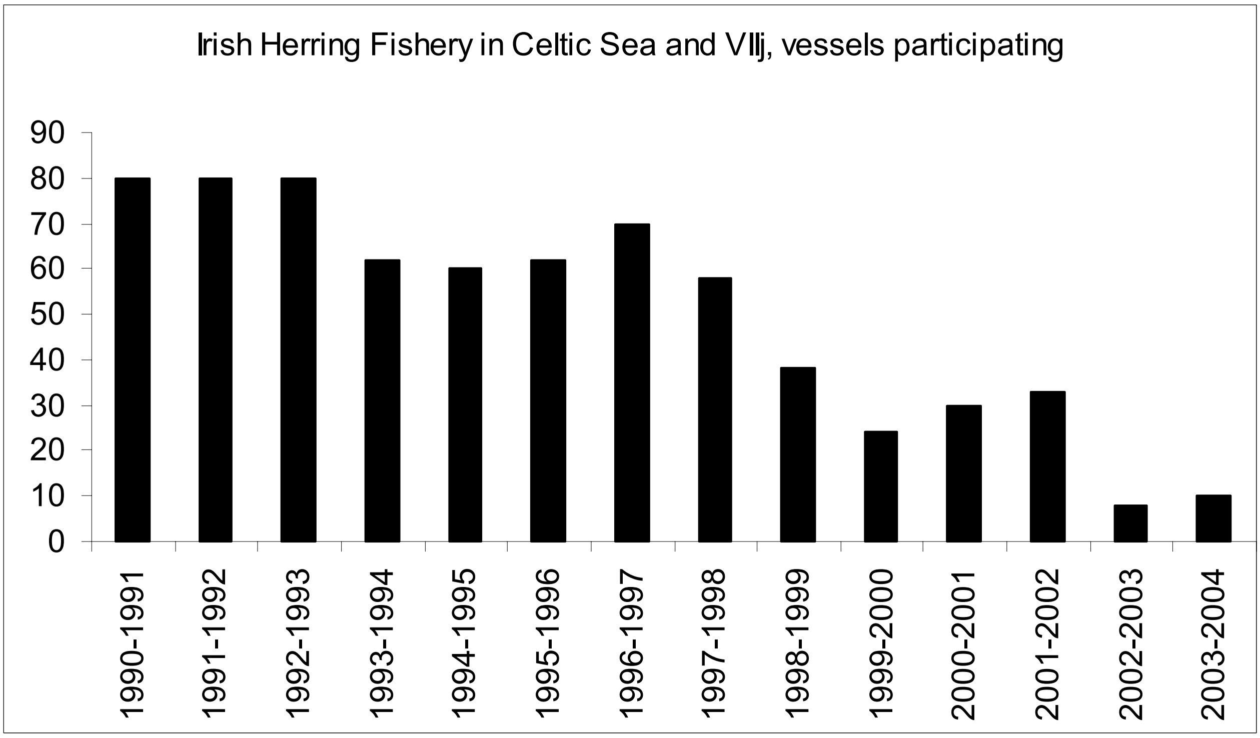


Figure 4.1.2.2**.** Celtic Sea and VIIj approximate number of vessels participating in the Irish fishery for herring in the Celtic Sea and VIIj in recent seasons.

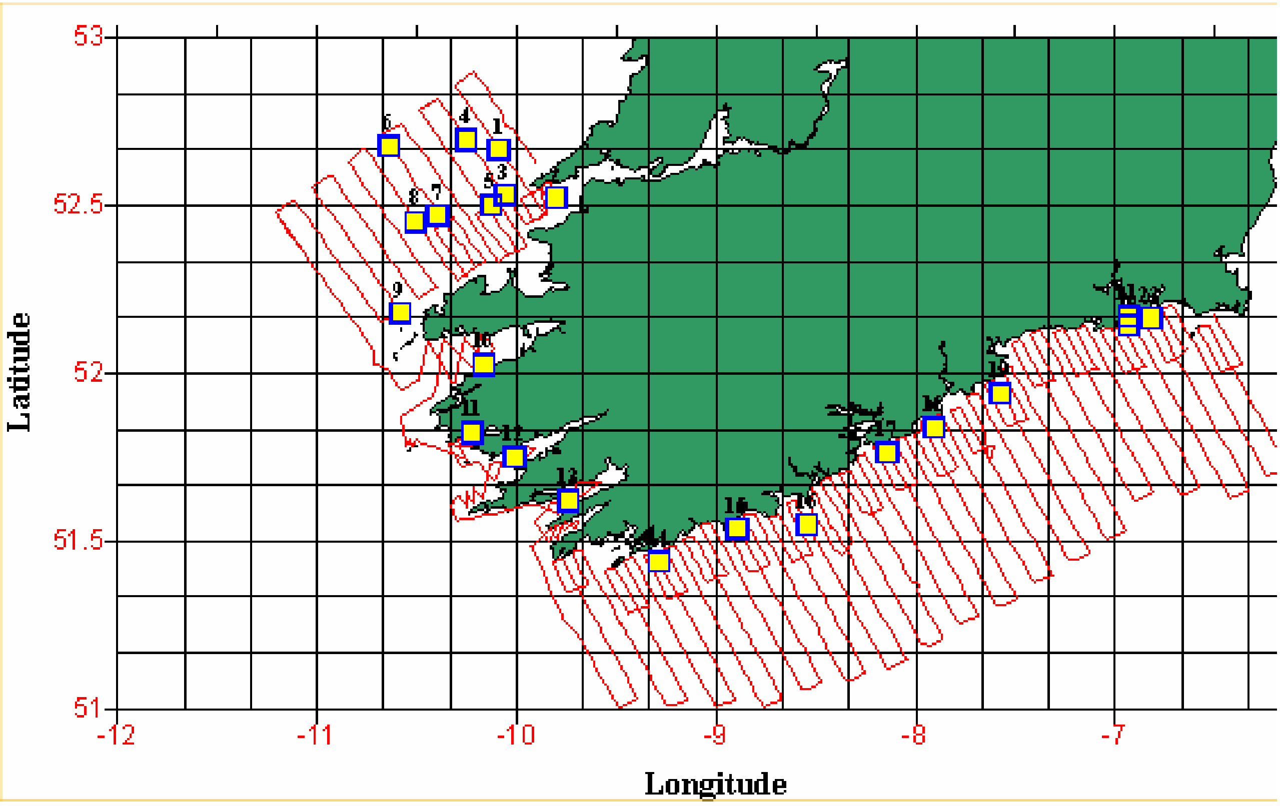


Figure 4.3.1.1a Celtic Sea and Division VIIj acoustic survey 2003, survey track and haul positions from acoustic survey, October and November 2003.

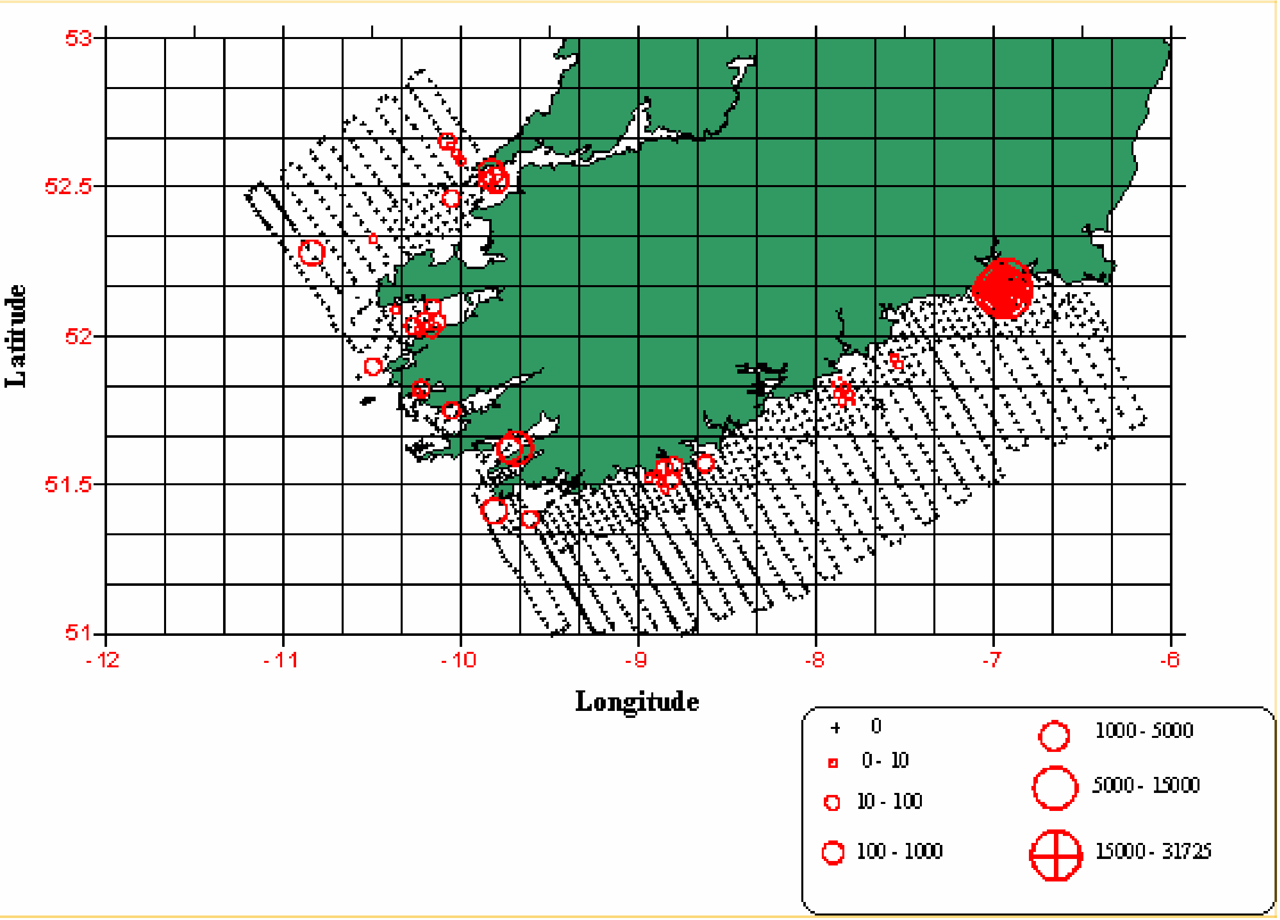


Figure 4.3.1.1b Celtic Sea and Division VIIj acoustic survey 2003, total NASC values for herring obtained in October and November 2003.

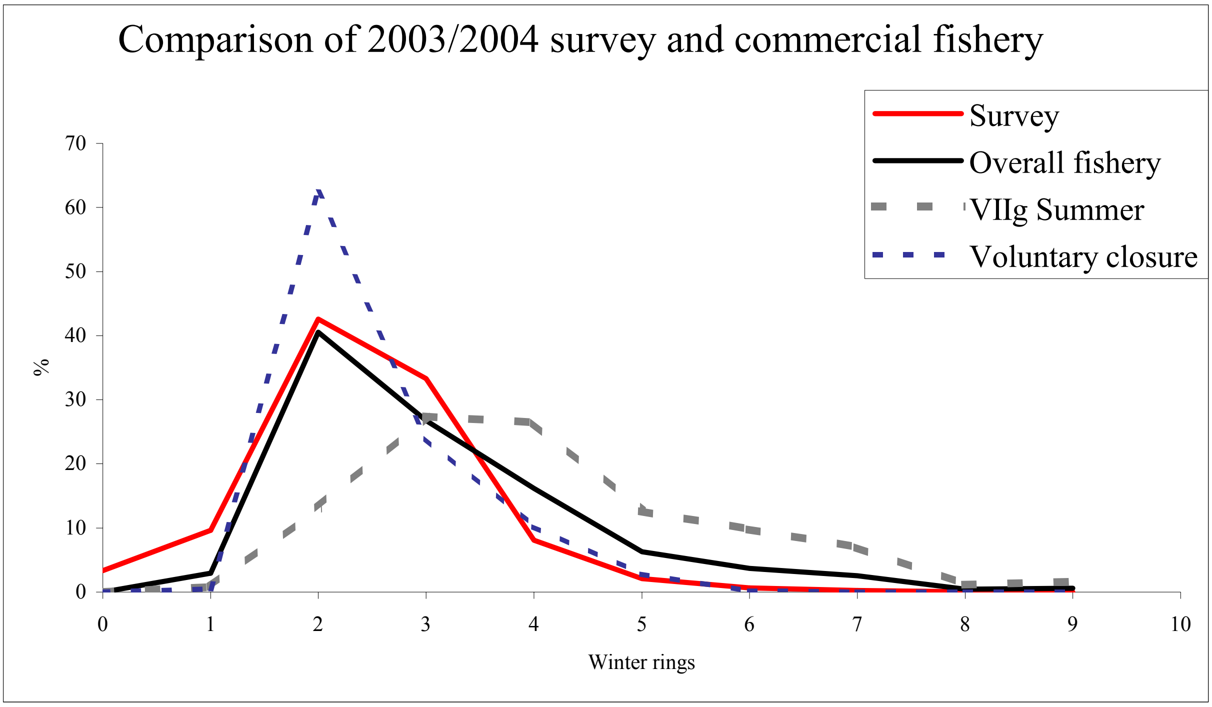


Figure 4.3.1.2 Celtic Sea & Division VIIj herring, comparison of percentage catches-at-age from the commercial fishery and from the acoustic survey in the 2002/2003 season.

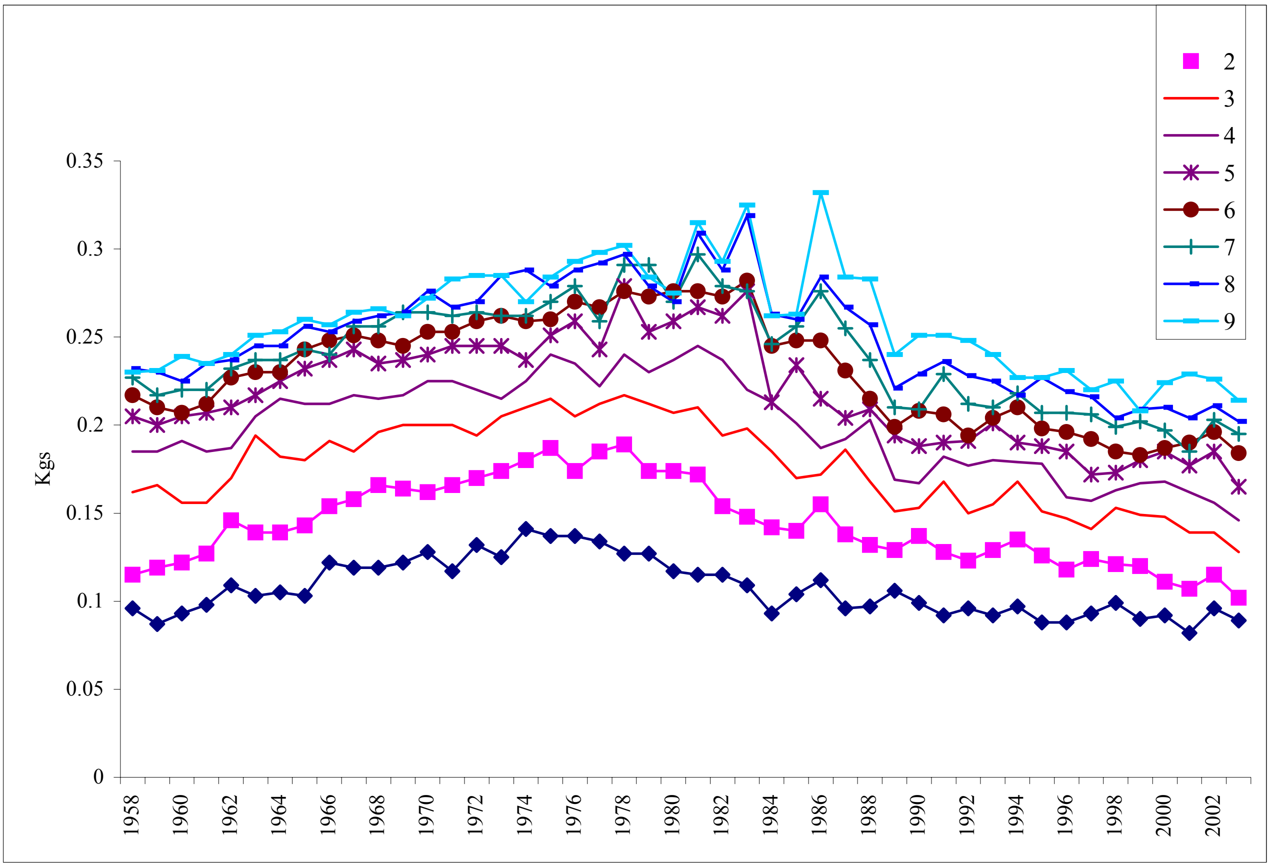


Figure 4.4.1. Celtic Sea and VIIj trends over time in mean weights in the catches of herring in the Celtic Sea and VIIj.

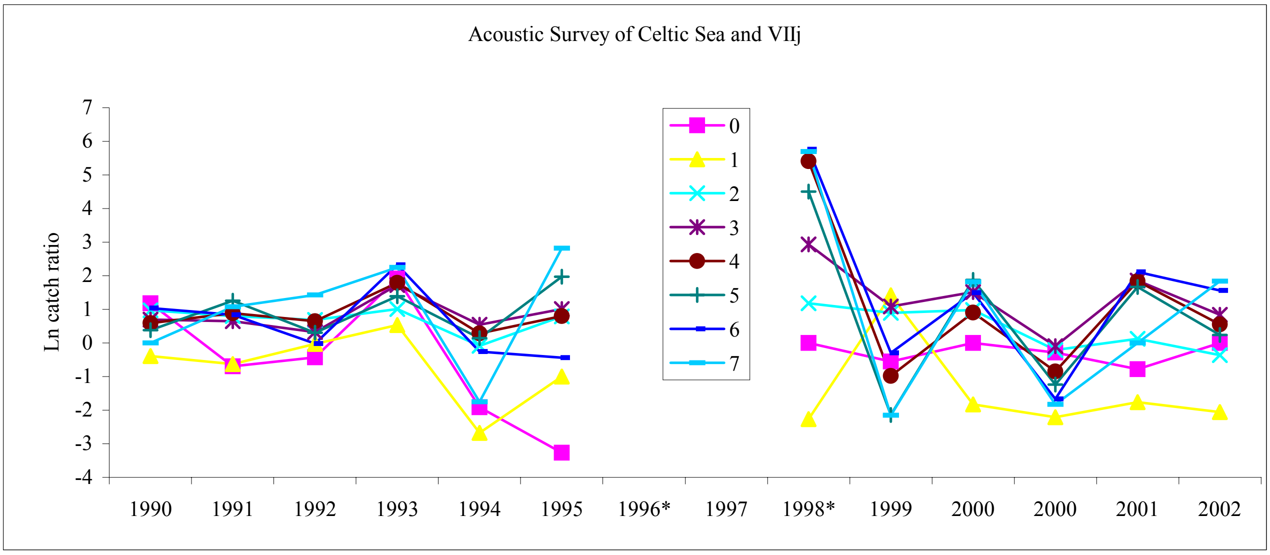


Figure 4.6.1.1. Celtic Sea and VIIj herring log abundance ratios. Calculated as ln (Ca,y / Ca+1,y+1). This can be considered a crude estimator of mortality of a cohort over two ages. No survey was carried out in 1997, hence the gap in the values for 1996 and 1997.

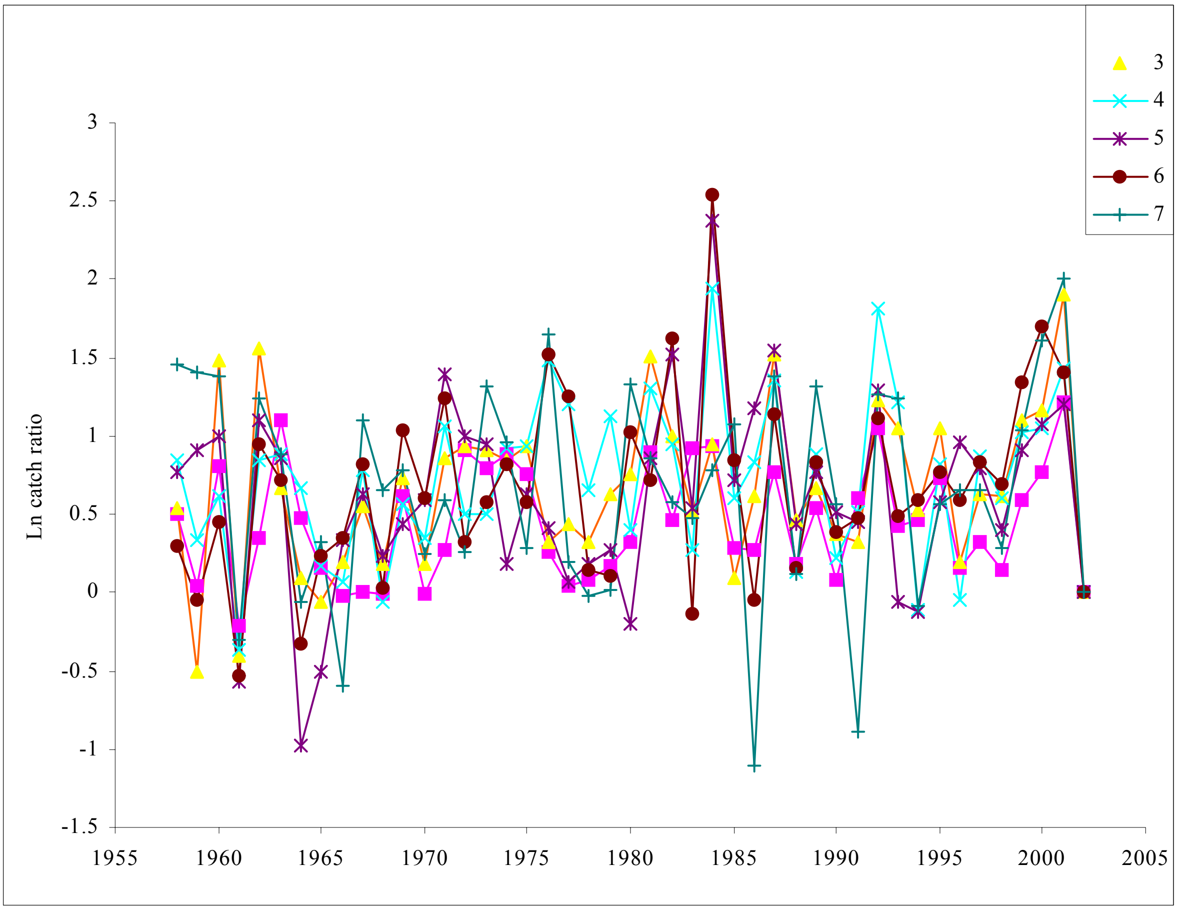


Figure 4.6.1.2. Celtic Sea and VIIj herring log catch ratios. Calculated as ln (Ca,y / Ca+1,y+1). This can be considered a crude estimator of mortality of a cohort over two ages.

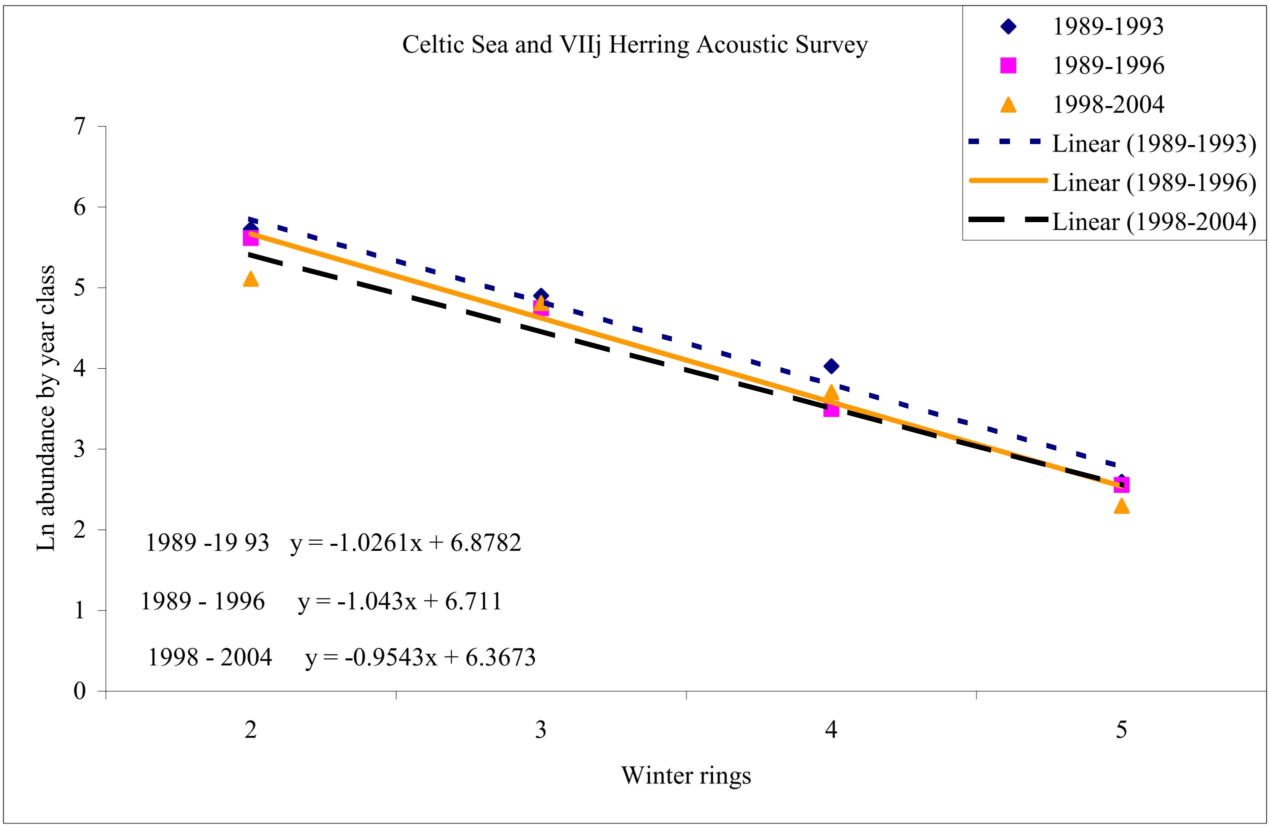


Figure 4.6.1.3. Celtic Sea and VIIj herring log abundance by year class (2-5 ringers) as estimated by the Celtic Sea and VIIj herring acoustic survey.

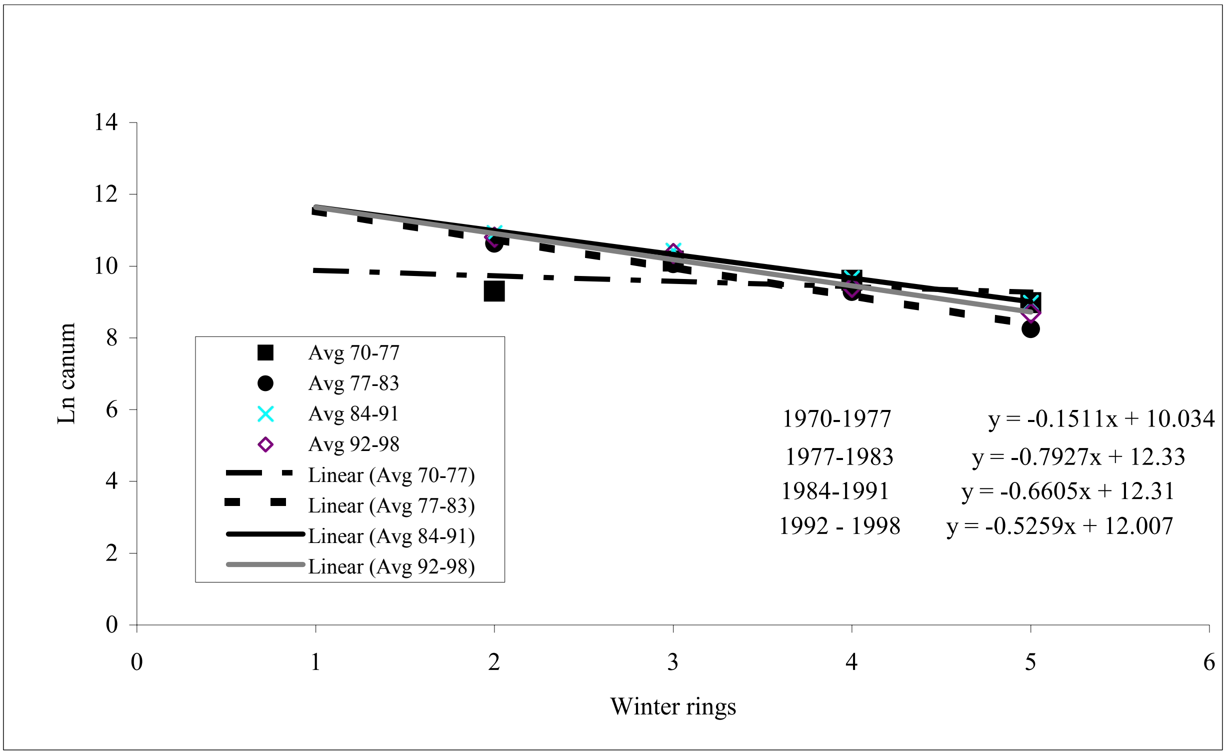


Figure 4.6.1.4. Celtic Sea and VIIj herring log canum by year class for 4 time periods.

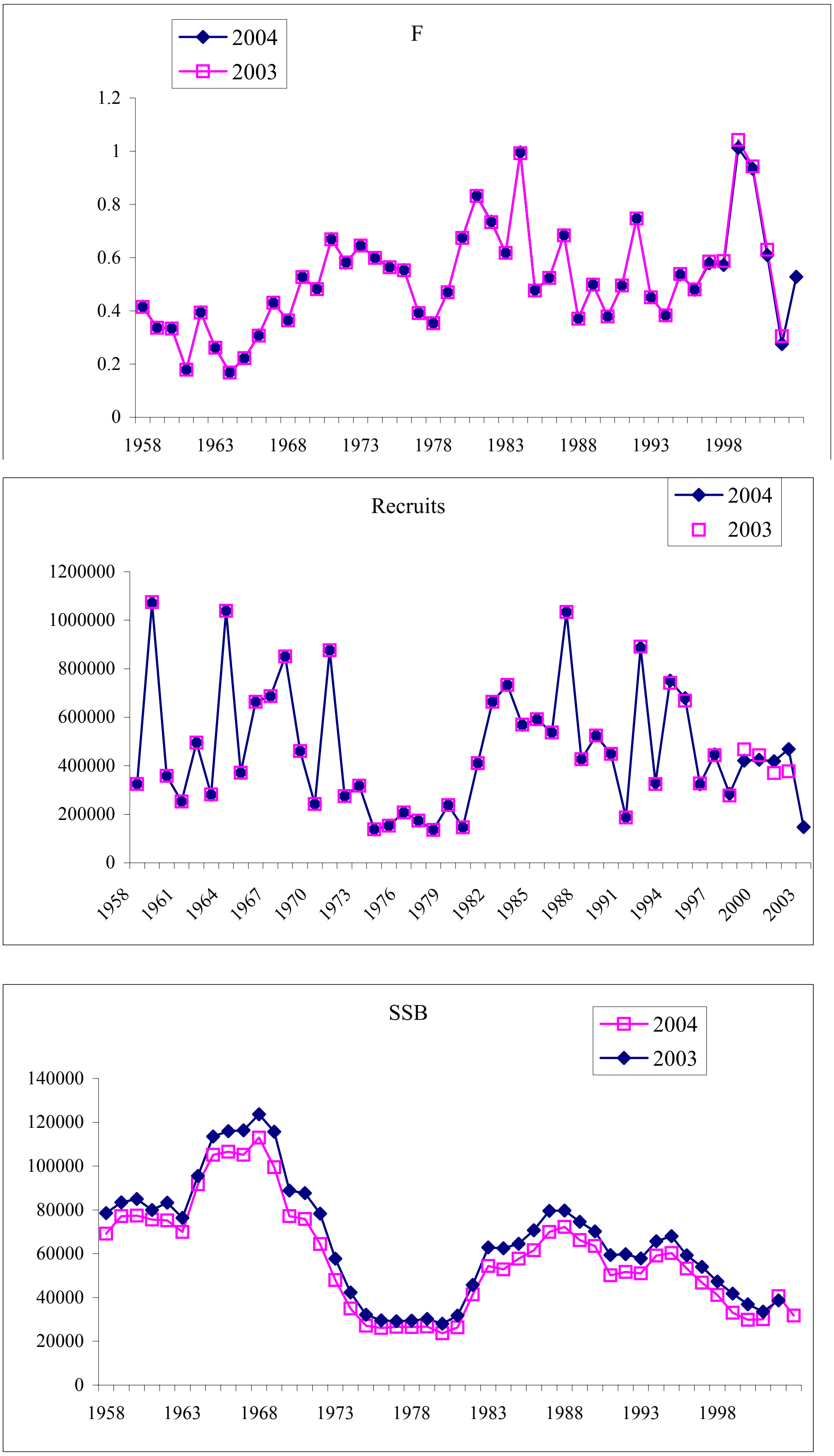


Figure 4.6.2.1. Celtic Sea and VIIj herring comparison of final run in 2004 with final run in 2003.

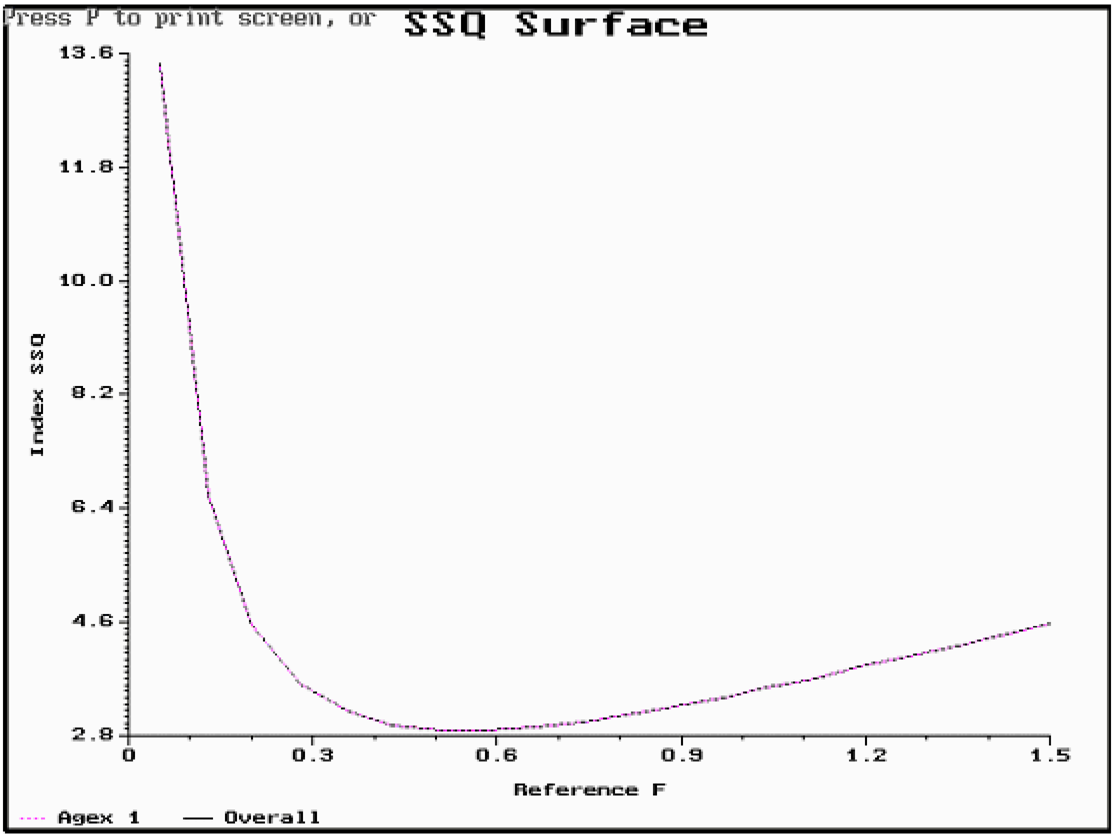


Figure 4.6.2.2 Herring in Celtic Sea and Division VIIj. SSQ for the baseline assessment.

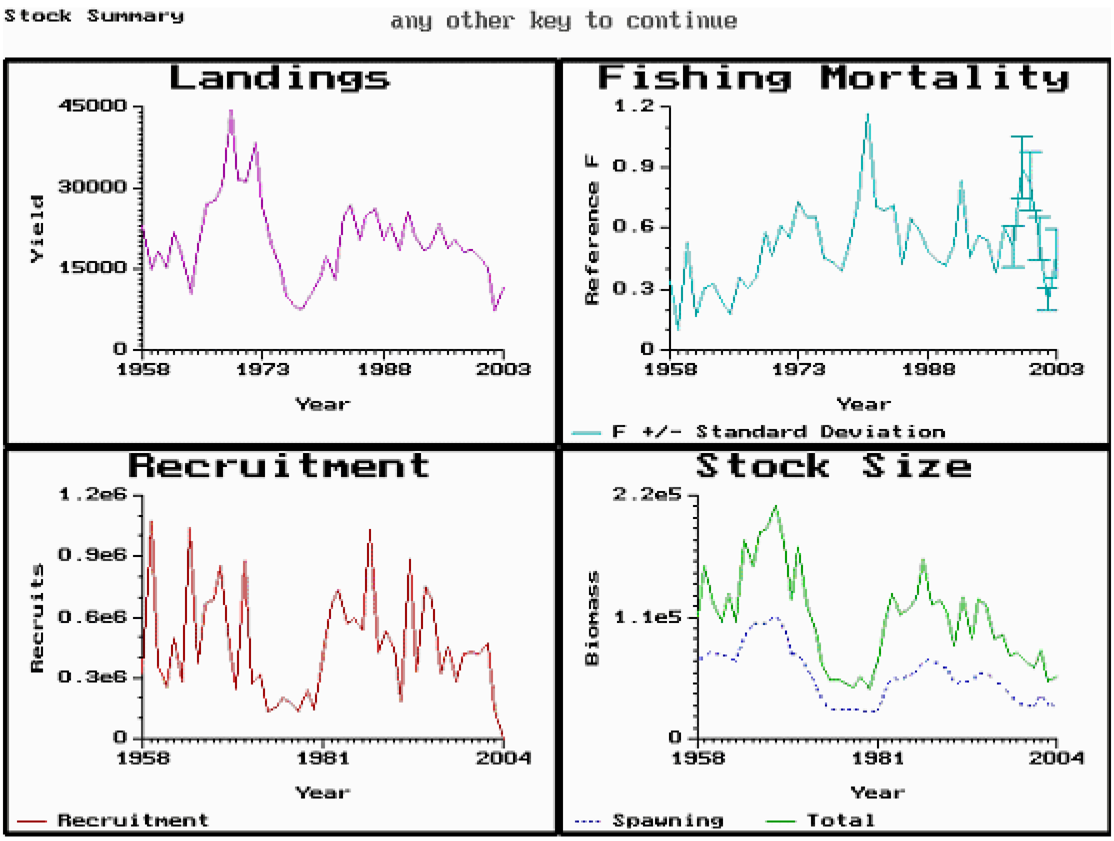


Figure 4.6.2.3 Herring in Celtic Sea and Division VIIj. Results of baseline assessment. Summary of estimates of landings, fishing mortality-at-age 3, recruitment age 1, stock size on Jan. 1 and spawning stock size at spawning time. Note: age corresponds to winter rings.

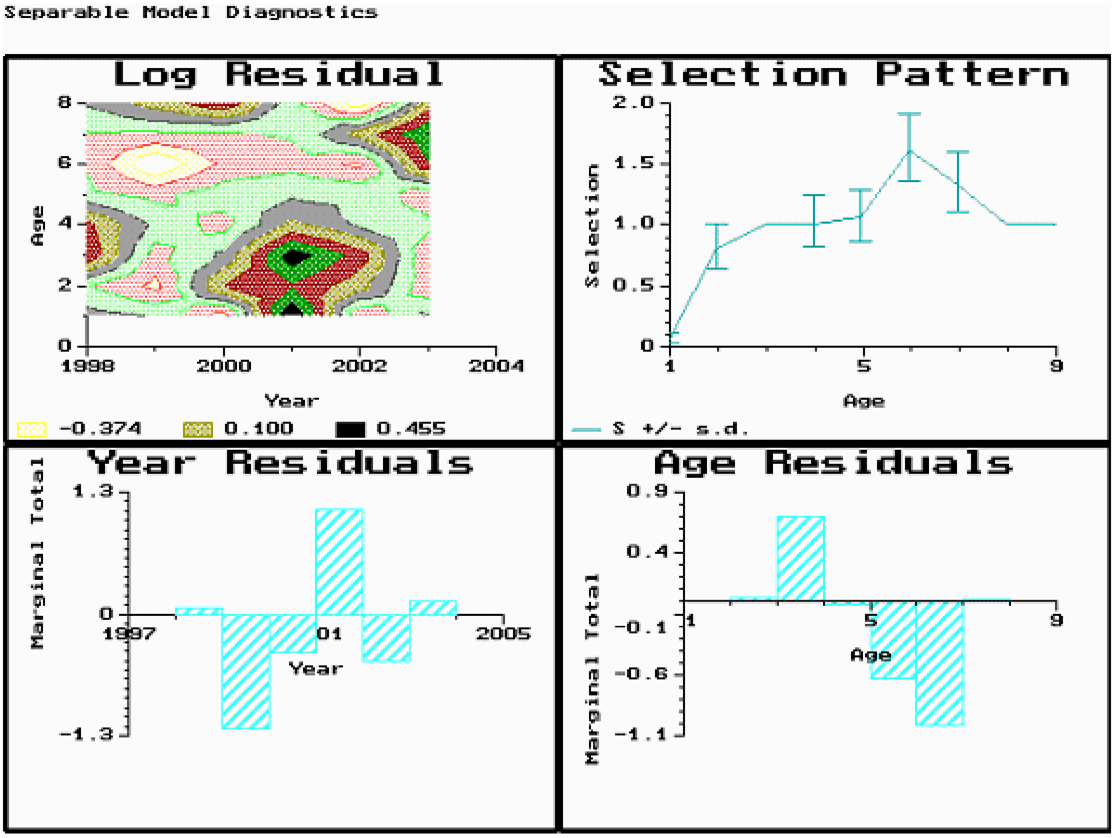


Figure 4.6.2.4 Herring in the Celtic Sea and Division VIIj. Results of the baseline assessment. Selection pattern diagnostics. Top left, contour plot of selection pattern residuals. Top right, estimated selection (relative to age 3) +/- standard deviation. Bottom, marginal totals of residuals by year and age(rings).

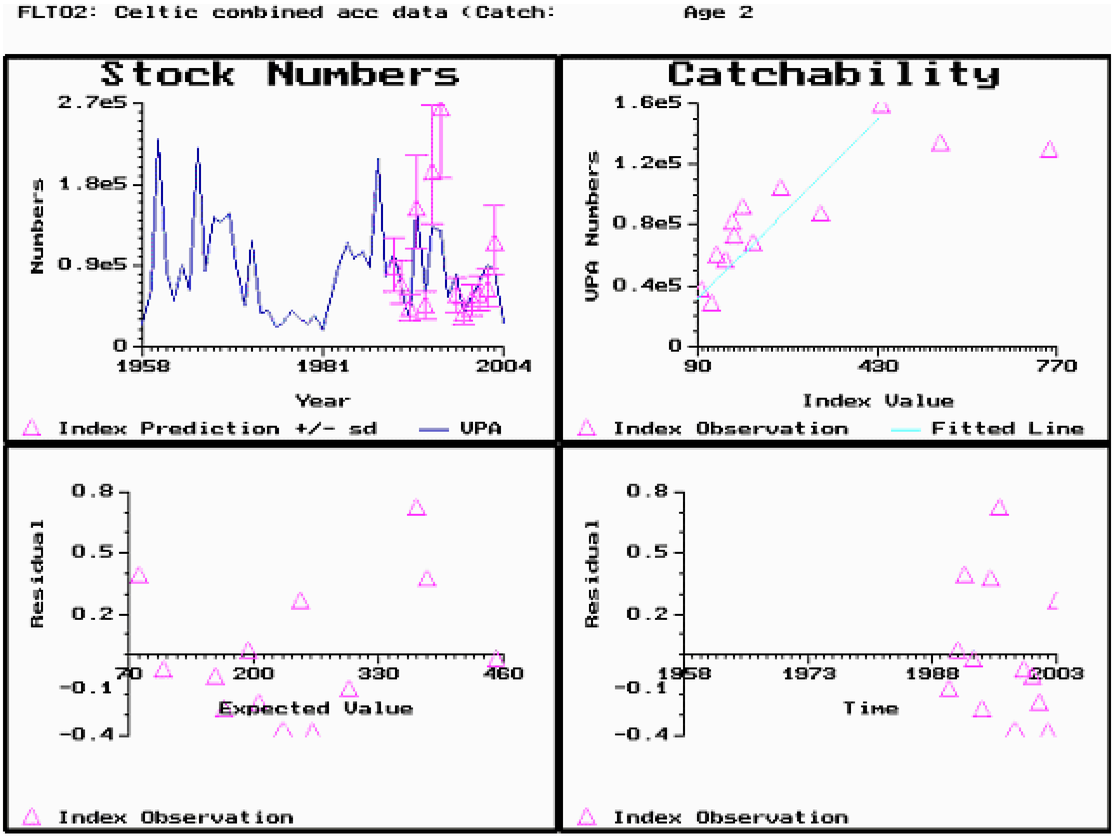


Figure 4.6.2.5 Herring in the Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic survey index at age 2 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) – ln(expected index) plotted against expected values and time.

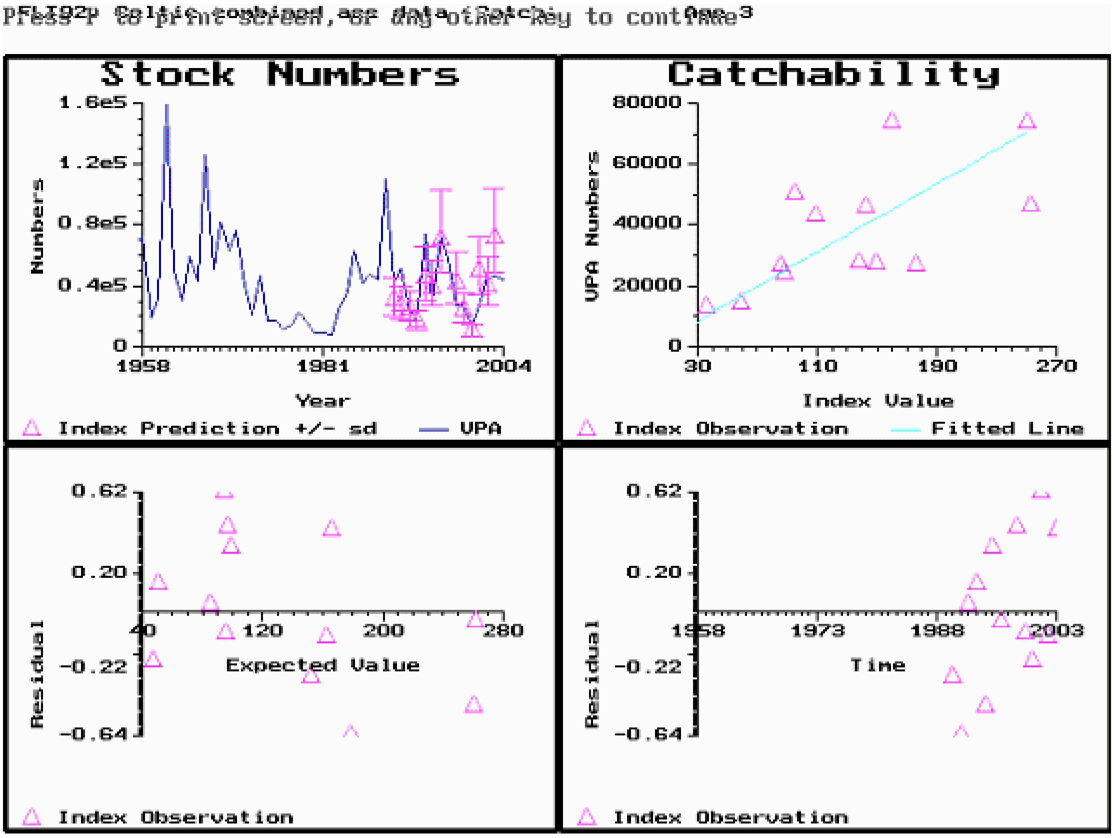


Figure 4.6.2.6 Herring in the Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic survey index at age 3 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) – ln(expected index) plotted against expected values and time.

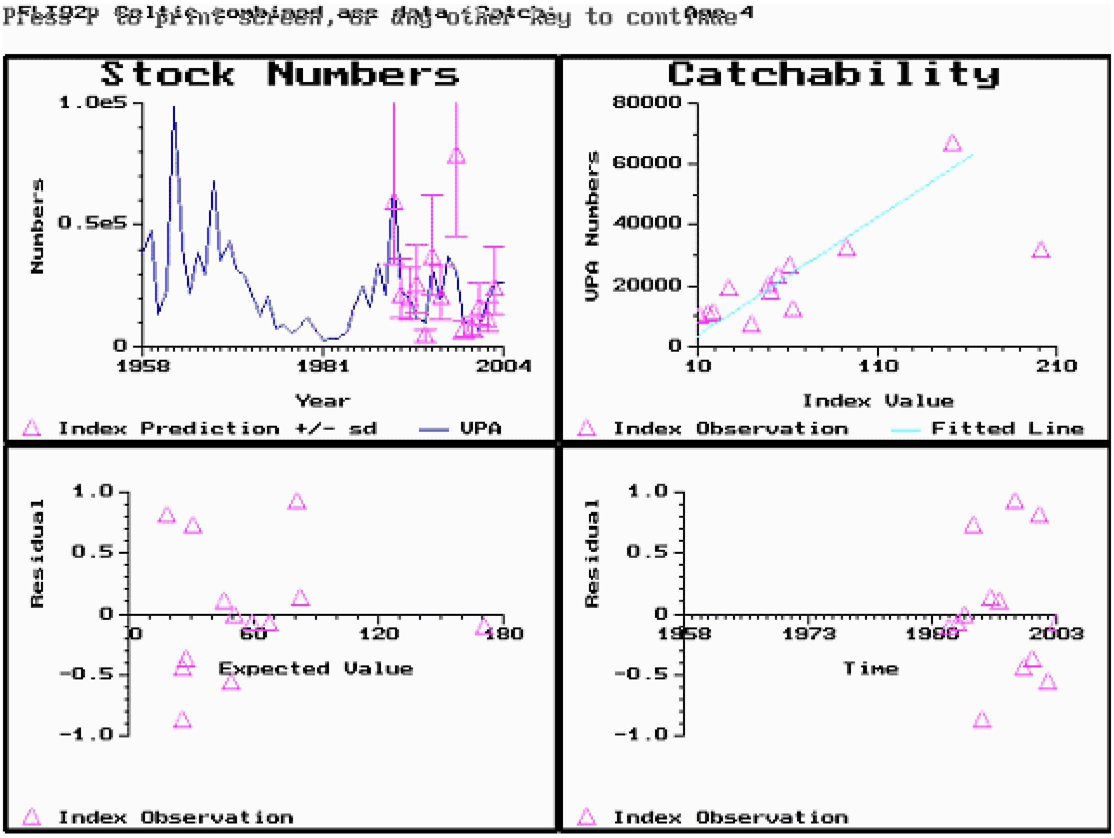


Figure 4.6.2.7 Herring in the Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic survey index at age 4 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) – ln(expected index) plotted against expected values and time.

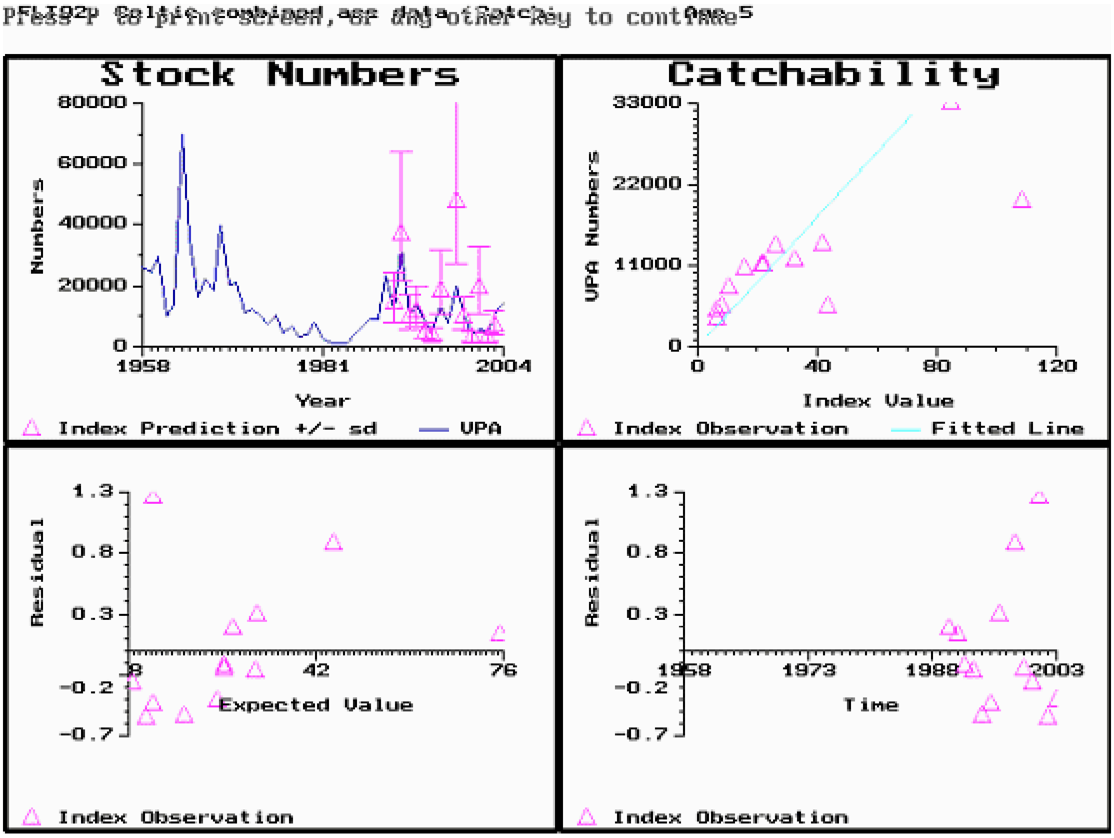


Figure 4.6.2.8 Herring in the Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic survey index at age (rings) 5 against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of spawning biomass from the fitted populations and larvae survey index observations. Bottom, residuals, as ln(observed index) – ln(expected index) plotted against expected values and time.

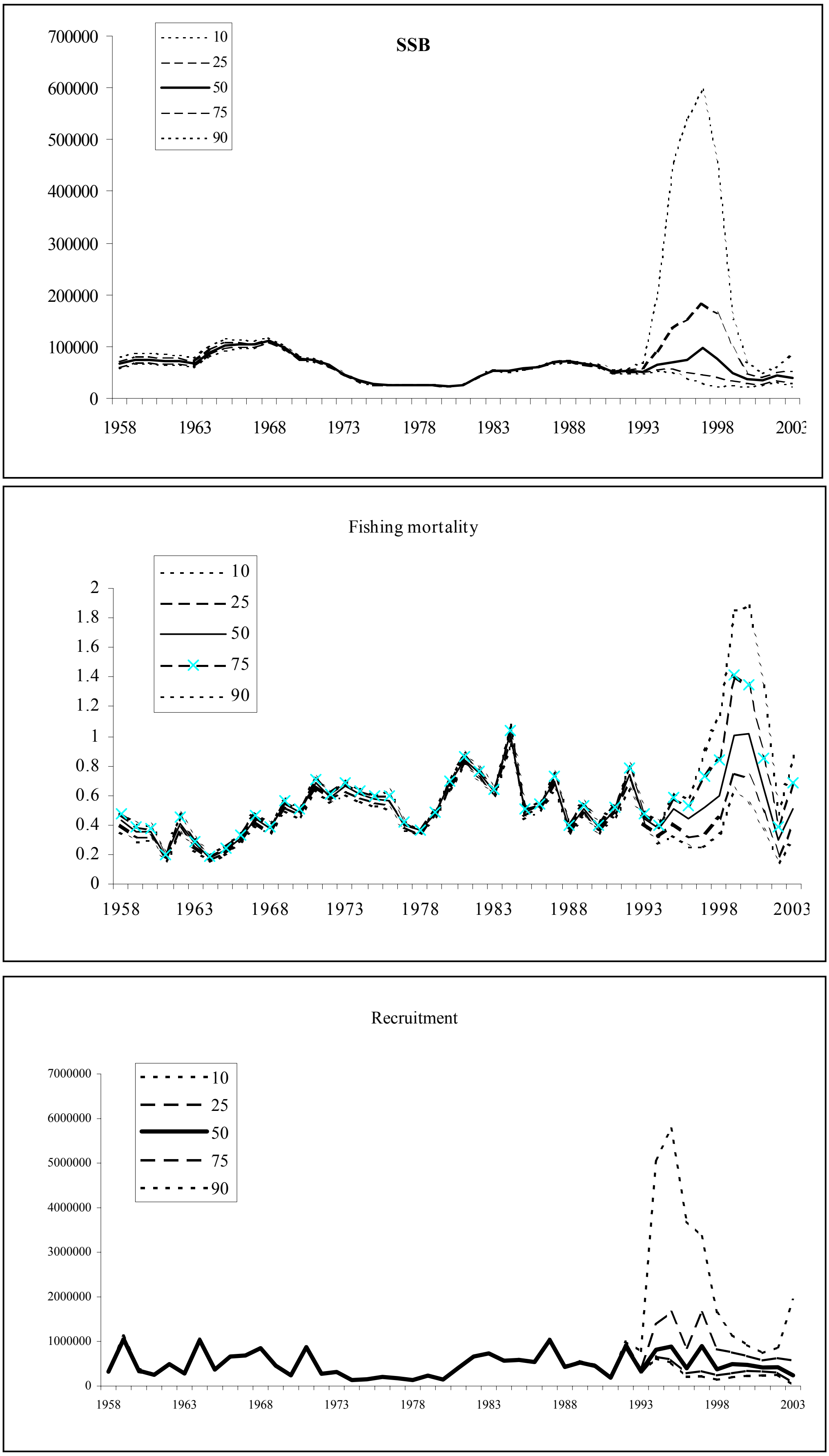
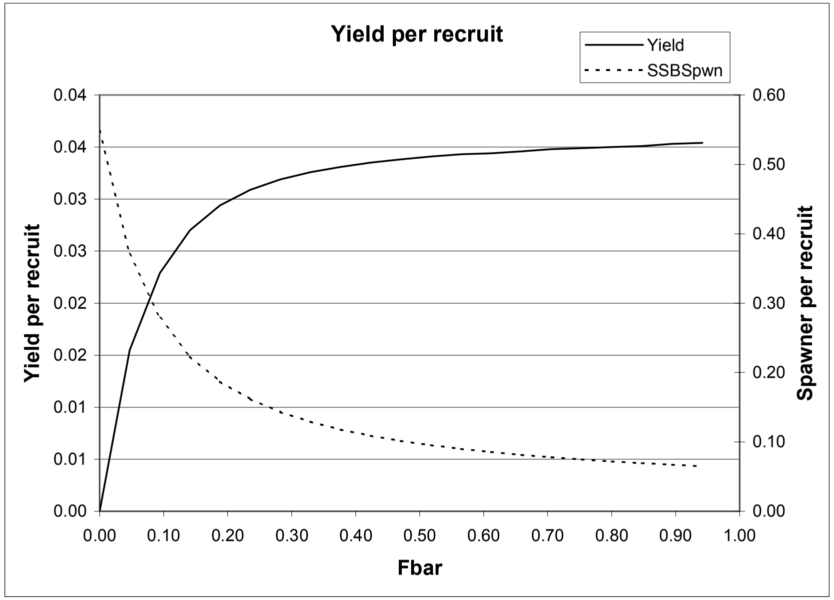
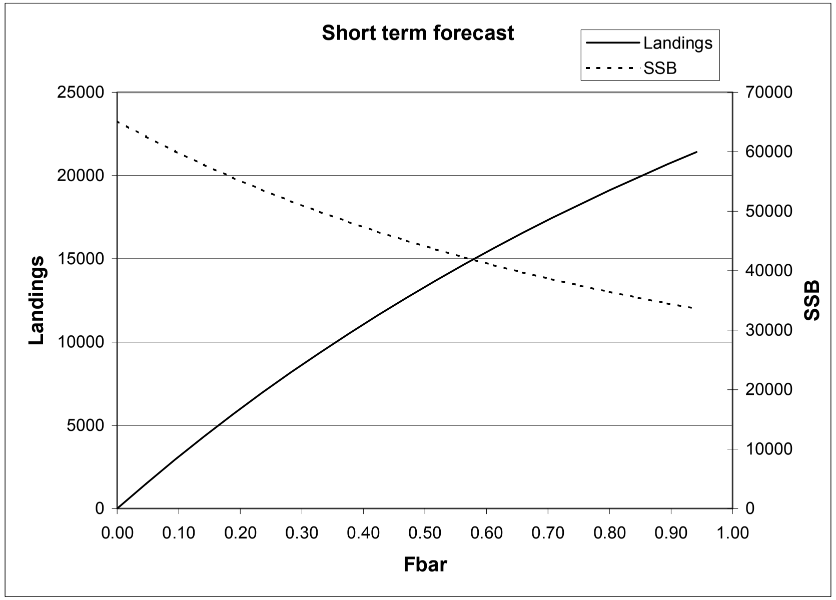


Figure 4.6.2.9. Historical uncertainty within the assessment of herring in Celtic Sea and VIIj, with respect to SSB, F and recruitment. Based on 100 estimates using ICA model, with 10th, 25th, 50th, 75th and 90th percentiles.





MFYPR version 2a
Run: celtic sea
Time and date: 10:32 17/03/2004

Reference point	F multiplier	Absolute F
Fbar(2-7)	1.0000	0.4708
FMax	>=1000000	
F0.1	0.3555	0.1674
F35%SPR	0.3838	0.1807
Flow	0.0780	0.0367
Fmed	0.2461	0.1159
Fhigh	0.8973	0.4225

MFDP version 1a
Run: Celti Sea F statquo
Herring VIIg
Time and date: 08:57 17/03/2004
Fbar age range: 2-7

Input units are thousands and kg - output in tonnes

Figure 4.7.1. Yield per recruit and short-term forecasts for Celtic Sea and VIIj herring.

5 West of Scotland Herring

5.1 Division VIa(North)

5.1.1 ACFM Advice Applicable to 2003 and 2004

ACFM reported in 2003 that the state of the stock remained uncertain although all the indications are that the stock is lightly exploited. Consequently, ACFM recommended that fishing mortality be maintained at *status quo* (=0.21), corresponding to catches in 2004 not exceeding 30,000 t.

The agreed TAC for 2004 is 30,000 t. The TAC in 2003 was 30,000 t.

There are no explicit management objectives for this stock, because of uncertainties about the historical catch data, the size of the biomass, and estimates of recruitment and fishing mortality. A $\mathbf{B}_{\text{lim}}$ of 50,000 t has been proposed for this stock (ICES 2003/ACFM:15).

5.1.2 The Fishery

Historically, catches have been taken from this area by three fisheries. 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. 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 has historically operated in deeper water near the shelf edge where older fish are distributed. These vessels are mostly registered in the Netherlands, Germany, France and England. In recent years the catch of these fleets has become more similar and has been dominated by younger adults resulting from increased recruitment into the stock.

In 2003, the Scottish trawl fleet fished only in very similar areas to the international fishery, and not in the more traditional coastal areas in the southern part of VIa (N). Catch-at-age data this year indicate that the catches are similar in age composition. Only the Irish fleet fished in the southern part of VIa (N) in 2003.

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.

5.1.3 Catches in 2003 and Allocation of Catches to Area

The WG 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 to around 5,000 t in 2002. 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 Herring Assessment WG 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. In 2003, for the first time since 1983, observer data indicated there was no misreported catch.

For 2003, the preliminary report of official catches corresponding to the VIa (N) herring stock unit total 28,835 t, compared with the TAC of 30,000 t. The Working Group's estimates of area misreported catches are 0 t. No herring has been reported as discarded. Currently, discarding is not perceived to be a problem. An insignificant amount (7 t) has been assigned as unallocated catch by the Working Group.

The Working Group's best estimate of removals from the stock in 2003 is 28,835 t. Details of estimated national catches from 1983 to 2003 are given in Table 5.1.1.

5.1.4 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 – see Figure 1.5.1) 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 annex to this report (Annex 1), the estimated catches in tonnes by country are shown in Table 5.1.2 and catches in number-at-age are given in Table 5.1.3.

5.2 Biological Composition of Commercial Catches

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 decreased from 52 in 2002 to 37 in 2003. However, this still exceeds the required one sample per 1,000 tonnes of catch. Comparison of the age structure of the German, Netherlands, and Scottish samples indicated that there was little difference in the age structure of the catch for these fleets in 2003.

Unsampled catches were allocated a mean age-structure (weighted by the sampled catch) of either the Scottish, or the German/Netherlands sampled fleets in the same quarter, or in adjacent quarters if no samples were available in the corresponding quarter. If no sampling data were available for a quarter, a mean age-structure of all samples from adjacent quarters was used. The allocation of age structures to unsampled catches, and the calculation of total international catch-at-age and mean weight-at-age in the catches were made using the ‘sallocl’ programme (Patterson, 1998).

Catch in number-at-age information is given in Table 5.2.2.

In the past concern has been raised over the quality of sampling of commercial catch. It was suggested in the 2001 ACFM technical minutes that an analysis of catch by quarter and country might shed some light on the variability in the catch information. In practice the fishery is often dominated by a single quarter catch, and a single country dominates sampling. Thus such an analysis is impossible. In 2002 the Working Group conducted an extensive analysis of the sensitivity of the assessment to missing catch information (Section 5.1.12 in ICES 2002/ACFM:12).

5.3 Fishery-independent Information

5.3.1 Acoustic Survey

The 2003 acoustic survey was carried out from 1-20 July using a chartered commercial fishing vessel (MFV *Enterprise*). The total biomass estimate obtained was higher than in the previous year (739,200 t this year compared to 548,800 t in 2002), and is the second highest in the survey time-series. Biomass estimated from the acoustic survey tends to be noisy and similar fluctuations have been observed in previous years. Herring were found in areas similar to those in 2002, namely south of the Hebrides off Barra Head, west of the Hebrides and along the shelf edge. However, the centre of the southern Hebrides distribution was more northerly than in previous years. Further details are available in the Report of the Planning Group for Herring Surveys (ICES 2004/G:05). Estimates of abundance by age and in aggregate spawning stock biomass for 2003 and for previous years are given in Table 5.3.1.

5.4 Mean Weight-at-age and Maturity-at-age

5.4.1 Mean Weight-at-age

Weights-at-age in the catches and weights-at-age in the stock from acoustic surveys are given in Table 5.4.1. The weights-at-age in the stock appear to be higher than the long-term mean for 1-ringers but slightly lower than the long-term mean across the rest of the age range.

Catch weights-at-age for 2003 are generally lower than the long-term average, except for 2- and 9+ ring herring.

5.4.2 Maturity Ogive

The maturity ogive is obtained from the acoustic survey (Table 5.4.2).

ACFM commented in 2002 that unlike in other years when maturity and size-at-age were correlated, in 2001 maturity-at-age increased and weight-at-age decreased. In 2003, maturity-at-age is lower than in 2002, but still higher than the mean of the series for 2-ringers. Weights-at-age in the catch show no consistent trend. Weights-at-age in the stock are generally lower than in 2002. However, in the 2003 Working Group, examination of the relationship between weight-at-age and proportion mature showed no relationship between the two.

5.5 Recruitment

There are no specific recruitment indices for this stock. Although both catch and acoustic survey have catches-at-age 1-ring both the fishery and survey encounter this age 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 Stock Assessment

5.6.1 Data Exploration and Preliminary Modelling

As last year, an exploratory assessment of the stock was 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 1998-2003 (Section 5.3.1).

This year the catch data for this stock were extended back to 1957 (refer to Section 5.1.4 and Annex 1). ICA was run on this extended data set with the same settings as in the 2003 Working Group (i.e., an eight year separable period with 1-ringers in the catch and survey down-weighted). This confirmed that the addition of the extended data set did not alter the perception of the status of the stock when compared to the 2003 assessment of the stock for the years 1976-2002. One concern for the stock assessment for the data extension period was that the selection on older age classes might have been different in history. The current assessment settings fix the selection on older ages (8 and 9+) equal to the selection at age 4 in the separable period. If the historical selection departed from this assumption then it would violate the assumptions in ICA used for production of the plus group in the historic part of the assessment. For the period 1980-2003, after the VIa (N) fishery closure, the depletion of age classes in the catches appeared constant across age (Figure 5.6.1), suggesting that fixing S at 1 for the older ages is appropriate. For part of the period prior to, and during, the closure (1970-1979) depletion across ages was variable, which might introduce some small errors into the estimate of numbers in the older ages in that period. However, it is only a relatively short period within the whole time-series. The assessment using the extended data set was therefore considered acceptable.

An examination of log catch ratios over the extended time-series 1957-2003 was carried out and showed no obvious trends in the exploitation patterns over time. As last year, there were no clear trends in exploitation patterns between ages or over years in the shorter time-series 1981 to present (Figure 5.6.2).

ICA was then run for the whole time-series, 1957-2003, (2004 assessment) to compare the model fit for this year with the 2003 Working Group assessment.

The residual patterns for the two runs are very similar (Figure 5.6.3). The surface plot is consistent and the year residuals follow the same pattern. The age residuals are different, with a relatively larger value for 8-ringers this year. However, the age residuals values are very small.

The selection pattern for the 2004 assessment is essentially identical to last year's assessment (Figure 5.6.4).

5.6.2 Stock Assessment

This essentially is an update assessment using the same settings as in 2003.

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 for 2003. The run log for the assessment is shown in Table 5.6.1. The period for the separable constraint is 8 years. The catch and survey data were down-weighted for 1-ring herring (see the 2001 Working Group assessment report (ICES 2001/ACFM:12)). The input data are given in Tables 5.6.2 to 5.6.8. The output data are given in Tables 5.6.9 to 5.6.18. The assessment results in an SSB for 2003 of 162,000 t and a mean fishing mortality (3-6 ringers) of 0.19 (Table 5.6.14). The model diagnostics (Tables 5.6.13 to 5.6.18 and Figures 5.6.6 to 5.6.16) show that the total residuals by age and year between the catch and the separable model are reasonably trend-free and small. The acoustic survey age and year residuals patterns are trend-free. The acoustic survey residuals are of similar magnitude to the catch model residuals but show more evidence of year effects. The current estimate of SSB shows a small decrease in biomass from 174,000 t in 2002 to 162,000 t in 2003. This is still above the estimate for 2001 (152,000 t). However, these estimates for 2001 and 2002 in the current assessment have been revised upwards from last year's assessment. The large recruitment of 1-ringers to the population in 2001 is still seen as a peak in numbers of 4-ringers in 2003 (the 1998 year class) in both the catch and acoustic survey data. The 2000 year class is abundant in the acoustic survey (the most abundant 2-ringer value since the 1995 survey). The 1999 year class is more dominant in the catch. Table 5.6.14 shows that the assessment model estimates similar values of recruitment for the 1999 and 2000 year classes.

The assessment shows 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 inclusion of the extended time-series in the assessment shows that the productivity in the period prior to the closure (1957-1979) was markedly higher.

Figure 5.6.17 shows the trajectories of 5, 25, 50, 75 and 95 percentiles from the estimates of historical uncertainty of F, SSB and recruits produced in the final assessment. These are based on 1000 bootstrapped samples of residuals. Uncertainty in the 2004 Working Group assessment is comparable to that in the 2003 Working Group assessment. In 2003 uncertainty was found to be considerably reduced from previous years (ICES 2003/ACFM:17), reflecting the stability of the input data over the final two or three years to that date. The greatest uncertainty in F is in 1997/98 when catch data were poorly sampled due to area misreporting that has now largely ceased.

5.7 Projections

5.7.1 Deterministic short-term projections

One scenario for deterministic short-term projections is presented: *status quo* F for 2004. This is consistent with both the current fishery and the level of catch that matches the TAC. Multiple options tables are available for 2005 (Table 5.7.3).

Short-term projections were carried out using MFDP. Input data are stock numbers on 1st January in 2004 from the 2004 ICA assessment (Section 5.6, Table 5.6.11), with geometric mean replacing recruitment at 1- and 2-ring in 2004 and 1-ring in 2003. 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 (Table 5.6.13). For the projections, data for maturity, natural mortality, mean weights-at-age in the catch and in the stock are means of the three previous years (i.e., 2001 - 2003) (Table 5.7.1). An example of a short-term projection is shown in the text table below, illustrating that at *status quo* F catches can be expected to be stable at around 30,000 t.

Scenario	2004	2005	2006
1 – *status quo* F	F_{2004}= F_{2003} = 0.19 *Status quo* F Catch = 29,797 t	F_{2005}= F_{2003} = 0.19 *Status quo* F Catch = 30,116 t	F_{2006}= F_{2003} = 0.19 *Status quo* F Catch = 30,691 t

The results of the short-term projections can be seen in Tables 5.7.2 – 5.7.3. Table 5.7.2 shows single option predictions for 2005 and 2006. Table 5.7.3 shows the multiple options for 2005. The short-term forecast for landings and SSB at *status quo* F is shown in Figure 5.7.2. SSB remains at about 170,000 t in the short-term. A catch constraint option was not considered as a scenario as the *status quo* F projection gives catches in the short-term around the current TAC, 30,000 t.

5.7.2 Yield-per-recruit

A yield-per-recruit analysis was carried out using MFYPR to provide a yield-per-recruit plot for VIa (N) (Figure 5.7.2). The values for $\mathbf{F}_{0.1}$ and $\mathbf{F}_{med}$ are 0.16 and 0.28 respectively. These may be compared with the current F (2004 assessment) of 0.19. The yield-per-recruit relationship starting from the same year as last year, suggests that at geometric mean recruitment (927 million for the period 1976-2002) a yield of approximately 29,000 t is possible at $\mathbf{F}_{0.1}$ and approximately 33,300 t is possible at $\mathbf{F}_{med}$ = 0.28.

5.7.3 Stochastic medium-term projections

No biological reference points are currently available for this stock, although a value for $\mathbf{B}_{lim}$ of 50,000 t has been proposed by the SGPRP (ICES 2003/ACFM:15). In the 2003 Working Group a value for $\mathbf{B}_{pa}$ was put forward (section 5.8 in ICES 2003/ACFM:17) and is discussed further below in section 5.8. The suggested $\mathbf{B}_{pa}$ value is used here to provide a value against which the stock trajectory in the medium-term projections can be measured.

Three sets of medium-term projections were carried out on the basis of (i) exploitation at *status quo* F, (ii) exploitation at *status quo* F * 1.35 and (iii) a catch of 40,000 t in 2005 onwards. The method used to calculate medium-term projections was that described in ICES 1996/ACFM:10 using the program ICP. Weights-at-age in the catch were calculated as the mean weights-at-age from 2001-2003. Weights-at-age in the stock, maturity ogives and natural mortality were as given in Section 5.6.2. Geometric mean recruitment for 1- and 2-ringers was used to replace the values in the assessment for 2004, however, the covariance values produced by ICA were retained. The stock-recruit relationship used in the medium-term projection was the Ockham option using the converged VPA 1972 to 2000 (Figure 5.7.3.1). Figure 5.7.3.2 shows a comparison between the cumulative distribution of recruitment from the assessment and the simulated recruitment in ICP. The agreement is good, and the arithmetic mean of the observed recruitment was 5% higher than the simulated recruitment. The input parameters are summarised in Table 5.7.4 and the run log is given in Table 5.7.5. Three scenarios are presented, based on the assessment using the eight-year separable period (Figure 5.7.3.3). The scenarios are chosen to provide *status quo* F exploitation, and a fixed F (F=1.35*F*status quo*) or fixed TAC exploitation (40,000 t) to provide a more or less stable stock.

The results of the stochastic medium-term projection are given in Figure 5.7.3.3 and summarised in the text table below. For the *status quo* F scenario, given a constant F exploitation pattern, catches and SSB both rise gently and stabilise to Landings of 34,000 t and SSB of 190,000 t. For *status quo* F * 1.35 (equivalent to F=0.25), catches rise in 2006 to around 38,000 t and, with some fluctuation, stabilise around 38,000 t in the medium-term. SSB rises to around 150,000 t in 2008 and remains there in the medium-term. The third scenario (a catch of 40,000 t in 2005 onwards) shows a stable SSB of around 145,000 t from 2004 across the medium-term. The risk of SSB falling below $\mathbf{B}_{\text{lim}}$ or suggested $\mathbf{B}_{\text{pa}}$, and the SSB in year 10 (2013), is given in the text table below.

	Status quo F (F=0.19)	*status quo* F * 1.35	a catch of 40,000 t in 2005 onwards
Average Yield	31,027 t	35,579 t	39,000 t
SSB in 2013	190,000 t	154,000 t	146,000 t
Risk of stock falling below suggested $\mathbf{B}_{\text{lim}}$	0.1%	0.4%	Increasing to 7% by 2013
Risk of stock falling below suggested $\mathbf{B}_{\text{pa}}$	0.7%	4%	Increasing from 5% in 2004 to 15% in 2013

5.8 Reference Points

The report of SGPRP (ICES 2003/ACFM:15) proposed a $\mathbf{B}_{\text{lim}}$ 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 last year.

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 90$^{\text{th}}$ 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%.

$\mathbf{B}_{\text{pa}} = \mathbf{B}_{\text{lim}} * 1.50$ and gives $\mathbf{B}_{\text{pa}} = 75{,}000$ t

The Working Group had considerable trouble developing F reference points but proposed a value based on rather limited data on errors of estimation. $\mathbf{F}_{\text{lim}}$ was derived directly from the equilibrium exploitation rate for an SSB for $\mathbf{B}_{\text{lim}}$. $\mathbf{F}_{\text{pa}}$ was obtained in a similar manner to $\mathbf{B}_{\text{pa}}$ with a factor of 50%. Full details of the method are given in last year's Working Group report.

ACFM had expressed concern with the proposed reference points from the 2003 Working Group, did not endorse them and was concerned about F reference points in particular. They noted that the analyses produce a high $\mathbf{F}_{\text{lim}}$ because there have been good recruitments at low SSB, hence the slope of the segmented regression is very steep, compared to other herring stocks. The ACFM decided that it would like the assessment Working Group to advise if there are biological reasons for expecting the atypically high productivity at low SSB. It was also noted that the lowest observed SSBs, with associated high recruitments, are at beginning of the time-series. ACFM asked the Working Group to consider how reliable the catch data were in those years, and if some of the catch may have been taken in the North Sea. Hence these apparent high productivities could be either immigration or misreporting into the area from the North Sea.

The Working Group examined the time-series of stock and recruitment and found that the ACFM subgroup had interpreted the data inconsistently because the recruitment was presented at 1-ring for autumn spawners and thus required a shift of 2 years to obtain the stock-recruit relationship. The highest recruitment had therefore occurred at mid-range biomass for the period 1976 to 2002, and not at the lower biomasses early in that period. In order to examine the productivity of the stock, data archives at FRS Marine Lab in Aberdeen were examined for data from this period and earlier, back to 1957 (see section 5.1.4 and Annex 1). John Morrison (who had been involved in data collection and the HAWG in the early 70s and dealt with the data at the time) was consulted about the validity of the data. His opinion was that the fishery had indeed moved to the west of Scotland, even before the closure of the North Sea fishery. There is a possibility of immigration but the six highest recruitments in the longer time-series do not coincide with the six highest in the North Sea, suggesting some considerable independence. The early data showed two very strong year classes (1963 and 1969) which do not occur in the North Sea.

A preliminary examination of the longer time-series suggests a period before 1970 with higher stock productivity and higher biomass. The 2004 assessment indicates that the stock has been exploited at a relatively low level for the last 20 years (F bar less than 0.30). Despite this relatively low exploitation rate the stock has failed to exceed its current level of 160,000 t, though it has reach this level twice since 1976. When the stock was at these higher levels fishing mortality was lower than the mean but further expansion of the stock did not occur. The Working Group did not manage to complete an analysis of the longer time-series to fully investigate the potential yield and suitable limit and reference points.

The Working Group is satisfied that the recruitment seen in the period 1976 to 2003 is correct and not atypical for this stock, and that the $\mathbf{B}_{\text{lim}}$ of 50,0000 t derived from this period is consistent with the productivity seen.

The Working Group is unable to establish if there are environmental reasons that might explain a change in productivity between the periods 1957 – 1975 and 1976 – 2000. In conclusion the WG considers that the reference points suggested last year are consistent with the stock summary from 1976 to 2000 when the productivity and yield are lower and might be considered conservative.

The Working Group did not repeat the extensive analysis carried out last year but suggests that, at the very least, a $\mathbf{B}_{lim}$ of 50,000 t and a $\mathbf{B}_{pa}$ of 75,000 t 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 based on a converged part of the VPA so should not change and 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 * $\mathbf{B}_{lim}$

5.9 Quality of the assessment

There was concern in the late 1990s about the retrospective error in the assessment, in particular sensitivity to poor sampling of catch. The sensitivity of the model to the catch was explored by examining the influence of groups of catch numbers-at-age on the assessment. It was concluded that these did not have a major influence on the perception of the state of the stock. The current sampling levels are much improved (Table 5.2.1). The addition of the new data to the beginning of the time-series has not changed the recent perception of the stock in the assessment. The 2002 and 2003 Working Groups inspected a number of possible sources of model uncertainty, including sensitivity to choice of length of separable period and sensitivity to a small number of isolated large cohort estimates in the Acoustic survey. They suggested that despite the large noise in the signals, the assessment was consistent and credible, although the choice of the length of the separable period was an important consideration in maintaining consistency.

Retrospective analyses of the assessment from 1999 to 2003 were carried out. Figure 5.9.1 shows the $F_{3\text{-}6}$ and SSB from ICA assessments with an 8-year separable period for assessments in 2001 to 2003, 7 years in 2000 and 6 years in 1999. The separable period is reduced from 8 to 6 years to exclude catch in 1993 that appears to have a different selection (see section 5.6.1 in last year's Working Group report, ICES 2003/ACFM:17). These retrospective analyses show rather stable estimation of F but more variable estimates of SSB. It is important to note that the assessment is currently underestimating SSB, and SSB is revised upwards with the addition of the extra year's data.

Analysis of the analytical retrospective for each cohort shows a high degree of stability (Figure 5.9.2). In some years the estimates of 1- and 2-ring fish abundance is unstable (e.g. 1997 and 1999). The 1-ringers are down-weighted in the assessment and the 1- and 2-ringer estimates are not used in the projections (where geometric mean values are used). However it is obvious that the estimations of cohorts after 2-ring are very stable. The retrospective analysis indicates that the problems (raised over the last few years) in estimating catch-at-age in both 1997 and 1998 are now causing little influence to the current assessment.

The current assessment seems very robust for estimation of F, although it gives a less precise estimate of SSB. However there now appears to be much greater stability in the assessment compared to 5-7 years ago and the assumptions used in the ICA model are credible and consistent with the information given in the catch and biological data.

5.10 Clyde herring

5.10.1 Advice and management applicable to 2003 and 2004

Management of herring in the Clyde is complicated by the presence of two stocks that are not separated currently; a resident spring-spawning population and the immigrant autumn-spawning component. Management strategies have been directed towards rebuilding the highly depleted spring-spawning component to historical levels.

The measures which remain in force in order to protect the indigenous spring-spawning stock are:

- A complete ban on herring fishing from 1 January to 30 April;
- A complete ban on all forms of active fishing from 1 February to 1 April, on the Ballantrae Bank spawning grounds, to protect the demersal spawn and prevent disturbance of the spawning shoals;
- A ban on herring fishing between 00:00 Saturday morning and 24:00 Sunday night;
- The TACs in 2003 and 2004 were maintained at the same level as in recent years (1,000 tonnes).

5.10.2 The fishery in 2003

Annual landings from 1955 to 2003 are presented in Table 5.10.1. Landings in 2003 were 328 t. The proportions of spring and autumn spawners in these landings could not be estimated. The sampling levels of the local fishery have been reduced in recent years (Table 5.10.2). In 2003, one sample of Clyde herring was taken.

5.10.3 Weight-at-age and stock composition

The catch in numbers-at-age for the period 1970 to 2003 is given in Table 5.10.3. Weights-at-age are given in Table 5.10.4. Mean weights in the stock have not been available from research vessel surveys since 1991, therefore the weights in the stock used are the weights-at-age in the catches. No data were available for 2002 as no samples were taken then.

5.10.4 Fishery-independent information

There were no surveys carried out in 2003. Historical estimates from these surveys are tabulated in (ICES 1995/ACFM:13).

5.10.5 Stock Assessment

The structure of the stock in the Clyde remains uncertain. No survey data are available from recent years therefore no assessment could be attempted.

5.10.6 Stock and catch projections

In the absence of an analytical assessment no stock projections can be provided.

5.11 Management Considerations

5.11.1 VIa (N) Management Considerations

In the 1990s management of this stock was complicated by area misreporting from area IVa in particular. Due to changes in the fishery and some management changes (in particular VMS) area misreporting into VIa (N) has declined from a high of 30,000t in the mid 1990s to 5000 t in 2002. It was estimated at effectively zero in 2003. This will considerably improve the possibilities for sound management.

The assessment presented here is more certain than those from the mid-1990s due to the improvements in the quality of the catch-at-age input data and the longer time-series for the acoustic survey. Current F_{3-6} is thought to be below 0.2 and SSB at 160,000 t is well above the suggested $\mathbf{B}_{pa}$ of 75,000 t. Though the SSB is more uncertain than F_{3-6}, this assessment provides a sound basis for assuming that the stock is currently lightly exploited and able to sustain the current fishery. The yield-per-recruit and the short-term and medium-term projections all indicate that a fishery at the same or slightly higher level is sustainable, with only limited risk of the stock falling below the suggested $\mathbf{B}_{pa}$ in the medium-term. Indications from the medium-term projections suggest that exploitation at F=0.25 (38,000 t) in 2006 is sustainable. It provides a higher yield and a stable, or slightly increasing, stock in the medium-term with minimal risk of falling below $\mathbf{B}_{pa}$. Exploitation at a fixed exploitation rate of 40,000 t is more risky; although this gives a higher medium-term yield, it gives an increased risk of SSB being below suggested $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$., because it precludes management response to possible reduced SSB.

5.11.2 Clyde herring Management Considerations

The management of this fishery is made difficult by the presence of a mixture of a severely depleted spring-spawning component and autumn spawners from Division VIa. The management objectives for these two components are necessarily distinct. The absence of fishery-independent data from surveys further compounds the problem. Historically the spring-spawning stock supported a fishery with catches up to 15,000 t per year in the 1960's. Landings began to decline through the 1970's and 1980's. In 1991 there was a dramatic drop in both landings and effort and since then landings have fluctuated at, or more usually below, 1,000 t.

In the absence of surveys and with no stock separation of the catches, nothing is currently known about the state of the spring-spawning stock. All the management measures, currently in force, need to remain. Catches should remain at the current low level until more is known about the dynamics of this stock.

Table 5.1.1 Herring in VIa (N). Catch in tonnes by country, 1983-2003. 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
Denmark		96					
Faroes	834	954	104	400			
France	1313		20	18	136	44	1342
Germany	6283	5564	5937	2188	1711	1860	4290
Ireland				6000	6800	6740	8000
Netherlands	20200	7729	5500	5160	5212	6131	5860
Norway	7336	6669	4690	4799	4300	456	
UK	31616	37554	28065	25294	26810	26894	29874
Unallocated	-4059	16588	-502	37840	18038	5229	2123
Discards							1550
Total	63523	75154	43814	81699	63007	47354	53039
Area-Misreported		-19142	-4672	-10935	-18647	-11763	-19013
WG Estimate	**63523**	**56012**	**39142**	**70764**	**44360**	**35591**	**34026**
Source (WG)	1985	1986	1987	1988	1989	1990	1991

Country	1990	1991	1992	1993	1994	1995	1996
Denmark							
Faroes	326	482					
France	1287	1168	119	818	274	3672	2297
Germany	7096	6450	5640	4693	5087	3733	7836
Ireland	10000	8000	7985	8236	7938	3548	9721
Netherlands	7693	7979	8000	6132	6093	7808	9396
Norway	1607	3318	2389	7447	8183	4840	6223
UK	38253	32628	32730	32602	30676	42661	46639
Unallocated	2397	-10597	-5485	-3753	-4287	-4541	-17753
Discards	1300	1180	200		700		
Total	69959	50608	51578	56175	54664	61271	64359
Area-Misreported	-25266	-22079	-22593	-24397	-30234	-32146	-38254
WG Estimate	**44693**	**28529**	**28985**	**31778**	**24430**	**29575**	**26105**
Source (WG)	1992	1993	1994	1995	1996	1997	1997

Country	1997	1998	1999	2000	2001	2002	2003
Denmark							
Faroes						800	400
France	3093	1903	463	870	760	1340	1370
Germany	8873	8253	6752	4615	3944	3810	2935
Ireland	1875	11199	7915	4841	4311	4239	3581
Netherlands	9873	8483	7244	4647	4534	4612	3609
Norway	4962	5317	2695				
UK	44273	42302	36446	22816	21862	20604	16947
Unallocated	-8015	-11748	-8155			878	-7
Discards	62	90					
Total	64995	65799	61514	37789	35411	36283	28835
Area-Misreported	-29766	-32446	-23623	-14626	-10437	-4496	
WG Estimate	**35233***	**33353**	**29736**	**23163**	**24974**	**31787**	**28835**
Source (WG)	1998	1999	2000	2001	2002	2003	2004

*WG estimate for 1997 has been revised according to the Bayesian assessment (see ICES CM 2000/ACFM:12).

Table 5.1.2 Herring in VIa (N). Estimated historic total catch-at-age of herring from VIa (N) for the period 1957 to 1972 using fleet factors based on fishing practices from 1970 to 1981.

Year	Faroe Isl	France	German F.R.	Netherlands	Norway	Poland	UK (Eng)	UK (N.Irl)	UK (Sco)	Moray Firth	Total
1957	0	0	0	0	0	0	99	0	41636	1703	43438
1958	0	0	6054	0	0	0	201	0	52250	1164	59669
1959	0	0	1768	0	0	0	16	0	60986	2451	65221
1960	0	154	3742	0	0	0	36	0	58921	906	63759
1961	0	353	1280	0	0	0	52	0	44083	585	46353
1962	0	489	7948	0	0	0	85	0	47831	1842	58195
1963	0	1121	3339	0	0	0	58	0	44394	118	49030
1964	0	1023	3796	56	0	0	26	0	58673	660	64234
1965	0	610	3570	274	0	0	28	0	53909	10278	68669
1966	0	1	10312	208	0	0	1	0	69363	20734	100619
1967	0	379	12203	3796	0	111	0	0	67404	6507	90400
1968	0	1124	10481	2453	0	428	3	0	65180	4945	84614
1969	0	966	11137	1256	0	489	0	0	90222	3100	107170
1970	15100	1293	11661	914	20199	569	0	0	103530	1385	160247
1971	8100	2055	5426	7674	76720	0	0	0	99537	5666	210594
1972	8094	680	28945	19384	17400	0	0	0	107638	10242	168399

Table 5.1.3 Herring in VIa (N). Catch in number from 1957 to 1975 derived from records of catch-at-age by national fleet held in FRS Marine Laboratory, Aberdeen, Scotland and historic fishing practices from 1970 to 1981.

Year / Age	1	2	3	4	5	6	7	8	9
1957	8952	102836	80048	35503	46827	27410	12244	1966	6095
1958	20889	41442	194493	52264	33319	36961	23283	13185	9577
1959	73207	93725	48624	160488	34397	23899	23440	10165	11852
1960	6274	179930	106224	40137	86122	20492	18230	11181	8134
1961	22370	77291	105377	56649	38479	21227	9141	8233	4416
1962	71254	120127	28836	87313	57416	25576	31246	7956	9167
1963	16931	112309	76725	17021	58155	37563	12469	19610	8738
1964	45983	143099	121385	46215	12615	41967	32284	15239	26162
1965	348968	23033	72992	69186	25944	5966	26673	22052	22758
1966	209236	495082	33071	59805	40436	19122	5499	17605	26771
1967	257607	33963	270913	45921	48618	36907	14581	6854	31960
1968	276553	118577	26365	199795	17564	29609	19685	8007	13578
1969	49817	122290	95002	30802	279090	27759	56496	34392	34624
1970	313219	130184	333590	147122	36474	187227	28412	35595	31663
1971	207711	335083	412816	302208	101957	25557	154424	16818	31999
1972	534963	621496	175137	54205	66714	25716	10342	55763	16631
1973	51170	235627	808267	131484	63071	54642	18242	6506	32223
1974	309016	124944	151025	519178	82466	49683	34629	22470	21042
1975	172879	202087	89066	63701	188202	30601	12297	13121	13698

Table 5.2.1 Herring in VIa (N). Catch and sampling effort by nations participating in the fishery.

Total over all areas and periods

Country	Official Catch	No. of samples	No. measured	No. aged	SOP %
England & Wales	4096.00	0	0	0	0.00
Faroes	400.00	0	0	0	0.00
France	1370.00	0	0	0	0.00
Germany	2935.00	6	1255	200	99.46
Ireland	3581.00	0	0	0	0.00
N. Ireland	14.00	0	0	0	0.00
Netherlands	3609.00	5	873	125	99.83
Scotland	12837.00	26	5320	1325	100.01
Total for Stock	28842.00	37	7448	1650	99.90

Sum of Official Catches	28842.00
Unallocated	-7.00
Working Group Catch	28835.00

PERIOD: 1

Country	Official Catch	No. of samples	No. measured	No. aged	SOP %
England & Wales	1.00	0	0	0	0.00
France	19.00	0	0	0	0.00
Ireland	1383.00	0	0	0	0.00
Netherlands	468.00	3	616	75	99.80
Scotland	80.00	0	0	0	0.00
Period Total	1951.00	3	616	75	99.80

Sum of Official Catches	1951.00
Unallocated	1589.00
Working Group Catch	3540.00

PERIOD: 2

Country	Official Catch	No. of samples	No. measured	No. aged	SOP %
England & Wales	4095.00	0	0	0	0.00
France	121.00	0	0	0	0.00
Germany	173.00	0	0	0	0.00
Ireland	11.00	0	0	0	0.00
N. Ireland	14.00	0	0	0	0.00
Period Total	4414.00	0	0	0	0.00

Sum of Official Catches	4414.00
Unallocated	0.00
Working Group Catch	4414.00

PERIOD: 3

Country	Official Catch	No. of samples	No. measured	No. aged	SOP %
France	1230.00	0	0	0	0.00
Germany	2762.00	6	1255	200	99.46
Ireland	3.00	0	0	0	0.00
Netherlands	3141.00	2	257	50	99.87
Scotland	12757.00	26	5320	1325	100.01
Period Total	19893.00	34	6832	1575	99.91

Sum of Official Catches	19893.00
Unallocated	-1596.00
Working Group Catch	18297.00

PERIOD: 4

Country	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroes	400.00	0	0	0	0.00
Ireland	2184.00	0	0	0	0.00
Period Total	2584.00	0	0	0	0.00

Sum of Official Catches	2584.00
Unallocated	0.00
Working Group Catch	2584.00

Table 5.2.2 Herring in VIa (N). Estimated catch numbers-at-age (thousands), 1976-2003. 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
1	9092	7635	4511	147	1145	53
2	74167	35252	22960	82214	35410	32709
3	34571	93910	21825	15295	90204	48449
4	31905	25078	51420	9490	9506	56629
5	22872	13364	15505	24896	19916	7987
6	14372	7529	9002	9493	29288	4667
7	8641	3251	3898	6785	9628	13527
8	2825	1257	1836	4271	1290	10376
9	3327	1089	576	1015	1203	1330

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
1	534 200	447 600	313 100	424 700	438 800
2	322 400	316 200	1 062 000	436 000	1 039 400
3	1 388 800	337 100	217 700	1 436 900	932 500
4	432 000	899 500	172 800	199 800	1 471 800
5	308 000	393 400	437 500	161 700	181 300
6	138 700	247 600	132 600	424 300	129 200
7	86 500	199 500	102 800	152 300	346 700
8	27 600	95 000	52 400	67 500	114 300
9+	35 400	65 000	34 700	59 500	75 200
SSB:	460 200	500 500	359 200	548 800	739 200

*Biomass of 2+ ringers in November.
The 1997 survey is not on the same basis as the other years, it was conducted in June (all other surveys were carried out in July) and it is not used for assessment purposes.

Table 5.4.1 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	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	73	80	82	79	84	91	89	83	105	81	89	97	76	83	49	107	72
2	143	112	142	129	118	122	128	142	142	134	136	138	130	137	140	146	143
3	183	157	145	173	160	172	158	167	180	178	177	159	158	164	163	159	158
4	211	177	191	182	203	194	197	190	191	210	205	182	175	183	183	171	167
5	220	203	190	209	211	216	206	195	198	230	222	199	191	201	192	156	183
6	238	194	213	224	229	224	228	201	213	233	223	218	210	215	196	173	196
7	241	240	216	228	236	236	223	244	207	262	219	227	225	239	205	182	193
8	253	213	204	237	261	251	262	234	227	247	238	212	223	281	224	245	185
9+	256	228	243	247	271	258	263	266	277	291	263	199	226	253	271	277	290

Weight in the stock from acoustic surveys													
Age	Historical	1992	1993	1994	1995	1996	1997#	1998	1999	2000	2001	2002	2003
1	90	68	75	52	45	45	57	65	54	62	62	62	64
2	164	152	162	150	144	140	150	138	137	141	132	153	138
3	208	186	196	192	191	180	189	177	166	173	170	177	176
4	233	206	206	220	202	209	209	193	188	183	190	198	190
5	246	232	226	221	225	219	225	214	203	194	198	212	204
6	252	252	234	233	226	222	233	226	219	204	212	215	213
7	258	271	254	241	247	229	248	234	225	211	220	225	217
8	269	296	260	270	260	242	266	225	235	222	236	243	223
9+	292	305	276	296	293	263	287	249	245	230	254	259	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

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 2004 used for the year 2003
west.dat
 Natural mortality in 2004 used for the year 2003
natmor.dat
 Maturity ogive in 2004 used for the year 2003
matprop.dat
 Name of age-structured index file (Enter if none) : -->fleet.dat
 Name of the SSB index file (Enter if none) -->
No indices of spawning biomass to be used.
 No of years for separable constraint ?--> 8
 Reference age for separable constraint ?--> 4
 Constant selection pattern model (Y/N) ?-->y
 S to be fixed on last age ?-->    1.000000000000000
 First age for calculation of reference F ?--> 3
 Last age for calculation of reference F ?--> 6
 Use default weighting (Y/N) ?-->n
Enter relative weights-at-age
 Weight for age 1-->    0.100000000000000
 Weight for age 2-->    1.000000000000000
 Weight for age 3-->    1.000000000000000
 Weight for age 4-->    1.000000000000000
 Weight for age 5-->    1.000000000000000
 Weight for age 6-->    1.000000000000000
 Weight for age 7-->    1.000000000000000
 Weight for age 8-->    1.000000000000000
 Weight for age 9-->    1.000000000000000
Enter relative weights by year
 Weight for year 1996-->    1.000000000000000
 Weight for year 1997-->    1.000000000000000
 Weight for year 1998-->    1.000000000000000
 Weight for year 1999-->    1.000000000000000
 Weight for year 2000-->    1.000000000000000
 Weight for year 2001-->    1.000000000000000
 Weight for year 2002-->    1.000000000000000
 Weight for year 2003-->    1.000000000000000
Enter new weights for specified years and ages if needed
 Enter year, age, new weight or -1,-1,-1 to end.  -1 -1   -1.000000000000000
 Is the last age of FLT01: West Scotland Summer Acoustic Sur a plus-group (Y-->y
You must choose a catchability model for each index.

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

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

 Model for FLT01: West Scotland Summer Acoustic Sur  is to be A/L/P ?-->L
 Fit a stock-recruit relationship (Y/N) ?-->n
 Enter lowest feasible F-->   2.0000000000000000E-02
 Enter highest feasible F-->    0.500000000000000
```

Table 5.6.1 Herring in VIa(N). ICA run log . Continued.

```
Mapping the F-dimension of the SSQ surface

    F                  SSQ
+--------+------------------
    0.02        15.6659436219
    0.05        11.8789224064
    0.07        10.4219123183
    0.10         9.9198643365
    0.12         9.8378049223
    0.15         9.9549006760
    0.17        10.1717329012
    0.20        10.4402452989
    0.22        10.7359747620
    0.25        11.0461803466
    0.27        11.3643032143
    0.30        11.6872930546
    0.32        12.0142245103
    0.35        12.3458302683
    0.37        12.6842844183
    0.40        13.0332768559
    0.42        13.3990345017
    0.45        13.7920375972
    0.47        14.2321575256
    0.50        14.7134770947
Lowest SSQ is for F =     0.116
-----------------------------------------------------------------
No of years for separable analysis : 8
Age range in the analysis : 1  . . . 9
Year range in the analysis : 1957  . . . 2003
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 38
Number of observations : 181

Conventional single selection vector model to be fitted.

-----------------------------------------------------------------
 Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 1-->    0.100000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 2-->    1.000000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 3-->    1.000000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 4-->    1.000000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 5-->    1.000000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 6-->    1.000000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 7-->    1.000000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 8-->    1.000000000000000
 Enter weight for FLT01: West Scotland Summer Acoustic Sur  at age 9-->    1.000000000000000
Enter estimates of the extent to which errors
in the age-structured indices are correlated
across ages. This can be in the range 0 (independence)
to 1 (correlated errors).
  Enter value for FLT01: West Scotland Summer Acoustic Sur-->    1.000000000000000
 Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.

Aged index weights
FLT01: West Scotland Summer Acoustic Sur
 Age   :       1     2     3     4     5     6     7     8     9
 Wts :     0.011 0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111
F in 2003  at age 4  is 0.166464  in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->D
 Output page width in characters (e.g. 80..132) ?--> 132
 Estimate historical assessment uncertainty ?-->y
 Sample from Covariances or Bayes MCMC (C/B) ?-->c
 Use default percentiles (Y/N)  ?-->y
 How many samples to take  ?--> 1000
 Enter SSB reference level (e.g. MBAL, Bpa..) [t]-->  0.0000000000000000E+000
Succesful exit from ICA
```

Table 5.6.2 Herring in VIa(N). Catch number-at-age (millions). N.B. In this table "age" refers to number of rings (winter rings in the otolith.

Output Generated by ICA Version 1.4

Herring VIa (north) (run: ICAPGF08/I08)

Catch in Number

AGE	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

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

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). Catch number-at-age (millions). Continued

Catch in Number

AGE	2002	2003
1	1.14	0.05
2	35.41	32.71
3	90.20	48.45
4	9.51	56.63
5	19.92	7.99
6	29.29	4.67
7	9.63	13.53
8	1.29	10.38
9	1.20	1.33

x 10 ^ 6

Table 5.6.3. Herring in VIa(N). Weight in the catch (kg). N.B. In this table "age" refers to number of rings (winter rings in the otolith.

Weights-at-age in the catches (Kg)

AGE	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

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). 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

AGE	2002	2003
1	0.10660	0.07200
2	0.14620	0.14290
3	0.15940	0.15780
4	0.17090	0.16650
5	0.15640	0.18300
6	0.17250	0.19580
7	0.18200	0.19270
8	0.24510	0.18450
9	0.27710	0.29010

Table 5.6.4. Herring in VIa(N). Weight in the stock (kg). N.B. In this table "age" refers to number of rings (winter rings in the otolith.

Weights-at-age in the stock (Kg)

AGE	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). Weight in the stock (kg). 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

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

AGE	2002	2003
1	0.06200	0.06400
2	0.15300	0.13800
3	0.17700	0.17600
4	0.19800	0.19000
5	0.21200	0.20400
6	0.21500	0.21300
7	0.22500	0.21700
8	0.24300	0.22300
9	0.25900	0.22800

Table 5.6.5 Herring in VIa(N). Natural mortality. N.B. In this table “age” refers to number of rings (winter rings in the otolith.

Natural Mortality (per year)

AGE	1957	1958	1959	1960	1961	-----	2000	2001	2002	2003
1	1.0000	1.0000	1.0000	1.0000	1.0000	-----	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	-----	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	-----	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	-----	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	-----	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	-----	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	-----	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	-----	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	-----	0.1000	0.1000	0.1000	0.1000

Table 5.6.6. Herring in VIa(N). Proportion mature. N.B. In this table “age” refers to number of rings (winter rings in the otolith.

Proportion of fish spawning

AGE	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). 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
1	0.0000	0.0000
2	0.9200	0.7600
3	1.0000	1.0000
4	1.0000	1.0000
5	1.0000	1.0000
6	1.0000	1.0000
7	1.0000	1.0000
8	1.0000	1.0000
9	1.0000	1.0000

Table 5.6.7 Herring in VIa(N). Tuning indices. N.B. In this table “age” refers to number of rings (winter rings in the otolith.

AGE-STRUCTURED INDICES

AGE	1987	1988	1989	1990	1991	1992	1993	1994	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). Tuning indices. Continued

AGE	2002	2003
1	424.7	438.8
2	436.0	1039.4
3	1436.9	932.5
4	199.8	1471.8
5	161.7	181.3
6	424.3	129.2
7	152.3	346.7
8	67.5	114.3
9	59.5	75.2

x 10 ^ 3

Table 5.6.8 Herring in VIa(N). Weighting factors for the catch in numbers. N.B. In this table "age" refers to number of rings (winter rings in the otolith.

Weighting factors for the catches in number

AGE	1996	1997	1998	1999	2000	2001	2002	2003
1	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 5.6.9 Herring in VIa(N). Predicted catch in number. N.B. In this table "age" refers to number of rings (winter rings in the otolith.

Predicted Catch in Number

AGE	1996	1997	1998	1999	2000	2001	2002	2003
1	1.51	5.37	1.69	0.85	3.78	1.45	1.35	0.08
2	26.01	78.00	117.10	25.86	18.12	83.36	36.38	33.43
3	25.72	50.36	59.16	64.17	20.97	15.43	81.85	35.27
4	11.30	35.20	25.98	22.14	36.43	12.58	10.71	56.08
5	8.39	20.32	24.09	13.08	16.90	29.42	11.75	9.88
6	4.08	11.43	10.22	8.93	7.49	10.27	20.75	8.18
7	4.77	6.47	6.75	4.49	6.04	5.39	8.57	17.10
8	7.81	5.07	2.50	1.90	1.96	2.81	2.91	4.57

x 10 ^ 6

Table 5.6.10 Herring in VIa(N). Fishing mortality (per year). N.B. In this table "age" refers to number of rings (winter rings in the otolith.

Fishing Mortality (per year)

AGE	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	0.0089	0.0110	0.0384	0.0086	0.0158	0.0367	0.0086	0.0430	0.0610	0.3608	0.1384	0.0879	0.0200	0.1148	0.0348
2	0.0955	0.0890	0.1007	0.1620	0.2456	0.2522	0.1118	0.1279	0.0675	0.2346	0.1221	0.1452	0.0804	0.1116	0.4154
3	0.3056	0.2886	0.1465	0.1289	0.1471	0.1948	0.2396	0.1467	0.1430	0.1647	0.1614	0.1370	0.1663	0.3481	0.9810
4	0.2006	0.3290	0.3741	0.1264	0.0922	0.2255	0.1433	0.1715	0.1694	0.1898	0.2626	0.1607	0.2104	0.3965	0.8586
5	0.2778	0.2708	0.3215	0.2367	0.1590	0.1541	0.1839	0.1105	0.1894	0.1515	0.1624	0.1339	0.2950	0.3675	0.6713
6	0.2739	0.3391	0.2734	0.2176	0.0780	0.1830	0.1151	0.1432	0.0951	0.2234	0.1412	0.1245	0.2714	0.2953	0.6003
7	0.1657	0.3630	0.3209	0.2325	0.1319	0.1915	0.1028	0.1009	0.1752	0.1276	0.1844	0.0924	0.3084	0.4367	0.5291
8	0.2002	0.2496	0.2295	0.1700	0.1447	0.1974	0.1416	0.1291	0.1269	0.1800	0.1621	0.1293	0.1953	0.2914	0.6354
9	0.2002	0.2496	0.2295	0.1700	0.1447	0.1974	0.1416	0.1291	0.1269	0.1800	0.1621	0.1293	0.1953	0.2914	0.6354

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.3665	0.0777	0.3341	0.1366	0.1911	0.0909	0.0393	0.0003	0.0048	0.0354	0.0274	0.0434	0.0030	0.0544	0.0607
2	0.2357	0.5018	0.4944	0.7352	0.7637	0.3448	0.2896	0.0005	0.0007	0.3188	0.6552	0.3870	0.2265	0.2059	0.5423
3	0.4269	0.5855	0.7706	0.8801	1.2074	0.5910	0.2606	0.0007	0.0004	0.4284	0.5915	0.5881	0.4942	0.2975	0.4571
4	0.2986	0.6273	0.9065	0.8509	1.0730	0.9195	0.5112	0.0003	0.0006	0.3934	0.8017	0.4823	0.4364	0.2989	0.3906
5	0.4049	0.5912	0.9249	0.8947	0.8827	0.9279	0.7322	0.0002	0.0002	0.3002	0.7058	0.9597	0.4309	0.3053	0.5454
6	0.3113	0.5999	1.1987	0.9775	1.0421	1.4110	1.0271	0.0014	0.0002	0.3011	0.5519	0.7539	0.6480	0.3070	0.6267
7	0.4595	0.3372	0.8545	1.0062	1.0591	0.8189	0.8955	0.0021	0.0015	0.2970	0.4366	0.7074	0.5517	0.9439	0.1679
8	0.3268	0.5197	0.7851	0.8335	0.9434	0.7491	0.5448	0.0008	0.0006	0.3272	0.6064	0.5848	0.4201	0.3442	0.4462
9	0.3268	0.5197	0.7851	0.8335	0.9434	0.7491	0.5448	0.0008	0.0006	0.3272	0.6064	0.5848	0.4201	0.3442	0.4462

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.0145	0.0029	0.0115	0.0515	0.1183	0.0107	0.0486	0.0031	0.0006	0.0024	0.0053	0.0049	0.0030	0.0026	0.0023
2	0.2780	0.1957	0.1343	0.1639	0.1854	0.2642	0.4815	0.2281	0.3507	0.1273	0.2806	0.2597	0.1606	0.1371	0.1200
3	0.3201	0.3031	0.2946	0.2296	0.1528	0.3334	0.3533	0.4116	0.3206	0.1864	0.4110	0.3803	0.2353	0.2008	0.1758
4	0.2905	0.3218	0.2074	0.3160	0.2333	0.1994	0.2275	0.1732	0.3779	0.1792	0.3950	0.3655	0.2261	0.1930	0.1689
5	0.2523	0.2613	0.3110	0.4406	0.2327	0.2542	0.1467	0.2122	0.2069	0.2235	0.4927	0.4560	0.2821	0.2408	0.2108
6	0.4448	0.1994	0.1357	0.3512	0.3745	0.3028	0.2447	0.1128	0.1600	0.2143	0.4724	0.4371	0.2704	0.2308	0.2020
7	0.4965	0.2734	0.1373	0.2343	0.3079	0.2690	0.2504	0.2455	0.1547	0.2454	0.5409	0.5006	0.3096	0.2644	0.2314
8	0.3210	0.2440	0.1904	0.2642	0.2276	0.2575	0.2916	0.2222	0.2654	0.1792	0.3950	0.3655	0.2261	0.1930	0.1689
9	0.3210	0.2440	0.1904	0.2642	0.2276	0.2575	0.2916	0.2222	0.2654	0.1792	0.3950	0.3655	0.2261	0.1930	0.1689

Table 5.6.10 Herring in VIa(N). Fishing mortality (per year). Continued.

Fishing Mortality (per year)

AGE	2002	2003
1	0.0023	0.0022
2	0.1200	0.1183
3	0.1757	0.1732
4	0.1689	0.1665
5	0.2107	0.2077
6	0.2019	0.1991
7	0.2313	0.2280
8	0.1689	0.1665
9	0.1689	0.1665

Table 5.6.11 Herring in VIa(N). Population abundance (1 January, millions). N.B. In this table "age" refers to number of rings (winter rings in the otolith.

Population Abundance (1 January)

AGE	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	1152.5	2251.5	2223.4	654.8	1322.4	2407.0	2176.4	993.3	7962.1	1073.7	2516.2	4110.4	3001.5	3442.8	9584.0
2	945.8	420.2	819.2	787.1	238.8	478.9	853.6	793.8	350.0	2755.7	275.3	806.0	1384.9	1082.3	1129.2
3	242.1	636.9	284.8	548.8	495.9	138.4	275.7	565.4	517.5	242.4	1614.5	180.5	516.4	946.7	717.1
4	148.7	146.0	390.7	201.4	394.9	350.5	93.2	177.6	399.8	367.2	168.3	1124.8	128.9	358.0	547.2
5	146.9	110.1	95.1	243.2	160.6	325.9	253.1	73.1	135.4	305.4	274.8	117.1	866.7	94.5	217.9
6	87.0	100.7	76.0	62.4	173.7	123.9	252.7	190.6	59.2	101.4	237.5	211.4	92.7	583.8	59.2
7	61.0	59.9	64.9	52.3	45.4	145.3	93.4	203.8	149.4	48.7	73.4	186.6	168.9	63.9	393.2
8	8.2	46.8	37.7	42.6	37.5	36.0	108.6	76.3	166.7	113.5	38.8	55.2	153.9	112.3	37.4
9	25.6	34.0	44.0	31.0	20.1	41.5	48.4	130.9	172.1	172.5	181.0	93.6	155.0	99.9	71.1

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	2677.4	1076.1	1675.3	2118.3	618.2	629.7	921.7	1219.4	895.7	1668.2	776.6	3043.0	1161.6	1213.6	902.3
2	3405.2	682.7	366.3	441.3	679.8	187.9	211.5	326.0	448.5	327.9	592.4	278.0	1072.0	426.1	422.8
3	552.1	1992.8	306.2	165.5	156.7	234.6	98.6	117.3	241.4	332.0	176.6	227.9	139.8	633.2	256.9
4	220.1	295.0	908.5	116.0	56.2	38.4	106.4	62.2	96.0	197.6	177.1	80.0	103.6	69.8	385.0
5	209.8	147.8	142.5	332.0	44.8	17.4	13.8	57.7	56.3	86.8	120.6	71.9	44.7	60.6	46.9
6	100.8	126.6	74.0	51.1	122.8	16.8	6.2	6.0	52.2	50.9	58.2	53.9	24.9	26.3	40.4
7	29.4	66.8	62.9	20.2	17.4	39.2	3.7	2.0	5.4	47.2	34.1	30.3	22.9	11.8	17.5
8	209.6	16.8	43.1	24.2	6.7	5.5	15.6	1.4	1.8	4.9	31.8	19.9	13.5	12.0	4.2
9	62.5	83.2	40.4	25.3	20.5	2.9	3.8	10.2	10.5	5.0	9.3	20.0	6.0	7.9	5.7

x 10 ^ 6

Table 5.6.11 Herring in VIa(N). 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	2133.4	919.8	856.9	448.5	370.8	783.5	588.6	869.3	682.9	998.4	1609.0	548.8	444.6	2317.9	1011.8
2	312.4	773.5	337.4	311.6	156.7	121.2	285.2	206.3	318.8	251.1	366.4	588.8	200.9	163.1	850.5
3	182.1	175.2	471.2	218.5	196.0	96.5	68.9	130.5	121.6	166.3	163.8	205.0	336.4	126.8	105.3
4	133.2	108.3	106.0	287.3	142.2	137.7	56.6	39.6	70.8	72.3	113.0	88.9	114.8	217.7	84.9
5	235.7	90.1	71.0	77.9	189.5	101.9	102.1	40.8	30.2	43.9	54.7	68.9	55.8	82.8	162.4
6	24.6	165.7	62.8	47.1	45.4	135.9	71.5	79.8	29.8	22.2	31.8	30.2	39.5	38.1	58.9
7	19.5	14.3	122.8	49.6	30.0	28.2	90.8	50.7	64.5	23.0	16.2	17.9	17.7	27.3	27.4
8	13.4	10.8	9.8	96.9	35.5	19.9	19.5	64.0	35.9	50.0	16.3	8.5	9.8	11.7	18.9
9	22.8	11.4	21.2	24.9	23.0	25.5	15.5	53.7	44.0	199.0	31.7	11.4	5.6	3.4	6.9

x 10 ^ 6

Population Abundance (1 January)

AGE	2002	2003	2004
1	942.3	53.8	906.3
2	371.4	345.9	19.8
3	558.8	244.0	227.6
4	72.3	383.8	168.0
5	64.9	55.3	294.0
6	119.0	47.6	40.6
7	43.5	88.0	35.3
8	19.6	31.3	63.4
9	8.1	9.1	30.9

x 10 ^ 6

Table 5.6.12 Herring in VIa(N). Predicted index values. N.B. In this table "age" refers to number of rings (winter rings in the otolith.

Predicted Age-Structured Index Values

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	692.8	*******	*******	*******	113.8	255.0	187.6	284.0	223.5	326.4	*******	179.2	145.3	757.6	330.8
2	631.5	*******	*******	*******	333.2	246.9	516.0	428.5	619.4	551.1	*******	1202.3	433.0	356.0	1874.1
3	593.0	*******	*******	*******	699.0	311.8	220.4	404.3	396.0	582.4	*******	646.0	1147.2	440.4	371.0
4	507.1	*******	*******	*******	558.7	551.1	223.0	160.9	257.1	292.5	*******	325.0	452.6	874.3	345.4
5	860.7	*******	*******	*******	699.5	371.7	394.8	152.2	112.9	162.9	*******	225.1	200.5	304.3	606.6
6	83.2	*******	*******	*******	159.7	497.3	270.1	323.7	118.0	85.2	*******	102.8	147.1	145.0	227.7
7	63.4	*******	*******	*******	107.8	103.7	337.2	188.5	252.1	85.6	*******	58.0	63.5	100.5	102.6
8	39.5	*******	*******	*******	110.3	60.9	58.6	199.4	109.1	159.4	*******	24.6	30.6	37.1	60.8
9	77.1	*******	*******	*******	81.6	89.0	53.2	191.5	153.3	726.1	*******	37.5	20.1	12.5	25.1

AGE	2002	2003
1	308.1	17.6
2	818.4	762.8
3	1968.4	860.7
4	294.3	1563.8
5	242.3	206.8
6	460.1	184.1
7	163.3	330.6
8	63.0	100.4
9	29.8	33.4

x 10 ^ 3

Table 5.6.13 Herring in VIa(N). Fitted selection pattern. N.B. In this table "age" refers to number of rings (winter rings in the otolith.

Fitted Selection Pattern

AGE	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	0.0446	0.0335	0.1026	0.0683	0.1709	0.1629	0.0601	0.2509	0.3602	1.9012	0.5272	0.5471	0.0952	0.2895	0.0405
2	0.4762	0.2705	0.2692	1.2817	2.6635	1.1186	0.7806	0.7457	0.3983	1.2364	0.4648	0.9034	0.3819	0.2814	0.4839
3	1.5236	0.8771	0.3917	1.0200	1.5952	0.8642	1.6726	0.8550	0.8441	0.8679	0.6147	0.8525	0.7904	0.8779	1.1426
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	1.3846	0.8230	0.8595	1.8728	1.7251	0.6836	1.2833	0.6440	1.1180	0.7984	0.6183	0.8335	1.4022	0.9269	0.7819
6	1.3651	1.0306	0.7308	1.7217	0.8463	0.8118	0.8032	0.8349	0.5616	1.1769	0.5378	0.7750	1.2897	0.7446	0.6993
7	0.8261	1.1033	0.8579	1.8397	1.4307	0.8491	0.7173	0.5884	1.0344	0.6725	0.7021	0.5748	1.4658	1.1014	0.6163
8	0.9982	0.7585	0.6136	1.3448	1.5695	0.8753	0.9884	0.7526	0.7488	0.9483	0.6172	0.8045	0.9283	0.7350	0.7401
9	0.9982	0.7585	0.6136	1.3448	1.5695	0.8753	0.9884	0.7526	0.7488	0.9483	0.6172	0.8045	0.9283	0.7350	0.7401

Table 5.6.13 Herring in VIa(N). Fitted selection pattern. Continued.

Fitted Selection Pattern

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	1.2275	0.1238	0.3685	0.1605	0.1781	0.0988	0.0769	0.9983	8.5282	0.0899	0.0342	0.0899	0.0069	0.1820	0.1554
2	0.7896	0.7998	0.5453	0.8640	0.7118	0.3750	0.5665	1.5708	1.2895	0.8105	0.8173	0.8024	0.5190	0.6889	1.3881
3	1.4300	0.9334	0.8501	1.0343	1.1253	0.6428	0.5097	2.2569	0.7774	1.0891	0.7378	1.2194	1.1325	0.9953	1.1701
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	1.3562	0.9424	1.0202	1.0515	0.8227	1.0091	1.4322	0.7371	0.4347	0.7633	0.8804	1.9898	0.9874	1.0214	1.3963
6	1.0426	0.9562	1.3223	1.1488	0.9713	1.5346	2.0091	4.3514	0.3242	0.7653	0.6884	1.5630	1.4849	1.0271	1.6043
7	1.5389	0.5375	0.9426	1.1826	0.9871	0.8906	1.7516	6.5019	2.7678	0.7551	0.5446	1.4667	1.2642	3.1581	0.4298
8	1.0947	0.8284	0.8661	0.9795	0.8793	0.8147	1.0657	2.3929	1.0338	0.8318	0.7564	1.2124	0.9625	1.1516	1.1422
9	1.0947	0.8284	0.8661	0.9795	0.8793	0.8147	1.0657	2.3929	1.0338	0.8318	0.7564	1.2124	0.9625	1.1516	1.1422

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.0500	0.0091	0.0556	0.1630	0.5069	0.0534	0.2136	0.0182	0.0016	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134
2	0.9570	0.6083	0.6476	0.5186	0.7946	1.3246	2.1162	1.3173	0.9280	0.7105	0.7105	0.7105	0.7105	0.7105	0.7105
3	1.1021	0.9419	1.4202	0.7264	0.6549	1.6718	1.5529	2.3771	0.8483	1.0405	1.0405	1.0405	1.0405	1.0405	1.0405
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	0.8684	0.8120	1.4994	1.3942	0.9975	1.2749	0.6446	1.2256	0.5476	1.2475	1.2475	1.2475	1.2475	1.2475	1.2475
6	1.5311	0.6197	0.6540	1.1112	1.6056	1.5183	1.0755	0.6511	0.4235	1.1959	1.1959	1.1959	1.1959	1.1959	1.1959
7	1.7092	0.8496	0.6618	0.7413	1.3200	1.3488	1.1003	1.4178	0.4094	1.3695	1.3695	1.3695	1.3695	1.3695	1.3695
8	1.1051	0.7585	0.9181	0.8360	0.9756	1.2913	1.2818	1.2835	0.7023	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.1051	0.7585	0.9181	0.8360	0.9756	1.2913	1.2818	1.2835	0.7023	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	2002	2003
1	0.0134	0.0134
2	0.7105	0.7105
3	1.0405	1.0405
4	1.0000	1.0000
5	1.2475	1.2475
6	1.1959	1.1959
7	1.3695	1.3695
8	1.0000	1.0000
9	1.0000	1.0000

Table 5.6.14. Herring in VIa(N). Stock summary. N.B. In this table "age" refers to number of rings (winter rings in the otolith.

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 6	SoP (%)
1957	1152530	427355	196842	43438	0.2207	0.2645	137
1958	2251540	528462	216630	59669	0.2754	0.3069	133
1959	2223370	566980	233491	65221	0.2793	0.2789	137
1960	654760	458633	270579	63759	0.2356	0.1774	176
1961	1322380	464293	270500	46353	0.1714	0.1191	171
1962	2407040	576316	259957	58195	0.2239	0.1894	129
1963	2176430	608327	284538	49030	0.1723	0.1705	143
1964	993320	555907	332476	64234	0.1932	0.1430	173
1965	7962130	1156651	339728	68669	0.2021	0.1492	116
1966	1073650	878671	450305	100619	0.2234	0.1824	98
1967	2516170	856293	479560	90400	0.1885	0.1819	123
1968	4110430	974153	453705	84614	0.1865	0.1390	125
1969	3001500	1001481	491474	107170	0.2181	0.2358	132
1970	3442830	1013911	454604	165930	0.3650	0.3519	136
1971	9583960	1525208	324038	207167	0.6393	0.7778	98
1972	2677410	1124788	451388	164756	0.3650	0.3604	97
1973	1076070	806359	389325	210270	0.5401	0.6010	95
1974	1675310	579562	206815	178160	0.8614	0.9502	88
1975	2118340	438157	109066	114001	1.0452	0.9008	98
1976	618220	267075	75357	93642	1.2426	1.0513	100
1977	629660	166172	53961	41341	0.7661	0.9624	109
1978	921710	174194	50872	22156	0.4355	0.6328	99
1979	1219410	221696	77260	60	0.0008	0.0007	99
1980	895690	258684	127196	306	0.0024	0.0004	99
1981	1668220	368146	134393	51420	0.3826	0.3558	103
1982	776570	309411	112411	92360	0.8216	0.6627	96
1983	3043000	435800	83855	63523	0.7575	0.6960	97
1984	1161620	362153	123944	56012	0.4519	0.5024	105
1985	1213590	357159	153441	39142	0.2551	0.3022	99
1986	902250	322703	139529	70764	0.5072	0.5050	95
1987	2133350	391627	130592	44360	0.3397	0.3269	102
1988	919780	345150	155254	35591	0.2292	0.2714	97
1989	856940	328963	172293	34026	0.1975	0.2372	98
1990	448500	281047	163200	44693	0.2739	0.3343	101
1991	370820	215025	132550	28529	0.2152	0.2483	93
1992	783520	221938	108367	28985	0.2675	0.2725	99
1993	588620	187745	102042	31778	0.3114	0.2431	100
1994	869250	182909	92841	24430	0.2631	0.2274	100
1995	682930	163835	74131	29575	0.3990	0.2664	99
1996	998350	209353	123659	26105	0.2111	0.2009	95
1997	1608960	238401	83490	35233	0.4220	0.4428	99
1998	548820	201325	105026	33353	0.3176	0.4098	100
1999	444580	156600	91256	29736	0.3258	0.2535	99
2000	2317910	261456	82189	23163	0.2818	0.2164	100
2001	1011820	265908	152367	24974	0.1639	0.1894	99
2002	942300	284494	173977	31787	0.1827	0.1893	99
2003	53830	216594	162217	28835	0.1778	0.1866	99

No of years for separable analysis : 8
Age range in the analysis : 1 . . . 9
Year range in the analysis : 1957 . . . 2003
Number of indices of SSB : 0
Number of age-structured indices : 1

Parameters to estimate : 38
Number of observations : 181

Conventional single selection vector model to be fitted.

Table 5.6.15**.** Herring in VIa(N). Parameter estimates. N.B. In this table “age” refers to number of rings (winter rings in the otolith.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1996	0.1792	15	0.1314	0.2444	0.1529	0.2100	0.1815
2	1997	0.3950	15	0.2943	0.5302	0.3399	0.4590	0.3995
3	1998	0.3655	15	0.2679	0.4987	0.3120	0.4283	0.3701
4	1999	0.2261	17	0.1608	0.3180	0.1900	0.2691	0.2296
5	2000	0.1930	18	0.1338	0.2785	0.1601	0.2327	0.1964
6	2001	0.1689	20	0.1133	0.2520	0.1378	0.2072	0.1725
7	2002	0.1689	22	0.1082	0.2637	0.1345	0.2120	0.1733
8	2003	0.1665	26	0.0993	0.2790	0.1279	0.2167	0.1723
Separable Model: Selection (S) by age								
9	1	0.0134	36	0.0066	0.0272	0.0093	0.0192	0.0143
10	2	0.7105	15	0.5257	0.9603	0.6093	0.8285	0.7189
11	3	1.0405	14	0.7865	1.3764	0.9020	1.2001	1.0511
	4	1.0000		Fixed : Reference Age				
12	5	1.2475	13	0.9664	1.6104	1.0951	1.4211	1.2582
13	6	1.1959	12	0.9392	1.5229	1.0572	1.3529	1.2050
14	7	1.3695	12	1.0780	1.7398	1.2121	1.5473	1.3797
	8	1.0000		Fixed : Last true age				
Separable model: Populations in year 2003								
15	1	53830	94	8365	346368	20821	139165	84514
16	2	345871	36	169768	704647	240565	497275	369436
17	3	244026	29	137247	433879	181936	327305	254775
18	4	383795	26	229041	643111	294930	499437	397340
19	5	55274	24	34197	89341	43264	70618	56958
20	6	47549	24	29654	76243	37370	60501	48949
21	7	88001	23	55170	140368	69347	111673	90534
22	8	31265	24	19327	50577	24462	39961	32221
Separable model: Populations at age								
23	1996	49978	30	27693	90196	36980	67546	52298
24	1997	16287	23	10293	25772	12887	20584	16740
25	1998	8538	21	5570	13087	6866	10617	8743
26	1999	9830	21	6437	15013	7920	12201	10063
27	2000	11725	21	7684	17890	9451	14546	12000
28	2001	18945	21	12390	28969	15254	23528	19395
29	2002	19641	22	12679	30425	15711	24555	20137

Age-structured index catchabilities

FLT01: West Scotland Summer Acoustic Su

Linear model fitted. Slopes at age :

30	1	Q	.5645	75	.2738	5.258	.5645	2.550	1.594
31	2	Q	2.770	24	2.180	5.797	2.770	4.562	3.667
32	3	Q	4.323	24	3.409	8.994	4.323	7.092	5.709
33	4	Q	4.711	24	3.718	9.778	4.711	7.716	6.216
34	5	Q	4.424	24	3.491	9.189	4.424	7.250	5.839
35	6	Q	4.558	24	3.591	9.504	4.558	7.488	6.025
36	7	Q	4.492	25	3.529	9.456	4.492	7.428	5.962
37	8	Q	3.714	25	2.906	7.909	3.714	6.190	4.954
38	9	Q	4.249	25	3.340	8.924	4.249	7.015	5.634

Table 5.6.16 Herring in VIa(N). Residuals about the model fit. N.B. In this table "age" refers to number of rings (winter rings in the otolith.

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1996	1997	1998	1999	2000	2001	2002	2003
1	0.255	-1.504	1.680	2.195	0.176	-2.285	-0.162	-0.357
2	0.375	-0.335	-0.457	0.310	0.237	-0.014	-0.027	-0.022
3	0.184	-0.365	-0.537	0.381	0.040	-0.009	0.097	0.317
4	-0.204	-0.106	0.205	0.125	0.345	-0.281	-0.119	0.010
5	-0.111	0.129	-0.052	0.021	-0.086	-0.167	0.528	-0.213
6	-0.490	0.426	0.341	-0.170	0.184	-0.079	0.345	-0.561
7	-0.016	0.467	0.248	-0.322	-0.438	0.230	0.116	-0.235
8	0.079	0.027	0.124	-0.412	-0.067	0.520	-0.813	0.820

AGE-STRUCTURED INDEX RESIDUALS

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-1.023	*******	*******	*******	1.090	-1.233	-4.219	0.554	0.723	-2.069	*******	1.920	1.302	-0.526	-0.055
2	-0.088	*******	*******	*******	-0.124	0.712	0.374	0.235	0.561	0.045	*******	-0.414	-0.295	-0.118	-0.568
3	-0.073	*******	*******	*******	-0.757	-0.390	1.128	0.407	0.177	0.321	*******	0.032	0.191	-0.267	-0.533
4	-0.362	*******	*******	*******	-0.418	-0.759	1.075	0.574	0.560	0.118	*******	0.371	-0.047	0.028	-0.693
5	-0.134	*******	*******	*******	-0.359	0.110	0.321	0.701	0.304	-0.535	*******	-0.229	0.429	0.257	-0.327
6	0.293	*******	*******	*******	0.099	-0.728	1.164	-0.188	0.460	-0.341	*******	-0.260	-0.059	0.535	-0.541
7	-0.276	*******	*******	*******	-0.088	0.019	-0.171	0.769	-0.399	-0.101	*******	-0.727	0.310	0.686	0.002
8	-0.911	*******	*******	*******	-0.206	-0.072	0.952	-0.138	0.774	-0.712	*******	-0.575	-0.102	0.940	-0.148
9	-2.474	*******	*******	*******	-0.341	-0.339	1.077	-0.373	0.273	-1.844	*******	-0.021	0.567	1.650	0.322

Age	2002	2003
1	0.321	3.216
2	-0.630	0.309
3	-0.315	0.080
4	-0.387	-0.061
5	-0.405	-0.132
6	-0.081	-0.354
7	-0.070	0.047
8	0.069	0.129
9	0.691	0.810

Table 5.6.17 Herring in VIa(N). Parameters of distributions. N.B. In this table "age" refers to number of rings (winter rings in the otolith.

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

 Separable model fitted from 1996  to 2003
 Variance                           0.2034
Skewness test stat.                -0.0613
Kurtosis test statistic            -0.1965
Partial chi-square                  0.8263
Significance in fit                 0.0000
Degrees of freedom                      35

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

DISTRIBUTION STATISTICS FOR FLT01: West Scotland Summer Acoustic Su

Linear catchability relationship assumed

Age                          1         2         3         4         5         6         7         8         9
Variance                0.0396    0.0197    0.0259    0.0321    0.0159    0.0290    0.0183    0.0387    0.1427
Skewness test stat.    -0.8088    0.1695    0.9667    0.5839    0.4346    1.1537    0.6328    0.5194   -1.2897
Kurtosis test statisti  0.2183   -0.7585    0.3602   -0.4641   -0.7912    0.1140   -0.0233   -0.5523    0.1537
Partial chi-square      0.0412    0.0178    0.0243    0.0306    0.0156    0.0281    0.0190    0.0424    0.1535
Significance in fit     0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
Number of observations      13        13        13        13        13        13        13        13        13
Degrees of freedom          12        12        12        12        12        12        12        12        12
Weight in the analysis  0.0111    0.1111    0.1111    0.1111    0.1111    0.1111    0.1111    0.1111    0.1111
```

Table 5.6.18. Herring in VIa(N). Analysis of variance. N.B. In this table "age" refers to number of rings (winter rings in the otolith.

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ANALYSIS OF VARIANCE
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Unweighted Statistics
Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                    98.5416      181          38  143   0.6891
Catches-at-age                     20.9569       64          29   35   0.5988

 Aged Indices
FLT01: West Scotland Summer Acoustic S 77.5848     117           9  108   0.7184

Weighted Statistics
Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                     7.5530      181          38  143   0.0528
Catches-at-age                      7.1180       64          29   35   0.2034

 Aged Indices
FLT01: West Scotland Summer Acoustic S  0.4350     117           9  108   0.0040
```

Table 5.7.1. Herring in VIa(N). Input data for short-term predictions, numbers-at-age from the assessment with ages 1 and 2 replaced by geometric mean values - natural mortality (M), proportion mature (Mat), proportion of fishing mortality prior to spawning (PF), proportion of natural mortality prior to spawning (PM), mean weights-at-age in the stock (SWt), selection pattern (Sel), mean weights-at-age in the catch (CWt). All biological data are taken as mean of the last 3 years. VIa(N) herring appears to have considerable annual variability in mean weights and in fraction mature. Last years values are not applicable. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	927314	1	0	0.67	0.67	6.27E-02	2.25E-03	7.59E-02
2	339130	0.3	0.87	0.67	0.67	0.141	0.119423	0.1429
3	227650	0.2	0.996667	0.67	0.67	0.174333	0.174893	0.159967
4	168020	0.1	1	0.67	0.67	0.192667	0.168087	0.173333
5	294020	0.1	1	0.67	0.67	0.204667	0.209697	0.177133
6	40636	0.1	1	0.67	0.67	0.213333	0.20102	0.188
7	35259	0.1	1	0.67	0.67	0.220667	0.230197	0.193067
8	63396	0.1	1	0.67	0.67	0.234	0.168087	0.218
9	30926	0.1	1	0.67	0.67	0.247	0.168087	0.2795

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	927314	1	0	0.67	0.67	6.27E-02	2.25E-03	7.59E-02
2	.	0.3	0.87	0.67	0.67	0.141	0.119423	0.1429
3	.	0.2	0.996667	0.67	0.67	0.174333	0.174893	0.159967
4	.	0.1	1	0.67	0.67	0.192667	0.168087	0.173333
5	.	0.1	1	0.67	0.67	0.204667	0.209697	0.177133
6	.	0.1	1	0.67	0.67	0.213333	0.20102	0.188
7	.	0.1	1	0.67	0.67	0.220667	0.230197	0.193067
8	.	0.1	1	0.67	0.67	0.234	0.168087	0.218
9	.	0.1	1	0.67	0.67	0.247	0.168087	0.2795

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	927314	1	0	0.67	0.67	6.27E-02	2.25E-03	7.59E-02
2	.	0.3	0.87	0.67	0.67	0.141	0.119423	0.1429
3	.	0.2	0.996667	0.67	0.67	0.174333	0.174893	0.159967
4	.	0.1	1	0.67	0.67	0.192667	0.168087	0.173333
5	.	0.1	1	0.67	0.67	0.204667	0.209697	0.177133
6	.	0.1	1	0.67	0.67	0.213333	0.20102	0.188
7	.	0.1	1	0.67	0.67	0.220667	0.230197	0.193067
8	.	0.1	1	0.67	0.67	0.234	0.168087	0.218
9	.	0.1	1	0.67	0.67	0.247	0.168087	0.2795

Table 5.7.2 Herring in VIa(N). Short-term prediction single option table, status quo F. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Year:	2004	F multiplier:	1	Fbar:	0.1884				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0023	1318	100	927314	58112	0	0	0	0
2	0.1194	33079	4727	339130	47817	295043	41601	222763	31410
3	0.1749	33203	5311	227650	39687	226891	39555	176495	30769
4	0.1681	24773	4294	168020	32372	168020	32372	140396	27050
5	0.2097	53022	9392	294020	60176	294020	60176	238925	48900
6	0.201	7054	1326	40636	8669	40636	8669	33214	7086
7	0.2302	6913	1335	35259	7780	35259	7780	28261	6236
8	0.1681	9347	2038	63396	14835	63396	14835	52973	12396
9	0.1681	4560	1274	30926	7639	30926	7639	25841	6383
Total		173268	29797	2126351	277087	1154191	212627	918868	170229

Year:	2005	F multiplier:	1	Fbar:	0.1884				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0023	1318	100	927314	58112	0	0	0	0
2	0.1194	33201	4744	340373	47993	296124	41754	223579	31525
3	0.1749	32518	5202	222953	38868	222210	38739	172853	30134
4	0.1681	23071	3999	156478	30148	156478	30148	130751	25191
5	0.2097	23174	4105	128509	26301	128509	26301	104428	21373
6	0.201	37445	7040	215713	46019	215713	46019	176314	37614
7	0.2302	5896	1138	30073	6636	30073	6636	24105	5319
8	0.1681	3737	815	25344	5930	25344	5930	21177	4955
9	0.1681	10637	2973	72141	17819	72141	17819	60281	14889
Total		170996	30116	2118898	277826	1146592	213346	913488	171001

Year:	2006	F multiplier:	1	Fbar:	0.1884				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
1	0.0023	1318	100	927314	58112	0	0	0	0
2	0.1194	33201	4744	340373	47993	296124	41754	223579	31525
3	0.1749	32637	5221	223770	39011	223024	38881	173487	30245
4	0.1681	22595	3917	153249	29526	153249	29526	128054	24672
5	0.2097	21582	3823	119681	24495	119681	24495	97255	19905
6	0.201	16366	3077	94283	20114	94283	20114	77062	16440
7	0.2302	31298	6043	159642	35228	159642	35228	127958	28236
8	0.1681	3187	695	21616	5058	21616	5058	18062	4227
9	0.1681	10993	3073	74561	18416	74561	18416	62302	15389
Total		173178	30691	2114488	277951	1142180	213471	907758	170637

Table 5.7.3 Herring in VIa (N). Short-term prediction multiple option table, status quo F.

2004				
Biomass	SSB	FMult	FBar	Landings
277087	170229	1	0.1884	29797

2005					2006	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
277826	192275	0	0	0	310351	222344
.	190030	0.1	0.0188	3251	306845	216457
.	187812	0.2	0.0377	6446	303402	210741
.	185621	0.3	0.0565	9586	300019	205194
.	183455	0.4	0.0754	12673	296696	199808
.	181316	0.5	0.0942	15707	293431	194580
.	179203	0.6	0.1131	18689	290225	189505
.	177115	0.7	0.1319	21619	287074	184577
.	175052	0.8	0.1507	24500	283979	179793
.	173014	0.9	0.1696	27332	280939	175147
.	171001	1	0.1884	30116	277951	170637
.	169011	1.1	0.2073	32852	275017	166257
.	167046	1.2	0.2261	35541	272134	162003
.	165104	1.3	0.245	38185	269301	157873
.	163185	1.4	0.2638	40784	266518	153862
.	161289	1.5	0.2826	43338	263784	149966
.	159416	1.6	0.3015	45850	261098	146182
.	157566	1.7	0.3203	48319	258459	142507
.	155738	1.8	0.3392	50746	255866	138937
.	153931	1.9	0.358	53132	253318	135469
.	152146	2	0.3768	55477	250815	132100

Table 5.7.4 Herring in VIa (N). Medium-term Projection Input control data. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Age	Fleet Catch Ratio	Retention Ogive	Mean weight-at-age	Year	F*status quo* F multiplier	F*status quo*1.35* F multiplier	Catch of 40,000 t in 2005 onwards	CV on target F multiplier
1	1	1	0.076	2004	1.00	1.00	30,000	0.0001
2	1	1	0.143	2005	1.00	1.35	40,000	0.0001
3	1	1	0.160	2006	1.00	1.35	40,000	0.0001
4	1	1	0.173	2007	1.00	1.35	40,000	0.0001
5	1	1	0.177	2008	1.00	1.35	40,000	0.0001
6	1	1	0.188	2009	1.00	1.35	40,000	0.0001
7	1	1	0.193	2010	1.00	1.35	40,000	0.0001
8	1	1	0.218	2011	1.00	1.35	40,000	0.0001
9+	1	1	0.280	2012	1.00	1.35	40,000	0.0001
				2013	1.00	1.35	40,000	0.0001

Table 5.7.5 Herring in VIa (N). Medium-Term Projections control file

```
                         Medium-Term Projections
                         -----------------------

                                  ICP

                              K.R. Patterson
                         SOAEFD Marine Laboratory
                                Aberdeen



                    Written  December 1997 for ICA v1.4 w
                              Revision March 1999


 Enter Random-Number seed--> 120
 Enter the no. of years between spawning and  recruitment at age--> 1
 Change any of the populations (Y/N) ?-->y
 Enter Year, Age, new Population: -1,-1,-1 to finish  2003 1   9.27314000000000000E+05
 Enter Year, Age, new Population: -1,-1,-1 to finish  2003 2   3.39130000000000000E+05
 Enter Year, Age, new Population: -1,-1,-1 to finish  -1 -1   -1.000000000000000
  New parameters: index, new value (-1,-1 to finish)  -1   -1.000000000000000
 Enter the name of the projection file -->fmult.dat
 Could not access the file. Another name ? -->fmult.dat
Population parameters for the projections are set by taking a mean over a
number of the last years of the data set.
 Use mean natural mortality from 2003  back to--> 2001
 Use mean maturity ogive from 2003  back to--> 2001
 Use mean weight-at-age in the stock from 2003  back to--> 2001
 Enter the reference spawning stock size (e.g. MBAL, Bpa)-->   7.5000000000000000E+04
 Enter the maximum allowable F-multiplier-->   10.000000000000000
Choose type of stock recruit relation :
S -     Shepherd        R = a.SSB/(1+SSB/b)^c
B -  Beverton-Holt   R = a.SSB/(1+SSB/b)
R -  Ricker          R = a.SSB.exp(-b.SSB)
O -  Ockham          R = GM over observed SSB range
                            then linear to origin
N -     None            R = Historic Geometric Mean R
 Enter your choice (S/B/R/O/N) ?-->o
 Enter first year of data for stock-recruit model--> 1972
 Enter last year of data for stock-recruit model--> 2000
 Autocorrelated or Independent errors (I/A)-->i
 Use ICA or SRR (I/S) model value for recruitment in 2003-->i
 Use ICA or SRR (I/S) model value for recruitment in 2004-->i
 Use default percentiles (Y/N)  ?-->y
 Use ICA-derived resamples ?-->y
```

Table 5.10.1 HERRING from the Firth of Clyde. Catch in tonnes by country, 1955–2003. Spring and autumn-spawners combined.

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
All Catches																	
Total	4,050	4,848	5,915	4,926	10,530	15,680	10,848	3,989	7,073	14,509	15,096	9,807	7,929	9,433	10,594	7,763	4,088

Year	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
All Catches										
Total	4,226	4,715	4,061	3,664	4,139	4,847	3,862	1,951	2,081	2,135

Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Scotland	2,506	2,530	2,991	3,001	3,395	2,895	1,568	2,135	2,184	713	929	852
Other UK	-	273	247	22	-	-	-	-	-	-	-	1
Unallocated[1]	262	293	224	433	576	278	110	208	75	18	-	-
Discards	1,253	1,265	2,308[3]	1,344[3]	679[3]	439[4]	245[4]	-[2]	-[2]	-[2]	-[2]	-[2]
Agreed TAC			3,000	3,000	3,100	3,500	3,200	3,200	2,600	2,900	2,300	1,000
Total	4,021	4,361	5,770	4,800	4,650	3,612	1,923	2,343	2,259	731	929	853

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Scotland	608	392	598	371	779	16	1	78	46	88
Other UK	-	194	127	475	310	240	0	392	335	240
Unallocated[1]	-	-	-	-	-	-	-	-	-	-
Discards	-[2]	-[2]	-	-	-	-	-	-	-	-
Agreed TAC	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Total	608	586	725	846	1089	256	1	480	381	328

[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 5.10.2 HERRING from the Firth of Clyde. Sampling levels 1988-2003.

Year	Reported catch (tonnes)	No. of samples	No. of fish measured	No. of fish aged	Discards
1988	1,568	41	5,955	2,574	Based on local
1989	2,135	45	8,368	4,152	reports
1990	2,184	37	5,926	3,803	" "
1991	713	29	4,312	2,992	" "
1992	929	23	4,604	1,579	No information
1993	853	16	3,408	798	No information
1994	608	16	3,903	1,388	No information
1995	586	16	2,727	1,073	No information
1996	725	9	1,915	679	No information
1997	846	3	650	383	No information
1998	1089	3	462	196	No information
1999	256	3	251	126	
2000[1]	1	1	105	96	
2001	480	3	799	143	
2002	381	0	0	0	
2003	328	1	1,175	50	

[1] One sample collected in first quarter, but not applied to catch, which was taken in third quarter.

Table 5.10.3 HERRING from the Firth of Clyde. Catch in numbers-at-age. Spring- and autumn-spawners combined. Thousands of fish. N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Age(Rings)	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	5008	2207	1351	9139	53081	2694	6194	1041	14123	507	333
2	7551	6503	8983	5258	8841	1876	10480	7524	1796	4859	5633
3	10338	1976	3181	4548	2817	2483	913	6976	2259	807	1592
4	8745	4355	1684	1811	2559	1024	1049	1062	2724	930	567
5	2306	3432	3007	918	1140	1072	526	1112	634	888	341
6	741	1090	1114	1525	494	451	638	574	606	341	204
7	760	501	656	659	700	175	261	409	330	289	125
8	753	352	282	307	253	356	138	251	298	156	48
9	227	225	177	132	87	130	178	146	174	119	56
10+	117	181	132	114	59	67	100	192	236	154	68

Age(Rings)	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	312	220	314	4156	1639	678	508	0	845	716	42
2	2372	11311	10109	11829	2951	4574	1376	1062	1523	1004	615
3	2785	4079	5232	5774	4420	4431	3669	1724	9239	839	472
4	1622	2440	1747	3406	4592	4622	4379	2506	876	7533	703
5	1158	1028	963	1509	2806	2679	3400	2014	452	576	1908
6	433	663	555	587	2654	1847	1983	1319	252	359	169
7	486	145	415	489	917	644	1427	510	146	329	92
8	407	222	189	375	681	287	680	234	29	119	113
9	74	63	85	74	457	251	308	66	16	49	22
10+	18	53	38	80	240	79	175	16	5	16	9

Age(Rings)	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	145	3	399	118	494	275	323	123	0	0	-	0
2	411	418	964	1425	1962	2005	2731	418	3	1427	-	153
3	493	261	964	186	1189	429	1779	318	2	67	-	645
4	385	268	358	189	273	346	667	393	1	20	-	466
5	1947	1305	534	149	544	18	344	122	1	406	-	92
6	333	327	319	130	183	52	77	36	0	40	-	111
7	91	78	76	66	208	0	55	36	0	0	-	138
8	69	111	57	35	127	5	35	13	0	22	-	-
9	32	38	16	15	52	61	55	19	0	0	-	-
10+	10	0	17	1	9	*						

*change to 9+ in 1997.

Table 5.10.4 HERRING in the Firth of Clyde. Mean weights-at-age in the catch and stock (g). N.B. In this table "age" refers to number of rings (winter rings in the otolith).

Age	Weight in the catch																		
(rings)	1970-81	1982-85	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-	-	-	-	-	-	-	-	-	-	-	102	90	112	103	87	97	-	-	-
2	225	149	166	149	156	149	170	143	141	141	92	151	146	142	148	152	140	136	-	179
3	270	187	199	194	194	174	186	163	187	174	157	174	184	174	174	169	162	156	-	185
4	290	228	224	203	207	203	202	188	188	198	184	201	203	192	189	184	180	201	-	215
5	310	253	253	217	211	221	216	192	216	213	212	226	233	231	204	197	194	196	-	235
6	328	272	265	225	222	227	237	198	227	216	249	241	255	228	218	202	213	235	-	232
7	340	307	297	236	230	235	234	210	206	229	248	249	257	189	229	220	242	-	-	242
8	345	291	298	247	225	237	234	222	218	261	240	252	255	286	240	229	249	288	-	-
9	350	300	298	255	244	219	257	200	201	233	249	242	284	218	246	241	256	-	-	-
10+	350	300	321	258	230	254	272	203	221	254	294	270	239	*						

* change to 9+ in 1997

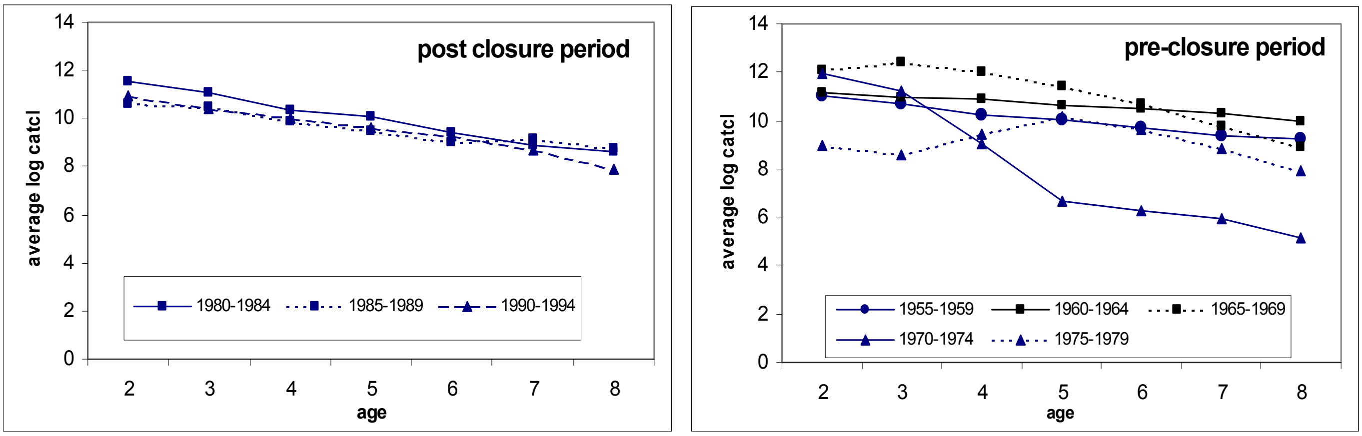


Figure 5.6.1 Herring in VIa (N). Log catch numbers-at-age, averaged over 5 year classes, to show depletion of year classes in the catches.

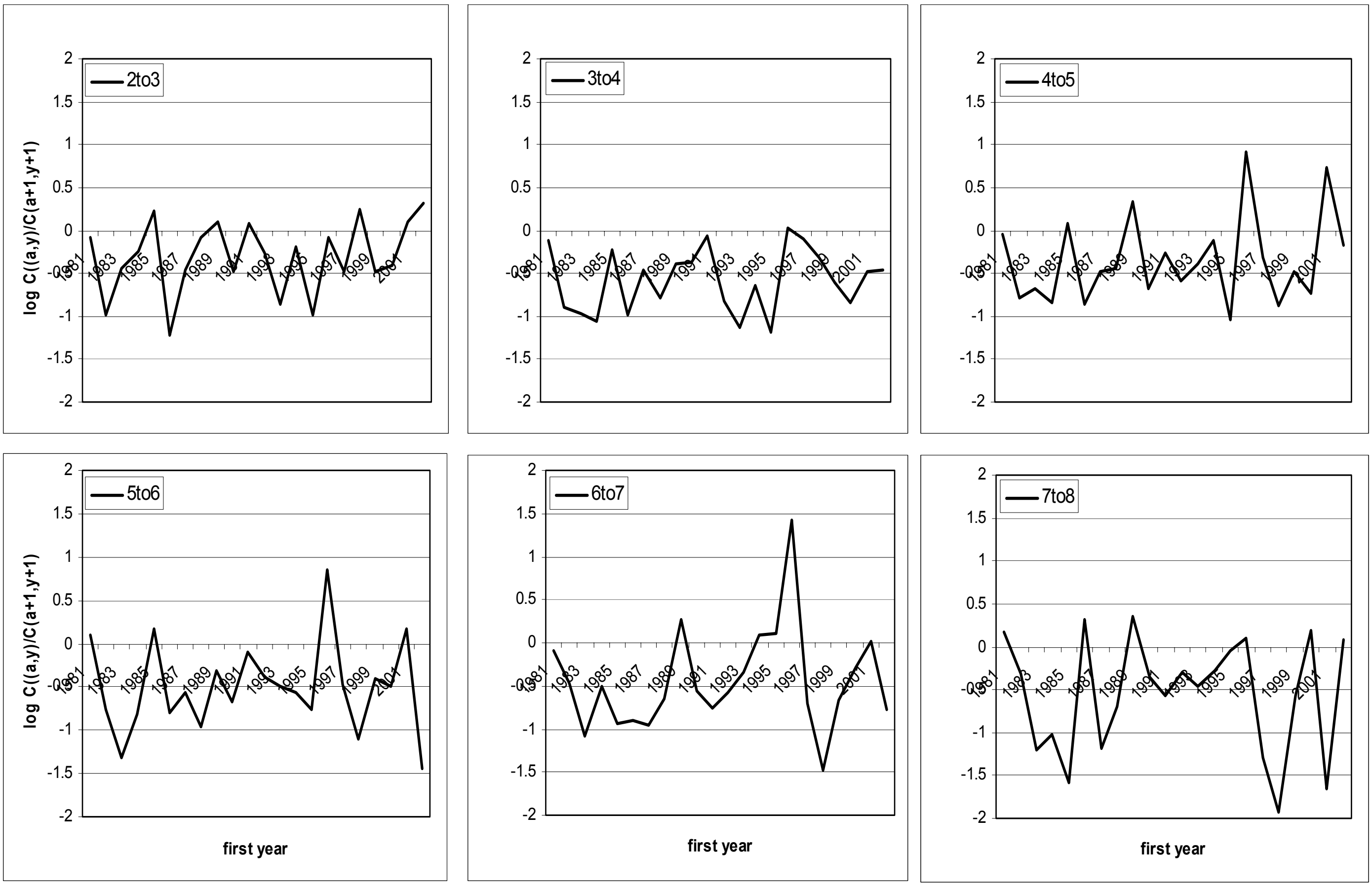


Figure 5.6.2 Herring in VIa (N). Log catch ratios (1981-2003), 8-year separable period, showing the noisy characteristic of the catch data, with no apparent trends or patterns in catch over all age classes.

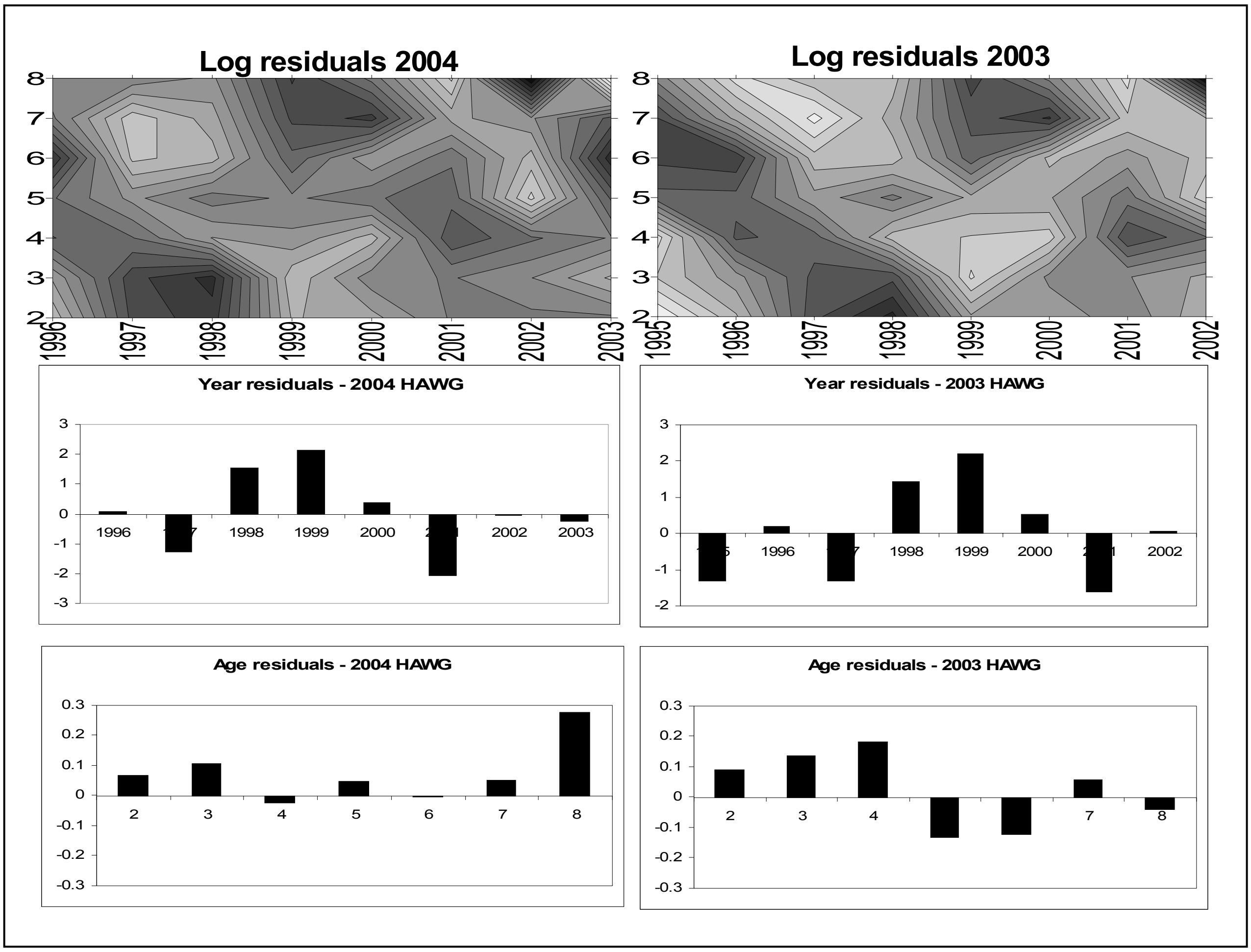


Figure 5.6.3 Herring in VIa (N). Residual plots for two assessments with data from 1957-2003 and 1976-2002 respectively to show the consistency in the year residuals and small differences in the low age residuals

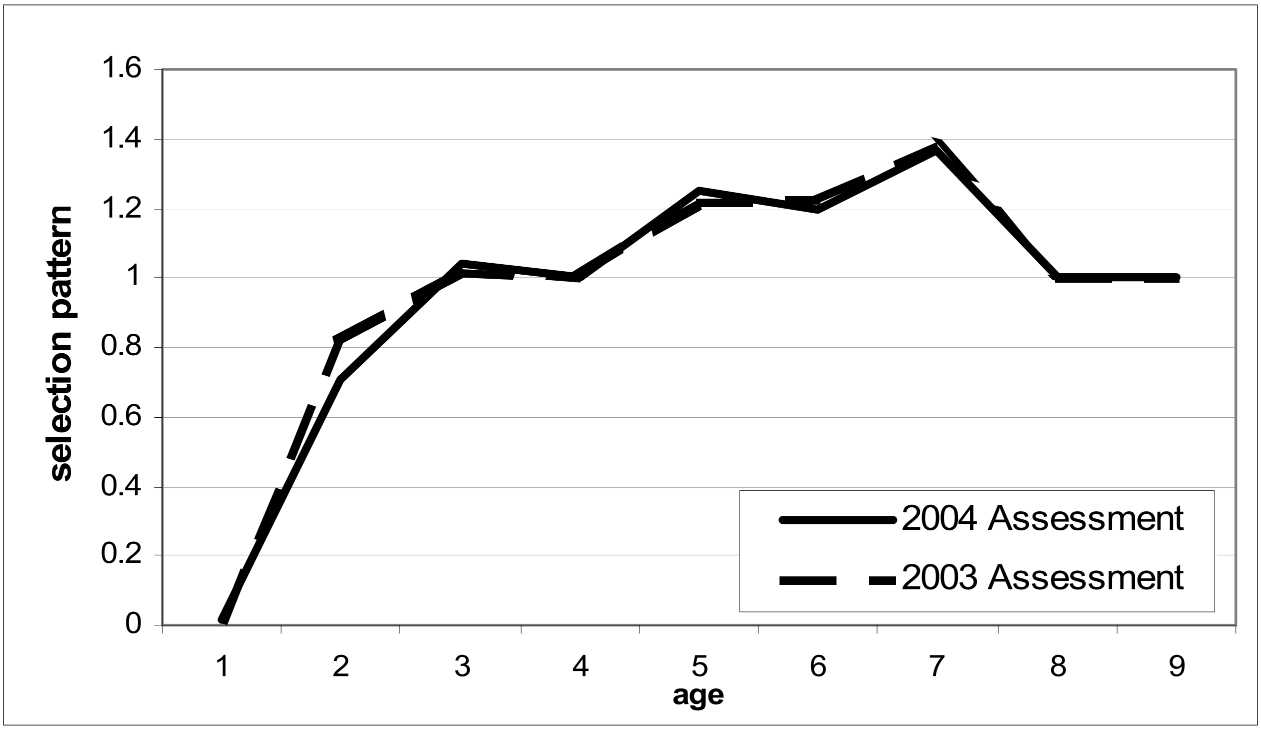


Figure 5.6.4 Herring in VIa (N). Plot to show the selection pattern in two assessments with data from 1957-2003 and 1976-2002 respectively to show the consistency in the selection pattern in the two assessments.

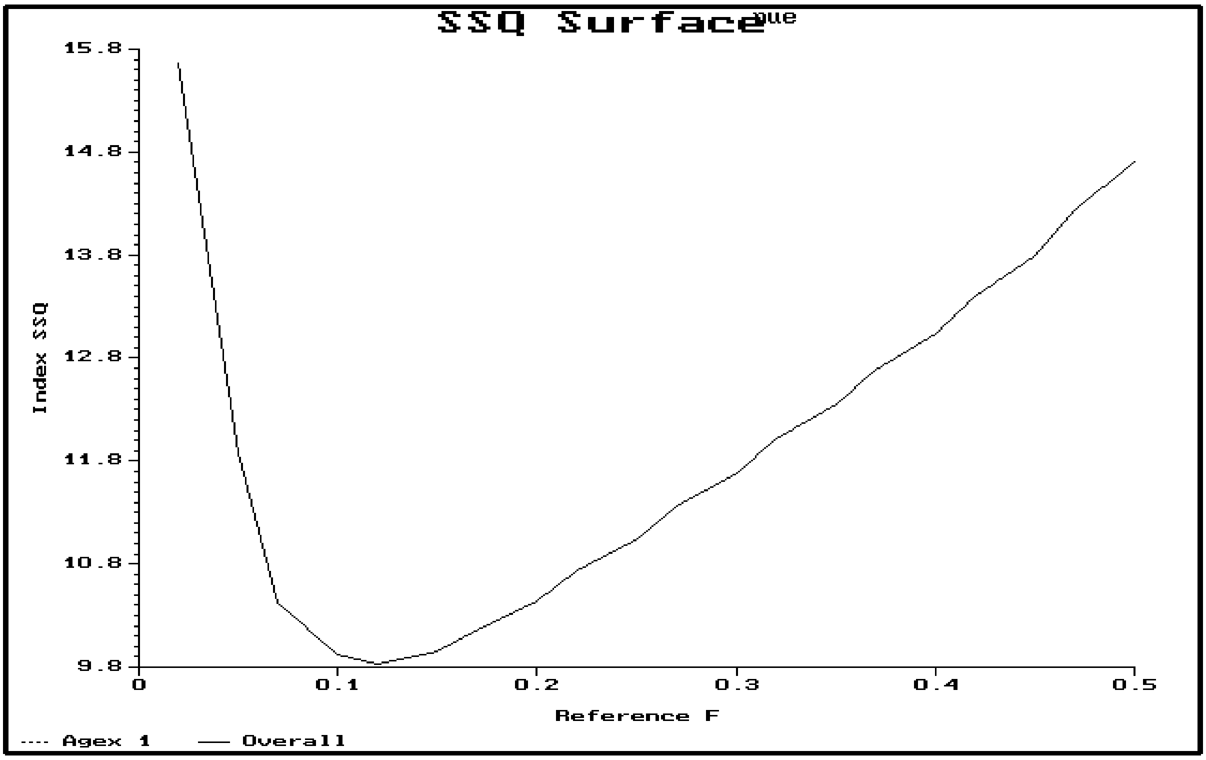


Figure 5.6.5 Herring in VIa (N). SSQ surface for the deterministic calculation of the 8-year separable period. Agex1- age disaggregated acoustic estimates.

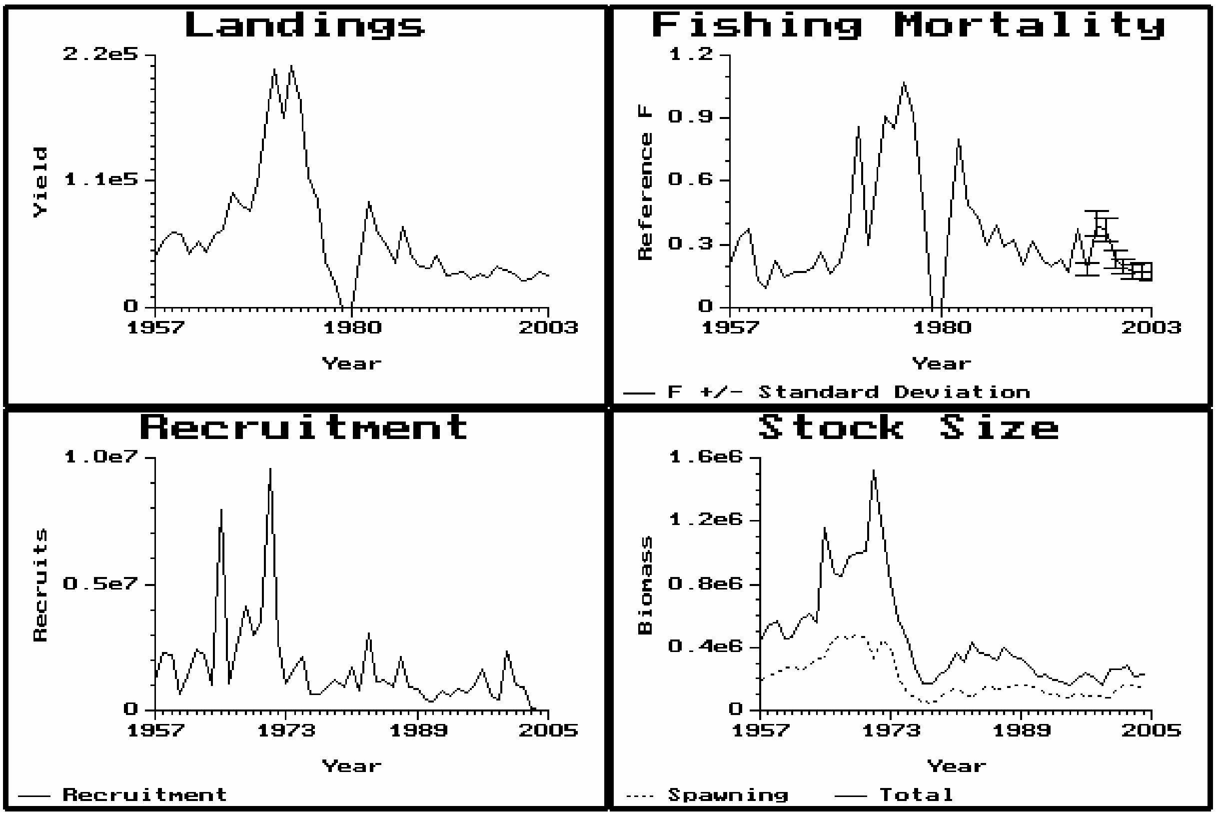


Figure 5.6.6 Herring in VIa (N). Illustration of stock trends from deterministic calculation (8-year separable period). Summary of estimates of landings, fishing mortality at 4-ring, recruitment at 1-ring, stock size on 1 January and spawning stock at spawning time.

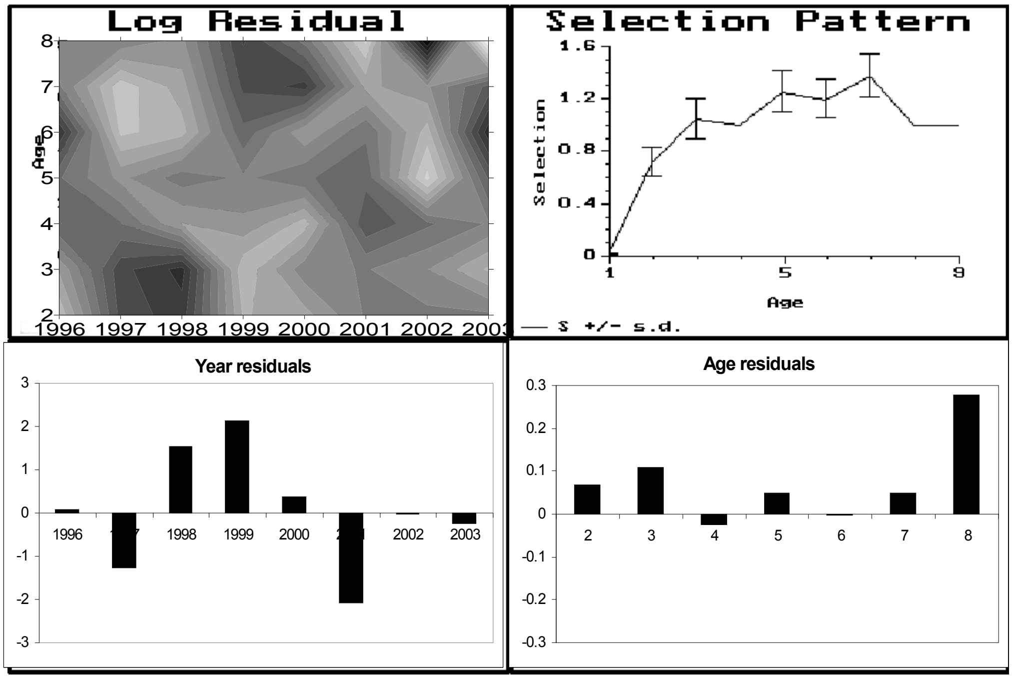


Figure 5.6.7 Herring in VIa (N). Illustration of selection patterns diagnostics, from deterministic calculation (8-year separable period). Top left, a contour plot of selection pattern residuals. Top right, estimated selection (relative to 4-ringers) +/- standard deviation. Bottom, marginal totals of residuals by year and ring.

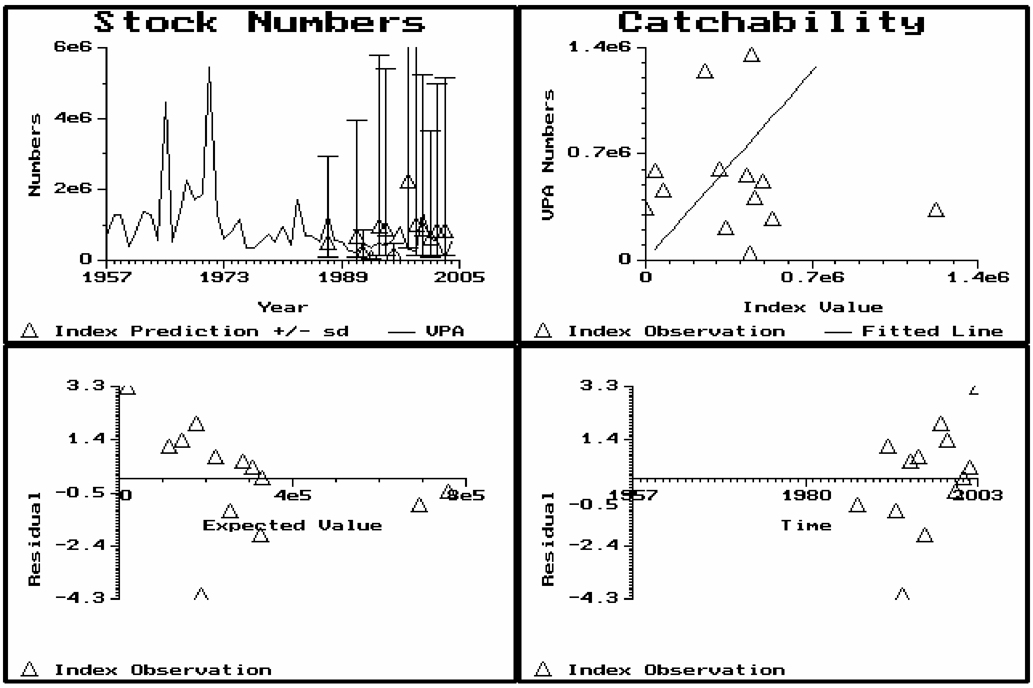


Figure 5.6.8 Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **1-ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 1-ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time. **N.B. 1-ringers are down-weighted in the catch and survey in the assessment.**

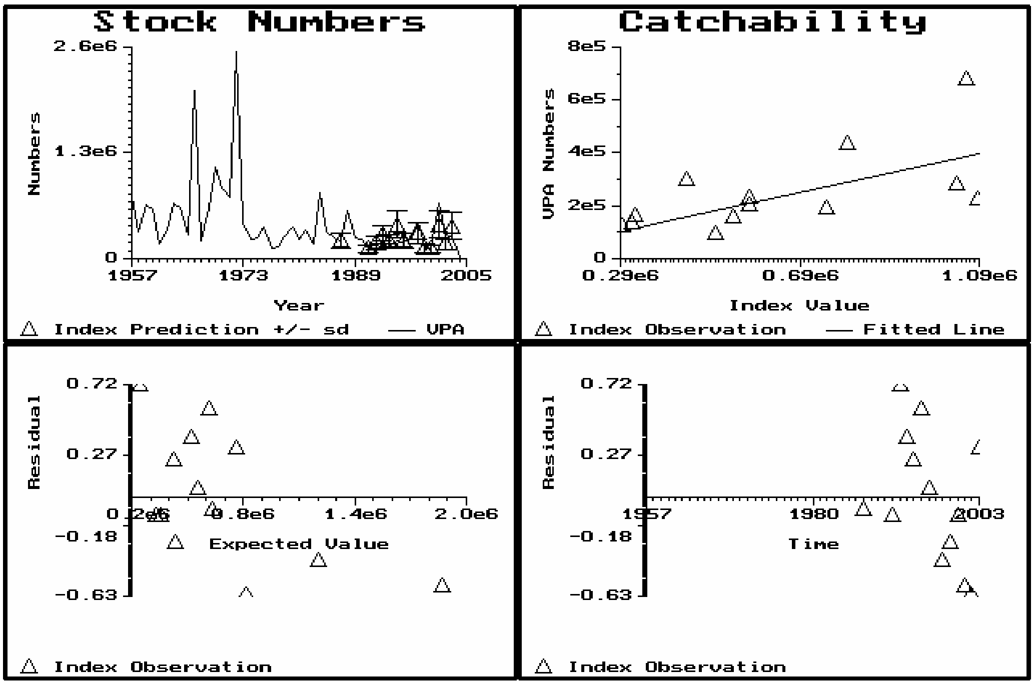


Figure 5.6.9 Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **2-ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 2-ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

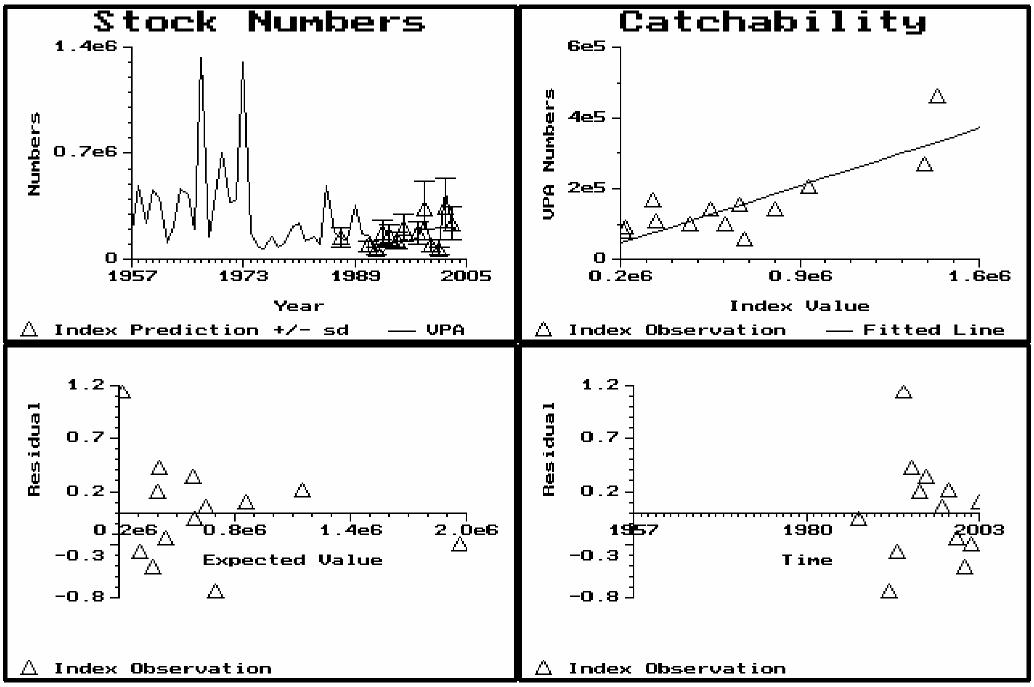


Figure 5.6.10 Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **3-ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 3-ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

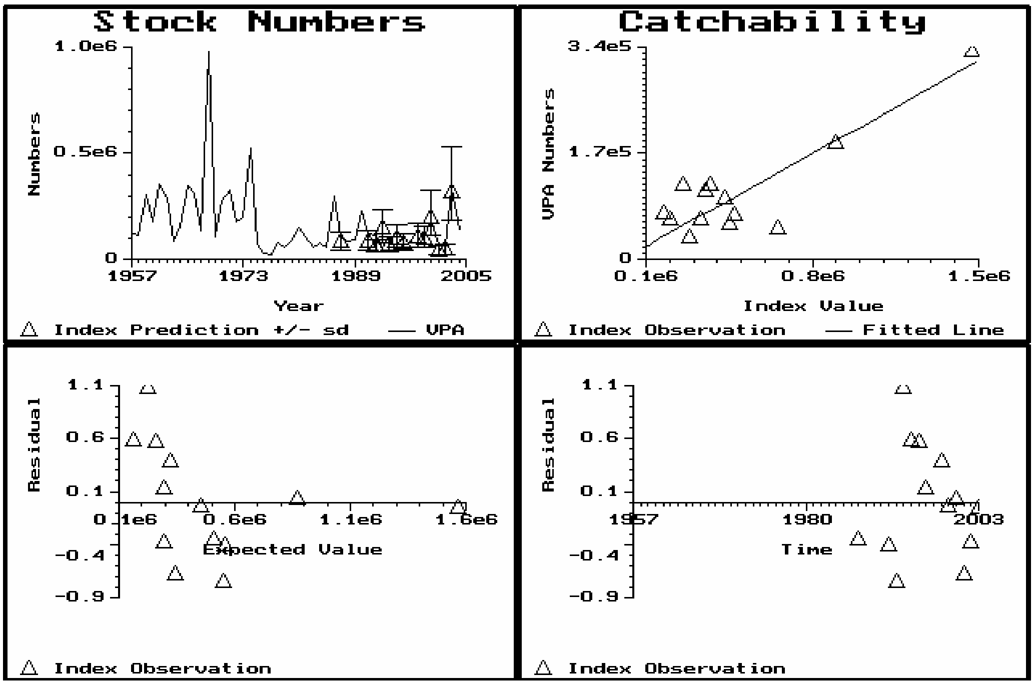


Figure 5.6.11 Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **4-ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 4-ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

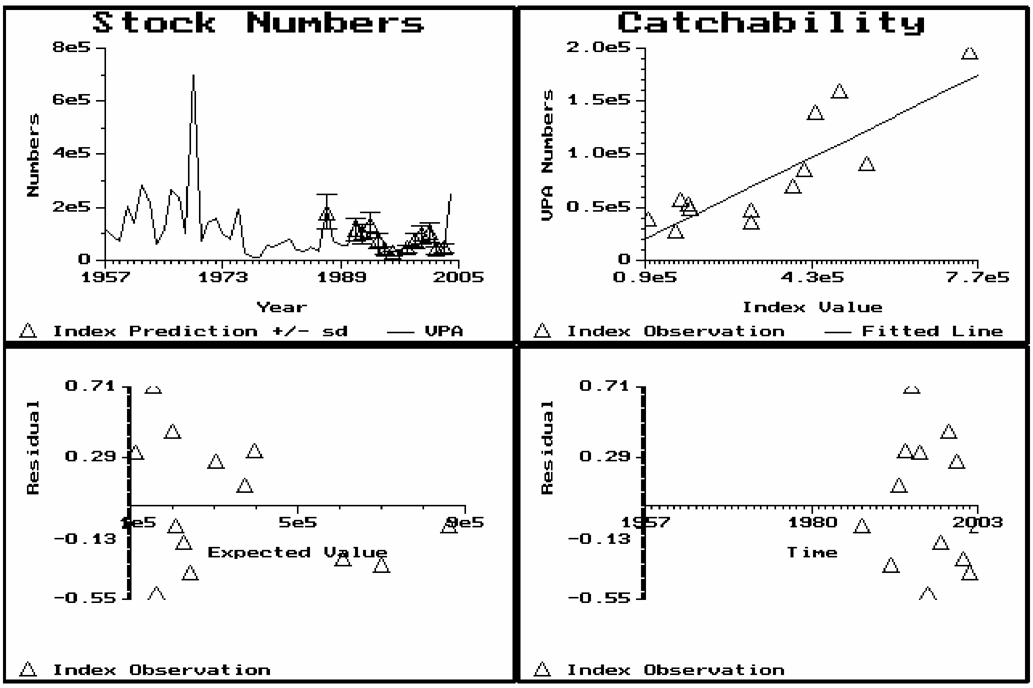


Figure 5.6.12 Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **5 ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 5 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

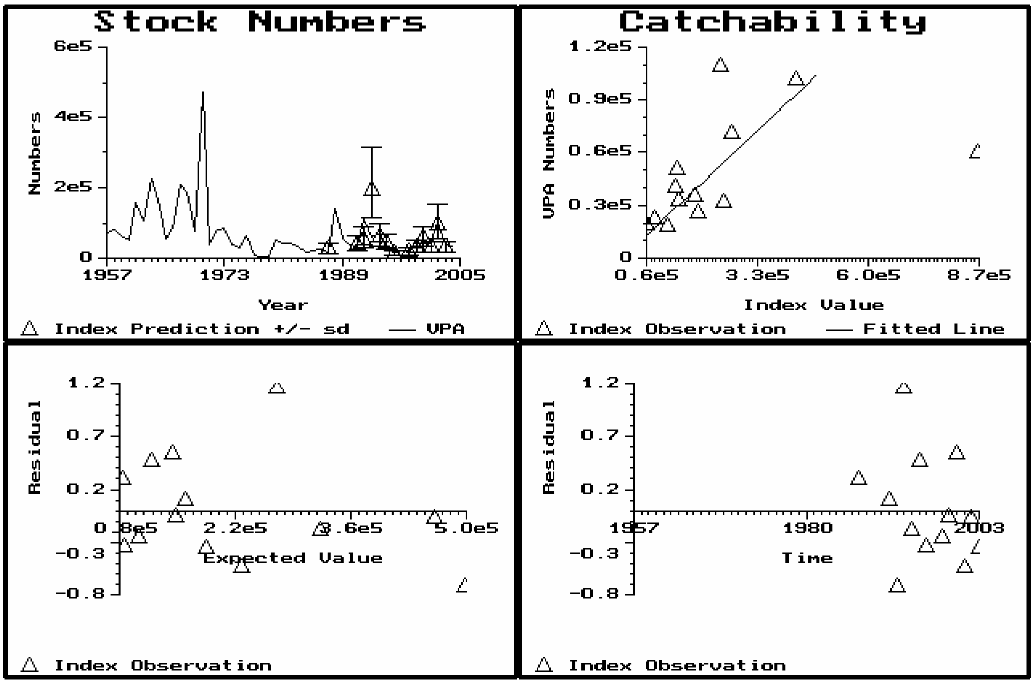


Figure 5.6.13 Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **6 ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 6 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

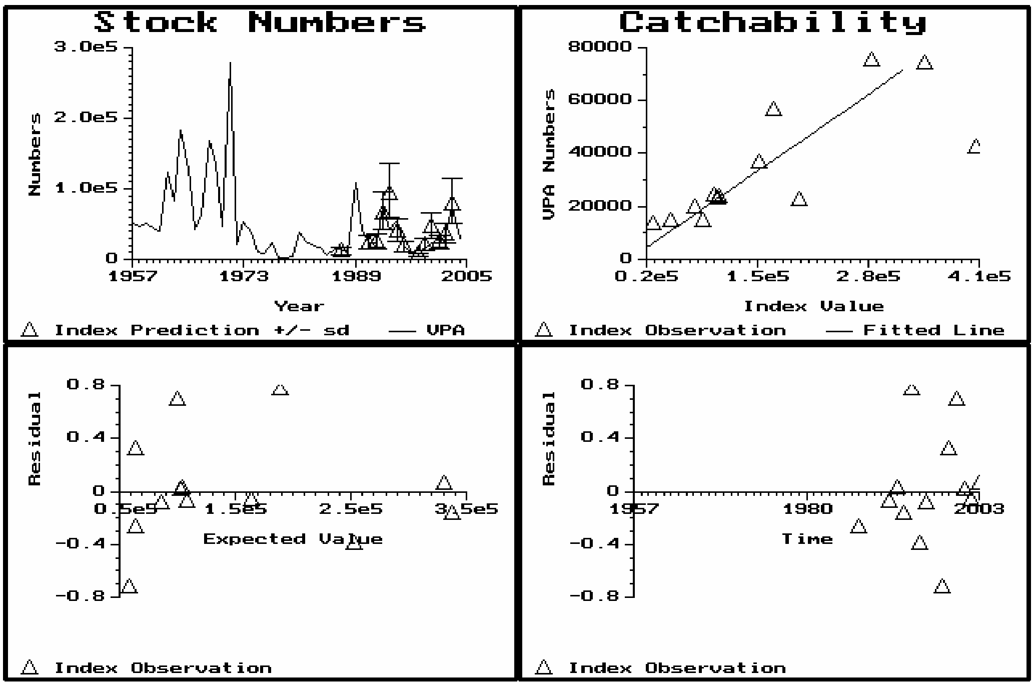


Figure 5.6.14 Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **7 ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 7 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

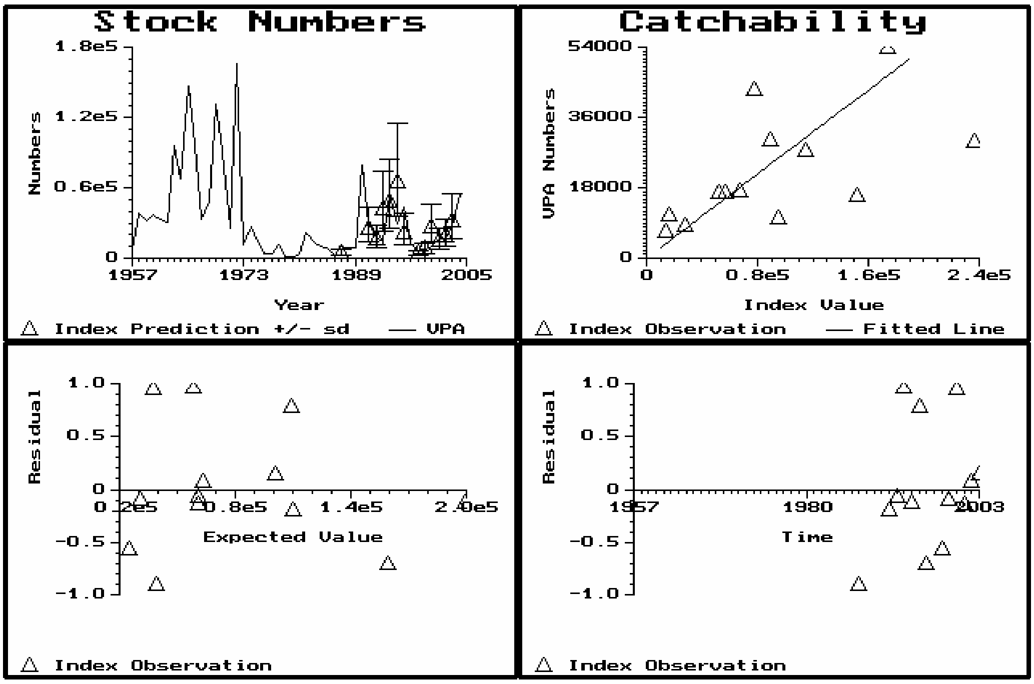


Figure 5.6.15 Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **8 ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 8 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

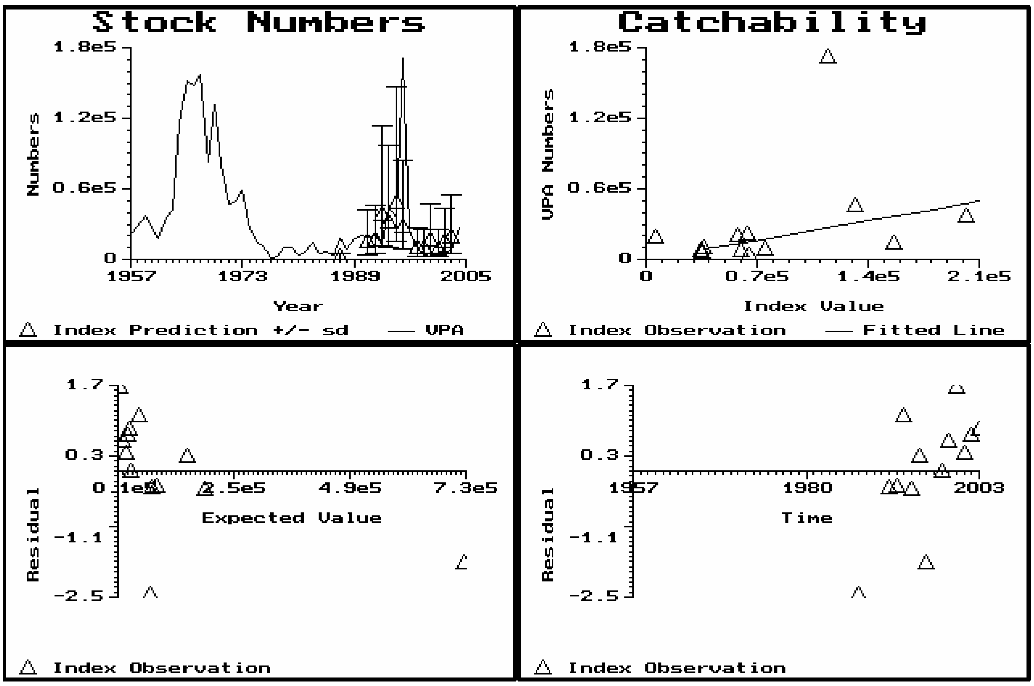


Figure 5.6.16 Herring in VIa (N). Illustration of residuals from deterministic calculation (8-year separable period). Diagnostics of the fit of the **9 ring** index against the **acoustic surveys**. Top left, fitted populations (line), and predictions of abundance in each year made from the index observations and estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatter plot and fitted relationship of abundance from fitted populations of 9 ringers in acoustic surveys. Bottom, residuals, as ln(observed index) - ln(expected index) plotted against expected values and against time.

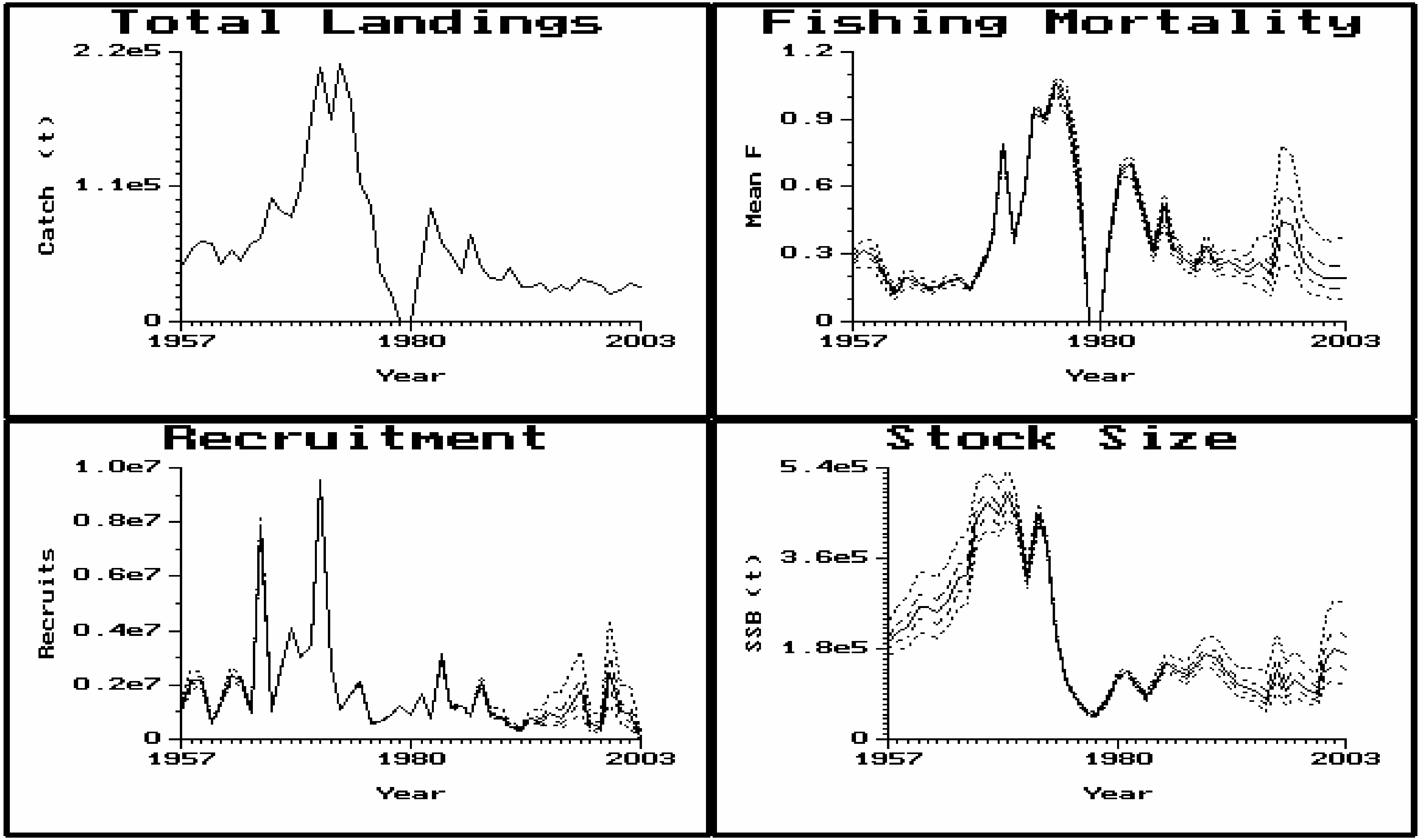
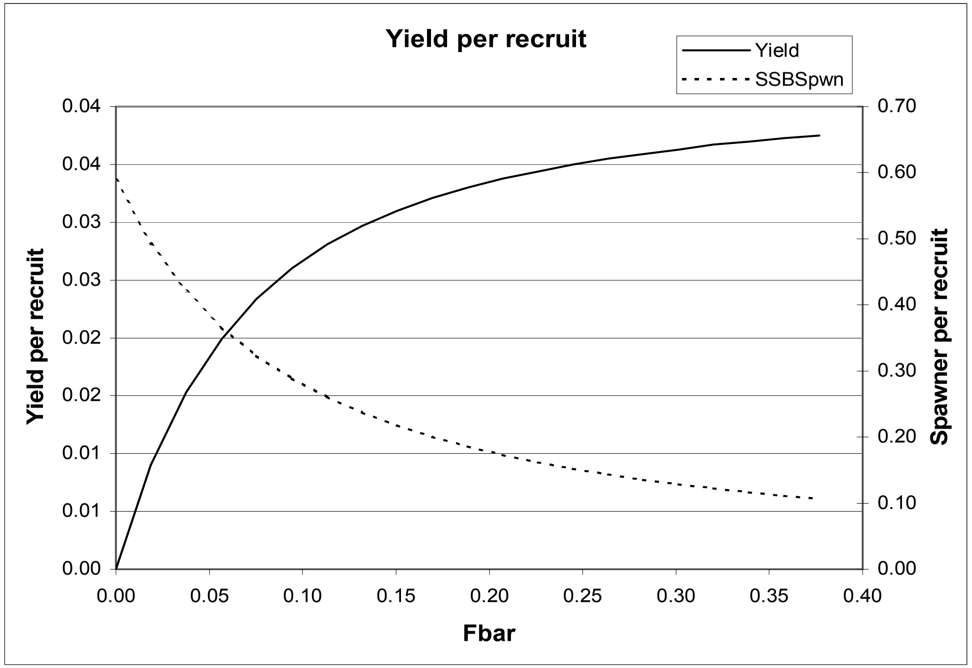
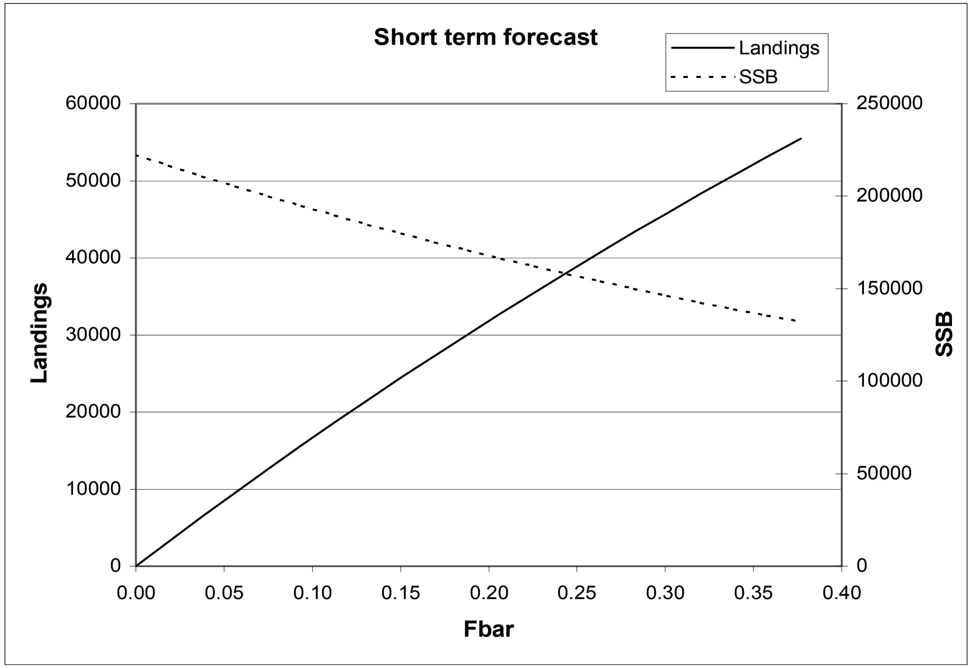


Figure 5.6.17 Herring in VIa (N). Trajectories of 5, 25, 50, 75 and 95 percentiles from the estimates of historical uncertainty of F, SSB and recruits produced in the final assessment. These were based on 1000 samples.





MFYPR version 2a
Run: VIA north Fstatquo
Time and date: 14:43 13/03/2004

Reference point	F multiplier	Absolute F
Fbar(3-6)	1.00	0.19
FMax		
F0.1	0.85	0.16
F35%SPR	0.86	0.16
Flow	0.44	0.08
Fmed	1.50	0.28
Fhigh	4.69	0.88

MFDP version 1a
Run: VIA north fstatquo
Herring VIa (north) (run: ICAPGF08/I08)
Time and date: 14:25 13/03/2004
Fbar age range: 3-6

Input units are thousands and kg - output in tonnes

Figure 5.7.2 Herring in VIa (N). Yield-per-recruit and short-term forecast. (Note that $\mathbf{F}_{low}$, $\mathbf{F}_{med}$ and $\mathbf{F}_{high}$ were calculated from the stock and recruit data using the correct time lag of one year for autumn spawning herring).

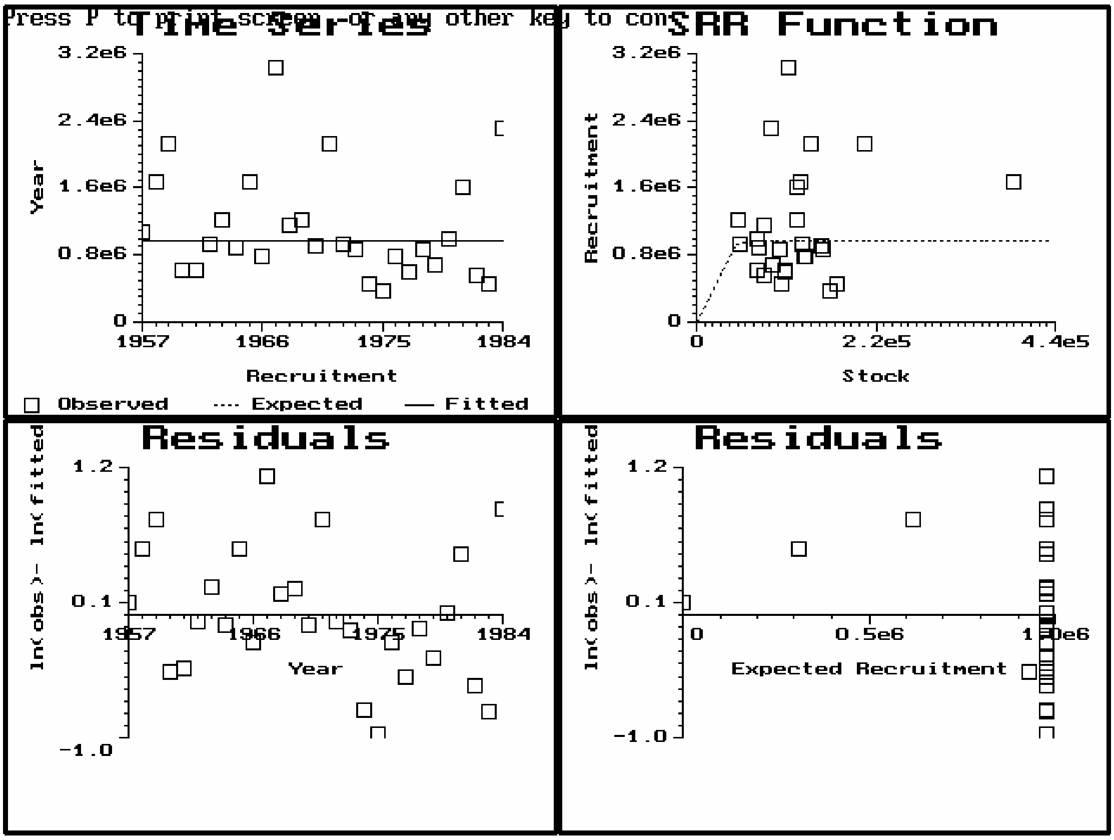


Figure 5.7.3.1 Herring in VIa (N). Stock recruit data, relationship and values used in the medium-term projections. The years used were from 1972 to 2000 inclusive, to exclude the earlier period of high recruitment. The years shown on the left hand graphs (produced by ICP) are incorrect and should read 1972 to 2000.

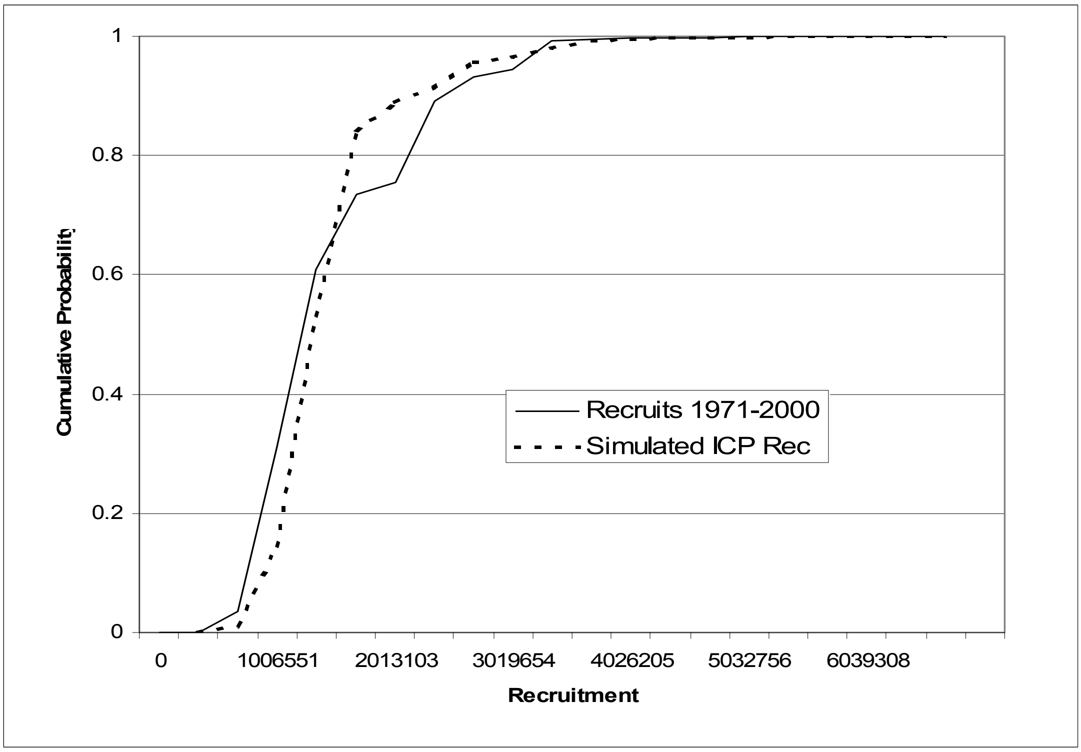


Figure 5.7.3.2 Herring in VIa (N). Graph to show the good agreement between the cumulative distribution of recruitment from the assessment and the simulated recruitment in ICP.

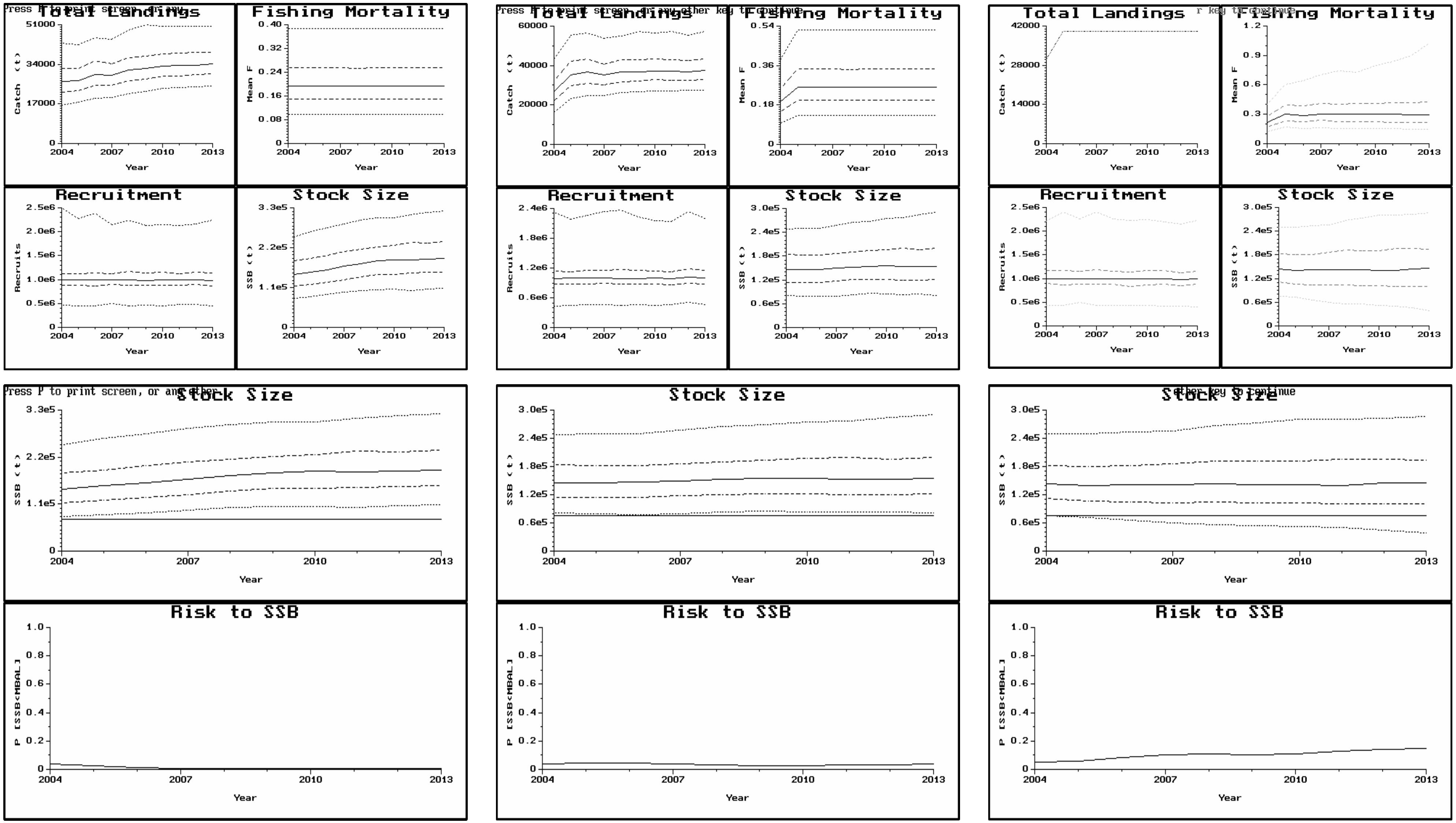
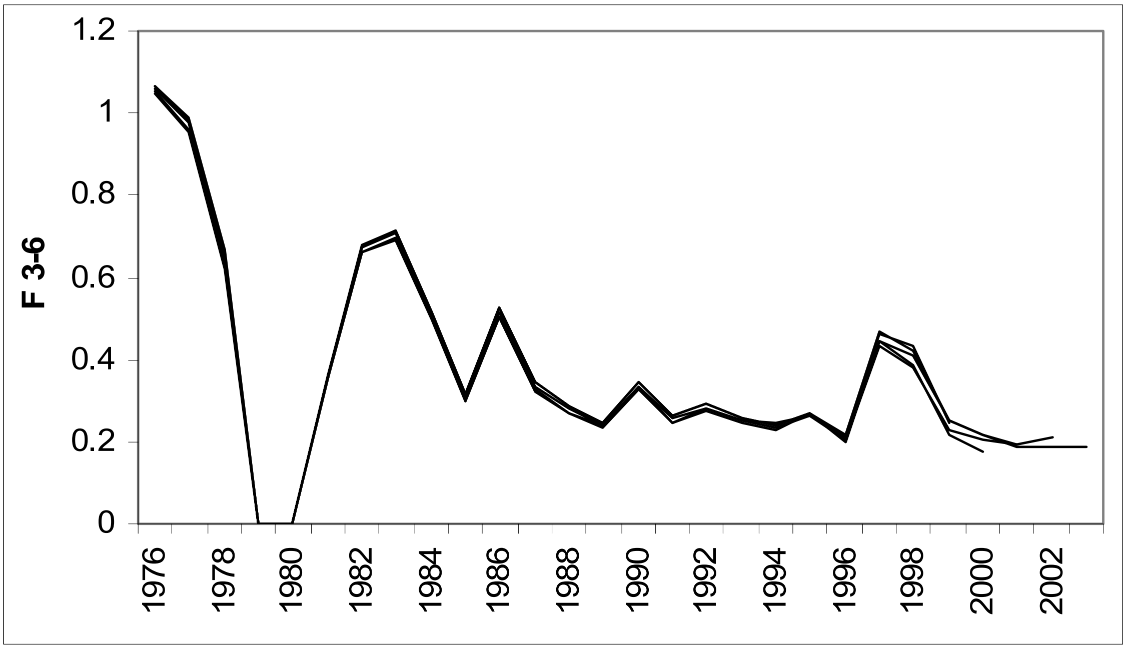


Figure 5.7.3.3 Herring in VIa (N). Medium-term predictions (upper row) with exploitation at F *status quo* 2004-2013, F *status quo* in 2004 followed by an F multiplier of 1.35 on F*status quo* and lastly F *status quo* in 2003 followed by at a catch of 40,000 t from 2005. Medium-term and risk to SSB decreasing below suggested $\mathbf{B}_{pa}$ with exploitation at F*status quo*, F *status quo* in 2004 followed by an F multiplier of 1.35 and F *status quo* in 2003 followed by at a catch of 40,000 t from 2005, respectively.



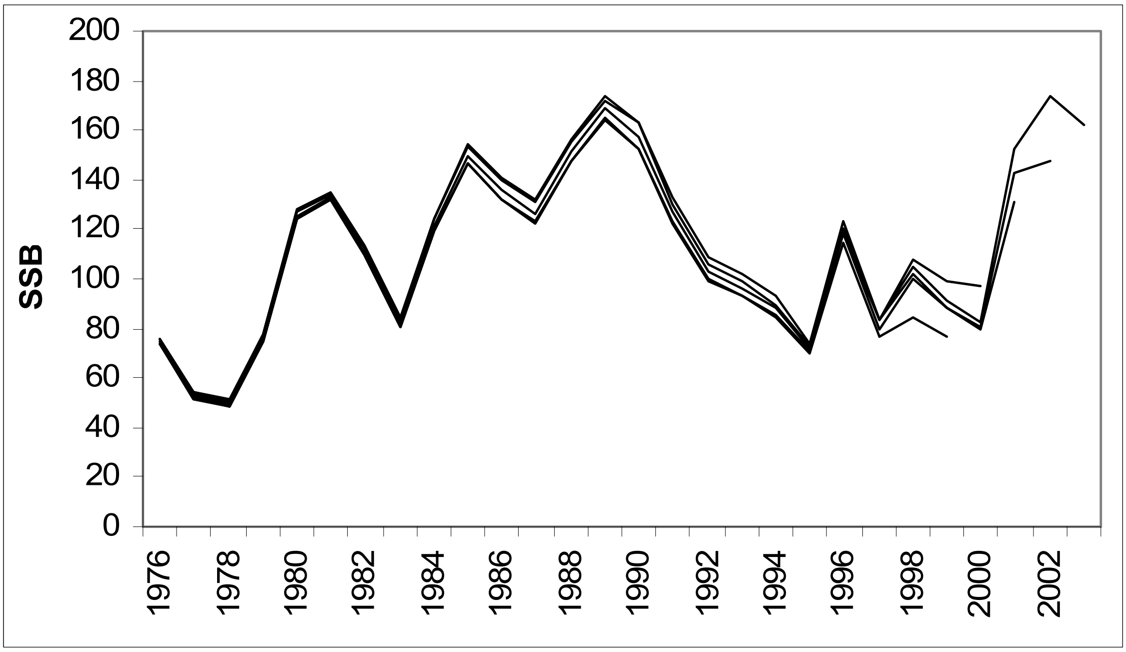


Figure 5.9.1 Herring in VIa (N). Analytical retrospective patterns of mean $F_{3\text{-}6}$ and SSB from the assessments using the extended data set.

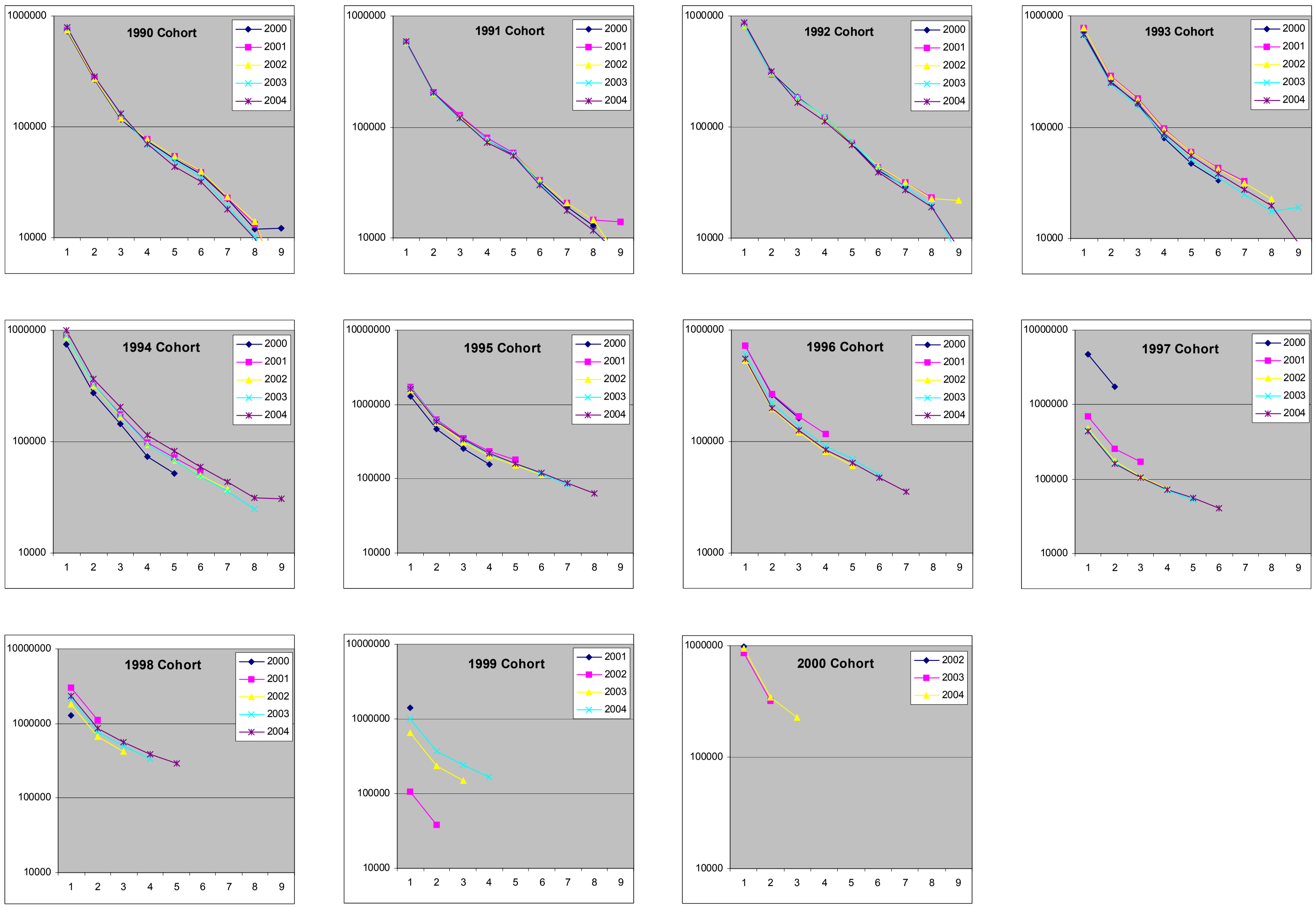


Figure 5.9.2 Herring in VIa(N). Retrospective cohort plots showing similarity in decline of numbers-at-age in the population for each cohort examined.

6 Herring in Divisions VIa (South) and VIIb,c

6.1 The fishery

The TAC for this area for 2003 was 14,000 t. This was the same TAC as in the previous three years. For 2004 ICES advised that catches should not exceed 14,000 t. In 2003 ACFM considered the state of the stock to be unknown with respect to safe biological limits because estimates of SSB and fishing mortality were highly uncertain over the previous 2-3 years. The current SSB is unknown but is likely to be below $\mathbf{B}_{pa}$ (110,000 t). For SSB to be above $\mathbf{B}_{lim}$ (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. F appears to have risen sharply during the late 1990s and although management measures since then have reduced F, the current F is unknown. Catches in the last three years have been the lowest observed due to restrictive TACs and the disincentive of poor market conditions.

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 $\mathbf{B}_{pa}$ 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.

6.1.1 Catches in 2003

The main working group landings from this fishery in 2003 are given in Table 6.1.2.1. Misreporting has decreased significantly in recent years and is now well below 1,000 t, though there may be some area misreporting from VIaS to VIaN. The total catch recorded for 2003 was around 13,000 t, about the same as last year. This figure is down over 1,000 t on the total for 2000. There has been a strong decline in landings from about 38,000 t in 1998. The main reason for the decrease in the total catch was a decrease in the quota, coupled with the decrease in misreported catches. There were no unallocated catches in 2003.

The catches and landings recorded by each country fishing in this area from 1988–2003 are shown in Table 6.1.2.1 and the total catches from 1970 to 2003 are shown in Figure 6.1.2.1. There were no estimates of discards reported for 2003 and there are no indications that discarding is a major problem in this fishery.

6.1.2 The fishery in 2003

The number of Irish vessels that participated in the fishery was the same as in recent years. There are two fleet components targeting this stock, large RSW vessels, and smaller dry-hold polyvalent vessels. Both types of vessels work mainly out of the port of Killybegs. Herring are mostly taken opportunistically, by boats targeting scad and mackerel. The dry-hold vessels, however, do direct effort at herring at some times of the year, when not fishing demersal species. About twenty vessels participated in the fishery in 2003/2004. These included small vessels of less than 25m and RSW vessels greater than 50m in length. Some of the larger RSW boats did not catch their quota in 2003, opting instead to fish for mackerel. Landings were reported from the end of October until the last week in February. Peak landings were reported in the last few weeks of 2003 and the first few weeks of 2004. Landings were concentrated around the northern boundary of VIIb along the north Connacht coast, the southern boundary of ICES division VIa south around Donegal Bay, and off Co. Donegal from off Tory Island to Malin Head. These locations are shown in Figure 6.1.3.1. The pattern of this fishery has changed over time. In the early part of the 20th Century the main spawning components were the winter spawners on the, off Co. Donegal, and this was where the main fishery took place. In the 1970's and 1980's the west of Ireland autumn spawning components were dominant and the fishery was mainly distributed along west Connaght, in Counties Galway and Mayo. More recently the northern grounds are more important again, and this is reflected in the much smaller catches in VIIb, being less than 1,000 t in the first quarter and less than 1,400 t in quarter 4.

Fish caught in the first quarter had a wider length distribution, and tend to be larger than fish caught at the end of the year (Table 6.1.2.2). A particular aspect of the first quarter fishery in VIa S has been the appearance of large fish off the north Ulster coast in February. These fish are usually over 31 cm TL.

6.2 Biological composition of the catch

6.2.1 Catch in numbers-at-age

The catches-at-age for this fishery since 1970 are shown in Table 6.2.1.1. In recent years the catches in numbers-at-age have been derived mainly from Irish sampling data. Dominant year classes are represented by the 2 and 3 ringers as was the case in 2002, accounting for 31% and 27% respectively. The numbers of 4-ringers has increased since 2002, and there was slight increase in the number of 5 and 6 ringers appearing in the commercial catches since 2002 (Figure 6.3.2.3). A decrease in the catches of older fish may be due to a increased targeting of mackerel in the first quarter of 2003.

6.2.2 Quality of the catch and biological data

The management of the Irish fishery in recent years has tightened considerably and the accuracy of reported catches in recent years is believed to have improved. The numbers of samples and the biological data are shown in Table 6.2.2.1. The length distributions of the catches taken per quarter by the Irish fleet, are shown in Table 6.1.2.2. The level of sampling was well up on 2002 levels. There is a need, however, to achieve a better coverage of VIIb, especially in the first quarter.

6.3 Fishery Independent Information

6.3.1 Ground Fish Surveys

Ground fish surveys have been carried out during November along the west coast of Ireland since 1993. More than 60 stations have been sampled each year with a bottom trawl fitted with fine mesh liner. Although these surveys are designed to obtain an abundance index for demersal fish it is hoped that they will also provide recruitment indices for herring. These surveys were conducted using a number of different commercial vessels over the time-series, and this along with the lack of attention paid to herring, may preclude its being used as recruit indices for this stock.

6.3.2 Acoustic Surveys

Acoustic surveys were carried out on this stock during the period 1994–1996, targeting fish in their summer feeding phase. A description of acoustic surveys in this area is presented in Table 6.3.2.1. The references cited are dealt with by O'Donnell *et al*. (in prep.).

In February 2003, a survey was carried out on the winter spawning component of the stock in VIa(S) and VIIb-c The survey track and NASC values from this survey are shown in Figure 6.3.2.1 and Figure 6.3.2.2. No autumn survey was carried out in 2003. In January 2004 a survey was carried out on the winter-spawning component of this stock for 2004 onboard the *Celtic Explorer*. The results will be available to the group in March 2005. It was felt that the timing of the survey did not coincide with the peak spawning for this component. Therefore it was considered that the stock was not contained in the survey area. Fishing success was reasonably good, although the majority of the estimate was attributed to "herring in a mixture" and "probably herring" categories. The majority of fish recorded during this survey were spent, accounting for 71% of the biomass and 62% of the numbers. This indicates that spawning may have taken place before the survey. Anecdotal information from fishermen suggests peak spawning time now occurs between January and February.

The age distribution of the abundance estimate from the acoustic survey and from the commercial fishery in 2003 is presented in Figure 6.3.2.3. Dominant ages in the acoustic survey were 2-ringers (2001 year class) and 3- ringer fish (2000 year class) making up 32% and 36% of numbers respectively. Fish of 4-rings and above accounted for 19% of numbers in the survey. The age distribution in the commercial fishery was different, with 2-ringers being slightly more numerous than 3-ringers. The total biomass estimate for the area surveyed was 10,300 t, with an SSB of 9,500 t. This is much lower than the estimates obtained in the mid- 1990's, though those surveys are not directly comparable, because they targeted the entire stock area during the feeding phase.

6.4 Mean weights-at-age

The mean weights (kg) at age in the catches in 2002 are based on Irish catches and are very similar to 2001 for ringers 1-6 (Table 6.4.1). These mean weights display quite a stable pattern over the time-series. Though there appears to be a slight increase in mean weights in the past three years (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). The values are higher for all the important age groups than in 2002.

6.5 Recruitment

There are currently no recruitment indices available for this stock. However an Irish ground fish survey conducted in the 4th quarter since 1996 regularly catches herring. The data from this survey series will be investigated as a potential 1-ringer index and a presentation will be made to the HAWG in 2005.

6.6 Stock Assessment

There is no reliable tuning series for this stock, and tuned assessments have not been carried out for a number of years. Recently, the group has carried out separable VPA's, screening over a range of terminal F's. This approach allows for a study of the development of the stock, but prevents any conclusions being made in the most recent years.

6.6.1 Data exploration and preliminary assessments

A separable VPA was used to screen over three terminal fishing mortalities, 0.2, 0.4 and 0.6. This was achieved in the Lowestoft VPA software (Darby and Flatman, 1994). Reference age for calculation of fishing mortality was 3-7 and terminal selection was fixed at 1, relative to age 4 (winter rings). Default downweighting was chosen. This assessment is still experimental, and no assessment has been accepted by ACFM in recent years.

6.6.2 Results of the assessment

Three assessments are presented, based on the three choices of terminal F. Without access to ancillary data, the group was unable to make an informed choice between them. The general development of the stock is presented in Figure 6.6.2.1. This figure is more informative for earlier years, but in most recent years it is less so.

Outputs from separable VPAs with terminal F's of 0.2, 0.4 and 0.6 are presented in Tables 6.6.2.1, 6.6.2.2 and 6.6.2.3 respectively. All scenarios suggest that F has decreased since 2001, and this is mirrored by a reduction in landings in recent years. Recruitment appears to have decreased slightly in the last year. SSB appears to have increased slightly, based on all scenarios, but in all cases it remains at a low level compared to the mid 1980's. Residual plots for these three runs are presented in Figure 6.6.2.2, 6.6.2.3 and 6.6.2.4.

In interpreting these data, it should be noted that herring is not a target fishery in this area at present. The catch-at-age data may not be considered very informative. For instance, larger fish (> 31cm) appear in the north Donegal area in the first quarter, but these are not always caught by the fishery, because the fleets are fishing mackerel instead. Indeed, the difference in the age compositions between the fishery and the acoustic survey may reflect the lack of coherence in the catch-at-age data.

6.7 Stock Forecasts and Catch Predictions

In the absence of an agreed assessment, it was not considered informative to carry out any predictions. However a prediction, produced for illustrative purposes, was produced by the HAWG in 2003. Since no final assessment was agreed on by the working group in 2004, the prediction carried out in 2003 is still considered relevant.

6.8 Medium-term Projections

No medium-term projections were carried out for this stock because of the absence of information. A management plan is currently being implemented to rebuild this stock.

6.9 Reference Points

As this assessment is still uncertain there was no revision of the precautionary reference points. The precautionary reference points for this stock were discussed in the 1999 Working Group Report (ICES 1999 ACFM:12). The present analysis, although it is uncertain, presents a similar picture of the stock as that shown in recent years. The SGPRP (ICES 2003/ACFM: 15) has reviewed the methodology for the calculation of biological reference points, and applying a segmented regression to the stock and recruit data from the 2002 HAWG assessment showed that the fit to the stock and recruit data for this stock was not significant. This may be due to the fact that recruitment does not show any clear dependence on the SSB.. The stock may be still below $\mathbf{B}_{pa}$ (110,000 t) but the fishing mortality has been reduced, since 1998.

6.10 Quality of the Assessment

The assessment presented was based on the results from a separable VPA without a tuning index, therefore the estimates of SSB and F for recent years will be depending on the choice of terminal F. Although landings seem to have been low and stable in recent years the real F cannot be determined therefore the VPA was run for a range of F values and the current perception of the stock would be highly influenced by that choice. Further, there is no information on recent recruitment levels both because the selectivity of the fishery appears to be low for the juveniles and for the lack of a recruitment index.

The fishery is opportunistic and changes in fishing patterns are to be expected in respect to herring so the catch-at-age data is likely to contain little information. A consistent time-series of fishery independent data would provide a tuning fleet which is the piece of information required to estimate the current state of the stock.

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. 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 reduction in catch. The management of the Irish fishery (which takes most of the catch) has improved over the past 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.

Despite the uncertainty about this stock, it is clear that it is at a much lower level in recent years, than before. The fisheries exploiting this stock should not be allowed to expand. At present the main fleet exploiting the stock is mainly targeting mackerel and horse mackerel. Measures should be taken to ensure that this stock is afforded protection if the current situation were to change.

SSB may be increasing slightly, but it is still well below historical levels. Though the peak in SSB in the 1980's may have been an isolated event the HAWG suggests that this stock should be exploited with 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.

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 polyvalent 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 may be useful to collect biological data from each fleet separately, in order to refine the information from catch-at-age data. In order to obtain a proper assessment of this stock for the most recent years, reliable survey data are required. The current acoustic survey index dates from 1999. By the next working group, 7 years of data will be available and it should be possible to use this a tuning index. However the timing of the surveys means that they only cover part of the stock.

Anecdotal information and observations by scientists shows that industrial fisheries are in operation in the area just north of the boundary of VIaN and VIaS. The by-catch of herring in these fisheries should be evaluated.

Table 6.1.2.1 VIa(S) & VIIb,c. Estimated Herring catches in tonnes, 1988–2003. 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
France	-	-	+	-	-	-	-	-	-	-	-	-	-	-	515	-
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	25,200	16,325	10,164	11,278	13,072	12,921
Netherlands	300	2,900	2,533	600	900	2,500	2,500	1,207	1,800	3,400	2,500	1,868	1,234	2,088	366	-
UK (N.Ireland)	-	-	80	-	-	-	-	-	-	-	-	-				
UK (England + Wales)	-	-	-	-	-	-	50	24	-	-	-	-	-	-	-	-
UK Scotland	-	+	-	+	-	200	-	-	-	-	-	-				
Unallocated	13,800	7,100	13,826	11,200	4,600	6,250	6,250	1,100	6,900	-700	11,200	7,916	3,607	695	366	-
Total landings	29,100	28,200	41,439	34,300	31,750	36,550	33,200	27,792	32,500	27,100	38,900	26,109	15,005	14,060	13,587	12,921
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	38,900	26,109	15,005	14,060	13,587	12,921

Table 6.1.2.2. VIa(S) and Division VIIb,c herring. Length distribution of Irish catches/quarter (thousands) 2003.

	VIaS Q1	VIIb Q1	VIaS Q4	VIIb Q4
20.5	15	4		
21	30	8		26
21.5	30	8	14	26
22	118	34	203	167
22.5	148	45	353	180
23	237	71	542	167
23.5	400	120	963	539
24	488	139	2 482	808
24.5	488	146	3 960	1 360
25	932	266	6 117	1 463
25.5	1 569	416	6 171	1 155
26	1 983	514	6 401	1 181
26.5	2 442	630	5 438	783
27	3 182	814	4 272	385
27.5	3 123	810	3 431	282
28	2 916	750	2 523	231
28.5	1 732	439	1 397	128
29	1 243	315	963	77
29.5	296	75	461	51
30	133	34	298	38
30.5	104	26	68	26
31	89	23		
31.5	59	15		
32	59	15		
32.5	30	8		
33	74	19		
33.5	15	4		
34	15	4		
34.5	15	4		
35				

Table 6.2.1.1 VIa(S) & VIIb,c herring. Catch in numbers-at-age (winter rings) from 1970 to 2003.

	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

Table 6.2.2.1 Divisions VIa (S) and VIIb,c. Sampling intensity of herring catches in 2002.

Country	Q	Catch (t)	No. of samples	No. of age readings	No. of fish measured	Aged per 1000 t.	Estimate of discards
Ireland	1	4,507	14	780	3,018	173	No
	2	-	-	-	-	-	No
	3	-	-	-	-	-	No
	4	8,413	26	2,366	4,103	281	No

Table 6.3.2.1. Details of acoustic surveys of herring in VIaS and VIIbc, 1996 – 2004. The references cited are dealt with by O'Donnell et al. (in prep.).

Year	Type	Biomass	SSB	Notes	Reference
1994	Feeding phase		353,772		Fernandes, 1994
1995	Feeding phase	137,670	125,800		Fernandes, 1995b
1996	Feeding phase	34,290	12,550		Fernandes, 1996b
1997	-	-	-		-
1998	-	-	-		-
1999	Autumn spawners	23,762	22,788		Breslin, 1999c
2000	Autumn spawners	21,000	20,500		Breslin and Griffin, 2001c
2001	Autumn spawners	11,100	9,800	See also 2002	Breslin and Griffin, 2002b
2002	Winter spawners	8,900	7,200	See also 2001	Breslin and Griffin, 2003b
2003	Winter spawners	10,300	9,500		Breslin and Griffin, 2003c
2004	Winter spawners				In prep.

Table 6.4.1 VIa(S) & VIIb,c herring. Mean weight-at-age (winter rings) in the catch.

	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

Table 6.4.2 Mean weight-at-age (winter rings) in the stock for herring in VIaS and VIIb,c.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9+**
1970	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1971	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1972	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1973	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1974	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1975	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1976	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1977	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1978	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1979	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1980	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1981	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1982	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1983	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1984	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1985	0.100	0.150	0.196	0.227	0.238	0.251	0.252	0.269	0.284
1986	0.098	0.169	0.209	0.238	0.256	0.276	0.280	0.287	0.312
1987	0.097	0.164	0.206	0.233	0.252	0.271	0.280	0.296	0.317
1988	0.097	0.164	0.206	0.233	0.252	0.271	0.280	0.296	0.317
1989	0.138	0.157	0.168	0.182	0.200	0.217	0.227	0.238	0.245
1990	0.113	0.152	0.170	0.180	0.200	0.217	0.225	0.233	0.255
1991	0.102	0.149	0.174	0.190	0.195	0.206	0.226	0.236	0.248
1992	0.102	0.144	0.167	0.182	0.194	0.197	0.214	0.218	0.242
1993	0.118	0.166	0.196	0.205	0.214	0.220	0.223	0.242	0.258
1994	0.098	0.156	0.192	0.209	0.216	0.223	0.226	0.230	0.247
1995	0.090	0.144	0.181	0.203	0.217	0.226	0.227	0.239	0.246
1996	0.086	0.137	0.186	0.206	0.219	0.234	0.233	0.249	0.253
1997	0.094	0.135	0.169	0.194	0.210	0.224	0.231	0.230	0.239
1998	0.095	0.136	0.145	0.173	0.191	0.196	0.202	0.222	0.217
1999	0.104	0.145	0.154	0.174	0.200	0.222	0.230	0.240	0.246
2000	0.100	0.134	0.157	0.177	0.197	0.207	0.217	0.230	0.245
2001	0.091	0.125	0.150	0.172	0.191	0.200	0.203	0.203	0.216
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

Table 6.6.2.1 VIa(S) and Division VIIb,c. Outputs from the separable VPA terminal F = 0.2. Age in winter rings.

Table 8 Fishing mortality (F) at age

YEAR	1970	1971	1972	1973
AGE				
1	0.0005	0.0017	0.0022	0.0192
2	0.3814	0.0489	0.1174	0.1897
3	0.2403	0.1286	0.2405	0.3055
4	0.1745	0.1419	0.1514	0.3012
5	0.1602	0.1513	0.1898	0.2443
6	0.1435	0.2157	0.2301	0.2962
7	0.166	0.1888	0.3373	0.3027
8	0.1845	0.1661	0.3106	0.2306
+gp	0.1845	0.1661	0.3106	0.2306
0 FBAR 3- 6	0.1796	0.1593	0.203	0.2868

Table 8 Fishing mortality (F) at age

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
1	0.0091	0.0289	0.0388	0.0123	0.0155	0.0097	0.0086	0.0038	0.0017	0.001
2	0.1933	0.2496	0.2597	0.2359	0.2486	0.166	0.1398	0.1442	0.0883	0.2203
3	0.3196	0.2671	0.4021	0.1945	0.2341	0.19	0.3579	0.2249	0.1655	0.3901
4	0.4967	0.3735	0.4726	0.3075	0.2855	0.257	0.3848	0.2789	0.2212	0.3733
5	0.5287	0.4753	0.5679	0.3673	0.2844	0.2964	0.4436	0.3072	0.2315	0.3678
6	0.4539	0.6184	0.5534	0.4029	0.2426	0.3376	0.3794	0.4392	0.2903	0.34
7	0.4081	0.5482	0.6167	0.3593	0.2695	0.3682	0.4551	0.2588	0.218	0.3663
8	0.5722	0.6506	0.6743	0.2834	0.377	0.4362	0.4979	0.2892	0.3656	0.2474
+gp	0.5722	0.6506	0.6743	0.2834	0.377	0.4362	0.4979	0.2892	0.3656	0.2474
0 FBAR 3- 6	0.4497	0.4336	0.499	0.3181	0.2616	0.2702	0.3914	0.3126	0.2271	0.3678

Table 8 Fishing mortality (F) at age

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	0.0047	0.0124	0.0015	0.006	0	0.005	0.0017	0.0021	0.0099	0.0005
2	0.1171	0.0518	0.0726	0.1597	0.0289	0.0474	0.1185	0.1445	0.1034	0.1705
3	0.2337	0.1418	0.1189	0.3361	0.266	0.1076	0.1932	0.1987	0.2834	0.2288
4	0.2244	0.147	0.1921	0.2818	0.2723	0.224	0.2939	0.1723	0.2838	0.4721
5	0.1535	0.1924	0.2241	0.4295	0.2266	0.2	0.2989	0.2871	0.2358	0.3793
6	0.2215	0.2165	0.1823	0.3401	0.3192	0.199	0.2609	0.3329	0.3122	0.3805
7	0.158	0.2183	0.2222	0.4293	0.2287	0.2572	0.3069	0.2781	0.2333	0.4638
8	0.1589	0.2745	0.1734	0.3472	0.124	0.1891	0.1127	0.3219	0.2177	0.3022
+gp	0.1589	0.2745	0.1734	0.3472	0.124	0.1891	0.1127	0.3219	0.2177	0.3022
0 FBAR 3- 6	0.2083	0.1744	0.1793	0.3469	0.271	0.1827	0.2617	0.2477	0.2788	0.3652

Table 8 Fishing mortality (F) at age

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	FBAR **-
AGE											
1	0.0234	0.001	0.0091	0.0145	0.0225	0.009	0.0077	0.005	0.0045	0.0029	0.0041
2	0.3359	0.1487	0.1837	0.2413	0.3313	0.3701	0.218	0.1087	0.1192	0.0766	0.1015
3	0.4494	0.3923	0.5323	0.3221	0.6927	0.5542	0.403	0.2864	0.2298	0.1593	0.2251
4	0.2524	0.5022	0.6767	0.6139	1.0523	0.7053	0.3975	0.3988	0.3121	0.2209	0.3106
5	0.4247	0.4449	0.48	0.6947	1.2929	0.7845	0.3977	0.5244	0.3387	0.233	0.3654
6	0.3532	0.5647	0.6827	0.5333	1.1777	0.8488	0.3158	0.7054	0.4121	0.2282	0.4486
7	0.3926	0.22	0.5544	0.8894	1.1543	0.719	0.3271	0.399	0.2889	0.1548	0.2809
8	0.3679	0.7531	0.8826	0.4207	1.0519	0.6839	0.3913	0.4745	0.5094	0.1369	0.3736
+gp	0.3679	0.7531	0.8826	0.4207	1.0519	0.6839	0.3913	0.4745	0.5094	0.1369	
0 FBAR 3- 6	0.3699	0.4761	0.5929	0.541	1.0539	0.7232	0.3785	0.4787	0.3232	0.2103	
1											

Table 6.6.2.1 Continued

Table 9 Relative F at age

	YEAR	1970	1971	1972	1973
	AGE				
	1	0.0029	0.0107	0.0106	0.0669
	2	2.1237	0.3069	0.5784	0.6616
	3	1.3378	0.8068	1.1849	1.0653
	4	0.9713	0.8902	0.7461	1.0503
	5	0.8917	0.9495	0.9351	0.8517
	6	0.7992	1.3534	1.1339	1.0328
	7	0.9244	1.1851	1.662	1.0555
	8	1.0271	1.0422	1.5305	0.8039
	+gp	1.0271	1.0422	1.5305	0.8039
0	REFMEA	0.1796	0.1593	0.203	0.2868

Table 9 Relative F at age

	YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
	AGE										
	1	0.0202	0.0666	0.0777	0.0387	0.0594	0.0358	0.0221	0.0121	0.0075	0.0028
	2	0.4298	0.5756	0.5205	0.7418	0.95	0.6143	0.3571	0.4612	0.3887	0.5991
	3	0.7106	0.6161	0.8058	0.6115	0.8946	0.7032	0.9143	0.7194	0.7286	1.0606
	4	1.1044	0.8614	0.9472	0.9668	1.0911	0.951	0.9831	0.8923	0.9739	1.015
	5	1.1757	1.0962	1.138	1.1548	1.0872	1.0967	1.1333	0.9829	1.0192	1
	6	1.0093	1.4263	1.109	1.2668	0.9272	1.2491	0.9693	1.4053	1.2783	0.9244
	7	0.9076	1.2643	1.236	1.1297	1.0299	1.3625	1.1627	0.8281	0.96	0.9959
	8	1.2725	1.5006	1.3514	0.8912	1.4408	1.6142	1.272	0.9254	1.6096	0.6726
	+gp	1.2725	1.5006	1.3514	0.8912	1.4408	1.6142	1.272	0.9254	1.6096	0.6726
0	REFMEA	0.4497	0.4336	0.499	0.3181	0.2616	0.2702	0.3914	0.3126	0.2271	0.3678
	1										

Table 9 Relative F at age

	YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	AGE										
	1	0.0225	0.0711	0.0086	0.0172	0	0.0276	0.0066	0.0087	0.0356	0.0013
	2	0.5622	0.2972	0.4046	0.4605	0.1067	0.2596	0.4529	0.5832	0.371	0.4668
	3	1.1221	0.8128	0.6631	0.9689	0.9814	0.5892	0.7384	0.8022	1.0164	0.6265
	4	1.0772	0.8425	1.0711	0.8124	1.0047	1.2263	1.1228	0.6953	1.0179	1.2928
	5	0.7371	1.1032	1.2492	1.2382	0.8361	1.095	1.1421	1.1587	0.8459	1.0386
	6	1.0635	1.2414	1.0166	0.9805	1.1779	1.0895	0.9967	1.3437	1.1198	1.042
	7	0.7587	1.2512	1.239	1.2375	0.8438	1.4078	1.1727	1.1226	0.8368	1.27
	8	0.7628	1.5735	0.9667	1.001	0.4577	1.0352	0.4306	1.2994	0.781	0.8277
	+gp	0.7628	1.5735	0.9667	1.001	0.4577	1.0352	0.4306	1.2994	0.781	0.8277
0	REFMEA	0.2083	0.1744	0.1793	0.3469	0.271	0.1827	0.2617	0.2477	0.2788	0.3652

Table 9 Relative F at age

	YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	MEAN **-
	AGE											
	1	0.0632	0.0021	0.0154	0.0269	0.0213	0.0125	0.0205	0.0105	0.0138	0.0137	0.0126
	2	0.908	0.3124	0.3098	0.446	0.3143	0.5117	0.5758	0.2271	0.3688	0.364	0.32
	3	1.2149	0.8241	0.8978	0.5953	0.6573	0.7663	1.0648	0.5982	0.711	0.7572	0.6888
	4	0.6823	1.055	1.1413	1.1348	0.9984	0.9753	1.0502	0.833	0.9657	1.0502	0.9496
	5	1.1482	0.9346	0.8096	1.2841	1.2268	1.0847	1.0507	1.0953	1.0482	1.1077	1.0837
	6	0.9547	1.1863	1.1513	0.9858	1.1175	1.1737	0.8344	1.4735	1.2752	1.0849	1.2779
	7	1.0613	0.4621	0.935	1.644	1.0953	0.9942	0.8643	0.8335	0.8939	0.736	0.8211
	8	0.9946	1.582	1.4886	0.7776	0.9981	0.9456	1.0337	0.9911	1.5764	0.651	1.0728
	+gp	0.9946	1.582	1.4886	0.7776	0.9981	0.9456	1.0337	0.9911	1.5764	0.651	
0	REFMEA	0.3699	0.4761	0.5929	0.541	1.0539	0.7232	0.3785	0.4787	0.3232	0.2103	
	1											

Table 6.6.2.1 Continued

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1970	1971	1972	1973
	AGE				
	1	406992	816720	733405	534069
	2	126960	149646	299942	269223
	3	133812	64228	105570	197591
	4	86803	86157	46241	67958
	5	27620	65969	67648	35962
	6	315417	21293	51310	50630
	7	20456	247241	15529	36883
	8	10383	15678	185214	10028
	+gp	11903	14814	16899	259641
0	TOTAL	1140345	1481744	1521757	1461984

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
	AGE										
	1	590147	408137	688719	579976	1041702	972044	524444	676356	692479	2315961
	2	192740	215141	145872	243727	210753	377309	354153	191271	247875	254314
	3	164975	117691	124178	83348	142612	121769	236759	228133	122674	168113
	4	119182	98125	73769	68008	56178	92395	82442	135522	149167	85119
	5	45497	65627	61116	41609	45246	38208	64656	50769	92781	108188
	6	25487	24263	36919	31341	26076	30805	25705	37542	33787	66604
	7	34067	14648	11829	19208	18954	18512	19888	15915	21894	22868
	8	24656	20495	7661	5777	12134	13099	11591	11416	11116	15930
	+gp	73326	69997	33455	17627	11087	12113	14232	21788	9837	20342
0	TOTAL	1270077	1034124	1183519	1090621	1564743	1676254	1333870	1368711	1381609	3057439
	1										

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	AGE										
	1	946341	1231622	938917	3233482	469557	704515	803898	496772	415141	614446
	2	851113	346514	447503	344875	1182464	172741	257873	295228	182360	151215
	3	151144	560855	243736	308314	217774	851026	122043	169683	189287	121823
	4	93182	97957	398489	177179	180370	136658	625668	82362	113886	116735
	5	53022	67370	76521	297549	120947	124302	98836	421975	62732	77589
	6	67766	41148	50288	55341	175226	87248	92082	66324	286541	44838
	7	42896	49134	29983	37919	35638	115220	64699	64188	43020	189751
	8	14346	33141	35741	21724	22335	25655	80614	43070	43979	30826
	+gp	28720	9470	14021	36386	17674	18487	11131	29167	33701	24163
0	TOTAL	2248529	2437211	2235199	4512769	2421985	2235853	2156845	1668768	1370646	1371385

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	GMST 70-**	AMST 70
	AGE													
	1	800359	456379	829297	817157	528335	421365	635097	698108	1099779	744422	0	714222	813186
	2	225931	287634	167728	302304	296280	190043	153620	231835	255536	402786	273071	254753	292693
	3	94466	119621	183635	103408	175940	157595	97240	91517	154051	168036	276399	157558	186580
	4	79343	49344	66154	88289	61350	72054	74133	53205	56269	100235	117320	97471	119169
	5	65878	55779	27021	30426	43237	19382	32205	45076	32309	37266	72720	61494	79086
	6	48046	38980	32345	15128	13744	10738	8004	19578	24143	20835	26711	41071	60329
	7	27731	30538	20052	14788	8031	3830	4158	5281	8749	14467	15005	25509	40773
	8	107981	16945	22176	10422	5498	2291	1689	2712	3206	5930	11213	16296	27385
	+gp	34349	28057	11516	13002	4710	2002	3917	1341	1287	1944	6213		
0	TOTAL	1484083	1083277	1359924	1394924	1137125	879301	1010061	1148654	1635328	1495921	798653		
	1													

Table 6.6.2.1 Continued

Table 17 Summary (with SOP correction)

Traditional vpa Terminal populations from weighted Separable populations

	RECR Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFA	FBAR 3- 6
1970	406992	201317	126425	20306	0.1606	0.8968	0.1796
1971	816720	225501	115337	15044	0.1304	0.8707	0.1593
1972	733405	239163	123521	23474	0.19	0.8975	0.203
1973	534069	285023	167167	36719	0.2197	1.0162	0.2868
1974	590147	218121	102048	36589	0.3585	0.9762	0.4497
1975	408137	210914	106303	38764	0.3647	1.1237	0.4336
1976	688719	201299	75584	32767	0.4335	1.0472	0.499
1977	579976	189743	83814	20567	0.2454	1.0778	0.3181
1978	1041702	238668	82484	19715	0.239	1.0161	0.2616
1979	972044	275929	113457	22608	0.1993	1.0664	0.2702
1980	524444	220645	114250	30124	0.2637	0.9636	0.3914
1981	676356	238298	116634	24922	0.2137	1.0312	0.3126
1982	692479	238595	120278	19209	0.1597	1.0301	0.2271
1983	2315961	441555	116486	32988	0.2832	1.0042	0.3678
1984	946341	356735	191446	27450	0.1434	0.9688	0.2083
1985	1231622	352146	185012	23343	0.1262	0.9846	0.1744
1986	938917	369979	224283	28785	0.1283	1.0002	0.1793
1987	3233482	563161	192027	48600	0.2531	0.9488	0.3469
1988	469557	426196	299788	29100	0.0971	0.9992	0.271
1989	704515	373134	223247	29210	0.1308	1.001	0.1827
1990	803898	339542	192826	43969	0.228	1.0006	0.2617
1991	496772	266922	165912	37700	0.2272	0.9971	0.2477
1992	415141	215446	132529	31856	0.2404	0.9951	0.2788
1993	614446	229250	111859	36763	0.3287	1.006	0.3652
1994	800359	212505	94440	33908	0.359	0.998	0.3699
1995	456379	160989	81818	27792	0.3397	1.0525	0.4761
1996	829297	167917	61225	32534	0.5314	0.9955	0.5929
1997	817157	171204	63045	27225	0.4318	1.0016	0.541
1998	528335	141251	51393	38895	0.7568	0.9988	1.0539
1999	421365	116579	44152	26109	0.5914	1.0018	0.7232
2000	635097	122870	41637	15005	0.3604	1.0011	0.3785
2001	698108	129663	47728	14061	0.2946	0.9988	0.4787
2002	1099779	179376	58689	13587	0.2315	0.9991	0.3232
2003	744422	183215	89269	12921	0.1447	1.002	0.2103
Arith. Mean	819592	250084	121062	28018	.2766		.3536
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			
1							

Table 6.6.2.2 VIa(S) and Division VIIb,c. Outputs from the separable VPA terminal F = 0.4. Age in winter rings.

Table 8 Fishing mortality (F) at age

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
1	0.009	0.0286	0.0384	0.0122	0.0154	0.0095	0.0085	0.0038	0.0017	0.001
2	0.192	0.2478	0.2572	0.2335	0.2458	0.1641	0.1378	0.1422	0.0872	0.2174
3	0.3173	0.2649	0.398	0.1922	0.231	0.1874	0.3524	0.221	0.1628	0.3839
4	0.4923	0.3697	0.4669	0.3031	0.2811	0.2527	0.3777	0.273	0.2165	0.3654
5	0.523	0.4685	0.5587	0.3606	0.279	0.2904	0.4332	0.2993	0.2252	0.3574
6	0.4468	0.6066	0.5404	0.3925	0.2367	0.3288	0.3687	0.4234	0.2803	0.3279
7	0.3978	0.5341	0.5954	0.3463	0.2598	0.3561	0.4377	0.2489	0.2073	0.3491
8	0.5483	0.6229	0.6432	0.2685	0.3576	0.4144	0.473	0.2735	0.3466	0.2323
+gp	0.5483	0.6229	0.6432	0.2685	0.3576	0.4144	0.473	0.2735	0.3466	0.2323
0 FBAR 3- 6	0.4448	0.4274	0.491	0.3121	0.2569	0.2648	0.383	0.3042	0.2212	0.3587

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Table 8 Fishing mortality (F) at age

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	0.0046	0.0123	0.0015	0.0059	0	0.005	0.0017	0.0022	0.0099	0.0005
2	0.1156	0.0512	0.0719	0.1585	0.0287	0.0472	0.1182	0.1444	0.1035	0.1709
3	0.2298	0.1397	0.1174	0.3322	0.2634	0.1069	0.1924	0.1981	0.2831	0.2291
4	0.2196	0.144	0.1888	0.2774	0.268	0.2213	0.2915	0.1713	0.2827	0.4714
5	0.1493	0.1874	0.2186	0.4196	0.2221	0.1961	0.2941	0.2839	0.2342	0.3773
6	0.2132	0.2094	0.1766	0.3292	0.3086	0.1941	0.2544	0.3257	0.3076	0.3771
7	0.1509	0.2081	0.2132	0.4112	0.2191	0.2459	0.2972	0.2692	0.2266	0.4538
8	0.1493	0.2593	0.1637	0.3287	0.1173	0.1794	0.1068	0.3081	0.2088	0.291
+gp	0.1493	0.2593	0.1637	0.3287	0.1173	0.1794	0.1068	0.3081	0.2088	0.291
0 FBAR 3- 6	0.203	0.1701	0.1754	0.3396	0.2655	0.1796	0.2581	0.2448	0.2769	0.3637

Table 8 Fishing mortality (F) at age

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	FBAR **-**
AGE											
1	0.0235	0.001	0.0094	0.0153	0.025	0.0112	0.0112	0.0084	0.0089	0.0068	0.0081
2	0.3369	0.1495	0.1862	0.2479	0.3533	0.4215	0.2788	0.1621	0.2096	0.1602	0.1773
3	0.451	0.394	0.5361	0.3279	0.7237	0.6142	0.4914	0.3985	0.3771	0.3163	0.364
4	0.2529	0.5051	0.6817	0.6217	1.0923	0.772	0.4713	0.5457	0.504	0.4335	0.4944
5	0.4237	0.4461	0.4846	0.7049	1.3379	0.8618	0.4666	0.6992	0.5539	0.4648	0.5726
6	0.3505	0.5625	0.6858	0.5417	1.224	0.9371	0.3724	0.955	0.684	0.4691	0.7027
7	0.3874	0.2178	0.5505	0.8986	1.199	0.7935	0.3916	0.5102	0.4968	0.3234	0.4435
8	0.3562	0.7355	0.8672	0.416	1.0813	0.7514	0.4662	0.6305	0.7789	0.2823	0.5639
+gp	0.3562	0.7355	0.8672	0.416	1.0813	0.7514	0.4662	0.6305	0.7789	0.2823	
0 FBAR 3- 6	0.3695	0.4769	0.597	0.549	1.0945	0.7963	0.4504	0.6496	0.5298	0.4209	

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1970	1971	1972	1973
AGE				
1	408879	820398	737137	537255
2	127610	150340	301295	270596
3	135004	64708	106084	198593
4	88004	87131	46634	68379
5	28178	67055	68530	36317
6	322479	21798	52292	51428
7	21027	253630	15986	37771
8	10772	16195	190994	10441
+gp	12349	15302	17427	270338
0 TOTAL	1154303	1496558	1536379	1481119

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
1	593963	411531	694882	585686	1053076	985047	531319	684511	700921	2344085
2	193913	216544	147120	245994	212854	381493	358936	193800	250875	257420
3	165991	118559	125217	84271	144289	123323	239857	231675	124546	170335
4	120001	98956	74479	68856	56933	93766	83713	138052	152064	86651
5	45878	66367	61867	42250	46013	38891	65896	51918	95070	110809
6	25809	24606	37587	32019	26655	31498	26322	38663	34826	68674
7	34788	14939	12139	19811	19566	19036	20515	16473	22907	23808
8	25459	21146	7923	6056	12679	13653	12064	11982	11621	16845
+gp	75716	72222	34600	18480	11585	12625	14814	22868	10283	21511
0 TOTAL	1281517	1044871	1195814	1103422	1583650	1699332	1353436	1389942	1403113	3100138

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Table 6.6.2.2. continued

Table 10	Stock number at age (start of year)			Numbers*10**-3						
YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	957303	1242879	945758	3253379	471407	706191	804549	496192	414156	612915
2	861460	350547	451644	347392	1189784	173421	258489	295467	182147	150852
3	153442	568517	246723	311382	219637	856448	122547	170139	189464	121665
4	94997	99837	404760	179624	182877	138182	630107	82775	114259	116880
5	54407	69012	78222	303222	123158	126569	100214	425988	63105	77926
6	70134	42401	51773	56879	180351	89248	94133	67570	290170	45176
7	44767	51277	31116	39262	37029	119854	66508	66043	44146	193032
8	15195	34834	37679	22749	23549	26912	84805	44705	45656	31845
+gp	30420	9954	14781	38103	18634	19394	11709	30275	34986	24962
0 TOTAL	2282124	2469257	2262456	4551991	2446425	2256219	2173061	1679155	1378089	1375252

Table 10	Stock number at age (start of year)			Numbers*10**-3									
YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	GMST 70-**	AMST 70
AGE													
1	796744	450605	809812	774336	475761	339402	438183	415230	548932	314628	0	689125	796671
2	225368	286304	165603	295136	280527	170703	123468	159395	151471	200142	114957	249805	289891
3	94197	119205	182651	101835	170637	145959	82967	69214	100410	90991	126322	155795	186221
4	79214	49126	65814	87487	60065	67749	64659	41558	38043	56380	54294	96857	119487
5	66009	55662	26823	30120	42513	18231	28327	36518	21789	20795	33070	61411	79721
6	48351	39099	32240	14950	13468	10093	6968	16074	16422	11331	11821	41217	61367
7	28036	30814	20159	14693	7869	3583	3578	4344	5597	7498	6414	25777	41828
8	110945	17220	22425	10519	5413	2147	1466	2188	2360	3082	4910	16631	28378
+gp	35292	28513	11645	13122	4637	1876	3402	1082	947	1010	2792		
0 TOTAL	1484155	1076547	1337173	1342197	1060891	759743	753018	745604	885972	705856	354580		

Table 6.6.2.2. continued

	Table 12	Stock biomass at age (start of year)			Tonnes
	YEAR	1970	1971	1972	1973
	AGE				
	1	49065	98448	88456	64471
	2	21566	25407	50919	45731
	3	28351	13589	22278	41704
	4	20769	20563	11006	16137
	5	7326	17434	17818	9443
	6	88037	5951	14276	14040
	7	5951	71777	4524	10689
	8	3124	4697	55388	3028
	+gp	3655	4529	5158	80020
0	TOTALBI(	227844	262396	269823	285263

	Table 12	Stock biomass at age (start of year)			Tonnes						
	YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
	AGE										
	1	71276	49384	83386	70282	126369	118206	63758	82141	84111	281290
	2	32771	36596	24863	41573	35972	64472	60660	32752	42398	43504
	3	34858	24897	26295	17697	30301	25898	50370	48652	26155	35770
	4	28320	23354	17577	16250	13436	22129	19756	32580	35887	20450
	5	11928	17255	16085	10985	11963	10112	17133	13499	24718	28810
	6	7046	6718	10261	8741	7277	8599	7186	10555	9507	18748
	7	9845	4228	3435	5607	5537	5387	5806	4662	6483	6738
	8	7383	6132	2298	1756	3677	3959	3499	3475	3370	4885
	+gp	22412	21378	10242	5470	3429	3737	4385	6769	3044	6367
0	TOTALBI(	225839	189941	194443	178361	237962	262499	232553	235085	235672	446563

Table 6.6.2.2. continued

	Table 12	Stock biomass at age (start of year)			Tonnes						
	YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	AGE										
	1	114876	124288	92684	315578	45726	97454	90914	50612	42244	72324
	2	145587	52582	76328	56972	195125	27227	39290	44025	26229	25041
	3	32223	111429	51565	64145	45245	143883	20833	29604	31640	23846
	4	22419	22663	96333	41853	42610	25149	113419	15727	20795	23960
	5	14146	16425	20025	76412	31036	25314	20043	83068	12242	16676
	6	19147	10643	14289	15414	48875	19367	20427	13919	57163	9939
	7	12669	12922	8713	10993	10368	27207	14964	14926	9447	43046
	8	4406	9370	10814	6734	6970	6405	19760	10550	9953	7706
	+gp	9004	2827	4612	12079	5907	4751	2986	7508	8467	6440
0	TOTALBI	374477	363149	375362	600179	431863	376758	342636	269939	218181	228980

	Table 12	Stock biomass at age (start of year)			Tonnes						
	YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	AGE										
	1	78081	40554	69644	72788	45197	35298	43818	37786	50502	29575
	2	35157	41228	22688	39843	38152	24752	16545	19924	19237	26219
	3	18086	21576	33973	17210	24742	22478	13026	10382	14660	14104
	4	16556	9972	13558	16972	10391	11788	11445	7148	6467	9866
	5	14258	12079	5874	6325	8120	3646	5580	6975	4140	3993
	6	10782	8836	7544	3349	2640	2241	1442	3215	3301	2300
	7	6336	6995	4697	3394	1590	824	776	882	1175	1740
	8	25517	4116	5584	2419	1202	515	337	444	536	684
	+gp	8717	7014	2946	3136	1006	462	833	234	217	245
0	TOTALBI	213490	152370	166508	165437	133040	102004	93803	86990	100235	88726

Table 6.6.2.2. continued

Table 17 Summary (with SOP correction)

Traditional vpa Terminal populations from weighted Separable populations

	RECR Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFA	FBAR 3- 6
1970	408879	204321	129027	20306	0.1574	0.8968	0.1767
1971	820398	228473	117747	15044	0.1278	0.8707	0.1566
1972	737137	242157	125934	23474	0.1864	0.8975	0.2004
1973	537255	289872	171321	36719	0.2143	1.0162	0.2838
1974	593963	220458	103820	36589	0.3524	0.9762	0.4448
1975	411531	213430	108235	38764	0.3581	1.1237	0.4274
1976	694882	203620	77030	32767	0.4254	1.0472	0.491
1977	585686	192242	85413	20567	0.2408	1.0778	0.3121
1978	1053076	241804	84069	19715	0.2345	1.0161	0.2569
1979	985047	279922	115542	22608	0.1957	1.0664	0.2648
1980	531319	224077	116616	30124	0.2583	0.9636	0.383
1981	684511	242416	119465	24922	0.2086	1.0312	0.3042
1982	700921	242758	123123	19209	0.156	1.0301	0.2212
1983	2344085	448435	119694	32988	0.2756	1.0042	0.3587
1984	957303	362800	195711	27450	0.1403	0.9688	0.203
1985	1242879	357558	188890	23343	0.1236	0.9846	0.1701
1986	945758	375423	228640	28785	0.1259	1.0002	0.1754
1987	3253379	569437	196153	48600	0.2478	0.9488	0.3396
1988	471407	431538	304478	29100	0.0956	0.9992	0.2655
1989	706191	377125	226709	29210	0.1288	1.001	0.1796
1990	804549	342848	195849	43969	0.2245	1.0006	0.2581
1991	496192	269169	168078	37700	0.2243	0.9971	0.2448
1992	414156	217109	134192	31856	0.2374	0.9951	0.2769
1993	612915	230345	113083	36763	0.3251	1.006	0.3637
1994	796744	213063	95318	33908	0.3557	0.998	0.3695
1995	450605	160369	81786	27792	0.3398	1.0525	0.4769
1996	809812	165759	60809	32534	0.535	0.9955	0.597
1997	774336	165705	61787	27225	0.4406	1.0016	0.549
1998	475761	132874	48417	38895	0.8033	0.9988	1.0945
1999	339402	102187	38971	26109	0.67	1.0018	0.7963
2000	438183	93907	33493	15005	0.448	1.0011	0.4504
2001	415230	86883	32839	14061	0.4282	0.9988	0.6496
2002	548932	100142	33744	13587	0.4027	0.9991	0.5298
2003	314628	88899	42561	12921	0.3036	1.002	0.4209
Arith. Mean	775207	244621	119957	28018	.2939		.3733
0 Units	(Thousands	(Tonnes)	(Tonnes)	(Tonnes)			

Table 6.6.2.3 VIa(S) and Division VIIb,c. Outputs from the separable VPA terminal F = 0.6. age in winter rings.

Table 8 Fishing mortality (F) at age

YEAR	1970	1971	1972	1973
AGE				
1	0.0005	0.0017	0.0021	0.019
2	0.3777	0.0485	0.1165	0.1881
3	0.2365	0.127	0.2384	0.3027
4	0.1704	0.1392	0.1493	0.2979
5	0.1549	0.1472	0.1856	0.24
6	0.1383	0.2071	0.2226	0.2879
7	0.1586	0.1808	0.3199	0.29
8	0.1734	0.1573	0.2939	0.215
+gp	0.1734	0.1573	0.2939	0.215
0 FBAR 3	0.175	0.1551	0.199	0.2821

Table 8 Fishing mortality (F) at age

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
1	0.009	0.0285	0.0382	0.0121	0.0153	0.0095	0.0085	0.0037	0.0017	0.001
2	0.1913	0.2467	0.2558	0.2321	0.2442	0.1629	0.1367	0.141	0.0866	0.2157
3	0.3159	0.2636	0.3957	0.1908	0.2293	0.1859	0.3493	0.2189	0.1613	0.3804
4	0.4898	0.3675	0.4637	0.3006	0.2786	0.2503	0.3738	0.2697	0.2139	0.3609
5	0.5197	0.4647	0.5535	0.3568	0.2759	0.287	0.4274	0.2949	0.2218	0.3516
6	0.4427	0.6	0.5331	0.3867	0.2333	0.3239	0.3628	0.4149	0.2749	0.3213
7	0.3921	0.5263	0.5836	0.3391	0.2546	0.3494	0.4283	0.2435	0.2016	0.3398
8	0.5355	0.608	0.6264	0.2605	0.3471	0.4027	0.4597	0.2652	0.3366	0.2244
+gp	0.5355	0.608	0.6264	0.2605	0.3471	0.4027	0.4597	0.2652	0.3366	0.2244
0 FBAR 3	0.442	0.424	0.4865	0.3087	0.2543	0.2618	0.3783	0.2996	0.2179	0.3536
1										

Table 8 Fishing mortality (F) at age

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	0.0046	0.0122	0.0015	0.0059	0	0.005	0.0017	0.0022	0.01	0.0005
2	0.1148	0.0509	0.0715	0.1578	0.0286	0.0471	0.118	0.1442	0.1036	0.171
3	0.2276	0.1386	0.1165	0.33	0.2619	0.1065	0.1919	0.1978	0.2828	0.2292
4	0.2169	0.1423	0.187	0.2749	0.2656	0.2197	0.2901	0.1708	0.282	0.4707
5	0.147	0.1846	0.2156	0.4141	0.2195	0.1939	0.2915	0.2822	0.2333	0.376
6	0.2086	0.2055	0.1735	0.3233	0.3028	0.1914	0.2508	0.3216	0.305	0.375
7	0.147	0.2027	0.2083	0.4013	0.2139	0.2399	0.2919	0.2643	0.2229	0.4482
8	0.1443	0.2512	0.1586	0.3189	0.1136	0.1743	0.1037	0.3008	0.204	0.2849
+gp	0.1443	0.2512	0.1586	0.3189	0.1136	0.1743	0.1037	0.3008	0.204	0.2849
0 FBAR 3	0.2	0.1678	0.1731	0.3356	0.2625	0.1779	0.2561	0.2431	0.2758	0.3627

Table 8 Fishing mortality (F) at age

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	FBAR
AGE											
1	0.0235	0.001	0.0094	0.0156	0.0259	0.0122	0.0132	0.0109	0.0131	0.0113	0.0117
2	0.3372	0.1497	0.1871	0.2501	0.3611	0.4413	0.3071	0.1938	0.2795	0.2435	0.2389
3	0.4515	0.3945	0.5373	0.3299	0.7346	0.6365	0.5289	0.4577	0.4801	0.4696	0.4691
4	0.253	0.506	0.6833	0.6243	1.1064	0.7969	0.5015	0.62	0.6337	0.6409	0.6315
5	0.4228	0.4464	0.486	0.7082	1.3535	0.8911	0.4949	0.7847	0.6992	0.6959	0.7266
6	0.3488	0.5604	0.6866	0.5444	1.2399	0.9703	0.3959	1.0847	0.8744	0.7167	0.8919
7	0.3844	0.2164	0.547	0.9008	1.2136	0.8211	0.4187	0.5623	0.653	0.4998	0.5717
8	0.3496	0.7253	0.8573	0.4117	1.0883	0.7751	0.4971	0.7073	0.9492	0.4342	0.6969
+gp	0.3496	0.7253	0.8573	0.4117	1.0883	0.7751	0.4971	0.7073	0.9492	0.4342	
0 FBAR 3	0.369	0.4768	0.5983	0.5517	1.1086	0.8237	0.4803	0.7368	0.6718	0.6308	
1											

Table 6.6.2.3 Continued

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1970	1971	1972	1973
	AGE				
	1	409973	822548	739306	539106
	2	127989	150742	302085	271394
	3	135691	64987	106382	199178
	4	88688	87694	46863	68623
	5	28493	67674	69038	36524
	6	326461	22083	52852	51888
	7	21343	257233	16244	38278
	8	10989	16481	194253	10674
	+gp	12597	15572	17724	276369
0	TOT/	1162225	1505014	1544748	1492034

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
	AGE										
	1	596170	413494	698436	588980	1059676	992586	535318	689251	705815	2360259
	2	194593	217356	147842	247301	214066	383921	361710	195272	252620	259220
	3	166582	119063	125817	84805	145256	124220	241654	233729	125636	171628
	4	120480	99438	74891	69346	57370	94558	84447	139521	153744	87543
	5	46098	66799	62303	42622	46456	39286	66612	52581	96398	112329
	6	25996	24805	37977	32412	26991	31899	26679	39309	35425	69875
	7	35204	15108	12318	20164	19922	19340	20877	16796	23491	24350
	8	25917	21522	8076	6218	12998	13975	12339	12309	11913	17374
	+gp	77078	73507	35266	18974	11876	12923	15151	23493	10542	22186
0	TOT/	1288118	1051093	1202927	1110823	1594612	1712707	1364788	1402260	1415584	3124763

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	AGE										
	1	963613	1249393	949713	3264967	472512	707288	805140	496059	413852	612420
	2	867410	352868	454041	348847	1194047	173828	258893	295684	182098	150740
	3	154774	572923	248442	313156	220714	859606	122849	170438	189625	121628
	4	96053	100926	408366	181032	184328	139063	632692	83021	114504	117011
	5	55213	69967	79208	306484	124431	127881	101011	428326	63328	78148
	6	71508	43130	52637	57771	183298	90399	95319	68290	292283	45378
	7	45853	52519	31776	40043	37835	122519	67549	67116	44797	194943
	8	15685	35816	38803	23345	24255	27642	87215	45647	46626	32434
	+gp	31401	10234	15222	39102	19193	19919	12042	30913	35730	25424
0	TOT/	2301508	2487777	2278207	4574748	2460613	2268145	2182710	1685494	1382843	1378125

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	GMST 70-**	AMS
	AGE													
	1	795560	448691	803395	760507	458780	312415	372778	322231	376750	191286	0	679059	792507
	2	225186	285868	164899	292775	275440	164456	113540	135334	117259	136800	69582	248111	289440
	3	94114	119070	182328	101315	168891	142202	78361	61874	82599	65683	79442	155349	186467
	4	79184	49058	65704	87224	59639	66332	61603	37803	32052	41841	33624	96815	119898
	5	66128	55635	26762	30021	42276	17849	27051	33758	18401	15389	19946	61540	80209
	6	48551	39206	32216	14895	13379	9882	6625	14922	13937	8275	6943	41417	62011
	7	28218	30995	20256	14671	7820	3504	3389	4034	4564	5260	3656	26003	42453
	8	112671	17385	22589	10606	5393	2102	1395	2017	2080	2149	2888	16868	28958
	+gp	35841	28786	11730	13231	4620	1837	3236	997	835	705	1673		
0	TOT/	1485453	1074694	1329879	1325244	1036238	720580	667977	612972	648477	467388	217754		
	1													

Table 6.6.2.3 Continued

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1970	1971	1972	1973
AGE				
1	49197	98706	88717	64693
2	21630	25475	51052	45866
3	28495	13647	22340	41827
4	20930	20696	11060	16195
5	7408	17595	17950	9496
6	89124	6029	14429	14165
7	6040	72797	4597	10833
8	3187	4779	56333	3096
+gp	3729	4609	5246	81805
0 TOTAL	229740	264334	271724	287976

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
1	71540	49619	83812	70678	127161	119110	64238	82710	84698	283231
2	32886	36733	24985	41794	36177	64883	61129	33001	42693	43808
3	34982	25003	26422	17809	30504	26086	50747	49083	26383	36042
4	28433	23467	17674	16366	13539	22316	19930	32927	36284	20660
5	11986	17368	16199	11082	12079	10214	17319	13671	25063	29205
6	7097	6772	10368	8849	7369	8708	7283	10731	9671	19076
7	9963	4275	3486	5706	5638	5473	5908	4753	6648	6891
8	7516	6242	2342	1803	3769	4053	3578	3570	3455	5038
+gp	22815	21758	10439	5616	3515	3825	4485	6954	3120	6567
0 TOTAL	227218	191238	195727	179703	239751	264669	234618	237400	238015	450519
1										

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	115634	124939	93072	316702	45834	97606	90981	50598	42213	72266
2	146592	52930	76733	57211	195824	27291	39352	44057	26222	25023
3	32503	112293	51924	64510	45467	144414	20884	29656	31667	23839
4	22668	22910	97191	42180	42948	25309	113885	15774	20840	23987
5	14355	16652	20277	77234	31357	25576	20202	83523	12286	16724
6	19522	10826	14528	15656	49674	19617	20684	14068	57580	9983
7	12976	13235	8897	11212	10594	27812	15199	15168	9587	43472
8	4549	9634	11136	6910	7179	6579	20321	10773	10164	7849
+gp	9295	2907	4749	12395	6084	4880	3071	7666	8647	6559
0 TOTAL	378093	366326	378508	604011	434961	379083	344578	271284	219205	229702

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
1	77965	40382	69092	71488	43584	32491	37278	29323	34661	17981
2	35129	41165	22591	39525	37460	23846	15214	16917	14892	17921
3	18070	21552	33913	17122	24489	21899	12303	9281	12059	10181
4	16549	9959	13535	16921	10318	11542	10904	6502	5449	7322
5	14284	12073	5861	6304	8075	3570	5329	6448	3496	2955
6	10827	8861	7538	3336	2622	2194	1371	2984	2801	1680
7	6377	7036	4720	3389	1580	806	735	819	958	1220
8	25914	4155	5625	2439	1197	505	321	409	472	477
+gp	8853	7081	2968	3162	1003	452	793	215	191	171
0 TOTAL	213968	152263	165843	163687	130327	97304	84248	72899	74981	59908
1										

Table 6.6.2.3 Continued

Table 17 Summary (with SOP correction)

Traditional vpa Terminal populations from weighted Separable populations

	RE(	TOTALE	TOTSPE	LANDIN	YIELD/S!	SOPCOI	FBAR 3- 6
	Age 1						
1970	409973	206021	130496	20306	0.1556	0.8968	0.175
1971	822548	230160	119109	15044	0.1263	0.8707	0.1551
1972	739306	243864	127304	23474	0.1844	0.8975	0.199
1973	539106	292629	173677	36719	0.2114	1.0162	0.2821
1974	596170	221804	104839	36589	0.349	0.9762	0.442
1975	413494	214886	109352	38764	0.3545	1.1237	0.424
1976	698436	204965	77868	32767	0.4208	1.0472	0.4865
1977	588980	193687	86339	20567	0.2382	1.0778	0.3087
1978	1059676	243623	84986	19715	0.232	1.0161	0.2543
1979	992586	282236	116749	22608	0.1936	1.0664	0.2618
1980	535318	226067	117985	30124	0.2553	0.9636	0.3783
1981	689251	244804	121104	24922	0.2058	1.0312	0.2996
1982	705815	245171	124772	19209	0.154	1.0301	0.2179
1983	2360259	452408	121553	32988	0.2714	1.0042	0.3536
1984	963613	366304	198177	27450	0.1385	0.9688	0.2
1985	1249393	360687	191132	23343	0.1221	0.9846	0.1678
1986	949713	378569	231158	28785	0.1245	1.0002	0.1731
1987	3264967	573072	198536	48600	0.2448	0.9488	0.3356
1988	472512	434634	307190	29100	0.0947	0.9992	0.2625
1989	707288	379453	228712	29210	0.1277	1.001	0.1779
1990	805140	344791	197603	43969	0.2225	1.0006	0.2561
1991	496059	270510	169348	37700	0.2226	0.9971	0.2431
1992	413852	218127	135179	31856	0.2357	0.9951	0.2758
1993	612420	231071	113832	36763	0.323	1.006	0.3627
1994	795560	213539	95883	33908	0.3536	0.998	0.369
1995	448691	160257	81865	27792	0.3395	1.0525	0.4768
1996	803395	165097	60719	32534	0.5358	0.9955	0.5983
1997	760507	163953	61403	27225	0.4434	1.0016	0.5517
1998	458780	130164	47451	38895	0.8197	0.9988	1.1086
1999	312415	97480	37285	26109	0.7003	1.0018	0.8237
2000	372778	84341	30827	15005	0.4867	1.0011	0.4803
2001	322231	72809	27908	14061	0.5038	0.9988	0.7368
2002	376750	74912	25467	13587	0.5335	0.9991	0.6718
2003	191286	60025	27438	12921	0.4709	1.002	0.6308
Arith. Mean	762596	243592	120096	28018	.3058		.3865
0 Units	(Thousar	(Tonnes	(Tonnes	(Tonnes)			
1							

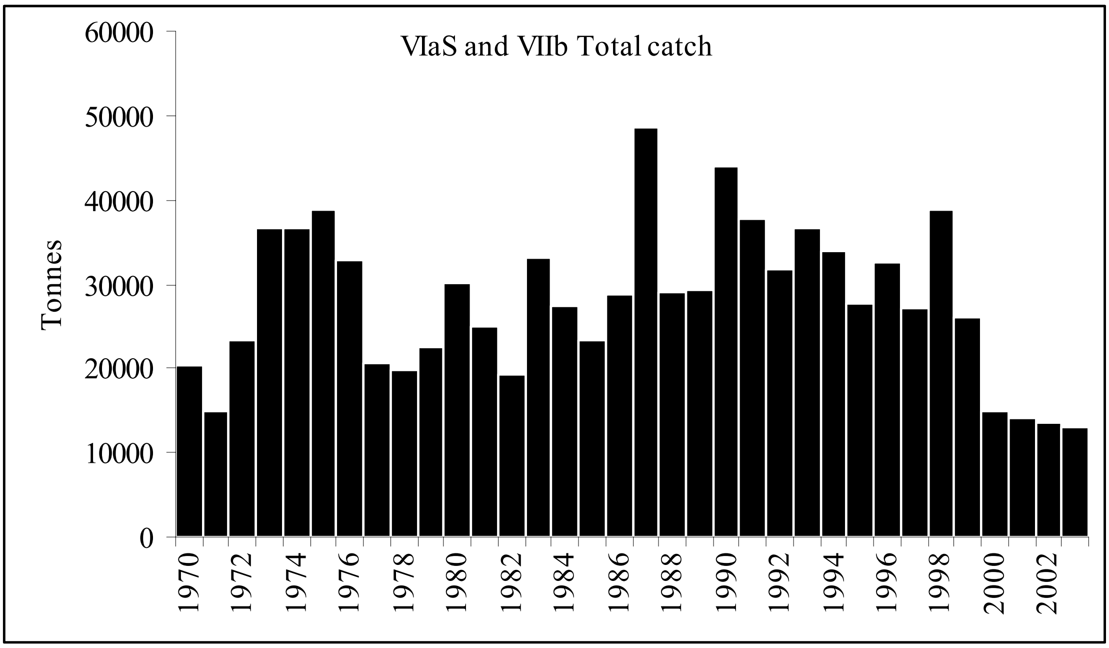

Figure 6.1.2.1 VIa(S) & VIIb,c herring catches from 1970-2003.

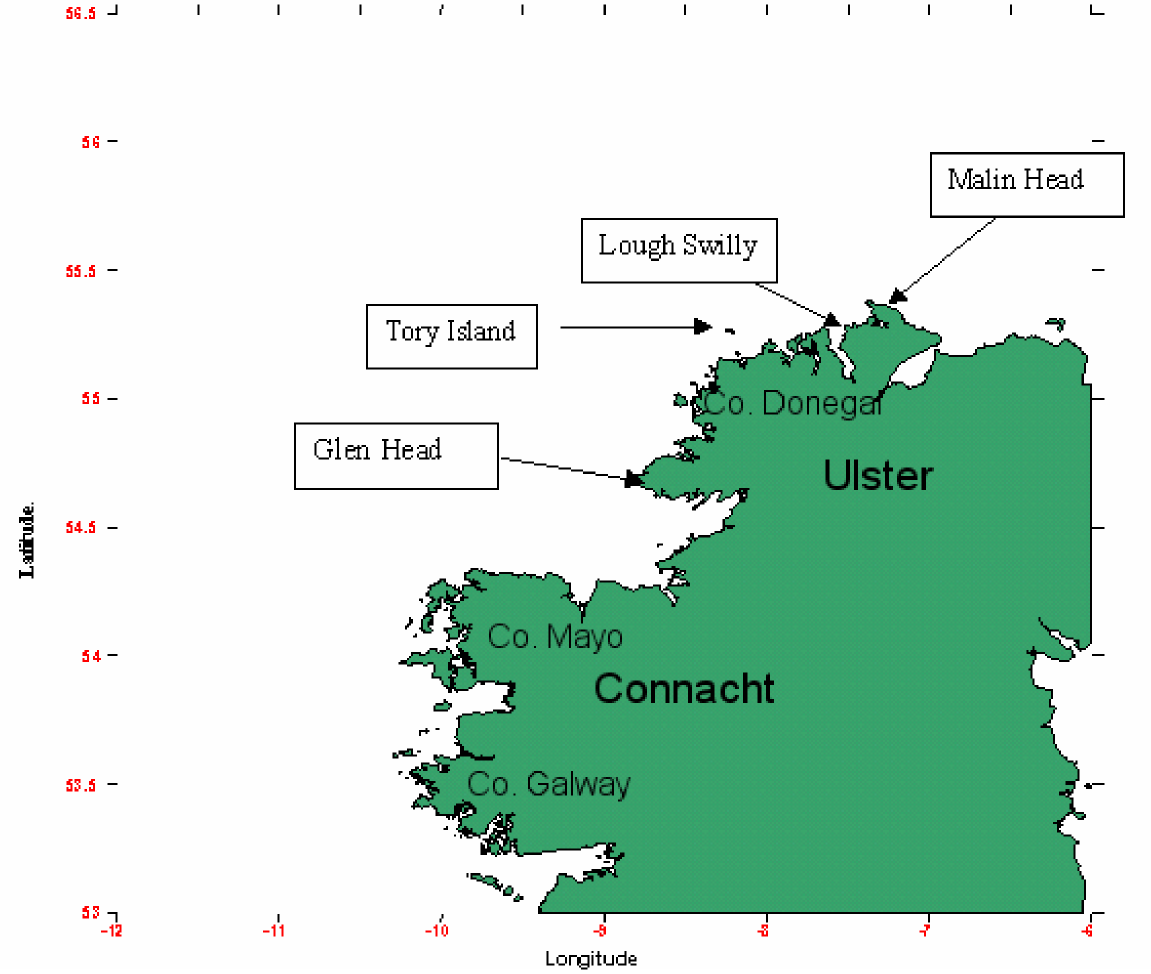

Figure 6.1.3.1 VIa(S) & Division VIIb,c. West and north coasts of Ireland, with locations mentioned in the text.

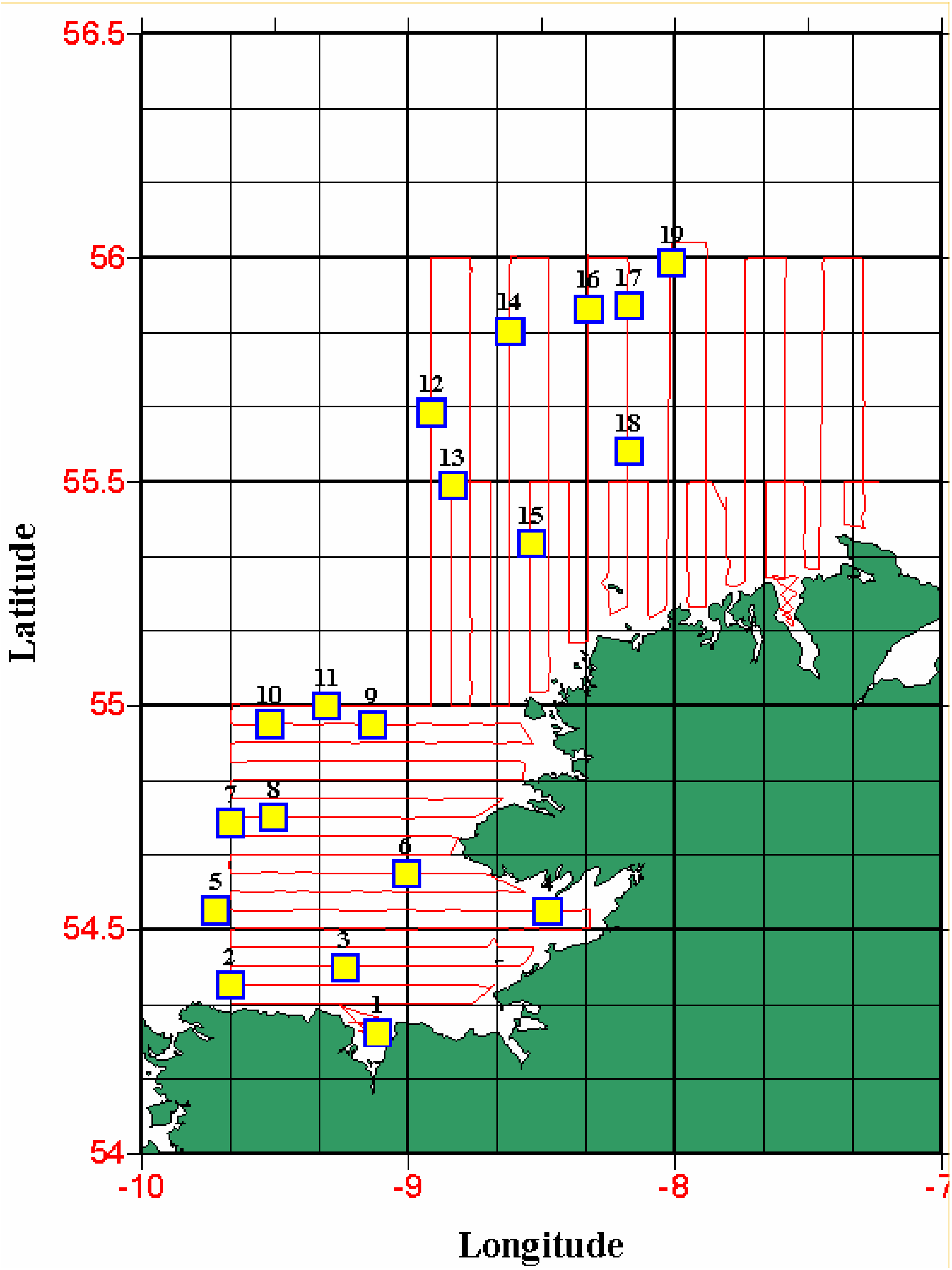

Figure 6.3.2.1 Cruise track and positions of fishing trawls undertaken during the 2003 north and west coast herring survey.

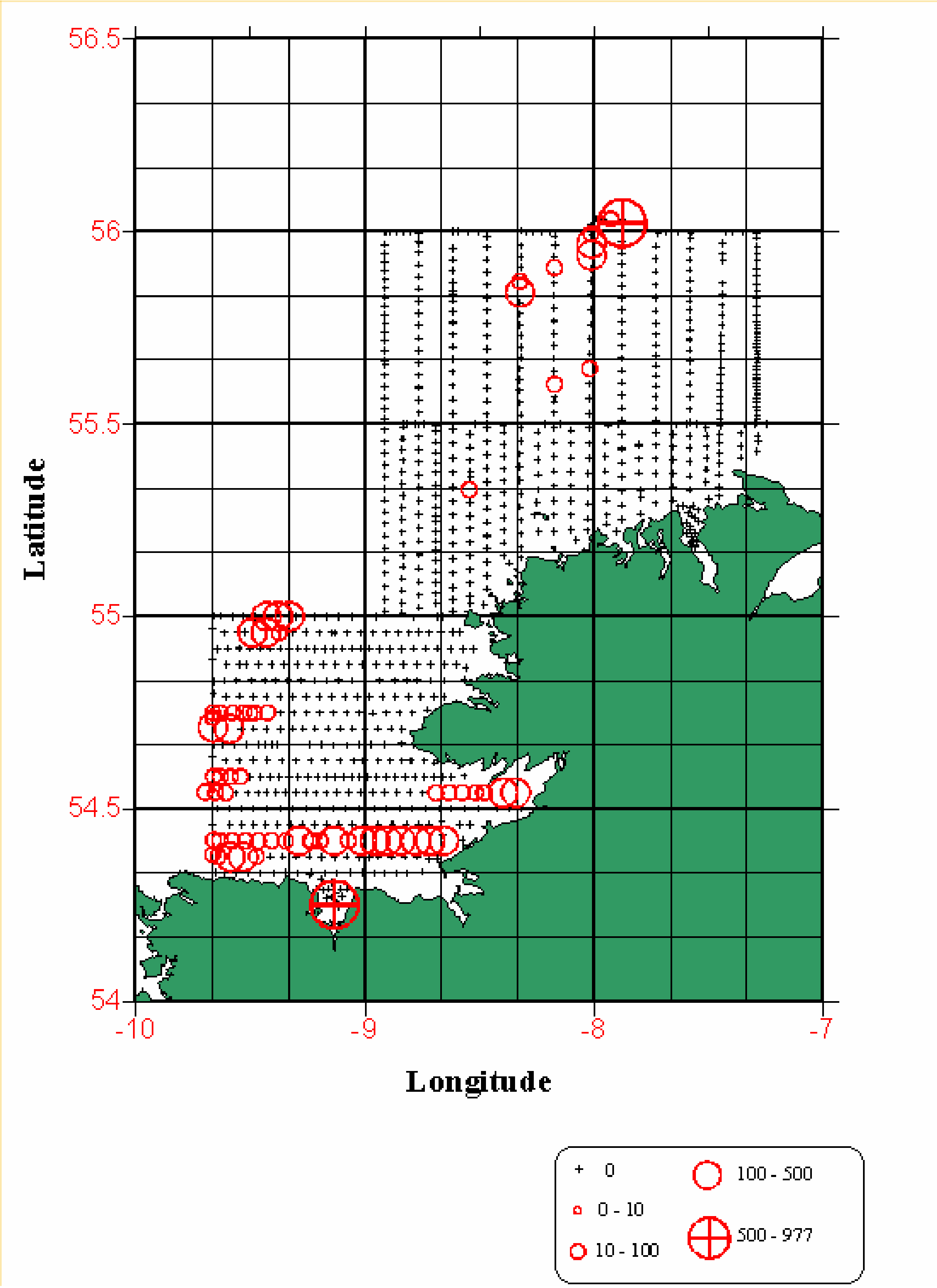

Figure 6.3.2.2 Post plot showing the distribution of total herring NASC values obtained during the 2003 Irish northwest coast herring acoustic survey.

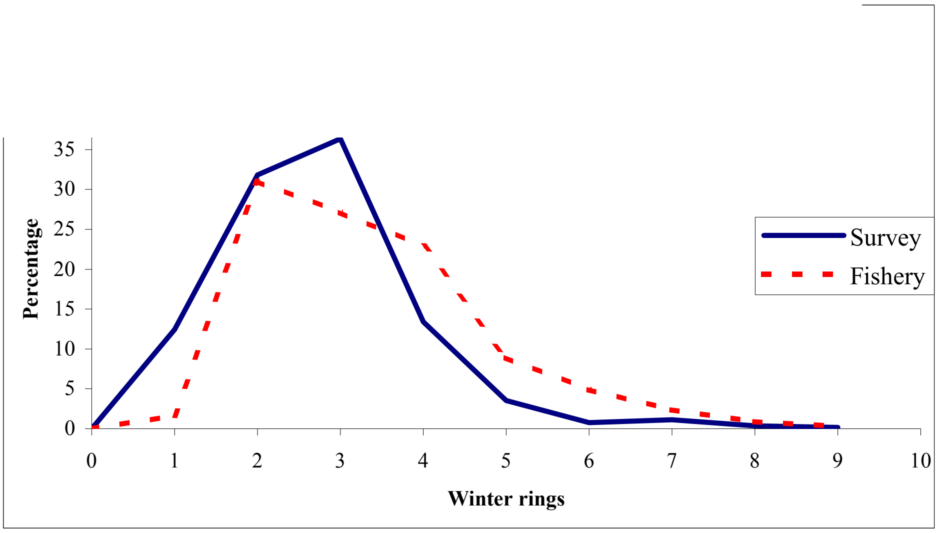

Figure 6.3.2.3. Age (winter rings) distribution in the commercial fishery and in the acoustic abundance estimate of winter spawning components of herring in VIIaS and VIIb in 2003.

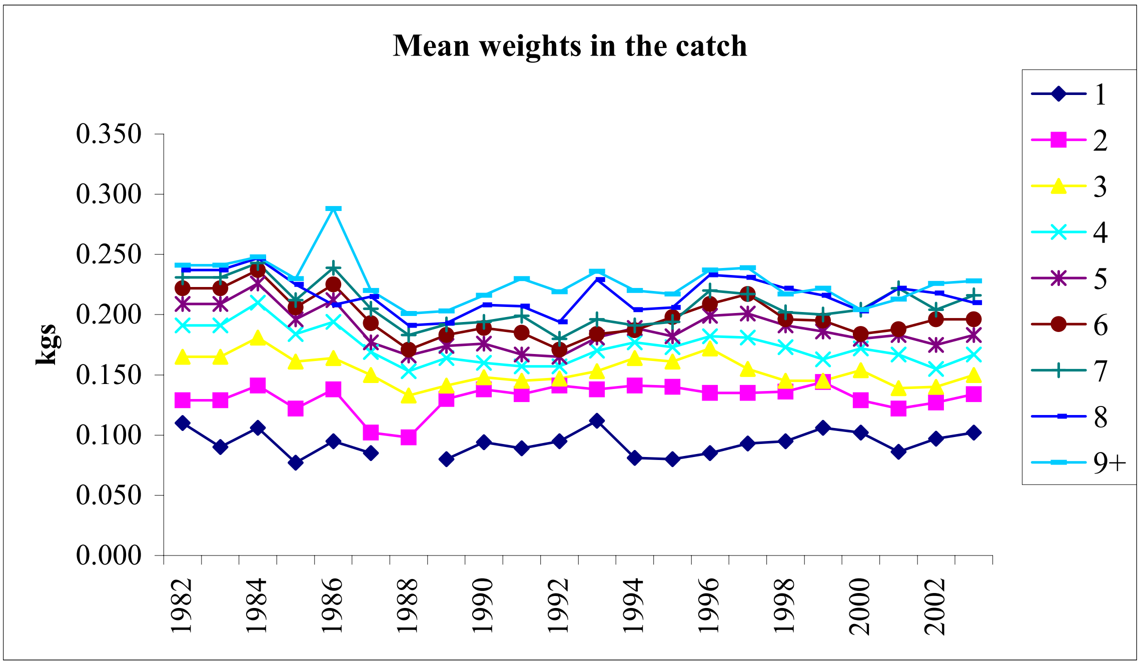

Figure 6.4.4.1. Mean weight in the catch of herring in VIaS and VIIb.

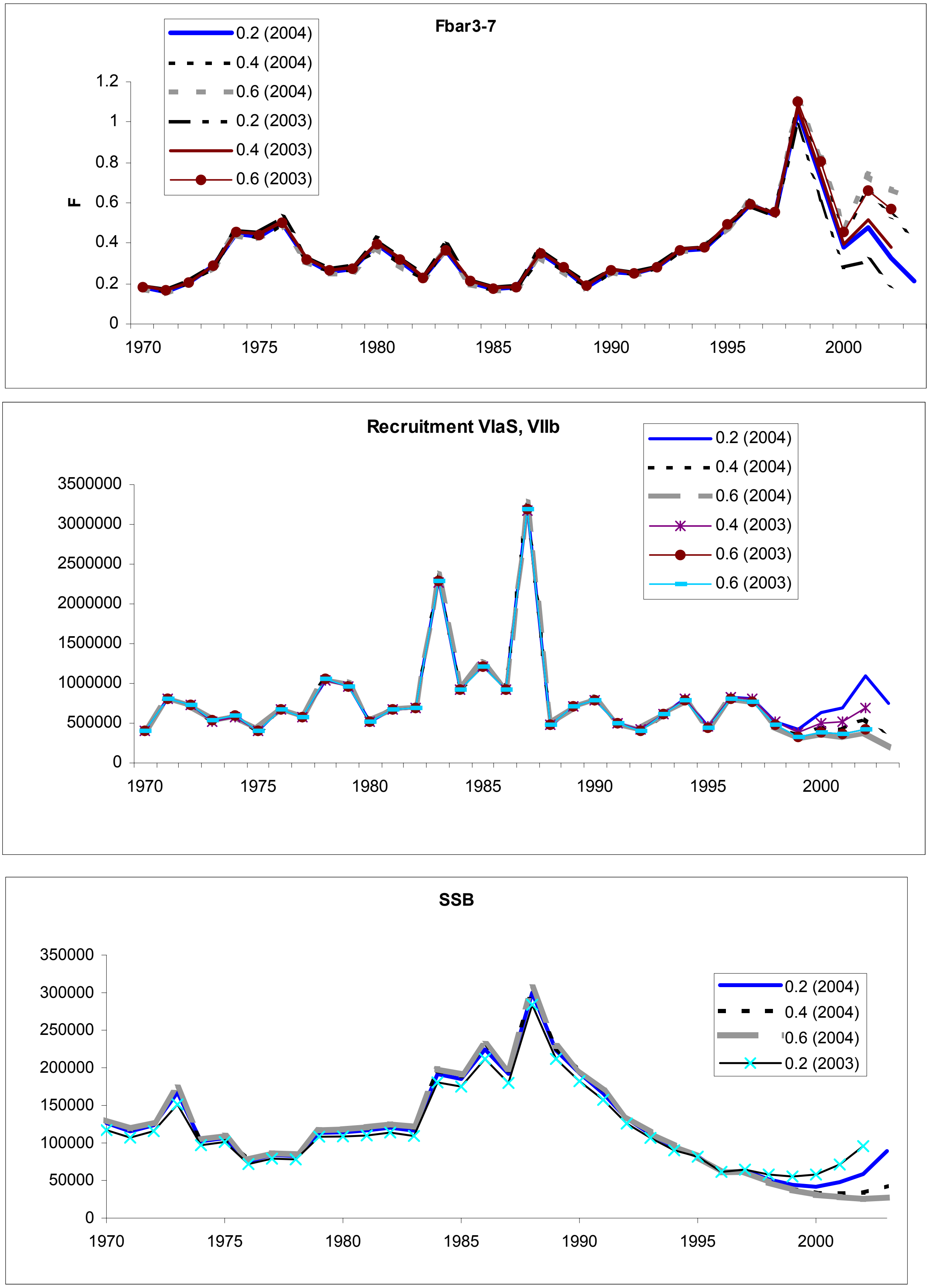

Figure 6.6.2.1. Comparison of three separable VPA runs in the current working group and the corresponding runs from 2003 working group. Runs correspond to terminal F's of 0.2, 0.4 and 0.6.

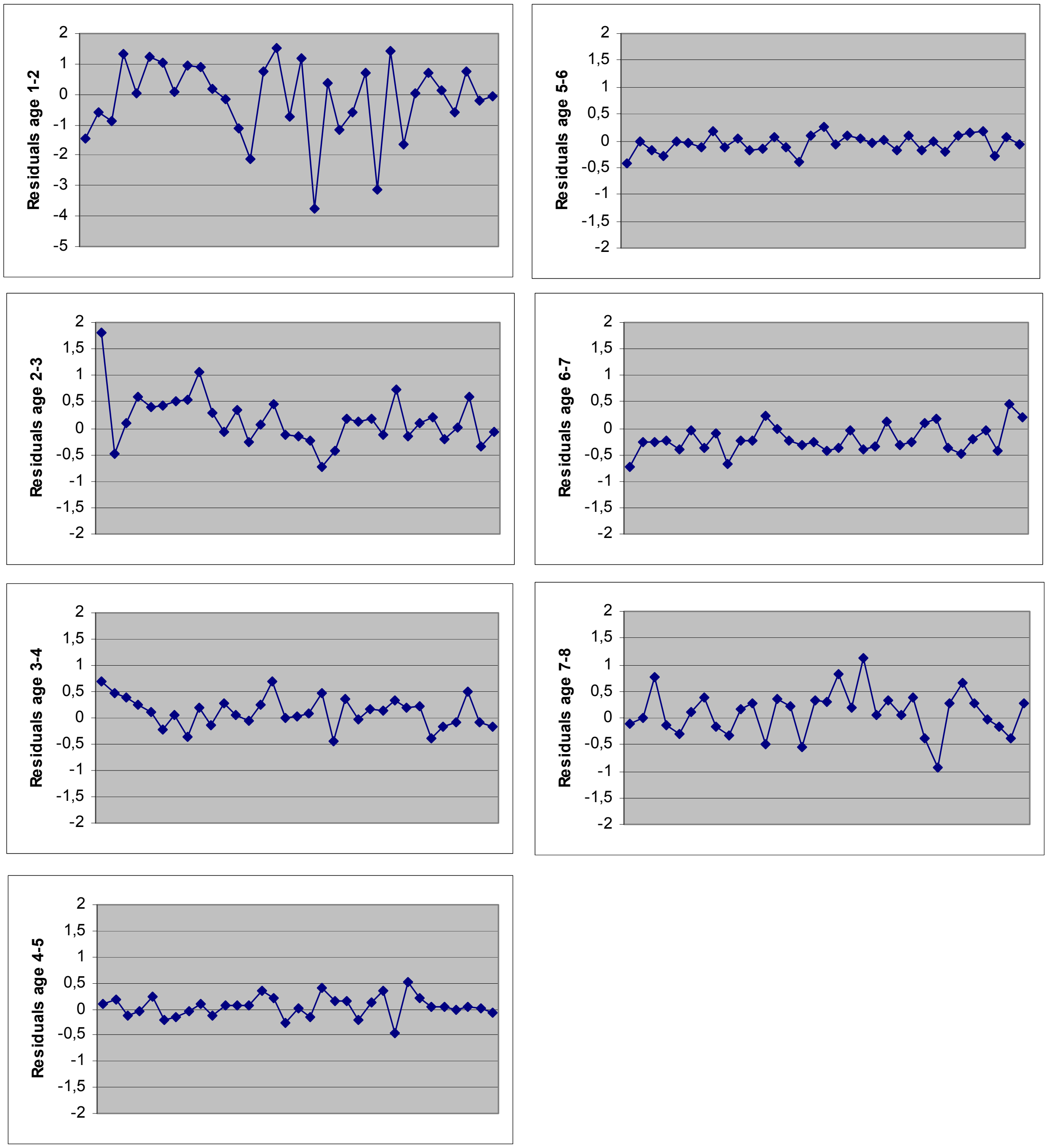

Figure 6.6.2.2. Herring in VIaS and VIIb, residuals from separable VPA, run 4, with terminal F of 0.2.

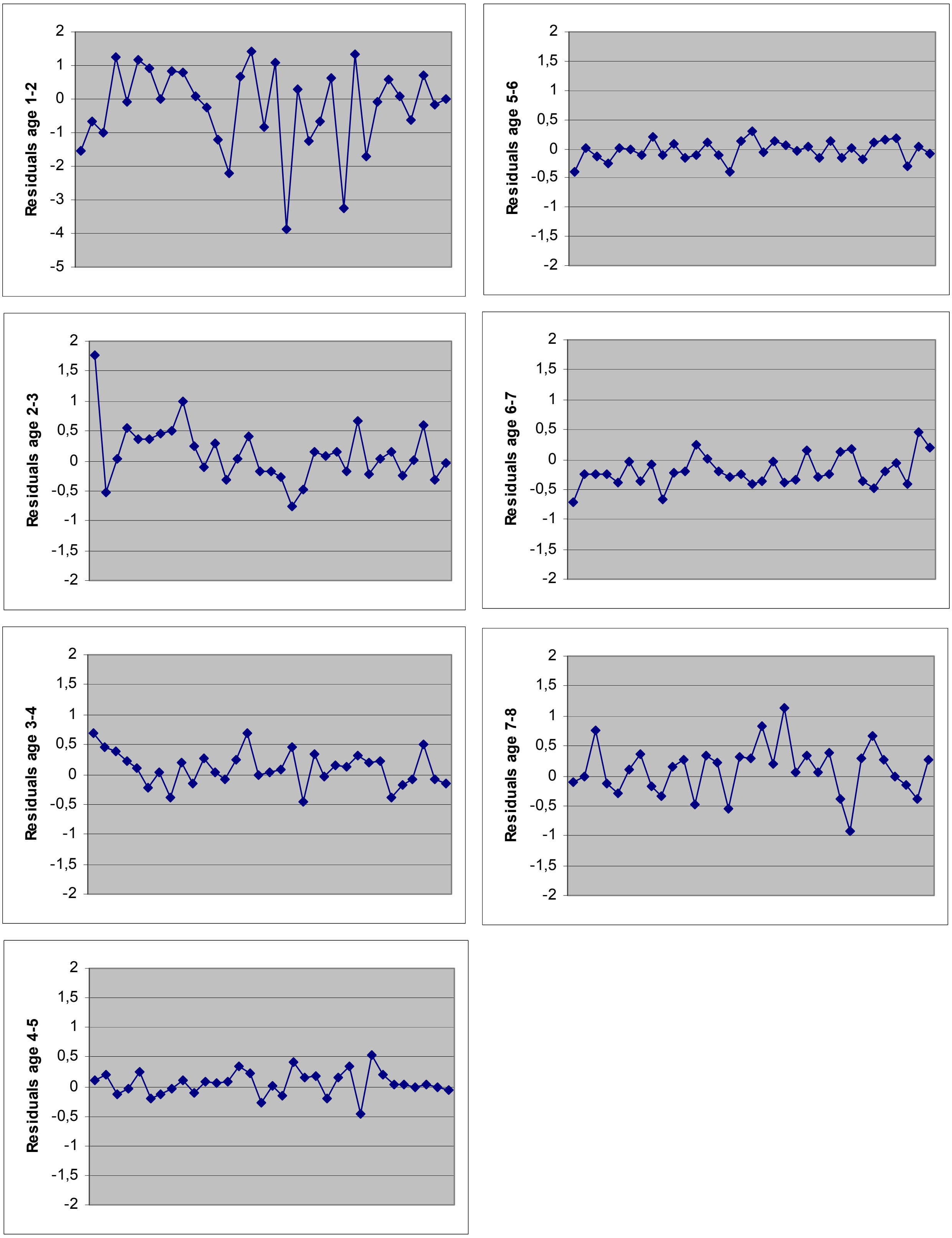

Figure 6.6.2.3. Herring in VIaS and VIIb, residuals from separable VPA, run 4, with terminal F of 0.4.

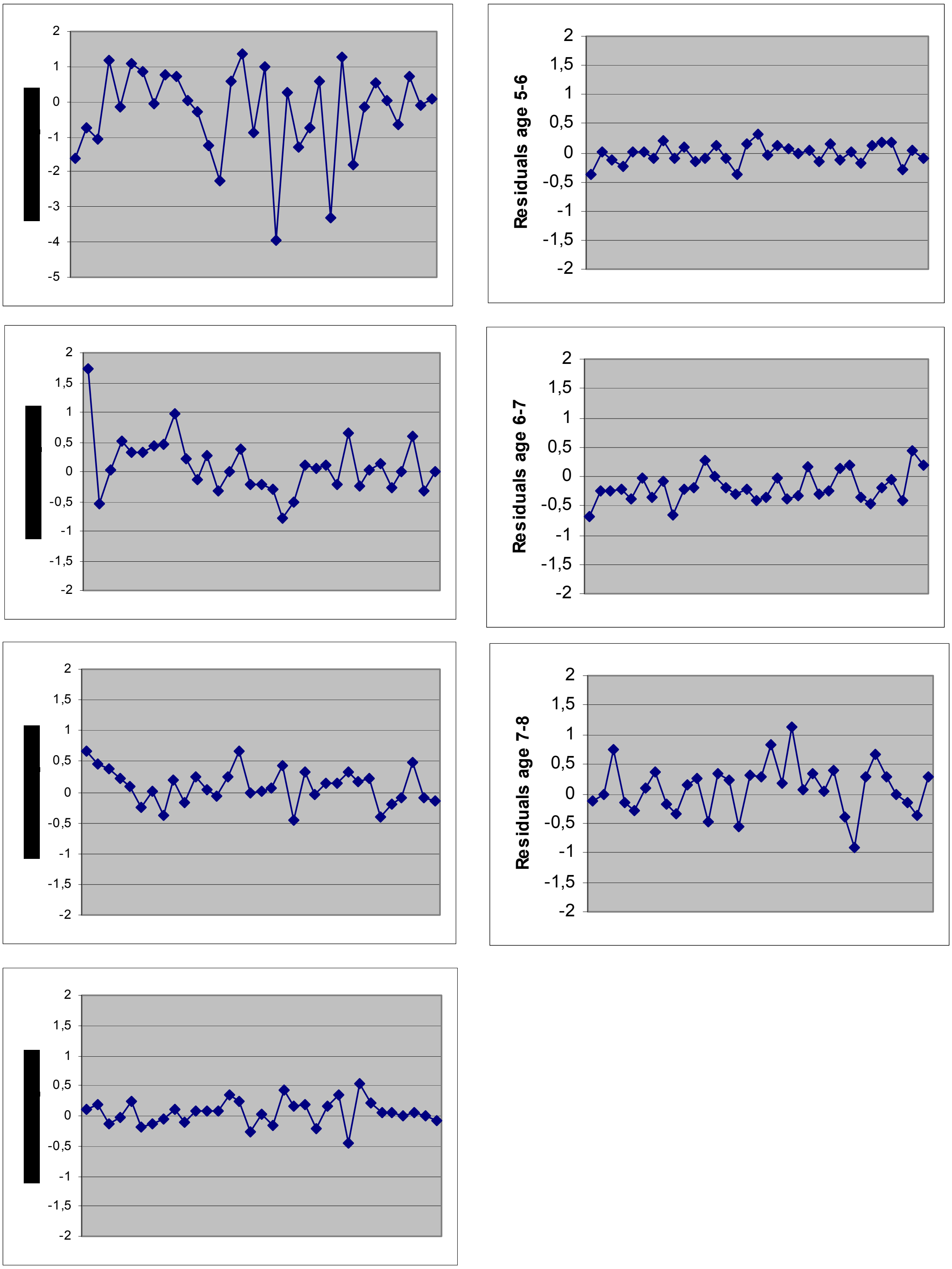

Figure 6.6.2.4. Herring in VIaS and VIIb, residuals from separable VPA, run 4, with terminal F of 0.6.

7 Irish Sea Herring (Division VIIA (North))

7.1 The Fishery

7.1.1 Advice and management applicable to 2003 and 2004

In 1998 and 1999 the shrinkage option in ICA was applied due to the instability in the assessment. The model estimate of F was shrunk to the mean of the ten previous years. In 1999, ACFM commented that F was still above $\mathbf{F}_{pa} = 0.36$, and should be reduced. In 2000 there was uncertainty in the size of the actual catches so a catch (6,900 t) reflecting *status quo* F (0.26) was recommended. In 2001, there was again uncertainty concerning the actual catches so a catch (4,800 t) based on the mean of the last five years was recommended for 2002. In the 2002 assessment, there was a suggestion of uncertainty in the size of the catches and the assessment was based on the official catches with the proviso that the SSB estimates were uncertain due to the unreliability of the size of the catch. Once again, ACFM felt that the HAWG 2002 assessment was too different from previous perceptions of the stock and advised that the catch in 2003 should not be allowed to increase above the advised 2002 TAC (4,800 t).

ACFM did not accept the HAWG 2003 assessment due to inconsistency in the survey data, a lack of a recruitment index, and the possibility of more than one stock in the management area. The advice was a catch equal to that reported in 2003 (approximately 2,400 t). A TAC of 4,800 t was subsequently adopted for 2004. This was partitioned as 3,550 t to the UK and 1,250 t to the Republic of Ireland.

7.1.2 The fishery in 2003

The catches reported from each country, for the period 1986 to 2003 are given in Table 7.1.1 and total catches from 1967 to 2003 in Figure 7.1.1 (catch-at-age in Figure 7.1.2). Reported landings in 2003 for the Irish Sea amounted to 2,399 t. In 2003, the UK did not take its entire quota and the Republic of Ireland reported no landings of herring from Division VIIa (N). The number of vessels targeting herring in the Irish Sea in 2003 was small, the majority from Northern Ireland with some representation from Scotland. According to the reported landings all of the significant catch was taken in the 3rd and 4th quarters. This year higher catches were slightly later in the year, in the fourth quarter. There was no Mourne gillnet fishery.

In 2003 the UK fishery opened in July. Closed areas for herring fishing in the Irish Sea along the east coast of Ireland and within 12 nautical miles of the west coast of Britain were maintained throughout the year. The traditional September gillnet fishery on the Mourne herring, which has a derogation to fish within the Irish closed box, did not take place again in 2003. 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 21 September to 15 November. Boats from the Republic of Ireland are not permitted to fish east of the Isle of Man.

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 2003 and a graphical representation is given in Figure 7.1.2. The predominant year class in 2003 was the 2- rings (2000-year class), with the 1996-year class also still being prevalent. The catch in numbers at length is given in Table 7.2.2 for 1988 to 2003. In 2003 two modes were evident, reflecting the relatively poor representation of 5-ring fish in the catch (see Table 7.2.2). The strong 1996-year class (6-ring) was also evident in the acoustic estimates (see Section 7.3.1).

7.2.2 Quality of catch and biological data

There was a suggestion that the landings data for herring in Division VIIa(N) were un-reliable between 1998 and 2001 (ICES 2002 ACFM:12). A re-examination of these data by the institute where most of the landings occur, resulted in the conclusion that the landings data for this time period are no more un-reliable than landings data in any adjacent management area. There are still no estimates of discarding or slippage of herring in the Irish Sea fisheries that target herring. Biological sampling of this fishery remains high (approximately 1 sample per 270 t landed) (Table 7.2.3), however, there is a suggestion that there may need to be some revisions for the 2003 data. All sampling was undertaken by Northern Ireland.

7.3 Fishery-independent information

7.3.1 Acoustic surveys

The information on the time-series of acoustic surveys in the Irish Sea is given in Table 7.3.1. Note that the 1+ biomass for 1998 has been revised from 21,200 t to 14,500 t to exclude 0-ring fish inadvertently included in the tables given in previous Working Documents and HAWG reports. Also note that the SSB data are different from those reported in previous Working Group Reports because they have been revised using the annually varying maturity ogive (see Table 7.4.3; estimated from the commercial catch data) used in the assessment by the Herring Assessment Working Group.

The acoustic survey in 2003 was carried out from 7 to 20 September (Figure 7.3.1), using a similar survey design of stratified, systematic transects used in previous years. Very few trawl catches of adult herring have been made off the Irish and English coasts over the period of the surveys, and 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 data on the age composition of the herring in the acoustic survey data. The survey followed the methods described in Armstrong *et al.,* 2004 WD 1; see Annex 7).

Mixed herring targets were detected at a number of locations off the west and south coasts of the Isle of Man, including in layers close to the seabed in deep water off the NW of the IOM (Fig. 7.3.1a). Trawl samples contained a relatively high proportion of young fish of 18 – 25 cm (mainly 1-2 ring fish attaining 2 – 3 years of age in autumn 2003), confirming reports from fishermen operating in this area. The survey was suspended overnight on 11/12 September to investigate herring schools detected by commercial vessels close inshore at Laxey on the NE coast of the Isle of Man. The presence of herring in this area was confirmed acoustically and the fish were caught by trawl. Herring were not detected in the surrounding regions during this exploratory survey. When the survey proper recommenced later in the day, herring were detected about 8 miles south of Laxey but not in the area where they had been found on the exploratory survey. It was possible that the fish had moved southwards with the tide during the intervening period. Data from the exploratory transects were therefore not included in the biomass estimate. A patch of dense herring schools was also detected further offshore off the east coast of the Isle of Man. As in previous years, no herring schools were detected in the area immediately north of the Isle of Man (Dickey-Collas *et al.* 2001), despite an abundance of early-stage larvae in this area in November (see Armstrong *et al.* 2004 WD1). Spawning in this area must have commenced after the date of the acoustic survey.

Herring in areas of the Irish Sea away from the Isle of Man were predominantly 0-rings of mean length 11-14 cm fish with some 1-rings of mean length 18-20 cm. Sprats and 0-ring herring were abundant around the periphery of the Irish Sea (Fig. 7.3.1b).

The estimate of herring SSB of 24,390 t for 2003 was above the average for the time-series, although close to the average for the last four years. The approximate coefficient of variation of 0.24 was the second lowest in the series of surveys. The biomass estimate for 1+ rings (49,500 t) was the largest in the series, whilst the CV of 0.22 for the stratified mean estimate was the second lowest in the series. The estimated age composition of the herring population, excluding 0-ring fish, is given in Table 7.3.2.

7.3.2 Larvae surveys

A larvae survey was undertaken by Northern Ireland (3-7 and 10-14 November 2003) but there was no survey by the Port Erin Marine Laboratory. The survey followed the methods and designs of previous surveys in the time-series (see Annex 7). The production estimate for 2003 in the NE Irish Sea was lower than the previous year for the November survey (Table 7.3.3). Once again, there were very few Mourne larvae caught in the Northern Irish survey.

7.3.3 Groundfish surveys of Area VIIa(N)

Groundfish surveys (see Annex 7), carried out by Northern Ireland since 1991 in the Irish Sea, were used by the 1996 to 1999 Herring Assessment Working Groups to obtain indices for 0- and 1-ring herring in the Irish Sea (Table 7.3.4) (Armstrong *et al.* 2004 WD1). The ground fish survey index, based on these data and used by the 1997 to 1999 Working Groups was a variance weighted mean abundance of each year class across the surveys. In 2000 the working group analysed these data and decided that the arithmetic mean abundance data (within strata) of 0-ring and 1-ring fish were more suitable as a prospective index of recruitment strength (Table 7.6.1). The standard errors are generally high over the series (coefficients of variation $\pm$ 50%). There is no consistent pattern between indices from the western and eastern Irish Sea and further investigations are required into the dynamics of juvenile abundance and distribution in the seas around Ireland. Both series are influenced by the variable number of Celtic Sea fish in the Irish Sea (see Brophy & Danilowicz 2002).

7.4 Mean length, weight, maturity and natural mortality-at-age

Mean lengths-at-age were calculated using the Northern Ireland data and are given for the years 1985 to 2003 in Table 7.4.1. In general, mean lengths have been relatively stable over the last few years.

Mean weights-at-age in the catch are given in Table 7.4.2. Mean weights-at-age of all ages were still generally low compared with previous years. 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. In the assessment, mean weights-at-age for the period 1972 to 1984 are taken as unchanging. In extending the data series back from 1971 to 1961 mean weights-at-age in the catch were taken from samples recorded by the Port Erin Marine Laboratory (see 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 is some uncertainty in the mean weights-at-age presented to the WG, as such the WG have used the average mean weights-at-age for the last five years. These will be revised next year.

Maturity-at-age (in the catches) for each year (1961 to 2003) are given in Table 7.4.3. Due to inconsistencies in the 2003 maturity data, a mean maturity ogive for the last nine years was used for 2003. The rationale for the 9 years was that there appeared to be a shift in the maturity ogive around 1993.

As in previous years, natural mortality per year was assumed to be 1.0 on 1-rings, 0.3 on 2-rings, 0.2 on 3-rings and 0.1 on all older age classes. These are based on the natural mortality rates determined for herring in the North Sea.

7.5 Recruitment

There are currently no recruitment indices for this stock.

7.6 Stock Assessment

7.6.1 Data exploration and preliminary modelling

In the previous year's the assessment, three fishery independent survey indices were used: Douglas Bank larvae abundance, Northern Irish larvae production and the age dis-aggregated abundance from the acoustic survey. There has now been some doubt raised as to the value of the age dis-aggregated acoustic data. This is due to the variability in the estimates of numbers at age, primarily caused by the low number of samples taken in the acoustic survey (Armstrong & Roel 2004 WD). The low sampling rate introduces a large amount of noise in to the age matrix in the acoustic survey data. In an effort to avoid the age structure problems associated with the acoustic data Armstrong and Roel (2004 WD) suggested the use of the 1+ biomass index as an alternative. The use of a 2+ biomass index or an SSB index from the acoustic survey would also be dependent on a reliable age matrix in the acoustic data. Roel and De Oliveira (2004 WD) also presented a two-stage biomass model as an alternative approach to using the standard ICA. This is also explored below.

This year, the preliminary modelling used catch-at-age data derived from the official landings, extended back to 1961. New data were added to the Northern Irish larvae series (NINEL), the Northern Irish acoustic survey (AC_1+, AC-VIIa(N), and ACAGE), October and March groundfish surveys for the east, west and combined areas (Table 7.6.1). No new data were added to the Douglas Bank larvae series (DBL). The Division VIIa(N) acoustic survey estimates are not considered as absolute because of discrepancies between acoustic estimates and tuned SSB estimates seen in other herring stocks.

The survey series available for inclusion in an assessment using the ICA package are documented in Appendix 7.

Due to the problems associated with mixing of Irish Sea and Celtic Sea juveniles none of the groundfish surveys were considered as suitable. However, due to the potential problem with the age structure of the acoustic data an acoustic 1+ biomass index was also considered. Therefore, only the three indices used last year plus the 1+ biomass index were considered suitable for this year (NINEL, DBL, ACAGE and AC_1+).

Initial fits within integrated catch-at-age analysis (ICA), were found in 2004 with all three indices. The following input values were used:

- Separable constraint over the last 6-years (weighting = 1.0 for each year)
- Reference age = 4
- Constant selection pattern model
- Selectivity on oldest age = 1.0
- First age for calculation of mean F = 2
- Last age for calculation of mean F = 6
- Weighting on 1-rings = 0.1; all other age classes = 1.0
- Weighting for all years = 1.0
- All indices treated as linear
- No S/R relationship fitted
- Lowest and highest feasible F = 0.05 and 2.0
- All survey weights fitted by hand i.e., 1.0 with the 1-rings in the acoustic survey weighted to 0.1.
- Correlated errors assumed i.e., = 1.0
- No shrinkage applied

The Northern Irish larvae index (NINEL) indicated the lowest reference F (0.225) compared to the acoustic index (ACAGE 0.328), however, both have relative large confidence intervals (Figure 7.6.1). The Douglas Bank larvae (DBL) gave the highest reference F (0.422) and the lowest precision with very wide confidence intervals probably partially reflecting the lack of new data for the last four years. As in last year the precision in F was greater for NINEL and ACAGE than DBL, however, the precision appeared less than last year. A run was undertaken using all the indices used last year (SPALY) and this indicated a reference F (0.288) intermediate between the various indices but with relatively poor precision compared to 2003 analyses.

Using the Acoustic age 1+ biomass as an SSB index (AC_1+) gave a lower and relatively precise reference F (0.164) (Figure 7.6.1) suggesting that the aggregate biomass indices from acoustics do not seem to be totally out of line with what ICA generates.

The larvae production estimates of SSB (NINEL) was combined with the Acoustic 1+ biomass to provide another perception of SSB. The result was a slightly increased Reference F (0.202) and similar level of precision compared to SPALY.

The historical and recent trends in log catch ratios and catch per estimated acoustic biomass (1+) were investigated along cohorts to give some indication of trends in Z and consistency between the different sources of information.

An investigation of the log abundance ratios estimated in the acoustic survey indicate a relatively noisy pattern across year classes with a few exceptions (Figure 7.6.2). In the period 2001 to 2002 there appeared a year effect in the older year classes that was not apparent in the younger years classes. This is not apparent in the catch data. The large year effect in 2000 in the catch data was caused by a very low reported catch in 2000.

Examination of the rate of exploitation in terms of the catch to acoustic estimated 1+ biomass ratios, suggest an increase from 1995 to 1998 and a relatively lower exploitation rate over the period 1999 to 2003 (Figure 7.6.3). This suggests that the fishing mortality has probably been relatively stable over this time period.

The historic average depletion rates of year classes over age show the very high depletion rate (high slopes) over the 1970 to 74 year classes and to a certain extent the 1975 to 79 year classes (Figure 7.6.4). This corresponds to the period of very high catches in the Irish Sea. In general, the 1980 year classes onward have shown a consistent lower depletion rate, especially in the last few year classes (1995 to 98), suggesting a relatively stable Z over this time period. These data suggest that in the recent past there has not been a substantial increase in total mortality and, assuming a constant natural mortality (M), that there has not been a substantial increase in fishing mortality (F).

To examine how the 1+ biomass index performed as a 1+ biomass index ICA was run with the maturity ogive set to 1.00 for all ages and AC_1+ used as the index. The resultant trajectory of SSB for the runs using AC_1+ as a biomass index and as an SSB index are given in Figure 7.6.5. Overall, the pattern is similar, however, there are small differences in the most recent years that are not likely to be significant. However, the 1+ index includes 1- and 2-ring fish which are from two different stocks (Celtic Sea and Irish Sea) therefore it should be treated with caution. Further, the influence of year to year variations in numbers and proportions of these young fish in the Irish Sea is still unknown (Brophy and Danilowicz 2002).

To investigate the uncertainty in the estimated F and SSB from ICA a series of estimates of uncertainty from the ICA bootstrapped mean F and SSB for the three main indices was obtained (Figures 7.6.6; 7.6.8-9). The NINEL index has the largest range in both F and SSB. As is to be expected with relatively noisy data the Acoustics age-structured index (ACAGE) has a greater variability in F than AC_1+ but the reverse is true in the estimates of SSB. The noisy nature of the indices is transferred to a large uncertainty in F in the SPALY run (Figure 7.6.7-9), SSB in the AC_1+ run and in both for the AC_1+ & NINEL run. However, an examination of the box plots for the various individual choices and combined suggest similar variability in the case of F although the acoustic 1+ index provides more precise estimates compared with the other options. The acoustics age-structured index performs best when estimating SSB.

Explorations were made on the retrospective use of the 1+ biomass index (see also Armstrong and Roel 2004 WD) and on the SPALY run (DBL, NINEL and ACAGE). There was a relatively constant retrospective performance in estimating SSB by the 1+ biomass index (Figure 6.7.10). The pattern from the SPALY run showed similar features although it was performed only for the last four years. The largest deviation from all other values corresponds to an extremely high estimate of recruitment in 2002 (Figure 6.7.11). As information on recruitment is poor in both the catch at age and the survey, that is not surprising.

Two-stage biomass model

An Assessment of Irish Sea VIIa herring using a Two-Stage Biomass model was presented by Roel and De Oliveira (2004 WD) based on an approach developed by Roel and Butterworth (2000). The model was fitted to the biomass of 1-ringers and 2+ ringers of the Northern Ireland acoustic survey for the period 1994 – 2003. The dynamics takes into account only two stages in the population: the recruits (1-ringer) and the fully recruited fish (2-ringer and older). Maximum likelihood estimation is used, assuming survey indices are log-normally distributed about their expected values. Standard errors of the log-distributions are approximated by the sampling CVs. The results are sensitive to the choice of the composite parameter *g* (see equation 1) which is fixed externally. A comparison is made between the total biomass estimates from the survey, the two-stage biomass model and ICA (using the acoustic 1+ index). Both the acoustics index and the two-stage model suggest an increasing trend in the stock biomass starting in 1998. Given the number of "independent" data versus number of estimable parameters the two-stage biomass model is likely to be over-parameterised. A more constrained model (e.g. not allowing the recruitments to vary so freely) could be attempted to address that concern.

Population Dynamics: The biomass dynamics are represented by the following:

$$B_{2+,y+1} = \left[(B_{2+,y} + B_{1,y})e^{-3g/4} - C_y\right]e^{-g/4} \qquad [1]$$

where:
$B_{1,y}$ is the biomass of recruitment (tons) at the start of year y;
$B_{2+,y}$ is the biomass of 2+ aged fish (tons) at the start of year y;
C_y is the biomass of fish caught (tons) during year y, assumed to be taken in a pulse fishery 3/4 of the way into year y; and
g is a composite parameter, treated as an annual rate, which accounts for natural mortality and growth.

Fitting criterion: Maximum likelihood estimation is used, assuming survey indices are log-normally distributed about their expected values. Standard errors of the log-distributions are approximated by the sampling CVs of the untransformed distributions. The negative log-likelihood function to be minimised is as follows:

$$-\ln L = \tfrac{1}{2}\sum_{a=1,2+}\sum_{y=1994}^{2003}\left\{\frac{[\ln I_{a,y} - \ln(q_a B_{a,y} e^{-3g/4})]^2}{\sigma_y^2} + \ln(2\pi\sigma_y^2)\right\} \qquad [2]$$

where q_1 and q_{2+} are the catchabilities associated with the survey indices $I_{1,y}$ and $I_{2+,y}$ respectively, and σ_y^2 represents the survey sampling CV (the same value is assumed to apply to both indices), calculated from the 15-minute acoustic interval estimates within strata.
The estimable parameters are g, $B_{2+,1994}$, $B_{1,1994}$,...,$B_{1,2003}$, q_1 and q_{2+}. However, only $B_{2+,1994}$, $B_{1,1994}$,...,$B_{1,2003}$, are included as search parameters in the minimisation routine, because g is treated as an input parameter (and therefore fixed externally), while closed form solutions exit for q_1 and q_{2+} as follows:

$$q_a = \exp\left\{\tfrac{1}{10}\sum_{y=1994}^{2003}[\ln I_{a,y} - \ln(B_{a,y}e^{-3g/4})]\right\} \quad \text{, for } a = 1 \text{ or } 2+ \qquad [3]$$

In order to investigate appropriate values for g, an estimate of g_a was obtained based on estimates of biomass at age ($B_{y,a}$) from ICA (acoustic 1+ biomass as a tuning index) and the landings ($C_{y,a}$) for the period 1994 - 2003 as follows:

$$g_a = \ln\left[\frac{B_{y,a} - C_{y,a}}{B_{y+1,a}}\right] \qquad [4]$$

The distribution of g_a suggests that a value around 0.2 could be appropriate. Sensitivity to that assumption was tested for values of g equal to 0.4 and 0.6.

Results: A comparison between the biomass estimates from ICA (procedure as in last year (SPALY) and using acoustics 1 plus as SSB index), the biomass estimate from the acoustic survey and the biomass estimate from the two-stage biomass model are shown in Figure 7.6.12 showing a good fit from the model to the survey index.

The normalised residuals from the model fit for g = 0.2, 0.4 and 0.6 are shown in Figure 7.6.13. Stronger patterns are shown for g = 0.2.

Conclusion to explorations

Due to uncertainty in the various tuning indices and potential assessments examined in relation to the 2003 assessment it was decided to present the SPALY run, updated for the current year to provide an indication of the historical development of the stock. The results from the two-stage biomass models were presented as exploratory.

7.6.2 Stock Assessment

The work shown is an updated exploratory assessment and no analytical assessment is presented this year. The results of a baseline model fit (with ACAGE, NINEL and DBL) are shown in Figures 7.6.14-7.6.18, for illustrative purposes only. The run log is given in Table 7.6.2. Some of the standard plots for the indices are not shown due to problems encountered with using IcaView in Windows 2000, the residuals and fitted values are given in Table 7.6.3. The SSQ for the index shows a minimum at a relatively low level of fishing mortality (Figure 7.6.3). The estimate for $F_{(2-6)}$ for 2003 using the official landing data was 0.25 (Table 7.6.3) with a corresponding SSB estimate of approximately 8,400t. The assessment shows estimated fishing mortality and SSB in the last few years to be similar to previous estimates. The standard fish stock summary plots are not given as these may be misleading, similarly there is no plot of $\mathbf{F}_{low}$, $\mathbf{F}_{med}$ and $\mathbf{F}_{high}$.

7.7 Stock and Catch Projection

No Short-term predictions were carried out due to the uncertainty of the current F, SSB and subsequently numbers-at-age. The explorations of the data suggest that current total (Z) and fishing (F) mortalities are either similar or lower than in the recent past and that the SSB has been stable. Similarly there does not appear to have been any major shift in the selection pattern within this fishery in recent years.

In 2003, the UK did not take its full quota and the Republic of Ireland did not participate in the fishery. There is still no evidence that the fleets will take their quota (4,800 t) in 2004, therefore there is every possibility that fishing mortality in 2004 will not rise dramatically. These low levels of fishing should allow the stock to maintain a status quo SSB, if not allow the SSB to rise.

7.8 Medium-term predictions of stock size

The Working Group decided that there was no basis for undertaking medium-term projections of stock size until the assessment is stable and there is agreement that advice can be given based on the assessment. The current state of herring recruitment to VIIa(N) is unclear, considering the imprecision in the assessments and the variable mixing of Celtic Sea and Irish Sea juveniles. Also the historical assessments of recruitment have incorporated both Manx and Mourne components and the contribution of the Mourne component is now thought to be negligible.

7.9 Reference points

Until there is confidence in the assessment the Working Group decided not to revisit the estimation of $\mathbf{B}_{pa}$ (9,500 t) and $\mathbf{B}_{lim}$ (6,000 t). There were no new points to add to the discussions and deliberations presented in 2000 (ICES 2000/ACFM:12).

7.10 Quality of the Assessment

The current time-series of survey data are prone to providing variable perceptions of stock development due to variability in catchabilities of the indices. This WG explored the data using a wide range of techniques, some of them fairly crude and others, innovative. The exploration of the data showed poor precision in the estimation of SSB and F, but a broad suggestion that mean $F_{2\text{-}6}$ was below 0.4 (Figures 7.6.7-9) in 2003. The analysis suggests that the selection pattern has stabilised in the last 6 years.

The tuning data used in the assessment are noisy and that results in imprecision and, at times instability. The imprecise estimates of SSB show either no trend with time in recent years or are slightly divergent, depending on the indices or assessment methods used. There have probably been changes in this stock since the early 1990s, with reductions in weights-at-age and changes in spawning behaviour. Spawning sites have varied with notable spawning to the north of the Isle of Man and the reduction in the Mourne component and may partially explain the changes referred to above. It is likely, however, that the SSB has stabilised over recent years.

7.11 Spawning and Juvenile Fishing Area Closures

The arrangement of closed areas in Division VIIa(N) prior to 1999 are discussed in detail in ICES (1996/ACFM:10) with a change to the closed area to the east of the Isle of Man being altered in 1999 (see ICES 2001/ACFM:10). The closed areas consist of: all year juvenile closures along part of the east coast of Ireland, and the west coast of Scotland, England and Wales; spawning closures along the east coast of the Isle of Man from 21st September- 15th November, and along the east coast of Ireland all year round. The Working Group recommends that any alterations to the present closures are considered carefully, in the context of this report, to ensure protection for all components of this stock.

7.12 Management considerations

The tuning data sets have varied considerably between years, for example including or excluding groundfish survey data, thus providing considerable between year variation in the perception of the stock. Currently there are no recruitment indices to provide a forecast of recruitment plus the juveniles in the area are a mixture of two adjacent stocks (Celtic Sea and VIIa(N)). However, the catches have been low in recent years and there are no indications of problems in the catch-at-age for this stock. Analytical retrospectives suggest that the assessments examined are relatively stable. Further, a broad range of year classes is present in the stock. 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). Official catch in tonnes by country, 1986-2003. The total catch does not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994
Ireland	1,640	1,200	2,579	1,430	1,699	80	406	0	0
UK	4,376	3,290	7,593	3,532	4,613	4,318	4,864	4,408	4,828
Unallocated	1,424	1,333	-	-	-	-	-	-	-
Total	7,440	5,823	10,172	4,962	6,312	4,398	5,270	4,408	4,828

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003
Ireland	0	100	0	0	0	0	862	286	0
UK	5,076	5,180	6,651	4,905	4,127	2,002	4,599	2,107	2,399
Unallocated	-	22	-	-	-	-	-		-
Total	5,076	5,302	6,651	4,905	4,127	2,002	5,461	2,393	2,399

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

Table 7.2.2 Irish Sea herring Division VIIa (N). Catch-at-length for 1988-2003. Numbers of fish in thousands

Length	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
14	1															
	1															
15	1				95											
	10				169							10				
16	13		6		343			21	21	17		19	12	9		
	16		6	2	275			55	51	94		53	49	27		
17	29		50	1	779		84	139	127	281	26	97	67	53		
	44	24	7	4	1106		59	148	200	525	30	82	97	105		
18	46	44	224	31	1263		69	300	173	1022	123	145	115	229		
	85	43	165	56	1662		89	280	415	1066	206	135	134	240	36	
19	247	116	656	168	1767	39	226	310	554	1720	317	234	164	385	18	
	306	214	318	174	1189	75	241	305	652	1263	277	82	97	439	0	29
20	385	226	791	454	1268	75	253	326	749	1366	427	218	109	523	0	73
	265	244	472	341	705	57	270	404	867	1029	297	242	85	608	18	215
21	482	320	735	469	705	130	400	468	886	1510	522	449	115	1086	307	272
	530	401	447	296	597	263	308	782	1258	1192	549	362	138	1201	433	290
22	763	453	935	438	664	610	700	1509	1530	2607	1354	1261	289	1748	1750	463
	1205	497	581	782	927	1224	785	2541	2190	2482	1099	2305	418	1763	1949	600
23	2101	612	2400	1790	1653	2016	1035	4198	2362	3508	2493	4784	607	2670	2490	1158
	3573	814	1908	1974	1156	2368	1473	4547	2917	3902	2041	4183	951	2254	1552	1380
24	5046	1183	3474	2842	1575	2895	2126	4416	3649	4714	3695	4165	1436	3489	1029	1273
	5447	1656	2818	2311	2412	2616	2564	3391	4077	4138	2769	3397	1783	4098	758	1249
25	5276	2206	4803	2734	2792	2207	3315	3100	4015	5031	2625	2620	2144	5566	776	1163
	4634	2720	3688	2596	3268	2198	3382	2358	3668	3971	2797	1817	1791	4785	1335	1211
26	4082	3555	4845	3278	3865	2216	3480	2334	2480	3871	3115	1694	1349	3814	1570	1140
	4570	3293	3015	2862	3908	2176	2617	1807	2177	2455	2641	1547	840	2243	1552	1573
27	4689	2847	3014	2412	3389	2299	2391	1622	1949	1711	2992	1475	616	1489	776	1607
	4124	2018	1134	1449	2203	2047	1777	990	1267	1131	1747	867	479	644	433	1189
28	3406	1947	993	922	1440	1538	1294	834	906	638	1235	276	212	496	162	726
	2916	1586	582	423	569	944	900	123	564	440	170	169	58	179	108	569
29	2659	1268	302	293	278	473	417	248	210	280	111	61	42	10	36	163
	1740	997	144	129	96	160	165	56	79	59	92		12	0	36	129
30	1335	801	146	82	70	83	9	40	32	8	84		6	9		43
	685	557	57	36	36	15	27	5	0	5	3					43
31	563	238	54	12	2	4		1	2							43
	144	128	31	3												
32	80	57	29													
	7	7														
33	2	5														
	1	6														
34		0														
		5														

Table 7.2.3 Irish Sea herring Division VIIa (N). Sampling intensity of commercial landings in 2003.

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)	1	0	0	0	-
2	UK (Isle of Man)	*	0	0	0	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
	Ireland	0	-	-	-	-
	UK (N. Ireland)	725	3	307	148	No
3	UK (Isle of Man)	*	0	0	0	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
	Ireland	0	-	-	-	-
	UK (N. Ireland)	1524	6	825	297	No
4	UK (Isle of Man)	3	0	0	0	-
	UK (Scotland)	146	0	0	0	-
	UK (England & Wales)	0	-	-	-	-

** <1t*

Table 7.3.1 Irish Sea herring Division VIIa (N): Summary of acoustic survey information for the period 1989-2003. 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

[1] sprat only; [2]Data can be made available for the IoM waters only

Table 7.3.2 Irish Sea herring Div. VIIa (N). Age-disaggregated acoustic estimates of herring abundance from the Northern Ireland surveys in September (**ACAGE**).

Age (rings)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	66.8	319.1	11.3	134.1	110.4	157.8	78.5	387.6	391.0	349.2
2	68.3	82.3	42.4	50.0	27.3	77.7	103.4	93.4	71.9	220.0
3	73.5	11.9	67.5	14.8	8.1	34.0	105.3	10.1	31.7	32.0
4	11.9	29.2	9.0	11.0	9.3	5.1	27.5	17.5	24.8	4.7
5	9.3	4.6	26.5	7.8	6.5	10.3	8.1	7.7	31.3	3.9
6	7.6	3.5	4.2	4.6	1.8	13.5	5.4	1.4	14.8	4.1
7	3.9	4.9	5.9	0.6	2.3	1.6	4.9	0.6	2.8	1.0
8+	10.1	6.9	5.8	1.9	0.8	6.3	2.4	2.2	4.5	0.9

Table 7.3.3 Irish Sea herring Division VIIa (N). Larval production (10^{11}) indices for the Manx component.

Year	Douglas Bank Isle of Man			Northeast Irish Sea 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

SE = Standard Error

Table 7.3.4 Irish Sea herring Division VIIa (N). Northern Ireland groundfish survey indices for herring (Nos. per 3 miles.)

(a) 0-ring herring: October survey

	Western Irish Sea			Eastern Irish Sea			Total Irish Sea		
Survey	Mean	N.obs	SE	Mean	N.obs.	SE	Mean	N. obs	SE
1991	54	34	22						
1992	210	31	99	240	8	149	177	46	68
1993	633	26	331	498	10	270	412	44	155
1994	548	26	159	8	7	5	194	41	55
1995	67	22	23	35	9	18	37	35	11
1996	90	26	58	131	9	79	117	42	50
1997	281	26	192	68	9	42	138	43	70
1998	980	26	417	12	9	10	347	43	144
1999	389	26	271	90	9	29	186	43	96
2000	202	24	144	367	9	190	212	38	89
2001	553	26	244	236	11	104	284	45	93
2002	132	26	84	18	11	10	63	45	31
2003	1203	26	855	75	11	47	446	45	296

(b) 1-ring herring: March Surveys. a. Unusually large catch removed, b. unusually large catch retained.

	Western Irish Sea			Eastern Irish Sea			Total Irish Sea		
Survey	Mean	N.obs	SE	Mean	N.obs.	SE	Mean	N.obs	SE
1992	392	20	198	115	10	73	190	34	77
1993	1755	27	620	175	10	66	681	45	216
1994	2472	25	1852	106	9	51	923	39	641
1995	1299	26	679	73	8	32	480	42	235
1996	1055	22	638	285	9	164	487	39	230
1997	1473	26	382	260	9	96	612	43	137
1998	3953	26	1331	250	9	184	1472	43	466
1999	5845	26	1860	736	9	321	2308	42	655
2000	2303	26	853	546	10	217	1009	44	306
2001	3518	26	916	1265	11	531	1763	45	381
2002[a]	2255	25	845	185	11	84	852	44	294
2002[b]	7870	26	5667	185	11	84	2794	45	1960
2003	2103	26	876	896	11	604	1079	45	382

(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

Table 7.4.1 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

Table 7.4.2 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

Table 7.4.3 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

*Mean for the years 1994-2002.

Table 7.6.1 Irish Sea herring Division VIIa (N). Tuning indices used for the assessment. Values and CVs are given. Age = rings.

Year	GFS-octeast[1]		GFS-octtot[1]		GFS-martot[2]	DBL[3]	NINEL[3]	AC_VIIa(N)[4]	AC_1+[5]
	Age 1	Age 2	Age 1	Age 2	Age 1	SSB	SSB	SSB	SSB
1989						3.39 (1.54)		-	-
1990						1.92 (0.78)		-	-
1991						1.56 (0.73)		-	-
1992					190	15.64 (2.32)		-	-
1993	240	20	177	21	681	4.81 (0.77)	38.3 (0.48)	-	-
1994	498	4	412	44	923	7.30 (2.26)	71.2 (0.12)	25,133 (na)	34,000 (0.20)
1995	8	17	194	176	480	1.58 (1.68)	15.1 (0.62)	20,167 (na)	38,400 (0.29)
1996	35	3	37	55	487	-	4.7 (0.30)	21,426 (0.25)	24,500 (0.25)
1997	131	2	117	11	612	5.59 (1.25)	29.1 (0.11)	10,702 (0.28)	20,100 (0.28)
1998	68	0	138	302	1472	2.27 (1.43)	5.8 (1.02)	9,157 (0.18)	14,500 (0.20)
1999	12	13	347	53	2308	3.87 (0.88)	16.7 (0.57)	21,040 (0.75)	31,600 (0.59)
2000	90	104	186	74	1009		35.5 (0.12)	33,144 (0.32)	40,200 (0.26)
2001	367	74	212	579	1763		55.3 (0.55)	13,647 (0.42)	35,400 (0.40)
2002	236	5	284	513	852		31.5 (0.47)	25,102 (0.83)	41,400 (0.56)
2003	18	4	63	291	1079		15.8 (0.58)	24,390 (0.24)	49,500 (0.22)
2004	75	410	446	267					

1. Mean abundance of juveniles (within strata) per 3nm trawl, surveyed when aged 0 in September and 1 in the following September and used as indices for the following years, for either the eastern Irish Sea or total northern Irish Sea.
2. Mean abundance of juveniles (within strata) per 3nm trawl, aged 1 in March from the eastern Irish Sea.
3. Numbers of larvae at 6mm x 10^{11}, a size weighted index.
4. Biomass of SSB, tonnes from acoustic surveys of the northern Irish Sea.
5. Biomass of total stock in VIIa(N) aged 1-ring and greater, tonnes from acoustic surveys.

na- not available. GFS-Ground fish survey. DBL- Douglas Bank Larvae. NINEL- Northeast Larvae. AC- Acoustic.

Table 7.6.2 Herring in Div. VIIa(N). Run log of HAWG 2004 Irish Sea final run. Age = ring.

```
  Integrated Catch at Age       Version 1.4 w
     K.R.Patterson        8 March 1998

 Enter the name of the index file -->index.txt      canum.txt; weca.txt
 Stock weights in 2004  used for the year 2003; west.txt
 Natural mortality in 2004  used for the year 2003; natmor.txt
 Maturity ogive in 2004  used for the year 2003; 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 ?-->    1.00
 First age for calculation of reference F ?--> 2:  Last age for calculation of reference F ?--> 6
 Use default weighting (Y/N) ?-->n
Enter relative weights at age
 Weight for age 1-->    0.100:  Weight for age 2-->    1.000:  Weight for age 3-->    1.000
 Weight for age 4-->    1.000:  Weight for age 5-->    1.000:  Weight for age 6-->    1.000
 Weight for age 7-->    1.000:  Weight for age 8-->    1.000
Enter relative weights by year:  Weight for year 1998-->    1.0:  Weight for year 1999-->    1.0
 Weight for year 2000-->    1.0: Weight for year 2001-->    1.0:  Weight for year 2002-->    1.0
 Weight for year 2003-->    1.0
Is the last age of FLT01: Northern Ireland acoustic surveys a plus-group (Y-->y
Model for   DBL  is to be A/L/P ?-->L: 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-->   5.0E-02:  Enter highest feasible F-->    2.0
Mapping the F-dimension of the SSQ surface
                    F              SSQ
                  --------------------------------
                    0.05        27.9630025913
                    0.15        20.3732906221
                    0.26        19.8316673666
                    0.36        20.1901425387
                    0.46        20.8187257084
                    0.56        21.5545331339
                    0.67        22.3403245978
                   0.77         23.1568850143
                    0.87        24.0041131340
                    0.97        24.8968828183
                    1.08        25.8713146881
                    1.18        27.0153926093
                    1.28        27.9908254737
                    1.38        28.5950989084
                    1.49        29.2198516044
                    1.59        29.8328975272
                    1.69        30.2320685396
                    1.79        30.6038052317
                    1.90        30.9504423152
                    2.00        31.2740642113
                  Lowest SSQ is for F =       0.242
No of years for separable analysis : 6: Age range in the analysis : 1. 8
Year range in the analysis : 1961  . . . 2003
Number of indices of SSB : 2: Number of age-structured indices : 1
Parameters to estimate : 33: Number of observations : 144
Conventional single selection vector model to be fitted.
```

Table 7.6.2 (cont'd)

Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
Enter weight for DBL--> 1.0: Enter weight for NINEL--> 1.00
Enter weight for age 1--> 0.10 Enter weight for age 2--> 1.00
Enter weight for age 3--> 1.00 Enter weight for age 4--> 1.00
Enter weight for age 5--> 1.00 Enter weight for age 6--> 1.00
Enter weight for age 7--> 1.00 Enter weight for age 8--> 1.00
Enter estimates of the extent to which errors in the age-structured indices are
correlated across ages. This can be in the range 0 (independence) to 1 (correlated errors).
Enter value for FLT01: Northern Ireland acoustic surveys--> 1.0
Do you want to shrink the final fishing mortality (Y/N) ?-->N
SSB index weights 1.000 1.000
Aged index weights FLT01: Northern Ireland acoustic surveys
Age : 1 2 3 4 5 6 7 8
Wts : 0.012 0.125 0.125 0.125 0.125 0.125 0.125 0.125
F in 2003 at age 4 is 0.287546 in iteration 1
Detailed, Normal or Summary output (D/N/S)-->D: Output page width in characters (e.g. 80..132)?> 80

Table 7.6.3 Herring Irish Sea VIIa(N).ICA assessment of Irish Sea herring catches from official landings. Output Generated by ICA Version 1.4 . Age = rings

Catch in Number x 10 ^ 6

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	4.54	0.38	4.84	1.51	0.85	0.94	4.44	1.02
2	11.47	12.30	9.44	18.09	27.08	15.05	40.92	30.18
3	2.63	7.34	2.34	4.35	8.18	15.63	5.60	13.46
4	12.43	1.81	2.89	0.71	0.99	2.00	4.63	4.08
5	0.24	5.43	2.26	0.53	0.70	0.12	1.35	0.82
6	0.48	0.19	2.26	0.71	0.99	0.35	0.00	0.61
7	1.20	0.19	0.55	0.00	0.42	0.12	0.00	0.00
8	2.15	0.67	0.62	0.18	0.70	0.00	0.00	0.00

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	1.32	5.61	12.17	40.64	42.15	43.25	33.33	34.74
2	42.80	31.18	66.92	46.66	32.74	109.55	48.24	56.16
3	16.91	33.63	31.94	26.95	38.24	39.75	39.41	20.78
4	12.68	16.46	29.41	13.18	11.49	24.51	10.84	15.22
5	1.32	12.61	5.07	13.75	6.92	10.65	7.87	4.58
6	2.64	1.75	3.55	6.76	5.07	4.99	4.21	2.81
7	0.53	2.10	1.01	2.66	2.59	5.15	2.09	2.42
8	0.00	1.05	1.01	1.67	2.60	1.63	1.64	1.27

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	30.28	15.54	11.77	5.84	5.05	5.10	1.30	1.17
2	39.04	36.95	38.27	25.76	15.79	16.03	12.16	8.42
3	22.69	13.41	23.49	19.51	3.20	5.67	5.60	7.24
4	6.75	6.78	4.25	8.52	2.79	2.15	2.82	3.84
5	4.52	1.74	2.20	1.98	2.30	0.33	0.45	2.22
6	1.46	1.34	1.05	0.91	0.33	1.11	0.48	0.38
7	0.91	0.67	0.40	0.36	0.29	0.14	0.26	0.23
8	1.12	0.35	0.29	0.23	0.24	0.38	0.06	0.48

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	2.43	4.49	2.23	2.61	1.16	2.31	2.00	12.14
2	10.05	15.27	12.98	21.25	6.38	12.84	9.75	6.88
3	17.34	7.46	6.15	13.34	12.04	5.73	6.74	6.74
4	13.29	8.55	3.00	7.16	4.71	9.70	2.83	6.69
5	7.21	4.53	4.18	4.61	1.88	3.60	5.07	3.26
6	2.65	3.20	2.78	5.08	1.25	1.66	1.49	5.12
7	0.67	1.46	2.33	3.23	1.56	1.04	0.72	1.04
8	0.72	0.88	1.67	4.21	1.96	1.61	0.81	0.39

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.65	1.97	3.20	5.33	9.55	3.07	1.81	1.22
2	14.64	7.00	21.33	17.53	21.39	11.88	16.93	3.74
3	3.01	12.16	3.39	9.76	7.56	3.88	5.94	5.87
4	3.02	1.83	5.27	1.16	7.34	4.45	1.57	2.06
5	2.90	2.57	1.20	3.60	1.64	6.67	1.48	0.56
6	1.61	2.10	1.15	0.78	2.28	1.03	1.99	0.35
7	2.18	1.28	0.93	0.96	0.84	2.05	0.44	0.25
8	0.85	1.99	1.45	1.36	1.43	0.45	0.62	0.15

AGE	2001	2002	2003
1	2.71	0.18	0.69
2	11.47	9.02	4.69
3	7.15	1.89	3.35
4	13.05	1.87	2.56
5	3.39	2.40	0.88
6	0.94	0.95	2.94
7	0.65	0.47	0.87
8	0.80	0.34	0.60

Predicted Catch in Number x 10 ^ 3

AGE	1998	1999	2000	2001	2002	2003
1	4530.	1038.	516.	2148.	616.	702.
2	15580.	18317.	3159.	10398.	6996.	4660.
3	4318.	4540.	4476.	5654.	2574.	4541.
4	4258.	1923.	1739.	11879.	2178.	2573.
5	4542.	1220.	490.	3230.	2989.	1490.
6	1173.	1533.	363.	1043.	955.	2367.
7	1828.	375.	438.	743.	294.	728.

Table 7.6.3 continued Herring Irish Sea VIIa(N). Age = rings

Weights at age in the catches (Kg)

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	0.08200	0.06700	0.06700	0.07800	0.06500	0.09200	0.09300	0.09100
2	0.12300	0.12500	0.13100	0.12900	0.13200	0.14000	0.14900	0.15300
3	0.17800	0.15200	0.18400	0.15600	0.17600	0.18500	0.18000	0.19600
4	0.19800	0.17700	0.20800	0.17100	0.19200	0.21800	0.19900	0.23100
5	0.23200	0.19900	0.22800	0.22600	0.21000	0.25800	0.22300	0.24600
6	0.22600	0.21400	0.23400	0.24000	0.23000	0.25300	0.24300	0.26900
7	0.25300	0.27500	0.26600	0.00000	0.27200	0.22500	0.22700	0.23400
8	0.24800	0.25100	0.25800	0.29600	0.26500	0.26400	0.27500	0.26400

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	0.07400	0.10100	0.10800	0.07400	0.07400	0.07400	0.07400	0.07400
2	0.15200	0.16200	0.15800	0.15500	0.15500	0.15500	0.15500	0.15500
3	0.20400	0.20600	0.18900	0.19500	0.19500	0.19500	0.19500	0.19500
4	0.23100	0.22500	0.21400	0.21900	0.21900	0.21900	0.21900	0.21900
5	0.25400	0.24500	0.22500	0.23200	0.23200	0.23200	0.23200	0.23200
6	0.26600	0.25100	0.26600	0.25100	0.25100	0.25100	0.25100	0.25100
7	0.23900	0.26900	0.24100	0.25800	0.25800	0.25800	0.25800	0.25800
8	0.27000	0.25800	0.24100	0.27800	0.27800	0.27800	0.27800	0.27800

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07600
2	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.14200
3	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.18700
4	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21300
5	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.22100
6	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.24300
7	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.24000
8	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27300

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	0.08700	0.06800	0.05800	0.07000	0.08100	0.09600	0.07300	0.06200
2	0.12500	0.14300	0.13000	0.12400	0.12800	0.14000	0.12300	0.11400
3	0.15700	0.16700	0.16000	0.16000	0.15500	0.16600	0.15500	0.14000
4	0.18600	0.18800	0.17500	0.17000	0.17400	0.17500	0.17100	0.15500
5	0.20200	0.21500	0.19400	0.18000	0.18400	0.18700	0.18100	0.16500
6	0.20900	0.22800	0.21000	0.19800	0.19500	0.19500	0.19000	0.17400
7	0.22200	0.23900	0.21800	0.21200	0.20500	0.20700	0.19800	0.18100
8	0.25800	0.25400	0.22900	0.23200	0.21800	0.21800	0.21700	0.19700

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.08900	0.07000	0.07500	0.06700	0.06400	0.08000	0.06900	0.06400
2	0.12700	0.12300	0.12100	0.11600	0.11800	0.12300	0.12000	0.12000
3	0.15700	0.15300	0.14600	0.14800	0.14600	0.14800	0.14500	0.14800
4	0.17100	0.17000	0.16400	0.16200	0.16500	0.16300	0.16700	0.16800
5	0.18200	0.18000	0.17600	0.17700	0.17600	0.18100	0.17600	0.18800
6	0.19100	0.18900	0.18100	0.19900	0.18800	0.17700	0.18800	0.20400
7	0.19800	0.20200	0.19300	0.20000	0.20400	0.18800	0.19000	0.20000
8	0.21200	0.21200	0.20700	0.21400	0.21600	0.22200	0.21000	0.21300

AGE	2001	2002	2003
1	0.06700	0.08500	0.08100
2	0.10600	0.11300	0.11600
3	0.13900	0.14400	0.13600
4	0.15600	0.16700	0.16000
5	0.16800	0.18000	0.16700
6	0.18500	0.18400	0.17200
7	0.19800	0.19100	0.18600
8	0.20500	0.21700	0.19000

Table 7.6.3 continued Herring Irish Sea VIIa(N). Age = rings

Weights at age in the stock (Kg)

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	0.08200	0.06700	0.06700	0.07800	0.06500	0.09200	0.09300	0.09100
2	0.12300	0.12500	0.13100	0.12900	0.13200	0.14000	0.14900	0.15300
3	0.17800	0.15200	0.18400	0.15600	0.17600	0.18500	0.18000	0.19600
4	0.19800	0.17700	0.20800	0.17100	0.19200	0.21800	0.19900	0.23100
5	0.23200	0.19900	0.22800	0.22600	0.21000	0.25800	0.22300	0.24600
6	0.22600	0.21400	0.23400	0.24000	0.23000	0.25300	0.24300	0.26900
7	0.25300	0.27500	0.26600	0.00000	0.27200	0.22500	0.22700	0.23400
8	0.24800	0.25100	0.25800	0.29600	0.26500	0.26400	0.27500	0.26400

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	0.07400	0.10100	0.10800	0.07400	0.07400	0.07400	0.07400	0.07400
2	0.15200	0.16200	0.15800	0.15500	0.15500	0.15500	0.15500	0.15500
3	0.20400	0.20600	0.18900	0.19500	0.19500	0.19500	0.19500	0.19500
4	0.23100	0.22500	0.21400	0.21900	0.21900	0.21900	0.21900	0.21900
5	0.25400	0.24500	0.22500	0.23200	0.23200	0.23200	0.23200	0.23200
6	0.26600	0.25100	0.26600	0.25100	0.25100	0.25100	0.25100	0.25100
7	0.23900	0.26900	0.24100	0.25800	0.25800	0.25800	0.25800	0.25800
8	0.27000	0.25800	0.24100	0.27800	0.27800	0.27800	0.27800	0.27800

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07400	0.07600
2	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.15500	0.14200
3	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.19500	0.18700
4	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21900	0.21300
5	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.23200	0.22100
6	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.25100	0.24300
7	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.25800	0.24000
8	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27800	0.27300

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	0.08700	0.06800	0.05800	0.07000	0.08100	0.07700	0.07000	0.06100
2	0.12500	0.14300	0.13000	0.12400	0.12800	0.13500	0.12100	0.11100
3	0.15700	0.16700	0.16000	0.16000	0.15500	0.16300	0.15300	0.13600
4	0.18600	0.18800	0.17500	0.17000	0.17400	0.17500	0.16700	0.15100
5	0.20200	0.21500	0.19400	0.18000	0.18400	0.18800	0.18000	0.15900
6	0.20900	0.22900	0.21000	0.19800	0.19500	0.19600	0.18900	0.17100
7	0.22200	0.23900	0.21800	0.21200	0.20500	0.20700	0.19500	0.17900
8	0.25800	0.25400	0.22900	0.23200	0.21800	0.21700	0.21400	0.19100

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.08800	0.07300	0.07200	0.06700	0.06300	0.07300	0.06800	0.06300
2	0.12600	0.12600	0.12000	0.11500	0.11900	0.12100	0.12100	0.12000
3	0.15700	0.15400	0.14700	0.14800	0.14800	0.15000	0.14500	0.14900
4	0.17100	0.17400	0.16800	0.16200	0.16700	0.16600	0.16800	0.17100
5	0.18300	0.18100	0.18000	0.17700	0.17800	0.17900	0.17800	0.18800
6	0.19100	0.19000	0.18500	0.19500	0.18900	0.19000	0.18900	0.20400
7	0.19800	0.20300	0.19700	0.19900	0.20600	0.20000	0.19900	0.20500
8	0.21400	0.21400	0.21200	0.21200	0.21400	0.23000	0.21400	0.21500

AGE	2001	2002	2003
1	0.06600	0.08500	0.08100
2	0.10500	0.11300	0.11600
3	0.13900	0.14400	0.13600
4	0.15600	0.16700	0.16000
5	0.16700	0.18000	0.16700
6	0.18300	0.18400	0.17200
7	0.19900	0.19100	0.18600
8	0.20500	0.21700	0.19000

Table 7.6.3 continued Herring Irish Sea VIIa(N). Age = rings

Natural Mortality (per year)

AGE	19972-96	1997	1998	1999	2000	2001	2002	2003
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

Proportion of fish spawning

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0200	0.0000
2	0.2200	0.2400	0.3400	0.5300	0.6100	0.4700	0.3700	0.8800
3	0.6300	0.8300	0.8800	0.8100	0.9000	0.9100	0.7500	0.9400
4	1.0000	0.9200	0.8900	1.0000	1.0000	1.0000	0.8300	0.9400
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	0.0000	0.0200	0.1500	0.1100	0.1200	0.3600	0.4000	0.0700
2	0.7100	0.9200	0.8700	0.8800	0.7700	0.9900	0.9900	0.9600
3	0.9200	0.9400	0.9700	0.9000	0.8900	0.9600	1.0000	0.9800
4	0.9400	0.9600	0.9800	1.0000	0.9700	1.0000	0.9400	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	0.0300	0.0400	0.0000	0.2000	0.1900	0.1000	0.0200	0.0000
2	0.9200	0.8100	0.8400	0.8800	0.8900	0.8000	0.7300	0.6900
3	0.9600	0.8800	0.8100	0.9500	0.9000	0.8900	0.8800	0.8300
4	1.0000	0.9100	0.7800	0.9500	0.9400	0.9100	0.9000	0.9300
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	0.1400	0.3100	0.0000	0.0000	0.0700	0.0600	0.0400	0.2800
2	0.6200	0.7300	0.8500	0.9000	0.6300	0.6600	0.3000	0.4800
3	0.7100	0.6600	0.9100	0.9600	0.9300	0.9000	0.7400	0.7200
4	0.8800	0.8100	0.8700	0.9900	0.9500	0.9500	0.8200	0.8100
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.0000	0.1900	0.1000	0.0200	0.0400	0.3000	0.0200	0.1400
2	0.4600	0.6800	0.8600	0.6000	0.8200	0.8300	0.8400	0.7900
3	0.9900	0.9900	0.9400	0.9600	0.9500	0.9700	0.9500	0.9900
4	1.0000	0.9700	0.9900	0.8300	1.0000	0.9900	0.9700	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	2001	2002	2003
1	0.1500	0.0200	0.1100
2	0.5400	0.9200	0.7600
3	0.8800	0.9500	0.9500
4	0.9700	0.9800	0.9700
5	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000

Table 7.6.3 continued   Herring Irish Sea VIIa(N). Age = rings

INDICES OF SPAWNING BIOMASS

DBL	1989	1990	1991	1992	1993	1994	1995	1996
	339.0	192.0	156.0	1564.0	481.0	730.0	158.0	480.0
	1997	1998	1999	2000	2001	2002	2003	
	559.0	227.0	387.0	*******	*******	*******	*******	

NINEL	1989	1990	1991	1992	1993	1994	1995	1996
	999990.	999990.	999990.	999990.	38300.	71200.	15100.	4700.
	1997	1998	1999	2000	2001	2002	2003	
	29100.	5800.	16700.	35500.	55300.	31500.	15800.	

x 10 ^ -3

AGE-STRUCTURED INDICES   FLT01: Northern Ireland acoustic surveys

AGE	1994	1995	1996	1997	1998	1999	2000	2001
1	66.83	319.12	11.34	134.15	110.44	157.76	78.52	387.56
2	68.29	82.26	42.37	49.98	27.31	77.72	103.44	93.40
3	73.53	11.94	67.47	14.81	8.08	34.02	105.29	10.19
4	11.86	29.25	8.95	10.98	9.27	5.11	27.54	17.49
5	9.30	4.57	26.47	1.75	6.48	10.26	8.07	7.70
6	7.55	3.50	4.17	4.55	1.78	13.52	5.43	1.37
7	3.87	4.89	5.91	0.57	2.25	1.59	4.90	0.63
8	10.12	6.89	5.82	1.91	0.78	6.29	2.36	2.26

AGE	2002	2003
1	390.98	349.22
2	71.94	220.01
3	31.70	31.98
4	24.80	4.74
5	31.28	3.92
6	14.83	4.09
7	2.76	0.98
8	4.46	0.91

x 10 ^ 3

Table 7.6.3 continued Herring Irish Sea VIIa(N). Age = rings

Fishing Mortality (per year)

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	0.1152	0.0115	0.0619	0.0109	0.0111	0.0041	0.0203	0.0029
2	0.5162	1.0416	0.8162	0.6345	0.4870	0.4974	0.4328	0.3213
3	0.3180	0.8118	0.6091	1.3701	0.7283	0.6291	0.3716	0.2622
4	0.7798	0.3576	0.8589	0.3538	1.5287	0.3673	0.3627	0.4817
5	0.1692	0.8448	0.8945	0.3261	0.6252	0.6550	0.4025	0.0892
6	0.8048	0.1777	0.9432	0.6975	1.5287	0.6550	0.3523	0.2855
7	0.5818	0.7896	0.9432	0.3538	1.0853	0.6550	0.3627	0.4817
8	0.5818	0.7896	0.9432	0.3538	1.0853	0.6550	0.3627	0.4817

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	0.0056	0.0186	0.0393	0.1666	0.1044	0.2142	0.1526	0.2303
2	0.2746	0.3028	0.5804	0.3626	0.3451	0.8258	0.7538	0.7954
3	0.3201	0.3850	0.6254	0.5276	0.6167	1.0179	0.9097	0.9813
4	0.3989	0.5580	0.6505	0.5440	0.4253	1.0135	0.8350	1.1100
5	0.2509	0.7702	0.2941	0.6418	0.5437	0.7794	0.9757	0.9385
6	0.4046	0.5397	0.4491	0.6977	0.4577	0.8539	0.7253	1.0553
7	0.3781	0.5762	0.6114	0.6328	0.5582	1.0457	0.9776	1.1230
8	0.3781	0.5762	0.6114	0.6328	0.5582	1.0457	0.9776	1.1230

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	0.1592	0.1048	0.1460	0.0644	0.0397	0.0374	0.0094	0.0148
2	0.8613	0.5423	0.7666	1.1211	0.4392	0.2937	0.1989	0.1285
3	1.0045	0.9349	0.8873	1.3995	0.4116	0.2961	0.1673	0.1849
4	1.0084	0.9334	0.8559	0.9338	0.7263	0.5092	0.2232	0.1574
5	1.1020	0.6878	0.8073	1.1876	0.6197	0.1511	0.1653	0.2454
6	0.7960	1.0751	1.0722	0.8384	0.5482	0.6122	0.3065	0.1858
7	1.1087	0.9578	1.0137	1.2982	0.6219	0.4196	0.2421	0.2079
8	1.1087	0.9578	1.0137	1.2982	0.6219	0.4196	0.2421	0.2079

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	0.0271	0.0436	0.0136	0.0394	0.0128	0.0333	0.0486	0.1041
2	0.2926	0.4171	0.2946	0.2988	0.2175	0.3314	0.3313	0.4139
3	0.4487	0.3931	0.3140	0.6015	0.2937	0.3290	0.3099	0.4306
4	0.5675	0.3949	0.2563	0.6924	0.4167	0.3862	0.2549	0.5439
5	0.4347	0.3400	0.3036	0.6825	0.3425	0.5727	0.3181	0.4591
6	0.4561	0.3111	0.3209	0.6453	0.3500	0.5095	0.4384	0.5405
7	0.5026	0.4350	0.3474	0.6642	0.3681	0.4847	0.3830	0.5475
8	0.5026	0.4350	0.3474	0.6642	0.3681	0.4847	0.3830	0.5475

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.0161	0.0163	0.0400	0.0744	0.1218	0.0347	0.0213	0.0089
2	0.3053	0.4263	0.4328	0.5785	0.9307	0.5425	0.3322	0.1392
3	0.3419	0.4808	0.4042	0.3861	0.5744	0.5189	0.3178	0.1332
4	0.3303	0.3406	0.3748	0.2221	0.5328	0.7138	0.4372	0.1831
5	0.4261	0.4580	0.3487	0.4208	0.4911	0.6552	0.4013	0.1681
6	0.3824	0.5536	0.3411	0.3566	0.4557	0.6933	0.4246	0.1779
7	0.4120	0.5263	0.4463	0.4680	0.7103	0.7138	0.4372	0.1831
8	0.4120	0.5263	0.4463	0.4680	0.7103	0.7138	0.4372	0.1831

AGE	2001	2002	2003
1	0.0281	0.0130	0.0140
2	0.4387	0.2034	0.2185
3	0.4197	0.1945	0.2091
4	0.5773	0.2676	0.2875
5	0.5299	0.2456	0.2640
6	0.5607	0.2599	0.2793
7	0.5773	0.2676	0.2875
8	0.5773	0.2676	0.2875

Table 7.6.3 continued Herring Irish Sea VIIa(N). Age = rings

Population Abundance (1 January) x 10 ^ 6

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	65.41	52.79	126.92	220.71	120.68	364.08	349.79	558.68
2	32.51	21.44	19.20	43.89	80.32	43.90	133.39	126.10
3	10.59	14.37	5.61	6.29	17.24	36.56	19.78	64.10
4	23.96	6.31	5.23	2.50	1.31	6.81	15.96	11.17
5	1.61	9.94	3.99	2.00	1.59	0.26	4.27	10.05
6	0.90	1.23	3.86	1.48	1.31	0.77	0.12	2.58
7	2.83	0.37	0.93	1.36	0.67	0.26	0.36	0.08
8	5.10	1.28	1.07	0.62	1.11	0.54	0.38	0.46

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	374.71	480.24	497.62	413.39	667.03	348.66	367.95	262.23
2	204.93	137.08	173.41	176.01	128.75	221.06	103.53	116.20
3	67.74	115.37	75.02	71.90	90.74	67.54	71.71	36.09
4	40.38	40.27	64.27	32.86	34.73	40.10	19.98	23.64
5	6.24	24.52	20.86	30.34	17.26	20.54	13.17	7.84
6	8.31	4.39	10.27	14.06	14.45	9.07	8.53	4.49
7	1.76	5.02	2.32	5.93	6.33	8.27	3.49	3.73
8	0.30	2.51	2.32	3.72	6.36	2.62	2.74	1.96

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	321.32	245.07	135.41	147.45	204.70	219.15	221.16	125.57
2	76.63	100.81	81.19	43.05	50.86	72.38	77.66	80.60
3	38.86	23.99	43.42	27.94	10.39	24.29	39.97	47.16
4	11.08	11.65	7.71	14.64	5.64	5.64	14.79	27.68
5	7.05	3.66	4.15	2.96	5.21	2.47	3.07	10.70
6	2.78	2.12	1.66	1.67	0.82	2.53	1.92	2.35
7	1.41	1.13	0.65	0.51	0.65	0.43	1.24	1.28
8	1.74	0.59	0.47	0.33	0.54	1.16	0.29	2.68

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	143.22	165.95	260.46	106.32	143.80	111.57	66.41	192.75
2	45.52	51.28	58.45	94.53	37.60	52.23	39.70	23.27
3	52.51	25.16	25.03	32.25	51.94	22.41	27.78	21.12
4	32.09	27.45	13.91	14.97	14.47	31.70	13.20	16.68
5	21.40	16.46	16.73	9.74	6.78	8.63	19.49	9.26
6	7.58	12.54	10.60	11.18	4.45	4.35	4.40	12.83
7	1.77	4.35	8.31	6.96	5.30	2.84	2.37	2.57
8	1.92	2.60	5.97	9.07	6.65	4.40	2.68	0.97

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	63.83	192.11	128.82	116.98	130.48	209.34	77.86	91.94
2	63.90	23.11	69.53	45.53	39.95	42.50	74.38	28.04
3	11.40	34.88	11.18	33.41	18.91	11.67	18.30	39.53
4	11.24	6.63	17.66	6.11	18.59	8.72	5.69	10.90
5	8.76	7.31	4.27	10.98	4.43	9.88	3.86	3.32
6	5.29	5.18	4.18	2.72	6.52	2.45	4.64	2.34
7	6.76	3.27	2.69	2.69	1.73	3.74	1.11	2.75
8	2.63	5.09	4.22	3.82	2.94	0.92	1.84	0.92

AGE	2001	2002	2003	2004
1	122.40	75.26	79.83	110.42
2	33.52	43.78	27.33	28.96
3	18.07	16.02	26.47	16.27
4	28.33	9.73	10.79	17.58
5	8.22	14.39	6.73	7.33
6	2.54	4.38	10.18	4.68
7	1.77	1.31	3.05	6.97
8	1.91	1.51	2.42	3.89

Table 7.6.3 continued Herring Irish Sea VIIa(N). Age = rings

Weighting factors for the catches in number

AGE	1998	1999	2000	2001	2002	2003
1	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Predicted SSB Index Values

DBL	1989	1990	1991	1992	1993	1994	1995	1996
	544.18	494.38	362.07	317.62	344.94	383.21	413.91	340.08
	1997	1998	1999	2000	2001	2002	2003	
	288.43	337.06	369.08	*******	*******	*******	*******	

NINEL	1989	1990	1991	1992	1993	1994	1995	1996
	999990.	999990.	999990.	999990.	20836.	23148.	25002.	20543.
	1997	1998	1999	2000	2001	2002	2003	
	17423.	20360.	22295.	26483.	18429.	24075.	23060.	

x 10 ^ -3

Predicted Age-Structured Index Values

FLT01: Northern Ireland acoustic survey Predicted

AGE	1994	1995	1996	1997	1998	1999	2000	2001
1	231.95	152.80	135.22	145.57	249.29	93.66	111.63	146.50
2	41.69	124.82	73.28	49.37	70.27	144.00	62.74	59.92
3	42.28	14.35	43.47	21.37	13.74	25.06	62.17	22.93
4	7.97	20.70	8.03	19.36	7.93	6.36	14.76	28.53
5	8.43	5.34	13.02	4.98	9.82	4.65	4.76	8.98
6	5.43	5.14	3.31	7.36	2.31	5.36	3.25	2.65
7	2.94	2.57	2.53	1.35	2.93	1.07	3.20	1.54
8	6.78	5.98	5.32	3.42	1.07	2.62	1.59	2.46

AGE	2002	2003
1	91.10	96.56
2	93.36	57.62
3	24.06	39.33
4	12.36	13.51
5	19.46	8.98
6	5.72	13.11
7	1.43	3.29
8	2.44	4.16

x 10 ^ 3

Table 7.6.3 continued Herring Irish Sea VIIa(N). Age = rings

Fitted Selection Pattern

AGE	1961	1962	1963	1964	1965	1966	1967	1968
1	0.1477	0.0321	0.0720	0.0307	0.0073	0.0111	0.0558	0.0060
2	0.6619	2.9124	0.9502	1.7931	0.3186	1.3543	1.1933	0.6670
3	0.4078	2.2697	0.7091	3.8720	0.4764	1.7130	1.0245	0.5443
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.2170	2.3622	1.0414	0.9217	0.4090	1.7834	1.1099	0.1851
6	1.0320	0.4969	1.0981	1.9713	1.0000	1.7834	0.9713	0.5926
7	0.7461	2.2078	1.0981	1.0000	0.7099	1.7834	1.0000	1.0000
8	0.7461	2.2078	1.0981	1.0000	0.7099	1.7834	1.0000	1.0000

AGE	1969	1970	1971	1972	1973	1974	1975	1976
1	0.0140	0.0333	0.0604	0.3062	0.2455	0.2114	0.1828	0.2074
2	0.6883	0.5427	0.8922	0.6665	0.8115	0.8147	0.9028	0.7165
3	0.8025	0.6900	0.9614	0.9699	1.4502	1.0043	1.0895	0.8840
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.6291	1.3803	0.4522	1.1799	1.2786	0.7690	1.1685	0.8455
6	1.0144	0.9672	0.6904	1.2826	1.0763	0.8425	0.8687	0.9507
7	0.9478	1.0325	0.9400	1.1634	1.3127	1.0317	1.1707	1.0117
8	0.9478	1.0325	0.9400	1.1634	1.3127	1.0317	1.1707	1.0117

AGE	1977	1978	1979	1980	1981	1982	1983	1984
1	0.1579	0.1122	0.1706	0.0689	0.0546	0.0734	0.0420	0.0941
2	0.8542	0.5810	0.8957	1.2006	0.6047	0.5768	0.8912	0.8166
3	0.9961	1.0016	1.0367	1.4987	0.5667	0.5816	0.7498	1.1749
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0928	0.7369	0.9433	1.2718	0.8532	0.2966	0.7405	1.5593
6	0.7894	1.1518	1.2528	0.8978	0.7547	1.2021	1.3733	1.1806
7	1.0994	1.0261	1.1844	1.3902	0.8563	0.8239	1.0849	1.3209
8	1.0994	1.0261	1.1844	1.3902	0.8563	0.8239	1.0849	1.3209

AGE	1985	1986	1987	1988	1989	1990	1991	1992
1	0.0478	0.1104	0.0530	0.0569	0.0307	0.0861	0.1906	0.1913
2	0.5157	1.0562	1.1498	0.4315	0.5221	0.8581	1.2999	0.7609
3	0.7907	0.9954	1.2254	0.8687	0.7049	0.8519	1.2158	0.7916
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.7660	0.8609	1.1847	0.9857	0.8221	1.4828	1.2479	0.8440
6	0.8037	0.7877	1.2522	0.9319	0.8400	1.3190	1.7199	0.9937
7	0.8856	1.1015	1.3556	0.9591	0.8833	1.2548	1.5026	1.0065
8	0.8856	1.1015	1.3556	0.9591	0.8833	1.2548	1.5026	1.0065

AGE	1993	1994	1995	1996	1997	1998	1999	2000
1	0.0488	0.0480	0.1067	0.3350	0.2285	0.0487	0.0487	0.0487
2	0.9244	1.2517	1.1548	2.6045	1.7468	0.7600	0.7600	0.7600
3	1.0351	1.4118	1.0785	1.7380	1.0781	0.7270	0.7270	0.7270
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.2901	1.3450	0.9304	1.8944	0.9217	0.9180	0.9180	0.9180
6	1.1580	1.6255	0.9101	1.6054	0.8552	0.9713	0.9713	0.9713
7	1.2475	1.5455	1.1907	2.1068	1.3332	1.0000	1.0000	1.0000
8	1.2475	1.5455	1.1907	2.1068	1.3332	1.0000	1.0000	1.0000

AGE	2001	2002	2003
1	0.0487	0.0487	0.0487
2	0.7600	0.7600	0.7600
3	0.7270	0.7270	0.7270
4	1.0000	1.0000	1.0000
5	0.9180	0.9180	0.9180
6	0.9713	0.9713	0.9713
7	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000

Table 7.6.3 continued Herring Irish Sea VIIa(N). Age = rings

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 6	SoP (%)
1961	65400	18551	4869	5710	1.1726	0.5176	99
1962	52790	12181	2901	4343	1.4966	0.6467	100
1963	126910	15474	2137	3947	1.8464	0.8244	100
1964	220710	25276	2453	3593	1.4641	0.6764	99
1965	120670	22839	5023	5923	1.1792	0.9796	99
1966	364070	48352	5709	5666	0.9924	0.5608	99
1967	349780	60307	8447	8721	1.0324	0.3844	99
1968	558670	88583	22337	8660	0.3877	0.2880	100
1969	374700	86323	30608	14141	0.4620	0.3298	99
1970	480230	112644	35872	20622	0.5749	0.5112	100
1971	497620	117615	34301	26807	0.7815	0.5199	100
1972	413390	92223	32808	27350	0.8336	0.5547	112
1973	667020	105649	30406	22600	0.7433	0.4777	100
1974	348650	91921	28334	38640	1.3637	0.8981	99
1975	367940	68493	20880	24500	1.1734	0.8399	102
1976	262230	54087	13132	21250	1.6181	0.9761	99
1977	321320	48839	8923	15410	1.7269	0.9544	95
1978	245060	42828	9763	11080	1.1349	0.8347	92
1979	135400	34440	8146	12338	1.5144	0.8779	92
1980	147440	27570	5632	10613	1.8842	1.0961	97
1981	204700	28026	7657	4377	0.5716	0.5490	90
1982	219150	35048	10760	4855	0.4512	0.3725	98
1983	221150	41030	14517	3933	0.2709	0.2122	98
1984	125570	39678	18373	4066	0.2213	0.1804	96
1985	143210	39156	13467	9187	0.6822	0.4399	102
1986	165950	36090	14416	7440	0.5161	0.3712	97
1987	260460	37794	13875	5823	0.4196	0.2979	103
1988	106310	34414	14027	10172	0.7251	0.5841	105
1989	143790	31682	11972	4949	0.4134	0.3241	100
1990	111570	28861	10876	6312	0.5803	0.4258	101
1991	66410	21284	7965	4398	0.5521	0.3305	100
1992	192750	24044	6987	5270	0.7542	0.4776	101
1993	63830	21896	7588	4409	0.5810	0.3572	101
1994	192100	27520	8431	4828	0.5726	0.4518	102
1995	128810	25195	9106	5076	0.5574	0.3803	99
1996	116980	22829	7482	5301	0.7085	0.3928	100
1997	130480	21884	6345	6651	1.0481	0.5969	100
1998	209330	26815	7415	4905	0.6614	0.6247	100
1999	77860	20082	8120	4127	0.5082	0.3826	99
2000	91940	18774	9645	2002	0.2076	0.1603	100
2001	122400	21112	6712	5461	0.8136	0.5053	99
2002	75260	19247	8768	2393	0.2729	0.2342	100
2003	79820	18867	8398	2399	0.2856	0.2517	100

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-----------------------------------------------------------------
No of years for separable analysis : 6
Age range in the analysis : 1  . . . 8
Year range in the analysis : 1961  . . . 2003
Number of indices of SSB : 2
Number of age-structured indices : 1
Parameters to estimate : 33
Number of observations : 144
Conventional single selection vector model to be fitted.
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Table 7.6.3 continued Herring Irish Sea VIIa(N). Age = rings

PARAMETER ESTIMATES

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³Parm.³      ³ Maximum ³    ³         ³         ³         ³         ³ Mean of ³
³ No. ³      ³ Likelh. ³ CV ³  Lower ³ Upper   ³  -s.e.  ³   +s.e. ³ Param.  ³
³     ³      ³ Estimate³ (%)³ 95% CL ³ 95% CL  ³         ³         ³ Distrib.³
Separable model : F by year
   1   1998     0.7138  22    0.4569    1.1150    0.5685    0.8962    0.7325
   2   1999     0.4372  24    0.2702    0.7072    0.3420    0.5588    0.4505
   3   2000     0.1831  25    0.1111    0.3019    0.1419    0.2363    0.1892
   4   2001     0.5773  25    0.3522    0.9462    0.4486    0.7428    0.5959
   5   2002     0.2676  28    0.1537    0.4659    0.2016    0.3551    0.2785
   6   2003     0.2875  31    0.1553    0.5325    0.2100    0.3938    0.3021

Separable Model: Selection (S) by age
   7      1     0.0487  62    0.0143    0.1660    0.0260    0.0910    0.0592
   8      2     0.7600  25    0.4637    1.2457    0.5906    0.9779    0.7845
   9      3     0.7270  23    0.4545    1.1630    0.5721    0.9239    0.7482
          4     1.0000     Fixed : Reference Age
  10      5     0.9180  20    0.6113    1.3786    0.7460    1.1297    0.9380
  11      6     0.9713  20    0.6516    1.4478    0.7923    1.1907    0.9916
          7     1.0000     Fixed : Last true age

Separable model: Populations in year 2003
  12      1      79828 138       5296   1203250     20000    318623    208052
  13      2      27328  45      11193     66721     17331     43091     30314
  14      3      26465  33      13624     51411     18860     37137     28028
  15      4      10793  30       5922     19670      7946     14660     11311
  16      5       6733  29       3797     11937      5027      9018      7026
  17      6      10183  28       5882     17630      7696     13474     10591
  18      7       3052  30       1689      5513      2257      4127      3194

Separable model: Populations at age
  19   1998       3742  42       1636      8559      2453      5707      4091
  20   1999       1107  35        550      2229       775      1582      1180
  21   2000       2745  32       1451      5191      1983      3799      2894
  22   2001       1771  29        995      3152      1320      2377      1849
  23   2002       1311  32        697      2465       950      1809      1381

SSB Index catchabilities
  DBL
Linear model fitted. Slopes at age :
  24   1  Q  .4545E-01  12 .4016E-01 .6658E-01 .4545E-01 .5883E-01 .5214E-01
  NINEL
Linear model fitted. Slopes at age :
  25   2  Q  .2746E-02  15 .2372E-02 .4311E-02 .2746E-02 .3724E-02 .3235E-02


Age-structured index catchabilities
                                         FLT01: Northern Ireland acoustic survey

Linear model fitted. Slopes at age :
  26   1  Q  2.588     120 .8121     92.19     2.588     28.93     17.93
  27   2  Q  3.110      39 2.137     9.895     3.110     6.799     4.964
  28   3  Q  2.019      38 1.391     6.379     2.019     4.393     3.212
  29   4  Q  1.674      38 1.152     5.303     1.674     3.648     2.666
  30   5  Q  1.752      39 1.202     5.607     1.752     3.845     2.804
  31   6  Q  1.711      40 1.165     5.596     1.711     3.810     2.766
  32   7  Q  1.440      41 .9696     4.870     1.440     3.280     2.365
  33   8  Q  2.132      40 1.450     6.987     2.132     4.754     3.450
```

RESIDUALS ABOUT THE MODEL FIT

```
       Separable Model Residuals
------+---------------------------------------------
Age   |    1998    1999    2000    2001    2002    2003
------+---------------------------------------------
  1   |  -0.389   0.556   0.861   0.234  -1.236  -0.011
  2   |  -0.271  -0.079   0.170   0.098   0.254   0.007
  3   |  -0.108   0.268   0.272   0.235  -0.307  -0.306
  4   |   0.044  -0.205   0.172   0.094  -0.154  -0.006
  5   |   0.385   0.192   0.130   0.047  -0.221  -0.524
  6   |  -0.130   0.260  -0.046  -0.108  -0.002   0.218
  7   |   0.114   0.169  -0.557  -0.134   0.478   0.181
------+---------------------------------------------
```

Table 7.6.3 continued Herring Irish Sea VIIa(N). Age = rings

SPAWNING BIOMASS INDEX RESIDUALS

DBL	1989	1990	1991	1992	1993	1994	1995	1996
	-0.473	-0.946	-0.842	1.594	0.333	0.644	-0.963	0.345

	1997	1998	1999	2000	2001	2002	2003
1	0.662	-0.395	0.047	*******	*******	*******	*******

NINEL	1989	1990	1991	1992	1993	1994	1995	1996
	*******	*******	*******	*******	0.609	1.124	-0.504	-1.475

	1997	1998	1999	2000	2001	2002	2003
	0.513	-1.256	-0.289	0.293	1.099	0.269	-0.378

AGE-STRUCTURED INDEX RESIDUALS

FLT01: Northern Ireland acoustic survey

Age	1994	1995	1996	1997	1998	1999	2000	2001
1	-1.244	0.736	-2.479	-0.082	-0.814	0.521	-0.352	0.973
2	0.494	-0.417	-0.548	0.012	-0.945	-0.617	0.500	0.444
3	0.553	-0.184	0.440	-0.366	-0.531	0.305	0.527	-0.811
4	0.397	0.345	0.109	-0.567	0.156	-0.219	0.624	-0.489
5	0.098	-0.155	0.709	-1.045	-0.416	0.792	0.528	-0.153
6	0.331	-0.385	0.231	-0.480	-0.263	0.926	0.513	-0.658
7	0.274	0.641	0.848	-0.863	-0.261	0.397	0.427	-0.897
8	0.400	0.143	0.089	-0.581	-0.315	0.876	0.395	-0.082

Age	2002	2003
1	1.457	1.286
2	-0.261	1.340
3	0.276	-0.207
4	0.697	-1.049
5	0.475	-0.829
6	0.954	-1.165
7	0.653	-1.213
8	0.605	-1.524

Table 7.6.3 continued Herring Irish Sea VIIa(N). Age = rings

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1998 to 2003	
Variance	0.1196
Skewness test stat.	-0.8228
Kurtosis test statistic	-0.3665
Partial chi-square	0.3195
Significance in fit	0.0000
Degrees of freedom	19

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR **DBL**

Linear catchability relationship assumed
Last age is a plus-group

Variance	0.6537
Skewness test stat.	0.5864
Kurtosis test statistic	-0.4476
Partial chi-square	1.1088
Significance in fit	0.0003
Number of observations	11
Degrees of freedom	10
Weight in the analysis	1.0000

DISTRIBUTION STATISTICS FOR **NINEL**

Linear catchability relationship assumed

Variance	0.7495
Skewness test stat.	-0.4913
Kurtosis test statistic	-0.6281
Partial chi-square	2.4737
Significance in fit	0.0087
Number of observations	11
Degrees of freedom	10
Weight in the analysis	1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR FLT01: **Northern Ireland acoustic surve**y

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8
Variance	0.0195	0.0597	0.0291	0.0402	0.0506	0.0615	0.0703	0.0589
Skewness test stat.	-0.8601	0.6429	-0.3986	-0.6404	-0.4006	-0.0906	-0.6648	-1.2823
Kurtosis test statisti	-0.3244	-0.3837	-0.8274	-0.5523	-0.7350	-0.7015	-0.8516	0.3183
Partial chi-square	0.0149	0.0484	0.0256	0.0378	0.0515	0.0634	0.0826	0.0653
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	10	10	10	10	10	10	10	10
Degrees of freedom	9	9	9	9	9	9	9	9
Weight in the analysis	0.0125	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250

ANALYSIS OF VARIANCE
Unweighted Statistics
Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	59.5042	144	33	111	0.5361
Catches at age	4.7793	42	23	19	0.2515
SSB Indices					
DBL	6.5373	11	1	10	0.6537
NINEL	7.4948	11	1	10	0.7495
Aged Indices					
FLT01: Northern Ireland acoustic surve	40.6928	80	8	72	0.5652

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	16.7238	144	33	111	0.1507
Catches at age	2.2727	42	23	19	0.1196
SSB Indices					
DBL	6.5373	11	1	10	0.6537
NINEL	7.4948	11	1	10	0.7495
Aged Indices					
FLT01: Northern Ireland acoustic survey	0.4189	80	8	72	0.0058

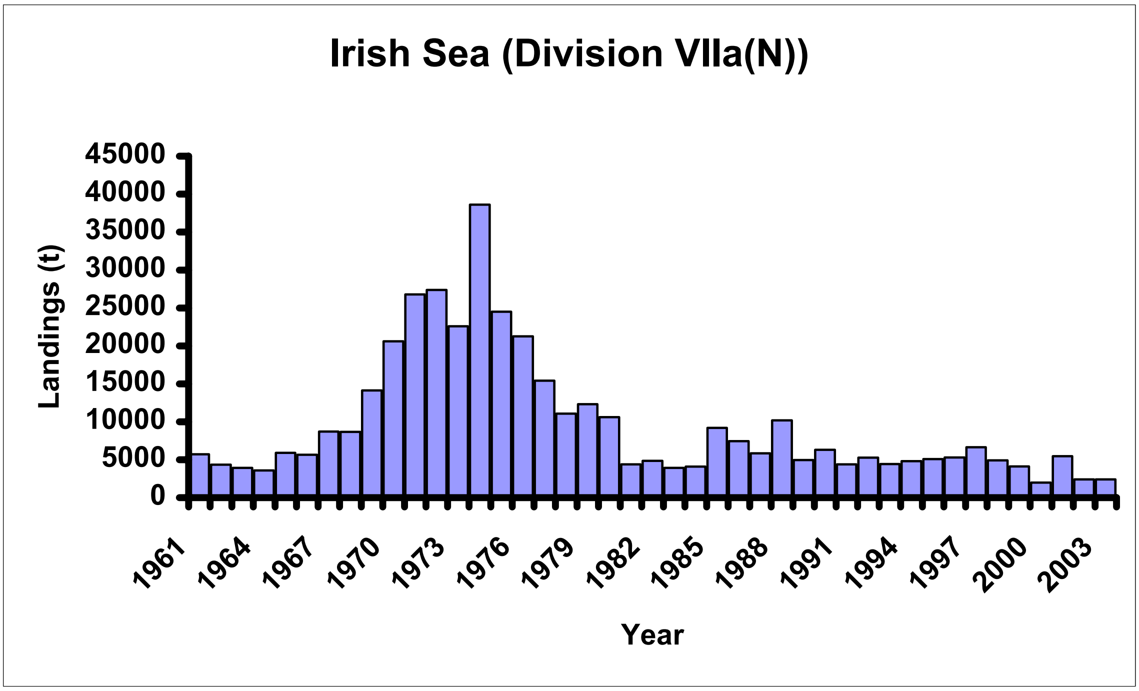


Figure 7.1.1 Irish Sea Herring VIIa(N). Landings of herring from VIIa(N) from 1961 to 2003.

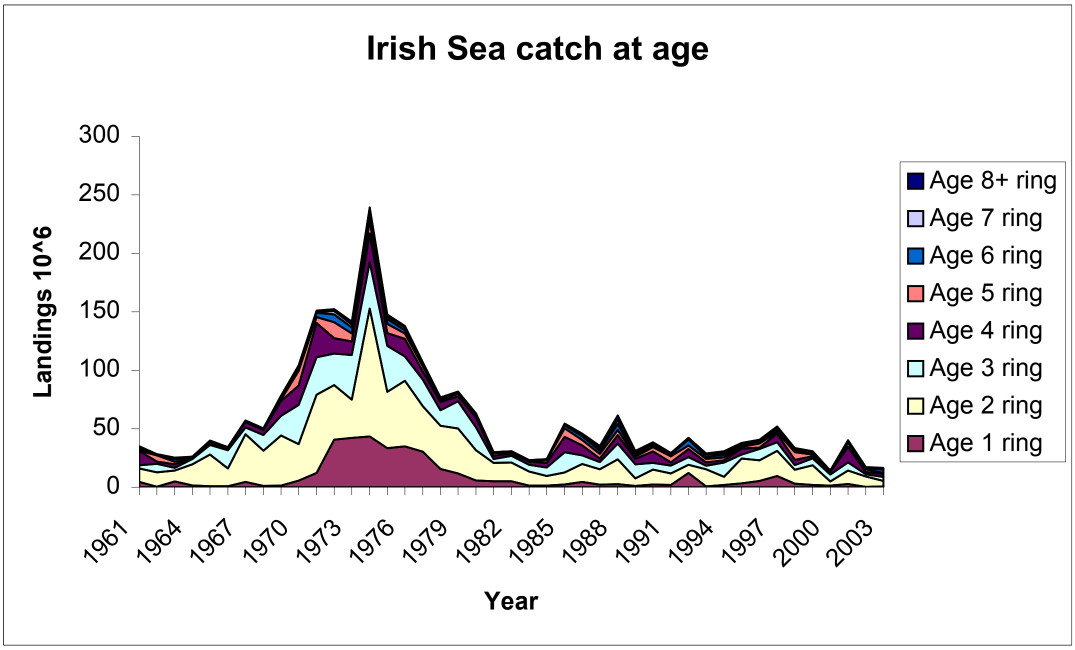


Figure 7.1.2 Irish Sea Herring VIIa(N). Landings (catch-at-age) of herring from VIIa(N) from 1961 to 2003.

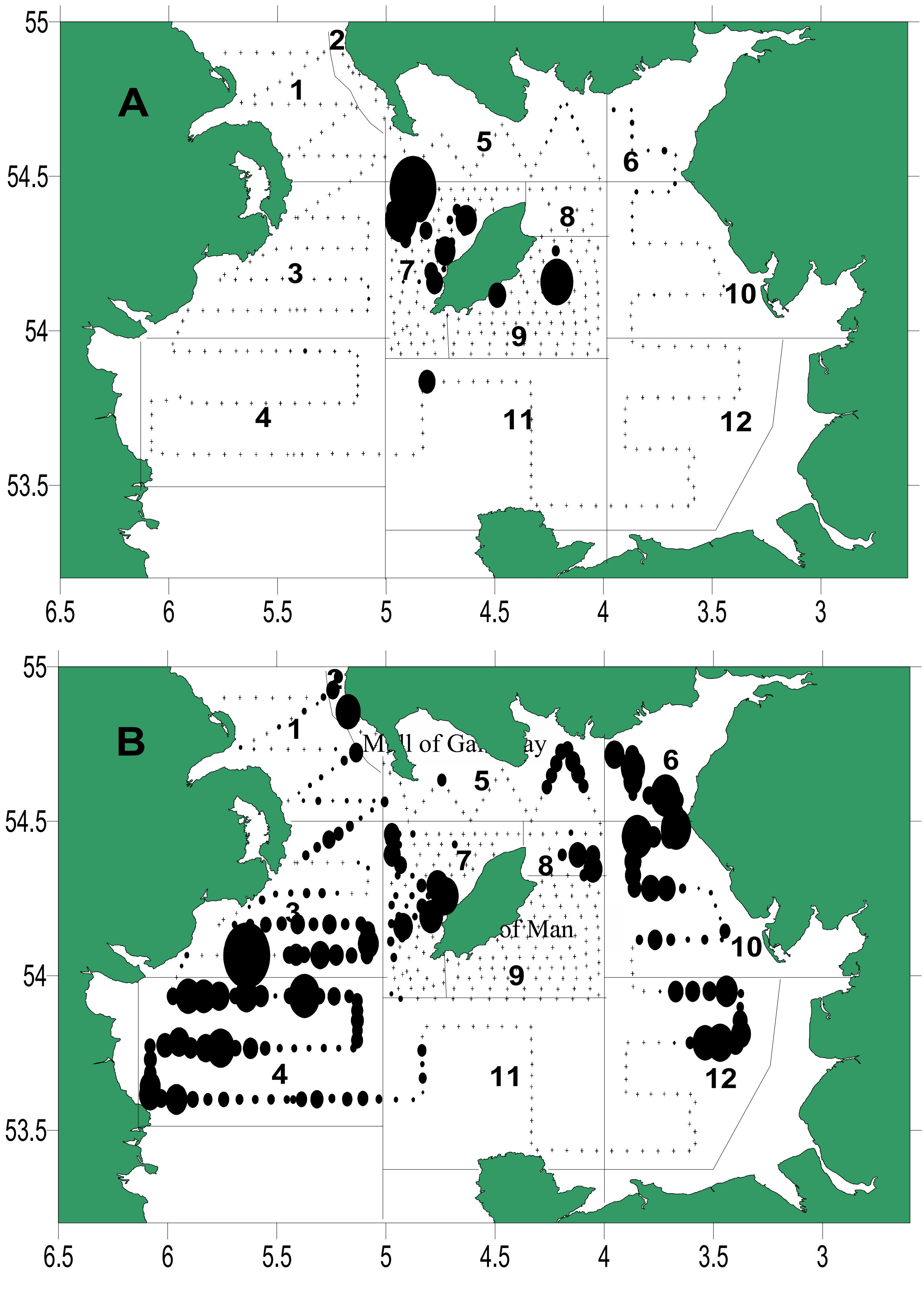


Figure 7.3.1 Irish Sea Herring VIIa(N). DARD acoustic survey. Density distribution of (A) herring schools (mainly 1-ring and older) and (B) sprats and 0-group herring. Size of elipses is proportional to square root of the S_A value for each 15-minute interval (same scale for figures A and B). Crosses indicate starting positions for 15-minute EDSUs. Acoustic survey strata are indicated.

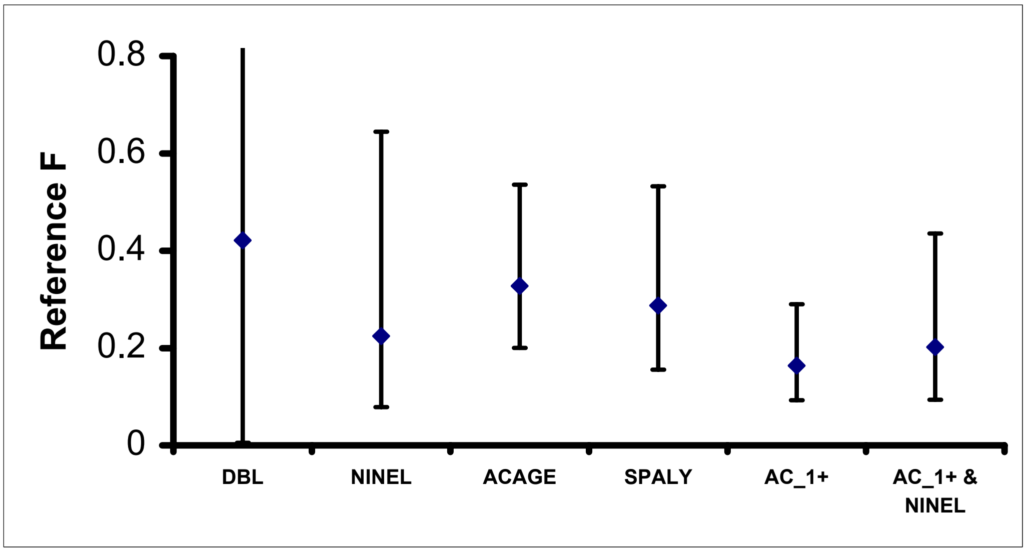


Figure 7.6.1 Irish Sea Herring VIIa(N). Results in terms of reference F (age 4), of the preliminary modelling with ICA of survey indices described in Table 7.6.1. Error bars show the upper and lower 95% confidence limits.

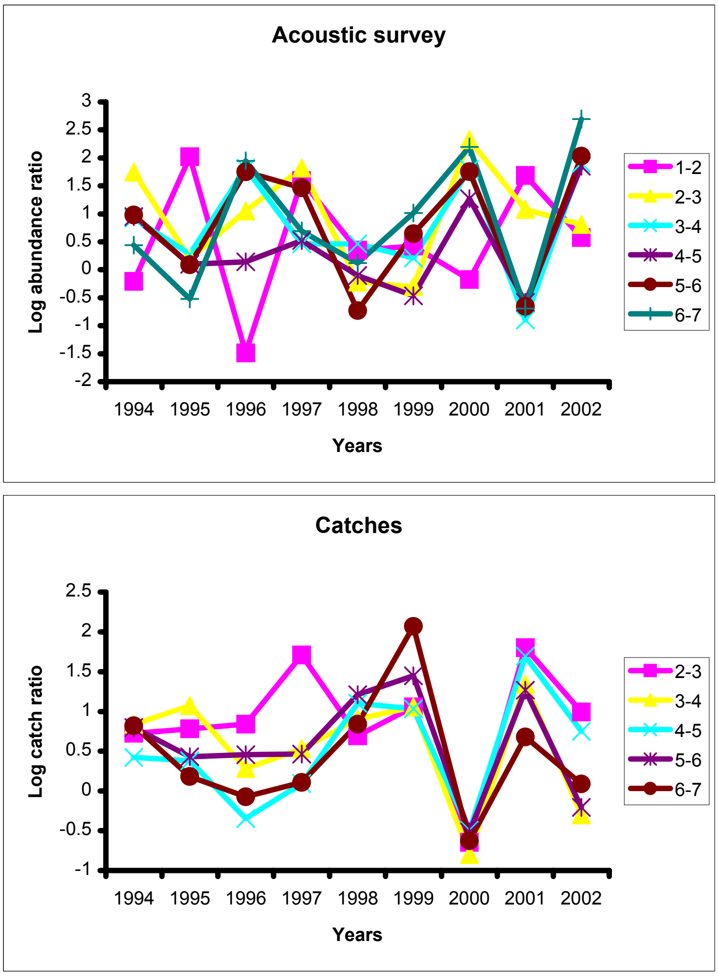


Figure 7.6.2 Irish Sea herring VIIa(N). Log anundance/catch ratios for the period 1994 to 2002/3 by year for a. the acoustic survey (ACAGE and b. the catch at age.

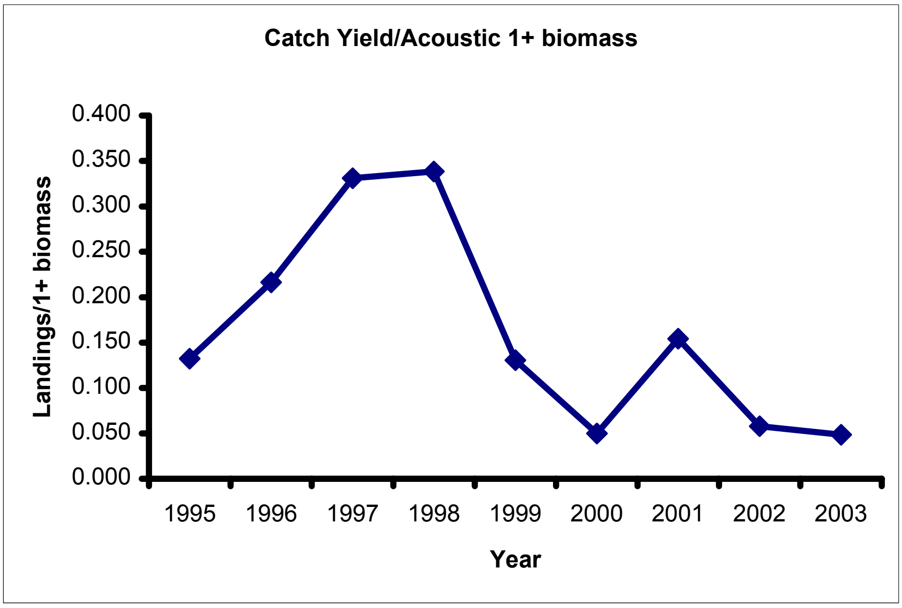


Figure 7.6.3 Irish Sea Herring VIIa(N). Ratio of catch versus acoustic estimate of 1+ biomass for the years 1995 to 2003.

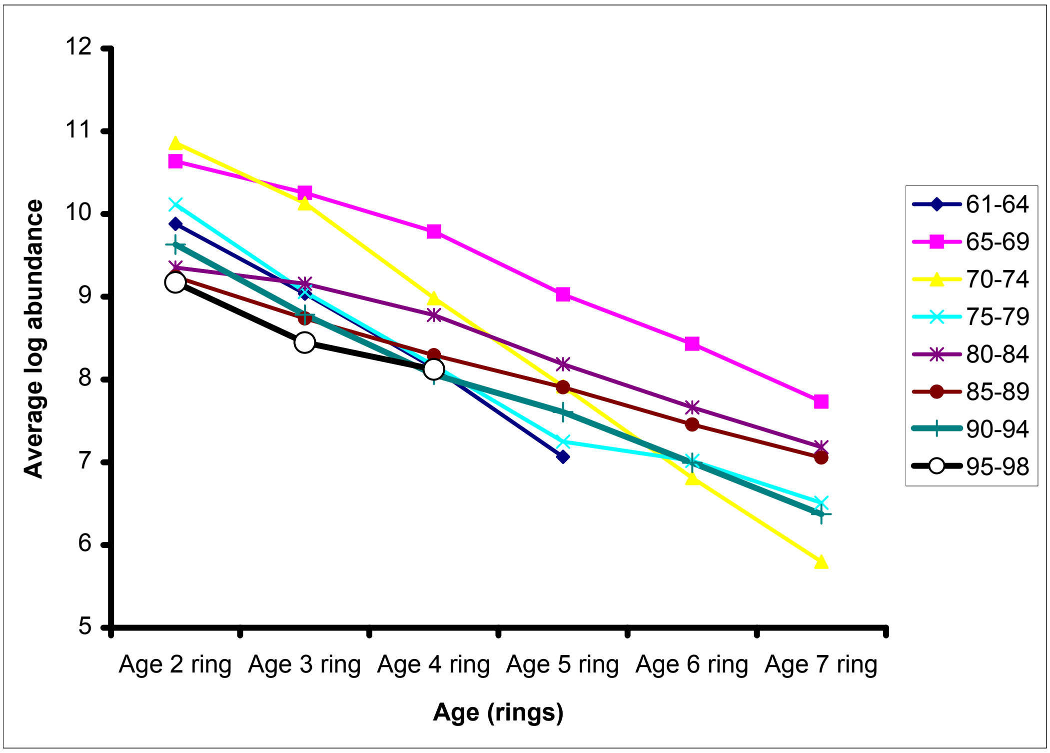


Figure 7.6.4 Irish Sea Herring VIIa(N). Change in average log abundance of year classes (1961-1998) per age class (rings) for 5 year periods.

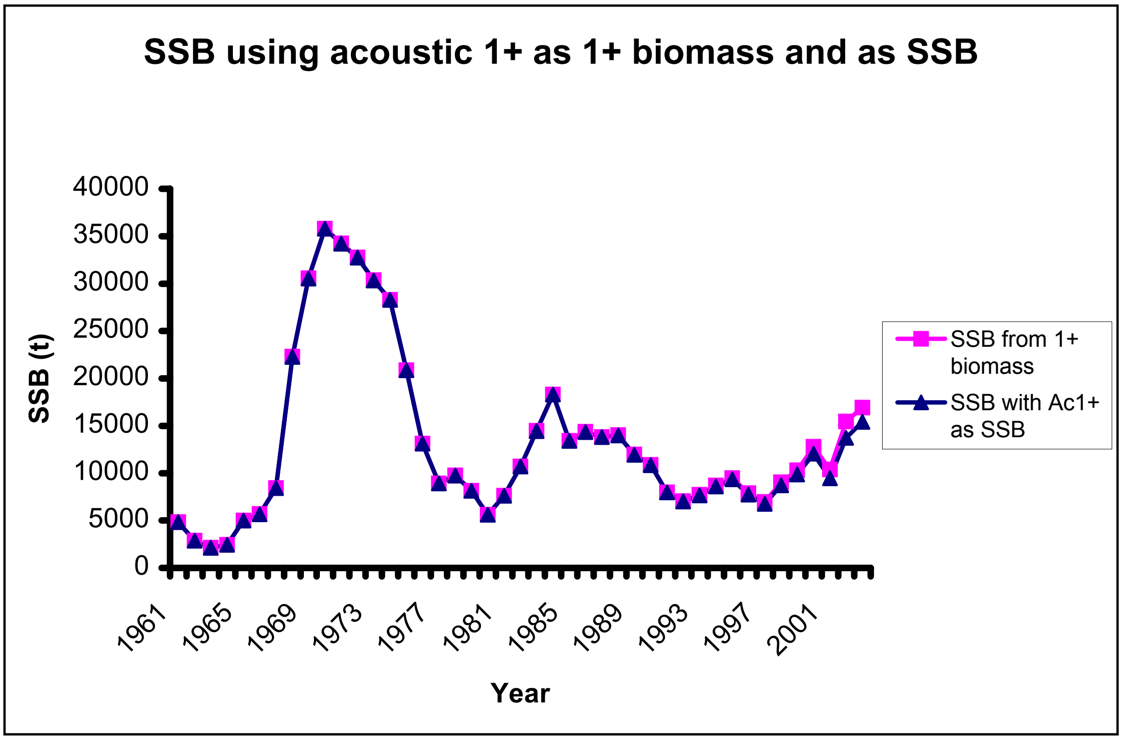


Figure 7.6.5 Irish Sea Herring VIIa(N). Variation in perception of SSB using the acoustic estimate of 1+ biomass either as an SSB or a total biomass index in ICA.

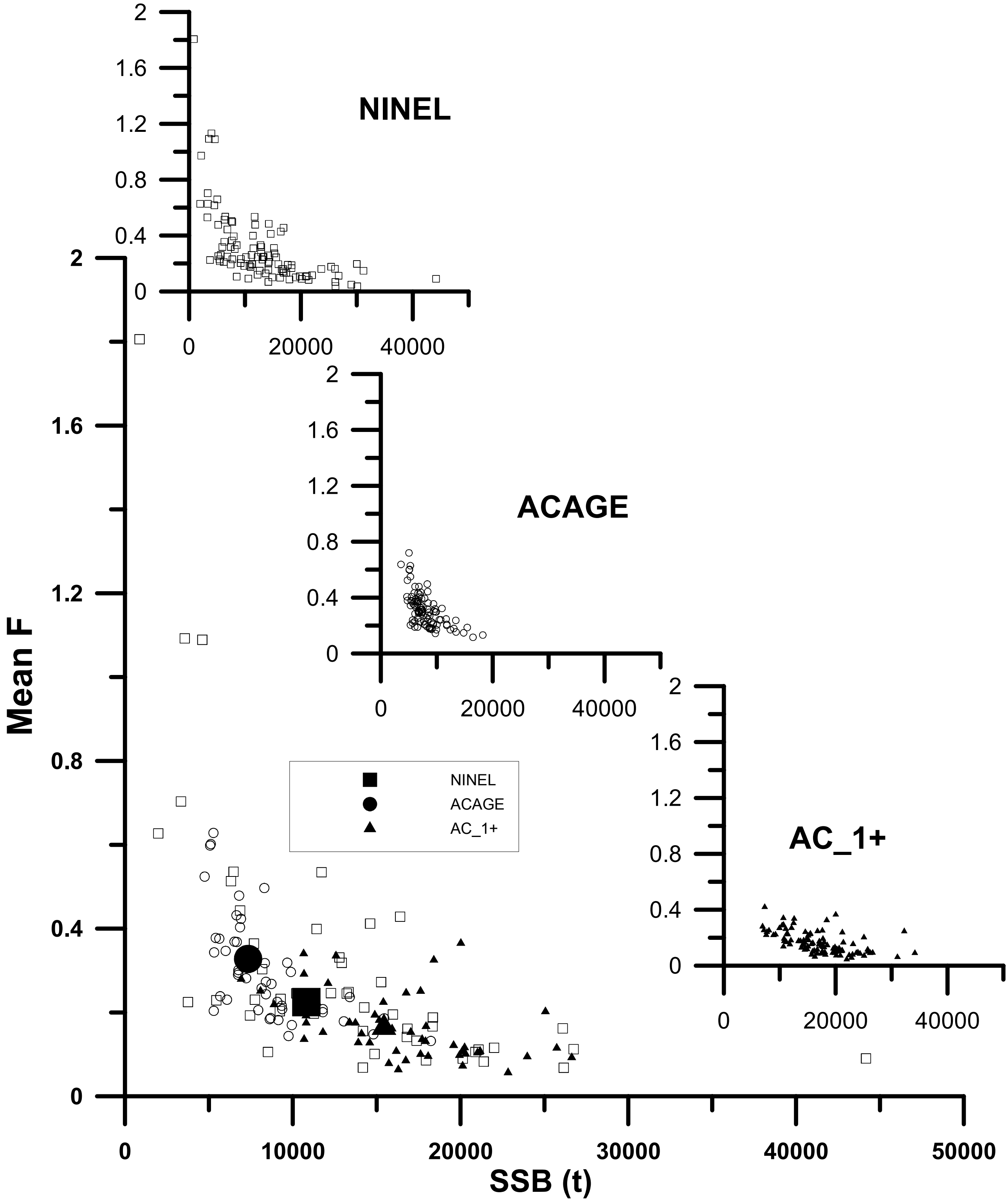


Figure 7.6.6 Irish Sea Herring VIIa(N). Estimates of uncertainty from the ICA bootstrapped mean F and SSB for the three main indices for the Irish Sea herring: Larvae production (NINEL), Acoustic numbers at age (ACAGE) and acoustic 1+ biomass index (AC_1+). 50 bootstrapped values shown on the combined graph and 100 for each individual index. Estimated value for 2003 for each index is shown as the large symbol in the combined graph.

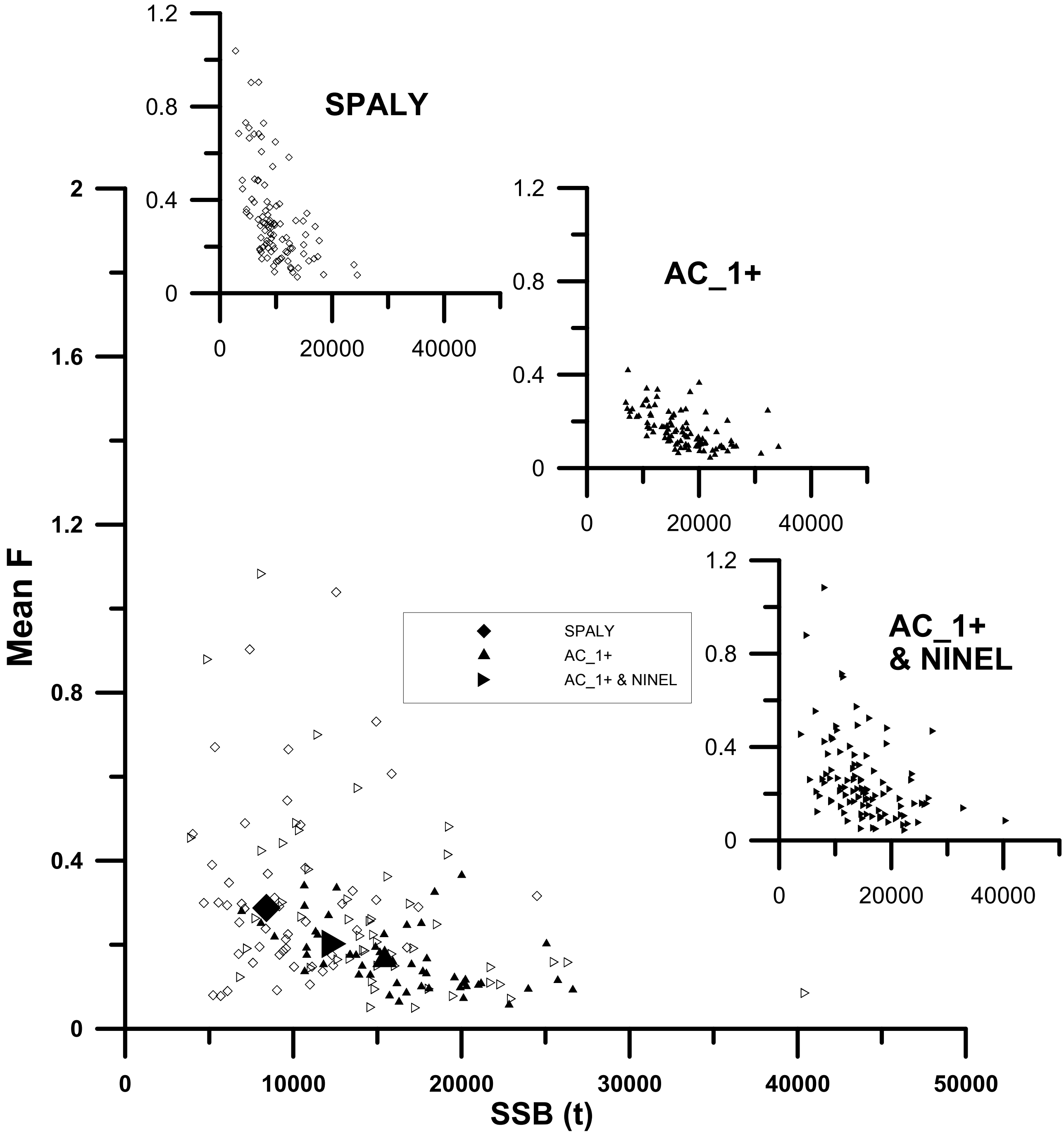


Figure 7.6.7 Irish Sea Herring VIIa(N). Estimates of uncertainty from the ICA bootstrapped mean F and SSB for the three options of single or combined indices in ICA for the Irish Sea herring: SPALY (DBL, NINEL & ACAGE), acoustic 1+ biomass index (AC_1+) and Acoustic 1+ biomass plus NINEL. 50 bootstrapped values shown on the combined graph and 100 for each individual index. . Estimated value for 2003 for each run is shown as the large symbol in the combined graph.

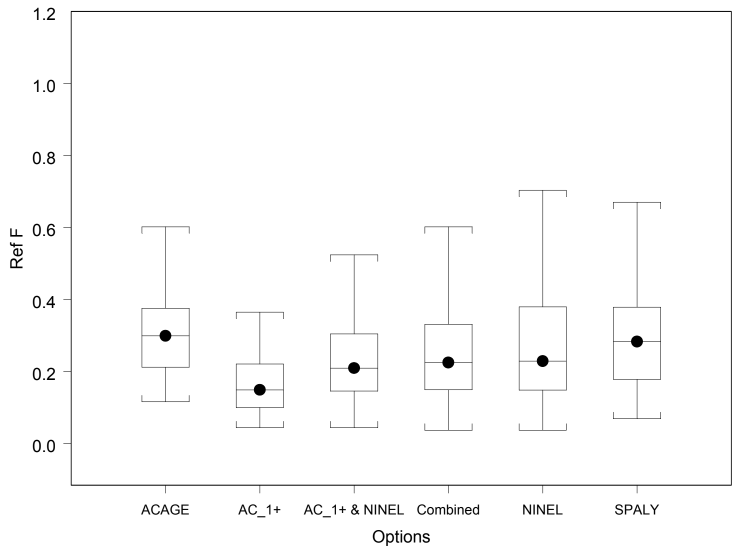


Figure 7.6.8 Irish Sea Herring VIIa(N). Comparison of 2003 Reference F from ICA bootstrap realisations corresponding to the various tuning fleets or SSB (x-axis) explored: Acoustic age-structured (ACAGE), acoustic 1+ and larvae index (AC_1+ & NINEL), Acoustic 1+ (AC_1+), larvae index only (NINEL), same procedure as last year (SPALY) and all the bootstrap estimates combined. The box corresponds to the quartiles, the median is indicated with a dot and the caps indicate the nearest value not beyond a standard span from the quartiles (standard span is 1.5*(Inter-Quartile range).

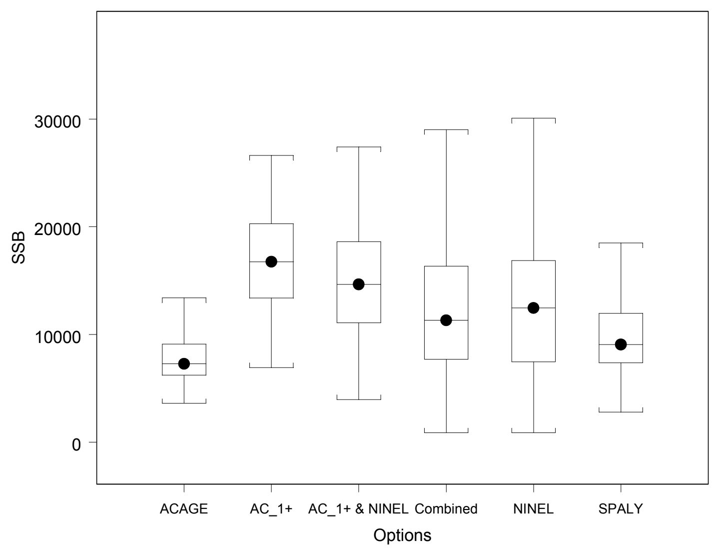


Figure 7.6.9 Irish Sea Herring VIIa(N). Comparison of 2003 SSB from ICA bootstrap realisations corresponding to the various tuning fleets or SSB (x-axis) explored: Acoustic age-structured (ACAGE), acoustic 1+ and larvae index (AC_1+ & NINEL), Acoustic 1+ (AC_1+), larvae index only (NINEL), same procedure as last year (SPALY) and all the bootstrap estimates combined. The box corresponds to the quartiles, the median is indicated with a dot and the caps indicate the nearest value not beyond a standard span from the quartiles (standard span is 1.5*(Inter-Quartile range).

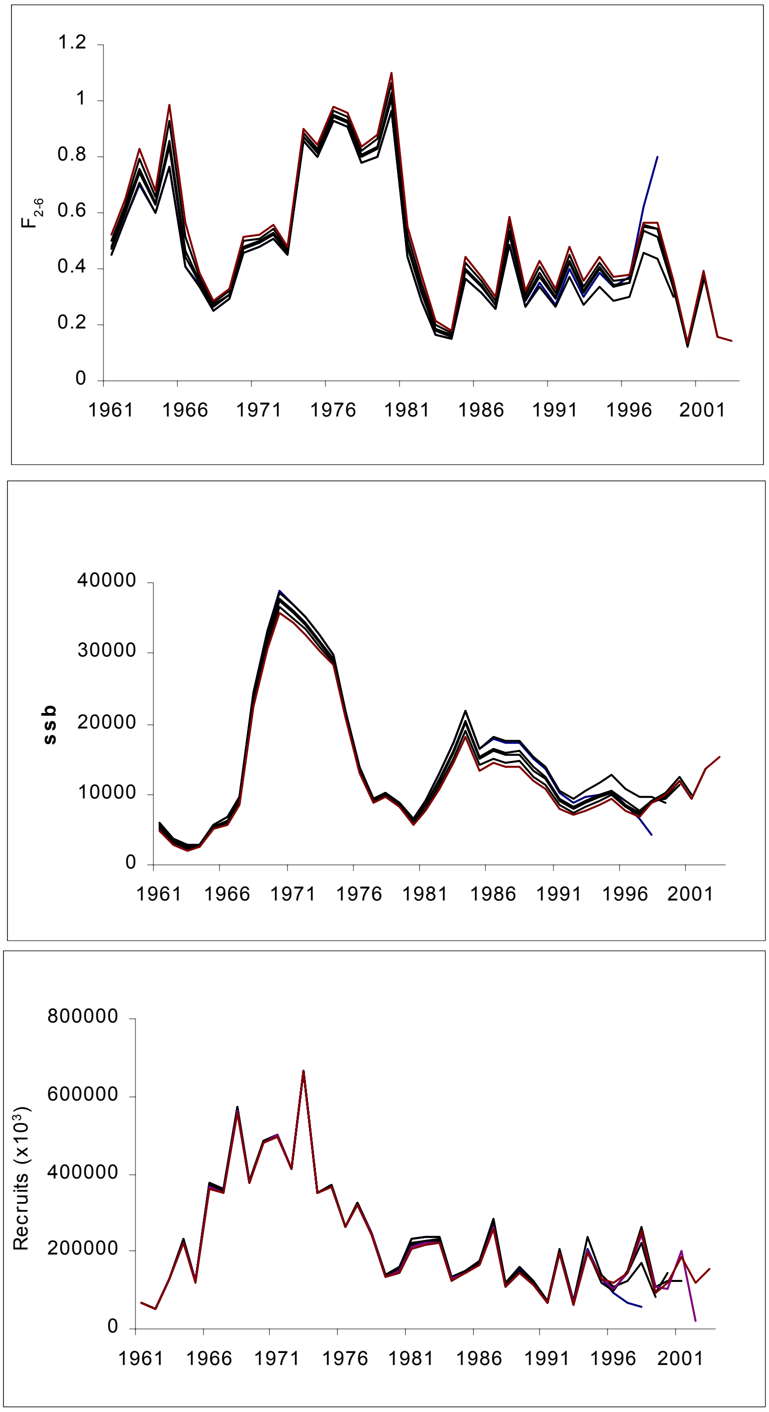


Figure 7.6.10**.** Irish Sea Herring VIIa(N). Retrospective trends in fishing mortality (F_{2-6}), SSB and recruitment (1-ringers) from ICA tuned with the 1+ ringer biomass index from the same survey series.

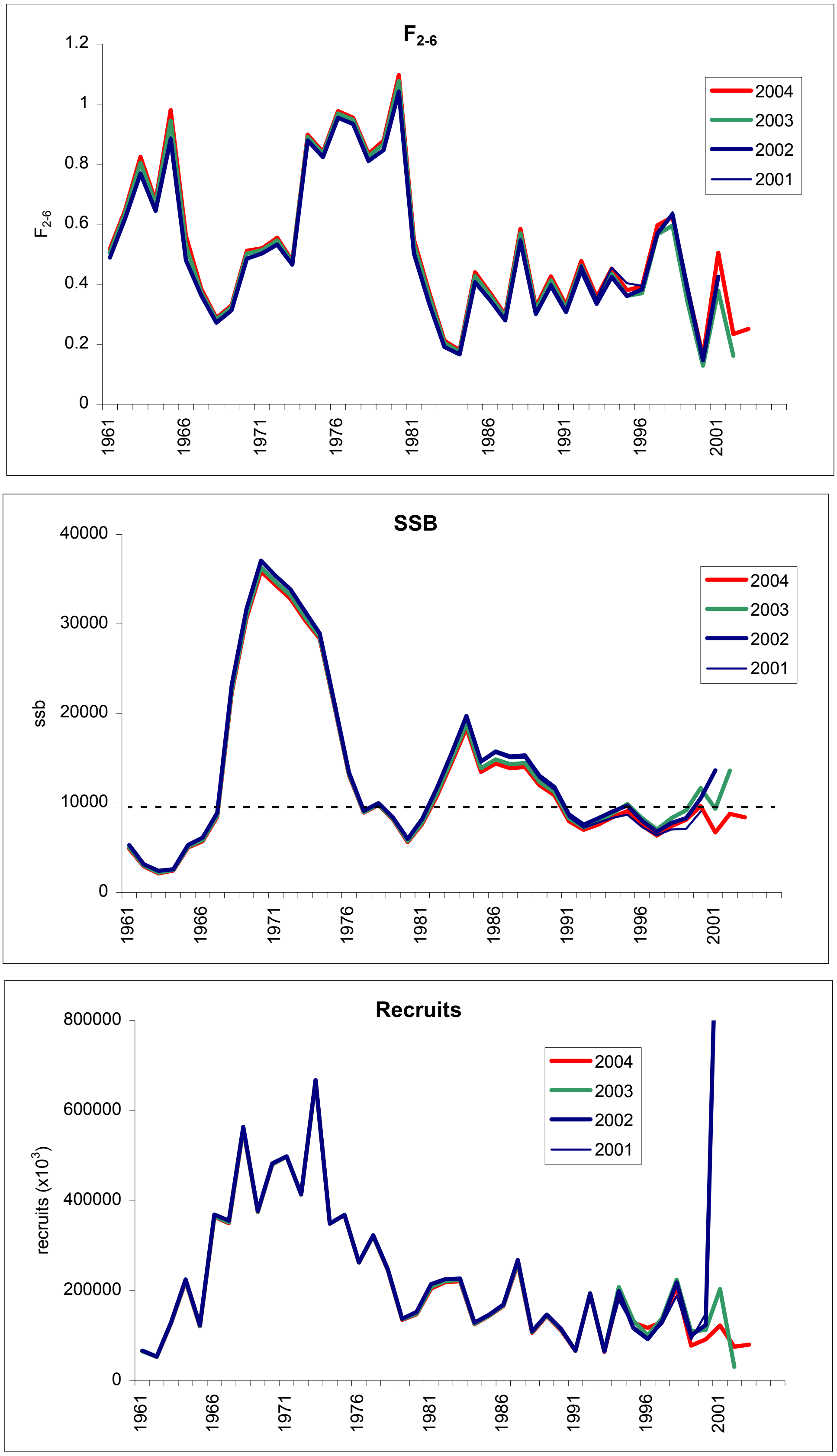


Figure 7.6.11. Irish Sea Herring VIIa(N). Retrospective trends in fishing mortality (F_{2-6}) (from the SPALY run), SSB and recruitment (1-ringers) from ICA tuned with DBL, NINEL and ACAGE.

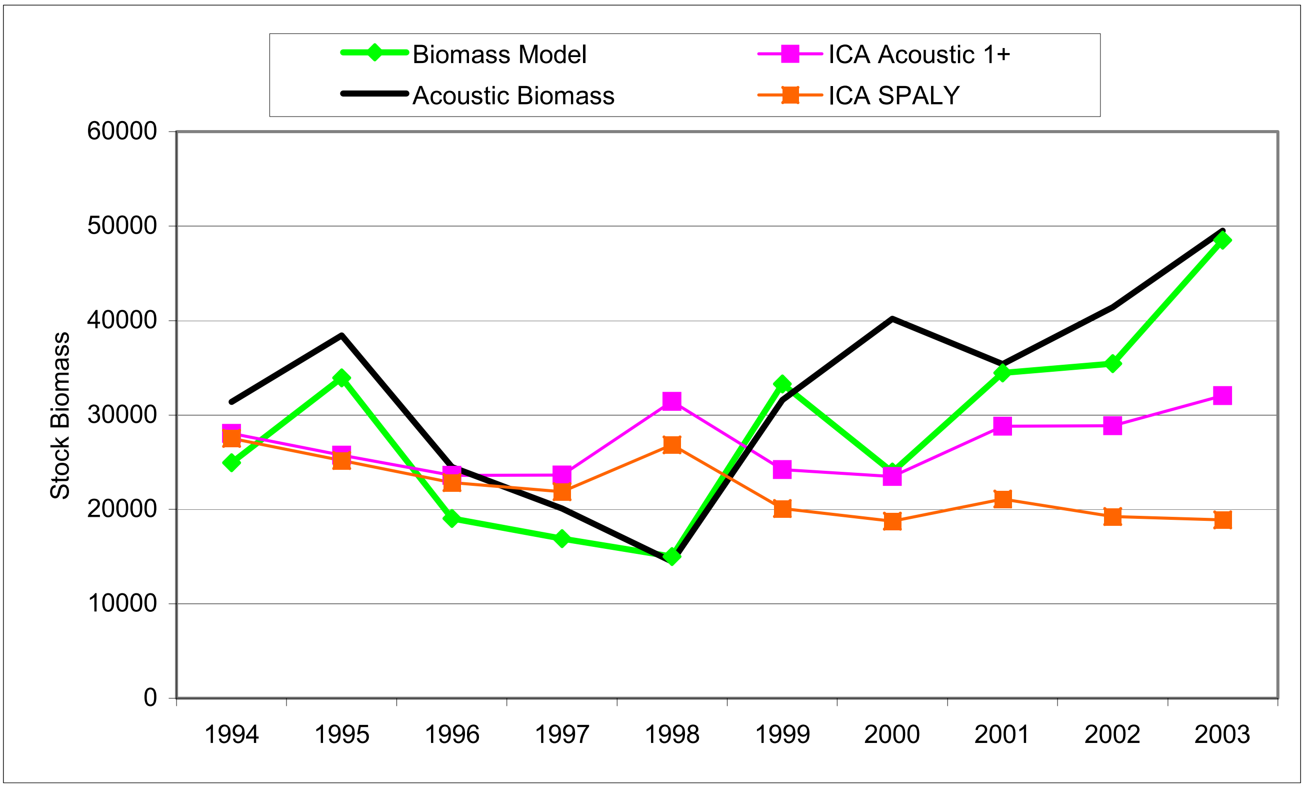


Figure 7.6.12 Irish Sea Herring VIIa(N). Total biomass estimates from the survey, the biomass model and two 2004 ICA runs: using the survey 1+ estimate as tuning index (Acoustic 1+) and using the the acoustic age-structured index and the larvae SSB indices (SPALY).

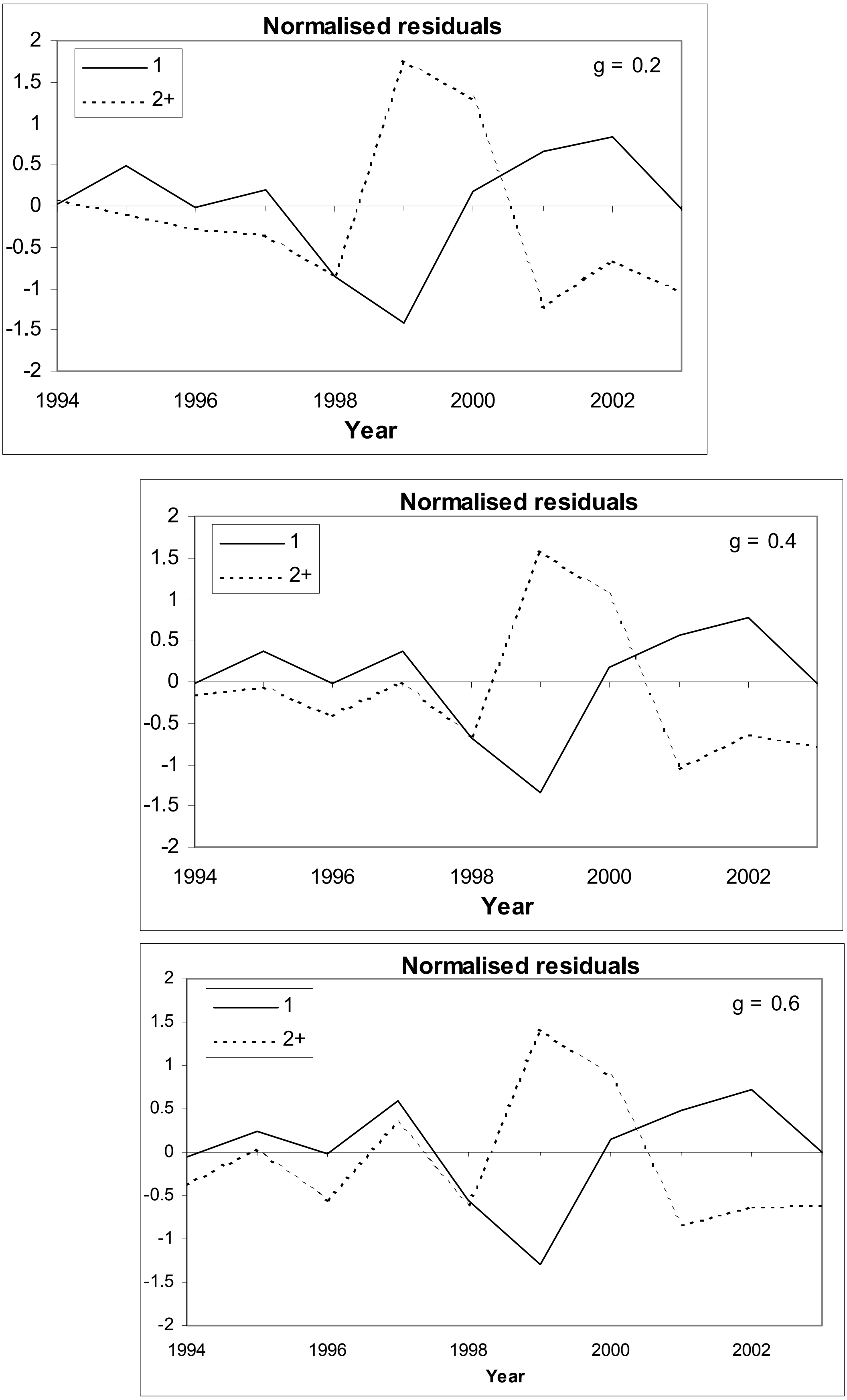


Figure 7.6.13 Irish Sea Herring VIIa(N). Normalised residuals from the model fit to 1 and 2^+-ringers survey indices for *g* equal 0.4 and 0.6.

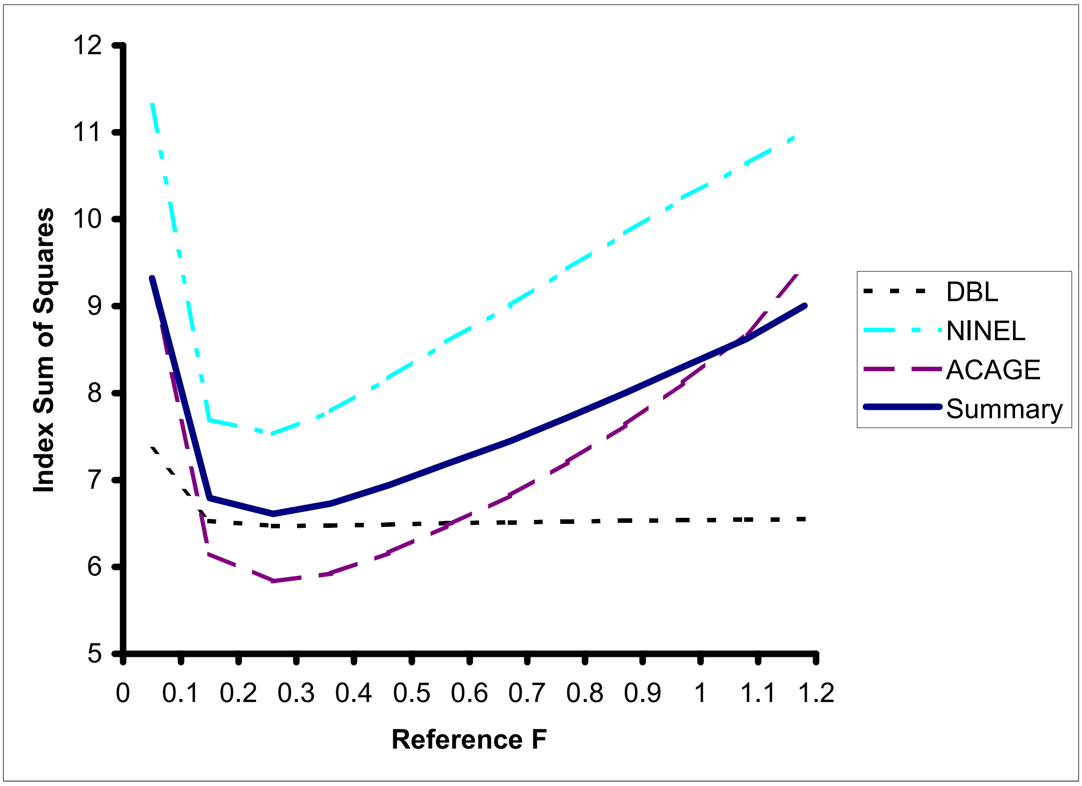


Figure 7.6.14 Irish Sea Herring VIIa(N). SSQ surface for the deterministic calculation of the 6-year separable period.

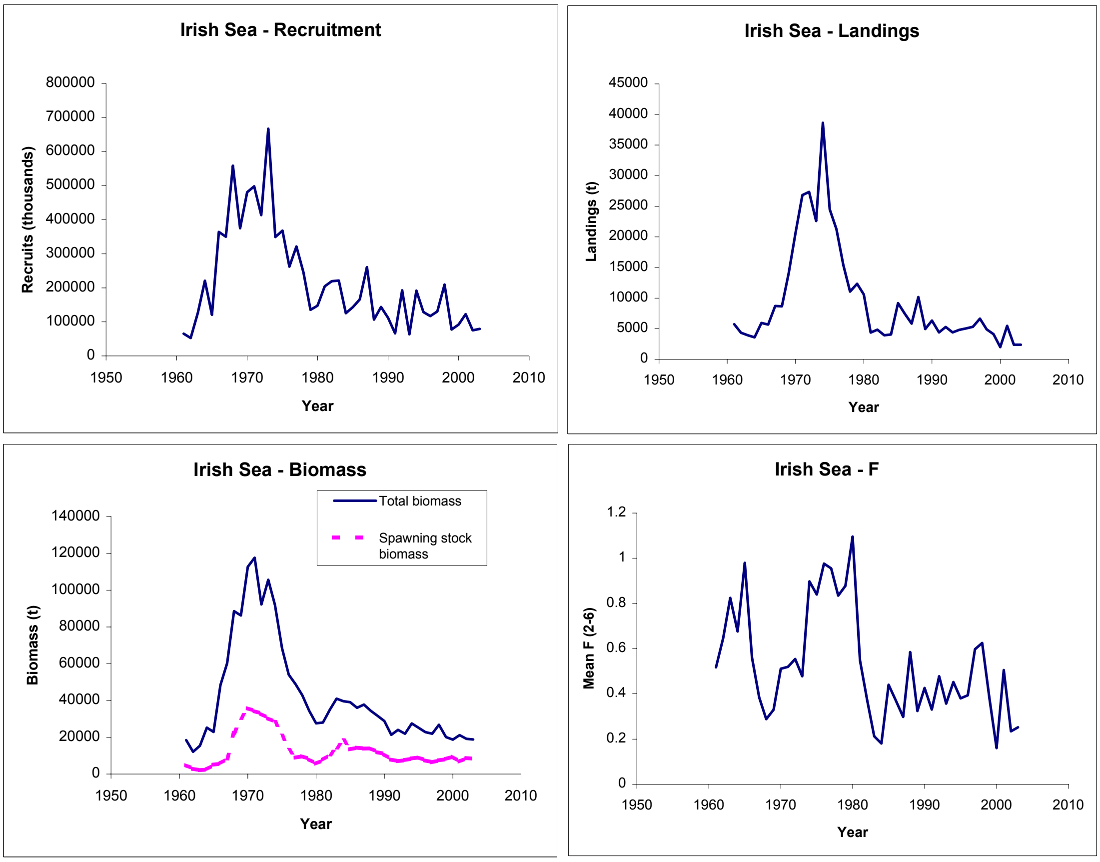


Figure 7.6.15 Irish Sea Herring VIIa(N). Illustration of stock trends from deterministic calculation (6-year separable period). Summary of estimates of landings, fishing mortality-at-age 4, recruitment at age 1, stock size on 1 January and SSB at spawning.

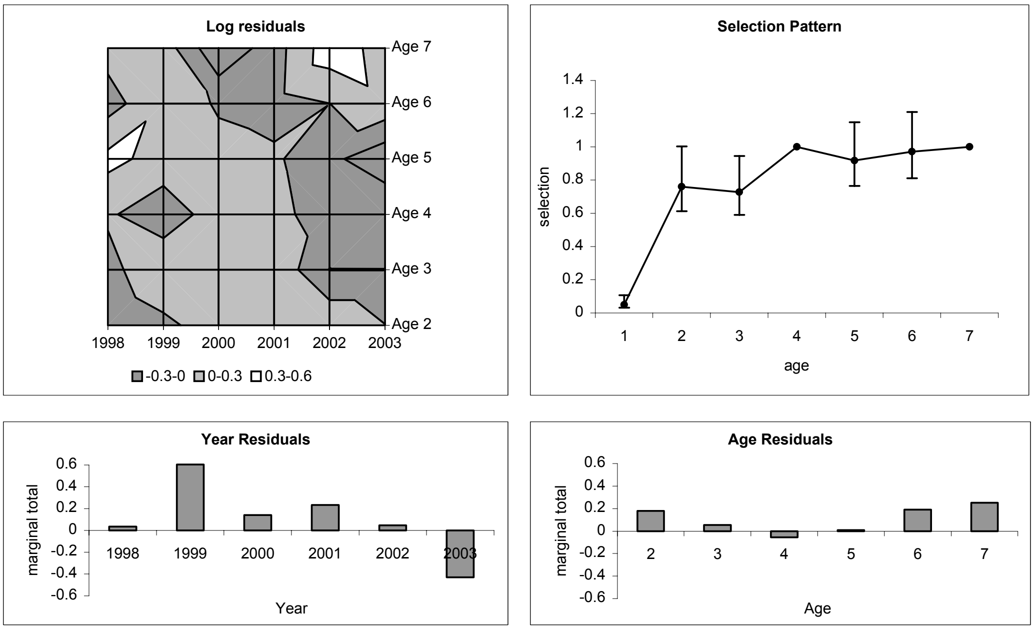


Figure 7.6.16 Irish Sea Herring VIIa(N). Illustration of selection patterns diagnostics, from deterministic calculation (6-year separable period). Top left, a contour plot of selection pattern residuals. Top right, estimated selection (relative to age 4) +/- standard deviation. Bottom, marginal totals of residuals by year and age

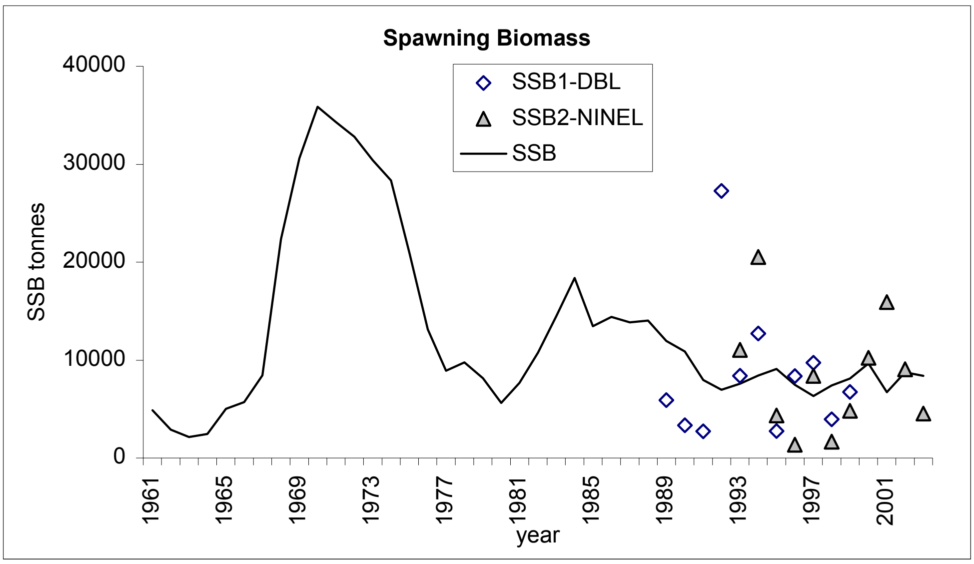


Figure 7.6.17 Irish Sea Herring VIIa(N). Fitted SSB (line) and predicted SSB from indices and estimated catchability. Indices described in Table 7.6.1.

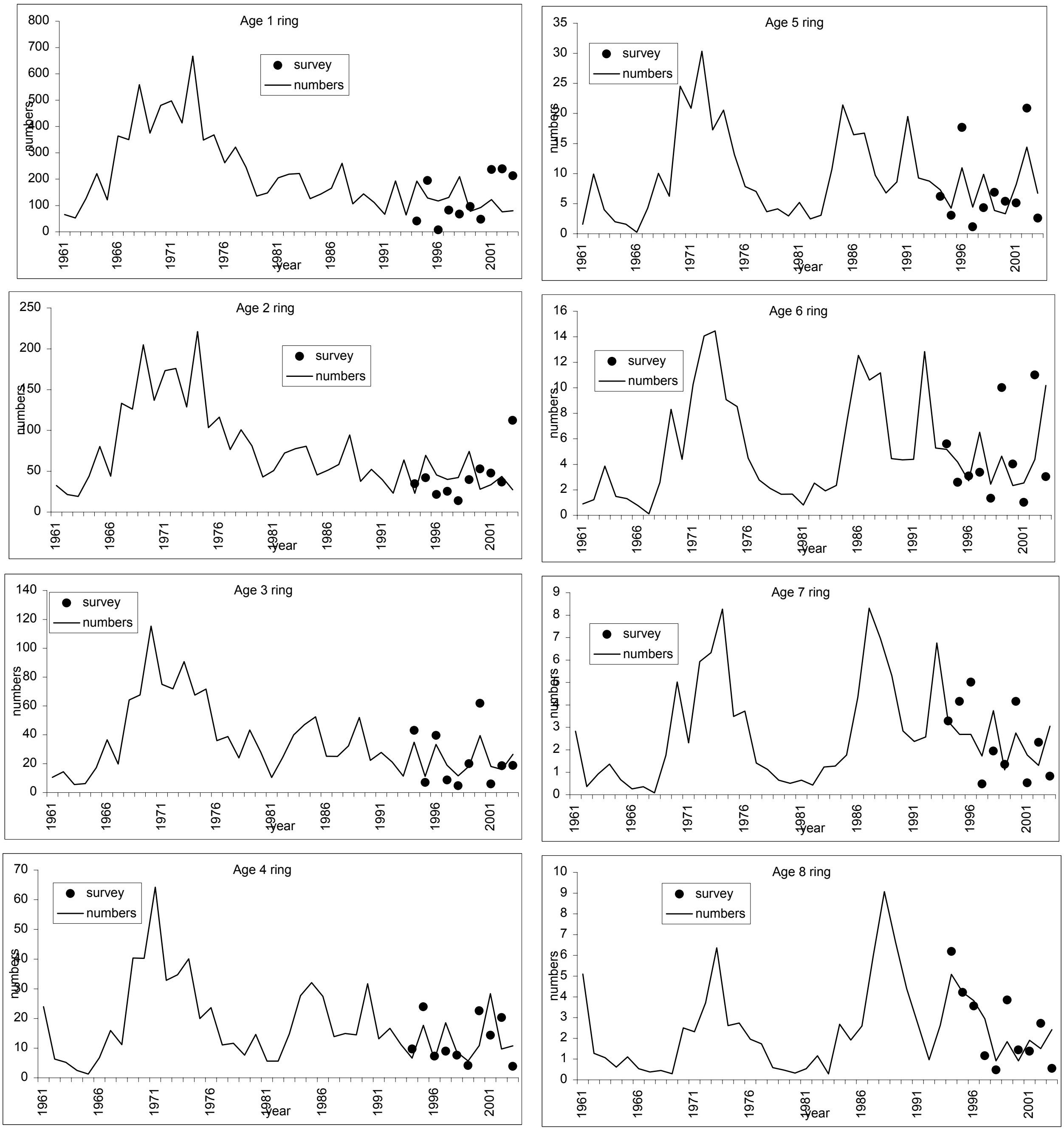


Figure 7.6.18 Irish Sea Herring VIIa(N). Fitted numbers-at-age (line) and predicted numbers from acoustic estimates of age and estimated catchability.

8 Sprat in the North Sea

8.1 The Fishery

8.1.1 ACFM advice applicable for 2003 and 2004

ACFM advised that a catch of 257,000 t in 2003 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 2004 The TAC set by management for Subarea IV (EU zone) and Division IIa (EU zone) has been 257,000 t.

8.1.2 Total landings in 2003

Landing statistics for sprat for the North Sea by area and country are presented in Table 8.1.1 for 1987–2003. As in previous years, sprats from the fjords of western Norway are not included in the landings for the North Sea. Landings from the fjords are presented separately (Table 8.1.2) due to their uncertain stock identity. Table 8.1.3 shows the landings for 1994–2003 by year, quarter, and area in the North Sea.

The landings in 2003 were 176,000 t and higher compared to the landings in 2002, which were 144,000 t. This increase was partly because the Danish fishery was not closed in late February and March, which it was in 2002. There was no Norwegian fishery in 2003. Neither Denmark nor UK (England and Wales) took their quota in 2003. The Danish fishery was responsible for all catches taken in the second and third quarter. Anecdotal information states that in November and December the sprat stock was more widely spread, and by-catch of herring was a limiting factor, therefore the small-meshed fishing fleet moved towards Norway pout instead.

No sprat was reported as by-catch in the landings from the Norwegian or the Swedish small-meshed fishery targeted at sandeel and Norway pout.

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

As requested by ACFM, 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. In general, more than 80% of the catches consist of sprat. The amount of herring caught as by-catch in the sprat fishery in 2003 is less than 6% of the total catch which is the lowest since 1999.

8.2.2 Catches in number

The estimated quarterly catch-at-age in numbers for the years 1995 to 2003 is presented in Table 8.2.2. Denmark provided age composition data of commercial landings in 2003 for all quarters except the 2nd quarter. The age composition data from the 1st quarter was used to raise the catches from the second quarter. Danish samples were used to raise the catches from England and Wales.

1-ringer sprat dominates the catches over all the years although the relative importance does vary with year. 0-ringer sprat catches in 2003 were only slightly higher compared to 2002, being right on the average for the whole time period. The majority of catches is taken during the fourth quarter.

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 2003 is lower than in previous years. In Denmark the provisions in the EU regulation 1639/2001 have been implemented. This provision requires 1 sample per 2000 tonnes landed. This sampling level is lower than the guidelines (1 sample per 1000 tonnes) previously used by the HAWG, but as the fishery was carried out in a limited area, the recommended sampling level can be regarded as adequate.

The Danish monitoring schemes for management purposes for species composition in the Danish small-meshed fisheries has worked well in 2003. A total of 1201 samples were collected from landings taken in the North Sea by Danish vessels. The sampling figure for 2002 was 1054 samples. The total landings from the Danish small mesh fishery in 2003 were 506,000 t (all species) compared to 885,000 t in 2002. This reduction is mainly due to changes in the sandeel fishery. The recommended sampling levels for species composition were achieved. The species composition in the Danish sprat fishery is shown in Table 8.2.1.

8.3 Fishery-independent information

The acoustic surveys for the North Sea Herring in June-July have estimated sprat abundance since 1996. In June-July 1998, sprat was mainly detected west of 1°W (R/V Tridens) (Simmonds *et al*, 1999). The acoustic estimates of sprat biomass in 1996–1998 were in the range of 40,000 t to 210,000 t. In 1999 the acoustic estimate of sprat was very low. The low value was not thought to be representative mainly due to inappropriate coverage of the south-eastern area (ICES CM 2000/D:07), the area expected to have the highest abundance of sprat in the North Sea. In 2000 the survey was extended by 30 n.mi to the south and covered for the first time the south-eastern area considered to have the highest abundance of sprat in the North Sea. By doing so, the estimate of sprat increased significantly. The distribution pattern in 2003 demonstrates, however, that the southern distribution border was still not reached by the survey though it was expanded even further south in 2003. The total sprat biomass estimated in 2003 was 270,000 t, 29,000 t higher than in 2002 (ICES/2003:G:05).

8.4 Mean Weight-at-age and Maturity-at-age

Mean weights (g) at age in the catches during 2003 are presented by quarter in Table 8.2.3. The table includes mean weights-at-age for 1995-2003 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. No reliable data on sprat maturity has been available since 2001 and thus the time-series was not updated during the Working Group 2004.

8.5 Recruitment

The IBTS (February) sprat indices (no. per hour) in IVb (sprat standard area) are used as an index of abundance. The historical data were revised in 1995 (ICES 1995/Assess:13) and 1999 (ICES 1999/ACFM:12). The IBTS Working Group redefined the sprat index to be calculated as an area weighted mean over means by rectangles for the entire North Sea sprat stock. Based on this, the IBTS WG asked ICES Secretariat to carry out new calculations in 2001 (ICES 2000/D:07), which are the ones used in the present report. The old and the revised IBTS index is available in the Working Group report from 2003 for comparison (ICES 2003/ACFM:17). The fishing method (gear) in the IBTS-survey was standardised in 1983 and the data series from 1984, are comparable. The IBTS-indices for 1984–2004 are shown in Table 8.5.1 for age groups 1–4, 5+ and total. The index of 1-group decreased slightly compared to the index from 2003, but is still above the mean of the time-series. The abundance of the 1998 year class was not detected as higher than average and is as 5+-group below the average. The total-abundance index shows a minor increase compared to 2003, and is well above the average for the whole time-series. The old IBTS-indices are available in ICES 2001/ACFM:12.

The IBTS data by rectangle are given in Figure 8.3.1a-c for age groups 1, 2 and 3+. Age 1-group was again found to be concentrated in the south-eastern areas of Division IVb and Division IVc. The mean lengths (mm) of age group 1 by rectangle are presented in Figure 8.3.2.

8.6 State of the Stock

8.6.1 Data Exploration and Preliminary Modelling

Sprat is a relatively short-living species, 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 Working Group using an executable version made available by B. Mesnil (IFREMER). 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 which corresponds to the 1 year-old) and the fully recruited ages (the 2+ group).

Model input data consisting of the time-series of catch numbers for each stage, mean weight for each stage in the stock at the start of the year and the 1st quarter IBTS index of abundance for the 1 year-old sprat (age = number of winter rings) and older than 2 years-old are shown in Table 8.6.1 Weight-at-age, assumed constant for the whole period (1984-2003), was based on commercial data from the 1st quarter. Reservations regarding the ability of the IBTS 1-year-old index to fully reflect strong and weak cohorts for sprat were expressed in previous Working Group 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. The Working Group in 2003 examined the biomass and the 1 year-old index trajectories and concluded that the observed fluctuations in overall biomass were likely to be related to 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.

CSA requires values for the instantaneous rate of natural mortality (M) and a parameter corresponding to the ratio of the survey catchability of the recruits to the fully recruited ages (s). Both parameters are fixed externally. The value of natural mortality is based on predation mortality estimates from a multispecies VPA (ICES 2002 CM/D:04). The results from the Study Group MSVPA for the North Sea were examined to provide information about plausible values for natural mortality. A value of 0.2 needs to be added to the estimate of predation mortality to account for other sources of mortality. Estimates of predation mortality at-age and 90% confidence intervals representing the variation over time from the MSVPA are shown in Fig. 8.6.1 for the period 1963 – 2000. The regression line in Fig. 8.6.2 indicates a decline in predation mortality in the period 1963 – 2000.

An observation-error only model which estimates catchability of the fully recruited stage by close-form solution $q_n = \exp(mean(Log(n_t/N_t)))$ was implemented. Numbers at the start of the year of fish >2-year-old in the first year of data and all the recruit numbers were estimated by least-squares minimisation. The recruits corresponding to the last year in the series were computed from the survey index and the recruitment catchability. 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 and 0.8. In the absence of data that would support an alternative value *s* was equated to 1.Model output is shown in Table 8.6.2. for M = 0.7.

Model fits for M = 0.7 to the IBTS indices are shown in Figure 8.6.3. Some conflict between the recruitment and the 2+ indices is shown in 1989 - 1990 where the model was not able to account for the high recruitment estimated by IBTS. The model does not fit well the high IBTS 2+ index in 1998 given a low recruitment index in 1997; this could be an example of a late recruitment scenario where IBTS underestimated total recruitment. Estimated numbers of recruits and fully recruited and total biomass are shown in Fig. 8.6.4. Examination of the residuals suggests patterns in the fit to the recruits index, but less so in the case of the fully recruited. (Fig. 8.6.5). Confidence intervals for the parameters were estimated by means of non-parametric bootstrapping. Biomass point estimates (for M= 0.7 and 0.8) and 95% confidence intervals (M = 0.7) are shown in Figure 8.6.6. The biomass trajectory estimated by using M = 0.8 falls between the confidence intervals for M= 0.7. Exploratory runs with M declining linearly between 0.83 and 0.68 were attempted, but the model failed to converge. Given that the dynamics depends largely on the 1-year olds, it would be expected that the biomass trajectory would bend slightly downwards in recent years in relation to the run using M = 0.8. In other words, initially the biomass would follow a similar trajectory to the one corresponding to M = 0.8 but increasingly less so in recent years where it would approximate the trajectory corresponding to the run with M = 0.7.

Results from a retrospective analysis are shown on Figure 8.6.7 suggesting a recent period of negative bias preceded by a long period where the biomass was revised upwards. The Working Group concluded from examination of Fig 8.6.5 that the retrospective bias was relatively small.

Although the Working Group was requested to do an update assessment the recent assessment should be regarded as still exploratory.

8.7 Projections of Catch and Stock

The SHOT- approach (Shepherd, 1991) was used in the past by the Working Group to estimate the landings in the assessment year. The Working Group considered that approach inappropriate for a short-lived species like sprat therefore the projection was based on the results from CSA. Biomass projections in 2004 and 2005, assuming median recruitment in 2005, for annual catches in 2004 and 2005 corresponding to the same exploitation rate as in 2003 are shown in Figure 8.7.1. The biomass trajectories suggest that the stock, depending on 2005 recruitment, would remain relatively stable under that level of exploitation.

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 2003 are shown on Figure 8.7.2 and the corresponding catch prediction for 2004 is about 171,000 t.

8.8 Quality of the Assessment

Trends in the mean weights-at -age during the first quarter used to compute the biomass index from the IBTS have been reviewed. No trend was observed in the mean weights-at-age over time, therefore an average for the period 1995 – 2000 (sampling levels prior to 1995 were low) was used to compute stock biomass by means of Catch Survey Analysis. The model fits time-series of abundance for 2 stages in the stock: the recruits and the fully recruited to the fishery. The IBTS indices for the 1st quarter were used as indicators. The Working Group is aware of problems associated with sprat in the IBTS (February) which may have hatched in autumn. However examination of the residuals from the model fit suggests that the problem results in additional noise in the data but the model still attains a reasonably good fit to the data. The results are sensitive to the value assumed for the catchability ratio *s*, the estimated biomass being scaled accordingly. Therefore, when examining the model output, emphasis should be placed on stock trends rather than on absolute values until an independent estimate of *s* becomes available. Results from sensitivity tests to the assumed value of M showed that the stock biomass would be scaled upwards when M increases. Further, available estimates of M suggest that it has declined in the period 1963-2000 from values just above 0.8 to about 0.7. 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, a value of s

= 1 for IBTS is compatible with perceptions that catchability of recruits is no different from the one of the fully recruited. 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

Prior to 1993, the sprat was caught with a relative high percentage of herring by-catch. In 1993, 1994 and 1995 the sprat fishery could be conducted with rather low herring by-catch percentages. In some periods in 1997 and 1998 it was stopped with the aim of protecting the juvenile herring and due to high by-catch of herring.

The sprat stock shows signs of being in good condition as the biomass appears to increase and there is indication from the IBTS (February)-2004-survey of a good 2003-year class recruiting to the 2004 fishery. In 1998–2000 the by-catch of herring was not a limiting factor in the sprat fishery and the main controlling factor was the TAC limits. The Working Group is not able to assess the impact on the biomass of catch levels in 2004 other than assuming average recruitment. The fishery in a given year is very dependent on that year's incoming year class; therefore a catch projection for 2004 assuming average recruitment is meaningless. If a TAC regime was necessary and the required data was available, a management approach including a mid-year revision of the TAC taking into account an estimate of incoming recruitment would have to be considered for sprat. Despite the short-comings of the exploratory assessment presented here there are indications that the stock is lightly exploited.

Attempts to assess this stock have demonstrated the need for a better sampling coverage for both length and age composition. There is also a need for better knowledge of spawning seasons and recruitment from a possible autumn spawning. There are indications that larvae from autumn spawning will over-winter as larvae and metamorphose the year after. As sprat is aged by counting winter-rings with reference to January 1 as the birthday this will result in incorrect allocation to year classes. The group recommends a review of the criteria used for ageing sprat and further validation of the formation of winter rings and allocation to year classes.

Table 8.1.1. Sprat in the North Sea. Catches (' 000 t) 1987-2003. Catch in fjords of western Norway excluded. (Data provided by Working Group members except where indicated). These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Division IVa West (North Sea) stock																	
Denmark	0.2	0.1				0.3	0.6						0.7		0.1	1.1	
Netherlands																	
Norway					0.1												
Sweden															0.1		
UK(Scotland)								0.1									
Total	0.2	0.1			0.1	0.3	0.6	0.1					0.7		0.2	1.1	
Division IVa East (North Sea) stock																	
Denmark										0.3							
Norway						0.5	2.5		0.1								
Sweden					2.5												
Total					2.5	0.5	2.5		0.1	0.3							
Division IVb West																	
Denmark	3.4	1.4	2.0	10.0	9.4	19.9	13.0	19.0	26.0	1.8	82.2	21.1	13.2	18.8	11.1	16.3	22.0
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)	0.1						0.5						0.8				
Total	3.5	4.9	2.1	11.2	13.8	38.8	30.8	31.6	47.0	3.7	84.5	21.1	14.0	18.8	12.0	16.3	22.0
Division IVb East																	
Denmark	28.0	80.7	59.2	59.2	67.0	66.6	136.2	251.7	283.2	74.7	10.9	98.2	147.1	144.1	132.9	109.8	130.9
Germany																	
Norway		0.6		0.6	25.1	9.5	24.1	19.1	14.7	50.9	0.8	15.3	13.1	0.9	5.0		
Sweden				+	+				0.2	0.5		1.7	2.1		1.4		
UK(Scotland)													0.6				
Total	28.0	81.3	59.2	59.8	92.1	76.1	160.3	270.8	298.1	126.1	11.7	115.2	162.9	145.0	139.3	109.8	131.0
Division IVc																	
Denmark		0.1	0.5	1.5	1.7	2.5	3.5	10.1	11.4	3.9	5.7	11.8	3.3	28.2	13.1	14.8	22.3
France									+								
Netherlands		0.4	0.4										0.2				
Norway							0.4	4.6	0.4		0.1	16.0	5.7	1.8	3.6		
UK(Engl.&Wales)	0.7	0.6	0.9	0.2	1.8	6.1	2.0	2.9	0.2	2.6	1.4	0.2	1.6	2.0	2.0	1.6	1.3
Total	0.7	1.1	1.8	1.7	3.5	8.6	5.9	17.6	12.0	6.5	7.2	28.0	10.8	32.0	18.7	16.4	23.6
Total North Sea																	
Denmark	31.6	82.3	61.7	70.7	78.1	89.2	153.3	280.8	320.6	80.7	98.8	131.1	164.3	191.1	157.2	142.0	175.2
France									+								
Germany																	
Netherlands		0.4	0.4										0.2				
Norway		4.1	0.1	1.8	29.6	28.4	43.8	36.3	36.2	52.8	3.2	31.3	18.8	2.7	9.5	0.0	
Sweden					2.5								2.7		1.4		
UK(Engl.&Wales)	0.7	0.6	0.9	0.2	1.8	6.6	2.5	2.9	0.2	2.6	1.4	0.2	1.6	2.0	2.0	1.6	1.3
UK(Scotland)	0.1						0.5	0.1					0.8				
Total	32.4	87.4	63.1	72.7	112.0	124.3	200.1	320.1	357.0	136.1	103.4	162.6	188.4	195.9	170.1	143.6	176.5

Table 8.1.2. Sprat catches ('000 t) in the fjords of western Norway, 1985-2003.

1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003 [1]
7.1	2.2	8.3	5.3	2.4	2.7	3.2	3.8	1.9	5.3	3.7	3.3	3.1	2.5	3.3	3.4	1.5	1.5	2.3

[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	
1994	1		42	2,616	17,227	16,081	35,966
	2			242	10,857	1	11,100
	3			10,479	184,747		195,226
	4	109		18,224	57,959	1,503	77,796
Total		109	42	31,561	270,790	17,586	320,088
1995	1			17,752	16,900	7,324	41,976
	2			1,138	5,752	1	6,891
	3		86	25,305	183,500	6	208,897
	4		5	2,826	92,054	4,693	99,578
Total			91	47,021	298,206	12,024	357,342
1996	1		459	2,471	81,020	6,103	90,053
	2			615	2,102	18	2,735
	3			242	6,259		6,501
	4		353	411	36,273	386	37,423
Total			812	3,739	125,654	6,507	136,712
1997	1			1,025	147	7,089	8,261
	2			189	1,054		1,243
	3		3	27,487	569		28,059
	4		81	55,814	9,878		65,773
Total			84	84,515	11,648	7,089	103,336
1998	1			1,917	3,726	1,616	7,259
	2		4	529	206	4	743
	3			4,926	55,155	215	60,296
	4			13,712	54,433	25,984	94,129
Total			4	21,084	113,520	27,819	162,427
1999	1			450	20,862	9,071	30,383
	2			108	1,048		1,156
	3	1	17	7,840	121,186	415	129,459
	4	679	31	5,550	19,731	1,167	27,158
Total		680	48	13,948	162,827	10,653	188,156
2000	1			2,686	15,440	28,063	46,189
	2			1,599	123	45	1,767
	3			14,405	116,901	1,216	132,522
	4			158	12,522	2,718	15,398
Total				18,848	144,986	32,042	195,876
2001	1	115		1,643	39,260	9,716	50,734
	2	0		699	372		1,071
	3	0		947	43,226	480.9284	44,655
	4	79		8,681	56,421	8537.876	73,719
Total		194		11,970	139,279	18,735	170,177
2002	1	1,136		222	1,960	2,790	6,108
	2			122	313	93.484	528
	3			9,131	61,373	647	71,151
	4			6,809	46,133	12910.52	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

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 1998-2003.

	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
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

Table 8.2.2 North Sea Sprat. Catch in numbers (millions) by quarter and by age 1995-2003.

Year	Quarter	Age						
		0	1	2	3	4	5+	Total
1995	1		5.9	2,990.5	991.4	54.0		4,041.7
	2		2.3	595.1	182.5			779.9
	3	531.3	12,097.4	7,990.0	262.6	3.3		20,884.7
	4		4,541.1	3,309.7	377.8			8,228.6
	Total	531.3	16,646.7	14,885.3	1,814.3	57.3		33,934.8
1996	1		524.7	4,615.4	2,621.9	316.4	11.3	8,089.7
	2		1.9	241.5	32.7	15.5	0.3	291.9
	3		400.5	100.7	22.9	0.3		524.5
	4		1,190.7	1,069.0	339.6	5.6		2,604.8
	Total		2,117.9	6,026.6	3,017.0	337.8	11.5	11,510.8
1997	1		74.4	314.0	229.2	55.3	2.5	675.4
	2		11.3	47.8	34.9	8.4	0.4	102.9
	3		1,991.9					1,991.9
	4	127.6	3,597.2	996.2	117.8	58.1	0.0	4,896.9
	Total	127.6	5,674.8	1,358.1	381.9	121.8	2.8	7,667.1
1998	1		683.2	537.2	18.3	0.1		1,238.8
	2		70.9	55.3	1.8			127.9
	3	74.2	3,356.6	693.3				4,124.2
	4	772.4	4,822.4	2,295.1	483.5	39.5		8,412.8
	Total	846.6	8,933.1	3,580.9	503.6	39.6		13,903.7
1999	1		728.1	2,226.0	554.2	86.6	9.2	3,604.2
	2		38.6	58.4	18.1	2.6		117.7
	3		12,919.0	38.9				12,957.8
	4	105.0	2,143.2	211.5				2,459.7
	Total	105.0	15,828.9	2,534.8	572.3	89.2	9.2	19,139.5
2000	1		559.2	3,177.3	797.5	247.5	72.0	4,853.7
	2		6.8	107.4	60.1	12.8	0.5	187.6
	3		9,928.9	1,111.9	77.8			11,118.6
	4		1,153.7	129.2	9.0			1,291.9
	Total		11,648.7	4,525.8	944.4	260.3	72.6	17,451.8
2001	1		746.3	3,197.7	1,321.9	22.2		5,023.1
	2		15.9	66.2	26.1			108.2
	3	0.4	3,338.8	299.9				3,559.1
	4	1,205.0	4,178.7	1,224.6	261.9			6,651.4
	Total	1,205.4	8,279.8	4,788.4	1,609.9	22.2		15,341.7
2002	1	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

Table 8.2.3 North Sea Sprat. Mean weight (g) by quarter and by age for 1995 - 2003.

Year	Quarter	Age						SOP
		0	1	2	3	4	5+	Tonnes
1995	1		3.0	9.4	12.9	19.4		41,976.0
	2		3.0	8.4	10.3			6,891.0
	3	2.4	7.6	13.9	16.4	20.7		208,897.0
	4		10.5	13.9	16.2			99,578.0
Weighted mean		2.40	8.38	12.79	13.83	19.47		357,342.0
1996	1		3.9	9.3	14.9	15.3	16.1	88,807.0
	2		6.9	8.4	11.6	20.0	15.2	2,735.0
	3		11.6	14.2	18.2	21.5		6,501.0
	4		12.1	15.9	17.2	20.5		37,359.0
Weighted mean			9.97	10.49	15.12	15.58	16.03	135,401.0
1997	1		8.0	10.0	15.0	17.0	19.0	8,161.0
	2		8.0	10.0	15.0	17.0	19.0	1,243.0
	3		14.2					28,285.0
	4	3.7	11.9	16.4	19.1	19.6		63,083.0
Weighted mean		3.73	12.67	14.66	16.26	18.24	19.00	100,772.0
1998	1		5.6	6.0	8.7	15.0		7,232.0
	2		5.6	6.0	8.3			743.0
	3	3.7	14.7	15.3				60,149.0
	4	4.1	10.6	13.8	16.3	14.6		94,173.0
Weighted mean		4.03	11.69	12.80	15.98	14.65		162,297.0
1999	1		3.3	8.7	12.5	14.4	16.3	30,168.0
	2		3.1	10.1	13.6	15.4		993.0
	3		10.0	18.3				129,383.0
	4	4.4	11.0	14.4				27,126.0
Weighted mean		4.42	9.78	9.39	12.49	14.43	16.34	187,670.0
2000	1		4.2	10.1	10.7	10.2	10.5	46,192.0
	2		3.3	9.0	10.2	12.8	10.5	1,767.0
	3		11.9	11.9	11.0			132,563.0
	4		11.9	11.9	11.0			15,403.0
Weighted mean			11.55	10.56	10.68	10.33	10.52	195,925.0
2001	1		3.3	9.7	12.9	16.5		50,794.0
	2		3.3	10.3	12.9			1,071.0
	3	4.0	12.0	15.3				44,656.0
	4	3.8	11.6	12.6	19.1			73,444.0
Weighted mean		3.75	10.99	10.80	13.91	16.53		169,967.0
2002	1		7.0	12.0	14.0	13.0		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

Table 8.2.4 North Sea Sprat. Sampling commercial landings for biological samples in 2003

Country	Quarter	Landings 000t	No samples	No fish meas.	No fish aged
Denmark	1	18	11	615	302
	2	1	32	162	
	3	56	11	565	140
	4	100	27	1,397	1015
Total		175	81	2739	1457
UK (England and Wales)	1	1			
	4	0			
Total		1			
Total North Sea		176	81	2739	1457

Table 8.5.1 North Sea sprat. Abundance indices by age from IBTS (February) from 1984-2004.
New standard area as implemented in by the Working Group in 2003 (ICES 2003/ACFM:17).

Year	Age					
	1	2	3	4	5+	Total
1984	232.40	330.20	39.60	6.20	0.30	608.70
1985	375.90	195.30	26.70	3.80	0.40	602.10
1986	44.20	73.60	22.00	1.20	0.20	141.20
1987	542.40	66.80	19.60	2.00	0.20	631.00
1988	91.40	887.20	61.60	6.90	0.00	1047.10
1989	2297.20	472.80	269.80	5.40	1.60	3046.80
1990	234.90	452.00	102.10	28.10	2.20	819.30
1991	677.30	93.30	23.30	2.60	0.10	796.60
1992	1041.00	291.90	42.40	7.10	0.50	1382.90
1993	1030.60	604.40	118.40	6.10	0.30	1759.80
1994	2428.50	932.60	91.40	3.60	0.50	3456.60
1995	647.40	1613.90	87.30	2.50	0.80	2351.90
1996	182.40	387.20	146.80	18.30	0.70	735.40
1997	591.40	412.40	179.60	15.50	2.20	1201.10
1998	1171.10	1457.20	306.10	15.80	3.40	2953.60
1999	2509.50	562.40	80.40	4.80	25.10	3182.2
2000	1058.80	907	277.5	43.9	0.9	2288.1
2001	883.10	1055.80	185.20	17.50	0.10	2141.70
2002	1382.60	604.50	74.40	8.40	0.60	2070.50
2003	1823.12	292.30	39.16	2.32	0.01	2156.89
2004	1491.64	560.69	123.22	4.51	3.09	2183.14

Table 8.6.1 : CSA Input data: catch in numbers (CatRec & CatFull), abundance indices (Urec & Ufull) and catch at age for each stage, and catchability ratio Srat.

Year	CatRec	CatFull	Urec	Ufull	Wrec	Wfull	Srat
1984	6455.2	1432.4	232.4	376.3	4.5	9.67	1
1985	2361.16	1680.36	375.9	226.2	4.5	9.67	1
1986	917.3294	385.2029	44.2	97	4.5	9.67	1
1987	2102.31	464.56	542.4	88.6	4.5	9.67	1
1988	529.28	5460.05	91.4	955.7	4.5	9.67	1
1989	2658.36	3431.79	2297.2	749.6	4.5	9.67	1
1990	1415.95	1421.13	234.9	584.4	4.5	9.67	1
1991	2653.3	1890.71	677.3	119.3	4.5	9.67	1
1992	8801.13	2590.83	1041	341.9	4.5	9.67	1
1993	4992.73	4069.87	1030.6	729.2	4.5	9.67	1
1994	36190.2	5173	2428.5	1028.1	4.5	9.67	1
1995	16646.7	16756.9	647.4	1704.5	4.5	9.67	1
1996	2117.9	9392.9	182.4	553	4.5	9.67	1
1997	5674.8	1864.6	591.4	609.7	4.5	9.67	1
1998	8933.1	4124.1	1171.1	1782.5	4.5	9.67	1
1999	15828.9	3205.5	2509.5	672.7	4.5	9.67	1
2000	11648.7	5803.1	1058.8	1229.3	4.5	9.67	1
2001	8279.8	6420.5	883.1	1258.6	4.5	9.67	1
2002	10442	1850.3	1382.6	687.9	4.5	9.67	1
2003	12528.7	3449.1	1823.116	333.7776	4.5	9.67	1
2004			1491.637	691.505			

Table 8.6.2 CSA Output: Estimated 1 year-old (RecN) and 2+ (FullN) numbers in the stock, total stock biomass, fishing mortality and harvest rates for the 1year-old and 2+ (M=0.7).

Year	RecN	FullN	TSBiom	F*	HRrec	HRfull	CatRec	CatFull	Sratio	M
1984	14591	22653.8	0.284722	0.357	0.442	0.063	6455.2	1432.4	1	0.7
1985	16835.1	12936.9	0.200858	0.214	0.14	0.13	2361.2	1680.4	1	0.7
1986	3002.9	11936.4	0.128938	0.132	0.305	0.032	917.3	385.2	1	0.7
1987	90643.3	6500.7	0.470757	0.038	0.023	0.071	2102.3	464.6	1	0.7
1988	6777.9	46431.4	0.479493	0.174	0.078	0.118	529.3	5460.1	1	0.7
1989	68489.9	22202.4	0.522901	0.1	0.039	0.155	2658.4	3431.8	1	0.7
1990	11995.4	40744.8	0.447981	0.079	0.118	0.035	1416	1421.1	1	0.7
1991	40893.8	24190.7	0.417947	0.104	0.065	0.078	2653.3	1890.7	1	0.7
1992	81451.7	29117.9	0.648103	0.158	0.108	0.089	8801.1	2590.8	1	0.7
1993	84282	46879.5	0.832593	0.103	0.059	0.087	4992.7	4069.9	1	0.7
1994	224680.5	58746.5	1.579142	0.232	0.161	0.088	36190.2	5173	1	0.7
1995	49598.6	111597.6	1.302342	0.348	0.336	0.15	16646.7	16756.9	1	0.7
1996	14817.6	56508.5	0.613117	0.26	0.143	0.166	2117.9	9392.9	1	0.7
1997	81593.7	27308	0.63124	0.103	0.07	0.068	5674.8	1864.6	1	0.7
1998	72592.8	48766	0.798235	0.166	0.123	0.085	8933.1	4124.1	1	0.7
1999	157656.1	51063.8	1.203239	0.139	0.1	0.063	15828.9	3205.5	1	0.7
2000	70980.3	90233.9	1.191973	0.167	0.164	0.064	11648.7	5803.1	1	0.7
2001	49523.2	67758.5	0.878079	0.196	0.167	0.095	8279.8	6420.5	1	0.7
2002	59960.5	47881.2	0.732834	0.176	0.174	0.039	10442	1850.3	1	0.7
2003	124428.7	44890.4	0.994019	0	0.101	0.077	12528.7	3449.1	1	0.7

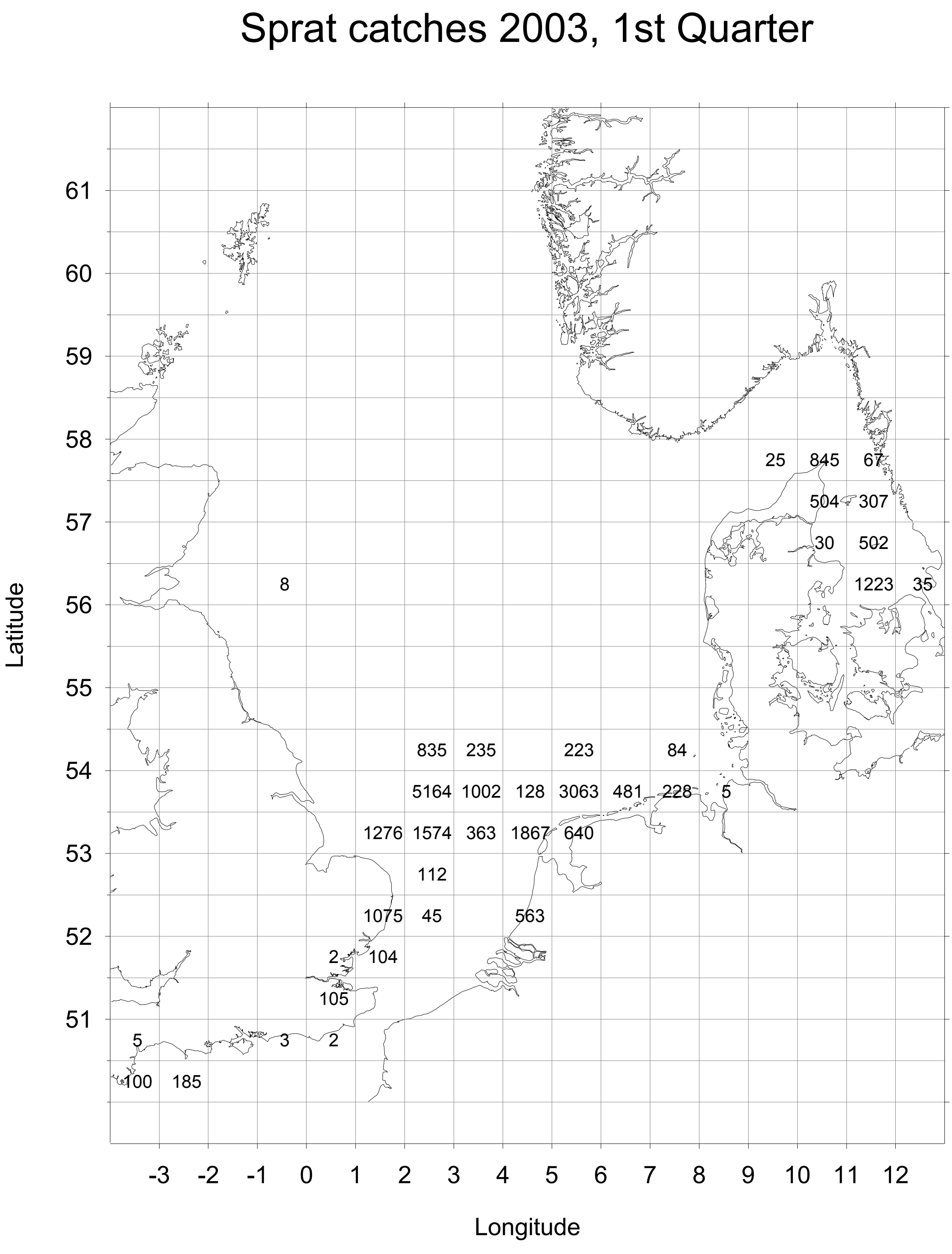


Figure 8.1.1a Sprat catches (in tonnes) in the North Sea in 2003 by statistical rectangle. Working group estimates (if available). First quarter.

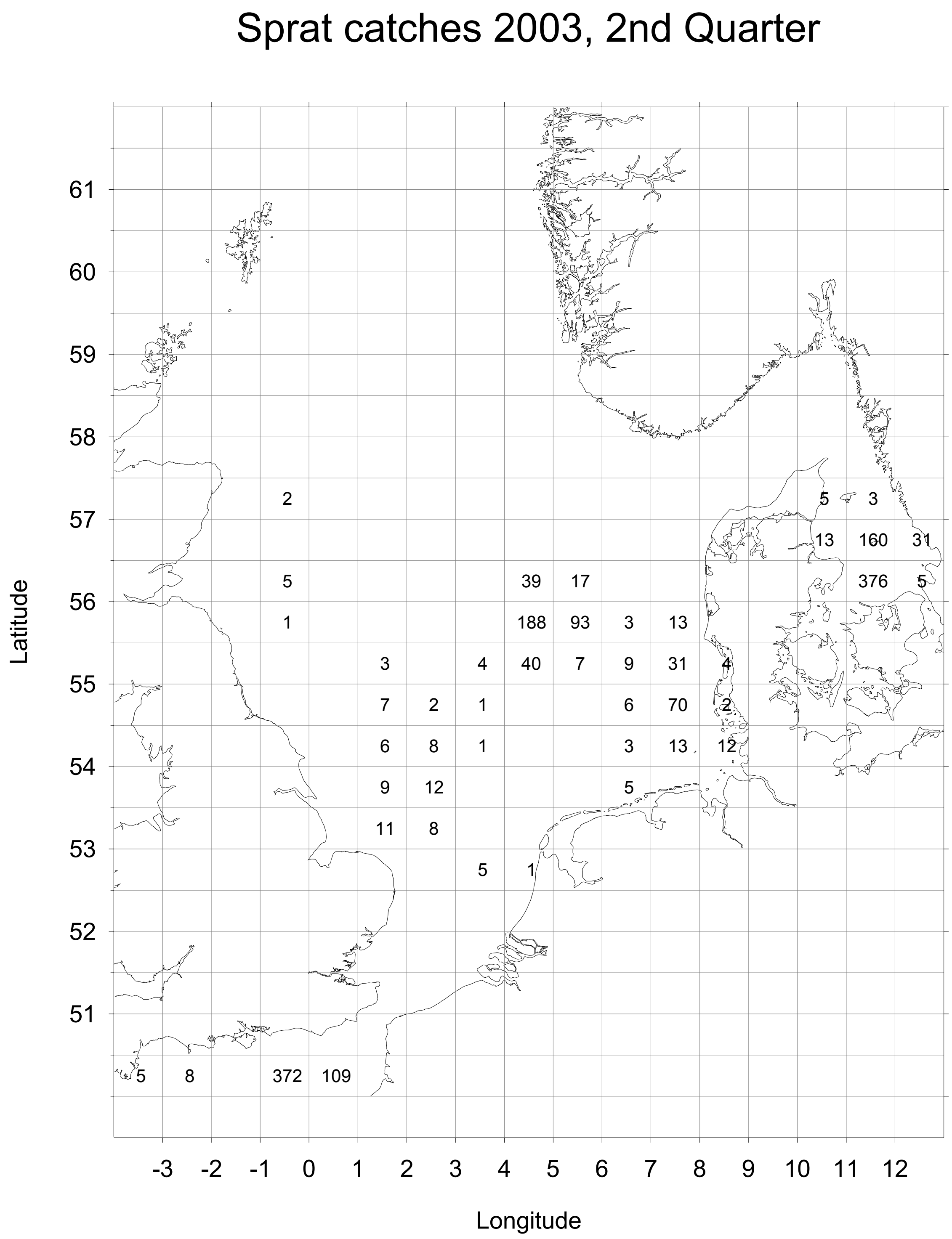


Figure 8.1.1b Sprat catches (in tonnes) in the North Sea in 2003 by statistical rectangle. Working group estimates (if available). Second quarter.

Sprat catches 2003, 3rd Quarter

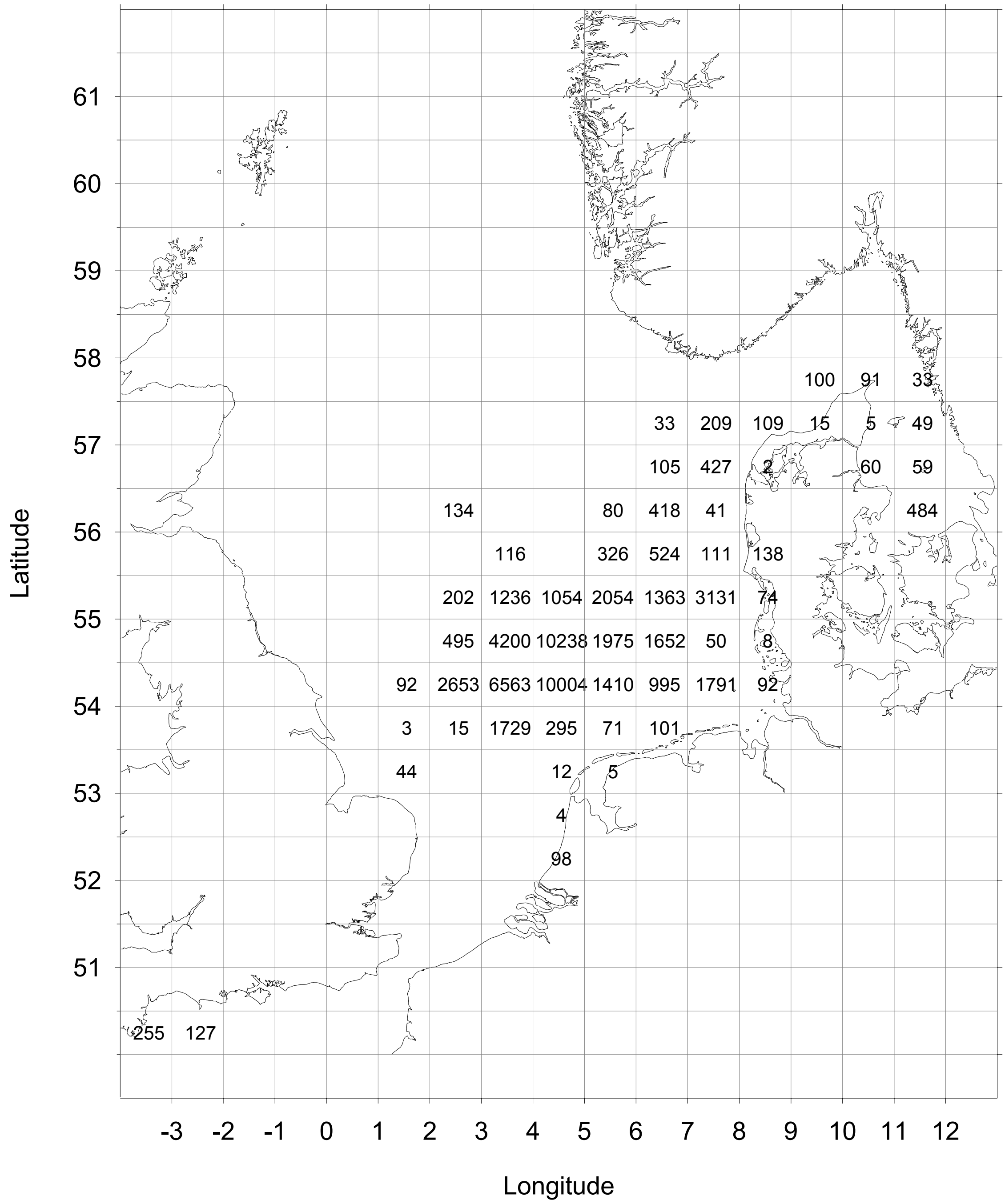


Figure 8.1.1c Sprat catches (in tonnes) in the North Sea in 2003 by statistical rectangle. Working group estimates (if available). Third quarter.

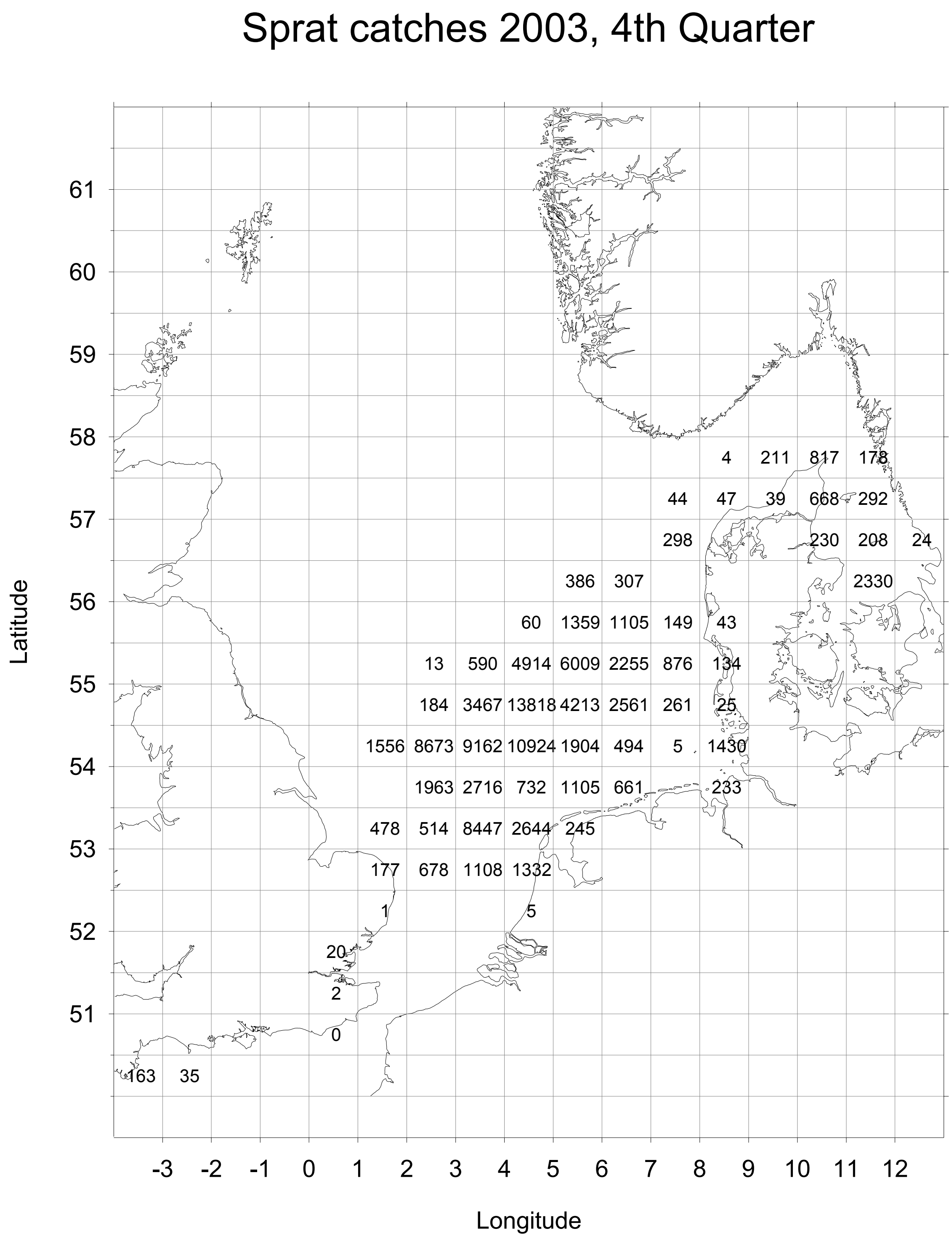


Figure 8.1.1d Sprat catches (in tonnes) in the North Sea in 2003 by statistical rectangle. Working group estimates (if available). Fourth quarter.

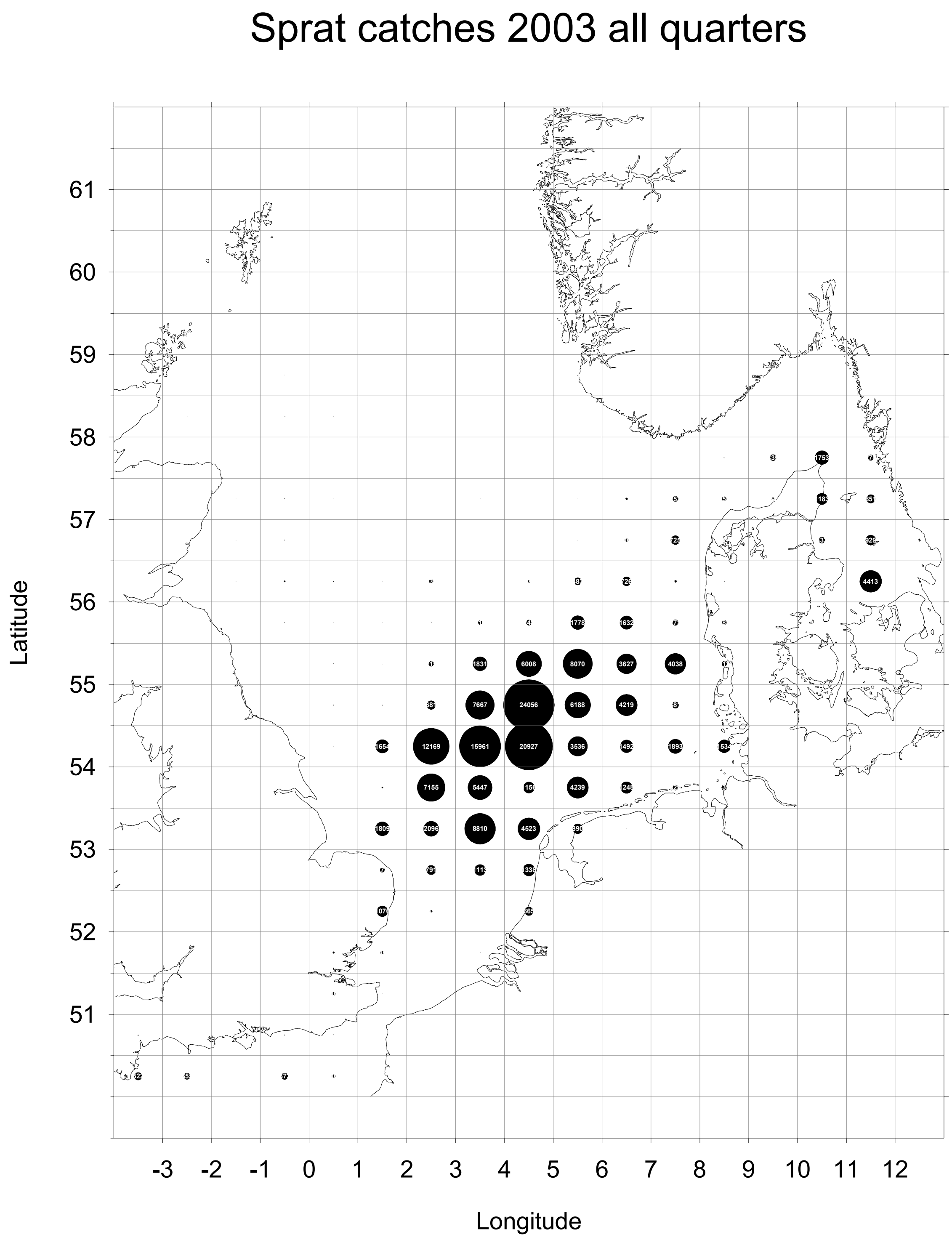


Figure 8.1.2 Total Sprat catches (in tonnes) in the North Sea in 2003 by statistical rectangle. Circle diameter is proportional to catch in tonnes. Working group estimates (if available).

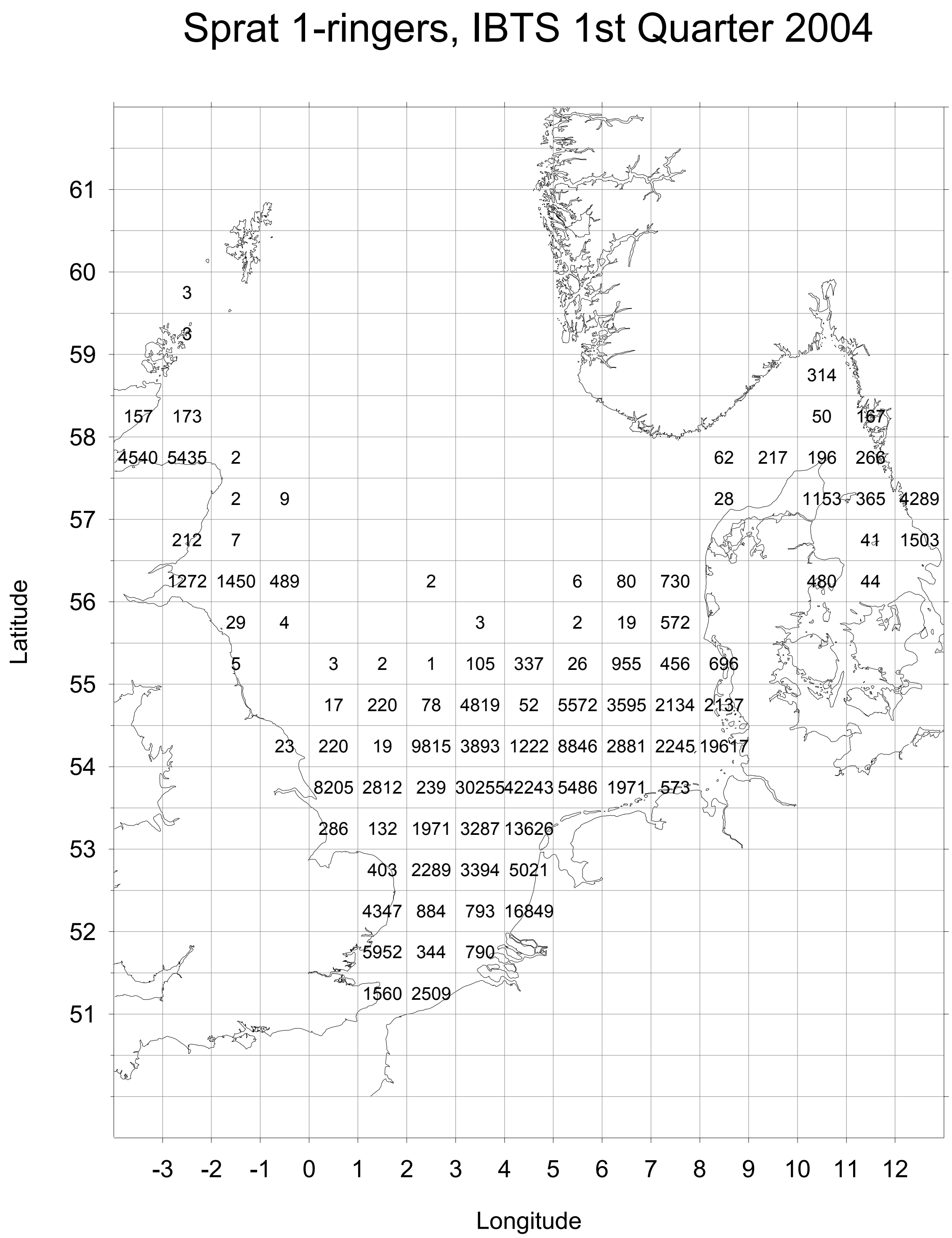


Figure 8.3.1a Distribution of age group 1 in the IBTS (February) 2004 in the North Sea and Division IIIa.

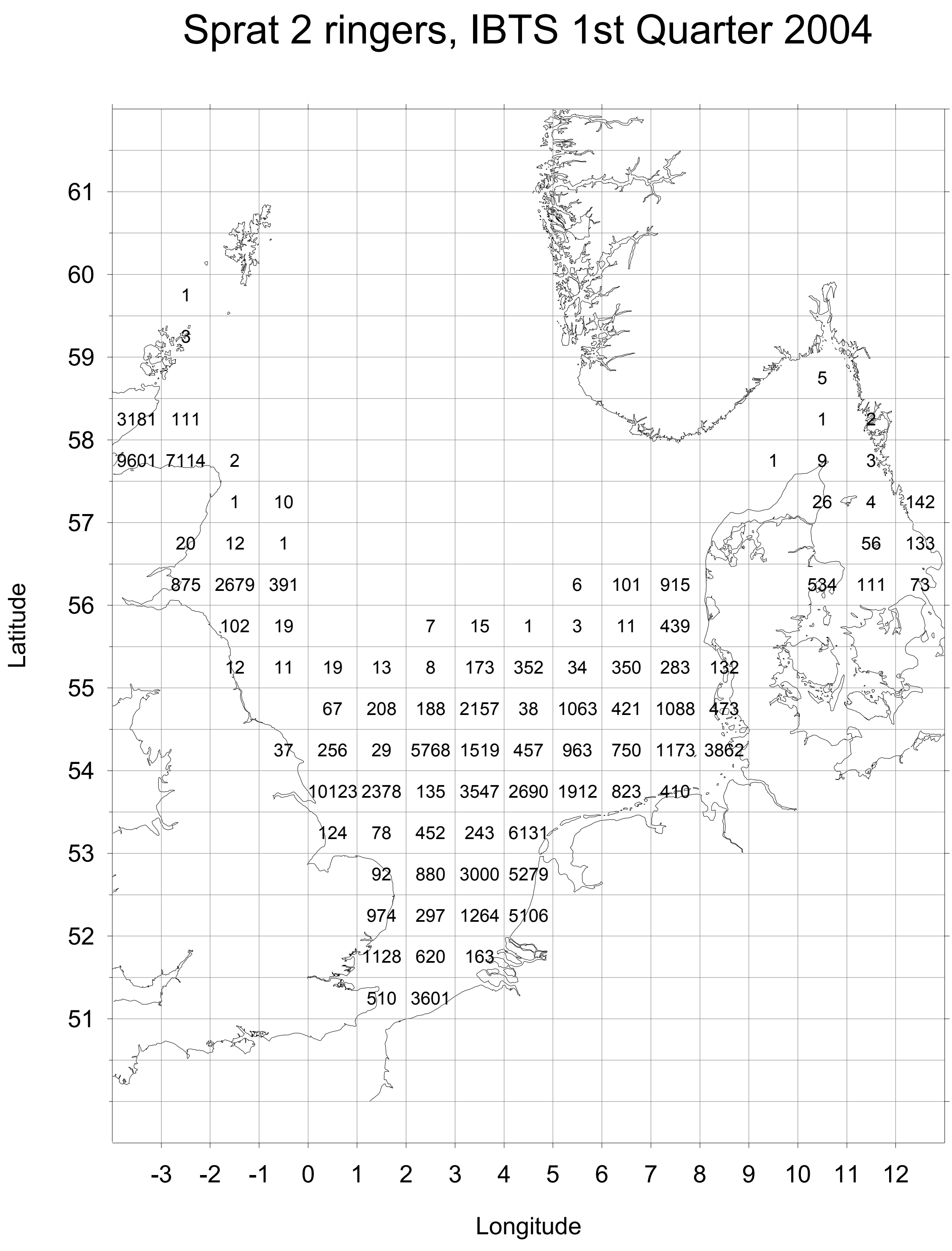


Figure 8.3.1b Continued. Distribution by age groups in the IBTS (February) 2004 in the North Sea and Division IIIa. Sprat age group 2.

Sprat 3+ ringers, IBTS 1st Quarter 2004

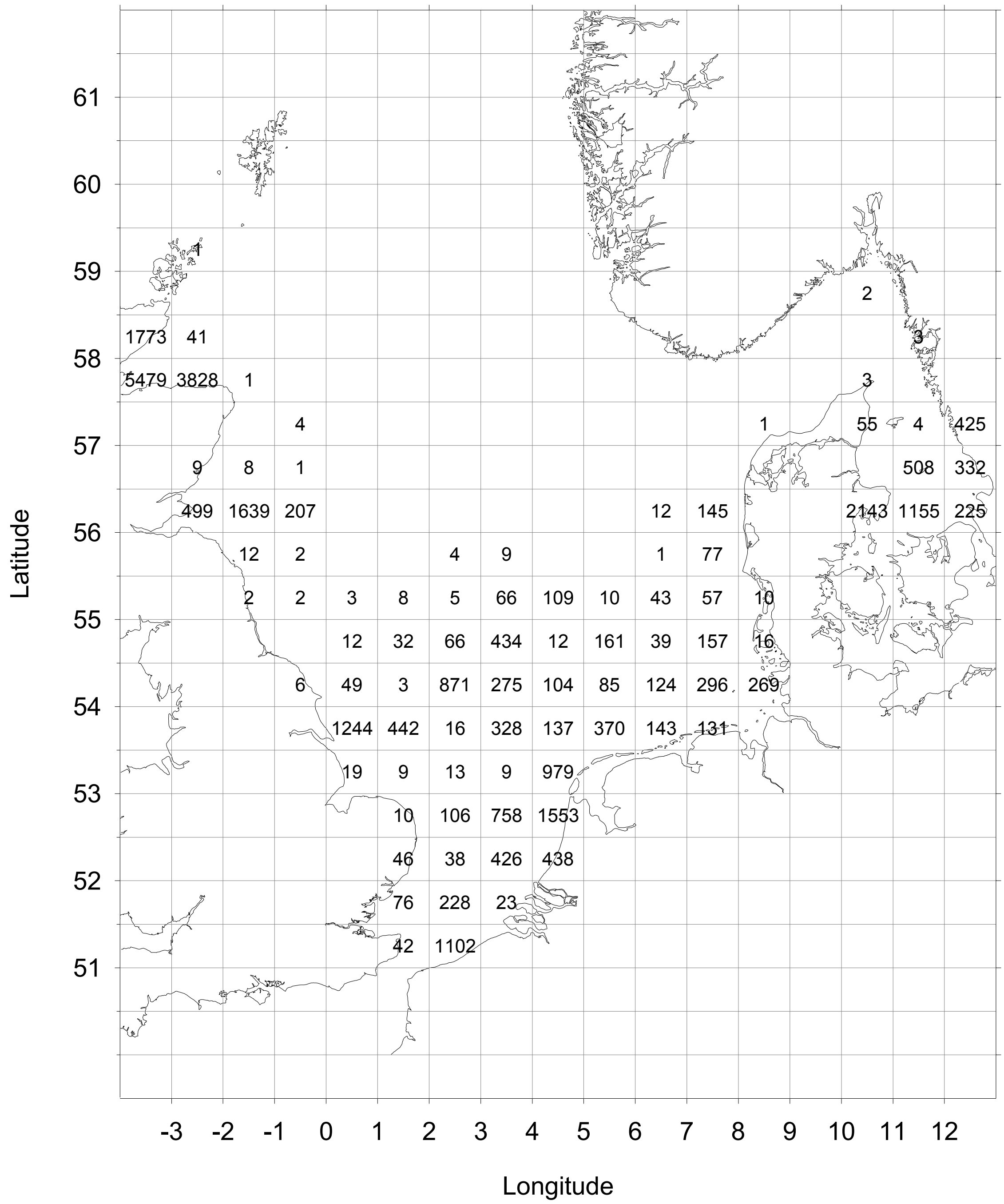


Figure 8.3.1c Continued. Distribution by age groups in the IBTS (February) 2004 in the North Sea and Division IIIa. Sprat age group 3+.

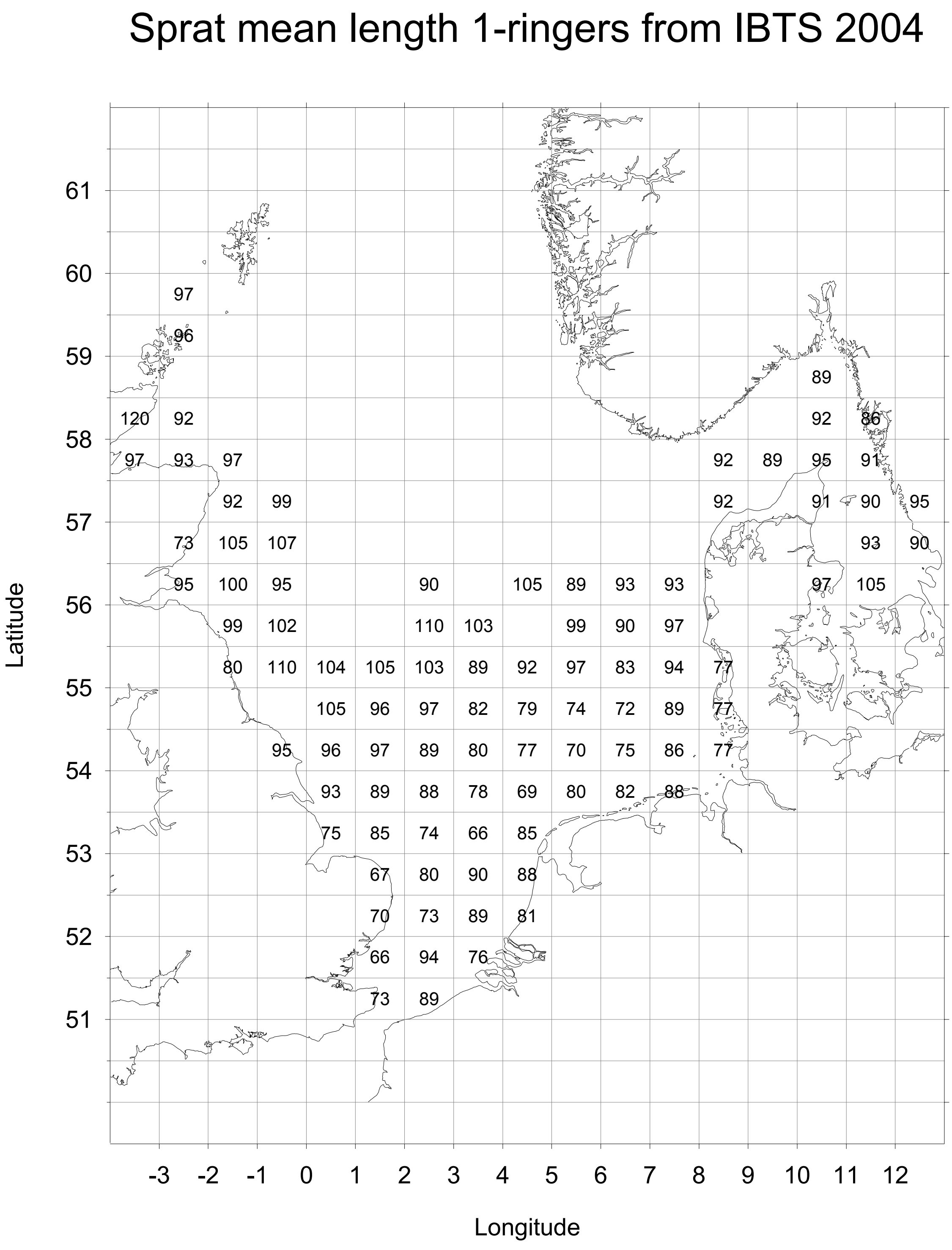


Figure 8.3.2 Mean length (mm) of age group 1 sprat in the IBTS (February) 2004 in the North Sea and Division IIIa.

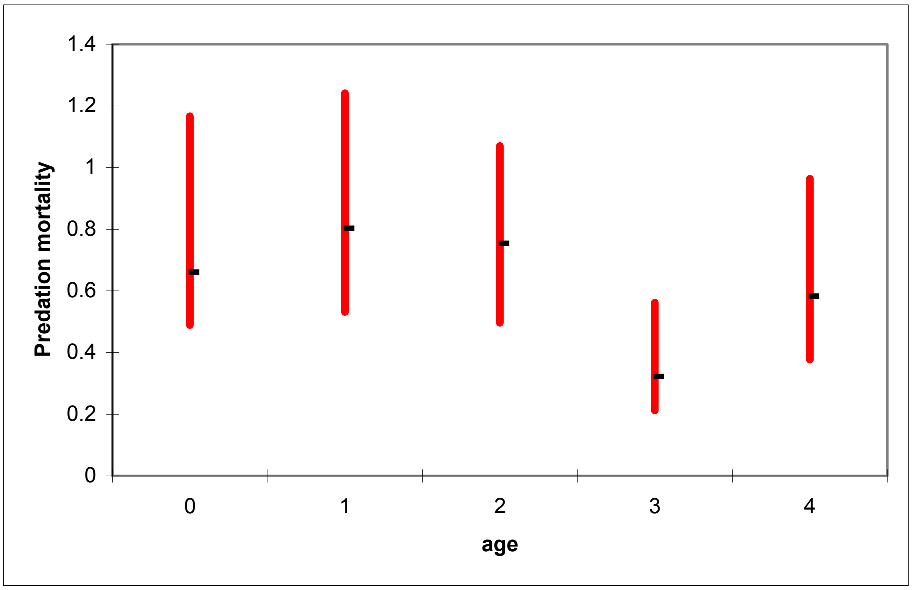


Figure 8.6.1: Predation mortality-at-age (median and 90% confidence intervals) representing the variation over the period 1963 – 2000 of the M values from MSVPA.

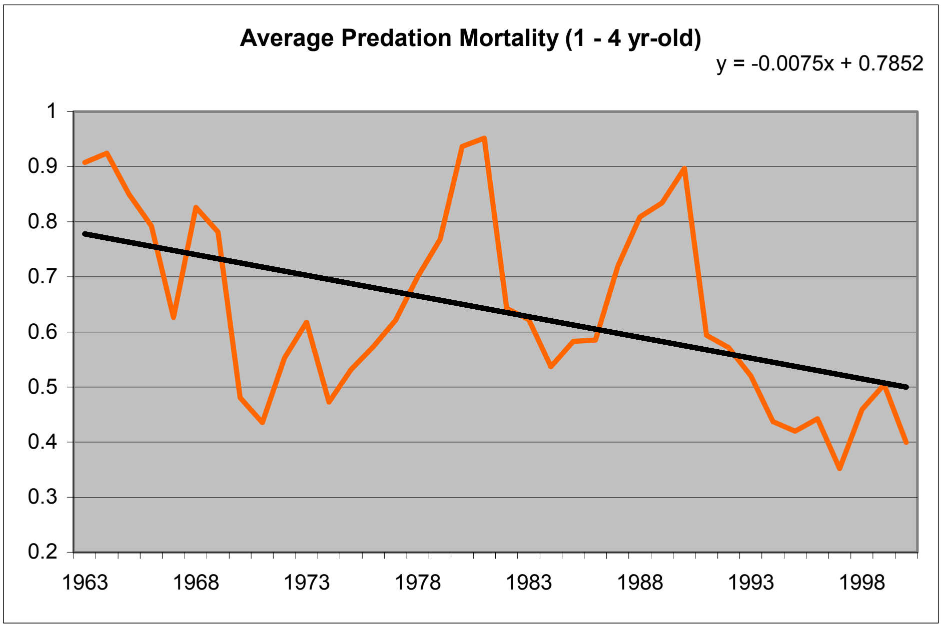
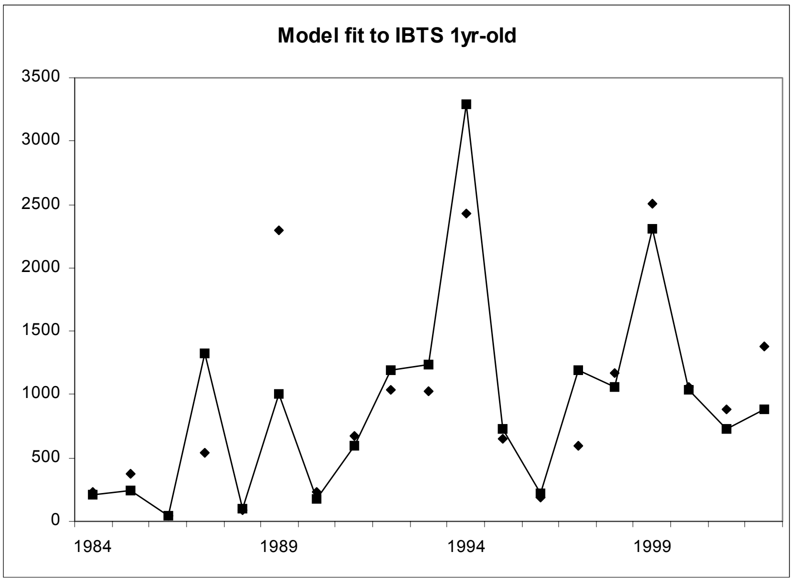


Figure 8.6.2. Predation mortality, average over 1 to 4 year-old sprat for the period 1963 – 2000 from MSVPA.



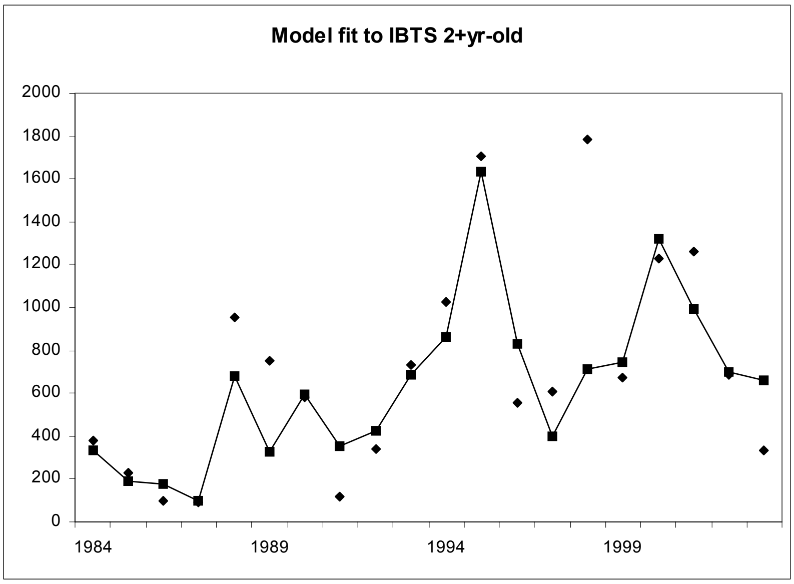


Figure 8.6.3. CSA model fits to the IBTS indices of recruits (1 year-old) and 2+, M = 0.7.

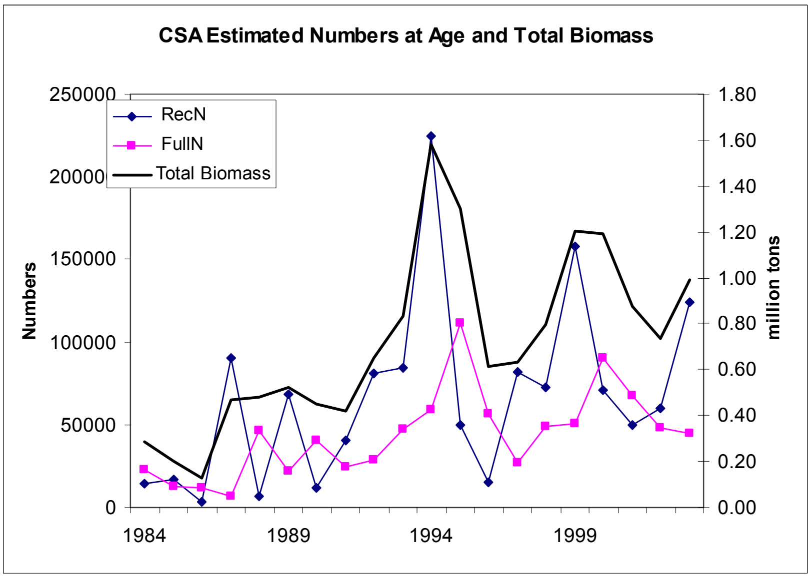


Figure 8.6.4: sprat biomass and numbers-at-age estimated by CSA.

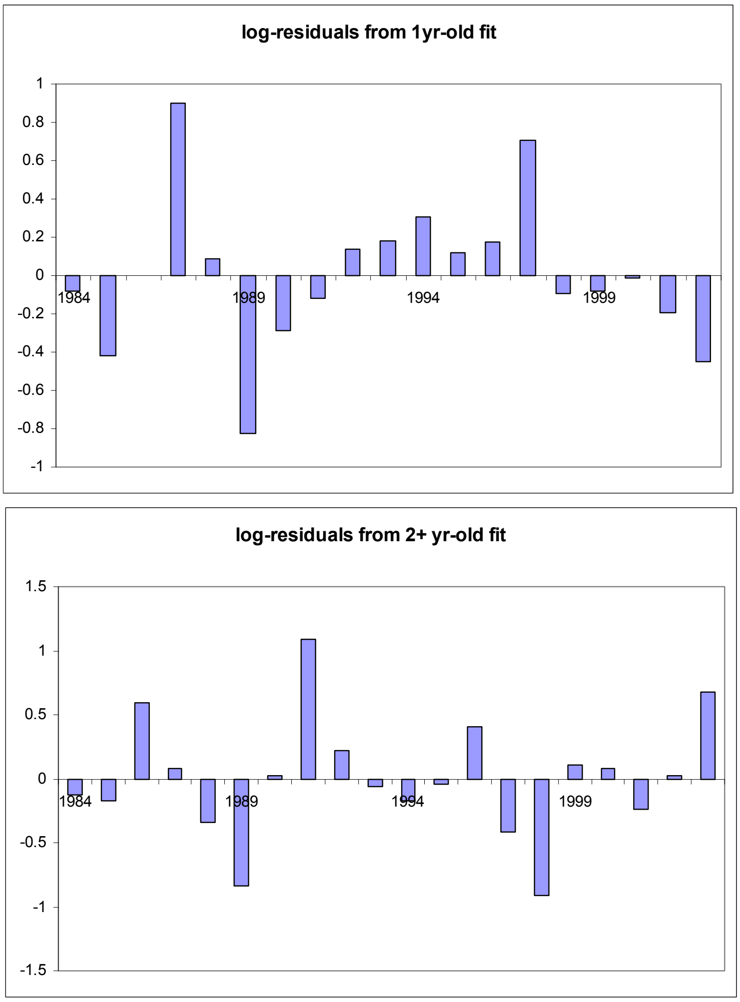


Figure 8.6.5: log-residuals from the model fit to the two stages, M = 0.7.

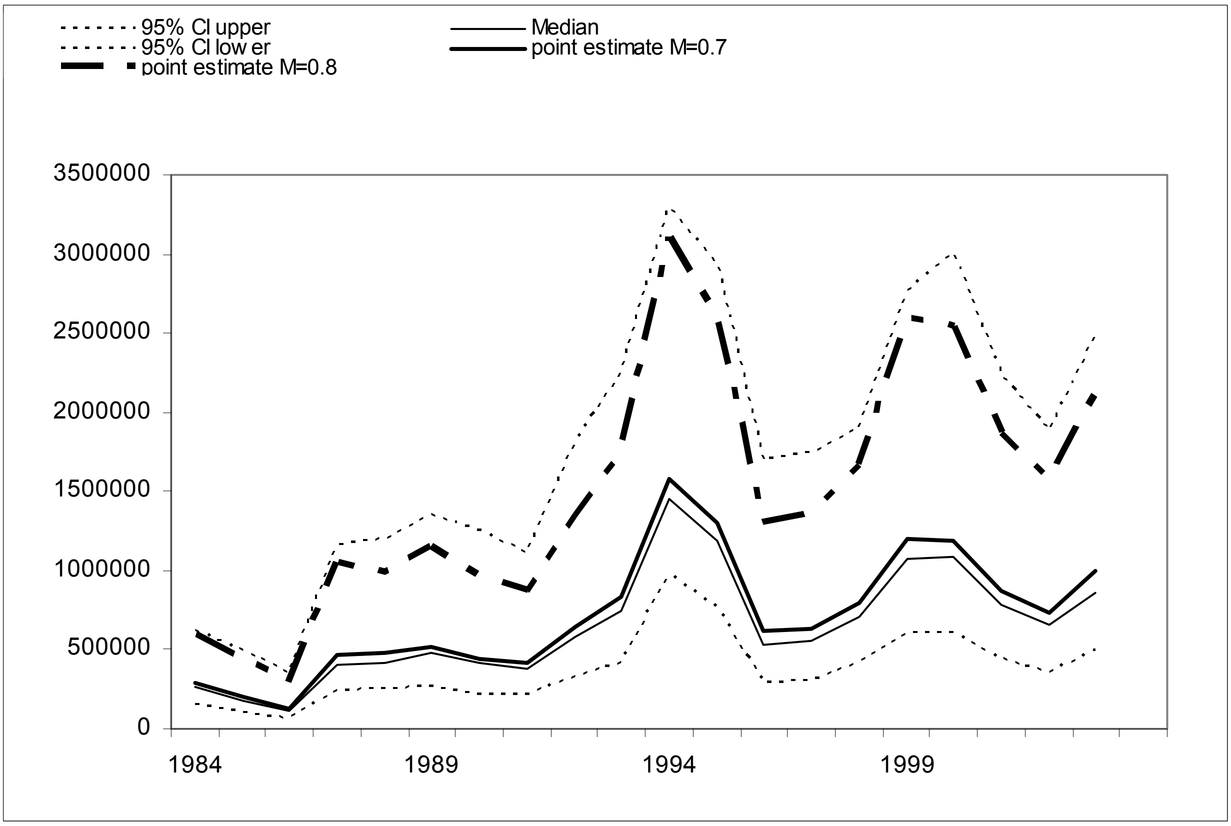


Figure 8.6.6. CSA estimated stock biomass, median and 95% confidence intervals for M = 0.7. Stock biomass estimate for M=0.8 is shown as dotted line.

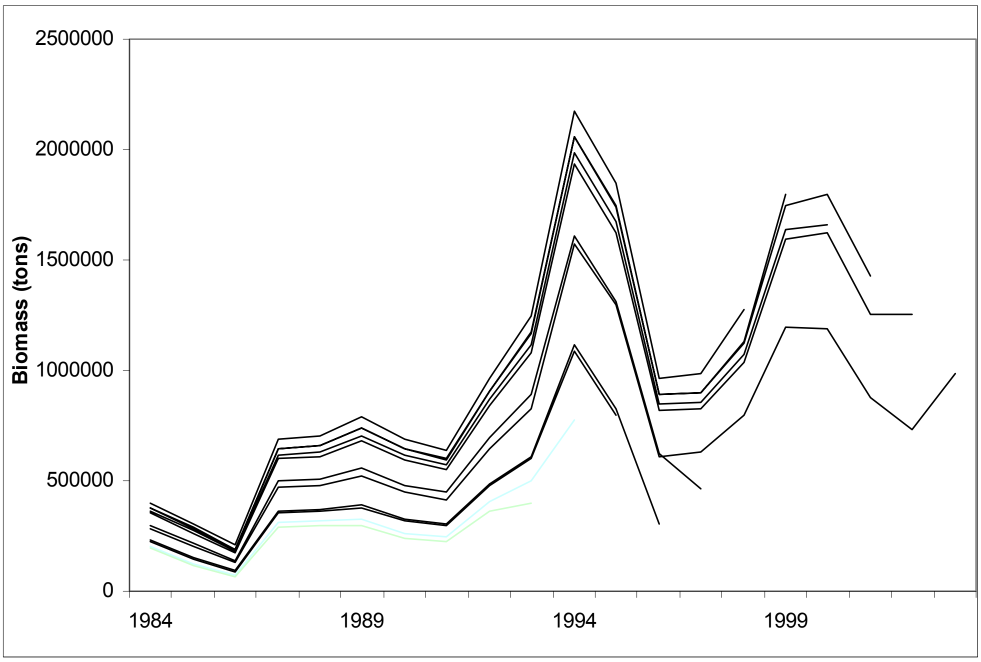


Figure 8.6.7. CSA biomass estimates, retrospective plot (M=0.7)

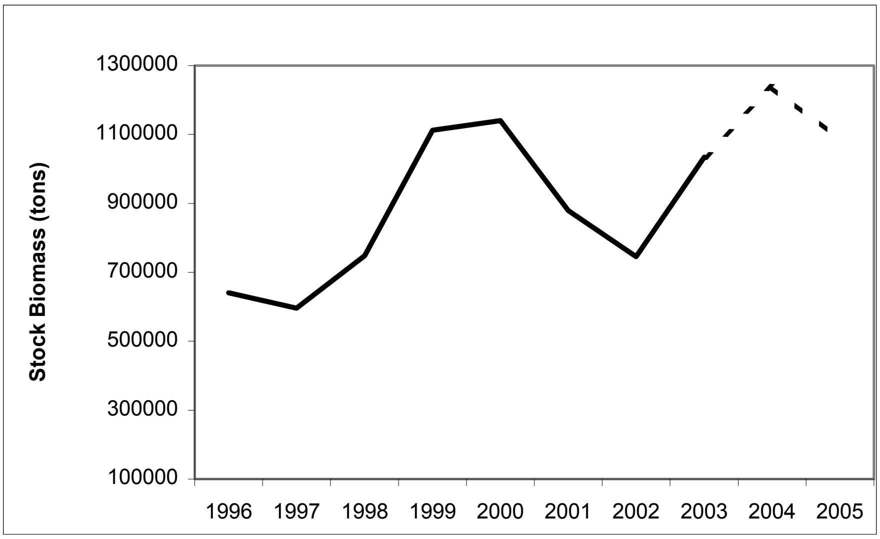


Figure 8.7.1. Stock biomass projections for 2004 and 2005 under 2003 exploitation rate and median recruitment in 2005.

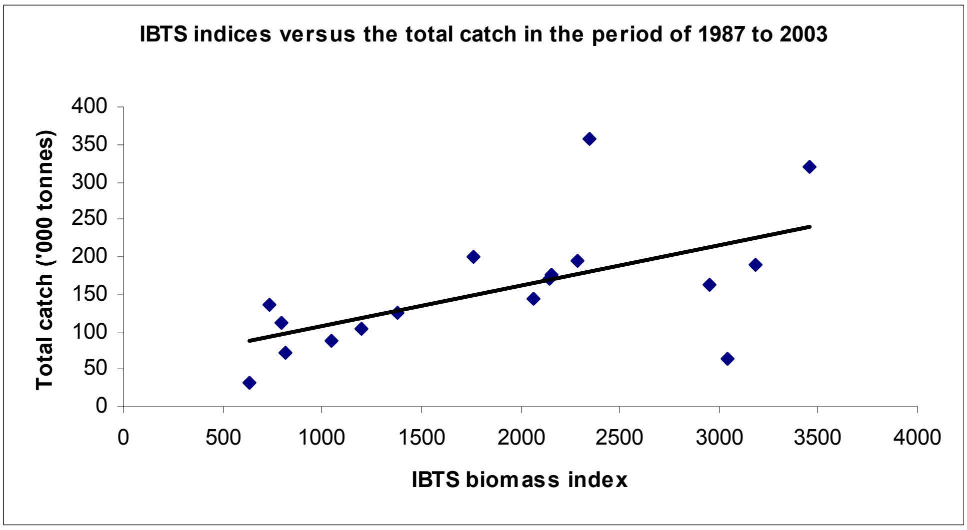


Figure 8.7.2. IBTS indicies versus the total catch (1987- 2003). A fittet regression line to the data results in a R-square of 0.34. The arrow indicates the biomass index for 2004 (2183).

9 Sprat in Divisions VIId,e

9.1 The fishery

9.1.1 ACFM advice applicable for 2003

The TAC for this fishery was set to 9,600 t for 2003 and 9,600t for 2004. No ACFM advice has been provided in recent years.

9.1.2 Catches in 2003

Table 9.1.1 shows the nominal landings in 1985–2003. The landings in 2003, as reported by UK (England and Wales), increased slightly in 2003 but were lower than the average for the period. The landings are commercial data from English and Welsh vessels landing into England and Wales. Monthly catches for the Lyme Bay sprat fishery in the period from 1991 to 2002 is shown in Table 9.1.2. Catches are mainly taken in the third and fourth quarter. No such information was available for the working group regarding catches from 2003.

9.1.3 Catch Composition

Catch compositions and the mean weights for 1991–1998 are given in Table 9.1.3. No samples of commercial catches have been available for the period 1999-2003.

Table 9.1.1 Divisions VIId,e, sprat. Nominal catch (t) in 1985–2003.

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*
Denmark			
France			
Netherlands			
UK (Engl.&Wales)	1,349	1,196	1,377
Total	1,349	1,196	1,377

* Preliminary

Table 9.1.2 Lyme Bay sprat fishery. Monthly catches (t) 1991-2003. UK vessels only.

Season	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total
1991/92	0	0	0	205	450	952	60	358	258	109	51	0	2443
1992/93	0	0	0	302	472	189	294	248	284	158	78	0	2025
1993/94	0	8	0	156	82	302	529	208	417	134	53	0	1889
1994/95	0	0	0	299	834	545	608	232	112	68	0	0	2698
1995/96	0	0	0	154	409	301	307	151	15	80	28	4	1449
1996/97	0	0	0	309	452	586	47	243	239	74	30	0	1980
1997/98	2	0	14	259	625	105	255	19	50	184	45	0	1558
1998/99	0	0	0	337	728	206	56	318	15	149	33	0	1842
1999/00	0	0	0	699	1306	547	544	242	75	34	0	0	3447
2000/01	0	0	0.02	173	541	586	163	114	74	35.6	0	0	1686
2001/02	0	0	0	458	338	171	50	213	60	34	5	0	1329
2002/03	0	0	0	236	631	121	51	55	-	-	-	-	1094
2003/04	-	-	-	-	-	-	-	-					

Table 9.1.3. Lyme Bay sprat fishery. Number caught by age group (millions).

Season		0/1	1/2	2/3	3/4	4/5	5/6
1991/92		1.7	56.03	44.69	16.24	0.57	0.03
1992/93[1]		0.22	28.23	48.61	12.94	1.56	0
1993/94[2]		0	0.83	44.81	15.7	1.95	0.58
1994/95				No data			
	0	1	2	3	4	5	6
1995[3]		0.33	5.20	2.31	0.23	0.03	
1996	0.72	12.60	71.35	22.00	1.24	0.20	
1997		8.81	42.88	31.87	5.43	0.10	
1998		4.08	81.16	37.52	5.05	0.39	
1999-2003				No data			

[1] August to December only (samples in August and December only, so these are best estimates

[2] August to December only (samples in August, September and November only, so these are best estimates

[3] Only September (one sample)

10 Sprat in Division IIIa

10.1 The Fishery

10.1.1 ACFM advice applicable for 2003 and 2004

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 2003 was 50,000 t, with a restriction on by-catches of herring not exceeding 21,000 t. For 2004 the same values were set as in 2003.

10.1.2 Landings

In 1997 a mixed-clupeoid fishery management regime was changed to a new agreement between the EU and Norway that resulted in a TAC for sprat as well as a by-catch ceiling for herring.

The total annual landings for Division IIIa by area and country are given in Table 10.1.1 for 1974 -2003. The total landings decreased by approximately 10,000 t from 2002 to 2003, and are the lowest since 1998.

The Norwegian and Swedish landings include the coastal and fjord fisheries. The Swedish coastal sprat fishery increased slightly in 2003.

Landings by countries and by quarter are shown in Table 10.1.2. For 2003 the landings were taken in all quarters with the bulk of the catch in the 1st and 4th quarter. In the second quarter 1,400 t were landed. Denmark has a total ban on the sprat fishery in Division IIIa from May to September.

10.1.3 Fleets

Fleets from Denmark, Norway and Sweden carry out the sprat fishery in Division IIIa.

The Danish sprat fishery consists of trawlers using a 16 mm-mesh size codend and all landings are used for fishmeal and oil production. Some of the sprat landings from Denmark and Sweden are by-catches in the herring fishery using 32 mm mesh-size cod ends.

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 an inshore purse seine fishery for human consumption.

10.2 Biological Composition of the Catch

10.2.1 Catches in number and weight-at-age

The numbers and the mean weight-at-age in the landings from 1995 to 2003 are presented in Table 10.2.1 and Table 10.2.2, respectively. Landings, for which samples were collected, were raised using a combination of Swedish and Danish samples, without any differentiation in types of fleets. Quarterly and annual distributions of catches by rectangle are shown in Figures 8.1.1–8.1.2.

10.2.2 Quality of catch and biological data

Denmark reorganised and improved its monitoring system for management and scientific purposes in 1996. The required level of one sample per 1,000 t landed was more than met in 2003 with 72 samples from a total landing of 10,840 tonnes.

Denmark has provided biological samples from all the quarters where there were landings in the Kattegat, but the Skagerrak was less intensely sampled. Sweden provided biological samples from the fishery in Skagerrak from all quarters except the 3rd quarter and did not provide samples for any catches in the Kattegat. No Norwegian samples were collected.

The samples were used to estimate the numbers of sprat-at-age and the mean weight-at-age, in all sprat landings (Tables 10.2.1 and Table 10.2.2 respectively). The sample size (87 samples) has increased compared to the level in 2002 (75 samples). As in previous years, no samples of sprat were taken from the fisheries for human consumption. Therefore, data from the industrial landings were used for the estimation of numbers of sprat-at-age and the mean weight-at-age. Details on the sampling for biological data per country, area and quarter are shown in Table 10.2.3.

10.3 Fishery-independent information

Acoustic estimates of sprat have been available from the ICES co-ordinated Herring Acoustic surveys since 1996. In 1996 the total estimate was 7.9 x 10^8 fish or 14,267 tonnes. About 95 % of the biomass was recorded in Kattegat. There were very low estimates of sprat from 1997 to 2002, but the estimates increased in 2003 in Kattegat, where total biomass was estimated to be 13,000 tonnes. Again sprat was only encountered in the south eastern Kattegat (ICES 2004/G:05).

10.4 Mean weight-at-age

Mean weights-at-age (g) in the catches during 2003 are presented, by quarter, in Table 10.2.2. The table includes mean weights-at-age for 1995-2002 for comparison. These have been very variable over time, but whether this is due to actual variation in mean weight or difficulties in ageing of sprat is uncertain.

10.5 Recruitment

The IBTS (February) sprat indices for 1984-2004 are presented in Table 10.5.1. The IBTS data are provided by rectangle in Figure 8.3.1 for age groups 1, 2 and 3+, and the mean length (mm) of 1-ringer sprat in Figure 8.3.2. The indices are calculated as mean no./hr (CPUE) weighted by area where water depths are between 10 and 150 m (ICES 1995/Assess:13). The indices were revised in 2002 (ICES 2002/ACFM:12) based on an agreement in the IBTS WG in 1999, where it was decided to calculate the sprat index as an area weighted mean over means by rectangles for the IIIa (ICES 1999/D:2). The old time-series of IBTS indices (from 1984-2001) is shown in ICES 2001/ACFM:10.

The total IBTS index for 2004 is extremely low, the lowest in the series. The 2004 index for age-group 1, however, is in line with the IBTS index 2003 for the same age-group, but the index for the remaining age-groups (2 – 5+) are considerable lower in 2004 than in any other year since 1990, especially age-group 2. The reason for this is uncertain; the procedure for the 2004 survey did not differ from previous years, though, the amount of hauls in area 9 was lower than in previous years (7 hauls less than in 2003). Also there are still considerable difficulties in ageing of sprat from this area.

10.6 State of the Stock

No assessments of the sprat stock in Division IIIa have been presented since 1985 and this year is no exception. A Schaefer model was fit to the data in 1999 (ICES 1999/ACFM:12) but that attempt was not successful and was subsequently abandoned. Last year 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). The model fitting was poor, probably due to the highly variable IBTS recruitment index. CSA is not deemed to be an appropriate model for this stock and this year no effort was done to fit the data to CSA or any other model.

According to the IBTS (February)-index for 2003, the sprat stock in the area has decreased from last year and is now at the lowest level in the whole time-series.

10.7 Projection of Catch and Stock

There is no relationship between the IBTS (February) index (no./h) and the total catch in the same year (r^2=0.01)—the data is shown in Figure 10.7.1—and the index was not considered useful for management of sprat in Division IIIa.
The estimated yield for 2004 using the total IBTS index was 6,000 tonnes (Table 10.6.1) in a SHOT-estimate (Shepherd, 1991). This is the lowest estimated yield since 1990; however, this method is not considered to provide any reliable projection under the present management regime and the IBTS index is poor for this particular stock.

10.8 Reference Points

There are no reference points for this stock.

10.9 Management Considerations

Sprat in Division IIIa is short-lived with large inter-annual fluctuations in stock biomass. The natural inter-annual variability in stock abundance, mainly driven by recruitment variability, is high and does not appear to be strongly influenced by the observed levels of fishing effort.

The sprat has mainly been fished together with herring, except for 1994 and 1995 when a directed sprat fishery was carried out with low by-catches of herring. The human consumption fishery takes only a minor part of the total catch.

With the current management regime, where there are by-catch ceilings of herring as well as by-catch percentage limits, the sprat fishery is controlled by these factors. Attempts to assess this stock have demonstrated the need for:

- Improved sprat sampling for age data
- Development of a suitable biomass index
- Improvement of the ageing techniques

There is also a need for better knowledge of spawning seasons and possible recruitment from the North Sea stock.

Table 10.1.1 Division IIIa sprat. Landings in ('000 t) 1974-2003.
(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

Table 10.1.2. Division IIIa sprat. Landings of sprat ('000 t) by quarter by countries, 1994-2003.
(Data provided by the Working Group members)

	Quarter	Denmark	Norway	Sweden	Total
1994	1	0.3	0.0	0.5	0.8
	2	6.0	0.0	0.3	6.3
	3	37.0	0.1	23.0	60.1
	4	16.1	1.7	11.0	28.8
	Total	59.4	1.8	34.8	96.0
1995	1	4.8	0.1	4.8	9.7
	2	10.4	0.0	0.9	11.3
	3	19.3	0.0	2.3	21.6
	4	6.3	0.4	6.3	13.0
	Total	40.8	0.5	14.3	55.6
1996	1	5.6	+	4.2	9.8
	2	3.4		0.2	3.6
	3	+	0.4	+	0.4
	4	1.4	0.6	2.2	4.2
	Total	10.4	1.0	6.6	18.0
1997	1	0.7	-	0.3	1.0
	2	0.4	-	1.2	1.6
	3	2.3	-	0.1	2.4
	4	8.2	0.4	2.2	10.8
	Total	11.6	0.4	3.8	15.8
1998	1	4.0	0.1	0.1	4.2
	2	0.9		+	0.9
	3	1.1	0.3	0.4	1.8
	4	5.4	0.7	5.7	11.7
	Total	11.4	1.1	6.1	18.6
1999	1	3.5	0.0	4.0	7.5
	2	0.1		0.2	0.3
	3	7.4	0.1	1.9	9.4
	4	6.2	0.1	3.3	9.6
	Total	17.2	0.2	9.3	26.7
2000	1	4.1	0.1	2.3	6.5
	2	0.0		1.9	1.9
	3	4.8	0.1	0.0	4.9
	4	3.8	0.7	2.3	6.8
	Total	12.7	0.9	6.4	20.0
2001	1	2.5		2.6	5.2
	2	6.6		0.1	6.7
	3	10.2		0.1	10.2
	4	0.9	1.4	4.8	7.1
	Total	20.2	1.4	7.6	29.1
2002	1	3.8	0.0	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]	1.7	5.3
	2	0.6		0.8	1.4
	3	1.0		0.7	1.7
	4	5.0	0.8 [1]	2.3	8.1
	Total	10.2	0.8 [1]	5.5	16.5

+ Catch record, but amount not precisely known.
[1] Preliminary figures

Table 10.2.1 Division IIIa sprat. Landed numbers (millions) of sprat by age groups in 1995-2003.

	Quarter	Age						Total
		0	1	2	3	4	5+	
1995	1		312.04	784.37	53.50	27.29	9.01	1,186.20
	2		1248.72	993.29	61.06	15.24	4.77	2,323.08
	3		1724.02	133.56	14.17			1,871.74
	4		902.76	139.95	29.95	10.58		1,083.25
	Total		4187.54	2051.17	158.68	53.12	13.77	6,464.27
1996	1		288.42	546.53	62.11	15.65	5.07	917.78
	2		0.89	414.10	42.76	0.71	0.06	458.51
	3		0.34	1.81	0.30	0.02		2.47
	4		31.19	165.65	27.34	2.03		226.21
	Total		320.84	1128.08	132.51	18.41	5.13	1,604.97
1997	1			3.43	18.31	20.60	4.59	46.94
	2		1.00	2.76	19.56	1.51	0.25	25.07
	3	4.35	209.25	9.51	1.92	6.24		231.26
	4	32.39	644.28	58.31	7.16	28.02		770.16
	Total	36.74	854.53	74.01	46.95	56.37	4.84	1,073.43
1998	1		14.91	103.38	94.00	76.99	6.34	295.61
	2		3.24	21.49	20.59	16.63	1.33	63.28
	3	53.62	26.03	41.84	5.65	0.74		127.88
	4	192.13	253.98	226.55	53.14	29.80		755.61
	Total	245.75	298.16	393.25	173.38	124.17	7.67	1,242.38
1999	1	0.0	560.5	158.0	151.2	77.4	6.8	953.9
	2		32.8	1.6	1.7	1.1	0.3	37.6
	3	9.6	741.7	46.7	6.3	5.9		810.0
	4	8.5	645.4	20.5	6.8	0.6	0.3	682.1
	Total	18.0	1,980.4	226.8	166.0	85.0	7.4	2,483.6
2000	1		116.6	384.3	40.3	7.3	1.6	550.0
	2		17.3	127.4	11.2			155.9
	3	2.1	223.3	51.4	12.2			289.1
	4	18.0	277.6	81.4	13.1	0.8		390.9
	Total	20.2	634.8	644.6	76.8	8.1	1.6	1,386.0
2001	1	0.0	342.6	173.0	73.3	10.0	1.6	600.4
	2	0.0	1746.4	13.4	0.4	0.0	0.0	1,760.2
	3	5.7	924.1	31.7	0.0	0.0	0.0	961.5
	4	22.9	488.1	39.1	18.5	1.5	0.5	570.6
	Total	28.6	3,501.2	257.2	92.2	11.5	2.1	3,892.8
2002	1	0.0	63.8	323.2	38.5	24.7	2.4	452.6
	2	0.0	185.5	63.2	4.8	1.0	0.0	254.5
	3	1.3	326.2	102.0	23.9	6.6	0.6	460.5
	4	21.3	205.4	45.9	10.6	5.9	0.4	289.6
	Total	22.5	780.9	534.3	77.9	38.2	3.4	1,457.2
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

Table 10.2.2. Division IIIa Sprat. Quarterly mean weight-at-age (g) in the landings.
(1994-1995 and 1998-2003 Danish and Swedish data, 1996-1997 Danish data)

Year	Age							SOP
	Quarter	0	1	2	3	4	5+	Corrected landings
1995	1		2.3	8.9	18.8	22.9	26.1	9,519
	2		2.9	7.3	12.4	23.7	27.0	12,054
	3		10.5	18.4	15.5			20,765
	4		11.5	15.6	15.5	18.2		13,262
Weighted mean			7.8	9.2	15.3	22.2	26.4	55,600.3
1996	1		9.2	10.6	14.2	17.4	17.7	9,724
	2		8.6	12.5	15.1	17.4	17.0	5,847
	3		4.2	10.9	15.5	21.0		26
	4		4.2	10.9	15.5	21.0		2,403
Weighted mean			8.7	7.6	14.8	19.6	17.7	18,000.3
1997	1			17.3	18.6	21.8	26.0	968
	2		8.3	17.6	20.0	22.1	31.0	489
	3	4.1	13.6	17.2	21.1			3,062
	4	4.7	14.7	17.5		19.5		11,176
Weighted mean		4.6	14.4	17.5	19.6	20.4	26.3	15,696.2
1998	1		6.6	14.0	18.0	19.0	21.3	4,828
	2		6.6	13.9	17.8	18.7	21.0	1,027
	3	4.6	17.7	20.7	22.1	24.7		1,718
	4	4.8	17.5	20.4	22.5	27.5		11,998
Weighted mean		4.8	16.9	18.5	19.6	21.2	21.2	19,570.0
1999	1		4.6	6.4	17.3	13.4	13.1	7,319
	2		5.3	17.1	18.6	22.2	17.8	264
	3	3.0	11.4	12.6	16.8	18.3		9,257
	4	4.8	13.9	17.6	20.8	21.2	23.5	9,521
Weighted mean		3.8	10.2	8.8	17.4	13.9	13.7	26,361.0
2000	1		5.3	13.1	15.3	20.7	22.7	6,438
	2		5.2	12.8	14.1			1,873
	3	4.3	16.6	18.0	21.9			4,897
	4	7.0	16.9	19.9	22.1	24.6		6,742
Weighted mean		6.7	14.3	14.3	17.3	21.1	22.7	19,949.3
2001	1		3.77	14.34	16.24	17.75	17.33	5,168
	2		3.72	6.49	21.00			6,598
	3	5.35	10.50	12.06		13.00		10,114
	4	5.06	12.00	19.66	22.64	19.35	25.60	7,200
Weighted mean		5.1	6.7	14.5	17.5	18.0	19.2	29,078.5
2002	1		5.70	12.70	17.30	19.30	20.60	5,411
	2		7.90	13.70	16.00	17.00		2,175
	3	8.00	12.40	15.10	18.10	17.00	17.00	5,900
	4	5.70	15.60	18.20	21.60	21.50	22.00	4,278
Weighted mean		5.8	11.6	13.7	18.1	19.2	20.1	17,763.2
2003	1		6.00	14.10	16.20	18.90	23.76	5,293
	2		5.00	16.00	17.60	21.60	22.76	1,401
	3	4.00	12.00	19.00	19.00	21.00		1,661
	4	8.90	16.40	21.10	21.70	25.20	24.33	8,211
Weighted mean		7.1	14.8	16.5	17.8	20.3	23.7	16,565.3

Table 10.2.3 Division IIIa sprat. Sampling commercial landings for biological samples in 2003.

Country Area	Quarter	Landings (tonnes)	No. samples	No. meas.	No. aged
Denmark	1	869	3	116	
Skagerrak	2				
	3	314			
	4	1118	18	1,000	283
	Total	2302	21	1,116	283
Denmark	1	2674	20	2,049	1,340
Kattegat	2	593	4	359	200
	3	690	1	138	95
	4	3925	26	2,650	1,034
	Total	7882	51	5,196	2,669
Norway	1	60			
Skagerrak	2				
	3				
	4	776			
	Total	836			
Sweden	1	549	7	336	335
Skagerrak	2	484	1	150	139
	3	101			
	4	1308	7	500	498
	Total	2442	15	986	972
Sweden	1	1125			
Kattegat	2	320			
	3	615			
	4	998			
	Total	3058	0	0	0
Denmark		10184	72	6,312	2,952
Norway		836			
Sweden		5500	15	986	972
	Total	16520	87	7,298	3,924

[1] Preliminary data

Table 10.5.1. Division IIIa sprat. IBTS(February) indices of sprat per age group 1984-2004. (Mean number per hour per rectangle weighted by area. Only hauls taken in depths of 10-150 m are included).

Year	No Rect	No hauls	Age Group					
			1	2	3	4	5+	Total
1984	15	38	5,676	869	205	79	64	6,892
1985	14	38	2,158	2,347	393	140	51	5,089
1986	15	38	629	1,979	2,035	144	38	4,825
1987	16	38	2,736	2,846	3,003	2,582	157	11,324
1988	13	38	915	5,263	1,485	2,088	453	10,203
1989	14	38	414	911	989	555	136	3,004
1990	15	38	418	224	65	61	46	814
1991	14	38	496	732	700	128	376	2,433
1992	16	38	5,994	599	264	204	75	7,135
1993	16	38	1,590	4,169	907	199	240	7,105
1994	16	38	1,789	716	1,021	313	70	3,908
1995	17	38	2,204	1,770	35	45	4	4,058
1996	15	38	186	5,627	751	128	218	6,909
1997	16	41	233	391	1,239	139	135	2,137
1998	15	39	72	1,585	620	1,618	522	4,416
1999	16	42	4,535	355	250	44	314	5,498
2000	16	41	292	738	60	51	24	1,165
2001	16	42	6,540	1,144	677	92	46	8,499
2002	16	42	1,119	966	87	58	13	2,242
2003	17	46	463	1,247	1,172	381	125	3,388
2004	16	41	403	49	157	87	24	719

Table 10.6.1. Division IIIa Sprat. SHOT forecast of landings in 2004 using total landings and the total IBTS-indices as input data.

IIIa SHOT forecast spreadsheet version 4

Total Index April 1996

running recruitment weights

older	0.00		G-M =	0.00
central	1.00		exp(d)	1.00
younger	0.00		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		719	719	0.77	0.23		3	6		8	6

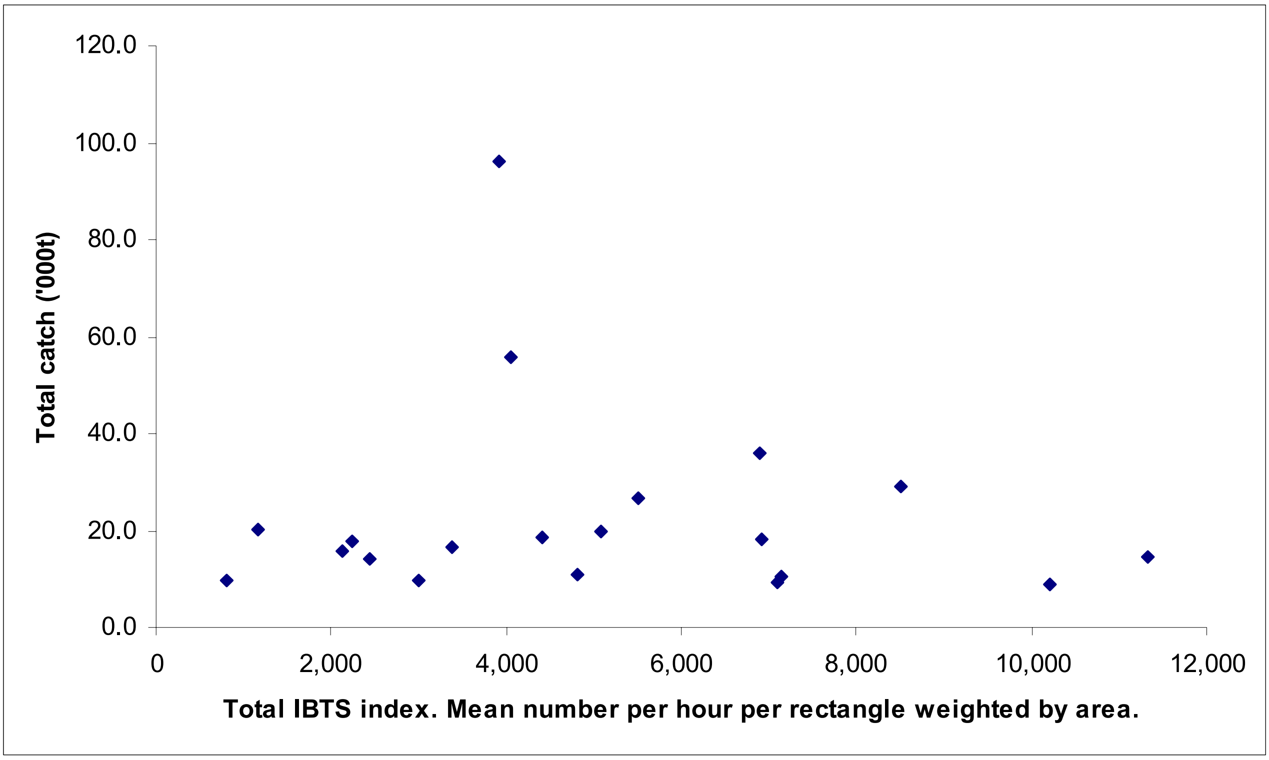


Figure 10.7.1 Division IIIa sprat IBTS indices vs. the total catches in 1984 to 2004. The R-square equal 0.01

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ANNEX 1

EXTENSION OF HISTORIC CATCH DATA FOR VIA NORTH

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Introduction

Very high recruitment had been observed near the beginning of the current time series for VIa north, 1976-2002, and it was though that an extension of the time series might improve information on the stock dynamics. Prior to 1982 herring stocks in ICES Area VIa were assessed as one stock, along with the herring by-catch from sprat fishery in the Moray Firth.

In the 1982 working group report, and in subsequent years, Area VIa was split into a northern and a southern area at 56°N (ICES, 1982). This paper explores the data available for reconstructing catch data back to 1957.

Sources of Data.

The data used for this study has been sourced primarily from historic working group reports, and catch at age data by national fleets was obtained from historic paper records kept at FRS's Marine Laboratory.

Catch in Tonnes.

The data for catches, in tonnes, by country from 1957 to 1973 for area VIa (Table 1) was taken from Table 4.6 in the Report of the Herring Assessment Working Group 1974 (ICES CM 1974/H:4). This table also included data from the juvenile herring by-catch from the Moray Firth sprat fishery . A minor correction carried out subsequently by the WG was included in the table presented here which has altered the 1972 total (see footnote below Table 1).

Catch by country for VIa and Moray Firth was extended forward to 1980 using data from Table 5.1 in the 1981 ICES Herring Assessment Working Group Report (CM 1981/H:8.(Table 2). This report confirmed the validity and stability of the last few years of data from the 1974 report, (1971 to 1972) and added data for the period 1974 to1980.

In 1982 the WG carried out an analysis of catch at age data and split the VIa catches into VIa north and VIa south and combined the latter with data from VIIb. Tonnes of herring caught by country from 1971 to 1981 in Area VIa north (Table 3) were taken from Table 5.1 in the 1982 ICES Herring Assessment Working Report (CM 1982/Assess:7). The method used by the WG is not described in the WG report and cannot therefore be exactly duplicated today.

Catch in Numbers.

The catch in numbers at age over the period, 1971 to 1980 for VIa north was taken from Table 5.2 in the 1982 Working Group Report (Table 4).

For the period 1976 to 2002, catch in numbers at age in VIa north, were available from the assessment files and reported in Table 5.2.2, in the 2003 ICES Report of the Herring Assessment Working Group (CM 2003/ACFM:17).Table 5.

The 1982 Working Group report gave a four year overlap into the 2003 Working Group report catch at age data (1976 – 1980) and these data matched, suggesting that the data from 1971 to 1975 was calculated on the same basis at the time it was constructed in 1982. Inspection of the intermediate reports suggested there was a practice of deleting data year by year as new data became available. This practice ceased in about 1987.

FRS Marine Laboratory archive contained a series of paper records of summarised catch in numbers at age for autumn spawning herring by national fleet from 1957 to 1972. (Table 6). These where believed to have been assembled in 1973/74, and used at the 1974 working group to calculate catch data for the whole of VIa.

The totals were similar but not identical to the data in Table 4.8 in the 1974 Working Group Report (Table 7).

Mean Weights in the Catch.

Several sources of mean weights at age were examined for the period.

From 1976 to 2002 the data was taken from Table 5.6.3 in the 2003 Working group report (Table 8).

For earlier mean weights at age, working group reports from 1982 back to 1974 were examined. Table 9 lists the mean weights at age from each of those reports.

An ICES paper by Saville and Morrison (1973) referenced in the 1974 working group report was used for mean weights from 1957 to 1972. Although mean weights were not explicitly tabulated. The values used were obtained by dividing the biomass at age by the stock numbers at age, Three years were tested and constant mean weights were found to have been used throughout the period (Table 10).

Data validation and Assembly

Catches in Tonnes.

The fraction of fish caught in VIa north, from 1957 to 1975, was not explicitly available. However, the 1980 and 1981 Working G reports contained catches in tonnes by national fleet for whole of VIa and the following year, the 1982 WG report, contained data for the same period, and fleets, for VIa north only. These three sources of data were used to determine fleet fishing practices. Table 11 shows that with only a few exceptions most fleets fished exclusively in either VIa north or VIa south only. Using these fishing patterns National Fleet Factors (NFF) for catch in VIa north were obtained. The factors used are given at the base of Table 11. A comparison of two methods has been made for the three earliest years available, 1970 to 1972. Table 12 shows the results of this comparison expressed as the difference in total catch using NFF compared with the 1982 WG method. The WG method is not explicitly documented in the report. The difference is negligible. The proportion of the total catch that depends on fleet factors is shown in Table 13 by year from 1957 to 1971. On average less that 10% of catch uses fleet factors that differ from either unity or zero indicating that the precise magnitude of these factors is not particularly important. This total catch contains both spring and autumn spawners and reflects total catch taken in VIa north

The resulting total catch in tonnes, and proportion of autumn and spring spawning herring in the area by weight, is given in Figure 1. This indicates that the proportion of spring spawners caught decreased from around 30% in the early part of the period, to about 15% in the later part. Thus the by the 1970s it was no longer so important to differentiate between these different herring. Examination of the sample data for the acoustic survey in July 2003 in VIa north shows that that this survey detects about 10% juvenile, 85% Autumn spawning adults and only 5% spent herring which are probably spring spawners.

Catch at Age.

Catch at age from 1971-1975.

Catch at age from 1971 to 1975 for VIa north has been calculated by the WG in 1982 but then deleted year by year from the WG reports as new data was added, each report showing only the last 10 or 11 years of data. This procedure stopped in 1987 with the first year set at 1976. This catch at age data is taken directly as it is thought to be consistent with later data from 1976 to 1981 prepared at the 1982 WG and thus compatible with subsequent data used in 2003. Thus catch in the period 1971 to 2002 represents all herring caught in VIa north irrespective of whether this is autumn or spring spawning herring.

Checks on validity of FRS Aberdeen numbers at age data by national fleet.

The quality of the fleet based data recorded in Aberdeen (Table 6) was tested against tabulated catch at age data for the period 1957 to 1970 presented in the 1974 WG report (Table 7). The total numbers at age were seen to be different for the sum of catch at age recorded at FRS Aberdeen but the total numbers by year agreed very closely. This suggested that the WG had reviewed the fleet data and reallocated some age keys, however, this process was not documented in the WG report. There was complete agreement for the period 1957 to 1961. Using Solver in excel a series of annual fleet multipliers were estimated for the 13 fleets independently by year for the years 1962 to 1972. This gives a total of 143 factors. The results of this showed a very clear pattern of reallocation of age structures. This pattern is summarised in Table 14 where the percentage of the total VIa catch reallocated and the change in allocation by country is shown. The differences are dominated by the decision to remove reported Irish age information and to substitute this by either Scottish or German data. Irish data was regarded as suspect for VIa. However, we will see later that all Irish catch with or without age keys is excluded from VIa north data using the NFF so this reallocation is not required when estimating VIa north catch at age. The remaining reallocation is only required for 1963, 1969 and 1971, each are less than 2% of the catch. This is thought to be negligible.

The Validity of The Fleet Factors when allocating catch at age.

In 1982 the WG split VIa catch between VIa north (Table 4) and VIa south for the period 1971 to 1981. As indicated above the data for catch at age by national fleet for the whole of VIa was held on paper records in FRS Martine Laboratory in Aberdeen Scotland for the period 1957-1972 (Table 6) giving two years of overlap, 1971 & 1972. The splitting method described above to estimate catch by fleet in VIa north was tested on age data using the FRS fleet at age data and compared with the results presented at the 1982 WG for these two years. The Age structures can be compared in Figures 2a and 2b for 1971 and 1972 respectively. These age structures are sufficiently similar to give confidence to both the records retained at FRS Aberdeen but also the simple fleet factor method proposed to split the catch and allocate age structures.

Final selection of catch at age data.

The catch at age assembled in 1982 for the period 1973 to 1975 is of a similar quality to the data currently in use from 1976 and can be used directly. There are two possible methods of obtaining catch at age for 1971 and 1972. The fleet based method produces a lower SOP correction and has been selected for these two years

The data 1957-1972 data held in Aberdeen is very similar to that used at the 1981 WG the only major difference is the exclusion of Irish fleet catch at age data. However, in constructing VIa north data the Irish data is excluded anyway and its quality is not relevant. By using fleet factors it is possible to allocate age proportions reasonably accurately for 1971 and 1972 suggesting the fleet procedure is adequate for the period. Catch at age for autumn spawning herring for 1957 to 1972 can be constructed for VIa north autumn spawning herring with some confidence (Table 15).

This leaves two options, direct estimation of autumn spawning herring or raising to total catch by setting SOP values to unity. The first may underestimate the productivity in the past relative to today. The latter may overestimate past productivity as the spring spawning component today is thought to be smaller than the part in the past.

Mean Weight at Age

A full mean weights at age table was constructed directly from data used by WG to give mean weights at age (Table 16). Data for 1957 to 1972, were temporally invariate and obtained from Saville and Morrison (1973). The mean weights at age from 1973 to 1976 were calculated from the mean of two years data 1974 and 1975 weights at age (taken from 1976 working group report). For 1974 & 5 the mean was chosen in preference to individual annual values as the sum of products was further from unity using these values than using the mean weights presented in the 1976 report. The same values have also been used from 1976 to and including 1981. Subsequent data was the same as the 2003 WG report. Thus from 1975 onwards there is no change in the data.

Table 1 Total catches of herring (tonnes), by country, in Area VIa, 1957 – 1973. Taken from the 1974 HAWG report, Table 4.6.

	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973[1]
Belgium		192	24	40			1			23							
England	99	201	16	36	52	85	58	26	28	1		3					340
Faeroes														15100	8100	8094	15800
France				154	353	489	1121	1023	610	1	379	1124	966	1293	2055	680	2417
Germany		8592	2509	5311	1816	11279	4739	5387	5066	14634	17318	14874	15805	16548	7700	4108	17754
Netherlands								68	330	251	4576	2957	1514	1102	9252	23370	30328
Iceland														5595	5416	2066	3545
Ireland	5069	4049	4449	3768	5637	4015	3633	4540	6440	7759	12290	13390	11895	11716	12161	17308	13452
N. Ireland	1	6					3	1				4	3	1			
Norway														20199[2]	76720	17400	30557
Poland											727	2791	3188	3709			2500
Scotland	41636	52250	60986	58921	44083	47831	44394	58673	53909	69363	67404	65180	90222	103530	99537	107638	120800
USSR														3		0	2500
Total	46805	65290	67984	68230	51941	63699	53949	69718	66383	92032	102694	100323	123593	178796	220941	180664[3]	239993
Moray Firth	1703	1164	2451	906	585	1842	118	660	10278	20734	6507	4945	3100	1385	5666	10242	7219

[1] Preliminary figures for that years report.
[2] In the 1982 ICES Working Group Report this value is recorded as 27250 tonnes.
[3] In the 1974 ICES Working Group Report this value is recorded as 173,938 tonnes. This is an incorrectly summed value. The table above shows the correct value.

Table 2 Total catches of herring (tonnes), by country, in Division VIa, 1971 – 1980. Taken from the 1981 HAWG report, Table 5.1.

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980[4]
Belgium						12				
Denmark	554	150	932		374	249	626	128		
Faeroe Isl.	8100	8094	10003	5371	3895	4017	3564			
France	2055	680	2441	547	1293	1528	1548	1435	3	0.4[5]
German Dem. Rep.	330	935	2507	2037	1994	929				
German, Fed. Rep.	7700	4108	17443	14354	9099	4980	221	126	5	256
Iceland	5416	2066	2532	9566	2633	3273				
Ireland	12161	17308	14668	12557	10417	8558	7189	12071	4569	4607
Netherlands	9252	23370	32715	19635	19360	20812	8515	5929	1214	640
Norway	76720	17400	36302	26218	512	5307	1098	4462		
Poland			5685	6368	2934	3085	6			
Sweden						2206	261			
UK (England)				45	125	20	301	134	54	33
UK (N. Ireland)				3	6	1	1	6	2	
UK (Scotland)	99537	107638	120800	107475	85395	53351	25238	10097	3	15
USSR		0	2052	5388	3232	3092				
Unspecified catches									1752	1110
Total	221825	181749	248080	209564	141269	111420	48568	34388	7602	6661
Moray Firth	5666	10242	7219	13003	2454	313	205	1502	21	273

Table 3 Catch in weight (tonnes), by country, for division VIa (North), 1970 – 1981. Taken from the 1982 HAWG report, Table 5.1.

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Denmark		554	150	932		374	249	626	128			1580
Faeroe Isl.	15100	8100	8094	10003	5371	3895	4017	3564				
France	1293	2055	680	2441	411	1244	1481	1548	1435	3	2	1243
German Dem. Rep.	52	30	94	251	200	600	279					
German, Fed. Rep.	11716	6414	3282	9663	8687	5582	4084		26		256	3029
Ireland[6]	5595	5416	2066	2532	9566	2633	3273					
Netherlands	464	8340	22673	27892	17461	12024	16573	8705	5874			4048
Norway	27250	76721	17400	32557	26218	509	5183	1098	4462			3850
Poland	927		743	2062	334	376	390					
Sweden							2206	261				
UK (England)					45	125	20	301	134	54	33	1094
UK (Scotland)	103530	99537	107638	120800	107475	85395	53351	25238	10097	3	15	30389
USSR	3		1936	1137	2392	1244	2536					
Unallocated												3879
Total	165930	207167	164756	210270[7]	178160[8]	114001	93642	41341	22156[9]	60	306	49112

[4] Preliminary figures for that years report.

[5] Original table shows this as 0.4 tonnes, subsequent records show this to be 2 tonnes, it is the latter figure that is used for this analysis.

[6] The figures for Ireland in the 1982 HAWG report were incorrectly allocated to Ireland. The catches were originally the ownership of Iceland. See Table 2, in this report, to compare.

[7] The original table has the total value recorded as 208270 tonnes, this is 2000 tonnes below the actual summed value, which has been entered here.

[8] The total for 1974 is 4 tonnes less than the original table. Probably due to rounding of the original figures.

[9] Original total for 1978 read 22176. This may be a typing error.

Table 4 Catch in numbers ('000) at age (ring) of herring in division VIa (North), 1971 – 1980. Adapted from Table 5.2 in the 1982 HAWG report.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
0	209598	24941	267872	536119	82676	8225	11508	108199	1614	0
1	169947	801663	51170	309016	172879	69053	34836	22525	392	12867
2	372615	804097	235627	124944	202087	319604	47739	46284	225	1335
3	560348	219502	808267	151025	89066	101548	95834	20587	122	452
4	357745	63069	131484	519178	63701	35502	22117	40692	31	246
5	113391	85920	63071	82466	188202	25195	10083	6879	21	62
6	54571	37341	54642	49683	30601	76289	12211	3833	12	43
7	181592	13377	18242	34629	12297	10918	20992	2100	7	40
8	18042	100938	6506	22470	13121	3914	2758	6278	2	3
9+	36395	20465	32223	21042	13698	12014	1486	1544	0	1
Total	2074244	2171313	1669104	1850572	868328	662262	259564	258921	2426	15049

Table 5 Estimated catch in numbers ('000) at age[10] of herring in VIa (North), 1976 – 2002. From the 2003 HAWG report, Table 5.2.2.

Age	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	69053	34836	22525	247	2692	36740	13304	81923	2207
2	319604	47739	46284	142	279	77961	250010	77810	188778
3	101548	95834	20587	77	95	105600	72179	92743	49828
4	35502	22117	40692	19	51	61341	93544	29262	35001
5	25195	10083	6879	13	13	21473	58452	42535	14948
6	76289	12211	3833	8	9	12623	23580	27318	11366
7	10918	20992	2100	4	8	11583	11516	14709	9300
8	3914	2758	6278	1	1	1309	13814	8437	4427
9	12014	1486	1544	0	0	1326	4027	8484	1959
	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
1	40794	33768	19463	1708	6216	14294	26396	5253	17719
2	68845	154963	65954	119376	36763	40867	23013	24469	95288
3	148399	86072	45463	41735	109501	40779	25229	24922	18710
4	17214	118860	32025	28421	18923	74279	28212	23733	10978
5	15211	18836	50119	19761	18109	26520	37517	21817	13269
6	6631	18000	8429	28555	7589	13305	13533	33869	14801
7	6907	2578	7307	3252	15012	9878	7581	6351	19186
8	3323	1427	3508	2222	1622	21456	6892	4317	4711
9	2189	1971	5983	2360	3505	5522	4456	5511	3740
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
1	1728	266	1952	1193	9092	7635	4511	147	1145
2	36554	82176	37854	55810	74167	35252	22961	82214	35410
3	40193	30398	30899	34966	34571	93910	21825	15295	90204
4	6007	21272	9219	31657	31905	25078	51420	9490	9506
5	7433	5376	7508	23118	22872	13364	15505	24896	19916
6	8101	4205	2501	17500	14372	7529	9002	9493	29288
7	10515	8805	4700	10331	8641	3251	3898	6785	9628
8	12158	7971	8458	5213	2825	1257	1836	4721	1290
9	10206	9787	31108	9883	3327	1089	576	1015	1203

[10] In this table "age" refers to number of winter rings in the otolith.

Table 6 Autumn spawning herring, catch in numbers at age, by country, by year from 1957 to 1972 in division VIa and Moray Firth. Sourced from hand written data, supplied by J.A. Morrison (FRS Marine Labs).

1957	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**10+**
Belgium												
England			120.3	155.9	22	97	32.3	14.9	4.5	7.8		
France												
Germany												
Holland												
Ireland			6193.9	8006.7	1119.9	5008.3	1650.4	757.9	230.8	395.2		
N. Ireland			1.3	1.3		1.3	0.6					
Poland												
Scotland			54486.4	56369.4	25740.1	33882.2	19857.4	8869.8	1422.4	2202.9	578.4	1633.4
Moray Firth		6496	20015	1561								
Total	0	6496	80816.9	66094.3	26882	38988.8	21540.7	9642.6	1657.7	2605.9	578.4	1633.4
1958	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**10+**
Belgium			1.5	23.9	12.4	19.9	14.3	7.1	4	4.8	2.8	2.8
England		4.3	130.4	464.5	159.2	33.1	139	91.5	23	7.2	8.6	4.3
France												
Germany			888.4	16663.2	6474.2	8716.9	6262.4	3088.8	1735	2115.7	1227.2	1227.2
Holland												
Ireland		78.7	2368.6	8448.1	2895.1	605.2	2526.6	1658.2	421.2	131.3	118.3	118.3
N. Ireland			3.6	13.7	5	0.7	4.3	2.9	0.7			
Poland												
Scotland		2680.6	25715.4	132544	34328.9	18732.4	23078.4	15137.2	8611.2	1466.3	1234.7	1217.7
Moray Firth		12931	4508	643	20							
Total	0	15694.6	33615.9	158801	43894.8	28108.2	32025	19985.7	10795.1	3725.3	2591.6	2570.3
1959	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**10+**
Belgium		1.3	9.9	8.7	25	20.2	8.8	11.4	1.5	1.7	1.4	1.4
England		1.9	19.4	9.7	24.6	7.1	3.9	4.5	2.6	1.3		0.6
France												
Germany		247.2	1408.5	1198.4	3126.2	2780	1211	1569.1	210.3	234.9	197.5	197.5
Holland												
Ireland		896.4	6217.3	2920.5	6969.3	2111.2	1243.5	1359.2	722.8	375.7	101.1	101.1
N. Ireland												
Poland												
Scotland		13186.7	66112.8	34362.3	114163	22979.9	16475	15889	7221.1	4015.3	2670.5	1463.5
Moray Firth		39729	847	47								
Total	0	54062.5	74614.9	38546.6	124308	27898.4	18942.2	18833.2	8158.3	4628.9	2970.5	1764.1
1960	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**10+**
Belgium		0.4	11.4	20.8	17.9	14.3	8.8	7.3	2.2	2.1	1.3	1.2
England		0.8	68.6	38.3	24.7	14.4	4.8	6.4	4	2.4		
France		3.2	96.3	175.1	151	120.4	74.4	61.3	18.6	17.5	10.9	9.8
Germany		784.5	16974.8	4655.9	1386.4	1150.9	392.5	523	183.2	78.3	26.1	26.1
Holland												
Ireland		146.9	8351.9	4017	2180.1	1322.8	440.7	587.6	367.3	171.6	12.4	12.4
N. Ireland												
Poland												
Scotland		1199.2	75885.6	56555	21580.1	47935.1	11275	9910.7	6194.4	2757.2	1507.7	219.3
Moray Firth	21	1805	14112	241	48							
Total	21	3940	115501	65703.1	25388.2	50557.9	12196.2	11096.3	6769.7	3029.1	1558.4	268.8

Table 6 (Cont'd)

1961	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**10+**
Belgium												
England		5.2	44.9	69	37.8	16.3	14.3	3.3	4.6	2	0.7	0.7
France			71.7	816.9	322.8	77.2	175.7	67.9	26.8	23	11.5	3.8
Germany			644.1	4435.7	1958.6	411.2	921	268.4	143.3	98.5	53.6	8.8
Holland												
Ireland		1392.3	5423	10002.9	4617	1832.4	1612	366.6	512.9	183.3	36.8	36.8
N. Ireland												
Poland												
Scotland		2643.6	44418	57589.2	31384.5	22117.5	11573.3	5084.7	4682	1434.6	664.1	328.5
Moray Firth		10432	207	18								
Total	0	14473.1	50808.7	72931.7	38320.7	24454.6	14296.3	5790.9	5369.6	1741.4	766.7	378.6
1962	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**10+**
Belgium												
England		10.9	132.5	28.7	107.7	62.8	28.7	31.8	10.1	5.4	1.6	0.8
France		10.9	815.9	224.9	471.1	352.9	77.7	192.6	45.4	21.3	10.9	5.5
Germany		777.6	19219.1	5388.2	11331.5	7831.9	2555	6332.3	1277.5	611.2	333.5	166.5
Holland												
Ireland		1643.9	5950.1	1278.6	4958.9	2635.8	1774.5	1983.2	548	313.3	52.4	52.4
N. Ireland												
Poland												
Scotland		19938.5	78207.5	18227.2	58890.4	38422.6	17852	19452.8	5191.1	4416.4	1347.8	489.5
Moray Firth		34540	106									
Total	0	56921.8	104431	25147.6	75759.6	49306	22287.9	27992.7	7072.1	5367.6	1746.2	714.7
1963	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**10+**
Belgium			0.5	1.6	0.5	1.1	0.5	0.5	0.5			
England		25.1	104.5	53.4	6.3	58.1	34.6	11.8	24.4	7.1	6.3	
France			361.7	1674.4	423	1398.6	748.6	380.3	331.1	30.6	61.3	55.3
Germany			1657.2	6768.2	2123.6	6067.9	3220.8	1587.2	1423.8	116.7	233.4	210.3
Holland												
Ireland			934.8	2374.8	4036.6	2294.7	1514.7	1550.1	1662.6	1215.6	505.6	505.6
N. Ireland		1.6	5.5	3.1		3.1	1.6	0.8	1.6			
Poland												
Scotland		9885.7	76406.7	46957.5	9933.2	34784.7	23117.4	7176.8	12303.5	2879.1	2188.2	465.1
Moray Firth		1885	206									
Total	0	11797.4	79676.9	57833	16523.2	44608.2	28638.2	10707.5	15747.5	4249.1	2994.8	1236.3
1964	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**10+**
Belgium												
England		5.7	23.9	25.8	12.6	4.4	10.7	7.5	3.1	5	1.9	1.9
France			403.3	688.4	979.6	621.6	604.7	789.1	330.5	229.3	95.2	27.9
Germany			2547.1	4377.7	5252.8	3130.7	3422.3	3899.9	2042.8	1193.8	504.2	159
Holland			31.7	46	65.1	41	39.9	52.5	25.7	15.9	6.6	1.6
Ireland		893.6	5492.7	3160.8	1186.6	1113.4	2649.2	1350.2	911.1	1212.5	315.1	515.1
N. Ireland			0.6	1.3	0.6		0.6					
Poland												
Scotland		3564.6	74929.7	66238.8	21932.6	4416.5	21167.4	15049.1	7002.9	9492.1	2503.1	1418.5
Moray Firth	2781	22976	5433									
Total	2781	27439.9	88862	74538.8	29429.9	9327.6	27894.8	21148.3	10316.1	12148.6	3426.1	2124

Table 6 (Cont'd)

1965	0	1	2	3	4	5	6	7	8	9	10	10+
Belgium												
England		21.9	9.1	37.7	21.3	14.6	1.2	11	4.9	1.8	4.9	1.2
France		130.2	100.1	394	443.8	267	166.9	751.3	437.2	246.8	166.9	83.7
Germany		698.3	2919	6386.9	11301.9	1572	823.4	3892.1	2245.2	673.7	1322.3	648.6
Holland		70.6	54.2	212.9	240.2	144.5	90.3	406.6	236.4	133.5	90.3	45.1
Ireland		1469.1	8843.5	5041.1	1814.8	1325.1	4061.7	2074	1094.6	1699.6	691.3	691.3
N. Ireland												
Poland												
Scotland		30964.9	13879.7	56958.6	50746.4	20755.9	4296.9	19048.6	16704.4	5380.7	8803.2	2754.8
Moray Firth	46891	267815	3676	574								
Total	46891	301170	29481.6	69605.2	64568.4	24079.1	9440.4	26183.6	20722.7	8136.1	11078.9	4224.7
1966	0	1	2	3	4	5	6	7	8	9	10	10+
Belgium			66.8	6.6	12	5.5	6	1.6	1.6	4.9	1.6	2.7
England			3.5		0.7							
France			2.7	0.5	0.5							
Germany			44034.3	4252.1	10161.8	3387.2	3387.2	864.8	864.8	2810.6	864.8	1441.5
Holland			725	162	182.8	110	68.9	309.2	180	101.8	68.9	34.5
Ireland		125.7	23933	3604.6	3856.1	2221.4	1257.4	2892.1	1802.3	670.6	838.3	838.3
N. Ireland												
Poland												
Scotland		6298.8	202686	18534.3	52844.5	38428.7	16900.5	4697.4	17051.9	12533.6	4733.9	6039.3
Moray Firth	211639	205376	266530	11791	344	1						
Total	211639	211801	537982	38351.1	67402.4	44153.8	21620	8765.1	19900.6	16121.5	6507.5	8356.3
1967	0	1	2	3	4	5	6	7	8	9	10	10+
Belgium												
England												
France			4.4	721.8	493.6	213.4	201.4	78.8		18.6	12.6	10.4
Germany			3411.5	45202.3	17228	7164.1	6567.2	3411.5		1535	1023.4	853
Holland			50.3	8713.6	5959.6	2579	2429	951.6		225.4	150.5	125.3
Ireland		747.6	11303.2	44523.6	4721.2	3261.4	1881.3	1849	1746.2	612.5	472.6	472.6
N. Ireland												
Poland			8.2	1384.4	946.7	409.9	385.8	151		35.6	24.1	19.7
Scotland		30944.4	18690.5	168832	18741.8	31581.4	22889.7	8474.8	5532.6	10200.5	8628.8	4096.7
Moray Firth	186598	177003	6274	9843	605	201						
Total	186598	208695	39742.1	279221	48695.9	45410.2	34354.4	14916.7	7278.8	12627.6	10312	5577.7
1968	0	1	2	3	4	5	6	7	8	9	10	10+
Belgium												
England		3.8	3.8	0.8	6.1	0.8	0.8	0.8				
France			215	197	3911.9	393.4	461.3	153.8	73.9	55.3	61.3	36.7
Germany			6079.6	6307.5	47725.5	4180	6611.4	2583.8	684.2	684.2	684.2	380.2
Holland			733.9	290.1	11791.1	565.8	260.2				76.5	76.5
Ireland		804.9	8234.9	14801.9	50485.2	3550.6	1460.2	908.3	949.3	831.1	299.4	299.4
N. Ireland		4.6	4.6	0.8	7.6	0.8	0.8	0.8	0.8			0.8
Poland			534.6	488.6	9713.3	977.3	1145.2	381.9	183.3	137.3	152.7	550
Scotland		57595.7	73923.7	16040	110305	10029.5	18069.3	13643.6	5792.9	2073	3635.7	3464
Moray Firth	71425	162655	15321									
Total	71425	221064	105051	38126.7	233945	19698.2	28009.2	17673	7684.4	3780.9	4909.8	4807.6

Table 6 (Cont'd)

1969	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**10+**
Belgium												
England												
France		21.3	956.5	496.9	68.9	2056.4	111.1	232.6	89.7	26.3	42.1	58
Germany		311.3	18684.2	11521.7	4515.4	33164.3	2647.1	3425.3	1790.5	389.2	622.6	856
Holland		74.4	2137.8	754.2	58	2717.9	132.4	331.7	124.2	149.4	74.4	74.4
Ireland		575.6	7258.6	5675.9	15977.2	26899.7	3226.7	1584.9	904	483.2	696.6	696.6
N. Ireland		0.7	5.6	2.1	0.7	5.6	0.7	0.7	0.7			
Poland		942.3	4448.2	3017.8	872.2	5948.6	401.1	453.6	244.1	122	226.5	
Scotland		12176.6	74816.7	62203.5	19881.7	182651	18862.9	39770.7	24539.6	9702.2	3150.5	11611.1
Moray Firth	192368	25083	1167									
Total	192368	39185.2	109475	83672.1	41374.1	253444	25382	45799.5	27692.8	10872.3	4812.7	13296.1
1970	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**10+**
Belgium												
England												
France			672	1266.2	806.6	240.8	2568.6	233.7	354	84.8	28.5	28.5
Germany			8205.4	17405	11271.6	4807.2	32654.9	2900.9	4641.4	1077.3	331.6	331.6
Holland		184.2	1986.7	1441.3	435.2	97.9	1134.7	91.8	36.7	61.2	18.4	18.4
Ireland		376	6165.5	7481.9	5378.3	11518.9	26565.5	2339.3	1223.7	281.3	457.5	457.5
N. Ireland		1.4	0.7	1.4	0.7		1.4					
Poland		122	852.5	4322.9	2739.8	994.3	7712.2	527.5	426.3	263.8	304.2	
Scotland		157671	67688.2	145872	51718.9	10039.1	111246	11314.3	21818.5	11496.3	3379.5	4985
Iceland		37.6	2797.4	9988.1	5271.7	1418.3	345	786.2	153.5	95.9	57.6	115.1
Faeroe			7406.6	33087.5	18205.1	4983.6	1246	2838.1	553.8	346.1	207.6	415.4
Norway			11054.3	49383	27171.1	7438.6	1859.6	4235.7	826.5	516.5	310	620
Moray Firth	16299	80346	1835									
Total	16299	238738	108664	270249	122999	41538.7	185334	25267.5	30034.4	14223.2	5094.9	6971.5
1971	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**10+**
Belgium												
England												
France		33.9	1371.8	1473	2125.3	1169.4	449.8	2755.2	191	337.6	112.7	78.8
Germany		107.6	4659.5	5017.9	7240.1	4086	1577.1	8888.9	609.3	1075.2	358.4	250.9
Holland		671.8	18141.5	9574.9	10134.7	4591.7	616.1	8118.8	504.1	1568.1	504.1	392.2
Ireland		1190.7	8334.1	5438.3	9190.1	8293.4	2890.3	31328.7	1811.2	369.2	1271	113.5
N. Ireland												
Poland												
Scotland		49604.6	178448	97451.6	114965	44511.4	11450.7	93066	9409.8	10471.4	3785.7	2374.9
Iceland		38.9	4880.6	19191.7	10343.7	2787.3	687	1570.4	294.5	196.2	98.1	196.2
Faeroe		1361.4	34888.6	66787	28610.2	6920.4	1389.9	3165.6	617.6	386	231.5	463
Norway		104	31629	138392	75522.7	20605.7	5125.5	11674.6	2278	1423.7	854.1	1708.2
Moray Firth	209598	116667	2186									
Total	209598	169780	284539	343326	258132	92965.3	24186.4	160568	15715.5	15827.4	7215.6	5577.7

Table 6 (Cont'd)

1972	0	1	2	3	4	5	6	7	8	9	10	10+
Belgium												
England												
France												
Germany			9963	3846	1694	3152	1339	764	3057	294.3	294.3	294.3
Holland		171.1	88410.5	18475.1	2769.9	7893.2	3238.2	443.3	11594.7	412.1	412.1	412.1
Ireland	146.6	652.2	13893.2	13534.8	3958.9	8963.8	7730	2369.8	35127	1237.7	345.5	816.1
N. Ireland												
Poland												
Scotland		31185.3	387812	145441	48175	55325.5	21067.9	8995.8	42170.3	6064.8	4658.3	3709.6
Iceland		203.5	6355.3	1017.7	768.9	271.4	158.3		22.6			
Faeroe												
Norway		199870	21710	3180	40	220	40	110	20	5	5	10
Moray Firth	24794	286492	105436	1876								
Total	24940.6	518574	633580	187371	57406.7	75825.9	33573.4	12682.9	91991.6	8013.9	5715.2	5242.1

Table 7 Total numbers at age 1957 to 1972 for the whole of VIa taken from the 1974 Herring Working Group report.

	Age(ring)											
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**10+**
1957	0	6496	80817	66094	26882	38989	21541	9643	1658	2606	578	1633
1958	0	15695	33616	158801	43895	28108	32025	19986	10795	3725	2592	2570
1959	0	54063	74615	38547	124307	27898	18942	18833	8158	4629	2971	1764
1960	21	3940	115501	65703	25388	50558	12196	11096	6770	3029	1558	269
1961	0	14473	50809	72914	38321	24455	14296	5791	5370	1741	767	379
1962	0	55278	99167	27189	76706	49002	22707	27787	7614	5676	2097	662
1963	0	11890	82849	57688	13310	42796	28698	10171	14585	3915	3239	731
1964	2781	26609	87652	74309	29583	8857	27075	21347	10109	11956	4028	1671
1965	46891	299701	23351	72085	67768	24525	7001	28806	21475	7500	11609	4406
1966	211639	211675	517616	45317	70793	38471	22691	12656	20790	17005	7418	8752
1967	186598	207947	28648	273732	49755	48320	36143	15226	10397	15068	10962	7937
1968	71425	220870	105348	26031	243304	19679	28436	17699	7275	4493	5326	4570
1969	192368	39160	107189	84565	27604	264558	25795	45908	27932	11003	5197	13058
1970	16299	238431	108872	272693	124498	42623	185380	24821	29920	14276	5156	6903
1971	209598	169780	286148	346206	261891	94206	25876	166165	16425	16286	8038	5578
1972	24941	321539	753355	210243	72885	83361	37428	13445	94577	8154	5855	5377

Table 8 Mean weights (kg) at age in the catch for herring in VIa (North) sourced from the 2003 HAWG report, Table 5.6.3. N.B. in this table “age” refers to winter rings in the otolith.

Age	1976	1977	1978	1979	1980	1981	1982
1	0.09	0.09	0.09	0.09	0.09	0.09	0.08
2	0.121	0.121	0.121	0.121	0.121	0.121	0.14
3	0.158	0.158	0.158	0.158	0.158	0.158	0.175
4	0.175	0.175	0.175	0.175	0.175	0.175	0.205
5	0.186	0.186	0.186	0.186	0.186	0.186	0.231
6	0.206	0.206	0.206	0.206	0.206	0.206	0.253
7	0.218	0.218	0.218	0.218	0.218	0.218	0.27
8	0.224	0.224	0.224	0.224	0.224	0.224	0.284
9	0.224	0.224	0.224	0.224	0.224	0.224	0.295
	1983	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
1	0.08	0.08	0.069	0.113	0.073	0.08	0.082
2	0.14	0.14	0.103	0.145	0.143	0.112	0.142
3	0.175	0.175	0.134	0.173	0.183	0.157	0.145
4	0.205	0.205	0.161	0.196	0.211	0.177	0.191
5	0.231	0.231	0.182	0.215	0.22	0.203	0.19
6	0.253	0.253	0.199	0.23	0.238	0.194	0.213
7	0.27	0.27	0.213	0.242	0.241	0.24	0.216
8	0.284	0.284	0.223	0.251	0.253	0.213	0.204
9	0.295	0.295	0.231	0.258	0.256	0.228	0.243
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
1	0.079	0.084	0.091	0.089	0.083	0.106	0.081
2	0.129	0.118	0.119	0.128	0.142	0.142	0.134
3	0.173	0.16	0.183	0.158	0.167	0.181	0.178
4	0.182	0.203	0.196	0.197	0.19	0.191	0.21
5	0.209	0.211	0.227	0.206	0.195	0.198	0.23
6	0.224	0.229	0.219	0.228	0.201	0.214	0.233
7	0.228	0.236	0.244	0.223	0.244	0.208	0.262
8	0.237	0.261	0.256	0.262	0.234	0.227	0.247
9	0.247	0.271	0.256	0.263	0.266	0.277	0.291
							Contd.

	1997	1998	1999	2000	2001	2002
1	0.089	0.097	0.076	0.0834	0.049	0.1066
2	0.136	0.138	0.13	0.1373	0.1396	0.1462
3	0.177	0.159	0.158	0.1637	0.1627	0.1594
4	0.205	0.182	0.175	0.1829	0.1826	0.1709
5	0.222	0.199	0.191	0.2014	0.192	0.1564
6	0.223	0.218	0.21	0.2147	0.1957	0.1725
7	0.219	0.227	0.225	0.2394	0.2045	0.182
8	0.238	0.212	0.223	0.2812	0.2244	0.2451
9	0.263	0.199	0.226	0.2526	0.2713	0.2771

Table 9 Mean weights (grams) at age, sourced from HAWG reports 1974 to 1982.

Working	Age (ring)									
Group Report	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Year**
1974	112.7	148.1	186.2	226.7	234.2	243.4	257.7	261.7	264.6	1973
1975	88	124	163	171	190	212	218	220	220	1974
1976	91	118	152	179	182	199	217	228	228	1975
1977	90	121	158	175	186	206	218	224	224	1976
1978	90	121	158	175	186	206	218	224	224	1977
1979	90	121	158	175	186	206	218	224	224	1978
1980		121	158	175	186	206	218	224	224	1979
1981		121	158	175	186	206	218	224	224	1980
1982		121	158	175	186	206	218	224	224	1981

Table 10 Mean weights at age in VIa, derived from dividing biomass per age group by stock numbers per age group. Adapted from Table 5 in Saville and Morrison (1973).

	1957			**1964**			**1971**		
Age (rings)	No. (x1000)	weight (tonnes)	Mean weight (g)	No. (x1000)	weight (tonnes)	Mean weight (g)	No. (x1000)	weight (tonnes)	Mean weight (g)
0	588473	7062	12.0	2923804	35086	12.0	1579250	18951	12.0
1	304803	24018	78.8	386991	30495	78.8	2081973	164059	78.8
2	671710	69609	103.6	553594	57369	103.6	856185	88701	103.6
3	234719	30551	130.2	390385	50813	130.2	552380	71898	130.2
4	135995	21548	158.4	162080	25682	158.5	498899	79051	158.5
5	124122	20332	163.8	72367	11854	163.8	197081	32284	163.8
6	65438	11140	170.2	137974	23489	170.2	62668	10669	170.2
7	32789	5910	180.2	90213	16260	180.2	441433	79564	180.2
8	11365	2080	183.0	37946	6945	183.0	40087	7337	183.0
9	11532	2133	185.0	36717	6793	185.0	24381	4510	185.0
10	844	159	188.4	16133	3001	186.0	21747	4045	186.0

Table 11 Proportion of catch that each country fishes from VIa north in each year from 1970 to 1980 with average National Fleet Factor over the decade.

Country	Belgium	Denmark	Faeroe Isl.	France	German D.R.	German F.R.	Iceland	Ireland	Netherlands	Norway	Poland	Sweden	UK (Eng.)	UK (N.Irl.)	UK (Scot)	USSR	unallocated	Moray Firth
1970			1.00	1.00	0.25	0.71	1.00		0.42	1.35	0.25				1.00	1.00		
1971		1.00	1.00	1.00	0.09	0.83	1.00		0.90	1.00					1.00			
1972		1.00	1.00	1.00	0.10	0.80	1.00		0.97	1.00					1.00			
1973		1.00	1.00	1.00	0.10	0.55	1.00		0.85	0.90	0.36				1.00	0.55		
1974			1.00	0.75	0.10	0.61	1.00		0.89	1.00	0.05		1.00		1.00	0.44		
1975		1.00	1.00	0.96	0.30	0.61	1.00		0.62	0.99	0.13		1.00		1.00	0.38		
1976		1.00	1.00	0.97	0.30	0.82	1.00		0.80	0.98	0.13	1.00	1.00		1.00	0.82		
1977		1.00	1.00	1.00					1.02	1.00		1.00	1.00		1.00			
1978		1.00		1.00		0.21			0.99	1.00			1.00		1.00			
1979				1.00					0.00				1.00		1.00			
1980				1.00		1.00			0.00				1.00		1.00			
National Fleet Factor	0.00	1.00	1.00	1.00	0.18	0.70	1.00	0.00	0.83	1.00	0.15	0.00[11]	1.00	0.00	1.00	0.64	0.00	1.00

Table12 Comparison between National Fleet Factor derived total catch (tonnes) and 1982 working group report total catch (tonnes) data.

	NFF derived catch total	1982 HAWG catch total	% difference
1970	160247	165930	-3.4%
1971	210594	207167	1.7%
1972	168399	164756	2.2%
total	539240	537853	0.3%

Table 13 Percentage of total VIa north catch in tonnes affected by none zero or none unity fleet factors

Year	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	Total
	0%	10%	3%	6%	3%	14%	7%	6%	6%	10%	18%	16%	12%	8%	6%	13%	9%

[11] Sweden has been allocated 0 catch for VIa north as the amount caught by them in 1976 and 1977 totals less than 2500 tonnes and is considered insignificant with regards to other countries.

Table 14 Difference in total catches at age allocations in the whole of VIa for 1962 to 1970 by fleet recorded in FRS Aberdeen fleet data and the totals recorded in the 1973 WG report. % Total is the percentage of catch reallocated at the WG, % Irish is the % of he total reallocated specifically from Irish age compositions and given other age length keys for VIa.

Year	% Total	% Irish	From	To
1962	2		Scotland	
1963	5	3	Germany and Ireland	Scotland
1964	0		None	
1965	4	4	Ireland	Scotland
1966	2	1	Ireland	Scotland Germany
1967	7	7	Ireland	Scotland Germany
1968	11	11	Ireland	Germany
1969	9	5	Ireland Germany	Scotland
1970	0		None	
1971	1		Faeroes	Norway

Table 15 Resulting catch in numbers (x1000) at age of autumn spawning herring in VIa north after National Fleet Factor was applied to data in Table 6.

	Age (ring)									
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9+**
1957	0	6496	74622	58086	25762	33979	19890	8885	1427	4423
1958	0	15616	30980	145394	39070	24908	27630	17405	9857	7159
1959	0	53092	67972	35263	116390	24946	17332	16999	7372	8595
1960	21	3561	102124	60290	22781	48881	11631	10347	6346	4617
1961	0	13081	45195	61619	33125	22501	12412	5345	4814	2582
1962	0	55048	92805	22278	67454	44357	19759	24139	6147	7082
1963	0	11796	78247	53455	11859	40517	26170	8687	13662	6088
1964	2781	26546	82611	70076	26680	7283	24227	18637	8797	15103
1965	46891	299483	19767	62642	59375	22265	5120	22891	18925	19531
1966	211639	211675	500853	33456	60502	40908	19344	5563	17811	27083
1967	186598	207947	27416	218689	37069	39246	29793	11770	5533	25799
1968	71425	220255	94438	20998	159122	13988	23582	15677	6377	10814
1969	192368	37706	92561	71907	23314	211243	21011	42762	26031	26207
1970	16299	238226	99014	253719	111897	27741	142399	21609	27073	24082
1971	209598	168443	271735	334773	245075	82682	20725	125230	13638	25949
1972	24794	517893	601665	169549	52475	64585	24896	10012	53984	16100

Table 16 Mean Weight in Catch (kilograms).

Age (ring)	1	2	3	4	5	6	7	8	9+
1957	0.079	0.104	0.130	0.158	0.164	0.170	0.180	0.183	0.185
1958	0.079	0.104	0.130	0.158	0.164	0.170	0.180	0.183	0.185
1959	0.079	0.104	0.130	0.158	0.164	0.170	0.180	0.183	0.185
1960	0.079	0.104	0.130	0.158	0.164	0.170	0.180	0.183	0.185
1961	0.079	0.104	0.130	0.158	0.164	0.170	0.180	0.183	0.185
1962	0.079	0.104	0.130	0.158	0.164	0.170	0.180	0.183	0.185
1963	0.079	0.104	0.130	0.158	0.164	0.170	0.180	0.183	0.185
1964	0.079	0.104	0.130	0.158	0.164	0.170	0.180	0.183	0.185
1965	0.079	0.104	0.130	0.158	0.164	0.170	0.180	0.183	0.185
1966	0.079	0.104	0.130	0.158	0.164	0.170	0.180	0.183	0.185
1967	0.079	0.104	0.130	0.158	0.164	0.170	0.180	0.183	0.185
1968	0.079	0.104	0.130	0.158	0.164	0.170	0.180	0.183	0.185
1969	0.079	0.104	0.130	0.158	0.164	0.170	0.180	0.183	0.185
1970	0.079	0.104	0.130	0.158	0.164	0.170	0.180	0.183	0.185
1971	0.079	0.104	0.130	0.158	0.164	0.170	0.180	0.183	0.185
1972	0.079	0.104	0.130	0.158	0.164	0.170	0.180	0.183	0.185
1973	0.090	0.121	0.158	0.175	0.186	0.206	0.218	0.224	0.224
1974	0.090	0.121	0.158	0.175	0.186	0.206	0.218	0.224	0.224
1975	0.090	0.121	0.158	0.175	0.186	0.206	0.218	0.224	0.224
1976	0.090	0.121	0.158	0.175	0.186	0.206	0.218	0.224	0.224
1977	0.090	0.121	0.158	0.175	0.186	0.206	0.218	0.224	0.224
1978	0.090	0.121	0.158	0.175	0.186	0.206	0.218	0.224	0.224
1979	0.090	0.121	0.158	0.175	0.186	0.206	0.218	0.224	0.224
1980	0.090	0.121	0.158	0.175	0.186	0.206	0.218	0.224	0.224
1981	0.090	0.121	0.158	0.175	0.186	0.206	0.218	0.224	0.224
1982	0.080	0.140	0.175	0.205	0.231	0.253	0.270	0.284	0.295
1983	0.080	0.140	0.175	0.205	0.231	0.253	0.270	0.284	0.295
1984	0.080	0.140	0.175	0.205	0.231	0.253	0.270	0.284	0.295
1985	0.069	0.103	0.134	0.161	0.182	0.199	0.213	0.223	0.231
1986	0.113	0.145	0.173	0.196	0.215	0.230	0.242	0.251	0.258
1987	0.073	0.143	0.183	0.211	0.220	0.238	0.241	0.253	0.256
1988	0.080	0.112	0.157	0.177	0.203	0.194	0.240	0.213	0.228
1989	0.082	0.142	0.145	0.191	0.190	0.213	0.216	0.204	0.243
1990	0.079	0.129	0.173	0.182	0.209	0.224	0.228	0.237	0.247
1991	0.084	0.118	0.160	0.203	0.211	0.229	0.236	0.261	0.271
1992	0.091	0.119	0.183	0.196	0.227	0.219	0.244	0.256	0.256
1993	0.089	0.128	0.158	0.197	0.206	0.228	0.223	0.262	0.263
1994	0.083	0.142	0.167	0.190	0.195	0.201	0.244	0.234	0.266
1995	0.106	0.142	0.181	0.191	0.198	0.214	0.208	0.227	0.277
1996	0.081	0.134	0.178	0.210	0.230	0.233	0.262	0.247	0.291
1997	0.089	0.136	0.177	0.205	0.222	0.223	0.219	0.238	0.263
1998	0.097	0.138	0.159	0.182	0.199	0.218	0.227	0.212	0.199
1999	0.076	0.130	0.158	0.175	0.191	0.210	0.225	0.223	0.226
2000	0.083	0.137	0.164	0.183	0.201	0.215	0.239	0.281	0.253
2001	0.049	0.140	0.163	0.183	0.192	0.196	0.205	0.224	0.271
2002	0.107	0.146	0.159	0.171	0.156	0.173	0.182	0.245	0.277

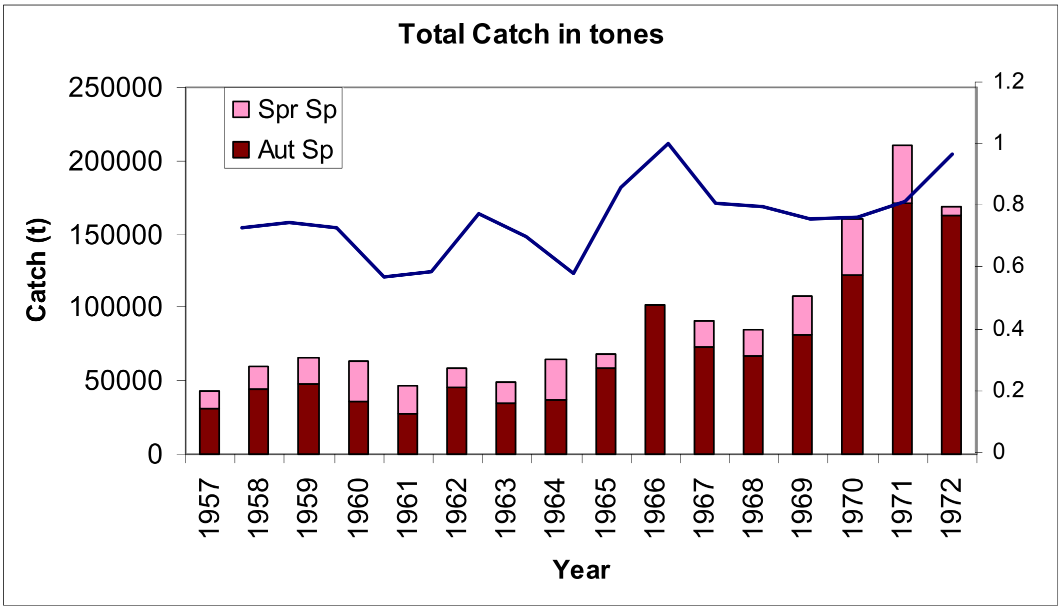

Figure 1 Estimated catch in tonnes in the VIa north 1957 to 1972 and split autumn and spring spawners and fraction of autumn spawners in the total.

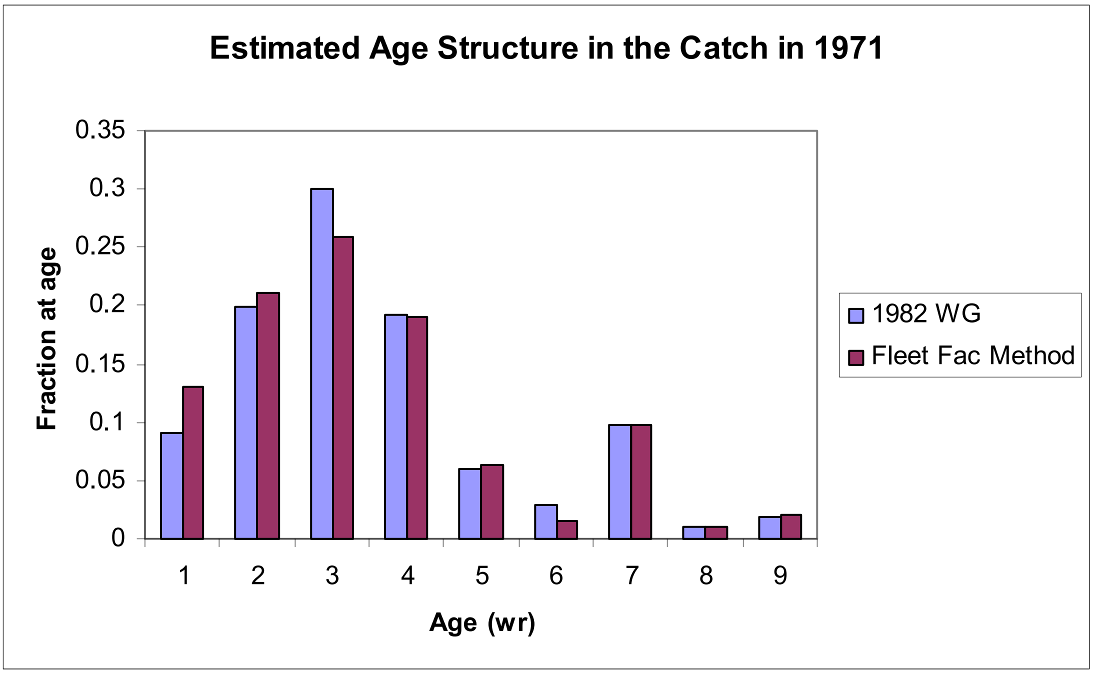

Figure 2a Estimated age proportions in 1971 from 1982 WG and using fleet factors on FRS Aberdeen data on catch at age

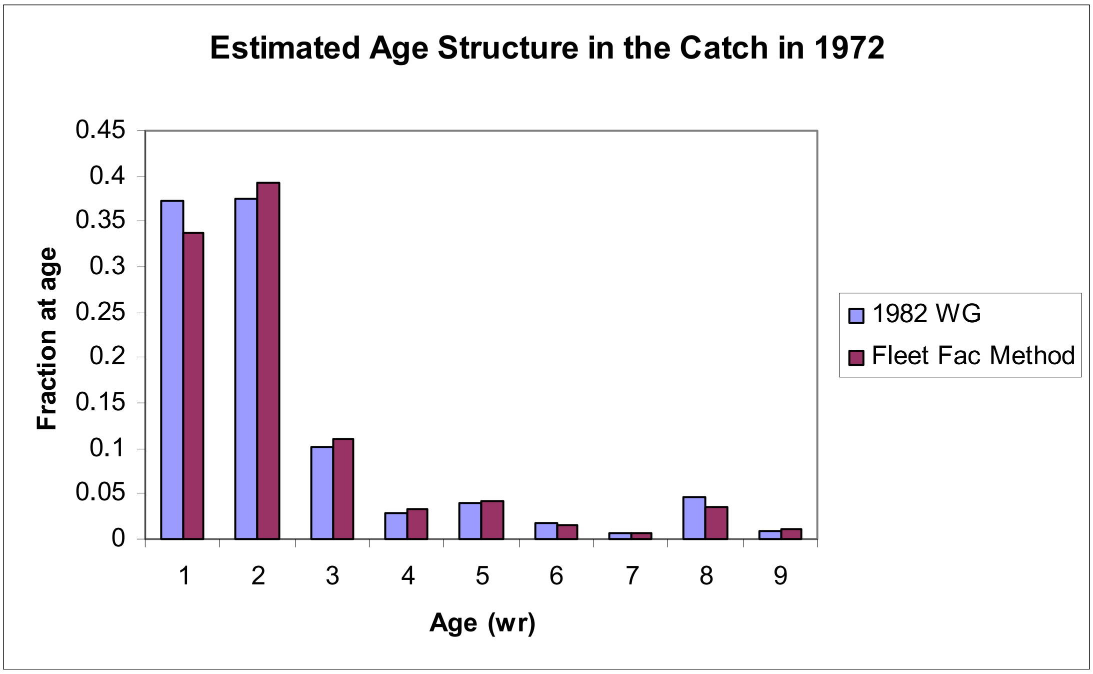

Figure 2b Estimated age proportions in 1972 from 1982 WG and using fleet factors on FRS Aberdeen data on catch at age.

APPENDIX 1

HERRING ASSESSMENT WORKING GROUP FOR THE AREA SOUTH OF 62°N

9 - 18 March 2004

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Appendix 2 – Stock Annex

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: 18 March 2004

Authors: C. Zimmermann (ed.), J. Dalskov, M. Dickey-Collas, H. Mosegaard, P. Munk, J. Nichols, M. Pastoors, N. Rohlf, E.J. Simmonds, D. Skagen

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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:

$$
\begin{aligned}
&\textstyle\sum_{a=0,y=1997}^{a=8,y=2002} \lambda_a \left(\ln(\hat{C}_{a,y}) - \ln(C_{a,y}) \right)^2 + \\
&\textstyle\sum_{y=1979}^{y=2002} \lambda_{mlai} \cdot \left(\ln(q_{mlai} . S\hat{S}B_y^K) - \ln(MLAI_y) \right)^2 + \\
&\textstyle\sum_{a=1,y=1983**}^{a=5+,y=2003} \lambda_{a,ibtsa} \left(\ln(q_{a,ibtsa} \cdot \hat{N}_{a,y}) - \ln(IBTS_{a,y}) \right)^2 + \\
&\textstyle\sum_{a=1,y=1989}^{a=9+,y=2002} \lambda_{a,acoust} \left(\ln(q_{a,acoust} \cdot \hat{N}_{a,y}) - \ln(ACOUST_{a,y}) \right)^2 + \\
&\textstyle\sum_{y=1977}^{y=2003} \lambda_{mik} \left(\ln(q_{mik} \cdot \hat{N}_{0,y}) - \ln(MIK_y) \right)^2 + \\
&\textstyle\sum_{y=1960}^{y=2002} \lambda_{ssr} \left(\ln(\hat{N}_{0,y+1}) - \ln\left(\dfrac{\alpha\, S\hat{S}B_y}{\beta + S\hat{S}B_y} \right) \right)^2
\end{aligned}
$$

** 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:

1. Initial stock size:
2. Natural mortality:
3. Maturity:
4. F and M before spawning:
5. Weight at age in the stock:
6. Weight at age in the catch:
7. Exploitation pattern:
8. Intermediate year assumptions:

9. 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 $F_{ages\ 0-1}$= 0.12, $F_{ages\ 2-6}$= 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.*

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

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

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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Appendix 3 – Stock Annex

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

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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 DivIIIa 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

1. Initial stock size:

2. Natural mortality:

3. Maturity:

4. F and M before spawning:

5. Weight-at-age in the stock:

6. Weight-at-age in the catch:

7. Exploitation pattern:

8. Intermediate year assumptions:

9. 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

I. Reference

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Appendix 4 - Stock Annex

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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Appendix 5 - Stock Annex.

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 2004

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:

1. Initial stock size:
2. Natural mortality:
3. Maturity:
4. F and M before spawning:
5. Weight at age in the stock:
6. Weight at age in the catch:
7. Exploitation pattern:
8. Intermediate year assumptions:
9. 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 $\mathbf{B}_{\mathrm{lim}}$ 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%.

$\mathbf{B}_{\mathrm{pa}} = \mathbf{B}_{\mathrm{lim}} * 1.50$ and gives $\mathbf{B}_{\mathrm{pa}} = 75{,}000$ 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:

$\mathbf{B}_{\mathrm{lim}}$ is 50,000 t	$\mathbf{B}_{\mathrm{pa}}$ be set at 75,000 t
$\mathbf{F}_{\mathrm{lim}}$ is 0.75	$\mathbf{F}_{\mathrm{pa}} = 0.35$

Technical basis:

$\mathbf{B}_{\mathrm{lim}}$: $\mathbf{B}_{\mathrm{loss}}$ Estimated SSB for sustained recruitment	$\mathbf{B}_{\mathrm{pa}}$: = 1.5 * $\mathbf{B}_{\mathrm{lim}}$
$\mathbf{F}_{\mathrm{lim}}$ corresponding to $\mathbf{B}_{\mathrm{lim}}$ from the yield-per-recruit $\mathbf{F}_{\mathrm{lim}} = 0.75$	$\mathbf{F}_{\mathrm{pa}} = 0.5$ * $\mathbf{B}_{\mathrm{lim}}$

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

I. References

Anon, 1982. Herring Assessment Working Group for the Area South of 62°N. ICES C.M. 1982/Assess:7.

Anon. 1987a. Report of the ad hoc Multispecies Assessment WG. ICES, Doc. C.M. 1987/Assess:9.

Anon. 1987b. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES Doc. C.M. 1987/Assess:19.

Anon. 1990. Report of the ICES Herring Larvae Surveys in the North Sea and adjacent waters. ICES CM 1990/H:40

ICES 1992. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES 1992/Assess:11

ICES 1996. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1996/Assess:10.

ICES 2002. Report of the Herring Assessment Working Group for the Area South of 62° N. CM 2001/ACFM:12.

ICES 2003. Report of the Study Group on Precautionary Reference Points for Advice on Fishery Management. ICES CM 2003/ACFM:15

ICES 2003. Report of the Herring Assessment Working Group for the Area South of 62° N. ICES 2003/ACFM:17

Patterson, K.R. 1998a: A programme for calculating total international catch-at-age and weight-at-age. WD to HAWG 1998.

Patterson, K.R. 1998b. Integrated Catch at Age Analysis Version 1.4. Scottish Fisheries Research Report. No. 38.

Patterson 1999 ICP

Appendix 6 - Stock Annex

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.

Appendix 7 – Stock Annex

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 vertebral 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.

Year	Coverage	% of landings sampled	No of samples	Total landings	landings by Q?	IRELAND				NORTHERN IRELAND				ISLE OF MAN				OTHERr UK/UK OFFSHORE				TOTAL			
						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 atlantic		NEmax 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**		

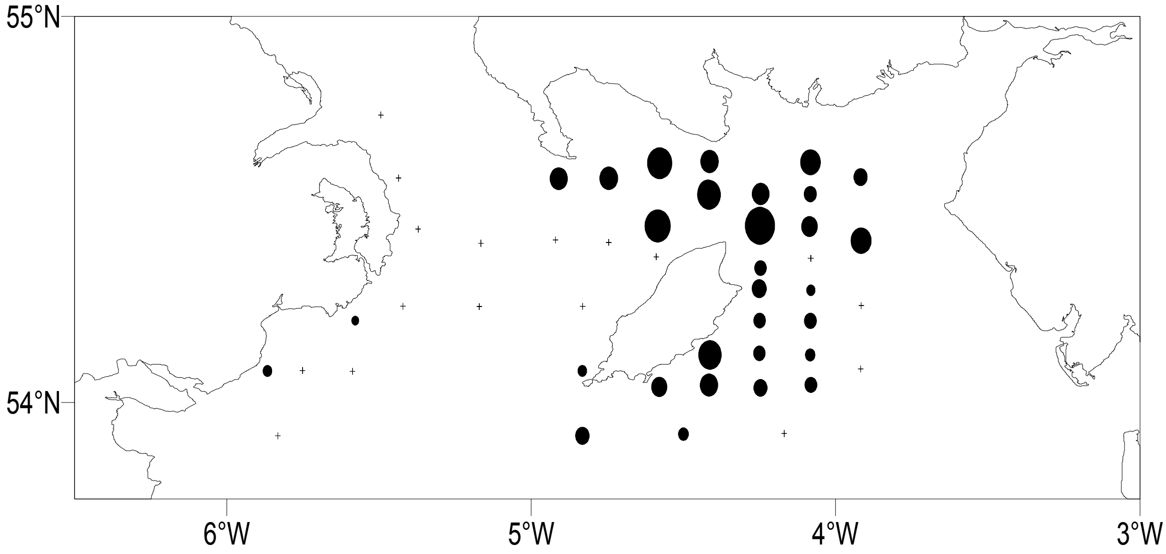
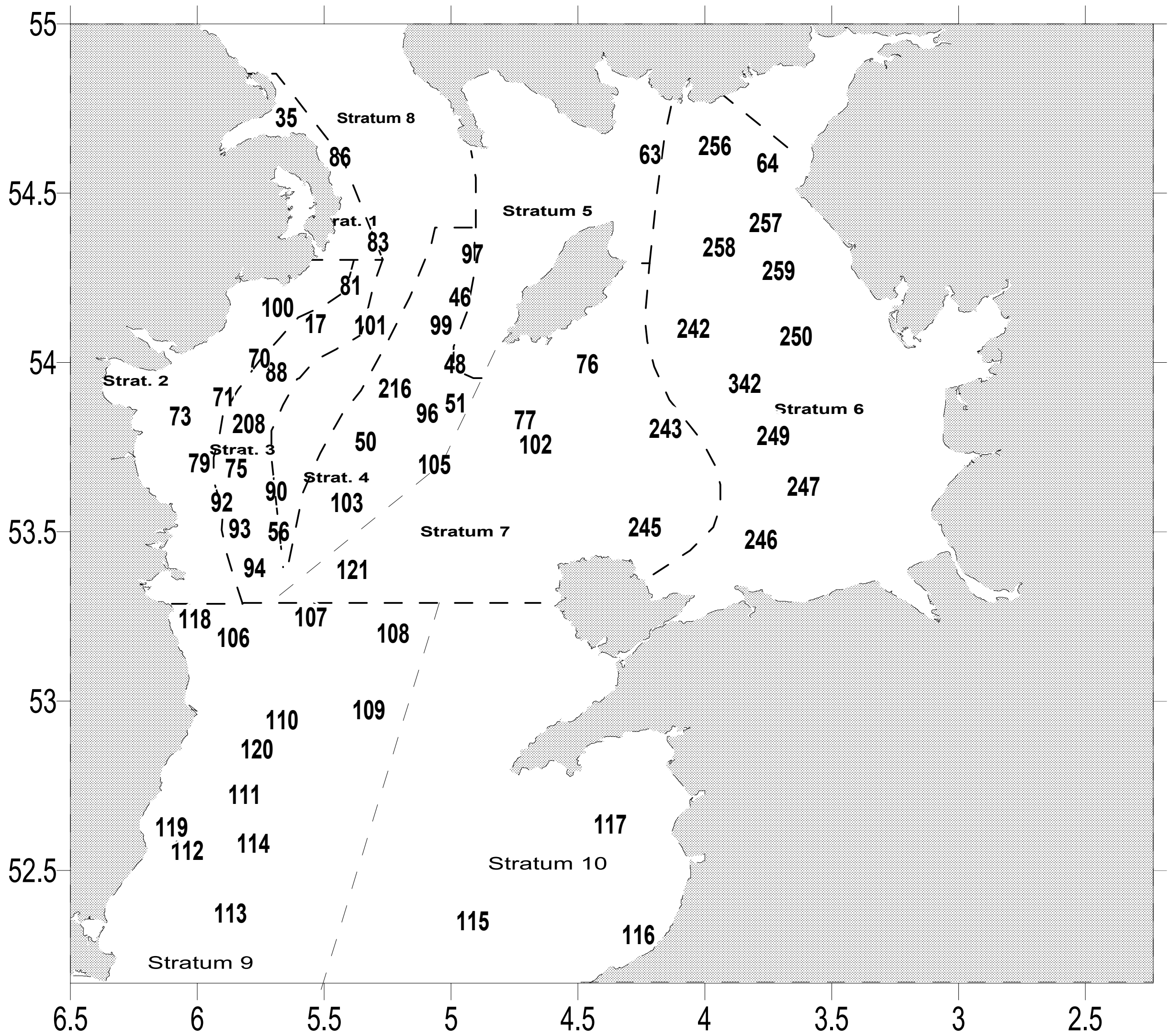


Figure 1**.** Sampling stations for larvae in the North Irish Sea (NINEL). Sampling is undertaken in November each year.



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.

Appendix 8 - Stock Annex

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 Herring Assessment Working Group (HAWG)

Date: 4^{TH} 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

Appendix 9 - Stock Annex.

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

Appendix 10 Stock Annex

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$_o$N. ICES CM 1998/ACFM:14.

TECHNICAL MINUTES

Herring Assessment Working Group (HAWG)

Vigo, 3 May 2004

Present:

Reviewers: Carmela Porteiro, Spain, (Chair)
Andre Forest, France

Chair HAWG: Else Torstensen, Norway

Observers:
Jose Maria Bellido (IEO, Spain)
M. Begoña Santos (IEO, Spain)

1. General

The reviewers would like to acknowledge the effort made by the WG in compiling all the information and particularly to Else Torstensen for her excellent presentations on the different stocks.

New templates of the *Summary Sheets* have been introduced this year and some time was devoted to go through all the new headings that are now requested.

All together 12 stocks are considered; this year full analytical assessment has been carried out only for 4 stocks. For the rest, the assessment has either been updated or is experimental.

The new system of sampling requirements implemented by the EU has not been fulfilled for all stocks. The reviewers believe that perhaps sampling should be divided across areas and across seasons not be only an agreed amount per 1,000 t.

1.1 North Sea Autumn Spawners (NSAS)

The assessment was accepted as a good assessment (similar to last year).

The differences between official landings and the information provided by WG members (official figures are consistently lower across all years) were noted. Landings have been well above the TAC. The fact that misreporting is still substantial and has increased from last year (i.e. catch area misreproted) was also noted. The reviewers believe that discarding could be a problem historically for this stock (in 2002 observers on board mackerel vessels in the Shetland Orkney area noted large discards of herring due probably to the fact that, at the time, the herring quota had already been fished so they continued fishing for mackerel). This year the mackerel quota has decreased and the herring quota is higher so discarding is not expected to be a problem.

The reviewers appreciated the effort that had gone into updating landings and recalculating catches for the period 1995-2002, based on the information that the Norwegian landings are now assumed to be taken in the North Sea and not in IIIa (this has potential effects on the mean weight at age, since fish landed from the North Sea are larger than those from IIIa).

The reviewers point out that landings abroad should be covered by the respective countries to be sure that biological data is collected.

The changes in maturity of the 2- and 3- ringers between last year and this year were noted (last year maturity was extremely high and this year it has averaged 40% for 2-ringers, which is the lowest maturity for the whole period). The mean weight at age has also decreased and the reviewers suggested this could be related to a density-dependence effect.

The reviewers note that there is a sign of two poor year classes coming in after a period of good recruitment, although SSB is well above the precautionary biomass and F has stabilised over the last few years.

The reviewers appreciated the use of the new MFST (Multi Fleet Short Term) model and its further development in 2004 to be able to take into account changes in growth and maturity (2004 appears to be well in line with 2003, once corrected for the low maturity of this year which could not have been foreseen).

1.2 Downs herring (IVc and VIId)

The reviewers noted the lack of data available for this stock and the need for more historical information. Downs herring has shown independent trends in exploitation rate and recruitment but its current state is unknown. It is separated from North Sea herring by the size of juvenile fish from the larval survey (up 11 mm is considered Downs herring, smaller than 10 mm is North Sea herring). Downs herring spawns in the Channel and it is mainly taken by Dutch and German fleets on the spawning grounds.

It is a political stock component; it is important at least in some areas although its importance has been much larger in previous years than it is now.

Western Baltic Spring Spawners (WBSS)

The assessment for this stock is accepted (same as last year).

The reviewers highlighted the need for a specific TAC to be set for the Western Baltic stock and noted that a separate management regime for WBSS in Division IIIa and Subdivision 22-24, should be considered with some urgency.

The reviewers noted the lack of survey coverage of the whole stock at the same time, also the problem that juvenile herring from the North Sea stock has a feeding area in the Skagerrak and Kattegat.

It was noted that the relationships between the recruitment indices have improved although there is still some noise.

For the mean weights-at-age in catches (except for 1-ringers they are all below historical values), the reviewers would like to know (since there are differences between mean weight at age between fish from the Kattegat and Skagerrak) why are they merged in the assessment.

The reviewers noted the reduction in mean F, although its value is probably still high compared with other herring stocks. They also noted the reduction in stock size and SSB from 2002-2003 although it is not considered to be a dramatic change. The recruitment (age 0) improved in 2003 in relation to 2002.

Celtic Sea and Division VIIj herring

The stock is problematic, the assessment was not accepted last year or the previous year.

The new system of sampling requirements implemented by the EU has not been fulfilled for the Celtic Sea herring, of which very few samples have been analysed. The reviewers note that the ICA model does not fit well in this case (changes in the exploitation pattern, migration, conflicting information, few data for tuning, mixture of spring and autumn spawners, etc.).

From the age composition in the survey and commercial catches (there are differences between both), it seems the fishing pattern has changed towards older fish.

The reviewers hope the data from BTS UK-1q will be made available to the assessment group soon.

Maturity at age (is assumed to be) very different from North Sea stock.

VIa North

Assessment was accepted last year. State of the stock: uncertain but it is likely lightly exploited.

The reviewers note that, since Scotland introduced a new fishery regulation in 1997, area misreporting has been reduced. The quality of the discard information has also improved and discards are not perceived to be a problem.

Independent strong year classes from the ones in the North Sea. Mean F has been decreasing and in the last 3 years has been relatively stable (little below 0.2). However, even with low level of F the stock has not increased.

Suggestion of reference points last year, but not accepted by ACFM. It is raised again this year. The reviewers note that the presented value for F_{lim} of 0.75 is high compared to other herring stocks but that this value is presented more as the result of an exercise than a final proposal. When the review group revised the Summary Sheet for Herring in VIaN, it was clarified that the WG suggest a reference point for B_{lim} of 50,000t and for B_{pa} of 75,000t. The reviewers also asked why the longer time series wasn't used to calculate the new reference points and it was indicated to them that lack of time and appropriate tools had prevented it.

Herring in Divisions VIa (South) and VIIb,c

The state of the stock unknown with respect to biological limits.

In the absence of tuning data, the assessments have been carried out by assuming various terminal F values on the catch-at-age data. Tuning indices are necessary to gain precision in estimates.

The reviewers note that misreporting decreased in recent years (<1000 t).

Irish Sea herring (VIIa north)

The assessment for this stock was not accepted by the WG.

The reviewers noted that current F, SSB and number at age are highly uncertain, also the conflicting signals in survey data, the lack of recruitment index and the unknown mixture of stocks in the area. The assessment of this stock should continue to be treated with caution.

The reviewers noted that perhaps the WG should try a combined assessment of the 3 stocks since we could be dealing with metapopulations.

Sprat in the North Sea (Subarea IV)

The assessment is regarded as exploratory.

Due to the characteristics of the stock (short-lived species, with the stock dominated by 1-and 2-year olds and with unreliable numbers-at age from surveys and catches), Catch Survey Analysis (CSA) has been used for data exploration. It is a new method, also used last year but still with the problem of the results being sensitive to M (it is assumed and set externally, in this case assumed to be constant across ages = 0.7 from MSVPA) and s (ratio of the survey catchability of the recruits to the fully recruited, fixed externally=1, in absence of any other info) parameters. There are problems in understanding the outcome of the model because is missing a good value for M.

The reviewers noted that although survey coverage has improved from last year, it still does not cover the southern part of IVb and into the Channel (due to navigation restrictions).

The reviewers noted that it should be made clear how the WG arrived at the prediction / projection “the projections suggest that the stock would be relative stable or decrease”.