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REPORT OF THE

HERRING ASSESSMENT WORKING GROUP FOR THE AREA SOUTH OF 62°N

ICES Headquarters
15-24 March 1999

PART 1 OF 2

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1.2 Terms of Reference

The **Herring Assessment Working Group for the Area South of 62°N** [HAWG] (Chair: E.J. Simmonds, UK) will meet at ICES Headquarters from 15–24 March 1999 to:

a) assess the status of and provide catch options (by fleet where possible) for 2000 for the North Sea autumn-spawning herring stock in Division IIIa, Sub-area IV, and Division VIId (separately, if possible, for Divisions IVc and VIId), for the herring stocks in Division VIa and Sub-area VII and the stock of spring-spawning herring in Division IIIa and Sub-divisions 22–24 (Western Baltic); in the case of North Sea autumn-spawning herring the forecasts should be provided by fleet for a range of fishing mortalities that have a high probability of rebuilding or maintaining the stock above 1.3 mill tonnes by spawning time in 2000;

b) assess the status of and provide catch options for 2000 for the sprat stocks in Sub-area IV and Divisions IIIa and VIId,e;

c) review progress in determining precautionary reference points;

d) provide the data required to carry out multispecies assessments (quarterly catches and mean weights at age in the catch and stock for 1998 by statistical rectangle of the North Sea for herring and sprat) and suggest and document a time series of quarterly catch and weight at age for sprat in the North Sea from 1972–1991 for use in the multispecies modelling and by the WGECO;

e) analyse the length distribution of sprat based on the IBTS data in relation to its usefulness in length based assessment.

1.3 Summary of the report of the planning group for herring surveys in the North Sea (PGHERS)

The Planning Group for Herring Surveys met in Hirtshals, Denmark from 2–4 February 1999, to:

- coordinate the timing, area allocation and methodologies for acoustic and larval surveys for herring in the North Sea, Division VIa and IIIa and the Western Baltic;
- combine the survey data to provide estimates of abundance for the population within the area;
- review the existing manual of the North Sea acoustic survey (Doc. ICES 1994b), taking into consideration recent developments in methodology and the results of the scrutiny workshop;
- plan for a further echogram scrutiny workshop to be held in 2000;
- for the historical database of larvae surveys, complete the analysis of the effect of reduced sampling effort, in order to improve the basis for a final decision on the index and the target sampling units to be used;
- provide a revised MLAI with explanation of any differences between this and the MLAI presented in Patterson *et al.* (1997a);
- investigate the methodological problem related to estimation of larval indices when very high numbers are caught in single hauls;
- develop and coordinate an international survey to be carried out by Denmark, Germany and Sweden which should cover the whole area where Western Baltic spring-spawner herring are distributed;
- obtain peer review of the Planning Group report from the appropriate Assessment Working Group prior to the 1999 Annual Science Conference;
- comment on the draft objectives and activities in the Living Resources Committee component of the ICES Five-Year Strategic Plan, and specify how the purpose of the Working Group contributes to it.

Review of larvae surveys

Seven units and time periods have been covered in the North Sea during the 1998 surveys. Preliminary data of larval abundance in the North Sea were presented as the measurements necessary for the calculation of larvae abundance was not complete. The final data was presented to the HAWG, see Section 2.5.

In the Western Baltic a recruitment forecast based on larval abundance was established last year. These are made available to the HAWG.

Herring larvae survey methodology

One major problem after the transfer of the ICES Herring Larvae database has been to have complete documentation of all routines used in the estimation of the indices; in the abundance index (LAI) and production index (LPE), independent area definition files had been used, and some mixing of station grids for the two indices had occurred. A single area definition file has now been established, based primarily on the 1985 manual (Anon. 1985).

LAI estimates have been computed for the three length classes which have been traditionally used (total length (TL) < 10 mm; 10–15 mm; > 10 mm). A detailed description of the calculation procedure is given in Rohlf *et al.* (1998) and in a Working Document to the meeting (ICES 1999b). For inclusion into the multiplicative model for calculation of the MLAI-values, a weighting factor is applied to LAI-values for individual sampling units, the weight being proportional to the degree of coverage of each sampling unit and the inverse coefficient of variation within the unit. This down-weights hauls with an exceptionally high amount of larvae.

Revised MLAI-values were presented and differences between this data series and the MLAI-series presented in Patterson *et al.* (1997a) were explained. Some minor differences are still apparent for the earlier period, where uncertainties with regard to the utilised area definitions and interpolation methods could not be solved completely. The remaining differences are mainly due to the weighting procedure as opposed to using some interpolation method for missing values, see Section 2.5.

The influence of reduced survey effort has been tested by simulating the reduction through systematic elimination of single survey units or complete areas from the MLAI calculation procedure.

The minimum input for MLAI calculations requires concentration of effort on those areas and time periods which best detect the overall variability in the herring SSB. A more complete or full coverage of the whole spawning area should be carried out preferably on a three-year basis in order to become aware of possible shifts in spawning time and location, and to test the validity of the present results from a 10-year period. Calculation of MLAI has to be based on the complete set of available data, until a more stable data set builds up over some years.

Co-ordination of larvae surveys for 1999/2000

The present effort for the herring larvae program includes survey by Germany and The Netherlands. This is sufficient to provide the minimum requirement effort.

The surveys for this period are planned for a complete coverage. This will require additional survey time in the Central North Sea in the first period. For this, additional vessel time in the range of about 40 days in total is to be envisaged for the period September/October. The participation of Norway is recommended, but will depend on the availability of ship time.

Reviewed acoustic surveys in 1998 from the North Sea/west of Scotland, Western Baltic and the Sounds

In the North Sea/west of Scotland six acoustic surveys were carried out during late June and July in 1998. A total SSB of autumn spawning herring from the North Sea was 1,831,000 t, for IVa (North) 375,000 t. The SSB for Baltic spring spawners was 162,000 t (see Section 2.4.1).

In the RV Scotia survey an increase in number of Ichthyophonus infected herring was observed. No Ichthyophonus were reported in any of the other surveys. The infection was mainly shown in 3+ age groups.

In the Western Baltic the abundance of herring was 12% lower than in the year before but similar to the abundance in 1996.

The environmental impact-monitoring program in the Sound (Sub-division 23), recorded higher biomass estimates during the 1996/97 and 1997/98 migration period compared to the 1995/96 migration period (Nielsen *et al.* 1998). This higher biomass seems to be due to the recruitment of a strong 1994 year class of Western Baltic herring.

In the North Sea/Division IIIa data on sprat were available from RV Tridens, RV Dana and RV Walther Herwig III. No catches were reported from RV Scotia and RV G.O.Sars. Sprat was found in 28 out of 146 investigated rectangles. From the results it was obvious that the northern distribution limit of the sprat stock was reached during the surveys. In order to cover the southern edge, the survey area is planned to extend more southwards in 1999.

Area coverage for acoustic surveys of the North Sea and IIIa

The biomass of herring is not distributed evenly over the North Sea, with the area to the east of 2° E containing only a small percentage of stock biomass in 1997 and 1998. Currently the herring stock is recovering from low numbers. If the stock were to follow the same pattern of area expansion as it exhibited from 1987 to 1990 (as it increased in biomass) it would again extend over much of the northern North Sea in July. Consequently, full coverage of the North Sea, particularly to the area east of 2° E, is essential if the survey is to ensure sufficient coverage of the stock.

During the July surveys for North Sea and Baltic herring a substantial part of the Baltic spring spawning herring is located in IIIa, Sub-area IVa and IVb. While the influence of the IIIa survey on estimates of North Sea SSB is negligible, the estimates of North Sea 1 ring and to some extent 2 ring herring are significant. However, the survey has a significant influence on the assessment of Baltic spring spawning herring. Its removal, even with substitution, is likely to have an unquantifiable effect on the assessment for Baltic spring spawning herring in the next 4 to 5 years.

Plan for International Surveys for Western Baltic spring-spawning herring

The present acoustic international surveys for Western Baltic spring-spawning herring in October should be intensified in the Sound (Sub-div 23) and extended to the whole Division IIIa to achieve a complete coverage of the total spawning stock in one survey. This will include an acoustic survey with a smaller vessel to cover the shallow waters during the same period. Both the annual acoustic survey in July and the new survey in October should continue for the present time until the new survey can provide data for the assessment. These surveys should focus on the Baltic spring spawning herring and the immature North Sea herring in Division IIIa. This will require participation by Denmark.

Revision of the North Sea acoustic survey manual

A revised structure of the manual was adopted. Individuals responsible for the revision of certain sections and an overall coordinator were identified. A complete draft version of the manual will be available for the planning group meeting in 2000 where a revised manual will be prepared.

Plan for echogram scrutiny workshop in 2000

One major part of the analysis of the results of acoustic surveys, is the visual examination of the echogram and the allocation of the calculated Echo-integral into species and categories. This part of the data analysis (scrutiny) is essentially subjective and requires an experienced operator.

In order to improve data analyses, a workshop on echogram scrutiny was held in 1998 (Reid *et al.*, 1998). The experiences gained during the workshop were invaluable but the exercise did not provide a statistically valid evaluation of the process and it will, therefore, be repeated. A workshop will be combined with the PGHERS meeting to be held in Bergen in February 2000.

Inter-ship calibration

An inter-ship calibration of the acoustic equipment was performed between the RV Walther Herwig III and RV DANA. This intercalibration did not show significant difference from a 1:1 relationship between RV Dana and RV Walther Herwig III.

ICES Five-Year Strategic Plan

Contrary to what was expected no ICES Five-Year Strategic Plan was available at the time of the Planning Group meeting.

The Herring Survey Planning Group recommends that:

General:

- the planning group report should be peer reviewed by the Herring Assessment Working Group before the 1999 Annual Science Conference;

- the planning group for herring surveys should meet in Bergen, Norway, from 1 to 4 February 2000 under the co-chairmanship of Karl-Johan Stæhr, Denmark and Else Torstensen, Norway, to:

  a) coordinate the timing, area allocation and methodologies for acoustic and larval surveys for herring in the North Sea, Division Via and IIIa and the Western Baltic;

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

  c) complete the revision of the existing manual of the North Sea Acoustic survey (ICES 1994b)

  d) hold a workshop on echogram scrutiny

For acoustic surveys:

The planning group recommends that present acoustic international surveys for Western Baltic spring-spawning herring in October should be intensified in the Sound (Sub-division 23) and extended to the whole Division IIIa to achieve a complete coverage of the total spawning stock in one survey.

The Planning Group recommends that both the annual acoustic survey in July and the new survey in October should continue for the present time until the new survey can provide data for the assessment. These surveys should focus on the Baltic spring spawning herring and the immature North Sea herring in Division IIIa. This will require participation by Denmark.

For larvae surveys:

- the North Sea Herring Larvae Surveys should be continued with concentration on the following units: Orkney/Shetland (15/9 – 30/9), Buchan area (1/9 – 15/9) and Southern North Sea (15/12 - 31/12 and 15/1 - 31/1);

- for the year 2000 and subsequently every three years, attempts should be made to achieve complete coverage with the following sampling units included: Orkney/Shetland (1–15/9 and 16–30/9), Buchan (1–15/9 and 16–30/9), Central North Sea (1–15/9, 16–30/9 and 1–15/10) and Southern North Sea (15–31/12, 1–15/1 and 16–31/1);

- MLAI values should be calculated according to the refined procedure explained above;

- Herring larvae survey activities in the Western Baltic should be reviewed with regard to their potential for supporting spawning stock size estimates.

Review of the report by the working group

The working group agreed that the planning groups terms of reference were addressed (with the exception of the comments on the ICES 5-years strategic plan). A detailed review of the scientific basis for the report was not addressed by the working group. The recommendations of the planning group were discussed and, as appropriate, brought forward as WG recommendations (Sec. 1.8).

1.4 Summary of the Report of the Study Group on IIIa Herring (SG3AH)

The Study Group on IIIa Herring (SG3AH) met at the Danish Institute for Fisheries Research, Charlottenlund, Denmark from 11 to 15 January 1999 in order to:

- review and update catch at age and mean weight at age data including information on proportions of North Sea autumn spawners (NSAS) and Western Baltic spring spawners (WBSS) for the period 1990 -1997 and for all fishing fleets catching herring in Division IIIa and Sub-divisions 22–24,

- review and update data including information on proportions of North Sea autumn spawners and Western Baltic spring spawners from acoustic surveys and bottom trawl surveys carried out in the eastern part of the North Sea, Division IIIa and in Sub-divisions 22–24 in the period 1990 - 1997,

- further improve the migration model of Western Baltic spring spawning herring which can be used for the understanding of the results of an analytical assessment.

There are changes in the fishing pattern after the reunification of the GDR and FRG in 1989 and additional general problems in updating data for the year 1990. Therefore, current assessments should be based on data from 1991 onwards only and catch at age data, survey data and other relevant data for this period were revised. For the catch data, a constant fishing pattern is assumed for the period 1991–1997 (in accordance to ICES 1998a; ICES 1998 c).

Background

Discrimination between the herring stocks in Divisions IIIa and IIIc remains one of the main problems when assessing the Western Baltic herring stock. In the past seven years the HAWG has applied a variety of stock discrimination methods. The estimated proportions have varied substantially especially for age groups 1 and 2, which have the most abundant components of North Sea herring in Division IIIa.

Discrimination methods based on vertebrae counts

In order to analyse the characteristics of the two major herring populations mixing in Division IIIa (Skagerrak, Kattegat) as well as in ICES-Sub-division 23 (Sound) and to be able to separate them, two reference samples of vertebra counts have been taken in 1995 (Gröger & Gröhsler 1995, 1996). These two reference samples of vertebra counts were used to verify different stochastic herring separation models by:

- Regression approach
- Discriminant analysis approach
- Logistic Regression

Due to implicit statistical problems the linear regression was not further investigated (Gröger 1999). Discriminant and logistic regression separation models did not show such inherent statistical problems. Hence, the group decided to use the logistic regression approach in order to split the data of the Swedish IBTS for the years 1991 to 1997 into Baltic Sea and North Sea fractions of herring. The estimated fractions of Baltic spring spawners based on the VS means show a tendency to decrease from the South to the North. The fraction of the spring spawning component (WBSS characteristics) increased by age but also by distance from the North Sea (i.e., lowest fraction in the Skagerrak and highest fraction in the Sound) but not as drastically as assumed by the theory. The fractions of spring spawners among older age groups now estimated are apparently much smaller than earlier WG estimates (ICES 1997a).

Separation of more than two components is doubtful if only based on vertebrae counts (VS). Considering only the two major components WBSS and NSAS, the vertebrae frequency distribution per age shows for the Western Baltic reference sample a range of VS = 52 to 58 but concentrated on 55 and 56 vertebrae leading in total to a variance of 0.67. The North Sea reference sample has a range from 53 to 58 vertebrae with a main concentration on 56 and 57 vertebrae, leading to a variance of 0.48. The two variances differ significantly from one each other. Linear models ignore the existing overlapping or shared information, i.e., the stock related variances tend to stretch the splitting results. Models which include the stock related variances (logistic and discriminant approach) result in estimated fractions with a narrower range around the mean VS value. Separation is further complicated as the probability for a young herring with 0 or 1 winter rings and 57 vertebra caught in the Baltic Sea near Rügen to be a Baltic Sea herring should be higher than for a 0 or 1 winter ring herring with 57 vertebra caught in the North Sea. This means that two factors interact, one expressed by a VS splitting model, the other expressed by a model which describes the probability of finding a herring from a specific stock at given location. Incorporating further stock characterising information may increase ability to separate between different stock components.

Discrimination by otolith microstructure analysis

Otolith microstructure analyses (OM) have been successfully used to separate spring and autumn spawned juveniles (Moksness & Fossum 1991). The method is based on the observation that growth of autumn spawners is lower than that of spring spawners during early life-stages. Early life growth can be obtained from relative widths of primary increments ("daily rings") at the centre of otoliths. Since the formation of otoliths is a cumulative process these larval formed increments can also be identified in otoliths of adult individuals (Mosegaard and Popp-Madsen 1996).

Calibration of vertebrae counts and otolith microstructure based proportions

The individual-based comparisons from the years 1991 to 1997 determined by VS and otolith microstructure of spring spawners fractions are presently being worked up. An incomplete Swedish IBTS data set stratified by ICES rectangles by year (1996 and 1997), quarter (I and III), Sub-division (20, 21, and 23), and age class (1, 2, 3, and 4+) was used to estimate fractions from VS counts. Herring samples from Danish research vessels and commercial landings stratified in the same way were used to estimate fractions directly from individual data on microstructure. A comparison of the two geographically based data sets on stock fractions did not encourage the development of a VS to otolith based geographically weighted function.

Comparison of individual vertebral counts and spawning type from otolith microstructure

Six samples from the Swedish IBTS surveys taken in the 1st and 3rd quarters in 1996 and 1997 in the Kattegat and Skagerrak areas were analysed. Only 2-ringers were analysed for this comparison. Hatch month obtained by otolith microstructure analysis and VS counts were compared for the same individuals. The analysis of six samples yielded a reasonable correspondence between VS based and otolith microstructure based proportions.

The results showed good correlation between proportions based on the logistical transformation of VS counts and directly derived proportions of spring spawners in the samples. These results suggest that calibration of the time series of VS based proportions is possible but the individual material consisted of only age-class 2 herring. Also the number of samples (6) and the total number of individuals analysed (91) was considered to be too small to reliably calibrate the VS-derived proportions.

An analysis of more material on corresponding individual data on otolith microstructure and VS counts may provide sufficient information to allow a robust calibration.

Revision of commercial catch data

In general, samples from the commercial fishery have been used to calculate numbers of fish landed. When reviewing sampling levels, it should be taken into account that the recommended sampling level should be one sample per 1 000 tons fish landed per quarter (ICES 1997a). SGSSBH (ICES 1998 c) presented an overview of the sampling level for the years 1993–1996 that shows that the recommended sampling level was reached in most quarters. However, not all landings by the different fishing fleets were covered adequately. For Denmark and Sweden the human consumption fishery has been sampled at a satisfactory level. The Danish "Mixed" fishery as well as the "Other" fishery was in all years sampled adequately and these figures are also regarded as reliable. The landings for reduction purposes taken by the Swedish human consumption fishing fleet (32 mm mesh size) in the Skagerrak and Kattegat have not been sampled adequately in 1991 to 1995, if sampled at all. These landings are split into numbers by age group using Danish samples from the "Mixed" fishery. The use of these samples may cause the estimated numbers of fish caught to be too high and may have biased the age distribution (0, 1 and 2 w-ringers). The human consumption fishery took place in the deeper part of the Skagerrak (depth > 75 m) and the age distribution of the catches probably mainly consisted of older fish at variance with the age composition obtained from the "Mixed" fishery. The catches of older herring in Division IIIa mainly consisted of spring spawners causing that the total numbers in the catch of spring spawning herring could be underestimated.

Landings of herring from Sub-divisions 22–24 have not been sampled adequately, in some years Danish and Swedish landings have not been sampled in all quarter. German landings in the period 1991–1997 were at a rather low level, between 7 000 to 15 000 tons. The major part of these landings has been taken in trap- and gill nets. In some quarters no samples have been taken and for some quarters survey data have been used to estimate numbers caught by age group. This latter procedure is invalid as the age distribution in surveys are different from gillnet catches. At this Study Group meeting it was decided that for the purpose of producing input-data for the ICA (Integrated Catch Analyses) only total catch by year and quarter was needed.

During the revision of the historical data some changes have been made for the year 1992 and 1993. As mentioned above, there is still uncertainty in the estimated catch at age data. A major concern is the Swedish landings for reduction purposes taken by the human consumption fleet from 1991–1996. If possible, all these landings should be re-analysed following the methodology described above, as they constitute up to 30% of the total landings in Division IIIa.

The mean weights at age are calculated from mixed samples including both autumn and spring spawners and therefore do not reflect neither mean weight of the spring or of the autumn spawners. The Study Group was not able to revise these data, as stock related data could not be presented to the meeting.

Revision of survey data

Research surveys have been conducted during all seasons in Division IIIa and the Sub-divisions 22, 23 (the Sound) and 24. However, none of the available fishery independent surveys were specifically designed to account for the two major problems in the assessment of the WBSS:

- to provide reliable discrimination between stock components over the WBSS distribution area,
- to describe spatial distribution of stock components and migration patterns between seasons.

In addition, none of the surveys cover the total distribution area and there is little temporal overlap between these surveys.

The acoustic surveys are conducted every year to supply the HAWG with an index value for the stock size of herring in the Western Baltic area. However, the design of these surveys was not tailored to study the dynamics of the WBSS.

The Danish survey in July has been co-ordinated with other hydroacoustic surveys conducted by national institutes around the North Sea in order to provide stock estimates of the North Sea autumn spawners and Baltic spring spawners in Division IIIa.

The German survey in September/October was traditionally co-ordinated with other international surveys in the Baltic. The main objective has been to assess clupeoid resources in the Baltic Sea. The German hydroacoustic data series have been revised for 1993 to 1998. The revision followed procedures recommended in the Baltic International Acoustic Survey manual (ICES 1998b). Available data suggest that a large part of the WBSS stock have migrated south to the Sound or at least to the southern Kattegat by October (ICES 1998 c). Therefore, the German hydroacoustic survey was considered to have an appropriate coverage. It was agreed that the survey could provide a major input for the assessment of the WBSS stock. The design of the survey can be further improved to increase precision of the survey results.

The main purpose of the Danish acoustic monitoring in Sub-division 23 was to provide information on herring migration and an evaluation of possible environmental impacts from the construction of the Sound bridge between Denmark and Sweden. Results from the Danish monitoring hydroacoustic surveys have been revised for the whole data set including 1993 to 1998. There are no plans to continue the surveys.

A German larval survey is carried out annually since 1977 from March/April to June on the main spawning grounds of the Western Baltic spring spawning herring in Greifswalder Bodden and adjacent waters. It was shown previously that calculated larval index (0 group) and the estimated age 1 from the hydroacoustic surveys in the subsequent year in Sub-division 24 differ substantially (ICES 1998a). The SG members assume that an alternative use of the data could be to back-calculate spawning biomass. Such an approach might necessitate an extended and redesigned sampling strategy. The SG members recommend that the possibility to extend the sampling design to include estimates of spawning biomass should be explored. The larval surveys may also be extended to include other spawning areas along the German, Danish and Swedish coasts. Pilot studies were recommended to evaluate the possibility to use larval surveys for assessment purposes.

The SG members discussed co-ordination between the current surveys. The lack of a survey that covers the total WBSS distribution area in the same season was thought to be a major obstacle to obtain a reliable analytical assessment. A possible solution might be to organise an international bottom trawl or hydroacoustic survey. The SG members considered that the stable stock distribution during summer suggests that the better option is to conduct an extended hydroacoustic survey in July. However, it was recognised that trawl sampling is difficult at the same time in the Kattegat due to large by-catch of jellyfish.

Purpose and structure of a migration model

Members of the study group agreed that a proper migration model could not be constructed without extensive preparation and including external expertise in model construction. The SG therefore recommends that modelling experts should work together with herring biologists to supply an operational model based on appropriate data on the stock discrimination of the WBSS stock.

Recommendations

- The Study Group recommends maintaining the German hydroacoustic survey in October. It is considered that the Western Baltic herring starts its spawning (southward) migration in late summer and has by October left the Skagerrak-Kattegat area. Thus the hydroacoustic survey covers all the area of the Western Baltic spring spawner distribution at that period.

- The Study Group recommends that the area of larval investigations in the Baltic Sea (Sub-divisions 22 and 24) be extended to other important reproduction areas for Baltic herring. It would be desirable that historical and future larval surveys could be used to provide an index of spawning stock biomass of Western Baltic herring.

- The Study Group recommends that sampling of Western Baltic herring from commercial trap-net catches during the spawning period be intensified. It is recommended to collect samples of spawning herring along the entire coast in Sub-divisions 22, 24 and Division IIIa. The purpose of the sampling should be to estimate the importance of all local spring spawning stocks and to obtain one-population samples for analysis of vertebral counts and other biological characteristics.

- The Study Group recommends that all institutes, which collect samples of herring in areas where Western Baltic herring is mixed with North Sea autumn spawning herring, should retain and store otolith samples for microstructure analysis.

- The Study Group recommends that modelling experts work together with biologist in order to supply an operative migration model which can be tested with appropriate data on stock discrimination. Such data can be made available from Study Group members.

Review of the report by the Working Group

The Working Group agreed that the Study Groups terms of reference were addressed. A detailed review of the scientific basis for the report was not addressed by the Working Group. The recommendations of the Study Group were discussed and, as appropriate, brought forward as WG recommendations (Section 1.8).

1.5 Summary of the Report of the Study Group on Stock-recruitment Relationships for North Sea Autumn- spawning herring (ICES 1998e)

The Working Group met in Lowestoft in 26–28 May 1998 to address the following terms of reference:

1. establish the data series of recruitment and SSB for as long a period as possible.
2. investigate the performance of different stock-recruitment models
3. propose standard models to be used for different purposes.

Revision of data

The Group considered possible ways of revising catch at age and weight at age data as far back in time as possible. The Herring Working Group in the past provided data back to 1947 (ICES 1977). It was considered important to include the years 1947–1959 because this would include a period where the exploitation was lighter than later on. It was realised that a full revision from the raw data would be a major task, and in some instances, the original data would no longer be accessible. The group considered the large discrepancies in SOP in the early years, and concluded that the most likely explanation to this would be that the catch weights were incorrect. This would not affect the estimates of stock numbers, but if the error in the catch weights carry over to the stock weights, this would have implications for the SSB estimates. There is some evidence that the growth rates were lower in those early years, and an attempt was made to correct the weights for this based on length at age data from the literature. A new set of stock-recruit pairs were estimated covering the period 1947 - 1997 with revised stock weights, using ICA with essentially the same options as in the most recent Working Group assessment (ICES 1998a). The parameters in the Beverton-Holt stock recruitment relation

$R = a*SSB/(b + SSB)$ were estimated to be $a = 6.199*10^7$ and $b = 4.28*10^5$. These corrections did not totally resolve the problems with SOP discrepancies.

The Study Group noted several areas where further improvements might be possible:

- Further revision of catch weights, stock weights and catch numbers for the entire period 1947–83.
- Revision of maturity at age
- Inclusion of catches of North Sea autumn-spawners from Division IIIa for the whole time range. At present, such data are only included from 1980 onwards.
- Use of fecundity weight relationships to enable calculation of effective fecundity instead of SSB.

- If density dependence is confirmed by such studies, it should also be taken into account in long term calculations of yield and stock size.

Stock-recruitment models

The group studied several ways of modelling the relation between stock and recruitment, and attempted to give an overview over some methods that have been applied to ICES stocks in recent years. These include parametric models as well as various approaches to non-parametric models and smoothers. It was noted that different approaches might be appropriate for different purposes and that estimation of the slope at the origin may have to be treated separate from estimating a relation to be used in simulation. It was also emphasised that no model is informative outside the range of the observed data.

Several of these methods represent quite recent developments, and their behaviour is not fully understood. Because of this, and because the group was not in the position to make extensive comparative studies, it did not give any final recommendation as to which models should be used in the future.

The Working Group considered that all terms of reference have been addressed. The Study Group pointed out some areas where further work was expected to be valuable. If further revisions of the data can be made, reconvening of the Study Group should be considered.

1.6 Assessment Methods

Assessment methods available to the Working Group were as described in ICES (1996a), where reasons for the choice of method are also documented. The most recent implementation of the assessment and projection software was used (ICA version 1.4) The developments of this software are documented in Patterson (WD 1998). Methodological developments special to individual stocks are described in the relevant sections. Run logs for the final assessments documenting program version and input parameters are tabulated for each stock. The details of the structural model are described most fully in Section 2.8 for North Sea assessment.

A working document was presented by Huiskes (WD 1999) featuring a new tool to evaluate parametric and structural uncertainties in stock assessment models based on automatic differentiation for optimization, with an application to North Sea herring. As a starting point the performance of the assessment procedure as implemented in ICA was studied. A preliminary outcome is that the relative bias could be reduced by choosing less parameters. An example: in the age-structured acoustic index each age class has a proportionality parameter for every age class. If a single constant is chosen for all ages, the number of parameters is reduced from 7 to 1. As a result the relative bias in the calculation of the acoustic index is reduced from approximately 8% to 1.3%.

1.7 Precautionary reference points

In last year's report, the Working Group suggested values for precautionary reference points according to the guidelines given by the Study Group on the Precautionary Approach to Fisheries Management (ICES 1998f). Specific reference points were not suggested by the Study Group for the stocks assessed by the HAWG. Some of the HAWG suggestions were later modified by ACFM. The text table below gives an overview of the reference points suggested by ACFM for stocks covered by this WG.

Table 1.7.1. Precautionary reference points as suggested by the HAWG and as adopted by ACFM. SSB values in '000 tonnes.

Stock	B_{lim}	B_{pa}	F_{lim}	F_{pa}	Comments
North Sea					No values adopted as management considered consistent with the precautionary approach
ViaS	81	110	-	0.22	$F_{lim} = F_{loss}$ $F_{pa} = F_{med}$
Irish Sea	6	9.5		0.36	$F_{pa} = F_{med}$
Celtic Sea	27	44	0.13	0.27	F_{lim} = highest sustainable at low recruitment $F_{pa} = F_{med}$
VIa(N)	-	-	-	-	Insufficient information
Western Baltic	-	-	-	-	Insufficient information

For some of the stocks, the Working Group has used simulation studies to evaluate the risks and benefits associated with candidate reference points and harvest control rules. In general, this is considered to be better to using F_{med} as a guideline for precautionary exploitation. The Working Group intends to carry this work further, both to cover all its stocks, and to follow up developments in this field of research.

The 1999 Working Group recommendations on the reference points are as follows:

North Sea: ACFM noted that the management agreement between EU and Norway is consistent with the precautionary approach, and was the basis for the previous Working Group suggested reference points. Hence the Working Group supports the current strategy of ACFM. The EU-Norway agreement (Dec. 1997) states that efforts will be made to maintain the SSB above the MBAL of 800,000 t. An SSB reference point of 1.3 million tonnes is set above which the TACs will be based on F = 0.5 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.

VIa South: The Working Group accepts ACFM figures.

Irish Sea: The Working Group still is concerned about the reference points defined by ACFM, given the uncertainty of the assessment and the low level of recruitment in recent years. Particular concerns are with regard to the use of F_{med} as a guideline, when the SSB and the recruitment estimates are uncertain, and to the principle of using F-based reference points when the state of the stock is highly uncertain. The F_{pa} for Irish Sea herring is much higher than those proposed for other herring stocks covered by this working group.

Celtic Sea and VII: The working group recommends $F = 0.3$ and a B_{pa} of 40,000 t. Details of the justification are found in Section 4.7.

VIa(N) and IIIA: Currently the states of the stocks are uncertain and the historical time series are not well established. Hence the Working Group is unable to recommend any reference points.

1.8 Recommendations and Requirements

The Working Group recommends that the planning group for herring surveys should meet in Bergen, Norway, from 1 to 4 February 2000 under joint chairmanship of Karl-Johan Stæhr, Denmark and Else Torstensen, Norway, to:

a) coordinate the timing, area allocation and methodologies for acoustic and larval surveys for herring in the North Sea, Division VIa and IIIa, the Western Baltic, Celtic Sea;

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

c) complete the revision of the existing manual of the North Sea Acoustic survey (ICES 1994b)

d) hold a workshop on echogram scrutiny

e) examine inter calibration of acoustic surveys.

The Working Group recommends that present acoustic international surveys for Western Baltic spring-spawning herring in October should be intensified in the Sound (Sub-div 23) and extended to Division IIIa to achieve complete coverage of the total Western Baltic Spring Spawning stock in one survey.

The Working Group recommends that both the annual acoustic survey in July and the new survey in October should continue for the present time until the new survey can provide data for the assessment. These surveys should be designed for the Western Baltic and Div IIIa Spring Spawning herring and secondarily for immature North Sea herring in IIIa.

The Working Group recommends that the North Sea Herring Larvae Surveys should:

be continued with concentration on the following units: Orkney/Shetland (15/9 – 30/9), Buchan area (1/9 – 15/9) and Southern North Sea (15/12 - 31/12 and 15/1 - 31/1);

and for the year 2000 and subsequently every three years, be organised to give a complete coverage with the following sampling units included: Orkney/Shetland (1–15/9 and 16–30/9), Buchan (1–15/9 and 16–30/9), Central North Sea (1–15/9, 16–30/9 and 1–15/10) and Southern North Sea (15–31/12, 1–15/1 and 16–31/1);

It is recommended that hydrographic data which are measured concurrently with the samples of herring larvae should be supplied with this data and should be included in the IHLS database

The Working Group recommends extending the area of larval investigations in the Baltic Sea from Sub-divisions 24 through 22 to reveal other important reproduction areas for Baltic herring, with a view to developing a sampling strategy for the provision of a larval index for Western Baltic Spring Spawning herring.

The Working Group recommends increasing the sampling of Western Baltic herring from commercial catches during the spawning period. It is recommended to collect samples of *spawning* herring in Sub-divisions 22, 24 and Division

IIIa. The purpose of the sampling should be to estimate the importance of all local spring spawning stocks and to obtain samples for the analysis of vertebral counts and other biological characteristics.

The Working Group recommends that all institutes, which collect samples of herring in areas where Western Baltic herring is mixed with North Sea Autumn Spawning herring, should retain and store otolith samples for microstructure analysis.

The Working Group recommends that modelling experts and biologists collaborate to derive an operative migration model which can be tested with appropriate data on stock discrimination. Such data can be made available from Study Group members.

The Working Group recommends the development of an input file for providing commercial landings and sampling data, based on a stand-alone database application (e.g., an MS Access runtime version) for the 2001 working group meeting. Data exchange to the evaluation routines already created (i.e., DIFAD) has to be ensured

The Working Group recommends that the North Sea herring 1-ringer indices of the IBTS survey be split in two components: 1-ringers from the "Downs" component (length below 13 cm) and 1-ringers from the central and northern North Sea (length above 13 cm) and the information to allow this analysis be made available to the next HAWG 1 month before the meeting.

The Working Group recommends an increase in the sampling regime for otoliths taken per 0.5 cm length groups in the IBTS surveys for length groups of 8.0 cm and above, with the aim of improving the precision.

The Working Group recommends that the database of MIK-samples should be examined for any occurrence of autumn spawned sprat (larvae / newly metamorphosed).

The Working Group recommends that studies should be pursued to estimate natural mortality at age for the spring spawning herring in the Division IIIa and Subdivision 22 to 24. It is recommended that national laboratories should use the results from the ICES Stomach program in Division IIIa to assess the predation mortality in this area.

The Working Group recommends that, as it is aware of the fluxes within and between the herring stocks studied, further investigations into stock discrimination of herring in the NE Atlantic should be conducted.

Requirements for the Herring Assessment Working Group to be provided by ICES

The Working Group requests the following data sets to be available:

A. At least one month before the first morning of the Working Group Meeting in 2000

Herring:

1. IBTS I ringer herring length frequencies split into two components based on the length distribution (see Section 2.9) for the years 1979–1999.

B. Either before or at the very least on the first morning of the Working Group Meeting in 2000

Herring:

1. IBTS I ringer herring length frequencies split into two components based on the length distribution (see Section 2.9) for the year 2000.

2. IBTS indices for age groups I to V+ for herring for the years 1983–2000.

Sprat:

3. IBTS sprat indices in area corrected format for the year 2000.

4. IBTS sprat data as mean weights and maturity state by rectangle for the whole time series.

5. MIK sprat larvae and juveniles as numbers by rectangle for the whole time series.

Facility requirements:

• The working group recommends to provide a network hub with a noise-reduced fan.

1.9 Requests from the Multispecies Assessment Working Group

The Multispecies Assessment Working Group (MAWG) requests data on quarterly catches and mean weights at age in the catch of North Sea herring and sprat for 1998. The herring assessment working group (HAWG) has produced the data for 1998 in the same detail as in the past.

For sprat the MAWG requests to suggest and document a time series of quarterly catch and weight at age in the North Sea from 1972–1991.

1.9.1 Quarterly database (numbers and mean weights at age)

Herring data

Quarterly catch-at-age data, together with weights at age in the catch and in the stock at spawning time for North Sea herring for 1998 are provided in Table 1.9.1.

Mean weight-at-age data for the herring stock at spawning time are best provided by samples taken during the July acoustic surveys which cover Divisions IVa and IVb, and these are shown in the lower panel of Table 1.9.1. for 1998.

Sprat data

Uncertainties in the reliability and/or absence of quarterly aged samples have prevented the Industrial Fisheries Working Group and later the HAWG, from running a VPA since 1984 (ICES 1998a). Mean weights at age for sprat over 1998 are given in Table 8.2.2. The working group is not able to construct or simulate input parameters for this period better than the MSWG already has done. For convenience, data from 1972–1991 so far presented by the Industrial Fisheries Working Group and the HAWG are presented in Table 1.9.2 (ICES 1974; ICES 1978; ICES 1979; ICES 1980; ICES 1981; ICES 1982; ICES 1983; ICES 1984; ICES 1985; ICES 1986; ICES 1987; ICES 1988; ICES 1989b; ICES 1990d; ICES 1991a; ICES 1992d).

1.9.2 Geographical distribution of the herring catches in in the North Sea in 1998

Data on the geographical distribution of herring catches in the North Sea (Sub-areas IV and Division VIId) in 1998 were available from Denmark, the Netherlands, Norway, Sweden, the U.K. (Scotland and England), Germany and France. The data represents the total catch (both juveniles and adults), but misreporting (from VIa) was not included. Figures 1.9.1 - 1.9.12 show the catch by ICES rectangles for each month. Figures 8.1.1 - 8.1.12 show the sprat catch by rectangles by month.

1.10 Further development of the input format providing landings and sampling of commercial catches

In the light of the development of the ICES Code of Practise for Data Handling, for 1999 the working group members used a spreadsheet to provide all necessary landing and sampling data, which was developed originally for the Mackerel Working Group (MHSA).

There was a need to develop this input table, especially to adapt it to the special needs of the Herring Assessment Working Group. Apart from these minor changes, 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.

The Working Group agreed that an input file based on a stand-alone database application (e.g., an MS Access runtime version) would be most preferable, because it is less error-prone than a spreadsheet, and results can easily be interpreted. It is recommended to develop an input application for the 2001 working group meeting (see Section 1.8). For the interim period, the input spreadsheet was modified in the following way:

- some minor adjustments were made for the needs of the HAWG (areas now covering all stocks; length range adjusted for herring and sprat; age range truncated at 9+)

- an additional quarter (1st quarter of the following year) was added to enable input for fleets with annual fishing periods different from a calendar year

- in the 'catch-data' sheet, a column was added where the direction of transfers and target area(s) of misreported or unallocated catches should be stated. The future input application should allow multiple entries for the same area, to cover each fraction of misreported catches (fractions that are transferred to a specific area) reported in a separate line

- a separate sheet was inserted for remarks, to state any problems that need discussion within the working group and to provide brief fleet profiles

- some summarising and evaluation routines were implemented to reduce the risk of erroneous data input

- It might be useful to change the input data provided for this year's working group (1998 landings and sampling) according to the new format during the working group meeting in 2000.

Table 1.9.1 Herring North Sea,
1998
Numbers (millions) and weights (g) at age (winter ring) per year class of herring caught in each quarter. Spring spawners transferred to Division IIIa are included. Autumn spawners caught in Division IIIa are not included.

	Age (ring)	0	1	2	3	4	5	6	7	8	9+	Total	
	Year class	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	Numbers	SOP (' 000)
Quarter													
I	Nb		159	53	49	22	13	22	4	4	1	328.4	
	W		31	63	94	129	164	209	234	294	182		25.2
II	Nb		25	181	60	30	9	4	2	1	0	312.6	
	W		30	108	138	159	190	213	215	223	229		36.7
III	Nb	86	53	530	199	121	99	41	7	3	7	1145.8	
	W	20	42	132	172	208	240	262	270	288	315		171.3
IV	Nb	123	14	304	204	96	43	18	3	2	1	807.1	
	W	17	51	109	135	170	196	218	243	238	233		91.5
Total	Nb	208	251	1068	512	269	165	85	16	10	10	2594.0	
	W	18	35	118	146	183	220	237	250	275	286		324.6

The stocks weight shown below are derived from acoustic survey samples taken in July from division IVa,b and used in SSVPA.

Age (w. ring)	1	2	3	4	5	6	7	8	9+
Year class	1996	1995	1994	1993	1992	1991	1990	1989	1988
Stocks weights	47	96	196	237	275	307	288	308	363

Table 1.9.2 Numbers (millions) and weights (g) at age (winter ring) per year class of sprat caught in each quarter. Data in the period 1984-1991 are very poor and considered Unsuitable for reliable catch at age estimation (ICES 1992d). For grey table cells no data was presented in the documents referred to. Only if the working group at the time came up with simulated values, these are provided between brackets.

year	quarter		age 0	1	2	3	4	5+	comments
1972	I	numbers (mill)							
		mean weight (g)							
	II	numbers (mill)							
		mean weight (g)							
	III	numbers (mill)							
		mean weight (g)							
	IV	numbers (mill)							
		mean weight (g)							
1973	I	numbers (mill)							
		mean weight (g)							
	II	numbers (mill)							
		mean weight (g)							
	III	numbers (mill)							
		mean weight (g)							
	IV	numbers (mill)							
		mean weight (g)							
1974	I	numbers (mill)	-	7620	7341.8	1043	198.7	40.3	
		mean weight (g)							
	II	numbers (mill)	-	361.8	2083.5	148.6	26.1	4.7	
		mean weight (g)							
	III	numbers (mill)	46.7	4909.8	1784.5	36.2	0.9	4.6	
		mean weight (g)							
	IV	numbers (mill)	1549.3	6172.9	865.1	74.5	10.6	7.2	
		mean weight (g)							
1975	I	numbers (mill)	-	4096.6	14973	3929	233.7	14.1	
		mean weight (g)							
	II	numbers (mill)	-	446.2	1163.2	68.9	6.5	-	
		mean weight (g)							
	III	numbers (mill)	15	10588.1	5760	75.1	3.1	-	
		mean weight (g)							
	IV	numbers (mill)	675.2	6351.6	6122.5	660.2	57.3	4.4	
		mean weight (g)							

Table 1.9.2 continued

year	quarter		age 0	1	2	3	4	5+	comments
1976	I	numbers (mill)	-	9360.9	9997	6678	373	7.6	
		mean weight (g)	-	*2.3*	*9.9*	*16.6*	*21*	*26.2*	
	II	numbers (mill)	-	2017.2	964.6	740.1	40.9	0.8	
		mean weight (g)	-	*2.6*	*11.2*	*16.4*	*23*	*24.7*	
	III	numbers (mill)	79.6	16536.4	599.5	40.1	-	-	
		mean weight (g)	*2.5*	*6.6*	*15.8*	*19.6*	-	-	
	IV	numbers (mill)	2780.4	8443.7	2659.4	612.7	37.1	-	
		mean weight (g)	*2.5*	*8.4*	*17.9*	*21*	*23.1*	-	
1977	I	numbers (mill)	-	4197.2	11963	962.9	104.7	12	
		mean weight (g)	-	*2.4*	*7.2*	*15.3*	*20.2*	-	
	II	numbers (mill)	-	540.3	670.9	52.7	1.5	-	
		mean weight (g)	-	*2*	*8.2*	*13.9*	*22.5*	-	
	III	numbers (mill)	57.3	2803.1	3248.4	165.9	11.1	-	
		mean weight (g)	*6.9*	*8.7*	*9.2*	*23.5*	-	-	
	IV	numbers (mill)	1060.8	4705	3049.5	311.2	1.5	-	
		mean weight (g)	*2.7*	*9.3*	*16.5*	*22.2*	*30.2*	-	
1978	I	numbers (mill)	-	2461.9	2839.3	3770	344.5	-	
		mean weight (g)		*(2.3)*	*(8.5)*	*(15.9)*	*(20.6)*	*(26.2)*	-->mean weights are averages from '76-'77
	II	numbers (mill)	-	1077.5	123.8	3.2	0	-	
		mean weight (g)		*(2.3)*	*(9.7)*	*(15.1)*	*(22.8)*	*(24.7)*	
	III	numbers (mill)	6.3	17785.5	216.5	14.7	0.7	-	
		mean weight (g)	*(2.5)*	*(7.6)*	*(12.5)*	*(21.6)*	*(22.8)*		
	IV	numbers (mill)	636.8	6932.7	3955.8	1159	214.9	-	
		mean weight (g)	*(2.6)*	*(8.9)*	*(17.2)*	*(21.6)*	*(26.6)*		
1979	I	numbers (mill)	-	2270	6422.2	2671	131.2	0.7	
		mean weight (g)		*(2.3)*	*(8.5)*	*(15.9)*	*(20.6)*	*(26.2)*	-->mean weights are averages from '76-'77
	II	numbers (mill)	-	203.6	452	14	1.1	-	Though data was available,
		mean weight (g)		*(2.3)*	*(9.7)*	*(15.1)*	*(22.8)*	*(24.7)*	it was not presented in ICES 1980. Instead, it
	III	numbers (mill)	-	25379.1	388.3	2.1	0	-	was decided to apply the
		mean weight (g)	*(2.5)*	*(7.6)*	*(12.5)*	*(21.6)*	*(22.8)*		average weights from '76-'77 because of "the strange
	IV	numbers (mill)	433	8394.8	1494.6	122.4	34.9	-	distribution of the fishery
		mean weight (g)	*(2.6)*	*(8.9)*	*(17.2)*	*(21.6)*	*(26.6)*		in 1978".

Table 1.9.2 continued

year	quarter		0	1	age 2	3	4	5+	comments
1980	I	numbers (mill)	-	1448	12764	1323	103.7	0.7	
		mean weight (g)	-	*1.8*	*7*	*14.3*	*20.4*	-	
	II	numbers (mill)	-	134	84.5	2.4	0.3	-	
		mean weight (g)	-	*6.5*	*12.7*	-	-	-	
	III	numbers (mill)	15.1	10143.3	811.6	4.7	-	-	
		mean weight (g)	*2.1*	*7.6*	*13.2*	*19*	-	-	
	IV	numbers (mill)	515.7	4518.5	2767.4	111.8	19.5	-	
		mean weight (g)	*3.6*	*10.8*	*17.7*	*23.3*	-	-	
1981	I	numbers (mill)	-	2249.3	5218.6	1056	22.1	1.5	
		mean weight (g)	-	*1*	*7.4*	*15.4*	*(20.6)*	*(26.2)*	-->incomplete weight-data for 4&5 groups: averages
	II	numbers (mill)	23	87	189.2	29.1	-	1.7	were taken from '76-'77.
		mean weight (g)	-	*5.7*	*12*	*19.9*	*(22.8)*	*(24.7)*	
	III	numbers (mill)	192.2	7626.5	140.8	46.1	3	-	
		mean weight (g)	*4.5*	*8.4*	*13.7*	*19.3*	*(22.8)*		
	IV	numbers (mill)	158	2326.8	1448.9	69.9	0.7	0.4	
		mean weight (g)	*3.7*	*10.6*	*17*	*22.3*	*(26.6)*		
1982	I	numbers (mill)	-	1020.7	5877.8	595.1	116.4	5	
		mean weight (g)	-	*3.4*	*8.1*	*16*	*16.9*	*20.7*	
	II	numbers (mill)	-	3.4	31.2	5.5	0.7	-	
		mean weight (g)	-	*6.2*	*7.4*	*14.2*	*27*	-	
	III	numbers (mill)	20.8	4813.2	60.8	2.1	-	-	
		mean weight (g)	*3.7*	*7.2*	*18.7*	*25.5*	-	-	
	IV	numbers (mill)	34.8	2700.7	623.9	10.5	0.6	1.2	
		mean weight (g)	*4.9*	*10.8*	*16.9*	*25.9*	*26*	*30.7*	
1983	I	numbers (mill)	-	357.3	932.9	483	38.1	3	
		mean weight (g)	-	*3.3*	*8.7*	*13.5*	*32*	-	
	II	numbers (mill)	1.7	25.4	56.1	5.3	-	-	
		mean weight (g)	-	*6.8*	*13.8*	*21*	-	-	
	III	numbers (mill)	10.3	2656.4	341.1	27	-	-	
		mean weight (g)	*2.6*	*7*	*13.2*	*14.5*	-	-	
	IV	numbers (mill)	130.7	2016.6	761.4	46.7	0.1	-	
		mean weight (g)	*3.9*	*12.4*	*18.5*	*25.4*	*19*	-	

Table 1.9.2 continued

year	quarter		age 0	1	2	3	4	5+	comments
1984	I	numbers (mill)	-	134.1	580.5	206.8	34.8	0.3	
		mean weight (g)	-	*2.6*	*9.3*	*12.9*	*15.4*	*21.4*	
	II	numbers (mill)	-	22.4	4.9	3	-	-	
		mean weight (g)	-	*3.8*	*9.1*	*16.1*	-	-	
	III	numbers (mill)	-	4094.5	341.3	36.6	3	-	
		mean weight (g)	(3.1)	(7.1)	(16.0)	(20.0)	(25.0)		-->average 82-83
	IV	numbers (mill)	91.4	2204.2	151.8	64.4	5	-	
		mean weight (g)	*3.4*	*12.9*	*21.1*	*25.5*	*22*	*21.4*	
1985	I	numbers (mill)		(230.0)	(711.8)	(72.3)	(1.5)	(0.3)	-->numbers constructed from average age in DK-catches '81-'83
		mean weight (g)							
	II	numbers (mill)		(41.7)	(37.8)	(4.2)	(0.2)	(0.1)	
		mean weight (g)							
	III	numbers (mill)	(3.3)	(410.1)	(60.2)	(3.0)	(0.1)		
		mean weight (g)							
	IV	numbers (mill)	(230.4)	(1680.4)	(729.0)	(55.7)	(3.4)	(0.8)	
		mean weight (g)							
1986	I	numbers (mill)							
		mean weight (g)							
	II	numbers (mill)							
		mean weight (g)							
	III	numbers (mill)							
		mean weight (g)							
	IV	numbers (mill)							
		mean weight (g)							
1987	I	numbers (mill)	-	1	37.2	12.1	0.8	-	
		mean weight (g)							
	II	numbers (mill)	-	-	-	-	-	-	
		mean weight (g)							
	III	numbers (mill)	-	555.1	85.2	1	-	-	
		mean weight (g)							
	IV	numbers (mill)	28.8	1546	320	8.4	-	-	
		mean weight (g)							

Table 1.9.2 continued

year	quarter		age 0	1	2	3	4	5+	comments
1988	I	numbers (mill)	-	7.8	57.3	8	1.7	0.1	
		mean weight (g)							
	II	numbers (mill)	-	1.1	101.5	5.2	-	-	
		mean weight (g)							
	III	numbers (mill)	-	471.8	4741	58.4	3.9	-	
		mean weight (g)							
	IV	numbers (mill)	1	48.6	474.3	8.6	-	-	
		mean weight (g)							
1989	I	numbers (mill)	-	562.4	897.2	53			
		mean weight (g)	-	*6.9*	*13.9*	*23.5*	-->3+ group		
	II	numbers (mill)	-	12.1	19.4	5.2			
		mean weight (g)	-	*6.9*	*13.9*	*23.5*	-->3+ group		
	III	numbers (mill)	60	2026.7	2120.3	273.8			
		mean weight (g)	*1.6*	*8.5*	*10.7*	*15.1*	-->3+ group		
	IV	numbers (mill)	1.6	57.2	54.5	7.4			
		mean weight (g)	*1.6*	*8.5*	*10.7*	*15.1*	-->3+ group		
1990	I	numbers (mill)	-	538	225.9	28.3	2.1	0.1	
		mean weight (g)	-	*4.2*	*10.8*	*15.6*	-->3+ group		
	II	numbers (mill)							
		mean weight (g)							
	III	numbers (mill)*	-	878	1165.8	-	-	-	*data only from
		mean weight (g)*	-	*16.5*	*18.7*	-	-->3+ group		DK in div. IVb
	IV	numbers (mill)							
		mean weight (g)							
1991	I	numbers (mill)	-	47	51.2	18	1	0.6	
		mean weight (g)	-	*4.2*	*12.6*	*15*	-->3+ group		
	II	numbers (mill)	-	0.5	3.4	0.9	1	-	
		mean weight (g)							
	III	numbers (mill)*	9.7	664.8	1086.3	328	79.1	-	*data only from
		mean weight (g)*	*4*	*13*	*15.8*	*18.7*	-->3+ group		DK in div. IVb
	IV	numbers (mill)	296.1	1941	281.4	36	4.6	-	
		mean weight (g)	*4*	*14.2*	*18.8*	*19.7*	-->3+ group		

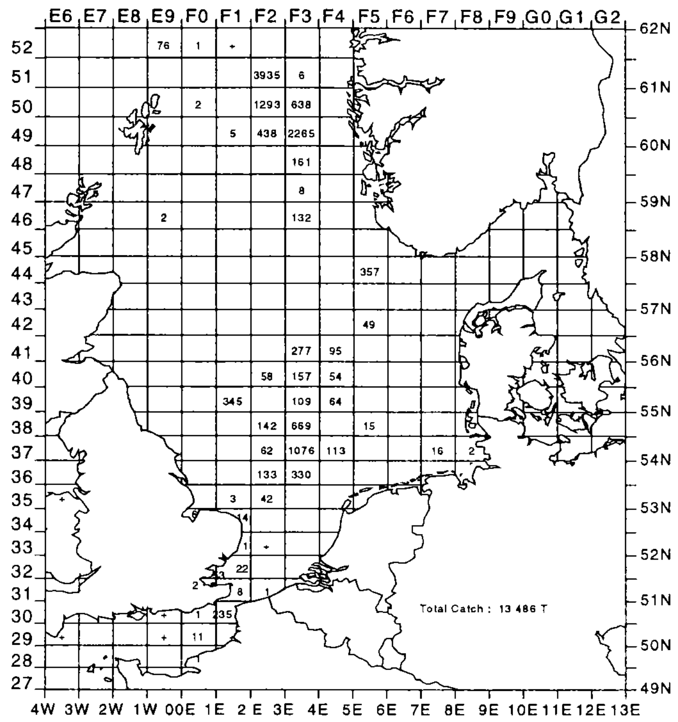


Figure 1.9.1 : Herring North Sea catches (in tonnes) , January 1998

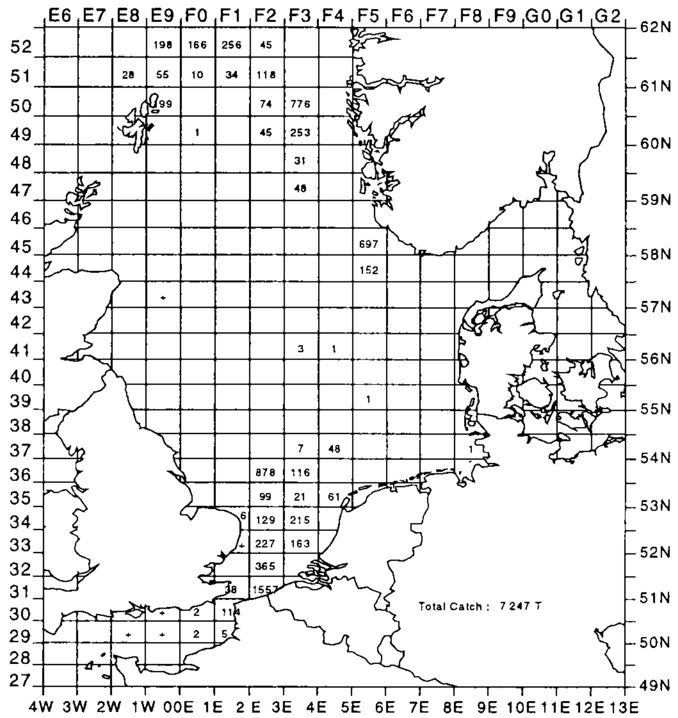


Figure 1.9.2 : Herring North Sea catches (in tonnes) , February 1998

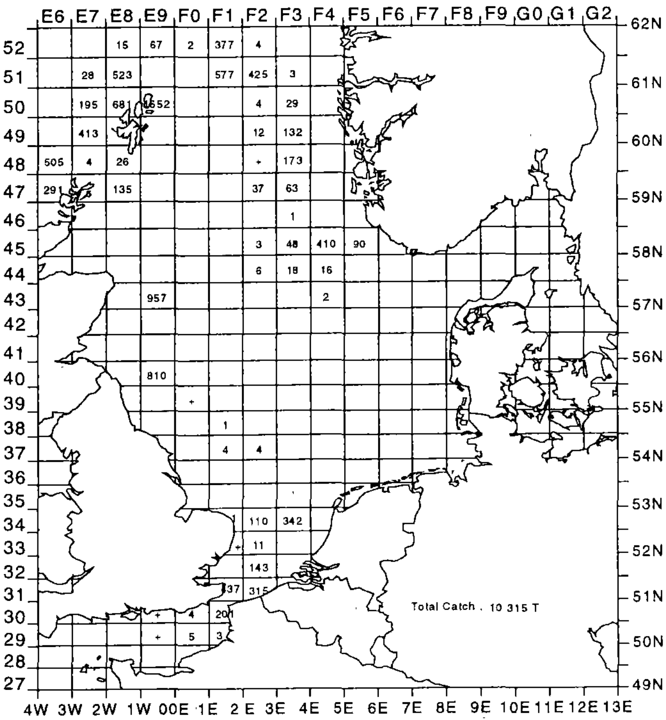


Figure 1.9.3 : Herring North Sea catches (in tonnes) , March 1998

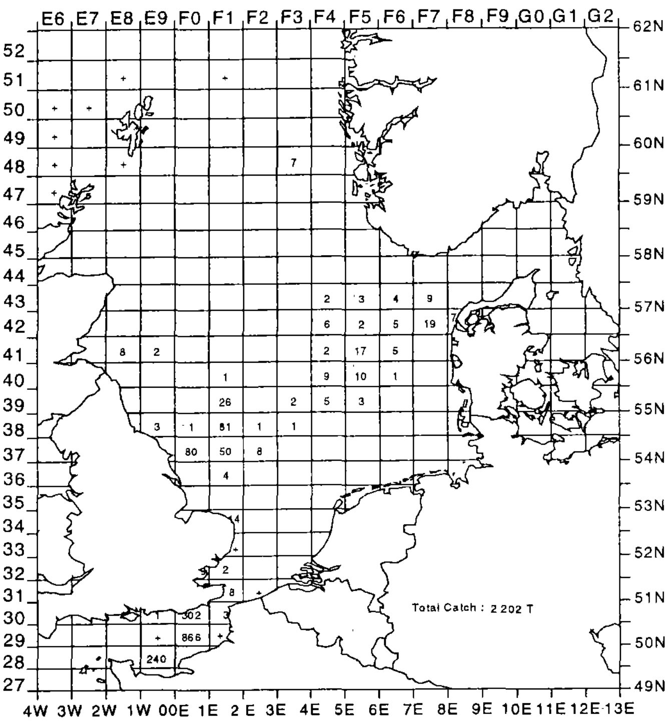


Figure 1.9.4 : Herring North Sea catches (in tonnes) , April 1998

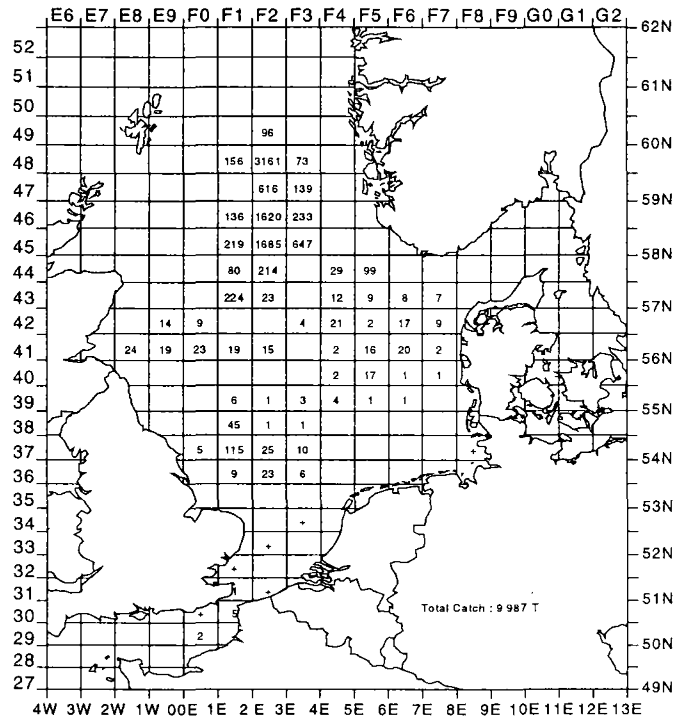


Figure 1.9.5: Herring North Sea catches (in tonnes) , May 1998

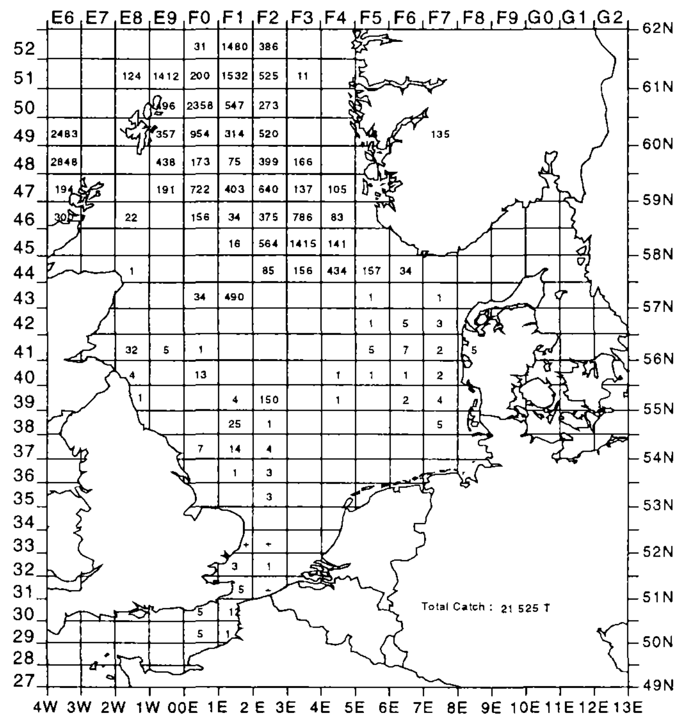


Figure 1.9.6: Herring North Sea catches (in tonnes) , June 1998

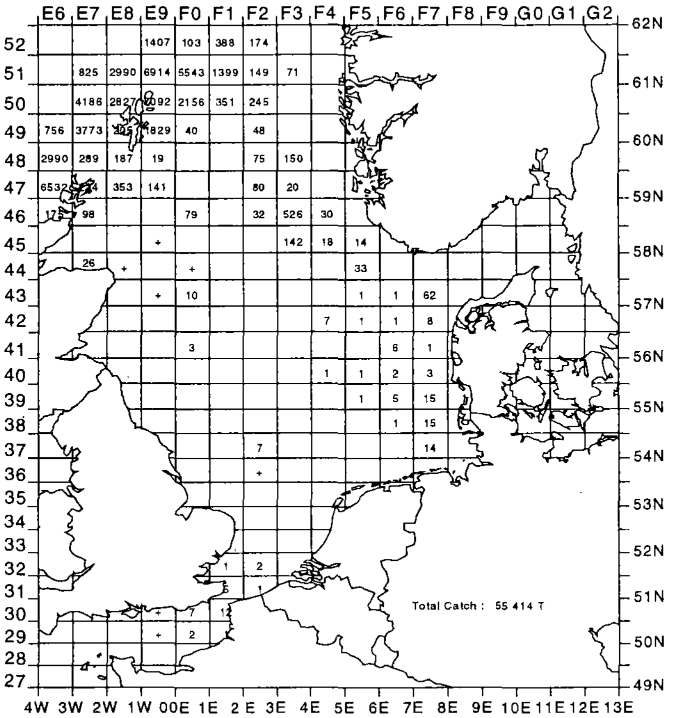


Figure 1.9.7: Herring North Sea catches (in tonnes) , July 1998

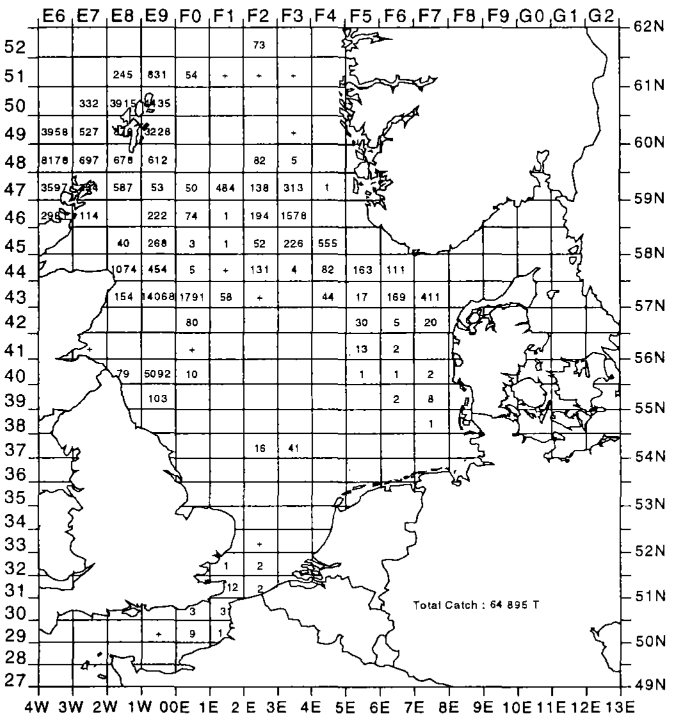


Figure 1.9.8: Herring North Sea catches (in tonnes) , August 1998

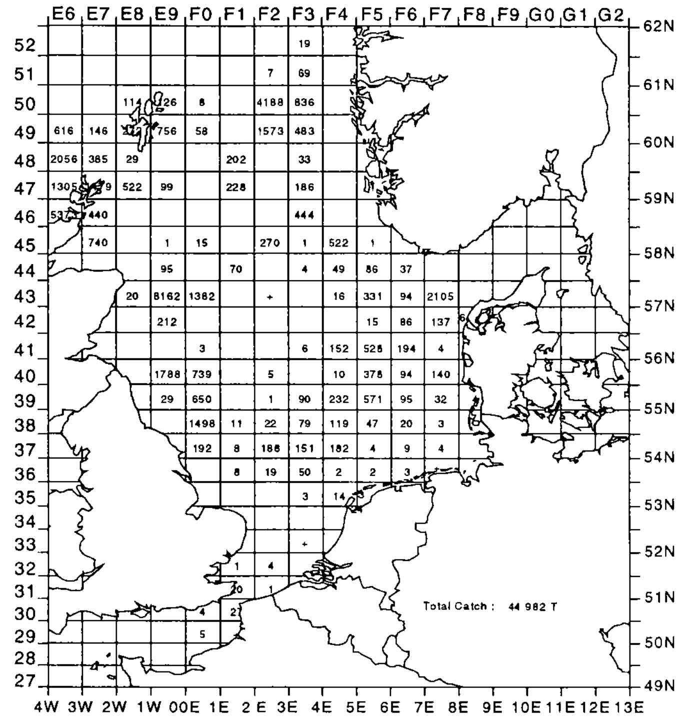


Figure 1.9.9 : Herring North Sea catches (in tonnes) , September 1998

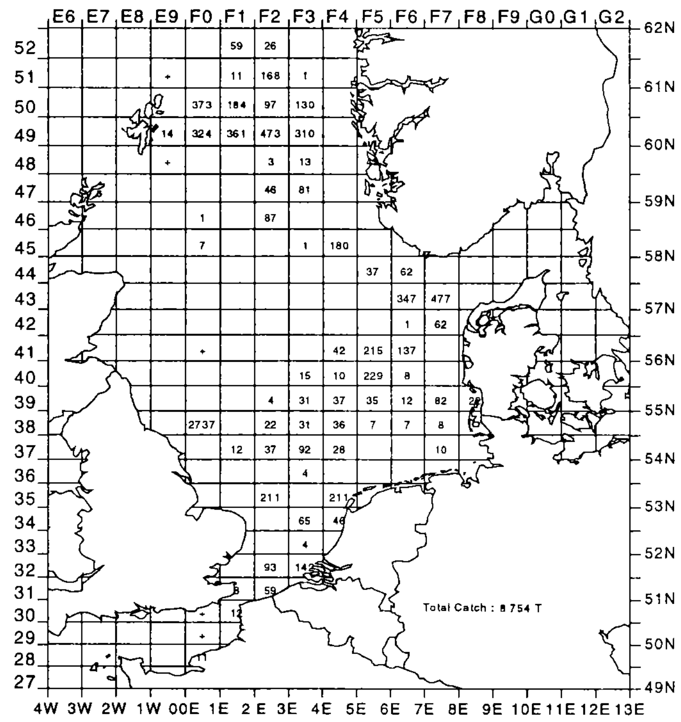


Figure 1.9.10 : Herring North Sea catches (in tonnes) , October 1998

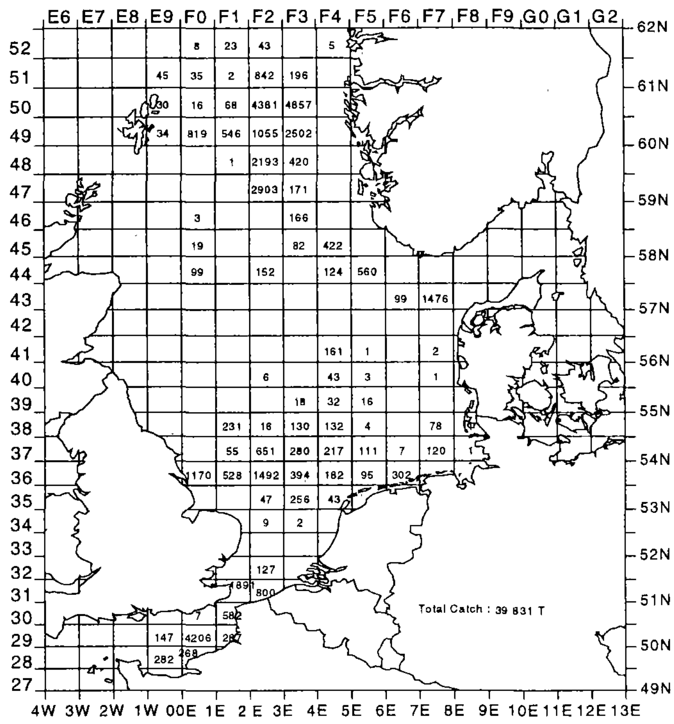


Figure 1.9.11 : Herring North Sea catches (in tonnes) , November 1998

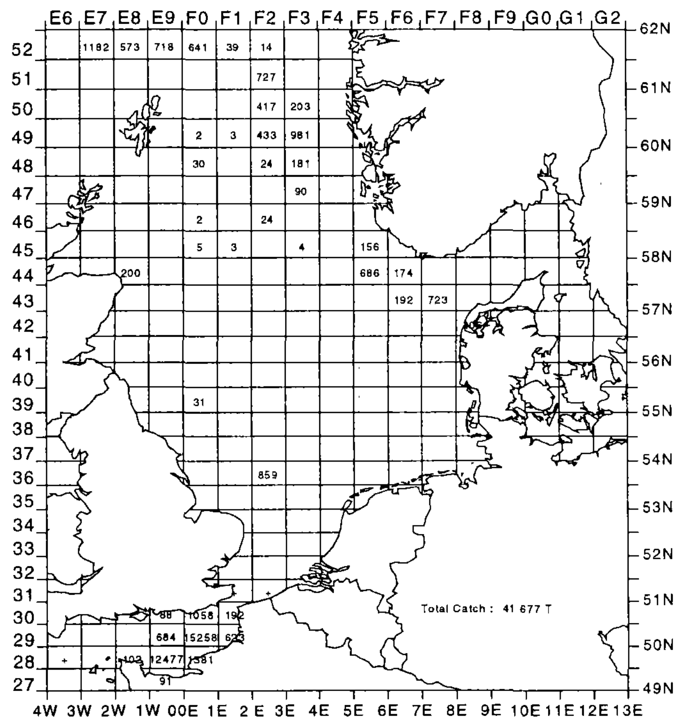


Figure 1.9.12 : Herring North Sea catches (in tonnes) , December 1998

2 NORTH SEA HERRING

2.1 The Fishery

2.1.1 ACFM advice and management applicable to 1998 and 1999

In 1996, the fishing mortality was halved for the adult part of the stock and reduced by 75% for the juveniles. In 1997, the fishing mortality on the adult stock was reduced to 0.25 and for juveniles to less than 0.1 to aim of rebuilding the SSB up to 1.1 million t in 1998.

According to the EU and Norway agreement (December 1997), efforts will be made to maintain the SSB above the MBAL (Minimum Biologically Acceptable Level) of 800 000 t. 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.

ACFM recommended for 1999 that the management for 1998 should be continued to ensure the rebuilding of the spawning stock biomass. The measures consist of adoption of a F_{2-6} of 0.2 and a $F_{0-1} < 0.1$ until the spawning biomass is rebuilt to a precautionary level of 1.3 million tonnes. And it was noted that continued fishing at *status quo* leads to increase in SSB to 1 471 000 t in 1999.

The final TAC's adopted by the management bodies for 1999 were 290,000 t for Divisions IV and VIId. The by catch ceiling for fleet B in the North Sea was 30,000 t.

2.1.2 Catches in 1998

Total landings 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. Misreporting landings from VIa North and unallocated landings (from IIa, VIIb,c,j,h) are given separately.

The total catch in 1998 of 329 000 t is higher than the catch in the two last years. In the Division IVa West (Table. 2.1.2), the catch of 140 000 t is more than twice the catch of 1997 (60,524 t). The 32 000 t of 80 000 t increased landings in 1998 from Division IVa West is due to misreporting of catches taken in the North Sea but reported as have been taken in Division VIa North.

Landings of herring taken as by-catch in the Danish small meshed fishery has again in 1998 been much lower than the by-catch ceiling set for Denmark. The Danish sprat fishery was closed in mid February, as the by-catches of herring was too high, and first reopened in August. Though, for smaller vessels it was allowed to land up to 50 t sprat per week. By-catches of herring in these smaller vessels sprat fishery were negligible.

TACs for Sub-area IV and Division VIId have been exceeded by a significant amount for several years. This excess of the catches over the TACs for the years 1993 to 1998 is shown in the text table below, where estimates of misreporting are include in the Working Group Landings. It should be noted that prior to 1996 the TAC applies only to the human consumption fishery in Sub-area IV and Division VIId. The TAC for 1996 to 1998 the by-catch for herring to be taken in the small mesh-fishery is included in the text table below.

Year	1993	1994	1995	1996	1997	1998
TAC ('000 t)	430	440	440	200[(1)]	183[(1)]	276[(1)]
Official landings ('000 t)	409	414	415	136	155	265
Working Group catch ('000 t)	521	465	534	263	209 [(2)]	328
Excess of landings over TAC ('000 t)	91	25	94	63	26	52

[(1)] including by-catch ceiling
[(2)] Misreporting of catches from Division VIa North is not included.

2.2 Biological Composition of the catch

2.2.1 Catch in numbers at age

Quarterly and annual catches in numbers and mean weights at age were compiled for Division IVa (East and West), IVb, VIId/IVc and for the total North Sea. Table 2.2.1 provides a breakdown of the numbers caught by age group for each Division on a quarterly and annual basis for 1998. North Sea catches in numbers at age over the years 1990–1998 are given in Table 2.2.2 and are shown in Figure 2.2.1. The total number of herring taken in the North Sea in 1998 (2.6 billion) is higher than the number taken in 1997 (less than 2 billion), but lower than the number caught in previous years. The catch of 0-ringers has reduced considerably and it is the lowest since 1977. The catches of the 1-ringer have increased slightly, but the catch for the 2-ringers was twice as high as in 1997.

The catches in numbers of Division IIIa-Western Baltic spring spawners caught in the North Sea in 1990–1998 and transferred to the Division IIIa-Western Baltic stock are presented in Table 2.2.3. In 1998, the numbers of all year classes were higher than the two last year. This increase is due to higher landings from the transfer area compared to 1997.

The estimated numbers of North Sea autumn spawners caught in Division IIIa in 1990–1998 and transferred to the North Sea assessment are given in Table 2.2.4.

Table 2.2.5 summarises the total catch in numbers at age of North Sea autumn spawners used in the assessment.

Table 2.2.6 summarises the total catch in tonnes of North Sea autumn spawners. After the splitting of the IIIa autumn spawners and the North Sea spring spawners, the amount of the total catch used for the assessment was 380,178 tonnes.

The percentage age composition of herring caught in the North Sea and VIId, as 2-ringers, 3-ringers and older, in 1998 is presented for each Division in Table 2.2.7. The percentage of 2-ringers is 50% of the total catch and higher than the 3-ringers in all the Divisions.

The SOP (in tonnes) by age and Division for each quarter is given in Table 2.2.8.

Landings in numbers and mean weight by fleet required for short term prediction are shown in Table 2.2.10. As the WG has changed the fleet definitions the data for 1997 is shown in Table 2.2.9.

2.2.2 Quality of catch and biological data

It was again in 1998 possible to get reliable information on misreportings from several countries fishing for herring in the North Sea and adjacent areas. An estimate of 32 446 t from VIa North and an unallocated landings from IIa, VIIb,c,j,h of 27,722 were transferred into the North sea and were used in the assessment. It should be noted that these landings from IIa, VIIb,c,j,h are more important than these unallocated landings from these areas estimated in 1997.

Only the Netherlands provided estimates of discards, but discards are known to occur in the fisheries of most countries and they could represent a significant amount, which is not included in the assessment. There is still a need to improve the quality of the landing data in the North Sea, in relation with discards.

As a general rule, sampling of commercial landings for age, length and weight was at the same level as last year (Table 2.2.11). It was low in some fisheries and in others no samples were taken in some quarters, especially in the second and third quarter in the Southern North Sea (Divisions IVc and VIId). This introduces uncertainties in the biological composition of the catches, which affects the quality of the assessment. But, it should be noted that this year, efforts were made to enhance procedures in data exchanges, and an EU study project will start in April 1999 where five institutes will participate, to evaluate the adequacy of the international market sampling effort for some commercial species (including herring) and to develop procedures for consistent data storage and retrieval (EMAS project).

2.2.3 Treatment of the spring spawners herring in the North Sea

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

Western Baltic and Division IIIa spring spawners 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 2.2.3 specifies the estimated catch number at age of Division IIIa/Western Baltic spring spawners which are transferred from the North Sea assessment to the assessment of the Division IIIa/Western Baltic in 1998.

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

To calculate the proportion of spring spawners caught in the transfer area, two samples that have been taken in May and four in June 1998 were used for the second quarter. For the third quarter, nine samples taken in July were used (Figure 2.2.2).

The resulting proportion of spring spawners and the quarterly catches of these in the transfer area in 1998 are as follows:

Quarter	2 - ring (%)	3 - ring (%)	4 + ring (%)	No of rectangles sampled	Catch in the transfer area (t)	Catch of Spring Spawners in the North Sea (t)
Q.2	31	42	57	6	4 270	1 756
Q.3	29	74	100	9	7 877	6 077

The quarterly age distributions in Sub-division IVa East were 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.

2.2.4 Catch at age for North Sea herring 1997

From 1983 to 1996 there were unallocated catches added to the North Sea (Table 2.1.1). In 1997 the amount of unallocated catch was reduced because it was believed that the area misreporting had been reduced due to changes in the licensing regulations ICES (1998a). In 1998, the amount of area misreporting is again believed to be at similar levels to 1996 (Table 2.1.1). However, there is no new information concerning 1997. It is however possible that some area misreporting did occur in 1997 and in order to investigate the effect of this an assessment was carried out with catches modified to include area misreporting derived in the manner consistent with 1996 and 1998. An additional 25,126 tonnes was added to the total catch, increasing the catch from 248,000 to 273,000 tonnes. The catch at age and the mean weights at age were recalculated adding in the increases in catch by age. The values used for the calculation were taken from the sample data for the fleet and area where the misreported herring were thought to have been caught. The revised catch at age, mean weights and biomass are given in Table 2.2.12.

2.3 Recruitment

2.3.1 The IBTS index of 1-ringer recruitment

The 1-ringer index of recruitment is based on the IBTS, 1st quarter (trawl catches at daytime February 1999). The index is calculated for the entire survey area, weighting statistical rectangles as described in the WG report of 1995 (ICES 1995).

The indices based on surveys from the period 1979 to 1999 (estimates of the strength of year classes 1977 to 1997) are given in Table 2.3.1. and the temporal trend in indices is illustrated in Figure 2.3.1. This years estimate of the 1997 year class is very low, it is about a third of last year's estimate and the lowest observed since 1979.

Figure 2.3.2 illustrates the spatial distribution of 1-ringers as estimated by the trawling in February. In 1999 the 1-ringers were predominantly distributed in the south-eastern North Sea, very few were found in the south-western areas where concentrations have been observed in preceding years.

2.3.2 The MIK index of 0-ringer recruitment

The 0-ringer index is based on catches by a fine-meshed ring net (the MIK) at night-time during the February survey of the IBTS. Index values are calculated as described in the WG report of 1996 (ICES 1996a). The index estimate of the abundance of 0-ringers in 1999, the 1998 year class, is estimated to 244.0 (Table 2.3.2).

This estimate of the 1998 year class indicates a large increase in recruitment compared to the poor 1997 year class. While the 1997 year class was estimated as one of the lowest on record, the 1998 year class estimate reach a magnitude comparable to the good year classes in the mid-eighties. The spatial distribution of the 0-ringers follows the trend of a north-westerly displacement which has been observed during the last years (Figure 2.3.3). This year the major concentrations of 0-ringers extend from the east coast of Scotland towards the Skagerrak.

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

The relationship between the two indices is illustrated in Figure 2.3.4 and described by the inserted linear regression line. The comparison between the indices for the 1997 year class reveals a relation that is in accordance with the long-term trend. Both indices indicate a poor 1997 year class.

2.3.4 Trends in recruitment as estimated by the assessment

The long-term trend in recruitment of 1-ringers to the stock of North Sea autumn spawners is illustrated by Figure 2.3.5. Recruitment estimates are based on the present 1999 ICA assessment. The figure illustrates the decline during the sixties and the seventies, followed by the marked increase in the early eighties. From the high year class 1985 a new decline was observed, while recruitment of 1-ringers during the last six years has fluctuated around a level, without obvious trends of increase or decrease.

The last three ICA estimates of 1-ringer recruitment are 17.0, 18.4 and 7.52 billions for year classes 1995 to 1997 respectively, while the estimates for 0-ringers are 50.9, 20.8 and 95.3 for year classes 1996 to 1998 respectively.

2.4 Combined acoustic surveys of IVa & b, VIaN and IIIa

Survey Methods

Six surveys were carried out during late June and July covering most of the continental shelf north of 54°N in the North Sea and Ireland 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 coasts, and to the west by the Shelf edge between 200 and 400 m depth. The surveys are reported individually, and a combined report has been prepared from the data from all surveys Simmonds *et al* (1999 WD).

The Vessels, dates and areas covered by the coordinated Acoustic Surveys:

Kings Cross	10–28 July 1998	North of 56° N west of 4°W
Dana	26 June – 17 July 1998	North of 57° east of 5°E
GO Sars	27 June - 18 July 1998	North of 57° 1°E to 8°E
Scotia	10 - 27 July 1998	North of 58° 30' between 4° 30'W and 2°E
Tridens	22 June –17 July 1998	South of 59°N west of 2°E
W Herwig	23 June - 13 July 1998	South of 57°N east of 2°E

The surveys are line transect surveys with abundances derived from acoustic observations, opportunistic fishing provides identification of the schools and data on the age structure of the herring. The combined survey results provide spatial distributions of herring abundance by number and biomass at age by statistical rectangle. The survey areas for each vessel are given in Figure 2.4.1. The results for the six surveys have been combined. Procedures and TS values are the same as for the 1997 surveys (Simmonds *et al.* 1998). Stock estimates have been calculated by age and maturity stage by ICES statistical rectangle for the whole survey area. Where the survey areas for individual vessels overlap, the effort weighted mean estimates by age and maturity stage for each overlapping rectangle have been used. The split between autumn spawning herring and spring spawning herring is calculated using otolith microstructure for the survey by RV Dana and by regression analysis of vertebral counts for G.O. Sars.

Results

The combined data gives estimates of immature and mature (spawning) herring for ICES areas VIa_{north}, IVa, and IVb separately and parts of IIIa. The data from all areas have been split between autumn spawners, in the North Sea and West of Scotland, and spring spawning Baltic stocks. The total SSB of autumn spawning herring from the North Sea was 1,831,000 tonnes and for IVa_{north} 376,000 tonnes. The SSB for Baltic spring spawners was 162,000 tonnes. Stock estimates by number and biomass are shown in Tables 2.4.1 and 2.4.2 respectively for areas VIa_{north}, IVa and IVb separately; mean weights at age are shown in Table 2.4.3. Stock estimates for Baltic herring by number and biomass are shown in Tables 2.4.4 and 2.4.5 respectively for ICES areas IIIa, IVa and IVb; mean weights at age for Baltic herring are shown in Table 2.4.6. The results of the surveys, (numbers, biomass, mean weight and maturity at age) are summarised by stock in Table 2.4.7 Figure 2.4.2 shows the distribution of abundance (numbers and biomass) of mature autumn spawning herring for all areas surveyed. Figure 2.4.3 shows the distribution split by age of 1 ring, 2 ring and 3 ring and older herring. Estimates of '0' group have been omitted in all plots. Figure 2.4.4 shows the density distribution of numbers of adult autumn spawning herring as a contour plot and Figure 2.4.4 shows the distribution for all 1 ring and older.

The numbers of fish infected with Ichthyophonus have increased in the RV Scotia survey from 5 in 1997, to 30 in 1998, although no Ichthyophonus were reported in any of the other surveys. The split by age is shown in Table 2.4.8.

The numbers of North Sea autumn spawning herring estimated from the acoustic survey are shown as a time series in Table 2.4.9. The table also shows the estimated total mortality calculated from 2+ to 3+ age classes from the time series.

2.5 Larvae surveys

Internationally co-ordinated herring larvae surveys have been conducted in the North Sea and adjacent waters since 1972. In last years only The Netherlands and Germany continued to participate in this program. Five cruises covering seven survey units were carried out in the 1998/99 period. The data administration and analysis were compiled by IfM Kiel and BFA Hamburg/Rostock.

The updated estimates for the larvae abundance index (LAI) in length class less than 10 mm is given in Table 2.5.1. Compared to 1997, an increase in abundance is observed in the Orkney/Shetland and Buchan areas. In the Southern North Sea (SNS) the abundance is near the average level; in the first sampling period the abundance appears to be much lower compared to 1997, but this is due to an exceptionally high value in the previous year depending on one single haul, in which more than 33,000 larvae were caught.

The LAI values presented last year had to be corrected and were reduced by this correction due to the fact that the numbers of larvae measured and reported as length frequencies to the data base had already been raised to the numbers caught. They were, nevertheless, taken as numbers measured and the raising factor (caught/measured) was applied for a second time in the standard LAI calculation procedure. This error was introduced by an undocumented inconsistency in the data base, which originally included numbers of larvae measured for length frequencies. In later years length frequencies, still reported as numbers measured, had already been raised to numbers caught and the raising factor in the LAI calculation procedure had correspondingly been set to one. This inconsistency in the data base has now been documented.

The parameter values of the multiplicative model (MLAI calculation) are given in Table 2.5.2, including year effects and standard errors. The year effects and several transformations are given in Table 2.5.3. Three different MLAI series are presented in Figure 2.5.1. The G99 series represent this year's estimates, which are compared to those used in the 1996 and 1998 assessment (P96, Ass98). Comparable trends are evident for all three series, indicating a recovery in stock size since 1994.

Differences between the MLAI values previously reported and the revised calculations have been resolved and were reported and described to the Planning Group for Herring Surveys. The refined calculation procedure produces abundance estimates per station showing no discrepancies compared to historical estimates given in the data base. Remaining differences in the LAI values aggregated for sampling units are due to the different methods used for missing station corrections, which have not been sufficiently documented for an exact recalculation. At present, no correction is made for any missing value. Refined and historical MLAI values compare, nevertheless, very well, with less that 3% unexplained variance in the regression for the two data series.

The problems related to incomplete coverage of sampling units and to single exceptionally high abundance values are considered in the refined MLAI calculation procedure by including a weighting process. LAI values for individual sampling units are given weights proportional to the degree of station coverage and to the inverse coefficient of variance of abundance values within sampling units (Rohlf *et al.* 1998, Gröger *et al.* 1999).

2.6 International Bottom Trawl Survey (IBTS)

The International Bottom Trawl Survey (IBTS) started out as a young herring fish survey in 1966 with the objective of obtaining annual recruitment indices for the combined North Sea herring stocks. It has been carried out every year since and it was realised that the survey could provide recruitment indices not only for herring, but for roundfish species as well. Later, when catch data from the survey were examined in detail it also turned out that the data from the first quarter also gave an indication of the status of the adult herring. It is the time series from the first quarter and from 1983 onwards, after fishing gear and survey practices were standardised, which has shown the most consistent results and which has therefore been used in the assessments of the herring. Table 2.6.1 and Figure 2.6.1 shows the time series of the abundance at age obtained from the first quarter coverage of the IBTS. The numbers at age 2 and above show some correlation so the series is used as two age disaggregated indices, 1 ring, discussed in Section 2.3 recruitment and 2–5+ ring, presented here. The data shown in Table 2.6.1 has been updated from the data presented in previous years reports, for these years some preliminary values for the IBTS have been included in the assessment and have not been updated. The values here are correct for the years 1996–1998. It has not been possible to check all years, this will be done before the WG in 2000. The IBTS data series is available for years 1971 to 1999, the years used in the 2–5+ series are from 1983 to 1999 inclusive which is consistent with earlier assessments. Standardisation of fishing gear among participating vessels was implemented in 1983 but there were some adjustments following flume tank measurements and standardisation was completed by 1985, the data should be evaluated to indicate which years are the most appropriate.

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

2.7.1 Mean weights at age

The mean weights at age of fish in the catches in 1998 (weighted by the numbers caught) are presented by ICES division and by quarter in Table 2.7.1. Table 2.7.2 shows a comparison of mean weights at age, 2-ringers and older by ICES division over the years 1990 to 1998.

For the whole North Sea the mean weight in the catch is very close to the mean of the last 9 years, 3 g above the mean. For Division IVa the mean weight of the younger fish are above the mean and the older fish below. For Divisions IVb, the mean weight at all ages are scattered on either side of the 9 year mean. For IVc and VIId the weights are close to the maximum for the last nine years.

Table 2.7.3 presents the mean weights at age in the catch during the 3rd quarter in Divisions IVa and IVb for 1987 to 1997. In this quarter most fish are approaching their peak weights just prior to spawning. For comparison the mean weights in the stock from the last six years of summer acoustic surveys are shown in the same table. (From Table 2.4.3 for the 1998 values). The mean weights at age in the catch are about 8 g per fish above the mean. The mean weights at age in the population are higher than the seven year mean by about 10 g per fish. However, the 2 ring herring are at a seven year low level and the older age classes are close to a 8 year high.

The year effect in the mean weight at age in the observed values in the population is considerable and the issue of the correct values to be used in the assessment was addressed in detail in 1996 (ICES 1996/Assess:10). The cause of the year effect is likely to be the result of variability in the estimates of abundance in different parts of the survey area, coupled with the spatial variability in mean weight at age. This is most likely due to sampling variability in estimating local abundance in the acoustic survey, as this local abundance is required to weight the mean weights at age from differing parts of the area. To reduce the impact of this sampling variability in the assessment a 3 year running mean was chosen in 1996 to give the weight at age for the assessment and the same method has been used this year to smooth the year effect in mean weight at age.

2.7.2 Maturity Ogive

The percentage of North Sea autumn spawning herring (at age) that spawned in 1998 was estimated from the acoustic survey. This was determined from samples of herring from the research vessel catches examined for maturity stage, and raised by the local abundance. All herring at maturity stage between 3 and 6 inclusive in June or July were assumed to spawn in the autumn. The method and justification for the use of values derived from a single years data was described fully in ICES (1996/Assess:10). The maturity in 1998 was within the normal range of values (over the last 10 years). The proportion of herring found to be mature were almost equal to the average for both 2 and 3 ring. The percentages are given in Table 2.7.4.

2.8 Stock assessment

2.8.1 Data exploration and preliminary modelling

Assessment of the stock was carried out by fitting an integrated catch-at-age model including a separable constraint over a seven-year period (Patterson and Melvin 1996; Deriso *et al.* 1985; Gudmundsson, 1986).

Survey indices available

The information available was the MIK index of 0-ringer abundance (Section 2.3), the acoustic survey index (Section 2.4) and the IBTS survey index (Sections 2.3 and 2.6). In addition, larvae survey information including the multiplicative larvae abundance index (MLAI) up to 1998 was available at this year's meeting. The problems with the calculation of this index have been solved and are outlined in Section 2.5.

Catch-at-age matrix

The catches in number at age (Section 2.2) were available for the period 1947–1998. The year range of 1960 to 1998 has been chosen for the assessment thereby excluding the years 1947 to 1959 on account of the large discrepancies in the sum of products in those earlier years.

In 1997 a large proportion of the catches taken between 4°W and 5°W in Division VIa were not transferred to the North Sea, following management measures taken in that year (see Sections 2.2.3 and 2.2.4). Table 2.2.12 lists the catch in numbers at age and weights at age in the catch for 1997 for the North Sea herring for both the situation where these catches are included or excluded from the North Sea herring. The effect of including this reallocated catch was tested using an extra run of the ICA with the same conditions as the final assessment. The implications are discussed in Section 2.12.

Choice of period of separable constraint

At last year's meeting, however, due to the changes in the management regime for North Sea herring in 1996, the hypothesis of constant selection was thought to be inappropriate. Therefore the separable model was fitted using two separate selection periods: one from 1992 to 1995 and the other from 1996 to 1997. Furthermore the selection on adults (3–9+) was forced to be equal over the two separable periods, which effectively means that only for juveniles (0–2) two selection periods were estimated.

At this years meeting the hypothesis of constant selection was again thought to be inappropriate due to the changes in the management regime for North Sea herring in 1996. Therefore the separable model was again fitted using two separate selection periods. Also the selection on adults (3–9+) was forced to be equal over the two separable periods, which effectively means again that only for juveniles (0–2) two selection periods were estimated. The preliminary modelling started with two separate selection periods from 1992 to 1995 and the other from 1996 to 1998 similar to last year's assessment by extending the second period with one year. Since the management measures in 1996 became effective only in the middle of the year, it caused a relative high catch of 1-ringers compared to 0-ringers, which would only be caught in the second half of the year. Therefore, two different separate selection periods from 1992 to 1996 and from 1997 to 1998 were also tested, because the selection patterns in 1997 and 1998 were assumed to be more comparable.

Comparable run of XSA

Last year, ICA was fitted with an assumption of two selection patterns, one applying to 1997 and 1996, the other applying to the 4 years prior to 1996. Because of similar potential difficulties in fitting ICA this year, and because ACFM requested it, the WG also explored the use of XSA in the assessment of the North Sea stock.

XSA Inputs and settings

The input data (landings, catch numbers, catch weights, stock weights, maturity and mortality at age, and proportions of M and F before spawning) to XSA was identical to the ICA input data (Table 2.8.3), but the tuning data differed slightly. First, the MLAI index, which is a biomass index, could not be used in XSA. Second, plus groups of all indices, i.e., the IBTS 5+ and the Acoustic survey 9+ indices, had to be removed, since XSA does not use plus-group indices in tuning.

So, the tuning indices used were:

Fleet	First year	Last year	First age	Last age	Alpha	Beta
ACO89: acoustic survey,	1989	1998	2	8	0.540	0.560
IBTSA: 2–4,	1983	1998	2	4	0.080	0.170
IBTSY: 1-wr,	1979	1998	1	1	0.080	0.170
MIK: MIK 0-wr,	1977	1998	0	0	0.080	0.170

The Alpha and Beta parameters indicate the timing of the survey relative to 1 January.

A summary of the settings used with the data is given below:

Time series weights:
Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis:
Catchability independent of stock size for all ages
Catchability independent of age for ages > = 6

Terminal population estimation:
Final estimates not shrunk towards mean F

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

Tuning converged after 32 iterations

XSA Diagnostics

Residual plots by age and fleet showed some patterns for the acoustic survey, but overall residuals were small (absolute values < 0.5). The IBTS 2–4 series fitted quite poorly with large residuals and patterns. Apart from a short run of negative residuals at the start of the series, the IBTS 1-ringer index fitted reasonably well (small residuals). The MIK-0 series is more noisy, but residuals were reasonable.

In terms of estimates of survivors, the acoustic survey tends to get most weight, particularly for older age classes. This is because XSA uses inverse variance weighting when combining results from the different indices.

XSA Results

In general terms results were not very different from results of ICA runs (see Section 2.8.2). There were, however, two noticeable differences. First, the inverse variance weighting means that estimates of stock size, and hence SSB, are closer to values indicated by the acoustic survey than the IBTS. This means that estimated SSB in 1998 (1051 thousand t) is a little higher than estimates from ICA.

Second, the fishing mortality at age in the period 1994 to 1998 shows that although there has been a change in the selection pattern, it did not happen suddenly, and 1996 can be considered a 'transition' year. Figure 2.8.1 shows relative F's at age for 0–3 ringers, scaled to the F at age 3 in the relevant year (hence a series of 1's for 3-ringers). The 1996 relative F on 0-ringers has clearly declined, but the 1-ringer relative F has actually increased.

In the light of this contribution of the different age groups in the catch-at-age matrix was reviewed. Proportions of catch at age are shown in Figure 2.2.1. This indicates that the starting year of the separable period should be chosen as 1992. Figure 2.8.1 indicates that the greatest changes in selection pattern for 0-ringers occurred in 1996, but for 1-ringers it occurred in 1997. However, the greatest changes in selection pattern occur from 1996 to 1997 for 0- and 1-wr. Therefore the following two periods of separable constraint were used in ICA: 1992–1996 and 1997–1998.

Data exploration by abundance index

The Working Group attempted to evaluate the consistency of the different sources of information. In a number of exploratory analyses, the model was fitted to the catch at age matrix and to each survey index separately. The maximum likelihood estimates of terminal fishing mortality at reference age 4 and the 95% confidence intervals for each model fit are plotted in Figure 2.8.2 and are compared to those of last years Working Group.

The multiplicative larvae abundance index (MLAI) index for larvae smaller than 10 mm was tested using the year range of 1979 to 1998 and assuming a power relationship of index value to stock abundance as in last year's assessment. The MLAI index was reduced to cover a time period of 20 years (maximum numbers of years in the biomass abundance index for the ICA program). The indicated F at reference age 4 is much higher compared to last years assessment. This is due to extending the time series with values of two more years and smaller changes in the values of earlier years because of a recalculation of the MLAI index (see Section 2.5). The multiplicative larvae abundance index (MLAI) was used in the final assessment.

The series of acoustic survey indices have been used for the period 1989 to 1998. The reasons for using this restricted period have been discussed earlier in ICES (1995 and 1996a). However, the extended survey period (1984–1997) was tested in a separate model fit. Four test runs were performed with the acoustic survey time-series:

1. Age disagregated for ages 2–9+ for the years 1984–1998
2. Age disagregated for ages 2–9+ for the years 1989–1998 (as in last year's assessment)
3. SSB index for the years 1984–1998
4. SSB index for the years 1989–1998

The estimated fishing mortalities in the final year for the age-structured indices behaved consistently, but for the spawning stock biomass index of 1989–1998 the confidence interval decreased considerably by including an extra year. The age-structured index series from 1989 onwards was chosen, because it is consistent with the spawning stock biomass index for the years 1989–1998 and because it offers more information than the spawning stock biomass index and because it has been used in previous years.

The IBTS survey indices for the 1- to 5+-ringers and for the 2- to 5+-ringers indicate the highest F compared to the other indices as in last year. The confidence intervals decreased because of including an extra year and possibly because of updating the indices for the years 1996–1998 (see Sections 2.3 and 2.6). As in earlier years the age disagregated IBTS survey indices were split in two sets: the IBTS 1-ringer indices and the IBTS indices for 2–5+-ringers. By applying the IBTS 1-ringers as a separate index they get the same weight as the combined 2–5+ ringer index.

The two recruitment indices (IBTS 1-wr and MIK 0-wr) have also been tested in separate model fits. Both appeared to fit well to the historic recruitment information, especially the MIK 0-wr index. These indices are poor predictors of adult stock size and fishing mortality. They were both used as recruitment indices in the final assessment.

The spread of the terminal fishing mortalities in Figure 2.8.2 was less than the spread in last years assessment. It was decided to keep the same indices, but with the addition of one year:

- acoustic survey 1989–1998 (2–9+ wr)
- IBTS 1983–1999 (2–5+ wr)
- IBTS 1979–1999 (1-wr)
- MIK 1977–1999 (0-wr)
- MLAI< 10 1979–1998 (biomass index).

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

The spawning stock biomass that is indicated by the individual indices for the adult part of the population is shown in Figure 2.8.3. These are compared to spawning stock biomass of the final assessment. The acoustic survey indices indicate a relatively high and the IBTS2–5+ survey indices indicate a relatively low spawning stock biomass, when compared to the spawning stock biomass of the final run. The spawning stock biomass as indicated by the MLAI index is closest to the spawning stock biomass of the final run.

2.8.2 Stock assessment

The stock-recruitment model was weighted by 0.1, as in last year's assessment in order to prevent bias in the assessment due to this model component.

Details on input parameters for the final ICA are presented in Tables 2.8.1 and 2.8.2. The ICA program operates by minimising the following general objective function:

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

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

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

$$\sum_{a=0,y=1992}^{a=8,y=1994} \lambda_a (\ln(\hat{C}a, y - \ln(C_{a,y}))^2 +$$

$$\sum_{y=1982}^{y=1992} (\ln(QV.\hat{S}SB_y) - \ln(LPE_y))^2 +$$

$$\sum_{a=2,y=1985}^{a=5+,y=1995} (\ln(QI_a \cdot N^*_{a,y}) - \ln(IBTS_{a,y}))^2 +$$

$$\sum_{1,1979}^{1,1995} (\ln(QL.\, N^*_{1,y}) - \ln(IBTS_{1,y}))^2 +$$

$$\sum_{a=2,y=1989}^{a=9+,y=1994} (\ln(QA_a \cdot N^*_{a,y}) - \ln(ACOUST_{a,y}))^2 +$$

$$\sum_{a=0,y=1978}^{a=0,y=1995} (\ln(QM.\, N^*_{0,y}) - \ln(MIK_y))^2 +$$

$$\sum_{y=1958}^{y=1994} (\ln(N_{0,y+1}) - \ln\left(\frac{A.\, SSB_y}{B + SSB_y} \right))^2$$

with the following variables:

a,y	age and year
C	Catch at age
$\hat{C}$	Estimated catch at age in the separable model
I	Index variable (by age)
$\hat{N}$	Estimated population numbers
$S\hat{S}B$	Estimated spawning stock size
q	Catchability
k	power of catchability model
α, β	parameters to the Beverton stock-recruit model
$S_{1,a}$	selection at age in the first selection period
$S_{2,a}$	selection at age in the second selection period
λc	Weighting for catches (by age and year)
λi	Weighting for indices (by age)
λr	Weighting for recruitment model

Errors were assumed to be correlated by age for both the acoustic survey and the age-disaggregated IBTS (2–5+) index. This has as a consequence that each survey will have a weight of 1 in the calculation of the total sum of squares.

The standard ICA model includes the separability assumption, i.e., that the exploitation pattern is constant between recent years. The regulations in 1996 affected the various components of the fishery differently. The TACs for fleets A and C (the human consumption fleet in the North Sea and Division IIIa) was reduced to 50%. By-catch ceilings for the other fleets (B, D and E) were implemented corresponding to a reduction in fishing mortality of 75% compared to 1995. These fleets exploit the juvenile herring as by-catch. As a result a single separability assumption is likely to be violated in 1996. This has been addressed by calculating two selection patterns in which the selection on the older ages was forced to be equal, while the selection on the juveniles was allowed to change abruptly between 1996 and 1997. The selection on adults was forced to be equal by introducing a penalty function on the difference between the selection patterns from ages 3 and higher. The penalty function was added to the objective function (see above). A special version of ICA was compiled to enable the addition of the penalty function to the objective function. This version is available on the IFAP system under the menu 4.10.4.

Information on the consistency between the assessments carried out during the Working Group meetings from 1996–1999 is provided in Table 2.8.1. The settings of the ICA program are given in Table 2.8.2.

The ICA output is presented in Table 2.8.3 and Figures 2.8.3 - 2.8.11. Long-term trends in yield, fishing mortality, spawning stock biomass and recruitment are given in Figure 2.8.3. The spawning stock at spawning time 1998 shows an increase and is currently estimated to be around 878,000 tonnes which is around 130,000 tonnes higher than in 1997 as estimated at last years Working Group meeting. The fitted selection pattern in the final two years (1997–1998) shows a reduced selection on juveniles compared to the earlier selection pattern (1992–1996). Mean fishing mortality over the ages 2–6 increased from 0.31 in 1997 to 0.35 in 1998. Fishing mortality on 1-ringers decreased from 0.38 in 1995 to 0.16 in 1996 and then to an even lower level of about 0.07 in 1997 and 1998.

The diagnostics of the model fit show relatively high residuals in the 1996 juvenile catches which indicates that the fitted selection pattern did not conform to the catch data on juveniles. However, the overall level of residuals was thought to be acceptable. The final run with separable periods of 5+2 years was compared to a similar run, which only differed in the separable constraint period being 4+3 years. The analyses of variance showed that the SSQ for the total model was less for the run with separable constraint periods 5+2 and was therefore used for the final assessment.

The sensitivity of the assessment was explored using a covariance matrix method where 1000 random draws were taken from the parameter-distributions of the ICA model. Using these random parameter vectors, the historical assessment uncertainty was calculated and plotted in Figure 2.8.12. It can be seen that the estimates of fishing mortality, spawning stock biomass and recruitment have become less uncertain in recent years, when compared to the beginning of the 1990s. The sensitivity of the assessment is further discussed in Section 2.15 on quality of the assessment.

The standard fish stock summary plots are shown in Figure 2.8.14 and the stock recruitment plot in Figure 2.8.15.

2.9 Herring in Division IVc and VIId

The difference in age structure between the catches in Division IVc, VIId and in the rest of the North Sea clearly indicates that the development of the southern North Sea/Channel population ("Downs herring") is different from that in the rest of the North Sea.

The evaluation of this stock component has been based on the herring larvae surveys in the area. The time series of the herring larvae surveys in the southern North Sea and eastern Channel show low values in 1995 and a spawning stock biomass on a very low level, comparable to that in 1980 when the herring fishery was closed (ICES 1996a). In May 1997 ACFM recommended that: "the effort should be reduced in this area as recommended for the total North Sea". In the middle of 1996 the TAC for human consumption herring was revised in the current year to half the agreed TAC and the same TAC was set for 1997 (to avoid a complete closure of the herring fishery in 1997). However, the advice that no directed fishing for herring should be allowed in Division IVc and VIId in 1996 and 1997 was not followed by EU regulations neither in 1996 nor in 1997. In 1998 the TAC was kept on the same level as 1997 (Figure 2.9.3).

Figure 2.9.1 shows the age composition of the herring in Divisions IVc and VIId in the Dutch catches from December 1980–1998. Figure 2.9.2 shows information on the larvae abundance over the same period and the changes in the mean age in the Dutch herring catches in December. In general it appears that the spawning stock biomass decreases when in the preceding year age 3 w-r has been more abundant than age 2 w-r (compare larvae abundance in Figure 2.9.2 with the age composition in Figure 2.9.1). In these cases a weak recruitment at age 2 appears to be recruited to the Downs spawning stock. Year classes 1990 and 1991 appear to have been weak and seem to have contributed to the fast decline in the spawning stock biomass. Year classes 1992 and 1993 appear to have been at least average and probably explain the increase in spawning stock in 1996. The observed values in 1997 indicate an increase in spawning stock biomass in this area even if the very large value from December 1997 is disregarded (see Section 2.5). Both the spawning stock and the mean age show a steady increase from 1996 to 1998.

ACFM catches have overshoot the agreed TAC's considerably since 1988 (see Figure 2.9.3). In the last three years, in which the TAC was half as low as in the period 1991–1995, catches were twice as high as the TAC. Considerable catches taken in Divisions IVc and VIId were misreported to other Divisions. The high catches together with the weaker year classes 1990 and 1991 have contributed to a fast decline in spawning stock biomass over the period 1991–1995. Since 1996 the stock seems to increase again.

The mean age in the catch seems to be related to the herring larvae abundance and therefore also to the spawning stock biomass (Figure 2.9.2). Since 1991 the spawning stock biomass and the mean age have decreased considerably, but not yet to the low mean age of 2.2 in 1980. The mean age in the Dutch catches is somewhat higher in 1998 than in the last two years. The larval abundance has been steadily increasing since 1996.

For the management advice of Downs herring it is important to know what year class strength will recruit to the adult spawning component. The IBTS survey supplies recruitment indices of 1-ringers, but these indices are for the whole North Sea herring population. Part of these 1-ringers will recruit to the Downs herring. Length distributions of the 1-ringers of the IBTS survey show very often a bimodal distribution. The fish of the smallest distribution are Downs herring recruits (born later), while fish of the largest distribution are recruits from the central and northern North Sea (born earlier). On average the minimum between the two modes in the length distribution occurs at 13 cm. The index of the strength of the Downs 1-ringers possibly predicts what the strength is of the recruiting year class to the spawning stock. In 1997 and 1998, the Working Group recommended that the 1-ringer indices of the IBTS survey be split in two components: 1-ringers from the Downs component (length below 13 cm) and 1-ringers from the central and northern North Sea (length above 13 cm). However it was difficult to implement this new procedure, as it would need quite a bit of programming and testing. As a reaction in 1998 the working group recommended this problem to be a matter which could be taken up by the Study Group on the Evaluation of the Quarterly IBTS Surveys in August 1998. This study group, however, did not carry out this term of reference. Therefore the working group recommends again that the 1-ringer indices of the IBTS survey be split in two components (see Section 1.8).

2.10 Short term projection by area and fleet

Fleet Definitions

The fleet definitions were changed from last year with fleets D and E now combined (called D&E in this report), because there are no separate quotas for the two fleets. The new fleet definitions are:

North Sea

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

Division IIIa

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

Input Data for Short Term Projections

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

The starting point for the projection is the stock of North Sea autumn-spawners in the North Sea and Division IIIa combined at 1 January 1999. The ICA estimates of all age groups from 0–9+ are used (Table 2.8.3).

Catches by fleet in reference year: 1998 data from input files Table 2.2.10.

Stock Numbers:

For 1998 the total stock number was taken from ICA (Population Abundance year 1998, Table 2.8.3).

For 2000 0-ringer the stock number was set to 44 000 million (arithmetic mean of the last 10 years, 1989–1998) This figure happens to be identical to the value that has been used in the past four years.

Fishing Mortalities: fishing mortalities for all age classes are taken from Table 2.8.3 for 1998. No adjustments to estimates for the youngest age classes were required, because there was no down-weighting of the young age classes in this year's assessment.

Mean Weights at age in the stock: the averages of the last 2 years' mean weights (1997 and 1998) were used (Table 2.8.3)

Maturity at age: The average maturity at age for 1997 and 1998 was used (Table 2.7.4)
Mean weights in the catch by fleet: A mean of the last two years was taken i.e., 1997 and 1998, (Table 2.2.10)
Natural Mortality: Unchanged from last year ICES (1998/ACFM:14) Table 2.8.3.

Proportion of M and F before spawning: Unchanged from last year ICES (1998/ACFM:14) Table 2.8.3.
Split factors: Proportions North Sea autumn spawners in the North Sea and Division IIIa in 1999–2000

To get a projection as realistic as possible, the calculations were carried out by fleet and area. The proportion of 0- and 1-ringers that occur in Division IIIa is likely to vary between years depending on the size of the year class. The procedure for splitting and the results are shown below. The split factor used for the short term predictions distinguishes the proportions of North Sea autumn spawners being present in the North Sea and Division IIIa. Some of the split factors are directly estimated from surveys, other values are estimated from a general linear model (GLM) which relates the proportion of 1-ringers in Division IIIa to the MIK index of 0-ringers. This is discussed in detail below. In general the split-factor is estimated from proportions of the IBTS 1-ringers in the North Sea and in Division IIIa, and not from the 0-ringers. It is then assumed that the split-factor that applies to a year class as 1-ringers, also applied to that same year class as 0-ringers. The assumption is that the spatial distribution occurs as 0-ringers. 1-ringers remain in the area where they ended up as 0-ringers, and only migrate back to the North sea from Division IIIa as 2-ringers. This assumption and the origin of the split-factors used in the short-term predictions are illustrated in the text table below.

Year	0-ringer distribution	1-ringer distribution
1998 (last yr in ICA)	This split-factor (0-ringers in 1998) is equal to the split-factor of IBTS 1-ringers in 1999	This split-factor (1-ringers in 1998) is obtained from the proportions estimated for the 1-ringers in the IBTS in 1998
1999 (Assessment year)	This split-factor is equal to the regressed 1-ringer distribution of 1999, i.e., obtained from the MIK value for 1999 (year class 1998) and the GLM	This split-factor is obtained from the proportions estimated for the 1-ringers in the IBTS in 1999
2000	This split-factor is equal to that of 1-ringers in 2001, i.e., estimated by taking the average MIK index for the year classes 1981–1998 and using the GLM to predict the split.	This split-factor is obtained from the MIK value for 1999 (yr class 1998), and a general linear model (GLM) to predict the split.
		This split-factor (1-ringers in 2001) is estimated by taking the average MIK index for the year classes 1981–1998 and the GLM to predict the split-factor.

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

	1-ringers	0-ringers
1998	0.84	0.63
1999	0.63	0.54
2000	0.54	0.68

The value of 1-ringers in 2000 and 0-ringers in 1999 (0.54) was determined by a general linear model between the MIK index and the IBTS 1-ringer proportion in Division IIIa (see comments below). The MIK index of 0-ringers in 1999 is 244 which predicts a proportion of 0.46 in Division IIIa (1–0.46 = 0.54 in the North Sea). The value of 0-ringers in 2000 and 1-ringers in 2001 (0.68) was estimated from the general linear model and an average MIK index over 1981–1998 (137.6), which gives an estimated proportion of 0.32 in Division IIIa.

Comments on the General Linear Model

Last year, results from fitting two general linear models relating the proportion of North Sea autumn spawners in Division IIIa to the MIK index of 0-ringers were presented (ICES CM1998/ACFM:14). The models were re-fitted with the new observations for 1998.

Table 2.10.2 shows the observed values and the two models: one with Gamma errors and an inverse link function, and one with Gamma errors and an identity link. The details of these models are discussed in detail in O'Brien and Darby (1997, Working Document to HAWG) and Basson (1997, and 1998 Working Documents to HAWG). The analysis was done in Splus, and summary results are given in Table 2.10.3 for completeness. Results are not very different from those presented last year. For the range of MIK-observations, the two models lead to reasonably similar estimates of the proportion in Division IIIa. Both models are, however, likely to break down when used for prediction with an MIK index that lies outside the range of observed values. Problems are likely to be particularly acute if the predicted value is close to 0 or 1. The MIK index for 1999 is the second highest observed (244; the highest value is 271 in 1986). This implies that, although we are not predicting outside the range of observed values, the prediction lies in a region where the fit is not based on many data points, and the standard errors of the prediction are therefore relatively high. For the model with identity link (linear model), the SE of the prediction is 0.06, whereas for the inverse link (curvilinear model) it is 0.11. It also means that the values themselves are rather different (0.46 for the identity link; 0.53 for the inverse link). In the absence of any knowledge of a mechanistic relationship, the WG decided to use the linear model for prediction purposes because the SE of the prediction is lower.

Comments on the short-term projections

The same spreadsheet used last year was used again. The compiled software was not used. The process is in two steps. The first is to compute local partial fishing mortalities for each fleet, corresponding to the stock in the area where the fleet operates. This is done using stock numbers and fleetwise catches in a reference year, which would be the last assessment year. The next step is to project the stock forwards, starting with the stock numbers at the start of the first prediction year from the assessments, and applying the local fishing mortalities, each raised by an F-factor. Catches by fleet, the ensuing overall fishing mortality, and the SSB are computed and presented.

The area-specific stock numbers and fishing mortalities apply only to 0- and 1- ringers. Older fish are treated as one uniform stock, because North Sea autumn spawners have been assumed to leave Division IIIa as 2- ringers.

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

- The initial stock number at age N0(a) is divided between the areas according to the assumed split factors.
- Stock numbers N1(a) at the end of the year are computed in each area j using Pope's approximation:
  N1j(a) = N0j(a)*exp(-M(a)) - Cj(a)*exp(-M(a)/2) where Cj(a) is the total catch at age in the area.
- Total local mortality Zj(a) is computed as log(N0j(a)/N1j(a)) and the local fishing mortality as Fj(a) = Zj(a)-M(a)
- Fleetwise partial F's are obtained by dividing the total area F proportional to the catches
- For ages 2 and older, the total F according to the input is divided between the fleets proportional to the catches.

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

- The initial stock number at age N0(a) is divided between the areas according to the assumed split factors.
- The local (area j) partial F's, as adjusted by the f-factors are used to compute the catches at age by fleet using Cj(a) = N0j(a)*(1-exp(-Z(j(a)))/Zj(a)
- Stock numbers N1(a) at the end of the year for the whole stock are computed in each area j using Pope's approximation:
  N1(a) = N0(a)*exp(-M(a)) - C(a)*exp(-M(a)/2) where C(a) is the total catch at age by all fleets.
- Total mortality Z (a) for the whole stock is computed as log(N0 (a)/N1(a)) and the total fishing mortality as F(a) = Z(a)-M(a)
- Yield is obtained by multiplying catches at age with fleet-specific weights at age.

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

In 1997, fleets C, D and E took some catches of age 3 and older North Sea autumn spawners, and this was again the case in 1998. In the present version of the programme (from last year), these catches are included.

Assumptions and Predictions for 1999

In recent years, there have been some overshoot of the overall TAC for North Sea autumn spawners. A catch constraint, based on TACs and recent observed overshoots of the set TACs, was therefore used for projections in 1999. There are two steps involved in calculating the fleet-specific catch constraints. First, for fleets operating in Division IIIa where the official TACs apply to autumn spawners and spring spawners, we assumed that the proportion of autumn spawners in the TAC would be similar to proportions observed in recent catches. The rounded, average proportions (based on 1997 and 1998 catches) are 0.5 for fleet C, and 0.7 for fleet D&E. This leads to expected North Sea autumn spawner TACs for each fleet. The second step is to increase these TACs by expected levels of overshoot. The observed overshoot levels can be highly variable, particularly for fleets operating in Division IIIa where the relative proportions of autumn to spring spawners in the area affect any overshoot with regard to the separate populations. For fleet A, we used the 20% which was the estimated overshoot percentage in 1998. For the other fleets an approximate figure of 10% was applied to the TACs in 1999. The resulting expected catches (in '000 t) used as catch constraints are shown in the following text table.

FLEET:	A	B	C	D&E	TOTAL
TACs as set	290	30	80	19	
Autumn spawners	290	30	40 (= 0.5*80)	13 (= 0.7*19)	373
Overshoot factor	1.2	1.1	1.1	1.1	
CATCH Constraint	348	33	44	14	439

The overall overshoot is 18% (439/373 = 1.18), which is very similar to the overall overshoot observed in 1998 (19%).

The fishing mortalities for 1998, in the context of the short-term predictions, were estimated at $F_{2\text{–}6} = 0.35$ and $F_{0\text{–}1} = 0.1$. A projection with F-factors equal to 1 for each fleet was also performed for illustrative purposes. This option implies that local fleetwise F's are constant. This is discussed below.

Difficulties with short term projections

This year, some difficulties were again encountered with the short term projections. The problem manifests itself as unrealistically high predicted catches for fleet C in 2000 under similar scenarios to the ones in last year's prediction table accepted by ACFM May 1998. As an example, predictions based on status quo local fleetwise fishing mortalities in 1999 and 2000 are shown in the following text table (predictions were also done on the same basis for 2001, but only the predicted SSB is shown).

			Predictions for 1999, based on SQ Fs (in '000 t)								
	F_{juv}	F_{ad}	Fleet F's		Fleet Yields in '000 t				TOTAL	SSB	
Local	(0–1 ring)	(2–6 ring)	$F_{B\text{-}D\&E}$	F_A	A	B	C	D&E	Yield	1999	
SQ F	0.101	0.354	0.101	0.330	406	20	54	9	489	1129	
	Prediction summary: Yields for 2000 (in '000 t)										
	F_{juv}	F_{ad}	Fleet F's		Fleet Yields in '000 t				TOTAL	SSB	SSB
Local	(0–1 ring)	(2–6 ring)	$F_{B\text{-}D\&E}$	F_A	A	B	C	D&E	Yield	2000	2001
SQ F	0.123	0.354	0.123	0.330	391	20	179	17	607	1129	1378

$F_{B\text{-}D\&E}$ is the average F of 0–1 ringers for fleets B, C and D&E
F_A is the average F of 2–6 ringers for fleet A only.

Although the projections for 1999 appear reasonable, the projected catch for fleet C in 2000 is extremely high. The unrealistically high catch for fleet C arises from a combination of factors, and it is exaggerated by the switch from a single-area assessment model (ICA) to a multi-fleet, two-area prediction model (Short term prediction). In 1998, 2/3 of the 1-ringers were caught by fleet C. The numbers caught are high in comparison with previous years and other fleets, and the mean weight is also high. The year class, as estimated by ICA was relatively small, and a small proportion was estimated to have been in IIIa. This implies a very high local (i.e., in IIIa) fishing mortality for fleet C on age 1 of 0.43.

This high F does not have too strong an effect on predictions for fleet C in 1999, because the number of 1-ringers is not very large. In 2000, however, the predicted number of 1-ringers is very large (the 1998 year class which is estimated at 95 billion as 0-ringers). The fact that the year class is large, also implies a high proportion in IIIa (0.46 compared to an average of about 0.3 in IIIa). When the very high local F for fleet C on age 1 is applied to the estimated numbers in IIIa, an enormous catch of 1-ringers, both in terms of numbers and in terms of weight, results. The weight of 1-ringers caught by fleet C is, in fact 159,000 t of the total 179,000 t. This is also illustrated in Figure 2.10.1.

This combination of high local F, strong year class and high split-factor also leads to the increase in the juvenile F from 0.101 in 1999 to 0.123 in 2000. Since the prediction procedure is rather complicated, this change is explained here by an example which shows the estimates of local fleetwise F's for 1-ringers and average numbers (i.e., in the middle of the year) in the two areas. Fleet A is left out of this illustration because it only contributes a very small amount to the fishing mortality on 1-ringers.

1999	North Sea	IIIa	Total
Avg. no. 1-ringers	2961	1439	4400
Fleet F by area	0.025 (B)	0.43 (C), 0.075 (D&E)	
Catch no's	74	619 +108	801

The ratio of catches to average population numbers (801/4400) is the approximate OVERALL F on 1-ringers, i.e., 0.18. When this is averaged with overall F for 0-ringers, 0.02, we get 0.10. If the status quo local fleetwise F's (as in the above table) are now applied to the 1-ringers estimated for 2000, we get the following table:

2000	North Sea	IIIa	Total
Avg. no. 1-ringers	11601	8178	19779
Fleet F by area	0.025 (B)	0.43 (C), 0.075 (D&	
Catch no's	290	3516 +613	4420

Now the ratio of catches to average population numbers (4420/19779) implies an overall F on 1-ringers of 0.22, which together with the 0-ring F of 0.02 gives an average juvenile F of 0.12.

Even with a smaller fraction predicted to be in Division IIIa (0.3) there is not much of a decrease in the catch predicted for fleet C: a decrease from 159 thousand t 1-ringers to 103 thousand t 1-ringers. The two main culprits are therefore the combination of the very large number of 0-ringers in 1999 (95 billion vs an average of 44 billion) and the very high local F assumed for 1-ringers by the C fleet which again was caused by a high proportion of 1-ringers in the C-fleet catches of 1998.

There are several possible solutions to obtain more realistic catch predictions. One solution would be to use some form of smoothing for the fleet-specific selection patterns (as calculated from catch-at-age in numbers) over several years. Care should then be taken if there have been real changes in the selection patterns (e.g., due to changes in fleet behaviour or regulations).

A second option, and the one the working group adopted, is to determine F-multipliers that satisfy the fishing mortality targets or constraints defined in the prediction scenarios, but to maintain the relative TAC ratios that have been in operation in recent years as far as necessary to obtain a unique solution.

A third option would be to use overall fleet F's at age rather than 'local' F's at age. This would imply NOT using a split-factor, and the WG did not feel that this would be an appropriate approach at this stage.

Management Option Tables for 2000

Table 2.10.4 gives management options for 1999 based on a catch constraint in 1999. The method for estimating the expected catches by fleet was described above. Scenarios for 2000 were constructed in such a way that the ratios between the expected catches by fleets in 1999 were maintained as far as necessary. Recall that this was required to ensure that the predicted catches for fleet C would not be highly unrealistic. This approach also ensures that a unique solution for F-factors by fleet can be obtained. The 5 scenarios for 2000 are listed in Table 2.10.4, but repeated here for clarity:

Scenario I: Decrease F on all fleets to get $F_{ad} = 0.2$, $F_{juv} <= 0.1$, but maintain catch ratios between all fleets as they are in the 1999 catch constraint

Scenario II: Decrease F on fleets A and C to get $F_{ad} = 0.2$, $F_{juv} <= 0.1$, but maintain the ratio for A and C as it is in the 1999 catch constraint

Scenario III: Decrease F on A and C, increase F on B and D&E to get $F_{ad} = 0.2$, $F_{juv} = 0.1$, but maintain the ratios between A/C and B/D as they are in the 1999 catch constraint

Scenario IV: Decrease F on A and C, increase F on B and D&E to get $F_{ad} = 0.25$, $F_{juv} = 0.12$, but maintain the ratios between A/C and B/D as they are in the 1999 catch constraint

ScenarioV: Decrease F on A and C, increase F on B and D&E to get $F_{ad} = 0.35$, $F_{juv} = 0.1$, but maintain the ratios between A/C and B/D as they are in the 1999 catch constraint

The SSB in 2001 was based on the same scenario as that applied in 2000. The predicted increase in SSB is strongly influenced by the strong 1998 year class which would be 2-ringers in 2001 (autumn spawners remain 0-ringers for a year and a half).

The short term projections presented here do not reflect the uncertainty in the assessment, recruitment or any of the other input parameters. Sections 2.8 and 2.15 show the extent of the uncertainties in the assessment.

2.11 Medium-Term Projections

The method used for the calculation of stochastic medium-term projections was the same used in last years' assessment and follows the procedure described in ICES (1996a). It is summarised here again for convenience. The vector of parameters X (comprising the fishing mortality at reference age, the selections at age, the fitted populations in 1998 and the expected recruitment in 1999) is estimated by the assessment procedure on a logarithmic scale with variance-covariance matrix C. The projection method is based on drawing Monte-Carlo pseudo-data sets to initiate the projections with a mean X and multivariate normal errors C. Recruitment, however, is treated differently. A Beverton-Holt stock-recruit relationship fitted but with no autocorrelation in the errors (Figure 2.11.1). A non-parametric bootstrap method was used to generate recruitments in the pseudo-data sets used for the projections: Uncertainty in future recruitments around the stock-recruitment relationship was modelled by randomly drawing values from the historic time-series of log residuals. The 'ICP' (Version 1.4w) programme was used to implement the method. No explicit modelling of migrations nor of area-specific mortalities was included in the medium-term projections.

The following assumptions were made in the medium-term projections:

- The Working Group has chosen to hold F that the human consumption fleet in the North Sea (Fleet A) should subject the stock to a fishing mortality of 0.2 or 0.3 (defined as an arithmetic mean from ages 2 to 6 w.r.). The fleets B (industrial by-catch in the North Sea), C, (IIIa human consumption), D&E (small mesh fleet in Div IIIa) were supposed to be of primary importance for the juvenile autumn-spawning herring. Forecasts based on fishing mortality on ages 0–1w.r.(arithmetic mean) by these fleets is set at levels of F = 0, 0.1, 0.2 or 0.3.
- The mean maturity ogive as measured in 1997 –1998 has been assumed to hold for the years 1999 and thereafter.
- The natural mortality that was used for the assessment has been assumed to hold for the years 1999 and thereafter.
- The proportions of F and M before spawning in the projections were as used in the assessment.
- The weight at age in the stock for forecasting purposes was taken as the mean value from 1997 and 1998
- The weights at age in the catches by fleet were also taken as the mean values from 1997 and 1998
- The projections start from the populations on 1 January 1999(ages 1–9+) and recruitment on 1 January 1999 (age 0) calculated in the assessment procedure.
- The overall exploitation pattern as estimated for 1998 and 1999 was assumed to hold for 1999 and thereafter.
- The relative fishing mortality by fleet and at age as estimated for 1997 and 1998 (arithmetic mean) was assumed to hold in future years.

A summary of input data (additional to that used in the assessment) is given in Table 2.11.1. In this example, fishing mortality for fleet A has been set to 0.3 (by using an F-multiplier of 0.909264 for fleet A), and the fishing mortality at ages 0–1 has been set to 0.2 (by setting an F-multiplier for fleets B-E of 1.988642). The entry log for running ICP program is given in Table 2.11.2.

The medium-term projection scenarios modelled are given in detail in Figures 2.11.2–2.11.9. Perceptions of future stock development are similar to those previously estimated by the Working Group (ICES 1998a).

2.12 Quality of assessment

In recent years, assessments have been quite consistent from year to year, although the present assessment indicates somewhat reduced SSB-levels compared to the previous assessments. This is different from the years prior to 1993, where the stock in the current year was systematically overestimated to a much larger extent. This is illustrated by the retrospective comparisons shown in Figure 2.12.1. in the adopted assessment.

The estimate of the SSB in 1998 is considerably lower than predicted for 1998 last year, the values being 878 000 and 1145 000 tonnes respectively. In order to explore the reasons for this difference, the short term prediction from last year was repeated with the reported catches for 1998 instead of the assumed ones, and with the stock numbers at the start of 1998 according to the present assessment instead of those obtained last year. The resulting SSBs by age class are shown in Figure 2.12.2. Changing the catches from what was assumed for 1998 to what was reported led to a minor reduction in the predicted SSB. Changing the stock numbers at the start of 1998 to the numbers estimated in the present assessment had a larger impact. Most of the difference is due to the ages 2 and 3, which dominate the spawning biomass. With both these changes, the predicted SSB was 895 000 t, which is not very different from the actual assessment estimate. Additional effects of changes in selection pattern, weights at age and maturity at age were not considered.

The year classes which by now are 2- and 3-ringers are those for which the selection pattern was changed directly by the change of periods with constant selection, discussed in Section 2.8.1. The change implied that the higher selection on the juveniles from previous years would be applied to these year classes in 1996, while the selection pattern used previously, which was adapted to the recent restrictions on the fishery of juveniles, would indicate a lower F on those ages in 1996. Accordingly, the catches in 1996 would indicate that these year classes were smaller with the present selection pattern than with the previous one.

The restrictions on the fishery for juveniles were introduced in the middle of 1996. A large part of the 1-ringer catch was taken by then, while the catch of 0-ringers, was small. Ideally, the selection pattern of the first period should therefore apply to the 1-ringers, while that for the second period should apply to the 0-ringers. This arrangement is not possible with the presently available software.

An exploratory run with XSA was made, as described in Section 2.8.1. This indicated a selection pattern in 1996 compatible with that outlined above. The SSB estimate by age for 1998 according to the XSA is included in Figure 2.12.2, and again confirms the above explanation of the difference between predicted and estimated SSB. Although XSA can more easily cope with this change in selection pattern, the WG decided to continue to use ICA for its assessment. This is both for consistency, because ICA can handle SSB-indices, because it allows for noise in the catch data, and because the present EU-Norway agreement relies in computations originating from ICA assessments.

Another source of uncertainty are the catches from the North -Western part of the North Sea. This problem is discussed in Section 5.1.3. For 1997, all catches reported from Division VIa were assumed to be have taken there, while part of them have been transferred to Division IVa in other years. An exploratory ICA run was done with these catches transferred to the North Sea also in 1997. This gave an estimate of F2–6 in 1998 of 0.362 and of the SSB in 1998 of 863 000 t, compared to 0.353 and 878 000 t respectively in the ordinary assessment. Therefore, at least for the North Sea, this problem does not have an important effect on the assessment.

2.13 Management considerations

The current assessment shows that the spawning stock biomass increased to a level of 878 000 t by around 220,000 t between 1997 and 1998. However, the estimate of SSB in 1997 has been reduced by 90,000 in the current assessment giving an apparent increase of 130,000 over the estimate presented in 1998. The probability that SSB is below MBAL is around 25%. Recruitment of 1 ring in 1999 is expected to be low, but recruitment of 0 ring in 1999 is the second highest on record. Projections show that this stock may have a positive development in the near future, up to 1.17 million t in 1999. If the assumptions of the short term projection are correct and if the strategy agreed upon by the parties dealing with this stock is followed, an SSB level of about 1.3 million t may be reached in 2000.

The adopted management regimes for protecting the juveniles (w.ring 0 and 1) have kept the Fs at about 0.07 which is lower than the ACFM advice of Fjuv below 0.1. On the other hand the estimated level of F on the adult stock (w.ring 2–6) shows a higher F of 0.35 which is higher than both the ACFM advice of F = 0.2 and the F implied by the TACs of F = 0.25. The agreed Fs on juveniles and adults of 0.12 and 0.25 respectively (EU-Norway agreement) should not be implemented until the spawning stock exceeds 1.3 mill t.

The Working Group continues to be aware of the important misreporting of catches in several parts of the North Sea and adjacent areas and has included allowance for this within the short term projections. Catches taken in the period 1984 to 1998 in Division IV and reported in areas VIa North, IIa and IIIa, were included in the catch-in-numbers used for the assessment of this stock. However, there is not much evidence for the extent of this misreporting and the catch reallocation is carried out with limited confidence.

The level of discards and slippage is largely unknown. However, several discard sampling programs have recently been started to address this issue.

The situation for the stock in the southern North Sea and the eastern English Channel ('Downs herring') appears to have improved since last year. This is probably due to a recent good recruitment as indicated by two years high values in the larvae survey.

Table 2.1.1 North Sea HERRING (Sub-area IV and Division VIId). Catch in tonnes by country, 1987-1998. 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
Belgium	39	4	434	180	163	242
Denmark	138,596	263,006	210,315[2]	159,280	194,358	193,968
Faroe Islands	2,228	810	1,916	633	334	-
France	7,266	8,384	29,085	23,480	24,625	16,587
Germany, Fed.Rep.	5,552	13,824	38,707	43,191	41,791	42,665
Netherlands	91,478	82,267	84,178	69,828	75,135	75,683
Norway[4]	241,765	222,719	221,891[2]	157,85[2]	124,991	116,863
Sweden	1,725	1,819	4,774	3,754	5,866	4,939
UK (England)	873	8,097	7,980	8,333	11,548	11,314
UK (Scotland)	76,413	64,108	68,106	56,812	57,572	56,171
UK (N.Ireland)	-	-	-	-	92	-
Unallocated landings (from IIa, VIIb,c,j,h	58,972	33,411	26,749[2]	21,081	24,435	25,867
Misreporting from VIa North	18,647	11,763	19,013	25,266	22,079	22,594
Total landings	643,554	710,212	713,148[2]	569,688	582,969	566,892
Discards[3]	-	-	4,000	8,660	4,617	4,950
Total catch	643,554	710,212	771,148	578,348	587,606	571,842
Estimates of the parts of the catches which have been allocated to spring spawning stocks						
IIIa type	19,654	23,306	19,869	8,357	7,894	7,854
Coastal type	490	250	2,283	1,136	252[5]	202

Country	1993	1994	1995	1996	1997	1998
Belgium	56	144	12	-	-	1
Denmark	164,817	121,559	153,361	67,496	38,431	58,924
Faroe Islands	-	-	-	-	-	25
France	12,627	27,941	29,504	12,500	14,524	20,783
Germany	41,669	38,394	43,798	14,215	13,381	22,259
Netherlands	79,190	76,155	78,491	35,276	35,129	50,654
Norway[4]	122,815	125,522	131,026	43,739	38,745	68,523
Sweden	5,782	5,425	5,017	3,090	2,253	3,221
Russia	-	-	-	-	1,619	-
UK (England)	19,853	14,216	14,676	6,881	3,421	7,635
UK (Scotland)	55,531	49,919	44,802	17,473	22,914	32,403
UK (N.Ireland)	-	-	-	-	-	-
Unallocated landings (from IIa, VIIb,c,j,h	18,410	5,749	33,594	24,475	27,583	27,722
Misreporting from VIa North	24,397	30,234	32,146	38,254	5,039	32,446
Total landings	544,917	495,258	566,427	263,399	203.040	324,596
Discards[3]	3,470	2,510	-	1,469	6,005	3,918
Total catch	548,417	497,768	566,427	264,868	209,045	328,514
Estimates of the parts of the catches which have been allocated to spring spawning stocks						
IIIa type	8,928	13,228	10,315	855	979	7,833
Coastal type[5]	201	215	203	168	202	88

[1]Preliminary.
[2]Working Group estimates.
[3]Any discards prior to 1989 were included in unallocated landings.
[4]Catches of Norwegian spring spawners removed (taken under a separate TAC).
[5]Landings from the Thames estuary area.

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

Country	1989	1990	1991	1992	1993
Denmark	29,298	9,037	5,980	10,751	10,604
Faroe Islands	1,916	633	334	-	-
France	-[1]	2,581	3,393	4,714[4]	3,362
Germany, Fed.Rep.	26,528	20,422	20,608	21,836	17,342[4]
Netherlands	24,600	29,729	29,563	29,845	28,616
Norway	41,768	24,239	37,674	39,244	33,442
Sweden	742	-	1,130	985	1,372
UK (N. Ireland)	-	-	92	-	-
UK (England)	5,104	3,337	4,873	4,916	4,742
UK (Scotland)	58,455	46,431	42,745	39,269	36,628[4]
Unallocated landings (from IIa, VIIb,c,j,h	3,173	4,621	5,492	4,855	-8,271[5]
Misreporting from VIa North	19,013	25,266	22,079	22,593	24,397
Total Landings	219,597	166,296	173,963	179,008	152,234
Discards[2]	900	750	883	850	825
Total catch	211,497	167,046	174,846	179,858	153,059

Country	1994	1995	1996	1997	1998
Denmark	20,017	17,748	3,237	2,667	4,634
Faroe Islands	-	-	-	-	25
France	11,658	10,427	3,177	361	4,757
Germany	18,364	17,095	2,167	-	7,752
Netherlands	16,944	24,696	2,978	6,304	11,851
Norway	56,422	56,124	22,187	16,485	27,218
Sweden	2,159	1,007	2,398	1,617	245
Russia	-	-	-	1,619	-
UK (N. Ireland)	-	-	-	-	-
UK (England)	3,862	3,091	2,391	-	4,306
UK (Scotland)	44,687	40,159	12,762	17,120	30,552
Unallocated landings (from IIa, VIIb,c,j,h	2,944	26,018	9,959	7,574	8,961
Misreporting from VIa North	30,234	32,146	38,254	5,039	32,446
Total Landings	207,561	228,511	99,510	59,386	139,739
Discards[2]	550	-	356	1,138	730
Total catch	208,111	228,511	99,866	60,524	140,468

[1]Included in Division IVb.
[2]Any discards prior to 1989 were included in unallocated.
[3]Preliminary.
[4]Including IVa East.
[5]Negative unallocated catches due to misreporting from other areas.

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	1989	1990	1991	1992[3]	1993
Denmark	44,269	44,364	48,875	53,692	43,224
Faroe Islands	-	-	-	-	-
France	-	892	-	-[3]	4
Netherlands	-	-	-	-	-
Norway[1]	168,365	121,405	77,465	61,379	56,215
Sweden	612	2,482	114	508	711
UK (Scotland)	-	-	173	196	-[3]
Germany, Fed.Rep.	-	5,604	-[3]	-[3]	-[3]
Unallocated landings	-	-	-	-	-
Total landings	213,246	174,747	126,627	115,775	100,154
Discards[2]		-	-	-	-
Total catch	213,246	174,747	126,627	115,775	100,154

Country	1994	1995	1996	1997	1998
Denmark	43,787	45,257	19,166	22,882	25,750
Faroe Islands		-	-	-	
France	14	+	-	3	
Netherlands		-	-	-	
Norway[1]	40,658	62,224	18,256	18,490	41,260
Sweden	1,010	2,081	693	427	1,259
UK (Scotland)		-	-	-	
Germany		-	-	4,576	
Unallocated landings		-	-	-	
Total landings	85,469	109,562	38,115	46,378	68,269
Discards[2]			-	-	-
Total catch	85,469	109,562	38,115	46,378	68,269

[1]Catches of Norwegian spring spawners herring removed (taken under a separate TAC).
[2]Any discards prior to 1989 would have been included in unallocated.
[3]Included in IVa West.

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	1989	1990	1991	1992	1993
Denmark	136,239	105,614	138,555	125,229	109,994
Belgium	-	-	3	13	-
France	14,415[2]	10,289	4,120	2,313	2,086
Faroe Islands	-	-	-	-	-
Germany, Fed.Rep.	11,880	17,165	20,479	20,005	23,628
Netherlands[1]	47,388	28,402	26,266	26,987	31,370
Norway	11,758	12,207	9,852	16,240	33,158
Sweden	3,420	1,276	4,622	3,446	3,699
UK (England)	957	3,200	2,715	3,026	3,804
UK (Scotland)	9,651	10,381	14,587	16,707	18,904
Unallocated landings	-23,947[3]	-15,616[3]	3,180	-13,637[3]	-16,415[3]
Total landings	211,711	172,914	224,376	200,329	210,228
Discards[1]	1,900	2,560	1,072	1,900	245
Total catch	213,611	175,474	225,448	202,229	210,473

Country	1994	1995	1996[6]	1997	1998
Denmark	55,060	87,917	43,749	11,636	26,667
Belgium	-	-	-	-	
France	5,492	7,639	2,373	6,069	8,944
Faroe Islands	-	-	-	-	
Germany	14,796	21,707	11,052	7,456	13,591
Netherlands[1]	39,052	30,065	18,474	14,697	27,408
Norway	28,442	12,678	3,296	3,770	45
Sweden	2,256	1,929	-	209	1,717
UK (England)	7,337	9,688	2,757	2,033	1,767
UK (Scotland)	5,101	4,654	4,449	5,461	1,851
Unallocated landings	-26,988[3]	10,831	-8,826[3]	-1,615[3]	-11,270
Total landings	130,548	165,355	77,324	49,716	70,720
Discards[1]	460-	-	592	1,855	1,188
Total catch	131,008	165,455	77,916	51,571	71,908

[1]Any discards prior to 1989 were included in unallocated.
[2]Includes catch in Division IVa.
[3]Negative unallocated catches due to misreporting from other areas.

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	1989	1990	1991	1992	1993
Belgium	434	180	163	229	56
Denmark	509	265	948	4,296	995
France	14,670	9,718	17,112	9,560	7,171
Germany, Fed.Rep.	299	-	704	824	649
Netherlands	12,240	11,697	19,306	18,851	19,204
Norway	-	-	-	-	-
UK (England)	1,919	1,796	3,960	3,372	11,307
UK (Scotland)	-	-	67	-	-
Unallocated landings	47,523	32,076	15,763	34,649	43,096
Total landings	77,594	55,732	58,023	71,781	82,478
Discards[1]	1,200	5,350	2,662	2,200	2,400
Total catch	78,794	61,082	60,685	73,981	84,878
Coastal spring spawners included above	2,283	1,136	252	202	201

Country	1994	1995	1996	1997	1998
Belgium	144	12	-	1	1
Denmark	2,695	2,441	1,344	1,246	1,873
France	10,777	11,433	6,950	8,091	7,081
Germany	4,964	4,996	997	1,349	916
Netherlands	20,159	23,730	13,824	13,528	11,935
Norway	-	-	-	-	
UK (England)	3,016	1,896	1,733	1,388	1,562
UK (Scotland)	131	-	262	333	
Unallocated landings	29,792	18,397	23,934	21,624	23,040
Total landings	71,678	62,905	49,044	47,559	45,868
Discards[1]	2,400	-	521	3,012	2,000
Total catch	74,078	62,905	49,565	50,571	47,868
Coastal spring spawners included above	215	203	168	143	88

[1]Any discards prior to 1989 would have been included in unallocated.

Table 2.2.1 North Sea Herring, Millions caught by age group (winter ring), year class, division and quarter.

Catches in : 1998

		0	1	2	3	4	5	6	7	8	9+		0+1
Division	Quarter	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	Total	ring
	I	0.0	0.0	1.2	1.2	1.5	2.0	4.5	1.2	0.3	0.9	12.8	0.0
IVa	II	0.0	1.4	105.9	26.8	11.2	2.9	1.2	0.6	0.2	0.0	150.2	1.4
(West of 2E)	III	0.0	0.3	302.9	132.3	89.4	64.6	29.2	5.7	2.0	6.4	632.7	0.3
	IV	0.0	0.0	23.9	8.8	5.7	3.7	1.8	1.4	0.5	0.8	46.7	0.0
	Total	0.0	1.6	434.0	169.2	107.8	73.1	36.7	8.8	3.1	8.1	842.4	1.6
	I	0.0	0.0	30.7	16.5	13.2	9.9	15.1	2.6	4.0	0.0	92.1	0.0
Iva	II	0.0	0.1	62.0	32.2	17.2	6.2	2.0	0.6	0.4	0.2	120.9	0.1
(East of 2E)	III	0.0	0.4	37.3	23.4	14.2	8.8	4.5	0.4	0.6	0.8	90.3	0.4
	IV	0.0	0.0	50.6	34.0	25.4	24.6	9.6	1.3	1.6	0.4	147.4	0.0
	Total	0.0	0.5	180.7	106.1	69.9	49.5	31.2	4.9	6.6	1.3	450.7	0.5
	I	0.0	123.6	15.7	0.1	1.8	0.1	2.1	0.3	0.1	0.0	143.7	123.6
	II	0.0	23.2	13.4	0.9	1.1	0.4	1.0	0.5	0.1	0.1	40.6	23.2
IVb	III	84.6	52.0	189.9	41.9	17.2	25.4	7.1	1.1	0.1	0.1	419.5	136.6
	IV	105.6	10.5	66.2	39.1	14.7	5.0	0.0	0.0	0.0	0.0	241.0	116.1
	Total	190.2	209.3	285.3	81.9	34.8	30.8	10.2	1.9	0.4	0.2	844.9	399.5
	I	0.0	35.4	5.3	30.8	6.0	1.2	0.7	0.0	0.0	0.4	79.8	35.4
	II	0.0	0.2	0.1	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.9	0.2
IVc + VIId	III	1.0	0.4	0.1	1.4	0.3	0.1	0.0	0.0	0.0	0.0	3.3	1.4
	IV	17.0	3.4	162.9	122.1	50.2	10.0	6.4	0.0	0.0	0.0	372.0	20.4
													0.0
	Total	18.0	39.4	168.4	154.8	56.5	11.3	7.2	0.0	0.0	0.4	456.0	57.4
	I	0.0	159.0	53.0	48.6	22.4	13.2	22.4	4.1	4.4	1.3	328.4	159.0
Total	II	0.0	24.9	181.4	60.4	29.6	9.4	4.2	1.6	0.8	0.3	312.6	24.9
North	III	85.7	53.0	530.3	199.0	121.1	98.8	40.9	7.1	2.7	7.3	1145.8	138.6
Sea	IV	122.6	13.9	303.6	204.0	95.9	43.2	17.8	2.7	2.1	1.2	807.1	136.5
	Total	208.2	250.8	1068.4	512.0	269.0	164.7	85.3	15.6	10.0	10.0	2594.0	459.1

Table 2.2.2 Numbers (millions) of herring caugth per age group (winter rings) in the North Sea ,1988-1998.

Year	Winter ring 0	1	2	3	4	5	6	7	8	9+	Total
1990	888.4	1557.3	616.4	783.9	871.9	386.1	82.2	55.8	29.2	12.1	5283.3
1991	1657.7	1301.3	801.4	567.9	563.1	506.8	207.0	39.8	25.7	12.9	5683.5
1992	7873.6	704.8	995.1	423.6	344.2	351.1	370.1	148.8	38.7	23.8	11273.7
1993	7254.0	1385.4	791.6	613.9	314.8	221.9	229.7	190.9	88.1	42.3	11132.6
1994	3834.5	497.1	1438.4	504.0	354.5	117.0	97.9	77.7	71.3	46.0	7038.3
1995	6794.9	583.0	1485.8	918.6	259.4	126.2	58.9	43.3	54.6	73.1	10397.8
1996	1795.7	738.0	549.0	600.4	196.6	59.7	20.5	11.1	8.0	18.3	3997.1
1997	363.5	175.3	471.9	425.6	247.7	88.9	23.1	10.9	9.2	8.9	1825.2
1998	208.2	250.8	1068.4	512.0	269.0	164.7	85.3	15.6	10.0	10.0	2594.0

Table 2.2.3 Catches(numbers in millions) of IIIa spring spawners taken in the North Sea, and transfered to assessement of IIIa spring spawning stock, 1988-1998.

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

Table 2.2.4 Catches(numbers in millions) of North Sea autumn spawners taken in IIIa, and transfered to assessement of North Sea autumn spawners (1990 - 1998).

Year	Winter ring 0	1	2	3	4	5	6	7	8	9+	Total
1990	397.9	1424.3	283.7								2105.9
1991	712.3	822.7	330.2								1865.2
1992	2407.5	1587.1	283.8	26.8	26.6	16.0	12.3	5.5	1.0		4366.6
1993	2910.7	2403.8	377.5								5691.9
1994	542.2	1239.7	305.2								2087.1
1995	1722.8	1069.6	126.4								2918.8
1996	632.1	869.5	159.4	31.5							1692.5
1997	93.6	351.6	210.6	71.5	12.3	5.7	1.8	0.7	0.9		748.6
1998	49.78	707.9	156.6	26.08	19.03	2.97	2.98	1.17	0.48	0.1	967.04

Table 2.2.5 Total catch (numbers in millions) per age of North Sea autumn spawning stock used for the assessment (1990 - 1998).

Year	Winter ring 0	1	2	3	4	5	6	7	8	9+	Total
1990	1286.3	2981.6	887.7	769.2	850.1	382.5	79.2	53.7	28.5	11.7	7330.5
1991	2370.0	2124.0	1124.9	552.8	545.1	497.7	203.9	39.0	25.4	12.9	7495.7
1992	10281.1	2291.9	1278.6	440.5	359.7	358.7	373.8	151.7	39.0	23.2	15598.2
1993	10164.7	3789.2	1164.8	603.1	302.5	213.5	223.8	186.2	86.4	41.3	16775.5
1994	4376.7	1736.7	1734.8	475.8	338.2	106.0	89.3	74.3	68.1	45.3	9045.2
1995	8517.7	1652.6	1589.8	907.6	244.5	122.2	56.0	41.4	54.1	72.9	13258.8
1996	2427.8	1607.5	708.3	629.1	195.8	59.3	20.4	11.0	7.9	18.1	5685.2
1997	457.1	526.9	680.3	495.8	258.5	94.2	24.7	11.5	9.9	8.9	2567.7
1998	258.0	958.7	1213.9	525.1	276.2	161.0	85.0	16.4	10.0	9.5	3513.9

Table 2.2.6 Catches in the North sea:

Area	Allocated	Unallocated	Discards	Total
IVa West	91,340	48,398	730	140,468
IVa East	68,269	-	-	68,269
IVb	81,990	-11,270	1,188	71,908
IVc/VIId	22,827	23,040	2,000	47,867
	Total catch in the North sea			328,513
	IIIa autumn spawners transferred to the North sea			59,498
	Coastal spring spawners transferred to IIIa			7,833
	Total Catch used for the assessment			380,178

Table 2.2.7 Percentage age composition of herring caught in the North Sea and VIId (2-ringers and olders).

Catches in: 1998

Division	age in W.Rings Quarter/y.c	2 1995	3 1994	Older >= 1993	Total (millions)
	I	9.4	9.6	81.0	12.8
IVa West	II	71.2	18.0	10.8	148.8
	III	47.9	20.9	31.2	632.5
	IV	51.3	18.9	29.8	46.7
	Total	51.6	20.1	28.3	840.8
	I	33.4	17.9	48.7	92.1
IV a East	II	51.4	26.7	21.9	120.8
	III	41.5	26.0	32.5	89.9
	IV	34.3	23.1	42.6	147.4
	Total	40.1	23.6	36.3	450.2
	I	78.0	0.3	21.7	20.2
IVb	II	77.1	5.3	17.6	17.4
	III	67.1	14.8	18.1	282.9
	IV	53.0	31.3	15.7	124.9
	Total	64.1	18.4	17.5	445.4
	I	12.0	69.3	18.6	44.4
IVc + VIId	II	9.2	71.6	19.3	0.6
	III	7.1	73.2	19.7	1.9
	IV	46.3	34.7	18.9	351.6
	Total	42.3	38.8	18.9	398.6
	I	38.1	14.2	47.6	125.0
IVa + IVb	II	63.2	20.9	15.9	287.0
	III	52.7	19.7	27.6	1005.3
	IV	44.1	25.7	30.2	319.0
	Total	51.8	20.6	27.6	1736.3
	I	31.3	28.7	40.0	169.4
Total	II	63.1	21.0	15.9	287.7
North	III	52.7	19.8	27.6	1007.2
Sea and VIId	IV	45.3	30.4	24.3	670.6
	Total	50.0	24.0	26.0	2134.9

Table 2.2.8 Catches (SOP,tons) of herring caught in the North Sea and VIId by quarter and division.
Catches in :1998

Quarter	Division /y.c	0 1997	1 1996	2 1995	3 1994	4 1993	5 1992	6 1991	7 1990	8 1989	9+ 1988	SOP Total
	IVa W	0	0	119	160	221	330	956	279	96	165	2327
I	IVa E	0	0	2195	1918	1861	1692	3167	608	1140	0	12582
	IVb	0	3789	742	12	197	12	471	67	50	0	5339
	IVc+VIId	0	1219	294	2494	620	135	101	0	0	63	4926
	Total	0	5008	3350	4584	2900	2168	4695	955	1286	228	25174
	IVa W	0	100	11539	3790	1920	644	310	144	48	0	18495
II	IVa E	0	9	7200	4390	2645	1085	393	114	97	46	15979
	IVb	0	622	927	99	126	53	196	86	24	13	2147
	IVc+VIId	0	7	4	37	9	2	2	0	0	1	62
	Total	0	738	19669	8317	4701	1784	900	344	169	60	36683
	IVa W	0	20	41474	23378	19020	16118	7964	1572	615	2064	112224
III	IVa E	0	29	4836	3722	2555	1833	1059	96	138	189	14457
	IVb	1670	2166	23867	6975	3601	5778	1682	254	36	36	46065
	IVc+VIId	21	14	9	113	28	6	5	0	0	3	199
	Total	1691	2229	70186	34188	25204	23734	10710	1922	790	2291	172946
	IVa W	0	0	3057	1437	1070	748	408	335	119	196	7370
IV	IVa E	0	0	6516	5612	4886	5247	2185	331	390	77	25245
	IVb	1851	482	7497	5252	2413	882	0	0	0	0	18378
	IVc+VIId	289	231	15972	15271	7975	1617	1277	0	0	0	42632
	Total	2141	714	33042	27573	16343	8494	3870	666	509	273	93625
Total N. Sea and VIId	1998	3831	8689	126248	74662	49149	36181	20175	3887	2754	2853	328427

Table 2.2.9 Total catch in the North Sea VIId and. IIIa in 1997.

North Sea Autumn Spawners

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Fleet A		Fleet B		Fleet C		Fleet D+E		TOTAL	
Total Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight
0			363.5	14	8.9	21	84.8	19	457.1	15
1	18.4	80	156.9	33	249.0	32	102.6	22	526.9	32
2	445.9	118	23.8	61	156.0	84	54.5	35	680.3	101
3	419.5	148	4.8	85	67.3	130	4.2	99	495.8	144
4	245.6	192	0.6	137	11.8	170	0.5	110	258.5	191
5	85.9	230	2.6	151	5.5	183	0.2	142	94.2	225
6	22.8	230	0.1	146	1.7	192	0.1	168	24.7	227
7	10.8	228			0.7	194	0.0	192	11.5	226
8	9.0	224			0.9	201	0.0	217	9.9	222
9+	8.9	297							8.9	297
TOTAL	1,266.8		552.3		501.7		246.9		2,567.7	
Land. (SOP)(t)		195,293		12,757		33,584		6,381		248,015

Table 2.2.10 Total catch in the North Sea , VIId and. IIIa 1998.

North Sea Autumn Spawners

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Fleet A		Fleet B		Fleet C		Fleet D+E		TOTAL	
Total Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight
0			208.2	18	15.0	30	34.79	27.0	258.0	20
1	19.2	73	231.6	32	602.2	59	105.65	24.0	958.7	49
2	1024.6	120	32.8	58	134.5	82	22.11	64.0	1,214.0	113
3	497.3	146	1.7	134	24.8	119	1.28	96.0	525.1	144
4	252.7	184	4.5	131	17.9	164	1.11	157.0	276.2	182
5	157.3	221	0.8	198	2.7	181	0.32	193.0	161.1	220
6	81.5	237	0.6	210	3.0	201			85.1	236
7	15.1	250	0.1	232	1.2	180			16.4	245
8	9.4	275	0.2	285	0.5	226			10.0	273
9+	9.5	286							9.5	286
TOTAL	2,066.7		480.4		801.7		165.3		3,514.0	
Land. (SOP)(t)		306,498		14,277		54,293		5,249		380,316

Table 2.2.11 Sampling of commercial landings in 1998 (Divisions IV and VIId) Number of fish measured and aged by quarter.

Country	Quarter	Landings in '000 tons	Number of samples	Number of fish measured	aged
Denmark	I	19.0	14	1492	548
	II	1.6	23	84	71
	III	10.8	21	971	560
	IV	27.7	23	1601	647
	Total	59.1	81	4148	1826
France	I	0.8	0	0	0
	II	0.0	0	0	0
	III	11.7	0	0	0
	IV	8.2	0	0	0
	Total	20.7	0	0	0
Germany	I	0.4	0	0	0
	II	2.4	0	0	0
	III	18.5	0	0	0
	IV	7.4	0	0	0
	Total	28.7	0	0	0
Norway	I	1.7	0		
	II	30.0	28	2545	2545
	III	30.3	8	750	750
	IV	11.9	1	100	100
	Total	73.8	37	3395	3395
Sweden	I	0.0	0	0	0
	II	0.4	0	0	0
	III	2.4	0	0	0
	IV	0.4	0	0	0
	Total	3.2	0	0	0
The Netherlands	I	3.1	6	709	150
	II	1.7	16	3190	400
	III	35.1	33	4003	825
	IV	32.2	16	2859	400
	Total	72.1	71	10761	1775
U.K (England)	I	0.1	0	0	0
	II	0.0	0	0	0
	III	0.0	0	0	0
	IV	1.4	0	0	0
	Total	1.6	0	0	0
U.K (Scotland)	I	0.1			
	II	0.6	2	674	125
	III	58.2	98	20983	3752
	IV	4.4			
	Total	63.2	100	21657	3877
All Countries	I	25.2	22	2875	823
	II	36.7	69	6493	3141
	III	166.9	160	26707	5887
	IV	93.7	40	4560	1147
	Total	322.5	291	40635	10998

Table 3.3.11 Total catch in numbers (mill) and mean weight (g), SOP (tonnes) of Western Baltic Spring spawners in Division IIIa and the North Sea in the years 1988 - 1998

Year	Rings	0	1	2	3	4	5	6	7	8+	Total
	Number			2075.00	563.00	62.00	8.00	2.00	0.50	0.50	2,711.00
1988	Mean W.			47.3	77.0	138.3	156.0	166.0	149.0	209.0	
	SOP			98,148	43,351	8,575	1,248	332	75	105	151,832
	Number			497.69	503.66	115.23	29.96	13.68	5.35	2.34	1,167.91
1989	Mean W.			56.5	79.9	125.5	151.6	167.3	189.2	204.8	
	SOP			28,119	40,242	14,461	4,542	2,289	1,012	479	91,145
	Number		140.90	1006.23	259.90	192.21	62.07	9.99	19.09	2.20	1,692.59
1990	Mean W.		56.6	65.0	84.6	102.4	111.1	109.3	141.0	84.3	
	SOP		7,975	65,405	21,988	19,682	6,896	1,092	2,692	185	125,915
	Number	64.80	43.00	352.05	447.07	174.71	108.85	22.35	7.62	3.09	1,223.54
1991	Mean W.	33.7	60.5	77.4	101.7	127.5	148.6	165.4	182.5	194.9	
	SOP	2,184	2,602	27,249	45,467	22,276	16,175	3,697	1,391	602	121,641
	Number		66.98	214.33	156.34	128.78	63.88	43.59	12.65	7.76	694.31
1992	Mean W.		53.4	96.2	115.2	138.6	172.9	184.0	201.7	201.3	
	SOP		3,577	20,619	18,010	17,849	11,045	8,021	2,552	1,562	83,234
	Number		52.92	185.91	245.60	101.75	63.05	43.65	23.86	8.88	725.62
1993	Mean W.		60.4	88.6	121.5	147.2	160.3	182.9	195.6	218.2	
	SOP		3,196	16,472	29,840	14,978	10,107	7,984	4,667	1,938	89,181
	Number			157.34	248.54	137.01	80.20	45.92	14.75	8.40	692.16
1994	Mean W.			127.2	120.1	148.6	165.3	190.6	204.1	216.5	
	SOP			20,014	29,850	20,360	13,257	8,752	3,010	1,819	97,061
	Number	84.40	504.27	254.11	132.29	81.25	52.50	16.07	10.14	4.70	1,139.73
1995	Mean W.	17.5	37.8	101.2	148.3	165.5	188.7	213.0	233.1	232.2	
	SOP	1,477	19,061	25,716	19,619	13,447	9,907	3,423	2,364	1,091	96,104
	Number	23.97	173.92	509.10	90.41	54.32	30.39	13.69	7.08	5.94	908.83
1996	Mean W.	7.3	22.9	74.1	127.0	172.0	182.8	200.9	197.7	212.3	
	SOP	175	3,983	37,702	11,481	9,345	5,554	2,751	1,399	1,262	73,653
	Number		27.12	88.77	142.37	32.16	13.43	4.66	1.49	2.34	312.32
1997	Mean W.		63.8	82.4	131.3	174.5	190.6	195.6	205.9	210.2	
	SOP	0	1,729	7,313	18,695	5,612	2,560	911	306	492	37,618
	Number	32.12	148.85	305.60	90.24	61.23	12.97	8.31	2.11	2.22	663.65
1998	Mean W.	27.9	48.7	72.8	110.3	142.0	176.4	210.4	192.7	231.8	
	SOP	896	7,246	22,239	9,955	8,693	2,287	1,748	407	516	53,987

There may be minor corrections in data from 1987 and 1988.

Table 2.3.2 Density and abundance estimates of 0-ringers caught in February during the IBTS. Values given for year classes by areas are density estimates in numbers per square metre. Total abundance is found by multiplying density by area and summing up.

Area	North west	North east	Central west	Central east	South west	South east	Division IIIa	South Bight	0-ringers abundance
Area $m^2 \times 10^9$	83	34	86	102	37	93	31	31	no. in10^9
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

Table 2.4.1 Numbers (millions) of autumn spawning herring by ICES area in the North Sea and VIaN.

	IIIa	IVa	IVb	VIaN
0	493.46	0.00	0.00	0.00
1	1978.98	514.61	2196.30	1221.70
2i	195.68	1650.04	431.44	117.95
2m	34.23	2695.23	1891.96	676.69
3i	5.58	268.42	2.68	19.56
3m	30.86	2133.17	123.87	647.22
4	1.14	1597.10	41.98	471.07
5	0.37	980.65	1.34	179.05
6	0.19	444.82	0.17	79.27
7	0.00	170.31	0.00	28.05
8	3.87	41.28	0.02	13.85
9+	0.00	121.39	0.00	36.77
Immature	2673.70	2433.07	2630.41	1359.21
Mature	70.66	8183.95	2059.35	2131.98
Total	2744.36	10617.02	4689.76	3491.18

Table 2.4.2 Biomass (thousands of tonnes) of autumn spawning herring by ICES area in the North Sea and VIaN.

	IIIa	IVa	IVb	VIaN
0	4.45	0.00	0.00	0.00
1	120.26	33.09	68.95	80.05
2i	17.19	152.22	24.02	14.47
2m	3.01	342.38	125.78	95.06
3i	0.58	45.95	0.31	3.19
3m	3.32	439.91	13.43	114.33
4	0.16	382.61	5.96	91.36
5	0.06	270.22	0.26	38.35
6	0.04	136.50	0.04	17.93
7	0.00	49.21	0.00	6.58
8	0.49	13.41	0.00	3.12
9+	0.00	44.04	0.00	9.16
Immature	138.04	231.26	93.27	97.71
Mature	7.08	1678.28	145.47	375.89
Total	149.56	1909.54	238.74	473.60

Table 2.4.3 Mean weight of autumn spawning herring (g) by ICES area in the North Sea and VIaN.

	IIIa	IVa	IVb	VIaN
0	9.02			
1	60.77	64.29	31.39	65.53
2i	87.85	92.25	55.67	122.64
2m	87.90	127.03	66.48	140.48
3i	104.77	171.20	114.06	163.10
3m	107.63	206.22	108.40	176.65
4	140.38	239.57	141.98	193.94
5	152.70	275.55	194.28	214.20
6	216.50	306.86	216.50	226.18
7		288.93		234.49
8	126.30	324.94	126.30	225.04
9+		362.78		249.07
Mean (i)	84.46	109.25	67.04	117.09
Mean (m)	138.57	266.49	142.32	207.51
Mean (all)	109.38	223.60	117.23	182.85

Table 2.4.4 Number of Baltic spring spawning herring (millions) by ICES area.

	IIIa	IVa	IVb
0	0.00	0.00	0.00
1	102.83	4.90	29.97
2I	1221.92	113.27	88.01
2m	216.33	25.20	17.04
3I	111.40	15.42	12.91
3m	628.39	66.49	66.12
4	172.41	82.00	27.92
5	76.02	27.85	6.66
6	29.82	12.98	7.85
7	19.53	8.80	2.24
8	23.93	6.98	6.61
9+	6.83	4.94	3.70
Immature	1436.15	133.58	130.89
Mature	1173.24	235.25	138.15
Total	2609.39	368.83	269.04

Table 2.4.5 Biomass of Baltic spring spawning herring (thousands of tonnes) by ICES area.

	IIIa	IVa	IVb
0	0.00	0.00	0.00
1	5.55	0.31	1.28
2I	97.25	10.24	7.19
2m	17.21	2.79	1.43
3I	10.07	1.71	1.30
3m	56.81	8.04	6.84
4	18.37	13.31	3.52
5	7.83	4.38	0.91
6	3.34	2.35	1.19
7	2.73	1.69	0.35
8	3.67	1.36	1.14
9+	1.12	0.89	0.77
Immature	112.87	12.26	9.77
Mature	111.09	34.82	16.15
Total	223.96	47.07	25.93

Table 2.4.6 Mean weight of Baltic spring spawning herring (g) by ICES area

	IIIa	IVa	IVb
0			
1	53.99	62.73	42.69
2i	79.59	90.45	81.70
2m	79.56	110.64	84.06
3i	90.36	110.61	100.94
3m	90.41	120.92	103.48
4	106.55	162.32	125.95
5	102.99	157.42	136.34
6	111.90	181.10	152.09
7	139.97	192.48	156.92
8	153.34	194.48	172.32
9+	164.69	180.03	207.60
Mean (i)	74.65	87.93	75.11
Mean (m)	118.68	162.42	142.34
Mean (all)	106.67	142.11	124.01

Table 2.4.7 Numbers (millions), biomass (thousands of tonnes), maturity ogive and mean weight (g) for North Sea autumn spawning, Baltic spring spawning and West Scotland autumn spawning herring by age group. (Four year and older are assumed 100% mature).

North Sea	Numbers	Biomass	Maturity	x weight(g)	Baltic	Numbers	Biomass	Maturity	x weight(g)	West Scot	Numbers	Biomass	Maturity	x weight(g)
0	493.46	4.45	0.00	9.02	0	0.00	0.00	0.00		0	0.00	0.00	0.00	
1	4689.89	222.30	0.00	47.40	1	137.70	7.14	0.00	51.84	1	1221.70	80.05	0.00	65.53
2	6898.59	664.60	0.67	96.34	2	1681.76	136.12	0.15	80.94	2	794.63	109.53	0.85	137.83
3	2564.57	503.50	0.89	196.33	3	900.72	84.77	0.84	94.11	3	666.78	117.52	0.97	176.25
4	1640.21	388.73	1.00	237.00	4	282.33	35.20	1.00	124.67	4	471.07	91.36	1.00	193.94
5	982.36	270.54	1.00	275.40	5	110.53	13.12	1.00	118.71	5	179.05	38.35	1.00	214.20
6	445.18	136.58	1.00	306.79	6	50.66	6.88	1.00	135.87	6	79.27	17.93	1.00	226.18
7	170.31	49.21	1.00	288.93	7	30.57	4.78	1.00	156.33	7	28.05	6.58	1.00	234.49
8	45.17	13.90	1.00	307.82	8	37.52	6.17	1.00	164.34	8	13.85	3.12	1.00	225.04
9+	121.39	44.04	1.00	362.78	9+	15.47	2.78	1.00	179.85	9+	36.77	9.16	1.00	249.07
Immature	7737.19	462.57			Immature	1700.61	134.90			Immature	1359.21	97.71		
Mature	10313.96	1830.83			Mature	1546.64	162.05			Mature	2131.98	375.89		
Total	18051.14	2297.84			Total	3247.26	296.95			Total	3491.18	473.60		

Table 2.4.8 Percentage of Ichthyophonus infected herring found on survey by FRV Scotia. No other vessels reported ichthyophonus infection

Age/Maturity	1	2I	2M	3I	3M	4	5	6	7	8	9+	Total
% Infected	0.0	0.0	0.0	0.0	0.6	1.7	2.5	2.4	1.3	5.8	3.9	1.4

Table 2.4.9 Estimates of North Sea autumn spawners (millions) at age from acoustic surveys, 1984-1997. 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 1998 estimates are from the summer survey in Divisions IVa,b, and IIIa excluding estimates of Division IIIa/Baltic spring spawners.

	Numbers (millions)														
Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Age (ring)															
1	551	726	1,639	13,736	6,431	6,333	6,249	3,182	6,351	10,399	3,646	4,202	6,189	9,416	4690
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	4,550	6,363	6899
3	1,005	1,433	1,637	955	1,732	3,751	3,530	1,501	1,633	1,855	957	2,056	2,823	3,287	2565
4	394	323	833	657	528	1,612	3,370	2,102	1,397	909	429	656	1,087	1,696	1640
5	158	113	135	368	349	488	1,349	1,984	1,510	795	363	272	310.9	692.1	982
6	44	41	36	77	174	281	395	748	1,311	788	321	175	98.75	259.2	445
7	52	17	24	38	43	120	211	262	474	546	238	135	82.83	78.63	170
8	39	23	6	11	23	44	134	112	155	178	220	110	133	78.33	45
9+	41	19	8	20	14	22	43	56	163	116	132	84	206	158.3	121
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	17558
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	0.75
Smoothed Z(2+/3+)		0.75	0.80	0.91	0.46	0.11	0.34	0.47	0.55	0.97	0.87	0.48	0.41	0.57	0.64
SSB('000 t)	807	697	942	817	897	1,637	2,174	1,874	1,545	1,216	1,035	1,082	1,445	1,780	1,830

Table 2.5.1: Estimated abundance of herring larvae < 10 mm in length, by standard sampling area and time periods
The number of larvae are expressed as mean number per m² per ICES rectangle * 10^9

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

Table 2.5.2: Parameter estimates obtained on fitting the multiplicative model to the estimates of larval abundance by area and time-period. Model fitted to abundances of larvae < 10mm in length.

a) Analysis of variance of the model fit

	DF	Sum of Squares	Mean Square	F Value	P
Model	36	142,5	3,96	8,357	0,0001
Error	196	92,8	0,4736		
C Total	232	235,3			

b) Estimates of parameters

Reference Mean

Estimate	Standard Error	
6,8245	0,5598	Reference: 1972, Orkney/Shetland 09/01 – 09/15

Year Effects

Year	Estimate	Standard Error	Year	Estimate	Standard Error
1973	0,3476	0,6959	1986	1,4737	0,6133
1974	-0,1558	0,7454	1987	2,0321	0,6133
1975	-1,2370	0,7576	1988	2,7204	0,6016
1976	-1,3335	0,7435	1989	2,6881	0,6155
1977	-0,4289	0,7130	1990	2,9216	0,6383
1978	-0,2282	0,7236	1991	2,2730	0,6918
1979	0,4911	0,6968	1992	1,5239	0,7310
1980	0,1394	0,6936	1993	1,2106	0,7081
1981	0,5592	0,6913	1994	0,8325	0,7457
1982	0,8719	0,6265	1995	1,0331	0,7359
1983	1,1191	0,6424	1996	1,6995	0,7752
1984	1,7220	0,6234	1997	1,9108	0,7269
1985	2,1359	0,6019	1998	2,2253	0,6834

Sampling Unit Effects

Sampling Unit	Estimate	Standard Error
Or/Shet 16-30 Sep	-0,7164	0,3398
Buchan 01-15 Sep	-1,6548	0,4298
Buchan 16-30 Sep	-2,4273	0,3796
CNS 01-15 Sep	-1,6558	0,4099
CNS 16-30 Sep	-1,3749	0,3734
CNS 01-15 Oct	-2,0597	0,3955
CNS 16-31 Oct	-4,1689	0,5331
SNS 12-31 Dec	-2,0018	0,4164
SNS 01-15 Jan	-2,5741	0,3476
SNS 16-31 Jan	-3,9148	0,4085

Table 2.5.3: updated MLAI time-series obtained from a multiplicative model

Reference: 6.824515 (Orkney/Shetland, 1st-15th September 1972)

Year	MLAI	MLAIrefer	un-logged	div 100
1973	0.3476	7.1721	1302.6	13.0
1974	-0.1558	6.6687	787.4	7.9
1975	-1.2370	5.5875	267.1	2.7
1976	-1.3335	5.4910	242.5	2.4
1977	-0.4290	6.3956	599.2	6.0
1978	-0.2282	6.5963	732.4	7.3
1979	0.4911	7.3156	1503.6	15.0
1980	0.1394	6.9640	1057.8	10.6
1981	0.5592	7.3837	1609.6	16.1
1982	0.8719	7.6965	2200.5	22.0
1983	1.1191	7.9436	2817.5	28.2
1984	1.7220	8.5466	5149.0	51.5
1985	2.1359	8.9604	7788.4	77.9
1986	1.4737	8.2982	4016.8	40.2
1987	2.0321	8.8566	7020.9	70.2
1988	2.7204	9.5449	13973.7	139.7
1989	2.6881	9.5127	13529.9	135.3
1990	2.9216	9.7461	17088.1	170.9
1991	2.2730	9.0975	8933.3	89.3
1992	1.5239	8.3484	4223.5	42.2
1993	1.2106	8.0352	3087.6	30.9
1994	0.8325	7.6570	2115.5	21.2
1995	1.0331	7.8577	2585.5	25.9
1996	1.6995	8.5241	5034.5	50.3
1997	1.9108	8.7354	6219.0	62.2
1998	2.2253	9.0498	8517.0	85.2

Table 2.6.1. The IBTS time series of herring abundance at age as estimated in the first quarter,
* updated for 1996-8 from preliminary to final figures

		Age		
YEAR	2	3	4	5+
1983	109	42	14	34
1984	161	75	32	7
1985	716	256	26	36
1986	661	235	57	17
1987	838	117	56	44
1988	4100	783	55	26
1989	775	411	86	10
1990	580	322	271	70
1991	794	283	250	170
1992	377	181	63	102
1993	762	236	45	64
1994	1090	199	64	40
1995	1285	152	46	9
1996	194*	43*	13*	9*
1997	437*	181*	34*	14*
1998	743	90	20	19
1999	421	506	103	37

Table 2.7.1 North sea Herring,
Mean weight (g) at age (w.r.) and year class weighted by number caught

Cathes in : 1998

		0	1	2	3	4	5	6	7	8	9+
Division	Quarter	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988
	I			99	130	150	164	214	230	336	184
IV a	II		73	109	141	171	225	249	260	195	
(W of 2E)	III		77	137	177	213	250	272	278	302	323
	IV			128	163	186	205	231	235	227	249
	Total		73	129	170	206	244	263	263	284	300
	I			71	116	141	170	210	233	289	228
IV a	II		68	116	136	154	176	198	205	239	232
(E of 2 E)	III		75	130	159	180	209	235	253	237	249
	IV			129	165	193	213	228	252	241	201
	Total		73	115	147	171	199	218	236	269	232
	I		31	47	207	110	198	220	262	346	
IV b	II		27	69	107	118	145	200	175	228	221
	III	20	42	126	167	209	227	237	231	307	305
	IV	18	46	113	134	164	178				
	Total	19	34	116	151	182	218	230	220	299	277
	I		34	55	81	104	111	136			176
IVc	II		34	61	81	104	111	136			176
+	III	20	38	69	81	104	111	136			176
VIId	IV	17	69	98	125	159	161	199			
	Total	17	37	97	116	153	155	192			176
IVa	Total		73	125	161	192	226	242	254	274	291
	I		31	64	117	139	169	212	234	294	184
IVa	II		30	108	138	159	190	213	215	223	230
+	III	20	42	132	172	208	240	262	270	288	315
IVb	IV	18	46	121	150	183	207	229	243	238	233
	Total	19	34	122	159	191	224	241	250	275	290
	I		31	63	94	129	164	209	234	294	182
Total	II		30	108	138	159	190	213	215	223	229
North	III	20	42	132	172	208	240	262	270	288	315
Sea	IV	17	51	109	135	170	196	218	243	238	233
	Total	18	35	118	146	183	220	237	250	275	286

Table 2.7.2 Comparison between mean weights (g) at age in catch of North Sea Herring (adults) from earlier years and 1990 - 1998.

		Age in winter rings							
Division	Year	2	3	4	5	6	7	8	9+
	1990	123	154	177	194	229	234	251	295
IVa	1991	146	164	181	198	214	231	263	275
	1992	149	184	189	208	223	240	243	285
	1993	133	156	193	210	234	249	268	319
	1994	135	171	201	223	246	258	278	295
	1995	142	172	208	220	260	253	284	290
	1996	133	162	200	213	239	253	254	291
	1997	126	159	197	234	241	245	232	304
	1998	125	161	192	226	242	254	274	291
	1990	102	145	194	219	250	272	259	277
IVb	1991	119	173	196	220	225	277	257	263
	1992	81	179	198	213	232	255	272	313
	1993	102	146	199	220	236	261	275	306
	1994	122	150	177	205	237	251	255	245
	1995	135	174	197	205	261	266	272	282
	1996	106	178	213	238	243	268	270	263
	1997	122	153	201	228	245	227	270	296
	1998	116	151	182	218	230	220	299	277
	1990	113	152	181	198	232	238	252	290
IVa+IVb	1991	131	167	184	203	217	239	262	272
	1992	100	183	191	209	224	243	250	290
	1993	116	152	195	212	234	251	269	317
	1994	131	164	192	218	245	258	277	292
	1995	140	173	205	216	260	256	283	289
	1996	126	165	203	219	240	258	259	281
	1997	125	157	198	232	243	236	236	302
	1998	122	159	191	224	241	250	275	290
	1990	118	131	152	171	195	216	208	231
IVc+VIId	1991	123	165	184	200	212	196	237	161
	1992	100	183	191	209	224	243	250	290
	1993	113	139	152	174	182	191	211	216
	1994	117	145	172	191	209	224	229	218
	1995	114	130	161	177	203	208	184	241
	1996	118	140	154	178	181	201	186	250
	1997	99	133	159	180	156	193	165	158
	1998	125	161	192	226	242	254	274	291
	1990	114	149	177	193	229	236	250	287
	1991	130	166	184	203	217	235	259	271
Total	1992	103	175	189	207	223	237	249	287
North Sea	1993	115	145	189	204	228	244	256	310
	1994	130	159	181	214	240	255	273	281
	1995	136	167	196	200	247	249	278	287
	1996	123	160	192	207	211	252	255	281
	1997	115	147	192	228	230	228	224	297
	1998	118	146	183	220	237	250	275	286

Table 2.7.3 Herring mean weight at age in the third quarter, in Division IVa and IVb.

Age	Mean weights at age in the catch															
	Third quarter (Divisions IVa and IVb)								July acoustic Survey							
(w.r)	1991	1992	1993	1994	1995	1996	1997	1998	1991	1992	1993	1994	1995	1996	1997	1998
1	73	51	53	55	52	10	38	42	65	78	69	60	58	44	44	47
2	164	127	145	131	151	126	125	132	158	142	115	138	132	118	119	96
3	189	200	161	164	190	165	157	172	198	209	147	209	180	196	166	196
4	210	215	179	192	221	203	198	208	224	219	202	220	200	253	227	237
5	229	235	199	218	231	219	232	240	236	243	225	251	195	262	236	275
6	246	252	221	245	277	240	243	262	260	255	277	289	228	299	239	307
7	276	276	239	258	276	258	236	270	275	272	286	315	257	305	246	289
8	296	286	240	277	316	259	236	288	298	312	305	323	302	324	269	308
9+	293	330	283	292	316	281	302	315	317	311	340	346	324	335	329	363

Table 2.7.4 Maturity at age 2, 3 and 4+ for Autumn Spawning herring in the North Sea

Year \Age (W ring)	2	3	>3
1988	65.6	87.7	100
1989	78.7	93.9	100
1990	72.6	97.0	100
1991	63.8	98.0	100
1992	51.3	100	100
1993	47.1	62.9	100
1994	72.1	85.8	100
1995	72.6	95.4	100
1996	60.5	97.5	100
1997	65.1	94.2	100
1998	67.0	89.0	100

Table 2.8.1 Input parameters of the final ICA assessments for the years 1996-1999.

Assessment year			1999	1998	1997	1996
First data year			1960	1960	1960	1976
Last data year			1998	1997	1996	1995
No of years for separable constraint ?			7	6	5	4
Reference age for separable constraint			4	4	4	4
Constant selection pattern model (Y/N)			s1 (92-96), s2(97-98)-constrained	s1 (92-95), s2(96-97)-constrained	y	na
S to be fixed on last age			1 / 1	1 / 1	1	1
First age for calculation of reference F			2	2	2	2
Last age for calculation of reference F			6	6	6	6
Shrink the final populations			no	no	no	no
Tuning indices	*survey*	*age*				
Year ranges for survey indices	MLAI		79-98	77-96	77-96	76-95
	Acoustic survey	2-9+	89-98	89-97	89-96	89-95
	IBTSA	2-5+	83-99	83-98	83-97	83-96
	IBTSY	1	79-99	79-98	79-97	79-96
	MIK	0	77-99	77-98	77-97	77-96
Catchability models	MLAI		power	power	power	power
	Acoustic survey	2-9+	linear	linear	linear	linear
	IBTSA	2-5+	linear	linear	linear	linear
	IBTSY	1	linear	linear	linear	linear
	MIK	0	linear	linear	linear	linear
Model weighting						
Relative weights in catch at age matrix			all 1	all 1	all 1, except age 0 (96)=0.01 and age 1(96)=0.01	all 1
Total weight catch at age matrix			49	42	33	28
Survey indices weights	MLAI		1.0	1.0	1.0	1.0
	Acoustic survey	2	0.125	0.125	0.125	0.125
	Acoustic survey	3	0.125	0.125	0.125	0.125
	Acoustic survey	4	0.125	0.125	0.125	0.125
	Acoustic survey	5	0.125	0.125	0.125	0.125
	Acoustic survey	6	0.125	0.125	0.125	0.125
	Acoustic survey	7	0.125	0.125	0.125	0.125
	Acoustic survey	8	0.125	0.125	0.125	0.125
	Acoustic survey	9+	0.125	0.125	0.125	0.125
	IBTSA	2	0.25	0.25	0.25	0.25
	IBTSA	3	0.25	0.25	0.25	0.25
	IBTSA	4	0.25	0.25	0.25	0.25
	IBTSA	5+	0.25	0.25	0.25	0.25
	IBTSY	1	1.0	1.0	1.0	1.0
	MIK	0	1.0	1.0	1.0	1.0
Stock recruitment weight			0.1	0.1	0.1	0.1
Parameters to be estimated			55	53	44	?
Number of observations			313	289	265	?

Table 2.8.2 Input to the final ICA assessment

Integrated Catch at Age Analysis (Version 1.4 w, constrained separability)

Enter the name of the index file -->index
canum
weca
Stock weights in 1999 used for the year 1998
west
Natural mortality in 1999 used for the year 1998
natmor
Maturity ogive in 1999 used for the year 1998
matprop
Name of age-structured index file (Enter if none) : -->fleet
Name of the SSB index file (Enter if none) -->ssb
No of years for separable constraint ?--> 7
Reference age for separable constraint ?--> 4
Constant selection pattern model (Y/N) ?-->n
Enter last year in which selection is constant--> 1996
Gradual or Abrupt change in selection (G/A) ?-->a
S to be fixed on last age ?--> 1.000000000000000
S for last age in later selection pattern ?--> 1.000000000000000
First age for calculation of reference F ?--> 2
Last age for calculation of reference F ?--> 6
Use default weighting (Y/N) ?-->y
Is the last age of ACO89: acoustic survey 2-9+ a plus-group (Y/N) ?-->y
Is the last age of IBTSA: 2-5+ a plus-group (Y/N) ?-->y
Is the last age of IBTSY: 1-wr a plus-group (Y/N) ?-->n
Is the last age of MIK: 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 < 10 mm is to be A/L/P ?-->p
Model for ACO89: acoustic survey 2-9+ is to be A/L/P ?-->L
Model for IBTSA: 2-5+ is to be A/L/P ?-->L
Model for IBTSY: 1-wr is to be A/L/P ?-->L
Model for MIK: 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--> 1.000000000000000

No of years for separable analysis : 7
Age range in the analysis : 0 . . . 9
Year range in the analysis : 1960 . . . 1998
Number of indices of SSB : 1
Number of age-structured indices : 4
Stock-recruit relationship to be fitted.
Parameters to estimate : 55
Number of observations : 313

Two selection vectors to be fitted.
Selection assumed constant up to and including : 1996
Abrupt change in selection specified.

Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
Enter weight for MLAI < 10 mm--> 1.000000000000000
Enter weight for ACO89: acoustic survey 2-9+ at age 2--> 1.000000000000000
Enter weight for ACO89: acoustic survey 2-9+ at age 3--> 1.000000000000000
Enter weight for ACO89: acoustic survey 2-9+ at age 4--> 1.000000000000000
Enter weight for ACO89: acoustic survey 2-9+ at age 5--> 1.000000000000000
Enter weight for ACO89: acoustic survey 2-9+ at age 6--> 1.000000000000000
Enter weight for ACO89: acoustic survey 2-9+ at age 7--> 1.000000000000000
Enter weight for ACO89: acoustic survey 2-9+ at age 8--> 1.000000000000000
Enter weight for ACO89: acoustic survey 2-9+ at age 9--> 1.000000000000000
Enter weight for IBTSA: 2-5+ at age 2--> 1.000000000000000
Enter weight for IBTSA: 2-5+ at age 3--> 1.000000000000000
Enter weight for IBTSA: 2-5+ at age 4--> 1.000000000000000
Enter weight for IBTSA: 2-5+ at age 5--> 1.000000000000000
Enter weight for IBTSY: 1-wr at age 1--> 1.000000000000000
Enter weight for MIK: MIK 0-wr at age 0--> 1.000000000000000
Enter weight for stock-recruit model--> 0.100000000000000
Enter estimates of the extent to which errors
in the age-structured indices are correlated
across ages. This can be in the range 0 (independence)
to 1 (correlated errors).
Enter value for ACO89: acoustic survey 2-9+--> 1.000000000000000
Enter value for IBTSA: 2-5+--> 1.000000000000000
Enter value for IBTSY: 1-wr--> 1.000000000000000
Enter value for MIK: MIK 0-wr--> 1.000000000000000
Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.
SSB index weights
1.000
Aged index weights
ACO89: acoustic survey 2-9+
Age : 2 3 4 5 6 7 8 9
Wts : 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125
IBTSA: 2-5+
Age : 2 3 4 5
Wts : 0.250 0.250 0.250 0.250
IBTSY: 1-wr
Age : 1
Wts : 1.000
MIK: MIK 0-wr
Age : 0
Wts : 1.000
Stock-recruit weight 0.100
F in 1998 at age 4 is 0.400380 in iteration 1
Detailed, Normal or Summary output (D/N/S)-->D
Output page width in characters (e.g. 80..132) ?--> 103
Estimate historical assessment uncertainty ?-->y
Sample from Covariances or Bayes MCMC (C/B) ?-->c
Use default percentiles (Y/N) ?-->y
How many samples to take ?--> 1000
Enter SSB reference level (e.g. MBAL, Bpa..) [t]--> 8.0000000000000000E+05
Succesful exit from ICA

Table 2.8.3 Output of the final ICA run for North Sea autumn spawning herring. ICES Div. IV, Sub- Div.VIId & IIIa (RUN #16, 2 periods of separable constraint (5+2), ICA Her Version 1.4).

Catch in Number (Millions)

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

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

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

AGE	1993	1994	1995	1996	1997	1998
0	10265.	4499.	8426.	2429.	457.	258.
1	3827.	1785.	1635.	1608.	527.	959.
2	1176.	1783.	1573.	709.	680.	1214.
3	609.	489.	898.	629.	496.	525.
4	306.	348.	242.	196.	259.	276.
5	216.	109.	121.	59.	94.	161.
6	226.	92.	55.	20.	25.	85.
7	188.	76.	41.	11.	12.	16.
8	87.	70.	54.	8.	10.	10.
9	42.	47.	72.	18.	9.	10.

Predicted Catch in Number (Millions)

AGE	1992	1993	1994	1995	1996	1997	1998
0	7948.9	8808.1	5213.4	7798.7	3863.0	506.5	233.4
1	1882.8	3697.9	2864.5	2231.5	1271.6	642.8	783.6
2	1238.5	1435.3	1981.3	1980.1	643.5	745.2	1184.1
3	621.7	700.7	551.3	995.2	413.2	371.2	688.5
4	435.9	338.8	256.9	264.8	200.2	238.2	267.8
5	399.6	216.2	112.1	112.2	47.4	104.3	155.7
6	331.5	220.3	80.2	54.6	22.5	27.0	74.5
7	138.9	180.5	80.7	38.7	10.7	12.5	18.7
8	39.6	89.5	79.0	46.0	9.3	7.2	10.5

Table 2.8.3: North Sea herring ICA output (continued)

Weights at age in the catches (Kg)

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

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

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

AGE	1993	1994	1995	1996	1997	1998
0	0.01000	0.00600	0.00900	0.01600	0.01600	0.02000
1	0.03300	0.05600	0.04800	0.01000	0.03200	0.04900
2	0.11500	0.13000	0.13600	0.12300	0.10100	0.11300
3	0.14500	0.15900	0.16700	0.16000	0.14400	0.14400
4	0.18900	0.18100	0.19600	0.19200	0.19100	0.18200
5	0.20400	0.21400	0.20000	0.20700	0.22500	0.22000
6	0.22800	0.24000	0.24700	0.21100	0.22700	0.23600
7	0.24400	0.25500	0.24900	0.25200	0.22600	0.24500
8	0.25600	0.27300	0.27800	0.25400	0.22200	0.27300
9	0.31000	0.28100	0.28700	0.28100	0.29700	0.28600

Table 2.8.3: North Sea herring ICA output (continued)

Weights at age in the stock (Kg)

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

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

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	0.01500	0.01500	0.01300	0.01000	0.00700	0.00600	0.00800	0.01200	0.01500	0.01400	0.01200
1	0.05000	0.05000	0.05400	0.06400	0.06400	0.05700	0.04800	0.05300	0.06000	0.06900	0.07100
2	0.15500	0.15500	0.15000	0.14700	0.14000	0.13400	0.13200	0.13600	0.14800	0.14800	0.13800
3	0.18700	0.18700	0.18900	0.19000	0.18900	0.17900	0.17500	0.17600	0.18700	0.19800	0.18500
4	0.22300	0.22300	0.22500	0.22500	0.22400	0.22000	0.21500	0.21100	0.21400	0.21700	0.21500
5	0.23900	0.23900	0.24200	0.24500	0.24800	0.24500	0.24700	0.24200	0.24100	0.23700	0.23500
6	0.27600	0.27600	0.27000	0.27200	0.26700	0.27100	0.27200	0.27000	0.26700	0.25700	0.26400
7	0.29900	0.29900	0.29900	0.29500	0.29100	0.28300	0.28300	0.28200	0.28200	0.27600	0.27800
8	0.30600	0.30600	0.31000	0.31700	0.31900	0.31200	0.30800	0.29700	0.29700	0.29600	0.30500
9	0.31200	0.31200	0.31200	0.33100	0.34100	0.33900	0.33800	0.33000	0.33300	0.31500	0.32300

AGE	1993	1994	1995	1996	1997	1998
0	0.00900	0.00800	0.00600	0.00400	0.00600	0.00700
1	0.07000	0.06400	0.05500	0.04900	0.04500	0.04600
2	0.13200	0.12800	0.12900	0.12300	0.11100	0.10700
3	0.18600	0.17700	0.19300	0.18100	0.18600	0.18100
4	0.21300	0.20700	0.22300	0.22700	0.23900	0.23200
5	0.23900	0.22300	0.23500	0.23700	0.26400	0.26500
6	0.27400	0.26500	0.27200	0.25500	0.28200	0.27300
7	0.29100	0.28600	0.29200	0.27000	0.28000	0.26800
8	0.31300	0.31000	0.31700	0.29900	0.30100	0.28900
9	0.33200	0.33700	0.33500	0.32900	0.34200	0.34600

Natural Mortality (per year)

AGE	1960	1961	1962	1963	1964	1965	...	1995	1996	1997	1998
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	...	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	...	1.0000	1.0000	1.0000	1.0000
2	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000	...	0.3000	0.3000	0.3000	0.3000
3	0.2000	0.2000	0.2000	0.2000	0.2000	0.2000	...	0.2000	0.2000	0.2000	0.2000
4	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	...	0.1000	0.1000	0.1000	0.1000
5	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	...	0.1000	0.1000	0.1000	0.1000
6	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	...	0.1000	0.1000	0.1000	0.1000
7	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	...	0.1000	0.1000	0.1000	0.1000
8	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	...	0.1000	0.1000	0.1000	0.1000
9	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	...	0.1000	0.1000	0.1000	0.1000

Table 2.8.3: North Sea herring ICA output (continued)

Proportion of fish spawning

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

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

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

AGE	1993	1994	1995	1996	1997	1998
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.4700	0.7200	0.7300	0.6100	0.6500	0.6700
3	0.6300	0.8600	0.9500	0.9800	0.9400	0.8900
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

Table 2.8.3: North Sea herring ICA output (continued)

INDICES OF SPAWNING BIOMASS

MLAI < 10 mm

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	15.04	10.58	16.10	22.01	28.17	51.49	77.88	40.17	70.21	139.74	135.30

	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	170.88	89.33	42.24	30.88	21.15	25.85	50.34	62.19	85.17

AGE-STRUCTURED INDICES

ACO89: acoustic survey 2-9+ (Thousands)

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
2	3726.0	2971.0	2834.0	4179.0	3710.0	3280.0	3799.0	4550.6	6363.0	6898.6
3	3751.0	3530.0	1501.0	1633.0	1885.0	957.0	2056.0	2823.1	3287.0	2564.6
4	1612.0	3370.0	2102.0	1397.0	909.0	429.0	656.0	1087.3	1696.0	1640.2
5	488.0	1349.0	1984.0	1510.0	795.0	363.0	272.0	310.9	692.0	982.4
6	281.0	395.0	748.0	1311.0	788.0	321.0	175.0	98.7	259.0	445.2
7	120.0	211.0	262.0	474.0	546.0	328.0	135.0	82.8	79.0	170.3
8	44.0	134.0	112.0	155.0	178.0	220.0	110.0	132.9	78.0	45.2
9	22.0	43.0	56.0	163.0	116.0	132.0	84.0	206.0	158.0	121.4

IBTSA: 2-5+

AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	109.0	161.0	716.0	661.0	838.0	4100.0	775.0	580.0	794.0	377.0	762.0
3	42.0	75.0	256.0	235.0	117.0	783.0	411.0	322.0	283.0	181.0	236.0
4	14.0	32.0	26.0	57.0	56.0	55.0	86.0	271.0	250.0	63.0	45.0
5	34.0	7.0	36.0	17.0	44.0	26.0	10.0	70.0	170.0	102.0	64.0

AGE	1994	1995	1996	1997	1998	1999
2	1090.0	1285.0	194.0	437.0	743.0	421.0
3	199.0	152.0	43.0	181.0	90.0	506.0
4	64.0	46.0	13.0	34.0	20.0	104.0
5	40.0	9.0	9.0	14.0	19.0	37.0

IBTSY: 1-wr

AGE	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	172.0	312.0	431.0	772.0	1260.0	1440.0	2080.0	2540.0	3680.0	4530.0	2310.0

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	1020.0	1160.0	1160.0	2940.0	1667.0	1186.0	1735.0	4069.0	2067.0	721.0

MIK: MIK 0-wr

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

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

AGE	1999
0	244.00

Table 2.8.3: North Sea herring ICA output (continued)

Fishing Mortality (per year)

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	0.0257	0.0186	0.0049	0.0148	0.0126	0.0071	0.0215	0.0256	0.0348	0.0082	0.0351
1	0.2549	0.1291	0.0896	0.1240	0.3084	0.2461	0.1852	0.2980	0.3002	0.3291	0.2680
2	0.4270	0.6136	0.2495	0.2974	0.3889	0.7753	0.5919	0.4221	1.3264	0.7842	0.9727
3	0.3181	0.3415	0.6203	0.2746	0.4121	0.7385	0.7082	0.8042	1.8709	0.9108	1.2659
4	0.3215	0.3903	0.4027	0.2234	0.3686	0.7757	0.5713	0.9244	1.0702	0.8722	1.3232
5	0.2455	0.3756	0.4971	0.1417	0.3013	0.6549	0.8322	0.8262	1.2339	1.0507	0.8710
6	0.2924	0.3416	0.7217	0.1643	0.2208	0.5035	0.3854	1.0026	1.1693	1.9001	1.0699
7	0.5210	0.2284	0.5325	0.2322	0.2486	0.4116	0.3694	1.4791	1.5574	1.2793	4.0734
8	0.4285	0.4105	0.5071	0.2555	0.4135	0.6945	0.6094	0.9649	1.4110	1.1914	1.6278
9	0.4285	0.4105	0.5071	0.2555	0.4135	0.6945	0.6094	0.9649	1.4110	1.1914	1.6278

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.0339	0.0583	0.0459	0.0747	0.1506	0.1432	0.0960	0.0448	0.0833	0.1250	0.4801
1	0.6018	0.5776	0.6735	0.4489	0.6849	0.2365	0.2884	0.1965	0.1639	0.1126	0.2835
2	0.8822	0.8113	1.0198	1.0272	1.2917	1.3219	0.2107	0.0234	0.0927	0.3560	0.3221
3	1.2142	0.8007	1.3296	0.9671	1.4967	1.3556	1.3441	0.0394	0.0641	0.4081	0.2674
4	1.2231	0.7988	0.9856	0.9845	1.3462	1.6949	0.3771	0.0947	0.0865	0.2844	0.2922
5	1.0660	0.5461	0.9490	1.1782	1.8071	1.4728	1.0919	0.0142	0.0472	0.2412	0.3878
6	2.5262	0.4990	1.3552	1.0709	1.2476	0.9269	0.5880	0.0651	0.0106	0.0603	0.3784
7	2.5300	0.0887	0.7510	0.7385	1.9617	1.3817	0.5381	0.0443	0.3520	0.0860	0.8094
8	1.7087	0.7568	1.2422	1.0989	1.6886	1.3681	0.7483	0.1114	0.1626	0.2657	0.4917
9	1.7087	0.7568	1.2422	1.0989	1.6886	1.3681	0.7483	0.1114	0.1626	0.2657	0.4917

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	0.3330	0.3980	0.2253	0.0852	0.0622	0.1618	0.1232	0.1240	0.0602	0.1121	0.2178
1	0.2238	0.2503	0.2041	0.3805	0.3153	0.3740	0.5819	0.4241	0.4248	0.3166	0.2888
2	0.2582	0.3000	0.3122	0.4014	0.4552	0.4055	0.3580	0.4005	0.3682	0.5166	0.5691
3	0.5036	0.3206	0.4254	0.6632	0.5166	0.4981	0.3997	0.4141	0.3726	0.4388	0.6512
4	0.2379	0.4301	0.5272	0.7244	0.5693	0.5775	0.5673	0.5534	0.4746	0.4634	0.6981
5	0.1472	0.2624	0.6118	0.6416	0.5356	0.5926	0.6401	0.6264	0.4965	0.4953	0.6417
6	0.1337	0.3245	0.3366	0.6950	0.6845	0.5984	0.6267	0.6524	0.4541	0.4724	0.6313
7	0.1923	0.3526	0.6295	0.5022	0.7369	0.5391	0.6172	0.6136	0.5932	0.3732	0.5996
8	0.3096	0.4002	0.5186	0.6998	0.6630	0.6353	0.7071	0.6616	0.5836	0.5469	0.6981
9	0.3096	0.4002	0.5186	0.6998	0.6630	0.6353	0.7071	0.6616	0.5836	0.5469	0.6981

AGE	1993	1994	1995	1996	1997	1998
0	0.2735	0.2446	0.2895	0.1229	0.0158	0.0179
1	0.3627	0.3243	0.3839	0.1629	0.0613	0.0692
2	0.7147	0.6391	0.7565	0.3211	0.2330	0.2629
3	0.8177	0.7312	0.8656	0.3674	0.3310	0.3736
4	0.8766	0.7839	0.9279	0.3939	0.3547	0.4004
5	0.8057	0.7205	0.8529	0.3620	0.3258	0.3677
6	0.7927	0.7088	0.8391	0.3562	0.3210	0.3623
7	0.7530	0.6733	0.7970	0.3383	0.3042	0.3434
8	0.8766	0.7839	0.9279	0.3939	0.3547	0.4004
9	0.8766	0.7839	0.9279	0.3939	0.3547	0.4004

Table 2.8.3: North Sea herring ICA output (continued)

Population Abundance (1 January) (Billions)

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	12.11	108.90	46.28	47.66	62.79	34.90	27.86	40.26	38.70	21.59	41.09
1	16.48	4.34	39.32	16.94	17.27	22.81	12.75	10.03	14.44	13.75	7.88
2	3.76	4.70	1.40	13.23	5.51	4.67	6.56	3.90	2.74	3.93	3.64
3	7.92	1.82	1.88	0.81	7.28	2.76	1.59	2.69	1.89	0.54	1.33
4	0.63	4.72	1.06	0.83	0.50	3.95	1.08	0.64	0.99	0.24	0.18
5	0.81	0.41	2.89	0.64	0.60	0.32	1.64	0.55	0.23	0.31	0.09
6	0.47	0.57	0.26	1.59	0.50	0.40	0.15	0.65	0.22	0.06	0.10
7	0.32	0.32	0.37	0.11	1.22	0.36	0.22	0.09	0.21	0.06	0.01
8	0.39	0.17	0.23	0.20	0.08	0.86	0.22	0.14	0.02	0.04	0.02
9	0.43	0.27	0.23	0.24	0.18	0.16	0.54	0.29	0.13	0.04	0.02

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	32.33	20.87	10.16	21.77	2.95	2.79	4.40	4.67	10.65	16.82	37.99
1	14.59	11.50	7.24	3.57	7.43	0.93	0.89	1.47	1.64	3.61	5.46
2	2.22	2.94	2.37	1.36	0.84	1.38	0.27	0.25	0.44	0.51	1.19
3	1.02	0.68	0.97	0.63	0.36	0.17	0.27	0.16	0.18	0.30	0.27
4	0.31	0.25	0.25	0.21	0.20	0.07	0.04	0.06	0.13	0.14	0.16
5	0.04	0.08	0.10	0.08	0.07	0.05	0.01	0.02	0.05	0.11	0.09
6	0.03	0.01	0.04	0.04	0.02	0.01	0.01	0.00	0.02	0.04	0.08
7	0.03	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.02	0.04
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
9	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	65.00	62.03	53.69	81.03	97.27	86.02	42.77	41.05	35.08	35.27	63.12
1	8.65	17.14	15.33	15.77	27.37	33.63	26.92	13.91	13.34	12.15	11.60
2	1.51	2.54	4.91	4.60	3.96	7.35	8.51	5.53	3.35	3.21	3.26
3	0.64	0.87	1.40	2.66	2.28	1.86	3.63	4.41	2.75	1.72	1.42
4	0.17	0.31	0.51	0.75	1.12	1.11	0.93	1.99	2.39	1.55	0.91
5	0.11	0.12	0.19	0.27	0.33	0.57	0.57	0.48	1.04	1.34	0.88
6	0.06	0.09	0.08	0.09	0.13	0.17	0.29	0.27	0.23	0.57	0.74
7	0.05	0.05	0.06	0.05	0.04	0.06	0.09	0.14	0.13	0.13	0.32
8	0.01	0.03	0.03	0.03	0.03	0.02	0.03	0.04	0.07	0.06	0.08
9	0.00	0.04	0.05	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.05

AGE	1993	1994	1995	1996	1997	1998	1999
0	56.95	37.26	47.94	52.32	50.93	20.82	95.33
1	18.68	15.94	10.73	13.20	17.02	18.44	7.52
2	3.20	4.78	4.24	2.69	4.13	5.89	6.33
3	1.37	1.16	1.87	1.47	1.45	2.42	3.35
4	0.61	0.49	0.46	0.64	0.84	0.85	1.36
5	0.41	0.23	0.20	0.16	0.39	0.53	0.52
6	0.42	0.16	0.10	0.08	0.10	0.26	0.33
7	0.36	0.17	0.07	0.04	0.05	0.07	0.16
8	0.16	0.15	0.08	0.03	0.03	0.03	0.04
9	0.07	0.09	0.12	0.06	0.03	0.03	0.04

Weighting factors for the catches in number

AGE	1992	1993	1994	1995	1996	1997	1998
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.8.3: North Sea herring ICA output (continued)

Predicted SSB Index Values

MLAI < 10 mm

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	8.51	10.47	15.76	22.62	35.88	59.48	62.33	63.83	74.03	96.77	108.60

	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	98.99	82.21	59.08	37.26	41.54	40.53	39.45	53.92	73.23

Predicted Age-Structured Index Values

ACO89: acoustic survey 2-9+ Predicted (Thousands)

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
2	6004.8	3698.9	3266.4	3221.1	2918.1	4549.3	3781.8	3049.3	4909.8	6892.9
3	5672.9	3616.9	2179.7	1602.1	1407.9	1252.8	1876.7	1946.2	1947.5	3187.2
4	2856.5	3572.1	2334.8	1200.3	726.8	623.6	533.0	1008.2	1336.8	1326.0
5	720.3	1685.7	2185.4	1324.6	559.9	327.9	272.7	286.2	702.2	925.9
6	421.5	400.8	984.5	1170.1	607.6	249.8	141.5	144.6	193.0	470.5
7	225.5	208.5	244.6	526.1	535.1	270.0	107.7	74.0	95.8	127.1
8	72.5	122.4	116.5	138.9	244.6	244.4	118.1	59.7	51.6	66.1
9	37.3	58.3	68.2	94.2	131.3	166.1	213.1	133.8	73.3	69.1

IBTSA: 2-5+ Predicted

AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	346.6	668.0	618.7	529.9	988.1	1151.5	744.8	452.5	425.6	429.2	413.7
3	83.9	133.5	247.1	215.6	176.6	348.2	422.2	264.5	163.9	131.9	124.4
4	18.8	30.3	43.0	65.9	65.3	54.4	117.1	141.6	92.1	52.3	34.2
5	11.6	13.9	16.5	19.3	29.1	33.9	32.5	52.0	74.9	71.3	47.7

AGE	1994	1995	1996	1997	1998	1999
2	624.5	545.7	365.7	567.1	806.4	866.9
3	106.7	169.2	142.0	139.9	233.2	322.9
4	28.2	25.6	38.6	50.4	50.9	81.8
5	27.4	19.4	13.1	21.5	32.6	38.8

IBTSY: 1-wr Predicted

AGE	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	183.3	404.8	600.1	957.3	1891.2	1700.8	1711.6	2995.9	3653.3	2849.6	1502.0

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	1440.0	1329.7	1273.6	2031.8	1742.2	1164.8	1472.7	1922.9	2081.5	849.0

MIK: MIK 0-wr Predicted

AGE	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	11.16	11.92	27.05	42.49	91.79	159.95	151.40	133.90	205.65	247.59	216.26

AGE	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	108.05	103.68	89.32	89.22	157.57	141.18	92.72	118.60	132.17	130.40	53.28

AGE	1999
0	244.00

Table 2.8.3: North Sea herring ICA output (continued)

Fitted Selection Pattern

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	0.0799	0.0476	0.0121	0.0662	0.0341	0.0092	0.0376	0.0277	0.0325	0.0094	0.0265
1	0.7929	0.3307	0.2226	0.5553	0.8368	0.3173	0.3242	0.3223	0.2805	0.3773	0.2025
2	1.3280	1.5721	0.6197	1.3314	1.0550	0.9995	1.0361	0.4567	1.2394	0.8991	0.7351
3	0.9893	0.8751	1.5406	1.2293	1.1180	0.9521	1.2397	0.8700	1.7481	1.0443	0.9567
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.7637	0.9622	1.2346	0.6342	0.8176	0.8442	1.4567	0.8938	1.1529	1.2046	0.6582
6	0.9094	0.8752	1.7923	0.7357	0.5990	0.6490	0.6746	1.0846	1.0925	2.1785	0.8085
7	1.6205	0.5853	1.3225	1.0396	0.6744	0.5307	0.6467	1.6001	1.4552	1.4668	3.0783
8	1.3328	1.0517	1.2593	1.1439	1.1218	0.8954	1.0667	1.0438	1.3184	1.3659	1.2301
9	1.3328	1.0517	1.2593	1.1439	1.1218	0.8954	1.0667	1.0438	1.3184	1.3659	1.2301

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.0278	0.0730	0.0466	0.0759	0.1119	0.0845	0.2547	0.4737	0.9628	0.4397	1.6432
1	0.4920	0.7231	0.6834	0.4560	0.5087	0.1395	0.7647	2.0762	1.8943	0.3961	0.9701
2	0.7213	1.0157	1.0347	1.0434	0.9596	0.7799	0.5587	0.2469	1.0718	1.2519	1.1025
3	0.9927	1.0024	1.3491	0.9824	1.1118	0.7998	3.5642	0.4165	0.7404	1.4353	0.9152
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8715	0.6837	0.9629	1.1968	1.3424	0.8690	2.8954	0.1501	0.5455	0.8483	1.3272
6	2.0653	0.6247	1.3750	1.0879	0.9268	0.5469	1.5591	0.6879	0.1225	0.2120	1.2949
7	2.0685	0.1111	0.7620	0.7501	1.4573	0.8152	1.4270	0.4681	4.0687	0.3023	2.7700
8	1.3970	0.9475	1.2604	1.1162	1.2544	0.8072	1.9843	1.1767	1.8791	0.9344	1.6827
9	1.3970	0.9475	1.2604	1.1162	1.2544	0.8072	1.9843	1.1767	1.8791	0.9344	1.6827

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	1.3995	0.9255	0.4274	0.1176	0.1092	0.2801	0.2171	0.2242	0.1269	0.2420	0.3120
1	0.9406	0.5820	0.3871	0.5252	0.5540	0.6476	1.0259	0.7664	0.8951	0.6833	0.4137
2	1.0851	0.6976	0.5922	0.5541	0.7996	0.7022	0.6311	0.7238	0.7758	1.1148	0.8153
3	2.1167	0.7453	0.8069	0.9155	0.9074	0.8624	0.7046	0.7483	0.7850	0.9469	0.9328
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.6187	0.6100	1.1605	0.8856	0.9408	1.0261	1.1285	1.1320	1.0461	1.0690	0.9191
6	0.5621	0.7546	0.6385	0.9594	1.2024	1.0363	1.1047	1.1789	0.9569	1.0195	0.9043
7	0.8080	0.8199	1.1941	0.6932	1.2944	0.9335	1.0880	1.1088	1.2499	0.8054	0.8589
8	1.3013	0.9306	0.9837	0.9660	1.1647	1.1001	1.2465	1.1955	1.2298	1.1803	1.0000
9	1.3013	0.9306	0.9837	0.9660	1.1647	1.1001	1.2465	1.1955	1.2298	1.1803	1.0000

AGE	1993	1994	1995	1996	1997	1998
0	0.3120	0.3120	0.3120	0.3120	0.0446	0.0446
1	0.4137	0.4137	0.4137	0.4137	0.1728	0.1728
2	0.8153	0.8153	0.8153	0.8153	0.6567	0.6567
3	0.9328	0.9328	0.9328	0.9328	0.9330	0.9330
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.9191	0.9191	0.9191	0.9191	0.9183	0.9183
6	0.9043	0.9043	0.9043	0.9043	0.9049	0.9049
7	0.8589	0.8589	0.8589	0.8589	0.8576	0.8576
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 2.8.3: North Sea herring ICA output (continued)

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 6	SoP (%)
1960	12113160	3881687	2004417	696200	0.3473	0.3209	84
1961	108900670	4460853	1752543	696700	0.3975	0.4125	88
1962	46283780	4479157	1192247	627800	0.5266	0.4983	85
1963	47657740	4708530	2263665	716000	0.3163	0.2203	116
1964	62794120	4860575	2091062	871200	0.4166	0.3383	93
1965	34899760	4394978	1498975	1168800	0.7797	0.6896	86
1966	27864980	3346834	1309983	895500	0.6836	0.6178	93
1967	40261930	2826594	931938	695500	0.7463	0.7959	85
1968	38700920	2525552	417423	717800	1.7196	1.3341	79
1969	21585990	1907443	426186	546700	1.2828	1.1036	103
1970	41089570	1923039	375528	563100	1.4995	1.1006	103
1971	32333540	1850949	267018	520100	1.9478	1.3824	93
1972	20868450	1551008	289102	497500	1.7208	0.6912	108
1973	10157850	1158206	234499	484000	2.0640	1.1278	104
1974	21767420	915315	163229	275100	1.6854	1.0456	103
1975	2948050	685702	83734	312800	3.7356	1.4379	107
1976	2791980	365244	81009	174800	2.1578	1.3544	104
1977	4401860	218445	52296	46000	0.8796	0.7224	83
1978	4673160	234305	70813	11000	0.1553	0.0474	82
1979	10654760	391956	113799	25100	0.2206	0.0602	99
1980	16823240	641583	138579	70764	0.5106	0.2700	91
1981	37994460	1171988	204266	174879	0.8561	0.3296	99
1982	65002470	1859991	287904	275079	0.9555	0.2561	102
1983	62029680	2502235	446135	387202	0.8679	0.3275	92
1984	53690050	2749539	720897	428631	0.5946	0.4426	94
1985	81025890	3296461	753579	613780	0.8145	0.6251	95
1986	97270370	3818608	770870	671488	0.8711	0.5522	87
1987	86023580	4212307	887287	792058	0.8927	0.5344	98
1988	42772980	3850008	1144303	887686	0.7757	0.5184	85
1989	41046680	3424437	1276674	787899	0.6171	0.5294	96
1990	35082330	3222867	1169165	645229	0.5519	0.4332	95
1991	35270180	3013652	980157	658008	0.6713	0.4773	98
1992	63118330	3020642	716278	716799	1.0007	0.6383	100
1993	56948820	3015878	462326	671397	1.4522	0.8015	97
1994	37264770	2458284	512679	568234	1.1084	0.7167	95
1995	47937940	2050978	500848	639146	1.2761	0.8484	98
1996	52318630	1697506	488163	306157	0.6272	0.3601	99
1997	50934090	2163234	656703	247909	0.3775	0.3131	100
1998	20816140	2508599	878178	380178	0.4329	0.3534	99

No of years for separable analysis : 7
Age range in the analysis : 0 . . . 9
Year range in the analysis : 1960 . . . 1998
Number of indices of SSB : 1
Number of age-structured indices : 4
Stock-recruit relationship to be fitted.
Parameters to estimate : 55
Number of observations : 313

Two selection vectors to be fitted.
Selection assumed constant up to and including : 1996
Abrupt change in selection specified.

Table 2.8.3: North Sea herring ICA output (continued)

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	1992	0.6981	11	0.5592	0.8715	0.6234	0.7818	0.7026
2	1993	0.8766	10	0.7101	1.0821	0.7873	0.9761	0.8817
3	1994	0.7839	11	0.6293	0.9763	0.7008	0.8768	0.7888
4	1995	0.9279	11	0.7425	1.1596	0.8282	1.0397	0.9339
5	1996	0.3939	13	0.3035	0.5111	0.3448	0.4499	0.3974
6	1997	0.3547	16	0.2589	0.4862	0.3021	0.4166	0.3594
7	1998	0.4004	17	0.2856	0.5614	0.3370	0.4757	0.4064

Separable Model: Selection (S1) by age 1992 1996

8	0	0.3120	14	0.2357	0.4130	0.2704	0.3600	0.3152
9	1	0.4137	14	0.3132	0.5464	0.3590	0.4768	0.4179
10	2	0.8153	13	0.6292	1.0564	0.7143	0.9305	0.8224
11	3	0.9328	12	0.7256	1.1992	0.8206	1.0604	0.9405
	4	1.0000	Fixed : Reference Age					
12	5	0.9191	12	0.7241	1.1667	0.8138	1.0381	0.9260
13	6	0.9043	11	0.7247	1.1284	0.8077	1.0124	0.9101
14	7	0.8589	11	0.6868	1.0742	0.7663	0.9628	0.8645
	8	1.0000	Fixed : Last true age					

Separable Model: Selection (S2) by age from 1997 to 1998

15	0	0.0446	27	0.0263	0.0759	0.0340	0.0585	0.0463
16	1	0.1728	26	0.1030	0.2897	0.1327	0.2249	0.1789
17	2	0.6567	25	0.3977	1.0843	0.5084	0.8482	0.6785
18	3	0.9330	12	0.7235	1.2032	0.8195	1.0623	0.9409
	4	1.0000	Fixed : Reference Age					
19	5	0.9183	12	0.7212	1.1693	0.8118	1.0388	0.9253
20	6	0.9049	11	0.7225	1.1332	0.8067	1.0149	0.9108
21	7	0.8576	11	0.6835	1.0761	0.7638	0.9629	0.8634
	8	1.0000	Fixed : Last true age					

Separable model: Populations in year 1998

22	0	20816142	17	14819802	29238702	17503126	24756250	21131266
23	1	18443242	15	13662004	24897752	15825084	21494558	18660670
24	2	5889536	13	4549414	7624417	5162667	6718742	5940853
25	3	2421762	13	1876369	3125680	2126151	2758473	2442370
26	4	850011	13	655759	1101804	744620	970318	857491
27	5	530306	13	403208	697468	461119	609873	535513
28	6	256732	14	193469	340681	222225	296598	259421
29	7	67561	16	49247	92685	57496	79388	68446
30	8	33266	17	23695	46704	27979	39553	33769

Separable model: Populations at age

31	1992	82347	26	49334	137453	63406	106948	85209
32	1993	159959	20	107937	237052	130872	195510	163213
33	1994	151845	18	106545	216406	126735	181930	154346
34	1995	79404	16	56961	110691	67025	94070	80553
35	1996	29953	18	20870	42989	24911	36017	30467
36	1997	25313	17	18062	35476	21309	30070	25692

Recruitment in year 1999

37	1998	95329154	27	55942233	162446994	72630773	125121173	98920179

SSB Index catchabilities

MLAI < 10 mm

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

38	1	Q	2.867	11	2.498	3.934	2.792	3.520	3.156
39	1	K	.4023E-04	11	.1045E-03	.1646E-03	.1168E-03	.1473E-03	.1390E-03

Table 2.8.3: North Sea herring ICA output (continued)

PARAMETER ESTIMATES (continued)

Parm. No.			Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Age-structured index catchabilities									
ACO89: acoustic survey 2-9+									
Linear model fitted. Slopes at age :									
40	2	Q	1.595	24	1.266	3.249	1.595	2.579	2.088
41	3	Q	1.804	24	1.432	3.681	1.804	2.921	2.363
42	4	Q	2.054	24	1.629	4.202	2.054	3.332	2.694
43	5	Q	2.258	24	1.789	4.634	2.258	3.670	2.965
44	6	Q	2.363	24	1.869	4.872	2.363	3.853	3.109
45	7	Q	2.401	24	1.891	5.013	2.401	3.948	3.175
46	8	Q	2.617	25	2.046	5.592	2.617	4.371	3.495
47	9	Q	3.015	24	2.376	6.286	3.015	4.954	3.986
IBTSA: 2-5+									
Linear model fitted. Slopes at age :									
48	2	Q	.1469E-03	13	.1295E-03	.2166E-03	.1469E-03	.1910E-03	.1689E-03
49	3	Q	.1034E-03	13	.9116E-04	.1527E-03	.1034E-03	.1346E-03	.1190E-03
50	4	Q	.6378E-04	13	.5618E-04	.9435E-04	.6378E-04	.8310E-04	.7344E-04
51	5	Q	.3764E-04	13	.3311E-04	.5589E-04	.3764E-04	.4917E-04	.4341E-04
IBTSY: 1-wr									
Linear model fitted. Slopes at age :									
52	1	Q	.1290E-03	6	.1216E-03	.1547E-03	.1290E-03	.1458E-03	.1374E-03
MIK: MIK 0-wr									
Linear model fitted. Slopes at age :									
53	0	Q	.2907E-05	5	.2746E-05	.3463E-05	.2907E-05	.3272E-05	.3089E-05
Parameters of the stock-recruit relationship									
54	1	a	.8149E+08	39	.5582E+08	.2616E+09	.8149E+08	.1792E+09	.1306E+09
55	1	b	.6639E+06	66	.3512E+06	.4731E+07	.6639E+06	.2502E+07	.1606E+07

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1992	1993	1994	1995	1996	1997	1998
0	0.2621	0.1531	-0.1474	0.0774	-0.4640	-0.1025	0.1002
1	0.2015	0.0343	-0.4728	-0.3111	0.2348	-0.1988	0.2017
2	0.0367	-0.1990	-0.1053	-0.2303	0.0964	-0.0911	0.0249
3	-0.3396	-0.1403	-0.1198	-0.1029	0.4208	0.2894	-0.2709
4	-0.1871	-0.1034	0.3024	-0.0903	-0.0215	0.0818	0.0310
5	-0.1030	-0.0030	-0.0278	0.0751	0.2247	-0.1015	0.0339
6	0.1249	0.0256	0.1355	0.0143	-0.0977	-0.0878	0.1334
7	0.0929	0.0407	-0.0544	0.0589	0.0232	-0.0812	-0.1333
8	-0.0102	-0.0250	-0.1213	0.1502	-0.1643	0.3163	-0.0469

SPAWNING BIOMASS INDEX RESIDUALS

MLAI < 10 mm

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	0.5694	0.0102	0.0214	-0.0275	-0.2420	-0.1443	0.2228	-0.4632	-0.0529	0.3674	0.2198

	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.5460	0.0831	-0.3356	-0.1877	-0.6751	-0.4498	0.2437	0.1427	0.1511

Table 2.8.3: North Sea herring ICA output (continued)

AGE-STRUCTURED INDEX RESIDUALS

ACO89: acoustic survey 2-9+

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
2	-0.4772	-0.2191	-0.1420	0.2603	0.2401	-0.3271	0.0045	0.4004	0.2593	0.0008
3	-0.4137	-0.0243	-0.3731	0.0191	0.2919	-0.2693	0.0912	0.3720	0.5234	-0.2173
4	-0.5721	-0.0583	-0.1050	0.1517	0.2237	-0.3741	0.2076	0.0755	0.2380	0.2126
5	-0.3894	-0.2228	-0.0967	0.1310	0.3507	0.1018	-0.0026	0.0830	-0.0146	0.0592
6	-0.4055	-0.0146	-0.2747	0.1137	0.2599	0.2508	0.2125	-0.3817	0.2944	-0.0553
7	-0.6307	0.0121	0.0687	-0.1043	0.0202	0.1947	0.2262	0.1124	-0.1928	0.2927
8	-0.4992	0.0905	-0.0398	0.1094	-0.3180	-0.1051	-0.0707	0.7994	0.4135	-0.3809
9	-0.5270	-0.3041	-0.1971	0.5484	-0.1241	-0.2296	-0.9308	0.4315	0.7678	0.5640

IBTSA: 2-5+

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	-1.157	-1.423	0.146	0.221	-0.165	1.270	0.040	0.248	0.624	-0.130	0.611
3	-0.692	-0.577	0.035	0.086	-0.412	0.810	-0.027	0.197	0.546	0.317	0.640
4	-0.294	0.053	-0.502	-0.144	-0.153	0.011	-0.309	0.649	0.999	0.186	0.275
5	1.079	-0.689	0.782	-0.129	0.412	-0.266	-1.178	0.297	0.819	0.359	0.293

Age	1994	1995	1996	1997	1998	1999
2	0.557	0.856	-0.634	-0.261	-0.082	-0.722
3	0.623	-0.107	-1.195	0.257	-0.952	0.449
4	0.820	0.585	-1.089	-0.393	-0.935	0.241
5	0.379	-0.768	-0.377	-0.429	-0.540	-0.046

IBTSY: 1-wr

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	-0.0638	-0.2604	-0.3310	-0.2152	-0.4061	-0.1665	0.1950	-0.1651	0.0073	0.4635	0.4305

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	-0.3448	-0.1365	-0.0934	0.3695	-0.0441	0.0180	0.1639	0.7495	-0.0070	-0.1634

MIK: MIK 0-wr

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	0.427	0.094	0.656	0.867	-0.180	-0.178	-0.500	-0.152	-0.126	-0.333	0.225

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.447	-0.373	-1.238	-0.244	0.242	0.298	0.092	0.068	-0.216	0.127	-0.003

Age	1999
0	0.000

Table 2.8.3: North Sea herring ICA output (continued)

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1992 to 1998

Variance	0.0734
Skewness test stat.	-1.1150
Kurtosis test statistic	0.5352
Partial chi-square	0.1515
Significance in fit	0.0000
Degrees of freedom	34

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR MLAI < 10 mm

Power catchability relationship assumed
Last age is a plus-group

Variance	0.1149
Skewness test stat.	-0.3286
Kurtosis test statistic	-0.4606
Partial chi-square	0.5847
Significance in fit	0.0000
Number of observations	20
Degrees of freedom	18
Weight in the analysis	1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR ACO89: acoustic survey 2-9+

Linear catchability relationship assumed

Age	2	3	4	5	6	7	8	9
Variance	0.0105	0.0130	0.0098	0.0052	0.0092	0.0089	0.0187	0.0380
Skewness test stat.	-0.2733	0.3059	-1.3355	-0.4289	-0.5528	-1.7073	0.9710	-0.1128
Kurtosis test statisti	-0.7598	-0.7769	-0.1588	-0.0154	-0.8796	0.7758	-0.0354	-0.7185
Partial chi-square	0.0062	0.0080	0.0062	0.0034	0.0066	0.0066	0.0151	0.0297
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	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250

DISTRIBUTION STATISTICS FOR IBTSA: 2-5+

Linear catchability relationship assumed

Age	2	3	4	5
Variance	0.1243	0.0859	0.0828	0.0972
Skewness test stat.	-0.5372	-0.9775	-0.1672	-0.0972
Kurtosis test statisti	-0.2962	-0.5719	-0.4720	-0.7135
Partial chi-square	0.3112	0.2704	0.3425	0.5052
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	17	17	17	17
Degrees of freedom	16	16	16	16
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

DISTRIBUTION STATISTICS FOR IBTSY: 1-wr

Linear catchability relationship assumed

Age	1
Variance	0.0893
Skewness test stat.	1.7009
Kurtosis test statisti	0.1467
Partial chi-square	0.2427
Significance in fit	0.0000
Number of observations	21
Degrees of freedom	20
Weight in the analysis	1.0000

DISTRIBUTION STATISTICS FOR MIK: MIK 0-wr

Linear catchability relationship assumed

Age	0
Variance	0.1837
Skewness test stat.	-1.1522
Kurtosis test statisti	1.5964
Partial chi-square	0.9827
Significance in fit	0.0000
Number of observations	23
Degrees of freedom	22
Weight in the analysis	1.0000

Table 2.8.3: North Sea herring ICA output (continued)

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance	SSQ	Data	Parameters	d.f.	Variance
Total for model	56.9268	313	55	258	0.2206
Catches at age	1.9818	63	36	27	0.0734
SSB Indices					
MLAI < 10 mm	2.0686	20	2	18	0.1149
Aged Indices					
ACO89: acoustic survey 2-9+	8.1536	80	8	72	0.1132
IBTSA: 2-5+	24.9716	68	4	64	0.3902
IBTSY: 1-wr	1.7863	21	1	20	0.0893
MIK: MIK 0-wr	4.0415	23	1	22	0.1837
Stock-recruit model	13.9233	38	2	36	0.3868

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	11.7057	313	55	258	0.0454
Catches at age	1.9818	63	36	27	0.0734
SSB Indices					
MLAI < 10 mm	2.0686	20	2	18	0.1149
Aged Indices					
ACO89: acoustic survey 2-9+	0.1274	80	8	72	0.0018
IBTSA: 2-5+	1.5607	68	4	64	0.0244
IBTSY: 1-wr	1.7863	21	1	20	0.0893
MIK: MIK 0-wr	4.0415	23	1	22	0.1837
Stock-recruit model	0.1392	38	2	36	0.0039

TABLE 2.10.1 Input data for Short term projections

Data for 1998 =Reference year

				Catches in numbers by fleet					Fraction of Stock in North sea
	Stock	Fishing		North Sea		IIIa			The remainder is in the IIIa
Age	Numbers	mortality	Nat. mort	A	B	C	D	E	
0	20820		1	0	208.2	15	34.79		0.63
1	18440		1	19.2	231.6	602.2	105.65		0.84
2		0.2629	0.3	1024.6	32.8	134.5	22.11		
3		0.3736	0.2	497.3	1.7	24.8	1.28		
4		0.4004	0.1	252.7	4.5	17.9	1.11		
5		0.3677	0.1	157.3	0.8	2.7	0.32		
6		0.3623	0.1	81.5	0.6	3	0		
7		0.3434	0.1	15.1	0.1	1.2	0		
8		0.4004	0.1	9.4	0.2	0.5	0		
9+		0.4004	0.1	9.4	0	0	0		

Data for 1999

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

	Stock	Nat. mort	Weight	Fraction	Weight in catch by fleet					Fraction of Stock in North sea
Age	Numbers		in sp.stock	mature	A	B	C	D	E	The remainder is in the IIIa
0	95330	1	0.007	0	0	16	25.5	23		0.54
1	7520	1	0.046	0	76.5	32.5	45.5	23		0.63
2	6330	0.3	0.107	0.66	119	59.5	83	49.5		
3	3350	0.2	0.181	0.92	147	109.5	124.5	97.5		
4	1360	0.1	0.232	1	188	134	167	133.5		
5	520	0.1	0.265	1	225.5	174.5	182	167.5		
6	330	0.1	0.273	1	233.5	178	196.5	168		
7	160	0.1	0.268	1	239	232	187	192		
8	40	0.1	0.289	1	249.5	285	213.5	217		
9+	40	0.1	0.346	1	291.5					

Proportions before spawning
F 0.67
M 0.67

Data for 2000

	Recruits	Nat. mort	Weight	Fraction	Weight in catch by fleet					Fraction of Stock in North sea
Age			in sp.stock	mature	A	B	C	D	E	The remainder is in the IIIa
0	44000	1	0.007	0	0	16	25.5	23		0.68
1		1	0.046	0	76.5	32.5	45.5	23		0.54
2		0.3	0.107	0.66	119	59.5	83	49.5		
3		0.2	0.181	0.92	147	109.5	124.5	97.5		
4		0.1	0.232	1	188	134	167	133.5		
5		0.1	0.265	1	225.5	174.5	182	167.5		
6		0.1	0.273	1	233.5	178	196.5	168		
7		0.1	0.268	1	239	232	187	192		
8		0.1	0.289	1	249.5	285	213.5	217		
9+		0.1	0.346	1	291.5					

Proportions before spawning
F 0.67
M 0.67

Data for 2001

	Recruits	Nat. mort	Weight	Fraction	Weight in catch by fleet					Fraction of Stock in North sea
Age			in sp.stock	mature	A	B	C	D	E	The remainder is in the IIIa
0	44000	1	0.007	0	0	16	25.5	23		0.68
1		1	0.046	0	76.5	32.5	45.5	23		0.68
2		0.3	0.107	0.66	119	59.5	83	49.5		
3		0.2	0.181	0.92	147	109.5	124.5	97.5		
4		0.1	0.232	1	188	134	167	133.5		
5		0.1	0.265	1	225.5	174.5	182	167.5		
6		0.1	0.273	1	233.5	178	196.5	168		
7		0.1	0.268	1	239	232	187	192		
8		0.1	0.289	1	249.5	285	213.5	217		
9+		0.1	0.346	1	291.5					

Proportions before spawning
F 0.67
M 0.67

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

Year-class	MIK-0	IBTS 1-ring Prop.IIIa	Fitted (Predicted in bold) Proportion 1-ringers in IIIa: Inverse link	(se)	Identity link	(se)
1981	133.9	0.254	0.29	0.025	0.31	0.028
1982	91.8	0.276	0.25	0.025	0.26	0.025
1983	115	0.255	0.27	0.025	0.29	0.025
1984	181.3	0.439	0.36	0.034	0.38	0.043
1985	177.4	0.267	0.35	0.032	0.37	0.041
1986	270.9	0.636	0.65	0.191	0.49	0.078
1987	168.9	0.3	0.34	0.030	0.36	0.039
1988	71.4	0.177	0.23	0.025	0.23	0.027
1989	25.9	0.134	0.20	0.025	0.17	0.041
1990	69.9	0.199	0.23	0.025	0.23	0.028
1991	200.7	0.611	0.40	0.044	0.40	0.050
1992	190.1	0.25	0.38	0.038	0.39	0.046
1993	101.7	0.23	0.26	0.025	0.27	0.024
1994	126.9	0.45	0.28	0.025	0.30	0.027
1995	106.2	0.3	0.26	0.025	0.28	0.024
1996	148.1	0.16	0.31	0.026	0.33	0.032
1997	53.1	0.37	0.22	0.025	0.21	0.032
1998	244		0.53	0.102	0.46	0.067
Average	137.6		0.30		0.32	

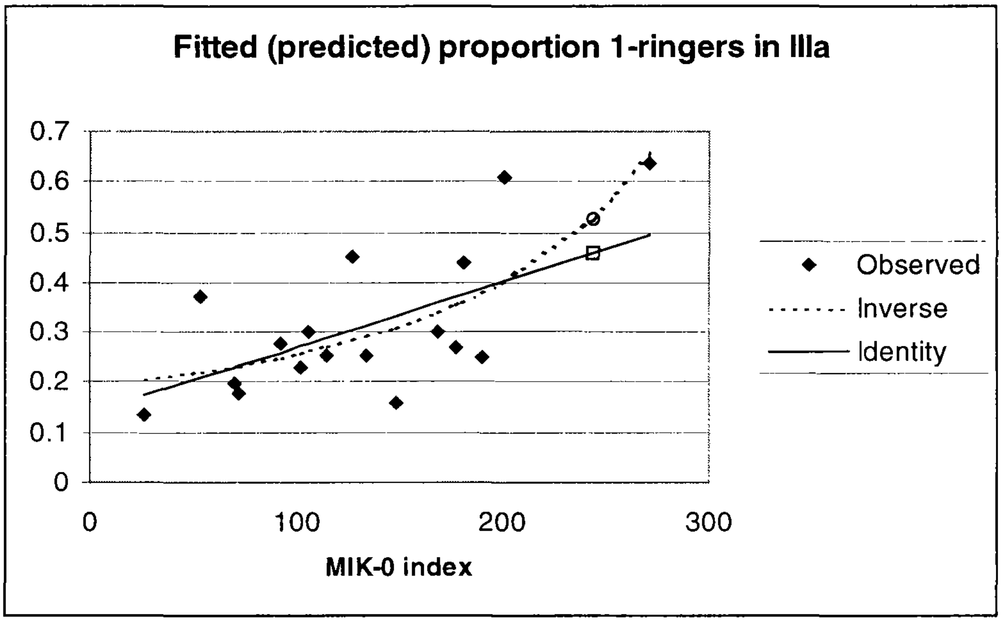


Table 2.10.3 North Sea Herring – Models of split factors

Data are the same as in Table 2.10.2
Models were fitted in Splus.

Model: Gamma errors, Inverse link
summary(modgin)
Call: glm(formula = prop3a ~ mik0, family = Gamma(link = inverse), data = splitdat, subset = 1:17)
Deviance Residuals:

Min	1Q	Median	3Q	Max
-0.5962222	-0.2650335	-0.1157085	0.1344845	0.5660496

Coefficients:

	Value	Std. Error	t value
(Intercept)	5.26577881	0.691071101	7.619735
mik0	-0.01378387	0.003727759	-3.697629

(Dispersion Parameter for Gamma family taken to be 0.1204686)

Null Deviance: 3.141007 on 16 degrees of freedom

Residual Deviance: 1.720605 on 15 degrees of freedom

Number of Fisher Scoring Iterations: 4

Correlation of Coefficients:

	(Intercept)
mik0	-0.9287429

Model: Gamma errors, Identity link
summary(modgid)
Call: glm(formula = prop3a ~ mik0, family = Gamma(link = identity), data = splitdat, subset = 1:17)
Deviance Residuals:

Min	1Q	Median	3Q	Max
-0.6523648	-0.2421715	-0.141844	0.1587973	0.6363859

Coefficients:

	Value	Std. Error	t value
(Intercept)	0.138529314	0.0500342597	2.768689
mik0	0.001310251	0.0004357545	3.006855

(Dispersion Parameter for Gamma family taken to be 0.1285742)

Null Deviance: 3.141007 on 16 degrees of freedom

Residual Deviance: 1.838576 on 15 degrees of freedom

Number of Fisher Scoring Iterations: 3

Correlation of Coefficients:

	(Intercept)
mik0	-0.8738587

TABLE 2.10.4

NORTH SEA HERRING SHORT TERM PREDICTIONS

Predictions for 1999, based on Catch Constraint in 1999 (in '000t)

F_{juv}	F_{ad}	Fleet F's		Fleet Yields in '000t				TOTAL	SSB
(0-1 ring)	(2-6 ring)	$F_{B\text{-}D\&E}$	F_A	A	B	C	D&E	Yield	1999
0.106	0.300	0.106	0.276	348	33	44	14	439	1169

Prediction summary: Yields for 2000 (in '000t)

Scenario	F_{juv}	F_{ad}	Fleet F's		Fleet Yields in '000t				TOTAL	SSB	SSB
	(0-1 ring)	(2-6 ring)	$F_{B\text{-}D\&E}$	F_A	A	B	C	D&E	Yield	2000	2001
I	0.044	0.200	0.044	0.192	256	24	32	10	323	1316	1832
II	0.070	0.200	0.070	0.188	251	34	32	29	346	1316	1806
III	0.100	0.200	0.100	0.181	242	71	31	30	373	1317	1789
IV	0.120	0.250	0.120	0.227	296	83	37	35	452	1272	1656
V	0.100	0.350	0.099	0.331	411	61	52	26	550	1185	1462

F_{juv} is the average F of ages 0-1 for all fleets
F_{ad} is the average F of ages 2-6 for all fleets
$F_{B\text{-}D\&E}$ is the average F of ages 0-1 for fleets B,C,D&E
F_A is the average F of ages 2-6 for fleet A only

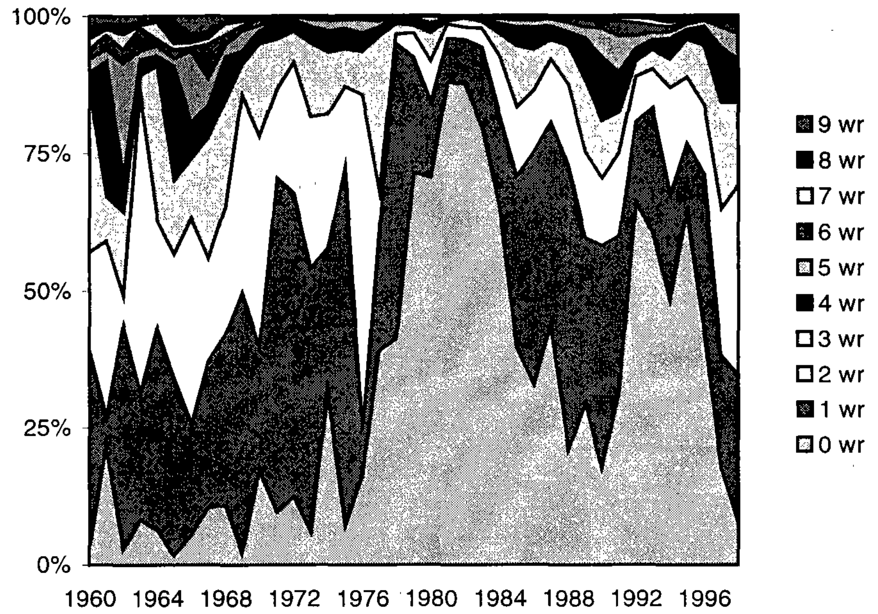
Scenarios are as follows:
Scenario I: Decrease F on all fleets to get F_{ad}=0.2, F_{juv}<=0.1 BUT maintain catch ratios between all fleets as they are in the 1999 catch constraint
Scenario II: Decrease F on fleets A and C to get F_{ad}=0.2, F_{juv}<=0.1, but maintain the ratio for A and C as it is in the 1999 catch constraint
Scenario III: Decrease F on A and C, increase F on B and D&E to get F_{ad}=0.2, F_{juv}=0.1, but maintain the ratios between A/C and B/D as they are in the 1999 catch constraint
Scenario IIV: Decrease F on A and C, increase F on B and D&E to get F_{ad}=0.25, F_{juv}=0.12, but maintain the ratios between A/C and B/D as they are in the 1999 catch constraint
ScenarioV: Decrease F on A and C, increase F on B and D&E to get F_{ad}=0.35, F_{juv}=0.1, but maintain the ratios between A/C and B/D as they are in the 1999 catch constraint

Table 2.11.1 Example of a projection input file, for options F(A)=0.3 and F(B-E)=0.2. Negative exploitation constraints are F-multipliers relative to 1998. The projections were constraint to specified fishing mortalities with no simulation of uncertainty in F.

```
Projection input file

Number of Fleets

          4          10

Mean Catch Ratio by Fleet (1998-1999)

A          B          C          D&E

          0  0.0000     0.8070     0.0581     0.1349

          1  0.0200     0.2416     0.6282     0.1102

          2  0.8440     0.0270     0.1108     0.0182
          3  0.9471     0.0032     0.0472     0.0024
          4  0.9149     0.0163     0.0648     0.0040
          5  0.9763     0.0050     0.0168     0.0020
          6  0.9577     0.0071     0.0353     0.0000
          7  0.9207     0.0061     0.0732     0.0000
          8  0.9307     0.0198     0.0495     0.0000
          9  1.0000     0.0000     0.0000     0.0000
Retention Ogive
          0          1          1          1          1
          1          1          1          1          1
          2          1          1          1          1
          3          1          1          1          1
          4          1          1          1          1
          5          1          1          1          1
          6          1          1          1          1
          7          1          1          1          1
          8          1          1          1          1
          9          1          1          1          1
Exploitation Constraint by Year
       1999         -1         -1         -1         -1
       2000         -1         -1         -1         -1
       2001         -1         -1         -1         -1
       2002         -1         -1         -1         -1
       2003         -1         -1         -1         -1
       2004         -1         -1         -1         -1
       2005         -1         -1         -1         -1
       2006         -1         -1         -1         -1
       2007         -1         -1         -1         -1
       2008         -1         -1         -1         -1
Mean Weight at age in the catches of each fleet
          0  0.0000     0.0160     0.0255     0.0230
          1  0.0765     0.0325     0.0455     0.0230
          2  0.1190     0.0595     0.0830     0.0495
          3  0.1470     0.1095     0.1245     0.0975
          4  0.1880     0.1340     0.1670     0.1335
          5  0.2255     0.1745     0.1820     0.1675
          6  0.2335     0.1780     0.1965     0.1680
          7  0.2390     0.2320     0.1870     0.1920
          8  0.2495     0.2850     0.2135     0.2170
          9  0.2915     0.2850     0.2135     0.2170
Mean weights at age in the discard by fleet
          0  0.0000     0.0160     0.0255     0.0230
          1  0.0765     0.0325     0.0455     0.0230
          2  0.1190     0.0595     0.0830     0.0495
          3  0.1470     0.1095     0.1245     0.0975
          4  0.1880     0.1340     0.1670     0.1335
          5  0.2255     0.1745     0.1820     0.1675
          6  0.2335     0.1780     0.1965     0.1680
          7  0.2390     0.2320     0.1870     0.1920
          8  0.2495     0.2850     0.2135     0.2170
          9  0.2915     0.2850     0.2135     0.2170
First year for F-constraint
       2000
Target Multiplier by fleet and by year
       2000    -0.909264    -1.988642  -1.988642  -1.988642
       2001    -0.909264    -1.988642  -1.988642  -1.988642
       2002    -0.909264    -1.988642  -1.988642  -1.988642
       2003    -0.909264    -1.988642  -1.988642  -1.988642
       2004    -0.909264    -1.988642  -1.988642  -1.988642
       2005    -0.909264    -1.988642  -1.988642  -1.988642
       2006    -0.909264    -1.988642  -1.988642  -1.988642
       2007    -0.909264    -1.988642  -1.988642  -1.988642
       2008    -0.909264    -1.988642  -1.988642  -1.988642
CV           of          Target      F-Multipliers
       2000       0.0001     0.0001     0.0001     0.0001
       2001       0.0001     0.0001     0.0001     0.0001
       2002       0.0001     0.0001     0.0001     0.0001
       2003       0.0001     0.0001     0.0001     0.0001
       2004       0.0001     0.0001     0.0001     0.0001
       2005       0.0001     0.0001     0.0001     0.0001
       2006       0.0001     0.0001     0.0001     0.0001
       2007       0.0001     0.0001     0.0001     0.0001
       2008       0.0001     0.0001     0.0001     0.0001
```

Table 2.11.2 Input to the medium term prediction program (ICP)

```
Enter Random-Number seed--> 120
 Change any of the populations (Y/N) ?-->N
 Enter the name of the projection file -->t2111.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 1998  back to--> 1998
 Use mean maturity ogive from 1998  back to--> 1997
 Use mean weight at age in the stock from 1998  back to-->  1997
 Enter the reference spawning stock size (e.g. MBAL, Bpa)--> 800000
 Enter the maximum allowable F-multiplier-->  10
Choose type of stock recruit relation :
S -   Shepherd      R = a.SSB/(1+SSB/b)^c
B -  Beverton-Holt  R = a.SSB/(1+SSB/b)
R -  Ricker        R = a.SSB.exp(-b.SSB)
O -  Ockham          R = GM over observed SSB range
                   then linear to origin
N -    None          R = Historic Geometric Mean R
 Enter your choice (S/B/R/O/N) ?-->B
 Enter first year of data for stock-recruit model--> 1960
 Enter last year of data for stock-recruit model--> 1998
 Autocorrelated or Independent errors (I/A)-->i
 Use ICA or SRR (I/S) model value for recruitment in 1998-->i
 Use ICA or SRR (I/S) model value for recruitment in 1999-->i
 Use default percentiles (Y/N)  ?-->Y
 Use ICA-derived resamples ?-->Y
```



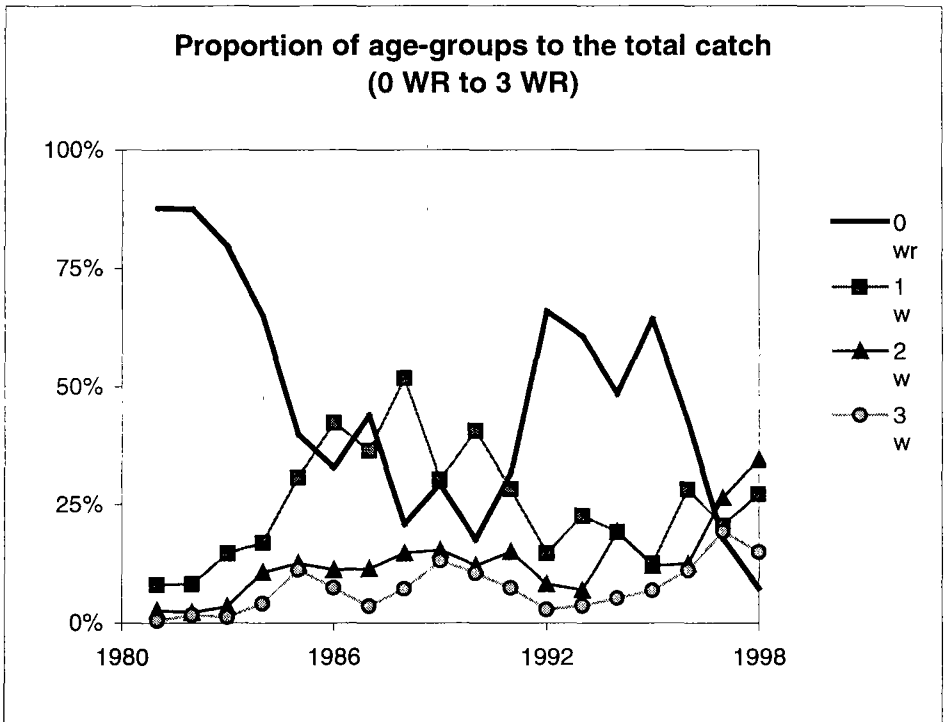
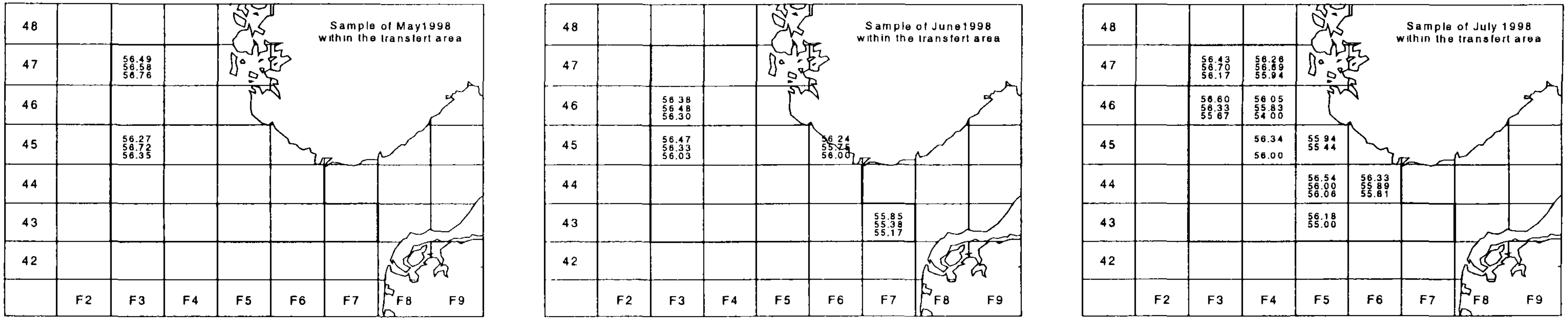


Figure 2.2.1: Proportion of age-group in the total catch of North Sea herring. Proportion of all Wr (winter ring) from 1960 to 1997, and proportion of 0 Wr to 3 Wr from 1980 to 1998.



	Quarter II		Quarter III	
Winter Ring	Mean Vs	Percentage of Spring Spawners	Mean Vs	Percentage of Spring Spawners
2	56.28	31	56.29	29
3	56.20	42	55.98	74
4+	56.10	57	55.66	100

Figure 2.2.2 : Mean vertebral counts of 2, 3, and 4+ rings herring. Quarter II and III - 1998

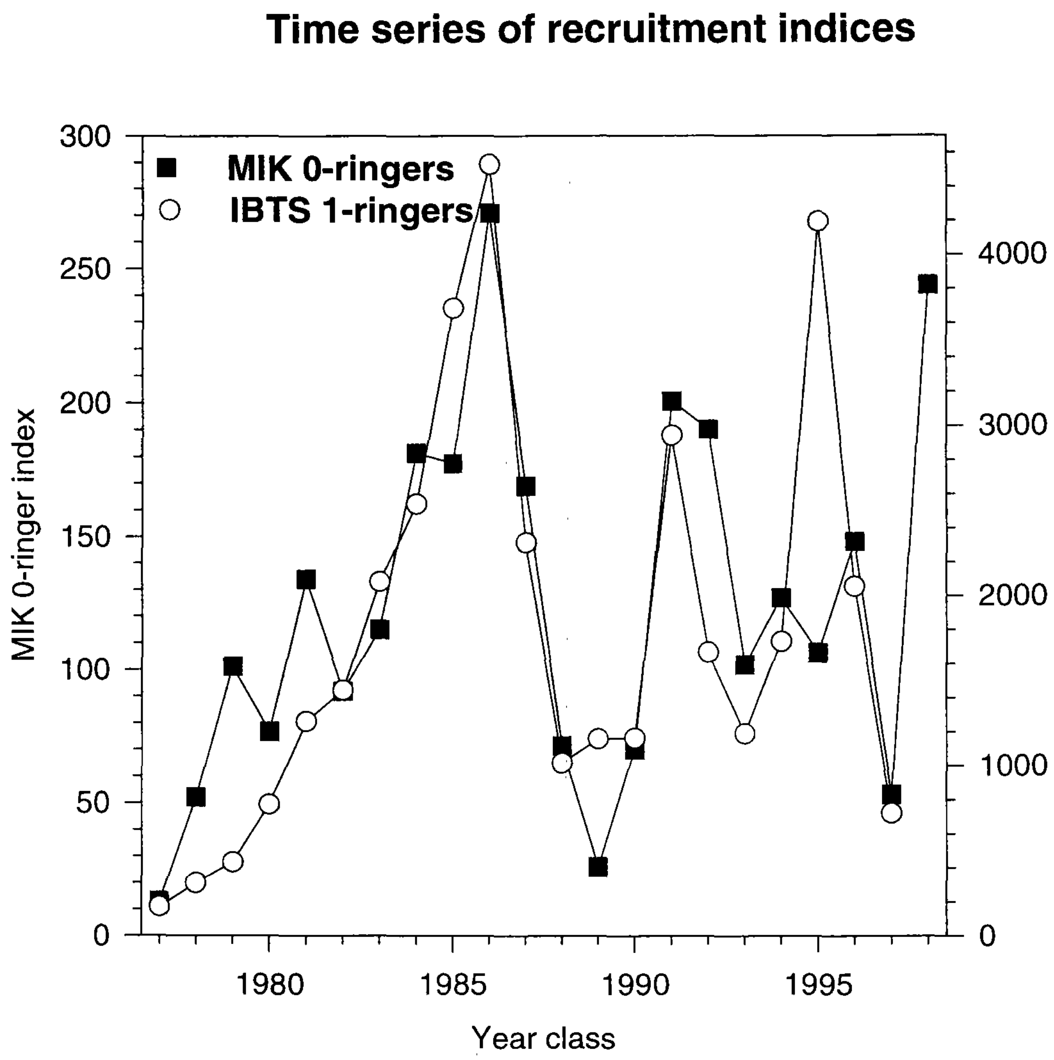


Figure 2.3.1 Time series of the 0-ringer and the 1-ringer indices; 0-ringers are illustrated by filled squares, 1-ringers by open circles.

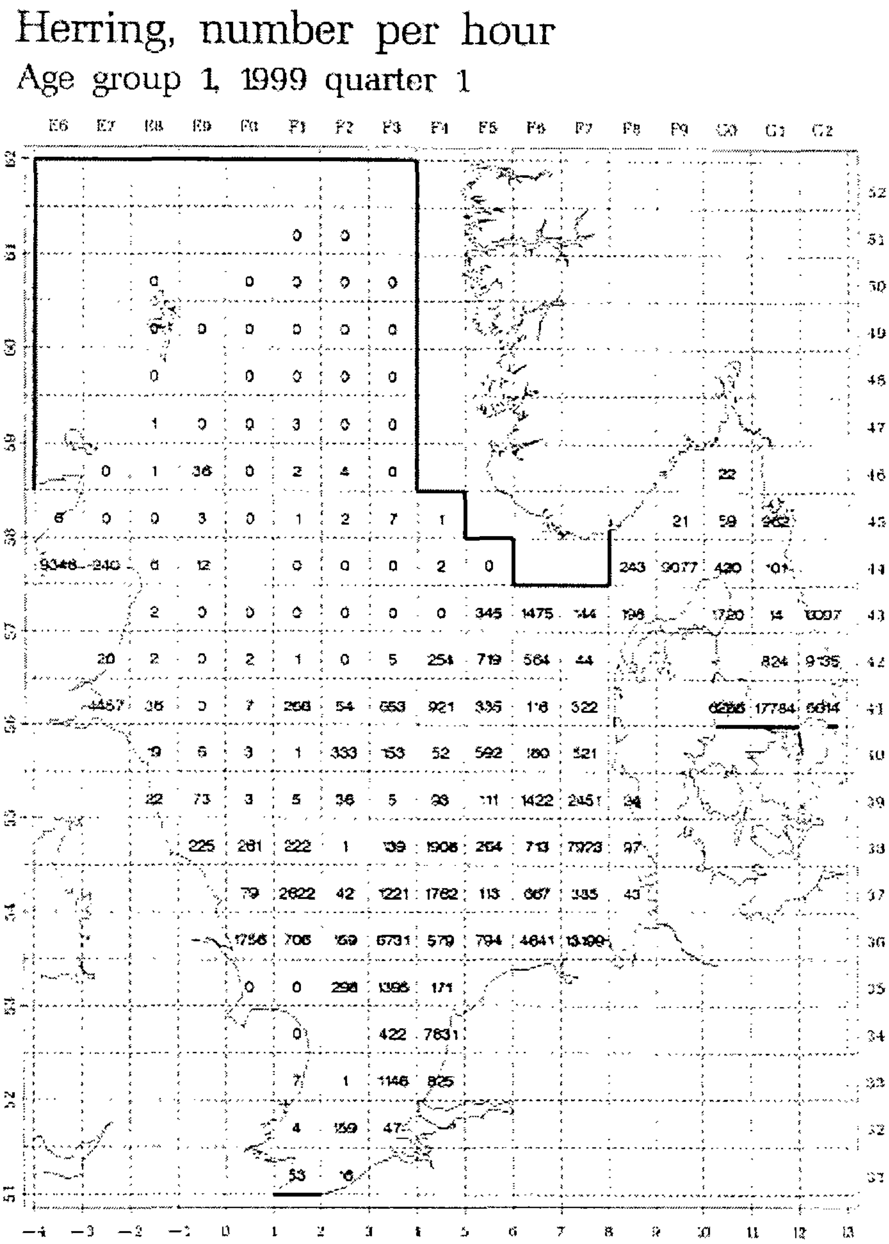


Figure 2.3.2 Abundance estimates for 1-ringer herring from the IBTS, 1st quarter. Values are catch estimates for each statistical rectangle in numbers per hour.

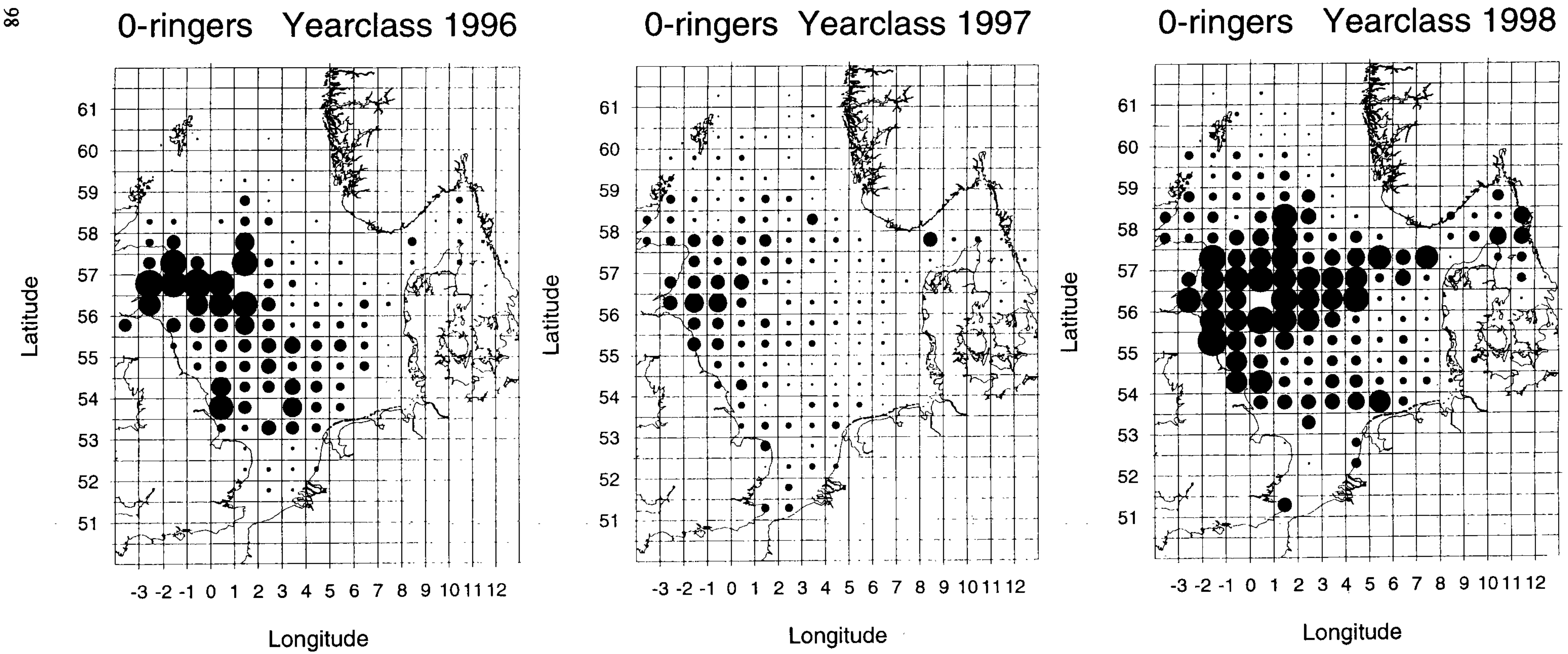


Figure 2.3.3 Distribution of 0-ringer herring, year classes 1996-1998. Abundance estimates of 0-ringers within each statistical rectangle are based on MIK catches during IBTS in February. Areas of filled circles illustrate densities in no m^{-2}, the area of a circle extending to the border of a rectangle represents 1 m^{-2}

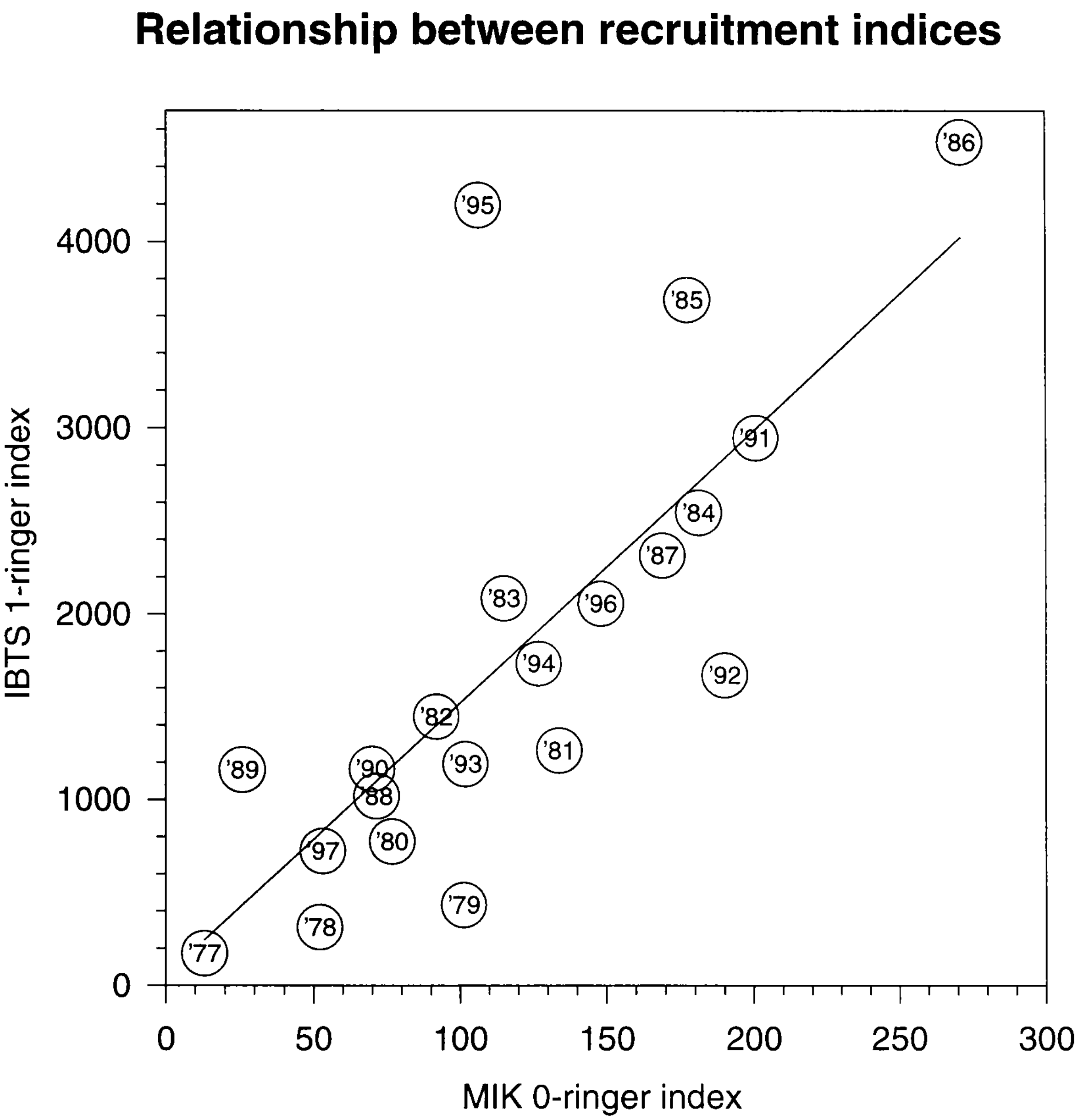


Figure 2.3.4 Regression between the MIK 0-ringer index and the IBTS 1-ringer indices for year classes 1977 to 1997. Numbers in symbols indicate year class.

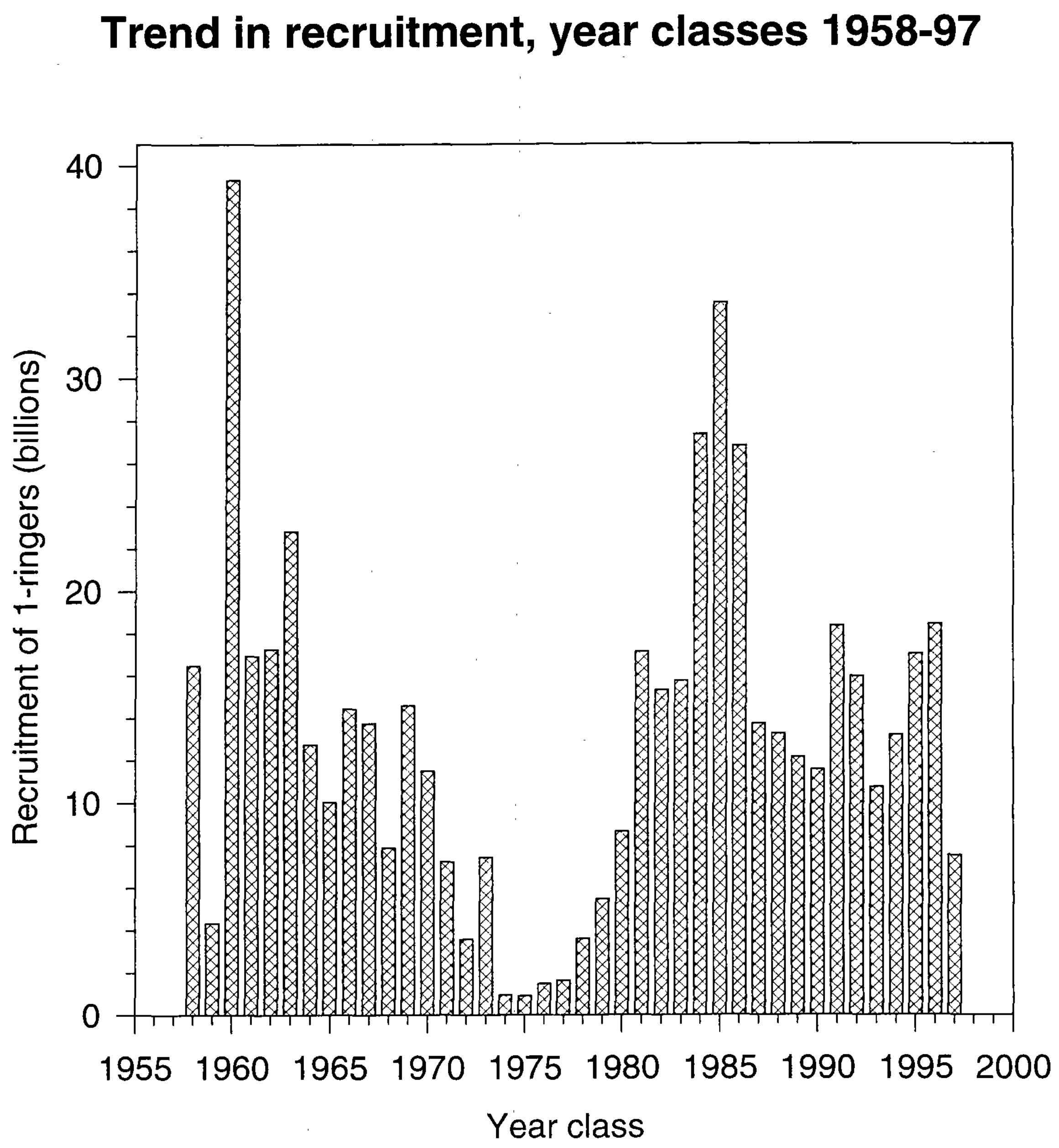


Figure 2.3.5 Recruitment of 1-ringer North Sea autumn spawned herring. Estimates from the 1999 ICA assessment.

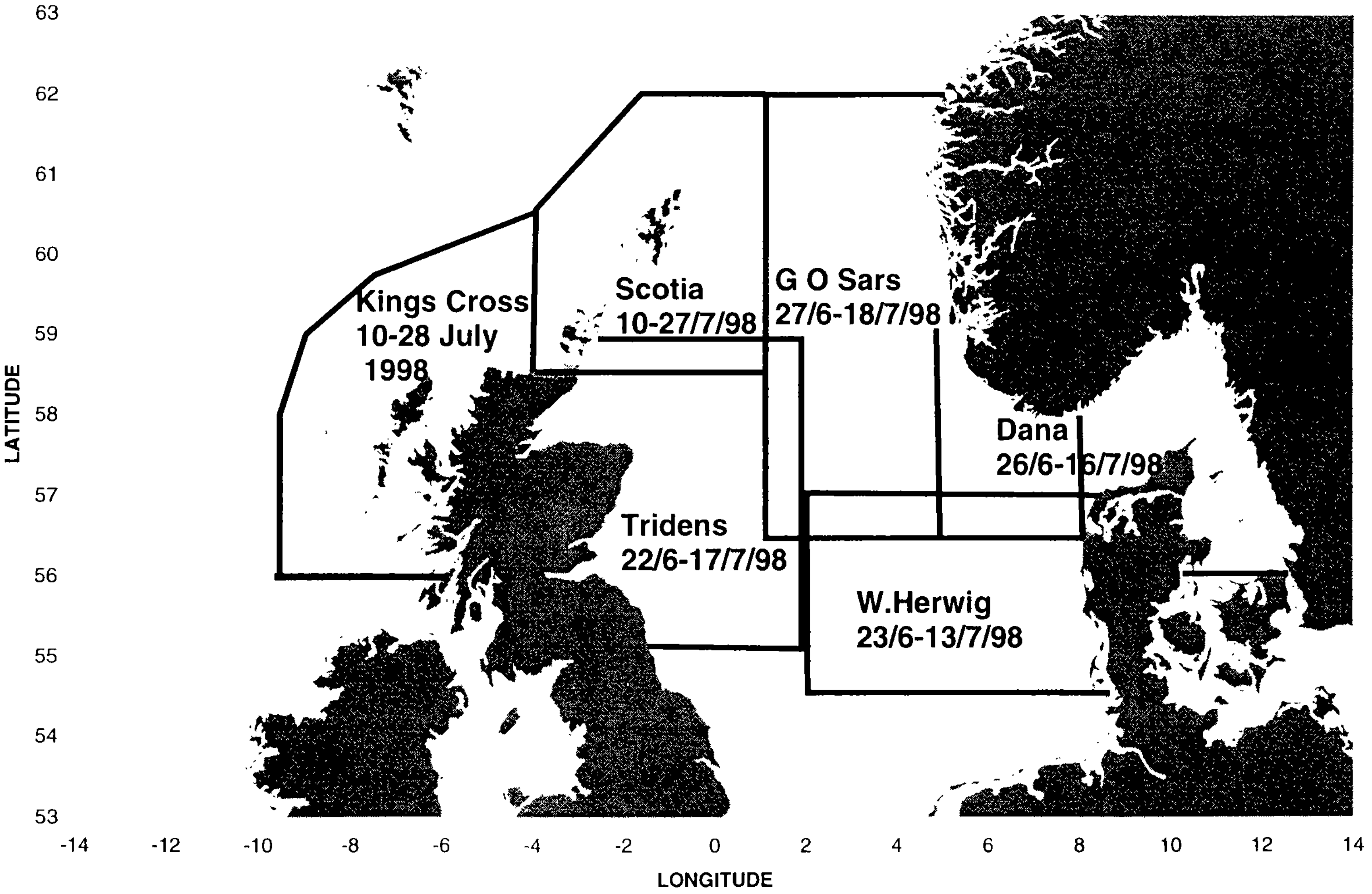


Figure 2.4.1 Layout of areas and dates of surveys for combined surveys June, July 1998.

Figure 2.4.2 Numbers (millions) and biomass ('000 tonnes) of mature autumn spawning herring combined acoustic survey 1998.

Figure 2.4.3 Numbers (millions) of autumn spawning herring from combined survey in 1998; 1, 2 and 3+ groups.

Figure 2.4.4 Numbers (millions) of mature autumn herring (1998) combined acoustic survey July 1998.

Figure 2.4.5 Numbers (millions) of autumn spawning herring (1998) combined acoustic survey July 1998.

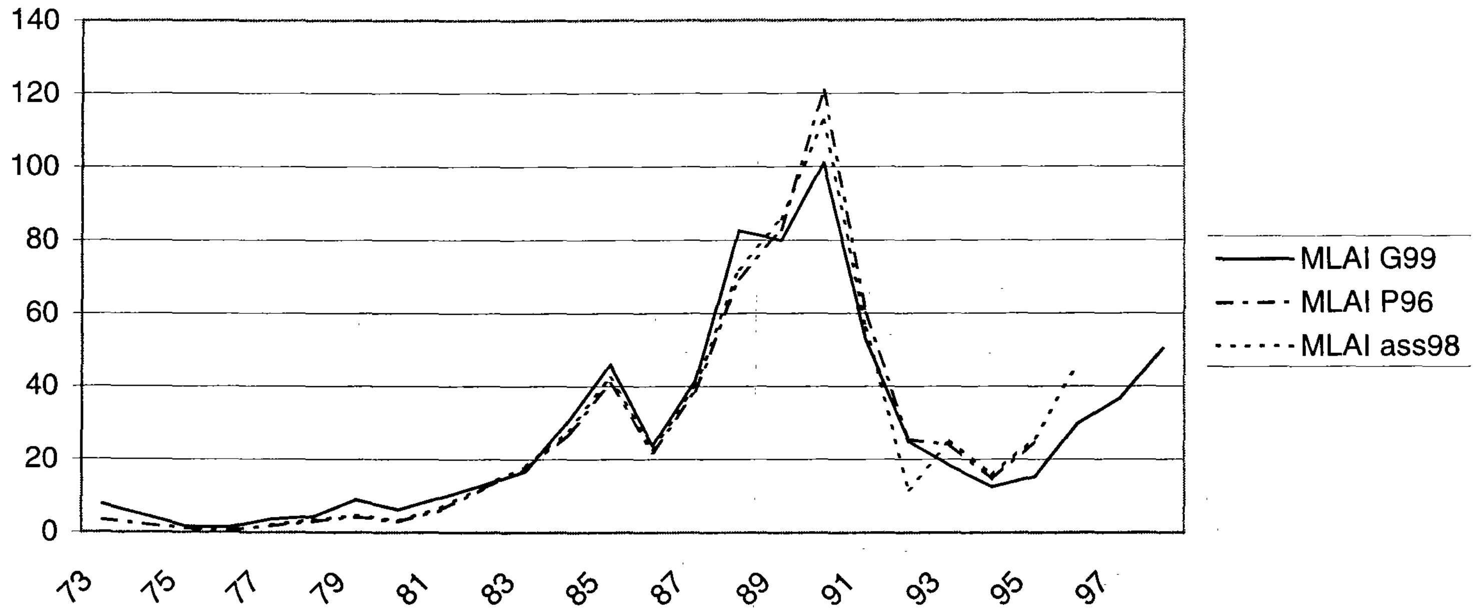


Figure 2.5.1 Comparison of the MLAI indecies used in assessments from 1996 to 1999

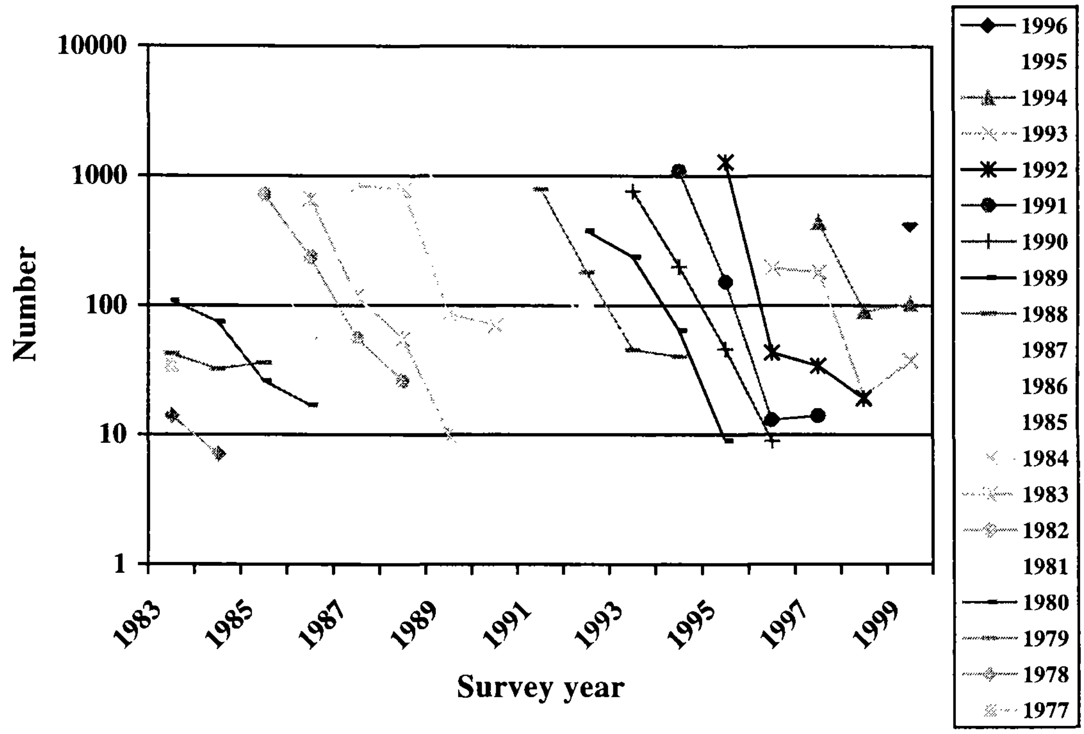
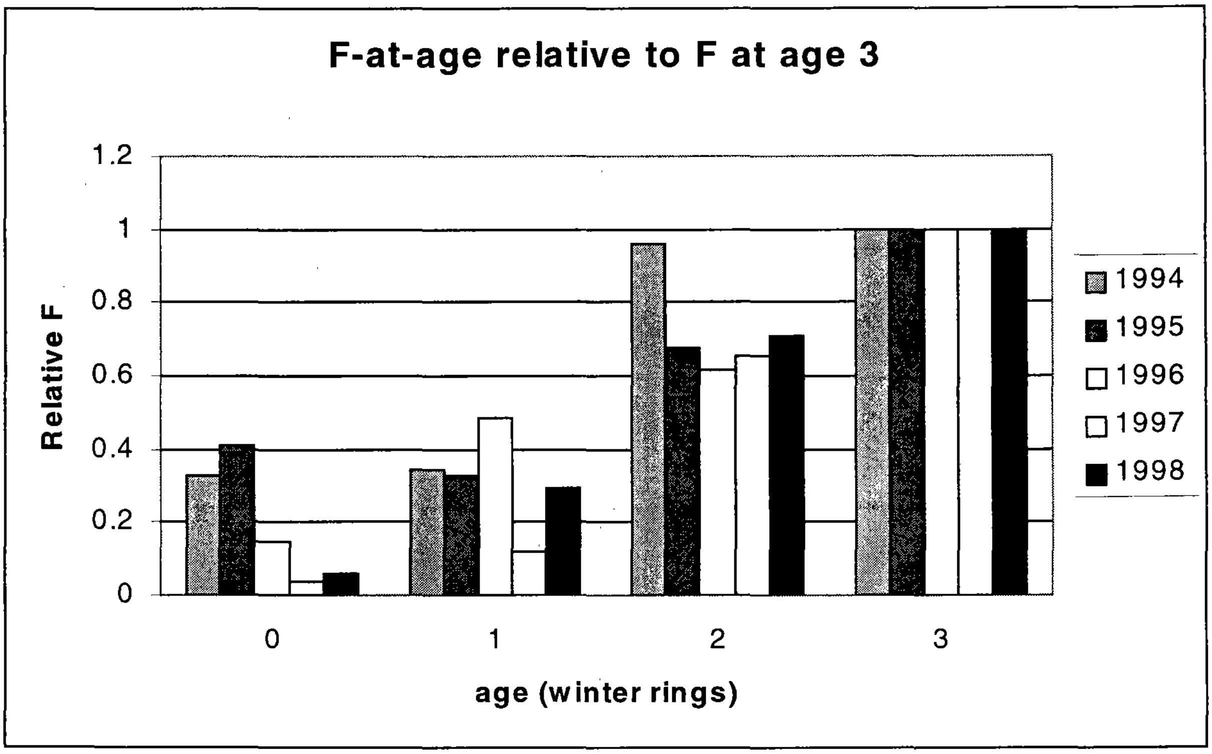


Figure 2.6.1 1977 to 1996 cohort abundance ages 2 to 5+ from IBTS surveys 1983 to 1999

Figure 2.8.1 North Sea Autumn Spawners, Fishing mortalities from XSA



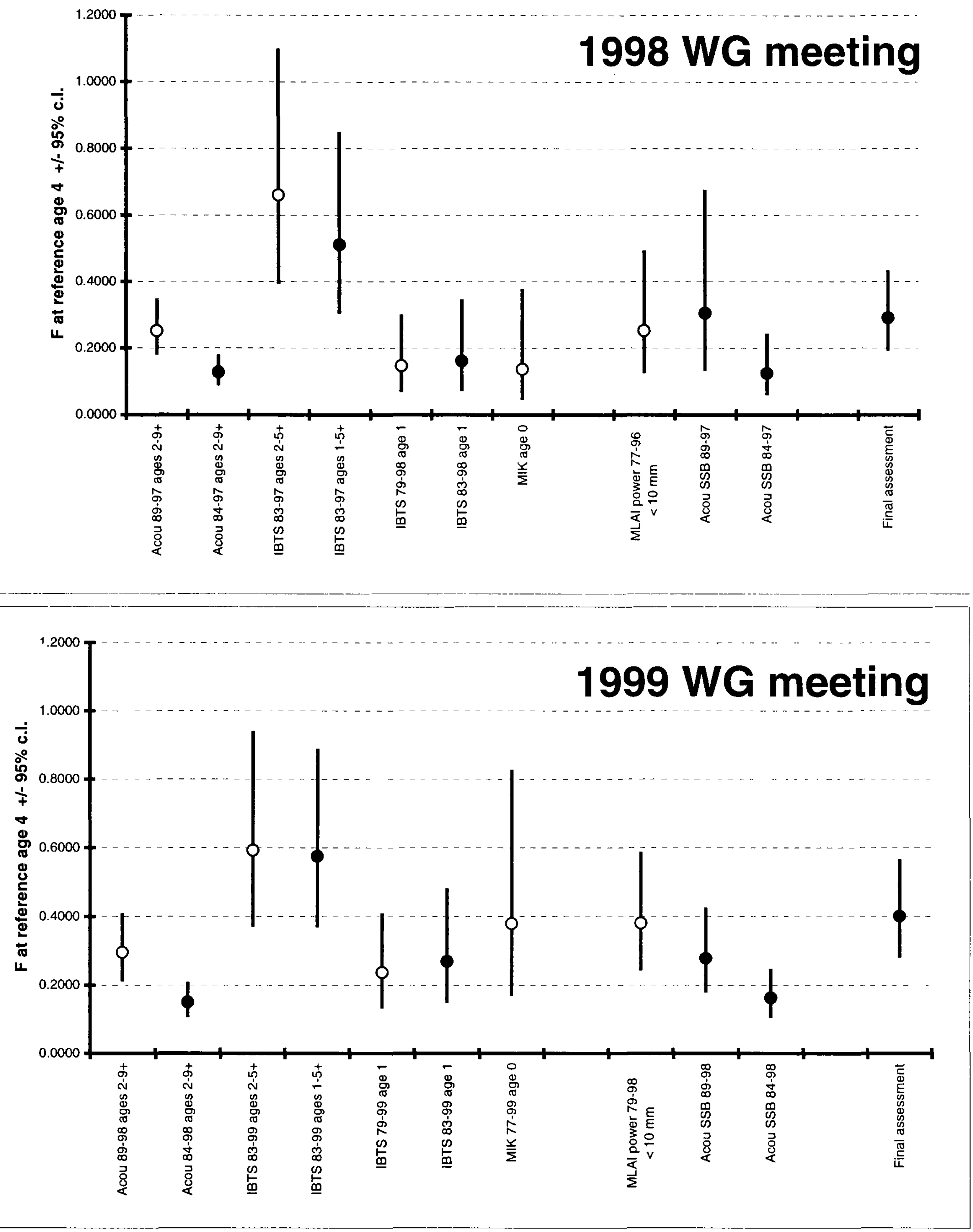


Figure 2.8.2 Herring in Sub-area IV, Divisions VIId and IIIa. Estimates of fishing mortality (+/- 95 c.l.) in population models fitted to the separate indices and the catch at age matrix. Each index is given an equal weight. The open circles indicate, which indices are used in the final assessment.
The upper panel refers to last years assessment and the lower panel to this years assessment.

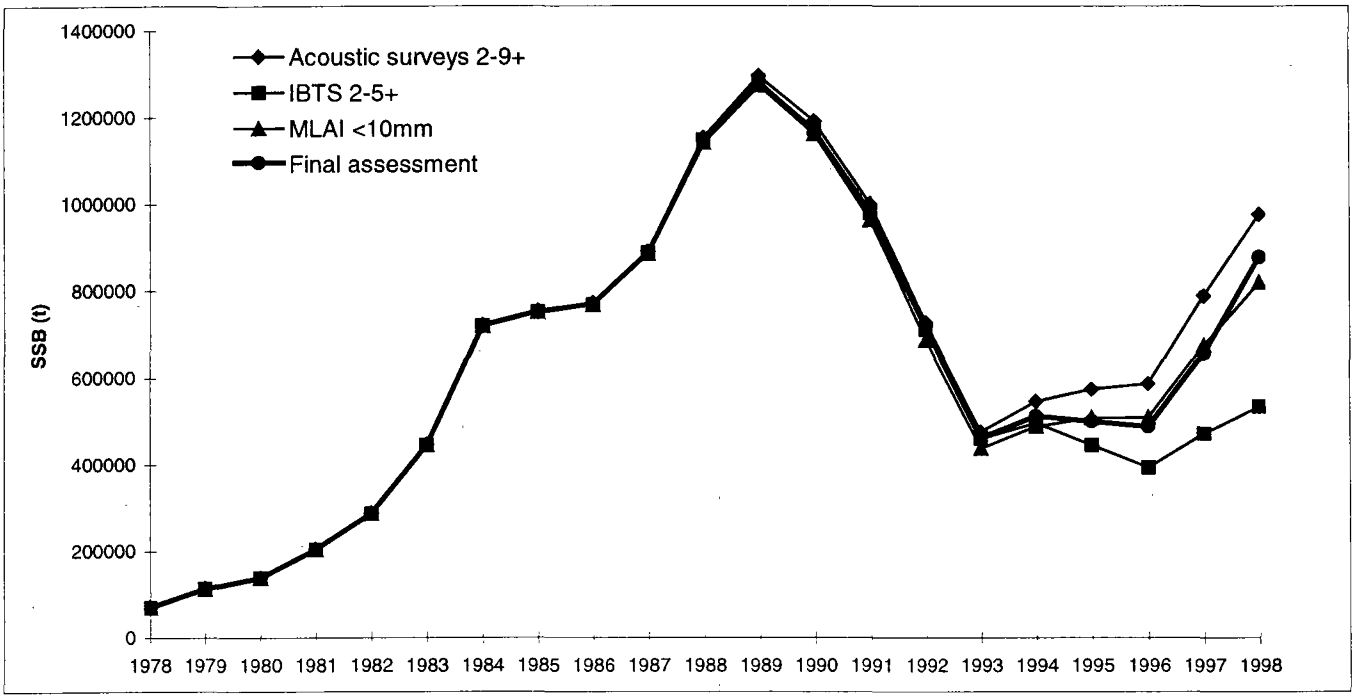


Figure 2.8.3 SSB estimates obtained from model fits with separate indices compared to the SSB estimate in the final assessment.

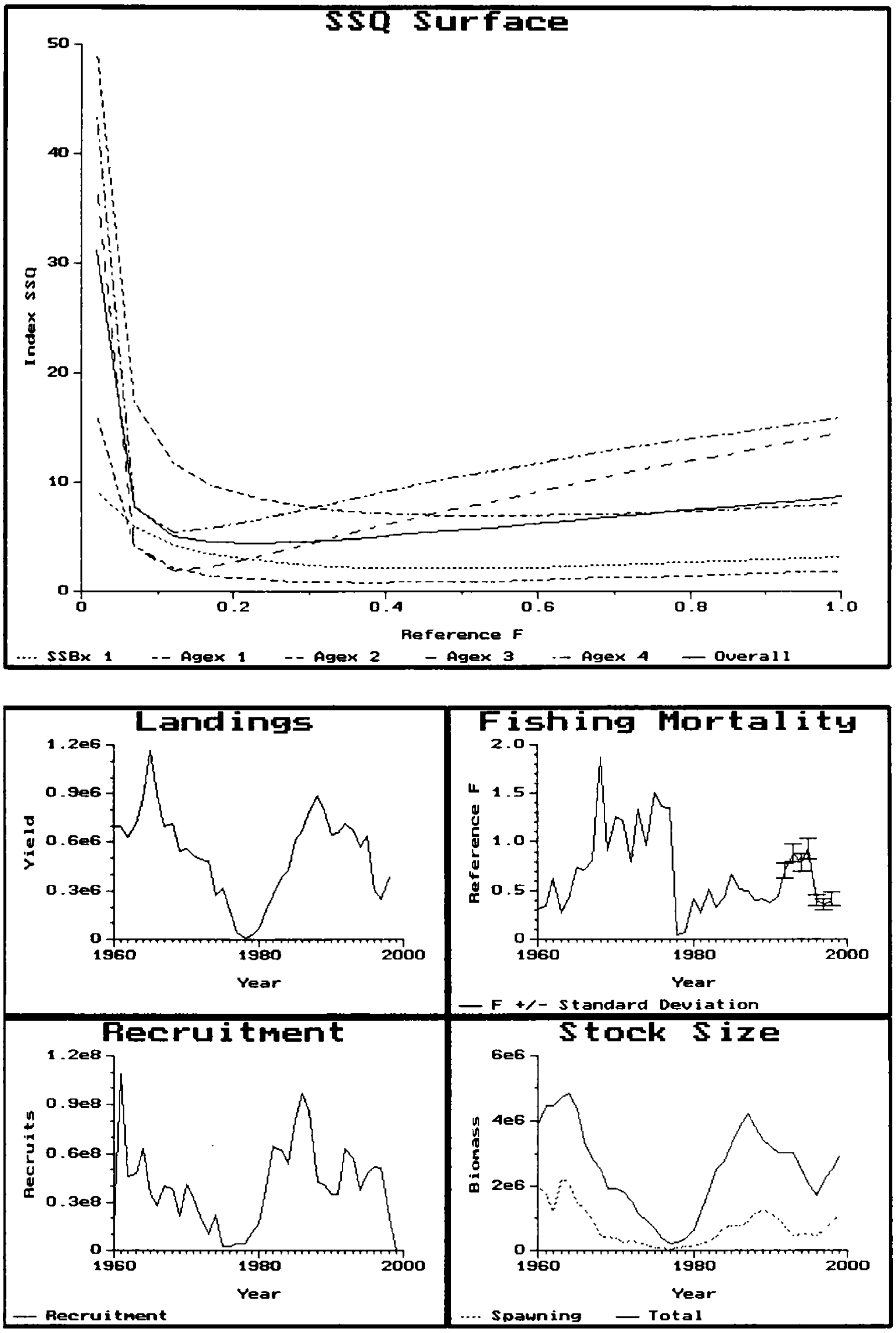


Figure 2.8.4 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Upper panel: sum of squares (SSQ) surfaces for the tuning indices. SSBx1 refers to the MLAI estimate of total biomass, the age-indices 1 to 4 refer to the acoustic index (1), the IBTS 2-5+ index (2), the IBTS 1-ringer index (3) and the MIK 0-ringer index (4). Lower panel: summary of landings, estimated fishing mortality at reference age 4 (wr), recruitment of 0-ringers and total biomass and spawning biomass at spawning time.

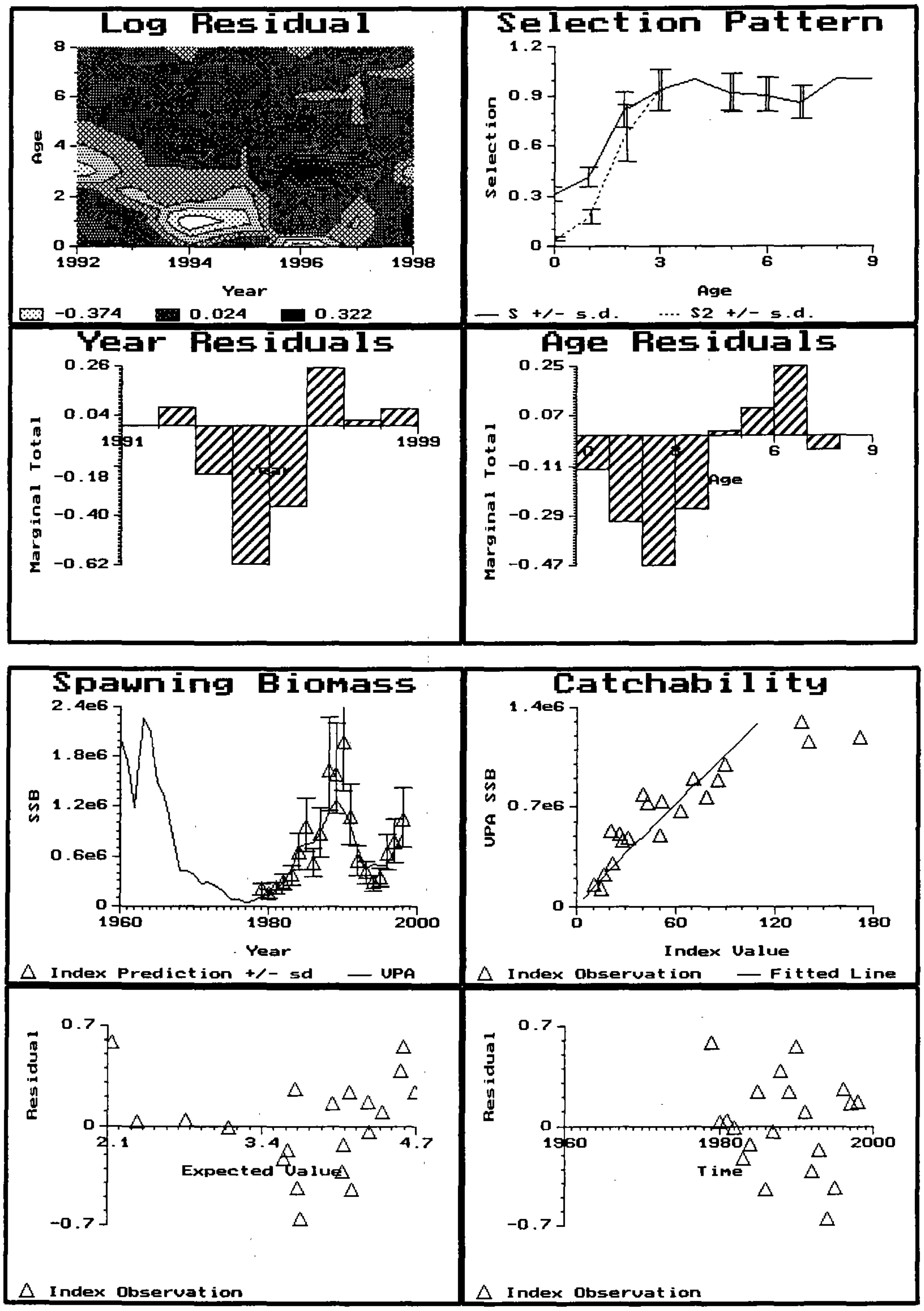


Figure 2.8.5 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Final assessment. Upper panel: selection patterns diagnostics. Top left: contour plot of selection pattern residuals. Top right: two estimated selection patterns S1 (1992-1996) and S2 (1997-1998). Bottom: marginal totals of residuals by year and age. Lower panel: diagnostics of the fit of the MLAI spawning stock biomass against the estimated SSB. Top left: spawning biomass from the fitted populations (line) and the predicted spawning biomasses from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of spawning biomass from the fitted populations and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

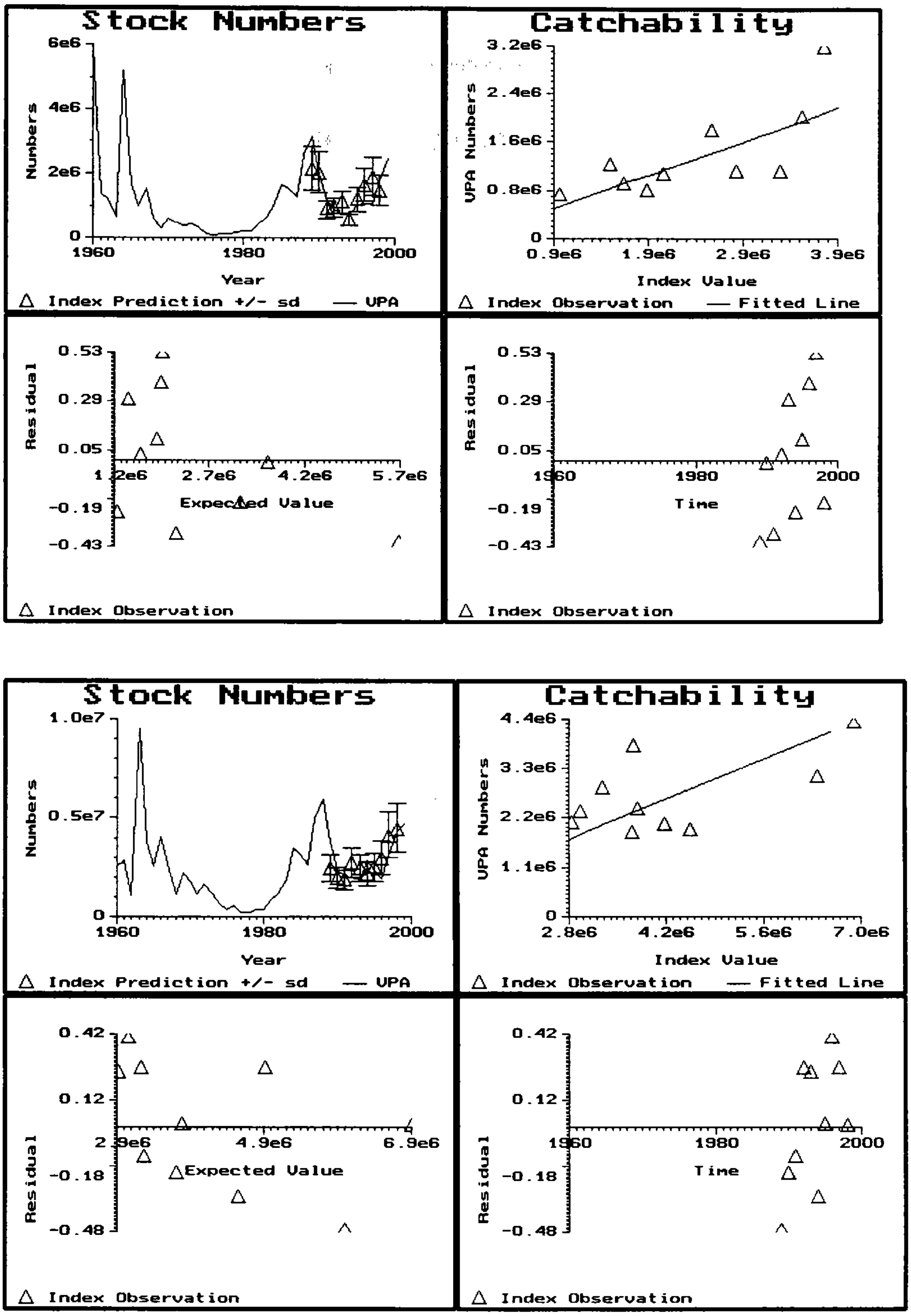


Figure 2.8.6 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Final assessment. Upper panel: diagnostics of the fit of the acoustic 2-ringer index against the estimated stock numbers at age 2. Top left: fitted populations at age 2 (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age 2 and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right). Lower panel: diagnostics of the fit of the acoustic 3-ringer index against the estimated stock numbers at age 3. Top left: fitted populations at age 3 (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age 3 and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

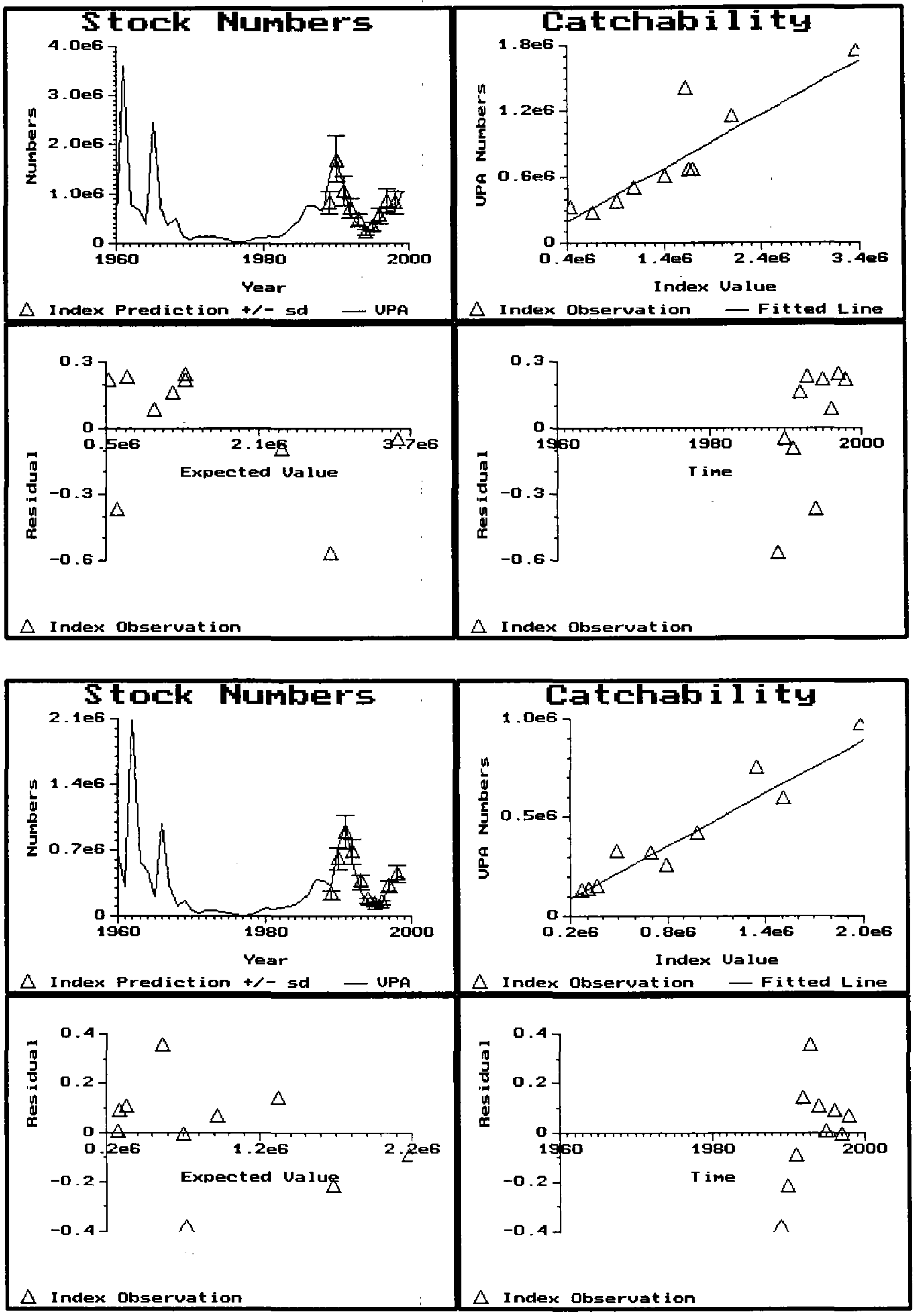


Figure 2.8.7 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Final assessment. Upper panel: diagnostics of the fit of the acoustic 4-ringer index against the estimated stock numbers at age 4. Top left: fitted populations at age 4 (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age 4 and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right). Lower panel: diagnostics of the fit of the acoustic 5-ringer index against the estimated stock numbers at age 5. Top left: fitted populations at age 5 (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age 5 and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

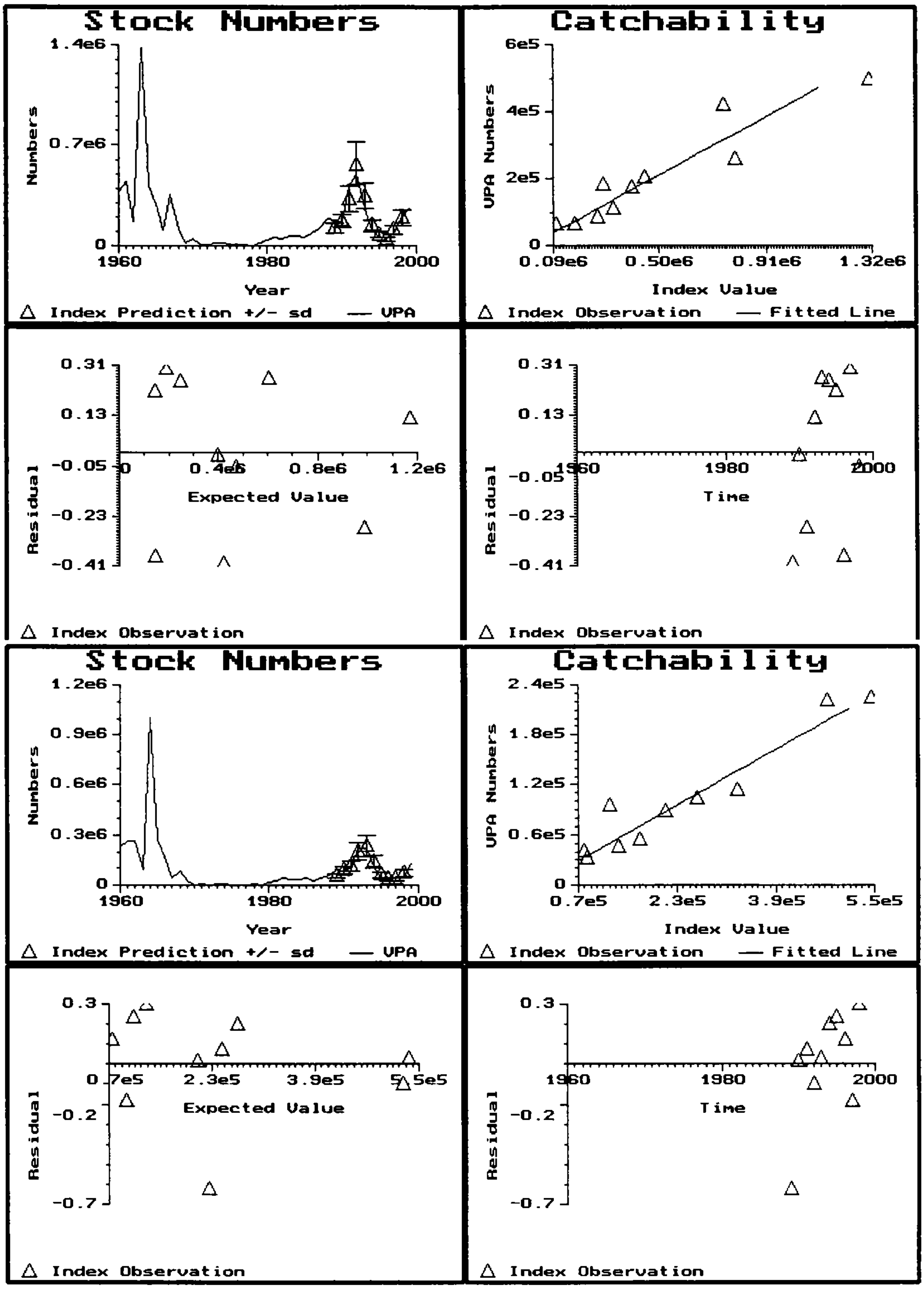


Figure 2.8.8 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Final assessment. Upper panel: diagnostics of the fit of the acoustic 6-ringer index against the estimated stock numbers at age 6. Top left: fitted populations at age 6 (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age 6 and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right). Lower panel: diagnostics of the fit of the acoustic 7-ringer index against the estimated stock numbers at age 7. Top left: fitted populations at age 7 (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age 7 and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

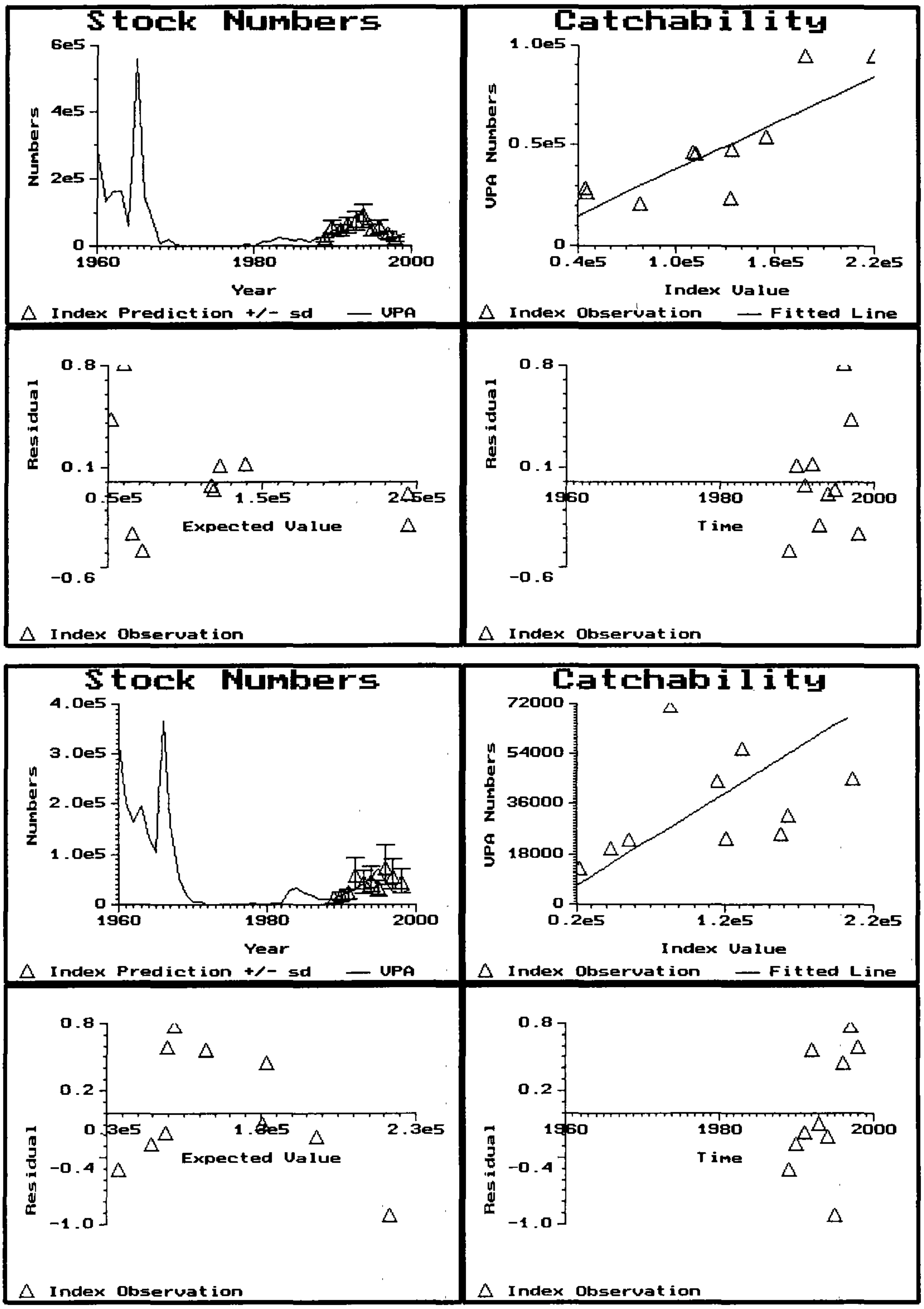


Figure 2.8.9 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Final assessment. **Upper panel**: diagnostics of the fit of the **acoustic 8-ringer index** against the estimated stock numbers at age 8. Top left: fitted populations at age 8 (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age 8 and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right). **Lower panel**: diagnostics of the fit of the **acoustic 9+ ringer index** against the estimated stock numbers at ages 9+. Top left: fitted populations at ages 9+ (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at ages 9+ and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

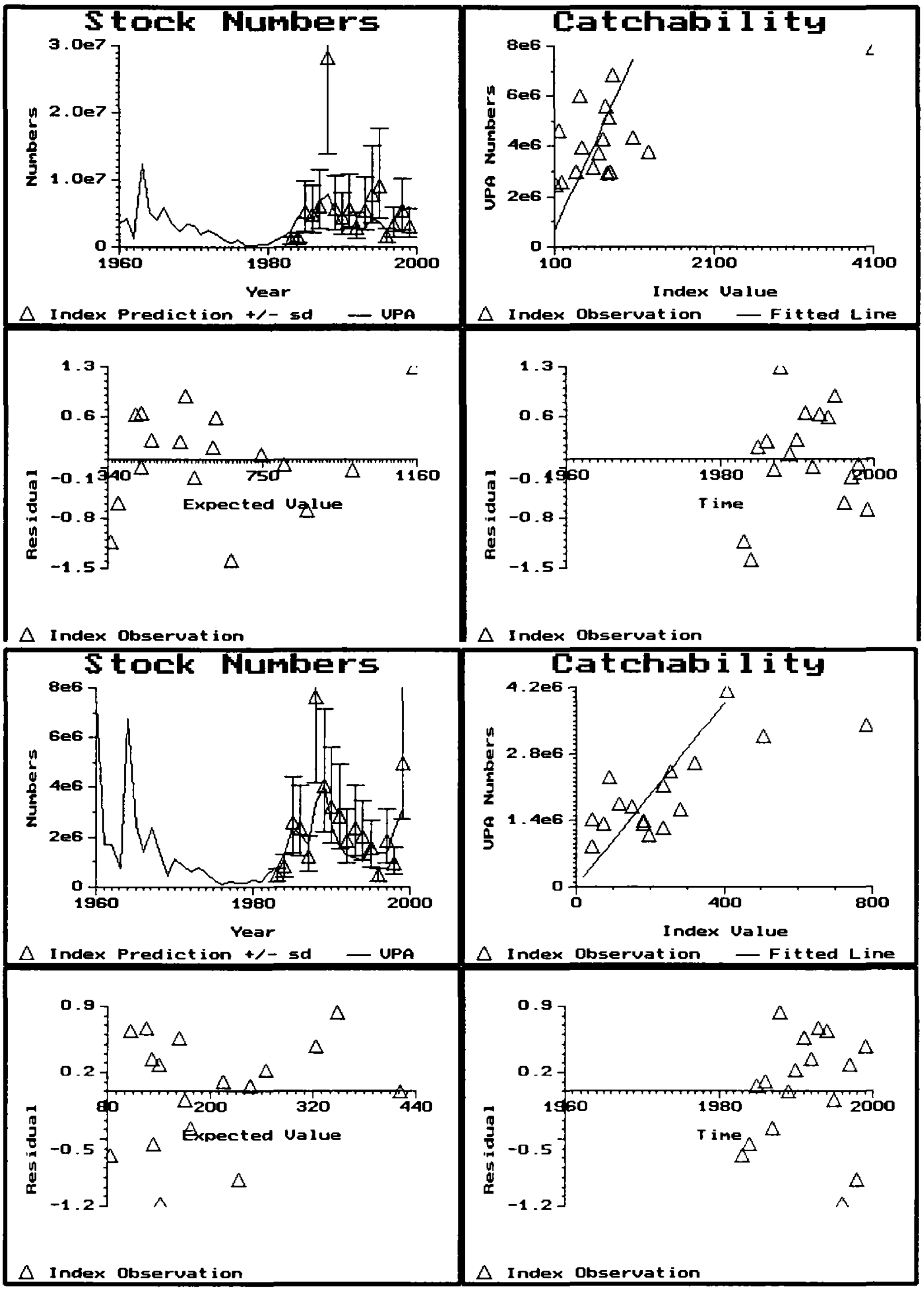


Figure 2.8.10 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Final assessment. Upper panel: diagnostics of the fit of the IBTS 2-ringer index against the estimated stock numbers at age 2. Top left: fitted populations at age 2 (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age 2 and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right). Lower panel: diagnostics of the fit of the IBTS 3-ringer index against the estimated stock numbers at age 3. Top left: fitted populations at age 3 (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age 3 and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

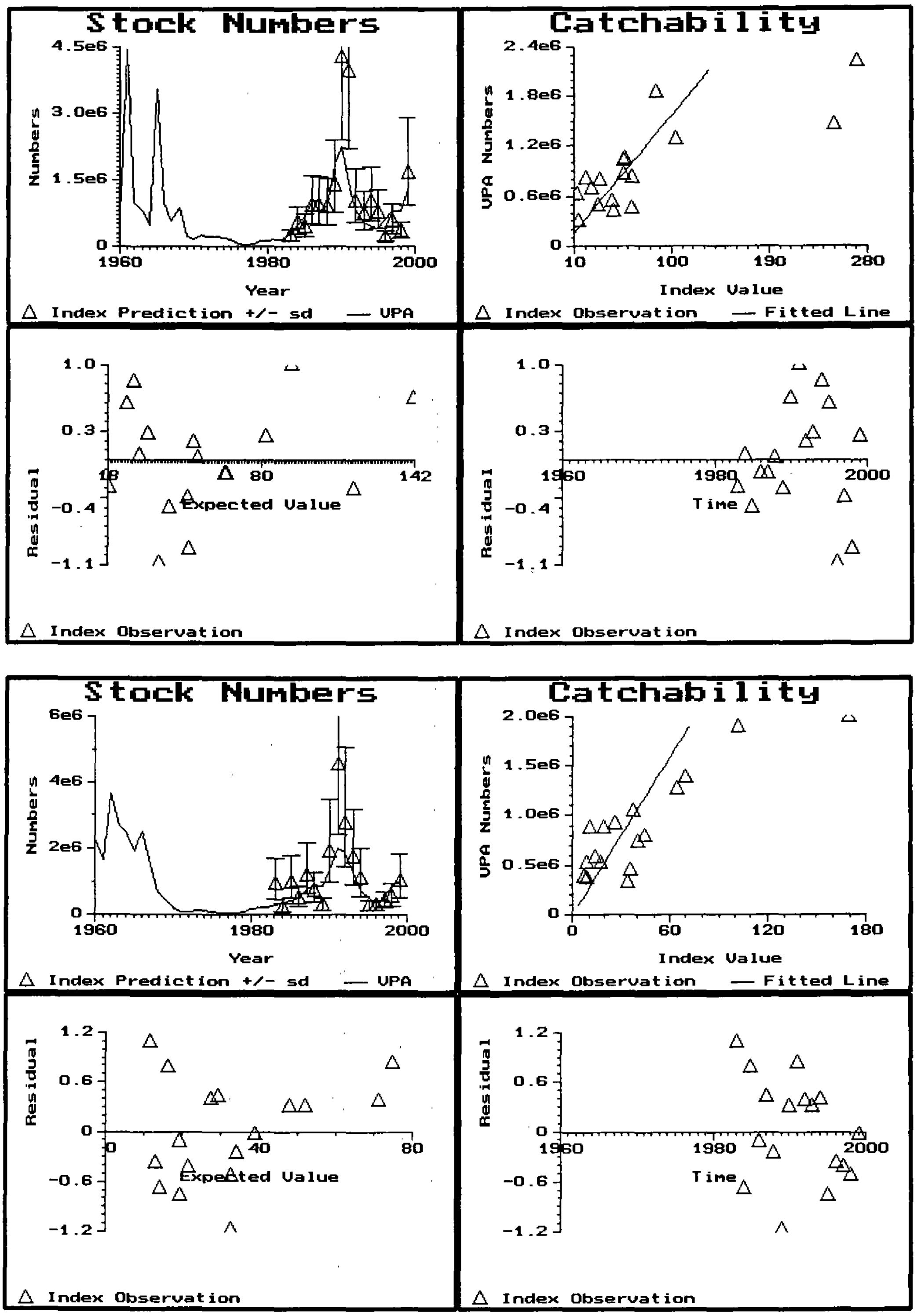


Figure 2.8.11 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Final assessment. Upper panel: diagnostics of the fit of the IBTS 4-ringer index against the estimated stock numbers at age 4. Top left: fitted populations at age 4 (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age 4 and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right). Lower panel: diagnostics of the fit of the IBTS 5+ ringer index against the estimated stock numbers at ages 5+. Top left: fitted populations at ages 5+ (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at ages 5+ and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

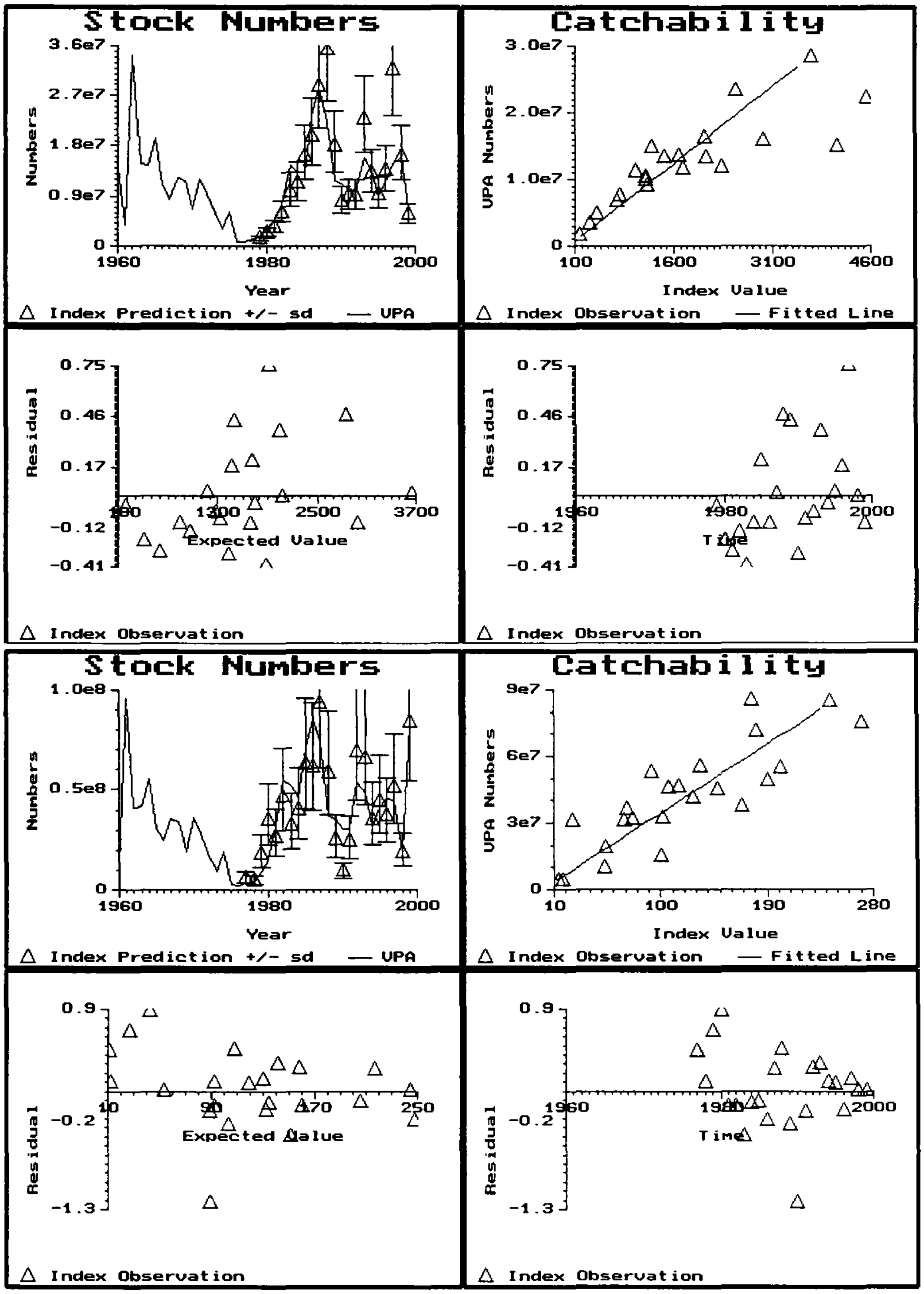


Figure 2.8.12 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Final assessment. Upper panel: diagnostics of the fit of the separate IBTS 1-ringer index against the estimated stock numbers at age 1. Top left: fitted populations at age 1 (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age 1 and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right). Lower panel: diagnostics of the fit of the MIK 0-ringer index against the estimated stock numbers at age 0. Top left: fitted populations at age 0 (line) and the predicted stock numbers from the index observations (triangles +/- standard deviation). Top right: scatterplot and fitted catchability model of fitted populations at age 0 and the tuning index observations. Bottom: residuals as [ln(observed index)-ln(expected index)] plotted against expected values from the fitted populations (left) and time (right).

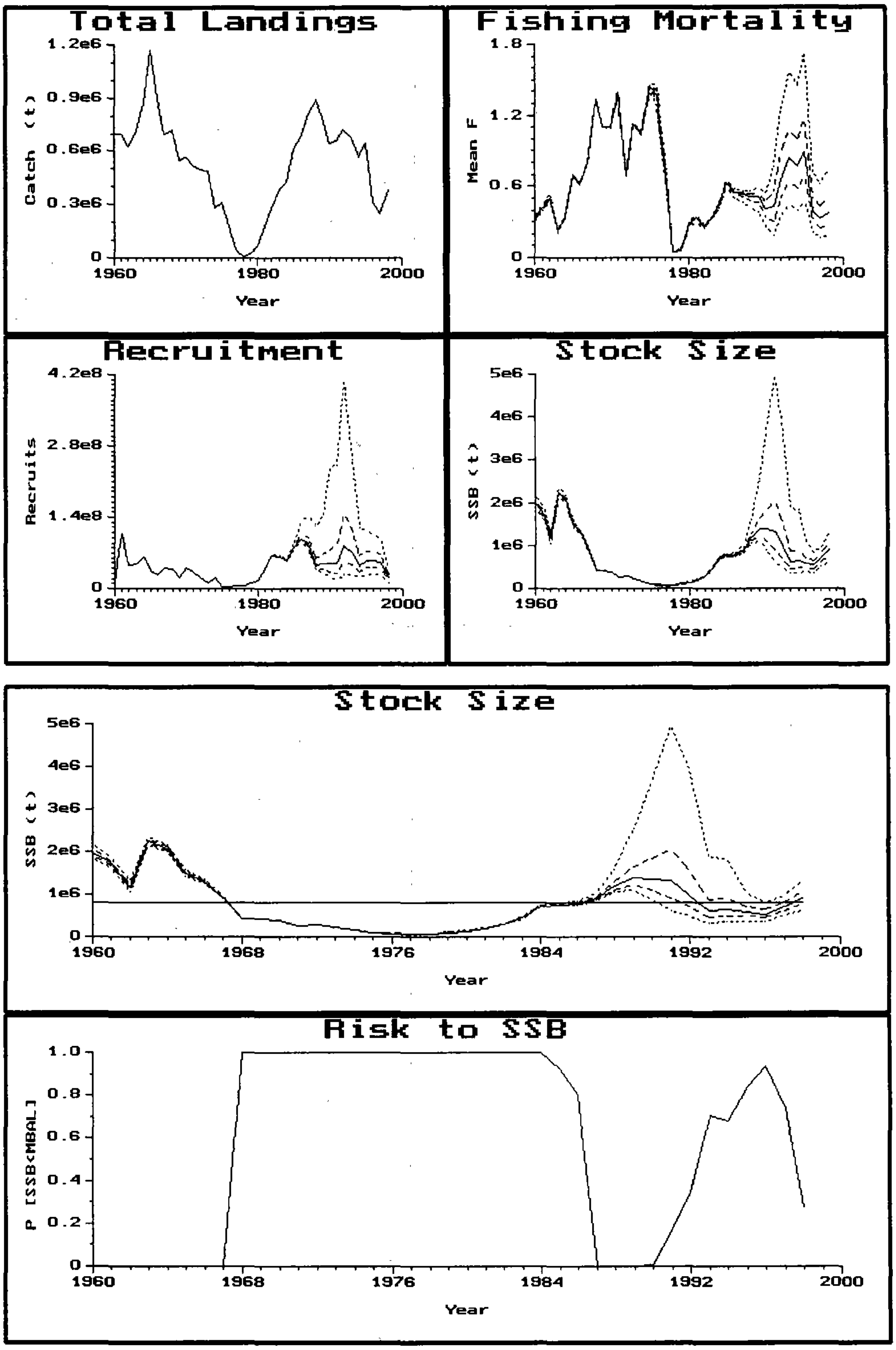


Figure 2.8.13 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Evaluation of assessment uncertainty using a covariance matrix method with 1000 random draws of all the parameters estimated in the ICA model (e.g. selection patterns, reference fishing mortalities in the separable period, stock numbers in the final year and at the final ages, catchabilities of the survey indices and recruitment) . Upper panel: summary of landings, estimated mean fishing mortality (age 2-6), recruitment of 0-ringers and spawning biomass. Shown are the 5, 25, 50, 75 and 95 percentiles. Lower panel: distribution of spawning stock biomass in relation to MBAL (800.000 tonnes) and the risk of being below MBAL.

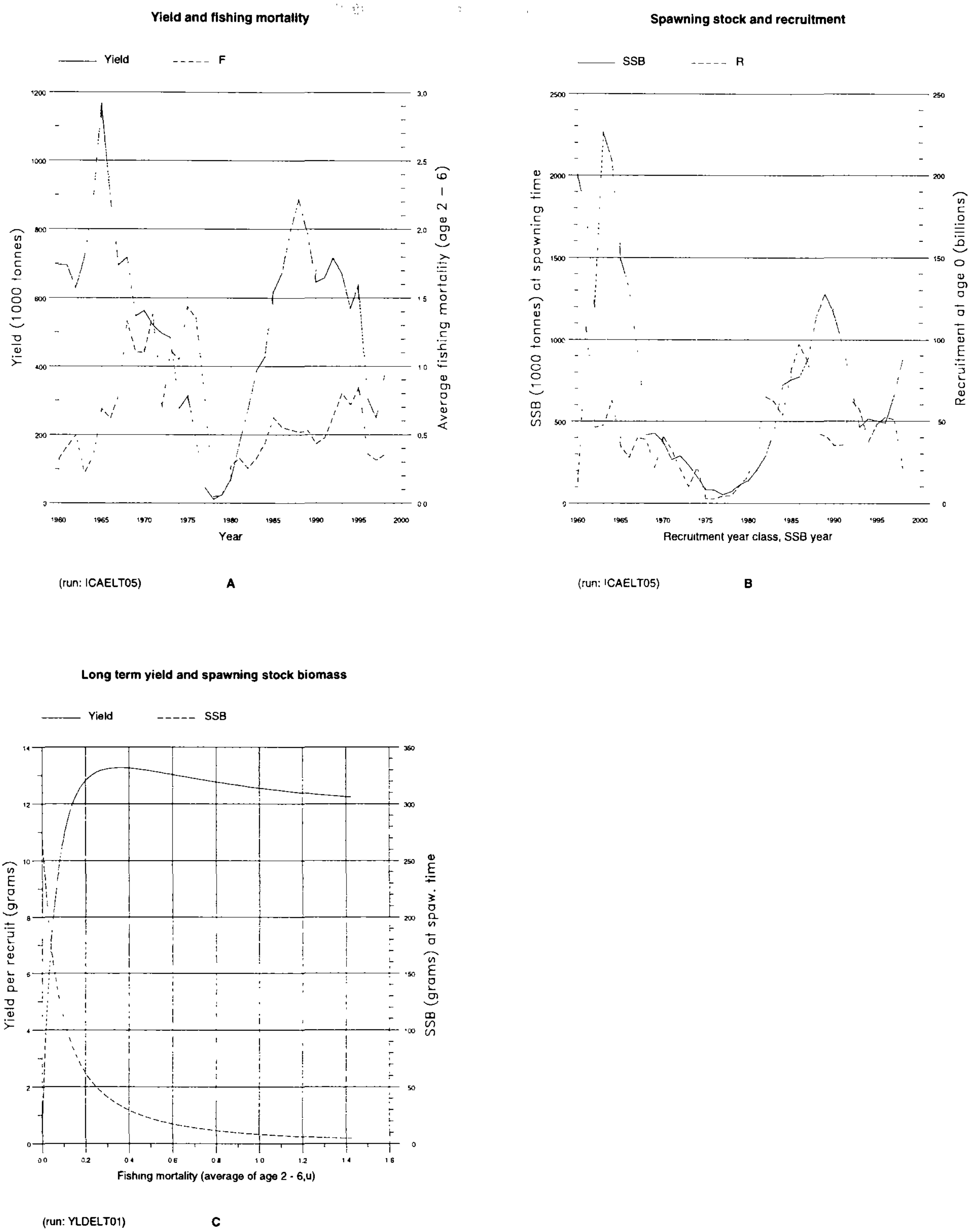


Figure 2.8.14 Standard plots for North Sea Herring (autumn spawners).

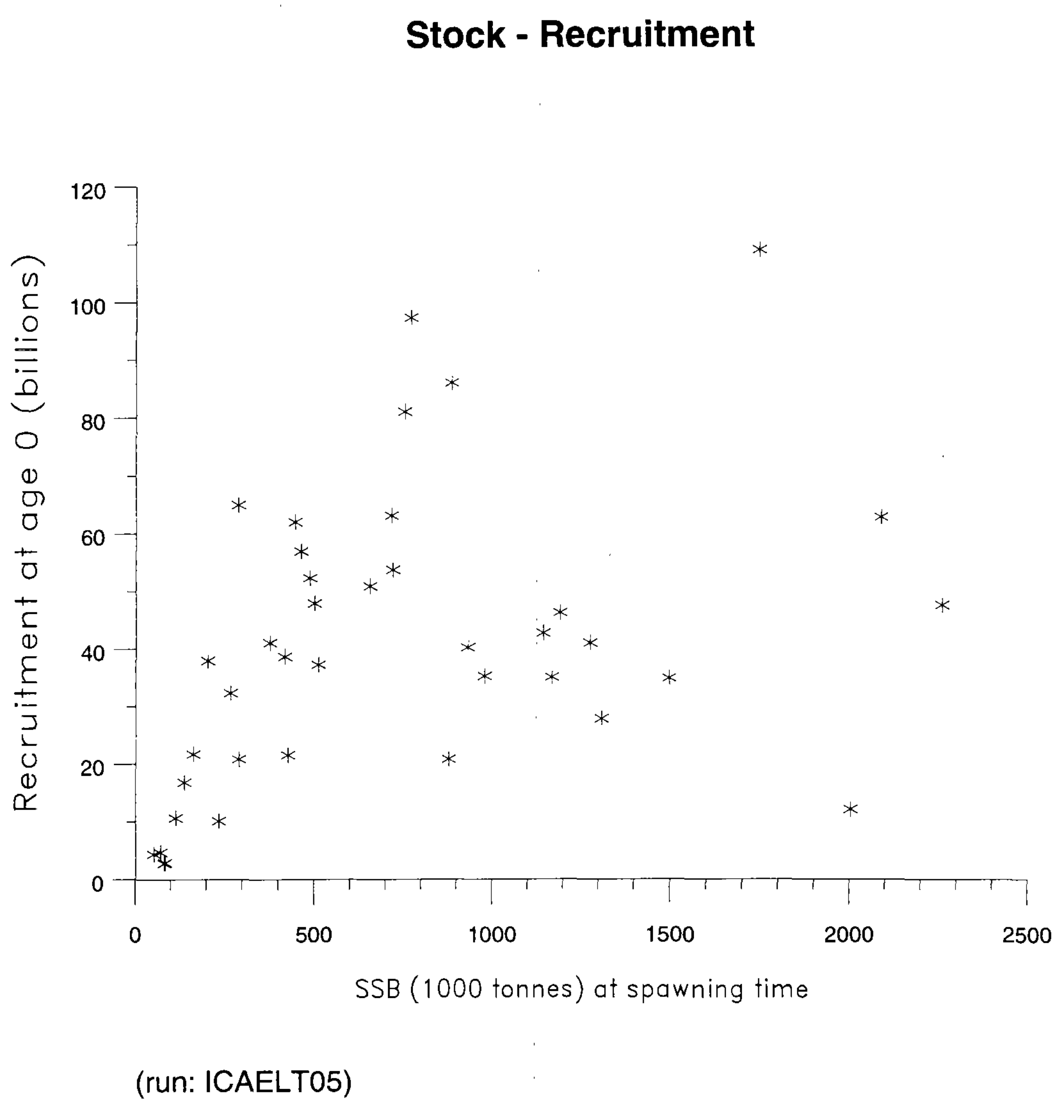


Figure 2.8.15 Stock recruitment plot for North Sea Herring (autumn spawners).

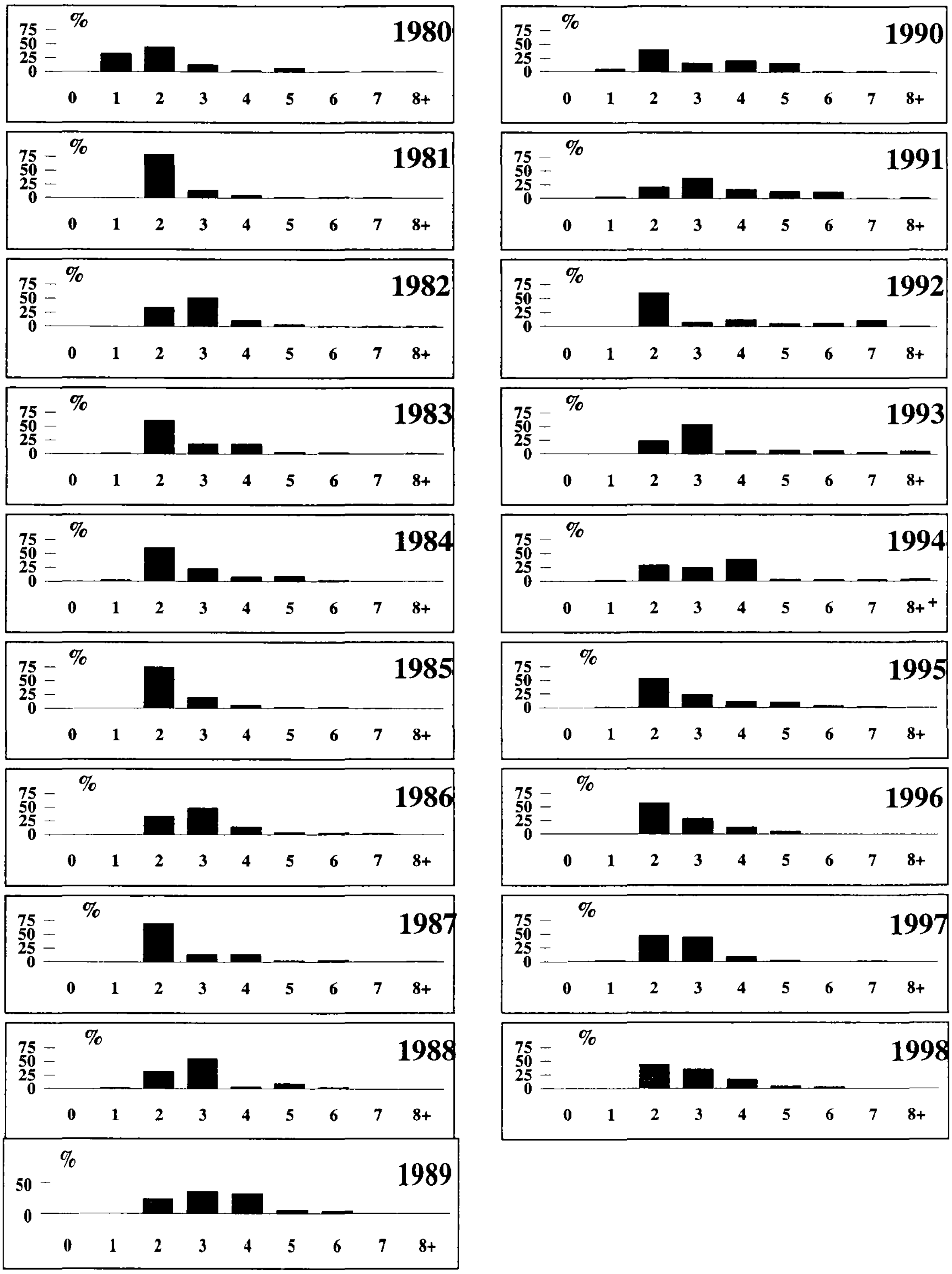


Figure 2.9.1 The age composition (winter-ring) of herring in Divisions IVc and VIId in the D catches from December 1980-1998.

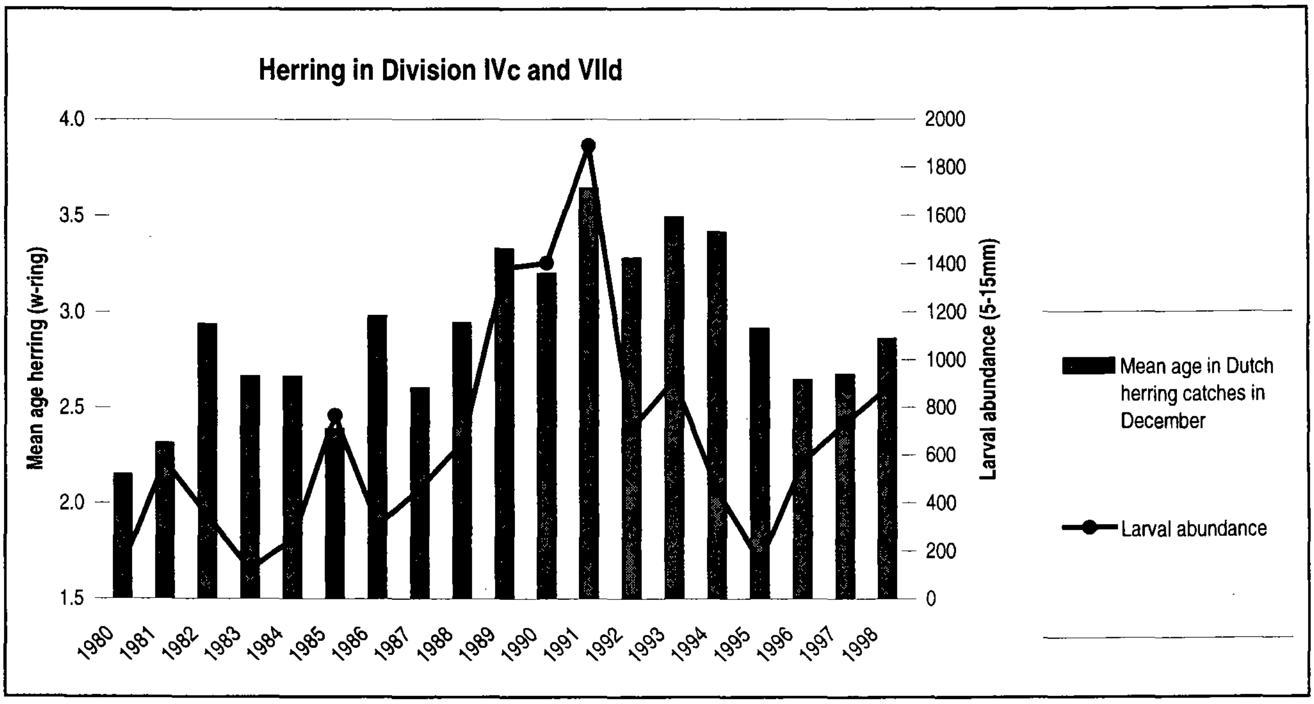


Figure 2.9.2 Changes in the herring larval abundance compared to changes in the mean age (winter-ring) in the Dutch herring catch

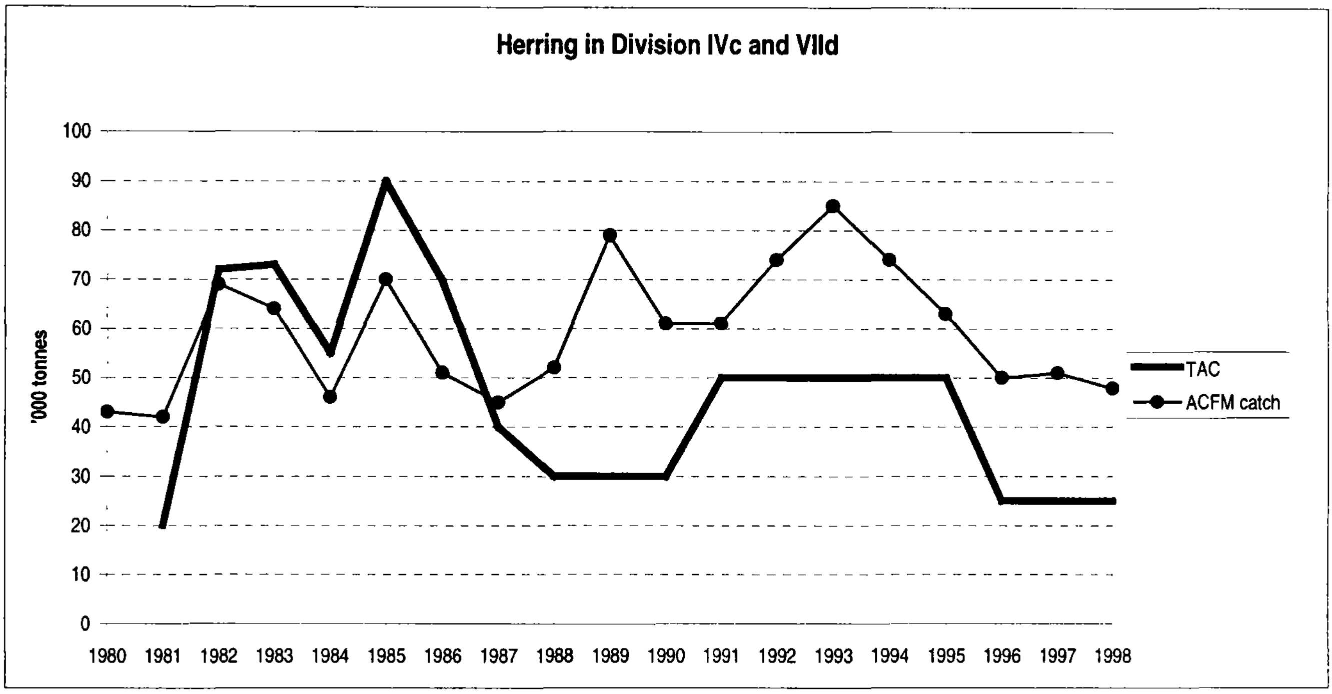
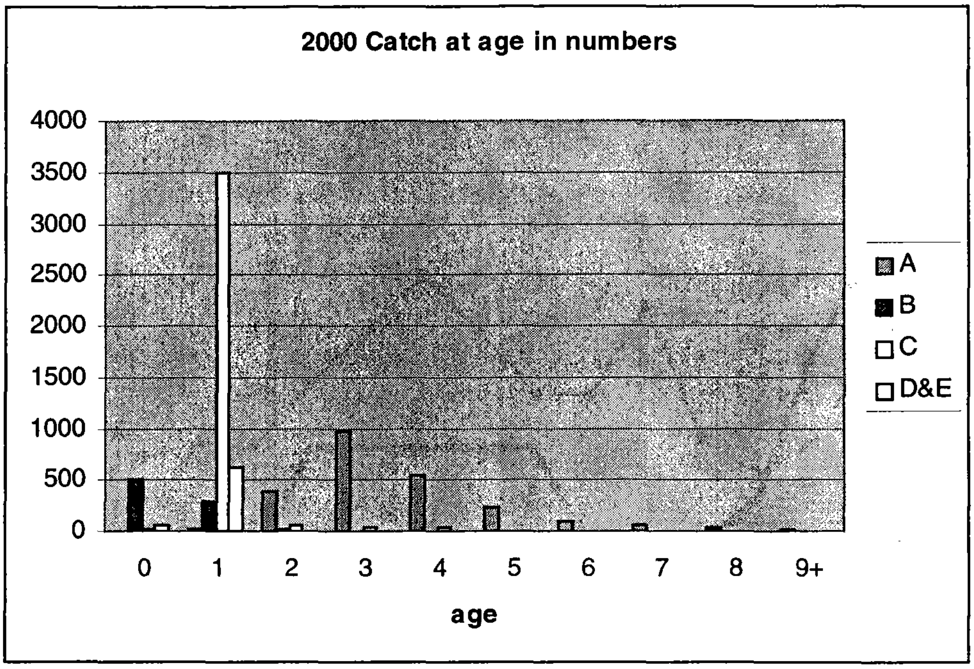
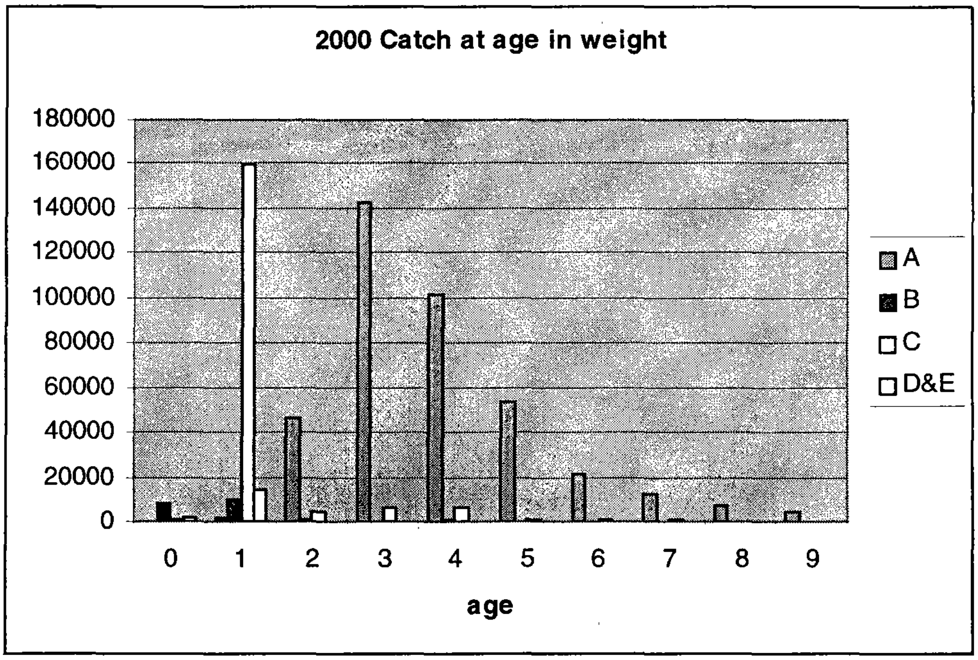


Figure 2.9.3 The agreed TAC for Divisions IVc and VIId compared to the ACFM catch in that area.
In 1996 the agreed TAC was reduced by 50% in the middle of the year.

Figure 2.10.1 North Sea Herring predicted catch at age in weight and numbers by fleet





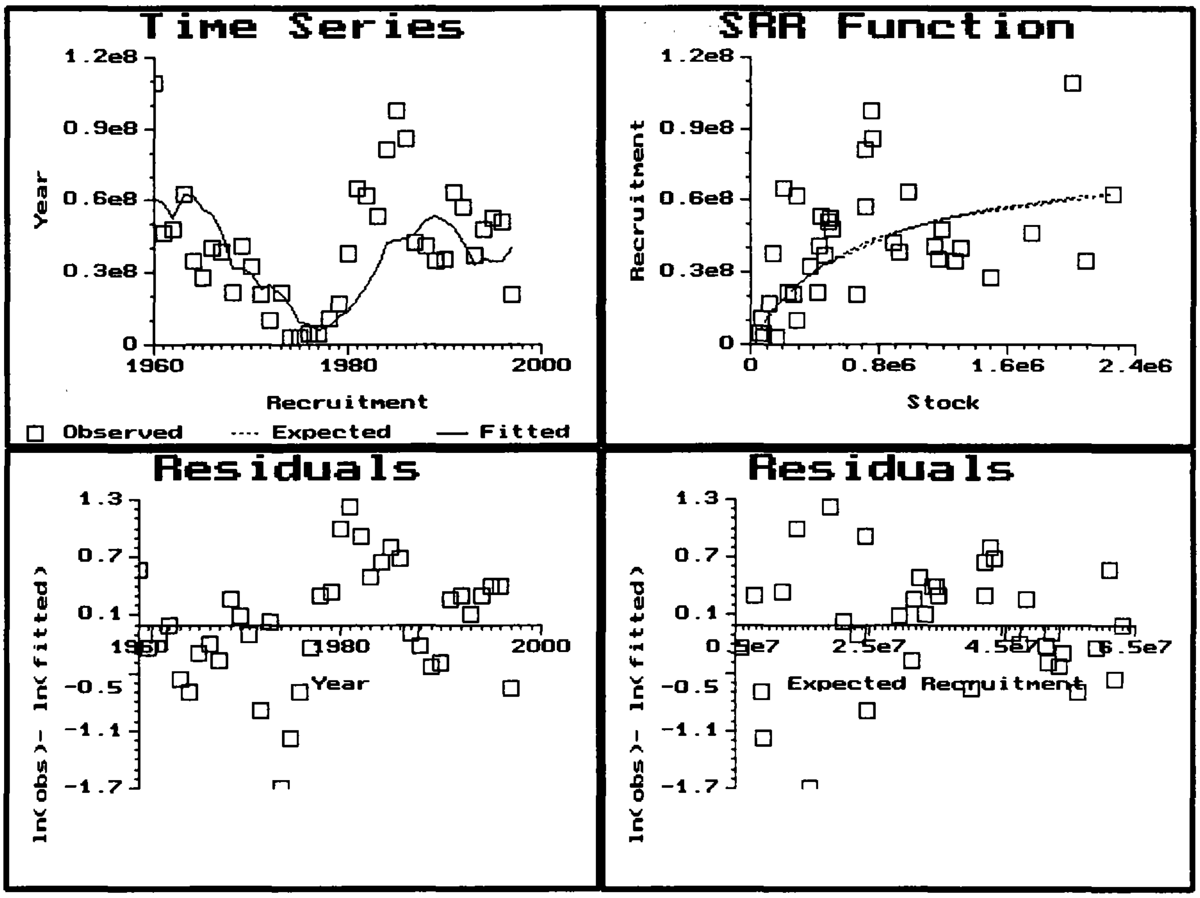


Figure 2.11.1. North Sea Herring: stock-recruitment relationship used for the medium-term projections (Beverton-Holt model). a. Time series of recruitment (ICA estimates), expected recruitment (fitted value from the Beverton-Holt model) and fitted (almost indistinguishable); b. Stock-recruitment functions and observed and expected recruitment plotted in the stock-recruitment plane; c. Scatter-plot of residuals vs. time; d. Scatter-plot of residuals vs. expected recruitment.

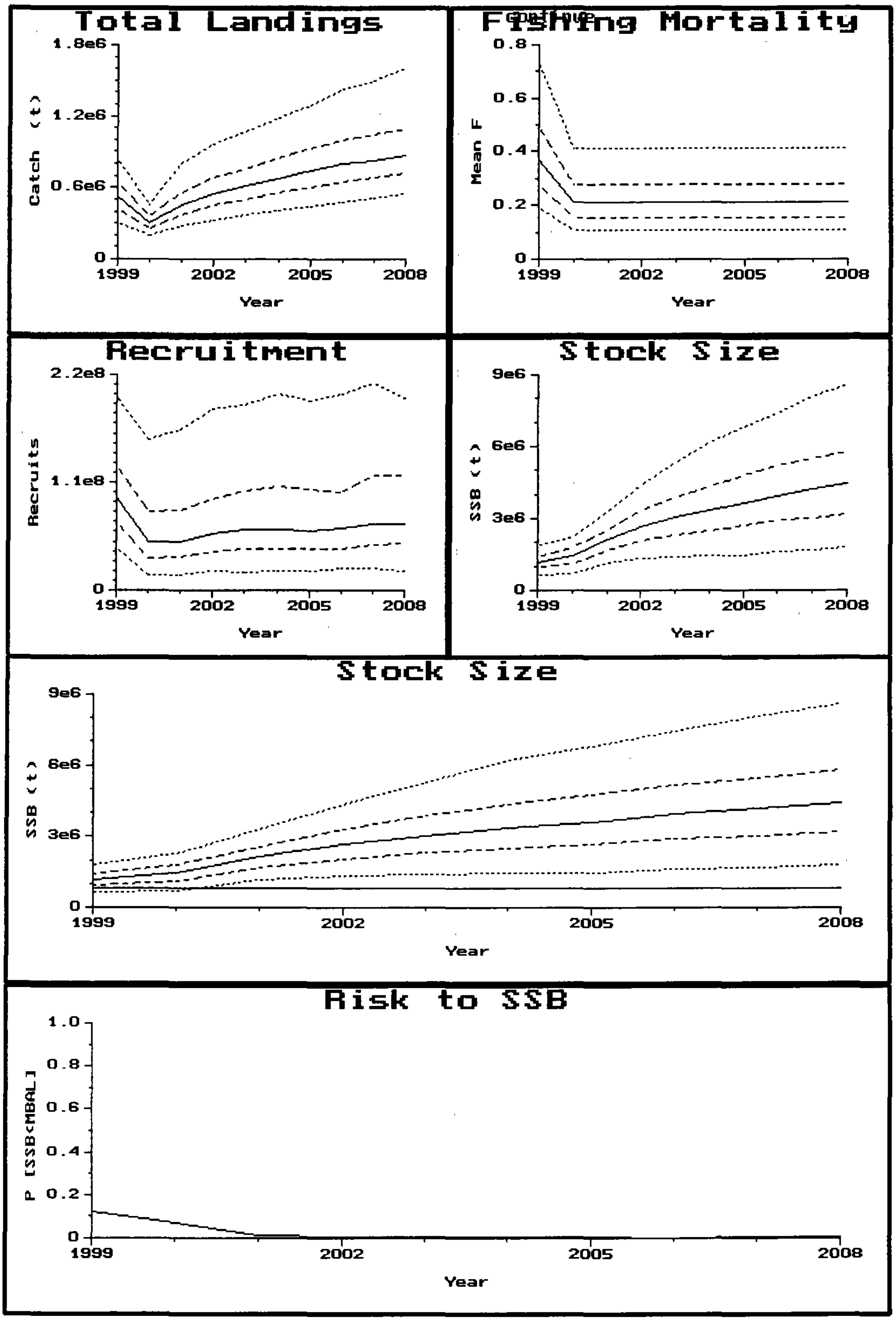


Figure 2.11.2a. North Sea Herring: Medium-term projections assuming F_A=0.2 and F_{B-E}=0.0. Dotted lines indicate 5th and 95th percentiles, dashed lines 25th and 75th percentiles, solid line indicates the median. Upper panel: Top left: landings by all fleets. Top right: fishing mortality (mean for ages 2-6 by all fleets). Bottom left: recruitment at age 0. Bottom right: spawning stock biomass at spawning time. Lower panel: Top: Trajectory of the spawning stock size. Bottom: Estimates of the risk that the SSB could fall below 800,000 t (MBAL).

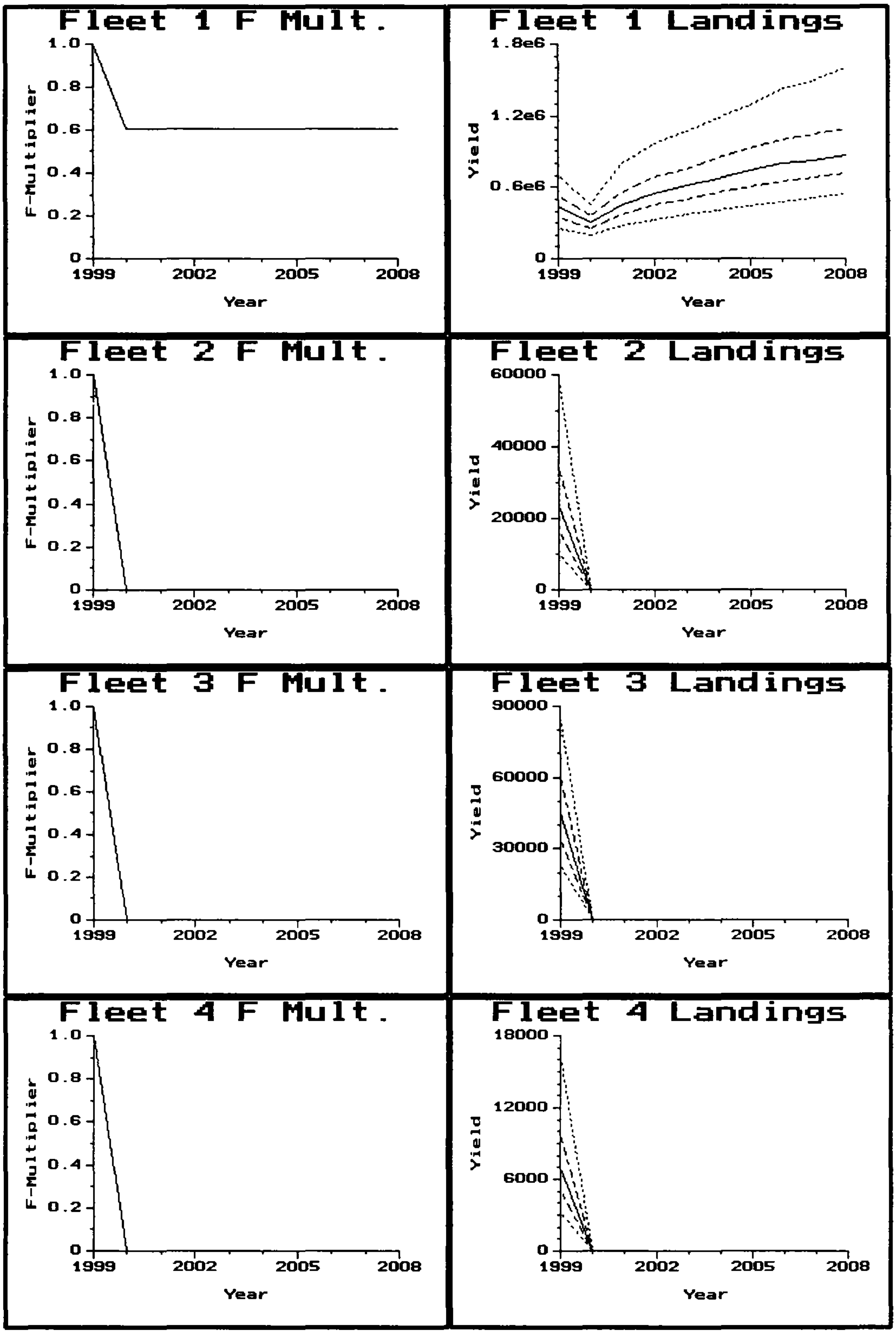


Figure 2.11.2b. North Sea Herring: Medium-term projections F_A=0.2 and F_{B-E}=0.0. F-multiplier and projected landings by fleets A (labelled 1), B (2), C (3) and D+E (4).

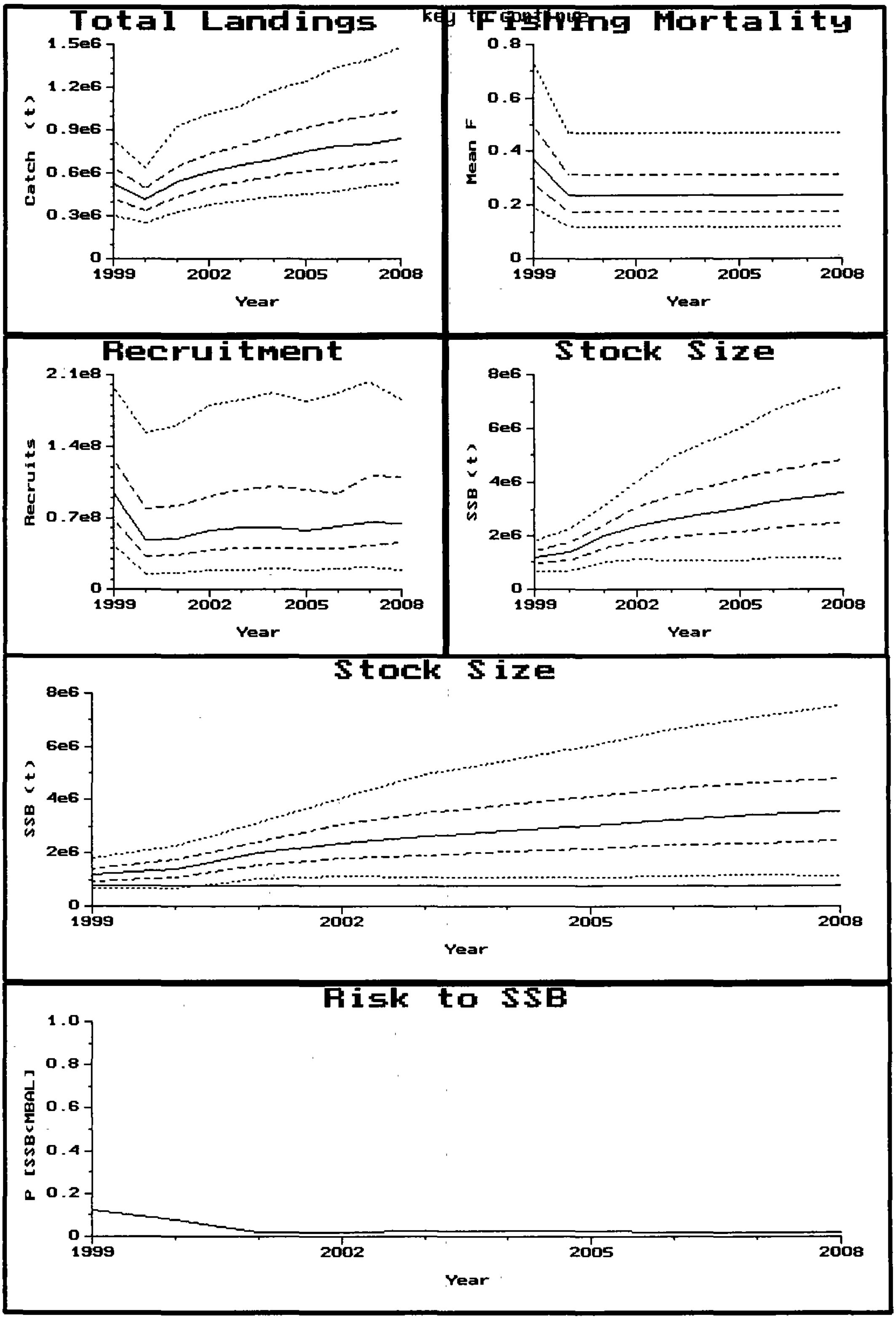


Figure 2.11.3a. North Sea Herring: Medium-term projections assuming F_A=0.2 and F_{B-E}=0.1. Dotted lines indicate 5th and 95th percentiles, dashed lines 25th and 75th percentiles, solid line indicates the median. Upper panel: Top left: landings by all fleets. Top right: fishing mortality (mean for ages 2-6 by all fleets). Bottom left: recruitment at age 0. Bottom right: spawning stock biomass at spawning time. Lower panel: Top: Trajectory of the spawning stock size. Bottom: Estimates of the risk that the SSB could fall below 800,000 t (MBAL).

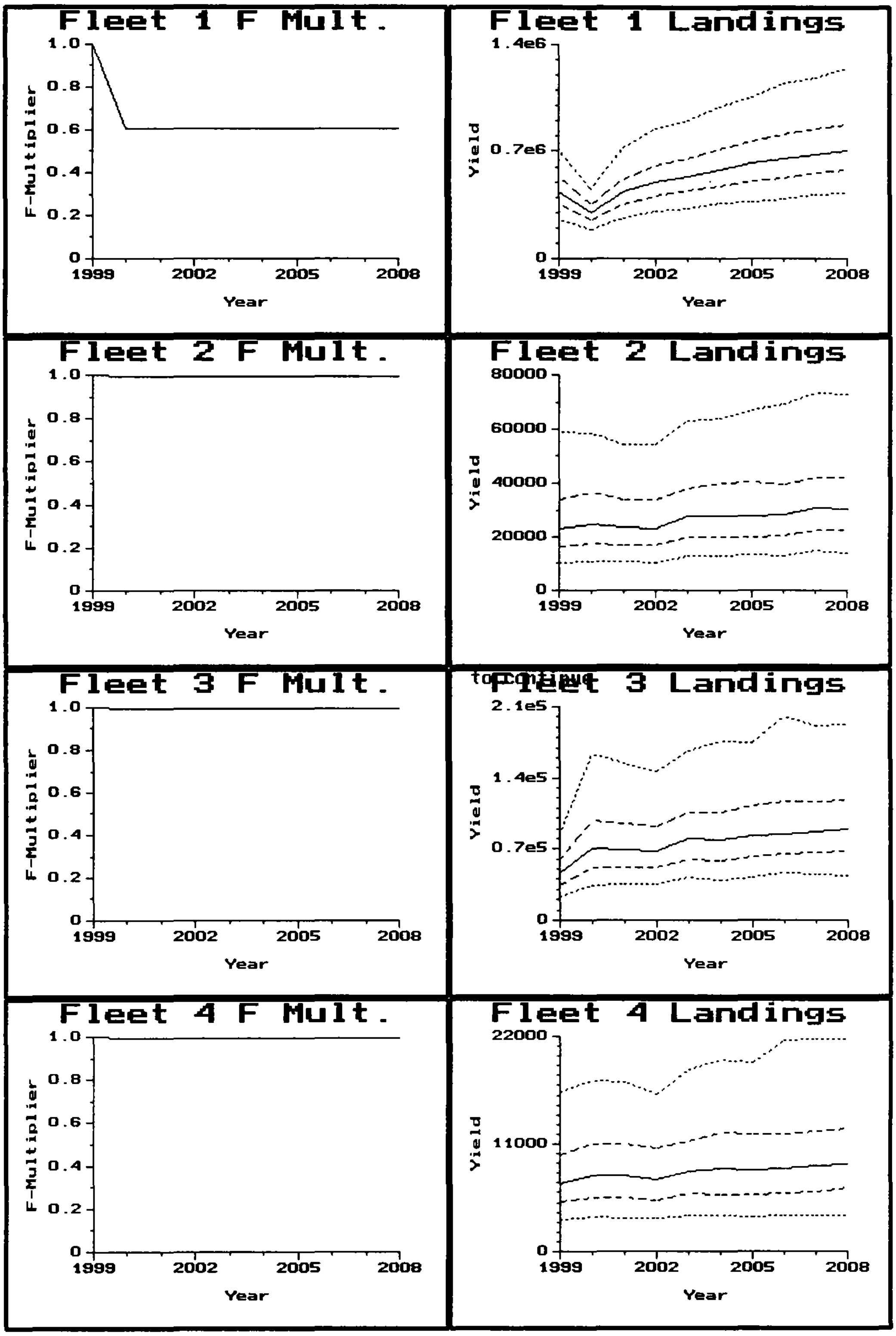


Figure 2.11.3b. North Sea Herring: Medium-term projections F_A=0.2 and F_{B-E}=0.1. F-multiplier and projected landings by fleets A (labelled 1), B (2), C (3) and D+E (4).

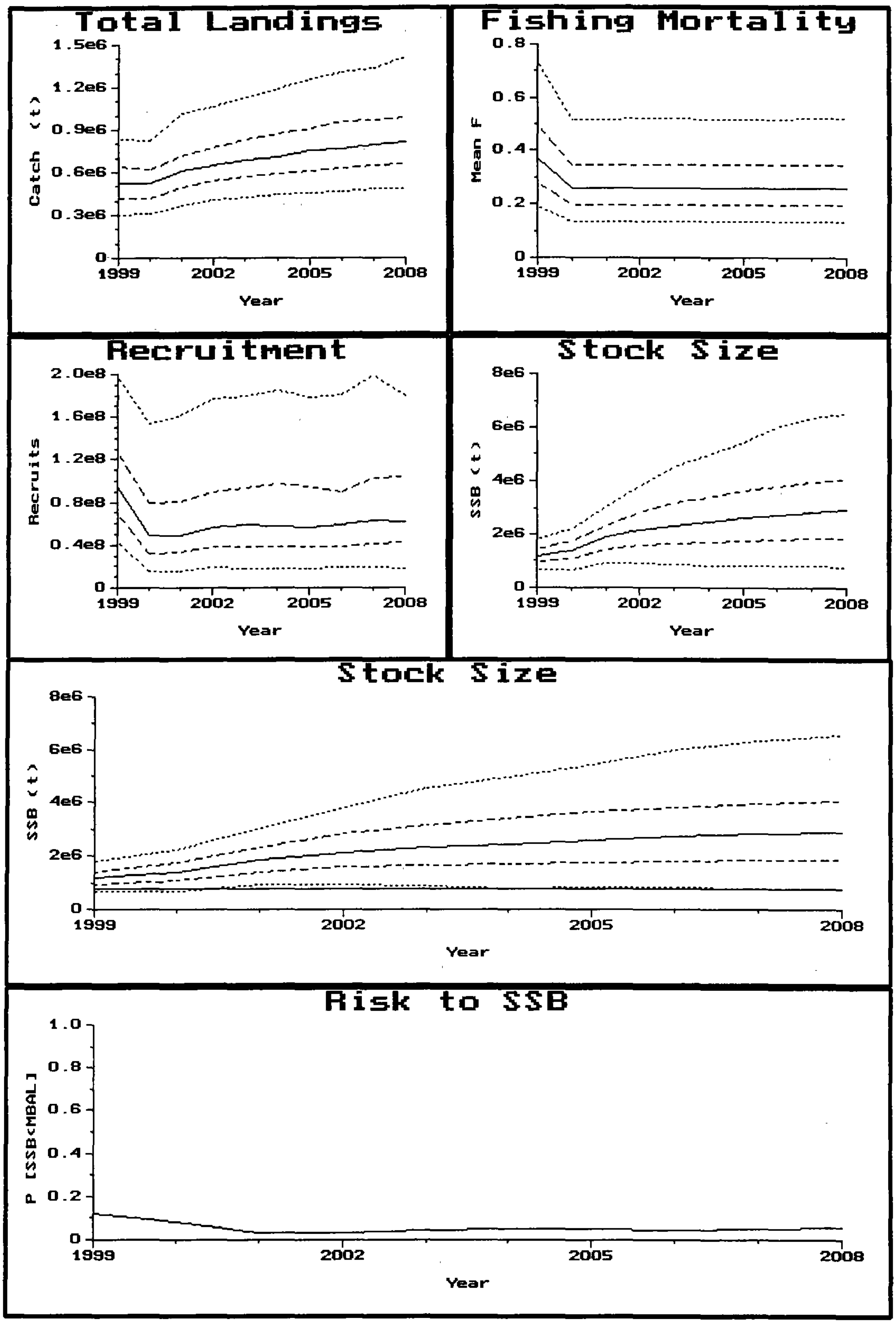


Figure 2.11.4a. North Sea Herring: Medium-term projections assuming F_A=0.2 and F_{B-E}=0.2. Dotted lines indicate 5th and 95th percentiles, dashed lines 25th and 75th percentiles, solid line indicates the median. Upper panel: Top left: landings by all fleets. Top right: fishing mortality (mean for ages 2-6 by all fleets). Bottom left: recruitment at age 0. Bottom right: spawning stock biomass at spawning time. Lower panel: Top: Trajectory of the spawning stock size. Bottom: Estimates of the risk that the SSB could fall below 800,000 t (MBAL).

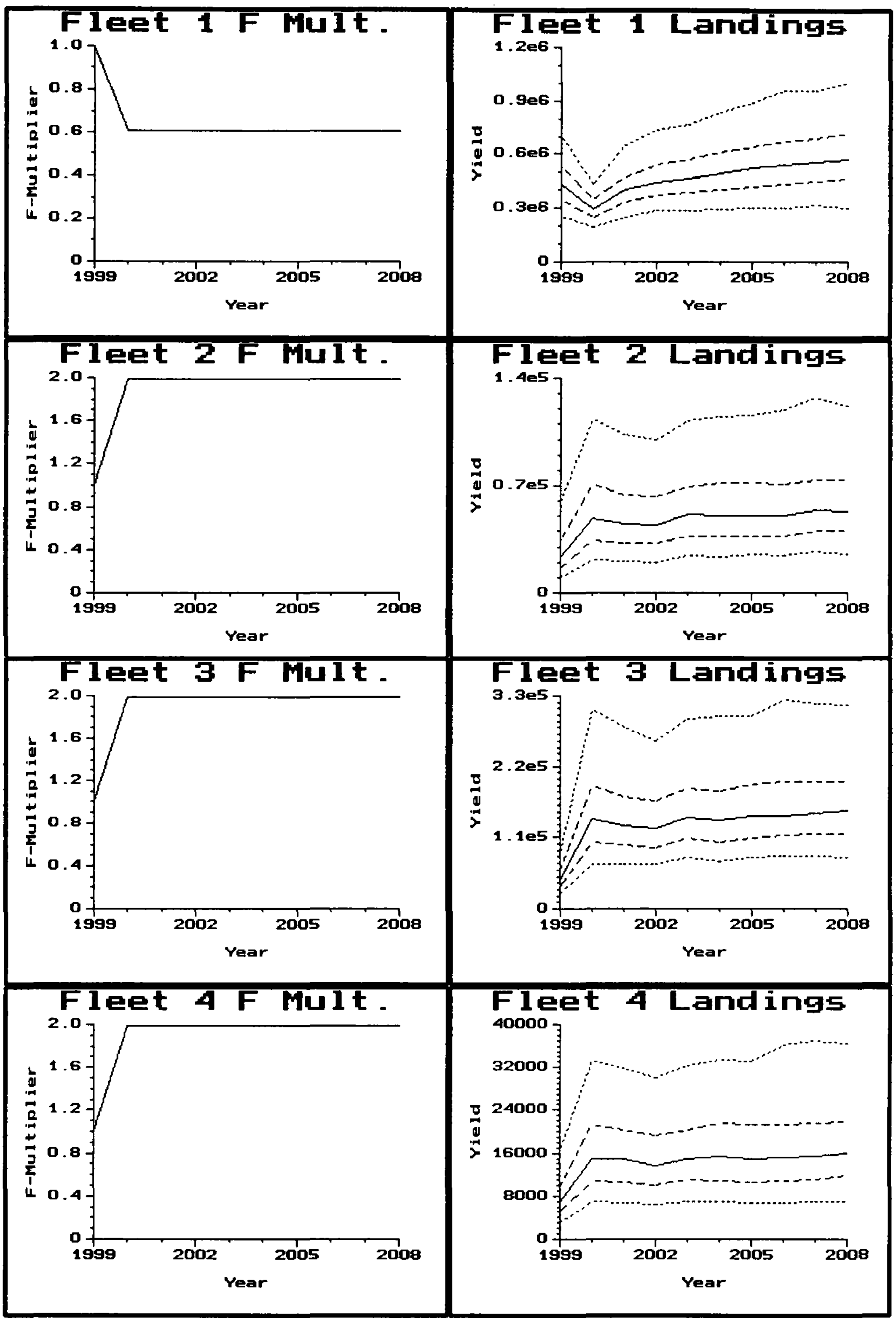


Figure 2.11.4b. North Sea Herring: Medium-term projections F_A=0.2 and F_{B-E}=0.2. F-multiplier and projected landings by fleets A (labelled 1), B (2), C (3) and D+E (4).

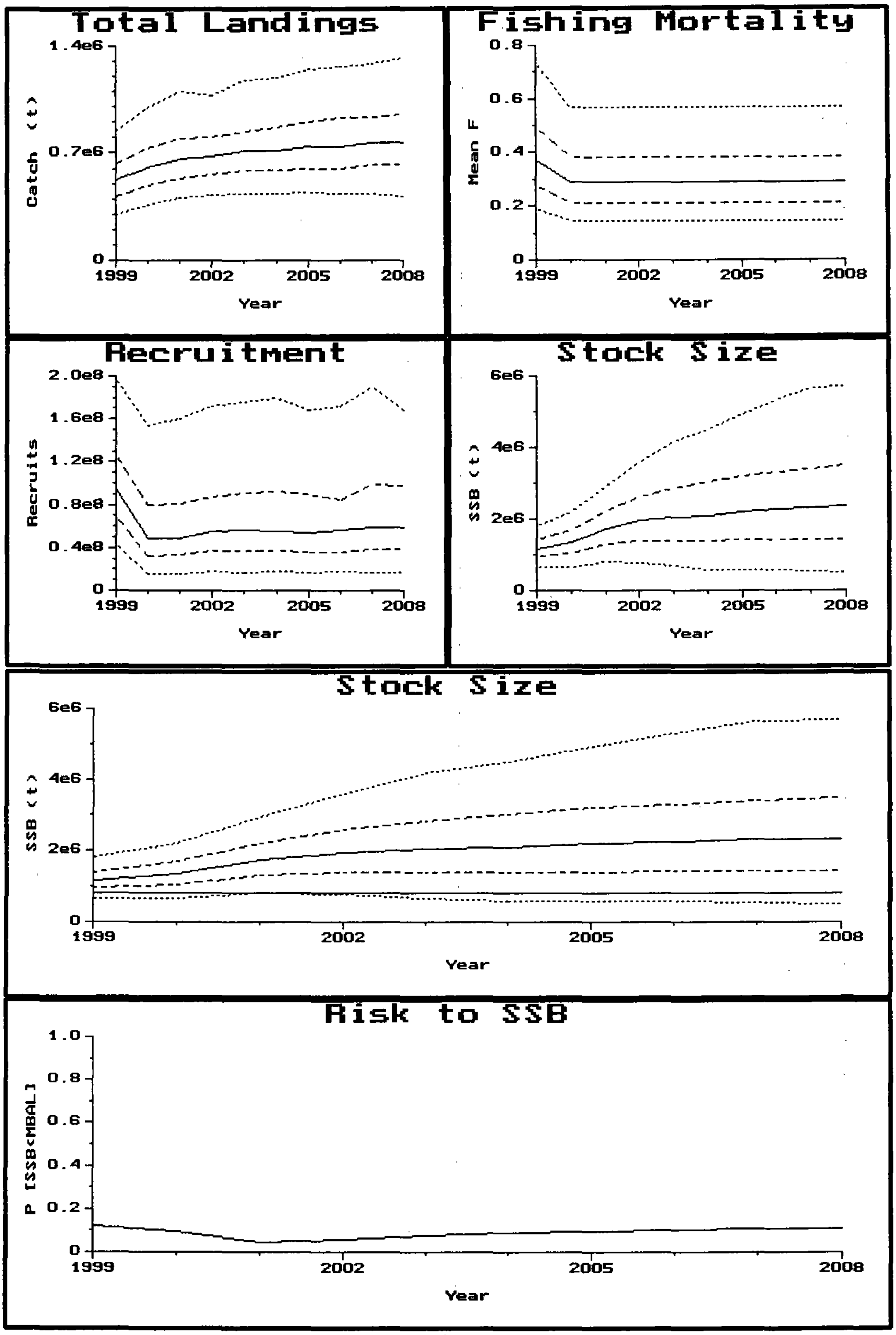


Figure 2.11.5a. North Sea Herring: Medium-term projections assuming F_A=0.2 and F_{B-E}=0.3. Dotted lines indicate 5th and 95th percentiles, dashed lines 25th and 75th percentiles, solid line indicates the median. Upper panel: Top left: landings by all fleets. Top right: fishing mortality (mean for ages 2-6 by all fleets). Bottom left: recruitment at age 0. Bottom right: spawning stock biomass at spawning time. Lower panel: Top: Trajectory of the spawning stock size. Bottom: Estimates of the risk that the SSB could fall below 800,000 t (MBAL).

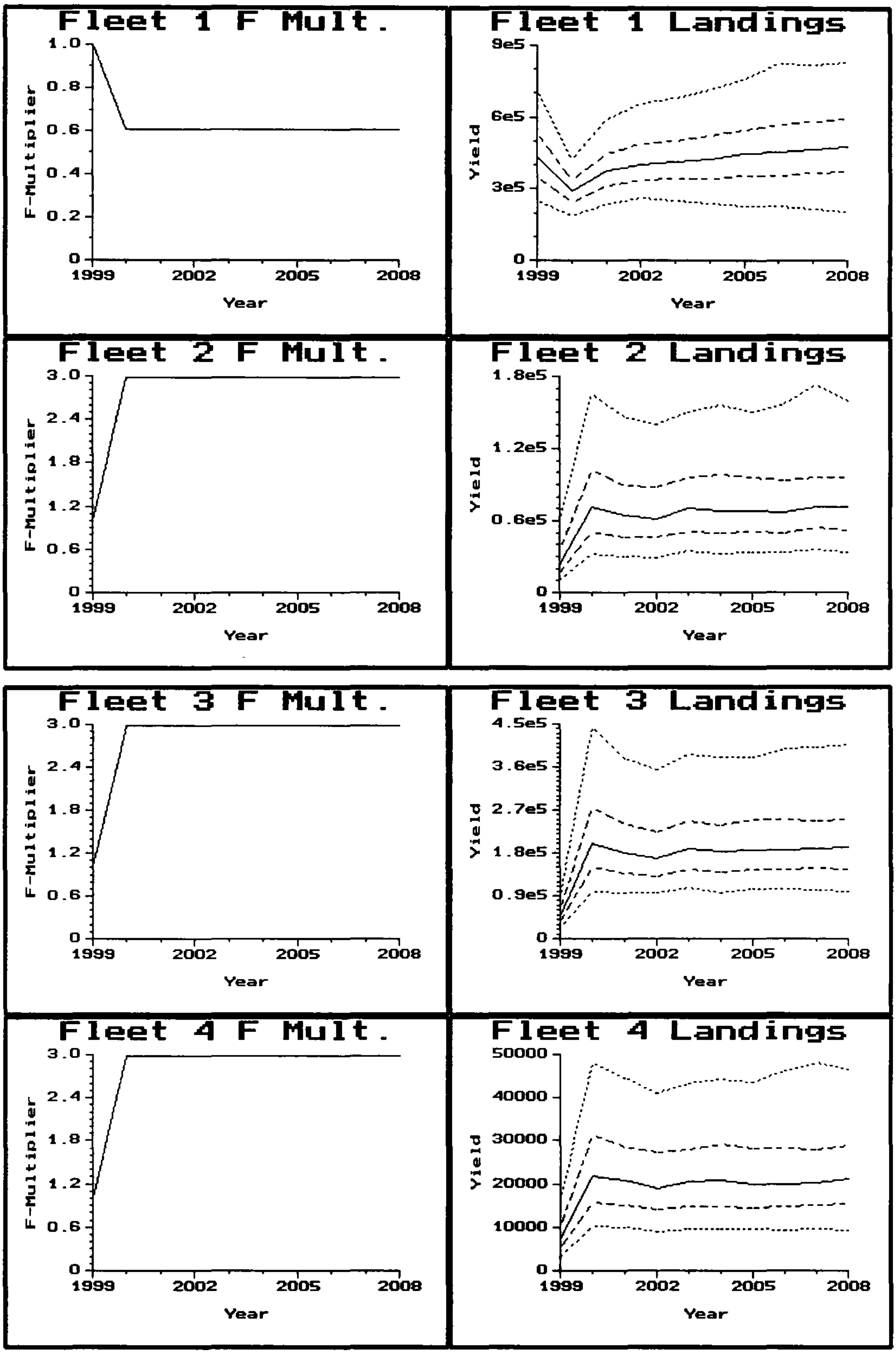


Figure 2.11.5b. North Sea Herring: Medium-term projections F_A=0.2 and F_{B-E}=0.3. F-multiplier and projected landings by fleets A (labelled 1), B (2), C (3) and D+E (4).

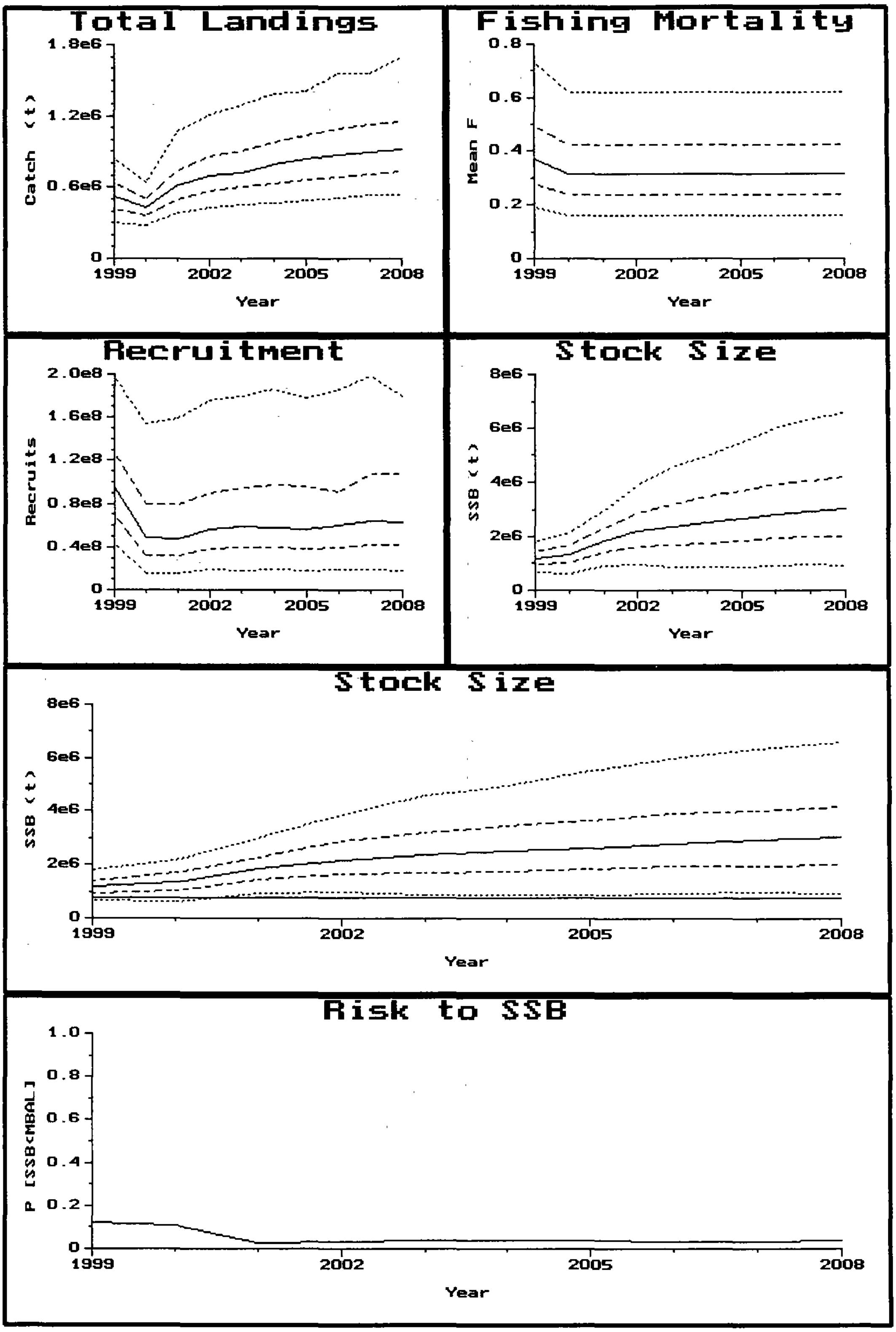


Figure 2.11.6a. North Sea Herring: Medium-term projections assuming F_A=0.3 and F_{B-E}=0.0. Dotted lines indicate 5th and 95th percentiles, dashed lines 25th and 75th percentiles, solid line indicates the median. Upper panel: Top left: landings by all fleets. Top right: fishing mortality (mean for ages 2-6 by all fleets). Bottom left: recruitment at age 0. Bottom right: spawning stock biomass at spawning time. Lower panel: Top: Trajectory of the spawning stock size. Bottom: Estimates of the risk that the SSB could fall below 800,000 t (MBAL).

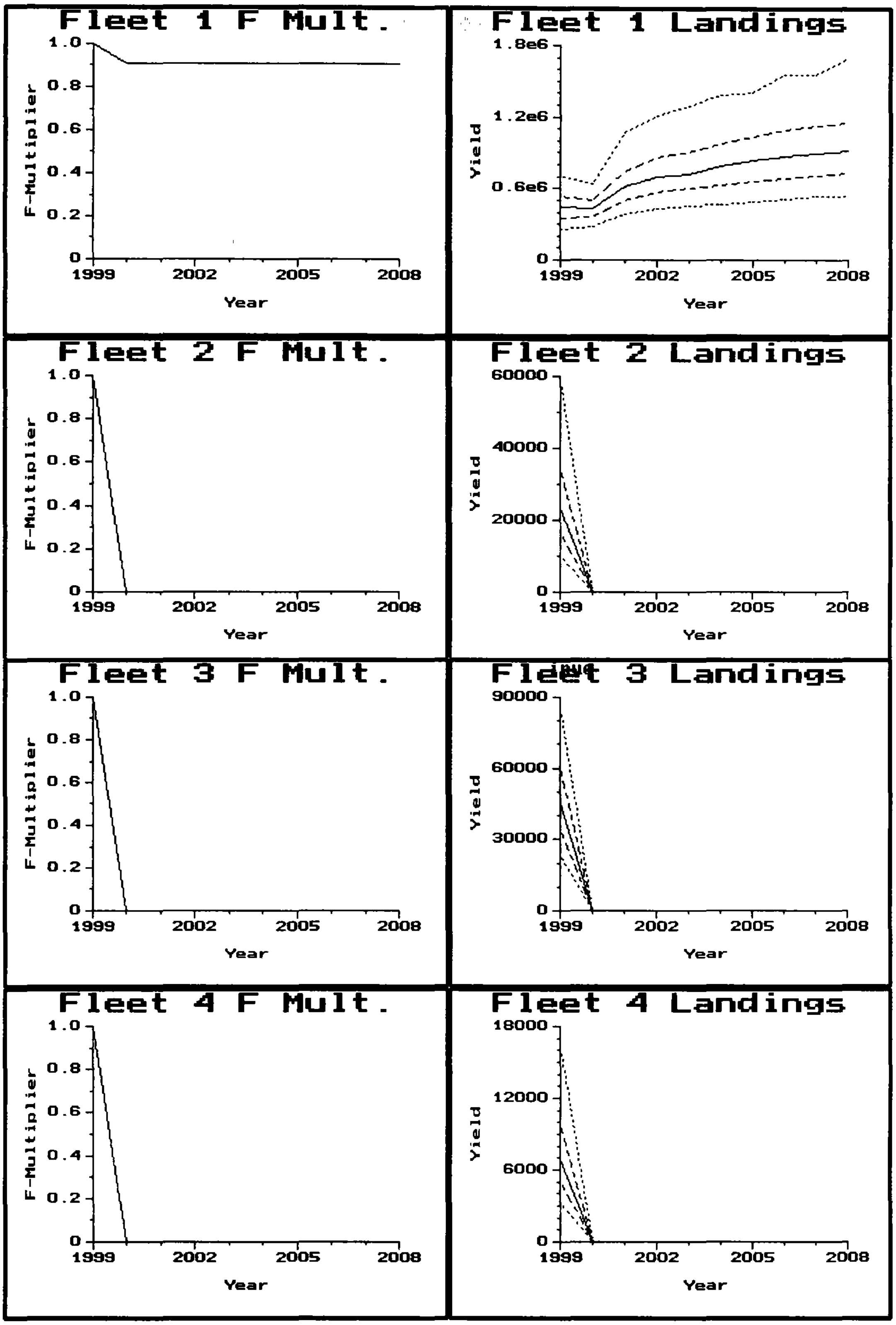


Figure 2.11.6b. North Sea Herring: Medium-term projections F_A=0.3 and F_{B-E}=0.0. F-multiplier and projected landings by fleets A (labelled 1), B (2), C (3) and D+E (4).

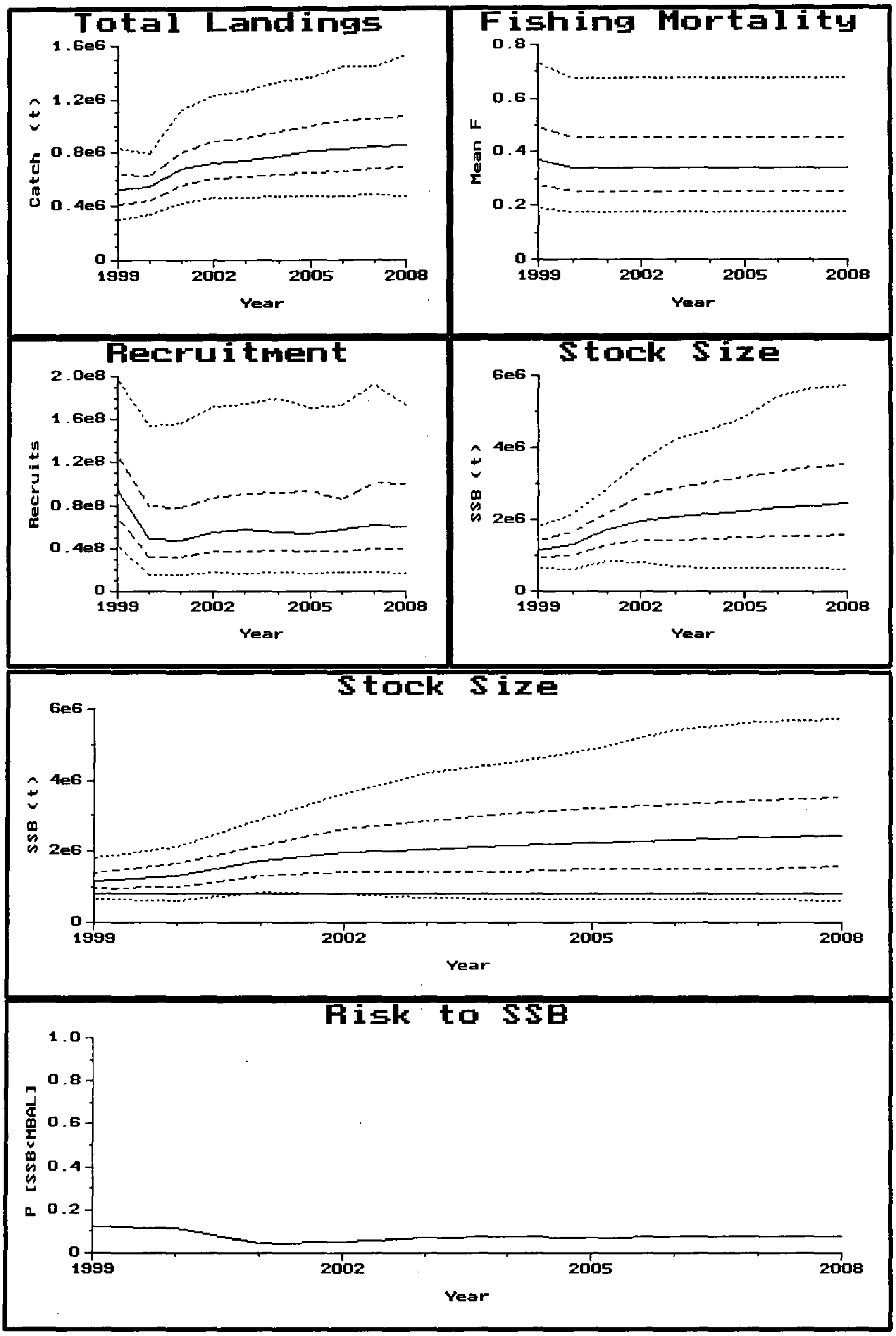


Figure 2.11.7a. North Sea Herring: Medium-term projections assuming F_A=0.3 and F_{B-E}=0.1. Dotted lines indicate 5th and 95th percentiles, dashed lines 25th and 75th percentiles, solid line indicates the median. Upper panel: Top left: landings by all fleets. Top right: fishing mortality (mean for ages 2-6 by all fleets). Bottom left: recruitment at age 0. Bottom right: spawning stock biomass at spawning time. Lower panel: Top: Trajectory of the spawning stock size. Bottom: Estimates of the risk that the SSB could fall below 800,000 t (MBAL).

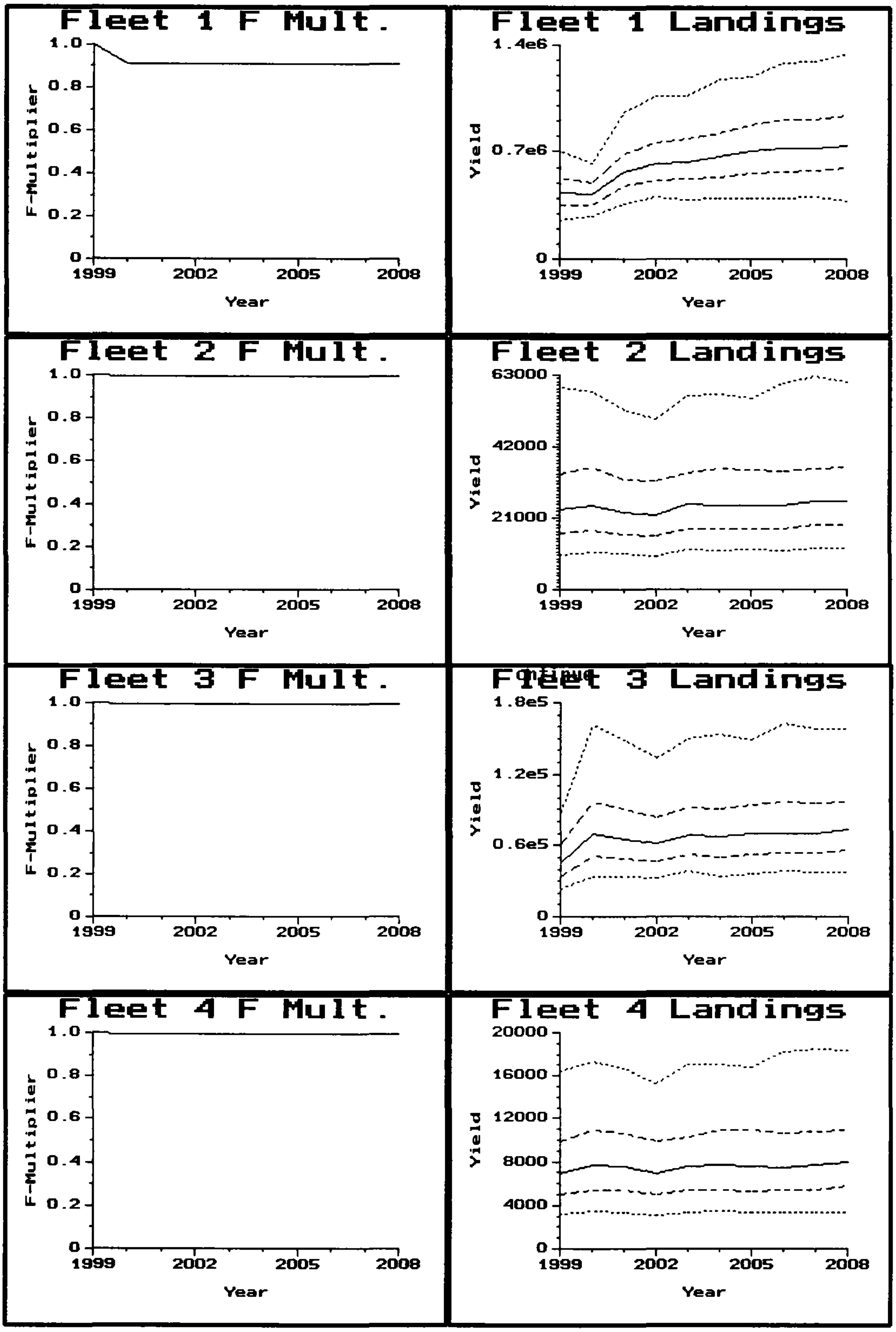


Figure 2.11.7b. North Sea Herring: Medium-term projections F_A=0.3 and F_{B-E}=0.1. F-multiplier and projected landings by fleets A (labelled 1), B (2), C (3) and D+E (4).

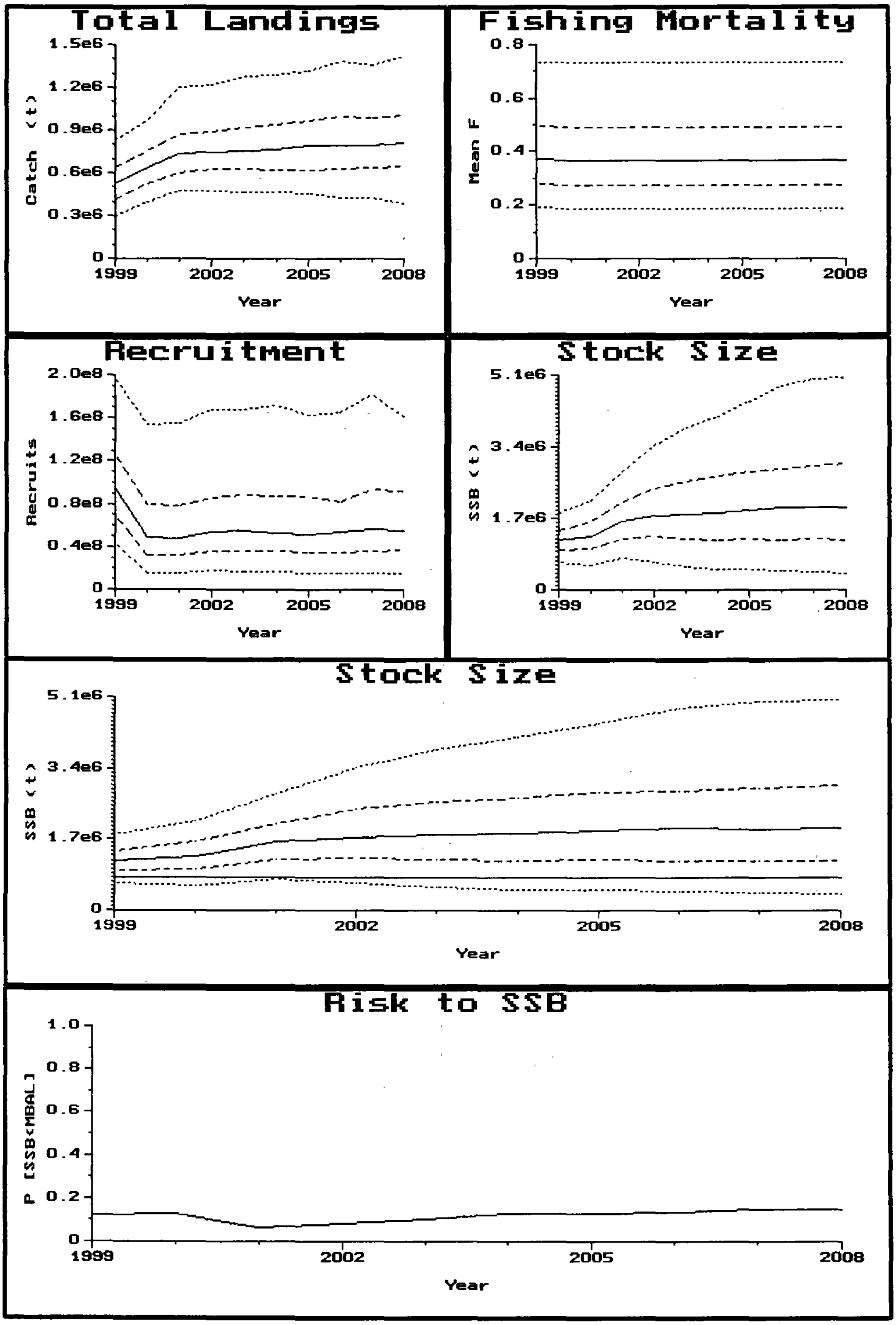


Figure 2.11.8a. North Sea Herring: Medium-term projections assuming F_A=0.3 and F_{B-E}=0.2. Dotted lines indicate 5th and 95th percentiles, dashed lines 25th and 75th percentiles, solid line indicates the median. Upper panel: Top left: landings by all fleets. Top right: fishing mortality (mean for ages 2-6 by all fleets). Bottom left: recruitment at age 0. Bottom right: spawning stock biomass at spawning time. Lower panel: Top: Trajectory of the spawning stock size. Bottom: Estimates of the risk that the SSB could fall below 800,000 t (MBAL).

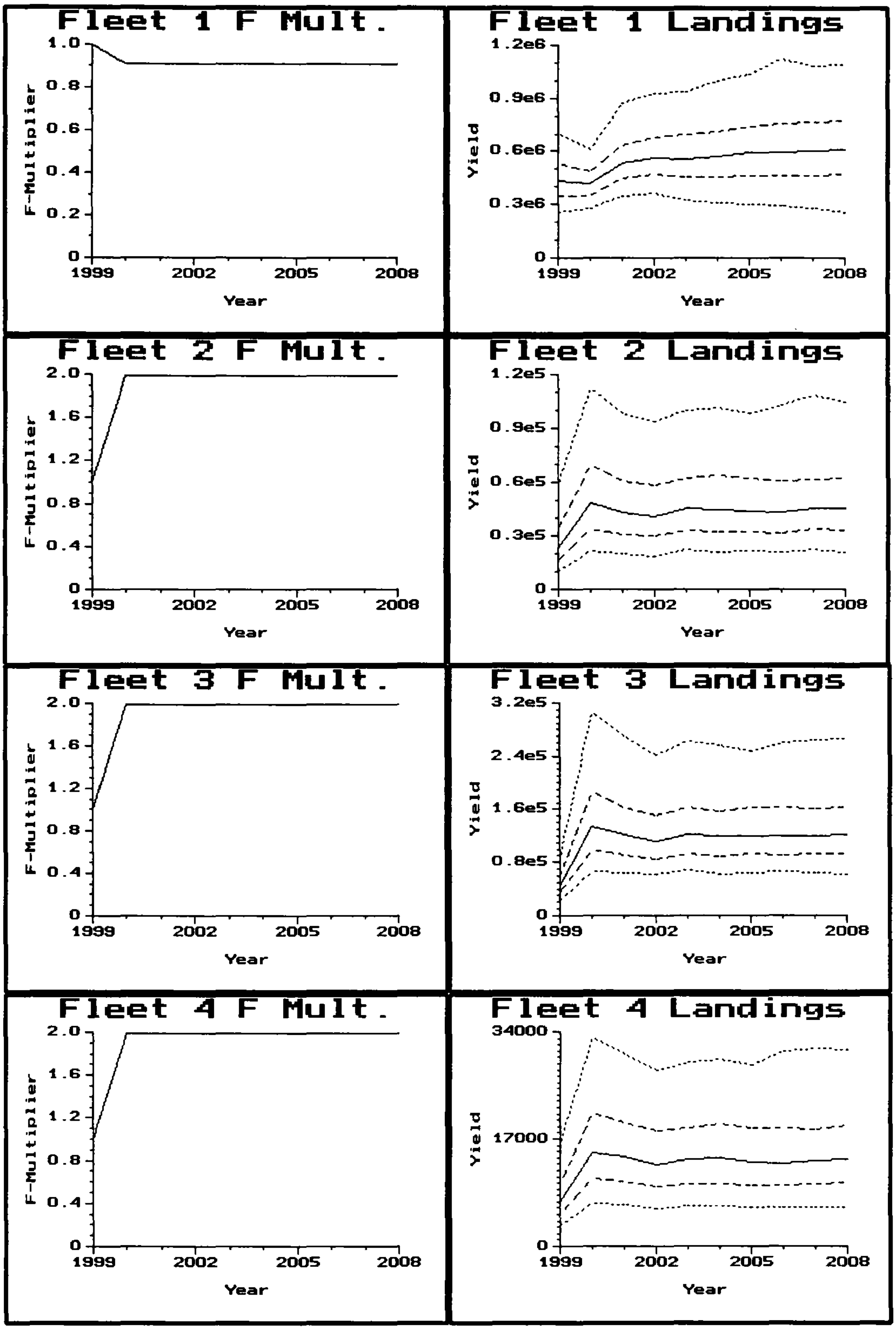


Figure 2.11.8b. North Sea Herring: Medium-term projections F_A=0.3 and F_{B-E}=0.2. F-multiplier and projected landings by fleets A (labelled 1), B (2), C (3) and D+E (4).

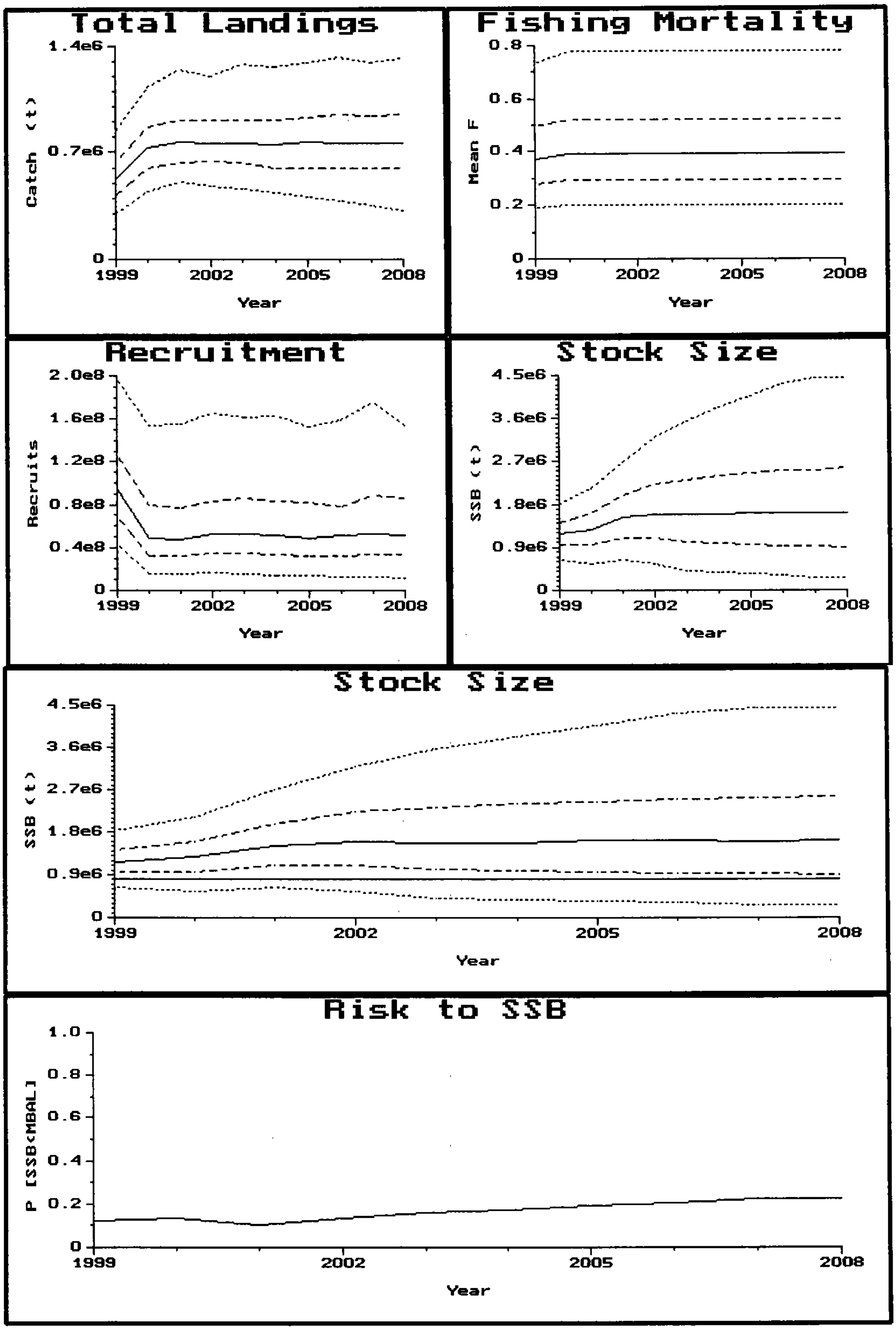


Figure 2.11.9a. North Sea Herring: Medium-term projections assuming F_A=0.3 and F_{B-E}=0.3. Dotted lines indicate 5th and 95th percentiles, dashed lines 25th and 75th percentiles, solid line indicates the median. Upper panel: Top left: landings by all fleets. Top right: fishing mortality (mean for ages 2-6 by all fleets). Bottom left: recruitment at age 0. Bottom right: spawning stock biomass at spawning time. Lower panel: Top: Trajectory of the spawning stock size. Bottom: Estimates of the risk that the SSB could fall below 800,000 t (MBAL).

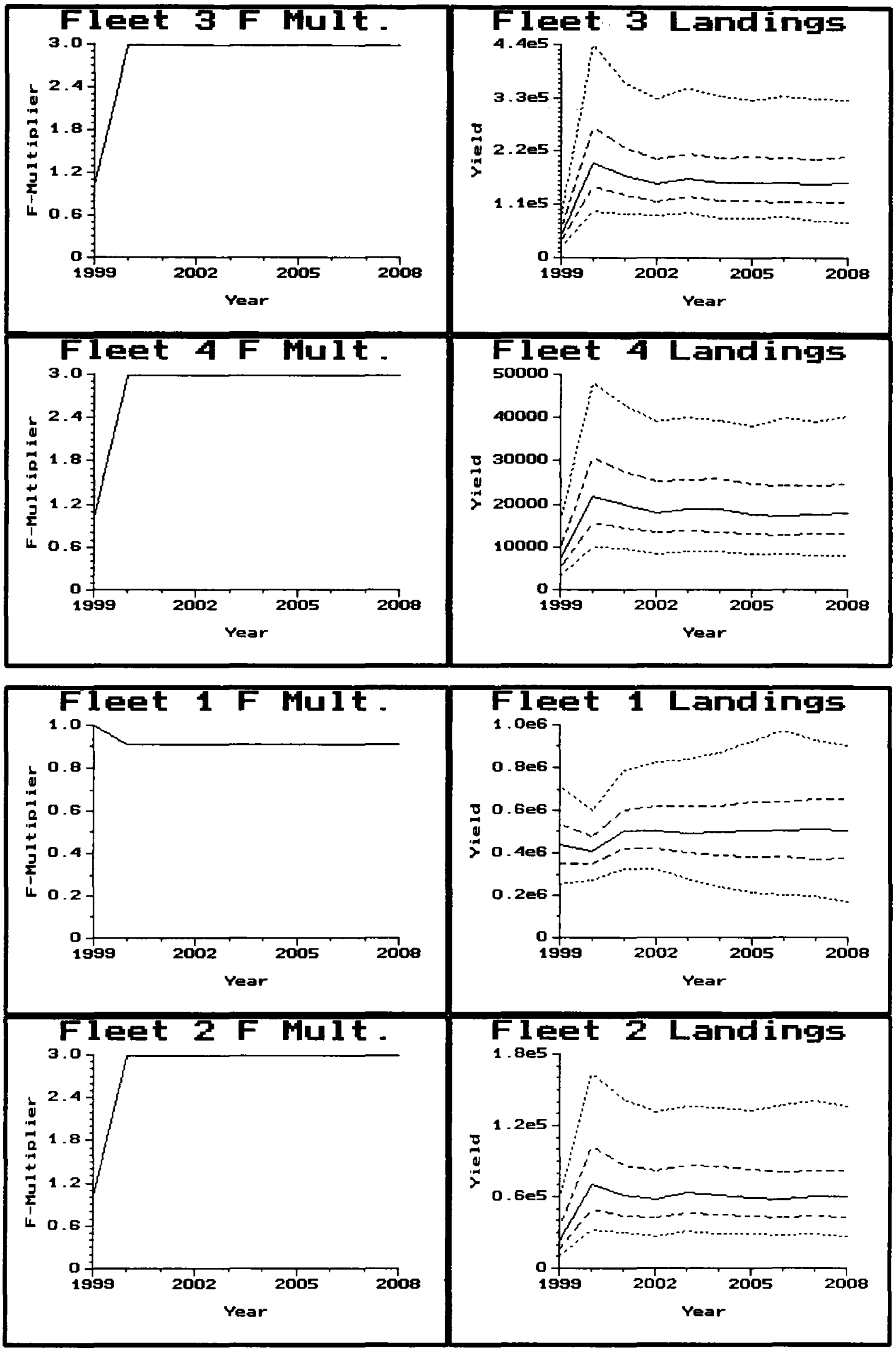


Figure 2.11.9b. North Sea Herring: Medium-term projections F_A=0.3 and F_{B-E}=0.3. F-multiplier and projected landings by fleets A (labelled 1), B (2), C (3) and D+E (4).

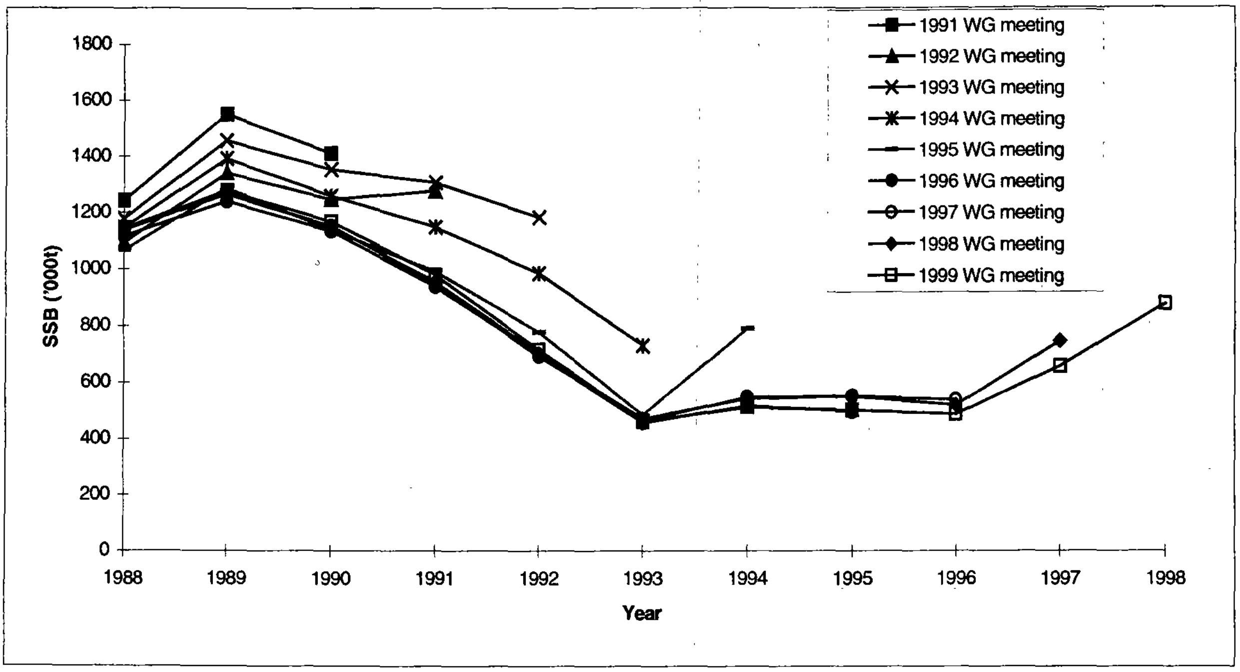


Figure 2.12.1 Spawning stock biomass estimated at the Herring Assessment Working Group meetings from 1991 - 1999. The assessments carried out at Working Group meetings in 1991-1995 and to a lesser extent 1998 show a systematic overestimate of the spawning stock biomass.

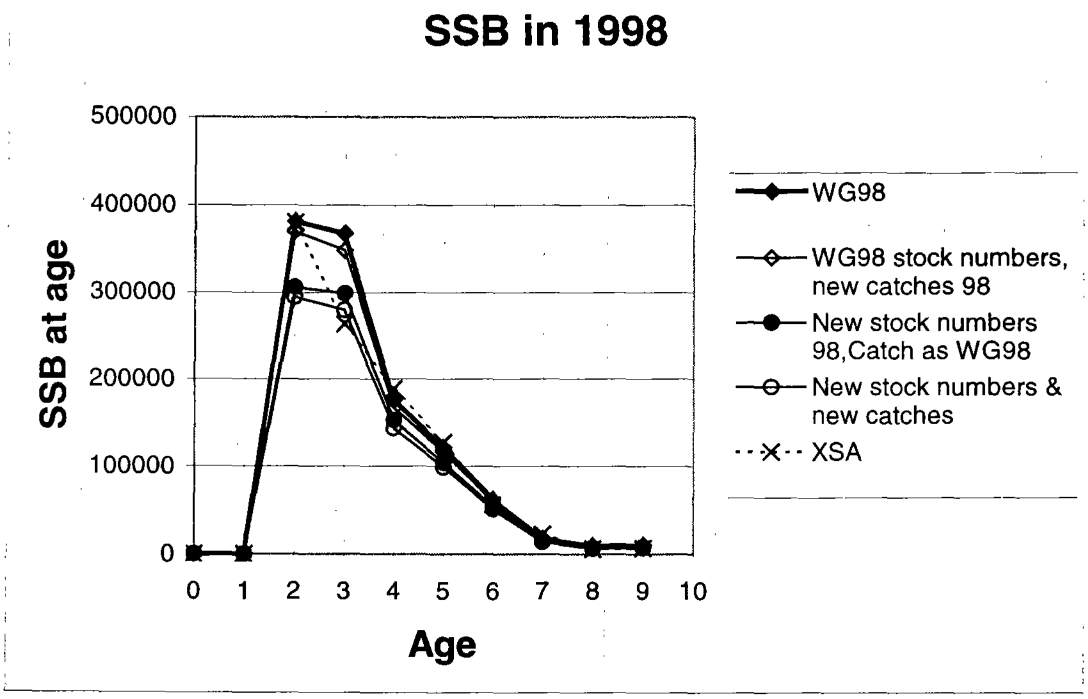


Figure 2.12.2
Predicted SSB at age for 1998 compared. 1) WG estimate in 1998, 2) by correcting for 1998 catches, 3) using new assessment with estimated catches, 4) new assessment with 1998 catches and 5) an XSA assessment

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

3.1 The Fishery

3.1.1 ACFM advice and management applicable to 1998 and 1999

ACFM stated again in 1998 that the state of the stock is uncertain due to problems with splitting in proportions of spring and autumn spawners in the historical data and the lack of a co-ordinated comprehensive survey. Neglecting the precise levels of SSB and F the trends seen from 1991 – 1996 have changed. The SSB in 1997 were above the 1996 estimate and the F in 1997 was below those seen in recent years.

ACFM recommended that the fisheries on herring in Division IIIa should be managed in accordance with the advise given on autumn-spawning herring in the North Sea, and if a catch limit is required in Sub-divisions 22–24, ACFM advised that it should not exceed recent catches in that area.

Prior to 1998 TACs were set for three fleets in Division IIIa: the human consumption fishery (Fleet C), the mixed clupeiod fishery and by-catches in the small mesh fishery (Fleet D and E). For 1998 Norway and EU have agreed on setting TACs for only two fleets: 80,000 t for the human consumption fleet and a by-catch ceiling of 17,000 t to be taken in the small mesh fishery.

The EU and Norway agreed on a herring TAC for 1999 of 80,000 t in Division IIIa for the human consumption fleet and a TAC or by-catch ceiling of 19,000 t to be taken in the small meshed fishery.

As in previous years no special TAC for 1998 was set by the International Baltic Sea Fishery Commission (IBSFC) in 1998 for the stock component in the Western Baltic area. For the Baltic there was a TAC of 660,000 t for all the Sub-divisions 22–32. The TAC was reduced to 570,000 t for the same area in 1999.

Introduction to landing statistics

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

3.1.2 Total Landings

Landings from 1985 to 1998 are given in Table 3.1.1. In 1998 the total landings increased to around 173,000 tons in Division IIIa and Sub-divisions 22–24 compared with 1997 where the landings were 150,000 tons. In 1998 44,000 tons were taken in the Kattegat, about 65,000 t from the Skagerrak and 64,000 t from Sub-divisions 22–24. These landings represent an increase of 23,000 t compared to 1997. The landings in 1997 were the lowest records in the time series, but landings in 1998 were at the same level as in 1996.

Misreporting of fishing grounds still occurs. Some of the Danish landings of herring for human consumption reported in Division IIIa may have been taken in the adjacent waters of the North Sea in quarters 1, 2 and 4. These landings are included in the figures for the North Sea. A substantial part of Swedish landings have been misreported as caught in the triangle (an area in the southern Kattegat, which is a part of the Baltic area: Gilleleje, DK - Kullen, S - Helsingborg, S - Helsingør, DK). This amount is included in the figures for Kattegat and Skagerrak. Some Danish landings, reported as taken in this triangle, may have been taken outside this area. These landings are listed under Sub-division 23.

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

Prior to 1998 the herring catches in Division IIIa were taken mainly in three types of fisheries:

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

- A "Mixed clupeoid fishery" (fleet D) carried out under a special "Sprat" TAC for all species caught in this fishery. Danish boats have been obliged to use 32 mm mesh size (from 1991 to 1997). The Swedish fishery by purse seiners is fishing for sprat along the coast, and Norwegian purse seiners catch sprat for the canning industry.

- Catches of herring also occur as by-catches in the small mesh fisheries (fleet E) (mesh size< 32 mm), such as the Norway pout, blue whiting and sandeel fisheries.

New fleet definitions

The1998 landing data are calculated by fleet according to the above fleet definitions. In the autumn 1998 the EU and Norway have agreed on setting TACs for only two fleets, the HAWG has therefore decided to merge Fleet D and Fleet E and only present data according to these new fleet definitions.

The new fleet definitions used for 1998 are:

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

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

All Norwegian landings for 1998 and all landings from fisheries with mesh sizes of min. 32 mm are categorised in Fleet C. Danish and Swedish by-catches of herring from the sprat fishery and the Norway pout and blue-whiting fisheries are listed under fleet D+E.

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

- C: Fleet using 32 mm mesh size in Division IIIa.
- D+E: Fleets using mesh size less than 32 mm Division IIIa.
- F: Landings from Sub-divisions 22–24.

In the table below the landings are given for 1996 to 1998 in thousands of tonnes by fleet and quarter. The landings figures in the text table below are SOP figures.

Year	Quarter	Fleet C	Fleet D+E	Fleet F	Total
1996	1	13.9	12.1	9.3	35.3
	2	12.5	2.2	23.9	38.6
	3	46.2	3.2	10.1	39.5
	4	19.4	8.3	13.5	41.2
	Total	92.0	25.8	56.8	174.6
1997	1	11.7	2.5	17.4	31.6
	2	16.9	1.3	27.2	45.4
	3	22.6	1.1	7.8	31.5
	4	21.7	4.2	15.1	41.0
	Total	72.9	9.1	67,5	149.5
1998	1	17.6	3.1	18.5	39.2
	2	8.2	0.9	16.9	26.0
	3	44.2	2.0	14.7	60.9
	4	34.3	2.6	13.6	50.5
	Total	104.3	8.6	63.7	176.6

The landings from fleets C-F are SOP figures.

3.2 Stock composition

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

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

The herring stocks in the Kattegat and the Skagerrak have been identified within samples by a number of different methods. Some of them have not been fully documented in earlier WG-reports. In a number of scientific papers the average counts in number of vertebrae in herring samples have been considered (Rosenberg & Palmén, 1982; Gröger & Gröhsler, 1995 and 1996). NSAS have a mean number of 56.5 vertebrae while the WBSS are represented by a lower mean number, 55.8 vertebrae. The most abundant local spring spawning herring, the Skagerrak spring spawners (SSS), are represented by a higher mean number, 57.0 vertebrae.

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

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

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

3.2.1 Treatment of spring spawning herring in the North Sea

The split was performed on age classes 2, 3, and 4+ WR using proportion of spring spawners f(sp) calculated from VS-counts using the equation f(sp) = [56.5-VS(sample]/[56.5–55.8] where VS (sample) was the sample mean vertebral count (ICES 1992/H:5). For quarter two the proportion was calculated from Norwegian samples of commercial catches in May and June 1998, and for quarter three the proportion was calculated from Norwegian samples of commercial catches in July 1998; for the actual split see Section 2.2.3.

3.2.2 Treatment of autumn spawners in Division IIIa

The split of the Danish catches was conducted using a random subsample of herring where analysis of individual otolith micro-structure determined the spawning type (Mosegaard and Popp-Madsen 1996). A total of 3282 otoliths from the year 1998 were analysed for spawning type. Distributed on quarters the following numbers were analysed Q1:234, Q2:502, Q3:1878 and Q4:668. By areas, 10% were from the subdivisions 22–24, 39% from the Kattegat, 29% from the Skagerrak and 22% from the transfer area in the eastern part of the North Sea. Samples from the small mesh fishery constituted 21% of the analyses, 33% from the human consumption fishery, and the remaining 46% came from Danish and Swedish research vessels from four different cruises.

Data were disaggregated by area (Kattegat and Skagerrak), age group (0–4+ WR) and quarter (1–4).

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

Proportions taken from 1997 years report were applied to: Skagerrak: Q3, 0-ringers and Q1, 1-ringers.

Proportions taken from the North Sea transfer area 1998 data were applied to: Skagerrak: Q1: 3 and 4+ ringers.

Proportions calculated as means of the corresponding data from the North Sea transfer area and the Kattegat 1998 were applied to: Skagerrak: Q2: 1,2,3 and 4+ -ringers.

The resulting split for the Skagerrak and the Kattegat is summarised in Table 3.2.1 as% autumn spawners and spring spawners by age in each quarter.

3.2.3 Autumn spawners in the small mesh fishery in SD 22 and 24

In the western Baltic a small percentage of the herring caught in the small mesh fishery consisted of autumn spawned individuals. Compared to the 1997 years assessment (ICES 1998a) the magnitude of the problem in 1998 was minor. Juvenile autumn spawned herring of the age groups 0 and 1 comprised between 3 and 11% of the catches. The small size at age however, indicated that the herring were local autumn spawners rather than originating from the North Sea stock. Since this problem is of limited influence and since it only affects the younger age classes (0 to 2 WR), the catches were treated as coming from the Western Baltic spring spawning stock. The existence of varying proportions of autumn spawners in subdivisions 22–24 however, indicates a potential problem for the assessment that should be kept in mind.

3.3 Catch in numbers and mean weights at age

The Swedish catches for industrial purposes from the Skagerrak were sampled in all quarters (see Table 3.4.1). Sampling of the human consumption landings was generally acceptable in the Skagerrak and the Kattegat. In Sub-divisions 22–24 the Danish fishery was sampled in all quarters, while the Swedish fishery was only sampled in quarter 3. Therefore, Danish samples were used in quarter 1, 2 and 4 to estimate catch in numbers and mean weight at age for the Swedish landings. German landings were sampled in quarter 1 and 2. These 2 quarters were the most important and the landings in quarter 3 and 4 were only 83 tons. In Sub-division 23 only quarter 4 was sampled by Denmark. Danish samples from Kattegat were used in quarter 1–3 to estimate catch in numbers for this Sub-division. Polish data on landings in numbers and mean weight at age for all quarters were available to the WG.

Table 3.3.1, 3.3.2 and 3.3.9 show the total numbers and mean weights at age for herring landed from the Kattegat, Skagerrak and Sub-division 22 - 24 by fleets.

Based on the proportions of spring- and autumn spawners (see section 3.2.3) in the catches, number and mean weights by age and spawning stock are calculated (Tables 3.3.7 - 3.3.8). The landings of spring spawners taken in Division IIIa and the North Sea in 1998 were estimated to be about 54,000 tons (Table 3.3.14) compared to about 38,000 t in 1997 and 74,000 t in 1996. This increase in landings is due to an increase in the TAC for 1998 compared with the TAC set for 1997. Also a change in proportions between spring and autumn spawners for the period is estimated (see section 3.2.2). The total catch in numbers of BSS in Division IIIa and the North Sea is shown in Table 3.3.10 and 3.3.13.

The landings of North Sea autumn spawners in Division IIIa amounted to 59,000 t compared to 40,000 t in 1997 and 42,000 t in 1996 (Table 3.3.12). The total catch in number and mean weight at age of Baltic spring spawners in the North Sea, Division IIIa and in Sub-divisions 22–24 for 1988–1998 are given in Tables 3.3.13 and 3.3.14.

3.4 Quality of data

3.4.1 Quality of catch data and biological sampling data

The sampling intensity of the landings in 1998 was acceptable and above the recommended level. Danish landings were sampled in all quarters for the Skagerrak, the Kattegat and for Sub-divisions 22 and 24. Only one sample from Sub-division 23 was taken from the Danish fishery. Swedish landings from the human consumption fishery were sampled in all quarters and landings for industrial purposes from the Skagerrak and the Kattegat have been sampled at highest level ever. From the Norwegian landings from the Skagerrak only 2 samples were taken in the second quarter but no samples from the third quarter where landings amounted to 5,000 tons.

Table 3.4.1 shows the number of fish aged by country, area, fishery and quarter. The total landings from Divisions IIIa, IIIb and IIIc were 173,000 tons from which 234 samples were taken, 36,000 fish were measured and 12,000 fish were aged. For comparison the figures for 1997 were 142,000 tons herring landed, 222 samples were taken, 32,400 herring measured and 12,200 were aged. Still the distribution over seasons, areas and fishing fleets needs to be improved.

Sampling of the Danish catches for industrial purposes were at the same high level in 1998 as in the two previous years. The number of samples and number of fish investigated were considered to be at adequate level. Again in 1998 there have been difficulties in getting samples from the Danish directed herring human consumption fishery in Skagerrak. There is uncertainty about where the Danish catches for human consumption, reported from Division IIIa (quarters 1, 2 and 4), were actually taken. Most of the landings from quarter 1, 2 and 4 supposed to have been taken in the North Sea and were therefore transferred to the North Sea.

In 1996 Sweden established a new sampling programme for the industrial landings from Division IIIa. This sampling programme also met the requirement of the agreed level of one sample per 1000 t landed in 1998.

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

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

3.4.2 Accuracy and precision in stock identification

The HAWG has during the last decade encountered a suite of overpowering difficulties in the assessment of the Western Baltic Spring Spawning (WBSS) stock. Although the work this year show some consistency with last years analysis it is still only possible to a realistic model fit using only the old age classes (3+ ringers). These problems caused by using information from the younger age-classes may be illustrated by the high degree of variability in the estimated proportions of WBSS (e.g., 2 ringers in Skagerrak in the 3rd and 4th quarters vary between 0% and 100% in the years between 1991 and 1997 (ICES 1999a, table 2.1).

To investigate if this variation is real or caused by bias and uncertainty in earlier estimates, preliminary results from an ongoing EU study project on proportions based on otolith microstructure were compared to the proportions used in earlier WG reports as summarised in the study group report (ICES 1999a, table 2.1).

Frequencies of spawning type were disaggregated by year (1991–1995), quarter (1+3), age (1–4+) and subdivision (Skagerrak and Kattegat). The proportion of spring spawners in relation to spring + winter + autumn spawners were compared with historical splits for all combinations with data giving 59 data points.

The R-square for the correlation between the historical and the new frequencies was 0.42 (n = 59). If only data with 10 or more otolith analyses were compared the R-square increased to 0.52 (n = 11). Both figures are significantly below what should expected allowing for binomial distributed errors in the otolith data and an error in the historical split calculated as:

$ABS(f_{Hist} - er1_{Uni} * lim)$ for f_{Hist} equal to 0 or 1 and

$f_{Hist} + lim/2*(er2_{Uni} - 0.5))$ for $1 > f_{Hist} > 0$

Where f_{Hist} equals the proportion in the historical split, lim is a coefficient of 0.26 chosen as the maximum value restricting the simulated frequencies between 0 and 1, and $er1_{Uni}$ and $er2_{Uni}$ are uniform randomly distributed error terms between 0 and 1.

The less than 50% correspondence between historical splits and the new preliminary estimate indicate a substantial source of uncertainty especially for the 1 and 2 ringers. The preliminary data are, however, still too scarce to allow a sufficiently accurate correction.

The introduction of otolith microstructure analysis enables an accurate and precise split between three groups, autumn, winter and spring spawners, however, different spring spawning populations are not resolved with the present level of analysis. In a few cases the mean VS counts for the identified fraction of 1 or 2 group spring spawners significantly diverge from the expected average of 55.8 (assuming a standard deviation of 0.82). The three significant values are 1st quarter, age 2 in both Skagerrak and Kattegat, as well as 3rd quarter, age 1 in Skagerrak (p-values were < 0.01, < 0.0001 and < 0.0001 respectively, see Table 3.4.2). The higher VS counts indicate proportions of local spring spawners in these samples between 30 and 50% (with a higher mean VS of 57).

An effort was made to compare individual VS counts with otolith microstructure based spawning type, "f(Oto)" for the years 1991 to 1998 (Figure 3.4).

The data were disaggregated by sub-area, age, and quarter. The sub-areas were: the Sound + South Kattegat = 1, mid Kattegat = 2, north Kattegat = 3, East Skagerrak = 4, and West Skagerrak = 5, age-classes were 1, 2, and 3+; and quarters 1 and 3.

f(Oto) was regressed versus an optimised logistic transformation of VS count, logist(VS), an overall R-square of 0.44 was found. The relationship improved by only including samples with more than 10 otoliths analysed (R-square = 0.64). However, using combined posterior information on spawning type and VS-count the relationship came out very tight. Thus by taking into the regression only data sets where n> = 10 and the further restriction of a high probability of identified spring spawners being WBSS by letting $(VS\text{-}55.8)/(0.67/n_{Spring})^{\wedge 2} < 1.4$, where 0.67 is the variance of WBSS VS counts.

Due to the number of complicating factors in identifying the immature WBSS herring we chose to focus on the older age-classes (3+ groups) as in last years stock analyses.

The 1998 years data on proportions of different spawning components is much more extensive than earlier years. The sampling of catches in 1998 shows indications of very low proportions of spring spawners in Skagerrak in the 4th quarter, whereas Kattegat has comparable high values in the same period (Table 3.2.1). This result is either a deviation from the earlier concept of the timing of the spawning migration (see ICES 1999a, table 2.1) where the WBSS constitutes 100% of the 4+ group before 1997 and 100% of the 3+ group before 1996 or may be due to area misreporting.

3.5 Fishery-independent estimates

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

The following trawl surveys are conducted every year:

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

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

Abundance indices for 0, 1, 2, and 3+ ringed herring obtained by bottom-trawl surveys carried out in November/ December of each year in Sub-divisions 24 and 22 are given in Tables 3.5.1 and 3.5.2. Combined estimates for the total area are calculated by weighting the single survey estimate by the survey areas of each Sub-division. The resulting time index series is shown in Table 3.5.3. In Sub-division 24 the 1998 estimates are the second highest recorded values for the 0-group since 1979. In Sub-division 22 the 1998 estimates are below the average of the recorded time period for all age groups.

Abundance indices for 1 to 8+ ringed herring from bottom-trawl surveys conducted each year in January/February in Sub-division 24 are given in Table 3.5.4. Since the 1987 survey was influenced by a strong winter with high ice coverage, the estimated abundance indices for this year should be used with caution. In 1998 there is an increase for 1 and 2 -ringers and a slight decrease for 3 -ringers as compared to last years estimates. The estimates for all other ages reached less than 60% of the 1997 values.

3.5.2 International Bottom Trawl Survey in Division IIIa

Results from the annual IBTS surveys in Division IIIa are available since 1980. The surveys are conducted during the 1st quarter (February) using standard gear and a depth stratified survey design (Addendum to ICES 1996b). From 1990 to 1995 standard surveys were also implemented during the 2nd (April), 3rd (September) and 4th (November) quarters. Since 1995 only the surveys in the 1st and the 3rd have been conducted. These survey indices were split into components of autumn and spring spawners by modal length analysis from 1990 to 1995. The index from the 3rd quarter survey were decomposed according to spawner type by results from otolith microstructure analysis for 1996 to 1998. The February index from 1996 to 1998 could not be updated. The derived estimates of the relative density of spring spawning herring in the Skagerrak and the Kattegat for quarter 1 and 3 are presented in Table 3.5.5 and Table 3.5.6.

3.5.3 Summer Acoustic survey in Division IIIa

This survey is part of an annual survey covering the North Sea and Division IIIa in July-August. As in previous years the survey in Division IIIa was conducted by R/V DANA. The echo integration survey from 26 to 16 July 1998 covered the North Sea east of 5°E and between 57°N and 59°N, (Skagerrak and Kattegat). Acoustic data was sampled using a Simrad EK400 and a Simrad EY500 38 kHz echo sounder with a towed body (type Es 38–29) and a hull mounted split-beam transducer (type ES 38), respectively. The echointegration data were stored by the echo analysis system ECHOANN (Degnbol *et al.*, 1990).

A total of 53 trawl hauls were carried out using a Fotö trawl (16 mm meshsize in the codend) for pelagic trawling, while an Expo trawl (16 mm codend) was used for bottom trawling. Trawling was carried out in the time intervals 1200–1800 h and 2300–0500 h.

The TS relationships used in this survey were:

- Clupeids: TS = 20 log L (cm) - 71.2 (dB)
- Gadoids: TS = 20 log L (cm) - 67.5 (dB)

Further details of the survey are given in Simmonds *et al.* (WD 1999).

The total stock size of Western Baltic spring spawning herring in 1998 was estimated by combining the results from the Danish (Division IIIa) and Norwegian Acoustic Survey (Sub-areas IVa and IVb). The result is summarised in Table 3.5.7. The total stock estimate of 297,000 t is about 40% higher than in 1997 (207,500 t). The resulting higher biomass is mainly caused by an increase in the abundance of 2-ringers.

3.5.4 October Acoustic Survey in Western Baltic and the Southern Part of Division IIIa (Kattegat)

A joint German-Danish acoustic survey was carried out with R/V SOLEA from September 2 nd to October 19 th 1998. The survey covered the whole of Sub-divisions 22, 23, 24 and the southern part of the Kattegat. As in last years, all investigations were performed at night. The acoustic equipment used was an echosounder EK500 connected to the Bergen-Integrator BI500. The transducer 38–26 was installed in a towed body. The lateral distance of the towed body to the ship was set to 30 m in order to minimise possible escape reactions of fish. The cruise track was 930 nm long, and 48 trawl hauls were carried out to identify the targets. The total number of fish calculated from the echo soundings was separated into species and age groups according to the trawling results.

The acoustic backscattering strength (S_A values) for each stratum were converted into fish numbers using the TS-length regressions:

- Clupeids: TS = 20 log L (cm) - 71.2 (dB)
- Gadoids: TS = 20 log L (cm) - 67.5 (dB)

The result for 1998 is presented in Table 3.5.8. The data series have been recalculated and revised for 1993–1997. The revision followed procedures recommended in the Baltic international acoustic survey manual (ICES 1998b). In 1998 the total estimated stock size of herring in Sub-divisions 22–24 reaches 204,200 t, which is below the average for the whole time period of about 239,000 t.

3.5.5 Acoustic Monitoring in Sub-division 23 (the Sound)

A base-line study on the migration of herring was initiated in autumn 1993. The main purpose of this study was to provide information on possible environmental impacts of the construction of the Sound Bridge between Denmark and Sweden. The survey series have been terminated and there are no plans for future activities. A description of the survey and the corresponding results concerning the numbers and the biomass during the period September 1993 to May 1998 is presented in Nielsen *et. al* 1998. The estimates for the total survey area are summarised in Table 3.5.9. As expected the highest biomass values are found in the period from autumn to spring.

3.5.6 Larvae surveys

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

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

Further details concerning the surveys and the treatment of the samples are given in Brielmann (1989) and Müller & Klenz (1994). The estimated numbers of larvae for the period 1977 to 1998 are summarised in Table 3.5.10. The 1998 estimate of the larval index is the highest recorded value for the 0-group in the whole time period.

3.6 Recruitment estimates

Indices of 0-ringer abundance were available from larval surveys during the spawning season on the main spawning area (Table 3.5.10) and from the German Bottom Trawl Surveys during November-December in Sub-divisions 22–24 (Table 3.5.1).

Indices of 1-ringer abundance were available from the German Bottom Trawl Surveys during November-December in Sub-division 22 and 24 (Table 3.5.1, 3.5.2, 3.5.3) and from German Bottom Trawl Surveys during January-February in Sub-division 24 (Table 3.5.4). Successive pairs of log transformed indices were compared by year class in Figure 3.6.1 The larvae 0-ringer and November 0-ringer indices for the year classes 1977 to 1998 showed some similar year-to-year variability. The November 0-ringer, the January 1-ringer and the November 1-ringer indices for the year classes 1978 to 1998 showed less covariation. The indices illustrated in Figure 3.6.1 show the following time trends: Poor recruitment of year classes 1980–82 was followed by an increase to a high level of recruitment for year classes 1983–88. From year class 1990 the recruitment declined until 1992 when recruitment was very low. An increase in year classes 1993–1994 is indicated. The year class 1996 was below average but the estimates of the 1997 and the 1998 year are high and comparable to historical high levels of recruitment. High recruitment of the 1998 year class in 1999 is suggested by the larvae survey in March, the bottom trawl survey in Sub-division 24 in November, the acoustic survey in Sub-division 24 in October.

3.7 Data exploration

Catch at age and survey data are presented in Tables 3.3.10, 3.5.1 - 3.5.8 and 3.5.10. Catch and survey data before 1987 has not been decomposed into spring and autumn spawners. Furthermore catch data has been revised from 1991 and onwards (ICES 1998f). Therefore, the working group agreed that an attempted analytical assessment had to be restricted to the time period from 1991 to 1998.

Natural mortality was assumed to equal 0.2 for all age-groups. This is justified by the following reasons. An estimate of 0.16 was derived by Sparholt (1989) who used catch and survey data to formulate a migration model for the spring spawning stock in Division IIIa and Sub-divisions 22 to 24. In addition the non-predatory component of the mortality is generally believed to be higher in the Baltic Sea compared to the North Sea due to environmental stress. A natural mortality of 0.15 to 0.2 is currently applied in the assessments of other Baltic herring stocks (ICES 1997e). The working group had no information on the natural mortality by age group. Estimates of natural mortality can be obtained from results of the ICES stomach sampling program in Division IIIa during the early 1990s. The working group recommends that national laboratories should use these data to pursue an analysis of predation mortality.

The maturity ogive and proportions of F and M before spawning were assumed to remain constant between years. F-prop. was set to be 0.1 and M-prop. 0.25 for all age groups. The applied maturity ogive was the same as that used at the working group meeting in 1997:

Age	0	1	2	3	4	5	6	7	8+
Maturity	0	0	0.2	0.75	0.9	1	1	1	1

Six surveys with age disaggregated data and one larvae survey were available as indices of abundance:

- **Index 1**: Acoustic. survey in Division IIIa, July 1989–98, 0–8+ ringers
- **Index 2**: Acoustic. survey in SD 22+24, Oct. 1989–98, 0–8+ ringers
- **Index 3**: Larvae survey in SD 24 (Greifswalder Bodden), March-June 1977–98, 0-group
- **Index 4**: German bottom trawl survey (GBTS) in SD 22, Nov. 1979–98, 0–3+ ringers
- **Index 5**: German bottom trawl survey (GBTS) in SD 24, Nov. 1978–98, 0–3+ ringers
- **Index 6**: German bottom trawl survey (GBTS) in SD 24, February 1979–98, 1–8+ ringers
- **Index 7**: IBTS in Div. IIIa, Sept. 1991–98, 1–5 ringers

The ICA software was used to conduct trial runs for each of these indices. The runs were made for 3+ ringers only. The input data for the 0-, 1- and 2 age groups prior to 1988 was considered inaccurate, due to an imprecise split into spring and autumn spawners of these age groups. These were as in the last year assessment excluded from the analyses. Older age groups has traditionally been perceived as spring spawners. Results from otolith microstructure analysis for the year 1998 indicate that a substantial part of the 3+ ringers in Skagerrak during the 4th quarter belong to the autumn spawners (Table 3.2.1). The working group agreed to await further results from the separation of spring and autumn spawners of historical data before this historical data could be updated. If these patterns are repeated in earlier years then the result will be an underestimate of fishing mortality and an overestimate of SSB during the 4th quarter in these years. The 0-group estimates from the larvae survey were used in the model as an indicator of the year class strength at age 3. A constant selection pattern was assumed for the period 1991 to 1998.

In all ICA runs the following parameters were kept constant:

- The weighting factor to all indices (lambda = 1).
- The linear catchability model for all indices.
- The range of years for separable constraint (= 6)
- The reference F at age 4 and the selection 1 for oldest age.

Six runs were made with single indices and two runs with multiple indices. The results of the runs were compared using the estimates and upper and lower confidence levels of the reference F and the SSB in 1998. The estimates from the individual runs are given below:

Run No.	Index No.	Index	Mean F 1998	Lower 95% CL	Upper 95% CL	SSB (x 1000 t) 1998
1	1	Acoustic Surv. Div. IIIa (3–8+ ringers)	0.43	0.29	0.62	132
2	2	Acoustic Surv. SD 22–24 (3–8+ ringers)	0.12	0.07	0.22	393
3	3	Larvae Surv. SD 24 (as 3 ringers)	0.12	0.02	0.61	475
4	4	GBTS SD 24 Nov (3+ ringers)	< 0.001	-	-	> 10 000
5	5	GBTS SD 22 Nov (3+ ringers)	< 0.001	-	-	> 10 000
6	6	GBTS SD 24 Feb. (3–8+ ringers)	0.02	0.01	0.03	2 496
7	1+2+3	combined (3–8+ ringers)	0.18	0.10	0.33	298
8	1+2	combined (3–8+ ringers)	0.27	0.17	0.40	193

The runs by individual indices gave highly varying estimates of fishing mortality and SSB. Indices 4, 5 and 6 show very low fishing mortalities and corresponding unrealistic high estimates of SSB. Since all runs were made on 3+

disaggregated data, these trawl indices contributed with only one point estimate (one 3+value) per year. The working group will welcome efforts to revise these indices to fully age disaggregated series. The acoustic index 1 resulted in higher Fs and the acoustic index 2 in lower Fs with corresponding inverse changes in SSB levels. The estimates from both indices are each consistent with the results from the last years working group. Overall age and year residuals for the acoustic indices are low but show systematic patterns indicating a low correspondence between survey and catch data. Index 3 gives the same fishing mortality as index 2 but shows a large confidence interval for terminal F.

The larvae index is specially designed to provide annual estimates of recruitment (Sect 3.5.6). The combined ICA run 7 was made with the larvae index projected as 3 group (Z_{0-3} assumed constant among years) and the two acoustic indices (i.e., indices 1,2 and 3). High and systematic residuals in the estimated Fs indicated conflicting trends between survey indices and a low correspondence to catch data.

Th effect of input values used for natural mortality was investigated in a repeated ICA run 7 using natural mortalities that are currently applied in assessment of North Sea autumn spawners. These are M = 0.2 for age group 3 and M = 0.1 for all older age groups. The results showed an increase in mean F_{3-6} during 1998 from 0.19 to 0.23. The estimate of SSB decreased by almost 20% using the North Sea Ms as compared to the M = 0.2 regime used for the WBSS in Divison III a and Sub-division 22 to 24. The SSQ between the two runs were similar.

The ICA run 8 was based on a combination of the two acoustic indices (index 1 and 2). The results are consistent with the results from the run conducted at the 1998 meeting. The ICA output from run 8 is presented to illustrate the current problems in an analytical assessment of spring spawning herring in Division IIIa and Sub-divisions 22 to 24.

Details on input parameters for the ICA are presented in Table 3.7.1. Input data are shown in Tables 3.7.2 - 3.7.5, outputs are given in Tables 3.7.6 - 3.7.15 and in Figures 3.7.1 - 3.7.5.

The combined SSQ indicates a minimum as the average between the two acoustic indices (Figure 3.7.1). Mean annual Fs were estimated at approximately 0.5 up to 1996 with a decrease to around 0.3 in 1997 and 1998 (Figure 3.7.2). Both catches and SSB decline up from 1992 to 1996 when they flatten out. The SSB decreased by 40% from 1992 to 1996. The simultaneous decrease in catch, SSB and F could be explained from management measures to reduce quotas in order to protect the North Sea autumn spawners. The derived selection pattern is flat topped as expected for an assessment on fully recruited age classes

The diagnostic plots (Figure 3.7.3 - 3.7.5) show flat catchability patterns by age which suggests a poor fit between survey indices and model estimates. Overall age residuals are relatively small. However, residuals of both indices indicate systematic over- and under-estimates in single years (1992 and 1996).

A simple graph on the total biomass estimates by the acoustic surveys and the total biomass predicted by ICA indicate opposing trends between the two surveys (Figure 3.7.6). The downward trend in index 1 is also reflected in the ICA output.

The ICA predicts a mean F_{3-6} of around 0.5 for 1992 to 1996. This estimate was compared to the observed Z values in available age disaggregated surveys and the catch at age data. Plots were constructed for the survival of year classes 1985 – 1993 of 3+ ringers during 1990 to 1998 (Figure 3.7.7). The Z values derived from year class survival indicate a mean Z estimate for 3+ ringers of around 0.7 approximately corresponding to year 1990–96. (Figure 3.7.8). Deducting an assumed M = 0.2 indicate that the ICA estimates from 1992 to 1996 are consistent with observed mortalities within year-classes.

Relative age distributions (3+ ringers) from surveys and catch data do not show pronounced differences between years (Figure 3.7.9). Despite the absence of large year classes similar trends in year class strength can be inferred from the available age structured data. One example is the relatively larger age group 3 in 1997 which is followed by a relatively larger age group 4 both in the catch and the acoustic surveys.

Catch at age data (3+ ringers) were used in a series of Separable VPAs to assess the influence of catch data from 1991 to 1992. Terminal S were set at 1.0 and reference age for F at age 4. The output is presented in figure 3.7.10 and in tables 3.7.16 to 3.5.18. Terminal Fs were set from 0.2 to 0.7 in steps of 0.1. The model converge after 3 to 4 years and terminal Fs have a large influence on the Fs of preceding years. The results from the ICA output comply with the pattern in the Separable VPA when terminal F is set to F = 0.3. Catch by fleet data suggest that a change in exploitation pattern occurred from 1996 to 1997. A Separable VPA run from 1991 to 1996 yielded identical F arrays as the 1991 to 1998 results.

The working group concluded that the data exploration by the ICA software could not resolve the apparent incompatibility between surveys and catch data. In addition the runs were based on the 3+ ringers only, excluding close to 50% of landings in weight from the calculations. The working group agreed that the present restrictions in the assessment preclude a full analytical assessment of the state of the stock.

3.8 State of the stock

Despite the failure to contribute a conclusive assessment the survey and catch data provide some information on stock development. Since the runs of the ICA model have been performed on the 3+ age groups it is expected that the results will primarily reflect changes in the SSB, and that the estimated fishing mortalities are only relevant for the older age classes.

Last year's Working Group report indicated that the Western Baltic stock may have declined continuously until 1996 when the SSB seemed to level off. The ICA runs presented during this working group meeting confirm this observation. The model results suggest that the total biomass and the SSB have stabilised with corresponding low fishing mortalities during the last 4 years.

While landings of 0–2 ringers increased compared to 1997 the 3+ ringer landings continued to decrease compared to previous years. The increase of the 0–2 ringers occurred in Division IIIa only. The decrease of 3+ landings together with an estimated stable SSB may be an indication of a decrease in the exploitation of older fish in 1997 and 1998 compared to previous years (Figure 3.8.1).

The overall results of these analyses indicate that the stock is stable after a decline during the first part of the 1990's. Recruitment indices suggest that the recent trend of a decrease in recruitment has been turned. With the present level of fishing mortality the stock does not seem to be in any immediate danger. However, the Working Group members feel that both the data on the commercial fishery and on the surveys are questionable. The exclusive use of 3+ ringers in the calculations makes the method insensitive to changes in young ages and in recruitment, therefore the assessment trials cannot provide an accurate indication about the development of the total stock. As a consequence, projections for the Western Baltic spring spawning herring were not considered.

Table 3.1.1 **HERRING in Division IIIa and Sub-Division 22-24. 1985 - 1998**
Landings in thousands of tonnes.
(Data provided by Working Group members 1999).

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

Year	1995	1996	1997	1998[1]
Skagerrak				
Denmark	43.7	28.7	14.3	10.3
Faroe Islands				
Norway	16.7	9.4	8.8	8.0
Sweden	48.5	32.7	32.9	46.9
Total	108.9	70.8	56.0	65.2
Kattegat				
Denmark	16.9	17.2	8.8	14.5
Sweden	30.8	27.0	18.0	29.9
Total	47.7	44.2	26.8	44.4
Sub. Div. 22+24				
Denmark	36.8	34.4	30.5	30.1
Germany	13.4	7.3	12.8	9.0
Poland	7.3	6.0	6.9	6.5
Sweden	15.8	9.0	14.5	4.3
Total	73.3	56.7	64.7	49.9
Sub. Div. 23				
Denmark	0.9	0.7	2.2	13.4
Sweden	0.2	0.3	0.1	0.3
Total	1.1	1.0	2.3	13.7
Grand Total	231.0	172.7	149.8	173.2

[1] Preliminary data.

Table 3.1.2 Landings from Division IIIa by Fleets 1991 - 1998 in '000 tons. (SOP figures)

Year	Area	Fleet C	Fleet D+E	Total
1991	Kattegat	32	37	**69**
	Skagerrak	62	60	**122**
	Total	94	97	**191**
1992	Kattegat	24	35	**59**
	Skagerrak	75	93	**168**
	Total	99	128	**227**
1993	Kattegat	18	28	**46**
	Skagerrak	94	75	**169**
	Total	112	103	**215**
1994	Kattegat	18	20	**38**
	Skagerrak	81	48	**129**
	Total	99	68	**167**
1995	Kattegat	36	7	**43**
	Skagerrak	87	22	**109**
	Total	123	29	**152**
1996	Kattegat	33	11	**44**
	Skagerrak	59	12	**71**
	Total	92	23	**115**
1997	Kattegat	24	2	**26**
	Skagerrak	48	8	**56**
	Total	72	10	**82**
1998	Kattegat	39	4	**43**
	Skagerrak	59	5	**64**
	Total	98	9	**107**

Note: Fleet definitions have been changed two times: for 1995 onwards and for 1998 onwards. All landings taken by Fleet D and E were merged for all previous years in 1998.

Table 3.2.1
Proportion of North Sea autumn spawners (NSAS) and Baltic spring spawners (WBSS) given in % in Skagerrak and Kattegat by age and quarter.
Year: 1998

		Skagerrak		Kattegat	
Quarter	W-rings	North Sea Autumn Spawner	Western Baltic Spring Spawner	North Sea Autumn Spawner	Western Baltic Spring Spawner
1	1	100%	0%	**71%**	**29%**
	2	77%	23%	17%	83%
	3	**93%**	**7%**	2%	98%
	4	**93%**	**7%**	0%	100%
	5	**93%**	**7%**	0%	100%
	6	**93%**	**7%**	0%	100%
	7	**93%**	**7%**	0%	100%
	8+	**93%**	**7%**	0%	100%
2	1	**59%**	**41%**	24%	76%
	2	**44%**	**56%**	43%	57%
	3	**29%**	**71%**	10%	90%
	4	**5%**	**95%**	1%	99%
	5	**5%**	**95%**	1%	99%
	6	**5%**	**95%**	1%	99%
	7	**5%**	**95%**	1%	99%
	8+	**5%**	**95%**	1%	99%
3	0	**100%**	**0%**	39%	61%
	1	95%	5%	58%	43%
	2	27%	73%	8%	92%
	3	8%	92%	1%	99%
	4	3%	97%	8%	92%
	5	3%	97%	8%	92%
	6	3%	97%	8%	92%
	7	3%	97%	8%	92%
	8+	3%	97%	8%	92%
4	0	75%	25%	43%	57%
	1	87%	13%	68%	32%
	2	79%	21%	14%	86%
	3	100%	0%	5%	95%
	4	100%	0%	5%	95%
	5	100%	0%	5%	95%
	6	100%	0%	5%	95%
	7	100%	0%	5%	95%
	8+	100%	0%	5%	95%

Figures in **Bold** typeface are estimated. All other figures are calculated by using otolith microstructure.

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

Total

Div: **Skagerrak** **Year:** **1998** **Country:** **All**

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
1	1	0.20	22	9.91	20	10.11	20
	2	18.83	64	14.41	58	33.24	61
	3	0.42	84	0.41	64	0.83	74
	4	0.19	81	0.11	81	0.30	81
	5						
	6						
	7						
	8+						
	Total	19.64		24.84		24.84	
	SOP		1,260		1,067		2,327
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	5.94	44	0.40	39	6.34	44
	2	36.57	84	2.41	66	38.98	83
	3	5.98	115	0.80	82	6.78	111
	4	2.71	140	0.01	116	2.72	140
	5	0.78	162			0.78	162
	6	0.28	177			0.28	177
	7	0.14	161			0.14	161
	8+	0.21	207			0.21	207
	Total	52.61		3.62		3.62	
	SOP		4,633		240		4,873
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	1.49	36	5.05	22	5.05	22
	1	379.53	59	41.01	32	420.54	56
	2	67.61	85	1.80	83	69.41	85
	3	9.33	104	0.53	87	9.86	103
	4	5.36	141	0.26	136	5.62	141
	5	1.39	180			1.39	180
	6	0.46	190	0.08	127	0.54	181
	7	0.12	241			0.12	241
	8+	0.12	227	0.07	205	0.19	219
	Total	465.41		48.80		48.80	
	SOP		30,164		1,671		31,835
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	14.72	29	19.50	28	34.22	28
	1	142.41	70	16.92	69	159.33	70
	2	57.88	105	3.78	96	61.66	105
	3	20.24	122	0.52	129	20.76	123
	4	16.29	165	0.99	165	17.28	165
	5	2.38	184	0.32	193	2.70	185
	6	2.63	201			2.63	201
	7	1.05	179			1.05	179
	8+	0.38	227			0.38	227
	Total	257.98		42.03		42.03	
	SOP		22,903		2,369		25,271
Quarter	**W-rings**	**Fleet C Numbers**	**Fleet C Mean W.**	**Fleet D+E Numbers**	**Fleet D+E Mean W.**	**Total Numbers**	**Total Mean W.**
Total	0	16.21	30	24.55	27	24.55	27
	1	528.08	62	68.24	39	68.24	39
	2	180.89	89	22.40	67	22.40	67
	3	35.97	116	2.26	91	2.26	91
	4	24.55	156	1.37	152	1.37	152
	5	4.55	179	0.32	193	0.32	193
	6	3.37	197	0.08	127	0.08	127
	7	1.31	183				
	8+	0.71	221	0.07	205	0.07	205
	Total	795.64		119.29		119.29	
	SOP		58,960		5,347		64,307

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

Total

Div: Kattegat Year: 1998 Country: ALL

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
1	1	28.94	22	47.14	24	76.08	23
	2	142.54	57	14.49	57	157.03	57
	3	35.40	91	0.83	73	36.23	90
	4	25.80	118	0.22	113	26.02	118
	5	1.90	127	0.03	75	1.93	126
	6	0.58	164			0.58	164
	7	0.16	161			0.16	161
	8+	0.13	208			0.13	208
	Total	235.45		62.71		298.16	
	SOP		15,366		2,039		17,406
2	1	36.56	24	1.36	24	37.92	24
	2	24.15	59	9.32	61	33.47	59
	3	3.04	68	0.73	85	3.77	71
	4	0.99	102	0.21	113	1.20	104
	5	0.08	126	0.03	75	0.11	112
	6						
	7						
	8+	0.03	184			0.03	184
	Total	64.85		11.65		76.50	
	SOP		2,637		692		3,328
3	0	0.92	25	0.08	9	1.00	24
	1	55.31	54	11.88	27	67.19	49
	2	39.49	76	0.31	75	39.80	76
	3	18.94	124			18.94	124
	4	12.50	164			12.50	164
	5	2.22	140			2.22	140
	6	3.93	207			3.93	207
	7	1.22	191			1.22	191
	8+	0.99	226			0.99	226
	Total	134.60		12.19		146.79	
	SOP		11,992		343		12,336
4	0	5.01	29	35.13	28	40.14	28
	1	77.70	74	1.52	70	79.22	74
	2	17.37	105	0.21	130	17.58	105
	3	5.96	127	0.19	137	6.15	128
	4	2.71	159	0.11	171	2.82	160
	5	0.20	176	0.01	156	0.21	176
	6	0.13	176			0.13	176
	7	0.18	110	0.01	258	0.19	117
	8+						
	Total	104.25		2.05		106.30	
	SOP		8,854		182		9,036
Total	0	5.93	29	35.21	28	41.14	28
	1	198.51	52	61.90	26	260.41	46
	2	223.55	64	24.33	60	247.88	64
	3	63.34	103	1.75	85	65.09	103
	4	42.00	134	0.54	125	42.54	134
	5	4.40	136	0.07	87	4.47	135
	6	4.64	201			4.64	201
	7	1.56	178	0.01	258	1.57	179
	8+	1.15	223			1.15	223
	Total	545.08		123.81		668.89	
	SOP		39,019		4,229		43,248

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

North Sea
Autumn spawners

Div: **Skagerrak** **Year:** **1998** **Country:** **All**

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
1	1	0.20	22	9.91	20	10.11	20
	2	14.48	64	11.08	58	25.57	61
	3	0.39	84	0.38	64	0.77	74
	4	0.18	81	0.10	81	0.28	81
	5						
	6						
	7						
	8+						
	Total	15.25		21.48		36.73	
	SOP		978		873		1,851
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	3.48	44	0.23	39	3.72	44
	2	16.23	84	1.07	66	17.30	83
	3	1.73	115	0.23	82	1.96	111
	4	0.14	140	0.00	116	0.14	140
	5	0.04	162			0.04	162
	6	0.01	177			0.01	177
	7	0.01	161			0.01	161
	8+	0.01	207			0.01	207
	Total	21.65		1.54		23.18	
	SOP		1,742		98		1,840
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	1.49	36	5.05	22	6.54	25
	1	360.62	59	38.97	32	399.58	56
	2	18.05	85	0.48	83	18.53	85
	3	0.79	104	0.04	87	0.83	103
	4	0.17	141	0.01	136	0.18	141
	5	0.05	180			0.05	180
	6	0.01	190	0.00	127	0.02	181
	7	0.00	241			0.00	241
	8+	0.00	227	0.00	205	0.01	219
	Total	381.19		44.56		425.74	
	SOP		22,844		1,397		24,242
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	10.97	29	14.53	28	25.50	28
	1	123.42	70	14.66	69	138.09	70
	2	45.48	105	2.97	96	48.45	105
	3	20.24	122	0.52	129	20.76	123
	4	16.29	165	0.99	165	17.28	165
	5	2.38	184	0.32	193	2.70	185
	6	2.63	201			2.63	201
	7	1.05	179			1.05	179
	8+	0.38	227			0.38	227
	Total	222.84		33.99		256.83	
	SOP		20,158		1,997		22,154
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	12.46	30	19.58	26	32.04	28
	1	487.72	61	63.77	39	551.50	59
	2	94.24	91	15.60	66	109.84	88
	3	23.15	121	1.18	97	24.32	119
	4	16.78	164	1.10	157	17.88	163
	5	2.46	183	0.32	193	2.78	185
	6	2.66	201	0.00	127	2.66	201
	7	1.06	179			1.06	179
	8+	0.39	226	0.00	205	0.40	226
	Total	640.92		101.56		742.49	
	SOP		45,722		4,365		50,087

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

North Sea
Autumn spawners

Div: Kattegat **Year:** 1998 **Country:** All

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
1	1	20.67	22	33.67	24	54.34	23
	2	24.44	57	2.48	57	26.92	57
	3	0.74	91	0.02	73	0.75	90
	4						
	5						
	6						
	7						
	8+						
	Total	45.84		36.17		82.02	
	SOP		1,911		944		2,855

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	8.92	24	0.33	24	9.25	24
	2	10.29	59	3.97	61	14.26	59
	3	0.31	68	0.07	85	0.38	71
	4	0.01	102	0.00	113	0.01	104
	5	0.00	126	0.00	75	0.00	112
	6						
	7						
	8+	0.00	184			0.00	184
	Total	19.52		4.38		23.90	
	SOP		845		258		1,103

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
3	0	0.36	25	0.03	9	0.39	24
	1	31.80	54	6.83	27	38.63	49
	2	3.01	76	0.02	75	3.04	76
	3	0.28	124			0.28	124
	4	1.00	164			1.00	164
	5	0.18	140			0.18	140
	6	0.31	207			0.31	207
	7	0.10	191			0.10	191
	8+	0.08	226			0.08	226
	Total	37.13		6.89		44.02	
	SOP		2,289		186		2,475

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
4	0	2.16	29	15.18	28	17.34	28
	1	53.12	74	1.04	70	54.16	74
	2	2.48	105	0.03	130	2.51	105
	3	0.32	127	0.01	137	0.33	128
	4	0.14	159	0.01	171	0.14	160
	5	0.01	176	0.00	156	0.01	176
	6	0.01	176			0.01	176
	7	0.01	110	0.00	258	0.01	117
	8+						
	Total	58.25		16.27		74.52	
	SOP		4,331		499		4,830

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
Total	0	2.53	29	15.21	28	17.74	28
	1	114.51	55	41.87	25	156.39	47
	2	40.22	62	6.51	60	46.72	61
	3	1.65	99	0.10	88	1.75	99
	4	1.15	162	0.01	154	1.15	162
	5	0.19	141	0.00	124	0.19	141
	6	0.32	206			0.32	206
	7	0.11	184	0.00	258	0.11	184
	8+	0.08	226			0.08	226
	Total	160.75		63.70		224.45	
	SOP		9,376		1,887		11,263

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

Baltic Spring spawners

Div: Skagerrak Year: 1998 Country: All

		Fleet C		Fleet D+E		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1						
	2	4.35	64	3.33	58	7.67	61
	3	0.03	84	0.03	64	0.06	74
	4	0.01	81	0.01	81	0.02	81
	5						
	6						
	7						
	8+						
	Total	4.39		3.36		7.75	
	SOP		282		194		476
		Fleet C		Fleet D+E		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	2.46	44	0.17	39	2.62	44
	2	20.34	84	1.34	66	21.68	83
	3	4.25	115	0.57	82	4.82	111
	4	2.57	140	0.01	116	2.58	140
	5	0.74	162			0.74	162
	6	0.27	177			0.27	177
	7	0.13	161			0.13	161
	8+	0.20	207			0.20	207
	Total	30.96		2.08		33.05	
	SOP		2,891		142		3,033
		Fleet C		Fleet D+E		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0						
	1	18.91	59	2.04	32	20.96	56
	2	49.56	85	1.32	83	50.88	85
	3	8.54	104	0.49	87	9.03	103
	4	5.19	141	0.25	136	5.44	141
	5	1.34	180			1.34	180
	6	0.45	190	0.08	127	0.52	181
	7	0.12	241			0.12	241
	8+	0.12	227	0.07	205	0.18	219
	Total	84.22		4.24		88.47	
	SOP		7,320		274		7,594
		Fleet C		Fleet D+E		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	3.75	29	4.97	28	8.72	28
	1	18.99	70	2.26	69	21.24	70
	2	12.40	105	0.81	96	13.21	105
	3						
	4						
	5						
	6						
	7						
	8+						
	Total	35.14		8.04		43.18	
	SOP		2,745		372		3,117
		Fleet C		Fleet D+E		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	3.75	29	4.97	28	8.72	28
	1	40.36	63	4.47	51	44.82	62
	2	86.65	87	6.80	69	93.45	85
	3	12.82	108	1.08	84	13.91	106
	4	7.77	141	0.27	134	8.04	141
	5	2.09	174			2.09	174
	6	0.71	185	0.08	127	0.79	179
	7	0.25	198			0.25	198
	8+	0.32	214	0.07	205	0.38	213
	Total	154.72		17.73		172.45	
	SOP		13,238		982		14,220

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

Baltic Spring spawners

Div: Kattegat Year: 1998 Country: All

		Fleet C		Fleet D+E		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	8.27	22	13.47	24	21.74	23
	2	118.10	57	12.01	57	130.11	57
	3	34.66	91	0.81	73	35.48	90
	4	25.80	118	0.22	113	26.02	118
	5	1.90	127	0.03	75	1.93	126
	6	0.58	164			0.58	164
	7	0.16	161			0.16	161
	8+	0.13	208			0.13	208
	Total	189.61		26.54		216.14	
	SOP		13,455		1,095		14,550
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	27.64	24	1.03	24	28.67	24
	2	13.86	59	5.35	61	19.21	59
	3	2.73	68	0.66	85	3.39	71
	4	0.98	102	0.21	113	1.19	104
	5	0.08	126	0.03	75	0.11	112
	6						
	7						
	8+	0.03	184			0.03	184
	Total	45.33		7.27		52.60	
	SOP		1,792		434		2,226
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0	0.56	25	0.05	9	0.61	24
	1	23.51	54	5.05	27	28.56	49
	2	36.48	76	0.29	75	36.76	76
	3	18.66	124			18.66	124
	4	11.50	164			11.50	164
	5	2.04	140			2.04	140
	6	3.62	207			3.62	207
	7	1.12	191			1.12	191
	8+	0.91	226			0.91	226
	Total	98.39		5.38		103.77	
	SOP		9,726		158		9,884
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	2.85	29	19.95	28	22.80	28
	1	24.58	74	0.48	70	25.06	74
	2	14.89	105	0.18	130	15.07	105
	3	5.64	127	0.18	137	5.82	128
	4	2.57	159	0.10	171	2.68	160
	5	0.19	176	0.01	156	0.20	176
	6	0.12	176			0.12	176
	7	0.17	110	0.01	258	0.18	117
	8+						
	Total	51.01		20.91		71.92	
	SOP		4,669		656		5,325
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	3.40	28	20.00	28	23.40	28
	1	84.00	47	20.03	26	104.02	43
	2	183.33	65	17.82	60	201.16	64
	3	61.69	103	1.65	85	63.34	103
	4	40.85	133	0.53	124	41.39	133
	5	4.21	135	0.07	86	4.28	135
	6	4.32	200			4.32	200
	7	1.45	178	0.01	258	1.46	179
	8+	1.07	223			1.07	223
	Total	384.33		60.11		444.44	
	SOP		29,643		2,342		31,985

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

North Sea Autumn spawners

Division: IIIa **Year:** 1998 **Country:** All

Quarter	W-rings	Fleet C		Fleet D+E		Total	
		Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	20.87	22	43.58	23	64.45	23
	2	38.92	59	13.57	58	52.49	59
	3	1.13	88	0.40	64	1.53	82
	4	0.18	81	0.10	81	0.28	81
	5						
	6						
	7						
	8+						
	Total	61.09		57.65		118.74	
	SOP		2,889		1,817		4,706
Quarter	W-rings	Fleet C Numbers	Mean W.	Fleet D+E Numbers	Mean W.	Total Numbers	Mean W.
2	1	12.40	30	0.57	30	12.97	30
	2	26.51	74	5.04	62	31.55	72
	3	2.04	108	0.31	83	2.34	105
	4	0.15	138	0.00	114	0.15	137
	5	0.04	161	0.00	75	0.04	160
	6	0.01	177			0.01	177
	7	0.01	161			0.01	161
	8+	0.01	206			0.01	206
	Total	41.17		5.91		47.09	
	SOP		2,587		356		2,943
Quarter	W-rings	Fleet C Numbers	Mean W.	Fleet D+E Numbers	Mean W.	Total Numbers	Mean W.
3	0	1.85	34	5.08	22	6.93	25
	1	392.42	58	45.80	31	438.22	55
	2	21.07	84	0.50	82	21.57	84
	3	1.07	109	0.04	87	1.12	108
	4	1.17	160	0.01	136	1.18	160
	5	0.22	148			0.22	148
	6	0.33	206	0.00	127	0.33	206
	7	0.10	193			0.10	193
	8+	0.08	226	0.00	205	0.09	225
	Total	418.32		51.44		469.76	
	SOP		25,134		1,583		26,717
Quarter	W-rings	Fleet C Numbers	Mean W.	Fleet D+E Numbers	Mean W.	Total Numbers	Mean W.
4	0	13.13	29	29.71	28	42.84	28
	1	176.54	71	15.70	69	192.25	71
	2	47.96	105	3.00	96	50.96	105
	3	20.56	123	0.53	130	21.09	123
	4	16.43	165	1.00	165	17.42	165
	5	2.39	184	0.32	193	2.71	185
	6	2.64	201			2.64	201
	7	1.06	178	0.00	258	1.06	178
	8+	0.38	227			0.38	227
	Total	281.09		50.26		331.35	
	SOP		24,488		2,496		26,984
Quarter	W-rings	Fleet C Numbers	Mean W.	Fleet D+E Numbers	Mean W.	Total Numbers	Mean W.
Total	0	14.99	30	34.79	27	49.78	28
	1	602.23	59	105.65	24	707.88	54
	2	134.46	82	22.11	64	156.57	80
	3	24.80	119	1.28	96	26.08	118
	4	17.92	164	1.11	157	19.03	163
	5	2.65	181	0.32	193	2.97	182
	6	2.98	201	0.00	127	2.98	201
	7	1.17	180	0.00	258	1.17	180
	8+	0.47	226	0.00	205	0.48	226
	Total	801.68		165.26		966.94	
	SOP		54,264		5,234		59,498

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

Baltic Spring spawners

Div: IIIa **Year:** 1998 **Country:** All

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D+E Numbers	Fleet D+E Mean W.	Total Numbers	Total Mean W.
1	1	8.27	22	13.47	24	21.74	23
	2	122.45	57	15.33	57	137.78	57
	3	34.69	91	0.84	73	35.53	90
	4	25.81	118	0.23	112	26.04	118
	5	1.90	127	0.03	75	1.93	126
	6	0.58	164			0.58	164
	7	0.16	161			0.16	161
	8+	0.13	208			0.13	208
	Total	194.00		29.90		223.90	
	SOP		13,737		1,289		15,026
2	1	30.10	26	1.19	26	31.29	26
	2	34.21	74	6.69	62	40.90	72
	3	6.98	97	1.22	84	8.21	95
	4	3.55	130	0.22	113	3.77	129
	5	0.82	158	0.03	75	0.85	156
	6	0.27	177			0.27	177
	7	0.13	161			0.13	161
	8+	0.23	204			0.23	204
	Total	76.29		9.36		85.64	
	SOP		4,683		576		5,259
3	0	0.56	25	0.05	9	0.61	24
	1	42.42	56	7.09	28	49.51	52
	2	86.03	81	1.61	81	87.64	81
	3	27.20	118	0.49	87	27.68	117
	4	16.69	157	0.25	136	16.94	156
	5	3.39	156			3.39	156
	6	4.06	205	0.08	127	4.14	204
	7	1.24	196			1.24	196
	8+	1.03	226	0.07	205	1.09	225
	Total	182.61		9.63		192.24	
	SOP		17,046		432		17,478
4	0	6.60	29	24.92	28	31.52	28
	1	43.57	72	2.74	69	46.30	72
	2	27.29	105	0.99	102	28.28	105
	3	5.64	127	0.18	137	5.82	128
	4	2.57	159	0.10	171	2.68	160
	5	0.19	176	0.01	156	0.20	176
	6	0.12	176			0.12	176
	7	0.17	110	0.01	258	0.18	117
	8+						
	Total	86.15		28.95		115.10	
	SOP		7,414		1,027		8,442
Total	0	7.16	29	24.97	28	32.12	28
	1	124.36	52	24.49	30	148.85	49
	2	269.98	72	24.62	62	294.60	71
	3	74.51	104	2.73	84	77.24	103
	4	48.63	134	0.80	127	49.43	134
	5	6.30	148	0.07	86	6.37	147
	6	5.03	198	0.08	127	5.11	197
	7	1.70	181	0.01	258	1.71	181
	8+	1.39	221	0.07	205	1.45	220
	Total	539.05		77.84		616.88	
	SOP		42,881		3,325		46,205

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

Division: 22-24 Year: 1998 Country: ALL

		Sub-division 22		Sub-division 23		Sub-division 24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1	204.89	24	0.46	14	39.86	12	245.21	22
	2	27.98	50	2.06	53	4.54	53	34.59	51
	3	0.06	89	3.75	82	29.75	74	33.56	75
	4	0.84	166	3.29	104	30.72	107	34.85	108
	5	0.67	182	0.26	108	13.63	133	14.56	134
	6	0.47	200	0.06	142	6.86	166	7.39	168
	7	0.40	209	0.02	145	5.53	166	5.95	168
	8+	0.26	227	0.02	202	4.29	181	4.58	184
	Total	235.57		9.92		135.19		380.68	
	SOP		6,828		810		10,841		18,479
		Sub-division 22		**Sub-division 23**		**Sub-division 24**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1	94.41	25	2.69	18	17.70	17	114.80	24
	2	47.33	46	2.38	56	8.07	40	57.78	46
	3	2.81	57	1.89	71	32.59	74	37.29	72
	4	0.77	115	0.83	99	38.37	102	39.96	102
	5	0.30	157	0.08	126	14.57	130	14.95	130
	6	0.14	175			5.32	154	5.45	155
	7	0.14	186			6.15	164	6.29	165
	8+	0.12	205	0.03	184	5.23	176	5.38	176
	Total	146.00		7.90		128.01		281.91	
	SOP		4,934		414		11,572		16,921
		Sub-division 22		**Sub-division 23**		**Sub-division 24**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0	215.67	11	1.86	25	7.42	14	224.95	12
	1	44.26	43	38.02	49	13.26	38	95.53	45
	2	4.82	51	47.62	72	8.66	70	61.10	70
	3	2.14	46	12.51	86	9.12	90	23.76	84
	4	1.34	61	0.93	73	8.16	87	10.43	82
	5			0.93	73	2.27	93	3.20	87
	6			1.45	69	1.17	90	2.62	78
	7					0.69	91	0.69	91
	8+					0.86	174	0.86	174
	Total	268.23		103.32		51.60		423.14	
	SOP		4,772		6,666		3,277		14,716
		Sub-division 22		**Sub-division 23**		**Sub-division 24**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0	274.69	15			15.65	14	290.35	15
	1	15.20	40			13.67	42	28.86	41
	2	1.16	55			6.80	86	7.96	82
	3			6.63	172	5.34	128	11.97	152
	4	0.58	46	17.29	179	6.05	107	23.92	157
	5	0.58	37	2.95	187	1.57	66	5.10	133
	6			2.95	194	0.80	38	3.75	160
	7			0.74	187	0.24	133	0.97	174
	8+			1.47	207	1.12	179	2.59	195
	Total	292.21		32.02		51.24		375.46	
	SOP		4,783		5,789		3,077		13,649
		Sub-division 22		**Sub-division 23**		**Sub-division 24**		**Total**	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	490.36	13	1.86	25	23.07	14	515.29	13
	1	358.75	27	41.17	46	84.49	22	484.40	28
	2	81.29	48	52.07	71	28.08	63	161.44	58
	3	5.01	53	24.78	107	76.79	80	106.58	85
	4	3.52	95	22.34	160	83.31	102	109.16	114
	5	1.54	122	4.21	156	32.05	125	37.80	129
	6	0.61	194	4.45	152	14.14	148	19.21	150
	7	0.54	203	0.76	186	12.61	160	13.91	163
	8+	0.38	220	1.52	206	11.50	178	13.41	182
	Total	942.01		153.15		366.04		1,461.20	
	SOP		21,318		13,679		28,768		63,765

Table 3.3.10 Landings in numbers (mill.), mean weight (g) and SOP (t) by age and quarter from.

Western Baltic Spring Spawners

Div: IV + IIIa + 22-24 Year: 1998

		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			21.74	23	245.21	22	266.95	22
	2			137.78	57	34.59	51	172.37	56
	3			35.53	90	33.56	75	69.09	83
	4			26.04	118	34.85	108	60.89	112
	5			1.93	126	14.56	134	16.49	133
	6			0.58	164	7.39	168	7.97	168
	7			0.16	161	5.95	168	6.11	168
	8+			0.13	208	4.58	184	4.71	184
	Total	0.00		223.90		380.68		604.58	
	SOP		0		15,026		18,479		33,506
		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			31.29	26	114.80	24	146.09	24
	2	5.10	116	40.90	72	57.78	46	103.78	59
	3	3.60	136	8.21	95	37.29	72	49.09	81
	4	2.60	154	3.77	129	39.96	102	46.33	107
	5	0.90	176	0.85	156	14.95	130	16.70	134
	6	0.30	198	0.27	177	5.45	155	6.02	158
	7	0.10	205	0.13	161	6.29	165	6.53	165
	8+	0.10	239			5.38	176	5.48	178
	Total	12.70		85.42		281.91		380.03	
	SOP		1,744		5,212		16,921		23,877
		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			0.61	24	224.95	12	225.56	12
	1			49.51	52	95.53	45	145.05	47
	2	5.90	130	87.64	81	61.10	70	154.64	79
	3	9.40	159	27.68	117	23.76	84	60.85	111
	4	9.20	180	16.94	156	10.43	82	36.56	141
	5	5.70	209	3.39	156	3.20	87	12.29	163
	6	2.90	235	4.14	204	2.62	78	9.65	179
	7	0.30	253	1.24	196	0.69	91	2.23	171
	8+	0.90	243	1.09	225	0.86	174	2.85	215
	Total	34.30		192.24		423.14		649.68	
	SOP		6,085		17,478		14,716		38,279
		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			31.52	28	290.35	15	321.86	16
	1			46.30	72	28.86	41	75.17	60
	2			28.28	105	7.96	82	36.24	100
	3			5.82	128	11.97	152	17.79	144
	4			2.68	160	23.92	157	26.60	157
	5			0.20	176	5.10	133	5.29	134
	6			0.12	176	3.75	160	3.87	161
	7			0.18	117	0.97	174	1.15	165
	8+					2.59	195	2.59	195
	Total	0.00		115.10		375.46		490.57	
	SOP		0		8,442		13,649		22,090
		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			32.12	28	515.29	13	547.42	14
	1			148.85	49	484.40	28	633.25	33
	2	11.00	124	294.60	71	161.44	58	467.04	68
	3	13.00	153	77.24	103	106.58	85	196.82	97
	4	11.80	174	49.43	134	109.16	114	170.39	124
	5	6.60	205	6.37	147	37.80	129	50.77	141
	6	3.20	232	5.11	197	19.21	150	27.51	169
	7	0.40	241	1.71	181	13.91	163	16.02	167
	8+	1.00	243	1.22	223	13.41	182	15.63	189
	Total	47.00		616.65		1,461.20		2,124.85	
	SOP		7,829		46,158		63,765		117,752

Table 3.3.11 Total catch in numbers (mill) and mean weight (g), SOP (tonnes) of Western Baltic Spring spawners in Division IIIa and the North Sea in the years 1988 - 1998

Year	Rings	0	1	2	3	4	5	6	7	8+	Total
	Number			2075.00	563.00	62.00	8.00	2.00	0.50	0.50	2,711.00
1988	Mean W.			47.3	77.0	138.3	156.0	166.0	149.0	209.0	
	SOP			98,148	43,351	8,575	1,248	332	75	105	151,832
	Number			497.69	503.66	115.23	29.96	13.68	5.35	2.34	1,167.91
1989	Mean W.			56.5	79.9	125.5	151.6	167.3	189.2	204.8	
	SOP			28,119	40,242	14,461	4,542	2,289	1,012	479	91,145
	Number		140.90	1006.23	259.90	192.21	62.07	9.99	19.09	2.20	1,692.59
1990	Mean W.		56.6	65.0	84.6	102.4	111.1	109.3	141.0	84.3	
	SOP		7,975	65,405	21,988	19,682	6,896	1,092	2,692	185	125,915
	Number	64.80	43.00	352.05	447.07	174.71	108.85	22.35	7.62	3.09	1,223.54
1991	Mean W.	33.7	60.5	77.4	101.7	127.5	148.6	165.4	182.5	194.9	
	SOP	2,184	2,602	27,249	45,467	22,276	16,175	3,697	1,391	602	121,641
	Number		66.98	214.33	156.34	128.78	63.88	43.59	12.65	7.76	694.31
1992	Mean W.		53.4	96.2	115.2	138.6	172.9	184.0	201.7	201.3	
	SOP		3,577	20,619	18,010	17,849	11,045	8,021	2,552	1,562	83,234
	Number		52.92	185.91	245.60	101.75	63.05	43.65	23.86	8.88	725.62
1993	Mean W.		60.4	88.6	121.5	147.2	160.3	182.9	195.6	218.2	
	SOP		3,196	16,472	29,840	14,978	10,107	7,984	4,667	1,938	89,181
	Number			157.34	248.54	137.01	80.20	45.92	14.75	8.40	692.16
1994	Mean W.			127.2	120.1	148.6	165.3	190.6	204.1	216.5	
	SOP			20,014	29,850	20,360	13,257	8,752	3,010	1,819	97,061
	Number	84.40	504.27	254.11	132.29	81.25	52.50	16.07	10.14	4.70	1,139.73
1995	Mean W.	17.5	37.8	101.2	148.3	165.5	188.7	213.0	233.1	232.2	
	SOP	1,477	19,061	25,716	19,619	13,447	9,907	3,423	2,364	1,091	96,104
	Number	23.97	173.92	509.10	90.41	54.32	30.39	13.69	7.08	5.94	908.83
1996	Mean W.	7.3	22.9	74.1	127.0	172.0	182.8	200.9	197.7	212.3	
	SOP	175	3,983	37,702	11,481	9,345	5,554	2,751	1,399	1,262	73,653
	Number		27.12	88.77	142.37	32.16	13.43	4.66	1.49	2.34	312.32
1997	Mean W.		63.8	82.4	131.3	174.5	190.6	195.6	205.9	210.2	
	SOP	0	1,729	7,313	18,695	5,612	2,560	911	306	492	37,618
	Number	32.12	148.85	305.60	90.24	61.23	12.97	8.31	2.11	2.22	663.65
1998	Mean W.	27.9	48.7	72.8	110.3	142.0	176.4	210.4	192.7	231.8	
	SOP	896	7,246	22,239	9,955	8,693	2,287	1,748	407	516	53,987

There may be minor corrections in data from 1987 and 1988.

Table 3.3.12 Transfers of North Sea autumn spawners from Div. IIIa to the North Sea. Numbers (mill) and mean weight, SOP in (tonnes) 1988 – 1998.

Year	Rings	0	1	2	3	4	5	6	7	8+	Total
	Number	1830.00	5792.00	292.00							7,914.00
1988	Mean W.	12.0	28.0	57.0							
	SOP	21960	162176	16,644							200,780
	Number	1028.2	1170.5	654.80							2,853.50
1989	Mean W.	16.2	33.4	53.3							
	SOP	16656.84	39094.7	34,901							90,652
	Number	397.9	1424.30	283.70							2,105.90
1990	Mean W.	31.0	34.1	55.4							
	SOP	12334.9	48,569	15,717							76,621
	Number	712.30	822.70	330.20							1,865.20
1991	Mean W.	25.3	40.7	77.8							
	SOP	18,021	33,484	25,690							77,195
	Number	2407.51	1587.09	283.80	26.79	26.61	15.98	12.33	5.46	1.00	4366.57
1992	Mean W.	12.3	50.6	94.8	164.0	171.7	184.7	197.5	202.7	219.8	
	SOP	29612.37	80,307	26,904	4,394	4,569	2,952	2,435	1,107	220	152,499
	Number	2956.7	2,351.10	350.01							5,657.81
1993	Mean W.	12.7	27.5	86.6							
	SOP	37550.09	64,655	30,311							132,516
	Number	542.23	1,240	305.19							2,087.07
1994	Mean W.	16.5	43	77.3							
	SOP	8946.795	53,181	23,591							85,719
	Number	1722.84	1069.58	126.37							2,918.79
1995	Mean W.	12.5	32.8	102.7							
	SOP	21,536	35,082	12,978							69,596
	Number	632.07	869.53	159.35	31.52						1692.47
1996	Mean W.	11.0	22.7	73.0	121.2						
	SOP	6,953	19,738	11,633	3,820						42,144
	Number	93.61	351.60	210.56	71.48	12.29	5.66	1.77	0.69	0.91	748.57
1997	Mean W.	19.0	29.0	71.0	129.0	167.0	182.0	191.0	194.0	202.0	
	SOP	1,779	10,196	14,950	9,221	2,052	1,030	338	134	184	39,884
	Number	49.78	707.88	156.57	26.08	19.03	2.97	2.98	1.17	0.48	966.94
1998	Mean W.	27.7	53.6	79.9	118.1	163.3	181.8	201.2	179.6	226.2	
	SOP	1,379	37,955	12,517	3,079	3,107	541	600	210	108	59,498

There are minor corrections for the years previous to 1991.

Table 3.3.13 Total catch in numbers (mill) and mean weight (g), SOP (tonnes) of spring spawners in Division IIIa and the North Sea + in Sub-Divisions 22-24 in the years 1988 - 1998

Year	Area / Rings	0	1	2	3	4	5	6	7	8+	Total
	North Sea +Div. IIIa			2,075.00	563.00	62.00	8.00	2.00	0.50	0.50	2,711.00
1988	Sub-Division 22-24	789.50	861.00	364.00	363.00	142.00	119.00	34.00	10.00	6.00	2,688.50
	North Sea +Div. IIIa			497.69	503.66	115.23	29.96	13.68	5.35	2.34	1,167.91
1989	Sub-Division 22-24	129.70	682.00	285.00	386.00	244.00	59.00	34.00	11.00	4.00	1,834.70
	North Sea +Div. IIIa		140.90	1,006.23	259.90	192.21	62.07	9.99	19.09	2.20	1,692.59
1990	Sub-Division 22-24	160.50	286.30	162.10	215.10	263.90	105.90	27.00	12.30	4.40	1,237.50
	North Sea +Div. IIIa	64.80	43.00	352.05	447.07	174.71	108.85	22.35	7.62	3.09	1,223.54
1991	Sub-Division 22-24	22.34	787.65	179.89	184.82	114.88	67.59	25.97	6.14	1.81	1,391.09
	North Sea +Div. IIIa		66.98	214.33	156.34	128.78	63.88	43.59	12.65	7.76	694.31
1992	Sub-Division 22-24	36.01	210.71	280.77	190.84	179.52	104.87	84.01	34.75	14.04	1,135.52
	North Sea +Div. IIIa		52.92	185.91	245.60	101.75	63.05	43.65	23.86	8.88	725.62
1993	Sub-Division 22-24	44.85	159.21	180.13	196.06	166.87	151.07	61.80	42.21	16.31	1,018.51
	North Sea +Div. IIIa			157.34	248.54	137.01	80.20	45.92	14.75	8.40	692.16
1994	Sub-Division 22-24	202.58	96.29	103.84	161.01	136.06	90.84	74.02	35.11	24.47	924.22
	North Sea +Div. IIIa	84.40	504.27	254.11	132.29	81.25	52.50	16.07	10.14	4.70	1,139.73
1995	Sub-Division 22-24	490.99	1,358.18	233.95	128.88	104.01	53.57	38.82	20.87	13.22	2,442.49
	North Sea +Div. IIIa	23.97	173.92	509.10	90.41	54.32	30.39	13.69	7.08	5.94	908.82
1996	Sub-Division 22-24	5.30	413.09	85.05	124.32	104.76	99.79	53.24	24.16	19.60	929.31
	North Sea +Div. IIIa		27.12	88.77	142.37	32.16	13.43	4.66	1.49	2.34	312.32
1997	Sub-Division 22-24	350.83	595.19	130.62	96.86	45.13	28.96	35.15	19.46	21.83	1,324.02
	North Sea +Div. IIIa	32.12	148.85	305.60	90.24	61.23	12.97	8.31	2.11	2.22	663.65
1998	Sub-Division 22-24	515.29	484.40	161.44	106.58	109.16	37.80	19.21	13.91	13.41	1,461.20

Table 3.3.14 **Mean weight (g) and SOP (tons) of spring spawners in Division IIIa + the North Sea and in Sub-Divisions 22-24 in the years 1988 - 1998**

	Rings	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**	**SOP**
Year	**Area**				**Mean weight (g)**						
	North Sea +Div. IIIa			47.3	77.0	138.3	156.0	166.0	149.0	209.0	151,832
1988	Sub-Division 22-24	11.0	16.9	29.1	83.8	108.5	124.8	142.2	143.7	135.8	92,908
	North Sea +Div. IIIa			56.5	79.9	125.5	151.6	167.3	189.2	204.8	91,145
1989	Sub-Division 22-24	13.5	17.5	43.6	70.5	105.9	122.0	125.5	137.8	131.5	91,002
	North Sea +Div. IIIa		56.6	65.0	84.6	102.4	111.1	109.3	141.0	84.3	125,915
1990	Sub-Division 22-24	13.8	24.2	44.5	75.5	95.9	121.1	142.6	138.7	145.8	73,978
	North Sea +Div. IIIa	33.7	60.5	77.4	101.7	127.5	148.6	165.4	182.5	194.9	121,641
1991	Sub-Division 22-24	11.5	31.5	58.5	78.8	98.5	120.9	138.6	152.2	179.0	82,390
	North Sea +Div. IIIa		53.4	96.2	115.2	138.6	172.9	184.0	201.7	201.3	83,234
1992	Sub-Division 22-24	19.1	23.3	44.8	77.4	99.2	123.3	152.9	166.2	184.2	84,874
	North Sea +Div. IIIa		60.4	88.6	121.5	147.2	160.3	182.9	195.6	218.2	89,181
1993	Sub-Division 22-24	16.2	24.5	44.5	73.6	94.1	122.4	149.4	168.5	169.1	80,358
	North Sea +Div. IIIa			127.2	120.1	148.6	165.3	190.6	204.1	216.5	97,061
1994	Sub-Division 22-24	12.9	28.2	54.2	76.4	95.0	117.7	133.6	154.3	173.9	66,425
	North Sea +Div. IIIa	17.5	37.8	101.2	148.3	165.5	188.7	213.0	233.1	232.2	96,102
1995	Sub-Division 22-24	9.3	16.3	42.8	68.3	88.9	125.4	150.4	193.3	207.4	74,157
	North Sea +Div. IIIa	7.3	22.9	74.1	127.0	172.0	182.8	200.9	197.7	212.3	73,653
1996	Sub-Division 22-24	12.1	22.9	45.3	73.6	91.2	115.3	119.4	137.8	181.3	56,817
	North Sea +Div. IIIa		63.8	82.4	131.3	174.5	190.6	195.6	205.9	210.2	37,618
1997	Sub-Division 22-24	30.4	24.7	58.4	101.0	120.7	155.2	181.3	197.1	208.8	67,513
	North Sea +Div. IIIa	27.9	48.7	72.8	110.3	142.0	176.4	210.4	192.7	231.8	53,987
1998	Sub-Division 22-24	13.3	28.0	57.9	84.9	114.0	128.6	150.4	163.3	182.3	63,765

There may be minor corrections in data from 1988.

Table 3.4.1 Herring in Division IIIa, IIIb and IIIc.
Samples of commercial catches by Sub-Div., Country and quarter for 1998 available to the Working Group.

	Country	Quarter	Landings in '000 tons	Number of samples	Number of fish meas.	Number of fish aged
Skagerrak	Denmark	1	0.3	6	426	309
		2	0.4	4	18	16
		3	7.2	22	1,932	550
		4	2.4	31	1,705	1,054
		Total	10.3	63	4,081	1,929
	Norway	1				
		2	3.0	2	200	200
		3	5.0			
		4				
			8.0	2	200	200
	Sweden	1	2.0	6	1,433	302
		2	1.7	9	1,951	627
		3	20.6	17	1,578	556
		4	22.6	18	2,997	906
		Total	46.9	50	7,959	2,391
Kattegat	Denmark	1	5.8	7	859	401
		2	0.5	3	582	304
		3	3.6	3	591	135
		4	4.6	7	1,394	436
		Total	14.5	20	3,426	1,276
	Sweden	1	11.9	14	2,692	915
		2	3.0	1	332	91
		3	9.1	13	421	259
		4	5.9	4	803	360
		Total	29.9	32	4,248	1,625
Sub-Division 22-24	Denmark	1	9.6	3	580	55
		2	8.0	8	1,727	333
		3	13.2	8	1,063	227
		4	12.7	4	899	326
		Total	43.5	23	4,269	941
	Germany	1	4.9	15	3,781	1,050
		2	4.0	17	5,305	1,582
		3	+			
		4	0.1			
		Total	9.0	32	9,086	2,632
	Poland	1	1.8			
		2	4.1		Not reported	
		3	0.3			
		4	0.4			
		Total	6.6	0	0	0
	Sweden	1	2.2			
		2	0.7			
		3	1.2	12	2,742	766
		4	0.4			
		Total	4.5	12	2,742	766
Total			**173.2**	**234**	**36,011**	**11,760**

Table 3.4.2 Mean vertebral counts (VS) for the three major spawning types of herring in the Skagerrak (20), the Kattegat (21) and the Sound (23) during 1990-1998. Figures in bold italics are mean VS counts for spring spawners statistically different from WBSS VS of 55.8

1st. Quarter

Age 0-4+	Subd.	mean VS			n				variance(VS)		
		Autumn	Winter	Spring	Autumn	Winter	Spring	Total	Autumn	Winter	Spring
1	20	56.18	56.00	57.00	55	1	2	58	0.45		0.00
	21	56.51	56.17	56.00	41	6	11	58	0.56	0.57	0.60
	23	57.00			2			2	0.00		
2	20	56.55	57.07	***56.42***	55	15	24	94	0.36	0.50	0.60
	21	56.51	56.45	***56.17***	47	11	53	111	0.56	0.27	0.53
	23	57.00		55.67	2		3	5	0.00		0.33
3	20	56.67	55.50	55.60	6	2	5	13	0.67	4.50	0.80
	21	55.00	55.00	56.00	1	1	17	19			0.38
	23			56.00			6	6			0.80
4+	20	56.67	56.50	55.33	9	2	3	14	1.00	0.50	0.33
	21	55.00		55.85	1		13	14			0.97
	23			56.50			2	2			0.50
Overall		56.44	56.55	56.11	219	38	139	396	0.52	0.74	0.60

3rd. Quarter

Age 0-4+	Subd.	mean VS			n				variance(VS)		
		Autumn	Winter	Spring	Autumn	Winter	Spring	Total	Autumn	Winter	Spring
1	20	56.35	56.00	***56.22***	34	4	9	47	0.48	0.67	0.94
	21	56.55	57.00	55.73	11	2	11	24	0.47	0.00	0.62
	23	55.50	57.00	55.89	2	1	9	12	0.50		1.11
2	20	56.33	57.00	55.74	3	3	27	33	0.33	1.00	0.51
	21	55.50	57.00	56.05	2	3	20	25	0.50	1.00	0.58
	23			55.84			19	19			0.25
3	20	56.00		56.25	1		4	5			0.25
	21	56.00		55.80	1		15	16			0.31
	23			55.50			2	2			0.50
4+	20			56.00			7	7			0.33
	21		57.00	55.73		1	11	12			0.42
	23			55.60			5	5			0.80
Overall		56.31	56.71	55.86	54	14	139	207	0.48	0.68	0.51

Table 3.5.1 German Bottom Trawl Survey in Sub-Div. 24.
Young Fish survey in November/December
Mean Herring catch at age in numbers per haul.

Year	Month	Winter rings 0	1	2	3+	Total numbers	Mean catch (kg)
1979	Nov.	8,665.90	240.47	103.36	10.33	9,020.06	89.61
1981	Nov.	332.63	96.79	60.05	21.30	510.77	16.36
1982	Dec.	695.71	108.21	70.63	34.72	909.27	24.57
1983	Dec.	1,995.97	387.11	63.71	46.11	2,492.90	46.68
1984	Nov.	1,581.66	377.15	88.03	24.26	2,071.10	39.79
1985	Nov.	3,085.64	340.92	169.95	74.76	3,671.27	45.99
1986	Dec.	2,984.47	368.35	46.41	69.30	3,468.53	44.42
1989	Nov.	2,881.81	319.38	48.99	55.12	3,305.30	47.76
1990	Nov.	103.92	14.79	21.69	32.90	173.30	7.09
1991	Nov.	117.38	134.20	103.14	144.63	499.35	27.16
1992	Nov.	233.85	88.05	57.15	113.58	492.63	19.86
1993	Nov.	1,116.34	25.09	50.01	476.29	1,667.30	53.97
1994	Nov.	1,020.49	13.21	73.47	583.23	1,690.40	79.34
1995	Nov.	635.09	33.22	47.97	324.98	1,041.27	47.53
1996	Nov.	514.52	36.12	49.04	349.44	949.12	25.82
1997	Nov.	627.20	66.33	93.57	126.50	913.60	18.30
1998	Nov.	4,651.43	273.67	146.42	563.65	5,635.18	88.85

Table 3.5.2 **German Bottom Trawl Survey in Sub-Div. 22.**
Young Fish survey in November/December
Mean Herring catch at age in numbers per haul.

Year	Month	Winter rings 0	1	2	3+	Total numbers	Mean catch (kg)
1979	Nov.	3,561.79	1,358.84	137.11	7.68	5,065.42	86.91
1981	Nov.	1,033.40	118.85	28.35	9.10	1,189.70	17.69
1982	Dec.	354.00	239.45	44.50	26.20	664.15	19.97
1983	Dec.	7,917.00	834.70	80.10	29.50	8,861.30	117.51
1984	Nov.	6,596.32	1,830.32	150.47	40.47	8,617.58	147.45
1985	Nov.	3,506.20	958.80	219.80	25.25	4,710.05	83.38
1986	Nov.	6,863.75	175.35	16.55	5.60	7,061.25	54.18
1989	Nov.	10,587.70	1,444.50	117.75	76.45	12,226.40	176.53
1992	Nov.	572.68	87.68	19.16	17.26	696.78	13.13
1993	Nov.	8,419.70	1,644.05	1,293.70	898.10	12,255.55	301.71
1994	Nov.	2,158.10	317.35	1,588.45	326.35	4,390.25	135.65
1995	Nov.	1,226.63	158.75	29.00	123.31	1,537.69	31.17
1996	Nov.	8.76	193.71	101.24	57.76	361.47	15.23
1997	Nov.	11,289.45	2,196.45	257.75	159.90	13,903.55	209.24
1998	Nov.	3,042.10	597.05	113.40	112.50	3,865.05	70.79

Table 3.5.3 **German Bottom Trawl Survey in Sub-Div. 22 and 24.**
Young Fish survey in November/December
Mean Herring catch at age in numbers per haul.

Sum weighted by area of sub-division :	
Area of 24 is	2325 sq.nm
Area of 22 is	485 sq.nm
Total	**2810 sq.nm**

Year	**Month**	**Winter rings**				**Total**	**Mean catch**
		0	**1**	**2**	**3+**	**numbers**	**(kg)**
1979	Nov.	7784.9	433.5	109.2	9.9	8337.5	89.1
1981	Nov.	453.6	100.6	54.6	19.2	628.0	16.6
1982	Dec.	636.7	130.9	66.1	33.2	867.0	23.8
1983	Dec.	3017.9	464.4	66.5	43.2	3592.1	58.9
1984	Nov.	2447.2	628.0	98.8	27.1	3201.0	58.4
1985	Nov.	3158.2	447.6	178.6	66.2	3850.6	52.4
1986	Nov.	3654.0	335.0	41.3	58.3	4088.6	46.1
1989	Nov.	4211.8	513.6	60.9	58.8	4845.1	70.0
1992	Nov.	292.3	88.0	50.6	97.0	527.9	18.7
1993	Nov.	2376.9	304.5	264.7	549.1	3495.2	96.7
1994	Nov.	1216.8	65.7	335.0	538.9	2156.4	89.1
1995	Nov.	737.2	54.9	44.7	290.2	1126.9	44.7
1996	Nov.	427.2	63.3	58.0	299.1	847.7	24.0
1997	Nov	2467.5	434.0	121.9	132.3	3155.6	51.3
1998	Nov	4373.7	329.5	140.7	485.8	5329.7	85.7

Table 3.5.4 **German Bottom Trawl Survey in January/February in Sub-Div. 24.**
Mean catch at age in numbers per haul.

Year	**Winter rings**								**Total**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8+**	**numbers**
1979	1597.6	702.2	106.5	23.0	4.9	0.0	0.5	0.0	2434.7
1981	1038.7	642.8	67.9	54.9	13.0	1.4	0.4	0.6	1819.7
1984	4865.4	1094.8	153.7	32.0	11.4	0.8	0.6	0.0	6158.7
1985	3018.3	3253.6	1012.2	307.8	87.9	38.8	8.8	0.8	7728.2
1986	7585.8	514.0	386.7	85.4	20.0	10.5	3.6	0.9	8606.9
1987	712.9	338.1	154.7	201.7	51.2	21.2	2.6	0.9	1483.3
1988	5031.7	2553.0	291.6	31.8	20.9	4.4	1.6	0.2	7935.2
1989	6654.5	2099.3	612.6	103.7	21.8	6.1	5.7	1.3	9505.0
1990	4568.5	1393.1	124.4	52.1	4.4	8.5	0.8	0.2	6152.0
1991	1961.0	636.2	261.4	87.1	34.5	8.8	2.0	2.1	2993.1
1992	2778.1	820.6	251.2	79.7	26.8	9.7	3.1	1.1	3970.3
1993	959.9	371.2	94.8	61.3	44.4	13.9	5.6	1.0	1552.1
1994	996.3	214.9	201.9	329.5	130.6	75.8	30.3	21.0	2000.3
1995	1949.0	91.7	328.7	131.1	83.6	24.4	27.9	11.3	2647.7
1996	1221.7	188.9	83.3	87.9	86.7	41.4	33.3	35.2	1778.4
1997	1163.1	206.0	395.8	163.5	61.2	32.6	23.2	28.4	2073.7
1998	2253.7	836.3	321.1	74.4	33.1	15.5	10.2	7.1	3551.4

Table 3.5.5 **International Bottom Trawl Survey in Division IIIa in quarter 1. Mean catch of spring spawning herring at age in number per haul**

Year	Winter rings	
	2	3+
1980	307	162
1981	1318	349
1982	445	196
1983	946	240
1984	1419	445
1985	1867	2037
1986	1562	1897
1987	2921	1199
1988	7834	7084
1989	0	3989
1990	3192	508
1991	480	3392
1992	771	1268
1993	203	264
1994	0	1148
1995	0	344
1996	1870	0
1997	*	*
1998	*	*

* not available for this report

Table 3.5.6 **International Bottom Trawl Survey in Division IIIa in quarter 3. Mean catch of spring spawning herring at age in number per haul**

Year	Winter rings				
	1	2	3	4	5
1991	214	214	234	80	88
1992	0	333	199	156	52
1993	0	333	44	44	61
1994	0	190	213	83	66
1995	1198	234	168	172	69
1996	3240	1625	128	55	34
1997	149	649	436	68	65
1998	539	294	72	64	10

Table 3.5.7. **Acoustic surveys on the Spring Spawning HERRING in the North Sea / Division IIIa in 1989-1998 (July).**

Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	Numbers in millions									
W-rings										
0		31		3,853	372	964				
1		135		277	103	5	2,199	1,091	128	138
2	1,105	1,497	1,864	2,092	2,768	413	1,887	1,005	715	1,682
3	714	549	1,927	1,799	1,274	935	1,022	247	787	901
4	317	319	866	1,593	598	501	1,270	141	166	282
5	81	110	350	556	434	239	255	119	67	111
6	51	24	88	197	154	186	174	37	69	51
7	16	10	72	122	63	62	39	20	80	31
8+	4	5	10	20	13	34	21	13	77	53
Total	2,288	2,680	5,177	10,509	5,779	3,339	6,867	2,673	2,088	3,248
3+ group	1,183	1,017	3,313	4,287	2,536	1,957	2,781	577	1,245	1,428

	Biomass ('000 tonnnes)									
W-rings										
0	0.0	0.5	0.0	34.3	1	8.7				
1	0.0	6.8	0.0	26.8	7	0.4	77.4	52.9	4.7	7.1
2	86.2	122.8	177.1	169.0	139	33.2	108.9	87.0	52.2	136.1
3	83.5	59.8	219.7	206.3	112	114.7	102.6	27.6	81.0	84.8
4	54.2	41.2	116.0	204.7	69	76.7	145.5	17.9	21.5	35.2
5	16.0	15.8	51.1	83.3	65	41.8	33.9	17.8	9.8	13.1
6	11.4	3.8	19.0	36.6	26	38.1	27.4	5.8	9.8	6.9
7	3.4	1.8	13.0	24.4	16	13.1	6.7	3.3	14.9	4.8
8+	0.9	0.8	2.0	5.0	2	7.8	3.8	2.7	13.6	9.0
Total	255.7	252.7	597.9	756.1	436.5	325.8	506.2	215.1	207.5	297.0
3+ group	169.5	123.2	420.9	560.3	291.0	292.3	319.9	75.2	150.6	153.7

	Mean weight (g)									
W-rings										
0		17		8.9	4.0	9.0				
1		50		96.8	66.3	80.0	35.2	48.5	36.9	51.8
2	78	82	95	80.8	50.1	80.3	57.7	86.6	73.0	80.9
3	117	109	114	114.7	87.9	122.7	100.4	111.9	103.0	94.1
4	171	129	134	128.5	116.2	153.0	114.6	126.8	129.6	124.7
5	198	144	146	149.8	149.9	175.1	132.9	149.4	145.0	118.7
6	211	159	216	185.7	169.6	205.0	157.2	157.3	143.1	135.9
7	215	176	181	199.7	256.9	212.0	172.9	166.8	185.6	156.3
8+	226	156	200	252.0	164.2	230.3	183.1	212.9	178.0	168.0
Total	111.6	95.8	115.6	123.9	75.8	100.2	73.7	80.5	99.4	91.4

* The data from 1992-1996 were revised in 1997.

Table 3.5.8. **Acoustic survey on the Spring Spawning Herring in Sub- divisions 22-24 in 1989-1998 (September/October).**

Year	1989	1990	1991	1992	1993*	1994*	1995*	1996*	1997*	1998
	Numbers in millions									
W-rings										
0	3,825	21,157	7,359	3,412	1,079	5,613	4,968	1,797	3,276	3,655
1	2,137	1,785	3,224	1,658	452	419	1,372	1,188	1,769	811
2	213	892	1,764	657	409	760	365	516	551	658
3	161	146	1,437	282	536	495	387	410	395	404
4	102	79	461	156	417	413	429	287	162	265
5	23	19	174	37	133	180	306	273	118	113
6	4	8	44	25	56	61	149	115	97	60
7	3	4	24	4	32	25	53	46	30	24
8+	1	2	21		14	3	36	16	40	9
Total	6,469	24,092	14,508	6,231	3,129	7,967	8,066	4,649	6,436	5,999
3+ group	294	258	2,161	504	1,189	1,176	1,360	1,147	841	875
	Biomass ('000 tonnnes)									
W-rings										
0	**	287.7	**	53.2	15.8	62.3	52.6	14.6	34.8	35.6
1	**	65.9	**	61.3	16.1	14.6	46.9	35.8	47.2	35.3
2	**	56.2	**	39.6	18.2	35.1	24.5	29.7	32.8	45.9
3	**	12.3	**	20.6	33.5	37.2	35.4	32.2	36.9	34.4
4	**	7.6	**	14.4	26.5	40.2	51.5	22.5	22.4	28.4
5	**	1.9	**	4.6	14.1	22.9	37.2	34.7	16.4	12.3
6	**	0.9	**	3.3	8.0	12.9	18.6	16.4	14.0	6.6
7	**	0.4	**	0.7	3.2	5.7	11.5	6.7	4.9	3.6
8+	**	0.2	**		2.4	0.7	8.5	2.5	8.8	2.1
Total	**	438.5	**	197.7	137.9	231.7	286.7	195.1	218.3	204.2
3+ group	**	23.4	**	43.6	87.8	119.7	162.7	115.1	103.5	87.5
	Mean weight (g)									
W-rings										
0	**	13.6	**	15.6	14.7	11.1	10.6	8.1	10.6	9.7
1	**	36.9	**	37.0	35.7	34.8	34.2	30.1	26.7	43.5
2	**	63.0	**	60.2	44.5	46.2	67.2	57.5	59.7	69.6
3	**	84.5	**	73.0	62.6	75.3	91.4	78.7	93.5	85.1
4	**	96.6	**	92.1	63.4	97.3	120.1	78.5	138.7	107.2
5	**	101.4	**	125.6	106.2	127.8	121.4	127.1	139.6	109.3
6	**	112.2	**	132.0	142.6	209.8	125.0	142.3	144.6	110.7
7	**	100.6	**	168.1	101.1	230.9	217.2	145.4	165.6	149.0
8+	**	102.5	**		164.1	269.4	234.4	158.5	219.7	231.3
Total	**	18.2	**	31.7	44.1	29.1	35.5	42.0	33.9	34.0

* revised in 1999

** no data available

Table 3.5.9 **Environmental Impact Monitoring: Biomass and abundance estimates of herring in the Sound (SD 23) during the period Sept. 1993 to May 1998 (Nielsen *et al.* 1998)**

Year*	Month	Biomass (t)	Abundance (N in millions)
1993	Sept.	118 832	1151.44
	Oct.	87 794	792.08
	Dec.	65 462	680.47
1994	Jan.	77 421	674.29
	Febr.	91 061	835.97
	Mar.	15 933	132.02
	Apr.	5 609	51.30
	Oct.	83 609	513.32
	Nov.	50 049	320.07
	Dec.	50 795	314.88
1995	Jan.	31 395	205.17
	Febr.	8 270	61.42
	Mar.	17 703	127.22
	Apr.	11 511	86.91
	May	10 759	82.67
	Jul.	1 548	24.80
	Aug.	65 075	370.40
	Oct.	45,690	284.93
1996	Mar.	34 989	207.56
	Apr.	19 069	113.07
	Oct.	90 595	839.50
	Nov.	88 404	857.73
1997	Mar.	58 406	553.13
	Apr.	56 554	537.45
	Nov.	163 184	1125.67
1998	Mar.	62 144	608.93
	May	7 089	116.48

* 1993-1997 revised in 1998

Table 3.5.10 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[3]
1993	199[3]
1994	788[2]
1995	171[2]
1996	31[2]
1997	54[2]
1998	2202[2]

[1] Brielmann 1989
[2] not yet published
[3] Müller & Klenz 1994

Table 3.7.1 Western Baltic Herring: Input parameters for ICA

/users/fish/ifad/ifapwork/hawg/her_3a22/CANUM.I07
/users/fish/ifad/ifapwork/hawg/her_3a22/WECA.I07
Stock weights in 1999 used for the year 1998
/users/fish/ifad/ifapwork/hawg/her_3a22/WEST.I07
Natural mortality in 1999 used for the year 1998
/users/fish/ifad/ifapwork/hawg/her_3a22/NATMOR.I07
Maturity ogive in 1999 used for the year 1998
/users/fish/ifad/ifapwork/hawg/her_3a22/MATPROP.I07
No indices of spawning biomass to be used.
No of years for separable constraint ? --> 6
Reference age for separable constraint ? --> 4
Constant selection pattern model (Y/N) ? --> y
S to be fixed on last age ? --> 1
First age for calculation of reference F ? --> 3
Last age for calculation of reference F ? --> 6
Use default weighting (Y/N) ? --> y
Is the last age of FLT03: Acoustic Survey in Div IIIa+IVaE a plus-group (Y/ --> y
Is the last age of FLT04: Acoustic Survey in Sub div 22-24 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 FLT03: Acoustic Survey in Div IIIa+IVaE is to be A/L/P ? --> l
Model for FLT04: Acoustic Survey in Sub div 22-24 is to be A/L/P ? --> l
Fit a stock-recruit relationship (Y/N) ? --> n
Enter lowest feasible F --> .05
Enter highest feasible F --> 1

No of years for separable analysis : 6
Age range in the analysis : 3 . . . 8
Year range in the analysis : 1991 . . . 1998
Number of indices of SSB : 0
Number of age-structured indices : 2
Parameters to estimate : 31
Number of observations : 125
Conventional single selection vector model to be fitted.

Survey weighting to be Manual (recommended) or Iterative (M/I) ? -->m
Enter weight for FLT03: Acoustic Survey in Div IIIa+IVaE at age 3 --> 1
Enter weight for FLT03: Acoustic Survey in Div IIIa+IVaE at age 4 --> 1
Enter weight for FLT03: Acoustic Survey in Div IIIa+IVaE at age 5 --> 1
Enter weight for FLT03: Acoustic Survey in Div IIIa+IVaE at age 6 --> 1
Enter weight for FLT03: Acoustic Survey in Div IIIa+IVaE at age 7 --> 1
Enter weight for FLT03: Acoustic Survey in Div IIIa+IVaE at age 8 --> 1
Enter weight for FLT04: Acoustic Survey in Sub div 22-24 at age 3 --> 1
Enter weight for FLT04: Acoustic Survey in Sub div 22-24 at age 4 --> 1
Enter weight for FLT04: Acoustic Survey in Sub div 22-24 at age 5 --> 1
Enter weight for FLT04: Acoustic Survey in Sub div 22-24 at age 6 --> 1
Enter weight for FLT04: Acoustic Survey in Sub div 22-24 at age 7 --> 1
Enter weight for FLT04: Acoustic Survey in Sub div 22-24 at age 8 --> 1

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 FLT03: Acoustic Survey in Div IIIa+IVaE --> 1
Enter value for FLT04: Acoustic Survey in Sub div 22-24 --> 1
Do you want to shrink the final fishing mortality (Y/N) ? --> n
Seeking solution. Please wait.

Aged index weights
FLT03: Acoustic Survey in Div IIIa+IVaE
Age : 3 4 5 6 7 8
Wts : .167 .167 .167 .167 .167 .167
FLT04: Acoustic Survey in Sub div 22-24
Age : 3 4 5 6 7 8
Wts : .167 .167 .167 .167 .167 .167
SSQ --- > 6.25088690746726
SSQ --- > 6.26997238334916
SSQ --- > 6.26845010610214
Computing covariance matrix. Please wait
F in 1998 at age 4 is .266077 in iteration 1
Detailed, Normal or Summary output (D/N/S) --> n
Output page width in characters (e.g. 80..132) ? --> 80
Estimate historical assessment uncertainty ? --> n
Succesful exit from ICA

Table. 3.7.2 WESTERN BALTIC HERRING. Input to ICA. Catch in number (millions)

AGE	1991	1992	1993	1994	1995	1996	1997	1998
3	631.90	360.20	441.64	409.55	255.67	214.73	239.22	196.82
4	289.60	317.80	268.45	273.07	193.56	159.08	77.29	170.39
5	176.40	173.80	214.11	171.04	106.87	130.18	42.40	50.77
6	48.30	130.40	105.47	119.94	55.59	66.93	39.81	27.51
7	13.80	48.30	66.07	49.86	32.11	31.23	20.94	16.02
8	4.90	22.00	22.37	32.87	18.63	25.55	24.17	15.63

Table. 3.7.3WESTERN BALTIC HERRING. Input to ICA. Mean weight in catch (kg)

AGE	1991	1992	1993	1994	1995	1996	1997	1998
3	.09500	.09100	.10000	.10300	.10700	.09600	.11900	.09700
4	.11600	.11200	.11400	.12200	.12600	.11900	.14300	.12400
5	.13800	.13800	.13400	.14000	.15700	.13100	.16600	.14100
6	.15100	.16000	.16300	.15500	.17000	.13600	.18300	.16900
7	.16900	.17200	.17600	.16900	.20600	.15100	.19800	.16700
8	.18000	.18900	.18800	.18500	.21500	.18900	.20900	.18900

Table. 3.7.4 WESTERN BALTIC HERRING. Input to ICA . Mean weight in stock (kg)

AGE	1991	1992	1993	1994	1995	1996	1997	1998
3	.07800	.08200	.08300	.08400	.07500	.08800	.10600	.08300
4	.10400	.10600	.11100	.10800	.13300	.12200	.13200	.11200
5	.11100	.12900	.13700	.13900	.16800	.12700	.16500	.13300
6	.13700	.15900	.15800	.15700	.18900	.16600	.19400	.16800
7	.14100	.17100	.17900	.17700	.21000	.17800	.20900	.16800
8	.14300	.18700	.18600	.20300	.23400	.14900	.22600	.18400

Table. 3.7.5 a WESTERN BALTIC HERRING. Input to ICA.
AGE - STRUCTURED INDICES.
FLT04: Acoustic Survey in Div IIIa, Ages 3-8+(Catch: Number)

AGE	1991	1992	1993	1994	1995	1996	1997	1998
3	1927.0	1799.0	1274.0	935.0	1022.0	247.0	787.0	901.0
4	866.0	1593.0	598.0	501.0	1270.0	141.0	166.0	282.0
5	350.0	556.0	434.0	239.0	255.0	119.0	67.0	111.0
6	88.0	197.0	154.0	186.0	174.0	37.0	69.0	51.0
7	72.0	122.0	63.0	62.0	39.0	20.0	80.0	31.0
8	10.0	20.0	13.0	34.0	21.0	13.0	77.0	53.0

Table. 3.7.5 b WESTERN BALTIC HERRING. Input to ICA.
AGE - STRUCTURED INDICES.
FLT05: Acoustic Survey in Sub-div. 22-24, Ages 3-8+ (Catch: Number)

AGE	1991	1992	1993	1994	1995	1996	1997	1998
3	1434.0	282.0	536.0	495.0	387.0	410.0	395.0	404.0
4	461.0	156.0	417.0	413.0	429.0	287.0	162.0	265.0
5	174.0	37.0	133.0	180.0	306.0	273.0	118.0	113.0
6	44.0	25.0	56.0	61.0	149.0	115.0	97.0	60.0
7	24.0	4.0	32.0	25.0	53.0	46.0	30.0	24.0
8	21.0	*******	14.0	3.0	36.0	16.0	40.0	9.0

Table. 3.7.6WESTERN BALTIC HERRING. Output from ICA.
FISHING MORTALITY (per year)

AGE	1991	1992	1993	1994	1995	1996	1997	1998
3	.43279	.32651	.45537	.51923	.35598	.47105	.25626	.24899
4	.40298	.40469	.48663	.55487	.38041	.50339	.27385	.26608
5	.36625	.45175	.51622	.58861	.40355	.53400	.29050	.28226
6	.25453	.50821	.52003	.59296	.40653	.53794	.29265	.28434
7	.32880	.43537	.48663	.55487	.38041	.50339	.27385	.26608
8	.32880	.43537	.48663	.55487	.38041	.50339	.27385	.26608

Table. 3.7.7WESTERN BALTIC HERRING. Output from ICA.
POPULATION ABUNDANCE (millions)- 1 January

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	1970.4	1419.0	1476.4	1257.1	755.2	650.9	1077.7	963.7	976.0
4	956.9	1046.5	838.1	766.6	612.4	433.1	332.7	682.9	615.1
5	630.8	523.6	571.6	421.8	360.4	342.7	214.3	207.2	428.5
6	236.1	358.1	272.9	279.3	191.7	197.1	164.5	131.2	127.9
7	54.0	149.9	176.4	132.8	126.4	104.5	94.2	100.5	80.9
8	19.2	68.3	63.5	84.4	64.6	70.7	110.8	73.5	109.2

Table. 3.7.8WESTERN BALTIC HERRING. Output from ICA.
STOCK SUMMARY

Year	Recruits Age 3 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 6	SoP (%)
1991	1970420	365950	290589	191500	.6590	.3641	149
1992	1418950	390164	319403	168000	.5260	.4228	133
1993	1476380	380389	308386	171000	.5545	.4946	125
1994	1257080	331509	267040	164000	.6141	.5639	123
1995	755170	276499	232653	173187	.7444	.3866	195
1996	650930	215495	177092	130470	.7367	.5116	173
1997	1077670	270170	219584	105131	.4788	.2783	166
1998	963670	236476	193447	117752	.6087	.2704	204

Table. 3.7.9WESTERN BALTIC HERRING. Output from ICA.
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	1993	.4866	14	.3665	.6461	.4211	.5623	.4917
2	1994	.5549	14	.4201	.7329	.4814	.6395	.5605
3	1995	.3804	15	.2830	.5114	.3271	.4424	.3848
4	1996	.5034	15	.3695	.6859	.4299	.5894	.5097
5	1997	.2738	18	.1900	.3947	.2273	.3300	.2786
6	1998	.2661	21	.1748	.4049	.2148	.3296	.2723
Separable Model: Selection (S) by age								
7	3	.9358	14	.7030	1.2456	.8087	1.0828	.9458
	4	1.0000	Fixed : Reference Age					
8	5	1.0608	12	.8247	1.3646	.9329	1.2062	1.0696
9	6	1.0686	12	.8375	1.3636	.9437	1.2101	1.0769
	7	1.0000	Fixed : Last true age					
Separable model: Populations in year 1998								
10	3	963674	27	558039	1664163	729250	1273456	1001847
11	4	682866	21	446843	1043557	550004	847823	699040
12	5	207161	19	141368	303573	170465	251756	211136
13	6	131245	19	90020	191348	108278	159083	133696
14	7	100509	19	68026	148503	82359	122659	102522
Separable model: Populations at age								
15	1993	176362	24	108948	285491	137936	225494	181769
16	1994	132817	19	90351	195241	109115	161666	135407
17	1995	126385	18	87900	181719	105010	152110	128572
18	1996	104520	17	73480	148672	87322	125105	106223
19	1997	94217	19	64375	137892	77577	114425	96013

Table. 3.7.10 WESTERN BALTIC HERRING. Output from ICA.
Age-structured index catchabilities

FLT04: Acoustic Survey in Div IIIa+IVaE

Linear model fitted. Slopes at age :

20	3	Q	.1227E-02	23	.9776E-03	.2476E-02	.1227E-02	.1972E-02	.1600E-02
21	4	Q	.1082E-02	23	.8623E-03	.2177E-02	.1082E-02	.1736E-02	.1409E-02
22	5	Q	.8375E-03	23	.6662E-03	.1697E-02	.8375E-03	.1349E-02	.1094E-02
23	6	Q	.6852E-03	24	.5417E-03	.1414E-02	.6852E-03	.1118E-02	.9018E-03
24	7	Q	.6992E-03	25	.5476E-03	.1486E-02	.6992E-03	.1164E-02	.9317E-03
25	8	Q	.5444E-03	24	.4303E-03	.1124E-02	.5444E-03	.8883E-03	.7166E-03

FLT05: Acoustic Survey in Sub div 22-24

Linear model fitted. Slopes at age :

26	3	Q	.6745E-03	23	.5365E-03	.1366E-02	.6745E-03	.1087E-02	.8809E-03
27	4	Q	.7329E-03	23	.5833E-03	.1481E-02	.7329E-03	.1179E-02	.9562E-03
28	5	Q	.6207E-03	24	.4928E-03	.1264E-02	.6207E-03	.1003E-02	.8123E-03
29	6	Q	.4996E-03	24	.3940E-03	.1039E-02	.4996E-03	.8194E-03	.6597E-03
30	7	Q	.3581E-03	25	.2797E-03	.7666E-03	.3581E-03	.5989E-03	.4787E-03
31	8	Q	.3899E-03	26	.3014E-03	.8621E-03	.3899E-03	.6665E-03	.5284E-03

Table. 3.7.11 WESTERN BALTIC HERRING. Output from ICA.
RESIDUALS ABOUT THE MODEL FIT Separable Model Residuals
(log(Observed Catch)-log(Expected Catch))

Age	1993	1994	1995	1996	1997	1998
3	-.1104	-.1279	.2150	-.0394	.0759	.0180
4	-.0945	-.0894	.0910	.0160	.0630	.1598
5	.0160	-.0041	-.0214	.0040	-.1490	.0902
6	.0418	.0477	-.0498	-.1135	.0462	-.0725
7	.0622	-.0369	-.1275	-.1905	.0188	-.2885

Table. 3.7.12 WESTERN BALTIC HERRING. Output from ICA.
Aged Index Residuals: log(Observed Index) - log(Expected Index)

FLT04: Acoustic Survey in Div IIIa+IVaE

Age	1991	1992	1993	1994	1995	1996	1997	1998
3	.168	.361	.057	-.051	.445	-.755	-.234	.008
4	.198	.719	.013	-.032	1.013	-.761	-.478	-.672
5	-.058	.645	.349	.102	.209	-.422	-.679	-.145
6	-.325	.223	.256	.467	.660	-.833	-.183	-.264
7	.975	.549	-.243	.068	-.455	-.856	.490	-.527
8	.287	-.223	-.549	.171	-.152	-.645	.540	.573

FLT05: Acoustic Survey in Sub div 22-24

Age	1991	1992	1993	1994	1995	1996	1997	1998
3	.582	-.801	-.095	.037	.170	.468	-.245	-.116
4	.063	-1.109	.162	.296	.419	.462	-.030	-.263
5	-.358	-1.651	-.408	.256	.796	.837	.272	.257
6	-.623	-1.401	-.314	-.193	.927	.746	.560	.299
7	.638	-2.088	-.130	-.039	.622	.769	.262	-.032
8	1.455	*******	-.022	-1.791	.822	.019	.302	-.785

Table. 3.7.13 WESTERN BALTIC HERRING. Output from ICA.
PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1993 to 1998

Variance	.0306
Skewness test stat.	-1.6720
Kurtosis test statistic	.4246
Partial chi-square	.0303
Significance in fit	.0000
Degrees of freedom	11

Table. 3.7.14 **WESTERN BALTIC HERRING. Output from ICA. PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES**

DISTRIBUTION STATISTICS FOR FLT04: Acoustic Survey in Div IIIa+IVaE

Linear catchability relationship assumed

Age	3	4	5	6	7	8
Variance	.0235	.0677	.0299	.0398	.0661	.0362
Skewness test stat.	-1.0062	.3863	-.1642	-.3320	.2318	-.1312
Kurtosis test statisti	.0892	-.6382	-.4585	-.5044	-.7035	-.7994
Partial chi-square	.0254	.0775	.0397	.0615	.1243	.0787
Significance in fit	.0000	.0000	.0000	.0000	.0000	.0000
Number of observations	8	8	8	8	8	8
Degrees of freedom	7	7	7	7	7	7
Weight in the analysis	.1667	.1667	.1667	.1667	.1667	.1667

DISTRIBUTION STATISTICS FOR FLT05: Acoustic Survey in Subdiv 22-24

Linear catchability relationship assumed

Age	3	4	5	6	7	8
Variance	.0312	.0430	.1086	.1025	.1389	.1864
Skewness test stat.	-.4901	-1.5852	-1.1641	-.5911	-1.8850	-.4217
Kurtosis test statisti	-.1797	.5339	.1296	-.4434	.9387	-.3087
Partial chi-square	.0347	.0507	.1488	.1660	.2920	.4868
Significance in fit	.0000	.0000	.0000	.0000	.0001	.0020
Number of observations	8	8	8	8	8	7
Degrees of freedom	7	7	7	7	7	6
Weight in the analysis	.1667	.1667	.1667	.1667	.1667	.1667

Table. 3.7.15 **WESTERN BALTIC HERRING. Output from ICA. ANALYSIS OF VARIANCE TABLE**

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	35.9252	125	31	94	.3822
Catches at age	.3365	30	19	11	.0306
Aged Indices					
FLT03: Acoustic Survey in Div IIIa+IVa	11.0568	48	6	42	.2633
FLT04: Acoustic Survey in Sub div 22-2	24.5319	47	6	41	.5983

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	1.3251	125	31	94	.0141
Catches at age	.3365	30	19	11	.0306
Aged Indices					
FLT03: Acoustic Survey in Div IIIa+IVa	.3071	48	6	42	.0073
FLT04: Acoustic Survey in Sub div 22-2	.6814	47	6	41	.0166

Table 3.7.16 **Western Baltic Herring. Output from Separable VPA. Shrinkage of F's over 7 years (Run 7) Fishing mortality (F) at age.**

Run title : Herring IIIa 22-24 (run: SEPTOM03/S03)
At 22-Mar-99 09:57:49

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	FBAR 96-98
AGE									
3,	.4493,	.3635,	.4729,	.5171,	.5196,	.5751,	.3732,	.4441,	.4641,
4,	.4176,	.4285,	.5075,	.6082,	.4960,	.7258,	.4195,	.4987,	.5480,
5,	.3654,	.4773,	.5782,	.7191,	.5121,	.7452,	.4290,	.5401,	.5714,
6,	.3174,	.5063,	.6024,	.7637,	.5430,	.7133,	.5359,	.5510,	.6001,
7,	.3599,	.6052,	.5239,	.6479,	.4725,	.6807,	.5092,	.4294,	.5398,
+gp,	.3599,	.6052,	.5239,	.6479,	.4725,	.6807,	.5092,	.4294,	
FBAR 3- 7,	.3819,	.4762,	.5370,	.6512,	.5086,	.6880,	.4533,	.4927,	

Table 3.7.17 **Western Baltic Herring. Output from Separable VPA. Run 7. Matrix of residuals, fishing mortalities and selection-at-age**

Title : Herring IIIa 22-24 (run: SEPTOM03/S03)
At 22-Mar-99 09:57:30
Separable analysis
from 1991 to 1998 on ages 3 to 7
with Terminal F of .500 on age 4 and Terminal S of 1.000
Initial sum of squared residuals was 3.206 and
final sum of squared residuals is .768 after 49 iterations

Matrix of Residuals

Years,	1991/92,	1992/93,	1993/94,	1994/95,	1995/96,	1996/97,	1997/98,	TOT,	WTS,
3/ 4,	.415,	-.049,	.062,	-.158,	.141,	-.040,	-.008,	-.002,	.266,
4/ 5,	.162,	-.032,	-.061,	-.066,	-.029,	.165,	-.009,	-.001,	.488,
5/ 6,	-.087,	.026,	.014,	.064,	-.011,	-.027,	-.042,	-.001,	1.000,
6/ 7,	-.573,	.025,	.005,	.065,	-.078,	-.247,	.254,	-.001,	.186,
TOT ,	-.003,	.002,	.001,	.001,	-.002,	-.002,	-.001,	-.119,	
WTS ,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)

,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,
F-values,	.3609,	.4346,	.5267,	.6550,	.4973,	.6666,	.4218,	.5000,

Selection-at-age (S)

,	3,	4,	5,	6,	7,
S-values,	.8919,	1.0000,	1.0767,	1.1458,	1.0000,

Table 3.7.18 **Western Baltic Herring. Output from Separable VPA. Run 7. Fishing mortality residuals.**

Run title : Herring IIIa 22-24 (run: SEPTOM03/S03)
At 22-Mar-99 09:57:33

Traditional vpa Terminal populations from weighted Separable populations

Fishing mortality residuals

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,
AGE								
3,	.1274,	-.0242,	.0032,	-.0671,	.0760,	-.0194,	-.0030,	-.0018,
4,	.0567,	-.0061,	-.0192,	-.0468,	-.0013,	.0591,	-.0023,	-.0013,
5,	-.0232,	.0094,	.0111,	.0138,	-.0234,	.0275,	-.0252,	.0018,
6,	-.0961,	.0083,	-.0011,	.0132,	-.0268,	-.0505,	.0526,	-.0219,
7,	-.0010,	.1706,	-.0028,	-.0071,	-.0248,	.0141,	.0874,	-.0706,

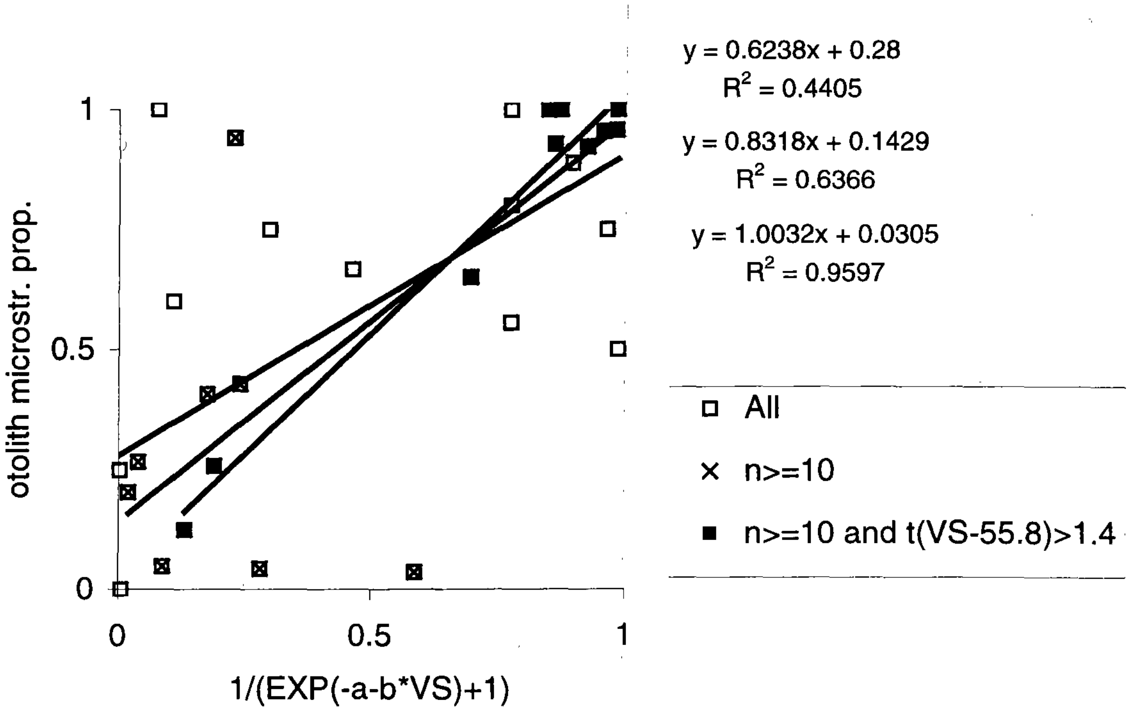


Figure 3.4: The relationship between a logistic transformation of VS count to proportion of spring spawners with increasing constraints on the data selection. The optimised equation was estimated to be: prop.spring spawner(otolith) = 1/(EXP(-a-b*VS)+1), a= 469.2, b= -8.356.

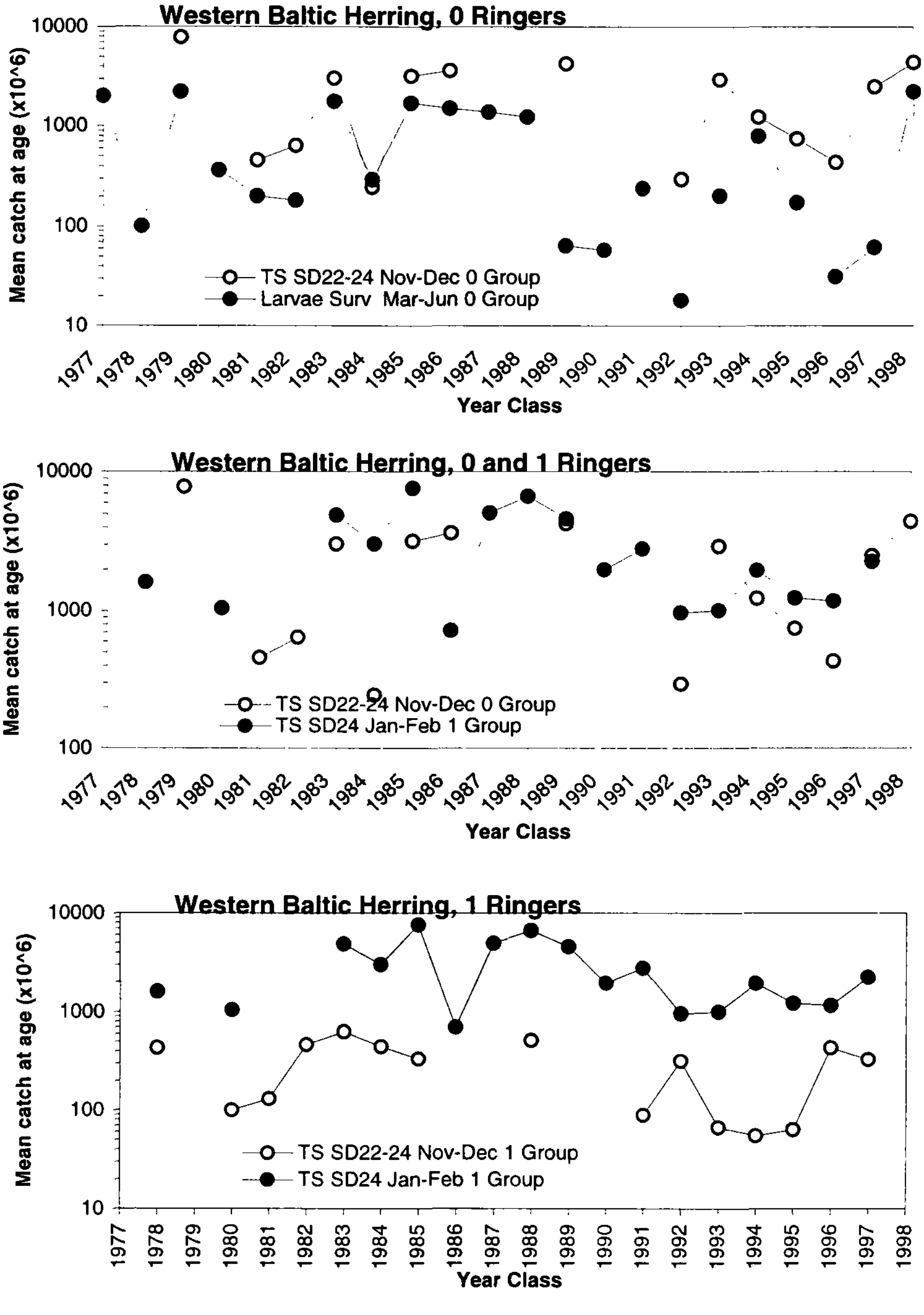


Figure 3.6.1 0- and 1- ringers of recruitment from larvae and trawl surveys

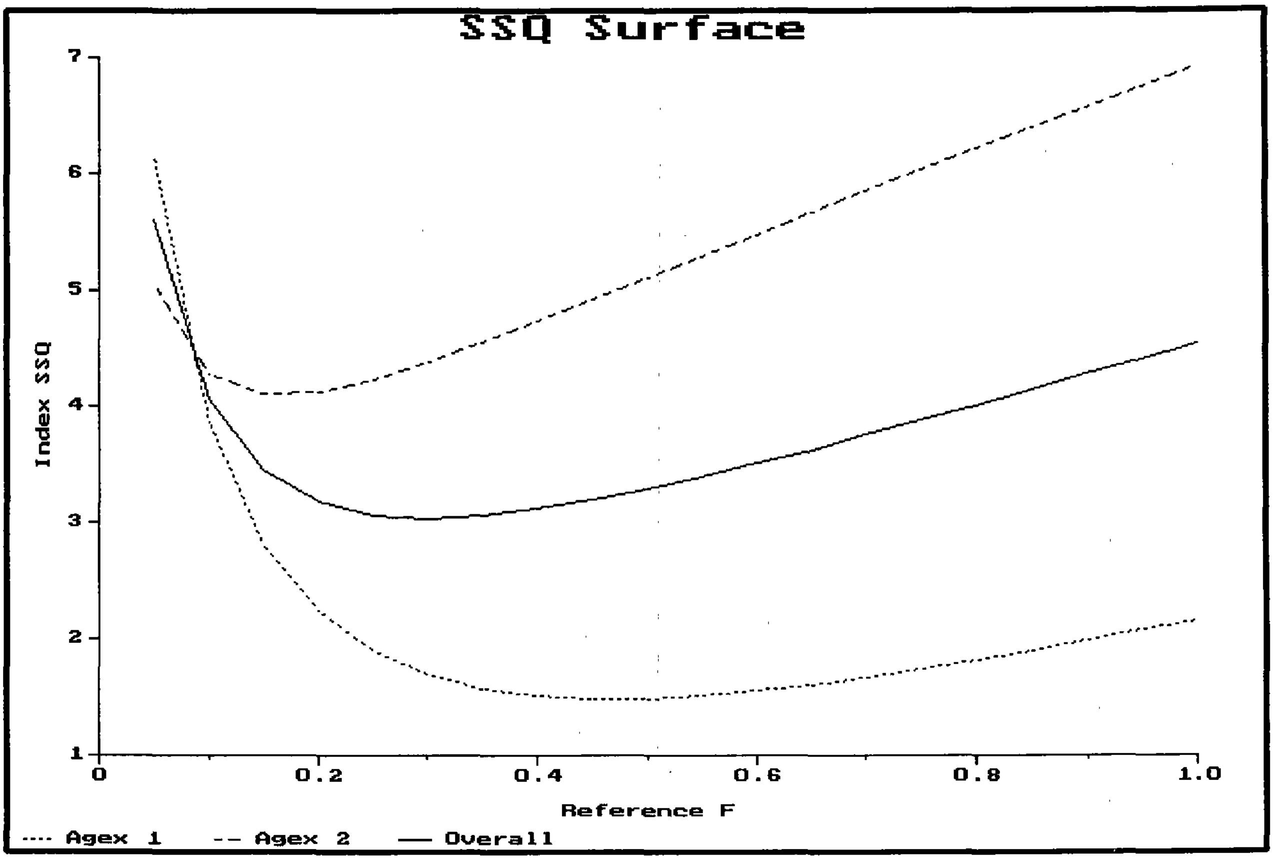


Figure 3.7.1 Western Baltic Herring. Output from ICA:
Index sum of squares of deviations between model and observations (survey index) as a function of the reference F in 1998.
INDEX 1: 1989-1998: Acoustic survey in Div. IIIa, Age groups 3-8+
INDEX 2: 1989-1998: Acoustic survey in Sub-divisions 22-24,Age groups 3-8+

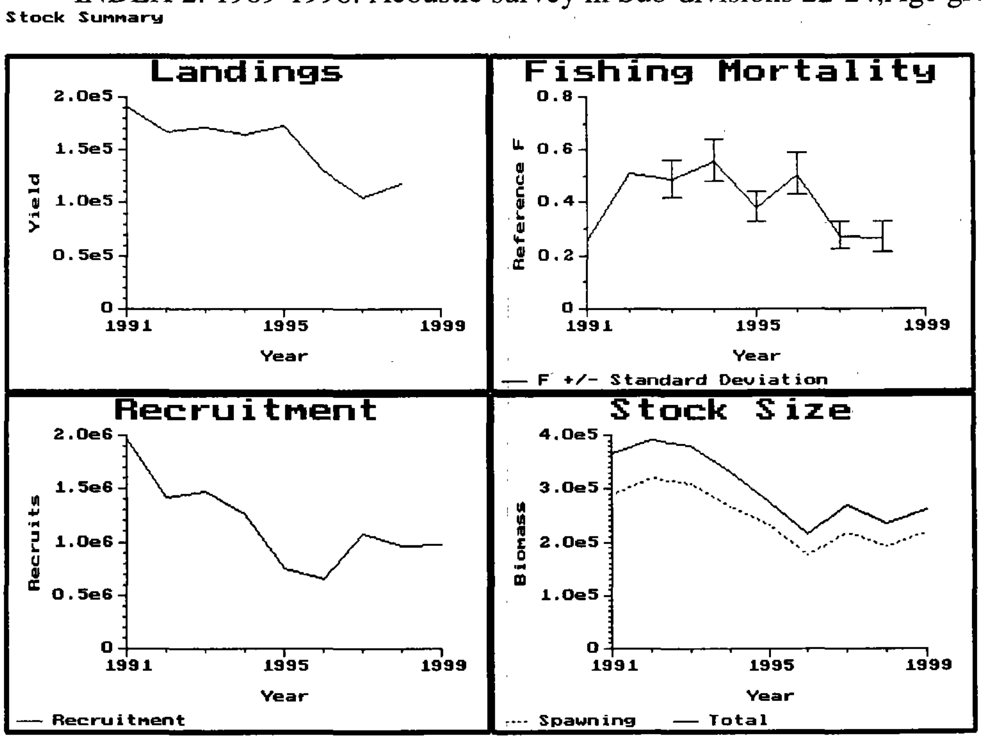


Figure 3.7.2 Western Baltic Herring. Out put from ICA: Stock Summary

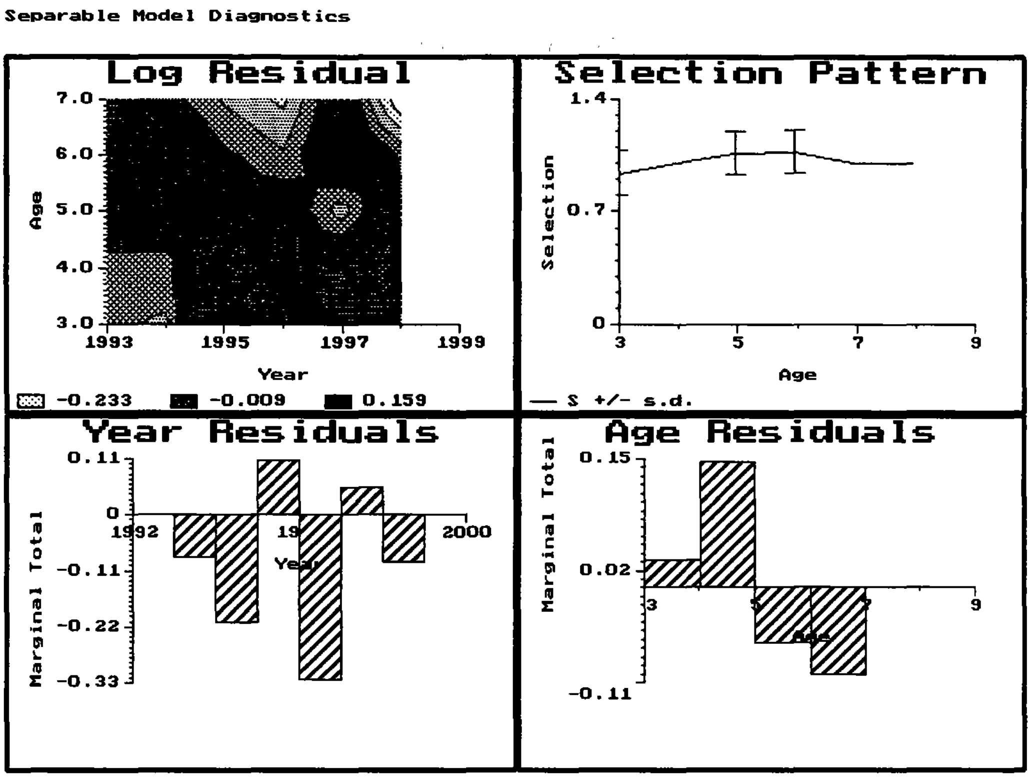


Figure 3.7.3 Western Baltic Herring. Output from ICA: Separable Model Diagnostics.

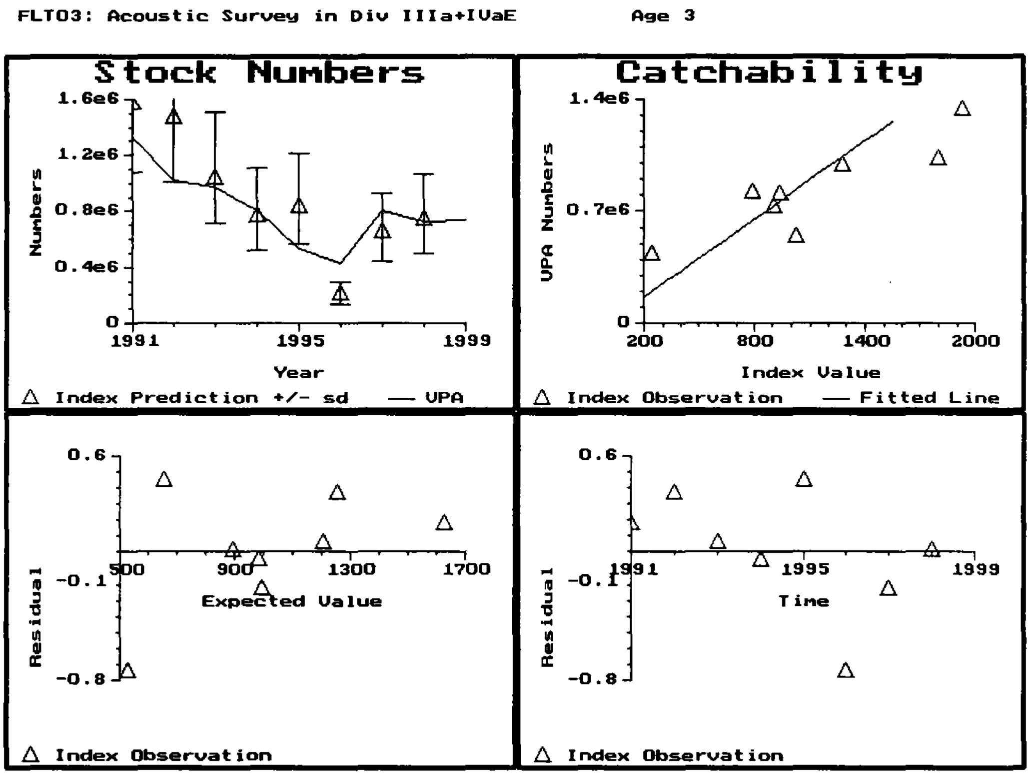


Figure 3.7.4a Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 1: Acoustic Survey in Division IIIa, 1991-1998, Age group 3

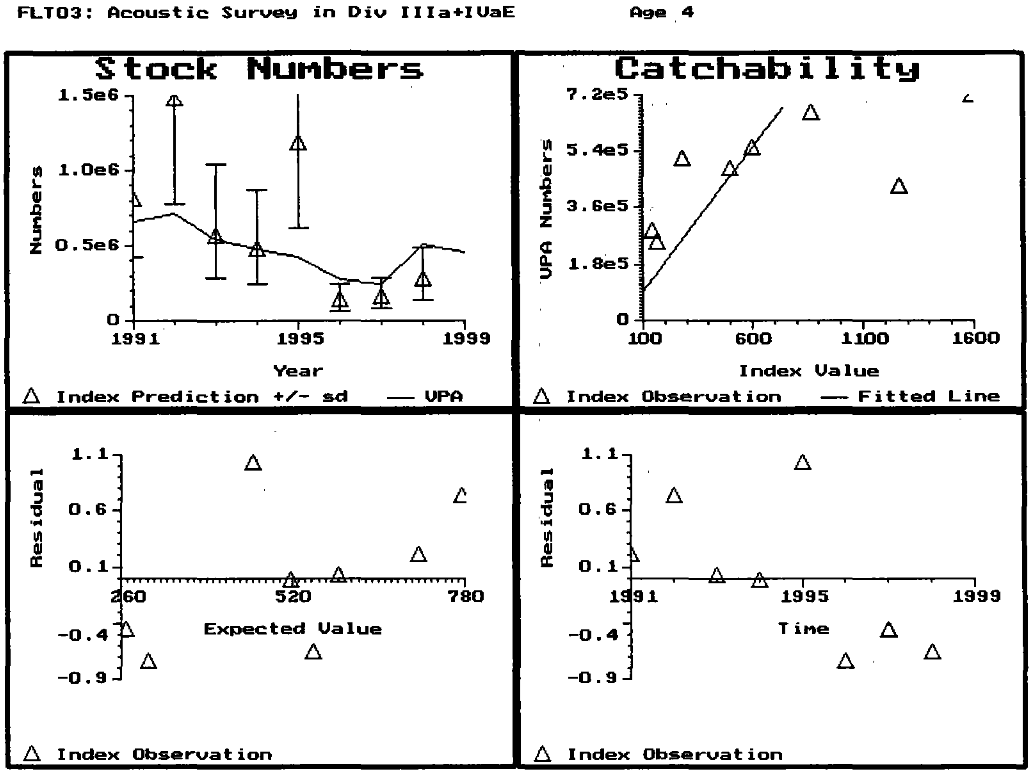


Figure 3.7.4b Western Baltic Herring. Output from ICA: Tuning Diagnostics. Index 1: Acoustic Survey in Division IIIa, 1991-1998, Age group 4

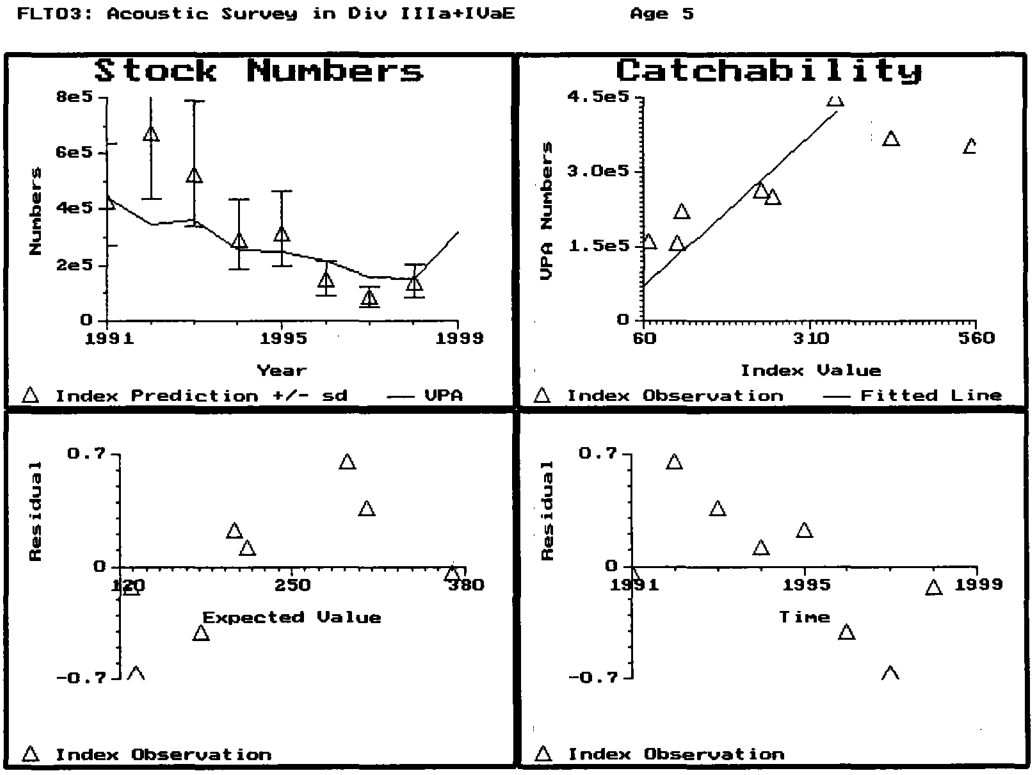


Figure 3.7.4c Western Baltic Herring. Output from ICA: Tuning Diagnostics. Index 1: Acoustic Survey in Division IIIa, 1991-1998, Age group 5

FLT03: Acoustic Survey in Div IIIa+IVaE Age 6

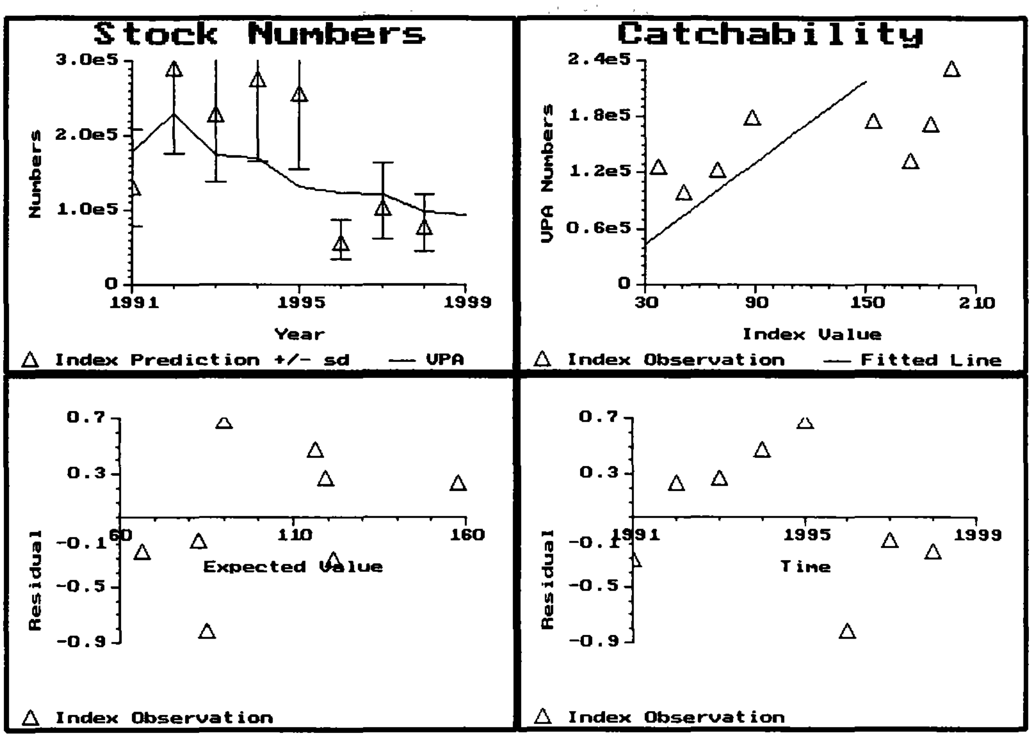


Figure 3.7.4d Western Baltic Herring. Output from ICA: Tuning Diagnostics. Index 1: Acoustic Survey in Division IIIa, 1991-1998, Age group 6

FLT03: Acoustic Survey in Div IIIa+IVaE Age 7

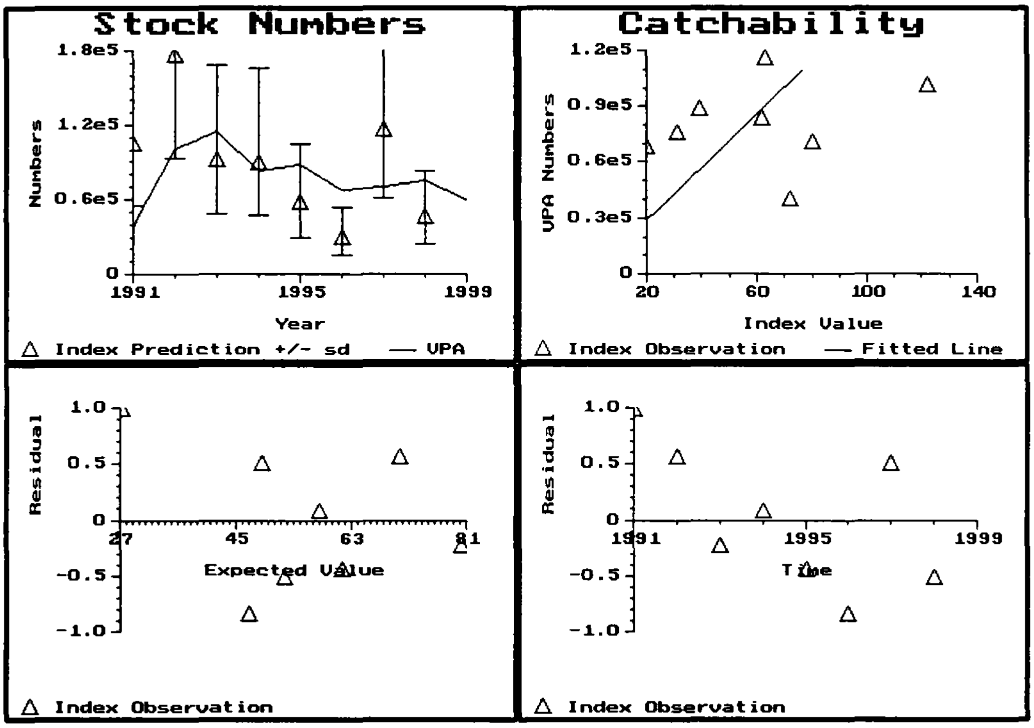


Figure 3.7.4e Western Baltic Herring. Output from ICA: Tuning Diagnostics. Index 1: Acoustic Survey in Division IIIa, 1991-1998, Age group 7

FLT03: Acoustic Survey in Div IIIa+IVaE   Age 8

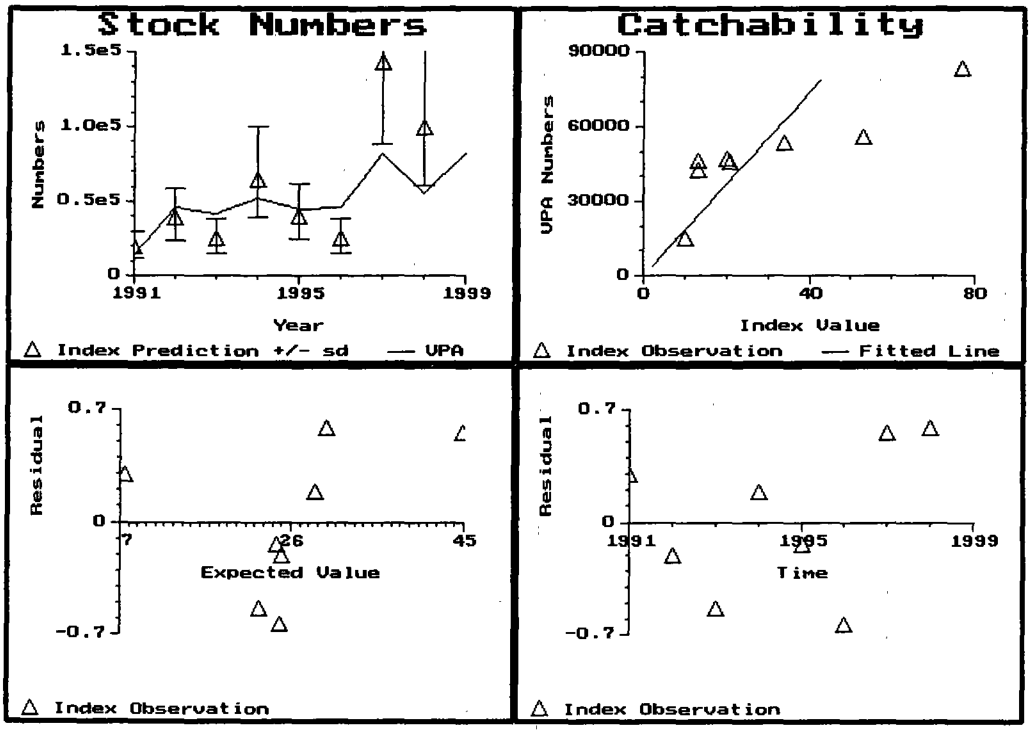


Figure 3.7.4f Western Baltic Herring. Output from ICA: Tuning Diagnostics. Index 1: Acoustic Survey in Division IIIa, 1991-1998, Age group 8

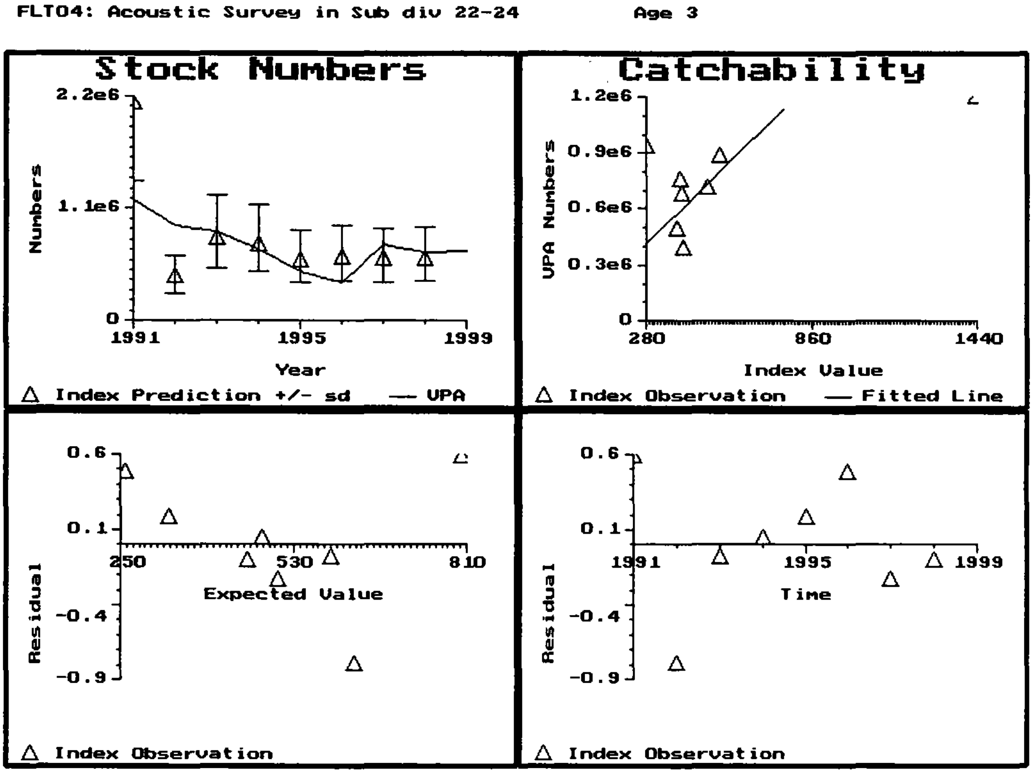


Figure 3.7.5a Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 1: Acoustic Survey in Sub-divisions 22-24, 1991-1998, Age group 3

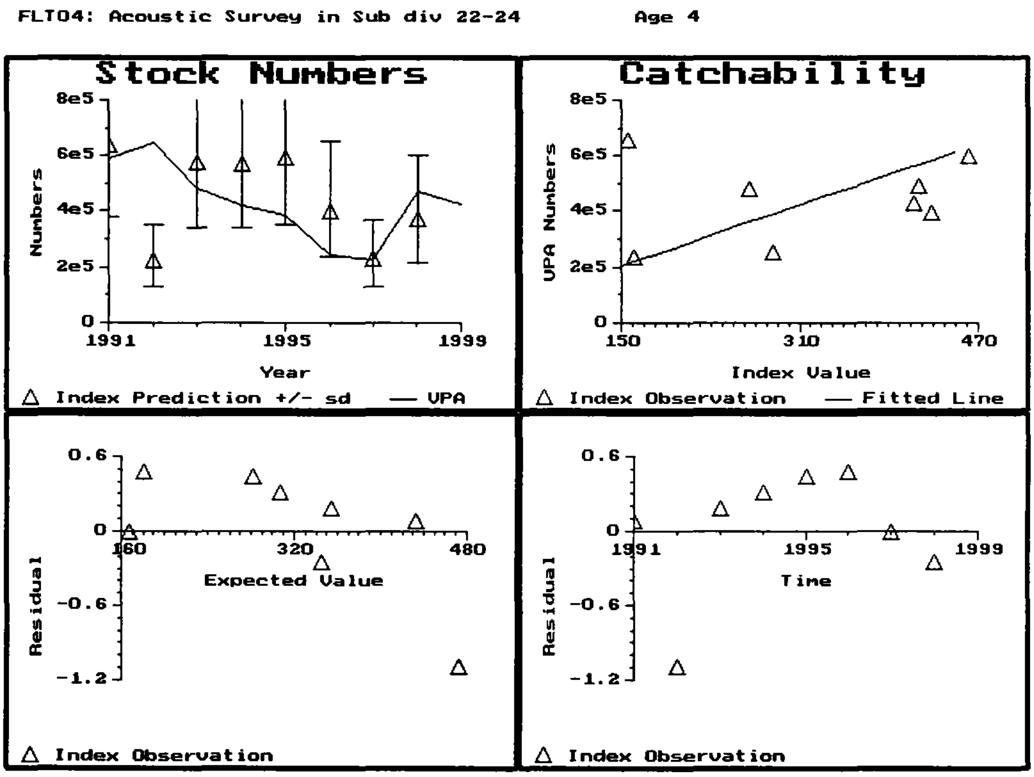


Figure 3.7.5b Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 1: Acoustic Survey in Sub-divisions 22-24, 1991-1998, Age group 4

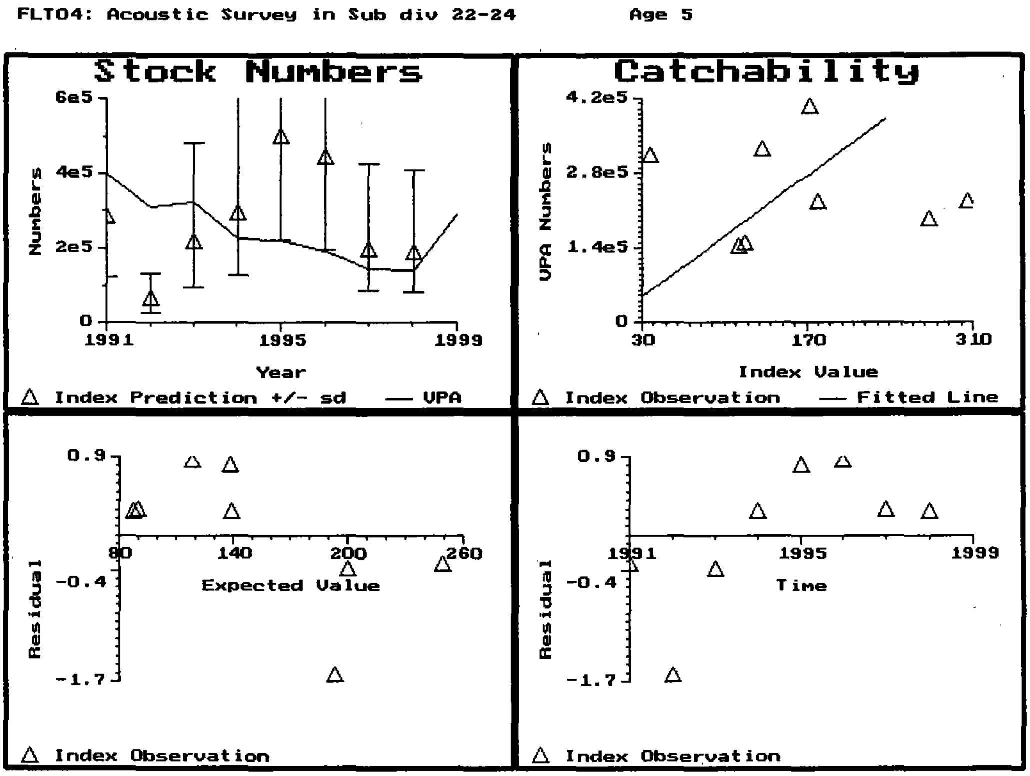


Figure 3.7.5c Western Baltic Herring. Output from ICA: Tuning Diagnostics. Index 1: Acoustic Survey in Sub-divisions 22-24, 1991-1998, Age group 5

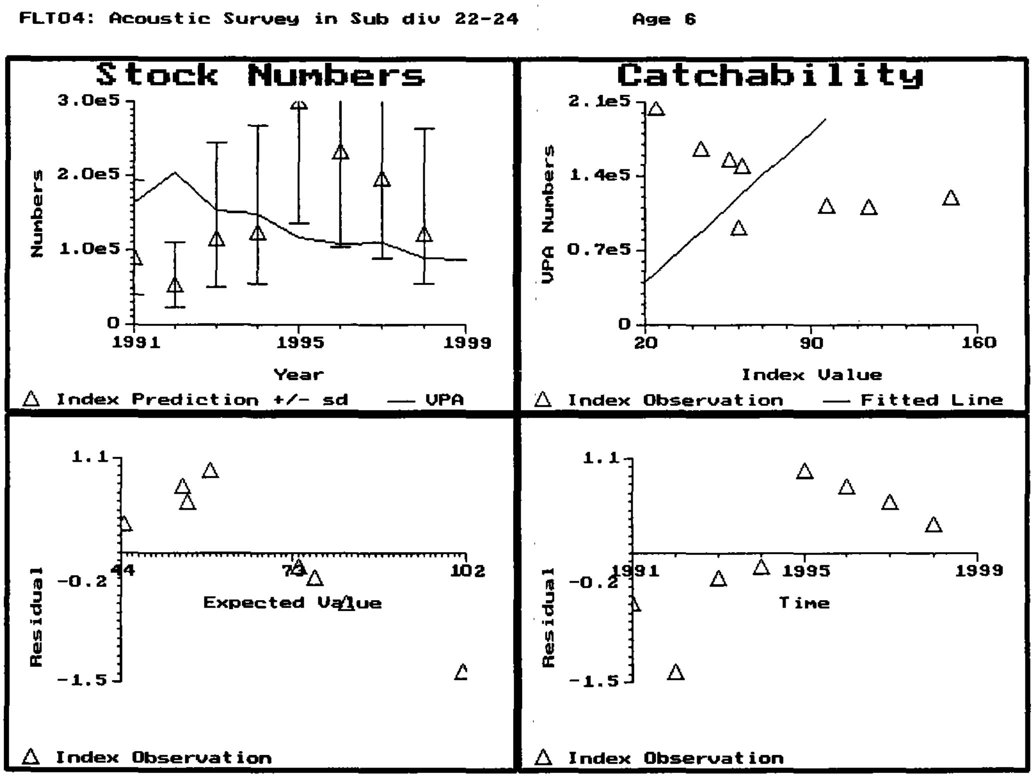


Figure 3.7.5d Western Baltic Herring. Output from ICA: Tuning Diagnostics. Index 1: Acoustic Survey in Sub-divisions 22-24, 1991-1998, Age group 6

FLT04: Acoustic Survey in Sub div 22-24 Age 7

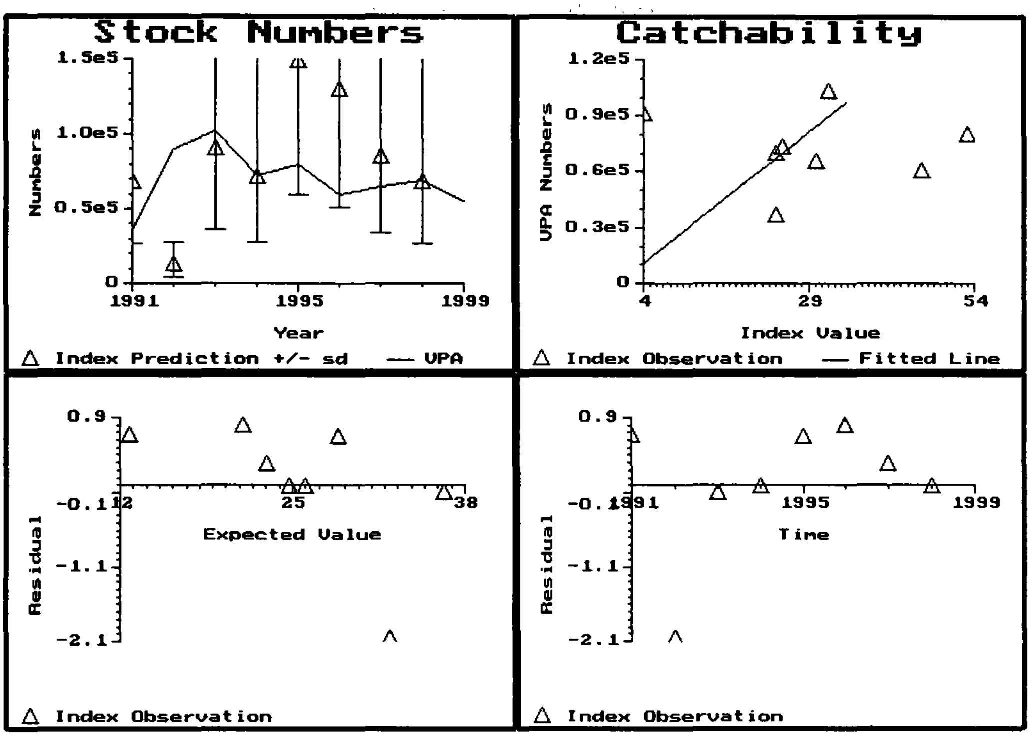


Figure 3.7.5e Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 1: Acoustic Survey in Sub-divisions 22-24, 1991-1998, Age group 7

FLT04: Acoustic Survey in Sub div 22-24 Age 8

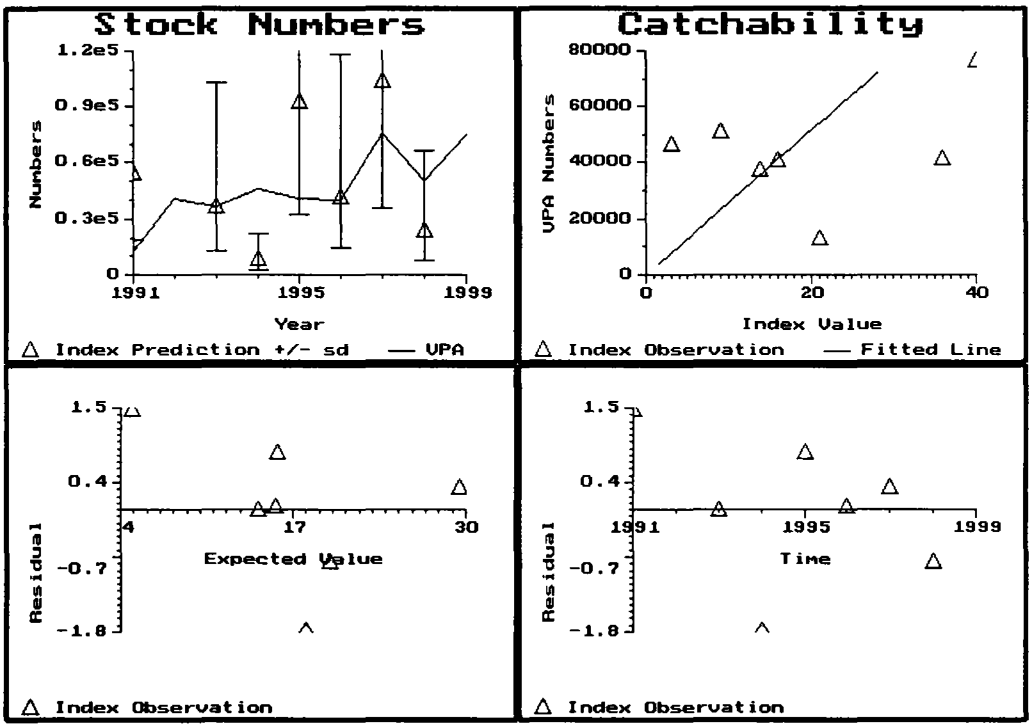


Figure 3.7.5f Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 1: Acoustic Survey in Sub-divisions 22-24, 1991-1998, Age group 8

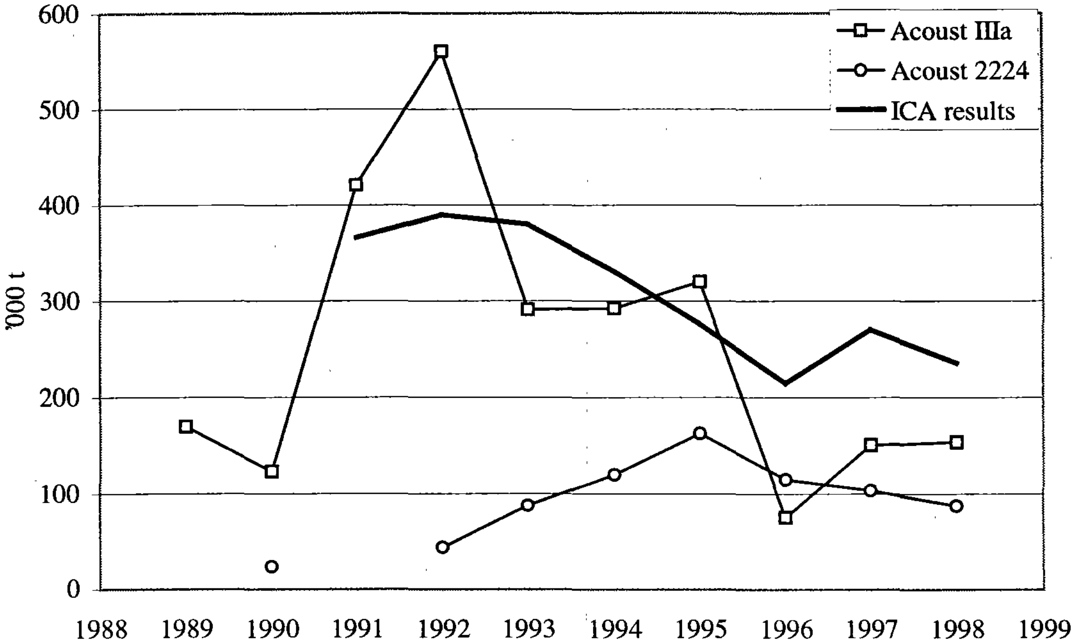


Figure 3.7.6a **Biomass estimates from acoustic surveys and ICA run 8**

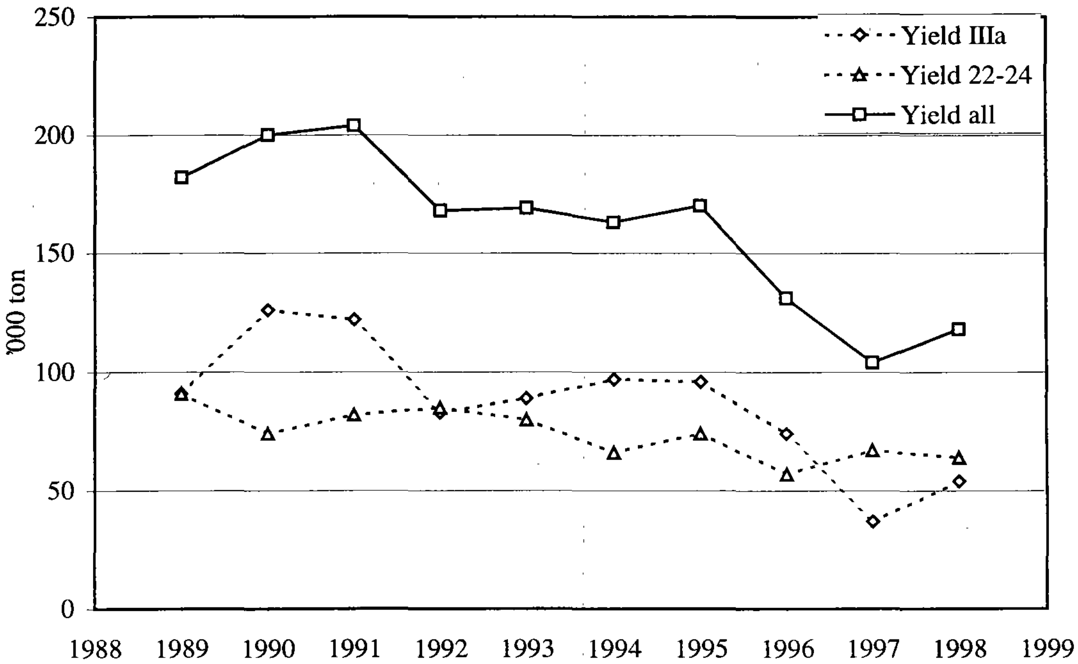


Figure 3.7.6b **Landings in Division IIIa and Sub-divisions 22 to 24**

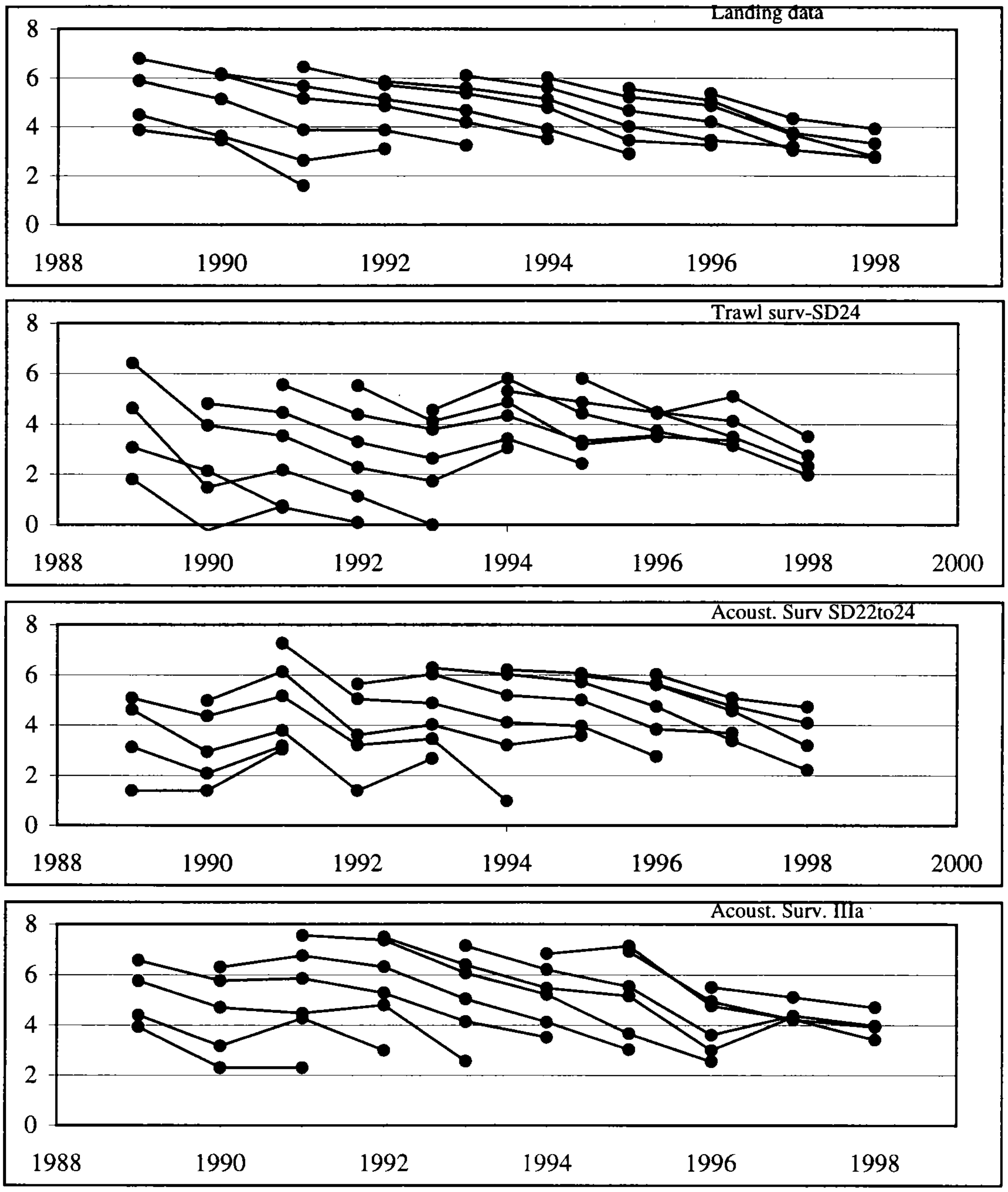


Figure 3.7.7 LN plots of yearclass survival for yearclasses 1985 to 1993.

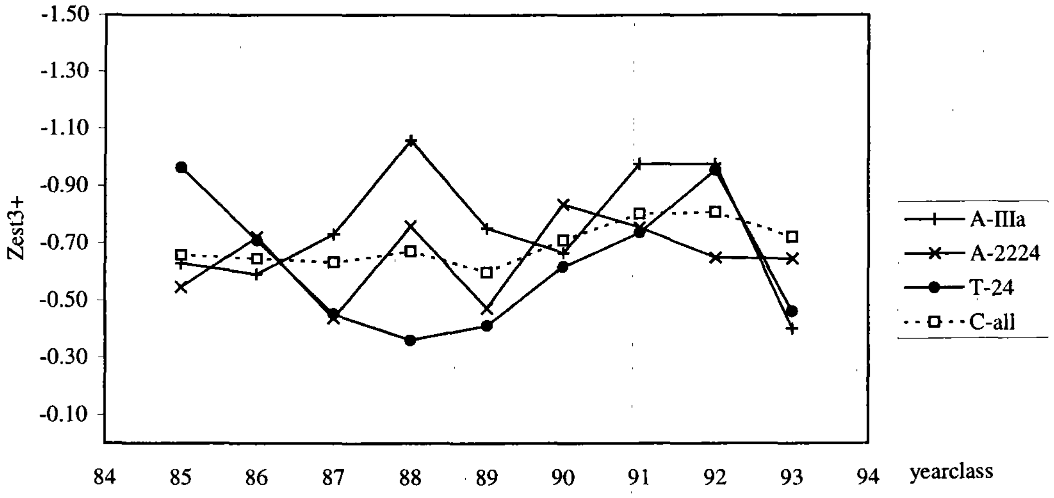


Figure 3.7.8a Estimated Z3+ for year classes 1985 -1993.

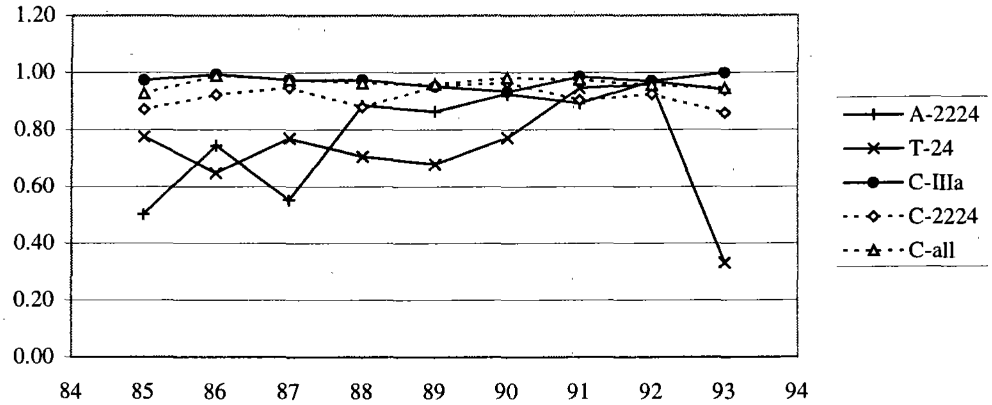


Figure 3.7.8b Correlation coefficient for Zest from LN(Numbers) by year class

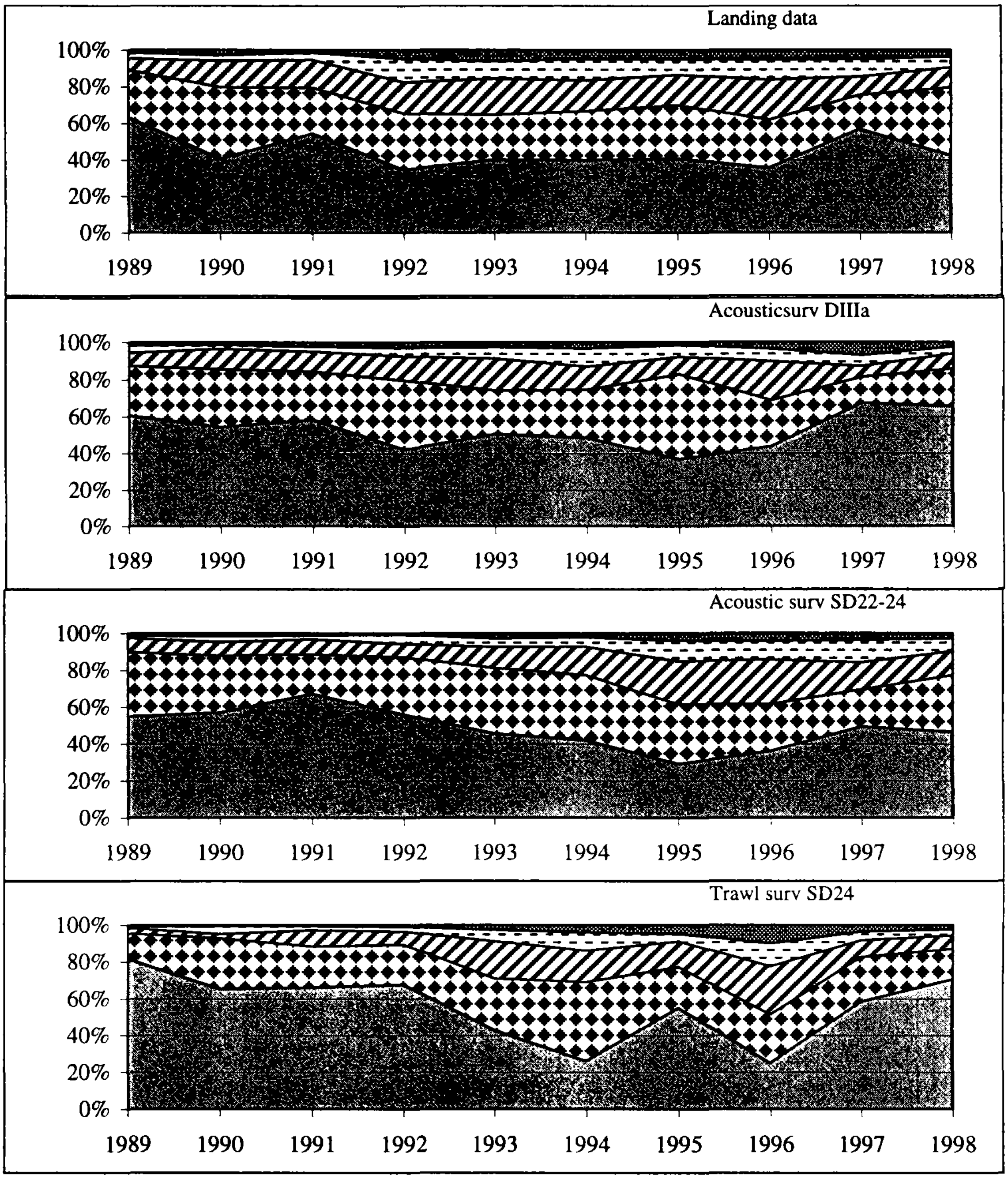


Figure 3.7.9 Age composition in total catch and surveys.

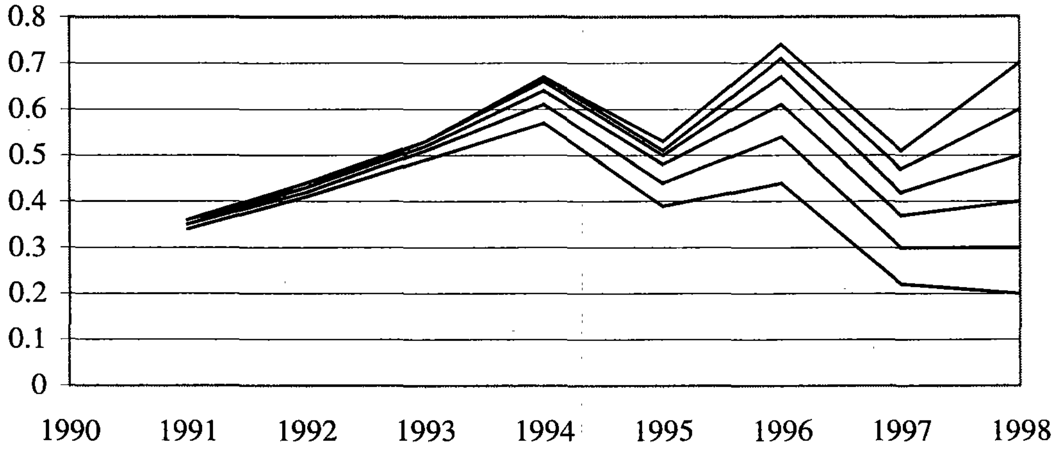


Figure 3.7.10 Herring in Div IIIa and SD 22-24. Separable VPA with S=1.0, Fage=4 for Fterm 0.2-0.7Herring in Div IIIa and SD 22-24

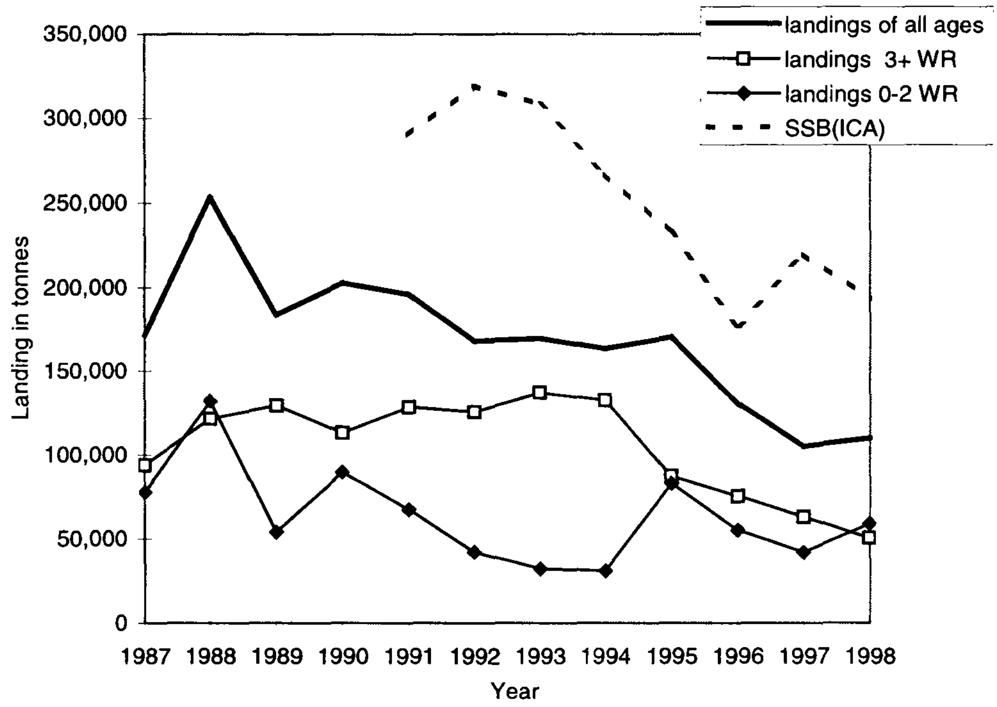


Figure 3.8.1: Trends in landings by age groups and estimates of SSB from the ICA run 7.