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

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1.2 Terms of Reference

The Working Group met at ICES Headquarters from 9–18 March 1998 with the following terms of reference (C.Res.1997/2:11:5):

a) assess the status of and provide catch options (by fleet where possible) for 1999 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), and for 1999 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 the stock to the MBAL level by spawning time in 1999;

b) for North Sea autumn-spawning herring provide medium-term forecasts of catch by fleet, and development of SSB, based on stochastic recruitment around a conventional stock-recruitment relationship for the stock; at levels of exploitation by fleets B, C, D and E of: F=0, 0.1, 0.2 and 0.3, while the levels of exploitation by fleet A are: F=0.2 and 0.3;

c) assess the status of and provide catch options for 1998 for the sprat stocks in Sub-area IV and Divisions IIIa and VIId,e;

d) provide the data required to carry out multispecies assessments (quarterly catches and mean weights at age in the catch and stock for 1997 by statistical rectangle of the North Sea for herring and sprat) and review the time series of quarterly catch and weights at age for North Sea herring used by the MAWG in Doc. ICES C.M.1997/Assess:16, suggesting and documenting any necessary revisions to those series; in addition, suggest and document a time series of quarterly catch and weight at age for sprat in the North Sea from 1972–1997 for use by the MAWG and by the WGECO;

e) consider the reference points proposed by the SGPAFM, adopting those reference points or presenting alternatives with reasons for the alternative selection;

f) consider the harvest control rules proposed by the SGPAFM, taking into account uncertainties in the data, in the assessments and in the biological processes, and assuming a stock-recruitment relationship, to estimate the probability of avoiding limit reference points;

g) update information on quantities of discards by gear type for the stocks and fisheries considered by this group using the format proposed by the WGECO with a view to establishing a time series.

1.3 Changes in fishery regulations from 1996 to 1997

Over the years many different rules and regulations have been used when managing the herring and sprat fishery. Some of these regulations can have substantial impact on total catches and catches in numbers at age and their relative proportions.

Therefore, it is very important to be aware of this, when comparisons are made e.g., on catch data from one year with catch data from another year. This information can also have an impact on the assessment methodology, short term prediction and exploitation pattern.

1.3.1 Herring fishery

Denmark

In the North Sea a herring by-catch ceiling in the small meshed fishery was set at 24,000 t. In Division IIIa a by-catch ceiling for the mixed-clupeoid fishery at 10,000 t and 20,000 t in other small meshed fishery. The EU countries divided all these by-catch ceilings.

The sprat fishery from the 1 July to 15 August was closed to reduce by-catches of herring 0-ringers. A part of the Danish by-catch quota was earmarked to secure the continuation of the sprat fishery in the 4th quarter and the Norway pout fishery in the second half of 1997. The fishery in Skagerrak and Kattegat was managed similarly as the fishery in the North Sea.

Scotland

Among other regulations, changes in licence system were introduced. Fishermen had to elect, at any one time, to fish for herring either in the North Sea or in the West Coast (VIa North). If electing to fish for North Sea herring vessels were not permitted to fish off the West Coast while holding permission for fishing for North Sea herring. This regulation system was introduced to improve accurate reporting of catches in the North sea and in VIa North.

1.3.2 Sprat fishery

Denmark

The Sprat fishery in the North Sea was closed from 1 July to 15 August to reduce by-catches of 0-ringers of herring.

1.4 Report of the planning group for herring Surveys in the North Sea

The Planning Group for Herring Surveys met in Bergen, Norway from 12–14 January 1998, to:

a) co-ordinate 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) hold a Workshop on acoustic echogram examination procedures;
d) assess the results of studies on the separation of west coast and North Sea herring stocks within the acoustic survey time series; the examination of the pre–1991 surveys for possible under-estimation due to signal saturation in the electronics; the inter ship-calibration and the study of variability of trawl performance between participants;
e) review the results of the above studies and then report on the applicability of further study on the herring survey time series.

Separation of North Sea and VIa North Herring

Since 1995 the abundance of herring in the area 30nm either side of 4°W has increased considerably. The location of this line used to separate the stock has become increasingly critical.

A study on separation of west coast and North Sea herring stocks in the Orkney-Shetland and West of Scotland surveys from 1993 to 1997 inclusive, was presented. The preliminary results suggest that there is considerable mixing to the North of Scotland and that the group of hauls may be rather independent of either the West Coast or the North Sea. However further work is required.

Further details are given in Section 1.7.

Inter-Calibration of Echo-Sounders

In order to minimise the effect of spatial and temporal variability of herring abundance, three inter-ship calibrations were performed. The inter-ship calibration required some extra time for cruising, which inevitably reduced the coverage of the sampling area to some extent and it was important to plan this efficiently. It was decided that pairwise inter-calibrations would be more efficient than trying to organise all vessels to be together at the same time, and it was judged to be acceptable to carry out up to two inter-calibrations per vessel.

The results of the inter-calibration are given in summary in the following text table:

Vessels	Ratio	CV	Intercept	Approx. Limits
G.O. Sars / Walther Herwig	0.76	0.04	−13.4	±50
Dana / Walther Herwig	0.88	0.12	0.6	±200
G.O. Sars / Scotia	0.98	0.04	0.8	±360

Conclusions from the intercalibrations

In all cases the differences between the slope from the regression and the slope estimated with zero intercept were negligibly different. In two cases they were effectively identical. *G.O. Sars* and *Scotia* were found to have the same performance. The ratio from the calibration from *Dana* and *Walther Herwig III* was not significantly different from unity but did indicate slightly lower sensitivity for *Walther Herwig III.* The calibration between *G.O. Sars* and *Walther Herwig III* gave a ratio factor of 0.76. However, the accuracy of this factor and how it should be applied is currently uncertain. During this inter-calibration the weather was poor and there was some evidence of loss of signal from *Walther Herwig*, not seen on *G.O. Sars* which has a keel system for the transducer. The weather was the worst encountered during the whole survey, thus the effect was at its greatest. These data requires further investigation to establish if the apparent reduction from *Walther Herwig III* is weather dependant.

It was recommended that as many opportunities as possible for inter-ship calibration should be utilised during the 1998 surveys.

Trawl Variability in the 1995 Herring Acoustic Survey

A study to examine the spatial variability in length and age and assess to what extent the observed variability may be affected by obtaining trawl samples from different vessels, was presented. Length and age distributions from trawl hauls carried out during the 1995 co-ordinated herring acoustic survey were taken from Denmark, Norway, the Netherlands, Germany, Scotland (North Sea and west Atlantic) and the Republic of Ireland.

Conclusions from the study:

There is a trend in mean lengths of herring: small fish occur in the south east of the North Sea and larger fish occur towards the north west of the North Sea towards the Orkney and Shetland Isles. Trawls close together have more similar length distributions than those further away. Inter- and intra-ship comparison showed no difference in the variability. Thus, any spatial variability in length is likely to be due to natural variability at a location rather than any variability derived from the sampling technique.

The greatest differences in variability occur in areas where length changes occur across short distances such as the region between the German and Dutch surveys and that between Danish and Norwegian surveys. These regions should be trawled more extensively if large numbers of fish are observed during the survey so that the mean length can be determined with greater precision.

Age proportions have a structured spatial distribution only for the youngest ages (linear variograms). Older ages are distributed almost randomly; distribution by length is evidently the determining factor.

Examination of Pre–1991 Surveys for Signal Saturation in the Electronics

This work has been postponed due to lack of resources. The data will be examined during 1998 and 1999 for preparation for the acoustic survey database being developed under EU project HERSUR and study will be carried out during this period.

Workshop on scrutinising of echograms

The visual scrutiny of echograms and the allocation of the echointegral values to particular species, is a vital step in the analysis of an acoustic survey. As this process is essentially subjective, a workshop was carried out to examine the consistency of echogram scrutinisation. Echograms, each of one days duration, were provided from the five different surveys, Scotia, Tridens, G.O. Sars and Walther Herwig in the North Sea, and Christina S in ICES area VIa(N). These were supported with trawl data. Six scrutiny groups were set up, representing the originators of the data. Each group was then required to scrutinise all five surveys to a common format.

In general there was remarkable agreement between the analyses by the different teams. Three of the surveys had CV values for one day's data of 10 % or less. In one survey the bulk of the biomass was concentrated in dense schools which were believed by the originators to contain about 10 % herring. One team, unfamiliar with this area, chose to assign these as 100 % herring, resulting in a high CV for that survey. This specifically highlights the need for developments in species classification and identification methodology.

Review of Larvae Surveys

The substantial decline in ship time and sampling effort allocated to the herring larvae surveys in recent years, required a study on the effects on the estimates of larvae abundance (LAI) and production (LPE) derived from these surveys. A first step of the analysis discussed at last years meeting considered the effect of a reduction in the number of sub-areas to be sampled and the required frequency of intermediate complete surveys. The main result was that it would be prudent to concentrate effort on a few target areas rather than attempting to cover all spawning areas of the North Sea, but that a complete coverage would nevertheless be required, to observe long term trends in the relative importance of different spawning areas and in values of mortality rates (z/k).

For the further analysis the effect of survey timing on larvae abundance indices and production estimates should be examined in more detail from the historical database. This should try to confirm or disprove the indications so far available.

Reliability and changes of the z/k values should be studied as the LPE is especially sensitive to this parameter. A standard procedure to estimate z/k should be defined and the existing data series revised accordingly.

An intermediate status report of the requested analysis was presented during the present meeting, concentrating on the LPE index. From the discussion the following conclusions were drawn:

The z/k values include some substantial degree of random variation; in addition some area specific trends are indicated, the time scales of which are, however, difficult to identify within the given variability, the restricted extent of the time series and the data gaps included.

The regressions of LPE on SSB so far obtained for complete coverage as compared to different subsets of sampling units, defined by time and area, do not indicate a reduction in the precision of stock size estimates, when the index is generally based on a sampling scheme of the kind presently achieved. The analysis is, however, yet incomplete and results could have been largely effected by methodical problems. This is related to the exclusion of too many sampling units by too narrow criteria leading to insufficiently complete sampling within these units.

The analysis should be completed, including a comparison of the performance of LPE, LAI and MLAI (multiplicative larvae abundance index) under restricted sampling effort conditions. For the time being, the MLAI should be used for assessment purpose.

Recommendations of the Planning Group is presented in Section 1.8.

1.5 Assessment Methods

Assessment methods available to the Working Group were as described in ICES (Anon. 1996/Assess:10), where reasons for the choice of method are also documented. A new implementation of the assessment and projection software was provided (ICA version 1.4) in which the following developments had been included:

- Facility to calculate Bayes posterior distributions (with uniform priors) for both assessment and projections;
- Facility to estimate assessment uncertainty by Monte-Carlo sampling from the estimated variance-covariance matrix;
- Increased year- and age- range capability;
- Implementation for Windows-95.

These developments are documented in Patterson (WD 1998).

Methodological developments special to individual stocks are described in the relevant sections.

1.6 Precautionary reference points and harvest control laws

The Working Group attempted to define reference points according to the guidelines given by the recent meeting in the Study Group on the Precautionary Approach to Fisheries Management (SGPAFM). The final report from that meeting is still not available, and the reference points suggested here are based on an interpretation of preliminary information from the Study Group.

According to these guidelines, the primary goal should be to establish precautionary values Fpa (precautionary fishing mortality) and Bpa (precautionary level of SSB) for F and SSB respectively. Limit points are not required in their own right, but may be used as a guideline to establish Fpa and Bpa.

Fpa is to be defined according to the interpretation that exceeding Fpa would be regarded as non-precautionary management. Two lines of argument may be put forward in this respect. One is that fishing at an exploitation rate exceeding that where a further increase cannot be expected to give any substantial rise in the long term yield, would not be precautionary, because it only implies a greater risk without any gain in the yield. The other is that the exploitation may be precautionary as long as it is sustainable. This may be when there is an equilibrium between SSB and recruitment which is stable, at least in the sense that both SSB and recruitment vary around stable values, and there is a low risk of bringing the stock outside what is considered as safe biological limits. This equilibrium may not necessarily be optimal in terms of long term yield.

Some of the herring stocks that are handled by this Working Group have been through a collapse. The experience from these may indicate that herring stocks can be more vulnerable than e.g., many demersal stocks. One cause for this is that, as for most schooling species, the association between effort and exploitation rate is not very tight. This implies that a stock decline may be compensated by an increased fishing mortality, which may be difficult to detect because it is not clearly associated with increased effort. Lacking this kind of indicator, the management of these stocks is strongly dependent on the ability of the assessment to detect changes in the stock abundance and in the mortality at an early stage. Since, for most of the stocks, survey data are sparse, or noisy and conflicting, assessments have to rely on strong assumptions of stable selection, which make them less suited to identify rapid changes at an early stage. A further complication is that migration routes and dominating spawning components tend to vary over time, making both stock identity and the representativeness of surveys and catch statistics uncertain.

For such reasons, using the risk for depletion of the stock as a guideline for setting precautionary reference points needs to include a consideration of how efficiently the assessment will be able to recognise a decline in the stock abundance. This is conceptually different from the variance of the parameter estimates, which is commonly presented as the assessment variance. This is because this concept also includes the uncertainty in the data (e.g., in the representativeness of surveys) and the poor ability of most models to cope with rapid changes in fishing pattern. The exploratory studies for the North Sea herring both with models fitted to separate indices, by simulating noisy data and by exploring various model formulations, as described in Section 2.16, illustrates some of this uncertainty. The exploratory study of the relation between terminal F and recent recruitment for the herring in Division VIa South (Figures 6.5.2-4) can serve as an illustration of the problem of early recognition of a change in the fishery.

There are no well established methods for estimating these kinds of uncertainly routinely. Taking these uncertainties fully into account would probably have led to more restrictive reference points than those presented here.

The background material for establishing reference points has been the yield per recruit and biomass per recruit functions, and stock recruitment functions. For the stock-recruitment relations, the Beverton-Holt function was applied since there were no clear indications in the data that the recruitment would decline at large SSB.

For some of the stocks, it was decided not to attempt to define reference points, as explained below.

North Sea herring

For this stock, an agreement was reached in 1997 for the management, based on scientific advise on precautionary management (Patterson *et al*, WD. 1997, Anon. WD. 1997). This is a regime where quotas are to be set yearly according to a fishing mortality of 0.25 for adults (2-ringers and older) and 0.12 for 0–1 ringers. A trigger level was agreed at 1.3 million t, at which special measures should be negotiated.

The adult F=0.25 is an obvious candidate for Fpa. It is slightly above F0.1 (=0.21) and below FMSY (approximately 0.3, but poorly defined), and the risk of declining to the trigger level of 1.3 million t because of natural variations in recruitment, growth and maturity in a long term equilibrium was estimated to be less than 1 %. The levels of F0.1 and FMSY (the F-level giving the maximum sustainable yield) are not very sensitive to the level of juvenile F, compared to the risk that SSB will fall below limit points. It may be argued that a higher F-level might also be considered as precautionary according to the present guidelines. The HAWG in 1997 calculated a relationship between juvenile and adult F which would imply a 5 % risk of bringing the stock below the MBAL level of 800 000 t. This relationship was a nearly straight line, where the sum of the two F-levels was 0.55. Taking into account that a 5-percentile is more uncertain that an estimate of a mean, it was recognised that the sum of these levels should be well below that value, perhaps in the order of 0.4. With the presently agreed exploitation level on juveniles, the Fpa should therefore not be much above 0.25. The Fcrash (the fishing mortality where the equilibrium point between SSB per recruit and recruitment as function of the SSB reaches the origin) was estimated by Patterson *et al.* (1997) to be 0.98 - 1.56, depending on the exploitation pattern, and is not considered useful as a guideline for defining reference points.

The MBAL of 800 000 t SSB has been maintained for a long time, and has effectively served as a level signalling danger of stock collapse. This is suggested as a Blim. The trigger level of 1.3 million t is a candidate for Bpa. The probability of reaching this level if Fpa is adhered to is small. A rule recommended by the SGPAFM is to take Bpa = Blim*exp(1.645σ), where σ is the assumed standard deviation of the assessment SSB. A Bpa of 1.3 million t would ensue with a σ of 0.3, which may be a realistic value for the uncertainty in the assessment. A value of 1.3 million t is therefore suggested as Bpa. For comparison, the BMSY was estimated at 2.02 - 2.26 depending on the fishing pattern (Patterson *et al*, WD. 1997).

The reference points in relation to the historical values for SSB, recruitment and fishing mortality are illustrated in Figures 1.6.1-3

Division VIa South Herring

The recruitment for this stock does not show any clear dependence on the SSB, and there are no marked periodic variations. Apart from the outstanding 1985 year class, the recruitment has been quite stable. Following the guidelines by the SGPAFM, an Flim is suggested at Floss (F giving an equilibrium SSB at the lowest observed SSB when average recruitment is assumed), using the lowest SSB in the series except for the two most recent ones, which still are uncertain, and a geometric mean recruitment of 716.5 million. This Floss is 0.33. Assuming a c.v. of the assessment of 0.3 leads to an Fpa of 0.20. Bpa is suggested by applying the same rule on Bloss (lowest observed SSB), which gives Bpa=130 000 t.

It is worth noticing, that Floss, which is used as Flim here, is below the F0.1 of 0.37 (computed including the ages 1-8), and that the yearly F-values have been above the suggested Fpa in most of the time series. This may, however, have been possible for a period without severe depletion of the stock thanks to the outstanding 1985 year class. One should not rely on a similar year class appearing, but take it into consideration when it does.

The reference points in relation to the historical values for SSB, recruitment and fishing mortality are illustrated in Figures 1.6.4 - 1.6.6.

Celtic Sea and Division VIIj Herring

This stock had a collapse in the 1970's, when a series of low recruitment's were followed by a rapidly declining SSB. Before that, the stock was relatively stable with SSB's around 100 000 t and fishing mortalities largely between 0.2 and 0.45. Based on the experience for that period, an F-value at or below 0.4 has been recommended. This is close to F0.1 computed without including the plus group.

By inspection, the time series of recruitments appears to have quite strong periodic trends, one with period at approximately 16 years and one at 4-5 years. By modelling the slow trend by a cosine function and the rapid trend as an autoregressive function, the residuals are virtually uncorrelated to the SSB. This was done on a spreadsheet, where first a cosine function was fitted to log ratio of the recruitments and their geometric mean, with amplitude, phase and frequency as parameters The period of this was 16 years. Then, four coefficients in an autoregressive model for the residuals r_y:

$r_y = \Sigma a_i * r_{y-i}$ were estimated. Both estimations were done using the 'Solver' in the Excel spreadsheet. There is a close association between the autoregressive coefficients and the power spectrum of a time series, and the power spectrum in this case indicated a period of 4.5 years for this process. The trend emerging from this model is shown together with the historical series of stock-recruit pairs in Figure 1.6.8.

It is not clear to which extent these trends can be explained as resulting from physical or biological effects, or they are just coincidental. If they are real, this both has implications for predictions, and for the definition of reference points. In any case, the management of this stock should take into account that the recruitment may fail in periods, without any clear relation to the SSB, and that different reference points will apply to such periods. In the periods of low recruitments, the equilibrium SSB will be as low as 40-50,000 t. A fishing mortality of 0.13 corresponds to the lowest observed SSB of 26,000 t and a recruitment at the average over the five lowest observed values, from which the stock started to recover with the 1979 year class. Any Blim should not be lower than that. Assuming an assessment standard coefficient of variation of approximately 0.3, Bpa would become 40,000 t according to the SGPAFM rule, which in practise would imply a recommendation to close the fishery in periods with low recruitment over several years. This is also the equilibrium SSB at F=0.4 with geometric mean recruitment of 4,000 millions.

Thus, if a new period of low recruitment ensues, the fishing mortality should be reduced irrespective of SSB, to a level not higher than 0.13. However, in periods with good recruitment, it may be suggested a Bpa of 40 000 t and an Fpa of 0.4.

Some reference points in relation to the historical values for SSB, recruitment and fishing mortality are illustrated in Figures 1.6.7, 1.6.9 and 1.6.10.

It should be noticed that these reference points require that the stock and recruitment can be monitored very precisely. Given the problematic assessment for this stock, a more cautious exploitation would be relevant.

Herring in Division IIIa and Sub-divisions 22 - 24

For this stock, a tentative assessment has been done for the first time. Due to the uncertainty of the separation of the stocks in this area, the assessment is still very uncertain, and for the time being, the Working Group did not find it appropriate to attempt to define reference points at this stage. Moreover, the yield and biomass per recruit are strongly influenced by the choice of natural mortalities, for which there is little evidence. Quite different values are used for this stock compared to other stocks.

Herring in Division VIa North

The assessment is at present very uncertain. In particular, since it is unclear how representative the catches from this stock are, any reference points relating to the biomass should not be defined on this basis. In addition, the fishing pattern is uncertain, and may have changed markedly during the last year. This also makes the calculation of F-related reference points and yield and biomass per recruit uncertain. Therefore, the Working Group decided not to attempt to define reference points until these problems are solved. If a precautionary level of fishing mortality is needed for this stock, the Working Group would suggest to use the value of 0.25, as for the North Sea herring.

Herring in the Irish Sea

The assessments done in the last few years have been based on conflicting and uncertain data, and have varied substantially. The Working Group considered these assessments to be inappropriate background for the establishment of reference points.

1.7 The divide between IVa and IVaN

The 4°W line of latitude has been used to separate two distinct stocks of herring, for exploitation and management purposes, North Sea (IV) to the east and West of Scotland (VIaN) to the west. The exact location of this separating line has become increasingly critical. Figure 1.7.1 shows the acoustic survey index of the spawning stock biomass of autumn spawning herring for the ICES divisions and three 30nm wide strips near the 4° W line. Figure 1.7.1 illustrates the problem clearly, there has been a substantial increase in abundance in the region between 3°W and 4°W and a sharp decline in the biomass in VIaN, although the latter area was surveyed 1 month earlier in 1997 and may be in error. The importance of the correct allocation of this biomass to either IVa or VIaN is clear from Figure 1.7.1. Data on the characteristics of fish from the fishery this area is unreliable and the catch samples cannot be guaranteed to have valid locations. Two surveys, the Acoustic survey and the young fish (IBTS) surveys provide information from known locations. The Acoustic survey is directed at the adult stock, ages 2-9+ while the IBTS catches predominantly young fish, mostly 1 and 2 ring and rarely any over 5 years old. Thus the acoustic survey provides the best data on the spatial distribution of the adult stock. A study of the herring trawl data which had been collected during the acoustic surveys in June and July 1993 – 97 has been carried out to investigate the likely split in population between West of Scotland and North Sea (Simmonds WD1998a). Descriptions of the surveys and the data can be found in Simmonds *et al.* (1994–1998). The aim of the analysis was to establish a discriminant function that would separate North Sea and West of Scotland herring and then to use this to establish the best location for the dividing line.

1.7.1 Data used in the study

A total of 192 trawls with a catch of more than 50 herring were carried out using the same fishing gear in the Orkney Shetland area and West of Scotland surveys from 1993 to 1997 inclusive. These hauls were all sampled in a consistent manner providing an independent estimate of biological parameters in each haul including parameters on age proportion, length distribution, length at age, and proportion mature at age. Eighteen of the trawl hauls are from the area 30nm either side of the 4°W line, between 3°W to 5°W. Sampling from the West of Scotland was not available from earlier years. This gives three groups of hauls:

West of Scotland,	West of 5°W,	77 hauls
North Sea	East of 3°E	97 hauls
Unknown	3°E to 5°W	18 hauls

Initially a total of 82 biological parameter values were selected for the analysis but these were reduced to two parameter groups:-

1) Age proportion: A_1, $A_{1\text{-}2}$, $A_{1\text{-}3}$, $A_{1\text{-}4}$, $A_{1\text{-}5}$, $A_{1\text{-}6}$, $A_{1\text{-}7}$, $A_{1\text{-}8}$ & year

Where $A_{1\text{-}3}$ is the proportion of herring age 3 and below in the catch. It is known from the assessments that the North Sea herring is a heavily exploited stock and the West of Scotland is lightly exploited, the stock age structure might be expected to be different due to different recruitment and exploitation. Cumulative age was selected in preference to age proportion because the error distribution of cumulative age is more raussian than for age proportion. However, the implications are thought to be insignificant as one is the linear combination of the other.

2) Growth parameters: L_2, L_3, L_4, L_5, L_6, L_7, L_8, L_{9+}, α, L_∞, α_{33} and year

Where L is mean length at age and α is the coefficient in an exponential growth curve fitted to the mean length at age. The data indicated that the growth rate of North Sea herring might be faster than that of the West of Scotland herring.

Although the data was examined using growth and age separately and combined the final conclusions were based on growth and length combined.

Two classification methods were used; Discriminant Analysis and Artificial Neural Networks. The two known groups of haul data were used to develop the discriminant functions and the hauls from the unknown group were then classified to determine to which group each haul most probably belonged.

1.7.2 Results

Discriminant analysis

The results are reported in the following text table and a frequency plot of discriminant score is shown separately for each category in Figure 1.7.2.

Combined age and growth

West Coast	77	72	(93.5 %)	5	(6.5 %)
North Sea	97	4	(4.1 %)	93	(95.9 %)
Unknown	18	3	(16.7 %)	15	(83.3 %)

Percent of "grouped" cases correctly classified: 94.83 %.

The accuracy of these scores are dependent on the validity of the assumptions of discriminant analysis, that the data is multivariate normal. This is not the case for this data and therefore the success rates may not be valid.

Artificial Neural Networks

The output of an ANN is a recognition score (similar in concept to the discriminant score above) but scaled from 0 (West Coast) to 1 (North Sea). The discrimination using artificial neural networks is shown in Figure 1.7.3

The clear separation of North Sea and West of Scotland herring using the neural network (Figure 1.7.3) is impressive but the suitability of the network for assigning unknown hauls is less certain. To estimate the reliability of the network, 10 % of the known hauls were removed from the training sets and the networks retrained again completely. The missing 10 % of the hauls were then examined for correct allocation. The results were:-

Age Structure Data	85 % correct
Growth Data	90 % correct
Age and Growth Combined	95 % correct

These values are similar to the success rates for the discriminant analysis, however, they are independent of assumptions.

Location of North Sea - West of Scotland Separation

The spatial distribution of the both discriminant scores and the artificial neural network factor can be mapped by gridding and placing a contour at the crossover level (Figures 1.7.4 and 1.7.5).

The results from the classification data sets show that it is possible to discriminate between herring found in the North Sea and herring found to the West of Scotland based on herring growth and age structure data with about 95 % accuracy either by Artificial Neural Network or by Discriminant analysis. Growth parameters appear to be more successful at separating the stocks than age structure, though a combination of both gives the best results.

The best separation between these groups of herring in July lies follows a line from 3° 30'W 58° 30'N at the Scottish coast, to about 4°W by 59°N and extends to the shelf edge at 5°W by 60°N. The patch of 'West Coast herring' south of Foula, seen in the discriminant analysis is in a low density area with mostly young fish, and discrimination in this area may be poor. The small patch of North Sea herring seen near Cape Wrath is caused by similar factors. Neither patch is seen with the neural network. Although separation appears to be better suited to a NW - SE line from 59°N 3° 30'W, the north west of Orkney, the major components of abundance of adult autumn spawning herring (Figure 1.7.1) lie on the correct side of the current line. If management of these stocks remains separate it may be worth considering a different separating line. These results provide some basis for the long running discussions on the separation of these stocks, which is reported earlier (Anon. 1979).

1.8 Recommendations

The Planning Group for Herring Surveys should meet in Hirtshals, Denmark from 2–4 February 1999 under the chairmanship of K.-J. Stæhr, Denmark and E. 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) review the existing manual of the North Sea acoustic survey (ICES C.M. 1994/H:3), taking into consideration recent developments in methodology and the results of the scrutiny workshop;
d) to complete the analysis of the historical database on the effect of the reduced sampling effort, in order to provide an improved basis for a final decision on the index and the target sampling units to be used;
e) provide a revised MLAI with explanation of any differences presented in Patterson et al. (1997);
f) look into the methodological problem related to estimation of larval indices when very high numbers are caught in single hauls.

The Planning Group recommends that:

- development of species recognition methods should be a priority.
- the echogram scrutiny workshop be repeated on a regular basis. To this end a further workshop should be held in 2000.

For larvae surveys:

Yearly surveys should continue for the present time to focus on Southern North Sea as well as on the Orkney/Shetland and/or Buchan area. Complete coverage should take place every three years beginning in the year 2000. This will require participation by Germany, Netherlands and Norway. If possible other countries should be involved.

Acoustic surveys:

The Working Group recommends that acoustic surveys continue in the North Sea and IIIa, should be resumed on the stocks in the Celtic Sea and in Divisions VIaS and VIIb as a matter of urgency and that sufficient resources should be made available in order that the surveys can be maintained. That the survey in VIaN should be scheduled at a time that best covers the stock and joins with the surveys in the North Sea.

Data examination:

The Working Group recommends that further examination should be carried out on the biological data on the stocks in Divs. VIaS and VIIb in order to study possible changes in growth rate and in the age compositions of the different spawning components.

Catch Sampling:

In order provide an insight into adequate levels of sampling for herring and sprat stocks in the North Sea and adjacent waters, the Herring Assessment Working Group recommends that a Study Group should be set up to meet in IJmuiden on a date to be decided (Chairman: M. A. Pastoors Netherlands) with the following terms of reference:

a) to assess the current methods and levels of sampling of commercial catches for herring/pelagic stocks in the North Sea and adjacent waters;
b) to evaluate the spatial and temporal variability in the available sampling data;
c) to advice on adequate methods and levels of sampling commercial catches for herring / pelagic stocks in the North Sea and adjacent waters;
d) Consider the use of survey data to fill in missing age structures in the catch.

This study group should invite participation from members of other pelagic Working Groups to investigate sampling levels for other pelagic species.

The Herring Assessment Working Group has noticed that the historic data series on catch-in-numbers and weight-at-age for herring and sprat cannot be reproduced due to a lack of adequate storage of the data. The Working Group has also noticed that several different methods are used to combine national catch statistics into area based catch data. The Working Group recommends that:

a) a generic database system should be set up that complies with the following requirements:

- multi-annual storage
- flexible import/export routines (cut and paste in windows)
- system independent software
- possibility to generate 'local' data-files that can be integrated by the stock-coordinator
- possibility to combine data-files by area, sex, gear and stock
- possibility to deal with misreporting and discards
- possibility to take account of split-factors for mixed stocks
- the level at which data should be aggregated in the data base
- the location and maintenance of the database.

b) a Study Group should be set up to meet in IJmuiden on a date to be decided (Chairman: H. Welleman Netherlands) to specify the database structure and the software lay-out.

In order to increase the possibilities and speed up the process of a full analytical assessment of the Western Baltic Spring Spawning Herring in Division IIIa and Sub-division 22-24, the Herring Assessment Working Group recommends that a Study Group should set up to meet at Charlottenlund Castle, Copenhagen, 11-15 January, 1999 (Chairman Tomas Gröhsler, Germany) with the following terms of reference to:

a) review and update catch at age and mean weight at age data including information on proportions of North Sea autumn spawners and Western Baltic spring spawners for the period 1990 –1997 and for all fishing fleets that catch herring in Division IIIa and Sub-division 22-24;
b) 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;
c) further improve a migration model of Western Baltic spring spawning herring which can be used for the understanding for the results of an analytical assessment;
d) develop and co-ordinate a international survey to be carried out by Denmark, Germany and Sweden which should cover the whole area where Western Baltic spring spawning herring is distributed.

The Working Group considered the research required improving the quality of the sprat assessment and recommends the following to be addressed before the next meeting of the Working Group: Data from the IBTS-surveys should be revised for length distributions and their usefulness in length based analyses shall be examined.

The Working Groups recommends that a sub-group should work by correspondence to re-evaluate the stock of herring in VIa(N) as soon as the results of the July 1997 acoustic survey are available. Results should be communicated in a Working Document to ACFM by November 1998.

1.9 Request 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 1997 and a review of the timeseries of herring used by the MAWG in ICES (1997/Assess:16. The herring assessment working group (HAWG) produced the data for 1997 in the same detail as in the past.

The review of the timeseries led to a correction of some inconsistencies between the dataset used by the MAWG and the HAWG. The herring catches in numbers over the period 1984–1995 were revised in 1997. Misreported catches in Division VIa between 4W and 5W were assumed to have been taken in Division IVa. The mean weights at age in the catch have not been changed.

For sprat the MAWG requests data on quarterly catches and mean weights at age for the North Sea over the period 1992–1997.

1.9.1 Quarterly database (numbers and mean weights at age)

1.9.1.1 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 1997 are provided in Table 1.9.1.

Quarterly catch-at-age data for herring (winter ringers) in the North Sea for 1974–1996 are provided in Table 1.9.2. This timeseries has been updated from 1984 onwards for misreported catches in Division VIa between 4W and 5W, listed in ICES (1996/Assess:10, Table 5.1.1). The catch numbers are raised according to the increase of the catch weight. The mean weights at age in the catch have not been changed (1997/Assess:8).

Mean weight-as-age data for the herring stock at spawning time are best provided by samples taken during the July acoustic surveys in which cover Divisions IVa and IVb, and these are shown in the bottom line of Table 1.9.1. for 1997.

1.9.1.2 Sprat data

Estimated quarterly catch-at-age data, for North Sea sprat over 1992–1997 are provided in Table 1.9.3, based on landing statistics by area, quarter and country not including sprat from the Norwegians fjords (1997/Assess:8, Table 8.1.3 and 1994/Assess:13, Table 8.2.1). 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 (see Sections 8.2.1 and 8.2.3). Mean weight at age for sprat over 1992 –1997 are given in Table 8.2.2.

1.9.2 Geographical distribution of the herring catches in the North Sea in 1997

Data on the geographical distribution of catches in the North Sea (Sub-areas IV and Division VIId) in 1997 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.

Table 1.9.1 Herring North sea, 1997
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		1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	Numbers	SOP (' 000)
Quarter													
I	Nb		11.5	26.1	55.4	51.6	11.1	3.4	1.2	2.6	0.1	163.0	
	W		30.8	65.3	117.1	152.6	173.2	173.1	192.3	196.2	161.7		19.7
II	Nb		61.2	141.7	74.3	35.3	9.5	4.0	3.0	0.5	0.6	330.1	
	W		22.6	119.4	145.6	184.0	205.6	221.3	207.3	241.9	245.1		39.3
III	Nb	203.9	25.8	93.3	73.8	102.6	53.9	9.2	3.6	1.6	7.9	575.6	
	W	12.0	39.1	133.5	183.7	223.3	248.4	266.3	277.5	279.7	308.7		72.1
IV	Nb	159.6	76.9	210.8	222.1	58.3	14.5	6.5	3.1	4.5	0.3	756.5	
	W	18.0	51.0	109.3	142.8	175.8	207.8	212.6	205.5	217.4	155.0		77.8
Total	Nb	363.5	175.3	471.9	425.6	247.7	88.9	23.1	10.9	9.2	8.9	1825.2	
	W	14.6	38.0	114.7	147.0	191.8	227.9	229.8	228.2	223.7	297.2		209.0

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	1995	1994	1993	1992	1991	1990	1989	1988	1987
Stocks weights	44	119	166	227	236	239	246	269	329

Table 1.9.2 Revised quarterly catch numbers of age ('1000) of herring in the North Sea (IV and VIId)

		age group herring									
year	q	0	1	2	3	4	5	6	7	8	9
1974	1	0	279500	144900	29100	17400	5500	4500	900	400	100
	2	0	23600	74900	50200	14300	6800	1500	1300	100	0
	3	605500	249900	434000	223700	80500	40300	15800	2500	1400	800
	4	390600	293200	118700	59000	13900	3600	500	400	0	100
1975	1	0	1614200	130800	19200	7500	7900	2700	1800	600	600
	2	0	174400	136300	77300	43600	22100	3800	2800	1500	400
	3	188100	350500	114000	108900	74200	22600	7500	4000	1300	400
	4	75700	321400	160600	54300	15200	4600	2200	500	100	1
1976	1	0	15000	166100	21000	8800	3300	100	100	100	0
	2	0	22900	189900	14800	9500	6500	1100	1000	300	100
	3	183700	26100	298700	31500	28000	20500	2600	3200	600	300
	4	54500	62600	246800	50100	5800	4200	2300	100	100	1
1977	1	0	62300	18100	177300	9400	5000	2700	1500	400	0
	2	4100	46000	18300	5400	600	1700	1200	0	300	0
	3	134900	17200	2000	1000	200	200	100	0	0	0
	4	117800	18900	6200	2700	600	200	0	0	0	1
1978	1	0	72700	300	400	400	0	0	200	200	0
	2	2100	54100	1400	600	1300	0	100	0	0	0
	3	68300	20500	300	700	700	100	0	0	0	0
	4	59700	21400	2900	3900	2600	200	100	0	0	1
1979	1	0	94600	0	300	400	200	0	0	0	0
	2	0	13900	4500	300	900	600	100	0	0	0
	3	139000	39600	4700	300	2100	300	100	100	0	0
	4	403000	11200	24900	9100	6700	1000	0	700	600	100
1980	1	0	64100	5400	14100	3900	3700	100	0	0	0
	2	0	7700	700	2300	1900	800	100	100	0	0
	3	458800	62600	900	2400	1300	0	0	600	0	0
	4	332900	26800	101000	73000	25000	17200	2000	700	400	100
1981	1	0	59200	12800	900	300	200	700	0	0	0
	2	5400	54800	2800	200	0	0	1100	0	0	0
	3	7451100	250400	19700	8700	2500	2100	1400	500	900	0
	4	432200	82500	228800	47000	36600	26300	19400	18200	4500	1100
1982	1	0	59300	86800	100500	10100	5500	2200	2000	1800	500
	2	0	8300	3700	3500	800	300	0	0	0	0
	3	8248800	318100	41800	5300	2500	500	300	0	0	0
	4	1307900	454700	136100	120800	20300	8100	4300	5800	1800	600
1983	1	0	50200	78700	22000	17600	2800	1200	400	200	0
	2	0	58300	83500	31000	13800	5500	7400	5700	4100	3500
	3	9012800	775400	100400	40600	16300	6300	7800	4000	4100	6900
	4	1017100	262800	282200	122800	57500	11600	6400	2700	3000	1700
1984	1	0	119163	140104	86635	36036	14882	3827	2232	2339	2445
	2	0	80257	335379	136171	69521	30189	4784	8717	850	3721
	3	1982190	165298	296154	127773	61229	17540	9248	12756	5847	8079
	4	345159	231736	265858	97584	37949	19985	5209	2020	2232	4677
1985	1	0	896768	84018	242776	94306	35201	9078	7060	4539	3530
	2	123456	27031	204146	367240	117606	39437	15835	4438	3833	6253
	3	1157396	563014	469313	372485	97131	33688	10591	5749	3429	4640
	4	23198	147259	476171	201019	59811	16743	8372	2925	1513	1614
1986	1	0	257155	262668	274204	165482	47878	27359	7452	7452	10413
	2	163542	99636	343214	100044	78504	27257	6942	4594	1429	1531
	3	540751	705212	313915	235819	114541	33280	15925	3165	1633	1021
	4	14190	738083	259605	234288	109334	22153	12046	5513	3267	1940
1987	1	0	1734977	418056	223918	166212	80994	16384	4740	2370	2061
	2	0	223300	247103	101088	91298	48844	16693	5255	2370	1649

	3	469991	310476	424960	179402	113453	79448	24628	10098	2061	3607
	4	1382253	1360922	977490	203721	125303	47195	20197	4534	1443	1030
1988	1	0	154649	224852	267584	144475	113952	51889	17296	5087	3561
	2	0	185172	237061	126161	60028	34593	16279	5087	2035	916
	3	993011	1304344	741706	312351	96656	61046	40697	11192	7122	2544
	4	322525	360170	785455	499558	104795	55959	22383	5087	1017	1526
1989	1	0	48837	240383	272256	153710	37733	19329	11310	2159	1953
	2	0	25498	114228	192163	136951	23442	16759	7506	1748	617
	3	1660989	1666026	308961	523435	253441	84206	52230	26321	11207	3393
	4	349882	212623	290249	434705	307316	79168	44828	20049	6272	2879
1990	1	0	312068	92930	120348	144522	74406	9837	7849	4291	314
	2	0	107057	110197	84244	94290	42907	11093	7953	3453	1256
	3	642345	726693	148394	275440	382393	157918	41128	26791	16535	9732
	4	251266	400288	269056	318765	267487	118150	21767	14337	5546	942
1991	1	0	25474	114583	94203	118534	100858	31505	9774	3951	1040
	2	0	202131	228022	95659	90980	83286	33169	3847	4991	3327
	3	1185858	652144	265661	184559	205043	200572	77047	15285	10502	6447
	4	471848	414141	193709	201092	156173	128828	67793	11437	6551	2287
1992	1	0	12914	293488	71549	64884	72070	64155	14685	5103	1666
	2	205587	111125	177051	87692	69987	53532	48324	23017	6457	1875
	3	6858845	411175	147785	138412	111438	143515	166219	62072	19059	12914
	4	848907	134871	382326	131122	102065	86547	96336	50928	8644	7811
1993	1	0	836002	209288	80302	43554	28373	18217	20835	9423	419
	2	0	220491	127939	99880	72764	49521	45962	36434	11726	5758
	3	5935769	67529	202274	133279	114747	82396	109094	87526	36644	27012
	4	1373932	220281	256611	312414	89411	66064	61038	49836	32037	9946
1994	1	0	103914	153103	45462	57174	9689	10008	12563	9689	7027
	2	97420	60262	482626	123824	50360	26937	15864	11925	9476	2129
	3	3238054	241686	554067	200482	91777	53022	39500	34070	38755	25979
	4	622314	73783	292152	153316	168435	31941	36306	21933	16077	12563
1995	1	0	56247	85482	157405	28706	14088	3284	2542	2754	24469
	2	0	111646	246595	99358	35273	22456	6250	5614	6038	3707
	3	5370747	132089	539267	348178	105184	38769	30613	20126	27435	30083
	4	1281064	211745	600492	309832	90037	50632	18643	14936	18113	14618
1996	1	0	554627	64191	147978	40570	14194	6991	2013	847	530
	2	0	156346	130394	132619	23939	5614	2648	424	0	2119
	3	583544	2542	160901	176472	83363	26270	7097	6144	3072	12711
	4	1318562	68216	226045	178802	60272	17054	4873	3178	4449	4131

Table 1.9.3 North Sea Sprat. Catch in numbers (millions) taken by quarter in 1992, 1993 (Denmark, Norway and UK-England),1994,1995 (Denmark and Norway) and 1996 (Denmark, Norway and UK-England).

year	Quarter	Age					
		0	1	2	3	4	5+
1992	1		12.55	377.52	58.29	2.16	
	2		239.35	37.12	12.42	1.61	
	3	9.57	5969.46	1179.8	262.08	29.44	5.06
	4	226	1476.27	262.03	10.06	1.2601	1.54
1993	1		704.71	2769.2	568.49	24.81	
	2						
	3		19.97	17.29	2.32	0.17	
	4	294.64	4268.05	639.86	47.15	0.47	
1994	1		507.76	2138.16	591.11	40.81	
	2		2983.78	15			
	3		24541.41	272.95			
	4	888.91	4616.31	1313.81	149.03	3.2	5.38
1995	1		5.78	2949.08	977.65	53.24	
	2		2.17	553	169.58		
	3	513.23	11686.31	7718.48	253.69	3.22	
	4		4534.76	3305.14	377.3		
1996	1		524.74	4615.39	2621.86	316.42	11.26
	2		1.93	241.49	32.67	15.51	0.26
	3		400.52	100.72	22.94	0.33	
	4		1190.68	1069.01	339.55	5.55	
1997	1						
	2						
	3		1991.88				
	4	131.47	3786.88	1047.1	128.38	1.99	

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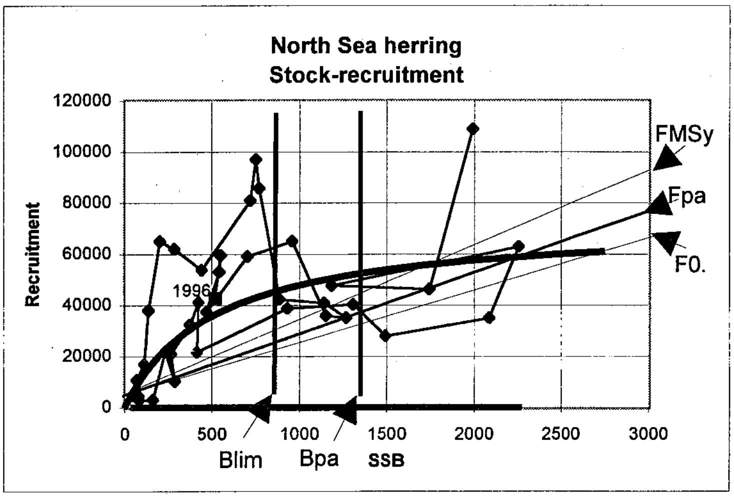

Figure 1.6.1.
Historic stock recruit pairs, replacement lines
for some selected F-values and stock - recruit function.

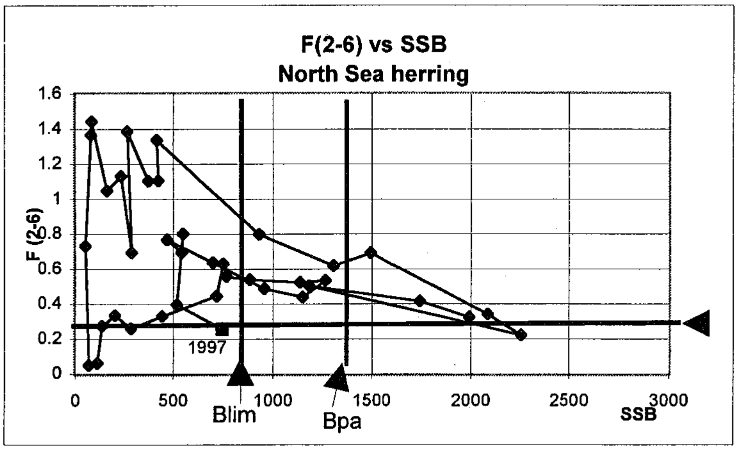

Figure 1.6.2
Historic SSB and fishing mortality, with reference points
indicated.

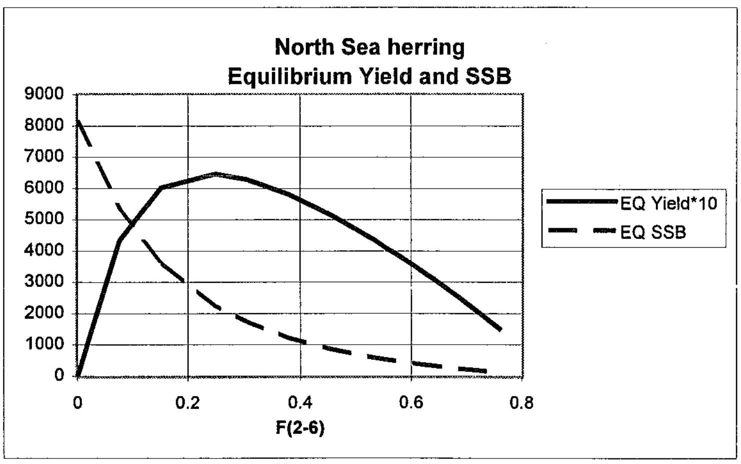

Figure 1.6.3.
Equilibrium yield and biomass per recruit.
assuming 1997 fishing pattern.

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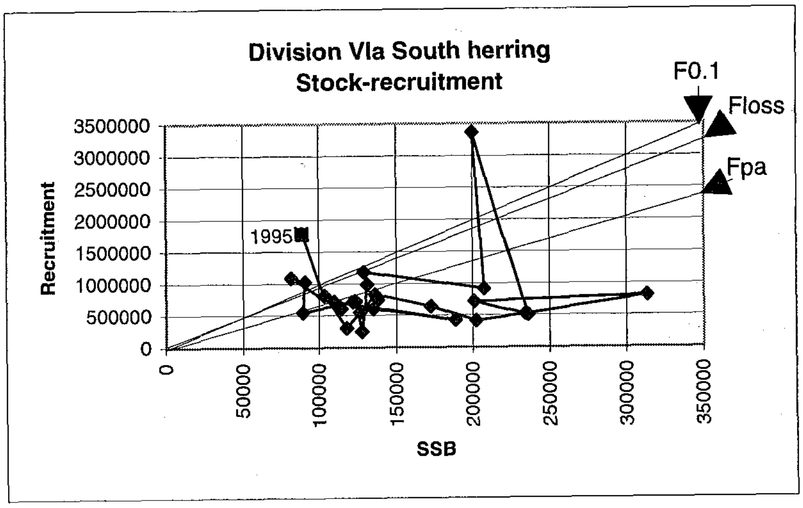

Figure 1.6.4.
Historic stock-recruit pairs and replacement lines
for some selected F-values

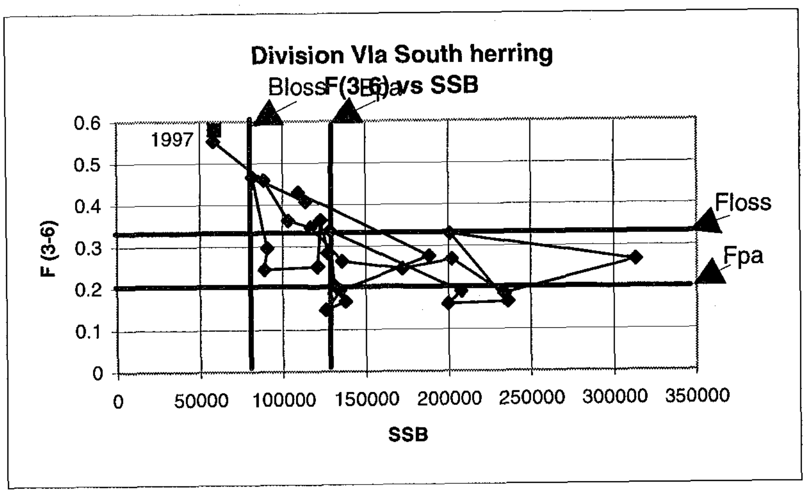

Figure 1.6.5.
Historic SSB and fishing mortality, with reference points indicated

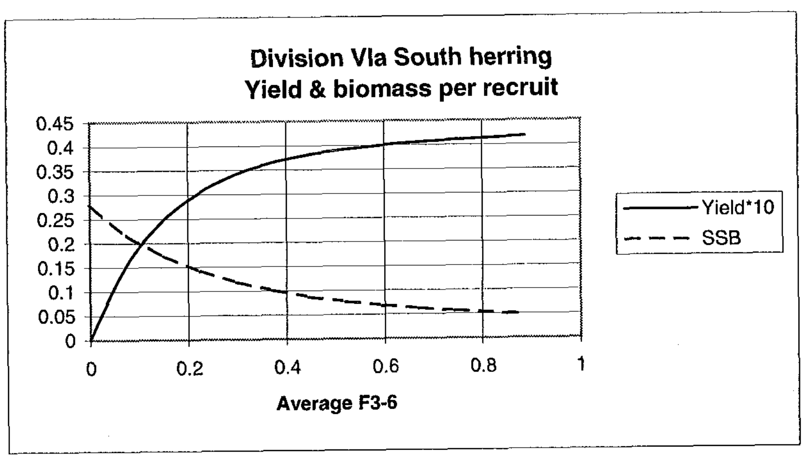

Figure 1.6.6.
Yield and biomass per recruit

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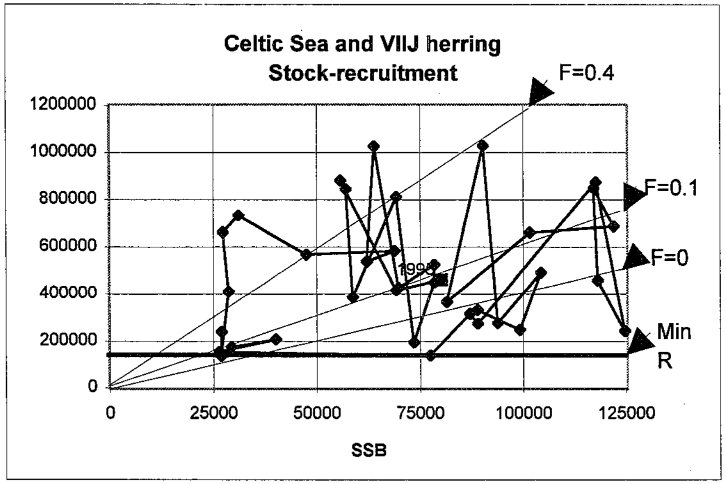

Figure 1.6.7.
Historic stock recruit pairs and replacement lines
for some selected F-values

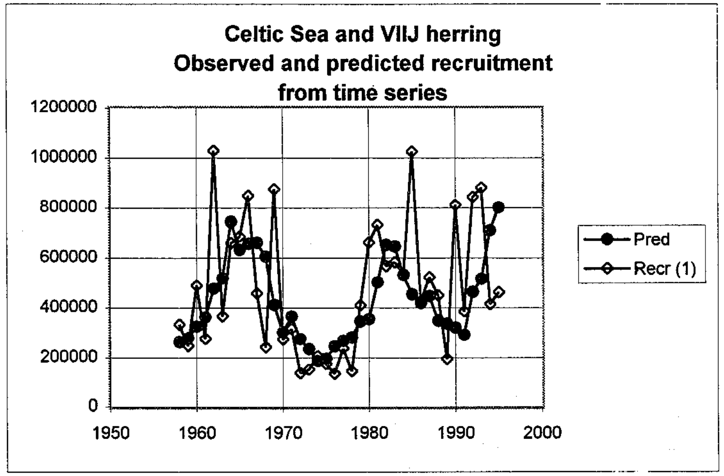

Figure 1.6.8.
Historic stock-recruit pairs and predicted recruitment according
to time trends.

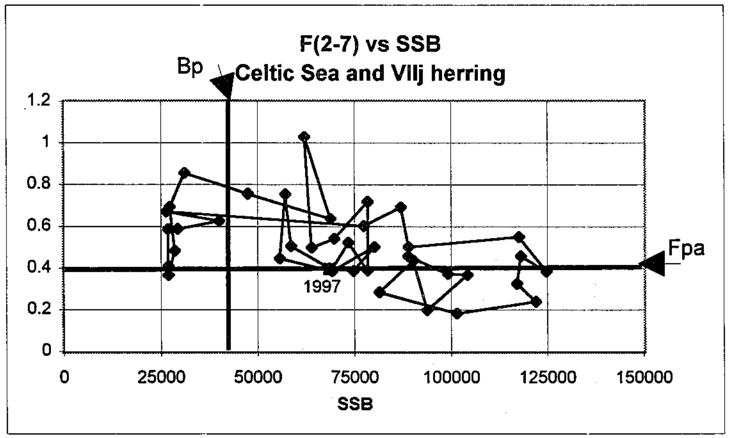

Figure 1.6.9
Historic SSb and fishing mortality, with reference points
indicated

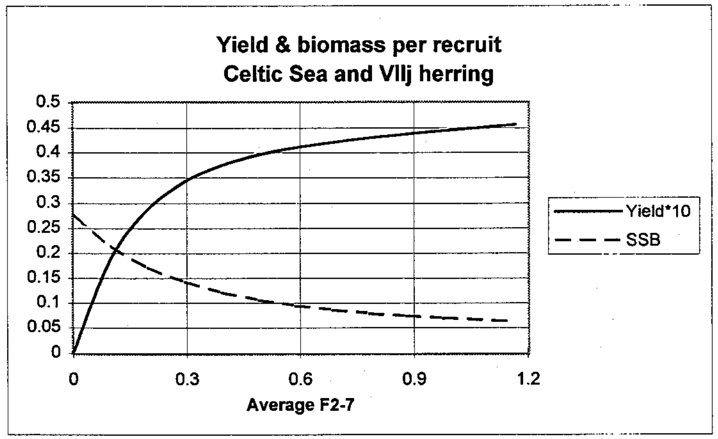

Figure 1.6.10.
Yield and biomass per recruit.

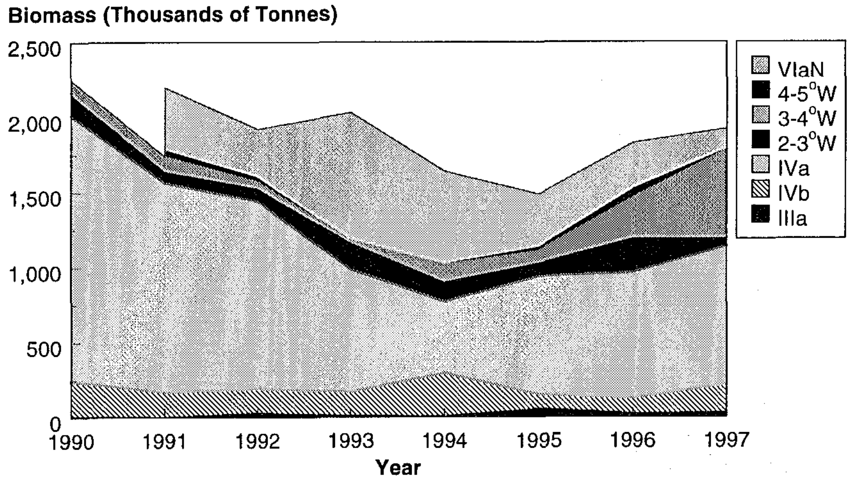

Figure 1.7.1. Acoustic survey index of biomass of autumn spawning herring in ICES Divisions IIIa, IVa and VIa and close to the boundary between IVa and VIa. Cumulative graph showing relative contributions of each region to the abundance of mature autumn spawning herring.

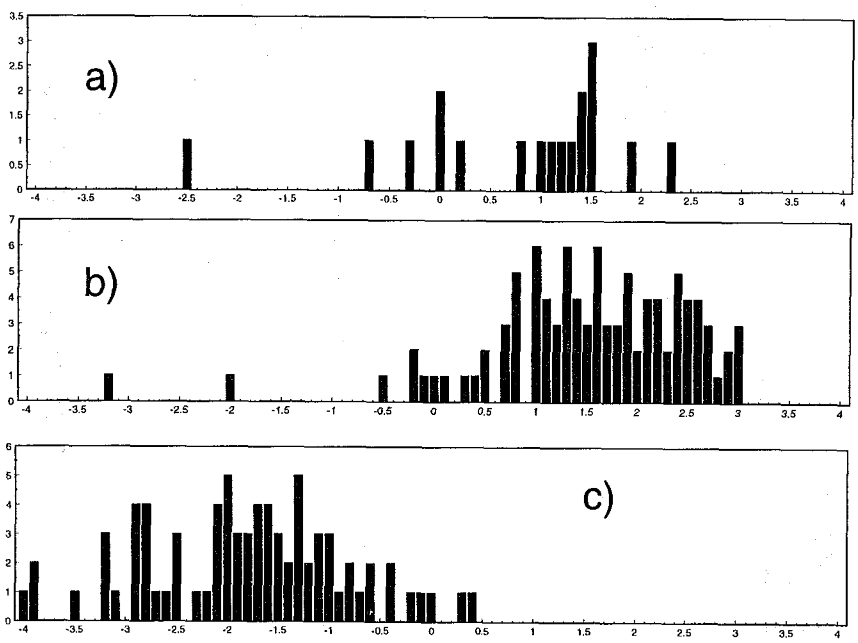

Figure 1.7.2 Frequency distribution of discriminant scores for age and growth data combined a) unknown 3°W-5°W, b) North Sea east of 3°W and c) West of Scotland west of 5°W

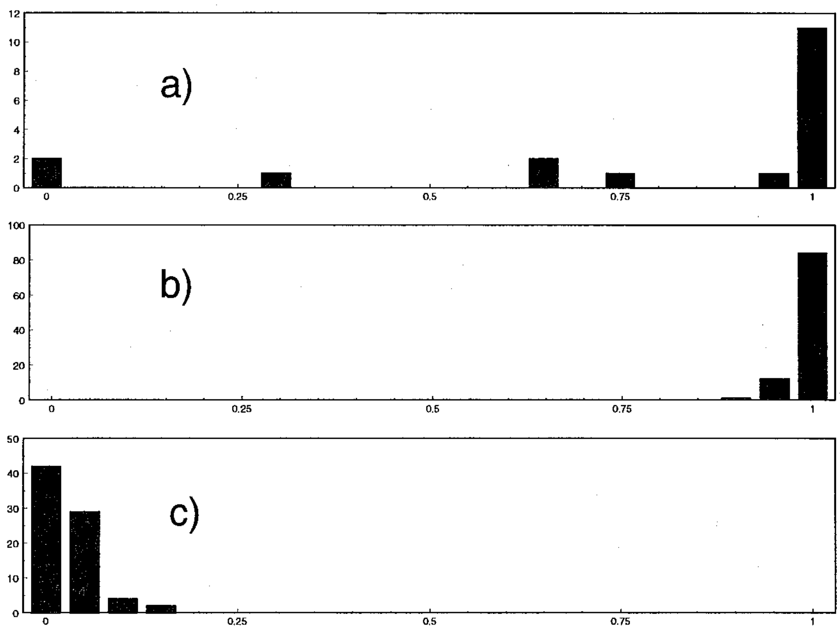

Figure 1.7.3 Frequency distributions of Artificial Neural Network recognition scores for age and growth data combined a) unknown 3°W-5°W, b) North Sea east of 3°W and c) West of Scotland west of 5°W

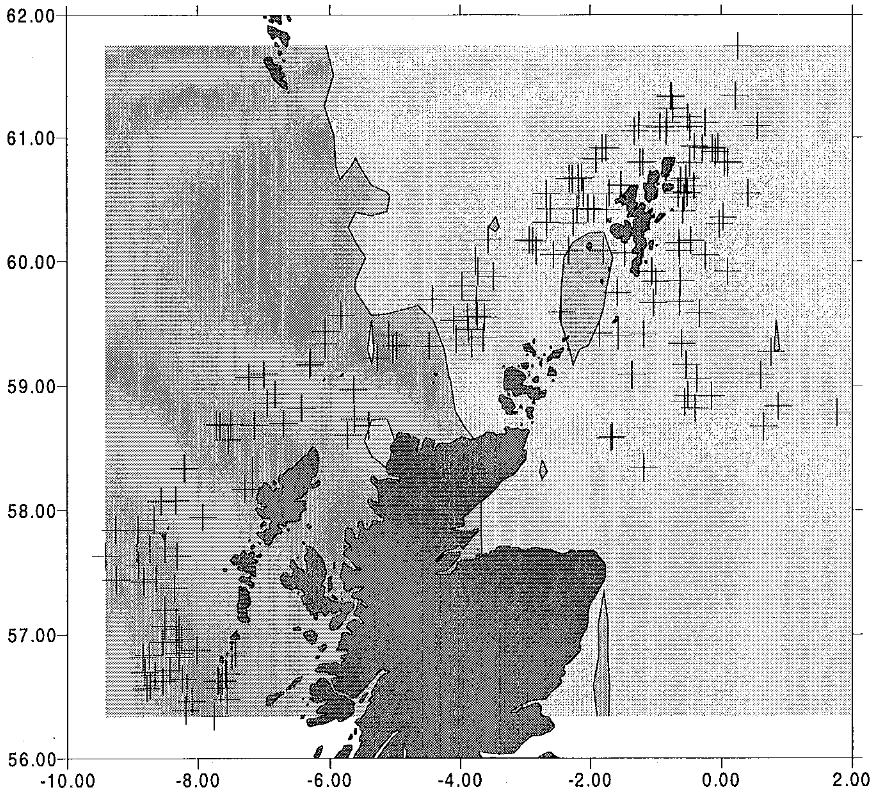

Figure 1.7.4 Map of location of the divide between North Sea and West of Scotland showing the dividing line based on the discriminant analysis using the discriminant scores from all the trawl hauls 1993-1997. Haul locations are shown as crosses.

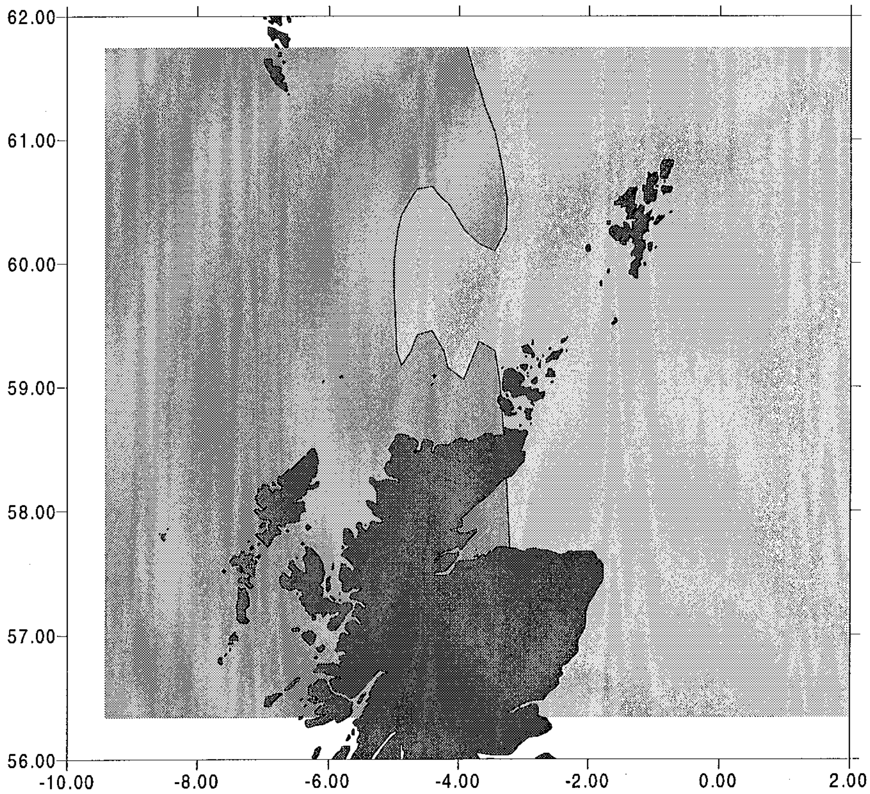

Figure 1.7.5 Map of the location of the divide between North Sea and West of Scotland showing the dividing line based on the Artificial Neural Network Factor and the split between North Sea and West of Scotland herring.

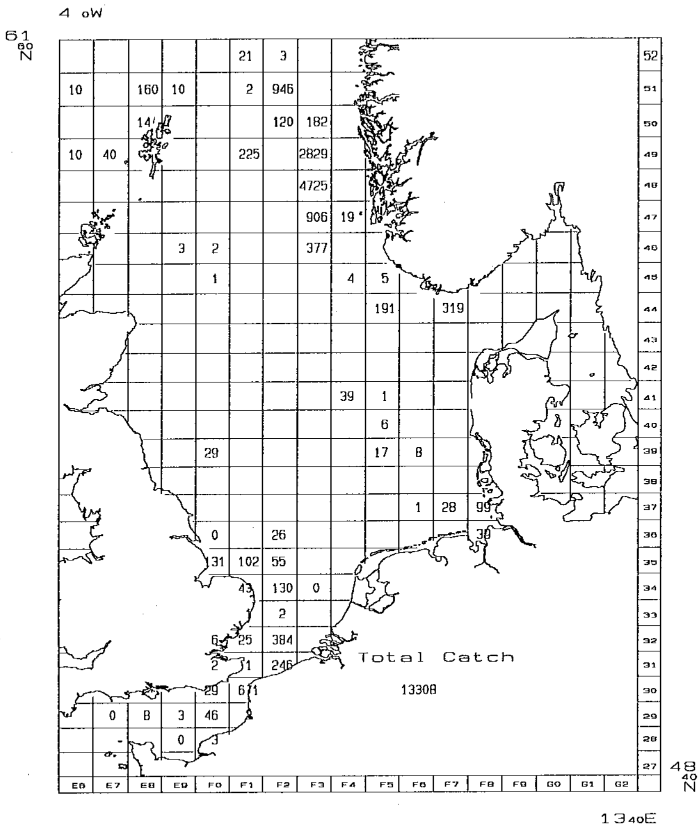

Figure 1.9.1 : Herring North Sea catches (in tonnes) - January 1997

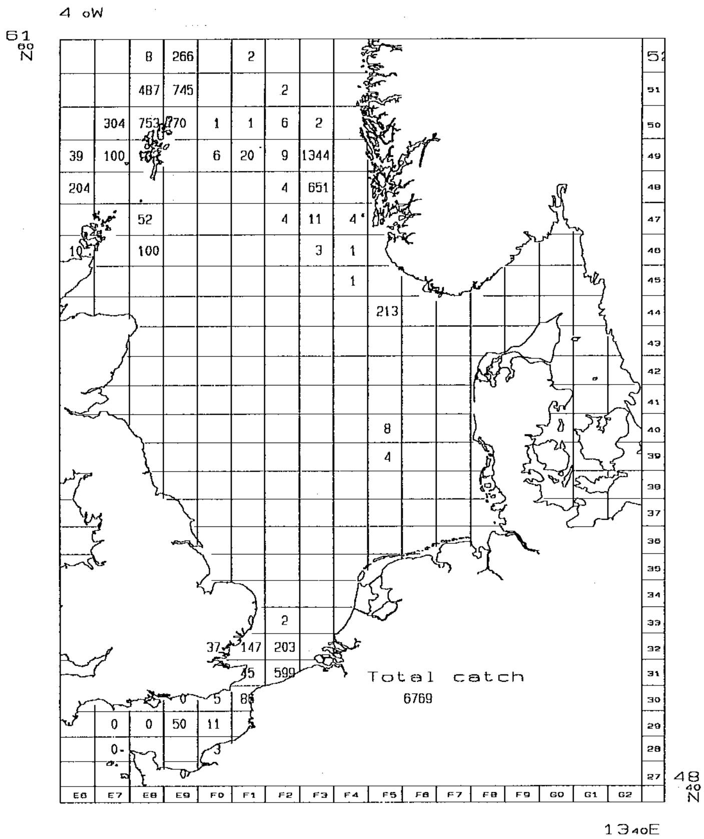

Figure 1.9.2 : Herring North Sea catches (in tonnes) - February 1997

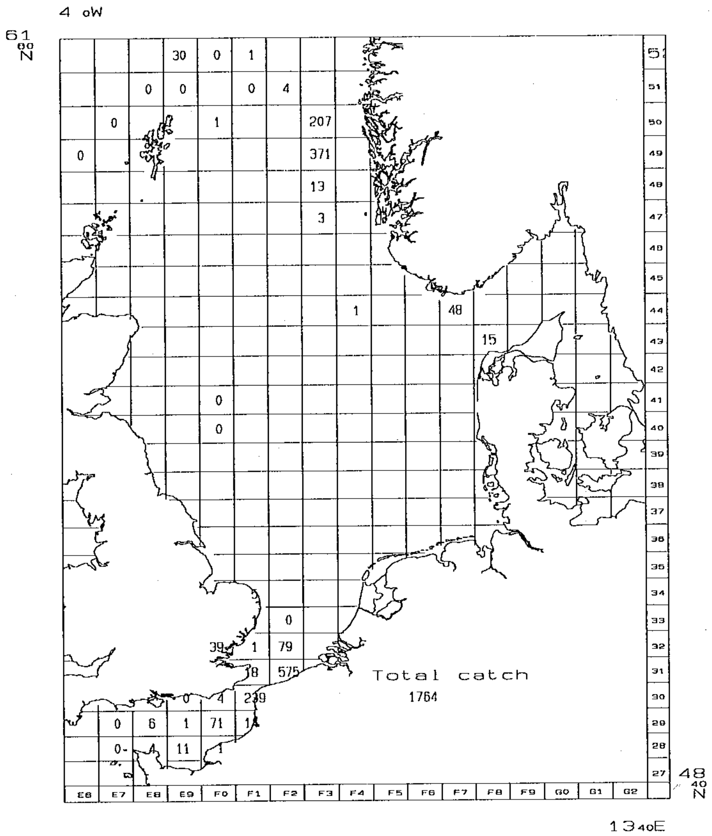

Figure 1.9.3 : Herring North Sea catches (in tonnes) - March 1997

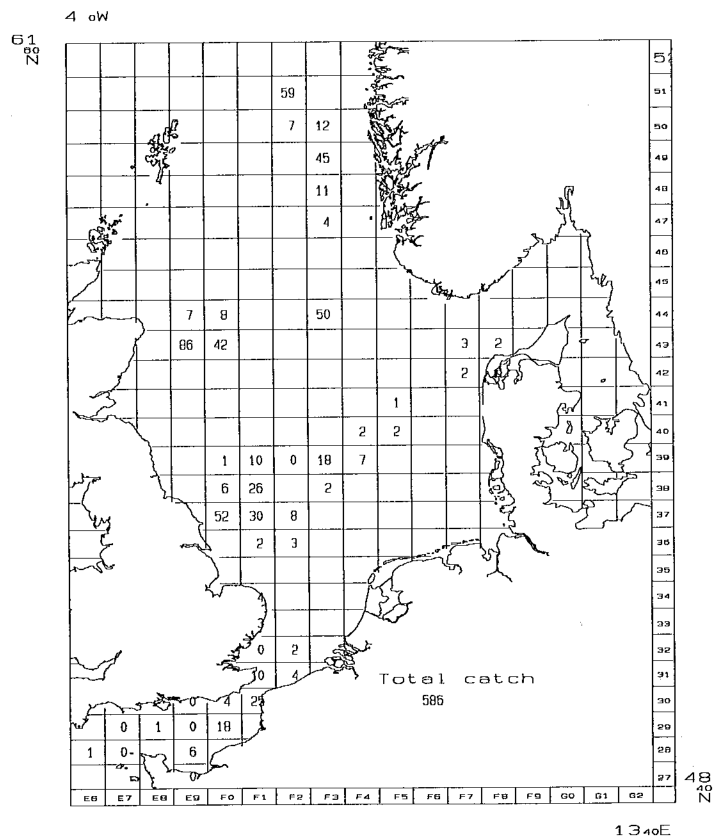

Figure 1.9.4 : Herring North Sea catches (in tonnes) - April 1997

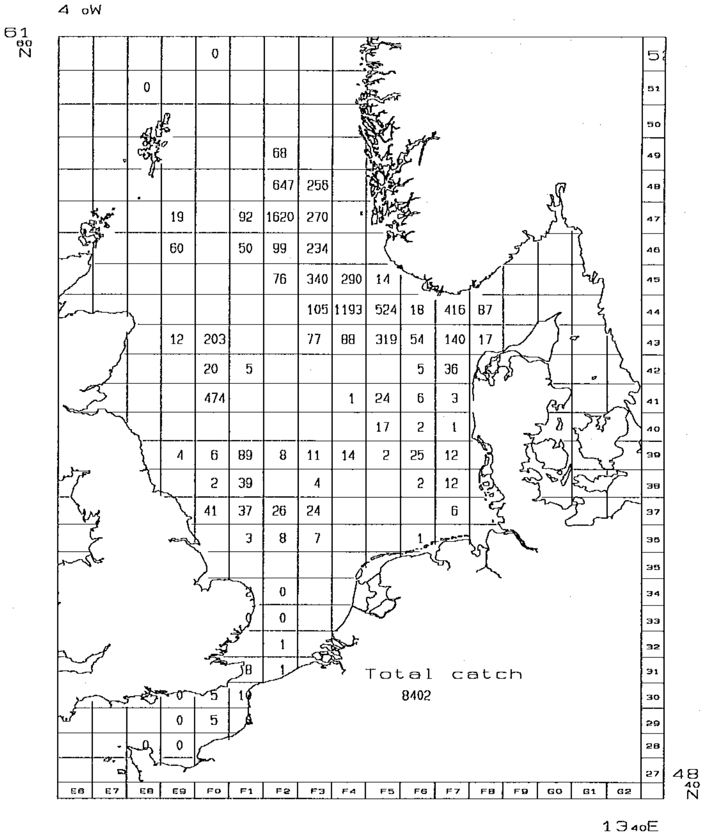

Figure 1.9.5 : Herring North Sea catches (in tonnes) - May 1997

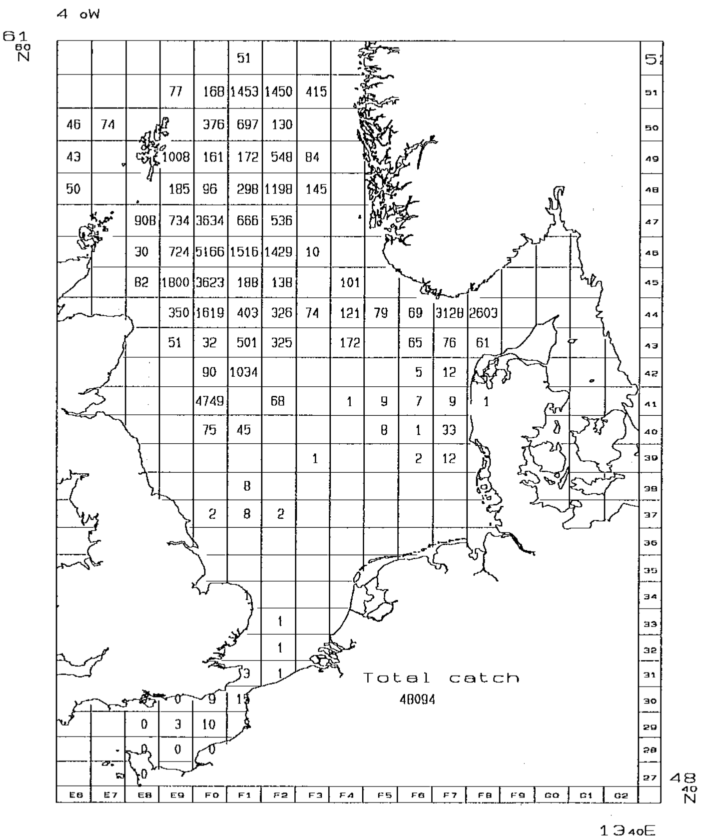

Figure 1.9.6 : Herring North Sea catches (in tonnes) - June 1997

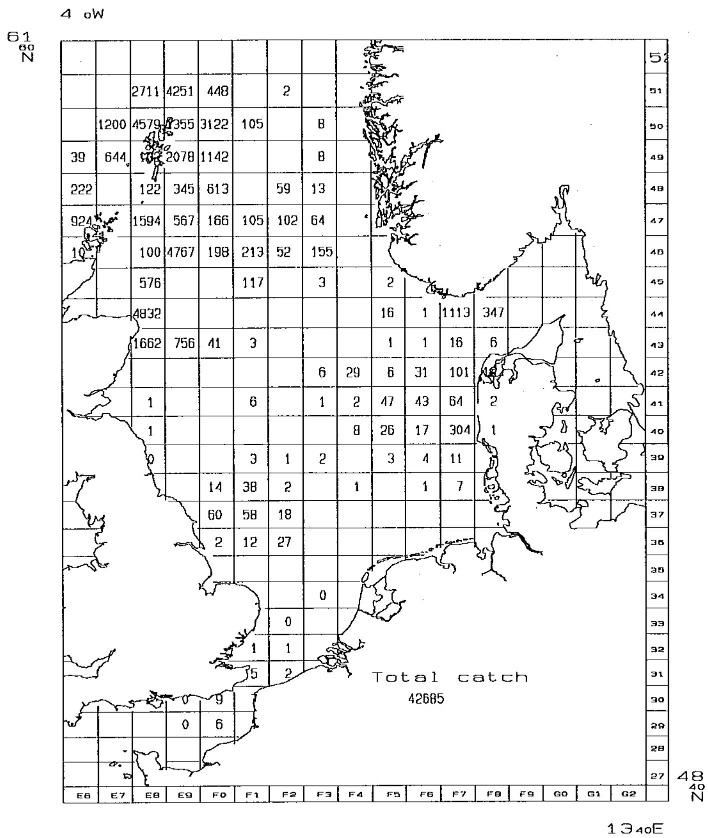

Figure 1.9.7 : Herring North Sea catches (in tonnes) - July 1997

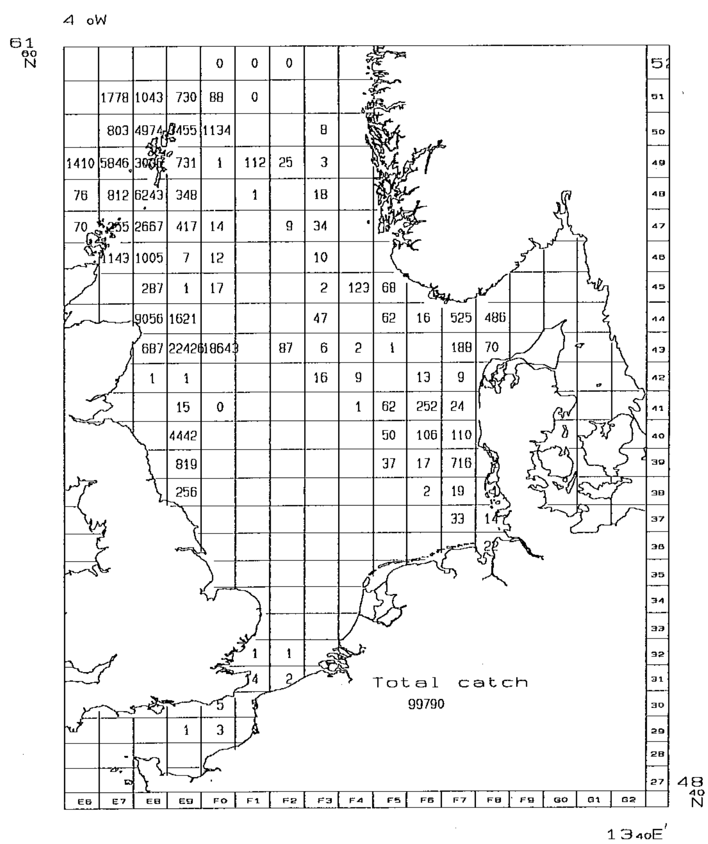

Figure 1.9.8 : Herring North Sea catches (in tonnes) - August 1997

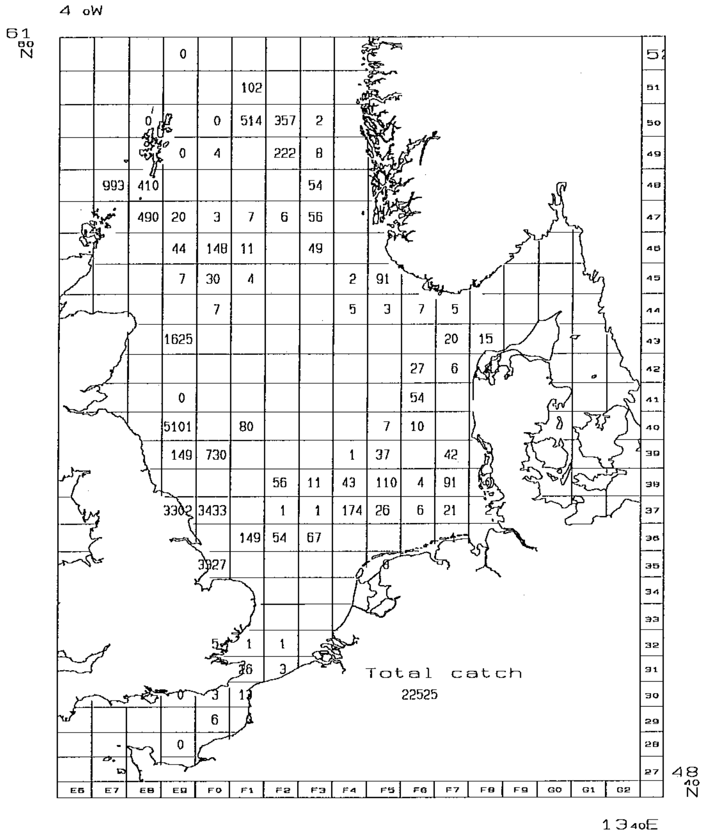

Figure 1.9.9 : Herring North Sea catches (in tonnes) - September 1997

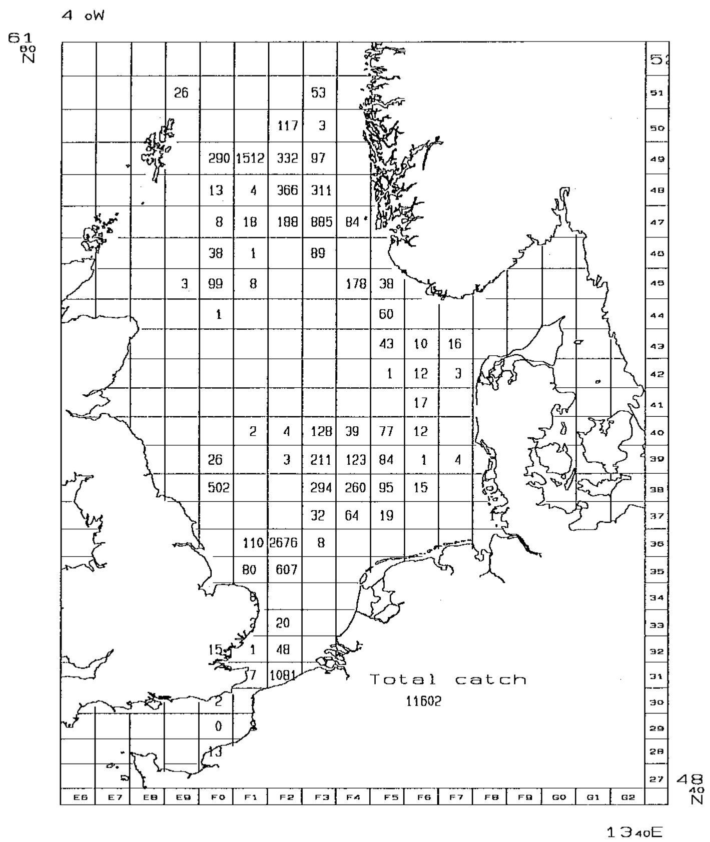

Figure 1.9.10 : Herring North Sea catches (in tonnes) - October 1997

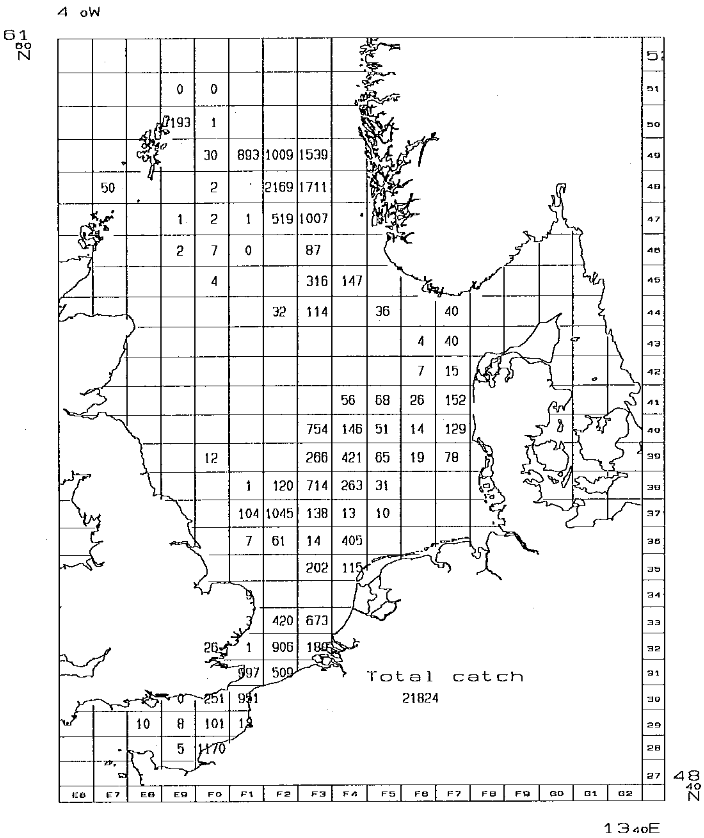

Figure 1.9.11 : Herring North Sea catches (in tonnes) - November 1997

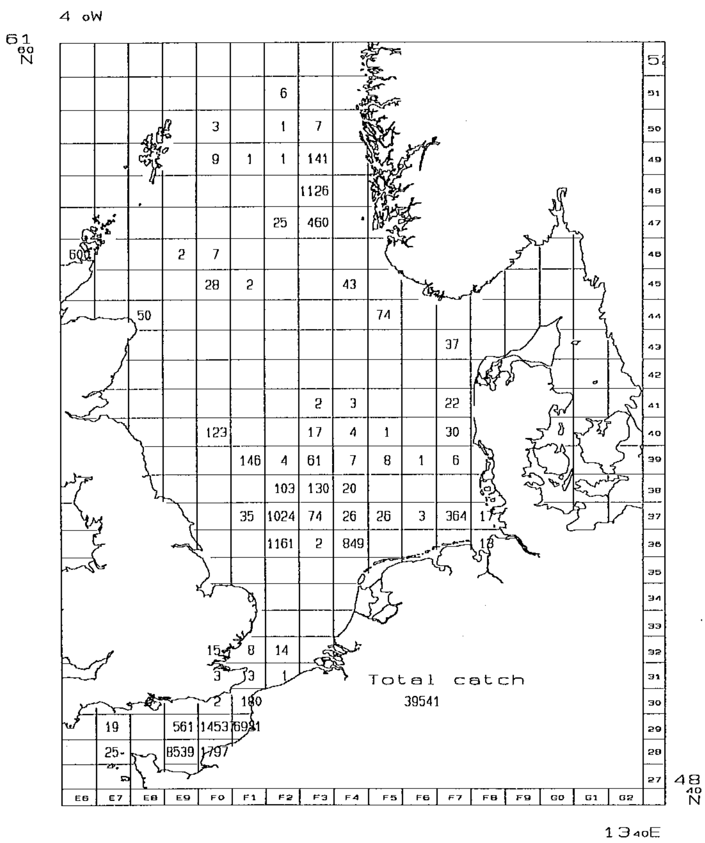

Figure 1.9.12 : Herring North Sea catches (in tonnes) - December 1997

2 NORTH SEA HERRING

2.1 The Fishery

2.1.1 ACFM advice and management applicable to 1997 and 1998

At the meeting in 1996, ACFM decided to modify the advice for 1996 because of a more pessimistic view of the state of the stock than previously, given by the HAWG assessment in April 1996. Therefore ACFM recommended that rapid action should be taken immediately to rebuilt the spawning stock and to reduce the fishing mortality.

For 1996, the recommendations corresponded to a 50 % reduction of the agreed TAC for fleet A (human consumption fleet), to a new TAC of 156,000 t of which no more than 25,000 t should be taken in Divisions IVc and VIId. It was also recommended that there should be a reduction in the fishing mortality on herring in the other fleets.

This same strategy was recommended for 1997 and consisted of adopting an $F_{2\text{-}6}$ of 0.2 and a reduction of 75 % of the fishing mortality on the juveniles compared to the 1995 level. A TAC for fleet A of 159,000 t, including that for Divisions IVc and VIId, which was restricted to 25,000 t, and a by-catch ceiling for fleet B (small mesh fleet for reduction purposes) of 24,000 tonnes.

For 1998, ACFM specified that the management strategy adopted for 1997 should be continued to rebuild the spawning stock biomass which was still at a low level. ACFM noted that there was a high probability of rebuilding the stock to above 800,000 t in 1998 if fishing mortality on all groups including juveniles was kept low.

In the Southern North sea and Eastern Channel (Divisions IVc and VIId), ACFM recommended that the fishing effort should be reduced in this area as recommended for the total North Sea. ACFM noted, however, that the TAC for this stock component have been exceeded by a significant amount in all years and this can only result in a disproportionate increase in a fishing pressure.

In December 1997, the EU and Norway agreed the following arrangements for North Sea Herring management:

- effort will be made to maintain an MBAL (Minimum Biologically Acceptable Level) of 800,000 tonnes,
- a medium term management strategy has been implemented under which TACs will based on an F = 0.25 for adult herring, and an F = 0.12 for juveniles;
- a reference point of 1.3 million tonnes SSB below which a stock recovery plan will be agreed and implemented, was fixed.

The final TAC's adopted by the management bodies for 1998 were 229,000 t for Divisions IVa,b and 25,000 t for Divisions IVc,VIId. And the by catch ceiling for fleet B was 22,000 t.

2.1.2 Catches in 1997

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. Unallocated landings in these tables include the misreported landings.

The total North Sea catch in 1997 of 209,045 t is lower than the catch in 1996 (264,868) which was also the lowest catch since 1981 (174,880 t). Strict enforcement measures by Denmark to control the by-catch of herring in the small mesh fisheries contributed to a reduced impact on 0-ringers and 1-ringers. By-catches in the small mesh fishery in the North Sea in 1997 are at a historic low level. The small mesh fishing fleet had a very good sandeel season in 1997 with good prices on the world marked prices. This good season together with closures in the Danish sprat fishery in July and August and a significant change in fishing pattern have caused that the by-catch of herring only amounts to 12,000 t.

It should be noted that an official catch from Russia of 1,619 t was taken in the Division IVa. It is assumed that this catch was caught in the Division IVa West during the third quarter.

In each of the last six years, TACs have been exceeded by a significant amount. This excess of the catches over the TACs for Sub-area IV and Division VIId, for the years 1992 to 1997 is shown in the text table below, where estimates of misreporting are include in the Working Group Landings. It should be noted that the TAC applies only to the human consumption fishery in Sub-area IV and Division VIId and not to the herring by-catch in the small mesh-fishery.

Year	1992	1993	1994	1995	1996	1997
TAC ('000 t)	430	430	440	440	181 (1)	184 (1)
Official landings ('000 t)	403	409	414	415	136	155
Working Group Landings ('000 t)	544	521	465	534	263	209 (2)
Excess of landings over TAC ('000 t)	114	91	25	94	82	25

(1) including by-catch ceiling
(2) Scottish landings from 4°W- 5° W no longer included in North Sea (see Table 5.1.1)

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 each Division 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 1997. North Sea catches in numbers at age over the year 1987–1997 are given in Table 2.2.2.

The catches in numbers of Division IIIa-Western Baltic spring spawners caught in the North Sea in 1987–1997 and transferred to the Division IIIa-Western Baltic stock are presented in Table 2.2.3. Except for the 2-ringers, the numbers of all other year classes were as low as in 1996. This was because the total catch off the Norwegian coast, in the area where spring spawners are normally taken, was low.

The estimated numbers of North Sea autumn spawners caught in Division IIIa in 1987–1997 and transferred to the North Sea assessment are given in Table 2.2.4.

Table 2.2.5 and Figure 2.2.1 summarises the total catch in numbers at age of North Sea autumn spawners used in the assessment.

The total number of herring taken in the North Sea in 1997 (less than 2 billion) is half the number taken in 1996 (4 billions), which was still lower than the number caught in previous years. The catch of 0-ringers, 1-ringers and 2-ringers has been reduced considerably and is the lowest since 1977. The catches of the 4-ringers and more has been increased slightly (Table 2.2.2).

Table 2.2.6 summarises the total catch in tonnes of North Sea autumn spawners. After the splitting of the IIIa Autumns spawners and the North Sea spring spawners, the amount of the total catch used for the assessment was 247,909 tonnes.

The percentage age composition of North Sea herring, as 2-ringers, 3-ringers and older, in the catch in 1997 is presented for each Division in Table 2.2.7. The percentage of 2-ringers and 3-ringers are almost the same, except in the Division IVa West where the percentage of the 2-ringers is dominant.

The SOP 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 2.2.9. The fleet definition is described in section 3.1.2. Catches of herring around the border line 4^0W between Sub-area IV and Sub-division VIa North and possibilities of misreporting of catches from IV to IIa may influence the total catches of North Sea herring. The Working Group therefore decided that total landings of fleet A may be under estimated by up to 50,000 t. This catch was used as input for an assessment for comparison purposes (see section 2.13). Catches of North Sea herring with raised catches for fleet A is shown in Table 2.2.10 for comparison.

2.2.2 Quality of catch and biological data

There is a large discrepancy between official and actual catches but the full extend of this is unknown. As in 1996, reliable information was obtained on misreporting from several countries fishing for herring in the North Sea. An estimate totalling 32,622 t were transferred from other areas into the North Sea (mainly from IIa and VIa North) and were used in the assessment. But, it should be noted that this unallocated landings is less than half the unallocated landings estimated in 1996.

Estimates of discards were only provided by The Netherlands, 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. But, it should be noted that Norway, Denmark and Scotland have a project to measure discards in the North Sea. There is still a need to improve the quality of the landings data in the North Sea, in relation to discards.

The Danish sampling scheme for the small mesh fishery worked satisfactorily in 1997. The sampling level was again in 1997 at a very high level, even higher than in 1996 and more than 1,500 landings were inspected. Denmark has collected biological samples for age-length compositions in all quarters

As a general rule, sampling of commercial landings for age, length and weight is 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 quarter, especially in the second and third quarter in the Southern North Sea (Divisions VIc and VIId). There is a need to reconsider adequate levels of market sampling for this fishery, and the Working Group recommends to set up a study group to address this issue (see Section 1.8).

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 (Thames Estuary) are caught in small quantities regulated by a local TAC. These catches are given in Table 2.1.1 and 2.1.5. With the exception of 1990, these catches are included in the assessment of the North Sea autumn spawners.

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 1997.

The method of separating these fish, and 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, six samples which have been taken in May and two in June 1997 were used for the second quarter. For the third quarter, twelve 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 1997 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	9	20	38	7	4835	847
Q.3	60	100	100	12	272	615

The quarterly age distribution in Sub-division IVa East were applied to the catches of the months of May, June and July, in the whole area. The numbers of spring spawners by age were obtained by applying the estimated proportion by age.

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 1998). The index is calculated for the entire survey area, weighting statistical rectangles as described in the Working Group report of 1995 (ICES 1995/ Assess:13).

The indices based on surveys from the period 1979 to 1998 (estimates of the strength of year classes 1977 to 1996) 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 1996 year class falls within the intermediate range of earlier estimates, but it represent a drastic decline from last years estimate of the 1995 year class.

Figure 2.3.2 illustrates the spatial distribution of 1-ringers as estimated by the trawling in February. In 1998 the 1-ringers were predominantly distributed off the coast of Holland and in the German Bight. An outstandingly high estimate of abundance within a statistical rectangle was made in the inner German Bight.

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 is calculated is described in the Working Group report of 1996 (ICES 1996/Assess:10). The index estimate of the abundance of 0-ringers in 1998, the 1997 year class, is estimated to 53.1 (Table 2.3.2).

This estimate represents a marked decline compared to the preceding years, and is among the lowest estimates in the series of MIK indices. The spatial distribution of the 0-ringers follows the trend of a westerly displacement of major distributions observed during the last three years (Figure 2.3.3). However, this year the density in the westerly sections has declined significantly leading to the marked decline in the index.

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. As mentioned in last years Working Group report (ICES 1997/Assess:8) the IBTS estimate of the 1995 was much higher than the MIK estimate of the same year class, showing an exceptionally disagreement between the two indices. This year's IBTS estimate of the 1996 year class, on the other hand, is very much in accordance with last years predictions by the MIK index.

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 1998 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 14.4, 21.0 and 15.3 billions for year classes 1994 to 1996 respectively, while the estimates for 0-ringers are 59.4, 42.8 and 20.9 for year classes 1995 to 1997 respectively.

2.4 Acoustic Surveys

The ICES Co-ordinated surveys were carried out during late June and July covering most of the continental shelf north of 54°N in the North Sea and North of 56°N to the west of Ireland and Scotland to a northern limit of 62°N. The eastern edge of the survey area is bounded by the Norwegian and the Swedish coasts, and to the west by the Shelf edge at about 250m depth. The surveys are reported individually, and a combined report was prepared from the data from all six surveys and presented at the meeting (Simmonds *et al.* WD1998b).

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

Scotia	16 June - 3 July	North of 56° 30'N west of 3°W
Dana	19 - 30 July	North of 57° east of 7°E
GO Sars	27 June - 18 July	North of 57° 1°E to 8°E
Scotia	8-28 July	North of 58° 30' between 4°W and 2°E
Tridens	23 June - 16 July	South of 59°N west of 2°E
W Herwig	23 June - 16 July	South of 57°N east of 2°E

The stock estimates have been calculated by age and maturity stage for 30'N-S by 1°E-W statistical rectangles for the ICES areas IIIa IVa, IVb and VIa north, separately. Where the survey areas for individual vessels overlap the estimates by age and maturity stage have been calculated by survey effort (length of cruise track) weighted means. The data from areas IIIa, IVa and IVb have been split between North Sea and Baltic stocks by vertebral count, maturity stage and otolith microstructure methods. The combined survey results provide spatial distributions of herring abundance by number and biomass at age and maturity by stat. rectangle. Procedures and TS values are the same as for the 1994 surveys (Simmonds *et al.* 1995).

Figure 2.4.1 shows survey areas for each vessel. Stock estimates for autumn spawning herring by number and biomass and the percentage mature are shown in Tables 2.4.1 and 2.4.2 respectively, for areas VIaN, IVa, IVb, and IIIa separately. The mean weights at age are shown in Table 2.4.3. Figure 2.4.2 shows the distribution of 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. Figures 2.4.4 shows the density distribution of autumn spawning herring 1 ring and older as a contour plot. Figure 2.4.5 shows the distribution of all spawning stock numbers of adult autumn spawning herring.

The numbers of North Sea autumn spawning herring estimated from the acoustic survey are shown as a time series in Table 2.4.4, the table also shows the estimated total mortality calculated from 2+ to 3+ age classes from the time series.

Evidence of *Ichthyophonus* infection is now at low levels, only 15 of over 4,000 fish sampled for otoliths and *Ichthyophonus* showed macroscopic evidence of the infection. This gives an infection rate of about 0.25 % This compares with 0.05%, 0.2 %, 0.8 %, 3.6 % and 5 % in the previous 5 years 1996 to 1992 respectively. This level is a small rise on the levels in 1996 and is more similar to the levels found in 1995. These survey results indicate the possibility of a rise and although the levels are not a cause for concern the possible rise indicates there is still a need to record the infection levels and monitoring of *Ichthyophonus* infection should continue on these surveys.

2.5 Larvae surveys

Internationally co-ordinated herring larvae surveys have been conducted in the North Sea and Adjacent Waters in 1997 but only The Netherlands and Germany participated. Five surveys were done in total. The data administration and analysis were taken over and completed by Germany. Total amount of larvae for each length classes less than 10 mm, from 10 to 15 mm and between 5 and 15 mm, respectively, was recalculated for each sub-unit since 1972. The results for the length class less than 10 mm is given in Table 2.5.1.

In 1997 an extreme abundance was observed in for the Southern North Sea, period 16-31 December. This values depended on a single haul with a catch of more than 33,000 larvae. A discussion takes place how to deal with such a haul, which should be regarded as an outlier. In former years also some of these extraordinary hauls were reported and not discarded from the calculation, but they had never reached such a high value as this one.

Plots of the MLAI index are presented to show inclusion and exclusion of the outlier (Figure 2.5.1). The corresponding analyses of variance for each length with and without the outlier is given in Table 2.5.2. The Working Group agreed on the elimination of the whole survey (December 16-31) and the use of the MLAI index as a method for replacing the value for the survey. The MLAI-values since 1973 obtained from the multiplicative model is given in Table 2.5.3. Subsequent comparison of the series indicated differences of about a factor of 2 between the MLAI index values used in the assessment in 1997 and the newly calculated index values for the years, 1989, and 1993-96. A comparison of Table 2.5.1 with the same data presented in Patterson *et al.* (1997) indicated that the most likely cause of the differences was the inclusion of some partially covered areas in the new index which had previously been estimated fully by the MLAI. However, the reason needs to be further investigated. It proved impossible to complete the re-analyses of the MLAI during the Working Group and the series reported in Patterson *et al.* (1997), from 1977- 1996 was used without the addition of the new value from the 1997/8 surveys.

It is important that this index is made available to the Working Group. The differences between the MLAI previously presented in Patterson *et al.* (1997) and the newly calculated version need to be resolved. In addition there is a need to develop a formal methodology for dealing with any large values derived from single stations. The Planning Group for Herring Surveys should address these issues before the Working Group in 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 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 on 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.

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 1997 (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 over the years 1989 to 1997.

For Division IVa the mean weight of all but one age class in the catch are above the mean of the range. For Divisions IVb, IVc and VIId the mean weight at all ages are scattered on either side of the 9 year mean. For the whole area the mean weight at age in the catch is about 15g above the 10 year mean.

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 1997 values). The mean weights at age are lower than the long term mean by about 20g per fish.

The year effect in 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. This is most likely due to sampling variability in the acoustic survey, as the 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 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 1997 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 1997 was within the normal range of values (over the last 9 years). The proportion of herring found to be mature were almost equal to the average for 2 ring and a slightly higher than average for 3 ring. The percentages are given in the table below.

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

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 six-year period (Patterson and Melvin 1996; Deriso *et al.* 1985; Gudmundsson, 1986). 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 was forced to be equal over the two separable periods, which effectively means that only for juveniles two selection periods were estimated.

The information available was the catches in number at age and year (Section 2.2), 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) was available. Problems with the calculation of this index have been outlined in Section 2.5. The Scottish groundfish survey has not been provided this year. The Working Group attempted to evaluate the consistency of these different sources of information.

The year range of 1960 to 1997 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 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 2.8.1.

Data exploration by abundance index

In the assessments of this stock that were made before 1995 an **LPE (larvae production estimates)** index was used from 1983 - 1992. However, information from the LPE carried out from 1993 onwards was not used in the 1995 assessment (ICES 1995/Assess: 13) as survey coverage had declined to such an extent that the LPE measure of abundance could no longer be calculated. Consequently, the LPE index was replaced in 1996 by the multiplicative larvae abundance index (MLAI), which covers the time period 1977 - 1996 and therefore uses also the information on larvae abundance during the period 1993 - 1996. Due to inconsistencies in the data-series the MLAI value for 1997 could not be calculated. It was therefore decided to apply the index series that was used in last years assessment (see Section 2.5).

The MLAI index for larvae smaller than 10 mm was tested using the year range of 1977 to 1996 and assuming a power relationship of index value to stock abundance as in last year's assessment (Figure 2.8.1).

The series of **acoustic survey** indices have been used for the period 1989 to 1997. The reasons for using this restricted period have been discussed earlier in ICES (1995/Assess:13 and 1996/Assess:10). 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 2-9+, years 1984–1997
2. age 2-9+, years 1989–1997 (as in last year's assessment)
3. SSB, years 1984–1997
4. SSB, years 1989–1997

It was found that the estimated fishing mortalities in the final year for the age-structured index and the spawning stock biomass behaved consistently. The age-structured index series from 1989 onwards was chosen 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 2- to 5+-ringers** indicates the highest F compared to the other indices, leading to an estimate of terminal fishing mortality between 0.5 and 0.7. As in earlier years the age disaggregated 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 possibility of using the IBTS survey as a single age-disaggregated index (1-5+) has been discussed but it was agreed that it was desirable to have some further evaluation before this decision could be taken.

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, but were 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 2.8.1 was comparable to the spread in last years assessment. It was therefore decided to keep the same indices as in last years assessment:

- acoustic survey 1989–1997 (2-9+ wr)
- IBTS 1983–1998 (2-5+ wr)
- IBTS 1979–1998 (1-wr)
- MIK 1977–1998 (0-wr)
- MLAI<10 1977–1996 (biomass index).

Catch-at-age matrix

At last years working group it was concluded that the catch at age matrix that was used in previous assessments needed revision. Catches of North Sea herring that had been misreported to Division VIa North had been taken out of the VIa North assessment but had not been added to the North Sea assessment. New and corrected figures have been calculated and the catch-in-tonnes and catch-in-numbers for the North Sea herring stock have been updated for the years 1984–1997.

Year	Last years estimate of VIa misreporting (tonnes)	Current year estimate of VIa misreporting
1984	11270	19142
1985	4819	4672
1986	8987	10935
1987	18902	18647
1988	11839	11763
1989	19094	19013
1990	25185	25266
1991	18218	22079
1992	22697	22593
1993	24155	24397
1994	24619	30234
1995	33794	32146
1996	38254	38254
1997		5039

The contribution of the different age-groups in the catch-at-age matrix was analysed. Proportions at age are shown in Figure 2.2.1 which indicates that changes in selection patterns are likely to have occurred in 1992 and 1996. The change in selection pattern in 1996 can probably be attributed to the change in management in that year. This lends credit to the decision to split up the selection into two year ranges: 1992–1995 and 1996–1997.

2.8.2 Stock assessment

The Working Group used the same stock assessment model as in ICES (1997/Assess:8) with the following modifications:

1. ICA version 1.4 was used instead of the version 1.3 of last year

2. The assumption of separability was extended to a six year period, covering 1992 to 1997. Recent catch data appear to confirm to the assumption of separability except for the 0- and 1-ringers. Changes in the management regime introduced in July 1996 make the separability assumption invalid for these age-groups. Therefore, the separability for juveniles was split in two periods: 1992–1995 and 1996–1997. This is further discussed below.

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. In section 2.15 on quality of assessment the weighting of the stock-recruitment model is further discussed.

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:

$$\begin{aligned}
&\sum_a \sum_y \left\{\ln(\hat{C}_{a,y}) - \ln(C_{a,y})\right\}^2 \cdot \lambda c_{a,y} + \\
&\sum_y \left\{\ln(q_{mlai} . S\hat{S}B_y^K) - \ln(I_{y,mlai})\right\}^2 \cdot \lambda i_{\,mlai} + \\
&\sum_a \sum_y \left\{\ln(q_{a,ibtsa} . \hat{N}_{a,y}) - \ln(I_{a,y,ibtsa})\right\}^2 \cdot \lambda i_{\,a,ibtsa} + \\
&\sum_y \left\{\ln(q_{ibtsy} . \hat{N}_{1,y}) - \ln(I_{1,y,ibtsy})\right\}^2 \cdot \lambda i_{\,1,ibtsy} + \\
&\sum_a \sum_y \left\{\ln(q_{a,acoust} . \hat{N}_{a,y}) - \ln(I_{a,y,acoust})\right\}^2 \cdot \lambda i_{\,a,acoust} + \\
&\sum_y \left\{\ln(q_{mik} . \hat{N}_{0,y}) - \ln(I_{y,mik})\right\}^2 \cdot \lambda i_{\,0,mik} + \\
&\sum_y \left\{\ln(N_{0,y+1}) - \ln\left(\alpha . S\hat{S}B_y / (\beta + S\hat{S}B_y)\right)\right\}^2 \cdot \lambda_r + \\
&\sum_{a=3}^{8} \left\{\ln(S_{1,a}) - \ln(S_{2,a})\right\}^2 \cdot 10
\end{aligned}$$

with the following variables:

a,y	age and year
C	Catch at age
$\hat{C}$	Estimated catch at age in the separable model
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 both in the acoustic survey and the age-disaggregated IBTS (2-5+) index were assumed to be correlated by age for each survey. This has as a consequence that each survey will have a weight of 1 in the calculation of the total sum of squares. Because the IBTS 1-ringer index is taken as a separate index, it will have a much higher weight than the individual age-groups in the IBTS 2-5+ index. This is further discussed in the section on quality of the assessment (2.15)

The standard ICA model includes the assumption of the exploitation pattern being constant between recent years, i.e., the separability assumption. 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 1995 en 1996. 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. The new version is available on the IFAP system under the menu XXXX.

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 1997 shows an increase and is currently estimated to be around 750,000 tonnes which is around 200,000 tonnes higher than in 1996. The fitted selection pattern in the final two years shows a reduced selection on juveniles compared to the earlier selection pattern (1992–1995). Mean fishing mortality over the ages 2-6 has gone down to around 0.25 in 1997. Fishing mortality on 1-ringers has gone down from around 0.33 in 1995 to 0.07 in 1997.

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 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. Several further tests were performed on the sensitivity of the assessment. They will be discussed in Section 2.15 on quality of the assessment.

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 indicates low values in 1995 and that the spawning stock biomass in this year might have been on a very low level and comparable to that in 1980 when the herring fishery was closed (ICES, 1996/Assess:10). 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.

Figure 2.9.1 shows the age composition of the herring in Divisions IVc and VIId in the Dutch catches from December 1980–1997. Figure 2.9.2 shows information on the larvae abundance over the same period and in addition the changes in the mean age in the Dutch herring catches in December. In genereal it appears that the spawning stock biomass decreases when in the preceding year age 4 has been more abundant than age 3 (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 3 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 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. Although the larvae abundance in 1997 is uncertain due to inconsistencies in the time series, 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.

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 3.2 in 1980. The mean age in the Dutch catches is somewhat higher in 1997 than in 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 (2 year olds), but these indices are for the whole North Sea herring population. Part of these 2-year olds 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 "Down" 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. Last year, 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) and this information be made available to the next ACFM meeting in May 1997. However, it was difficult to implement this new procedure as it would need quite a bit of programming and testing. **The Working Group therefore recommends this problem to be a matter which could be taken up by the Study Group on the Evaluation of the Quarterly IBTS Surveys in 13–18 August 1998.**

ACFM catches have overshoot the agreed TAC's considerably since 1988 (see Figure 2.9.3). 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. However, the latest larvae abundance estimates and the mean age at age in the catches indicates that the stock is in a better condition than recently thought.

2.10 Short term projection by area and fleet (Final)

Fleet Definitions

The fleet definitions were as defined last year (see CM 1997/Assess:16, section 2.10), see section 3.2:

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: Vessels fishing under the mixed clupeoid (sprat) quota
Fleet E: All other vessels participating in fisheries where herring is taken as by-catch

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 1998. The ICA estimates of all age groups from 0-9+ are used (Table 2.8.3).

Catches by fleet: 1997 data from input files Table 2.2.9.

Stock Numbers:

For 1997 the total stock number was taken from ICA (Population Abundance year 1997).
For 1998 the total stock number was taken from ICA (Population Abundance year 1998).

For 1999 0-ringer the stock number was set to 44 000 million (the historic, arithmetic mean) which is the same value that has been used the past four years. This Figure is likely to be revised following the meeting of the North Sea Herring Stock-Recruitment study group meeting.

Fishing Mortalities: fishing mortalities for all age classes are taken from Table 2.8.3 for 1997. 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 (1996 and 1997) were used (Table 2.8.3)

Maturity at age: The average maturity at age for 1996 and 1997 was used (Table 2.7.2)

Mean weights in the catch by fleet: A mean of the last two years was taken i.e., 1996 and 1997, (Table 2.2.9)

Natural Mortality: Unchanged from ICES (1997/Assess:16) Table 2.8.3.

Proportion of M and F before spawning: Unchanged from ICES (1997/Assess:16) Table 2.8.3.

Split factors

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 caught 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.

It is generally assumed that the split-factor that applies to a year class as 0-ringers, also applies to that same year class as 1-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
1997 (last yr in ICA)	This split-factor (0-ringers in 1997) is equal to the split-factor of IBTS 1-ringers in 1998	This split-factor (1-ringers in 1997) is obtained from the proportions estimated for the 1-ringers in the IBTS in 1997
1998 (Assessment year)	This split-factor is equal to the regressed 1-ringer distribution of 1999, i.e., obtained from the MIK value for 1998 (yr class 1997) and the GLM	This split-factor is obtained from the proportions estimated for the 1-ringers in the IBTS in 1998
1999	This split-factor is equal to that of 1-ringers in 2000, i.e., estimated by taking the average MIK index for the year classes 1981–1997 and using the GLM to predict the split.	This split-factor is obtained from the MIK value for 1998 (yr class 1997), and a general linear model (GLM) to predict the split.
		This split-factor (1-ringers in 2000) is estimated by taking the average MIK index for the year classes 1981–1997 and the GLM to predict the split-factor.

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

	0-ringers	1-ringers
1997	0.8400	0.7000
1998	0.7966	0.8400
1999	0.7202	0.7966

The value of 0.7 (1-ringers in 1997) is the 1997 IBTS 1-ringer split-factor. The value of 0.84 (1-ringers in 1998 and 0-ringers in 1997) is the IBTS 1-ringer split factor for 1998. The proportion in Division IIIa was estimated at 0.16 (hence an estimated proportion of 0.84 in the North Sea.)

The value of 0.7966 (1-ringers in 1999 and 0-ringers in 1998) 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 1998 is 53.1 which predicts a proportion of 0.2034 in Division IIIa (1-0.2034=0.7966 in the North Sea).

The value of 0.7202 (0-ringers in 1999 and 1-ringers in 2000) was estimated from the general linear model and an average MIK index over 1981–1997 (131.4), which gives an estimated proportion of 0.2798 in Division IIIa.

Comments on the General Linear Model

The standard linear regression between the MIK index of 0-ringers and the proportion North Sea autumn spawners in Division IIIa as estimated from the IBTS 1-ringer index, has been criticised in the past (O'Brien and Darby 1997, and Basson 1997, Working Documents to HAWG). The basic assumptions of the regression (normally distributed errors, constant variance) are violated. The two Working Documents presented at last year's meeting (Referenced above) showed results from fitting general linear models which have more acceptable diagnostics than the standard regression. For the range of MIK-observations, the different models lead to reasonably similar estimates of the proportion in Division IIIa. All these models are, however, likely to break down when used with an MIK index that lies outside the range of observed values. Problems are likely to be particularly acute if the index is very high or very low.

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 more detail in O'Brien and Darby (1997, Working Document to HAWG) and Basson (1997, and 1998 Working Documents to HAWG). The two models were re-fitted with the new data-point for the 1996 year class. No extensive re-evaluation of the models was attempted. The analysis was done in Splus, and summary results are given in Table 2.10.3 for completeness.

Comments on the short-term projections

Two tools for short term prediction were made for this meeting. One was a revised spreadsheet made with a new lay-out, to make data entry and the use simpler. It does the same computations as the one used in previous years, except for a few minor errors in the previous one, which were corrected. The other was a more extensive compiled piece of software, written specifically for doing North Sea herring predictions, allowing for future extensions to include uncertainty estimates. Both pieces of software were used, and results compared, to minimise errors in inputs.

The process as it was done this year, 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 total 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 the spreadsheet used previously, catches that would have been taken by the fleets C, D and E at age 3 and older, were ignored. Such catches would be predicted if there were catches at those ages in the input data for the reference year. In the present version of the programmes, these catches are included, but they can be removed if necessary.

Prediction for 1998 and management option tables for 1999

Four management prediction tables are presented here. The first reason for this is that there are now indications of catches of North Sea autumn spawners of age 3 and above being taken in Division IIIa. The assumption previously used in projections, was that all North Sea autumn spawners migrate back to the North Sea at age 2. The second reason is that although status quo fishing mortality has been assumed for the first prediction year (1998 in this case) in past Working Group Reports, there is now reason to believe that misreporting may be less of a problem, and a TAC constraint for 1998 may therefore be realistic.

Assumptions and Predictions for 1998

The first two management prediction tables are essentially done on the same basis as in previous years, and catches of 3-ringers and older in Division IIIa are set to zero i.e., ignored. The first table assumes status quo (1997) fishing mortalities (Table 2.10.4), and the second table assumes a TAC constraint in 1998 (Table 2.10.5). Predictions for 1998 based on status quo (1997) fishing mortalities give catches which are below the set TACs for some fleets, and above the TACs for others. It is, however, expected that misreportings from the North Sea for Fleet A will be less serious than it has been in the past. Therefore, both options are provided.

It is worth noticing that the human consumption fishery in Division IIIa (the C-fleet) largely exploits Baltic spring spawning herring. The TAC for this fleet in 1998 is 80 000 tonnes out of which 24 400 tonnes are assumed to be North Sea autumn spawners. Thus, the predicted catches for the C-fleets by some of the options would imply TAC's well over 500 000 tonnes for that fleet. The reason for this is two-fold. First, since the fishing mortality for this fleet is referred to by the F on juveniles, and the juvenile F was very low in the reference year, most options would imply a large increase in the F for the fleets B-E. Secondly, a much larger part of the catches by the C-fleet appears to be autumn-spawners than previously assumed. It is not clear whether this is due to changes in methods for identifying autumn-spawners, appearance of Baltic autumn spawners or both.

The predicted SSB for 1998 is 1.1 million tonnes representing an increase compared to the estimated SSB in 1997 of 745 thousand tonnes (Table 2.8.3). This is a result of the reduction in fishing mortality achieved between 1996 and 1997, as well as the expected levels of fishing in 1998.

On the basis of status quo fishing mortality (Table 2.10.4), the projection for fleet A suggests that the TAC for this fleet may be restrictive, although the possible misreporting of catches between the North Sea and Sub area VI a North may affect this. The projection for fleet B for 1998 suggests that, under status quo fishing, the by-catch ceiling (22 thousand tonnes) may not be restrictive. The predicted status quo yield for fleet C is close to the set TAC (24.4 thousand tonnes). The agreed TAC or by-catch ceiling for fleets D and E is unlikely to be restrictive when only viewed in terms of North Sea autumn spawners. These fleets have a dominant contribution of Baltic spring spawning herring and it is therefore difficult to assess if the TAC (including both autumn and spring spawning herring) for these fleets will be restrictive.

Management Option Tables for 1999

Table 2.10.4 gives management options for 1999 based on status quo fishing mortality in 1998. The first option is given for the values of juvenile (0–1 ringers) and adult (2-6 ringers) fishing mortalities (for all fleets), in the EU-Norway agreement. The other options are in terms of fishing mortalities for fleet A (2-6 ringers) and fleets B,C,D,E (0–1 ringers) as requested by ACFM:

Fleets B,C,D and E: levels of fishing mortality of 0, 0.1, 0.2 and 0.3
Fleet A: levels of fishing mortality of 0.2 and 0.3.

When options are requested in terms of fishing mortalities, particularly for the group of fleets B,C,D and E, there are many different combinations of F-multipliers for these four fleets that would give a particular fishing mortality. The projections in Tables 2.10.4 and 2.10.5 were based on the assumption that the F-multipliers are identical for fleets B,C,D,E. The 1997 catch-by- fleet data (Table 2.10.1) show that a relatively large number of 2-year olds were taken by fleets C and E in particular. This leads to high projected catches of 2-year olds, which implies a potentially large difference between the average F for 2-6 ringers for fleet A only, and the average F for 2-6 ringers for all fleets combined. This is shown in Table 2.10.4, for example, by comparing the columns named F-A and Fad.

All options predict an SSB in 1999 of above 1.1 million tonnes. Some of the options predict SSB-levels above the suggested B_{pa} of 1.3 million tonnes.

Table 2.10.5 only differs from Table 2.10.4 in that a TAC constraint was used for 1998. Projections for 1999 are very similar to those based on status quo fishing mortality in 1998.

Additional management option tables for 1999

Two additional management option tables are presented. The 1997 catch-by-fleet (Table 2.10.1) shows relatively large numbers of 3-ringers and older taken by fleets fishing in Division IIIa compared to historic data. Since 1996, a new method (otolith microstructure analysis) for separating North Sea autumn spawners from Baltic spring spawners has been used on some samples from Division IIIa. This may mean better discrimination between the two stocks. In the past, the projections have ignored any catches of (North Sea autumn spawner) 3-ringers and older taken in Division IIIa, because it was assumed that all North Sea autumn spawners migrate out of Division IIIa at age 2. The catches in 1997 suggest that this may no longer be a realistic option.

The assumptions used for Tables 2.10.4 and 2.10.5 could not be used directly with the inclusion of 3-ringers and older in catches by fleets C,D and E, because this leads to unrealistically high catches of the older age classes when the F-multipliers are based on fishing mortalities for juveniles. Recall that fishing mortality on juveniles is estimated at a low level in 1997, so that very large F-multipliers are required for options where F for fleets B,C,D,E (0 and 1 ringers) are 0.2 and 0.3.

Table 2.10.6 assumes that the F-multipliers for fleets A and C are the same, and F-multipliers for fleets B,D and E are the same. The only exception is in the option where fishing mortality for B,C,D,E is 0, when the F-multiplier for fleet C is also set to 0. *Status quo* fishing mortality for 1998 was assumed. The main difference between this set of projections and those presented in Tables 2.10.4 and 2.10.5 is that the projected catches for fleet C are lower. Predicted SSB values are very similar.

Table 2.10.7 shows results for the assumption that the F-multipliers for fleets B,C,D and E in 1999 remain in the proportions as the F-multipliers required to achieve the 1998 TACs. This assumption ensures that the projected catches for fleet C are more similar to projections in Tables 2.10.4 and 2.10.5. Predicted SSB values are again very similar.

Conclusions

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. The short term projections for North Sea herring also includes predictions of 'split-factors' which describe the proportion of 0- and 1-ringers in the North Sea and in Division IIIa. A working paper presented at the meeting (Basson, 1998) explored ways of incorporating uncertainty in the split-factors into the predictions. After discussion, the Working Group decided to examine ways of merging the approaches for short and medium term projections to incorporate the different sources of uncertainty into short term projections.

2.11 Medium-Term Projections

The Working Group considered point (2) in the terms of reference in which it is asked for medium-term forecasts of catch by fleet, and the development of SSB on stochastic recruitment around a conventional stock-recruitment relationship. In the terms of reference, the following levels of exploitation are specified:

- Fleets B,C, D and E: levels of fishing mortality of 0, 0.1, 0.2 and 0.3.
- Fleet A: levels of fishing mortality of 0.2 and 0.3

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 (1996/Assess:10). 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 1995 and the expected recruitment in 1996) 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 interpreted the request as to hold 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(IIIa mixed clupeoid) and E (IIIa industrial) 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 at levels of F=0, 0.1, 0.2 or 0.3 were calculated.

Due to the revision of the estimates of the separation of herring caught in Division IIIa into fish of North Sea autumn-spawning stock and fish of the IIIa/Western Baltic stock, the assumption that fleets C-E do not catch adult fish no longer agrees with the reported data. Higher estimates of partial mortality at older ages by these fleets from using the new estimates, with the result that exploitation by fleets B-E contribute to mortality of adult fish.

The following options are as specified for the short-term options (see Section 2.10. and are described here again for convenience:

- The mean maturity ogive as measured in 1996 –1997 has been assumed to hold for the years 1998 and thereafter.
- The natural mortality that was used for the assessment has been assumed to hold for the years 1998 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 1996 and 1997.
- The weights at age in the catches by fleet were also taken as the mean values from 1996 and 1997
- The projections start from the populations on 1 January 1998 (ages 1-9+) and recruitment on 1 January 1999 (age 0) calculated in the assessment procedure.
- The overall exploitation pattern as estimated for 1997 and 1998 was assumed to hold for 1999 and thereafter.
- The relative fishing mortality by fleet and at age as estimated for 1996 and 1997 (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 1.16686 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 4.0486.

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 1997/Assess:8).

2.12 Request by the Working Group on Ecosystem Effects of Fishing Activities

Catch and discard data for pelagic stocks are currently only available for one fleet (Table 2.12.1). Three other countries discard programs recently started, so it is expected that more data will become available.

The available data consist of catches and discards by month, by species (herring, mackerel, horse mackerel, blue whiting) and by statistical area or herring spawning area. At the Working Group only preliminary data for 1997 was available. The discard sampling program started around 1985 so that data is available for a number of years.

Discards are estimated on board by the crew themselves for a small number of fixed vessels in the fleet. Discards and catches on the sampled vessels are raised to the total landings. Discards are not weighed on board, but rather estimated as a volume. They are not estimated as a percent of the catch. The vessels that cooperate in the discard program take around 20 % of the total landings of that fleet and are supposed to be representative for the fleet and its fishing behaviour. Cooperation is, however, on a voluntary basis because confidential information is supplied.

Data could be made available by ICES rectangle if required and it can be either by trip or for the total fleet. It is estimated that the preparation of the data in a suitable (to be defined) format will take a limited number of days work.

2.13 Quality of the assessment

The assessments carried out from 1988 to 1993 showed a systematic overestimate of the spawning stock biomass while the stock was decreasing. At the assessment Working Group meetings in 1990–1994 the spawning stock biomass was considerably reduced in each following assessment (Figure 2.13.1). Since 1995 the assessments have been consistent.

The trends in biomass from three different surveys that include biomass information on the adult part of the stock were examined over the period 1984–1997/1998 (Figure 2.13.2). The adult biomass from the acoustic survey, the MLAI index from the herring larvae surveys and the adult biomass from the 1st quarter IBTS survey were compared to the biomass estimate from this years assessment. To make these indices comparable they were normalised to 1 over the period 1984–1997. The consistency of the indices by age is shown in Figure 2.13.3. There are indications that the acoustic survey and the IBTS survey tend to diverge in the recent years, especially for the 2 and 3 ringers.

The information from the catch at age data (see biomass from this years assessment) does not agree with the survey indices on adult biomass in the earlier years. Up to 1988 the catch in number data indicated a higher biomass than the survey indices, while after 1990 this has changed and the opposite was observed. However, recent assessments (1997 and 1998) show a much higher degree of consistency.

In recent assessments, misreporting of catches between the North Sea and adjacent areas has been made up for in the catch at age matrix, which may have improved the consistency in the assessments. The misreporting has been large, especially in Division VIa and IIIa but in 1996 also in Division IIa. The 1997 Working Group came to the conclusion that a total of about 62,000 t of North Sea herring catches had been reported as taken in other areas (see Table 2.1.1 and 5.1.1).The misreported catches were adjusted for in the catch figures back to 1987. There is little quantitative data for such an adjustment of the catch matrix, but the catches are reallocated on the basis of reliable information from the countries that exploit herring in the area. One of the countries exploiting herring in the area north of Scotland has made measures to deal with this problem and it is likely that there has been less misreporting in 1997 than in previous years. However, there is uncertainty about this and the Working Group therefore made an extra ICA-run, using an extra 50,000 t of catch, to see the effect on the assessment of including a large amount of misreporting or not. The results show that the estimated spawning stock biomass in 1997 was about the same while the estimated F is somewhat higher.

	final assessment	assessment with 50000 t extra
SSB_{97}	744	745
$F(2\text{-}6)_{97}$	0.26	0.31
SSQ weighted model	13.3	13.7

The effect of uncertainty in the stock assessment model parameters on the present perception of stock size due to uncertainty in the data (i.e., excluding possible model mis-specification) is presented in Figure 2. 8.12. It is based on a covariance matrix method with 1000 random draws of all parameters. It shows that the model fit appears to give reasonably precise estimates of stock size (90 % confidence interval between 560 and 1040 thousand tonnes). The probability that the SSB is below MBAL is around 60 %.

Furthermore, the uncertainty in the model formulation itself has been explored. Five additional runs were carried out with the following settings:

- 1 separable period 1992–1997, no downweighting
- 2 separable periods (1992–1995, 1996–1997), not constrained to be equal for older ages
- 2 constrained separable periods but with downweighting of the catch matrix (total weight by year = 1)
- 2 constrained separable periods but with equal weight to all ages in the survey indices
- 2 constrained separable periods, no stock recruitment relationship

Results are shown in Figures 2.13.4-2.15.8. Figure 2.13.4 shows the variability of the estimate of the reference fishing mortality at age 4 in the final year of the assessment. Selection at age 1 in the final year is shown in Figure 2.13.5. The time-series of SSB under the different model assumptions are shown in Figure 2.13.6. Residual plots for a number of runs are shown in Figures 2.13.7 and 2.13.8.

Downweighting the catch matrix resulted in a much wider confidence interval on the estimate of F. Using only one separable pattern caused the terminal fishing mortality to be estimated lower and the selection on 1-ringers to be higher (Figure 2.13.5). If selection was split into two periods but not constrained to be equal for the older ages, the results were similar to the final run. However the selection on 3 ringers was very high and selection on older ages relatively low (Figure 2.13.7).

Lowest SSBs were derived by using the two separable periods unconstrained, highest SSBs by using two contrained separable periods and downweighting the catches.

Giving full weight to the survey age indices caused the estimates to become more variable, especially for the ages 5-9+ that depend on the acoustic survey data. Figure 2.15.8 shows that the age residuals are behaving erratic due to the variability of the older ages in the acoustic survey.

Exclusion of the stock recruitment relationship from the model fit caused a slight decrease in the estimated recruitment in 1998. It is concluded that no decisive arguments can be found to set the weighting of the stock-recruitmodel to 0.1 as has been done in the assessment. However, is has been kept at that level for reasons of consistency.

It can be concluded that the model specification account for around half of the spread in terminal fishing mortality when compared to the spread generated by the individual tuning indices. The choice of selection period is shown to be very important, but information from thé fisheries and the management enable sensible choices to be made. The analysis gives an idea of the spread in the output of several key variables.

2.14 Management considerations

The current assessment shows that the spawning stock biomass increased by around 200 000 t compared to last year. It is now estimated at 745 000t and the probability that SSB is below MBAL is around 60 %. Even with recruitment (1-ringers) in 1998 in the intermediate range of earlier estimates and the MIK index (0-ringers) in 1998 suggesting a low 1997 year class, the projections show that this stock may have a positive development in the near future, up to 1.1 million t in 1998. 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 1.4 million t may be reached in 1999. Current short term projections are consistent with the 1997 ACFM advice.

The by-catch of herring in the small mesh fisheries decreased in 1997 compared with the level in 1996. The Working Group considered that this decrease was related to the management measures to regulate the industrial fisheries. The Working Group has for many years been concerned about the impact that the industrial fisheries have on herring recruitment and SSB. The Working Group acknowledges the measures that have been implemented to this end and that the total catch of North Sea autumn spawners taken in all areas, now comprises about 45 % immature fish (in numbers) which is significantly lower than the level of 75-85 % in previous years.

The Working Group continues to be aware of the large scale misreporting of catches in several parts of the North Sea and adjacent areas (see Section 2.1.1 and 5.1.1). Catches taken in the period 1984 to 1997 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 the larvae survey.

Table 2.1.1 North Sea HERRING (Sub-area IV and Division VIId). Catch in tonnes by country, 1983-1994. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1986	1987	1988	1989	1990	1991
Belgium	414	39	4	434	180	163
Denmark	121,631	138,596	263,006	210,315[2]	159,280[2]	194,358[2]
Faroe Islands	623	2,228	810	1,916	633	334
France	9,729	7,266	8,384	29,085	23,480	24,625
Germany, Fed.Rep.	3,934	5,552	13,824	38,707	43,191	41,791
Netherlands	85,998	91,478	82,267	84,178	69,828	75,135
Norway[4]	223,058	241,765	222,719	221,891[2]	157,850[2]	124,991[2]
Sweden	1,872	1,725	1,819	4,774	3,754	5,866
UK (England)	1,404	873	8,097	7,980	8,333	11,548
UK (Scotland)	77,459	76,413	64,108	68,106	56,812	57,572
UK (N.Ireland)	-	-	-	-	-	92
Unallocated landings	21,089	58,972	33,411	26,749[2]	21,081	24,435
Total landings	547,211	624,907	698,449	694,135[2]	544,422	560,910
Discards[3]	-	-	-	4,000	8,660	4,617
Total catch	547,211	624,907	698,449	698,135	553,082	565,527
Estimates of the parts of the catches which have been allocated to spring spawning stocks						
IIIa type	17,386	19,654	23,306	19,869	8,357	7,894
Coastal type	905	490	250	2,283	1,136	252[5]

Country	1992	1993	1994	1995	1996[1]	1997
Belgium	242	56	144	12	-	-
Denmark	193,968[2]	164,817	121,559	153,361	67,496	38,431
Faroe Islands	-	-	-	-	-	-
France	16,587	12,627	27,941	29,504	12,500	14,524
Germany	42,665	41,669	38,394	43,798	14,215	13,381
Netherlands	75,683	79,190	76,155	78,491	35,276	35,129
Norway[4]	116,863	122,815	125,522	131,026	43,739	38,745
Sweden	4,939	5,782	5,425	5,017	3,090	2,253
UK (England)	11,314	19,853	14,216	14,676	6,881	3,421
UK (Scotland)	56,171	55,531	49,919	44,802	17,473	22,914
UK (N.Ireland)	-	-	-	-	-	-
Unallocated landings	25,867	18,410	5,749	33,594	62,729	32,622
Total landings	544,299	520,550	465,024	534,281	263,399	203,040
Discards[3]	4,950	3,470	2,510	-	1,469	6,005
Total catch	549,249	524,020	467,534	534,281	264,868	203,045
Estimates of the parts of the catches which have been allocated to spring spawning stocks						
IIIa type	7,854	8,928	13,228	10,315	855	979
Coastal type	202[5]	201[5]	215[5]	203[5]	168[5]	

[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	1988	1989	1990	1991	1992
Denmark	25,268	29,298	9,037	5,980	10,751
Faroe Islands	810	1,916	633	334	-
France	266	-[1]	2,581	3,393	4,714[4]
Germany, Fed.Rep.	9,308	26,528	20,422	20,608	21,836
Netherlands	32,639	24,600	29,729	29,563	29,845
Norway	30,657	41,768	24,239	37,674	39,244
Sweden	1,197	742	-	1,130	985
UK (N.Ireland)	-	-	-	92	-
UK (England)	4,820	5,104	3,337	4,873	4,916
UK (Scotland)	48,791	58,455	46,431	42,745	39,269
Unallocated landings	-	3,173	4,621	5,492	4,855
Total Landings	153,751	191,584	141,030	151,884	156,415
Discards[2]	-	900	750	883	850
Total catch	153,751	192,484	141,780	152,767	157,265

Country	1993	1994	1995	1996[3]	1997
Denmark	10,604	20,017	17,748	3,237	2,667
Faroe Islands	-	-	-	-	-
France	3,362	11,658	10,427	3,177	361
Germany	17,342[4]	18,364	17,095	2,167	-
Netherlands	28,616	16,944	24,696	2,978	6,304
Norway	33,442	56,422	56,124	22,187	16,485
Sweden	1,372	2,159	1,007	2,398	1,617
Russia	-	-	-	-	1,619
UK (N.Ireland)	-	-	-	-	-
UK (England)	4,742	3,862	3,091	2,391	-
UK (Scotland)	36,628[4]	44,687	40,159	12,762	17,120
Unallocated landings	-8,271[5]	2,944	26,018	48,213	12,613
Total Landings	127,837	177,327	196,365	99,510	59,386
Discards[2]	825	550	-	356	1,138
Total catch	128,662	177,877	196,365	99,866	60,524

[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	1986	1987	1988	1989	1990	1991
Denmark	4,540	7,101	47,183	44,269	44,364	48,875
Faroe Islands	-	2,126	-	-	-	-
France	-	159	45	-	892	-
Netherlands	-	-	200	-	-	-
Norway[1]	118,408	145,843	153,496	168,365	121,405	77,465
Sweden	-	957	622	612	2,482	114
UK (Scotland)	-	-	-	-	-	173
Germany, Fed.Rep.	-	-	-	-	5,604	-[4]
Unallocated landings	-	-	-	-	-	-
Total landings	122,348	156,186	201,546	213,246	174,747	126,627
Discards[2]	-	-	-	-	-	-
Total catch	122,948	156,186	201,546	213,246	174,747	126,627

Country	1992[3]	1993	1994	1995[3]	1996	1997
Denmark	53,692	43,224	43,787	45,257	19,166	22,882
Faroe Islands	-	-		-	-	-
France	-[4]	4	14	+	-	3
Netherlands	-	-		-	-	-
Norway[1]	61,379	56,215	40,658	62,224	18,256	18,490
Sweden	508	711	1,010	2,081	693	427
UK (Scotland)	196	-[4]		-	-	-
Germany	-[4]	-[4]		-	-	4,576
Unallocated landings	-	-		-	-	-
Total landings	115,775	100,154	85,469	109,562	38,115	46,378
Discards[2]	-	-		-	-	-
Total catch	115,775	100,154	85,469	109,562	38,115	46,378

[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]Preliminary.
[4]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	1988	1989	1990	1991	1992
Denmark	190,555	136,239	105,614	138,555	125,229
Belgium	-	-	-	3	13
France	617	14,415[5]	10,289	4,120	2,313
Faroe Islands	-	-	-	-	-
Germany, Fed.Rep.	4,516	11,880	17,165	20,479	20,005
Netherlands[4]	37,192	47,388	28,402	26,266	26,987
Norway	38,566	11,758	12,207	9,852	16,240
Sweden	-	3,420	1,276	4,622	3,446
UK (England)	2,011	957	3,200	2,715	3,026
UK (Scotland)	15,317	9,651	10,381	14,587	16,707
Unallocated landings	1,969	-23,947[7]	-15,616[7]	3,180	-13,637[7]
Total landings	290,743	211,711	172,914	224,376	200,329
Discards[4]	-	1,900	2,560	1,072	1,900
Total catch	290,743	213,611	175,474	225,448	202,229

Country	1993	1994	1995	1996[6]	1997
Denmark	109,994	55,060	87,917	43,749	11,636
Belgium	-	-	-	-	-
France	2,086	5,492	7,639	2,373	6,069
Faroe Islands	-	-	-	-	-
Germany	23,628	14,796	21,707	11,052	7,456
Netherlands[4]	31,370	39,052	30,065	18,474	14,697
Norway	33,158	28,442	12,678	3,296	3,770
Sweden	3,699	2,256	1,929	-	209
UK (England)	3,804	7,337	9,688	2,757	2,033
UK (Scotland)	18,904	5,101	4,654	4,449	5,461
Unallocated landings	-16,415[7]	-26,988[7]	10,831[7]	-8,826[7]	-1,615[7]
Total landings	210,228	130,548	165,355	77,324	49,716
Discards[4]	245	460-	-	592	1,855
Total catch	210,473	131,008	165,455	77,916	51,571

[1]Includes catches misreported from Division IVc.
[2]Includes Division IVa catches.
[3]Included in Division IVa.
[4]Any discards prior to 1989 were included in unallocated.
[5]Includes catch in Division IVa.
[6]Preliminary.
[7]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	1988	1989	1990	1991	1992
Belgium	4	434	180	163	229
Denmark	-	509	265	948	4,296
France	7,456	14,670	9,718	17,112	9,560
Germany, Fed.Rep.	-	299	-	704	824
Netherlands	12,236	12,240	11,697	19,306	18,851
Norway	-	-	-	-	-
UK (England)	1,266	1,919	1,796	3,960	3,372
UK (Scotland)	-	-	-	67	-
Unallocated landings	31,442	47,523	32,076	15,763	34,649
Total landings	52,404	77,594	55,732	58,023	71,781
Discards[1]	-	1,200	5,350	2,662	2,200
Total catch	52,404	78,794	61,082	60,685	73,981
Coastal spring spawners included above	250	2,283	1,136	252	202

Country	1993	1994	1995	1996[2]	1997
Belgium	56	144	12	-	1
Denmark	995	2,695	2,441	1,344	1,246
France	7,171	10,777	11,433	6,950	8,091
Germany	649	4,964	4,996	997	1,349
Netherlands	19,204	20,159	23,730	13,824	13,528
Norway	-	-	-	-	-
UK (England)	11,307	3,016	1,896	1,733	1,388
UK (Scotland)	-	131	-	262	333
Unallocated landings	43,096	29,792	18,397	23,934	21,624
Total landings	82,478	71,678	62,905	49,044	47,559
Discards[1]	2,400	2,400	-	521	3,012
Total catch	84,878	74,078	62,905	49,565	50,571
Coastal spring spawners included above	201	215	203	168	

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

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

Catches in : 1997

Division	Quarter	0 1996	1 1995	2 1994	3 1993	4 1992	5 1991	6 1990	7 1989	8 1988	9+ 1987	Total	0+1 ring
	I	0.0	0.0	0.1	1.4	2.3	1.0	0.3	0.0	0.1	0.1	5.4	0.0
IVa	II	0.0	1.1	52.2	37.4	15.9	4.7	1.6	0.7	0.2	0.3	114.0	1.1
(West of 2E)	III	0.0	1.7	62.4	46.5	51.9	30.1	4.9	1.7	0.9	5.5	205.6	1.7
	IV	0.0	3.3	13.7	1.7	0.1	0.8	0.0	0.0	0.0	0.0	19.6	3.3
	Total	0.0	6.1	128.3	87.1	70.2	36.7	6.8	2.3	1.2	5.9	344.7	6.1
	I	0.0	1.5	5.9	32.8	41.4	8.5	1.4	0.7	2.4	0.0	94.6	1.5
IVa	II	0.0	5.2	61.4	14.3	9.7	2.7	1.6	0.4	0.4	0.3	95.8	5.2
(East of 2E)	III	0.0	1.2	9.5	9.5	5.7	2.4	0.5	0.1	0.4	0.4	29.7	1.2
	IV	0.0	5.0	14.0	29.8	18.6	7.9	3.6	0.9	2.7	0.0	82.5	5.0
	Total	0.0	12.8	90.8	86.4	75.5	21.4	7.1	2.1	5.8	0.7	302.6	12.8
	I	0.0	1.9	0.7	0.6	0.7	0.0	0.0	0.0	0.0	0.0	3.9	1.9
	II	0.0	55.0	27.8	21.8	9.4	2.0	0.8	1.9	0.0	0.0	118.7	55.0
IVb	III	203.9	22.9	19.9	16.2	44.6	21.3	3.8	1.8	0.3	2.0	336.7	226.8
	IV	159.4	67.1	25.1	34.7	7.0	0.4	1.2	0.8	0.4	0.0	296.1	226.5
	Total	363.3	146.8	73.5	73.3	61.7	23.8	5.8	4.5	0.7	2.0	755.4	510.1
	I	0.0	8.1	19.4	20.6	7.1	1.5	1.6	0.5	0.1	0.0	59.0	8.1
	II	0.0	0.0	0.4	0.8	0.3	0.1	0.1	0.0	0.0	0.0	1.6	0.0
IVc + VIId	III	0.0	0.0	1.6	1.6	0.3	0.1	0.0	0.0	0.0	0.0	3.6	0.0
	IV	0.3	1.5	158.0	155.8	32.6	5.4	1.7	1.4	1.4	0.3	358.3	1.8
													0.0
	Total	0.3	9.6	179.4	178.8	40.3	7.0	3.4	1.9	1.5	0.3	422.6	9.9
	I	0.0	11.5	26.1	55.4	51.6	11.1	3.4	1.2	2.6	0.1	163.0	11.5
Total	II	0.0	61.2	141.7	74.3	35.3	9.5	4.0	3.0	0.5	0.6	330.1	61.2
North	III	203.9	25.8	93.3	73.8	102.6	53.9	9.2	3.6	1.6	7.9	575.6	229.6
Sea	IV	159.6	76.9	210.8	222.1	58.3	14.5	6.5	3.1	4.5	0.3	756.5	236.5
	Total	363.5	175.3	471.9	425.6	247.7	88.9	23.1	10.9	9.2	8.9	1825.2	538.9

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Table 2.2.2 Numbers (millions) of herring caugth per age group (winter rings) in the North Sea ,1987-1997.

Year	Winter ring										
	0	1	2	3	4	5	6	7	8	9+	Total
1987	2018.7	3706.1	2062.8	705.1	493.7	255.5	77.7	24.5	8.1	8.3	9360.5
1988	1378.8	2184.4	2016.1	1214.7	408.5	267.5	132.1	38.9	15.5	8.6	7665.1
1989	2037.9	1984.0	970.5	1420.2	849.8	224.0	132.7	64.9	21.2	8.9	7714.1
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

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, 1987-1997.

Year	Winter ring										
	0	1	2	3	4	5	6	7	8	9+	Total
1987			35.5	35.0	25.0	8.9	2.8	0.7	0.1	0.1	108.1
1988			44.6	108.9	19.5	8.2	2.2	0.4			183.8
1989			27.3	52.7	38.3	11.6	8.7	3.8	1.7	0.2	144.3
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

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, (1987,1997).

Year	Winter ring										
	0	1	2	3	4	5	6	7	8	9+	Total
1987	6238.0	3153.0	117.0								9508.0
1998	1830.0	5792.0	292.0								7914.0
1989	1028.2	1170.5	654.8								2853.5
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

Table 2.2.5 Total catch (numbers in millions) per age of North Sea autumn spawning stock used for assessment, 1987-1997.

Year	Winter ring										
	0	1	2	3	4	5	6	7	8	9+	Total
1987	8256.7	6859.1	2144.3	670.1	468.7	246.6	74.9	23.8	8.0	8.2	18760.4
1988	3208.8	7976.4	2263.5	1105.8	389.0	259.3	129.9	38.5	15.5	8.6	15395.3
1989	3066.1	3154.5	1598.0	1367.5	811.5	212.4	124.0	61.1	19.5	8.7	10423.3
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	24.6	11.5	10.1	8.9	2567.9

Table 2.2.6 : North Sea catches in tonnes (subarea IV and Division VIId) for 1997.

	Catches(in tonnes)		
Area	allocated	unallocated	discards
IVa west	46 773	12 613	1 138
IVa east	46 378	-	-
IVb	51 331	-1 615	1 855
IVc & VIId	25 935	21 624	3 012
Total	170 417	32 622	6 005

Total catch in North Sea	209 044
IIIa autumn-spawners transferred to North Sea	39 844
Coastal spring spawners transferred to IIIa	-979
Total catch in The North Sea used for the assessment	247 909

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Table 2.2.7 Percentage age composition of North Sea Herring
(2-ringers and olders) in the catch.
Catches in : 1997

Division	age in W.Rings Quarter	2 1994	3 1993	Older >= 1992	Total (millions)
	I	2.1	25.5	72.4	5.4
IVa West	II	46.2	33.1	20.7	112.9
	III	30.6	22.8	46.6	203.9
	IV	83.8	10.6	5.6	16.3
	Total	37.9	25.7	36.4	338.6
	I	6.3	35.2	58.4	93.1
IV a East	II	67.7	15.7	16.6	90.7
	III	33.4	33.5	33.1	28.5
	IV	18.1	38.5	43.5	77.5
	Total	31.3	29.8	38.9	289.8
	I	34.2	29.2	36.6	2.0
IVb	II	43.6	34.3	22.1	63.7
	III	18.1	14.7	67.2	110.0
	IV	36.1	49.9	14.0	69.6
	Total	30.0	29.9	40.2	245.3
	I	38.1	40.5	21.3	50.9
IVc + VIId	II	24.8	48.5	26.7	1.6
	III	44.0	44.0	12.1	3.6
	IV	44.3	43.7	12.0	356.6
	Total	43.5	43.3	13.2	412.7
	I	6.7	34.6	58.7	100.6
IVa + IVb	II	52.9	27.5	19.6	267.3
	III	26.8	21.1	52.1	342.3
	IV	32.3	40.6	27.1	163.4
	Total	33.5	28.3	38.3	873.7
	I	17.2	36.6	46.2	151.5
Total	II	52.7	27.6	19.7	268.9
North	III	27.0	21.3	51.7	346.0
Sea	IV	40.5	42.7	16.8	520.0
	Total	36.7	33.1	30.2	1286.4

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Table 2.2.8 Catches (SOP,tons) of North Sea Herring, by quarter and division.
Catches in : 1997

		0	1	2	3	4	5	6	7	8	9+	SOP
Quarter	Division	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	Total
	IVa W	0	0	13	172	341	163	68	2	20	20	798
I	IVa E	0	87	624	4332	6542	1527	269	147	469	0	13998
	IVb	0	56	32	77	117	0	0	0	0	0	281
	IVc/VIId	0	210	1035	1910	868	228	246	90	17	4	4608
	Total	0	353	1704	6490	7868	1918	584	239	505	24	19685
	IVa W	0	72	6438	5514	3067	998	331	138	43	61	16662
II	IVa E	0	314	7344	2251	1876	583	368	94	87	85	13004
	IVb	0	995	3108	2974	1520	360	174	387	0	0	9519
	IVc/VIId	0	0	27	76	33	9	10	4	1	0	159
	Total	0	1381	16918	10815	6496	1950	884	624	131	147	39344
	IVa W	0	120	8396	8673	12084	7898	1330	466	267	1709	40942
III	IVa E	0	87	1221	1727	1202	546	122	25	94	141	5166
	IVb	2447	800	2679	2944	9565	4933	998	501	86	593	25545
	IVc/VIId	0	1	166	220	56	10	3	3	2	0	461
	Total	2447	1008	12462	13563	22907	13388	2453	994	448	2444	72114
	IVa W	0	261	1518	227	9	129	3	1	2	0	2151
IV	IVa E	0	453	1944	4741	3603	1732	860	214	644	0	14190
	IVb	2868	3090	3123	5239	1182	134	243	135	101	0	16116
	IVc/VIId	5	116	16449	21498	5448	1018	275	277	235	44	45367
	Total	2873	3920	23033	31706	10243	3013	1382	627	982	44	77824
Total N. Sea	1997	5320	6662	54118	62573	47513	20268	5303	2484	2067	2658	208966

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

North Sea Autumn Spawners

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

NB: ***All reported catches of North Sea autumn spawners taken in the North Sea and Div. IIIa***

	Fleet A		Fleet B		Fleet C		Fleet D		Fleet E		TOTAL	
Total Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight
0			363.53	14.3	8.85	21.1	83.55	19.2	1.21	21.8	457.14	15.4
1	18.41	79.5	156.89	33.1	249.04	31.8	83.71	18.1	18.85	41.9	526.90	32.1
2	445.92	117.8	23.78	60.9	156.04	83.8	13.84	57.2	40.69	27.7	680.26	101.4
3	419.46	147.8	4.84	85.3	67.27	130.4	2.19	116.0	2.03	80.2	495.78	144.4
4	245.58	192.0	0.62	136.7	11.81	169.6	0.22	134.6	0.26	90.1	258.49	190.6
5	85.90	230.5	2.60	151.3	5.48	183.3	0.16	150.5	0.02	81.3	94.16	225.4
6	22.83	230.1	0.07	146.0	1.68	191.8	0.06	147.9	0.03	208.0	24.67	227.0
7	10.80	228.2			0.66	194.0	0.02	170.6	0.01	229.0	11.49	226.1
8+	17.90	259.8			0.89	201.4	0.01	241.0	0.01	205.0	18.81	257.0
TOTAL	1,266.79		552.33		501.72		183.74		63.12		2,567.70	
Land. (SOP)(t)		195,284		12,757		33,584		4,237		2,144		248,007

Table 2.2.10 **Total catch in the North Sea and Div. IIIa** **1997**

North Sea Autumn Spawners

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

NB: ***Same as Table 2.2.9 but Fleet A is raised with 50,000 tons.***

	Fleet A		Fleet B		Fleet C		Fleet D		Fleet E		TOTAL	
Total Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight
0			363.53	14.3	8.85	21.1	83.55	19.2	1.21	21.8	457.14	15.4
1	23.13	79.5	156.89	33.1	249.04	31.8	83.71	18.1	18.85	41.9	531.61	32.5
2	560.09	117.8	23.78	60.9	156.04	83.8	13.84	57.2	40.69	27.7	794.44	103.7
3	526.85	147.8	4.84	85.3	67.27	130.4	2.19	116.0	2.03	80.2	603.18	145.0
4	308.46	192.0	0.62	136.7	11.81	169.6	0.22	134.6	0.26	90.1	321.37	190.9
5	107.90	230.5	2.60	151.3	5.48	183.3	0.16	150.5	0.02	81.3	116.15	226.3
6	28.67	230.1	0.07	146.0	1.68	191.8	0.06	147.9	0.03	208.0	30.52	227.6
7	13.57	228.2			0.66	194.0	0.02	170.6	0.01	229.0	14.26	226.5
8+	22.48	259.8			0.89	201.4	0.01	241.0	0.01	205.0	23.39	257.5
TOTAL	1,591.14		552.33		501.72		183.74		63.12		2,892.05	
Land. (SOP)(t)		245,284		12,757		33,584		4,237		2,144		298,007

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Table 2.2.11 Sampling of commercial landings in1997
Number of fish measured and aged by quarter.
(Divisions IV and VIId)

Country	Quarter	Landings in ' 000 tons	Number of samples	Number of fish measured	aged
Denmark	I	14.5	9	431	410
	II	1.3	6	39	39
	III	5.1	12	349	256
	IV	16.8	25	866	623
	Total	37.7	52	1685	1328
France	I	1.2	0	0	0
	II	0.1	0	0	0
	III	4.4	0	0	0
	IV	8.7	0	0	0
	Total	14.5	0	0	0
Germany	I	0.4	0	0	0
	II	0.1	0	0	0
	III	6.2	0	0	0
	IV	6.7	0	0	0
	Total	13.5	0	0	0
Norway	I	0.1	25	1373	275
	II	27.6	95	6812	3347
	III	10.3	54	3386	2525
	IV	5.6	64	2373	175
	Total	43.6	238	13944	6322
Sweden	I	0.0	0	0	0
	II	1.2	0	0	0
	III	1.0	0	0	0
	IV	0.0	0	0	0
	Total	2.3	0	0	0
The Netherlands	I	2.8	12	1491	300
	II	6.2	4	495	100
	III	21.2	16	1633	400
	IV	38.5	23	2875	575
	Total	68.7	55	6494	1375
U.K (England)	I	0.2	0	0	0
	II	0.0	0	0	0
	III	2.0	0	0	0
	IV	1.2	0	0	0
	Total	3.5	0	0	0
U.K (Scotland)	I	0.0			
	II	2.6	11	2564	712
	III	20.2	32	3523	1366
	IV	0.1			
	Total	22.9	43	6087	2078
All Countries	I	19.2	46	3295	985
	II	39.2	116	9910	4198
	III	70.4	114	8891	4547
	IV	77.7	112	6114	1373
	Total	206.6	388	28210	11103

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Table 2.3.1 IBTS 1-ringer indices (1st quarter)

Year class	Year of sampling	1-ringer index
1977	1979	172
1978	1980	312
1979	1981	431
	1982	772
	1983	1260
	1984	1443
	1985	2083
	1986	2542
	37	3684
	38	4530
	39	2313
		1016
		1159
		1162
		2943
		1667
1993	1995	188
		9
		2
		4

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

Table 2.4.1 Numbers (millions) of Autumn Spawning Herring and percentage mature (combined acoustic survey 1997)

	IIIa	IVa	IVb	Total NS	Mat NS
0	919.06	0.00	942.87	1861.93	0.00
1	1444.65	1351.76	6619.38	9415.80	0.00
2	322.71	4620.76	1419.13	6362.59	65.10
3	131.61	2584.81	570.93	3287.35	94.16
4	3.62	1641.57	50.49	1695.67	100.00
5	15.55	624.16	52.42	692.12	100.00
6	14.44	204.95	39.76	259.16	100.00
7	1.90	75.96	0.78	78.63	100.00
8	1.13	69.72	7.48	78.33	100.00
9+	0.00	158.28	0.00	158.28	100.00
Imm	2544.82	3095.43	8050.15	13690.40	
Mature	309.85	8236.53	1653.08	10199.47	
Total	2854.67	11331.96	9703.24	23889.87	

Table 2.4.2 Biomass (thousands of tonnes) of Autumn Spawning Herring and percentage mature (combined acoustic survey 1997)

	IIIa	IVa	IVb	Total NS	Mat NS
0	3.93	0.00	4.61	8.53	0.00
1	64.03	74.44	271.84	410.31	0.00
2m	25.69	600.26	127.93	753.88	72.25
3m	14.62	462.09	70.14	546.85	95.18
4	0.47	376.77	8.29	385.53	100.00
5	2.55	165.18	7.93	175.66	100.00
6	2.40	53.53	6.06	61.99	100.00
7	0.22	19.05	0.09	19.36	100.00
8	0.15	19.84	1.09	21.09	100.00
9+	0.00	52.12	0.00	52.12	100.00
Imm	79.06	261.19	305.61	645.86	
Mature	31.06	1562.09	187.77	1780.93	
Total	114.06	1823.28	497.99	2435.32	

Table 2.4.3 Mean Weights (g) of Autumn Spawning Herring (combined acoustic survey 1997)

	IIIa	IVa	IVb	Total NS
0	4.27		4.89	4.58
1	44.32	55.07	41.07	43.58
2	79.61	129.90	90.15	118.49
3	111.07	178.77	122.86	166.35
4	130.44	229.52	164.26	227.36
5	164.20	264.64	151.30	253.80
6	165.98	261.18	152.41	239.19
7	114.04	250.83	114.28	246.18
8	136.84	284.56	146.25	269.22
9+		329.30		329.30
Imm	31.07	84.38	37.96	47.18
Mature	100.25	189.65	113.59	174.61
Total	39.95	160.90	51.32	101.94

Table 2.4.4 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 1997 estimates are from the summer survey in Divisions IVa,b, and IIIa excluding estimates of Division IIIa/Baltic spring spawners.

Age (rings)	Numbers (millions)													
	Year													
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
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
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
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
4	394	323	833	657	528	1,612	3,370	2,102	1,397	909	429	656	1,087	1,696
5	158	113	135	368	349	488	1,349	1,984	1,510	795	363	272	310.9	692.1
6	44	41	36	77	174	281	395	748	1,311	788	321	175	98.75	259.2
7	52	17	24	38	43	120	211	262	474	546	238	135	82.83	78.63
8	39	23	6	11	23	44	134	112	155	178	220	110	133	78.33
9+	41	19	8	20	14	22	43	56	163	116	132	84	206	158.3
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
Z(2+/3+)		0.92	0.57	1.01	0.81	0.11	0.11	0.56	0.37	0.73	1.17	0.55	0.43	0.40
Smoothed Z(2+/3+)		0.79	0.78	0.76	0.60	0.34	0.26	0.35	0.56	0.76	0.82	0.80	0.55	0.41
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

SSB defined as all fish >maturity stage III.

Table 2.5.1: Estimated abundance of herring larvae < 10 mm long, by standard sampling area standard 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	1095	3369	44		167	87	134	23	2	36	
1973	2034	801	3	5	492	828	1211	151			1
1974	761	406	96	283	81		1184			9	
1975	326	45	312			90	77	6			
1976	541	79		1	65	110		9		4	
1977	1157	225	124	34	520	260	87	4	1		
1978	2991	45		162	1405	82	292	1	33	3	
1979	2876	2346	201	8	657	132	507	6		111	77
1980	3660	713	21	1	341	215	9	13	95	64	24
1981	3729	283	3	12	902	236	20		1456		59
1982	2350	1109	341	318	87	64	1076	23	711	275	53
1983	2481	901	3651	849	1461	284	63		71	244	58
1984	1751	1803	2325	2306	731	2403	825	494	526	169	29
1985	6371	3374	2292	1598	130	13148	1800	209	1847	313	34
1986	3510	1815	3684	342	1612	7562	191	35	782	122	22
1987	7395	1810	2555	696	797	6551	1991	113	845	302	125
1988	7453	8475	6818	5238	8966	4901	1900	208	417	113	85
1989	11434	5528	5885	626	1442	5841	2337	2	1326	1784	303
1990		9889	4592	2044	20357	1400	974		2284	1174	
1991	1005	2397		2048	4943	2419	1255		4301	930	
1992	190	4812		848	11	323	165		190	1250	
1993		67		175		762	88		1351	931	
1994	26	1163				1785	44		537	469	
1995		8693					42		71	221	156
1996		809		186		640			221	510	543
1997		6701		27					(2887744)	903	1801

,() value in bracket was discarded for MLAI calculation

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Table 2.5.2: Analyses of variance of model fit

Larvae less 10 mm, outlier included

	SSQ	d.f.	MS
Total	1134.80	224	5.07
Due to sampling units	274.00	10	27.40
Due to years	376.50	25	15.06
Residual	484.30	189	2.56

Larvae less 10 mm, outlier excluded

	SSQ	d.f.	MS
Total	1052.20	223	4.72
Due to sampling units	273.50	10	27.35
Due to years	344.20	25	13.77
Residual	434.30	188	2.31

Larvae 10 to 15 mm

	SSQ	d.f.	MS
Total	736.70	229	3.22
Due to sampling units	151.90	10	15.19
Due to years	336.80	25	13.47
Residual	248.00	194	1.28

Larvae 5 to 15, outlier included

	SSQ	d.f.	MS
Total	924.09	232	3.98
Due to sampling units	160.10	10	16.01
Due to years	424.60	25	16.98
Residual	339.42	197	1.72

Larvae 5 to 15, outlier excluded

	SSQ	d.f.	MS
Total	855.96	231	3.71
Due to sampling units	169.90	10	16.99
Due to years	394.10	25	15.76
Residual	292.01	196	1.49

Table 2.5.3: MLAI since 1973 obtained from a multiplicative model

Year	MLAI
1973	740.78
1974	882.27
1975	379.33
1976	163.53
1977	420.82
1978	484.69
1979	1290.39
1980	484.83
1981	746.28
1982	2000.20
1983	2586.34
1984	5563.60

Year	MLAI
1985	7623.57
1986	4188.09
1987	7547.71
1988	12076.30
1989	9045.29
1990	18069.85
1991	9828.09
1992	1540.71
1993	2088.08
1994	1221.82
1995	2373.21
1996	3797.13
1997	8510.02

Table 2.6.1. The IBTS time series of herring abundance at age as estimated in the fisrt quarter.

		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	195	46	14	9
1997	391	85	26	18
1998	743	90	20	19

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

Cathes in : 1997

		0	1	2	3	4	5	6	7	8	9+
Division	Quarter	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987
IVa (W of 2E)	I			114	124	146	158	202	210	190	156
	II		67	123	147	193	210	211	208	239	196
	III		72	135	186	233	262	271	280	299	311
	IV		78	111	131	170	157	245	227	281	
	Total		75	128	168	221	250	254	259	281	302
IVa (E of 2 E)	I		59	106	132	158	179	191	210	198	
	II		61	120	158	192	219	234	220	244	299
	III		72	128	181	211	229	262	242	257	343
	IV		91	139	159	193	220	239	247	236	
	Total		73	123	151	175	205	230	229	222	325
IVb	I		29	46	130	158					
	II		18	112	136	162	178	223	205		
	III	12	35	135	182	214	231	262	278	258	296
	IV	18	46	124	151	170	312	207	165	281	
	Total	15	34	122	153	201	228	245	227	270	296
IVc + VIId	I		26	53	93	123	151	151	169	160	198
	II			68	97	119	148	151	168	151	
	III		79	104	138	167	189	161	203	165	155
	IV	18	78	104	138	167	189	161	203	165	155
	Total	18	34	99	133	159	180	156	193	165	158
IVa	Total		74	126	159	197	234	241	245	232	304
IVa + IVb	I		42	100	132	157	177	193	210	198	156
	II		23	120	146	184	206	223	208	242	245
	III	12	39	134	185	223	248	266	278	281	309
	IV	18	50	125	154	187	219	231	208	242	
	Total	15	38	125	157	198	232	243	236	236	302
Total North Sea	I		31	65	117	153	173	173	192	196	162
	II		23	119	146	184	206	221	207	242	245
	III	12	39	134	184	223	248	266	278	280	309
	IV	18	51	109	143	176	208	213	206	217	155
	Total	15	38	115	147	192	228	230	228	224	297

Table 2.7.2 Comparison between mean weights (g) at age in catch of North Sea Herring (adults) from earlier years and 1985-1997.

		Age in winter rings							
Division	Year	2	3	4	5	6	7	8	9+
IVa	1989	129	157	175	210	233	246	268	256
	1990	123	154	177	194	229	234	251	295
	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
IVb	1989	93	162	199	225	280	276	273	333
	1990	102	145	194	219	250	272	259	277
	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
IVa+IVb	1988	112	147	176	199	217	238	257	263
	1989	116	158	179	212	237	250	269	259
	1990	113	152	181	198	232	238	252	290
	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
IVc+VIId	1988	103	132	156	178	197	185	165	
	1989	110	127	151	182	198	201	198	179
	1990	118	131	152	171	195	216	208	231
	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
Total North Sea	1988	111	145	174	197	216	237	253	263
	1989	115	153	173	208	231	247	265	259
	1990	114	149	177	193	229	236	250	287
	1991	130	166	184	203	217	235	259	271
	1992	103	175	189	207	223	237	249	287
	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

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Table 2.7.3 Herring mean weight at age in the third quarter, in Didision 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	1991	1992	1993	1994	1995	1996	1997
1	73	51	53	55	52	10	38	65	78	69	60	58	44	44
2	164	127	145	131	151	126	125	158	142	115	138	132	118	119
3	189	200	161	164	190	165	157	198	209	147	209	180	196	166
4	210	215	179	192	221	203	198	224	219	202	220	200	253	227
5	229	235	199	218	231	219	232	236	243	225	251	195	262	236
6	246	252	221	245	277	240	243	260	255	277	289	228	299	239
7	276	276	239	258	276	258	236	275	272	286	315	257	305	246
8	296	286	240	277	316	259	236	298	312	305	323	302	324	269
9+	293	330	283	292	316	281	302	317	311	340	346	324	335	329

Table 2.8.1 input parameters of the final ICA assessments for the years 1995-1998.

Assessment year	1998	1997	1996	1995
First data year	1960	1960	1976	1976
Last data year	1997	1996	1995	1994
No of years for separable constraint ?	6	5	4	3
Reference age for separable constraint	4	4	4	4
Constant selection pattern model (Y/N)	s1 (92-95), s2(96-97)-constrained	y	na	na
S to be fixed on last age	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*	1998	1997	1996	1995
Year ranges for survey indices	MLAI		77-96	77-96	76-95	
	LPE					83-93
	Acoustic survey	2-9+	89-97	89-96	89-95	89-94
	IBTSA	2-5+	83-98	83-97	83-96	83-95
	IBTSY	1	79-98	79-97	79-96	79-95
	MIK	0	77-98	77-97	77-96	78-95
Catchability models	MLAI		power	power	power	
	LPE					linear
	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			1998	1997	1996	1995
Relative weights in catch at age matrix			all 1	all 1, except age 0 (96)=0.01 and age 1(96)=0.01	all 1	all 1 except age 0 = 0.01 and age 1=0.5
Total weight catch at age matrix			42	33	28	21
Survey indices weights	MLAI		1.0	1.0	1.0	
	LPE					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	1.0
Parameters to be estimated			53	44	?	?
Number of observations			289	265	?	?

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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 1998  used for the year 1997
west
Natural mortality in 1998  used for the year 1997
natmor
Maturity ogive in 1998  used for the year 1997
matprop
Name of age-structured index file (Enter if none) : -->age
File not found: age
Name of age-structured index file (Enter if none) : -->fleet
Name of the SSB index file (Enter if none) -->ssb
No of years for separable constraint ?--> 6
Reference age for separable constraint ?--> 4
Constant selection pattern model (Y/N) ?-->n
Enter last year in which selection is constant--> 1995
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
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.
Enter the lag in years (rounded up)--> 1
Enter lowest feasible F-->   5.0000000000000003E-02
Enter highest feasible F-->    1.000000000000000
----------------------------------------------------------------
No of years for separable analysis : 6
Age range in the analysis : 0  . . . 9
Year range in the analysis : 1960  . . . 1997
Number of indices of SSB : 1
Number of age-structured indices : 4
Stock-recruit relationship to be fitted.
Parameters to estimate : 53
Number of observations : 289

Two selection vectors to be fitted.
Selection assumed constant up to and including : 1995
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 1997  at age 4  is 0.290533  in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->D
 Output page width in characters (e.g. 80..132) ?--> 100
 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 final ICA run for North Sea autumn spawning herring (Division IV, VIId and IIIa)

Catch in Number

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

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

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

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

x 10 ^ 6

Predicted Catch in Number

AGE	1992	1993	1994	1995	1996	1997
0	8993.5	9680.5	5585.7	9008.8	1530.1	722.9
1	1778.5	3340.8	2643.3	1951.4	956.1	923.7
2	1213.3	1425.4	1992.2	1976.5	636.0	741.6
3	621.7	700.4	595.6	1055.5	520.8	334.7
4	417.0	321.1	259.0	280.5	246.4	211.9
5	386.7	198.9	109.0	112.6	59.4	91.8
6	318.9	207.3	76.4	53.5	26.9	24.3
7	139.4	176.1	82.2	38.7	13.2	11.3
8	38.9	85.8	78.2	46.3	10.9	6.3

x 10 ^ 6

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
0	0.01000	0.00600	0.00900	0.01600	0.01600
1	0.03300	0.05600	0.04800	0.01000	0.03200
2	0.11500	0.13000	0.13600	0.12300	0.10100
3	0.14500	0.15900	0.16700	0.16000	0.14400
4	0.18900	0.18100	0.19600	0.19200	0.19100
5	0.20400	0.21400	0.20000	0.20700	0.22500
6	0.22800	0.24000	0.24700	0.21100	0.22700
7	0.24400	0.25500	0.24900	0.25200	0.22600
8	0.25600	0.27300	0.27800	0.25400	0.22200
9	0.31000	0.28100	0.28700	0.28100	0.29700

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
0	0.00900	0.00800	0.00600	0.00400	0.00400
1	0.07000	0.06400	0.05500	0.04900	0.04400
2	0.13200	0.12800	0.12900	0.12300	0.11800
3	0.18600	0.17700	0.19300	0.18100	0.18100
4	0.21300	0.20700	0.22300	0.22700	0.24000
5	0.23900	0.22300	0.23500	0.23700	0.25800
6	0.27400	0.26500	0.27200	0.25500	0.26900
7	0.29100	0.28600	0.29200	0.27000	0.27600
8	0.31300	0.31000	0.31700	0.29900	0.29700
9	0.33200	0.33700	0.33500	0.32900	0.33200

Natural Mortality (per year)

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	1.0000	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	1.0000
2	0.3000	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	0.2000
4	0.1000	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	0.1000
6	0.1000	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	0.1000
8	0.1000	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	0.1000

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	1.0000	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	1.0000
2	0.3000	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	0.2000
4	0.1000	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	0.1000
6	0.1000	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	0.1000
8	0.1000	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	0.1000

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	1.0000	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	1.0000
2	0.3000	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	0.2000
4	0.1000	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	0.1000
6	0.1000	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	0.1000
8	0.1000	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	0.1000

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

Proportion of fish spawning

AGE	1960	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
0	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.4700	0.7200	0.7300	0.6100	0.6500
3	0.6300	0.8600	0.9500	0.9800	0.9400
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000

INDICES OF SPAWNING BIOMASS

MLAI < 10 mm

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	2.07	3.41	4.61	3.26	6.68	12.65	17.99	27.99	42.35	22.76	40.08

	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	72.10	85.88	112.60	56.04	11.73	25.08	15.74	25.87	45.88

AGE-STRUCTURED INDICES

ACO89: acoustic survey 2-9+

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

x 10 ^ 3

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
2	1090.0	1285.0	195.0	391.0	743.0
3	199.0	152.0	46.0	85.0	90.0
4	64.0	46.0	14.0	26.0	20.0
5	40.0	9.0	9.0	18.0	19.0

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
1	1020.0	1160.0	1160.0	2940.0	1667.0	1186.0	1729.0	4192.0	2054.0

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

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	0.2551	0.1291	0.0896	0.1240	0.3084	0.2461	0.1852	0.2980	0.3002	0.3291	0.2680
2	0.4279	0.6141	0.2496	0.2974	0.3889	0.7753	0.5919	0.4222	1.3265	0.7842	0.9727
3	0.3191	0.3426	0.6212	0.2746	0.4121	0.7386	0.7082	0.8043	1.8710	0.9110	1.2661
4	0.3232	0.3920	0.4045	0.2238	0.3687	0.7759	0.5713	0.9244	1.0704	0.8724	1.3241
5	0.2475	0.3784	0.5005	0.1425	0.3022	0.6553	0.8326	0.8263	1.2339	1.0511	0.8715
6	0.2952	0.3453	0.7314	0.1659	0.2223	0.5056	0.3858	1.0038	1.1697	1.9002	1.0710
7	0.5289	0.2313	0.5415	0.2372	0.2515	0.4156	0.3719	1.4832	1.5641	1.2809	4.0804
8	0.4409	0.4204	0.5163	0.2619	0.4258	0.7078	0.6194	0.9776	1.4272	1.2108	1.6363
9	0.4409	0.4204	0.5163	0.2619	0.4258	0.7078	0.6194	0.9776	1.4272	1.2108	1.6363

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.0339	0.0583	0.0460	0.0747	0.1514	0.1436	0.0962	0.0449	0.0834	0.1251	0.4805
1	0.6019	0.5777	0.6736	0.4493	0.6852	0.2380	0.2895	0.1970	0.1643	0.1127	0.2838
2	0.8823	0.8114	1.0201	1.0273	1.2944	1.3236	0.2124	0.0235	0.0930	0.3571	0.3224
3	1.2143	0.8008	1.3303	0.9678	1.4974	1.3657	1.3505	0.0398	0.0644	0.4096	0.2685
4	1.2235	0.7989	0.9858	0.9859	1.3493	1.6985	0.3835	0.0955	0.0874	0.2860	0.2937
5	1.0682	0.5465	0.9493	1.1791	1.8182	1.4868	1.1009	0.0145	0.0477	0.2440	0.3909
6	2.5364	0.5012	1.3579	1.0718	1.2508	0.9474	0.6027	0.0660	0.0108	0.0609	0.3843
7	2.5489	0.0898	0.7572	0.7424	1.9691	1.3953	0.5629	0.0458	0.3582	0.0878	0.8227
8	1.7408	0.7804	1.2724	1.1222	1.7217	1.3932	0.7688	0.1185	0.1688	0.2720	0.5062
9	1.7408	0.7804	1.2724	1.1222	1.7217	1.3932	0.7688	0.1185	0.1688	0.2720	0.5062

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	0.3332	0.3983	0.2255	0.0852	0.0623	0.1624	0.1248	0.1248	0.0603	0.1105	0.2419
1	0.2240	0.2505	0.2043	0.3808	0.3156	0.3752	0.5851	0.4312	0.4280	0.3172	0.2661
2	0.2586	0.3004	0.3126	0.4019	0.4558	0.4059	0.3597	0.4042	0.3775	0.5230	0.5556
3	0.5044	0.3212	0.4261	0.6645	0.5176	0.4992	0.4004	0.4170	0.3776	0.4557	0.6658
4	0.2392	0.4311	0.5288	0.7268	0.5713	0.5794	0.5694	0.5549	0.4799	0.4730	0.7011
5	0.1482	0.2642	0.6141	0.6452	0.5388	0.5963	0.6441	0.6308	0.4987	0.5044	0.6354
6	0.1351	0.3272	0.3398	0.7001	0.6919	0.6048	0.6340	0.6602	0.4595	0.4758	0.6178
7	0.1963	0.3573	0.6379	0.5093	0.7480	0.5500	0.6292	0.6270	0.6064	0.3800	0.6105
8	0.3185	0.4117	0.5294	0.7184	0.6803	0.6546	0.7342	0.6865	0.6071	0.5688	0.7011
9	0.3185	0.4117	0.5294	0.7184	0.6803	0.6546	0.7342	0.6865	0.6071	0.5688	0.7011

AGE	1993	1994	1995	1996	1997
0	0.2918	0.2634	0.3043	0.0414	0.0270
1	0.3210	0.2897	0.3348	0.1101	0.0718
2	0.6702	0.6049	0.6990	0.3050	0.1988
3	0.8032	0.7250	0.8377	0.4255	0.2773
4	0.8458	0.7634	0.8821	0.4458	0.2905
5	0.7664	0.6918	0.7994	0.4041	0.2634
6	0.7453	0.6727	0.7773	0.3920	0.2555
7	0.7364	0.6647	0.7681	0.3869	0.2522
8	0.8458	0.7634	0.8821	0.4458	0.2905
9	0.8458	0.7634	0.8821	0.4458	0.2905

Population Abundance (1 January)

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	12.11	108.89	46.28	47.66	62.79	34.90	27.86	40.26	38.70	21.59	41.09
1	16.47	4.34	39.32	16.94	17.27	22.81	12.75	10.03	14.44	13.75	7.88
2	3.76	4.69	1.40	13.23	5.51	4.67	6.56	3.90	2.74	3.93	3.64
3	7.90	1.82	1.88	0.81	7.28	2.76	1.59	2.69	1.89	0.54	1.33
4	0.63	4.70	1.05	0.83	0.50	3.95	1.08	0.64	0.99	0.24	0.18
5	0.80	0.41	2.87	0.64	0.60	0.32	1.64	0.55	0.23	0.31	0.09
6	0.46	0.57	0.26	1.58	0.50	0.40	0.15	0.65	0.22	0.06	0.10
7	0.32	0.31	0.36	0.11	1.21	0.36	0.22	0.09	0.21	0.06	0.01
8	0.38	0.17	0.22	0.19	0.08	0.85	0.22	0.14	0.02	0.04	0.02
9	0.42	0.27	0.23	0.23	0.17	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	10.15	21.76	2.93	2.78	4.39	4.66	10.65	16.81	37.97
1	14.59	11.50	7.24	3.57	7.43	0.93	0.89	1.47	1.64	3.60	5.46
2	2.22	2.94	2.37	1.36	0.84	1.38	0.27	0.24	0.44	0.51	1.18
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	0.07
7	0.03	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.02	0.03
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
9	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	64.97	61.99	53.66	80.98	97.01	85.71	42.25	40.82	35.03	35.78	64.93
1	8.64	17.13	15.31	15.75	27.36	33.53	26.81	13.72	13.25	12.13	11.79
2	1.51	2.54	4.90	4.59	3.96	7.34	8.48	5.49	3.28	3.18	3.25
3	0.64	0.86	1.39	2.66	2.28	1.86	3.62	4.38	2.72	1.67	1.40
4	0.17	0.31	0.51	0.75	1.12	1.11	0.92	1.99	2.36	1.52	0.86
5	0.11	0.12	0.18	0.27	0.33	0.57	0.56	0.47	1.03	1.32	0.86
6	0.06	0.09	0.08	0.09	0.13	0.17	0.29	0.27	0.23	0.57	0.72
7	0.05	0.04	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
0	59.10	37.35	52.99	59.44	42.84	20.87
1	18.75	16.24	10.56	14.38	20.98	15.34
2	3.32	5.01	4.47	2.78	4.74	7.18
3	1.38	1.26	2.02	1.65	1.52	2.88
4	0.59	0.51	0.50	0.72	0.88	0.94
5	0.39	0.23	0.21	0.19	0.42	0.60
6	0.41	0.16	0.10	0.09	0.11	0.29
7	0.35	0.18	0.08	0.04	0.05	0.08
8	0.16	0.15	0.08	0.03	0.03	0.04
9	0.08	0.09	0.13	0.05	0.04	0.04

x 10 ^ 9

Weighting factors for the catches in number

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

Predicted SSB Index Values

MLAI < 10 mm

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	1719.	2427.	4176.	5227.	8136.	12031.	19803.	34201.	35953.	36873.	43267.

	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	57671.	65071.	58388.	47360.	33296.	21133.	24874.	25206.	23592.

x 10 ^ -3

Predicted Age-Structured Index Values

ACO89: acoustic survey 2-9+ Predicted

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997
2	5709.4	3458.9	3094.3	3107.9	2983.5	4658.3	3951.6	3051.1	5513.9
3	5595.9	3544.9	2082.0	1554.1	1426.3	1357.6	2051.6	2092.7	2093.1
4	2714.6	3364.6	2177.9	1089.3	683.2	616.7	569.6	1040.1	1391.0
5	693.7	1628.0	2080.3	1257.0	527.9	323.2	285.4	310.5	745.7
6	407.7	387.8	957.2	1128.4	599.3	246.9	147.6	153.5	215.1
7	209.7	193.8	228.5	493.3	509.0	265.5	106.8	75.1	100.0
8	72.4	122.0	116.2	141.1	253.5	258.6	130.5	63.7	57.9
9	33.4	52.0	60.9	87.3	127.3	159.2	210.0	109.6	83.8

x 10 ^ 3

IBTSA: 2-5+ Predicted

AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	349.0	672.7	623.0	533.6	995.1	1155.8	744.9	446.2	424.6	432.4	435.8
3	75.9	120.7	223.5	195.0	159.7	314.9	380.1	236.8	143.8	117.3	114.2
4	17.9	28.9	41.0	62.8	62.2	51.8	111.7	134.1	86.6	47.7	31.8
5	11.5	13.9	16.4	19.3	29.1	33.8	32.3	51.8	74.3	70.1	47.0

AGE	1994	1995	1996	1997	1998
2	661.9	584.4	381.6	659.2	999.5
3	105.1	166.6	142.6	134.0	254.0
4	27.7	26.9	40.9	51.2	54.7
5	27.8	20.3	14.2	23.3	37.7

IBTSY: 1-wr Predicted

AGE	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	183.5	405.9	601.5	959.6	1895.8	1705.0	1715.8	3003.7	3654.5	2845.7	1484.9

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	1435.0	1331.7	1302.1	2057.8	1788.7	1156.7	1619.9	2375.0	1736.3

MIK: MIK 0-wr Predicted

AGE	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	11.08	11.84	26.90	42.25	91.31	159.11	150.60	133.19	204.57	245.78	214.45

AGE	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	106.21	102.60	88.76	90.10	160.84	145.48	92.29	130.25	150.99	109.00	53.10

Fitted Selection Pattern

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	0.0795	0.0474	0.0120	0.0661	0.0341	0.0092	0.0375	0.0277	0.0325	0.0094	0.0265
1	0.7891	0.3293	0.2216	0.5541	0.8365	0.3172	0.3242	0.3223	0.2805	0.3772	0.2024
2	1.3237	1.5664	0.6171	1.3286	1.0547	0.9993	1.0361	0.4567	1.2393	0.8988	0.7346
3	0.9871	0.8739	1.5359	1.2269	1.1178	0.9519	1.2396	0.8700	1.7480	1.0442	0.9562
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.7657	0.9653	1.2375	0.6365	0.8196	0.8446	1.4573	0.8939	1.1528	1.2047	0.6582
6	0.9132	0.8807	1.8083	0.7410	0.6030	0.6517	0.6752	1.0859	1.0928	2.1780	0.8089
7	1.6362	0.5900	1.3387	1.0595	0.6820	0.5357	0.6509	1.6045	1.4612	1.4681	3.0817
8	1.3642	1.0724	1.2764	1.1698	1.1548	0.9123	1.0841	1.0576	1.3334	1.3878	1.2358
9	1.3642	1.0724	1.2764	1.1698	1.1548	0.9123	1.0841	1.0576	1.3334	1.3878	1.2358

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.0277	0.0730	0.0466	0.0758	0.1122	0.0846	0.2510	0.4703	0.9541	0.4376	1.6358
1	0.4919	0.7232	0.6832	0.4557	0.5078	0.1401	0.7549	2.0624	1.8804	0.3942	0.9662
2	0.7211	1.0157	1.0347	1.0420	0.9593	0.7792	0.5539	0.2457	1.0645	1.2485	1.0978
3	0.9925	1.0024	1.3494	0.9817	1.1098	0.8041	3.5217	0.4165	0.7368	1.4323	0.9142
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8730	0.6842	0.9629	1.1960	1.3475	0.8753	2.8707	0.1518	0.5456	0.8531	1.3310
6	2.0730	0.6274	1.3774	1.0871	0.9270	0.5578	1.5717	0.6912	0.1238	0.2130	1.3085
7	2.0832	0.1124	0.7680	0.7531	1.4593	0.8215	1.4679	0.4797	4.0994	0.3071	2.8009
8	1.4228	0.9770	1.2906	1.1383	1.2760	0.8202	2.0048	1.2408	1.9321	0.9512	1.7234
9	1.4228	0.9770	1.2906	1.1383	1.2760	0.8202	2.0048	1.2408	1.9321	0.9512	1.7234

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	1.3930	0.9240	0.4264	0.1173	0.1091	0.2802	0.2191	0.2249	0.1257	0.2336	0.3450
1	0.9365	0.5812	0.3863	0.5240	0.5524	0.6476	1.0275	0.7772	0.8919	0.6707	0.3795
2	1.0809	0.6969	0.5911	0.5530	0.7979	0.7006	0.6317	0.7284	0.7867	1.1058	0.7924
3	2.1084	0.7451	0.8058	0.9144	0.9060	0.8615	0.7031	0.7516	0.7868	0.9636	0.9497
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.6194	0.6128	1.1613	0.8877	0.9431	1.0291	1.1311	1.1369	1.0391	1.0666	0.9062
6	0.5649	0.7591	0.6425	0.9634	1.2112	1.0437	1.1133	1.1898	0.9576	1.0061	0.8812
7	0.8206	0.8290	1.2064	0.7008	1.3095	0.9491	1.1050	1.1301	1.2636	0.8034	0.8708
8	1.3313	0.9550	1.0012	0.9884	1.1908	1.1296	1.2894	1.2373	1.2651	1.2027	1.0000
9	1.3313	0.9550	1.0012	0.9884	1.1908	1.1296	1.2894	1.2373	1.2651	1.2027	1.0000

AGE	1993	1994	1995	1996	1997
0	0.3450	0.3450	0.3450	0.0929	0.0929
1	0.3795	0.3795	0.3795	0.2470	0.2470
2	0.7924	0.7924	0.7924	0.6841	0.6841
3	0.9497	0.9497	0.9497	0.9546	0.9546
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.9062	0.9062	0.9062	0.9065	0.9065
6	0.8812	0.8812	0.8812	0.8795	0.8795
7	0.8708	0.8708	0.8708	0.8680	0.8680
8	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000

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	12111300	3866575	1990810	696200	0.3497	0.3226	84
1961	108894070	4449941	1742421	696700	0.3998	0.4145	88
1962	46283150	4470143	1183745	627800	0.5304	0.5014	85
1963	47657720	4699861	2255552	716000	0.3174	0.2209	116
1964	62793220	4853556	2084458	871200	0.4180	0.3389	93
1965	34899240	4389460	1493626	1168800	0.7825	0.6901	86
1966	27864260	3343505	1306784	895500	0.6853	0.6180	93
1967	40261290	2825337	930684	695500	0.7473	0.7962	85
1968	38700680	2525128	416974	717800	1.7214	1.3343	79
1969	21585490	1907164	425908	546700	1.2836	1.1038	103
1970	41087240	1922920	375449	563100	1.4998	1.1011	103
1971	32330660	1850765	266905	520100	1.9486	1.3849	93
1972	20867690	1550833	289008	497500	1.7214	0.6917	108
1973	10151270	1157945	234366	484000	2.0651	1.1287	104
1974	21760560	914944	163087	275100	1.6868	1.0464	103
1975	2933520	685094	83488	312800	3.7466	1.4420	107
1976	2783690	364486	80666	174800	2.1669	1.3644	104
1977	4392880	217516	51762	46000	0.8887	0.7300	83
1978	4663470	233185	70118	11000	0.1569	0.0479	82
1979	10647750	390784	113026	25100	0.2221	0.0606	99
1980	16808220	640215	137687	70764	0.5139	0.2715	91
1981	37973930	1170266	203234	174879	0.8605	0.3320	99
1982	64965660	1857741	286746	275079	0.9593	0.2571	102
1983	61994860	2499215	444536	387202	0.8710	0.3288	92
1984	53656830	2746196	718993	428631	0.5962	0.4443	94
1985	80977130	3292531	751295	613780	0.8170	0.6277	95
1986	97012440	3812610	768178	671488	0.8741	0.5551	87
1987	85711270	4201436	884247	792058	0.8957	0.5371	98
1988	42252060	3832349	1138626	887686	0.7796	0.5215	85
1989	40816220	3398336	1266239	787899	0.6222	0.5334	96
1990	35027450	3193706	1151072	645229	0.5605	0.4386	95
1991	35777760	2992639	957442	658008	0.6873	0.4864	98
1992	64929330	3030302	702220	716799	1.0208	0.6351	100
1993	59095300	3047945	470703	671397	1.4264	0.7662	97
1994	37354070	2529266	543290	568234	1.0459	0.6916	95
1995	52989630	2147071	549669	639146	1.1628	0.7991	98
1996	59444830	1849945	518584	306157	0.5904	0.3945	99
1997	42835940	2312163	745556	247909	0.3325	0.2571	99

No of years for separable analysis : 6
Age range in the analysis : 0 . . . 9
Year range in the analysis : 1960 . . . 1997
Number of indices of SSB : 1
Number of age-structured indices : 4
Stock-recruit relationship to be fitted.
Parameters to estimate : 53
Number of observations : 289

Two selection vectors to be fitted.
Selection assumed constant up to and including : 1995
Abrupt change in selection specified.

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	0.7011	12	0.5468	0.8990	0.6176	0.7959	0.7068
2	1993	0.8458	12	0.6657	1.0746	0.7485	0.9557	0.8521
3	1994	0.7634	12	0.5954	0.9788	0.6725	0.8666	0.7696
4	1995	0.8821	13	0.6784	1.1470	0.7715	1.0086	0.8901
5	1996	0.4458	18	0.3108	0.6394	0.3708	0.5359	0.4534
6	1997	0.2905	19	0.1971	0.4283	0.2384	0.3541	0.2963
Separable Model: Selection (S1) by age 1992 1995								
7	0	0.3450	16	0.2476	0.4807	0.2913	0.4086	0.3500
8	1	0.3795	17	0.2714	0.5307	0.3198	0.4503	0.3851
9	2	0.7924	15	0.5838	1.0756	0.6781	0.9261	0.8021
10	3	0.9497	14	0.7085	1.2729	0.8178	1.1028	0.9603
	4	1.0000	Fixed : Reference Age					
11	5	0.9062	14	0.6853	1.1984	0.7858	1.0451	0.9155
12	6	0.8812	13	0.6815	1.1394	0.7729	1.0046	0.8888
13	7	0.8708	13	0.6701	1.1315	0.7618	0.9953	0.8786
	8	1.0000	Fixed : Last true age					
Separable Model: Selection (S2) by age from 1996 to 1997								
14	0	0.0929	29	0.0516	0.1672	0.0689	0.1254	0.0972
15	1	0.2470	29	0.1392	0.4381	0.1844	0.3309	0.2578
16	2	0.6841	28	0.3951	1.1846	0.5170	0.9053	0.7115
17	3	0.9546	15	0.7102	1.2829	0.8209	1.1100	0.9655
	4	1.0000	Fixed : Reference Age					
18	5	0.9065	14	0.6838	1.2017	0.7850	1.0467	0.9159
19	6	0.8795	13	0.6781	1.1405	0.7702	1.0042	0.8872
20	7	0.8679	13	0.6661	1.1310	0.7583	0.9935	0.8759
	8	1.0000	Fixed : Last true age					
Separable model: Populations in year 1997								
21	0	42835942	18	29623370	61941566	35488445	51704659	43601065
22	1	20981093	16	15094808	29162758	17736530	24819186	21279260
23	2	4738245	15	3499168	6416086	4059268	5530791	4795257
24	3	1517884	15	1114225	2067779	1296390	1777221	1536884
25	4	880812	16	643333	1205954	750356	1033949	892201
26	5	415606	16	298588	578484	351084	491985	421563
27	6	112971	18	78410	162766	93767	136108	114949
28	7	53127	19	35989	78426	43553	64806	54186
29	8	26399	21	17311	40258	21286	32741	27018
Separable model: Populations at age								
30	1992	80580	28	46083	140902	60591	107164	83923
31	1993	156804	22	101795	241540	125785	195474	160660
32	1994	152880	19	103431	225970	125248	186609	155949
33	1995	82364	18	56888	119250	68193	99481	83846
34	1996	31618	21	20938	47746	25622	39018	32325
Recruitment in year 1998								
35	1997	20867140	29	11678907	37284099	15518885	28058557	21802368

SSB Index catchabilities

MLAI < 10 mm

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

36	1	Q	3.116	13	2.564	4.354	2.919	3.825	3.372
37	1	K	.7548E-05	13	.1436E-04	.2438E-04	.1635E-04	.2142E-04	.2002E-04

Age-structured index catchabilities

ACO89: acoustic survey 2-9+

Linear model fitted. Slopes at age :

38	2	Q	1.531	27	1.175	3.463	1.531	2.657	2.095
39	3	Q	1.793	27	1.375	4.062	1.793	3.116	2.456
40	4	Q	1.958	27	1.500	4.450	1.958	3.410	2.685
41	5	Q	2.191	27	1.677	4.998	2.191	3.825	3.010
42	6	Q	2.315	28	1.769	5.309	2.315	4.056	3.187
43	7	Q	2.285	28	1.739	5.304	2.285	4.036	3.163
44	8	Q	2.720	29	2.053	6.470	2.720	4.885	3.804
45	9	Q	2.809	28	2.138	6.512	2.809	4.957	3.885

IBTSA: 2-5+

```
Linear model fitted. Slopes at age :
  46    2  Q  .1481E-03  14 .1286E-03 .2289E-03 .1481E-03 .1987E-03 .1734E-03
  47    3  Q  .9368E-04  14 .8131E-04 .1450E-03 .9368E-04 .1258E-03 .1098E-03
  48    4  Q  .6098E-04  14 .5289E-04 .9461E-04 .6098E-04 .8205E-04 .7152E-04
  49    5  Q  .3781E-04  14 .3275E-04 .5888E-04 .3781E-04 .5100E-04 .4441E-04

                                       IBTSY: 1-wr

Linear model fitted. Slopes at age :
  50    1  Q  .1294E-03   6 .1212E-03 .1585E-03 .1294E-03 .1484E-03 .1389E-03

                                       MIK: MIK 0-wr

Linear model fitted. Slopes at age :
  51    0  Q  .2893E-05   6 .2716E-05 .3514E-05 .2893E-05 .3300E-05 .3096E-05


Parameters of the stock-recruit relationship
  52    1  a  .8459E+08  43 .5559E+08 .3087E+09 .8459E+08 .2029E+09 .1441E+09
  53    1  b  .6853E+06  72 .3409E+06 .5902E+07 .6853E+06 .2936E+07 .1848E+07
```

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1992	1993	1994	1995	1996	1997
0	0.1387	0.0587	-0.2164	-0.0668	0.4621	-0.4584
1	0.2585	0.1358	-0.3925	-0.1770	0.5200	-0.5614
2	0.0573	-0.1921	-0.1108	-0.2285	0.1080	-0.0862
3	-0.3395	-0.1398	-0.1971	-0.1618	0.1893	0.3928
4	-0.1428	-0.0498	0.2943	-0.1482	-0.2295	0.1990
5	-0.0702	0.0805	0.0003	0.0709	-0.0010	0.0261
6	0.1637	0.0864	0.1831	0.0356	-0.2769	0.0126
7	0.0888	0.0655	-0.0734	0.0584	-0.1793	0.0182
8	0.0085	0.0177	-0.1104	0.1451	-0.3185	0.4641

MLAI < 10 mm

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	0.186	0.340	0.099	-0.472	-0.197	0.050	-0.096	-0.200	0.164	-0.482	-0.077

	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.223	0.277	0.657	0.168	-1.043	0.171	-0.458	0.026	0.665

AC089: acoustic survey 2-9+

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997
2	-0.4268	-0.1521	-0.0879	0.2961	0.2179	-0.3508	-0.0394	0.3998	0.1432
3	-0.4000	-0.0042	-0.3272	0.0495	0.2788	-0.3496	0.0022	0.2994	0.4513
4	-0.5212	0.0016	-0.0355	0.2488	0.2856	-0.3630	0.1412	0.0444	0.1982
5	-0.3517	-0.1880	-0.0474	0.1834	0.4095	0.1161	-0.0481	0.0012	-0.0747
6	-0.3722	0.0184	-0.2467	0.1500	0.2738	0.2624	0.1702	-0.4412	0.1858
7	-0.5584	0.0849	0.1366	-0.0400	0.0701	0.2112	0.2344	0.0978	-0.2361
8	-0.4978	0.0941	-0.0367	0.0943	-0.3535	-0.1616	-0.1710	0.7354	0.2977
9	-0.4161	-0.1910	-0.0845	0.6241	-0.0929	-0.1874	-0.9164	0.6312	0.6337

IBTSA: 2-5+

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	-1.164	-1.430	0.139	0.214	-0.172	1.266	0.040	0.262	0.626	-0.137	0.559
3	-0.591	-0.476	0.136	0.187	-0.311	0.911	0.078	0.308	0.677	0.434	0.726
4	-0.248	0.101	-0.455	-0.097	-0.105	0.059	-0.261	0.703	1.061	0.278	0.347
5	1.086	-0.686	0.786	-0.125	0.415	-0.262	-1.172	0.301	0.828	0.375	0.308

Age	1994	1995	1996	1997	1998
2	0.499	0.788	-0.671	-0.522	-0.297
3	0.638	-0.092	-1.132	-0.455	-1.037
4	0.836	0.535	-1.071	-0.677	-1.006
5	0.365	-0.814	-0.458	-0.258	-0.686

IBTSY: 1-wr

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	-0.0649	-0.2630	-0.3332	-0.2176	-0.4086	-0.1689	0.1925	-0.1677	0.0070	0.4649	0.4419

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	-0.3413	-0.1381	-0.1155	0.3568	-0.0705	0.0250	0.0652	0.5682	0.1680

MIK: MIK 0-wr

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987

0	0.434	0.101	0.661	0.873	-0.174	-0.172	-0.495	-0.147	-0.121	-0.326	0.234

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.464	-0.363	-1.232	-0.254	0.221	0.267	0.097	-0.025	-0.349	0.307	0.000

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1992	to 1997
Variance	0.1329
Skewness test stat.	-0.1208
Kurtosis test statistic	0.3004
Partial chi-square	0.2113
Significance in fit	0.0000
Degrees of freedom	27

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR MLAI < 10 mm

Power catchability relationship assumed
Last age is a plus-group

Variance	0.1720
Skewness test stat.	-1.1919
Kurtosis test statistic	0.5821
Partial chi-square	1.1126
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 AC089: acoustic survey 2-9+

Linear catchability relationship assumed

Age	2	3	4	5	6	7	8	9
Variance	0.0102	0.0119	0.0095	0.0060	0.0098	0.0080	0.0168	0.0358
Skewness test stat.	-0.1533	-0.0066	-1.0818	0.3955	-0.7387	-1.6245	0.8186	-0.1140
Kurtosis test statisti	-0.7411	-0.8183	-0.2997	-0.1167	-0.7948	0.4143	-0.0350	-0.5656
Partial chi-square	0.0054	0.0065	0.0054	0.0036	0.0062	0.0053	0.0119	0.0246
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	9	9	9	9	9	9	9	9
Degrees of freedom	8	8	8	8	8	8	8	8
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	0.1262	0.0968	0.0965	0.1076
Skewness test stat.	-0.5909	-0.5484	-0.1602	-0.1461
Kurtosis test statisti	-0.2670	-0.7420	-0.6174	-0.8341
Partial chi-square	0.2961	0.2867	0.3711	0.5210
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	16	16	16	16
Degrees of freedom	15	15	15	15
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	0.0811
Skewness test stat.	1.0245
Kurtosis test statisti	-0.6592
Partial chi-square	0.2088
Significance in fit	0.0000
Number of observations	20
Degrees of freedom	19
Weight in the analysis	1.0000

DISTRIBUTION STATISTICS FOR MIK: MIK 0-wr

Linear catchability relationship assumed

Age	0
Variance	0.1987
Skewness test stat.	-0.9891
Kurtosis test statisti	1.0987
Partial chi-square	1.0140
Significance in fit	0.0000
Number of observations	22
Degrees of freedom	21
Weight in the analysis	1.0000

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	57.5338	289	53	236	0.2438
Catches at age	2.6581	54	34	20	0.1329
SSB Indices					
MLAI < 10 mm	3.0955	20	2	18	0.1720
Aged Indices					
AC089: acoustic survey 2-9+	6.9089	72	8	64	0.1080
IBTSA: 2-5+	25.6277	64	4	60	0.4271
IBTSY: 1-wr	1.5410	20	1	19	0.0811
MIK: MIK 0-wr	4.1733	22	1	21	0.1987
Stock-recruit model	13.5294	37	2	35	0.3866

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	13.3128	289	53	236	0.0564
Catches at age	2.6581	54	34	20	0.1329
SSB Indices					
MLAI < 10 mm	3.0955	20	2	18	0.1720
Aged Indices					
AC089: acoustic survey 2-9+	0.1080	72	8	64	0.0017
IBTSA: 2-5+	1.6017	64	4	60	0.0267
IBTSY: 1-wr	1.5410	20	1	19	0.0811
MIK: MIK 0-wr	4.1733	22	1	21	0.1987
Stock-recruit model	0.1353	37	2	35	0.0039

Table 2.10.1 Summary of input data used in the short term projections

Fleet catch in numbers at age REPORTED for 1997

Age	A	B	C	D	E
0	0	363,53	8.85	83.55	1.21
1	18.41	156.89	249.04	83.71	18.85
2	445.92	23.78	156.04	13.84	40.69
3	419.46	4.84	67.27	2.19	2.03
4	245.58	0.62	11.81	0.22	0.26
5	85.9	2.6	5.48	0.16	0.02
6	22.83	0.07	1.68	0.06	0.03
7	10.8	0	0.66	0.02	0.01
8	17.9	0	0.89	0.01	0.01
9	17.9	0	0	0	0

Fleet weights at age (averages for 1996 and 1997)

Age	A	B	C	D	E
0	0	15.3	19.25	15.09	15.97
1	82.03	21.25	39.97	16.42	29.59
2	122.06	57.7	79.76	49.13	39.08
3	154.04	103.85	130.68	85.9	76.9
4	192.19	137.1	169.6	134.6	90.1
5	219.02	145.95	183.3	150.5	81.3
6	221.02	143.35	191.8	147.9	208
7	240.17	235.7	194	170.6	229
8	266.49	249.5	201.4	241	205
9	266.49	249.5	201.4	241	205

Population parameters (Weights at age and maturity at age are averages of 1996 and 1997)

Age	Mean Weight in stock at spawning	Mean Weight in stock at 1 Jan.	Maturity at age	Natural mortality	Proportion M and F before spawning	F.1997 from ICA
0	4	4	0	1	0.67	0.027
1	44	44	0	1	0.67	0.0717
2	118	118	0.628	0.3	0.67	0.1987
3	181	181	0.9585	0.2	0.67	0.2773
4	240	240	1	0.1	0.67	0.2905
5	258	258	1	0.1	0.67	0.2634
6	269	269	1	0.1	0.67	0.2555
7	276	276	1	0.1	0.67	0.2521
8	297	297	1	0.1	0.67	0.2905
9	332	332	1	0.1	0.67	0.2905

Population NUMBERS at start of 1997 and 1998 from ICA

Age	1997	1998
0	42840	20870
1	20980	15340
2	4740	7180
3	1520	2880
4	880	940
5	420	600
6	110	290
7	50	80

8	30	40
9	40	40

Recruitment at age 0 in two prediction years 1998,1999

1998	1999
20870	44000

Splitfactors

Age	1997	1998	1999
0	0.8400	0.7966	0.7202
1	0.7000	0.8400	0.7966

Table 2.10.2

year-class	MIK-0	IBTS 1-ringer Prop.IIIa	FITTED/PREDICTED (bold) 1-ringer proportion in IIIa Inverse link	Identity link
1981	133.9	0.254	0.277	0.303
1982	91.8	0.276	0.233	0.236
1983	115	0.255	0.255	0.273
1984	181.3	0.439	0.351	0.379
1985	177.4	0.267	0.344	0.373
1986	270.9	0.636	0.714	0.523
1987	168.9	0.3	0.328	0.359
1988	71.4	0.177	0.216	0.203
1989	25.9	0.134	0.187	0.130
1990	69.9	0.199	0.215	0.200
1991	200.7	0.611	0.395	0.410
1992	190.1	0.25	0.370	0.393
1993	101.7	0.23	0.242	0.251
1994	126.9	0.45	0.269	0.292
1995	106.2	0.3	0.246	0.259
1996	148.1	0.16	0.296	0.326
1997	53.1		**0.203**	**0.173**
Average	131.36471		**0.280**	**0.307**

Table 2.10.3

Model : GAMMA errors, INVERSE link

Call: glm(formula = prop3a ~ mik0, family = Gamma(link = inverse), data = splitdat)

Deviance Residuals:

Min	1Q	Median	3Q	Max
-0.5571208	-0.2066019	-0.08145521	0.1813841	0.5649442

Coefficients:

	Value	Std. Error	t value
(Intercept)	5.77204619	0.691092969	8.352055
mik0	-0.01613594	0.003536121	-4.563176

(Dispersion Parameter for Gamma family taken to be 0.1009537)

Null Deviance: 3.108336 on 15 degrees of freedom

Residual Deviance: 1.344056 on 14 degrees of freedom

Number of Fisher Scoring Iterations: 4

Correlation of Coefficients:

	(Intercept)
mik0	-0.937835

Model: GAMMA errors, IDENTITY link

Call: glm(formula = prop3a ~ mik0, family = Gamma(link = identity), data = splitdat)

Deviance Residuals:

Min	1Q	Median	3Q	Max
-0.636294	-0.1726485	-0.03660848	0.1548482	0.4664986

Coefficients:

	Value	Std. Error	t value
(Intercept)	0.088026169	0.037513429	2.346524
mik0	0.001606473	0.000338602	4.744430

(Dispersion Parameter for Gamma family taken to be 0.0867399)

Null Deviance: 3.108336 on 15 degrees of freedom

Residual Deviance: 1.286089 on 14 degrees of freedom

Number of Fisher Scoring Iterations: 4

Correlation of Coefficients:

	(Intercept)
mik0	-0.8625558

Table 2.10.4

NORTH SEA HERRING SHORT TERM PREDICTIONS - F-multipliers on fleets B,C,D,E assumed identical
F-constraint in 1998
NB Catches of 3+ ringers in IIIa EXCLUDED

Predictions for 1998, based on TAC in 1998 ('000t)

	F_{juv} (0-1 ring)	F_{ad} (2-6 ring)	Fleet F's $F_{B-E,0-1}$	$F_{A,2-6}$	Fleet Yields in '000t A	B	C	D	E	TOTAL Yield	SSB 1998
	0.025	0.257	0.024	0.241	282	9	25	3	3	322	1137

Prediction summary: Yields for 1999 assuming TAC in 1998

Scenario	F_{juv} (0-1 ring)	F_{ad} (2-6 ring)	Fleet F's $F_{B-E,0-1}$	$F_{A,2-6}$	Fleet Yields in '000t A	B	C	D	E	TOTAL Yield	SSB 1999
I	**0.12**	**0.25**	0.119	0.174	264	47	79	16	9	415	1467
II	0.00	0.20	**0.0**	**0.2**	311	0	0	0	0	311	1512
III	0.10	0.26	**0.1**	**0.2**	302	39	67	13	8	430	14[illegible]
IV	0.20	0.33	**0.2**	**0.2**	295	77	121	26	14	533	1397
V	0.30	0.40	**0.3**	**0.2**	288	114	164	37	19	623	1348
VI	0.00	0.30	**0.0**	**0.3**	444	0	0	0	0	444	1413
VII	0.10	0.36	**0.1**	**0.3**	432	39	66	13	8	557	1355
VIII	0.20	0.43	**0.2**	**0.3**	422	76	119	26	14	656	1302
IX	0.30	0.50	**0.3**	**0.3**	412	112	161	37	19	741	1255

* Catches of 3 ringers and older in Division IIIa EXCLUDED, i.e. ASSUMED to be 0, as in the past
* F-multipliers on fleets B,C,D,E assumed to be equal
* F-A is the F for fleet A, averaged over 2-6-ringers
* FB-E,0-1 is the average F for 0-1 ringers, fleets B,C,D,E

Table 2.10.5

NORTH SEA HERRING SHORT TERM PREDICTIONS - F-multipliers on fleets B,C,D,E assumed identical
TAC constraint in 1998
NB Catches of 3+ ringers in IIIa EXCLUDED

Predictions for 1998, based on TAC in 1998											('000t)
	F_{juv}	F_{ad} Fleet F's			Fleet Yields in '000t					TOTAL	SSB
	(0-1 ring)	(2-6 ring)	$F_{B-E,0-1}$	$F_{A,2-6}$	A	B	C	D	E	Yield	1998
	0.050	0.240	0.049	0.215	254	22	24	6	5	311	1147

	Prediction summary: Yields for 1999 assuming TAC in 1998										
Scenario	F_{juv}	F_{ad} Fleet F's			Fleet Yields in '000t					TOTAL	SSB
	(0-1 ring)	(2-6 ring)	$F_{B-E,0-1}$	$F_{A,2-6}$	A	B	C	D	E	Yield	1999
I	**0.12**	**0.25**	0.119	0.174	265	46	77	16	9	413	1471
II	0.00	0.20	**0.0**	**0.2**	311	0	0	0	0	311	1515
III	0.10	0.26	**0.1**	**0.2**	303	39	65	13	8	428	1455
IV	0.20	0.33	**0.2**	**0.2**	296	77	118	25	14	530	1402
V	0.30	0.40	**0.3**	**0.2**	289	113	160	37	19	618	1353
VI	0.00	0.30	**0.0**	**0.3**	445	0	0	0	0	445	1415
VII	0.10	0.36	**0.1**	**0.3**	433	38	64	13	8	556	1358
VIII	0.20	0.43	**0.2**	**0.3**	423	76	116	25	14	653	1306
IX	0.30	0.50	**0.3**	**0.3**	413	112	157	36	19	737	1260

* Catches of 3 ringers and older in Division IIIa EXCLUDED, i.e. ASSUMED to be 0, as in the past
* F-multipliers on fleets B,C,D,E assumed to be equal
* $F_{A,2-6}$ is the F for fleet A, averaged over 2-6-ringers
* $F_{B-E,0-1}$ is the average F for 0-1 ringers, fleets B,C,D,E

Table 2.10.6

NORTH SEA HERRING SHORT TERM PREDICTIONS - FLEETS AC and BDE grouped
F-Constraint for 1998
NB Catches of 3+ringers in IIIa INCLUDED

Predictions for 1998, based on TAC in 1998 ('000t)

	F_{juv} (0-1 ring)	F_{ad} (2-6 ring)	Fleet F's $F_{B-E,0-1}$	$F_{A,2-6}$	Fleet Yields in '000t A	B	C	D	E	TOTAL Yield	SSB 1998
	0.025	0.257	0.024	0.224	263	9	40	3	3	319	1137

Prediction summary: Yields for 1999 assuming TAC in 1998

Scenario	F_{juv} (0-1 ring)	F_{ad} (2-6 ring)	Fleet F's $F_{B-E,0-1}$	$F_{A,2-6}$	Fleet Yields in '000t A	B	C	D	E	TOTAL Yield	SSB 1999
I	**0.12**	**0.25**	0.119	0.174	275	58	34	24	15	406	1463
II	0.00	0.20	**0.0**	**0.2**	309	0	0	0	0	309	1515
III	0.10	0.26	**0.1**	**0.2**	299	48	37	20	12	417	1452
IV	0.20	0.33	**0.2**	**0.2**	294	96	36	39	24	490	1414
V	0.30	0.40	**0.3**	**0.2**	289	141	35	56	35	556	1379
VI	0.00	0.30	**0.0**	**0.3**	442	0	0	0	0	442	1417
VII	0.10	0.36	**0.1**	**0.3**	426	46	53	19	12	556	1346
VIII	0.20	0.43	**0.2**	**0.3**	419	93	52	38	23	625	1311
IX	0.30	0.50	**0.3**	**0.3**	412	137	50	55	34	688	1278

* Catches of 3 ringers and older in Division IIIa have been INCLUDED
* F-multipliers on fleets A and C assumed equal, EXCEPT for options where F-BCDE=0.0
* F-multipliers on fleets B,D and E assumed equal
* F-A is the F for fleet A, averaged over 2-6-ringers
* FB-E,0-1 is the average F for 0-1 ringers, fleets B,C,D,E

Table 2.10.7

NORTH SEA HERRING SHORT TERM PREDICTIONS -F-multipliers for BCDE in same ratios as for TAC 1998
TAC constraint in 1998
NB Catches of 3+ringers in IIIa INCLUDED

Predictions for 1998, based on TAC in 1998 ('000t)

F_{juv} (0-1 ring)	F_{ad} (2-6 ring)	Fleet F's $F_{B\text{-}E,0\text{-}1}$	$F_{A,2\text{-}6}$	Fleet Yields in '000t A	B	C	D	E	TOTAL Yield	SSB 1998
0.047	0.246	0.046	0.215	254	22	24	6	5	311	1145

Prediction summary: Yields for 1999 assuming TAC in 1998

Scenario	F_{juv} (0-1 ring)	F_{ad} (2-6 ring)	Fleet F's $F_{B\text{-}E,0\text{-}1}$	$F_{A,2\text{-}6}$	Fleet Yields in '000t A	B	C	D	E	TOTAL Yield	SSB 1999
I	**0.12**	**0.25**	0.119	0.174	258	58	63	21	10	409	1466
II	0.00	0.20	**0.0**	**0.2**	309	0	0	0	0	309	1519
III	0.10	0.26	**0.1**	**0.2**	300	49	52	18	8	427	1450
IV	0.20	0.33	**0.2**	**0.2**	290	94	100	34	16	534	1386
V	0.30	0.40	**0.3**	**0.2**	282	135	144	48	22	631	1325
VI	0.00	0.30	**0.0**	**0.3**	443	0	0	0	0	443	1421
VII	0.10	0.36	**0.1**	**0.3**	429	48	51	17	8	553	1356
VIII	0.20	0.43	**0.2**	**0.3**	416	92	97	33	15	653	1294
IX	0.30	0.50	**0.3**	**0.3**	403	133	139	48	21	745	1237

* Catches of 3 ringers and older in Division IIIa have been INCLUDED
* F-multipliers on fleets BCDE were kept in the ratio of F-multipliers required to achieve the 1998 TACs
* F-A is the F for fleet A, averaged over 2-6-ringers
* FB-E,0-1 is the average overall F for 0-1 ringers, fleets B,C,D and E

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 1997. The projections were constrained to speficied fishing mortalities with no simulation of uncertainty in F.

Projection input file

Number of Fleets

5	10

Mean Catch Ratio by Fleet (1997-1998)

A	B	C	D	E	
0	0	0.767439	0.011559	0.202137	0.018865
1	0.019302	0.376577	0.292801	0.192573	0.118746
2	0.697344	0.035407	0.216235	0.012965	0.038049
3	0.894658	0.008307	0.089161	0.00426	0.003614
4	0.971646	0.004582	0.022844	0.000426	0.000503
5	0.952035	0.01791	0.029099	0.00085	0.000106
6	0.956122	0.008004	0.034049	0.001216	0.000608
7	0.96592	0.004054	0.028721	0.00087	0.000435
8	0.971994	0.003817	0.023658	0.000266	0.000266
9	0.971994	0.003817	0.023658	0.000266	0.000266

Retention Ogive

0	1	1	1	1	1
1	1	1	1	1	1
2	1	1	1	1	1
3	1	1	1	1	1
4	1	1	1	1	1
5	1	1	1	1	1
6	1	1	1	1	1
7	1	1	1	1	1
8	1	1	1	1	1
9	1	1	1	1	1

Exploitation Constraint by Year

1998	-1	-1	-1	-1	-1
1999	-1	-1	-1	-1	-1
2000	-1	-1	-1	-1	-1
2001	-1	-1	-1	-1	-1
2002	-1	-1	-1	-1	-1
2003	-1	-1	-1	-1	-1
2004	-1	-1	-1	-1	-1
2005	-1	-1	-1	-1	-1
2006	-1	-1	-1	-1	-1
2007	-1	-1	-1	-1	-1

Mean Weight at age in the catches of each fleet

0	0.0307	0.0153	0.019254	0.015095	0.015971
1	0.082034	0.02125	0.039966	0.016415	0.029589
2	0.122061	0.0577	0.07976	0.049132	0.039085
3	0.154037	0.10385	0.130685	0.0859	0.076901
4	0.192186	0.1371	0.1696	0.1346	0.0901
5	0.219025	0.14595	0.1833	0.1505	0.0813
6	0.221019	0.14335	0.1918	0.1479	0.208
7	0.240167	0.2357	0.194	0.1706	0.229
8	0.26649	0.2495	0.2014	0.241	0.205
9	0.000294	0.000272	0.0001	0.0001	0.0001

Mean weights at age in the discard by fleet

0	0.0307	0.0153	0.019254	0.015095	0.015971
1	0.082034	0.02125	0.039966	0.016415	0.029589
2	0.122061	0.0577	0.07976	0.049132	0.039085
3	0.154037	0.10385	0.130685	0.0859	0.076901
4	0.192186	0.1371	0.1696	0.1346	0.0901
5	0.219025	0.14595	0.1833	0.1505	0.0813
6	0.221019	0.14335	0.1918	0.1479	0.208
7	0.240167	0.2357	0.194	0.1706	0.229
8	0.26649	0.2495	0.2014	0.241	0.205
9	0.000294	0.000272	0.0001	0.0001	0.0001

First year for F-constraint

1999

Target Multiplier by fleet and by year

1999	-1.16686	-4.0486	-4.0486	-4.0486	-4.0486
2000	-1.16686	-4.0486	-4.0486	-4.0486	-4.0486
2001	-1.16686	-4.0486	-4.0486	-4.0486	-4.0486
2002	-1.16686	-4.0486	-4.0486	-4.0486	-4.0486
2003	-1.16686	-4.0486	-4.0486	-4.0486	-4.0486
2004	-1.16686	-4.0486	-4.0486	-4.0486	-4.0486
2005	-1.16686	-4.0486	-4.0486	-4.0486	-4.0486
2006	-1.16686	-4.0486	-4.0486	-4.0486	-4.0486
2007	-1.16686	-4.0486	-4.0486	-4.0486	-4.0486

CV of Target F-Multipliers

1999	0.0001	0.0001	0.0001	0.0001	0.0001
2000	0.0001	0.0001	0.0001	0.0001	0.0001
2001	0.0001	0.0001	0.0001	0.0001	0.0001
2002	0.0001	0.0001	0.0001	0.0001	0.0001
2003	0.0001	0.0001	0.0001	0.0001	0.0001
2004	0.0001	0.0001	0.0001	0.0001	0.0001
2005	0.0001	0.0001	0.0001	0.0001	0.0001
2006	0.0001	0.0001	0.0001	0.0001	0.0001
2007	0.0001	0.0001	0.0001	0.0001	0.0001

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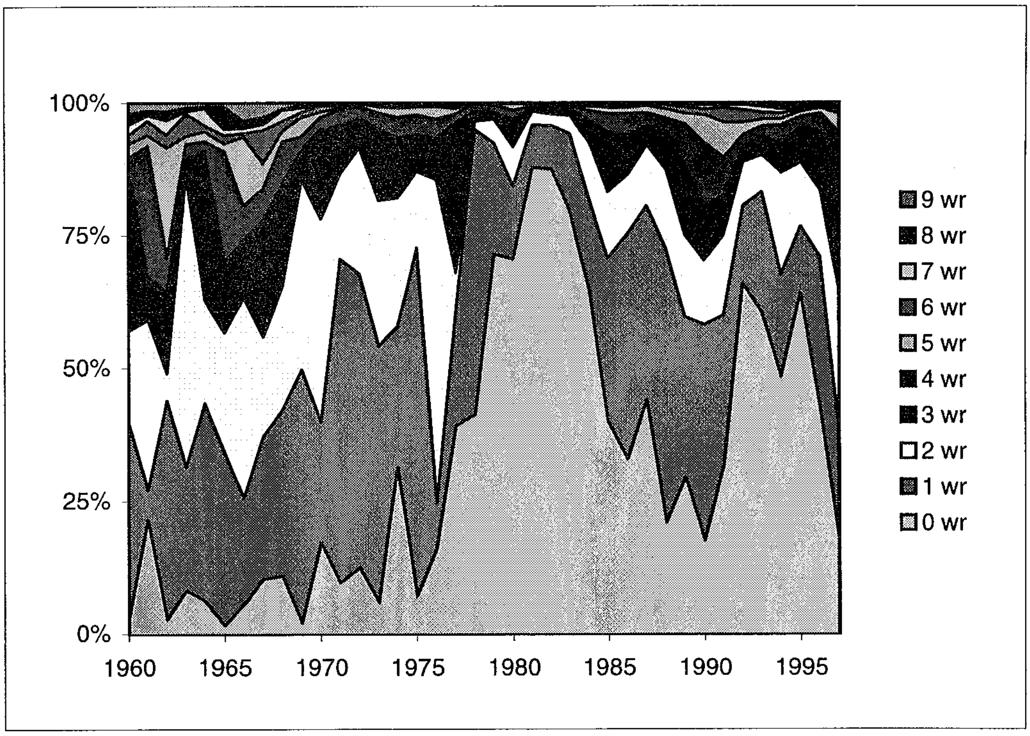
Table 2.12.1

spec **herring**
country
gear **Pelagic trawl**

year	month	Area IIa		IVa west		Buchan		IVb		IVc		Dogger		NE bank		VIa north		VIa south		VIId		TOTALS	
		catch	discards	catch	discards	catch	discards	catch	discards	catch	discards	catch	discards	catch	discards	catch	discards	catch	discards	catch	discards	catch	discards
1997	jan	0	50							630	0									42	50	**672**	**100**
	feb	1	0	41	397					955	4			0	0	114	50			30	18	**1141**	**469**
	mar			32	0					634	0			0	0	18	12					**684**	**12**
	apr	0	0	0	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0	**0**	**0**
	may	6923	65	34	34	684	49	0	0	0	0			0	0	0	0	0	0	0	0	**7641**	**148**
	jun	1706	0	1335	8	2400	960	401	201	0	0			0	0	123	0	0	0	0	0	**5965**	**1169**
	jul			9717	696	140	0							0	0	1670	0	0	2			**11527**	**698**
	aug			3319	4	957	0							3001	698	1525	0					**8802**	**702**
	sep					950	0					248	0	2330	87							**3528**	**87**
	oct							2128	0	1570	0											**3698**	**0**
	nov									3432	63									807	101	**4239**	**164**
	dec									126	0									26556	2776	**26682**	**2776**
	TOTAL	8630	115	14478	1139	5131	1009	2529	201	7347	67	248	0	5331	785	3450	62	0	2	27435	2945	**74579**	**6325**



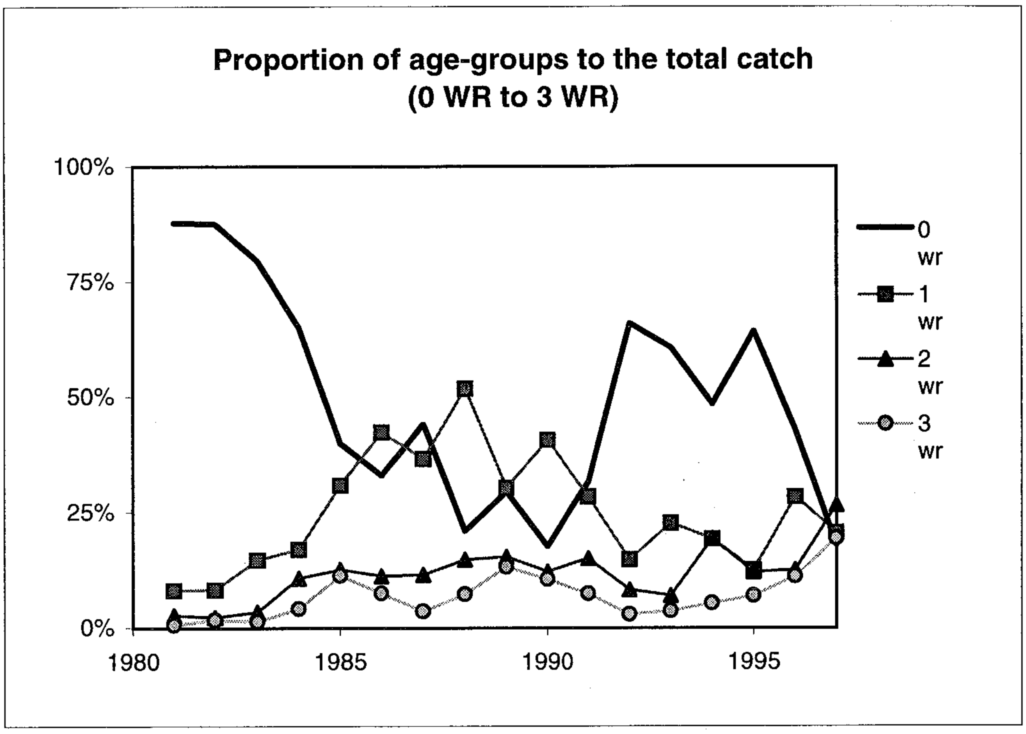


Figure 2.2.1 Proportion of age-groups in the total catch of North Sea herring
Proportion of all WR (Winter Ring) from 1960 to 1997, and proportion of 0 WR to 3 WR in recent years.

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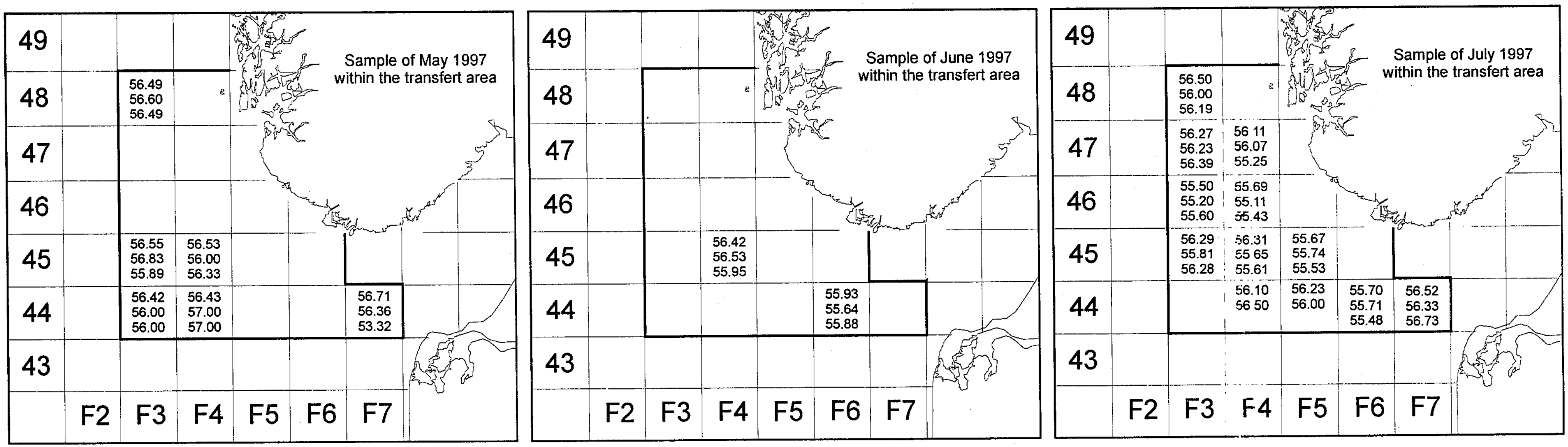

	Quarter II		Quarter III	
Winter Ring	Mean Vs	Percentage of Spring Spawners	Mean Vs	Percentage of Spring Spawners
2	56.43	9	56.08	59
3	56.35	20	55.79	100
4+	56.23	38	55.58	100

Figure 2.2.2 : Mean vertebral counts of 2, 3, and 4+ rings herring. Quarter II and III - 1997.

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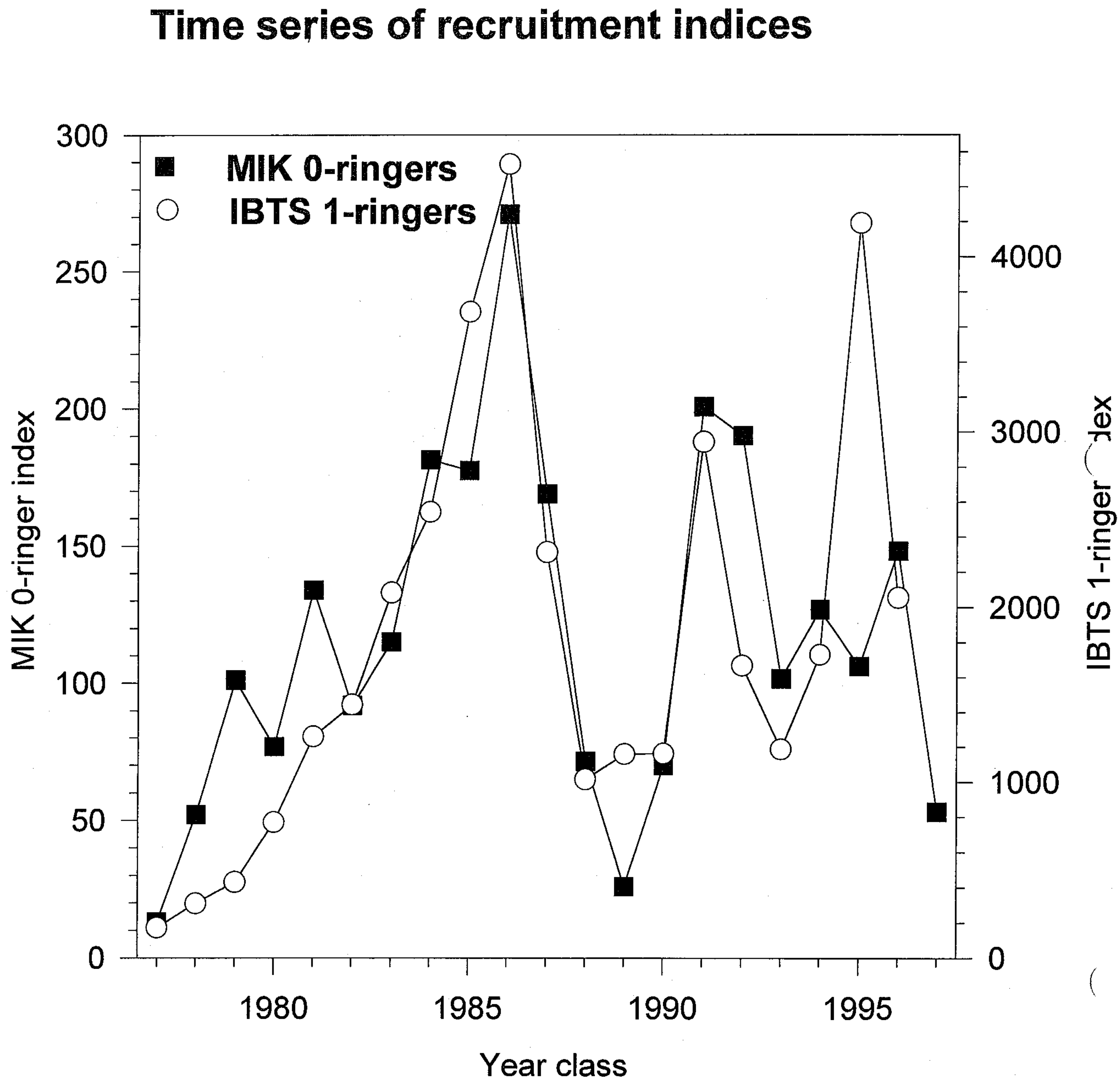

Figure 2.3.1 Time series of the 0-ringer and the 1-ringer indices, 0-ringers are illustrated by filled squares, 1-ringers by open circles.

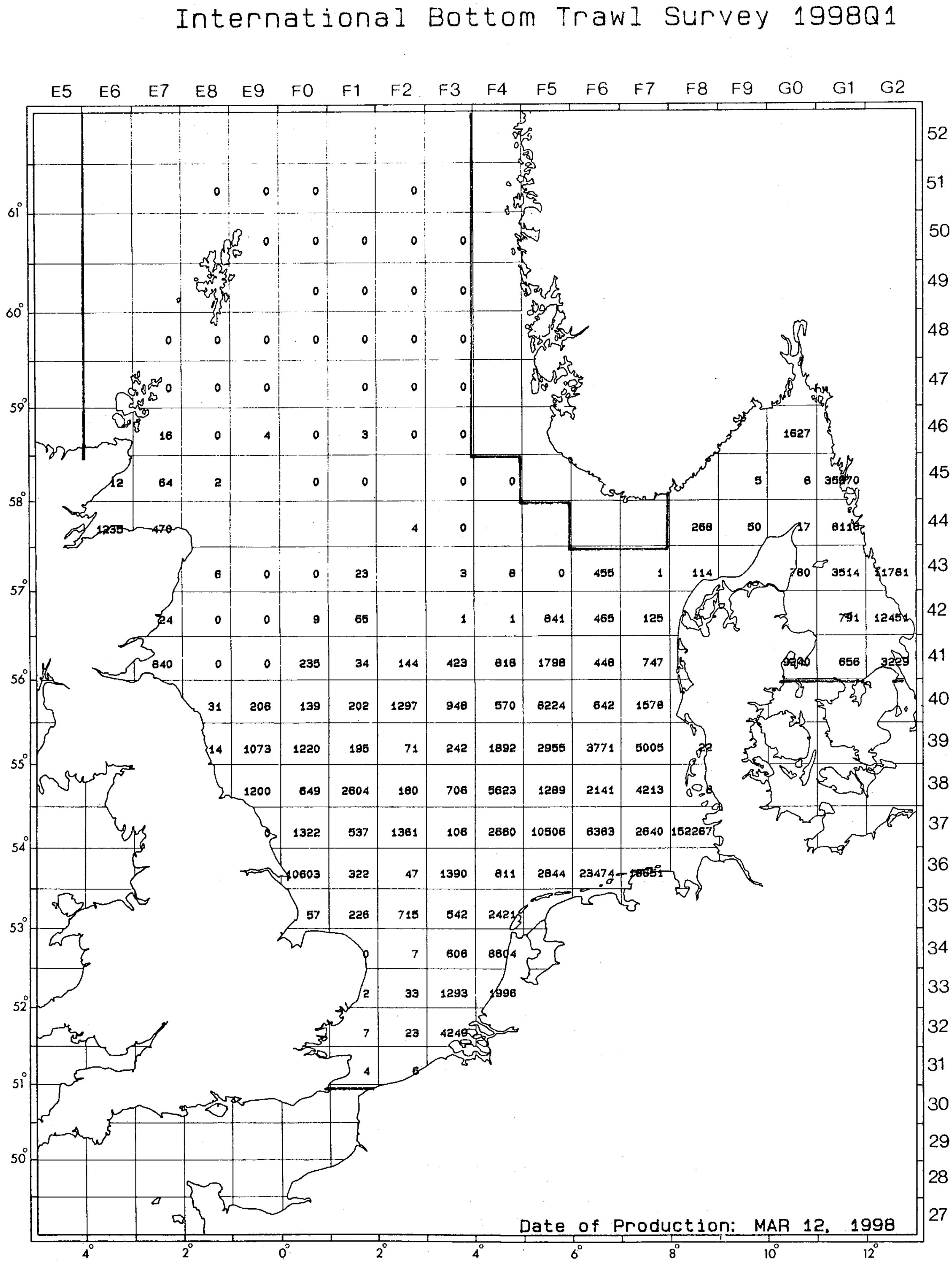

Figure 2.3.2 Abundance estimates of 1-ringer herring from IBTS, first quarter. Values are catch estimates for each statistical rectangle in numbers caught per hour

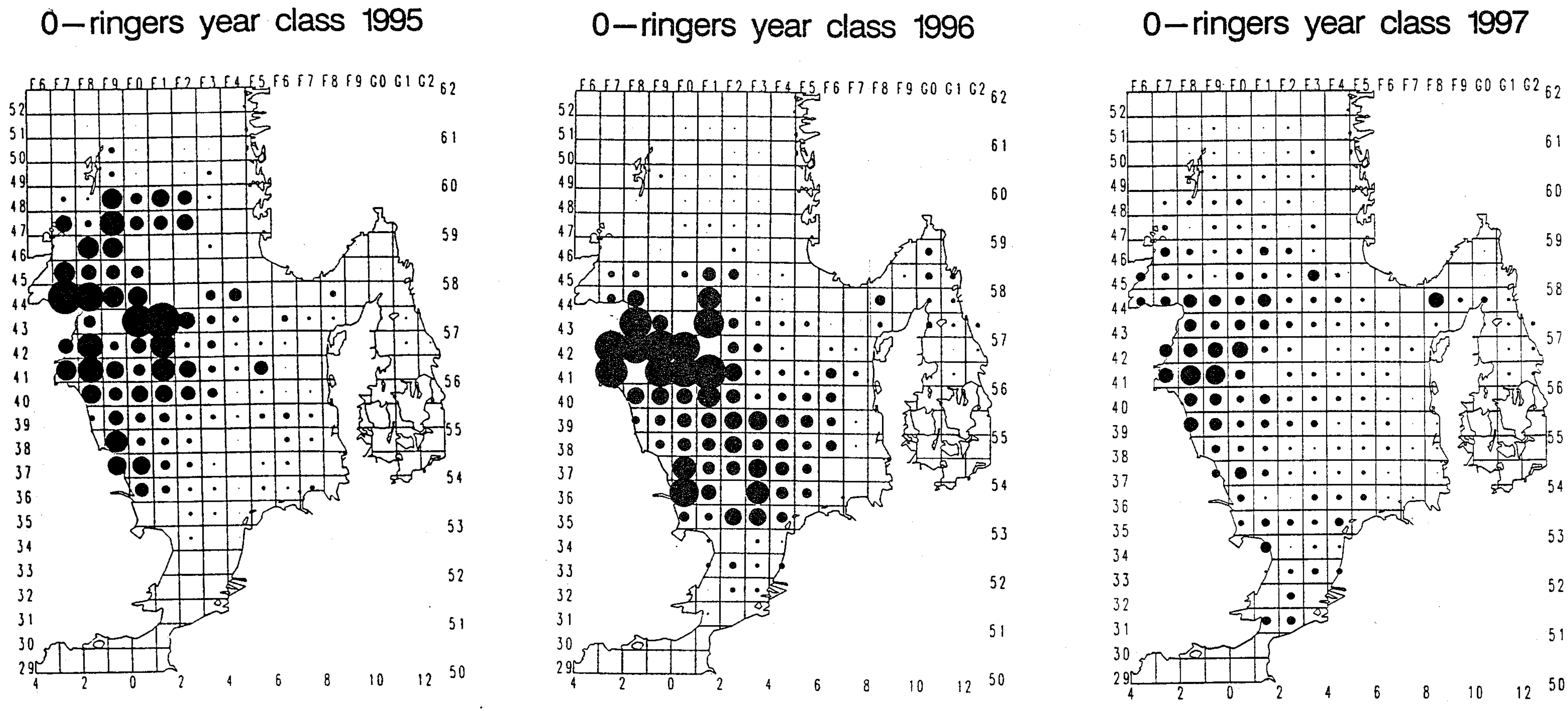

Figure 2.3.3 Distribution of 0-ringer herring, year classes 1995-1997. Abundance estimates of 0-ringers within each statistical rectangle are based on MIK catches during IBTS in February. Areas of filled circles illustrate densities in no m^{-2}, the area of a circle extending to the border of a rectangle represents 1.5 m^{-2}

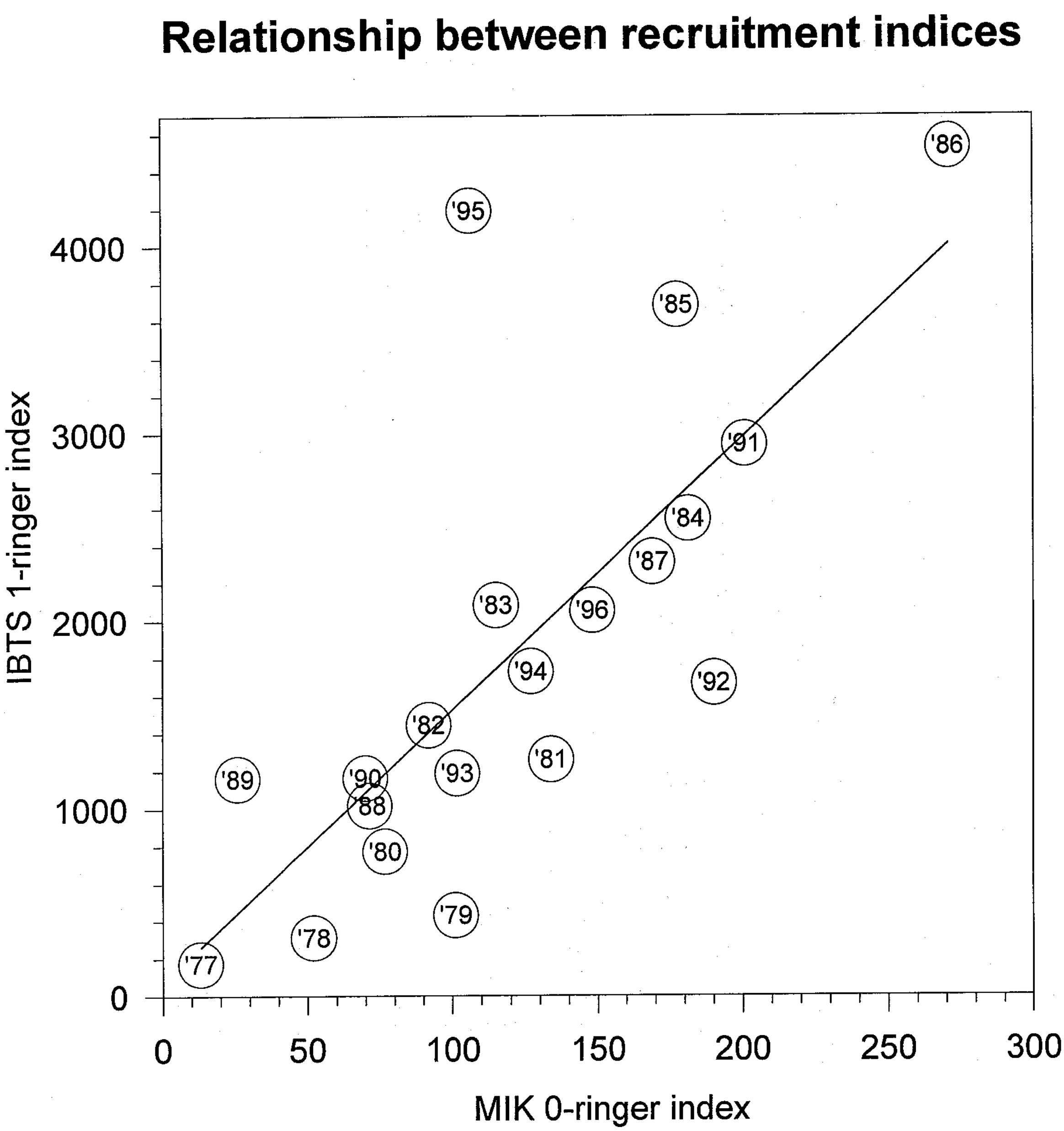

Figure 2.3.4 Regression between the MIK 0-ringer index and the IBTS 1-ringer indices for year classes 1977 to 1996. Numbers in symbols indicate year class.

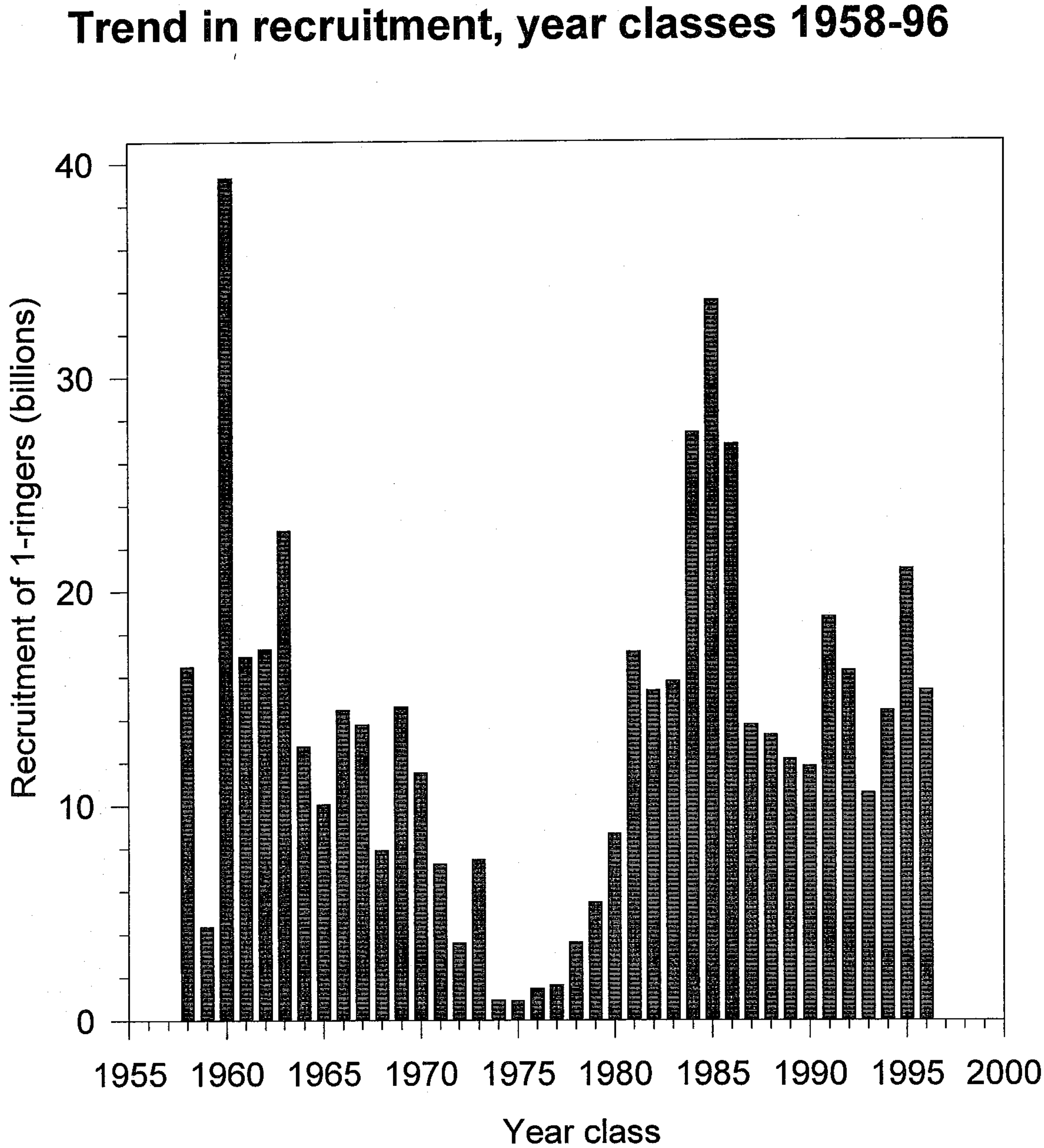

Figure 2.3.5 Recruitment of 1-ringer North Sea autumn spawned herring. Estimates from the 1998 ICA assessment.

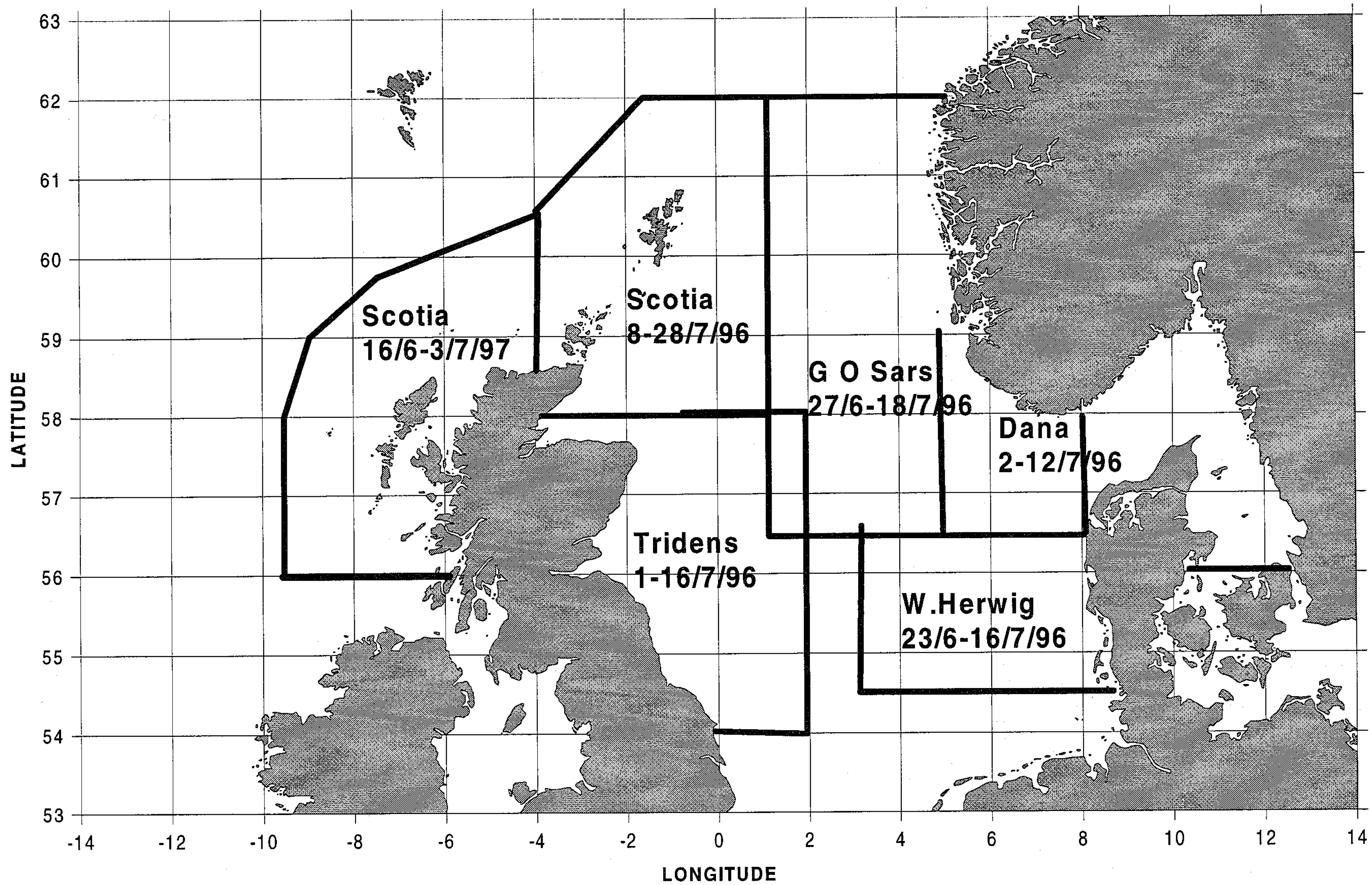

Figure 2.4.1 Survey Areas for 1997 ,Combined Acoustic Surveys

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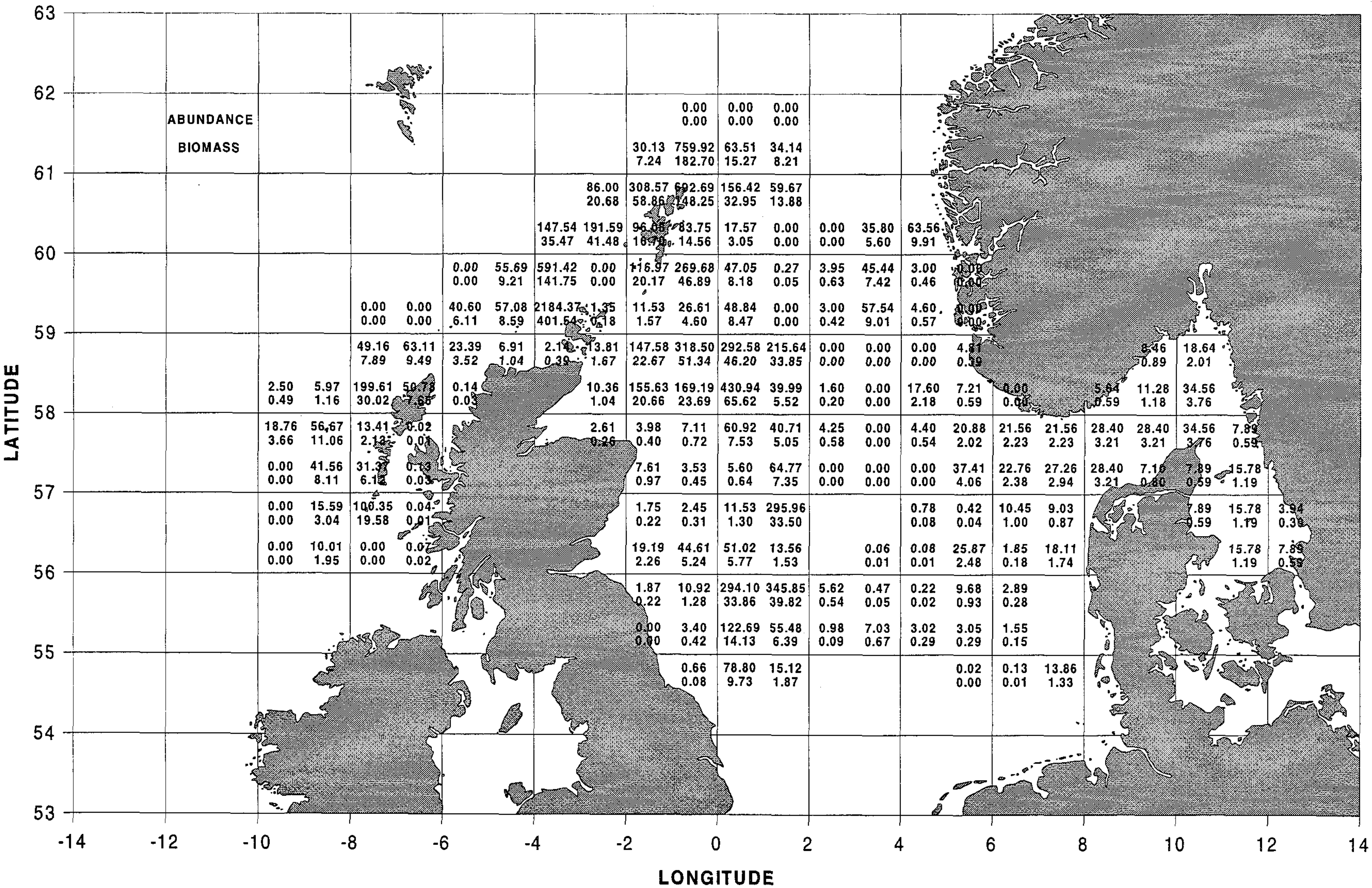

Figure 2.4.2 Numbers (millions upper) and Biomass (Thousands of tonnes lower) adult autumn spawning herring, Combined Acoustic Surveys 1997

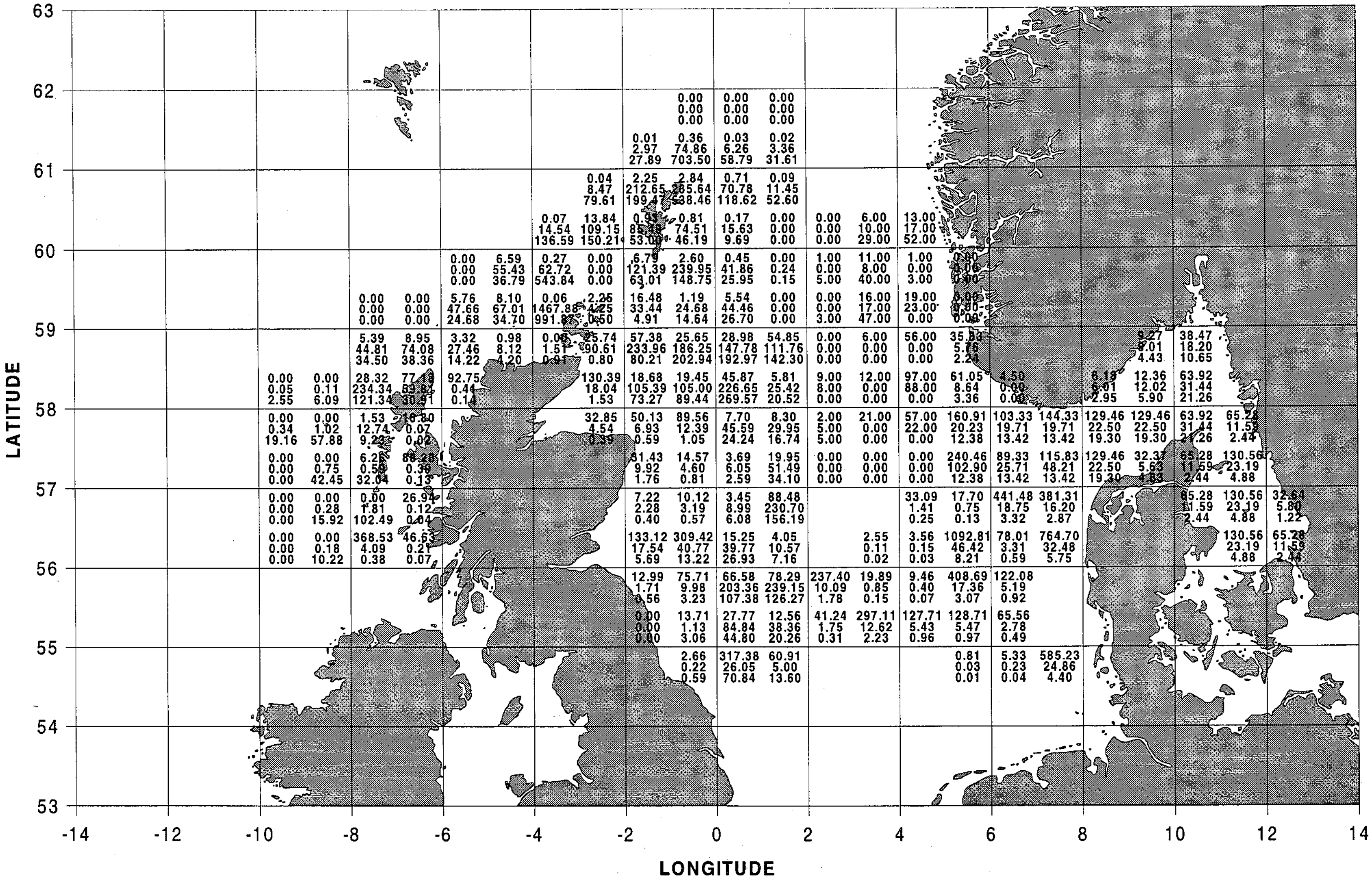

Figure 2.4.3 Numbers (millions) of autumn spawning herring ages 1 (upper), 2(mid) and 3 (lower) ,Combined Acoustic Surveys 1997

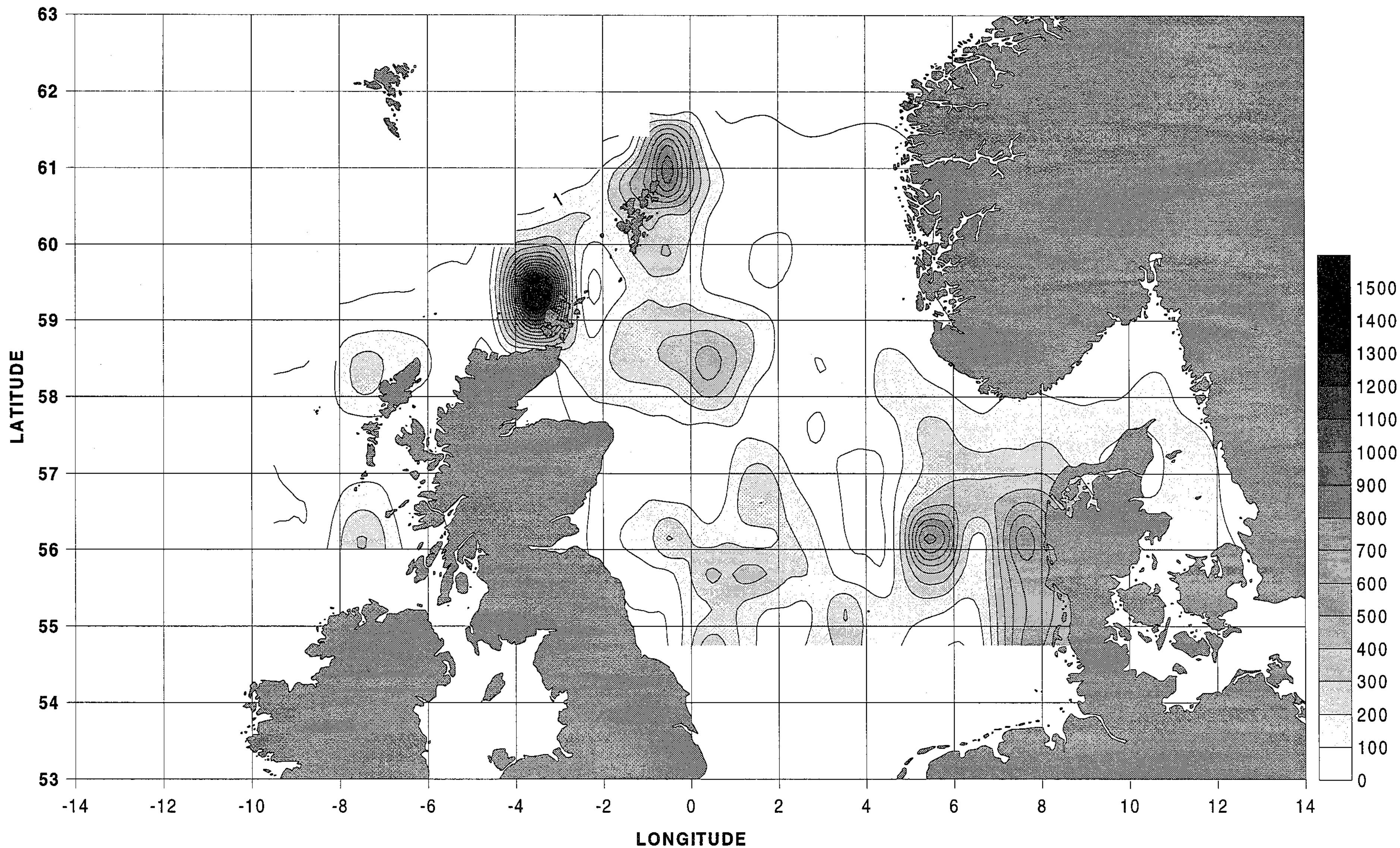

Figure 2.4.4 Numbers (millionss) of autumn spawning herring ages 1 to 9+, Combined Acoustic Surveys 1997

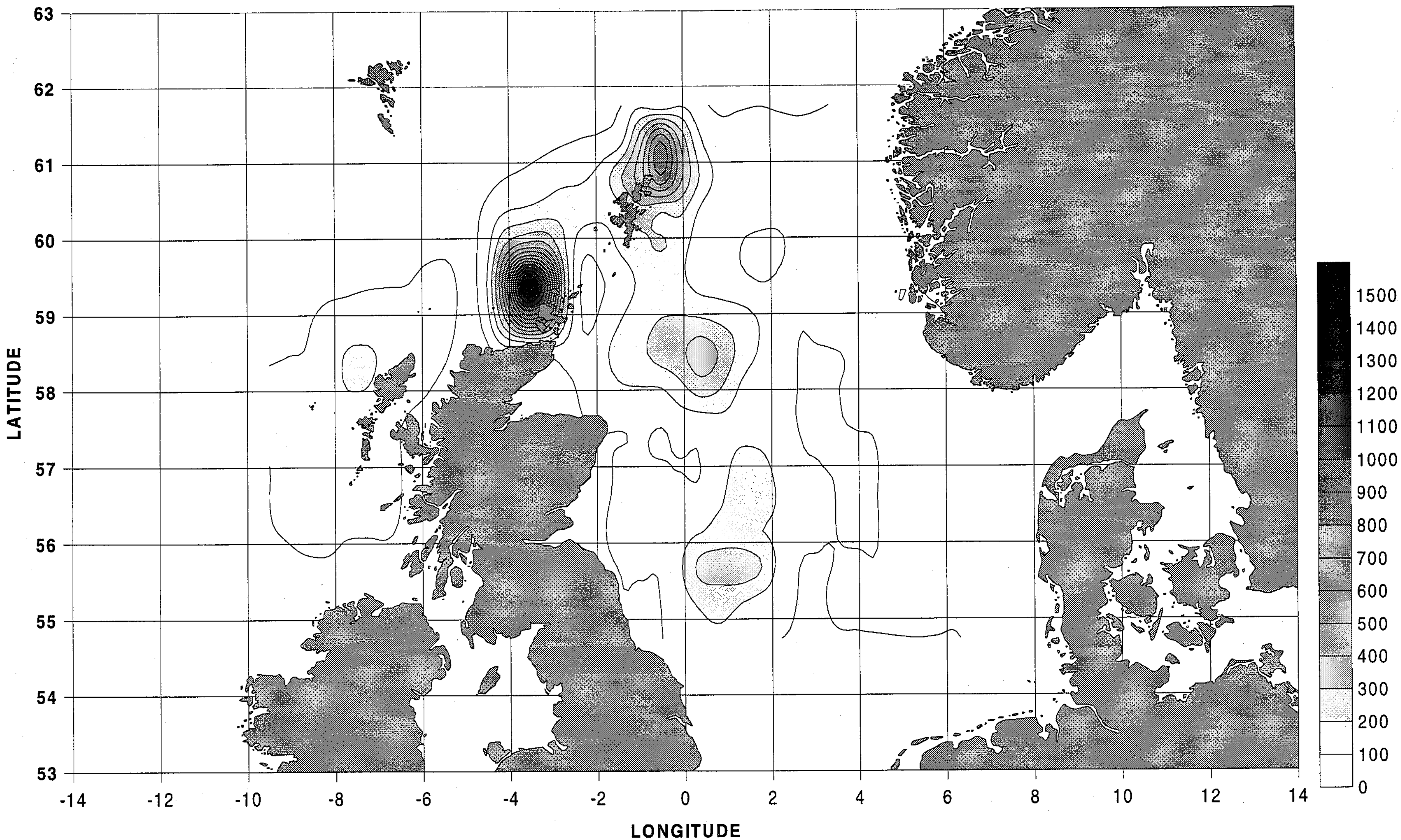

Figure 2.4.5 Numbers (millions) of adult autumn spawning herring ,Combined Acoustic Surveys 1997

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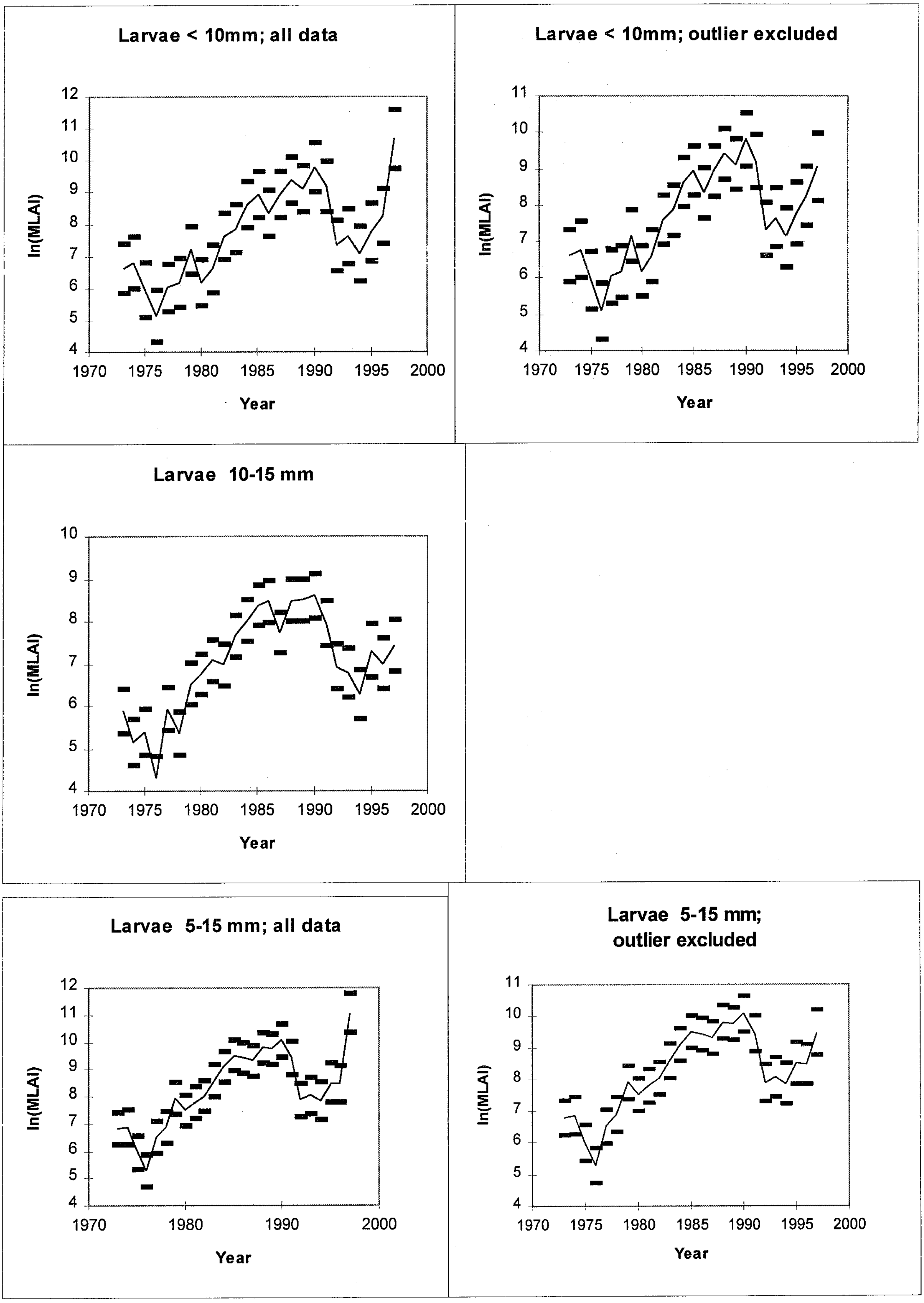
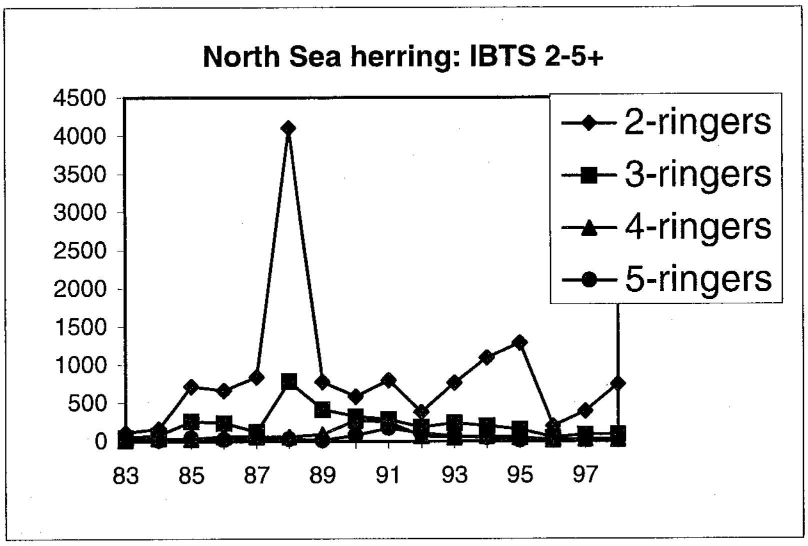


Figure 2.5.1: Influence of an outlier on the resulting MLAI. Inclusion of outlier is presented on the left, exclusion on the right side

Figure 2.6.1



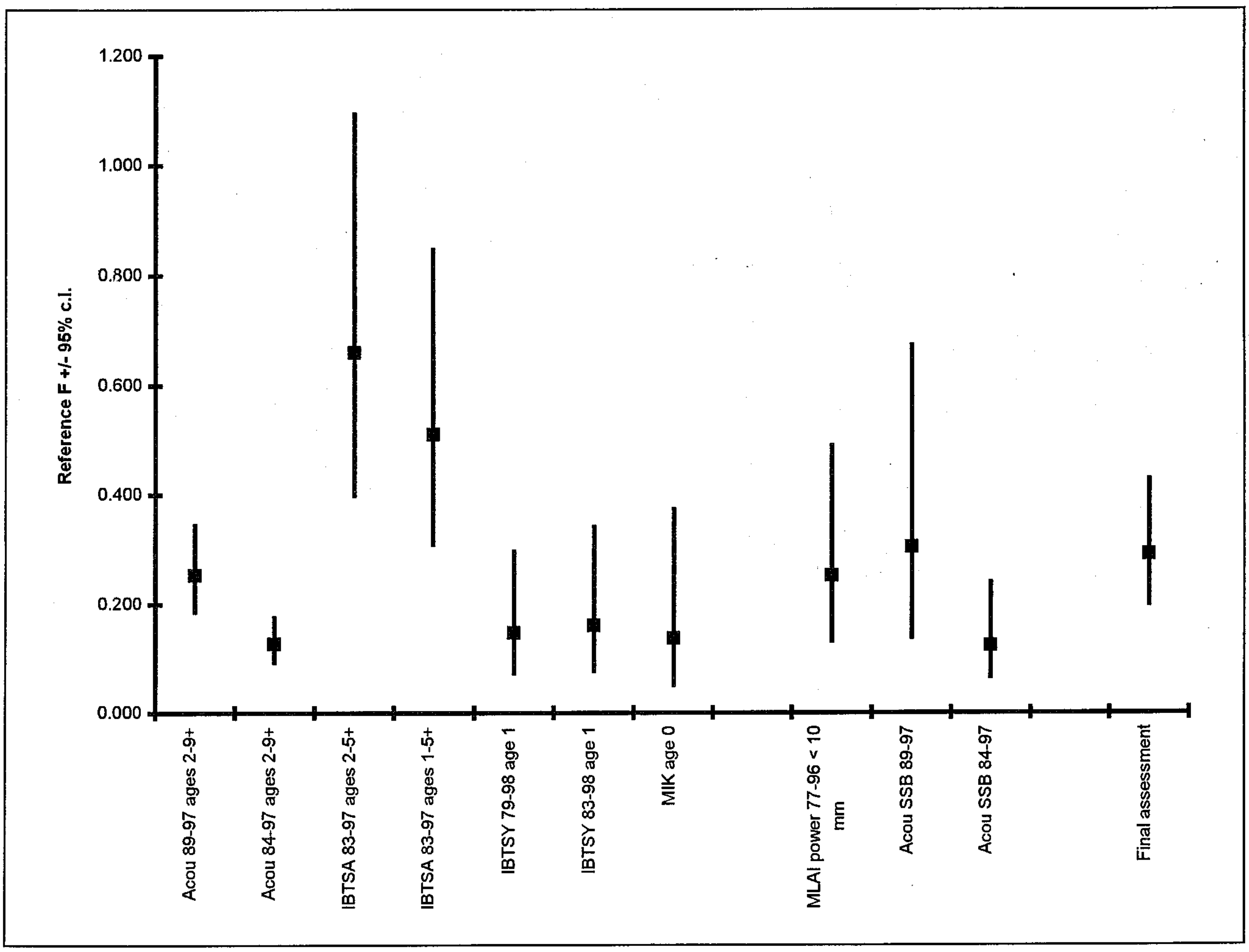


Figure 2.8.1 Herring in Sub-area IV, Divisions VIId and IIIa. Estimates of fishing mortality (+/- 95 c.l.) in population models fitted to the separate indices and the catch at age matrix. Each index is given an equal weight. The encircled index numbers indicate which indices are used in the final assessment.

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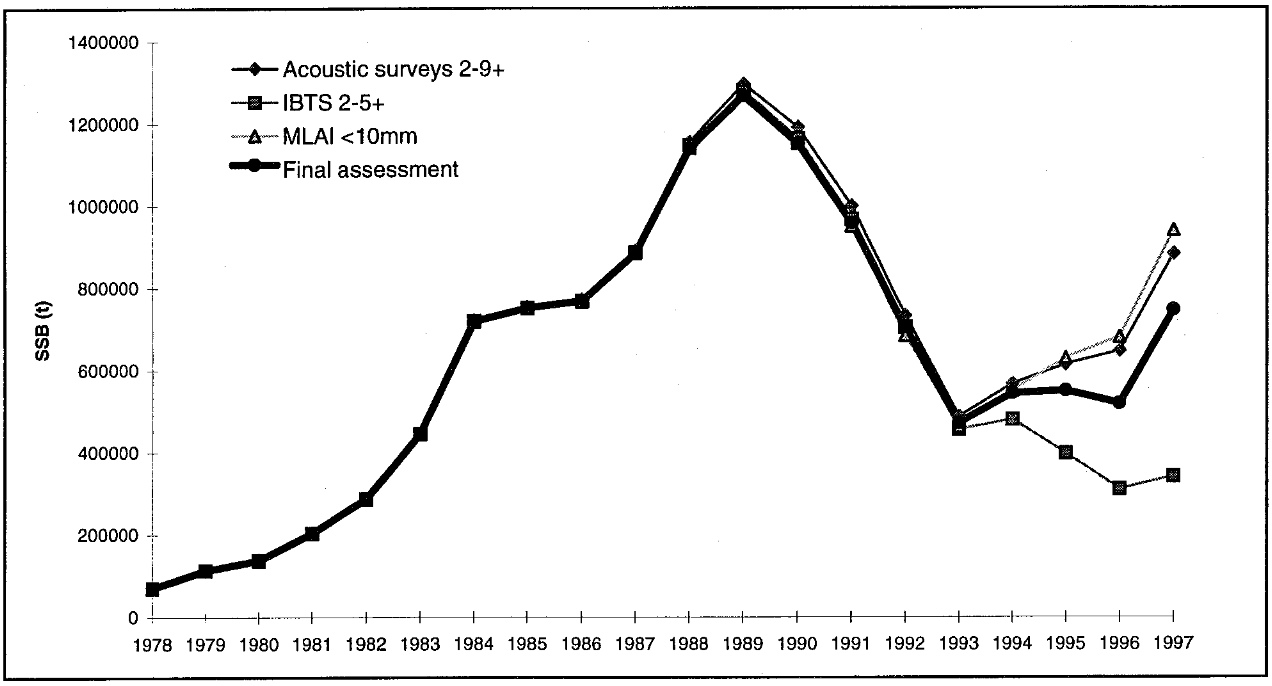


Figure 2.8.2 SSB estimates obtained from model fits with separate indices compared to the SSB estimate in the final assessment

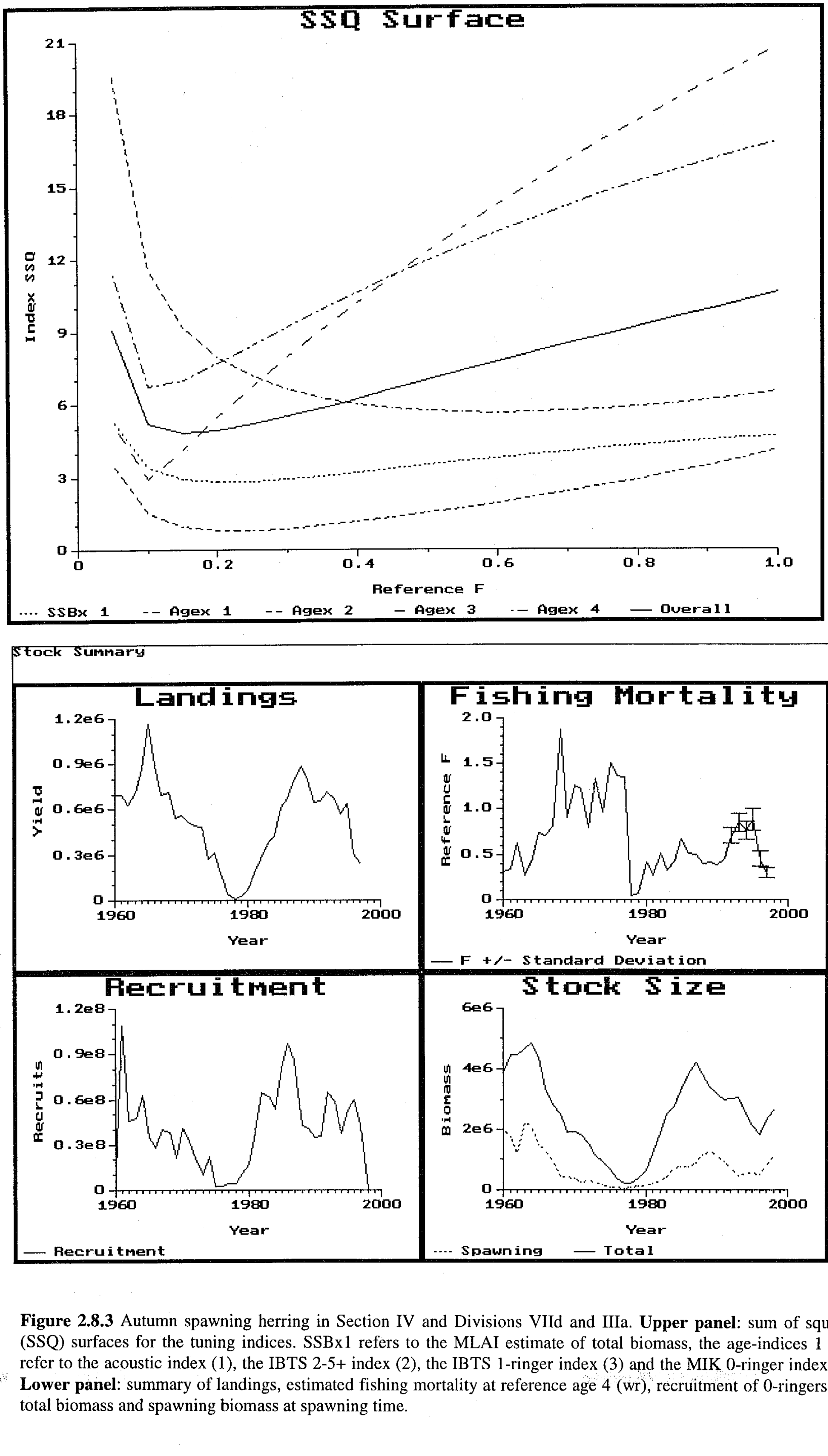


Figure 2.8.3 Autumn spawning herring in Section IV and Divisions VIId and IIIa. **Upper panel**: sum of squares (SSQ) surfaces for the tuning indices. SSBx1 refers to the MLAI estimate of total biomass, the age-indices 1 to 4 refer to the acoustic index (1), the IBTS 2-5+ index (2), the IBTS 1-ringer 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.

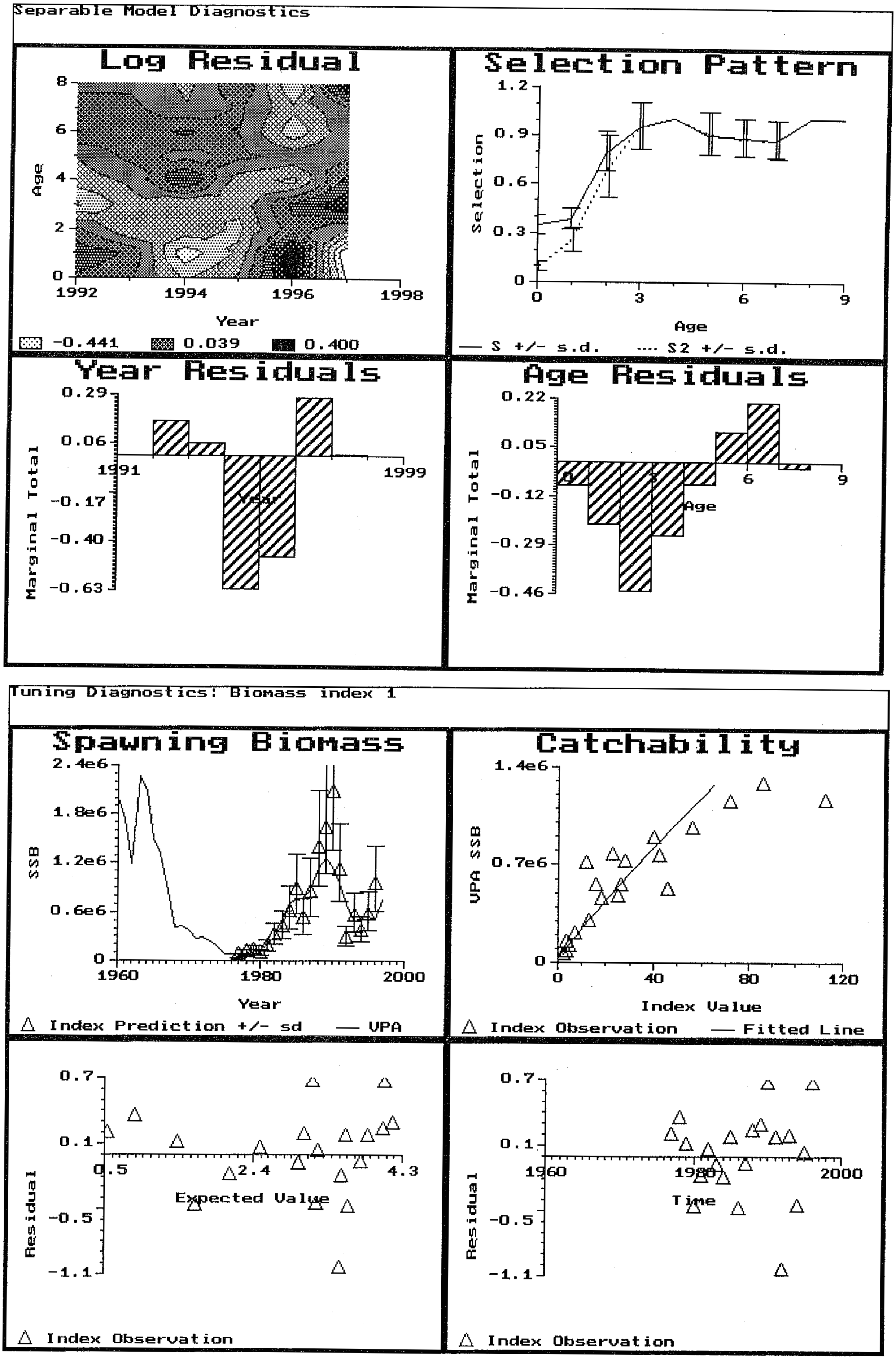


Figure 2.8.4 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Final assessment. **Upper panel**: selection patterns diagnostics. Top left: contour plot of selection pattern residuals. Top right: two estimated selection patterns S1 (1992-1995) and S2 (1996-1997). Bottom: marginal totals 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).

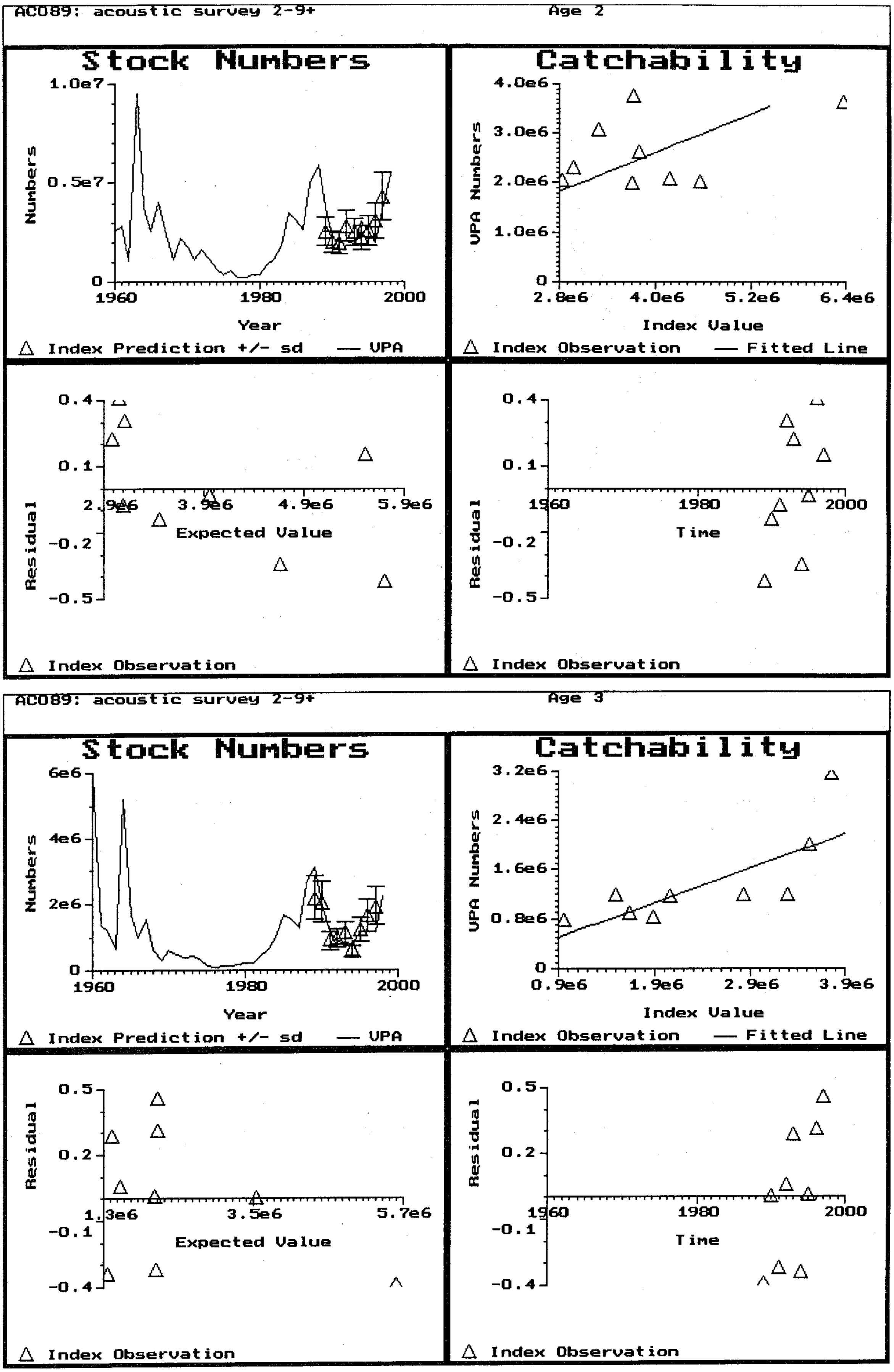


Figure 2.8.5 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Final assessment. **Upper panel**: diagnostics of the fit of the **acoustic 2-ringer index** against the estimated stocknumbers at age 2. Top left: fitted populations at age 2 (line) and the predicted stocknumbers from the 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 stocknumbers at age 3. Top left: fitted populations at age 3 (line) and the predicted stocknumbers 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).

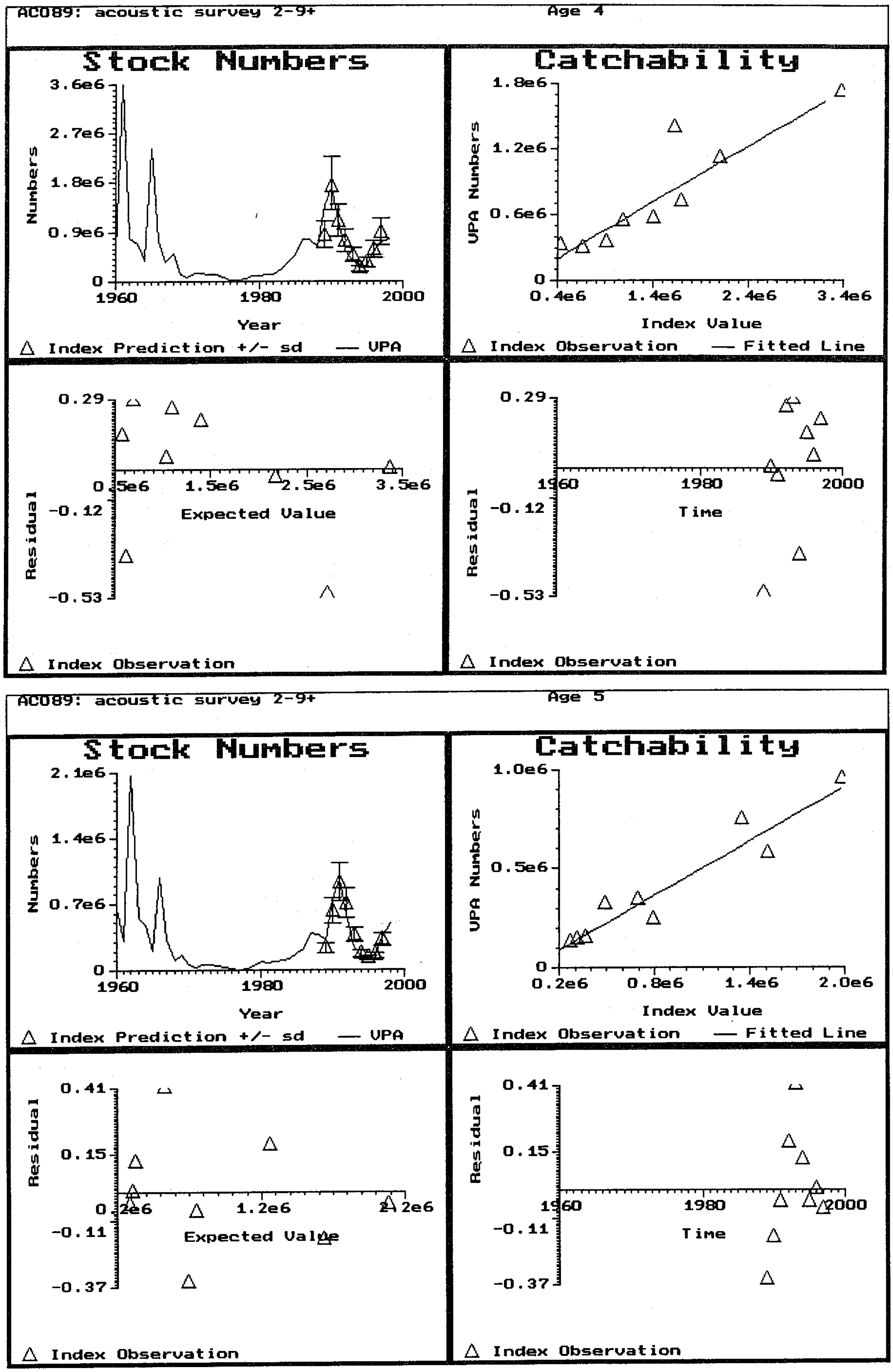
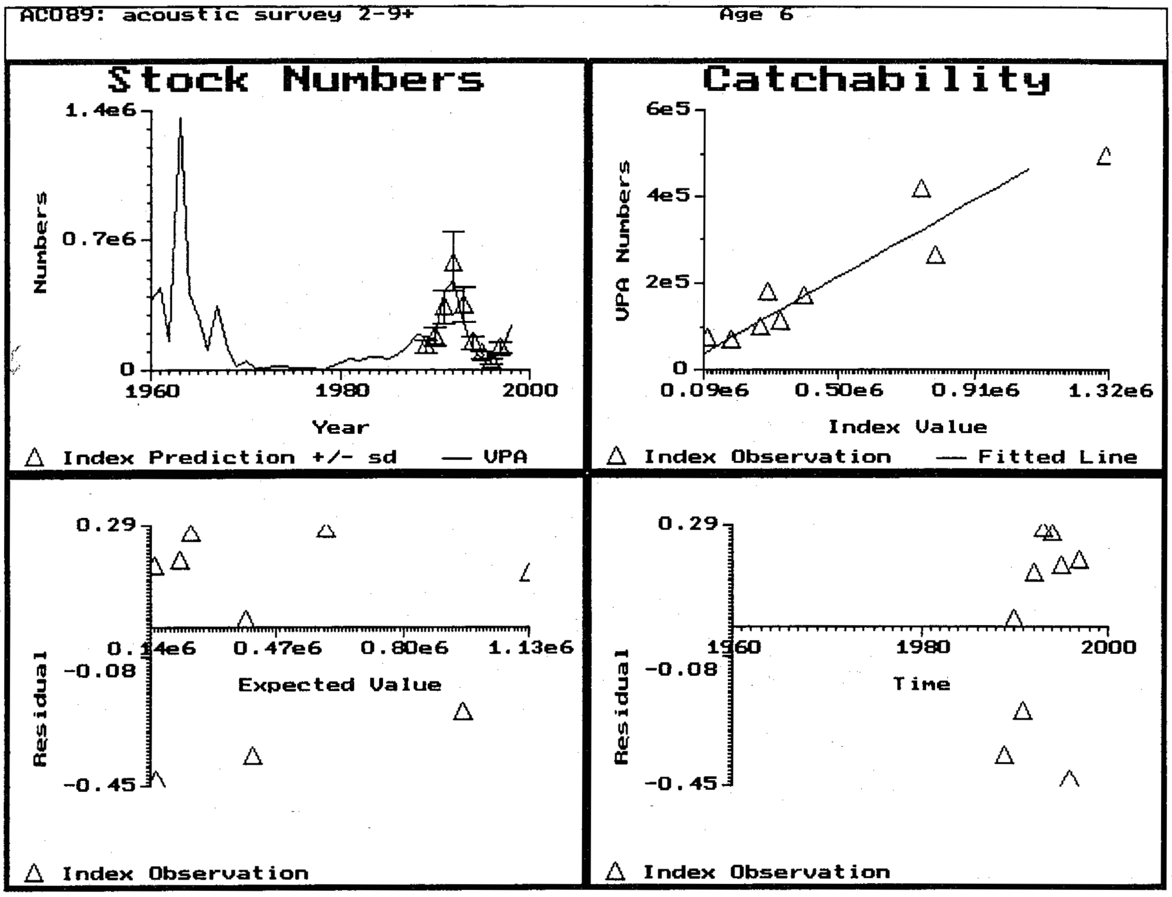


Figure 2.8.6 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Final assessment. **Upper panel**: diagnostics of the fit of the **acoustic 4-ringer index** against the estimated stocknumbers at age 4. Top left: fitted populations at age 4 (line) and the predicted stocknumbers from the 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 stocknumbers at age 5. Top left: fitted populations at age 5 (line) and the predicted stocknumbers 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).



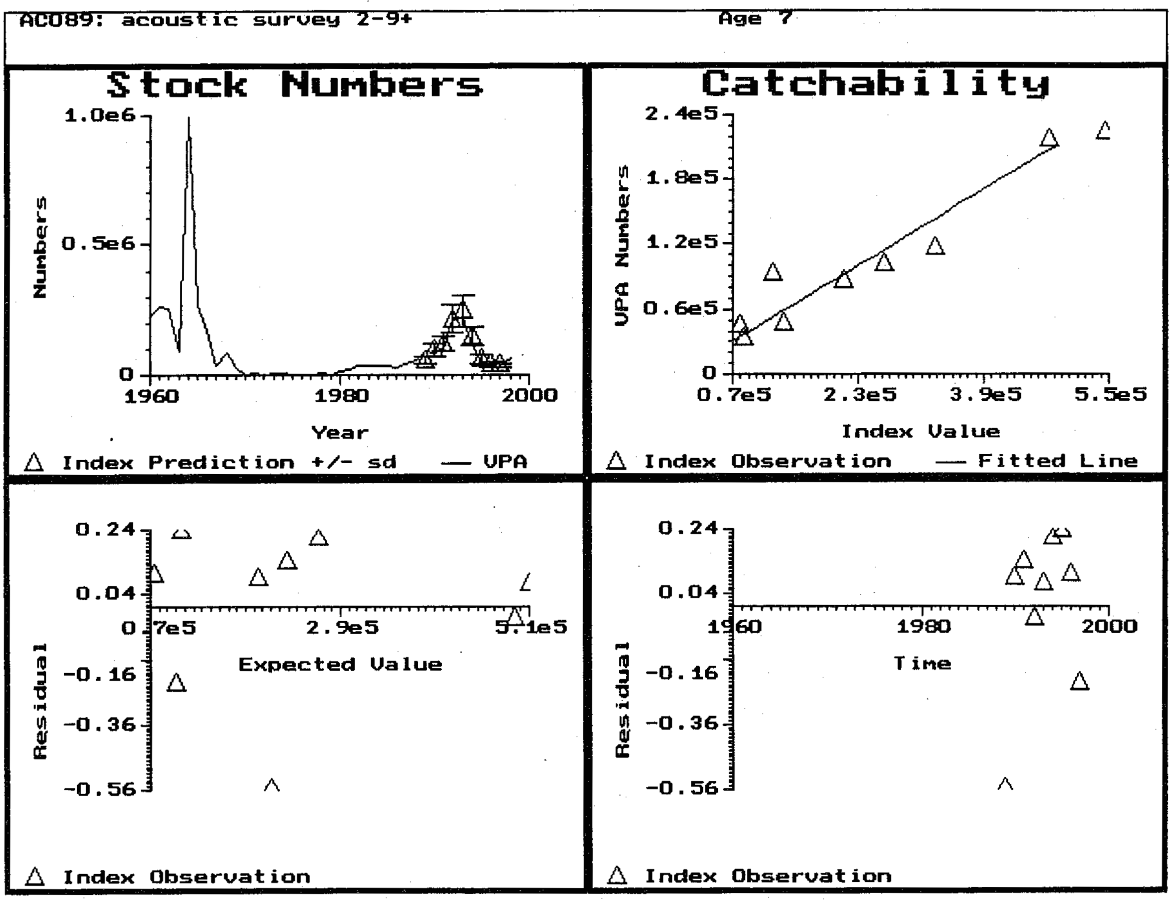


Figure 2.8.7 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Final assessment. **Upper panel**: diagnostics of the fit of the **acoustic 6-ringer index** against the estimated stocknumbers at age 6. Top left: fitted populations at age 6 (line) and the predicted stocknumbers from the 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 stocknumbers at age 7. Top left: fitted populations at age 7 (line) and the predicted stocknumbers 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).

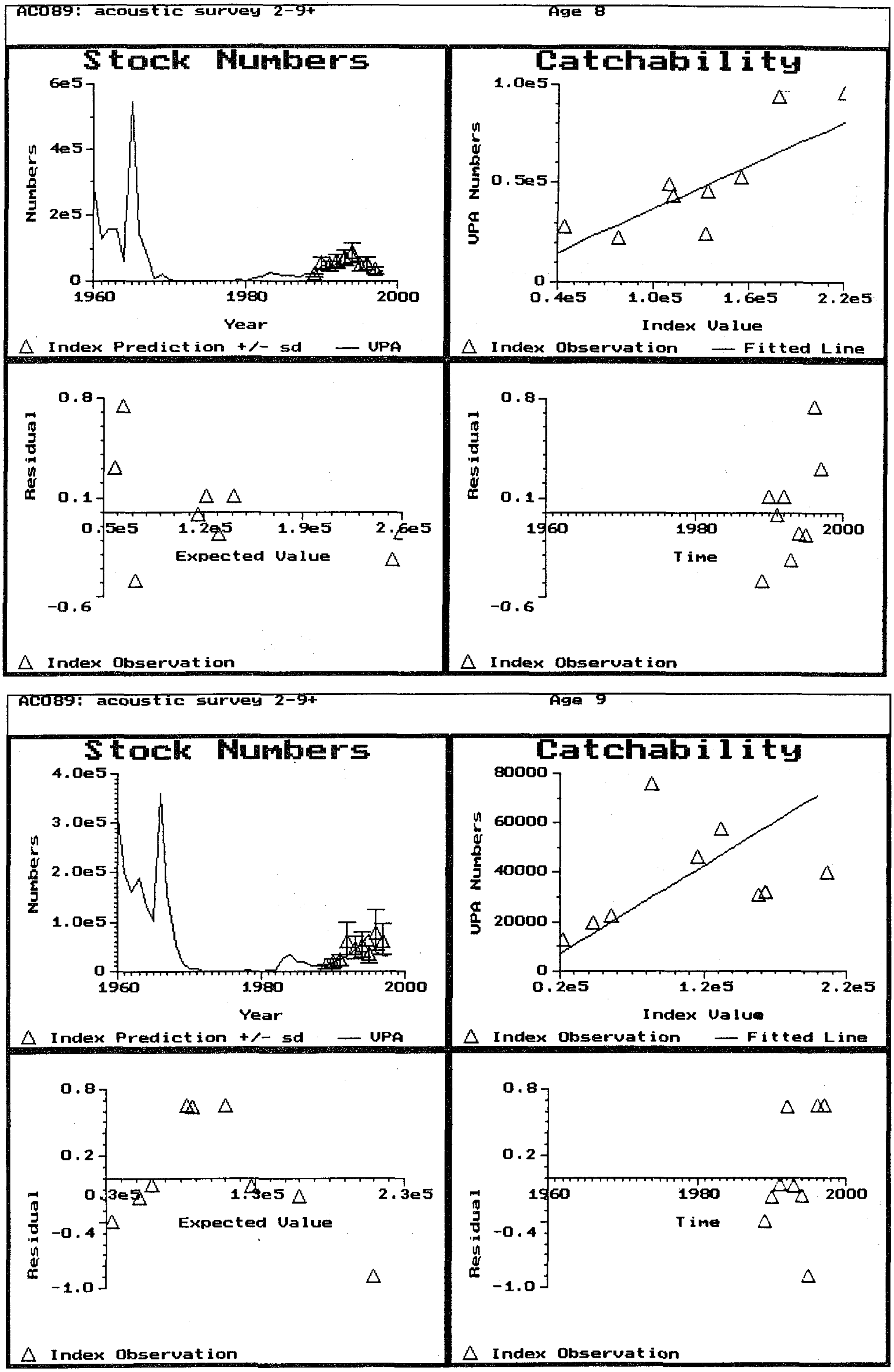


Figure 2.8.8 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Final assessment. **Upper panel**: diagnostics of the fit of the **acoustic 8-ringer index** against the estimated stocknumbers at age 8. Top left: fitted populations at age 8 (line) and the predicted stocknumbers from the 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 stocknumbers at ages 9+. Top left: fitted populations at ages 9+ (line) and the predicted stocknumbers 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).

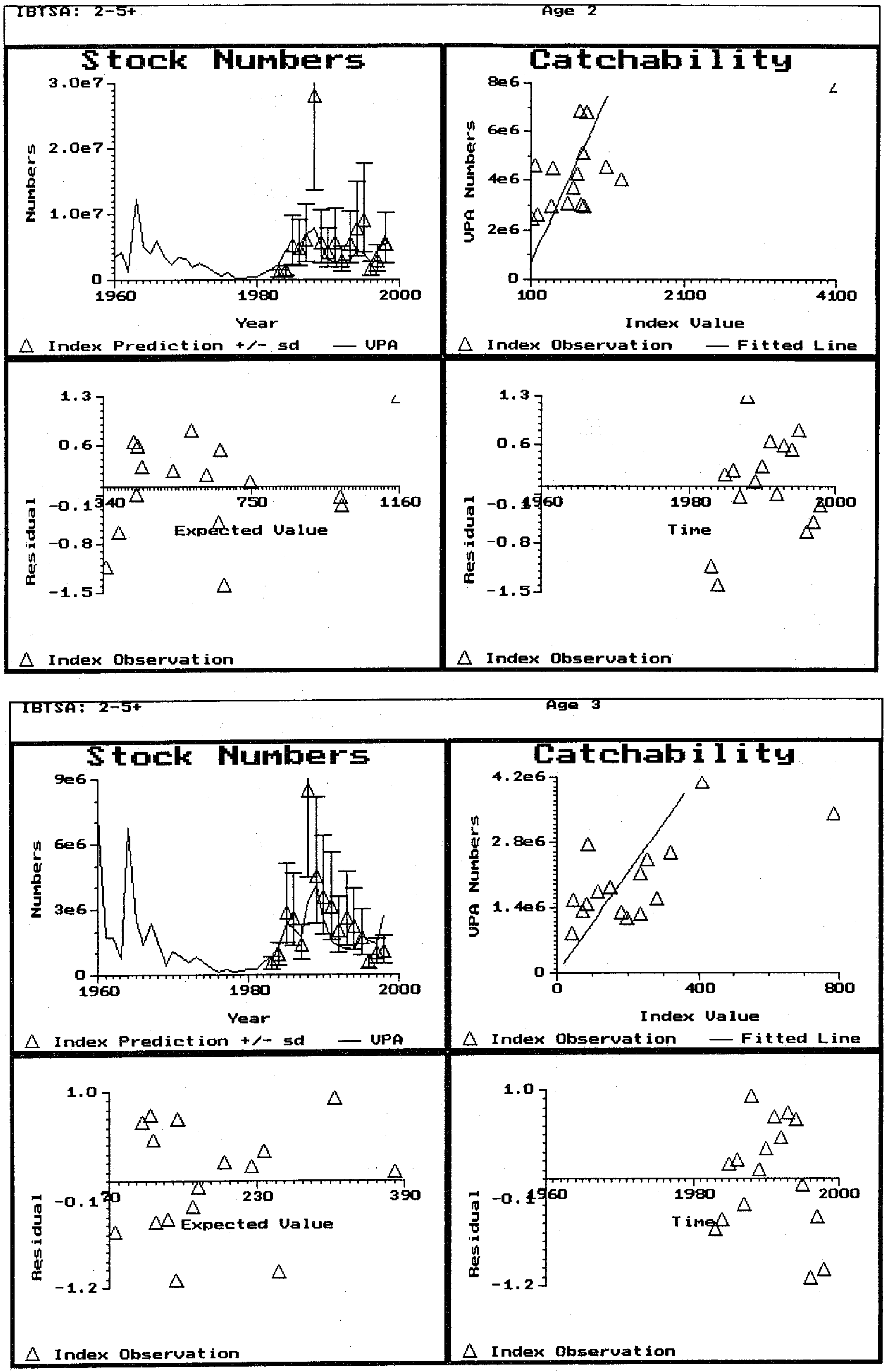


Figure 2.8.9 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Final assessment. **Upper panel**: diagnostics of the fit of the **IBTS 2-ringer index** against the estimated stocknumbers at age 2. Top left: fitted populations at age 2 (line) and the predicted stocknumbers from the index 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 stocknumbers at age 3. Top left: fitted populations at age 3 (line) and the predicted stocknumbers 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).

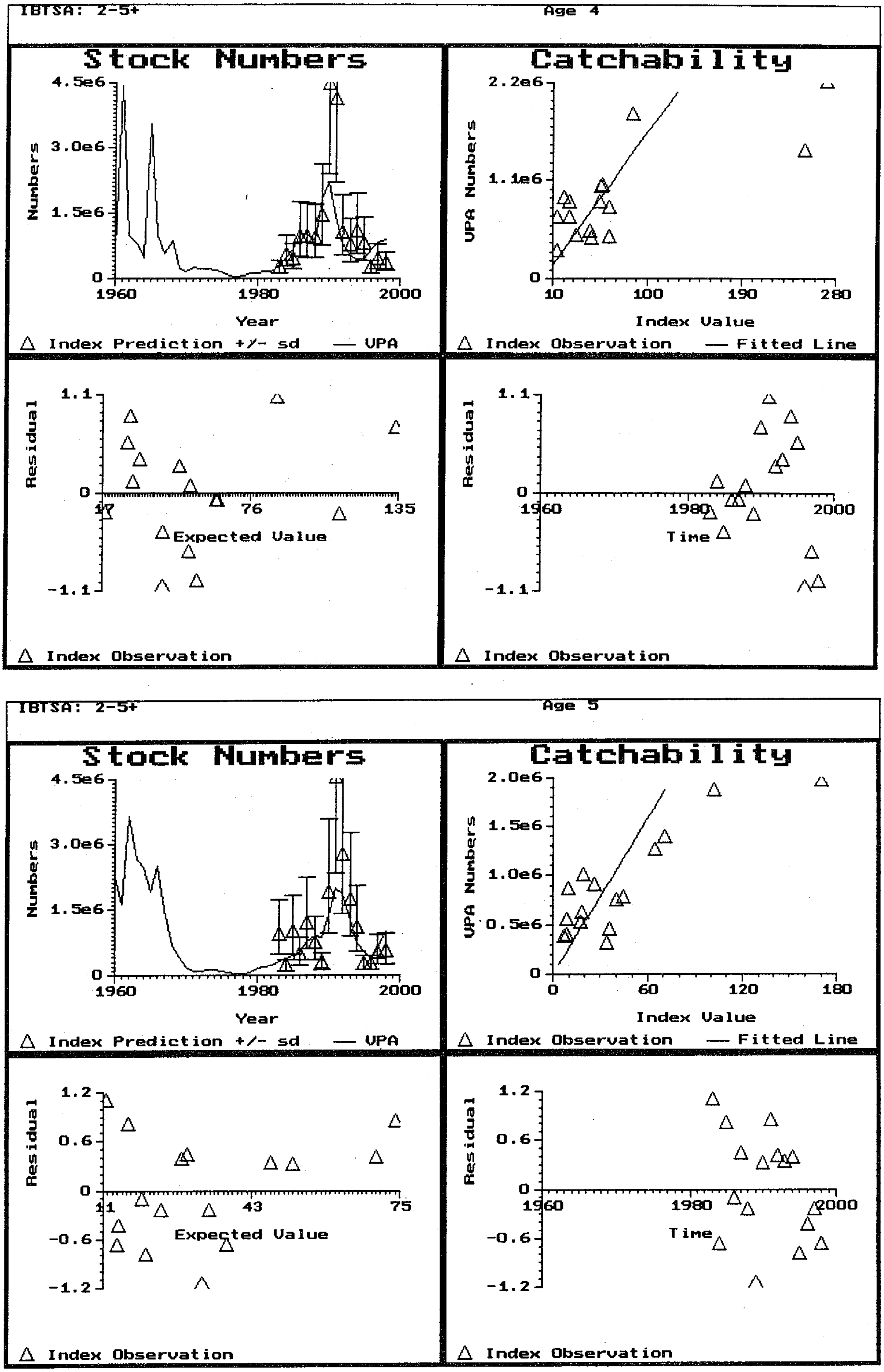


Figure 2.8.10 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Final assessment. **Upper panel**: diagnostics of the fit of the **IBTS 4-ringer index** against the estimated stocknumbers at age 4. Top left: fitted populations at age 4 (line) and the predicted stocknumbers from the index 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 stocknumbers at ages 5+. Top left: fitted populations at ages 5+ (line) and the predicted stocknumbers 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).

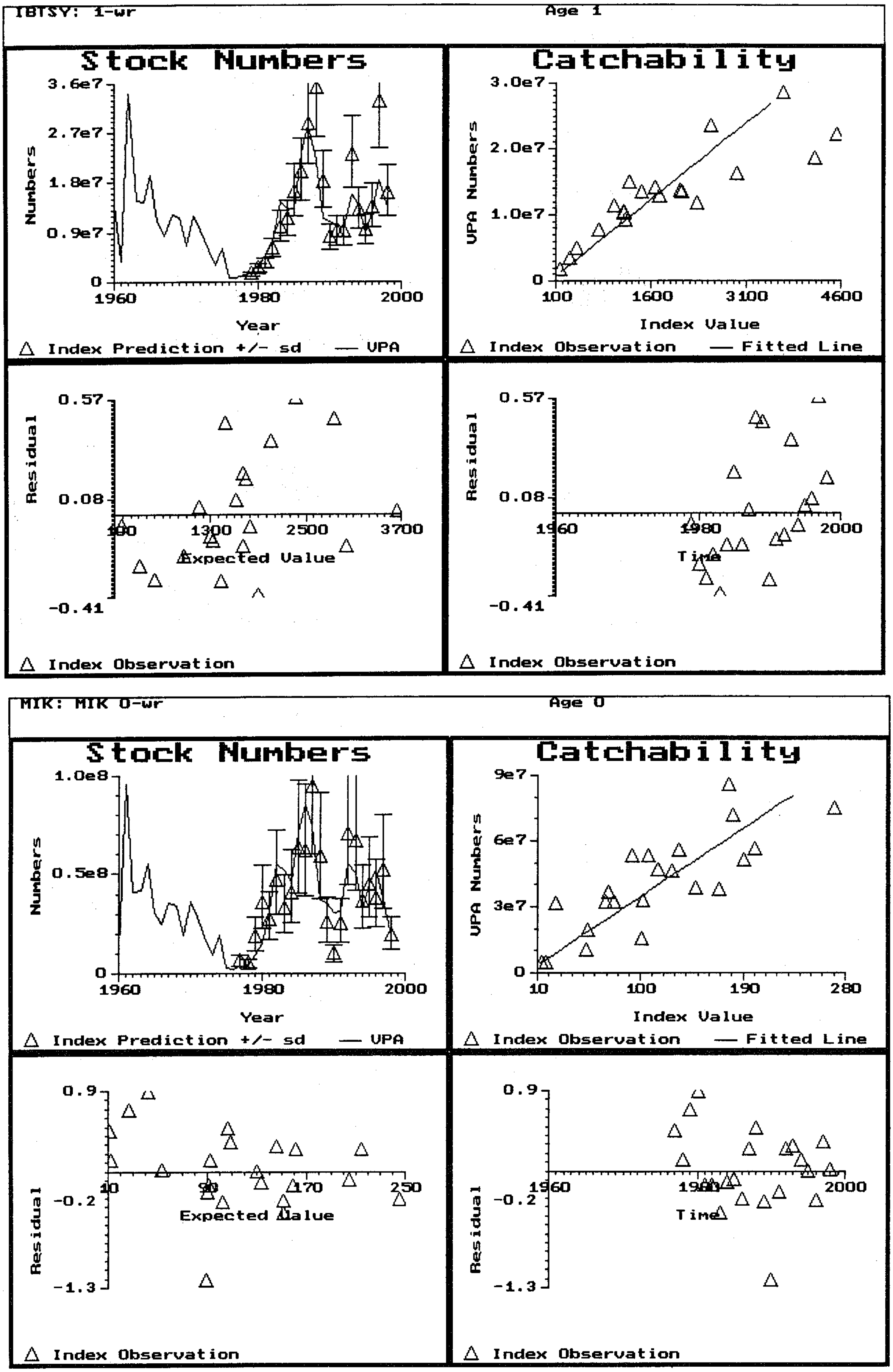


Figure 2.8.11 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Final assessment. **Upper panel**: diagnostics of the fit of the separate **IBTS 1-ringer index** against the estimated stocknumbers at age 1. Top left: fitted populations at age 1 (line) and the predicted stocknumbers from 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 stocknumbers at age 0. Top left: fitted populations at age 0 (line) and the predicted stocknumbers 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).

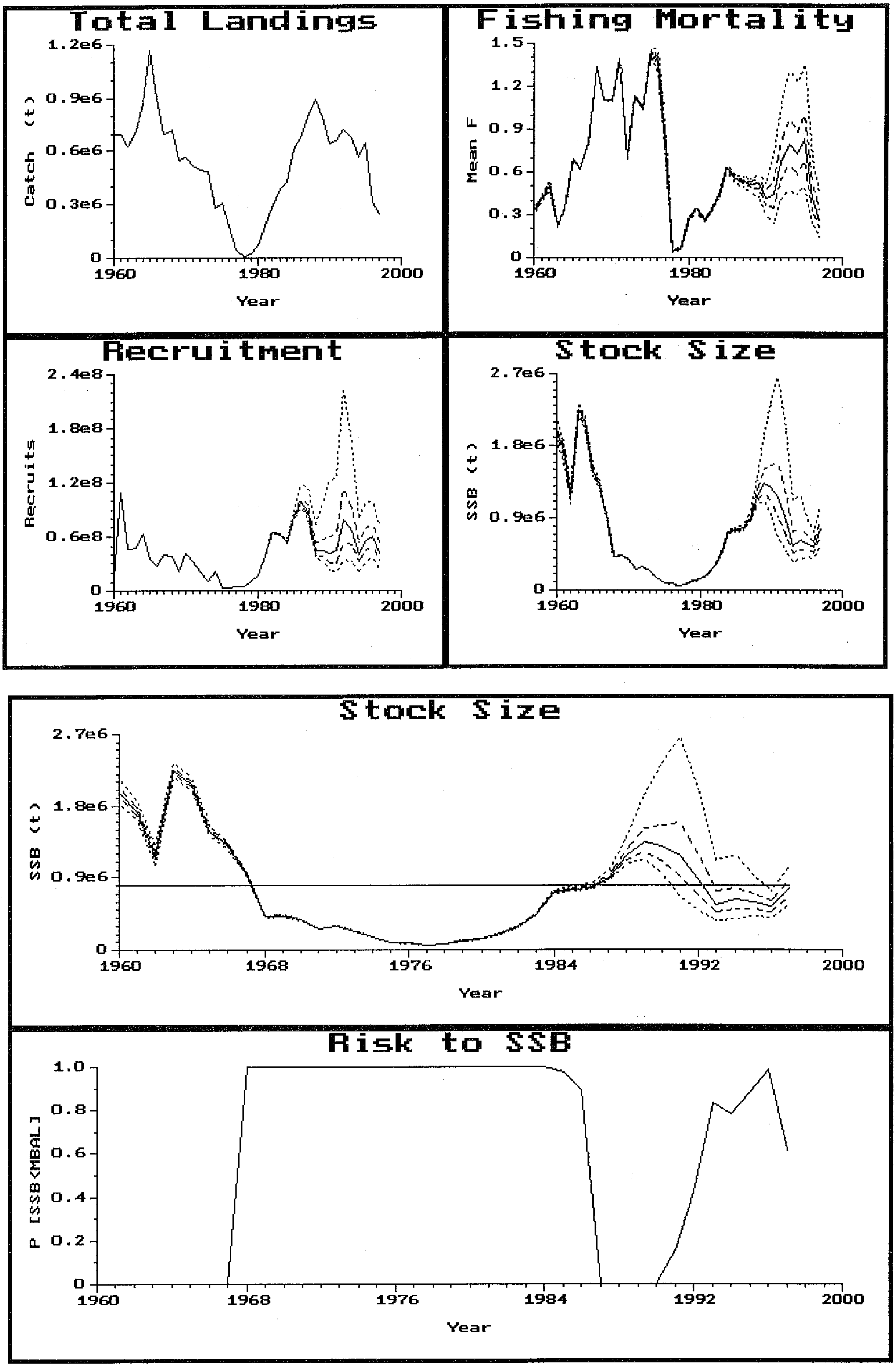


Figure 2.8.12 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Evaluation of assessment uncertainty using a covariance matrix method with 1000 random draws of all the parameters estimated in the ICA model (e.g. selection patterns, reference fishing mortalities in the separable period, stock numbers in the final year and at the final ages, catchabilities of the survey indices and recruitment in 1998) . **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.

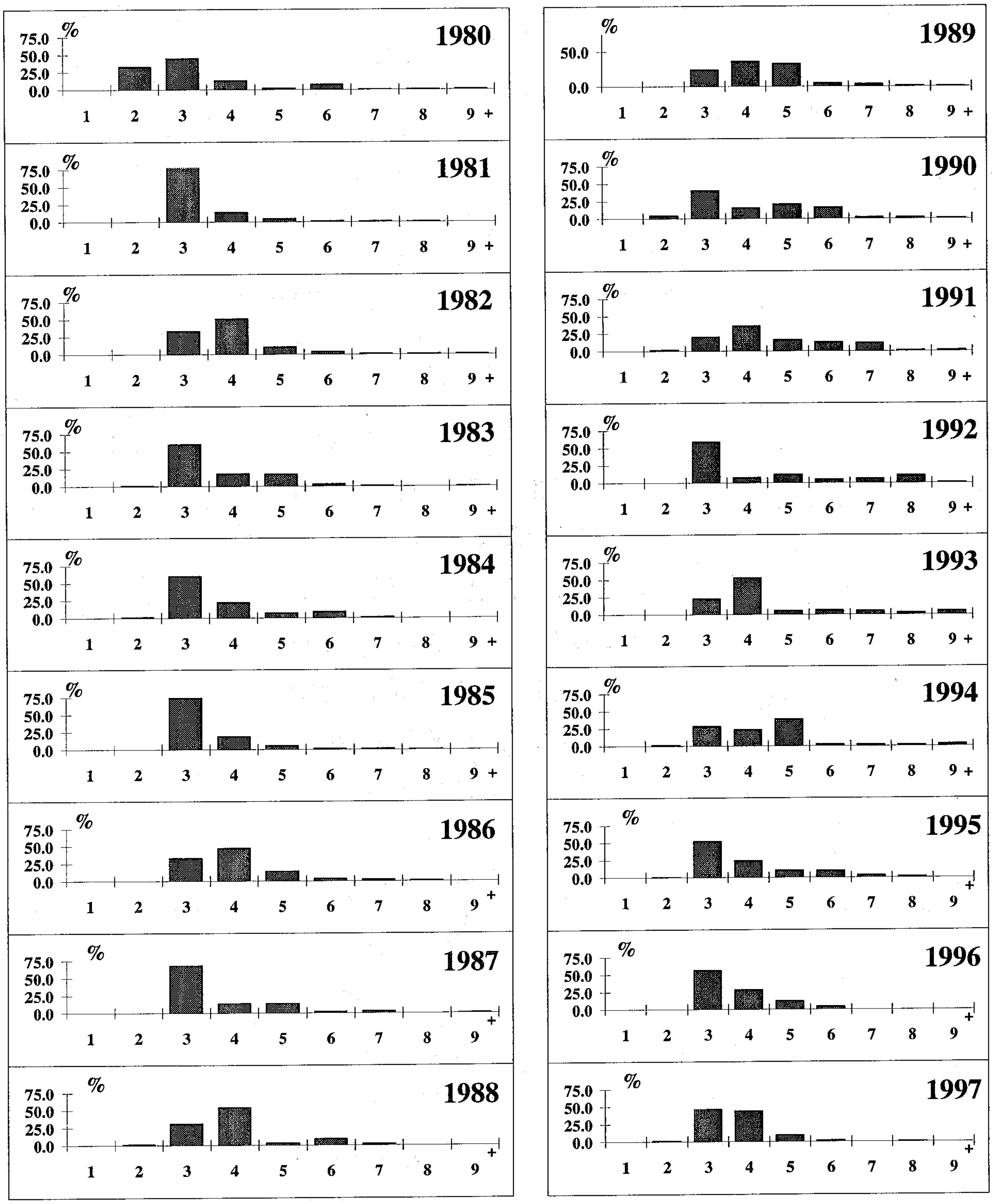


Figure 2.9.1 The age composition of herring in Divisions IVc and VIId in the Dutch catches from December 1980-1997.

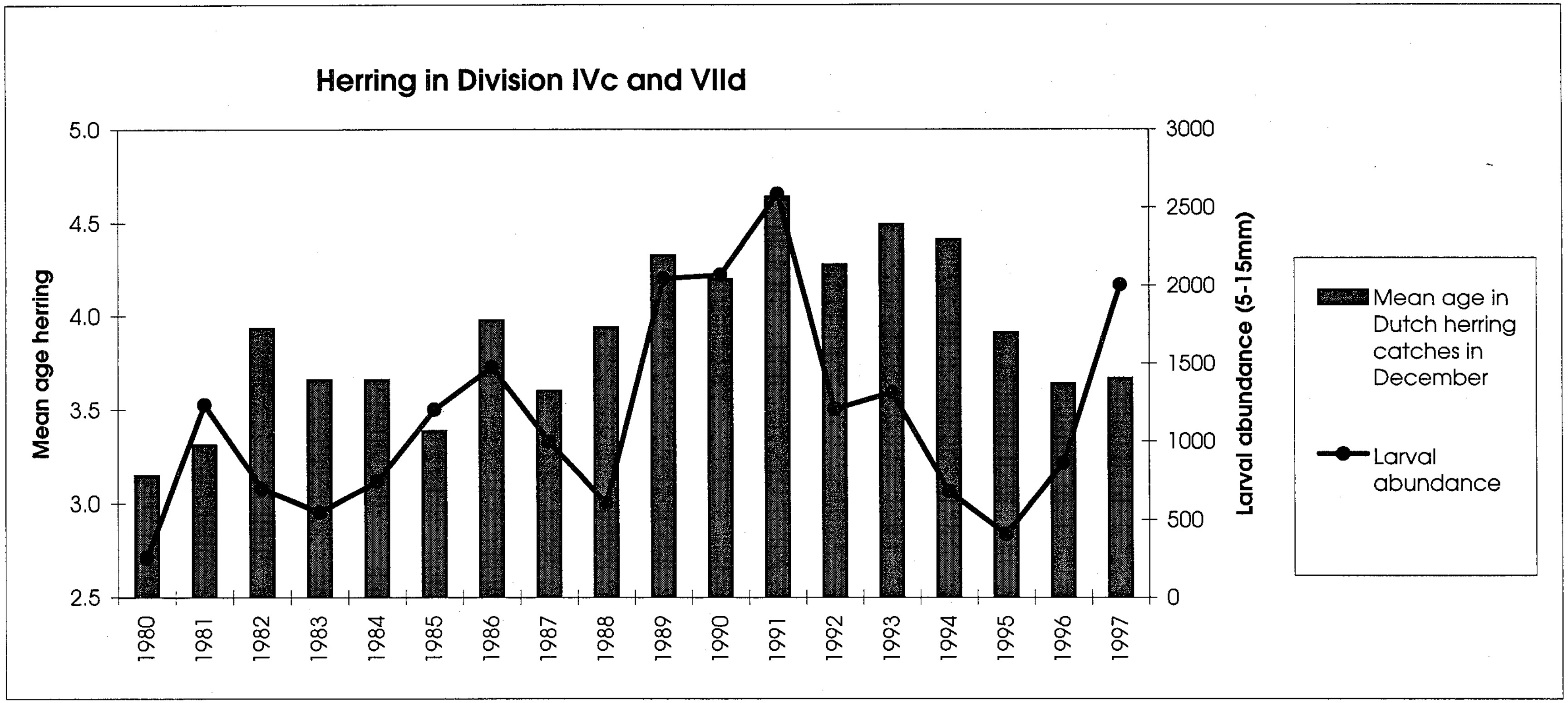


Figure 2.9.2 Changes in the herring larval abundance compared to changed in the mean age in the Dutch herring catches in December.

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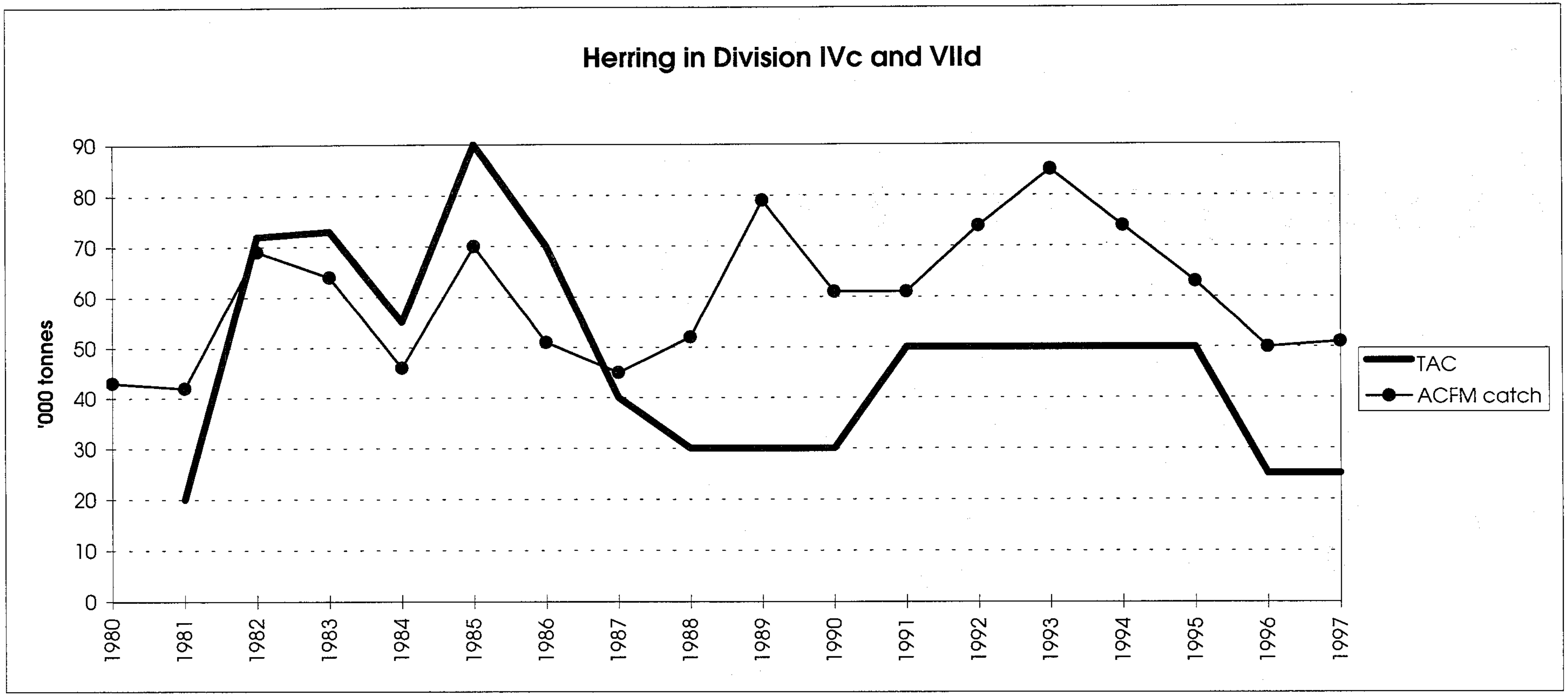

Figure 2.9.3 The agreed TAC for Divisions IVc and VIId compared to the ACFM catch in that area. In 1996 the agreed TAC was reduced by 50% in the middle of the year.

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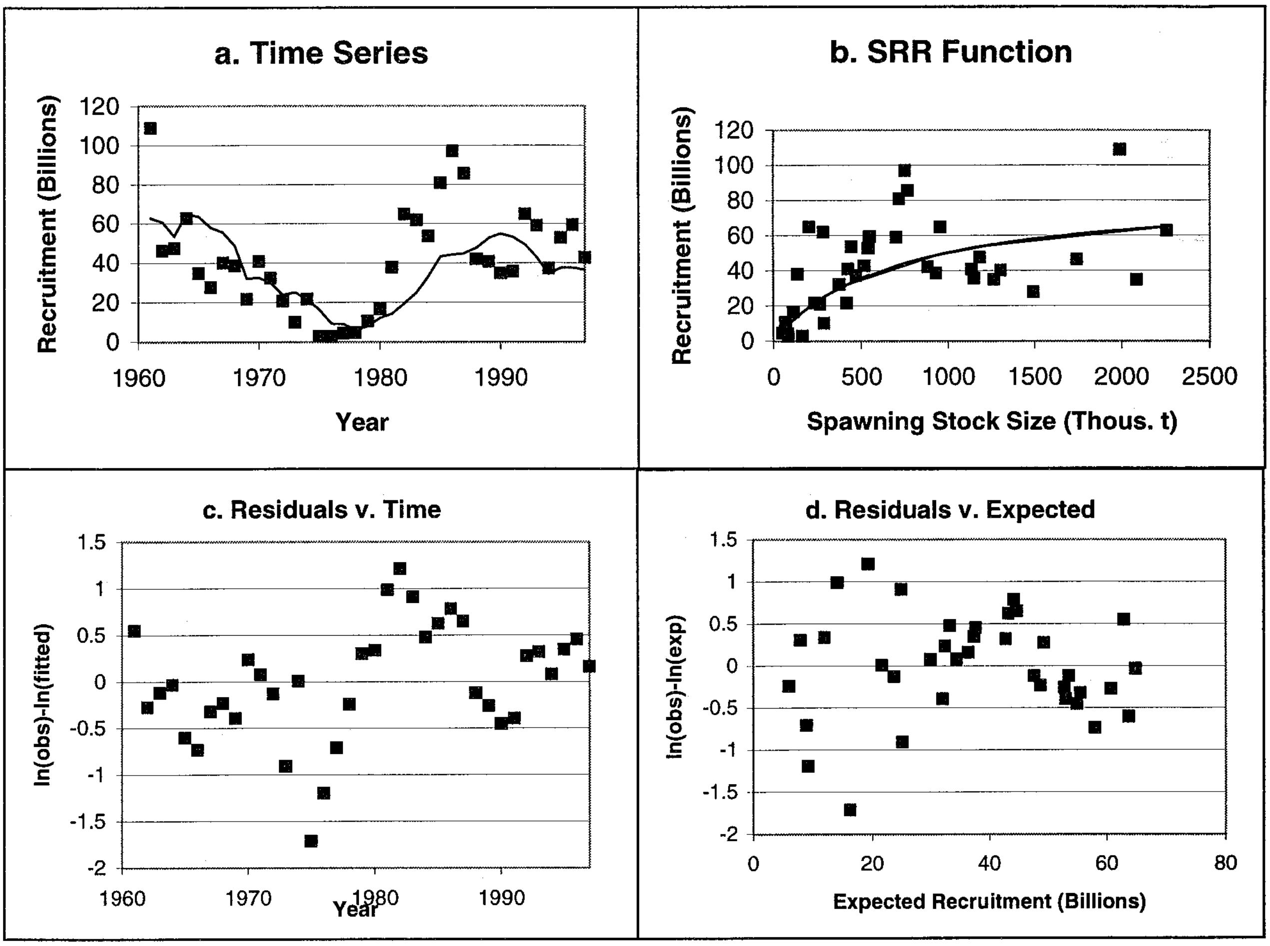

Figure 2.11.1. North Sea Herring.Stock-recruitment relationship used for the medium-term projections.A Beverton-Holt model. Clockwise from top left, first panel: Time series of recruitment (ICA estimates, open squares), expected recruitments (fitted value from Beverton-Holt model) and fitted recruitments (including autocorrelation term). Second panel, the stock-recruit function and the observed and expected recruitments plotted in the stock-recruitment plane. Third panel, scatterplot of residuals on time. Fourth panel, scatterplot

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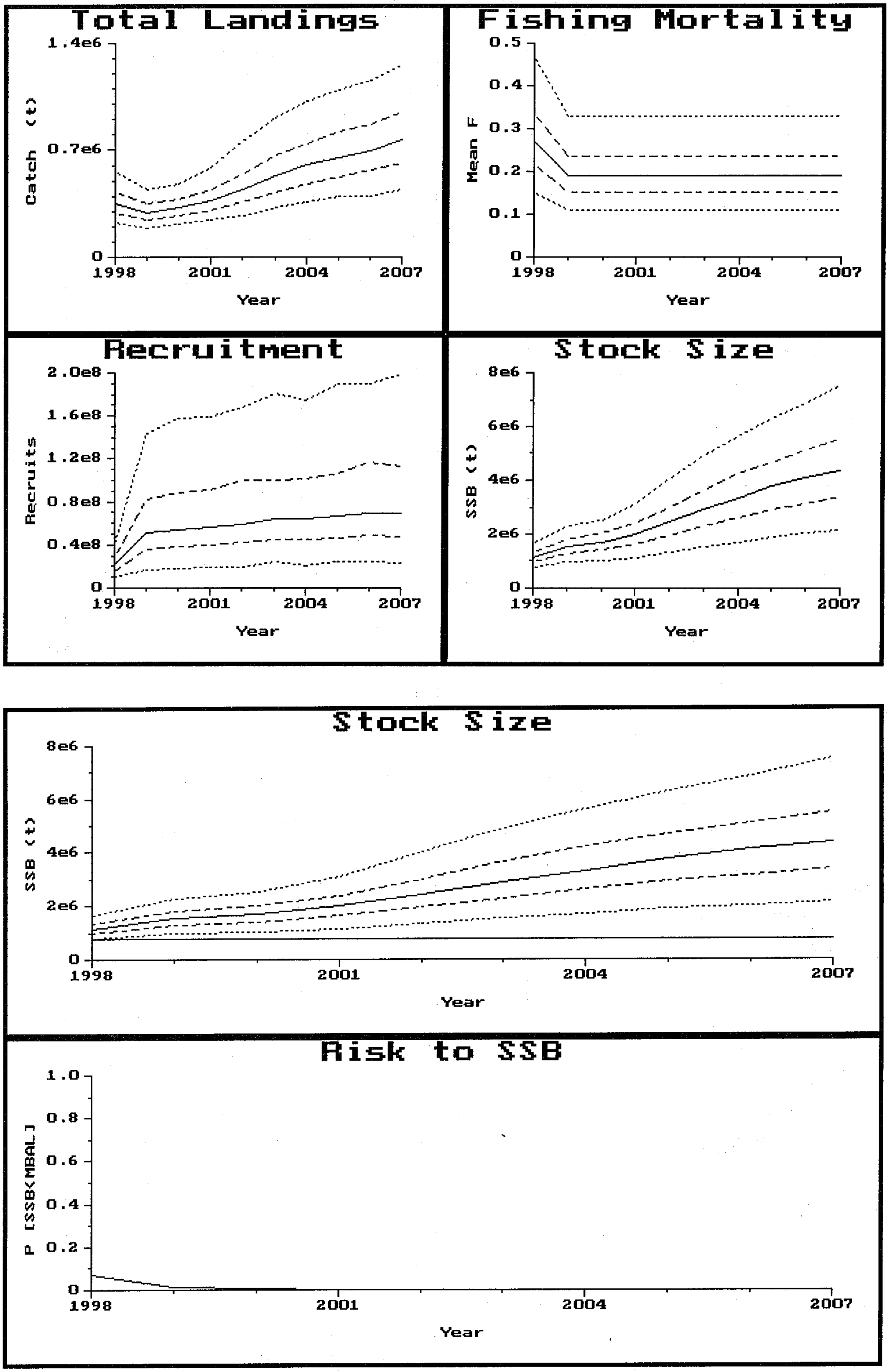

Figure 2.11.2a. North Sea Herring. Medium-term projections assuming F_A =0.2 and F_{B-E} = 0.0. Dotted lines indicate 5th and 95th percentiles, dashed lines indicate 25th and 75th percentiles. Unbroken line indicates median. **Upper panel** : Top left, landings by all fleets. Top right, fishing mortality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

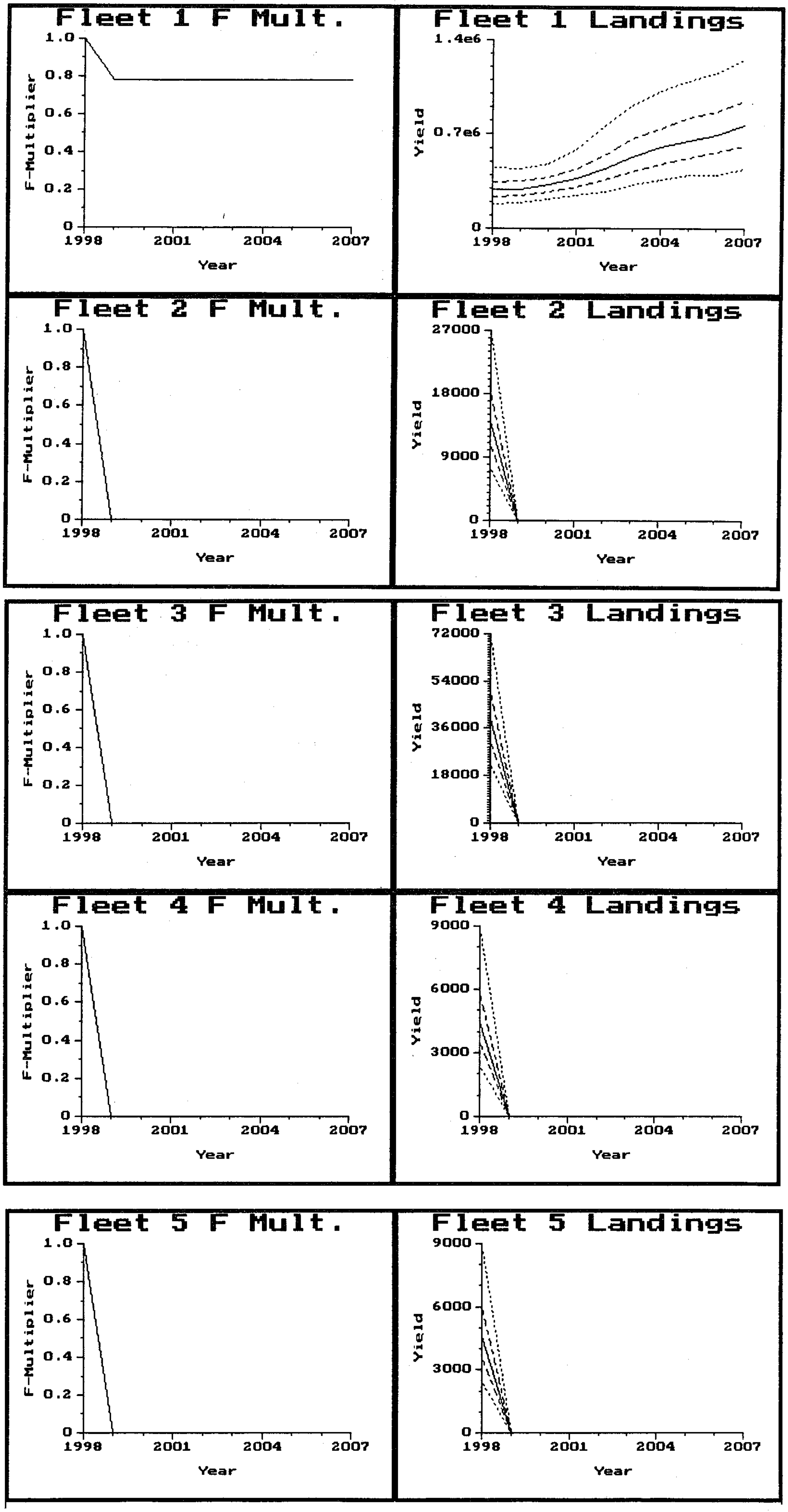

Figure 2.11.2.b. North Sea Herring. Medium-term projections assuming $F_A = 0.2$ and $F_{B\text{-}E} = 0.0$. Projected landings by fleets A to E (labelled 1 to 5 respectively)

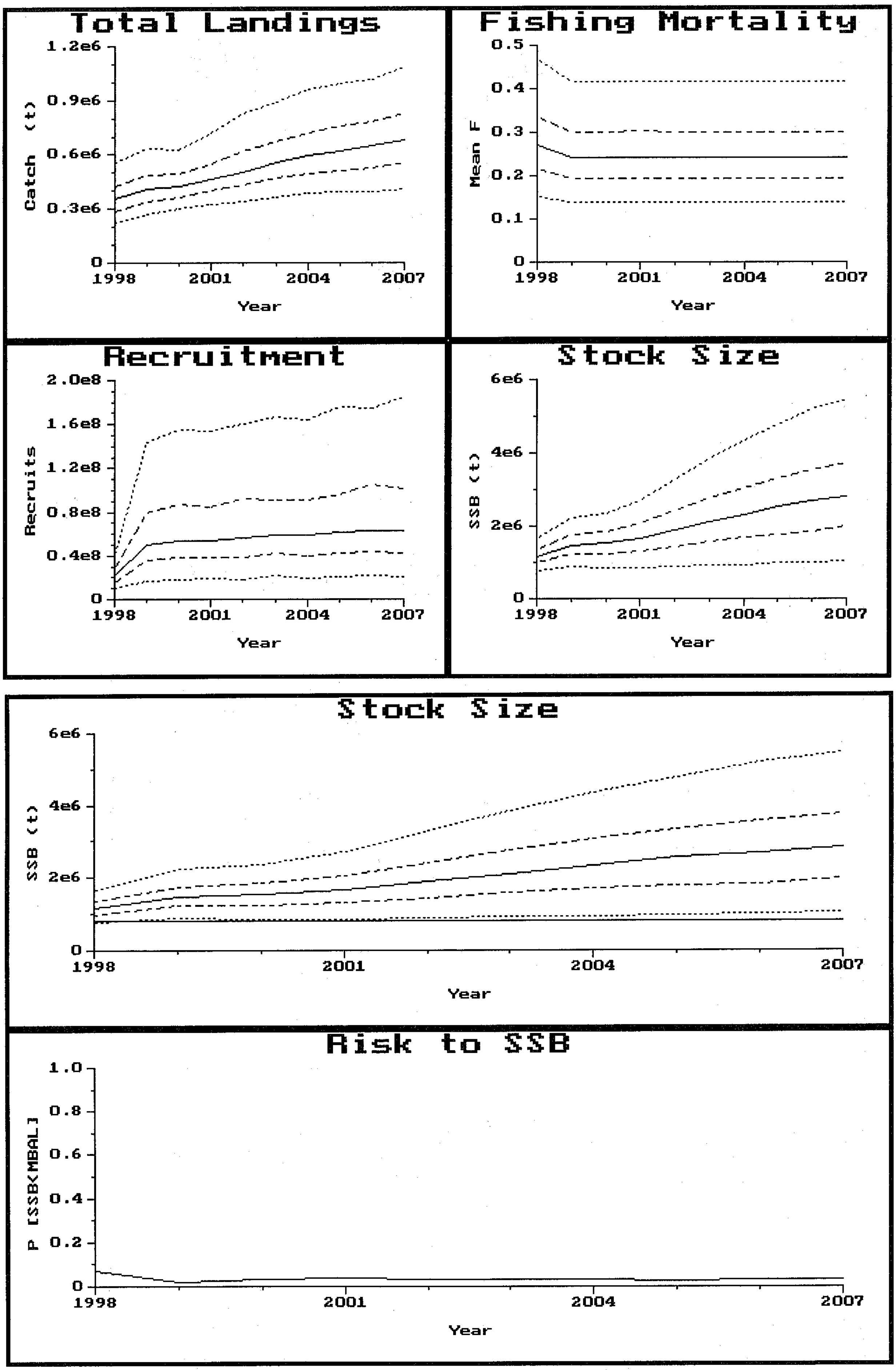

Figure 2.11.3a. North Sea Herring. Medium-term projections assuming F_A =0.2 and F_{B-E} = 0.1. Dotted lines indicate 5th and 95th percentiles, dashed lines indicate 25th and 75th percentiles. Unbroken line indicates median. **Upper panel** : Top left, landings by all fleets. Top right, fishing mortality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

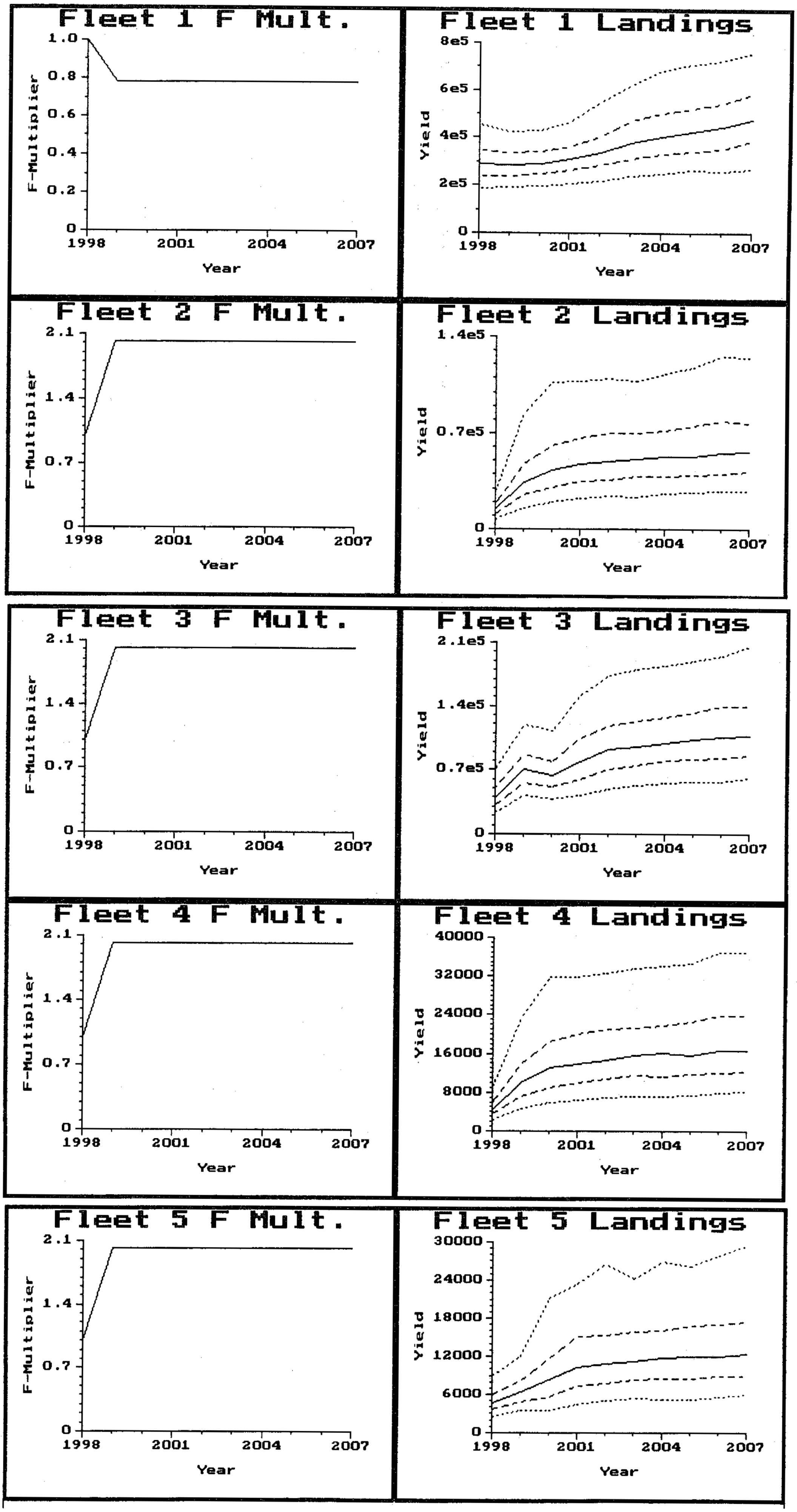

Figure 2.11.3.b. North Sea Herring. Medium-term projections assuming F_A =0.2 and F_{B-E} = 0.1. Projected landings by fleets A to E (labelled 1 to 5 respectively)

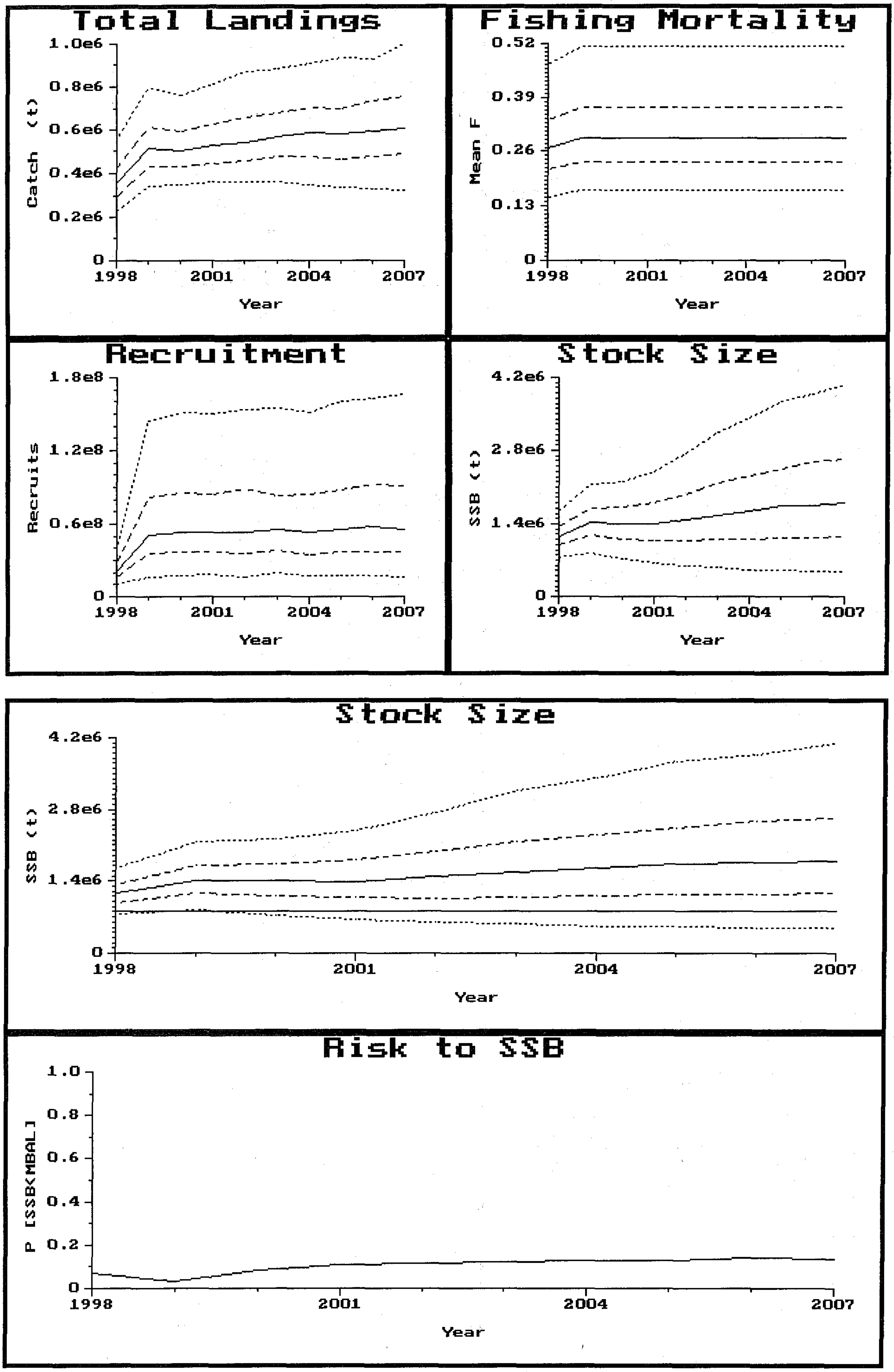

Figure 2.11.4a. North Sea Herring. Medium-term projections assuming F_A =0.2 and F_{B-E} = 0.2. Dotted lines indicate 5th and 95th percentiles, dashed lines indicate 25th and 75th percentiles. Unbroken line indicates median. **Upper panel** : Top left, landings by all fleets. Top right, fishing mortality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

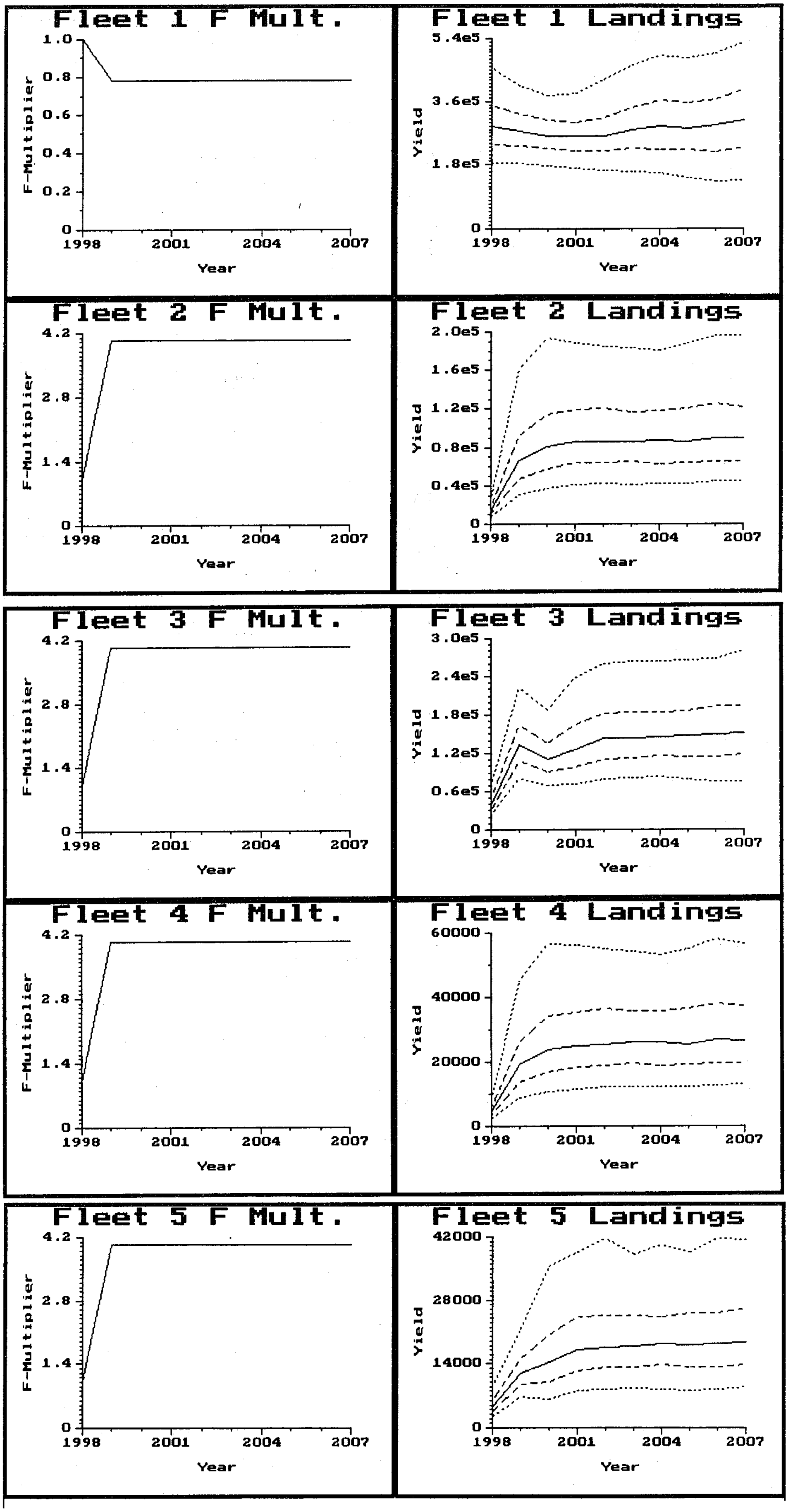

Figure 2.11.4.b. North Sea Herring. Medium-term projections assuming F_A =0.2 and F_{B-E} = 0.2. Projected landings by fleets A to E (labelled 1 to 5 respectively)

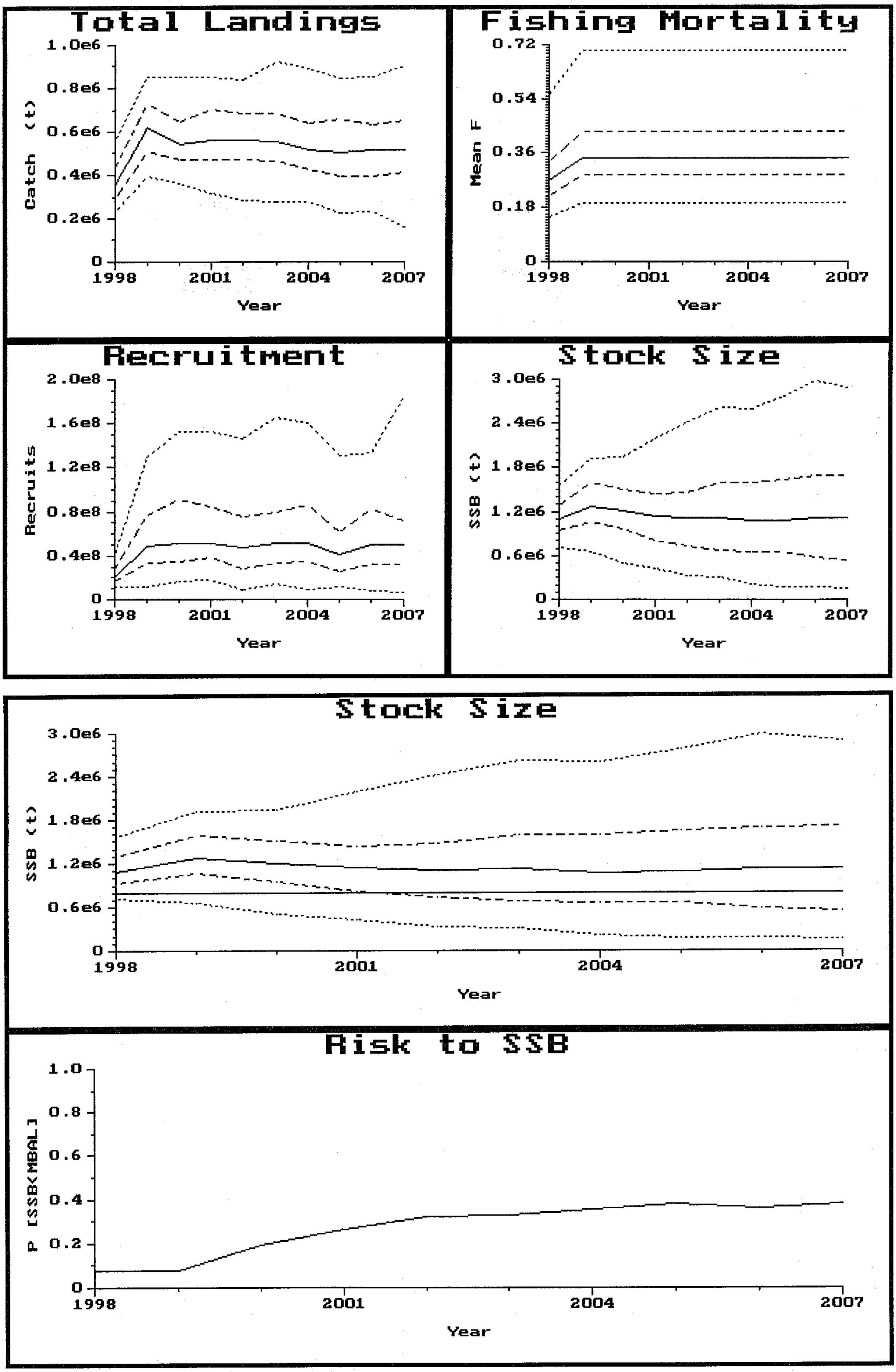

Figure 2.11.5a. North Sea Herring. Medium-term projections assuming F_A =0.2 and F_{B-E} = 0.3. Dotted lines indicate 5th and 95th percentiles, dashed lines indicate 25th and 75th percentiles. Unbroken line indicates median. **Upper panel** : Top left, landings by all fleets. Top right, fishing mortality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

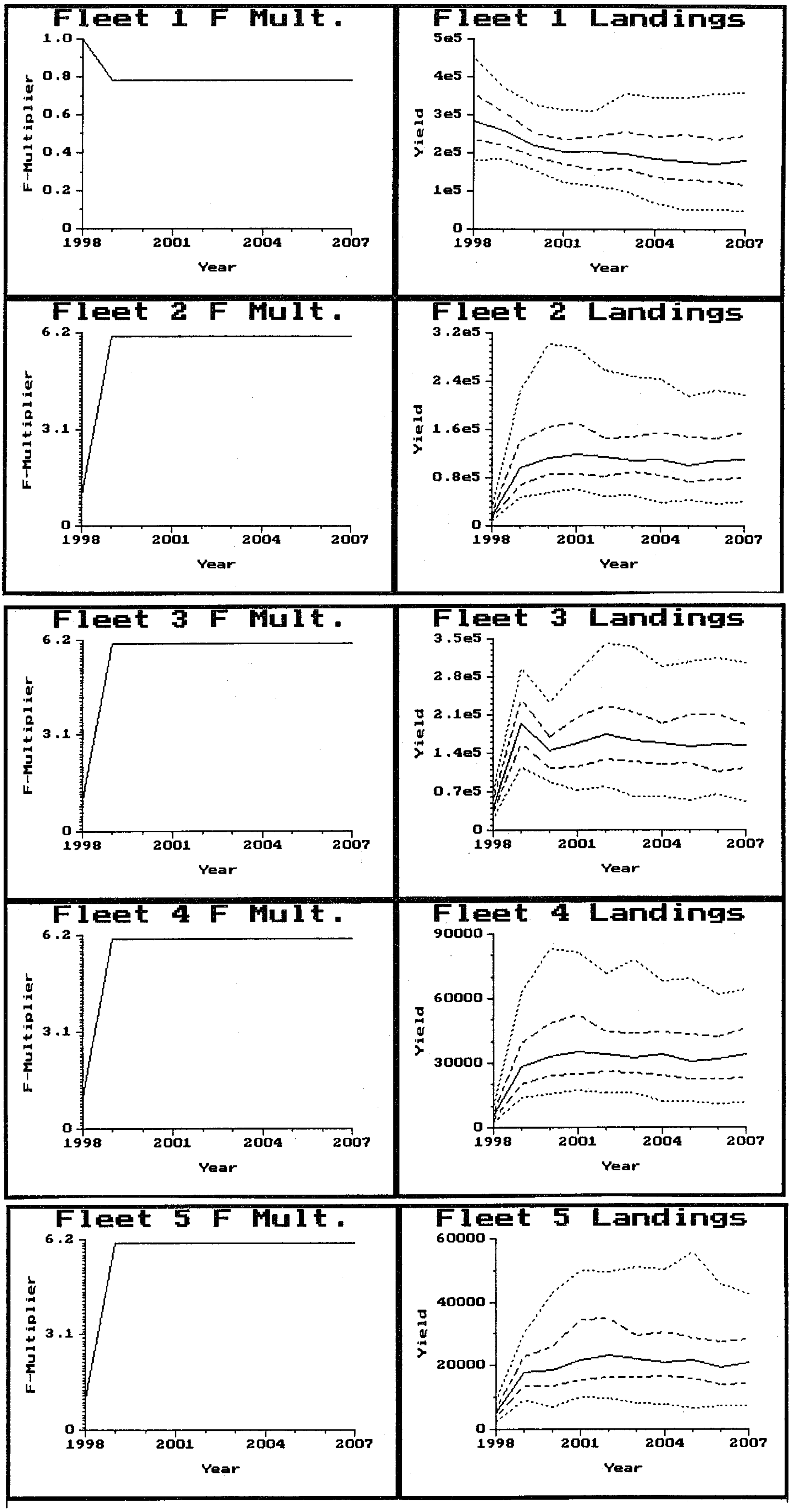

Figure 2.11.5.b. North Sea Herring. Medium-term projections assuming $F_A = 0.2$ and $F_{B\text{-}E} = 0.3$. Projected landings by fleets A to E (labelled 1 to 5 respectively)

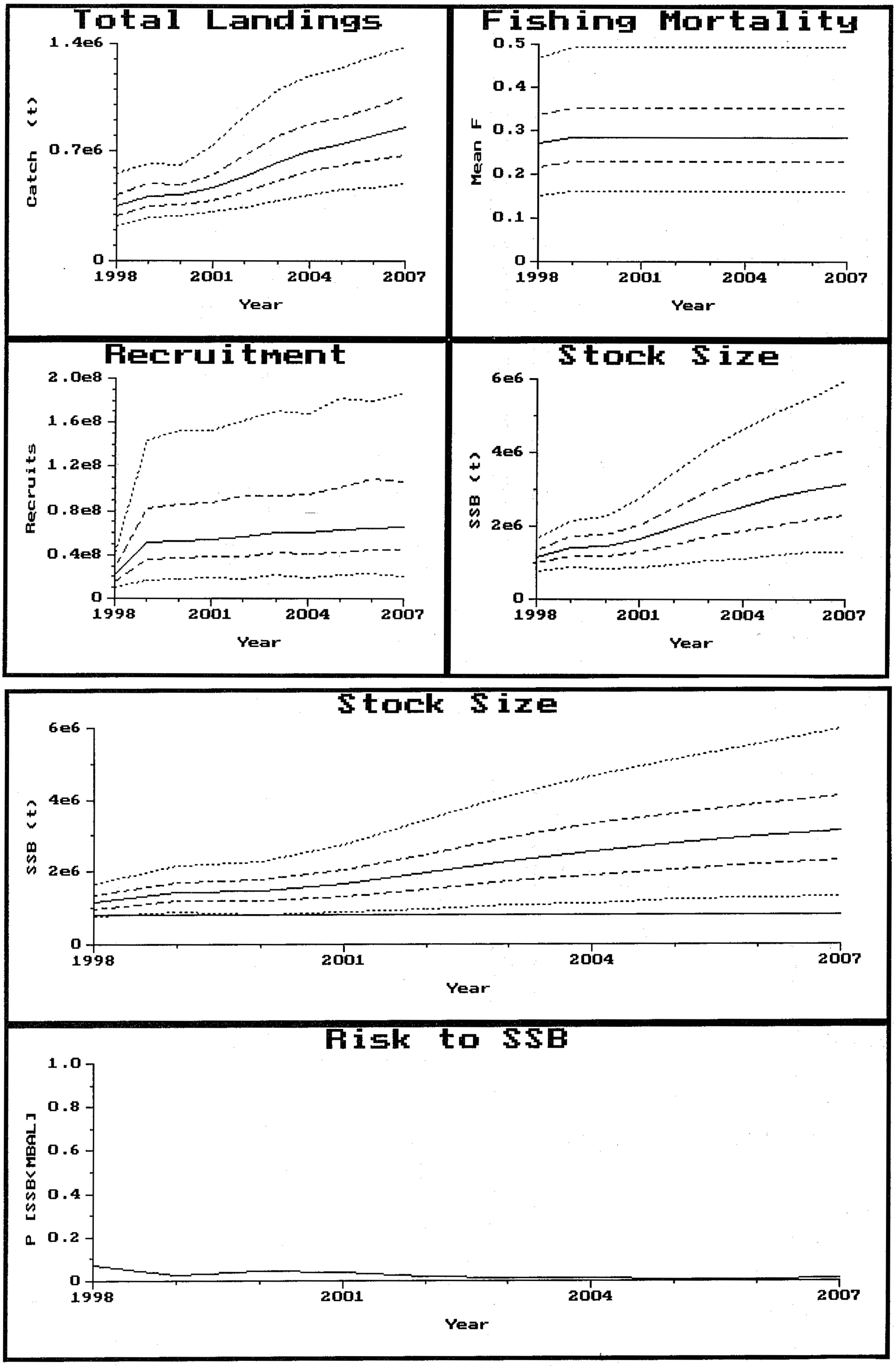

Figure 2.11.6a. North Sea Herring. Medium-term projections assuming $F_A = 0.3$ and $F_{B-E} = 0$. Dotted lines indicate 5th and 95th percentiles, dashed lines indicate 25th and 75th percentiles. Unbroken line indicates median. **Upper panel :** Top left, landings by all fleets. Top right, fishing mortality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

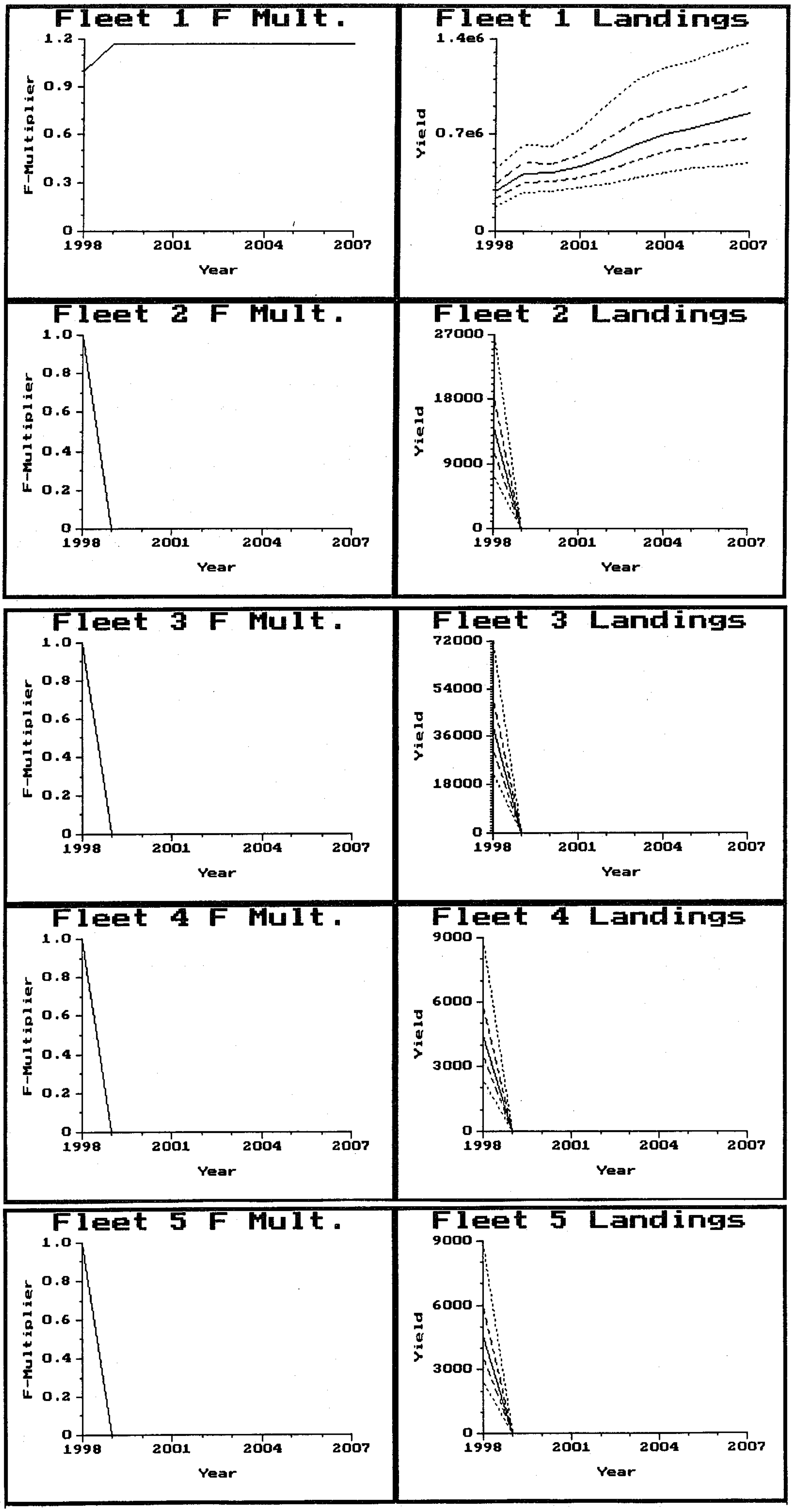

Figure 2.11.6.b. North Sea Herring. Medium-term projections assuming $F_A = 0.3$ and $F_{B\text{-}E} = 0$.. Projected landings by fleets A to E (labelled 1 to 5 respectively)

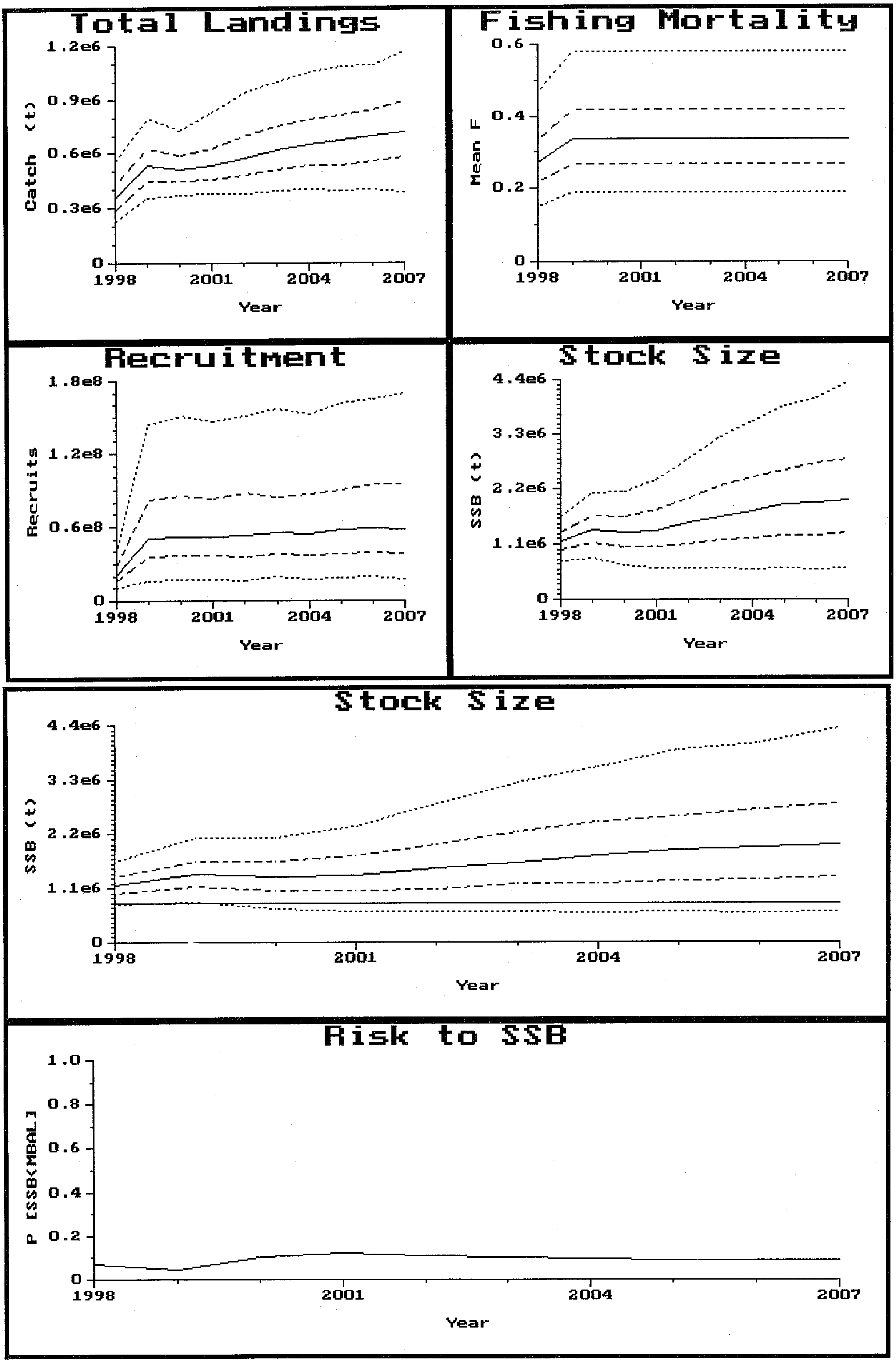

Figure 2.11.7a. North Sea Herring. Medium-term projections assuming F_A=0.3 and F_{B-E} = 0.1 Dotted lines indicate 5th and 95th percentiles, dashed lines indicate 25th and 75th percentiles. Unbroken line indicates median. **Upper panel :** Top left, landings by all fleets. Top right, fishing mortality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

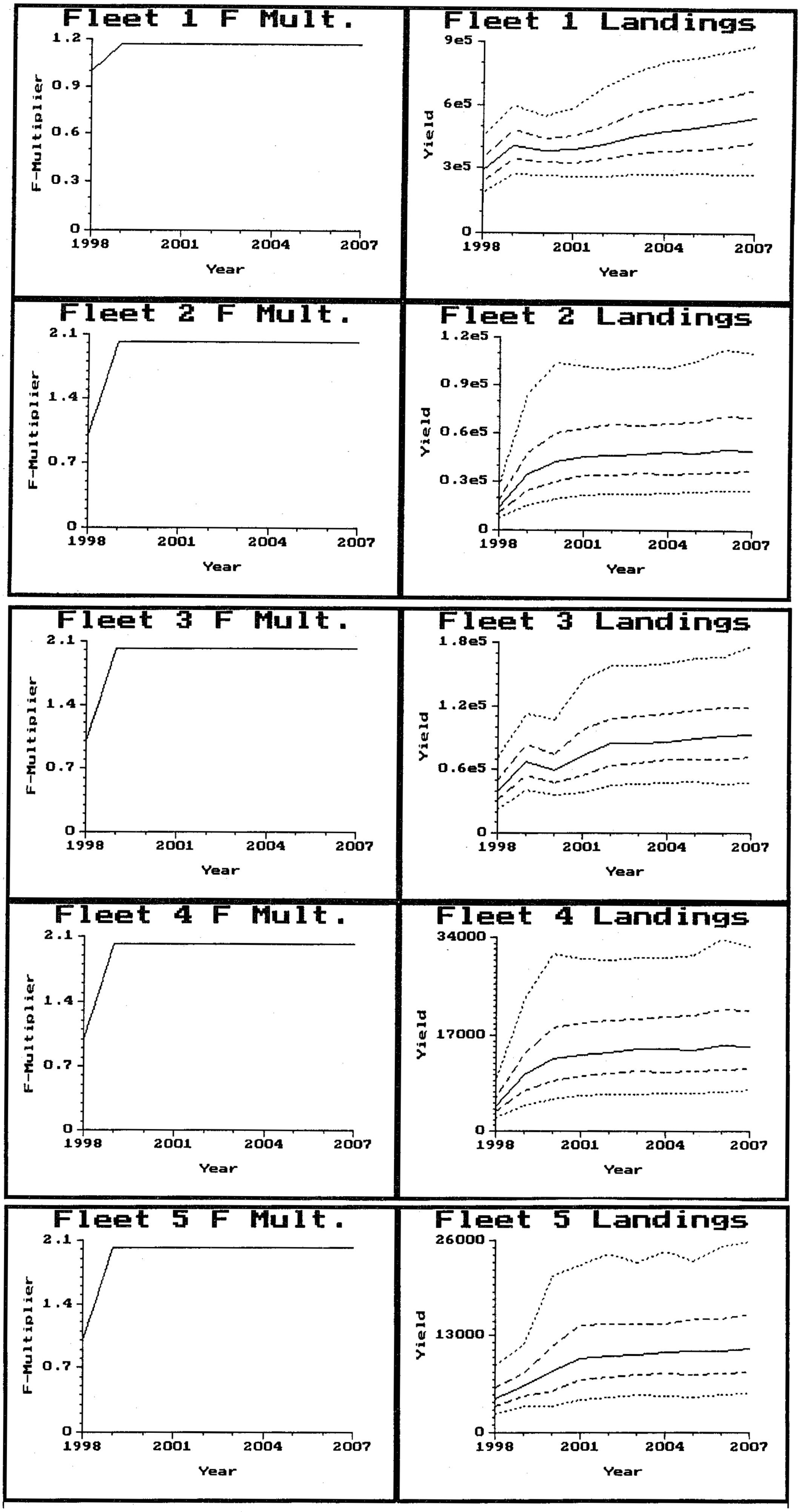

Figure 2.11.7.b. North Sea Herring. Medium-term projections assuming F_A =0.3 and $F_{B\text{-}E}$ = 0.1. Projected landings by fleets A to E (labelled 1 to 5 respectively)

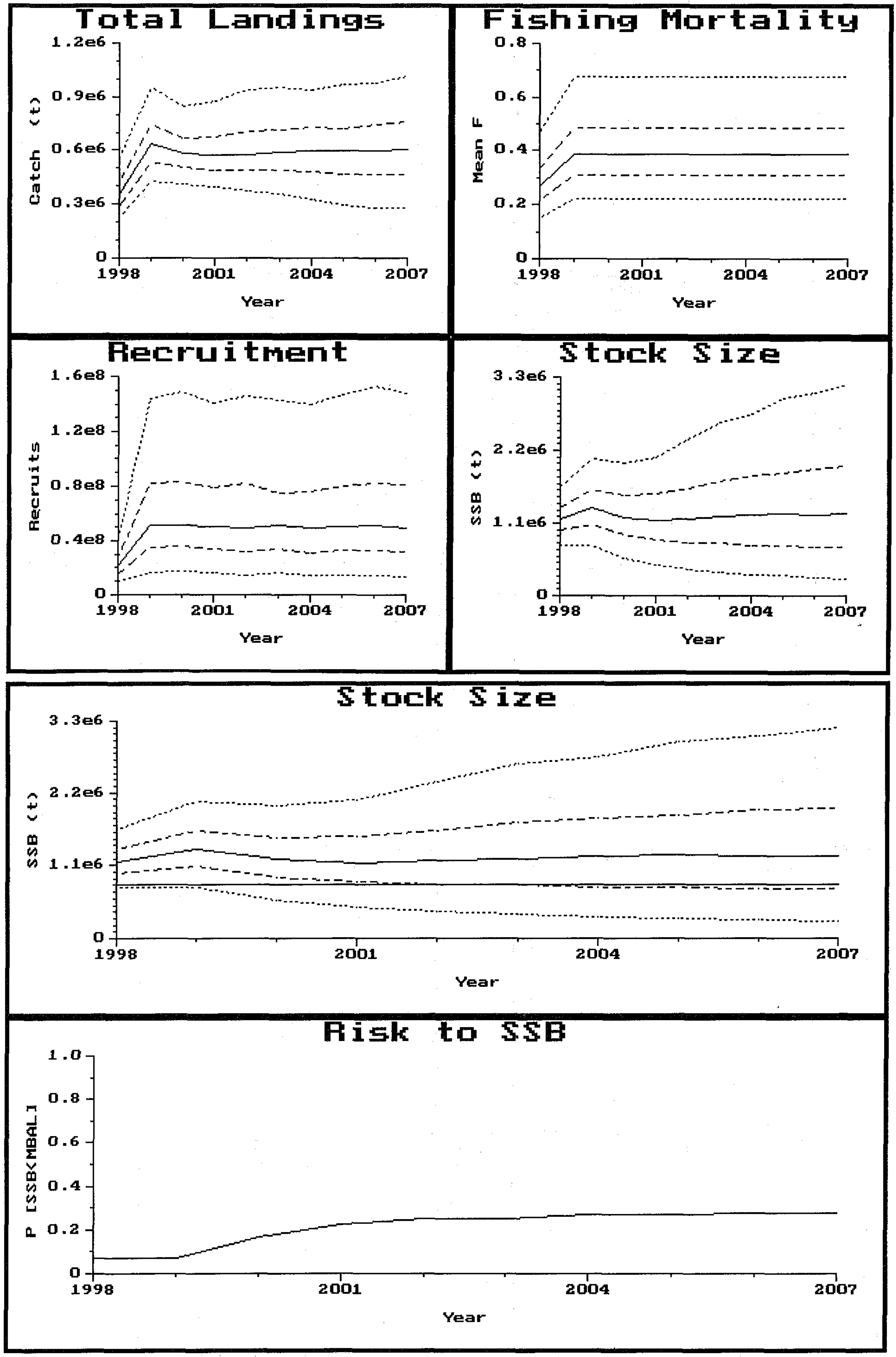

Figure 2.11.8a. North Sea Herring. Medium-term projections assuming F_A =0.3 and F_{B-E} = 0.2 Dotted lines indicate 5th and 95th percentiles, dashed lines indicate 25th and 75th percentiles. Unbroken line indicates median. **Upper panel :** Top left, landings by all fleets. Top right, fishing mortality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

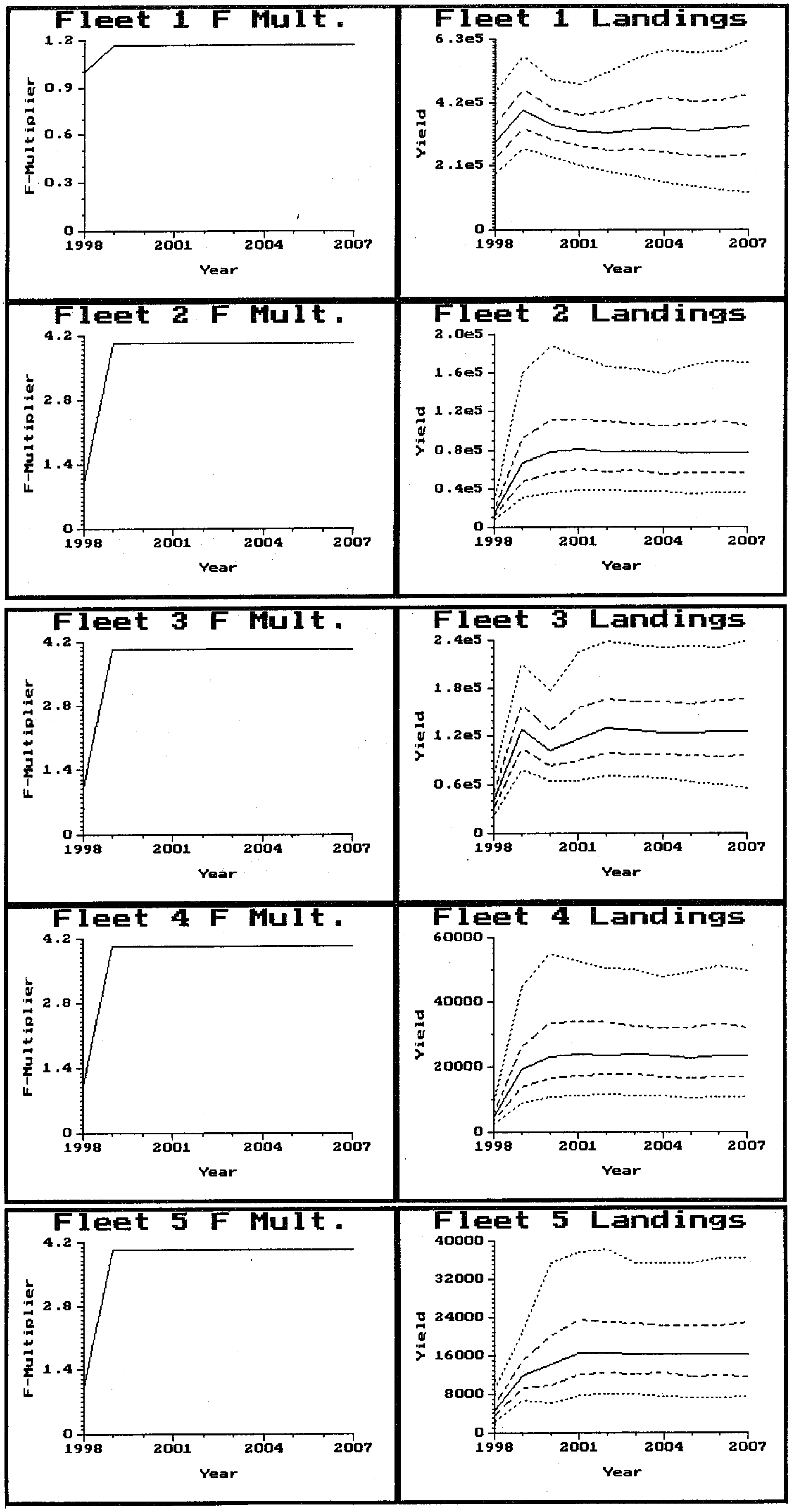

Figure 2.11.8.b. North Sea Herring. Medium-term projections assuming $F_A = 0.3$ and $F_{B\text{-}E} = 0.2$. Projected landings by fleets A to E (labelled 1 to 5 respectively)

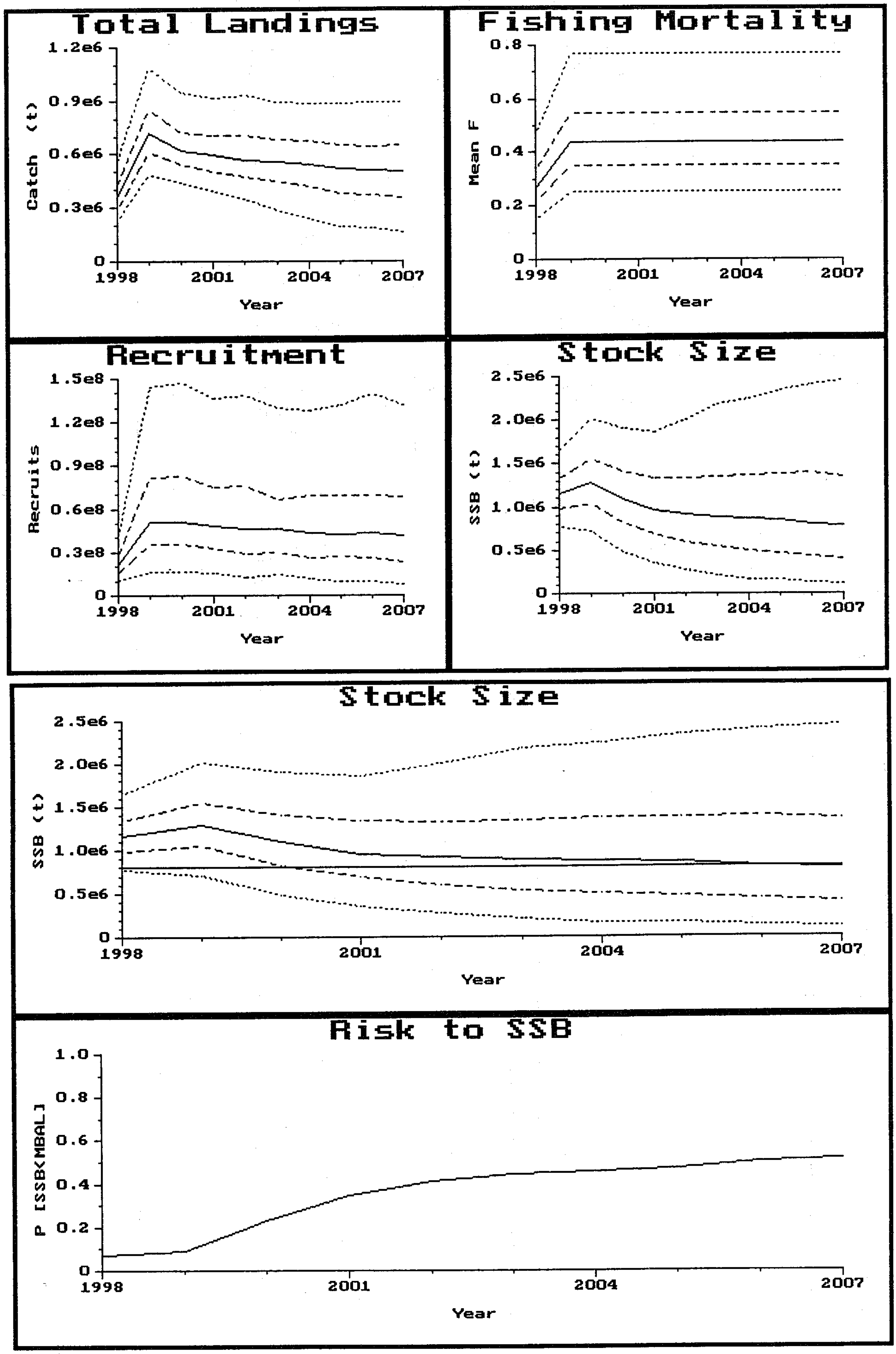

Figure 2.11.9a. North Sea Herring. Medium-term projections assuming F_A=0.3 and F_{B-E} = 0.3 Dotted lines indicate 5th and 95th percentiles, dashed lines indicate 25th and 75th percentiles. Unbroken line indicates median. **Upper panel :** Top left, landings by all fleets. Top right, fishing mortality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

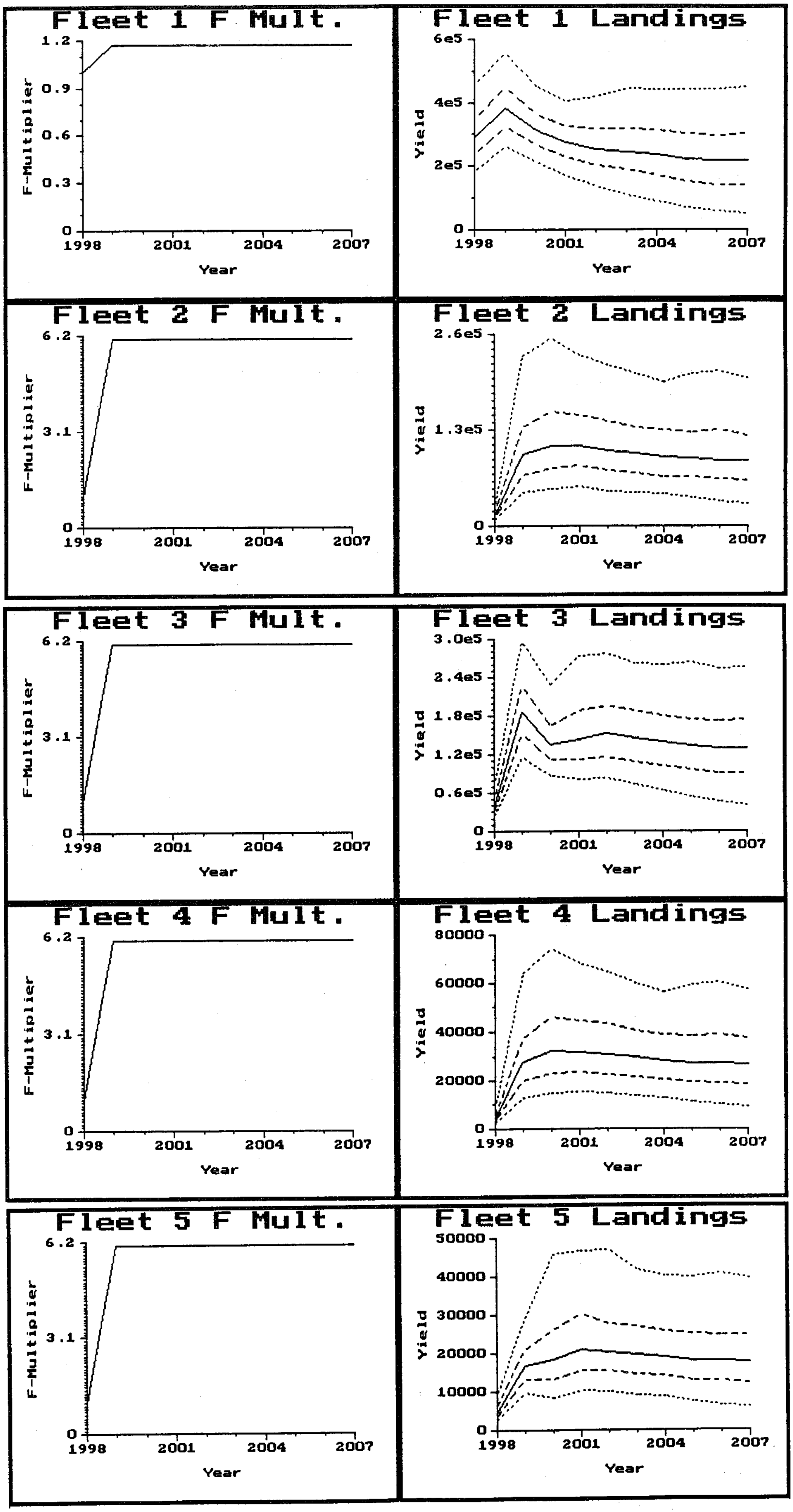

Figure 2.11.9.b. North Sea Herring. Medium-term projections assuming F_A=0.3 and $F_{B\text{-}E}$ = 0.3. Projected landings by fleets A to E (labelled 1 to 5 respectively)

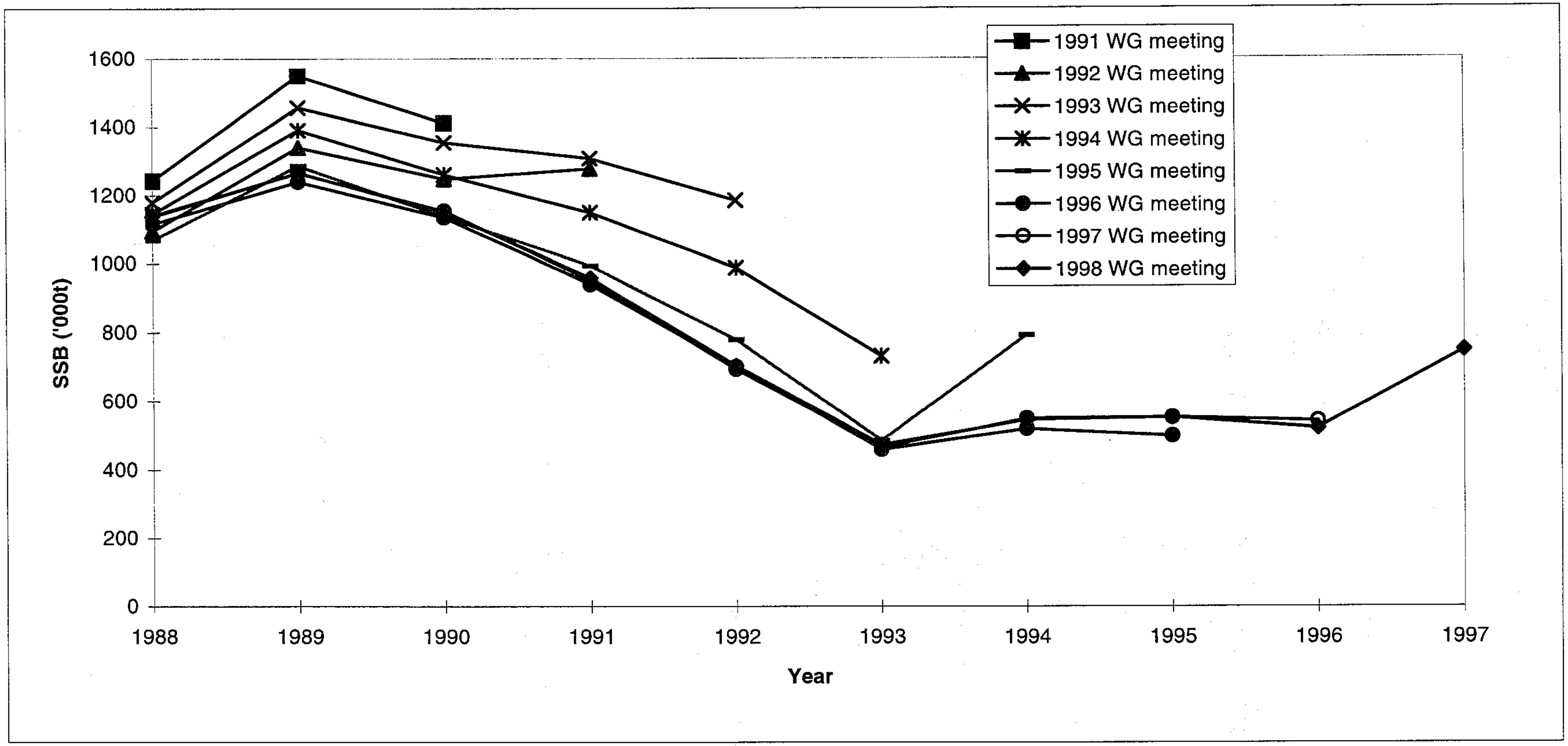

Figure 2.13.1 **Spawning stock biomass estimated at the Herring Assessment Working Group meetings from 1991 - 1998. The assessments carried out at Working Group meetings in 1991-1995 show a systematic overestimate of the spawning stock biomass.**

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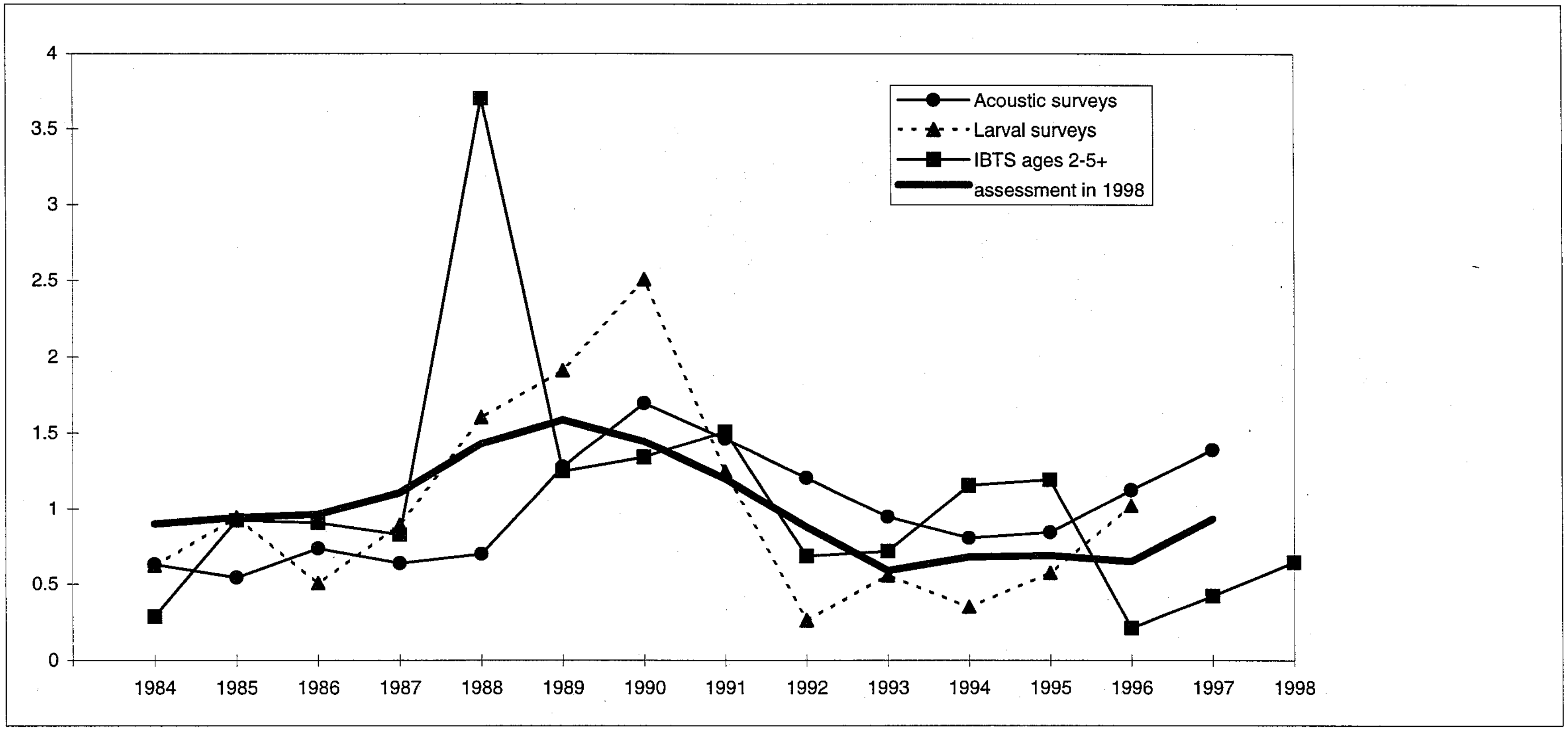

Figure 2.13.2 **Biomass normalised to 1 over the period 1984-1997 from the 3 indices that provide information on adult fish compared to the spawning stock biomass of this years assessment.**

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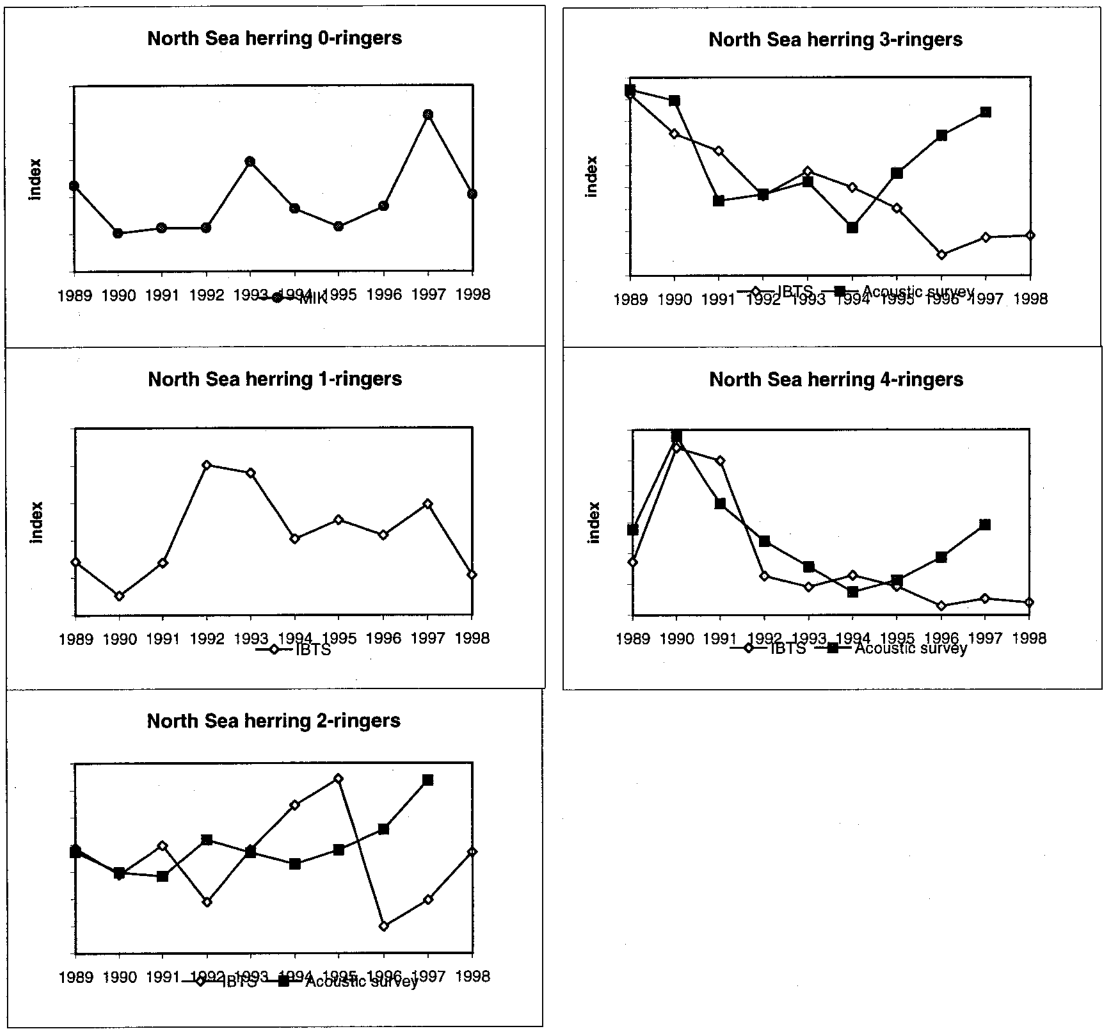


Figure 2.13.3
Trends in index values by age for the relevant surveys: MIK (0-ringers), IBTS (1-ringers), IBTS (2-5+ ringers) and acoustic (2-9+ ringers)

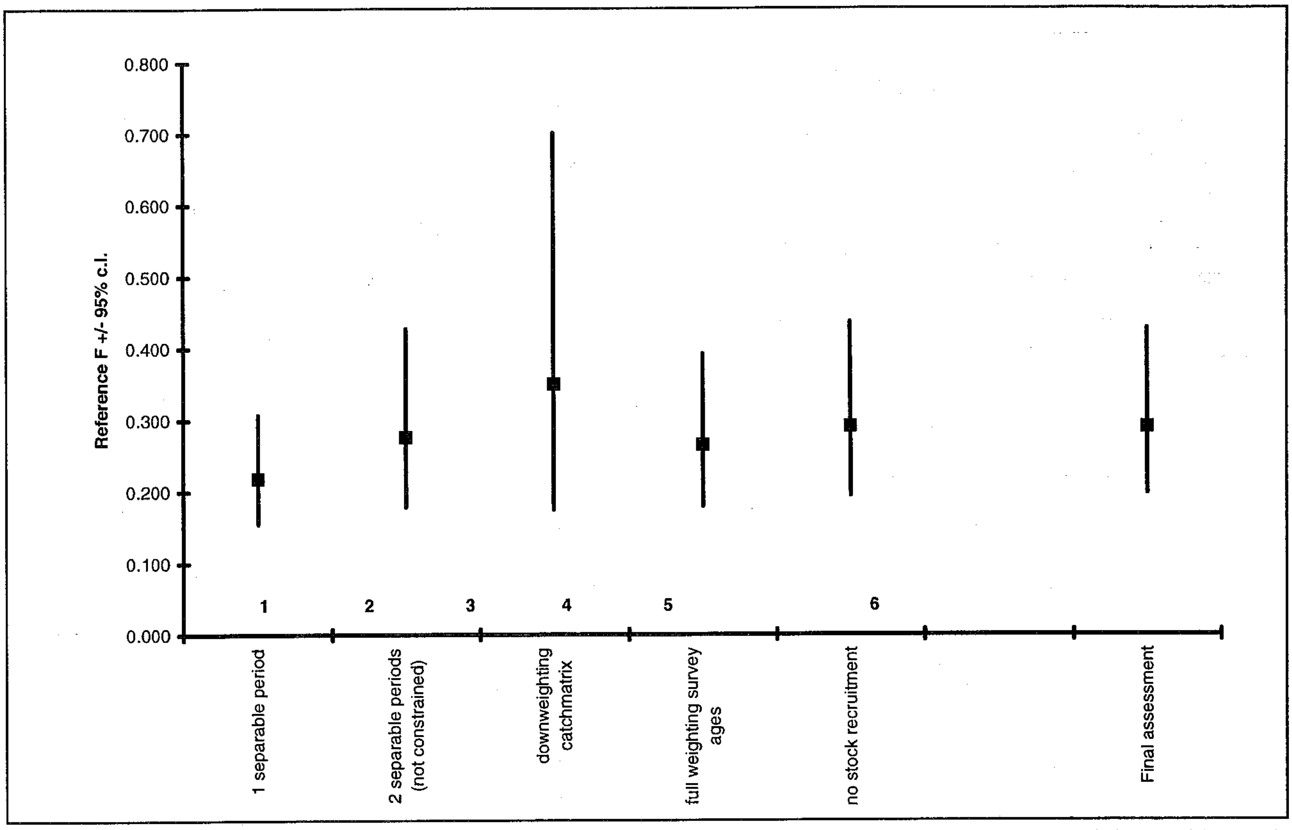


Figure 2.13.4 Herring in Sub-area IV, Divisions VIId and IIIa. Estimates of fishing mortality (+/- 95 c.l.) in population models fitted using different assumptions in the model fit

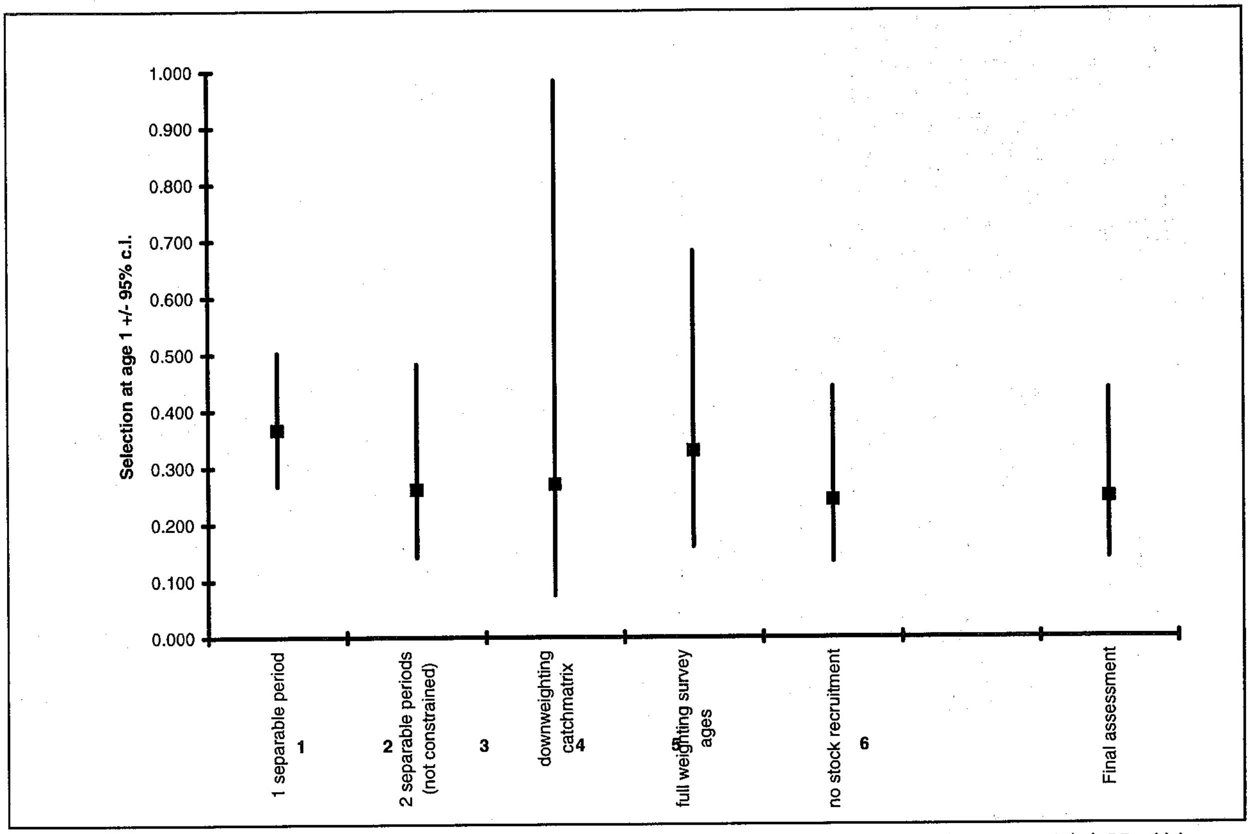


Figure 2.13.5 Herring in Sub-area IV, Divisions VIId and IIIa. Estimates of selection at age 1 (+/- 95 c.l.) in population models fitted using different assumptions in the model fit

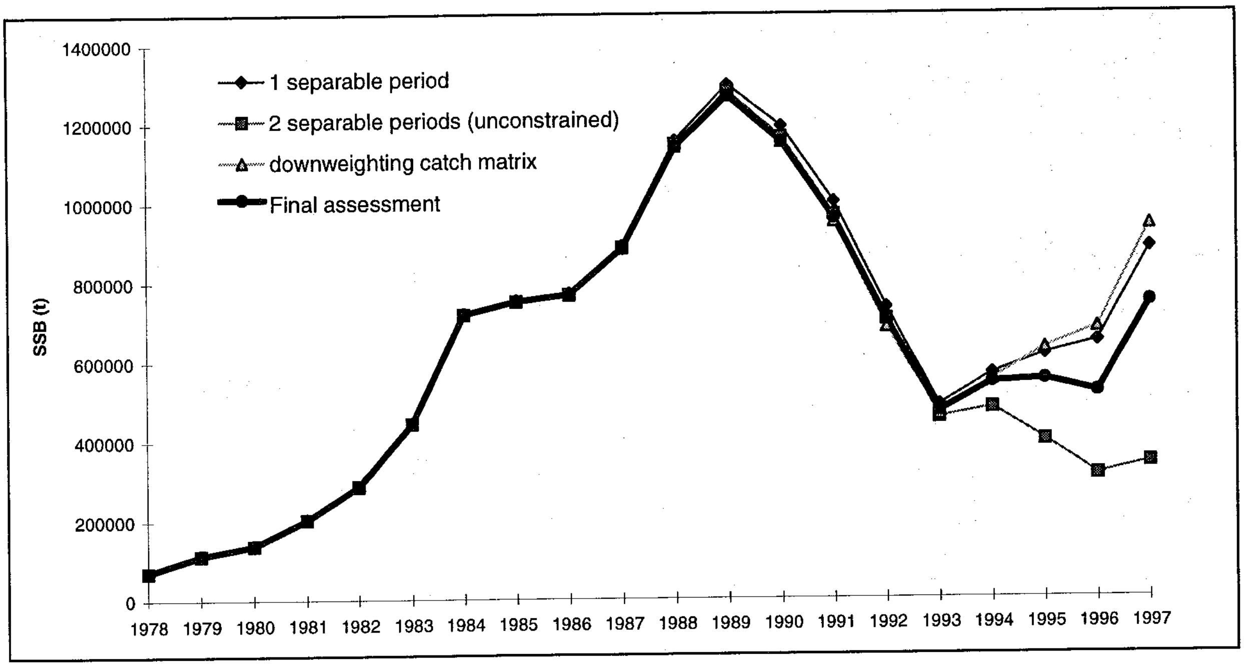
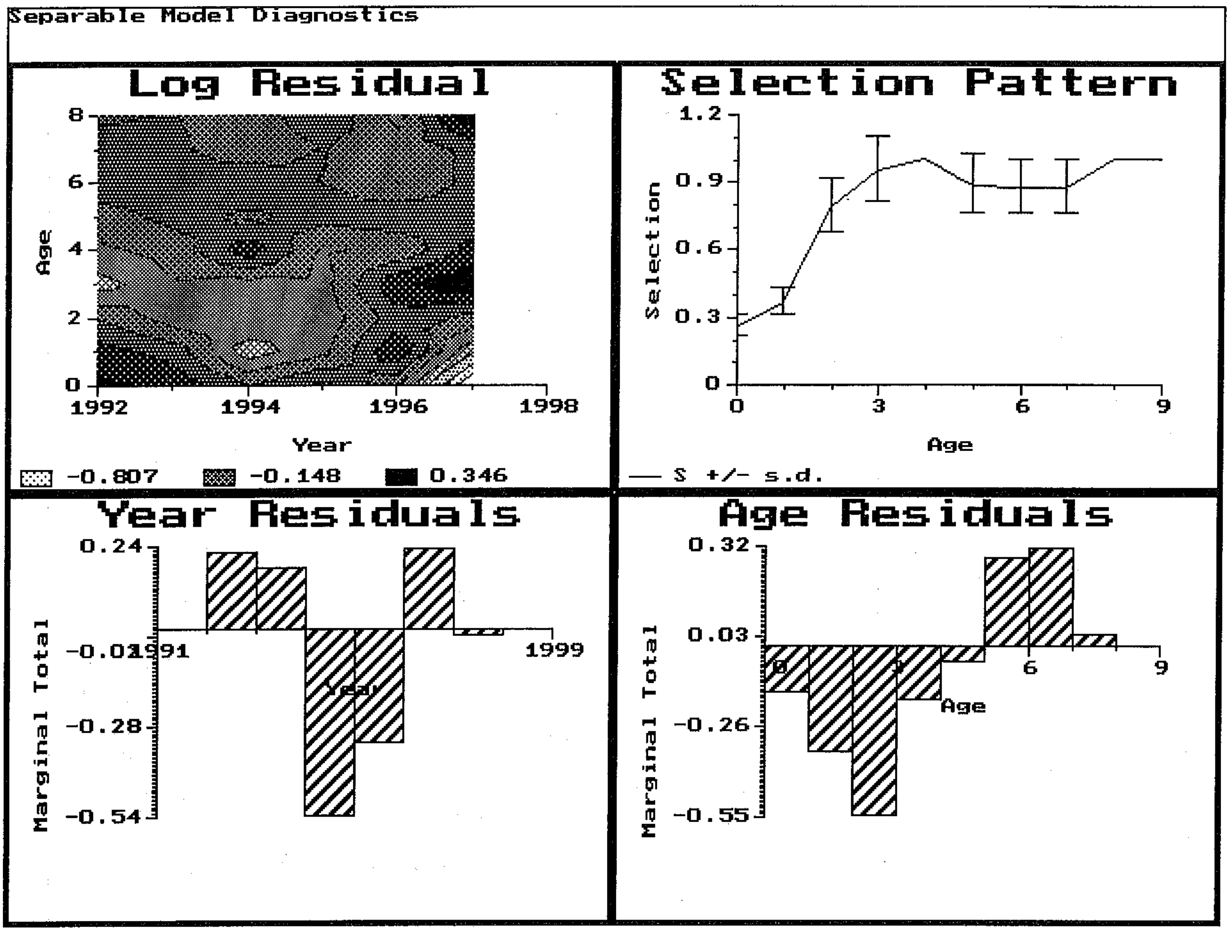


Figure 2.13.6 SSB estimates obtained from model fits with different model assumptions compared to the SSB estimates in the final assessment



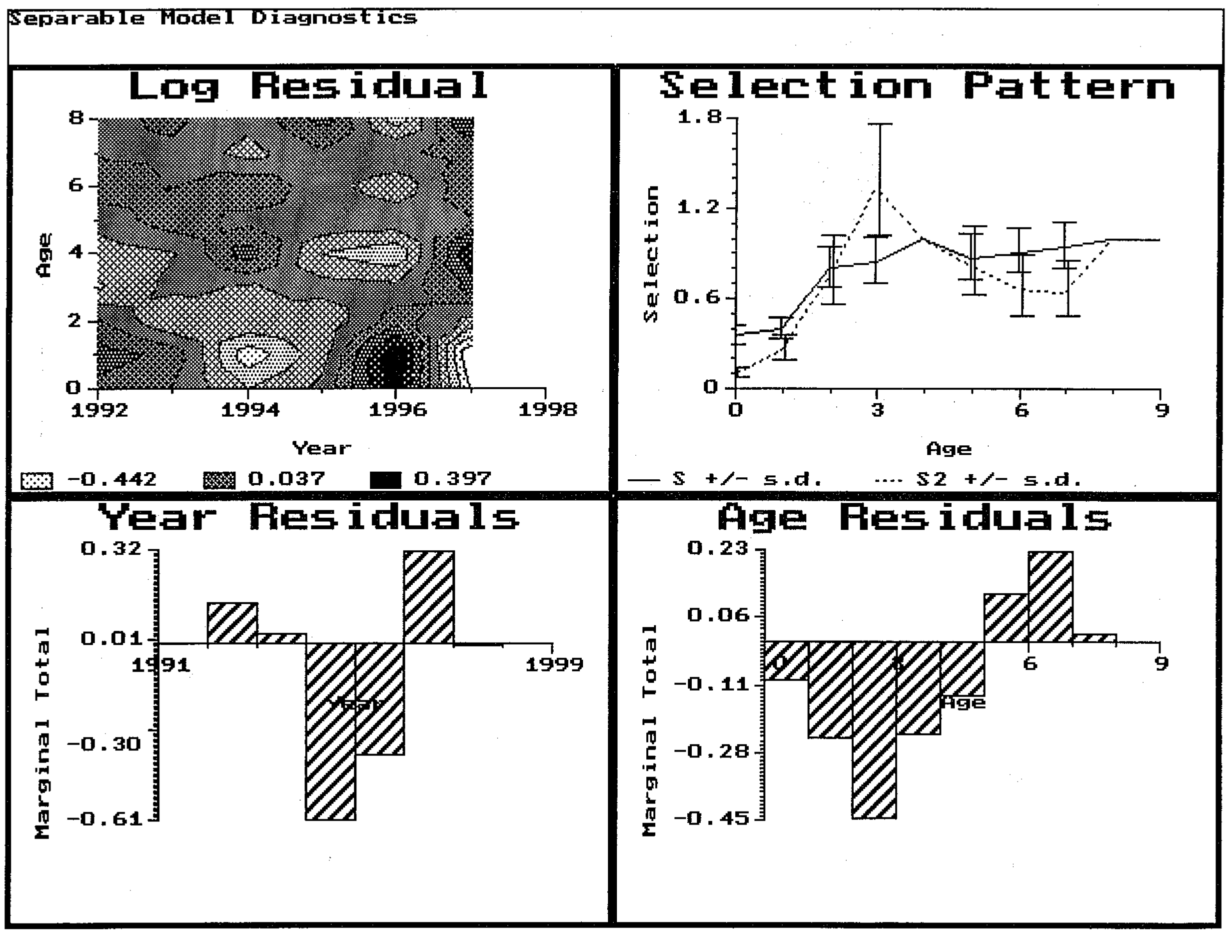
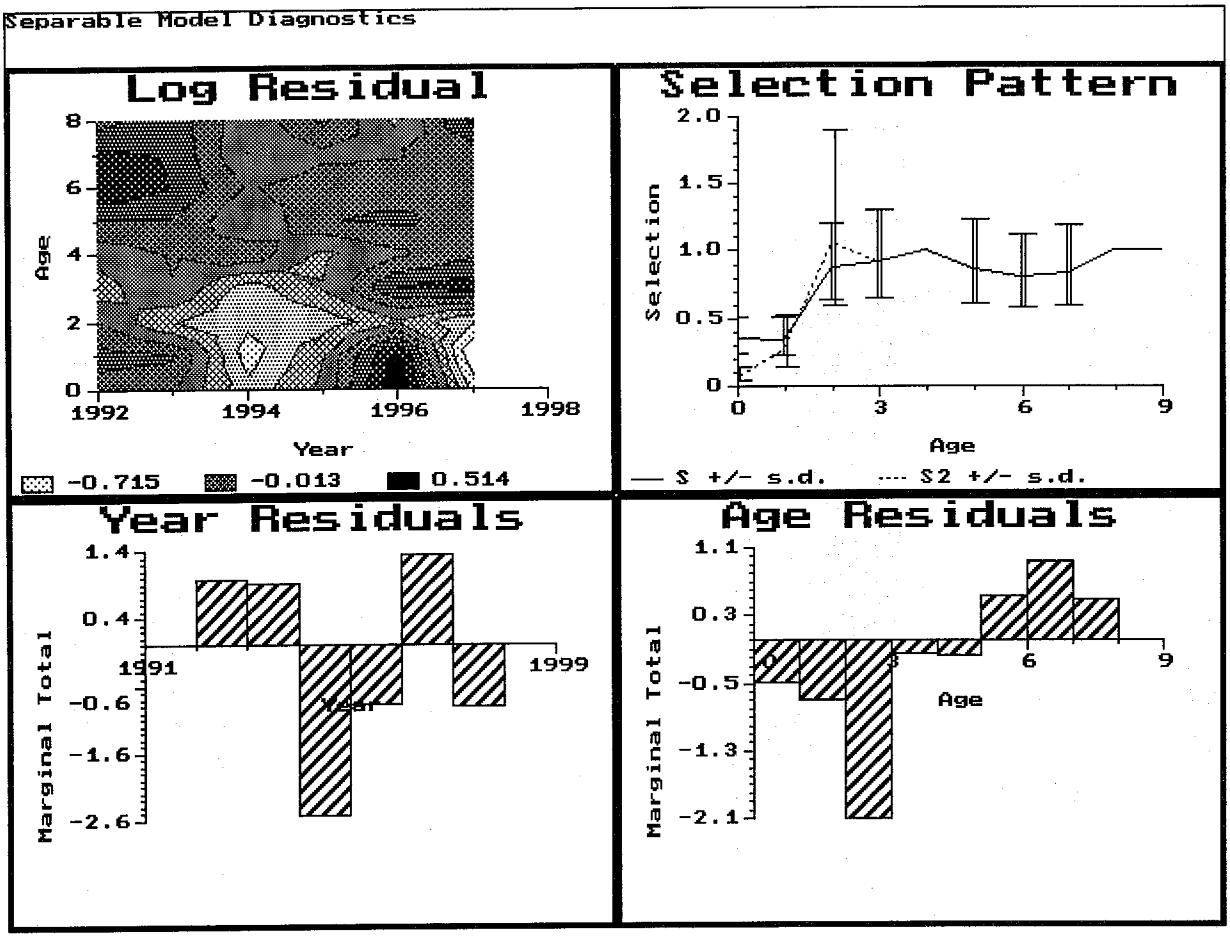


Figure 2.13.7 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Model evaluations by selection pattern diagnostics. **Upper panel**: *1 selection period.* Top left: contour plot of selection pattern residuals. Top right: estimated selection pattern (1992-1997). Bottom: marginal totals of residuals by year and age. **Lower panel**: *2 selection periods, unconstrained.* Top left: contour plot of selection pattern residuals. Top right: two estimated selection patterns S1 (1992-1995) and S2 (1996-1997). Bottom: marginal totals of residuals by year and age.



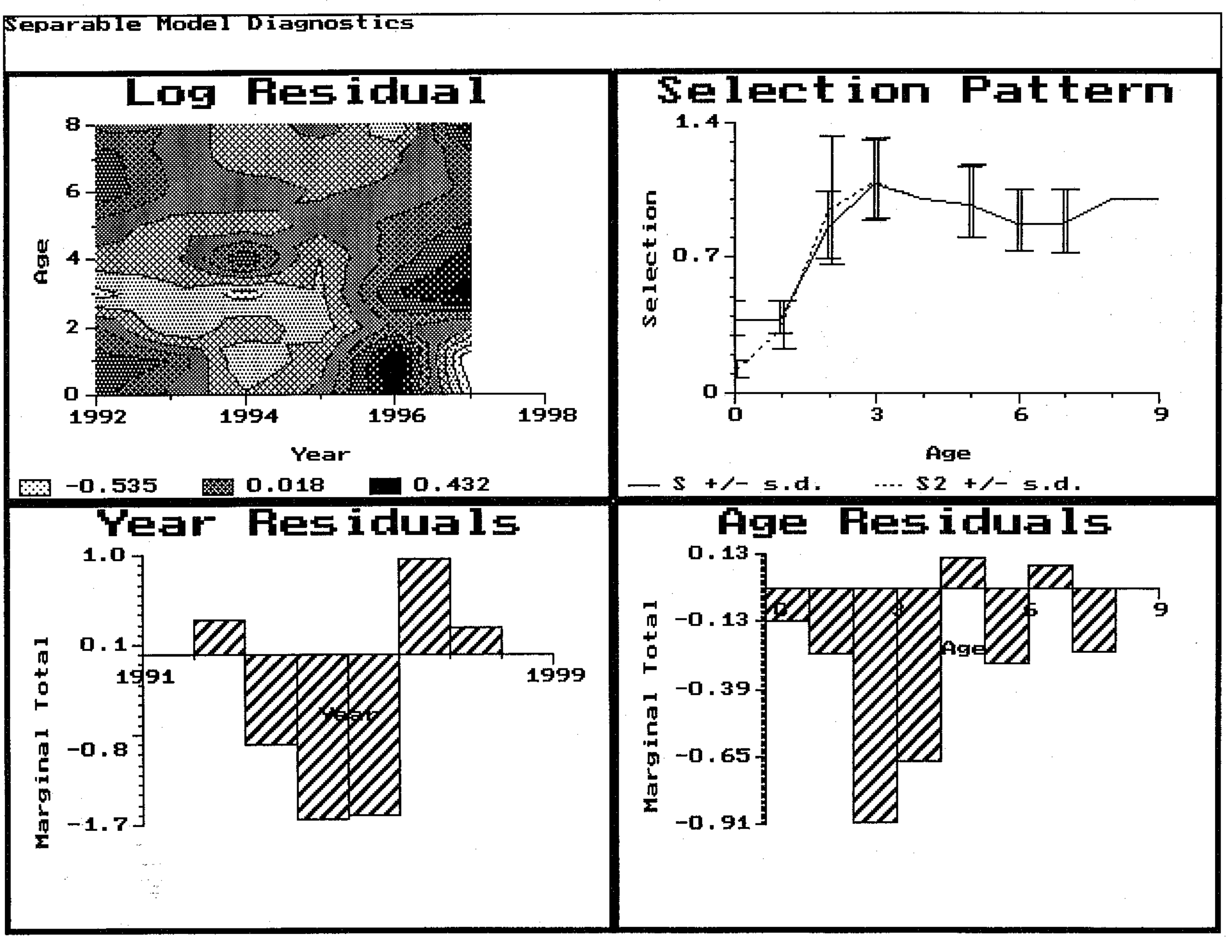


Figure 2.13.8 Autumn spawning herring in Section IV and Divisions VIId and IIIa. Model evaluations by selection pattern diagnostics. **Upper panel**: *2 selection periods, constrained, downweighting catches.* Top left: two estimated selection patterns S1 (1992-1995) and S2 (1996-1997). Top right: estimated selection pattern (1992-1997). Bottom: marginal totals of residuals by year and age. **Lower panel**: *2 selection periods, constrained, equal weighting on survey ages.* Top left: contour plot of selection pattern residuals. Top right: two estimated selection patterns S1 (1992-1995) and S2 (1996-1997). Bottom: marginal totals of residuals by year and age.

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

3.1 The Fishery

3.1.1 ACFM advice and management applicable to 1997 and 1998

ACFM stated again in 1997 that the state of the stock is uncertain, as available information is conflicting. Results from research surveys indicate intermediate to high levels of mortality. The management advice was that if a precautionary total allowable catch (TAC) was required for Sub-divisions 22-24, the catch levels in that area should not exceed recent catches.

The 1997 agreed herring TAC between the EU and Norway to be taken in Division IIIa by the human consumption fleet was 80,000 t. A TAC or by-catch ceiling, to be taken in the mixed clupeoid fishery, was set to 10,000 t. Also a by-catch ceiling at 20,000 t was set for landings of herring taken in small mesh fishery.

As in previous years no special TAC was set by the International Baltic Sea Fishery Commission (IBSFC) for the stock component in the Western Baltic area in 1997. In the Baltic there is a TAC for all the Sub-divisions 22-32.

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 to be taken in the small mesh fishery.

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 1997 are given in Table 3.1.1. In 1997 the total landings decreased to around 150,000 t in Division IIIa and Sub-Divisions 22-24, of which 27,000 t were from the Kattegat, about 56,000 t from the Skagerrak and 65,000 t from Sub-Divisions 22-24. These landings represent a decrease of 23,000 t compared to 1996 and are the lowest records in the time series.

There are several reasons for this significant drop in total landings: Reduction in TACs and new by-catch regimes in the small mesh fishery. Again in 1997, a very restrictive management of the small mesh fishery in Kattegat and Skagerrak was carried out. The herring fishing fleet in Sub-divisions 22-24 has increased their catches from 58,000 t in 1996 to 67,000 t in 1997.

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 and 2. These landings are included in the Figures for the North Sea. A substantial part of Swedish landings have been misreported to be 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.

No estimates of discards were available to the Working Group. The magnitude of discarding in Skagerrak may 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 and for 1997 the herring catches in Division IIIa are 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.

- The "Mixed clupeoid fishery" (fleet D) is carried out under a special "Sprat" TAC for all species caught in this fishery. Danish boats have been obliged to use a 32 mm mesh (from 1991 to 1997). The Swedish fishery by purse seiners are 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 small mesh fisheries (fleet E) (mesh size<32 mm), such as the Norway pout, blue whiting and sandeel fisheries.

For 1997, all catches from fisheries with mesh sizes of min. 32 mm are categorised in Fleet C as well as all Norwegian catches. Danish and Swedish by-catches of herring in the mixed fishery are listed under Fleet D. Fleet E constitutes only of Danish by-catches from the Norway pout and blue-whiting fisheries. The landings in the different fisheries for the period 1991–1997 in thousands of tonnes are shown in Table 3.1.2.

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-Div. 22-24 are treated in this section as one fleet. The landings from this stock could therefore be split into four fleets:

- C: Fleet using 32 mm mesh size in Division IIIa.
- D: Mixed clupeoid fleet in Division IIIa.
- E: Fleet 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 and 1997 in thousands of tonnes by fleet and quarter. Landings by fleet and quarter for 1995 can not directly be compared with 1996 and 1997 as fleet definitions have been changed (ICES 1997/Assess:8) and 1995 data has not been updated.

Year	Quarter	Fleet C	Fleet D	Fleet E	Fleet F	Total
1995	1	11.3	4.6	9.2	25.1	50.2
	2	10.5	0.0	10.9	32.2	53.6
	3	33.9	1.5	40.8	7.8	84.0
	4	21.1	2.1	11.1	9.1	43.4
	Total	76.8	8.2	72.0	74.2	231.2
1996	1	13.9	6.9	5.2	9.3	35.3
	2	12.5	0.0	2.2	23.9	38.6
	3	46.2	1.0	2.2	10.1	39.5
	4	19.4	5.9	2.4	13.5	41.2
	Total	92.0	13.8	10.1	56.8	174.6
1997	1	11.7	1.6	0.9	17.4	31.6
	2	16.9	0.6	0.7	27.2	45.4
	3	22.6	0.5	0.6	7.8	31.5
	4	21.7	3.5	0.7	15.1	41.0
	Total	72.9	6.2	2.9	67,5	149.5

The landings from fleets C-F are SOP Figures.

3.2 Stock composition

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

The North Sea autumn spawners (NSAS) enter Skagerrak and Kattegat as larvae and migrate back to the North Sea at an age of 2-3 years (Rosenberg and Palmén, 1982). The Baltic spring spawners (BSS) 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 traditionally been separated by the average counts in number of vertebrae in herring samples (Rosenberg & Palmén, 1982; Gröger and Gröhsler, 1995 and 1996). NSAS have a mean number of 56.5 vertebrae while the BSS 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 and Palmén, 1982). The use of most of these variables was evaluated by an ICES study group in 1992 (ICES 1992/H:5). 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. Errors in the estimate of this withdrawal will clearly affect the quality of the assessment of the BSS stock. A more precise measure is needed.

The diameter of the first winter ring (annuli) on the otoliths of autumn spawners are significantly larger than for spring spawners (Rosenberg & Palmén, 1982). The analysis of otolith annuli has, however, not been applied on a routine basis in the Kattegat - Skagerrak area, because it is more labour-demanding. New image analysis systems can, however, remove this obstacle.

Otolith microstructural otolith analysis has also been tested to separate spring and autumn spawned larvae (Moksness and Fossum, 1991) and adults (Zhang and Moksness, 1993). Otolith growth, which can be inferred from microscopical examination, is significantly slower for autumn spawners. Mosegaard and 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 outweighted by a very high precision. Efficient grinding methods opens up the possibility to include ages more than 2 years old in a routine examination.

Modal length analysis may be questionable when samples are taken from the commercial landings with unknown or mixed patterns of selectivity, or when growth varies among population components.

From 1996 the method using otolith micro-structure to separate Baltic spring spawners from North Sea autumn spawners has been employed (Mosegaard and Popp-Madsen, 1996). The method allows the stocks to be separated at the individual level for all age classes and will produce proportions directly from the samples taken.

In last year's Working Group-report a possible bias was noted when estimating the split in the landings from stock identification of different age classes in the surveys. A higher mean VS in herring sampled from the landings compared to surveys indicated that more North Sea herring are taken by the fisheries than is representative for Div. IIIa (ICES 1997/Assess:8). As a consequence of this Danish catch in the eastern North Sea, in Division IIIa and in Sub-divisions 22-24 were sampled for otolith microstructure analysis to obtain proportions of spring spawners by quarter and age. A comparison of the proportion spring spawners based on Swedish VS counts and on Danish otolith microstructure, by ICES statistical rectangle, age, and quarter in 1996 showed a reasonable agreement (ICES 1998/D:1). Therefore, it was decided that the split should be conducted using otolith microstructure supplemented by VS count analyses when the microstructure data were not available. The split based on VS counts was performed according to the following formula:

$$f(sp)=[VS(sample)-55.8]/[56.5-55.8]$$

where VS (sample) was the sample mean vertebral count (ICES 1992/H:5). The mean proportion of spring spawners for each of the age classes 0, 1, 2, 3, and 4+ within each of the Sub-divisions, Skagerrak and Kattegat, was calculated as the average of the individual proportions over the respective statistical rectangles.

3.2.1 Treatment of spring spawning herring in the North Sea

The split was performed on age classes 2, 3, and 4+ WR. For May and June 1997 the split was conducted according to Norwegian VS counts from a general unweighted average from May. In July the split was based on the average Norwegian VS counts from catches in July. For the rest of the year only Danish samples from October and November based on otolith microstructure were available. The distribution of sampling locations showed that the samples did not reflect that catches in the 4th quarter primarily were taken in the northern part of the area, which is assumed to consist predominantly of autumn spawners. It was, therefore, decided that all herring caught in the eastern transfer area in the North Sea should be calculated as being exclusively autumn spawners.

3.2.2 Treatment of autumn spawners in Div IIIa

The split of the Danish catches was conducted using a random sub-sample of herring where analysis of individual micro-structure determined the spawning type. From the small mesh fishery seven samples were analysed from the Skagerrak/Kattegat area and four samples from Sub-divisions 22+24, giving in all 272 individual identifications. From the >31mm fishery six samples were taken from the North sea, five samples from the Skagerrak/Kattegat area and one sample from Sub-division 22, giving in all 333 individual identifications. Swedish catches were split according to the mean VS count weighted by catches at age and quarter. The resulting split 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 Sub-divisions 22 and 24

In the western Baltic a large percentage of the herring caught in the small mesh fishery consisted of autumn spawned individuals. In the 4th quarter in Sub-division 22, 83 %, and in the 2nd quarter in Sub-division 24, 45 % of the numbers caught were autumn spawners. Juvenile herring of age groups 0 and 1 comprised the dominating part 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 has not been investigated in earlier years and since it mostly affected the younger age classes (0 to 2 WR), the catches were treated as coming from the Western Baltic spring spawning stock. The existence of autumn spawners in Sub-divisions 22-24, however, indicates a problem in the assessment that should be dealt with in a coming revision of the historical stock separation (see Section 3.9).

3.3 Catch in numbers and mean weights at age

The Swedish catches from Skagerrak for industrial purposes were sampled in the last three quarters (see Table 3.4.1). Sampling of the human consumption landings was generally acceptable in Skagerrak and Kattegat. The Danish sampling intensity in Sub-division 24 has improved since 1996 and is now 1 sample per 1,262 t. The Swedish fishery in Sub-divisions 22-24 was not sampled at all. Therefore, Danish samples were used to estimate catch in numbers and mean weight for the Swedish landings. German landings were sampled in the 1st and 2nd quarter. Samples from gill-net fishery taken during a Danish monitoring program were used to estimate catch in numbers and mean weight in Sub-division 23.

No Polish data on weight at age were available to the Working Group. Therefore data from the Danish samples in Sub-division 24 were used for the Danish and Polish samples.

Based on these data, the total numbers and mean weights at age for herring landed from the Kattegat, Skagerrak and Sub-divisions 22 - 24 by the fleets, listed in Section 3.1.3 were compiled and shown in Tables 3.3.1, 3.3.2 and 3.3.9.

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 type is calculated. These figures on numbers and mean weight per age group for spring- and autumn- spawning herring in each of the three fisheries in Division IIIa, are given in Tables 3.3.7 - 3.3.8. The landings of spring spawners taken in Division IIIa and the North Sea in 1997 were thus estimated to be about 37,000 t (Table 3.3.14) compared to about 74,000 t in 1996, 96,000 t in 1995 and 97,000 t in 1994. This reduction in landings is due to the reduction in the TAC for 1997 compared with previous years and do to a change in proportions between spring and autumn spawners (see Section 3.2.2). The total catch in numbers of BSS in Division IIIa and the North Sea is shown in Table 3.3.13.

The landings of North Sea autumn spawners in Division IIIa amounted to 40,000 tons compared to 42,000 tons in 1996 and to 70,000 t in 1995 (Table 3.3.12). The total catch in number and mean weight at age of Division IIIa/Baltic spring spawners in the North Sea, Division IIIa and in Sub-divisions 22-24 for 1987–1996 are given in Tables 3.3.13 and 3.3.14.

3.4 Quality of catch data and biological sampling data

The sampling intensity of the landings in 1996 was very high and far above the recommended level. In 1997 the sampling intensity was lower compared to 1996, but still above 1 sample per 1000 t landed.

Still numbers of samples, fish measured and aged reach the recommended level. Danish landings were sampled in all quarters for Skagerrak, Kattegat and for Sub-divisions 22 and 24. No commercial samples were taken from the Sound (Sub-division 23). Samples taken during a monitoring program related to the fixed link between Denmark and Sweden were used. Swedish landings from the human consumption fishery were sampled in all quarters and landings for industrial purposes from Skagerrak and Kattegat have been sampled at highest level ever. From the Norwegian landings from Skagerrak only 2 samples were taken.

Table 3.4.1 shows the number of fish aged by country, area, fishery and quarter. The total landings from Division IIIa, IIIb and IIIc were 142,000 t, from which 222 samples were taken. A total of 32,400 herring were measured and 12,200 aged. The sampling intensity by quarter over all landings is acceptable, with a mean of more than one sample per 1000 t landed. 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 as in 1996. The number of samples and number of fish investigated were considered to be at an adequate level. Again in 1997 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 and 4), were actually taken. The landings from quarter 1 were most likely to have been taken in the North Sea and were, therefore, transferred to the North Sea.

The German and Danish samples showed considerable differences in size at age for three and four WR. The German samples from the 1st and 2nd quarters are predominantly taken from the fisheries on the spawning population, whereas the Danish samples are from both 32mm and small mesh trawl fisheries. However, both three and four WR in the Danish samples were larger than in the German samples, this indicates either sampling problems, age reading problems, or a difference in the selection pattern.

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 1997.

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. 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 due to a failure in earlier attempts to make a split between the North Sea autumn spawners and the Baltic spring spawners in Division IIIa. 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. There are substantial differences in weight at age of catches in Division IIIa and Sub-divisions 22 and 24 (Figure 3.4.1), partly due to the historical split not being able to split by size classes and partly due to systematic differences in age estimation.

Although the overall sampling meets the recommended level of one sample per 1000 t landed per quarter (see section 2.1.8), there is an unequal coverage of some areas and times of the year.

3.5 Fishery-independent estimates

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

The following trawl surveys are conducted every year:

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

The German bottom trawl surveys have been conducted in Sub-divisions 22 and 24 since 1978 by the Institut fur 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 Institut fur Ostseefischerei in Rostock.. The main purpose of these surveys have been to estimate recruitment indices for cod stocks. The survey stations were randomly selected in the first year. After the first year a fixed station grid was used. Sub-division 22 is only covering the Mecklenburger Bucht (20 stations), which is taken 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 in 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 index series is shown in Table 3.5.3.

The 1997 survey shows in Sub-division 22 the highest recorded values for the 0- and 1-group since 1979. In Sub-division 24 the 1997 estimates are just above for the 2-group and even below the average of the recorded time period for all other 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 should be used with caution. Compared to last years estimates there is a slight increase for 2, 3 and 4 -ringers. The estimates for the other ages reached just about the same level as last year.

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 February using standard gear and survey set up (Addendum to ICES 1996/H:1). From 1990 to 1995 standard surveys were also implemented during the 2nd, 3rd and 4th quarter. Since 1995 only the surveys in February and September have been conducted. Estimates of relative density in Skagerrak and Kattegat (Division IIIa) for the first and third quarter are presented in Table 3.5.5 and Table 3.5.6.

3.5.3 Summer Acoustic survey in Division IIIa

This survey is part of an annual survey covering the North Sea and Division IIIa in July-August. As in previous years the survey was conducted by R/V DANA. The echo integration survey from 2 to 12 July 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).

Pelagic trawling was carried out using a Fotö trawl (16 mm in the codend), 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
- Gadoids: TS = 20 log L (cm) - 67.5

A total of 37 trawl hauls were carried out. Further details of the survey are given in Simmonds *et al.* (W.D.1998b).

The total stock size of Western Baltic spring spawning herring in 1997 was estimated by combining the results from the Danish (Division IIIa) and Norwegian Acoustic Survey (Sub-area IVa and IVb). The result is summarised in Table 3.5.7. The total stock estimate of 207,000 t reached just about the low level of 1996 (215,100 t). The indicated downward trend from 1995 to 1996 is confirmed by the 1997 estimate. The reduction in biomass was mainly due to a decline in the abundance of 1- and 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 12th to October 2nd 1997. 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 1,035 nm long, and 48 trawl hauls were carried out to identify the targets. The total number of fish calculated from the echo soundings was divided into species and age groups according to the trawl results.

The sa values for each stratum were converted into fish numbers using the TS-length regressions:

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

The result for 1997 is presented in Table 3.5.8. The total estimated stock size of herring in Sub-divisions 22-24 in 1997 reached a low level of 192,100 t and confirms the downward trend during the last years (1996: 229,200 t, 1995: 244,200 t, 1994: 255,900 t).

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

A base-line study on the migration of herring was initiated in the autumn of 1993. The main purpose of this study is to provide information for the evaluation of possible environmental impacts of the construction of the Sound Bridge between Denmark and Sweden. A description of the survey and the corresponding results concerning the numbers and the biomass during the period September 1993 to November 1997 are presented in the 1998 Report of the Planning Group for Herring Surveys (ICES 1998/G:4). The estimates for the total survey area are summarised in Table 3.5.9.

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, which are the Greifswalder Bodden (area: 510.2 km², volume: 2,960 x 106 m³, mean depth: 5.8 m, greatest 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 by 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 extended to length-classes. To get the index for the estimation of the year-class strength, the number of larvae which have reached the length of TL = 30 mm (larvae after metomorphosis) were calculated taking into consideration growth and mortality.

Further details concerning the surveys and the treatment of the samples are given in Brielmann (1989) and Mueller & Klenz (1994). The estimated numbers of larvae for the period 1977 to 1997 are summarised in Table 3.5.10.

3.5.7 Quality in survey data

The bottom trawl surveys are primarily designed for cod and will underestimate the proportions of the older age groups of herring.

The acoustic surveys, although designed for herring, have been focused on the North Sea for the summer survey and on the Baltic proper for the autumn survey. The lack of coordination in time could give a poor total estimate of the migrating Western Baltic stock. Further the shallow areas (large parts of the Kattegat and Sub-division 22) cannot be monitored by large vessels traditionally performing these surveys.

For the different trawl and acoustic surveys no consistent splitting of spring and autumn spawners is performed at the moment. The surveys in Sub-divisions 22-24 are traditionally considered to exclusively monitor the Western Baltic spring spawning population although the analysis of catches in 1997 indicate the presence of other populations in the area as well (see Section 3.2.2).

The larval survey is designed for herring larvae indices during the whole spawning period. The survey is based on size structured larval indices which may be questionable with the changing production conditions of a spring spawned population. At present no age based information is available (from otolith microstructure).

3.6 Recruitment indices of 0- and 1-ringers

Indices of 0-ringer abundance are available from larval surveys at Greifswalder Bodden and adjacent waters during March to June (Table 3.5.10), and from German Bottom Trawl Surveys during November-December in Sub-divisions 22-24 (Table 3.5.1).

Indices of 1-ringer abundance are available from German Bottom Trawl Surveys during November-December in Div. 22-24 (Table 3.5.1) 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 spring 0-ringer and November 0-ringer indices for the year classes 1977 to 1997 showed some similar year-to-year variability. Whereas the November 0-ringer, the January 1-ringer and the November 1-ringer indices for the year classes 1978 to 1997 exhibited less similar short term covariation. The indices illustrated in Figure 3.6.1 show the following trends: A poor recruitment of year classes 1980-81 was followed by an increase to a high level of recruitment for year classes 1983-88. From year class 1990 the recruitment declined markedly and has been at a low level since. An increase in year classes 1993–1994 is indicated. The present estimate of the 1997 year class has increased compared to 1996 but is still low to medium compared to historical records.

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. The input data are restricted to the period 1987 to 1997. This restriction in time was decided in 1996 (ICES 96/Assess:10) by the fact that splitting of spring and autumn spawners in Divisions IIIa and Sub-area IVa was not carried out before 1987. In light of the problems in the splitting methodology it should be emphasised that the basis for any assessment of the stock relies on questionable catch and survey data (see Section 3.4 and 3.5.7).

Natural mortality, maturity ogive and proportions of F and M before spawning were all assumed to remain constant between years. M is assumed to be 0.2, F-prop. 0.1 and M-prop. 0.25 for all age groups. The maturity ogive used was the same as that used at last years Working Group meetings:

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

It was noted that the estimated maturity ogives obtained from acoustic surveys differs between samples taken in the Division IIIa and in the spawning area in Sub-division 22.

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

- **Index 1**: IBTS in Div. IIIa, Feb. 1980–1996, 2 and 3+ ringers
- **Index 2**: German bottom trawl survey (GBTS) in SD 22, Nov. 1979-97, 0-3+ ringers
- **Index 3**: German bottom trawl survey (GBTS) in SD 24, Nov. 1978-97, 0-3+ ringers
- **Index 4**: Acoustic. survey in Division IIIa, July 1989-97, 0-8+ ringers
- **Index 5**: Acoustic. survey in SD 22+24, Oct. 1989-97, 0-8+ ringers
- **Index 6**: Larvae survey in SD 24 (Greifswalder Bodden), March-June 1977–1997, biomass
- **Index 7**: German bottom trawl survey (GBTS) in SD 24, February 1979-97, 1-8+ ringers
- **Index 8**: IBTS in Div. IIIa, Sept. 1991–1995, 1-5 ringers

Due to the uncertainties in the input data for the 0-, 1- and 2 groups, these age-groups were excluded from further investigations. In addition only the catch data for the years 1991 onwards was used in the calculation assuming a constant fishing pattern for the period 1991 to 1997. Due to these uncertainties in the available data it was agreed not to present a conclusive assessment. However, the ICA program was used to explore any possible changes in stock development.

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 separability constraint (=6)
- The reference F at age 4 and the selection 1 for oldest age.

Five runs were made with single indices and one run 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 1997. The estimates of the comparative runs obtained are given below:

Run No.	Index No.	Index	Mean F 1997	Lower 95 % CL	Upper 95 % CL	SSB (x 1000 t) 1997
1	2	GBTS SD 24 Nov	0.13	0.04	0.45	391
2	3	GBTS SD 22 Nov	0.19	0.02	2.00	311
3	4	Acou. Surv.IIIa+IVaE	0.44	0.29	0.65	143
4	5	Acou. Surv. SD 22-24	0.16	0.08	0.32	359
5	6	Larv. Surv. SD 24	0.79	0.07	9.08	93
6	4+5	combined (3-8+ ringers)	0.30	0.19	0.48	205

The runs by individual indices gave highly varying estimates of fishing mortality and SSB level. Indices 3 and 6 show very large confidence limits and therefore do not add much information to the model. The larvae index may rather reflect 0-ringers than SSB. Index 2 is a bottom trawl survey typically picking up 0-2 ringers but here covering an area and a time with high abundances of mature herring.

To illustrate the assessment problems, an ICA run using a combination of index 4 and 5 (the acoustic July survey in Division IIIa and the acoustic October/November survey in SD 22-24) were chosen. The run showed the smallest confidence interval for terminal F; however, due to reasons mentioned above the results should not be regarded as particularly reliable.

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 diagnostic plots (Figure 3.7.3 - 3.7.5) show rather flat catchability patterns for age classes higher than three as well as occasionally strong trends in residuals with time for both survey indices.

Due to the strong trend in residuals, it was decided to run an ICA with an option of a shrinkage of Fs over 7 years (an inverse variance weighted average of the ICA F's and a traditional VPA using the final Fs from the ICA run above as a starting point. This run with a shrinkage was therefore performed with a minimum CV of the mean F of 0.0. The estimate of the final (1997) $F_{3\text{-}6}$ was 0.426 with a spawning stock biomass of 192,700 tonnes, the output of the run with a shrinkage is presented in Table 3.7.16. Compared to the mean F from ICA run 6 the $F_{mean\ shrunk}$, was larger (0.30 and 0.426 respectively). However, the confidence limits overlapped with $F_{mean\ shrunk}$.

To improve the present interpretation of the Baltic spring spawning stock a revision is needed of the basic data (see section 3.10). Consequently, no attempt was made to predict the stock size of herring in Division IIIa and Sub-divisions 22-24.

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 had a gradual decline from 1991 to 1996. Both ICA runs, with and without shrinkage indicate that there may have been a change in this trend for 1997. The biomass and the SSB show an increase in both versions of this run, with a corresponding decrease in fishing mortalities.

The decrease in catches of both 0-2 ringers and 3+ ringers together with an estimated increase in SSB indicate a decrease in the exploitation of both young and older fish in 1996 and 1997 compared to previous years (Figure 3.8.1).

The overall results of these analyses indicate that the stock is slightly increasing 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 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 stock. As a consequence, projections for the Western Baltic spring spawning herring were not considered

3.9 Bias in estimates of Western Baltic Spring Spawner parameters caused by migration

The HAWG has during the last decade encountered a suite of overpowering difficulties in the assessment of the Western Baltic Spring Spawning (WBSS) stock. These problems can be illustrated by the difficulties in finding convincing fits of various abundance indices to stock number estimated by the ICA. The Working Group discussed why the abundance indices did not conform to the traditional theory behind the assessment methodology. To mention a few possible explanations:

- Incorrect or biased catch statistics.
- Biased age determination (discrepancies between otolith-readers)
- Large random variation of survey indices.
- Incorrect splitting of stocks in areas where stocks mix.
- Bias caused by migration.

The last two items may also be categorised as "use of inappropriate models".

This section discusses the possible bias caused by migration of the WBSS. In order to focus on the migration aspects, it is assumed here that the data of the stock have not been separated by otolith microstructure, vertebrate counts or any other method.

Comprehensive information on the migration routes and the timing of migrations was not available to the WG. The following analysis is based on the knowledge available on the life cycle and consequent migrations of this stock. It should be noted that the hypothetical example used here is *to illustrate the nature of the problem, not really to suggest a migration model for the WBSS stock.* The knowledge available is too scarce to secure a reliable estimation of the migration coefficients.

The spawning grounds are off the North German coast in shallow water. Therefore, this stock is also called the "Rügen herring". The feeding grounds extend from Sub-divisions 22-24, Belts, Kattegat, Skagerrak and the eastern part of the North Sea off Skagerrak. The WBSS mixes with the North Sea autumn spawning stock and with a local smaller spring spawning stock of Skagerrak/Kattegat. There may be up to seven herring stocks in the area occupied by the WBSS. Based on this general perception, a hypothetical, but plausible simple migration model was made by a spreadsheet. The objective of the migration model is to simulate the age composition in an area (where stocks are mixed, and stocks are partly present). When sampling for the abundance index it is assumed that only one stock is present, and that the samples are representative for the entire stock. Sampling from such a mixture of parts of stocks, under the assumption that it is a single stock, may result in heavily biased estimates of mortality rates.

The model is by quarter and simplified to operate with three stocks and for each stock migration between three areas. The spreadsheet is composed of the basics table:

N-Start	N(Area1)	N(Area2)	N(Area3)
F	F(Area 1)	F(Area 2)	F(Area 3)
N-End	N(Area1)*exp(-M-F)	N(Area2)*exp(-M-F)	N(Area3)*exp(-M-F)
Area 1	*Migration Coeff 1-> 1*	*Migration Coeff 2-> 1*	*Migration Coeff 3-> 1*
Area 2	*Migration Coeff 1-> 2*	*Migration Coeff 2-> 2*	*Migration Coeff 3-> 2*
Area 3	*Migration Coeff 1-> 3*	*Migration Coeff 2-> 3*	*Migration Coeff 3-> 3*

Migration is modelled in a very simple way. It takes place at the end of quarter, and takes zero time.

$$N(\text{Area } x) = \Sigma_j N(\text{Area } j) * \text{Migration Coefficient } (j\text{->}x)/100 \text{ where } \Sigma_k \text{ Migration Coefficient } (j\text{->}k) = 100\ \%$$

The three first lines of the basic tables shows the number at the beginning of the quarter and the end of the quarter. As the primary objective is to investigate the effects of migration, the Fs and Ms were fixed at F = 0.2 and M = 0.2 for all stocks in all areas. The time step, dt = 0.25 year. Also the recruitment numbers are arbitrary and equal. In the hypothetical example, only five age groups are considered. For each stock we consider a spawning ground (Sp.Gr.) and two feeding grounds. Using the model for a single cohort from each of the three stocks, with plausible values of the migration coefficients, the results given in Table 3.9.1 emerged.

Figure 3.9.1 compares the WBSS stock to the mixture of stocks present in area IIIa/NS, during five years of three cohorts of three stocks. In this hypothetical example, the difference is conspicuous. However, had the true migration coefficient been known and applied, the difference is expected to be equally clear.

Perhaps the difference appears clearer in the four small tables below Figure 3.9.1. The left-hand tables show the numbers of the mixed stocks in area IIIa/NS, and the apparent mortalities of the mixture under the assumption that it is a stock. The right hand tables shows the numbers in the WBSS stock. Thus, with migratory and mixing species, estimates of mortality rates from indices may be heavily biased, and migration may explain the problems encountered when assessing the WBSS.

As appears elsewhere in this report, there are severe difficulties in the identification and the separation of stocks. If it was assumed that stocks were separated in this example, the bias would be different, but not removed. Even with only one stock in the entire area, migration could still create serious bias problems.

This exercise focus on the problems caused by the timing of migrations. There are, however, other features of migration, which may create other types of bias in the estimates of population parameters. For example, it is well known that migration is size-dependent (the large individuals arrive and leave first on the spawning grounds), the timing of migrations varies from year to year, and spawning grounds may also change.

3.10 Future work

In the report of the study group on the stock structure of the Baltic spring spawning herring (SGSSBH) (ICES 1998/D:1 Ref. H) several problems are addressed, and the Study Group has also listed some ideas for future work such as:

- Swedish historical material on VS counts should be compared with the corresponding OM (otolith microstructure) at the individual level to intercalibrate the two methods.
- Additional analysis of the variation in VS count and frequency analysis of otolith size at age should be conducted on the Swedish historical material.
- A multivariate discriminant function should be developed relating vertebral counts, geographical area of sampling, time of year, age, size and maturity to OM identified stock proportions.
- A revision of the split for the years 1991 to 1997 should be conducted on both Danish and Swedish data from both commercial and survey samples utilising the canonical discriminant function on VS counts, geographical area of sampling, time of year, age, size, and maturity.
- A revision of the mean weight at age should be conducted according to the revised split of the spawning stocks.

Therefore, due to these persisting problems with catch data and survey data the Working Group recommends (see section 1.8) that a Study Group should be set up with the following terms of reference:

a) review and update catch at age and mean weight at age data including information on proportions of North Sea autumn spawners and Western Baltic spring spawners for the period 1990–1997 and for all fishing fleets catching herring in Division IIIa and Sub-divisions 22-24;
b) 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;
c) further improve a migration model of Western Baltic spring spawning herring which can be used for the understanding of the results of an analytical assessment;
d) develop and co-ordinate an international survey carried out by Denmark, Germany and Sweden which should cover the whole distribution area of Western Baltic spring spawning herring.

It should be mentioned that an EU funded research project on the discrimination of herring stocks in the Kattegat and Skagerrak started in March 1997. The objectives are to evaluate the use of vertebrae counts, otolith macrostructure (annuli) and microstructure analysis (primary increment units) for the separation into spring- and autumn spawning stock components. The task includes a revision of the separation in commercial and survey samples for the period 1993–1997. Participants belong to the Danish, German and Swedish national fishery laboratories. The first part of the project includes an assessment of various discrimination methods for the analysis of VS numbers. After an evaluation of these results during spring 1998 analysis of annuli will start from a selected set of sub-samples of the otoliths gathered in the Swedish national sampling programs. Microstructural analysis of the same individuals will start in late 1998.

Table 3.1.1 **Herring in Division IIIa and Sub.-Division 22-24, 1986 - 1997**
Landings in thousands of tonnes.
(Data provided by Working Group members 1998).

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997 [1]
Skagerrak													
Denmark	88.2	94.0	105.0	144.4	47.4	62.3	58.7	64.7	87.8	44.9	43.7	28.7	14.3
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	16.7	9.4	8.8
Sweden	40.3	43.0	51.2	57.2	47.9	56.5	54.7	88.0	56.4	66.4	48.5	32.7	32.9
Total	133.5	139.1	157.4	207.3	96.9	124.4	121.5	166.6	168.4	129.0	108.9	70.8	56.0
Kattegat													
Denmark	69.2	37.4	46.6	76.2	57.1	32.2	29.7	33.5	28.7	23.6	16.9	17.2	8.8
Sweden	39.8	35.9	29.8	49.7	37.9	45.2	36.7	26.4	16.7	15.4	30.8	27.0	18.0
Total	109.0	73.3	76.4	125.9	95.0	77.4	66.4	59.9	45.4	39.0	47.7	44.2	26.8
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	36.8	34.4	30.5
Germany	54.6	60.0	53.1	54.7	56.4	45.5	15.8	15.6	11.1	11.4	13.4	7.3	12.8
Poland	16.7	12.3	8.0	6.6	8.5	9.7	5.6	15.5	11.8	6.3	7.3	6.0	6.9
Sweden	11.4	5.9	7.8	4.6	6.3	8.1	19.3	22.3	16.2	7.4	15.8	9.0	14.5
Total	98.6	92.2	101.4	99.0	92.9	76.9	65.9	80.3	77.1	64.6	73.3	56.7	64.7
Sub. Div. 23													
Denmark	6.8	1.5	0.8	0.1	1.5	1.1	1.7	2.9	3.3	1.5	0.9	0.7	2.2
Sweden	1.1	1.4	0.2	0.1	0.1	0.1	2.3	1.7	0.7	0.3	0.2	0.3	0.1
Total	7.9	2.9	1.0	0.2	1.6	1.2	4.0	4.6	4.0	1.8	1.1	1.0	2.3
Grand Total	349.0	307.5	336.2	432.4	286.4	279.9	257.8	311.4	294.9	234.4	231.0	172.7	149.8

[1] Preliminary data.

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Table 3.1.2 Landings from Division IIIa by Fleets 1991 - 1997 in '000 tons.

Year	Area	Fleet C	Fleet D	Fleet E	Total
1991	Kattegat	32	13	24	69
	Skagerrak	62	6	54	122
	Total	94	19	78	191
1992	Kattegat	24	11	24	59
	Skagerrak	75	14	79	168
	Total	99	25	103	227
1993	Kattegat	18	12	16	46
	Skagerrak	94	15	60	169
	Total	112	27	76	215
1994	Kattegat	18	8	12	38
	Skagerrak	81	5	43	129
	Total	99	13	55	167
1995	Kattegat	36	5	2	43
	Skagerrak	87	3	19	109
	Total	123	8	21	152
1996	Kattegat	33	9	2	44
	Skagerrak	59	4	8	71
	Total	92	13	10	115
1997	Kattegat	24	2	+	26
	Skagerrak	48	5	3	56
	Total	72	7	3	82

Note: It should be remembered that fleet definition has been changed and the new definition has been used for 1995 and 1996

Table 3.2.1 Proportion of North Sea autumn spawners and Baltic spring spawners given in % in Skagerrak and Kattegat by age and quarter. Year: 1997

		Skagerrak		Kattegat	
		North Sea	Baltic	North Sea	Baltic
Quarter	W-rings	Autumn Spawner	Spring Spawner	Autumn Spawner	Spring Spawner
1	1	100%	0%	100%	0%
	2	100%	0%	100%	0%
	3	46%	54%	37%	63%
	4	25%	75%	37%	63%
	5	25%	75%	37%	63%
	6	25%	75%	37%	63%
	7	25%	75%	37%	63%
	8+	25%	75%	37%	63%
2	1	100%	0%	100%	0%
	2	71%	29%	31%	69%
	3	13%	87%	25%	75%
	4	13%	87%	25%	75%
	5	13%	87%	25%	75%
	6	13%	87%	25%	75%
	7	13%	87%	25%	75%
	8+	13%	87%	25%	75%
				3. Quarter used	3. Quarter used
3	0	100%	0%	100%	0%
	1	100%	0%	100%	0%
	2	100%	0%	31%	69%
	3	44%	56%	25%	75%
	4	44%	56%	25%	75%
	5	44%	56%	25%	75%
	6	44%	56%	25%	75%
	7	44%	56%	25%	75%
	8+	44%	56%	25%	75%
4	0	100%	0%	100%	0%
	1	75%	25%	100%	0%
	2	33%	67%	21%	79%
	3	33%	67%	25%	75%
	4	33%	67%	25%	75%
	5	33%	67%	25%	75%
	6	33%	67%	25%	75%
	7	33%	67%	25%	75%
	8+	33%	67%	25%	75%

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

Division: **Skagerrak** **Year:** **1997** **Country:** **All**

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
1	1	2.37	66	27.05	26			29.42	29
	2	23.62	70	1.16	63	19.63	24	44.41	50
	3	13.80	113	0.26	84	1.94	68	16.00	107
	4	0.95	169	0.01	111	0.49	84	1.45	140
	5	0.41	190					0.41	190
	6	0.31	216	0.01	120			0.32	213
	7	0.10	236					0.10	236
	8+	0.14	261					0.14	261
	Total	41.70		28.49		22.06		92.25	
	SOP		3,744		789		644		5,177

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
2	1	78.44	42	7.06	24			85.50	41
	2	20.17	95	0.70	68	23.54	24	44.41	57
	3	29.19	150	0.17	84	2.33	68	31.69	143
	4	13.28	199			0.58	84	13.86	194
	5	4.69	218					4.69	218
	6	1.81	208					1.81	208
	7	0.35	260					0.35	260
	8+	0.94	220					0.94	220
	Total	148.87		7.93		26.45		183.25	
	SOP		13,912		231		772		14,915

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
3	0			13.69	16			13.69	16
	1	2.36	73	6.18	27	9.19	43	17.73	41
	2	40.11	106			0.87	96	40.98	106
	3	60.59	134			0.80	117	61.39	134
	4	12.69	169			0.13	115	12.82	168
	5	5.88	181			0.03	87	5.91	181
	6	1.31	190			0.07	208	1.38	190
	7	0.78	185			0.03	229	0.81	187
	8+	0.62	180			0.03	205	0.65	181
	Total	124.34		19.87		11.15		155.36	
	SOP		16,254		386		617		17,257

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
4	0	2.57	19	31.60	21	0.20	36	34.37	21
	1	75.53	65	24.10	62	8.83	59	108.46	64
	2	21.50	112	3.97	107	0.61	75	26.08	110
	3	35.88	145	3.87	141	1.00	88	40.75	143
	4	6.35	161	0.43	157			6.78	161
	5	3.84	177	0.38	163			4.22	176
	6	0.94	170	0.09	196			1.03	173
	7	0.38	162	0.06	179			0.44	165
	8+	0.97	185	0.02	241			0.99	186
	Total	147.96		64.52		10.64		223.12	
	SOP		14,661		3,279		662		18,602

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
TOTAL	0	2.57	19	45.29	19	0.20	36	48.06	20
	1	158.70	54	64.39	39	18.02	51	241.11	50
	2	105.40	97	5.83	94	44.65	26	155.88	77
	3	139.46	138	4.30	135	6.07	78	149.83	135
	4	33.27	179	0.44	156	1.20	87	34.91	176
	5	14.82	192	0.38	163	0.03	87	15.23	191
	6	4.37	195	0.10	188	0.07	208	4.54	195
	7	1.61	199	0.06	179	0.03	229	1.70	199
	8+	2.67	200	0.02	241	0.03	205	2.72	201
	Total	462.87		120.81		70.30		653.98	
	SOP		48,570		4,686		2,696		55,952

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

Division: **Kattegat** **Year:** **1997** **Country:** **ALL**

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
1	1	4.60	61	11.76	17	2.85	13	19.21	27
	2	50.37	68	10.07	49	3.27	48	63.71	64
	3	30.46	113	1.55	76	0.40	74	32.41	111
	4	2.04	169	0.13	84	0.02	61	2.19	163
	5	0.85	190	0.06	83	0.02	71	0.93	180
	6	0.68	216	0.05	104			0.73	208
	7	0.22	236					0.22	236
	8+	0.27	261					0.27	261
	Total	89.49		23.62		6.56		119.67	
	SOP		7,957		838		226		9,021

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
2	1	28.07	43	8.24	24	0.10	24	36.41	39
	2	6.58	91	2.01	55	0.01	50	8.60	83
	3	6.73	129	0.53	83			7.26	126
	4	1.10	151	0.08	99			1.18	148
	5	0.37	166	0.01	142			0.38	165
	6	0.18	175	0.05	104			0.23	160
	7	0.02	175	0.01	104			0.03	151
	8+	0.02	246					0.02	246
	Total	43.07		10.93		0.11		54.11	
	SOP		2,946		367		3		3,316

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
3	0			0.24	17			0.24	17
	1	37.78	48	1.65	43			39.43	48
	2	41.54	67	0.51	81			42.05	68
	3	8.76	113	0.21	104			8.97	113
	4	2.58	141	0.01	125			2.59	141
	5	1.42	163	0.02	143			1.44	163
	6	0.47	177					0.47	177
	7	0.06	180					0.06	180
	8+	0.10	198					0.10	198
	Total	92.71		2.40				95.11	
	SOP		6,317		138				6,455

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
4	0	6.28	22	38.02	19	1.01	19	45.31	19
	1	38.77	58	3.69	45	0.09	44	42.55	57
	2	26.71	91	0.08	92			26.79	91
	3	13.93	131	0.05	134			13.98	131
	4	1.97	162	0.01	151			1.98	162
	5	0.61	170					0.61	170
	6	0.26	173					0.26	173
	7	0.07	187					0.07	187
	8+	0.04	263					0.04	263
	Total	82.36		3.83		0.09		86.28	
	SOP		6,992		181		4		7,177

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
TOTAL	0	6.28	22	38.26	19	1.01	19	45.55	19
	1	109.22	51	25.34	25	3.04	14	137.60	45
	2	125.20	74	12.67	52	3.28	48	141.15	71
	3	59.88	119	2.34	82	0.40	74	62.62	117
	4	7.69	155	0.23	94	0.02	61	7.94	153
	5	3.25	172	0.09	103	0.02	71	3.36	169
	6	1.59	193	0.10	104			1.69	188
	7	0.37	214	0.01	104			0.38	211
	8+	0.43	246					0.43	246
	Total	313.91		79.04		7.77		400.72	
	SOP		24,350		2,251		252		26,854

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

North Sea Autumn sparners

Division: Skagerrak Year: 1997 Country: All

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
1	1	2.37	66	27.05	26			29.42	29
	2	23.62	70	1.16	63	19.63	24	44.41	50
	3	6.35	113	0.12	84	0.89	68	7.36	107
	4	0.24	169	0.00	111	0.12	84	0.36	140
	5	0.10	190					0.10	190
	6	0.08	216	0.00	120			0.08	213
	7	0.03	236					0.03	236
	8+	0.04	261					0.04	261
	Total	32.82		28.33		20.64		81.80	
	SOP		2,625		775		542		3,942
2	1	78.44	42	7.06	24			85.50	41
	2	14.32	95	0.50	68	16.71	24	31.53	57
	3	3.79	150	0.02	84	0.30	68	4.12	143
	4	1.73	199			0.08	84	1.80	194
	5	0.61	218					0.61	218
	6	0.24	208					0.24	208
	7	0.05	260					0.05	260
	8+	0.12	220					0.12	220
	Total	99.29		7.58		17.09		123.97	
	SOP		5,782		205		428		6,415
3	0			13.69	16			13.69	16
	1	2.36	73	6.18	27	9.19	43	17.73	41
	2	40.11	106			0.87	96	40.98	106
	3	26.66	134			0.35	117	27.01	134
	4	5.58	169			0.06	115	5.64	168
	5	2.59	181			0.01	87	2.60	181
	6	0.58	190			0.03	208	0.61	190
	7	0.34	185			0.01	229	0.36	187
	8+	0.27	180			0.01	205	0.29	181
	Total	78.49		19.87		10.54		108.90	
	SOP		9,627		386		540		10,553
4	0	2.57	19	31.60	21	0.20	36	34.37	21
	1	56.65	65	18.08	62	6.62	59	81.35	64
	2	7.10	112	1.31	107	0.20	75	8.61	110
	3	11.84	145	1.28	141	0.33	88	13.45	143
	4	2.10	161	0.14	157			2.24	161
	5	1.27	177	0.13	163			1.39	176
	6	0.31	170	0.03	196			0.34	173
	7	0.13	162	0.02	179			0.15	165
	8+	0.32	185	0.01	241			0.33	186
	Total	82.27		52.59		7.35		142.21	
	SOP		6,933		2,149		442		9,524
TOTAL	0	2.57	19	45.29	19	0.20	36	48.06	20
	1	139.82	52	58.37	37	15.81	50	214.00	48
	2	85.15	95	2.97	83	37.41	26	125.53	74
	3	48.64	135	1.42	135	1.88	81	51.94	133
	4	9.64	172	0.14	156	0.26	91	10.04	170
	5	4.57	185	0.13	163	0.01	87	4.71	184
	6	1.20	190	0.03	190	0.03	208	1.26	190
	7	0.54	188	0.02	179	0.01	229	0.57	189
	8+	0.75	192	0.01	241	0.01	205	0.77	193
	Total	292.87		108.37		55.63		456.87	
	SOP		24,967		3,516		1,952		30,434

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

North Sea Autumn sparners

Division: **Kattegat** **Year:** **1997** **Country:** **All**

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
1	1	4.60	61	11.76	17	2.85	13	19.21	27
	2	50.37	68	10.07	49	3.27	48	63.71	64
	3	11.27	113	0.57	76	0.15	74	11.99	111
	4	0.75	169	0.05	84	0.01	61	0.81	163
	5	0.31	190	0.02	83	0.01	71	0.34	180
	6	0.25	216	0.02	104			0.27	208
	7	0.08	236					0.08	236
	8+	0.10	261					0.10	261
	Total	67.74		22.49		6.28		96.52	
	SOP		5,295		750		206		6,251
Quarter	**W-rings**	**Fleet C Numbers**	**Mean W.**	**Fleet D Numbers**	**Mean W.**	**Fleet E Numbers**	**Mean W.**	**Total Numbers**	**Mean W.**
2	1	28.07	43	8.24	24	0.10	24	36.41	39
	2	2.04	91	0.62	55	0.00	50	2.67	83
	3	1.68	129	0.13	83			1.82	126
	4	0.28	151	0.02	99			0.30	148
	5	0.09	166	0.00	142			0.10	165
	6	0.05	175	0.01	104			0.06	160
	7	0.01	175	0.00	104			0.01	151
	8+	0.01	246					0.01	246
	Total	32.21		9.03		0.10		41.35	
	SOP		1,679		247		3		1,928
Quarter	**W-rings**	**Fleet C Numbers**	**Mean W.**	**Fleet D Numbers**	**Mean W.**	**Fleet E Numbers**	**Mean W.**	**Total Numbers**	**Mean W.**
3	0			0.24	17			0.24	17
	1	37.78	48	1.65	43			39.43	48
	2	12.88	67	0.16	81			13.04	68
	3	2.19	113	0.05	104			2.24	113
	4	0.65	141	0.00	125			0.65	141
	5	0.36	163	0.01	143			0.36	163
	6	0.12	177					0.12	177
	7	0.02	180					0.02	180
	8+	0.03	198					0.03	198
	Total	54.00		2.11				56.11	
	SOP		3,107		94				3,202
Quarter	**W-rings**	**Fleet C Numbers**	**Mean W.**	**Fleet D Numbers**	**Mean W.**	**Fleet E Numbers**	**Mean W.**	**Total Numbers**	**Mean W.**
4	0	6.28	22	38.02	19	1.01	19	45.31	19
	1	38.77	58	3.69	45	0.09	44	42.55	57
	2	5.61	91	0.02	92			5.63	91
	3	3.48	131	0.01	134			3.50	131
	4	0.49	162	0.00	151			0.50	162
	5	0.15	170					0.15	170
	6	0.07	173					0.07	173
	7	0.02	187					0.02	187
	8+	0.01	263					0.01	263
	Total	54.88		41.74		1.10		97.72	
	SOP		3,477		891		23		4,392
Quarter	**W-rings**	**Fleet C Numbers**	**Mean W.**	**Fleet D Numbers**	**Mean W.**	**Fleet E Numbers**	**Mean W.**	**Total Numbers**	**Mean W.**
TOTAL	0	6.28	22	38.26	19	1.01	19	45.55	19
	1	109.22	51	25.34	25	3.04	14	137.60	45
	2	70.90	71	10.87	50	3.27	48	85.04	67
	3	18.63	118	0.77	80	0.15	74	19.54	116
	4	2.17	157	0.07	92	0.01	61	2.25	154
	5	0.91	174	0.03	98	0.01	71	0.95	171
	6	0.48	197	0.03	104			0.51	191
	7	0.12	219	0.00	104			0.12	217
	8+	0.14	250					0.14	250
	Total	208.84		75.38		7.49		291.70	
	SOP		13,559		1,982		232		15,773

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

Baltic Spring sparners

Division: Skagerrak **Year:** 1997 **Country:** All

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
1	1								
	2								
	3	7.45	113	0.14	84	1.05	68	8.64	107
	4	0.71	169	0.01	111	0.37	84	1.09	140
	5	0.31	190					0.31	190
	6	0.23	216	0.01	120			0.24	213
	7	0.08	236					0.08	236
	8+	0.11	261					0.11	261
	Total	8.88		0.16		1.42		10.46	
	SOP		1,119		14		102		1,235
2	1								
	2	5.85	95	0.20	68	6.83	24	12.88	57
	3	25.40	150	0.15	84	2.03	68	27.57	143
	4	11.55	199			0.50	84	12.06	194
	5	4.08	218					4.08	218
	6	1.57	208					1.57	208
	7	0.30	260					0.30	260
	8+	0.82	220					0.82	220
	Total	49.58		0.35		9.36		59.28	
	SOP		8,130		26		344		8,500
3	0								
	1								
	2								
	3	33.93	134			0.45	117	34.38	134
	4	7.11	169			0.07	115	7.18	168
	5	3.29	181			0.02	87	3.31	181
	6	0.73	190			0.04	208	0.77	190
	7	0.44	185			0.02	229	0.45	187
	8+	0.35	180			0.02	205	0.36	181
	Total	45.85				0.61		46.46	
	SOP		6,627				78		6,705
4	0								
	1	18.88	65	6.03	62	2.21	59	27.12	64
	2	14.41	112	2.66	107	0.41	75	17.47	110
	3	24.04	145	2.59	141	0.67	88	27.30	143
	4	4.25	161	0.29	157			4.54	161
	5	2.57	177	0.25	163			2.83	176
	6	0.63	170	0.06	196			0.69	173
	7	0.25	162	0.04	179			0.29	165
	8+	0.65	185	0.01	241			0.66	186
	Total	65.69		11.93		3.29		80.91	
	SOP		7,728		1,130		220		9,078
TOTAL	0								
	1	18.88	65	6.03	62	2.21	59	27.12	64
	2	20.25	107	2.86	104	7.24	27	30.35	88
	3	90.82	140	2.88	135	4.19	76	97.89	137
	4	23.63	182	0.30	156	0.94	86	24.87	178
	5	10.25	195	0.25	163	0.02	87	10.52	194
	6	3.17	197	0.07	188	0.04	208	3.28	197
	7	1.07	205	0.04	179	0.02	229	1.13	204
	8+	1.92	203	0.01	241	0.02	205	1.95	203
	Total	170.00		12.44		14.67		197.11	
	SOP		23,603		1,170		744		25,517

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

Baltic Spring sparners

Division: **Kattegat** **Year:** **1997** **Country:** **All**

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
1	1								
	2								
	3	19.19	113	0.98	76	0.25	74	20.42	111
	4	1.29	169	0.08	84	0.01	61	1.38	163
	5	0.54	190	0.04	83	0.01	71	0.59	180
	6	0.43	216	0.03	104			0.46	208
	7	0.14	236					0.14	236
	8+	0.17	261					0.17	261
	Total	21.75		1.13		0.28		23.15	
	SOP		2,662		88		20		2,771

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
2	1								
	2	4.54	91	1.39	55	0.01	50	5.93	83
	3	5.05	129	0.40	83			5.45	126
	4	0.83	151	0.06	99			0.89	148
	5	0.28	166	0.01	142			0.29	165
	6	0.14	175	0.04	104			0.17	160
	7	0.02	175	0.01	104			0.02	151
	8+	0.02	246					0.02	246
	Total	10.86		1.90		0.01		12.76	
	SOP		1,267		121		0		1,388

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
3	0								
	1								
	2	28.66	67	0.35	81			29.01	68
	3	6.57	113	0.16	104			6.73	113
	4	1.94	141	0.01	125			1.94	141
	5	1.07	163	0.02	143			1.08	163
	6	0.35	177					0.35	177
	7	0.05	180					0.05	180
	8+	0.08	198					0.08	198
	Total	38.71		0.53				39.24	
	SOP		3,209		48				3,257

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
4	0								
	1								
	2	21.10	91	0.06	92			21.16	91
	3	10.45	131	0.04	134			10.49	131
	4	1.48	162	0.01	151			1.49	162
	5	0.46	170					0.46	170
	6	0.20	173					0.20	173
	7	0.05	187					0.05	187
	8+	0.03	263					0.03	263
	Total	33.76		0.11				33.87	
	SOP		3,653		12				3,665

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
TOTAL	0								
	1								
	2	54.30	79	1.80	61	0.01	50	56.11	78
	3	41.25	120	1.57	82	0.25	74	43.08	118
	4	5.52	155	0.16	95	0.01	61	5.69	153
	5	2.34	171	0.06	105	0.01	71	2.41	169
	6	1.11	191	0.07	104			1.18	186
	7	0.25	212	0.01	104			0.26	209
	8+	0.29	244					0.29	244
	Total	105.07		3.66		0.28		109.02	
	SOP		10,792		268		21		11,081

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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:** **1997** **Country:** **All**

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
1	1	6.97	63	38.81	23	2.85	13	48.63	28
	2	73.99	69	11.23	51	22.90	27	108.12	58
	3	17.62	113	0.69	78	1.04	69	19.35	110
	4	0.99	169	0.05	86	0.13	83	1.17	156
	5	0.42	190	0.02	83	0.01	71	0.45	183
	6	0.33	216	0.02	106			0.35	209
	7	0.11	236					0.11	236
	8+	0.13	261					0.13	261
	Total	100.56		50.83		26.93		178.31	
	SOP		7,920		1,525		748		10,193

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
2	1	106.51	42	15.30	24	0.10	24	121.91	40
	2	16.36	94	1.12	61	16.72	24	34.20	59
	3	5.48	143	0.15	83	0.30	68	5.93	138
	4	2.00	192	0.02	99	0.08	84	2.10	188
	5	0.70	211	0.00	142			0.70	211
	6	0.28	203	0.01	104			0.29	198
	7	0.05	252	0.00	104			0.05	245
	8+	0.13	221					0.13	221
	Total	131.51		16.61		17.19		165.32	
	SOP		7,461		452		431		8,344

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
3	0			13.93	16			13.93	16
	1	40.14	49	7.83	30	9.19	43	57.16	46
	2	52.99	97	0.16	81	0.87	96	54.02	96
	3	28.85	132	0.05	104	0.35	117	29.25	132
	4	6.23	166	0.00	125	0.06	115	6.29	165
	5	2.94	179	0.01	143	0.01	87	2.96	179
	6	0.69	187			0.03	208	0.72	188
	7	0.36	185			0.01	229	0.37	186
	8+	0.30	182			0.01	205	0.31	183
	Total	132.50		21.98		10.54		165.02	
	SOP		12,734		480		540		13,754

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
4	0	8.85	21	69.62	20	1.21	22	79.68	20
	1	95.42	62	21.77	59	6.71	59	123.90	61
	2	12.70	103	1.33	107	0.20	75	14.23	103
	3	15.32	142	1.29	141	0.33	88	16.94	140
	4	2.59	162	0.14	157			2.73	161
	5	1.42	176	0.13	163			1.55	175
	6	0.38	171	0.03	196			0.40	173
	7	0.14	165	0.02	179			0.16	167
	8+	0.33	187	0.01	241			0.34	188
	Total	137.15		94.33		8.45		239.93	
	SOP		10,410		3,041		465		13,916

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
TOTAL	0	8.85	21	83.55	19	1.21	22	93.61	19
	1	249.04	32	83.71	18	18.85	42	351.60	29
	2	156.04	84	13.84	57	40.69	28	210.56	71
	3	67.27	130	2.19	116	2.03	80	71.48	129
	4	11.81	170	0.22	135	0.26	90	12.29	167
	5	5.48	183	0.16	151	0.02	81	5.66	182
	6	1.68	192	0.06	148	0.03	208	1.77	191
	7	0.66	194	0.02	171	0.01	229	0.69	194
	8+	0.89	201	0.01	241	0.01	205	0.91	202
	Total	501.72		183.74		63.12		748.58	
	SOP		33,584		4,237		2,144		39,966

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

Baltic Spring sparners

Division: **IIIa** **Year:** **1997** **Country:** **All**

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
1	1								
	2								
	3	26.64	113	1.12	77	1.30	69	29.06	110
	4	2.00	169	0.09	87	0.38	83	2.47	153
	5	0.84	190	0.04	83	0.01	71	0.89	184
	6	0.66	216	0.04	107			0.70	210
	7	0.21	236					0.21	236
	8+	0.28	261					0.28	261
	Total	30.63		1.28		1.69		33.61	
	SOP		3,781		101		122		4,005

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
2	1								
	2	10.39	93	1.59	56	6.83	24	18.81	65
	3	30.44	146	0.55	83	2.03	68	33.02	140
	4	12.38	196	0.06	99	0.50	84	12.94	191
	5	4.36	215	0.01	142			4.37	215
	6	1.71	205	0.04	104			1.75	203
	7	0.32	256	0.01	104			0.33	253
	8+	0.83	220					0.83	220
	Total	60.43		2.25		9.37		72.04	
	SOP		9,397		147		344		9,888

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
3	0								
	1								
	2	28.66	67	0.35	81			29.01	68
	3	40.50	131	0.16	104	0.45	117	41.11	130
	4	9.04	163	0.01	125	0.07	115	9.12	162
	5	4.36	177	0.02	143	0.02	87	4.39	176
	6	1.09	185			0.04	208	1.13	186
	7	0.48	184			0.02	229	0.50	186
	8+	0.42	183			0.02	205	0.44	184
	Total	84.55		0.53		0.61		85.69	
	SOP		9,836		48		78		9,962

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
4	0								
	1	18.88	65	6.03	62	2.21	59	27.12	64
	2	35.51	99	2.72	107	0.41	75	38.64	100
	3	34.49	140	2.63	141	0.67	88	37.79	140
	4	5.73	162	0.30	157			6.03	161
	5	3.03	176	0.25	163			3.28	175
	6	0.82	171	0.06	196			0.89	173
	7	0.31	167	0.04	179			0.35	168
	8+	0.68	188	0.01	241			0.69	189
	Total	99.45		12.04		3.29		114.78	
	SOP		11,381		1,142		220		12,743

Quarter	W-rings	Fleet C Numbers	Fleet C Mean W.	Fleet D Numbers	Fleet D Mean W.	Fleet E Numbers	Fleet E Mean W.	Total Numbers	Total Mean W.
TOTAL	0								
	1	18.88	65	6.03	62	2.21	59	27.12	64
	2	74.56	86	4.66	88	7.24	27	86.47	81
	3	132.07	133	4.45	117	4.44	76	140.97	131
	4	29.15	177	0.45	135	0.96	86	30.56	173
	5	12.59	191	0.31	152	0.03	80	12.93	189
	6	4.28	195	0.14	145	0.04	208	4.46	194
	7	1.32	206	0.05	167	0.02	229	1.39	205
	8+	2.21	209	0.01	241	0.02	205	2.24	209
	Total	275.06		16.11		14.95		306.12	
	SOP		34,395		1,438		764		36,598

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Table 3.3.9

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

Division: 22-24 **Year:** 1997 **Country:** ALL

Quarter	W-rings	Sub-division 22 Numbers	Sub-division 22 Mean W.	Sub-division 23 Numbers	Sub-division 23 Mean W.	Sub-division 24 Numbers	Sub-division 24 Mean W.	Total Numbers	Total Mean W.
1	1	300.06	13	0.14	13	2.08	13	302.28	13
	2	6.15	42	1.27	38	20.56	38	27.98	39
	3	1.23	85	1.30	104	21.46	101	23.99	100
	4			0.53	126	12.99	128	13.52	128
	5			0.32	157	8.37	164	8.69	164
	6			0.38	186	13.03	193	13.41	193
	7			0.26	195	7.59	208	7.85	208
	8+			0.34	217	11.93	225	12.27	225
	Total	307.44		4.54		98.02		410.00	
	SOP		4,114		497		12,794		17,405

Quarter	W-rings	Sub-division 22 Numbers	Sub-division 22 Mean W.	Sub-division 23 Numbers	Sub-division 23 Mean W.	Sub-division 24 Numbers	Sub-division 24 Mean W.	Total Numbers	Total Mean W.
2	1	138.27	23	0.03	21	10.86	21	149.16	23
	2	44.56	51	0.04	49	13.35	49	57.95	51
	3	4.80	114	0.17	106	60.83	101	65.80	102
	4	2.40	160	0.04	123	28.73	115	31.17	119
	5	3.40	182	0.03	148	16.40	148	19.83	154
	6	3.20	188	0.03	164	17.62	172	20.85	174
	7	1.60	202	0.02	177	9.64	189	11.26	191
	8+	1.60	197	0.01	148	7.25	186	8.86	188
	Total	199.83		0.38		164.68		364.89	
	SOP		8,243		41		18,939		27,222

Quarter	W-rings	Sub-division 22 Numbers	Sub-division 22 Mean W.	Sub-division 23 Numbers	Sub-division 23 Mean W.	Sub-division 24 Numbers	Sub-division 24 Mean W.	Total Numbers	Total Mean W.
3	0	12.59	20	11.63	42	62.71	42	86.93	39
	1	29.76	40	3.28	74	17.67	74	50.71	54
	2	2.47	61	2.33	86	12.61	86	17.40	82
	3	0.13	67	0.41	100	2.16	100	2.70	98
	4								
	5								
	6								
	7								
	8+								
	Total	44.95		17.65		95.15		157.74	
	SOP		1,602		972		5,241		7,815

Quarter	W-rings	Sub-division 22 Numbers	Sub-division 22 Mean W.	Sub-division 23 Numbers	Sub-division 23 Mean W.	Sub-division 24 Numbers	Sub-division 24 Mean W.	Total Numbers	Total Mean W.
4	0	151.74	17	9.80	42	102.36	42	263.90	28
	1	61.40	40	2.77	74	28.87	74	93.04	52
	2	4.82	51	1.97	86	20.50	86	27.29	80
	3	0.44	60	0.34	100	3.58	100	4.37	96
	4	0.44	45					0.44	45
	5	0.44	53					0.44	53
	6								
	7								
	8+								
	Total	219.28		14.88		155.31		389.47	
	SOP		5,351		820		8,556		14,727

Quarter	W-rings	Sub-division 22 Numbers	Sub-division 22 Mean W.	Sub-division 23 Numbers	Sub-division 23 Mean W.	Sub-division 24 Numbers	Sub-division 24 Mean W.	Total Numbers	Total Mean W.
Total	0	164.33	17	21.43	42	165.07	42	350.83	30
	1	529.49	20	6.22	72	59.48	62	595.19	25
	2	58.00	50	5.61	75	67.02	64	130.62	58
	3	6.60	104	2.23	103	88.03	101	96.86	101
	4	2.84	142	0.57	126	41.72	119	45.13	121
	5	3.84	167	0.35	156	24.77	153	28.96	155
	6	3.20	188	0.41	184	30.65	181	34.26	182
	7	1.60	202	0.28	194	17.23	197	19.11	198
	8+	1.60	197	0.35	215	19.18	210	21.13	209
	Total	771.50		37.44		513.15		1,322.10	
	SOP		19,309		2,331		45,531		67,170

Table 3.3.10

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

Division: IIIa + IV + 22-24 Year: 1997

		IIIa + IV		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
1	1			302.28	13	302.28	13
	2			27.98	39	27.98	39
	3	29.06	110	23.99	100	53.05	106
	4	2.47	153	13.52	128	15.98	132
	5	0.89	184	8.69	164	9.59	165
	6	0.70	210	13.41	193	14.11	194
	7	0.21	236	7.85	208	8.06	209
	8+	0.28	261	12.27	225	12.55	226
	Total	33.61		410.00		443.60	
	SOP		4,005		17,405		21,411
		IIIa + IV		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
2	1			149.16	23	149.16	23
	2	20.91	71	57.95	51	78.86	56
	3	34.12	141	65.80	102	99.92	115
	4	14.34	191	31.17	119	45.52	141
	5	4.77	215	19.83	154	24.60	166
	6	1.95	206	20.85	174	22.80	177
	7	0.43	245	11.26	191	11.69	193
	8+	0.93	223	8.86	188	9.79	191
	Total	77.44		364.89		442.33	
	SOP		10,763		27,222		37,986
		IIIa + IV		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
3	0			86.93	39	86.93	39
	1			50.71	54	50.71	54
	2	29.21	68	17.40	82	46.62	73
	3	41.41	131	2.70	98	44.10	129
	4	9.32	163			9.32	163
	5	4.49	178			4.49	178
	6	1.13	186			1.13	186
	7	0.50	186			0.50	186
	8+	0.44	184			0.44	184
	Total	86.49		157.74		244.24	
	SOP		10,107		7,815		17,922
		IIIa + IV		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
4	0			263.90	28	263.90	28
	1	27.12	64	93.04	52	120.15	54
	2	38.64	100	27.29	80	65.93	91
	3	37.79	140	4.37	96	42.15	135
	4	6.03	161	0.44	45	6.47	153
	5	3.28	175	0.44	53	3.72	160
	6	0.89	173	0.89	173	1.77	173
	7	0.35	168	0.35	168	0.69	168
	8+	0.69	189	0.69	189	1.39	189
	Total	114.78		391.39		506.17	
	SOP		12,743		15,070		27,813
		IIIa + IV		Sub-division 22-24		Total	
Quarter	W-rings	Numbers	Mean W.	Numbers	Mean W.	Numbers	Mean W.
Total	0	0.00	0	350.83	30	350.83	30
	1	27.12	64	595.19	25	622.31	26
	2	88.77	82	130.62	58	219.39	68
	3	142.37	131	96.86	101	239.22	119
	4	32.16	175	45.13	121	77.29	143
	5	13.43	191	28.96	155	42.40	166
	6	4.66	196	35.15	181	39.81	183
	7	1.49	206	19.46	197	20.94	198
	8+	2.34	210	21.83	209	24.17	209
	Total	312.32		1,324.02		1,636.34	
	SOP		37,618		67,513		105,131

Table 3.3.11 Total catch in numbers (x 10^6) and mean weight (g), SOP (tonnes) of spring spawners in Division IIIa and the North Sea in the year 1987 - 1997.

Year	Rings	0	1	2	3	4	5	6	7	8+	Total
	Number			767.00	167.10	82.90	27.70	9.30	1.20	0.20	1055.40
1987	Mean W.			57.00	85.00	105.60	145.30	154.60	201.20	280.40	
	SOP			43719.00	14203.50	8754.24	4024.81	1437.78	241.44	56.08	72436.85
	Number			2075.00	563.00	62.00	8.00	2.00	0.50	0.50	2711.00
1988	Mean W.			47.30	77.00	138.30	156.00	166.00	149.00	209.00	
	SOP			98147.50	43351.00	8574.60	1248.00	332.00	74.50	104.50	151832.10
	Number			497.69	503.66	115.23	29.96	13.68	5.35	2.34	1167.91
1989	Mean W.			56.50	79.90	125.50	151.60	167.30	189.20	204.80	
	SOP			28119.49	40242.43	14461.37	4541.94	2288.66	1012.22	479.23	91145.34
	Number		140.90	1006.23	259.90	192.21	62.07	9.99	19.09	2.20	1692.59
1990	Mean W.		56.60	65.00	84.60	102.40	111.10	109.30	141.00	84.30	
	SOP		7974.94	65404.95	21987.54	19682.30	6895.98	1091.91	2691.69	185.46	125914.77
	Number	64.80	43.00	352.05	447.07	174.71	108.85	22.35	7.62	3.09	1223.54
1991	Mean W.	33.70	60.50	77.40	101.70	127.50	148.60	165.40	182.50	194.90	
	SOP	2183.76	2601.50	27248.67	45467.02	22275.53	16175.11	3696.69	1390.65	602.24	121641.17
	Number		66.98	214.33	156.34	128.78	63.88	43.59	12.65	7.76	694.31
1992	Mean W.		53.40	96.20	115.20	138.60	172.90	184.00	201.70	201.30	
	SOP		3576.73	20618.55	18010.37	17848.91	11044.85	8020.56	2551.51	1562.09	83233.56
	Number		52.92	185.91	245.60	101.75	63.05	43.65	23.86	8.88	725.62
1993	Mean W.		60.40	88.60	121.50	147.20	160.30	182.90	195.60	218.20	
	SOP		3196.37	16471.63	29840.40	14977.60	10106.92	7983.59	4667.02	1937.62	89181.13
	Number			157.34	248.54	137.01	80.20	45.92	14.75	8.40	692.16
1994	Mean W.			127.20	120.10	148.60	165.30	190.60	204.10	216.50	
	SOP			20013.65	29849.65	20359.69	13257.06	8752.35	3010.48	1818.60	97061.48
	Number	84.40	504.27	254.11	132.29	81.25	52.50	16.07	10.14	4.70	1139.73
1995	Mean W.	17.50	37.80	101.20	148.30	165.50	188.70	213.00	233.10	232.20	
	SOP	1477.00	19061.41	25715.93	19618.61	13446.88	9906.75	3422.91	2363.63	1091.34	96104.45
	Number	23.97	173.92	509.10	90.41	54.32	30.39	13.69	7.08	5.94	908.83
1996	Mean W.	7.30	22.90	74.06	126.99	172.03	182.76	200.92	197.70	212.32	
	SOP	175.02	3983.37	37702.15	11481.28	9345.26	5554.20	2750.58	1398.99	1261.98	73652.83
	Number		27.12	88.77	142.37	32.16	13.43	4.66	1.49	2.34	312.32
1997	Mean W.		63.76	82.39	131.32	174.52	190.60	195.56	205.91	210.24	
	SOP	0.00	1728.79	7313.05	18694.98	5612.42	2560.31	910.83	306.08	492.00	37618.47

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

Table 3.3.12 Herring Division IIIa, 1987 - 1997
Transfers of autumn spawners from Div. IIIa to the North Sea
Numbers (x 10^6) and mean weight, SOP in (tonnes).

Year	Rings	0	1	2	3	4	5	6	7	8+	Total
	Number	6238.00	3153.00	117.00							9508.00
1987	Mean W.	8.00	33.00	63.00							
	SOP	49904.00	104049.00	7371.00							161324.00
	Number	1830.00	5792.00	292.00							7914.00
1988	Mean W.	12.00	28.00	57.00							
	SOP	21960.00	162176.00	16644.00							200780.00
	Number	1028.20	1170.50	654.80							2853.50
1989	Mean W.	16.20	33.40	53.30							
	SOP	16656.84	39094.70	34900.84							90652.38
	Number	397.90	1424.30	283.70							2105.90
1990	Mean W.	31.00	34.10	55.40							
	SOP	12334.90	48568.63	15716.98							76620.51
	Number	712.30	822.70	330.20							1865.20
1991	Mean W.	25.30	40.70	77.80							
	SOP	18021.19	33483.89	25689.56							77194.64
	Number	2407.51	1587.09	283.80	26.79	26.61	15.98	12.33	5.46	1.00	4366.57
1992	Mean W.	12.30	50.60	94.80	164.00	171.70	184.70	197.50	202.70	219.80	
	SOP	29612.37	80306.75	26904.24	4393.56	4568.94	2951.51	2435.18	1106.74	219.80	152499.09
	Number	2956.70	2351.10	350.01							5657.81
1993	Mean W.	12.70	27.50	86.60							
	SOP	37550.09	64655.25	30310.87							132516.21
	Number	542.23	1239.65	305.19							2087.07
1994	Mean W.	16.50	42.90	77.30							
	SOP	8946.80	53180.99	23591.19							85718.97
	Number	1722.84	1069.58	126.37							2918.79
1995	Mean W.	12.50	32.80	102.70							
	SOP	21535.50	35082.22	12978.20							69595.92
	Number	632.07	869.53	159.35	31.52						1692.47
1996	Mean W.	11.00	22.70	73.00	121.20						
	SOP	6952.77	19738.33	11632.55	3820.22						42143.88
	Number	93.61	351.60	210.56	71.48	12.29	5.66	1.77	0.69	0.91	748.57
1997	Mean W.	19.00	29.00	71.00	129.00	167.00	182.00	191.00	194.00	202.00	
	SOP	1778.59	10196.40	14949.76	9220.92	2052.43	1030.12	338.07	133.86	183.82	39883.97

There are minor corrections for the years previous to 1991.

Table 3.3.13 Total catch in numbers (x 10^6) of spring spawners in Division IIIa and the North Sea and in Sub-divisions 22-24 in the years 1987 - 1997

	Rings	0	1	2	3	4	5	6	7	8+	Total
Year	**Area**					**Numbers (x 10^6)**					
	North Sea +Div. IIIa			767.00	167.10	82.90	27.70	9.30	1.20	0.20	1,055.40
1987	Sub-Division 22-24	771.20	1,090.00	221.00	220.00	311.00	97.00	28.00	8.00	4.00	2,750.20
	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

Table 3.3.14 Mean weight (g) and SOP (tonnes) of spring spawners in Division IIIa and the North Sea and in Sub-divisions 22-24 in the years 1987 - 1997

	Rings	0	1	2	3	4	5	6	7	8+	SOP
Year	**Area**				**Mean Weight (g)**						**(t)**
	North Sea +Div. IIIa			57.0	85.0	105.6	145.3	154.6	201.2	280.4	72,437
1987	Sub-Division 22-24	11.7	15.7	34.8	76.7	98.4	121.9	141.4	151.4	163.4	89,954
	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

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

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Table 3.4.1 Herring in Division IIIa, IIIb and IIIc. Samples of commercial catches
Samples of commercial catches by quarter and Sub-Div.
for 1997 available to the Working Group.

Area	Country	Quarter	Landings in '000 tons	Number of samples	Number of fish meas.	Number of fish aged
Skagerrak	**Denmark**	1	1.6	3	4	4
		2	1.0	20	91	91
		3	4.8	28	1,965	1,065
		4	6.9	20	1,318	1318
		Total	14.3	71	3,378	2,478
	Norway	1				
		2	6.4		288	288
		3	2.4		150	150
		4				
		Total	8.8	0	438	438
	Sweden	1	3.6			
		2	7.5	12	2,075	371
		3	10.1	4	667	246
		4	11.6	16	3,211	846
		Total	32.8	32	5,953	1,463
Kattegat	**Denmark**	1	2.0	2	307	307
		2	0.4	4	124	124
		3	3.6	4	238	281
		4	2.7	3	221	221
		Total	8.7	13	890	933
	Sweden	1	6.9	15	3,607	1,040
		2	2.9	11	2,056	470
		3	2.9	7	1,438	329
		4	5.3	11	2,554	612
		Total	18.0	44	9,655	2,451
Sub-Division 22-24	**Denmark**	1	9.9	5	1,034	276
		2	11.6	11	1,897	1,277
		3	3.0	7	1,095	149
		4	8.3	3	513	364
		Total	32.8	26	4,539	2,066
	Germany	1	5.3	17	3,746	1,040
		2	6.9	19	3,783	1,313
		3	+			
		4	0.5			
		Total	12.7	36	7,529	2,353
	Poland	1		?		
		2		?		
		3		?		
		4		?		
		Total				
	Sweden	1	1.8			
		2	2.8			
		3	4.6			
		4	5.3			
		Total	14.5	0	0	0

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

Year	Month	Winter rings				Total	Mean catch
		0	1	2	3+	numbers	(kg)
1979	Nov.	8,665.90	240.47	103.36	10.33	9,020.06	89.61
1981	Nov.	332.63	96.79	60.05	21.30	510.77	16.36
1982	Dec.	695.71	108.21	70.63	34.72	909.27	24.57
1983	Dec.	1,995.97	387.11	63.71	46.11	2,492.90	46.68
1984	Nov.	1,581.66	377.15	88.03	24.26	2,071.10	39.79
1985	Nov.	3,085.64	340.92	169.95	74.76	3,671.27	45.99
1986	Dec.	2,984.47	368.35	46.41	69.30	3,468.53	44.42
1989	Nov.	2,881.81	319.38	48.99	55.12	3,305.30	47.76
1990	Nov.	103.92	14.79	21.69	32.90	173.30	7.09
1991	Nov.	117.38	134.20	103.14	144.63	499.35	27.16
1992	Nov.	233.85	88.05	57.15	113.58	492.63	19.86
1993	Nov.	1,744.19	37.10	63.87	544.65	2,389.81	66.46
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

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

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

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.	2896.4	314.5	276.1	605.7	4092.6	107.1
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

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

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	*	*

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	*	*	*	*	*
1997	*	*	*	*	*

* not available for this report

Table 3.5.7. Acoustic surveys on the Spring Spawning HERRING in the North Sea / Div. IIIa in 1989-1997*. (July)

Year	1989	1990	1991	1992	1993	1994	1995	1996	1997
	Numbers in millions								
W-rings									
0		31		3,853	372	964			
1		135		277	103	5	2,199	1,091	128
2	1,105	1,497	1,864	2,092	2,768	413	1,887	1,005	715
3	714	549	1,927	1,799	1,274	935	1,022	247	787
4	317	319	866	1,593	598	501	1,270	141	166
5	81	110	350	556	434	239	255	119	67
6	51	24	88	197	154	186	174	37	69
7	16	10	72	122	63	62	39	20	80
8+	4	5	10	20	13	34	21	13	77
Total	2,288	2,680	5,177	10,509	5,779	3,339	6,867	2,673	2,088
3+ group	1,183	1,017	3,313	4,287	2,536	1,957	2,781	577	1,245
	Biomass ('000 tonnes)								
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
2	86.2	122.8	177.1	169.0	139	33.2	108.9	87.0	52.2
3	83.5	59.8	219.7	206.3	112	114.7	102.6	27.6	81.0
4	54.2	41.2	116.0	204.7	69	76.7	145.5	17.9	21.5
5	16.0	15.8	51.1	83.3	65	41.8	33.9	17.8	9.8
6	11.4	3.8	19.0	36.6	26	38.1	27.4	5.8	9.8
7	3.4	1.8	13.0	24.4	16	13.1	6.7	3.3	14.9
8+	0.9	0.8	2.0	5.0	2	7.8	3.8	2.7	13.6
Total	255.7	253.2	597.9	790.4	438.0	334.5	506.2	215.1	207.5
3+ group	169.5	123.2	420.9	560.3	291.0	292.3	319.9	75.2	150.6
	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
2	78	82	95	80.8	50.1	80.3	57.7	86.6	73.0
3	117	109	114	114.7	87.9	122.7	100.4	111.9	103.0
4	171	129	134	128.5	116.2	153.0	114.6	126.8	129.6
5	198	144	146	149.8	149.9	175.1	132.9	149.4	145.0
6	211	159	216	185.7	169.6	205.0	157.2	157.3	143.1
7	215	176	181	199.7	256.9	212.0	172.9	166.8	185.6
8+	226	156	200	252.0	164.2	230.3	183.1	212.9	178.0
Total	111.6	95.8	115.6	123.9	75.8	100.2	73.7	80.5	99.4

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

Table 3.5.8. Acoustic survey on the Spring Spawning Herring in Sub-Div. 22-24 in 1989-1997 (October).

Year	1989	1990	1991	1992	1993	1994	1995	1996	1997
	Numbers in millions								
W-rings									
0	3,825	21,157	7,359	3,412	1,414	6,749	4,765	1,841	2,977
1	2,137	1,785	3,224	1,658	466	457	1,315	1,391	1,578
2	213	892	1,764	657	393	831	353	559	468
3	161	146	1,437	282	518	525	354	430	328
4	102	79	461	156	402	449	375	313	142
5	23	19	174	37	145	195	269	278	95
6	4	8	44	25	64	63	133	119	80
7	3	4	24	4	31	25	37	47	26
8+	1	2	21		16	2	25	16	34
Total	6,469	24,092	14,508	6,231	3449	9,295	7,626	4,994	5,728
3+ group	294	258	2,161	504	1,176	1,258	1,193	1,203	705
	Biomass ('000 tonnes)								
W-rings									
0	*	287.7	*	53.2	21	77.0	51.5	18.0	31.1
1	*	65.9	*	61.3	16	16.0	44.4	45.6	43.8
2	*	56.2	*	39.6	18	38.1	22.4	40.6	28.4
3	*	12.3	*	20.6	34	38.8	30.6	38.5	31.6
4	*	7.6	*	14.4	28	43.2	41.1	31.5	19.7
5	*	1.9	*	4.6	16	24.9	27.1	29.8	13.7
6	*	0.9	*	3.3	9	12.9	13.9	13.6	11.8
7	*	0.4	*	0.7	4	5.0	7.6	8.9	4.4
8+	*	0.2	*		3	0.0	5.4	2.7	7.6
Total	*	438.5	*	197.7	149.6	255.9	244.2	229.2	192.1
3+ group	*	23.4	*	43.6	94.2	124.9	125.8	125.0	88.8
	Mean weight (g)								
W-rings									
0	*	13.6	*	15.6	14.9	11.4	10.8	9.8	10.5
1	*	36.9	*	37.0	35.2	34.9	33.8	32.8	27.7
2	*	63.0	*	60.2	45.6	45.8	63.4	72.6	60.5
3	*	84.5	*	73.0	65.8	73.8	86.6	89.5	96.3
4	*	96.6	*	92.1	69.7	96.3	109.7	100.6	139.3
5	*	101.4	*	125.6	111.2	127.7	100.8	107.0	144.4
6	*	112.2	*	132.0	146.2	206.3	104.4	114.2	147.1
7	*	100.6	*	168.1	125.4	204.5	206.0	189.4	169.0
8+	*	102.5	*		171.3		217.5	171.4	221.3
Total	*	18.2	*	31.7	43.4	27.5	32.0	45.9	33.5

* no data available

Table 3.5.9 Environmental Impact Monitoring: Biomass, number, mean length and mean weight estimates for the total Sound area during period Sept. 1993 to Nov. 1997

Year	Month	Biomass ($t\ nm^{-2}$)	Abundance ($x10^6\ nm^{-2}$)	Mean Length (cm)	Mean Weight (g)
1993	Sep	130241.01			
	Oct	96741.95			
	Nov	69504.27			
1994	Mar	15291.28			
	Apr	5342.55			
	Oct	99723.53			
	Nov	67146.45			
1995	Mar	19673.69			
	Apr	14651.56			
	Oct	60417.47	344.83	27.2	175.2
1996	Mar	36329.08	221.82	27.7	163.8
	Apr	20304.09	122.91	27.8	165.2
	Oct	187596.58	1156.42	26.3	162.2
	Nov	162172.70	1052.06	26.5	165.0
1997	Mar	61498.63	438.44	25.9	140.3
	Apr	58863.57	422.13	25.9	139.4
	Nov	180666.10	1239.60	25.9	145.8

Table 3.5.10 Estimation of the herring O-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	61[2]

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

Table 3.7.1 Western Baltic Herring: Input parameters for ICA

/users/fish/ifad/ifapwork/hawg/her_3a22/CANUM.I09
/users/fish/ifad/ifapwork/hawg/her_3a22/WECA.I09
Stock weights in 1998 used for the year 1997
/users/fish/ifad/ifapwork/hawg/her_3a22/WEST.I09
Natural mortality in 1998 used for the year 1997
/users/fish/ifad/ifapwork/hawg/her_3a22/NATMOR.I09
Maturity ogive in 1998 used for the year 1997
/users/fish/ifad/ifapwork/hawg/her_3a22/MATPROP.I09
Nage ix: 102
Years: 1991 1997
Ages: 3 8
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 FLT04: Acoustic Survey in Div IIIa+IVaE a plus-group (Y/ --> y
Is the last age of FLT05: 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 FLT04: Acoustic Survey in Div IIIa+IVaE is to be A/L/P ? --> l
Model for FLT05: 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 . . . 1997
Number of indices of SSB : 0
Number of age-structured indices : 2

Parameters to estimate : 31
Number of observations : 113

Conventional single selection vector model to be fitted.

Survey weighting to be Manual (recommended) or Iterative (M/I) ? --> m
Enter weight for FLT04: Acoustic Survey in Div IIIa+IVaE at age 3 --> 1
Enter weight for FLT04: Acoustic Survey in Div IIIa+IVaE at age 4 --> 1
Enter weight for FLT04: Acoustic Survey in Div IIIa+IVaE at age 5 --> 1
Enter weight for FLT04: Acoustic Survey in Div IIIa+IVaE at age 6 --> 1
Enter weight for FLT04: Acoustic Survey in Div IIIa+IVaE at age 7 --> 1
Enter weight for FLT04: Acoustic Survey in Div IIIa+IVaE at age 8 --> 1
Enter weight for FLT05: Acoustic Survey in Sub div 22-24 at age 3 --> 1
Enter weight for FLT05: Acoustic Survey in Sub div 22-24 at age 4 --> 1
Enter weight for FLT05: Acoustic Survey in Sub div 22-24 at age 5 --> 1
Enter weight for FLT05: Acoustic Survey in Sub div 22-24 at age 6 --> 1
Enter weight for FLT05: Acoustic Survey in Sub div 22-24 at age 7 --> 1
Enter weight for FLT05: 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 FLT04: Acoustic Survey in Div IIIa+IVaE --> 1
Enter value for FLT05: 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
FLT04: Acoustic Survey in Div IIIa+IVaE
Age : 3 4 5 6 7 8
Wts : .167 .167 .167 .167 .167 .167
FLT05: Acoustic Survey in Sub div 22-24
Age : 3 4 5 6 7 8
Wts : .167 .167 .167 .167 .167 .167
SSQ ---> 5.72500444952331
SSQ ---> 5.82846276599938
SSQ ---> 5.86259017845587
SSQ ---> 5.86937994997914
SSQ ---> 5.87066233444578
Computing covariance matrix. Please wait
F in 1997 at age 4 is .299338 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

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

AGE	1991	1992	1993	1994	1995	1996	1997
3	631.90	360.20	441.64	409.55	255.67	214.73	239.22
4	289.60	317.80	268.45	273.07	193.56	159.08	67.97
5	176.40	173.80	214.11	171.04	106.87	130.18	37.91
6	48.30	130.40	105.47	119.94	55.59	66.93	38.68
7	13.80	48.30	66.07	49.86	32.11	31.23	20.44
8	4.90	22.00	22.37	32.87	18.63	25.55	23.73

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

AGE	1991	1992	1993	1994	1995	1996	1997
3	.09500	.09100	.10000	.10300	.10700	.09600	.11900
4	.11600	.11200	.11400	.12200	.12600	.11900	.14000
5	.13800	.13800	.13400	.14000	.15700	.13100	.16500
6	.15100	.16000	.16300	.15500	.17000	.13600	.18300
7	.16900	.17200	.17600	.16900	.20600	.15100	.19800
8	.18000	.18900	.18800	.18500	.21500	.18900	.20900

Table. 3.7.4 WESTERN BALTIC HERRING. Input to ICA . Mean weight in stock (kg)

AGE	1991	1992	1993	1994	1995	1996	1997
3	.07800	.08200	.08300	.08400	.07500	.08800	.10600
4	.10400	.10600	.11100	.10800	.13300	.12200	.13200
5	.11100	.12900	.13700	.13900	.16800	.12700	.16500
6	.13700	.15900	.15800	.15700	.18900	.16600	.19400
7	.14100	.17100	.17900	.17700	.21000	.17800	.20900
8	.14300	.18700	.18600	.20300	.23400	.14900	.22600

Table. 3.7.5 a WESTERN BALTIC HERRING. Input to ICA.
AGE - STRUCTURED INDICES.
FLT04: Acoustic Survey in Div IIIa+IVaE, Ages 3-8+(Catch: Number)

AGE	1991	1992	1993	1994	1995	1996	1997
3	1927.0	1799.0	1274.0	935.0	1022.0	247.0	787.0
4	866.0	1593.0	598.0	501.0	1270.0	141.0	166.0
5	350.0	556.0	434.0	239.0	255.0	119.0	67.0
6	88.0	197.0	154.0	186.0	174.0	37.0	69.0
7	72.0	122.0	63.0	62.0	39.0	20.0	80.0
8	10.0	20.0	13.0	34.0	21.0	13.0	77.0

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
3	1434.0	282.0	518.0	525.0	354.0	430.0	328.0
4	461.0	156.0	402.0	449.0	375.0	313.0	142.0
5	174.0	37.0	145.0	195.0	269.0	278.0	95.0
6	44.0	25.0	64.0	63.0	133.0	119.0	80.0
7	24.0	4.0	31.0	25.0	37.0	47.0	26.0
8	21.0		16.0	2.0	25.0	16.0	34.0

Table. 3.7.6 **WESTERN BALTIC HERRING. Output from ICA.**
FISHING MORTALITY (per year)

AGE	1991	1992	1993	1994	1995	1996	1997
3	.44230	.41552	.44312	.51659	.35866	.47487	.24396
4	.43298	.50983	.54370	.63385	.44007	.58265	.29934
5	.41559	.47700	.50869	.59304	.41173	.54514	.28007
6	.34004	.53853	.57431	.66953	.46484	.61545	.31619
7	.39970	.50983	.54370	.63385	.44007	.58265	.29934
8	.39970	.50983	.54370	.63385	.44007	.58265	.29934

Table. 3.7.7 **WESTERN BALTIC HERRING. Output from ICA.**
POPULATION ABUNDANCE (millions)- 1 January

AGE	1991	1992	1993	1994	1995	1996	1997	1998
3	1936.3	1427.9	1446.8	1294.7	731.9	564.2	1075.0	1099.8
4	902.7	1018.6	771.6	760.5	632.4	418.6	287.3	689.6
5	568.4	479.4	500.9	366.8	330.3	333.4	191.4	174.4
6	183.8	307.1	243.6	246.6	166.0	179.2	158.3	118.4
7	45.9	107.1	146.8	112.3	103.4	85.4	79.3	94.4
8	16.3	60.3	58.3	76.4	57.3	63.2	100.7	109.2

Table. 3.7.8 **WESTERN 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	1936250	341994	268829	125400	.4665	.4077	97
1992	1427940	365323	294821	125700	.4264	.4852	100
1993	1446770	349953	281440	138400	.4918	.5175	101
1994	1294710	315981	251424	132900	.5286	.6033	100
1995	731880	260975	217791	88600	.4068	.4188	100
1996	564230	197426	161863	75200	.4646	.5545	99
1997	1075000	253487	204660	60600	.2961	.2849	100

Table. 3.7.9 WESTERN BALTIC HERRING. Output from ICA.
PARAMETER ESTIMATES

Parm No.		Maximum Likelih. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. distrib.
1	1992	.5098	15	.3766	.6903	.4368	.5951	.5160
2	1993	.5437	14	.4069	.7264	.4690	.6303	.5497
3	1994	.6338	14	.4750	.8458	.5471	.7344	.6408
4	1995	.4401	16	.3189	.6073	.3734	.5187	.4460
5	1996	.5826	18	.4060	.8362	.4846	.7006	.5926
6	1997	.2993	23	.1881	.4765	.2361	.3795	.3079
Separable Model: Selection (S) by age								
7	3	.8150	15	.6024	1.1027	.6985	.9509	.8248
	4	1.0000		Fixed : Reference Age				
8	5	.9356	13	.7191	1.2174	.8180	1.0701	.9441
9	6	1.0563	12	.8228	1.3560	.9299	1.1999	1.0649
	7	1.0000		Fixed : Last true age				
Separable model: Populations in year 1997								
10	3	1075003	29	604528	1911627	801424	1441974	1122379
11	4	287320	22	183156	450725	228349	361522	295003
12	5	191388	21	125005	293023	154005	237846	195961
13	6	158261	21	104164	240452	127847	195909	161906
14	7	79275	23	50230	125113	62810	100055	81452
Separable model: Populations at age								
15	1992	107123	25	64630	177555	82779	138627	110743
16	1993	146749	20	97733	220348	119263	180569	149939
17	1994	112292	18	77568	162561	92977	135620	114310
18	1995	103352	19	70020	152550	84732	126064	105411
19	1996	85360	19	58401	124765	70332	103599	86976

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	.1267E-02	26	.9829E-03	.2767E-02	.1267E-02	.2147E-02	.1708E-02
21	4	Q	.1297E-02	26	.1007E-02	.2830E-02	.1297E-02	.2198E-02	.1748E-02
22	5	Q	.9509E-03	26	.7357E-03	.2097E-02	.9509E-03	.1623E-02	.1287E-02
23	6	Q	.8416E-03	27	.6456E-03	.1906E-02	.8416E-03	.1462E-02	.1152E-02
24	7	Q	.9621E-03	29	.7268E-03	.2284E-02	.9621E-03	.1726E-02	.1345E-02
25	8	Q	.5851E-03	27	.4491E-03	.1323E-02	.5851E-03	.1015E-02	.8006E-03

FLT05: Acoustic Survey in Sub div 22-24

Linear model fitted. Slopes at age :

26	3	Q	.6896E-03	26	.5343E-03	.1515E-02	.6896E-03	.1173E-02	.9319E-03
27	4	Q	.8221E-03	26	.6369E-03	.1806E-02	.8221E-03	.1399E-02	.1111E-02
28	5	Q	.6515E-03	26	.5029E-03	.1447E-02	.6515E-03	.1117E-02	.8846E-03
29	6	Q	.5633E-03	28	.4304E-03	.1291E-02	.5633E-03	.9867E-03	.7754E-03
30	7	Q	.4314E-03	29	.3246E-03	.1037E-02	.4314E-03	.7804E-03	.6063E-03
31	8	Q	.4573E-03	29	.3432E-03	.1108E-02	.4573E-03	.8317E-03	.6449E-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	1992	1993	1994	1995	1996	1997
3	-.2071	-.0683	-.1535	.2400	.0972	.1218
4	-.1571	-.0975	-.1802	-.0600	-.0615	.0039
5	.0452	.1595	.1301	.0492	.0158	-.1159
6	.1089	.0799	.0839	-.0136	-.1192	-.0105
7	.2111	.1602	.0322	-.0451	-.0994	.0900

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
3	.1604	.3794	.0385	-.1139	.4468	-.6405	-.2706
4	.0940	.6308	-.0501	-.1562	.8373	-.8591	-.4966
5	-.0498	.6218	.3500	.1177	.1739	-.5142	-.6992
6	-.2267	.1900	.1980	.4340	.6353	-.8953	-.3350
7	.8635	.6123	-.3421	-.0342	-.5359	-.9233	.3599
8	.4222	-.1234	-.5003	.2469	-.0681	-.5567	.5796

FLT05: Acoustic Survey in Sub div 22-24

Age	1991	1992	1993	1994	1995	1996	1997
3	.585	-.758	-.141	.042	.092	.640	-.460
4	.030	-1.113	.139	.336	.185	.531	-.109
5	-.263	-1.591	-.244	.431	.712	.843	.112
6	-.424	-1.344	-.143	-.095	.884	.817	.305
7	.672	-1.879	-.119	.006	.326	.870	.125
8	1.515	*******	.084	-2.194	.465	.034	.096

Table. 3.7.13 **WESTERN BALTIC HERRING. Output from ICA.**
PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1992 to 1997

Variance	.0381
Skewness test stat.	.5182
Kurtosis test statistic	-1.0202
Partial chi-square	.0353
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	.0241	.0589	.0364	.0453	.0697	.0321
Skewness test stat.	-.4816	.0727	-.3581	-.5674	-.0439	-.0342
Kurtosis test statisti	-.4386	-.5631	-.5732	-.4017	-.6968	-.7496
Partial chi-square	.0223	.0578	.0413	.0595	.1087	.0650
Significance in fit	.0000	.0000	.0000	.0000	.0000	.0000
Number of observations	7	7	7	7	7	7
Degrees of freedom	6	6	6	6	6	6
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	.0436	.0472	.1133	.0988	.1354	.2448
Skewness test stat.	-.1059	-1.5237	-1.0484	-.5284	-1.4968	-.8591
Kurtosis test statisti	-.6053	.5081	.0211	-.3180	.4882	.0850
Partial chi-square	.0425	.0477	.1341	.1386	.2595	.5422
Significance in fit	.0000	.0000	.0000	.0001	.0003	.0095
Number of observations	7	7	7	7	7	6
Degrees of freedom	6	6	6	6	6	5
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	33.1321	113	31	82	.4041
Catches at age	.4187	30	19	11	.0381
Aged Indices					
FLT04: Acoustic Survey Div IIIa+IVa	9.5914	42	6	36	.2664
FLT05: Acoustic Survey Sub div 22-2	23.1221	41	6	35	.6606

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	1.3274	113	31	82	.0162
Catches at age	.4187	30	19	11	.0381
Aged Indices					
FLT04: Acoustic Survey Div IIIa+IVa	.2664	42	6	36	.0074
FLT05: Acoustic Survey Sub div 22-2	.6423	41	6	35	.0184

Table 3.7.16 Output from ICA. Conventional VPA with Fishing Mortality Shrinkage (An inverse variance weighted average of the ICA F's and a traditional VPA using the final F's from the ICA as a starting point).

Fs shrunk over 7 years
Minimum CV of the mean taken as 0.0

Shrinkage Diagnostics

F from model fit Estimate	Variance	Historic Mean F Estimate	Variance	Wt for F from Model	Shrunk estimate
.244	.063	.404	.009	.123	.379
.299	.056	.480	.009	.137	.450
.280	.059	.450	.009	.130	.423
.316	.062	.486	.012	.165	.453
.299	.056	.474	.009	.144	.449
*****	.076	.474	.009	.111	.449

Fishing Mortality (per year)

AGE	1991	1992	1993	1994	1995	1996	1997
3	.44268	.35143	.46825	.46387	.44619	.51247	.37938
4	.41949	.41887	.48207	.59794	.41698	.55616	.44962
5	.40012	.48069	.55709	.65524	.49730	.55176	.42334
6	.34004	.58499	.60974	.71104	.45984	.67610	.45253
7	.42805	.47941	.55732	.63514	.48282	.60368	.44900
8	.42805	.47941	.55732	.63514	.48282	.60368	.44900

Population Abundance (1 January)

AGE	1991	1992	1993	1994	1995	1996	1997	1998
3	1934.9	1333.4	1293.1	1208.2	777.9	585.9	1075.0	1099.8
4	926.1	1017.5	768.2	662.9	622.0	407.7	287.3	602.3
5	586.3	498.5	548.0	388.4	298.5	335.6	191.4	150.1
6	183.8	321.7	252.4	257.0	165.1	148.6	158.3	102.6
7	43.4	107.1	146.8	112.3	103.4	85.4	61.9	82.4
8	15.4	63.2	57.2	76.3	53.2	61.6	71.8	69.9

x 10 ^ 6

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	1934930	345835	272304	125400	.4605	.4006	97
1992	1333390	362798	295384	125700	.4255	.4590	100
1993	1293140	344465	279074	138400	.4959	.5293	101
1994	1208160	302785	242273	132900	.5486	.6070	100
1995	777940	256591	212443	88600	.4171	.4551	100
1996	585850	192956	157345	75200	.4779	.5741	99
1997	1075000	243329	192546	60600	.3147	.4262	100

IFAP run code: I11

Table 3.9.1 Exemplary output of the Migration model, migration coefficients given separately for the three Herring stocks in the Western Baltic. Note that all results are hypothetical.

			Western Baltic Spring Spawners			**Skagerak/Kattegat Spring Spawners**			**North Sea Autumn Spawners**		
Age Gr	**Quarter**		**Rugen**	**22-24**	**IIIa/NS**	**Sp.Gr**	**22-24**	**IIIa/NS**	**Sp.Gr.**	**NS**	**IIIa/NS**
0		N-Start	100.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0
0	**MAR**	**F**	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***
0		N-End	90.5	0.0	0.0	45.2	0.0	0.0	0.0	0.0	0.0
0	**APR**	Rugen	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0
0		22-24	0.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0
0	**MAY**	IIIa/NS	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0
0		N-Start	90.5	0.0	0.0	45.2	0.0	0.0	0.0	0.0	0.0
0	**JUN**	**F**	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***
0		N-End	81.9	0.0	0.0	40.9	0.0	0.0	0.0	0.0	0.0
0	**JUL**	Rugen	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
0		22-24	100.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0
0	**AUG**	IIIa/NS	0.0	0.0	100.0	100.0	0.0	100.0	0.0	0.0	100.0
0		N-Start	0.0	81.9	0.0	0.0	0.0	40.9	2000	0.0	0.0
0	**SEP**	**F**	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***
0		N-End	0.0	74.1	0.0	0.0	0.0	37.0	1809.	0.0	0.0
0	**OCT**	Rugen	0.0	0.0	0.0	100.0	0.0	0.0	50.0	0.0	0.0
0		22-24	100.0	100.0	0.0	0.0	100.0	0.0	50.0	100.0	0.0
0	**NOV**	IIIa/NS	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0
0		N-Start	0.0	74.1	0.0	0.0	0.0	37.0	904.8	904.8	0.0
0	**DEC**	**F**	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***
0		N-End	0.0	67.0	0.0	0.0	0.0	33.5	818.7	818.7	0.0
0	**JAN**	Rugen	100.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
0		22-24	0.0	100.0	0.0	0.0	100.0	0.0	100.0	95.0	0.0
0	**FEB**	IIIa/NS	0.0	0.0	100.0	0.0	0.0	100.0	0.0	5.0	100.0
1		N-Start	0.0	67.0	0.0	0.0	0.0	33.5	0.0	1596.5	40.9
1	**MAR**	**F**	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***
1		N-End	0.0	60.7	0.0	0.0	0.0	30.3	0.0	1444.6	37.0
1	**APR**	Rugen	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0
1		22-24	0.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0
1	**MAY**	IIIa/NS	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0
1		N-Start	0.0	60.7	0.0	0.0	0.0	30.3	0.0	1444.6	37.0
1	**JUN**	**F**	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***
1		N-End	0.0	54.9	0.0	0.0	0.0	27.4	0.0	1307.1	33.5
1	**JUL**	Rugen	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0
1		22-24	0.0	50.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0
1	**AUG**	IIIa/NS	0.0	50.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0
1		N-Start	0.0	27.4	27.4	0.0	0.0	27.4	0.0	1307.1	33.5
1	**SEP**	**F**	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***
1		N-End	0.0	24.8	24.8	0.0	0.0	24.8	0.0	1182.7	30.3
1	**OCT**	Rugen	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0
1		22-24	0.0	50.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0
1	**NOV**	IIIa/NS	0.0	50.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0
1		N-Start	0.0	12.4	37.2	0.0	0.0	24.8	0.0	1182.7	30.3
1	**DEC**	**F**	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***
1		N-End	0.0	11.2	33.7	0.0	0.0	22.5	0.0	1070.2	27.4
1	**JAN**	Rugen	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0
1		22-24	0.0	50.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0
1	**FEB**	IIIa/NS	0.0	50.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0
2		N-Start	0.0	5.6	39.3	0.0	0.0	22.5	0.0	1070.2	27.4
2	**MAR**	**F**	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***
2		N-End	0.0	5.1	35.6	0.0	0.0	20.3	0.0	968.3	24.8
2	**APR**	Rugen	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0
2		22-24	0.0	50.0	0.0	0.0	100.0	0.0	0.0	100.0	10.0
2	**MAY**	IIIa/NS	0.0	50.0	100.0	0.0	0.0	100.0	0.0	0.0	90.0
2		N-Start	0.0	2.5	38.1	0.0	0.0	20.3	0.0	970.8	22.3
2	**JUN**	**F**	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***
2		N-End	0.0	2.3	34.5	0.0	0.0	18.4	0.0	878.4	20.2
2	**JUL**	Rugen	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0
2		22-24	0.0	50.0	0.0	0.0	100.0	0.0	0.0	100.0	10.0
2	**AUG**	IIIa/NS	0.0	50.0	100.0	0.0	0.0	100.0	0.0	0.0	90.0
2		N-Start	0.0	1.1	35.6	0.0	0.0	18.4	0.0	880.5	18.2
2	**SEP**	**F**	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***
2		N-End	0.0	1.0	32.2	0.0	0.0	16.6	0.0	796.7	16.5
2	**OCT**	Rugen	100.0	0.0	10.0	100.0	0.0	0.0	100.0	100.0	100.0
2		22-24	0.0	50.0	30.0	0.0	100.0	0.0	0.0	0.0	0.0
2	**NOV**	IIIa/NS	0.0	50.0	60.0	0.0	0.0	100.0	0.0	0.0	0.0

Table 3.9.1 (continued)

			Western Baltic Spring Spawners			Skagerak/Kattegat Spring Spawners			North Sea Autumn Spawners		
Age Gr	Quarter		Rugen	22-24	IIIa/NS	Sp.Gr	22-24	IIIa/NS	Sp.Gr.	NS	IIIa/NS
2		N-Start	3.2	10.2	19.9	0.0	0.0	16.6	813.1	0.0	0.0
2	DEC	F	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2		N-End	2.9	9.2	18.0	0.0	0.0	15.1	735.8	0.0	0.0
2	JAN	Rugen	100.0	100.0	90.0	100.0	0.0	50.0	0.0	0.0	0.0
2		22-24	0.0	0.0	10.0	0.0	100.0	50.0	95.0	100.0	0.0
2	FEB	IIIa/NS	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	100.0
3		N-Start	28.3	1.8	0.0	7.5	7.5	0.0	0.0	699.0	36.8
3	MAR	F	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3		N-End	25.6	1.6	0.0	6.8	6.8	0.0	0.0	632.5	33.3
3	APR	Rugen	0.0	0.0	0.0	0.0	50.0	0.0	100.0	0.0	0.0
3		22-24	60.0	50.0	0.0	50.0	50.0	0.0	0.0	100.0	0.0
3	MAY	IIIa/NS	40.0	50.0	100.0	50.0	0.0	100.0	0.0	0.0	100.0
3		N-Start	0.0	16.2	11.1	3.4	6.8	3.4	0.0	632.5	33.3
3	JUN	F	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3		N-End	0.0	14.6	10.0	3.1	6.2	3.1	0.0	572.3	30.1
3	JUL	Rugen	0.0	0.0	0.0	50.0	0.0	0.0	100.0	0.0	0.0
3		22-24	0.0	50.0	0.0		50.0	0.0	0.0	100.0	50.0
3	AUG	IIIa/NS	100.0	50.0	100.0	50.0	50.0	100.0	0.0	0.0	50.0
3		N-Start	0.0	7.3	17.3	1.5	3.1	7.7	0.0	587.3	15.1
3	SEP	F	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3		N-End	0.0	6.6	15.7	1.4	2.8	7.0	0.0	531.4	13.6
3	OCT	Rugen	100.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0
3		22-24	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	NOV	IIIa/NS	0.0	80.0	100.0	100.0	100.0	100.0	0.0	0.0	0.0
3		N-Start	0.0	1.3	21.0	0.0	0.0	11.2	545.1	0.0	0.0
3	DEC	F	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3		N-End	0.0	1.2	19.0	0.0	0.0	10.1	493.2	0.0	0.0
3	JAN	Rugen	100.0	80.0	80.0	100.0	0.0	100.0	0.0	0.0	0.0
3		22-24	0.0	20.0	20.0	0.0	100.0	0.0	95.0	100.0	0.0
3	FEB	IIIa/NS	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	100.0
4		N-Start	16.2	4.0	0.0	10.1	0.0	0.0	0.0	468.5	24.7
4	MAR	F	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4		N-End	14.6	3.7	0.0	9.1	0.0	0.0	0.0	423.9	22.3
4	APR	Rugen	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
4		22-24	60.0	50.0	0.0	50.0	100.0	0.0	0.0	100.0	0.0
4	MAY	IIIa/NS	40.0	50.0	100.0	50.0	0.0	100.0	0.0	0.0	100.0
4		N-Start	0.0	10.6	7.7	0.0	4.6	4.6	0.0	423.9	22.3
4	JUN	F	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4		N-End	0.0	9.6	6.9	0.0	4.1	4.1	0.0	383.6	20.2
4	JUL	Rugen	0.0	0.0	0.0	10.0	0.0	0.0	100.0	0.0	0.0
4		22-24	0.0	50.0	0.0	20.0	20.0	0.0	0.0	100.0	0.0
4	AUG	IIIa/NS	100.0	50.0	100.0	70.0	80.0	100.0	0.0	0.0	100.0
4		N-Start	0.0	4.8	11.7	0.0	0.8	7.4	0.0	383.6	20.2
4	SEP	F	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4		N-End	0.0	4.3	10.6	0.0	0.7	6.7	0.0	347.1	18.3
4	OCT	Rugen	100.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0
4		22-24	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	NOV	IIIa/NS	0.0	0.0	100.0	100.0	100.0	100.0	0.0	0.0	0.0
4		N-Start	0.0	4.3	10.6	0.0	0.0	7.5	365.4	0.0	0.0
4	DEC	F	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
4		N-End	0.0	3.9	9.6	0.0	0.0	6.8	330.6	0.0	0.0
4	JAN	Rugen	100.0	80.0	80.0	100.0	0.0	100.0	0.0	0.0	0.0
4		22-24	0.0	20.0	20.0	0.0	100.0	0.0	95.0	100.0	0.0
4	FEB	IIIa/NS	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	100.0
5		N-Start	10.8	2.7	0.0	6.8	0.0	0.0	0.0	314.1	16.5
5	MAR	F	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5		N-End	9.8	2.4	0.0	6.1	0.0	0.0	0.0	284.2	15.0
5	APR	Rugen	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
5		22-24	60.0	50.0	0.0	60.0	100.0	0.0	0.0	100.0	0.0
5	MAY	IIIa/NS	40.0	50.0	100.0	40.0	0.0	100.0	0.0	0.0	100.0
5		N-Start	0.0	7.1	5.1	0.0	3.7	2.4	0.0	284.2	15.0
5	JUN	F	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5		N-End	0.0	6.4	4.7	0.0	3.3	2.2	0.0	257.1	13.5
5	JUL	Rugen	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
5		22-24	0.0	50.0	0.0	60.0	80.0	0.0	0.0	100.0	0.0
5	AUG	IIIa/NS	100.0	50.0	100.0	40.0	20.0	100.0	0.0	0.0	100.0

Table 3.9.1 (continued)

			Western Baltic Spring Spawners			Skagerak/Kattegat Spring Spawners			North Sea Autumn Spawners		
Age Gr	**Quarter**		**Rugen**	**22-24**	**IIIa/NS**	**Sp.Gr**	**22-24**	**IIIa/NS**	**Sp.Gr.**	**NS**	**IIIa/NS**
5		N-Start	0.0	3.2	7.9	0.0	2.7	2.9	0.0	257.1	13.5
5	**SEP**	**F**	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***
5		N-End	0.0	2.9	7.1	0.0	2.4	2.6	0.0	232.7	12.2
5	**OCT**	Rugen	100.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0
5		22-24	0.0	100.0	0.0		20.0	0.0	0.0	0.0	0.0
5	**NOV**	IIIa/NS	0.0	0.0	100.0	100.0	80.0	100.0	0.0	0.0	0.0
5		N-Start	0.0	2.9	7.1	0.0	0.5	4.5	244.9	0.0	0.0
5	**DEC**	**F**	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***
5		N-End	0.0	2.6	6.4	0.0	0.4	4.1	221.6	0.0	0.0
5	**JAN**	Rugen	100.0	80.0	80.0	100.0	0.0	100.0	0.0	0.0	0.0
5		22-24	0.0	20.0	20.0	0.0	100.0	0.0	95.0	100.0	0.0
5	**FEB**	IIIa/NS	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	100.0
6		N-Start	7.3	1.8	0.0	4.1	0.4	0.0	0.0	210.5	11.1

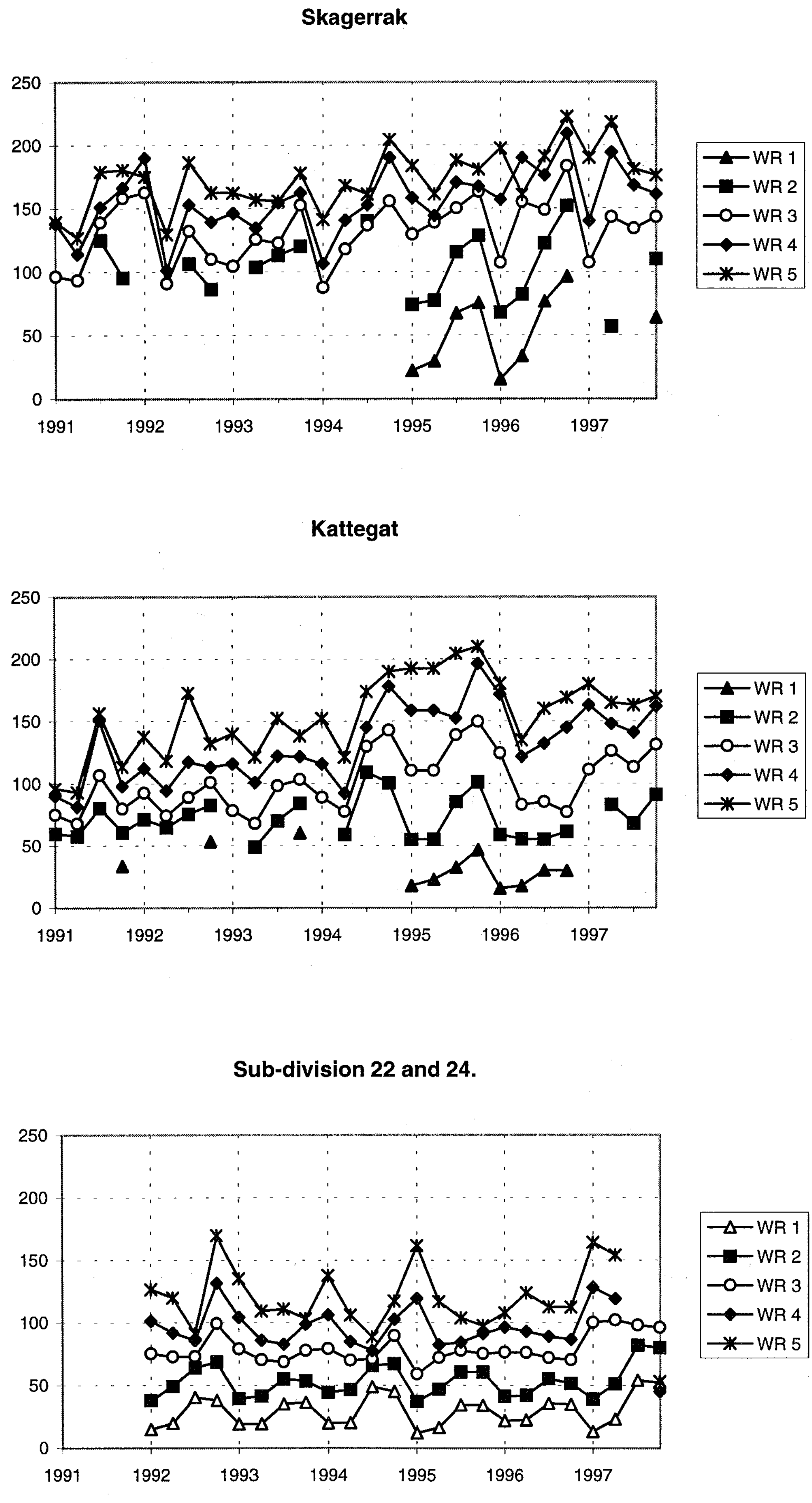

Figure 3.4.1 Mean weights at age (g) in the catches of Baltic spring spawning herring by quarter 1991-1997.

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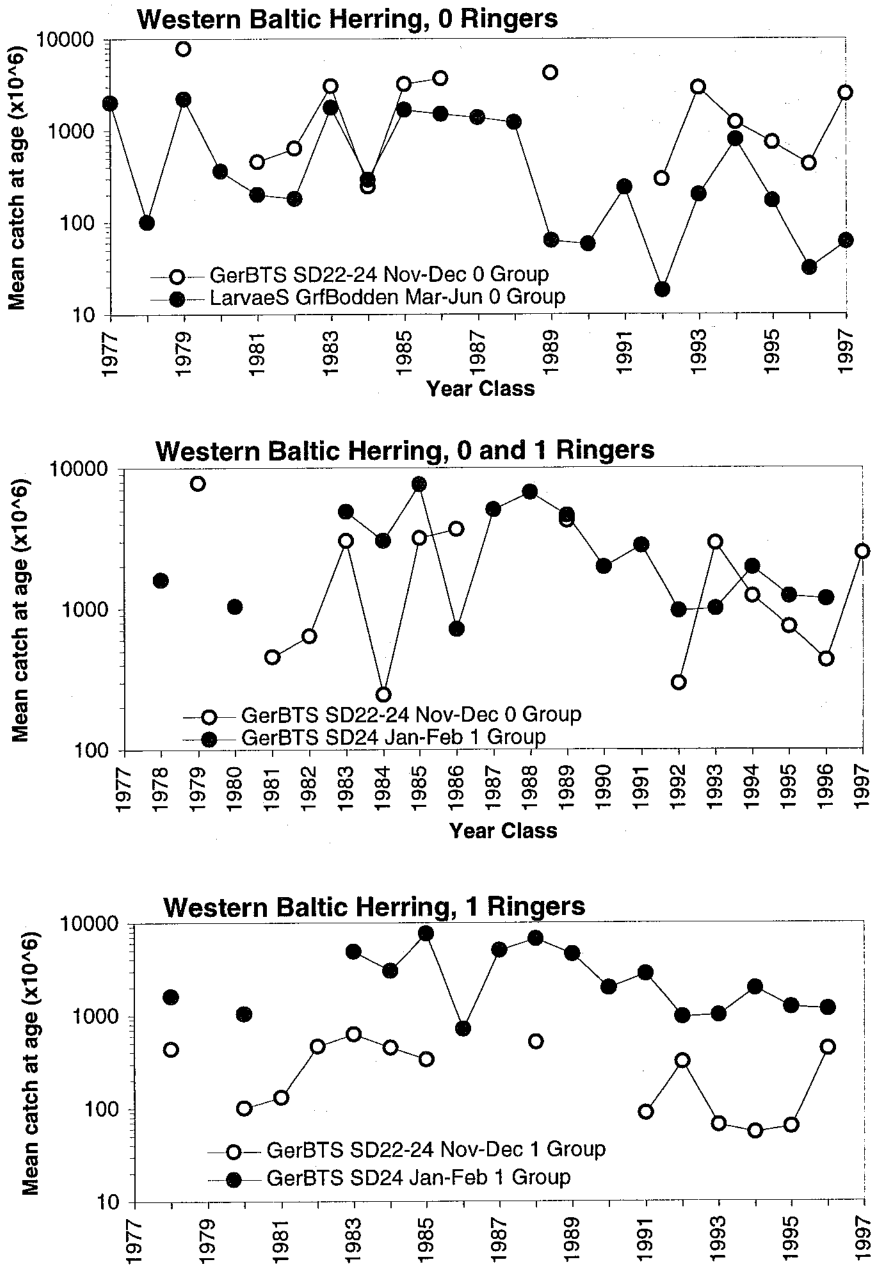


Figure 3.6.1 0- and 1- ringers of recruitment from larvae and trawl surveys

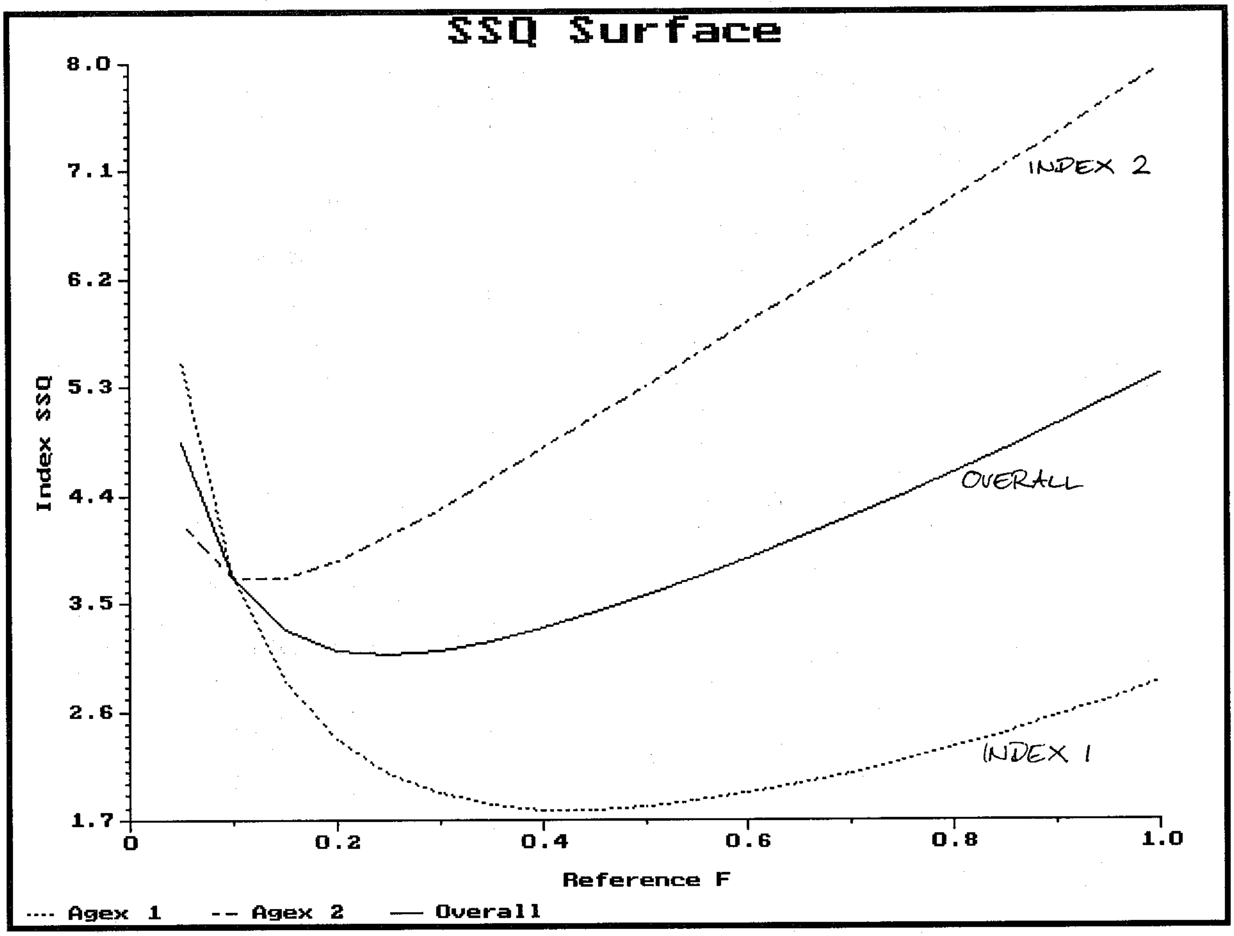


Figure 3.7.1 **Western Baltic Herring. Output from ICA:**
Index sum of squares of deviations between model and observations
(survey index) as a function of the reference F in 1997
INDEX 1: 1989-1997: Acoustic survey in Div. IIIa+IVaE, Age groups 2-8+.
INDEX 2: 1989-1997: Acoustic survey in Sub-Div. 22-24, Age groups 2-8+.

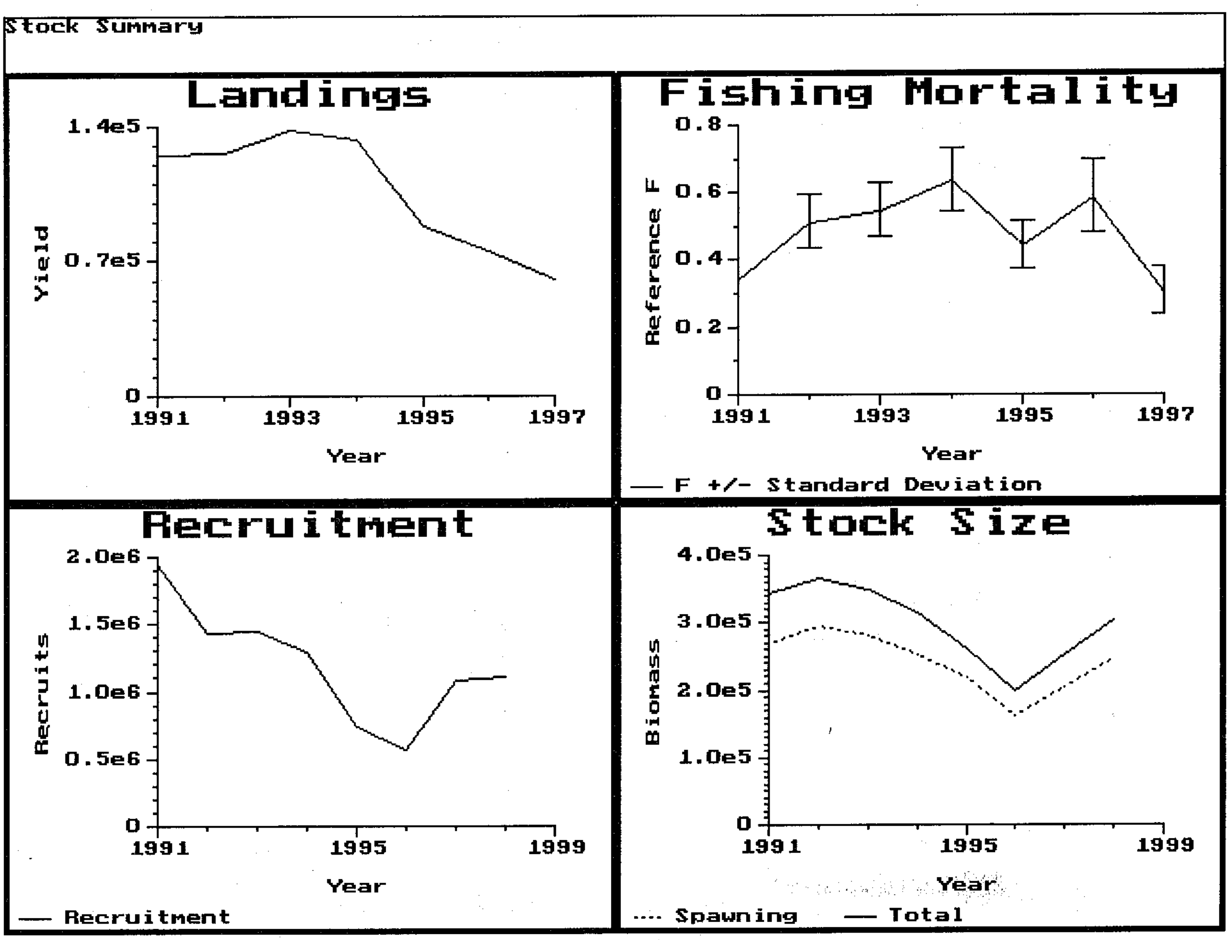


Figure 3.7.2 **Western Baltic Herring. Output from ICA: Stock Summary**

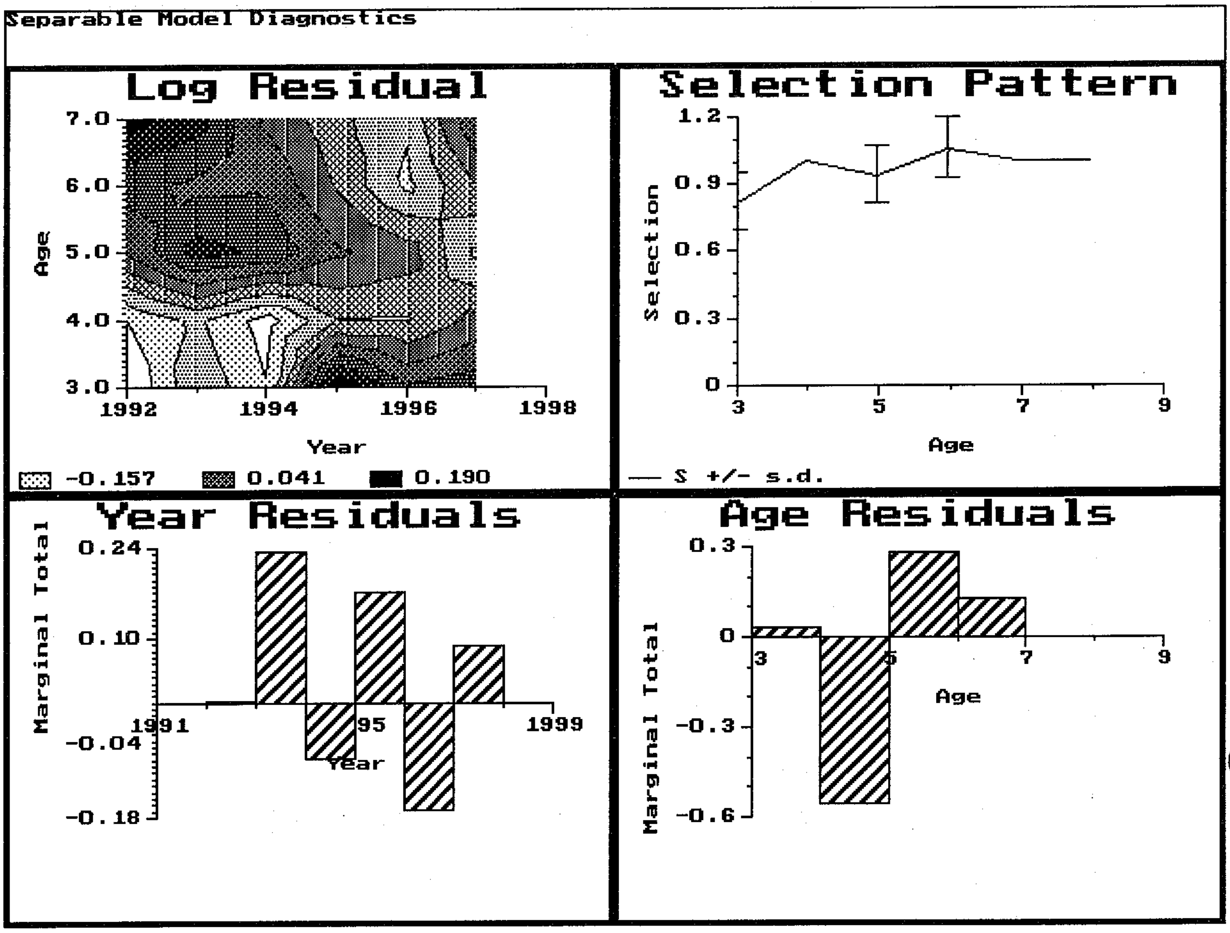


Figure 3.7.3 Western Baltic Herring. Output from ICA: Separable Model Diagnostics

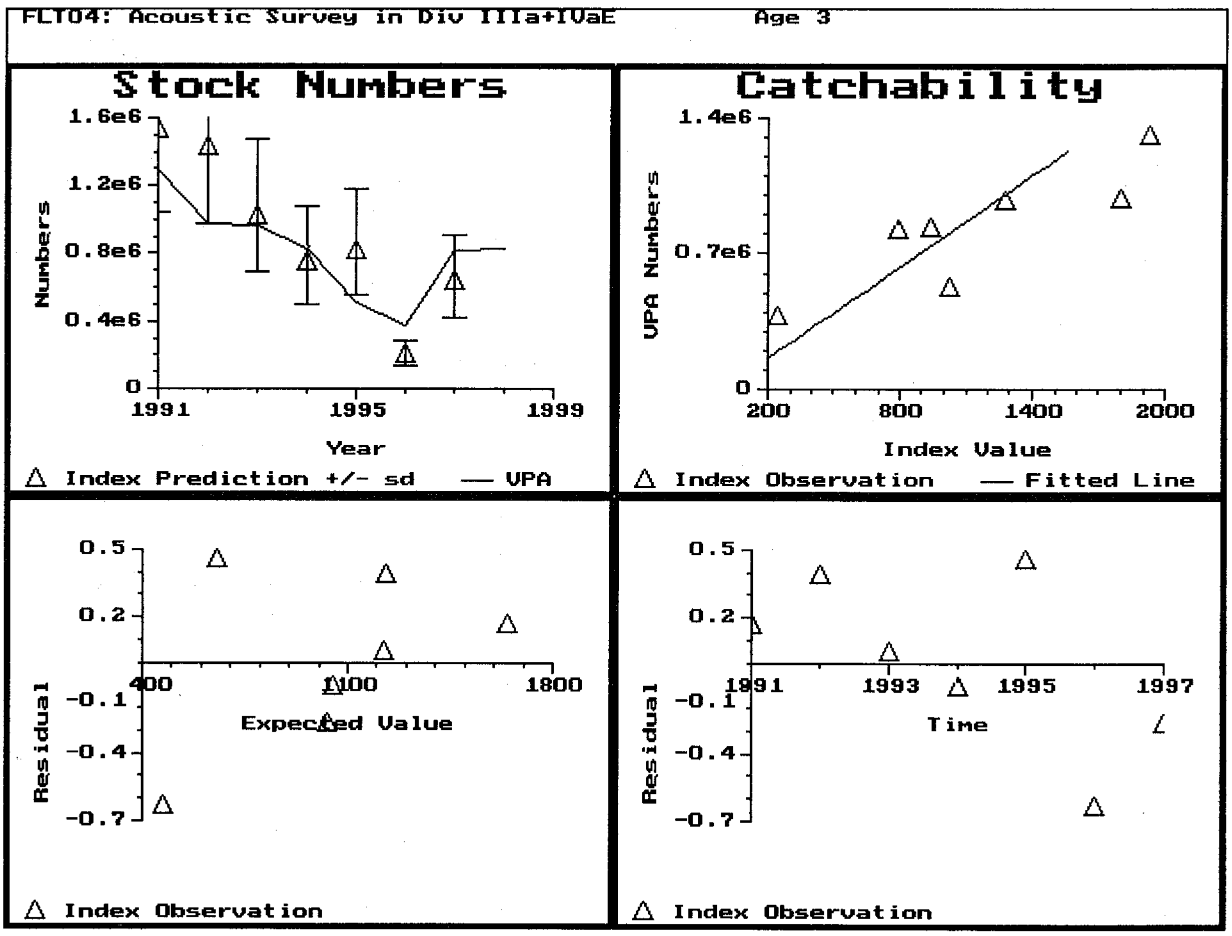


Figure 3.7.4a Western Baltic Herring. Output from ICA: Tuning Diagnostics.
Index 1: Acoustic Survey in Div IIIa and IVa East 1989-1997, Age Group 3

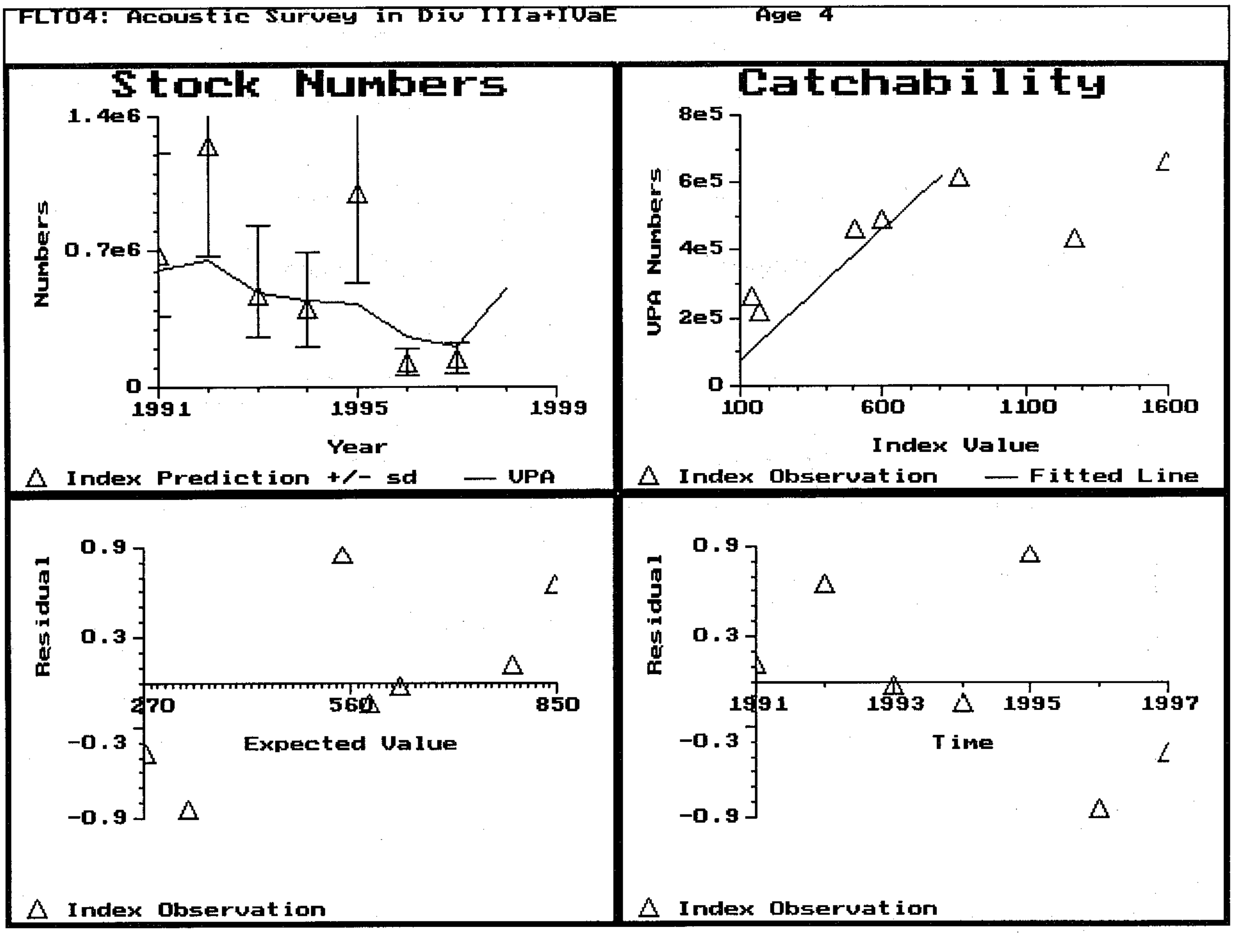


Figure 3.7.4b **Western Baltic Herring. Output from ICA: Tuning Diagnostics.**
Index 1: Acoustic Survey in Div IIIa and IVa East 1989-1997, Age Group 4

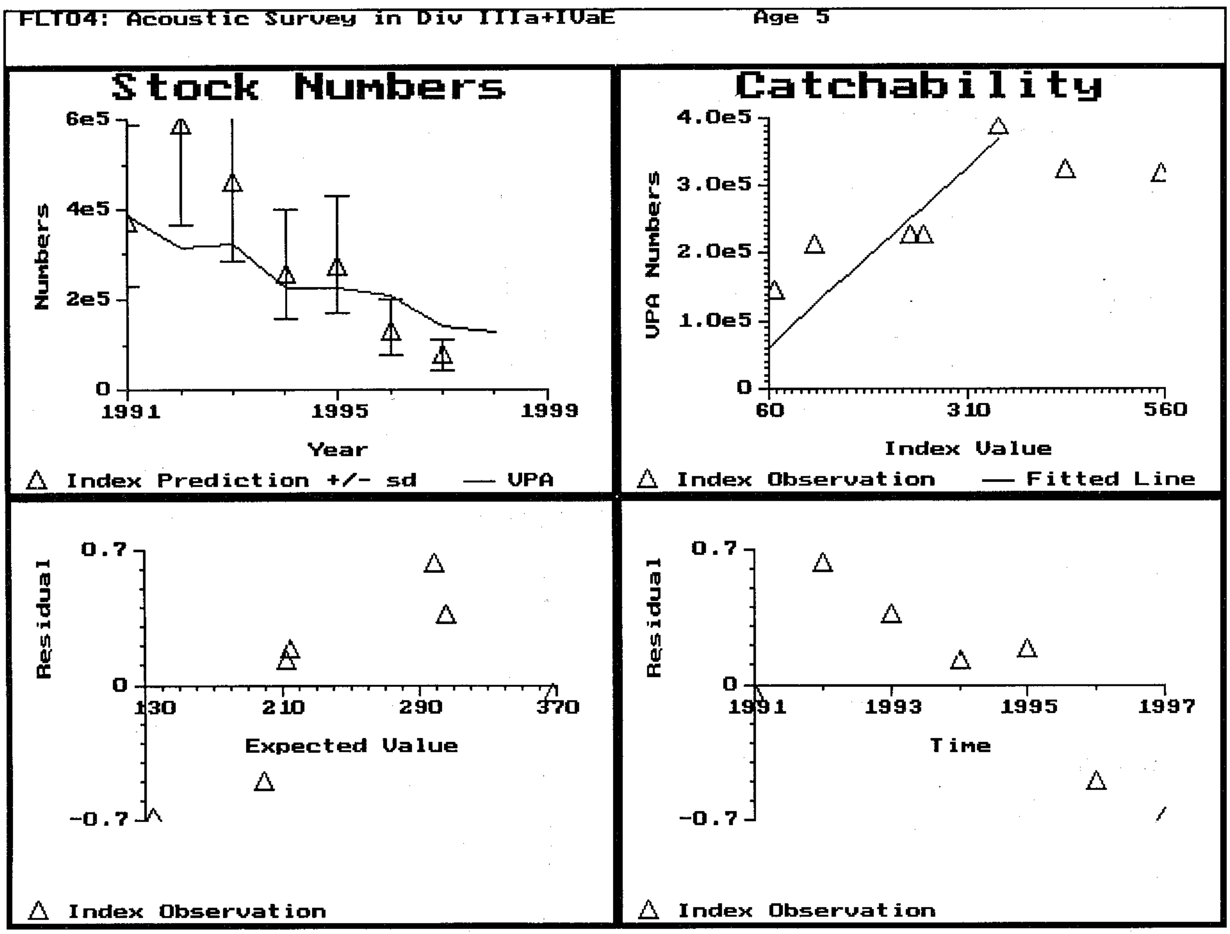


Figure 3.7.4c **Western Baltic Herring. Output from ICA: Tuning Diagnostics.**
Index 1: Acoustic Survey in Div IIIa and IVa East 1989-1997, Age Group 5

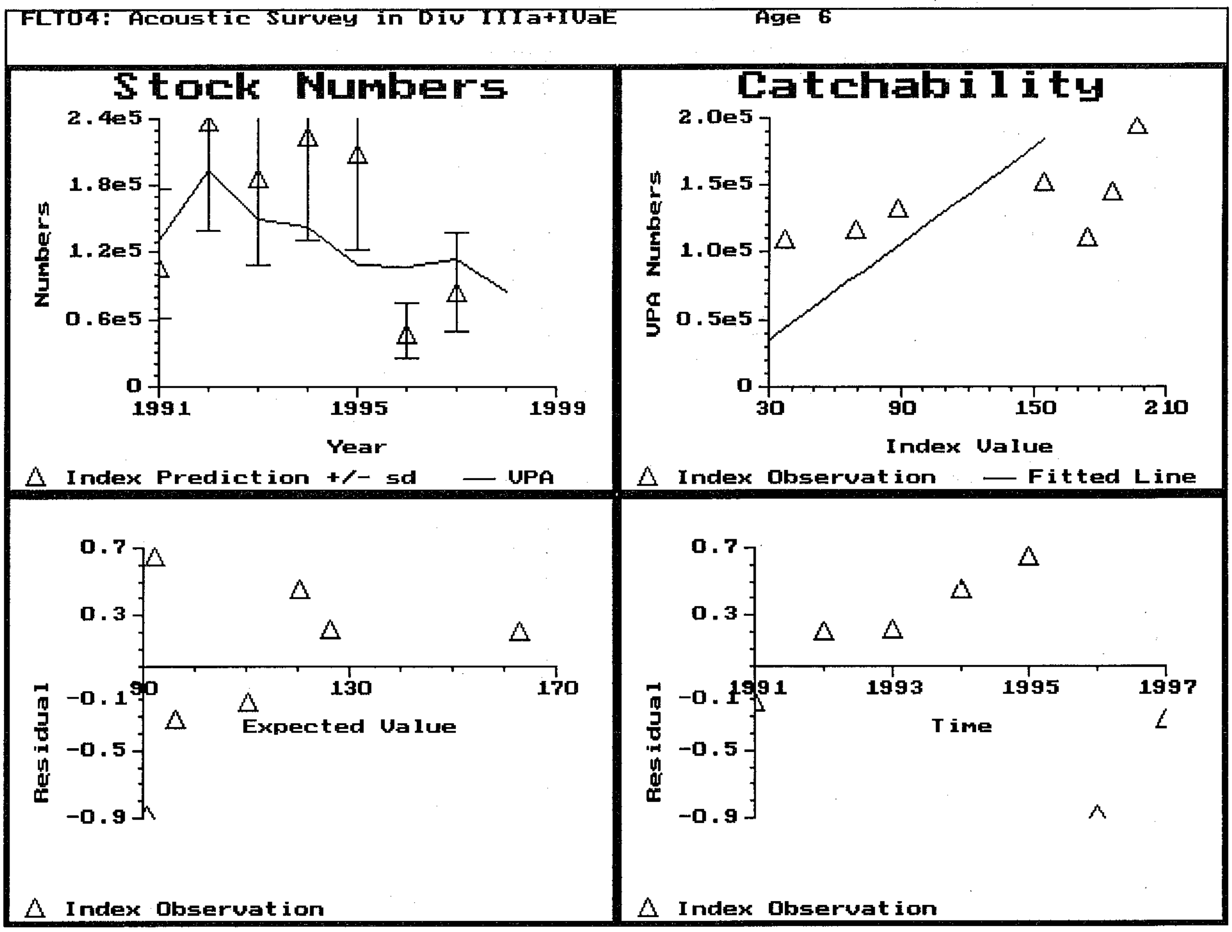


Figure 3.7.4d **Western Baltic Herring. Output from ICA: Tuning Diagnostics.**
Index 1: Acoustic Survey in Div IIIa and IVa East 1989-1997, Age Group 6

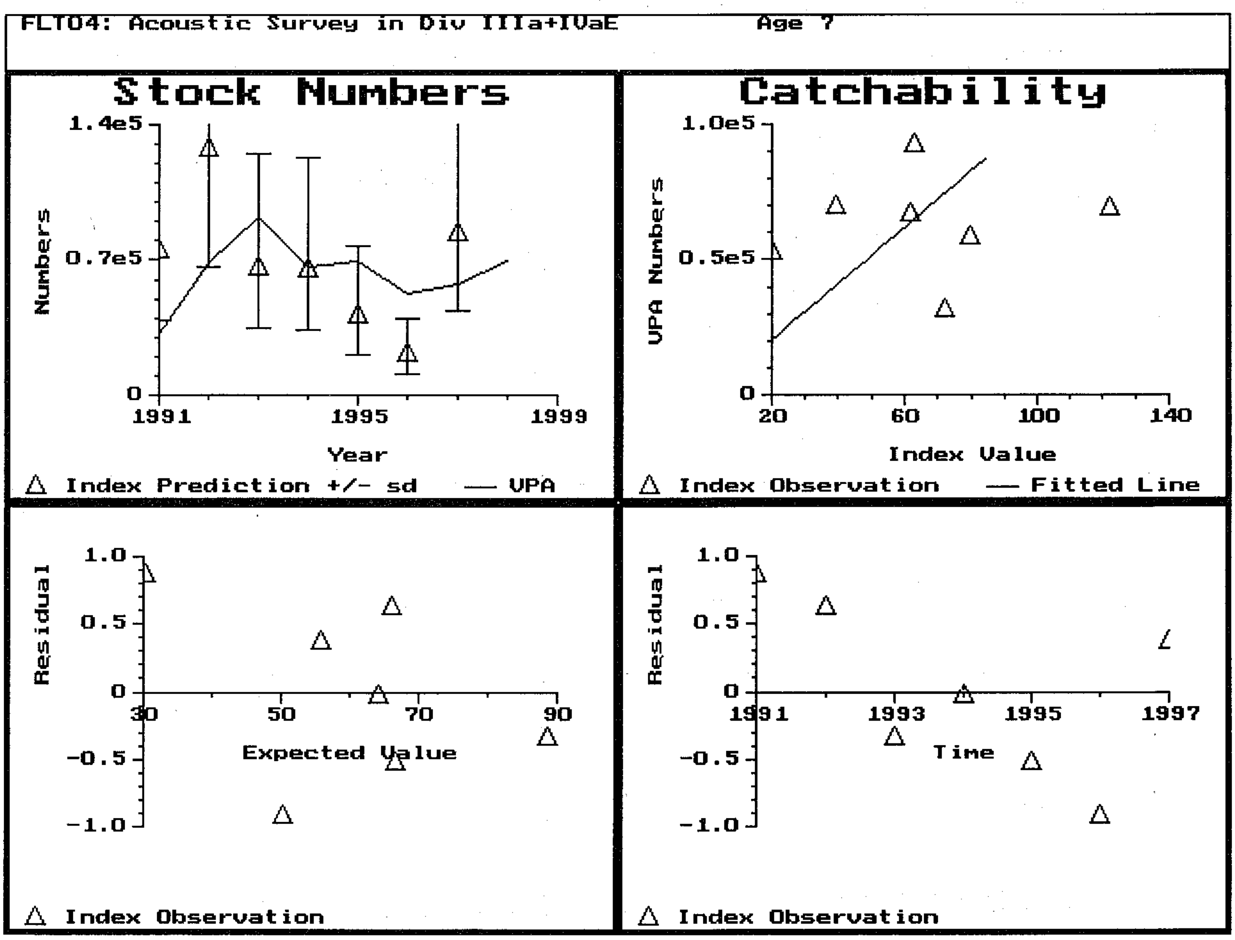


Figure 3.7.4e **Western Baltic Herring. Output from ICA: Tuning Diagnostics.**
Index 1: Acoustic Survey in Div IIIa and IVa East 1989-1997, Age Group 7

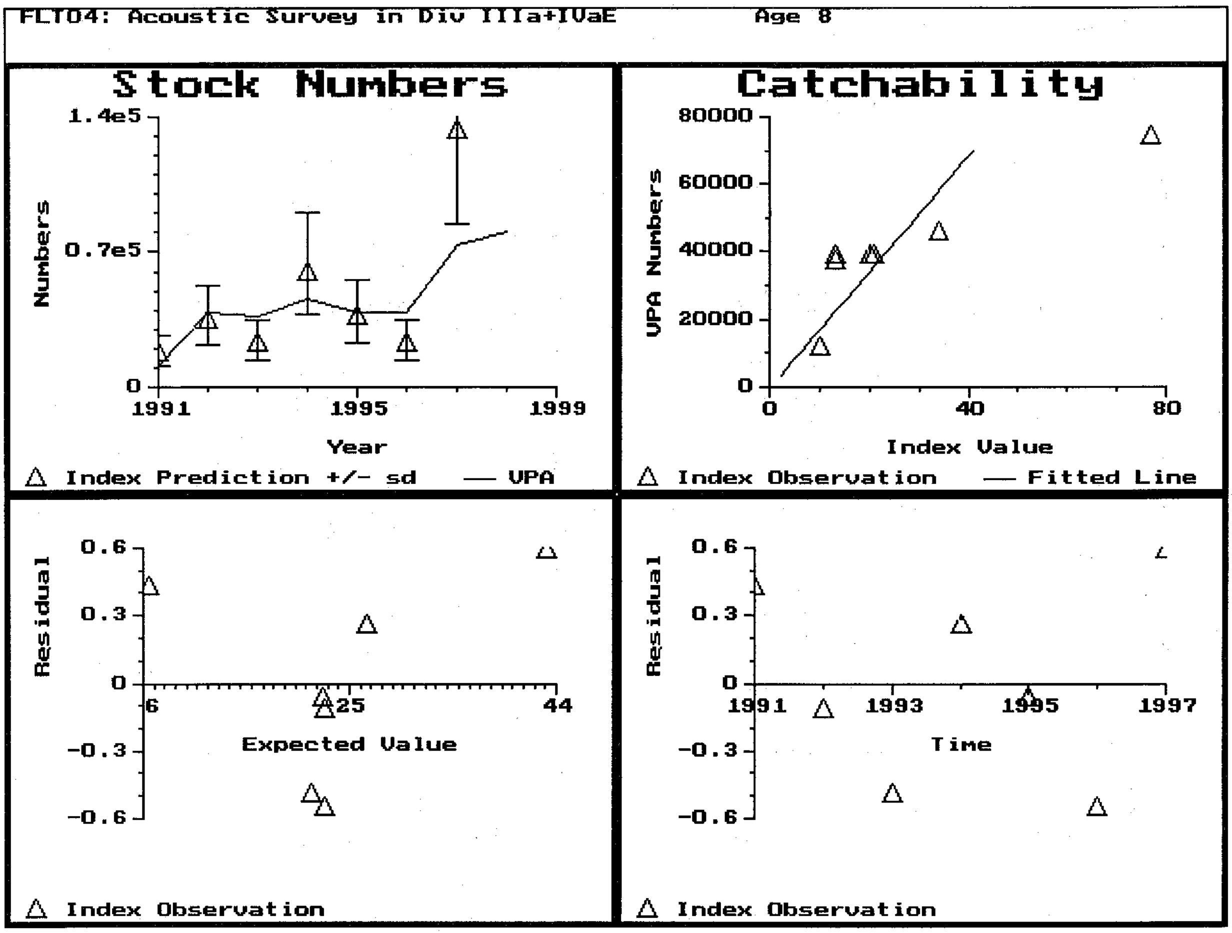


Figure 3.7.4f **Western Baltic Herring. Output from ICA: Tuning Diagnostics.**
Index 1: Acoustic Survey in Div IIIa and IVa East 1989-1997, Age Group 8+

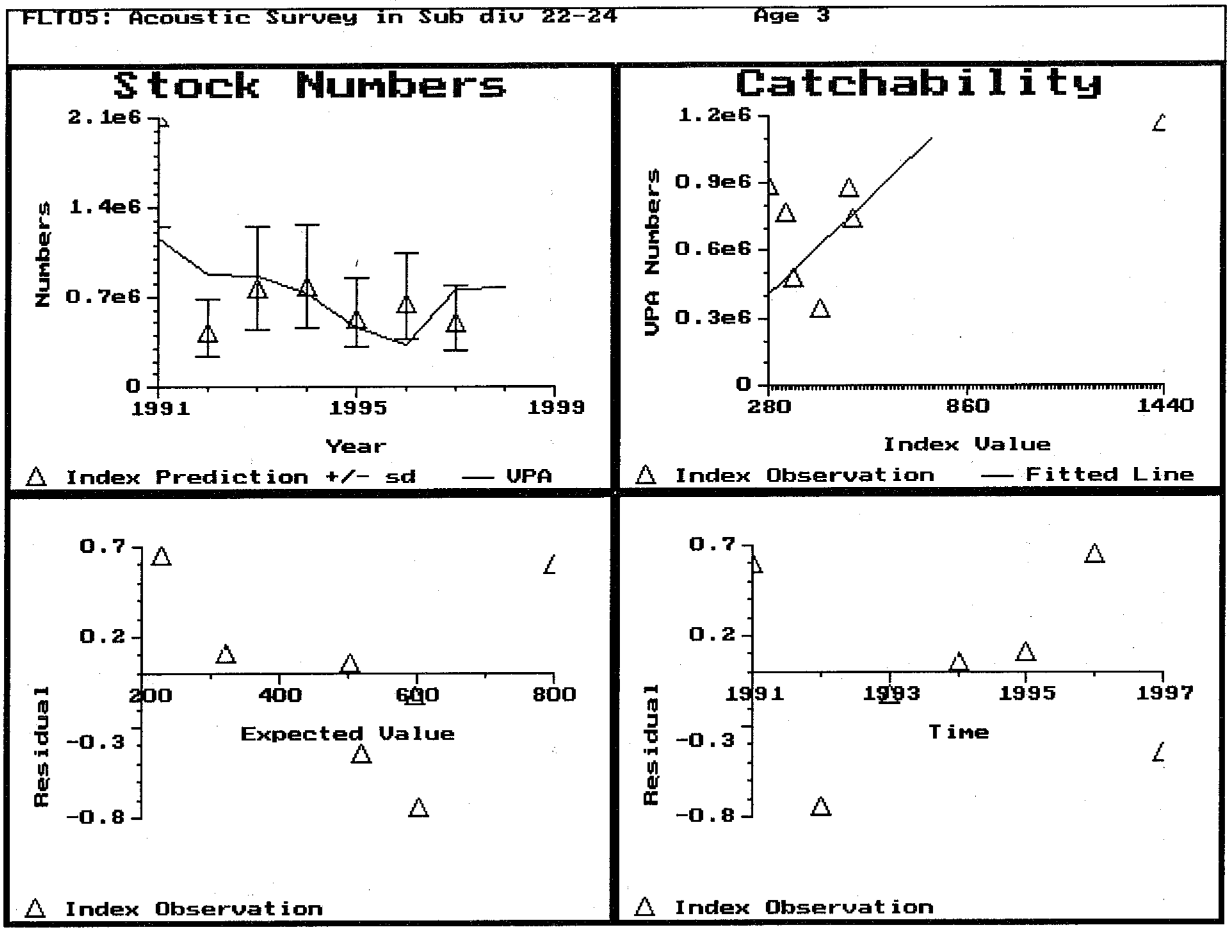


Figure 3.7.5a **Western Baltic Herring. Output from ICA: Tuning Diagnostics.**
Index 2: Acoustic Survey in Sub-Div 22-24 1989-1997, Age Group 3

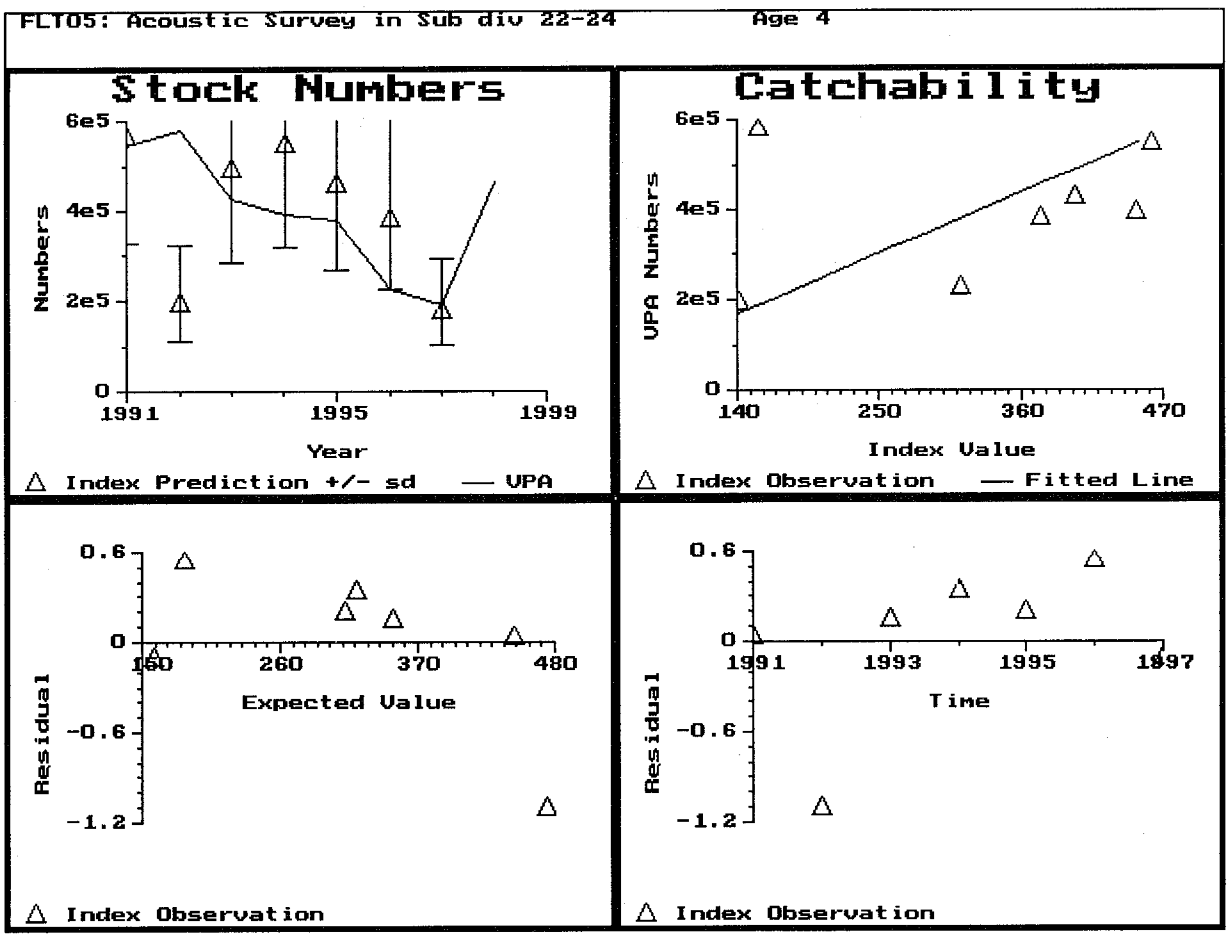


Figure 3.7.5b **Western Baltic Herring. Output from ICA: Tuning Diagnostics.**
Index 2: Acoustic Survey in Sub-Div 22-24 1989-1997, Age Group 4

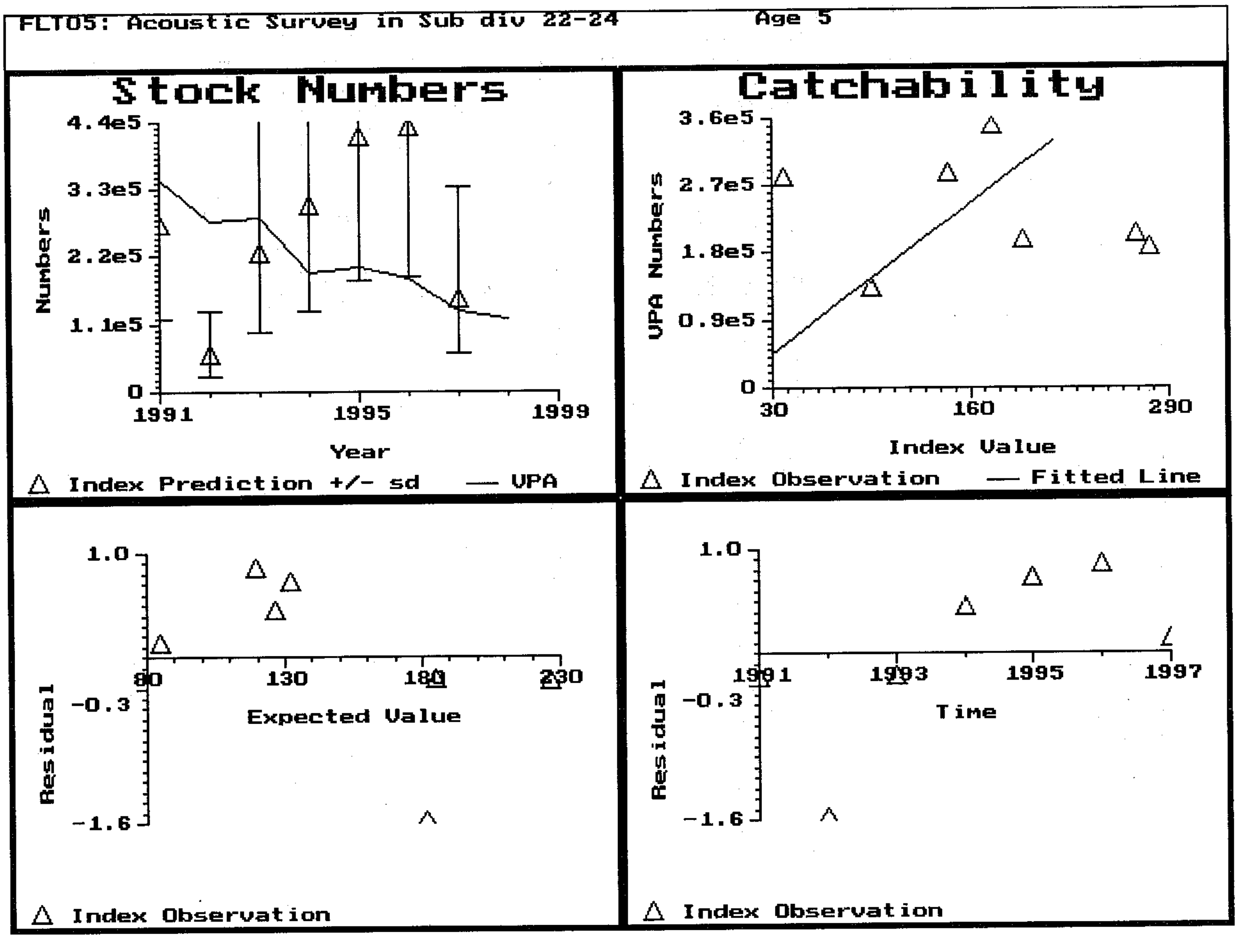


Figure 3.7.5c **Western Baltic Herring. Output from ICA: Tuning Diagnostics.**
Index 2: Acoustic Survey in Sub-Div 22-24 1989-1997, Age Group 5

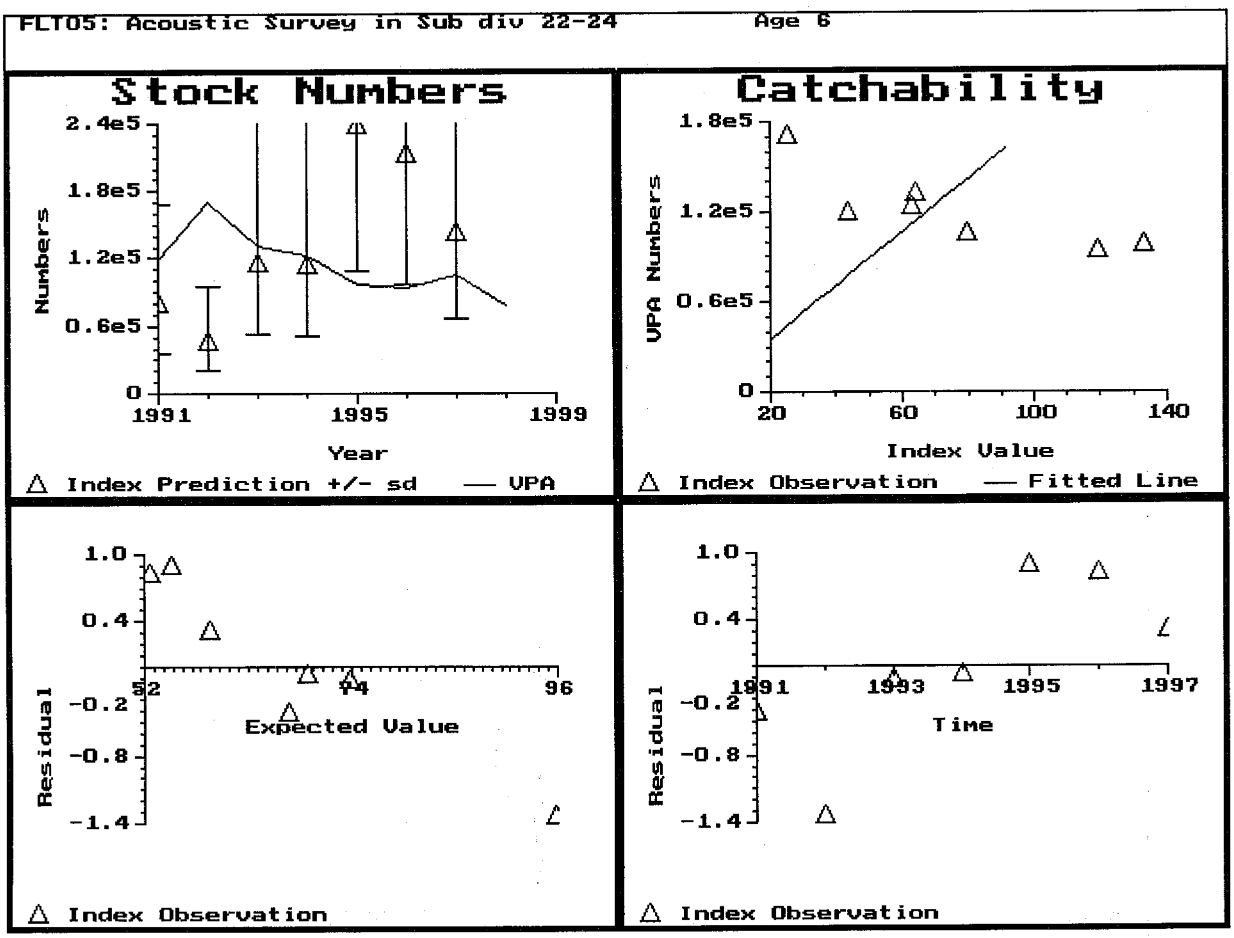


Figure 3.7.5d **Western Baltic Herring. Output from ICA: Tuning Diagnostics.**
Index 2: Acoustic Survey in Sub-Div 22-24 1989-1997, Age Group 6

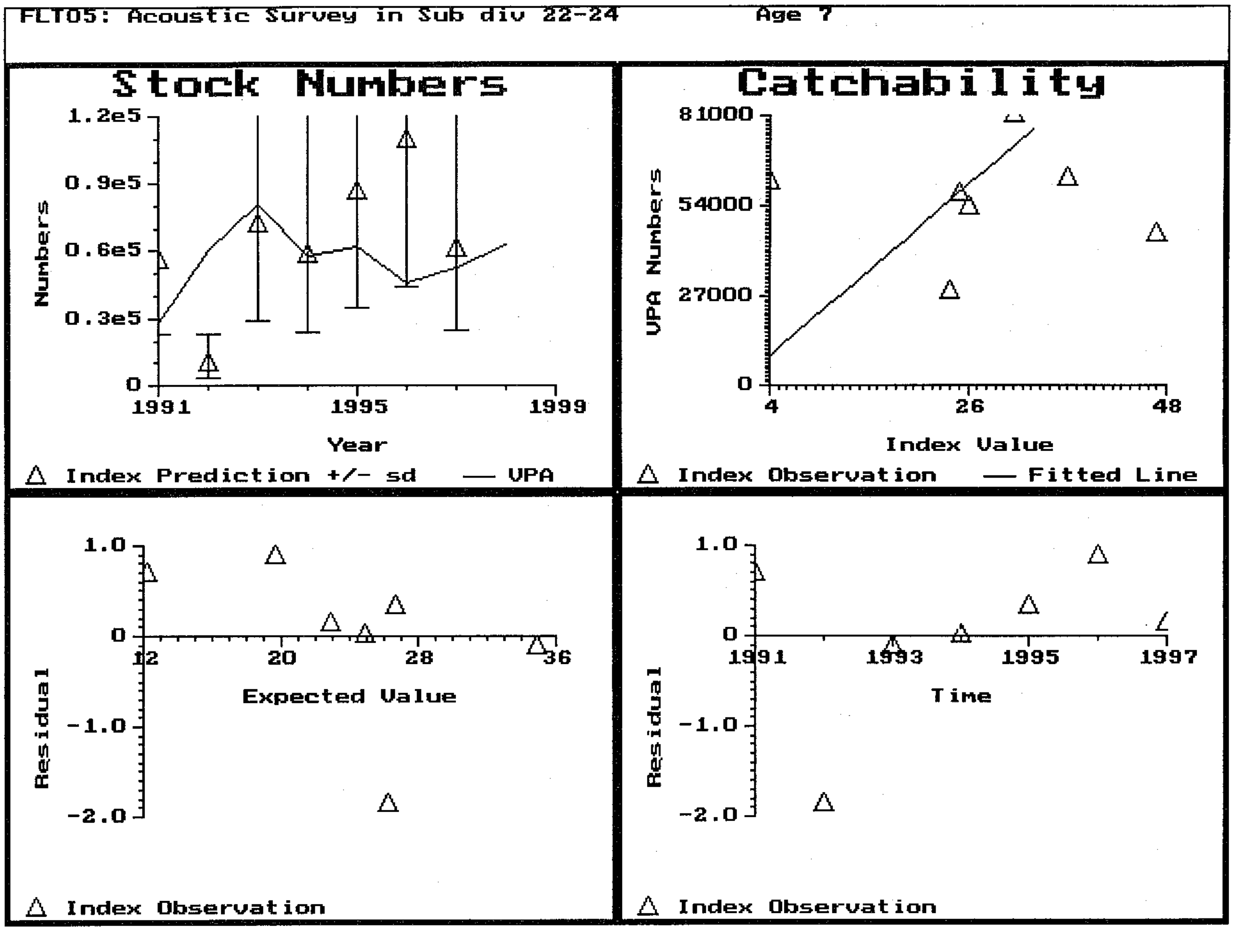


Figure 3.7.5e **Western Baltic Herring. Output from ICA: Tuning Diagnostics.**
Index 2: Acoustic Survey in Sub-Div 22-24 1989-1997, Age Group 7

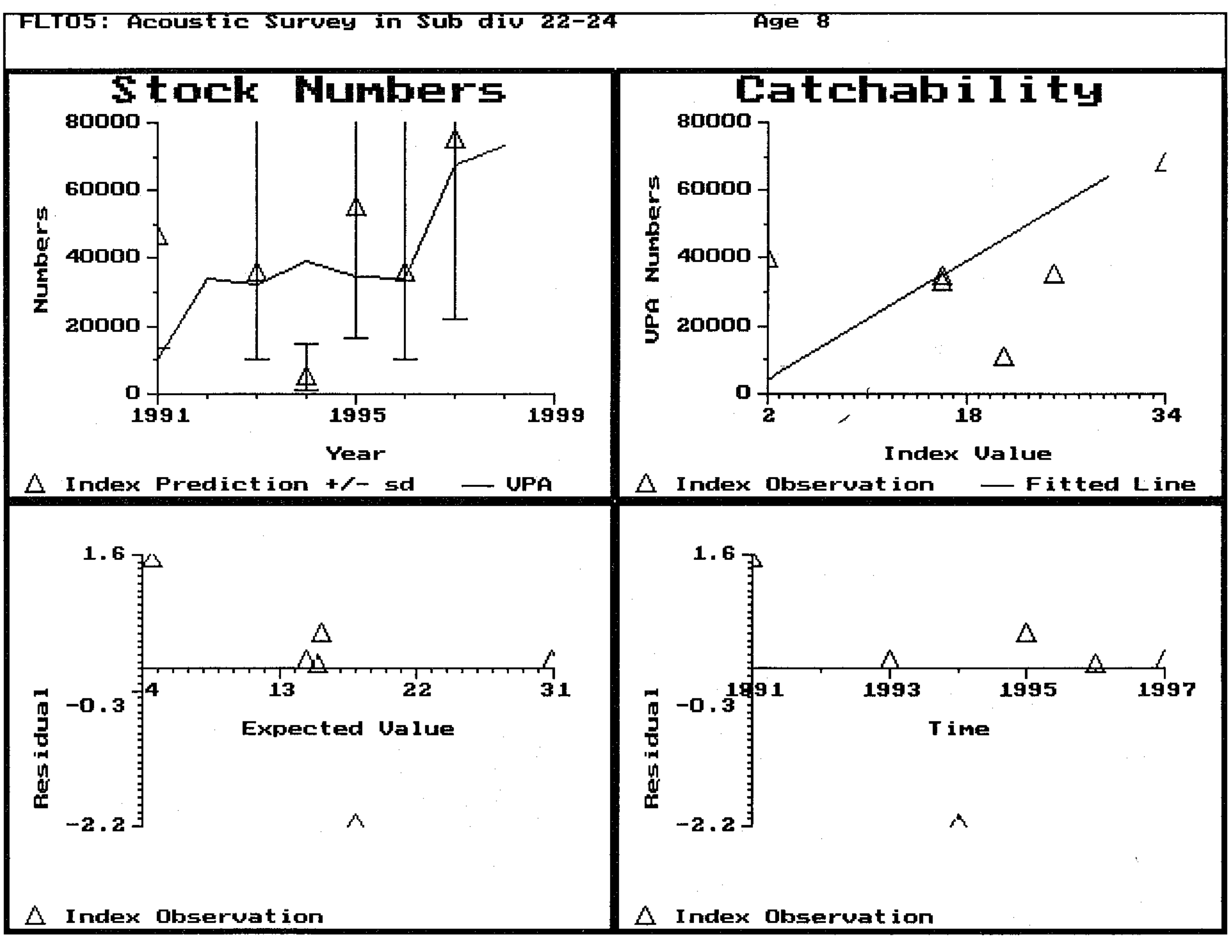


Figure 3.7.5f **Western Baltic Herring. Output from ICA: Tuning Diagnostics.**
Index 2: Acoustic Survey in Sub-Div 22-24 1989-1997, Age Group 8+

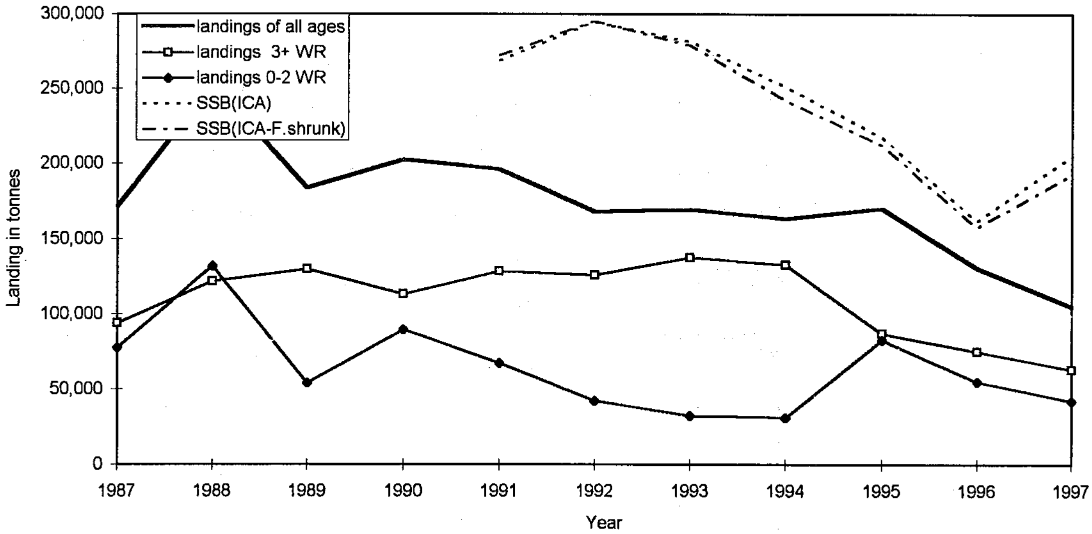
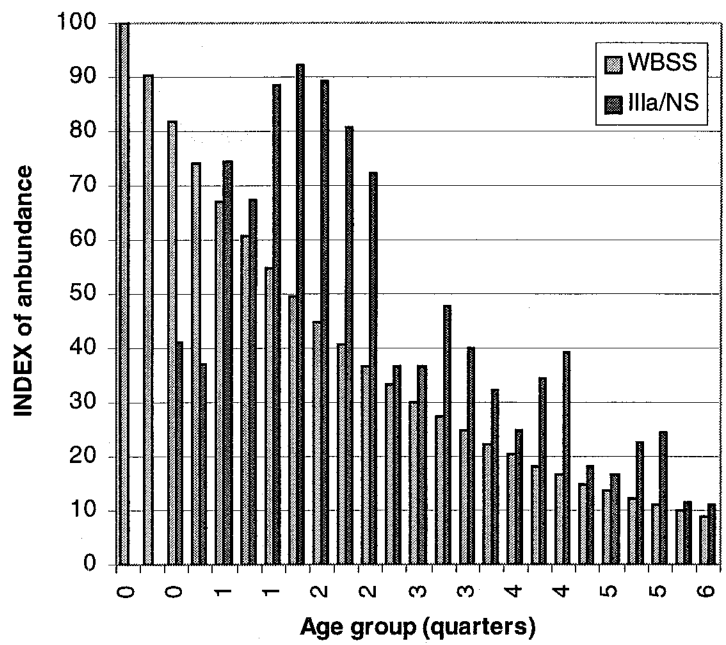


Figure 3.8.1: Trends in landings by age groups and estimates of SSB from the ICA with and without shrinkage



NUMBERS BY AGE IN AREA IIIa/NS

Age	Q1	Q2	Q3	Q4
0	0.0	0.0	81.9	74.1
1	67.0	60.7	27.4	12.4
2	5.6	2.5	1.1	10.2
3	9.3	23.0	10.4	1.3
4	4.0	15.2	5.6	4.3
5	2.7	10.8	5.9	3.4

NUMBERS BY AGE IN STOCK

Age	Q1	Q2	Q3	Q4
0	100.0	90.5	81.9	74.1
1	67.0	60.7	54.9	49.7
2	44.9	40.7	36.8	33.3
3	30.1	27.3	24.7	22.3
4	20.2	18.3	16.5	15.0
5	13.5	12.2	11.1	10.0

APPARENT Z AT AGE IN IIIa/NS

Age	Q1	Q2	Q3	Q4
0			1.09	1.79
1	2.48	3.17	3.17	0.20
2	-1	-2.20	-2.20	2.04
3	0.8	0.42	0.62	-1.19
4	0.4	0.34	-0.04	0.25
5				

TRUE Z AT AGE

Age	Q1	Q2	Q3	Q3
0	0.4	0.4	0.4	0.4
1	0.4	0.4	0.4	0.4
2	0.4	0.4	0.4	0.4
3	0.4	0.4	0.4	0.4
4	0.4	0.4	0.4	0.4
5				

Figure 3.9.1 Comparison of Western Baltic Spring Spawners to Herring in Div IIIa and the North Sea. Note that all results are hypothetical.