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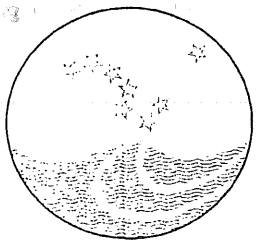

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HERRING

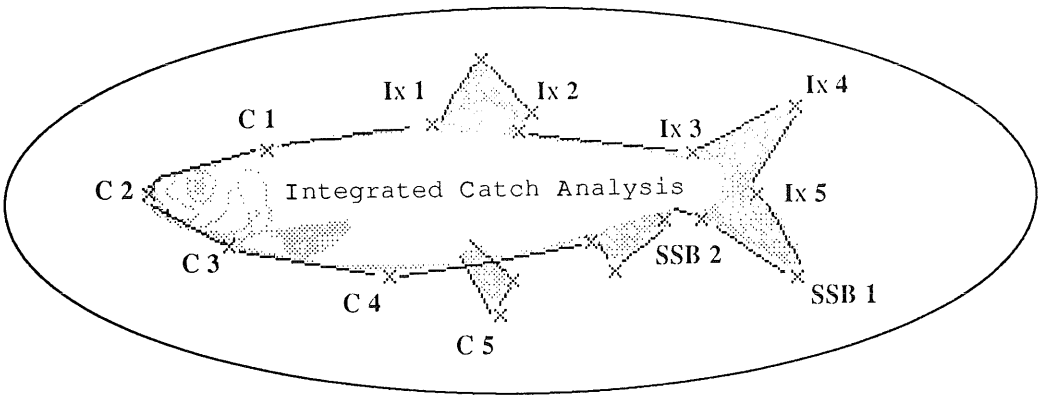
ASSESSMENT WORKING GROUP FOR THE AREA

SOUTH OF 62° N

COPENHAGEN,

21 -31 MARCH

1994



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1 INTRODUCTION

1.1 Participants

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1.2 Terms of Reference

The Working Group met at ICES Headquarters from 21-31 March 1994 with the following terms of reference (C.Res. 1993/2:6:6):

a) assess the status of and provide catch options (by fleet where possible) for 1995 and, where appropriate, 1996 within safe biological limits 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), the herring stocks in Division VIa and Sub-area VII and, in collaboration with appropriate members of the Working Group on the Assessment of Pelagic Stocks in the Baltic, the stock of spring-spawning herring in Division IIIa and Sub-divisions 22-24;

b) provide catch options by fleet for the fisheries in Division IIIa, the North Sea and Sub-division 22-24 that exploit the stocks of North Sea autumn-spawning herring and Sub-division 22-24 spring-spawning herring using consistent assumptions for both stocks;

c) assess the status of the sprat stocks in Sub-area IV and Division IIIa and VIId,e;

d) provide the data requested by the Multispecies Assessment Working Group (quarterly catches and mean weights at age in the catch and stock for 1993 by sub-divisions of the North Sea for species in the multispecies model that are assessed by this Working Group.

1.3 Evaluation of the ICA program

A computer program "Integrated Catch Analysis" (ICA) was presented to the Working Group (Patterson, WD 1994c). The ICA method is able to handle all types of data currently available to the Herring Working Group in an integrated manner and therefore potentially represents a more satisfactory method of analysis than the *ad hoc* method presently applied by the Herring Working Group. The standard XSA program was investigated at the Herring Working Group meeting in 1993 and was found inferior to the *ad hoc* method used by the Herring Working Group (Anon, 1993). The ICA software had been tested using simulation (Patterson, WD 1994b). The Working Group commissioned a subgroup to investigate the ICA program further.

A user manual has been prepared for the ICA program (Patterson, WD 1994a) and this manual together with a diskette containing the ICA-software was distributed to Working Group members before the meeting. This allowed the Working Group members to familiarize themselves with the methodology and software prior to the meeting. This new procedure for the introduction of software in ICES was very much appreciated by the Working Group.

The subgroup decided to make the following evaluations of the ICA program:

1. A theoretical examination of the theory applied in the ICA program with special reference to the established ICES XSA method.

2. Further simulations with the ICA program based on data with a level of contrasts in recruitment and in fishing mortalities typical of the North Sea herring.

3. An investigation of the influence of the relative weighting attached to the survey indices and catch-at-age data on estimated reference fishing mortality levels.

4. An XSA analysis on a restricted set of survey indices. This restriction was required since not all survey indices can be handled by XSA in its present form. These results should be compared with results from an ICA analysis made on the same data set.

5. A comparison of the results from the ICA program and the *ad hoc* method on North Sea herring data up to and including 1992.

The subgroup undertook these studies and its full report is given in Appendix 1. All results presented in Appendix 1 were made to study the performance of the ICA program and results should not be interpreted as an assessment of the North Sea herring stock.

The subgroup reported back to the Working Group which, after discussion, concluded that:

1. The ICA program proposed for application to ICES herring stocks is not a new conceptual model, but rather an application of well established theory. The ICA program represents another implementation of the suite of efforts that have already found wide acceptance in the Pacific and in the Northwest Atlantic. The ICES XSA program presents the same concept, but on a restricted set of types of tuning indices. Successful application of this methodology in assessment work has a history of about 10 years.

2. The ICA program appears to perform correctly and to produce reliable estimates for a data set similar to that available for the North Sea herring. The estimation procedure provides biased catchability estimates, which is probably due to correlations among the parameters. However, this bias seems to be limited to 10-15 % for realistic coefficients of variation in the survey indices. Furthermore, the estimated fishing mortalities and stock sizes do not seem to be influenced by this bias. The Working Group considered that this bias was acceptable but also recommends that work be done to clarify the source of this bias. Performance of the ICA program under process error, e.g. under deviation from the separability assumption of fishing mortalities, has not been tested.

3. Weighting of the data items against one another should be based on their standard deviation. However, these standard deviations are often not available, particularly for the catch-at-age. The weighting of the survey indices seems to have little influence on the estimated reference fishing mortality provided this weight is comparable to that of the catches, i.e. weight of surveys should be in the range 0.1 - 0.2. The Working Group recommends for the time being that all survey indices should be weighted equally and also equally to the catch-at-age data. For small weights ($<<$ 1) the ICA program essentially becomes a separable VPA. The Working Group requests that every effort be made to obtain estimates of the variances for both the catch data and the survey indices so that more realistic formulations of the estimation procedure can be utilized.

4. The assessment results obtained with XSA and separable VPA were compared with those obtained with the ICA program (Patterson, WD 1994b). The comparison suggests that Spawning Stock Biomass, Total biomass and recruitment estimates generated by the ICA program are intermediate between those generated by separable VPA and by XSA. This is as expected as the method provides population estimates that are a compromise between the best fits to the separable model and to the tuning index.

5. Comparing the estimates obtained in 1993 by the *ad hoc* method with those from a comparable run with the ICA program showed that the ICA-estimated stock sizes are somewhat lower than those estimated in the *ad hoc* method.

6. The ICA program does not generate a set of stock and fishing mortality estimates which will reproduce the catch-at-age exactly, like the VPA does. The Working Group did not feel the need for a VPA output. The estimates of stock in numbers and fishing mortalities may be used directly in the forecast procedure.

7. The ICA program includes the separability assumption on the fishing mortalities and the program should be used with caution and probably not at all in cases when the selection pattern is not constant over time.

1.4 Evaluation of Multispecies Assessment Working Group Report

In the latest report of the Multispecies Assessment Working Group (MSWG), new estimates are provided for natural mortality in the various age groups of herring over the period 1974-1992 (Anon., 1994a). These estimates are rather different from the ones that have been used by the Herring Assessment Working Group in recent years. The results from the MSWG indicate a lower natural mortality on 0- and 1-ringers, and a decreasing trend over time. The text table below compares the standard values used by the HAWG with the mean values over some recent periods, calculated from Table 4.8.1.F in the Multispecies Working Group Report.

Age (rings)	HAWG	MSWG 1978-1982	MSWG 1983-1987	MSWG 1988-1992
0	1.0	.55	.38	.36
1	1.0	.76	.61	.58
2	.30	.45	.40	.36
3	.20	.35	.31	.27
4	.10	.21	.20	.18
5	.10	.19	.15	.14
6	.10	.10	.10	.10
7	.10	.10	.10	.10
8	.10	.10	.10	.10
9	.10	.10	.10	.10

Two factors explain the lower estimates made by the MSWG. Firstly, the new analysis is based on the results of the stomach sampling in 1991. These stomach samples showed that juvenile herring made up a smaller proportion of the diet of its main predators than it did in the previous stomach sampling exercise (1981). The second factor responsible for the lower natural mortalities on juvenile herring is a decrease in predator abundance. This explains the decreasing trend over the last 15 years shown in the text table above.

The Working Group discussed whether the evidence provided by the MSWG was sufficiently strong to change the values of M presently used by the Working Group. The new estimates by the MSWG are by no means final. Some of the main predators on 0-ringed herring, such as western mackerel in the southern and central North Sea, have not been properly incorporated in the MSVPA. If the predation by mackerel on 0-ringed herring is likely to be underestimated by the MSWG, it may not be appropriate to change the current M value of 1.0 to the lower estimate provided by the MSWG.

The Working Group decided to postpone any changes in M until next year's meeting. In the meantime some of its members will make a new run of the MSVPA, using more extensive information on the presence of herring predators in the North Sea. In this respect it is important that stomach samples of horse mackerel collected in 1991 are analysed so that the contribution by horse mackerel to herring mortality may be quantified.

1.5 Evaluation of the effects of *Ichthyophonus*

Reports of substantial numbers of herring infected with *Ichthyophonus* caught in the northern North Sea, the Norwegian coast and the Division IIIa area were received in 1991. In response, information on the prevalence of infected fish in catches and in surveys has been gathered by Scotland, England, Norway, Denmark and Sweden. These sampling programmes were incomplete in 1991, but reasonably good information was reported for 1992 and 1993. Working documents were received from van Banning (pers. comm. 1994) (Netherlands), Skagen (WD 1994) (Norway) and information was also available from ICES-coordinated acoustic surveys in the North Sea for 1993 (Simmonds *et al.* WD 1994). Additional information from national sampling schemes was presented informally.

The available information shows that prevalence of the disease in the surveys has been declining since 1991. As the collation of this detailed information is the responsibility of another working group, it was decided to present only the salient points of the data collection exercise. Prevalences by age and year for the North Sea stock were extracted from the most complete reports and are given in Table 1.5.1. The calculation of infection rates is not comparable as the rates calculated by Skagen (WD 1994) are rates of infection in the samples; rates calculated by Simmonds *et al.* (WD, 1994) take into account the spatial distribution of the biomass to weight the samples. These rates should therefore better represent the prevalence of the disease in the population. A recalculation of infection rates from Norwegian data on a spatially-weighted basis showed results similar to those presented by Simmonds. Substantial information was made available on sampling of commercial catches for *Ichthyophonus* in 1993 from both the North Sea and the Division IIIa areas. Results of Swedish sampling of catches are given in Table 1.5.2, which also show a marked decrease in the prevalence of the disease from 1992 to 1993.

For both the North Sea and the Division IIIa areas, it was decided that the time-series of available information was too short for analysis at present.

Estimates of the possible consequences of *Ichthyophonus*-induced mortality in Division IIIa and the North Sea were made assuming that the disease is in equilibrium in the stock (Hagström and Patterson, WD 1993). A variety of scenarios were tested. Worst-case reductions in stock size were up to 20% lower in the North Sea and up to 18% lower in Division IIIa and the South-western Baltic. Projected *status quo F* catches were up to 19% lower in the North Sea and up to 26% lower in Division IIIa and the Western Baltic. However, depending on the values assumed for various parameters of the dynamics of the disease that are poorly known, the impact of the disease could be calculated as reducing the stock and catches by typically 5 to 10%.

A dynamic time-series model for estimating the impact of the disease (Patterson, WD 1994d) was available and tested using preliminary data. The trial runs showed a high sensitivity to information available about the dynamics of the disease in 1991 (the peak of the infection). The model indicated that allowing for a large disease-induced mortality in 1991 results in a perception of stock abundance in 1993 that is around 30% lower than would be estimated if the disease were ignored (Figure 1.5.1). This much reduced stock size estimate was robust to either (1) the use of Norwegian prevalence data for 1991, or (2) assigning observed infected population sizes in 1991 to a missing value. In contrast, attempting to fit the rather low prevalences observed since 1992 made only a very small change to population sizes. It was concluded from this very preliminary analysis that the stock may have suffered considerable mortality from the disease in 1991. However, there are few data available on infection rates in this year, and no information on disease-induced mortality in the years beforehand. Furthermore, the analysis suggested that the present low levels of infection rate are rather unimportant for stock dynamics. This view of a high mortality occurring in

1991 is reinforced by examination of the residual patterns in the VPA tuning indices. Both acoustic and IYFS indices show a pattern of high residuals for 1990 and low values in 1992, suggesting that a larger change in stock size occurred in this interval than is accounted for by the natural and fishing mortalities that are estimated in the VPA. As the critical data for the estimation of the stock reduction due to the disease are the historical data for 1990 and 1991, it is unlikely that much more information can be gained about the outbreak. Further modelling studies are, however, encouraged in order to gain a coherent view of the dynamics of the stock and disease in relation to available data, and to test the sensitivities of the assessments to assumptions about disease dynamics.

In conclusion, there is no evidence from presently available information that *Ichthyophonus*-induced herring mortality is significant at present, although there are substantial indications that high mortalities occurred in 1991.

1.6 Evaluation of Draft Report of the Workshop on Herring Age Reading

A workshop on herring age reading was held in IJmuiden from 20-24 January 1994(Anon. WD, 1994). The workshop reviewed methodologies used in age determination of herring, and considered the results of a number of comparative age reading exercises. Overall agreement between 15 age readers varied from 63% to 72%. The main causes of discrepancies were:

- Problems in identifying the new summer growth zone in early summer. This problem occurs particularly in 2- and 3-ringed fish, which lay down the new growth zone earlier than the older fish. The time of formation of the new growth zone is also dependent upon the area, and may change from one year to another.

- Problems in identifying herring as spring- or autumn spawners. This leads to errors in the selection of the first winter ring.

- Readers were asked to record the full age of older fish. Agreement was shown to drop for herring of more than 8 rings. In the assessment, these fish are combined into a plus-group, so these errors will not affect the assessment.

- Readers were asked to read all otoliths in the samples, including bad ones. In most laboratories, otoliths that are hard to read are normally discarded and replaced by otolith from other fish in the same length class.

Although there were reasons to assume that the agreement achieved during routine sampling at national laboratories will be higher than that found during the workshop, it was considered advisable that the workshop should have a follow up in the form of regional otolith exchange programmes at least every 2 years. The ICES Herring Assessment Working Group should take the initiative for such exchange programmes, and appoint a coordinator.

Classification of herring into spring and autumn spawners depends largely on the maturity stage of the fish. The Workshop therefore advised the use of the 8-stage Hjort maturity scale, rather than the simplified 4-stage maturity scale that has been proposed recently by the International Bottom Trawl Survey Working Group.

1.7 Report of the Study Group on Herring Assessment and Biology in the Irish Sea and Adjacent Areas

The Study Group met in Belfast (Northern Ireland) from 21 - 25 February 1994 and the report is cited as Anon. (1994b). The terms of reference are summarised as: a) Investigate the stock structure of herring in the management units in the Irish Sea and adjacent areas (Divisions VIIa(N), Celtic Sea + VIIj, VIa(S) + VIIb, Clyde and VIa(N)), b) revise existing databases for analysis purposes if found necessary, c) examine all available survey data with a view to obtaining recruitment indices and d) suggest plans of research to improve the present assessments.

The Study Group produced a comprehensive report covering all available biological information for herring on the west side of the British Isles and Ireland. The report documents the historical development of the herring management units in the area including when and where TACs and closed areas were first implemented. The various spawning grounds are indicated along with the present knowledge of the larval drift patterns (which are in most cases to the north of the spawning grounds and very often into adjacent management units). Locations of nursery grounds (again very often in adjacent management units) and the adult migrations are also indicated. Concern was raised about the lack of information in relation to adult migrations as it became clear that very often migration paths are unknown for at least part of the year. There is therefore the possibility that catches in a management area may include individuals from another management area (this is possibly especially true for the Division VIIa(N) spawning stock). The available data suggest that there is a reasonable degree of discreteness of the individual spawning stocks and that it is possible to separate them using a variety of methods. The report also documents the relevant biological parameters including long-term changes in mean

weight, vertebral counts and the maturity ogives and natural mortalities used in these stocks.

The section on scientific assessment of the stocks reviews the methods and results, the quality of the landings and biological data and larval, groundfish and acoustic surveys for all areas. The only stock in the area with an adequate time-series of abundance estimates from research vessel surveys is Division VIa(N). In the most recent years analytical assessments have not been undertaken for any of the other stocks. Questions were raised about the quality of the catch statistics in the southern areas (VIIa(N), Celtic Sea + VIIj and VIa(S) + VIIb) but any inconsistencies could not be corrected. Therefore there are periods in which the catch data are suspect. Biological sampling is generally good in all areas but there is room for improvement in VIIa(N). The larval indices in VIIa(N) are a new series and they will not become useful for a few more years. The larval indices in the Celtic Sea + VIIj and VIa(S) + VIIb are now of historical interest only. Data from bottom trawl surveys for the purposes of estimating recruitment are reported. However, they have not been used for a variety of reasons including high variances, potential mixing of stocks and variations in catchability between survey vessels. Acoustic surveys have been undertaken in all areas except VIa(S) + VIIb. The results are variable in VIIa(N) with large differences between spawning ground estimates on the Manx spawning ground and whole area coverage. The Celtic Sea surveys now have a time series of 4 years and could be used for tuning purposes. Division VIa(N) has the best series of acoustic surveys yet there is still only a time-series dating from 1987 (4 surveys to 1994).

The Study Group also considered the appropriateness of the current management units. The main points were the possibility of adult and juvenile fish being caught in adjacent management units. Unfortunately, the extent of this is unknown. The other major issue was the boundary between VIIj and VIIb. The group considered that a change in this boundary to the south would alleviate some of the problems associated with misreported catches and create a new assessment area more appropriate to the known distribution of the stock. The Study Group suggested a variety of research programmes to resolve some of the problems associated with the quality of the assessments.

The Study Group suggested that tagging studies should be initiated to resolve the distribution of adults when away from their spawning grounds (especially Division VIIa(N) fish). Tagging studies would also resolve the extent (also on an interannual basis) of 1- and 2-ringers from the Celtic Sea in Division VIIa(N). The Study Group also suggested that biological parameters, e.g. maturity ogives, be re-examined and updated. The Study Group was concerned that there was not a comprehensive co-ordinated approach to surveys in all areas and that in future meetings should be held to ensure that the most effective surveys were being undertaken. Similarly, these meetings would provide a forum for discussion of problems relating to research and objectives.

2 NORTH SEA HERRING

2.1 The Fishery

2.1.1 ACFM advice and management applicable to 1993 and 1994

1993

The 1992 ACFM meeting presented a small number of scenarios of catch options for the five different fleets exploiting North Sea herring (see Section 2.8) but no formal TAC advice was given. It was pointed out that "In the long-term a relatively low fishing mortality would tend to stabilise catches and any increases in F beyond 0.3 will not result in any long-term increases in yield".

For the southern North Sea and Channel (Downs herring) it was stated that a catch of 50,000 t in 1993 might allow the stock to remain at an acceptable level but any rebuilding of the stock towards historic levels would require a lower catch level. The geographical restriction of the spawning was stressed as a likely indication of high susceptibility of this stock to environmental conditions.

The TACs adopted by the management bodies for 1993 were the same as those set for 1992; Division IVa,b: 380,000 t; Divisions IVc and VIId: 50,000 t.

1994

Again at the 1993 ACFM meeting report there were presented a small number of scenarios of catch options for the five different fleets exploiting North Sea herring but no formal TAC advice was given. It was stated that the SSB has been fairly stable, fluctuating between 1.0-1.8 million t. The stock was therefore considered to be within safe biological limits. Yield-per-recruit calculations based on the present exploitation pattern indicate that there are no long-term gains when fishing mortality is in excess of 0.3.

ACFM also reiterated that catches of juveniles, both in the North Sea and Division IIIa, substantially reduce the long-term yield of adult herring and the spawning biomass.

For the southern North Sea and Channel (Downs herring) it was stated that a catch in 1994 at the same level

as the TAC for 1993 (50,000 t) is expected to allow the stock to remain at a fairly stable level.

The TACs adopted by the management bodies for 1994 are: Divisions IVa,b: 390,000 t; Divisions IVc and VIId: 50,000 t.

2.1.2 Catches in 1993

Total landings in 1993 are given in Table 2.1.1 for the total North Sea and for each division in Tables 2.1.2 to 2.1.5.

The total catch in 1993 of 524,000 t is close to the catches in the three previous years, and lower than in the years 1987-1989 (674,000 t on average). The 1993 catch exceeded the TAC by 94,000 t (and by 147,000 t in 1991 and 143,000 t in 1992).

As in previous years, Norwegian catches of Norwegian spring spawners (counted against another TAC) were removed.

Catches of autumn spawners have been reported by the Faroese fleet in Division Vb. As in previous years these catches, about 1,500 t in 1993, were not included in the North Sea assessment.

In Divisions IVc and VIId, the estimated catch of close to 84,000 t is 10,000 t higher than in 1992 and 35,000 t over the TAC for that area. The 1993 catch includes estimated discards of 2,400 t from only the Dutch fleet during the herring season (November-December) and a catch of 201 t taken in the Thames estuary area predominantly composed of spring spawners. The catch is therefore considered to be underestimated.

2.2 Biological Composition of the Catch

2.2.1 Catch in number and weights 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 numbers caught by age group for each division on a quarterly and annual basis for 1993. Table 2.2.2 presents a comparison of total North Sea catches in numbers at age over the years 1970-1993.

The catches in numbers of Division IIIa spring spawners caught in the North Sea in 1987-1993 and transferred to the assessment of the Division IIIa - SW Baltic stock are presented in Table 2.2.3. The estimated numbers of North Sea autumn spawners caught in Division IIIa in 1987-1993 and transferred to the North Sea assessment are given in Table 2.2.4. Table 2.2.5 summarizes the total catch in numbers at age of North Sea autumn spawners used in the assessment.

The total catch in number in the North Sea in 1993 (10.6 billion) is close to the 1992 catch of 10.8 billion fish. As in 1992, the catch of 0-ringers is very high. The catch in number of 2-ringers and older was at the same level as in 1992. The contribution to the total catch in number of young herring was 66% for 0-ringers and 12% for the 1-ringers. The catch of 1-ringers was about twice that in 1992.

In the North Sea 99% of the 0-ringers were caught in Division IVb in the third and fourth quarters (80.5% in quarter 3; 18.5% in quarter 4). The fisheries in Division IVb account for 91% of the catch of 1-ringers and 48% of the catch of 2-ringers. The percentage age composition of 2-ringers and older is shown in Table 2.2.6

Large catches of juvenile North Sea autumn spawners were also taken in Division IIIa. These catches (2.9 billion 0-ringers and 2.4 billion 1-ringers) were the highest since 1987. The total catch of 0- and 1-ringers in 1992 and 1993 were among the highest recorded and indicate a major change in exploitation pattern in the fisheries. The strength of the 1985 year class is still apparent and the catch in number of 7-ringers is the highest since 1970 (Table 2.2.2).

The SOP by age and division for each quarter is given in Table 2.2.7.

As in last year's report, Table 2.2.8 gives the age compositions separately for the catch of the human consumption fishery (fleet A) and the small-mesh industrial fishery (fleet B).

2.2.2 Quality of catch and biological data

The relationship between official and actual catches is unknown. Estimates of discards were provided by only one country, but discards occur in the fisheries of most countries and could be a considerable amount.

Sampling of commercial landings for age, length and weight was low in some fisheries and in other fisheries no samples have been taken at all (Table 2.2.9). These unsampled landings represent 15% of the total landings (Table 2.2.9) and a minimum of one sample per 1,000 t landed should be taken by all countries.

The Working Group therefore strongly **recommends** that adequate sampling be conducted in all fisheries in the North Sea in which herring are caught.

2.2.3 Treatment of spring spawning herring in the North Sea

Norwegian spring spawners are taken close to the Norwegian coast under a separate TAC. These catches are not included in the catch tables. Coastal spring spawners

in the southern North Sea are caught in small quantities in most years. These catches are given in Tables 2.1.1 and 2.1.5. With the exception of 1990, these catches are included in the assessment of North Sea autumn spawners.

Western Baltic and Division IIIa spring spawners are taken in the deeper parts of the eastern North Sea during the summer feeding migration. These catches are included in Table 2.1.1. The table specifies the estimated amount of Division IIIa/ Western Baltic spring spawners which are transferred from the North Sea assessment to the assessment in the Baltic. The methods for separating these fish from North Sea autumn spawners are described in former reports from this Working Group and in Anon (1990a and 1992c).

The method for estimating the fraction to transfer in recent years has been to use the vertebral counts as follows: the fraction of spring spawners (fsp) is (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 separation of the two components in the summer acoustic survey is based on the same method.

The Working Group estimated the amount to transfer in a somewhat different way this year because samples of vertebral counts in the months May-June and August 1993 were very sparse. Only one sample was taken in each of the months in spring while in August no samples were obtained. In July the sampling in the actual area was relatively good and altogether 13 rectangles were sampled (Figure 2.2.1). Due to the uncertainty about the situation in 1993 caused by the small number of samples, it was decided to apply the mean proportion for the second quarter (May and June) applied in 1991 and 1992. The samples in July 1993, however, have also been used for August so the samples from this month are looked upon as being representative of the 3rd quarter.

The resulting proportions of spring spawners and the quarterly catches in the transfer area in 1993 are as follows:

	Proportion (%)				
Quarter	2-ring	3-ring	4+ring	No. of rectangles sampled	Catch in transfer area (t)
Q^2	13	53	63		12330
Q^3	43	71	86	13	3850

The quarterly age distributions in Sub-division IVa East were applied to the catches in the whole transfer 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

At last year's meeting of the Working Group a new 1-ringer index was introduced. The previous index was based on IBTS February catches in the "herring standard area" only, and did not include the often substantial catches in Division IIIa. The new index considers the entire survey area. It is based on the sum of catch rate estimates (number/hour) from all rectangles in the area, and is expressed as this sum divided by 100. Only daytime sampling is considered. If rectangles are unsampled they are allocated the mean catch rate estimated within the areas North Sea, Skagerrak or Kattegat, respectively. Catch rates are down-weighted if rectangles include significant areas unlikely to contain 1-ringers (land, shallow areas, water depths >150 m). The weighting factors used are given in Anon. (1993), Table 2.3.6.

The IBTS 1-ringer index for the period 1979-1994 (year classes 1977-1992) is given in Table 2.3.1. Due to an error in last year's calculation of the 1993 index, this index was overestimated and the revised figure is given in Table 2.3.1. The present 1994 index indicates a decline in recruitment compared with last year (Figure 2.3.1).

2.3.2 The MIK index of 0-ringer recruitment

The 0-ringer index is based on night catches of larvae with modal length more than 20 mm during the IBTS in February. The sampling gear is a fine-meshed ring-net (MIK). An index value is determined in the following way: first, mean densities within sampled rectangles are calculated and averaged within 8 sections covering the survey area. The densities are then multiplied by the area of the sections and these abundance estimates are summed to a total abundance estimate (Table 2.3.2). The total abundance estimate divided by 10^9 is referred to as the 0-ringer index.

Last year, all data for calculating the index of the 1992 year class were not available at the time of the meeting. The preliminary index has now been revised including all sampling performed. The final index is 190.1 (preliminary: 212.4). At the present meeting all data were available for the 1993 year class estimation. The index is estimated to be 101.7, thus indicating a 50% decrease compared to the 1992 year class (Figure 2.3.1).

In Figure 2.3.2 the spatial distribution of herring larvae with modal length more than 20 mm is illustrated for the year classes 1991-1993. Last year an unusual distribution

was observed for the 1992 year class, the 0-ringers being concentrated in the western parts of the North Sea. The same distribution pattern is observed for the 1993 year class.

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

The correlation between the 0- and 1-ringer indices was investigated by linear regression (Figure 2.3.3). The indices are highly correlated (r-square 0.72) and no systematic trend in residuals is evident. This year's index of the 1992 year class as 1-ringers is lower than indicated by the 0-ringer index determination.

2.3.4 Recruitment prediction by the RCT3 regression programme

At the 1993 meeting a combined regression (RCT3) of recruitment indices against earlier VPA estimates was used to predict recruitment for the 1990-1992 year classes.

The same type of regression was carried out this year, including revised indices and new data. The IBTS 2-ringer index used in last year's prediction has very little weight in the prediction, and it was decided not to include it in the present prediction. Data used in the regression are given in Table 2.3.3, together with the predictions made. The output of the RCT3 is given in Table 2.3.4 for the prediction of 0-ringers and in Table 2.3.5 for the prediction of 1-ringers.

The expectations of the 1991 year class are not as high as calculated last year, the present predictions being 71.9 billion as 0-ringers and 21.4 billion as 1-ringers. The 1992 year class is predicted to be 56.8 billion as 0-ringers and 16.9 billion as 1-ringers, whereas the prediction of the 1993 year class strength as 0-ringers is 39.5 billion.

2.3.5 Trends in recruitment

The long-term trend in recruitment of 1-ringers to the North Sea autumn spawners is illustrated in Figure 2.3.4. The estimates for the 1970-1990 year classes are based on the VPA, the 1991-1992 year classes on the predictions from Section 2.3.4.

2.4 Acoustic Surveys

2.4.1 Northern and central North Sea (Divisions IVa,b) and Division IIIa summer survey

The 1993 acoustic survey of the North Sea and Division VIa was carried out by vessels from Norway, the Netherlands and Scotland over the period 29 June - 30 July (Simmonds *et al.*, WD 1994). In addition, a survey of Division IIIa was carried out by Denmark from 10-23 July.

The coverage of the survey in 1993 was reasonably complete and stock estimates have been worked out by age, maturity stage and ICES statistical rectangle for the complete survey area. The data have been combined to give estimates of immature and mature herring for ICES Divisions VIa (N), IVa and IVb, separately.

The results of the survey are given in Table 2.4.1. The total estimate of 1.91 million t for Divisions IVa and b, excluding estimates of Division IIIa/Western Baltic spring spawners, compares with an estimate of 1.90 million t in 1992 and 1.87 million t in 1991 (the 1992 and 1991 estimates also include North Sea autumn spawners in Division IIIa) (see Table 2.4.2).

The proportion of 2- and 3-ringers mature on the 1993 surveys was 47% and 63% respectively, which is rather close to the proportions for 2-ringers in 1992 but significantly less for 3-ringers. The average survey date for the main area of distribution was about 15 July.

To make the spawning stock estimate from the acoustic survey comparable to the estimate from the VPA, the catches of mature autumn spawners taken between the average survey date (15 July) and the date when 67% of the annual fishing mortality is reached should be deducted. In the VPA run, it is assumed that 67% of the annual fishing mortality is reached prior to spawning. According to Figures 2.10.1-12, the 67% catch date was about 15 October in 1993. The catch taken in the period between 15 July and this date was 175,000 t. The adult part of the catch in the third quarter is 64% by weight (Table 2.2.7), which contains 47% of 2-ringers and 63% of 3-ringers mature. Applying this proportion to the catch calculated for the period 15 July to 15 October leads to a figure of 112,000 t. Deducting this last value from the acoustic estimate gives an estimated SSB at spawning time of 1,104,000 t.

2.5 Larvae surveys

Reports on the international larvae surveys were incomplete at the time of the meeting and were not presented to the Working Group.

2.6 Mean Weight and Maturity At Age

2.6.1 Mean weight at age in the catch and stock

The mean weights at age (weighted by numbers caught) of fish in the catches in 1993 are presented by division and quarter in Table 2.6.1.

Table 2.6.2 shows a comparison of mean weights at age 2-ring and older over the years 1985-1993. For the age

groups 3 and older there was a declining trend up to 1988 and then an increase. For these age groups, except 3-ringers, the mean weights at age observed in 1993 are still somewhat higher than in 1992, except in Divisions IVc and VIId where all weights are declining. The mean weight of 3-ringers for the total North Sea is the lowest since 1988. For the 2-ringers, the mean weight at age is higher than in 1992.

Table 2.6.3 provides a convenient comparison of the changes in mean weights at age in the catch during the third quarter in Divisions IVa and IVb for the years 1986 to 1993. In this quarter, most fish are at or approaching their peak weights just prior to spawning. The mean weights in the stock obtained from the last three summer acoustic surveys are displayed in the same table. In the acoustic survey, the weights of 2- and 3-ringers were down by 19% and 30% compared to 1992. The weight of 4- and 5-ringers decreased by 7%. The decrease in weight of 2- and 3-ringers is more pronounced in the acoustic survey than in the commercial catch. Apparently, the fishery concentrated on the faster-growing components of the year class.

2.6.2 Maturity ogive

The percentage of 2- and 3- ringers likely to mature in 1992 was estimated from the summer acoustic survey. The percentages likely to have spawned in 1993 (maturity stage 3 and above during the survey) compared with the five previous years were as follows:

Age (winter-rings)	2	3	Older
1988	65.6	87.7	100
1989	78.7	93.9	100
1990	72.6	97.0	100
1991	63.8	97.1	100
1992	50.1	100	100
1993	46.7	62.9	100

The estimated percentages of maturity for 2-ringers are based on the Division IVa,b acoustic estimates only.

The maturity of the 3-ringers is significantly lower in 1993 than in earlier years. This is probably caused by a very low growth of this cohort which is also reflected in a low mean weight observed during the acoustic summer survey.

2.7 State of the Stocks

2.7.1 Total North Sea

Table 2.7.1 shows the time series of spawning stock indices from larvae surveys, acoustic surveys and bottom trawl surveys (IBTS). For 1993 no spawning stock index derived from larvae surveys was available. The table also shows the spawning stock estimate from the converged part of this year's VPA. Both the IBTS index and the acoustic estimates show a decrease in the spawning stock in 1993 compared to 1992.

Different methods of assessing the abundance indices and the catch data were used. These were the Integrated Catch Analysis (ICA) (Patterson WD 1994a), XSA and the *ad hoc* tuning method used in previous years. The ICA method performed differently depending on whether the data were entered age-disaggregated as numbers or as SSB indices. Also the assumption of a constant fishing pattern over years, which this method is based on, is probably not valid for this stock in recent years. The XSA method, on the other hand, does not depend on this assumption, but the Working Group last year concluded that this method was not appropriate because it is not able to use all the information available about the size of the SSB, i.e. the LPE and the IBTS 5+ indices. The Working Group this year was therefore not satisfied with any of these methods, including the *ad hoc* assessment method used earlier, as concluded in last year's report (Anon. 1993). This is further discussed in Section 2.11. In view of the uncertainties in the data and their interpretation, however, it was decided for consistency with previous assessments to use the *ad hoc* method.

On the basis of trial VPAs applying the new catch data but the terminal Fs from last year's final VPA, the spawning stock estimates were considered to be reasonably converged for 1990 and earlier years; increasing the relative fishing mortality by a factor of 2 caused a decrease in the estimated stock of less than 20 %.

Using the RCT3 program, each series of indices was regressed against the VPA estimates of the spawning stock for the converged years (log-log regression). The input and output data for the RCT3 program are given in Tables 2.7.2 and 2.7.3. The regression forms and results were similar to those described in the previous two Working Group reports; the regression of LPE and acoustic estimates had slopes well above 1 and the IBTS (or IYFS) regression had a slope slightly below 1. This implies a curvilinear relationship between the non-logged indices and the VPA. Last year, the Working Group discussed this feature of the different indices both from a biological and a statistical point of view and concluded that it is probably not correct to replace the regression for just one index by a log-log regression with slope fixed to 1, as was done the year before. For practical

reasons and consistency with previous years, the unconstrained RCT3 regressions were applied for the IBTS and the LPE indices and a linear relationship, fixing the slope for the log-log regression to 1, was used between the acoustic estimates and VPA.

Table 2.7.3 gives the regression parameters, predicted SSB values with standard errors and the weighting factors used to calculate a weighted average SSB for the three most recent years. The weighting factor was $1/SE^2$, where SE is the estimated standard error of the individual predictions. The weighting factors applied to the three indices in 1991 and 1992 were similar to those used in the 1993 assessment. In 1993, when no LPE estimate of SSB was available, a slightly greater weight was given to the IYFS index than to the acoustic index.

A VPA was tuned by the method described in the 1993 Working Group report (Anon. 1993). For all the years included in the VPA, annual natural mortality rates of 1.0 for 0- and 1-ringers, 0.3 for 2-ringers, 0.2 for 3-ringers, and 0.1 for older fish was applied. A number of separable VPAs were made using different 1993 terminal fishing mortalities. Because the selection pattern in recent years was not considered to be stable (see Section 2.11), due largely to the increased proportion of 0-ringers in the catch, the VPAs were run only on ages 1-8. The separable VPA with 0.48 as the reference fishing mortality (at age 4 in 1993) was the one which minimized the residuals between total 1991-1993 SSB as predicted from the indices and as estimated by the VPA (Figure 2.7.1). This VPA was, therefore, considered to produce the best fit to the survey data. The selection pattern based on the years 1988-1993 and the fishing mortality on the oldest true age group by year is shown in Table 2.7.8. All other input values for the separable VPA are given in Tables 2.7.4-2.7.7. The 1993 values for weight at age in the stock and proportions of maturity are derived from the summer acoustic surveys. The average fishing mortality in 1993 of 0.45 for 2-6-ringed fish was nearly identical to the F value estimated for 1992. Average F values at age for 1991-1993 were quite similar, with slightly lower values for the ages 1 and 3 fish.

A final VPA was then run for the years 1947-1993 with input Fs for the last year derived from the separable VPA. The Fs for the oldest true age groups, also derived from the separable VPA, or from VPAs carried out in previous years for the years prior to 1970, were also entered as input for the final run. The results from the final VPA are shown in Tables 2.7.9-2.7.11.

The estimated SSB in 1993 was 730,000 t which is a severe drop in level compared with last year's prediction for that year. The drop in biomass can be explained by the significantly lower mean stock weights observed in 1993 than in 1992. The maturity ogive has also changed, as 37% of the 3-ringers did not mature to spawn in 1993. However, the total stock number for 1-ringers and older fish showed an increase from 1992-1993.

2.8 Projection of Catch and Stock of North Sea Autumn Spawners by Area and Fleet

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 1994. For 2-ringers and older the VPA estimate is used (Table 2.7.10). The numbers of 1-ringers and 0-ringers at 1 January 1994 are the RCT3 estimates of 16,900 million 1-ringers and 39,500 million 0-ringers as described in Section 2.3. 0-ringers at 1 January 1995 are set at 44,000 million.

Mean weight at age in the stock, maturity at age, natural mortality and proportions of F and M before spawning are all taken from the VPA input for the year 1993 (Table 2.8.2). The fishing pattern for the total stock is taken from the separable VPA for 2-ringers and older (Table 2.7.8). For 0- and 1-ringers the fishing mortalities by fleet are calculated from catch and stock numbers in 1993.

The reference fishing mortalities for 2-ringers and older by age, fleet and area were calculated by combining the exploitation patterns, the 1993 fishing level and the distribution of the catch in numbers by fleet.

Catch predictions for 1994 and 1995 were made for the same five fleets as in last year's assessment:

A) Human consumption fisheries in the North Sea. A minor part of the catches taken in this fishery may be landed for industrial purposes;

B) Small-mesh fisheries in the North Sea. Landings used for industrial purposes;

C) Human consumption landings in Division IIIa;

D) Mixed clupeoid landings in Division IIIa. Some landings taken under the "mixed clupeoid quota" may be included in the catches taken by fleet E;

E) Other industrial landings in Division IIIa.

Mean weights at age in the 1993 catches by fleet were applied for the predictions.

To get as realistic a projection 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. For the 1-ringers this is reflected in the IBTS results presented in Table 2.8.1.

The abundance of 0- and 1-ringers in Division IIIa was estimated using the procedure suggested by the Workshop on Methods of Forecasting Herring Catches in Division IIIa (Anon., 1992c). The proportion of 1-ringers in Division IIIa estimated during the IBTS was regressed against the MIK index with a time lag of 1 year. The result of the regression is given in Table 2.8.1. The 1994 MIK index was used to predict the proportion of 1-ringers in 1995. This proportion was also applied to separate the 0-ringers in 1994 by area. The IBTS 1-ringer catches in 1994 were used to separate the 1-ringers in 1994 between the North Sea and Division IIIa. The recruitment and proportion of 0-ringers (year class 1994) by area in 1995 was estimated as follows:

The recruitment was taken as the mean 0-ringer abundance from 1947-1993 from the VPA;

A hypothetical MIK index value corresponding to this mean was derived from the regression between MIK and VPA;

This MIK index was used to predict the proportion of the same year class as 1-ringers in 1996;

The same distribution by area was assumed for the 0-ringers in 1995.

The 2-ringers migrate from Division IIIa to the North Sea during the year and very few 3-ringers and older are found in Division IIIa. Total mixing of 2-ringers in Division IIIa and the North Sea was assumed. Therefore, the stock numbers of 2-ringers given in Table 2.8.2 are the same for Division IIIa and the North Sea. 3-ringers and older were assumed to be exclusively in the North Sea.

The input data for the projection are given in Table 2.8.2.

Projections were made, assuming *status quo* fishing mortalities in 1994. A summary of the projections is given in Table 2.8.3. SSB is given at spawning time.

The catches in 1994 were estimated assuming unchanged effort (i.e. F by area) in all five fleets from 1993 to 1994, giving a total catch in 1994 of 610,000 t and a SSB of 736,000 t. As seen in Table 2.8.3 the catches in Division IIIa are predicted to be 86,000 t. The Working Group considered this figure to be low compared to the catches in recent years. This is explained by the lower recruitment and hence lower yield in the small-meshed and mixed clupeoid fisheries (i.e. fleets E and D).

The catches in 1995 by different combinations of effort by fleet under the assumption of catches as outlined above for 1994 are shown in Table 2.8.3. The catches taken in Division IIIa will have very little effect on the catches in the North Sea taken in the same year as the model used assumes no migration between areas for 0- and 1-ringers and the proportion of 2-ringers taken in Division IIIa is relatively small. For that reason the predictions are given independently for the North Sea and Division IIIa fleets.

In all options the SSB at spawning time is predicted to be at or below the minimum biologically acceptable level (MBAL) of 800,000 t in 1995. To bring the SSB above the MBAL a further reduction in the fishing mortality of fleet A is required in the short-term forecast. The catches of 0-, 1- and 2-ringers in the forecast period will affect the SSB in 1996 and later. The consequences of juvenile catches in 1993 are given in Section 2.9.

2.9 Management Considerations

The effect of catches of juvenile herring on potential catches of adult herring and future stock biomass were investigated by a calculation presented in Table 2.9.1. This table gives the potential gains that would have been obtained if catches of juvenile herring by different fleets exploiting North Sea autumn spawners in 1993 had been reduced to zero.

If catches of 0- and 1-ringed herring had been prevented in all fisheries in 1993, the accumulated gains in catches of adult herring over the subsequent years would have been 445,000 t. The increment to the spawning stock, summed over the subsequent years would have been 1,074,000 t. The effect by year from 1994-2002 is shown in the text table below:

Year	Extra SSB	Extra yield in the North Sea
1994	91,736	49,026
1995	260,594	109,648
1996	271,902	97,915
1997	169,164	70,320
1998	107,376	45,179
1999	66,533	27,506
2000	42,890	17,207
2001	38,866	16,957
2002+	24,988	11,648
SUM	1,074,049	445,407

The year classes recruiting as 0- and 1-ringers in 1993 were of average strength. This implies that a permanent reduction of 0- and 1-ringed catches to zero would result in annual increments of adult catches and spawning stock of the order indicated above.

It is obvious that management measures resulting in a reduction of juvenile catches will not only have a substantial effect on the future catches of adult herring, but also on the size of the spawning stock. Considering the fact that the present assessment indicates a spawning stock size close to the minimum biologically acceptable level, there may be a case for considering such measures.

2.10 Requests from the Multispecies Working Group

2.10.1 Quarterly data base (numbers and mean weights at age)

The Multispecies Assessment Working Group has requested annual provision of quarterly catch-at-age data, together with quarterly weights at age in the catch and in the stock at spawning time for North Sea herring. The data for 1993 are provided in Table 2.10.1.

Weight-at-age data for the stock at spawning time are best provided by samples taken during the July acoustic surveys which cover Divisions IVa and b, and these are shown in the bottom line of Table 2.10.1.

A comparable breakdown of catches of spring spawners taken in the North Sea and transferred to Division IIIa is shown in Table 2.2.3.

2.10.2 Geographical distribution of the catches in the North Sea in 1993

Data on the geographical distribution of catches in the North Sea (Sub-area IV and Division VIId) in 1993 were available from Denmark, the Netherlands, Norway, Sweden and the UK (Scotland and England). The data represent 89% of the total catch, and include both juveniles and adults. Figures 2.10.1-2.10.12 show the catch by ICES rectangles for each month. The total catches by month were also available from France and Germany. The cumulative catch by month for the total North Sea, shown in Figure 2.10.13, therefore includes all the catch in the North Sea except 56 t caught by Belgium.

2.11 Assessment Methods and Data Consistency

2.11.1 Data used by *ad hoc* method

The Working Group has in previous years used an *ad hoc* method for tuning the VPA based on

- catch-at-age in numbers by year and by age

and the following SSB indices obtained from surveys:

- the LPE larvae index. However, the 1993 LPE index was not available.

- the IBTS (February) age compositions raised using the maturity ogive and mean weights at age for the fishery on the spawning concentrations observed the year before. This is taken as an index of the SSB of the year before, that is the February 1994 IBTS age composition is applied to maturity and weight data for autumn 1993 to provide a SSB index for 1993.

- the July-August acoustic survey results raised to SSB for the same year using maturity ogive and mean weight-at-age data for that year.

2.11.2 Data used in assessment with the ICA program

The Working Group conducted an assessment of the North Sea herring stock using the ICA program ("Integrated catch analysis") which allowed the use of a more comprehensive data set than was possible with the *ad hoc* method. This data set included

- catch-at-age in numbers by year and by age

supplemented by

- the LPE larvae index.

- the IBTS (February) index in number/hr for age groups 1, 2, 3, 4 and 5+

- the acoustic survey results in numbers by year and by age.

- the MIK (February) index for stock at age 0.

2.11.3 Modelling tuning indices and consistency of the time series

Trial runs with the ICA program were made to investigate the consistency of the data series both with respect to how long a time series should be considered in the assessment and how the indices should be modelled in terms of estimated stock sizes. The conclusions from a rather long series of trials presented in Patterson (WD 1994b) and from runs made by the Working Group to supplement his analysis are presented in the text table below:

Index	Period applied in ICA	Model applied in ICA
LPE	1983 -	Proportionally related to SSB
IBTS(Feb.) age group 1	Entire time series	Power function related to stock in numbers of age 1
IBTS(Feb.) age groups 2,3,4,5+	Entire time series	Proportionally related to stock in numbers of age 2,3,4 and 5+
Acoustic Survey Age disaggregated data for ages 1-9	1987 -	Absolute estimates of the stock in numbers of the relevant age group
MIK large larvae index	Entire time series	Proportionally related to stock in numbers of age group 0

2.11.4 Data inconsistencies

In its 1993 report (Anon. 1993) the Working Group recognized that individual application of each of the three SSB (LPE, SSB(IBTS) and SSB (Acoustic) indices gave rather different stock estimates. Similar problems occurred this year when the age- disaggregated indices were applied in stock estimation.

The Group identified two major problems:

- Inconsistency between assessments based on the IBTS SSB index and age-disaggregated indices for the same survey ;

- Lack of fit to the Separability assumption in the fishing mortalities into a year and an age component.

Subsequent analysis suggested that these two problems are related.

The Working Group conducted trial runs with the ICA and XSA programs to investigate these problems. The data used in these runs were

- LPE SSB index

- age-disaggregated data series from IBTS (February) and from the Acoustic surveys

- the two SSB indices used by the *ad hoc* method, SSB(IBTS) and SSB(Acoustic)

Results with only one data series at a time suggested that particularly the IBTS (February) 2-5+ indices were in conflict with the SSB(IBTS) index derived from the same survey results. Including the SSB(IBTS) index reduced the estimated SSB substantially compared to the SSB estimated without this data item. The SSB(Acoustic) and the age- disaggregated stock numbers from the acoustic survey appeared to be internally consistent.

The Working Group inspected the separable VPA used in the *ad hoc* method. This separable VPA down-weighted the log-residuals for both the younger and the older age groups compared to the age groups 4/5. A run made with the ICA program without the SSB(IBTS) index but with a similar downweighting of the log-residuals of the catch-at-age fit gave results comparable to those from the *ad hoc* assessment. The apparent conflict between the SSB(IBTS) and the IBTS age-disaggregated 2-5+ indices could be resolved by lessening the assumption of separability in the fishing mortalities.

In Section 1.5 the Working Group discussed the possibility of an abnormal high additional mortality in 1991 due to *Ichthyophonus* infection. Based on experiments and observed infection rates this extra mortality was estimated to be 0.6 per year to be applied to age group 4 and older. This extra mortality was introduced in the calculations and the catch-at-age log-residuals were all given equal weight. A run with the ICA program also gave results which were in accordance with those obtained from the *ad hoc* method. This different assumption also removed the inconsistency in the IBTS data series.

Runs with the ICA program showed that for the most recent years the mortality of 0-group herring has increased substantially. This was confirmed by XSA runs on the age-disaggregated tuning indices. The XSA results indicated that the increase was restricted to 1992 and 1993.

The Working Group restricted the *ad hoc* analysis to age group 1 and older fish. This did not substantially change the assessment but the SSB obtained was about 10% lower when the 0-group was included in the separable VPA.

2.11.5 Conclusion

The Working Group was left with a choice between

- Updating the assessment from previous years using the *ad hoc* method based on the SSB indices, thereby not utilizing the age-disaggregated information and ignoring the lack of separability.

- Using the ICA program despite the inherent assumption of separability which is known to be violated in this case.

- Introducing the XSA method in the North Sea herring assessment. It would be possible through shrinkage and appropriate weighting to hide the inherent incompatibility of the various data sets.

None of these approaches appeared attractive to the Working Group.

The Working Group, as discussed in Section 1.3 (Evaluation of the ICA program), has adopted the ICA program as the better estimation procedure currently available but has also concluded that violation of the separability assumption would prevent the appropriate use of the ICA program.

The XSA program is only able to use age-disaggregated data where the index is assumed to be proportionally related to stock size. The XSA method therefore appeared to have little advantage over the *ad hoc* method and the Working Group maintained its conclusion in Section 2.11.2 of Anon. (1993).

Further investigations on the problems identified above are required and the Working Group recommends that the influence of the separability assumption on the fishing mortalities and the apparent inconsistency within the IBTS(February) data should be further investigated before the next meeting of the Working Group.

The Working Group recognizes that the problems with the model formulation give problems in the use of the *ad hoc* method, the ICA program and the XSA method. The Working Group recommends that data be collected with the objective of elucidating the source of the apparent inconsistency in the data series.

The Working Group has for yet another year based its assessment on the same series of SSB indices and the *ad hoc* estimation procedure as in previous years. Compared to the assessment conducted in 1993 the LPE index could not be updated as the 1993 LPE index was not available. Also, because of the increase in fishing mortality on the 0-group, the separable VPA was restricted to age groups 1 to 8. The *ad hoc* method provides a lower estimate of the spawning stock biomass in 1993 than those obtained with age-disaggregated data included in the analysis. All stock indices suggest that at present the SSB is declining. All analyses also indicate that the fishing mortality on the youngest age groups is increasing.

Using a wide range of methods and models (none of which are inherently unreasonable) leads to perceptions of current stock size in the range of 750,000 to 1.5 million t and of fishing mortalities F_{2-6} between 0.25 and 0.45 per year. It was not possible to make an objective choice amongst the models tested. This leads to a major source of uncertainty in the present assessment.

Adopting the *ad hoc* method estimates constitutes a cautious approach to setting a TAC for the North Sea herring stock for 1995.

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

3.1 The Fishery

3.1.1 ACFM advice and management applicable to 1993 and 1994.

1993

Again in 1992 ACFM did not recommend a TAC for Division IIIa in 1993 and stated that if the management objective is to increase SSB and maximize catches of adult herring, then catches of juveniles should be substantially reduced.

If the fishing mortality on spring-spawning herring in Division IIIa and Sub-divisions 22-24 in 1993 is the same as in 1991, a predicted catch would be about 189,000 t, of which 113,000 t could be taken in Division IIIa, 68,000 t in Sub-divisions 22-24 and 8,000 t in the North Sea.

The herring TAC agreed between the EU, Norway and Sweden to be taken in Division IIIa was 165,000 t. A TAC including all catches of all species taken in the mixed clupeoid fishery and landed unsorted was set at 45,000 t.

As in earlier years no special TAC was set by the International Baltic Sea Fishery Commission (IBSFC) for the Western Baltic Spring-spawning stock in 1993. In the Baltic there is a total TAC for all the Sub-divisions 22-32. Also in Division IIIa no special TAC was given for this stock.

1994

As in previous years ACFM did not recommend a TAC for 1994. ACFM stated that the catches of juveniles, both in the North Sea and Division IIIa, substantially reduced the long-term yield of adult herring and the spawning stock. Therefore, the catches of juveniles should be reduced substantially.

The herring TAC agreed between the EU, Norway and Sweden to be taken in Division IIIa was 148,000 t. A TAC including all catches of all species taken in the mixed clupeoid fishery and landed unsorted was set at 43,000 t.

The forecast for 1994 suggested a catch of about 174,000 t, of which 86,000 t would be taken in Division IIIa and 88,000 t in Sub-divisions 22-24. This forecast

was made using the same fishing mortality in 1994 as in 1990-1992 for the western Baltic spring-spawning herring.

In its management advice ACFM stated that the stock of Western Baltic spring-spawning herring had increased over the last 20 years and that it reached a record high level in 1991. The stock was considered to be within safe biological limits, but the recent year classes were poor and the spawning stock was expected to decrease in 1993. If catches in the range 130,000 to 180,000 t were taken from the stock in 1994, the stock would maintain its present level.

3.1.2 Introduction to landing statistics

The landings of 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.

3.1.3 Total Landings

Landings from 1985 to 1993 are given in Table 3.1.1. In 1993 the landings amounted to around 295,000 t in Division IIIa and Sub-divisions 22-24, of which 45,000 t were from the Kattegat, about 168,000 t from the Skagerrak and 81,000 t from Sub-divisions 22-24 (in total a decrease of 16,000 t compared to 1992).

The data on landings are uncertain partly because, as in earlier years, a substantial part of the Swedish landings for industrial purposes were not sampled and their species composition is, therefore, not known. In 1993 this amount was 70,000 t (all species) of the Swedish Skagerrak landings. It was assumed that the species composition was the same as that of the Danish industrial landings (data from Mixed Clupeoid fishery excluded) and that it thus contained 33,000 t of herring.

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 4. These landings are included in the figures for the Skagerrak.

The herring catches in Division IIIa are taken mainly in three types of fisheries (see also Anon, 1992a), *viz.*:

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

The "**Mixed clupeoid fishery**" is carried out under a special "Sprat" TAC for all species caught in this fishery. Danish boats are obliged to use a 32 mm mesh (since 1 Jan 1991). The Swedish fishery includes purse seiners fishing for sprat along the coast and trawlers using small-meshed gear (less than 32 mm). The Norwegian fishery is a purse seine sprat fishery for the canning industry.

Catches of herring also occur as **by-catches in other fisheries**, such as the Norway pout and sandeel fisheries.

Attempts have been made to separate the landings of these fisheries. The category "Mixed clupeoids" only refers to Denmark since it was not possible to separate the Norwegian and Swedish "Mixed" landings from other industrial landings. All Swedish landings for industrial purposes are counted under "Landings for industrial purposes" and the Norwegian landings are under "Landings for Human consumption". The landings in the different fisheries for the period 1991-1993 in thousands of tonnes are shown in the text table below:

	Human Consumption	Mixed clupeoids	Landings for oil and meal	Total
1991 Kattegat	32	13	24	69
Skagerrak	62	6	54	122
Div.IIIa	94	19	78	191
1992 Kattegat	24	11	24	59
Skagerrak	75	14	79	168
Div.IIIa	99	25	103	227
1993 Kattegat	18	12	16	46
Skagerrak	94	15	60	169
Div.IIIa	112	27	76	215

In Sub-divisions 22-24 all the catches are taken in a directed fishery for herring which is treated in this section as one fleet.

The landings from this stock could therefore be split into four components:

C: Human consumption fleet in Division IIIa.
D: Mixed clupeoid fleet in Division IIIa.
E: Landings for industrial purposes in Division IIIa.
F: Landings from Sub-Divisions 22 - 24.

In the text table below the 1993 landings are given in thousands of tonnes by fleet and quarter.

Quart./ Fleet	Fleet C	Fleet D.	Fleet E.	Fleet F.	Total
1	9.4	9.8	23.8	35.7	78.7
2	17.7	2.3	10.1	29.4	59.5
3	47.2	8.1	29.8	6.1	91.2
4	37.4	6.0	12.8	8.6	64.8
Total	111.7	26.2	76.5	79.8	294.2

The landings from fleets C-F are SOP figures.

3.1.4 Catch in numbers and mean weight at age

The unsampled Swedish catches from the Skagerrak (about 20 % of the total catches) introduced considerable uncertainty in the estimated catch in number. The Working Group estimated the age composition of this catch component by applying age compositions from trawl surveys with R/V Argos in the Skagerrak for quarters 1-3 and from Danish industrial landings for quarter 4 (excluding data from the Mixed Clupeoid fisheries).

It was uncertain where the Danish catches for human consumption reported in Division IIIa (quarters 1 and 4) were actually taken. The Division IIIa catches were converted using the age distributions from the Danish landings from adjacent areas in Division IVa East. The Danish sampling programme in 1993 was considered to be at an acceptable level. In Division IIIa, all landings were sampled in all quarters. In Division IIIc (The Sound) no samples were taken and samples from research vessels were used.

The landings in Sub-divisions 22 and 24 were sampled except for the Danish landings in the 4th quarter, for which samples from the 3rd quarter were used.

Tables 3.1.2 and 3.1.3 give total numbers and mean weights at age for herring landed from the Kattegat and Skagerrak by the fleets listed in Section 3.1.3. Table 3.1.4 gives the total number and mean weight for Sub-divisions 22-24.

3.2 Stock Composition

3.2.1 Spring spawners in the North Sea

The separation of catches from the NE North Sea into spring and autumn spawners is described in Section 2.2.3. The total amount of spring spawners of Division IIIa-Baltic origin taken in the North Sea was estimated to be 8,800 t in the 1993 catches. Table 2.2.3 presents numbers and mean weights at age.

3.2.2 Stock Composition in Division IIIa

The mixing of spring- and autumn-spawned herring has been described in earlier reports of this Working Group (Anon., 1990a). Landings in Division IIIa were allocated to spawning stock using a combination of modal length analysis and mean numbers of vertebrae (Anon, 1992a). The split is based mainly on the Swedish and Danish samples of vertebrae counts.

The resulting split is summarized below:

Age Grp	Quar-ter	Skagerrak		Kattegat	
		Spring Spawners	Autumn Spawners	Spring Spawners	Autumn Spawners
0	All	0%	100%	0%	100%
1	1	0%	100%	0%	100%
	2	0%	100%	0%	100%
	3	0%	100%	0%	100%
	4	0%	100%	69%	31%
2	1	0%	100%	100%	0%
	2	0%	100%	95%	5%
	3	23%	77%	100%	0%
	4	100%	0%	100%	0%

All landings from Sub-divisions 22-24 are assumed to be Baltic spring spawners.

Tables 3.2.1 - 3.2.6 present the catches in number and mean weight by age group for spring- and autumn-spawning herring separately in each of the three fisheries in Division IIIa, based on the above proportions.

The landings of North Sea autumn spawners in Division IIIa amounted to 132,000 t in 1993 (Tables 3.2.6. and 3.2.9). The figure for 1992 was 152,000 t.

The landings of spring spawners taken in Division IIIa in 1993 was thus estimated to be about 80,000 t (Table 3.2.3) compared to about 75,000 t in 1992.

Table 3.2.7 gives the total catch in number-at-age of Division IIIa/Baltic spring spawners in Division IIIa and the North Sea by area and quarter for 1993 and the totals for 1987-1993 are given in Table 3.2.8.

Tables 3.2.10 and 3.2.11 give the landings in numbers and mean weight by fleet of the Division IIIa/Baltic spring-spawning herring and North Sea autumn-spawners respectively.

3.2.3 Quality of catch and biological sampling data

Table 3.2.12 shows the number of fish aged by country, area, fishery and quarter.

Sampling of the Danish catches for industrial purposes was at a higher level compared to the last 10 years. The

number of samples and number of fish investigated were considered at a reasonable level. As mentioned in Section 3.1.4 there were some uncertainties about misreporting of Danish human consumption landings in quarter 1 and 4 in the Skagerrak.

There were no samples from the Swedish landings for industrial purposes taken in the Skagerrak in 1993, except for some samples taken by the Danish authorities which provide only the species composition. There may thus be some uncertainties in the Swedish landings due to gaps in the Swedish sampling.

Discards occur in the purse seine fishery in Division IIIa, especially in June, July and August, but no data were available.

The total landings from Sub-Divisions 22-24 were 85,000 tonnes from which 129 samples were taken and 6,800 herring aged.

The sampling level increased for most countries , but the Working Group still notes that there are unacceptable gaps and therefore, **the Working Group recommends that adequate sampling is conducted for all fisheries in Division IIIa and Sub-divisions 22-24.**

3.3 Fishery-independent stock estimates of Western Baltic spring-spawning stock

3.3.1 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 Division IIIa was covered by R/V DANA in 1993. The survey technique and parameters used for estimating the stock in number by age group are given in the report by Simmonds *et al.* (WD 1994). The Target Strength (TS) relationships given in that report, however, were recognized to be different from those used in the North Sea. It was also discovered that a different TS regression was used in the 1992 survey and that estimate was also revised and the survey results recalculated. The TS relationships used in 1992 and 1993 now are for all species:

Clupeoids	TS = 20 log L - 71.2 dB (L is the fish length in cm)
Gadoids	TS = 20 log L - 67.5 dB (L is the fish length in cm)

The recalculated results for 1992 and 1993 are given in Tables 3.3.1 and 3.3.2.

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

This survey was as in previous years conducted with R/V SOLEA. Survey tracks and trawl stations are shown in Figure 3.3.1. The TS relationships used in this survey were:

Clupeoids	TS = 20 log L - 70.8 dB (L is the fish length in cm)
Gadoids	TS = 20 log L - 67.5 dB (L is the fish length in cm)

The survey estimates obtained from the R/V SOLEA and R/V DANA surveys are therefore not directly comparable even when they refer to the same area.

The survey results from the Western Baltic in 1992 and 1993 are given in Tables 3.3.1 and 3.3.2.

3.3.3 Comparison of acoustic estimates from R/V DANA and R/V SOLEA

Both surveys cover a part of the Kattegat in which the major proportion of herring occurs. Therefore the two estimates should be comparable. However, because of migration of spring spawners from Division IIIa to the western Baltic the stock estimates do not refer to the same part of the population and therefore cannot be directly compared.

The Working Group therefore recommends that the acoustic surveys presently conducted by R/V DANA in July/August and by R/V SOLEA in October be synchronized.

The Working Group also noted the difference in TS relationships applied in estimating stock in numbers for the two surveys. The Working Group recommends that the basis for the choice of the TS relationships be investigated and that reasons for this difference be described.

3.4 Abundance indices

3.4.1 General remarks on the 1994 IBTS February survey in Division IIIa

The 1994 survey was carried out in February as in previous years and a total of 47 hauls were made. All standard stations were sampled and the weather situation during the survey was good. The 1993/1994 winter was colder than previous winters since 1987/88. Table 3.4.1 presents the final indices of 1, 2 and 3+ -ringed herring.

3.4.2 Abundance of 1-ringed herring

The final 1-ring index in 1994 was 8,777 which is about 68% of the long-term mean. The length distribution observed in 1994 was bimodal and a length split was attempted. The vertebral count (VS) for separated length

cohorts showed that dominating cohorts were of North Sea autumn spawners with an average VS of 56.4 in all depth strata. Therefore, all 1-ringed herring were assigned as North Sea autumn spawners.

3.4.3 Abundance of 2-ringed herring

The final index of 2-ring herring in 1994 was 2,333 which is about 80% of the long-term mean. The 2-ring index was up to 1988 dominated by spring spawners but after 1989 autumn spawners from the North Sea became more abundant. The modal length frequency analysis applied in the separation of the herring into spring and autumn spawners has performed better on the 2-ringed than on 1-ringed herring. It has generally been possible to verify the split with vertebral counts. In the analysis of the 1994 data, all length cohorts had VS counts between 56.2 and 56.45. The results indicate that the majority of the 2-ring herring were North Sea autumn spawners with a mean vertebral count of 56.33.

3.4.4 Abundance of 3+ ringed herring

The final index of 3+ ringed herring was 1,148 which was close to the mean since 1980. The 3-ringers and older are all local spring spawners with a VS count in the range 55.8-55.9.

3.4.5 Abundance indices for subdivisions 22-24

Recruitment indices from bottom-trawl surveys carried out in November each year in Sub-divisions 24 and 22 are given in Tables 3.4.2. and 3.4.3. The 1993 indices of the 0-group are high in both areas. The 3+ indices are the highest recorded since the beginning of the series in 1978.

3.5 Assessment

This year, the Working Group did not carry out a conventional VPA for Western Baltic herring but used the Integrated Catch Analysis (ICA) program (see Section 1.3). This was the first time WG-members had used the ICA program, so some beginners' problems were encountered, although the ICA was found to be more user-friendly than the XSA program.

The same sort of problems as last year were encountered when trying to assess the Western Baltic herring stock. The survey indices did not signal the same development as the data from the commercial fishery. The overall results of the ICA-analysis showed a decreasing fishing mortality and an increasing stock during the last five years. The Working Group felt that both the data on the commercial fishery and the survey data were questionable. Below follows a description of the ICA assessment and a discussion of the results. Due to the dubious quality of the assessment, the WG decided not to make predictions.

3.5.1 Integrated Catch Analysis

Catch at age and survey indices used as input data to ICA are given in Tables 3.5.1.a-b. It should be noted that some input data cover the time period 1975 to 1993, but that the splitting of the Division IIIa/IVa herring stocks started only in 1983. In future assessments consideration should be given to excluding data from before 1983 from the analysis.

Natural mortality, maturity ogive, proportions of F and M before spawning are all assumed to remain constant from year to year. M is assumed to be 0.2 per year, F-prop 0.1 and M-prop 0.25 for all age groups.

The maturity ogive is:

Age	0	1	2	3	4	5	6	7	8+
Maturity	0	0	.2	.75	.9	1	1	1	1

No multispecies VPA has been executed by the Baltic Multispecies Working Group for the Western Baltic and Kattegat area. The group discussed the possibility of using the same M's as those used for the North Sea, but decided to use the same M's as last year.

Five indices for tuning the ICA were considered for the Western Baltic Spring-spawning herring

INDEX 1: 1978-93: German Bottom Trawl Survey in Sub-division 24, Age groups 0-3.

INDEX 2: 1979-93: German Bottom Trawl Survey in Sub-division 22, Age groups 0-3.

INDEX 3: 1989-93: Acoustic survey in IIIa+IVaE, Age groups 2-8.

INDEX 4: 1989-93: Acoustic survey in Sub-division 22-24, Age groups 0-8

INDEX 5: 1980-94: IYFS IIIa, Age groups 2 and 3+.

No biomass index was used, but this may have been preferable to using age-disaggregated indices as biomass indices may be less subject to random noise. Shortage of time, however, did not allow the group to investigate this question.

In all ICA runs the following parameters were kept constant:

Weighting factor (or lambda) (= 1.0) for all indices.
The linear model was used for all indices.
The range of years used in separable constraint: 6

The reference F was given for age 4, and the selection for oldest age was 1

Seven runs were made with different combinations of indices as given in the text table below. In addition an attempt was made to fit the power function instead of the linear function, but apparently the data do not conform to that model because the program gave various error messages and eventually stopped.

The seven runs were compared by using the estimates and confidence limits of the reference F in 1993 were:

Run No.	F in 1993 from ICA			
	Index	Mean F	Lower L	Upper L
1	All	.2268	.1443	.3567
2	1	.3518	.2156	.5741
3	2	.1272	.0670	.2414
4	3	.0428	.0118	.1550
5	4	.1044	.0475	.2297
6	5	6.7516	1.6973	26.8568
7	1,2,3,4	.2169	.1376	.3418

As can be seen, index 5 (IYFS IIIa, Age groups 2 and 3+) did not yield a realistic value of F in 1993. Actually, none of the indices showed a convincing relationship with estimated stock numbers, but indices 1-4 produced estimates of the reference F in 1993 in the same order of magnitude. Consequently, index 5 was excluded from the analysis.

As a basis for the assessment indices 1-4 were used as indicated in the last line of the above text table. Outputs from ICA Run No. 7 are given in Tables 3.5.2.a-f. The key-results of the ICA are also shown in Figures 3.5.1.a-c.

3.5.2 Discussion of assessment

The sum of squares of deviations between estimated and observed indices (SSQ) as a function of the reference F (in 1993) is shown in Figure 3.5.1.a. The optimum reference F should be the one with the minimum SSQ.

As can be seen, there is no clear indication of the best reference F in 1993. Only index 3 has a conspicuous minimum, whereas the other curves are rather flat.

Figure 3.5.1.b shows an increasing trend in stock biomass, from about 200,000 t in 1975 to 800,000 t in 1993. Fishing mortality showed the opposite trend, decreasing from 1.0 in the mid-seventies to 0.2 in 1993. The trend in landings is somewhat in contradiction with the trends in F and stock biomass, as landings show an increasing trend until around 1989, and a slight decrease until 1993. Proportionally the decrease in landings is much smaller than the decrease in fishing mortality.

The approximate confidence bands (log-transformed mean $\pm$ std.dev) of F were estimated to be [.14, .34] for Run No. 7. However, this estimate of confidence limits does not account for a possible bias in the data.

The estimate of F = 0.22 is only about 50% of last year's estimated terminal F, and the F for 1992 is also lower this year compared to last year's assessment. Last year the Baltic Pelagic Working Group did not use tuning in their VPA, but shrank the terminal F to the average F. It is therefore difficult to identify the reasons for the lower terminal F this year. As can be seen from Table 3.5.2.a, the F-at-age has undergone a dramatic change during the time series of the analysis. From very high values in the eighties of around 1.0 for ages 4-8 fishing mortalities for these age groups dropped to a low level of around 0.25 in the nineties. This feature of F should be seen in conjunction with the fact that the catch-at-age-pattern has undergone a dramatic change (Table 3.5.1.a). Catches in the eighties were dominated by the 0-3 groups whereas in the nineties the bulk of the landings stems from the older age groups.

Whether in fact there has been such a dramatic change in the fishing pattern was discussed by the Working Group. The predominance of older fish in the catch in recent years can also be explained by a series of good year classes. It was suggested that the apparent change in the fishing pattern was not real, but that it was caused by an inappropriate sampling procedure (raising) used in the eighties. Before 1990 the Danish sampling was not stratified by fleet. From 1990 samples were collected from the different fleets and applied to the human consumption fleet, the mixed clupeoid fishery and the other industrial fishery for reduction separately (see Section 3.1.3). Before 1990 the samples might have overestimated the smaller size groups because most samples were taken from small vessels participating in the mixed fishery. Small herring caught in the human consumption fishery were separated on board the vessels (using sorting machines) and landed for reduction. These bycatches of small herring were probably not adequately covered by the sampling programme, and most often they were assumed to be of the same size as those in the mixed fishery. There is some suspicion that in fact they were larger than those in the mixed fishery.

The cessation of the East German herring fishery in Subdivision 24 after German unification may explain some change in the fishing pattern, but as this fishery was targeting large sizes, it cannot explain the observed change in size composition.

Another factor worth mentioning is that major landings of herring for reduction purposes from Division IIIa are not covered by age composition samples. This applies in particular to large Swedish landings for which Danish age compositions have been applied. Whether this procedure is appropriate is not known.

The apparent increase in stock biomass and reduction in fishing mortality cannot be explained by a change in the fishing. The explanation may be found in the survey indices. Figures 3.5.2.a-d show the indices used for the tuning of the ICA. None of the surveys covered the entire distributional area of the stock. Therefore, none of the surveys gave an estimate of the entire stock. If, however, the surveys estimated a constant proportion of the stock, they would still be useful as indices. But if the estimated proportion varied from year to year, this would introduce a bias. Being a migratory species, it could be suspected that the proportion of the stock in each survey area varied from year to year.

Figures 3.5.2.a and b (the German bottom trawl survey) show relatively high abundance of the 1983-86 and 1989 year classes at age 0 and age 1. These are the age groups which are abundant in the nineties. The acoustic survey on the other hand (see Figure 3.5.2.c) does not indicate an increase in biomass in recent years, nor does the IYFS in Division IIIa indicate an increase of stock biomass. The signals from the surveys are thus conflicting and not clear.

The group found it difficult to accept the unexpected results of the assessment, and it was decided not to present any assessment. The results in Table 3.5.2 are shown only to illustrate the problems encountered. Consequently, no attempt to predict the catches for the Western Baltic herring was made.

4 CELTIC SEA AND DIVISION VIIJ HERRING

4.1 Introduction

The herring fisheries to the south of Ireland in the Celtic Sea and in Division VIIj have been considered to exploit the same stock. For the purposes of stock assessment and management these areas have been combined since 1982. The areas for which the assessment is now made, together with the area for which the TAC is set by the European Union (EU) are shown in Figure 4.1.1. It should be noted however that although the management unit covers all of Divisions VIIg, h, j and k, the total Irish catch which constitutes over 95% of the catch from the entire management unit is taken from the inshore waters along the Irish coast.

The Study Group on Herring Assessment and Biology in the Irish Sea and Adjacent Areas has proposed a change in the area over which this stock should be assessed. This change involves an alteration of the boundary between Divisions VIIb and VIIj and is shown in Figure 4.1.2.

4.2 The Fishery in 1993-1994

4.2.1 Advice and management applicable to 1993 and 1994

ACFM suggested that if a precautionary TAC for this stock for 1993 is to be implemented it could be in the range of 20,000 - 24,000 t, including discards. The TAC set by the EU was 21,000 t which was the same as that since 1991. The preliminary estimated catch for 1993 was 21,100 t, including discards of about 1,900 t.

ACFM again did not recommend a TAC for this stock for 1994 but commented that if a TAC should be implemented then it should be a precautionary one and around 20,000 - 24,000 t, including discards. A TAC of 21,000 t was again set by the EU. The spawning box closure system was continued during 1993 and is also in operation for 1994.The spawning box closed during the 1993/1994 season was that in Division VIIa (south). This closure was prolonged until the end of the season because of the poor quality of the herring.

The major portion of the catches in this area is taken by the Irish fishery and the stated management policy for the Irish fishery is directed towards the Japanese roe market. The Irish fishery therefore continues to be operated on a seasonal basis and fishing is confined to the spawning season which usually lasts from October to mid-February. The fishery in 1993-1994 was opened on 10 October and closed on 25 February. The total Irish quota was subdivided into boat quotas per week. The number of boats participating in the fishery was about 62 compared with about 80 in the previous two seasons. The reason for the decrease was the poor economic returns from the fishery in recent years. All boats participating in the fishery were again regulated by licences which restrict landings to specific ports and specific times.

4.2.2 The fishery in 1993/1994

The Irish fishery during 1993/1994 was carried out on the usual inshore spawning grounds. There appeared to be a scarcity of fish during autumn on the spawning grounds in the northern part of Division VIIj. Shoals were also notably absent from the important spawning grounds in Division VIIa (south) throughout the season. The main catches were taken from Division VIIg where good fishing was experienced particularly in December and January. As in 1993 winter spawning fish appeared

in Division VIIj during January 1994 at a time and in an area where they are not normally expected.

The Working Group estimates of catches taken in the fishery by statistical rectangle and quarter are shown in Figure 4.2.1a-d.

4.2.3 The catch data

The estimated catches from the combined areas by year and by season (1 April - 31 March) are given in Tables 4.2.1 and 4.2.2 respectively. The reported catches, including estimates of discards and un-allocated landings, taken during 1993/1994 were about 18,600 t compared with 21,100 t in 1992/1993. Catches have therefore continued to be reasonably stable in recent years. The decreased catch in 1993/1994 is probably a reflection of the poor demand for herring throughout the season. Some small alterations have been made to the 1991/1992 and 1992/1993 data but the total catches are not affected. The level of discards is believed to have decreased in this fishery in recent years. Observers were placed on a number of Irish vessels throughout the 1993/1994 season and catches were discarded on only one occasion. Nevertheless, an unknown level of discarding certainly does continue throughout the season. The Irish catches were therefore raised by 10% to include this amount. Estimates of discards are also available for the small catches taken by the Dutch fleet.

4.2.4 Quality of catch and biological data

Previous Working Groups have had major problems estimating accurate catches from this fishery particularly during the eighties and substantial revisions have been made to the catch figures on a number of occasions. Management authorities are now confident that the accuracy of the landings statistics has improved considerably in recent years. It is still possible that an unknown amount of under-reporting may occur. Misreporting of catches between Division VIIb and Division VIIj also takes place but the quantity misreported during 1993 probably decreased because of smaller catches from around the boundary between the two areas. As discussed in the previous section there is no precise estimate of the amount of discards. Biological sampling of the catches from this area continues to be satisfactory although the number of samples obtained during 1993 appears to have decreased. The sampling data are shown in Table 4.2.3 and the length distributions of the catches taken by the Irish fleet are shown in Table 4.2.4.

4.2.5 Catch in number at age

The total catches in numbers at age, including discards, per season are shown in Table 4.2.5 from 1958-1993. The data for 1993/1994 are mainly based on Irish samples during the spawning season. The age distribution during 1993/1994 is heavily dominated by 2 winter ring fish - i.e. the 1990/1991 year class which made up over 70% of the total catch. This year class was also well represented during the 1992/1993 season as 1 winter ring fish.

4.3 Mean Weight at Age

The major portion of the catches from this fishery are taken during the spawning season. The mean weights at age in the catches have therefore traditionally been taken as the mean weights at age in the stock at spawning time (1 October). The mean weights (g) are shown below for the four most recent seasons.

Season	1	2	3	4	5	6	7	8
1990-1991	99	137	153	167	188	208	209	229
1991-1992	92	128	168	172	190	206	229	237
1992-1993	96	123	150	177	191	194	212	228
1993-1994	92	129	155	178	201	204	210	225

In general the mean weights are very similar to those observed during 1992-1993.

4.4 Stock Assessment

4.4.1 Acoustic surveys

Acoustic surveys have been carried out on this stock each season since 1989/1990. Since 1991/1992 the surveys have been carried out by the Marine Laboratory, Aberdeen. A report of the 1993/1994 survey was available to the meeting (Reid and Simmonds, WD 1994) and the results of this and previous surveys were discussed in a working document (Molloy and Fernandes, WD 1994). There are difficulties in interpreting the results of acoustic surveys from this area. These arise because the surveys are carried out on spawning concentrations which are located inshore and spawning takes place over a prolonged period (October to February). Two surveys are therefore carried out each season designed to estimate the size of the autumn and winter spawning components. The results of the surveys must therefore be interpreted taking into account the possibility of double counting, the likelihood of the total spawning concentrations being within the survey area at the time of the survey, and the difficulties that arise because of species identification - e.g. there appears to be a very large sprat population present in the area.

Despite these difficulties the Working Group decided to try to use the results of the surveys carried out since 1990/1991 as estimates of stock size. It was also decided that the results of the first survey carried out in 1989/1990 gave an unrealistic estimate of stock size and should not be used.

The total stock size has been estimated by adding the numbers of immature 0 and 1-group from the survey that gave the highest estimate of these age groups to the combined estimate of spawning stock from the two surveys.

Age-disaggregated data were not available for the 1990/1991 survey. The spawning stock biomass for that year was therefore converted to numbers at age using the commercial catch data. In the absence of any data the number of immature fish for 1990 was assumed to be the average number observed during the following three surveys. This number was then added to the spawning stock numbers to give the total stock in numbers at age.

Celtic Sea - Division VIIj Total stock at age estimated from acoustic surveys (10^{-6}).

	Surveys			
W Rings	1990/ 1991	1991/ 1992	1992/ 1993	1993/ 1994
0	204.8	213.8	141.8	258.8
1	131.6	62.6	426.9	217.1
2	249.0	195.2	117.0	437.9
3	108.6	94.7	87.8	58.7
4	152.5	54.0	49.6	63.4
5	32.4	84.8	22.2	26.0
6	14.9	22.1	24.2	16.3
7	6.1	5.3	9.6	24.6
8	2.5	6.1	1.8	2.3
>8	1.5	-	1.1	1.7
Total	1,329.8	738.6	882.0	1,106.8
TSB (000't)	103.0	84.4	88.5	104.0
SSB (000't)	91.0	77.0	71.0	90.0

The acoustic surveys appear to indicate the presence of a very strong 1990/1991 year class. These fish present as 2 winter ring fish in 1993/1994 were also well represented as 0 and 1-group in the 1991/1992 and 1992/1993 surveys. This year class is, as referred to in a previous section, also very well represented in the catches taken during the last two seasons.

4.4.2 Results of assessments

The integrated catch analysis program (ICA) was used for the first time in the current assessment to reconstruct the stock sizes in this area based on the acoustic survey data which is the only tuning index available. Age-disaggregated acoustic abundance estimates are available for the period 1990/1991 to 1993/1994 inclusive and these estimates were used in this analysis excluding the 0-ring fish. Two alternative assumptions for the relationship between the acoustic survey abundance and total stock abundance were investigated: 1) absolute and 2) proportionate. Assuming that the acoustic survey provides an absolute measure of abundance results in spawning and total biomass estimates of 155,000 and 217,000 tonnes, respectively. The recent increasing trend in biomass occurs in conjunction with a drastic decline in the estimated fishing mortality from 0.48 in 1989 to 0.14 in 1993. The estimate of recruitment for the strong 1990/1991 year class is for 2.2 billion fish almost 4 times larger than any other year class observed since 1975. The model diagnostics showed a poor fit of the populations to the survey data and the view of the stock being at such a high level seems unlikely. Consequently this model fit was rejected.

The model formulation assuming absolute estimates of stock size from the acoustic surveys was:

$$\sum_{a,y} (\log(C_{a,y}) - \log(\hat{C}_{a,y}))^2 + \lambda_a \sum_{a,y} (\log(ACOUST_{a,y}) - \log({}_a\hat{N}_{a,y}))^2$$

where a and y suffices indicate year and age; lambda is a weighting value set at 0.1 for age 1 and at 1 for all other ages; $N_{a,y}$ are population sizes calculated for the time of the acoustic survey; and $ACOUST_{a,y}$ are the numbers of fish observed by the acoustic survey for each year and age.

The second model fit assumes that the acoustic survey provides a proportional index of stock abundance and results in estimates of spawning and total stock biomass of 57,000 and 99,000 tonnes, respectively. The estimates of recruitment of the strong 1990/1991 year class are 1.02 billion fish, about the same level as the 1985/1986 year class. The estimate of the relationship between the VPA abundance and the catchability from the acoustic survey index is consistent for most age-classes for this analysis. The assumption of a proportional relationship between acoustic surveys and stock abundance provides a more consistent description of the assessment data available for this stock. The results of the output from this run are shown in Table 4.4.1 and Figures 4.4.1, 4.4.2 and 4.4.3.

The second model formulation assumes, that proportional estimates of stock abundance are obtained from the acoustic survey whereby:

$$\sum_{a,y} (\log(C_{a,y}) - \log(\hat{C}_{a,y}))^2 + \lambda_a \sum_{a,y} (\log(ACOUST_{a,y}) - \log(Q_{ACU,\,a}\hat{N}_{a,y}))^2$$

and Q_{ACU} is the coefficient relating the indices from the acoustic survey to the stock size estimates.

4.4.3 State of the stock

The results of the assessment using the disaggregated age data from the acoustic surveys in the ICA model as a proportionate estimate of stock size appear to give the best estimate of the state of the stock in the most recent period. The spawning stock appears to have been between 55,000 t and 63,000 t from 1991-1993. These levels are lower than the levels calculated directly from the acoustic surveys, i.e. 71,000 - 91,000 t. The stock is also heavily dependent on the 1990/1991 year class which recruited during 1992/1993. Although this year class appears to have been the strongest one to have entered the fishery for some time it has not produced any corresponding increase in spawning stock. Fishing mortalities for this stock are known to fluctuate quite rapidly in response to changes in effort and these fluctuations are again evident from 1990 to 1993 when F has varied between 0.6 and 0.40. Levels of F in this stock have always appeared to have been high in comparison with those in other stocks. It is important to stress, as has been pointed out by previous Working Groups, that it is not possible to detect any period in the development of the stock when F values were at a stable and low level.

4.5 Recruitment Estimates

There are as yet no recruitment indices available for this stock which can be used for predictive purposes. The Study Group on Herring Assessment and Biology in the Irish Sea and Adjacent Waters (Anon. 1994b) have stressed the importance of re-examining the data obtained from young fish surveys carried out in the Irish Sea but this has not as yet been done. The results from this assessment indicate that the 1990/1991 year class is a very strong one. In order to get an estimate of recruitment for predictions the geometric mean value of the numbers of 1 ring fish from 1983-1992 was calculated including and excluding the very high value in 1992. The estimates obtained were 553 million and 517 million respectively. The more conservative value was used in the stock and catch predictions.

4.6 Stock and Catch Projections

Stock and catch projections were made for 1995 and 1996 using the stock in numbers at age at 1 January 1994 estimated from the ICA model and a mean geometric recruitment in 1995 and 1996 of 517,086 million fish. Catches in 1994/1995 were assumed to be 21,000 t, i.e. the TAC level. This catch level was also assumed for 1995/1996. A further projection was carried out for $F_{status\ quo} = 0.53$, i.e. the average level of the last five years. The results of the projection show that the spawning stock will remain at about the present level for the next two years. A continuation of fishing at the *status quo* level will produce catches in 1995 of about 18,000 t. Because of the uncertainty about the recruitment level it is not advisable to continue the projection further than 1996. The recruitment of the strong 1990/1991 year class would normally have produced a significant increase in SSB. This year class was, however, subjected to a high fishing level in 1993/1994 and was followed by what appears to be a poor 1991/1992 year class. The SSB, therefore, has not shown any increase in 1993 or 1994.

The summary of the projections is shown in Tables 4.6.1 and 4.6.2. The yield/recruit curve is shown in Figure 4.6.1.

4.7 Management Considerations

In the absence of any analytical assessments the stock in this area was managed in 1993 on the basis of a precautionary TAC. The most recent assessment, based on the acoustic surveys, must be treated with caution for reasons stated in previous sections.

There are a number of important aspects, however, which should be considered. The stock in this area has been subjected to a relatively high fishing rate in relation to that in other stocks. The SSB has consequently fluctuated considerably and decreased to a very low level in the 1977 to 1982 period. The stock is now heavily dependent on the 1990/1991 year class and is predicted to decrease after 1996 at present catch rates. Because of the history of the stock and the presence of a roe fishery the present spawning box closures should be maintained. The boundaries of these boxes may need to be modified in view of the possible changes in management units. The spawning boxes should, therefore, be re-evaluated at the 1995 Working Group.

5 WEST OF SCOTLAND HERRING

5.1 Division VIa (North)

5.1.1 ACFM Advice applicable to 1993 and 1994

The ACFM recommended a TAC for 1993 of 54,000 - 58,000 t while the agreed TAC was 62,000 t. The ACFM figure was calculated on the basis of maintaining *status quo* fishing mortality, at which level the stock biomass was expected to be maintained. This TAC was set on the assumption of geometric mean recruitment in 1991 - 1993 and the agreed TAC being caught in 1992.

Over the years 1988 to 1992 reported catches did not reach the agreed TACs. The agreed TAC for 1994 was 62,000 t.

5.1.2 The fishery

The catches reported for each country are given in Table 5.1.1. The total catch was estimated to be 56,175 t including discards and unallocated catches, compared with the agreed TAC of 62,000 t. This is the sixth year in succession in which the TAC was not reached. Estimates of discards were available for one fleet and estimates of unallocated catches were available for three fleets. Negative unallocated landings arise because of misreporting of catches taken in adjacent areas.

Fishing was reported to be good with catches increasing slightly in 1993 compared with 1991 and 1992. Quality of fish in the early part of the year was poor, with small spent fish being caught inshore. However, very good quality full herring were caught from September onwards. Fleets moved southwards during the season in order to target pre-spawning herring. There have been informal reports of misreporting of North Sea herring catches as having been taken in the Division VIa(N) area. From one fleet, five reports of such misdeclarations were made, accounting for 660 t of fish. It is likely that more undetected misreportings also occurred. Such misdeclarations are likely to happen when the North Sea quota is nearing completion as the Division VIa(N) quota has not been reached in recent years. The North Sea fishery also takes place somewhat earlier than the Division VIa(N) fishery.

In addition the Faroese fishery in Division Vb caught approximately 10,600 t of herring in 1992 and approximately 1 500 t in 1993. Although these fish may belong to the Division VIa(N) stock, it was shown in the 1992 assessment that the impact of including these catches in the analysis is small. As the catches are even lower in 1993, the analysis will not again be repeated with the inclusion of these catches.

5.1.3 Catch in number at age

Age composition data for 1993 were available from Scotland (all quarters), the Netherlands (quarters 1-3) and Norway (second quarter). French and German catches were assumed to have the same age structure as Dutch catches except for the fourth quarter in which the Scottish age structure was assumed. English catches were assumed to have the same age structure as Scottish landings. Catches by Scotland include landings from the Minch fishery which is not exploited by the non-UK fleets and also exploits a higher proportion of juvenile fish.

The sampling effort used to derive the catch in numbers is summarised in Table 5.1.2. and the estimated catches in numbers at age are given in Table 5.1.3, including historical data back to 1970. Some minor historical revisions to the Scottish catch-at-age data for 1991 and 1992 have been necessary. Data given in Table 5.1.3. have been amended accordingly.

5.1.4 Larvae surveys

Sampling coverage of the Division VIa(N) larval survey improved in 1993. A total of 323 samples were taken compared with 198 samples in 1992 and 193 samples in 1993. Coverage returned to historical levels, but it is unlikely that there will be a larval survey in 1994.

The sampling period recommended in Anon. (1990b) for the calculation of the larval production estimate (LPE) in this area is compared with the available samples in the text table below:

Recommended Period	Period sampled	n
15/09 - 7/10	03/09 - 12/09	177
	08/10 - 19/10	194

The requirements for the calculation of the larval abundance index (LAI) compared to the available data are as follows:

Time periods required for			
Full Index	Reduced Index	Available samples	n
01 - 30/09 01 - 31/10	01 - 30/09	03/09 - 12/09	177
		08/10 - 19/10	194

Although the number of samples taken was much improved over the two previous years, in 1993 the timing of the larval survey was inappropriate, and no samples were taken in the recommended period from 15 September to 7 October. This suggests that the LAI and LPE indices may not be consistent with the indices from previous years.

Values of the LAI and LPE estimates for the area are given in Table 5.1.4.

5.1.5 Acoustic survey

In the report of the Working Group in 1991 reasons are discussed for omitting the acoustic surveys in November or December from 1985-1990 with the exception of 1987, from the analysis. This information will again be

omitted from the analyses. In order to use the entire available information from the acoustic surveys, these were used in an age-disaggregated form. The age structure information for the 1991 survey is poor, and in order to allow inclusion of this survey in an age structured analysis it was assumed that the age structure of the surveyed biomass was similar to that of the commercial catches from the area. Commercial catches are the best available source of information on the age structure of the catchable fish in the area, and the pattern of availability of fish by age to the acoustic survey was similar to that in the commercial catches in 1993.

An acoustic survey of Division VIa (N) was completed from 14 July to 29 July 1993 using a chartered purse-seine fishing vessel. As the 1992 survey found a large concentration of herring close to the southern limit at 56°30'N this limit was extended a further 30'southwards in 1993. Consequently survey efficiency may have improved slightly in 1993.

The usual sampling area was extended slightly and echotraces were allocated among the categories 'herring', probably herring', 'surface schools' (mostly sprat), 'other pelagics' and 'gadoids and others'. 75% of the integrator output allocated to 'herring' was derived from the 'herring' category, the remaining 25% being derived from the 'probably herring' category. A total of 936 successful trawl hauls were shot on the echotraces, of which 21 captured sufficient herring to provide adequate samples. The age structure of the stock is consistent with that observed in the 1992 survey when 2/3 and 6-ringers predominated in the samples

The spawning biomass of the stock was estimated to be 866,510 t, compared with 428,600 t in 1992. This increase is inconsistent with the age structure of the stock (it is not due to recruitment) indicating that survey efficiency was substantially higher in 1993 than in 1992. The reasons for this are not known and, although the extension of the survey area may have played a part, the additional stock biomass recorded from the extended area was only 7.5% of the total. The high inter-year variability of the index may be attributable to a high sampling variance on local and dense aggregations of fish. Results of the surveys by age are given in Table 5.1.5.

In fitting the age-structure model to the survey data it was assumed that 50% of annual mortality had been incurred before the surveys. This figure was calculated by assuming that natural mortality is constant throughout the year, and that fishing mortality can be apportioned in the ratio of seasonal catches in 1993.

5.1.6 Recruitment

The acoustic index is still not usable as an index of recruitment because the time series is too short. In addition the few data available are so variable that it seems likely that the acoustic index will be a poor predictor of the strength of the recruiting year-class.

No index of recruitment from the Scottish groundfish surveys is presently available. This survey has been executed slightly later in the year, and together with the slightly earlier timing of this assessment working group meeting it has proved impracticable to provide this information. The loss is perhaps small as this survey has a poor proven predictive power for estimating herring recruitment, and a geometric mean recruitment has been assumed even for those years when the index was available.

5.1.7 Mean weight at age

Weight at age data from the 1993 fishery were available from Scotland, Norway and the Netherlands and are shown in Table 5.1.6. In previous assessments a historical mean weight at age in the stock has been used. Beginning in 1992, however, reasonably good estimates of mean weight at age in the stock are available from the acoustic surveys. It was decided to begin using these estimates rather than historical means. These are given in Table 5.1.6. Consequently, the historical mean weights at age were replaced with the weights at age estimated in the acoustic surveys in 1992 and 1993.

5.1.8 Description of the assessment method

In recent years the herring stock in Division VIa(N) has been assessed using a manually-tuned least-squares separable method, although a comparative assessment based on an integrated statistical analysis was provided in 1993. Following further software development it has been decided to base the current assessment on an integrated analysis of the Deriso-Gudmundsson-Kimura style, which is essentially a separable VPA tuned by computer rather than by hand. As such, it is very similar to the method used in recent years to assess this stock. Details of the method are given in Appendix 1.

5.1.8.1 Model Formulation

For consistency with previous assessments, a separable model was fitted over the last six years of the assessment with terminal selection set at 1.2 relative to reference age 3 rings.

In the present assessment there are three possible treatments of the larval survey information, as the traditional LAI and LPE indices and also a 10% trimmed mean. These could bear either a proportionate or a power

relationship to stock size. There are only four years for which usable acoustic survey information is available, and it is therefore inherently infeasible to consider investigating a power relationship due to the small number of degrees of freedom. There are thus (2*3)+2 = 8 possible ways to index stock size. In order to investigate the relationships of these models and data treatments all eight combinations were fitted separately. It was not found to be feasible to fit the LPE or the 10% trimmed mean of the larval indices as power measures of stock size, as the sums of squares surface did not have a minimum over a reasonable range of terminal fishing mortalities. An example is given in Figure 5.1.1. Estimates of terminal fishing mortality from the other model fits are given in Figure 5.1.2, which shows that in all cases fishing mortality estimates were below 0.2. In such a case it is clearly difficult to use VPA methodology to estimate stock sizes reliably.

It was decided to formulate the baseline assessment using (1) the larval abundance index as a power measure of abundance, and (2) the acoustic index as a proportionate measure of stock numbers at age. This choice was made on the basis of the following considerations:

(1) Only a single measure of abundance from the larval surveys should be included in the assessment, in order to avoid including two or more measures based on the same observations.
(2) Of the available larval measures, the LAI was chosen on the basis of historical consistency. It was chosen to assume a power relationship for this index because forcing a proportionate relationship leads to a perception of fishing mortality that is low in comparison with the other estimators.
(3) The other measures based on the larval index (except the LAI(linear)) lead to almost identical views of the stock. Including these also in the assessment would not therefore change the estimation substantially.
(4) In the 1993 assessment the desirability of fitting the acoustic index in a proportionate relationship was noted, but there was then insufficient information to allow this to be done. In the present assessment there are now 4 observations, which allow such a formulation to be used.
(5) The acoustic surveys used as an absolute index and the LAI used as a proportionate index lead to consistent and very low estimates of F. Whilst there is no *a priori* reason to believe that such is not the case, it was decided to maintain the consistency with the 1993 assessment. It was decided to use the LAI as a power measure of stock size and to use the acoustic index as a proportional measure. This leads to a cautious view of current stock dynamics.
(6) For medium-term predictive purposes a Beverton and Holt stock-recruitment relationship was included in the model, but such 'observations' were down-weighted to 1% of the weights of the other observations. This ensures that the estimated populations are not constrained towards fitting to the stock recruitment relationship, although there may be arguments for forcing the model in this way.

The final model formulation used was therefore:

$$\sum_{a,y}(\log(C_{a,y}) - \log(C'_{a,y}))^2 +$$
$$\sum_{y}(\log(K_{LAI}SSB_y^{Q_{LAI}}) - \log(LAI_y))^2 +$$
$$\lambda_a\sum_{a,y}(\log(Q_{ACU,a}N^*_{a,y}) - \log(ACOUST_{a,y}))^2 +$$
$$0.01\sum_{y}(\log(N_{1,y+2}) - \log(\frac{aSSB_y}{b+SSB_y}))^2$$

where a and y suffices indicate year and age, Q_{LAI}, K_{LAI} and $Q_{ACU,a}$ are the coefficients relating the indices and the acoustic abundance estimates to the stock size; lambda is a weighting value set to 0.1 for age 1 and to 1.0 for all other ages; $N^*_{a,y}$ are population sizes calculated for the time of the acoustic survey; LAI_y are the values of larval abundance in each year; $ACOUST_{a,y}$ are the values of the acoustic survey for each year and age. Lastly a and b are the parameters of the Beverton and Holt stock recruitment relationship.

5.1.9 Baseline Assessment

Using the criteria defined in the previous section a baseline assessment has been calculated. No attempt was made to use an inverse-variance weighting procedure on account of (1) the possibility of over fitting the separable model, and (2) inability to estimate variances of the acoustic index reliably. Instead, all observations were given equal weight in the assessment, with the exception that the acoustic estimate of 1-ringers was down weighted to 10% on account of a perception that this survey is a poor indicator of this age group (Anon. 1993). Values so estimated are given in Table 5.1.7. and Figures 5.1.3.-5.1.16. Some comments on the diagnostics have been included in the figure legends. Salient points of the assessment are:

1. Fishing mortality is low, and in the range 0.086 to 0.24 (Parameter 95% C.I.s) (Figure 5.1.4).
2. The catches at age are reasonably consistent with the separable model, except for the 1-ringers (Figure 5.1.5).
3. 1-ringers are highly variable in the acoustic index (Figure 5.1.7).
4. 4-ringers may have been overestimated and 5-ringers underestimated in the acoustic index (Figures 5.1.10-11).
5. Assumptions of log normality in the index observations are not demonstrably violated (Table 5.1.7).

6. Perception of fishing mortality in 1992 has risen from 0.13 in last year's assessment to 0.14 (95% C.I. 0.093 to 0.24) in the present assessment (Table 5.1.7), but the assessments are consistent as last year's estimate falls within the confidence interval calculated in this year's assessment.

5.1.10 Short-term projections

Short-term projections were calculated on a similar basis to that in the 1993 assessment. Specifically:

1. The starting populations for the projections were the terminal populations from the separable model, estimated on 1 January 1994 except that populations of 3-ringers were replaced with the geometric mean of 2-ringers over the years 1982-1991, decremented by natural mortality and estimated fishing mortality on 2-ringers in 1993.
2. *Status quo* fishing mortality was defined as the mean fishing mortality of 3-6 ringers over the period 1991-1993.
3. 1-ring fish were excluded from the projection.
4. Catches in 1994 were assumed equal to the TAC, *ie* 62, 000 t.
5. Fishing mortality in the projections was assumed to follow the selection pattern estimated in the separable model.

For comparative purposes stock projections were calculated for $F_{status\ quo}$ in 1994 and 1995. The resulting projected catches were 56,978 t in 1994 and 56,827 t in 1995. The present analysis and projections are highly consistent with advice given in 1993 that catch levels of 54,000 to 58,000 t would result in fishing mortality at around *status quo* levels.

A catch projection assuming that 62,000 t will be taken in 1994 and that $F_{status\ quo}$ mortalities will apply in 1995 is given in Table 5.1.8. This indicates a *status quo* catch for 1995 of 59,271 t. A further projection was carried out for $F = F_{status\ quo} * 1.2$, in order to provide an option for a 20% increase in fishing mortality. The catch in 1995 corresponding to this option is estimated as being 69,882 t (Table 5.1.9).

5.1.11 Medium-term projections

A medium-term stock projection calculated as given in Patterson (Working Document 1994a) is given in Figures 5.1.17 and 5.1.18, based on the starting populations in 1993 and assuming that fishing mortalities in the period 1994-2013 remain fixed at the fishing mortality estimated for 1993, weights at age in the stock remain fixed at their mean values over the period 1988 to 1993, weights at age in the catches remain fixed at their values estimated in 1993, selection remains constant, and that recruitment depends on stock size according to the Beverton and Holt stock-recruitment model. Variances about the projections are calculated on the assumption that errors are log normally distributed, that the variances of the parameter estimates are correct and that delta-method estimators of variance are appropriate. The estimates of variance so calculated are provided for illustrative purposes only, as the method has not yet been thoroughly tested. Nevertheless, they appear intrinsically reasonable, and suggest that the stock assessment is insufficiently well defined at present to estimate stock sizes or projected catches beyond about 1998. Fishing at present levels would seem to be a low-risk strategy.

5.1.12 Long-term yield

A conventional yield-per-recruit analysis was repeated with the updated population estimates (Figure 5.1.19). $F_{0.1}$ was again estimated at 0.136. F_{max} is poorly defined and is arguably an unsuitable reference point for a pelagic fish. Its value was estimated at 0.581.

5.1.13 Uncertainties in the assessment

5.1.13.1 Uncertainty in model formulation

Figure 5.1.2. shows that the estimated fishing mortality is somewhat different depending on the tuning index used and on the way in which it is treated in the model. There is no *a priori* objective criterion for making such a model choice, hence uncertainty is introduced due to lack of prior knowledge as to which model formulation is correct. On this basis, estimates of current year fishing mortalities could lie in the range 0.083 to 0.163 depending on the tuning index used, the way in which it is calculated, and the relationship it is assumed to hold to stock abundance. The highest upper 95% confidence interval of terminal-year fishing mortality was below 0.45. The range of estimates is generally consistent and below the assumed natural mortality.

5.1.13.2 Parametric uncertainty

Research in methods for assessing uncertainty in stock assessments is still at a rather early stage. Simple simulation trials indicate that estimates of the variance of terminal-year fishing mortality can be made (predicated on parametric error assumptions) that are accurate to within +/- 30%. As an indicator of uncertainty in the overall assessment, simple separable VPAs were initiated with terminal Fs corresponding to the estimated F +/- 1.96 * estimated parameter standard deviation, in order to approximate 95% confidence bands. The estimated time series of biomass together with the upper and lower confidence bands are given in Figure 5.1.20.

5.1.13.3 Misreporting and discarding

It is likely that discarding and slipping can be important contributors of fish mortality in this area, as herring markets are very sensitive to size, condition and maturity stage. It has not proved possible to quantify the uncertainty from this source.

5.1.13.4 Changes in selection

The analytic method used here assumes, as has that used in recent years, that selection pattern was constant over the six most recent years of the fishery. It is difficult to discriminate changes in selection from a time-trend in recruitment. For example, increased catches of smaller fish can be due either to an increase in recruitment or to an increase in selection on younger ages; the model cannot discriminate between the two without external information. In an attempt to investigate any such possible changes, a model fit was repeated with very high weights (10.0) forced on the tuning indices, so that the selection pattern of the commercial fleets could be examined for consistency against the populations tuned on the survey data alone. This affords a simple test of the validity of the separable assumption. Figure 5.1.21 shows that there is little evidence of changes in selection.

5.1.13.5 Uncertainty for management

This assessment in common with recent assessments of this stock indicates that fishing mortality is very low in comparison to most other exploited stocks in the ICES area. Although there are known to be marketing difficulties, it is worthwhile considering whether any set of circumstances or biasses may have arisen that could have led to this view being wholly erroneous. Two circumstances satisfy this condition:

1. Continuous improvement in the efficiency of the surveys
2. Improved quality of catch reporting by fishermen, such that an increase in catches in Division VIa North is marked by a decrease in misreported catches in the North Sea.

As both the teams involved in surveying the stocks and also the fisheries inspectorate have been attempting to improve the efficiency of their work, this combination of circumstances is regrettably entirely plausible, but cannot at present be quantified.

5.1.13.6 Consistency of assessments

It is not possible to calculate an informative retrospective analysis for this stock, as the assessments are heavily dependent on a short time series of acoustic survey data. Thus, deleting recent data leaves a data set which is too small for a comparable analysis to be calculated. Recent assessments have been calculated using a variety of assumptions about survey indices, but in general the assessments have been relatively stable considering the low fishing mortality in this stock and also the uncertainty introduced by having few and variable survey indices. A summary of estimates of fishing mortality made in recent assessments is given as Figure 5.1.22. Recent estimates of F have fluctuated in a narrow band around F =0.2. The spawning biomass in the previous assessment was calculated as 430,000 t in 1992, whereas in this assessment it is estimated to be only 293,000 t. The difference arises largely as a result of the use of new and substantially lower weights-at-age (Section 5.1.7) but also as a result of the slightly higher estimate of fishing mortality in 1992 made in this assessment. The 1992 populations in number from the two assessments are presented in Figure 5.1.23, which indicates that the perception of the population size and structure of the stock in 1992 has not undergone a very marked change. The change in the estimate of the 1992 stock size was partly due to the new mean weights (40%) and partly due to the new assessment (60%).

5.2 Clyde Herring

5.2.1 Advice and management applicable to 1993 and 1994

Management of herring in the Clyde is complicated by the presence of two virtually indistinguishable stocks: a resident spring-spawning population and the immigrant autumn-spawning component. In recent years management strategies have been directed towards rebuilding the highly depleted spring-spawning component to historical levels.

For 1993 and 1994 the TAC was reduced to 1,000 t from 2,300 t in 1992. The ban on herring fishing to protect the indigenous spring-spawners, initiated in 1990 and extended in 1992 from 1 January until 30 April, was continued for 1994. Other fishing activities were allowed a 200 t maximum by-catch during the closed season. In addition the spawning grounds at Ballantrae Bank were closed to all forms of active fishing from 1 February to 1 April in order to prevent disturbance to spawning shoals and to the demersal eggs themselves.

5.2.2 The fishery in 1993

Landings up to 1993 are presented in Table 5.2.1. Total landings were estimated to be 852 t compared with 926 t in 1992. Both estimates were below the TAC of 1 000 t. Of the total landings, 740 t were taken by pair trawlers in the directed fishery between July and December, and 92 t were taken as a by-catch in demersal trawl fisheries in all months. A further 20 t was taken by single-vessel pelagic trawl gear. No information on

discarding was available for 1993. In 1991 by-catch sampling of herring from demersal trawl catches indicated a high proportion by number of the 1986 year-class in the catches. Historically the contribution of this year-class to the catches in number has been large and is recorded in the 1993 assessment. Sampling levels are given in Table 5.2.2.

An index of effort has been calculated by raising the number of days absence from port by pair trawlers, raised by the ratio of pair trawl to total landings. Values are given in Table 5.2.4. Effort in 1993 increased slightly from the lowest recorded level of 1992.

The proportions of spring and autumn spawners in the catches could not be estimated by the Working Group as only the spring-spawning aggregations were sampled in 1993.

5.2.3 Weight at age and stock composition

Problems in age-readings of Clyde herring in 1992 were noted in the 1993 report. These have now been addressed, and amended estimates of catches at age are given in Table 5.2.3. Despite revision, there still exists an anomalous age-distribution with a marked high catch of 5-ring fish for the past three years in succession. There is no obvious explanation for this age distribution, except the immigration of fish from areas other than the Clyde. The age structure shows no indication of improved recruitment into this fishery.

Weights at length have been assigned using the weight-length relationship observed in 1991 and assigned to ages accordingly. Mean weights at age are given in Table 5.2.5. As mean weights in the stock from research vessel surveys are not available for 1993 the weights in the stock used are simply the weights at age in the catches. Weights at age in previous years are as used in the 1993 assessment.

No attempt has been made to apportion catches between spring and autumn-spawning stocks for 1993. The analysis attempted in 1992 indicated that only a small part of the catch could be allocated with any precision. Furthermore, 85% of the catches were taken between September and November, which may suggest that the fishery has been directed at aggregations of autumn-spawning fish.

5.2.4 Surveys

A demersal egg survey was carried out in April 1993 on the Ballantrae and Brown Head spawning sites (Table 5.2.6.). Unfortunately, timing of the survey was somewhat inappropriate as eggs were still being deposited on the last days of the survey. As such only a minimum estimate of stock size can be calculated. Using this approach it is estimated that the stock size was at least 3,000 t. This is the lowest value yet recorded from surveys of this type, and although the survey was incomplete the survey result is indicative that the stock is at a very low level. The age composition of samples from four trawl catches taken from spring-spawning aggregations is given in Table 5.2.7, together with comparable data from earlier years. The samples indicate a somewhat unexpected age composition, being predominantly three- and five- ring fish. There was no indication that the 1986 year-class in 1991 was carried forward, nor from the earlier surveys that the cohort represented by the five-ringers in 1993 was a strong one. Although the sample size was small, this finding would seem to cast doubt on our current understanding of the spring-spawning Clyde population as an isolated stock.

No acoustic surveys have been conducted in the Clyde since 1992. Historical survey data are presented in Table 5.2.8.

5.2.5 Stock assessment

Because of uncertainty about stock structure no formal analytic stock assessment has been attempted in 1994. No joint-stock VPA will be calculated on account of the known extensive migrations of autumn spawners in and out of the area.

5.2.6 Stock and catch projections

As no analytical estimates of the stock have been calculated, no new stock projections can be provided.

5.2.7 Management considerations

Management of this fishery continues to be problematic due to the mixed-stock nature of the fishery. Further research is required to improve our understanding of the Clyde stock structure.

Suitable management objectives for the spring-spawners and autumn-spawners are necessarily distinct. The spring-spawning stock supported a strong and locally important fishery from 1955 to 1974 at catch levels of the order of 8,000 t. The stock appears to be at a record low level, but the appearance of significant numbers of three-ringers in the survey catches may indicate some beginnings of a recovery. If the stock is to enjoy continued protection, current management measures should remain in force. This could be achieved by reducing the catch and by maintaining the technical measures to protect the spring-spawning stock that are already in place.

5.2.8 Future research requirements

Provision of improved survey data for this area is imperative if an analytic assessment for the stock is to be provided.

6 HERRING IN DIVISIONS VIA (SOUTH) AND VIIB,C

6.1 The Fishery

6.1.1 Advice and Management applicable in 1993 and 1994

The TAC set for this area for 1993 was 28,000 t. This precautionary TAC was the same as that set in 1992. The total catch estimated by the Working Group to have been taken from the stock in this area during 1993 was about 36,800 t, compared with 31,800 t in 1992. The total catch was therefore, as it has been every year since 1982, considerably higher than the recommended level. ACFM in 1993 did not recommend a specific TAC for this stock but suggested that if a precautionary TAC is to be set for 1994 then the currently agreed level of 28,000 t seems appropriate. A TAC of 28,000 was subsequently set by the EU for 1994.

6.1.2 Catch data

As has been the position for a number of years the main catches from this area are taken by the Irish fleet. The catches taken by this fleet during 1993 were again regulated by weekly boat quotas and a closed season was introduced during July. The total amount of unallocated catches during 1993 was over 6,000 t. This was mainly made up of catches in excess of national quotas and catches which were misreported as having been taken from Division VIa (North).

The catches taken by each country fishing in this area from 1984-1993 are shown in Table 6.1.1. The catches for 1993 are preliminary. It has not been found necessary to make any alterations to the 1992 catch data. The quantities of herring discarded in this fishery are believed to be insignificant. Estimates are only available from the Dutch fleet but catches by this fleet are comparatively small.

The pattern of the Irish fishery in 1993 was similar to that of 1992, and the recent more northerly distribution of the fish in this area appears to have been maintained during 1993. The Irish fleet has been very stable for a number of years and is composed of 18 vessels which use pair mid-water trawls. The large tank vessels which usually fish mackerel have not in recent years fished for herring because of poor markets.

The total catch taken during the 1st quarter was 8,700 t. As mentioned in the 1993 Working Group report these catches taken from the northern part of Division VIa (South) contained a large proportion (40%) of winter spawning herring. Catches taken during the 2nd quarter were again from the area off the north coast of Ireland. Over 22,000 t or about 60% of the total catch were taken in the 4th quarter. Most of these fish were full and spawning fish and very few spent fish were taken. This is very different to the traditional fishery in this area which used to exploit mainly spent fish. Catches during the 1st quarter of 1994 also contained a large component of winter/spring spawners (41%).

The distribution of the catches by quarter are shown in Figures 4.2.1a-d.

6.1.3 Catch in number at age

The catches in numbers at age for this fishery since 1970 are shown in Table 6.1.2. The catches in numbers at age are based mainly on samples from the Irish fishery taken throughout the year, together with a small number of Dutch samples. The Irish data have been used to convert the UK (Scotland) catches to numbers at age. The age composition of the catches are mainly composed of 7-ring fish (1985 year class) which constitute 33% of the total. This year class is well represented throughout the area and also in the catches from Division VIa North and Division VIIj. The 1988 year class (4-ringed fish) constituted over 20% of the catches.

6.1.4 Quality of the catch and biological data

The quality of the catch data from this area appears to be reasonably good. Although considerable amounts of catches which are in fact taken in Division VIa (South) are reported as having been taken in Division VIa (North) it is possible to reallocate them using information from the fisheries. Misreporting of catches also takes place between Division VIIb and Division VIIj but the amount in 1993 is believed to be small. Under-reporting of catches may occur but it is difficult to estimate to what extent it exists. The level of biological sampling is satisfactory for the fishery and good coverage of the catches has been maintained. The numbers of samples and biological data are given in Table 6.1.3 and the length distribution of the catches taken by the Irish fleet by quarter are given in Table 6.1.4.

6.2 Mean weight at age

The mean weights (g) at age in the catches in 1993 are based on a combination of Irish and Dutch data and are shown below with those for 1991 and 1992:

	Age							
Year	1	2	3	4	5	6	7	8
1991	89	134	145	157	167	185	199	207
1992	95	141	147	157	165	171	180	194
1993	112	138	153	170	181	184	196	229

The mean weights in 1993, apart from the 2-ringers, are higher than those in 1992. This may be explained by the fact that a higher proportion of the total catch was taken during the spawning fishery.

The mean weights at age for the stock at spawning time are based on Irish samples taken from the spawning fishery during the October to December period. The mean weights are shown below compared with those from 1992. A table showing the mean weights from 1988 to 1992 is shown in the 1993 Working Group report and suggests that the 1993 values are slightly higher than those obtained in recent years.

	Age							
Year	1	2	3	4	5	6	7	8
1992	144	167	182	194	197	214	218	242
1993	166	196	205	214	220	223	242	258

6.3 Young Fish Surveys

Young fish surveys have been carried out intermittently in this area for a number of years. The results up to 1992 were examined by the Irish Sea Study Group (Anon. 1994b). However, it has not been possible to use the results as indices of recruitment - probably because of the small numbers of stations (<10) sampled on many of the surveys. An expanded survey was carried out in November 1993 during which over 60 stations were sampled. Very small numbers of 0 and 1-group herring were taken. It is important that these surveys should be continued and that they be properly planned and executed in future if meaningful results are to be expected.

6.4 State of the Stock

Recent Working Groups have been unable to carry out any analytical assessment for the stock in this area due to the absence of any fishery independent data. The situation has not changed in 1993 and no assessment was carried out by the present Working Group which could be used for the purpose of providing management advice.

The fishery in this area has been very constant in recent years with little change in the composition of the fleets. Poor markets and low prices have prevented any increase in effort. Reports from fishermen suggest that shoals are abundant and the age composition of the catches does not suggest a stock that is heavily exploited.

In the absence of any data necessary for assessments, it was decided to adopt the same procedure as was adopted by the 1993 Working Group. A VPA was thus carried out in order to study the development of the stock in recent years. A separable VPA was carried out using the updated data and a terminal S value of 1.2 and downweighted prior to 1988 to 0.001. Using a reference age of 4 the exploitation pattern rose sharply on age groups 6 and 7. This was also apparent in the exploitation pattern which was calculated by the separable VPA carried out in 1993 and may indicate some sampling inconsistencies (Table 6.5.1). The terminal populations from the separable populations were used to carry out a traditional VPA using an input F value = 0.30. This value was selected merely to be consistent with that chosen for the corresponding VPA carried out in 1993. The results from this VPA are summarized in Table 6.5.2.

The results from this VPA show the very big recruitment of the 1985 year class in 1987 and the dramatic subsequent increase in SSB in 1988. Since 1987 there appears to have been no high recruitment and the spawning stock has slowly declined. However, the results of this VPA contain no information which can be used for stock predictions. The present state of the stock is unknown and there is no evidence to suggest that it is being heavily exploited. For comparative purposes VPAs were also carried out using input F values of 0.2 and 0.4. The resulting spawning stocks are shown in Figure 6.4.1. The slow convergence in the VPA with the input terminal F's of 0.2 - 0.4 indicate a fishing mortality that is likely to be low at present.

6.5 Future assessments

As has been pointed out in this and recent Working Group reports it has not been possible to carry out a analytical assessment of the stock in this area. The reasons for this are the lack of surveys and also the area over which the stock has been assessed previously. These difficulties have been discussed in detail by the Study Group which met in February 1994 (Anon. 1994b). Arising out of the report of this Study Group this Working Group recommends:

1. That acoustic surveys should be carried out to assess the size of the herring stock along the west coast of Ireland between 56°N Lat. and 52°N Lat. These surveys should be coordinated with the ICES co-ordinated acoustic survey. (A first survey in this area will in fact be carried out by Ireland in July 1994).

2. That young fish surveys should be continued in this area. These surveys should be properly designed and standardized. Previous surveys should be re-evaluated.

3. That future assessments should be carried out over Divisions VIa South, VIIb and the northern part of Division VIIj as far south as 52°N.

4. That the data bases should be altered to include the additional catches from the proposed new area and that these should be available for the 1995 Working Group meeting.

6.6 Management Considerations

The Working Group endorses the recommendation made by the Study Group on Herring Assessments and biology in the Irish Sea and adjacent waters that this assessment area should be enlarged to include a section of Division VIIj. It is not envisaged that this alteration will result in any dramatic changes in the estimated stock sizes in either the enlarged Division VIa (South)/VIIb unit or in the reduced Celtic Sea/Division VIIj unit. The actual effects will not be known until the new assessments are carried out.

If precautionary TACs are to be set for these areas the proposed new stock boundaries should be considered. The existing regulation with closed areas could be maintained or amended if considered necessary.

7 IRISH SEA HERRING (DIVISION VIIA, NORTH)

7.1 The Fishery

7.1.1 Advice and management applicable to 1993 and 1994.

In 1992 no analytical assessment could be undertaken and there was uncertainty concerning fishing mortality and level of SSB. It was suggested that the stock was unlikely to decline at the recent catch levels and that a TAC of 7,000 t would only result in a slight reduction in SSB. ACFM suggested that continued fishing at recent levels is likely to provide catches in 1993 in the range of 4,900 to 7,400 t. The EU subsequently adopted a TAC of 7,000 t which was partitioned as 1,820 t to the Republic of Ireland and 5,180 t to the UK. The spawning and juvenile fishery closures were maintained.

The UK fishery in 1993 opened in the third week of June with the area to the east of the Isle of Man (encompassing the Douglas Bank spawning ground) being closed on 21 September until the end of the year. The Mourne shore skiff fishery opened in September and closed in November. Fishing by the Republic of Ireland opened in the second week of August but no catches were recorded.

In 1993 ACFM concluded that the current fishing mortality is unknown and the state of the stock is not precisely known. Consequently ACFM advice was that if a precautionary TAC is to be set it should not exceed the average catches in the period 1989-1992, i.e. around 5,300 t. A TAC of 7,000 t was subsequently adopted of which 1,820 t was allocated to the Republic of Ireland and 5,180 t to the UK. Spawning and juvenile closures were maintained.

7.1.2 The fishery in 1993

The catches reported from each country for Division VIIa(N) from 1980 to 1993 are given in Table 7.1.1. Once again there has not been an estimate of discarding or slipping. The total catch of 4,408 t was again below the recommended TAC of 7,000 t. The UK took about 85% of its allocated quota but the Republic of Ireland did not take any herring in Division VIIa(N). The reason for the complete withdrawal of the Republic of Ireland fleet (2 vessels) was again due to a lack of fish in August west of the Isle of Man. The Northern Irish fleet took 66% of their catch in the 2nd and 3rd quarters and 34% in the fourth quarter. The Isle of Man kipper processors ceased taking catches early, in the first week of September, due to poor quality fish.

7.1.3 Quality of catch and biological data

There is considerable doubt as to the accuracy of landings data, especially over the period 1981 to 1987, with a strong suggestion of considerable under-reporting. This brings the catch in numbers at age data into question and hence the accuracy of any assessment using data from this period.

Biological sampling in this fishery is still relatively high at one sample per 92 t landed (Table 7.1.2). However, the coverage was not good with no samples taken in the 1st or 4th quarters. The latter case was particularly worrying because of the relatively high landings. There were also problems with undersampling of landings into Northern Ireland in July and August. The Isle of Man data were applied to these landings. There is still a question concerning ageing of older fish in the Isle of Man which is currently being examined. It appears that Isle of Man readers tend to underestimate age by about 1 year in older fish.

7.1.4 Catch in number at age

Catches in numbers at age are given in Table 7.1.3 for the years 1972-1993. The predominant year class was the 2-ringers (1990 year class) which was prevalent in

the 1992 fishery as 1-ringers. This year class constituted approximately 51% of the total catch in numbers. The last above-average year class (1985) only constituted approximately 35% of the catch in numbers when it was at 2-ringer age. There was fairly even representation of 3,4 and 5 ringers. The 1985 year class (7-ringer) was still distinctive. The catch in numbers at length is given in Table 7.1.4 for 1988 to 1993. The most notable features are the reduction in range of lengths, with few small herring and the continued low abundance of fish larger than 30 cm.

7.2 Mean Length, Weight and Maturity at Age

Mean lengths at age were calculated for the 3rd quarter using data from Northern Ireland and are given in Table 7.2.1 for the years 1985 to 1993. In general, mean lengths at age for all year classes have been reasonably stable since 1988.

Mean weights at age in the stock are given in Table 7.2.2. The mean weight at age is lower than in the early 1980s but has risen since the previous year. The weight at age in the stock (WEST) file again utilised third quarter mean weights.

The maturity ogive was examined by Anon. (1994b). Data on the maturity status of 1, 2 and 3+ ringers in August supported the continued use of the following maturity ogive: 0.08 for 1-ringers, 0.85 for 2-ringers and 1.00 for 3+-ringers.

7.3 Research Surveys

7.3.1 Acoustic surveys

An acoustic survey was initiated by Northern Ireland in June/July with the intention of covering the important parts of Division VIIa(N). Unfortunately this survey was terminated early due to an accident. However, the west coast of the Isle of Man was covered. The results have not been fully worked up at present but in any case they will not provide a full assessment of Division VIIa(N). The survey showed that the larger fish were inshore (1-5 nm) on the west of the Isle of Man and that mixed 1- and 2-ringers were further offshore (5-10 nm).

A small scale acoustic survey was undertaken by the Isle of Man in the vicinity of Douglas Bank (east side of the Isle of Man) on 23 and 24 September. These results will not be presented until a problem with the EY500 software is resolved. One major shoal was located approximately 4nm north and east of where the main shoal was noted in 1989 and 1990. Local boats had noted large quantities of herring to the north of the Isle of Man at this time. There also appeared to be fish coming in to the area to join the shoal from the north during the survey period. This suggests that any results will not give a total Manx spawning stock estimate. The same shoal was noted on 28 September and appeared to be approximately 1.4 by 1.1 km and fish occupying 30 m depth.

There are problems with the current series of acoustic surveys in Division VIIa(N) which are discussed in Anon (1994b). The series currently available should not be used as absolute estimates of stock size. It is now apparent that part of the stock is not in the survey area, possibly not even in Division VIIa(N) during June and early August. Therefore, the surveys are missing some unknown part of the stock. The Douglas Bank surveys only cover the Manx component.

7.3.2 Groundfish surveys

Three groundfish surveys were undertaken in 1993 (March, June and September). Estimates of mean abundance of 0- and 1-ringer herring in the eastern and western Irish Sea were calculated (Table 7.3.1). Data from previous year classes are also given. There is some concern over the relatively high CVs associated with these values. There is also the problem that there is an unknown quantity of 1- and 2-ringers from the Celtic Sea and Division VIIj included in these estimates. The problems are further discussed in Anon. (1994b).

7.3.3 Larval surveys

Larval surveys were undertaken in 1993 on Douglas Bank (18-19 October) and to the east and north of the Isle of Man (22-23 November by the Isle of Man and 14-19 November by Northern Ireland). It was intended that the Northern Irish survey would cover the west and south of the Isle of Man to give complete coverage of Division VIIa(N) but extremely bad weather conditions meant only the east of the survey area was covered.

The Douglas Bank survey indicated that the numbers of larvae were much lower than in 1992 and this translated into a much lower estimate of larval production back-calculated to 6 mm for the area (Table 7.3.2). The estimated main spawning period was 25 September to 1 October. The results are described in Nash and Hughes (1994a).

The Isle of Man survey to the northeast of the Isle of Man also indicated much lower numbers of larvae in 1993 compared with 1992 (Nash and Hughes, 1994b). Again this translated into a much lower estimate of larval production (Table 7.3.2). In 1992 the estimated main spawning date was around 28 September with spawning continuing at a reduced level until at least 1 November. In 1993 the main spawning period appeared to be around 12-24 October with a further spawning to at least 10 November. The numbers of larvae produced were of the same order of magnitude as in the late spaw-

ning in 1992 and there did not appear to be any evidence of the earlier spawning which was seen both in fish aggregations on Douglas Bank and in the Douglas Bank survey.

The Northern Irish survey indicated fairly large numbers of small larvae to the north of the Isle of Man which is consistent with the large aggregations of herring seen in the area in the previous month. There is, therefore, a suggestion that some fish may be spawning north of the Bahamas Banks (north of the Isle of Man). Whether this is usual or not is unknown.

The coverage of these larval series is too incomplete, not covering the two spawning components and their spawning sites, and there is doubt if these estimates could be used for tuning a VPA.

7.4 Stock Assessment

7.4.1 The consequences of Celtic Sea + Divisions VIIj 1- and 2-ringers in Division VIIa(N)

Tagging data (Anon. 1994b) suggested that approximately 40% of the 1- and 2-ringers in Division VIIa(N) could come from the Celtic Sea + Division VIIj. As a consequence the Working Group explored the effects of Celtic Sea + Division VIIj fish being caught in the Irish Sea on the VPA by moving 40% of the catches of 1- and 2-ringers out of Division VIIa(N). There was a small effect on SSB and recruitment over the period prior to 1984 but due to the relatively small catches of 1- and 2-ringers in Division VIIa(N) in recent years the effect was negligible. Therefore, it was decided not to attempt to make any alteration to the catches. However, if recruitment indices are to be used in the future some account must be taken of 1- and 2-ringers from adjacent areas.

7.4.2 Estimation of fishing mortality and trends in abundance

In 1993 the four acoustic surveys (1989-1992, Anon. 1993) were used as absolute estimates of stock size to tune the recent Fs even though these were very different surveys which probably had some considerable error (missing part of the spawning stock due to surveying only one spawning ground or missing part of the stock because it was not in the area - see Anon. 1994b). A minimum sum of squares of residuals was determined to give an input F of approximately 0.30, resulting in an SSB of 13,300 t for 1992. There are no further surveys for 1993 which could be used to tune a VPA, therefore no new analytical assessment could be undertaken. A separable VPA and VPA which gives an SSB of approximately 13,600 t in 1992 (F=0.17) is given for illustrative purposes only.

Natural mortality was assumed to be 1.0 on 1-ringers, 0.3 on 2-ringers, 0.2 on 3-ringers and 0.1 on older age classes.

7.4.3 Exploitation pattern

Age 3-ring herring were chosen as the reference age for the exploitation pattern generated by separable VPA and unweighted means were generated for age classes 2-6. This is consistent with the previous year's analysis. The separable VPA output with a terminal F of 0.17 is given in Table 7.4.1. A slightly domed selection pattern was still prevalent (see Anon. 1993), even over S values ranging from 0.8 to 1.2; therefore a value of 1.0 was selected. There did not appear to be any pattern to the residuals. The separable VPA was used to initiate a conventional VPA.

7.4.4 Results of VPA

There is considerable doubt as to the stock level since there are still no reliable fishery-independent data. The VPA with an input F of 0.17 is given to illustrate trends in fishing mortality, landings, SSB and recruitment (Figure 7.4.1). The outputs for F = 0.17 are given in Tables 7.4.2 to 7.4.4. This VPA suggests a slow decline in SSB from 1988 onwards with a sharp increase in 1993 due to the strong 1990 year class (as 2-ringers). Due to the uncertainties in the assessment a number of plausible input Fs (0.15 to 0.30) are also presented (Figure 7.4.2). A similar pattern is seen in the SSB over the range of input Fs.

7.5 Stock and Catch Projection

Again it must be stressed that the Working Group is very unsure of the SSB level and fishing mortality for this stock. It appears that the 1990 year class is strong and that the 1993 Working Group was rather cautious in replacing the VPA estimate of 2-ringers with a geometric mean (see Anon. 1993). This strong year class should be dominant in the fishery for a number of years.

The input parameters for a prediction for 1994, using the outputs from a VPA with an input of F=0.17 in 1993, are given in Table 7.5.1. The outputs, assuming a) that the TAC of 7,000 t will be taken in 1994 and b) that the catch in 1994 will be the same as in 1993 are given in Table 7.5.2 and illustrated in the text table below. In the absence of recruitment estimates, the geometric mean over the period 1984-1991 was used in 1994.

	1993		1994 Fishery		Spawning time 1994	
Input F	$F_{(2-6)}$	SSB (t) at spawning time	Catch (t)	$F_{(2-6)}$	Spawning stock size (mill.)	SSB (t)
0.17	0.18	24,553	7,000	0.27	137	22,132
0.17	0.18	24,553	4,500	0.16	150	24,232

These results indicate a small decrease in SSB in 1994 if the TAC is taken with a corresponding F_{2-6} of 0.27. If the catches in 1994 remain at their 1993 level, however, the SSB would be similar in 1994 with a corresponding reference F_{2-6} of 0.16.

7.6 Management Considerations

7.6.1 Management Advice

As stated in both the 1992 and 1993 Working Group Reports (Anon 1992a 1993) it is not possible to accurately assess the current value of fishing mortality in Division VIIa(N). Similarly it is difficult to determine the current level of SSB. Therefore, the Working Group feels there is insufficient information to carry out a stock prediction for 1995.

7.6.2 Spawning and Juvenile Fishing Area Closures

The Working Group has no basis to suggest a change in existing regulations on nursery ground closures. A subgroup will evaluate the present spawning box closure and report to ACFM at the 1994 May meeting.

7.7 Research and Data Requirements

Data and research requirements for a co-ordinated assessment of all western herring stocks are laid out in Anon. (1994b). There is a need for a co-ordinated approach to age reading and data analysis (e.g. length-age keys) by all laboratories working with Irish Sea herring. Tagging experiments should continue in order to provide more information on potential stock mixing (Division VIIa (N) adults outside the area and the presence of juveniles from adjacent management units in Division VIIa(N)). The larval surveys should be maintained to provide fishery-independent data on spawning stock biomass. Attempts should be made to estimate the levels of discarding and slippage in the fishery.

8 SPRAT IN THE NORTH SEA

8.1 The Fishery

8.1.1 ACFM advice applicable for 1992 - 1994

No ACFM advice on sprat TAC has been given for 1992 - 1994. The TAC set by the management bodies was 55,000 t for 1992, 83,000 t for 1993 and 114,000 t for 1994 for the EU zone of Sub-area IV and Division IIa.

8.1.2 Catches in 1993

Landing statistics for North Sea sprat by area and country are presented in Table 8.1.1 from 1982-1993. The monthly distribution of catches by rectangle for Sub-area IV is shown in Figures 8.1.1-8.1.12. As in previous years, sprat from the fjords of western Norway were not included in the landings for the North Sea due to the uncertainty of sprat stock identity. Norwegian catches in the western fjords for 1983-1993 are presented in Table 8.1.2.

Preliminary sprat landings figures for Denmark, Norway, Sweden and UK (England and Scotland) indicate that 200,300 t were landed from the North Sea in 1993. This represents an increase of 61% in landings over 1992. Landings for both Denmark and Norway increased while the English catches decreased slightly between 1992 and 1993. Catches by Denmark, representing 77% of the North Sea sprat landings, continued their upward trend started in 1989 and were the largest reported since 1981. Norwegian catches, which have also increased since 1989, rose by 54% from 1992 to 1993. The English catches in 1993 accounted for only 1% of the total. Catches by Norway in the fjords decreased by 50%.

Landings by area and quarter are shown in Table 8.1.3. As in previous years, the largest component of the catch was reported from Division IVb, predominantly Division IVb (E) in the third quarter. Significant catches from this division were also made during the fourth quarter. The reduction in UK (England) landings was observed in Division IVc during the first and fourth quarters. Small sprat catches were also reported off the northeastern coast of England and Scotland in 1993.

8.1.3 Fleets

Fleet descriptions are provided in the Industrial Fisheries Working Group (IFWG) in 1992 (Anon., 1992b, Section 2.4.2).

8.2 Catch Composition

8.2.1 Catches in number

Uncertainties in the reliability and/or absence of quarterly age samples have prevented the IFWG from running a VPA since 1984. A historical perspective of the problems associated with estimates of catch in numbers and age by previous groups until 1992 are described in last year's Working Group report.

The 1989-1993 quarterly catch-at-age in numbers is presented in Table 8.2.1. Age distribution data for commercial catches were provided by Denmark, Norway and UK (England). Several inconsistencies observed in the data are believed to be the result of an ageing problem, as identified by the sprat age-reading workshop (Torstensen, WD 1994), and the poor representation of older age groups in the samples. Although the data are presented, the Working Group concluded that the data were poor and unsuitable for catch-at-age estimation.

8.2.2 Weight at age

The North Sea weights-at-age by quarter for 1993 are provided in Table 8.2.2. Weights were estimated from Danish, Norwegian and UK (England) commercial samples data as provided by Working Group members (Table 8.2.3).

8.3 Recruitment

8.3.1 Abundance

In 1993 it was decided to break from the traditional presentation of indices for the North Sea (all ages), Division IVb (1-group) and Division IVb E (1-group) and concentrate on Division IVb only, as Division IVb is considered to be the IBTS standard area applicable for North Sea sprat assessment. The revised IBTS (no./hr) sprat indices from 1981 to 1994 are presented in Table 8.3.1 for age groups 1 to 5. Data in the old format can be found in the 1992 IFWG report (Anon., 1992b).

The 1994 IBTS February data indicate that the indices for age groups 1-3 have increased for another year, while age groups 4^+ have decreased. With the exception of 1989, the 1994 1-group (4013/hr) and total index (5440/hr) represent the highest on record since 1981. The recent increasing trend in abundance is clearly tracked in the indices for age groups 1-3 and the total since 1990. The IBTS data are provided by rectangle in Figure 8.3.1 for age groups 1, 2 and 3^+ and show the abundance of 1-group to be concentrated in the central-eastern portion of Divisions IVb and IVc. The mean lengths of age group 1 by rectangle are presented in Figure 8.3.2.

8.4 Acoustic Survey

No acoustic estimates were available to the Working Group for 1993.

8.5 State of the Stock

8.5.1 Catch-Survey Data Analysis

Inadequate catch-at-age data (Anon.,1992b,1993) have prevented the use of standard VPA techniques for assessing the North Sea sprat stock. The IBTS survey appears to have difficulties following strong and weak cohorts. This is illustrated in the text table below which is extracted from Table 8.3.1. The 1-group:2-group ratio varies between 0.34 (1987 year class) and 7.62 (1988 year class).

Year Class	1-group	2-group	1-gr: 2-gr
1980	941.46	501.87	1.88
1981	295.82	754.08	0.39
1982	210.04	387.05	0.54
1983	382.37	297.67	0.28
1984	660.12	102.75	6.42
1985	71.36	74.33	0.96
1986	803.37	1,436.80	0.56
1987	148.49	441.86	0.34
1988	4,245.98	557.41	7.62
1989	176.81	116.08	1.52
1990	1,121.06	340.17	3.30
1991	1,560.54	422.47	3.69
1992	1,754.61	1,294.30	1.36

The Working Group concluded that the catch-survey analysis undertaken in 1993 did not provide a sufficiently accurate assessment of the status of the stock to be useful for management purposes. Similar problems were encountered in 1994.

8.6 Projections of Catch and Stock

It has been proposed that the Working Group should investigate the relationship between the total IBTS (February) index and the total landings for the same year. This was done for the Division IIIa sprat in the 1993 report (Anon. 1993). Investigations using data for the North Sea for 1982-1993 suggested a strong correlation, excluding the 1989 data as an outlier. The observations and linear regression lines with and without the 1989 observation are shown in Figure 8.6.1.

The regression coefficients and the corresponding R^2 are given in the text table below for the relationship

Total landing ('000 t) = A + B * Total-IBTS(February)

together with a prediction of the landings for 1994 based on the Total-IBTS(February) index of 5436.

	R^2	A	B	Predicted 1994 catch '000 t
1989 incl.	0.0362	77.4615	0.007924	122
1989 excl.	0.5701	9.015807	0.069476	387

The Working Group could not discard the 1989 IBTS observation based on performance of the survey in that year. The Group further observed that a similar relationship was found for Division IIIa when the 1992-index was considered as an outlier. Again, there were no obvious reasons for removing the 1992 index in Division IIIa.

The regression itself is based on very uncertain catch data; the reported catches for the second half of the 1980s are prone to uncertainties about how well they reflect the actual fisheries in these years. This has been discussed thoroughly by the IFWG and later by this Working Group (Anon.,1992b, 1993).

The Working Group also observed that the standard deviation around the regression was almost 37,000 tonnes, even when the 1989 observation was ignored. This suggests that the predicted landing would be uncertain by about twice this amount for the observed IBTS indices below 3000. For higher values, such as in 1994, the uncertainty increases sharply as the regression is extrapolated into a region for which there are no observations. The catch in 1993 was predicted by the above regression, excluding the 1989 and including the 1993 index, at 166,000 t while the reported catch was over 200,000 t. When the regression was used on data up to 1992, the observed prediction for 1993 was 139,000 tonnes.

Given the uncertainties in fleet effort and activities, the Working Group was doubtful whether such a simple regression is valid. Part of the effort directed at sprat is produced by fleets also fishing several other stocks e.g. capelin in the Barents Sea. The distribution and densities of sprat relative to other species, e.g. herring, will also be a determining agent in the total amount of sprat landed.

8.7 Management Considerations

The stock does not show signs of over exploitation as both the catch and indices appear to be increasing at present. There are also no indications of re-direction of effort from other areas to this stock. Therefore, as far as the sprat stock is concerned, there are no reasons for any severe management constraints apart from the exist ing by-catch regulation on the current fishery.

The assessment is hampered by the poor quality of the catch-at-age data. Whether or not the IBTS survey indices reflect stock status cannot be evaluated with the available data. Furthermore, sprat is a short-lived species which would make catch and stock predictions for more than a year ahead difficult, even if the data were adequate.

The Working Group recommends that the sampling for sprat be improved in future years, recognizing that it improved in 1992 and deteriorated in 1993.

8.8 Request from the Working Group on Ecosystems Effects of Fishing Activities

Catches in weight by rectangle and month are given in Figures 8.1.1-8.1.12. The area breakdown is based on logbook information provided by the fishermen.

The IBTS (February) data are provided in Table 8.3.1 and by rectangle in Figure 8.3.1.

9 SPRAT IN DIVISIONS VIId,e

9.1 The Fishery

The nominal landings are shown in Table 9.1.1 and monthly distributions of catches by rectangle in Figures 8.1.1-8.1.12.

In the eastern Channel, landings were very small at both ends of the year, with the majority of the landings (27 t) being made into Poole.

In the western Channel, the 1993/94 Lyme Bay sprat fishery began in August and ended in March (Table 9.1.2). The provisional catch for the 1993/1994 season is 1,800 t, which is some 100 t more than the 1992/1993 season.

9.2 Catch Composition

In the early part of the season, the 1991 and 1990 year classes contributed 67% and 29% by weight respectively to the landings (Table 9.2.1). Biological sampling was carried out in August, September and November only,

so these results should be treated with due caution. Mean weight at age is shown in Table 9.2.2.

10 SPRAT IN DIVISION IIIa

10.1 The Fishery

10.1.1 ACFM advice applicable for 1993 and 1994

ACFM advice on a sprat TAC was not provided for 1993 and 1994. Sprat is landed under the TAC for the mixed clupeoid fishery, a fishery which lands a mixture of species. The mixed clupeoid fishery at present mainly consists of herring (see Section 3.1.2). The agreed TACs for this fishery adopted by the management bodies were 45,000 and 43,000 t for 1993 and 1994 respectively.

10.1.2 Catches in 1993

The total landings for Division IIIa by area and country are given in Table 10.1.1. Norwegian and Swedish catches included the coastal and the fjord fishery. The total landings in 1993 as estimated by the Working Group were 9,100 t. This is lower than in 1992, and at about the same level as in the late 1980s. Samples from the Danish mixed clupeoid fishery indicate a much lower catch of sprat than presented in the official statistics.

The sprat fishery in Division IIIa is conducted by fleets from Denmark, Norway and Sweden. These were described by the Herring Assessment Working Group in 1993 (Anon., 1993). Landings by quarter for all three countries in 1993 are shown in Table 10.1.2. Nearly 80% of the landings were taken in the first and last quarters.

10.2 Catch composition

10.2.1 Catches in number and weight at age

No weight-at-age data in the catches were available for 1983-1991. For 1992 and 1993 data were supplied by Denmark.

The numbers and mean weights-at-age in the Danish landings in 1992 and 1993 are presented in Tables 10.2.1 and 10.2.2. The Danish landings accounted for only 35 and 15% respectively of the total and these samples represent landings for the industrial fishery only. The entire Norwegian and 64 % of the Swedish sprat catches are taken by the human consumption fishery. As a result, no conversion of the total landings in weight to total landings in numbers was possible with any precision and conversion was therefore not undertaken.

10.2.2 Quality of catch and biological data

In 1993 the sampling intensity and coverage of the landings in the mixed clupeoid fishery increased compared to the previous years. A total of 391 samples were analysed for species composition and 57 samples were taken for age and weight at age. Herring is at present the most important component in the landings from the mixed-clupeoid fishery (see Section 3.1.2), with small amounts of sprat (about 6% in weight). In the present sampling scheme, designed for the most important species, estimated landings of sprat are uncertain and may well vary by 25% or more.

No information on catch and catch at age from either the human consumption fishery or from the Swedish industrial fishery was available. In addition, there are uncertainties about the species composition in the Swedish landings. The Working Group again this year recommends strongly that sampling in the human consumption sprat fisheries be established.

10.3 Recruitment

10.3.1 Abundance of 1-group and older sprat from IBTS

The mean number of sprat caught per hour by rectangle and age group, were weighted by the area of the rectangle (see Anon., 1993). The weighted indices are given in Table 10.3.1. These indices are considered the best available.

The index of 1-group sprat in 1994 was 1,494 which is slightly lower than the 1993 index. The 1993-1994 level is about 75 % below the high 1992 index but higher than the indices in the late 1980s.

There is little consistency in IBTS 1- and 2-group indices, and estimates of total mortality from the IBTS survey are not considered useful. This is demonstrated in the following text table:

Year class	1-group	2-group	1-group-2 group
1983	5,818	2,426	0.42
1984	2,404	1,934	1.24
1985	670	2,219	0.30
1986	2,234	5,527	0.40
1987	950	1,012	0.94
1988	435	243	1.79
1989	510	468	1.09
1990	659	634	1.03
1991	5,897	4,237	1.39
1992	1,593	586	2.72

The lack of consistency in the indices of 1- and 2-group might be explained by a discrepancy in ageing. Results from the workshop on comparative age reading (Torstensen, WD 1994) showed high coefficients of variance. The highest C.V was observed for sprat in the Kattegat, in the range of 12.0-34.1% for the overall readings. This is the area making the highest contribution to the abundance indices.

10.4 State of the Stock

No assessments of the sprat stock in Division IIIa have been carried out since 1985. Since that time there has been little confidence in the accuracy of the catch data, and catch-at-age data prior to 1992 are very limited.

As discussed above the IBTS indices are not consistent and there are also problems with the catch data.

The Working Group is therefore not able to provide reliable estimates of either recruitment or fishing mortalities.

10.5 Projection of Catch and Stock

The IBTS indices indicate that both the 1991 and the 1993 year classes will contribute significantly to the fishery in 1994. However, regression of the 1-group and pooled indices against total catches, shown in Figure 10.5.1, demonstrate no significant relationships; consequently, the present regression was rejected for catch prediction in this fishery. It is therefore not possible to make a reliable projection for the fishing possibilities either in 1994 or in 1995.

10.6 Management Considerations

The Working Group considered that the sprat fisheries in Division IIIa could be managed by a precautionary TAC for the directed sprat fisheries rather than by a mixed cluepoid TAC for the directed and industrial fisheries together.

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Table 1.5.1 Percent of herring infected with *Ichthyophonus* by age. Results from Norwegian surveys (N) presented in Skagen (WD, 1994), and from international acoustic surveys presented in Simmonds *et al.* (WD, 1994) (A).

Age	Summer 91(N)	Autumn 91(N)	Summer 92(N)	Summer 92(A)	Autumn 92(N)	Summer 93(N)	Summer 93(A)	Autumn 93(N)
1	3.8	-	-	0	0	0.1	0	0
2	4.7	-	4.0	0	0	0.8	0.1	0.5
3	6.3	6.5	10.4	0.72	3.4	0	0.6	0
4	23.5	24.2	5.8	4.96	5.0	2.3	3.4	2.1
5	30.5	18.2	28.7	12.28	7.1	0.6	8.3	4.3
6	53.1	8.0	31.4	14.09	8.7	12.4	5.0	6.7
7	54.6	16.7	32.7	-	8.9	13.6	3.0	7.0
8	-	-	52.9	11.29	4.8	14.3	4.8	0
9	-	-	16.0	-	-	20.0	6.9	5.3

Table 1.5.2 Prevalence of *Ichthyophonus* infection in herring in Division IIIa in swedish catches and in Swedish Research Vessel Surveys. Proportion of fish infected with the disease, by age-group.

SUMMARY OF COMMERCIAL SAMPLES

Year	Length (cm)	Ages					Total	No. Examined
		0	1	2	3	4+		
1992	20	0.000	0.004	0.011	0.023	0.039	0.012	2,615
	21	0.075	0.006	0.008	0.005	0.006	0.007	3,893
	24	0.000	0.000	0.001	0.003	0.001	0.003	1,502
1993	20	0.000	0.017	0.007	0.010	0.003	0.009	1,351
	21	0.000	0.002	0.000	0.005	0.003	0.002	2,721
	23							
	24	0.000	0.000	0.000	0.000	0.000	0.000	731
1992 ALL		0.030	0.003	0.007	0.011	0.016	0.008	8,010
1993 ALL		0.000	0.006	0.002	0.005	0.002	0.003	4,803

SUMMARY OF RESEARCH VESSEL SAMPLES

Year	Length (cm)	Ages					Total	No. Examined
		0	1	2	3	4+		
1992	20		0.04	0.04	0.33	0.43	0.09	352
	21	0	0	0	0	0.01	0.001	789
1993	20	0	0.01333	0.02	0.05667	0.04167	0.01533	1,152
	21	0	0.004	0	0	0.00333	0.00367	1,896
	23	0	0	0	0	0.02333	0.00333	504
1992 ALL		0	0.01333	0.01333	0.11	0.14667	0.03033	1,389
1993 ALL		0	0.00578	0.00667	0.01889	0.02278	0.00744	3,552

Table 2.1.1 North Sea HERRING (Sub-area IV and Division VIId). Catch in tonnes by country, 1981-1993. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1982	1983	1984	1985	1986	1987
Belgium	9,700	5,969	5,080	3,482	414	39
Denmark	67,851	10,467	38,777	129,305	121,631	138,596
Faroe Islands	-	-	-	-	623	2,228
France	15,310	16,353	20,320	14,400	9,729	7,266
Germany, Fed.Rep.	349	1,837	11,609	8,930	3,934	5,552
Netherlands	22,300	40,045	44,308	79,335	85,998	91,478
Norway[4]	-	32,512	98,706	159,947	223,058	241,765
Sweden	-	284	886	2,442	1,872	1,725
UK (England)	3,703	111	1,689	5,564	1,404	873
UK (Scotland)	1,780	17,260	31,393	55,795	77,459	76,413
UK (N.Ireland)	-	-	-	-	-	-
Unallocated landings	114,252	181,116	64,487	74,220	21,089	58,972
Total landings	235,245	305,954	317,255	533,420	547,211	624,907
Discards[3]	-	-	-	-	-	-
Total catch	235,245	305,954	317,255	533,420	547,211	624,907
Catches of spring spawners (included above)						
IIIa type	-	-	6,958	17,386	19,654	14,207
Coastal type	-	-	520	905	490	250

Country	1988	1989	1990	1991	1992	1993[1]
Belgium	4	434	180	163	242	56
Denmark	263,006	210,315[2]	159,280[2]	194,358[2]	193,968[2]	164,817
Faroe Islands	810	1,916	633	334	-	-
France	8,384	29,085	23,480	24,625	16,587	12,627
Germany, Fed.Rep.	13,824	38,707	43,191	41,791	42,665	41,669
Netherlands	82,267	84,178	69,828	75,135	75,683	79,190
Norway[4]	222,719	221,891[2]	157,850[2]	124,991[2]	116,863	122,815
Sweden	1,819	4,774	3,754	5,866	4,939	5,782
UK (England)	8,097	7,980	8,333	11,548	11,314	19,853
UK (Scotland)	64,108	68,106	56,812	57,572	56,171	55,531
UK (N.Ireland)	-	-	-	92	-	-
Unallocated landings	33,411	26,749[2]	21,081	24,435	25,867	18,410
Total landings	698,449	694,135[2]	544,422	560,910	544,299	520,550
Discards[3]	-	4,000	8,660	4,617	4,950	3,470
Total catch	698,449	698,135	553,082	565,527	549,249	524,020
Catches of spring spawners (included above)						
IIIa type	23,306	19,869	8,357	7,894	7,854	8,928
Coastal type	250	2,283	1,136	252[5]	202[5]	201[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	1984	1985	1986	1987	1988
Denmark	26,786	77,788	48,590	50,184	25,268
Faroe Islands	-	-	275	102	810
France	1,408	2,075	462	285	266
Germany, Fed.Rep.	12,092	4,790	2,510	3,250	9,308
Netherlands	19,143	49,965	42,900	44,358	32,639
Norway	21,305	10,507	63,848	55,311	30,657
Sweden	-[1]	-[1]	-[1]	768	1,197
UK (N.Ireland)	-	-	-	-	-
UK (England)	-	-	-	4,820	4,820
UK (Scotland)	24,634	52,100	71,285	66,774	48,791
Unallocated landings	24,030	4,249	-	16,092	-
Total Landings	129,398	197,225	229,870	221,032	153,751
Discards[2]	-	-	-	-	-
Total catch	129,298	201,474	229,870	237,124	153,751

Country	1989	1990	1991	1992	1993[3]
Denmark	29,298	9,037	5,980	10,751	10,604
Faroe Islands	1,916	633	334	-	-
France	-[1]	2,581	3,393	4,714[4]	3,362
Germany, Fed.Rep.	26,528	20,422	20,608	21,836	17,342[4]
Netherlands	24,600	29,729	29,563	29,845	28,616
Norway	41,768	24,239	37,674	39,244	33,442
Sweden	742	-	1,130	985	1,372
UK (N.Ireland)	-	-	92	-	-
UK (England)	5,104	3,337	4,873	4,916	4,742
UK (Scotland)	58,455	46,431	42,745	39,269	36,628[4]
Unallocated landings	3,173	4,621	5,492	4,855	-8,271[5]
Total Landings	191,584	141,030	151,884	156,415	127,837
Discards[2]	900	750	883	850	825
Total catch	192,484	141,780	152,767	157,265	128,662

[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	1984	1985	1986	1987	1988
Denmark	126	-	4,540	7,101	47,183
Faroe Islands	-	-	-	2,126	-
France	-	-	-	159	45
Netherlands	-	-	-	-	200
Norway[1]	51,581	109,975	118,408	145,843	153,496
Sweden	-	-	-	957	622
UK (Scotland)	74	-	-	-	-
Germany, Fed.Rep.	-	-	-	-	-
Unallocated landings	-	-	-	-	-
Total landings	51,781	109,975	122,348	156,186	201,546
Discards[2]	-	-	-	-	-
Total catch	51,781	109,975	122,948	156,186	201,546

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

[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	1984	1985	1986	1987	1988
Denmark	13,808	51,517	67,966	81,280	190,555
France	2,299	1,037	605	387	617
Faroe Islands	-	-	348	-	-
Germany, Fed.Rep.	2	4,139	1,424	2,302	4,516
Netherlands[4]	4,600	-[3]	21,101	31,371	37,192
Norway	25,820	39,465	40,682	40,111	38,566
Sweden	884	2,442[2]	1,872[2]	-	-
UK (England)	1,956	5,214	1,101[1]	329	2,011
UK (Scotland)	2,477	2,894	6,057	9,639	15,317
Unallocated landings	41,294	47,799	1,594	20,829	1,969
Total landings	93,140	154,507	142,750	186,248	290,743
Discards[4]	-	-	-	-	-
Total catch	93,140	154,507	142,750	186,248	290,743

Country	1989	1990	1991	1992	1993[6]
Denmark	136,239	105,614	138,555	125,229	109,994
Belgium	-	-	3	13	-
France	14,415[5]	10,289	4,120	2,313	2,086
Faroe Islands	-	-	-	-	-
Germany, Fed.Rep.	11,880	17,165	20,479	20,005	23,628
Netherlands[4]	47,388	28,402	26,266	26,987	31,370
Norway	11,758	12,207	9,852	16,240	33,158
Sweden	3,420	1,276	4,622	3,446	3,699
UK (England)	957	3,200	2,715	3,026	3,804
UK (Scotland)	9,651	10,381	14,587	16,707	18,904
Unallocated landings	-23,947[7]	-15,616[7]	3,180	-13,637[7]	-16,415[7]
Total landings	211,711	172,914	224,376	200,329	210,228
Discards[4]	1,900	2,560	1,072	1,900	245
Total catch	213,611	175,474	225,448	202,229	210,473

[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	1984	1985	1986	1987	1988
Belgium	5,080	3,482	414	39	4
Denmark	53	-	535	31	-
France	16,613	11,288	8,662	6,435	7,456
Germany, Fed.Rep.	-	-	-	-	-
Netherlands	21,922	32,370	21,997	15,749	12,236
Norway	-	-	-	-	-
UK (England)	571	350	303	544	1,266
UK (Scotland)	-	799	117	-	-
Unallocated landings	1,788	21,595	19,495	22,051	31,442
Total landings	-	69,884	51,523	44,849	52,404
Discards[1]	-	-	-	-	-
Total catch	46,027	69,884	51,523	44,849	52,404
Coastal spring spawners included above	-	905	496	250	250

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

[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 : 1993

Division	Quarter	0 1992	1 1991	2 1990	3 1989	4 1988	5 1987	6 1986	7 1985	8 1984	9 1983	Total	0+1 ring
	I	0.0	0.0	1.3	0.7	1.1	1.2	5.0	4.2	3.6	0.0	17.0	0.0
IVa	II	0.0	0.4	33.6	26.0	19.0	18.2	21.1	18.0	5.9	3.4	145.5	0.4
(West of 2E)	III	0.0	6.7	81.8	50.7	41.2	32.4	58.5	46.3	25.3	20.1	362.9	6.7
	IV	0.0	8.4	14.3	6.5	7.1	4.7	7.3	9.0	6.8	4.5	68.5	8.4
	Total	0.0	15.5	130.9	83.8	68.3	56.5	91.8	77.5	41.6	28.0	594.0	15.5
	I	0.0	0.1	72.1	26.3	34.0	18.5	9.6	8.7	1.7	0.0	171.1	0.1
IVa	II	0.0	1.9	42.0	41.6	36.5	25.1	20.0	15.3	4.8	2.1	189.2	1.9
(East of 2E)	III	0.0	14.8	7.1	5.0	5.9	5.0	3.0	2.8	1.4	0.6	45.6	14.8
	IV	0.0	71.2	34.0	15.3	30.2	22.3	25.3	24.3	9.7	2.2	234.5	71.2
	Total	0.0	88.0	155.2	88.2	106.5	70.8	57.8	51.1	17.7	4.9	640.3	88.0
	I	0.0	793.0	123.1	2.7	0.2	0.0	0.0	0.0	0.0	0.0	919.1	793.0
	II	0.0	206.1	46.4	26.8	12.4	2.8	2.2	1.5	0.5	0.0	298.7	206.1
IVb	III	5651.3	43.0	104.2	67.5	50.5	25.9	35.8	28.5	6.9	4.6	6018.4	5694.3
	IV	1312.0	124.8	91.4	39.3	26.4	13.1	9.5	3.5	0.1	0.6	1620.6	1436.8
	Total	6963.3	1166.9	365.1	136.4	89.6	41.8	47.5	33.5	7.5	5.2	8856.8	8130.2
	I	0.0	5.4	3.4	47.0	6.3	7.4	2.8	6.9	3.7	0.4	83.2	5.4
	II	0.0	2.2	0.3	0.9	1.7	1.2	0.6	0.1	0.0	0.0	6.9	2.2
IVc + VIId	III	18.1	0.0	0.0	4.2	12.1	15.4	7.0	6.0	1.3	0.4	64.6	18.1
	IV	0.3	5.9	105.5	237.3	22.2	23.0	16.1	10.8	14.1	2.2	437.5	6.2
													0.0
	Total	18.4	13.5	109.2	289.4	42.3	47.1	26.5	23.7	19.1	3.0	592.2	31.9
	I	0.0	798.5	199.9	76.7	41.6	27.1	17.4	19.9	9.0	0.4	1190.4	798.5
Total	II	0.0	210.6	122.2	95.4	69.5	47.3	43.9	34.8	11.2	5.5	640.4	210.6
North	III	5669.5	64.5	193.2	127.3	109.6	78.7	104.2	83.6	35.0	25.8	6491.4	5733.9
Sea	IV	1312.3	210.4	245.1	298.4	85.9	63.1	58.3	47.6	30.6	9.5	2361.1	1522.7
	Total	6981.7	1283.9	760.4	597.7	306.7	216.2	223.7	185.9	85.8	41.2	10683.3	8265.7

Table 2.2.2 Millions of HERRING caught annually per age group (winter rings) in the North Sea, 1970-1993.

Year	Winter ring										Total
	0	1	2	3	4	5	6	7	8	9+	
1970	898.1	1,196.2	2,002.8	883.6	125.2	50.3	61.0	7.9	12.0	12.2	5,294.3
1971	684.0	4,378.5	1,146.8	662.5	208.3	26.9	30.5	26.8	-	12.4	7,176.7
1972	750.4	3,340.6	1,440.5	343.8	130.6	32.9	5.0	0.2	1.1	0.4	6,045.5
1973	289.4	2,368.0	1,344.2	659.2	150.2	59.3	30.6	3.7	1.4	0.6	4,906.6
1974	996.1	846.1	772.6	362.0	126.0	56.1	22.3	5.0	2.0	1.1	3,189.3
1975	263.8	2,460.5	541.7	259.6	140.5	57.2	16.1	9.1	3.4	1.4	3,753.3
1976	238.2	126.6	901.5	117.3	52.0	34.5	6.1	4.4	1.0	0.4	1,482.0
1977	256.8	144.3	44.7	186.4	10.8	7.0	4.1	1.5	0.7	+	656.3
1978	130.0	168.6	4.9	5.7	5.0	0.3	0.2	0.2	0.2	0.3	315.4
1979	542.0	159.2	34.1	10.0	10.1	2.1	0.2	0.8	0.6	0.1	759.2
1980	791.7	161.2	108.1	91.8	32.1	21.8	2.3	1.4	0.4	0.2	1,211.0
1981	7,888.7	447.0	264.3	56.9	39.5	28.5	22.7	18.7	5.5	1.1	8,772.9
1982	9,556.7	840.4	268.4	230.1	33.7	14.4	6.8	7.8	3.6	1.1	10,963.0
1983	10,029.9	1,146.6	544.8	216.4	105.1	26.2	22.8	12.8	11.4	12.2	12,128.2
1984	2,189.4	561.1	986.5	417.1	189.9	77.8	21.7	24.2	10.6	17.8	4,496.1
1985	1,292.9	1,620.2	1,223.2	1,187.6	367.6	124.1	43.5	20.0	13.2	15.9	5,908.2
1986	704.0	1,763.2	1,155.1	827.1	458.3	127.7	61.1	20.2	13.4	14.6	5,144.7
1987	1,797.5	3,522.4	2,005.4	687.2	481.6	248.9	75.7	23.9	7.9	8.1	8,858.1
1988	1,292.9	1,970.8	1,955.5	1,185.1	398.1	260.6	128.6	37.9	15.1	8.4	7,253.0
1989	1,955.8	1,899.5	927.7	1,383.6	828.1	218.3	129.4	63.3	20.7	8.7	7,435.1
1990	853.9	1,477.4	592.8	763.3	849.1	375.9	80.1	54.4	28.4	11.8	5,087.1
1991	1594.3	1244.4	771.2	553.1	548.5	493.5	201.4	38.8	25.0	12.6	5,482.7
1992	7598.2	643.4	960.9	411.8	334.6	341.5	360.1	144.7	37.7	23.2	10,856.1
1993	6981.7	1283.9	760.4	597.7	306.7	216.2	223.7	185.9	85.8	41.2	10,683.2

Table 2.2.3 Catches (numbers in millions) of Division IIIa spring spawners taken in the North Sea, and transferred to assessment of Division IIIa spring spawning stock (1987-1993).

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

Table 2.2.4 Catches (numbers in millions) of North Sea autumn spawners taken in IIIa, and transferred to assessment of North Sea autumn spawners.

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

Table 2.2.5 Total catch (numbers in millions) per age group (winter rings) of North Sea autumn spawning stock used in the assessment.

Year	Winter ring										
	0	1	2	3	4	5	6	7	8	9+	Total
1987	8035.5	6675.4	2086.9	652.2	456.1	240.0	72.9	23.2	7.8	8.0	18258.0
1988	3122.9	7762.8	2202.9	1076.2	378.6	252.4	126.4	37.5	15.1	8.4	14983.2
1989	2984.0	3070.0	1555.2	1330.9	789.8	206.7	120.7	59.5	19.0	8.5	10144.3
1990	1251.8	2901.7	864.1	748.6	827.3	372.3	77.1	52.3	27.7	11.4	7134.3
1991	2306.5	2067.1	1094.8	538.0	530.5	484.4	198.4	38.0	24.7	12.6	7294.9
1992	10005.7	2230.5	1244.4	428.7	350.1	349.1	363.8	147.6	38.0	22.6	15180.6
1993	9892.4	3687.7	1133.6	586.9	294.4	207.8	217.8	181.2	84.1	40.2	16326.1

Table 2.2.6 Percentage age composition of North Sea HERRING (2-ringers and olders) in the catch.
Catches in : 1993

Division	age in W.Rings / Quarter	2 1990	3 1989	Older >= 1988	Total (millions)
IVa West	I	7.7	3.9	88.5	17.0
	II	23.1	17.9	59.0	145.1
	III	23.0	14.2	62.8	356.2
	IV	23.7	10.8	65.5	60.1
	Total	22.6	14.5	62.9	578.5
IV a East	I	42.2	15.4	42.5	171.0
	II	22.4	22.2	55.4	187.3
	III	23.3	16.1	60.6	30.7
	IV	20.8	9.4	69.8	163.3
	Total	28.1	16.0	55.9	552.3
IVb	I	97.7	2.2	0.2	126.1
	II	50.1	29.0	20.9	92.6
	III	32.2	20.8	47.0	324.1
	IV	49.7	21.4	28.9	183.8
	Total	50.3	18.8	31.0	726.6
IVc + VIId	I	4.4	60.4	35.2	77.8
	II	5.9	19.8	74.3	4.8
	III	0.0	9.0	91.0	46.5
	IV	24.5	55.0	20.5	431.3
	Total	19.5	51.7	28.9	560.3
IVa + IVb	I	62.6	9.4	28.0	314.1
	II	28.7	22.2	49.1	425.1
	III	27.2	17.3	55.5	711.0
	IV	34.3	15.0	50.7	407.2
	Total	35.1	16.6	48.3	1857.3
Total North Sea	I	51.0	19.6	29.4	391.9
	II	28.4	22.2	49.4	429.8
	III	25.5	16.8	57.7	757.5
	IV	29.2	35.6	35.2	838.5
	Total	31.5	24.7	43.8	2417.6

Table 2.2.7 Catches (SOP,tons) of North Sea Herring, by quarter and division.
Catches in : 1993

Quarter	Division	0 1992	1 1991	2 1990	3 1989	4 1988	5 1987	6 1986	7 1985	8 1984	9 1983	SOP Total
I	IVa W	0	0	169	94	203	233	1038	942	861	1	3540
	IVa E	0	3	7293	3359	5154	3026	1669	1592	358	0	22454
	IVb	0	15973	6789	221	32	0	0	0	0	0	23015
	IVc	0	111	321	4557	800	1040	398	1171	597	51	9045
	Total	0	16087	14572	8231	6189	4299	3105	3705	1815	52	58054
II	IVa W	0	20	4653	4105	3799	3879	5074	4628	1610	994	28762
	IVa E	0	128	5706	6183	6616	4910	4075	3366	978	563	32526
	IVb	0	4320	4340	3015	1702	370	409	324	93	0	14572
	IVc	0	82	17	95	191	153	79	9	4	3	634
	Total	0	4551	14715	13398	12308	9312	9636	8328	2684	1561	76493
III	IVa W	0	553	12348	8680	9520	7953	15301	12966	7545	6667	81534
	IVa E	0	1064	782	659	983	927	624	689	377	165	6270
	IVb	48036	1790	14976	10502	11219	6233	8812	7599	1942	1438	112547
	IVc	241	0	0	517	1722	2362	1153	1035	235	77	7343
	Total	48277	3407	28105	20358	23443	17475	25890	22289	10099	8348	207692
IV	IVa W	0	973	2100	1122	1564	1108	1780	2456	1936	1488	14527
	IVa E	0	6951	5110	2694	5922	4648	5423	5407	2206	635	38996
	IVb	20860	9635	11142	6142	4894	2605	2012	803	20	160	58272
	IVc	10	556	12026	35016	3708	4621	3205	2307	3200	523	65172
	Total	20871	18115	30377	44974	16087	12982	12420	10974	7361	2805	176966
Total N. Sea	1993	69148	42159	87769	86962	58027	44069	51052	45296	21959	12765	519206

Table 2.2.8 Catch in numbers (millions) and mean weight (g) by fleet in the North Sea.

	Human consumpt. Fleet A		Small mesh fishery Fleet B		TOTAL	
1. QUARTER						
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight
0						
1	1.9	39.8	796.61	20.1	798.5	20.1
2	90.8	98.1	109.08	51.9	199.9	72.9
3	74.6	107.9	2.14	86.6	76.7	107.3
4	40.8	148.7	0.84	152	41.6	148.8
5	26.6	158.5	0.47	164.7	27.1	158.6
6	17.1	178.4	0.29	180.4	17.4	178.4
7	19.6	186.1	0.26	189.3	19.9	186.2
8+	9.3	198.4	0.08	222.3	9.4	198.6
TOTAL	280.7		909.8		1190.5	
Landings (SOP)		35,872		22,183		58,055
2. QUARTER						
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight
0						
1	7.8	55.8	202.83	20.3	210.6	21.6
2	119.3	121.8	2.93	62.2	122.2	120.4
3	95.4	140.4	0.02	142.9	95.4	140.4
4	69.5	177.1			69.5	177.1
5	47.3	196.9			47.3	196.9
6	43.9	219.5			43.9	219.5
7	34.8	239.3			34.8	239.3
8+	16.7	254.2			16.7	254.2
TOTAL	434.6		205.8		640.4	
Landings (SOP)		72,190		4,303		76,493
3. QUARTER						
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			5669.5	8.5	5669.5	8.5
1	25.7	75.4	38.9	37.9	64.5	52.8
2	190.3	145.8	2.9	123	193.2	145.5
3	126.7	159.8	0.6	179.3	127.3	159.9
4	108.5	214.2	1.1	180.2	109.6	213.9
5	77.6	222.3	1.1	200.1	78.7	222.0
6	103.4	248.8	0.8	211.6	104.2	248.5
7	82.8	266.9	0.8	232.6	83.6	266.6
8+	60.4	303.8	0.4	244.7	60.8	303.4
TOTAL	775.4		5716.0		6491.4	
Landings (SOP)		156,616		50,988		207,691
4. QUARTER						
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	0.0	287.4	1312.3	15.9	1312.3	15.9
1	181.9	90.4	28.5	58.9	210.4	86.1
2	241.9	123.9	3.2	123.1	245.1	123.9
3	298.3	150.7	0.1	174.0	298.4	150.7
4	85.5	187.4	0.4	168.7	85.9	187.3
5	62.9	205.8	0.2	199.8	63.1	205.7
6	58.0	213.1	0.3	209.9	58.3	213.0
7	47.4	230.6	0.2	217.1	47.6	230.5
8+	40.0	253.6	0.1	222.8	40.1	253.5
TOTAL	1015.9		1345.3		2361.2	
Landings (SOP)		153,771		23,195		176,966
TOTAL YEAR						
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	0.0	287	6981.7	10	6981.8	10
1	217.2	87	1066.8	22	1284.0	33
2	642.3	126	118.2	56	760.4	115
3	594.9	146	2.9	111	597.8	145
4	304.3	189	2.3	168	306.6	189
5	214.5	204	1.7	190	216.2	204
6	222.4	228	1.4	205	223.8	228
7	184.6	244	1.3	221	185.9	244
8	126.4	274	0.6	237	127.0	273
TOTAL	2506.6		8176.8		10683.5	
Landings (SOP)		418,449		100,669		519,205

Table 2.2.9 : North Sea herring. Sampling intensity of commercial catches.

Division IVa

Country	Total Landings ('000t)	Number of samples	Number of age reading	Number of fishes measured	Estimates of discards	Catches to which the age composition has been applied
Denmark	54	22	1090	1113	no	54
France	7	-	-	-	no	0
Germany	17	-	-	-	no	0
Netherlands	29	17	1059	2056	yes	49
Norway	90	83	5450	8461	no	91
Sweden	1	-	-	-	no	0
(UK) England	5	-	-	-	no	0
(UK) Scotland	37	57	3379	8633	no	37

Division IVb

Country	Total Landings ('000t)	Number of samples	Number of age reading	Number of fishes measured	Estimates of discards	Catches to which the age composition has been applied
Denmark	110	88	6907	6934	no	110
France	2	-	-	-	no	0
Germany	24	-	-	-	no	0
Netherlands	31	18	2011	3526	yes	61
Norway	33	31	2187	4289	no	37
Sweden	4	-	-	-	no	0
(UK) England	4	-	-	-	no	0
(UK) Scotland	19	13	*	2704	no	19

* For Scotland, numbers of age reading in IVb are included in the IVa

Division IVc and VIId

Country	Total Landings ('000t)	Number of samples	Number of age reading	Number of fishes measured	Estimates of discards	Catches to which the age composition has been applied
Belgium	0.05	-	-	-	no	0
Denmark	1	1	3	3	no	1
France	7	9	646	1970	no	21
Germany	0.6	-	-	-	no	0
Netherlands	19	13	1152	4644	yes	64
England	11	-	-	-	no	0

Table 2.3.1.

IBTS 1-ringer indices

Year class	Year of sampling	1-ringer index
1977	1979	261
1978	1980	456
1979	1981	571
1980	1982	1142
1981	1983	1771
1982	1984	2156
1983	1985	3109
1984	1986	3908
1985	1987	5307
1986	1988	6796
1987	1989	3187
1988	1990	1585
1989	1991	1784
1990	1992	1664
1991	1993	3268
1992	1994	2416

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

Area	North west	North east	Central west	Central east	South west	South east	Division IIIa	South Bight	0-ringers abundance
Area $m^2 \times 10^9$	83	34	86	102	37	93	31	31	no. in 10^9
Year class									
1976	0.054	0.014	0.122	0.005	0.008	0.002	0.002	0.016	17.1
1977	0.024	0.024	0.050	0.015	0.056	0.013	0.006	0.034	13.1
1978	0.176	0.031	0.061	0.020	0.010	0.005	0.074	0.000	52.1
1979	0.061	0.195	0.262	0.408	0.226	0.143	0.099	0.053	101.1
1980	0.052	0.001	0.145	0.115	0.089	0.339	0.248	0.187	76.7
1981	0.197	0.000	0.289	0.199	0.215	0.645	0.109	0.036	133.9
1982	0.025	0.011	0.068	0.248	0.290	0.309	0.470	0.140	91.8
1983	0.019	0.007	0.114	0.268	0.271	0.473	0.339	0.377	115.0
1984	0.083	0.019	0.303	0.259	0.996	0.718	0.277	0.298	181.3
1985	0.116	0.057	0.421	0.344	0.464	0.777	0.085	0.084	177.4
1986	0.317	0.029	0.730	0.557	0.830	0.933	0.048	0.244	270.9
1987	0.078	0.031	0.417	0.314	0.159	0.618	0.483	0.495	168.9
1988	0.036	0.020	0.095	0.096	0.151	0.411	0.181	0.016	71.4
1989	0.083	0.030	0.040	0.094	0.013	0.035	0.041	0.000	25.9
1990	0.075	0.053	0.202	0.158	0.121	0.198	0.086	0.196	69.9
1991	0.255	0.390	0.431	0.539	0.500	0.369	0.298	0.395	200.7
1992[1]	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

[1]Revised, additional data received since WG-meeting 1993.

Table 2.3.3 Data used in RCT3 regression and the prediction of year classes 1990-1993.

Year class	0-ringers			1-ringers		
	MIK index	VPA est. billions	Prediction billions	IBTS index	VPA est. billions	Predictions billions
1976	17.1	2.6			1.47	
1977	13.1	4.4		261	1.61	
1978	52.1	4.6		456	3.64	
1979	101.1	10.8		571	5.44	
1980	76.7	16.8		1,142	8.60	
1981	133.9	37.9		1,771	17.03	
1982	91.8	64.7		2,156	15.39	
1983	115.0	62.2		3,109	15.93	
1984	181.3	53.6		3,907	28.05	
1985	177.4	82.8		5,307	34.44	
1986	270.9	99.4		6,796	27.26	
1987	168.9	86.6		3,187	14.23	
1988	71.4	43.6		1,585	13.68	
1989	25.9	41.9		1,784	14.37	
1990	69.9	41.0		1,664		10.97
1991	200.7		71.9	3,268		21.39
1992	190.1		56.8	2,416		16.87
1993	101.7		39.5			

Table 2.3.4

PREDICTION OF 0-RINGERS FROM IBTS1 AND MIK INDICES

Data for 2 surveys over 19 years : 1975 - 1993

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1991

	I----------Regression----------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IBTS 1	.97	-1.30	.33	.887	13	8.09	6.57	.379	.757
MIK	1.37	-.21	.70	.700	14	5.31	7.06	.813	.165
					VPA Mean =		5.63	1.183	.078

Yearclass = 1992

	I----------Regression----------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IBTS 1	.97	-1.30	.33	.887	13	7.79	6.28	.375	.761
MIK	1.37	-.21	.70	.700	14	5.25	6.98	.810	.163
					VPA Mean =		5.63	1.183	.076

Yearclass = 1993

	I----------Regression----------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IBTS 1									
MIK	1.37	-.21	.70	.700	14	4.63	6.13	.786	.694
					VPA Mean =		5.63	1.183	.306

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1991	719	6.58	.33	.23	.50		
1992	568	6.34	.33	.23	.51		
1993	395	5.98	.65	.23	.13		

Table 2.3.5

PREDICTION OF 1-RINGERS FROM IBTS1 AND MIK INDICES

Data for 2 surveys over 17 years : 1976 - 1992

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1990

	I----------Regression----------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IBTS 1	.93	.15	.26	.924	13	7.42	7.04	.292	.817
MIK	1.34	1.04	.70	.690	14	4.26	6.76	.781	.114
					VPA Mean =		6.92	1.000	.069

Yearclass = 1991

	I----------Regression----------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IBTS 1	.93	.15	.26	.924	13	8.09	7.67	.297	.818
MIK	1.34	1.04	.70	.690	14	5.31	8.16	.810	.110
					VPA Mean =		6.92	1.000	.072

Yearclass = 1992

	I----------Regression----------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IBTS 1	.93	.15	.26	.924	13	7.79	7.39	.293	.821
MIK	1.34	1.04	.70	.690	14	5.25	8.09	.807	.108
					VPA Mean =		6.92	1.000	.071

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1990	1097	7.00	.26	.06	.06		
1991	2139	7.67	.27	.18	.46		
1992	1687	7.43	.27	.18	.47		

Table 2.4.1 **Estimated numbers, biomass and mean weight of autumn spawners by age,maturity and area. Acoustic Survey June and July 1993**

Winter Rings	Numbers in millions				
	IVa	IVb	IVa + IVb	IIIa	Total
0				547.00	547.00
1	4,690.96	1,180.09	5,871.05	4,528.00	10,399.05
2 Immature	991.40	766.89	1,758.29	408.87	2,167.16
2 Mature	1,046.84	495.66	1,542.50		1,542.50
3 Immature	543.92	155.59	699.51		699.51
3 Mature	846.84	338.74	1,185.58		1,185.58
4	782.93	126.39	909.32		909.32
5	666.95	127.84	794.79		794.79
6	753.32	34.19	787.51		787.51
7	509.03	36.88	545.91		545.91
8	162.07	16.35	178.42		178.42
9 +	115.63	0.34	115.97		115.97
Total Immature	6,226.28	2,102.57	8,328.85	5,483.87	13,812.72
Total Mature	4,883.61	1,176.39	6,060.00	0.00	6,060.00
Grand total	11,109.89	3,278.96	14,388.85	5,483.87	19,872.72

Winter Rings	Mean weight in grams				
	IVa	IVb	IVa + IVb	IIIa	Total
0				3.90	3.90
1	70.05	65.36	69.11	55.04	62.98
2 Immature	127.28	96.50	113.86	71.28	105.82
2 Mature	130.92	122.86	128.33		128.33
3 Immature	134.62	117.14	130.73		130.73
3 Mature	162.13	143.41	156.78		156.78
4	207.63	168.69	202.22		202.22
5	236.51	167.64	225.43		225.43
6	282.15	172.74	277.40		277.40
7	293.02	193.46	286.29		286.29
8	316.62	192.22	305.22		305.22
9 +	340.64	193.02	340.21		340.21
Total Immature	84.80	80.55	83.73	51.15	70.79
Total Mature	214.39	143.21	200.58		200.58
Grand total	141.77	103.03	132.94	51.15	110.37

Winter Rings	Biomass in '000' t				
	IVa	IVb	IVa + IVb	IIIa	Total
0	0	0	0	2	2
1	329	77	406	249	655
2 Immature	126	74	200	29	229
2 Mature	137	61	198	0	198
3 Immature	73	18	91	0	91
3 Mature	137	49	186	0	186
4	163	21	184	0	184
5	158	21	179	0	179
6	213	6	218	0	218
7	149	7	156	0	156
8	51	3	54	0	54
9 +	39	0	39	0	39
Total Immature	528	169	697	280	978
Total Mature	1,047	168	1,215	0	1,215
Grand total	1,575	338	1,913	280	2,193

Table 2.4.2. Estimates of North Sea autumn spawners (millions) at age from Acoustic Survey, 1984 - 1993. For 1984 - 1986 the estimates are the sum of those from the Division IVa summer survey, the Division IVb autumn survey, and the Division IVc, VIId winter survey.
The 1987 - 1993 estimates are from the summer survey in Division IVa,b and IIIa excluding estimates of Divison IIIa/Baltic string spawners.

Winter Rings	Numbers in millions Year																	
	1984		1985		1986		1987		1988		1989		1990		1991		1992		1993
1	551		726		1,639		13,736		6,431		6,333		6,249		3,182		6,351		10,399
2	3,194		2,789		3,206		4,303		4,202		3,726		2,971		2,834		4,179		3,710
3	1,005		1,433		1,637		955		1,732		3,751		3,530		1,501		1,633		1,885
4	394		323		833		657		528		1,612		3,370		2,102		1,397		909
5	158		113		135		368		349		488		1,349		1,984		1,510		795
6	44		41		36		77		174		281		395		748		1,311		788
7	52		17		24		38		43		120		211		262		474		546
8	39		23		6		11		23		44		134		112		155		178
9+	41		19		8		20		14		22		43		56		163		116
Total	5,478		5,484		7,524		20,165		13,496		16,377		18,252		12,781		17,173		19,326
Z(2+/3+)		0.92		0.57		1.01		0.81		0.11		0.11		0.56		0.49		0.73	
SSB 000 t.	807		697		942		817		897		1,637		2,174		1,874		1,545		1,216

SSB defined as all fisk > maturity stage III.

Table 2.6.1 North Sea Herring,
Mean weight (g) at age (w.r.) and year class weighted by number caught catches in 1993.

Division	Quarter	0 1992	1 1991	2 1990	3 1989	4 1988	5 1987	6 1986	7 1985	8 1984	9 1983
IV a W of 2E	I			129	144	189	191	208	223	240	198
	II		50	139	158	200	213	240	257	273	295
	III		83	151	171	231	246	262	280	298	331
	IV		115	147	173	221	235	244	272	286	333
	Total		100	147	167	221	233	253	271	287	327
IV a E of 2 E	I		35	101	128	151	164	174	182	206	
	II		68	136	149	182	196	204	220	204	264
	III		72	109	133	167	187	211	246	261	292
	IV		98	150	176	196	209	214	222	228	283
	Total		93	122	146	175	191	204	216	222	276
IV b	I		20	55	81	138	174	170	185		
	II		21	94	112	137	133	183	219	198	
	III	9	42	144	156	222	240	246	266	280	310
	IV	16	77	122	156	185	199	211	233	276	272
	Total	10	27	102	146	199	220	236	261	275	306
IVc + VIId	I		20	95	97	127	141	142	170	163	130
	II		38	61	100	115	127	140	139	160	165
	III	13			123	142	153	164	173	182	191
	IV	33	94	114	148	167	201	199	214	227	236
	Total	14	56	113	139	152	174	182	191	211	216
IVa	Total		94	133	156	193	210	234	249	268	319
IVa + IVb	I		20	73	124	152	165	186	195	229	198
	II		21	121	141	179	199	221	239	240	283
	III	9	53	145	161	223	239	255	274	292	326
	IV	16	86	131	163	194	209	219	235	252	313
	Total	10	33	116	152	195	212	234	251	269	317
Total North Sea	I		20	73	107	149	159	179	187	202	131
	II		22	120	141	177	197	220	239	240	282
	III	9	53	145	160	214	222	248	267	288	324
	IV	16	86	124	151	187	206	213	231	240	295
	Total	10	33	115	145	189	204	228	244	256	310

Table 2.6.2 Comparison between mean weights (g) at age (w.r) in catch of North Sea Herring (adult) from earlier years and 1985-1993.

Division	Year	Age in winter rings							
		2	3	4	5	6	7	8	9+
IVa	1985	137	170	199	216	235	263	270	293
	1986	123	158	183	209	222	246	253	263
	1987	118	157	186	214	237	260	278	304
	1988	126	150	176	200	218	237	260	263
	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
IVb	1985	123	177	202	216	223	250	267	291
	1986	120	157	191	219	232	220	207	237
	1987	70	131	179	215	233	225	273	244
	1988	98	136	175	195	208	244	228	205
	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
IVa+IVb	Pre-1985	126	176	211	243	256	267	271	271
	1985	133	171	200	216	233	261	270	293
	1986	122	158	184	210	223	245	253	263
	1987	99	152	186	214	237	259	278	304
	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
IVc+VIId	Pre-1985	117	141	170	192	221	224	216	208
	1985	113	124	148	170	168	212	207	193
	1986	108	139	164	185	208	174	202	232
	1987	105	128	148	164	198	211	197	234
	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
Total North Sea	Pre-1985	125	166	204	228	253	266	271	270
	1985	128	164	194	211	220	258	270	292
	1986	121	153	182	207	221	238	252	262
	1987	99	149	180	211	234	258	278	295
	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

Spring spawners transferred to Division IIIa and North Sea autumn spawners caught in Division IIIa are not included.

Table 2.6.3 HERRING mean weight at age in the third quarter in Divisions IVa and IVb.

Age (WR.)	Mean weights (g) at age in the catch											
	Third quarter (Divisions IVa and IVb)								July Acoustic Survey			
	1986	1987	1988	1989	1990	1991	1992	1993	1990	1991	1992	1993
1	78	54	58	42	58	73	51	53	64	65	78	69
2	146	134	124	126	128	164	127	145	128	158	142	115
3	190	182	179	179	180	189	200	161	186	198	209	147
4	214	219	207	207	208	210	215	179	207	224	219	202
5	248	248	244	244	228	229	235	199	232	236	243	225
6	282	265	274	274	256	246	252	221	257	260	255	277
7	288	286	288	288	267	276	276	239	282	275	272	286
8	327	310	296	296	272	296	286	240	278	298	312	305
9+	364	342	350	350	295	293	330	283	318	317	311	340

Table 2.7.1 Time series of spawning stock indices, and the spawning stock from the converged part of the separable VPA ('000 t).

Year	SSB VPA	SSB LPE	SSB Acoustic	SSB IBTS
1972	289	146	-	-
1973	233	116	-	-
1974	162	77	-	-
1975	80	61	-	-
1976	77	20	-	-
1977	45	-	-	-
1978	61	108	-	-
1979	104	224	-	-
1980	128	365	-	-
1981	194	636	305	5.94
1982	280	480	402	12.55
1983	433	635	440	14.07
1984	729	871	807	35.64
1985	763	1,022	697	37.46
1986	815	1,244	942	28.66
1987	944	699	667[1]	50.83
1988	1,146	1,249	801[2]	35.99
1989	1,391	1,328	1,490[3]	84.76
1990	1,260	1,547	2,009[4]	89.50
1991	-	889	1,743[5]	46.52
1992	-	860	1,457[6]	38.68
1993	-	-	1,102[7]	26.03

[1]Reduced by 150,000 t (catches of spawners beteen time of the survey (15 July) and 1 November).
[2]Reduced by 94,000 t (catches of spawners between time of the survey (15 July) and 1 September).
[3]Reduced by 147,000 t (catches of spawners between time of the survey and 1 September).
[4]Reduced by 165,000 t (catches of spawners between time of the survey (13 July) and 27 September).
[5]Reduced by 131,000 t (catches of autumn spawners between time of the survey (15 July) and 15 September).
[6]Reduced by 88,000 t (catches of autumn spawners between time of the survey (15 July) and 24 September).
[7]Reduced by 112,000 t (catches of autumn spawners between time of survey (15 July) and 15 October).

Table 2.7.2

Prediction of SSB from IYFS, LPE and Acoustic Surveys, Total North Sea

3 12 2

'YEAR'	'VPA'	'ACOUST'	'IYFS'	'LPE'
1978	58	-11	-11	108
1979	100	-11	-11	224
1980	124	-11	-11	365
1981	205	305	5.94	636
1982	289	402	12.55	480
1983	446	442	14.07	635
1984	743	807	35.64	871
1985	775	697	37.46	1022
1986	836	942	28.66	1244
1987	949	667	50.83	699
1988	1132	801	35.99	1249
1989	1332	1490	84.76	1328
1990	1157	2009	89.50	1547
1991	-11	1743	46.52	889
1992	-11	1457	38.68	860
1993	-11	1104	26.03	-11

Table 2.7.3

Analysis by RCT3 ver3.1 of data from file :

d:\ifapwork\rct3.new

Prediction of SSB from IYFS, LPE and Acoustic Surveys, Total North Sea

Data for 3 surveys over 16 years : 1978 - 1993

Regression type = C
Tapered time weighting not applied
Survey weighting not applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean included
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1991

	I----------Regression----------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights	Net wts
ACOUST	1.23	-1.60	.36	.775	10	7.46	7.59	.464	.193	(not used)
IYFS	.81	3.75	.22	.898	10	3.86	6.86	.265	.594	.447
LPE	1.44	-3.27	.39	.888	13	6.79	6.52	.442	.213	.161
ACOUST	1.0	-0.08				7.46	7.38	.283		.392
					VPA Mean =		6.06	1.048	.000	

Yearclass = 1992

	I----------Regression----------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights	Net wts
ACOUST	1.23	-1.60	.36	.775	10	7.28	7.36	.448	.203	(not used)
IYFS	.81	3.75	.22	.898	10	3.68	6.72	.262	.589	.452
LPE	1.44	-3.27	.39	.888	13	6.76	6.47	.441	.208	.160
ACOUST	1.0	-0.08				7.28	7.21	.283		.388
					VPA Mean =		6.06	1.048	.000	

Yearclass = 1993

	I----------Regression----------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights	Net wts
ACOUST	1.23	-1.60	.36	.775	10	7.10	7.14	.435	.266	(not used)
IYFS	.81	3.75	.22	.898	10	3.30	6.41	.262	.734	.538
LPE	(not used)									
ACOUST	1.0	-0.08				7.10	7.02	.283		.462
					VPA Mean =		6.06	1.048	.000	

Net weighted average predictions

1991	1107
1992	963
1993	806

} = 2,876,000

Table 2.7.4

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: NSFINAL2)

At 30-Mar-94 18:36

Table 1 Catch numbers at age Numbers*10**-4

YEAR,	1970,	1971,	1972,	1973,
AGE				
1,	119620,	437850,	334060,	236800,
2,	200280,	114680,	144050,	134420,
3,	88360,	66250,	34380,	65920,
4,	12520,	20830,	13060,	15020,
5,	5030,	2690,	3290,	5930,
6,	6100,	3050,	500,	3060,
7,	790,	2680,	20,	370,
8,	1200,	10,	110,	140,
+gp,	1220,	1240,	40,	60,
TOTALNUM,	435120,	649280,	529510,	461720,
TONSLAND,	563100,	520100,	497500,	484000,
SOPCOF %,	106,	95,	111,	105,

Table 1 Catch numbers at age Numbers*10**-4

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
1,	84610,	246050,	12660,	14430,	16860,	15920,	24510,	87200,	111640,	244860,
2,	77260,	54170,	90150,	4470,	490,	3410,	13400,	28430,	29940,	57380,
3,	36200,	25960,	11730,	18640,	570,	1000,	9180,	5690,	23010,	21640,
4,	12600,	14050,	5200,	1080,	500,	1010,	3220,	3950,	3370,	10510,
5,	5610,	5720,	3450,	700,	30,	210,	2170,	2850,	1440,	2620,
6,	2230,	1610,	610,	410,	20,	20,	230,	2270,	680,	2280,
7,	500,	910,	440,	150,	20,	80,	140,	1870,	780,	1280,
8,	200,	340,	100,	70,	20,	60,	40,	550,	360,	1100,
+gp,	110,	140,	40,	0,	30,	10,	10,	110,	110,	1210,
TOTALNUM,	219320,	348950,	124380,	39950,	18540,	21720,	52900,	132920,	171330,	342880,
TONSLAND,	275100,	312800,	174800,	46000,	11000,	25100,	70764,	174879,	275079,	387202,
SOPCOF %,	109,	109,	107,	90,	96,	147,	121,	159,	184,	136,

Table 1 Catch numbers at age Numbers*10**-4

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
1,	173720,	322820,	472320,	667529,	776281,	307100,	285500,	206710,	223100,	368769,
2,	109500,	131620,	124610,	212370,	224750,	158300,	87700,	110160,	124470,	113363,
3,	42170,	117340,	82710,	68710,	118510,	138358,	76330,	55350,	43860,	58686,
4,	19250,	36570,	45830,	48150,	39810,	82812,	84910,	54890,	36120,	29441,
5,	7750,	12360,	12770,	24880,	26060,	21834,	37590,	49390,	35750,	20782,
6,	2160,	4330,	6110,	7570,	12860,	12940,	8010,	20160,	37240,	21783,
7,	2410,	2000,	2020,	2370,	3790,	6327,	5440,	3880,	15020,	18121,
8,	1060,	1300,	1340,	790,	1510,	2073,	2840,	2500,	3840,	8414,
+gp,	1780,	1600,	1460,	800,	840,	865,	1180,	1260,	2350,	4017,
TOTALNUM,	359800,	629940,	749171,	1033170,	1204409,	730608,	589500,	504300,	521750,	643375,
TONSLAND,	409489,	609108,	660553,	773411,	875923,	768886,	619963,	635929,	694206,	647435,
SOPCOF %,	112,	102,	91,	108,	87,	100,	98,	103,	116,	115,

Table 2.7.5

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: NSFINAL2)

At 30-Mar-94 18:36

Table 2 Catch weights at age (kg)

YEAR,	1970,	1971,	1972,	1973,
AGE				
1,	.0500,	.0500,	.0500,	.0500,
2,	.1260,	.1260,	.1260,	.1260,
3,	.1760,	.1760,	.1760,	.1760,
4,	.2110,	.2110,	.2110,	.2110,
5,	.2430,	.2430,	.2430,	.2430,
6,	.2510,	.2510,	.2510,	.2510,
7,	.2670,	.2670,	.2670,	.2670,
8,	.2710,	.2710,	.2710,	.2710,
+gp,	.2710,	.2710,	.2710,	.2710,
SOPCOFAC,	1.0619,	.9479,	1.1147,	1.0542,

Table 2 Catch weights at age (kg)

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
1,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0490,	.0590,	.0590,
2,	.1260,	.1260,	.1260,	.1260,	.1260,	.1260,	.1260,	.1180,	.1180,	.1180,
3,	.1760,	.1760,	.1760,	.1760,	.1760,	.1760,	.1760,	.1420,	.1490,	.1490,
4,	.2110,	.2110,	.2110,	.2110,	.2110,	.2110,	.2110,	.1890,	.1790,	.1790,
5,	.2430,	.2430,	.2430,	.2430,	.2430,	.2430,	.2430,	.2110,	.2170,	.2170,
6,	.2510,	.2510,	.2510,	.2510,	.2510,	.2510,	.2510,	.2220,	.2380,	.2380,
7,	.2670,	.2670,	.2670,	.2670,	.2670,	.2670,	.2670,	.2670,	.2650,	.2650,
8,	.2710,	.2710,	.2710,	.2710,	.2710,	.2710,	.2710,	.2710,	.2740,	.2740,
+gp,	.2710,	.2710,	.2710,	.2710,	.2710,	.2710,	.2710,	.2710,	.2750,	.2750,
SOPCOFAC,	1.0945,	1.0850,	1.0724,	.8975,	.9634,	1.4668,	1.2107,	1.5948,	1.8386,	1.3630,

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: NSFINAL2)

At 30-Mar-94 18:36

Table 2 Catch weights at age (kg)

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
1,	.0590,	.0360,	.0670,	.0350,	.0550,	.0430,	.0550,	.0580,	.0530,	.0330,
2,	.1180,	.1280,	.1210,	.0990,	.1110,	.1150,	.1140,	.1300,	.1020,	.1150,
3,	.1490,	.1640,	.1530,	.1500,	.1450,	.1530,	.1490,	.1660,	.1750,	.1450,
4,	.1790,	.1940,	.1820,	.1800,	.1740,	.1730,	.1770,	.1840,	.1890,	.1890,
5,	.2170,	.2110,	.2080,	.2110,	.1970,	.2080,	.1930,	.2030,	.2070,	.2040,
6,	.2380,	.2200,	.2210,	.2340,	.2160,	.2310,	.2290,	.2170,	.2230,	.2280,
7,	.2650,	.2580,	.2380,	.2580,	.2370,	.2470,	.2360,	.2350,	.2370,	.2440,
8,	.2740,	.2700,	.2520,	.2770,	.2530,	.2650,	.2500,	.2590,	.2490,	.2560,
+gp,	.2750,	.2920,	.2620,	.2990,	.2630,	.2590,	.2870,	.2710,	.2870,	.3100,
SOPCOFAC,	1.1215,	1.0202,	.9058,	1.0824,	.8658,	1.0015,	.9759,	1.0274,	1.1586,	1.1498,

Table 2.7.6

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: NSFINAL2)

At 30-Mar-94 18:36

Table 3 Stock weights at age (kg)

YEAR,	1970,	1971,	1972,	1973,
AGE				
1,	.0500,	.0500,	.0500,	.0500,
2,	.1550,	.1550,	.1550,	.1550,
3,	.1870,	.1870,	.1870,	.1870,
4,	.2230,	.2230,	.2230,	.2230,
5,	.2390,	.2390,	.2390,	.2390,
6,	.2760,	.2760,	.2760,	.2760,
7,	.2990,	.2990,	.2990,	.2990,
8,	.3060,	.3060,	.3060,	.3060,
+gp,	.3120,	.3120,	.3120,	.3120,

Table 3 Stock weights at age (kg)

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
1,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,
2,	.1550,	.1550,	.1550,	.1550,	.1550,	.1550,	.1550,	.1550,	.1550,	.1550,
3,	.1870,	.1870,	.1870,	.1870,	.1870,	.1870,	.1870,	.1870,	.1870,	.1870,
4,	.2230,	.2230,	.2230,	.2230,	.2230,	.2230,	.2230,	.2230,	.2230,	.2230,
5,	.2390,	.2390,	.2390,	.2390,	.2390,	.2390,	.2390,	.2390,	.2390,	.2390,
6,	.2760,	.2760,	.2760,	.2760,	.2760,	.2760,	.2760,	.2760,	.2760,	.2760,
7,	.2990,	.2990,	.2990,	.2990,	.2990,	.2990,	.2990,	.2990,	.2990,	.2990,
8,	.3060,	.3060,	.3060,	.3060,	.3060,	.3060,	.3060,	.3060,	.3060,	.3060,
+gp,	.3120,	.3120,	.3120,	.3120,	.3120,	.3120,	.3120,	.3120,	.3120,	.3120,

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: NSFINAL2)

At 30-Mar-94 18:36

Table 3 Stock weights at age (kg)

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
1,	.0500,	.0640,	.0780,	.0490,	.0430,	.0510,	.0640,	.0650,	.0780,	.0690,
2,	.1550,	.1410,	.1460,	.1330,	.1220,	.1400,	.1450,	.1580,	.1420,	.1150,
3,	.1870,	.1930,	.1900,	.1830,	.1630,	.1780,	.1860,	.1980,	.2090,	.1470,
4,	.2230,	.2280,	.2240,	.2200,	.2150,	.2110,	.2080,	.2240,	.2190,	.2020,
5,	.2390,	.2480,	.2480,	.2470,	.2390,	.2540,	.2320,	.2360,	.2430,	.2250,
6,	.2760,	.2580,	.2810,	.2630,	.2700,	.2830,	.2570,	.2600,	.2550,	.2770,
7,	.2990,	.3000,	.2870,	.2850,	.2770,	.2880,	.2820,	.2750,	.2720,	.2860,
8,	.3060,	.3180,	.3280,	.3100,	.2970,	.3160,	.2780,	.2980,	.3120,	.3050,
+gp,	.3120,	.3160,	.3640,	.3420,	.3100,	.3630,	.3180,	.3170,	.3110,	.3400,

Table 2.7.7

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: NSFINAL2)

At 30-Mar-94 18:36

Table 5 Proportion mature at age

YEAR,	1970,	1971,	1972,	1973,
AGE				
1,	.0000,	.0000,	.0000,	.0000,
2,	1.0000,	1.0000,	.8200,	.8200,
3,	1.0000,	1.0000,	1.0000,	1.0000,
4,	1.0000,	1.0000,	1.0000,	1.0000,
5,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.8200,	.8200,	.8200,	.8200,	.8200,	.8200,	.8200,	.8200,	.8200,	.8200,
3,	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,
5,	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,
7,	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,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: NSFINAL2)

At 30-Mar-94 18:36

Table 5 Proportion mature at age

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.8200,	.7000,	.7500,	.6300,	.6600,	.7900,	.7300,	.6400,	.5100,	.4700,
3,	1.0000,	1.0000,	1.0000,	1.0000,	.9000,	.9400,	.9700,	.9700,	1.0000,	.6300,
4,	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,
6,	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,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 2.7.8

Title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: NSFINAL2)

At 30-Mar-94 18:35

Separable analysis
from 1970 to 1993 on ages 1 to 8
with Terminal F of .480 on age 4 and Terminal S of 1.050

Initial sum of squared residuals was 173.287 and
final sum of squared residuals is 68.177 after 59 iterations

Matrix of Residuals

Years, Ages	1970/71	1971/72	1972/73
1/ 2,	-1.432,	-1.069,	.104,
2/ 3,	-.056,	-.662,	.296,
3/ 4,	.485,	.012,	.564,
4/ 5,	.302,	-.057,	.316,
5/ 6,	-.789,	-.277,	-.443,
6/ 7,	-.495,	3.028,	-.246,
7/ 8,	3.163,	1.325,	-2.393,
TOT ,	.000,	.001,	.001,
WTS ,	.001,	.001,	.001,

Years,	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83
1/ 2,	-.351,	-.696,	-.797,	-1.053,	-.189,	1.015,	.392,	-.579,	-.267,	.099,
2/ 3,	.158,	.262,	.032,	-.212,	-1.190,	-.965,	-.440,	.755,	-.796,	.088,
3/ 4,	.728,	.309,	.300,	.817,	.674,	-.525,	-.337,	1.012,	-.198,	.823,
4/ 5,	-.196,	-.100,	-.225,	.110,	.388,	.776,	-.074,	.130,	.114,	.133,
5/ 6,	-.253,	.309,	.547,	.171,	.310,	.284,	.569,	-.071,	.501,	-.612,
6/ 7,	.548,	-.068,	-.420,	-.588,	-.276,	-1.556,	-1.331,	-2.163,	.091,	-.828,
7/ 8,	-.536,	-.477,	.610,	-.023,	-1.143,	-1.161,	1.411,	-1.333,	.782,	-.434,
TOT ,	.000,	.001,	.001,	.003,	.011,	.015,	.010,	.006,	.006,	.005,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years,	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93,	TOT,	WTS,
1/ 2,	.141,	-.402,	-.228,	-.206,	.071,	.545,	.052,	-.011,	-.316,	-.268,	-.003,	.392,
2/ 3,	-.028,	-.422,	-.390,	-.084,	-.108,	-.234,	-.145,	-.175,	.426,	.134,	.002,	.479,
3/ 4,	.050,	.044,	.348,	.122,	.115,	-.099,	-.115,	-.034,	.199,	.047,	.004,	.540,
4/ 5,	.070,	.165,	.263,	.003,	-.006,	-.047,	-.001,	.002,	.025,	.021,	.003,	1.000,
5/ 6,	-.077,	.267,	-.124,	-.123,	.001,	.014,	.174,	.047,	-.157,	-.074,	.003,	.617,
6/ 7,	-.367,	-.276,	-.107,	.261,	-.007,	-.017,	-.005,	.106,	-.186,	.110,	.003,	.230,
7/ 8,	-.018,	.367,	-.359,	.360,	-.141,	-.015,	.040,	.267,	-.365,	.076,	.003,	.197,
TOT ,	.004,	.004,	.003,	.003,	.003,	.003,	.002,	.002,	.001,	.000,	-6.344,	
WTS ,	.001,	.001,	.001,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)

,	1970,	1971,	1972,	1973,
F-values,	1.2181,	1.3974,	.6806,	1.0707,

,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
F-values,	1.0194,	1.5624,	1.6404,	1.1439,	.0995,	.1080,	.2801,	.4318,	.2710,	.3529,

,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
F-values,	.4469,	.6169,	.5424,	.5504,	.5551,	.5434,	.4356,	.4199,	.4711,	.4800,

Selection-at-age (S)

,	1,	2,	3,	4,	5,	6,	7,	8,
S-values,	.7267,	.8076,	.8099,	1.0000,	1.0321,	1.0356,	.9879,	1.0500,

Table 2.7.9

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: NSHERRING)

At 30-Mar-94 18:55

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1947,	1948,	1949,	1950,	1951,	1952,	1953,
AGE							
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0039,
1,	.0000,	.0002,	.0000,	.0000,	.0448,	.0706,	.0858,
2,	.1251,	.0456,	.0692,	.1149,	.1822,	.3072,	.3095,
3,	.1684,	.2652,	.1699,	.2228,	.3286,	.2543,	.4235,
4,	.1929,	.1846,	.2340,	.2313,	.4322,	.3407,	.3247,
5,	.2108,	.2504,	.2180,	.2400,	.3475,	.3718,	.3339,
6,	.2682,	.2742,	.4164,	.2719,	.3157,	.4127,	.4473,
7,	.2811,	.1987,	.4009,	.3421,	.2151,	.4609,	.4127,
8,	.2250,	.2350,	.2890,	.2620,	.3290,	.3690,	.3900,
+gp,	.2250,	.2350,	.2890,	.2620,	.3290,	.3690,	.3900,
FBAR 2- 6,	.1931,	.2040,	.2215,	.2162,	.3212,	.3374,	.3678,

Table 8 Fishing mortality (F) at age

YEAR,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,
AGE										
0,	.0074,	.0052,	.0053,	.0031,	.0044,	.0000,	.0257,	.0186,	.0049,	.0148,
1,	.1077,	.2073,	.1549,	.2485,	.1388,	.2175,	.2554,	.1291,	.0896,	.1239,
2,	.3008,	.3583,	.5323,	.3912,	.4987,	.4184,	.4238,	.6153,	.2495,	.2974,
3,	.4977,	.3746,	.4326,	.4463,	.4703,	.5035,	.3118,	.3378,	.6235,	.2745,
4,	.4503,	.3931,	.3081,	.4054,	.3388,	.4294,	.3019,	.3793,	.3963,	.2251,
5,	.3901,	.4431,	.3233,	.3094,	.5030,	.3902,	.2234,	.3440,	.4757,	.1387,
6,	.4678,	.4126,	.4396,	.4329,	.1875,	.4945,	.2948,	.3015,	.6223,	.1547,
7,	.6896,	.2742,	.2930,	.6185,	.2385,	.2054,	.4422,	.2309,	.4416,	.1851,
8,	.5020,	.3810,	.3610,	.4450,	.3490,	.4060,	.3160,	.3200,	.5150,	.1960,
+gp,	.5020,	.3810,	.3610,	.4450,	.3490,	.4060,	.3160,	.3200,	.5150,	.1960,
FBAR 2- 6,	.4213,	.3963,	.4072,	.3970,	.3997,	.4472,	.3111,	.3956,	.4734,	.2181,

Table 8 Fishing mortality (F) at age

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
0,	.0126,	.0071,	.0215,	.0256,	.0348,	.0082,	.0351,	.0340,	.0583,	.0466,
1,	.3084,	.2460,	.1852,	.2981,	.3002,	.3291,	.2681,	.6023,	.5786,	.6731,
2,	.3884,	.7752,	.5915,	.4222,	1.3278,	.7842,	.9727,	.8830,	.8125,	1.0236,
3,	.4121,	.7371,	.7080,	.8030,	1.8710,	.9136,	1.2662,	1.2142,	.8022,	1.3357,
4,	.3684,	.7758,	.5692,	.9238,	1.0661,	.8723,	1.3357,	1.2241,	.7986,	.9901,
5,	.3044,	.6544,	.8326,	.8200,	1.2315,	1.0391,	.8713,	1.0986,	.5471,	.9485,
6,	.2153,	.5112,	.3849,	1.0037,	1.1456,	1.8816,	1.0368,	2.5323,	.5323,	1.3615,
7,	.2309,	.3978,	.3782,	1.4745,	1.5634,	1.1959,	3.3513,	2.0956,	.0894,	.8516,
8,	.3060,	.6180,	.5760,	1.0120,	1.3930,	1.2090,	1.2590,	.4990,	.3970,	1.2600,
+gp,	.3060,	.6180,	.5760,	1.0120,	1.3930,	1.2090,	1.2590,	.4990,	.3970,	1.2600,
FBAR 2- 6,	.3378,	.6908,	.6172,	.7945,	1.3284,	1.0982,	1.0965,	1.3904,	.6985,	1.1319,

Continued

Table 2.7.9 (Cont'd)

Table 8 Fishing mortality (F) at age YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
0,	.0747,	.1658,	.1515,	.0960,	.0457,	.0825,	.1255,	.4821,	.3346,	.3967,
1,	.4573,	.6858,	.2658,	.3091,	.1965,	.1672,	.1114,	.2848,	.2251,	.2520,
2,	1.0257,	1.3532,	1.3268,	.2448,	.0254,	.0927,	.3653,	.3178,	.2599,	.3023,
3,	.9767,	1.4893,	1.6343,	1.3630,	.0468,	.0699,	.4080,	.2771,	.4934,	.3233,
4,	.9983,	1.3908,	1.6540,	.6001,	.0973,	.1040,	.3157,	.2920,	.2491,	.4163,
5,	1.1945,	1.9231,	1.6992,	.9999,	.0257,	.0486,	.3010,	.4505,	.1471,	.2784,
6,	1.0695,	1.3073,	1.1787,	.8931,	.0562,	.0194,	.0622,	.5197,	.1630,	.3243,
7,	.7478,	1.9485,	1.6723,	.9483,	.0815,	.2946,	.1638,	.8497,	.3001,	.4581,
8,	1.5990,	1.7690,	1.3250,	1.4340,	.2670,	.3300,	.2100,	1.4470,	.3370,	.7840,
+gp,	1.5990,	1.7690,	1.3250,	1.4340,	.2670,	.3300,	.2100,	1.4470,	.3370,	.7840,
FBAR 2- 6,	1.0529,	1.4927,	1.4986,	.8202,	.0503,	.0669,	.2904,	.3714,	.2625,	.3289,

Table 8 Fishing mortality (F) at age YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	FBAR 91-93
AGE											
0,	.2145,	.0826,	.0598,	.1565,	.1191,	.1184,	.0490,	.0934,	.2544,	.3000,	.2159,
1,	.1933,	.3727,	.3011,	.3537,	.5631,	.4011,	.3857,	.2522,	.2922,	.3400,	.2948,
2,	.2987,	.3905,	.4363,	.3840,	.3424,	.3825,	.3384,	.4596,	.4261,	.4270,	.4376,
3,	.4065,	.6509,	.4892,	.4928,	.4111,	.3918,	.3428,	.3970,	.3574,	.3910,	.3818,
4,	.5034,	.7062,	.5436,	.5601,	.5634,	.5350,	.4207,	.4197,	.4636,	.4100,	.4311,
5,	.5453,	.6233,	.5054,	.5678,	.5960,	.6133,	.4388,	.4099,	.4704,	.4700,	.4501,
6,	.3458,	.5934,	.6396,	.5633,	.5738,	.5926,	.4212,	.3954,	.5476,	.5180,	.4870,
7,	.5914,	.5483,	.5410,	.4853,	.5423,	.5473,	.4718,	.3294,	.5090,	.4980,	.4455,
8,	.7560,	.6550,	.7760,	.3720,	.5790,	.5710,	.4490,	.3660,	.5550,	.5290,	.4833,
+gp,	.7560,	.6550,	.7760,	.3720,	.5790,	.5710,	.4490,	.3660,	.5550,	.5290,	
FBAR 2- 6,	.4199,	.5929,	.5228,	.5136,	.4973,	.5030,	.3924,	.4163,	.4530,	.4432,	

Table 2.7.10

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: NSHERRING)

At 30-Mar-94 18:55

Traditional vpa using file input for terminal F

Table 10 Stock number at age (start of year)							Numbers*10**-5
YEAR,	1947,	1948,	1949,	1950,	1951,	1952,	1953,
AGE							
0,	611061,	420249,	337520,	451574,	452443,	531628,	607851,
1,	174099,	224797,	154601,	124167,	166125,	166444,	195575,
2,	48487,	64047,	82678,	56875,	45678,	58437,	57055,
3,	29495,	31698,	45335,	57154,	37559,	28203,	31840,
4,	38133,	20406,	19907,	31317,	37448,	22140,	17907,
5,	29040,	28451,	15351,	14255,	22485,	21994,	14248,
6,	33687,	21283,	20041,	11169,	10146,	14372,	13721,
7,	18444,	23311,	14638,	11958,	7700,	6695,	8607,
8,	32619,	12600,	17292,	8871,	7685,	5619,	3821,
+gp,	35612,	33297,	26034,	18274,	8949,	13183,	8906,
TOTAL,	1050677,	880139,	733396,	785613,	796218,	868716,	959531,

Table 10 Stock number at age (start of year)							Numbers*10**-5			
YEAR,	1954,	1955,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,
AGE										
0,	471468,	504728,	285448,	1407818,	349408,	447137,	121153,	1088949,	463208,	476607,
1,	222743,	172173,	184723,	104452,	516289,	127975,	164493,	43440,	393226,	169580,
2,	66035,	73574,	51482,	58205,	29971,	165311,	37878,	46875,	14046,	132257,
3,	31015,	36210,	38092,	22398,	29159,	13484,	80595,	18368,	18769,	8108,
4,	17069,	15437,	20385,	20234,	11737,	14917,	6673,	48311,	10727,	8237,
5,	11711,	9845,	9428,	13554,	12207,	7568,	8785,	4464,	29914,	6531,
6,	9232,	7174,	5719,	6174,	9001,	6679,	4635,	6358,	2864,	16822,
7,	7938,	5233,	4297,	3334,	3623,	6751,	3686,	3123,	4255,	1391,
8,	5154,	3604,	3599,	2900,	1625,	2583,	4975,	2143,	2244,	2476,
+gp,	8402,	3488,	6483,	4471,	2571,	6861,	5493,	3349,	2256,	3006,
TOTAL,	850767,	831465,	609654,	1643541,	965591,	799267,	438365,	1265380,	941510,	825013,

Table 10 Stock number at age (start of year)							Numbers*10**-5			
YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
0,	628212,	348994,	278544,	402602,	387012,	215773,	410672,	322940,	208774,	100103,
1,	172760,	228217,	127474,	100295,	144360,	137502,	78727,	145865,	114833,	72457,
2,	55113,	46689,	65650,	38967,	27386,	39335,	36400,	22151,	29382,	23687,
3,	72773,	27687,	15931,	26919,	18926,	5378,	13302,	10195,	6786,	9659,
4,	5045,	39457,	10847,	6425,	9873,	2386,	1766,	3070,	2479,	2491,
5,	5951,	3158,	16434,	5555,	2308,	3076,	902,	420,	817,	1009,
6,	5144,	3972,	1485,	6468,	2214,	610,	985,	342,	127,	428,
7,	13040,	3753,	2155,	914,	2145,	637,	84,	316,	25,	67,
8,	1046,	9367,	2281,	1336,	189,	406,	174,	3,	35,	20,
+gp,	2294,	1778,	5644,	2829,	1269,	372,	177,	330,	13,	9,
TOTAL,	961377,	713071,	526445,	592310,	595683,	405476,	543189,	505631,	363270,	209930,

Table 2.7.10 (Cont'd)

Table 10 Stock number at age (start of year) Numbers*10**-5										
YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
0,	217474,	26945,	26478,	44027,	45915,	107579,	167589,	378684,	647224,	622084,
1,	35148,	74242,	8398,	8371,	14714,	16137,	36443,	54379,	86022,	170382,
2,	13597,	8185,	13757,	2368,	2261,	4447,	5023,	11993,	15046,	25267,
3,	6305,	3611,	1567,	2704,	1374,	1633,	3003,	2582,	6466,	8596,
4,	2080,	1944,	667,	250,	567,	1073,	1247,	1635,	1603,	3232,
5,	837,	693,	438,	115,	124,	465,	875,	823,	1105,	1130,
6,	354,	229,	92,	72,	38,	110,	401,	586,	474,	863,
7,	99,	110,	56,	26,	27,	33,	97,	341,	315,	365,
8,	26,	42,	14,	10,	9,	22,	22,	75,	132,	211,
+gp,	14,	17,	6,	0,	13,	4,	6,	15,	40,	232,
TOTAL,	275934,	116020,	51472,	57944,	65042,	131504,	214705,	451113,	758427,	832363,

Table 10 Stock number at age (start of year) Numbers*10**-5												
YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	GMST
AGE												
0,	536449,	828046,	993912,	866469,	435824,	418552,	410330,	405939,	690249,	589258,	0,	3269
1,	153913,	159250,	280465,	344418,	272585,	142332,	136778,	143729,	136015,	196892,	160593,	1125
2,	48719,	46670,	40357,	76354,	88956,	57102,	35060,	34214,	41089,	37358,	51556,	322
3,	13835,	26772,	23396,	19327,	38527,	46791,	28856,	18516,	16007,	19879,	18057,	149
4,	5093,	7543,	11433,	11744,	9667,	20911,	25892,	16769,	10192,	9167,	11008,	69
5,	1929,	2786,	3368,	6007,	6069,	4979,	11081,	15383,	9973,	5801,	5505,	37
6,	774,	1012,	1352,	1839,	3080,	3026,	2440,	6466,	9239,	5638,	3281,	19
7,	564,	496,	506,	645,	947,	1570,	1514,	1449,	3940,	4834,	3039,	10
8,	209,	283,	259,	266,	359,	498,	822,	855,	943,	2143,	2659,	5
+gp,	350,	348,	282,	270,	200,	208,	342,	431,	577,	1023,	1688,	
TOTAL,	761836,	1073206,	1355330,	1327337,	856214,	695970,	653114,	643749,	918224,	871994,	257385,	

Table 2.7.11

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: NSHERRING) ,

At 30-Mar-94 18:55

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

,	RECRUITS. (0-group)	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 2- 6,
1947,	61106048,	8225109,	4939302,	586600,	.1188,	.1931,
1948,	42024944,	7183683,	4064810,	502100,	.1235,	.2040,
1949,	33751952,	6551569,	3751413,	508500,	.1355,	.2215,
1950,	45157460,	5794995,	3269583,	491700,	.1504,	.2162,
1951,	45244252,	5316776,	2618719,	600400,	.2293,	.3212,
1952,	53162816,	5262297,	2406569,	664400,	.2761,	.3374,
1953,	60785120,	5140106,	2087927,	698500,	.3345,	.3678,
1954,	47146824,	4996976,	1901795,	762900,	.4011,	.4213,
1955,	50472776,	4588597,	1806215,	806400,	.4465,	.3963,
1956,	28544782,	4140687,	1876701,	675200,	.3598,	.4072,
1957,	140781856,	5228528,	1746530,	682900,	.3910,	.3970,
1958,	34940780,	5155570,	1397309,	670500,	.4799,	.3997,
1959,	44713732,	5317878,	2601470,	784500,	.3016,	.4472,
1960,	12115316,	4018935,	2133604,	696200,	.3263,	.3111,
1961,	108894912,	4543627,	1830966,	696700,	.3805,	.3956,
1962,	46320808,	4529123,	1239819,	627800,	.5064,	.4734,
1963,	47660696,	4779593,	2329719,	716000,	.3073,	.2181,
1964,	62821148,	4911398,	2138496,	871200,	.4074,	.3378,
1965,	34899436,	4425268,	1527896,	1168800,	.7650,	.6908,
1966,	27854342,	3356653,	1319586,	895500,	.6786,	.6172,
1967,	40260220,	2823796,	929250,	695500,	.7485,	.7945,
1968,	38701164,	2526678,	418661,	717800,	1.7145,	1.3284,
1969,	21577270,	1908080,	427025,	546700,	1.2803,	1.0982,
1970,	41067172,	1924088,	377244,	563100,	1.4927,	1.0965,
1971,	32293970,	1855487,	272770,	520100,	1.9067,	1.3904,
1972,	20877350,	1550159,	288985,	497500,	1.7215,	.6985,
1973,	10010326,	1154584,	233148,	484000,	2.0759,	1.1319,
1974,	21747382,	910970,	161853,	275100,	1.6997,	1.0529,
1975,	2694527,	677410,	80204,	312800,	3.9000,	1.4927,
1976,	2647761,	354398,	76911,	174800,	2.2728,	1.4986,
1977,	4402722,	206567,	44963,	46000,	1.0231,	.8202,
1978,	4591523,	221328,	60883,	11000,	.1807,	.0503,
1979,	10757920,	381378,	104014,	25100,	.2413,	.0669,
1980,	16758938,	631143,	128325,	70764,	.5514,	.2904,
1981,	37868416,	1159341,	194525,	174879,	.8990,	.3714,
1982,	64722412,	1845033,	280201,	275079,	.9817,	.2625,
1983,	62208376,	2484944,	432682,	387202,	.8949,	.3289,
1984,	53644932,	2803345,	728881,	409489,	.5618,	.4199,
1985,	82804688,	3241225,	763048,	609108,	.7983,	.5929,
1986,	99391152,	4228616,	815051,	660553,	.8104,	.5228,
1987,	86646792,	4067678,	943952,	773411,	.8193,	.5136,
1988,	43582388,	3669614,	1146010,	875923,	.7643,	.4973,
1989,	41855220,	3582315,	1391185,	768886,	.5527,	.5030,
1990,	41032928,	3511748,	1259650,	619963,	.4922,	.3924,
1991,	40593932,	3517251,	1148648,	635929,	.5536,	.4163,
1992,	69024984	3386794,	986051,	694206,	.7040,	.4530,
1993,	58925840 [1]	3379912,	730169,	647435,	.8867,	.4432,
Arith. Mean ,	44235960,	3435559,	1306653,	565513,	.8010,	.5511,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

[1]Replaced in projection by RCT3 estimate which back-calculated is equivalent to 62,248 million 0-group in 1993.

Table 2.8.1 Proportion and abundance of each year class as 1-ringers in Division IIIA related to MIK-indices.

Year class (autumn sp.)	Proportion of 1-ringers in IIIa	Number of 1-ringers in IIIa (millions)	MIK-index 0-ringers in North Sea and IIIa
1981	0.254	4,328	133.9
1982	0.276	4,250	91.8
1983	0.255	4,062	115
1984	0.439	12,314	181.3
1985	0.267	9,195	177.4
1986	0.636	17,337	270.9
1987	0.300	4,269	168.9
1988	0.177	2,421	71.4
1989	0.134	1,926	25.9
1990	0.199	2,706	69.9
1991	0.611	13,069	200.7
1992	0.250	4,218	190.1
1993	0.240[1]	4,247[1]	101.7

Regression:

Number of 1-ringers in Division IIIa (millions) = 61.0*MIK - 1957 (r-square = 0.71).

Proportion of 1-ringers in Division IIIa = 0.00192*MIK + 0.0447 (r-square = 0.68).

[1]Prediction based on regression.

Table 2.8.2 North Sea Herring Short Term Prediction Program.

INPUT DATA

A AND B ARE NORTH SEA FLEETS — C, D, and E ARE DIV. IIIa FLEETS

FIRSTYEAR : 1994 FLEET: A: IV HC B: IV IND C: IIIa HC D: IIIa MC E: IIIa IND. F: Fleet in 22+24

NORTH SEA HERRING STOCK SIZE 1. JANUARY 1994

AGE	TOTAL NUMBER	IV NUMBER	IIIa NUMBER	TOTAL BIOMASS	SP STOCK NUMBER	SP STOCK BIOMASS
0	39500.0	30020.0	9480.0	316.0	0.0	0.0
1	16870.0	12652.5	4217.5	1164.0	0.0	0.0
2	5155.6	5155.6	5155.6	592.9	1528.0	175.7
3	1805.7	1805.7	0.0	265.4	767.8	112.9
4	1100.8	1100.8	0.0	222.4	748.6	151.2
5	550.5	550.5	0.0	123.9	370.5	83.4
6	328.1	328.1	0.0	90.9	220.6	61.1
7	303.9	303.9	0.0	86.9	207.4	59.3
8	265.9	265.9	0.0	81.1	177.9	54.3
9+	168.8	168.8	0.0	57.4	113.0	38.4
TOTAL	66049.3	52351.8	18853.1	3000.9	4133.8	736.3

NORTH SEA HERRING. MEAN WEIGHT AT AGE IN THE CATCH BY FLEET

AGE	A	B	C	D	E	F
0	18	10	17.6	13.1	12.4	
1	87	22	69.1	14.2	23.5	
2	126	56	104.1	46.7	70	
3	146	111	0	0	0	
4	189	168	0	0	0	
5	204	190	0	0	0	
6	228	205	0	0	0	
7	244	221	0	0	0	
8	274	237	0	0	0	
9+	274	237	0	0	0	

MEAN WEIGHT AT AGE IN THE STOCK / MATUR. OGIVE

AGE	SPAW.	1. JAN.	
0	8	8	0
1	69	69	0
2	115	115	0.47
3	147	147	0.63
4	202	202	1
5	225	225	1
6	277	277	1
7	286	286	1
8	305	305	1
9+	340	340	1

FISHING MORTALITY BY FLEET RELATIVE TO AREA 0

AGE	A	B	C	D	E	F	
0	0	0.3017	0.00005	0.1208	0.2447		0
1	0.0479	0.2609	0.0521	0.1178	0.1747		0
2	0.2209	0.0407	0.0606	0.0029	0.0569		0
3	0.3812	0.0019	0	0	0		0
4	0.4694	0.0035	0	0	0		0
5	0.4843	0.0038	0	0	0		0
6	0.4868	0.0031	0	0	0		0
7	0.464	0.0033	0	0	0		0
8	0.4943	0.0023	0	0	0		0
9	0.4966	0	0	0	0		0

NORTH SEA HERRING. FISHING MORTALITY BY FLEET (TOTAL) 1994

AGE	TOTAL	A	B	C	D	E	F
0	0.343	0.000	0.250	0.000	0.031	0.062	0.000
1	0.348	0.039	0.213	0.016	0.032	0.048	0.000
2	0.388	0.224	0.041	0.062	0.003	0.058	0.000
3	0.387	0.385	0.002	0.000	0.000	0.000	0.000
4	0.476	0.472	0.004	0.000	0.000	0.000	0.000
5	0.491	0.487	0.004	0.000	0.000	0.000	0.000
6	0.493	0.490	0.003	0.000	0.000	0.000	0.000
7	0.470	0.467	0.003	0.000	0.000	0.000	0.000
8	0.500	0.497	0.002	0.000	0.000	0.000	0.000
9+	0.500	0.500	0.000	0.000	0.000	0.000	0.000
AVG 2-6	0.447	0.412	0.011	0.012	0.001	0.012	0.000

NATURAL MORTALITY

AGE	M	Z 1994	Z 1995
0	1		
1	1		
2	0.3	0.682	0.7055
3	0.2	0.5831	0.5831
4	0.1	0.5729	0.5729
5	0.1	0.5881	0.5881
6	0.1	0.5899	0.5899
7	0.1	0.5673	0.5673
8	0.1	0.5966	0.5966
9+	0.1	0.5966	0.5966

NORTH SEA HERRING. F-FACTOR , CATCH, YIELD BY FLEET 1994

	TOTAL	A	B	C	D	E	F	IV	IIIa
F-FACTOR		1	1	1	1	1	0	1	1
CATCH	12905.7	2670.4	7066.9	362.7	914.3	1891.4	0.0	9737.3	3168.4
YIELD	610322.6	423225.4	101182.5	32974.5	12647.8	40292.4	0.0	524407.9	85914.7
SSB	736264.9		AVG F 2-6	0.447		Sum:		534145.2	89083.1

NORTH SEA HERRING. CATCH AT AGE BY FLEET 1994

AGE	TOTAL	A	B	C	D	E	F
0	6954.9	0.0	5064.8	0.3	624.6	1265.2	0.0
1	3007.1	338.0	1840.8	135.9	278.8	413.5	0.0
2	1427.7	825.6	152.1	226.5	10.8	212.7	0.0
3	524.2	521.6	2.6	0.0	0.0	0.0	0.0
4	396.3	393.3	2.9	0.0	0.0	0.0	0.0
5	203.1	201.6	1.6	0.0	0.0	0.0	0.0
6	121.4	120.7	0.8	0.0	0.0	0.0	0.0
7	108.4	107.6	0.8	0.0	0.0	0.0	0.0
8	99.4	99.0	0.5	0.0	0.0	0.0	0.0
9+	63.1	63.1	0.0	0.0	0.0	0.0	0.0
TOTAL	12905.7	2670.4	7066.9	362.7	914.3	1891.4	0.0

NORTH SEA HERRING. YIELD AT AGE BY FLEET 1994

AGE	TOTAL	A	B	C	D	E	F
0.	74524.2	0.0	50648.4	5.3	8182.1	15688.5	0.0
1.	92971.0	29403.2	40498.3	9392.0	3959.5	9717.9	0.0
2.	151512.1	104024.4	8518.3	23577.2	506.2	14886.0	0.0
3.	76438.2	76149.7	288.6	0.0	0.0	0.0	0.0
4.	74834.5	74341.7	492.7	0.0	0.0	0.0	0.0
5.	41419.1	41118.6	300.5	0.0	0.0	0.0	0.0
6.	27666.5	27509.0	157.5	0.0	0.0	0.0	0.0
7.	26427.0	26257.8	169.1	0.0	0.0	0.0	0.0
8.	27231.8	27122.6	109.2	0.0	0.0	0.0	0.0
9+	17298.2	17298.2	0.0	0.0	0.0	0.0	0.0
TOTAL	610322.6	423225.4	101182.5	32974.5	12647.8	40292.4	0.0

4. Proportion of fishing mortality and natural mortality before spawning is 0.67 as in previous assessments.

NORTH SEA HERRING. STOCK SIZE 1. JANUARY 1995

AGE	TOTAL NUMBER	IV NUMBER	IIIa NUMBER	TOTAL BIOMASS	SP STOCK NUMBER	SP STOCK BIOMASS
0	44083.9	33062.9	11021.0	352671.2	0.0	0.0
1	10312.9	7837.8	2475.1	711587.6	0.0	0.0
2	4382.2	4382.2	4382.2	503956.9	1157.4	133100.9
3	2590.5	2590.5	0.0	380809.7	1032.7	151810.4
4	1004.1	1004.1	0.0	202826.4	662.6	133854.9
5	619.1	619.1	0.0	139296.6	404.5	91011.7
6	304.9	304.9	0.0	84451.0	198.8	55076.8
7	181.4	181.4	0.0	51873.8	120.1	34358.1
8	171.9	171.9	0.0	52425.3	111.5	34012.1
9+	215.4	215.4	0.0	73219.0	149.1	50692.2
TOTAL	63866.2	50370.2	17878.3	2553117.7	3836.8	683917.1

Table 2.8.2 Continued

NORTH SEA HERRING. F-FACTOR, CATCH AND YIELD BY FLEET.								1995		
FLEET	TOTAL	A	B	C	D	E	F	IV	IIIa	2+
F-FACTOR		1	1	1.2	1	1.2	0	1	1	
CATCH	13025	2558	6847	503	883	2234	0	9405	3620	
YIELD	595894	409855	88035	42702	12051	43252	0	497890	98004	944795
SSB	683917		AVG F 2-6	0.45			Sum:	507295.2	101624.0	

NORTH SEA HERRING. CATCH AT AGE BY FLEET								1995	
AGE	TOTAL	A	B	C	D	E	F	G	
0	8023.7	0.0	5578.2	1.1	712.5	1731.9	0.0	0.0	
1	2071.6	209.4	1140.3	273.3	161.4	287.2	0.0	0.0	
2	1274.8	694.5	128.0	228.6	9.1	214.7	0.0	0.0	
3	748.3	748.3	0.0	0.0	0.0	0.0	0.0	0.0	
4	358.8	358.8	0.0	0.0	0.0	0.0	0.0	0.0	
5	226.7	226.7	0.0	0.0	0.0	0.0	0.0	0.0	
6	112.1	112.1	0.0	0.0	0.0	0.0	0.0	0.0	
7	64.2	64.2	0.0	0.0	0.0	0.0	0.0	0.0	
8	64.0	64.0	0.0	0.0	0.0	0.0	0.0	0.0	
9+	80.5	80.5	0.0	0.0	0.0	0.0	0.0	0.0	
TOTAL	13024.7	2558.5	6846.5	503.0	883.0	2233.8	0.0	0.0	

NORTH SEA HERRING YIELD AT AGE BY FLEET								1995
AGE	TOTAL	A	B	C	D	E	F	
0	86610.0	0.0	55782.2	19.5	9333.3	21475.0	0.0	
1	71225.9	18214.3	25087.3	18882.3	2291.9	6750.1	0.0	
2	133922.9	87505.3	7165.6	23799.8	425.8	15026.6	0.0	
3	109247.9	109247.9	0.0	0.0	0.0	0.0	0.0	
4	67810.6	67810.6	0.0	0.0	0.0	0.0	0.0	
5	46242.3	46242.3	0.0	0.0	0.0	0.0	0.0	
6	25561.9	25561.9	0.0	0.0	0.0	0.0	0.0	
7	15671.5	15671.5	0.0	0.0	0.0	0.0	0.0	
8	17532.9	17532.9	0.0	0.0	0.0	0.0	0.0	
9+	22068.6	22068.6	0.0	0.0	0.0	0.0	0.0	
TOTAL	595894.5	409855.2	88035.1	42701.5	12051.0	43251.7	0.0	

NORTH SEA HERRING. FISHING MORTALITY BY FLEET							1995
AGE	TOTAL	A	B	C	D	E	F
0	0.357	0.000	0.248	0.000	0.032	0.077	0.000
1	0.402	0.041	0.221	0.053	0.031	0.056	0.000
2	0.412	0.225	0.041	0.074	0.003	0.069	0.000
3	0.385	0.385	0.000	0.000	0.000	0.000	0.000
4	0.471	0.471	0.000	0.000	0.000	0.000	0.000
5	0.486	0.486	0.000	0.000	0.000	0.000	0.000
6	0.489	0.489	0.000	0.000	0.000	0.000	0.000
7	0.466	0.466	0.000	0.000	0.000	0.000	0.000
8	0.497	0.497	0.000	0.000	0.000	0.000	0.000
9+	0.400	0.497	0.000	0.000	0.000	0.000	0.000
AVG 2-6	0.449	0.411	0.008	0.015	0.001	0.014	0.000

NORTH SEA HERRING STOCK SIZE 1. JANUARY 1996		
AGE	TOTAL NUMBER	TOTAL BIOMASS
0		0.0
1	11351.0	783216.9
2	2537.4	291801.6
3	2149.2	315927.5
4	1443.9	291666.0
5	567.3	127631.5
6	344.6	95442.8
7	169.2	48396.4
8	103.0	31421.6
9+	94.7	32184.8
TOTAL	18760.1	2017689.1

Table 2.8.3. North Sea Herring projections by fleet.

1994

NORTH SEA HERRING. F-FACTOR , CATCH, YIELD BY FLEET								1994	
	TOTAL	A	B	C	D	E	F	IV	IIIa
F-FACTOR		1	1	1	1	1	0	1	1
CATCH	12906	2670	7067	363	914	1891	0	9737	3168
YIELD	610323	423225	101183	32975	12648	40292	0	524408	85915
SSB	736265		AVG F 2-6	0.45					

1995

NORTH SEA HERRING. F-FACTOR, CATCH AND YIELD BY FLEET.							1995			
FLEET	TOTAL	A	B	C	D	E	F	IV	IIIa	
F-FACTOR		0.445	1	1	1	1	0	1	1	
CATCH	11353	1247	6867	434	899	1905	0	8114	3238	
YIELD	376930	201454	88784	37091	12290	37310	0	290239	86692	
SSB	800000		AVG F 2-6	0.21				Biomass of 2+:		1088465

NORTH SEA HERRING. F-FACTOR, CATCH AND YIELD BY FLEET.							1995			
FLEET	TOTAL	A	B	C	D	E	F	IV	IIIa	
F-FACTOR		0.6	1	1	1	1	0	1	1	
CATCH	11733	1640	6862	431	899	1902	0	8502	3232	
YIELD	438913	264213	88592	36719	12283	37105	0	352806	86107	
SSB	766401		AVG F 2-6	0.28				Biomass of 2+:		1048181

NORTH SEA HERRING. F-FACTOR, CATCH AND YIELD BY FLEET.							1995			
FLEET	TOTAL	A	B	C	D	E	F	IV	IIIa	
F-FACTOR		0.8	1	1	1	1	0	1	1	
CATCH	12195	2118	6855	426	899	1898	0	8973	3223	
YIELD	513852	340133	88349	36250	12275	36846	0	428482	85371	
SSB	725137		AVG F 2-6	0.36				Biomass of 2+:		998493

NORTH SEA HERRING. F-FACTOR, CATCH AND YIELD BY FLEET.							1995			
FLEET	TOTAL	A	B	C	D	E	F	IV	IIIa	
F-FACTOR		1	1	1	1	1	0	1	1	
CATCH	12628	2566	6848	421	899	1894	0	9414	3214	
YIELD	583533	410770	88110	35792	12266	36595	0	498880	84653	
SSB	686098		AVG F 2-6	0.44				Biomass of 2+:		951252

NORTH SEA HERRING. F-FACTOR, CATCH AND YIELD BY FLEET.							1995			
FLEET	TOTAL	A	B	C	D	E	F	IV	IIIa	
F-FACTOR		1.2	1	1	1	1	0	1	1	
CATCH	13033	2986	6841	417	899	1891	0	9827	3206	
YIELD	648371	476542	87876	35345	12258	36350	0	564418	83953	
SSB	649154		AVG F 2-6	0.53				Biomass of 2+:		906318

NORTH SEA HERRING. F-FACTOR, CATCH AND YIELD BY FLEET.							1995			
FLEET	TOTAL	A	B	C	D	E	F	IV	IIIa	
F-FACTOR		1	1	0.6	1	0.6	0	1	1	
CATCH	11796	2581	6851	255	932	1178	0	9431	2365	
YIELD	557992	412641	88263	21730	12714	22644	0	500904	57087	
SSB	690555		AVG F 2-6	0.43				Biomass of 2+:		964442

NORTH SEA HERRING. F-FACTOR, CATCH AND YIELD BY FLEET.							1995			
FLEET	TOTAL	A	B	C	D	E	F	IV	IIIa	
F-FACTOR		1	1	0.8	1	0.8	0	1	1	
CATCH	12219	2573	6849	339	915	1542	0	9422	2796	
YIELD	570902	411699	88186	28802	12487	29728	0	499885	71017	
SSB	688311		AVG F 2-6	0.44				Biomass of 2+:		957800

NORTH SEA HERRING. F-FACTOR, CATCH AND YIELD BY FLEET.							1995			
FLEET	TOTAL	A	B	C	D	E	F	IV	IIIa	
F-FACTOR		1	1	1.2	1	1.2	0	1	1	
CATCH	13025	2558	6847	503	883	2234	0	9405	3620	
YIELD	595894	409855	88035	42702	12051	43252	0	497890	98004	
SSB	683917		AVG F 2-6	0.45				Biomass of 2+:		944795

Table 2.9.1 North Sea autumn spawner herring.

Effect of juvenile catch on longterm yield and SSB 1993 catch data F as in 1993 y 2+/0-group rect = 13.944

Div IIIa Fleet C, D, and E Data from Table 3.x.x in 1994/Assess:xx SSB/0-group = 33.622

quarter	age	reduced catch in millions	Weca gram	red. catch of juv. t	Gain of 2+ catch t	Gain of SSB t	Net yield gain t	M	Accum. M	Total m -Ac.M	N-factor
3	0	2015.06	11.00	22166	46247	111512	24081	0.2106	1.5017	0.4983	1.645921
4	0	941.64	16.30	15349	28976	69867	13627	0.3759	1.20845	0.7916	2.206814
1	1	1539.75	15.50	23866	67804	163490	43938	0.3409	0.85005	1.1500	3.158035
2	1	255.51	25.40	6490	14176	34182	7686	0.1212	0.619	1.3810	3.978879
3	1	370.13	56.50	20912	27532	66386	6620	0.4652	0.3258	1.6742	5.334526
4	1	185.71	71.80	13334	18263	44036	4929	0.0932	0.0466	1.9534	7.052626
Total				102117	202998	489472	100881	2.0000			

N. Sea Fleet A and B Data fromTable 2.10.x in 1994/Assess:xx

quarter	age	reduced catch in millions	Weca gram	red. catch of juv. t	Gain of 2+ catch t	Gain of SSB t	Net yield gain t	M	Accum. M	Total m -Ac.M	N-factor
3	0	5669.50	9.00	51026	130119	313745	79094	0.2106	1.5017	0.4983	1.645921
4	0	1312.30	16.00	20997	40382	97369	19385	0.3759	1.20845	0.7916	2.206814
1	1	789.50	20.00	15790	34766	83829	18976	0.3409	0.85005	1.1500	3.158035
2	1	210.60	22.00	4633	11684	28174	7051	0.1212	0.619	1.3810	3.978879
3	1	64.50	53.00	3419	4798	11569	1379	0.4652	0.3258	1.6742	5.334526
4	1	210.40	86.00	18094	20691	49891	2597	0.0932	0.0466	1.9534	7.052626
Total				113958	242440	584576	128482	2.0000			

Div IIIa Fleet D Data from Table 3.2.x and 3.2.y ICES 1994/Assess:xx.

quarter	age	reduced catch in millions	Weca gram	red. catch of juv. t	Gain of 2+ catch t	Gain of SSB t	Net yield gain t	M	Accum. M	Total m -Ac.M	N-factor
3	0	688.46	11.20	7711	15801	38099	8090	0.2106	1.5017	0.4983	1.645921
4	0	328.17	17.30	5677	10098	24349	4421	0.3759	1.20845	0.7916	2.206814
1	1	696.42	13.60	9471	30667	73945	21196	0.3409	0.85005	1.1500	3.158035
2	1	105.49	16.20	1709	5853	14112	4144	0.1212	0.619	1.3810	3.978879
3	1	7.29	35.80	261	542	1308	281	0.4652	0.3258	1.6742	5.334526
4	1	1.85	42.10	78	182	439	104	0.0932	0.0466	1.9534	7.052626
Total				24907	63143	152252	38236	2.0000			
Whole year	2	10.04	67.1	674	774	1867	101	0.3	-0.15	1.7104	5.531174

SSB by age from y/r		Yield by age from y/r	
1	0	1	0
2	6.405	2	3.423
3	10.314	3	3.444
4	6.294	4	2.599
5	4.067	5	1.712
6	2.493	6	1.048
7	1.578	7	0.631
8	1.053	8	0.425
9+	1.418	9+	0.661

Div IIIa + North Fleet A, B, C, D, and E

quarter	age	reduced catch in millions	Weca gram	red. catch of juv. t	Gain of 2+ catch t	Gain of SSB t	Net yield gain t	M	Accum. M	Total m -Ac.M	N-factor	0-gr equiv.
3	0	7684.56	9.52	73191	176366	425257	103175	0.2106	1.5017	0.4983	1.645921	12648
4	0	2253.94	16.13	36346	69358	167237	33012	0.3759	1.20845	0.7916	2.206814	4974
1	1	2329.25	17.03	39656	102570	247318	62914	0.3409	0.85005	1.1500	3.158035	7356
2	1	466.11	23.86	11123	25860	62355	14737	0.1212	0.619	1.3810	3.978879	1855
3	1	434.63	55.98	24331	32330	77954	7999	0.4652	0.3258	1.6742	5.334526	2319
4	1	396.11	79.34	31428	38954	93927	7526	0.0932	0.0466	1.9534	7.052626	2794
Total				216075	445438	1074049	229363	2.0000				31945

17622
14323

Extra SSB by year		Extra yield in N.Sea	
1994	91736	1994	49026
1995	260594	1995	109648
1996	271902	1996	97915
1997	169164	1997	70320
1998	107376	1998	45179
1999	66533	1999	27506
2000	42890	2000	17207
2001	38866	2001	16957
2002+	24988	2002+	11648
Sum	1074049	Sum	445407

Table 2.10.1 **Herring total North Sea, 1993.**
Numbers (millions) and weights (g) at age (winter rings) per year class of herring caught in each quarter. Spring spawners tfansferred to Division IIIa, and North Sea autumn spawners caught in Division IIIa are not inclued.

		Winter ring										
Quarter		0	1	2	3	4	5	6	7	8	9	Total (numbers)	SOP ('000t)
		1992	1991	1990	1989	1988	1987	1986	1985	1984	1983		
	No	0.0	793.0	123.1	2.7	0.2	0.0	0.0	0.0	0.0	0.0	919.1	
I	W		20	73	107	149	159	179	187	202	131		58.0
	No	0.0	206.1	46.4	26.8	12.4	2.8	2.2	1.5	0.5	0.0	298.7	
II	W		22	120	141	177	197	220	239	240	282		76.5
III	No	5651.3	43.0	104.2	67.5	50.5	25.9	35.8	28.5	6.9	4.6	6018.4	
	W	9	53	145	160	214	222	248	267	288	324		207.7
IV	No	1312.0	124.8	91.4	39.3	26.4	13.1	9.5	3.5	0.1	0.6	1620.6	
	W	16	86	124	151	187	206	213	231	240	295		177.0
Total	No	6981.7	1283.9	760.4	597.7	306.7	216.2	223.7	185.9	85.8	41.2	10683.3	
	W	10	33	115	145	189	204	228	244	256	310		519.2

The stocks weights displated below are derived from acoustic survey samples taken in July from Divisions IVa,b and used in the SSVPA

	0	1	2	3	4	5	6	7	8	9
	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983
Stock weights		69	115	147	202	225	277	286	305	340

For the 2 and 3 ringers, the stocks weights displayed above are for combined immature and mature fish. 4 ringers and older were 100% mature

	Mean weight
2 immature	103
2 mature	128
3 immature	131
3 mature	157

Table 3.1.1 **HERRING in Division IIIa and Sub. Division 22-24. 1985 - 1993**
Landings in thousands of tonnes.
(Data provided by Working Group members 1993).

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

* Preliminary data.

Table 3.1.2 Kattegat 1993

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

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	2.15	28.0	386.02	13.0	299.85	16.0	688.02	14.3
2	22.66	65.8	1.94	44.5	41.98	41.5	66.58	28.4
3	6.88	93.4			3.32	46.5	10.20	161.3
4	4.58	118.4			0.21	58.0	4.79	136.7
5	2.84	139.9					2.84	190.9
6	1.45	152.4					1.45	274.0
7	0.69	165.0					0.69	320.3
8+	0.36	193.5					0.36	316.3
TOTAL	41.61		387.96		345.36		774.93	
Land. (SOP)(t)		3,538		5,105		6,706		15,279
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	0.01	22.1	23.58	22.6	37.71	22.4	61.30	22.5
2	9.81	65.6	12.44	41.8	31.48	46.3	53.73	48.8
3	5.37	80.0	0.89	54.0	5.19	57.4	11.45	67.7
4	4.03	105.0			0.47	63.4	4.50	100.7
5	3.71	122.5			0.09	66.0	3.80	121.2
6	1.88	146.8					1.88	146.8
7	1.22	156.2					1.22	156.2
8+	0.50	178.9					0.50	178.9
TOTAL	26.53		36.91		74.94		138.38	
Land. (SOP)(t)		2,507		1,101		2,636		6,244
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			211.44	10.2	137.25	8.9	348.69	9.7
1	5.60	50.1			39.02	40.2	44.62	41.4
2	11.13	78.7			5.23	51.2	16.36	69.9
3	7.72	102.8			0.92	57.9	8.64	98.0
4	4.94	123.8			0.16	62.0	5.10	121.9
5	3.02	154.5			0.11	98.0	3.13	152.5
6	1.47	144.1					1.47	144.1
7	0.67	156.9					0.67	156.9
8+	0.28	179.3					0.28	179.3
TOTAL	34.83		211.44		182.69		428.96	
Land. (SOP)(t)		3,395		2,157		3,132		8,684
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	0.43	17.6	180.29	15.6	129.38	14.5	310.10	15.1
1	41.41	70.9	5.98	42.1	29.31	49.4	76.70	60.4
2	29.91	85.8			2.14	59.4	32.05	84.0
3	12.81	103.9			0.24	61.6	13.05	103.1
4	5.41	120.5			0.34	139.5	5.75	121.6
5	2.91	138.3					2.91	138.3
6	1.64	180.7	0.56	180.0			2.20	180.5
7	1.37	192.5					1.37	192.5
8+	0.02	221.0						
TOTAL	95.91		186.83		161.41		444.13	
Land. (SOP)(t)		8,460		3,165		3,513		15133.5
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	0.43	17.6	391.73	12.7	266.63	11.6	658.79	12.3
1	49.17	66.6	415.58	14.0	405.89	21.3	870.64	20.4
2	53.00	78.2	14.38	42.2	80.83	44.5	148.21	56.3
3	48.56	83.3	0.89	54.0	9.67	53.8	59.12	78.0
4	21.26	109.6			1.18	84.2	22.44	108.2
5	14.22	131.2			0.20	83.6	14.42	130.5
6	7.83	150.9	0.56	180.0			8.39	152.8
7	4.71	165.7					4.71	165.7
8+	1.49	173.1					1.49	173.1
TOTAL	200.67		823.14		764.40		1788.21	
Land. (SOP)(t)		17,890		11,527		15,987		45,405

Table 3.1.3 Skagerrak 1993

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

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	0.68	38.1	310.40	14.3	540.65	17.6	851.73	16.4
2	21.42	91.9	4.73	40.9	88.51	66.8	114.66	53.5
3	8.41	120.9	0.32	108.0	7.65	86.1	16.38	162.5
4	8.34	149.2			2.83	136.7	11.17	125.7
5	4.44	162.6			0.22	151.0	4.66	274.2
6	2.25	172.5			1.14	160.0	3.39	266.8
7	2.05	181.9			1.53	157.7	3.58	175.8
8+	0.41	203.9			0.66	193.0	1.07	467.5
TOTAL	48.00		315.45		643.19		1006.64	
Land. (SOP)(t)		5,822		4,667		17,058		27,463
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	9.68	70.4	81.91	14.3	102.62	31.7	194.21	26.3
2	50.57	115.2	1.25	40.9	22.59	81.6	74.41	103.8
3	24.09	133.1	0.08	108.0	6.19	96.2	30.36	125.5
4	8.06	140.5			5.07	124.8	13.13	134.4
5	9.68	161.6			3.28	142.4	12.96	156.7
6	7.84	177.3			1.61	154.4	9.45	173.4
7	4.25	193.4			1.08	207.1	5.33	196.2
8+	2.51	220.6			0.79	198.7	3.30	215.4
TOTAL	116.68		83.24		143.23		343.15	
Land. (SOP)(t)		15,176		1,231		7,421		23,828
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			477.02	11.6	1189.35	11.1	1666.37	11.2
1	199.57	66.0	7.29	35.8	118.65	47.4	325.51	58.5
2	105.19	111.3	1.46	74.0	35.27	120.0	141.92	113.1
3	85.11	127.8			15.60	93.0	100.71	122.4
4	26.16	152.9			1.26	187.0	27.42	154.5
5	13.82	153.3			2.18	171.0	16.00	155.7
6	5.90	182.6			8.17	189.6	14.07	186.7
7	3.95	186.3					3.95	186.3
8+	0.67	210.1					0.67	210.1
TOTAL	440.37		485.77		1370.48		2296.62	
Land. (SOP)(t)		43,829		5,902		26,666		76,398
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			147.88	19.3	483.66	16.1	631.54	16.8
1	140.15	74.9			21.78	64.4	161.93	73.5
2	48.52	121.0			1.01	77.8	49.53	120.1
3	43.97	152.3					43.97	152.3
4	17.60	162.2					17.60	162.2
5	8.37	177.7					8.37	177.7
6	3.87	214.3					3.87	214.3
7	2.36	217.1					2.36	217.1
8+	0.58	263.9						
TOTAL	265.42		147.88		506.45		919.17	
Land. (SOP)(t)		28,902		2,854		9,268		40,871
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			624.90	13.4	1673.01	12.5	2297.91	12.8
1	350.08	69.6	399.60	14.7	783.70	25.3	1533.38	32.6
2	204.96	114.3	7.44	47.4	147.38	81.9	359.78	99.6
3	174.59	130.3	0.40	108.0	29.44	91.9	204.43	124.7
4	60.23	149.5			9.16	137.0	69.39	147.8
5	40.21	159.5			5.68	153.7	45.89	158.8
6	22.05	182.3			10.92	181.3	32.97	181.9
7	12.81	191.9			2.61	178.1	15.42	189.6
8+	5.81	210.1			1.45	196.1	7.26	207.3
TOTAL	870.74		1032.34		2663.35		4566.43	
Land. (SOP)(t)		93,671		14,654		60,413		168,738

Table 3.1.4 Sub-divisions 22-24 1993. Catch in numbers (millions) and mean weight at age.

	Sub. Division 22		Sub. Division 23		Sub. Division 24		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	54.10	18.1			4.14	18.0	58.24	18.1
2	31.11	36.7	0.01	93.0	6.11	52.1	37.23	39.2
3	13.68	80.1	0.02	115.3	47.02	78.5	60.72	78.9
4	9.19	107.5	0.38	136.2	53.70	103.6	63.27	104.3
5	3.56	129.3	3.14	167.5	71.77	134.1	78.47	135.2
6	2.09	158.7	4.05	184.2	27.63	153.85	33.77	157.8
7	1.45	157.4	2.81	195.0	22.16	179.39	26.42	179.8
8+	0.15	229.0	1.24	204.5	7.52	186.37	8.91	189.6
TOTAL	115.33		11.65		240.05		367.03	
Land. (SOP)(t)		5,259		2,128		28,893		36,281
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	43.23	18.5			7.19	23.4	50.42	19.2
2	43.54	39.2			49.44	43.4	92.98	41.4
3	20.38	75.2	0.2	105.60	74.30	69.0	94.83	70.4
4	11.11	96.9	0.3	108.70	61.02	83.9	72.40	86.0
5	4.96	111.4	1.1	118.30	46.55	109.1	52.60	109.5
6	0.74	120.5	0.6	121.90	20.53	139.4	21.88	138.3
7	0.40	105.0	0.6	124.30	12.27	151.9	13.28	149.2
8+			0.1	141.90	5.12	168.47	5.19	168.1
TOTAL	124.36		2.80		276.42		403.58	
Land. (SOP)(t)		5,799		334		23,228		29,361
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	14.00	14.4			7.7	16.3	21.70	15.1
1	8.64	35.8			8.99	34.1	17.63	34.9
2	4.30	55.4	0.09	90.8	17.99	54.9	22.38	55.1
3	2.87	69.4	0.78	135.0	17.64	65.6	21.29	68.7
4	2.15	88.2	0.51	147.3	10.21	78.3	12.87	82.7
5	1.09	93.3	1.81	162.9	5.5	97.1	8.40	110.8
6	0.70	104.4	0.44	165.8	1.35	139.0	2.49	134.0
7	0.09	103.0	0.20	206.4	0.45	126.0	0.74	144.9
8+	0.19	193.0	0.10	167.3	0.63	191.8	0.92	189.4
TOTAL	34.03		3.93		70.46		108.42	
Land. (SOP)(t)		1,359		614		4,277		6,250
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	9.00	19.1			14.15	16.1	23.15	17.3
1	21.25	36.7			11.67	35.9	32.92	36.4
2	8.82	54.0	0.06	119.0	18.66	53.1	27.54	53.5
3	2.96	77.9	1.02	128.1	15.24	74.18	19.22	77.6
4	2.56	97.8	2.16	139.7	13.61	92.5	18.33	98.8
5	1.62	93.3	1.68	161.0	8.3	105.42	11.60	111.8
6	0.40	135.7	0.57	190.7	2.69	141.87	3.66	148.8
7	0.14	103.0	0.39	213.8	1.24	161.37	1.77	168.3
8+	0.28	193.0	0.09	203.8	0.92	180.14	1.29	184.6
TOTAL	47.03		5.97		86.48		139.48	
Land. (SOP)(t)		2,183		920		5,649		8752.0
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	23.00	16.2			21.85	16.2	44.85	16.2
1	127.22	22.5			31.99	30.3	159.21	24.1
2	87.77	40.6	0.16	101.5	92.20	48.2	180.13	44.5
3	39.89	76.7	1.97	129.0	154.20	72.0	196.06	73.5
4	25.01	100.1	3.32	137.9	138.54	92.0	166.87	94.1
5	11.23	112.7	7.72	158.1	132.12	121.9	151.07	123.1
6	3.93	139.5	5.67	176.7	52.20	147.2	61.80	149.4
7	2.08	141.3	4.01	186.6	36.12	168.8	42.21	169.1
8+	0.62	201.7	1.50	199.1	14.19	179.7	16.31	182.4
TOTAL	320.75		24.35		673.41		1018.51	
Land. (SOP)(t)		14,600		3,998		62,047		80,644

Table 3.2.1 Skagerrak 1993 Spring Spawners.

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

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2								
3	8.41	120.9	0.32	108.0	7.65	86.1	16.38	104.4
4	8.34	149.2			2.83	136.7	11.17	146.0
5	4.44	162.6			0.22	151.0	4.66	162.1
6	2.25	172.5			1.14	160.0	3.39	168.3
7	2.05	181.9			1.53	157.7	3.58	171.6
8+	0.41	203.9			0.66	193.0	1.07	197.2
TOTAL	25.90		0.32		14.03		40.25	
Land. (SOP)(t)		3,828		35		1,630		5,492
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2								
3	24.09	133.1	0.08	108.0	6.19	96.2	30.36	125.5
4	8.06	140.5			5.07	124.8	13.13	134.4
5	9.68	161.6			3.28	142.4	12.96	156.7
6	7.84	177.3			1.61	154.4	9.45	173.4
7	4.25	193.4			1.08	207.1	5.33	196.2
8+	2.51	220.6			0.79	198.7	3.30	215.4
TOTAL	56.43		0.08		18.02		74.53	
Land. (SOP)(t)		8,669		9		2,325		11,002
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	24.19	111.3	0.37	74.0	8.11	120.0	32.67	113.0
3	85.11	127.8			15.60	93.0	100.71	122.4
4	26.16	152.9			1.26	187.0	27.42	154.5
5	13.82	153.3			2.18	171.0	16.00	155.7
6	5.90	182.6			8.17	189.6	14.07	186.7
7	3.95	186.3					3.95	186.3
8+	0.67	210.1					0.67	210.1
TOTAL	159.80		0.37		35.32		195.49	
Land. (SOP)(t)		21,642		27		4,581		26,251
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	48.52	121.0			1.01	77.8	49.53	120.1
3	43.97	152.3					43.97	152.3
4	17.60	162.2					17.60	162.2
5	8.37	177.7					8.37	177.7
6	3.87	214.3					3.87	214.3
7	2.36	217.1					2.36	217.1
8+	0.58	263.9						
TOTAL	125.27		0.00		1.01		125.70	
Land. (SOP)(t)		18,404		0		79		18,330
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	72.71	117.8	0.37	74.0	9.12	115.3	82.20	117.3
3	153.17	135.7	0.08	108.0	29.44	91.9	182.69	128.6
4	60.23	149.5	0.32	108.0	9.16	137.0	69.71	147.7
5	40.21	159.5			5.68	153.7	45.89	158.8
6	22.05	182.3			10.92	181.3	32.97	181.9
7	12.81	191.9			2.61	178.1	15.42	189.6
8+	5.81	210.1			1.45	196.1	7.26	207.3
TOTAL	366.99		0.77		68.38		436.14	
Land. (SOP)(t)		52,459		71		8,614		61,144

Table 3.2.2 Kattegat 1993 Spring Spawners

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

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2								
3	6.88	93.4			3.32	46.5	10.20	78.1
4	4.58	118.4			0.21	58.0	4.79	115.8
5	2.84	139.9					2.84	139.9
6	1.45	152.4					1.45	152.4
7	0.69	165.0					0.69	165.0
8+	0.36	193.5					0.36	193.5
TOTAL	16.80		0.00		3.53		20.33	
Land. (SOP)(t)		1,987		0		167		2,153
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	9.32	65.6	11.82	41.8	29.91	46.3	51.05	48.8
3	5.37	80.0	0.89	54.0	5.19	57.4	11.45	67.7
4	4.03	105.0			0.47	63.4	4.50	100.7
5	3.71	122.5			0.09	66.0	3.80	121.2
6	1.88	146.8					1.88	146.8
7	1.22	156.2					1.22	156.2
8+	0.50	178.9					0.50	178.9
TOTAL	26.03		12.71		35.66		74.40	
Land. (SOP)(t)		2,475		542		1,718		4,735
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	11.13	78.7			5.23	51.2	16.36	69.9
3	7.72	102.8			0.92	57.9	8.64	98.0
4	4.94	123.8			0.16	62.0	5.10	121.9
5	3.02	154.5			0.11	98.0	3.13	152.5
6	1.47	144.1					1.47	144.1
7	0.67	156.9					0.67	156.9
8+	0.28	179.3					0.28	179.3
TOTAL	29.23		0.00		6.42		35.65	
Land. (SOP)(t)		3,115		0		342		3,457
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	28.57	70.9	4.13	42.1	20.22	49.4	52.92	60.4
2	29.91	85.8			2.14	59.4	32.05	84.0
3	12.81	103.9			0.24	61.6	13.05	103.1
4	5.41	120.5			0.34	139.5	5.75	121.6
5	2.91	138.3					2.91	138.3
6	1.64	180.7	0.56	180.0			2.20	180.5
7	1.37	192.5					1.37	192.5
8+	0.02	221.0						
TOTAL	82.64		4.69		22.94		110.25	
Land. (SOP)(t)		7,542		275		1,188		9,000
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	28.57	70.9	4.13	42.1	20.22	49.4	52.92	60.4
2	50.36	80.5	11.82	41.8	37.28	47.7	99.46	63.6
3	25.90	98.6	0.89	54.0	6.35	57.6	33.14	89.6
4	21.26	109.6			4.29	56.3	25.55	100.6
5	14.22	131.2			0.41	70.5	14.63	129.5
6	7.83	150.9	0.56	180.0			8.39	152.8
7	4.71	165.7					4.71	165.7
8+	1.49	173.1					1.49	173.1
TOTAL	154.34		17.40		68.55		240.29	
Land. (SOP)(t)		15,048		817		3,415		19,280

Table 3.2.3 Division IIIa Spring Spawners.

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

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2								
3	15.29	108.5	0.32	108.0	10.97	74.1	26.58	94.3
4	12.92	138.3			3.04	131.3	15.96	136.9
5	7.28	153.7			0.22	151.0	7.50	153.7
6	3.70	164.6			1.14	160.0	4.84	163.5
7	2.74	177.6			1.53	157.7	4.27	170.5
8+	0.77	199.0			0.66	193.0	1.43	196.3
TOTAL	42.70		0.32		17.56		60.58	
Land. (SOP)(t)		5,814		35		1,796		7,645
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	9.32	65.6	11.82	41.8	29.91	46.3	51.05	48.8
3	29.46	123.4	0.97	58.5	11.38	78.5	41.81	109.7
4	12.09	128.7			5.54	119.6	17.63	125.8
5	13.39	150.8			3.37	140.4	16.76	148.7
6	9.72	171.4			1.61	154.4	11.33	169.0
7	5.47	185.1			1.08	207.1	6.55	188.7
8+	3.01	213.7			0.79	198.7	3.80	210.6
TOTAL	82.46		12.79		53.68		148.93	
Land. (SOP)(t)		11,143		551		4,043		15,737
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	35.32	101.0	0.37	74.0	13.34	93.0	49.03	98.6
3	92.83	125.7			16.52	91.0	109.35	120.5
4	31.10	148.3			1.42	172.9	32.52	149.4
5	16.84	153.5			2.29	167.5	19.13	155.2
6	7.37	174.9			8.17	189.6	15.54	182.6
7	4.62	182.0					4.62	182.0
8+	0.95	201.0					0.95	201.0
TOTAL	189.03		0.37		41.74		231.14	
Land. (SOP)(t)		24,757		27		4,923		29,707
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	28.57	70.9	4.13	42.1	20.22	49.4	52.92	60.4
2	78.43	107.6			3.15	65.3	81.58	105.9
3	56.78	141.4			0.24	61.6	57.02	141.0
4	23.01	152.4			0.34	139.5	23.35	152.2
5	11.28	167.5					11.28	167.5
6	5.51	204.3					5.51	204.3
7	3.73	208.1					3.73	208.1
8+	0.60	262.5						
TOTAL	207.91		4.13		23.95		235.39	
Land. (SOP)(t)		25,946		174		1,267		27,229
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	28.57	70.9	4.13	42.1	20.22	49.4	52.92	60.4
2	123.07	102.5	12.19	42.8	46.40	61.0	181.66	87.9
3	179.07	130.3	0.97	58.5	39.11	82.5	219.15	121.5
4	81.49	139.1	0.32	108.0	10.34	131.0	92.15	138.1
5	54.43	152.1			5.88	151.3	60.31	152.1
6	29.88	174.0			10.92	181.3	40.80	176.0
7	17.52	184.9			2.61	178.1	20.13	184.0
8+	7.30	202.5			1.45	196.1	8.75	201.5
TOTAL	521.33		17.61		136.93		675.87	
Land. (SOP)(t)		67,507		787		12,029		80,323

Table 3.2.4 Skagerrak 1993. Autumn Spawners.

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

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	0.68	38.1	310.40	14.3	540.65	17.6	851.73	16.4
2	21.42	91.9	4.73	40.9	88.51	66.8	114.66	70.4
3								
4								
5								
6								
7								
8+								
TOTAL	22.10		315.13		629.16		966.39	
Land. (SOP)(t)		1,994		4,632		15,428		22,054
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	9.68	70.4	81.91	14.3	102.62	31.7	194.21	26.3
2	50.57	115.2	0.08	108.0	6.19	96.2	56.84	113.1
3								
4								
5								
6								
7								
8+								
TOTAL	60.25		81.99		108.81		251.05	
Land. (SOP)(t)		6,507		1,180		3,849		11,536
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			477.02	11.6	1189.35	11.1	1666.37	11.2
1	199.57	66.0	7.29	35.8	118.65	47.4	325.51	58.5
2	81.00	111.3	1.09	74.0	27.16	120.0	109.25	113.1
3								
4								
5								
6								
7								
8+								
TOTAL	280.57		485.40		1335.16		2101.13	
Land. (SOP)(t)		22,187		5,875		22,085		50,147
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			147.88	19.3	483.66	16.1	631.54	16.8
1	140.15	74.9			21.78	64.4	161.93	73.5
2								
3								
4								
5								
6								
7								
8+								
TOTAL	140.15		147.88		505.44		793.47	
Land. (SOP)(t)		10,497		2,854		9,190		22,541
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			624.90	13.4	1673.01	12.5	2297.91	12.8
1	349.40	69.7	399.60	14.7	783.70	25.3	1532.70	32.6
2	132.25	112.4	5.90	47.9	121.86	80.2	260.01	95.8
3	21.42	91.9					21.42	91.9
4								
5								
6								
7								
8+								
TOTAL	503.07		1030.40		2578.57		4112.04	
Land. (SOP)(t)		41,186		14,541		50,551		106,278

Table 3.2.5 Kattegat 1993 Autumn Spawners.

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

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	2.15	28.0	386.02	13.0	299.85	16.0	688.02	14.4
2	22.66	65.8	1.94	44.5	41.98	41.5	66.58	49.9
3								
4								
5								
6								
7								
8+								
TOTAL	24.81		387.96		341.83		754.60	0.0
Land. (SOP)(t)		1,551		5,105		6,540		13,196
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	0.01	22.1	23.58	22.6	37.71	22.4	61.30	22.5
2	0.49	65.6	0.62	41.8	1.57	46.3	2.68	48.8
3								
4								
5								
6								
7								
8+								
TOTAL	0.50		24.20		39.28		63.98	
Land. (SOP)(t)		32		559		917		1,509
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			211.44	10.2	137.25	8.9	348.69	9.7
1	5.60	50.1			39.02	40.2	44.62	41.4
2								
3								
4								
5								
6								
7								
8+								
TOTAL	5.60		211.44		176.27		393.31	
Land. (SOP)(t)		281		2,157		2,790		5,227
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	0.43	17.6	180.29	15.6	129.38	14.5	310.10	15.1
1	12.84	70.9	1.85	42.1	9.09	49.4	23.78	60.4
2								
3								
4								
5								
6								
7								
8+								
TOTAL	13.27		182.14		138.47		333.88	
Land. (SOP)(t)		918		2,890		2,325		6,133
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	0.43	17.6	391.73	12.7	266.63	11.6	658.79	12.3
1	20.60	60.7	411.45	13.7	385.67	19.9	817.72	17.8
2	23.15	65.8	2.56	43.8	43.55	41.7	69.26	49.8
3								
4								
5								
6								
7								
8+								
TOTAL	44.18		805.74		695.85		1545.77	
Land. (SOP)(t)		2,782		10,711		12,572		26,065

Table 3.2.6 Division IIIa. Autumn Spawners.

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

	Landings for Human consumpt.		Mixed clupeoide		Landings for industrial purposes		TOTAL	
1. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	2.83	30.4	696.42	13.6	840.50	17.0	1539.75	15.5
2	44.08	78.5	6.67	41.9	130.49	58.7	181.24	62.9
3								
4								
5								
6								
7								
8+								
TOTAL	46.91		703.09		970.99		1720.99	
Land. (SOP)(t)		3,546		9,737		21,968		35,250
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	9.69	70.4	105.49	16.2	140.33	29.2	255.51	25.4
2	51.06	114.7	0.70	49.4	7.76	86.1	59.52	110.2
3								
4								
5								
6								
7								
8+								
TOTAL	60.75		106.19		148.09		315.03	
Land. (SOP)(t)		6,540		1,739		4,766		13,044
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			688.46	11.2	1326.60	10.9	2015.06	11.0
1	205.17	65.6	7.29	35.8	157.67	45.6	370.13	56.5
2	81.00	111.3	1.09	74.0	27.16	120.0	109.25	113.1
3								
4								
5								
6								
7								
8+								
TOTAL	286.17		696.84		1511.43		2494.44	
Land. (SOP)(t)		22,467		8,032		24,875		55,374
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	0.43	17.6	328.17	17.3	613.04	15.8	941.64	16.3
1	152.99	74.6	1.85	42.1	30.87	60.0	185.71	71.8
2								
3								
4								
5								
6								
7								
8+								
TOTAL	153.42		330.02		643.91		1127.35	
Land. (SOP)(t)		11,415		5,744		11,515		28,674
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	0.43	17.6	1016.63	13.1	1939.64	12.4	2956.70	12.7
1	370.68	69.1	811.05	14.2	1169.37	23.5	2351.10	27.5
2	176.14	104.1	8.46	46.7	165.41	70.0	350.01	86.6
3								
4								
5								
6								
7								
8+								
TOTAL	547.25		1836.14		3274.42		5657.81	
Land. (SOP)(t)		43,968		25,252		63,123		132,343

Table 3.2.7 **Total catch of spring spawners in Division IIIa and the North Sea.**

Numbers (millions) at age (rings) and SOP (t) by quarter.

Quarter	Rings	0	1	2	3	4	5	6	7	8	SOP
	North Sea										0
	Skagerrak				16.38	11.17	4.66	3.39	3.58	1.07	5,492
1	Kattegat				10.20	4.79	2.84	1.45	0.69	0.36	2,153
	Total			0.00	26.58	15.96	7.50	4.84	4.27	1.43	7,645
	North Sea			1.80	8.32	9.20	6.06	4.81	3.76	1.67	6,567
	Skagerrak			74.41	30.36	13.13	12.96	9.45	5.33	3.30	11,002
2	Kattegat			51.05	11.45	4.50	3.80	1.88	1.22	0.50	4,735
	Total			127.26	50.13	26.83	22.82	16.14	10.31	5.47	22,304
	North Sea			2.45	2.52	3.09	2.32	1.06	0.93	1.03	2,201
	Skagerrak			32.67	100.71	27.42	16.00	14.07	3.95	0.67	26,251
3	Kattegat			16.36	8.64	5.10	3.13	1.47	0.67	0.28	3,457
	Total			51.48	111.87	35.61	21.45	16.60	5.55	1.98	31,909
	North Sea										0
	Skagerrak			49.53	43.97	17.60	8.37	3.87	2.36		18,330
4	Kattegat		52.92	32.05	13.05	5.75	2.91	2.20	1.37		9,000
	Total		52.92	81.58	57.02	23.35	11.28	6.07	3.73		27,330
	North Sea			4.25	10.84	12.29	8.38	5.87	4.69	2.70	8,768
Total	Skagerrak			156.61	191.42	69.32	41.99	30.78	15.22	5.04	61,075
Year	Kattegat		52.92	99.46	43.34	20.14	12.68	7.00	3.95	1.14	19,345
	Total		52.92	260.32	245.60	101.75	63.05	43.65	23.86	8.88	89,188

Mean weight (g) at age by quarter.

Quarter	Rings	0	1	2	3	4	5	6	7	8+
	North Sea									
	Skagerrak				104.4	146.0	162.1	168.3	171.6	197.2
1	Kattegat				78.1	115.8	139.9	152.4	165.0	193.5
	Total				94.3	136.9	153.7	163.5	170.5	196.3
	North Sea			139.68	149.24	182.25	197.82	205.95	222.49	222.5
	Skagerrak			103.8	125.5	134.4	156.7	173.4	196.2	215.4
2	Kattegat			48.8	67.7	100.7	121.2	146.8	156.2	178.9
	Total			82.2	116.2	145.2	161.7	180.0	201.1	214.2
	North Sea			99.7	115.5	158.8	176.2	209.8	266.7	285.9
	Skagerrak			113.0	122.4	154.5	155.7	186.7	186.3	210.1
3	Kattegat			69.9	98.0	121.9	152.5	144.1	156.9	179.3
	Total			98.7	120.4	150.2	157.4	184.4	196.2	245.1
	North Sea									
	Skagerrak			120.1	152.3	162.2	177.7	214.3	217.1	
4	Kattegat		60.4	84.0	103.1	121.6	138.3	180.5	192.5	
	Total		60.4	105.9	141.0	152.2	167.5	202.0	208.1	
	North Sea			116.6	141.4	176.3	191.8	206.6	231.3	246.7
Total	Skagerrak			110.9	128.2	151.3	161.1	184.1	191.1	210.8
Year	Kattegat		60.4	63.6	86.8	115.6	137.0	158.0	170.4	183.6
	Total		60.4	92.9	121.5	147.2	160.3	182.9	195.6	218.2

Table 3.2.8 **Total catch in numbers (mill) and mean weight (g), SOP (tonnes) of spring spawners in Division IIIa and the North Sea in the year 1987 - 1993.**

Year	Rings	0	1	2	3	4	5	6	7	8+	Total
1987	Number			767.00	167.10	82.90	27.70	9.30	1.20	0.20	1,055.40
	Mean W.			57.0	85.0	105.6	145.3	154.6	201.2	280.4	
	SOP			43,719	14,204	8,754	4,025	1,438	241	56	72,437
1988	Number			2075.00	563.00	62.00	8.00	2.00	0.50	0.50	2,711.00
	Mean W.			47.3	77.0	138.3	156.0	166.0	149.0	209.0	
	SOP			98,148	43,351	8,575	1,248	332	75	105	151,832
1989	Number			497.69	503.66	115.23	29.96	13.68	5.35	2.34	1,167.91
	Mean W.			56.5	79.9	125.5	151.6	167.3	189.2	204.8	
	SOP			28,119	40,242	14,461	4,542	2,289	1,012	479	91,145
1990	Number		140.90	1006.23	259.90	192.21	62.07	9.99	19.09	2.20	1,692.59
	Mean W.		56.6	65.0	84.6	102.4	111.1	109.3	141.0	84.3	
	SOP		7,975	65,405	21,988	19,682	6,896	1,092	2,692	185	125,915
1991	Number	64.80	43.00	352.05	447.07	174.71	108.85	22.35	7.62	3.09	1,223.54
	Mean W.	33.7	60.5	77.4	101.7	127.5	148.6	165.4	182.5	194.9	
	SOP	2,184	2,602	27,249	45,467	22,276	16,175	3,697	1,391	602	121,641
1992	Number		66.98	214.33	156.34	128.78	63.88	43.59	12.65	7.76	694.31
	Mean W.		53.4	96.2	115.2	138.6	172.9	184.0	201.7	201.3	
	SOP		3,577	20,619	18,010	17,849	11,045	8,021	2,552	1,562	83,234
1993	Number		52.92	185.91	245.60	101.75	63.05	43.65	23.86	8.88	725.62
	Mean W.		60.4	88.6	121.5	147.2	160.3	182.9	195.6	218.2	
	SOP		3,196	16,472	29,840	14,978	10,107	7,984	4,667	1,938	89,181

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

Table 3.2.9 **Herring Division IIIa, 1987 - 1993**
Transfers of autumn spawners from Div. IIIa to the North Sea
Numbers (mill) and mean weight, SOP in (tonnes).

Year	Rings	0	1	2	3	4	5	6	7	8+	Total
1987	Number	6238.00	3153.00	117.00							9508.00
	Mean W.	8.0	33.0	63.0							
	SOP	49,904	104,049	7,371							161,324
1988	Number	1830.00	5792.00	292.00							7914.00
	Mean W.	12.0	28.0	57.0							
	SOP	21,960	162,176	16,644							200,780
1989	Number	1028.2	1170.5	654.8							2853.50
	Mean W.	16.2	33.4	53.3							
	SOP	16,657	39,095	34,901							90,652
1990	Number	397.9	1424.3	283.7							2105.90
	Mean W.	31.0	34.1	55.4							
	SOP	12,335	48,569	15,717							76,621
1991	Number	712.3	822.7	330.2							1865.20
	Mean W.	25.3	40.7	77.8							
	SOP	18,021	33,484	25,690							77,195
1992	Number	2407.51	1587.09	283.80	26.79	26.61	15.98	12.33	5.46	1.00	4366.57
	Mean W.	12.3	50.6	94.8	164	171.7	184.7	197.5	202.7	219.8	
	SOP	29,612	80,307	26,904	4,394	4,569	2,952	2,435	1,107	220	152,499
1993	Number	2956.70	2351.10	350.01							5657.81
	Mean W.	12.7	27.5	86.6							
	SOP	37,550	64,655	30,311							132,516

There are minor corrections for the years previous to 1991.

Table 3.2.10 Western Baltic Spring Spawning Herring

Landings of Herring from the North Sea, Div. IIIa and the Western Baltic area in 1993.

Catch in numbers (mill) and mean weight (g) by fleet.

Fleet: A: HC in the North Se C: Human consumption in Div. IIIa. D: Mixed clupeoid fleet in Div IIIa
E: Industrial fishery (for reduction) in Div IIIa F: Div. 22-24 Fisheries

1. Quarter

	Fleet A		Fleet C		Fleet D		Fleet E		Fleet F		Total	
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0												
1									58.24	19.09	58.24	19.09
2									37.23	39.24	37.23	39.24
3			15.29	108.50	0.32	108.00	10.97	74.10	60.72	78.87	87.30	83.57
4			12.92	138.30			3.04	131.30	63.27	104.32	79.23	110.90
5			7.28	153.80			0.22	151.00	78.47	135.18	85.97	136.80
6			3.70	164.60			1.14	160.00	33.77	157.79	38.61	158.51
7			2.74	177.60			1.53	157.70	26.42	179.84	30.69	178.54
8+			0.77	199.00			0.66	193.00	8.91	183.70	10.34	185.43
Total	0.00		42.70	136.17	0.32	108.00	17.56	102.30	367.03	98.86	427.61	102.74
SOP (t)		0		5,814		35		1,796		36,286		43,932

2. Quarter

	Fleet A		Fleet C		Fleet D		Fleet E		Fleet F		Total	
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0												
1									50.42	19.20	50.42	19.20
2	1.80	139.68	9.32	65.60	11.82	41.80	29.91	46.30	92.98	41.42	145.83	45.21
3	8.32	149.24	29.46	123.40	0.97	58.50	11.38	78.50	94.83	70.41	144.96	86.26
4	9.20	182.25	12.09	128.70			5.54	119.60	72.40	85.98	99.23	101.99
5	6.06	197.82	13.39	150.80			3.37	140.40	52.60	109.43	75.42	125.26
6	4.81	205.95	9.72	171.40			1.61	154.40	21.88	138.31	38.02	156.01
7	3.76	222.49	5.47	185.10			1.08	207.10	13.28	149.17	23.59	171.84
8+	1.67	222.49	3.01	213.70			0.79	198.70	5.19	168.11	10.66	191.77
Total	35.62	184.37	82.46	135.14	12.79	43.07	53.68	75.32	403.58	72.74	588.13	87.84
SOP (t)		6,567		11,144		551		4,043		29,357		51,662

3. Quarter

	Fleet A		Fleet C		Fleet D		Fleet E		Fleet F		Total	
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0									21.70	15.07	21.70	15.07
1									17.63	34.95	17.63	34.95
2	2.45	99.67	35.32	101.00	0.37	74.00	13.34	93.00	22.38	55.14	73.86	85.48
3	2.52	116.53	92.83	125.70			16.52	91.00	21.29	68.69	133.16	112.11
4	3.09	158.75	31.10	148.30			1.42	172.90	12.87	82.71	48.48	132.27
5	2.32	176.17	16.84	153.50			2.29	167.50	8.40	110.77	29.85	144.31
6	1.06	209.78	7.37	174.90			8.17	189.60	2.49	134.02	19.09	177.80
7	0.93	266.67	4.62	182.00					0.74	145.05	6.29	190.17
8+	1.03	285.85	0.95	201.00					0.92	11.83	2.90	171.12
Total	13.40	164.32	189.03	130.95	0.37	74.00	41.74	117.92	108.42	56.14	352.96	107.64
SOP (t)		2,202		24,754		27		4,922		6,087		37,992

4. Quarter

	Fleet A		Fleet C		Fleet D		Fleet E		Fleet F		Total	
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0									23.15	17.28	23.15	17.28
1			28.57	70.90	4.13	42.10	20.22	49.40	32.92	36.40	85.84	51.22
2			78.43	107.60			3.15	65.30	27.54	53.51	109.12	92.73
3			56.78	141.40			0.24	61.60	19.22	77.62	76.24	126.07
4			23.01	152.40			0.34	139.50	18.33	98.80	41.68	128.72
5			11.28	167.50					11.60	103.28	22.88	134.94
6			5.51	204.30					3.66	148.81	9.17	182.15
7			3.73	208.10					1.77	153.83	5.50	190.63
8+			0.60	262.50					1.29	184.58	1.89	209.32
Total	0.00		207.91	124.81	4.13	42.10	23.95	52.89	139.48	61.86	375.47	95.93
SOP (t)		0		25,949		174		1,267		8,628		36,017

Total Year

	Fleet A		Fleet C		Fleet D		Fleet E		Fleet F		Total	
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0									44.85	16.21	44.85	16.21
1			28.57	70.90	4.13	42.10	20.22	49.40	159.21	24.46	212.13	33.44
2	4.25	116.62	123.07	102.53	12.19	42.78	46.40	61.02	180.13	44.52	366.04	66.89
3	10.84	141.64	194.36	128.58	1.29	70.78	39.11	82.44	196.06	73.55	441.66	100.22
4	12.29	176.34	79.12	144.86			10.34	131.01	166.87	94.09	268.62	114.23
5	8.38	191.83	48.79	156.04			5.88	151.35	151.07	122.41	214.12	133.58
6	5.87	206.64	26.30	178.32			10.92	181.32	61.80	149.40	104.89	163.18
7	4.69	231.25	16.56	188.17			2.61	178.14	42.21	168.49	66.07	178.26
8+	2.70	246.66	5.33	214.81			1.45	196.11	16.31	169.11	25.79	188.19
Total	49.02	178.89	522.10	129.59	17.61	44.67	136.93	87.84	1018.51	78.90	1744.17	97.24
SOP (t)		8,769		67,661		787		12,028		80,358		169,603

Table 3.2.11 **North Sea Autumn Spawning Herring**

Landings of Herring from Div. IIIa and the Western Baltic area in 1993.
Catch in numbers (mill) and mean weight (g) by fleet.

Fleet: C: Human consumption in Div. IIIa. D: Mixed clupeoid fleet in Div IIIa
E: Industrial fishery (for reduction) in Div IIIa F: Div. 22-24 Fisheries

1. Quarter

	Fleet C		Fleet D		Fleet E		Fleet F		Total	
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0										
1	2.83	30.40	696.42	13.60	840.50	17.00			1539.75	15.49
2	44.08	78.50	6.67	41.90	130.49	58.70			181.24	62.90
3										
4										
5										
6										
7										
8+										
Total	46.91	75.60	703.09	13.87	970.99	22.60	0.00		1720.99	20.48
SOP (t)		3,546		9,751		21,948		0		35,245

2. Quarter

	Fleet C		Fleet D		Fleet E		Fleet F		Total	
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0										
1	9.69	70.40	105.49	16.20	140.33	29.20			255.51	25.40
2	51.06	114.70	0.70	49.40	7.76	86.10			59.52	110.20
3										
4										
5										
6										
7										
8+										
Total	60.75	107.63	106.19	16.42	148.09	32.18	0.00		315.03	41.42
SOP (t)		6,539		1,744		4,766		0		13,048

3. Quarter

	Fleet C		Fleet D		Fleet E		Fleet F		Total	
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0			688.46	11.20	1326.60	10.90			2015.06	11.00
1	205.17	65.60	7.29	35.80	157.67	45.60			370.13	56.49
2	81.00	111.30	1.09	74.00	27.16	120.00			109.25	113.09
3										
4										
5										
6										
7										
8+										
Total	286.17	78.54	696.84	11.56	1511.43	16.48	0.00		2494.44	22.22
SOP (t)		22,474		8,052		24,909		0		55,436

4. Quarter

	Fleet C		Fleet D		Fleet E		Fleet F		Total	
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0	0.43	17.60	328.17	17.30	613.04	15.80			941.64	16.32
1	152.99	74.60	1.85	42.10	30.87	60.00			185.71	71.86
2										
3										
4										
5										
6										
7										
8+										
Total	153.42	74.44	330.02	17.44	643.91	17.92	0.00		1127.35	25.47
SOP (t)		11,421		5,755		11,538		0		28,714

Total Year

	Fleet C		Fleet D		Fleet E		Fleet F		Total	
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0	0.43	17.60	1016.63	13.17	1939.64	12.45			2956.70	12.70
1	370.68	69.17	811.05	14.20	1169.37	23.46			2351.10	27.47
2	176.14	104.08	8.46	46.66	166.41	70.05			350.01	86.61
3										
4										
5										
6										
7										
8+										
Total	547.25	80.37	1836.14	13.78	3274.42	19.29	0.00		5657.81	23.41
SOP (t)		43,980		25,302		63,161		0		132,443

Table 3.2.12 Herring in Division IIIa, IIIb and IIIc.
Samples of commercial catches by quarter and Sub-Division for 1993 available to the Working Group.

Skagerrak	Country	Quarter	Landings in '000 tons	Number of samples	Number of fish meas.	Number of fish aged
	Denmark	1	13.2	21	2178	1937
		2	9.8	9	116	111
		3	47.0	34	2156	2151
		4	17.9	21	1588	1576
		Total	87.9	85	6,038	5,775
	Norway	1	0.2	0	0	0
		2	2.0	3	262	262
		3	8.9	1	100	100
		4	13.2	10	1223	364
			24.3	14	1,585	726
	Sweden	1	13.9	7	821	821
		2	12.1	4	364	364
		3	20.4	8	777	777
		4	10.0	10	534	534
		Total	56.4	29	2,496	2,496
Kattegat	Country	Quarter	Landings in '000 tons	Number of samples	Number of fish meas.	Number of fish aged
	Denmark	1	9.8	10	1,497	1,497
		2	2.6	6	500	396
		3	7.5	19	2,132	2,125
		4	8.1	11	1,450	1,445
		Total	28.0	30	5,579	5,463
	Sweden	1	5.5	15	1,234	1,234
		2	3.7	58	1,569	1,569
		3	1.2	21	894	894
		4	6.3	28	568	568
		Total	16.7	28	4,265	4,265
Sub-Division 22-24	Country	Quarter	Landings in '000 tons	Number of samples	Number of fish meas.	Number of fish aged
	Denmark	1	19.9	2	604	135
		2	11.6	12	6043	1102
		3	4.2	2	1529	200
		4	5.9	0	0	0
		Total	41.6	16	8,176	1,437
	Germany	1	4.2	11	3,336	1,290
		2	5.8	33	9,931	2,431
		3	+	0	0	0
		4	+	62	11,269	848
		Total	10.0	106	24,536	4,569
	Poland	1	2.5	2	604	135
		2	8.2	12	6,043	1,102
		3	0.3	2	1,529	200
		4	0.8	0	0	0
		Total	11.8	16	8,176	1,437
	Sweden	1	9.0	8	1,267	538
		2	4.0	5	832	328
		3	1.5	5	994	271
		4	1.6	4	766	208
		Total	16.1	22	3,859	1,345

Table 3.3.1

Acoustic surveys on the Spring-spawning HERRING in The North Sea, Div. IIIa and in Sub-Div. 22-24 in 1992.
(North Sea and Div. IIIa in july and Sub-Div. 22-24 in October)

Numbers in millions

W-rings	North Sea	Div. IIIa	Sub-Div. 22-24	Total
0			3412	3412
1			1658	1658
2	119	1993	657	2769
3	360	1601	282	2243
4	322	1389	156	1867
5	105	404	37	546
6	35	145	25	205
7	11	95	4	110
8+	2	9		11
Total	954	5636	6231	12821
3+ group	835	3643	504	4982

Biomass ('000 tonnnes)

W-rings	North Sea	Div. IIIa	Sub-Div. 22-24	Total
0			53	53
1			61	61
2	12	146	40	197
3	45	166	21	231
4	44	169	14	227
5	15	54	5	73
6	7	23	3	33
7	2	17	1	20
8+	0	2	0	2
Total	126	576	198	899

Mean weight (g)

W-rings	North Sea	Div. IIIa	Sub-Div. 22-24	Total
0			15.6	15.6
1			37.0	37.0
2	103.0	73.1	60.2	71.3
3	124.0	103.4	73.0	102.9
4	138.0	121.4	92.1	121.8
5	143.1	132.9	125.6	134.4
6	193.1	160.6	132.0	162.7
7	209.1	179.6	168.1	182.1
8+	150.0	237.6		221.7
Mean weight	125.7	102.2	31.7	70.2

Table 3.3.2

Acoustic surveys on the Spring-spawning HERRING in The North Sea, Div. IIIa and in Sub-Div. 22-24 in 1993.
(North Sea and Div. IIIa in july and Sub-Div. 22-24 in October)

Numbers in millions

W-rings	North Sea	Div. IIIa	Sub-Div. 22-24	Total
0			1414	1414
1			466	466
2	320	1488	393	2201
3	315	621	518	1454
4	192	380	402	974
5	150	246	145	541
6	50	91	64	205
7	44	27	31	102
8+	12	4	16	32
Total	1083	2857	3449	7389
3+ group	763	1369	1176	3308

Biomass ('000 tonnnes)

W-rings	North Sea	Div. IIIa	Sub-Div. 22-24	Total
0			21	21
1			16	16
2	29	75	18	122
3	35	54	34	124
4	27	42	28	98
5	24	39	16	79
6	9	15	9	34
7	11	7	4	22
8+	3	1	3	7
Total	139	234	150	523

Mean weight (g)

W-rings	North Sea	Div. IIIa	Sub-Div. 22-24	Total
0			14.9	14.9
1			35.2	35.2
2	90.3	50.6	45.6	55.5
3	111.6	87.6	65.8	85.0
4	142.4	111.3	69.7	100.3
5	162.0	158.7	111.2	146.9
6	187.8	164.2	146.2	164.3
7	247.0	276.8	125.4	217.9
8+	268.3	216.8	171.3	213.4
Mean weight	125.7	82.0	43.4	70.8

Table 3.4.1 Recruitment indices for 1- , 2- and 3+ ringed herring from the IBTS in Division IIIa. Indices are given for autumn and spring spawners based on modal length analysis and vertebral counts.
The indices are weighted by the area of four depth strata.

INDEX							
Year	Total		Spring spawners			Autumn spawners	
	1 - ring	2 - ring	1 - ring	2 - ring	3+ - ring	1 - ring	2 - ring
1980	2,311	387	1,607	307	162	704	80
1981	3,246	1,393	996	1,318	349	2,250	75
1982	2,560	549	1,408	445	196	1,152	104
1983	5,419	1,063	1,522	946	240	3,897	117
1984	6,035	1,947	2,793	1,419	445	3,242	528
1985	7,994	2,473	-*	1,867	2,037	-*	606
1986	21,489	2,738	-*	1,562	1,897	-*	1,175
1987	11,733	3,671	-*	2,921	1,199	-*	949
1988	67,753	10,095	-*	7,834	7,084	-*	2,161
1989	17,451	4,976	-*	0	3,989	-*	4,976
1990	3,544	3,876	0	3,192	508	3,544	684
1991	3,588	3,749	-*	480	3,392	-*	3,269
1992	5,057	1,934	0	771	1,268	5,057	1,163
1993	26,738	3,165	0	203	264	26,738	2,962
1994	8,777	2,333	0	0	1,148	8,777	2,333

* Separations not valid.

Table 3.4.2. German Bottom Trawl Survey in Sub-Div. 24.
Young Fish survey

Mean catch at age in numbers per haul.

Month	Year	Winter rings				Total numbers	Total catch in kg. Herring
		0	1	2	3+		
Nov.	1978	592.72	51.04	32.06	11.81	687.63	13.58
Nov.	1979	8,665.90	240.47	103.36	10.33	9,020.06	89.61
Nov.	1981	332.63	96.79	60.05	21.30	510.77	16.36
Dec.	1982	695.71	108.21	70.63	34.72	909.27	24.57
Dec.	1983	1,995.97	387.11	63.71	46.11	2,492.90	46.68
Nov.	1984	1,581.66	377.15	88.03	24.26	2,071.10	39.79
Nov.	1985	3,085.64	340.92	169.95	74.76	3,671.27	45.99
Dec.	1986	2,984.47	368.35	46.41	69.30	3,468.53	44.42
Nov.	1989	2,881.81	319.38	48.99	55.12	3,305.30	47.76
Nov.	1990	103.92	14.79	21.69	32.90	173.30	7.09
Nov.	1991	117.38	134.20	103.14	144.63	499.35	27.16
Nov.	1992	233.85	88.05	57.15	113.58	492.63	19.86
Nov.	1993	1,744.19	37.10	63.87	544.65	2,389.81	66.46

Table 3.4.3. German Bottom Trawl Survey in Sub-Div. 22.
Young Fish survey

Mean catch at age in numbers per haul.

Month	Year	Winter rings				Total Numbers	Total catch in kg. Herring
		0	1	2	3+		
Nov.	1979	3,561.79	1,358.84	137.11	7.68	5,065.42	86.91
Nov.	1981	1,033.40	118.85	28.35	9.10	1,189.70	17.69
Dec.	1982	354.00	239.45	44.50	26.20	664.15	16.36
Dec.	1983	7,917.00	834.70	80.10	29.50	8,861.30	24.57
Nov.	1984	6,596.32	1,830.32	150.47	40.47	8,617.58	46.68
Nov.	1985	3,506.20	958.80	219.80	25.25	4,710.05	39.79
Nov.	1986	6,863.75	175.35	16.55	5.60	7,061.25	45.99
Nov.	1989	10,587.70	1,444.50	117.75	76.45	12,226.40	44.42
Nov.	1992	572.68	87.68	19.16	17.26	696.78	47.76
Nov.	1993	8,419.70	1,644.05	1,293.70	898.10	12,255.55	301.71

Table 3.5.1.a. Input to ICA. WESTERN BALTIC (IIIa+Sub.Div.22-24) Spring Spawning Herring.

CATCH NUMBERS AT AGE (Thousands)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	91.	256.	89.	60.	204.	296.	2033.	1032.	1709.	555.	1173.	1053.	771.	611.	130.	161.	87.	36.	45.
1	466.	438.	1310.	703.	239.	636.	651.	1101.	1777.	2101.	1035.	1020.	1440.	861.	1232.	427.	831.	278.	212.
2	301.	585.	488.	931.	1074.	494.	1005.	572.	850.	1207.	849.	468.	988.	2443.	854.	1168.	532.	539.	366.
3	242.	229.	291.	586.	440.	908.	467.	779.	485.	521.	844.	611.	388.	928.	936.	475.	632.	360.	442.
4	257.	110.	140.	70.	105.	143.	277.	150.	348.	235.	353.	390.	394.	205.	359.	456.	290.	318.	268.
5	138.	55.	50.	19.	13.	25.	58.	84.	39.	162.	108.	123.	125.	152.	88.	168.	176.	174.	214.
6	51.	27.	21.	8.	4.	7.	18.	18.	14.	24.	35.	28.	37.	41.	45.	37.	48.	130.	105.
7	19.	11.	7.	4.	3.	2.	4.	4.	2.	8.	7.	10.	10.	11.	16.	31.	14.	48.	66.
8	2.	4.	4.	5.	1.	2.	4.	3.	3.	2.	6.	3.	4.	6.	6.	7.	5.	22.	22.

Table 3.5.1.b. Input to ICA. WESTERN BALTIC (IIIa+Sub.Div.22-24) Spring Spawning Herring.

NO INDICES OF SPAWNING STOCK BIOMASS
INDEX 1 : 1978-93: German Bottom Trawl Survey in Sub.Div. 24, Ages 0-3
INDEX 2 : 1979-93: German Bottom Trawl Survey in Sub.Div. 22, Ages 0-3
INDEX 3 : 1989-93: Acoustic survey in IIIa+Ivae, Ages 2-8
INDEX 4 : 1989-93: Acoustic survey in Sub.Div 22-24, Ages 0-8

AGE - STRUCTURED INDICES German Bottom Trawl Survey in Sub.Div. 24, Ages 0-3
INDEX : 1 from 1978 to 1993

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	.593E+03	.867E+04	No data	.333E+03	.696E+03	.200E+04	.158E+04	.309E+04	.298E+04	No data	No data	.288E+04	.104E+03	.117E+03	.234E+03	.174E+04
1	.510E+02	.240E+03	No data	.970E+02	.108E+03	.387E+03	.377E+03	.341E+03	.368E+03	No data	No data	.319E+03	.150E+02	.134E+03	.880E+02	.370E+02
2	.320E+02	.103E+03	No data	.600E+02	.710E+02	.640E+02	.880E+02	.170E+03	.460E+02	No data	No data	.490E+02	.220E+02	.103E+03	.570E+02	.640E+02
3	.120E+02	.100E+02	No data	.210E+02	.350E+02	.460E+02	.240E+02	.750E+02	.690E+02	No data	No data	.550E+02	.330E+02	.145E+03	.114E+03	.545E+03

INDEX : 2 from 1979 to 1993 German Bottom Trawl Survey in Sub.Div. 22, Ages 0-3

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	.356E+04	No data	.103E+04	.354E+03	.792E+04	.660E+04	.351E+04	.686E+04	No data	No data	.106E+05	No data	No data	.573E+03	.842E+04
1	.136E+04	No data	.119E+03	.239E+03	.835E+03	.183E+04	.959E+03	.175E+03	No data	No data	.144E+04	No data	No data	.880E+02	.164E+04
2	.137E+03	No data	.280E+02	.440E+02	.800E+02	.150E+03	.220E+03	.170E+02	No data	No data	.118E+03	No data	No data	.190E+02	.129E+04
3	.800E+01	No data	.900E+01	.260E+02	.300E+02	.400E+02	.250E+02	.600E+01	No data	No data	.760E+02	No data	No data	.170E+02	.898E+03

INDEX : 3 from 1989 to 1993 Acoustic survey in IIIa+IVaE, Ages 2-8

	1989	1990	1991	1992	1993
2	.111E+04	.104E+04	.186E+04	.211E+04	.181E+04
3	.714E+03	.343E+03	.193E+04	.196E+04	.936E+03
4	.317E+03	.109E+03	.866E+03	.171E+04	.572E+03
5	.807E+02	.453E+02	.350E+03	.509E+03	.396E+03
6	.514E+02	.708E+01	.880E+02	.180E+03	.141E+03
7	.163E+02	.731E+01	.720E+02	.106E+03	.710E+02
8	.420E+01	.194E+01	.100E+02	.110E+02	.160E+02

Continued

Table 3.5.1.a Continued

INDEX : 4 from 1989 to 1993 Acoustic survey in Sub.Div 22-24, Ages 0-8

	1989	1990	1991	1992	1993
0	.383E+04	.212E+05	.736E+04	.341E+04	.143E+04
1	.214E+04	.179E+04	.322E+04	.166E+04	.480E+03
2	.213E+03	.892E+03	.176E+04	.657E+03	.396E+03
3	.161E+03	.146E+03	.143E+04	.282E+03	.518E+03
4	.102E+03	.790E+02	.461E+03	.156E+03	.403E+03
5	.230E+02	.190E+02	.174E+03	.370E+02	.146E+03
6	.400E+01	.800E+01	.440E+02	.250E+02	.640E+02
7	.300E+01	.400E+01	.240E+02	.400E+01	.310E+02
8	.100E+01	.200E+01	.210E+02	No data	.160E+02

Table 3.5.2.a. Output from ICA. WESTERN BALTIC (IIIa + Sub.Div.22-24) Spring Spawning Herring.

FISHING MORTALITY

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	.0334	.0579	.0176	.0245	.0396	.0816	.3484	.1381	.2298	.1372	.1742	.1085	.1258	.0470	.0332	.0303	.0201	.0183	.0146
1	.3009	.2217	.4624	.1879	.1285	.1666	.2583	.3227	.3714	.4882	.4058	.2256	.2120	.3084	.2178	.1990	.1316	.1200	.0957
2	.4453	.7642	.4105	.7097	.4842	.4225	.4283	.3792	.4438	.4661	.3728	.3240	.3550	.5208	.3679	.3361	.2223	.2026	.1616
3	.7058	.7317	1.1793	1.3234	.9030	1.0155	.9218	.7011	.6454	.5406	.7035	.5047	.4885	.5872	.4148	.3789	.2506	.2284	.1822
4	1.1973	.8396	1.5843	1.0866	.9336	.8738	1.0658	.9015	.8061	.7669	.8916	.8552	.7240	.6991	.4938	.4511	.2984	.2720	.2169
5	1.3379	.9331	1.2915	1.0433	.5961	.6002	1.1661	1.2148	.6287	1.2045	1.0343	.9466	.7551	.6835	.4827	.4410	.2917	.2659	.2120
6	1.1693	1.1208	1.2574	.7341	.6458	.7647	1.2580	1.7724	.6667	1.0595	.9636	.8574	.8677	.6859	.4844	.4426	.2927	.2668	.2128
7	.9106	.8853	1.0647	.8887	.6867	.8048	1.5683	1.1541	1.1072	1.0707	1.1114	.8368	.8270	.6991	.4938	.4511	.2984	.2720	.2169
8	.9106	.8853	1.0647	.8887	.6867	.8048	1.5683	1.1541	1.1072	1.0707	1.1114	.8368	.8270	.6991	.4938	.4511	.2984	.2720	.2169

NUMBERS AT AGE (Thousands)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	3058.	5014.	5612.	2731.	5794.	4164.	7581.	8808.	9150.	4765.	8070.	11280.	7182.	9026.	5733.	4309.	3557.	2299.	7606.	4777.
1	1969.	2421.	3874.	4514.	2182.	4560.	3142.	4381.	6281.	5953.	3401.	5551.	8286.	5185.	7050.	4540.	3422.	2854.	1848.	6137.
2	917.	1193.	1588.	1998.	3063.	1571.	3160.	1987.	2597.	3547.	2991.	1856.	3627.	5488.	3119.	4642.	3047.	2456.	2073.	1375.
3	521.	481.	455.	863.	804.	1545.	843.	1686.	1113.	1364.	1822.	1687.	1099.	2082.	2669.	1768.	2716.	1997.	1642.	1444.
4	398.	211.	189.	115.	188.	267.	458.	275.	685.	478.	651.	738.	834.	552.	948.	1443.	991.	1731.	1301.	1121.
5	202.	99.	75.	32.	32.	61.	91.	129.	91.	250.	182.	218.	257.	331.	225.	473.	753.	602.	1080.	858.
6	80.	43.	32.	17.	9.	14.	27.	23.	31.	40.	61.	53.	69.	99.	137.	113.	249.	460.	378.	715.
7	35.	20.	12.	7.	7.	4.	5.	6.	3.	13.	11.	19.	18.	24.	41.	69.	60.	152.	289.	250.
8	4.	7.	7.	9.	2.	4.	5.	5.	5.	3.	10.	6.	8.	13.	17.	20.	21.	101.	126.	273.

Table 3.5.2.b. Output from ICA. Western baltic Spring Spawning Herring.

```
PARAMETER ESTIMATES +/- SD
Separable Model: Reference F by year
 1   1988            .6991           .4612          1.0597
 2   1989            .4938           .3183           .7661
 3   1990            .4511           .2857           .7122
 4   1991            .2984           .1866           .4771
 5   1992            .2720           .1718           .4305
 6   1993            .2169           .1376           .3418
Separable Model: Selection (S) by age
 7      0            .0673           .0411           .1102
 8      1            .4411           .2765           .7038
 9      2            .7450           .4758          1.1664
10      3            .8399           .5430          1.2992
        4           1.0000             Fixed : Reference age
11      5            .9776           .6695          1.4276
12      6            .9810           .6792          1.4171
        7           1.0000             Fixed : last true age
Separable Model: Populations in year      1993
13    0          7605911.        4723630.        12246911.
14    1          1847817.        1319402.         2587860.
15    2          2072622.        1543854.         2782492.
16    3          1642331.        1215412.         2219206.
17    4          1301228.         959006.         1765572.
18    5          1079595.         768357.         1516907.
19    6           377741.         249217.          572545.
20    7           288615.         173647.          479698.
Separable Model: Populations at age  7
21   1988        23851.          10588.          53730.
22   1989        40774.          21087.          78838.
23   1990        68999.          37703.         126273.
24   1991        59680.          32056.         111109.
25   1992       152375.          86413.         268689.
```

Table 3.5.2.c. Output from ICA. Western baltic Spring Spawning Herring.

```
Age-structured index catchabilities
    Age-Structured Index 1   German Bottom Trawl Survey in Sub.Div. 24, Ages 0-3

 Linear model fitted. Slopes at age:
26  0 Q      .21670E-03      .17370E-03      .27035E-03
27  1 Q      .50307E-04      .40412E-04      .62625E-04
28  2 Q      .38339E-04      .30774E-04      .47764E-04
29  3 Q      .39464E-04      .31446E-04      .49528E-04

     Age-Structured Index    2  German Bottom Trawl Survey in Sub.Div. 22, Ages 0-3
 Linear model fitted. Slopes at age:
30  0 Q      .62517E-03      .48696E-03      .80261E-03
31  1 Q      .20751E-03      .16213E-03      .26559E-03
32  2 Q      .53405E-04      .41718E-04      .68365E-04
33  3 Q      .23717E-04      .18493E-04      .30418E-04

     Age-Structured Index    3  Acoustic survey in IIIa+IVaE,  Ages 2-8
 Linear model fitted. Slopes at age:
34  2 Q      .64788E-03      .26081E-03      .16094E-02
35  3 Q      .58823E-03      .23614E-03      .14653E-02
36  4 Q      .51935E-03      .20660E-03      .13055E-02
37  5 Q      .45285E-03      .17598E-03      .11653E-02
38  6 Q      .34166E-03      .12795E-03      .91235E-03
39  7 Q      .50932E-03      .18010E-03      .14403E-02
40  8 Q      .22885E-03      .93362E-04      .56095E-03

     Age-Structured Index    4  Acoustic survey in Sub.Div 22-24,  Ages 0-8
  Linear model fitted. Slopes at age:
41  0 Q      .13578E-02      .48363E-03      .38120E-02
42  1 Q      .58663E-03      .20965E-03      .16415E-02
43  2 Q      .29990E-03      .10708E-03      .83994E-03
44  3 Q      .24229E-03      .86234E-04      .68076E-03
45  4 Q      .23260E-03      .81827E-04      .66121E-03
46  5 Q      .14678E-03      .50475E-04      .42681E-03
47  6 Q      .12373E-03      .40908E-04      .37424E-03
48  7 Q      .13389E-03      .41951E-04      .42731E-03
49  8 Q      .26105E-03      .83773E-04      .81349E-03
```

Table 3.5.2.d. Output from ICA. Western baltic Spring Spawning Herring.

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals: log(Observed Catch) - log(Expected Catch)

Age	1988	1989	1990	1991	1992	1993
1	.48514E+00	-.37567E+00	.18187E+00	.92188E-01	-.21645E+00	.11824E-01
2	-.92859E-01	.28150E-11	-.26978E+00	-.18788E-01	-.24241E-01	.12412E+00
3	.60610E-01	.11103E+00	-.55467E-01	.84496E-01	.31784E+00	-.55612E+00
4	-.33322E-01	-.68062E-01	-.48011E-01	.85989E-01	-.13595E-02	.31667E+00
5	.30692E+00	.77337E+00	-.37719E-01	.14257E+00	.21837E+00	.17061E-01
6	-.17675E+00	-.16045E-01	-.45518E-01	-.53685E-01	.27449E+00	-.29732E-01
7	-.16607E+00	.30646E+00	.28430E+00	.37989E+00	-.80053E+00	.32663E+00
8	.26439E+00	.57451E+00	.15126E+00	.13219E+00	.47112E+00	.25528E+00

Table 3.5.2.e. Output from ICA. Western baltic Spring Spawning Herring.

Aged Index Residuals: log(Observed Index) - log(Expected Index)

Aged Index 1 German Bottom Trawl Survey in Sub.Div. 24, Ages 0-3

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	.19744E+00	.21403E+01	-.10000E+01	-.11189E+01	-.71464E+00	.38059E+00	.72007E+00	.89351E+00	.46782E+00	-.10000E+01	-.10000E+01	.10444E+01
1	-.11560E+01	.10683E+01	-.10000E+01	-.89656E-01	-.25846E+00	.69988E+00	.82889E+00	.12167E+01	.64628E+00	-.10000E+01	-.10000E+01	.25750E+00
2	-.81325E-01	.46426E+00	-.10000E+01	-.15612E+00	.43351E+00	.11807E+00	.14427E+00	.89194E+00	.19826E-01	-.10000E+01	-.10000E+01	-.39807E+00
3	.43068E-01	-.46279E+00	-.10000E+01	.46924E-01	-.37123E-01	.28029E+00	-.51222E+00	.48250E+00	.28083E+00	-.10000E+01	-.10000E+01	-.50639E+00

Age	1990	1991	1992	1993
0	-.19944E+01	-.16937E+01	-.56558E+00	.24319E+00
1	-.23760E+01	.37860E-01	-.21122E+00	-.66401E+00
2	-.16243E+01	.24163E+00	-.15187E+00	.98159E-01
3	-.10003E+01	.14361E+00	-.16299E+00	.14046E+01

Aged Index 2 German Bottom Trawl Survey in Sub.Div. 22, Ages 0-3

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	.19165E+00	-.10000E+01	-.10463E+01	-.24502E+01	.69895E+00	.10883E+01	-.38399E-01	.24134E+00	-.10000E+01	-.10000E+01	.12861E+01	-.10000E+01
1	.13851E+01	-.10000E+01	-.13023E+01	-.88115E+00	.51860E-01	.99169E+00	.83372E+00	-.15140E+01	-.10000E+01	-.10000E+01	.35046E+00	-.10000E+01
2	.41808E+00	-.10000E+01	-.12497E+01	-.37641E+00	.97856E-02	.34614E+00	.81834E+00	-.13070E+01	-.10000E+01	-.10000E+01	.14936E+00	-.10000E+01
3	-.17675E+00	-.10000E+01	-.29119E+00	.17481E+00	.36203E+00	.50779E+00	-.10693E+00	-.16523E+01	-.10000E+01	-.10000E+01	.32620E+00	-.10000E+01

Age	1991	1992	1993
0	-.10000E+01	-.72953E+00	.75810E+00
1	-.10000E+01	-.16282E+01	.17129E+01
2	-.10000E+01	-.15819E+01	.27733E+01
3	-.10000E+01	-.15568E+01	.24131E+01

Continued

Table 3.5.2.e Continued

Aged Index 3 Acoustic survey in IIIa+IVaE, Ages 2-8

Age	1989	1990	1991	1992	1993
2	-.31963E+00	-.79680E+00	.15391E+00	.48427E+00	.47824E+00
3	-.48013E+00	-.81865E+00	.41276E+00	.72657E+00	.15946E+00
4	-.92258E-01	-.15989E+01	.76981E+00	.87970E+00	.41695E-01
5	.10998E+00	-.12352E+01	.27240E+00	.85750E+00	-.47189E-02
6	.43725E+00	-.13791E+01	.27857E+00	.36840E+00	.29487E+00
7	.10468E+00	-.12446E+01	.11115E+01	.54775E+00	-.51930E+00
8	.43237E+00	-.52809E+00	.98892E+00	-.51127E+00	-.38166E+00

Aged Index 4 Acoustic survey in Sub.Div 22-24, Ages 0-8

Age	1989	1990	1991	1992	1993
0	-.52394E+00	.14697E+01	.59728E+00	.26378E+00	-.18068E+01
1	-.32602E+00	-.81021E-01	.73895E+00	.24617E+00	-.57808E+00
2	-.10253E+01	-.16351E-01	.99569E+00	.20759E+00	-.16160E+00
3	-.89863E+00	-.61300E+00	.11394E+01	-.19723E+00	.56944E+00
4	-.21545E+00	-.92594E+00	.10921E+01	-.57046E+00	.61978E+00
5	.18620E+00	-.78397E+00	.84767E+00	-.49762E+00	.24772E+00
6	-.89506E+00	-.48454E-01	.74894E+00	-.44994E+00	.64452E+00
7	-.43674E-01	-.31618E+00	.14985E+01	-.12517E+01	.11313E+00
8	-.92625E+00	-.43397E+00	.17487E+01	-.10000E+01	-.38827E+00

Table 3.5.2.f. Output from ICA. Western baltic Spring Spawning Herring.

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1988 to 1993

Variance	.1538
Skewness test statistic	1.1073
Kurtosis test statistic	1.5147
Partial chi-square	.3151
Probability of chi-square	1.0000
Degrees of freedom	25

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR ln AGED INDEX 1

Linear catchability relationship assumed. German Bottom Trawl Survey in Sub.Div. 24, Ages 0-3

Age	0	1	2	3
Variance	1.3649	.9855	.3461	.3458
Skewness test stat.	-.2025	-1.4431	-2.1605	.9808
Kurtosis test stat.	-.4556	.4082	2.0666	.6493
Partial chi-square	2.4200	2.3999	.9218	.9452
Prob. of chi-square	.9984	.9985	1.0000	1.0000
Number of data	13	13	13	13
Degrees of freedom	12	12	12	12
Weight in analysis	1.0000	1.0000	1.0000	1.0000

DISTRIBUTION STATISTICS FOR ln AGED INDEX 2

Linear catchability relationship assumed. German Bottom Trawl Survey in Sub.Div. 22, Ages 0-3

Age	0	1	2	3
Variance	1.2921	1.5636	1.6214	1.2923
Skewness test stat.	-1.2384	-.1082	1.0107	.6130
Kurtosis test stat.	.0796	-.9744	.2247	.3227
Partial chi-square	1.4348	2.3072	3.3073	2.8842
Prob. of chi-square	.9976	.9856	.9509	.9687
Number of data	10	10	10	10
Degrees of freedom	9	9	9	9
Weight in analysis	1.0000	1.0000	1.0000	1.0000

DISTRIBUTION STATISTICS FOR ln AGED INDEX 3

Linear catchability relationship assumed. Acoustic survey in IIIa+IVaE, Ages 2-8

Age	2	3	4	5	6	7	8
Variance	.3060	.4061	.9833	.5868	.5983	.8413	.4627
Skewness test stat.	-.4702	-.1986	-.7724	-.6995	-1.3463	-.1751	.5767
Kurtosis test stat.	-.5750	-.6682	-.2650	-.1789	.0992	-.5453	-.5974
Partial chi-square	.1644	.2380	.6247	.4552	.6899	1.0027	1.3011
Prob. of chi-square	.9968	.9935	.9603	.9777	.9526	.9094	.8612
Number of data	5	5	5	5	5	5	5
Degrees of freedom	4	4	4	4	4	4	4
Weight in analysis	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

DISTRIBUTION STATISTICS FOR ln AGED INDEX 4

Linear catchability relationship assumed. Acoustic survey in Sub.Div 22-24, Ages 0-8

Age	0	1	2	3	4	5	6	7	8
Variance	1.5314	.2634	.5280	.7112	.7015	.4192	.4956	.9817	1.4183
Skewness test stat.	-.3550	.3587	-.0572	.2979	.2393	.0241	-.0881	.3602	.8210
Kurtosis test stat.	-.4247	-.4960	-.2998	-.6402	-.6699	-.5898	-.6898	-.2583	-.3097
Partial chi-square	.6974	.1465	.3288	.4778	.5374	.4165	.7104	1.9951	3.5009
Prob. of chi-square	.9516	.9974	.9879	.9756	.9698	.9811	.9500	.7367	.3207
Number of data	5	5	5	5	5	5	5	5	4
Degrees of freedom	4	4	4	4	4	4	4	4	3
Weight in analysis	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 4.2.1 Celtic Sea and Division VIIj HERRING landings by calendar year (t), 1977-1993. (Data provided by Working Group members.)

Year	France	Germany	Ireland	Netherlands	U.K.	Unallocated	Discards	Total
1977	100	100	5,500	1,500	-	-	+	7,200
1978	+	200	6,200	1,000	-	900	+	8,300
1979	600	+	7,000	900	-	3,700	+	12,200
1980	+	+	8,800	400	-	-	+	9,200
1981	100	-	15,600	1,200	-	-	+	16,900
1982	+	-	9,500	-	-	-	-	9,500
1983	500	-	10,000	1,500	-	10,200	4,000	26,200
1984	700	-	7,000	900	-	11,100	3,600	23,300
1985	600	-	11,000	-	-	4,600	3,100	19,300
1986	-	-	13,300	+	-	6,100	3,900	23,300
1987	800	-	15,500	1,500	-	5,300	4,200	27,300
1988	-	-	16,800	-	-	-	2,400	19,200
1989	+	-	16,000	1,900	-	1,300	3,500	22,700
1990	+	-	15,800	1,000	200	700	2,500	20,200
1991	+	100	19,400	1,600	-	600	1,900	23,600
1992	500	-	18,000	100	+	2,300	2,100	23,000
1993	-	-	19,000	1,300	+	-1,100	1,900	21,100

Table 4.2.2 Celtic Sea and Division VIIj Herring landings (t) by season (1 April - 31 March). (Data provided by Working Group members).

Year	France	Germany	Ireland	Netherlands	U.K.	Unallocated	Discards	Total
1977/1978	100	100	6,300	1,400	-	-	+	7,900
1978/1979	+	200	8,200	1,000	-	-	+	9,400
1979/1980	600	+	7,900	900	-	900	+	10,300
1980/1981	+	+	8,000	300	-	3,800	+	-
1981/1982	100	-	15,800	1,200	-	-	+	17,100
1982/1983	+	-	13,000	-	-	-	+	13,000
1983/1984	500	-	10,000	1,500	-	9,200	3,800	25,000
1984/1985	700	-	7,000	900	-	14,000	4,200	26,800
1985/1986	600	-	12,000	-	-	4,500	3,300	20,400
1986/1987	-	-	14,700	+	-	6,100	4,200	25,000
1987/1988	800	-	15,500	1,500	-	4,400	4,000	26,200
1988/1989	-	-	17,000	-	-	-	3,400	20,400
1989/1990	+	-	15,000	1,900	-	2,600	3,600	23,100
1990/1991	+	-	15,000	1,000	200	700	1,700	18,600
1991/1992	500	100	21,400	1,600	-	-100	2,100	25,600
1992/1993	-	-	18,000	1,300	-	-100	2,000	21,200
1993/1994	-	-	16,600	1,300	+	-1,100	1,800	18,600

Table 4.2.3 Celtic Sea, Division VIIj (1993 - 1994). Sampling intensity of commercial catches.

Country	Catch (t)	No. of samples	No. of age readings	No. of fish measured	Estimates of discards
Ireland	18,000	63	1,732	10,208	Yes
Netherlands	1,300	-	-	-	Yes

Table 4.2.4 Celtic Sea and Division VIIj. Length distribution (including discards) of Irish catches/quarter (thousands).

Length	Division VIIa South		Division VIIg		Division VIIj	
	Q4 93	Q1 94	Q4 93	Q1 94	Q4 93	Q1 94
19		7				
20		7				
		21				
21	9	35			12	
	43	111		29	-	
22	277	376	15	202	48	
	554	549	78	429	12	
23	1,463	1,550	529	1,274	132	
	2,363	1,557	732	1,851	326	667
24	5,177	2,356	1,915	2,633	795	1,037
	4,804	2,078	2,648	3,183	1,108	4,000
25	6,128	1,890	4,017	1,794	1,482	2,666
	3,913	1,008	3,457	2,460	1,506	2,518
26	3,333	855	3,379	1,794	1,759	943
	1,687	514	2,243	983	1,229	741
27	1,333	681	1,075	1,013	1,639	202
	796	555	732	868	1,880	471
28	1,143	452	794	1,013	2,470	337
	805	369	483	348	1,892	404
29	917	216	514	348	1,506	
	320	63	124	116	458	135
30	182	42	124	58	241	
	34	7	15		109	135
31	9	-	31		36	
	9	-	-		24	
32	-	-	15		12	
Total	35,299	13,924	22,920	20,459	18,676	14,256

Table 4.2.5 Celtic Sea and Division VIIj. Catches in numbers at age, 1958-1993.

18:09 Wednesday, March 30, 1994

Herring South and South West of Ireland (Fishing Areas VIIg-j)

Catch in Numbers (Thousands)

(CANUM)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1958	1642	3742	33094	25746	12551	23949	16093	9384	5584
1959	1203	25717	2274	19262	11015	5830	17821	3745	7352
1960	2840	72246	24658	3779	13698	4431	6096	4379	4151
1961	2129	16058	32044	5631	2034	5067	2825	1524	4947
1962	772	18567	19909	48061	8075	3584	8593	3805	5322
1963	297	51935	13033	4179	20694	2686	1392	2488	2787
1964	7529	15058	17250	6658	1719	8716	1304	577	2193
1965	57	70248	9365	15757	3399	4539	12127	1377	7493
1966	7093	19559	59893	9924	13211	5602	3586	8746	3842
1967	7599	39991	20062	49113	9218	9444	3939	6510	6757
1968	12197	54790	39604	11544	22599	4929	4170	1310	4936
1969	9472	93279	55039	33145	12217	17837	4762	2174	3469
1970	1319	37260	50087	26481	18763	7853	6351	2175	3367
1971	12658	23313	37563	41904	18759	10443	4276	4942	2239
1972	8422	137690	17855	15842	14531	4645	3012	2374	1020
1973	23547	38133	55805	7012	9651	5323	3352	2332	1209
1974	5507	42808	17184	22530	4225	3737	2978	903	827
1975	12768	15429	17783	7333	9006	3520	1644	1136	1194
1976	13317	11113	7286	7011	2872	4785	1980	1243	1769
1977	8159	12516	8610	5280	1585	1898	1043	383	470
1978	2800	13385	11948	5583	1580	1476	540	858	482
1979	11335	13913	12399	8636	2889	1316	1283	551	635
1980	7162	30093	11726	6585	2812	2204	1184	1262	565
1981	39361	21285	21861	5505	4438	3436	795	313	866
1982	15339	42725	8728	4817	1497	1891	1670	335	596
1983	13540	102871	26993	3225	1862	327	372	932	308
1984	19517	92892	41121	16043	2450	1085	376	231	180
1985	17916	57054	36258	16032	2306	228	85	173	132
1986	4159	56747	42881	32930	8790	1127	98	29	12
1987	5976	67000	43075	23014	14323	2716	1175	296	464
1988	2307	82027	30962	9398	5963	3047	869	297	86
1989	8260	42413	68399	19601	8205	3837	2589	767	682
1990	2702	41756	24634	35258	8116	3808	1671	695	462
1991	1912	63854	38342	16916	28405	4869	2588	954	593
1992	10410	26752	35019	27591	10139	18061	3021	6285	689
1993	1608	94061	9372	10221	4491	2790	5932	855	508

Table 4.4.1 Celtic Sea Division VII$_j$

CATCH NUMBERS AT AGE (Thousands)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	13.	13.	8.	3.	11.	7.	39.	15.	14.	20.	18.	4.	6.	2.	8.	3.	2.	10.	2.
2	15.	11.	13.	13.	14.	30.	21.	43.	103.	93.	57.	57.	67.	82.	42.	42.	64.	27.	94.
3	18.	7.	9.	12.	12.	12.	22.	9.	27.	41.	36.	43.	43.	31.	68.	25.	38.	35.	9.
4	7.	7.	5.	6.	9.	7.	6.	5.	3.	16.	16.	33.	23.	9.	20.	35.	17.	28.	10.
5	9.	3.	2.	2.	3.	3.	4.	1.	2.	2.	2.	9.	14.	6.	8.	8.	28.	10.	4.
6	4.	5.	2.	1.	1.	2.	3.	2.	0.	1.	0.	1.	3.	3.	4.	4.	5.	18.	3.
7	2.	2.	1.	1.	1.	1.	1.	2.	0.	0.	0.	0.	1.	1.	3.	2.	3.	3.	6.
8	1.	1.	0.	1.	1.	1.	0.	0.	1.	0.	0.	0.	0.	0.	1.	1.	1.	1.	1.
9	1.	2.	0.	0.	1.	1.	1.	1.	0.	0.	0.	0.	0.	0.	1.	0.	1.	1.	1.

INDICES OF SPAWNING STOCK BIOMASS

0

AGE - STRUCTURED INDICES

INDEX : 1 from 1990 to 1993

	1990	1991	1992	1993
1	.132E+06	.626E+05	.427E+06	.217E+06
2	.249E+06	.195E+06	.117E+06	.438E+06
3	.109E+06	.947E+05	.878E+05	.587E+05
4	.153E+06	.540E+05	.496E+05	.634E+05
5	.324E+05	.848E+05	.222E+05	.260E+05
6	.149E+05	.221E+05	.242E+05	.163E+05
7	.610E+04	.530E+04	.960E+04	.246E+05
8	.250E+04	.610E+04	.180E+04	.230E+04

FISHING MORTALITY

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	.1406	.1066	.0767	.0333	.0780	.0802	.1626	.0374	.0297	.0558	.0575	.0125	.0084	.0103	.0156	.0113	.0158	.0178	.0105
2	.4702	.3043	.2369	.3009	.4043	.5540	.6709	.4806	.6945	.5215	.4033	.4622	.5098	.2944	.4484	.3232	.4519	.5112	.3025
3	.6902	.4561	.4379	.3976	.5410	.7740	1.1657	.7071	.6968	.7307	.4244	.6538	.8497	.3796	.5781	.4168	.5827	.6592	.3900
4	.6695	.6139	.6697	.5373	.5301	.5892	1.0241	.8505	.5886	1.1962	.6760	.8179	.8636	.4206	.6405	.4618	.6456	.7303	.4321
5	.6645	.5328	.2388	.3800	.5224	.2904	.9070	.7709	.8504	1.1088	.4600	.8780	.9362	.4063	.6189	.4462	.6238	.7057	.4175
6	.7654	.8061	.7199	.3249	.5533	.8599	.6050	1.1842	.3306	1.9404	.2362	.3793	.6559	.4404	.6708	.4836	.6761	.7649	.4525
7	.5814	1.2451	.3561	.4040	.4596	1.3108	.7845	.5916	.6833	.6859	.7358	.1354	.7548	.5035	.7668	.5528	.7729	.8743	.5173
8	1.2598	1.0681	.7567	.4918	.8196	.9982	1.5609	.8090	.6878	1.1102	.6954	.5287	.6577	.3796	.5781	.4168	.5827	.6592	.3900
9	1.2598	1.0681	.7567	.4918	.8196	.9982	1.5609	.8090	.6878	1.1102	.6954	.5287	.6577	.3796	.5781	.4168	.5827	.6592	.3900

Continued

Table 4.4.1 (Continued)

NUMBERS AT AGE (Thousands)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	152.	207.	174.	135.	237.	146.	410.	660.	731.	566.	505.	528.	1136.	412.	526.	451.	204.	1022.	244.	469.
2	47.	49.	68.	59.	48.	81.	50.	128.	234.	261.	197.	175.	192.	414.	150.	191.	164.	74.	369.	89.
3	39.	22.	27.	40.	32.	24.	34.	19.	59.	86.	115.	98.	82.	85.	229.	71.	102.	77.	33.	202.
4	16.	16.	11.	14.	22.	15.	9.	9.	8.	24.	34.	62.	42.	29.	48.	105.	38.	47.	33.	18.
5	19.	7.	8.	5.	7.	12.	8.	3.	3.	4.	7.	16.	25.	16.	17.	23.	60.	18.	20.	19.
6	7.	9.	4.	6.	3.	4.	8.	3.	1.	1.	1.	4.	6.	9.	10.	8.	13.	29.	8.	12.
7	4.	3.	4.	2.	4.	2.	2.	4.	1.	1.	0.	1.	2.	3.	5.	4.	5.	6.	12.	5.
8	2.	2.	1.	2.	1.	2.	0.	1.	2.	0.	0.	0.	1.	1.	2.	2.	2.	2.	2.	7.
9	2.	3.	1.	1.	1.	1.	1.	1.	1.	0.	0.	0.	1.	0.	2.	1.	1.	1.	2.	2.

PARAMETER ESTIMATES +/- SD

Separable Model: Reference F by year

1	1988	.3796	.3452	.4174
2	1989	.5781	.5279	.6331
3	1990	.4168	.3774	.4603
4	1991	.5827	.5207	.6521
5	1992	.6592	.5571	.7799
6	1993	.3900	.2968	.5125

Separable Model: Selection (S) by age

7	1	.0270	.0239	.0305
8	2	.7756	.6996	.8598
	3	1.0000	Fixed : Reference age	
9	4	1.1080	1.0052	1.2213
10	5	1.0705	.9761	1.1742
11	6	1.1603	1.0629	1.2667
12	7	1.3264	1.2209	1.4410
	8	1.0000	Fixed : last true age	

Continued

Table 4.4.1 (Continued)

Separable Model: Populations in year 1993

13	1	244492.	171110.	349344.
14	2	369393.	290537.	469651.
15	3	32891.	26324.	41097.
16	4	32728.	26153.	40956.
17	5	20373.	16196.	25626.
18	6	8118.	6476.	10177.
19	7	12228.	9717.	15387.
20	8	2291.	1775.	2959.

Separable Model: Populations at age 8

21	1988	984.0244	810.3788	1194.8782
22	1989	1514.6158	1304.7519	1758.2353
23	1990	2133.2997	1853.0575	2455.9236
24	1991	2298.5047	2008.7861	2630.0081
25	1992	1932.7231	1644.4537	2271.5255

Age-structured index catchabilities
Age-Structured Index 1

Linear model fitted. Slopes at age:

26	1 Q	.84172E+00	.37252E+00	.19019E+01
27	2 Q	.20844E+01	.15522E+01	.27991E+01
28	3 Q	.20982E+01	.15638E+01	.28151E+01
29	4 Q	.22399E+01	.16674E+01	.30091E+01
30	5 Q	.20551E+01	.15307E+01	.27591E+01
31	6 Q	.23846E+01	.17733E+01	.32068E+01
32	7 Q	.25241E+01	.18579E+01	.34292E+01
33	8 Q	.19670E+01	.14388E+01	.26889E+01

Continued

Table 4.4.1 (Continued)

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals: log(Observed Catch) - log(Expected Catch)

Age	1988	1989	1990	1991	1992	1993
1	-.14289E+00	-.11435E+00	.23095E+00	.29328E-03	.16599E+00	.26852E-01
2	-.18687E+00	.00000E+00	.46886E+00	-.11013E+00	-.29506E+00	-.98235E-01
3	.87740E-01	-.15155E+00	-.58854E-02	.18687E+00	-.16761E+00	-.93823E-01
4	.10969E+00	-.51079E-01	.35362E-01	.22536E+00	-.70590E-01	.54680E-03
5	-.56361E-01	.20394E+00	-.74707E-01	-.29967E-01	.66161E-01	-.24273E+00
6	.81034E-01	-.17700E-01	-.93622E-01	.31366E-01	.24249E-01	.17375E+00
7	.14104E+00	.19461E+00	-.11615E+00	-.35220E+00	-.91318E-02	.11395E+00
8	-.33394E-01	-.70495E-01	-.39112E+00	-.11724E-01	.22847E+00	.19032E+00

Aged Index Residuals: log(Observed Index) - log(Expected Index)

Aged Index 1

Age	1990	1991	1992	1993
1	-.38103E+00	-.33062E+00	-.18892E-01	.73054E+00
2	-.49993E-01	-.56041E-01	.26673E+00	-.16069E+00
3	.97566E-01	-.29322E+00	-.37790E-01	.23345E+00
4	-.57150E-01	.36587E-01	-.19071E+00	.21127E+00
5	-.24578E-02	.11246E+00	.19697E-01	-.12970E+00
6	.10738E+00	.16645E+00	-.47192E+00	.19810E+00
7	-.16571E+00	-.20568E+00	.18473E+00	.18665E+00
8	-.17211E+00	.75652E+00	-.23951E+00	-.34490E+00

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1988 to 1993

Variance	:	.0454
Skewness test statistic	:	.2153
Kurtosis test statistic	:	.8428
Partial chi-square	:	.1486
Probability of chi-square	:	1.0000
Degrees of freedom	:	25

Continued

Table 4.4.1 (Continued)

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR ln AGED INDEX 1

Linear catchability relationship assumed.

Age	1	2	3	4	5	6	7	8
Variance	.2628	.0342	.0505	.0285	.0100	.1004	.0462	.2594
Skewness test stat.	.6959	.7217	-.3219	.1536	-.2379	-.9038	-.0140	.8874
Kurtosis test stat.	-.3900	-.3337	-.4801	-.4833	-.4134	-.2879	-.8071	-.2923
Partial chi-square	.0677	.0087	.0133	.0078	.0028	.0292	.0152	.0977
Prob. of chi-square	.9954	.9998	.9996	.9998	1.0000	.9987	.9995	.9921
Number of data	4	4	4	4	4	4	4	4
Degrees of freedom	3	3	3	3	3	3	3	3
Weight in analysis	.1000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

TOTAL AND SPAWNING BIOMASS

1975	45909.	27602.
1976	46583.	25134.
1977	44350.	26075.
1978	41539.	26116.
1979	51696.	27939.
1980	44505.	26841.
1981	69769.	30724.
1982	107037.	47101.
1983	140936.	68579.
1984	112345.	61940.
1985	108521.	61276.
1986	119142.	65567.
1987	166122.	77302.
1988	120983.	78912.
1989	124757.	72200.
1990	106910.	65258.
1991	79989.	54980.
1992	138303.	61584.
1993	90365.	62500.
1994	98673.	59147.

Table 4.6.1 Stock and Catch projections.

Year: 1994

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	517086.00	1.0000	0.5000	0.2000	0.5000	0.092	0.0270	0.092
2	187517.00	0.3000	1.0000	0.2000	0.5000	0.129	0.7760	0.129
3	43661.000	0.2000	1.0000	0.2000	0.5000	0.155	1.0000	0.155
4	97340.000	0.1000	1.0000	0.2000	0.5000	0.180	1.1080	0.180
5	9159.000	0.1000	1.0000	0.2000	0.5000	0.201	1.0710	0.201
6	9848.000	0.1000	1.0000	0.2000	0.5000	0.204	1.1600	0.204
7	5933.000	0.1000	1.0000	0.2000	0.5000	0.210	1.3260	0.210
8	2090.000	0.1000	1.0000	0.2000	0.5000	0.225	1.0000	0.225
9+	4793.000	0.1000	1.0000	0.2000	0.5000	0.240	1.0000	0.240
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Single option prediction: Summary table

Status quo F in 1995 and 1996

Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
1994	0.5504	0.6236	135224	21001	877427	102935	618884	79046	448611	59410
1995	0.4680	0.5302	116934	17967	879094	102681	620551	78792	453201	59700
1996	0.4680	0.5302	122735	18828	893502	104746	634959	80857	465170	61405
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Single option prediction: Summary table

TAC Constraint in 1995 and 1996

Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
1994	0.5504	0.6236	135219	21000	877427	102935	618884	79046	448612	59410
1995	0.5707	0.6466	136901	21000	879099	102682	620556	78792	447628	58834
1996	0.5815	0.6589	138282	21000	876226	101722	617683	77833	444502	57911
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Table 4.6.2 Stock and Catch projections.

Single option prediction: Detailed tables

Year: 1994 F-factor: 0.5504 Reference F: 0.6236

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0149	4827	444	517086	47779	258543	23889	156349	14447
2	0.4271	56914	7353	187517	24227	187517	24227	148183	19145
3	0.5504	16903	2613	43661	6750	43661	6750	35388	5471
4	0.6098	42506	7630	97340	17473	97340	17473	81961	14712
5	0.5895	3901	783	9159	1839	9159	1839	7743	1555
6	0.6385	4446	905	9848	2004	9848	2004	8245	1678
7	0.7298	2942	618	5933	1246	5933	1246	4877	1024
8	0.5504	846	190	2090	469	2090	469	1781	400
9+	0.5504	1939	465	4793	1148	4793	1148	4084	978
Total		135224	21001	877427	102935	618884	79046	448611	59410
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1995 F-factor: 0.4680 Reference F: 0.5302

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0126	4108	378	517086	47779	258543	23889	156418	14453
2	0.3632	49756	6428	187419	24215	187419	24215	150012	19382
3	0.4680	30938	4783	90628	14011	90628	14011	74676	11545
4	0.5185	7972	1431	20616	3701	20616	3701	17678	3173
5	0.5012	18031	3621	47864	9611	47864	9611	41187	8270
6	0.5429	1841	375	4596	935	4596	935	3922	798
7	0.6206	2081	437	4706	988	4706	988	3954	830
8	0.4680	924	208	2588	581	2588	581	2241	503
9+	0.4680	1282	307	3592	860	3592	860	3111	745
Total		116934	17967	879094	102681	620551	78792	453201	59700
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1996 F-factor: 0.4680 Reference F: 0.5302

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0126	4108	378	517086	47779	258543	23889	156418	14453
2	0.3632	49867	6443	187837	24269	187837	24269	150346	19425
3	0.4680	32964	5096	96562	14928	96562	14928	79565	12301
4	0.5185	17969	3225	46468	8341	46468	8341	39847	7153
5	0.5012	4184	840	11106	2230	11106	2230	9557	1919
6	0.5429	10506	2138	26236	5339	26236	5339	22389	4556
7	0.6206	1069	224	2417	507	2417	507	2030	426
8	0.4680	817	184	2289	514	2289	514	1983	445
9+	0.4680	1250	299	3502	839	3502	839	3033	726
Total		122735	18828	893502	104746	634959	80857	465170	61405
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : CELTFIN2
Date and time : 30MAR94:09:46
Computation of ref. F: Simple mean, age 3 - 7
Prediction basis : F factors

Continued

Single option prediction: Detailed tables

Year: 1994 F-factor: 0.5504 Reference F: 0.6236

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0149	4827	444	517086	47779	258543	23889	156349	14447
2	0.4271	56911	7353	187517	24227	187517	24227	148183	19145
3	0.5504	16903	2613	43661	6750	43661	6750	35388	5471
4	0.6098	42504	7630	97340	17473	97340	17473	81961	14712
5	0.5895	3901	783	9159	1839	9159	1839	7743	1555
6	0.6384	4446	905	9848	2004	9848	2004	8245	1678
7	0.7298	2942	618	5933	1246	5933	1246	4877	1024
8	0.5504	846	190	2090	469	2090	469	1781	400
9+	0.5504	1939	464	4793	1148	4793	1148	4084	978
Total		135219	21000	877427	102935	618884	79046	448612	59410
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1995 F-factor: 0.5707 Reference F: 0.6466

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0154	5004	460	517086	47779	258543	23889	156332	14445
2	0.4428	58572	7568	187419	24215	187419	24215	147641	19075
3	0.5707	36057	5574	90629	14011	90629	14011	73160	11311
4	0.6323	9242	1659	20616	3701	20616	3701	17281	3102
5	0.6112	20935	4204	47865	9611	47865	9611	40292	8091
6	0.6620	2129	433	4596	935	4596	935	3830	779
7	0.7567	2392	502	4706	988	4706	988	3848	808
8	0.5707	1076	242	2588	581	2588	581	2196	493
9+	0.5707	1493	358	3592	860	3592	860	3048	730
Total		136901	21000	879099	102682	620556	78792	447628	58834
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1996 F-factor: 0.5815 Reference F: 0.6589

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0157	5099	469	517086	47779	258543	23889	156323	14444
2	0.4513	59435	7679	187317	24201	187317	24201	147311	19033
3	0.5815	35981	5563	89167	13785	89167	13785	71823	11104
4	0.6443	19056	3421	41935	7527	41935	7527	35067	6294
5	0.6228	4395	883	9912	1990	9912	1990	8325	1672
6	0.6746	11036	2246	23505	4783	23505	4783	19537	3976
7	0.7711	1104	232	2145	451	2145	451	1749	367
8	0.5815	842	189	1998	449	1998	449	1692	380
9+	0.5815	1332	319	3160	757	3160	757	2676	641
Total		138282	21000	876226	101722	617683	77833	444502	57911
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Table 5.1.1. Nominal catch (t), Division VIa (North) Herring, 1982-1992 as reported to the Working Group.

Country	1982	1983	1984	1985	1986	1987
Denmark	-	-	96	-	-	-
Faroes	74	834	954	104	400	-
France	2 069	1 313	-	20	18	136
FDR	8 453	6 283	5 564	5 937	2 188	1 711
Ireland	-	-	-	-	6 000	6 800
Netherlands	11 317	20 200	7 729	5 500	5 160[2]	5 212[2]
Norway	10 018	7 336	6 669	4 690	4 799	4 300
UK England	90	-	-	-	-	-
UK Scotland	38 381	31 616	37 554	28 065	25 294	26 810
Unallocated	18 958	-4 059	16 588	502	37 840[2]	18 038[2]
Discards	-	-	-	-	-	-
Total	92 360	63 523	75 154	43 814	81 699	63 007

Country	1988	1989	1990	1991	1992	1993
Denmark	-	-	-	-	-	-
Faroes	-	-	326	482	-	-
France	44	1342	1287	1168	119	818
FDR	1 860	4 290	7 096	6 450	5 640	4 693
Ireland	6 740	8 000	10 000	8 000	7 985	8 236
Netherlands	6 131	5 680	7 693	7 979	8 000	6 132
Norway	456	-	1 607	3 318	2 389	7 447
UK Eng. & Wales	1 892	1 977	2 376	2 998	3 327	2 965
UK Scotland	25 002	27 897	35 877	29 630	29 403	29 637
Unallocated	5 229[2]	2 123[2]	2 397	-10 597	-5 485	-3 753
Discards	-	1 550	1 300	1 180	200	820
Total	47 354	53 039	69 959	50 606	51 585	56 175

(Discards are included in national catches)

Table 5.1.2 HERRING in Division VIa (North), 1993. Sampling intensity of commercial catches.

Country	Catch in tonnes	No. of samples	No. of age readings	No. of fish measured	Estimate of discards
France	818	0	0	0	NONE
FDR	4693	0	0	0	NONE
Ireland	8236	0	0	0	NONE
Netherlands	2965	13	325	1688	5368
Norway	7447	3	145	145	NONE
UK (E. & W)	2965	0	0	0	NONE
UK (Scotland)	29637	21	1361	2936	NONE

Table 5.1.3. Estimated catches at age in thousands of herring in Division VIa(N).

Rings	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	238738	169947	801663	51170	309016	172879	69053	34836	22525	392
2	205454	372615	804097	235627	124944	202087	319604	47739	46284	225
3	359711	560348	219502	808267	151025	89066	101548	95834	20587	122
4	139718	357745	63069	131484	519178	63701	35502	22117	40692	31
5	53320	113391	85920	63071	82466	188202	25195	10083	6879	21
6	203462	54571	37341	54642	49683	30601	76289	12211	3833	12
7	29141	181592	13377	18242	34629	12297	10918	20992	2100	7
8	32860	18042	100938	6506	22470	13121	3914	2758	6278	2
9+	30651	36395	20465	32223	21042	13698	12014	1486	1544	0

Rings	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	12867	36740	13304	81923	2961	45663	38943	27645	2273	9690
2	1335	77961	250010	77810	253291	77063	178714	93679	158832	57305
3	452	105600	72179	92743	66857	166112	99264	64575	55529	170687
4	246	61341	93544	29262	46963	19269	137077	45488	37815	29497
5	62	21473	58452	42535	20057	17027	21723	71188	26292	28228
6	43	12623	23580	27318	15250	7422	20759	11973	37993	11830
7	40	11583	11516	14709	12478	7731	2973	10378	4327	23400
8	3	1309	13814	8437	5940	3720	16177	4982	2956	2529
9+	1	1326	4027	8484	2629	2450	2273	8498	3140	5463

Rings	1990	1991	1992	1993
1	22374	46826	9346	41169
2	75241	40824	43538	147513
3	63832	44755	44344	30400
4	116270	50048	42228	18642
5	41512	66554	38818	24045
6	20826	24007	60262	27464
7	15463	13449	11301	36129
8	33585	12226	7681	8839
9+	8644	7904	9805	13825

Table 5.1.4. HERRING in Division VIa (North). Larvae abundance indices (Numbers in billions), larvae mortality rates (Z/K), fecundity estimate (10^5 eggs/g). LPE Biomass estimate in thousands of tonnes.

Year	LAI	10% Trim LAI	Z/K	LPE		
				Larvae	Fecundity	SSB
1973	2 442	46.49	0.74	318	(1.39)	229
1974	1 186	17.44	0.42	238	(1.39)	171
1975	878	22	0.46	157	1.46	108
1976	189	11.04	-	60	1.23	49
1977	787	25	-	223	1.49	150
1978	332	32.8	-	132	1.37	109
1979	1 071	26.94	-	118	1.49	79
1980	1 436	26.33	0.39	287	2.04	141
1981	2 154	35.61	0.34	448	2.12	211
1982	1 890	32.58	0.39	267	1.95	137
1983	668	24.55	-	112	1.88	60
1984	2 133	45.99	0.57	253	1.75	145
1985	2 710	50.03	0.37	418	(1.86)	225
1986	3 037	45.36	0.24	907	(1.86)	488
1987	4 119	45.47	0.53	423	(1.86)	227
1988	5 947	75.13	0.47	781	(1.86)	420
1989	4 320	82.68	0.40	752	(1.86)	404
1990	6 525	86.2	0.64	426	(1.86)	229
1991	4 430	63.06	0.60	632	(1.86)	340
1992	12 252	41.79	0.66	463	(1.86)	248
1993	2 941	65.01	0.56	538	(1.86)	289

Table 5.1.5. HERRING in Division VIa (North). Estimates of abundance from Scottish acoustic surveys. Thousands of fish at age.

Age	1987	1991	1992	1993
1	249 100	338 312	74 310	2 760
2	578 400	294 484	503 430	750 270
3	551 100	327 902	210 980	681 170
4	353 100	367 830	258 090	653 050
5	752 600	488 288	414 750	544 000
6	111 600	176 348	240 110	865 150
7	48 100	98 741	105 670	284 110
8	15 900	89 830	56 710	151 730
9	6 500	58 043	63 440	156 180

Table 5.1.6. HERRING in Division VIa (North). Mean weights at age (g).

Age	Weight in the catch									
(rings)	1982-1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	90	69	113	73	80	82	79	84	91	89
2	140	103	145	143	112	142	129	118	122	128
3	175	134	173	183	157	145	173	160	172	158
4	205	161	196	211	177	191	182	203	194	197
5	231	182	215	220	203	190	209	211	216	206
6	253	199	230	238	194	213	224	229	224	228
7	270	213	242	241	240	216	228	236	236	223
8	284	223	251	253	213	204	237	261	251	262
9+	295	231	258	256	228	243	247	271	258	263

	Weight in the stock		
	Historical	1992	1993
1	90	68	75
2	164	152	162
3	208	186	196
4	233	206	206
5	246	232	226
6	252	252	234
7	258	271	254
8	269	296	260
9+	292	305	276

Table 5.1.7. HERRING in Division VIa(N). Results of baseline assessment.

CATCH NUMBERS AT AGE (Thousands)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	173.	69.	35.	23.	0.	13.	37.	13.	82.	3.	46.	39.	28.	2.	10.	22.	47.	9.	41.
2	202.	320.	48.	46.	0.	1.	78.	250.	78.	253.	77.	179.	94.	159.	57.	75.	41.	44.	148.
3	89.	102.	96.	21.	0.	0.	106.	72.	93.	67.	166.	99.	65.	56.	171.	64.	45.	44.	30.
4	64.	36.	22.	41.	0.	0.	61.	94.	29.	47.	19.	137.	45.	38.	29.	116.	50.	42.	19.
5	188.	25.	10.	7.	0.	0.	21.	58.	43.	20.	17.	22.	71.	26.	28.	42.	67.	39.	24.
6	31.	76.	12.	4.	0.	0.	13.	24.	27.	15.	7.	21.	12.	38.	12.	21.	24.	60.	27.
7	12.	11.	21.	2.	0.	0.	12.	12.	15.	12.	8.	3.	10.	4.	23.	15.	13.	11.	36.
8	13.	4.	3.	6.	0.	0.	1.	14.	8.	6.	4.	16.	5.	3.	3.	34.	12.	8.	9.
9	14.	12.	1.	2.	0.	0.	1.	4.	8.	3.	2.	2.	8.	3.	5.	9.	8.	10.	14.

INDICES OF SPAWNING STOCK BIOMASS

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	.878E+03	.189E+03	.787E+03	.332E+03	.107E+04	.144E+04	.215E+04	.189E+04	.668E+03	.213E+04	.271E+04	.304E+04	.412E+04	.595E+04	.432E+04	.653E+04	.443E+04	-.100E+01	.294E+04

AGE - STRUCTURED INDICES

INDEX : 1 from 1987 to 1993

	1987	1988	1989	1990	1991	1992	1993
1	.249E+06				.338E+06	.743E+05	.276E+04
2	.578E+06				.294E+06	.503E+06	.750E+06
3	.551E+06				.328E+06	.211E+06	.681E+06
4	.353E+06				.368E+06	.258E+06	.653E+06
5	.753E+06		MISSING		.488E+06	.415E+06	.544E+06
6	.112E+06				.176E+06	.240E+06	.865E+06
7	.481E+05				.987E+05	.106E+06	.284E+06
8	.159E+05				.898E+05	.567E+05	.152E+06
9	.650E+04				.580E+05	.634E+05	.156E+06

Continued

Table 5.1.7 Continued

FISHING MORTALITY

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	.1351	.1850	.0846	.0375	.0004	.0207	.0321	.0221	.0334	.0031	.0417	.0403	.0111	.0097	.0101	.0159	.0143	.0104	.0101
2	.7374	.7510	.3303	.2659	.0008	.0027	.2885	.5733	.2984	.2335	.1731	.3992	.2188	.1173	.1217	.1915	.1731	.1258	.1214
3	.9096	1.2173	.5721	.2460	.0010	.0020	.3210	.5074	.4651	.4848	.2514	.3750	.2606	.1387	.1439	.2264	.2046	.1487	.1435
4	.8741	1.1759	.9410	.4835	.0005	.0024	.3723	.4953	.3760	.4311	.2363	.3213	.2790	.1583	.1643	.2585	.2337	.1698	.1639
5	.9368	.9421	1.2148	.7719	.0004	.0011	.2687	.6425	.3891	.4240	.2437	.4029	.2454	.1895	.1966	.3093	.2796	.2032	.1961
6	1.0247	1.1837	1.7906	1.8868	.0023	.0008	.2794	.4676	.6266	.2092	.2437	.4640	.3600	.1774	.1841	.2897	.2618	.1902	.1837
7	1.1579	1.2149	1.1688	2.8557	.1041	.0084	.2739	.3925	.5289	.5797	.1398	.1304	.3951	.1543	.1601	.2519	.2276	.1654	.1597
8	1.2001	1.4534	1.0856	1.3180	.0178	.0534	.3612	.5352	.4925	.3732	.3003	.4248	.2980	.1664	.1726	.2717	.2455	.1784	.1722
9	1.2001	1.4534	1.0856	1.3180	.0178	.0534	.3612	.5352	.4925	.3732	.3003	.4248	.2980	.1664	.1726	.2717	.2455	.1784	.1722

NUMBERS AT AGE (Thousands)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	2140.	637.	674.	964.	1553.	992.	1835.	963.	3934.	1523.	1764.	1553.	3955.	1380.	1451.	1233.	1814.	2228.	6152.	1947.
2	440.	688.	195.	228.	342.	571.	357.	654.	346.	1400.	559.	622.	549.	1439.	503.	528.	446.	658.	811.	2240.
3	162.	156.	240.	104.	129.	253.	422.	198.	273.	190.	821.	348.	309.	327.	948.	330.	323.	278.	430.	532.
4	114.	53.	38.	111.	66.	106.	207.	251.	98.	140.	96.	523.	196.	195.	233.	672.	215.	216.	196.	305.
5	323.	43.	15.	13.	62.	60.	96.	129.	138.	61.	83.	69.	343.	134.	151.	179.	470.	154.	165.	151.
6	50.	114.	15.	4.	6.	56.	54.	66.	61.	85.	36.	59.	41.	243.	100.	112.	119.	321.	114.	122.
7	19.	16.	32.	2.	0.	5.	51.	37.	37.	30.	62.	26.	33.	26.	184.	76.	76.	83.	240.	86.
8	20.	5.	4.	9.	0.	0.	5.	35.	23.	20.	15.	49.	20.	20.	20.	142.	53.	55.	63.	185.
9	20.	16.	2.	2.	0.	0.	5.	10.	23.	9.	10.	7.	35.	21.	36.	38.	38.	63.	92.	118.

PARAMETER ESTIMATES +/- SD

Separable Model: Reference F by year				
1	1988	.1386	.1112	.1729
2	1989	.1439	.1163	.1779
3	1990	.2264	.1832	.2797
4	1991	.2046	.1631	.2566
5	1992	.1487	.1169	.1890
6	1993	.1435	.1102	.1870
Separable Model: Selection (S) by age				
7	1	.0701	.0550	.0894
8	2	.8460	.6829	1.0480
	3	1.0000	Fixed : Reference age	
9	4	1.1421	.9391	1.3889
10	5	1.3664	1.1313	1.6504
11	6	1.2795	1.0639	1.5388
12	7	1.1126	.9208	1.3443
	8	1.2000	Fixed : last true age	
Separable Model: Populations in year 1993				
13	1	6151682.	3795399.	9970807.
14	2	811122.	597252.	1101577.
15	3	429647.	327113.	564321.
16	4	196244.	152827.	251995.
17	5	164678.	129750.	209008.
18	6	113910.	89510.	144962.

Continued

Table 5.1.7 Continued

19	7	240348.	189171.	305372.
20	8	63389.	48481.	82882.
Separable Model: Populations at age 8				
21	1988	20297.3969	13479.2757	30564.2774
22	1989	20308.6282	14691.9977	28072.4507
23	1990	141878.2135	107405.0251	187416.0677
24	1991	53148.7061	40618.2737	69544.6827
25	1992	54674.2272	41906.7986	71331.4120

SSB Index catchabilities

26	1	Power Model : Q	.46285E+01	.38420E+01	.55761E+01
27	1	Power Model : K	-.11063E+02	-.13285E+02	-.88406E+01

Age-structured index catchabilities

Age-Structured Index 1

Linear model fitted. Slopes at age:

28	1	Q	.30690E-01	.56089E-02	.16792E+00
29	2	Q	.10068E+01	.57784E+00	.17543E+01
30	3	Q	.14189E+01	.81630E+00	.24665E+01
31	4	Q	.21197E+01	.12211E+01	.36795E+01
32	5	Q	.24221E+01	.13957E+01	.42032E+01
33	6	Q	.25094E+01	.14424E+01	.43655E+01
34	7	Q	.14856E+01	.85062E+00	.25945E+01
35	8	Q	.15331E+01	.87228E+00	.26946E+01
36	9	Q	.95344E+00	.55916E+00	.16257E+01

Parameters of the B.-H. stock-recruit relationship

37	a	.2299224E+07	.3653507E+06	.1446947E+08
38	b	.7364538E+05	.1656376E+03	.3274404E+08

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals: log(Observed Catch) - log(Expected Catch)

Age	1988	1989	1990	1991	1992	1993
1	-.13131E+01	.14072E+00	.36845E+00	.32845E+00	.17559E+00	.97882E-02
2	.19308E+00	-.29911E-02	.50168E-01	.13762E+00	.39137E+00	-.13061E+00
3	.96313E-01	-.30737E+00	-.10293E+00	-.19353E+00	.59908E+00	-.60685E-01
4	.48795E-01	-.22790E+00	-.88821E-01	-.25490E+00	-.36883E-01	.42403E-01
5	.10521E+01	-.41062E+00	-.19498E+00	.15683E+00	-.49556E+00	-.82456E-01
6	-.90729E-01	.10265E+00	-.44763E+00	-.43660E+00	.23910E+00	.27421E+00
7	.36175E+00	.12740E+00	-.60849E-01	-.10310E+00	.54601E-01	.60727E+00
8	-.54050E+00	-.41654E+00	-.15068E+00	.41064E+00	.66535E-01	-.78250E-01

Continued

Table 5.1.7 Continued

Biomass Index Residuals: log(Observed Index) - log(Expected Index)

Idx	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	-.24030E-01	-.12305E+01	.82841E+00	-.40663E-01	.40709E+00	-.15453E+00	.22583E+00	.16857E+00	-.53859E+00	-.28688E+00	-.82761E-01	.86126E-01	.46115E+00	.15393E+00

1989	1990	1991	1992	1993
-.16951E+00	.34208E+00	.21431E+00	MISSING	-.36074E+00

Aged Index Residuals: log(Observed Index) - log(Expected Index)

Aged Index 1

Age	1987	1988	1989	1990	1991	1992	1993
1	.11234E+01				.22104E+01	.48740E+00	-.38214E+01
2	.25337E+00				-.23347E+00	-.10379E+00	.83784E-01
3	.41204E+00				-.17376E+00	-.48673E+00	.24834E+00
4	-.10431E-01				-.82433E-01	-.46384E+00	.55659E+00
5	.39198E-01		MISSING		-.69381E+00	.22571E+00	.42877E+00
6	.25351E+00				-.37937E+00	-.10952E+01	.12209E+01
7	.16987E+00				-.12876E-02	-.44047E-01	-.12466E+00
8	-.51084E+00				.23571E+00	-.27939E+00	.55439E+00
9	-.14644E+01				.60749E+00	.16669E+00	.68922E+00

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1988 to 1993

Variance	:	.2223
Skewness test statistic	:	-1.3065
Kurtosis test statistic	:	4.5211
Partial chi-square	:	.6299
Probability of chi-square	:	1.0000
Degrees of freedom	:	25

Continued

Table 5.1.7

PARAMETERS OF THE DISTRIBUTION OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR ln SSB INDEX 1

Power catchability relationship assumed.
Last age is a plus-group.

Variance	:	.2135
Skewness test statistic	:	-1.5067
Kurtosis test statistic	:	1.3624
Partial chi-square	:	.5126
Probability of chi-square	:	1.0000
Number of observations	:	18
Degrees of freedom	:	16
Weight in the analysis	:	1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR ln AGED INDEX 1

Linear catchability relationship assumed.

Age	:	1	2	3	4	5	6	7	8	9
Variance	:	6.9962	.0455	.1662	.1773	.2392	.9661	.0154	.2340	1.0054
Skewness test stat.	:	-.7382	.0974	-.1637	.3034	-.6543	.1549	.4714	.0788	-.8055
Kurtosis test stat.	:	-.3396	-.5886	-.6357	-.4032	-.3747	-.5083	-.4049	-.6555	-.3343
Partial chi-square	:	1.8416	.0105	.0389	.0413	.0534	.2259	.0041	.0646	.2897
Prob. of chi-square	:	.6059	.9997	.9980	.9978	.9968	.9733	.9999	.9957	.9620
Number of data	:	4	4	4	4	4	4	4	4	4
Degrees of freedom	:	3	3	3	3	3	3	3	3	3
Weight in analysis	:	.1000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Continued

Table 5.1.7 Continued

YEAR	TOTAL BIOMASS	SPAWNING BIOMASS
1975	433047.	115715.
1976	264827.	93332.
1977	168991.	61768.
1978	179569.	62010.
1979	254952.	99430.
1980	290474.	173710.
1981	412572.	176578.
1982	363866.	168309.
1983	562386.	135443.
1984	490911.	245179.
1985	495852.	250893.
1986	489423.	242052.
1987	674885.	231200.
1988	586280.	359057.
1989	590343.	359951.
1990	563804.	337386.
1991	544266.	284827.
1992	536794.	292620.
1993	881489.	317295.

Table 5.1.8. Herring in VIa(N). *Status quo* stock projection assuming 62 000t catch in 1994, and F in 1995 equal to the mean F over the years 1991-1993.

* Species: HERRING Year 1994. ALL FLEETS F-factor 1.0662 and ref. F .2114 *

	ALL FLEETS					at 1 January		at spawning time	
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass	sp.stock size	sp.stock biomass
2	.1493	76097.6	9740.49	632871.	102525.1	632871.0	102525.1	468369.3	75875.8
3	.1770	78054.3	12332.59	529351.	103752.8	529351.0	103752.8	411195.6	80594.3
4	.2015	53013.6	10443.67	304730.	62774.4	304730.0	62774.4	248990.1	51292.0
5	.2410	30773.8	6339.40	150720.	34062.7	150720.0	34062.7	119938.6	27106.1
6	.2260	23622.7	5385.96	122470.	28658.0	122470.0	28658.0	98437.6	23034.4
7	.1962	14564.8	3247.95	85778.	21787.6	85778.0	21787.6	70338.6	17866.0
8	.2122	33785.4	8851.77	185380.	48198.8	185380.0	48198.8	150392.9	39102.2
9+	.2122	21527.3	5661.68	118120.	32601.1	118120.0	32601.1	95827.0	26448.3
Total		331439.4	62003.52	2129420.	434360.5	2129420.0	434360.5	1663490.0	341319.1

* Species: HERRING Year 1995. ALL FLEETS F-factor 1.0000 and ref. F .1982 *

	ALL FLEETS					at 1 January		at spawning time	
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass	sp.stock size	sp.stock biomass
2	.1400	71679.7	9175.00	632871.	102525.1	632871.0	102525.1	471286.7	76348.4
3	.1660	56137.6	8869.75	403832.	79151.0	403831.8	79151.0	316011.5	61938.3
4	.1890	59598.6	11740.92	363094.	74797.4	363094.3	74797.4	299176.2	61630.3
5	.2260	43472.1	8955.24	225409.	50942.3	225408.5	50942.3	181180.6	40946.8
6	.2120	19518.2	4450.15	107175.	25078.9	107175.0	25078.9	86957.8	20348.1
7	.1840	14159.3	3157.52	88396.	22452.7	88396.4	22452.7	73079.8	18562.3
8	.1990	10972.1	2874.68	63789.	16585.2	63789.1	16585.2	52208.8	13574.3
9+	.1990	38205.5	10048.05	222118.	61304.5	222117.8	61304.5	181794.7	50175.3
Total		313743.0	59271.30	2106684.	432837.2	2106684.0	432837.2	1661696.0	343523.8

Table 5.1.9. Herring in Division VIa(N). *Status quo* stock projection assuming 62,000 t catch in 1994 and F in 1995 equal to 1.2 times the mean F over the years 1991-1993.

* Species: HERRING Year 1995. ALL FLEETS F-factor 1.2000 and ref. F .2379 *

	ALL FLEETS					at 1 January		at spawning time	
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass	sp.stock size	sp.stock biomass
2	.1680	84909.4	10868.40	632871.	102525.1	632871.0	102525.1	462527.8	74929.5
3	.1992	66326.1	10479.53	403832.	79151.0	403831.8	79151.0	309059.7	60575.7
4	.2268	70247.3	13838.72	363094.	74797.4	363094.3	74797.4	291694.3	60089.0
5	.2712	51067.6	10519.93	225409.	50942.3	225408.5	50942.3	175776.0	39725.4
6	.2544	22957.5	5234.30	107175.	25078.9	107175.0	25078.9	84522.2	19778.2
7	.2208	16696.8	3723.39	88396.	22452.7	88396.4	22452.7	71300.0	18110.2
8	.2388	12920.7	3385.22	63789.	16585.2	63789.1	16585.2	50835.0	13217.1
9+	.2388	44990.8	11832.57	222118.	61304.5	222117.8	61304.5	177011.0	48855.0
Total		370116.2	69882.05	2106684.	432837.2	2106684.0	432837.2	1622726.0	335280.1

Table 5.2.1. Catches of HERRING from the Firth of Clyde. Spring and autumn-spawners combined. Tonnes.

Year	Scotland	Other UK	Unallocated	Discards	Total used by WG	Agreed TAC
1955					4 050	
1956					4 848	
1957					5 915	
1958					4 926	
1959					10 530	
1960					15 680	
1961					10 848	
1962					3 989	
1963					7 073	
1964					14 509	
1965					15 096	
1966					9 807	
1967					7 929	
1968					9 433	
1969					10 594	
1970					7 763	
1971					4 088	
1972					4 226	
1973					4 715	
1974					4 061	
1975					3 664	
1976					4 139	
1977					4 847	
1978					3 862	
1979					1 951	
1980					2 081	
1981					2 135	
1982	2 506	-	262	1 253	4 021	
1983	2 530	273	293	1 265	4 361	
1984	2 991	247	224	2 308	5 770	3 000
1985	3 001	22	433	1 344[3]	4 800	3 000
1986	3 395	-	576	679[3]	4 650	3 100
1987	2 895	-	278	439[4]	3 612	3 500
1988	1 568	-	110	245[4]	1 923	3 200
1989	2 135	-	208	-[2]	2 343	3 200
1990	2 184	-	75	-[2]	2 259	2 600
1991	713	-	18	-[2]	731	2 900
1992	929	-	-	-	926	2 300
1993	852	-	-	-	852	1 000

[1] Calculated from estimates of weight per box and in some years estimated by-catch in the sprat fishery.
[2] Reported to be at a low level, assumed to be zero
[3] Based on sampling
[4] Estimated assuming the same discarding rate as in 1986.

Table 5.2.2 Sampling levels of Clyde HERRING 1988-1993.

Year	Reported landings (t)	No. of samples	No. of fish measured	No. of fish aged	Estimates of discards
1988	1 568	41	5 955	2 574	Based on local
1989	2 135	45	8 368	4 152	reports
1990	2 184	37	5 926	3 803	"
1991	713	29	4 312	2 992	"
1992	929	23	4 604	1 579	No information
1993	852	16	3 408	798	No information

Table 5.2.3 Clyde HERRING catch in numbers at age. Spring and autumn spawners combined. Thousands of fish.

Age(Rings)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	5008	2207	1351	9139	5308	12694	6194	1041	14123	507
2	7551	6503	8983	5258	8841	1876	10480	7524	1796	4859
3	10338	1976	3181	4548	2817	2483	913	6976	2259	807
4	8745	4355	1684	1811	2559	1024	1049	1062	2724	930
5	2306	3432	3007	918	1140	1072	526	1112	634	888
6	741	1090	1114	1525	494	451	638	574	606	341
7	760	501	656	659	700	175	261	409	330	289
8	753	352	282	307	253	356	138	251	298	156
9	227	225	177	132	87	130	178	146	174	119
9+	117	181	132	114	59	67	100	192	236	154

Age(Rings)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	333	312	220	314	4156	1639	678	508	0	845
2	5633	2372	11311	10109	11829	2951	4574	1376	1062	1523
3	1592	2785	4079	5232	5774	4420	4431	3669	1724	9239
4	567	1622	2440	1747	3406	4592	4622	4379	2506	876
5	341	1158	1028	963	1509	2806	2679	3400	2014	452
6	204	433	663	555	587	2654	1847	1983	1319	252
7	125	486	145	415	489	917	644	1427	510	146
8	48	407	222	189	375	681	287	680	234	29
9	56	74	63	85	74	457	251	308	66	16
9+	68	18	53	38	80	240	79	175	16	5

Age(Rings)

	1990	1991	1992	1993
1	716	42	145	3
2	1004	615	411	418
3	839	472	493	261
4	7533	703	385	268
5	576	1908	1305	1305
6	359	169	333	327
7	329	92	91	78
8	119	113	69	111
9	49	22	32	38
9+	16	9	10	0

Table 5.2.4 Effort on Clyde herring. Number of days' absence from port by pair trawlers in the Firth of Clyde, 1974 to 1993, and estimated total effort in pair trawl units.

Year	Days absent (pair trawl)	Raised to total landings
1974	3 376	3 376
1975	3 209	3 209
1976	3 016	3 016
1977	4 186	4 186
1978	4 379	4 379
1979	2 933	2 933
1980	1 982	1 982
1981	1 529	1 529
1982	1 755	1 755
1983	1 644	1 644
1984	1 401	1 401
1985	1 688	1 688
1986	1 375	1 375
1987	850	998
1988	540	626
1989	582	639
1990	388	429
1991	169	254
1992	137	165
1993	194	224

Table 5.2.5. HERRING in the Firth of Clyde. Mean weights at age in the catch and stock (g).

Age (rings)	Weight in the stock (Spr spawn)		Weight in the catch									
			1970-81	1982-85	1986	1987	1988	1989	1990	1991	1992	1993
2	-	-	225	149	166	149	156	149	170	143	141	141
3	171	173	270	187	199	194	194	174	186	163	187	174
4	195	218	290	228	224	203	207	203	202	188	188	198
5	210	215	310	253	253	217	211	221	216	192	216	213
6	210	245	328	272	265	225	222	227	237	198	227	216
7	234	-	340	307	297	236	230	235	234	210	206	229
8	-	-	345	291	298	247	225	237	234	222	218	261
9	-	-	350	300	298	255	244	219	257	200	201	233
10+	-	-	350	300	321	258	230	254	272	203	221	254

Table 5.2.6 Clyde herring. Estimates of stock biomass from egg surveys on Ballantrae Bank and Brown Head in April and from fish in acoustic surveys in July, except for acoustic surveys in 1985 and 1986 in June. Tonnes of spawning fish.

Year	1985	1986	1987	1988	1989	1990	1991	1993
Egg survey : Spring-spawners								
Ballantrae				760	5 200	4 843	2 984	1 730
Brown Head						1 187	3 976	1 344
Total						6 730	6 960	3 074
Acoustic survey								
Total (2+ ringers)		6 600	9 000	16 100	12 400	18 400	11 900	-

Table 5.2.7 Proportions of fish by age in the trawl surveys carried out in spring. These represent almost entirely spring-spawners.

Age (Rings)	1985	1986	1987	1988	1989	1990	1991	1993
1	5.8	11.3	10.4					
2	7.9	3.3	18.8	0.7	1.1		0.25	0.6
3	31.8	36.1	32.7	23.5	93.0	0.9	0.75	19.0
4	25.4	24.0	12.9	35.6	2.6	97.5	3.99	9.3
5	14.6	16.3	7.0	16.4	1.9	1.2	93.02	54.4
6	5.9	3.6	7.2	10.7	0.4	0.3	1.75	13.9
7	4.3	2.5	3.7	7.8	0.7		0.25	0.7
8	2.9	1.9	4.1	4.0				0.6
9	0.7	0.8	1.4	1.0	0.4			
10	0.5	0.3	1.6					
11+	0.2		0.6	0.2				

Table 5.2.8 Estimates of Clyde herring abundance at age from acoustic surveys.

Age (Rings)	1985	1986	1987	1988	1989
2	3 200	20 500	11 500	67 400	9 500
3	9 900	12 500	9 200	6 200	80 300
4	10 600	9 300	11 500	4 800	6 700
5	3 000	3 400	5 700	5 500	2 400
6	3 200	3 200	3 000	3 600	1 800
7	800	1 200	1 200	2 800	1 100
8	700		700	1 500	300

Table 6.1.1 Estimated Herring catches in tonnes in Divisions VIa (South) and VIIb,c, 1984-1993.

Country	1984	1985	1986	1987	1988
France	-	-	-	-	-
Germany, Fed.Rep.	-	-	-	-	-
Ireland	10,000	13,900	15,540	15,000	15,000
Netherlands	6,400	1,270	1,550	1,550	300
UK (N.Ireland)	-	-	-	5	-
UK (England + Wales)	-	-	-	51	-
UK Scotland	-	-	-	-	-
Unallocated	11,000	8,204	11,785	31,994	13,800
Total landings	27,400	23,374	28,785	48,600	29,100
Discards	-	-	-	-	-
Total catch	27,400	23,374	28,785	48,600	29,100

Country	1989	1990	1991	1992	1993[1]
France	-	+	-	-	-
Germany, Fed.Rep.	-	-	-	250	-
Ireland	18,200	25,000	22,500	26,000	27,600
Netherlands	2,900	2,533	600	900	2,500
UK (N.Ireland)	-	80	-	-	-
UK (England + Wales)	-	-	-	-	-
UK (Scotland)	+	-	+	-	200
Unallocated	7,100	13,826	11,200	4,600	6,250
Total landings	28,200	41,439	34,300	31,750	36,550
Discards	1,000	2,530	3,400	100	250
Total catch	29,200	43,969	37,700	31,850	36,800

[1]Provisional

Table 6.1.2 Herring west of Ireland & Porcupine Bank and lower part of Division VIa. Catch in '000.

(CANUM)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1970	0	135	35114	26007	13243	3895	40181	2982	1667	1911
1971	0	883	6177	7038	10856	8826	3938	40553	2286	2160
1972	0	1001	28786	20534	6191	11145	10057	4243	47182	4305
1973	46	6423	40390	47389	16863	7432	12383	9191	1969	50980
1974	0	3374	29406	41116	44579	17857	8882	10901	10272	30549
1975	194	7360	41308	25117	29192	23718	10703	5909	9378	32029
1976	823	16613	29011	37512	26544	25317	15000	5208	3596	15703
1977	0	4485	44512	13396	17176	12209	9924	5534	1360	4150
1978	82	10170	40320	27079	13308	10685	5356	4270	3638	3324
1979	4	5919	50071	19161	19969	9349	8422	5443	4423	4090
1980	0	2856	40058	64946	25140	22126	7748	6946	4344	5334
1981	0	1620	22265	41794	31460	12812	12746	3461	2735	5220
1982	0	748	18136	17004	28220	18280	8121	4089	3249	2875
1983	0	1517	43688	49534	25316	31782	18320	6695	3329	4251
1984	0	2794	81481	28660	17854	7190	12836	5974	2008	4020
1985	0	9606	15143	67355	12756	11241	7638	9185	7587	2168
1986	0	918	27110	24818	66383	14644	7988	5696	5422	2127
1987	0	12149	44160	80213	41504	99222	15226	12639	6082	10187
1988	0	0	29135	46300	41008	23381	45692	6946	2482	1964
1989	0	2241	6919	78842	26149	21481	15008	24917	4213	3036
1990	0	878	24977	19500	151978	24362	20164	16314	8184	1130
1991	0	675	34437	27810	12420	100444	17921	14865	11311	7660
1992	0	2592	15519	42532	26839	12565	73307	8535	8203	6286
1993	0	191	20562	22666	41967	23379	13547	67265	7671	6013

Table 6.1.3 Sampling intensity of commercial catches in 1993.

Country	Catch (t)	No. of samples	No. of age readings	No. of fish measured	Estimates of discards
Ireland[1]	26,000	33	1,237	7,371	No
Netherlands	1,000	2	50	-	Yes
UK (Scotland)	200	-	-	-	-

[1]including Division VIa (North).

Table 6.1.4 Divisions VIa(S) and VIIb.
Length distributions of Irish catches (pelagic trawlers) per quarter (10^3) in 1993.

Length	1st quarter	2 quarter	3 quarter + 4th quarter
20.5	38	30	-
21.0	169	-	35
21.5	526	30	-
22.0	713	148	-
22.5	788	296	-
23.0	751	622	-
23.5	451	622	249
24.0	582	918	569
24.5	582	1,066	391
25.0	1051	1,511	852
25.5	1971	1,777	2,807
26.0	5200	2,844	3,802
26.5	7172	3,969	4,264
27.0	10589	6,339	6,539
27.5	10814	5,717	11,904
28.0	9594	5,124	20,362
28.5	4956	2,518	20,078
29.0	2591	889	18,621
29.5	1333	415	6,609
30.0	695	118	4,193
30.5	394	-	1,279
31.0	188	-	853
31.5	113	30	426
32.0	19	-	107
32.5	19	-	-
Total	61,299	34,983	103,940

Table 6.5.1

Title : Herring West of Ireland & Porcupine Bank & lower part of VIa (Fish (run name: VI

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Separable analysis
from 1970 to 1993 on ages 1 to 8
with Terminal F of .300 on age 4 and Terminal S of 1.200

Initial sum of squared residuals was 386.218 and
final sum of squared residuals is 71.842 after 109 iterations

Matrix of Residuals

Years, Ages	1970/71	1971/72	1972/73
1/ 2,	-.509,	.317,	.028,
2/ 3,	1.985,	-.347,	.250,
3/ 4,	.639,	.370,	.306,
4/ 5,	.010,	.055,	-.246,
5/ 6,	-.358,	-.006,	-.135,
6/ 7,	-.471,	-.064,	-.065,
7/ 8,	-.404,	-.341,	.414,
TOT ,	.000,	.000,	.000,
WTS ,	.001,	.001,	.001,

Years,	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83,
1/ 2,	2.293,	.984,	2.229,	2.026,	1.034,	1.898,	1.847,	1.141,	.797,	-.155,
2/ 3,	.773,	.590,	.612,	.726,	.726,	1.245,	.479,	.132,	.498,	-.100,
3/ 4,	.175,	.054,	-.280,	-.012,	-.443,	.147,	-.209,	.201,	-.041,	-.153,
4/ 5,	-.132,	.133,	-.300,	-.241,	-.167,	.014,	-.228,	-.051,	-.075,	-.055,
5/ 6,	-.236,	.020,	.012,	-.074,	.208,	-.072,	.081,	-.154,	-.130,	.084,
6/ 7,	-.070,	-.244,	.107,	-.186,	.085,	-.459,	-.055,	-.050,	.416,	.146,
7/ 8,	-.501,	-.701,	-.311,	-.057,	-.548,	-.681,	-.216,	-.133,	-.866,	-.033,
TOT ,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years,	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93,	TOT,	WTS,
1/ 2,	-1.168,	1.678,	2.423,	.216,	2.107,	-2.898,	1.282,	-.270,	.286,	1.580,	.000,	.125,
2/ 3,	.247,	.611,	.024,	.021,	-.048,	-.603,	-.299,	.331,	.254,	.308,	.000,	.294,
3/ 4,	.166,	.610,	-.082,	-.043,	.005,	.341,	-.541,	.255,	-.127,	.070,	.000,	.550,
4/ 5,	.210,	.097,	-.397,	-.100,	-.280,	.250,	.021,	.047,	-.342,	.026,	.000,	.914,
5/ 6,	-.110,	-.381,	.129,	.293,	-.045,	.090,	.055,	-.020,	.026,	-.150,	.000,	1.000,
6/ 7,	-.040,	-.104,	-.035,	-.250,	-.172,	.135,	-.210,	-.145,	.332,	-.110,	.000,	.769,
7/ 8,	-.175,	-.884,	-.007,	-.048,	.456,	-.179,	.785,	-.290,	-.021,	-.290,	.000,	.399,
TOT ,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	19.830,	
WTS ,	.001,	.001,	.001,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)

,	1970,	1971,	1972,	1973,
F-values,	.2235,	.1897,	.2648,	.3470,

,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
F-values,	.5088,	.5417,	.6555,	.4257,	.3396,	.3525,	.4874,	.3773,	.2936,	.4719,

,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
F-values,	.2452,	.2205,	.2173,	.4135,	.2540,	.2226,	.2795,	.2609,	.2483,	.3000,

Selection-at-age (S)

,	1,	2,	3,	4,	5,	6,	7,	8,
S-values,	.0047,	.3125,	.7689,	1.0000,	1.0871,	1.2743,	1.3748,	1.2000,

Table 6.5.2

Run title : Herring West of Ireland & Porcupine Bank & lower part of VIa (Fish (run name: VI,

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Table 17 Summary (with SOP correction)

Traditional vpa Terminal populations from weighted Separable populations

	RECRUITS,	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 3- 7,
1970,	392140,	174578,	103027,	20306,	.1971,	.8968,	.2180,
1971,	790735,	199113,	93238,	15044,	.1614,	.8707,	.1993,
1972,	708064,	213678,	102206,	23474,	.2297,	.8975,	.2723,
1973,	511222,	248716,	135836,	36719,	.2703,	1.0162,	.3273,
1974,	560450,	200585,	88730,	36589,	.4124,	.9762,	.4954,
1975,	382413,	191788,	91418,	38764,	.4240,	1.1237,	.5268,
1976,	645157,	184308,	64713,	32767,	.5063,	1.0472,	.6251,
1977,	537094,	171258,	72014,	20567,	.2856,	1.0778,	.3933,
1978,	961521,	216169,	70940,	19715,	.2779,	1.0161,	.3146,
1979,	884927,	248018,	98409,	22608,	.2297,	1.0664,	.3540,
1980,	477720,	196544,	97365,	30124,	.3094,	.9636,	.5066,
1981,	593051,	205863,	96392,	24922,	.2585,	1.0312,	.3871,
1982,	639716,	208500,	98876,	19209,	.1943,	1.0301,	.2945,
1983,	2097720,	389788,	93008,	32988,	.3547,	1.0042,	.4813,
1984,	890527,	314321,	159441,	27450,	.1722,	.9688,	.2554,
1985,	1149604,	313240,	157097,	23343,	.1486,	.9846,	.2398,
1986,	910621,	332972,	192931,	28785,	.1492,	1.0002,	.2397,
1987,	3228050,	531823,	163108,	48600,	.2980,	.9488,	.4834,
1988,	427529,	393170,	272607,	29100,	.1067,	.9992,	.3177,
1989,	785368,	363537,	204001,	29210,	.1432,	1.0010,	.2412,
1990,	1083197,	358307,	180347,	43969,	.2438,	1.0006,	.3037,
1991,	564902,	283496,	172848,	37700,	.2181,	.9971,	.2784,
1992,	1253496,	312314,	142387,	31856,	.2237,	.9951,	.2582,
1993,	214009,	249443,	169129,	36763,	.2174,	1.0060,	.3454,
Arith. Mean	862051,	270897,	130003,	29607,	.2513		.3483,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 7.1.1 HERRING. Total catches (t) in North Irish Sea (Division VIIa, North), 1980-1993 as reported to the Working Group.

Country	1980	1981	1982	1983	1984	1985	1986
France	1	-	-	48	-	-	-
Ireland	1,340	283	300	860	1,084	1,000	1,640
UK	9,272	4,094	3,375	3,025	2,982	4,077	4,376
Unallocated	-	-	1,180	-	-	4,110	1,424
Total	10,613	4,377	4,855	3,933	4,066	9,187	7,440

Country	1987	1988	1989	1990	1991	1992	1993
France	-	-	-	-	-	-	-
Ireland	1,200	2,579	1,430	1,699	80	406	0
UK	3,290	7,593	3,532	4,613	4,318	4,864	4,408
Unallocated	1,333	-	-	-	-	-	-
Total	5,823	10,172	4,962	6,312	4,398	5,270	4,408

Table 7.1.2 HERRING. Sampling intensity of commercial landings for Division VIIa (N) in 1993.

Quarter	Country	Landings (t)	No. samples	No. fish measured	No. fish aged	Estimation of discards
1	Ireland	0	-	-	-	-
	UK (N.Ireland)	1	0	0	0	No
	UK (Isle of	0	-	-	-	-
	Man)	0	-	-	-	-
	UK (Scotland)					
2	Ireland	0	-	-	-	-
	UK (N.Ireland)	28	0	0	0	No
	UK (Isle of	72	1	214	50	No
	Man)	0	-	-	-	-
	UK (Scotland)					
3	Ireland	0	5*	1,378	245	No
	UK (N.Ireland)	2,083	34	3,744	832	No
	UK (Isle of	704	8	1,346	398	No
	Man)	0	-	-	-	-
	UK (Scotland)					
4	Ireland	0	-	-	-	-
	UK (N.Ireland)	1,520	0	0	0	No
	UK (Isle of	0	-	-	-	-
	Man)	0	-	-	-	-
	UK (Scotland)					

* Samples from NI landings

Table 7.1.3 Herring in the North Irish Sea (Manx plus Mourne herring, Division VIIa (N)).

Herring in the North Irish Sea (Manx plus Mourne herring)

Catch in Numbers (Thousands)

(CANUM)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8
1972	40640	46660	26950	13180	13750	6760	2660	1670
1973	42150	32740	38240	11490	6920	5070	2590	2600
1974	43250	109550	39750	24510	10650	4990	5150	1630
1975	33330	48240	39410	10840	7870	4210	2090	1640
1976	34740	56160	20780	15220	4580	2810	2420	1270
1977	30280	39040	22690	6750	4520	1460	910	1120
1978	15540	36950	13410	6780	1740	1340	670	350
1979	11770	38270	23490	4250	2200	1050	400	290
1980	5840	25760	19510	8520	1980	910	360	230
1981	5050	15790	3200	2790	2300	330	290	240
1982	5100	16030	5670	2150	330	1110	140	380
1983	1305	12162	5598	2820	445	484	255	59
1984	1168	8424	7237	3841	2221	380	229	479
1985	2429	10050	17336	13287	7206	2651	667	724
1986	4491	15266	7462	8550	4528	3198	1464	877
1987	2225	12981	6146	2998	4180	2777	2328	1671
1988	2607	21250	13343	7159	4610	5084	3232	4213
1989	1156	6385	12039	4708	1876	1255	1559	1956
1990	2313	12835	5726	9697	3598	1661	1042	1615
1991	1999	9754	6743	2833	5068	1493	719	815
1992	12145	6885	6744	6690	3256	5122	1036	392
1993	646	14636	3008	3017	2903	1606	2181	848

Table 7.1.4 HERRING in Division VIIa (North). Catch at length for 1988-1993. Numbers of fish in thousands.

Length	1988	1989	1990	1991	1992	1993
14	1					
	1					
15	1				95	
	10				169	
16	13		6		343	
	16		6	2	275	
17	29		50	1	779	
	44	24	7	4	1,106	
18	46	44	224	31	1,263	
	85	43	165	56	1,662	
19	247	116	656	168	1,767	39
	306	214	318	174	1,189	75
20	385	226	791	454	1,268	75
	265	244	472	341	705	57
21	482	320	735	469	705	130
	530	401	447	296	597	263
22	763	453	935	438	664	610
	1,205	497	581	782	927	1,224
23	2,101	612	2,400	1,790	1,653	2,016
	3,573	814	1,908	1,974	1,156	2,368
24	5,046	1,183	3,474	2,842	1,575	2,895
	5,447	1,656	2,818	2,311	2,412	2,616
25	5,276	2,206	4,803	2,734	2,792	2,207
	4,634	2,720	3,688	2,596	3,268	2,198
26	4,082	3,555	4,845	3,278	3,865	2,216
	4,570	3,293	3,015	2,862	3,908	2,176
27	4,689	2,847	3,014	2,412	3,389	2,299
	4,124	2,018	1,134	1,449	2,203	2,047
28	3,406	1,947	993	922	1,440	1,538
	2,916	1,586	582	423	569	944
29	2,659	1,268	302	293	278	473
	1,740	997	144	129	96	160
30	1,335	801	146	82	70	83
	685	557	57	36	36	15
31	563	238	54	12	2	4
	144	128	31	3		
32	80	57	29			
	7	7				
33	2	5				
	1	6				
34		0				
		5				

Table 7.2.1 HERRING in Division VIIa (North). Mean length at age.

Year	Lengths at age (cm)							
	Age (rings)							
	1	2	3	4	5	6	7	8
1985	22.1	24.3	26.1	27.6	28.3	28.6	29.5	30.1
1986	19.7	24.3	25.8	26.9	28.0	28.8	28.8	29.8
1987	20.0	24.1	26.3	27.3	28.0	29.2	29.4	30.1
1988	20.2	23.5	25.7	26.3	27.2	27.7	28.7	29.6
1989	20.9	23.8	25.8	26.8	27.8	28.2	28.0	29.5
1990	20.1	24.2	25.6	26.2	27.7	28.3	28.3	29.0
1991	20.5	23.8	25.4	26.1	26.8	27.3	27.7	28.7
1992	19.0	23.7	25.3	26.2	26.7	27.2	27.9	29.4
1993	21.6	24.1	25.9	26.7	27.2	27.6	28.0	28.7

Table 7.2.2 HERRING in Division VIIa (North). Mean weights at age.

Year	Weights at age (g)							
	Age (rings)							
	1	2	3	4	5	6	7	8
1976-1983	74	155	195	219	232	251	258	278
1984	76	142	187	213	221	243	240	273
1985	87	125	157	186	202	209	222	258
1986	68	143	167	188	215	229	239	254
1987	58	130	160	175	194	210	218	229
1988	70	124	160	170	180	198	212	232
1989	81	128	155	174	184	195	205	218
1990	77	135	163	175	188	196	207	217
1991	70	121	153	167	180	189	195	214
1992	61	111	136	151	159	171	179	191
1993	88	126	157	171	183	191	198	214

Table 7.3.1 Indices of abundance of 0- and 1-ring herring from ground surveys in the western and eastern Irish Sea. Mean catch with coefficients of variation (in parentheses) are given. n/a = not available.

Year class	September 0-ring	March 1-ring	June 1-ring	September 1-ring
		Western Irish Sea		
1989	n/a		420 (0.49)	104 (0.35)
1990	56 (0.42)	407 (0.51)	365 (0.40)	39 (0.53)
1991	234 (0.48)	1829 (0.35)	439 (0.42)	114 (0.54)
1992	660 (0.52)			
		Eastern Irish Sea		
1989	n/a		n/a	n/a
1990	n/a	63 (0.58)	40 (0.79)	15 (0.46)
1991	114 (0.62)	89 (0.37)	22 (0.56)	2 (0.56)
1992	246 (0.54)			

Table 7.3.2 Larval production (10^{11}) indices for Division VIIa(N).

Year	Douglas Bank	North east of the Isle of Man
1989	3.39	
1990	1.92	
1991	1.56	
1992	15.64	128.86
1993	4.81	1.10

Table 7.4.1

Title : Herring in the North Irish Sea (Manx plus Mourne herring) (run name: ISFINAL)

At 24-Mar-94 17:37

Separable analysis
from 1972 to 1993 on ages 1 to 7
With Terminal F of .170 on age 5 and Terminal S of 1.000

Initial sum of squared residuals was 136.503 and
final sum of squared residuals is 17.491 after 57 iterations

Matrix of Residuals

Years,	1972/73,
Ages	
1/ 2,	1.358,
2/ 3,	-.545,
3/ 4,	.013,
4/ 5,	-.246,
5/ 6,	.097,
6/ 7,	-.015,
TOT ,	-.005,
WTS ,	.001,

Years,	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83,
1/ 2,	.803,	.949,	.744,	.963,	.827,	.305,	.453,	-.490,	-.145,	.076,
2/ 3,	-.316,	.019,	.078,	-.101,	.038,	-.341,	-.108,	.576,	.254,	.281,
3/ 4,	.219,	.149,	.045,	-.038,	.032,	.224,	.096,	.311,	-.435,	-.117,
4/ 5,	-.198,	-.083,	-.109,	-.020,	.112,	.139,	-.218,	-.390,	1.261,	.725,
5/ 6,	.043,	-.304,	.047,	-.104,	-.041,	-.494,	-.111,	.080,	-.154,	-1.241,
6/ 7,	-.357,	-.423,	-.486,	-.178,	-.541,	.148,	.017,	-.647,	-.109,	.524,
TOT ,	-.005,	-.002,	.000,	.002,	.004,	.009,	.019,	.037,	.060,	.048,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years,	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93,	TOT,	WTS,
1/ 2,	-.498,	.145,	-.604,	.044,	-.261,	-.070,	-.736,	-.331,	.391,	.735,	-.005,	.264,
2/ 3,	.216,	-.108,	-.236,	.277,	.247,	-.394,	.065,	.014,	.289,	.030,	.006,	.574,
3/ 4,	.039,	-.037,	.111,	.227,	.068,	.016,	.124,	.022,	-.118,	-.039,	.005,	1.000,
4/ 5,	-.128,	-.089,	.442,	-.006,	-.243,	.272,	.143,	-.069,	-.298,	-.044,	.005,	.415,
5/ 6,	-.217,	.356,	.169,	-.241,	-.017,	.224,	-.013,	.153,	-.178,	-.180,	.005,	.484,
6/ 7,	.284,	-.109,	-.132,	-.498,	-.049,	.020,	-.030,	.025,	.115,	-.122,	.005,	.545,
TOT ,	.029,	.015,	.009,	.007,	.005,	.004,	.003,	.003,	.003,	.001,	2.068,	
WTS ,	.001,	.001,	.001,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)

,	1972,	1973,
F-values,	.6267,	.5338,

,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
F-values,	.9794,	.8836,	1.0233,	.9753,	.8390,	.8664,	.9494,	.4165,	.2801,	.1680,

,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
F-values,	.1519,	.3787,	.3233,	.2339,	.4435,	.2453,	.3218,	.2335,	.2897,	.1700,

Selection-at-age (S)

,	1,	2,	3,	4,	5,	6,	7,
S-values,	.0890,	.8223,	1.0000,	1.0865,	1.0962,	1.0987,	1.0000,

Table 7.4.2

Run title : Herring in the North Irish Sea (Manx plus Mourne herring) (run name: ISFINAL)

At 24-Mar-94 17:37

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR,	1972,	1973,
AGE		
1,	.1668,	.1042,
2,	.3624,	.3459,
3,	.5354,	.6162,
4,	.5512,	.4355,
5,	.6497,	.5563,
6,	.6821,	.4674,
7,	.6244,	.5355,
+gp,	.6244,	.5355,
FBAR 2- 6,	.5561,	.4842,

Table 8 Fishing mortality (F) at age

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
1,	.2140,	.1526,	.2292,	.1569,	.1025,	.1412,	.0609,	.0385,	.0349,	.0088,
2,	.8241,	.7524,	.7952,	.8544,	.5311,	.7416,	1.0529,	.4093,	.2836,	.1843,
3,	1.0226,	.9055,	.9770,	1.0040,	.9167,	.8505,	1.2711,	.3627,	.2679,	.1601,
4,	1.0115,	.8446,	1.0957,	.9964,	.9323,	.8164,	.8434,	.5681,	.4194,	.1963,
5,	.8148,	.9704,	.9652,	1.0607,	.6695,	.8050,	1.0464,	.5045,	.1058,	.1272,
6,	.8953,	.7985,	1.0396,	.8513,	.9654,	1.0051,	.8330,	.4186,	.4310,	.1993,
7,	1.0952,	1.1063,	1.4796,	1.0618,	1.1377,	.7705,	1.0671,	.6138,	.2797,	.1475,
+gp,	1.0952,	1.1063,	1.4796,	1.0618,	1.1377,	.7705,	1.0671,	.6138,	.2797,	.1475,
FBAR 2- 6,	.9137,	.8543,	.9746,	.9534,	.8030,	.8437,	1.0094,	.4526,	.3015,	.1735,

Table 8 Fishing mortality (F) at age

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	FBAR 91-93
AGE											
1,	.0140,	.0255,	.0397,	.0121,	.0352,	.0103,	.0251,	.0296,	.0414,	.0151,	.0287,
2,	.1205,	.2740,	.3871,	.2637,	.2616,	.1915,	.2590,	.2390,	.2295,	.1070,	.1918,
3,	.1687,	.4120,	.3587,	.2824,	.5080,	.2465,	.2792,	.2237,	.2750,	.1572,	.2186,
4,	.1494,	.4973,	.3477,	.2263,	.5836,	.3193,	.3042,	.2057,	.3419,	.1806,	.2427,
5,	.2092,	.4057,	.2785,	.2547,	.5626,	.2615,	.3820,	.2301,	.3421,	.2177,	.2633,
6,	.1370,	.3661,	.2819,	.2456,	.4929,	.2585,	.3457,	.2403,	.3406,	.2517,	.2775,
7,	.1226,	.3346,	.3146,	.3038,	.4424,	.2437,	.3155,	.2204,	.2336,	.2122,	.2220,
+gp,	.1226,	.3346,	.3146,	.3038,	.4424,	.2437,	.3155,	.2204,	.2336,	.2122,	
FBAR 2- 6,	.1570,	.3910,	.3308,	.2545,	.4817,	.2555,	.3140,	.2277,	.3058,	.1828,	

Table 7.4.3

Run title : Herring in the North Irish Sea (Manx plus Mourne herring) (run name: ISFINAL)

At 24-Mar-94 17:37

Traditional vpa Terminal populations from weighted Separable populations

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1972,	1973,
AGE		
1,	412719,	667819,
2,	176087,	128499,
3,	71095,	90796,
4,	32535,	34077,
5,	30080,	16963,
6,	14286,	14214,
7,	5988,	6535,
+gp,	3759,	6561,
TOTAL,	746549,	965465,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
1,	349018,	367985,	263342,	325752,	250170,	139742,	155616,	210796,	234391,	234904,
2,	221355,	103662,	116217,	77034,	102440,	83064,	44637,	53866,	74618,	83268,
3,	67361,	71926,	36188,	38871,	24286,	44619,	29312,	11538,	26502,	41629,
4,	40144,	19836,	23811,	11154,	11661,	7950,	15605,	6733,	6573,	16599,
5,	19948,	13210,	7713,	7202,	3726,	4154,	3180,	6075,	3451,	3910,
6,	8800,	7991,	4529,	2658,	2256,	1726,	1680,	1010,	3319,	2810,
7,	8059,	3252,	3254,	1449,	1027,	778,	572,	661,	602,	1952,
+gp,	2551,	2552,	1708,	1784,	536,	564,	365,	547,	1633,	452,
TOTAL,	717235,	590415,	456762,	465904,	396101,	282596,	250967,	291225,	351088,	385522,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	AMST
AGE												
1,	132877,	152063,	182136,	292145,	118828,	177652,	147184,	108195,	471830,	67992,	0,	2461
2,	85657,	48204,	54530,	64399,	106180,	42201,	64682,	52802,	38642,	166532,	24637,	891
3,	51305,	56255,	27151,	27432,	36650,	60557,	25814,	36983,	30803,	22756,	110853,	438
4,	29040,	35486,	30504,	15529,	16933,	18054,	38749,	15987,	24210,	19155,	15921,	213
5,	12342,	22629,	19527,	19495,	11206,	8548,	11871,	25865,	11776,	15563,	14468,	125
6,	3115,	9059,	13646,	13374,	13674,	5776,	5954,	7331,	18594,	7568,	11327,	68
7,	2083,	2458,	5684,	9314,	9466,	7558,	4036,	3813,	5217,	11968,	5324,	39
+gp,	4356,	2668,	3405,	6686,	12339,	9483,	6255,	4322,	1974,	4653,	12164,	
TOTAL,	320776,	328822,	336584,	448372,	325275,	329829,	304546,	255297,	603045,	316188,	194695,	

Table 7.4.4

Run title : Herring in the North Irish Sea (Manx plus Mourne herring) (run name: ISFINAL) ,

At 24-Mar-94 17:37

Table 17 Summary (with SOP correction)

,	Traditional vpa RECRUITS,	TOTALBIO,	Terminal populations from weighted Separable populations TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 2- 6,
1972,	412719,	103019,	36442,	27350,	.7505,	1.1200,	.5561,
1973,	667819,	106289,	31661,	22600,	.7138,	1.0073,	.4842,
1974,	349018,	91300,	23526,	38640,	1.6425,	.9958,	.9137,
1975,	367985,	70060,	16714,	24500,	1.4658,	1.0260,	.8543,
1976,	263342,	55619,	12244,	21250,	1.7356,	.9927,	.9746,
1977,	325752,	47001,	8880,	15410,	1.7354,	.9538,	.9534,
1978,	250170,	40231,	10100,	11080,	1.0970,	.9243,	.8030,
1979,	139742,	32920,	9154,	12338,	1.3479,	.9296,	.8437,
1980,	155616,	28110,	5650,	10613,	1.8784,	.9701,	1.0094,
1981,	210796,	26965,	7157,	4377,	.6116,	.9092,	.4526,
1982,	234391,	37145,	12559,	4855,	.3866,	.9837,	.3015,
1983,	234904,	43566,	18453,	3933,	.2131,	.9838,	.1735,
1984,	132877,	41586,	23110,	4066,	.1759,	.9623,	.1570,
1985,	152063,	43241,	18260,	9187,	.5031,	1.0202,	.3910,
1986,	182136,	39068,	17326,	7440,	.4294,	.9767,	.3308,
1987,	292145,	44200,	18162,	5823,	.3206,	1.0382,	.2545,
1988,	118828,	41895,	18848,	10172,	.5397,	1.0521,	.4817,
1989,	177652,	38768,	17017,	4949,	.2908,	1.0034,	.2555,
1990,	147184,	37123,	16722,	6312,	.3775,	1.0130,	.3140,
1991,	108195,	30018,	15642,	4398,	.2812,	1.0006,	.2277,
1992,	471930,	47803,	13303,	5270,	.3961,	1.0111,	.3058,
1993,	67992,	42025,	24553,	4409,	.1796,	1.0133,	.1828,
Arith. Mean ,	248325,	49361,	17067,	11771,	.7760		.5100,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 7.5.1

Herring in the North Irish Sea (Manx plus Mourne herring)

Single option prediction: Input data

Year: 1994								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	156586.00	1.0000	0.0800	0.9000	0.7500	0.088	0.0890	0.089
2	24637.000	0.3000	0.8500	0.9000	0.7500	0.126	0.8223	0.127
3	110853.00	0.2000	1.0000	0.9000	0.7500	0.157	1.0000	0.157
4	15921.000	0.1000	1.0000	0.9000	0.7500	0.171	1.0865	0.171
5	14468.000	0.1000	1.0000	0.9000	0.7500	0.183	1.0962	0.182
6	11327.000	0.1000	1.0000	0.9000	0.7500	0.191	1.0987	0.191
7	5324.000	0.1000	1.0000	0.9000	0.7500	0.198	1.0000	0.198
8+	12164.000	0.1000	1.0000	0.9000	0.7500	0.214	1.0000	0.212
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Table 7.5.2

Herring in the North Irish Sea (Manx plus Mourne herring)

Herring in the North Irish Sea (Manx plus Mourne herring)

Single option prediction: Detailed tables

Year: 1994 F-factor: 0.2634 Reference F: 0.2689

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0234	2298	205	156586	13780	12527	1102	5794	510
2	0.2166	4168	529	24637	3104	20941	2639	13760	1734
3	0.2634	23369	3669	110853	17404	110853	17404	75274	11818
4	0.2862	3780	646	15921	2722	15921	2722	11417	1952
5	0.2888	3461	630	14468	2648	14468	2648	10351	1894
6	0.2894	2715	519	11327	2163	11327	2163	8099	1547
7	0.2634	1176	233	5324	1054	5324	1054	3897	772
8+	0.2634	2687	570	12164	2603	12164	2603	8903	1905
Total		43653	7000	351280	45479	203525	32336	137494	22132
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Herring in the North Irish Sea (Manx plus Mourne herring)

Herring in the North Irish Sea (Manx plus Mourne herring)

Single option prediction: Detailed tables

Year: 1994 F-factor: 0.1616 Reference F: 0.1649

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0144	1415	126	156586	13780	12527	1102	5841	514
2	0.1329	2657	337	24637	3104	20941	2639	14837	1870
3	0.1616	15030	2360	110853	17404	110853	17404	82499	12952
4	0.1755	2443	418	15921	2722	15921	2722	12612	2157
5	0.1771	2238	407	14468	2648	14468	2648	11445	2094
6	0.1775	1756	335	11327	2163	11327	2163	8957	1711
7	0.1616	757	150	5324	1054	5324	1054	4271	846
8+	0.1616	1729	367	12164	2603	12164	2603	9758	2088
Total		28025	4500	351280	45479	203525	32336	150220	24232
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Table 8.1.1 Sprat catches in the North Sea ('000 t), 1982-1993. Catches in fjords of western Norway excluded. (Data provided by Working Group members except where indicated.)

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993[1]
Division IVa West												
Denmark	-	-	-	0.9	0.6	0.2	0.1	+	-		0.26	0.6
Germany	-	-	-	-	-	-	-	-	-		-	-
Netherlands	-	-	-	6.7	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	0.1	-	-
UK (Scotland)	+	-	+	6.1	+	+	-	-	+	-	-	-
Total	+	-	+	13.7	0.6	0.2	0.1	+	+	0.1	0.26	0.6
Division IVa East (North Sea) stock												
Denmark	+	-	-	+	0.2	+	+	+	-	-	-	+
Norway	0.3	-	-	-	-	-	-	-	-	-	0.54	2.5
Sweden	-	-	-	-	-	-	-	-	+[5]	2.5	-	-
Total	0.3	-	-	+	0.2	+	+	+	+	2.5	0.64	2.5
Division IVb West												
Denmark	23.1	32.6	5.6	1.8	0.4	3.4	1.4	2.0	10.0	9.4	19.9	13.0
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-
Norway	10.2	0.9	0.5	-	-	-	3.5	0.1	1.2	4.4	18.4	16.8
UK (England)	-	-	+	-	-	-	-	-	-	-	0.48	0.5
UK (Scotland)	0.2	+	+	-	-	0.1	-	-	-	-	-	0.5
Total	33.5	33.5	6.1	1.8	0.4	3.5	4.9	2.1	11.2	13.8	38.26	30.5
Division IVb East												
Denmark	91.2	39.2	62.1	36.6	10.3	28.0	80.7	59.2	59.2	67.0	66.56	136.2
Germany	1.5	-	0.6	0.6	0.6[3]	-	-	-	-	-	-	-
Norway	7.6	10.8	3.1	-	-	-	0.6	-	0.6	25.1	9.5	24.1
Sweden	-	-	-	-	-	-	-	-	+[2]	+[2]	-	-
Total	100.3	50.0	65.8	37.2	10.9	28.0	81.3	59.2	59.8	92.1	76.49	160.3
Division IVc												
Belgium	-	-	-	+	+	+	-	+[2]	+[2]	+[2]	-	-
Denmark	2.4	1.0	0.5	+	0.1	+	0.1	0.5	1.5	1.7	2.49	3.5
France	-	-	-	-	+	-	-	+[2]	-	+[2]	-	+
Netherlands	-	-	0.1	-	-	-	0.4	0.4[2,3]	-	+[2,3]	-	-
Norway	2.2	0.5	3.4	-	-	-	-	-	-	-	-	0.4
UK (England)	14.9	3.6	0.9	3.4	4.1	0.7	0.6	0.9	0.2	1.8	6.12[1]	2.0
Total	20.1	5.1	4.9	3.4	4.3	0.7	1.1	1.8	1.7	3.5	8.61	5.9
Total North Sea												
Belgium	-	-	-	+	+	+	-	+	+[2]	+[2]	-	-
Denmark	116.6	72.6	68.1	39.5	11.7	31.7	82.3	61.9	69.2	78.1	89.1	153.3
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-
France	-	-	-	-	+	-	-	+	-	+[2,3]	-	+
Germany	1.5	-	0.6	-	0.6	-	-	-	-	-	-	-
Netherlands	-	-	0.1	0.6	-	0.5	0.4	0.4	-	+[2,3]	-	-
Norway	20.6	12.0	7.0	6.1	-	-	4.1	0.1	1.8	29.6	28.5	43.8
Sweden	-	-	-	-	-	-	-	-	+[2]	+[2]	-	0.1
UK (England)	14.9	3.6	0.9	3.4	4.1	0.7	0.6	0.9	0.2	1.8	6.6	2.6
UK (Scotland)	0.2	+	+	-	+	0.2	-	-	+	-	-	0.5
Total	153.8	88.4	76.7	49.6	16.4	33.1	87.4	63.3	71.2	109.5	124.2	200.3

[1]Preliminary. [2]Official statistics. [3]Includes Divisions IVa-c. [5]Includes Division IVb East.
+ = less than 0.1. - = magnitude known to be nil.

Table 8.1.2 Sprat catches ('000 t) in the fjords of western Norway, 1983-1993.

1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3.2	4.4	7.1	2.2	8.3	-[1]	2.4	2.7	3.2	3.8	1.9

[1]Not available.

Table 8.1.3 Sprat catches (t) in the North Sea by quarter in 1986, 1987, 1988 (Denmark and the UK), 1989 (Denmark, Norway and the UK), 1990 (Denmark and Norway), and 1991, 1992 (Denmark, Norway and the UK) and 1993 (Denmark, Norway, Sweden and UK). Catches in fjords of western Norway excluded.

Year	Quarter	Area					Total
		IVa West	IVa East (North Sea stock)	IVb West	IVb East	IVc	
1986	1	282	123	104	2,899	4,134	7,542
	2	5	39	206	5,048	22	5,320
	3	3	10	6	389	9	417
	4	373	63	80	2,005	51	2,571
Total		663	235	396	10,341	4,216	15,851
1987	1	70	10	148	17	564	809
	2	-	7	118	3,297	57	3,479
	3	-	6	65	6,999	46	7,116
	4	98	-	3,191	16,456	17	19,762
Total		168	23	3,522	26,769	684	31,166
1988	1	-	-	5	206	529	740
	2	-	-	229	682	28	949
	3	-	11	4,682	72,317	73	77,083
	4	55	-	651	7,529	31	8,266
Total		55	11	5,567	80,734	621	87,028
1989	1	-	39	1,127	14,702	1,231	17,099
	2	-	-	241	242	14	497
	3	31	-	784	43,190	110	44,115
	4	10	-	2	1,092	101	1,205
Total		41	39	2,154	59,226	1,456	62,916
1990	1	-	-	222	4,896	-	5,118
	2	-	-	426	320	39	785
	3	-	-	6,759	31,054	10	37,823
	4	-	-	3,812	23,565	1,420	28,797
Total		-	-	11,219	59,835	1,469	72,523
1991	1	-	-	31	899	1,117	2,047
	2	-	-	55	87	1	143
	3	144	-	9,038	58,312	-	67,494
	4	-	-	4,821	33,389	-	38,210
Total		144	-	13,945	92,687	1,118	107,894
1992	1	1	-	19	404	5,234	5,658
	2	-	-	164	2,223	4	2,391
	3	252	-	26,736	62,248	869	90,105
	4	8	635	11,370	11,586	2,500	26,099
Total		261	635	38,289	76,461	8,607	124,253
1993	1	1	2,478	22,448	18,246	3,916	47,089
	2	5	-	278	4,280	10	4,573
	3	682	-	9,926	65,410	991	77,009
	4	-	-	8,014	60,887	1,964	70,865
Total		688	2,478	40,666	148,823	6,881	199,536

Table 8.2.1 North Sea Sprat. Catch in numbers (millions) taken by quarter in 1989 to 1993 by Denmark, Norway, and UK (England).

Country	Fishing area	Quarter	Age					
			0	1	2	3	4	5
1989								
Denmark	North Sea	1	-	551.35	864.77	21.57	-	-
	(Sub-area IV)	2	-	12.00	18.81	0.47	-	-
		3	60.04	2,026.65	2,120.30	273.77	-	-
		4	1.52	51.31	53.69	6.93	-	-
UK (Engl.)	(Thames + Wash)	1	-	11.1	32.40	31.42	1.01	-
	(Division IVc)	4	0.08	5.84	0.80	0.50	-	-
Norway	(Division IVb)	2	-	0.11	0.60	4.70	0.05	-
1990								
Denmark	(Division IVb)	1	-	537.96	225.91	28.26	2.05	0.13
		2			No samples			
		3	-	877.98	1,164.78	-	-	-
		4			No samples			
	(Division IVc)	2-4			No samples			
Norway	(Division IVb)	2-3			No samples			
1991								
Denmark	(Division IVb)	1	-	34.39	1.98	0.22	0.04	0.04
		2	-	0.51	3.36	0.93	0.05	-
		3	9.71	664.81	1086.27	328.04	79.07	-
		4	296.05	1896.74	271.93	34.60	4.58	-
Norway	(Division IV)	3			No samples			
UK (Engl.)	Thames	1	-	12.56	49.26	17.75	0.97	0.60
	(Division IVc)	4	-	44.29	9.43	1.59	-	-
1992								
Denmark	North Sea (Division IVa)	1[1]	-	0.18	0.04	-	-	-
		3[1]	0.04	22.17	3.06	0.73	0.11	0.02
		4[1]	0.14	0.53	0.03	-	-	-
Norway	(Division IVa)	4[2]	11.3	42.77	2.4	-	-	-
Denmark	(Division IVb)	1[1]	-	7.82	1.51	0.09	-	-
		2[1]	-	239.15	37.09	12.41	1.61	-
		3[2]	9.53	5,922.07	1,151.1	259.45	29.33	5.04
		4[2]	166.87	653.57	38.86	1.83	0.47	1.40
Norway	(Division IVb)	3[2]	1.32	1,103.50	283.17	61.77	5.31	0.70
		4[2]	39.17	606.47	178.87	1.59	0.01	-
UK (England)	(Division IVb)	4[3]	5.36	19.2	7.14	2.1	0.0001	-
Denmark	(Division IVc)	1[1]	-	0.36	0.07	-	-	-
		2[1]	-	0.20	0.03	0.01	-	-
		3	-	25.22	25.64	1.9	-	-
		4	3.02	125.25	7.41	1.51	-	-
UK (England)	(Division IVc)	1[3]	-	4.19	375.9	58.2	2.16	-
UK (England)	(Division IVc)	4[3]	0.14	28.48	27.32	3.03	0.78	0.14
1993								
Denmark	(Division Vb)	1	-	564.46	1,159.78	183.19	3.15	
		4	294.46	4,262.95	638.09	47.07	0.47	
Norway	(Division IVb)	1	-	134.27	1,438.56	326.07	19.18	
UK (England)	(Division IVb)	3	-	19.97	17.29	2.32	0.17	
	(Division IVc)	1	-	5.98	170.86	59.23	2.48	
		4	0.18	5.1	1.77	0.08	-	

[1]IVb east used. [2]Danish samples from same period used. [3]Research samples used.

Table 8.2.2 North Sea Sprat quarterly mean weight (g) at age. Weight were estimated from data provided by Working Group members.

1993					
Quarter	AGE				
	0	1	2	3	4
1	-	4.2[1]	12.0[1]	14.9[1]	20.0[1]
2	-	-	-	-	-
3	-	-	-	-	-
4	2.6[2]	11.4[2]	14.2[2]	13.7[2]	

[1]Denmark, Norway and UK (England)
[2]Denmark only

Table 8.2.3 North Sea sprat. Sampling of commercial landings in 1993.

Country	Total catch ('000 t)	No. Samples	No. aged	No. measured
Denmark	153.3	81	1,209	6,832
Norway	43.8	3	100	315
Sweden	0.1	-[1]	-[1]	-[1]
UK(England)	2.6	-	-	-
UK(Scotland)	0.5			

[1]No information on sample sizes or numbers

Table 8.3.1 North Sea Sprat. Abundance indices from IBTS for the standard area for sprat (Division IVb).

Year	No. of rectangles sampled	1-Group	2-Group	3-Group	4-Group	≥5-Group	Total
1981	72	941.46	1,379.85	333.286	4.0259	0.3016	2658.93
1982	69	295.82	501.87	123.141	5.5884	0.1884	926.61
1983	81	210.04	754.08	188.451	8.1393	0.8710	1,161.59
1984	82	382.37	387.05	46.427	6.5030	0.4008	822.75
1985	81	660.12	297.67	37.306	4.2101	0.8770	1000.18
1986	81	71.36	102.75	29.041	1.3109	0.2519	204.71
1987	80	803.37	74.33	24.179	3.5246	0.2014	905.61
1988	80	148.49	1,436.80	107.168	8.5611	0.0000	1,701.01
1989	80	4,245.98	441.86	315.169	4.0471	13.2736	5,020.33
1990	80	176.81	557.41	146.421	30.0234	0.5748	911.24
1991	80	1,121.06	116.08	27.898	2.3144	1.2079	1,268.56
1992	80	1,560.54	340.17	37.831	5.4531	0.4430	1,944.44
1993	81	1,754.61	422.47	71.163	3.2936	0.0370	2,251.57
1994	80	4,013.40	1,294.30	129.300	2.4000	0.0600	5,439.58

Table 9.1.1 Nominal catch of sprat in Divisions VIId,e, 1983-1993.

Country	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993[1]
Belgium	3	-	-	-	-	-	-	-	-	-	-
Denmark	638	1,417	-	15	250	2,529	2,092	608	-	-	-
France	60	47	14	-	23	2	10	-	-	35	2
Germany	-	-	-	-	-	-	-	-	-	-	-
Netherlands	1,454	589	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-	-
UK (Engl.& Wales	4,756	2,402	3,771	1,163	2,441	2,944	1,319	1,508	2,567	1,790	1,798
Total	6,011	4,455	33,785	1,178	2,714	5,475	3,421	2,116	2,567	1,825	1,800

[1]Preliminary

Table 9.1.2 Lyme Bay area fishery monthly catches (t) (UK vessels only).

Season	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
1991/92	0	0	205	450	952	60	358	258	109	51	2443
1992/93	0	0	302	472	189	294	248	284	158	78	1719
1993/94	8	0	156	82	302	529	208	261[1]	160[1]	102[1]	1800[1]

[1]Provisional.

Table 9.2.1 Lyme Bay sprat fishery. Number caught by age group (millions).

Season	0/1	1/2	2/3	3/4	4/5	5/6
1991/92	1.7	56.03	44.69	16.24	0.57	0.03
1992/93[1]	0.22	28.23	48.61	12.94	1.56	0
1993/94[2]	0	0.83	44.81	15.70	1.95	0.58

[1]August to December only (samples in August and December only, so these are best estimates.
[2]August to December only (samples in August September and November only, so these are best estimates.

Table 9.2.2 Lyme Bay area SPRAT. 1974-1993 mean weight at age.

Season	Quarter	0/1	1/2	2/3	3/4	4/5	5/6	Overall mean
1991/91	3	4.7	16.6	22.6	25.4	29.2	34.6	20.7
	4	6.6	17.1	23	26.3	30.9		21
	1	5.7	13.3	17.5	20.2	24.1		14.4
1992/93	3	4.2	12.1	22.8	24.6	32.4		21.8
	4		15.8	20.0	23.8	24.8		21.0
	1		13.2	17.1	21.2			14.2
1993/94	3			19.1	22.2	20.8		19.8
	4[1]		14.2	18.9	24.5	28.1	25.5	20.6

[1]Based on November samples only.

Table 10.1.1 Landings of SPRAT in Division IIIa (tonnes 10^{-3}). (Data provided by Working Group members).

Year	Skagerrak				Kattegat			Div. IIIa total
	Denmark	Sweden	Norway	Total	Denmark	Sweden	Total	
1974	17.9	2.0	1.2	21.1	31.6	18.6	50.2	71.3
1975	15.0	2.1	1.9	19.0	60.7	20.9	81.6	100.6
1976	12.8	2.6	2.0	17.4	27.9	13.5	41.4	58.8
1977	7.1	2.2	1.2	10.5	47.1	9.8	56.9	67.4
1978	26.6	2.2	2.7	31.5	37.0	9.4	46.4	77.9
1979	33.5	8.1	1.8	43.4	45.8	6.4	52.2	95.6
1980	31.7	4.0	3.4	39.1	35.8	9.0	44.8	83.9
1981	26.4	6.3	4.6	37.3	23.0	16.0	39.0	76.3

Year	Skagerrak			Kattegat		Div. IIIa	Division IIIa Total
	Denmark	Sweden	Norway	Denmark	Sweden	Sweden	
1982	10.5	-	1.9	21.4	-	5.9	39.7
1983	3.4	-	1.9	9.1	-	13.0	26.4
1984	13.2	-	1.8	10.9	-	10.2	36.1
1985	1.3	-	2.5	4.6	-	11.3	19.7
1986	0.4	-	1.1	0.9	-	8.4	10.8
1987	1.4	-	0.4	1.4	-	11.2	14.4
1988	1.7	-	0.3	1.3	-	5.4	8.7
1989	0.9	-	1.1	3.0	-	4.8	9.8
1990	1.3	-	1.3	1.1	-	6.0	9.7
1991	4.2	-	1.0	2.2	-	6.6	14.0
1992	1.1	-	0.6	2.2	-	6.6	10.5
1993[1]	0.6	4.7	1.3	0.8	1.7	-	9.1

[1]Preliminary.

Table 10.1.2 Landings of sprat (1000 tonnes) by quarter by the three countries from Division IIIa. (Data provided by the Working Group members).

1992	Quarter	Denmark	Norway	Sweden
	1	1.9	0.0	2.3
	2	0.8	-	0.7
	3	0.6	0.2	0.1
	4	0.1	0.3	3.5
	Total	3.0	0.5	6.6
1993	Quarter	Denmark	Norway	Sweden
	1	0.7	0.1	1.3
	2	0.2	-	0.4
	3	0.3	0.2	0.8
	4	0.2	1.0	3.8
	Total	1.4	1.3	6.3

Table 10.2.1 Landed numbers (millions) of sprat by age groups by the Danish fleet from Division IIIa, 1992-1993.

Quarter 1992	Age						Total
	0	1	2	3	4	5+	
1	-	220.30	46.22	3.43	0.34	-	270.29
2	-	96.84	11.71	1.09	0.14	-	109.78
3	-	15.42	14.55	1.99	0.23	-	32.19
4	0.19	7.51	0.79	0.04	0.01	0.01	8.55
Total year	0.19	340.07	73.27	6.55	0.72	0.01	420.81
Quarter 1993	Age						Total
	0	1	2	3	4	5+	
1	-	46.85	36.53	4.43	0.41	-	88.22
2	-	2.37	9.00	3.60	-	-	14.97
3	0.62	12.52	8.77	0.03	-	-	21.94
4	8.29	4.81	4.09	0.12	-	-	17.31
Total year	8.91	66.55	58.39	8.18	0.41	-	142.44

Table 10.2.2 Mean weights (g) at age of sprat in Division IIIa 1993 (Danish data).

Quarter	Area	Age 0	1	2	3	4	No samples	No samples	No samples
1	Skagerrak		4	14	13		18	32	505
	Kattegat		3.5	12.9	17.7	25	7	160	396
	Division IIIa		3.6	13.2	17	25	25	192	901
2	Skagerrak						2	0	66
	Kattegat						2	0	184
	Division IIIa						4	0	250
3	Skagerrak		11.5	13.8			7	66	181
	Kattegat	3.4	14	18.7	21.3		13	157	361
	Division IIIa	3.4	11.8	14.1	21.3		20	223	542
4	Skagerrak						5	0	0
	Kattegat						3	0	53
	Division IIIa						8	0	53

Table 10.3.1 Indices of sprat, 1-group, 2-group, >=3-group and all ages in Division IIIa from IBTS, 1984-1994. (Mean no./hr per rectangle weighted by area. Only hauls taken in depths of 10-150 m are included in the estimates).

Year	No of Hauls	1-group	2-group	>=3-group	Total
1984	-	5818	861	355	7034
1985	-	2404	2426	558	5388
1986	-	670	1934	1941	4545
1987	-	2234	2219	3595	8048
1988	-	950	5527	4157	10634
1989	-	435	1012	1863	3310
1990	-	510	243	191	944
1991	-	659	468	818	1945
1992	-	5897	634	591	7122
1993[1]	45	1593	4237	1356	7186
1994	48	1494	586	1281	3361

[1]Revised.

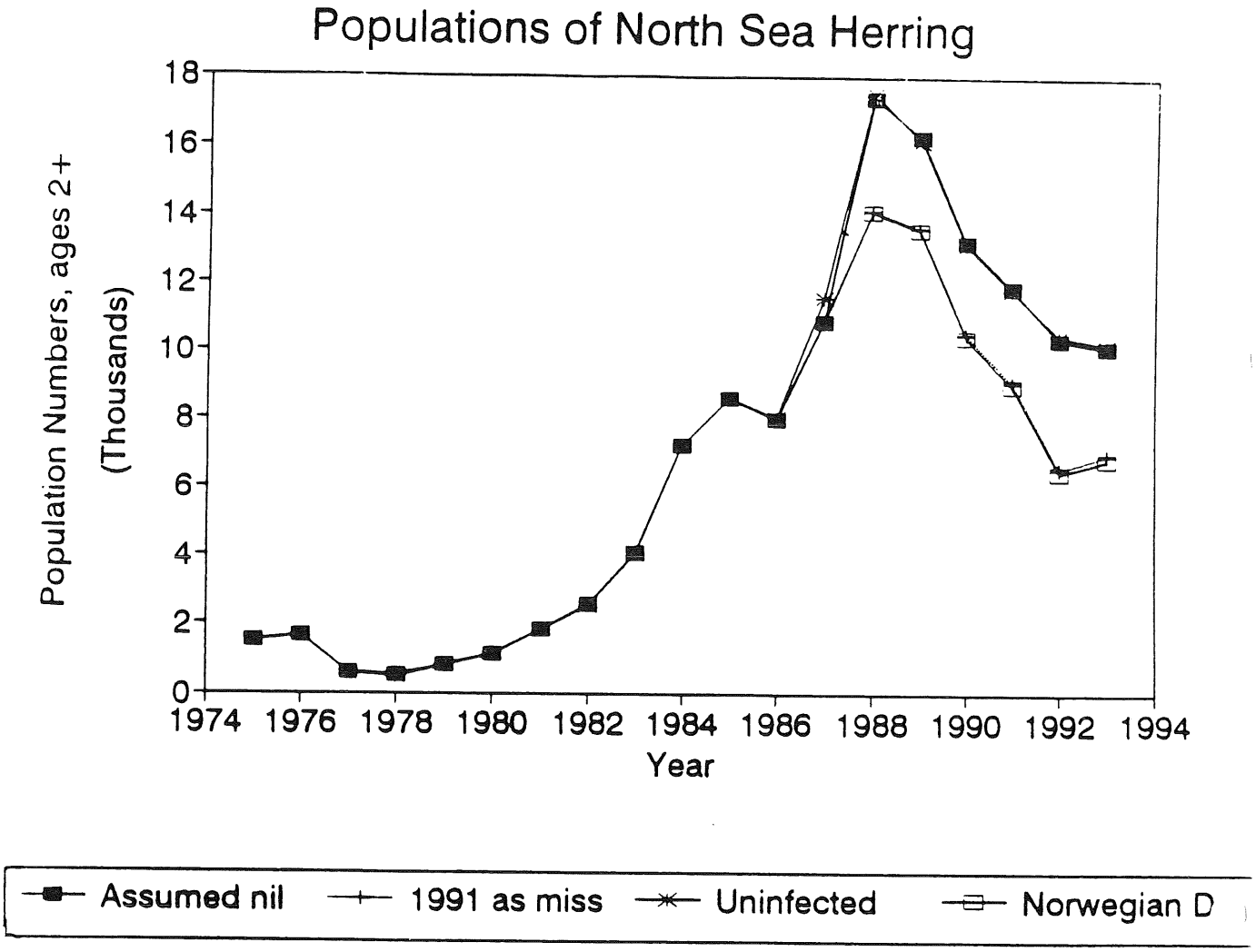


Figure 1.5.1 Preliminary results from disease dynamics model. Population trajectory of North Sea Herring estimated under four assumptions: (1) assuming no disease mortality (full squares); the next three cases are fitted to infection rates observed in the ICES-coordinated international acoustic survey in 1992 and 1993; (2) assuming no infection in 1991 (asterisks); (3) Assuming no infection in 1990 but unknown infection in 1991 (crosses); (4) Assuming no infection in 1990 but infection rates in 1991 as observed on the Autumn Norwegian trawl survey.

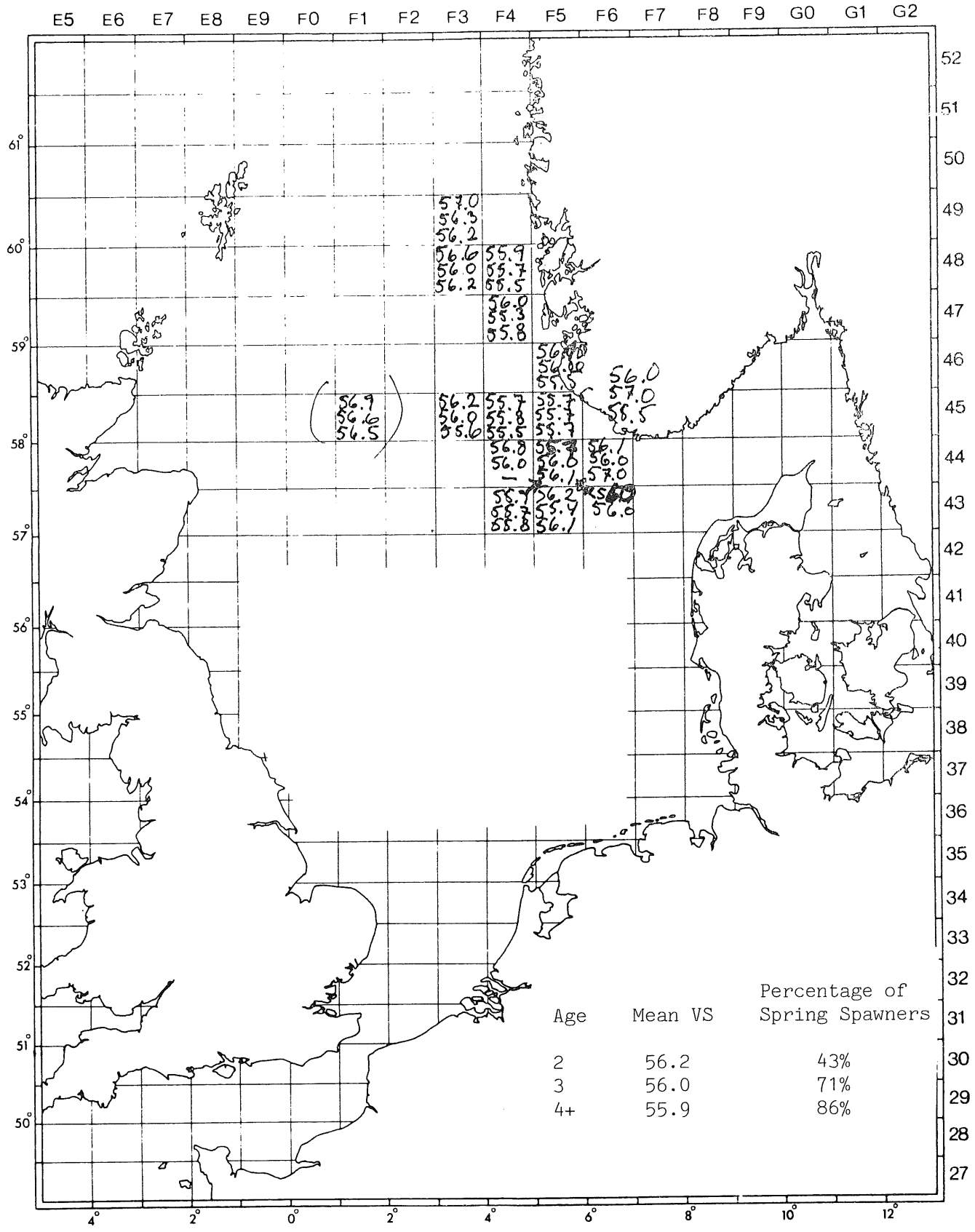


Figure 2.2.1 Mean vertebral counts of 2-, 3- and 4+ ring herring, July 1993.

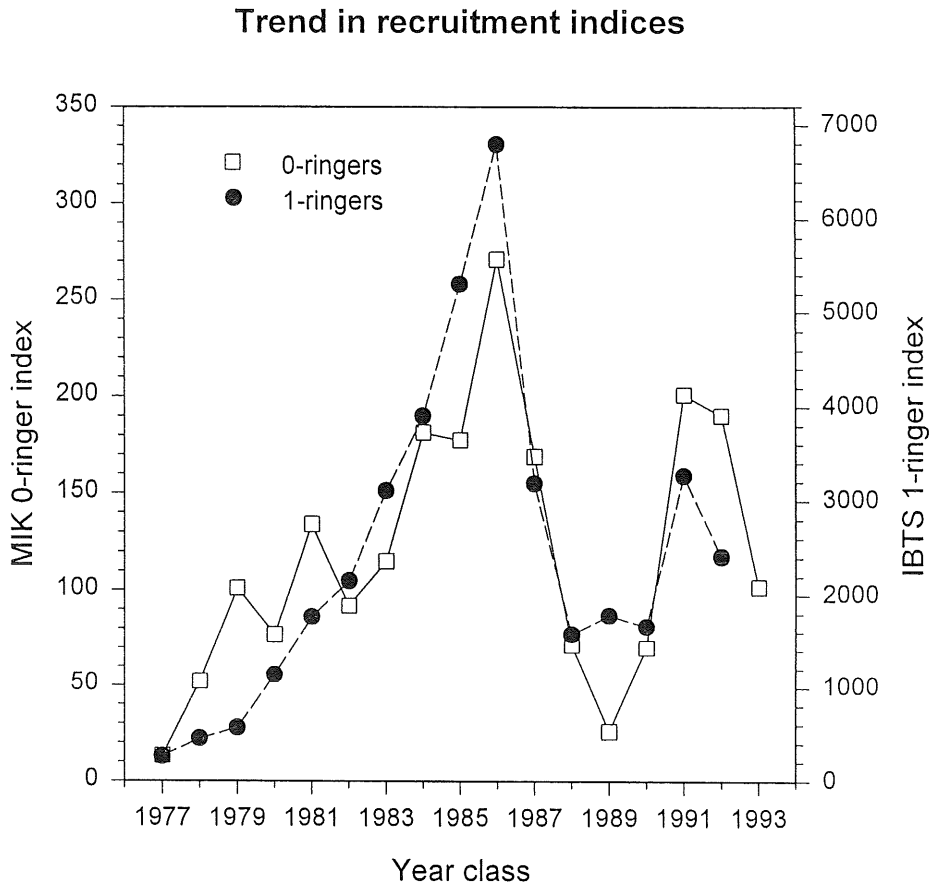


Figure 2.3.1 Trend in the MIK 0-ringer and IBTS 1-ringer indices for the year classes 1977 to 1993.

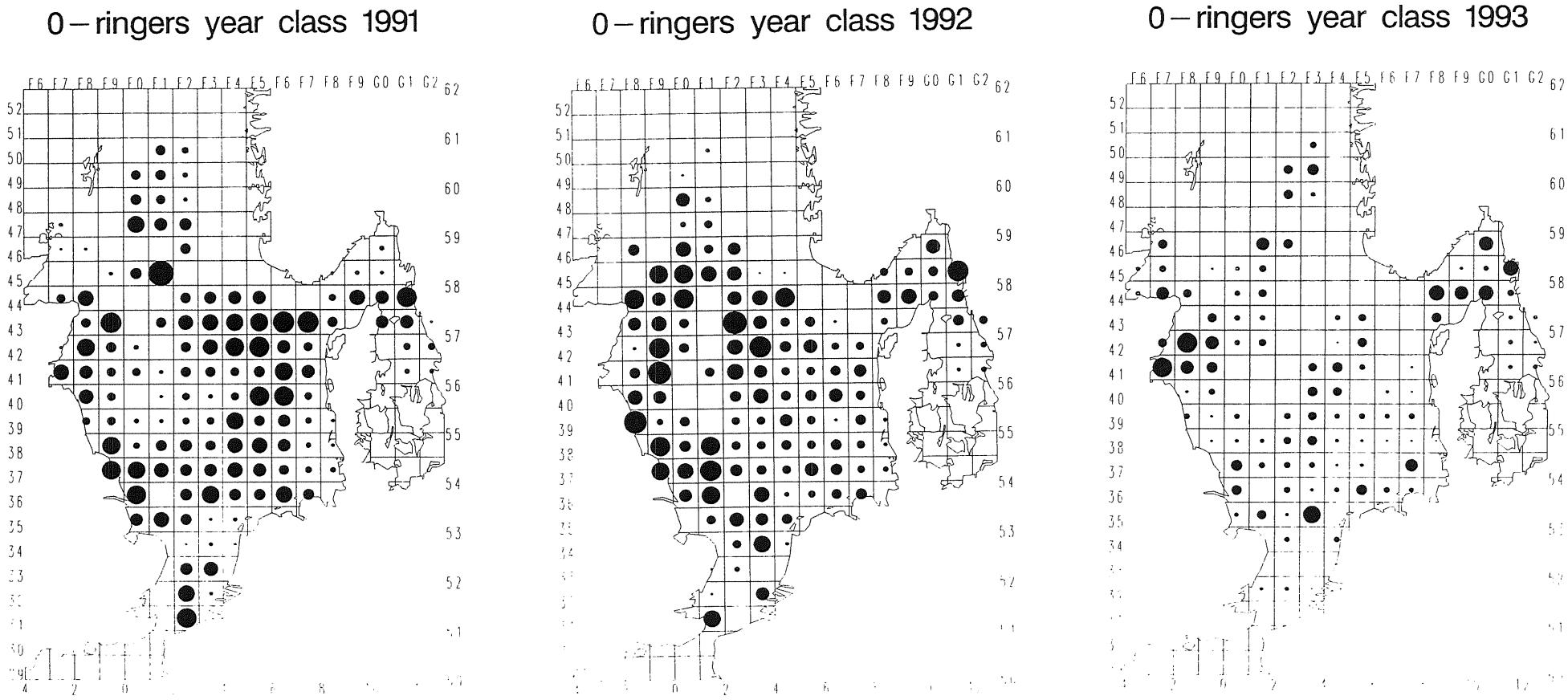


Figure 2.3.2 Distribution of 0-ringers, year classes 1991-1993. Density of 0-ringers within statistical rectangles estimated from catches by the MIK ring-net during IBTS in February. Areas of filled circles illustrate densities in no m^{-2}; the area of a circle extending to the border of a rectangle represents 1.8 m^{-2}.

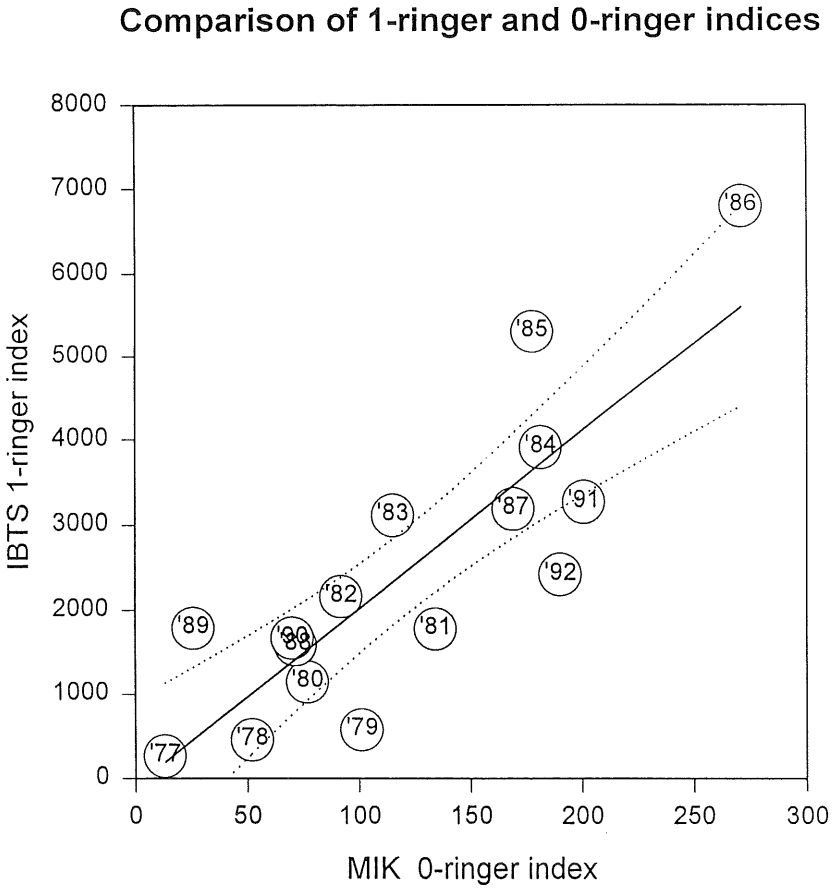


Figure 2.3.3 Regression of IBTS 1-ringer index against MIK 0-ringer index. The number within each symbol describes the year class. Regression line and 95% confidence limits illustrated.

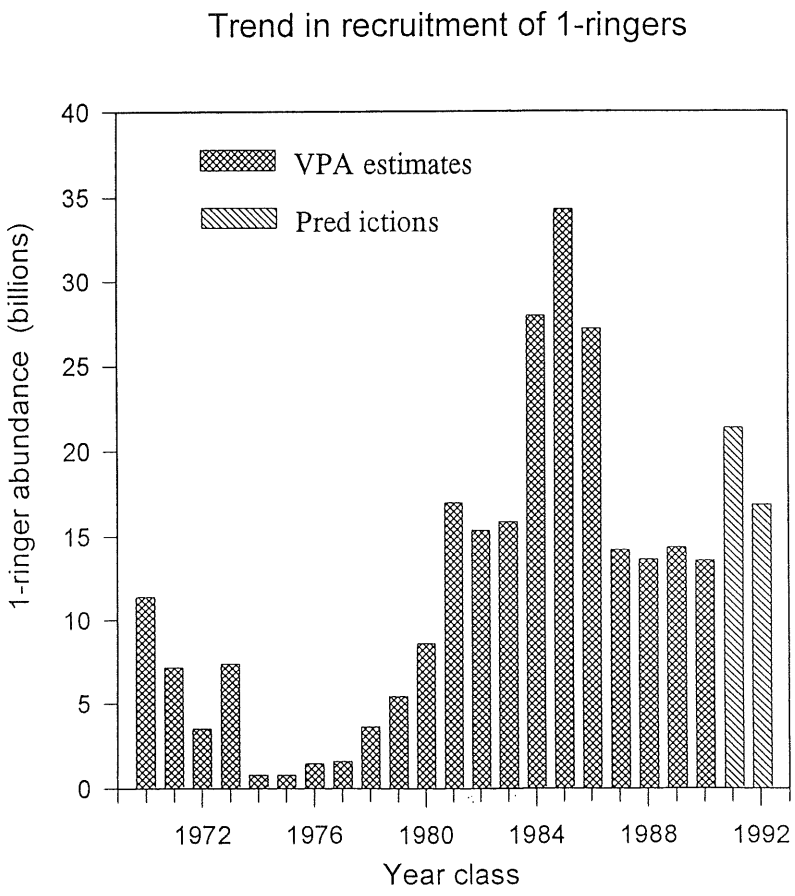


Figure 2.3.4 Trend in recruitment to the North Sea autumn spawners as estimated by the VPA for year classes 1970-1989 (cross-hatch), and as predicted by the 1-ringer index for year classes 1990-1992 (single hatch).

Figure 2.7.1 Sum of Squares Residuals Between 1991 - 1993
Total SSB Estimated from Indices and VPA

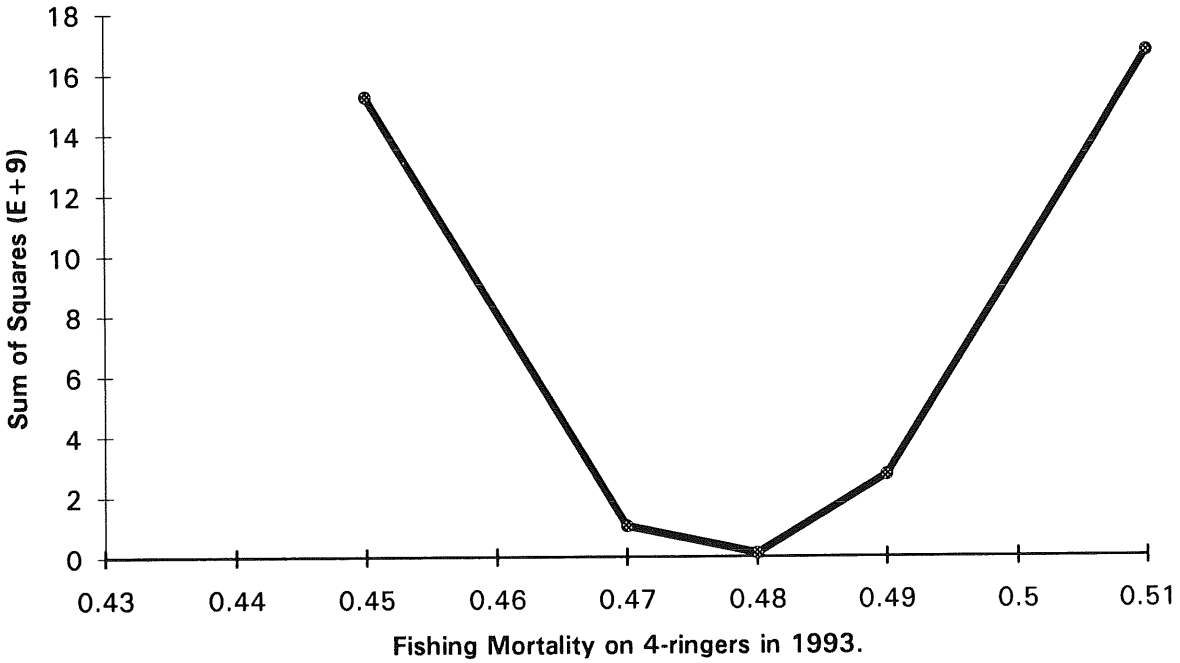


Figure 2.10.1 Herring North Sea catches (tonnes) - January 1993.

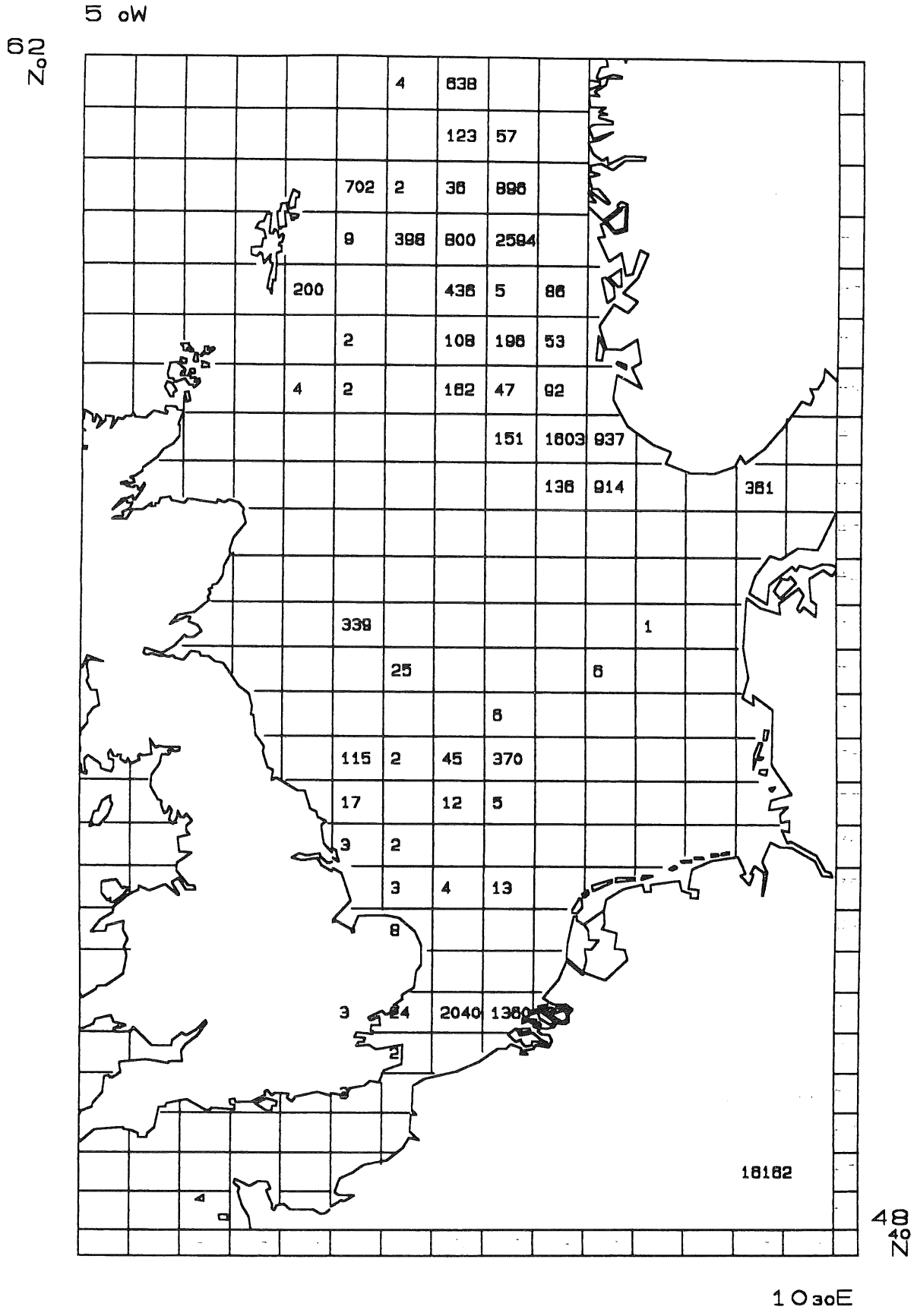


Figure 2.10.2 Herring North Sea catches (tonnes) - February 1993.

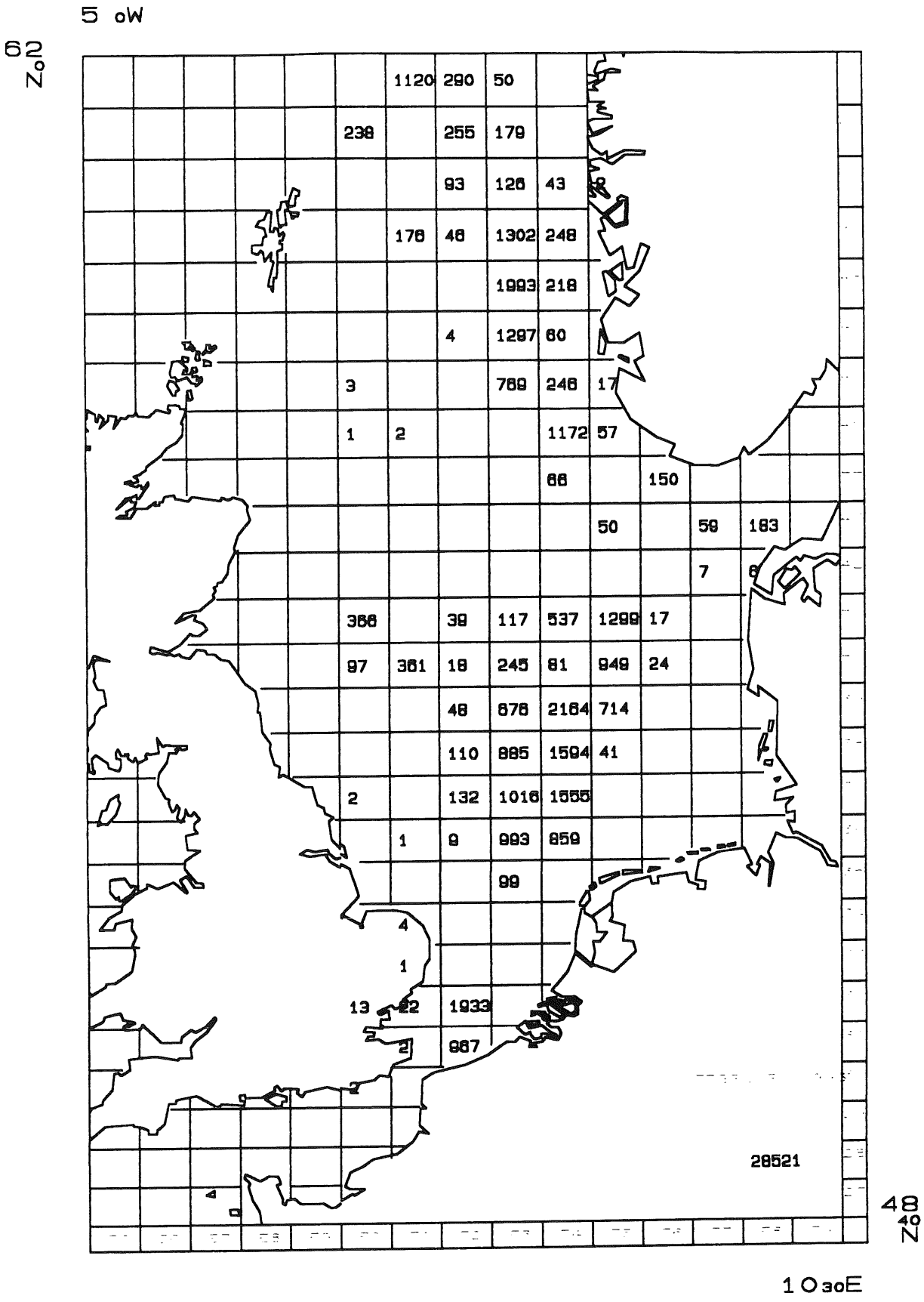


Figure 2.10.3 Herring North Sea catches (tonnes) - March 1993.

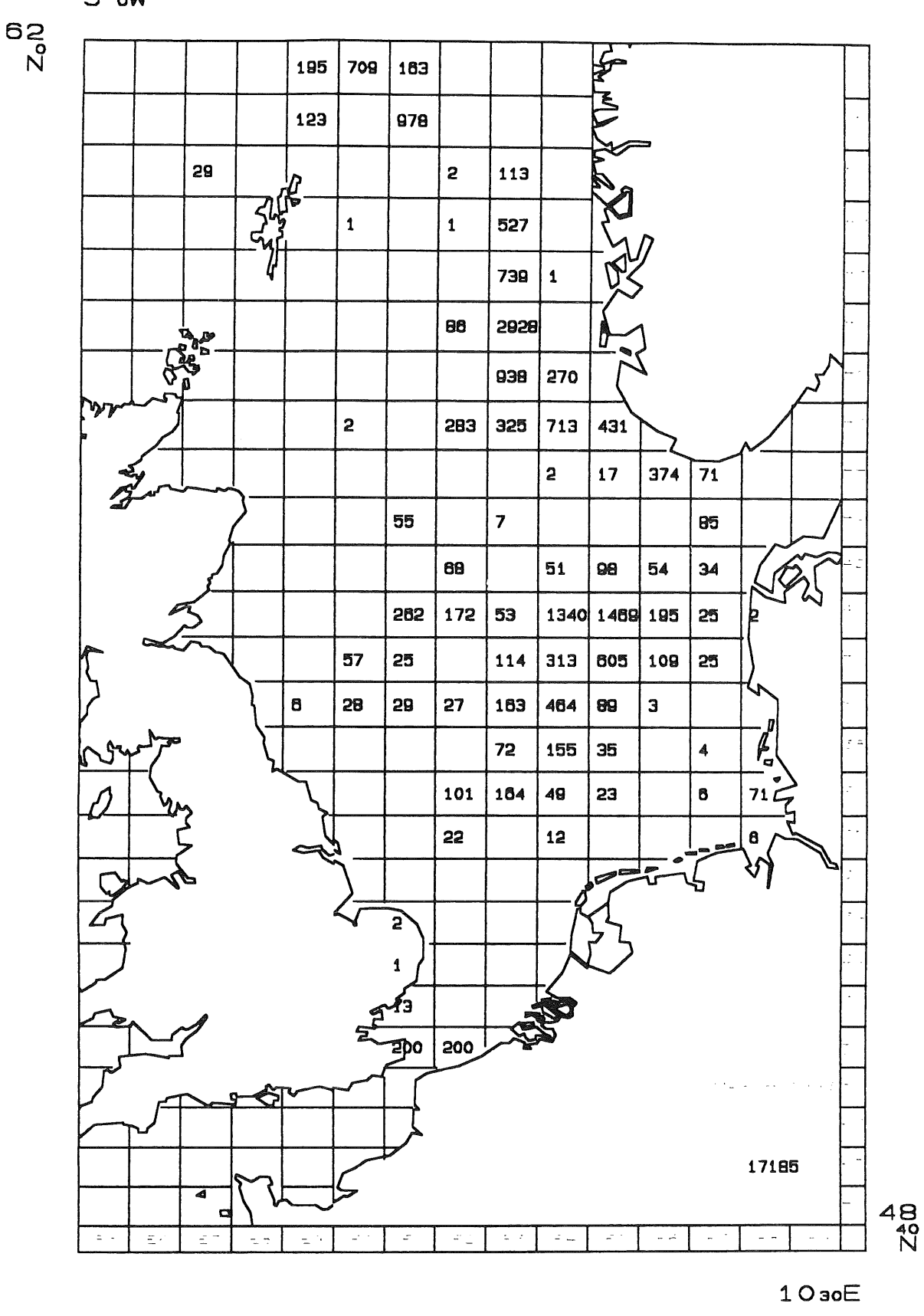


Figure 2.10.4 Herring North Sea catches (tonnes) - April 1993.

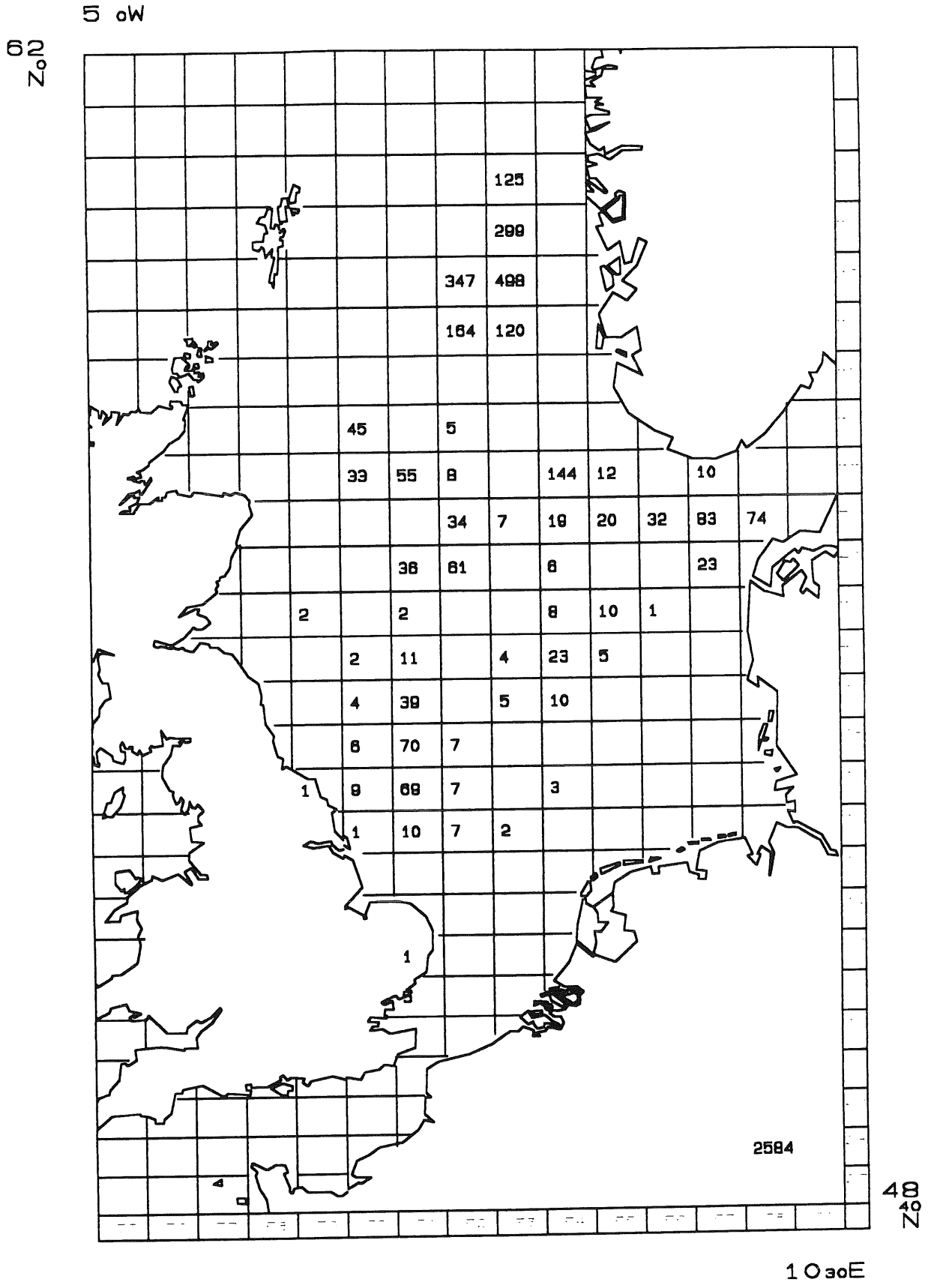


Figure 2.10.5 Herring North Sea catches (tonnes) - May 1993.

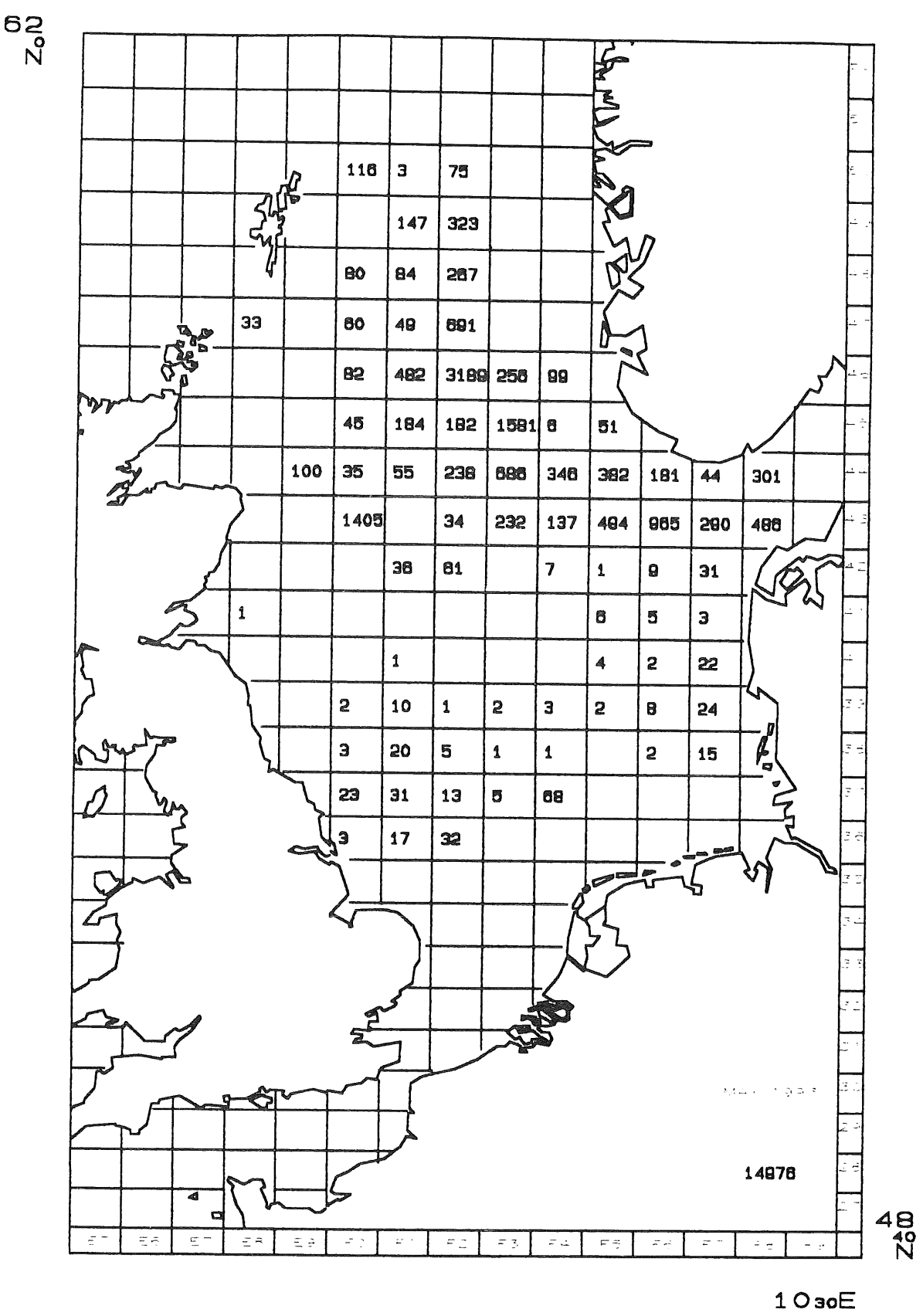


Figure 2.10.6 Herring North Sea catches (tonnes) - June 1993.

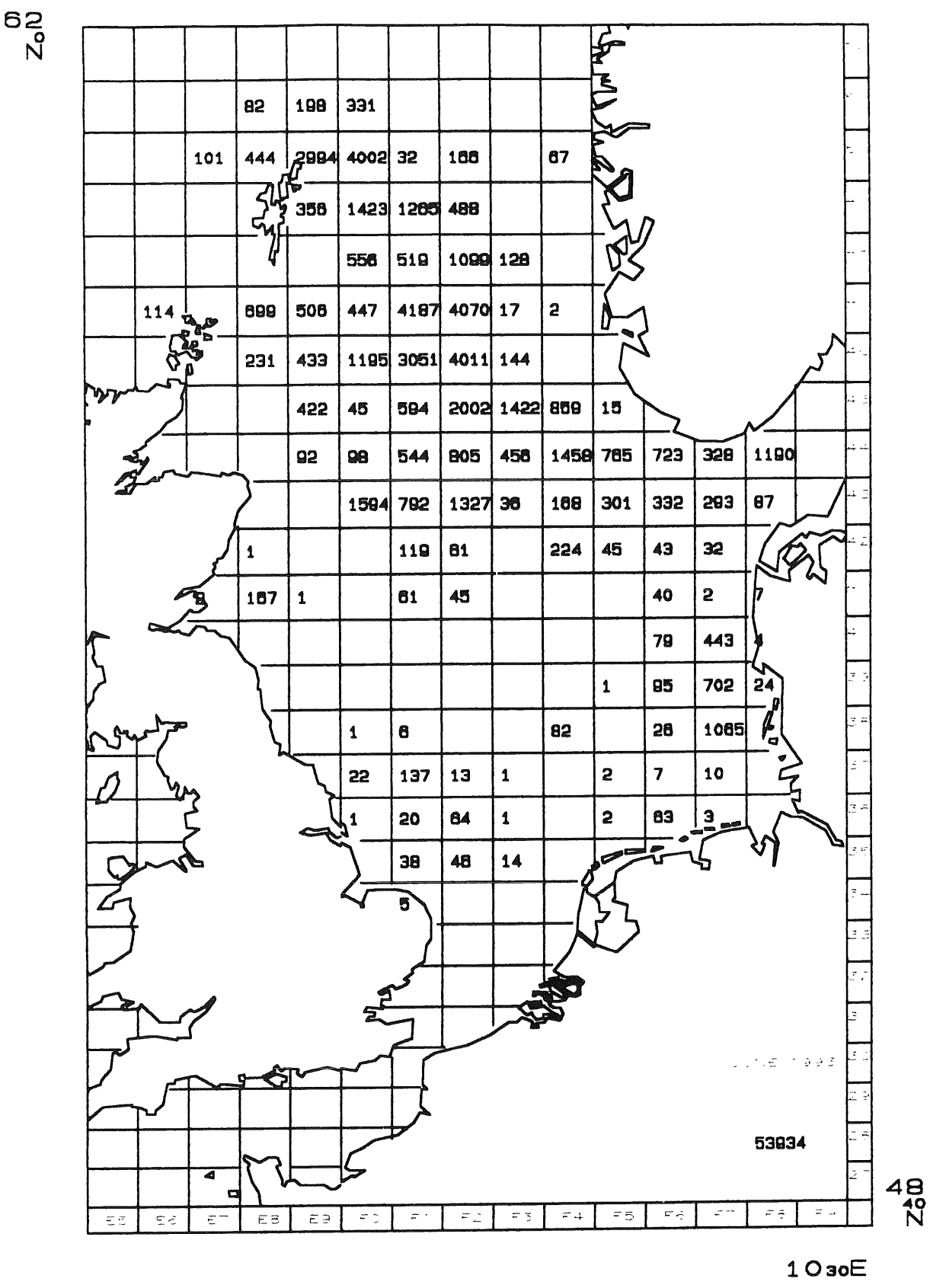


Figure 2.10.7 Herring North Sea catches (tonnes) - July 1993.

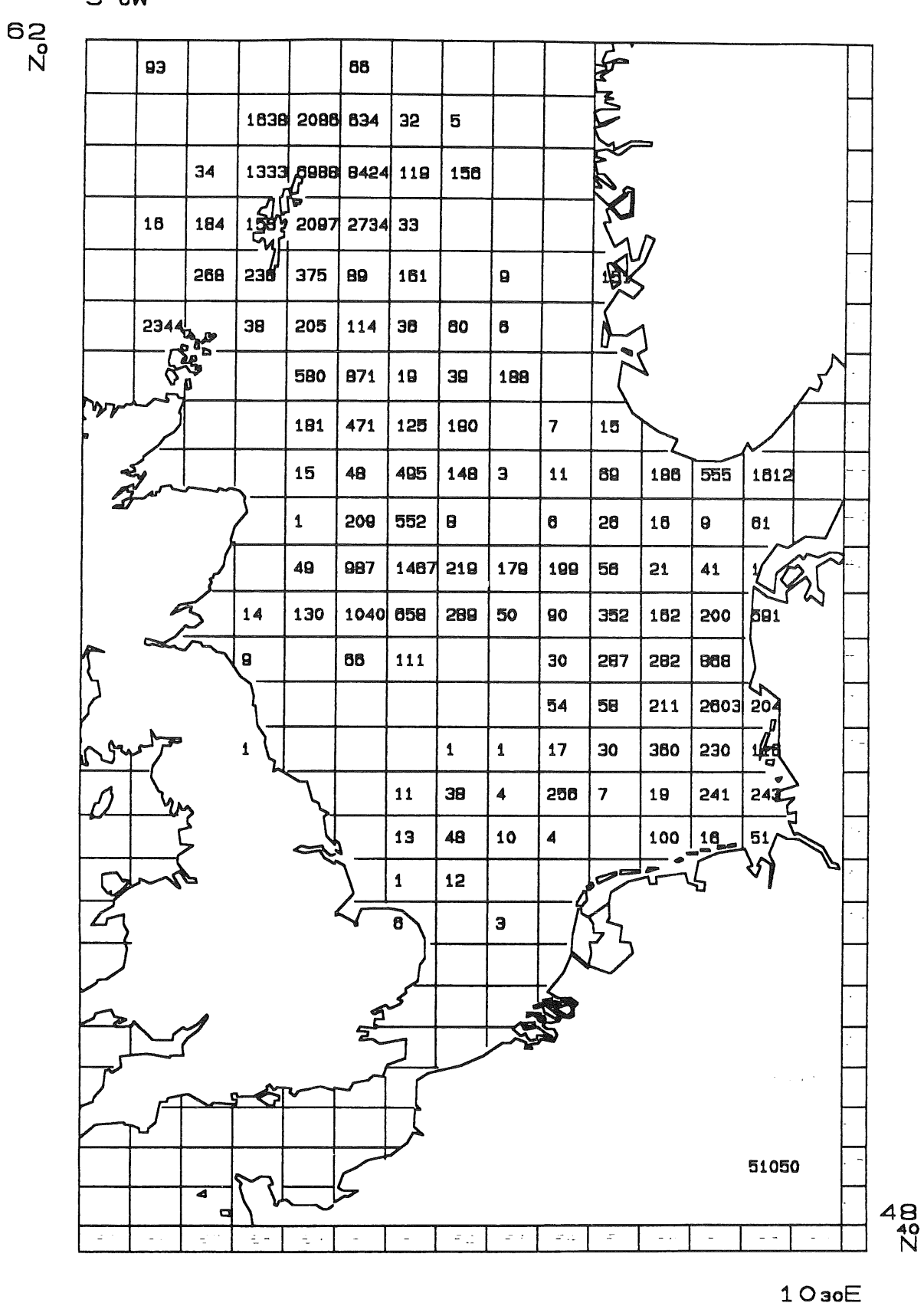


Figure 2.10.8 Herring North Sea catches (tonnes) - August 1993.

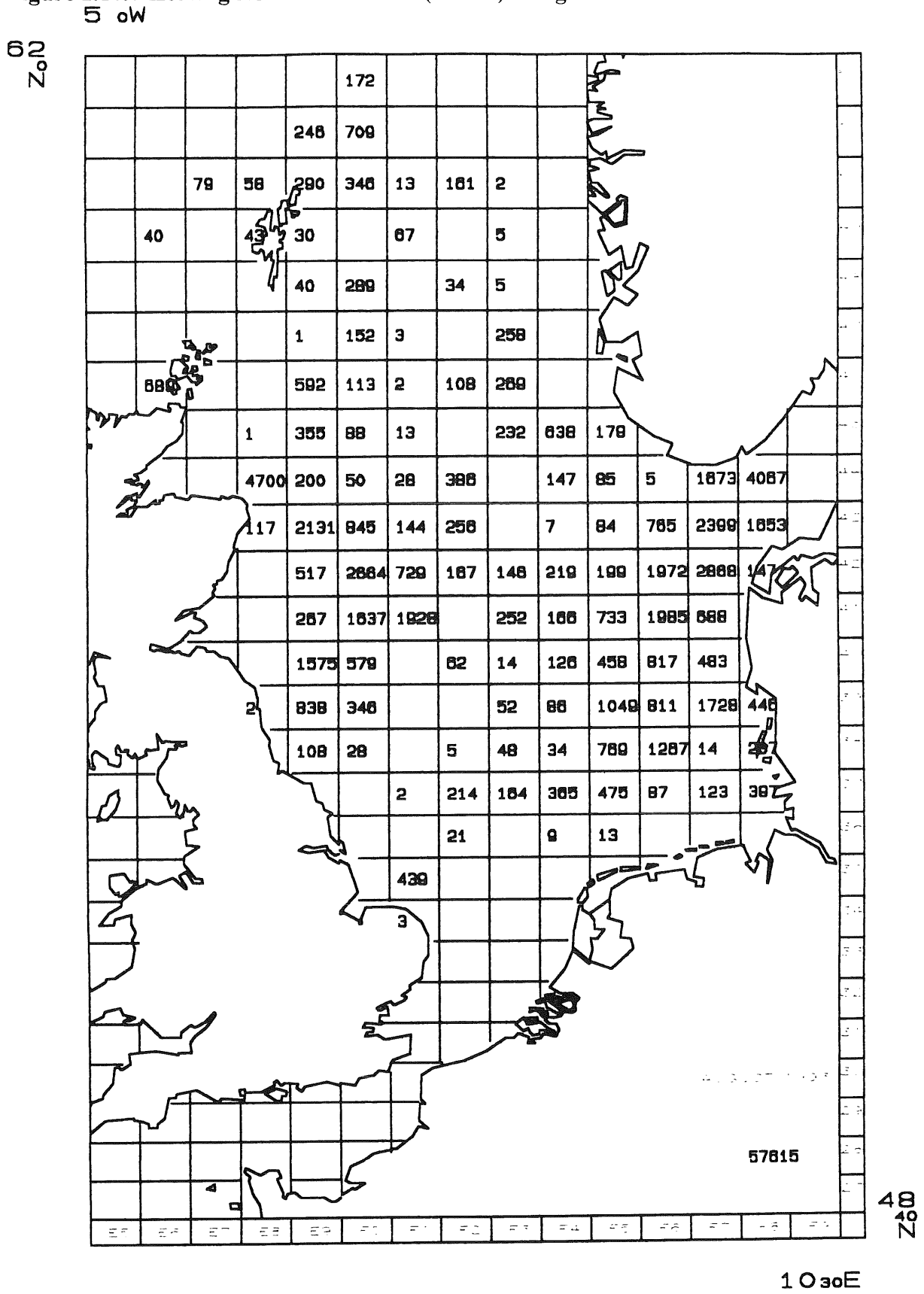


Figure 2.10.9Herring North Sea catches (tonnes) - September 1993.

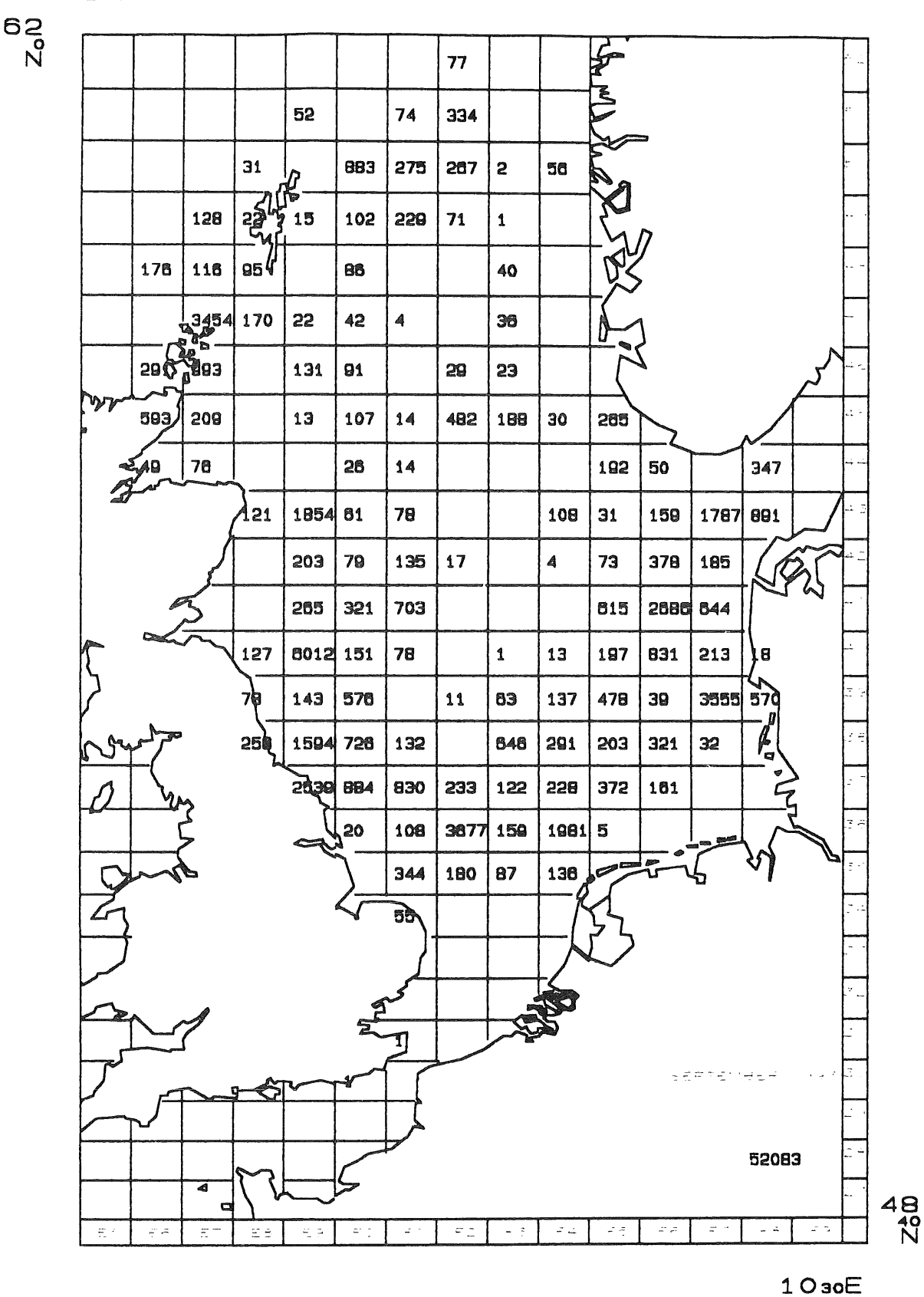


Figure 2.10.10 Herring North Sea catches (tonnes) - October 1993.

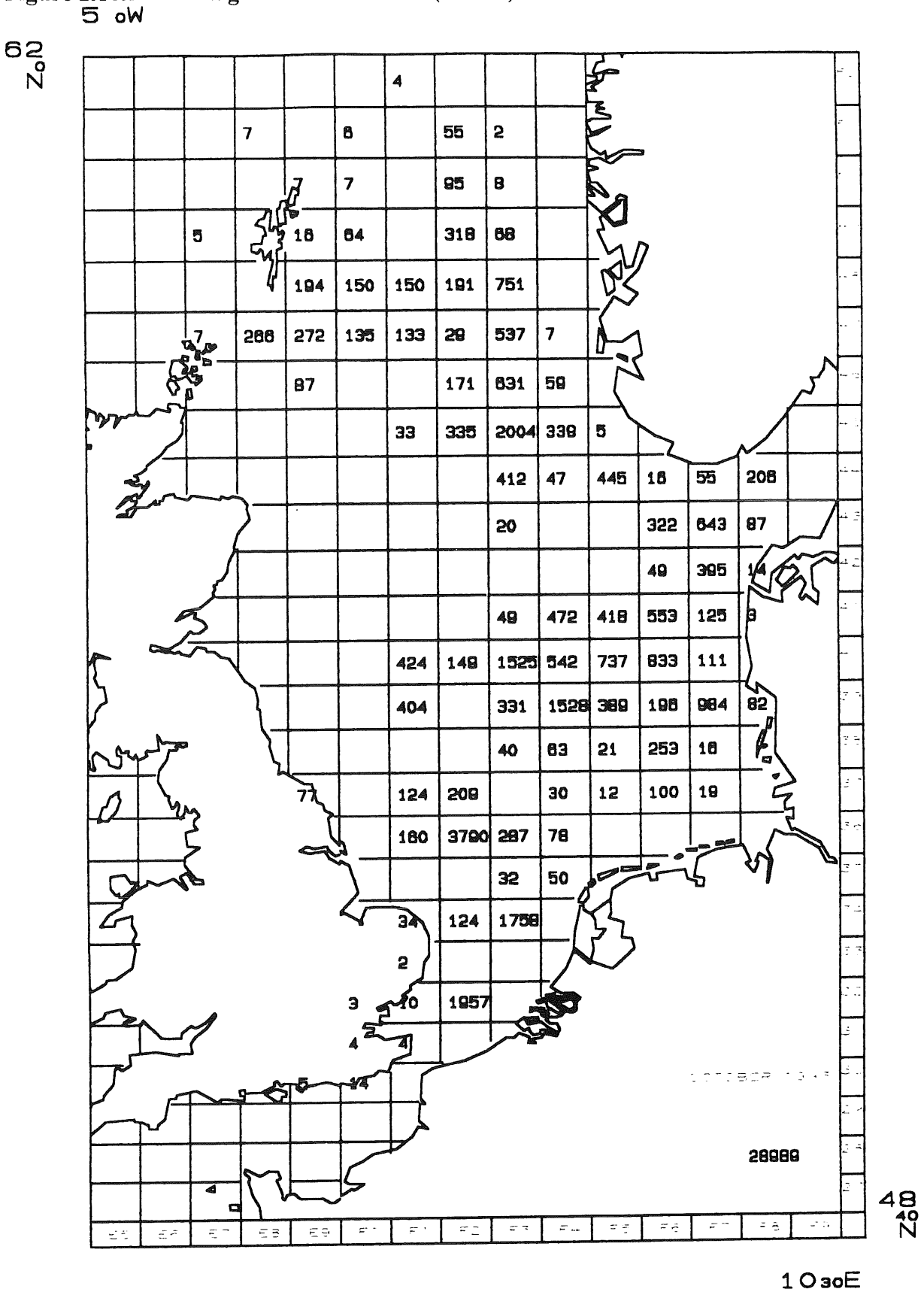


Figure 2.10.11 Herring North Sea catches (tonnes) - November 1993.

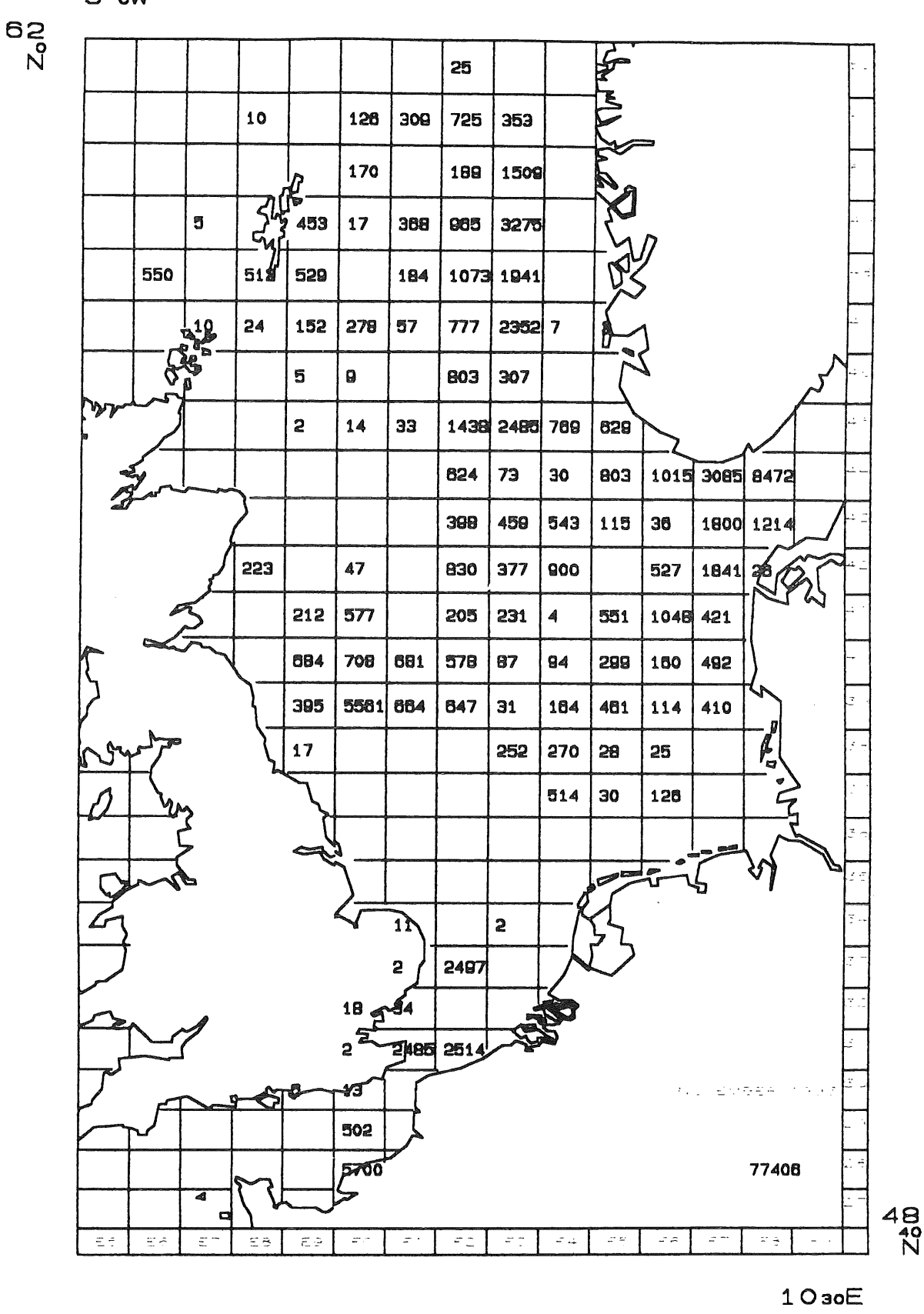


Figure 2.10.12 Herring North Sea catches (tonnes) - December 1993.

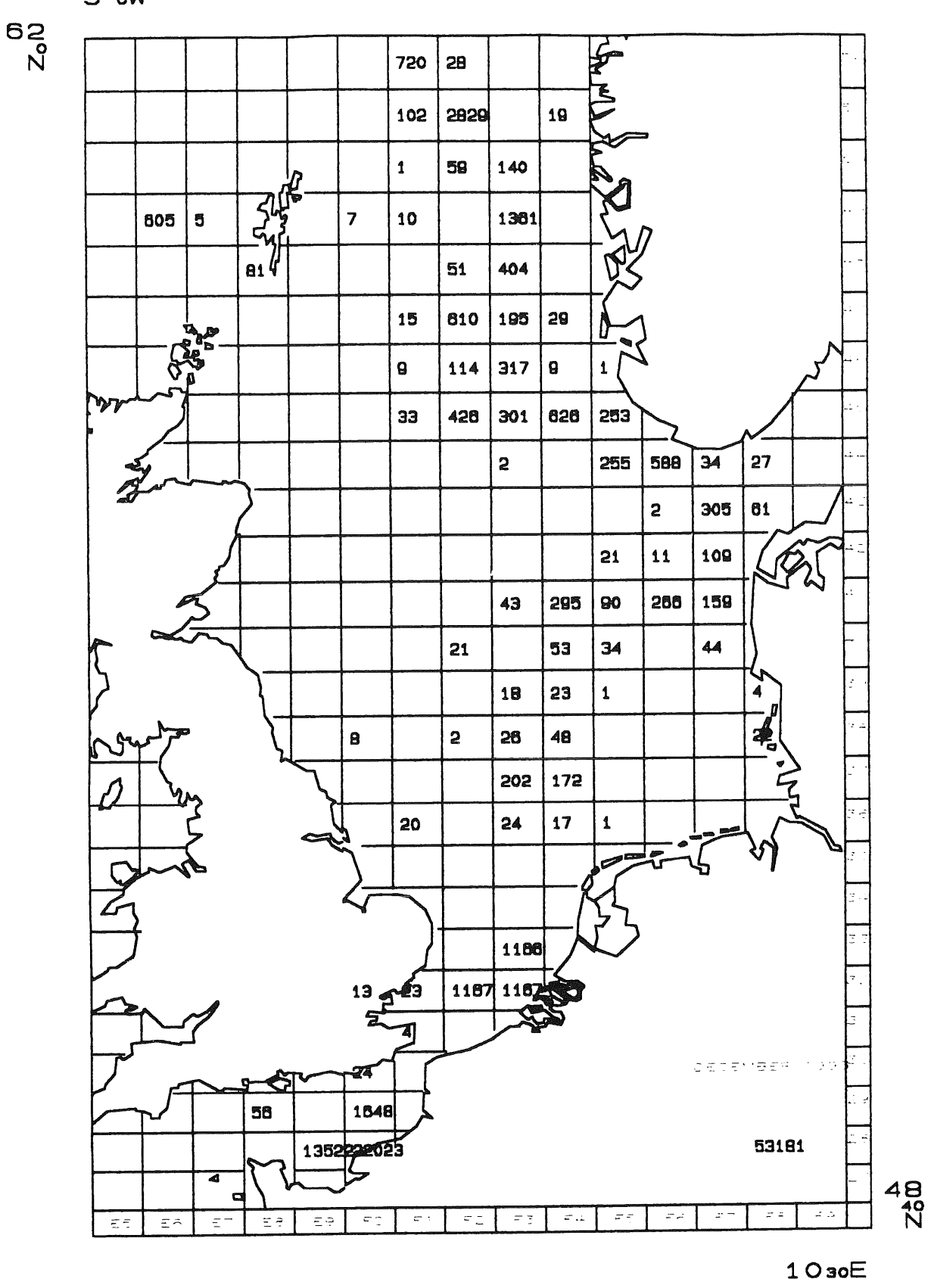
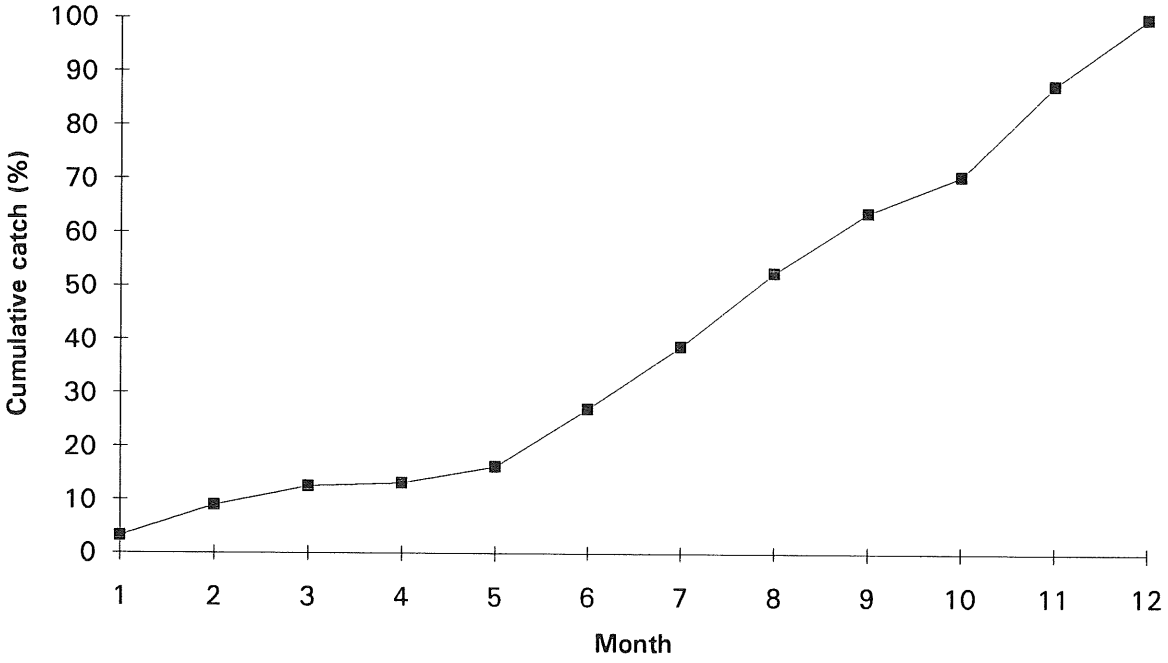


Figure 2.10.13 : North Sea Herring. Cumulative catch by month 1993.



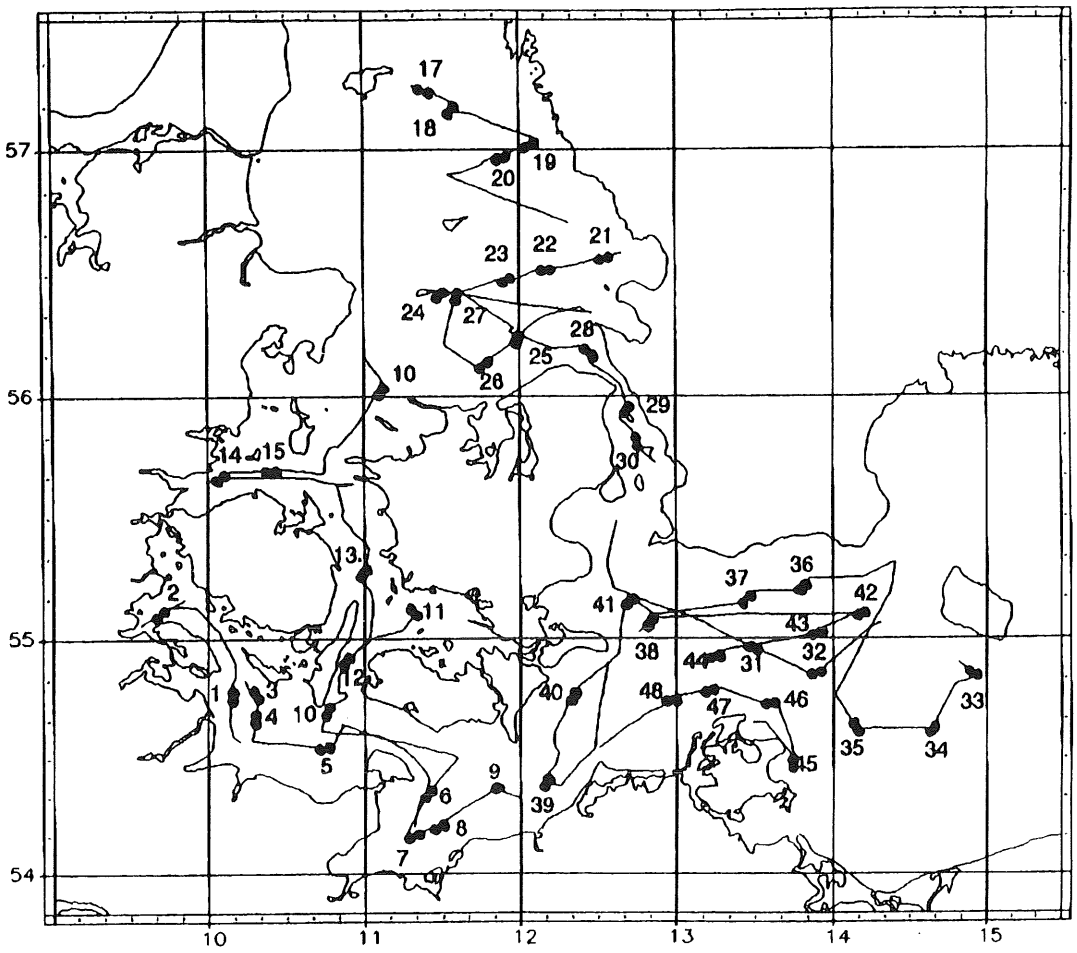
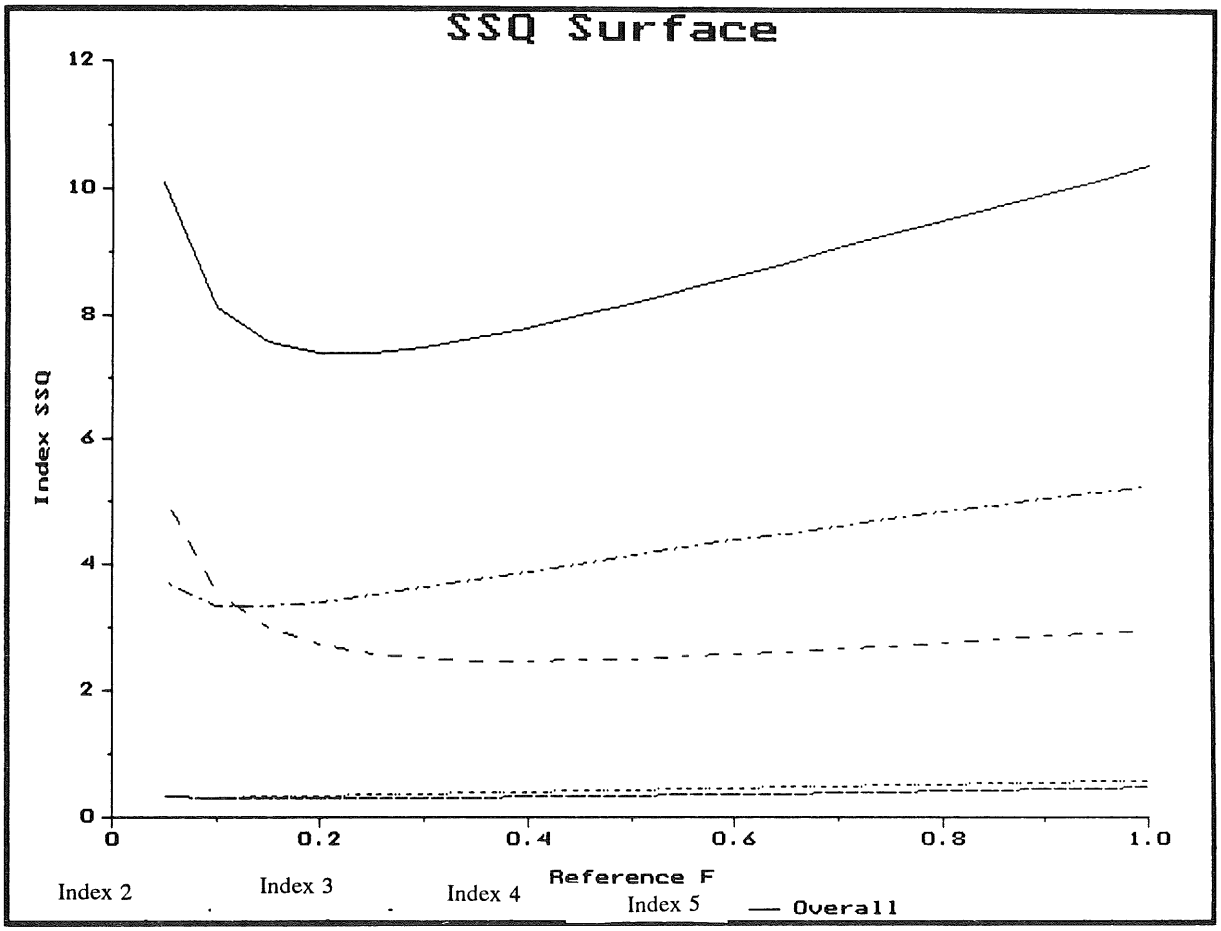


Figure 3.3.1 Survey grid and trawl positions 343 "Solea" October 1993



WESTERN BALTIC (IIIa+Sub.Div.22-24) Spring Spawning Herring.

Figure 3.5.1a

```
AGE - STRUCTURED INDICES:
INDEX 1 : Not used 1980-94:  IYFS IIIa,  Age groups 2 and 3+
INDEX 2 : 1978-93:  German Bottom Trawl Survey in Sub.Div. 24, Ages 0-3
INDEX 3 : 1979-93:  German Bottom Trawl Survey in Sub.Div. 22, Ages 0-3
INDEX 4 : 1989-93:  Acoustic survey in IIIa+IVaE,  Ages 2-8
INDEX 5 : 1989-93:  Acoustic survey in Sub.Div 22-24,  Ages 0-8

No Biomass index used.

Same weight (= 1.0) to all indices
Linear model used for all indices
Range of years used in separaple constraint: 6
Reference F at age 4.  S for oldeslt age = 1
```

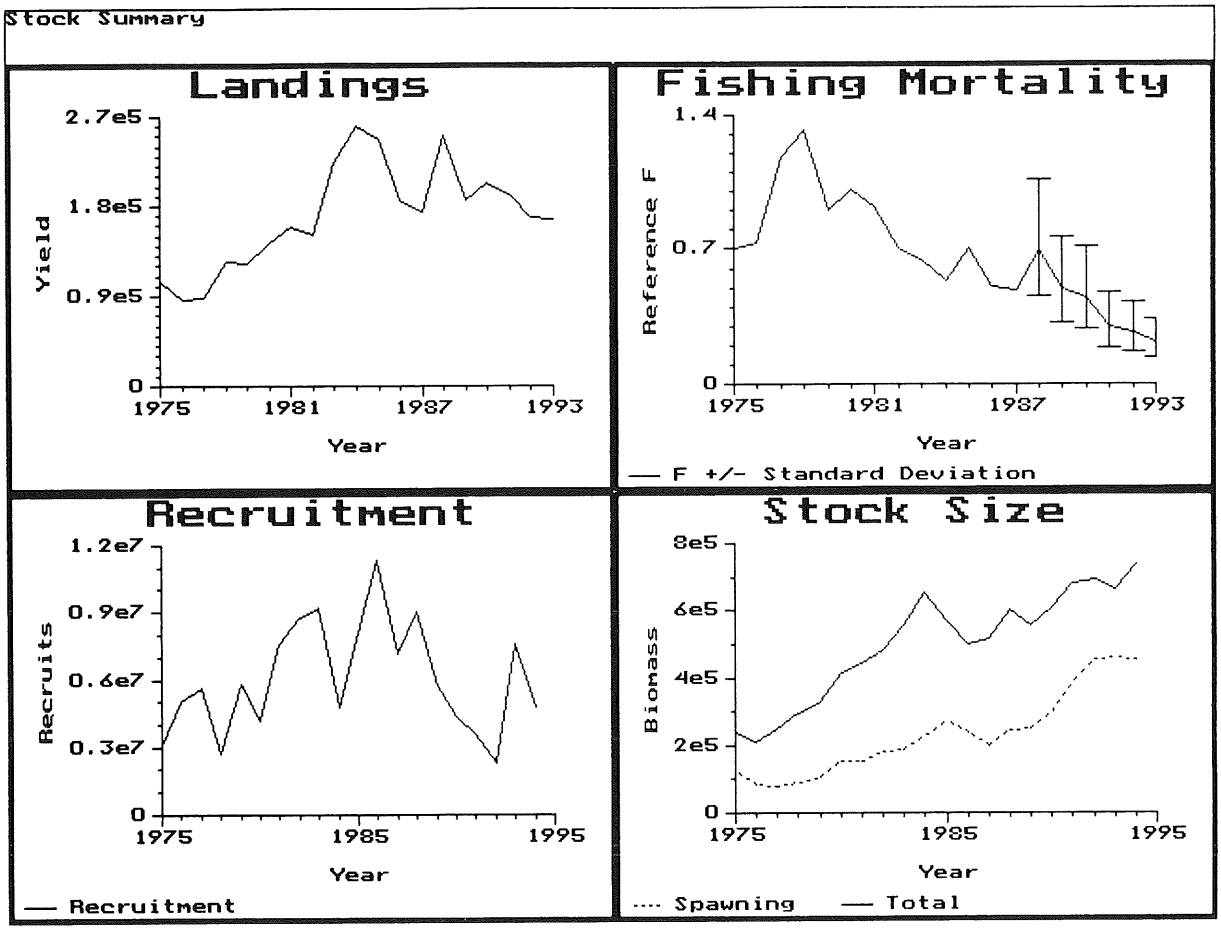


Figure 3.5.1B Stock Summary from ICA for Western Baltic spring spawning herring.

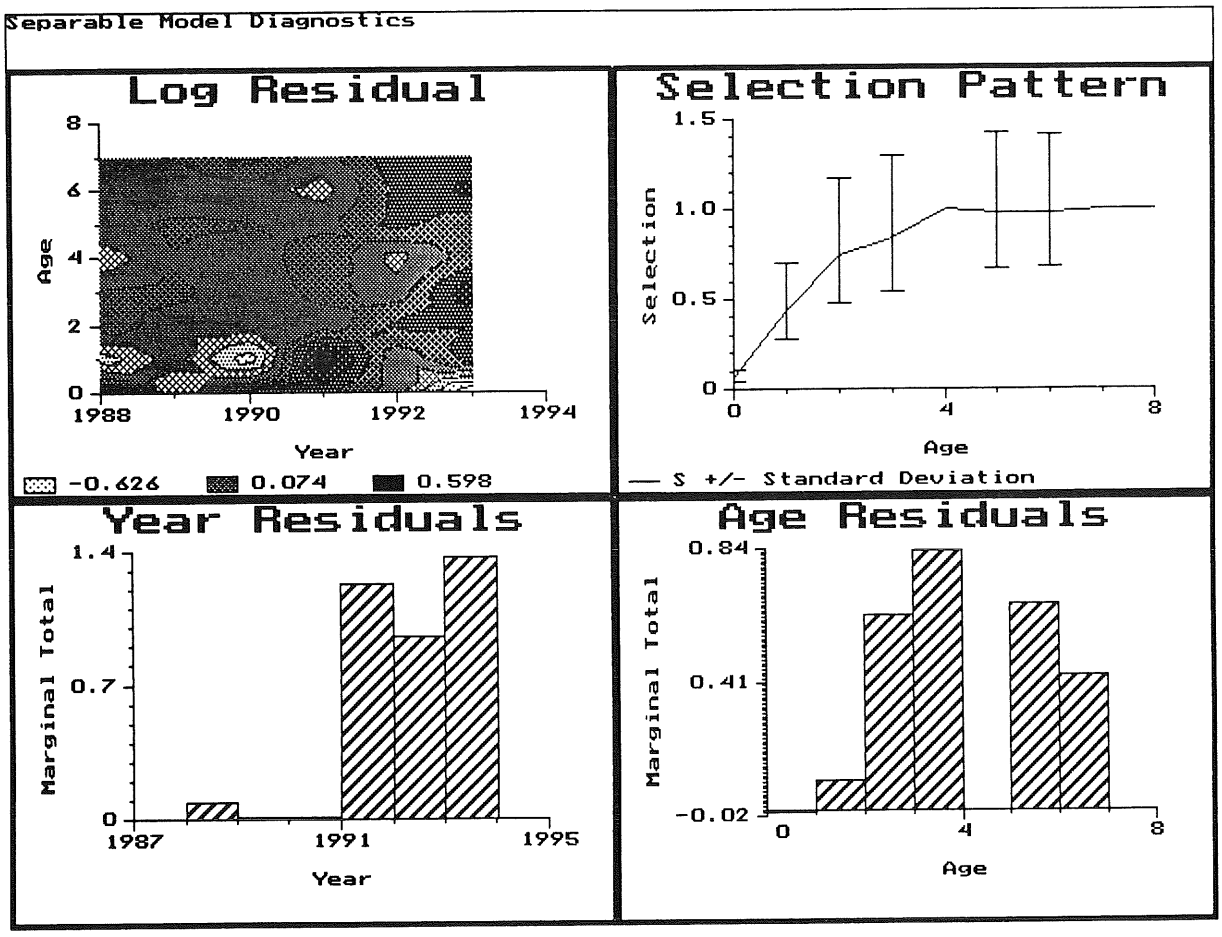
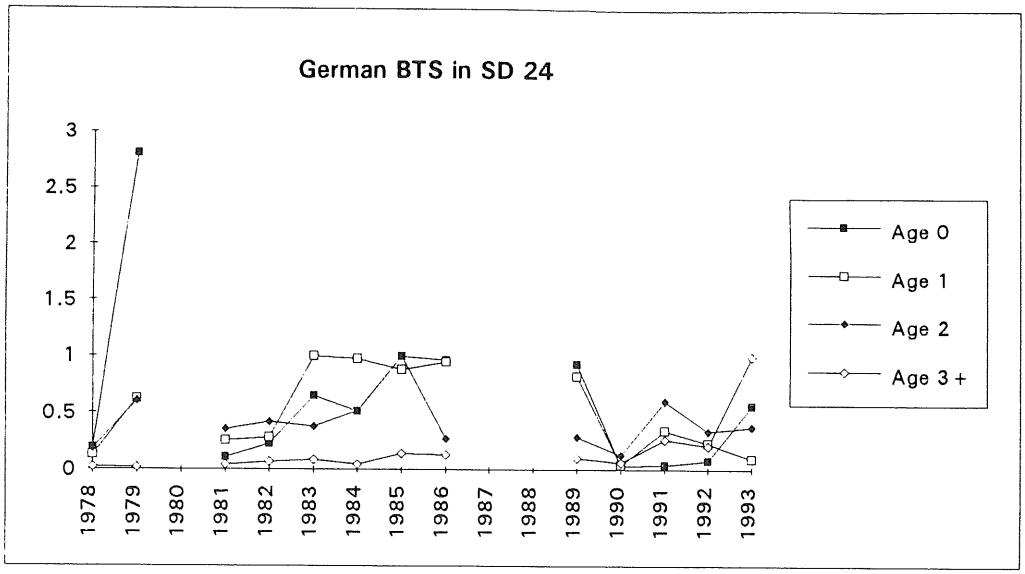
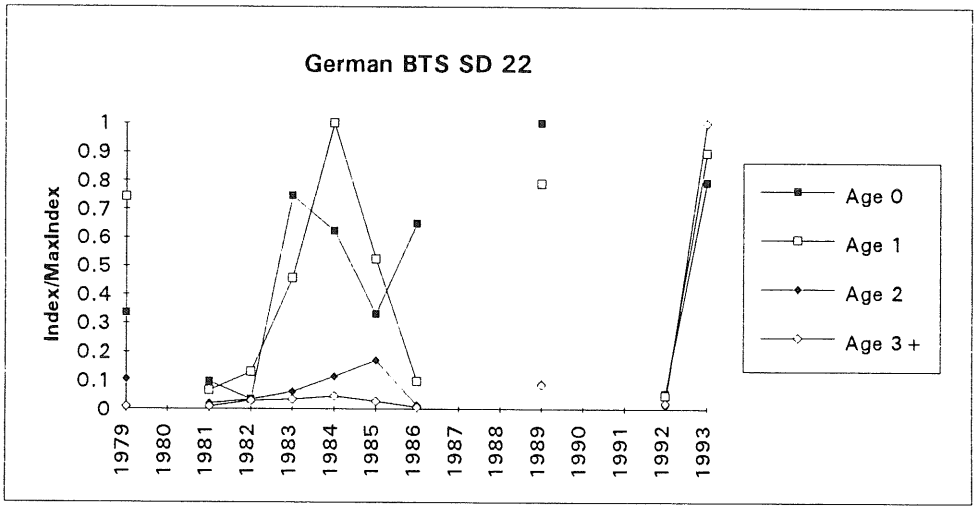


Figure 3.5.1C Dianostics from ICA for Western Baltic spring spawning herring.

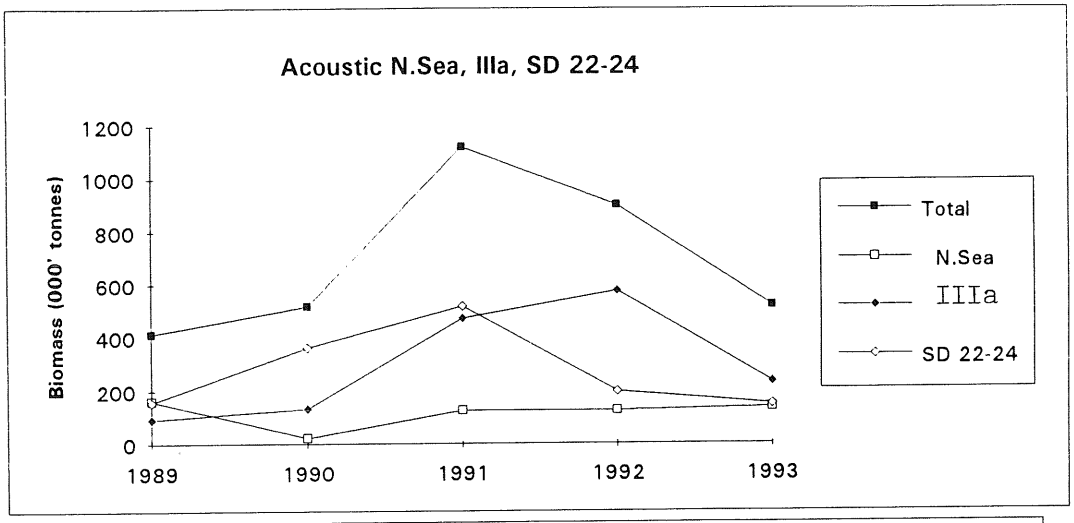


A

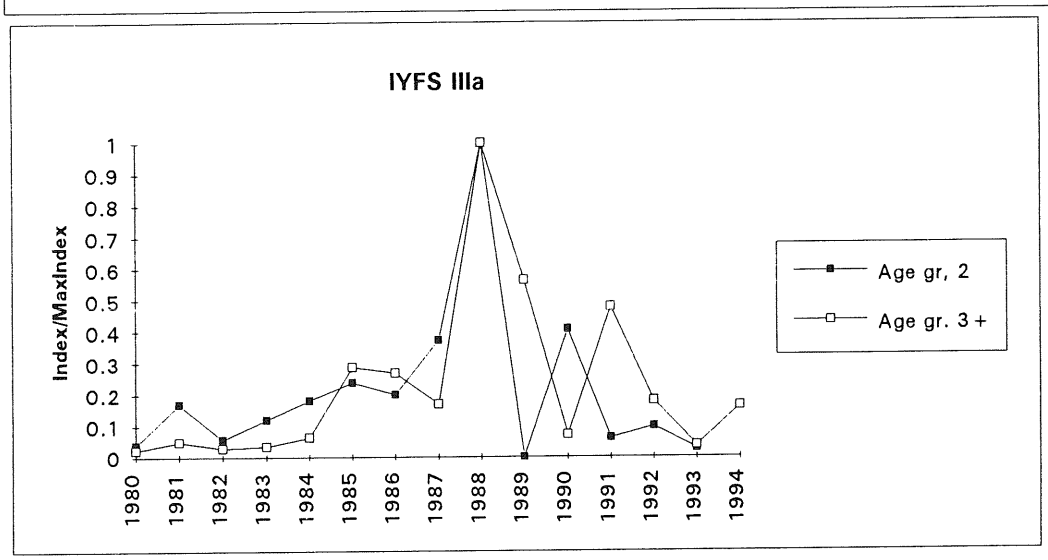


B

Figure 3.5.2 Survey indices for Western Baltic spring spawning herring.



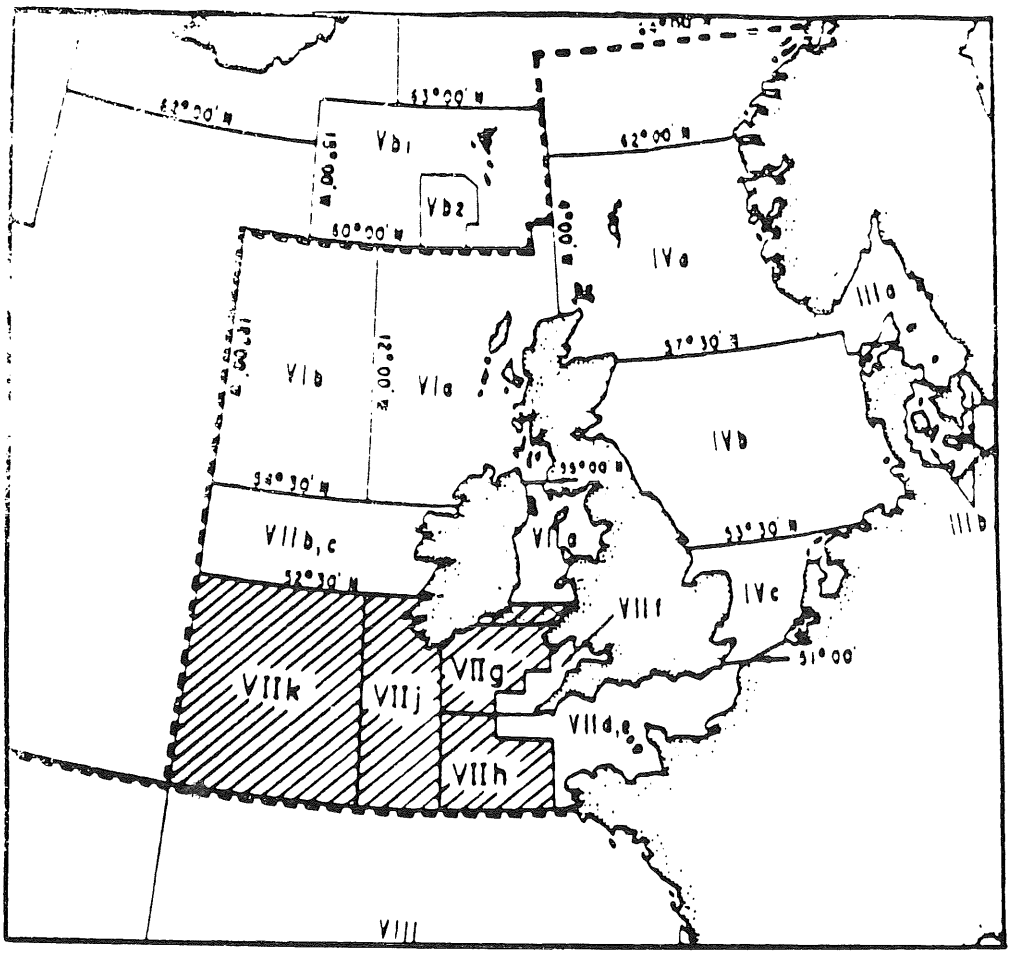
C



D

Figure 3.5.2 (Continued)

Figure 4.1.1 The assessment covers the area Divisions VIIj and VIIg and that part of Division VIIa below 52°30. TAC is set by EC for Divisions VIIg-k and that section of Division VIIa below 52°30.



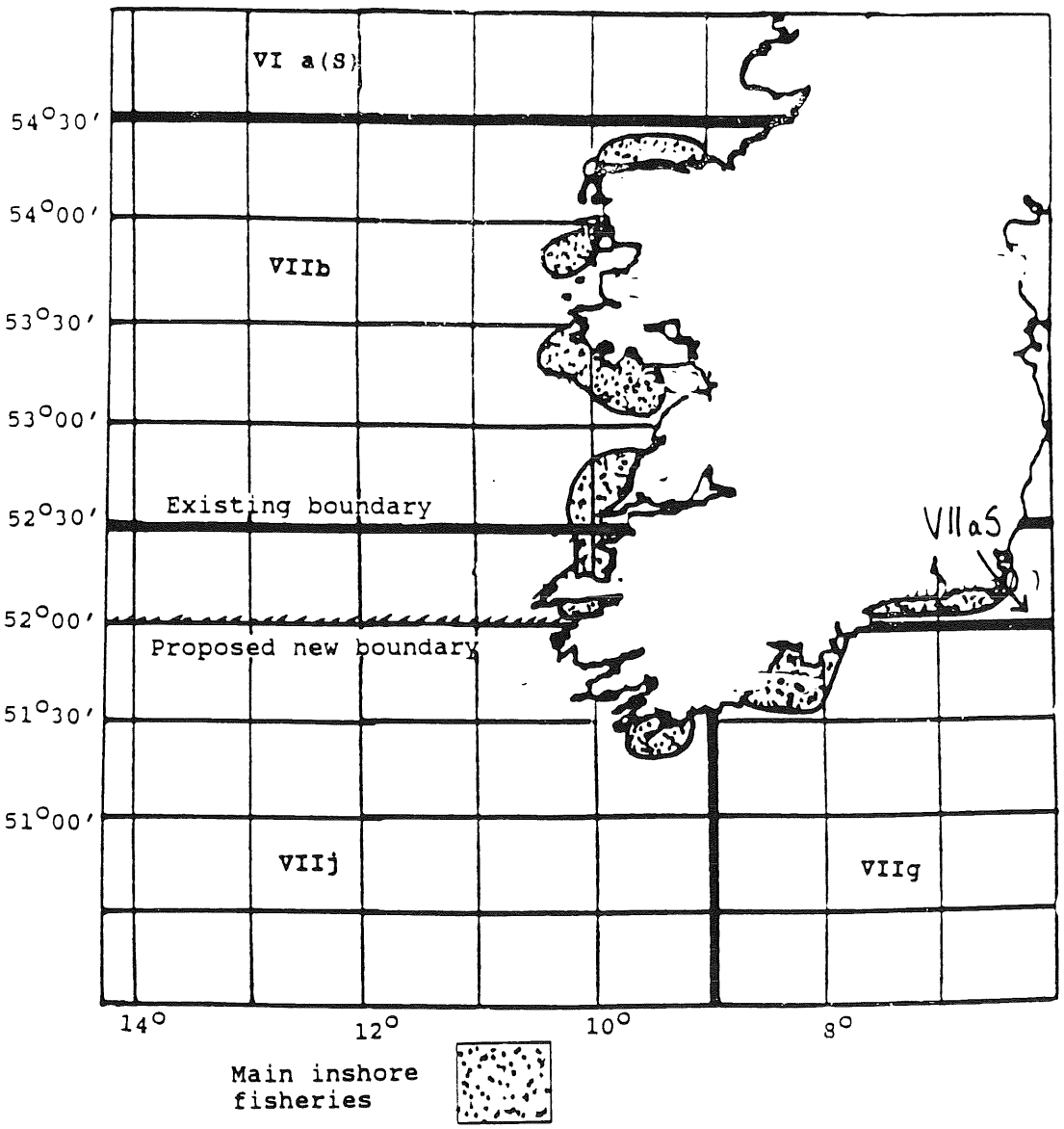


Figure 4.1.2 Location of the main inshore fisheries for herring in Divisions VIIb, Viij, VIIg and VIIa(S).
- - - - . Existing boundary and proposed new boundary between VIIb and VIIj are shown.

Figure 4.2.1.a Distribution of herring catches. 1 Quarter 1993. Total catch = 15,000 t. (Based on Irish, Norwegian, Dutch and UK (Scotland) data.)

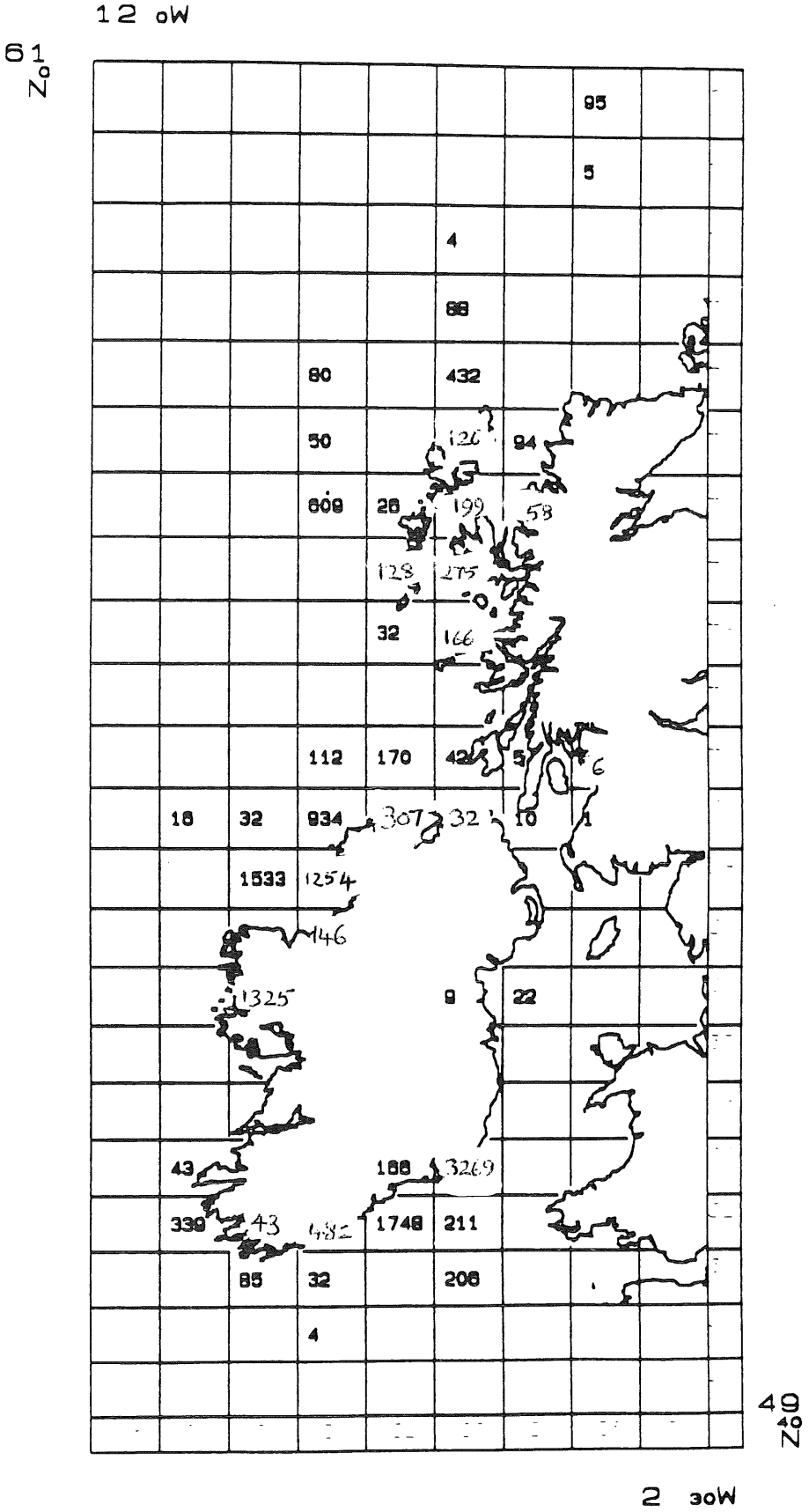


Figure 4.2.1.b Distribution of herring catches. 2 Quarter 1993. Total catch = 7,500 t. (Based on Irish, Norwegian, Dutch and UK (Scotland) data.)

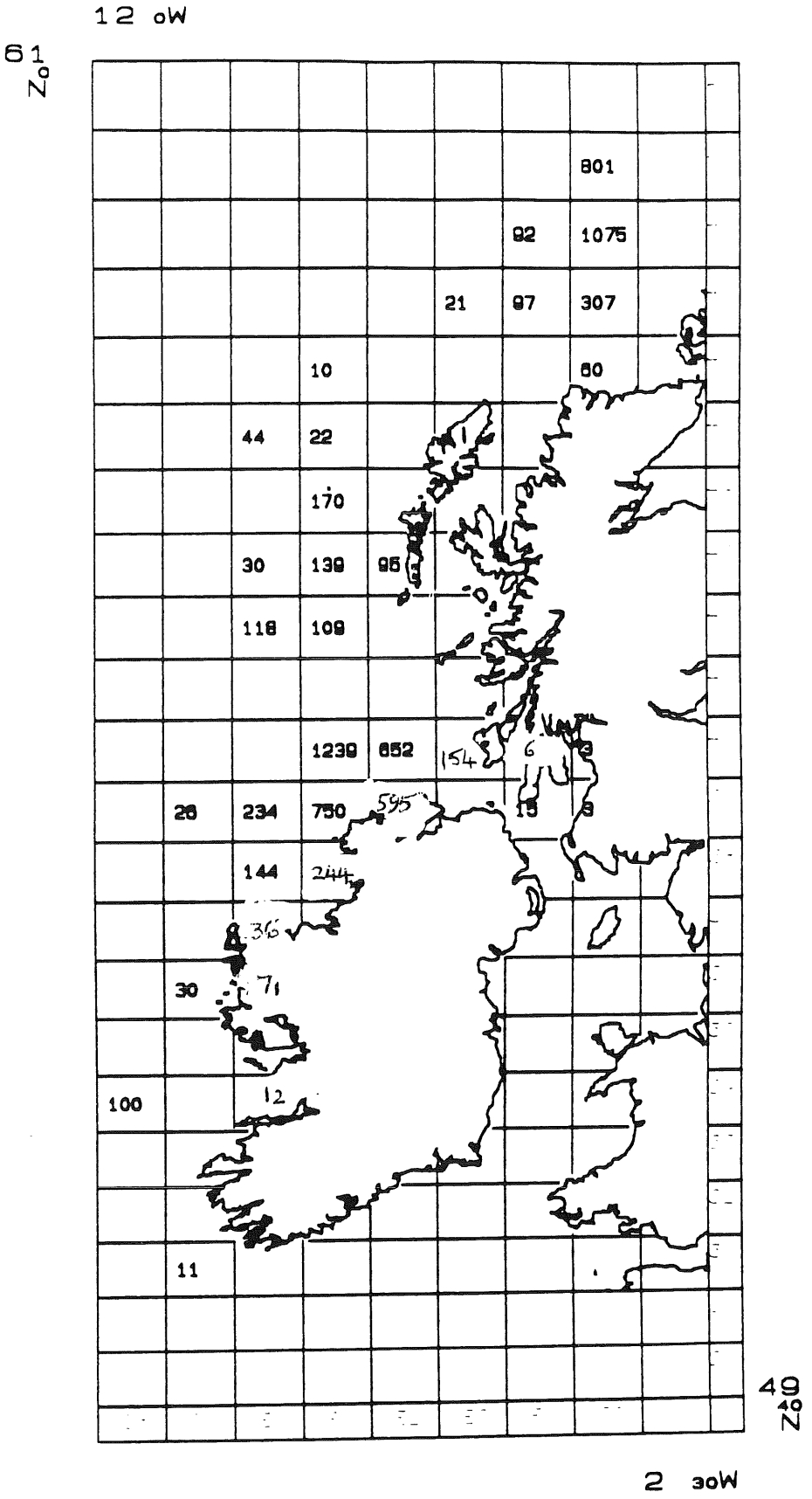


Figure 4.2.1.c Distribution of herring catches. 3 Quarter 1993. Total catch = 44,000 t. (Based on Irish, Norwegian, Dutch and UK (Scotland) data.)

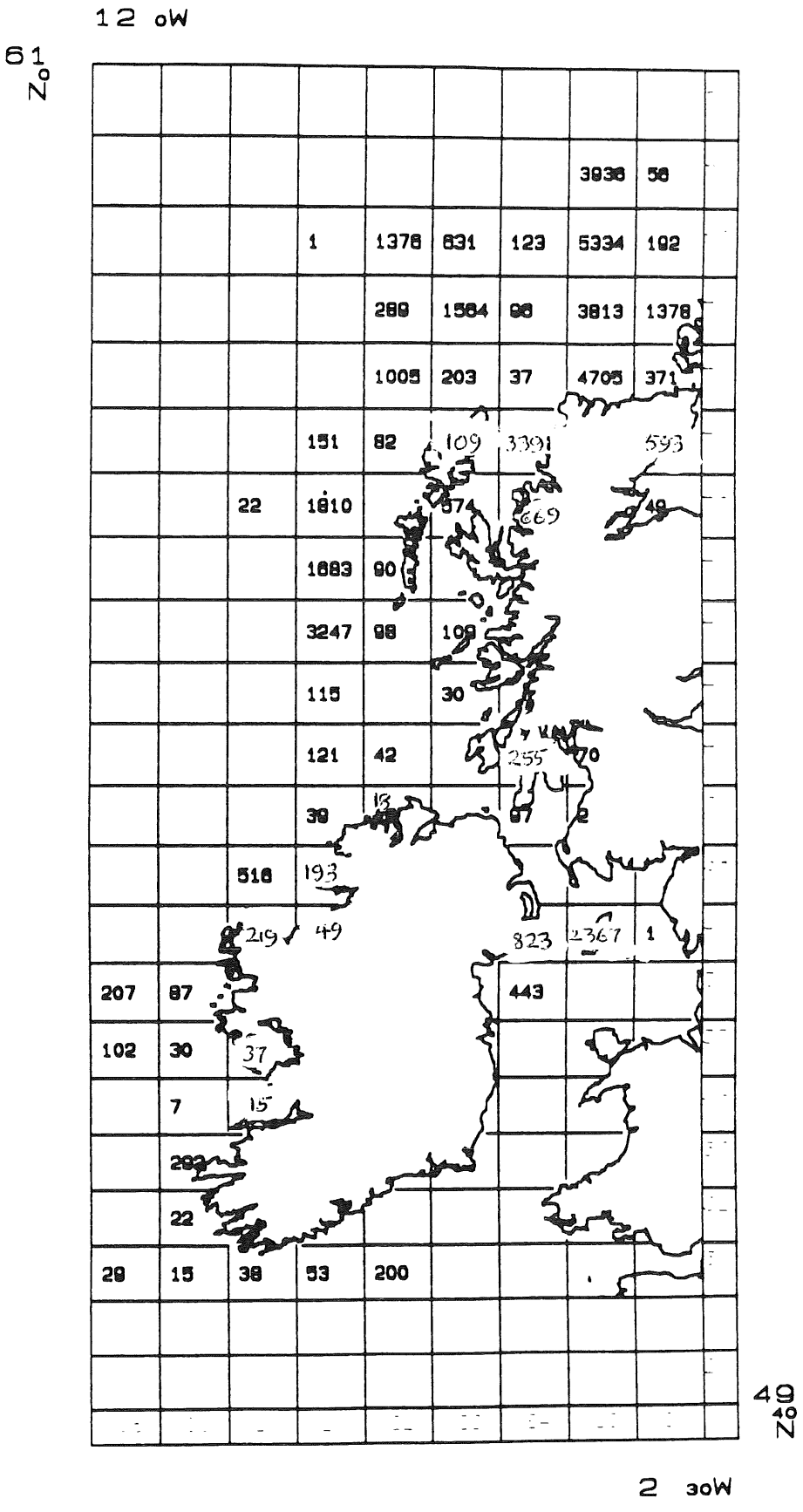
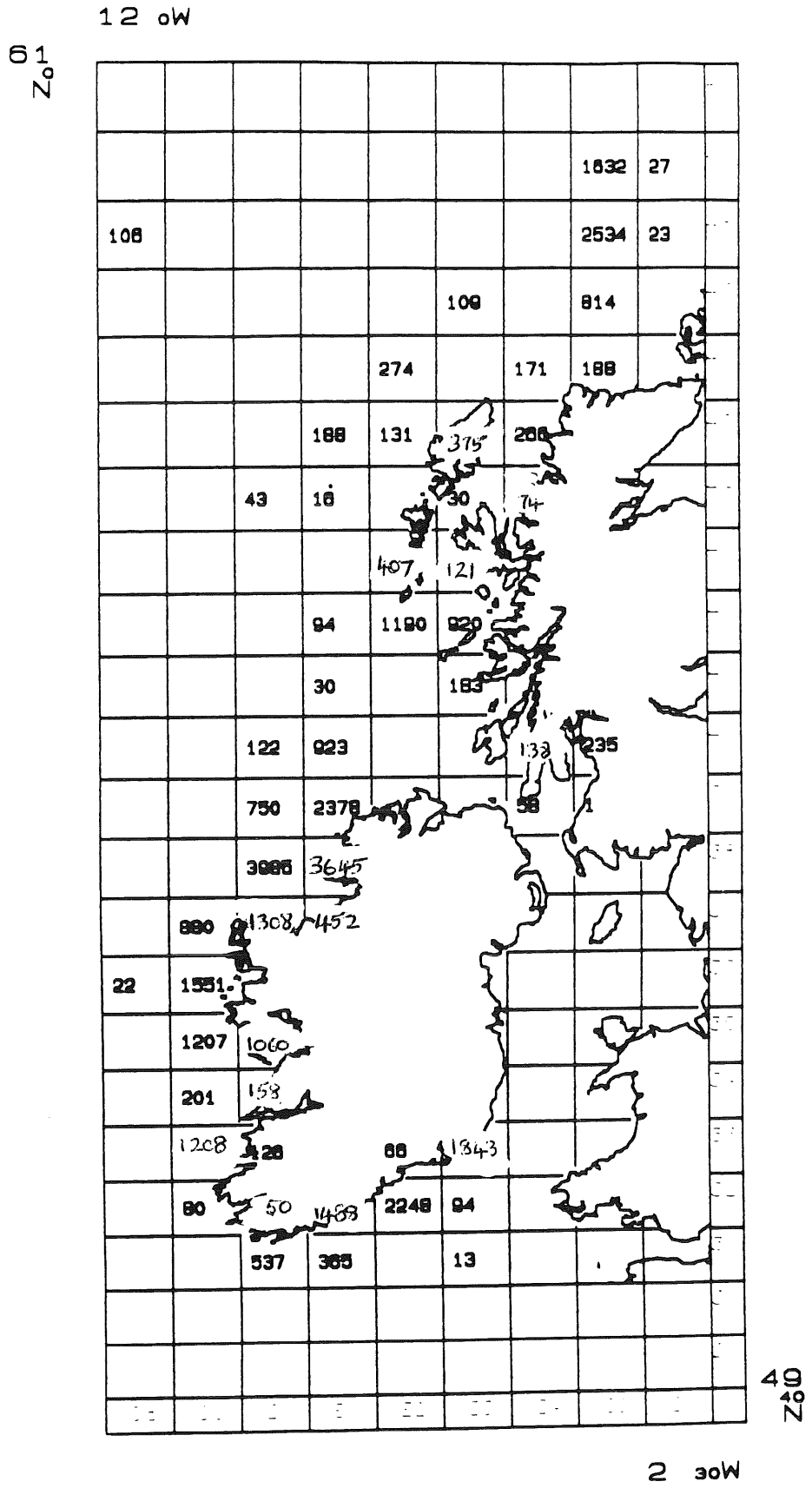


Figure 4.2.1.d Distribution of herring catches. 4 Quarter 1993. Total catch = 44,300 t. (Based on Irish, Norwegian, Dutch and UK (Scotland) data.)



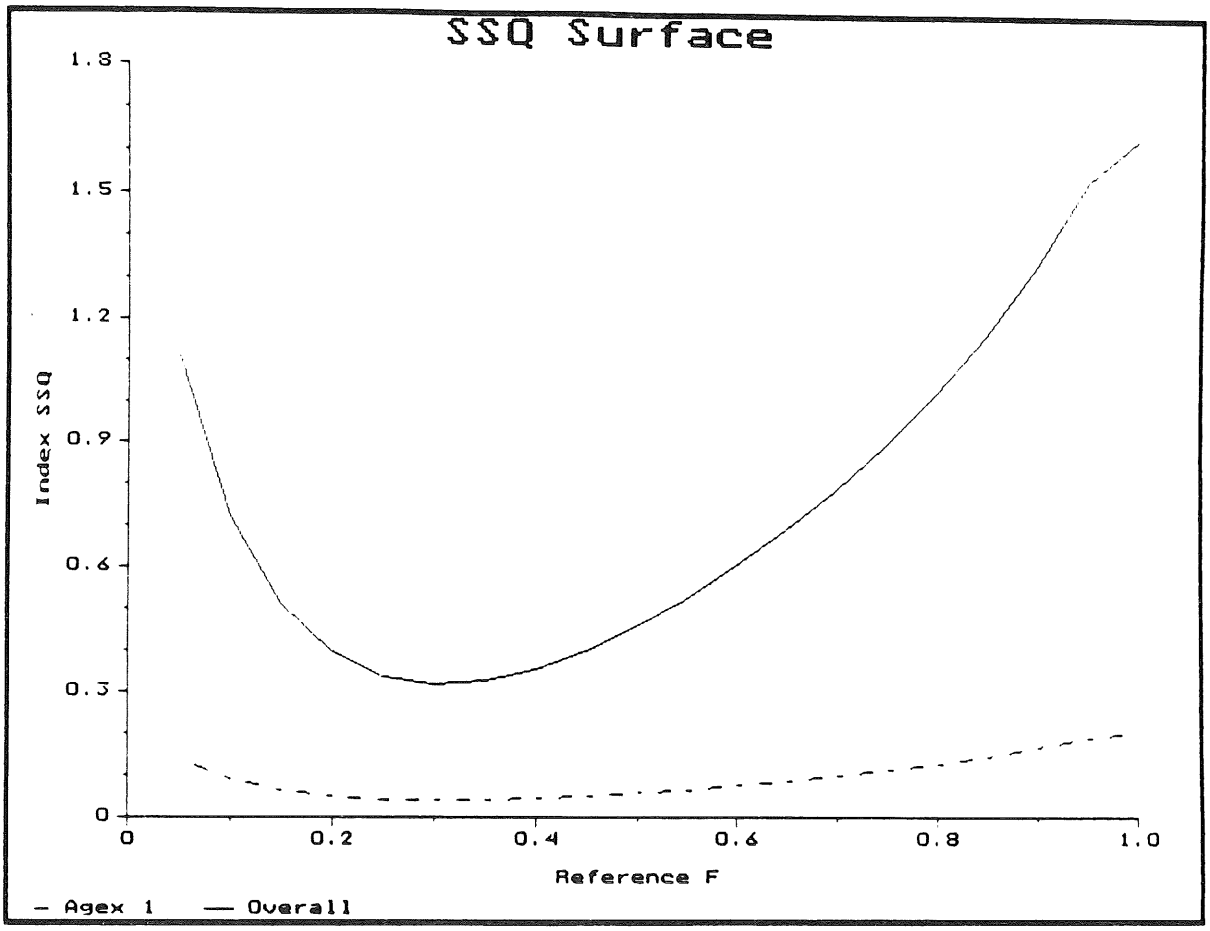
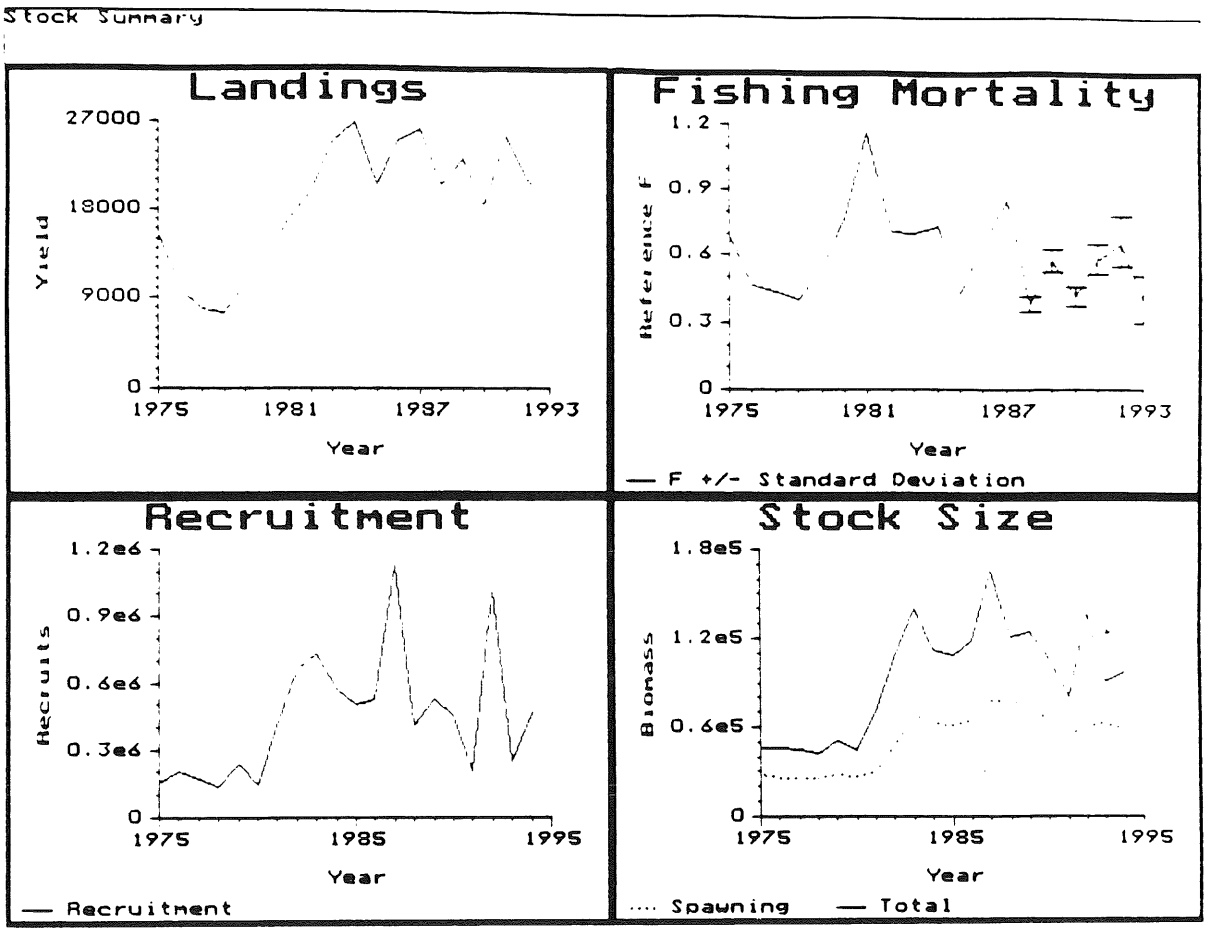


Figure 4.4.1 Celtic Sea Division VIIj


Stock Summary
Landings
27000
18000
9000
0
Yield
1975
1981
1987
1993
Year
Fishing Mortality
1.2
0.9
0.6
0.3
0
Reference F
1975
1981
1987
1993
Year
— F +/- Standard Deviation
Recruitment
1.2e6
0.9e6
0.6e6
0.3e6
0
Recruits
1975
1985
1995
Year
— Recruitment
Stock Size
1.8e5
1.2e5
0.6e5
0
Biomass
1975
1985
1995
Year
···· Spawning — Total

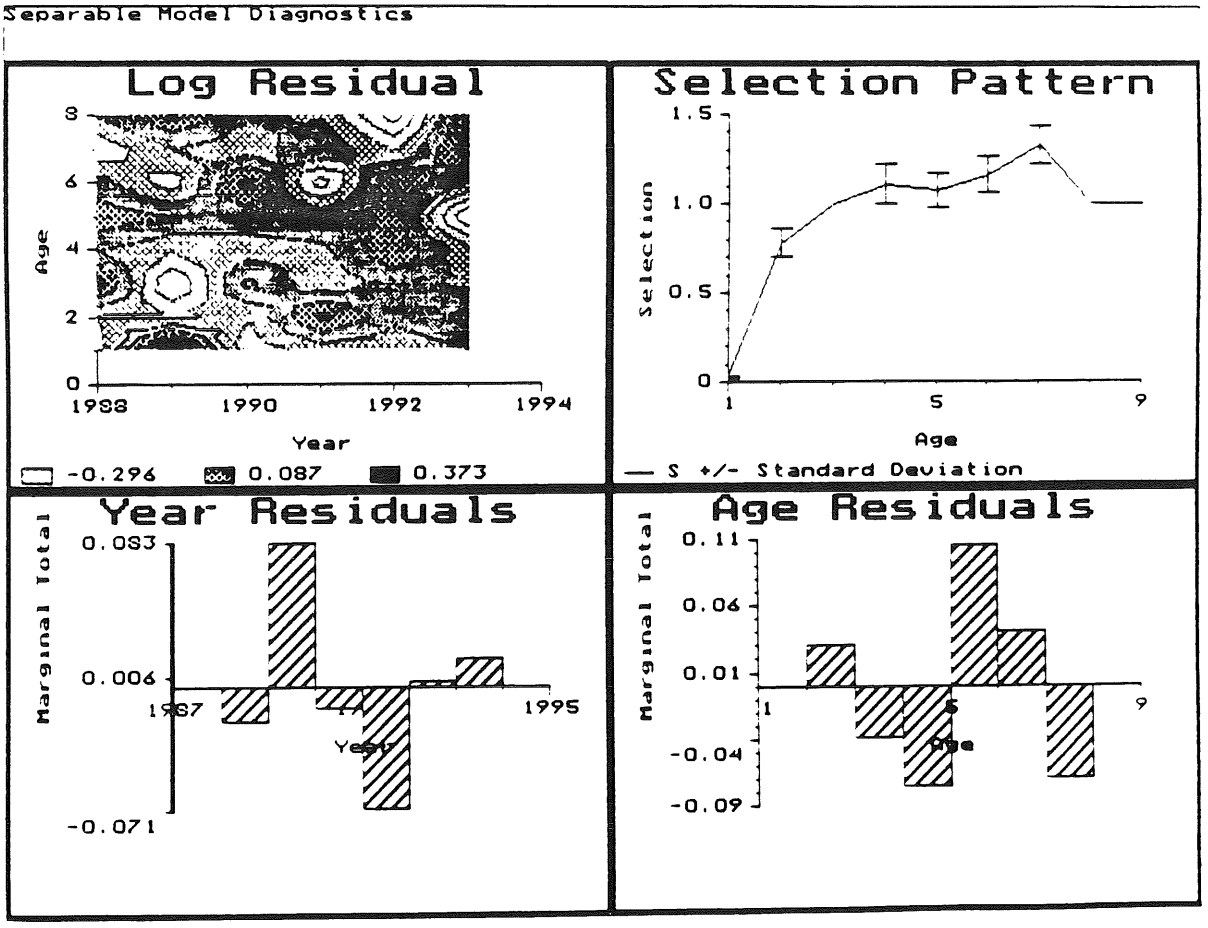
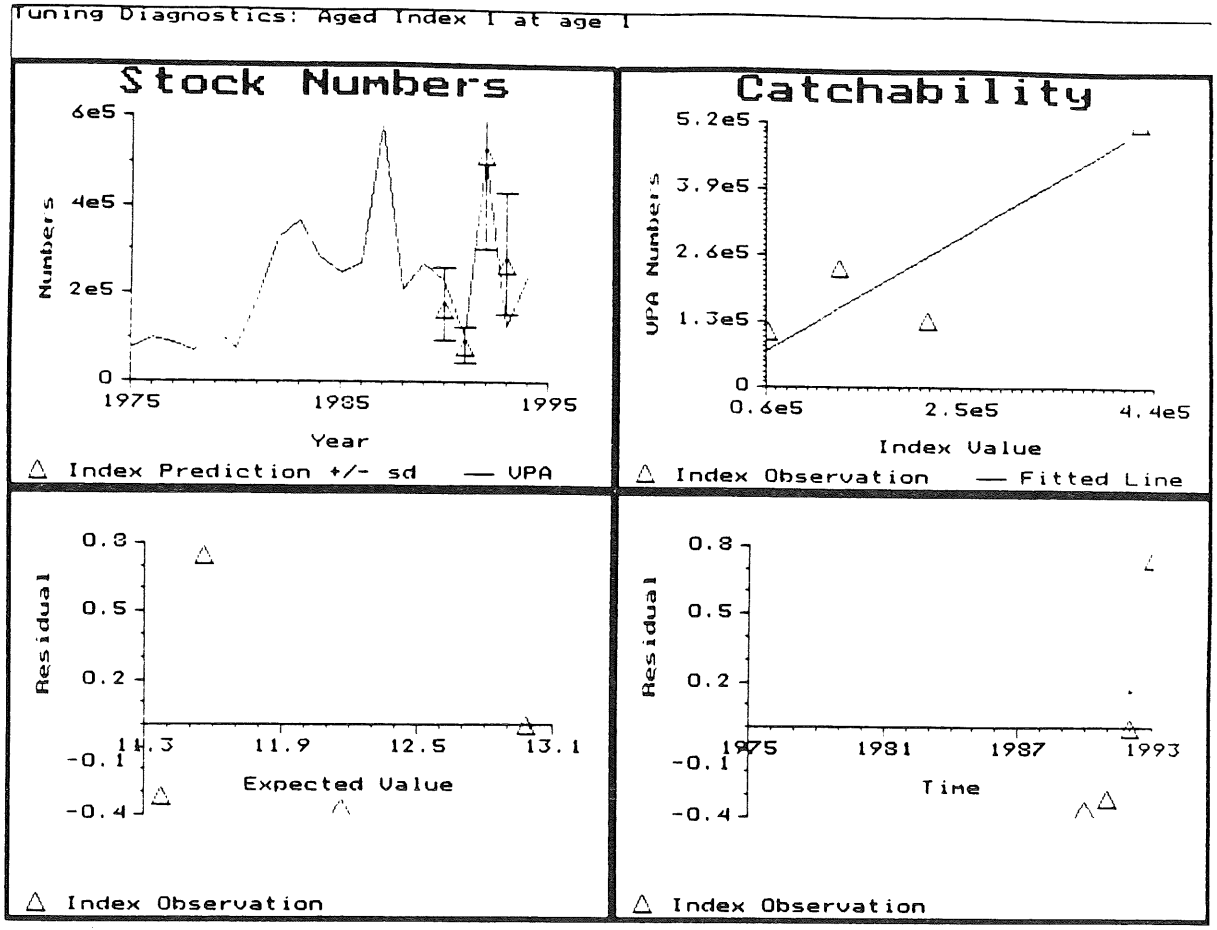

Separable Model Diagnostics
Log Residual
8
6
4
2
0
Age
1988
1990
1992
1994
Year
-0.296
0.087
0.373
Selection Pattern
1.5
1.0
0.5
0
Selection
1
5
9
Age
— S +/- Standard Deviation
Year Residuals
0.083
0.006
-0.071
Marginal Total
1987
1995
Year
Age Residuals
0.11
0.06
0.01
-0.04
-0.09
Marginal Total
1
5
9
Age

Figure 4.4.2


Tuning Diagnostics: Aged Index 1 at age 1
Stock Numbers
Numbers
6e5
4e5
2e5
0
1975
1985
1995
Year
Index Prediction +/- sd
VPA
Catchability
UPA Numbers
5.2e5
3.9e5
2.6e5
1.3e5
0
0.6e5
2.5e5
4.4e5
Index Value
Index Observation
Fitted Line
Residual
0.8
0.5
0.2
-0.1
-0.4
11.3
11.9
12.5
13.1
Expected Value
Index Observation
1975
1981
1987
1993
Time
Index Observation

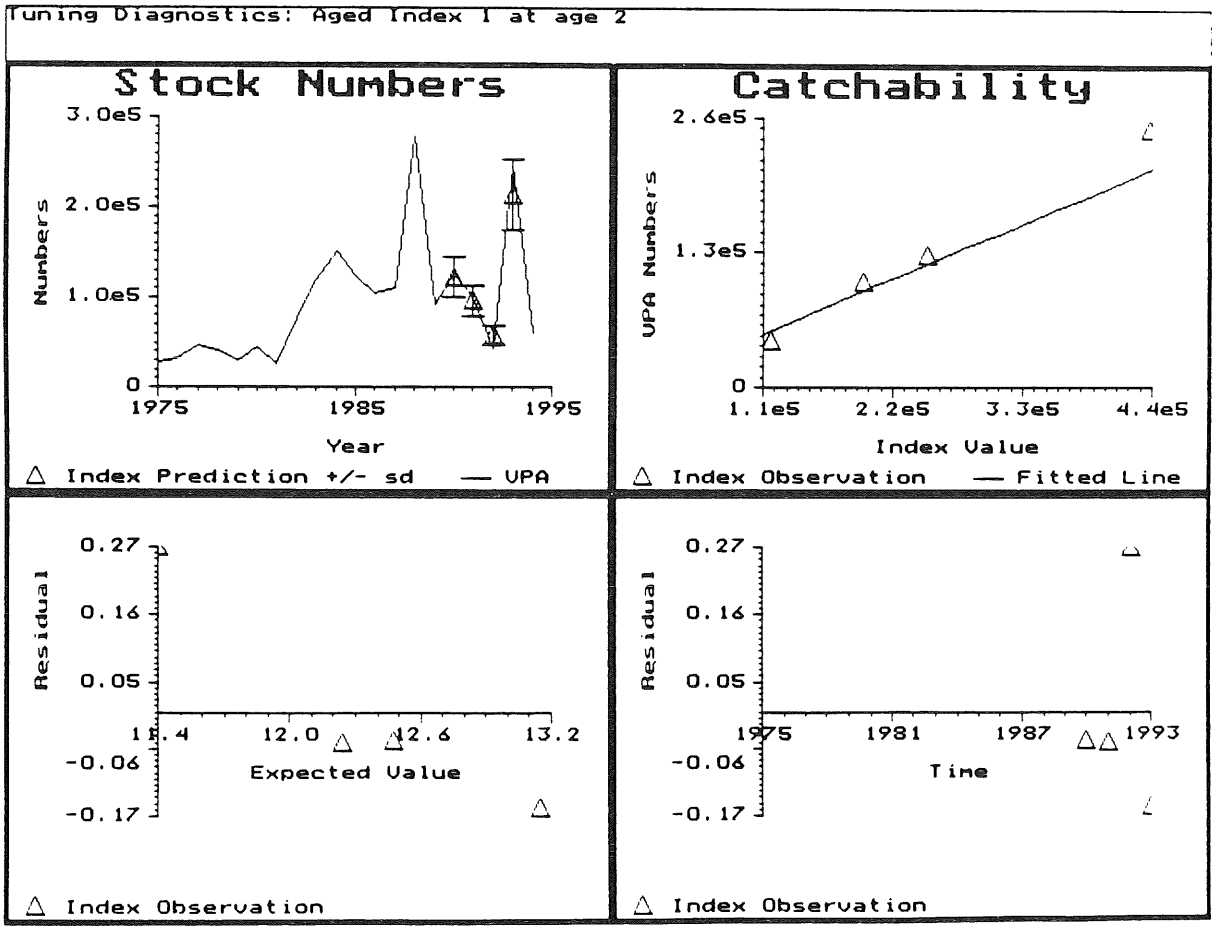
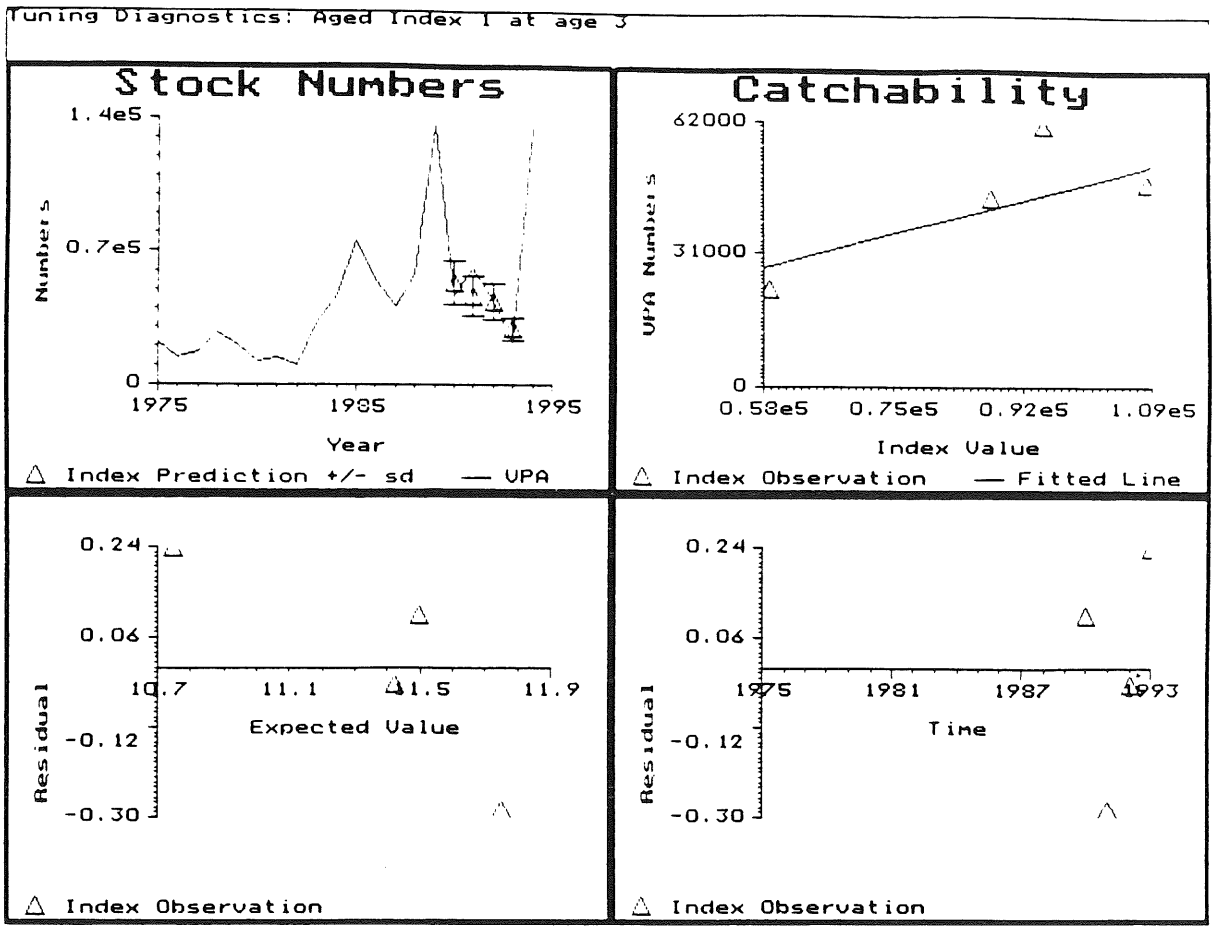

Tuning Diagnostics: Aged Index 1 at age 2
Stock Numbers
Numbers
3.0e5
2.0e5
1.0e5
0
1975
1985
1995
Year
Index Prediction +/- sd
VPA
Catchability
UPA Numbers
2.6e5
1.3e5
0
1.1e5
2.2e5
3.3e5
4.4e5
Index Value
Index Observation
Fitted Line
Residual
0.27
0.16
0.05
-0.06
-0.17
11.4
12.0
12.6
13.2
Expected Value
Index Observation
1975
1981
1987
1993
Time
Index Observation

Figure 4.4.3



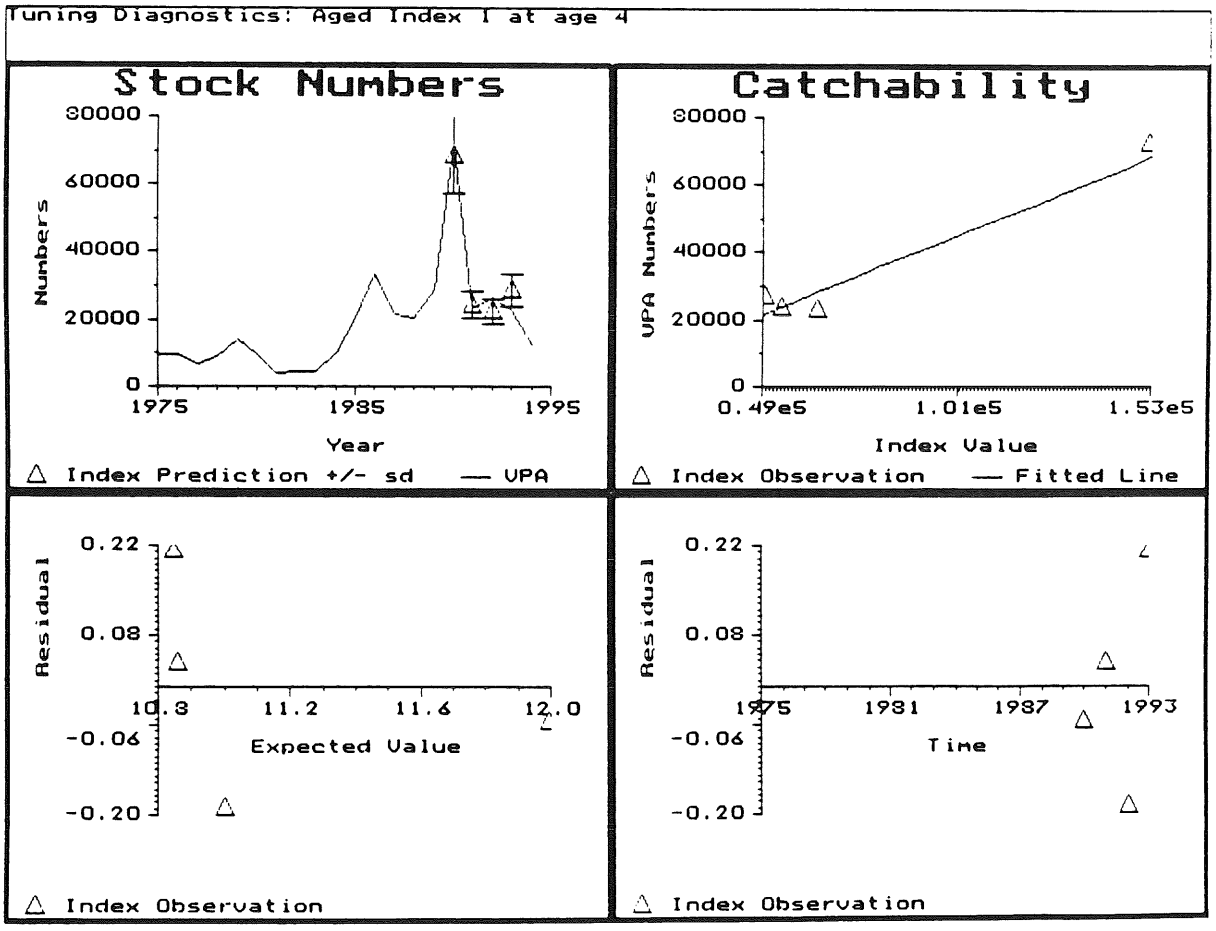
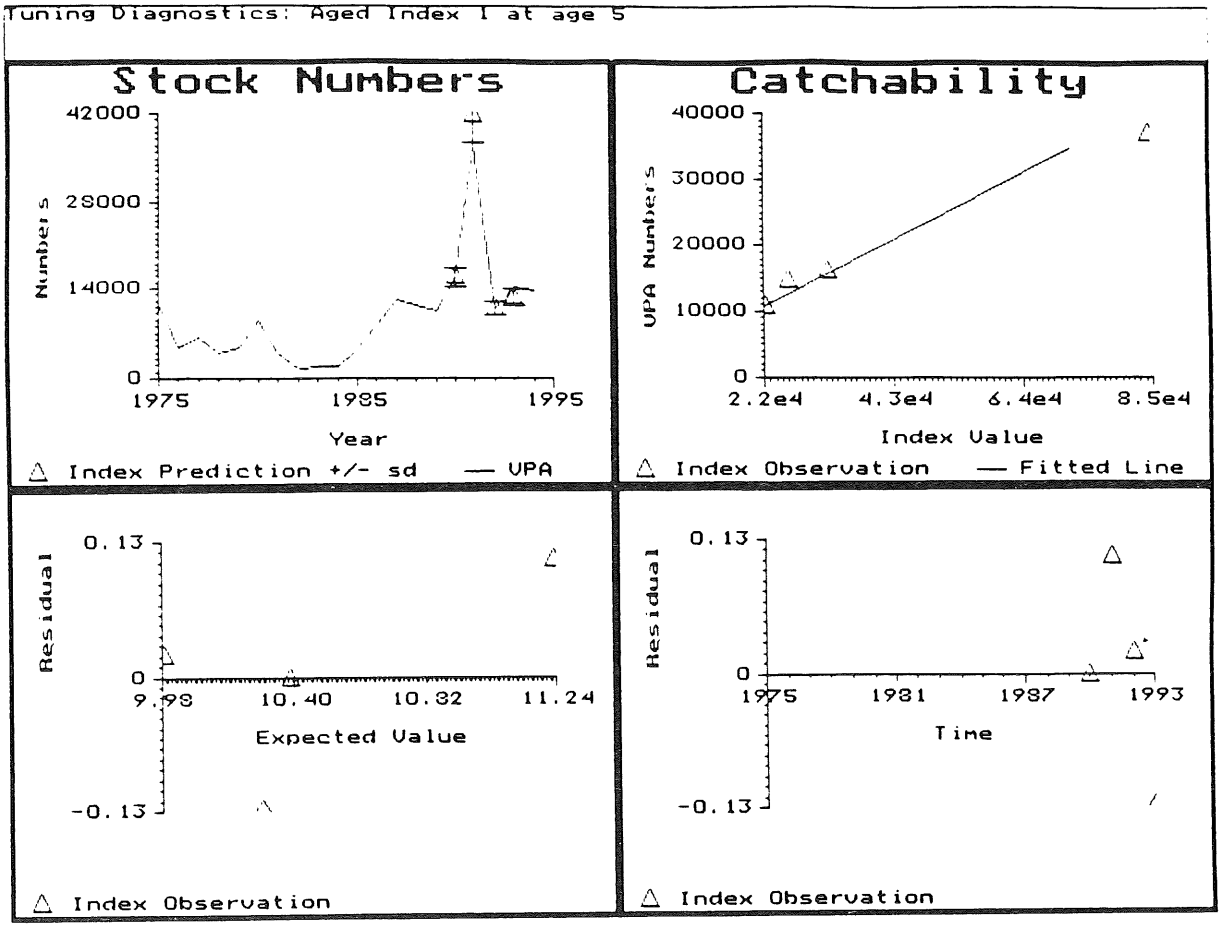


Figure 4.4.3 (Continued)



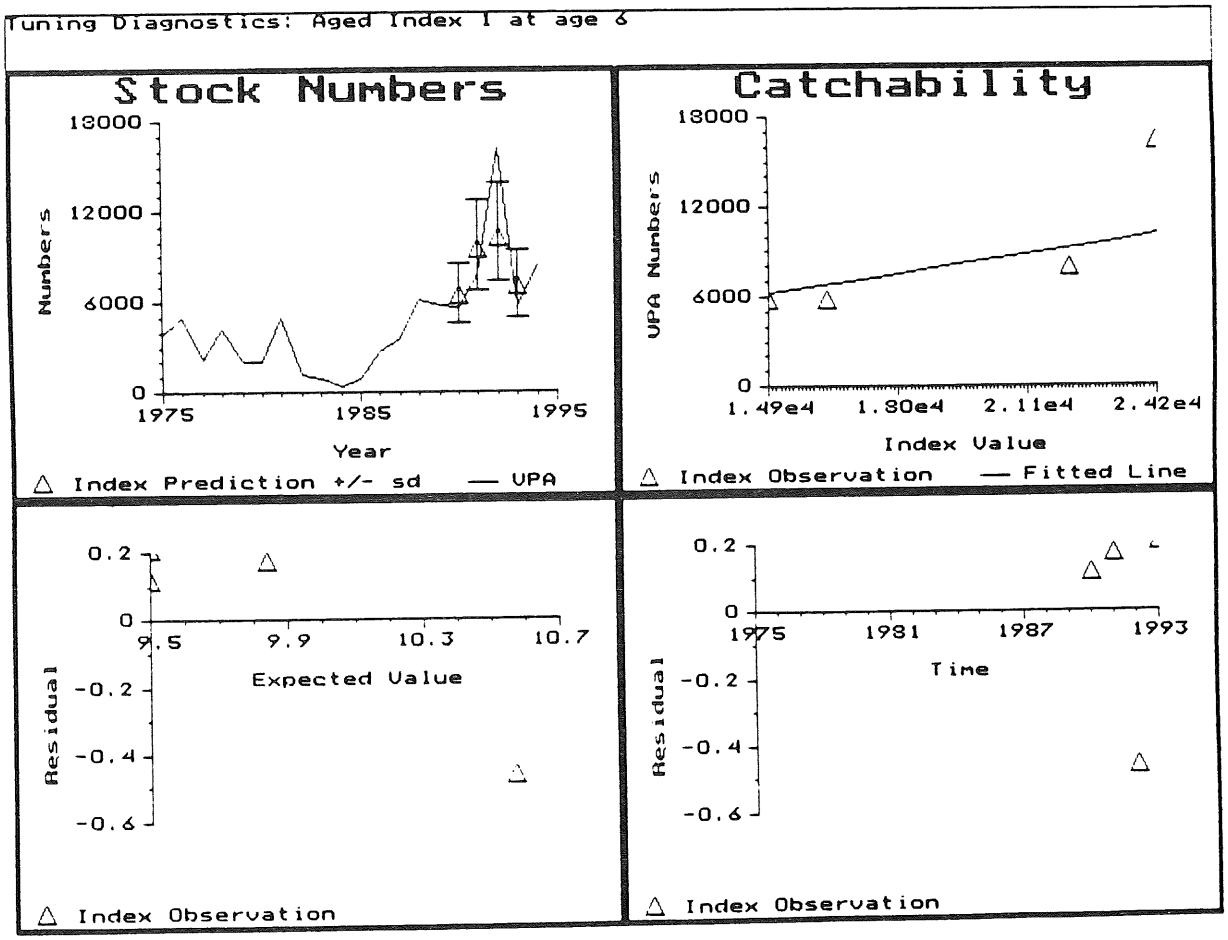
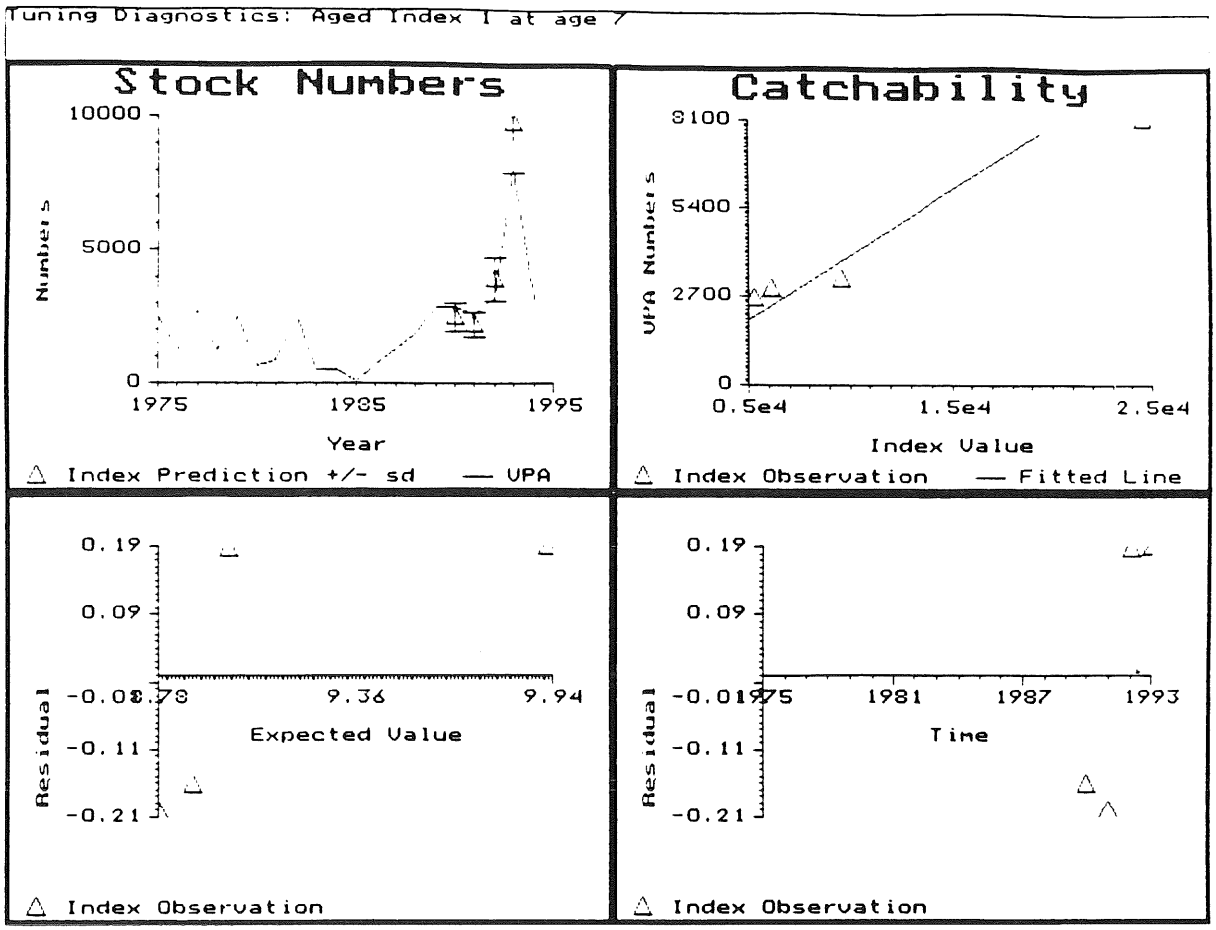


Figure 4.4.3 (Continued)



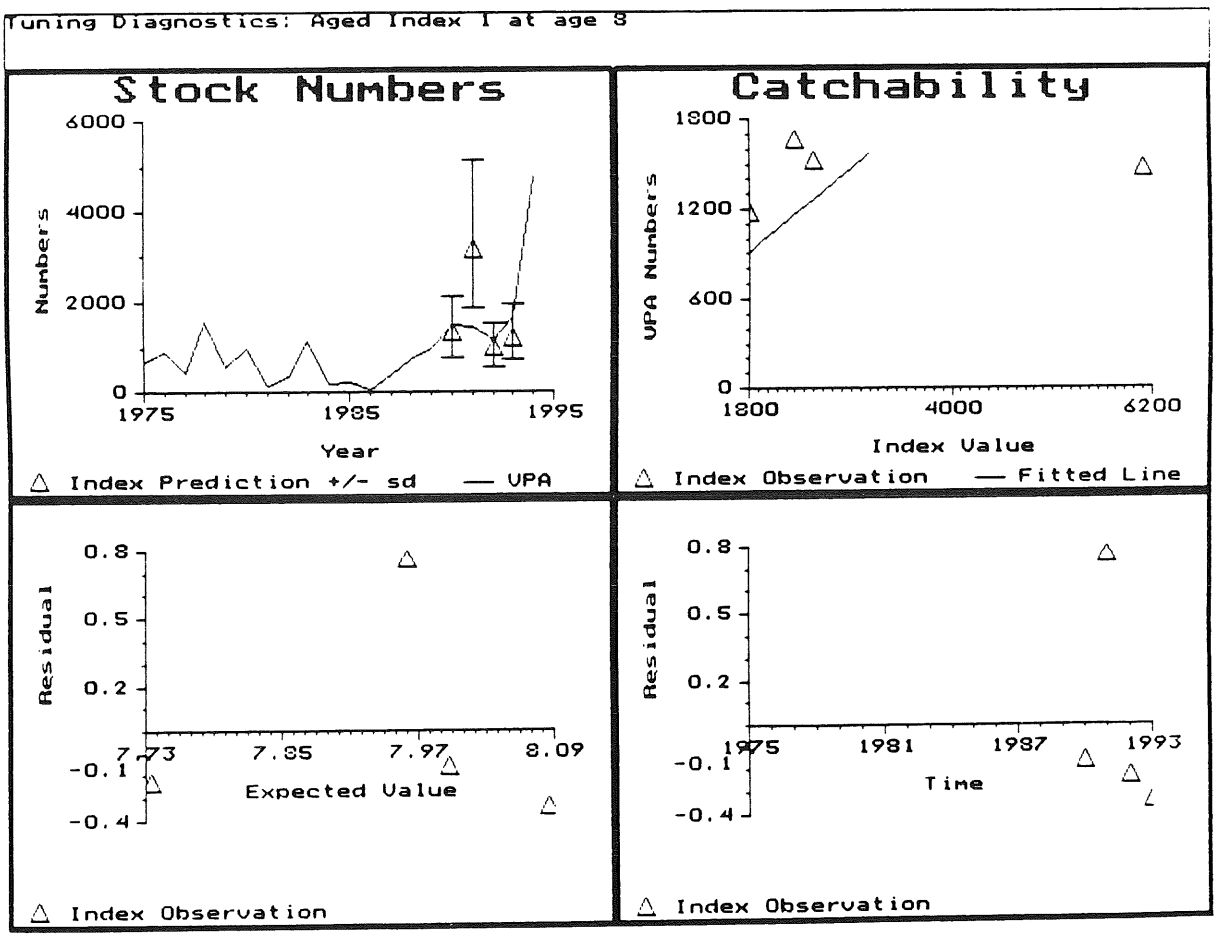


Figure 4.4.3 (Continued)

FISH STOCK SUMMARY
STOCK: Herring South and South West of Ireland (Fishing Areas VIIg–j)
30–3–1994

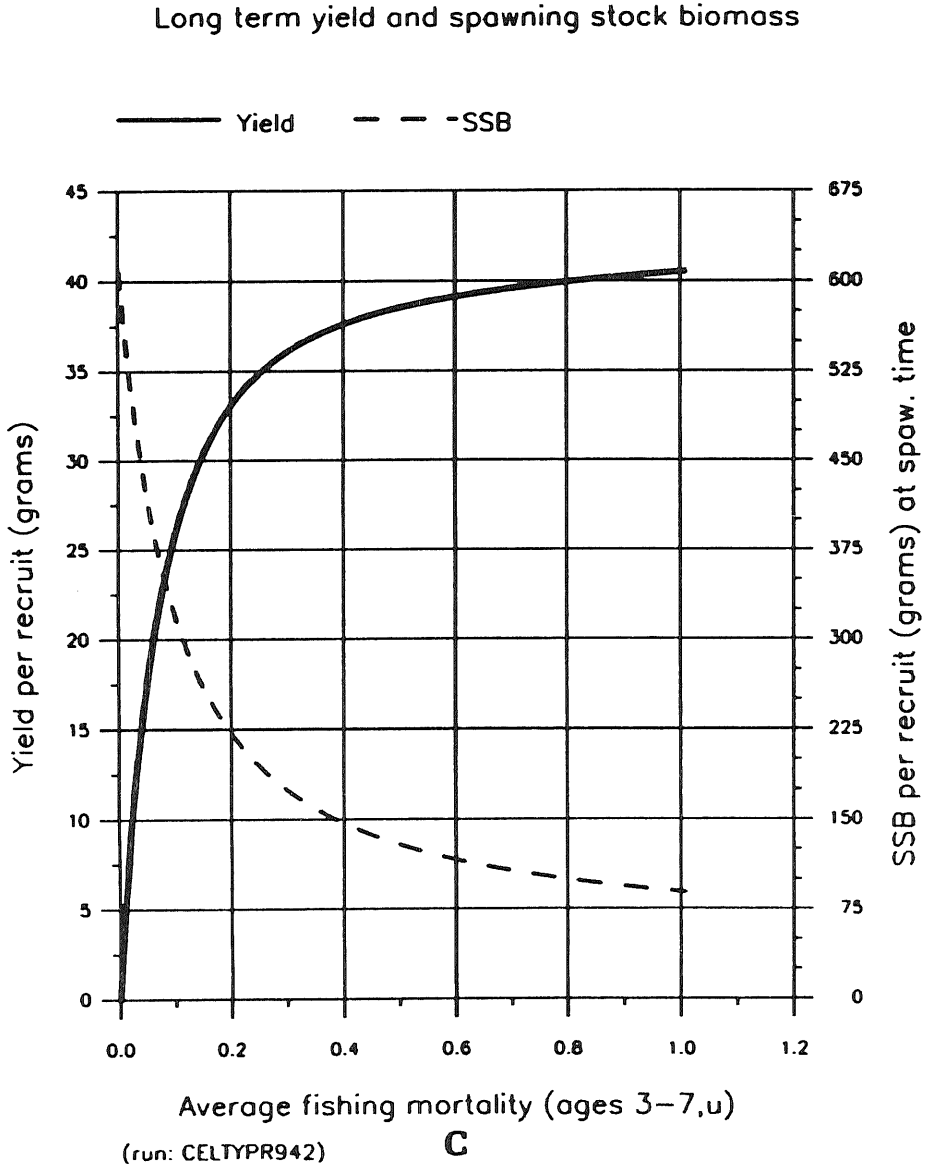


Figure 4.6.1 Celtic Sea - Division VIIj. Yield / recruit.

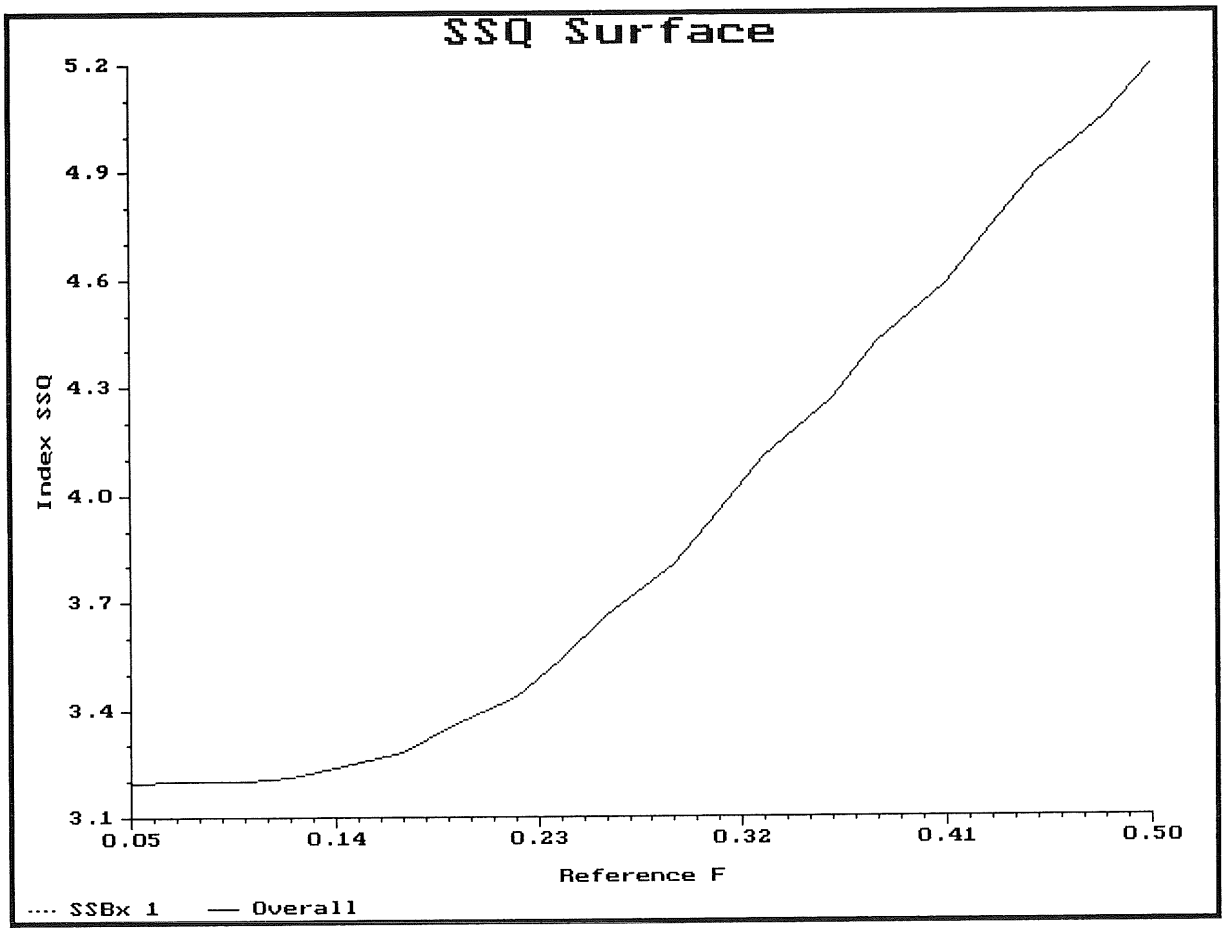


Figure 5.1.1. Sums of squares surface for the larval production estimate. Twenty independent conventional separable VPAs have been fitted to the catch at age data with a range of values of fishing mortality at age 3 from 0.05 to 1.5. For each calculated time series of spawning biomasses, a simple double-logarithmic regression of LAI on SSB was fitted. Sums of residuals of these regressions are plotted above, showing that the LAI index used in this way is uninformative as to current-year fishing mortality.

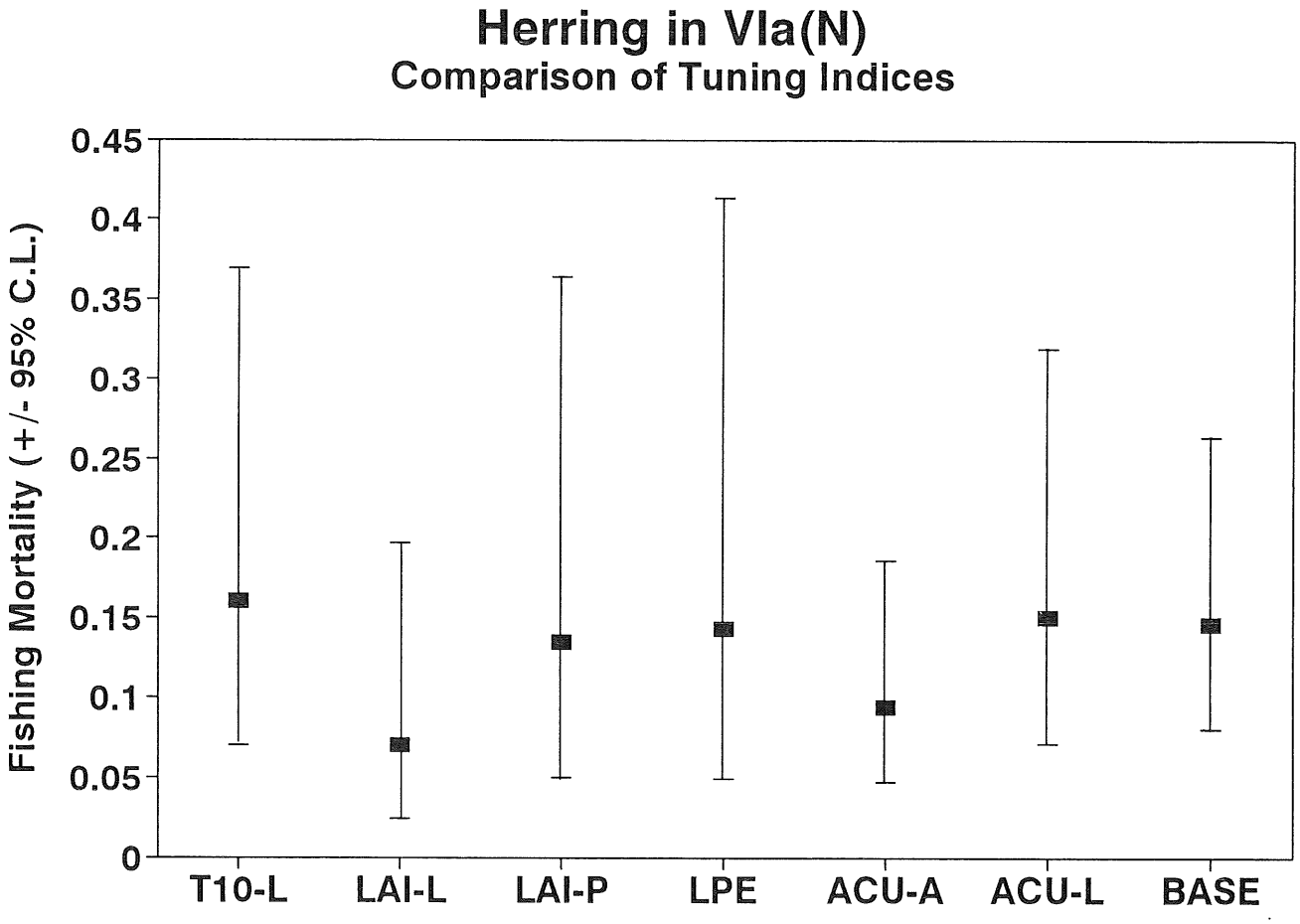


Figure 5.1.2. Estimates of fishing mortality at age 3 in population models fitted to the 10% trimmed mean of larval abundances (T10), the conventional larval abundance index (LAI-L, proportionate model; LAI-P, power model), the larval production estimate (LPE, in proportionate model), the acoustic survey used as an absolute estimator of abundance (ACU-A) and the acoustic survey used as a proportionate measure of abundance (ACU-L). In these independent model fits, the indices were given a high weight (=5) relative to the catch-at-age observations. Lastly, the estimate from the baseline fit in which the LPE index and the acoustic survey (used as a proportionate measure of abundance) are given equal weight to observations of catches at age (LAI+ACU-L).

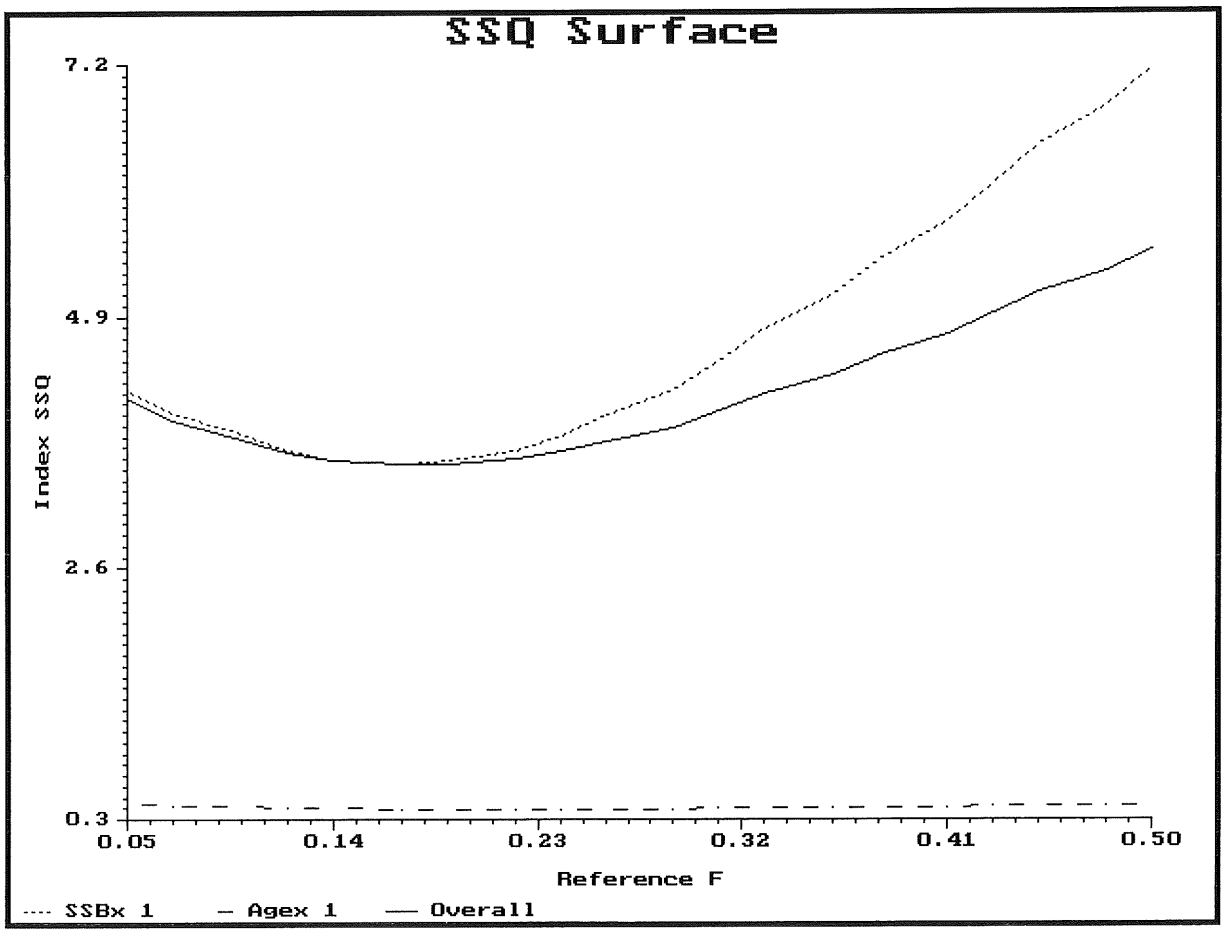


Figure 5.1.3. Sums of squares surface for the baseline model fit. Residuals calculated as for Figure 5.1.1. are plotted, but for the acoustic survey treated as a proportionate measure of stock size (Agex 1) and the larval abundance index (SSBx 1). This is for illustrative purposes only: the baseline assessment is calculated using a 38-dimensional minimisation.

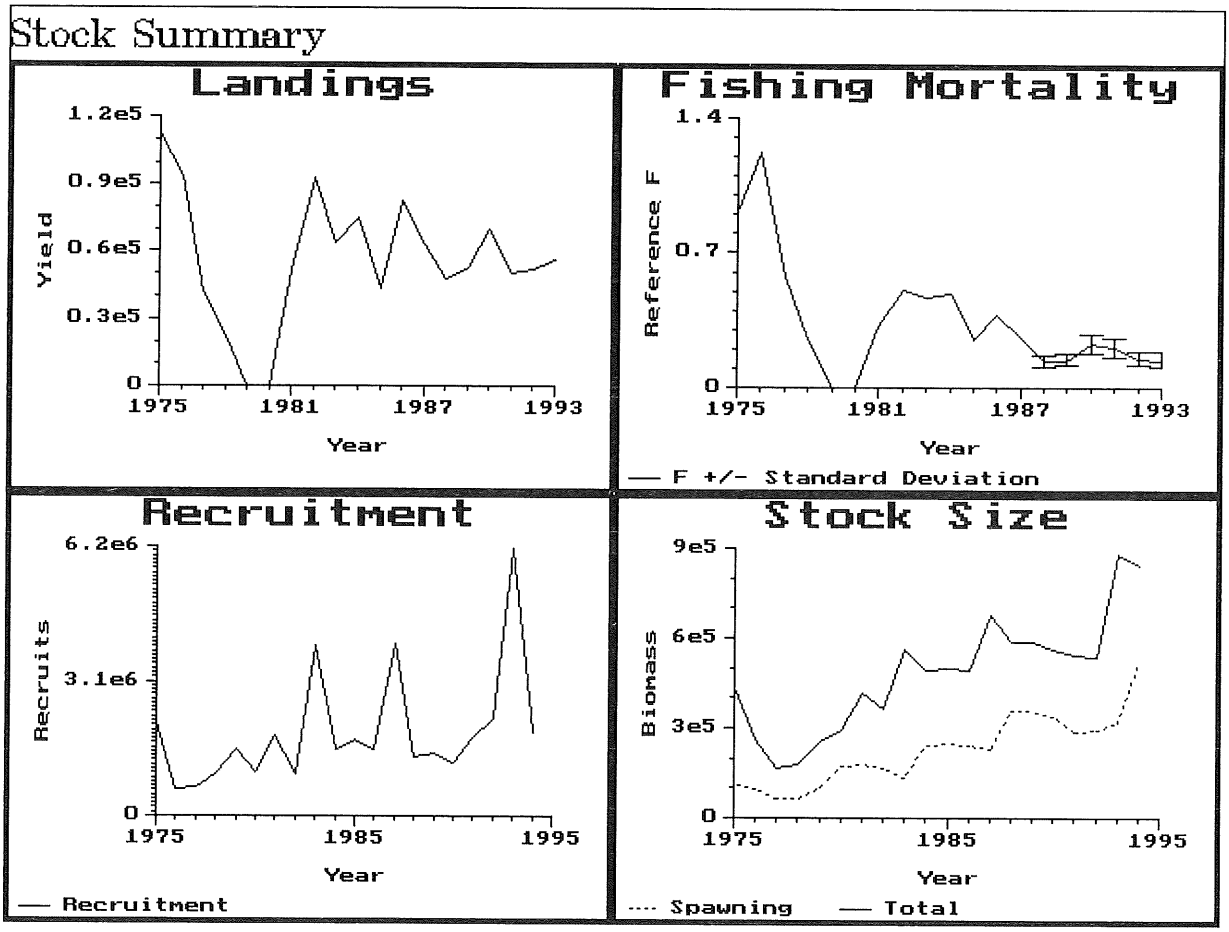


Figure 5.1.4. Results of baseline assessment. Summary of estimates of landings, fishing mortality at age 3, recruitment at age 1, stock size on 1 January and spawning stock size at spawning time.

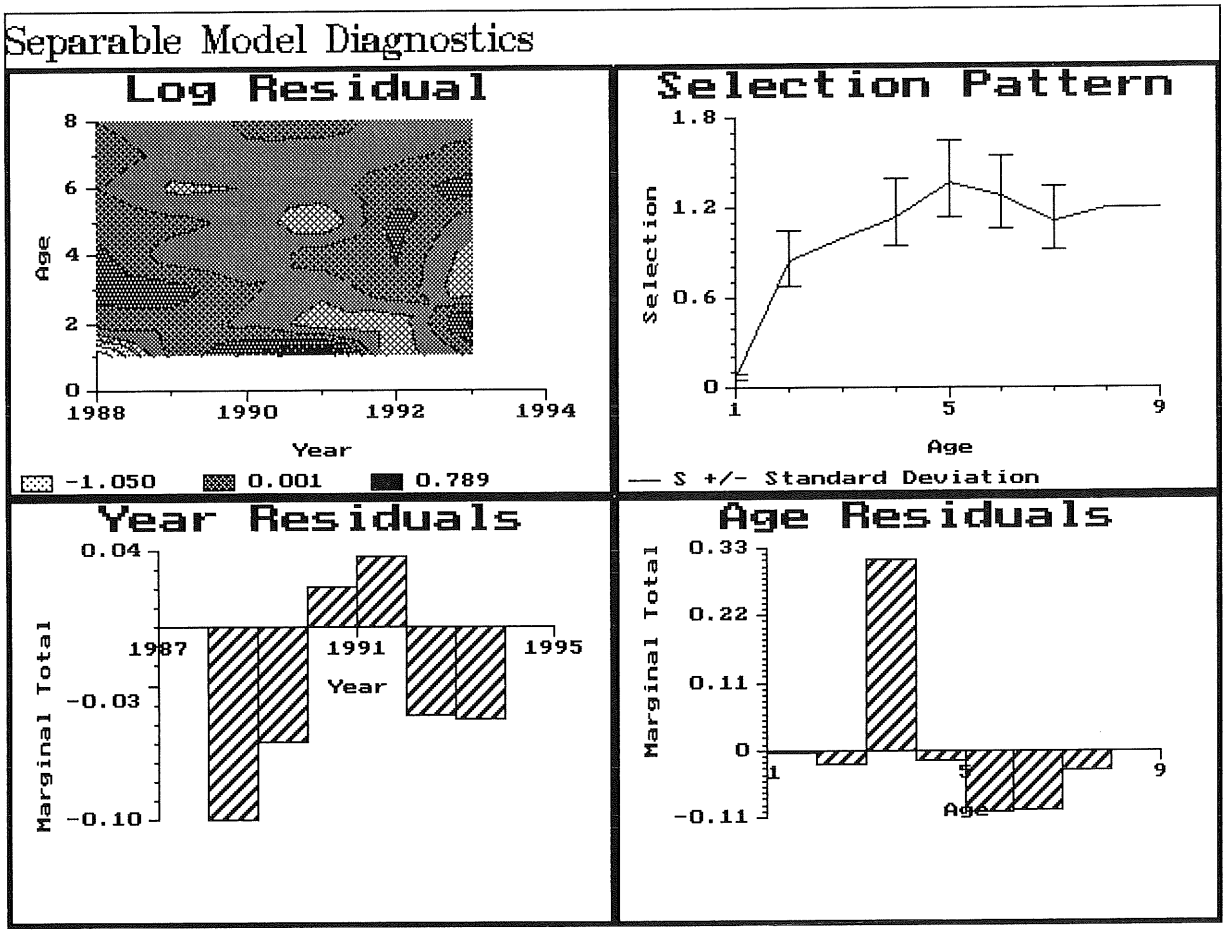


Figure 5.1.5. Results of baseline assessment. Selection pattern diagnostics. The model is driven by both the tuning indices and the catches at age: the above diagnostics indicate how well the resultant fit agrees with the observed catches at age. Overall the residuals are not large, but the highest values are along age 1; it appears there is increasing fishing mortality on this age since 1991.

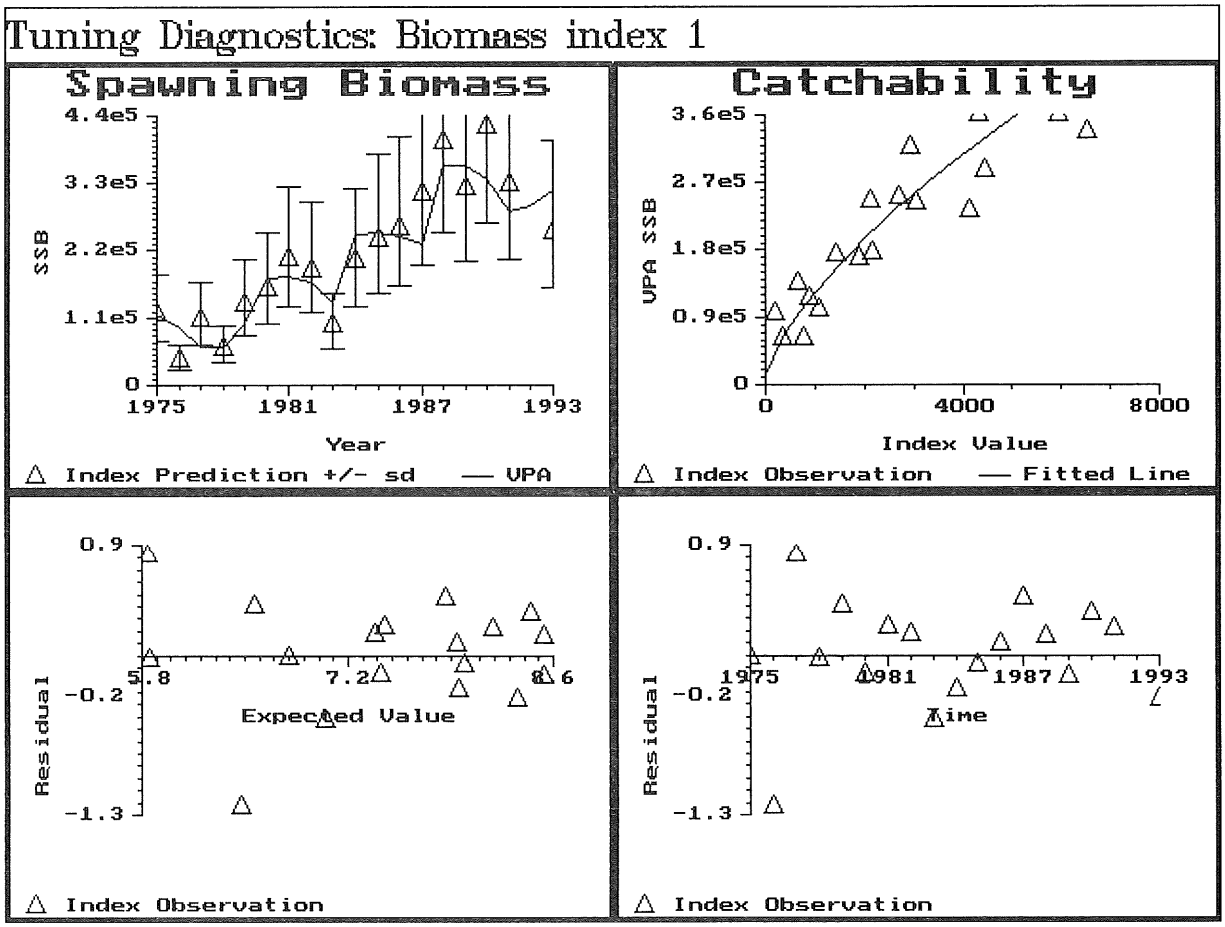


Figure 5.1.6. Results of the baseline assessment. Diagnostics of the fit of the larval abundance index against the estimated spawning biomass. The fit appears generally well-behaved with no marked trends in the residuals either with time or against expected values.

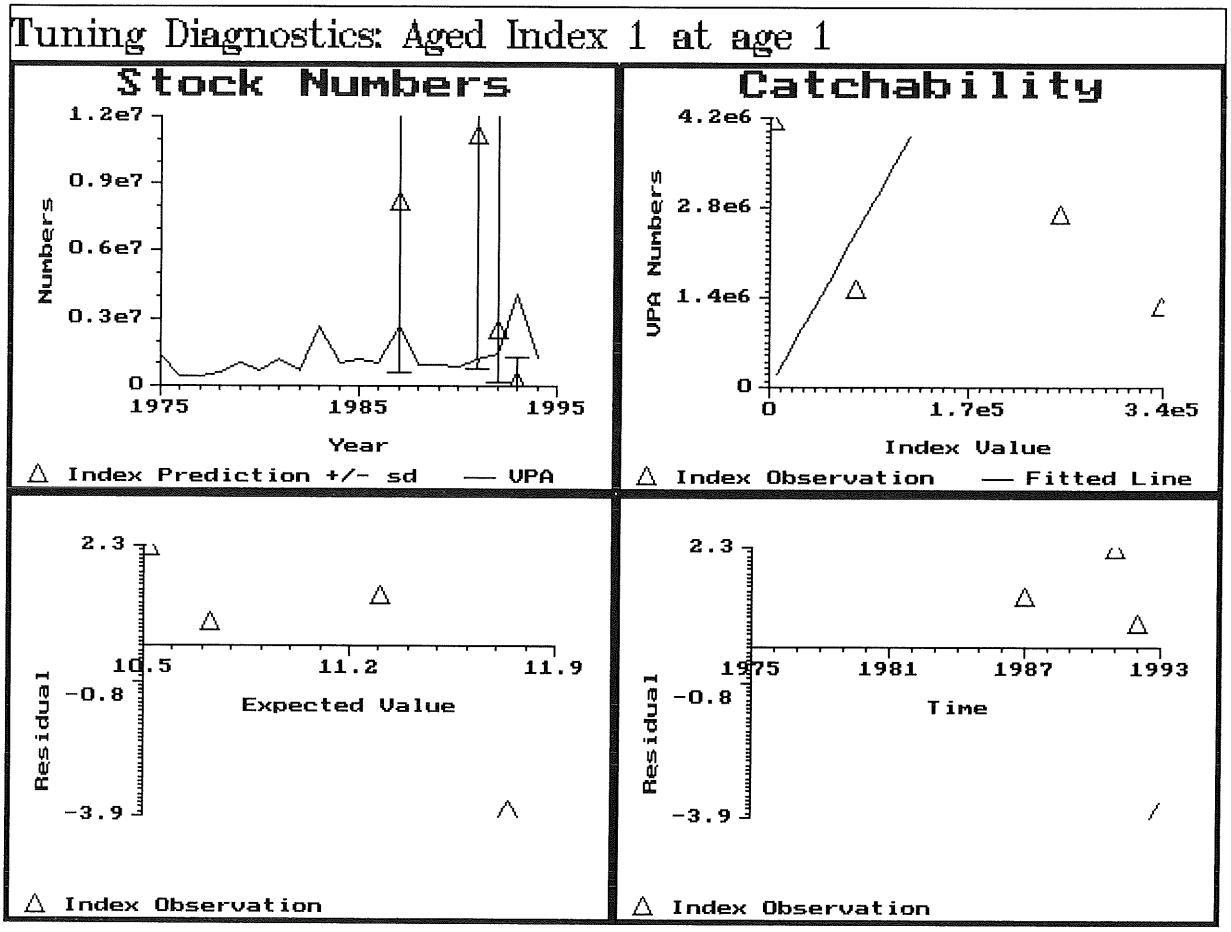


Figure 5.1.7. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 1 against the estimated populations. The fit is poor, and has effectively been downweighted out of the analysis. It is included here for illustration only.

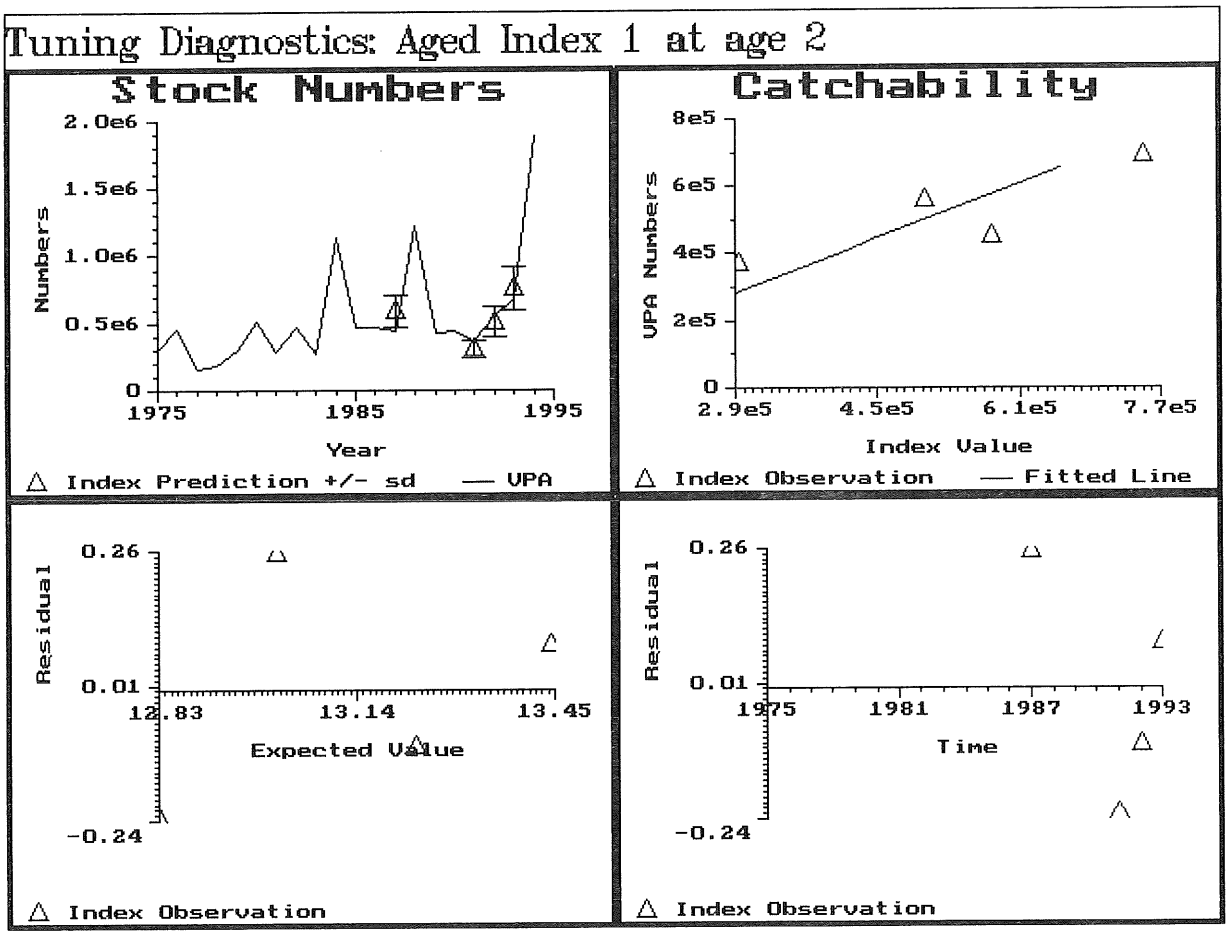


Figure 5.1.8. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 2 against the estimated populations. There are few values, but the fit seems reasonable.

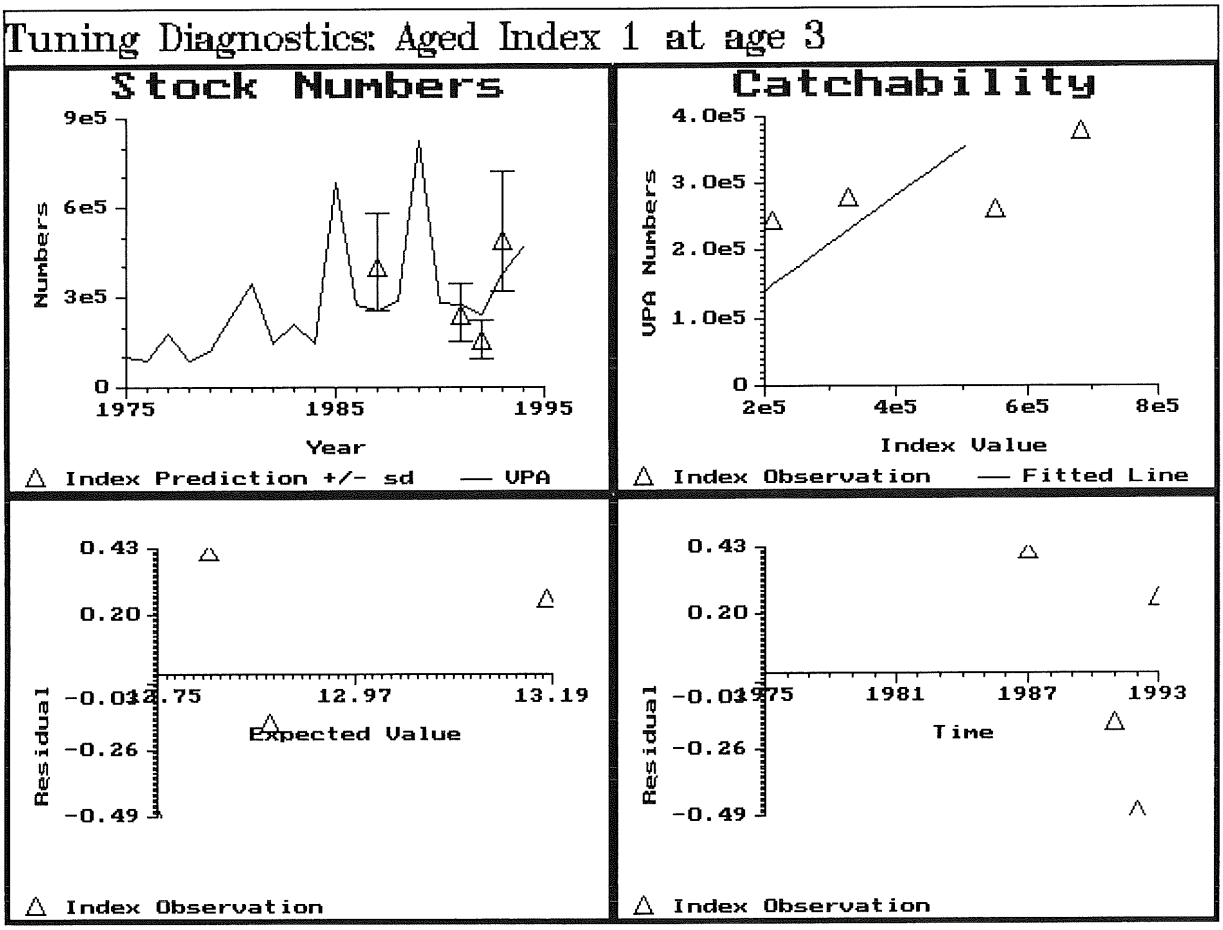


Figure 5.1.9. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 3 against the estimated populations. Although there are few values, the fit appears generally reasonable.

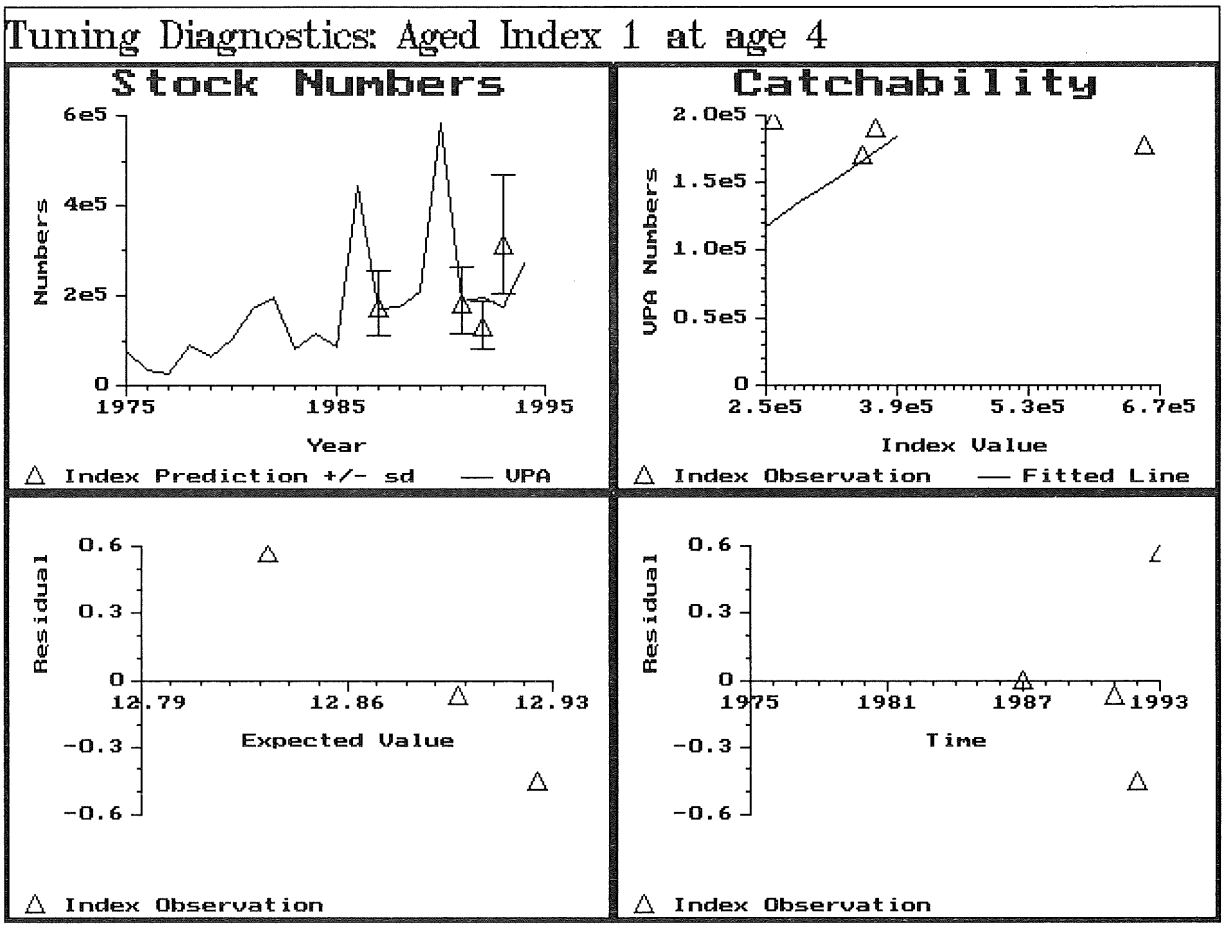


Figure 5.1.10. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 4 against the estimated populations. There is apprently an outlying high value at age 4 in 1993, which has not driven the model very strongly.

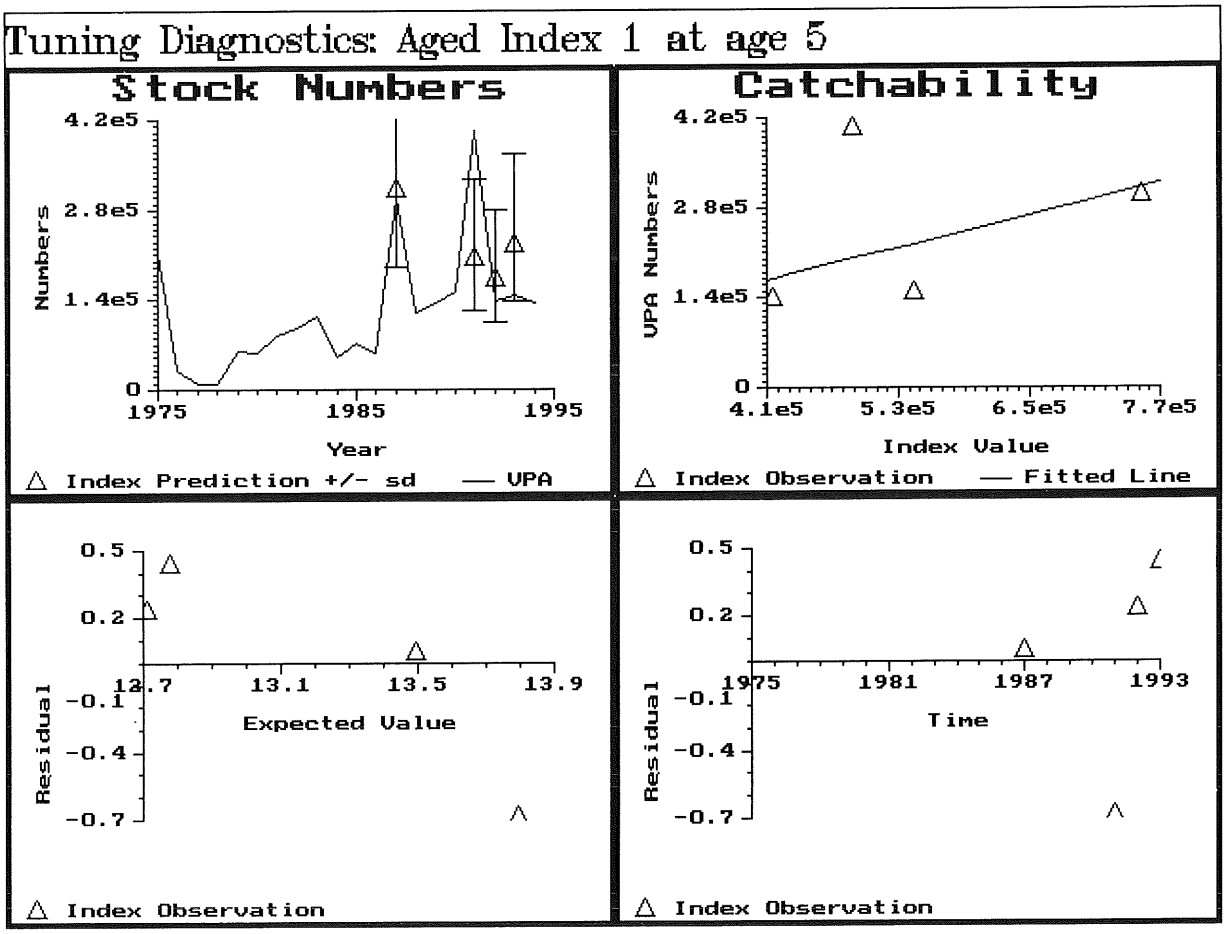


Figure 5.1.11. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 5 against the estimated populations. The model has fitted poorly to the populations at this age, and the estimate of the proportionality coefficient $Q_{ACOUST,4}$ is highly uncertain. The acoustic index has recorded a low abundance at age 5 in 1993, but this has coincided with the model fit.

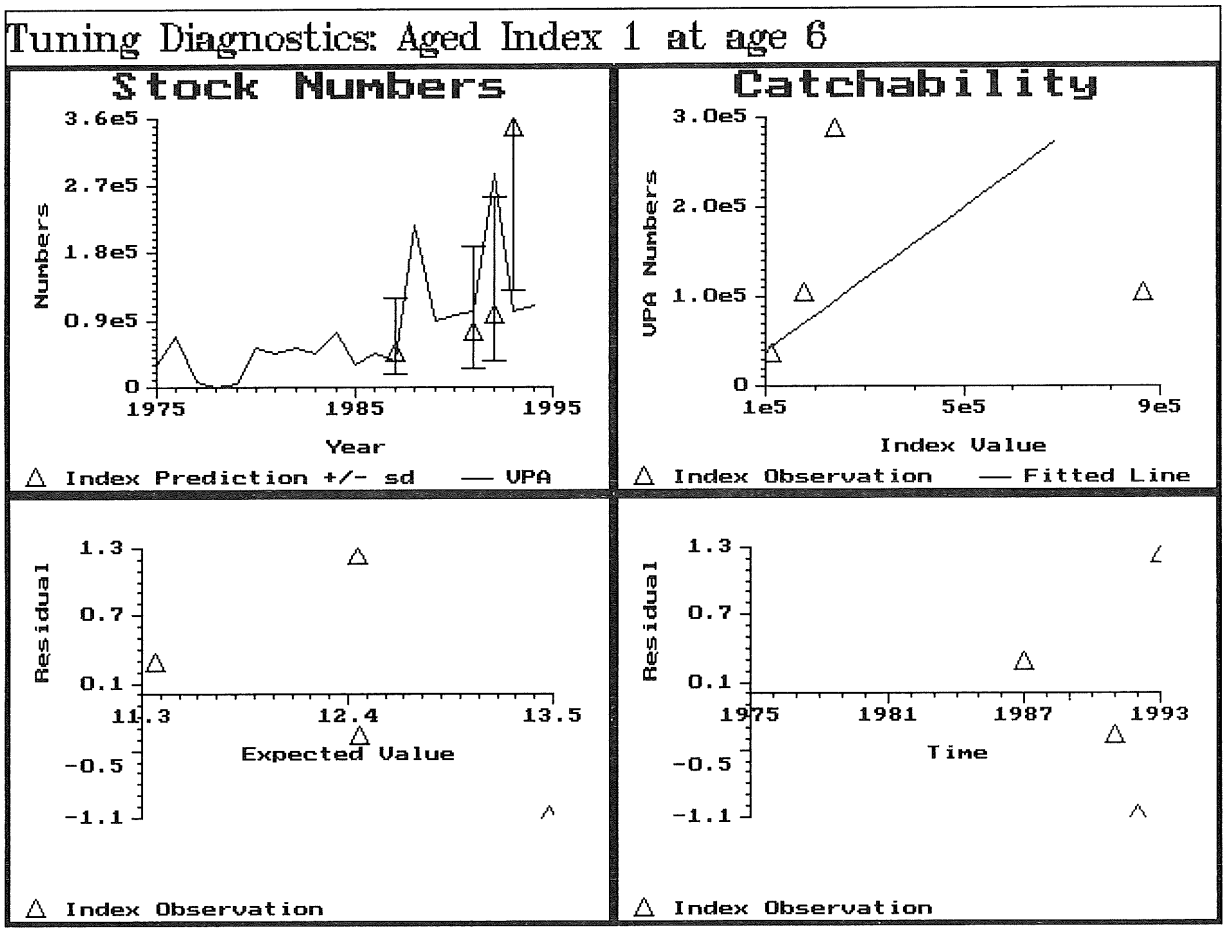


Figure 5.1.12. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 6 against the estimated populations. Acoustic index and estimated populations coincide well at this age.

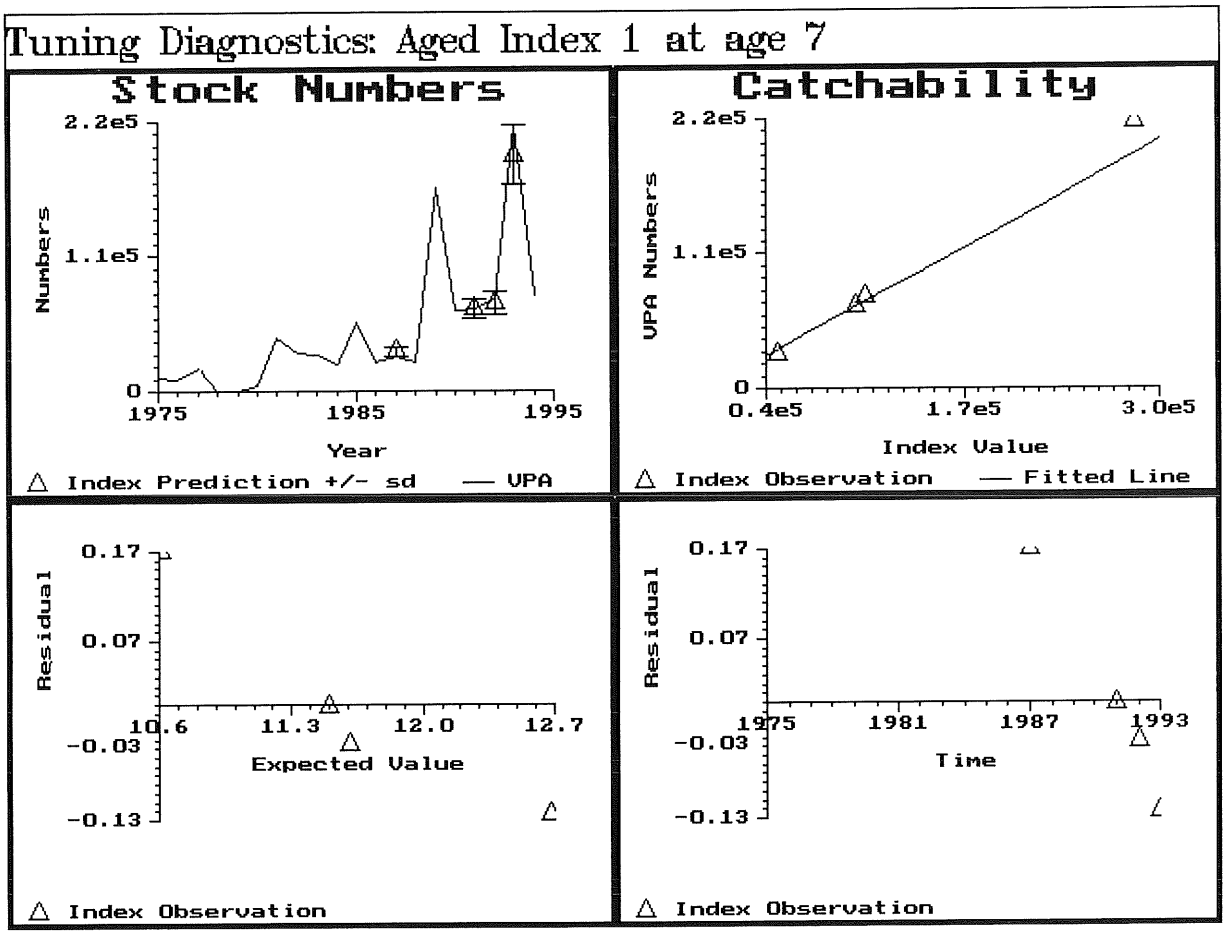


Figure 5.1.13. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 7 against the estimated populations. Acoustic index and estimated populations coincide well at this age.

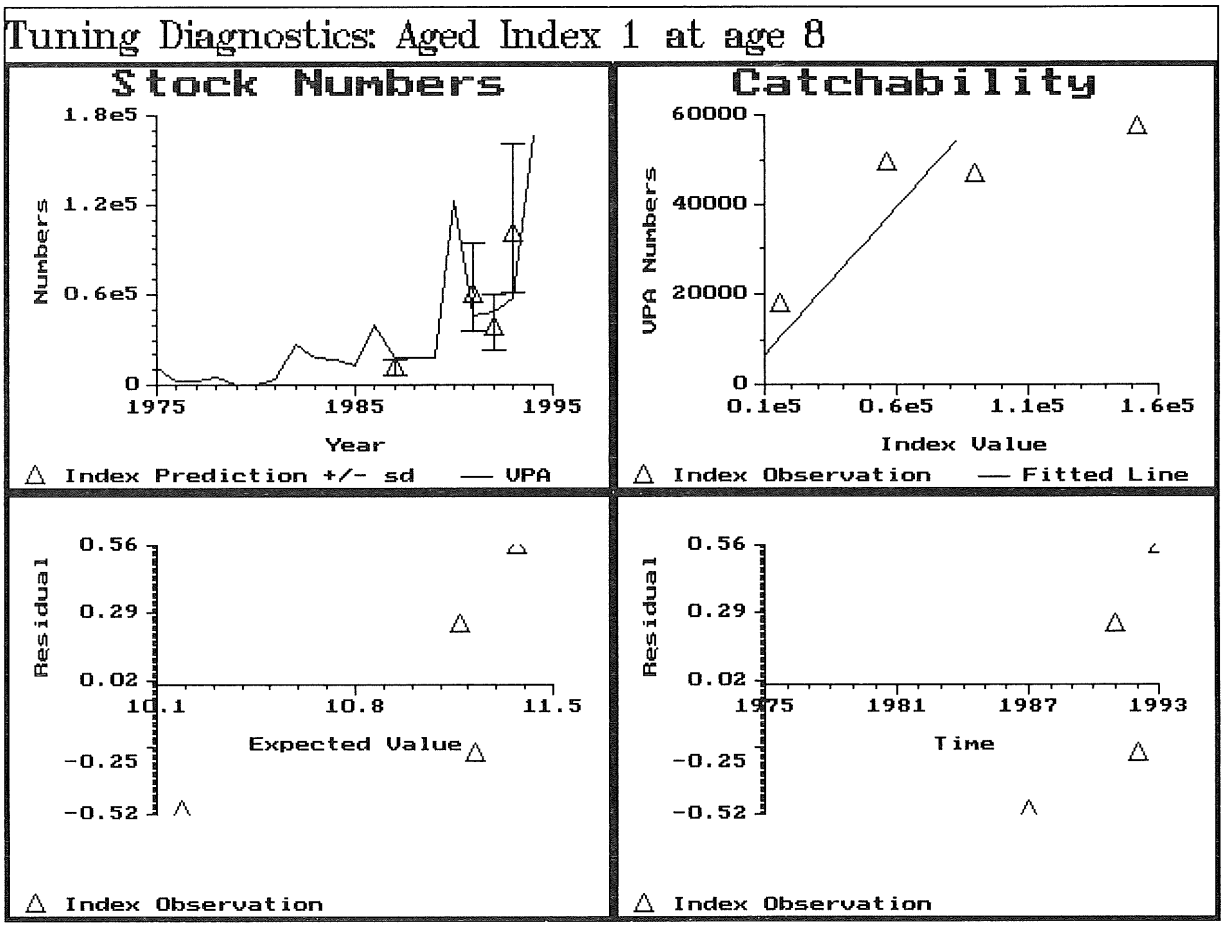


Figure 5.1.14. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 8 against the estimated populations. The index seems rather more variable at this age.

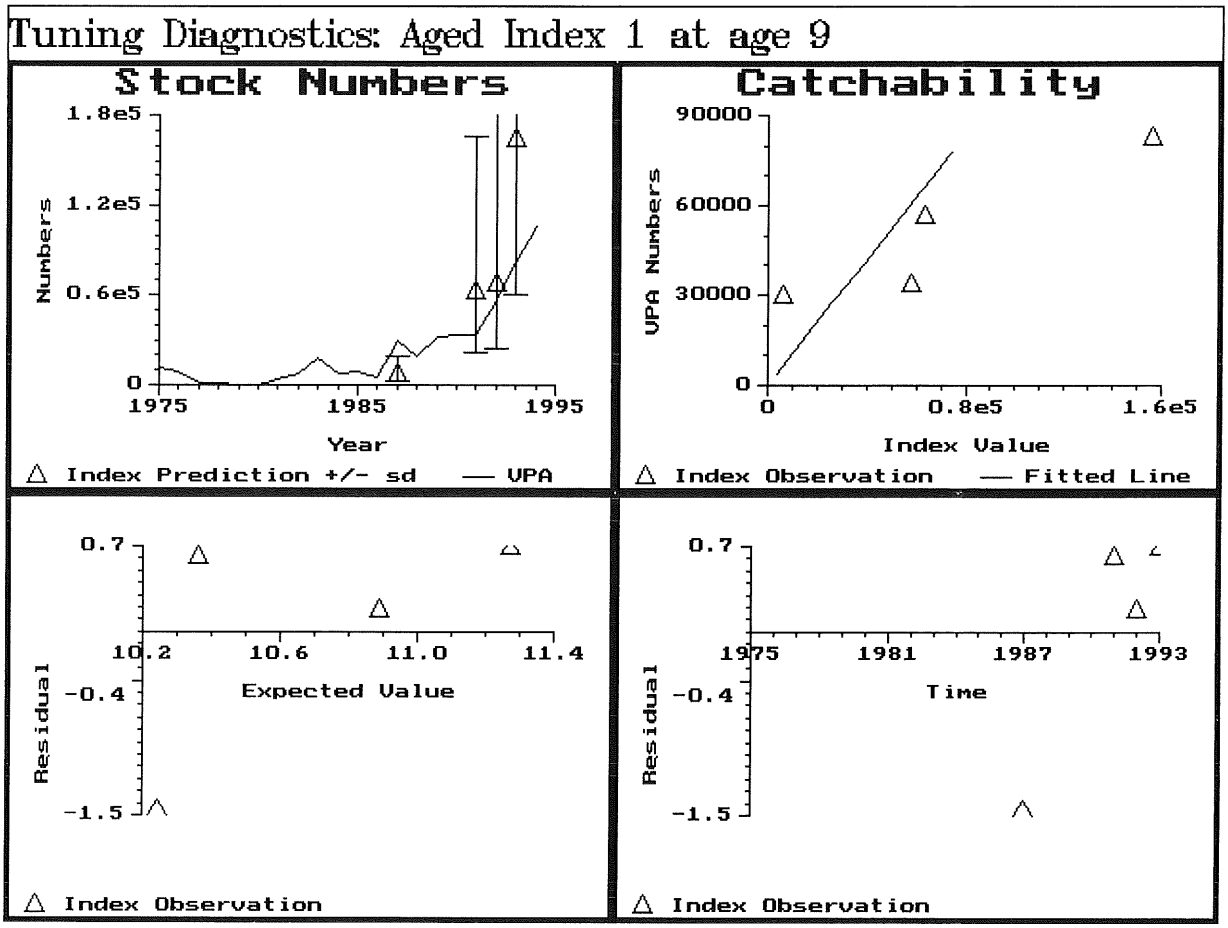


Figure 5.1.15. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at ages 9+ against the estimated populations. Again a passably good fit has been achieved.

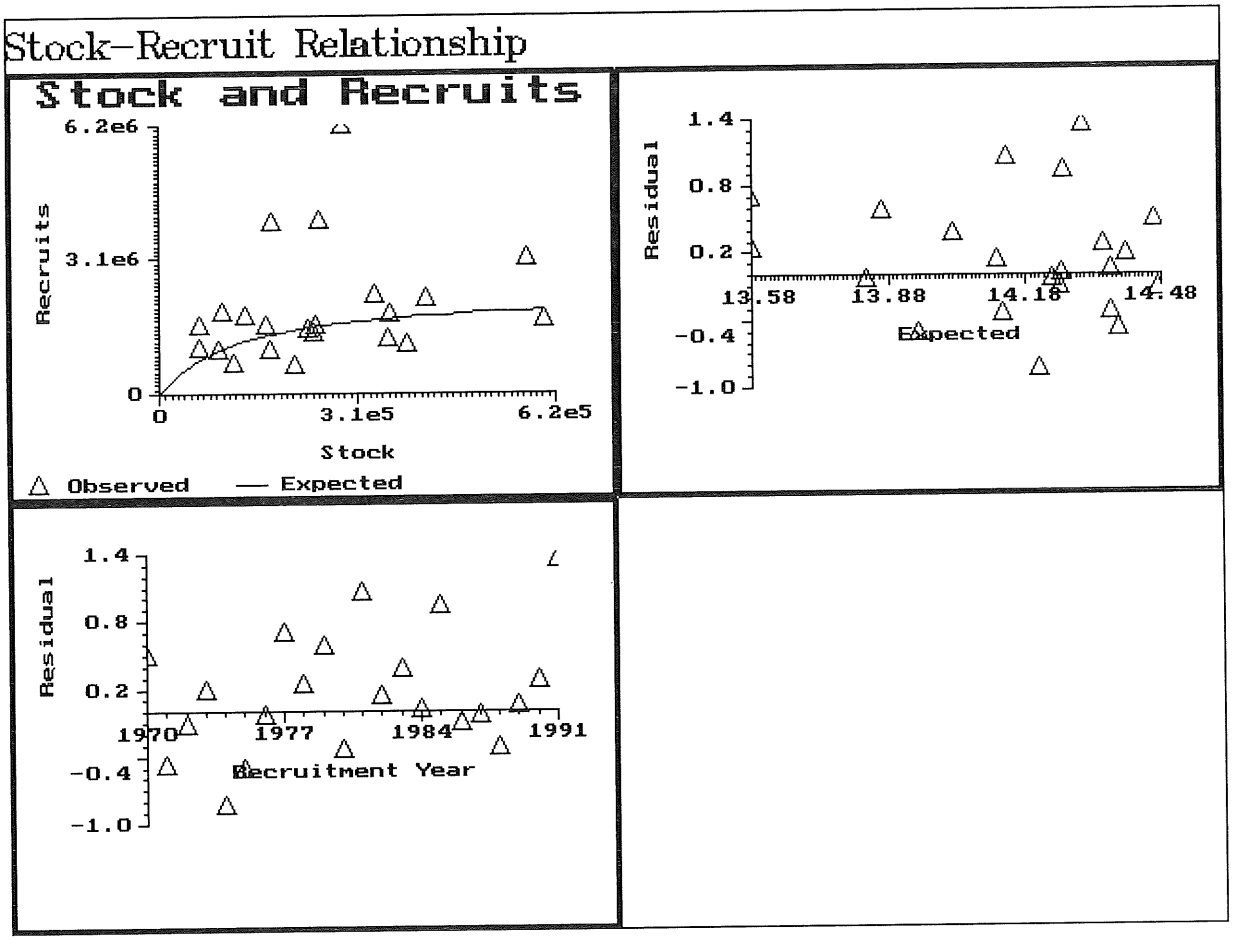


Figure 5.1.16. Results of the baseline assessment. Diagnostics of the stock-recruit model fit.

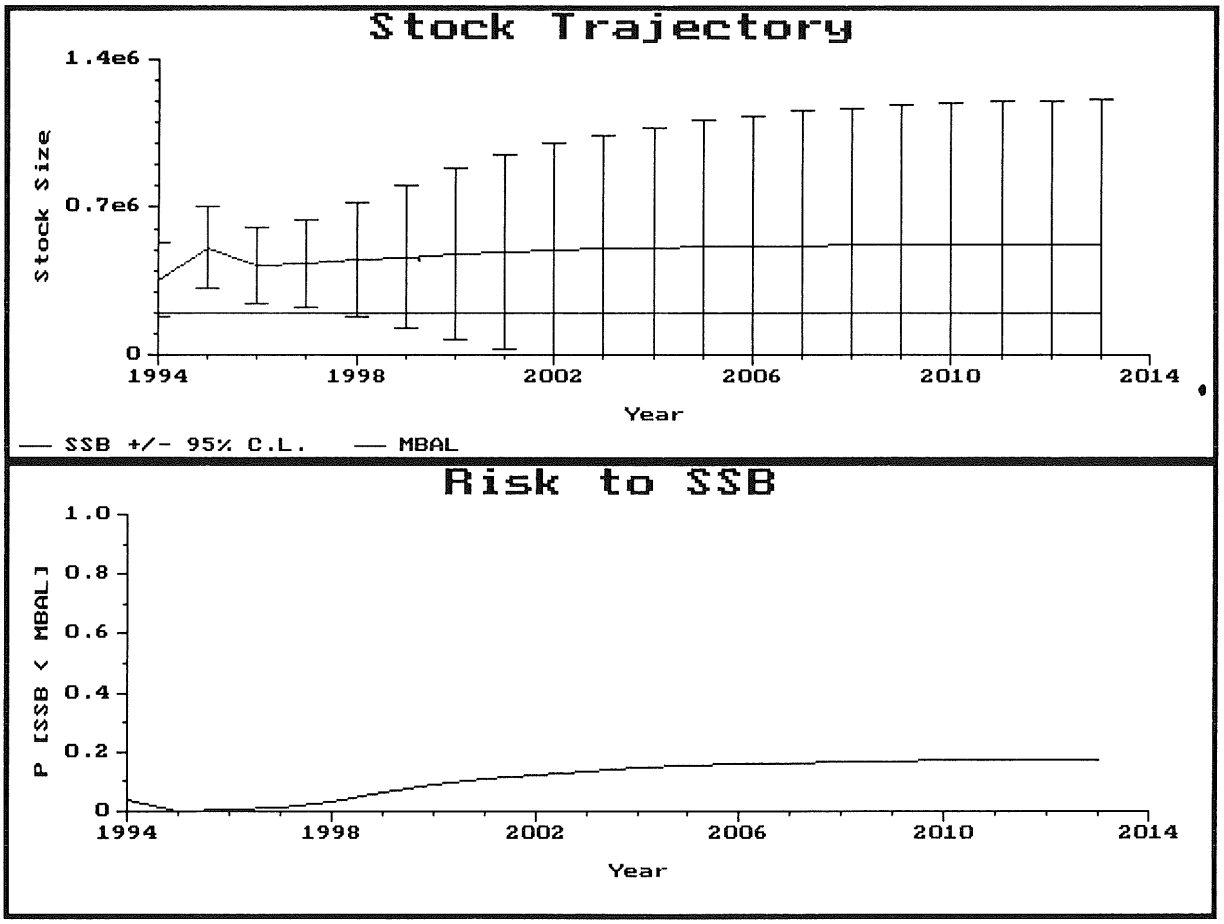


Figure 5.1.17. Medium-term stock projection +/- estimated 95% confidence interval. An MBAL of 200 000t has been assumed for illustrative purposes. Estimates of stock size. Constant fishing mortality at 1993 levels is assumed.

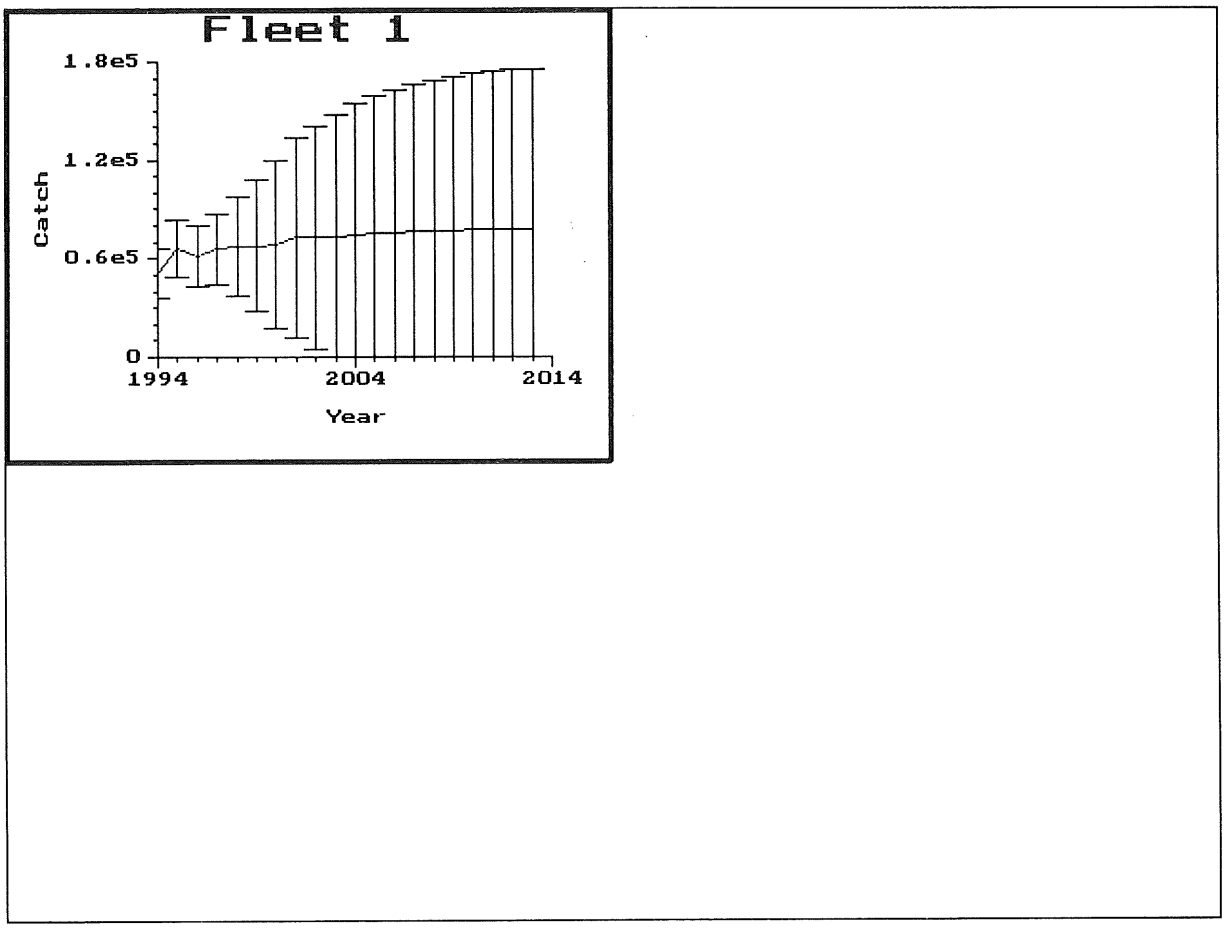


Figure 5.1.18. Medium-term stock projection +/- estimated 95% confidence interval. Projected yield from fishing at constant mortality levels equal to those estimated in 1993.

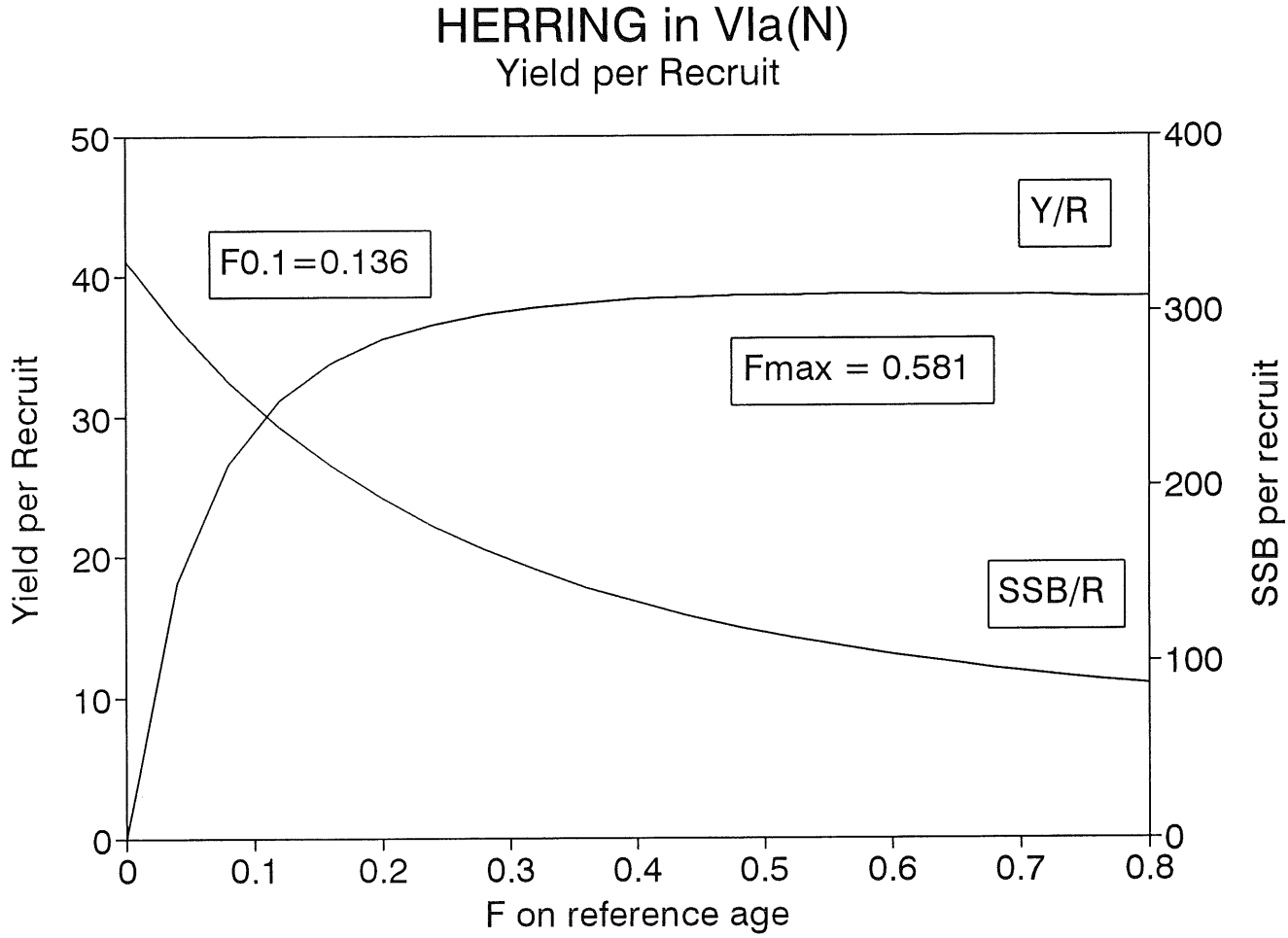


Figure 5.1.19. Herring in VIa(N). Yield per recruit analysis. Yield (g/recruit) ans spawning stock biomass (g/recruit) calculated for a range of values of fishing mortality on reference age 4.

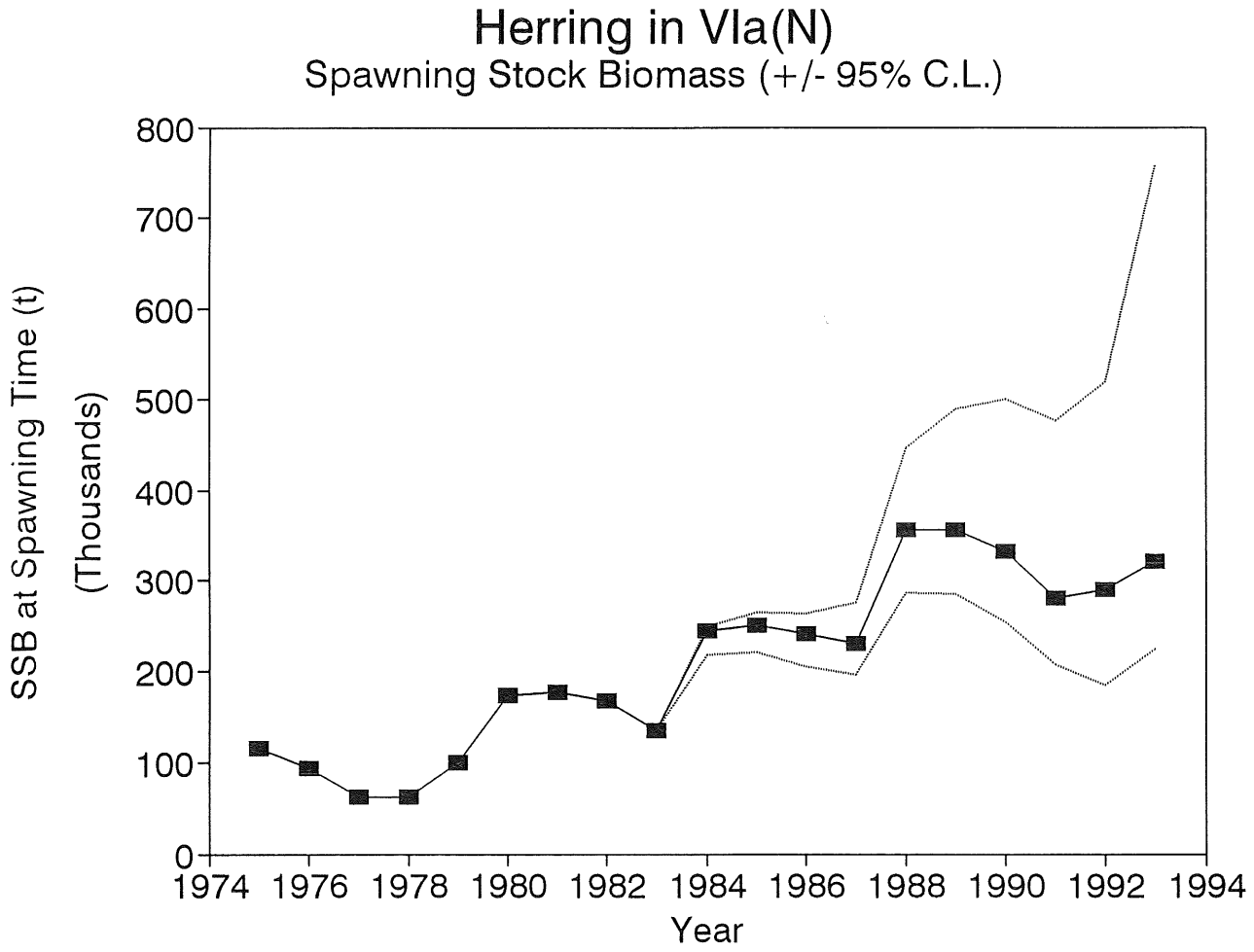
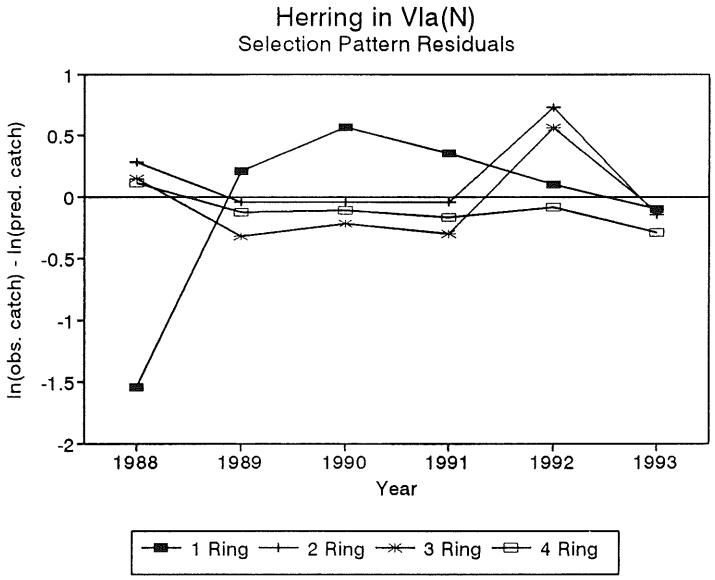


Figure 5.1.20. Herring in VIa(N) Estimated spawning stock biomass, +/- estimates of the 95% confidence interval.



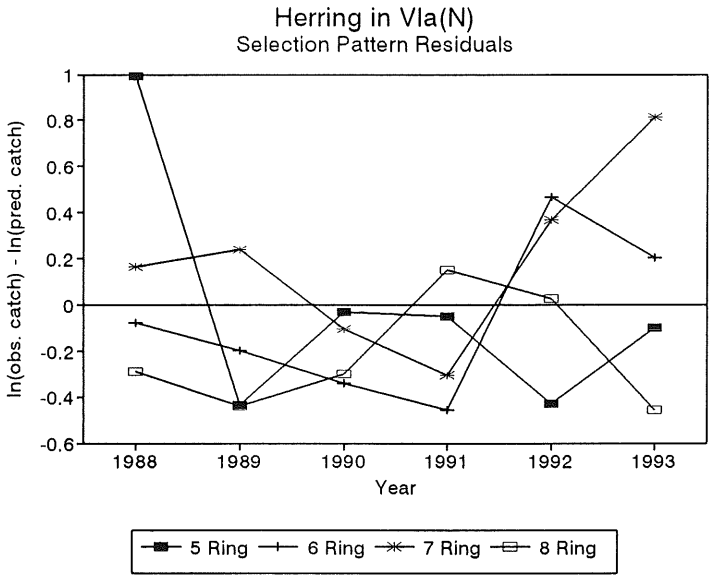


Figure 5.1.21. Selection pattern residuals for the catches at age against a model fit that was heavily driven by the survey indices. There is no marked indication of a change in seletion with time.

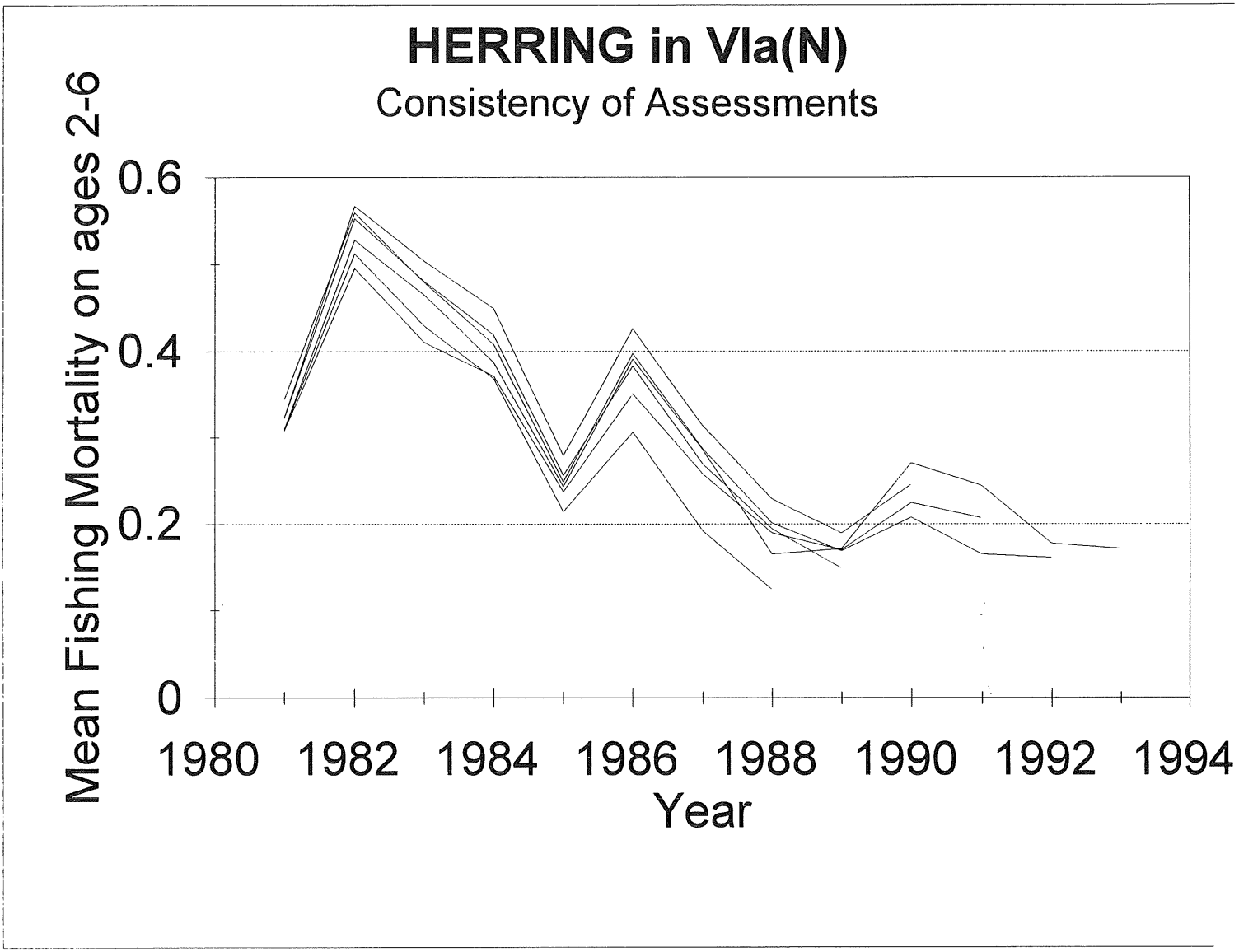


Figure 5.1.22. Herring in VIa(N). Estimates of fishing mortality (Arithmetic, unweighted mean over ages 3 to 6), as made by the Herring Assessment Working Group in meetings from 1988 to 1993.

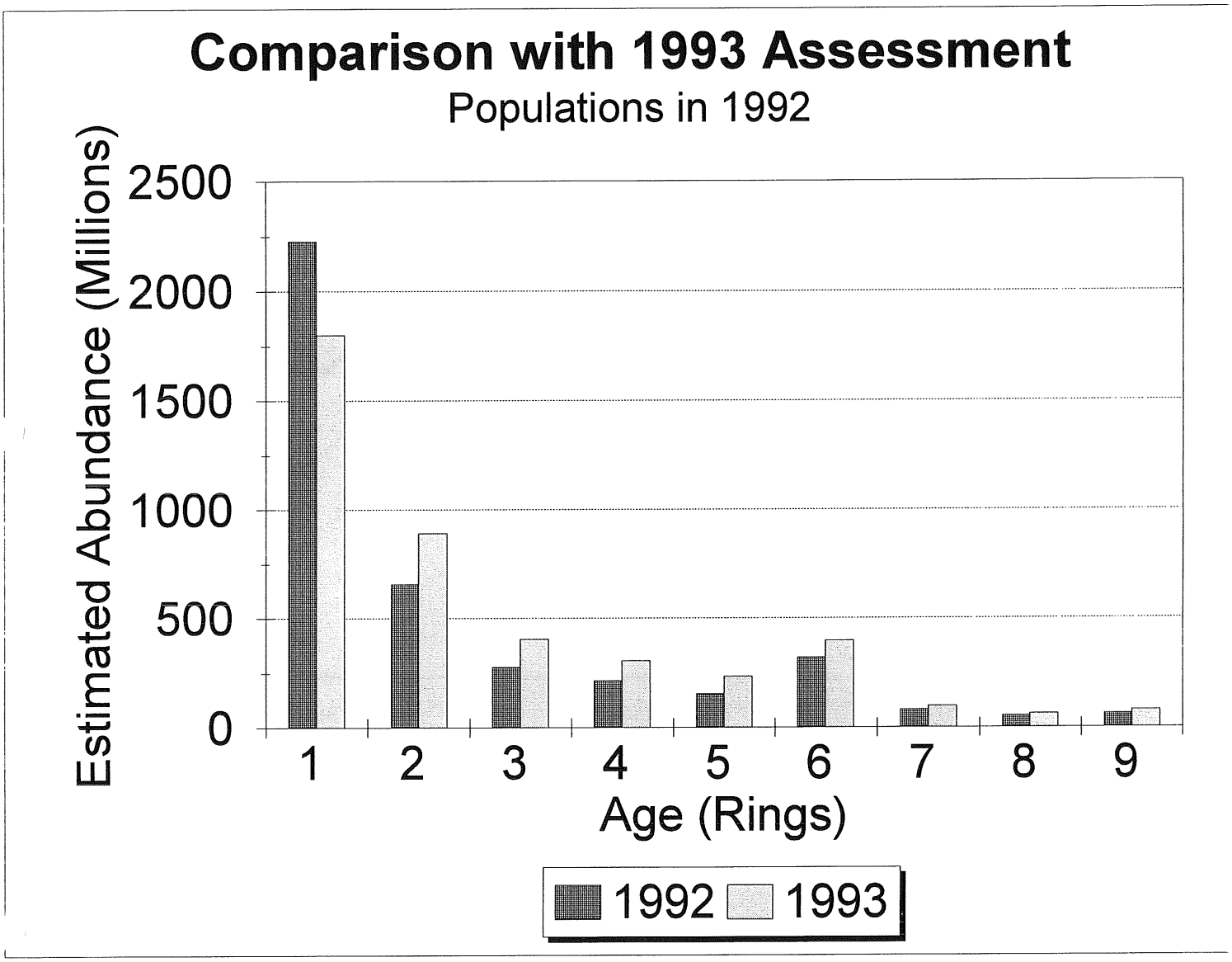


Figure 5.1.23 Herring in Division VIa(N). Comparison of population sizes in 1992 as estimated by the Working Group in 1993, and present estimates of population size.

Figure 6.4.1 SSB levels from different input F values in 1994.

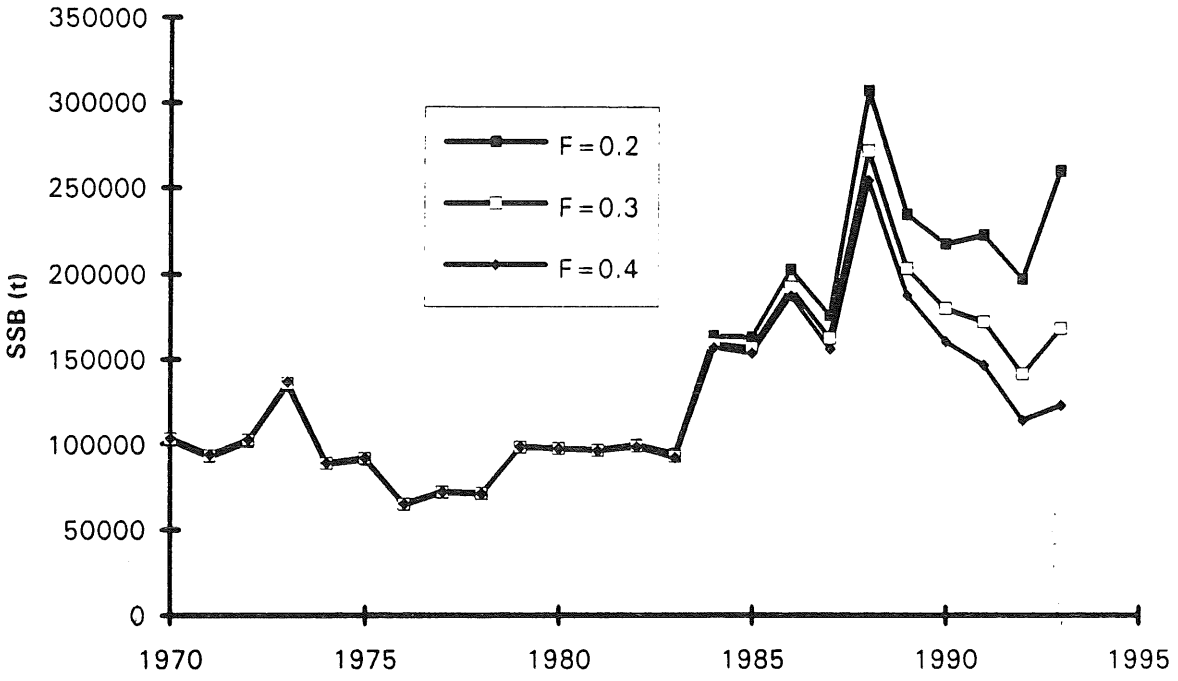
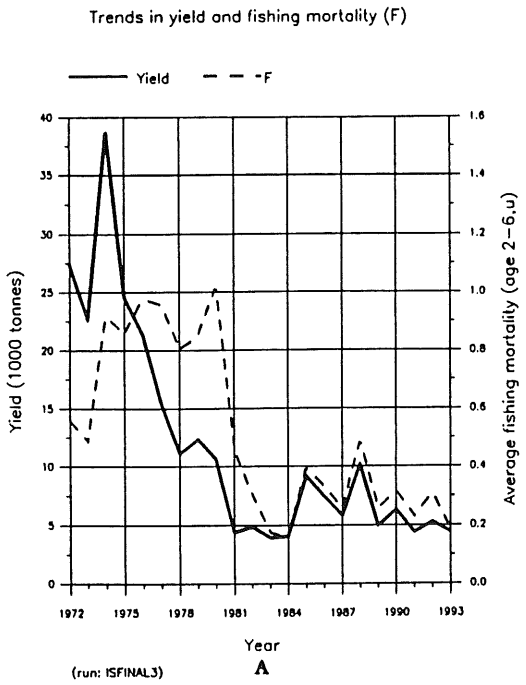
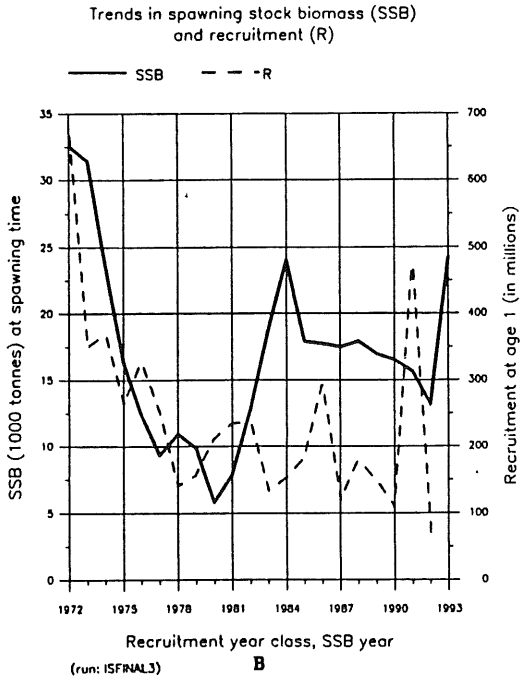


Figure 7.4.1

FISH STOCK SUMMARY
STOCK: Herring in the North Irish Sea (Manx plus Mourne herring)
25–3–1994





FISH STOCK SUMMARY
STOCK: Herring in the North Irish Sea (Manx plus Mourne herring)
25–3–1994

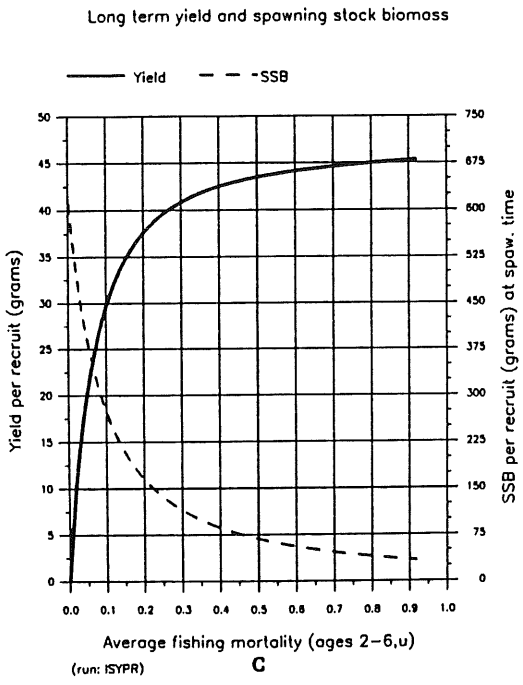


Figure 7.4.2 Division VIIa(N) herring (Manx plus Mourne). Trends in SSB estimated by VPA for a number of terminal F_s.

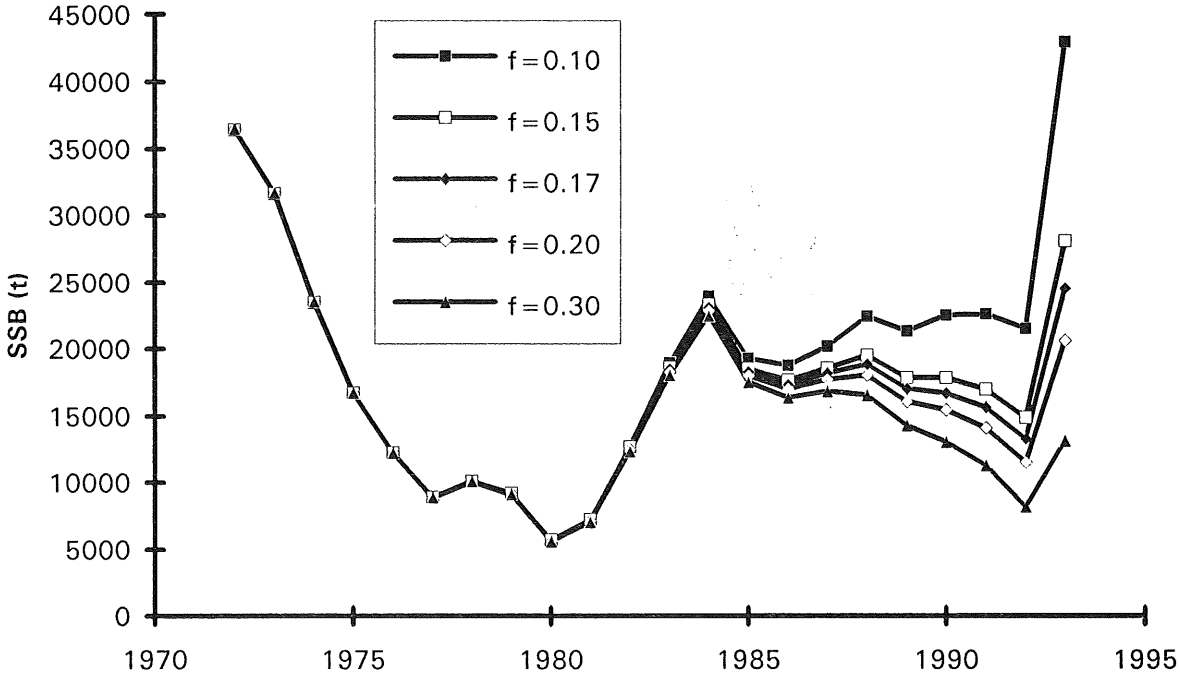


Figure 8.1.1 North Sea and Division VIId,e sprat catches in tonnes for January 1993.

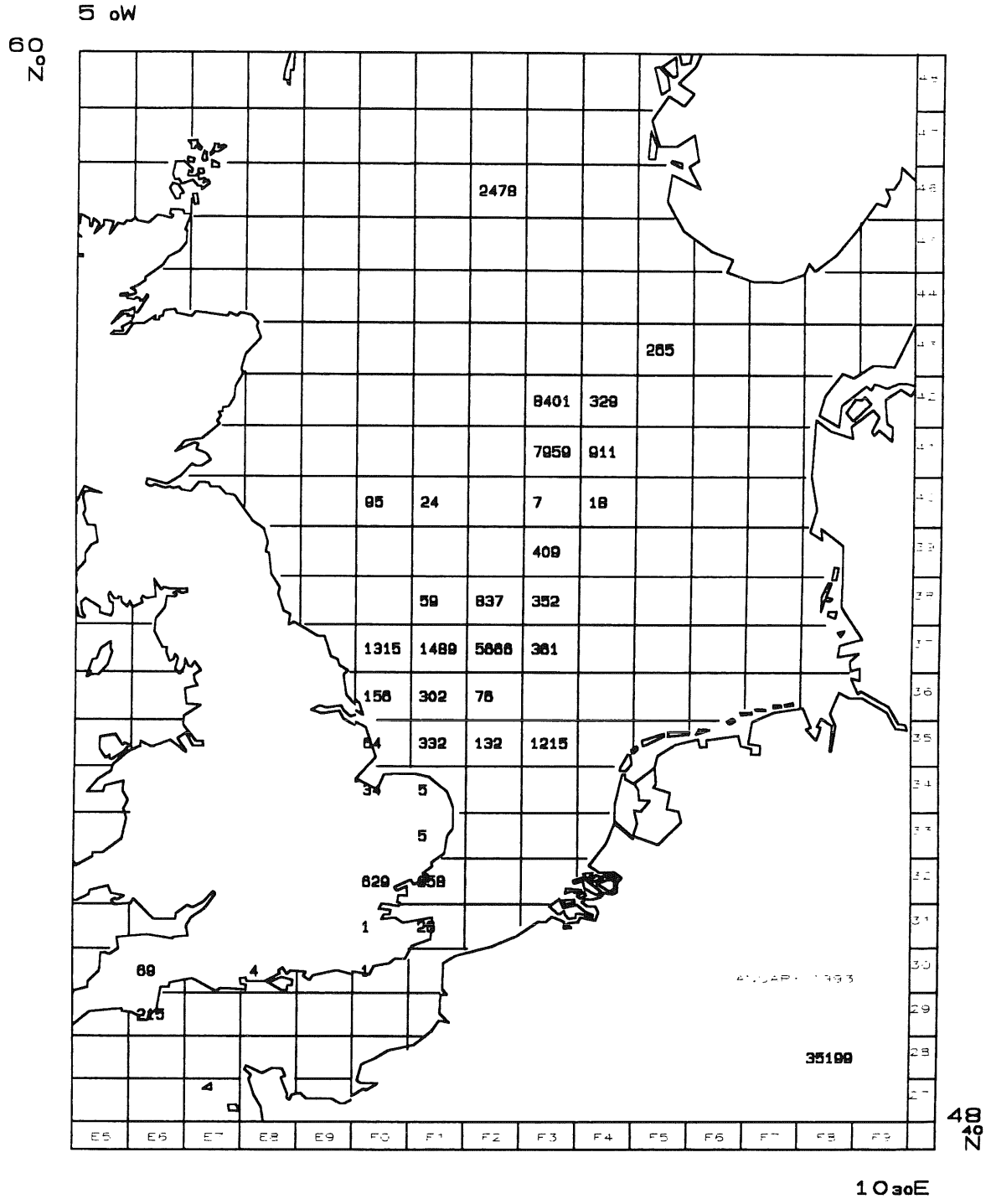


Figure 8.1.2 North Sea and Division VIId,e sprat catches in tonnes for February 1993.

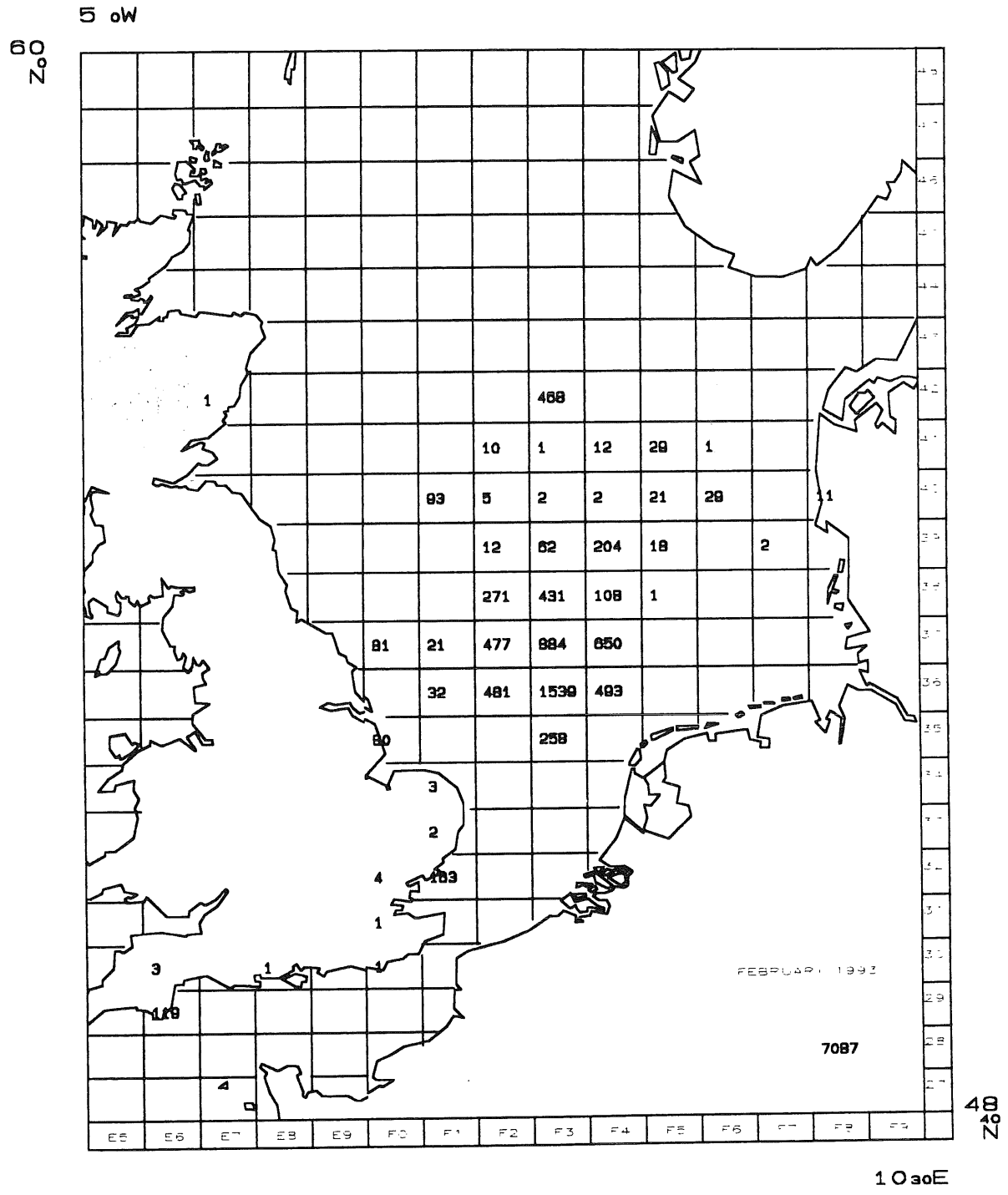


Figure 8.1.3 North Sea and Division VIId,e sprat catches in tonnes for March 1993.

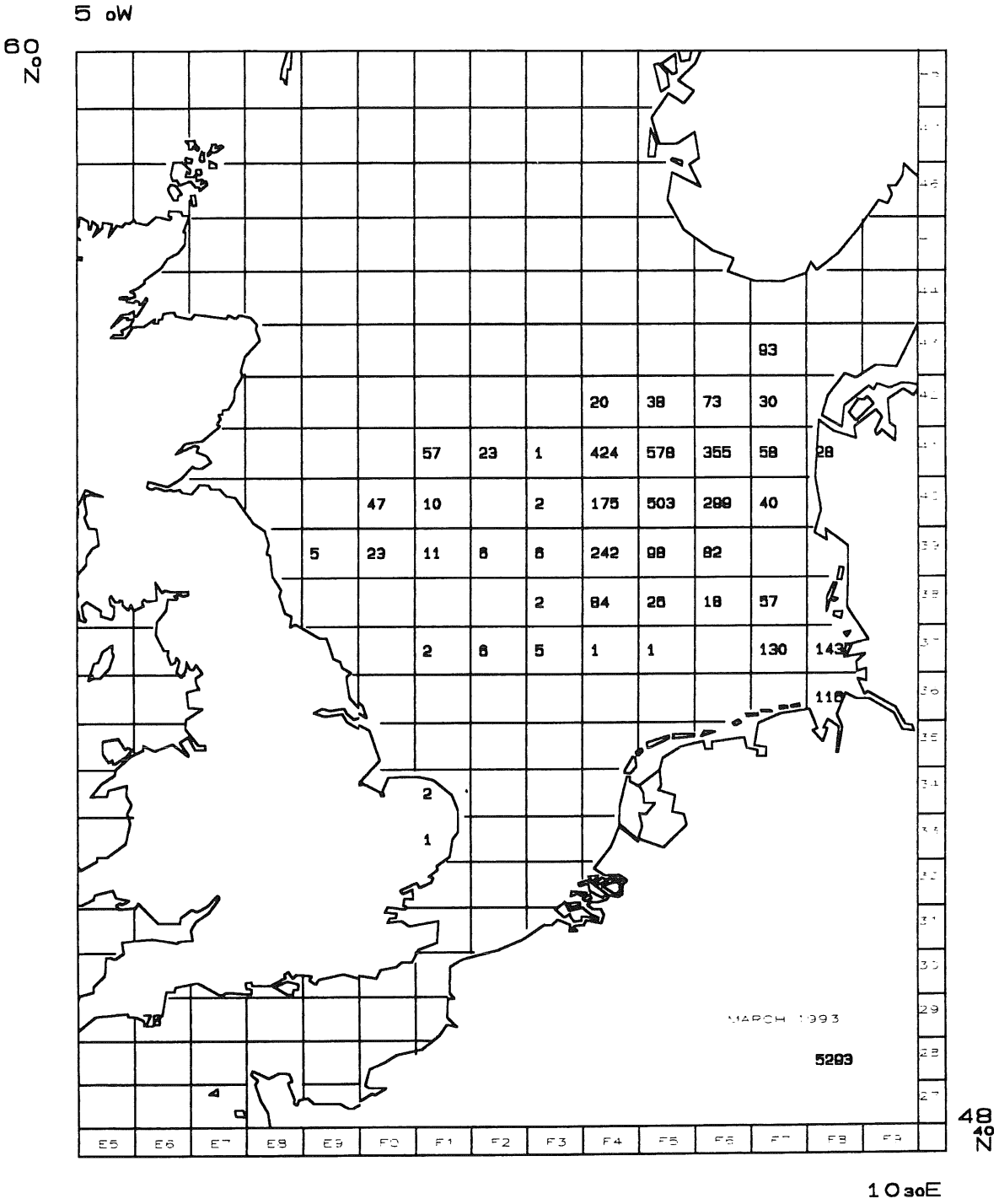


Figure 8.1.4 North Sea and Division VIId,e sprat catches in tonnes for April 1993.

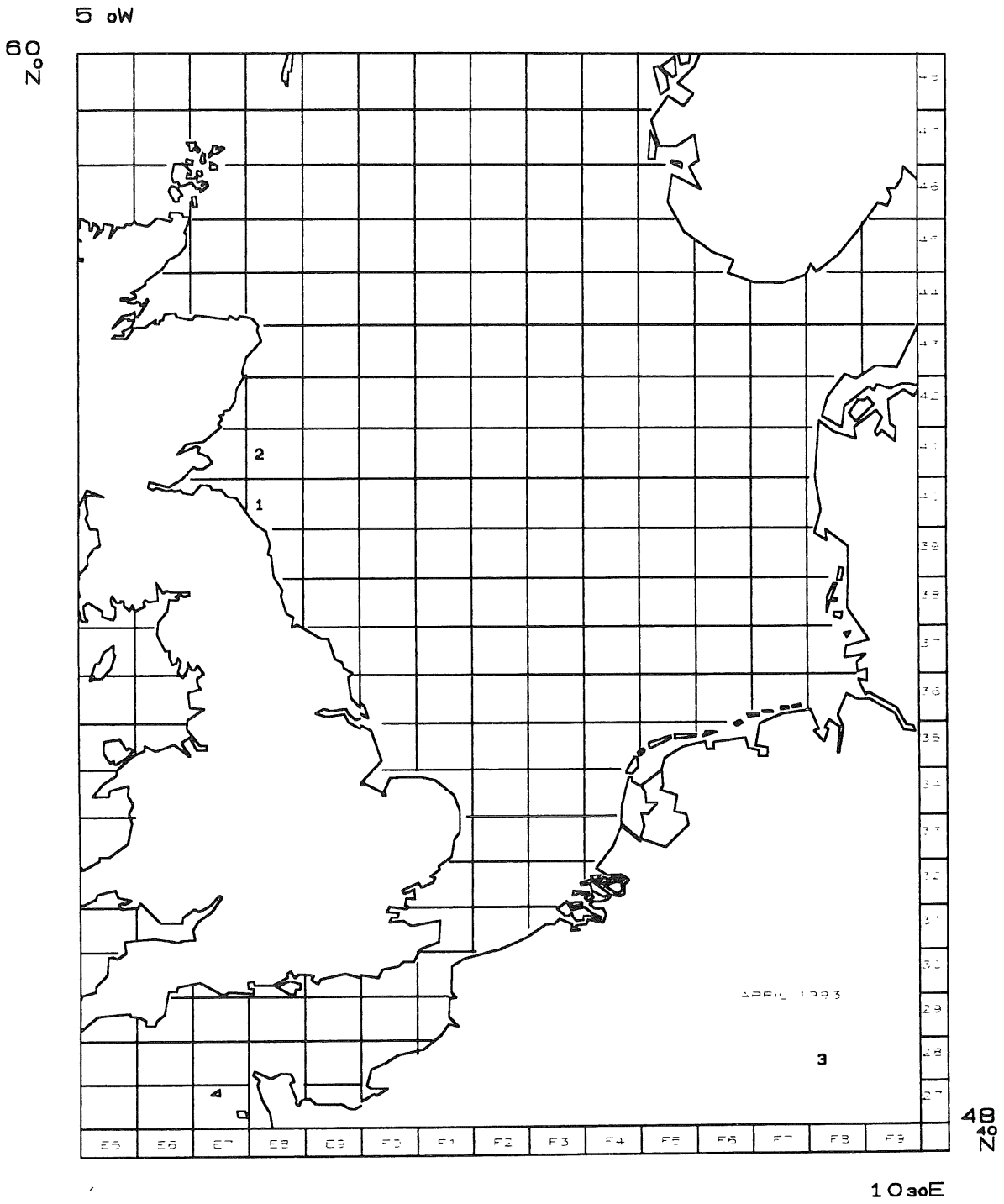


Figure 8.1.5 North Sea and Division VIId,e sprat catches in tonnes for May 1993.

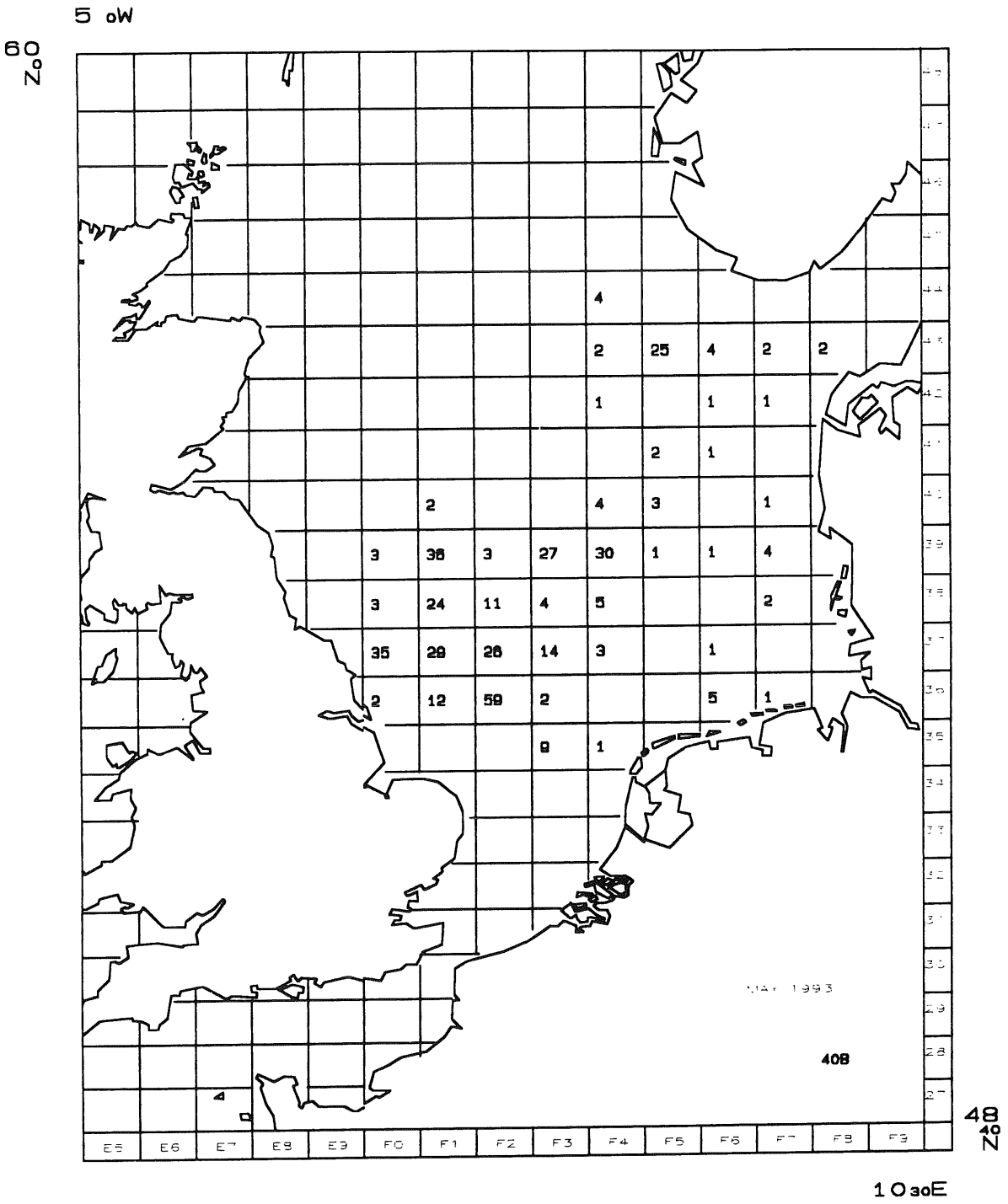


Figure 8.1.6 North Sea and Division VIId,e sprat catches in tonnes for June 1993.

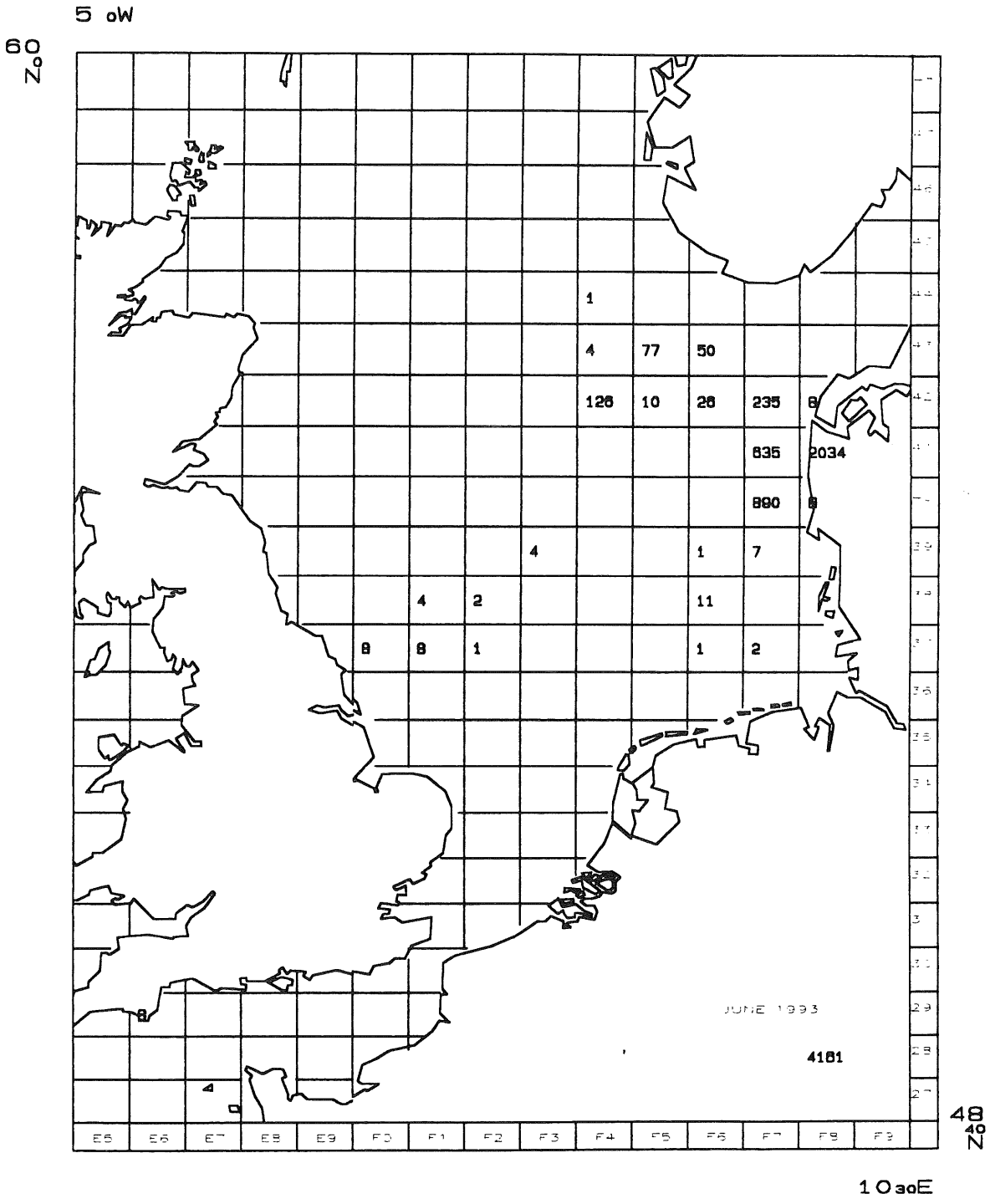


Figure 8.1.7 North Sea and Division VIId,e sprat catches in tonnes for July 1993.

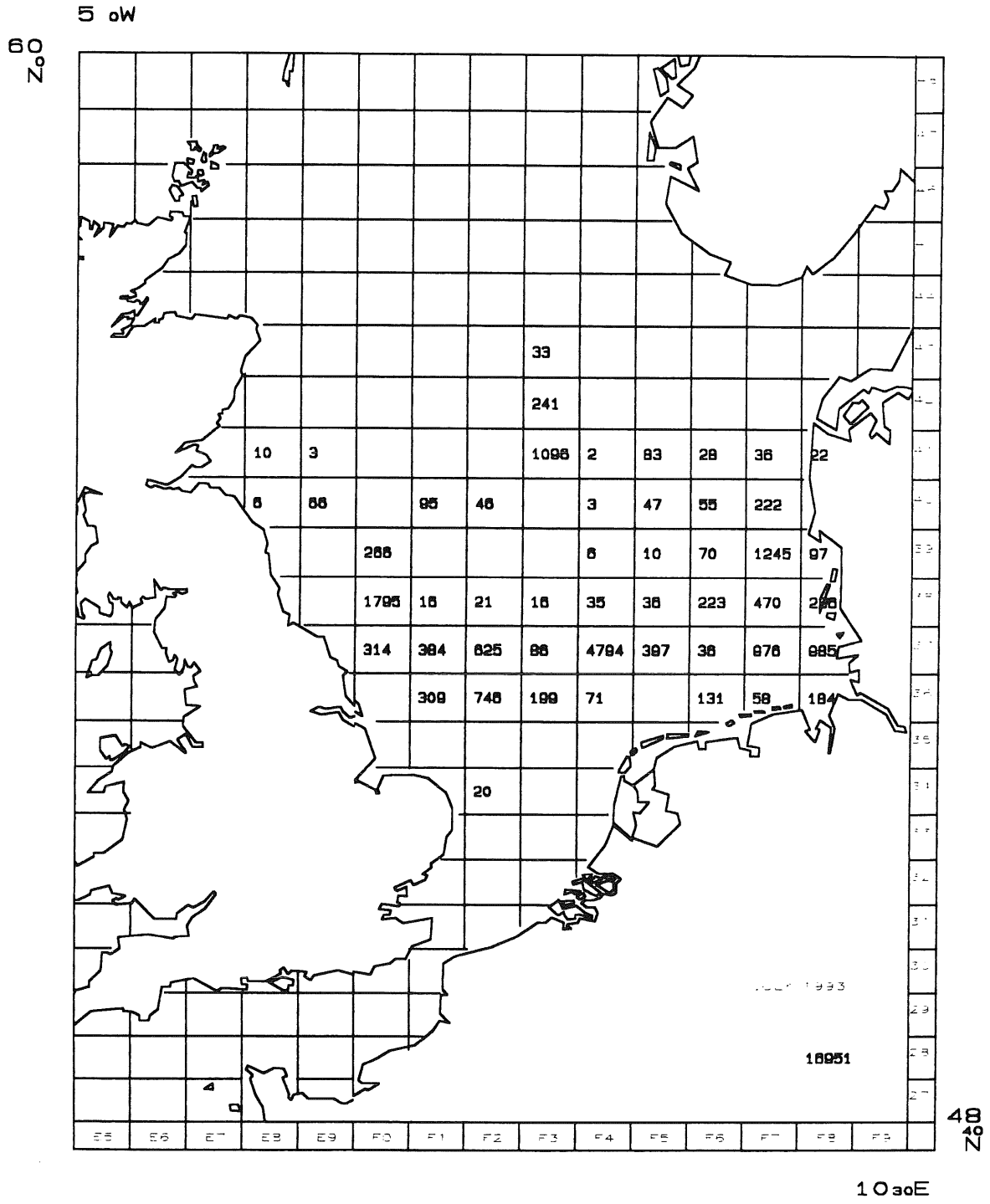


Figure 8.1.8 North Sea and Division VIId,e sprat catches in tonnes for August 1993.

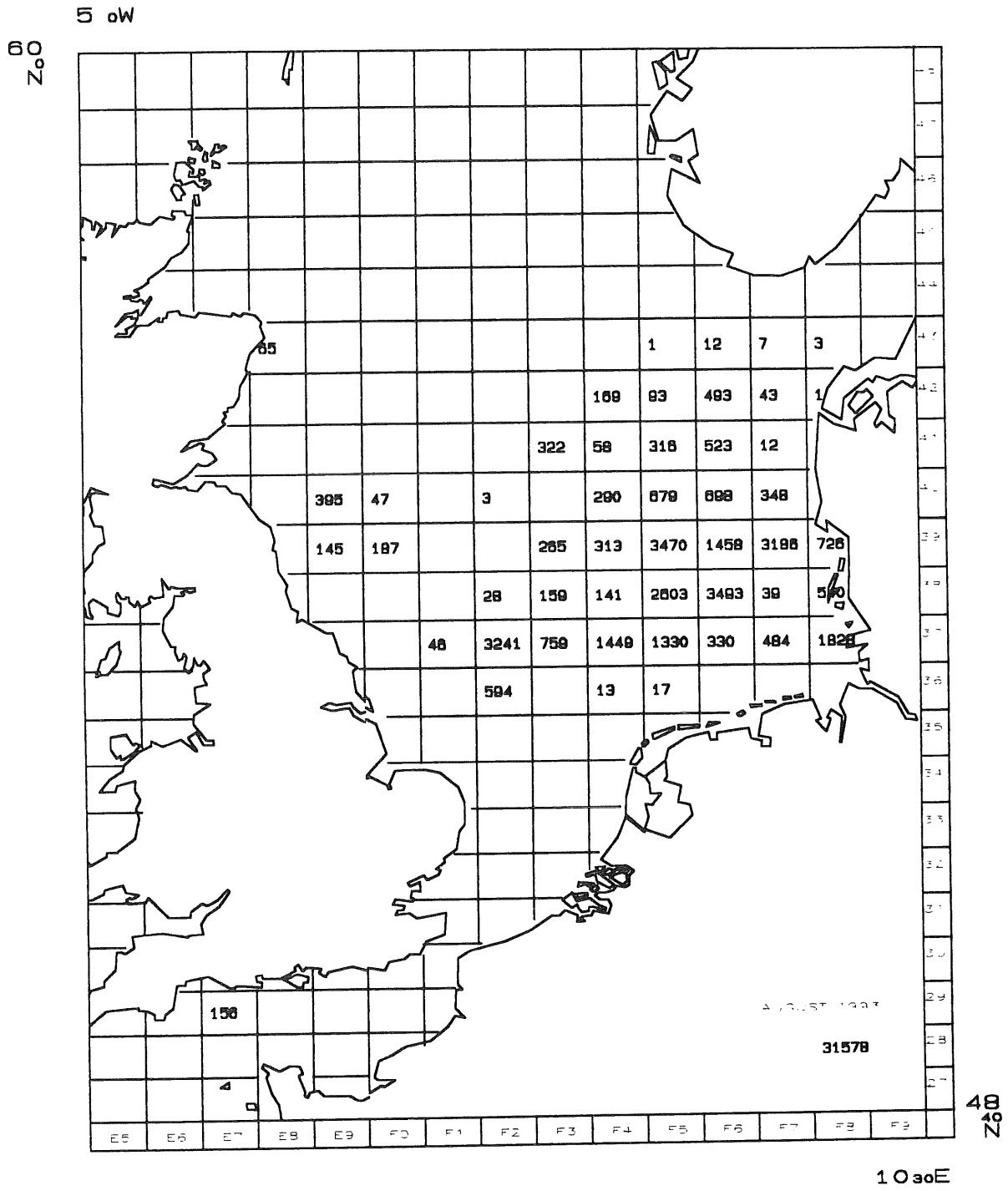


Figure 8.1.9 North Sea and Division VIId,e sprat catches in tonnes for September 1993.

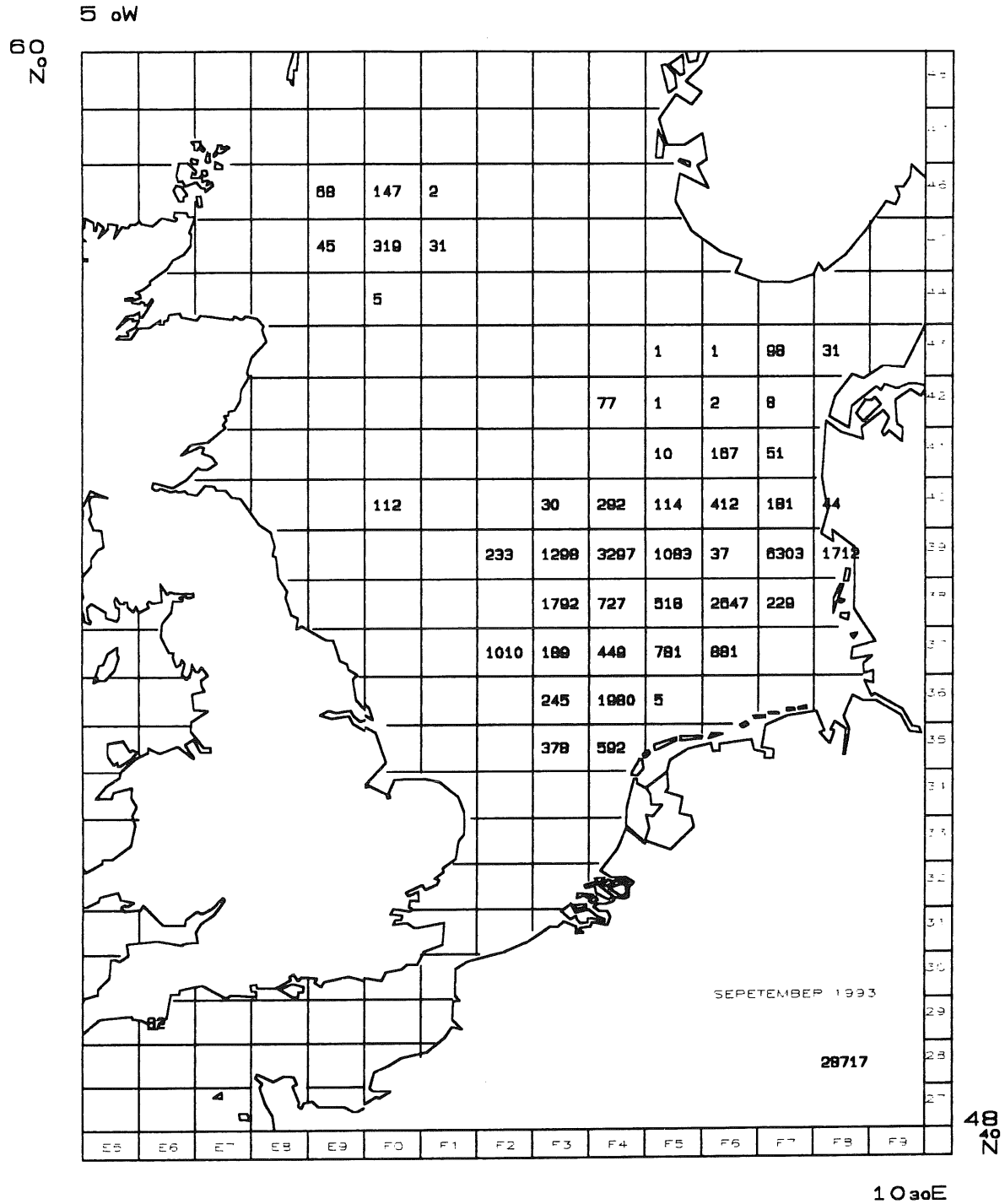


Figure 8.1.10 North Sea and Division VIId,e sprat catches in tonnes for October 1993.

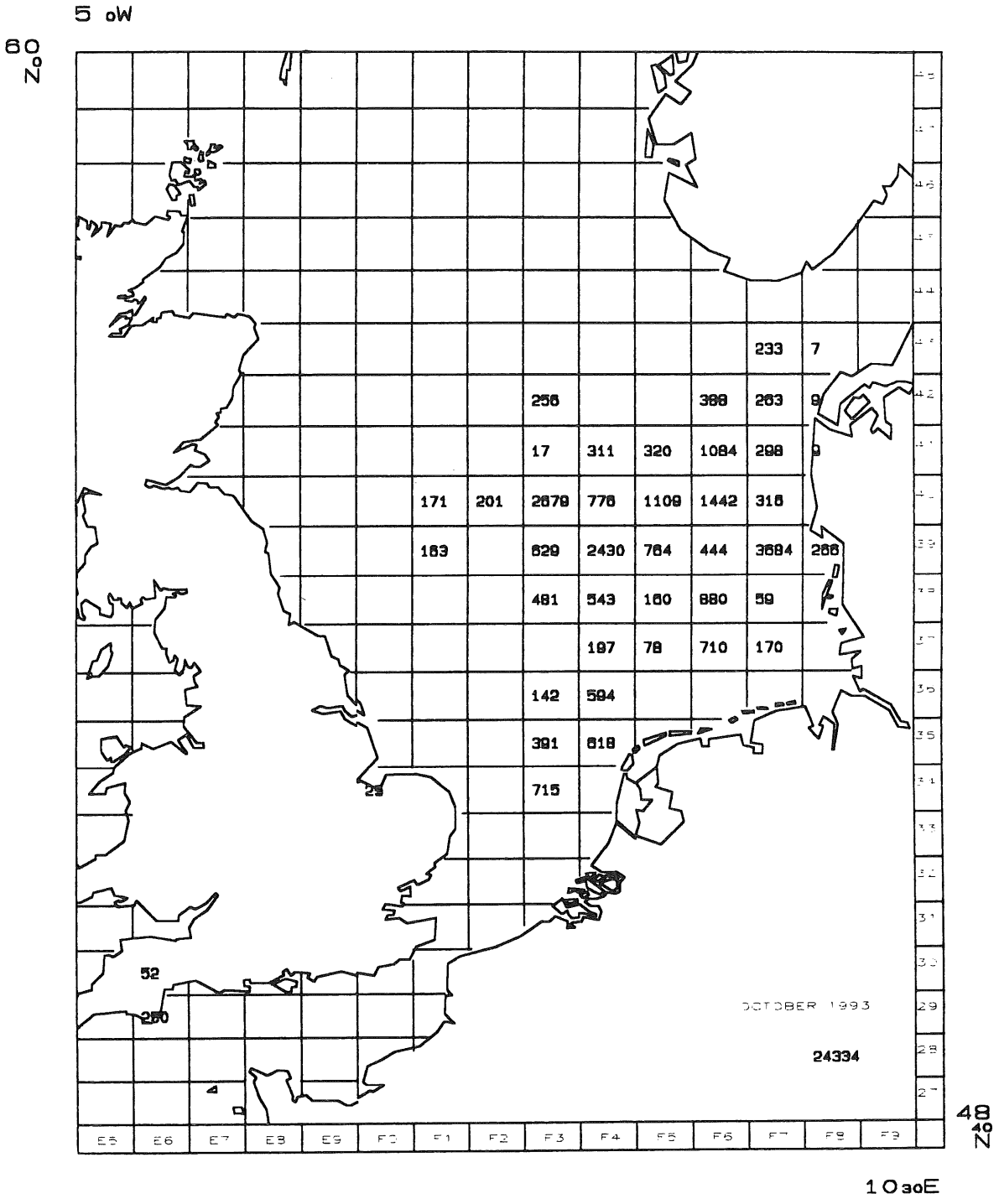


Figure 8.1.11 North Sea and Division VIId,e sprat catches in tonnes for November 1993.

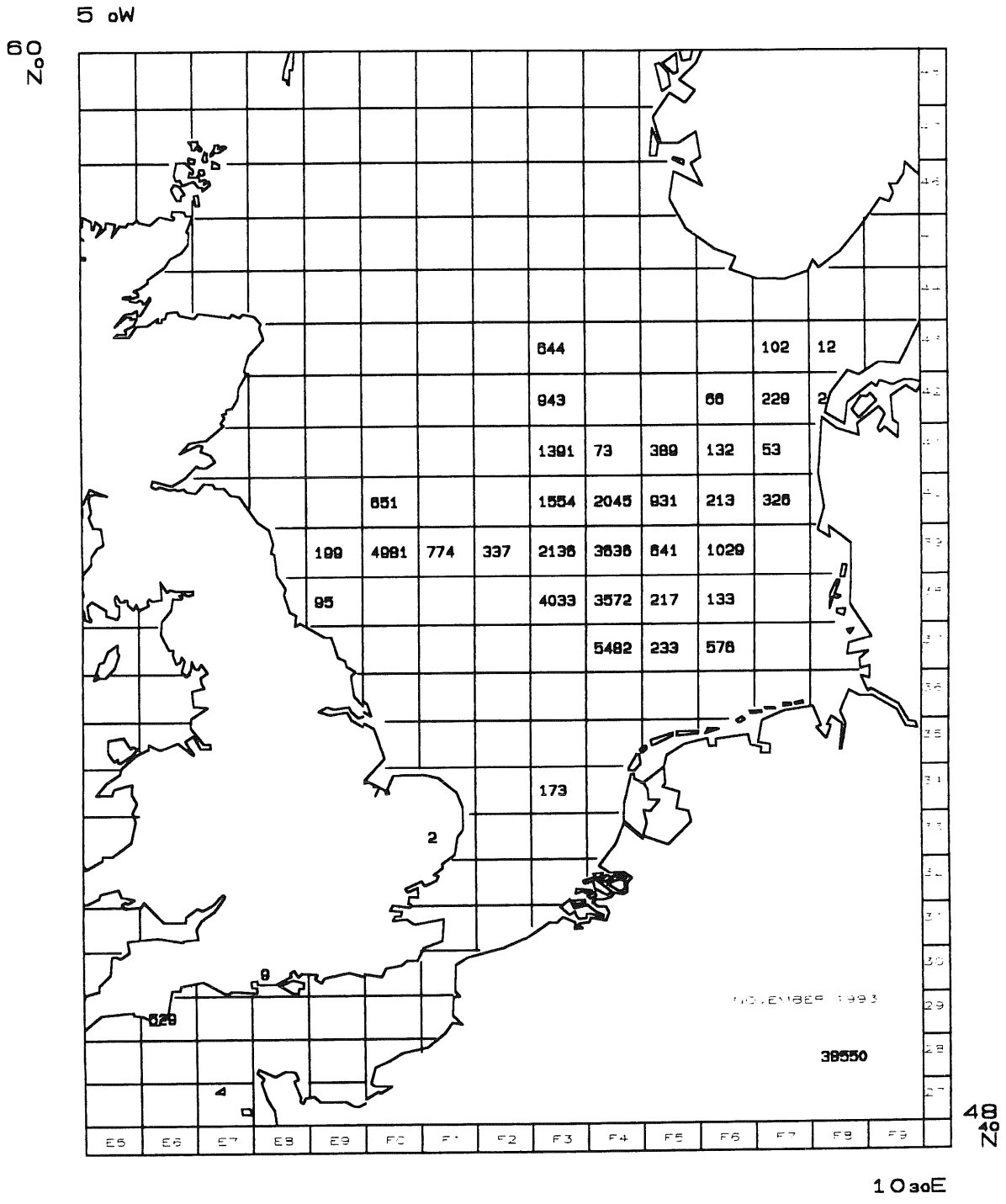
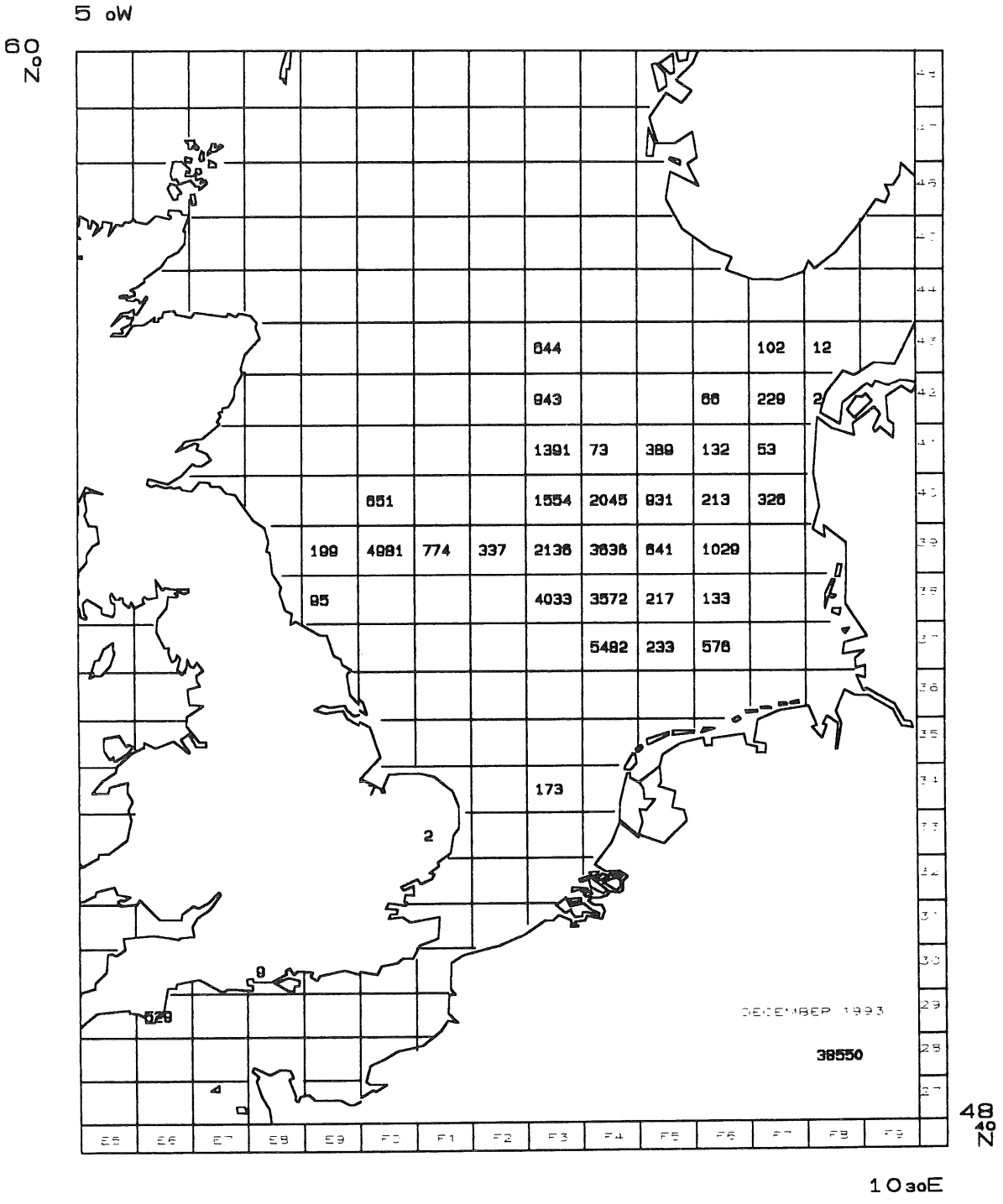
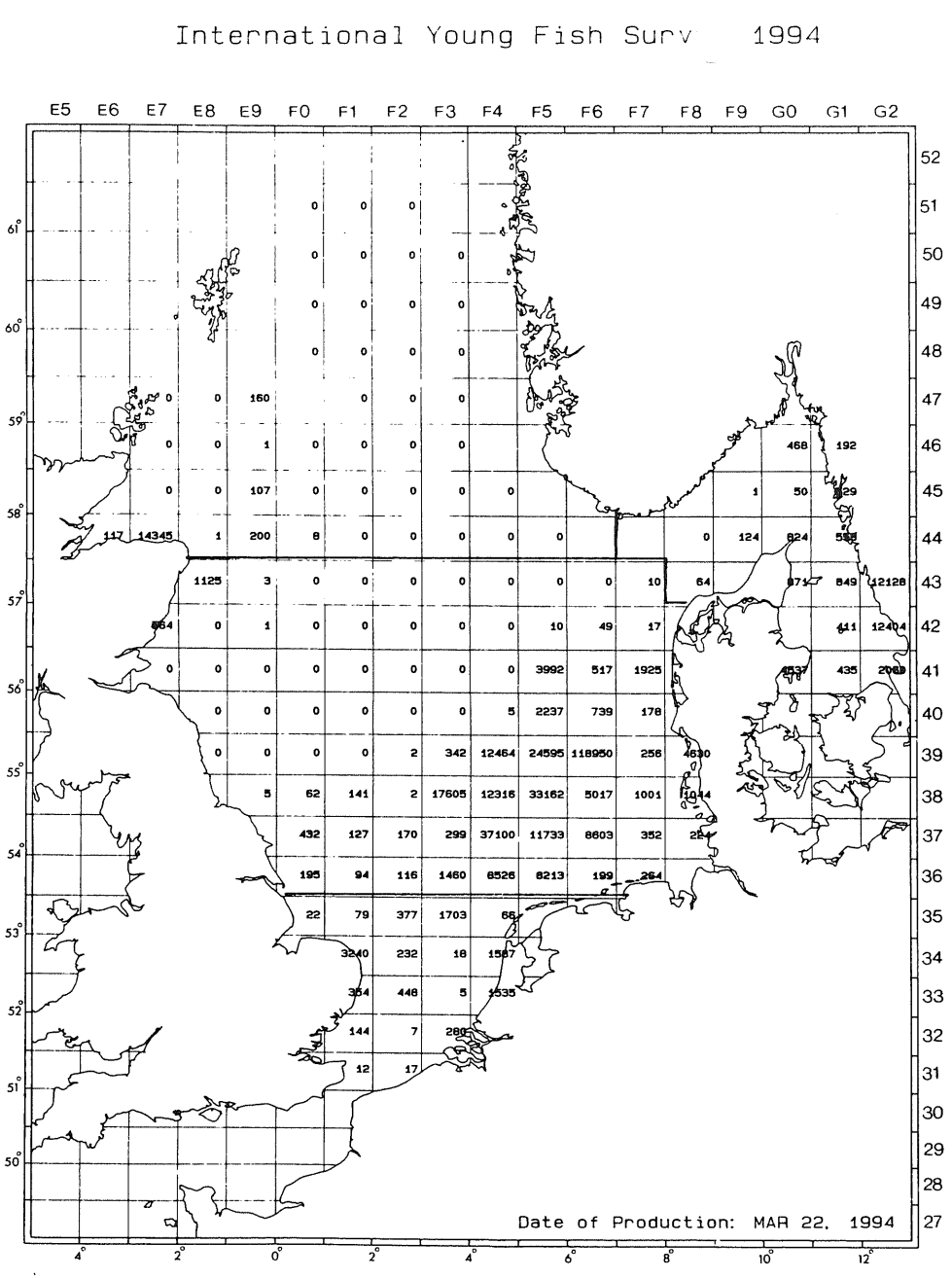


Figure 8.1.12 North Sea and Division VIId,e sprat catches in tonnes for December 1993.





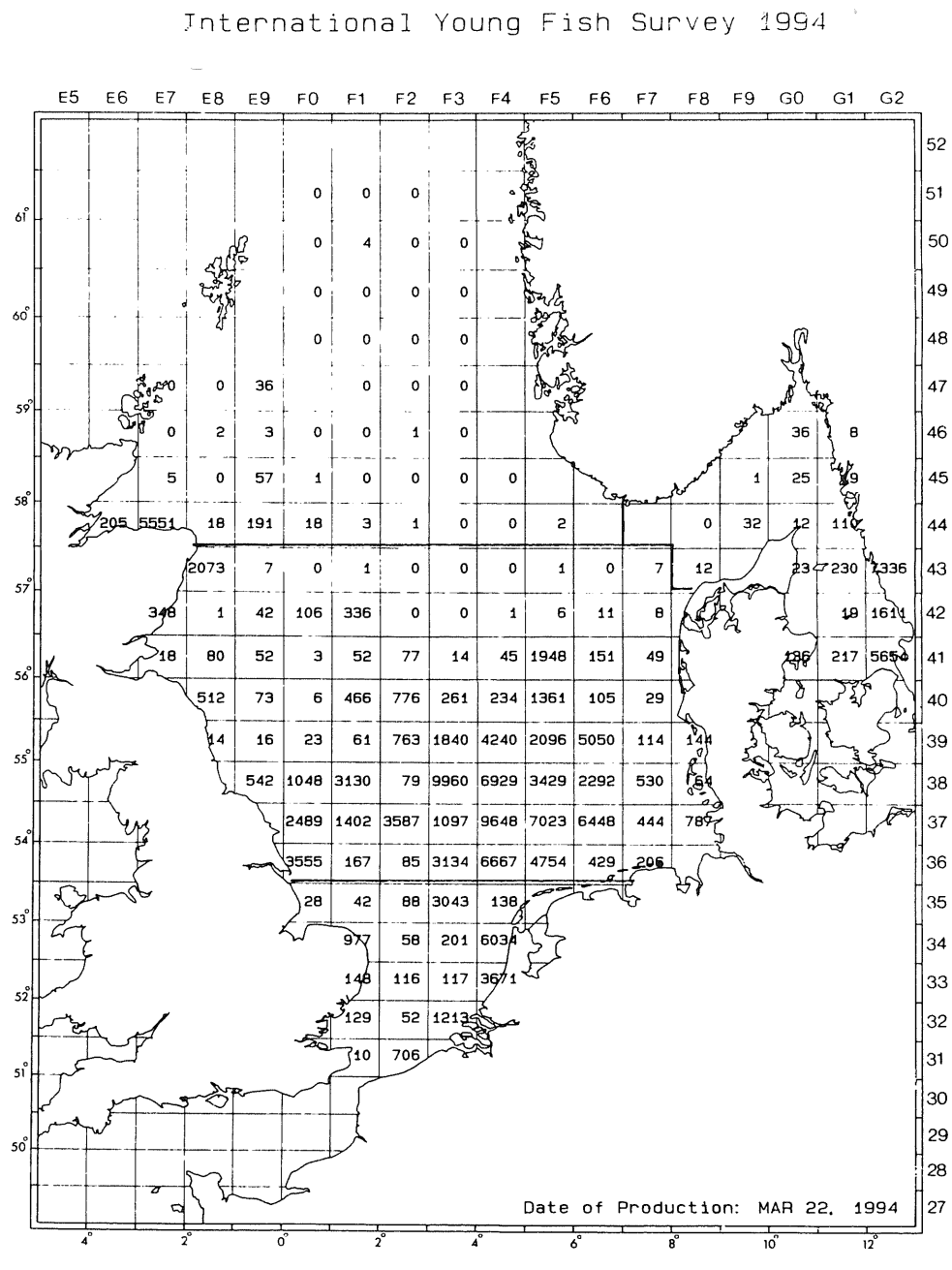
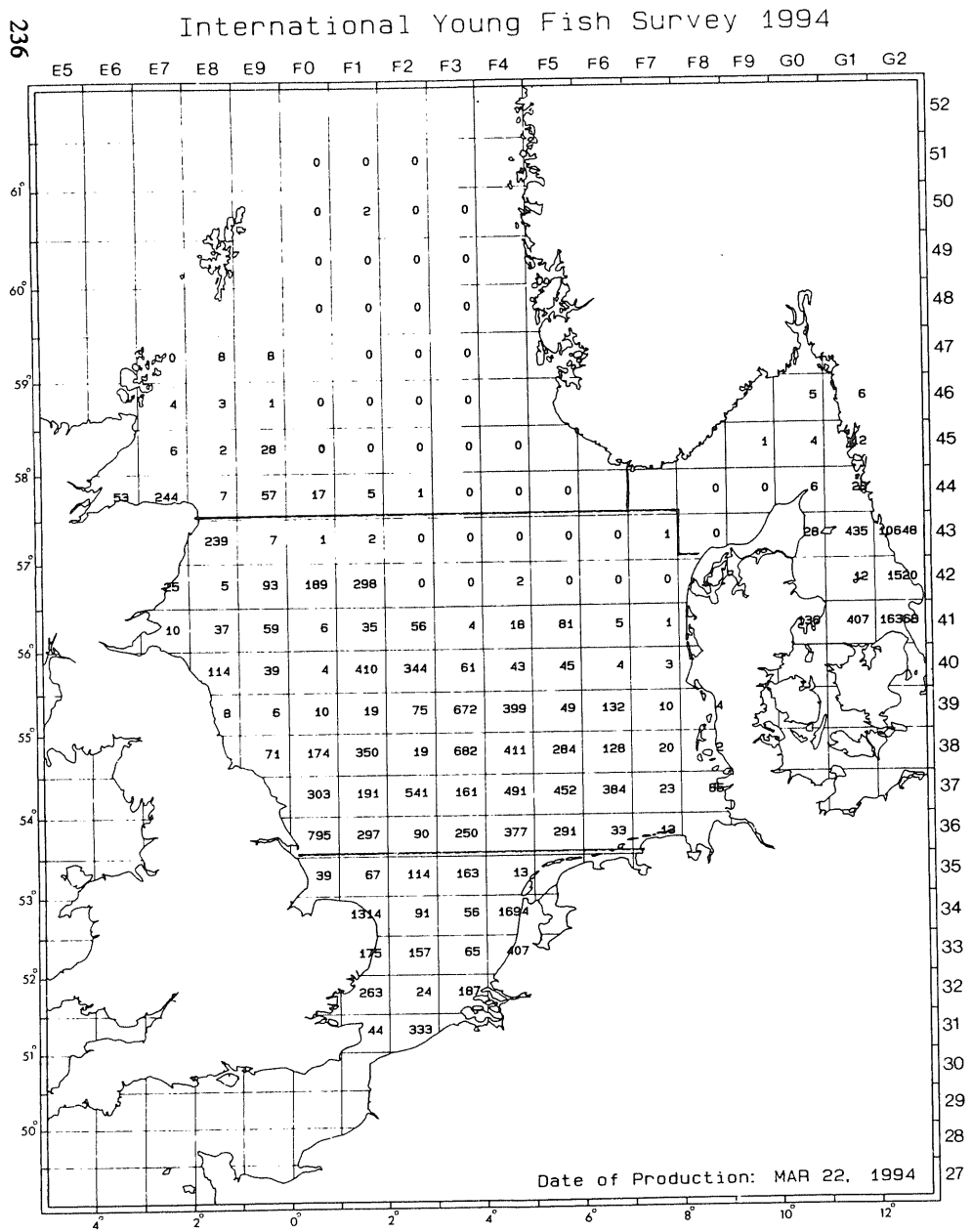
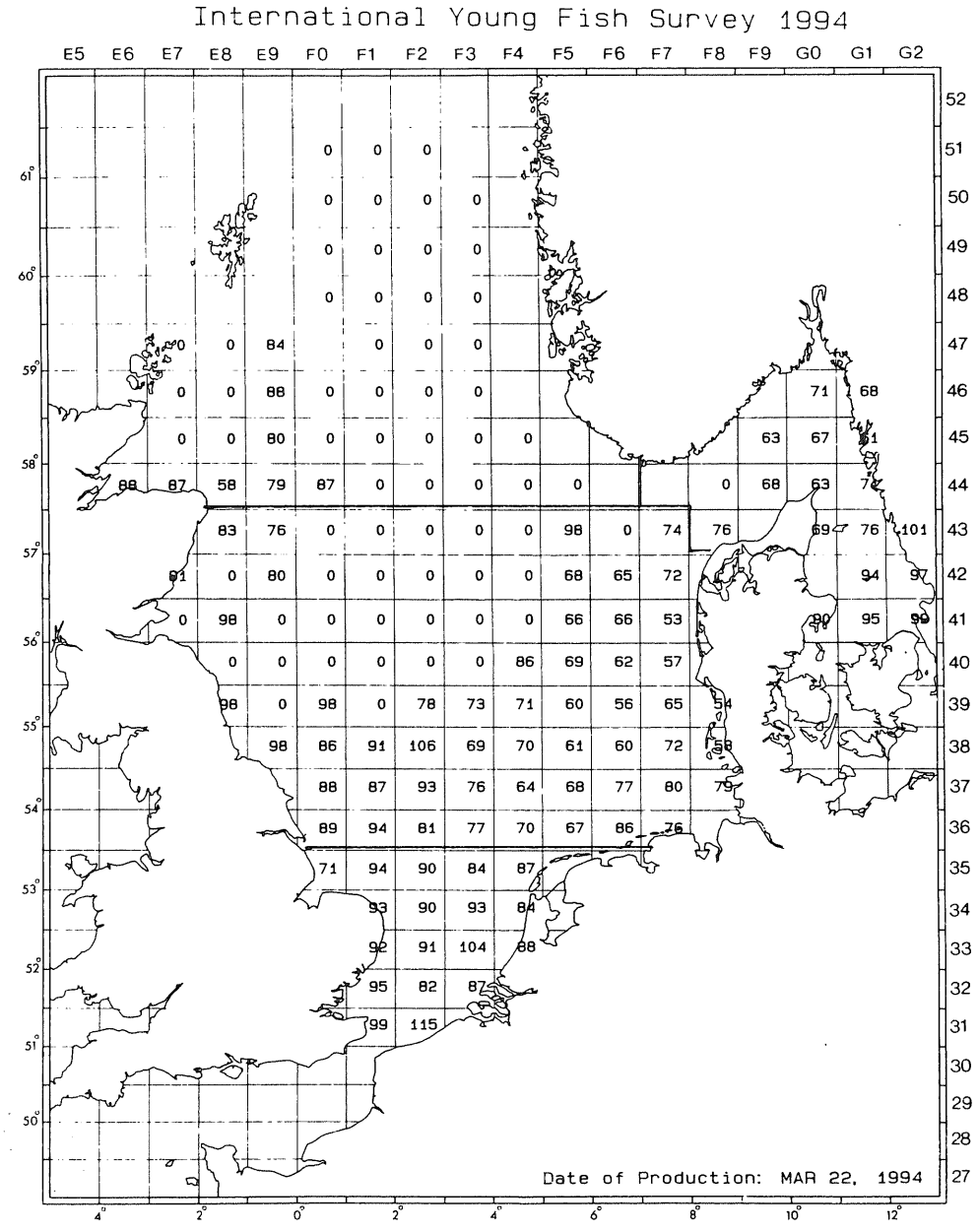


Figure 8.3.1 SPRAT. Distribution by age group in the IBTS (February) 1994, in the North Sea and Division IIIa.



Sprat, SPRA SPR
Number per Hour , Age Group 3+.

Figure 8.3.1 (continued)



Sprat, SPRA SPR
Mean Length, Age Group 1.

Figure 8.3.2 SPRA Mean length of age group 1 (mm), in the IBTS (February)

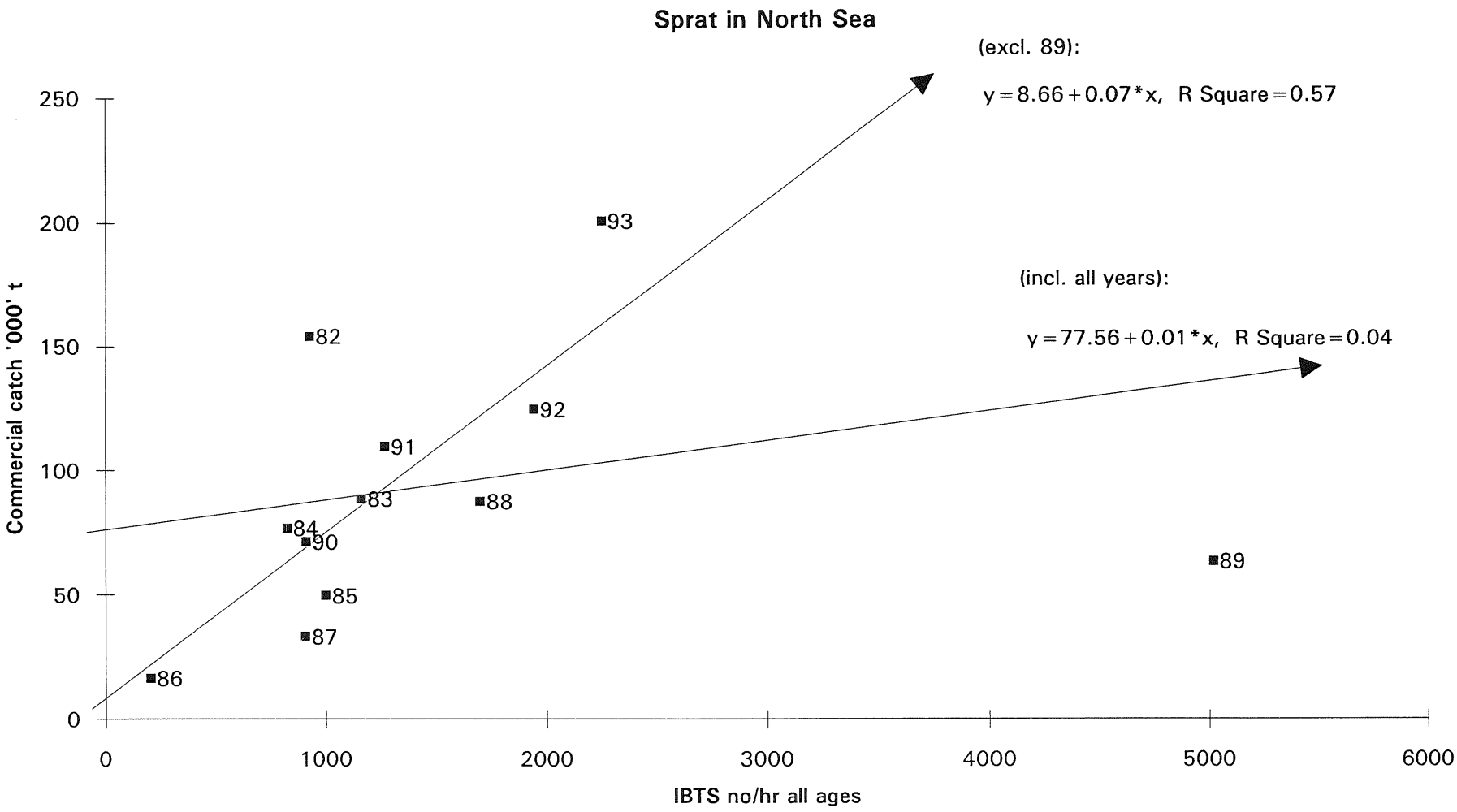
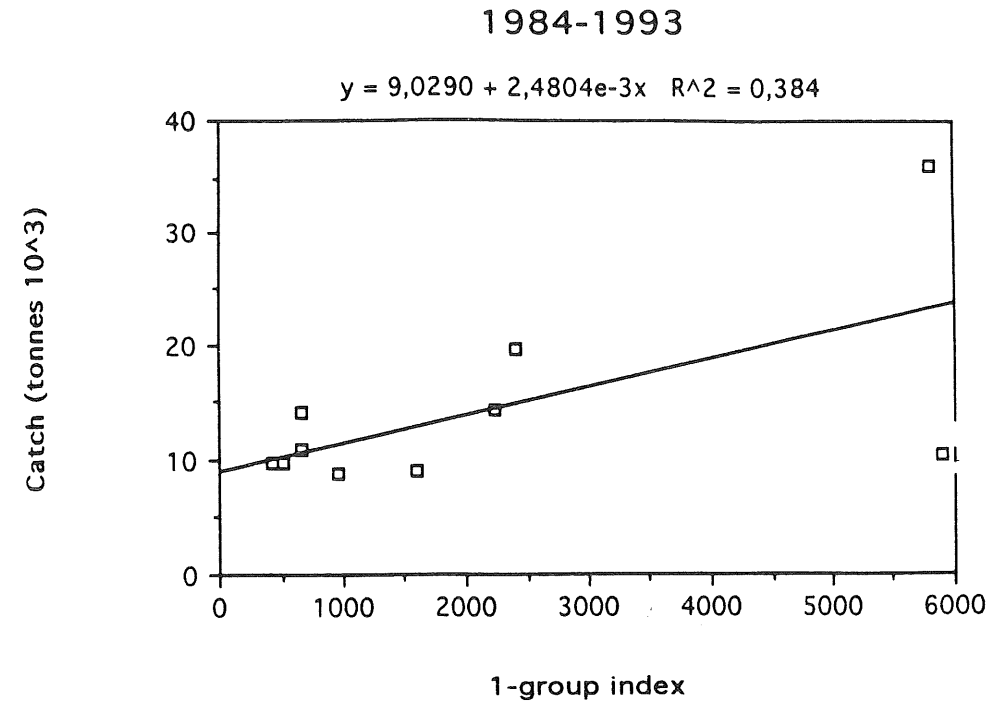
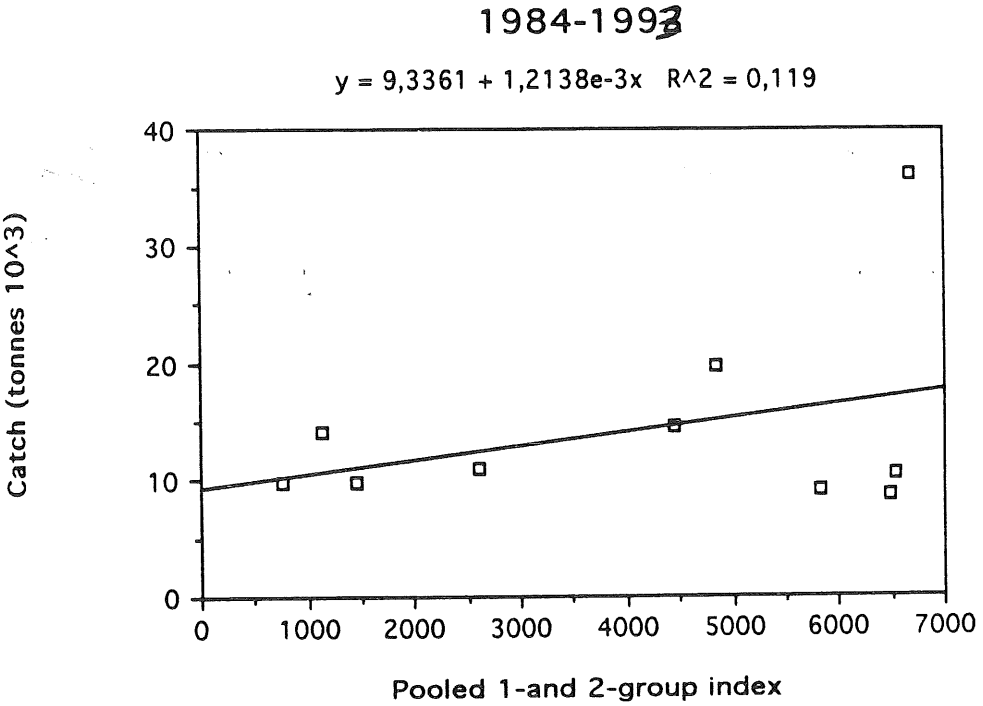


Figure 8.6.1 North Sea Sprat. Scatter diagram of commercial catches plotted against IBTS index of all age-groups in same year. Regression lines are given for all years 1982-1993 and excluding 1989.

Figure 10.5.1 Sprat in Division IIIa. Regressions of the 1-group index and the pooled 1- and 2-group index vs total catches for 1984-1993.





Appendix 1

Report
of the Subgroup to
Investigate the Applicability
of
the ICA method to Herring Assessment

Applications of Integrated Statistical Catch-at-age Analysis

The models to conduct an integrated statistical catch-at-age analysis have evolved from the theory described by Fournier and Archibald (1982) to the practical applications described by Deriso et al. (1985), Methot (1988), Lewy (1988), Kimura (1989, 1990), and others. The approach is fundamentally to build the model to describe the data rather than the more traditional ad hoc approaches of modifying the model implementation to incorporate unusual sets of data. The intent of these integrated catch-at-age analyses is to provide the flexibility to incorporate all available types of information ranging from catch-at-age data, acoustic survey, egg or larval survey, catch-per-effort, length frequency, stock-recruitment, to migration patterns within one statistical framework that allows for simultaneous fitting of all data sources and parameter estimation. For example, traditionally one would conduct a VPA and then use the output to investigate the stock-recruitment relationship as a separate and independent analysis. In the integrated approach the stock-recruitment parameters are estimated simultaneously with all the other parameters as an integral part of the analysis.

Applications of this approach have been in the Pacific coast of North America and in the Northwest Atlantic (Gavaris, ADAPT). Fournier (1983) has applied the methodology to Pacific cod, incorporating catch-at-age, stock-recruitment, and aging error considerations within an integrated model. Similarly, Methot (1986) has used catch-at-age, egg and larval survey data, and hydroacoustic data for analyses of Pacific anchovy. Quinn et al. (1990) have extended this formulation to include catch-per-effort data and tagging data in an analysis of Pacific halibut population structure including a migration component. A modification of the Fournier-Archibald model has been developed for Pacific herring stock assessment in British Columbia during the past decade which incorporates catch-at-age data, egg abundance data, stock-recruitment curves, multiple fisheries with differing selection patterns, and estimates natural mortality as either a density-dependent or density-independent process (Haist et al. 1993). The CAGEAN model developed by Deriso et al. (1985) has been used for Pacific herring assessment in Alaska.

The ADAPT framework (Gavaris, 1988) is based on a similar approach recognizing that no single model is applicable to all assessments and that the program tools should rather be a framework in which the researcher can build and estimate parameters in his model tailored to the specific situation. ADAPT

is also based on a Least Square fit of the model parameters to data.

Apparently, part of the difficulty in obtaining wider acceptance of this process has been the fact that no single model formulation actually exists. Instead each implementation is developed specifically for a particular fishery or fishing process. Although this is the real strength of the modelling approach, ie. it is not constrained by the need or availability of particular types of data but instead can be modelled to incorporate a wide variety of disparate data series of varying completeness and precision, it has limited the ability of the average practitioner of fisheries biology to develop their own version of this approach. Recently, Fournier (1993) has developed a complete package for simple model development based on a maximum likelihood approach using his AUTODIF software which should facilitate future developments in this area.

COMPARISON OF THE XSA AND ICA METHODOLOGIES.

The essential features of the two methodologies are summarized below, in the form of algorithms. The description is far from complete, and many details such as weighting and transformations have been ignored.

The XSA algorithm treats the catches as exact values, whereas the ICA considers them as stochastic variables, that is, ICA takes into account that catches are subject to measuring errors. The estimation procedure in XSA and ICA is in both cases the standard least squares method.

In the two subsequent tables the following apply a: age, y: year, w(a) is the mean weight at age, m(a) maturity ogive with age, F is the fishing mortality

Data model	XSA	ICA
Catch-at-age	Usual VPA assumption F varying with age and year	Separable VPA for the later years in the analysis $F(y,a) = E(y)*S(a)$
Egg-Larvae Surveys estimates Spawning stock biomass SSB(y)	Cannot be used	$SSB(y) = \Sigma w(a)*m(a)*N(y,a)$
Acoustic Surveys Estimates biomass B(y)	Cannot be used	$B(y) = \Sigma w(a)*N(y,a)$
Age disaggregated stock indices CPUE(y,a) eg. Trawl Surveys or Commercial CPUE data	$CPUE(y,a) = Q(a)*N(y,a)$	$CPUE(y,a) = Q(a)*N(y,a)$

Weighting of Tuning Indices	XSA	ICA
Catch-at-age	Assumed to be exact treated as in VPA	1
Tuning indices	Internal weighting from contribution to Sum of squares of residuals	Explicit, specified by the assessment expert. Could be calculated from standard errors in catch-at-age and in survey and CPUE indices

XSA ALGORITHM:

The XSA algorithm is described in Darby and Flatman(1994).

Let a be index of age group, y index of year and f index of fleet, and let P[1993,a] stand for "final population", that is, the stock number in the last data year.

A: Do a cohort analysis:
Input: C[y,a], M and P, the final population
Output: $N^{VPA}[y,a]$ and F[y,a].

B: For recruiting age groups (with variable catchability) do

Regression : $CPUE[y,a,f] = alfa[f]*N^{VPA}[y,a]^{beta[f]}$
Compute : $N^{est}[y,a,f]$ = Inverse function(CPUE[y,a,f])

For age groups with constant catchability (over years):
Compute: $q^{est}[a,f]$ = weighted mean $_{y}$ $N^{VPA}[y,a,f]/CPUE[y,a,f]$

Compute: $N^{est}[y,a,f] = CPUE[y,a,f]/q^{est}[a,f]$

C: Estimate terminal population:
P[1993,a] = weighted mean $_{f,\ (y,a)}$ $N^{est}[y,a,f]$ exp(- Accumulated Z)

Shrinkage to mean P or/and mean F may be applied

D: If $F^{current}$ differs from $F^{previous}$ then go to A

Alfa[f] and beta[f] are fleet-specific parameters. q[f,a] is the fleet- and age-specific catchability coefficient. There are indices available from one or several fleets in the form of catch per unit of effort, CPUE[y,a,f].

The factor "exp(- Accumulated Z)" projects a stock number to the terminal population in the last data year.

ICA ALGORITHM:

The model behind the ICA corresponds to the traditional ICES forecast model. It makes a "forecast" for the historical period,

and compares the "predicted" catches and survey indices to the observed ones. It determines the parameters which minimizes the difference between observed and predicted catches/indices. The ICA algorithm is an iterative process as the XSA algorithm, but since the ICA formulation is in accordance with standard methodology of statistics, the minimization problem can be solved by standard commercial software (for example NAG) and there is no need to specify the details of the (rather complex) algorithm here. Therefore, we present only the object function to be minimized:

Minimize:

$$\sum_y \sum_a \left(C[y,a] - S[a]*Fo[y]*\bar{N}[y,a]\right)^2 +$$

$$\sum_y \sum_a \sum_f \left(I^A[y,a,f] - alfa[f]*N[y,a]^{beta[f]}\right)^2 +$$

$$\sum_y \sum_a \sum_f \left(I^B[y,f] - Biomass[y]\right)^2$$

with respect of S,Fo,alfa and beta

where F[y,a] = S[a]*Fo[y] as in separable VPA, I^A is index of stock numbers and I^B is index of biomass.

Comparison between the XSA and the ICA-ALGORITHM

A basic difference between the ICA and the XSA methods, in the context of herring assessment, is that ICA can deal with indices of biomass, whereas the XSA method requires age disaggregated indices of abundance. The ICA method can handle both types of indices. Further concerning the catch-at-age data, the ICA method is based on the separable VPA while the XSA method is based on the standard VPA formulation.

The basic model in ICA is a versatile model which can easily be modified, without changing the minimization routine. For example, it would be easy to change the model for selection in the current version (F[y,a] = S[a]*Fo[y]) to a model based on, say, the logistic ogive.

In contrast to the XSA model, the ICA will not require a theoretical justification, as that can be found in numerous textbooks of statistical theory. The ICA is believed to be more transparent than the XSA, and much easier to grasp, in particular for non-mathematicians. The XSA on the other hand is an ad hoc method, developed from scratch, which does not fully utilize the already existing theory and software. Furthermore, the XSA is derived from lengthy mathematical manipulations, which are difficult for non-experts to modify.

The ICA and similar integrated approaches require powerful computers, and that is perhaps the reason why these methods have not got the attention in the past they deserved. But now that the powerful computers have become generally available, there seems to be no reason to maintain methods (such as VPA) which were developed before the computers.

Simulation testing the ICA program

A working document (Patterson, 1994c) was presented in which simulation tests of the ICA program were documented. These tests showed that the program was effective in recovering estimates of population parameters (Numbers at last age and at last year in the separable model) with very low bias. Estimates of catchabilities Q were biased when the tuning index used was highly-variable (with CVs over 0.5), but the reason for this could not be determined. Estimates of the variance of the terminal-year fishing mortality on the reference age were correct within +/- 30%, and it was noted that an improved method of variance-estimation was required.

A further simulation trial was calculated in order to assess the performance of the program when used to assess a stock with levels of contrast in recruitment and in fishing mortality that is typical of the North Sea herring. A baseline data set was constructed based on the 1993 herring working group stock assessment for herring for the years 1983-1992. Starting populations in the year 1983 and at age 0 were taken from the 'final' VPA fitted in 1993, and these were decremented by natural mortality and by the fishing mortalities estimated when fitting the separable VPA in order to fill out the population matrix. Baseline predicted catches were calculated from these populations and mortalities, and a baseline pseudo-tuning index was calculated from the fitted populations. Random lognormal errors with a CV of 0.1 on the catches at age and a CV of 0.5 on the index were applied in order to generate 200 pseudo-observation sets of catches at age and of survey index. The ICA programmes were then used to attempt to recover the population parameter estimates that had been used to generate the pseudo-indices. Bias was estimated by comparing the mean of the (log-transformed) fitted parameters with the actual values used in the baseline data set.

Results are given in Table A.1. Bias in the parameter estimates is indicated by deviation from zero, and bias in the variance estimates is indicated by deviation from unity. The simulation test was designed as a full functional test of the programmes including input and output routine. As the testing routines include the creation of pseudo-data input files in a restricted format, the precision with which the tests are calculated is not the full machine precision and small deviations from the expected values are to be anticipated. Table A.2 shows that the estimates of population size, selection and fishing mortality are recovered with negligible bias. Nevertheless estimates of Q appear to be too low. The reason for this could not be determined in the time available, but is not of particular importance as the fitted populations are unaffected. Variance estimates are too high for many parameters, reaching in this case a 60% overestimate in the variance of F at the reference age in the last year. The variance estimation method requires further attention, but does at least serve to provide an indication of the range of likely errors in the assessments.

Evaluation of the Index Weighting

The ICA program uses the Doubleday-Deriso least squares minimization for the catch-at-age models as:

$$\sum (C-\hat{C})^2 + \lambda \sum (I-\hat{I})^2$$

where C are the catch-at-age observations predicted by the separable model and the I hat are the index observations that are predicted by the model. Given complete information on the underlying processes involved in collecting the catch and index data observations, lambda should theoretically be approximately equal to the ratio of the variance of log(catch) to log(index). Unfortunately, it is not possible to determine this ratio in practice and various approaches have been used to estimate lambda indirectly (Kimura 1989). We investigated the sensitivity of the ICA modelling approach to lambda based on the results of varying this parameter between 0.001, 0.01, 0.25, and 2.0 relative to the reference value of 1.0. We examined several output parameters but have summarized only the reference F for age 4 in 1992 in table A.3. The estimations were conducted on the North Sea herring data set using the acoustic index, the IYFS age 2-5+ index, and all five abundance indices (acoustic, IYFS age 1 and 2-5+, MIK, and LPE) simultaneously.

It is clear from these results that the impact of a wide range of values of lambda (e.g., 0.1 to 2.0) on the results of the ICA analysis is relatively minor and as a first approximation an estimate of lambda equal to 1 is appropriate. However, the observed effects for one index (IYFS 2-5+) may be more severe than for another (acoustic). The subgroup requests again that every effort be made to obtain estimates of the variances for both the catch data and the survey indices so that more realistic formulations of the model can be utilized.

Comparison of estimates obtained with the ICA, the XSA and the Separable VPA programs

The subgroup performed an analysis of the North Sea herring data for consistency in model performance. This comparison used the ICA program, the XSA program and the Separable VPA program. Because of the inability of XSA to use age aggregated data we restricted our comparison to a run of the programs using the age disaggregated acoustic tuning index for the North Sea.
The results are given in table A.2.

The XSA program provides population estimates which are driven by the tuning index on the assumption that catches at age are precise, whereas a separable VPA calculates population estimates based on the best fit to a separable pattern. The integrated analysis method provides a weighted fit to both indices and to the separable pattern simultaneously. In consequence it was decided to compare estimates of recruitment, spawning stock size and total stock size generated by the three methods. The separable VPA was 'tuned' in a similar fashion to that used in previous years by this Working Group.

The results given in Table A.2 indicate that the ICA program generates estimates of terminal population sizes in the last year of the analysis which are intermediate between those estimated by the XSA and 'ad hoc' tuned separable VPA procedure. In earlier years of the analysis, the ICA generates population sizes that

are somewhat higher. It is likely that this is caused by the very high acoustic survey estimates recorded in 1990 and 1991.

The very low recruitment estimate for 1992 obtained with XSA is based on this method giving an F for the 0 group of 0.474 compared to 0.036 and 0.076 for 1990 and 1991 respectively. This 1992 value is not estimated within the XSA method. The manual, Darby and Flatman (1994) p. 33 states "At initialization the [XSA] program uses a seed value for the terminal population of each cohort (usually giving terminal F $\approx$ 0.65 and equal for all cohorts)." ... " If the shrinkage to the mean option is not selected [which it was not in this test], the terminal populations of cohorts without tuning data [which is the case for the 0-group in this test] will not be modified". For testing of the programs shrinkage was not considered applicable.

Comparison of the ICA program with results obtained by the *ad hoc* method.

A run of the ICA program was completed with data taken from the 1993 Working Group report, and using assumptions comparable to those made in that assessment. The LPE, acoustic and IYFS indices of biomass (given in Table 2.7.2. of the op. cit.) were used in the assessment, and an inverse-variance reweighting regimen was used to re-fit the model iteratively. Selection relative to age 4 was set to 1.05 on age 8. The LPE and IYFS indices were assumed to bear power-law relationships to stock size, whereas the acoustic index was assumed to bear a proportionate relationship. Results of the comparison are given in Table (A.4), which shows that the ICA-estimated stock sizes are somewhat lower than those estimated in the *ad hoc* method. This suggests that the *ad hoc* procedure failed to find a best fit to the observed data. The statistical problems in the herring assessment and the tuning data have been discussed elsewhere and will not be repeated here.

Table A.1. Results of simulation experiment based on the assessment of North Sea herring completed by the Herring Assessment Working Group in 1993. Bias in the parameter estimates is expressed as deviations from zero; bias in the variance estimates as deviations from unity. All parameters estimated on log scale.

Reference F Year	PARAMETER ESTIMATE BIAS	CV	VARIANCE ESTIMATE BIAS	CV
1983	-.00284	.05033	.80795	.11704
1984	-.00351	.05266	.69019	.11648
1985	-.00551	.04054	1.09402	.11864
1986	-.00961	.04766	.85865	.12241
1987	-.00104	.04659	1.01353	.13053
1988	.00193	.04949	1.19126	.14948
1989	.00072	.05810	1.43579	.16588
1990	.00717	.07941	1.44289	.15241
1991	.00520	.11253	1.35240	.12427
1992	.00507	.14103	1.70333	.12347

Selection Pattern Age	PARAMETER ESTIMATE BIAS	CV	VARIANCE ESTIMATE BIAS	CV
0	.00611	.05446	.82324	.11648
1	-.00463	.04792	.83879	.11565
2	.00496	.04526	.94369	.11608
3	.00256	.05147	.73146	.11483
5	.00589	.03615	1.22833	.11543
6	.00268	.04233	.76678	.11473
7	.00701	.03367	1.19397	.11617

Stock in Numbers Age	Year	PARAMETER ESTIMATE BIAS	CV	VARIANCE ESTIMATE BIAS	CV
For the Terminal Year					
0	1992	.00780	.17591	1.41000	.11760
1	1992	-.00796	.14351	1.31940	.11504
2	1992	-.01969	.12754	1.51052	.11757
3	1992	-.01927	.12988	1.35496	.11632
4	1992	-.02144	.12659	1.35283	.11920
5	1992	-.01508	.13149	1.32185	.11634
6	1992	-.01792	.13367	1.34803	.11609
7	1992	-.01873	.12171	1.68342	.11828
8	1992	-.02529	.12734	1.55464	.11606
For the terminal age group					
8	1983	.00036	.09971	1.05643	.11546
8	1984	.00756	.08093	.92887	.11535
8	1985	.00564	.07036	.92058	.11660
8	1986	-.00926	.06331	1.01755	.11758
8	1987	.00153	.06733	.89913	.11970
8	1988	-.00395	.05781	1.26762	.12693
8	1989	-.01871	.07043	1.06653	.14570
8	1990	-.01308	.07618	1.39941	.15394
8	1991	-.01411	.09653	1.47247	.13852

Table A.1 (continued)

Catchability Age	PARAMETER ESTIMATE BIAS	CV	VARIANCE ESTIMATE BIAS	CV
1	-.08182	.16862	.96752	.11571
2	-.11828	.13989	1.32593	.11549
3	-.11313	.15728	1.03881	.11560
4	-.10082	.14305	1.24625	.11543
5	-.11518	.15405	1.06756	.11552
6	-.09998	.14258	1.25628	.11548
7	-.09384	.15886	1.02022	.11552
8	-.12758	.14911	1.17583	.11587
9	-.12054	.16903	.94415	.11577
10	-.10746	.13923	1.21163	.11508

Table A.2. Comparison of estimates of recruitment, total stock size and spawning stock size generated using the XSA, ICA and separable VPA methods.

RECRUITMENT			
Year	XSA	ICA	SepVPA
1987	114353	114258	1086313
1988	56540	69900	63095
1989	53379	68412	74130
1990	57464	59081	72829
1991	51712	64410	94984
1992	43696	392737	523434

SPAWNING STOCK			
Year	XSA	ICA	SepVPA
1987	1095304	1166746	1116479
1988	1503545	1682614	11508440
1989	2177405	2436584	2150599
1990	2292365	2645605	2332663
1991	2401425	2928579	2710827
1992	2459382	3083478	3106379

TOTAL STOCK			
Year	XSA	ICA	SepVPA
1987	4888767	5758176	4801471
1988	4759681	5344290	4710868
1989	5019001	5828247	5344565
1990	5294256	61080169	6139987
1991	5576898	6624554	7240973
1992	5173824	9123279	11117682

Table A.3 Results of manual weighting for all surveys combined and for acoustic and IYFS surveys

Reference F (age 4 in 1992) estimates for different values of

	Weight Factor attached to Index					
INDEX	1.0	.001	.01	0.1	0.25	2.0
Acoustic	.341	.548	.457	.354	.344	.343
IYFS 2-5+	.246	.528	.330	.232	.230	.272
All	.411	.530	.43	.390	.392	.40

Standard deviation of reference F (+/-) for different values of

INDEX	1.0	.001	.01	0.1	0.25	2.0
All -	.336	.305	.323	.333	.335	.336
All +	.503	.922	.574	.457	.459	.474
Acoustic -	.288	.239	.25	.274	.282	.286
Acoustic +	.403	1.256	.836	.458	.418	.410
IYFS -	.185	.194	.18	.177	.18	.193
IYFS +	.328	1.433	.604	.304	.295	.384

Table A.4 Comparison of estimates of recruitment and of spawning stock size estiated by the 1993 Working group, and estimated using the ICA programmes by making similar assumptions.

	ICA		Ad hoc	
Year	Recruits	SSB	Recruits	SSB
1987	84614	899702	88357	958693
1988	43741	1064386	45622	1179108
1989	41721	1339687	45506	1455634
1990	32488	1223780	42447	1353585
1991	34813	1143955	42032	1306521
1992	143719	957906	199064	1183922