INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
CONSEIL INTERNATIONAL POUR L'EXPLORATION DE LA MER

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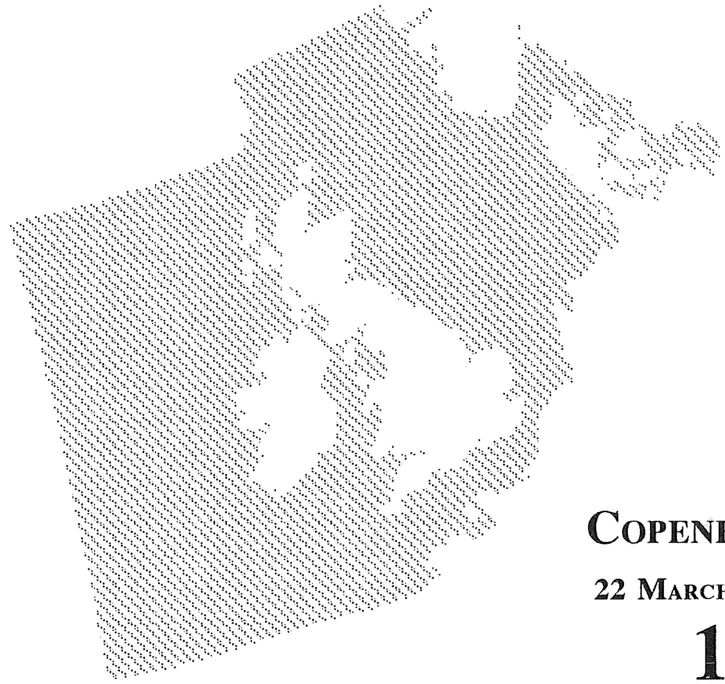
HERRING

ASSESSMENT WORKING GROUP FOR THE AREA

SOUTH OF 62° N



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CONTENTS

1 INTRODUCTION

1.1 Participants

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1.2 Terms of Reference

The Working Group met at ICES Headquarters from 22 March - 2 April 1993 with the following terms of reference (C.Res.1992/2:8:10):

a) assess the status of and provide catch options (by fleet where possible) for 1994 and, where appropriate, 1995 within safe biological limits for the North Sea autumn-spawning stock in Division IIIa, Sub-area IV, and Division VIId (separately, if possible, for Division IVc and VIId) and the herring stocks in Division VIa and Sub-area VII;

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

c) consider the Report of the Planning Group for Herring Surveys;

d) provide data to the Working Group on the Assessment of Pelagic Stocks in the Baltic, on the stock composition of herring catches in Division IIIa and adjacent areas of Sub-area IV in 1992;

e) provide the data requested by the Multispecies Assessment Working Group;

f) provide information on the sprat stocks, their age structure, their stock distribution, and their fisheries on an ICES standard rectangle basis, in order to allow the Working Group on Ecosystems Effects of Fishing Activities to evaluate the quantitative effects of industrial fisheries on the ecosystem.

1.3 Report of the Planning Group for Herring Surveys in the North Sea and Adjacent Areas

A preliminary draft of the report was made available to the Working Group (Anon., WD 1993a).

Planning of surveys for 1993

Acoustic surveys were planned for both the North Sea and Division VIa. In both areas, sampling effort in 1993 will be about equal to that in 1992. For the North Sea this means that vessel time available is just adequate to cover the main distribution area of adult herring. No sampling effort is available to cover the eastern central North Sea, the Moray Firth, and the Firth of Forth. The survey will, therefore, not cover some of the main distribution areas of 1-ringed herring, and an estimate for this age group will not be obtained. Survey transects are now spaced at 15 nm intervals, which is regarded as the minimum density for herring surveys.

The amount of vessel time available for herring larvae surveys will be further reduced in 1993. The sampling effort in the central and northern North Sea will now be insufficient to obtain a single coverage of all spawning areas. Unless additional vessel time is provided for this programme, no larval production estimate (LPE) will be obtained for the Divisions IVa and IVb herring stocks in 1993. This means that the larvae surveys will not provide an independent estimate of stock size for these areas.

The sampling effort scheduled for larvae surveys in Division VIa North and in Divisions IVc, VIId appears to be sufficient to obtain larval abundance indices (LAIs) for these areas.

There is uncertainty about the quality of the LPE for the central and northern North Sea in recent years. Due to the reduction in sampling effort, the precision of these estimates must have declined by an unknown amount. In the assessment procedure, the weight given to the LPE is based on the performance of this index in a historic period when sampling effort was considerable higher than at present. This procedure might attribute too much weight to the LPE for recent years.

Evaluation of survey performance

The comparative performance of the surveys was examined using both a statistical analysis of precision (also given in Patterson, WD 1993b) and a cost/use analysis. The comparisons indicated that the larval surveys performed relatively poorly both in comparisons of precision as an index of stock size and in the cost/use comparison with acoustic surveys.

The Working Group noted that the measures of cost and benefit used in the cost/benefit analysis may give a misleading indication of the real costs and benefits pertaining to each index. Specifically:

(1) In the cost/use analysis calculated by the Planning Group all research vessel days were costed equally. This method favours the acoustic series unduly, as vessel costs for a larval survey can be considerably lower than that needed to complete an acoustic survey. Larval surveys can be completed using a smaller vessel, with lower equipment costs and by a smaller, less highly-trained staff.

(2) Use of the variance of the prediction from the RCT3 program does not give an independent measure of either the precision of an index, nor of the usefulness of an index when used in a stock assessment procedure, as both the length of the index series and the relationship of the most recent data to the long-term mean influence the variance of the prediction.

The Working Group considers that the provision of a wholly independent index of abundance was highly valuable and that the larval surveys should be continued.

The Working Group considers that the present situation of a gradual reduction in larval survey expenditure in an unplanned manner is likely to lead to an inefficient allocation of resources.

The Working Group suggests that, should reduction in financial allocations to larvae surveys be unavoidable, the Planning Group should consider implementing the reduction by:

(1) Chartering small vessels for the larvae surveys.

(2) If reduction in survey effort is nevertheless unavoidable, this should be done by effecting comprehensive surveys at biennial intervals.

The Working Group also notes that rational allocation of resources between surveys and time periods depends on the ability to specify an objective measure of benefit accrued from surveys of different types in the stock assessment procedure. Consequently, the Working Group encourages further investigation of:

(1) The relationship between survey effort and survey precision.

(2) The relationship between survey precision and the precision of the stock assessment.

1.4 Evaluation of the Effect of *Ichthyophonus* on Herring Stocks

The first observations of infected herring in European waters were made in the North Sea and Kattegat in July 1991. At a Special Meeting held in November 1991, standardised and diagnostic methods were established. Since then extensive sampling has been carried out by several laboratories in order to estimate the prevalence of the disease in commercial catches and in research vessel catches.

A second Special Meeting was held in January 1993 with its terms of reference to update and analyse new information, and to estimate the mortality induced by *Ichthyophonus* in different herring stocks. A draft of the report from the 1993 meeting was made available to the Working Group (Anon., WD 1993b).

The report gives information on the present knowledge about taxonomy, pathogenicity and the dynamics of the disease. The Group concluded that there is no evidence that *Ichthyophonus* has occurred previously in European herring stocks and they found both similarities and dissimilarities with earlier events of *Ichthyophonus* in North American herring stocks. The underlying cause of the *Ichthyophonus* epizootic is not known but available evidence suggests an oral route of infection. Possible links to other species, plankton organisms and changes in hydrography were discussed. All available evidence indicates that *Ichthyophonus* is lethal to herring. Laboratory experiments on juvenile herring in USA suggest two different mortality rates: one acute, with mortality occurring within 15-30 days and one chronic with mortality spread over six months.

It was recognised that there are considerable difficulties in obtaining accurate estimates of prevalence. Infected herring are reported to change behaviour and stragglers from the main shoals become more susceptible to being caught in trawls than in purse seines. Particularly high prevalence estimates are reported from research vessel catches. It is, therefore, argued that sampling of commercial catches taken by purse seine probably provides the most accurate estimates of prevalence although they may on the other hand underestimate the true prevalence by targeting on shoaling fish.

The new information on the prevalence and distribution of infected herring shows that the disease has not spread to stocks other than those infected in 1991. The data confirm that the disease is present in the northern North Sea east of Shetland up to 64°N, in inshore areas along the Norwegian coast, in Division IIIa and in the western Baltic. A single herring with the disease was reported from Iceland. There is no evidence that the infection occurs west of the UK and Ireland.

Unfortunately, limited information on the distribution and prevalence of the disease is given in the report. The Working Group, therefore, recommends that these data be summarised, preferably by season, and disaggregated by age group and made available as soon as possible.

A preliminary attempt was made by the Working Group to calculate the mortality in the herring population in the North Sea. Based on data from laboratory experiments from the USA giving a mean life expectancy of 105 days for infected herring, a simple model was developed. The model is based on the following assumptions:

- the infection rate is uniform over the year,
- infected fish are not subject to other preferential mortality,
- infected fish are correctly represented in the samples,
- life expectancy for the diseased fish is correctly known,
- all infected fish in a sample are detectable.

Using the estimate of prevalence, of about 4.5% from the 1992 summer acoustic survey in the North Sea, the model suggests an annual mortality rate of about 16%. This estimate must be regarded as very tentative as all of the assumptions could be invalid. The effect of errors in the assumptions is discussed in the report. It should also be noted that the estimate is not separated on the two stocks of herring that are likely to occur in the area surveyed.

The *Ichthyophonus*-induced mortality cannot be added directly to the fishing mortality and natural mortality. To overcome this and to evaluate the possible effect on herring stocks with different levels of prevalence, mean life expectancy and infection rate, a model (Patterson, WD 1993c) was applied to the North Sea and the Division IIIa - SW Baltic stocks.

An epidemiological model of exploited populations (Dobson and May, 1987) indicates that under some circumstances it can be beneficial to increase fishing mortality on a disease-infected stock in order to reduce the stock size to a level below that at which the disease can sustain itself. A review of the available information on the present *Ichthyophonus* outbreak in relation to this model shows, however, that the conditions for this management action to be appropriate do not apply here. Instead appropriate action is to attempt to prevent the stock size from declining despite the additional mortality imposed by the parasite outbreak.

The method of calculating mortality used at the Special Meeting on *Ichthyophonus* assumes a static population in that no account is taken of conventional natural mortality (M) and fishing mortality. However, the mortality levels so calculated are of the same order as the current perception of fishing mortality, generating cause for concern. To address this problem more fully a simple epidemiological model was developed using standard methodology (Anderson and May, 1979), relying on the following principal assumptions:

- Infection rate of fish is assumed to be constant
- There is no substitution between disease-induced mortality (MI) and conventional natural mortality
- Mortality of fish due to the disease is assumed to be additional to conventional M
- The population is approximately in equilibrium
- Fishing affects infected and uninfected fish equally
- Infection rate and disease-induced mortality are exponential processes
- Sampling is unbiased.

If the prevalence of the disease in the population by age, the disease-induced mortality rate and the infection rate are known, the model can be used in stock projection calculations to assess the impact of the additional disease-induced mortality. By making an assumption of equilibrium the model can also be used to generate estimates of infection rate which can be used in the stock projections. The model thus affords a means both for estimating parameters of the disease dynamics and also for including these in stock projections.

As it was clear that there is a very wide uncertainty in both the input parameters and the basic assumptions of the model, a wide range of possible options was investigated, and their consequences for management action were assessed. Using the assumption of equilibrium and solving for infection rate from observed prevalences ($\sim$0.045), and assuming an MI which leads to 50% of infected fish dying after 15 weeks, an infection rate of 0.28 was calculated. This rate, is however, highly sensitive to the assumed MI, particularly at high values of MI. Although MI cannot strictly be taken as additional to conventional M, to a rough approximation this suggests that disease-induced mortality may be of the same order of magnitude as conventional M and, therefore, can have a significant impact on stock size.

The possible consequences of disease-induced mortality for management action was assessed using some trial calculations for the North Sea area and for the Division IIIa/Southwestern Baltic. In these calculations:

1. It was assumed that the management objective is to maintain SSB at its current level, and that a TAC will be set so that the SSB will be expected to remain stable.

2. Using estimated population sizes in 1992, a projected catch for 1993 was calculated to meet this objective. Conventional methods taking no account of disease-induced mortality were used.

3. Using the disease dynamics model, a new projected catch was calculated for which the stock size was again projected as remaining constant, but now taking account of disease-induced mortality.

4. The difference in projected catch between the two models was expressed as a percentage of the projected catch calculated in the conventional fashion.

This percentage reduction was used as a measure of the impact which a consideration of the disease dynamics could have on management action under the assumption that the management target is to maintain stock size at a constant level. The trial calculations indicated that in the North Sea area, where fishing mortalities are relatively low, observed parasite prevalences would indicate a reduction in the projected catches of the order of 10-20% to meet the management objective. In the Baltic, however, catch reductions of the order of 30-40% would be required. These reductions are not year to year reductions, but the percentage by which the disease dynamics model indicates that the projected catch should be reduced compared to the 'disease-free' projection. Although indicative only, these calculations were considered a warning that an explicit consideration of disease dynamics may have rather large implications for management action.

Results from the sampling programmes for *Ichthyophonus* should be made available as soon as possible in order that a consideration of the effects of disease dynamics in stock projections can be considered explicitly.

1.5 Results of Comparative Age Reading Experiment on North Sea Herring

The Herring Assessment Working Group for the Area South of 62°N in 1991 recommended a comparative age reading experiment on North Sea herring in order to check the uniformity of the existing age readings in various national institutes. The Netherlands Institute for Marine Research at IJmuiden consequently circulated a collection of 250 otoliths, originating from 10 different sampling positions, among laboratories in France, Denmark, Germany, Norway and Scotland.

The results of a comparison between the age readings by different laboratories were presented in a working document to this meeting (Corten, WD 1993). The agreement between different institutes varied from 70% - 90% if all otoliths are included in the comparison. If the comparison is restricted to otoliths of good quality (210 out of 250), the agreement increases to 73% - 92%. One of the institutes initially misread all otoliths from the 2nd, 3rd, and 4th quarter, and it had to repeat its readings institutes.

Considering the results of this experiment, the Working Group concluded that there is a need for increased standardisation of age readings between institutes. It is recommended that a workshop be organised for otolith readers in different countries, in order to compare their readings and minimise existing differences.

1.6 Assessments of Herring Stocks around Ireland

In recent years the Working Group has discussed the questions of stock unity and stock mixing in the various fisheries around Ireland. Information from larval surveys, tagging experiments and the distribution of the fisheries themselves all suggest that there is considerable mixing of the stocks between the various areas. This has created difficulties for the various assessments which have not been addressed and also raises doubts about the appropriateness of the various management units. These units are shown in Figure 4.1.1. The difficulties can be summarized as follows:

Division VIIa N (ie Division VIIa excluding the area south of 52°30'N). Tagging results show a strong possibility that a proportion of the young herring present in the Irish Sea are in fact recruits to the Celtic Sea stock. Herring originally tagged in the Clyde have also been recaptured in the Irish Sea. The stock in Division VIIa N is sub-divided into the Manx and Mourne components but the dynamics of the individual components are not understood in relation to the total stock. Larvae studies have also shown a drift of larvae from the spawning grounds in the eastern part of Division VIIa S into Division VIIa N.

Division VIIj - Celtic Sea. A similar situation exists in Division VIIj where larvae from the spawning grounds off the southwest coast are carried into Division VIIb. In addition, the important fisheries off southwest Ireland straddle the boundary between Division VIIb and Division VIIj at 52°30'N.

Division VIa S and Division VIIb. Larvae surveys in this area suggest a possible drift of larvae from the north coast of Ireland towards Scotland thus suggesting that at least some of the nursery areas for this stock are situated in Division VIa N. A number of tagged herring released in the Clyde area have in recent years been recovered in the fisheries in Division VIa S. There are also important fisheries on the Stanton Bank which is on the boundary (56°) between Division VIa N and Division VIa S.

The Working Group considers that a study group should be established to investigate the stock structure in the herring management units around Ireland and their relationship to stocks in other areas. This Study Group should also advise on the necessary changes that should be made to the existing databases if it were found necessary to carry out assessments for areas other than those in existence at present. It would also be advisable if the Study Group could examine all available survey data with a view to obtaining recruitment indices for various stocks and in addition draw up a programme of research necessary to carry out more meaningful assessments.

2 NORTH SEA HERRING

2.1 The Fishery

2.1.1 ACFM advice and management applicable to 1992 and 1993

1992

The 1991 ACFM meeting recommended a TAC of 352,000 t for Divisions IVa,b and a TAC of 54,000 t for the southern North Sea (Divisions IVc and VIId).

The agreed TACs adopted by the management bodies in December 1991 were: Divisions IVa,b: 380,000 t; Divisions IVc and VIId: 50,000 t.

It was additionally recommended that existing regulations designed to protect juvenile North Sea herring (sprat box closures, 20 cm minimum landing size, by-catch regulations) should be maintained and enforced more rigidly, that spawning area closures in Division IVb should be maintained and that the TAC for mixed clupeoids in Division IIIa should be reduced to zero.

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 (Divisions IVa,b): 380,000 t; Divisions IVc and VIId: 50,000 t).

2.1.2 Catches in 1992

Total landings for 1992 are shown in Table 2.1.1 for the total North Sea and in Tables 2.1 to 2.1.5 for each Division separately.

The total catch in 1992 of 549,000 t is close to the catches of the two previous years, and lower than in the years 1987-1989 (674,000 t on average). However, the 1992 catch represents an excess of 143,000 t over the TAC (that excess was 147,000 t in 1991).

As in previous years, Norwegian catches of Norwegian spring spawners (counted against another TAC) were removed and are not included in the catch tables.

As in recent years, catches of autumn spawners have been reported by the Faroese fleet in Division Vb. These catches amounted to 11,000 t; the age composition of these catches was not sampled in 1992 and there is no new information about whether they belong to the North Sea stock or to the Division VIa N stock. Thus, as in previous years, these catches were not included in the North Sea assessment.

In Divisions IVc and VIId, the estimated catch of almost 74,000 t represents a 14,000 t increase compared to that in 1991 and a 24,000 t (nearly 50%) overshoot of the TAC for that area. This catch includes estimated discards of 2,200 t which is an underestimate only taking account of the discards in the Dutch fleet during the herring season (November-December) and a catch of 202 t in the Thames estuary area predominantly composed of spring spawners. Some estimates of discards from other countries are included in national catch figures. Of the total catches 63,000 t were caught during the 4th and 8,000 t during the 1st quarter on spawning fish or during the spawning migration of autumn spawners, so the total catch of spring spawners can be considered negligible compared to that of autumn spawners.

2.2 Biological Composition of the Catch

2.2.1 Catch in number

Quarterly and annual catches in numbers at age were compiled for each Division and for the total North Sea.

Table 2.2.1 provides a breakdown of numbers caught in 1992 by age group for each Division on a quarterly and annual basis. Table 2.2.2 presents a comparison of total North Sea catches in numbers at age over the years 1970-1992.

The numbers of 0-, 1- and 2-ringer North Sea autumn spawners caught in Division IIIa were estimated (Table 2.2.3) and the assessment includes Division IIIa catches of North Sea autumn spawners.

The total catch in number in the North Sea in 1992 (10.9 billion) was twice that in 1991 (5.4 billion). This change is only due to a much higher catch of 0-ringers (7.6 billion against 1.6 in 1991). The sampling of the industrial landings improved in 1992, and the high estimate of 0-ringers is likely to be the result of a strong 1991 year class. This year class was distributed over a larger area in 1992 as indicated by the catches. A high proportion of the catches was taken outside the sprat box. The catch of 1-ringers in 1992 was nearly half that of 1991. The catch in numbers of 2-ringers and older remained fairly stable (2.6 billion). The contribution to the catch in number of young herring (0- and 1-ringers) was 76% but the figure for 1-ringers was the lowest since 1985 while the figure for 0-ringers was the highest since 1984 (the figures from 1984-1991 lie between 0.7 and 2.2 billion; the catch in 1992 was 7.6 billion).

The strength of the 1985 year class is still apparent in the catch: the catch in number of 6-ringers was the highest since 1970 (Table 2.2.2).

97% of the 0-ringers were caught in Division IVb in the third and fourth quarters (86.5% in quarter 3; 10.5% in quarter 4). In the same way, the catches in Division IVb account for 83% of the total 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 2.2.4.

The SOP by age and Division for each quarter is given in Table 2.2.5.

As in last year's report, Table 2.2.6 presents the age compositions separately for the catch of the human consumption fishery and the small-mesh industrial fishery.

2.2.2 Quality of catch and biological data

The Working Group was aware of several deficiencies in the available data. The catch data provided by most countries correspond to the official landing data for those countries. No information is available on possible discrepancies between official landing figures and actual landings. Estimates of discards were provided by only two countries (Table 2.2.7), but discards are likely to occur in fisheries by other countries as well.

Sampling of commercial catches for age and length was at a low level in certain fisheries. Only 10 samples were taken from the Norwegian catch of 100,000 t in Division IVa. Another 63,000 t taken in this area were converted into an age distribution using only 14 samples from the Dutch fishery (Table 2.2.7). No age or length samples were available for the entire German catch of 43,000 t in the North Sea.

The need for a further standardization of age reading in the North Sea area was indicated in Section 1.5.

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 the North Sea autumn spawners.

Baltic and Division IIIa spring spawners are taken in the deeper parts of the eastern North Sea during their summer feeding migration. These catches are included in Table 2.1.1. The table specifies the estimated amount of Division IIIa/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 1992a).

The 1992 Working Group estimated the fraction of spring spawners (fsp) as (56.50-v)/0.7), where v is the mean vertebral count of the (mixed) sample. The method requires that the two components have mean counts close to 56.50 and 55.80 for autumn and spring spawners, respectively, in all samples. The method is quite sensitive to within-stock variation (e.g. between year classes) in mean vertebral counts. Meristic samples from the 1992 summer acoustic survey were divided using this simple formula.

Figures 2.2.1-2.2.7 show mean vertebral counts by age group and by rectangle during May, June, July and August in 1991 and in May, June and July in 1992. The transfer area defined from meristic samples in previous years is indicated. The presence of spring spawners in both years in the southeastern part of the transfer area is evident from the low vertebral counts. None of the samples indicated any spring spawners among the 0- and 1-ringers in any month.

In July 1992, spring spawners seem to have occurred somewhat further north than in the other months.

Therefore, the transfer area was made larger in this month. The meristic sampling in August 1992 was too poor to verify the presence of spring spawners in the most important rectangles of the transfer area. However, the catches during this month in the area were significant and the proportions of spring spawners in this month were, therefore, calculated in the following way. The mean proportion by age of Baltic spring spawners in June-July and August 1990 and 1991 weighted by the catch in the transfer area was calculated. The calculated mean relative increase or decrease in the proportions from the two first months to August in these two years was then applied to the proportions for the appropriate age groups in 1992 to get the proportions for August 1992.

The resulting proportion of spring spawners and the monthly catches in the transfer area in 1992 are as follows:

Month	Proportion (%)				
	2-ring	3-ring	4+ring	No. of rectangles sampled	Catch in transfer area (t)
May	0	7	21	3	1,678
Jun	0	77	70	12	10,866
Jul	3	39	59	13	8,046
Aug	2	20	40	-	3,562
Q^2	0	68	63	15	12,544
Q^3	3	33	53	13	11,608

The table above also shows average proportions by quarter (weighted by monthly catch).

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 Relationship between IBTS 1-ringer index and VPA

Until now, recruitment forecasts for 1-ringers in the North Sea stock have been derived from the International Bottom Trawl Survey (IBTS or IYFS) by taking the mean of all rectangle means (catches in number/hour) in the standard area in the North Sea. This procedure does not consider the - sometimes substantial - numbers of North Sea 1-ringers taken during the IBTS in the Skagerrak and Kattegat.

The results of the IBTS in February 1993 forced the Working Group to reconsider this procedure. During the 1993 survey, the highest numbers of North Sea 1-ringers were found in the Kattegat and Skagerrak, and ignoring these catches would not be reasonable.

In order to incorporate the Skagerrak/Kattegat catches into the year-class estimate, a new survey index had to be calculated. This was done along the same lines as the calculation of the relative proportions of the year class in the North Sea and Division IIIa in last year's report (Anon., 1992a, Section 2.3.7). Mean numbers per rectangle for the entire survey area (North Sea + Skagerrak/Kattegat) were summed after they had been corrected for surface area. The surface area of each square was only corrected for the part of the rectangle that was unlikely to contain 1-ringers (land, shallow waters, water depths > 150 m). No corrections were made for differences in rectangle area due to different latitude. The weighting factors are given in Table 2.3.6.

The new series of survey indices is presented in Table 2.3.1 together with the latest VPA estimates of the corresponding year classes as 1-ringers. The predictive regression of VPA on IBTS indices is shown in Figure 2.3.1. The regression equation used for prediction is now:

$$y = 0.444x + 4.57 \qquad (r^2 = 0.81)$$

in which y is the VPA estimate of 1-ringers in billions, and x is the IBTS index for the whole survey (sum of all weighted rectangle means divided by 10,000).

2.3.2 Relationship between MIK indices and VPA

The calculation of MIK-indices for 0-group herring was described in last year's report of this Working Group (Anon., 1992a). The calculation of the combined index for North Sea and Division III a is shown in Table 2.3.2, and the comparison between the overall MIK index and VPA estimates of the same year class is shown in Table 2.3.3.

The updated predictive regression is shown in Figure 2.3.2. The regression equation used for prediction is now:

$$y = 0.341x + 11.038 \quad (r^2 = 0.66)$$

in which y is the VPA estimate of 0-ringers in billions, and x is the combined MIK index for the whole sampling area.

2.3.3 Relationship between IBTS 1-ringer index and MIK 0-ringer index

The relationships between survey indices and VPA can only be calculated for the period in which the VPA has converged. In the above calculations this is the period 1976 - 1988. Survey indices for more recent years can only be compared with each other, as no reliable VPA estimate is yet available.

Figures 2.3.3 and 2.3.4 show the relationship between the 1-ringer index from the IBTS and the 0-ringer index from the MIK for the same year class. Both indices appear to be highly correlated. The high MIK index for the 1991 year class has this year been confirmed by a high index for the same year class from the IBTS.

2.3.4 Recruitment prediction by RCT3

The Working Group also decided to make predictions of year class strength by using the RCT3 programme. The difficulty in using this programme for combining different recruitment indices of herring is that each series refers to a different age group (0-, 1- or 2-ringers). In using all series together to predict, for instance, 1-ringer recruitment, the assumption is made of constant mortality on 0- and 1-ringers.

Two runs of the RCT3 programme were made. In the first run (Table 2.3.4) the recruitment of 1-ringers was estimated from MIK indices, and from 1- and 2-ringer abundance in the IBTS. The predictions from this programme are compared with the predictions from the old regression in Table 2.3.1.

In the second run (Table 2.3.5), the recruitment of 0-ringers was estimated from the same series of indices as used in the first run. Table 2.3.3 compares the predictions derived from this run with the predictions from the old regression.

The Working Group decided to use the predictions from the RCT3 programme on recruitment estimates for the subsequent stock projections.

2.3.5 Recruitment forecast for the 1990 year class

The new IBTS index, based on the survey in 1992, and calculated for the entire survey area, is 16.64. Using this index in the traditional regression equation given above, the year class strength as 1-ringers is estimated at 11.96 billion. The RCT3 estimate of the year class at the same age is 10.52 billion (Table 2.3.1).

2.3.6 Recruitment forecast for the 1991 year class

The provisional index for 1-ringers from the IBTS in February 1993 is 50.34. This preliminary index is based on length frequency data from all participating countries, and age/length keys from five countries. Using the traditional regression, this index corresponds to a predicted VPA estimate of 26.92 billion 1-ringers. The RCT3 programme estimates the year class strength at 29.35 billion.

It should be noted that this year class had a highly unusual distribution as 1-ringers, with more than 60% of all fish being distributed in Division IIIa. It is not certain whether the survey estimate under these conditions is entirely comparable with the estimate in years with a normal distribution. The survey index is also at the upper end of the range on which the regressions are based. This results in a high standard error on the predicted VPA value.

Accepting the RCT3 prediction of 29.35 billion, the observed catch of 10.01 billion 0-ringers in 1992 corresponds to a fishing mortality of 0.19. This is a substantial increase over the 0-ring fishing mortality observed in previous years.

2.3.7 Recruitment forecast for the 1992 year class

The MIK index for this year class in February 1993 was 212.4. Using the traditional regression the VPA value for year class 1992 as 0-ringers is predicted at 80.1 billion. The RCT3 programme estimates the same age group at 85.1 billion (Table 2.3.3).

Figure 2.3.5 compares the distribution of 0-ringers during the 1993 survey with the distribution in the two preceding years. It is seen that the 1992 year class had an abnormally westerly distribution in February 1992. Since this means that the larvae were lagging behind on their normal schedule for crossing the North Sea, the mortality on this age group could be higher than usual. One has to be cautious, therefore, in using predictions based on the relationship between MIK-indices and VPA in years with a traditional distribution pattern. Another reason for caution is that the observed index is at the upper range of the values on which the historic relationship is based.

2.3.8 Trends in recruitment

The long-term series of 1-ringer recruitment is shown in Figure 2.3.6. Estimates of the 1970-1988 year classes are based on the VPA. For the 1989-1991 year classes, VPA estimates have been forecasted both in the traditional way (predictive regression, using the index for the North Sea standard area) and in the new way (RCT3 programme using MIK index and combined IBTS index for North Sea and Skagerrak/Kattegat). Using the new method, the strength of the 1991 year class is estimated at a considerably higher level than using the traditional method.

2.4 Acoustic Surveys

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

The 1992 acoustic survey of the North Sea and Division VIa was carried out by vessels from Norway, the Netherlands and Scotland over the period 24 June - 1 August (Simmonds *et al.*, WD 1993). In addition, a survey of Division IIIa was carried out by Denmark from 8-27 July. Results from this survey were not available.

The coverage of the survey in 1992 was reasonably complete and stock estimates have been worked out by age and maturity stage for ICES statistical rectangles 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 1.90 million t for Divisions IVa,b and IIIa combined, excluding estimates of Division IIIa/Baltic spring spawners, compares with an estimate of 1.87 million t in 1991 and 2.17 million t in 1990 (Table 2.4.2).

The proportion of 2- and 3-ringers mature on the 1992 surveys was 51% and 100%, respectively, which is rather close to the proportions in 1991 for the 3-ringers and significantly less for the 2-ringers. The average survey date in 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 24 September in 1992. The catch taken in the period between 15 July and this date is 139,000 t, from which an estimated catch of 3,000 t of spring spawners (3/4 of the catch of those fish in July and August) is deducted, giving a total catch of 135,000 t. The adult part of the catch in the third quarter is 65% by weight (Table 2.2.5), accounting for 60% proportion of maturity of 2-ringers. Applying this proportion to the calculated catch for the period 15 July to 24 September leads to a figure of 88,400 t. Deducting this last value from the acoustic estimate gives an estimated SSB at spawning time of 1,457,000 t.

2.5 Herring Larvae Surveys

2.5.1 Herring larvae surveys in 1992/1993

The results of the herring larvae surveys were presented in a working document (Patterson and Beveridge, WD 1993). The Netherlands, Scotland and Germany participated in the surveys in 1992 and 1993. Sampling effort again decreased, as illustrated in the text table below:

Year	No of Samples
1986/7	2040
1987/8	1978
1988/9	1886
1989/0	1672
1990/1	1005
1991/2	931
1992/3	739

Of the 739 samples taken in 1992/1993, 235 were taken in Division VIa N and 504 were taken in the North Sea.

2.5.2 Larvae production estimates

The sampling periods recommended in Anon. (1990b) for the calculation of larvae production estimates (LPE) are compared with the available samples below:

Area	Recommended Period	Actual Sampling Dates	No. of Samples taken
Buchan	15/09 - 07/10	17/09 - 21/09	48
Orkney and Shetland	10/09 - 30/09	15/09 - 22/09	124
Central North Sea	01/10 - 20/10	1/10 - 8/10	63
Southern North Sea	01/01 - 15/01	7/01 - 15/01	115

The distribution of sampling effort is considered barely adequate to calculate estimates of larvae production. As was noted in the 1992 Working Group report, the method assumes zero larvae production for time periods and areas for which no back-calculated estimates are available. In 1992, spatially incomplete larvae survey coverage in the Buchan area has resulted in an apparent loss of information in this way. As the Buchan area has historically made the largest contribution to the LPE (around one-third of the total), this suggests that for 1992/1993 the index is to some extent underestimated.

It is recommended that methods for estimating larvae production be reviewed in order to provide improved estimates of total production from the available data.

LPEs were calculated by the standard procedure described in Anon. (1987). Z/K values were estimated for each area based on the slope of the log mean abundance of larvae against length over the range 8-16 mm (10-16mm in the case of the southern North Sea). These were used to calculate the mean Z/K values over the years 1980-1991 in order to calculate the LPEs (Table 2.5.1). Growth rates were assumed to be 0.35 mm day^{-1} in all areas. The LPE values estimated for each area are given in Table 2.5.2.

Values of LPE raised by estimates of fecundity to spawning stock biomass are given in Table 2.5.3. It was noted that there are no estimates of fecundity since 1985.

2.5.3 Larvae abundance indices

The requirements for the calculation of the LAI for each area are compared with the availability of data in Table 2.5.4. The reduced index refers to the index suggested in Anon. (1990b) which could be calculated over core areas and time periods. As sampling was inadequate for several areas in 1992, such missing values were filled in using a multiplicative model, which simply provides estimates of the missing sampling areas on the basis of their contribution to the index in previous years and on the basis of the available data for the current year. The estimates of LAI are given in Table 2.5.5.

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 1992 are presented by Divisions and quarters in Table 2.6.1.

Table 2.6.2 shows a comparison of mean weights at age of 2-ringers and older over the years 1985-1992. For age group 3 and older there was a declining trend up to 1988 and then an increase. For these age groups, the mean weights at age observed in 1992 are somewhat higher than in 1991. For the 2-ringers, however, the pattern is different and the mean weights at age are low (the lowest of the series in Divisions IVc and VIId); this does not apply to Division IVa where the mean weight at age of 2-ringers is the highest of the series.

Table 2.6.3 provides a convenient comparison of the changes in the mean weights at age in the catch during the third quarter in Divisions IVa and IVb for the years 1986 to 1992. 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 three last summer acoustic surveys are displayed in the same table. The same pattern as in Table 2.6.2 is observed: a decrease in the mean weights of the younger fish, and a slight increase in those of 3-ringers and older.

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 1992 (maturity stage 3 and above during the survey) compared with the four previous years were as follows:

Age (winter-ring)	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

The estimated percentages of maturity for 2-ringers are based on both the North Sea and Division IIIa acoustic estimates.

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). The time series of the IBTS index is now recalculated to real spawning stock indices, including the mature portion of 2-ringers. The table also shows the spawning stock estimate from the converged part of this year's VPA.

The larvae production estimate (LPE) shows a small increase while the IBTS index and acoustic estimates indicate a decrease in the spawning stock in 1992 compared to 1991.

The discrepancy between the level of the 1992 indices was discussed. Concern about the reduced effort in the larvae surveys was expressed and may be a reason. It was discussed whether to include the LPE index in this year's assessment or not, and it was finally decided to include it.

On the basis of some trial VPAs, applying the new catch data but the terminal Fs from last year's final VPA, the spawning stock estimates were considered reasonably converged for 1989 and earlier years; increasing the relative fishing mortality in 1992 by a factor of 2 caused a decrease in the estimated stock of less than 20%.

By 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 data and outputs from RCT3 are given in Table 2.7.2. Concerning the slope of the regressions, the pattern described in the 1992 Working Group report was repeated; the regression of LPE and acoustic estimates had slopes well above 1 and the IBTS regression had a slope slightly below 1. This implies a curvilinear relationship between the non-logged indices and the VPA. The Working Group discussed this feature for the different indices both from a biological and a statistical point of view and concluded that it is probably incorrect to replace the regression for just one index by a log-log regression with slope fixed to 1, as was done last year for the acoustic index. It was the general opinion that the different indices should be treated in the same way, preferably fixing the slope of the log-log regression to a value of 1. The error which may be introduced by this method should be investigated more thoroughly by a small group of scientists before the Working Group meeting in 1994. 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 2.7.2 contains the regression parameters, predicted values with standard errors and the weighting factors obtained when applying the acoustic regression with fixed slope.

Predictions of spawning stock in the unconverged years were calculated from these regressions by making a weighted average. The weighting factor was $1/SE^2$, where SE is the estimated standard error of the individual predictions. Predictions from the IBTS have a relatively low standard error and get about 50% of the weighting when making the new average predictions.

A VPA was tuned by the method described in the 1991 Working Group report. For all the years in the VPA an annual natural mortality 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 with different terminal fishing mortalities in 1992. The selection pattern based on the years 1987-1992 and the fishing mortality on the oldest true age group by year is shown in Table 2.7.7. All other input values are shown in Tables 2.7.3 - 2.7.6. The 1992 values for weight at age in the stock and proportions of maturity are derived from the summer acoustic surveys.

The separable VPA with 0.41 as reference fishing mortality (for 4-ringers) for 1992 was the one giving the minimum sum of squared residuals relative to the average predicted values (Figure 2.7.1). This VPA was, therefore, considered as the best fit to the survey data. The outputs of this VPA are shown in Tables 2.7.8 - 2.7.10. Table 2.7.8 shows an average fishing mortality in 1992 of 0.39 for 2-6-ringed fish which is at the same level as in 1991.

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 1993. For 3-ringers and older the VPA estimate is used (Table 2.7.9). The numbers of 2-ringers at 1 January 1993 (1990 year class) is estimated using Pope's approximation from the RCT3 predicted number of that year class as 1-ringers in 1992 (10,520 million), a catch of 2,231 million in 1992 and natural mortality. The number of 1-ringers and 0-ringers at 1 January 1993 are the RCT3 estimates of 29,350 million 1-ringers and 85,100 million 0-ringers as described in Section 2.3. 0-ringers at 1 January 1994 are set at 65,000 million (1983-1990 average).

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 1992 (Table 2.8.2). The fishing pattern for the total stock is taken from the separable VPA for 2-ringers and older (Table 2.7.7).

Catch predictions for 1993 and 1994 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 1992 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 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 abundance of 0- and 1-ringers in Division IIIa were estimated using the procedure suggested by the Workshop on Methods of Forecasting Herring Catches in Division IIIa (Anon., 1992e). The proportion of 1-ringers in Division IIIa estimated during the IBTS is applied to the VPA estimate of the total year class giving a time series of 1-ringer abundance in Division IIIa (Table 2.8.1). These estimates of 1-ringer abundance in Division IIIa are regressed with the MIK indices. The results of the regression are given in Table 2.8.1. The 1993 MIK index was used to predict the 1-ringer abundance in Division IIIa and the North Sea on 1 January 1994. The results are 12.0 billion in Division IIIa and 14.6 billion in the North Sea. At 1 January 1993 the IBTS proportion observed in Division IIIa was applied to the total estimate of the year class giving 16.7 billion in the North Sea and 12.6 billion in Division IIIa.

The proportion of 0-ringers by area is estimated using the regression between the MIK indices and year class abundance in Division IIIa and the total abundance of 0-ringers in 1993 and 1994.

The reference fishing mortalities by age, fleet and area were calculated using the abundance by age and area on 1 January 1992 and the catches in 1992 by fleet.

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

Three sets of projections were made, based on different assumptions for the fisheries in 1993. A summary of the projections is given in Table 2.8.3.

Option 1:

In option 1 the catches in 1993 are estimated assuming unchanged effort (i.e. F by area) in all five fleets from 1992 to 1993, giving a total catch in 1993 of 983,000 t and a SSB of 1.05 million t. As seen in Table 2.8.3 the catches in Division IIIa are predicted to be 461,000 t. The Working Group considered this high figure to be unrealistic but decided to present the prediction for 1994 to illustrate the effect of assuming constant fishing mortality while large recruitment is expected.

The catches by different combinations of effort by fleet under option 1 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 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 the Division IIIa fleets.

Option 2:

The prediction for 1993 is based on unchanged fishing mortality for fleets A and B compared with 1992 and the catches of fleet C, D and E equal to the catches in 1992.

The total catch in 1993 is estimated to be 676,000 t of which about 60% is taken by fleet A. The reduction in the catch compared to option 1 has relatively little effect on the SSB in 1994. This is because the catch reduction is in Division IIIa where the fisheries are on the juveniles.

In 1994 the SSB is predicted to be around 1.1 million t.

Option 3:

This option is based on a TAC constraint (430,000 t) on fishery A, unchanged effort in fleet B and the same catch in tonnes by fleets C, D and E as in 1992. The total catch in 1993 is estimated to be 693,000 t.

The estimated catches and SSB for 1994 are very similar to those obtained under option 2.

All options presented for 1993 and 1994 show a fairly stable spawning stock biomass, while the catches vary considerably between years and between options for the fleets exploiting the young age groups. It should, however, be stressed that unchanged effort for fleet E will give a very high predicted catch of juveniles in 1993 and 1994, and will have a negative effect on the spawning stock in 1995, when the 1991 year class is fully recruited to the spawning stock.

The regression between VPA estimates of 0-group and the MIK index has wide confidence limits. The estimate of the total size of the 1992 year class is thus very uncertain. In addition, the same index is used to predict the proportion of the year class that will be in Division IIIa. The predicted catches of juveniles both in 1993 and in 1994 are, therefore, very uncertain, and can only be used as an indicator of the relative importance of the different fisheries in the exploitation of juvenile herring.

2.9 Management Considerations

2.9.1 Uncertainty in catch predictions

In choosing between different catch options for 1994, one has to be aware of the uncertainties of the stock estimates upon which the catch projections have been based.

Section 2.11 shows the effect of each index series on the results of the tuning. The acoustic surveys and IBTS tend to increase the absolute level of the predicted stock size, whereas the LPE has a reducing effect. The Working Group has expressed concerns about the quality of the LPE in recent years, and this index series may have been given too much weight in predicting stock sizes. This may have resulted in a conservative stock estimate for 1992.

However, there is also a possibility that the stock size in 1993 is lower than predicted, due to an increased natural mortality caused by the *Ichthyophonus* infection. Since limited quantitative estimates of the present infestation rate were made available to the Working Group, it was not possible to make allowances for an additional natural mortality in the projections (see Section 1.4).

Catch and stock predictions for 1993 and 1994 are also driven by the high predictions for the recruiting 1991 and 1992 year classes. Reservations about the accuracy of these recruitment forecasts are expressed in Section 2.3.

2.9.2 Exploitation of juveniles

Catches of juvenile herring, both in the directed herring fisheries and in industrial fisheries for other species, have a negative effect upon SSB and catches of adult herring in subsequent years (Anon., 1992a). If managers aim for an increase in SSB and catches of adult herring, the catches of juvenile herring have to be reduced.

The catch data for 1992 show substantial catches of juvenile herring both in the North Sea and Division IIIa. In the North Sea there was a substantial increase in catches of 0-ring herring. These increased catches were apparently related to a strong year class and a changed distribution of this age group. Therefore, the existing sprat box along the Danish west coast did not provide sufficient protection to this age group, and additional conservation measures are needed if the aim is to reduce the exploitation of this age group.

In Division IIIa large catches of 1-ringers were taken in 1992. These catches were mainly taken as a by-catch in the directed fishery for herring. In an attempt to reduce by-catches of juvenile herring, one country in this area has introduced a ban on ship-borne sorting equipment and enforced a ban on landing of herring for industrial purposes. The consequences of these measures on the by-catches of 1-ringers are unknown, and a full evaluation of the present measures is desirable before similar measures are introduced in other countries.

2.9.3 Selection of catch options

Yield per recruit calculations (Figure 2.9.1) indicate that there are no long-term gains from an increase in fishing mortality above 0.25. This applies to the present exploitation pattern in the stock. In earlier years, the Working Group has suggested a fishing mortality of 0.30 as a suitable management objective for adult North Sea herring. The expected increase in recruitment in 1994 and 1995 offers an opportunity for reducing the present F without reducing catches.

The final catch option selected will be composed of different fleet components. Catches of herring in any of these fleets should be counted against the overall TAC. Moreover, the various TAC components should be applied exclusively to the fleet for which they were calculated. In other words, the projected by-catch of juvenile herring in the small-mesh industrial fishery in the North Sea should not be added to the quota assigned to the directed herring fisheries.

Attention is drawn to the fact that catch options including a substantial by-catch of juvenile herring in the small-mesh industrial fishery have in recent years led to overshooting of the national quotas by certain countries.

2.9.4 Management advice for southern North Sea and Channel (Divisions IVc, VIId)

Little information was available to the Working Group on the development of the spawning population in this area due to the lack of an adequate larvae survey in December 1992. The survey in January 1993 indicated a normal production of larvae, and commercial catch data in 1992 showed a strong recruitment of the 1989 year class. The population, until now, appears to be stable under the present management regime.

However, it was stressed that the catch in 1992 reached the level of 1.5 times the TAC. The landings from this area have in recent years constantly been at a very high level quite independent of TACs. Without better enforcement, this situation is likely to continue in 1993.

At the current catch level, any rebuilding of this stock towards its past level seems unlikely and two consecutive lower-than-average (or one weak) year classes could sharply reduce this stock.

2.10 Requests from the Multispecies Assessment Working Group

2.10.1 Quarterly database (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 1992 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 IVb, 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 3.1.1.

2.10.2 Geographical distribution of the catches in the North Sea in 1992

Data on the geographical distribution of catches in the North Sea (Sub-area IV and Division VIId) in 1992 were available from Denmark, the Netherlands, Norway, Sweden and the UK (England and Scotland). The data represent 90% of the total catch, and include both juveniles and adults. Figures 2.10.1-2.10.12 show the catch by ICES rectangle 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 242 t caught by Belgium.

2.11 Other Assessment Methods

The Working Group made additional assessments of the herring in the North Sea using ADAPT and XSA. Retrospective analysis was carried out for these methods as well as for the *ad hoc* assessment method presently in use.

2.11.1 Comparative assessments using ADAPT methodology

Model formulation

In order to effect a model fit comparable to the assessment procedure used historically by the Working Group, an objective function was defined which closely reflects the decisions and assumptions made. These are:

1. The minimisation is performed on the basis of comparing SSBs at spawning time;
2. The LPE and IBTS indices are assumed to have a log-log relationship with SSB;
3. The Acoustic index is treated as directly proportional to SSB.

The final objective function used was, with obvious notation:

$$\sum_y (\ln(SSB) - \ln(Acoust_y \ . \ Q_{acoust}))^2 +$$
$$\sum_y (\ln(SSB) - Q_{lpe}.\ln(LPE_y) + K_{lpe})^2 +$$
$$\sum_y (\ln(SSB) - Q_{iyfs}.\ln(IYFS_y) + K_{iyfs})^2$$

in which

$$SSB = \sum_{ages} Numbers_{age}\ Weight_{age}\ Maturity_{age}\ \exp-(PZ(F_{age} + M_{age}))$$

where PZ is the proportion of Z that is incurred before spawning (= 0.67). Selection in the last year was calculated iteratively as a mean over the last six years. Fishing mortality on the last age was calculated as an arithmetic mean over ages 4 to 7. In the following section, the term 'catchability' refers to values of Q in the equations above.

In discussions it was proposed that improved consistency in the assessments might be achieved by assuming linear catchability relationships for all three series, rather than only for the acoustic index. This idea was tested using a retrospective analysis, and the effect on perception of current stock size was assessed.

Baseline Assessment

The model was fitted to the available data by giving equal weight to each index series. A summary of results so obtained is given in Figure 2.11.1, which shows in general a similar fit to that obtained using the ICES procedure, but with a somewhat higher stock size in 1992 of the order of 1.5 million t.

Examination of the residuals about the fitted stock size indicates that there was considerable index divergence in this baseline assessment: the predicted values of SSB from the LPE index for the last two years lie far below the model fit, and although the acoustic index prediction for 1992 coincides well with the model fit, there are marked positive residuals for 1990 and 1991. The IBTS residuals are high in 1989 and 1990 but low in 1991 and 1992. The overall model fit, which seeks to give the best explanation of these observations, indicates a rapid increase in stock size from 1975 to 1989, with a rather sharp reversal in the trend in the last three years of the analysis.

Importance of series divergence

In order to quantify the extent to which the various indices lead to different estimates of stock size the model was fitted to each of the indices in turn, and the consistency of the fits was compared. Summaries of these fits are given in Figures 2.11.2-4 and in the text table below.

	Million t SSB estimate in 1992 at spawning time
LPE - tuned analysis	0.7
Acoustic - tuned analysis	3.0
IBTS - tuned analysis	1.4
3 indices, equal weight	1.5

This comparison shows:

1. The acoustic-tuned fit (Figure 2.11.2) indicates a stock size of the order of 3 million t; in comparison with the fit with the IBTS index the fit is poor and the trend is quite different from that indicated by the LPE series.

2. Conversely, the LPE-tuned fit (Figure 2.11.3) indicates a stock size of the order of 0.7 million t; here the fit is rather inconsistent with the IBTS index and very different from the acoustic index predictions.

3. The IBTS-tuned fit (Figure 2.11.4) indicates a stock size of 1.4 million t; the fit so obtained is reasonably consistent with the other two series, although, as would be expected, the LPE shows negative residuals and the acoustic index shows positive ones in recent years.

Divergent trends in the index series lead to widely different perceptions of current stock sizes, and as no prior estimates of index variances are available there is no objective basis for using the three indices to generate a single estimate of stock size. The index divergence, therefore, leads to considerable uncertainty in the assessment. In order that a single assessment can be generated two choices are available: to use an inverse-variance reweighting procedure, or to assign equal prior weights. On account of a perception that the inverse-variance weighting procedure is predicated on the assumption of unbiased indices with uncorrelated errors (which here seems not to apply), a prior assumption of equal prior weights was preferred.

Retrospective Analysis

Retrospective analyses were completed in the usual fashion, by successively excluding the final year of data from the analysis. Two models were tested in this way: the conventional one in which LPE and IBTS are assumed to have a logarithmic relationship to stock size, and the new proposal that all three indices exhibit simple proportionality. Results of the two series are given as Figures 2.11.5 and 2.11.6. These suggest that using the conventional model (Figure 2.11.5):

(1) The method generates successive upward revisions of perceptions of stock size. This suggests that the method may have a tendency to underestimate stock sizes.

(2) There is large change in the stock size estimate from 1989 to 1990; this is apparently driven by the extremely high acoustic survey datum recorded for that year.

(3) Over the last three years, estimates of stock size are rather consistent.

In comparison with the above, the model assuming linear index relationships shows:

(1) The method generates perceptions of stock size which are more consistent and do not show a trend.

(2) The stock size estimates seem overall more consistent.

(3) There is a small reduction in SSB to 1.3 million t. Details are given in Table 2.11.1.

In both models there is an implicit assumption that catchabilities, whether linear or logarithmic, are consistent between years and that the relationships are sufficiently stable to be used in the prediction of future stock sizes. Some random error in the estimated catchabilites is of course expected, but no consistent trend should appear.

In order to test this assumption the catchabilities estimated in each year of the retrospective analysis have been plotted for comparison (Figures 2.11.7 and 2.11.8). These show marked trends in both the linear and logarithmic cases, which indicates that a violation of the basic model is likely. The cause of these trends could not be determined in the time available, but it was recommended that further work be undertaken to resolve this question.

On account of this indicative analysis, it was agreed that models assuming linear catchability relationships show good promise for use by the working group for future assessments. However, the cause of the instability in the catchability relationships needs to be resolved: this holds true for both the linear and logarithmic cases.

2.11.2 Comparative assessments using XSA

An XSA tuning was performed on this stock using the default settings as recommended in the draft of the revised Blue Pages, except that tapered time weighting was not applied.

Only the acoustic data and the IBTS SSB data were disaggregated by age and could be used in the model. Thus, the LPE index, which gives a low SSB, could not be included, and the results of the XSA will, therefore, probably give higher SSB values than the method described in Section 2.7. Furthermore, as the XSA cannot handle +-groups, the IBTS 5+ ringer index value could not be used.

Indices of recruitment, i.e. MIK 0-ringers, IBTS 1- and 2- ringers were included, except the MIK index value for 1993.

The IBTS indices were assumed to reflect the stock numbers of the relevant cohorts one year earlier than the year of the survey.

The results of the XSA are shown in Tables 2.11.2-5. It can be seen that the SSB is estimated to be 2.27 million t in 1992 and $F_{2\text{-}6}$ 0.22. According to this run the SSB has been stable around 2.1-2.3 million t in 1989-1992.

Retrospective analyses for XSA were conducted with shrinkage (as above) of CV = 0.5, with shrinkage CV = 0.2, and without shrinkage. Figure 2.11.9 gives the results. The XSA without shrinkage and the XSA with shrinkage of CV = 0.5 are stable while the XSA with the strong shrinkage of 0.2 is unstable.

Because the XSA is not able to use all the information available about the size of the SSB, i.e. the LPE and IBTS 5+ indices, the XSA was not found appropriate for this assessment.

2.11.3 Retrospective analysis of the current *ad hoc* (VPA) method

A retrospective analysis of the *ad hoc* VPA tuning method was carried out. Figure 2.11.10 shows the level of the F-bars (2-6 ringers) in the period 1981-1992. The method seems to perform well as there are only small deviations in the F-values between the three successive assessments. However, it appears that the Fs may have been underestimated somewhat in the last few years, and that the stock may have been overestimated.

2.11.4 Concluding remarks

The Working Group discussed the results from the retrospective analysis of the three methods and came to the conclusion that there were no reasons to change the assessment method at present. This conclusion is based on the following main points:

- to be consistent with the assessments in previous years;
- to apply a method which is well known to the Working Group members;
- not to choose any other method until it is proved to perform better than the one already applied, i.e. for the Working Group to go through any new method thoroughly in a process including any aspect which may be of importance for the performance of the method.

However, the alternative methods need to be considered seriously in the future and a sub-group of scientists from the Working Group, therefore, volunteered to look further into the matter before the Working Group meeting in 1994.

3 DIVISION IIIA HERRING

3.1 The Fishery

3.1.1 ACFM advice and management applicable to 1992 and 1993

1992

No TAC was recommended for 1992 but ACFM advised that the fishing mortality for the spring-spawning herring in Division IIIa and Sub-division 22-24 should be below the 1990 level. This could be achieved with a catch of about 180,000 t in 1992 of which 90,000 t could be taken in Division IIIa, 10,000 t in the North Sea and 80,000 t in Sub-division 22-24. A zero TAC for the mixed clupeoid fishery was recommended.

The TAC agreed between EEC, Norway and Sweden for herring in Division IIIa was 124,000 t. A further TAC of 50,000 t was set for the mixed clupeoid fishery.

1993

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

If the fishing mortality for spring spawning herring in Division IIIa and Sub-divisions 22-24 in 1993 is the same as in 1991, a catch of 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 could be calculated.

The herring TAC agreed between EEC, Norway and Sweden taken in Division IIIa is 165,000 t. A TAC including all catches of all species, which are taken when fishing for sprat and which are landed unsorted, was set at 45,000 t (the mixed clupeoid fishery).

3.1.2 Landings

Landings are shown in Table 3.1.1. In 1992 the landings amounted to around 227,000 t in the whole Division. Of these, 60,000 t were taken in the Kattegat and about 167,000 t in the Skagerrak. In total, there was an increase of 39,000 t compared with 1991.

The data on landings are uncertain, partly because the Swedish landings of 70,000 t from the Skagerrak for industrial purposes were not sampled and the species composition is, therefore, not known. However, 24 samples from Swedish vessels landing in Denmark were available. These samples were taken by the Danish Authorities and only species compositions were obtained. The proportion of herring was estimated to be 87% (about 60,000 t).

Some of the Danish landings of herring for human consumption reported in Division IIIa may have been taken in adjacent waters of the North Sea in quarters 1, 2 and 4. Information about the fishery and vertebral counts indicate that these catches were probably taken in Division IVa East.

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 take part. Catches are landed mainly for human consumption, but a variable proportion is landed for reduction purposes.

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. In the Danish mixed clupeoid fishery the proportion of herring has declined and in 1992 the proportion was 57%.

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 result is given in the text table below (in thousand tonnes). 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".

		Human consumption	Mixed clupeoids	Landings for oil and meal	Total
1991	Kattegat	32	13	24	69
	Skagerrak	62	6	54	122
	Division IIIa	94	19	78	191
1992	Kattegat	24	11	24	59
	Skagerrak	75	14	79	168
	Division IIIa	99	25	103	227

3.1.3 Catch in numbers and mean weight at age

The unsampled Swedish catches from Skagerrak (about 30% of the total catches) introduced considerable uncertainty in the estimated catch in number. The Working Group estimated the age composition of this catch component as follows:

> For quarters 1 and 2, the age distributions from the Danish Mixed fishery were applied;
>
> For quarter 3, data presented in Dalskov (WD 1992) were used. He analysed the catch composition from pelagic trawlers that have used sorting machines on board. Data on species composition, age and length distributions from 24 trawl hauls were recorded from catches sorted into one fraction intended for human consumption and another for industrial purposes or discarding. The age composition of the part not landed for human consumption (trash fish, including discards) was applied to the Swedish industrial Skagerrak landings;
>
> For quarter 4, the total number of fish caught was calculated from the Danish experimental fishery samples taken in the third quarter. This number was then broken down into age groups by applying the ratio between "human consumption"/"trash fish" for each age group. As an example, let the proportion of age group 4 in the Danish samples of the human consumption catches amount to 40% and in trash fish to 20% (both in numbers). The Swedish human consumption age composition showed that age group 4 constitutes, say, 30% in the fourth quarter and consequently the proportion of age group 4 in the Swedish landings for industrial purposes is estimated to be:

$$20\% \times \frac{30\%}{40\%} = 15\%$$

Owing to uncertainty about where they were taken, the Danish catches for human consumption reported in Division IIIa (quarters 1, 2 and 4) were converted using the age distributions from the Danish landings from Division IVa East.

Table 3.1.4 gives total numbers and mean weights at age for herring landed from Division IIIa for 1992. Tables 3.1.2 and 3.1.3 give the numbers and mean weights for each type of fishery.

The numbers of young herring (0- and 1-ringed fish) have increased substantially since 1991 and were in the order of 4 billion fish.

3.2 Stock Composition

3.2.1 Spring spawners in the North Sea

The separation of catches from the northeastern 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 7,800 t in the 1992 catches. Table 3.2.1 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 where vertebrae counts were made.

The resulting split is summarized below:

Age group	Quarter	Skagerrak		Kattegat	
		Spring	Autumn	Spring	Autumn
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%	88%	12%
2	1	0%	100%	78%	22%
	2	0%	100%	67%	33%
	3	25%	75%	100%	0%
	4	93%	7%	100%	0%

Tables 3.2.2 - 3.2.5 present the catches in number and mean weight by age group for each of the three fisheries based on applying the above proportions.

The landings of North Sea autumn spawners in Division IIIa amounted to 152,000 t in 1992 (Tables 3.2.6 and 3.2.9). The figure for 1991 was 77,000 t.

The landings of spring spawners taken in Division IIIa in 1992 were estimated to be about 75,000 t (Tables 3.2.7 and 3.2.8) compared to about 114,000 t in 1991.

3.2.3 Quality of catch and biological sampling data.

Table 3.2.10 shows the number of fish aged by country, area, fishery and quarter. The sampling of the Danish catches for industrial purposes was at a high level compared to the last 10 years. As mentioned in Section 3.1.2 no samples from the Danish human consumption fishery in the Skagerrak were available, except for quarter 3.

There were no samples from the Swedish landings for industrial purposes taken in the Skagerrak in 1992. Only samples of Swedish landings in Denmark taken by the Danish authorities were available, and these only provided species compositions.

Discards occur in Divisions IIIa, especially in June, July and August, but no data were available.

The Working Group strongly recommends that adequate sampling be conducted in all fisheries in Division IIIa in which herring are caught.

3.3 Acoustic Survey

The results from the Danish acoustic survey carried out in July 1992 were not available to the Working Group. Data will be provided to the Baltic Pelagic Assessment Working Group meeting in April 1993.

3.4 Recruitment

3.4.1 General remarks on the 1993 IBTS February survey

The 1993 survey was carried out in February as in previous years and a total of 45 hauls were made. All standard stations were sampled and the weather situation during the survey was good. The 1992/1993 winter was mild and the water temperature in 1993 was above the long-term mean as in previous years. 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 1993 was 26,738 which is the second highest on record and more than 5 times the 1992 index. The length distribution observed in 1993 was unimodal and the vertebral count (VS) per length group showed that all herring were of the North Sea type with an average VS of 56.45-56.47 in all depth strata. All 1-ringed herring were, therefore, assigned as North Sea autumn spawners.

3.4.3 Abundance of 2-ringed herring

The final index of 2-ring herring in 1993 was 3,165 which is close to the mean value since 1980. The 2-ring index has up to 1988 been dominated by the spring spawners but since 1989 the autumn spawners from the North Sea have become more abundant. The modal length frequency analysis applied in the separation of the herring into spring and autumn spawners has performed better on 2-ringed than on 1-ringed herring. It has generally been possible to verify the split with vertebral counts. The mean length, vertebral counts and proportion of the separated components are shown in the text table below.

Stratum (m)	Mean length	Mean VS	Proportion of autumn spawners
1. 10-34	17.7	55.85	0.07
	20.7	56.44	0.93
2. 34-44	17.7	55.85	0.03
	20.7	56.36	0.97
3. 45-65	17.5	55.81	0.13
	20.3	56.46	0.87
4. >65	21.7	56.42	1.00

Table 3.4.1 shows area-weighted indices of spring and autumn-spawning herring by age group. To obtain this split, cohorts with an average VS around 55.8 were considered to be spring-spawning herring while the autumn-spawning component had an average VS of 56.4-56.5.

In 1993 the proportion of autumn spawners increased further. The result indicates reduced abundance of 2-ringed herring in Division IIIa. This, however, may not indicate a decline in the recruitment to the spring-spawning stock, since the IBTS covers only a part of the spring spawning herring distribution area. Spring spawning herring also inhabit Sub-divisions 22 to 24. The low IBTS indices in 1989 and 1991 are not confirmed by catch data. The distribution of 2-ringed herring may thus vary between years and this could influence the abundance estimates in Division IIIa. Extending the survey area and a better coordination and standardisation of the present surveys to cover the whole area of distribution at the same time as IBTS could remedy this possible deficiency in the survey design.

3.4.4 Abundance of 3+ringed herring

The index of 3+ringed herring for 1980-1993 in Table 3.4.1 is used for tuning the VPA by the Working Group on the Assessment of Pelagic Stocks in the Baltic. This index of adult herring, assumed to be local spring spawners, is calculated as for 1- and 2-ringed herring. The 1993 index is one of the lowest in the time series but may be influenced by changes in distribution as discussed above for 2-ringed herring.

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 are considered to exploit the same stock. For 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 EC, 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 and the southern part of Division VIIa, the major part of the Irish total catch (over 95%) has in recent years come from the inshore waters along the Irish coast in this area.

4.2 The Fishery in 1992-1993

4.2.1 Advice and management applicable to 1992 and 1993

The TAC recommended by ACFM for this area for 1992 was 27,000 t, while the figure agreed by the EC was reduced to 21,000 t. The preliminary estimated catch for 1992 was approximately 23,000 t. This catch includes discards which are estimated at 2,100 t. ACFM did not recommend a TAC for this fishery for 1993 but suggested that if a precautionary TAC was implemented then it should be within the range 20,000-24,000 t including discards. A TAC was subsequently set by the EC at 21,000 t.

As has been the case for a considerable number of years the major portion of the catches in 1992 were taken by the Irish fleet. The stated management policy for the Irish fishery is geared towards the Japanese roe market. The Irish fishery is therefore managed on a seasonal basis and fishing is confined to the spawning seasons which usually last from early October to mid-February. The fishery in 1992/1993 was opened on 1 October and closed on 26 February.

The total Irish quota was sub-divided into boat quotas/night. The number of boats participating in the fishery was 80 which was about the same as in 1991/1992. All boats participating in the fishery are regulated by licences which restrict landings to specific ports and specific times.

The system whereby selected spawning grounds are closed in rotation and which was first introduced in 1988 was again continued during 1992/1993. The spawning grounds closed were those situated in Division VIIg, the closure lasting from 15-31 November.

4.2.2 The fishery in 1992/1993

The fishery in 1992/1993 was unusual in a number of respects. The usual early fishery in the northern part of Division VIIj was very disappointing and adult herring were very scarce in the area. At the same time a successful fishery was carried out in Galway Bay in Division VIIb, approximately 40 miles north of the usual areas. The fish exploited in this fishery were very similar in biological characteristics to those normally taken in the fishery in Division VIIj. A further unusual feature of the fishery during 1992/1993 was that the shoals which normally migrate close inshore to spawn in Division VIIa S and Division VIIg, tended to remain further offshore than usual. Many catches were taken between 12-15 miles offshore after the fleet had failed to locate shoals in the traditional areas between 3-6 miles offshore. At the end of the season (February) large shoals of mature fish appeared off southwest Ireland (Kenmare Bay) and appeared to spawn in an area which is not normally considered to be a winter spawning area. At the same time winter spawners appeared to be absent from their normal areas in Division VIIg.

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

4.2.3 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 unallocated landings taken during 1992/1993, were about 21,200 t compared with 25,500 t in 1991/1992. Catches since 1988 have been reasonably stable, fluctuating between 19,000 - 25,500 t. A small revision has been made to the 1992 catch data in order to include some additional French landings.

Discards

Considerable concern has been expressed by previous Working Groups about the possible high level of discards in this fishery. Although no estimates of the actual level of discards are available, the Working Group have raised the Irish catches by a factor of 20% for a number of years. This level was decreased to 10% since 1991 because it was considered that the level of discards may have decreased due to improved fishing practices and management measures. Therefore, the Irish catches taken in Divisions VIIa S and VIIg in 1992/1993 were again raised by 10% to include discards.

In an effort to obtain information on the extent of discards, observers were placed on a number of fishing vessels during January 1993. However, no discarding was observed during these investigations.

4.2.4 Quality of catch and biological data

Although there is a lack of information about discard levels, management authorities are confident that the landing statistics from this fishery have improved considerably in recent years. There are, however, some doubts about the origin of some of the catches, particularly in the northern parts of Division VIIj and some misreporting may occur. In general, the biological sampling of the catches is very satisfactory. The sampling data are shown in Table 4.2.3 and quarterly length distributions from the Irish fleet are shown in Table 4.2.4.

4.2.5 Catches in numbers at age

The total catches in numbers at age including discards per season are shown in Table 4.2.5 from 1970-1992. The catches in numbers at age for 1992/1993 are based entirely on samples obtained from the Irish fishery which, as already stated, accounted for 96% of the total catch. The 1991/1992 catch at age data have been adjusted to include the additional French catches. The age distribution was dominated by 3 winter-ring fish (1988/1989 year class). There were, however, significant amounts of 2 and 4 winter-ring fish while the 1985 year class (6 winter-rings) still contributed 13% of the total catches. An examination of the percentage age distribution per quarter indicates that the number of 2 and 3 winter-ring fish increased as the season progressed. The numbers of 1 winter-ring fish present (7.5%) was the highest recorded in the catches since 1985/1986.

4.3 Mean Weights at Age

The major portion of the catch from this fishery is taken during spawning time. The mean weights in the catches, therefore, have always been taken as the mean weights of the stock at spawning time (1 October). The mean weights (g) are shown below for the seasons 1990-1991 to 1992-1993.

Season	1	2	3	4	5	6	7	8
1990-1991	99	137	153	167	188	208	209	229
1991-1992	92	128	168	182	190	206	229	237
1992-1993	96	123	150	177	191	194	212	228

In general the mean weights appear consistent in recent years and, like those in Divisions VIaS/VIIb, have stabilized after a sudden decrease that occurred in 1986/1987.

4.4 Stock Assessment

4.4.1 Acoustic surveys

Acoustic surveys have now been carried out on this stock for the last four seasons. In each season two surveys have been carried out, designed to obtain estimates of the autumn and winter spawning components. The total spawning stock biomass estimated by the first survey, which was carried out during the 1989/1990 season, was only 18,000 t. This estimate was considered by the 1990 Working Group to be unrealistically low (Anon., 1990a). The total SSB estimated on the 1990/1991 surveys was 91,000 t. This estimate, while not accepted by the Working Group as an absolute level of spawning stock size, was considered to indicate that the stock was in a healthy state and was possibly a minimum estimate. The 1991/1992 surveys estimated that the total SSB was at least 77,000 t. It was felt, however, that these surveys had missed out the important autumn component and, if the first survey had been carried out at the appropriate time, the resultant overall SSB might have been comparable to that estimated for 1990/1991.

The results of the 1992/1993 surveys which were again carried out by the R/V "Lough Foyle" were presented in a report prepared by Reid and Simmonds (Marine Laboratory, Aberdeen) and discussed in a working document (Molloy, WD 1993). The total spawning stock estimated by the surveys was 71,000 t. Although the timing of the surveys during 1992/1993 was considered to be correct there were problems in species mixing, shoal behaviour, unusual distributions of the fish, and late spawning. However, it was apparent that in the survey area herring were less abundant than in either of the previous two surveys. It is difficult, therefore, to decide whether the surveys should be taken to indicate a decrease in the overall stock, a portion of which may have been outside of the survey area, or whether the amount estimated should again be taken as a minimum stock level.

The age distribution of the spawning stock estimated from the 1991/1992 and 1992/1993 surveys, together with the age distribution of the mature fish from the catches, are shown below. Similar age distributions for the previous surveys are not available.

W rs.	1991/1992 survey		1992/1993 survey	
	Acoustic survey Nos.(10^{-6})	Catches Nos. (10^{-6})	Acoustic survey Nos. (10^{-6})	Catches Nos. (10^{-6})
1	20.9	1.0	257.7	5.2
2	195.2	63.9	117.0	26.8
3	94.7	38.3	87.8	35.0
4	54.0	16.9	49.6	27.6
5	84.8	28.4	22.2	10.1
6	22.1	4.9	24.2	18.0
7	5.3	2.6	9.6	3.0
8	6.1	1.0	1.8	6.3
>8	-	0.6	1.1	0.7
Total	483.15		571.0	
Biomass(SSB)	77.0		71.0	

The age distribution of the spawning stock obtained during the 1992/1993 surveys is very different from that observed in the samples obtained from the commercial fleet. There is very little evidence of the strong 1985 year class seen in the acoustic survey data while the 1990/1991 year class, represented by 1 winter-ring fish, appears to be very abundant. This year class is, as already noted, present in higher than usual numbers in the commercial catches and may be indicative of a strong recruitment. The age distribution obtained from the acoustic surveys would suggest that there were problems in sampling the adult population in 1992/1993.
The results of the surveys have not yet been considered sufficiently reliable to be used to tune the VPA. However, it is felt that these surveys should continue as they will potentially produce reliable estimates of the spawning stock in the area.

4.5 Results from Tagging Experiments

The preliminary results from the tagging experiments carried out in 1991 were presented at the 1992 Working Group meeting (Molloy, WD 1992 cited in Anon., 1992a). Approximately 10,000 herring, mainly 1 winter-ring fish, were released in July 1991 off the Isle of Man in Division VIIa. The recaptures to date are shown in Figure 4.5.1. A total of 175 tags have been recovered to date. Most of the recoveries in the months immediately after tagging, i.e., July- October 1991, were recorded from the main fisheries in Division VIIa N on the Manx and Mourne spawning grounds. From October 1991 to February 1992, 53 tags were recovered from the spawning fishery in the Celtic Sea. Only one tag was recovered from the summer fisheries in Division VIIa N during 1992, but a further 12 tags were recovered from the Celtic Sea during 1992/1993.

The results would suggest that 1 winter-ring fish present in the Irish Sea may belong to either the Manx, Mourne or Celtic Sea spawning components. The fact that only one recovery was made from the Irish Sea during the second summer would suggest that fish may immediately migrate to the Celtic Sea as 1 winter-ring fish or else they may spawn once in the Irish Sea and subsequently migrate to the Celtic Sea as 2 winter-ring fish.

4.6 State of the Stock

As pointed out in last year's report, recent working groups have had extreme difficulty in carrying out analytical assessments for the stock in this area. The 1992 Working Group did not carry out any analytical assessment but suggested that the available information, based on the age distributions of the catches, the results from the acoustic surveys and information from the fishery itself, indicated that the stock was in a healthy condition and possibly around 90,000 t. ACFM accepted this assessment of the stock and suggested that, despite the poor data on the actual catch levels prior to 1989/1990, a VPA might give useful information about the development of the stock.

Separable VPAs were, therefore, run on the data from 1970 to 1992. All years prior to 1986 weredownweighted to .001. Using a reference age of 3, SVPAs were run with a range of terminal S values of 0.8 to 1.15. An examination of the output revealed some anomalies in the older age groups suggesting some problems in the ageing or sampling of these fish. Fish older than age 7 were, therefore, combined into a plus group and the exploitation pattern was flat-topped (Table 4.6.1). Traditional VPAs were, therefore, carried out using a range of input F values in 1992 from 0.3 to 0.75. The resulting SSBs are shown in Figure 4.6.1 for the various values of F while the summary output from the VPA using the input F of 0.5 in 1992 is shown in Table 4.6.2. The values from this table prior to 1987 may be used as an indication of the development of the stock.

The SSB, which was estimated at about 85,000 t in 1970 decreased rapidly from 1970 to 1975 and from 1976 to 1981 averaged about 27,000 t. During the period 1977 to 1982 the fishery in the Celtic Sea (Division VIIg) part of this area was closed. A rapid increase in SSB took place between 1981 and 1982 following recruitment of two good year classes (1979/1980 and 1980/1981). During the 1980s recruitment, compared with during the 1970s, remained at a high level and the stock gradually increased from 1984 to 1987. It is difficult to determine the level of the stock in recent years. In 1992, it was accepted by ACFM that the stock level during 1991 may have been about 90,000 t and this would indicate that F in 1992 would have been about 0.40. Over the long-term time series (1958-1992) it has been shown that F values in this fishery have always been at a very high level compared with those of other fisheries. Over the period 1958-1970 it is difficult to select any period when the F values were below 0.4 for more than 2 years. At the same time the fishery collapsed during the 1970s when there was a period of high catches together with low levels of recruitment. The low recruitment was not detected at that time because of the absence of recruit surveys. At the moment there are still no recruit indices and doubts have been expressed about the catches in the late 1980s. The average F during the five years prior to 1987 when convergence occurred was about 0.75. It is possible, therefore, that recent F values of this order may have been maintained. If this is realistic, the SSB in 1992 using $F = 0.75$ is estimated to have been 58,000 t, and has decreased each year since 1989 (Figure 4.6.1).

The trend is not, however, in agreement with observations from the fishery but should be considered as a possibility.

The results from the acoustic surveys have not been used to select the most appropriate level of F in 1992 because of the short time series (three surveys) and because of uncertainties about the results from the actual surveys themselves.

The Working Group, therefore, again had difficulty in estimating the size of the stock in this area. The general information from the fisheries in recent years and from the acoustic surveys suggest that the stock has not shown any obvious decrease. At the same time it should be remembered that this stock has collapsed in the past as a result of declining recruitment and that mortality rates have always been high.

4.7 Recruitment Estimates

As has been stated elsewhere there are no recruitment estimates for this stock. Results from VPA (Table 4.6.2) show that recruitment was very low during the 1970s but increased considerably during the 1980s. The average level during the period 1981-1989 was over three times higher than during 1972-1980. From the catches in numbers at age table (Table 4.2.5), it would appear that the 1985 and 1987 year classes were about average while the 1989 year class was poor. Indications from the 1992/1993 catch data and from the acoustic surveys suggest that the 1990 year class, which recruited to the fishery in 1992/1993 as 1 winter-ring fish, may be above average. However, the available information is as yet inconclusive and the strength of this year class will not be substantiated until the age distribution from the 1993/1994 fishery is available.

The collapse of this stock in the 1970s was due to recruitment failures which were undetected at the time. It would, therefore, seem imperative that every effort should be made to obtain recruitment estimates for the stock as soon as possible. As it is now accepted that potential recruits to the Celtic Sea are found in the north Irish Sea, consideration should be given to re-commencing the young fish surveys in that area and re-examining the data that are available from existing groundfish surveys.

4.8 Management Considerations

4.8.1 Management advice

The stock in this area can be defined according to the ACFM criterion as one whose state of exploitation cannot at present be precisely assessed. No accurate stock or recruitment estimates are available on which to base catch predictions. The available information does not suggest any decrease in stock in recent years but management advice should take into account the history of the stock in this area. The results of the 1993/1994 acoustic surveys will be available at the next meeting of the Working Group. It may, therefore, be advisable to study these results before the TAC for the 1994/1995 season is set. This would be possible if a minimum TAC is set for the January-March 1994 period and the TAC for the remainder of the year is set following advice from the 1994 meeting of ACFM. If it is felt that advice should be given for 1994, then catches should not be set at a higher level than those of recent years, i.e, around 21,000 t including discards.

5 WEST OF SCOTLAND HERRING

5.1 Division VIa (North)

5.1.1 ACFM advice applicable to 1992 and 1993

The ACFM recommended a TAC of 62,000 t for 1992. This was also the agreed TAC, corresponding to a fishing mortality of 0.22 at which level the stock biomass was expected to be maintained if recruitment was at its geometric mean. The agreed TAC for 1993 is 55,140 t.

5.1.2 The fishery

The catches reported for each country are given in Table 5.1.1. The total catch in 1992 was approximately 51,600 t compared with the TAC of 62,000 t. This is the fifth year in succession that the TAC was not reached, but as in previous years there is no evidence that this reflects any difficulties encountered by the fleets in reaching their quotas.

The estimates of discards shown in Table 5.1.1. are derived from only one fleet. Discarding is thought to occur in the other fleets but no estimates are available.

The distribution of catches per quarter for Norwegian, the Netherlands, Irish and United Kingdom fleets are shown in Figures 4.2.1a-d.

In addition to the catches shown in Table 5.1.1, the Faroese fishery in Division Vb caught approximately 6,700 t of herring in 1990, 16,000 t in 1991 and 10,600 t in 1992. The stock identity of these fish is unknown, but they may belong to the VIa(North) stock.

5.1.3 Catch in numbers at age

Age composition data for 1992 were available from Scotland for quarters 1, 2, 3 and 4, Ireland for quarter 2 and the Netherlands for quarters 2 and 3. Catches from England and Wales, Norway, and Germany were converted to numbers at age using the combined Scottish, Irish and Dutch data. The Scottish data were included for this conversion because no other data were available for quarters 1 and 4. This may overestimate the catch of 0 and 1 ringers, because the Scottish figures include catches from the Minch fishery which is not exploited by other fleets. The catches by quarter and the percentages of the catches for which age composition data were available are shown in the text table below.

Quarter	Catch (tonnes)	%sampled
1	2,785	100
2	5,249	65
3	31,519	82
4	11,905	67

In addition, a total of 126 t caught by France and Denmark which were not reported by quarter were converted to age compositions using the age composition of the sampled landings for the whole year.

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 (excluding the Faroese catches in Division Vb) for the years 1970 - 1992 are given in Table 5.1.3.

5.1.4 Larvae surveys

The overall effort invested in the larvae surveys has remained at a low level. A total of 235 samples were taken in Division VIa(N) in 1992 compared with 193 samples in 1991 and 367 in 1990.

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

Recommended period	Available samples n
04/09 - 11/09	43
15/09 - 07/10, 20/09-23/09, 07/10	78
08/10 - 14/10	114

The requirements for the calculation of the LAI compared to the available data are as follows:

Time periods required for:

Full Index	Reduced Index	Available samples samples	n
01 - 30/09	01 - 30/09	04/09 - 11/09	43
		20/09 - 23/09	58
01 - 31/10		07/10 - 14/10	134

A particular problem was encountered with the calculation of the LAI. In 1992 the index was very heavily influenced by a single sample taken close to 56°50'N 7°45'W. This sample, together with the adjacent interpolated values, comprised 88% of the September index for the area, or about 45% of the annual LAI. The resulting index for 1992 is 12,252 compared with 4,430 for 1991. The influence of the single outlying sample on the value of the LAI means that the standard index cannot be considered a meaningful indicator of stock size for 1992.

Consequently the entire index series was recalculated using a variety of robust measures of central tendency; these were tested for goodness of fit to the SSB as estimated from the VPA from last year's assessment. The most satisfactory result was obtained using the 10% trimmed means of non-zero samples in each year, which fitted the historical SSB estimates almost as well as the standard LAI series. Due to lack of time, the trimmed means were calculated using the mean numbers of larvae per square metre without raising to rectangle areas and without interpolating missing values. Another limitation is that where replicate samples were taken in areas of high abundance, these were treated as independent samples in the calculation. There is therefore potential to improve the performance of the trimmed mean values in the future.

The LAI, 10% trimmed mean LAI, and LPE series of indices are shown in Table 5.1.4.

Historically, the LAI has performed better than the LPE in this area, possibly because the Z/K value used in the calculation of the LPE is the running mean of previous years, whereas Z/K may in fact be highly variable due to variable rates of larval transport between Division VIa and Orkney - Shetland. In general, however, the LAIs and LPEs have shown good agreement. It is therefore a cause for concern that the LAI and LPE have shown divergent behaviour since about 1988 (Figure 5.1.1).

5.1.5 Acoustic surveys

Acoustic surveys were carried out in Division VIa(N) during November in 1985 - 1987, during December in 1988 and during January in 1990. As stated in last year's report, these surveys were often disrupted by bad weather and only the 1987 estimate was considered reliable. However, comparisons with the results of subsequent assessments suggest that the 1987 survey overestimated SSB. The 1991 Working Group speculated that one reason might be a migration of adult herring between VIa(N) and the North Sea. In 1991 the survey period was changed to July, both to avoid disruption by bad weather and to allow concurrent estimates of stock size in the North Sea and VIa(N).

The 1992 acoustic survey was completed from 16 July to 1 August using a chartered purse-seine fishing vessel. Echotraces were allocated to the categories "herring", "probably herring", "sprat" and "other fish". For the 1992 survey, 97% of the stock in number was attributable to the "herring" category. A total of 39 trawl hauls were carried out, of which 16 caught sufficient numbers of herring to provide adequate samples.

The total biomass estimate from the survey was 428,500 t in July, of which 423,000 t comprised 2 ringers and older. The stock was dominated by 2 ringers and 5 ringers, as shown in the text table below.

Age (rings)	Number (millions)
1	78
2	546
3	236
4	277
5	447
6	262
7	122
8	60
9+	62

The series of SSB estimates from the acoustic surveys are shown below. The November 1987 survey can be considered an estimate of SSB at spawning time. The estimates of SSB from the two summer surveys have been used to estimate SSB at spawning time by applying an annual natural mortality rate of 0.1 over the period 1 - 31 August, subtracting two thirds of the catch taken in the 3rd quarter, then applying the same natural mortality rate over the period 1 - 30 September.

	Estimated SSB (t)	
Year	Survey Estimate (July)	Adjusted Estimate (October)
1987	-	364,000
1988	-	-
1989	-	-
1990	-	-
1991	446,000	417,000
1992	423,000	385,000

5.1.6 Recruitment

Although the acoustic survey provides an estimate of age composition, a longer time series is required to establish a relationship with VPA estimates before this can be used to predict recruitment.

As in previous years the only available index of recruitment is the mean catch rate of 2-ringers in statistical rectangles 46E4-E6, 47E4-E6, 44E3-E4 and 45E3-E4 during the bottom trawl survey carried out by Scotland in March each year.

The index series and the number of hauls used in their calculation are shown in Table 5.1.5. Figure 5.1.2. shows the relationship between the natural logarithm of the indices and the corresponding VPA estimates of 2-ringer abundance for the years 1981 to 1990. This relationship is poor and can only be used as indicative of extreme recruitment values.

5.1.7 Mean weight at age

Weight at age data from the 1992 fishery were available from Scotland, Ireland and the Netherlands and are shown in Table 5.1.6. The mean weights at age in the stock, also shown in Table 5.1.6. are those used in previous years.

5.1.8 Description of the assessment method

The assessment was done using a manually-tuned least-squares method similar to that used last year. The procedure was to use the relations between the LAI and SSB and between LPE and SSB from the converged part of the VPA from last year's assessment to predict SSB for the unconverged part of the VPA. The weights given to each of the indices were established using the RCT3 programme. Although unavailable for 1992, the standard

LAI index was used in the analysis in preference to the 10% trimmed mean (see Section 5.1.4) because the latter measure shows trends very similar to the LPE (see Figure 5.1.12) and, therefore, adds little further information.

From Figure 5.1.3, it seems that the VPA for this stock has largely converged by 1987. This was the final year used in the regression, which was used to predict SSB in 1988,1989,1990, and 1991.

Individual plots of LAI and LPE against SSB are shown in Figures 5.1.4 and 5.1.5.

The predicted SSBs were used together with the acoustic survey estimates of SSB for 1987, 1991 and 1992 to tune the VPA. The input F chosen was the one which minimised the sum of squared residuals between the VPA estimates of SSB and the estimates of SSB both from the RCT3 programme and from the acoustic surveys.

There are disadvantages to this approach. As discussed in Section 5.1.4, the effort invested in the larvae surveys has declined markedly in the last few years, so the historical performance of the indices is likely to overestimate the reliability of the most recent indices. Moreover, the acoustic estimates of SSB are considered absolute estimates, without verification against a converged VPA, even though recent assessments suggest that the 1987 acoustic survey overestimated stock size. A longer time series of acoustic estimates is needed to check this assumption.

As stated in Section 5.1.2, catches by the Faroese fishery in Division Vb were significant in 1990, 1991 and 1992. Since these fish may belong to the VIa(N) stock, the above tuning procedure were repeated using catch in number data which included these catches.

5.1.9 Results of the assessment

Separable VPAs were run to examine the catch data with all years prior to 1987 downweighted to 0.001. With a reference age of 3, SVPAs were run with terminal S values of 0.8, 1.0 and 1.2. Terminal S values of 0.8 or 1.0 produced a dome shaped exploitation pattern, whereas a terminal S of 1.2 resulted in a fairly flat exploitation pattern for ages 5 to 8. This implies that recruitment to the fishery may not be complete at age 3, though there are some anomalous catches of 4 and 5 ringers in 1989, 1990 and 1991 which may be influencing the selection pattern at these ages (Table 5.1.3).

The SVPA with a terminal S of 1.2 was accepted. The results are summarised in Table 5.1.7.

The results of the RCT3 analysis are given in Table 5.1.8. Given the apparent trends in the indices over the last few years (Figure 5.1.1), the predicted SSB estimates were not shrunk towards the mean. The relative weights given by the analysis to indices were approximately 0.8 to the LAI and 0.2 to the LPE, reflecting the better historical performance of the LAI. However, since no LAI index was available for 1992 the estimated SSB for this year is based only on the LPE.

The SSB estimates used in the tuning procedure are summarised in the text table below:

Year	1992 VPA estimate	Predicted SSB (from RCT3)	SE	Acoustic SSB estimate
1987	259	-		364
1988	377	551	.44	-
1989	376	430	.42	-
1990	343	449	.42	-
1991	295	391	.39	417
1992	-	310	.89	385

Separable VPAs were run over a range of terminal fishing mortalities. In each case the fishing mortalities based on the terminal populations were used to run a series of VPAs. The sum of squared residuals between the SSBs estimated by the VPA and those in the above table were calculated, and also the sum of squared residuals excluding the RCT3 predictions. The results are shown in Figure 5.1.6. Both curves have very poorly defined minima at a fishing mortality of approximately 0.13. At this level of fishing mortality, SSB in 1992 is estimated to be 431,000 t (Figure 5.1.8).

Detailed results of the assessment are given in Tables 5.1.9 to 5.1.11 and in Figures 5.1.7A and 5.1.7B.

If the Faroese catches from 1990-1992 are included in the catch data, the sum of squared residuals is minimised at F = 0.16. This corresponds to a SSB in 1992 of 415,000 t. Figure 5.1.8 shows the trend in stock size from the VPA with a terminal F of 0.13 excluding the Faroese catches and with a terminal F of 0.16 including the Faroese catches. Also shown in this Figure are the SSB estimates from the acoustic surveys and the predicted SSBs from the RCT3 programme. The effect on the assessment of including the Faroese catches is very small.

5.1.10 Projection

The parameters used in the projections are given in Table 5.1.12. The reference F was taken to be the mean F over the age groups 3 - 6. From the yield per recruit calculations $F_{0.1}$ was estimated at a reference F of 0.136. From the plot of stock and recruitment (Figure 5.1.9) F_{med} was estimated at a reference F of 0.36.

In view of the uncertainty in the assessment, projections have been made only for 1994, assuming *status quo* fishing mortalities. This was done using the assessments both including and excluding the Faroese catches. The *status quo* fishing mortalities were defined as the mean fishing mortality of 3 - 6 ringers over the years 1990 - 1992. The index of 2-ringer recruitment in 1993 does not suggest an exceptionally large year class (Table 5.1.5), so recruitment was assumed to be the geometric mean of 2-ringer abundance over the years 1981-1990 (640 million). This value for recruitment was also assumed for 1992 and 1994. As in previous years, 1-ringers were excluded from the projection. This is because 1-ringers are partly exploited in the North Sea, so catches in Division VIa(N) do not necessarily reflect year class strength.

Assuming that catches in 1993 would be near the agreed TAC of 55,000 t, the catch in 1994 corresponding to the *status quo* fishing mortality is shown in the text table below. Note that the values for 1992 from the prediction differ slightly from those of the VPA. This is because the number of 2-ringers in 1992 from the VPA was replaced by the geometric mean. It should also be noted that the catches in this table exclude catches of 0- and 1-ringers.

	Terminal F	SSB	F(3-6)	Catch
1992	0.130	397	.162	50
1993	0.142	406	.165	56
1994	0.153	409	.178	61

The comparable table using the analysis which includes the Faroese catches is shown below. In this case, although the catches in 1992 include the Faroese landings, no estimate of the Faroese landings was added to the TAC used to constrain F in 1993.

	Terminal F	SSB	F(3-6)	Catch
1992	.160	392	.186	60
1993	.144	398	.168	55
1994	.180	395	.210	69

The prediction suggests that given average recruitment, the catches and spawning stock biomass will remain at around 50,000 - 60,000 t and 400,000 t, respectively at *status quo* fishing mortalities. The *status quo* fishing mortality is very close to $F_{0.1}$, suggesting that there are unlikely to be long-term gains in yield by increasing fishing mortality.

A detailed output from the analysis excluding the Faroese catches and based on the assumptions that the TAC will be taken in 1993 and that fishing mortality in 1994 will be the *status quo* value is shown in Table 5.1.13

5.1.11 Quality of the assessment

The sampling of landings from this stock is generally satisfactory, though there is little information on the quantities discarded or undeclared.

The tuning procedure relies heavily on the acoustic survey estimates of SSB, even though there are only three estimates available. Of these, the summer surveys in 1991 and 1992 would have most influence on the value of F chosen for the latest year. This makes it difficult to perform a retrospective analysis to explore the reliability of the assessment method.

In previous years, the Working Group expressed some concern that the estimates of SSB for this stock were sometimes substantially revised from one assessment to the next. The extent of these inconsistencies can be seen from Figure 5.1.10, which shows the trends in SSB estimated from the VPAs in successive assessment years. The solid line extending to 1992 represents the assessment by the present Working Group, the line extending to 1991 represents the assessment by the 1992 Working Group, and so on.

The biggest revision to the estimate of SSB was for 1987. The 1988 and 1989 Working Groups estimated the SSB in 1987 by tuning to the acoustic survey estimate for that year. The 1990 Working Group revised the estimate for 1987 downwards by over 100,000 t. Subsequent assessments seem to confirm that the 1987 acoustic survey was an overestimate.

The fact that the 1987 acoustic survey probably overestimated stock size suggests that the 1991 and 1992 surveys may also be overestimates, though the change in the timing of the surveys might also influence their reliability. Alternatively, the high 1987 estimate may simply be due to the variability of the estimate. Clearly, the results of the present assessment must be treated with a great deal of caution. The uncertainties associated with the inclusion of the various indices for the tuning are discussed more fully in the next section.

Despite the uncertainties of the biomass estimates in the most recent years, it would appear from Figure 5.1.10 that there is a real increasing trend in stock size. The available evidence, therefore, suggests that the stock size is in no immediate danger at current levels of exploitation.

5.1.12 Comparative assessments using ADAPT

Following ACFM recommendations, the consequences of using ADAPT methods to assess the herring stock in the northern part of Division VIa were evaluated in a number of trial runs. In total, 12 trials with differing input data series and models were run and discussed: only a selection of these are presented here in summary form in order to illustrate the main features of the discussions.

Model formulation

A number of prior choices about model formulation had to be made. Firstly, it was necessary to decide on the catchability model for the acoustic index. Three choices were proposed and investigated:

1. Index = SSB + e (i.e. used as an absolute stock size estimate)
2. Index = Q.SSB + e (i.e.linear catchability assumed)
3. Index = Q.ln(SSB) + K + e (i.e. logarithmic catchability assumed)

where e = lognormally-distributed error.

Integrated catch at age models were fitted to the data using one of the three catchability models described above. The results of these fits are given in Figure 5.1.11, which indicates that using the acoustic index alone to tune the analysis leads to stock size estimates of the order of 200 000 - 400 000 t depending on the catchability model used.

Similarly, three options for treating the larval surveys were compared. Here a logarithmic catchability model was used throughout, but three data series calculated from the surveys could be used. These are:

1. The existing LAI index, with 1992 treated as a missing value
2. The newly-calculated trimmed mean larval index (trimmed LA)
3. The LPE index

These series have somewhat different trends (see Section 5.1.4 and Figure 5.1.1). In order to assess the sensitivity of the assessment to the use of these different measures, three model fits were completed using either the LPE, LAI or trimmed LA. A summary of results is given in Figure 5.1.12. This shows that assessments tuned using the LAI led to extremely high values of stock size compared with those indicated by the other series. Results from using either the trimmed LA or the LPE were closely similar.

The very high stock sizes indicated by using the LAI series to tune the assessments is perhaps surprising, but it is noteworthy that over the past six years the LAIs have been at higher levels than in any year prior to 1987. For example, the series rose from 2710 in 1985 to 6525 in 1990 and 4430 in 1991. Furthermore, the lack of an LAI datum in the most recent year strongly suggests that stock size will in any event be less well determined by this series than by the others. As fishing mortality is low in this stock, the analytic method can be strongly driven by trends in the index series.

One trial run included the prediction of recruitment in the catch-at-age model, but the relationship obtained between recruitment and the 2-ringer index was so poor that it was considered that the use of a geometric mean from 1981 to 1990 was equally informative.

Following completion of the trial runs and inspection of the results the following points were agreed:

1. Use of the LAI index leads to high estimates of stock size (ca. 700,000 t).
2. Use of the LPE or trimmed LA series leads to low estimates of stock size (about 300,000 t).
3. Use of the acoustic surveys as an index also leads to low estimates of stock size (about 300,000 t).
4. Use of the acoustic surveys as an absolute estimator leads to intermediate estimates of stock size (about 420,000 t).

No justification could be found for preferring one index or one model formulation over another. It was considered that the available data could represent a wide range of stock sizes from 300,000 t to 700,000 t. However, it was decided to present a 'worst case' scenario by calculating an assessment based on trimmed LA data and also using the acoustic surveys as an index with assumed linear relationship to stock size. These were combined with equal weight given to each series in the objective function. Results are summarised in Figure 5.1.13. and in detail in Table 5.1.14.

In order to provide a between-methods comparison, a model was fitted using baseline assumptions as close as possible to those made in the conventional method. Specifically: LAI and LPE indices were included;

logarithmic catchability relationships for both indices were assumed, and the acoustic index was treated as a measure of absolute stock size. Equal weight was given to all three series in the model fit. Results so obtained are given in Table 5.1.15 and Figure 5.1.14, which, in comparison with the results from the conventional method, show that the results obtained are relatively insensitive to the assessment procedure.

Consequently, using this approach leads to an indication of stock sizes (on 1 January 1993) of 265,000 t in a worst-case scenario, and of 440,000 t in a model formulation comparable to the final VPA. On account of the considerable uncertainty introduced by the inability to choose objectively the best model fit, no bootstrap-estimated confidence intervals were calculated as it was thought that these would lead to a misleading view of the precision of the assessment.

Some additional uncertainty may have been introduced by the relatively poor convergence performance of the method on account of the rather flat SSQ surface when fitting to this data set: the SSQ minimum is rather poorly defined (see also Figure 5.1.6).

5.1.13 Management considerations

The assessments for this stock have been uncertain for the last few years. However, the indications are that the stock is in no immediate danger, and that fishing mortality is rather low and near $F_{0.1}$.

Maintaining fishing mortality near its current levels is likely to stabilise spawning stock biomass in the short term and will result in relatively stable catches.

5.1.14 Research and data requirements

One of the reasons for the uncertainty in recent assessments is the deterioration in the quality of the larvae indices at reduced levels of sampling effort. These indices have in the past shown a very good relationship with spawning stock biomass and should be continued. However, their performance must now be critically reviewed. If their reliability falls to unacceptable levels and if no more effort can be invested in the surveys, consideration should be given to carrying out more thorough surveys every two years.

The time series of summer acoustic surveys is too short to assess their reliability, but they potentially provide valuable estimates of biomass in Division VIa(N) at the same time as similar surveys in the North Sea. They may also provide better estimates of 2-ringer recruitment than are currently available.

The use of constant mean weights at age in the stock is undesirable. Efforts should be made to obtain better estimates with which to update these data annually.

5.2 Clyde Herring

5.2.1 Advice and management applicable to 1992 and 1993

Herring in the area are comprised of two stocks: the largely resident spring-spawning population and an immigrant autumn-spawning component. The spring-spawning component appears to predominate in the area from January until March, whilst later in the year the population is diluted with an influx of autumn-spawning fish from a number of adjacent sub-divisions. These remain to feed in the Clyde, but leave prior to spawning in around September and November. The two stocks are difficult to distinguish reliably except when they are close to spawning condition, making the management of the fishery in the area highly problematic. In the past, assessment has relied on assuming that the autumn-spawners comprise a relatively discrete population that suffers virtually no exploitation elsewhere and returns faithfully to the Clyde each year.

Management action has been directed at allowing the spring-spawning stock which is presently highly depleted to return to historical levels which supported a substantial fishery. A range of technical measures with this objective are in force and include the prohibition of fishing for Clyde herring from January to March and a closure of the principal spawning grounds to all fishing gear. This is complemented with a TAC set for the remaining months of the year.

In 1992, protection of the spring-spawning stock was extended by prolonging the ban on herring fishing to 30 April. A TAC of 2,300 t was set for 1992, which was reduced to 1,000 t for 1993. Up to 200 t of herring in by-catches during the closure period was allowed.

5.2.2 The fishery in 1992

Landings up to 1992 are given in Table 5.2.1. Sampling levels are shown in Table 5.2.2. Total landings are estimated to be 926 t compared with 731 t in 1992. A TAC of 2,300 t was in force for 1992. Reports of discarding were not available for 1992. Of the total landings, 768 t were taken by pair trawlers in the directed fishery between July and December, and 158 t were taken as a by-catch in demersal trawl fisheries in all months.

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:

Year	% of 1986 year class in the catches
1989	69
1990	65
1991	46

In 1992, the regular monthly sampling of herring by-catches in demersal trawls ceased.

An index of effort has been calculated as described in the 1991 Herring Working Group report and is given in Table 5.2.3. Effort has again decreased to its lowest recorded level.

5.2.3 Weight at age and stock composition

The age composition of the catches (Table 5.2.4) appears somewhat anomalous. The historically strong 1986 cohort would be expected to appear as 6-ringers in 1992, yet the reported age composition includes a large catch of 5-ringers. This cannot be discounted since because of the complex migration situation that pertains in the Clyde it is possible that a strong immigration of 5-ringers from other areas has occurred. However, there is also a possibility that at least part of the 6-ring cohort has been mis-read as 5-ringers, since in 1993 a new member of staff was responsible for reading the Clyde otoliths. It is recommended that the age readings should be checked in comparison with historical age readings.

Catches were not sampled for weight at length during the principal fishing season in 1992. Weights at length have been assigned using the weight-length relationship observed in 1991 and assigned to ages accordingly. These are given in Table 5.2.5. As mean weights in the stock from research vessels are not available for 1992 the weights in the stock used are simply the weights at age in the catches. Weights at age in previous years are as used by the Working Group in 1992.

Proportions of spring-spawners in the catches have been estimated by the working group in 1992 as:

Year	Proportion (%) of Spring-Spawners
1988	50
1989	27
1990	25-40
1991	42
1992	55

In 1992, the Working Group estimated that the spring spawners comprised some 55% of the catches. Monthly maturity data for 1992 are given in Table 5.2.6, and the race/maturity key given in the 1992 Working Group report was used where possible to allocate catches by number between the two stocks. Only 32% of the catches could be allocated in this fashion, and these were comprised of 27% spring spawners and 5% autumn-spawners. This information and the large contribution of 5-ringers (possibly mis-read 6-ringers) in the catches at age suggests that a large proportion of the catch was made up of spring spawners in 1992. However, it does not seem feasible to allocate the catches to stock any more precisely.

5.2.4 Surveys

No further acoustic or egg surveys were carried out in 1992. Historical survey information has been compiled from previous Working Group reports and is given as Tables 5.2.7 -5.2.9.

The egg surveys and associated trawl sampling indicate that the spring-spawning stock has been largely comprised of the 1986 year class, and subsequent recruitments have been poor. The acoustic surveys in summer also show this year class to be an exceptionally strong one, with no evidence of good recruitment thereafter.

5.2.5 Stock assessment

On account of uncertainty about stock structure, absence of survey information, and uncertainty about the accuracy of the age readings, no formal analytic stock assessment has been attempted.

5.2.6 Stock and catch projections

As no analytic assessment could be made for this stock, no projections could be calculated. Available information suggests that the spring-spawning population is at a historically low level.

5.2.7 Management considerations

Management of this fishery is clearly problematic, as the mixed-stock nature of the fishery complicates both stock assessment and management action.

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. It is currently in an extremely fragile state where virtually the entire stock is comprised of the 1986 year class. However, no quantitative advice can be provided on account of:

(1) Lack of survey information
(2) Possible errors in the age readings
(3) Uncertain stock structure

Hence, no formal advice on catch levels can be given for the Clyde herring stock, other than to note that available information indicates that the spring-spawning stock is likely to be at a very low level and comprised largely of a single year class. Furthermore, if otoliths have indeed been mis-read by one year, it appears likely that substantial catches may have been taken from this cohort.

Consequently, the spring-spawning stock is likely to be at a historically low level and in continued decline. The technical measures to protect the spring-spawning stock should remain in place.

5.2.8 Future research requirements

It is recommended that the age readings for 1992 be reviewed in comparison with earlier readings.

Improved provision of survey data for this area would be necessary in order to provide analytic assessments for the stock.

6 HERRING IN DIVISIONS VIa (SOUTH) AND VIIb,c

6.1 The Fishery

6.1.1 Advice and management applicable in 1992

The TAC set for the area for 1992 was 28,000 t which was slightly higher than that set for 1991 (27,500 t). The total catch estimated to have been taken from the stock in the area was about 31,800 t, compared with 37,600 t in 1991. The total catch was, as it has been every year since 1982, higher than the recommended level. In general, the agreed TACs have in recent years been very close to the levels recommended by ACFM.

6.1.2 Catch data

The main catches from this area are taken by the Irish fleet. The catches taken by this fleet were again regulated by weekly boat quotas and a closed season was again introduced during the June-August period. The total amount of unallocated catches decreased considerably during 1992, partly because of a decrease in the overall catch and partly because the level of misreporting of catches to Division VIa N was not as high as in recent years.

The catches taken by each country fishing in this area from 1983-1992 are shown in Table 6.1.1. The catches for 1992 are preliminary, and it should be noted that no official Irish statistics have been submitted for this area to ICES since 1989. It has not been found necessary to make any alterations to the 1991 catch data. The quantities of herring discarded in this fishery are believed to be quite small but estimates are available only for the Dutch fleet. The total catch taken from the area decreased from 44,000 t in 1990 to 31,600 t in 1992.

The pattern of the Irish fishery in 1992 was considerably different from that in recent years. During January and February the fishery took place mainly in the northern part of Division VIIb along the Irish coast. The total catch taken during this period was approximately 4,000 t and about 30% of this catch consisted of winter-spawning fish which had a typically high vertebral count, i.e., 56.95. Catches taken during the April-June period were very poor, and fishermen reported that shoals were very scarce and distributed much further north than usual, i.e., around the Stanton Bank and in the southern part of Division VIa N. Over 95% of these catches were recovering spents which had a typical autumn-spawning vertebral count of 56.40. The winter spawners present in January and February were not present in these catches. Catches during the July-September period were small because of the closed season and were composed mainly of autumn-spawning fish. Over 21,000 t (i.e., 68%) of the total Irish catch was taken during the October-December period. The main fishery took place in Division VIa S in fairly deep water off the Irish coast, in an area not usually associated with herring fishing. The fish taken in these catches were again typical autumn-spawning herring with a vertebral count of 56.43.

The distribution of the catches during the first quarter of 1993 was similar to that of the fourth quarter of 1992 and again contained a high proportion of winter-spawning fish (41% with a VS 56.87).

Considerable quantities of the catch taken during the year were utilized by the Japanese roe market. The problem of discarding in this fishery does not appear to be as serious as it was in the Celtic Sea some time ago mainly because of the more numerous shore facilities for non "roe" herring.

The composition of the Irish fleet has remained very stable in recent years. However, the overall effort may have decreased during 1992 because the two very large freezer trawlers engaged in the fishery in recent years did not participate for most of the year. The quarterly distribution of catches in this fishery, based on Working Group estimates, is shown in Figure 4.2.1 a-d.

6.1.3 Catches in numbers at age

The catches in numbers at age for this fishery since 1970 are shown in Table 6.1.2. No revisions have been found necessary to the 1991 data. The catches in numbers at age have been based mainly on samples from the Irish fishery throughout the year together with one sample from the Dutch fishery in the third quarter. The age composition of the catches were composed mainly of 6 winter-ring fish, i.e., the 1985 year class (37%) which recruited to the stock in 1989 and has dominated the catches each year since then. This year class has been well represented in all areas throughout Divisions VIa S and VIIb and is also a feature of the catches in Divisions VIa N and VIIj. In comparison to the 1985 year class, the 1986 and 1987 year classes appear rather weak but the 1988 year class (22% of the catch in number) may be strong.

6.1.4 Quality of catch and biological data

The quantities of unallocated catches and discards decreased for this fishery in 1992 and there appears to be reasonable confidence in the overall estimates of the total catches. As stated earlier, the amount of misreporting also decreased during 1992 because of the more northerly distribution of the fishery. The level of biological sampling is satisfactory for the fishery and good coverage of the catches has been maintained. The number of samples and biological data are shown in Table 6.1.3 and the length distributions of the catches taken by the Irish fleet per quarter are shown in Table 6.1.4.

6.2 Mean Weight at Age

The mean weights (g) at age in the catches are based on a combination of Irish and Dutch data and are shown below compared with those for 1990 and 1991:

	Age							
Year	1	2	3	4	5	6	7	8
1990	94	138	148	160	176	189	194	208
1991	89	134	145	157	167	185	199	207
1992	95	141	147	157	165	171	180	194

There has been little change in the overall mean weights in recent years and the 1992 values have, therefore, been used to update the VPA data set.

The mean weights at age for the stock at spawning time are based on Irish samples taken from the spawning fishery during the September-November period. A similar time period was used in 1990 and 1991. Spawning fish which have been taken in December both during 1990 and 1991 are therefore not included. The mean weights since 1988 are shown below and those for 1992 have been used to update the database.

	Age							
Year	2	3	4	5	6	7	8	9+
1988	164	206	233	252	271	280	296	317
1989	157	168	182	200	217	227	238	245
1990	152	170	180	200	217	225	233	255
1991	149	174	190	195	206	226	236	249
1992	144	167	182	194	197	214	218	242

The mean weights are similar to those of the 1989-1991 period and appear to have stabilized since the sudden and inexplicable decrease that occurred after 1988.

6.3 Young Fish Surveys

Young fish surveys have been carried out intermittently in this area for a number of years. The surveys, which were started in 1981, were carried out by a number of vessels using a variety of gears. No surveys were carried out in 1989. The indices of young herring abundance obtained from the surveys were examined by the 1991 Working Group and compared with numbers of 1- and 2-winter-ring fish obtained from VPAs. However, it was not possible to establish any relationship between the two sets of data. It was, however, concluded that these surveys should be continued because it was hoped that future surveys could be carried out using the same vessel and with standard gear.

The 1992 survey was carried out using the R/V "Lough Foyle". However, because of abnormally bad weather conditions in November, only seven stations were completed, all of which were in the northern part of the area. No herring were found at any of these stations. The 1992 survey was eventually abandoned and no abundance index is, therefore, available.

6.4 Results from Tagging Experiments

The preliminary results of a tagging experiment carried out in 1991 were presented at the 1992 Working Group meeting (Molloy, WD 1992). Approximately 10,000 herring were tagged and released at Broodhaven Bay in the northern part of Division VIIb. To date over 320 tags have been returned. Most of the returns have come from close to the release area and in the southern part of Division VIa S. A small number of tagged fish appear to have migrated southwards and were recaptured in the south of Division VIIb and the northern part of Division VIIj. The numbers of recaptures per statistical rectangle are shown in Figure 4.5.1.

6.5 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.

In the absence of the required data, the 1992 Working Group carried out a VPA in order to update the historical database. The results of this VPA were not, however, used for any assessment purposes and no stock predictions were made.

The fishing effort in this area appears to have been reasonably stable in recent years because the fleet has remained unchanged and the major pelagic effort has been directed to mackerel and horse mackerel. This would suggest a period in recent years in which the fishing mortality might have been rather constant. It was, therefore, decided that it would again be useful to carry out a VPA to observe the development of the stock in recent years. Separable VPAs were, therefore, carried out using the updated data and a range of terminal S values from 0.8 to 1.2 and down weighted prior to 1986 to 0.001. Using a reference age of 4 the exploitation pattern rose sharply on the age group 6 and 7, indicating some problems with the ageing of the older groups (Table 6.5.1).

The terminal populations from the separable VPAs using input F values in 1992 of 0.2, 0.3 and 0.4. The resulting spawning stock sizes are shown in Figure 6.5.1. The summary of the tentative VPA with a provisional F = 0.3 is shown in Table 6.5.2. The spawning stock size has been constant during the period 1970 to 1984 but subsequently increased sharply in 1985 following the recruitment of the 1981 year class and even more sharply in 1988 following the recruitment of the even stronger 1985 year class. Subsequent to 1988 the stock has decreased - the estimated rate of decrease depending on the F value used for 1992. The decrease will probably continue until another strong year class enters the fishery, unless the fishing mortality drops to a lower level.

According to the ACFM criteria this stock, therefore, is again one about which the exact size is not known.

6.6 Management Considerations

Because of the uncertainty about the current stock size and the lack of information about recruitment it is difficult to give any management advice for this fishery. Despite the continuing high catches in relation to the advised catch levels and agreed TACs the stock has increased from 1984 to 1988 because of the recruitment of two good year classes. Recent information from a "tentative" VPA would suggest a decrease in stock and this, together with the fact that good year classes do not recruit very often to the fishery, would indicate a cautious approach by management. If a precautionary TAC is to be set this should reflect the likely decreasing trend in stock size and it would seem highly inadvisable to allow any increase in the catches from the area until more information is available.

6.7 Research Requirements

It is extremely important to obtain fishery-independent estimates of stock size for this fishery together with information about the strength of recruiting year classes. Consideration should be given to carrying out acoustic surveys in Divisions VIa (S) and VIIb from the Stanton Bank to Loop Head area at the same time as similar surveys are carried out in Divisions VIa (N) and Sub-area IV.

7 IRISH SEA HERRING (DIVISION VIIa, NORTH)

7.1 The Fishery

7.1.1 Advice and management applicable to 1992 and 1993

The 1991 assessment was based on data up to 1990. However, there was concern that there was insufficient fishery-independent data for a full analysis. The most likely terminal F suggested a very small reduction in SSB in 1993 if a catch of 7,000 t was taken. ACFM recommended a TAC of 6,600 t with the management body opting for 7,000 t for 1992. The quota was partitioned as 1,820 t to the Republic of Ireland and 5,180 t to the UK. The UK quota was partitioned initially and then adjusted by reallocating 300 t of the non-sector quota to give the following: Anglo-Northern Irish Fish Producers Organisation (ANIFPO) 1,056 t; Northern Ireland Fish Producers Organisation (NIFPO) 2,881 t; Scottish Fishermen's Oganisation (SFO) 102 t; Fish Producers Organisation (FPO) 518 t; Non-sector 19 t; and the Mourne skiff (gill net) fishery 604 t. The spawning and juvenile fishery closures were maintained.

The UK fishery opened in the third week in June. The closed area to the east of the Isle of Man (encompassing the Douglas Bank spawning ground) closed on 21 September until the end of the year. The Mourne shore skiff fishery opened on 2 September and closed on 15 October. Fishing from the Republic of Ireland was regulated on a weekly basis from the second week in August to the end of September.

The 1992 Working Group explored 1993 TAC options against a background of uncertainty concerning the level of the SSB. It was concluded that the stock was unlikely to have declined with recent levels of catch. It was suggested that a catch of 7,000 t would result in a slight reduction of SSB. ACFM recommended a catch of 7,000 t for 1993 which was subsequently adopted by the management body. This has been allocated as 1,820 t to the Republic of Ireland and 5,180 t to the UK.

7.1.2 The fishery in 1992

The catches reported from each country for Division VIIa(N) from 1980 to 1992 are given in Table 7.1.1. There has been no allowance for under-reporting, discards or slippage. The total catch of 5,270 t was again below the recommended TAC of 7,000 t. The Republic of Ireland only took 22% of its allocation and the UK took 94% of its allocation.The reason for the low uptake by Ireland was a lack of fish in August west of the Isle of Man resulting in vessels moving elsewhere. The Northern Ireland fleet commented on the large quantities of fish seen inside the Isle of Man 3-mile territorial waters. This inshore distribution of herring was also seen in the summer acoustic survey (see Section 7.3). The extent of discarding throughout this fishery is still unknown.

7.1.3 Quality of catch and biological data

There is still relatively good biological sampling from this fishery (Table 7.1.2). However, there was a reduction in quarter 3 sampling by Northern Ireland and over all time periods by the Isle of Man. The sampling effort is approximately one sample per 165 t landed. There was some concern over the increased use of frozen samples for the Northern Ireland data (possibly affecting mean-weight-at-age) and some questions about ageing of older fish in the Isle of Man data. These will be examined in detail in 1993/1994.

7.1.4 Catches in numbers at age

Catches in numbers at age are given in Table 7.1.3 for the years 1972 to 1992. The dominant year class was the 1-ringers (1990 year class). Over the past few years (1985-1991) 1-ringers have contributed between 4 and 10% of the total catch in numbers whereas in 1992 they constituted approximately 29% of the total catch. This level of 1-ringers in the total catch has not been seen in this fishery since 1973-1977. There was a fairly even representation of the 2, 3, 4 and 6 ringers (year classes produced in 1989 to 1987 and 1985). The above-average 1985 year class was still distinctive in the catches. The catch in numbers at length is given in Table 7.1.4 for the years 1988 to 1992. The most notable feature of the 1992 data is the prevalence of small fish (17.5 to 20 cm). Since 1988 there has continued to be a decline in the numbers of herring greater than 30 cm represented in the catches.

7.2 Mean Length, Weight, and Maturity at Age

Mean lengths at age were calculated for the third quarter using data from Northern Ireland (to be consistent with previous years) and given in Table 7.2.1 for the years 1985 to 1992. In general, there has been a small reduction in mean length at age for all year classes since 1985.

Mean weight at age in the stock is given in Table 7.2.2 for the period 1976-1983 and 1984 to 1992. The mean weight at age has continued to fall for all age classes with 1992 giving the lowest on record. The use of third quarter mean weights were again used in the WEST (weight at age in the stock) files for consistency.

The maturity ogive used in the previous year is assumed still to be applicable. The ogive applied to the 1992 data was 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

7.3.1.1 1992 Acoustic surveys

An acoustic survey of Division VIIa(N) was undertaken by Northern Ireland between 20 and 31 July 1992 (Armstrong *et al.*, WD 1993). The survey was designed to give intensive coverage along the coasts of Ireland and the Isle of Man. A low intensity survey of the eastern Irish Sea was planned but there was insufficient time to cover the entire region. A number of other areas were sampled opportunistically. Once again there was no survey of the Manx spawning ground due to problems of ship availability at the Port Erin Marine Laboratory.

The acoustic survey was undertaken from the R/V "Lough Foyle" using an EY200 operating at 38 kHz. Integration was performed using the HADAS computer software package (Lindem Associates). The survey grid and trawl stations are given in Figure 7.3.1. A complex arrangement of survey strata around the Isle of Man (Figure 7.3.2) arose because of the presence of dense aggregations of herring close inshore on the southeast and northwest coasts. These fish tended to occur on the sea-bed in shallow water during daylight. These regions were resurveyed during darkness. The transects along the southwest coast were split into inshore and offshore sections to allow the inshore region to be surveyed at night. The area was restratified to ensure a uniform sampling intensity and length of transect in each stratum.

The total biomass of herring was estimated to be 12,800 t as compared with 17,800 t the previous year (1991). The estimated age composition given in Table 7.3.1 indicated 2,409 t of 1-ringers and 10,353 t of 2+-ringers. Approximately 90% of the adult herring seen in this survey were within 5 nm of the Isle of Man coast. There were very few positive sightings of herring on the Irish coast. However, if targets of questionable nature are included then there could be up to approximately 1,300 t along this coast. This survey confirmed comments by fishermen that adult herring were very close to the Isle of Man and very difficult to find elsewhere. There are a number of possible biases in the acoustic survey. These could include ship avoidance, especially in shallow water, fish above the transducer, particularly at night, and fish very close to the bottom.

7.3.1.2 Evaluation of acoustic surveys

Over the past four years four acoustic surveys have been undertaken. The two surveys on the Manx spawning ground (Douglas Bank) in 1989 and 1990 gave much higher estimates than the two later surveys over Division VIIa(N) (Table 7.3.2). The 1989 survey of Douglas Bank was the first acoustic survey of this stock. There were some concerns raised over this survey as an index of the total stock as it did not cover the Mourne component of the stock and there may have been fish on the spawning grounds earlier and later than the survey. The second survey gave a much higher estimate but conditions and timing were almost identical for the two surveys. The same concerns were raised about this survey. The location of the large shoal, and the time of locating it, is consistent with historical information and the aggregation of fish after the closure of the area on 21 September each year.

In 1991 and 1992 acoustic surveys were undertaken over the majority of Division VIIa (N). These surveys were intended to estimate the total biomass of herring in the area. Both surveys estimated similar biomasses of adult herring for 1991 and 1992. In both cases sprat was the dominant species, possibly leading to errors in the assessment of herring. However, there is generally a difference in distribution of the two species. Partitioning of the acoustic record is generally done on the basis of trawl catches where there are mixtures of species. In both summer acoustic surveys the strong 1985 year class was noticeable in the estimates (Table 7.3.1). This is consistent with the catch in number data for the area. However, relatively low numbers of 1-ringers in the 1992 acoustic survey cast some doubt on whether the elevated catches were due to a strong year class or a change in fishing pattern. Estimates of year class strength vary between the two surveys with higher estimates occasionally occurring in the second year (see e.g. 4- to 5- and 5- to 6-ringers). The total amount of 1-ringers estimated from the surveys may not in fact all be potential recruits to the Irish Sea stock as they contain a proportion which recruits to the Celtic Sea. Due to the distribution of this stock, e.g. in 1992 being very close inshore, there is some doubt as to whether these surveys accurately survey the full distribution.

7.3.2 Groundfish surveys

Groundfish surveys have been carried out each year since 1990 by the Department of Agriculture, Northern Ireland (DANI) in June and September to assess juvenile gadoids in Division VIIa (N) (Armstrong *et al.*, WD 1993). The Working Group considers that the data from these surveys may be useful and should be made available in the future.

7.3.3 Tagging studies

Approximately 10,000 herring were tagged off the west coast of the Isle of Man in 1991 (see Anon., 1992a). In 1991 the tag returns were from both the Irish Sea (VIIa(N)) and the Celtic Sea. In 1992 the only returns were in the Celtic Sea (see Section 4.5). This provides further evidence that juvenile herring from at least the Celtic Sea occur in the Irish Sea and, having once returned to their spawning ground, do not return to the Irish Sea.

7.3.4 Larvae surveys

The historical larvae sampling series (1974-1988) from the Douglas Bank spawning ground was presented as a working document (Nash and Hughes, WD 1993a). This series utilised 0.5 m ring trawls, has never been used and has now been discontinued. At present, the Isle of Man undertakes a survey of larvae over the same grid using a Gulf III (Nash and Hughes, WD 1993b), unfortunately there are no comparisons between the two data sets. The present series uses double oblique hauls on a 5 nm grid with sampling as close to 15 October as possible. The historical basis for the timing is that the majority of hatching should occur at or around this date and larvae are entrained out of the area very rapidly, usually heading north and east. There have been problems with this series due to the small numbers of samples in some years and variation in timing of the surveys due to ship commitments and weather. The only real value in these data is that they suggested that over the period 1990 to 1992, larvae hatch was fairly consistent between 1 and 15 October, but there are considerable doubts as to whether this is true for the whole time series. A further exploratory survey covering the area to the east of the Isle of Man was undertaken in 1992 (Nash and Hughes, WD 1993c). This survey confirmed the hatching date for the October 1992 Douglas Bank survey. It also suggested further hatching well into November. This will have consequences for any discussions concerning acoustic surveys on the spawning aggregations on Douglas Bank.

The Working Group agreed that these data should be considered again when a longer time series has been established.

7.4 Stock Assessment

7.4.1 Estimation of fishing mortality and trends in abundance

In 1993 it was decided to use the four acoustic surveys as absolute estimates of spawning stock size to tune the recent year Fs. It was not possible to correct these estimates for catches taken so these were taken as the stock at spawning time. A series of VPAs were performed and the minimum sum of squares residuals was determined (Figure 7.4.1). The minimum was found at an input F of approximately 0.30. This is higher than used by the past two Working Groups.

As with the previous Working Group, 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 all older age classes.

7.4.2 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 for a terminal F of 0.30 is given as an example and shown in Table 7.4.1. A range of terminal S (0.8, 1.0 and 1.2) were run and each gave a slightly domed selection pattern for the most recent six years of data. It was suggested that there may some problems with ageing of fish in this stock (see Section 7.1.3) which could influence the observed selection pattern. Similarly, the mixture of two stocks (Manx and Mourne) which may have slightly different age compositions and be represented in the catches slightly differently from year to year may also have an influence. It was not possible to remove the domed selection pattern so a selection of 1.0 was used. There did not appear to be any pattern in the residuals. This separable VPA was accepted for the initiation of conventional VPAs.

7.4.3 Results of VPA

There is considerable doubt as to the stock level since there are no reliable fishery-independent data. However, a VPA with an input F of 0.30 is given for illustrative purposes and trends in fishing mortality, landings, SSB and recruitment are shown in Figure 7.4.2. The outputs for an F of 0.30 are given in Tables 7.4.2 to 7.4.4. This VPA suggests that there has been a steady decline in SSB since 1987. Due to the uncertainties in the acoustic assessments a range of plausible Fs and subsequent SSBs are also presented (Figure 7.4.3). Over a range of input Fs of 0.25 to 0.4 there is a similar trend of decreasing SSB.

7.5 Stock and Catch Projection

It must be stressed that the Working Group is very unsure of the SSB level for this stock. Similarly the high catches of 1-ringers in 1992 may or may not be indicative of a very strong year class. There is some evidence from an adjacent stock (Celtic Sea Division VIIj) that the 1990 year class may be strong but there is no evidence in the Division VIIa(N) acoustic surveys that this is so. There is a possibility that some of the 1-ringers caught in Division VIIa(N) were from adjacent stocks (see Section 7.3.3). Even if this is a strong year class the Working Group believes the VPA has overestimated the likely numbers of 2-ringers in 1993. It was therefore decided to down-weight the impact of this year class on the SSB by replacing the numbers at age 2-ring with a geometric mean from the years 1984-1990 (53,991 $x10^3$). This value incorporated the strong 1985 year class but was still conservative.

The lack of a recruitment index was similarly a problem for estimating 1-ringers in 1993. As has been the practice of this Working Group, the geometric mean was applied as input on 1-ringers.

The impact of the fishery taking the allocated TAC of 7,000 t was examined on the basis of the VPA run with an input F of 0.30 and a conservative estimate of SSB in 1992 being 10,400 t, as estimated in the summer 1992 acoustic survey. Until further information is available the Working Group declined from making any predictions for 1994.

Details of the input parameters and output for a prediction for 1993 (on the VPA with an F of 0.30) are given in Table 7.5.1. The selection pattern used was identical to that from the Separable VPA. The results suggest that there would be a continued decline in SSB if the full TAC is taken. This indicates a reference $F_{(2-6)}$ of 0.50.

If the worst case, as seen by the Working Group, is considered, i.e. an SSB of 10,400 t in 1992, then taking the full TAC would result in an SSB at spawning time of 7,400 t (see below; a summary of the profile for a terminal F of 0.3 in 1992 is given for comparison).

1992			1993 Fishery		Spawning time 1993	
Input F	$F_{(2-6)}$	SSB (t) at spawning time	Catch (t)	$F_{(2-6)}$	Spawning stock size (millions)	SSB (t)
0.30	0.33	13,630	7,000	0.50	79	10,476
0.38	0.42	10,400	7,000	0.66	57	7,435

The resulting reference $F_{(2-6)}$ would be 0.66. The resulting SSB in 1993 would still be above the minimum seen in this stock.

7.6 Management Considerations

7.6.1 Management advice

As was stated by the 1992 Working Group (Anon., 1992a) it is not possible accurately to assess the value of the current fishing mortality in Division VIIa(N). Similarly it is very difficult to determine the current level of SSB. The Working Group, therefore, feels there is insufficient information at present to carry out a stock prediction for 1994.

7.6.2 Spawning and juvenile fishing area closures

Due to the continued uncertainty about the size of this stock and because a large proportion of the Manx stock aggregate in a small area for spawning, the closure of the spawning areas should be maintained for 1994. The closure of the existing nursery areas should also be maintained.

7.7 Research and Data Requirements

The Working Group expressed concerns at the continued lack of fishery-independent data for this stock but appreciated that steps are being made to rectify the situation. The continuation of acoustic surveys both for the whole of Division VIIa(N) and the Manx spawning grounds should be encouraged. Similarly, efforts should be made to continue the larvae surveys by the Isle of Man and to undertake much wider surveys of the area around November each year. Efforts should also be made to evaluate methods which can determine the contribution of juveniles occurring in Division VIIa(N) to their parent stocks. An otolith exchange programme should be set up to evaluate the precision of ageing by the different laboratories working in the area.

The Working Group strongly recommends a study group to discuss the problems associated with herring assessments and biology in the area.

8 SPRAT IN THE NORTH SEA

8.1 The Fishery

8.1.1 ACFM advice applicable for 1992 and 1993

No ACFM advice on sprat TAC has been given for 1992 and 1993. The TAC set by the management bodies was 55,000 t for 1992 and 83,000 t for 1993 [Subarea IV(EC zone) + Division IIa (EC zone)].

8.1.2 Catches in 1992

Landing statistics for sprat for the North Sea by area and country are presented in Table 8.1.1 for 1982-1992. 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. While there remains uncertainty concerning the sprat stock identity, landings from the fjords are considered separately. Norwegian catches in the western fiords for 1983-1992 are presented in Table 8.1.2.

Preliminary sprat landing figures for Denmark, Norway and UK (England) indicate that 124,280 t were harvested from the North Sea in 1992. This represents a 14% increase in landings from 1991. Landings for both Denmark and England increased while the Norwegian catches decreased slightly between 1991 and 1992. Catches by Denmark, which represent 72% of the North Sea sprat landings, continued their 4-year upward trend and were the largest reported since 1983. English catches which account for only 5% have also increased over the past few years. Catches by Norway in the fjords increased by 19%.

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. Major increases in UK (England) landings, relative to previous years, were also observed in Division IVc during the first and fourth quarters. No sprat catches were reported off the northeastern coast of England or Scotland in 1992.

8.1.3 Fleets

These were described by 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 aged samples have prevented the IFWG from running a VPA since 1984. In 1985 the IFWG seriously considered discontinuing the time series. However, it recognized that the Multispecies Working Group (MSWG) need input parameters for this stock. The problem with sampling continued in 1986 and no catch-at-age was estimated by the IFWG. During 1986 the only available catches were from England with 98% of the catches sampled originating from the Thames area.

Data collection improved slightly between 1987 and 1989 with age distribution data from Denmark, Norway and UK (England); thus an estimate of quarterly catch-at-age in numbers from the North Sea for these years was made. Unfortunately, the age distribution in 1987 was inconsistent with that from the Thames area in 1986. The problem of extremely poor sampling reappeared in 1990. Catch-at-age was calculated only for the first and second quarters in Division IVa where samples were collected. The 1990 estimate was considered extremely poor. No sampling was undertaken during the third quarter when approximately 70% of the catch was taken. Catch data from Denmark, Norway and England were provided in 1991. However, samples were extremely limited. Data on age composition were obtained from only a few (25) samples for the offshore area. Although a catch-at-age table was produced, the Working Group concluded that the data were very poor and unsuitable for catch-at-age estimation.

In order to overcome the uncertainty in the sprat catch-at-age data the MSWG developed the following approach to simulate input parameters (Anon., 1989).

(1) Stock numbers from the last sprat MSVPA (1984) were used as the starting point.

(2) The 1-group of the 1985-1988 year-classes were estimated from the regression of VPA numbers of 1-group on the recruitment index (IYFS 1979-1983).

(3) Relative F pattern taken as the average pattern of 1979-1983 in the MSVPA.

(4) F level was then adjusted to meet nominal catches.

(5) A "more reasonable" stock size in 1986 was estimated by choosing the 1-group in 1985 as being 1/3 the value predicted by the regression.

While this procedure continues to be used by the MSWG, the values generated by the above method differ greatly from those reported by the IFWG in years when catch-at-age was estimated.

The 1992 quarterly catch-at-age in numbers is presented in Table 8.2.1. Age distribution data for catches were provided by Denmark and the UK (England). Sampling appears to have vastly improved in 1992, yet there are still a number of areas and quarters which are not represented. No Danish samples were taken from Division IVa in any quarter or from Division IVb West and Division IVc in the first and second quarters. In these cases the age distribution from Division IVb East was used to estimate numbers-at-age. The UK (England) catches-at-age were estimated from research surveys in the appropriate quarter for each Division from which catches were reported. No age distribution data were provided for the Norwegian catches and the catch-at-age was estimated using Danish data for the same period. Given the increased sampling and seasonal distribution of samples, the Group considered the 1992 catch-at-age to be a reasonable estimate of the age distribution within the catches.

8.2.2 Weight at age

The North Sea weight-at-age by quarter in grams for 1992 are provided in Table 8.2.2. Weights were estimated from Danish and UK (England) data as provided by Working Group members and pro-rated according to catch numbers for each quarter.

8.3 Recruitment

8.3.1 Abundance

This year 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 the IBTS standard area applicable for North Sea sprat assessment. The revised IBTS (no./hr) sprat indices from 1981 to 1993 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 1993 data indicate that all indices for age groups 1-3 have increased for another year, while age groups 4-5 have decreased. With the exception of 1989, the 1993 1-group (1765/hr) and total index (2262/hr) represent the highest on record since 1981 for the former, and 1982 for the latter index. The recent increasing trend in abundance is clearly tracked in the indices for age groups 1-3 and the total since 1990.

8.4 Acoustic Survey

No acoustic estimates were available to the Working Group for 1992.

8.5 State of the Stock

8.5.1 Catch-Survey Data Analysis

Inadequate catch-at-age data have prevented the use of standard VPA techniques for assessing the North Sea sprat stock. To overcome this problem the IFWG has applied the SHOT method for projections of the yield from this stock. This method was considered unsuitable because it does not provide any indication of the status of the stock.

The Working Group considered two working papers (Patterson, WD 1993d and 1993e) on a non-equilibrium surplus-production model together with a computer program CEDA (Anon., 1992d). This model uses total catch data (in weight) and an index of total abundance from which the catch to biomass ratio can be inferred. Appendix 2 discusses the application of this model to both the North Sea sprat and Division IIIa sprat.

For sprat in the North Sea, total catches (1981-1992) and the IBTS survey indices as an abundance index were used as input parameters for the surplus-production model. Indices for different age groups derived from IBTS were examined as it is not clear because of ageing problems which index best accounts for the biomass development. The best fit was obtained with the 1-group (Division IVb) index. While both catch and biomass increased slightly over the most recent 8 years, which to some extent is reflected in the model, the model does not account for the observed dramatic change seen in the survey result of 1989. Residuals indicate that this observation is an outlier and it was subsequently removed from the analysis. Figure 8.5.1 shows the observed and fitted abundance indices after excluding the 1989 observation.

The IBTS survey appears to have difficulties following strong and weak cohorts. This is illustrated by 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	1.28
1984	660.12	102.75	6.42
1985	71.36	74.33	0.96
1986	803.37	1436.80	0.56
1987	148.49	441.86	0.34
1988	4245.98	557.41	7.62
1989	176.81	116.08	1.52
1990	1121.06	340.17	3.30
1991	1560.54	422.47	3.69

This, combined with the catch data problems, implies that the simulations do not adequately reflect the dynamics of this stock.

The Working Group concluded that this catch-survey analysis did not provide a sufficiently accurate assessment of the status of the stock to be useful for management purposes.

8.6 Projections of Catch and Stock

The data do not allow for projections of either catches or stock sizes.

8.7 Management Considerations

The stock does not show signs of overexploitation as both catch and biomass appear to be increasing slightly at present. There are no indications of re-direction of effort from other areas to this stock. There are therefore no reasons, as far as the sprat stock is concerned, for any severe management constraints 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 on the available database. 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 sampling in 1992 was much better compared to previous years.

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

Catch in weight by rectangles and by 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 8.8.1. Data from the autumn IBTS surveys in 1991 and 1992 have not yet been reported to ICES.

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 rectangles in Figures 8.1.1-8.1.12.

In the eastern Channel, landings were very small at both ends of the year, with some landings again made into Poole.

In the western Channel, the 1992/1993 Lyme Bay sprat fishery began in August and ended in March (Table 9.1.2). The provisional catch for the 1992/1993 season is 1,650 t, which is some 793 t down on the 1991/1992 season.

9.2 Catch Composition

In the early part of the season, the 1990 year class contributed 71% to the catch, with the 1989 year class contributing 22% (Table 9.2.1). With biological sampling being carried out in August and December only, these results should be treated with some 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 1992 and 1993

No ACFM advice on sprat TAC have been given for 1992 and 1993. The agreed TACs adopted by the management bodies, were 50,000 and 45,000 t, respectively, for a mixed clupeoid fishery.

10.1.2 Catches in 1992

The total landings for Division IIIa by area and country are given in Table 10.1.1. The Norwegian and Swedish catches include the coastal and the fjord fishery. The total landings in 1992 as estimated by the Working Group were 10,300 t. This is somewhat lower than in 1991, but at 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 mixed clupeoid fishery at present mainly consists of herring (see Section 3.1.2).

The landings by quarter by all three countries in 1992 are shown in Table. 10.1.2. Nearly 80% of the landings were taken in the first and last quarters.

The sprat fishery in Division IIIa are conducted by fleets from Denmark, Norway and Sweden:

Danish fleet: Until 1991, sprat fishing was part of the industrial fishery for sprat and juvenile herring, carried out with 16 mm mesh. Since January 1991 the "mixed clupeoid" fishery has only been allowed with meshes larger than 32 mm.

Norwegian fleet: The Norwegian fishery for sprat in Division IIIa is mainly an inshore and fjord fishery, taking place from July to December. The fleet comprises small purse seiners. The fishery is a directed sprat fishery for the canning industry. In 1991 and 1992, the average landing in weight contained 98-99% of sprat.

Swedish fleet: The Swedish fishery for sprat is based on two types of gear: purse seiners in the fjords and a mixed-clupeoid fishery in Skagerrak/Kattegat using small meshed (16 mm) trawls. The fishery is mainly by purse seiners in the fjords for the canning industry.

10.2 Catch composition

10.2.1 Catches in number and weight at age

No weight-at-age data in the catches have been available to the IFWG since 1983.

The numbers and the mean weight by age in the Danish landings in 1992 are presented in Tables 10.2.1 and 10.2.2. The Danish landings accounted for only 32% of the total and there was no information on the fishing pattern in the Swedish sprat fishery. As a result, no conversion of the total landing in weight to total landing in numbers was undertaken.

10.2.2 Quality of catch and biological data

In 1992 the sampling intensity and coverage of the landings in the "mixed clupeoid" fishery increased compared to the previous years. A total of about 450 samples were analysed for species composition and 23 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 very well be about 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 recommends strongly that the sampling in the sprat fisheries be improved.

10.3 Recruitment

10.3.1 Abundance of 1-group sprat

The IBTS indices given in previous IFWG reports (see Anon., 1992b) have been revised, based on data in the IBTS database. All the estimated indices (mean CPUE per rectangle) and the numbers of hauls from 1984 to 1992 were considered. In some years, a single haul in a small area accounted for 50-60% of the total index. All the indices were, therefore, weighted by the area of the rectangle. Sprat occurs mainly in the upper 150 m and only hauls taken between 10 and 150 m depth are included in the calculations. The new weighted indices are given in Table 10.3.1 and by rectangle in Figure 10.3.1. These indices are considered the best available. The rectangle weights used are presented in Table 10.3.2.

The index of 1-group sprat for 1993 is 1,660, which is a reduction of about 70% compared to the 1992 index, but higher than the indices in the late 1980s.

10.4 State of the Stock

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

The Working Group applied a catch-survey analysis (see Section 8.5.1) to sprat in Division IIIa. This analysis used the total catches and the weighted 1-group indices for 1984-1992 (Table 10.3.1). Appendix 2 discusses the application of this model for both the North Sea and Division IIIa sprat.

The fitted Shaefer model for sprat in Division IIIa is shown in Figure 10.4.1. The model does not appear to be able to account for drastic changes in the abundance indices as seen in the survey results of 1984 and 1992. There are no reliable estimates available for either the natural or fishing mortality. With little consistency in IBTS 1- and 2-group indices, estimates of total mortality from the IBTS survey are not meaningful. This is demonstrated in the following text table:

Year class	1-group	2-group	1-gr:2-gr
1983	5818	2426	0.42
1984	2402	1934	1.24
1985	670	2219	0.30
1986	2234	5527	0.40
1987	950	1012	0.94
1988	435	243	1.79
1989	510	468	1.09
1990	659	634	1.03
1991	5897	4620	1.28
1989	176.81	116.08	1.52
1990	1121.06	340.17	3.30
1991	1560.54	422.47	3.69

There are also problems with the catch data as discussed above and there are indications that the model does not reflect the dynamics of the sprat stock.

The Working Group therefore concluded that, based on the data available, this catch-survey analysis did not provide a sufficiently accurate assessment of the status of the stock to be useful for management purposes.

10.5 Projection of Catch and Stock

The IBTS indices indicate that the 1991 year class will be a strong component in the stock again in 1993. There is, however, little consistency in the indices of 1- and 2-group. Assuming that this might reflect some difficulties in the ageing of the sprat, caused by secondary rings or overwintering larvae, the indices of the two age groups were pooled. The regression of the pooled indices vs total catches, shown in Figure 10.5.1, shows no significant relationship; consequently, the present regression is rejected for catch prediction in this fishery.

SHOT estimates have been provided by the IFWG. As demonstrated in the report from the IFWG in 1992 (Anon., 1992b), they had little confidence in the estimates and, therefore, there are no reasons for continuing the SHOT estimates on the sprat from Division IIIa.

10.6 Management Considerations

The Working Group has no basis for management considerations for the sprat fisheries in Division IIIa for 1993.

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

Catch in weight by rectangles and by months are not available.

The IBTS (February) data are provided in Table 10.3.1 and by rectangles in Figure 10.3.1. Data from the autumn IBTS surveys in 1991 and 1992 have not yet been processed by ICES.

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Table 2.1.1 North Sea HERRING (Sub-area IV and Division VIId). Catch in tonnes by country, 1980-1992. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1981	1982	1983	1984	1985	1986
Belgium	-	9,700	5,969	5,080	3,482	414
Denmark	21,146	67,851	10,467	38,777	129,305	121,631
Faroe Islands	-	-	-	-	-	623
France	15,099	15,310	16,353	20,320	14,400	9,729
Germany, Fed.Rep.	2,300	349	1,837	11,609	8,930	3,934
Netherlands	7,700	22,300	40,045	44,308	79,335	85,998
Norway[4]	-	-	32,512	98,706	159,947	223,058
Sweden	-	-	284	886	2,442	1,872
UK (England)	303	3,703	111	1,689	5,564	1,404
UK (Scotland)	45	1,780	17,260	31,393	55,795	77,459
UK (N.Ireland)	-	-	-	-	-	-
Unallocated landings	94,309	114,252	181,116	64,487	74,220	21,089
Total landings	140,902	235,245	305,954	317,255	533,420	547,211
Discards[3]	-	-	-	-	-	-
Total catch	140,902	235,245	305,954	317,255	533,420	547,211
Catches of spring spawners (included above)						
IIIa type	-	-	-	6,958	17,386	19,654
Coastal type	-	-	-	520	905	490

Country	1987	1988	1989	1990	1991	1992[1]
Belgium	39	4	434	180	163	242
Denmark	138,596	263,006	210,315[2]	159,280[2]	194,358[2]	193,968[2]
Faroe Islands	2,228	810	1,916	633	334	-
France	7,266	8,384	29,085	23,480	24,625	16,587
Germany, Fed.Rep.	5,552	13,824	38,707	43,191	41,791	42,665
Netherlands	91,478	82,267	84,178	69,828	75,135	75,683
Norway[4]	241,765	222,719	221,891[2]	157,850[2]	124,991[2]	116,863
Sweden	1,725	1,819	4,774	3,754	5,866	4,939
UK (England)	873	8,097	7,980	8,333	11,548	11,314
UK (Scotland)	76,413	64,108	68,106	56,812	57,572	56,171
UK (N.Ireland)	-	-	-	-	92	-
Unallocated landings	58,972	33,411	26,749[2]	21,081	24,435	25,867
Total landings	624,907	698,449	694,135[2]	544,422	560,910	544,299
Discards[3]	-	-	4,000	8,660	4,617	4,950
Total catch	624,907	698,449	698,135	553,082	565,527	549,249
Catches of spring spawners (included above)						
IIIa type	14,207	23,306	19,869	8,357	7,894	7,854
Coastal type	250	250	2,283	1,136	252[5]	202[5]

[1]Preliminary.
[2]Working Group estimates.
[3]Any discards prior to 1989 estimates 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	1983	1984	1985	1986	1987
Denmark	4,282	26,786	77,788	48,590	50,184
Faroe Islands	-	-	-	275	102
France	680	1,408	2,075	462	285
Germany, Fed.Rep.	1,542	12,092	4,790	2,510	3,250
Netherlands	15,745	19,143	49,965	42,900	44,358
Norway	16,971	21,305	10,507	63,848	55,311
Sweden	213	-[1]	-[1]	-[1]	768
UK (N.Ireland)	-	-	-	-	-
UK (England)	-	-	-	-	4,820
UK (Scotland)	16,136	24,634	52,100	71,285	66,774
Unallocated landings	3,955	24,030	4,249	-	16,092
Total Landings	61,738	129,398	197,225	229,870	221,032
Discards[2]	-	-	-	-	-
Total catch	61,738	129,298	201,474	229,870	237,124

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

[1]Included in Division IVb.
[2]Any discards prior to 1989 were included in unallocated.
[3]Preliminary.
[4]Including IVa East.

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	1983	1984	1985	1986	1987
Denmark	-	126	-	4,540	7,101
Faroe Islands	-	-	-	-	2,126
France	-	-	-	-	159
Netherlands	-	-	-	-	-
Norway[1]	-	51,581	109,975	118,408	145,843
Sweden	-	-	-	-	957
UK (Scotland)	257	74	-	-	-
Germany, Fed.Rep.	-	-	-	-	-
Unallocated landings	431	-	-	-	-
Total landings	688	51,781	109,975	122,348	156,186
Discards[2]	-	-	-	-	-
Total catch	688	51,781	109,975	122,948	156,186

Country	1988	1989	1990	1991	1992[3]
Denmark	47,183	44,269	44,364	48,875	53,692
Faroe Islands	-	-	-	-	-
France	45	-	892	-	-[4]
Netherlands	200	-	-	-	-
Norway[1]	153,496	168,365	121,405	77,465	61,379
Sweden	622	612	2,482	114	508
UK (Scotland)	-	-	-	173	196
Germany, Fed.Rep.	-	-	5,604	-[4]	-[4]
Unallocated landings	-	-	-	-	-
Total landings	201,546	213,246	174,747	126,627	115,775
Discards[2]	-	-	-	-	-
Total catch	201,546	213,246	174,747	126,627	115,775

[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	1983	1984	1985	1986	1987
Denmark	6,050	13,808	51,517	67,966	81,280
France	705	2,299	1,037	605	387
Faroe Islands	-	-	-	348	-
Germany, Fed.Rep.	-	2	4,139	1,424	2,302
Netherlands[4]	300	4,600	-[3]	21,101	31,371
Norway	14,156	25,820	39,465	40,682	40,111
Sweden	71	884	2,442[2]	1,872[2]	-
UK (England)	40	1,956	5,214	1,101[1]	329
UK (Scotland)	867	2,477	2,894	6,057	9,639
Unallocated landings	159,124	41,294	47,799	1,594	20,829
Total landings	181,313	93,140	154,507	142,750	186,248
Discards[4]	-	-	-	-	-
Total catch	181,313	93,140	154,507	142,750	186,248

Country	1988	1989	1990	1991	1992[6]
Denmark	190,555	136,239	105,614	138,555	125,229
Belgium	-	-	-	3	13
France	617	14,415[5]	10,289	4,120	2,313
Faroe Islands	-	-	-	-	-
Germany, Fed.Rep.	4,516	11,880	17,165	20,479	20,005
Netherlands[4]	37,192	47,388	28,402	26,266	26,987
Norway	38,566	11,758	12,207	9,852	16,240
Sweden	-	3,420	1,276	4,622	3,446
UK (England)	2,011	957	3,200	2,715	3,026
UK (Scotland)	15,317	9,651	10,381	14,587	16,707
Unallocated landings	1,969	-23,947[7]	-15,616[7]	3,180	-13,637[7]
Total landings	290,743	211,711	172,914	224,376	200,329
Discards[4]	-	1,900	2,560	1,072	1,900
Total catch	290,743	213,611	175,474	225,448	202,229

[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	1983	1984	1985	1986	1987
Belgium	5,969	5,080	3,482	414	39
Denmark	135	53	-	535	31
France	14,968	16,613	11,288	8,662	6,435
Germany, Fed.Rep.	295	-	-	-	-
Netherlands	24,000	21,922	32,370	21,997	15,749
Norway	1,385	-	-	-	-
UK (England)	71	571	350	303	544
UK (Scotland)	-	-	799	117	-
Unallocated landings	17,606	1,788	21,595	19,495	22,051
Total landings	-	-	69,884	51,523	44,849
Discards[1]	-	-	-	-	-
Total catch	64,430	46,027	69,884	51,523	44,849
Coastal spring spawners included above	-	-	905	496	250

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

[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 : 1992

Division	Quarter	0 1991	1 1990	2 1989	3 1988	4 1987	5 1986	6 1985	7 1984	8 1983	9 1982	Total	0+1 ring
	I	0.0	0.0	0.2	0.8	1.2	1.3	1.2	0.3	0.1	0.0	5.1	0.0
IVa	II	0.0	0.2	27.8	39.5	34.5	32.9	27.3	13.9	5.1	1.1	182.3	0.2
West	III	0.0	0.9	47.7	57.8	61.8	99.8	112.7	40.8	10.8	8.8	441.0	0.9
of 2E	IV	0.1	1.1	8.2	11.2	12.0	28.0	27.2	6.9	3.8	3.0	101.3	1.2
	Total	0.1	2.2	83.8	109.3	109.4	162.1	168.4	61.9	19.7	12.9	729.8	2.3
	I	0.0	0.0	6.5	40.6	48.7	61.8	54.3	11.4	4.5	1.5	229.4	0.0
IVa	II	0.0	25.5	48.2	22.1	20.0	11.1	11.2	4.2	0.3	0.6	143.3	25.5
East	III	0.0	3.9	8.9	4.2	2.1	2.3	1.8	0.6	0.2	0.2	24.1	3.9
of 2E	IV	4.0	36.9	32.6	47.2	33.4	32.3	38.2	12.0	3.9	1.9	242.4	40.9
	Total	4.0	66.3	96.3	114.1	104.2	107.6	105.4	28.2	8.9	4.2	639.2	70.3
	I	0.0	12.0	232.0	6.6	3.7	2.6	3.2	0.5	0.2	0.1	260.8	12.0
	II	197.4	80.9	93.7	20.2	11.2	6.3	7.4	3.7	0.8	0.0	421.6	278.3
IVb	III	6569.5	377.2	79.6	68.1	41.7	34.5	44.8	17.9	7.4	3.4	7244.2	6946.7
	IV	791.2	61.3	51.8	26.7	9.2	5.7	8.2	1.8	0.2	0.1	956.3	852.5
	Total	7558.1	531.4	457.1	121.6	65.9	49.1	63.6	23.8	8.6	3.6	8882.9	8089.5
	I	0.0	0.4	43.1	20.7	8.7	3.5	2.9	2.0	0.1	0.0	81.3	0.4
	II	0.0	0.0	0.4	2.4	1.5	1.1	0.6	0.3	0.0	0.0	6.3	0.0
IVc + VIId	III	16.2	12.9	5.6	2.9	1.5	1.1	0.3	0.4	0.0	0.0	40.8	29.1
	IV	19.9	30.1	274.5	40.9	43.4	17.0	19.0	28.2	0.4	2.5	475.8	50.0
													0.0
	Total	36.0	43.5	323.7	66.8	55.0	22.7	22.8	30.8	0.5	2.5	604.2	79.5
	I	0.0	12.4	281.8	68.7	62.3	69.2	61.6	14.1	4.9	1.6	576.7	12.4
Total	II	197.4	106.7	170.0	84.2	67.2	51.4	46.4	22.1	6.2	1.8	753.5	304.1
North	III	6585.7	394.8	141.9	132.9	107.0	137.8	159.6	59.6	18.3	12.4	7750.0	6980.5
Sea	IV	815.1	129.5	367.1	125.9	98.0	83.1	92.5	48.9	8.3	7.5	1775.9	944.7
	Total	7598.2	643.4	960.9	411.8	334.6	341.5	360.1	144.7	37.7	23.2	10856.0	8241.6

Table 2.2.2 Millions of HERRING caught annually per age group (winter rings) in the North Sea, 1970-1992.

Year	Winter ring										Total
	0	1	2	3	4	5	6	7	8	>8	
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	5,908.3
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	8,859.7
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	7,252.8
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	10,856.0

Table 2.2.3 Transfers of juvenile autumn spawners from Division IIIa (used in North Sea assessment). Numbers (millions) per age group (winter rings).

Year	O-ring	1-ring	2-ring
1980	471	84	26
1981	1,631	425	20
1982	2,400	276	31
1983	3,267	1,302	29
1984	4,472	1,177	119
1985	2,886	1,608	93
1986	2,960	2,960	91
1987	6,238	3,153	117
1988	1,830	5,792	292
1989	1,028	1,171	655
1990	392	1,378	284
1991	712	823	330
1992	2,408	1,587	284

Table 2.2.4 Percentage age composition of North Sea HERRING (2-ringers and olders), in the catch.
Catches in : 1992

Division	age in W.Rings Quarter	2 1989	3 1988	Older >= 1987	Total (millions)
	I	3.8	15.7	80.4	5.1
IVa West	II	15.2	21.7	63.0	182.1
	III	10.8	13.1	76.0	440.1
	IV	8.2	11.1	80.7	100.1
	Total	11.5	15.0	73.5	727.5
	I	2.9	17.7	79.4	229.4
IV a East	II	40.9	18.7	40.3	117.7
	III	44.2	20.8	35.0	20.2
	IV	16.2	23.4	60.4	201.5
	Total	16.9	20.1	63.0	568.8
	I	93.2	2.6	4.1	248.9
IVb	II	65.4	14.1	20.5	143.3
	III	26.8	22.9	50.3	297.4
	IV	49.9	25.7	24.4	103.8
	Total	57.6	15.3	27.1	793.4
	I	53.3	25.6	21.1	80.9
IVc + VIId	II	6.8	37.5	55.7	6.3
	III	48.2	24.7	27.1	11.7
	IV	64.5	9.6	25.9	425.8
	Total	61.7	12.7	25.6	524.7
	I	49.4	9.9	40.7	483.4
IVa + IVb	II	38.3	18.5	43.3	443.1
	III	18.0	17.2	64.9	757.8
	IV	22.8	21.0	56.2	405.4
	Total	30.5	16.5	53.0	2089.7
	I	49.9	12.2	37.9	564.3
Total	II	37.8	18.7	43.4	449.4
North	III	18.4	17.3	64.3	769.5
Sea	IV	44.2	15.1	40.7	831.2
	Total	36.8	15.7	47.5	2614.4

Table 2.2.5 Catches (SOP,tons) of North Sea Herring, by quarter and division.
Catches in : 1992

		0	1	2	3	4	5	6	7	8	9	SOP
Quarter	Division	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	Total
	IVa W	0	0	23	116	171	218	209	52	16	4	809
I	IVa E	0	0	746	5773	7417	10287	9421	2182	906	292	37025
	IVb	0	415	12391	734	486	438	520	92	42	12	15130
	IVc	0	10	2576	2654	1178	501	469	339	22	0	7749
	Total	0	425	15736	9276	9252	11444	10618	2666	986	309	60713
	IVa W	0	14	3653	7357	6278	6274	5480	2814	950	257	33078
II	IVa E	0	2390	7518	4187	3531	1991	2433	863	89	170	23172
	IVb	1658	4003	9115	3220	1959	1186	1423	731	161	0	23455
	IVc	0	1	40	267	194	164	91	44	0	3	804
	Total	1658	6409	20326	15030	11962	9616	9426	4453	1200	430	80509
	IVa W	0	83	6943	11769	13405	23876	28345	11231	3116	2932	101700
III	IVa E	0	375	1420	1075	602	597	662	158	37	67	4994
	IVb	53217	19199	8974	13107	8722	7614	11087	4888	2087	1086	129980
	IVc	265	701	711	379	205	158	49	51	0	0	2519
	Total	53482	20357	18049	26330	22933	32245	40143	16328	5239	4085	239193
	IVa W	1	131	1417	2314	2454	6093	6152	1629	891	694	21778
IV	IVa E	120	3306	5072	8552	6495	6708	8228	2702	945	449	42577
	IVb	13828	4047	6441	4758	1887	1212	1747	370	56	29	34374
	IVc	354	2410	31595	5898	8172	3394	3895	6166	66	671	62621
	Total	14303	9893	44525	21522	19008	17407	20023	10866	1958	1843	161349
Total N. Sea	1992	69444	37085	98635	72159	63156	70712	80211	34313	9383	6667	541764

Table 2.2.6 Catch in numbers (millions) and mean weight (g) by fleet in the North Sea.

	Human consumpt.		Small mesh fishery		TOTAL	
1. QUARTER						
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight
0						
1	0.1	34	12.3	34	12.4	34
2	17.5	98	264.3	53	281.8	56
3	62.5	137	6.2	110	68.7	135
4	57.5	151	4.8	121	62.3	149
5	66.7	166	2.5	146	69.2	165
6	58.0	173	3.6	156	61.6	172
7	13.5	189	0.6	195	14.1	189
8	4.9	200			4.9	200
9+	1.6	199			1.6	199
TOTAL	282.3		294.3		576.6	
Landings (SOP)		43,920		16,733		60,652
2. QUARTER						
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			197.4	8	197.4	8
1	56.4	72	42.6	47	99.0	61
2	137.9	130	25.1	64	163.0	120
3	89.8	178	0.3	158	90.1	178
4	71.8	177	0.2	164	72.0	177
5	54.9	187			54.9	187
6	49.1	203			49.1	203
7	23.0	203			23.0	203
8	6.3	194			6.3	194
9+	2.0	249			2.0	249
TOTAL	491.2		265.6		756.8	
Landings (SOP)		77,304		5,268		82,572
3. QUARTER						
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			6585.7	8	6585.7	8
1	12.5	75	379.7	50	392.2	51
2	91.5	143	45.2	98	136.7	128
3	120.9	203	13.3	144	134.2	197
4	104.6	213	7.0	190	111.6	212
5	134.5	235	6.6	197	141.1	233
6	162.3	250	1.6	231	163.9	250
7	60.3	273	0.3	255	60.6	273
8	18.2	287	0.5	250	18.7	286
9+	12.7	327			12.7	327
TOTAL	717.5		7039.9		7757.4	
Landings (SOP)		158,865		81,217		240,082
4. QUARTER						
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	5.7	18	809.3	18	815.0	18
1	67.0	90	61.2	61	128.2	76
2	351.8	121	14.1	120	365.9	121
3	124.3	171	0.7	185	125.0	171
4	96.3	194	0.9	189	97.2	194
5	80.0	209	1.7	205	81.7	209
6	90.2	216	1.1	212	91.3	216
7	48.2	222	0.3	213	48.5	222
8	8.0	237	0.1	235	8.1	237
9+	7.3	246	0.1	242	7.4	246
TOTAL	878.8		889.5		1768.3	
Landings (SOP)		139,233		20,986		160,219
TOTAL YEAR						
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	5.7	18	7592.4	9	7598.1	9
1	136.0	81	495.8	51	631.8	57
2	598.7	126	348.7	62	947.4	102
3	397.5	177	20.5	135	418.0	175
4	330.2	189	12.9	164	343.1	188
5	336.1	207	10.8	186	346.9	207
6	359.6	223	6.3	185	365.9	222
7	145.0	237	1.2	215	146.2	237
8	37.4	249	0.6	248	38.0	249
9+	23.6	287	0.1	242	23.7	286
TOTAL	2369.8		8489.3		10859.1	
Landings (SOP)		419,322		124,203		543,524

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Table 2.2.7 : North Sea herring - sampling intensity of commercial catches

Division IVa

Country	Total Landings ('ooo t)	Number of samples	number of age reading	number of fish measured	Estimates of discards	Catches to which the age composition has been applied
Denmark	64	27	2299	2299	no	64
France	5	-	-	-	no	0
Germany	22	-	-	-	no	0
Netherlands	30	14	843	1420	yes	63
Norway	100	10	1000	1000	no	102
Sweden	1	-	-	-	no	0
UK(England)	5	-	-	-	no	0
UK(Scotland)	39	49	n/a	6167	no	44

Division IVb

Country	Total Landings ('ooo t)	Number of samples	number of age reading	number of fish measured	Estimates of discards	Catches to which the age composition has been applied
Denmark	125	73	6681	6681	no	125
France	2	2	93	296	no	0.3
Germany	20	-	-	-	no	0
Netherlands	27	20	1600	2282	yes	38
Norway	16	3	300	300	no	19
Sweden	3	-	-	-	no	0
UK(England)	3	-	-	-	no	0
UK(Scotland)	17	11	n/a	1895	no	20

Divisions IVc and VIId

Country	Total Landings ('ooo t)	Number of samples	number of age reading	number of fish measured	Estimates of discards	Catches to which the age composition has been applied
Belgium	0.3	-	-	-		0
Denmark	4	3	213	213	no	4
France	10	9	647	2084	yes	13
Germany	1	-	-	-	no	
Netherlands	19	26	1095	3863	yes	57
UK(England)	3	-	-	-	no	0

Table 2.3.1 Prediction of year class strength as 1-ringers

year class	IBTS 1-ringer index		VPA estimate	predictions		
	old (1)	new (2)		old index	new index	
					old regression	RCT3
1974	452					
1975	342					
1976	575		1.45			
1977	139	2.61	1.61			
1978	535	4.56	3.59			
1979	551	5.71	5.44			
1980	1293	11.42	8.62			
1981	1797	17.71	17.01			
1982	2663	21.56	15.48			
1983	3416	31.09	16.03			
1984	3667	39.07	28.32			
1985	5717	53.07	34.90			
1986	4192	67.96	27.89			
1987	3468	31.87	14.98			
1988	2146	15.85	15.39			
1989	2433	17.84		15.57	12.49	8.23
1990	2339	16.64		14.97	11.96	10.52
1991	2148	50.34		15.01	26.92	29.35
1992						25.37

1) based on herring standard area in the North Sea

2) sum of all rectangles in North Sea and Division IIIa divided by 10 000

Table 2.3.2 Denisty and abundance estimates of 0-ringers caught in February during the IYFS. 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 billions
Year class									
1976	0.054	0.014	0.122	0.005	0.008	0.002	0.002	0.016	17.1
1977	0.024	0.024	0.050	0.015	0.056	0.013	0.006	0.034	13.1
1978	0.176	0.031	0.061	0.020	0.010	0.005	0.074	0.000	52.1
1979	0.061	0.195	0.262	0.408	0.226	0.143	0.099	0.053	101.1
1980	0.052	0.001	0.145	0.115	0.089	0.339	0.248	0.187	76.7
1981	0.197	0.000	0.289	0.199	0.215	0.645	0.109	0.036	133.9
1982	0.025	0.011	0.068	0.248	0.290	0.309	0.470	0.140	91.8
1983	0.019	0.007	0.114	0.268	0.271	0.473	0.339	0.377	115.0
1984	0.083	0.019	0.303	0.259	0.996	0.718	0.277	0.298	181.3
1985	0.116	0.057	0.421	0.344	0.464	0.777	0.085	0.084	177.4
1986	0.317	0.029	0.730	0.557	0.830	0.933	0.048	0.244	270.9
1987	0.078	0.031	0.417	0.314	0.159	0.618	0.483	0.495	168.9
1988	0.036	0.020	0.095	0.096	0.151	0.411	0.181	0.016	71.4
1989	0.083	0.030	0.040	0.094	0.013	0.035	0.041	0.000	25.9
1990	0.075	0.053	0.202	0.158	0.121	0.198	0.086	0.196	69.9
1991	0.255	0.390	0.431	0.539	0.500	0.369	0.298	0.395	200.7
1992	0.138	0.039	1.006	0.414	0.734	0.239	0.389	0.305	212.4

Table 2.3.3 Prediction of year class strength as 0-ringers.

Year class	MIK-index	VPA estimate	Predictions	
			Old regression	RCT3
1976	17.1	4.3		
1977	13.1	4.6		
1978	52.1	10.6		
1979	101.1	16.8		
1980	76.7	37.9		
1981	133.9	64.9		
1982	91.8	62.4		
1983	115.0	53.9		
1984	181.3	83.5		
1985	177.4	100.6		
1986	270.9	88.4		
1987	168.9	45.6		
1988	71.4	46.5		
1989	25.9	42.4	19.9	23.7
1990	69.9	-	34.9	33.0
1991	200.7	-	79.5	97.8
1992	202.4		80.1	85.1

Note: MIK-indices for year classes 1990-1991 are based on catches by the MIK-Gear; others are converted from earlier IKMT indices (see text).

Table 2.3.4 North Sea Herring.

Analysis by RCT3 ver3.1 of data from file :
D:RCT1WR.CSV
PREDICTION OF 1 RINGERS FROM IBTS1 AND MIK,IBTS2
Data for 3 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 = 1989

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction		---------I	
IBTS 1	.94	.11	.27	.926	12	7.49	7.11	.308	.682
MIK	1.30	1.12	.45	.856	13	3.29	5.39	.541	.221
IBTS 2	1.35	-1.07	1.12	.299	11	5.98	6.99	1.300	.038
					VPA Mean =		6.91	1.049	.059

Yearclass = 1990

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction		---------I	
IBTS 1	.94	.11	.27	.926	12	7.42	7.04	.308	.663
MIK	1.30	1.12	.45	.856	13	4.26	6.64	.508	.243
IBTS 2	1.35	-1.07	1.12	.299	11	6.40	7.55	1.301	.037
					VPA Mean =		6.91	1.049	.057

Yearclass = 1991

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction		---------I	
IBTS 1	.94	.11	.27	.926	12	8.52	8.08	.322	.680
MIK	1.30	1.12	.45	.856	13	5.31	8.00	.525	.256
IBTS 2									
					VPA Mean =		6.91	1.049	.064

Yearclass = 1992

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction		---------I	
IBTS 1									
MIK	1.30	1.12	.45	.856	13	5.36	8.07	.527	.798
IBTS 2									
					VPA Mean =		6.91	1.049	.202

Table 2.3.4 Continued

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1989	823	6.71	.25	.41	2.58		
1990	1052	6.96	.25	.12	.22		
1991	2935	7.98	.27	.20	.57		
1992	2537	7.84	.47	.47	.98		

```
PREDICTION OF 1 RINGERS FROM IBTS1 AND MIK,IBTS2
3, 17, 2
'YEARCL','VPA','IBTS 1','MIK','IBTS 2'
1976,   145,    -11,  17.1,   -11
1977,   161,    261,  13.1,   -11
1978,   359,    456,  52.1,   658
1979,   544,    571, 101.1,   122
1980,   862,   1142,  76.7,   132
1981,  1701,   1771, 133.9,   145
1982,  1548,   2156,  91.8,   627
1983,  1603,   3109,   115,   639
1984,  2832,   3907, 181.3,   817
1985,  3490,   5307, 177.4,  2934
1986,  2789,   6796, 270.9,   673
1987,  1498,   3187, 168.9,   514
1988,  1539,   1585,  71.4,   649
1989,   -11,   1784,  25.9,   396
1990,   -11,   1664,  69.9,   603
1991,   -11,   5034, 200.7,   -11
1992,   -11,    -11, 212.4,   -11
```

Table 2.3.5 North Sea Herring.

Analysis by RCT3 ver3.1 of data from file :

D:RCT3HER2.CSV

PREDICTION OF 0-RINGER RECRUITMENT FROM IBTSI AND MIK,IBTS2

Data for 3 surveys over 18 years : 1975 - 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 = 1989

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
IBTS 1	.98	-1.34	.35	.889	12	7.49	6.00	.395	.627
MIK	1.35	-.23	.49	.839	13	3.29	4.20	.595	.277
IBTS 2	1.70	-4.36	1.53	.186	11	5.98	5.81	1.769	.031
					VPA Mean =		5.61	1.234	.064

Yearclass = 1990

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
IBTS 1	.98	-1.34	.35	.889	12	7.42	5.93	.395	.605
MIK	1.35	-.23	.49	.839	13	4.26	5.51	.558	.303
IBTS 2	1.70	-4.36	1.53	.186	11	6.40	6.53	1.770	.030
					VPA Mean =		5.61	1.234	.062

Yearclass = 1991

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
IBTS 1	.98	-1.34	.35	.889	12	8.52	7.01	.413	.615
MIK	1.35	-.23	.49	.839	13	5.31	6.92	.576	.316
IBTS 2									
					VPA Mean =		5.61	1.234	.069

Yearclass = 1992

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
IBTS 1									
MIK	1.35	-.23	.49	.839	13	5.36	7.00	.579	.820
IBTS 2									

Table 2.3.5 Continued

					VPA Mean =	5.61	1.234	.180
Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA	
1989	237	5.47	.31	.46	2.12			
1990	330	5.80	.31	.13	.19			
1991	978	6.89	.32	.25	.58			
1992	851	6.75	.52	.53	1.03			

PREDICTION OF 0-RINGER RECRUITMENT FROM IBTSI AND MIK

```
2,18,2
'YEARCL','VPA','IBTS 1','MIK'
1975,  26,  -11,   -11
1976,  43,  -11,    17.1
1977,  46,  261,    13.1
1978, 106,  456,    52.1
1979, 168,  571,   101.1
1980, 379, 1142,    76.7
1981, 649, 1771,   133.9
1982, 624, 2156,    91.8
1983, 539, 3109,   115
1984, 835, 3907,   181.3
1985,1006, 5307,   177.4
1986, 884, 6796,   270.9
1987, 456, 3187,   168.9
1988, 465, 1585,    71.4
1989, -11, 1784,    25.9
1990, -11, 1664,    69.9
1991, -11, 5034,   200.7
1992, -11,  -11,   212.4
```

Table 2.3.6 Weighting factors of 1-ringer abundance estimates (in no/hour) used in calculating the IBTS index for North Sea and Division IIIa.

Weight	Statistical Rectangle
0.1	35F5
0.2	37E9
0.3	33F1, 38F8, 43G2
0.4	33F4, 34F1, 36F7, 39F8, 42E7, 45E6, 46E6, 49E8
0.5	36F8, 39E8, 44E6, 44E7
0.6	31F1, 34F4, 47E7, 44G1
0.7	50E8, 43G1
0.8	31F2, 32F3, 35F0, 37F8, 40E8, 41E7, 44F9
0.9	32F1, 35F4, 36F0, 36F6, 38E9, 43E8, 44E8, 46E7, 48E8, 50E9
0.02	45F9
0.21	43G0
0.24	45G0
0.25	44F8
0.41	43F9
0.52	46G0
0.53	41G2
0.55	45G1
0.64	42G2
0.89	42G1
0.94	43F8, 44G0
0.97	41G1
1.00	All Rectangles not mentioned above

Table 2.4.1 Estimated numbers, biomass and mean weight of autumn spawning herring by age, maturity and area. Acoustic surveys june and july 1992.

AGE RINGS	NUMBERS (MILLIONS)						
	VIa	IVa	IVb	IVa+b	SKAGER.	KATTEGAT	TOTAL
1	74	1826	438	2264	2558	1455	6351
2 IMMATURE	268	1101	143	1244	546	0	2058
2 MATURE	235	1652	234	1886			2121
3	211	1116	306	1422			1633
4	258	977	162	1139			1397
5	415	1008	87	1095			1510
6	240	1015	56	1071			1311
7	106	323	45	368			474
8	57	98	0	98			155
9+	63	88	12	100			163
IMMATURE	343	2927	581	3508	3104	1455	8410
MATURE	1585	6276	901	7177	0	0	8762
TOTAL	1928	9203	1482	10685	3104	1455	17172

AGE RINGS	BIOMASS ('000 TONNES)						
	VIa	IVa	IVb	IVa+b	SKAGER.	KATTEGAT	TOTAL
1	5	148	28	176	177	62	420
2 IMMATURE	40	132	15	147	50		237
2 MATURE	37	267	32	299			336
3	39	235	61	296			335
4	53	217	32	249			302
5	97	249	17	266			363
6	61	261	12	273			334
7	29	91	9	100			129
8	17	31	0	31			48
9+	19	28	3	31			50
IMMATURE	45	280	43	323	227	62	657
MATURE	351	1378	167	1545			1896
TOTAL	397	1659	209	1868	227	62	2554

AGE RINGS	MEAN WEIGHTS IN GRAMS						
	VIa	IVa	IVb	IVa+b	SKAGER.	KATTEGAT	TOTAL
1	67.6	81.1	63.9	77.7	69.2	42.6	66.1
2 IMMATURE	149.3	119.9	104.9	118.2	91.6		115.2
2 MATURE	157.4	161.6	136.8	158.5			158.4
3	184.8	210.6	199.3	208.2			205.1
4	205.4	222.1	197.5	218.6			216.2
5	233.7	247.0	195.4	242.9			240.4
6	254.2	257.1	214.3	254.9			254.8
7	273.6	281.7	200.0	271.7			272.2
8	298.2	316.3		316.3			309.7
9+	301.6	318.2	250.0	310.0			306.7
IMMATURE	131.2	95.7	74.0	92.1	73.1	42.6	78.1
MATURE	221.5	219.6	185.3	215.3			216.4
TOTAL	205.9	180.3	141.0	174.8	73.1	42.6	148.7

Table 2.4.2 Estimates of North Sea autumn spawners (millions) at age from acoustic surveys, 1984-1992. For 1984-1986 the estimates are the sum of those from the Division IVa summer survey, the Division IVb autumn survey, and the Divisions IVc, VIId winter survey. The 1987 to 1992 estimates are from the summer survey in Divisions IVa,b, and IIIa excluding estimates of Division IIIa/Baltic spring spawners.

Age (rings)	Numbers (millions)								
	Year								
	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	551	726	1,639	13,736	6,431	6,333	6,249	3,182	6,351
2	3,194	2,789	3,206	4,303	4,202	3,726	2,971	2,834	4,179
3	1,005	1,433	1,637	955	1,732	3,751	3,530	1,501	1,633
4	394	323	833	657	528	1,612	3,370	2,102	1,397
5	158	113	135	368	349	488	1,349	1,984	1,510
6	44	41	36	77	174	281	395	748	1,311
7	52	17	24	38	43	120	211	262	474
8	39	23	6	11	23	44	134	112	155
9+	41	19	8	20	14	22	43	56	163
Z(2+/3+)		0.92	0.57	1.02	0.81	0.11	0.11	0.56	0.49
SSB('000 t)	807	697	942	817	897	1,637	2,174	1,874	1,896

SSB defined as all fish >maturity stage III.

Table 2.5.1 ICES International herring larvae surveys. Estimated mortality rates rates (z/k) per mm for the standard areas over the years 1980-1991. Estimates marked with an asterix (*) are based on regression over the larval length range 10-16 mm. Estimates marked with a double asterix (**) are based on the length range 11-16 mm. Other estimates are based on the length range 8-16 mm.

Year	Overall	Orkney-Shetland	Div. VIa (N) + Ork./Shet.	Buchan	Central North Sea	Divs.IVc + VIId
1980		-	0.29*	-	-	0.33**
1981		0.29	0.34	-	-	-
1982		0.25*	0.26*	-	0.40	0.80**
1983		0.27*	0.26*	0.43	0.34	-
1984		0.20	0.24	0.42	-	0.54**
1985		0.25*	0.29*	-	0.33*	0.56**
1986		0.28*	0.22*	0.27*	-	0.48**
1987		0.37*	0.36	0.37*	0.35*	0.64**
1988		0.53*	0.56	0.38	0.31	0.71**
1989		0.39*	0.41	0.22	0.46	-
1990		0.36	-	0.40*	0.38	1.07*
1991		0.39	-	0.29	0.39	0.90*
1992			0.38	0.28	1.11	0.66
Mean 1980-92	0.35		0.33	0.36	0.71	0.47
Mean 1980-91	0.35	0.33	0.33	0.37	0.67	0.45
Mean 1980-90	0.35	0.32	0.37	0.36	0.64	0.43

Table 2.5.2 Larvae production estimates (LPE x 10^{11} larvae) calculated using area-specific natural mortality rates (z/k). Division IVa is the sum of Orkney-Shetland and Buchan LPEs. Division VIa + Orkney/Shetland is combined LPEs for Orkney-Shetland and Division VIa(N).

Year	Ork/Shet	Buchan	IVa	VIa(N)+Ork/Sh	Central North Sea	IVc+VIId
1972	174	-	174	-	23	20
1973	95	-	95	229	80	10
1974	78	-	78	153	45	2
1975	54	-	54	147	46	1
1976	20	-	20	55	10	1
1977	-	-	-	151	67	-
1978	102	-	102	198	73	3
1979	299	-	299	517	57	11
1980	332	-	332	586	103	127
1981	225	-	225	457	187	406
1982	336	92	428	554	76	190
1983	282	277	559	396	64	258
1984	213	433	646	391	523	178
1985	314	477	791	575	633	206
1986	218	831	1,049	789	451	359
1987	359	200	559	597	331	175
1988	413	727	1,140	803	568	231
1989	730	703	1,433	1,422	313	275
1990	890	887	1,777	-	335	266
1991	359	437	796	-	270	257
1992	437	270	707	900	109	385

Table 2.5.3 The LPE index of SSB ('000 tonnes) estimated from larvae production estimates (LPE * 10^{11} larvae), and Fec, i.e., number of eggs (* 10^5) per kg SSB. SSB is the index of spawning stock biomass estimated as the ratio between LPE and Fecundity. Fecundities marked with an asterix are estimated as the average of the three closest years where an estimate was available.

Year	IVa (incl. Buchan)			IVb			IVa+IVb	IVc+VIId			North Sea
	LPE	Fec.	SSB	LPE	Fec.	SSB	SSB	LPE	Fec.	SSB	SSB
1972	174	1.56*	112	23	1.79*	13	124	20	0.94	21	146
1973	95	1.56*	61	80	1.79*	45	106	10	0.93	11	116
1974	78	1.56*	50	45	1.79*	25	75	2	0.87	2	77
1975	54	1.59	34	46	1.79*	26	60	1	1.01	1	61
1976	20	1.52	13	10	1.79*	6	19	1	0.74	1	20
1977	-	1.57	0	67	1.79*	37	-	2	1.02	2	-
1978	102	1.57	65	73	1.79*	41	106	3	1.18	3	108
1979	299	1.64	182	57	1.79*	32	214	11	1.07	10	224
1980	332	1.69	196	103	1.79*	58	254	127	1.14	111	365
1981	225	1.51	149	187	1.79*	104	253	406	1.06	383	636
1982	428	1.60	268	76	1.83*	42	309	190	1.11	171	480
1983	559	1.53	365	64	1.82*	35	401	258	1.10	235	635
1984	646	1.67	387	523	1.67	313	700	178	1.04	171	871
1985	791	1.60*	494	633	1.88	337	831	206	1.08	191	1,022
1986	1,049	1.60*	656	451	1.76*	256	912	359	1.08*	332	1,244
1987	559	1.60*	349	331	1.76*	188	537	175	1.08*	162	699
1988	1,140	1.60*	713	568	1.76*	323	1,035	231	1.08*	214	1,249
1989	1,433	1.60*	896	313	1.76*	176	1,074	230	1.08*	255	1,328
1990	1,777	1.60*	1,111	335	1.76*	190	1,301	266	1.08*	246	1,547
1991	796	1.60*	498	270	1.76*	153	651	257	1.08*	238	889
1992	707	1.60*	442	109	1.76*	62	504	385	1.08*	356	860

Table 2.5.4. Time periods required for the calculation of larval abundance indices in each area of the North Sea compared with the distribution of available samples. Calculated index values, and (in *italics*) missing values filled in using the multiplicative model. SCO - Scotland; NL - Netherlands; D - Germany.

Area	Time Period required for: Full index	Reduced index	Samples available	Coverage	Contribution	LAI
Buchan	1-15 Sep	1-15 Sep	None	None	*596*	1806
	16-30 Sep	16-30 Sep	47, 17-21 Sep, NL		1210	
Orkney/	1-15 Sep	1-15 Sep	15, 15 Sep only, D	Rejected	*4222*	9413
Shetland	16-30 Sep	16-30 Sep	109, 16-22 Sep, D	Adequate	5191	
Central	1-15 Sep	1-15 Sep	27, 15 Sep only, NL	Rejected	*1050*	367
North	16-30 Sep	16-30 Sep	22, 21-22 Sep, NL			
Sea			34, 16-17 Sep, NL			
			44, 28-15 Sep, NL	Adequate	167	
	1-15 Oct		63, 1-8 Oct, NL	Adequate	170	
	16-31 Oct		None	None	*82*	
Southern	16-31 Dec	16-31 Dec	28, 14-18 Dec, NL	Poor	314	2337
North	1-15 Jan	1-15 Jan	115, 7-15 Jan, D	Adequate	1965	
Sea	16-31 Jan		None	None	*59*	

Table 2.5.5. Larval abundance indices (LAI) by area and for the total North Sea.

Year	Buchan	Orkney & Shetland	Central North Sea	Southern North Sea	Total North Sea
1972	7	5779	112	171	6405
1973	10	2387	734	133	5466
1974	379	1284	635	25	4228
1975	441	439	59	25	1141
1976	1	655	76	18	978
1977	228	1321	174	23	2268
1978	363	3705	462	111	6027
1979	200	5649	188	403	7004
1980	18	3982	214	1193	6049
1981	20	3939	3364	4855	22270
1982	1002	3795	338	3709	9858
1983	4483	3346	661	2354	12827
1984	4296	3538	1055	2267	14321
1985	4351	10487	3802	4065	34111
1986	3780	5500	2027	4780	22168
1987	3308	9596	1970	3317	24101
1988	12319	16502	2946	3907	44512
1989	6940	17424	2205	7861	41045
1990					
1991				8646	
1992	1360	1856	92	254	3561

Table 2.6.1 North Sea herring. Mean weight (g) at age (w.r.) and year class weighted by number caught.

Catches in 1992

		0	1	2	3	4	5	6	7	8	9
Division	Quarter	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982
	I			114	143	146	162	171	190	199	199
IV a	II		65	132	186	182	191	201	202	186	229
W of 2°E	III		95	146	204	217	239	252	275	289	333
	IV	18	116	173	207	205	218	227	236	235	234
	Total	18	102	144	197	204	225	239	254	252	301
	I			114	142	152	166	174	191	200	199
IV a	II		94	156	190	176	179	218	205	273	267
E of 2°E	III		97	159	255	291	255	371	283	237	428
	IV	30	90	155	181	194	208	216	225	244	238
	Total	30	92	153	172	173	182	197	209	223	236
	I		35	53	111	130	168	163	192	201	199
IV b	II	8	49	97	159	174	189	192	200	200	
	III	8	51	113	193	209	220	247	273	283	318
	IV	17	66	124	178	204	212	213	208	247	227
	Total	9	52	81	179	198	213	232	255	272	313
	I		25	60	128	136	144	162	174	183	254
IVc	II		41	93	113	132	143	155	151		228
+	III	16	54	126	131	139	150	171	143		
VIId	IV	18	80	115	144	188	199	205	219	175	268
	Total	17	72	108	138	177	186	198	215	177	268
IVa	Total	30	92	149	184	189	208	223	240	243	285
	I		35	55	138	151	166	173	191	200	199
IVa	II	8	60	120	180	179	188	204	202	193	243
+	III	8	51	127	200	215	235	252	275	286	330
IVb	IV	18	75	140	184	198	212	219	227	240	235
	Total	9	57	100	183	191	209	224	243	250	290
	I		34	56	135	149	165	172	189	200	199
Total	II	8	60	120	179	178	187	203	202	193	242
North	III	8	52	127	198	214	234	252	274	286	330
Sea	IV	18	76	121	171	194	210	216	222	237	246
	Total	9	58	103	175	189	207	223	237	249	287

Table 2.6.2 Comparison between mean weights (g) at age (w.r) in catch of North Sea Herring (adult) from earlier years and 1985-1992.

Division	Age in winter rings							
	Year	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
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
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
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

Table 2.6.2 Continued

	1991	123	165	184	200	212	196	237	161
	1992	100	183	191	209	224	243	250	290
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

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	1990	1991	1992
1	78	54	58	42	58	73	51	64	65	78
2	146	134	124	126	128	164	127	128	158	142
3	190	182	178	179	180	189	200	186	198	209
4	214	219	217	207	208	210	215	207	224	219
5	248	248	239	244	228	229	235	232	236	243
6	282	265	261	274	256	246	252	257	260	255
7	288	286	283	288	267	276	276	282	275	272
8	327	310	283	296	272	296	286	278	298	312
9+	364	342	296	350	295	293	330	318	317	311

Table 2.7.1 Time series of spawning stock indices, and the spawning stock from the converged part of the 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	76	20	-	-
1977	43	-	-	-
1978	58	108	-	-
1979	100	224	-	-
1980	124	365	-	-
1981	188	636	305	5.94
1982	274	480	402	12.55
1983	427	635	440	14.07
1984	726	871	807	35.64
1985	765	1,022	697	37.46
1986	823	1,244	942	28.66
1987	958	699	667[1]	50.83
1988	1179	1,249	801[2]	35.99
1989	1456	1,328	1,490[3]	84.76
1990	-	1,547	2,009[4]	89.50
1991	-	849	1,743[5]	46.52
1992	-	860	1,457[6]	38.68

[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).

Table 2.7.2 North Sea Herring.

```
Prediction of SSB from LPE Acoustics IYFS  Total North Sea
3 15 2
'YEAR' 'VPA' 'LPE' 'ACOUST' 'IYFS'
1978     56    108     -11      -11
1979     98    224     -11      -11
1980    123    365     -11      -11
1981    186    636     305     5.94
1982    272    480     402    12.55
1983    423    635     442    14.07
1984    717    871     807    35.64
1985    751   1022     697    37.46
1986    813   1244     942    28.66
1987    952    699     667    50.83
1988   1174   1249     801    35.99
1989   1422   1328    1490    84.76
1990    -11   1547    2009    89.50
1991    -11    889    1743    46.52
1992    -11    860    1457    38.68
```

Table 2.7.2 Continued

Analysis by RCT3 ver3.1 of data from file :

hgrct3.txt

Prediction of SSB from LPE Acoustics IYFS Total North Sea

Data for 3 surveys over 15 years : 1978 - 1992

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 = 1990

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights	net weight
	I-----------Regression---------I					I-----------Prediction--------I				
LPE	1.51	-3.73	.43	.870	12	7.34	7.38	.527	.179	.141
ACOUST	1.51	-3.39	.30	.857	9	7.61	8.13	.448	.247	(not used)
IYFS	.92	3.39	.22	.916	9	4.51	7.53	.294	.574	.454
acoust	1.00	0.05				7.61	7.56	.311		.405
					VPA Mean =		5.95	1.070	.000	

Yearclass = 1991

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights	net weight
	I-----------Regression---------I					I-----------Prediction--------I				
LPE	1.51	-3.73	.43	.870	12	6.79	6.55	.501	.171	.141
ACOUST	1.51	-3.39	.30	.857	9	7.46	7.92	.427	.235	(not used)
IYFS	.92	3.39	.22	.916	9	3.86	6.94	.268	.595	.493
acoust	1.00	0.05				7.46	7.42	.311		.366
					VPA Mean =		5.95	1.070	.000	

Yearclass = 1992

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights	net weight
	I-----------Regression---------I					I-----------Prediction--------I				
LPE	1.51	-3.73	.43	.870	12	6.76	6.50	.500	.164	.140
ACOUST	1.51	-3.39	.30	.857	9	7.28	7.65	.404	.251	(not used)
IYFS	.92	3.39	.22	.916	9	3.68	6.77	.265	.586	.497
acoust	1.00	0.05				7.28	7.24	.311		.363
					VPA Mean =		5.95	1.070	.000	

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1990	2105	7.65	.22	.20	.80		
1991	1212	7.10	.21	.34	2.63		
1992	1038	6.95	.20	.30	2.13		

Net weighted average predictions		
	1990	1845
	1991	1165
	1992	995

Table 2.7.3 North Sea Herring.

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: REIDAR30)

At 31-Mar-93 13:06

Traditional vpa Terminal populations from weighted Separable populations

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

YEAR,	1970,	1971,	1972,
AGE			
0,	89810,	68400,	75040,
1,	119620,	437850,	334060,
2,	200280,	114680,	144050,
3,	88360,	66250,	34380,
4,	12520,	20830,	13060,
5,	5030,	2690,	3290,
6,	6100,	3050,	500,
7,	790,	2680,	20,
8,	1200,	10,	110,
+gp,	1220,	1240,	40,
TOTALNUM,	524930,	717680,	604550,
TONSLAND,	563100,	520100,	497500,
SOPCOF %,	104,	93,	109,

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

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
0,	28940,	99610,	26380,	23820,	25680,	13000,	54200,	126270,	951970,	1195670,
1,	236800,	84610,	246050,	12660,	14430,	16860,	15920,	24510,	87200,	111640,
2,	134420,	77260,	54170,	90150,	4470,	490,	3410,	13400,	28430,	29940,
3,	65920,	36200,	25960,	11730,	18640,	570,	1000,	9180,	5690,	23010,
4,	15020,	12600,	14050,	5200,	1080,	500,	1010,	3220,	3950,	3370,
5,	5930,	5610,	5720,	3450,	700,	30,	210,	2170,	2850,	1440,
6,	3060,	2230,	1610,	610,	410,	20,	20,	230,	2270,	680,
7,	370,	500,	910,	440,	150,	20,	80,	140,	1870,	780,
8,	140,	200,	340,	100,	70,	20,	60,	40,	550,	360,
+gp,	60,	110,	140,	40,	0,	30,	10,	10,	110,	110,
TOTALNUM,	490660,	318930,	375330,	148200,	65630,	31540,	75920,	179170,	1084889,	1366999,
TONSLAND,	484000,	275100,	312800,	174800,	46000,	11000,	25100,	70764,	174879,	275079,
SOPCOF %,	104,	103,	107,	105,	83,	82,	99,	91,	99,	102,

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: REIDAR30)

At 31-Mar-93n 13:06

Traditional vpa Terminal populations from weighted Separable populations

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

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
0,	1329690,	666190,	417890,	366400,	803550,	312290,	298400,	124600,	230660,	1000570,
1,	244860,	173720,	322820,	472320,	667530,	776280,	307100,	285500,	206710,	223100,
2,	57380,	109500,	131620,	124610,	212370,	224750,	158300,	87700,	110160,	124470,
3,	21640,	42170,	117340,	82710,	68710,	118510,	138358,	76330,	55350,	43860,
4,	10510,	19250,	36570,	45830,	48150,	39810,	82812,	84910,	54890,	36120,
5,	2620,	7750,	12360,	12770,	24880,	26060,	21834,	37590,	49390,	35750,
6,	2280,	2160,	4330,	6110,	7570,	12860,	12940,	8010,	20160,	37240,
7,	1280,	2410,	2000,	2020,	2370,	3790,	6327,	5440,	3880,	15020,
8,	1100,	1060,	1300,	1340,	790,	1510,	2073,	2840,	2500,	3840,
+gp,	1210,	1780,	1600,	1460,	800,	840,	865,	1180,	1260,	2350,
TOTALNUM,	1672571,	1025989,	1047831,	1115570,	1836718,	1516699,	1029009,	714100,	734960,	1522321,
TONSLAND,	387202,	409489,	609108,	660553,	773411,	875923,	768886,	619963,	635929,	694206,
SOPCOF %,	93,	95,	96,	88,	96,	84,	94,	94,	97,	99,

Table 2.7.4 North Sea Herring.

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: REIDAR30)

At 31-Mar-93n 13:06

Traditional vpa Terminal populations from weighted Separable populations

Table 2 Catch weights at age (kg)

YEAR,	1970,	1971,	1972,
AGE			
0,	.0150,	.0150,	.0150,
1,	.0500,	.0500,	.0500,
2,	.1260,	.1260,	.1260,
3,	.1760,	.1760,	.1760,
4,	.2110,	.2110,	.2110,
5,	.2430,	.2430,	.2430,
6,	.2510,	.2510,	.2510,
7,	.2670,	.2670,	.2670,
8,	.2710,	.2710,	.2710,
+gp,	.2710,	.2710,	.2710,
SOPCOFAC,	1.0356,	.9305,	1.0873,

Table 2 Catch weights at age (kg)

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
0,	.0150,	.0150,	.0150,	.0150,	.0150,	.0150,	.0150,	.0150,	.0070,	.0100,
1,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0500,	.0490,	.0590,
2,	.1260,	.1260,	.1260,	.1260,	.1260,	.1260,	.1260,	.1260,	.1180,	.1180,
3,	.1760,	.1760,	.1760,	.1760,	.1760,	.1760,	.1760,	.1760,	.1420,	.1490,
4,	.2110,	.2110,	.2110,	.2110,	.2110,	.2110,	.2110,	.2110,	.1890,	.1790,
5,	.2430,	.2430,	.2430,	.2430,	.2430,	.2430,	.2430,	.2430,	.2110,	.2170,
6,	.2510,	.2510,	.2510,	.2510,	.2510,	.2510,	.2510,	.2510,	.2220,	.2380,
7,	.2670,	.2670,	.2670,	.2670,	.2670,	.2670,	.2670,	.2670,	.2670,	.2650,
8,	.2710,	.2710,	.2710,	.2710,	.2710,	.2710,	.2710,	.2710,	.2710,	.2740,
+gp,	.2710,	.2710,	.2710,	.2710,	.2710,	.2710,	.2710,	.2710,	.2710,	.2750,
SOPCOFAC,	1.0444,	1.0331,	1.0703,	1.0494,	.8348,	.8229,	.9944,	.9144,	.9920,	1.0219,

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: REIDAR30)

At 31-Mar-93n 13:06

Traditional vpa Terminal populations from weighted Separable populations

Table 2 Catch weights at age (kg)

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
0,	.0100,	.0100,	.0090,	.0060,	.0110,	.0110,	.0170,	.0190,	.0170,	.0100,
1,	.0590,	.0590,	.0360,	.0670,	.0350,	.0550,	.0430,	.0550,	.0580,	.0530,
2,	.1180,	.1180,	.1280,	.1210,	.0990,	.1110,	.1150,	.1140,	.1300,	.1020,
3,	.1490,	.1490,	.1640,	.1530,	.1500,	.1450,	.1530,	.1490,	.1660,	.1750,
4,	.1790,	.1790,	.1940,	.1820,	.1800,	.1740,	.1730,	.1770,	.1840,	.1890,
5,	.2170,	.2170,	.2110,	.2080,	.2110,	.1970,	.2080,	.1930,	.2030,	.2070,
6,	.2380,	.2380,	.2200,	.2210,	.2340,	.2160,	.2310,	.2290,	.2170,	.2230,
7,	.2650,	.2650,	.2580,	.2380,	.2580,	.2370,	.2470,	.2360,	.2350,	.2370,
8,	.2740,	.2740,	.2700,	.2520,	.2770,	.2530,	.2650,	.2500,	.2590,	.2490,
+gp,	.2750,	.2750,	.2920,	.2620,	.2990,	.2630,	.2590,	.2870,	.2710,	.2870,
SOPCOFAC,	.9284,	.9484,	.9598,	.8793,	.9633,	.8374,	.9394,	.9409,	.9662,	.9928,

Table 2.7.5 North Sea Herring.

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: REIDAR30)

At 31-Mar-93n 13:06

Traditional vpa Terminal populations from weighted Separable populations

Table 3 Stock weights at age (kg)

YEAR,	1970,	1971,	1972,
AGE			
0,	.0150,	.0150,	.0150,
1,	.0500,	.0500,	.0500,
2,	.1550,	.1550,	.1550,
3,	.1870,	.1870,	.1870,
4,	.2230,	.2230,	.2230,
5,	.2390,	.2390,	.2390,
6,	.2760,	.2760,	.2760,
7,	.2990,	.2990,	.2990,
8,	.3060,	.3060,	.3060,
+gp,	.3120,	.3120,	.3120,

Table 3 Stock weights at age (kg)

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
0,	.0150,	.0150,	.0150,	.0150,	.0150,	.0150,	.0150,	.0150,	.0150,	.0150,
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: REIDAR30)

At 31-Mar-93n 13:06

Traditional vpa Terminal populations from weighted Separable populations

Table 3 Stock weights at age (kg)

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
0,	.0150,	.0150,	.0090,	.0060,	.0060,	.0070,	.0120,	.0160,	.0170,	.0080,
1,	.0500,	.0500,	.0640,	.0780,	.0490,	.0430,	.0510,	.0640,	.0650,	.0780,
2,	.1550,	.1550,	.1410,	.1460,	.1330,	.1220,	.1400,	.1450,	.1580,	.1420,
3,	.1870,	.1870,	.1930,	.1900,	.1830,	.1630,	.1780,	.1860,	.1980,	.2090,
4,	.2230,	.2230,	.2280,	.2240,	.2200,	.2150,	.2110,	.2080,	.2240,	.2190,
5,	.2390,	.2390,	.2480,	.2480,	.2470,	.2390,	.2540,	.2320,	.2360,	.2430,
6,	.2760,	.2760,	.2580,	.2810,	.2630,	.2700,	.2830,	.2570,	.2600,	.2550,
7,	.2990,	.2990,	.3000,	.2870,	.2850,	.2770,	.2880,	.2820,	.2750,	.2720,
8,	.3060,	.3060,	.3180,	.3280,	.3100,	.2970,	.3160,	.2780,	.2980,	.3120,
+gp,	.3120,	.3120,	.3160,	.3640,	.3420,	.3100,	.3630,	.3180,	.3170,	.3110,

Table 2.7.6 North Sea Herring.

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: REIDAR30)

At 31-Mar-93n 13:06

Traditional vpa Terminal populations from weighted Separable populations

Table 5 Proportion mature at age

YEAR,	1970,	1971,	1972,
AGE			
0,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,
2,	1.0000,	1.0000,	.8200,
3,	1.0000,	1.0000,	1.0000,
4,	1.0000,	1.0000,	1.0000,
5,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
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: REIDAR30)

At 31-Mar-93n 13:06

Traditional vpa Terminal populations from weighted Separable populations

Table 5 Proportion mature at age

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.8200,	.8200,	.7000,	.7500,	.6300,	.6600,	.7900,	.7300,	.6400,	.5100,
3,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9000,	.9400,	.9700,	.9700,	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,

Table 2.7.7 North Sea Herring.

Title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: REIDAR30)

At 31-Mar-93n 13:05

Separable analysis
from 1970 to 1992 on ages 0 to 8
with Terminal F of .410 on age 4 and Terminal S of 1.050

Initial sum of squared residuals was 237.559 and
final sum of squared residuals is 102.047 after 54 iterations

Matrix of Residuals

Years, Ages	1970/71,	1971/72,
0/ 1,	-1.626,	-2.286,
1/ 2,	-1.409,	-1.023,
2/ 3,	.094,	-.475,
3/ 4,	.569,	.120,
4/ 5,	.423,	.091,
5/ 6,	-.677,	-.143,
6/ 7,	-.335,	3.215,
7/ 8,	3.331,	1.524,
,	.000,	.001,
WTS ,	.001,	.001,

Years, Ages	1972/73,	1973/74,	1974/75,	1975/76,	1976/77,	1977/78,	1978/79,	1979/80,	1980/81,	1981/82,
0/ 1,	-.739,	-1.185,	-.690,	.437,	-.049,	-1.733,	.177,	1.881,	.947,	1.814,
1/ 2,	.087,	-.359,	-.730,	-.903,	-1.118,	-.150,	.967,	.233,	-.672,	-.413,
2/ 3,	.393,	.276,	.347,	.064,	-.133,	-1.008,	-.904,	-.492,	.771,	-.824,
3/ 4,	.599,	.773,	.321,	.246,	.806,	.772,	-.525,	-.451,	.959,	-.296,
4/ 5,	.373,	-.125,	-.066,	-.258,	.123,	.501,	.786,	-.179,	.087,	.023,
5/ 6,	-.399,	-.194,	.334,	.505,	.172,	.397,	.268,	.441,	-.135,	.386,
6/ 7,	-.162,	.654,	.005,	-.401,	-.525,	-.135,	-1.538,	-1.424,	-2.190,	.017,
7/ 8,	-2.296,	-.418,	-.398,	.635,	.049,	-.979,	-1.118,	1.339,	-1.341,	.730,
,	.002,	.000,	.001,	.003,	.011,	.034,	.047,	.032,	.022,	.020,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years, Ages	1982/83,	1983/84,	1984/85,	1985/86,	1986/87,	1987/88,	1988/89,	1989/90,	1990/91,	1991/92,	
0/ 1,	1.967,	2.315,	1.079,	-.157,	-.472,	.121,	.070,	-.066,	-.396,	.246,	-.023,
1/ 2,	-.043,	-.035,	-.515,	-.273,	-.241,	.001,	.472,	-.014,	-.056,	-.394,	.002,
2/ 3,	.057,	-.091,	-.423,	-.317,	-.003,	-.061,	-.190,	-.093,	-.106,	.461,	.008,
3/ 4,	.727,	-.076,	-.018,	.355,	.139,	.097,	-.118,	-.127,	-.025,	.176,	.008,
4/ 5,	.047,	-.045,	.118,	.290,	.038,	-.007,	-.048,	.007,	.030,	.022,	.007,
5/ 6,	-.721,	-.213,	.201,	-.117,	-.108,	-.019,	-.007,	.161,	.054,	-.181,	.007,
6/ 7,	-.900,	-.466,	-.304,	-.058,	.316,	.013,	.002,	.021,	.150,	-.174,	.008,
7/ 8,	-.485,	-.097,	.358,	-.292,	.433,	-.102,	.023,	.086,	.331,	-.331,	.007,
,	.016,	.013,	.010,	.009,	.008,	.007,	.006,	.004,	.002,	.000,	-3.565,
WTS ,	.001,	.001,	.001,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,	

Fishing Mortalities (F)

	1970,	1971,	1972,							
F-values	1.1004,	1.2557,	.6388,							
	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
F-values	1.0176,	1.0018,	1.5883,	1.6436,	1.1829,	.1194,	.1343,	.3256,	.5121,	.3136,
	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
F-values	.3907,	.4518,	.5903,	.5210,	.5391,	.5362,	.5124,	.4009,	.3841,	.4100,

Selection-at-age (S)

	0,	1,	2,	3,	4,	5,	6,	7,	8,
S-values	.2015,	.7528,	.7840,	.8215,	1.0000,	1.0301,	1.0036,	.9597,	1.0500,

Table 2.7.8 North Sea Herring.

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: REIDAR30)

At 31-Mar-93n 13:06

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR,	1970,	1971,	1972,
AGE			
0,	.0351,	.0340,	.0583,
1,	.2681,	.6023,	.5787,
2,	.9726,	.8829,	.8126,
3,	1.2655,	1.2138,	.8020,
4,	1.3310,	1.2218,	.7979,
5,	.8657,	1.0863,	.5448,
6,	1.0164,	2.4321,	.5194,
7,	3.1866,	1.9008,	.0797,
8,	1.1412,	.4020,	.3030,
+gp,	1.1412,	.4020,	.3030,
FBAR 2- 6,	1.0902,	1.3674,	.6953,

Table 8 Fishing mortality (F) at age

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
0,	.0467,	.0749,	.1693,	.1546,	.0974,	.0458,	.0836,	.1255,	.4812,	.3337,
1,	.6734,	.4578,	.6882,	.2727,	.3171,	.1998,	.1679,	.1130,	.2848,	.2245,
2,	1.0240,	1.0268,	1.3573,	1.3404,	.2532,	.0262,	.0946,	.3675,	.3235,	.2598,
3,	1.3358,	.9778,	1.4947,	1.6561,	1.4172,	.0487,	.0722,	.4186,	.2793,	.5068,
4,	.9897,	.9985,	1.3962,	1.6832,	.6230,	.1050,	.1086,	.3283,	.3029,	.2518,
5,	.9467,	1.1929,	1.9253,	1.7309,	1.0645,	.0270,	.0528,	.3172,	.4774,	.1540,
6,	1.3461,	1.0638,	1.3013,	1.1844,	.9513,	.0624,	.0204,	.0678,	.5633,	.1764,
7,	.8111,	.7253,	1.8994,	1.6380,	.9614,	.0902,	.3339,	.1734,	.9837,	.3394,
8,	1.0128,	1.3617,	1.5861,	1.1833,	1.3113,	.2736,	.3745,	.2475,	1.6740,	.4429,
+gp,	1.0128,	1.3617,	1.5861,	1.1833,	1.3113,	.2736,	.3745,	.2475,	1.6740,	.4429,
FBAR 2- 6,	1.1284,	1.0520,	1.4949,	1.5190,	.8619,	.0539,	.0697,	.2999,	.3893,	.2698,

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: REIDAR30)

At 31-Mar-93n 13:06

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
0,	.3949,	.2133,	.0819,	.0590,	.1532,	.1135,	.1061,	.0474,	.0901,	.0823,
1,	.2510,	.1921,	.3699,	.2978,	.3483,	.5471,	.3776,	.3363,	.2424,	.2799,
2,	.3013,	.2972,	.3873,	.4313,	.3781,	.3350,	.3651,	.3101,	.3746,	.4031,
3,	.3232,	.4045,	.6456,	.4830,	.4839,	.4017,	.3796,	.3208,	.3506,	.2664,
4,	.4344,	.5031,	.7001,	.5357,	.5482,	.5463,	.5155,	.4013,	.3815,	.3851,
5,	.2823,	.5849,	.6226,	.4975,	.5536,	.5738,	.5806,	.4134,	.3820,	.4068,
6,	.3437,	.3524,	.6742,	.6384,	.5484,	.5490,	.5540,	.3851,	.3618,	.4899,
7,	.5113,	.6498,	.5650,	.6856,	.4837,	.5180,	.5073,	.4220,	.2900,	.4443,
8,	.9847,	.9385,	.7874,	.8236,	.5554,	.5757,	.5280,	.3976,	.3105,	.4580,
+gp,	.9847,	.9385,	.7874,	.8236,	.5554,	.5757,	.5280,	.3976,	.3105,	.4580,
FBAR 2- 6,	.3370,	.4284,	.6060,	.5172,	.5024,	.4811,	.4790,	.3662,	.3701,	.3903,

Table 2.7.9

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: REIDAR30)

At 13-Apr-93ÿ 11:05

Traditional vpa Terminal populations from weighted Separable populations

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1970,	1971,	1972,
AGE			
0,	410668,	322894,	208711,
1,	78730,	145864,	114816,
2,	36403,	22152,	29382,
3,	13305,	10197,	6787,
4,	1769,	3073,	2480,
5,	906,	423,	819,
6,	996,	345,	129,
7,	85,	326,	27,
8,	184,	3,	44,
+gp,	187,	392,	16,
TOTAL,	543232,	505669,	363212,

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
0,	100011,	216930,	26424,	25978,	43407,	45732,	106236,	167618,	379258,	648815,
1,	72433,	35114,	74042,	8207,	8188,	14486,	16070,	35949,	54390,	86229,
2,	23681,	13589,	8172,	13686,	2298,	2194,	4364,	4998,	11812,	15050,
3,	9658,	6301,	3606,	1558,	2654,	1322,	1583,	2941,	2564,	6332,
4,	2492,	2079,	1940,	662,	244,	527,	1031,	1206,	1584,	1588,
5,	1010,	838,	693,	435,	111,	118,	429,	837,	786,	1059,
6,	430,	355,	230,	91,	70,	35,	104,	368,	551,	441,
7,	70,	101,	111,	57,	25,	24,	30,	92,	311,	284,
8,	23,	28,	44,	15,	10,	9,	20,	19,	70,	105,
+gp,	10,	15,	18,	6,	0,	13,	3,	5,	14,	32,
TOTAL,	209819,	275350,	115281,	50695,	57007,	64459,	129870,	214033,	451340,	759936,

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: REIDAR30)

At 13-Apr-93ÿ 11:05

Traditional vpa Terminal populations from weighted Separable populations

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE											
0,	624473,	539280,	835482,	1006391,	883572,	456224,	465057,	424472,	420320,	1990635,	0,
1,	170962,	154781,	160288,	283199,	349008,	278865,	149829,	153869,	148930,	141302,	674474,
2,	25343,	48932,	46988,	40734,	77353,	90628,	59358,	37785,	40438,	42994,	39291,
3,	8599,	13891,	26929,	23631,	19605,	39264,	48026,	30522,	20529,	20598,	21284,
4,	3123,	5096,	7589,	11560,	11936,	9894,	21512,	26901,	18131,	11837,	12920,
5,	1117,	1830,	2788,	3410,	6122,	6242,	5184,	11625,	16294,	11203,	7287,
6,	821,	762,	923,	1354,	1876,	3184,	3182,	2625,	6957,	10062,	6749,
7,	335,	527,	485,	425,	647,	981,	1664,	1655,	1616,	4383,	5578,
8,	183,	182,	249,	249,	194,	361,	529,	907,	982,	1094,	2543,
+gp,	201,	305,	307,	272,	196,	201,	221,	377,	495,	670,	1009,
TOTAL,	835157,	765585,	1082028,	1371225,	1350507,	885845,	754562,	690737,	674692,	2234779,	771135,

Table 2.7.10 North Sea Herring.

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: REIDAR30)

At 31-Mar-93n 13:06

Traditional vpa Terminal populations from weighted Separable populations

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1970,	1971,	1972,
AGE			
0,	0,	0,	0,
1,	0,	0,	0,
2,	[illegible]0532,	155435,	177214,
3,	93202,	73948,	64858,
4,	15123,	28264,	30303,
5,	11339,	4565,	12713,
6,	13014,	1745,	2354,
7,	280,	2553,	727,
8,	2445,	69,	1031,
+gp,	2535,	8745,	382,
TOTSPBIO,	378470,	275324,	289581,

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	123960,	71002,	34219,	57957,	20165,	22408,	42579,	40618,	98865,	131463,
3,	64547,	53518,	21662,	8402,	16793,	20924,	24670,	36338,	34775,	73742,
4,	26776,	22212,	15878,	4471,	3345,	10237,	19989,	20184,	26974,	27969,
5,	11977,	8423,	4265,	3046,	1219,	2594,	9256,	15121,	12756,	21350,
6,	4504,	4490,	2483,	1068,	950,	860,	2650,	9083,	9757,	10117,
7,	1129,	1742,	868,	529,	372,	641,	660,	2297,	4504,	6327,
8,	333,	321,	439,	194,	118,	209,	448,	464,	654,	2241,
+gp,	145,	180,	184,	79,	0,	319,	76,	118,	133,	698,
TOTSPBIO,	233370,	161887,	79999,	75745,	42964,	58192,	100328,	124223,	188419,	273906,

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: REIDAR30)

At 31-Mar-93n 13:06

Traditional vpa Terminal populations from weighted Separable populations

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	215299,	416832,	292625,	273268,	411498,	476861,	420428,	265766,	260221,	194389,
3,	113248,	173245,	294931,	284115,	226899,	384904,	544979,	388457,	272645,	314959,
4,	48682,	75863,	101227,	169136,	170086,	137960,	300524,	399897,	294150,	187298,
5,	20659,	27642,	42607,	56661,	97587,	94993,	83461,	191193,	278414,	193849,
6,	16843,	15530,	14169,	23190,	31950,	55662,	58106,	48739,	132735,	172815,
7,	6642,	9537,	9312,	7212,	12467,	17957,	31906,	32890,	34219,	82795,
8,	2708,	2771,	4370,	4403,	3875,	6814,	10968,	18060,	22222,	23488,
+gp,	3037,	4744,	5345,	5324,	4329,	3957,	5261,	8583,	11914,	14328,
TOTSPBIO,	427117,	726163,	764586,	823309,	958693,	1179108,	1455634,	1353585,	1306521,	1183922,

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	4,325	133.9
1982	0.276	4,272	91.8
1983	0.255	4,087	115
1984	0.439	12,432	181.3
1985	0.267	9,318	177.4
1986	0.636	17,736	270.9
1987	0.300	4,495	168.9
1988	0.177	2,723	71.4
1989	0.134	1,996	25.9
1990	0.199	2,814	69.9
1991	0.432		200.7
1992	-		202.4

Regressions:

Number of 1-ringers in Div.IIIA (millions) = 64.8 * MIK - 2043 (r-square = 0.81)

Proportion of 1-ringers in Div.IIIA = 0.00186 * MIK + 0.051 (r-square = 0.84)

Regressions through origin:

Number of 1-ringers in Div.IIIA (millions) = 52.5 * MIK (r-square = 0.77)

Proportion of 1-ringers in Div.IIIA = 0.00216 * MIK (r-square = 0.81)

Table 2.8.2 Input data for the projection.

NSHER93.XLS

NORTH SEA HERRING STOCK SIZE 1. JANUARY 1993						
AGE	TOTAL NUMBER	IV NUMBER	IIIa NUMBER	TOTAL BIOMASS	SP STOCK NUMBER	SP STOCK BIOMASS
0	85100.0	46805.0	38295.0	680.8	0.0	0.0
1	29350.0	16729.5	12620.5	2289.3	0.0	0.0
2	2517.0	2517.0	2517.0	357.4	839.0	119.1
3	2128.4	2128.4	0.0	444.8	1464.3	306.0
4	1292.0	1292.0	0.0	282.9	904.5	198.1
5	728.7	728.7	0.0	177.1	505.7	122.9
6	674.9	674.9	0.0	172.1	471.9	120.3
7	557.8	557.8	0.0	151.7	394.8	107.4
8	254.3	254.3	0.0	79.3	175.4	54.7
9+	100.9	100.9	0.0	31.4	69.6	21.6
TOTAL	122704.0	71788.5	53432.5	4666.9	4825.1	1050.2

NSHER93.XLS

NORTH SEA HERRING. MEAN WEIGHT AT AGE IN THE CATCH BY FLEET					
AGE	A	B	C	D	E
0	18	9.2	29.7	12.5	11.9
1	80.9	50.8	69.5	25.7	53.7
2	125.8	62.5	115	67.1	82.9
3	177	135.4	164		
4	189.1	163.6	171.7		
5	207.2	186.2	184.7		
6	222.7	184.7	197.5		
7	237.2	212.5	202.7		
8	249.2	247.1	210.4		
9+	286.7	242	241.4		

NSHER93.XLS

MEAN WEIGHT AT AGE IN THE STOCK			MATUR. OGIVE
AGE	SPAW.	1. JAN.	
0	8	8	0
1	78	78	0
2	142	142	0.51
3	209	209	1
4	219	219	1
5	243	243	1
6	255	255	1
7	272	272	1
8	312	312	1
9+	311	311	1

Table 2.8.3 Predicted catch and spawning biomass of North Sea autumn spawning herring.

Option 1. **F – 1993 by fleet and area equal to 1992 values.**

1993					
Fleet	A	B	C	D	E
Relative F	1	1	1	1	1
Yield '000 t.	412	110	68	42	351
SSB '000 t.	1050		Avg. F 2–6		0.400

North Sea	1994				
	Fleet A yield in '000 t.				
Relative F Fleet B	Relative F fleet A.				
	1.2	1.0	0.8	0.75 (F=0.3)	0.5
1.2	455	391	323	306	211
0.2	462	397	327	324	215
	Fleet B yield in '000 t.				
Relative F Fleet A	Relative F		Fleet B.		
	1.2	1.0	0.8	0.5	0.2
1.2	147	124	108	64	26
0.5	149	125	108	65	27

Div. IIIa	1994					
	Fleet C, D and E yield '000 t.					
	Relative F			Yield '000 t.		
Fleet	C	D	E	C	D	E
Constant F	1	1	1	71	36	335
Catch 1994 = 1992	0.42	0.41	0.15	47	23	83

	SSB and Average F (age 2 - 6) in 1994.					SSB '000 t.	Average F 2-6
Fleet	A	B	C	D	E		
Relative F	1	1	1	1	1	965	0.39
	1.2	0.2	1	1	1	919	0.45
	1.2	1.2	1	1	1	931	0.46
	0.8	0.8	1	1	1	1001	0.31
	0.75	1	1	1	1	1024	0.3
	0.75	0.2	1	1	1	1035	0.29
	1	1	0.42	0.41	0.15	974	0.38

cont'd.

Table 2.8.3 cont'd.

Option 2. **F – 1993 for fleet A and B equal to 1992 values. Catch by fleet C, D and E equal to the catch by fleet in 1992**

1993					
Fleet	A	B	C	D	E
Relative F	1	1	0.42	0.36	0.14
Yield '000 t.	413	110	47	23	83
SSB '000 t.	1055		Avg. F 2–6		0.389

North Sea	**1994**				
	Fleet A yield in '000 t.				
Relative F Fleet B	Fleet A relative F				
	1.2	1.0	0.8	0.75 (F=0.3)	0.5
1.2	518	444	366	345	239
0.2	527	452	372	351	243
	Fleet B yield in '000 t.				
Relative F Fleet A	Fleet B relative F				
	1.2	1.0	0.8	0.5	0.2
1.2	165	139	113	72	29
0.5	168	142	115	73	30

Div. IIIa	**1994**					
	Fleet C, D and E yield '000 t.					
	Relative F			Yield '000 t.		
fleet	C	D	E	C	D	E
Constant F	1	1	1	82	38	356
Catch 1994 = 1992	0.37	0.39	0.14	47	23	83

	SSB and Average F (age 2 - 6) in 1994.					SSB '000 t.	Average F 2–6
Fleet	A	B	C	D	E		
Relative F	1	1	1	1	1	1115	0.39
	1.2	0.2	1	1	1	1063	0.46
	1.2	1.2	1	1	1	1084	0.45
	0.8	0.8	1	1	1	1160	0.32
	0.75	1.0	1	1	1	1178	0.30
	0.75	0.2	1	1	1	1196	0.29
	1	1	0.37	0.39	0.14	1129	0.38

cont'd.

Table 2.8.3 cont'd.

Option 3. **Catch of fleet A and equal to the TAC of 430,000 t. F of fleet B equal to F in 1992. Catches by fleet C, D and E equal to the catch by fleet in 1992.**

1993					
Fleet	A	B	C	D	E
Relative F	1.05	1	0.42	0.36	0.14
Yield '000 t.	430	110	47	23	83
SSB '000 t.	1042		Avg. F 2–6		0.408

North Sea	1994				
	Fleet A yield in '000 t.				
Relative F	Fleet A relative F				
Fleet B	1.2	1.0	0.8	0.75 (F=0.3)	0.5
1.2	511	438	361	340	236
0.2	520	446	367	347	240
	Fleet B yield in '000 t.				
Relative F	Fleet B relative F				
Fleet A	1.2	1.0	0.8	0.5	0.2
1.2	165	139	113	72	29
0.5	168	141	115	73	30

Div. IIIa	1994					
	Fleet C, D and E yield '000t.					
	Relative F			Yield '000 t.		
Fleet	C	D	E	C	D	E
Constant F	1	1	1	82	38	355
Catch 1994 = 1992	0.37	0.39	0.14	47	23	83

SSB and Average F (age 2 - 6) in 1994.						SSB '000 t.	Average F 2–6
Fleet	A	B	C	D	E		
Relative F	1	1	1	1	1	1101	0.39
	1.2	0.2	1	1	1	1050	0.46
	1.2	1.2	1	1	1	1071	0.45
	0.8	0.8	1	1	1	1146	0.32
	0.75	1.0	1	1	1	1163	0.30
	0.75	0.2	1	1	1	1181	0.29
	1	1	0.37	0.39	0.14	1115	0.38

Table 2.10.1 Herring total North Sea, 1992. Numbers (millions) and weights (g) at age (winter rings) and year class of herring caught in each quarter. Spring spawners transferred to Division IIIa, and North Sea autumn spawners caught in Division IIIa are not included.

Catch in 1992: Total North Sea

Quarter		0	1	2	3	4	5	6	7	8	9	Total	SOP
		1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	numbers)	('000 t)
I	No	0.0	12.4	281.8	68.7	62.3	69.2	61.6	14.1	4.9	1.6	576.7	60.7
	W	0	34	56	135	149	165	172	189	200	199		
II	No	197.4	106.7	170.0	84.2	67.2	51.4	46.4	22.1	6.2	1.8	753.5	80.5
	W	8	60	120	179	178	187	203	202	193	242		
III	No	6585.7	394.8	141.9	132.9	107.0	137.8	159.6	59.6	18.3	12.4	7750.0	239.2
	W	8	52	127	198	214	234	252	274	286	330		
IV	No	815.1	129.5	367.1	125.9	98.0	83.1	92.5	48.9	8.3	7.5	1775.9	161.3
	W	18	76	121	171	194	210	216	222	237	246		
Total	No	7598.2	643.4	960.9	411.8	334.6	341.5	360.1	144.7	37.7	23.2	10856.0	541.8
	W	9	58	103	175	189	207	223	237	249	287		

The stock weights displayed 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
	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982
Stock weights		78	142	209	219	243	255	272	312	311

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

	2 immature	2 mature
Mean weight	118	158

Table 2.11.1 North Sea herring: Summary results of ADAPT run assuming linear catchability relationships for all three indices: acoustic LPE and IYFS.

Fishing Mortality Matrix

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	0.0350	0.0339	0.0582	0.0457	0.0741	0.1458	0.1430	0.0955	0.0446	0.0833	0.1252	0.4810	0.3339	0.3951	0.2126	0.0811	0.0576	0.1530	0.1154	0.1157	0.0407	0.0955	0.0793
1	0.2679	0.5999	0.5765	0.6726	0.4462	0.6760	0.2270	0.2883	0.1951	0.1626	0.1129	0.2842	0.2246	0.2506	0.1927	0.3674	0.2946	0.3389	0.5461	0.3859	0.3758	0.2048	0.2999
2	0.9721	0.8802	0.8075	1.0139	1.0233	1.2687	1.2731	0.2005	0.0234	0.0921	0.3535	0.3230	0.2594	0.3016	0.2973	0.3892	0.4274	0.3724	0.3222	0.3645	0.3203	0.4407	0.3210
3	1.2648	1.2125	0.7990	1.3123	0.9517	1.4777	1.2739	1.1837	0.0373	0.0641	0.4032	0.2642	0.5046	0.3226	0.4050	0.6449	0.4850	0.4773	0.3927	0.3594	0.3199	0.3670	0.3359
4	1.3181	1.2202	0.7988	0.9786	0.9444	1.2831	1.5933	0.3293	0.0748	0.0816	0.2850	0.2875	0.2349	0.4327	0.4998	0.7004	0.5337	0.5519	0.5329	0.4976	0.3701	0.3797	0.3980
5	0.8661	1.0512	0.5429	0.9453	1.1585	1.5379	1.2279	0.8830	0.0121	0.0367	0.2253	0.3880	0.1442	0.2579	0.5814	0.6168	0.4980	0.5520	0.5820	0.5579	0.3920	0.3394	0.4046
6	1.0463	2.4212	0.4845	1.3338	1.0615	1.1733	0.5678	0.3857	0.0461	0.0090	0.0463	0.3448	0.1337	0.3171	0.3116	0.6660	0.6263	0.5491	0.5444	0.5684	0.3610	0.3347	0.4106
7	4.0783	2.2252	0.0789	0.7142	0.7082	1.8770	1.1235	0.2338	0.0258	0.2335	0.0725	0.5506	0.1700	0.3538	0.5697	0.4676	0.6693	0.4679	0.5205	0.5007	0.4397	0.2654	0.3961
8	1.8272	1.7295	0.4763	0.9930	0.9681	1.4678	1.1281	0.4580	0.0397	0.0902	0.1573	0.3927	0.1707	0.3404	0.4906	0.6127	0.5818	0.5302	0.5450	0.5312	0.3907	0.3298	0.4023
9	1.8272	1.7295	0.4763	0.9930	0.9681	1.4678	1.1281	0.4580	0.0397	0.0902	0.1573	0.3927	0.1707	0.3404	0.4906	0.6127	0.5818	0.5302	0.5450	0.5312	0.3907	0.3298	0.4023

Population Size Matrix

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	41150384	32378698	20907050	10214668	21962686	3039917	2790415	4427141	4698917	10634672	16786760	37882048	64919016	62332892	54157632	84199928	102946008	88405424	44857628	42737224	49237364	39749956	206356096
1	7874290	14617081	11514135	7256722	3589817	7502832	966553	889711	1480367	1653260	3599443	5448794	8614625	17102172	15446180	16106938	28563314	35752252	27907164	14703341	14003749	17390308	13291209
2	3635679	2216048	2951533	2380005	1362486	845291	1403934	283359	245317	448067	516921	1182755	1508626	2531624	4897074	4686561	4103707	7826292	9371474	5946130	3677241	3537739	5212951
3	1332078	1018843	680830	975145	639687	362784	176079	291178	171775	177538	302720	268902	634332	862259	1387223	2694837	2352501	1982840	3995325	5030410	3059344	1977538	1686665
4	177688	307875	248119	250717	214917	202196	67767	40237	72981	135488	136326	165613	169047	313561	511285	757552	1157722	1185839	1007223	2208717	2875037	1819025	1121706
5	90599	43030	82225	100999	85265	75634	50713	12463	26251	61279	112984	92766	112410	120936	184072	280657	340247	614286	617862	534882	1215098	1796687	1125913
6	97812	34477	13609	43232	35511	24223	4702	13441	4663	23468	53449	81607	56946	88052	84554	93127	137049	187102	320039	312382	277038	742918	1157845
7	8231	31085	2771	7585	10306	11115	6780	7540	8270	4029	21044	46176	52306	45076	58024	56025	43291	66292	97761	168006	160103	174715	481007
8	14803	126	3039	2317	3360	4593	1539	1995	5400	7292	2887	17709	24092	39929	28633	29699	31759	20058	37569	52564	92134	93329	121243
9	15057	15603	1104	995	1847	1889	616	0	8094	1215	721	3553	7357	43941	48024	36519	34645	20361	20929	22016	38181	47039	42734

Continued...../

Table 2.11.1 Continued

Estimated Trajectory of Population Parameters

Year	SSB	SSB sd	F	F sd
1970	375526	0.00	1.8272	0.0000
1971	267987	0.00	1.7295	0.0000
1972	291029	0.00	0.4763	0.0000
1973	237129	0.00	0.9930	0.0000
1974	166306	0.00	0.9681	0.0000
1975	87914	0.00	1.4678	0.0000
1976	88077	0.00	1.1281	0.0000
1977	60488	0.00	0.4580	0.0000
1978	80047	0.00	0.0397	0.0000
1979	121004	0.00	0.0902	0.0000
1980	145311	0.00	0.1573	0.0000
1981	210686	0.00	0.3927	0.0000
1982	293281	0.00	0.1707	0.0000
1983	447944	0.00	0.3404	0.0000
1984	739033	0.00	0.4906	0.0000
1985	769755	0.00	0.6127	0.0000
1986	830291	0.00	0.5818	0.0000
1987	968414	0.00	0.5302	0.0000
1988	1212032	0.00	0.5450	0.0000
1989	1504571	0.00	0.5312	0.0000
1990	1396558	0.00	0.3907	0.0000
1991	1302899	0.00	0.3298	0.0000
1992	1279576	0.00	0.4023	0.0000
1993	1064751	0.00		

No varianmce estimates: Only one iteration run.
Method: ADAPT with 1 bootstrap iteration run.
Reference F is a mean over ages 4 to 7.
Bottom row F is a mean over ages 4 to 7.

Table 2.11.2 North Sea Herring. XSA.

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VPA Version 3.0 (MSDOS)

30-Mar-93ε  18:59

Extended Survivors Analysis

Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: HS9)

CPUE data from file /users/ifad/ifapwork/wg_114/her_ns3a/FLEET.HS9


Data for    3 fleets over   12 years
Age range from    0 to    8


     Fleet,                Alpha,     Beta
ACOU: Acoustic surve    ,  .000    , 1.000
IYFS1: iyfs data (Ca    ,  .000    , 1.000
MIK: MIK data (Catch    ,  .000    , 1.000


Time series weights :

     Tapered time weighting not applied


Catchability analysis :

     Catchability independent of stock size for all ages
     Catchability independent of age for ages >=    7


Terminal population estimation :

     Final estimates shrunk towards mean of the last   5 years and the   5 oldest ages.
     S.E. of the mean to which the estimates  are shrunk =    .500
     Prior weighting not applied

Tuning converged after   67 iterations


Total absolute residual between iterations
66 and  67 =    .000
```

Table 2.11.3

Regression weights

1.000,	1.000,	1.000,	1.000,	1.000,	1.000,	1.000,	1.000,	1.000,	1.000,	1.000,	1.000

Fishing mortalities

Age,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992
0,	.506,	.340,	.386,	.199,	.080,	.051,	.126,	.095,	.102,	.043,	.093,	.132
1,	.295,	.236,	.256,	.183,	.343,	.294,	.298,	.436,	.311,	.326,	.222,	.296
2,	.318,	.255,	.304,	.287,	.345,	.360,	.348,	.253,	.240,	.222,	.335,	.337
3,	.298,	.493,	.315,	.408,	.612,	.405,	.366,	.354,	.259,	.184,	.225,	.227
4,	.204,	.273,	.413,	.482,	.708,	.483,	.412,	.354,	.424,	.236,	.185,	.213
5,	.304,	.096,	.314,	.539,	.578,	.507,	.466,	.364,	.297,	.307,	.188,	.158
6,	.313,	.098,	.193,	.410,	.581,	.558,	.566,	.414,	.275,	.151,	.240,	.189
7,	.515,	.150,	.242,	.287,	.730,	.522,	.386,	.547,	.326,	.159,	.091,	.252
8,	.335,	.155,	.291,	.288,	.221,	1.590,	.351,	.403,	.579,	.213,	.092,	.111

Table 2.11.4

Log catchability residuals.

Fleet : ACOU: Acoustic surve

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	No data for this fleet at this age											
1				-1.47	-1.20	-.92	.87	.33	.92	1.02	.29	.16
2				.14	.00	.24	-.04	-.43	-.26	.03	.16	.15
3				.33	.06	.13	-.32	-.30	.00	.19	-.14	.05
4				.31	-.14	.20	-.25	-.43	.13	.26	-.02	-.07
5				.49	-.24	-.23	.02	-.32	-.01	.50	.12	-.33
6				.33	-.09	-.61	-.05	-.07	-.01	.22	.39	-.10
7				.00	.00	.00	.00	.00	.00	.00	.00	.00

Mean catchability and Standard error.

Age	0	1	2	3	4	5	6	7	8
Mean Q		-8.34	-7.23	-7.27	-7.24	-7.31	-7.42	-7.39	-7.39
S.E		.96	.22	.22	.25	.32	.30	.00	.51

Fleet : IYFS1: iyfs data (Ca

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	-.18	-.35	-.13	.28	.06	.05	.42	.33	-.26	-.12	-.04	-.05
1	-.20	-.58	-1.19	.28	.30	.01	.96	-.30	.03	.38	-.16	.46
2	-.15	-.30	-.31	.17	.30	-.42	.49	-.28	-.08	.28	.12	.18
3	-.21	.04	.35	-.27	.08	-.17	-.15	-.29	.51	.56	-.21	-.25
4	No data for this fleet at this age											
5	No data for this fleet at this age											
6	No data for this fleet at this age											
7	No data for this fleet at this age											

Mean catchability and Standard error.

Age	0	1	2	3	4	5	6	7	8
Mean Q	-11.92	-9.96	-10.03	-10.55					
S.E	.24	.55	.29	.31					

Fleet : MIK: MIK data (Catch

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	.30	.24	-.12	.15	.17	-.17	.37	.56	-.19	-1.18	-.04	-.10
1	No data for this fleet at this age											
2	No data for this fleet at this age											
3	No data for this fleet at this age											
4	No data for this fleet at this age											
5	No data for this fleet at this age											
6	No data for this fleet at this age											
7	No data for this fleet at this age											

Mean catchability and Standard error.

Age	0	1	2	3	4	5	6	7	8
Mean Q	-12.79								
S.E	.44								

Table 2.11.5

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (run name: HS9)

At 30-Mar-93n 18:59

Table 17 Summary (with SOP correct``n)

Extended survivors analysis.

	RECRUITS,	TOTALBIO,	TOTSPBIO,	LANDINGS,	SOPCOFAC,	FBAR 2- 6,
1981,	39504244,	1221902,	228230,	174879,	.9920,	.2874,
1982,	68352728,	1989226,	321657,	275079,	1.0219,	.2431,
1983,	68388128,	2473231,	438169,	387202,	.9284,	.3078,
1984,	60836840,	2909982,	745342,	409489,	.9484,	.4250,
1985,	90069656,	3458198,	828329,	609108,	.9598,	.5650,
1986,	122202016,	4199713,	855052,	660553,	.8793,	.4625,
1987,	111749720,	4744920,	1135535,	773411,	.9633,	.4316,
1988,	56696024,	3992381,	1325174,	875923,	.8374,	.3477,
1989,	50965160,	4688919,	2094253,	768886,	.9394,	.2989,
1990,	48648584,	4794143,	2187650,	619963,	.9409,	.2201,
1991,	42866260,	4986052,	2317399,	635929,	.9662,	.2344,
1992,	133180328,	5389069,	2273221,	694206,	.9928,	.2247,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

Table 3.1.1 **HERRING in Division IIIa, 1985 - 1992.**
Landings in thousands of tonnes.
(Data provided by Working Group members 1992).

Year	1985	1986	1987	1988	1989	1990	1991	1992*
Skagerrak								
Country								
Denmark	88.2	94.0	105.0	144.4	47.4	62.3	58.7	64.7
Faroe Islands	0.5	0.5						
Germany								
Norway (Open Sea)	2.8	0.7		3.0	0.2	4.1	6.5	12.3
Norway (Fjords)	1.7	0.9	1.2	2.7	1.4	1.5	1.6	1.6
Sweden	40.3	43.0	51.2	57.2	47.9	56.5	54.7	88.0
TOTAL	133.4	139.1	157.4	207.3	96.9	124.5	121.5	166.6
Kattegat								
Country								
Denmark	69.2	37.4	46.6	76.2	57.1	32.2	29.7	33.5
Sweden	39.8	35.9	29.8	49.7	37.9	45.2	36.7	26.4
TOTAL	109.1	73.3	76.4	125.8	95.0	77.5	66.4	59.9
TOTAL Div. IIIa	242.5	212.3	233.9	333.1	191.9	201.9	187.8	226.5

* Preliminary

Table 3.1.2 Skagerrak 1992
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	1.75	85.7	65.56	24.4	57.88	25.8	125.19	25.9
2	16.24	115.8	3.91	54.7	2.70	54.7	22.85	98.1
3	12.61	159.7	0.23	110.8	0.20	110.8	13.04	158.1
4	13.41	174.1	0.04	115.0			13.45	173.9
5	9.60	174.7					9.60	174.7
6	3.32	186.9	0.04	166.0			3.36	186.7
7	1.28	202.7					1.28	202.7
8	0.36	205.8					0.36	205.8
9+	0.20	209.4					0.20	209.4
TOTAL	58.77		69.78		60.78		189.33	
Land. (SOP)(t)		9,052		1,850		1,663		12,566
2. QUARTER Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	24.62	47.1	9.64	33.8	150.62	35.4	184.88	36.9
2	28.05	86.1	5.96	79.3	79.14	79.2	113.15	80.9
3	21.41	129.1	0.79	88.3	10.40	88.3	32.60	115.1
4	20.41	135.2	0.57	93.1	7.50	93.1	28.48	123.3
5	8.96	138.5	0.21	131.0	2.80	131.0	11.97	136.6
6	10.66	157.6	0.21	133.2	2.80	133.2	13.67	152.2
7	4.80	173.5	0.14	152.5	1.80	152.5	6.74	167.5
8	0.96	150.2	0.07	166.0	1.80	166	2.83	160.6
9+	0.21	183.5			0.90	166	1.11	169.3
TOTAL	120.08		17.59		257.76		395.43	
Land. (SOP)(t)		13,035		1,010		14,679		28,723
3. QUARTER Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	2.23	34.8	579.42	11.7	539.70	9.7	1121.35	10.8
1	73.77	82.5	1.74	68.5	323.60	70.2	399.11	72.5
2	70.21	117.2			72.37	97.4	142.58	107.2
3	30.18	137.4			11.31	117.3	41.49	131.9
4	37.34	157.7			6.34	124.2	43.68	152.8
5	16.49	184.5			5.02	191.5	21.51	186.1
6	11.55	200.4			0.40	153.8	11.95	198.8
7	2.66	209.4			0.10	160.3	2.76	207.6
8	0.27	257.6					0.27	257.6
9+	0.14	283.3					0.14	283.3
TOTAL	244.84		581.16		958.84		1784.84	
Land. (SOP)(t)		30,451		6,898		38,154		75,503
4. QUARTER Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	12.38	32.6	249.81	14.7	326.79	16.5	588.98	16.1
1	124.01	69.1	2.48	72.3	269.03	62.5	395.52	64.6
2	40.19	94.5	0.51	68.0	15.62	78.1	56.32	89.7
3	19.53	142.9			4.30	89.5	23.83	133.3
4	14.33	166.2			1.50	107.8	15.83	160.7
5	10.71	181.1	0.51	190.0	0.82	167.6	12.04	180.6
6	8.65	207.3			0.10	163.5	8.75	206.8
7	2.31	222.7					2.31	222.7
8	0.40	228.5					0.40	228.5
9+	0.30	241.4					0.30	241.4
TOTAL	232.81		253.31		618.16		1104.28	
Land. (SOP)(t)		22,354		3,983		24,127		50,464
TOTAL YEAR Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	14.61	32.9	829.23	12.6	866.49	12.3	1710.33	12.6
1	224.15	71.2	79.42	28.0	801.13	57.9	1104.70	58.4
2	154.69	105.5	10.38	69.5	169.83	86.5	334.90	94.7
3	83.73	139.9	1.02	93.4	26.21	101.2	110.96	130.3
4	85.49	156.3	0.61	94.5	15.34	107.4	101.44	148.6
5	45.76	172.6	0.72	172.8	8.64	169.6	55.12	172.2
6	34.18	187.5	0.25	138.4	3.30	136.6	37.73	182.7
7	11.05	195.8	0.14	152.5	1.90	152.9	13.09	189.1
8	1.99	190.6	0.07	166.0	1.80	166.0	3.86	178.7
9+	0.85	226.5			0.90	166.0	1.75	195.4
TOTAL	656.50		921.84		1895.54		3473.88	
Land. (SOP)(t)		74,892		13,741		78,622		167,255

Table 3.1.3 Kattegat 1992.
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			183.67	21.9	153.37	31.2	337.04	26.1
2	35.19	77.8	8.97	71.0	12.25	51.8	56.41	71.1
3	16.88	92.8	0.96	123.8	1.00	52.8	18.84	92.3
4	13.10	112.1			0.10	54.0	13.20	111.7
5	6.24	137.6					6.24	137.6
6	4.38	171.4					4.38	171.4
7	1.35	192.6					1.35	192.6
8	0.33	184.3					0.33	184.3
9+	0.16	254.1					0.16	254.1
TOTAL	77.63		193.60		166.72		437.95	
Land. (SOP) (t)		7,744		4,778		5,478		18,000
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0					0.20	10.0	0.20	10.0
1			22.52	29.0	16.82	45.4	39.34	36.0
2	7.19	75.2	6.26	51.6	53.56	64.6	67.01	64.5
3	7.68	85.2	1.73	82.7	24.10	69.6	33.51	73.9
4	10.52	104.9	1.09	104.9	14.00	85.6	25.61	94.3
5	6.64	125.3	0.39	138.7	2.50	96.0	9.53	118.2
6	4.92	144.3	0.10	155.8	1.30	101.3	6.32	135.6
7	1.02	165.6			0.20	98.2	1.22	154.6
8	0.57	173.5					0.57	173.5
9+	0.33	183.4	0.03	155.0			0.36	181.0
TOTAL	38.87		32.12		112.68		183.67	
Land. (SOP) (t)		4,169		1,308		7,493		12,969
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	0.19	11.0	155.19	12.0	331.83	9.9	487.21	10.6
1	27.95	57.4	35.56	38.4	33.38	60.2	96.89	51.4
2	35.85	71.5	2.51	61.7	23.24	82.8	61.60	75.4
3	12.01	87.6			4.45	91.2	16.46	88.6
4	7.88	112.8			0.52	184.0	8.40	117.2
5	2.18	137.4			1.89	213.5	4.07	172.7
6	0.85	179.9					0.85	179.9
7	0.44	210.5					0.44	210.5
8	0.60	240.2					0.60	240.2
9+	0.02	273.0					0.02	273.0
TOTAL	87.97		193.26		395.31		676.54	
Land. (SOP) (t)		6,805		3,383		8,124		18,312
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	3.27	16.3	118.17	12.2	88.33	16.0	209.77	13.9
1	40.23	61.9	0.65	62.1	35.22	43.5	76.10	53.4
2	19.44	85.2	0.21	95.5	2.26	58.8	21.91	82.6
3	6.47	100.7					6.47	100.7
4	5.11	113.1					5.11	113.1
5	1.45	132.9	0.11	120.0			1.56	132.0
6	0.82	154.8					0.82	154.8
7	0.32	83.5					0.32	83.5
8								
9+								
TOTAL	77.11		119.14		125.81		322.06	
Land. (SOP) (t)		5,776		1,515		3,078		10,369
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	3.46	16.0	273.36	12.1	420.36	11.2	697.18	11.6
1	68.18	60.1	242.40	25.1	238.79	38.1	549.37	35.1
2	97.67	76.8	17.95	63.2	91.31	67.4	206.93	71.4
3	43.04	91.2	2.69	97.4	29.55	72.3	75.28	84.0
4	36.61	110.3	1.09	104.9	14.62	88.9	52.32	104.2
5	16.51	132.2	0.50	134.6	4.39	146.6	21.40	135.2
6	10.97	158.7	0.10	155.8	1.30	101.3	12.37	152.6
7	3.13	175.2			0.20	98.2	3.33	170.5
8	1.5	202.6					1.50	202.6
9+	0.51	209.1	0.03	155.0			0.54	206.1
TOTAL	281.58		538.12		800.52		1620.22	
Land. (SOP) (t)		24,493		10,984		24,173		59,650

Table 3.1.4 HERRING Division IIIa in 1992.

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

Quarter	Rings	0	1	2	3	4	5	6	7	8	9+	Landings	SOP
1	Skagerrak		125.19	22.85	13.04	13.45	9.60	3.36	1.28	0.36	0.20	12,583	12,566
	Kattegat		337.04	56.41	18.84	13.20	6.24	4.38	1.35	0.33	0.16	18,385	18,000
	Div. IIIa		462.23	79.26	31.88	26.65	15.84	7.74	2.63	0.69	0.36	30,968	30,566
2	Skagerrak		184.88	113.15	32.60	28.48	11.97	13.67	6.74	2.83	1.11	28,475	28,723
	Kattegat	0.20	39.34	67.01	33.51	25.61	9.53	6.32	1.22	0.57	0.36	12,998	12,969
	Div. IIIa	0.20	224.22	180.16	66.11	54.09	21.50	19.99	7.96	3.40	1.47	41,473	41,692
3	Skagerrak	1121.35	399.11	142.58	41.49	43.68	21.51	11.95	2.76	0.27	0.14	75,372	75,503
	Kattegat	487.21	96.89	61.60	16.46	8.40	4.07	0.85	0.44	0.60	0.02	18,325	18,312
	Div. IIIa	1608.56	496.00	204.18	57.95	52.08	25.58	12.80	3.20	0.87	0.16	93,697	93,815
4	Skagerrak	588.98	395.52	56.32	23.83	15.83	12.04	8.75	2.31	0.40	0.30	50,167	50,464
	Kattegat	209.77	76.10	21.91	6.47	5.11	1.56	0.82	0.32			10,329	10,369
	Div. IIIa	798.75	471.62	78.23	30.30	20.94	13.60	9.57	2.63	0.40	0.30	60,496	60,833
Total	Skagerrak	1710.33	1104.70	334.90	110.96	101.44	55.12	37.73	13.09	3.86	1.75	166,597	167,256
Year	Kattegat	697.18	549.37	206.93	75.28	52.32	21.40	12.37	3.33	1.50	0.54	60,037	59,650
	Div. IIIa	2407.51	1654.07	541.83	186.24	153.76	76.52	50.10	16.42	5.36	2.29	226,634	226,906

Mean weight (g) at age by quarter.

Quarter	Rings	0	1	2	3	4	5	6	7	8	9+
1	Skagerrak		25.9	98.1	158.1	173.9	174.7	186.7	202.7	205.8	209.4
	Kattegat		26.1	71.1	92.3	111.7	137.6	171.4	192.6	184.3	251.1
	Div. IIIa										
2	Skagerrak		36.9	80.9	115.1	123.3	136.6	152.2	167.5	160.6	169.3
	Kattegat	10.0	36.0	64.5	73.9	94.3	118.2	135.6	154.6	173.5	181.0
	Div. IIIa										
3	Skagerrak	10.8	72.5	107.2	131.9	152.8	186.1	198.8	207.6	257.6	283.3
	Kattegat	10.6	51.4	75.4	88.6	117.2	172.7	179.9	210.5	240.2	273.0
	Div. IIIa										
4	Skagerrak	16.1	64.6	89.7	133.3	160.7	180.6	206.8	222.7	228.5	241.4
	Kattegat	13.9	53.4	82.6	100.7	113.1	132.0	154.8	83.5		
	Div. IIIa										
Total	Skagerrak	12.6	58.4	94.8	130.3	148.5	172.2	182.7	189.1	178.6	195.4
Year	Kattegat	11.6	35.1	71.5	84.0	104.2	135.2	152.6	170.6	202.6	205.2
	Div. IIIa	12.3	50.7	85.9	111.6	133.5	161.8	175.3	185.4	185.3	197.7

Table 3.2.1 Transfer of Division IIIa spring spawners taken in the North Sea catches in 1987-1992. Catch in number (millions) and mean weight (g) at age with SOP in tonnes.

Rings/Year		Quarter 2 and 3				Division IVa(e) and IVb				Total
		2	3	4	5	6	7	8	9+	
1987	Num.	35.500	35.000	25.000	8.900	2.800	0.700	0.100	0.100	108.100
	M. w.	94	124	147	177	195	216	278	283	
	SOP	3,337	4,340	3,675	1,575	546	151	28	28	13,681
1988	Num.	44.561	108.915	19.532	8.168	2.203	0.391			183.770
	M. w.	94	131	154	171	176	212			
	SOP	4,189	14,268	3,008	1,397	388	83			23,332
1989	Num.	27.313	52.687	38.325	11.615	8.651	3.811	1.700	0.224	144.326
	M. w.	91	120	164	180	178	191	202	209	
	SOP	2,485	6,322	6,285	2,091	1,540	728	343	47	19,842
1990	Num.	12.431	14.703	21.812	3.573	2.986	2.088	0.746	0.352	58.691
	M. w.	103	113	134	166	161	184	190	236	
	SOP	1,280	1,661	2,923	593	481	384	142	83	7,548
1991	Num.	6.650	15.074	18.007	9.145	3.050	0.821	0.289		53.036
	M. w.	115	136	148	168	205	216	221		
	SOP	765	2,050	2,665	1,536	625	177	64		7,883
1992	Num.	0.290	9.860	11.090	8.390	8.610	2.540	0.670	0.630	42.080
	M. w.	127	164	172	192	195	243	259	256	
	SOP	37	1,617	1,907	1,611	1,679	617	174	161	7,803

Table 3.2.2 Skagerrak 1992 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	5.44	166.5	0.23	110.8	0.20	110.8	5.87	162.4
4	3.70	190.4	0.04	115.0			3.74	189.6
5	1.19	174.9					1.19	174.9
6	1.55	181.4	0.04	166.0			1.59	181.0
7	0.50	205.4					0.50	205.4
8	0.10	223.7					0.10	223.7
9+	0.20	209.4					0.20	209.4
TOTAL	12.68		0.31		0.20		13.19	
Land. (SOP)(t)		2,266		37		22		2,325
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2								
3	9.59	93.2	0.79	88.3	10.40	88.3	20.78	90.6
4	10.46	107.7	0.57	93.1	7.50	93.1	18.53	101.3
5	7.40	128.8	0.21	131.0	2.80	131.0	10.41	129.4
6	6.31	140.8	0.21	133.2	2.80	133.2	9.32	138.3
7	2.00	151.4	0.14	152.5	1.80	152.5	3.94	151.9
8	0.90	148.3	0.07	166.0	1.80	166.0	2.77	160.2
9+	0.21	183.5			0.90	166.0	1.11	169.3
TOTAL	36.87		1.99		28.00		66.86	
Land. (SOP)(t)		4,337		211		3,079		7,627
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	17.55	115.7			18.10	97.4	35.65	106.4
3	30.18	137.4			11.31	117.3	41.49	131.9
4	37.34	157.7			6.34	124.2	43.68	152.8
5	16.49	184.5			5.02	191.5	21.51	186.1
6	11.55	200.4			0.40	153.8	11.95	198.8
7	2.66	209.4			0.10	160.3	2.76	207.6
8	0.27	257.6					0.27	257.6
9+	0.14	283.3					0.14	283.3
TOTAL	116.18		0.00		41.27		157.45	
Land. (SOP)(t)		18,089		0		4,916		23,005
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	34.99	90.1	0.47	68.0	14.52	78.1	49.98	86.4
3	11.73	117.3			4.30	89.5	16.03	109.8
4	7.38	145.6			1.50	107.8	8.88	139.2
5	4.70	158.4	0.51	190.0	0.82	167.6	6.03	162.3
6	2.44	200.4			0.10	163.5	2.54	198.9
7	0.43	219.1					0.43	219.1
8	0.02	329.0					0.02	329.0
9+								
TOTAL	61.69		0.98		21.24		83.91	
Land. (SOP)(t)		6,937		129		1,834		8,901
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	52.54	98.7	0.47	68.0	32.62	88.8	85.63	94.7
3	56.94	128.6	1.02	93.4	26.21	101.2	84.17	119.6
4	58.88	149.4	0.61	94.5	15.34	107.4	74.83	140.3
5	29.78	166.2	0.72	172.8	8.64	169.6	39.14	167.0
6	21.85	181.8	0.25	138.4	3.30	136.6	25.40	175.5
7	5.59	189.0	0.14	152.5	1.90	152.9	7.63	179.4
8	1.29	179.8	0.07	166.0	1.80	166.0	3.16	171.6
9+	0.55	218.3			0.90	166.0	1.45	185.8
TOTAL	227.42		3.28		90.71		321.41	
Land. (SOP)(t)		31,630		377		9,851		41,858

Table 3.2.3 **Kattegat 1992. 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	27.44	77.8	7.00	71.0	9.55	51.8	43.99	71.1
3	16.88	92.8	0.96	123.8	1.00	52.8	18.84	92.3
4	13.10	112.1			0.10	54.0	13.20	111.7
5	6.24	137.6					6.24	137.6
6	4.38	171.4					4.38	171.4
7	1.35	192.6					1.35	192.6
8	0.33	184.3					0.33	184.3
9+	0.16	254.1					0.16	254.1
TOTAL	69.88		7.96		10.65		88.49	
Land. (SOP)(t)		7,141		616		553		8,309
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	4.82	75.2	4.19	51.6	35.89	64.6	44.90	64.5
3	7.68	85.2	1.73	82.7	24.10	69.6	33.51	73.9
4	10.52	104.9	1.09	104.9	14.00	85.6	25.61	94.3
5	6.64	125.3	0.39	138.7	2.50	96.0	9.53	118.2
6	4.92	144.3	0.10	155.8	1.30	101.3	6.32	135.6
7	1.02	165.6			0.20	98.2	1.22	154.6
8	0.57	173.5					0.57	173.5
9+	0.33	183.4	0.03	155.0			0.36	181.0
TOTAL	36.50		7.53		77.99		122.02	
Land. (SOP)(t)		3,991		548		5,586		10,124
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1								
2	35.85	71.5	2.51	61.7	23.24	82.8	61.60	75.4
3	12.01	87.6			4.45	91.2	16.46	88.6
4	7.88	112.8			0.52	184.0	8.40	117.2
5	2.18	137.4			1.89	213.5	4.07	172.7
6	0.85	179.9					0.85	179.9
7	0.44	210.5					0.44	210.5
8	0.60	240.2					0.60	240.2
9+	0.02	273.0					0.02	273.0
TOTAL	59.83		2.51		30.10		92.44	
Land. (SOP)(t)		5,199		155		2,829		8,183
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	35.40	61.9	0.57	62.1	31.01	43.5	66.98	53.4
2	19.44	85.2	0.21	95.5	2.26	58.8	21.91	82.6
3	6.47	100.7					6.47	100.7
4	5.11	113.1					5.11	113.1
5	1.45	132.9	0.11	120.0			1.56	132.0
6	0.82	154.8					0.82	154.8
7	0.32	83.5					0.32	83.5
8								
9+								
TOTAL	69.01		0.89		33.27		103.17	
Land. (SOP)(t)		5,423		69		1,482		6,974
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	35.4	61.9	0.57	62.1	31.01	43.5	66.98	53.4
2	87.55	76.7	13.91	63.8	70.94	68.7	172.40	72.4
3	43.04	91.2	2.69	97.4	29.55	72.3	75.28	84.0
4	36.61	110.3	1.09	104.9	14.62	88.9	52.32	104.2
5	16.51	132.2	0.50	134.6	4.39	146.6	21.40	135.2
6	10.97	158.7	0.10	155.8	1.30	101.3	12.37	152.6
7	3.13	175.2			0.20	98.2	3.33	170.5
8	1.5	202.6					1.50	202.6
9+	0.51	209.1	0.03	155.0			0.54	206.1
TOTAL	235.22		18.89		152.01		406.12	
Land. (SOP)(t)		21,754		1,387		10,450		33,590

Table 3.2.4 Skagerrak 1992 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	1.75	85.7	65.56	24.4	57.88	25.8	125.19	25.9
2	16.24	115.8	3.91	54.7	2.70	54.7	22.85	98.1
3	7.17	154.6					7.17	154.6
4	9.71	167.9					9.71	167.9
5	8.41	174.7					8.41	174.7
6	1.77	191.8					1.77	191.8
7	0.78	201.0					0.78	201.0
8	0.26	198.9					0.26	198.9
9+								
TOTAL	46.09		69.47		60.58		176.14	
Land. (SOP)(t)		6,787		1,814		1,641		10,241
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	24.62	47.1	9.64	33.8	150.62	35.4	184.88	36.9
2	28.05	86.1	5.96	79.3	79.14	79.2	113.15	80.9
3	11.82	158.3					11.82	158.3
4	9.95	164.1					9.95	164.1
5	1.56	184.4					1.56	184.4
6	4.35	182.1					4.35	182.1
7	2.80	189.3					2.80	189.3
8	0.06	179.0					0.06	179.0
9+								
TOTAL	83.21		15.60		229.76		328.57	
Land. (SOP)(t)		8,699		798		11,600		21,097
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	2.23	34.8	579.42	11.7	539.70	9.7	1121.35	10.8
1	73.77	82.5	1.74	68.5	323.60	70.2	399.11	72.5
2	52.66	136.4			54.27	97.4	106.93	116.6
3								
4								
5								
6								
7								
8								
9+								
TOTAL	128.66		581.16		917.57		1627.39	
Land. (SOP)(t)		13,346		6,898		33,238		53,483
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	12.38	32.6	249.81	14.7	326.79	16.5	588.98	16.1
1	124.01	69.1	2.48	72.3	269.03	62.5	395.52	64.6
2	5.20	123.9	0.04	68.0	1.10	78.0	6.34	115.6
3	7.80	181.4					7.80	181.4
4	6.95	188.0					6.95	188.0
5	6.01	198.9					6.01	198.9
6	6.21	210.0					6.21	210.0
7	1.88	223.5					1.88	223.5
8	0.38	223.2					0.38	223.2
9+	0.30	241.4					0.30	241.4
TOTAL	171.12		252.33		596.92		1020.37	
Land. (SOP)(t)		15,415		3,854		22,292		41,562
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	14.61	32.9	829.23	12.6	866.49	12.3	1710.33	12.6
1	224.15	71.2	79.42	28.0	801.13	57.9	1104.70	58.4
2	102.15	118.7	9.91	69.5	137.21	85.9	249.27	98.7
3	26.79	164.0					26.79	164.0
4	26.61	171.7					26.61	171.7
5	15.98	184.7					15.98	184.7
6	12.33	197.5					12.33	197.5
7	5.46	202.7					5.46	202.7
8	0.7	210.4					0.70	210.4
9+	0.3	241.4					0.30	241.4
TOTAL	429.08		918.56		1804.83		3152.47	
Land. (SOP)(t)		44,248		13,365		68,771		126,383

Table 3.2.5 Kattegat 1992. 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			183.67	21.9	153.37	31.2	337.04	26.1
2	7.75	77.8	1.97	71.0	2.70	51.8	12.42	71.1
3								
4								
5								
6								
7								
8								
9+								
TOTAL	7.75		185.64		156.07		349.46	
Land. (SOP) (t)		603		4,162		4,925		9,690
2. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0					0.20	10.0	0.20	10.0
1			22.52	29.0	16.82	45.4	39.34	36.0
2	2.37	75.2	2.07	51.6	17.67	64.6	22.11	64.5
3								
4								
5								
6								
7								
8								
9+								
TOTAL	2.37		24.59		34.69		61.65	
Land. (SOP) (t)		178		760		1,907		2,845
3. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	0.19	11.0	155.19	12.0	331.83	9.9	487.21	10.6
1	27.95	57.4	35.56	38.4	33.38	60.2	96.89	51.4
2								
3								
4								
5								
6								
7								
8								
9+								
TOTAL	28.14		190.75		365.21		584.10	
Land. (SOP) (t)		1,606		3,228		5,295		10,129
4. QUARTER								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	3.27	16.3	118.17	12.2	88.33	16.0	209.77	13.9
1	4.83	61.9	0.08	62.1	4.21	43.5	9.12	53.4
2								
3								
4								
5								
6								
7								
8								
9+								
TOTAL	8.10		118.25		92.54		218.89	
Land. (SOP) (t)		352		1,447		1,596		3,395
TOTAL YEAR								
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	3.46	16.0	273.36	12.1	420.36	11.2	697.18	11.6
1	32.78	58.1	241.83	25.0	207.78	37.3	482.39	32.5
2	10.12	77.2	4.04	61.1	20.37	62.9	34.53	66.9
3								
4								
5								
6								
7								
8								
9+								
TOTAL	46.36		519.23		648.51		1214.10	
Land. (SOP) (t)		2,740		9,597		13,723		26,060

Table 3.2.6 HERRING Division IIIa in 1992. Autumn spawners transfered to the North Sea.

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

Quarter	Rings	0	1	2	3	4	5	6	7	8	9+	SOP
1	Skagerrak		125.19	22.85	7.17	9.71	8.41	1.77	0.78	0.26		10,241
	Kattegat		337.04	12.42								9,690
	Div. IIIa		462.23	35.27	7.17	9.71	8.41	1.77	0.78	0.26		19,931
2	Skagerrak		184.88	113.15	11.82	9.95	1.56	4.35	2.80	0.06		21,097
	Kattegat	0.20	39.34	22.11								2,845
	Div. IIIa	0.20	224.22	135.26	11.82	9.95	1.56	4.35	2.80	0.06		23,942
3	Skagerrak	1121.35	399.11	106.93								53,483
	Kattegat	487.21	96.89									10,129
	Div. IIIa	1608.56	496.00	106.93								63,612
4	Skagerrak	588.98	395.52	6.34	7.80	6.95	6.01	6.21	1.88	0.38	0.30	41,562
	Kattegat	209.77	9.12									3,395
	Div. IIIa	798.75	404.64	6.34	7.80	6.95	6.01	6.21	1.88	0.38	0.30	44,957
Total Year	Skagerrak	1710.33	1104.70	249.27	26.79	26.61	15.98	12.33	5.46	0.70	0.30	126,383
	Kattegat	697.18	482.39	34.53								26,059
	Div. IIIa	2407.51	1587.09	283.80	26.79	26.61	15.98	12.33	5.46	0.70	0.30	152,442

Mean weight (g) at age by quarter.

Quarter	Rings	0	1	2	3	4	5	6	7	8	9+
1	Skagerrak		25.9	98.1	154.6	167.9	174.7	191.8	201.0	198.9	
	Kattegat		26.1	71.1							
	Div. IIIa		26.0	88.6	154.6	167.9	174.7	191.8	201.0	198.9	
2	Skagerrak		36.9	80.9	158.3	164.1	184.4	182.1	189.3	179.0	
	Kattegat	10.0	36.0	64.5							
	Div. IIIa	10.0	36.7	78.2	158.3	164.1	184.4	182.1	189.3	179.0	
3	Skagerrak	10.8	72.5	116.6							
	Kattegat	10.6	51.4								
	Div. IIIa	10.7	68.4	116.6							
4	Skagerrak	16.1	64.6	115.6	181.4	188.0	198.9	210.0	223.5	223.5	241.4
	Kattegat	13.9	53.4								
	Div. IIIa	15.5	64.3	115.6	181.4	188.0	198.9	210.0	223.5	223.5	241.4
Total Year	Skagerrak	12.6	58.4	98.7	164.0	171.7	184.7	197.5	202.7	210.5	241.4
	Kattegat	11.6	32.5	66.9							
	Div. IIIa	12.3	50.6	94.8	164.0	171.7	184.7	197.5	202.7	210.5	241.4

Table 3.2.7 Total catch of spring spawners in Division IIIa and the North Sea in 1992.

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

Quarter	Rings	0	1	2	3	4	5	6	7	8	9+	SOP
1	North Sea											0
	Skagerrak				5.87	3.74	1.19	1.59	0.50	0.10	0.20	2,325
	Kattegat			43.99	18.84	13.20	6.24	4.38	1.35	0.33	0.16	8,309
	Total			43.99	24.71	16.94	7.43	5.97	1.85	0.43	0.36	10,634
2	North Sea				6.99	5.59	3.96	3.11	1.12	0.14	0.27	3,910
	Skagerrak				20.78	18.53	10.41	9.32	3.94	2.77	1.11	7,627
	Kattegat			44.90	33.51	25.61	9.53	6.32	1.22	0.57	0.36	10,124
	Total			44.90	61.28	49.73	23.90	18.75	6.28	3.48	1.74	21,661
3	North Sea			0.29	2.87	5.50	4.43	5.50	1.42	0.53	0.36	3,883
	Skagerrak			35.65	41.49	43.68	21.51	11.95	2.76	0.27	0.14	23,005
	Kattegat			61.60	16.46	8.40	4.07	0.85	0.44	0.60	0.02	8,183
	Total			97.54	60.82	57.58	30.01	18.30	4.62	1.40	0.52	35,071
4	North Sea											0
	Skagerrak			49.98	16.03	8.88	6.03	2.54	0.43	0.02		8,901
	Kattegat		66.98	21.91	6.47	5.11	1.56	0.82	0.32			6,974
	Total		66.98	71.89	22.50	13.99	7.59	3.36	0.75	0.02		15,875
Total Year	North Sea			0.29	9.86	11.09	8.39	8.61	2.54	0.67	0.63	7,793
	Skagerrak			85.63	84.17	74.83	39.14	25.40	7.63	3.16	1.45	41,858
	Kattegat		66.98	172.40	75.28	52.32	21.40	12.37	3.33	1.50	0.54	33,590
	Total		66.98	258.32	169.31	138.24	68.93	46.38	13.50	5.33	2.62	83,241

Mean weight (g) at age by quarter.

Quarter	Rings	0	1	2	3	4	5	6	7	8	9+
1	North Sea										
	Skagerrak				162.4	189.6	174.9	181.0	205.4	223.7	209.4
	Kattegat			71.1	92.3	111.7	137.6	171.4	192.6	184.3	254.1
	Total			71.1	109.0	128.9	143.6	174.0	196.1	193.5	229.3
2	North Sea				170.1	172.9	187.3	200.9	244.3	246.0	294.7
	Skagerrak				90.6	101.3	129.4	138.3	151.9	160.2	169.3
	Kattegat			64.5	73.9	94.3	118.2	135.6	154.6	173.5	181.0
	Total			64.5	90.5	105.7	134.5	147.8	168.9	165.8	191.2
3	North Sea			126.8	147.5	170.2	196.7	191.3	240.8	263.0	226.7
	Skagerrak			106.4	131.9	152.8	186.1	198.8	207.6	257.6	283.3
	Kattegat			75.4	88.6	117.2	172.7	179.9	210.5	240.2	273.0
	Total			86.9	120.9	149.3	185.8	195.7	218.1	252.2	243.7
4	North Sea										
	Skagerrak			86.4	109.8	139.2	162.3	198.9	219.1	329.0	
	Kattegat		53.4	82.6	100.7	113.1	132.0	154.8	83.5		
	Total		53.4	85.2	107.2	129.7	156.1	188.1	161.2	329.0	
Total Year	North Sea			126.8	163.5	171.6	192.3	194.8	242.3	259.4	255.8
	Skagerrak			94.7	119.6	140.3	167.0	175.5	179.3	171.6	185.8
	Kattegat		53.4	72.4	84.0	104.2	135.2	152.6	170.6	202.6	206.1
	Total		53.4	79.8	106.3	129.1	160.2	173.0	189.0	191.4	206.8

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 - 1992.

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	258.32	169.31	138.24	68.93	46.38	13.50	7.95	769.61
	Mean W.		53.4	79.8	106.3	129.1	160.2	173.0	189.0	196.5	
	SOP		3,577	20,614	17,998	17,847	11,043	8,024	2,552	1,562	83,215

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

Table 3.2.9 Herring Division IIIa, 1987 - 1992
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

There are minor corrections for the years prior to 1991.

Table 3.2.10 HERRING in Division IIIa. Samples of commercial catches by quarter and area for 1992 available to the Working Group.

Country	Quarter	Landings for consumption		Landings for industrial purposes	
		Catch (t)	No. aged	Catch (t)	No. aged
		Skagerrak			
Denmark	1	5,744	-	2,219	1,567
	2	6,065	-	2,135	584
	3	15,685	1,171	187222	1,184
	4	6,283	-	8,299	1,213
Total		33,777	1,171	30,875	4,548
Sweden	1	2,334	503	1,298	
	2	4,988	614	13,240	
	3	11,573	810	26,816	
	4	8,311	690	19,485	
Total		27,206	2,617	60,839	0
Norway	1	988	345		
	2	2,047	1,319		
	3	3,076	0		
	4	7,789	667		
Total		13,900	2,331	0	0
		Kattegat			
Denmark	1	3,555	270	5,962	1,388
	2	1,285	-	1,345	727
	3	5,813	357	8,986	1,014
	4	4,233	369	2,454	2,351
Total		14,886	996	18,747	5,480
Sweden	1	4,634	994	4,234	386
	2	2,893	678	7,475	619
	3	999	476	2,527	126
	4	1,529	558	2,113	215
Total		10,055	2,656	16,349	1,346

Table 3.4.1 Recruitment indices for 1- and 2-ringed herring from the International Young Fish Survey 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 areas of four depth strata.

Year	Index						
	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]	1,867	2,037	-[1]	606
1986	21,489	2,738	-[1]	1,562	1,897	-[1]	1,175
1987	11,733	3,671	-[1]	2,921	1,199	-[1]	949
1988	67,753	10,095	-[1]	7,834	7,084	-[1]	2,161
1989	17,451	4,976	-[1]	0	3,989	-[1]	4,976
1990	3,544	3,876	0	3,192	508	3,544	684
1991	3,588	3,749	-[1]	480	3,396	-[1]	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

[1]Separation not valid.

Table 4.2.1 Celtic Sea and Division VIIj HERRING landings by calendar year (t), 1977-1992. (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	1,800	-	400	1,900	23,600
1992	500	-	18,000	100	+	2,300	2,100	23,000

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	+	100	21,400	1,800	-	-300	2,100	25,100
1992/1993	-	-	18,000	100	-	1,100	2,000	21,200

Table 4.2.3 Celtic Sea, Division VIIj (1991 - 1992). 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	88	2,537	15,665	Yes
Netherlands	300	-	-	-	Yes

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

Length	Division VIIj			Divisions VIIa S. VIIg	
	$Q_3$92	$Q_4$92	$Q_1$93	$Q_4$92	$Q_1$93
19.0				7	
19.5				-	12
20.0			17	13	12
20.5		8	25	72	61
21.0		31	67	92	182
21.5	2	31	146	191	353
22.0	5	101	229	500	511
22.5	14	117	200	889	1,107
23.0	22	257	196	1,455	1,800
23.5	19	265	67	1,376	2,178
24.0	24	195	13	1,389	3,941
24.5	30	195	79	1,587	4,732
25.0	106	187	112	2,120	4,817
25.5	214	483	137	2,824	5,024
26.0	421	709	183	3,331	5,717
26.5	538	1,230	158	3,805	4,975
27.0	744	1,378	287	5,174	5,085
27.5	782	1,401	333	5,820	4,477
28.0	820	1,915	453	5,813	4,185
28.5	633	1,853	308	4,121	2,847
29.0	432	1,362	200	2,140	1,399
29.5	187	662	50	1,007	608
30.0	155	366	37	500	207
30.5	68	187	12	290	73
31.0	32	125	4	92	24
31.5	3	55	-	33	-
32.0	-	16	-	7	-
32.5	3	-	-	-	-
33.0	-	-	-	-	-
Total	5,254	13,129	3,313	44,648	54,327

Table 4.2.5 Catches in number per age, Celtic Sea/Division VIIj.

Run title : Herring South and South West of Ireland (Fishing Areas VIIg-j) (run name: SECOND

At 27-Mar-93 13:36

Traditional vpa Terminal populations from weighted Separable populations

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1970,	1971,	1972,
AGE			
1,	1319,	12658,	8422,
2,	37260,	23313,	137690,
3,	50087,	37563,	17855,
4,	26481,	41904,	15842,
5,	18763,	18759,	14531,
6,	7853,	10443,	4645,
7,	6351,	4276,	3012,
+gp,	5542,	7181,	3394,
TOTALNUM,	153656,	156097,	205391,
TONSLAND,	31727,	31396,	38203,
SOPCOF %,	96,	94,	99,

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
1,	23547,	5507,	12768,	13317,	8159,	2800,	11335,	7162,	39361	15339,
2,	38133,	42808,	15429,	11113,	12516,	13385,	13913,	30093,	21285,	42725,
3,	55805,	17184,	17783,	7286,	8610,	11948,	12399,	11726,	21861,	8728,
4,	7012,	22530,	7333,	7011,	5280,	5583,	8636,	6585,	5505,	4817,
5,	9651,	4225,	9006,	2872,	1585,	1580,	2889,	2812,	4438,	1497,
6,	5323,	3737,	3520,	4785,	1898,	1476,	1316,	2204,	3436,	1891,
7,	3352,	2978,	1644,	1980,	1043,	540,	1283,	1184,	795,	1670,
+gp,	3541,	1730,	2330,	3012,	853,	1340,	1186,	1827,	1179,	931,
TOTALNUM,	146364,	100699,	69813,	51376,	39944,	38652,	52957,	63593,	97860,	77598,
TONSLAND,	26936,	19940,	15588,	9771,	7833,	7559,	10321,	13130,	17103,	19900,
SOPCOF %,	95,	99,	114,	99,	104,	98,	103,	109,	103,	146,

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
1,	13540,	19517,	17916,	4159,	5976,	2307,	8260,	2702,	1912,	10410,
2,	102871,	92892,	57054,	56747,	67000,	82027,	42413,	41756,	63854,	26752,
3,	26993	41121,	36258,	42881,	43075,	30962,	68399,	24634,	38342,	35019,
4,	3225,	16043	16032,	32930,	23014,	9398,	19601,	35258,	16916,	27591,
5,	1862,	2450,	2306	8790,	14323,	5963,	8205,	8116,	28405,	10139,
6,	327,	1085,	228,	1127	2716,	3047,	3837,	3808,	4869,	18061,
7,	372,	376,	85,	98,	1175	869,	2589,	1671,	2588,	3021,
+gp,	1240,	411,	305,	41,	760,	383,	1449,	1157,	1547,	6974,
TOTALNUM,	150430,	173895,	130184,	146773,	158039,	134956,	154753,	119102,	158433,	137967,
TONSLAND,	24981,	26779,	20426,	25024,	26200,	20447,	23254,	18404,	25562,	21127,
SOPCOF %,	93,	99,	102,	100,	100,	100,	102,	99,	101,	96,

Table 4.6.1 Celtic Sea/Division VIIj. Separable VPA.

Title : Herring South and South West of Ireland (Fishing Areas VIIg-j) (run name: SECOND

At 27-Mar-93n 14:12

Separable analysis
from 1970 to 1992 on ages 1 to 7
with Terminal F of .500 on age 3 and Terminal S of .900

Initial sum of squared residuals was 216.396 and
final sum of squared residuals is 52.226 after 100 iterations

Matrix of Residuals

Years, Ages	1970/71,	1971/72,
1/ 2,	.024,	.035,
2/ 3,	-.175,	-.492,
3/ 4,	-.199,	-.140,
4/ 5,	.036,	.127,
5/ 6,	.170,	.350,
6/ 7,	.340,	.365,
,	.000,	.000,
WTS ,	.001,	.001,

Years, Ages	1972/73,	1973/74,	1974/75,	1975/76,	1976/77,	1977/78,	1978/79,	1979/80,	1980/81,	1981/82,
1/ 2,	1.004,	1.874,	1.444,	2 508,	2.382,	1.953,	1.181,	1.640,	1.663,	2.151,
2/ 3,	.254,	.090,	.171,	-.057,	-.546,	-.558,	-.178,	-.323,	-.104,	-.182,
3/ 4,	.046,	-.045,	-.101,	-.122,	-.710,	-.384,	-.136,	-.086,	.094,	.157,
4/ 5,	-.323,	-.374,	.035,	-.044,	.527,	.461,	.268,	.474,	-.199,	.019,
5/ 6,	.075,	-.043,	-.810,	-.464,	-.667,	-.796,	-.322,	-.490,	-.894,	-.542,
6/ 7,	-.439,	-.245,	-.005,	-.354,	.603,	.539,	-.219,	-.499,	.489,	-.486,
,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years, Ages	1982/83,	1983/84,	1984/85,	1985/86,	1986/87,	1987/88,	1988/89,	1989/90,	1990/91,	1991/92,		,,WTS
1/ 2,	.406,	.892,	.749,	1.482,	-.044,	-.431,	-.003,	.732,	-.345,	.024,	.000,	.267,
2/ 3,	-.437,	.558,	-.554,	-.141,	-.131,	-.198,	.109,	-.106,	-.060,	.257,	.000,	.842,
3/ 4,	-.154,	-.076,	-.844,	-.543,	-.048,	.221,	.141,	-.187,	.043,	-.214,	.000,	.920,
4/ 5,	-.127,	-.254,	.230,	.032,	.233,	.065,	-.165,	.105,	-.047,	.040,	.000,	1.000,
5/ 6,	.328,	-.085,	.537,	.031,	.462,	.133,	.020,	-.137,	.127,	-.140,	.000,	.579,
6/ 7,	.605,	-.602,	.902,	.309,	-.600,	-.115,	-.121,	.070,	.138,	.027,	.000,	.557,
,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	13.903,	
WTS ,	.001,	.001,	.001,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)
1970, 1971, 1972,

Table 4.6.2

Run title : Herring South and South West of Ireland (Fishing Areas VIIg-j) (run name: SECOND,

At 27-Mar-93n 14:12

~~Table 17~~ Summary (with SOP correction)

Traditional vpa Terminal populations from weighted Separable populations

	RECRUITS,	TOTALBIO,	TOTSPBIO,	LANDINGS,	SOPCOFAC,	FBAR 3- 6,
1970,	238047,	119171,	84954,	31727,	.9619,	.5671,
1971,	867470,	159976,	81207,	31396,	.9428,	.8166,
1972,	269626,	115580,	75346,	38203,	.9861,	.6181,
1973,	304995,	87068,	52167,	26936,	.9534,	.6636,
1974,	138287,	57805,	37835,	19940,	.9925,	.6756,
1975,	151547,	51375,	31067,	15588,	1.1353,	.7272,
1976,	197183,	44472,	24491,	9771,	.9919,	.6485,
1977,	174016,	45414,	26645,	7833,	1.0425,	.5381,
1978,	133343,	39806,	25137,	7559,	.9805,	.4436,
1979,	238793,	52673,	28347,	10321,	1.0312,	.5428,
1980,	143033,	47560,	28857,	13130,	1.0865,	.6600,
1981,	411116,	71615,	31482,	17103,	1.0310,	.9960,
1982,	661235,	155208,	68135,	19900,	1.4552,	.9000,
1983,	747274,	132907,	64533,	24981,	.9303,	.6372,
1984,	581098,	113561,	62605,	26779,	.9911,	1.1855,
1985,	511533,	113677,	64685,	20426,	1.0246,	.5006,
1986,	459008,	113257,	64936,	25024,	1.0008,	.6427,
1987,	760793,	127816,	70142,	26200,	.9958,	.7329,
1988,	367192,	109866,	77844,	20447,	1.0038,	.3808,
1989,	611467,	141129,	82281,	23254,	1.0232,	.4612,
1990,	577517,	130053,	79610,	18404,	.9901,	.3740,
1991,	262835,	104046,	73666,	25562,	1.0129,	.4281,
1992,	1330268,	180124,	85682,	21127,	.9555,	.5101,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

Table 5.1.1 Nominal catch (t), Division VIa (North) HERRING, 1983-1992, as reported to the Working Group.

Country	1983	1984	1985	1986	1987
Denmark	-	96	-	-	-
Faroes	834	954	104	400	-
France	1,313	-	20	18	136
Germany,Fed.Rep	6,283	5,564	5,937	2,188	1,711
Ireland	-	-	-	6,000	6,800
Netherlands	20,200	7,729	5,500	5,160[2]	5,212[2]
Norway	7,336	6,669	4,690	4,799	4,300
UK (England)	-	-	-	-	-
UK (Scotland)	31,616	37,554	28,065	25,294	26,810
Unallocated	-4,059	16,588	502	37,840[2]	18,038[2]
Discards	-	-	-	-	-
Total	63,523	75,154	43,814	81,699	63,007

Country	1988	1989	1990	1991	1992[1]
Denmark	-	-	-	-	7
Faroes	-	-	326	482	-
France	44	1,342	1,287	1,168	119
Germany,Fed.Rep	1,860	4,290	7,096	6,450	5,640
Ireland	6,740	8,000	10,000	8,000	7,985
Netherlands	6,131	5,860	7,693	7,979	8,000
Norway	456	-	1,607	3,318	2,389
UK (England)	1,892	1,977	2,376	2,998	3,327
UK (Scotland)	25,002	27,897	35,877	29,630	29,403
Unallocated	5,229[2]	2,123	2,397	-10,597	-5,485
Discards	-	1,550	1,300	1,180	200
Total	47,354	53,039	69,959	50,606	51,585

[1]Preliminary.
[2]Including discards.

Table 5.1.2 HERRING in Division VIa (North), 1992. Sampling intensity of commercial catches.

Country	Catch in tonnes	No. of samples	No. of age readings	No. of fish measured	Estimate of discards
Faroes	0	0	0	0	No
France	119	0	0	0	No
Germany	5,640	0	0	0	No
Ireland	7,985	?	719	3,915	No
Netherlands	8,200	8	200	820	Yes
Norway	2,389	0	0	0	No
UK (England)	3,327	0	0	0	No
UK (Scotland)	29,403	19	?	1,938	No

Table 5.1.3

Run title : Herring in the Northern part of VIa (run name: SVPAFINAL)

At 28-Mar-93 11:15

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1970	1971	1972
AGE			
1	238738	169947	801663
2	205454	372615	804097
3	359711	560348	219502
4	139718	357745	63069
5	53320	113391	85920
6	203462	54571	37341
7	29141	181592	13377
8	32860	18042	100938
+gp	30651	36395	20465
TOTALNUM	1293055	1864645	2146372
TONSLAND	165930	207167	164756
SOPCOF %	83	70	61

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
1	51170	309016	172879	69053	34836	22525	392	12867	36740	13304
2	235627	124944	202087	319604	47739	46284	225	1335	77961	250010
3	808267	151025	89066	101548	95834	20587	122	452	105600	72179
4	131484	519178	63701	35502	22117	40692	31	246	61341	93544
5	63071	82466	188202	25195	10083	6879	21	62	21473	58452
6	54642	49683	30601	76289	12211	3833	12	43	12623	23580
7	18242	34629	12297	10918	20992	2100	7	40	11583	11516
8	6506	22470	13121	3914	2758	6278	2	3	1309	13814
+gp	32223	21042	13698	12014	1486	1544	0	1	1326	4027
TOTALNUM	1401232	1314453	785652	654037	248056	150722	812	15049	329956	540426
TONSLAND	208270	177458	111922	93642	41341	22176	60	306	51420	92361
SOPCOF %	95	89	97	100	109	100	63	21	103	97

Run title : Herring in the Northern part of VIa (run name: SVPAFINAL)

At 28-Mar-93n 11:15

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
1	81923	2961	45663	38943	27645	2273	9690	22374	46052	9346
2	77810	253291	77063	178714	93679	158832	57305	75241	40086	43517
3	92743	66857	166112	99264	64575	55529	170687	63832	44635	44290
4	29262	46963	19269	137077	45488	37815	29497	116270	50070	42128
5	42535	20057	17027	21723	71188	26292	28228	41512	66459	38692
6	27318	15250	7422	20759	11973	37993	11830	20826	24005	60132
7	14709	12478	7731	2973	10378	4327	23400	15463	13441	11284
8	8437	5940	3720	16177	4982	2956	2529	33585	12228	7672
+gp	8484	2629	2450	2273	8498	3140	5463	8644	7901	9805
TOTALNUM	383221	426426	346457	517903	338406	329157	338629	397747	304877	266866
TONSLAND	63523	75154	43814	82280	63007	47354	53039	69959	50606	51585
SOPCOF %	97	105	99	92	103	94	98	99	94	100

Table 5.1.4 HERRING in Division VIa (North). Larvae abundance indices. Larvae mortality rates (Z/K), fecundity estimate (10^5 eggs/g).

Year	LAI	10% trimmed mean LA	Z/K	LPE		
				Larvae	Fecundity	SSB
1973	2,442	46.5	0.74	318	(1.39)	229
1974	1,186	17.4	0.42	238	(1.39)	171
1975	878	22.0	0.46	157	1.46	108
1976	189	11.0	-	60	1.23	49
1977	787	25.0	-	223	1.49	150
1978	332	32.8	-	132	1.37	109
1979	1,071	26.9	-	118	1.49	79
1980	1,436	26.3	0.39	287	2.04	141
1981	2,154	35.6	0.34	448	2.12	211
1982	1,890	32.6	0.39	267	1.95	137
1983	668	24.6	-	112	1.88	60
1984	2,133	46.0	0.57	253	1.75	145
1985	2,710	50.0	0.37	418	(1.86)	225
1986	3,037	45.4	0.24	907	(1.86)	488
1987	4,119	45.5	0.53	423	(1.86)	227
1988	5,947	75.1	0.47	781	(1.86)	420
1989	4,320	82.7	0.40	752	(1.86)	404
1990	6,525	86.2	0.64	426	(1.86)	229
1991	4,430	63.1	0.60	632	(1.86)	340
1992	12,251	41.8	0.66	463	(1.86)	248

Table 5.1.5 HERRING in Division VIa (North). Scottish bottom trawl survey indices of 2-ringed herring catch rates.

Trawl survey year	Year class	Number of GOV hauls	2-ringer index (millions)	ln (2-ringer index)
1981	1978	9	1,237	7.12
1982	1979	10	2,361	7.77
1983	1980	12	11	2.40
1984	1981	12	12,456	9.43
1985	1982	17	98	4.58
1986	1983	12	359	5.88
1987	1984	15	40	3.69
1988	1985	19	15,770	9.67
1989	1986	15	1,435	7.27
1990	1987	16	46	3.83
1991	1988	18	1,242	7.12
1992	1989	14	38	3.64
1993	1990	13	836	6.73

Table 5.1.6 HERRING in Division VIa (North). Mean weights at age (g).

Age (rings)	Weight in the stock	Weight in the catch								
		1982-1984	1985	1986	1987	1988	1989	1990	1991	1992
1	90	90	69	113	73	80	82	79	84	91
2	164	140	103	145	143	112	142	129	118	122
3	208	175	134	173	183	157	145	173	160	172
4	233	205	161	196	211	177	191	182	203	194
5	246	231	182	215	220	203	190	209	211	216
6	252	253	199	230	238	194	213	224	229	224
7	258	270	213	242	241	240	216	228	236	236
8	269	284	223	251	253	213	204	237	261	251
9	292	295	231	258	256	228	243	247	271	258

Table 5.1.7

Title : Herring in the Northern part of VIa (run name: SVPAFINAL)

At 28-Mar-93n 11:14

Separable analysis
from 1970 to 1992 on ages 1 to 8
with Terminal F of .130 on age 3 and Terminal S of 1.200

Initial sum of squared residuals was 562.657 and
final sum of squared residuals is 71.250 after 101 iterations

Matrix of Residuals

Years, Ages	1970/71,	1971/72,
1/ 2,	1.675,	-.532,
2/ 3,	-.704,	-.365,
3/ 4,	.021,	.949,
4/ 5,	.270,	.240,
5/ 6,	-.189,	-.356,
6/ 7,	-.045,	-.051,
7/ 8,	.370,	-.809,
,	.000,	.000,
WTS ,	.001,	.001,

Years, Ages	1972/73,	1973/74,	1974/75,	1975/76,	1976/77,	1977/78,	1978/79,	1979/80,	1980/81,	1981/82,
1/ 2,	2.876,	.948,	1.840,	.877,	1.591,	.937,	.092,	1.096,	4.316,	.078,
2/ 3,	-.173,	.401,	-.239,	.165,	.384,	.100,	-.381,	.045,	.423,	.314,
3/ 4,	.056,	.084,	-.086,	.016,	.304,	-.245,	-.115,	-.140,	-.314,	.100,
4/ 5,	-.398,	.141,	.082,	.032,	.049,	.099,	1.055,	-.003,	.227,	.097,
5/ 6,	-.186,	-.333,	-.227,	-.280,	-.792,	-.388,	-.435,	-.221,	-.810,	-.267,
6/ 7,	.083,	-.104,	.196,	-.132,	-.205,	.420,	-.486,	-.725,	-1.100,	-.081,
7/ 8,	.138,	-.714,	-.164,	.049,	-.049,	-.070,	.220,	1.360,	1.044,	-.304,
,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years, Ages	1982/83,	1983/84,	1984/85,	1985/86,	1986/87,	1987/88,	1988/89,	1989/90,	1990/91,	1991/92,		,,WTS
1/ 2,	-.386,	.281,	-2.114,	.559,	.452,	-.509,	-1.753,	-.167,	.808,	1.606,	.000,	.190,
2/ 3,	.558,	-.218,	-.171,	-.036,	.621,	.075,	-.254,	.121,	.252,	-.195,	.000,	.790,
3/ 4,	.180,	.038,	.396,	.173,	.135,	-.144,	.235,	.399,	-.245,	-.248,	.000,	.943,
4/ 5,	.133,	-.189,	.257,	-.050,	.101,	-.028,	.004,	-.220,	.180,	.063,	.000,	1.000,
5/ 6,	-.141,	.222,	.005,	-.343,	-.185,	-.167,	.300,	.219,	-.044,	-.302,	.000,	.984,
6/ 7,	-.427,	-.021,	-.315,	.765,	-.093,	.214,	-.025,	-.364,	-.164,	.341,	.000,	.684,
7/ 8,	-.536,	.151,	.262,	-.846,	-1.257,	.494,	.067,	-.418,	-.327,	.186,	.000,	.445,
,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	10.593,	
WTS ,	.001,	.001,	.001,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)

	1970,	1971,	1972,							
F-values	.3989,	.7899,	.4825,							
	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
F-values	.5598,	.8611,	.8806,	1.0100,	.8475,	.6703,	.0014,	.0026,	.3205,	.5139,
	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
F-values	.4383,	.3767,	.2373,	.3338,	.2538,	.1712,	.1444,	.1853,	.1438,	.1300,

Selection-at-age (S)

	1,	2,	3,	4,	5,	6,	7,	8,
S-values	.0634,	.6893,	1.0000,	1.0949,	1.2964,	1.2637,	1.2106,	1.2000,

Table 5.1.8

Analysis by RCT3 ver3.1 of data from file :

g:\her93\vian\rct3.dt1

Herring in VIaN.

Data for 2 surveys over 20 years : 1973 - 1992

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
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 .00
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1988

Survey/Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction			---------I
LAI	.75	-.32	.39	.662	15	8.69	6.22	.495	.802
LPE	1.55	-2.69	.78	.326	15	6.04	6.68	.995	.198
					VPA Mean =		5.13	.513	.000

Yearclass = 1989

Survey/Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction			---------I
LAI	.74	-.23	.37	.675	15	8.37	5.95	.461	.821
LPE	1.51	-2.47	.76	.327	15	6.00	6.57	.985	.179
					VPA Mean =		5.14	.504	.000

Yearclass = 1990

Survey/Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction			---------I
LAI	.72	-.13	.35	.689	15	8.78	6.22	.474	.781
LPE	1.45	-2.21	.75	.328	15	5.44	5.69	.895	.219
					VPA Mean =		5.16	.493	.000

Yearclass = 1991

Survey/Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction			---------I
LAI	.71	-.04	.33	.704	15	8.40	5.92	.432	.826
LPE	1.39	-1.89	.73	.331	15	5.83	6.21	.942	.174
					VPA Mean =		5.19	.480	.000

Table 5.1.8 Continued

Yearclass = 1992

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------- Regression	----------	----------	----------I	I----------- Prediction	----------	----------	----------	---------I
LAI									
LPE	1.32	-1.52	.71	.334	15	5.52	5.74	.886	1.000
					VPA Mean =		5.22	.464	.000

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1988	551	6.31	.44	.18	.17		
1989	430	6.06	.42	.24	.32		
1990	449	6.11	.42	.22	.28		
1991	391	5.97	.39	.11	.08		
1992	310	5.74	.89	.00	.00		

Table 5.1.9

Run title : Herring in the Northern part of VIa (run name: SVPAFIN)

At 28-Mar-93n 11:20

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR,	1970,	1971,	1972,
AGE			
1,	.1058,	.0270,	.5043,
2,	.1807,	.4244,	.2966,
3,	.4190,	1.1563,	.5133,
4,	.4616,	.9207,	.3421,
5,	.4475,	.7442,	.5148,
6,	.4052,	1.0091,	.5155,
7,	.5991,	.6767,	.6417,
8,	.4777,	.8219,	.8994,
+gp,	.4777,	.8219,	.8994,
FBAR 3- 6,	.4333,	.9576,	.4714,

Table 8 Fishing mortality (F) at age

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
1,	.0776,	.3333,	.1413,	.2072,	.0902,	.0370,	.0004,	.0208,	.0322,	.0223,
2,	.5014,	.4939,	.7323,	.8061,	.3842,	.2869,	.0008,	.0029,	.2896,	.5753,
3,	.5896,	.7697,	.8785,	1.1951,	.6585,	.3025,	.0011,	.0019,	.3474,	.5103,
4,	.6330,	.9202,	.8485,	1.0678,	.8936,	.6216,	.0006,	.0027,	.3662,	.5595,
5,	.5977,	.9434,	.9285,	.8769,	.9161,	.6874,	.0005,	.0014,	.2973,	.6251,
6,	.6400,	1.2326,	1.0296,	1.1536,	1.3817,	.9931,	.0019,	.0011,	.3696,	.5437,
7,	.4531,	.9840,	1.0950,	1.2330,	1.0792,	.8418,	.0035,	.0071,	.4039,	.5979,
8,	.6608,	1.4873,	1.2048,	1.2011,	1.1373,	1.0279,	.0014,	.0016,	.2971,	1.0571,
+gp,	.6608,	1.4873,	1.2048,	1.2011,	1.1373,	1.0279,	.0014,	.0016,	.2971,	1.0571,
FBAR 3- 6,	.6151,	.9665,	.9213,	1.0734,	.9624,	.6512,	.0010,	.0018,	.3451,	.5597,

Run title : Herring in the Northern part of VIa (run name: SVPAFIN)

At 28-Mar-93n 11:20

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
1,	.0342,	.0030,	.0398,	.0375,	.0102,	.0020,	.0085,	.0217,	.0296,	.0082,
2,	.3016,	.2395,	.1698,	.3775,	.2012,	.1242,	.1033,	.1413,	.0813,	.0581,
3,	.4678,	.4926,	.2597,	.3654,	.2413,	.1867,	.2019,	.1695,	.1233,	.1283,
4,	.3794,	.4352,	.2418,	.3356,	.2693,	.2062,	.1359,	.1955,	.1848,	.1557,
5,	.4733,	.4297,	.2469,	.4159,	.2601,	.2200,	.2093,	.2564,	.1467,	.1904,
6,	.5954,	.2748,	.2483,	.4727,	.3773,	.1928,	.1306,	.2106,	.2069,	.1720,
7,	.6879,	.5293,	.1951,	.1334,	.4066,	.2025,	.1564,	.2249,	.1830,	.1273,
8,	1.0789,	.5834,	.2619,	.6858,	.3065,	.1723,	.1567,	.3122,	.2489,	.1355,
+gp,	1.0789,	.5834,	.2619,	.6858,	.3065,	.1723,	.1567,	.3122,	.2489,	.1355,
FBAR 3- 6,	.4790,	.4081,	.2492,	.3974,	.2870,	.2014,	.1694,	.2080,	.1654,	.1616,

Table 5.1.10

Run title : Herring in the Northern part of VIa (run name: SVPAFIN)

At 28-Mar-93n 11:20

Traditional vpa Terminal populations from weighted Separable populations

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR,	1970,	1971,	1972,
AGE			
1,	372911,	1005418,	307450,
2,	143185,	123412,	360003,
3,	115145,	88536,	59809,
4,	39561,	62004,	22809,
5,	15474,	22562,	22344,
6,	63961,	8950,	9700,
7,	6761,	38593,	2952,
8,	9056,	3360,	17750,
+gp,	8447,	6779,	3599,
TOTAL,	774501,	1359614,	806416,

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
1,	107678,	167853,	205189,	57384,	63440,	97726,	145320,	98877,	183062,	95418,
2,	68309,	36653,	44246,	65539,	17159,	21326,	34644,	53437,	35627,	65212,
3,	198253,	30649,	16570,	15759,	21684,	8657,	11858,	25646,	39473,	19756,
4,	29307,	90010,	11622,	5636,	3905,	9190,	5237,	9698,	20956,	22833,
5,	14658,	14081,	32450,	4501,	1753,	1446,	4466,	4736,	8751,	13147,
6,	12083,	7296,	4960,	11603,	1695,	635,	658,	4039,	4279,	5882,
7,	5241,	5765,	1925,	1603,	3312,	385,	213,	594,	3651,	2676,
8,	1406,	3014,	1950,	583,	423,	1019,	150,	192,	534,	2206,
+gp,	6964,	2823,	2036,	1788,	228,	251,	0,	64,	541,	643,
TOTAL,	443899,	358144,	320948,	164396,	113599,	140634,	202547,	197283,	296875,	227773,

Run title : Herring in the Northern part of VIa (run name: SVPAFIN)

At 28-Mar-93n 11:20

Traditional vpa Terminal populations from weighted Separable populations

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE											
1,	384891,	155108,	184371,	167073,	430866,	183618,	180615,	164721,	249370,	179976,	0,
2,	34329,	136839,	56889,	65177,	59203,	156899,	67417,	65881,	59298,	89064,	65666,
3,	27175,	18809,	79782,	35564,	33103,	35866,	102656,	45043,	42377,	40498,	62254,
4,	9710,	13936,	9410,	50379,	20205,	21292,	24364,	68681,	31128,	30671,	29165,
5,	11807,	6012,	8160,	6686,	32588,	13967,	15677,	19244,	51107,	23412,	23752,
6,	6367,	6655,	3540,	5768,	3991,	22732,	10142,	11506,	13474,	39932,	17511,
7,	3090,	3176,	4575,	2499,	3253,	2476,	16962,	8053,	8434,	9913,	30423,
8,	1331,	1405,	1693,	3406,	1978,	1960,	1830,	13126,	5819,	6355,	7898,
+gp,	1339,	622,	1115,	479,	3375,	2082,	3953,	3378,	3760,	8122,	11440,
TOTAL,	480040,	342562,	349534,	337030,	588561,	440892,	423617,	399633,	464767,	427945,	248109,

Table 5.1.11

Run title : Herring in the Northern part of VIa (run name: SVPAFIN)

At 28-Mar-93 11:20

Table 16 Summary (without SOP correction)

Traditional vpa Terminal populations from weighted Separable populations

	RECRUITS,	TOTALBIO,	TOTSPBIO,	LANDINGS,	FBAR 3- 6,
1970,	3729107,	1167840,	577118,	165930,	.4333,
1971,	10054171,	1642357,	388684,	207167,	.9576,
1972,	3074502,	1189939,	599584,	164756,	.4714,
1973,	1076780,	793735,	415182,	208270,	.6151,
1974,	1678531,	568902,	212064,	177458,	.9665,
1975,	2051893,	427261,	120250,	111922,	.9213,
1976,	573841,	256277,	93015,	93642,	1.0734,
1977,	634405,	158370,	56275,	41341,	.9624,
1978,	977263,	171969,	54693,	22176,	.6512,
1979,	1453199,	238070,	92120,	60,	.0010,
1980,	988768,	276630,	161707,	306,	.0018,
1981,	1830625,	398863,	165384,	51420,	.3451,
1982,	954177,	348996,	156673,	92361,	.5597,
1983,	3848913,	542404,	128118,	63523,	.4790,
1984,	1551075,	480959,	235958,	75154,	.4081,
1985,	1843706,	495710,	246286,	43814,	.2492,
1986,	1670725,	496600,	239499,	82280,	.3974,
1987,	4308655,	714595,	245208,	63007,	.2870,
1988,	1836177,	656167,	381124,	47354,	.2014,
1989,	1806155,	667762,	399935,	53039,	.1694,
1990,	1647214,	652295,	396629,	69959,	.2080,
1991,	2493701,	690425,	379523,	50606,	.1654,
1992,	1799761,	688357,	430818,	51585,	.1616,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),	

Table 5.1.12

Herring in the Northern part of VIa

Herring in the Northern part of VIa

Single option prediction: Input data

Year: 1992								
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
2	640000.00	0.3000	1.0000	0.6700	0.6700	0.164	0.6893	0.122
3	404980.00	0.2000	1.0000	0.6700	0.6700	0.208	1.0000	0.172
4	306710.00	0.1000	1.0000	0.6700	0.6700	0.233	1.0949	0.194
5	234120.00	0.1000	1.0000	0.6700	0.6700	0.246	1.2964	0.216
6	399320.00	0.1000	1.0000	0.6700	0.6700	0.252	1.2637	0.224
7	99130.000	0.1000	1.0000	0.6700	0.6700	0.258	1.2106	0.236
8	63550.000	0.1000	1.0000	0.6700	0.6700	0.269	1.2000	0.251
9+	81220.000	0.1000	1.0000	0.6700	0.6700	0.292	1.2000	0.258
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1993								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	640000.00	0.3000	1.0000	0.6700	0.6700	0.164	0.6893	0.122
3	.	0.2000	1.0000	0.6700	0.6700	0.208	1.0000	0.172
4	.	0.1000	1.0000	0.6700	0.6700	0.233	1.0949	0.194
5	.	0.1000	1.0000	0.6700	0.6700	0.246	1.2964	0.216
6	.	0.1000	1.0000	0.6700	0.6700	0.252	1.2637	0.224
7	.	0.1000	1.0000	0.6700	0.6700	0.258	1.2106	0.236
8	.	0.1000	1.0000	0.6700	0.6700	0.269	1.2000	0.251
9+	.	0.1000	1.0000	0.6700	0.6700	0.292	1.2000	0.258
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

(cont.)

Herring in the Northern part of VIa

Herring in the Northern part of VIa

Single option prediction: Input data

(cont.)

Year: 1994								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	640000.00	0.3000	1.0000	0.6700	0.6700	0.164	0.6893	0.122
3	.	0.2000	1.0000	0.6700	0.6700	0.208	1.0000	0.172
4	.	0.1000	1.0000	0.6700	0.6700	0.233	1.0949	0.194
5	.	0.1000	1.0000	0.6700	0.6700	0.246	1.2964	0.216
6	.	0.1000	1.0000	0.6700	0.6700	0.252	1.2637	0.224
7	.	0.1000	1.0000	0.6700	0.6700	0.258	1.2106	0.236
8	.	0.1000	1.0000	0.6700	0.6700	0.269	1.2000	0.251
9+	.	0.1000	1.0000	0.6700	0.6700	0.292	1.2000	0.258
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : LEIF1
Date and time: 30MAR93:10:31

Table 5.1.13

Herring in the Northern part of VIa

Herring in the Northern part of VIa

Single option prediction: Detailed tables

Year: 1992 F-factor: 0.1300 Reference F: 0.1513

						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
2	0.0896	47498	5788	640000	104960	640000	104960	492961	80846
3	0.1300	44842	7702	404980	84236	404980	84236	324647	67527
4	0.1423	38769	7503	306710	71463	306710	71463	260743	60753
5	0.1685	34603	7463	234120	57594	234120	57594	195570	48110
6	0.1643	57648	12909	399320	100629	399320	100629	334519	84299
7	0.1574	13755	3245	99130	25576	99130	25576	83428	21525
8	0.1560	8747	2199	63550	17095	63550	17095	53533	14401
9+	0.1560	11178	2884	81220	23716	81220	23716	68418	19978
Total		257040	49694	2229030	485268	2229030	485268	1813821	397438
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1993 F-factor: 0.1420 Reference F: 0.1653

						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
2	0.0979	51682	6298	640000	104960	640000	104960	490237	80399
3	0.1420	52133	8955	433486	90165	433486	90165	344715	71701
4	0.1555	39947	7731	291150	67838	291150	67838	245346	57166
5	0.1841	38573	8319	240703	59213	240703	59213	198984	48950
6	0.1794	28021	6275	178985	45104	178985	45104	148424	37403
7	0.1719	46145	10886	306581	79098	306581	79098	255521	65924
8	0.1704	11442	2877	76635	20615	76635	20615	63936	17199
9+	0.1704	16733	4318	112073	32725	112073	32725	93502	27302
Total		284676	55658	2279613	499718	2279613	499718	1840665	406044
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Herring in the Northern part of VIa

Herring in the Northern part of VIa

Single option prediction: Detailed tables

(cont.)

Year: 1994 F-factor: 0.1530 Reference F: 0.1781

						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
2	0.1055	55489	6762	640000	104960	640000	104960	487752	79991
3	0.1530	55421	9519	429915	89422	429915	89422	339365	70588
4	0.1675	45260	8759	307926	71747	307926	71747	257397	59974
5	0.1983	38674	8341	225509	55475	225509	55475	184651	45424
6	0.1933	30360	6799	181177	45657	181177	45657	148849	37510
7	0.1852	21811	5145	135349	34920	135349	34920	111805	28846
8	0.1836	37342	9388	233592	62836	233592	62836	193169	51962
9+	0.1836	23020	5940	143998	42047	143998	42047	119079	34771
Total		307377	60653	2297467	507065	2297467	507065	1842069	409066
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : LEIF1
Date and time : 30MAR93:10:31
Computation of ref. F: Simple mean, age 3 - 6
Prediction basis : F factors

Table 5.1.14. Output from an ADAPT implementation chosen to illustrate the worst-case scenario. The objective function used for the minimisation was:

<< NOTE TO TYPISTS : PLEASE CHANGE FONT TO LINE PRINTER 16.67 CPS in FOLLOWING TABLES >>

$$\sum_y (\ln(SSB) - \ln(Q.Acoustic\ SSB\ )^2 + \sum_y (\ln(SSB) - Q.\ln(Trimmed\ LA))^2$$

Output Generated by MC VPA

Fishing Mortality Matrix

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	
1	0.1058	0.0270	0.5051	0.0781	0.3332	0.1338	0.1825	0.0853	0.0364	0.0004	0.0210	0.0326	0.0225	0.0328	0.0030	0.0428	0.0418	0.0112	0.0021	0.0094	0.0285	0.0670	0.0211	
2	0.1806	0.4243	0.2963	0.5027	0.4975	0.7316	0.7390	0.3246	0.2684	0.0007	0.0026	0.2934	0.5846	0.3046	0.2283	0.1657	0.4122	0.2280	0.1380	0.1090	0.1565	0.1088	0.1397	
3	0.4168	1.1548	0.5132	0.5889	0.7734	0.8913	1.1916	0.5548	0.2403	0.0011	0.0019	0.3078	0.5203	0.4806	0.5000	0.2444	0.3541	0.2724	0.2179	0.2290	0.1804	0.1387	0.1784	
4	0.4467	0.9112	0.3413	0.6327	0.9182	0.8578	1.1102	0.8863	0.4594	0.0005	0.0025	0.3584	0.4649	0.3911	0.4541	0.2470	0.3095	0.2579	0.2406	0.1634	0.2285	0.1993	0.1785	
5	0.4383	0.7009	0.5045	0.5953	0.9425	0.9229	0.9000	1.0193	0.6758	0.0003	0.0011	0.2719	0.6032	0.3534	0.4498	0.2622	0.4286	0.2336	0.2082	0.2542	0.3226	0.1770	0.2087	
6	0.3265	0.9667	0.4627	0.6175	1.2202	1.0271	1.1343	1.5056	1.3558	0.0019	0.0008	0.2711	0.4757	0.5583	0.1841	0.2649	0.5160	0.3946	0.1688	0.1224	0.2691	0.2789	0.2151	
7	0.5778	0.4785	0.5847	0.3826	0.9087	1.0611	1.2233	1.0268	1.1044	0.0059	0.0069	0.2545	0.3764	0.5443	0.4742	0.1203	0.1443	0.4673	0.2150	0.1337	0.2082	0.2488	0.1831	
8	0.4473	0.7644	0.4733	0.5570	0.9974	0.9672	1.0920	1.1095	0.8988	0.0021	0.0028	0.2890	0.4800	0.4617	0.3906	0.2236	0.3496	0.3383	0.2082	0.1684	0.2571	0.2260	0.1963	
9	0.4473	0.7644	0.4733	0.5570	0.9974	0.9672	1.0920	1.1095	0.8988	0.0021	0.0028	0.2890	0.4800	0.4617	0.3906	0.2236	0.3496	0.3383	0.2082	0.1684	0.2571	0.2260	0.1963	

Estimated Trajectory of Population Parameters

Year.	SSB	. SSB sd .	F .	F sd .
1970	614034	0.00	0.4473	0.0000
1971	422364	0.00	0.7644	0.0000
1972	636212	0.00	0.4733	0.0000
1973	421207	0.00	0.5570	0.0000
1974	216776	0.00	0.9974	0.0000
1975	121743	0.00	0.9672	0.0000
1976	98888	0.00	1.0920	0.0000
1977	65182	0.00	1.1095	0.0000
1978	65219	0.00	0.8988	0.0000
1979	102772	0.00	0.0021	0.0000
1980	179647	0.00	0.0028	0.0000
1981	182633	0.00	0.2890	0.0000
1982	173649	0.00	0.4800	0.0000
1983	141556	0.00	0.4617	0.0000
1984	251485	0.00	0.3906	0.0000
1985	261608	0.00	0.2236	0.0000
1986	248210	0.00	0.3496	0.0000
1987	237418	0.00	0.3383	0.0000
1988	353220	0.00	0.2082	0.0000
1989	368149	0.00	0.1684	0.0000
1990	360175	0.00	0.2571	0.0000
1991	318738	0.00	0.2260	0.0000
1992	295921	0.00	0.1963	0.0000
1993	264689	0.00		

Estimated F in the last year is an arithmetic mean between ages 4 and 7

Method : ADAPT with 1 Monte-Carlo iterations run

Table 5.1.15 Output from an ADAPT implementation based on the same assumptions as the final VPA in Section 5.1.9.

$$\sum_y (\ln(SSB)-\ln(Acoustic))^2$$
$$+\sum_y (\ln(SSB)-Q_{lai}\ln(LAI)+K_{lai})^2$$
$$+\sum_y (\ln(SSB))-Q_{lpe}\ln(LPE)+K_{lpe})^2$$

Fishing Mortality Matrix

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.1058	0.0270	0.5051	0.0780	0.3330	0.1334	0.1808	0.0844	0.0360	0.0004	0.0206	0.0321	0.0218	0.0304	0.0027	0.0394	0.0366	0.0093	0.0016	0.0069	0.0198	0.0448	0.0131
2	0.1806	0.4243	0.2963	0.5027	0.4974	0.7311	0.7359	0.3206	0.2651	0.0007	0.0026	0.2873	0.5748	0.2944	0.2100	0.1492	0.3720	0.1963	0.1122	0.0833	0.1120	0.0739	0.0903
3	0.4168	1.1547	0.5132	0.5888	0.7733	0.8910	1.1895	0.5504	0.2364	0.0010	0.0019	0.2997	0.5041	0.4671	0.4753	0.2201	0.3096	0.2364	0.1812	0.1793	0.1330	0.0950	0.1155
4	0.4467	0.9112	0.3413	0.6327	0.9180	0.8575	1.1092	0.8820	0.4534	0.0005	0.0024	0.3540	0.4472	0.3723	0.4341	0.2297	0.2701	0.2158	0.2010	0.1313	0.1694	0.1392	0.1159
5	0.4383	0.7009	0.5045	0.5953	0.9424	0.9225	0.8994	1.0168	0.6688	0.0003	0.0010	0.2675	0.5912	0.3336	0.4177	0.2460	0.3876	0.1961	0.1671	0.2030	0.2459	0.1240	0.1365
6	0.3265	0.9667	0.4627	0.6174	1.2201	1.0267	1.1328	1.5017	1.3449	0.0018	0.0007	0.2655	0.4647	0.5389	0.1709	0.2388	0.4703	0.3403	0.1368	0.0949	0.2027	0.1963	0.1416
7	0.5778	0.4785	0.5847	0.3825	0.9086	1.0608	1.2221	1.0231	1.0945	0.0058	0.0068	0.2498	0:3657	0.5236	0.4475	0.1104	0.1272	0.4034	0.1769	0.1051	0.1551	0.1748	0.1196
8	0.4473	0.7643	0.4733	0.5570	0.9973	0.9669	1.0909	1.1059	0.8904	0.0021	0.0028	0.2842	0.4672	0.4421	0.3675	0.2062	0.3138	0.2889	0.1704	0.1336	0.1933	0.1586	0.1284
9	0.4473	0.7643	0.4733	0.5570	0.9973	0.9669	1.0909	1.1059	0.8904	0.0021	0.0028	0.2842	0.4672	0.4421	0.3675	0.2062	0.3138	0.2889	0.1704	0.1336	0.1933	0.1586	0.1284

Estimated Trajectory of Population Parameters

Year.	SSB	. SSB se .	F .	F se .
1970	614041	0.00	0.4473	0.0000
1971	422374	0.00	0.7643	0.0000
1972	636243	0.00	0.4733	0.0000
1973	421243	0.00	0.5570	0.0000
1974	216818	0.00	0.9973	0.0000
1975	121812	0.00	0.9669	0.0000
1976	99245	0.00	1.0909	0.0000
1977	65805	0.00	1.1059	0.0000
1978	66161	0.00	0.8904	0.0000
1979	104150	0.00	0.0021	0.0000
1980	182809	0.00	0.0028	0.0000
1981	186668	0.00	0.2842	0.0000
1982	178788	0.00	0.4672	0.0000
1983	147822	0.00	0.4421	0.0000
1984	272197	0.00	0.3675	0.0000
1985	289938	0.00	0.2062	0.0000
1986	283019	0.00	0.3138	0.0000
1987	280966	0.00	0.2889	0.0000
1988	435341	0.00	0.1704	0.0000
1989	474229	0.00	0.1336	0.0000
1990	492901	0.00	0.1933	0.0000
1991	464296	0.00	0.1586	0.0000
1992	459866	0.00	0.1284	0.0000
1993	439894	0.00		

Estimated F in the last year is an arithmetic mean between ages 4 and 7

Method : ADAPT with 1 Monte-Carlo iterations run

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	926	-	-	-	926	2 300
1993						1 000

Table 5.2.2 Sampling levels of Clyde HERRING 1988-1991.

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	919	23	4,604	1,579	No information

Table 5.2.3 Effort on Clyde herring. Number of days' absence from port by pair trawlers in the Firth of Clyde, 1974 to 1992, 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

Table 5.2.4 Clyde Herring catch in numbers at age. Spring and autumn spawners combined. Thousands of fish.

Age	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
10+	117	181	132	114	59	67	100	192	236	154
Total	36546	20822	20567	24411	22258	20328	20477	19287	23180	9050

Age	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
10+	68	18	53	38	80	240	79	175	16	5
Total	8967	9667	20224	19647	28279	21357	20092	17905	9451	13383

Age	1990	1991	1992
1	716	42	327
2	1004	615	1004
3	839	472	648
4	7533	703	520
5	576	1908	1947
6	359	169	420
7	329	92	130
8	119	113	133
9	49	22	39
10+	16	9	31
Total	11540	4145	5199

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 catch									Mean weights in stock (spring spawners only)	
	1970-81	1982-85	1986	1987	1988	1989	1990	1991	1992	Feb[1] 1991	Mar[2] 1991
2	225	149	166	149	156	149	170	143	141	-	-
3	270	187	199	194	194	174	186	163	187	171	173
4	290	228	224	203	207	203	202	188	188	195	218
5	310	253	253	217	211	221	216	192	216	210	215
6	328	272	265	225	222	227	237	198	227	210	245
7	340	307	297	236	230	235	234	210	206	234	-
8	345	291	298	247	225	237	234	222	218	-	-
9	350	300	298	255	244	219	257	200	201	-	-
10+	350	300	321	258	230	254	272	203	221	-	-

Table 5.2.6 Estimated catches by number of herring at each maturity stage by month of 1992. Allocation to spring/autumn spawners using the Race/Maturity key given in the 1992 Working Group report.

Month	1-2	3	4-5	6-7	8	Spring	Autumn
Jan	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Feb	365	226	42152	111	16049	42263	16049
Mar	2393	17388	19488	12067	28579	31555	
Apr	4652	625	625	34447	123274	35072	
May	1562	30814	1654	23388	46287		
Jun	280	38148	2970		23588		
Jul	2806	32901	4540		15674		0
Aug	82774	165663	311480	2653	156116	156116	146483
Sep	n/s	n/s	n/s	n/s	n/s		
Oct	n/s	n/s	n/s	n/s	n/s		
Nov	208561	317883	323171	6308	94031	636486	10876
Dec	n/s	n/s	n/s	n/s	n/s		
			Total identifiable:			901492	173408
			As % of total catch:			27.0	5.2

a/s = No sample.

Table 5.2.7 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
Egg survey:							
Spring spawners							
Ballantrae				760	5,200	4,843	2,984
Brown Head						1,187	3,976
Total						6,130	6,960
Acoustic survey							
Total (2+ ringers)		6,600	9,000	16,100	12,400	18,400	11,900

Table 5.2.8 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
1	5.8	11.3	10.4				
2	7.9	3.3	18.8	0.7	1.1		0.25
3	31.8	36.1	32.7	23.5	93.0	0.9	0.75
4	25.4	24.0	12.9	35.6	2.6	97.5	3.99
5	14.6	16.3	7.0	16.4	1.9	1.2	93.02
6	5.9	3.6	7.2	10.7	0.4	0.3	1.75
7	4.3	2.5	3.7	7.8	0.7		0.25
8	2.9	1.9	4.1	4.0			
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 5.2.9. Estimates of Clyde herring abundance at age from acoustic surveys. Thousands of fish.

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, 1982-1992.

Country	1983	1984	1985	1986	1987
France	19	-	-	-	-
Germany, Fed.Rep.	-	-	-	-	-
Ireland	15,000	10,000	13,900	15,540	15,000
Netherlands	5,000	6,400	1,270	1,550	1,550
UK (N.Ireland)	-	-	-	-	5
UK (England + Wales)	-	-	-	-	51
UK Scotland	-	-	-	-	-
Unallocated	13,000	11,000	8,204	11,785	31,994
Total landings	33,019	27,400	23,374	28,785	48,600
Discards	-	-	-	-	-
Total catch	33,019	27,400	23,374	28,785	48,600

Country	1988	1989	1990	1991	1992[1]
France	-	-	+	-	-
Germany, Fed.Rep.	-	-	-	-	250
Ireland	15,000	18,200	25,000	22,500	26,000
Netherlands	300	2,900	2,533	600	900
UK (N.Ireland)	-	-	80	-	-
UK (England + Wales)	-	-	-	-	-
UK (Scotland)	-	+	-	+	-
Unallocated	13,800	7,100	13,826	11,200	4,600
Total landings	29,100	28,200	41,439	34,300	31,750
Discards	-	1,000	2,530	3,400	100
Total catch	29,100	29,200	43,969	37,700	31,850

[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

Table 6.1.3 Sampling intensity of commercial catches.

Country	Catch (t)	No. of samples	No. of age readings	No. of fish measured	Estimates of discards
Ireland	26,000	56	2,509	12,653	No
Netherlands	1,000	1	26	112	Yes

Table 6.1.4 Divisions VIa(S) and VIIb.
Length distributions of Irish catches (pelagic trawlers) per quarter (10^3).

Length	1st quarter	2 quarter	3 quarter	4 quarter
21.0	53	-	12	179
21.5	13	-	38	536
22.0	40	-	75	459
22.5	67	10	75	485
23.0	67	36	44	714
23.5	280	143	50	689
24.0	293	276	31	893
24.5	1200	727	181	1837
25.0	1227	803	281	3444
25.5	1787	1213	325	5613
26.0	1987	1965	563	9873
26.5	3467	2303	694	13164
27.0	5014	3429	775	17348
27.5	5214	3946	1075	20817
28.0	4734	2646	1019	21200
28.5	3254	1330	769	14057
29.0	2454	742	425	8087
29.5	1494	307	263	3903
30.0	667	107	169	3317
30.5	280	36	119	1429
31.0	120	15	88	842
31.5	40	-	31	306
32.0	13	-	-	153
Total	33765	20035	7103	129344

Table 6.5.1 Herring west of Ireland & Porcupine Bank and lower part of Division VIa. Results of the separable VPA.

Separable analysis
from 1970 to 1991 on ages 1 to 8
with Terminal F of .400 on age 4 and Terminal S of 1.200

Initial sum of squared residuals was 378.071 and
final sum of squared residuals is 67.610 after 94 iterations

Matrix of Residuals

Years,	1970/71,
Ages	
1/ 2,	-.655,
2/ 3,	2.073,
3/ 4,	.630,
4/ 5,	.027,
5/ 6,	-.425,
6/ 7,	-.315,
7/ 8,	-.520,
,	.000,
WTS ,	.001,

Years,	1971/72,	1972/73,	1973/74,	1974/75,	1975/76,	1976/77,	1977/78,	1978/79,	1979/80,	1980/81,
Ages										
1/ 2,	.164,	-.119,	2.147,	.838,	2.085,	1.884,	.885,	1.756,	1.708,	1.002,
2/ 3,	-.268,	.335,	.858,	.677,	.700,	.820,	.810,	1.336,	.568,	.224,
3/ 4,	.352,	.293,	.161,	.039,	-.294,	-.023,	-.461,	.138,	-.221,	.187,
4/ 5,	.063,	-.233,	-.121,	.143,	-.290,	-.226,	-.159,	.030,	-.216,	-.041,
5/ 6,	-.078,	-.201,	-.298,	-.043,	-.048,	-.138,	.137,	-.134,	.018,	-.224,
6/ 7,	.077,	.079,	.067,	-.101,	.246,	-.026,	.232,	-.310,	.083,	.096,
7/ 8,	-.463,	.292,	-.631,	-.845,	-.459,	-.211,	-.689,	-.807,	-.347,	-.282,
,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years,	1981/82,	1982/83,	1983/84,	1984/85,	1985/86,	1986/87,	1987/88,	1988/89,	1989/90,	1990/91,		,,WTS
Ages												
1/ 2,	.647,	-.295,	-1.308,	1.536,	2.288,	.100,	2.009,	-3.010,	1.201,	-.314,	.000,	.125,
2/ 3,	.579,	-.014,	.339,	.698,	.117,	.123,	.071,	-.500,	-.178,	.475,	.000,	.294,
3/ 4,	-.064,	-.170,	.149,	.593,	-.092,	-.049,	.003,	.326,	-.542,	.260,	.000,	.551,
4/ 5,	-.074,	-.049,	.217,	.106,	-.383,	-.085,	-.263,	.253,	.035,	.061,	.000,	.974,
5/ 6,	-.211,	.015,	-.189,	-.457,	.059,	.230,	-.116,	.006,	-.019,	-.099,	.000,	1.000,
6/ 7,	.554,	.275,	.108,	.038,	.112,	-.119,	-.028,	.261,	-.086,	-.030,	.000,	.848,
7/ 8,	-1.014,	-.167,	-.329,	-1.015,	-.130,	-.171,	.306,	-.327,	.648,	-.448,	.000,	.397,
,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	15.793,	
WTS ,	.001,	.001,	.001,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)

	1970,	1971,								
F-values	.2244,	.1911,								
	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
F-values	.2655,	.3479,	.5100,	.5430,	.6576,	.4296,	.3424,	.3579,	.4993,	.3904,
	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
F-values	.3038,	.4932,	.2593,	.2353,	.2360,	.4667,	.3037,	.2782,	.3786,	.4000,

Selection-at-age (S)

	1,	2,	3,	4,	5,	6,	7,	8,
S-values	.0051,	.2907,	.7777,	1.0000,	1.1046,	1.2032,	1.5204,	1.2000,

Table 6.5.2 Herring west of Ireland & Porcupine Bank and lower part of Division VIa. Summary table from the VPA run with a terminal F = 0.3.

Table 17 Summary (with SOP correction)

Traditional vpa Terminal populations from weighted Separable populations

	RECRUITS,	TOTALBIO,	TOTSPBIO,	LANDINGS,	SOPCOFAC,	FBAR 2- 7,	FBAR 3- 7,
1970,	390663,	172370,	101118,	20306,	.8968,	.2526,	.2227,
1971,	788086,	196728,	91265,	15044,	.8707,	.1781,	.2035,
1972,	705669,	211328,	100234,	23474,	.8975,	.2517,	.2777,
1973,	509497,	245073,	132613,	36719,	1.0162,	.3087,	.3309,
1974,	557817,	199113,	87613,	36589,	.9762,	.4512,	.5007,
1975,	379900,	190142,	90156,	38764,	1.1237,	.4894,	.5341,
1976,	641398,	182847,	63771,	32767,	1.0472,	.5789,	.6382,
1977,	532276,	169443,	70920,	20567,	1.0778,	.3772,	.4014,
1978,	951613,	213742,	69833,	19715,	1.0161,	.3127,	.3203,
1979,	872204,	244652,	96858,	22608,	1.0664,	.3315,	.3611,
1980,	485141,	195262,	95450,	30124,	.9636,	.4594,	.5198,
1981,	596057,	204509,	94738,	24922,	1.0312,	.3586,	.3990,
1982,	617209,	204487,	97655,	19209,	1.0301,	.2700,	.3039,
1983,	2069487,	383784,	90694,	32988,	1.0042,	.4538,	.4944,
1984,	847067,	305183,	155873,	27450,	.9688,	.2408,	.2626,
1985,	1107715,	303600,	152285,	23343,	.9846,	.2133,	.2443,
1986,	860854,	320074,	185863,	28785,	1.0002,	.2151,	.2420,
1987,	2862572,	489549,	155420,	48600,	.9488,	.4467,	.5009,
1988,	343284,	353620,	245918,	29100,	.9992,	.2955,	.3481,
1989,	732429,	326734,	177926,	29210,	1.0010,	.2325,	.2659,
1990,	1006587,	321693,	154559,	43969,	1.0006,	.3177,	.3585,
1991,	615421,	258032,	144597,	37700,	.9971,	.3041,	.3421,
1992,	2682737,	433853,	120011,	31856,	.9951,	.2967,	.3396,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 7.1.1 HERRING. Total catches (t) in North Irish Sea (Division VIIa, North), 1980-1992 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
France	-	-	-	-	-	-
Ireland	1,200	2,579	1,430	1,699	80	406
UK	3,290	7,593	3,532	4,613	4,318	4,864
Unallocated	1,333	-	-	-	-	-
Total	5,823	10,172	4,962	6,312	4,398	5,270

Table 7.1.2 HERRING. Sampling intensity of commercial landings for Division VIIa (N) in 1992.

Quarter	Country	Landings (t)	No. samples	No. fish measured	No. fish aged	Estimation of discards
	Ireland	0	-	-	-	-
	UK (N.Ireland)	1	0	0	0	No
	UK (Isle of Man)	0	-	-	-	-
1	UK (Scotland)	0	-	-	-	-
	Ireland	0	-	-	-	-
	UK (N.Ireland)	85	0	0	0	No
2	UK (Isle of Man)	0	2	547	100	No
	UK (Scotland)	0	0	-	-	-
	Ireland	300	2	323	50	No
	UK (N.Ireland)	2,289	6	683	270	No
3	UK (Isle of Man)	741	11	2,941	580	No
	UK (Scotland)	+	0	0	0	No
		+				
	Ireland	106	1	270	49	No
	UK (N.Ireland)	1,745	10	905	500	No
4	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	+	0	0	0	No

+ = <1t.

Table 7.1.3 Herring in the North Irish Sea (manx plus mourne herring, Division VIIa(N).

Traditional vpa Terminal populations from weighted Separable populations

0 Table 1 Catch numbers at age Numbers*10**-3

	YEAR,	1972,
	AGE	
	1,	40640,
	2,	46660,
	3,	26950,
	4,	13180,
	5,	13750,
	6,	6760,
	7,	2660,
	+gp,	1670,
0	TOTALNUM,	152270,
	TONSLAND,	27350,
	SOPCOF %,	112,

0 Table 1 Catch numbers at age Numbers*10**-3

	YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
	AGE										
	1,	42150,	43250,	33330,	34740,	30280,	15540,	11770,	5840,	5050,	5100,
	2,	32740,	109550,	48240,	56160,	39040,	36950,	38270,	25760,	15790,	16030,
	3,	38240,	39750,	39410,	20780,	22690,	13410,	23490,	19510,	3200,	5670,
	4,	11490,	24510,	10840,	15220,	6750,	6780,	4250,	8520,	2790,	2150,
	5,	6920,	10650,	7870,	4580,	4520,	1740,	2200,	1980,	2300,	330,
	6,	5070,	4990,	4210,	2810,	1460,	1340,	1050,	910,	330,	1110,
	7,	2590,	5150,	2090,	2420,	910,	670,	400,	360,	290,	140,
	+gp,	2600,	1630,	1640,	1270,	1120,	350,	290,	230,	240,	380,
0	TOTALNUM,	141800,	239480,	147630,	137980,	106770,	76780,	81720,	63110,	29990,	30910,
	TONSLAND,	22600,	38640,	24500,	21250,	15410,	11080,	12338,	10613,	4377,	4855,
	SOPCOF %,	101,	100,	103,	99,	95,	92,	93,	97,	91,	98,

1

0 Table 1 Catch numbers at age Numbers*10**-3

	YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
	AGE										
	1,	1305,	1168,	2429,	4491,	2225,	2607,	1156,	2313,	1999,	12145,
	2,	12162,	8424,	10050,	15266,	12981,	21250,	6385,	12835,	9754,	6885,
	3,	5598,	7237,	17336,	7462,	6146,	13343,	12039,	5726,	6743,	6744,
	4,	2820,	3841,	13287,	8550,	2998,	7159,	4708,	9697,	2833,	6690,
	5,	445,	2221,	7206,	4528,	4180,	4610,	1876,	3598,	5068,	3256,
	6,	484,	380,	2651,	3198,	2777,	5084,	1255,	1661,	1493,	5122,
	7,	255,	229,	667,	1464,	2328,	3232,	1559,	1042,	719,	1036,
	+gp,	59,	479,	724,	877,	1671,	4213,	1956,	1615,	815,	392,
0	TOTALNUM,	23128,	23979,	54350,	45836,	35306,	61498,	30934,	38487,	29424,	42270,
	TONSLAND,	3933,	4066,	9187,	7440,	5823,	10172,	4949,	6312,	4398,	5270,
	SOPCOF %,	98,	96,	102,	98,	104,	105,	100,	101,	100,	101,

1

Table 7.1.4 HERRING in Division VIIa (North). Catch at length for 1988-1992. Numbers of fish in thousands.

Length	1988	1989	1990	1991	1992
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
	306	214	318	174	1,189
20	385	226	791	454	1,268
	265	244	472	341	705
21	482	320	735	469	705
	530	401	447	296	597
22	763	453	935	438	664
	1,205	497	581	782	927
23	2,101	612	2,400	1,790	1,653
	3,573	814	1,908	1,974	1,156
24	5,046	1,183	3,474	2,842	1,575
	5,447	1,656	2,818	2,311	2,412
25	5,276	2,206	4,803	2,734	2,792
	4,634	2,720	3,688	2,596	3,268
26	4,082	3,555	4,845	3,278	3,865
	4,570	3,293	3,015	2,862	3,908
27	4,689	2,847	3,014	2,412	3,389
	4,124	2,018	1,134	1,449	2,203
28	3,406	1,947	993	922	1,440
	2,916	1,586	582	423	569
29	2,659	1,268	302	293	278
	1,740	997	144	129	96
30	1,335	801	146	82	70
	685	557	57	36	36
31	563	238	54	12	2
	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

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

Table 7.3.1. Comparison between estimated stock size and distribution of numbers with age from acoustic surveys in July/August and catches in Division VIIa(N).

Age (rings)	1991 Numbers (thousands)		1992 Numbers (thousands)	
	Acoustic	Catch	Acoustic	Catch
1	120927	1999	50118	12145
2	41426	9754	8751	6885
3	13088	6743	10755	6744
4	3281	2833	11284	6690
5	10884	5068	5658	3256
6	1082	1493	15884	5122
7	447	719	4158	1036
8+	198	815	4200	392
Total	191333	29424	110878	42270

Table 7.3.2 Acoustic surveys in Division VIIa(N).

Year	Location	Dates of survey	Adult Herring (t)	Sprat (t)
1989	Douglas Bank spawning ground	25-26 Sept	18,000	0
1990	Douglas Bank spawning ground	26-27 Sept	26,600	0
1991	VIIa(N) mainly west side and Isle of Man	26th July-8th Aug.	10,300	66,000
1992	VIIa(N) mainly west side and Isle of Man	20th-31st July	10,400	41,200

Table 7.4.1 Herring in the North Irish Sea (manx plus mourne herring, Division VIIa(N)).

Separable analysis
from 1972 to 1992 on ages 1 to 7
with Terminal F of .300 on age 3 and Terminal S of 1.000

Initial sum of squared residuals was 137.429 and
final sum of squared residuals is 19.581 after 67 iterations

Matrix of Residuals

Years, Ages	1972/73,	1973/74,	1974/75,	1975/76,	1976/77,	1977/78,	1978/79,	1979/80,	1980/81,	1981/82,
1/ 2,	1.556,	.998,	1.149,	.941,	1.161,	1.027,	.505,	.654,	-.275,	.044,
2/ 3,	-.594,	-.360,	-.033,	.027,	-.156,	-.016,	-.393,	-.162,	.521,	.190,
3/ 4,	-.006,	.207,	.136,	.032,	-.053,	.017,	.208,	.077,	.288,	-.477,
4/ 5,	-.204,	-.159,	-.038,	-.067,	.023,	.155,	.179,	-.181,	-.347,	1.282,
5/ 6,	.059,	.009,	-.348,	.004,	-.151,	-.087,	-.538,	-.160,	.030,	-.210,
6/ 7,	-.030,	-.369,	-.438,	-.500,	-.195,	-.558,	.132,	-.002,	-.669,	-.145,
,	-.002,	-.002,	-.001,	.000,	.000,	.001,	.002,	.004,	.009,	.014,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years, Ages	1982/83,	1983/84,	1984/85,	1985/86,	1986/87,	1987/88,	1988/89,	1989/90,	1990/91,	1991/92,		,,WTS
1/ 2,	.262,	-.306,	.336,	-.404,	.244,	-.065,	.133,	-.536,	-.128,	.588,	.000,	.277,
2/ 3,	.221,	.166,	-.154,	-.282,	.233,	.204,	-.440,	.023,	-.029,	.244,	.001,	.592,
3/ 4,	-.158,	.009,	-.062,	.089,	.204,	.047,	-.007,	.103,	.000,	-.143,	.001,	1.000,
4/ 5,	.749,	-.096,	-.056,	.481,	.035,	-.206,	.314,	.182,	-.028,	-.262,	.001,	.431,
5/ 6,	-1.291,	-.254,	.321,	.134,	-.274,	-.049,	.189,	-.044,	.121,	-.213,	.001,	.492,
6/ 7,	.491,	.262,	-.128,	-.148,	-.513,	-.064,	.004,	-.044,	.011,	.097,	.001,	.564,
,	.009,	.004,	.001,	.000,	.000,	.001,	.000,	.001,	.001,	.001,	3.803,	
WTS ,	.001,	.001,	.001,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)

	1972,
F-values	.6294,

	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
F-values	.5350,	.9818,	.8867,	1.0284,	.9818,	.8477,	.8814,	.9802,	.4391,	.2933,

	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
F-values	.1736,	.1556,	.3863,	.3302,	.2391,	.4540,	.2519,	.3316,	.2416,	.3000,

Selection-at-age (S)

	1,	2,	3,	4,	5,	6,	7,
S-values	.0752,	.8509,	1.0000,	1.0662,	1.1272,	1.1070,	1.0000,

Table 7.4.2 Herring in the North Irish Sea (manx plus mourne herring, Division VIIa(N)).

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR,	1972,
AGE	
1,	.1669,
2,	.3625,
3,	.5357,
4,	.5518,
5,	.6518,
6,	.6850,
7,	.6271,
+gp,	.6271,
FBAR 2- 6,	.5574,

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
1,	.1043,	.2140,	.1527,	.2295,	.1573,	.1029,	.1420,	.0615,	.0362,	.0352,
2,	.3459,	.8243,	.7527,	.7960,	.8560,	.5331,	.7455,	1.0630,	.4141,	.2642,
3,	.6165,	1.0230,	.9060,	.9780,	1.0064,	.9211,	.8570,	1.2901,	.3695,	.2723,
4,	.4359,	1.0126,	.8456,	1.0976,	.9992,	.9381,	.8257,	.8585,	.5889,	.4312,
5,	.5574,	.8164,	.9733,	.9681,	1.0660,	.6737,	.8170,	1.0774,	.5222,	.1112,
6,	.4701,	.8989,	.8020,	1.0482,	.8575,	.9786,	1.0200,	.8614,	.4441,	.4556,
7,	.5396,	1.1094,	1.1184,	1.5015,	1.0872,	1.1608,	.7956,	1.1128,	.6580,	.3045,
+gp,	.5396,	1.1094,	1.1184,	1.5015,	1.0872,	1.1608,	.7956,	1.1128,	.6580,	.3045,
FBAR 2- 6,	.4852,	.9151,	.8560,	.9776,	.9570,	.8089,	.8530,	1.0301,	.4678,	.3069,

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	FBAR 90-92
AGE											
1,	.0089,	.0141,	.0255,	.0398,	.0127,	.0374,	.0108,	.0252,	.0271,	.0226,	.0250,
2,	.1859,	.1213,	.2760,	.3860,	.2644,	.2760,	.2051,	.2711,	.2401,	.2079,	.2397,
3,	.1467,	.1704,	.4158,	.3622,	.2813,	.5100,	.2643,	.3047,	.2371,	.2767,	.2728,
4,	.2004,	.1350,	.5047,	.3523,	.2292,	.5802,	.3212,	.3340,	.2302,	.3697,	.3113,
5,	.1320,	.2146,	.3554,	.2846,	.2593,	.5737,	.2592,	.3852,	.2603,	.3981,	.3479,
6,	.2114,	.1428,	.3788,	.2351,	.2526,	.5059,	.2662,	.3416,	.2430,	.4031,	.3292,
7,	.1589,	.1314,	.3529,	.3301,	.2399,	.4604,	.2531,	.3281,	.2169,	.2370,	.2606,
+gp,	.1589,	.1314,	.3529,	.3301,	.2399,	.4604,	.2531,	.3281,	.2169,	.2370,	
FBAR 2- 6,	.1753,	.1568,	.3861,	.3241,	.2574,	.4892,	.2632,	.3273,	.2422,	.3311,	

Table 7.4.3 Herring in the North Irish Sea (manx plus mourne herring). Traditional VPA terminal populations from weighted separable populations.

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1972,
AGE	
1,	412649,
2,	176043,
3,	71059,
4,	32508,
5,	30010,
6,	14244,
7,	5969,
+gp,	3748,
TOTAL,	746229,

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
1,	667713,	348933,	367779,	263071,	324943,	249341,	139067,	154229,	223762,	232589,
2,	128474,	221316,	103630,	116142,	76935,	102143,	82759,	44389,	53356,	79387,
3,	90764,	67342,	71898,	36165,	38815,	24214,	44400,	29090,	11359,	26126,
4,	34048,	40117,	19821,	23789,	11135,	11616,	7892,	15428,	6555,	6427,
5,	16939,	19922,	13187,	7699,	7182,	3710,	4114,	3127,	5916,	3292,
	14150,	8778,	7968,	4508,	2646,	2238,	1711,	1644,	963,	3176,
	6497,	8002,	3233,	3233,	1430,	1016,	761,	558,	629,	559,
+gp,	6523,	2533,	2537,	1697,	1760,	531,	552,	357,	520,	1518,
TOTAL,	965109,	716943,	590052,	456302,	464847,	394808,	281257,	248824,	303061,	353072,

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	GMST 72-90	AMST 72-9(
AGE													
1,	233400,	132075,	152401,	181726,	278818,	111915,	170761,	146598,	117964,	859986,	0,	226574,	252199,
2,	82605,	85104,	47909,	54654,	64248,	101278,	39659,	62147,	52587,	42236,	309315,	81751,	90641,
3,	45156,	50815,	55845,	26933,	27523,	36538,	56931,	23933,	35108,	30643,	25416,	39256,	43942,
4,	16291,	31926,	35085,	30169,	15350,	17008,	17963,	35784,	14448,	22677,	19024,	18572,	21522,
5,	3778,	12064,	25240,	19165,	19192,	11044,	8615,	11789,	23184,	10385,	14177,	9427,	11894,
6,	2665,	2996,	8808,	16006,	13046,	13400,	5631,	6015,	7257,	16169,	6311,	5033,	6873,
7,	1822,	1952,	2350,	5457,	11448,	9169,	7311,	3904,	3868,	5149,	9777,	2631,	3963,
+gp,	422,	4083,	2551,	3269,	8217,	11953,	9173,	6051,	4385,	1948,	5067,		
TOTAL,	386139,	321014,	330188,	337380,	437844,	312306,	316044,	296222,	258801,	989193,	389087,		

Table 7.4.4 Herring in the North Irish Sea (manx plus mourne herring, Division VIIa(N)).

Table 17 Summary (with SOP correction)

Traditional vpa Terminal populations from weighted Separable populations

	RECRUITS,	TOTALBIO,	TOTSPBIO,	LANDINGS,	SOPCOFAC,	FBAR 2- 6,
1972,	412649,	102952,	36387,	27350,	1.1200,	.5574,
1973,	667713,	106222,	31607,	22600,	1.0073,	.4852,
1974,	348933,	91247,	23483,	38640,	.9958,	.9151,
1975,	367779,	70009,	16681,	24500,	1.0260,	.8560,
1976,	263071,	53561,	12210,	21250,	.9927,	.9776,
1977,	324943,	46897,	8837,	15410,	.9538,	.9570,
1978,	249341,	40098,	10038,	11080,	.9243,	.8089,
1979,	139067,	32759,	9058,	12338,	.9296,	.8530,
1980,	154229,	27868,	5523,	10613,	.9701,	1.0301,
1981,	223762,	27640,	7026,	4377,	.9092,	.4678,
1982,	232589,	37523,	12850,	4855,	.9837,	.3069,
1983,	233400,	43859,	18802,	3933,	.9838,	.1753,
1984,	132075,	41766,	23354,	4066,	.9623,	.1568,
1985,	152401,	43521,	18508,	9187,	1.0202,	.3861,
1986,	181726,	39326,	17588,	7440,	.9767,	.3241,
1987,	278818,	44075,	18766,	5823,	1.0382,	.2574,
1988,	111915,	40493,	18158,	10172,	1.0521,	.4892,
1989,	170761,	37167,	16148,	4949,	1.0034,	.2632,
1990,	146598,	35818,	15656,	6312,	1.0130,	.3273,
1991,	117964,	29659,	14724,	4398,	1.0006,	.2422,
1992,	859985,	71230,	13630,	5270,	1.0111,	.3311,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

Table 7.5.1 Herring in the North Irish Sea (manx plus mourne herring). Input variables for prediction and prediction for 1993.

Single option prediction: Input data

Year: 1993								
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	155000.00	1.0000	0.0800	0.9000	0.7500	0.061	0.0752	0.062
2	58430.000	0.3000	0.8500	0.9000	0.7500	0.111	0.8509	0.114
3	25416.000	0.2000	1.0000	0.9000	0.7500	0.136	1.0000	0.140
4	19024.000	0.1000	1.0000	0.9000	0.7500	0.151	1.0660	0.155
5	14177.000	0.1000	1.0000	0.9000	0.7500	0.159	1.1270	0.165
6	6311.000	0.1000	1.0000	0.9000	0.7500	0.171	1.1070	0.174
7	9777.000	0.1000	1.0000	0.9000	0.7500	0.179	1.0000	0.181
8+	5067.000	0.1000	1.0000	0.9000	0.7500	0.191	1.0000	0.197
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1994								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	155000.00	1.0000	0.0800	0.9000	0.7500	0.061	0.0752	0.062
2	.	0.3000	0.8500	0.9000	0.7500	0.111	0.8509	0.114
3	.	0.2000	1.0000	0.9000	0.7500	0.136	1.0000	0.140
4	.	0.1000	1.0000	0.9000	0.7500	0.151	1.0660	0.155
5	.	0.1000	1.0000	0.9000	0.7500	0.159	1.1270	0.165
6	.	0.1000	1.0000	0.9000	0.7500	0.171	1.1070	0.174
7	.	0.1000	1.0000	0.9000	0.7500	0.179	1.0000	0.181
8+	.	0.1000	1.0000	0.9000	0.7500	0.191	1.0000	0.197
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : PREDMEAN2
Date and time: 31MAR93:12:29

cont'd.

Table 7.5.1 Cont'd.

Single option prediction: Detailed tables

Year: 1993 F-factor: 0.4881 Reference F: 0.5028

Age	Absolute 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
1	0.0367	3542	220	155000	9455	12400	756	5667	346
2	0.4153	17334	1976	58430	6486	49666	5513	27290	3029
3	0.4881	8968	1256	25416	3457	25416	3457	14099	1917
4	0.5203	7375	1143	19024	2873	19024	2873	11050	1669
5	0.5501	5734	946	14177	2254	14177	2254	8017	1275
6	0.5403	2518	438	6311	1079	6311	1079	3600	616
7	0.4881	3608	653	9777	1750	9777	1750	5846	1046
8+	0.4881	1870	368	5067	968	5067	968	3030	579
Total		50949	7000	293202	28321	141838	18650	78600	10476
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1994 F-factor: . Reference F: .

Age	Absolute 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
1	.	0	0	155000	9455	12400	756	.	.
2	.	0	0	54966	6101	46721	5186	.	.
3	.	0	0	28575	3886	28575	3886	.	.
4	.	0	0	12773	1929	12773	1929	.	.
5	.	0	0	10231	1627	10231	1627	.	.
6	.	0	0	7401	1266	7401	1266	.	.
7	.	0	0	3327	595	3327	595	.	.
8+	.	0	0	8244	1575	8244	1575	.	.
Total		0	0	280516	26433	129671	16820	.	.
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : PREDMEAN2
Date and time : 31MAR93:12:29
Computation of ref. F: Simple mean, age 2 - 6
Prediction basis : TAC constraints

Table 8.1.1 Sprat catches in the North Sea ('000 t), 1982-1992. 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[1]	1992
					Division IVa West						
Denmark	-	-	-	0.9	0.6	0.2	0.1	+	-		0.26[1]
Germany	-	-	-	-	-	-	-	-	-		-
Netherlands	-	-	-	6.7	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	0.1	-
UK (Scotland)	+	-	+	6.1	+	+	-	-	+	-	-
Total	+	-	+	13.7	0.6	0.2	0.1	+	+	0.1	0.26
					Division IVa East (North Sea) stock						
Denmark	+	-	-	+	0.2	+	+	+	-	-	-
Norway	0.3	-	-	-	-	-	-	-	-	-	0.64[1]
Sweden	-	-	-	-	-	-	-	-	+[5]	2.5	-
Total	0.3	-	-	+	0.2	+	+	+	+	2.5	0.64
					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[1]
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-
Norway	10.2	0.9	0.5	-	-	-	3.5	0.1	1.2	4.4[1]	17.9[1]
UK (England)	-	-	+	-	-	-	-	-	-	-	0.48[1]
UK (Scotland)	0.2	+	+	-	-	0.1	-	-	-	-	-
Total	33.5	33.5	6.1	1.8	0.4	3.5	4.9	2.1	11.2	13.8	38.26
					Division IVb East						
Denmark	91.2	39.2	62.1	36.6	10.3	28.0	80.7	59.2	59.2	67.0	66.49[1]
Germany	1.5	-	0.6	0.6	0.6[3]	-	-	-	-	-	-
Norway	7.6	10.8	3.1	-	-	-	0.6	-	0.6	25.1[1]	10.0[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
					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[1]
France	-	-	-	-	+	-	-	+[2]	-	+[2]	-
Netherlands	-	-	0.1	-	-	-	0.4	0.4[2,3]	-	+[2,3]	-
Norway	2.2	0.5	3.4	-	-	-	-	-	-	-	-
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]
Total	20.1	5.1	4.9	3.4	4.3	0.7	1.1	1.8	1.7	3.5	8.61
					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[1]
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
Sweden	-	-	-	-	-	-	-	-	+[2]	+[2]	-
UK (England)	14.9	3.6	0.9	3.4	4.1	0.7	0.6	0.9	0.2	1.8	6.6[1]
UK (Scotland)	0.2	+	+	-	+	0.2	-	-	+	-	-
Total	153.8	88.4	76.7	49.6	16.4	33.1	87.4	63.3	71.2	109.5	124.28

[1]Preliminary. [2]Official statistics. [3]Includes Divisions IVa-e. [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, 1983-1992.

1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
3.2	4.4	7.1	2.2	8.3	-[1]	2.4	2.7	3.2	3.8

[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). 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

Table 8.2.1 North Sea Sprat. Catch in numbers (millions) taken by quarter in 1988 to 1992 by Denmark, Norway, and UK (England).

Country	Fishing area	Quarter	Age 0	1	2	3	4	5
1988								
Denmark	North Sea	1		0.24	23.04	1.19	-	-
	(Sub-area IV)	2	-	1.05	101.47	5.23	-	-
		3	-	471.43	4,615.42	9.68	-	-
		4	-	37.63	461.13	2.36	-	-
UK (Engl.)	Thames (Div.IVc)	1	-	7.53	34.24	6.89	1.66	0.14
Norway	North Sea	3	-	0.4	125.6	48.7	3.9	-
	(Division IVb)	4	0.7	11.0	13.2	6.2	-	-
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
Total			236.89	8,801.13	2,139.62	404.62	39.78	7.30

[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 Demark and UK (England) as provided by Working Group members.

	1992					
Quarter	AGE					
	0	1	2	3	4	5
1	-	3.13[1]	11.0[1]	15.00[1]	24.0[3]	-
2	-	6.56[2]	14.58[2]	18.97[2]	22.68[2]	-
3	6.80[2]	8.92[2]	13.99[2]	16.73[2]	20.27[2]	18.00[2]
4	5.16[1]	12.20[1]	17.78[1]	22.90[1]	19.00[1]	17.70[1]

[1]Denmark and UK (England)
[2]Denmark only.
[3]UK (England) only.

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	2,261.57

Table 9.1.1 Nominal catch of sprat in Divisions VIId,e, 1982-1992.

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992[1]
Belgium	-	3	-	-	-	-	-	-	-	-	-
Denmark	286	638	1,417	-	15	250	2,529	2,092	608	-	-
France	44	60	47	14	-	23	2	10	-	-	35
Germany	-	-	-	-	-	-	-	-	-	-	-
Netherlands	1,533	1,454	589	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-	-
UK (Engl.& Wales	4,749	4,756	2,402	3,771	1,163	2,441	2,944	1,319	1,508	2,567	1,790
Total	6,612	6,011	4,455	33,785	1,178	2,714	5,475	3,421	2,116	2,567	1,825

[1]Preliminary

Table 9.1.2 Lyme Bay area fishery monthly catches (t) (UK vessels only).

Season	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
1991/92	0	205	450	952	60	358	258	109	51	2443
1992/93	0	30	472	189	294	243	255[1]	158[1]	2[1]	1650[1]

[1]Provisional.

Table 9.2.1 Lyme Bay sprat fishery. Number caught by age group (millions.

Season	0/1	[1]1/2	[1]2/3	[1]3/4	[1]4/5	[1]5/6
1991/92	1.7	56.03	44.69	16.24	0.57	0.03
1992/93	0.22	2.67	41.5	12.6	1.57	

[1]August to December only (samples in Aug & Dec 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	12.2	22.1	25	33		22
	4		15.1	19.4	23.5	24.3		20.3

Table 10.1.1 Landings of SPRAT in Division IIIa (tonnes 10^{-3}). (Data provided by Working Group members).

Year	Skagerrak Denmark	Skagerrak Sweden	Skagerrak Norway	Skagerrak Total	Kattegat Denmark	Kattegat Sweden	Kattegat Total	Div. IIIa 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 Denmark	Skagerrak Norway	Kattegat Denmark	Div. IIIa Sweden	Division IIIa Total
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]	1.1	0.4	2.2	6.6	10.3

[1]Preliminary.

Table 10.1.2 Landings of sprat (tonnes) by quarter by the three countries from Division IIIa, 1992. (Data provided by the Working Group members).

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

Table 10.2.1 Landed numbers (millions) of sprat by age groups by the Danish fleet from Division IIIa, 1992.

Quarter	Age						Total
	0	1	2	3	4	5+	
1	-	-	46.22	3.43	0.34	-	49.99
2	-	-	11.71	1.09	0.14	-	12.94
3	0.19	15.42	14.55	1.99	0.23	-	32.19
4	0.07	7.51	0.79	0.04	0.01	0.01	8.55
Total year	0.07	340.07	73.27	6.55	0.72	0.01	420.69

Table 10.2.2 Mean weights (g) at age (w.r.) of sprat in Division IIIa 1992 (Danish data).

Quarter	Area	AGE					
		0	1	2	3	4	5+
1	Skagerrak		4.8	14.5	20.9		
	Kattegat		4.7	16.7	15.9	23.0	
	Division IIIa		4.7	16.3	18.3	23.0	
2	Skagerrak		5.7	16.0			
	Kattegat		5.9	16.9	19.6	22.0	
	Division IIIa		5.9	16.6	19.6	22.0	
3	Skagerrak		15.2	18.9	21.1	27.5	
	Kattegat		15.2	18.9	21.1	27.5	
	Division IIIa		15.2	18.9	21.1	27.5	
4	Skagerrak	3.1	16.1	20.8	23.1	28.0	31.0
	Kattegat	4.4	15.0	21.8	23.0		
	Division IIIa	3.6	15.4	21.6	23.1	28.0	31.0
Total year	Skagerrak	3.1	5.6	16.0	21.0	27.6	31.0
	Kattegat	4.4	5.8	17.2	18.6	24.0	
	Division IIIa	3.6	5.7	16.9	19.4	24.3	31.0

Table 10.3.1 Indices of sprat, 1-group, 2-group, > =3-group and all ages in Division IIIa from IBTS, 1984-1993. (Mean no./hr per rectangle weighted by area. Only hauls taken in depths of 10-150 m are included in the estimates).

Year	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	1660	4620	1366	7646

Table 10.3.2 Rectangle weights used in weighting of IBTS 1-group indices.

Rectangle weight	
46GO	0.05
46G1	0.02
45F9	0.00
45GO	0.03
45G1	0.03
44F8	0.03
44F9	0.09
44GO	0.08
44G1	0.06
43F8	0.09
43F9	0.04
43GO	0.02
43G1	0.08
43G2	0.01
42GO	0.03
42G1	0.10
41GO	0.01
42G2	0.07
41G2	0.11
41G2	0.06

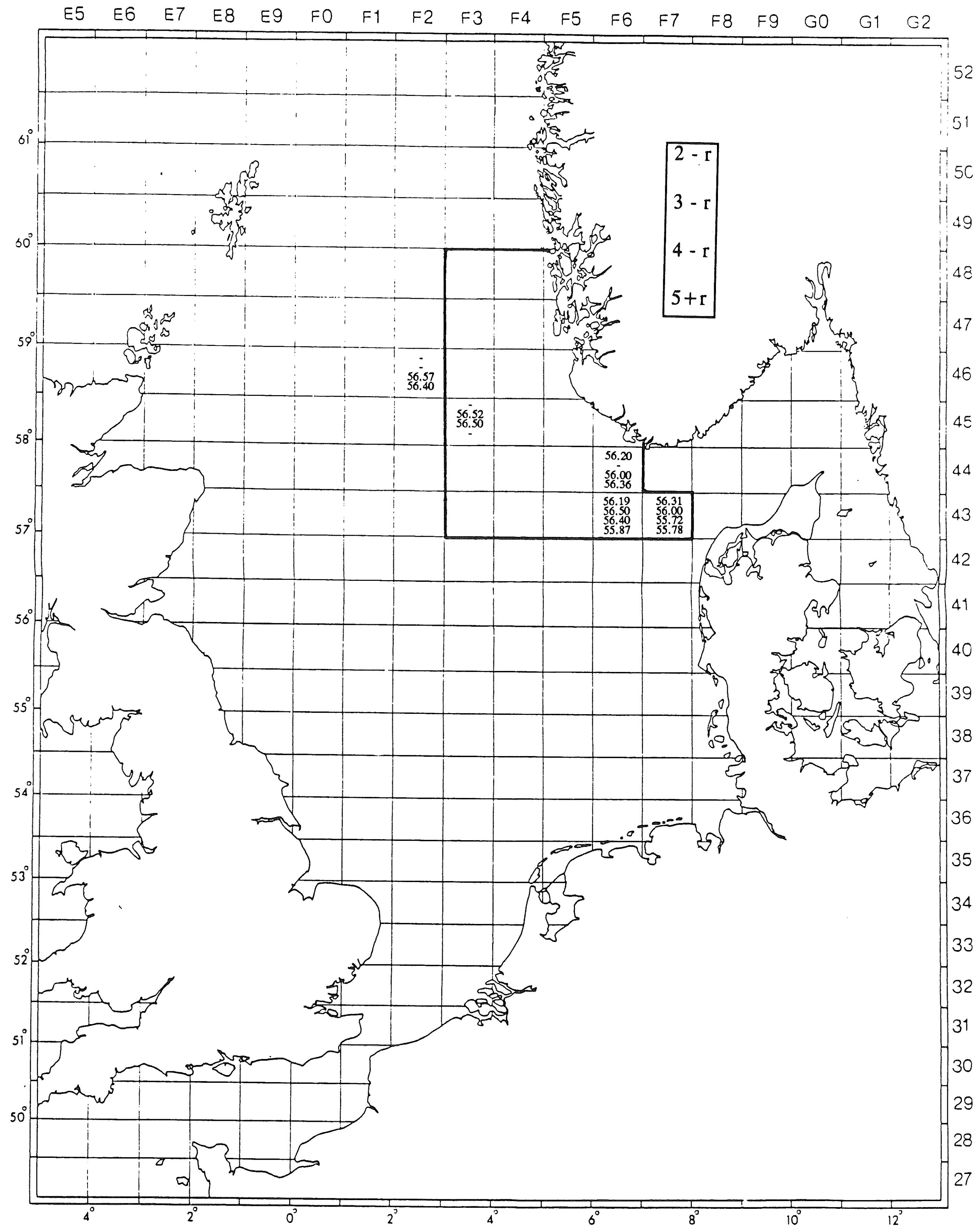


Figure 2.2.1 Mean vertebral counts of herring from samples in May 1991.

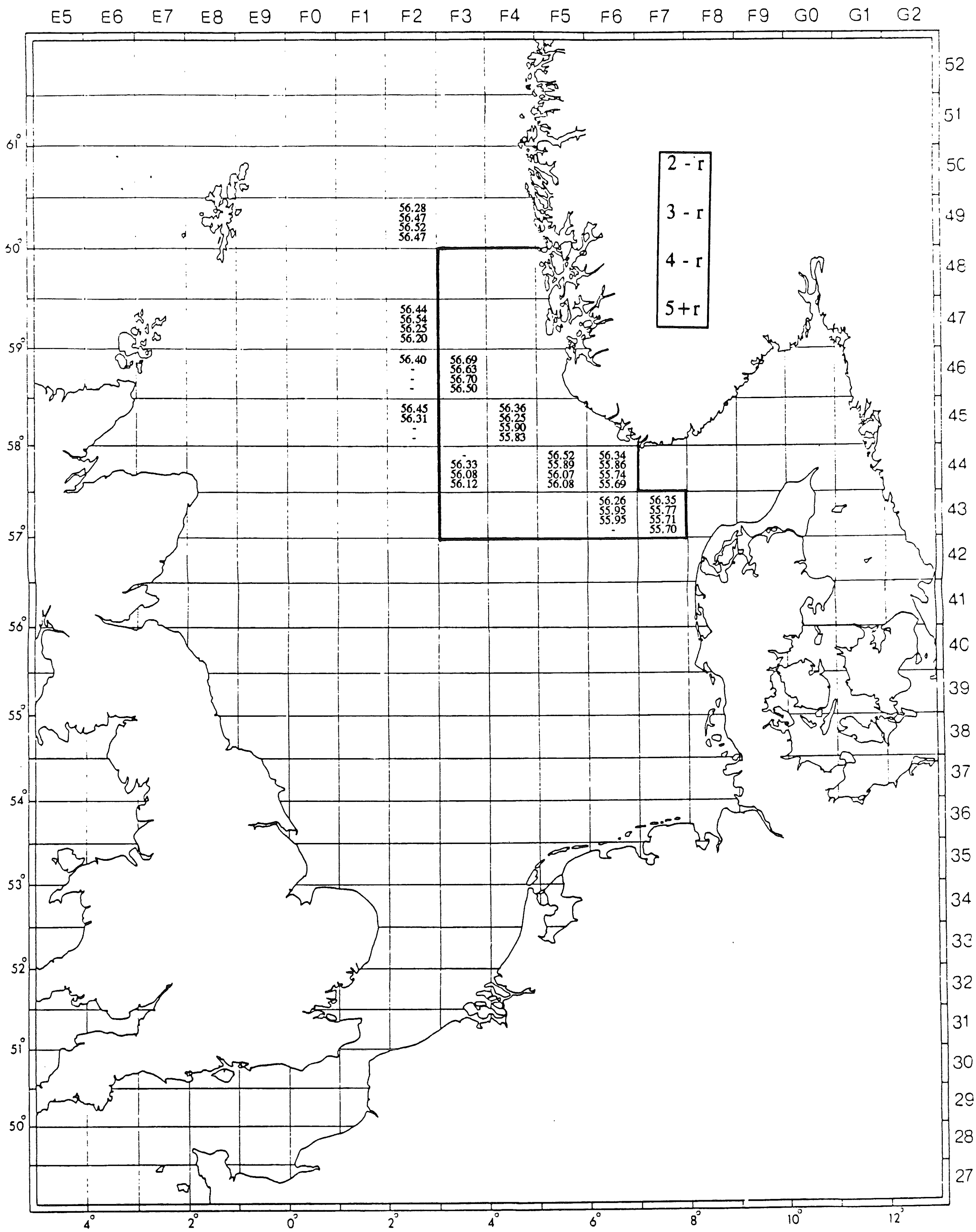


Figure 2.2.2 Mean vertebral counts of herring from samples in June 1991.

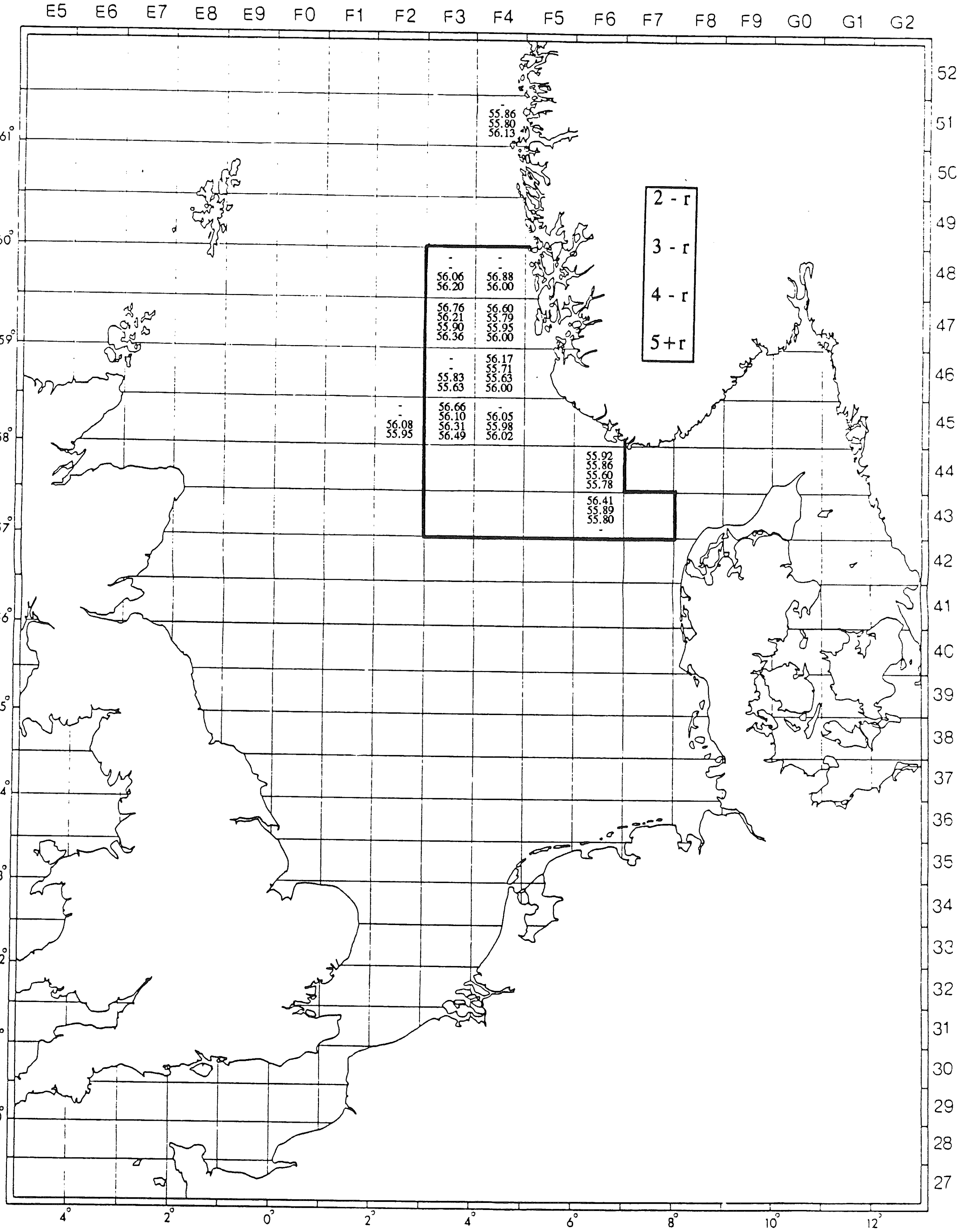


Figure 2.2.3 Mean vertebral counts of herring from samples in July 1991.

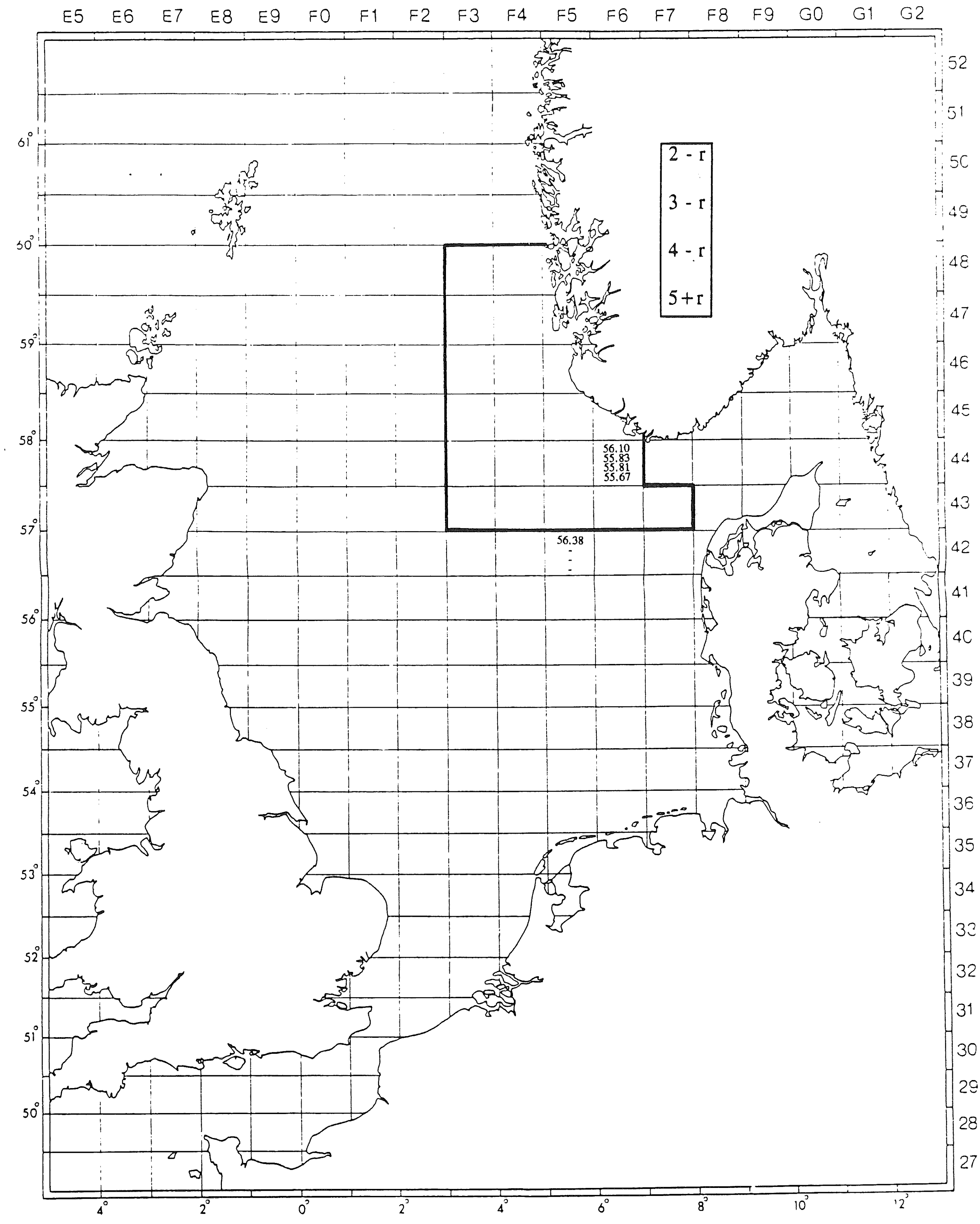


Figure 2.2.4 Mean vertebral counts of herring from samples in August 1991.

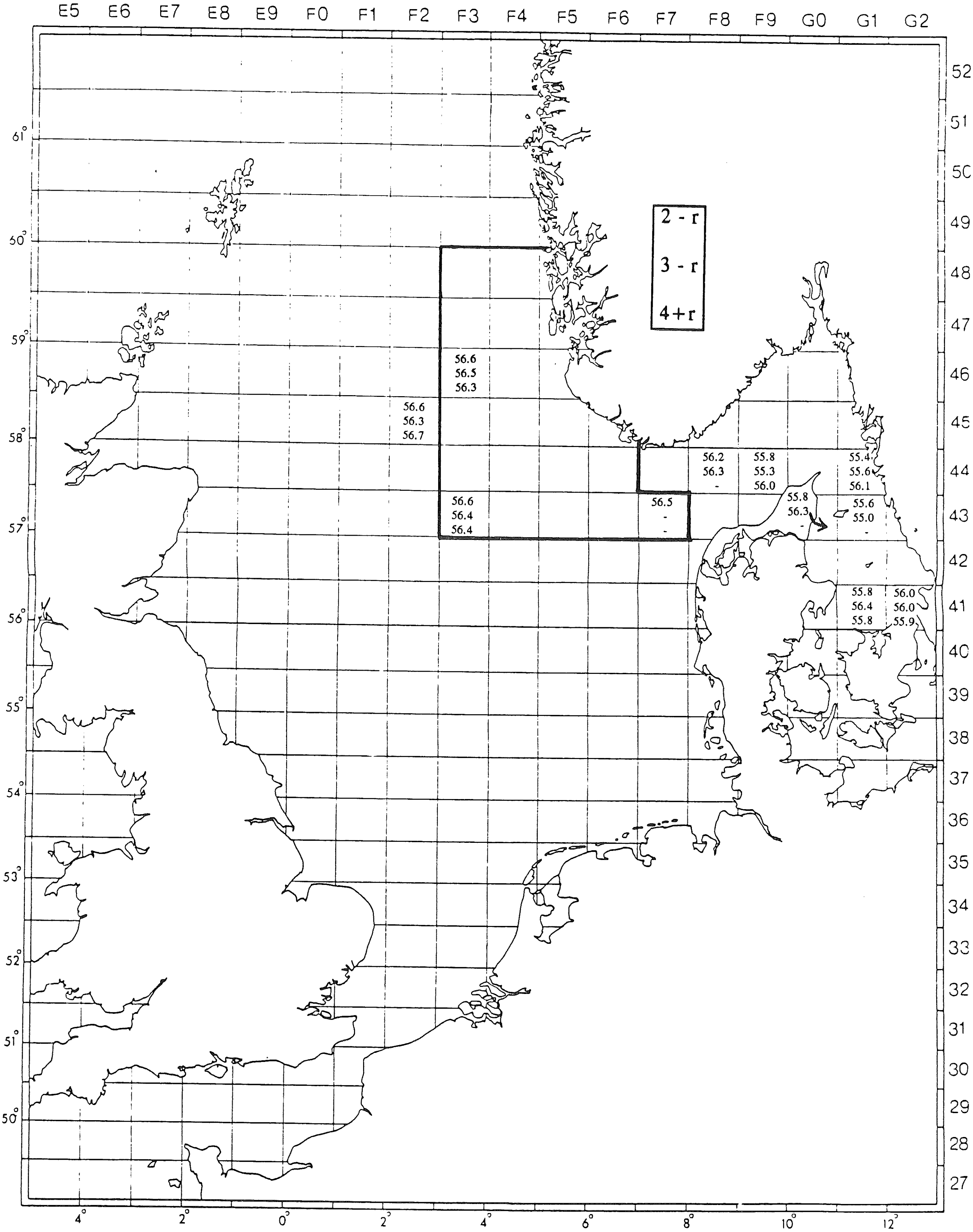


Figure 2.2.5 Mean vertebral counts of herring from samples in May 1992.

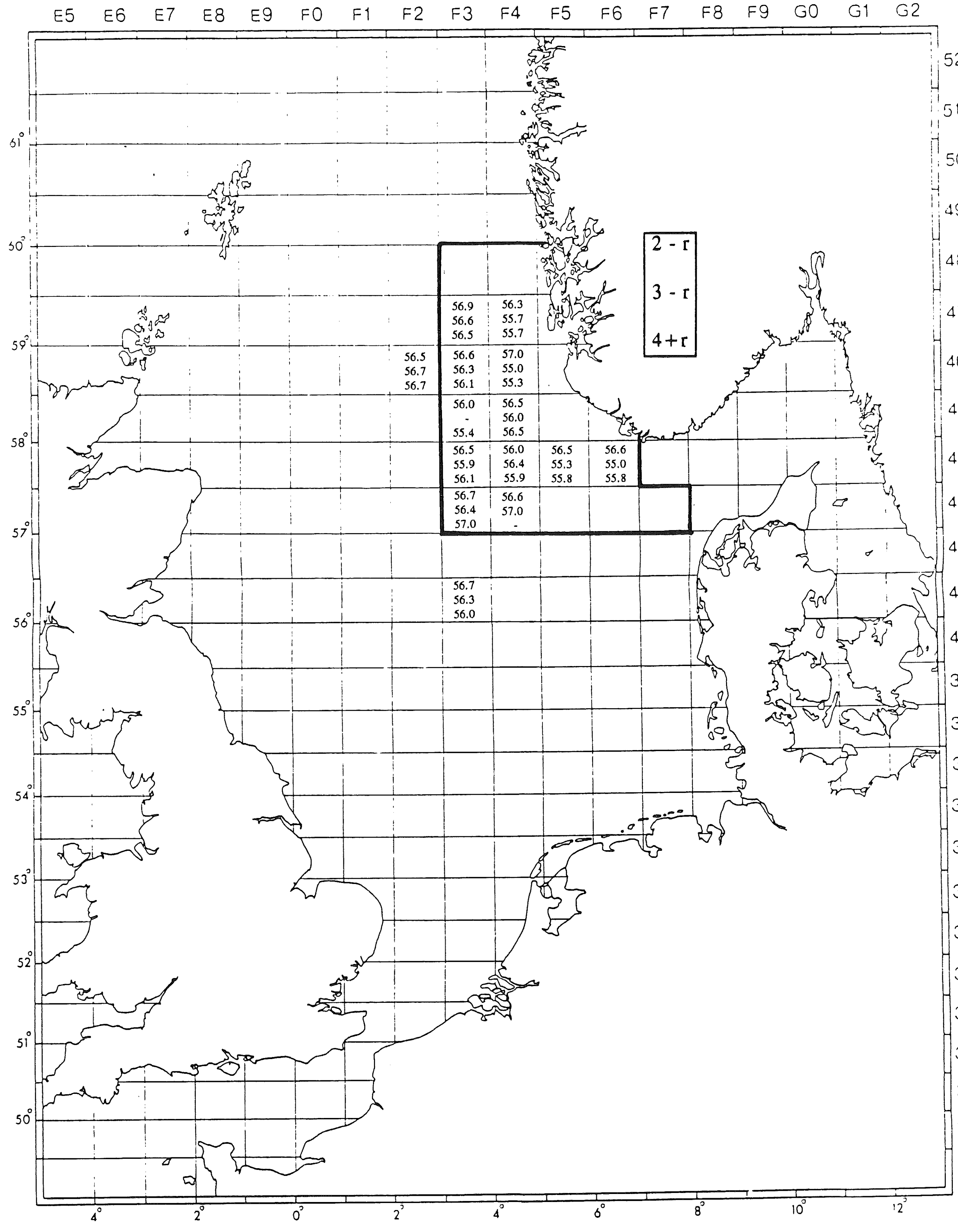


Figure 2.2.6 Mean vertebral counts of herring from samples in June 1992.

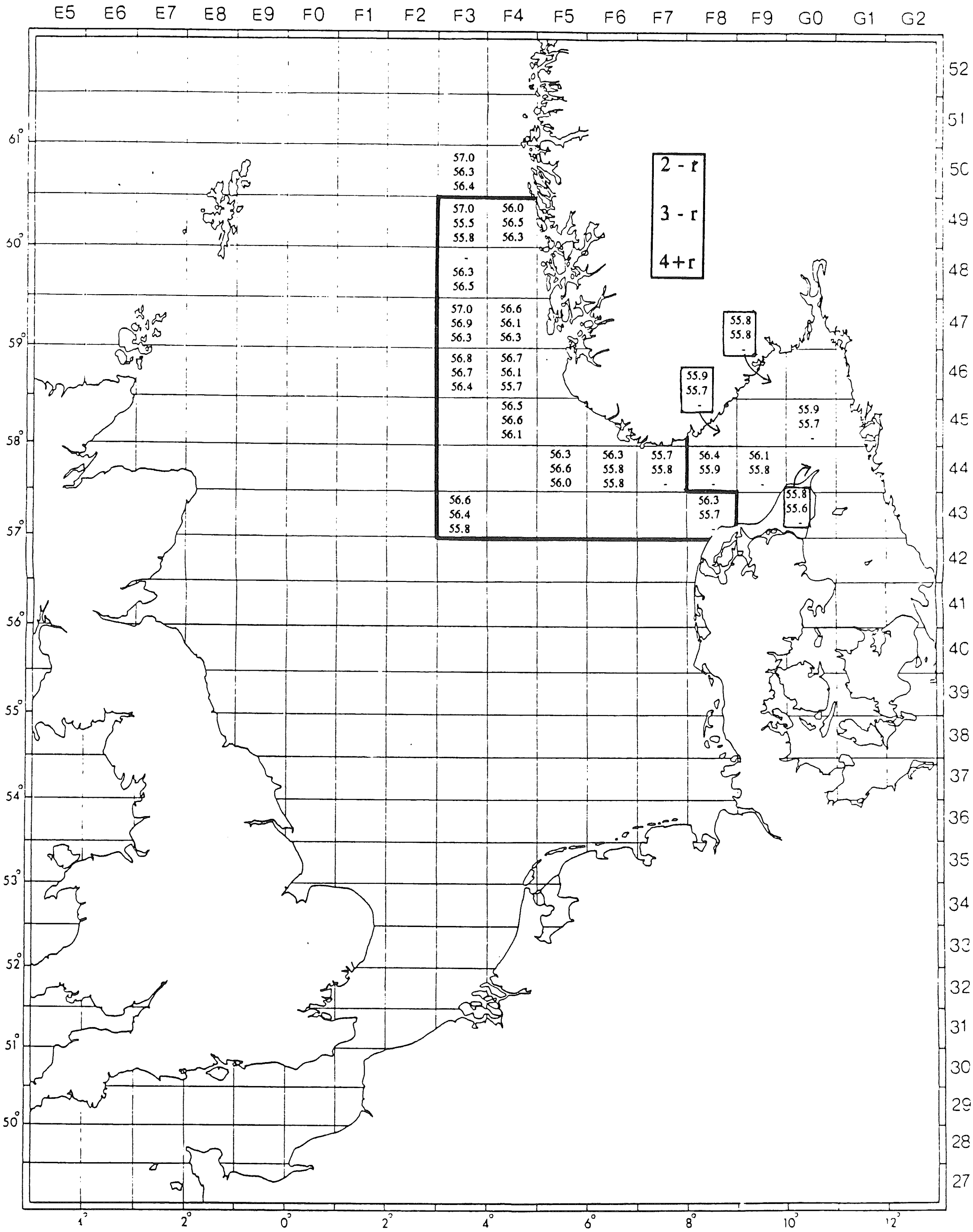


Figure 2.2.7 Mean vertebral counts of herring from samples in July 1992.

Figure 2.3.1 Regression of VPA 1-ringers on IBTS 1-ringer index.

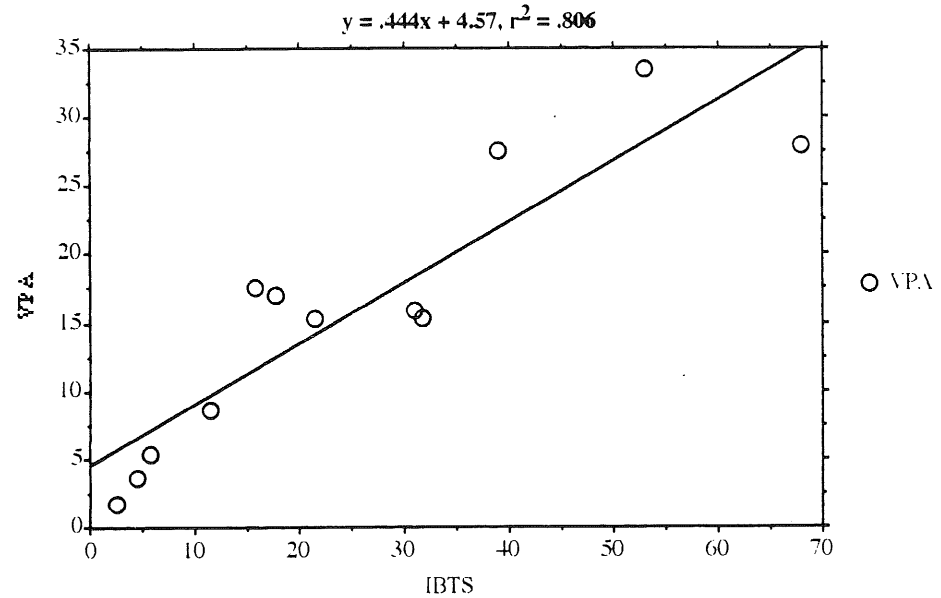


Figure 2.3.2 Regression of VPA 0-ringers on MIK 0-ringer index.

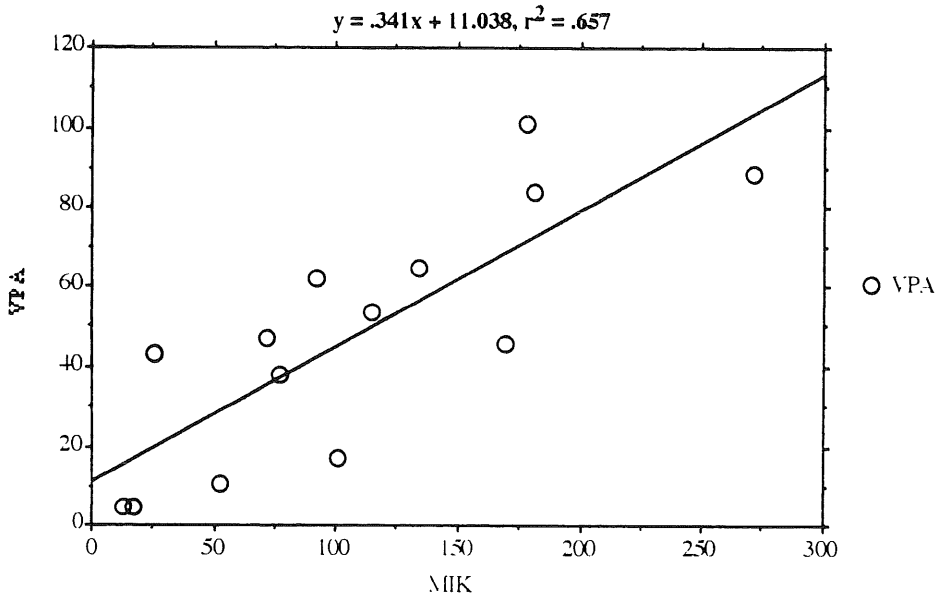


Figure 2.3.3 Relationship between IBTS 1-ringer index and MIK 0-ringer index for the same year class.

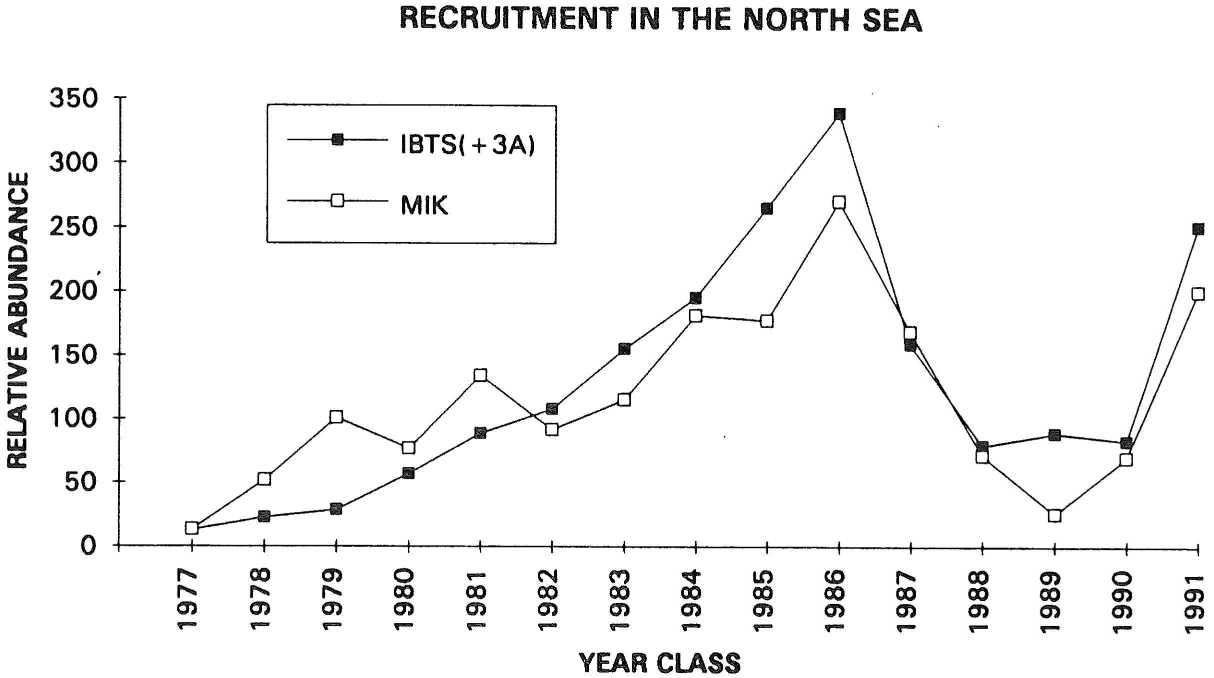


Figure 2.3.4 Correlation between IBTS 1-ringer index and MIK 0-ringer index for the same year class.

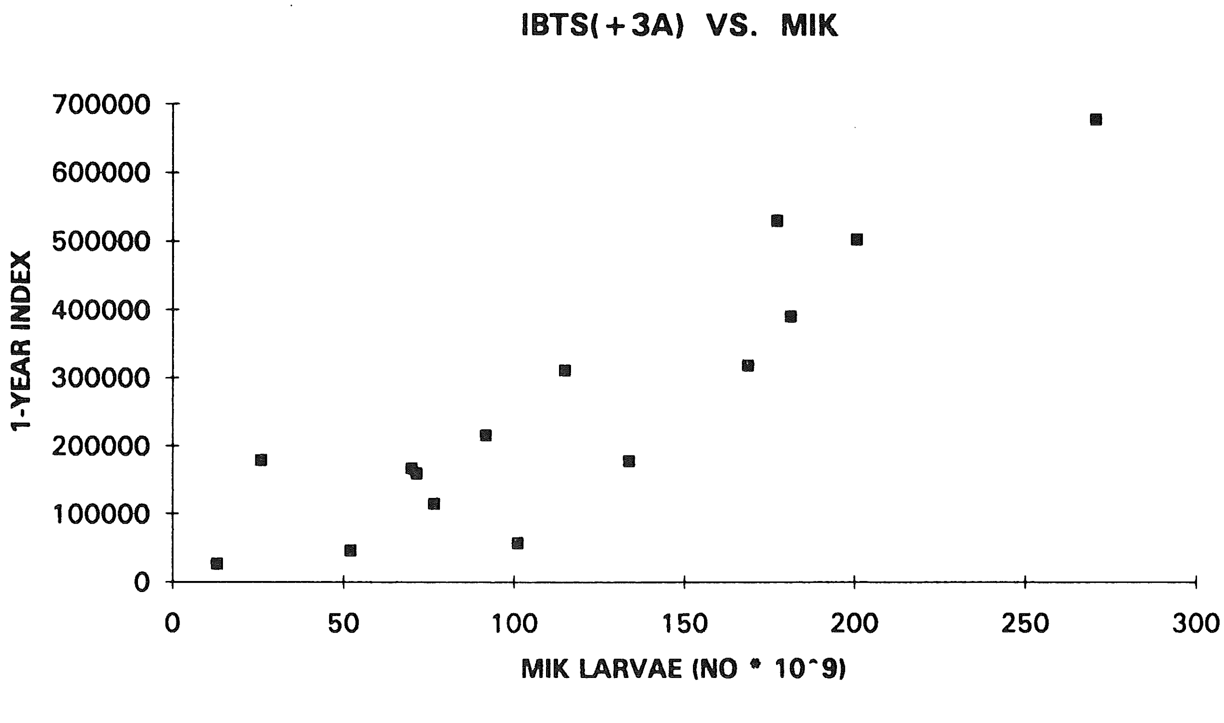


Figure 2.3.5 Distribution of 0-ringers, year classes 1990-1992. Density of 0-ringers within statistical rectangles, estimated from catches with either IKMT or MIK during the IYFS in February. Area of filled circles represents densities in no. m^{-2}, the area of circles that extends to the borders of a statistical rectangle represents 1.8 larvae m^{-2}.

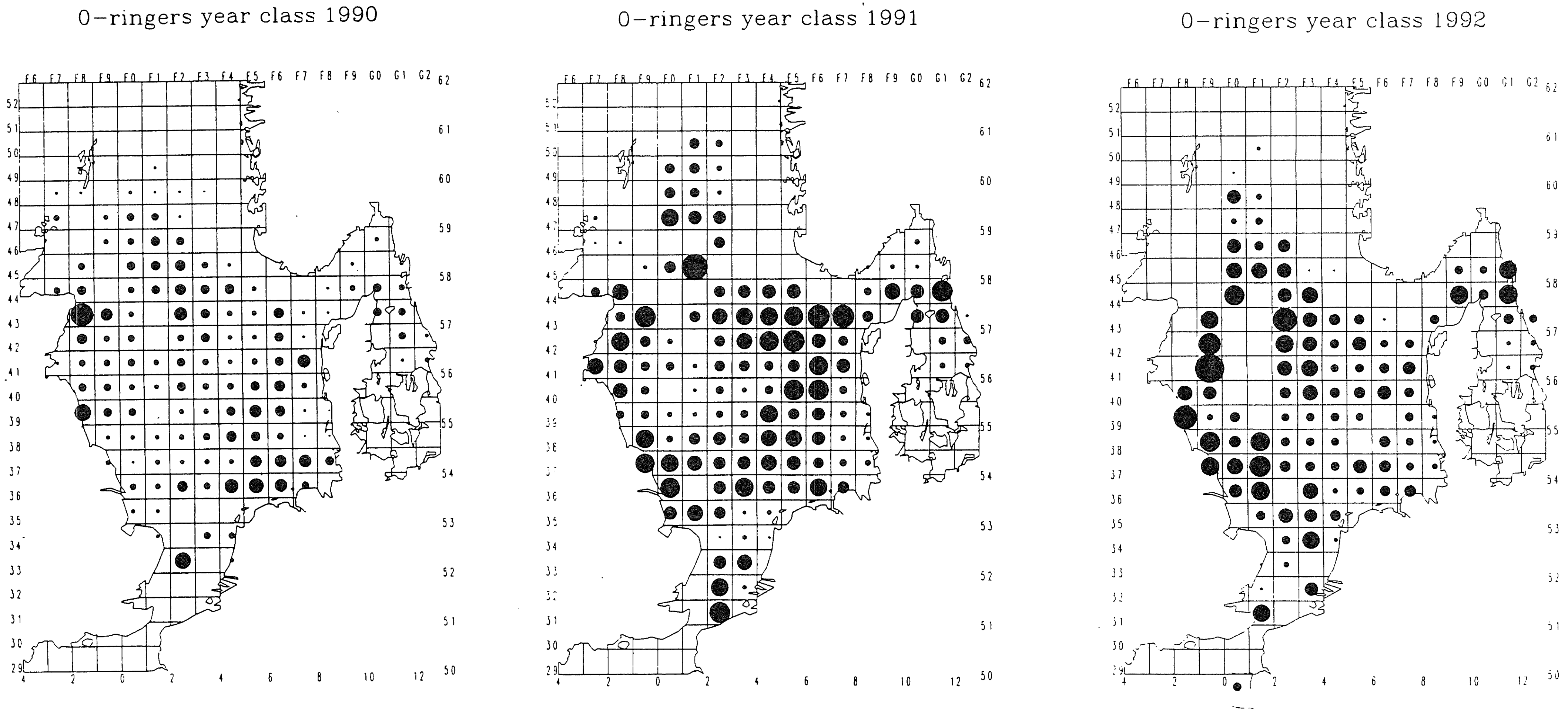


Figure 2.3.6

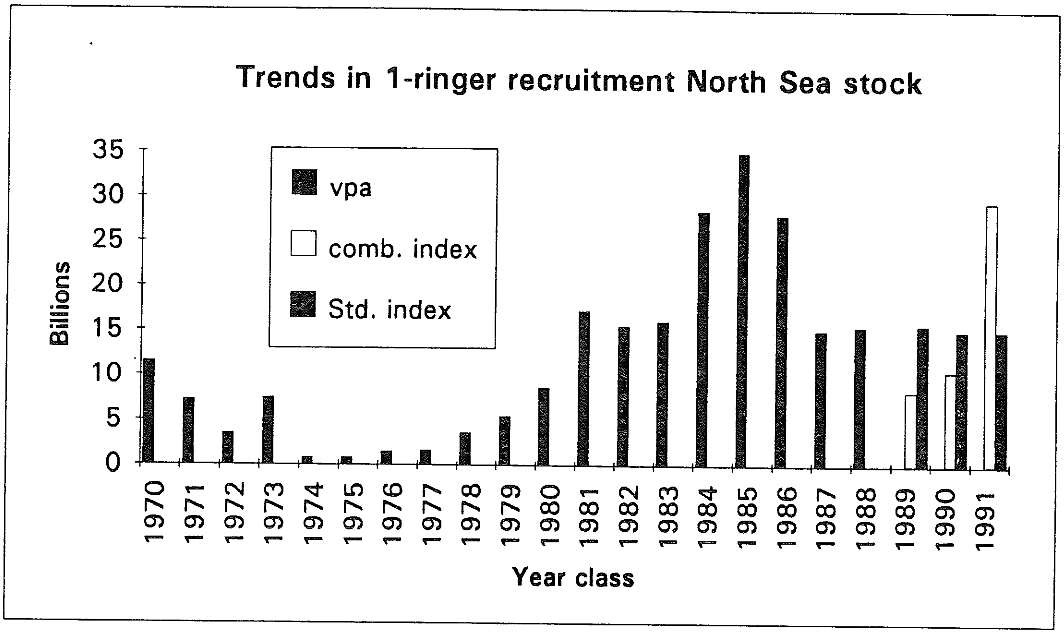

Trends in 1-ringer recruitment North Sea stock
vpa
comb. index
Std. index
Billions
35
30
25
20
15
10
5
0
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
Year class

Figure 2.7.1 Sum of squares residuals between SSB from VPA and from indices.

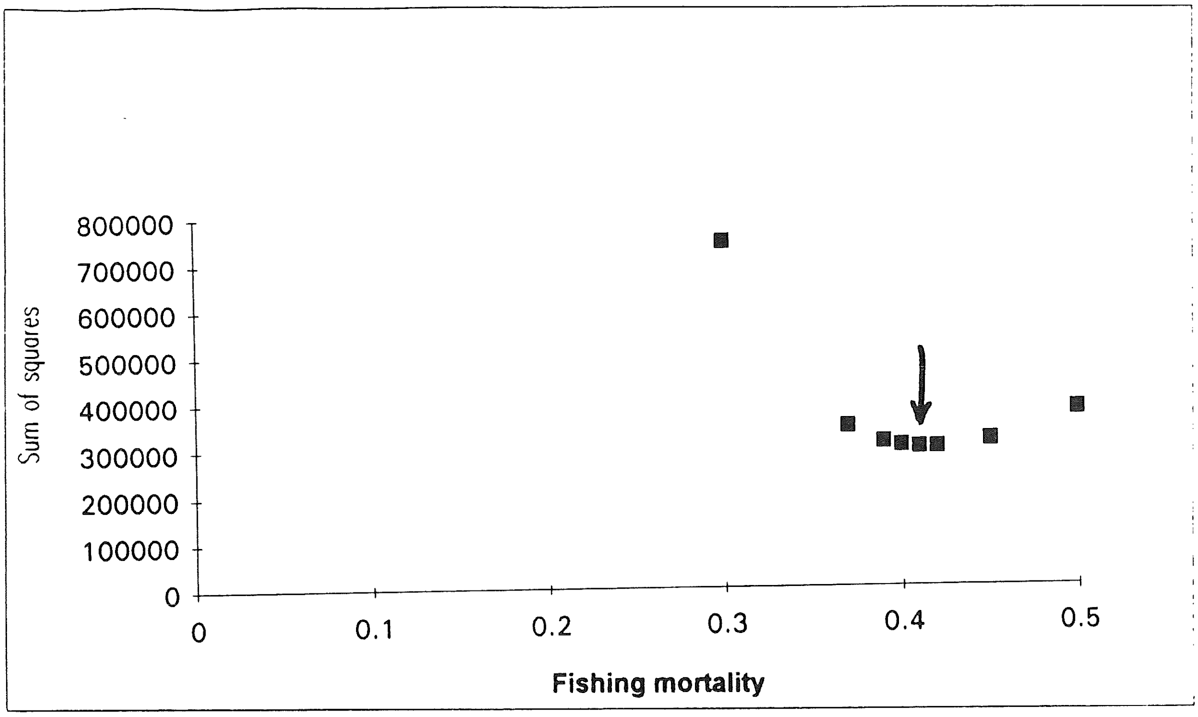
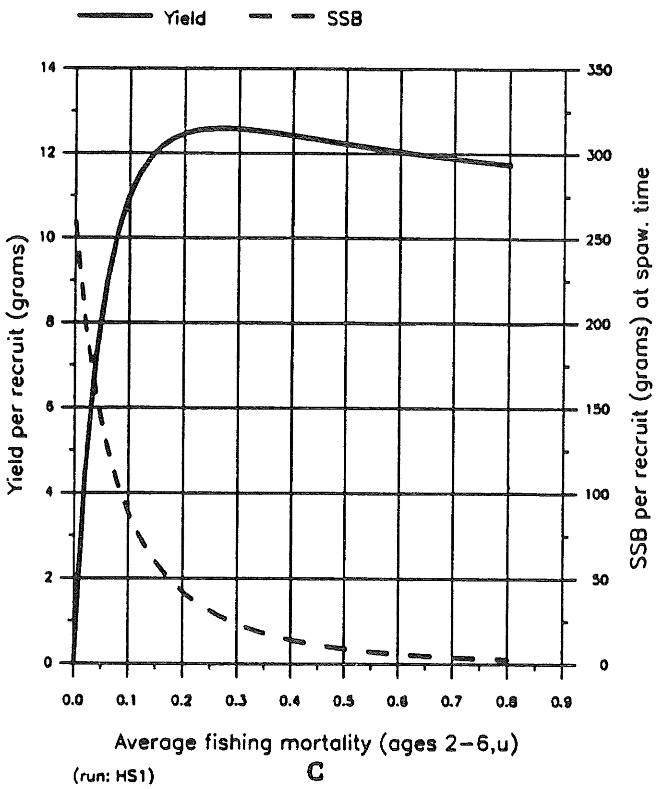


Figure 2.9.1

FISH STOCK SUMMARY
STOCK: Herring in the North Sea Area (Fishing Areas IV and IIIA)
1-4-1993

Long term yield and spawning stock biomass



C

Figure 2.10.1 Herring North Sea catches (tonnes)

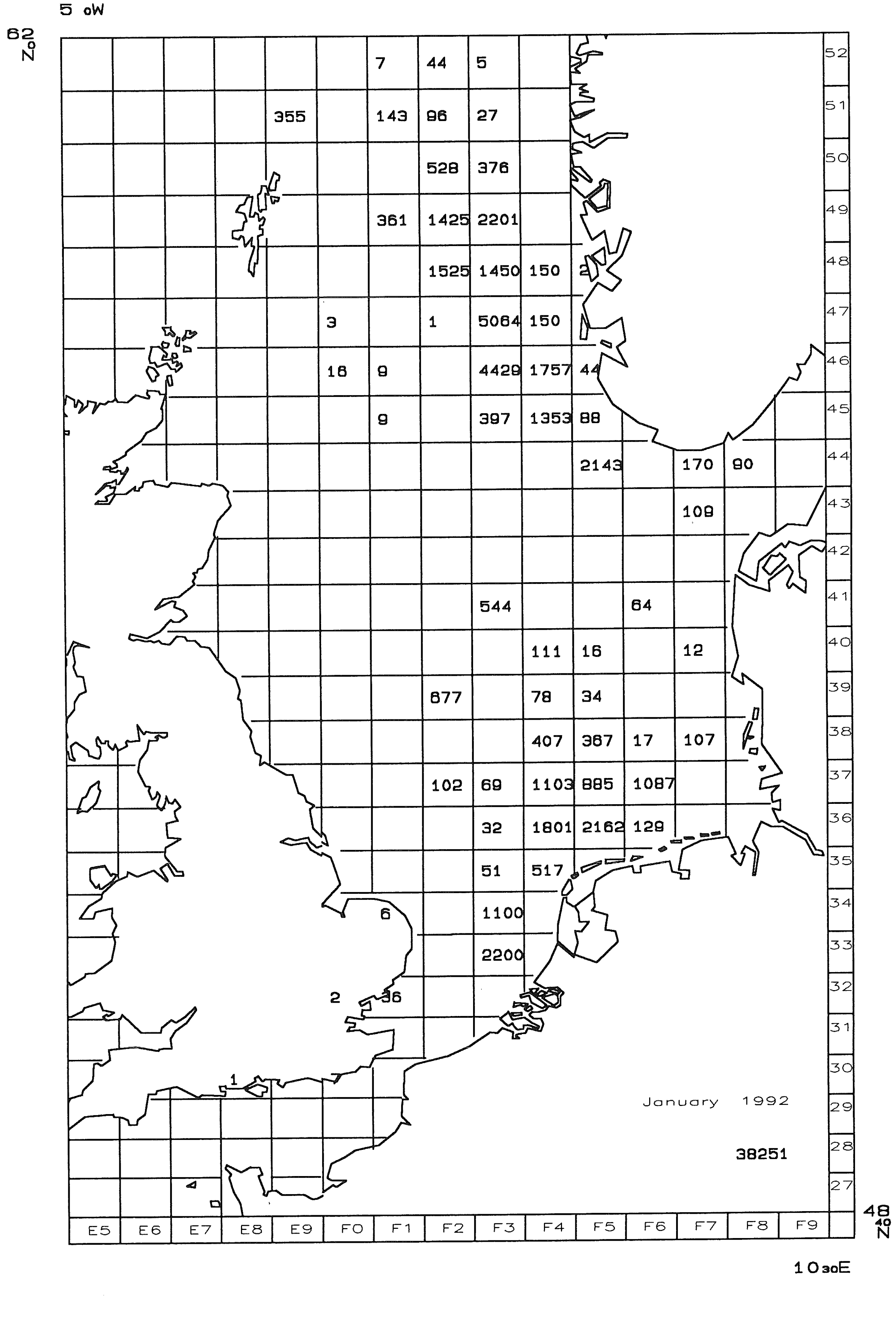


Figure 2.10.2 Herring North Sea catches (tonnes)

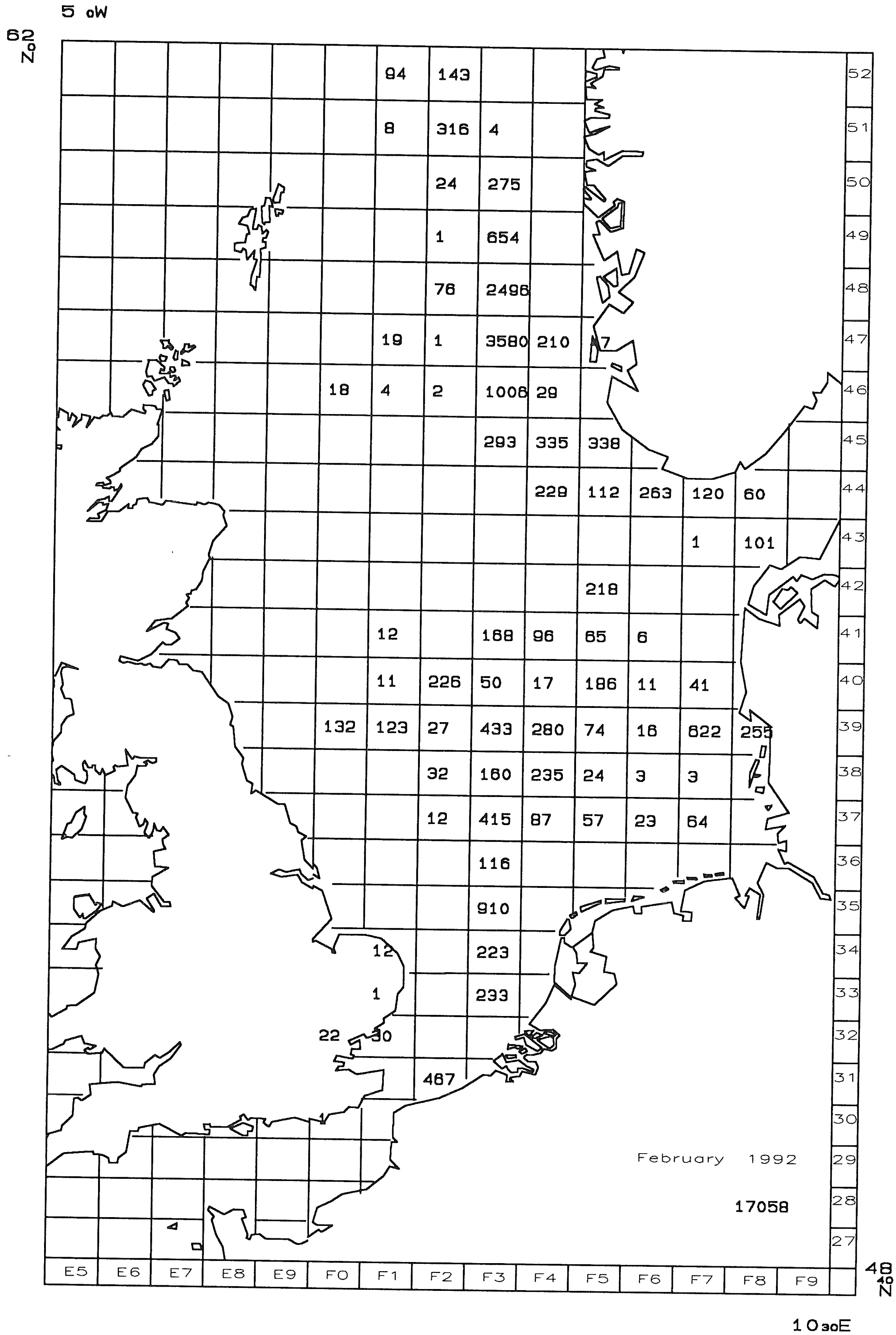


Figure 2.10.3 Herring North Sea catches (tonnes)

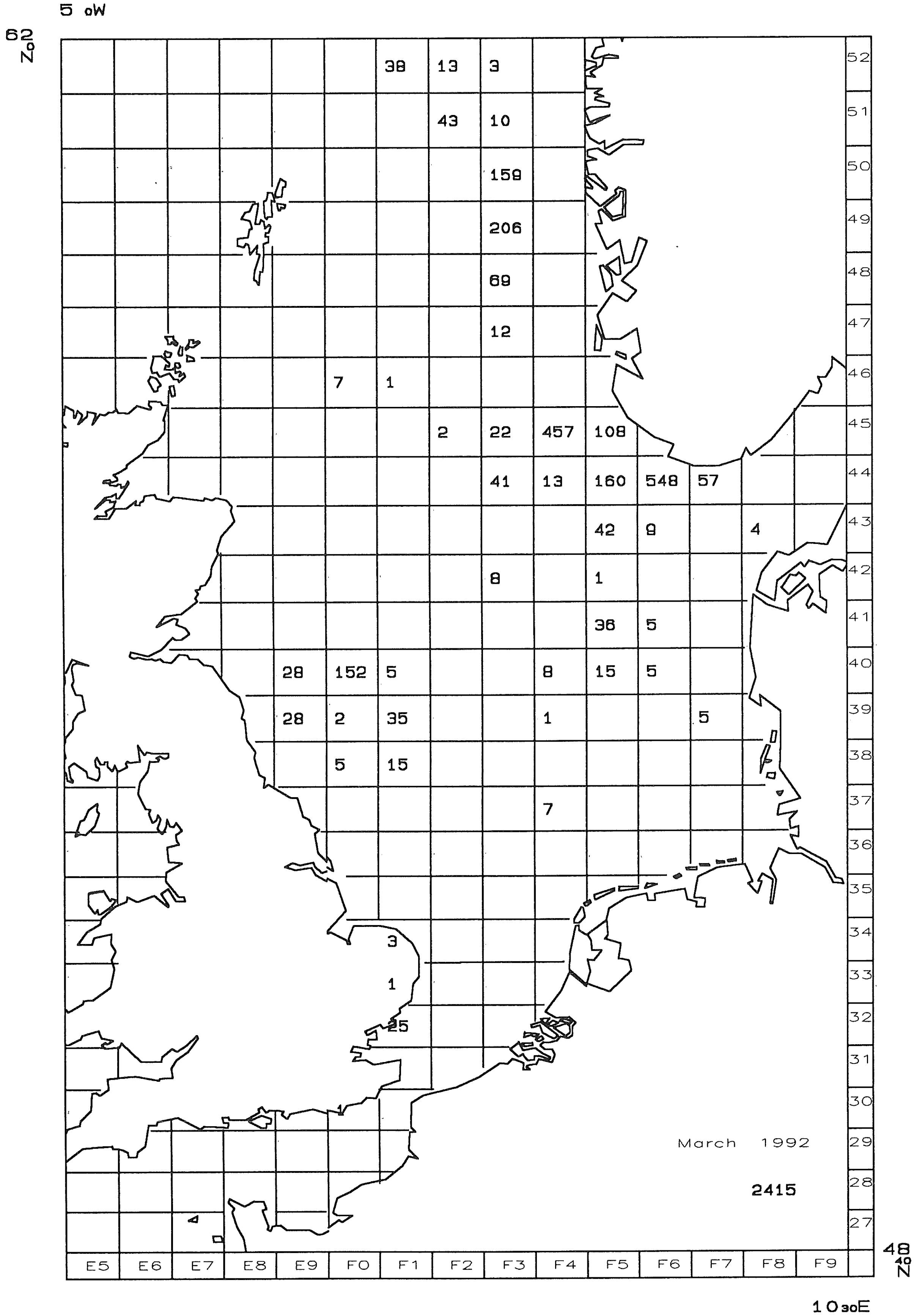


Figure 2.10.4 Herring North Sea catches (tonnes)

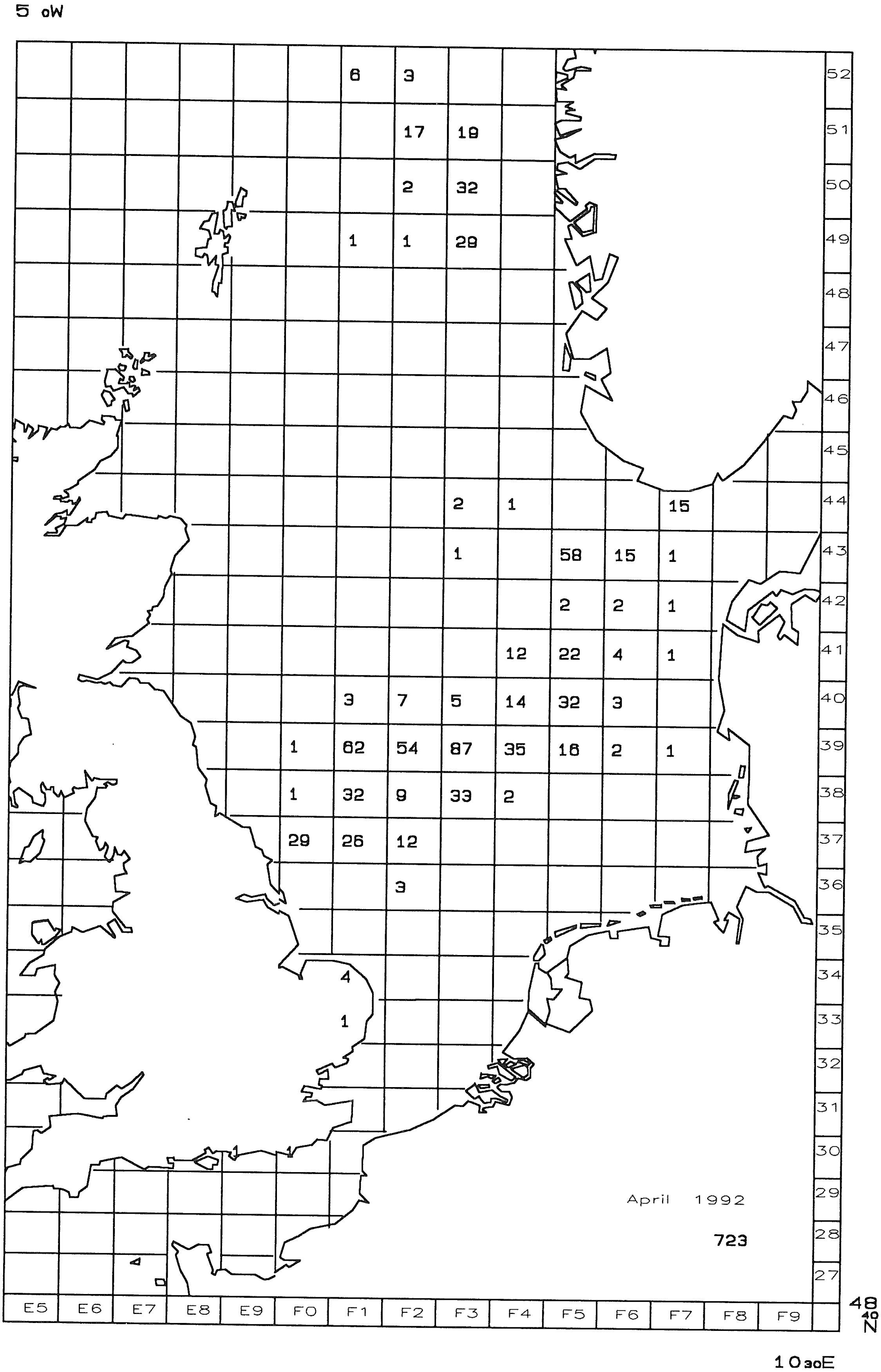


Figure 2.10.5 Herring North Sea catches (tonnes)

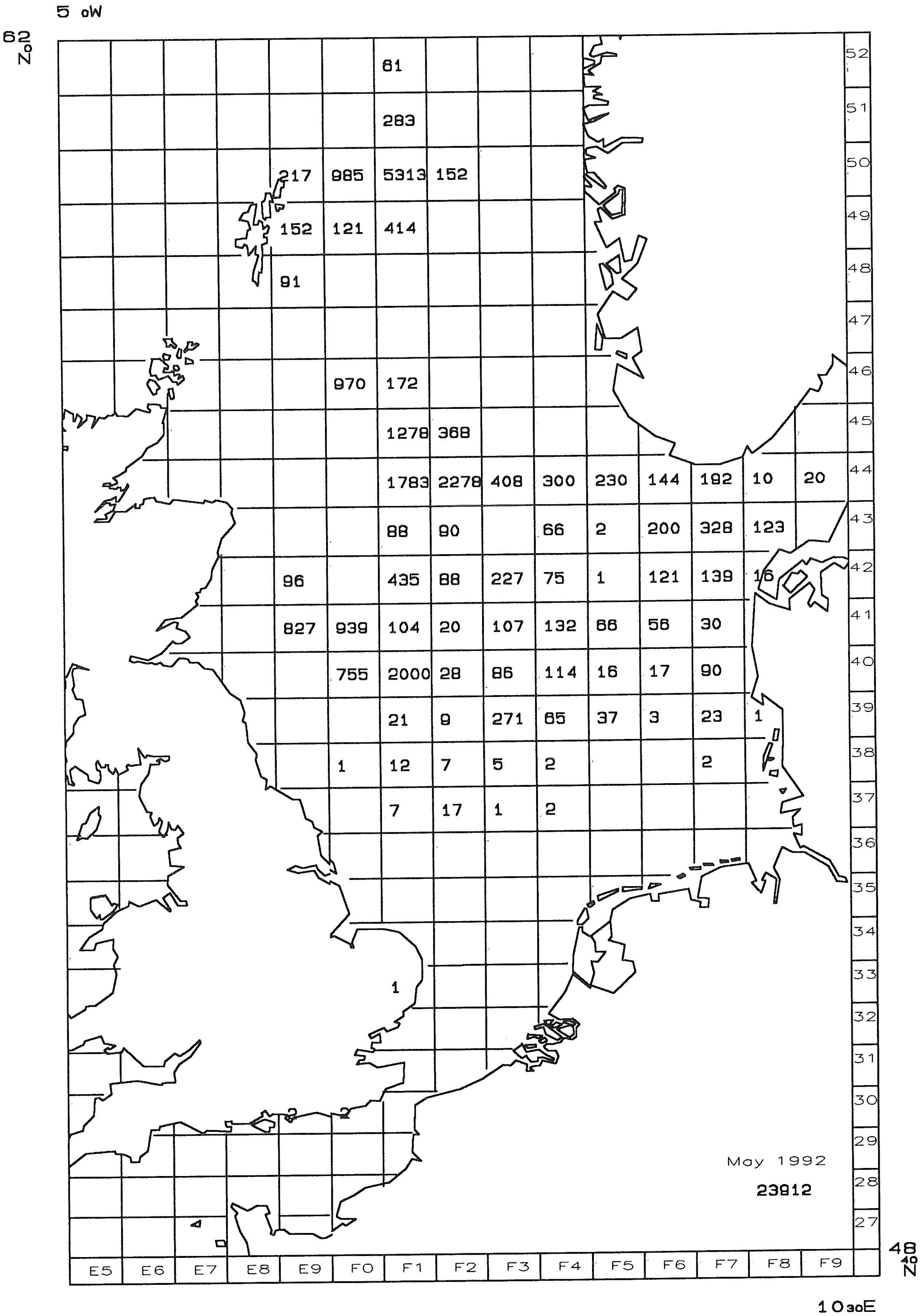


Figure 2.10.6 Herring North Sea catches (tonnes)

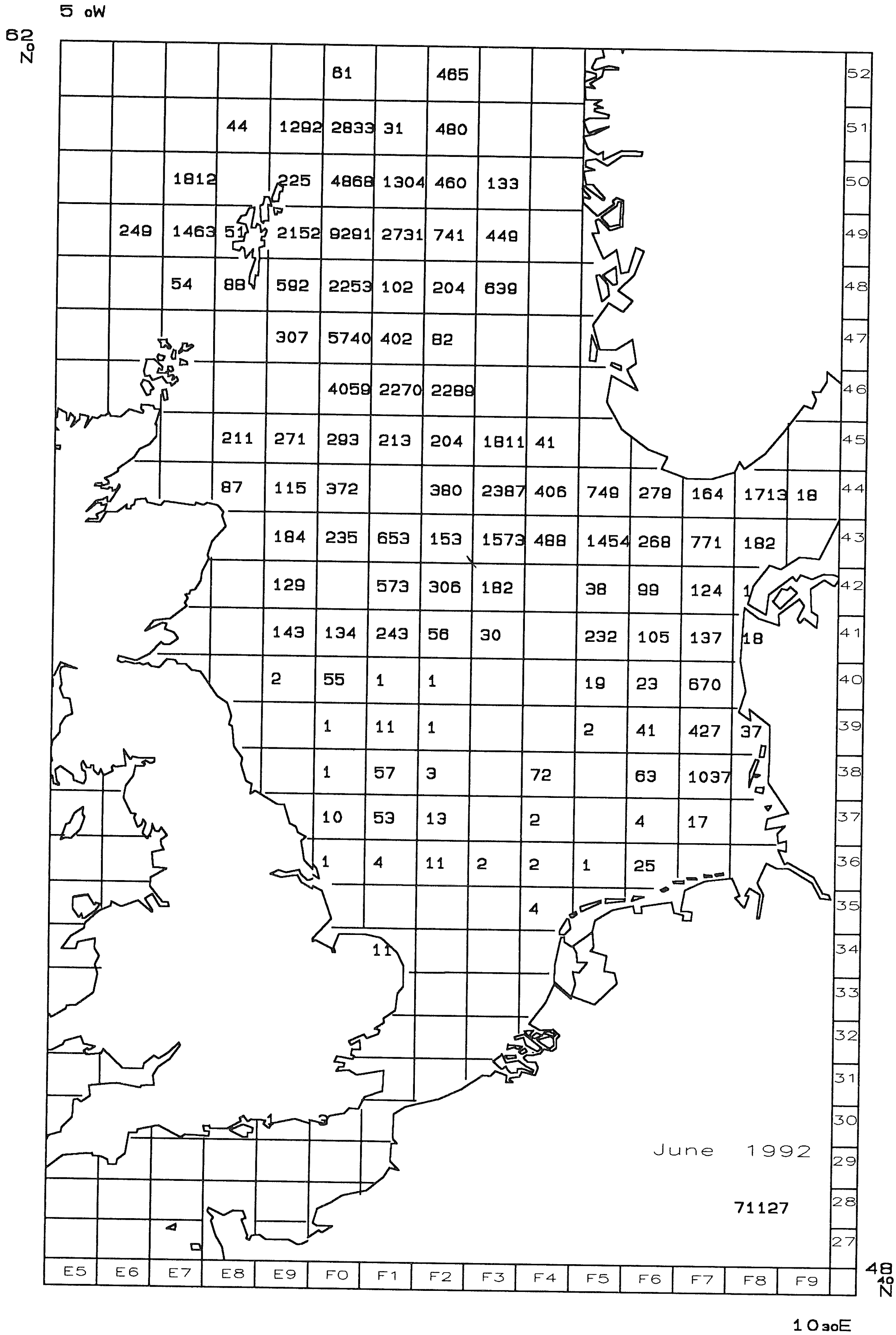


Figure 2.10.7 Herring North Sea catches (tonnes)

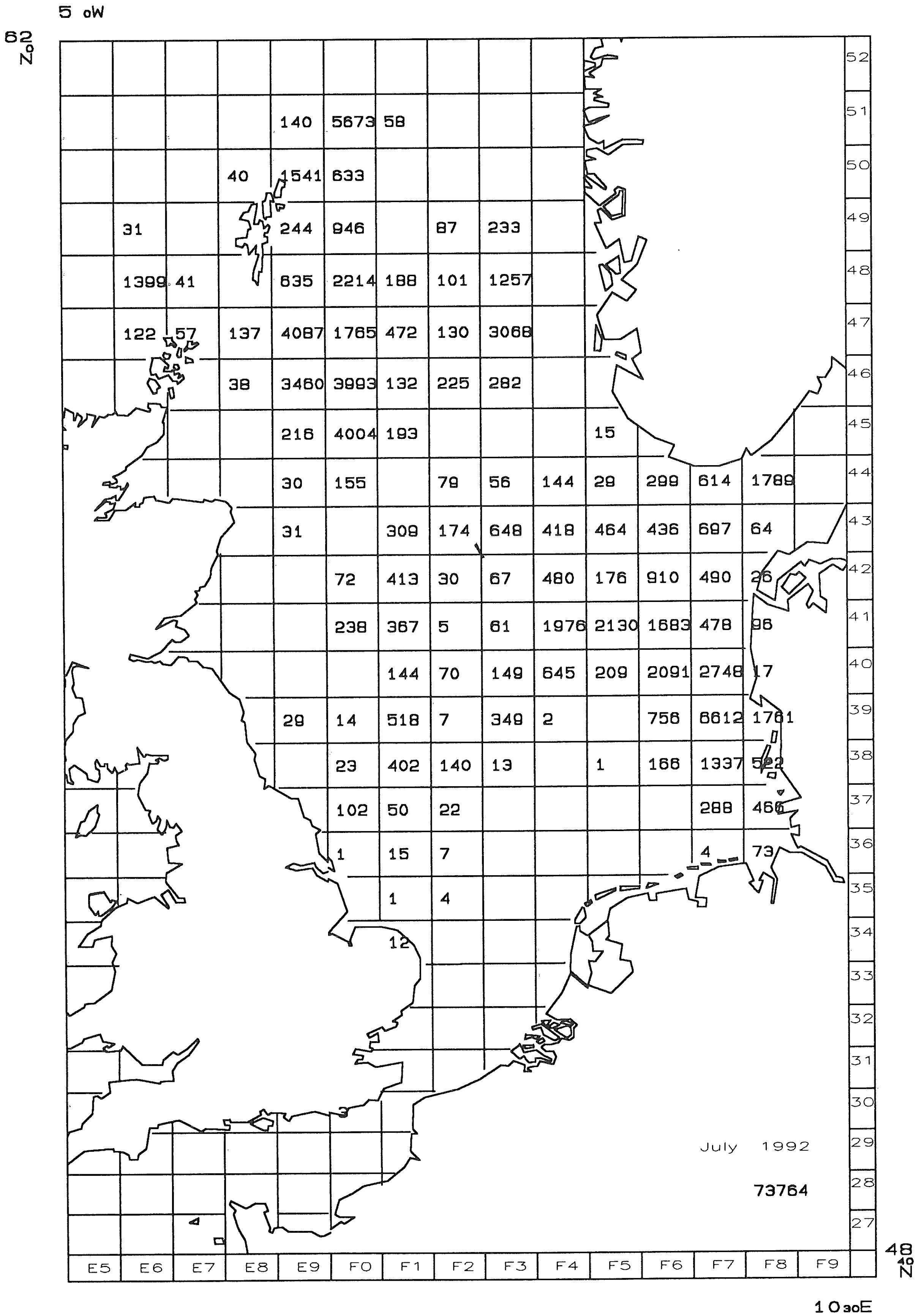


Figure 2.10.8 Herring North Sea catches (tonnes)

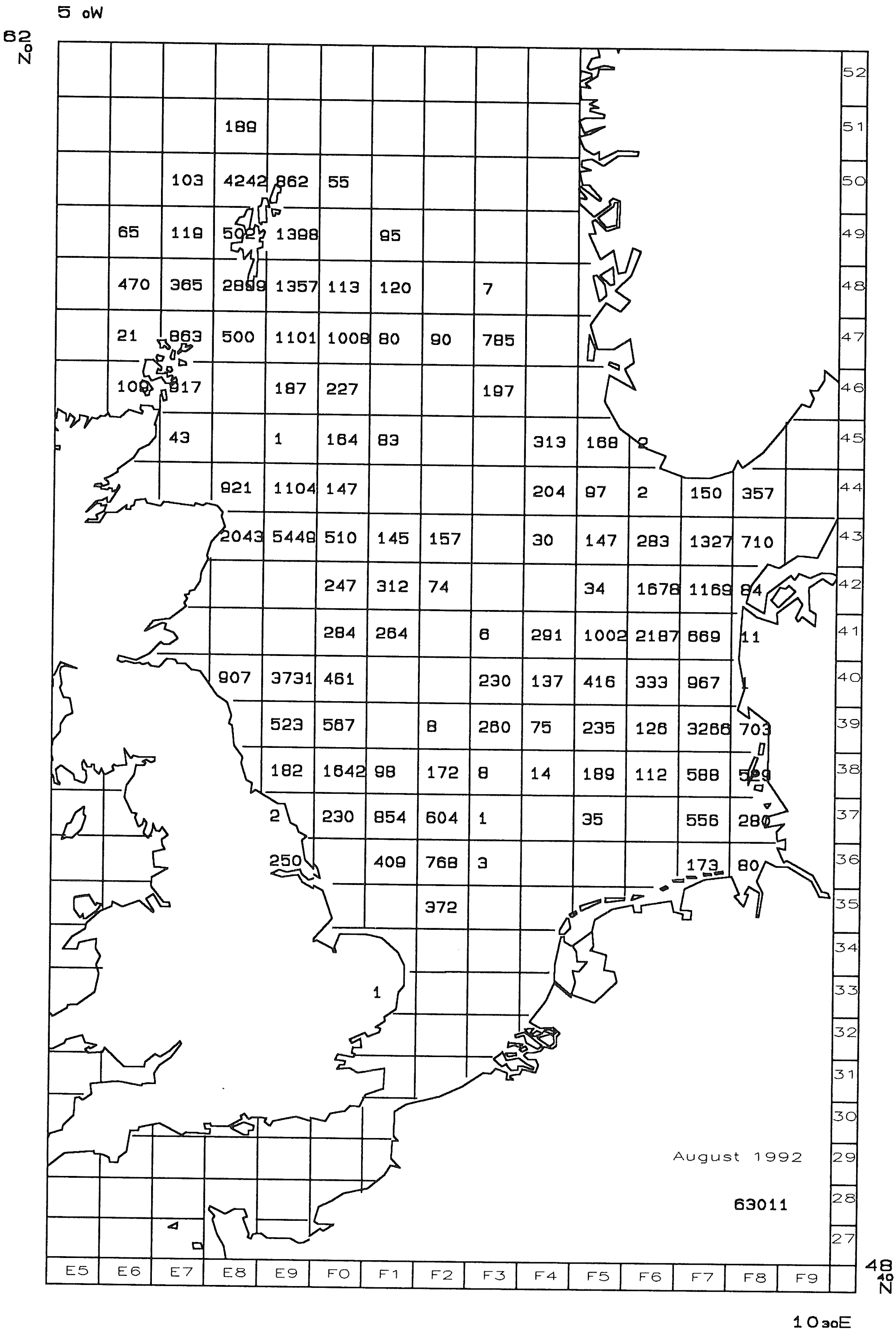


Figure 2.10.9 Herring North Sea catches (tonnes)

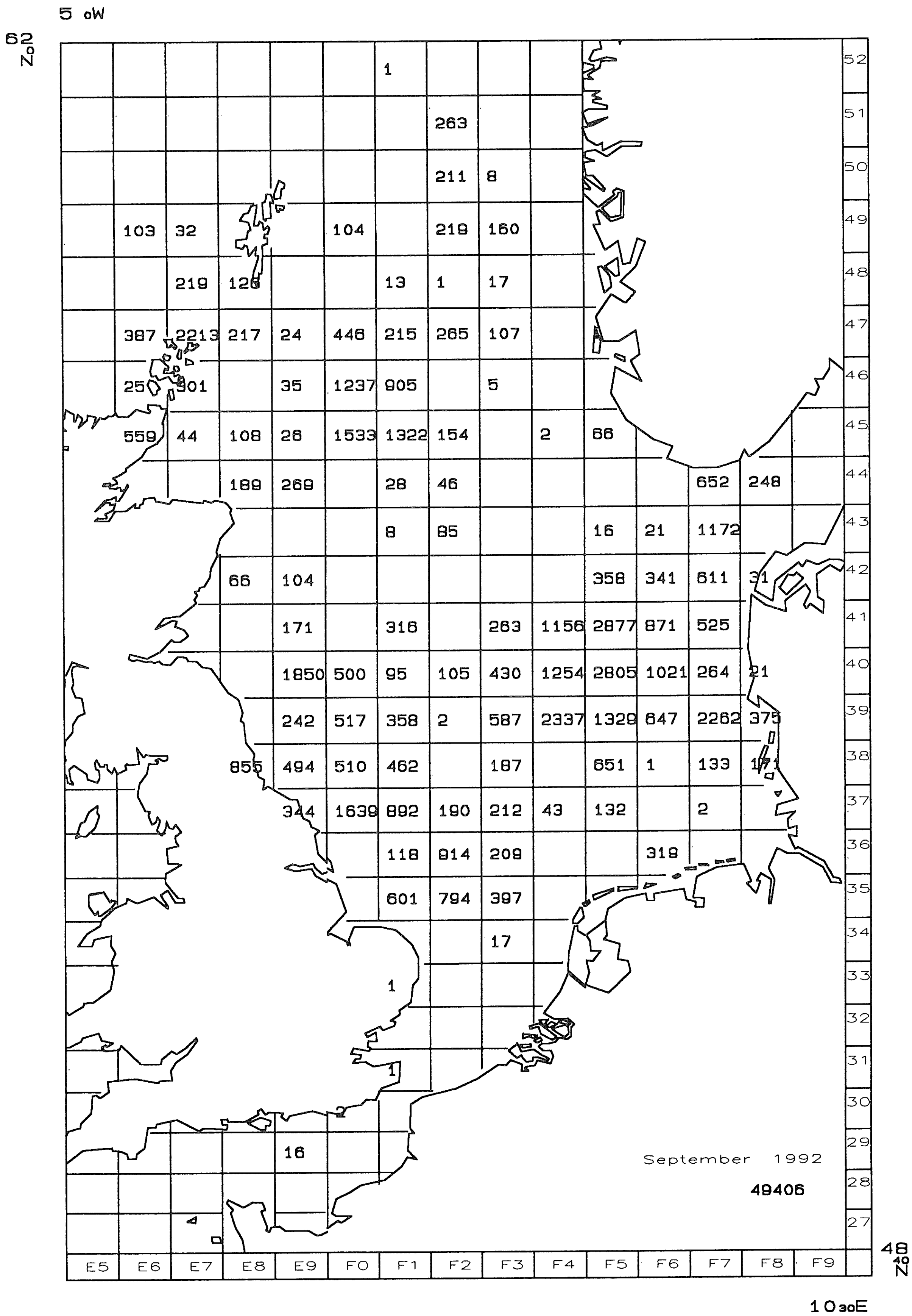


Figure 2.10.10 Herring North Sea catches (tonnes)

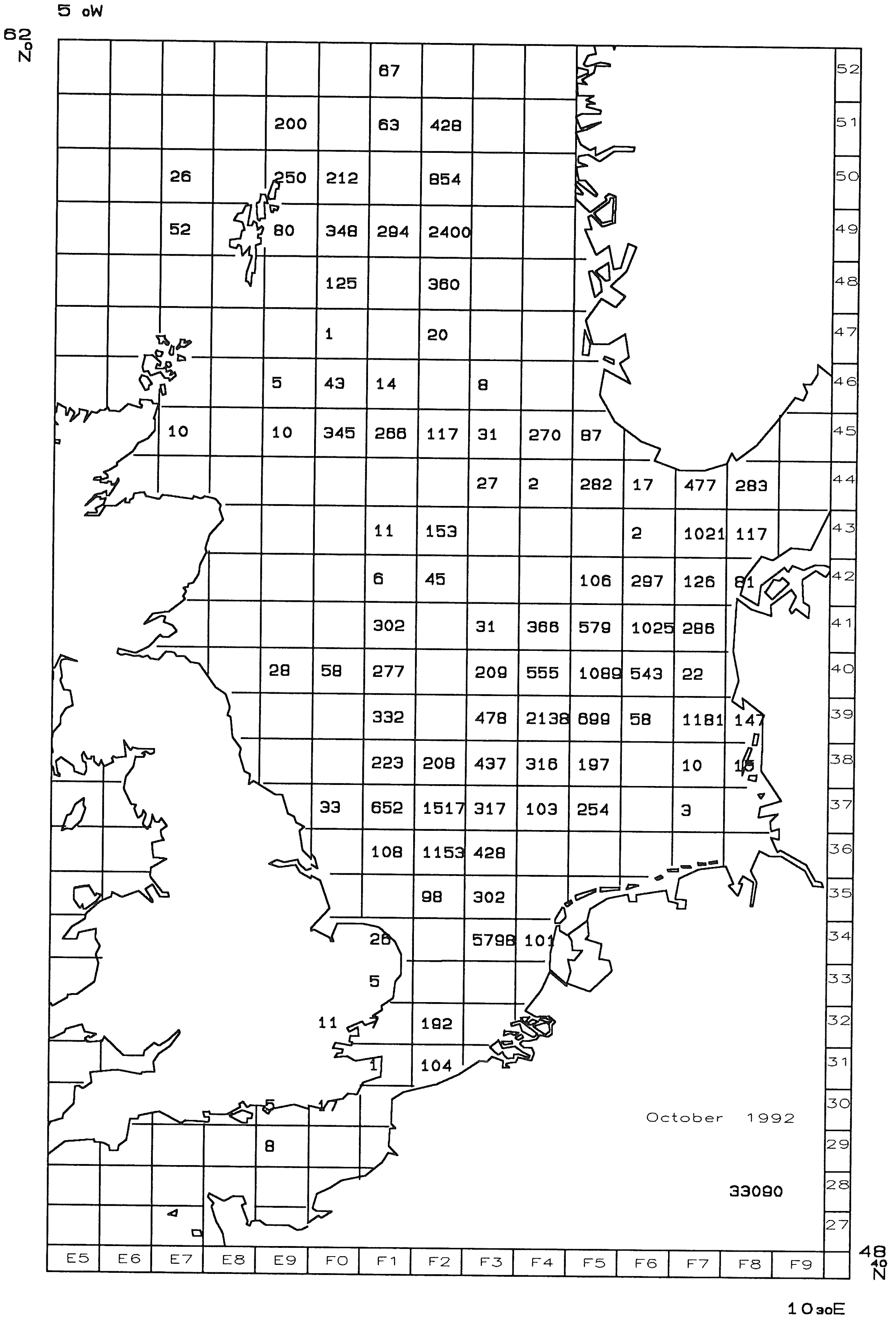


Figure 2.10.11 Herring North Sea catches (tonnes)

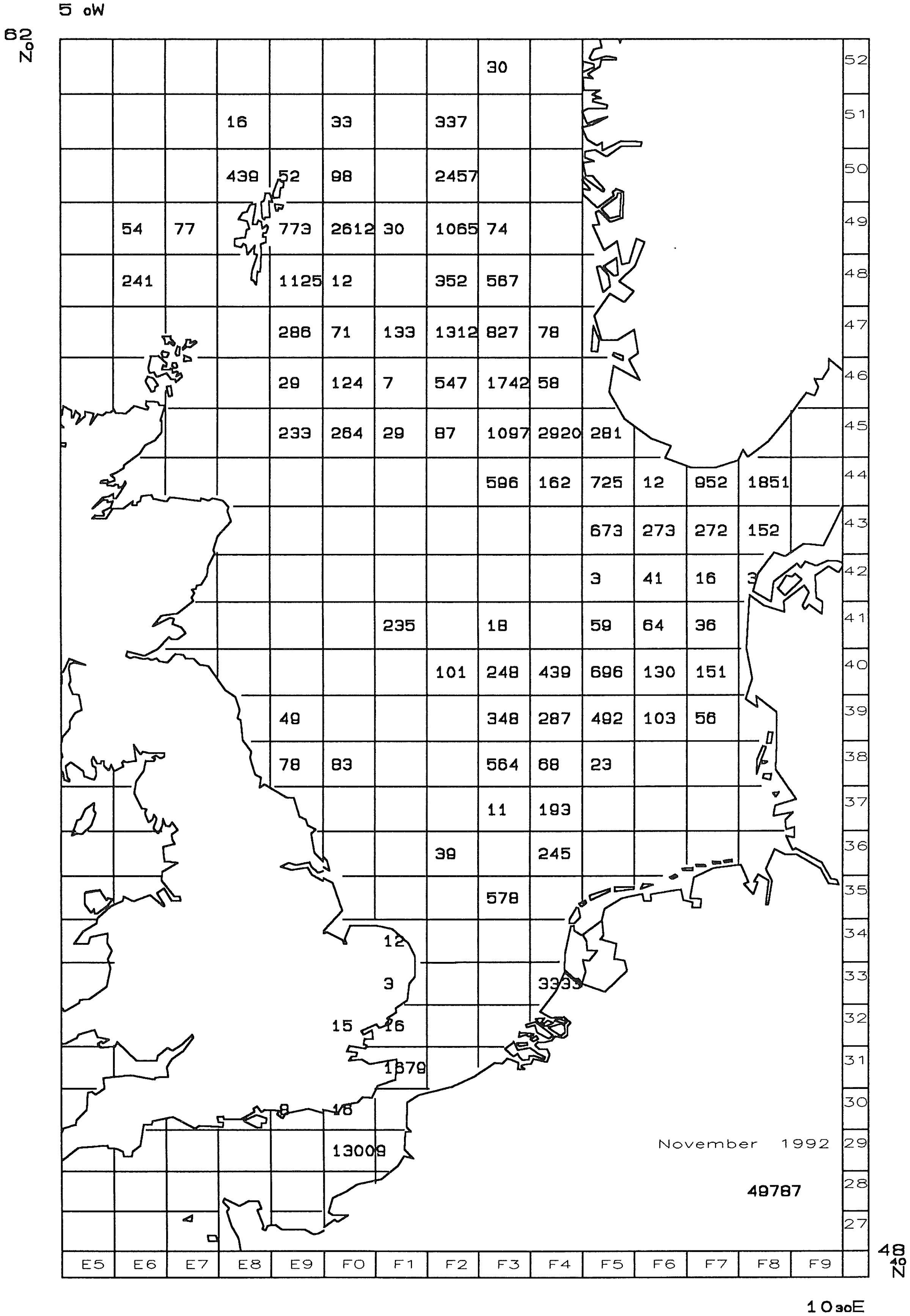


Figure 2.10.12 Herring North Sea catches (tonnes)

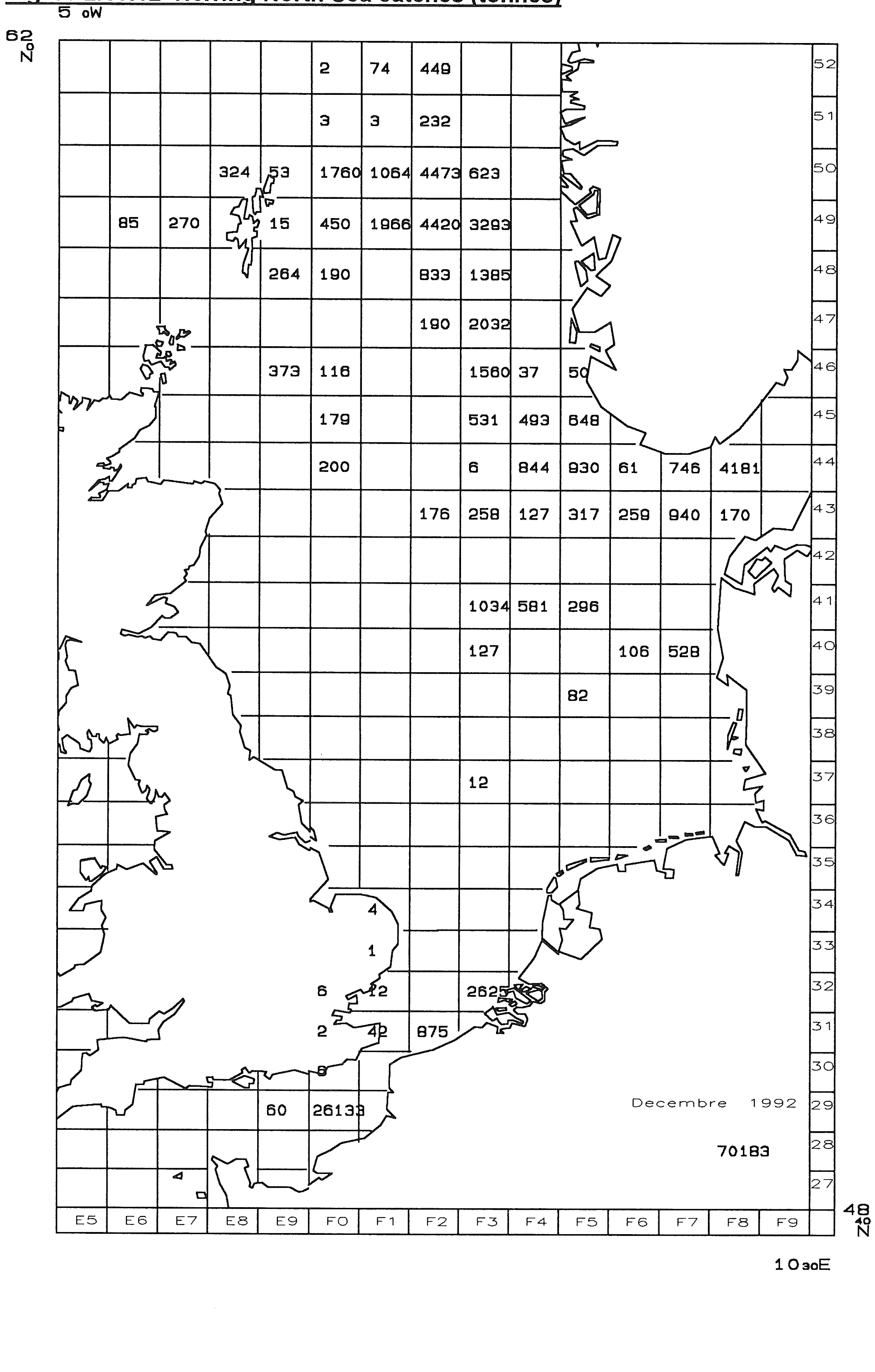


Figure 2.10.13 North Sea Herring. Cumulative catch by month.

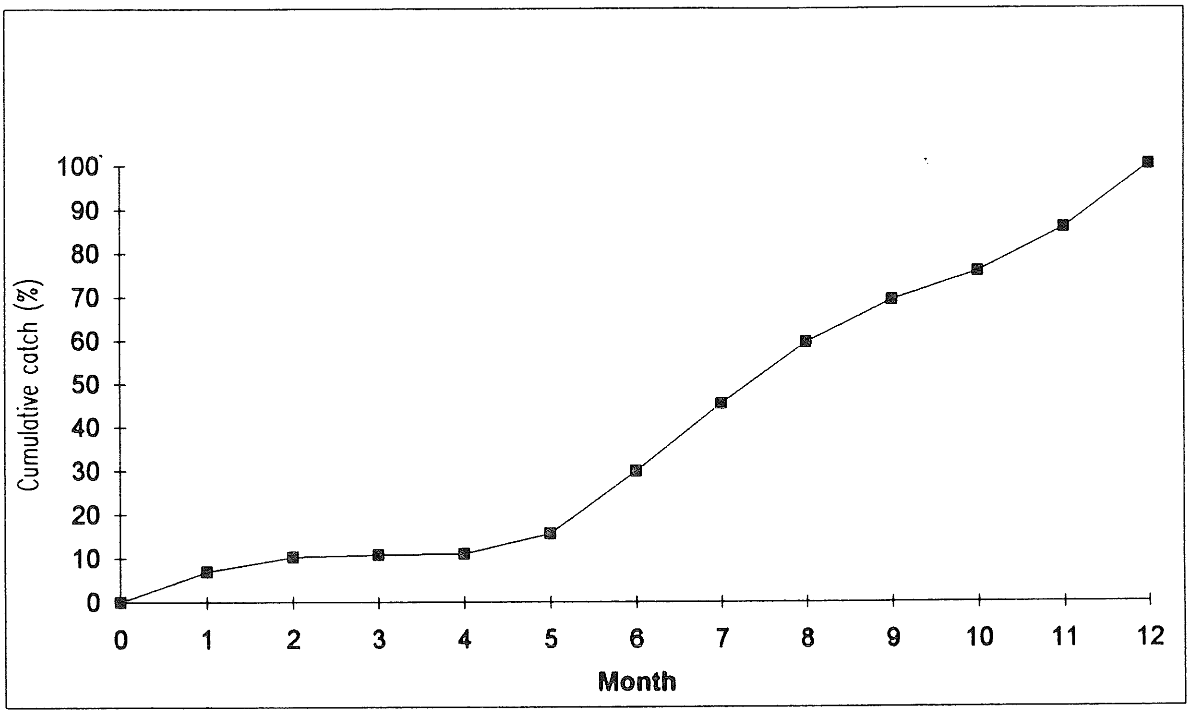


Figure 2.11.1 Summary results of an integrated model fit to North Sea herring data. The baseline model was used, and equal prior weight was given to all three index series. Dashed lines indicate the values of SSB returned by the fitted population sizes; the triangles indicate the predicted SSBs from each index series, using the fitted catchability relationships.

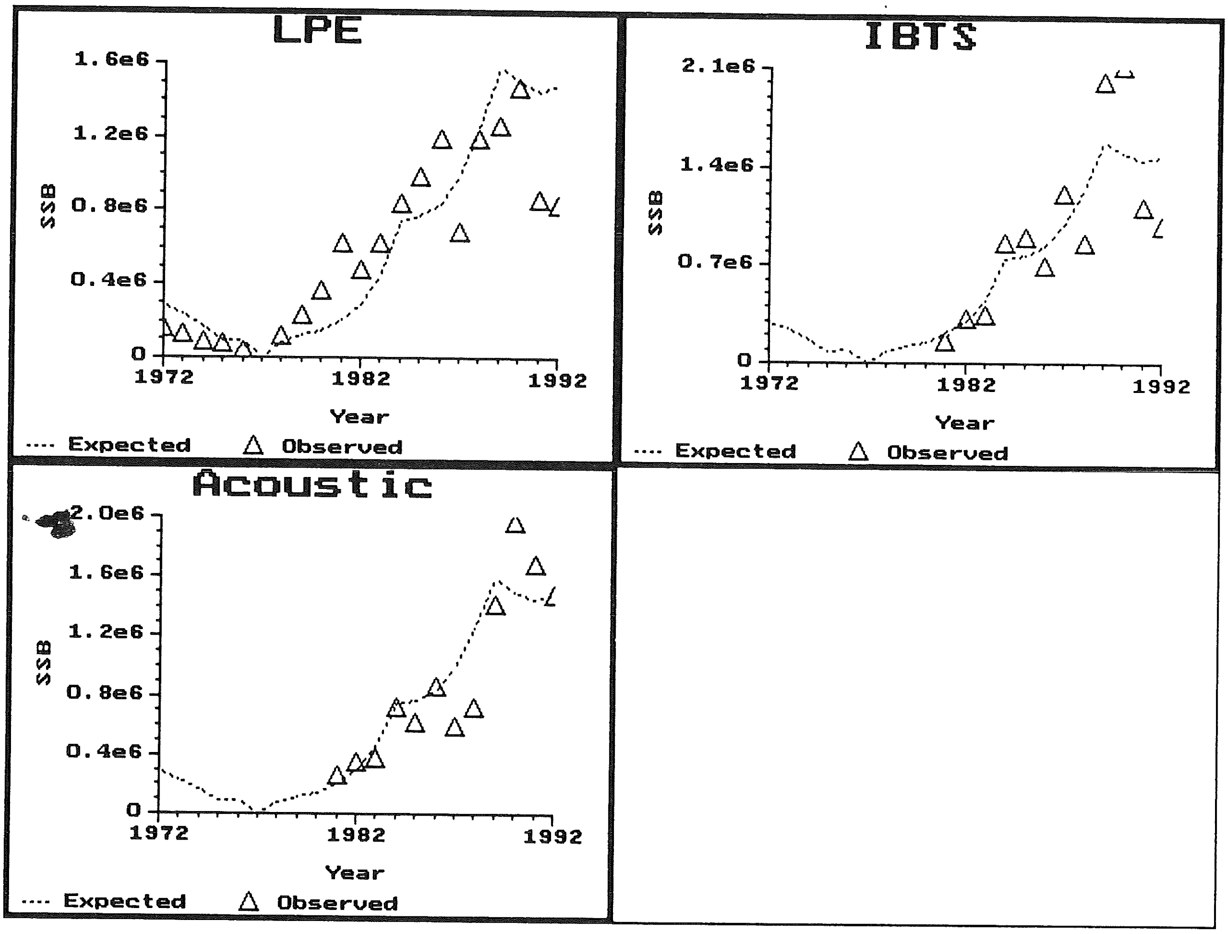


Figure 2.11.2 As Figure 2.11.1, but with 96% weight on the acoustic index term, i.e., essentially fitting to the acoustic index alone.

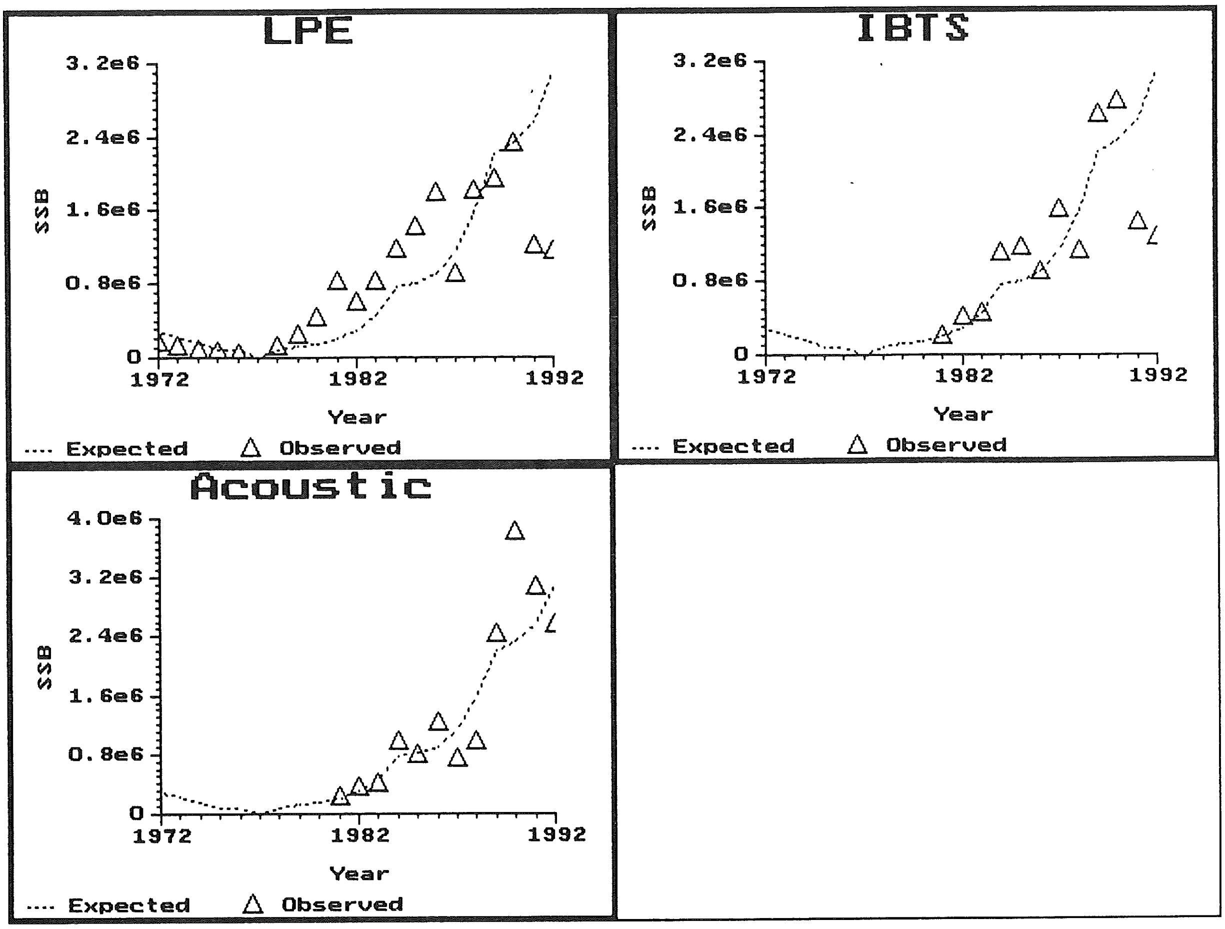


Figure 2.11.3 As Figure 2.11.2, but with 96% weight on the LPE index term, i.e., essentially fitting to the LPE index alone.

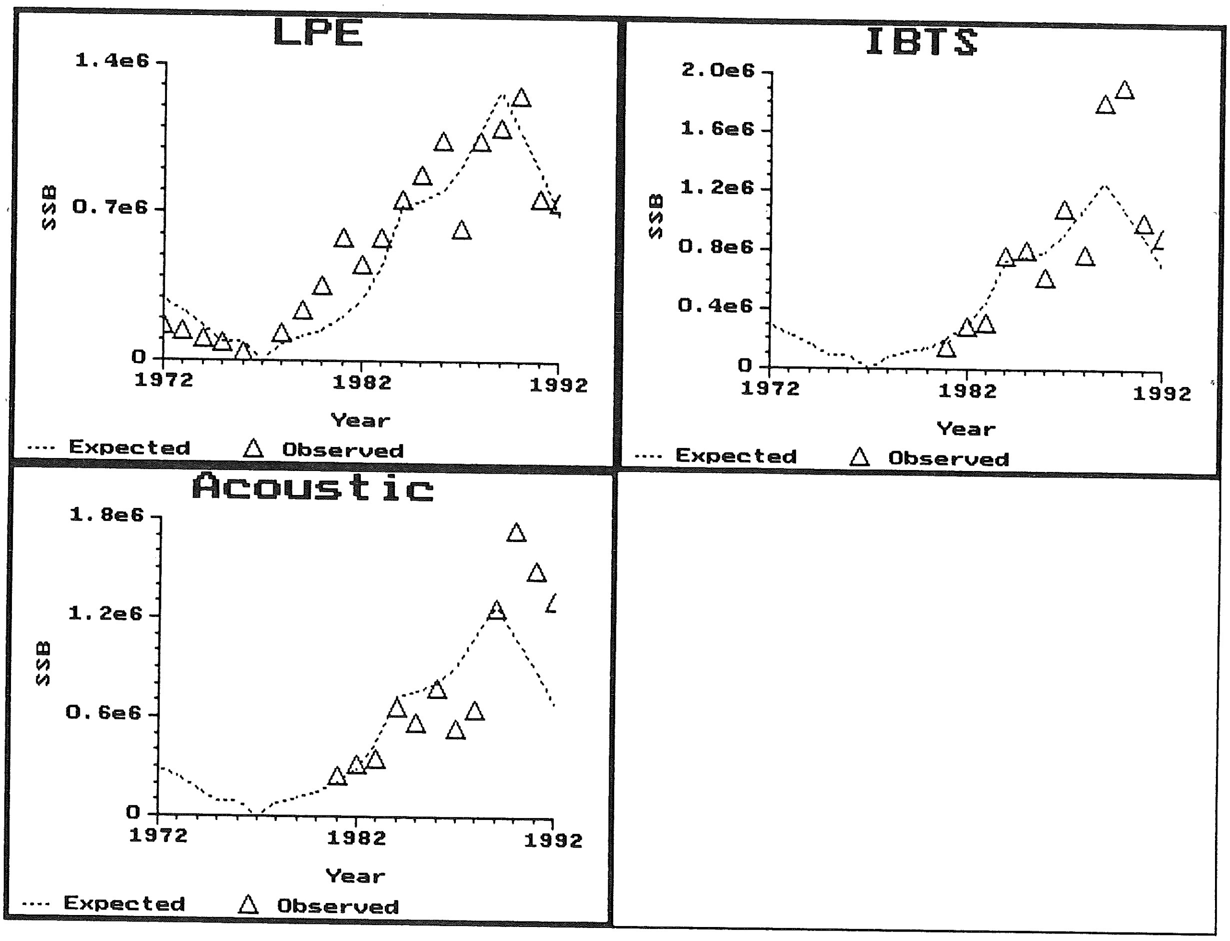


Figure 2.11.4 As Figure 2.11.3, but with 96% weight on the IYFS index term, i.e., essentially fitting to the IBTS index alone.

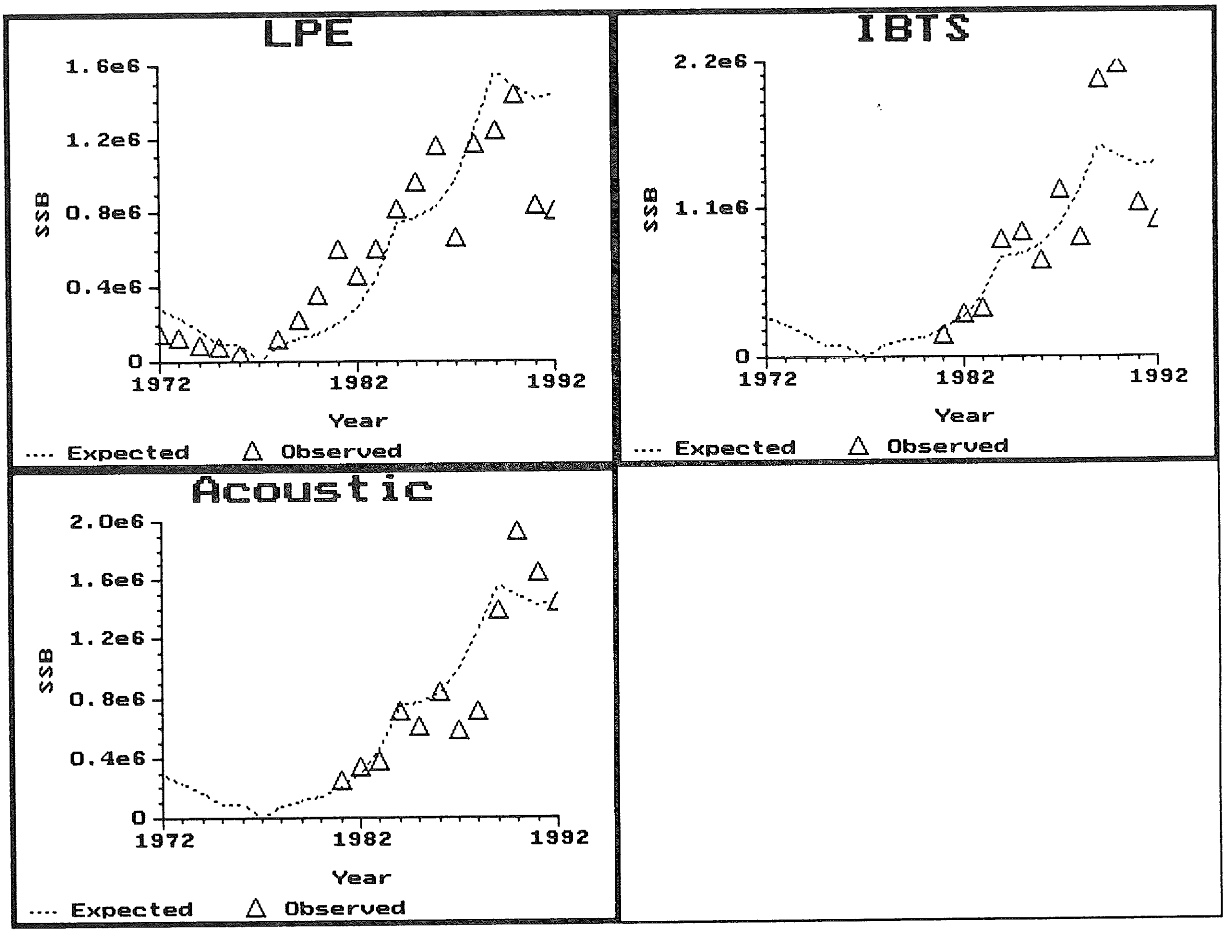


Figure 2.11.5 Retrospective analysis tuned on all three series given equal weight. The conventional model was used, with logarithmic catchability relationships for LPE and IBTS indices, but a linear relationship used for the acoustic series.

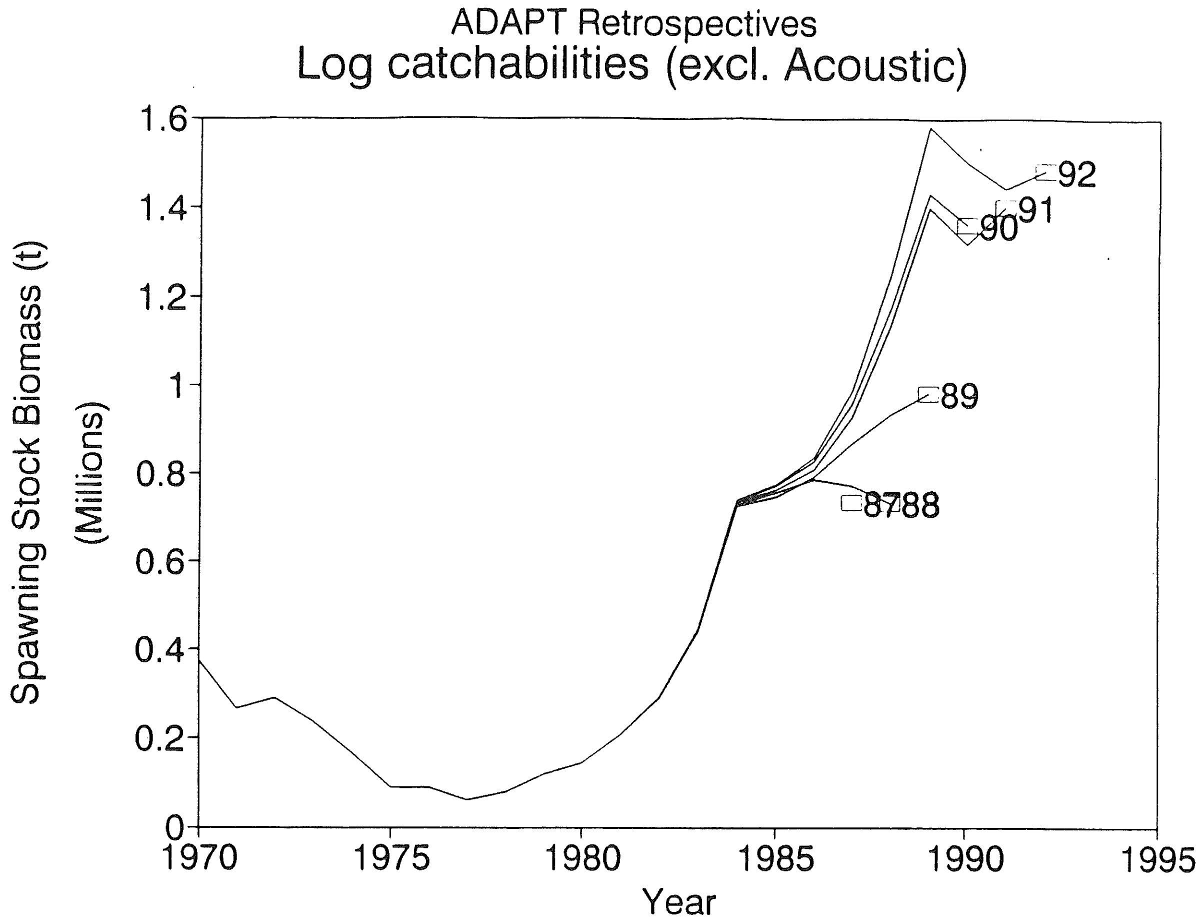


Figure 2.11.6 Retrospective analysis tuned on all three series given equal weight. The new proposal of using linear catchability relationships for all three series was used.

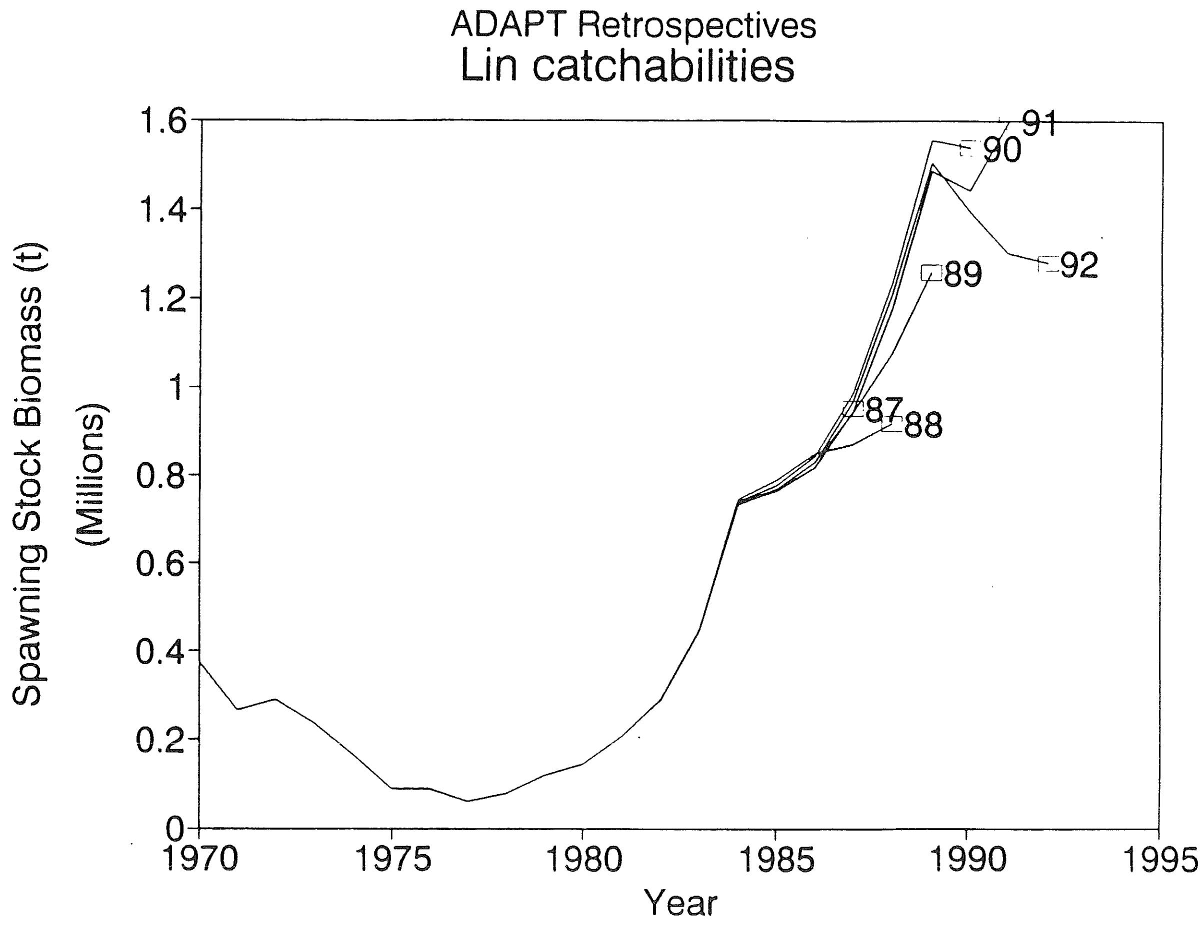


Figure 2.11.7 Catchability estimated in each year of the retrospective analyses. Logarithmic model for LPE and IBTS; acoustic log catchability constrained to 1 (i.e., linearity).

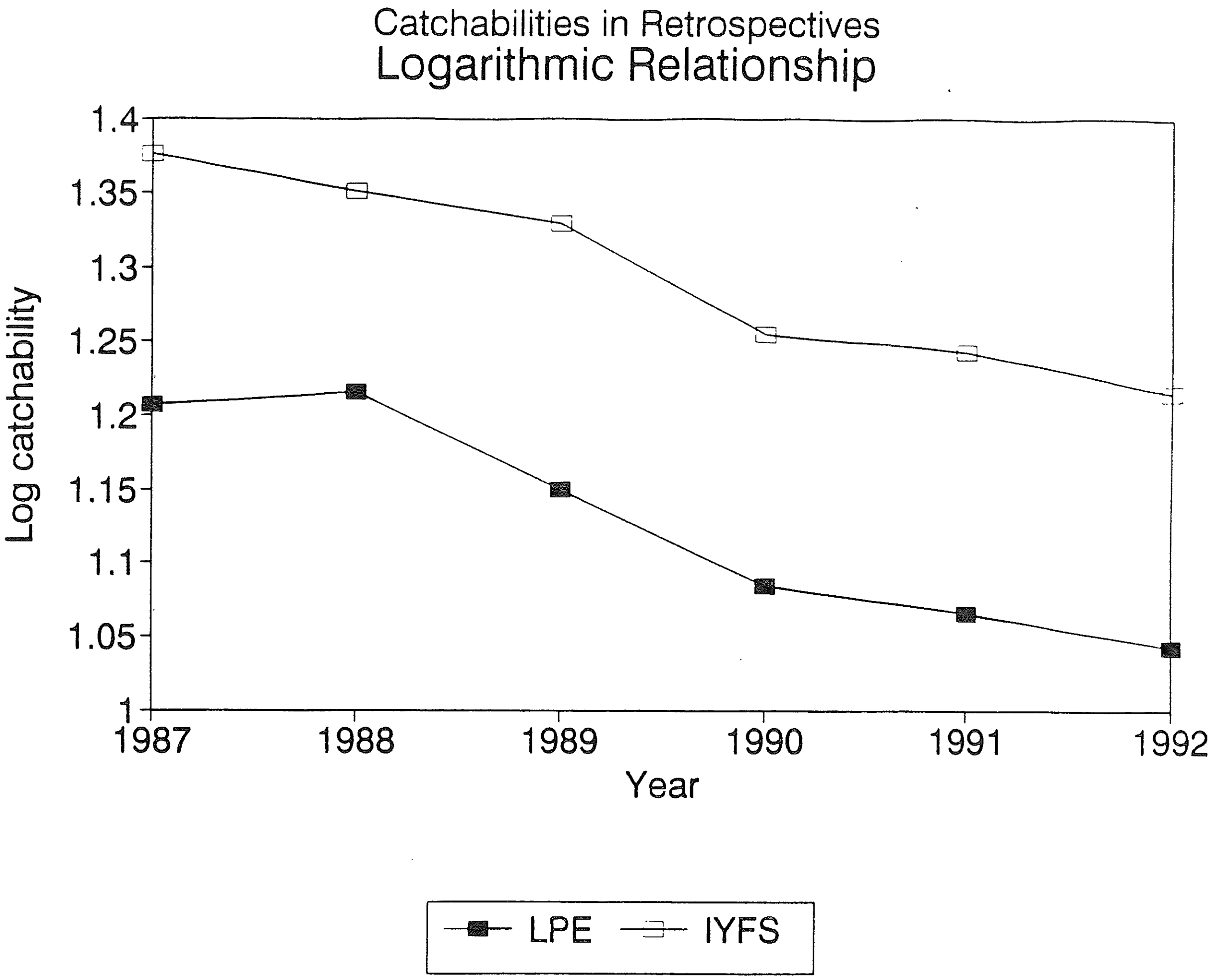


Figure 2.11.8 Catchability estimated in each year of the retrospective analyses. Linear model for all three series.

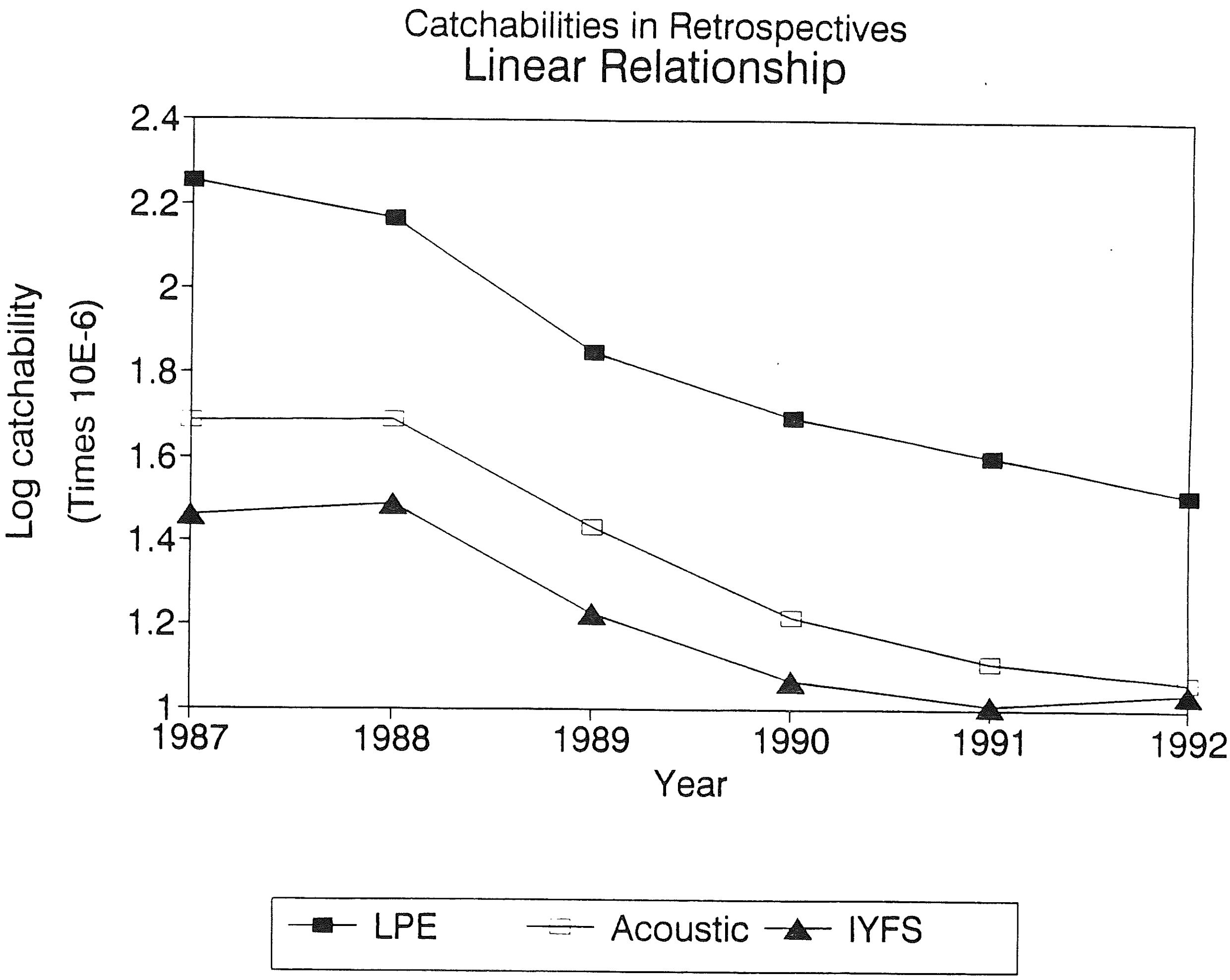
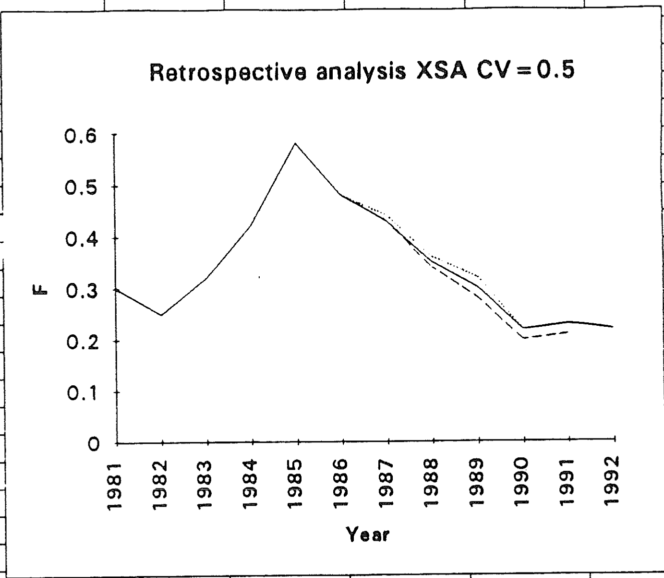
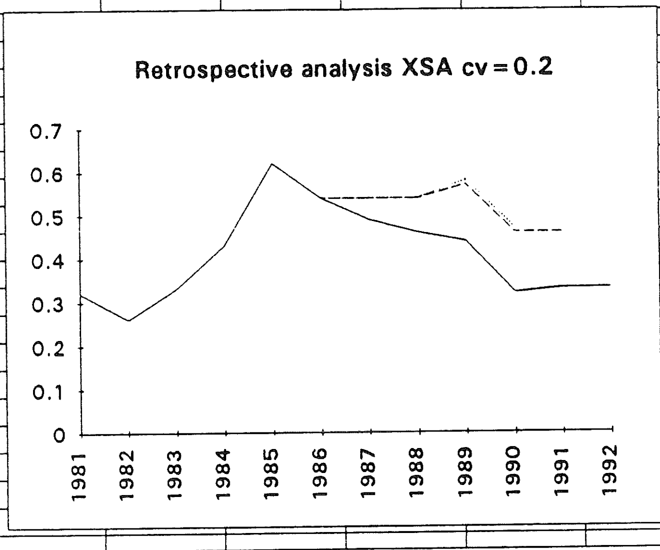


Figure 2.11.9 Retrospective analysis of XSA on North Sea herring with three different levels of shrinkage.

XSA Herring N.Sea			
With Sh cv=0.5			
1981	0.3	0.3	0.3
1982	0.25	0.25	0.25
1983	0.32	0.32	0.32
1984	0.42	0.42	0.42
1985	0.58	0.58	0.58
1986	0.48	0.48	0.48
1987	0.43	0.43	0.44
1988	0.35	0.34	0.36
1989	0.3	0.28	0.32
1990	0.22	0.2	0.22
1991	0.23	0.21	
1992	0.22		
With Sh cv=0.2			
1981	0.32	0.32	0.32
1982	0.26	0.26	0.26
1983	0.33	0.33	0.33
1984	0.43	0.43	0.43
1985	0.62	0.62	0.62
1986	0.54	0.54	0.54
1987	0.49	0.54	0.54
1988	0.46	0.54	0.54
1989	0.44	0.57	0.58
1990	0.32	0.46	0.47
1991	0.33	0.46	
1992	0.33		
Unshrunk			
1981	0.3	0.3	0.3
1982	0.25	0.25	0.25
1983	0.32	0.32	0.32
1984	0.42	0.42	0.42
1985	0.58	0.58	0.58
1986	0.48	0.48	0.48
1987	0.46	0.45	0.45
1988	0.37	0.36	0.36
1989	0.32	0.29	0.29
1990	0.23	0.2	0.19
1991	0.24	0.2	
1992	0.23		





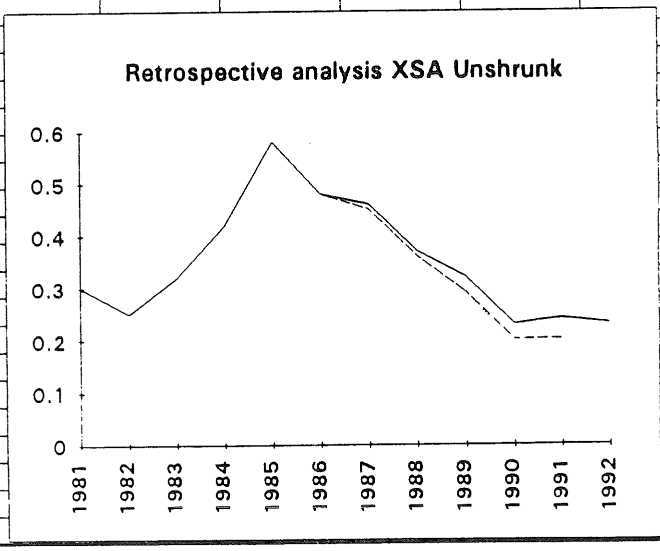


Figure 2.11.10 Retrospective analysis of the *ad hoc* (VPA) method currently applied on the herring in the North Sea.

f 2-6	1992	1991	1990
1981	0.39	0.36	0.35
1982	0.27	0.26	0.26
1983	0.34	0.34	0.33
1984	0.43	0.42	0.42
1985	0.61	0.61	0.59
1986	0.52	0.53	0.5
1987	0.5	0.51	0.48
1988	0.48	0.49	0.45
1989	0.48	0.48	0.42
1990	0.37	0.35	0.3
1991	0.37	0.32	
1992	0.39		
1993			

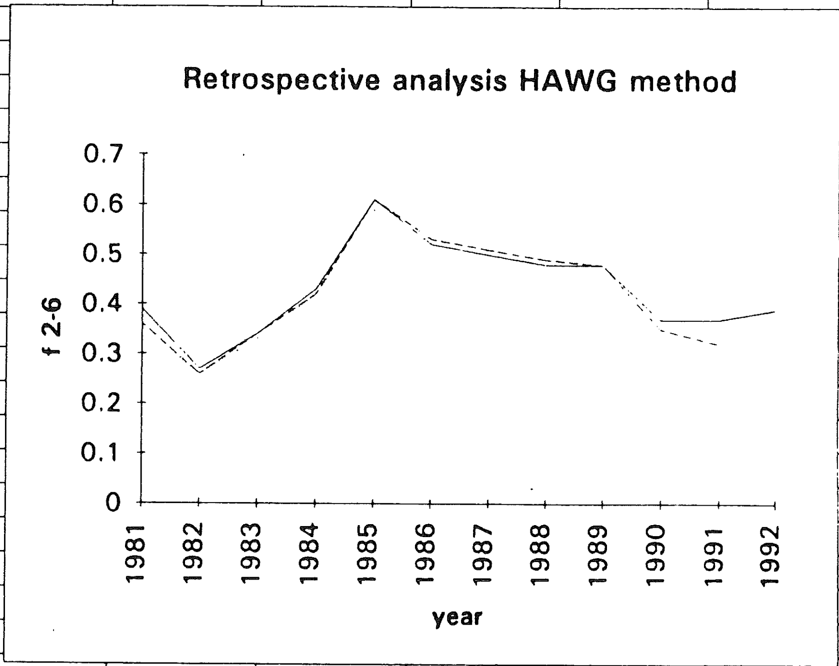
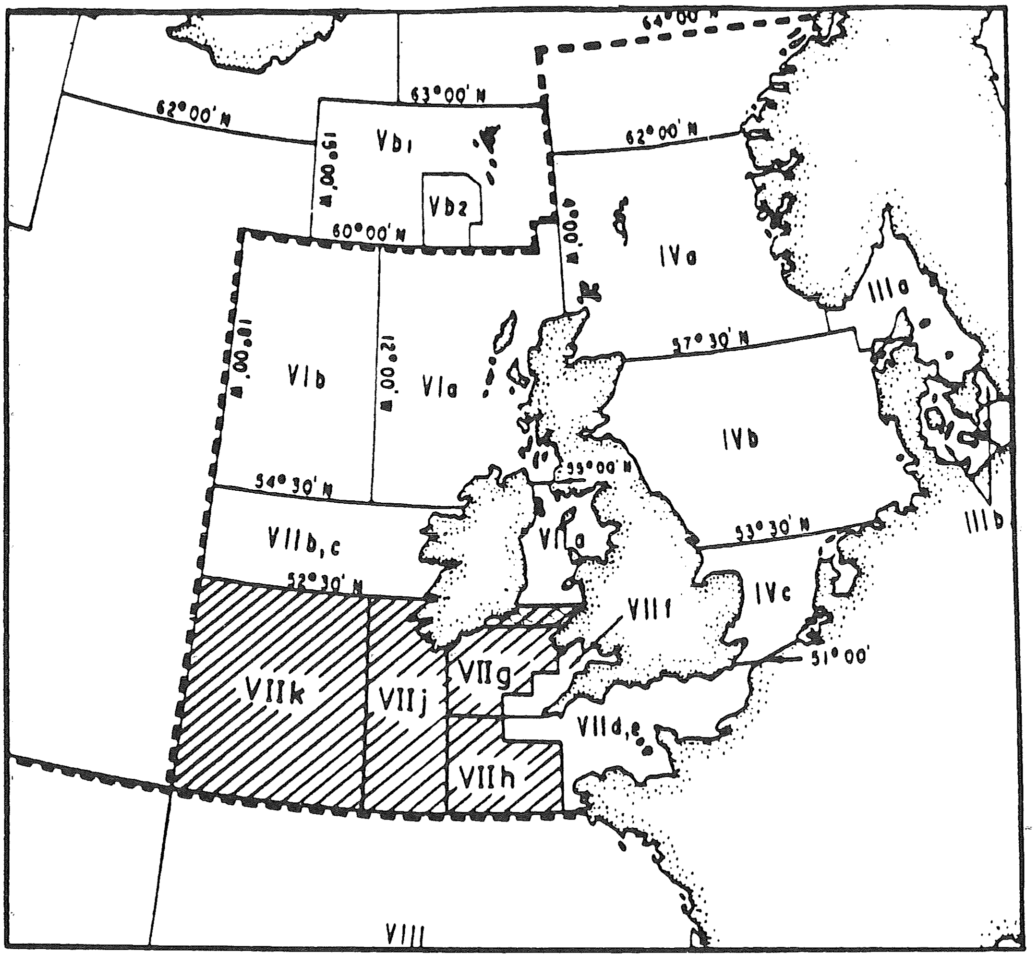


Figure 4.1.1 The assessment covers the area Divisions VIIj and VIIg and that part of Division VIIa below 52° 30. TAC is set by EC for Divisions VIIg-k and that section of Division VIIa below 52°30.



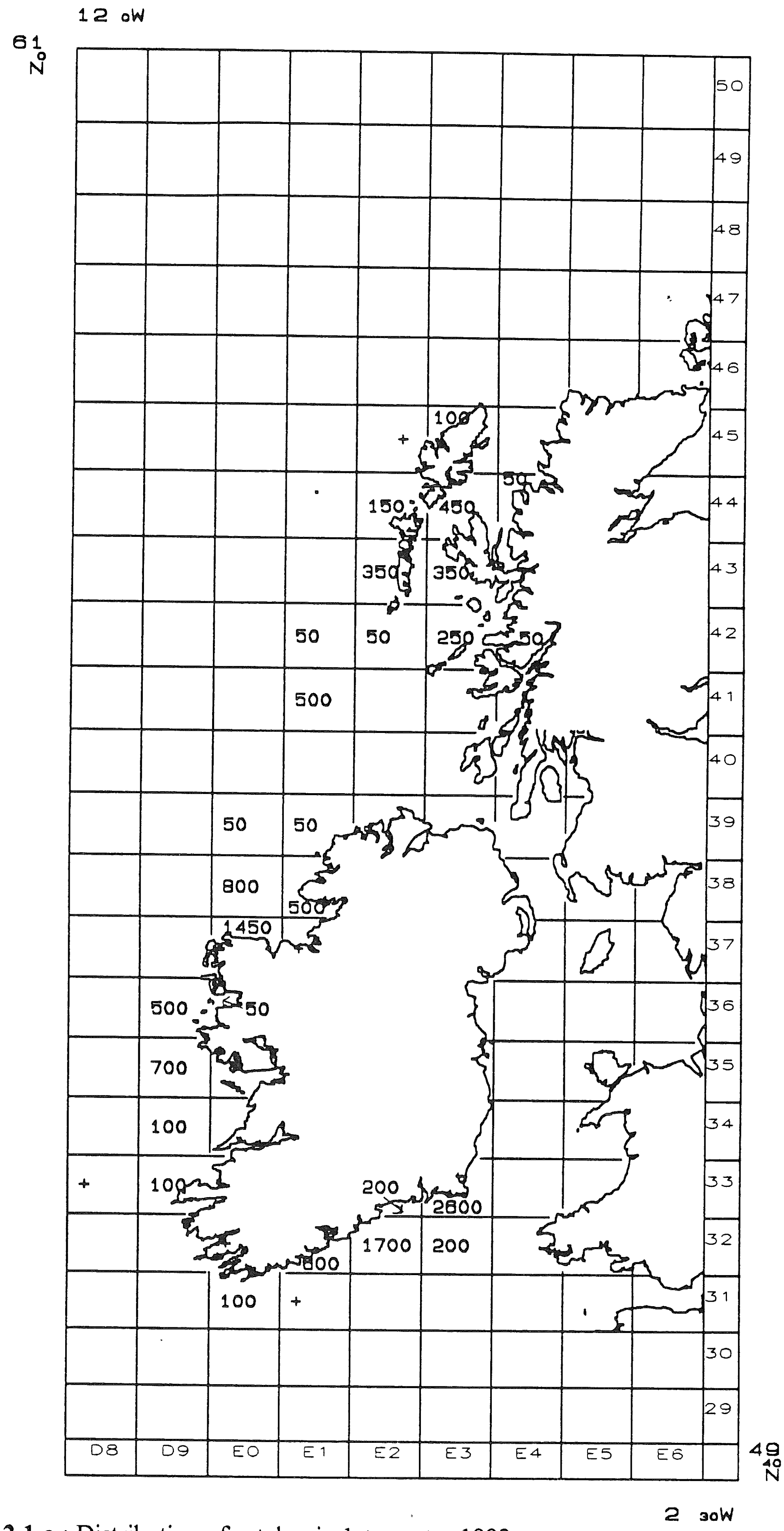


Figure 4.2.1 a : Distribution of catches in 1st quarter 1992.
Irish, Dutch, Norwegian and U.K. data - Total catch : 12100 t approximately.

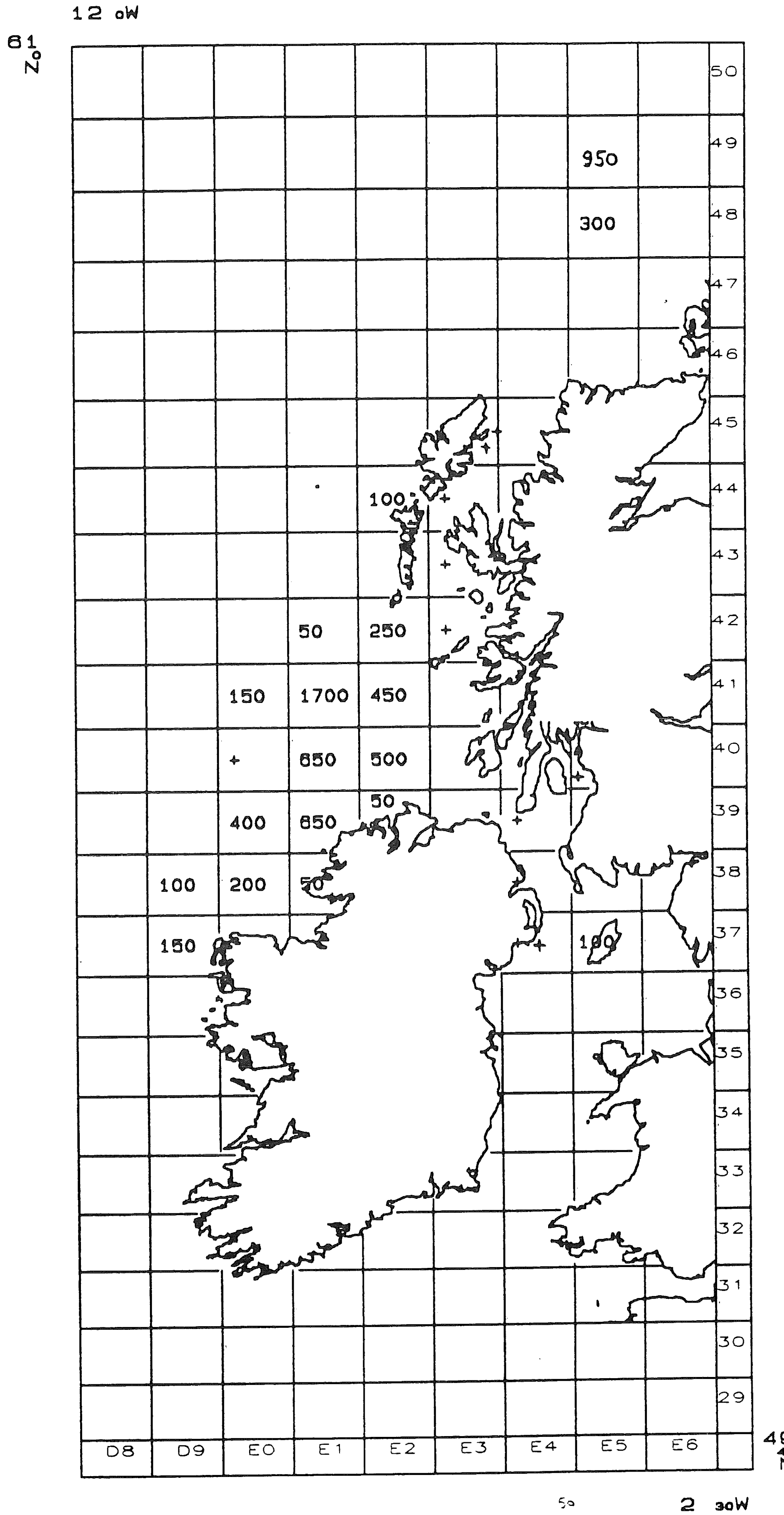


Figure 4.2.1 b : Distribution of catches in 2nd quarter 1992.
Irish, Dutch, Norwegian and U.K. data - Total catch : 12100 t approximately.

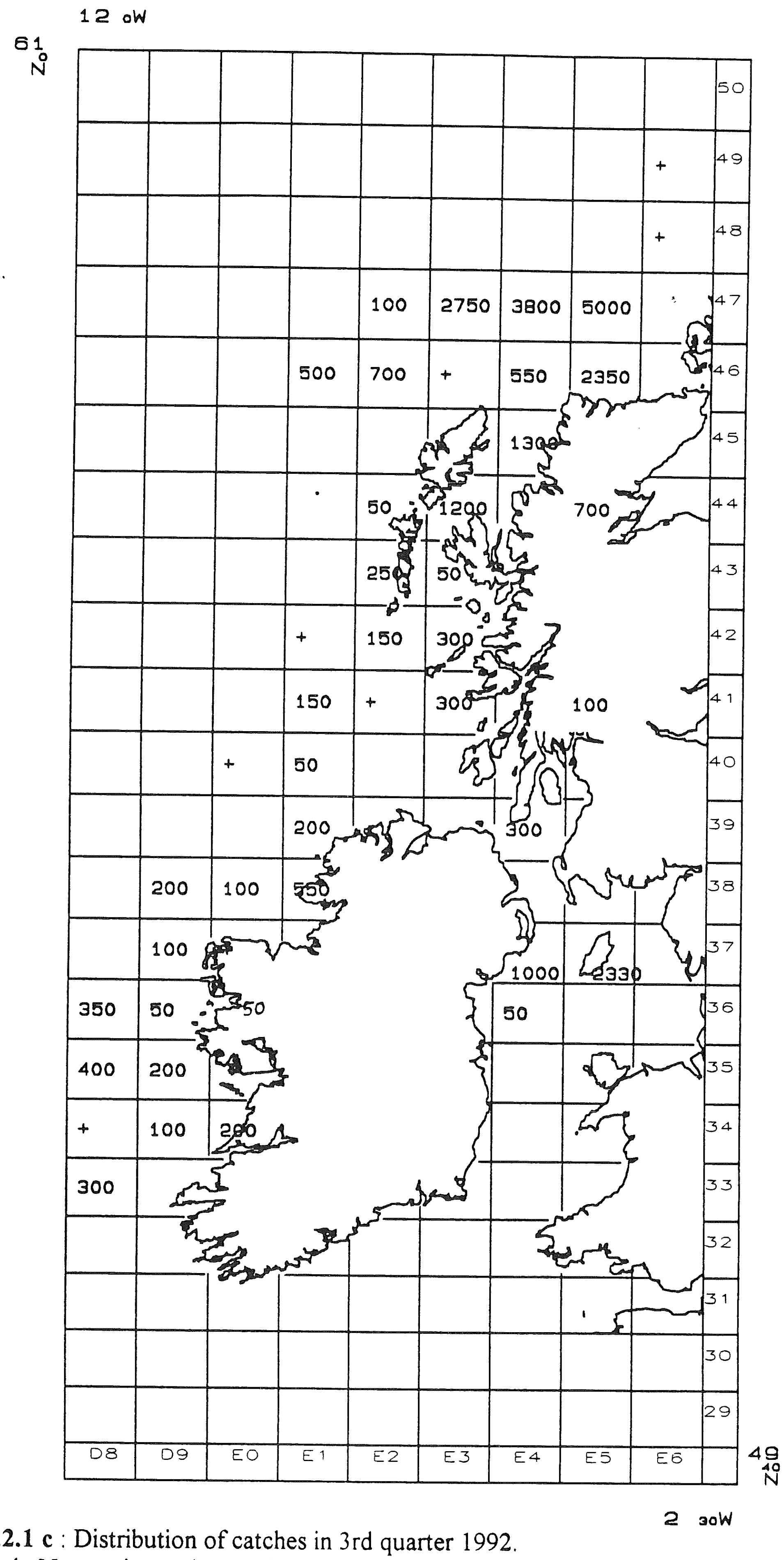


Figure 4.2.1 c : Distribution of catches in 3rd quarter 1992.
Irish, Dutch, Norwegian and U.K. data - Total catch : 12100 t approximately.

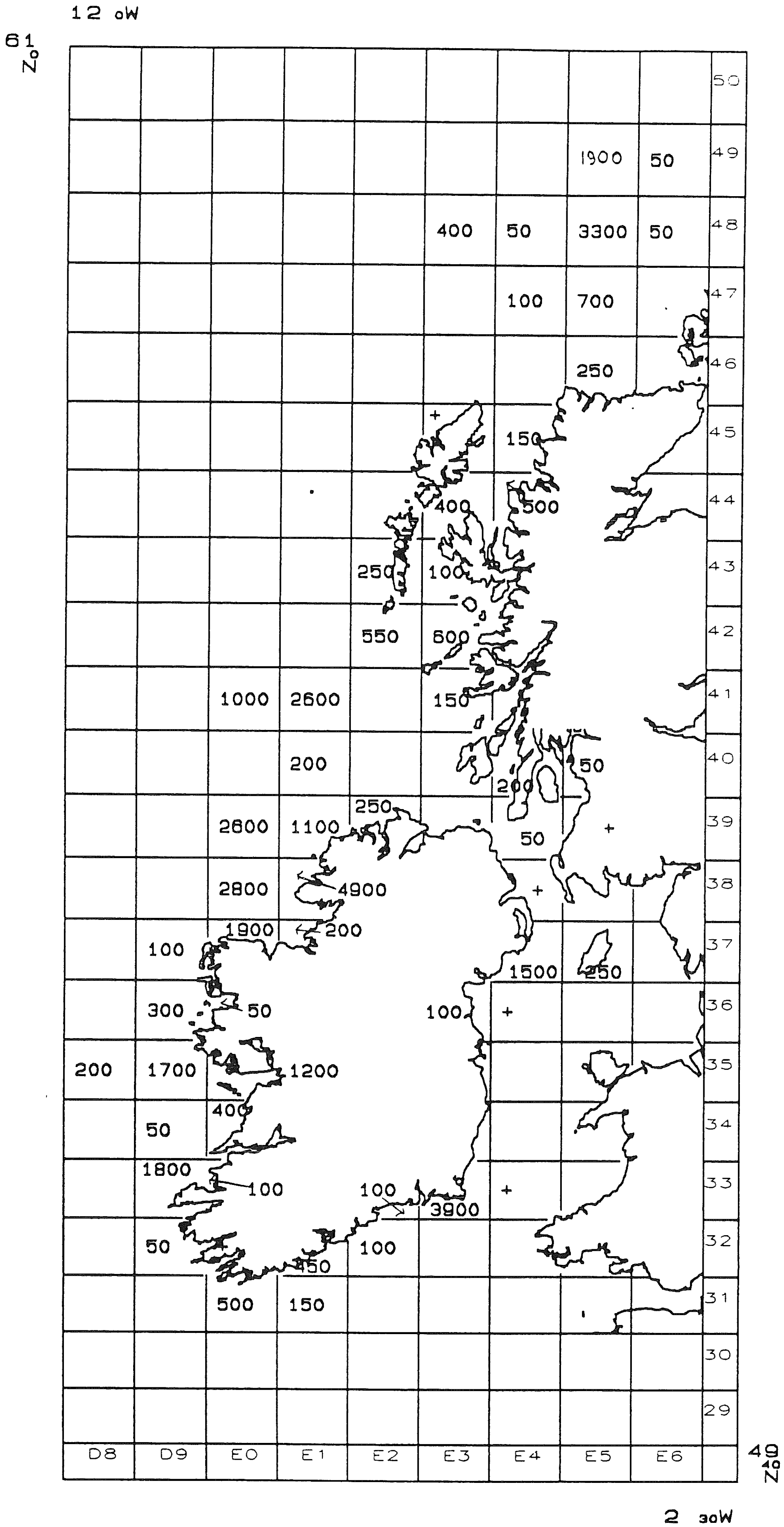


Figure 4.2.1 d : Distribution of catches in 4th quarter 1992.
Irish, Dutch, Norwegian and U.K. data - Total catch : 12100 t approximately.

Figure 4.5.1 Total numbers of recaptures of tagged herring. Released in July 1991. Numbers of recaptures from August 1992-February 1993 in brackets.

West coast release and recapture area □
Isle of Man release and recapture area ○

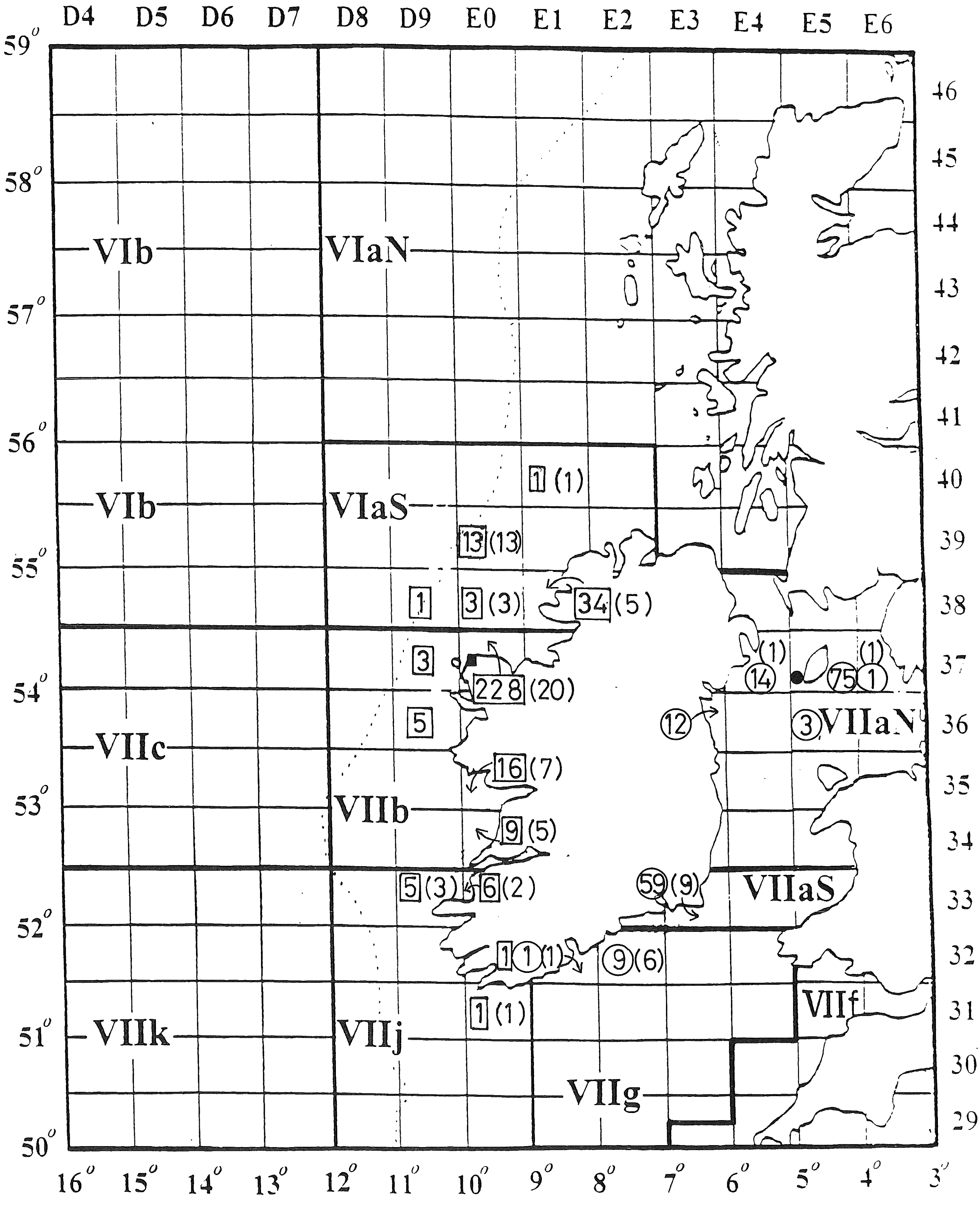


Figure 4.6.1 SSB levels derived from different input F values in 1992.

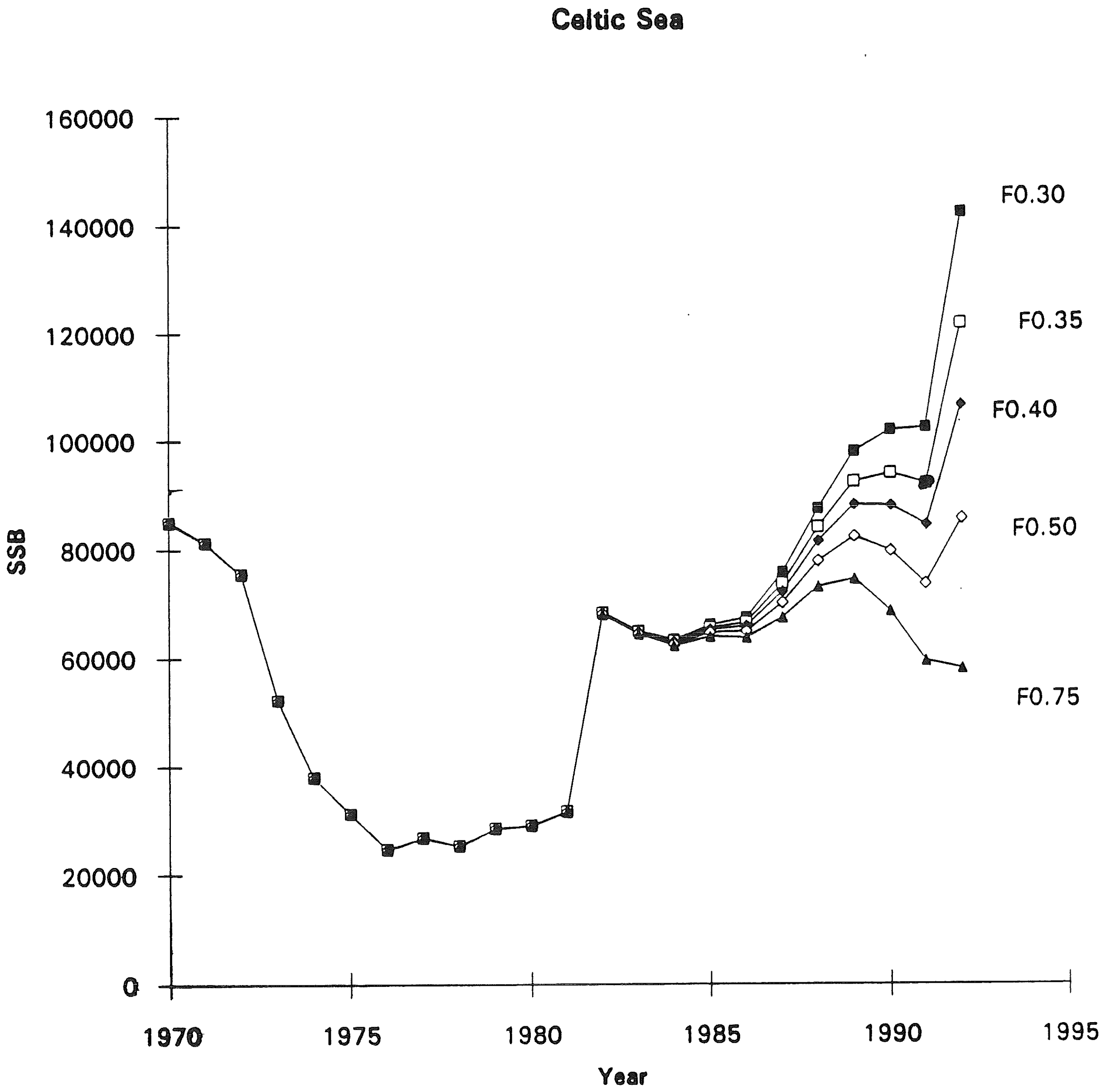


Figure 5.1.1 Trends in the LAI and LPE series of indices.

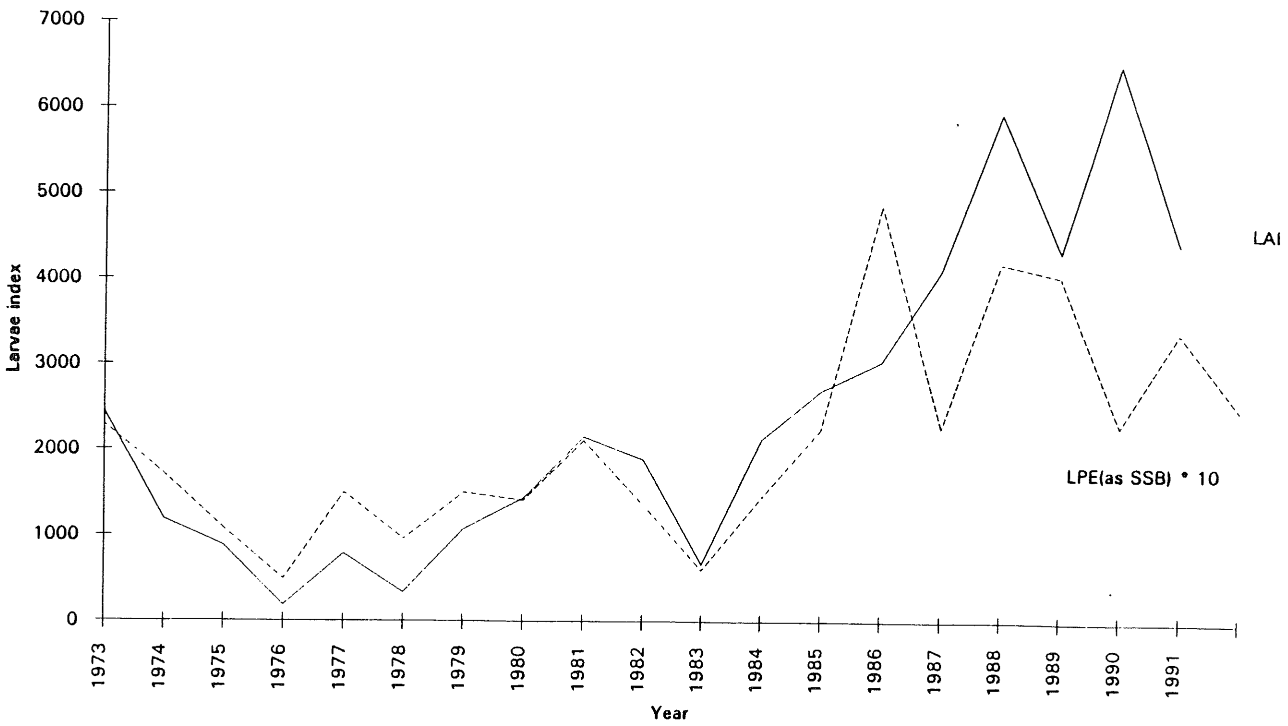


Figure 5.1.2 The natural logarithms of the mean catch rate of 2-ringers in statistical rectangles 45E4-E6, 47E4-E6, 44E3-E4 during the March 1993 bottom trawl survey, plotted against VPA estimates of 2-ringer abundance. Years refer to year classes.

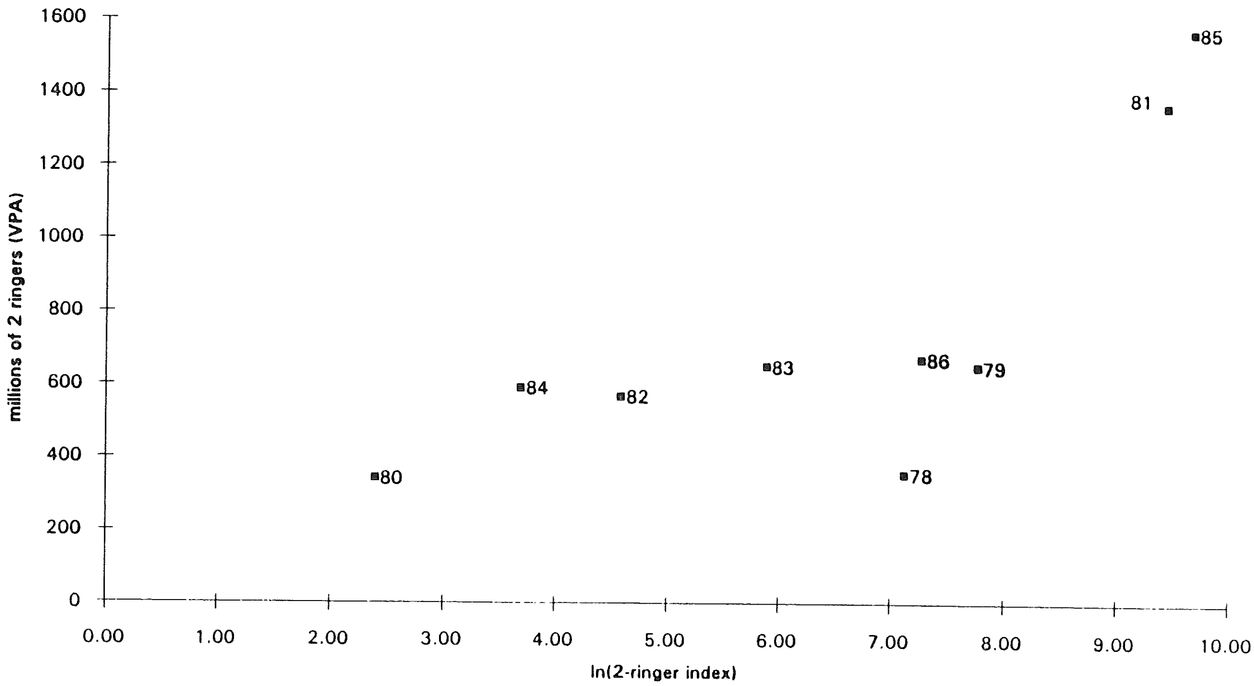


Figure 5.1.3 Convergence of the VPA with a range of values of input F.

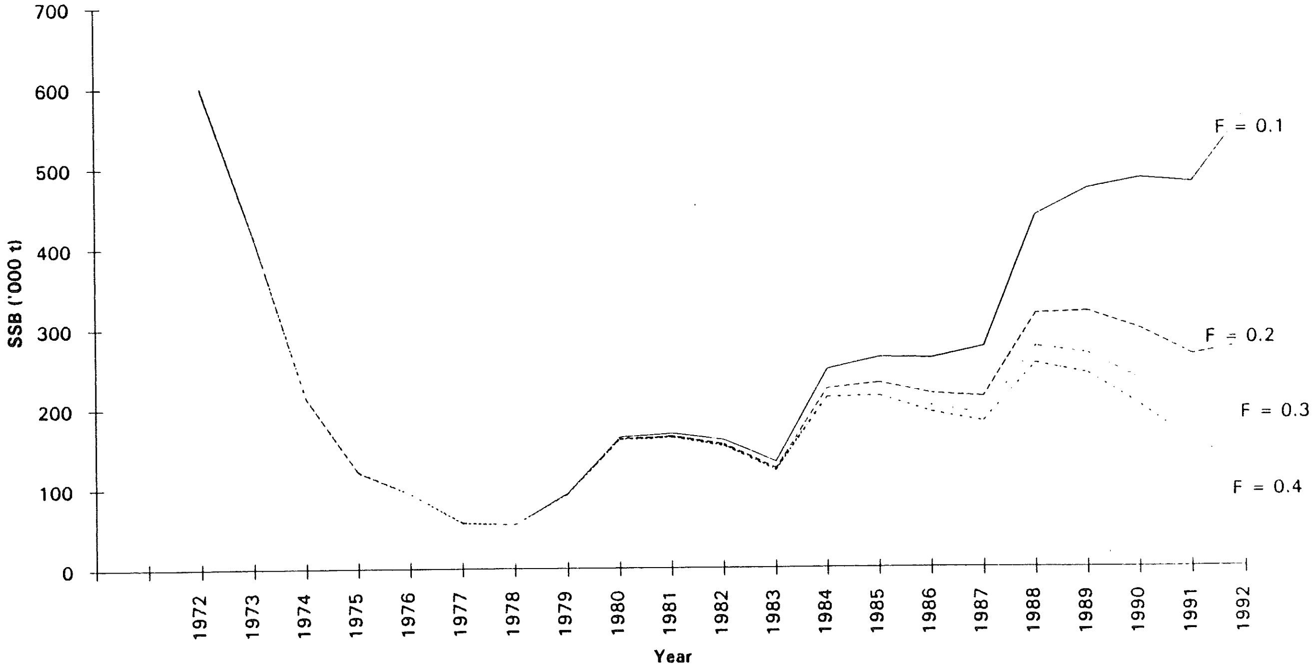


Figure 5.1.4 The relation between LAI and SSB from the VPA. Points marked with crosses were not included in the RCT3 regression.

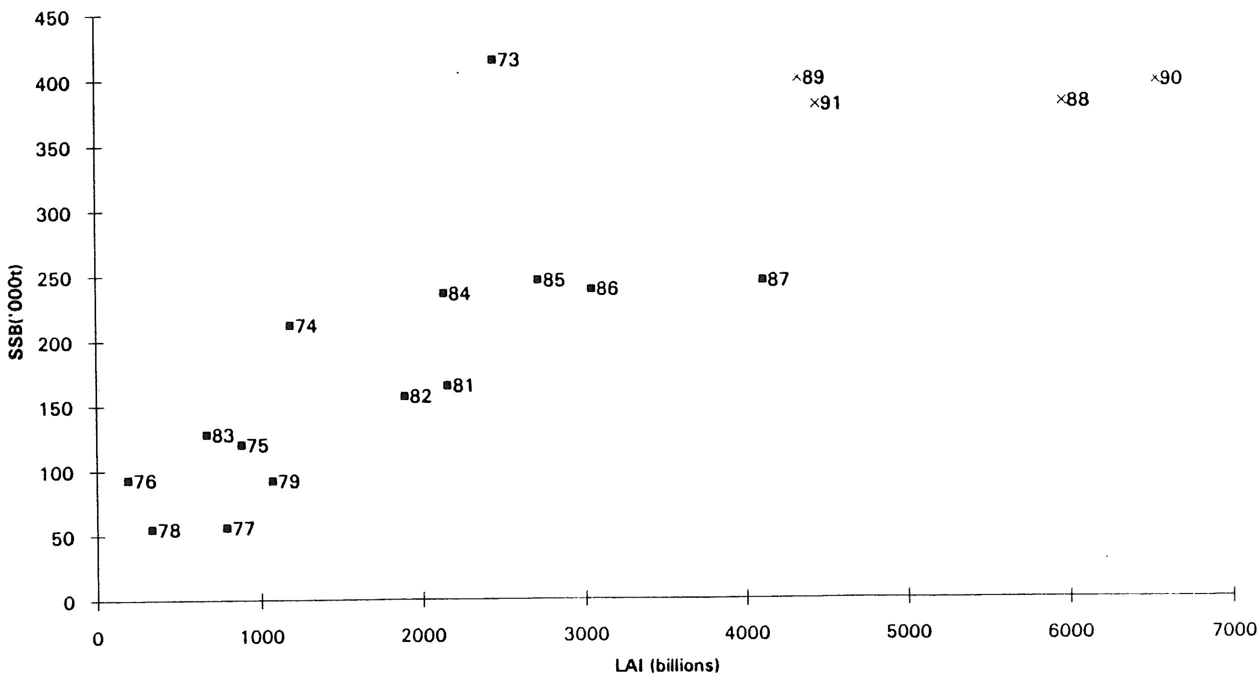


Figure 5.1.5 The relation between LPE and SSB from the VPA. Points marked with crosses were not included in the RCT3 regression.

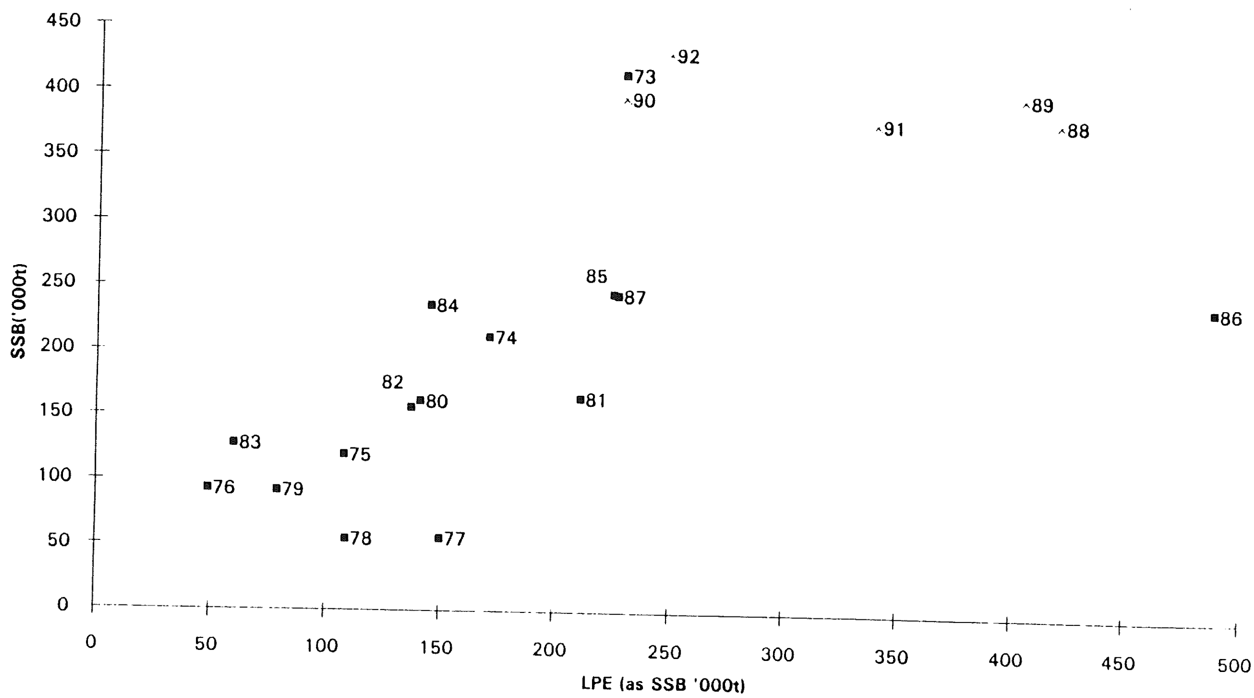


Figure 5.1.6 Sum of squared residuals between VPA estimates of SSB and the predicted estimates of SSB at a range of terminal F values.

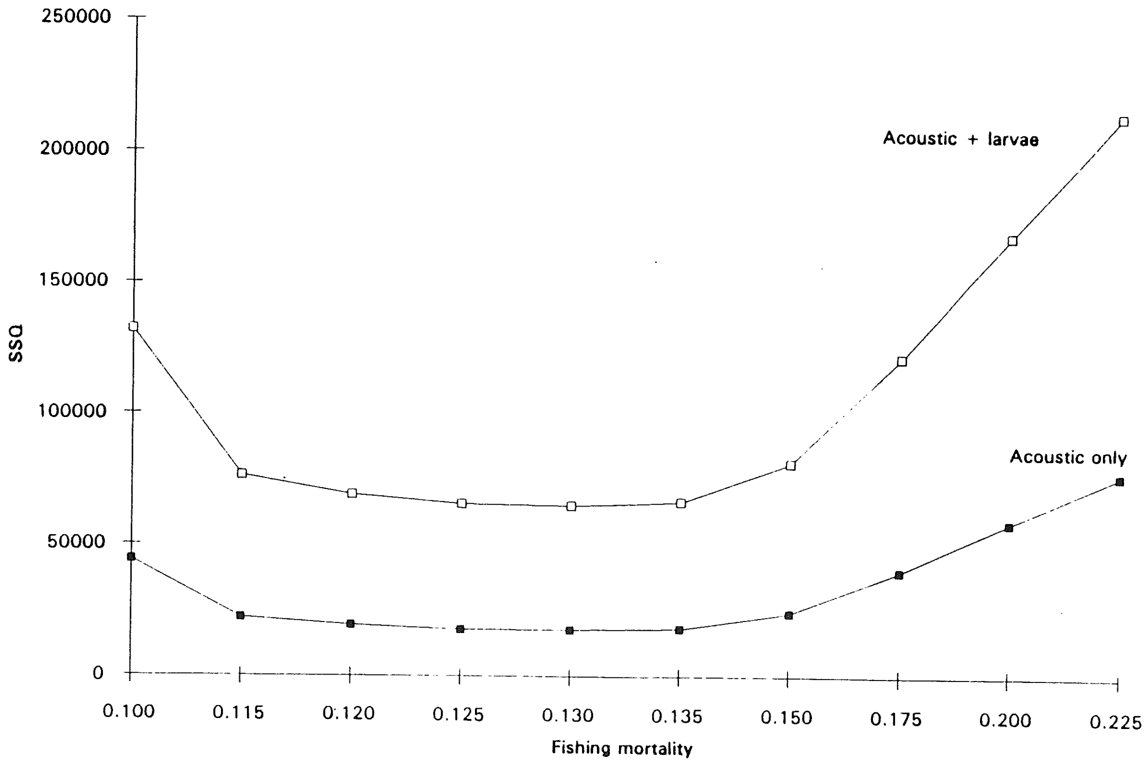


Figure 5.1.7

FISH STOCK SUMMARY
STOCK: Herring in the Northern part of VIa
28-3-1993

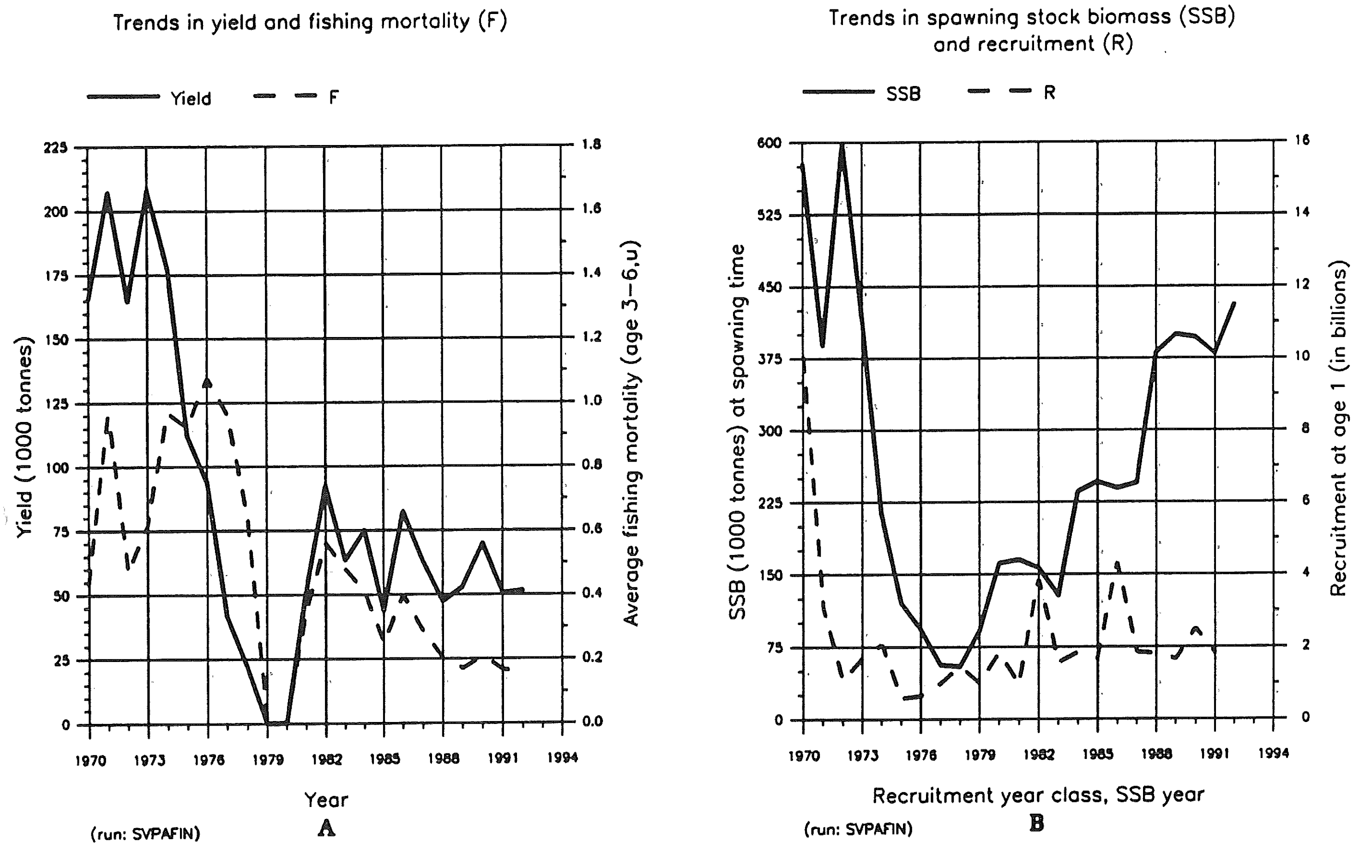


Figure 5.1.8 Trends in SSB estimated by the final VPAs including and excluding the Faroese catches in Area V. Also shown are the predicted SSB estimates used in the tuning procedure.

Figure 5.1.9 Plot of stock and recruitment and estimated values of F_{high} and F_{low}.

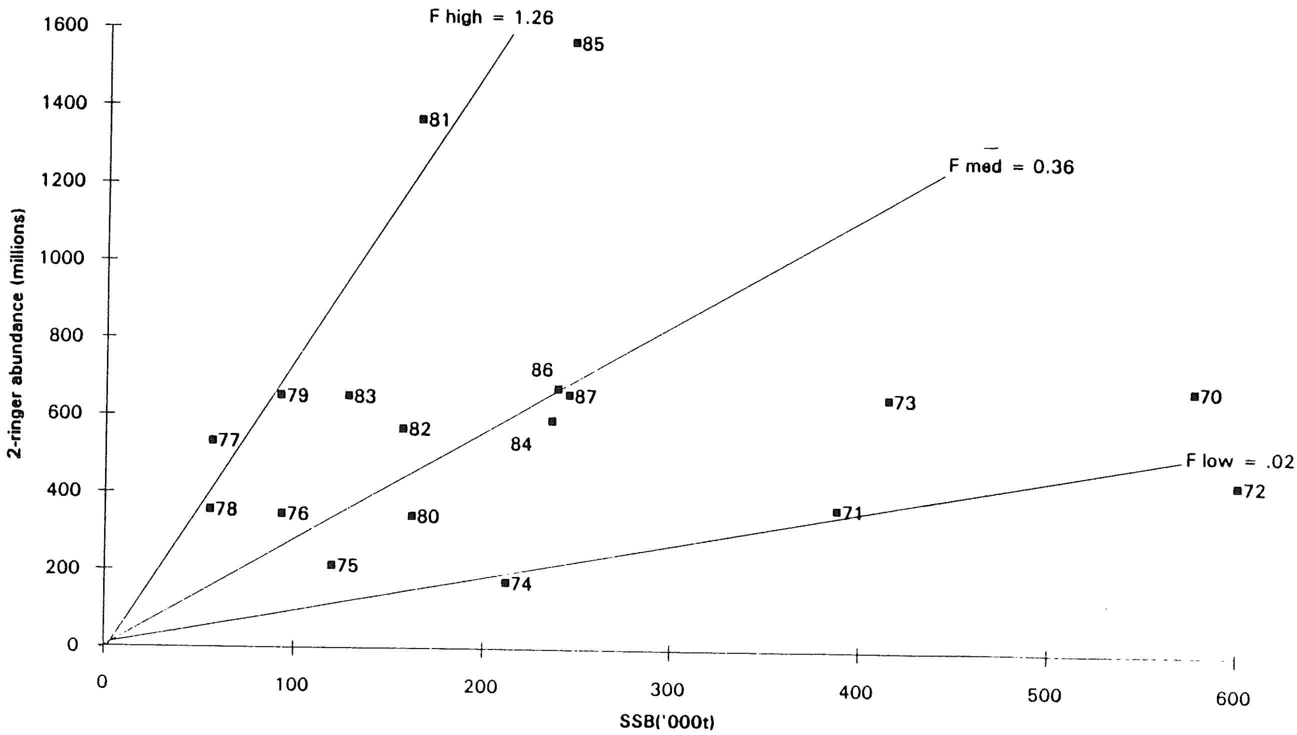


Figure 5.1.11 Comparison of integrated model fits to available acoustic survey information, to illustrate the dependence of the fit on the catchability model. Here the survey is used either as an estimator of absolute stock size, using a linear relationship (Index = Q.SSB) or using a logarithmic relationship (In(Index) = Q.In (SSB)+K).

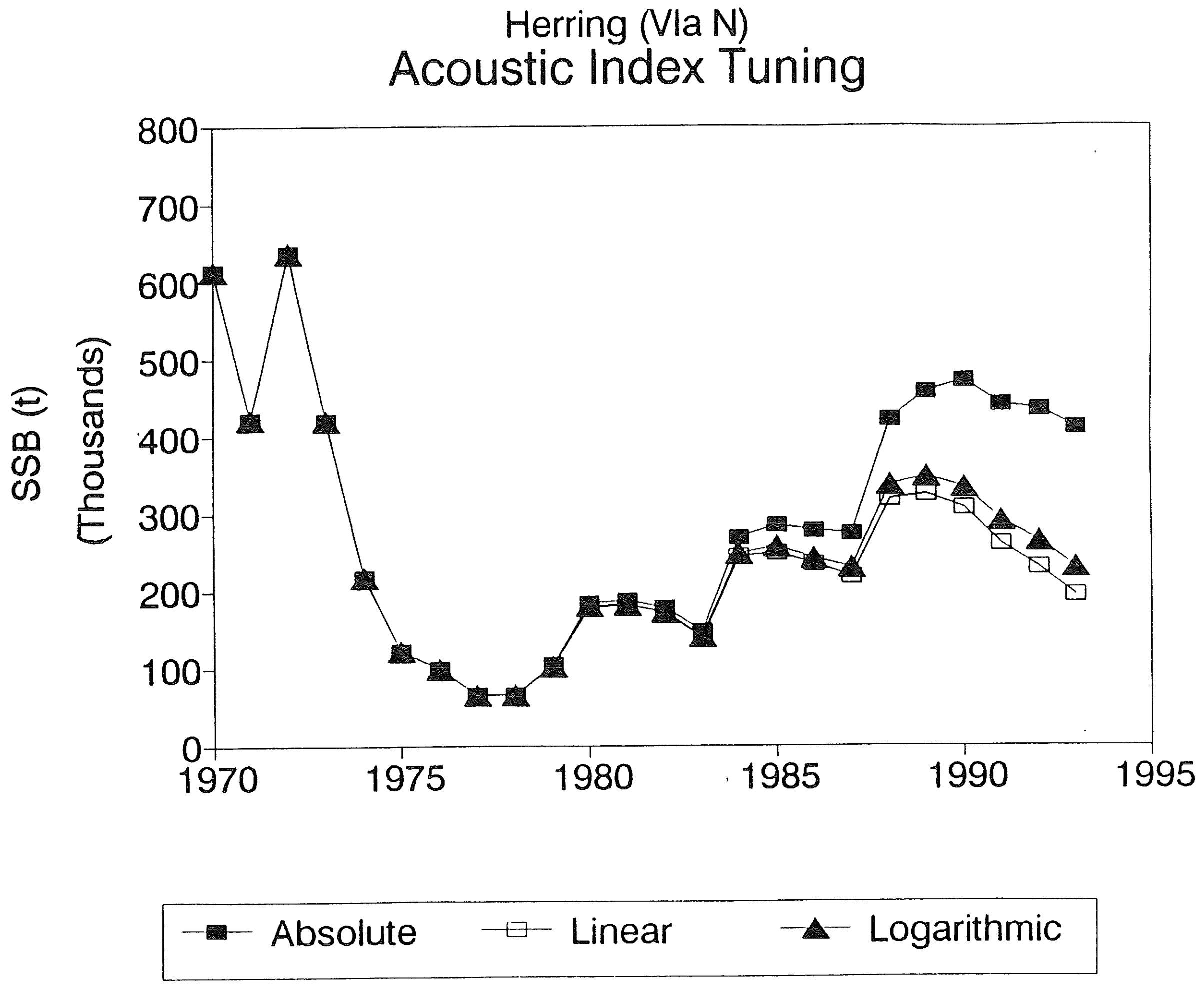


Figure 5.1.10 Herring in Division VIaN. Estimates of spawning stock biomass retrospective analysis using tuning methods adopted by the working group in successive years.

Figure 5.1.12 Comparison of integrated model fits to available larval survey information. Fits to either LAI, LPE or trimmed LA estimates. Here the relationship assumed is (Index = Q.In(SSB)+K) for all three series.

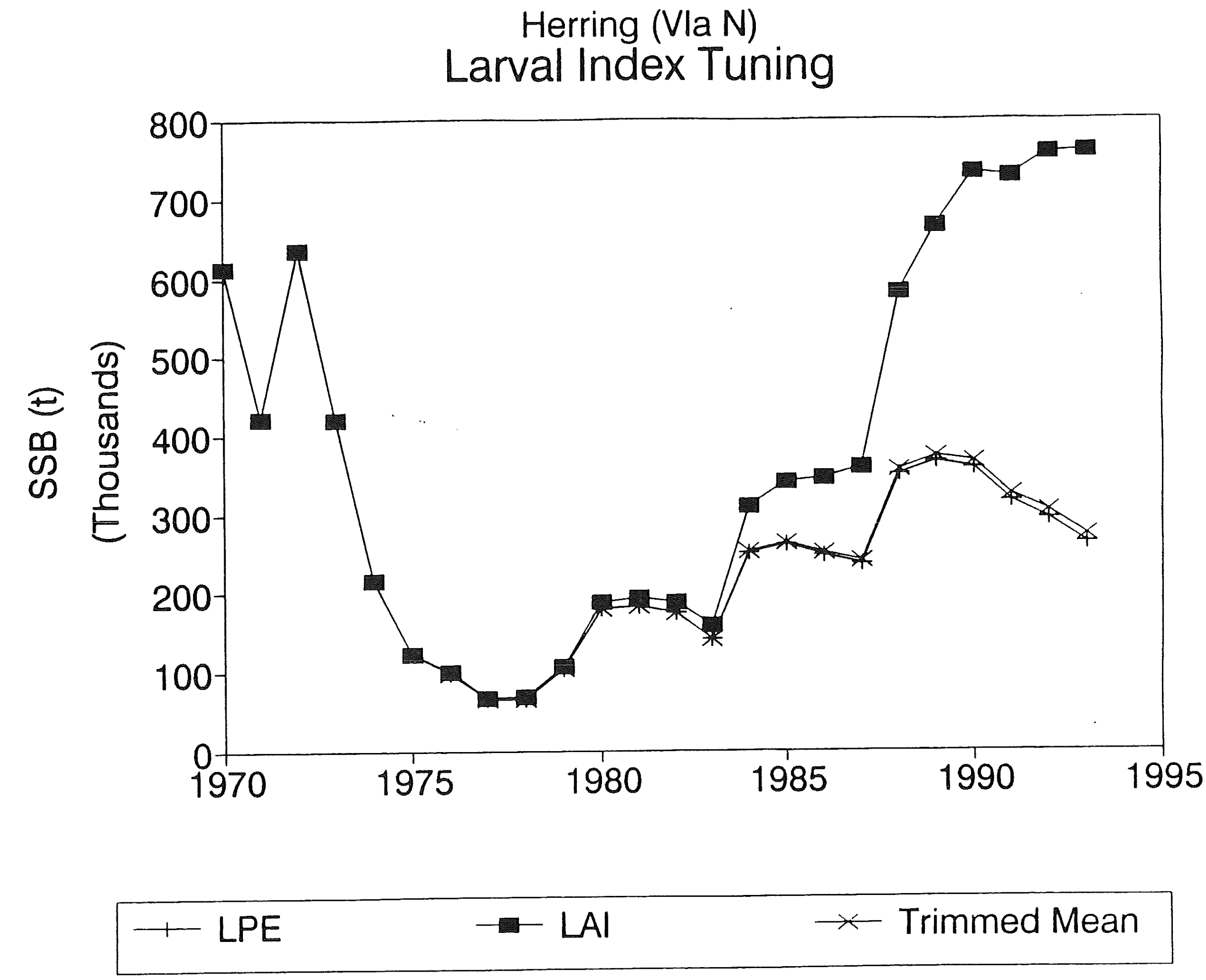


Figure 5.1.13 Summary of an integrated model fit using both acoustic survey data and larval survey information, combined with equal weight. Assumed relationships: ln(Trimmed LA)=Q.ln(SSB)+K; Acoustic Index=Q.SSB. Dashed lines indicate the SSB from the model fit; triangles indicate the predicted SSBs as estimated from the index data using the estimated catchability.

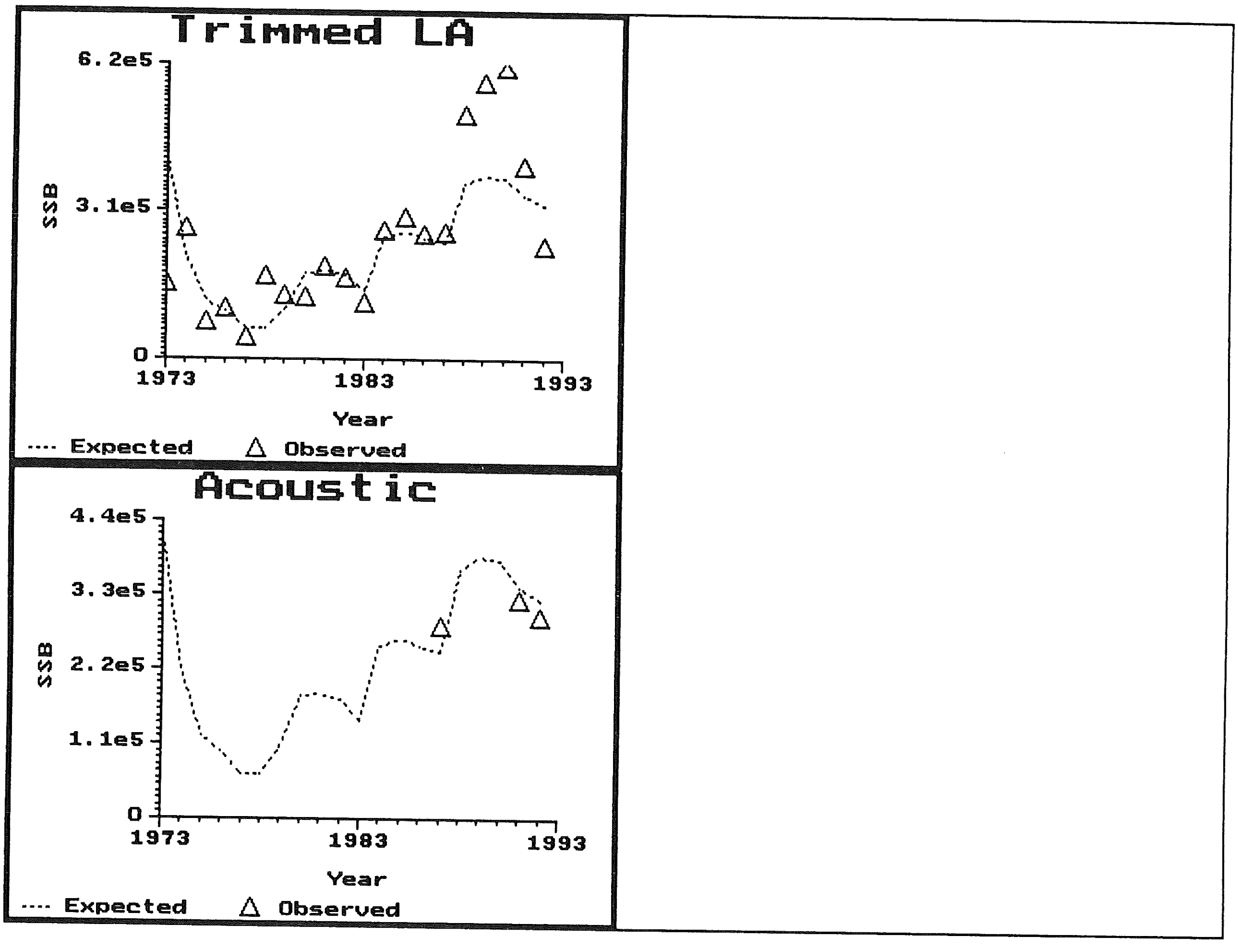


Figure 5.1.14 Summary of an integrated model fit based on the same assumptions as the final VPA in Section 5.1.9. Assumed relationships: In(LAI=Q. In(SSB)+K; Acoustic estimate used as an absolute estimator.

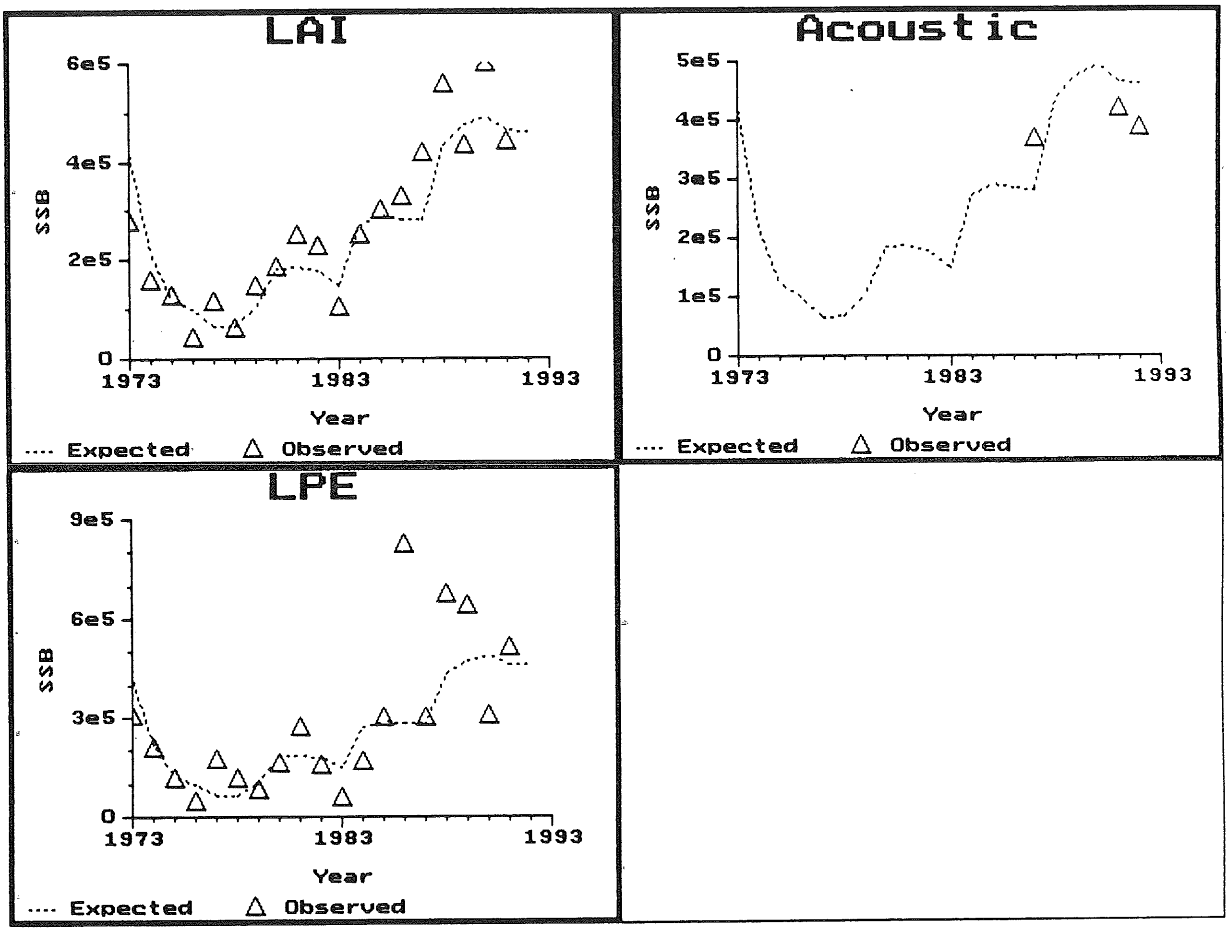


Figure 6.5.1 SSB levels from different input F values in 1992.

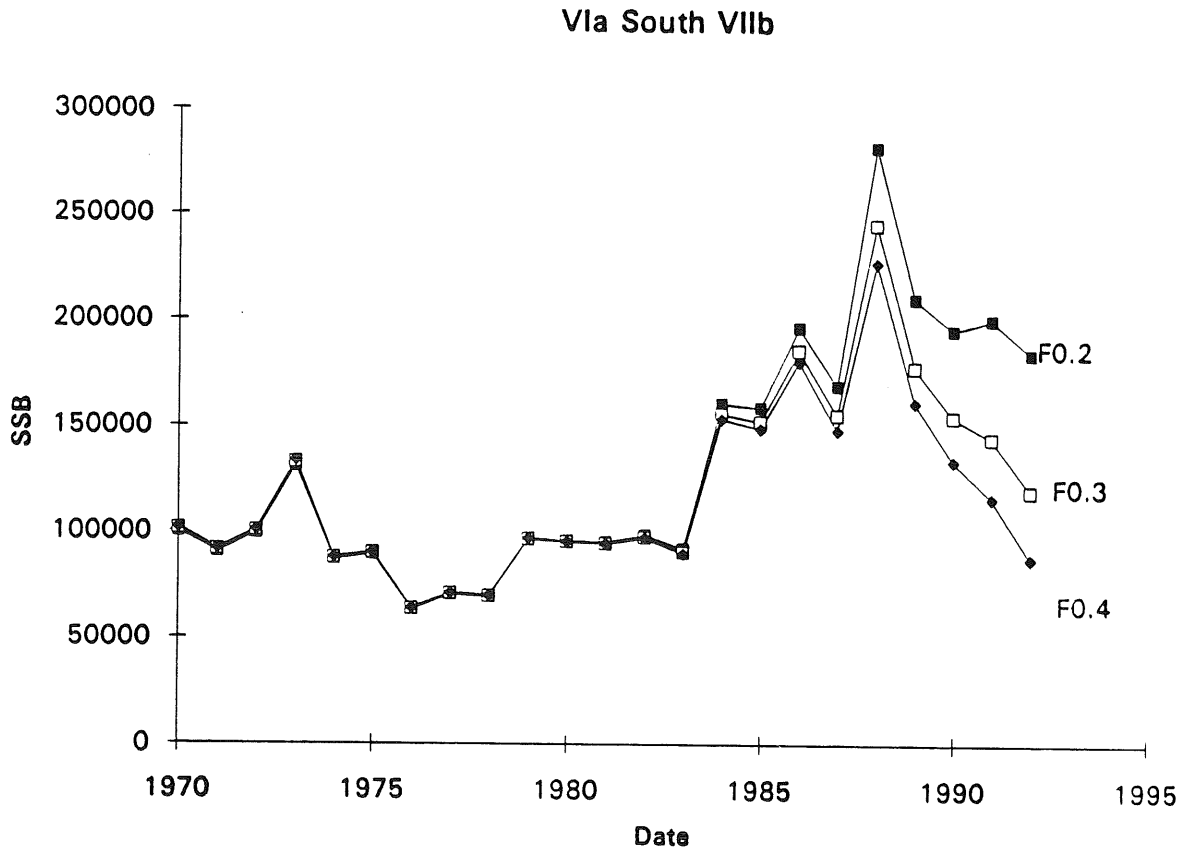


Figure 7.3.1 Cruise track during the July 1992 acoustic survey.

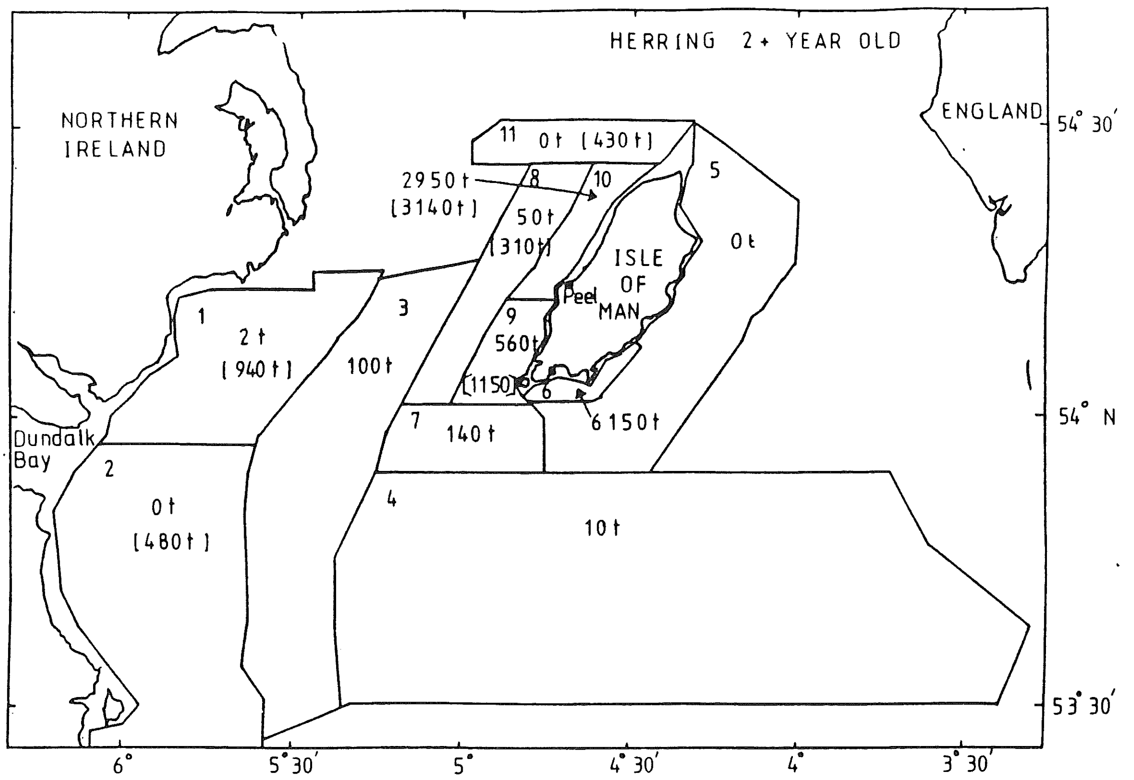


Figure 7.3.2 Biomass indices of 2+ ring herring during the July 1992 acoustic survey, by survey stratum. Indices for category "A" and "B" targets are shown, with estimates including category "C" targets in parenthesis.

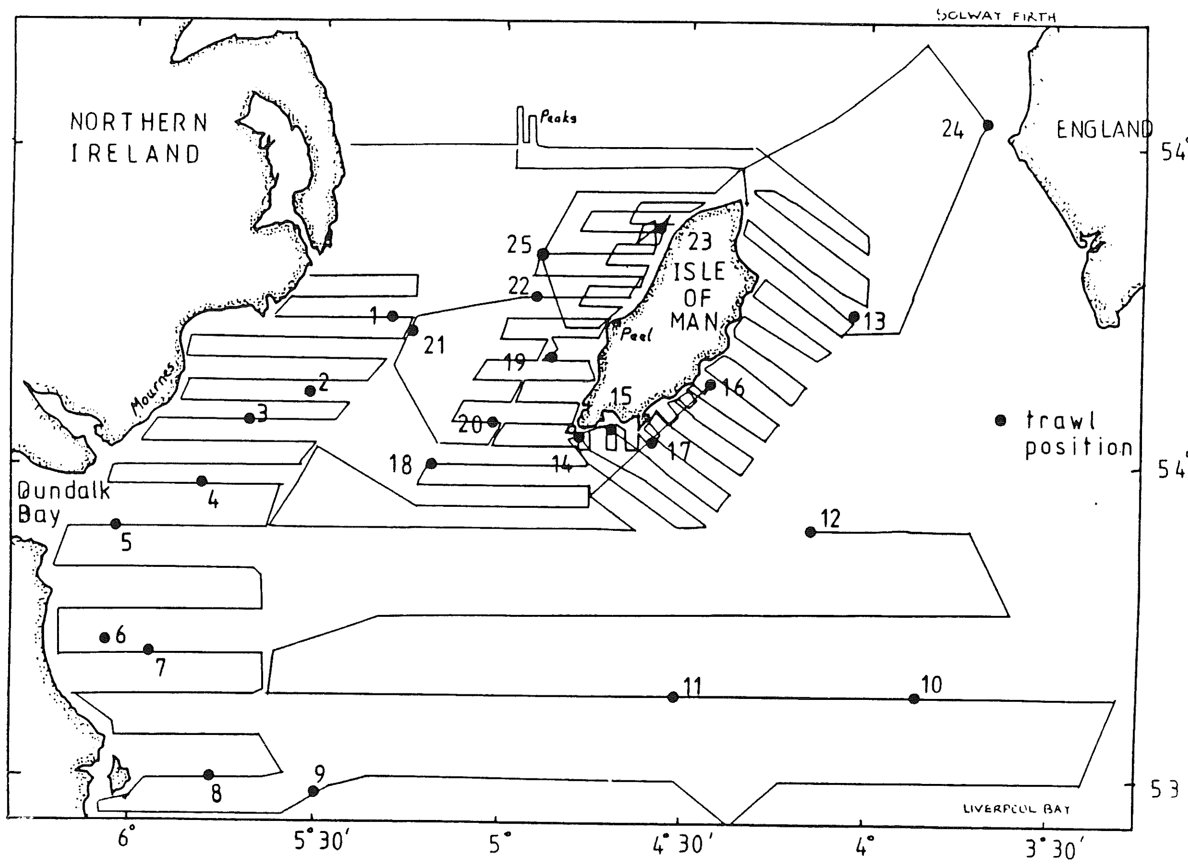


Figure 7.4.1 Sum of squared residuals between VPA estimates of SSB and acoustic estimates of biomass at a range of terminal F values.

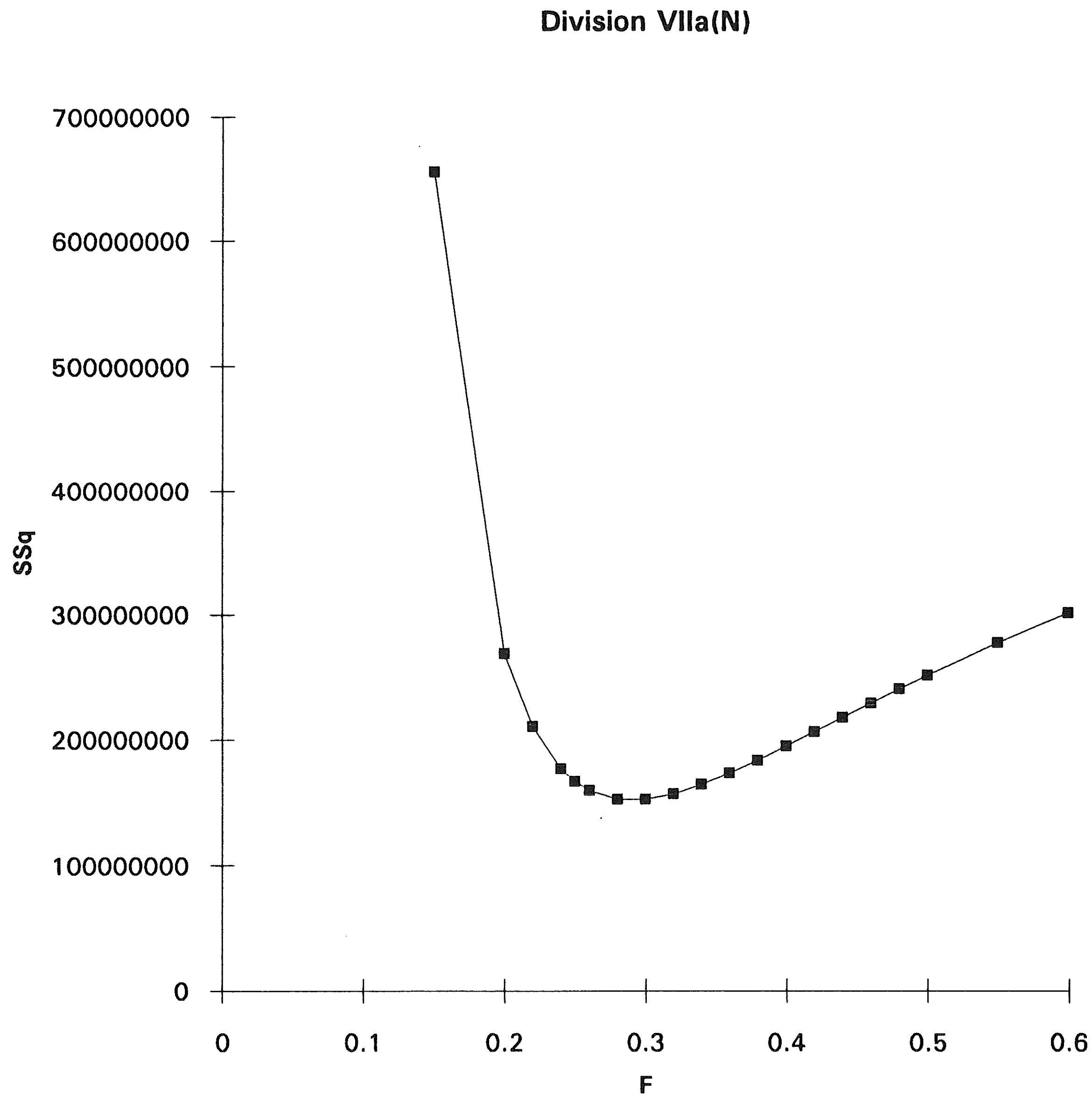
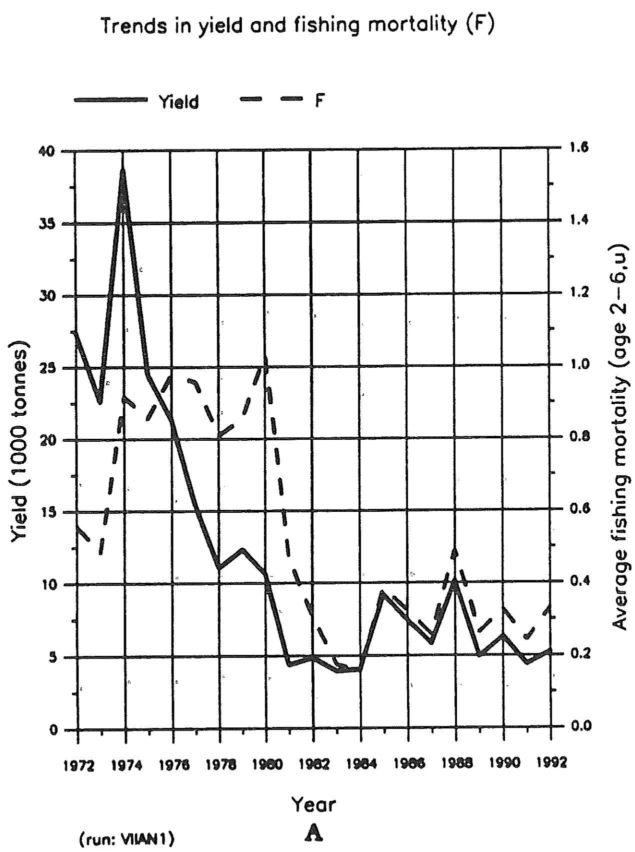
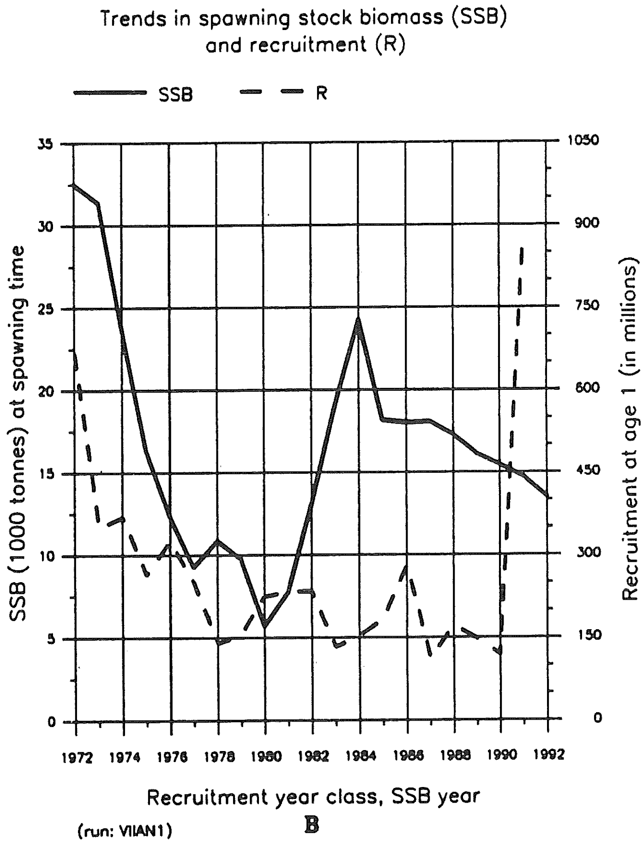


Figure 7.4.2

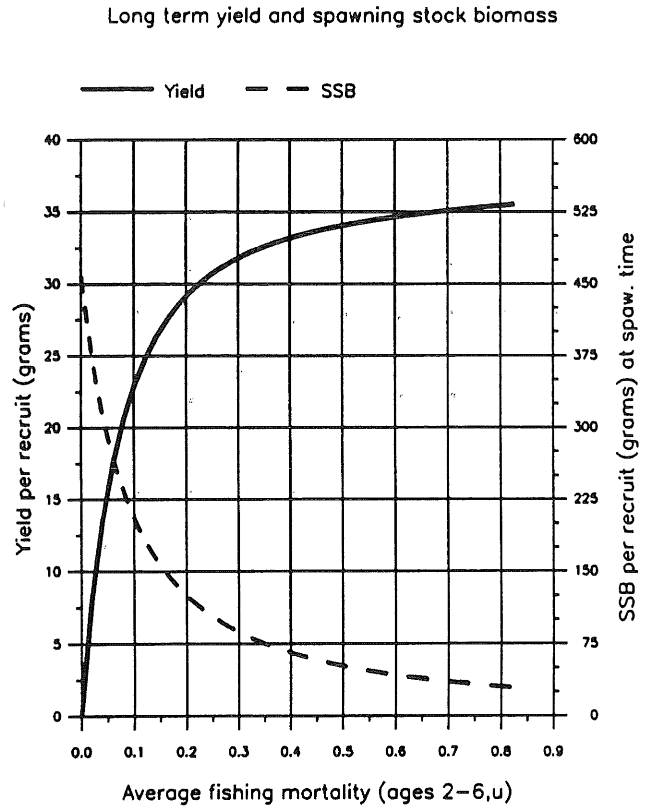
FISH STOCK SUMMARY
STOCK: Herring in the North Irish Sea (Manx plus Mourne herring)
29-3-1993



A

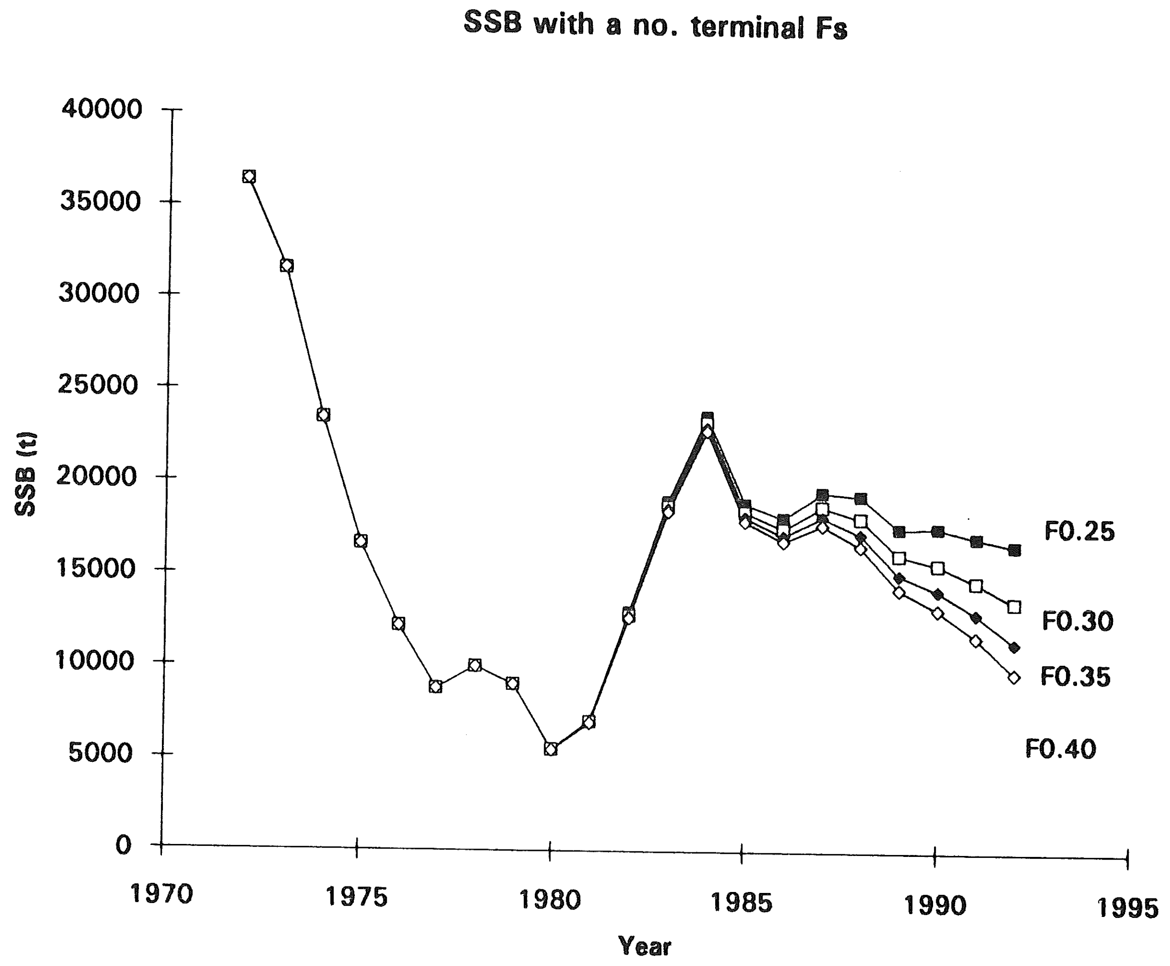


B



C

Figure 7.4.3 Trends in SSB estimated by VPA for a number of terminal Fs.



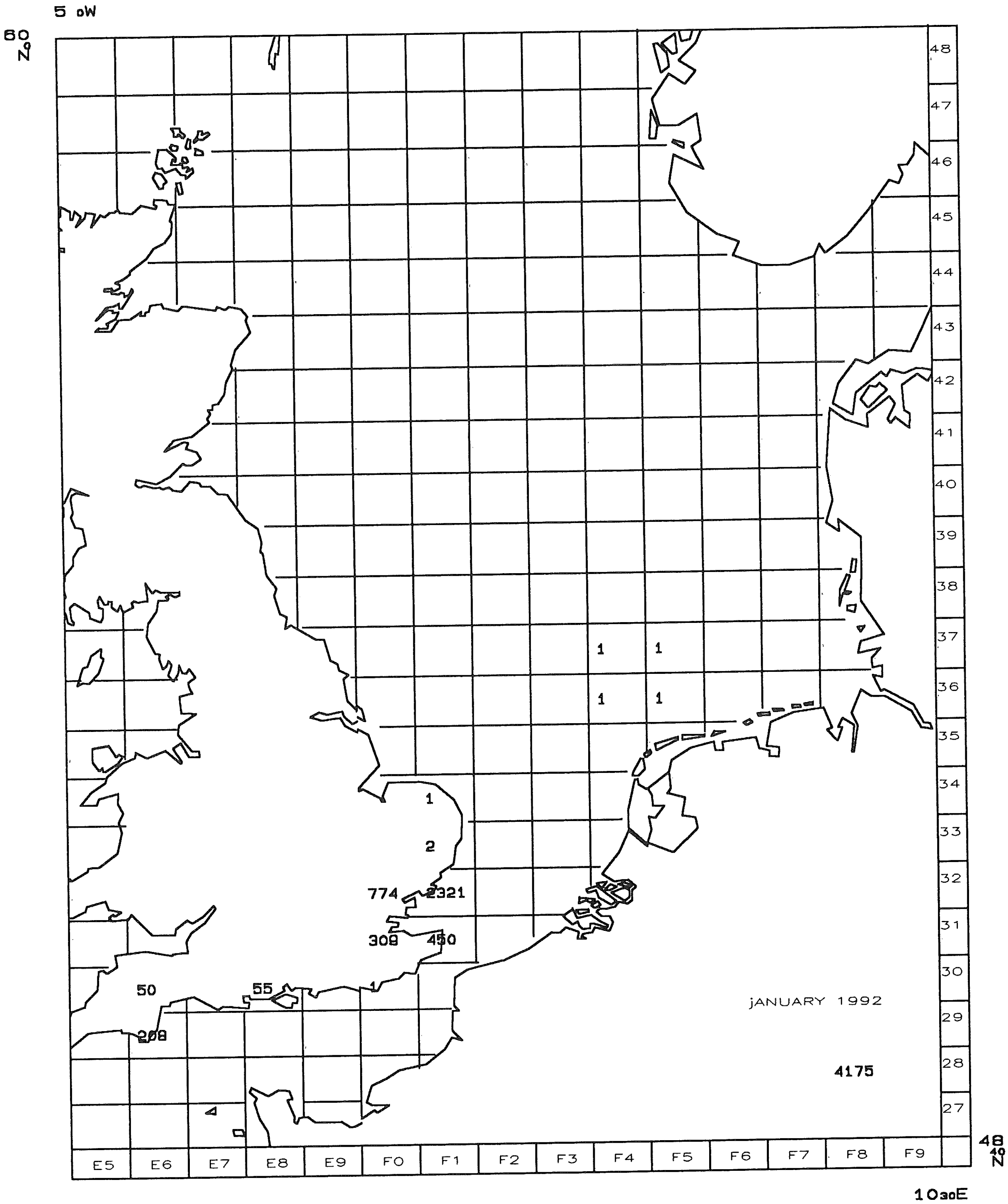


Figure 8.1.1 North Sea and Division VIId,e sprat catches in tonnes for January 1992.

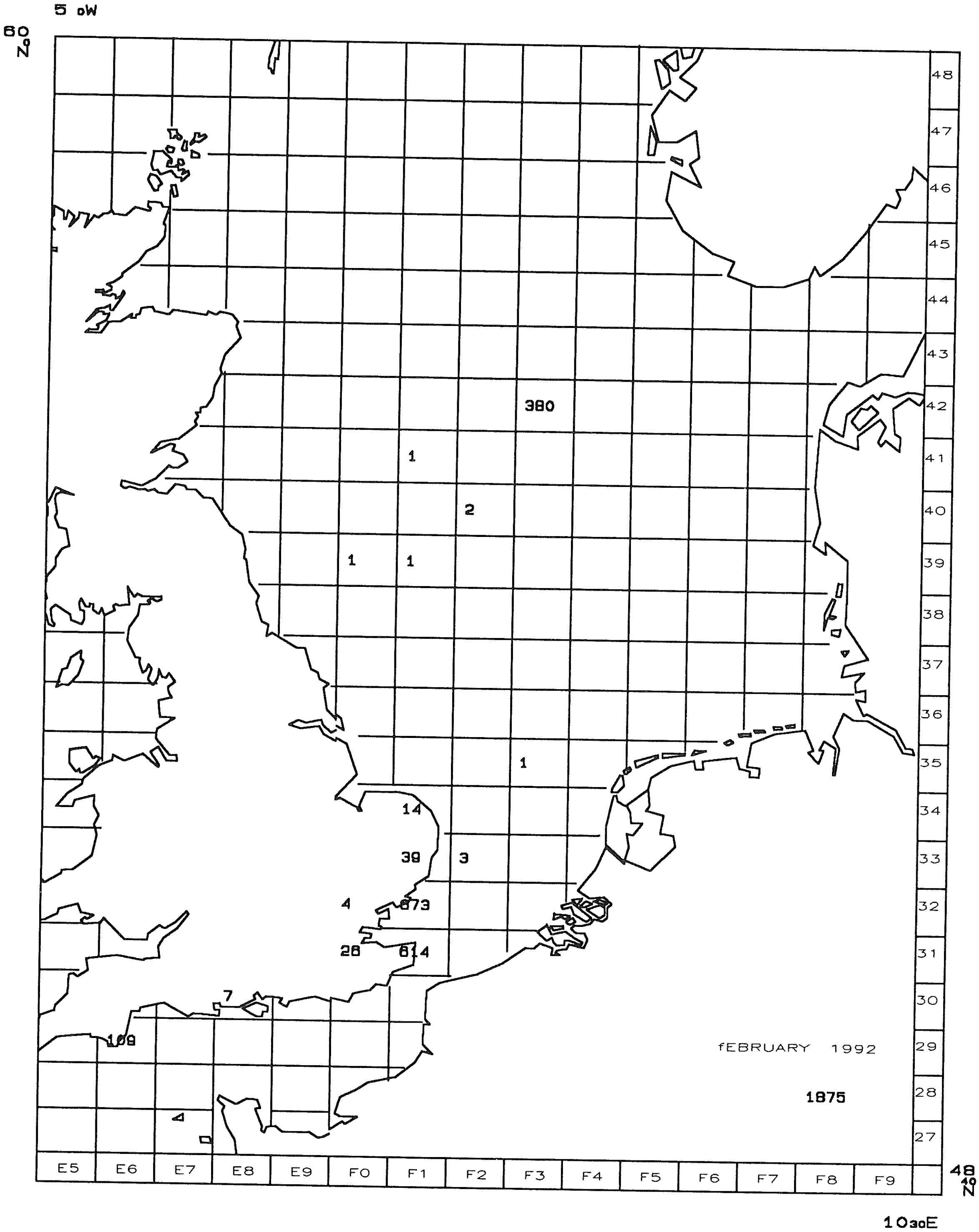


Figure 8.1.2 North Sea and Division VIId,e sprat catches in tonnes for February 1992.

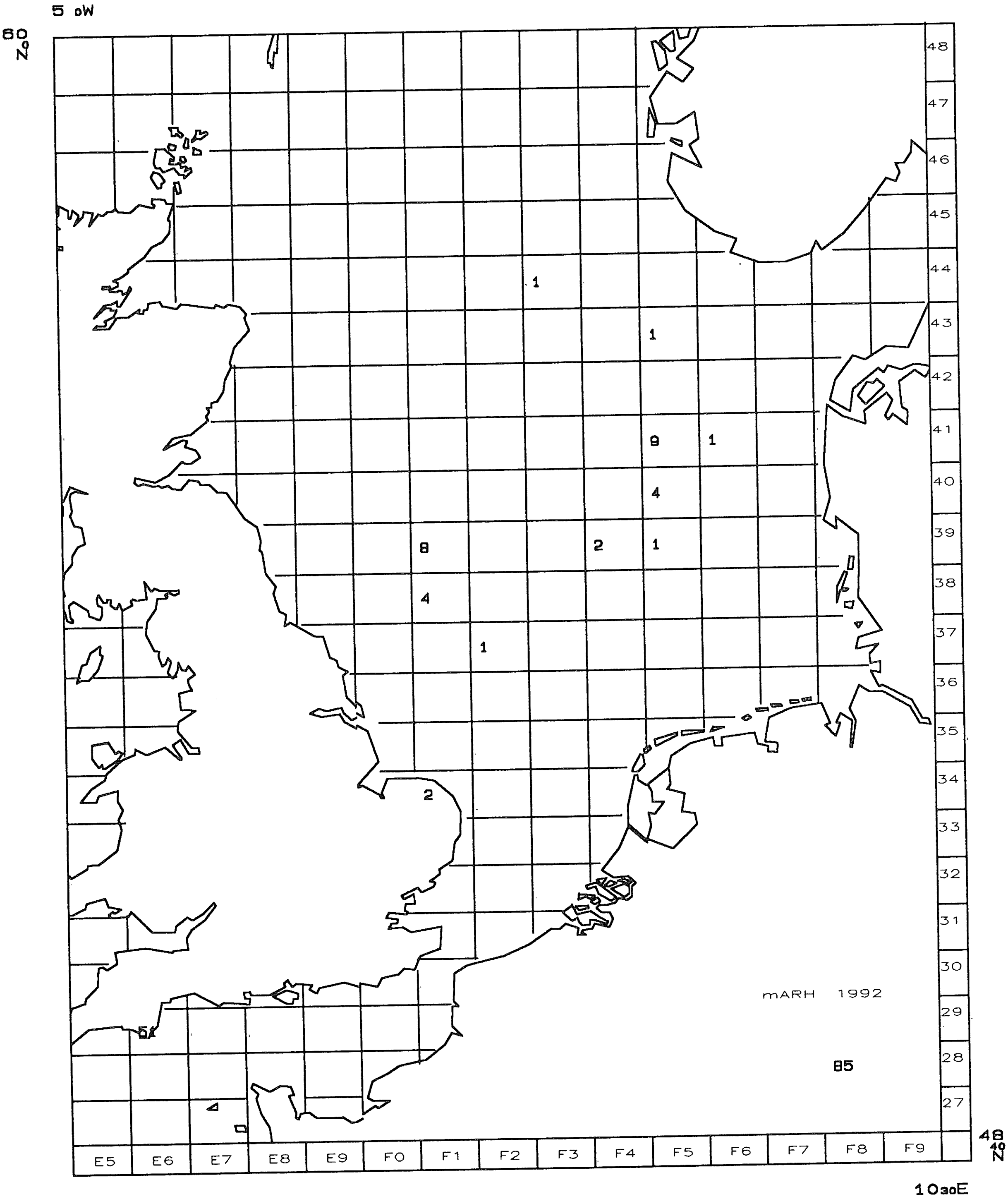


Figure 8.1.3 North Sea and Division VIId,e sprat catches in tonnes for March 1992.

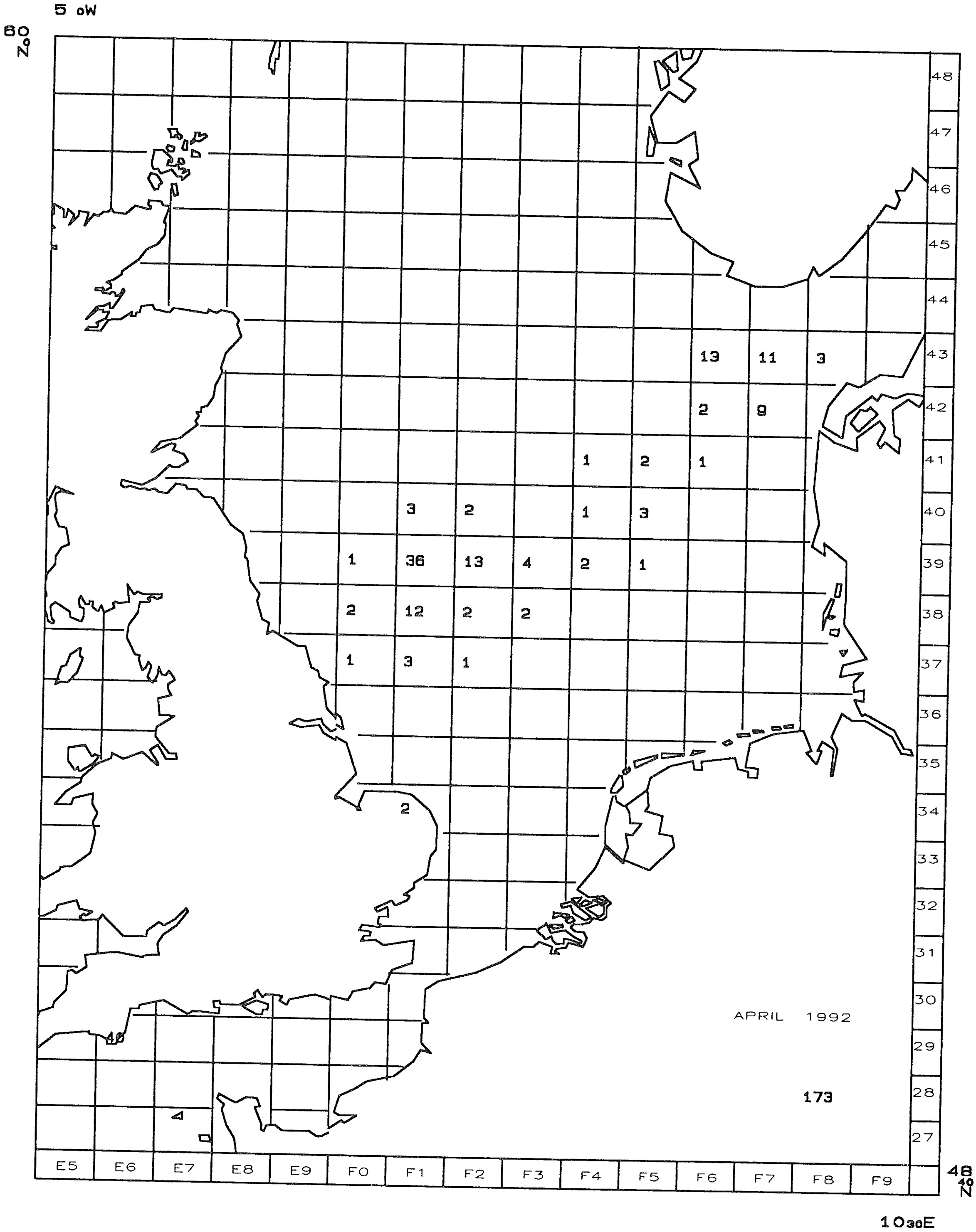


Figure 8.1.4 North Sea and Division VIId,e sprat catches in tonnes for April 1992.

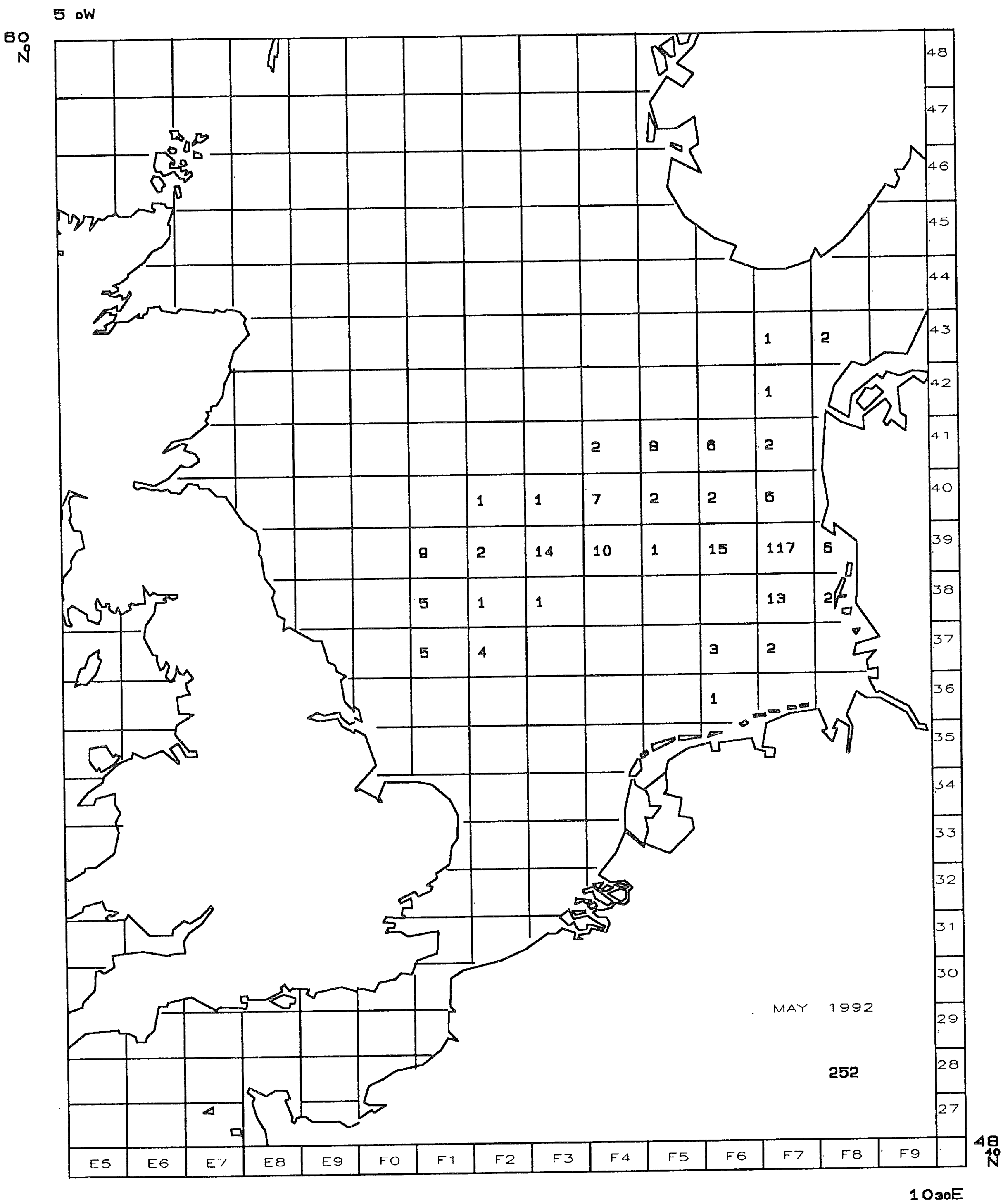


Figure 8.1.5 North Sea and Division VIId,e sprat catches in tonnes for May 1992.

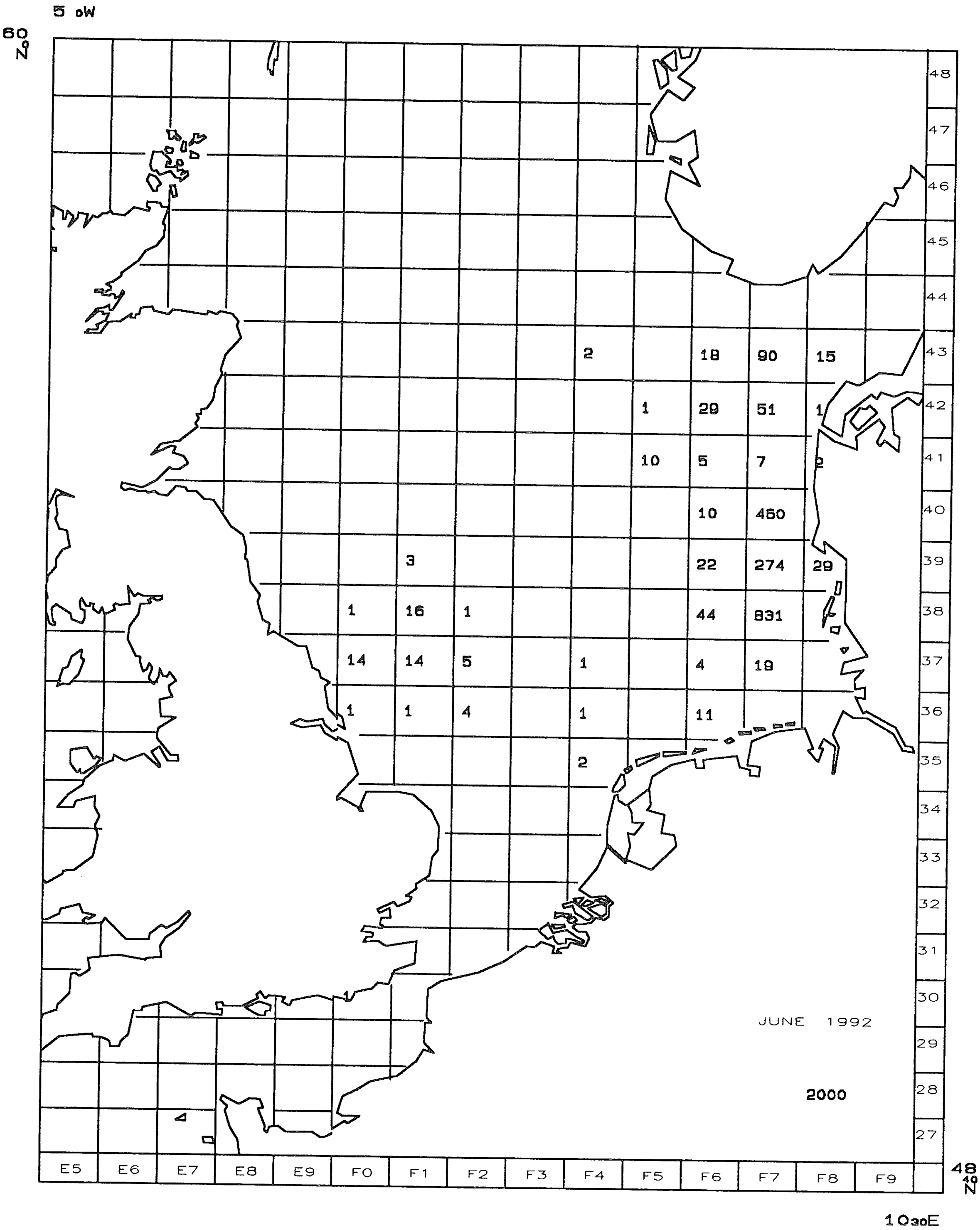


Figure 8.1.6 North Sea and Divisions VIId,e sprat catches in tonnes for June 1992.

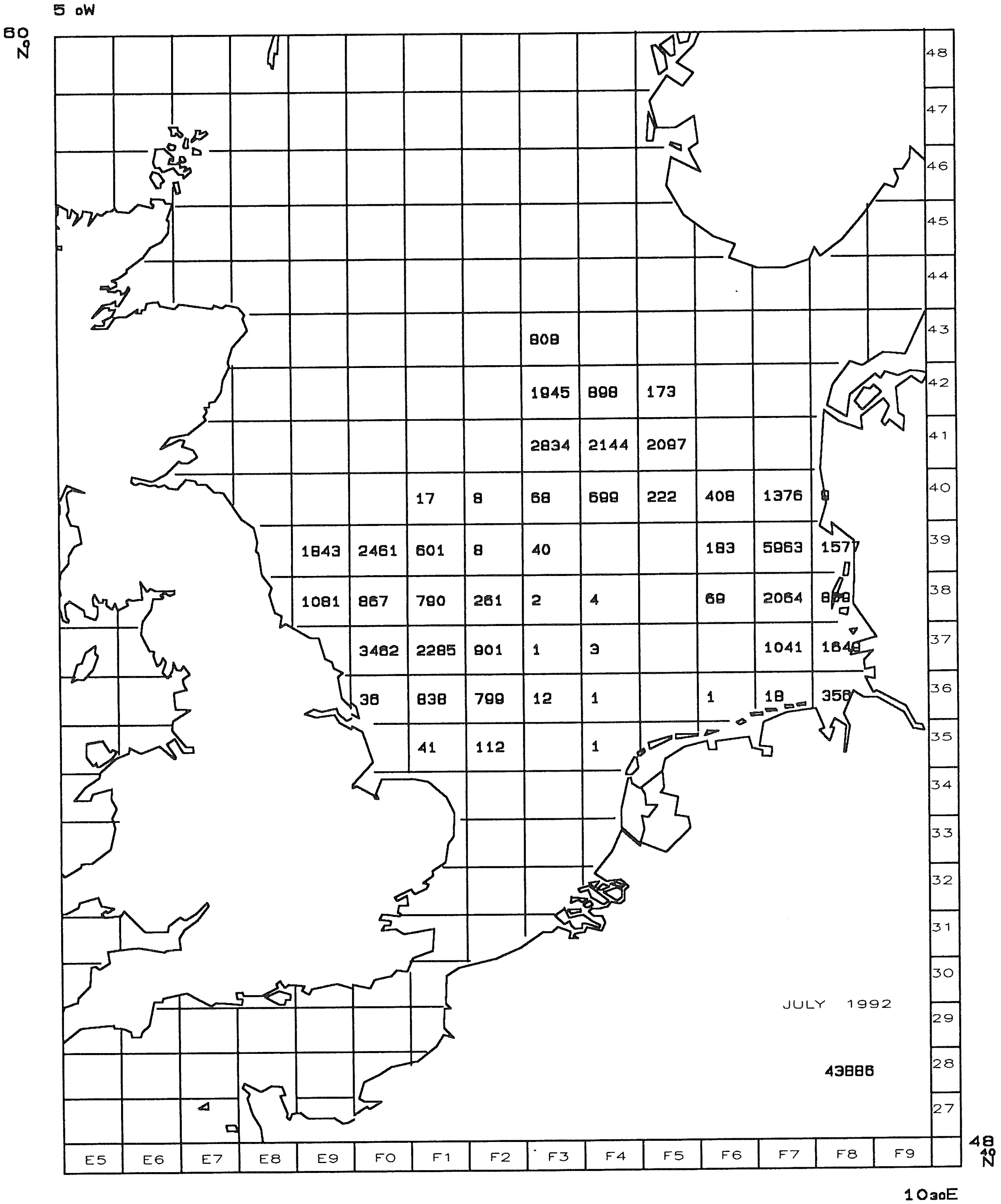


Figure 8.1.7 North Sea and Divisions VIId,e sprat catches in tonnes for July 1992.

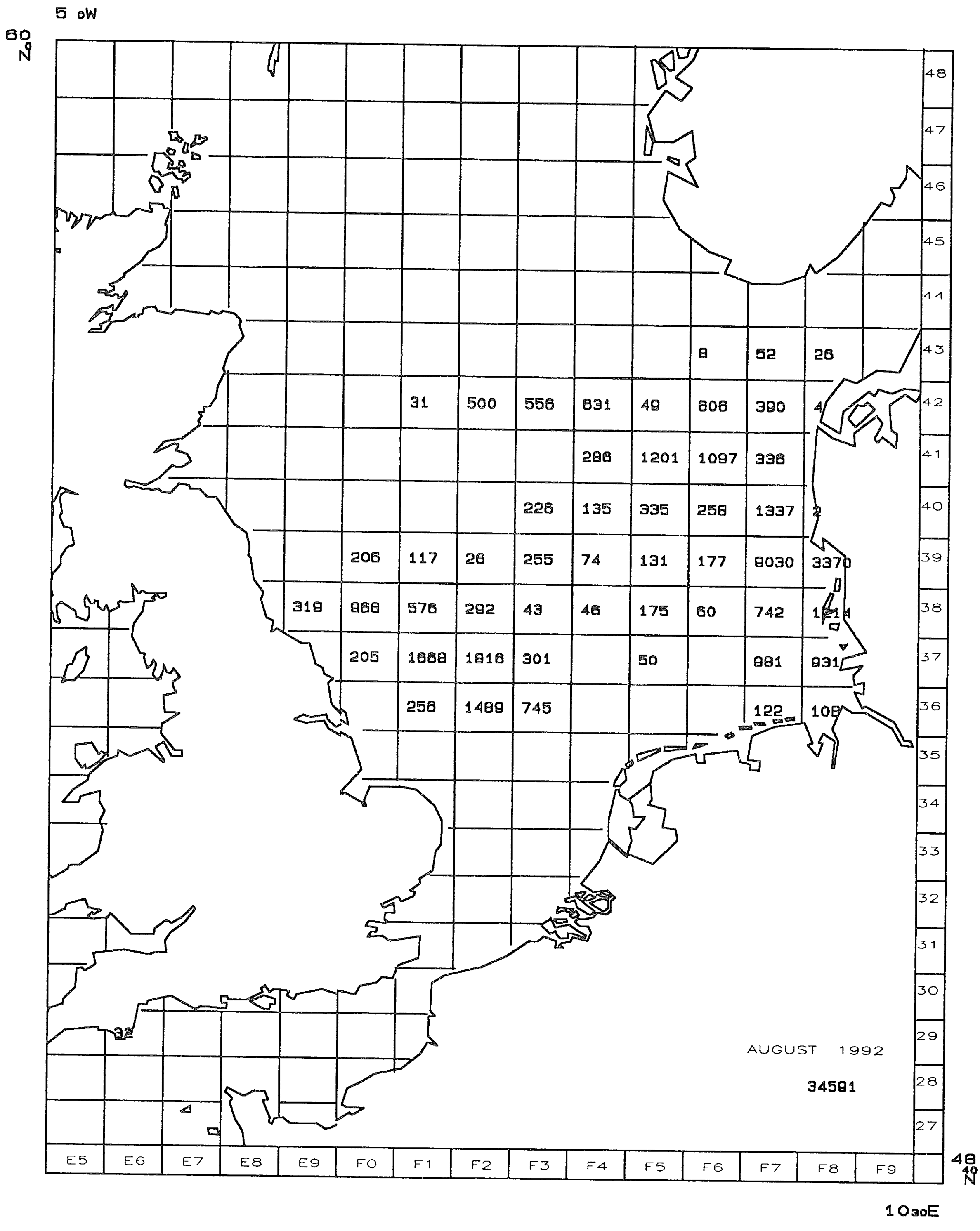


Figure 8.1.8 North Sea and Divisions VIId,e sprat catches in tonnes for August 1992.

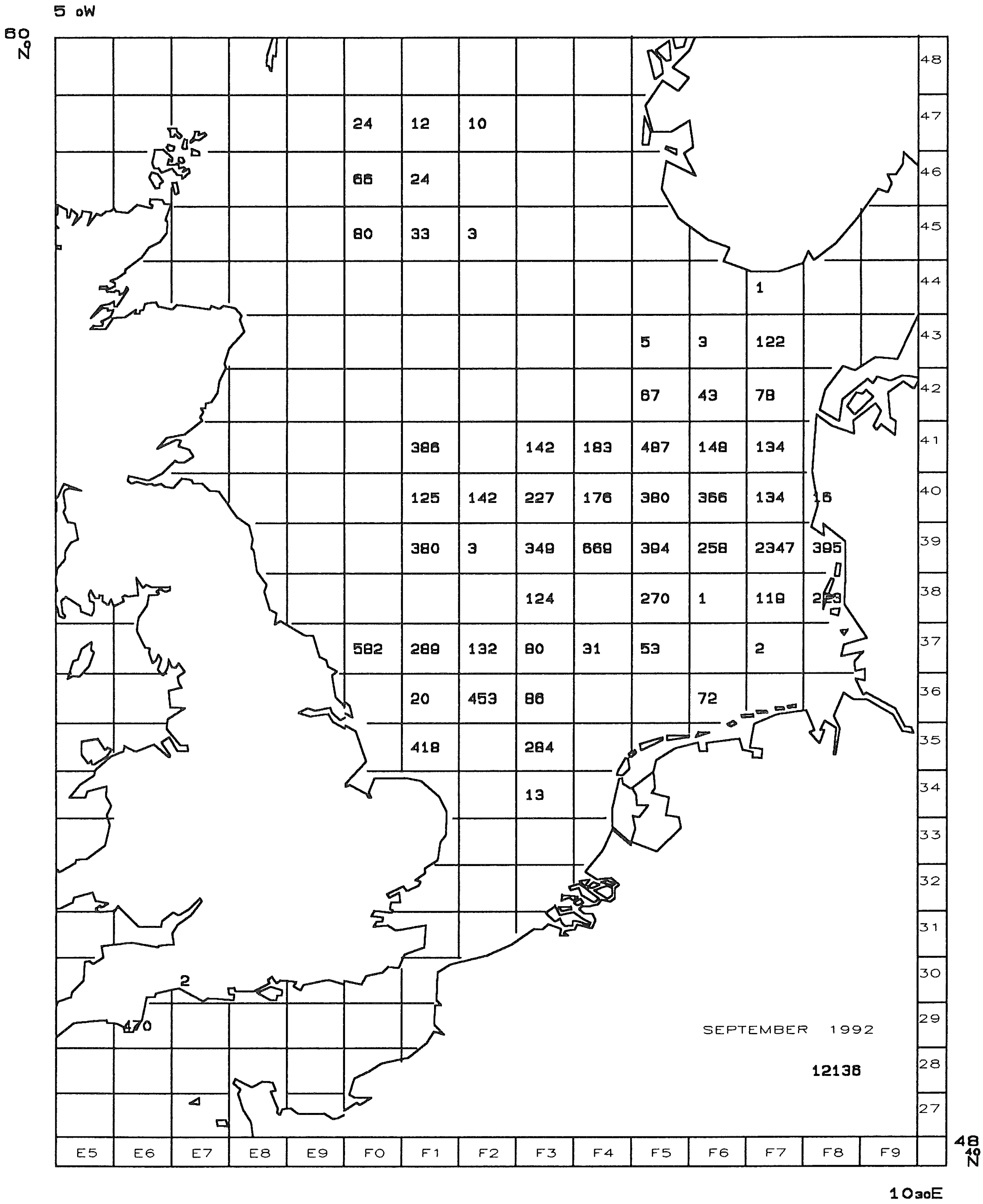


Figure 8.1.9 North Sea and Divisions VIId,e sprat catches in tonnes for September 1992.

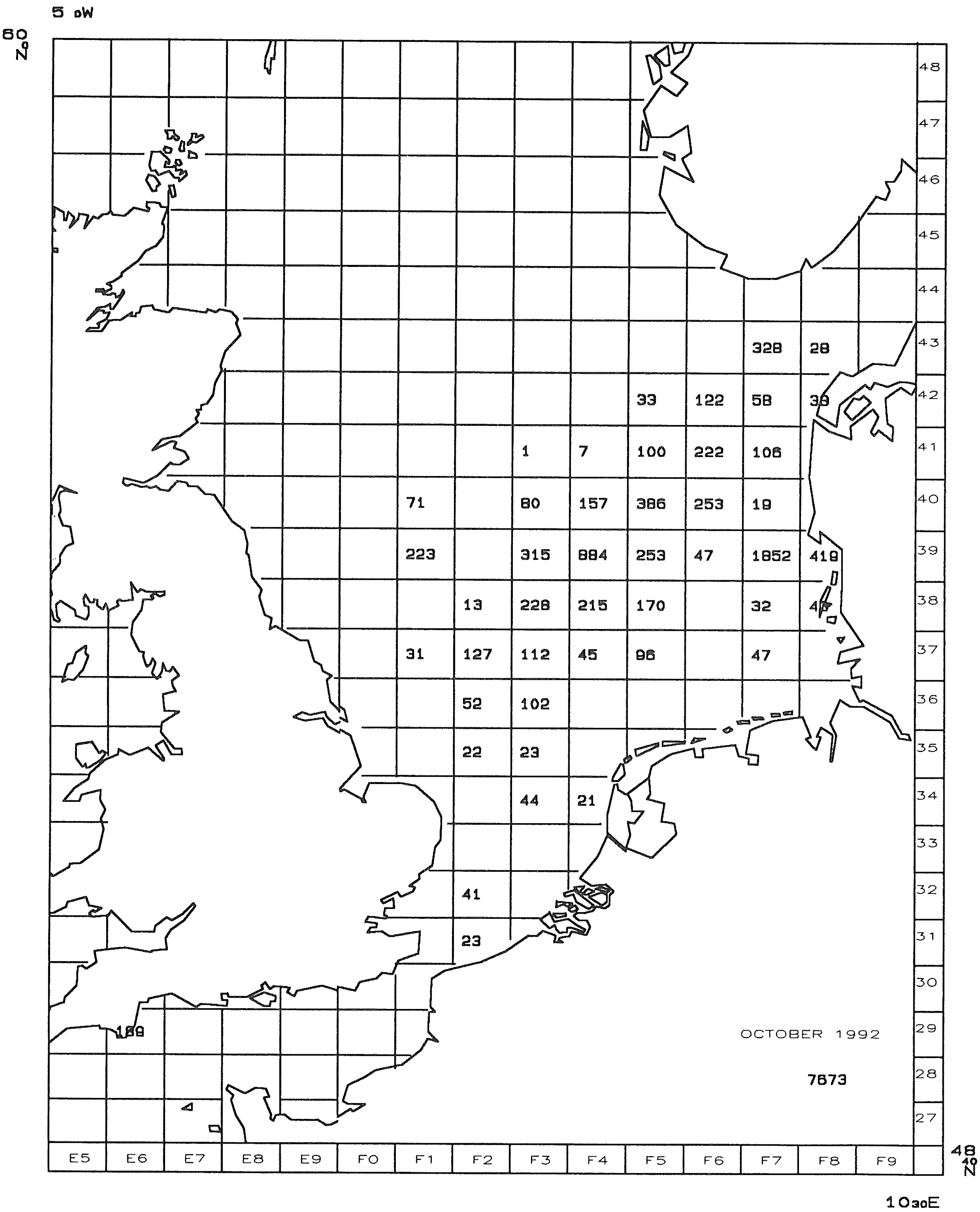


Figure 8.1.10 North Sea and Divisions VIId,e sprat catches in tonnes for October 1992.

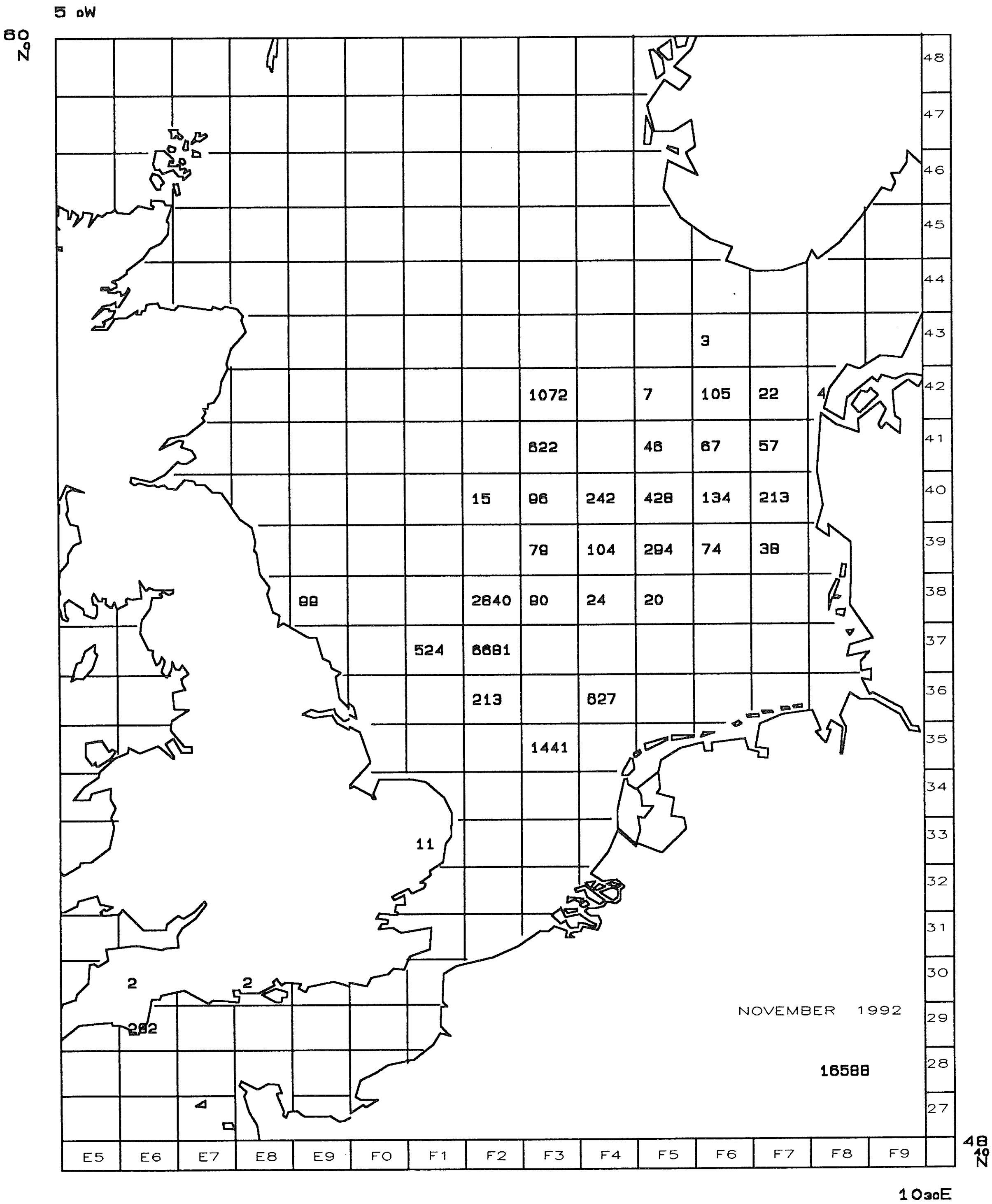


Figure 8.1.11 North Sea and Divisions VIId,e sprat catches in tonnes for November 1992.

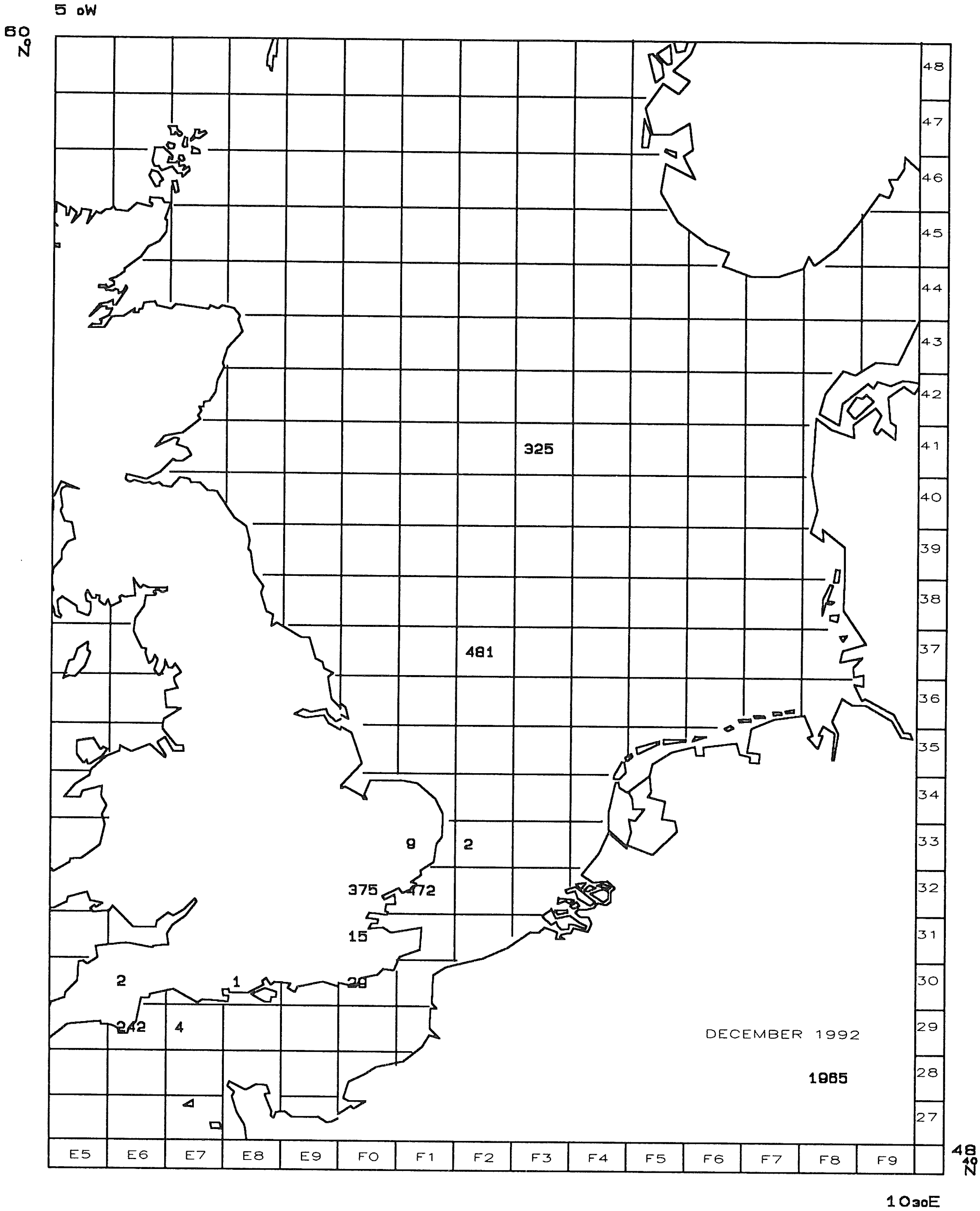
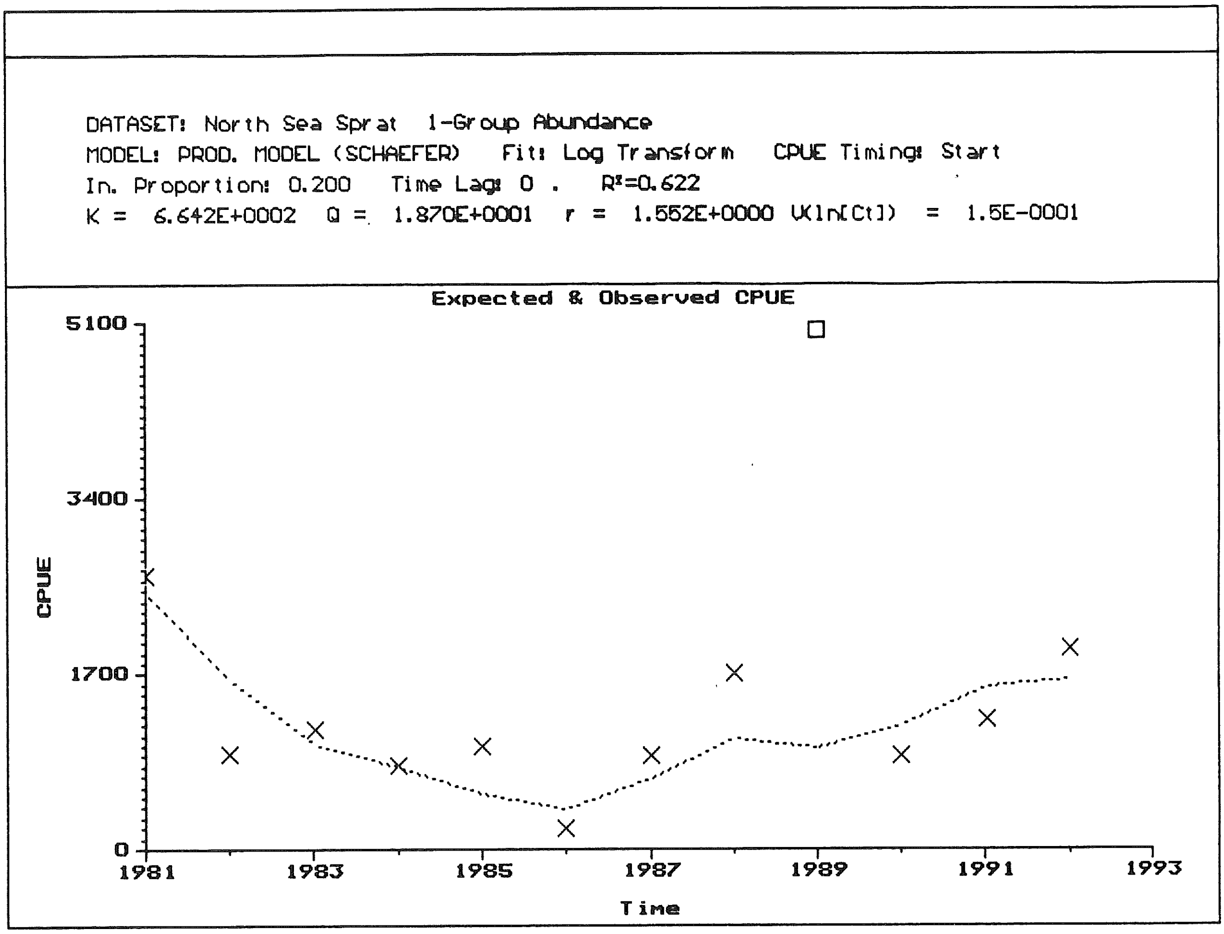
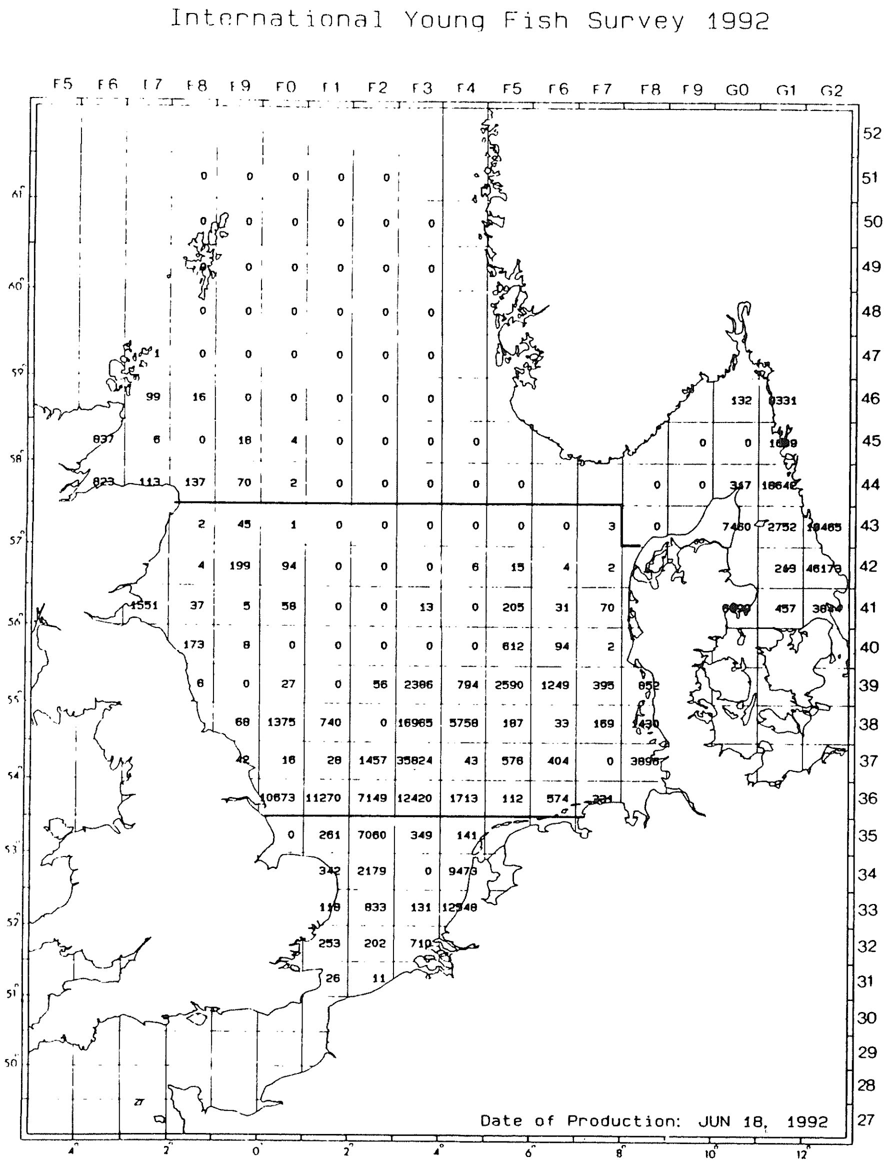


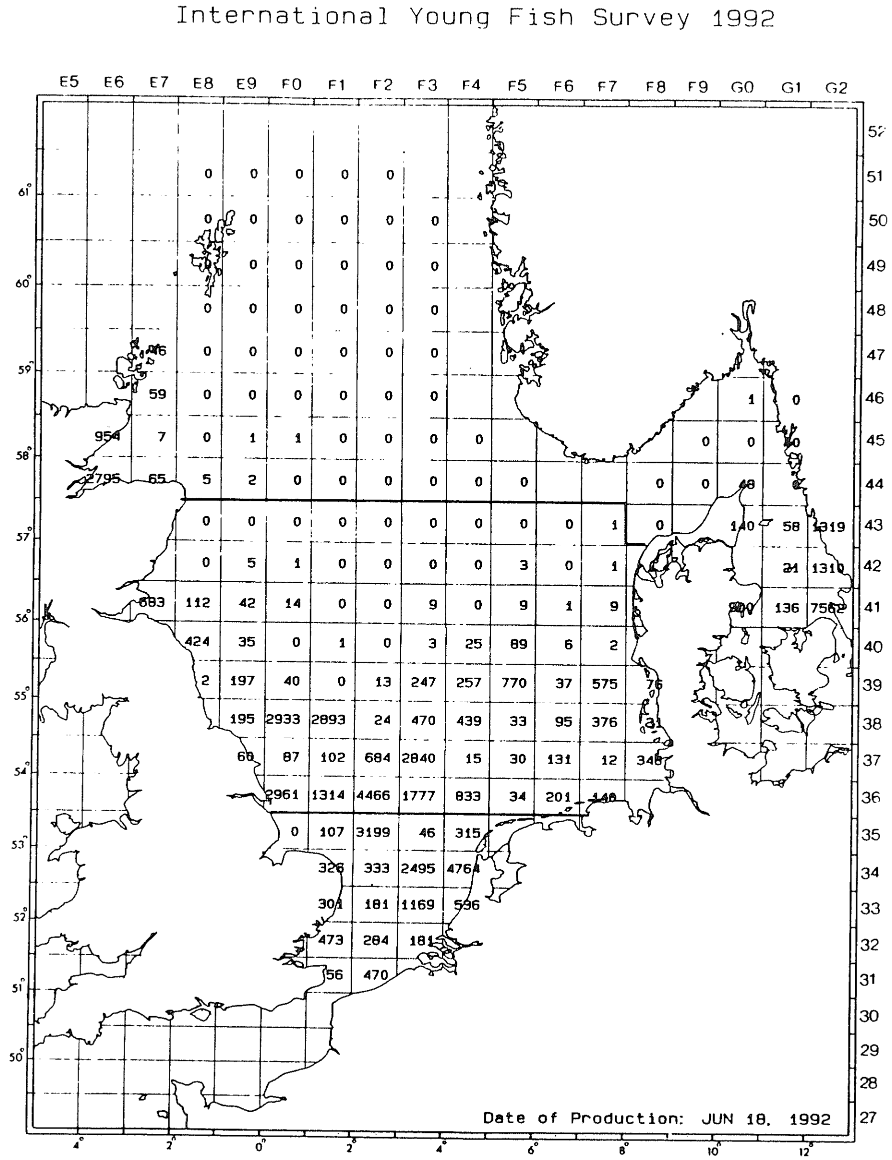
Figure 8.1.12 North Sea and Divisions VIId,e sprat catches in tonnes for December 1992.

Figure 8.5.1 Schaefer production model output from the CEDA model for the North Sea.





Sprat: number per hour, age group 1.

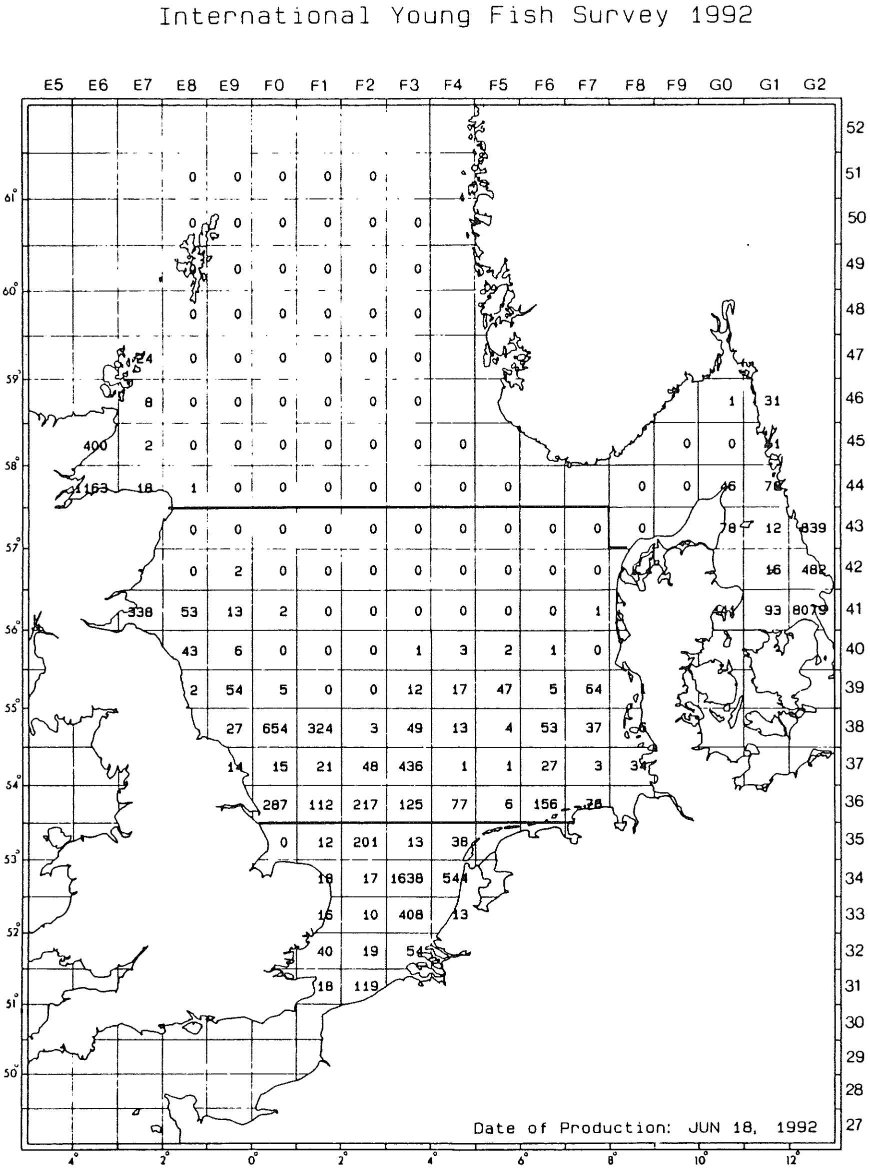


Sprat: number per hour, age group 2.

Figure 8.8.1 SPRAT. Distribution by age group in the IBTS 1992 (from Anon., 1992c).

cont'd.

Figure 8.8.1 cont'd.



Sprat: number per hour, age group 3+.

Figure 10.3.1 IBTS 1-group indices 1993 (unweighted).

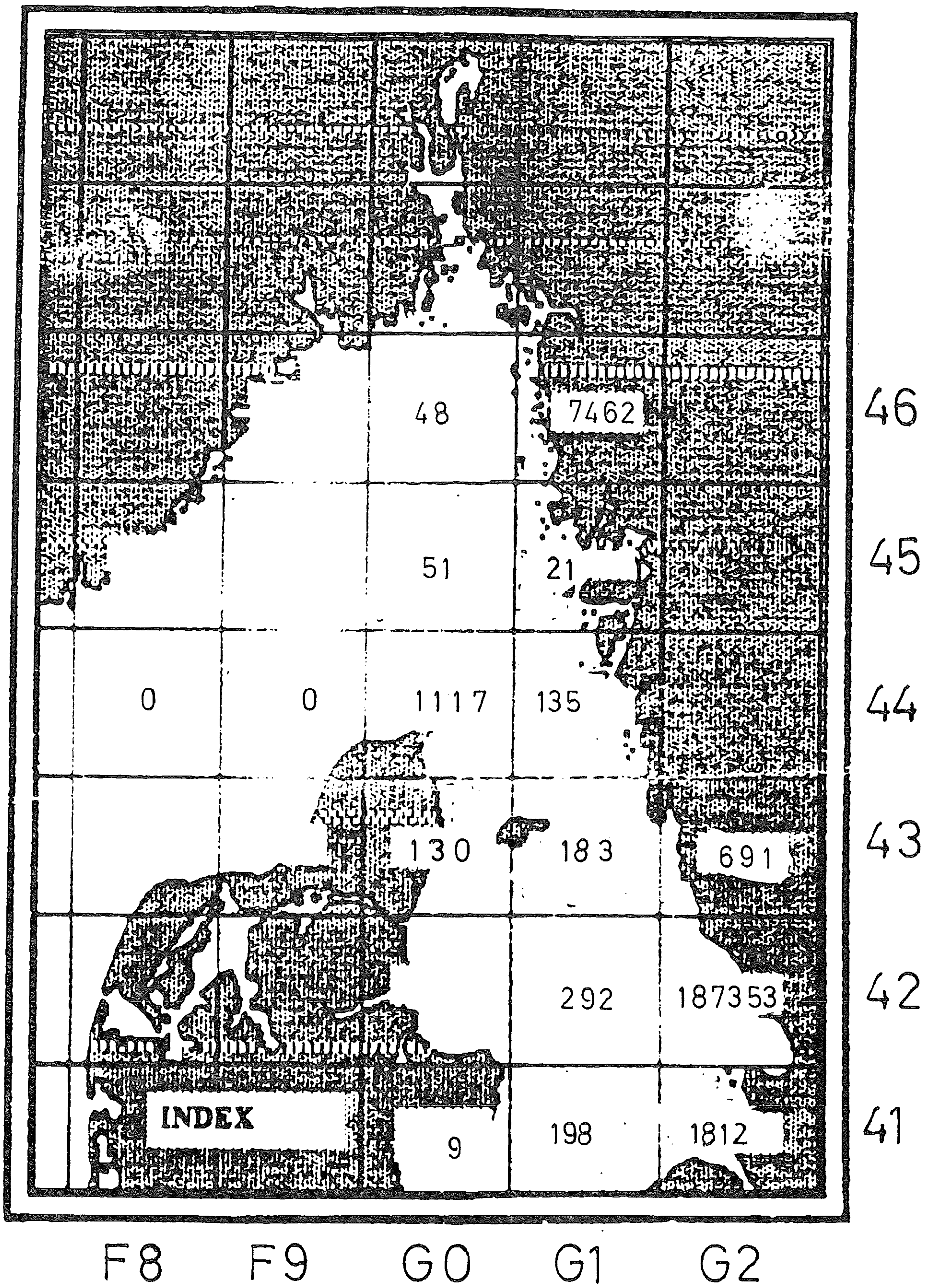


Figure 10.4.1 Schaefer production model output from the CEDA program, fitted for sprat in Division IIIa.

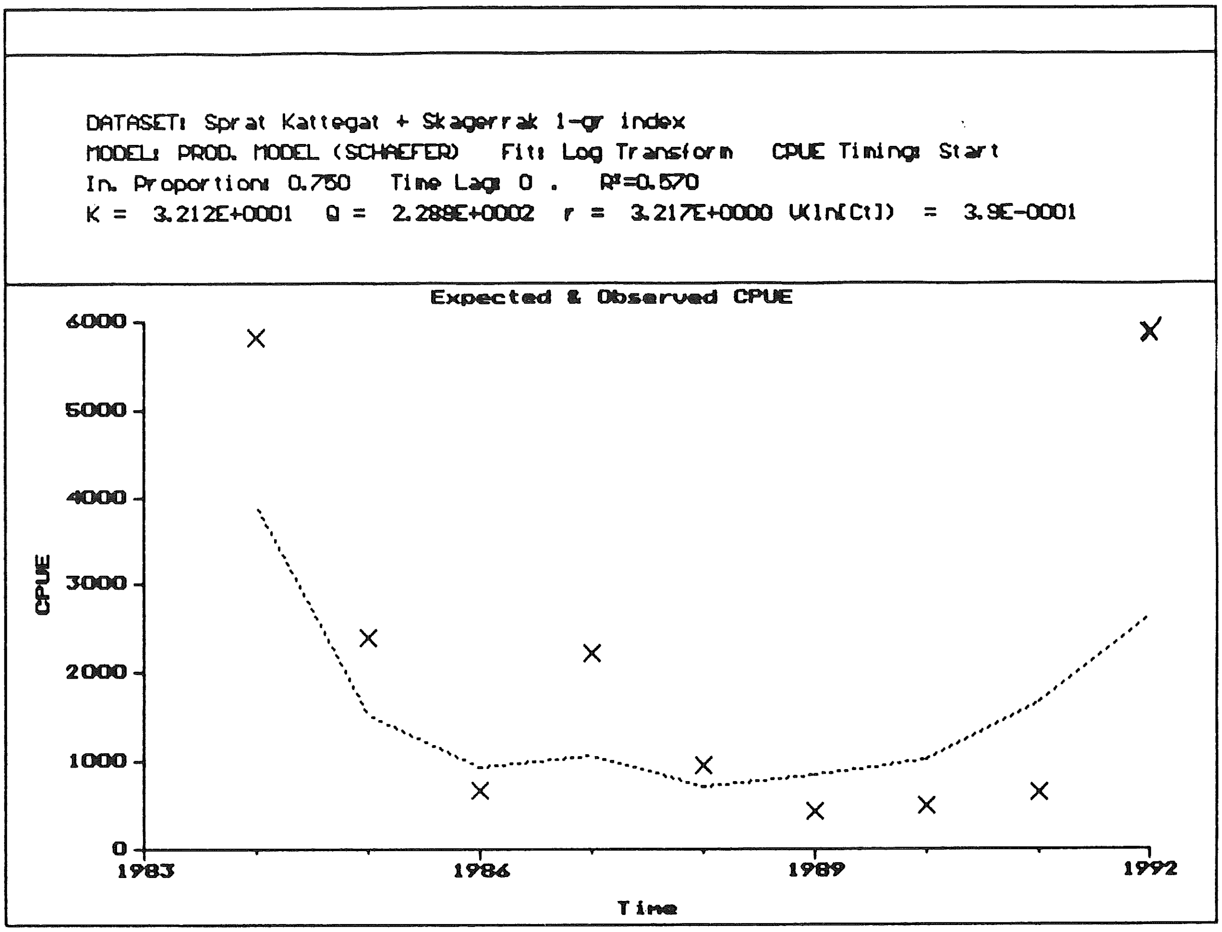
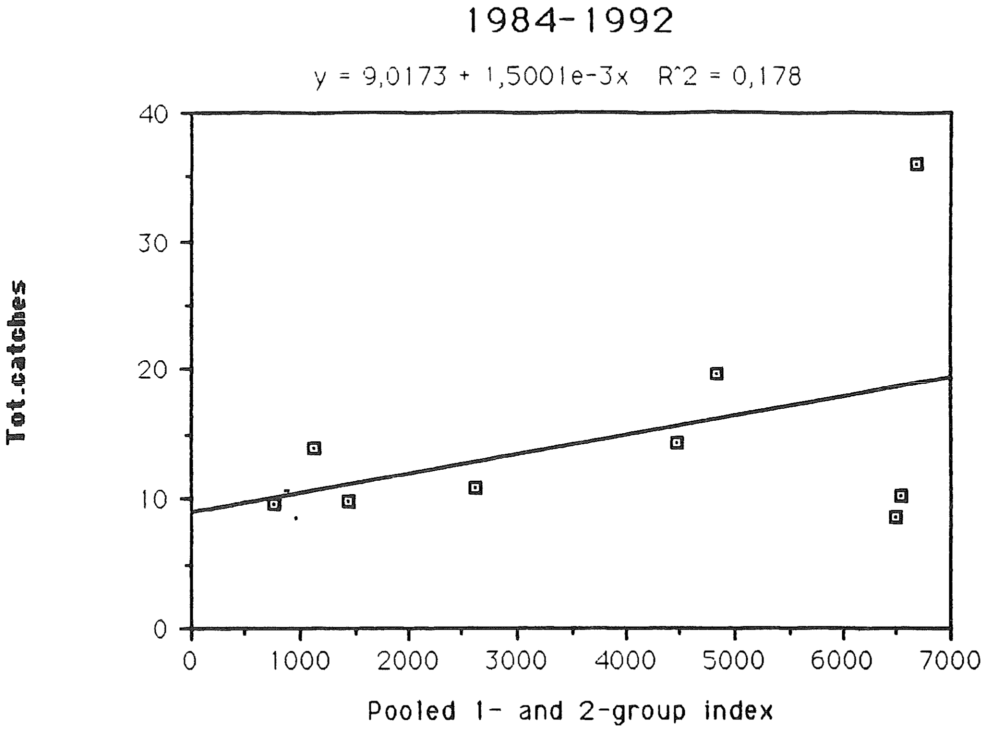


Figure 10.5.1 Regression of the pooled 1- and 2-group index vs total catches for 1984-1992.



Appendix 1

Integrated Analysis Methods

ADAPT-type methodology (Gavaris, 1988) was followed. An implementation generally following the approach of Powers (1990) and Restrepo *et al.* (1991) written by Patterson (WD, 1993a) was used.

The full objective function for the minimisation was:

$$\sum_{y,i}(\ln(SSB_y)-\ln(\hat{SSB}_y))^2+\sum_y(\ln(R_y)-\ln(\hat{R}_y))^2$$

where y, i suffices indicate years and indices respectively, and

R - Recruitment at age 2 in the VPA

SSB - Spawning stock biomass from the VPA.

Q,K - parameters of the logarithmic catchability relationship.

and in addition

$$\hat{R}=Q.\ln(Recruitment\ \ index)+K$$

$$SSB=\sum_{age}N_{age}.Weight_{age}.Maturity_{age}.\exp(-(F_{age}+M_{age})*PZ)$$

The three catchability models used were

$$\hat{SSB}=Q.\ln(Index\ \ Value)+K$$
$$\hat{SSB}=Q.Index\ \ Value$$
$$\hat{SSB}=Index\ \ Value$$

where

PZ = proportion of total mortality before spawning.

Selection in the last year of the analysis was iteratively re-estimated as mean selection over the previous six years of the VPA.

The parameters estimated by nonlinear least squares were the Q and K for each index, the recruitment in 1993 and the population size at the start of 1993 at the reference age.

Appendix 2

Catch-Survey Data Analysis

Two papers (Patterson, WD 1993d, 1993e) on a non-equilibrium surplus-production model were presented together with a computer program for PCs, CEDA (Anon., 1992d). This model uses total catch data (in weight) and an index of total abundance or of recruitment where the index of abundance can be a CPUE index from the commercial fleet or a survey index. The standard logistic model is used to account for growth and mortality. The catch is explicitly subtracted, when predicting biomass in the next year. The model is time discrete between year t and year t + 1

Biomass(t+1) = Biomass(t) + r*Biomass*(1 - Biomass/K) - Catch(t)

with parameters r and K. The model is fitted to an index reflecting biomass development. This involves a third parameter, the catchability.

Alternative formulations of the growth-mortality component of the model are available in the CEDA program, i.e Fox and Pella-Tomlinson models. The implications of using these models as opposed to the Schaefer model specified above were not investigated.

A basic assumption in these models is that the "carrying capacity" (K) of the sprat stock has not changed over time. This assumption is questionable when considering the very large stock changes which have been observed both in the North Sea and in Division IIIa over the last 25 years. Also, the assumption that growth and mortality can be modelled based on biomass only requires that the age composition in the stock is fairly stable.

The analysis was restricted to 1981-1992 for the North Sea sprat to avoid the very large changes seen in the late 1970s. For Division IIIa sprat the IBTS survey indices were only available for 1984 and later years and the analysis was done for the 1984-1992 period.

If the population dynamics of sprat is the same in the North Sea and in Division IIIa, and if the IBTS survey reflects abundance of sprat then these model fits can be used to investigate the model's ability to reflect sprat population dynamics.

North Sea Sprat

Several IBTS survey indices are available (Table 8.3.1). The model was run with the 1-group index, the 2-group index and a combined 1- + 2-group index. Based on R-square, it appeared that the 1-group index best reflected the development in the catches.

The 1989 observation (1-gr index 4296 no./hr) seemed to be an outlier, when examining residuals in the analysis. This observation was not included in the final analysis.

The CEDA program offers several assumptions about the error structure of the residuals. In this, as in many other cases, a log-normal error structure seems to be a sensible choice.

Figure 8.5.1 shows the best model fit obtained when selecting between the available indices and with the 1989 observation deleted.

While the residuals are quite large, there is no obvious trend. However, after deleting the 1989 observation, there is little contrast in the data particularly after introducing the log-transformation. The dataset is therefore not very appropriate for control of the model.

The CEDA program allows calculation of confidence limits of the parameters. These confidence limits were found to be extremely wide, e.g. the carrying capacity (K) could be as high as (97.5% upper limit) 3 million t compared to the point estimate of 546,000 t.

The stock development as indicated by this analysis is a slow but consistent increase in biomass since 1984 (Figure A.1). The catch:biomass ratio was around 1.2:1.

Division IIIa Sprat

As for the North Sea Sprat there are several IBTS survey indices available (Table 10.3.1). The model was run with the 1-group index and total index. Based on R-square (0.6 for the 1-group index, 0.135 for the total index), it appeared, as for the North Sea sprat, that the 1-group index best reflected the development in the catches.

The fit was, as for the North Sea sprat, done assuming log-normal errors.

The residuals were quite large, but no obvious outliers were identified.

There is, however, a highly influential 1992 data point. Excluding this point completely changes the estimated trend in biomass. While including 1992 indicates a somewhat optimistic future with increasing biomass, the exclusion of this data point suggests that sprat could well be extinct before very long (Figure A.2). Therefore, no confidence can be placed on this approach before validation of the method as applied to sprat becomes available.

Both the analyses of the North Sea and of the Division IIIa sprat data suggest that the model is not responding fast enough to stock changes. This observation is equivalent to the low value for the "hang-over (20%)" which has been estimated for the SHOT predictions. A low hang-over indicates that there is little relation between the stock abundance in one year and in the following year.

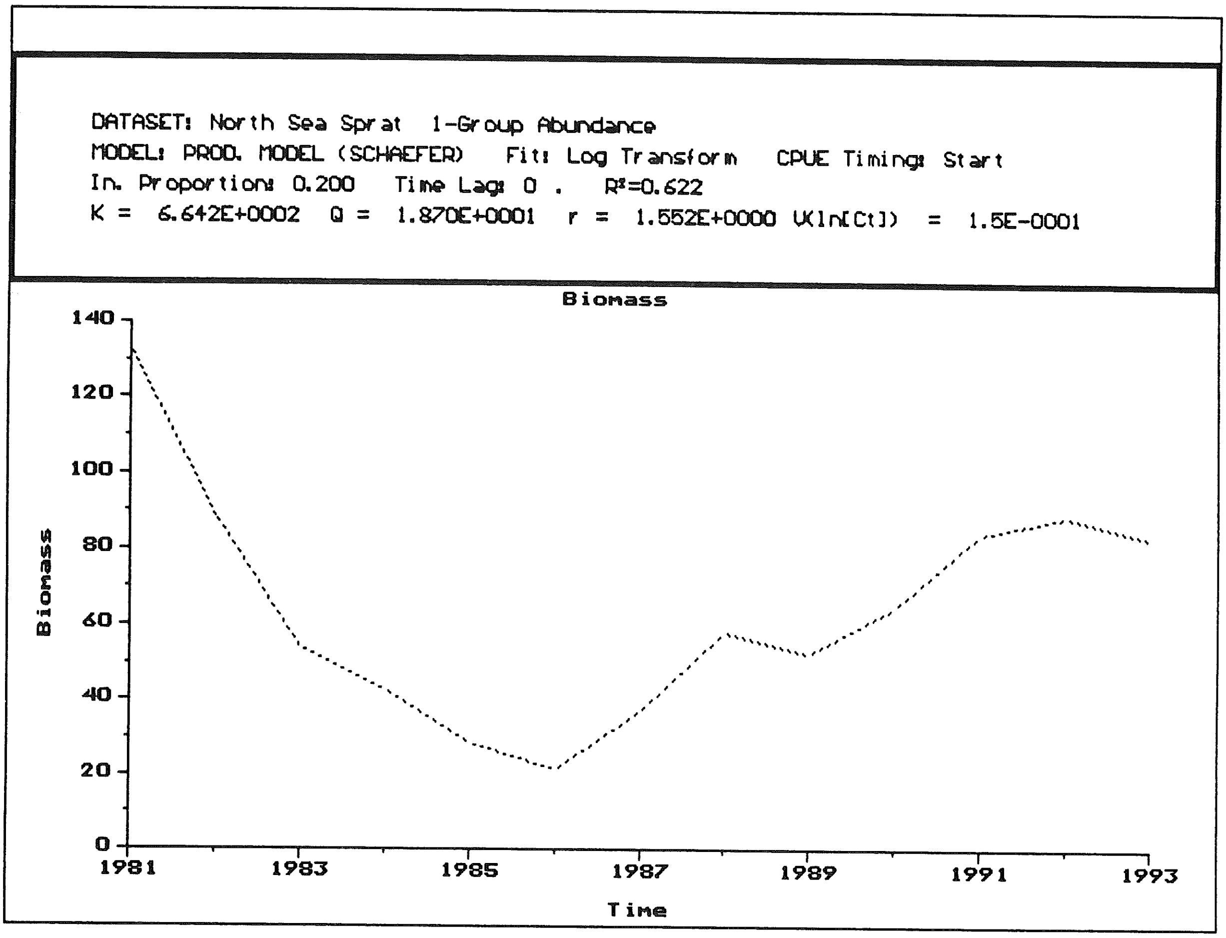


Figure A.1 Biomas vs year for North Sea sprat. Final analysis. 1989 observation excluded.

Figure A.2 Biomass vs year for Division IIIa sprat.

a) all observations included, and
b) with 1992 included.