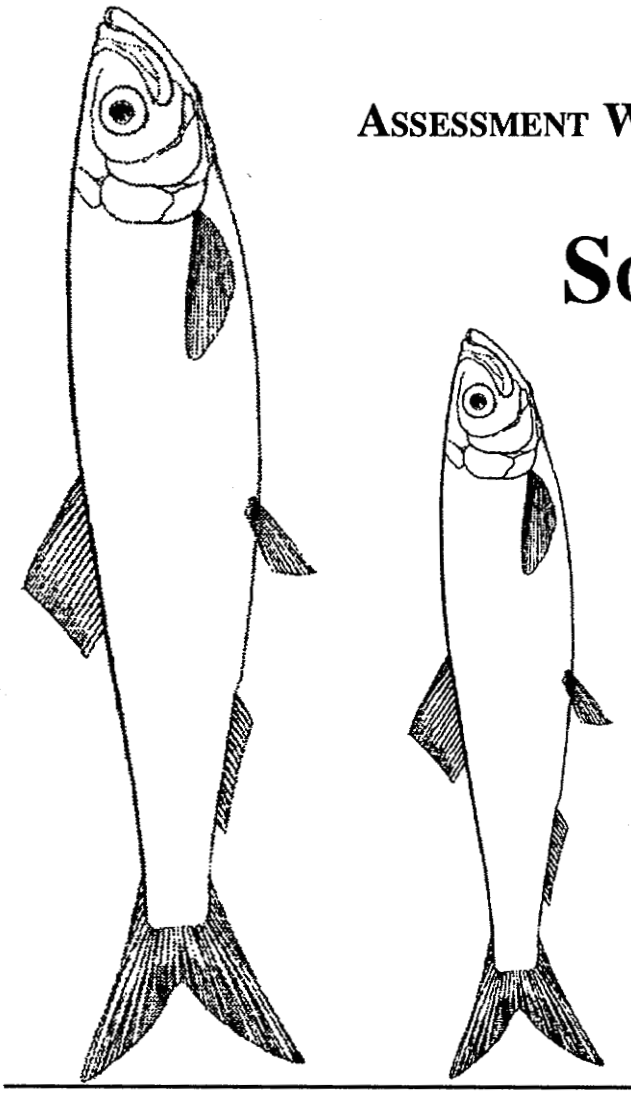
INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
CONSEIL INTERNATIONAL POUR L´EXPLORATION DE LA MER

C.M. 1991/Assess :15

HERRING

ASSESSMENT WORKING GROUP FOR THE AREA

SOUTH OF 62° N



COPENHAGEN,
2-12 APRIL 1991

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it should not be quoted without consultation with:

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1 INTRODUCTION

1.1 Participants

Aglen, A.	Norway
Bailey, R.	UK (Scotland)
Corten, A. (Chairman)	Netherlands
Dalskov, J.	Denmark
Hagström, O.	Sweden
Hopkins, P.	UK (Scotland)
King, D.	UK (Northern Ireland)
Lorance, P.	France
Molloy, J.	Ireland
Munk, P.	Denmark
Nash, R.	UK (Isle of Man)
Popp Madsen, K.	Denmark
Sparholt, H.	Denmark
Stephenson, R.	Canada
Winters, G.	Canada

Mr E. Kirkegaard attended the meeting for one day to present results from the acoustic surveys.

1.2 Terms of Reference

The Working Group met at ICES Headquarters from 2-12 April 1991 with the following terms of reference specified in C.Res.1990/2:5:11):

a) assess the status of and provide catch options for 1992 within safe biological limits for the herring stocks in Division IIIa (North Sea autumn spawners), Sub-area IV (separately, if possible, for Divisions IVa,b and Divisions IVc and VIId), Division VIa, and Sub-area VII;

b) consider the report of the Multispecies Assessment Working Group and provide the data requested by that Working Group;

c) 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 1990.

A number of additional requests was passed to the Working Group by the Chairman of ACFM before the start of the meeting. These requests were:

d) to evaluate new information available for North Sea herring, and to review the ACFM advice for 1991 in the light of this new information;

e) to evaluate the 1990/1991 acoustic survey results for herring in the Celtic Sea, and to review the ACFM advice for 1991 for this area;

f) to evaluate the feasibility of including North Sea autumn spawners caught in Division IIIa in either the North Sea or Sub-divisions 22-24 and Division IIIa herring assessments;

g) to evaluate the feasibility of including a component of juvenile North Sea autumn spawners in the TAC for the directed herring fishery in Division IIIa;

h) to assess the importance of the discard problem in the different fisheries for herring, and to propose solutions for solving this problem;

i) to examine the consequences of an increase of mesh size to 40, 60, and 80 mm in herring fisheries.

1.3 Evaluation of Multispecies Assessment Working Group (MSWG) Report

The multispecies VPA (MSVPA) key run made by Anon. (1991b) differed only slightly from the previous key run. Catch data for an additional year (1989) were added, and some more stomach data were included for whiting.

The new values of natural mortalities are shown below as mean values over the period 1983-1988, together with values from the previous key run based on the period 1981-1986 (Anon., 1989b) and the values used by the present Working Group in the single-species VPA (SSVPA):

Age (rings)	MSVPA (Anon. 1989b) 1981-1986	MSVPA (Anon. 1991a) 1983-1988	SSVPA
0	0.52[1]	0.50[1]	1.0
1	0.97	0.77	1.0
2	0.50	0.45	0.3
3	0.30	0.27	0.2
4	0.17	0.16	0.1
5	0.13	0.12	0.1
6	0.18	0.17	0.1
≥7	0.10	0.10	0.1

[1] Mortality rate per half year.

The M-values for 0-ringers from the MSVPAs are half-yearly rates and represent only the second half of the year. If the SSVPA M value for 0-groups is split equally into the two halves of the year, the MSVPA and SSVPA M values are almost equal for the second half of the year.

The reason for the discrepancies between the two MSVPA M-arrays shown is not due to differences in the two MSVPA key runs but is due to differences in the time-spans used.

The natural mortality for 1-ringers has decreased from 0.97 (1981-1986) to 0.77 (1983-1988) and is lower than the value of 1.0 used in the SSVPA. For 2-ringers and older, the MSVPA M-values are slightly higher than the SSVPA M-values.

The present Working Group retained the existing values to preserve consistency in TAC estimation on the grounds that the new values are not very different from those previously estimated by the MSVPA. Furthermore, the 1991 large-scale stomach sampling project will probably result in some changes in the M-values estimated by the MSVPA and the M-values used in the SSVPA may then need revision.

Former discrepancies between the catch-at-age figures used by this Working Group and those used by the Multispecies Assessment Working Group for the North Sea herring have disappeared, because the MSVPA catch figures have been revised. However, the SSVPA now used by this Working Group includes catches of autumn spawners taken in Division IIIa and it is probably not advisable to include

these catches in the MSVPA because the predators in Division IIIa are not included in the MSVPA. Therefore, in the future the MSVPA and SSVPA will differ as regards to herring catch-at-age data.

1.4 The Use of Up-to-Date Information for Management

In last year's report, a proposal was made for the utilization of new information from acoustic surveys that would become available only after the Working Group meeting. It was suggested that in the event that the July acoustic survey in the North Sea showed an estimate that was considerably below the predicted level, some members of the Working Group should prepare a working document for the November ACFM meeting, suggesting how the new information could be handled in an ad hoc assessment.

In order to decide whether the results from the acoustic survey differ significantly from the predicted stock size, the confidence limits on the predicted value from the acoustic estimate (Figure 2.7.2) should be considered. The 90% confidence limits are ± 45% of the predicted value. Only in the case when the upper confidence limit of the acoustic estimate (estimated value + 45%) is smaller than the stock size predicted during the present assessment, is there a need for a revised assessment at the November meeting.

1.5 Quality of Sampling Data

The level of sampling of commercial landings is a problem in some fisheries. Some countries did not undertake sampling in 1990, and others sampled only part of the temporal or spacial distribution of the fishery. The result is that the age composition of some fisheries could not be determined (for example the industrial fishery in Division IIIa - see Section 3.2) or had to be inferred from samples of other countries, areas or times (for example, see Table 2.2.5).

The Working Group discussed the fact that effective sampling of the commercial catch is critical to analytical assessments which rely on the catch at age. In fact, current assessment methods assume that the catch at age is precise, and that most variance is the result of error in abundance indices. Clearly, poor sampling will compromise this assumption. It is obvious that the sampling level is a problem and that some minimum acceptable level is necessary if the Working Group is to continue analytical assessments.

The Working Group discussed at length how to define minimum requirements. It is difficult to provide a single figure, since it obviously depends upon the variation in temporal and spacial aspects of the fishery. The Working Group also recognized that it would be inappropriate to suggest a minimum which may in fact be too low. In general, it is considered that a minimum could be in the range of one sample (100-200 fish) per 100 t to one sample per 1,000 t, depending upon the character of the fishery.

The Working Group made the following recommendations:

1) That all countries undertake an acceptable level of sampling; at present defined roughly as one sample per 1,000 t of catch per gear category, time period and area.

2) That the Working Group continues to record and review sampling levels; perhaps improving the way in which it is reported so that differences by quarter and area can be seen.

3) That the important topic of sampling precision be considered as an agenda item at a future working group meeting.

4) That Working Group members prepare descriptions of sampling schemes in preparation for a discussion on sampling levels and methods at the 1992 Working Group meeting.

1.6 Definition of Age in Herring

Contrary to the practice for most other fish species, herring has its age expressed in rings instead of in years. The reason for this old tradition is that herring may belong either to a spring-spawning race or to an autumn-spawning race. In the first instance, the age of the fish in years is equal to the number of rings on the otolith (in summer), whereas in the second case, the number of rings has to be increased by one in order to obtain the age in years. As it is not always clear whether a herring is an autumn spawner or a spring spawner, it is safer to describe the age in rings (about which there can be no argument) than in years.

However, defining the age in rings instead of years means that the decision as to whether the fish is classified as an autumn or spring spawner is only postponed. Eventually, the decision has to be taken, as the assessment for herring stocks is always done separately for spring and autumn spawners. The use of rings instead of ages only gives people some more time to make up the their mind about the racial classification.

In the meantime, the use of rings as a definition for age may create a large amount of confusion and errors, not so much among herring biologists, but among other people who read their report or use their data. If herring data are used by other working groups (e.g., IYFS, Multispecies), the definition of age in rings always gives rise to considerable errors (some of which may remain undetected). Major confusion also exists among managers and non-fish biologists who try to read reports on herring.

Although the use of rings for herring is based on a long tradition, it may be worthwhile to consider the case for a change to expressing age in years. This would mean that the age of the fish is equal to the year of sampling minus the year of birth; a definition also used for other fish species. Such a change in herring ageing will have major consequences, as a large number of data files will have to be adapted. The switch over from rings to years should, therefore, be thoroughly discussed and prepared for in advance.

The Working Group proposes that a Study Group consider the matter in detail (by correspondence) and prepare a recommendation for the 1992 Working Group meeting. At that meeting, a decision could be taken by the Working Group concerning the feasibility of the proposed change, and its timing.

2 NORTH SEA HERRING

2.1 The Fishery

2.1.1 ACFM advice applicable to 1990

The 1989 ACFM meeting recommended the following TACs for 1990: Division IVa,b: 373,000 t; Divisions IVc, VIId: 30,000 t.

The agreed TACs adopted by the management bodies were: Divisions IVa,b: 385,000 t; Divisions IVc, VIId: 30,000 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, and that spawning area closures in Division IVb should be maintained.

2.1.2 Catches in 1990

Total landings for 1990 are shown by countries in Table 2.1.1 for the total North Sea and for each division in Tables 2.1.2 - 2.1.5.

The catch in 1990 at 553,000 t has decreased from the catches in 1989 and 1988, when the catches were at a level of about 700,000 t. The unallocated catches in 1990 amounted to 21,000 t (3.8% of the total) which is about the same level as in 1989.

The TAC for the total North Sea in 1989 was 514,000 t and the catch was 698,000 t. In 1990, the TAC was 415,000 t and the catch amounted to 553,000 t. Between 1989 and 1990, the TAC fell by 99,000 t and the catch decreased by 145,000 t. The decrease in the catches is not thought to be the result of a decline in abundance, rather it is the result of a lower TAC with better enforcement. In 1990, the regulations to protect the juvenile herring were more strictly enforced.

As in previous years, Norwegian catches of Atlanto-Scandian herring were removed.

In recent years, catches of autumn-spawning herring have been reported by the Faroese fleet in Division Vb (Jacobsen, 1990). A sample of herring from the Division Vb summer fishery was analyzed by the method described by Jørgensen and Johannessen at the Alaska Herring Symposium (1990, in press) and results show close similarities with North Sea samples. Samples for comparison with Division VIa North spawners have been collected but have not yet been analyzed. However, as in previous years, the 5,334 t caught in 1990 have not been included in either the North Sea or the Division VIa N assessment.

The Netherlands catches included an additional estimate for discards. Discards are recorded separately (Table 2.1.1). The total amount of North Sea herring discarded at sea is probably underestimated. However, the change in the figure from 1989 (4,000 t) to 1990 (8,660 t) shows that there may be an increasing problem as the fisheries shift to roe fisheries.

In Divisions IVc and VIId, the estimated catch of 61,082 t 2-ringers and older herring considerably exceeded the 30,000 t recommended and agreed TAC. However, the overshoot of the TAC was smaller than in 1989 (when the catch was 78,795 t for the same TAC). The catch in 1990 includes estimated discards of 5,350 t and a catch of 1,136 t of spring spawners.

2.2 Catch Composition

2.2.1 Catch in number at age

Quarterly and annual catches in numbers and mean weights at age were compiled for each division and for the total North Sea, using data submitted by the main countries fishing herring in the North Sea in 1990 (Section 2.2.2).

Table 2.2.1 provides a breakdown of numbers caught 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 1970-1990.

The inadequate sampling of the catches in Division IIIa did not allow estimation of the numbers of 0-, 1- and 2-ringer North Sea autumn spawners caught in this area. It was, therefore, not possible to update Table 2.2.3 in last year's report and this Table is included in this report for reference only.

The total catch in number in the North Sea in 1990 was 68% of that in the previous year and the lowest since 1985 (Table 2.2.2). The 2-ringers and older accounted for 54% of the total number caught (compared with 48% in 1989).

The lower contribution of young herring to the catch in numbers is mainly due to a much reduced catch of 0-ringers (accounting for 17% of the catch in number compared with 26% in 1989). The proportion of 1-ringers in the catch in numbers show little change (29% instead of 25% in 1989). However, the absolute figure is the smallest since 1985.

The strength of the 1985 year class was still apparent in the catch in numbers, 4-ring fish being more abundant than 2- and 3-ringers in the catches.

The highest proportion of 2-ring fish was found in Division IVb, the third quarter excepted (Table 2.2.4). In Division IVa, the proportion of 2-ringers was smaller than that of 3-ringers in all quarters, this pattern was especially pronounced in Division IVa east.

The age composition of catches of spring spawners taken by the Netherlands in the southern North Sea is given in Table 2.2.7.

2.2.2 Quality of catch and biological data

The biological sampling of the landings shows that some important landings were poorly sampled or not at all sampled (Table 2.2.5). The general level of sampling was much lower than in 1989 when 579 samples were collected. This drop in the amount of biological information is related to the reduced budget of many national institutes and to the growing difficulties in obtaining access to the fish landed because of fishermen's reluctance to cooperate in some cases.

In order to estimate the age composition of the total catch, the numbers at age of the unsampled landings were calculated from the sampling by countries assumed to have similar fleets. This may have introduced errors in the catch in numbers especially as unsampled catches were in some cases larger than those of the countries whose samples were used to allocate the landings to numbers at age (i.e., sampling by the Netherlands and Norway were used for data for several other countries [Table 2.2.5]).

Even though the remarks made in Section 1.5 do not provide a basis for defining an optimal sampling level, it is clear that the 1990 sampling is inadequate. Consequently, the Working Group requests all countries whose annual landing of herring exceeded 1,000 t to schedule sampling of commercial landings in the current year.

As in the previous year, estimates of discards were available for only a few fleets. For the others, the question of whether discarding occurs or not remains unanswered. (In these cases the catch statistics are nothing more than landings statistics.)

2.2.3 Treatment of spring-spawning herring in North Sea catches

1) Atlanto-Scandian herring are taken close to the Norwegian coast in Division IVa. These catches are covered by a separate TAC, and are, therefore, not included in the North Sea assessment or catches tables.

2) Coastal spring spawners in the southern North Sea are caught in small quantities in most years. In earlier Working Group reports these catches have been included in the catch tables for Divisions IVc and VIId. In the present report they are given separately in Tables 2.1.1 and 2.2.7, and are not included in the assessment of North Sea autumn spawners.

3) Baltic and Division IIIa spring spawners migrate into the North Sea as described in Section 3.5. Figures 2.2.1 - 2.2.3 show vertebral counts by age of individual samples taken in the northeastern North Sea and Skagerrak during the summer of 1990. The average vertebral counts of samples of North Sea autumn spawners have been shown to be close to 56.50, while those of Baltic and Division IIIa spring spawners have been close to 55.80. Figures 2.2.1 - 2.2.3 show the transfer area where Baltic/Division IIIa spring spawners have been recorded during summer in recent years. Figure 2.2.2 shows that along the Norwegian coast (east of 4^0 East) the July research vessel samples contained a considerable proportion of spring spawners all the way north to 62^0 N. Since there were no catches in the area east of 4^0 East and north of 60^0 North during July, the transfer area was not extended. Figures 2.2.1 - 2.2.3 confirm the western border of the transfer area. The meristic sampling along the southern border was quite poor but it confirms the presence of spring spawners in the southeastern corner of the area during August. Both the fishery and the acoustic survey show low abundance of 2-ringers and older herring south of the transfer area.

By regarding 56.50 and 55.80 as stable averages for autumn spawners and spring spawners, respectively, the fraction of spring spawners (fsp) can be estimated as fsp = (56.50 -v)/0.7, where v is the average vertebral count for the (mixed) sample. When taking the average of all estimated fractions by month within the transfer area, the following results are obtained.

	Fraction spring spawners				Total catch in
Month	2-ringers	3-ringers	older	Number of samples	transfer area (tonnes)
May	-	-	-	0	5,392
June	0.49	0.90	1.00	1	3,826
July	0.30	0.59	0.61	13	4,827
August	0.23	0.36	0.29	11	4,300
September	0	0.10	0.16	3	2,341

Some Working Group members expressed severe reservations about the simple procedure used for splitting autumn- and spring-spawning herring in the transfer area, as this procedure does not take into account yearly differences in meristic characters of the various stocks.

In May and early June the fishery in the transfer area was concentrated between the Skagerrak border and 4^0 East. This was probably a fishery on the outward migrating spring spawners. Unfortunately only one meristic sample was obtained in that period. The spring-spawner fraction estimated from that sample was applied to all catches in the transfer area during May and June. For the period July-September, the monthly estimated fractions were weighted against monthly catch in the transfer area to give average fractions of spring spawners. The result is shown below together with the catches by quarter in each part of the transfer area.

	Catch in transfer area		Fraction spring spawners			Estimated catch of spring spawners (t)
	IVaE	IVb	2-r	3-r	Older	
Q2	5,615	3,602	0.49	0.90	1.00	5,301
Q3	8,848	2,621	0.21	0.40	0.40	3,056

These catches were split into age groups by applying samples from the appropriate areas, and the estimated number of spring spawners were deducted from the quarterly catch in number tables. Mean weights at age of spring spawners were taken from survey samples in the transfer area. Table 2.2.6 gives the details of the transfer. The total amount of fish transferred (8,358 t) is considerably less than in recent years.

2.3 Recruitment

2.3.1 IYFS indices

The updated series of IYFS indices for the standard area in the North Sea is given in Table 2.3.1. The provisional indices for the 1991 survey are based on data from all but one of the countries taking part and covered most of the hauls in the standard area.

The regression of VPA estimates of 1-ringers on IYFS indices of the same year classes was updated using the new VPA which now incorporates Division IIIa catches (Section 2.7). The scatter plot and fitted regression line are shown in Figure 2.3.1. The equation for the regression forced through the origin used for prediction purposes is:

$$y = 0.006478\ x$$

where x is the IYFS index (no/hr in the standard area) and y the VPA estimate of 1-ringers in billions.

The 1987 and 1988 year classes shown in the figure were not included in the regression. The provisional VPA estimate of the 1987 year class (12.8 billion) is lower than the predicted estimate from the regression (22.5 billion).

The new VPA estimate of the 1986 year class (27.9 billion) is higher than the estimate last year (15.5 billion), mainly as a result of including Division IIIa catches in the VPA and is now much closer to the fitted regression line.

Indices of 2-ringer abundance from IYFS for the total North Sea are also given in Table 2.3.1 together with the VPA estimates. The exceptionally high index of the 1985 year class in 1988 is not reflected in the VPA.

2.3.2 IKMT indices

The updated series of IKMT indices from the IYFS is given in Tables 2.3.2 and 2.3.3. The updated scatter plot and regression of 0-ringer abundance from VPA on the IKMT index values is given in Figure 2.3.2. The regression forced through the origin used for prediction purposes has a slope of .004135.

2.3.3 Recruitment forecast of the 1988 year class

The revised index of this year class as 1-ringers (2146) is very close to the preliminary index used in last year's assessment. The predicted recruitment as 1-ringers from the regression is 13.9 billion compared with a prediction of 10.68 billion last year. A preliminary estimate of the size of this year class from VPA is 9.9 billion.

In last year's report, an additional estimate of 1-ringer abundance was provided by the acoustic survey in July. To convert this to a recruitment estimate, however, it was necessary to make a correction for the catches in the North Sea and Division IIIa and for natural mortality in the first half of the year. Because of the sampling problem in Division IIIa, this has not been possible this year.

2.3.4 Recruitment forecast of the 1989 year class

The preliminary index of 1-ringers in the standard area during the 1991 IYFS was 2485. Using the new regression equation, the year-class strength is predicted to be 16.1 billion. This indicates that the IKMT index of this year class in 1990, which was the lowest since that for the 1977 year class and predicted an abundance of 11.0 billion fish as 0-ringers, underestimated the strength of this year class. The estimated proportion of this year class in Division IIIa from the 1991 IYFS was not available because of difficulties in separating the Division IIIa index into spring and autumn spawners. The figures for previous years are presented for information in Table 2.3.4.

2.3.5 Recruitment forecast for the 1990 year class

The IKMT index for this year class is 5072, suggesting that it is rather weak (Table 2.3.3). The predicted year-class strength as 0-ringers using the regression through the origin shown in Figure 2.3.2 is 21.0 billion.

2.3.6 Trends in recruitment

The distributions of 0-ringers of the 1989-1991 year classes are shown in Figure 2.3.3.

The time series of 1-ringer recruitment from 1947 to the present is shown in Figure 2.3.4.

2.3.7 GLM-analysis of the IYFS data

The IYFS catch rates of 1-ringers, 2-ringers and 3-ringers were analyzed by GLM models. The models were:

log (catch rate) = year + vessel + area + depth + time of day + epsilon

where epsilon is the error term. Compared to the model used last year, the interaction term year * area is not included because the models then become too big to be handled by the ICES PCs.

Data from 1982-1991 surveys were used. In order to avoid zero observations, only data from the area between 52^0 30'N to 58^0 30'N were considered for 1-ringers and only from depths less than 140 m. For 2-ringers only data from the area south of 61^0 00'N were considered and only from depths between 40 m and 200 m. For 3+-ringers only data from depths between 60 m and 200 m were considered. Furthermore, for 2- and 3+-ringers data from Division IIIa were excluded.

Data from 1990 and 1991 were preliminary because ALKs were not applied to transform length data into age. For these two years all herring below 18.5 cm were considered 1-ringers, all between 18.5 and 23 cm 2-ringers and all above 23 cm 3+ ringers.

The relation between the GLM 1-ringer index and the VPA is given in Table 2.3.5 for both a GLM index for the North Sea alone and a GLM index for the North Sea and Division IIIa. Compared to the standard IYFS index, the GLM indices are slightly better in terms of higher r^2 values and slopes closer to 1. The predictions for the year classes 1987, 1988, and 1989 are, however, very different from the standard index predictions (much lower).

A GLM run with only the year effect and with the catch rates untransformed gave a result nearly equal to the standard index. The same simple model, but with the catch rates log transformed, gave a result closer to the GLM models given in Table 2.3.5. It thus seems to be the log transformation which is the most important reason for the discrepancy between the standard index and the GLM index. This indicates that the catch rate distributions in 1989, 1990 and 1991 were more skewed than previously.

These results cast some doubts on the accuracy of the predictions for the North Sea herring stock for 1992 as presented in this report.

The relation between the 2-ringers GLM index and the VPA is shown in Table 2.3.6. The r^2 value is 0.77 but the slope is very high (1.76), mainly due to a very high GLM index for the year 1988. This represents the 1985 year class which indeed is a very strong one, but not 5 times the strength of year classes 1984 and 1986. This problem was investigated further by checking, 1) whether it was due to a few very high catches of 2-ringers in the approximately 400 trawl hauls made during the IYFS in 1988, 2) whether it was due to one or a few vessels and, 3) whether it was due to high catches in certain depth strata, etc. The conclusion was that all over the North Sea, for all vessels, and in all depths the catch rates were very much higher in 1988 than in other years. The catchabilities simply appear to have been very high for 2-ringers all over the North Sea in 1988. This was found to be the case for 3-ringers as well, although to a less extreme degree, but not for 1-ringers and 4+-ringers. The Working Group found no explanation for this phenomenon.

The GLM index of 2+-ringers seems to be better correlated to the VPA SSB than the standard 2+-ringer index (Table 2.7.2). However, the 3+ GLM index seems to be even better if this index is regarded as a measure of the SSB the previous year.

A preliminary run of the RCRTINX2 program for tuning the VPA showed that this GLM 3+-ringer index will get approximately the same weights as the acoustic estimate if the present VPA is correct.

Time did not allow the Working Group to make proper use of these GLM indices during the Working Group meeting, because the IYFS data from 1990 and 1991 were only available in the required format a few days before the end of the meeting.

2.4 Acoustic Surveys

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

The 1990 acoustic survey was carried out by five vessels over the period 26 June - 18 August, with one vessel participating in an experimental capacity for the first time. The stock estimates are based on the results from the other four

vessels (Anon., 1991).

The estimates of stock in number at age are given in Table 2.4.1 and the mean weights at age in Table 2.4.2. For Divisions IVa (E), IVb (E), Skagerrak and Kattegat, the estimates are divided between Division IIIa/Baltic spring spawners and North Sea autumn spawners on the basis of modal length analysis and vertebral counts.

The results of the survey were provided by the Planning Group on Acoustic Surveys in Sub-Area IV and Division IIIa (Anon., 1991b). The Planning Group met in January 1991 to combine the survey results and evaluate the possibility of bias arising from boundary problems, double counting as a result of migration during the survey, changes in depth distribution and changes in the extent to which echo traces were correctly identified. The conclusion of the Planning Group was that there was no evidence of any major source of bias in the 1990 survey compared with previous years.

The total estimate from the survey was a spawning stock biomass of 2.17 million t of North Sea autumn spawners. The results from the surveys in the years 1984-1990 are compared in Table 2.4.3.

The proportions of 2- and 3-ringers mature were 73% and 97%, compared with 79% and 99% in 1989. For comparison with the 1990 spawning stock estimated by the VPA, the acoustic spawning stock estimate needs to be reduced by the catches of spawners taken between the survey and the date when 67% annual catch is taken. The average survey date for FRV "Scotia" and FRV "Eldjarn" covering the major part of the spawning stock was 13 July. The 67% catch date is estimated to be 27 September by interpolating on the cumulative catch curve shown in Figure 2.10.13. Interpolating at 13 July indicates that at that time 28% of the annual catch was taken. Thus 39% (212,000 t) of the annual catch was taken in the period between these dates. By applying the age composition and mean weight at age in the third quarter catches and the estimated maturity ogive, it is estimated that the catches in the period totalled 165,000 t of spawners. This means that the estimated spawning stock at the 67% catch date is 2.009 million t when projected from an acoustic estimate of 2.174 million t in July. This figure is compared to several time series of spawning stock estimates in Table 2.7.1.

2.4.2 Eastern part of the North Sea

The FRV "Georg Sars" covered the area east of 3^0 E in Division IVb and Division IIIa during late November - early December. The estimates of 0- and 1-ringers are compared to earlier years in the text table below. It shows some increased abundance of 0-ringers (1989 year class), particularly in Division IVb. The 0-ringer abundance in the Kattegat was particularly low (about 200 million). The total 0-ringer estimate is at the level of the 1988 estimate (1987 year class). Some adult North Sea herring (2-, 3- and 4-ringers) were recorded in the outer Skagerrak. The abundance was, however, low (less than 15,000 t). In the Kattegat the estimated abundance of adult spring spawners was about 60,000 t.

Survey year	Division IVb (E of 2^0E)		Divison IIIa		Total	
	0-ringers	1-ringers	0-ringers	1-ringers	0-ringers	1-ringers
1985	3,723	153	5,814	574	9,537	727
1986	4,098	2,431	6,513	489	10,611	2,920
1987	3,792	1,986	10,192	3,619	13,984	5,605
1988	1,495	297	2,527	2,803	3,752	3,100
1989	984	554	(224)	(375)	1,208	929
1990	3,949	568	463	686	4,412	1,254

2.5 Herring Larvae Surveys

2.5.1 Herring larvae surveys in 1990/91

Only the Netherlands, Scotland and Germany participated in the surveys in 1990/1991, and coverage was consequently greatly reduced compared with previous years. This is illustrated in the text table below:

Year	Number of samples
1986/1987	2,040
1987/1988	1,978
1988/1989	1,886
1989/1990	1,672
1990/1991	1,005

It was decided at the last meeting of the Working Group on Herring Larvae Surveys (Anon., 1990a) that priority should be given to the calculation of the Larvae production estimates (LPE) rather than the Larvae abundance indices (LAI) in the North Sea, since the LPEs show the better correlation with VPA estimates of spawning stock biomass.

2.5.2 Larvae production estimates

The sampling periods recommended in Anon. (1990a) for the calculation of LPEs with reduced sampling effort are compared with the available samples below.

Area	Recommended period	Available samples
Buchan	15/9 - 7/10	4 - 7/9 (60) 18 - 19/9 (17) 2 - 4/10 (34)
Orkney/Shetland	10/9 - 30/9	15 - 26/9 (135)
Central North Sea	1/10 - 20/10	10 - 12/9 (55) 25 - 27/9 (52) 1 - 11/10 (98)
Southern North Sea	1/1 - 15/1	17 - 20/12 (70) 4 - 15/1 (117)

This distribution of effort is considered adequate to calculate estimates of LPE for all areas. However, the procedures used in the calculation of the estimates currently assume zero production for the days of the hatching periods for which there are no backcalculated estimates. This means that gaps in the temporal coverage of the survey area can lead to the underestimation of production. Interpolation of unestimated days is not straightforward because production is not continuous throughout the hatching period. This problem will be addressed by the Working Group on Herring Larvae Surveys.

The LPE estimates were calculated as described in Anon. (1987). Z/K values were estimated for each area based on the slope of the log of the mean abundance of larvae with length over the range 8-16 mm. These were used to calculate the mean Z/K over the years 1980-1990 in order to calculate the LPEs (Table 2.5.1). Growth rates were assumed to be 0.35 mm per day in all areas.

The LPE values for each area are given in Table 2.5.2. In previous years the LPE for Orkney/Shetland and Division VIa(N) combined was also given in this table. However, because priority was given to the calculation of LAI in Division VIa(N) no LPE estimate is available for this area in 1990.

The LPE values, expressed in units of spawning stock biomass by dividing by fecundity, are shown in Table 2.5.3. These are the index values used in all subsequent calculations.

2.5.3 Larvae abundance indices

The requirements for the calculation of the LAI for each area are compared to the available data below. The reduced index refers to the index suggested in Anon. (1990a) which could be calculated over core areas and time periods.

Area	Time periods required for full index	Time periods required for reduced index	Samples available (n)		Adequate coverage?
Buchan	1 - 15/9	1 - 15/9	4 - 7/9	(60)	? only 4 days
	16 - 30/9	16 - 30/9	18 - 19/9	(17)	No
			2 - 4/10	(34)	
Orkney/	1 - 15/9	1 - 15/9	15/9	(1)	No
Shetland	16 - 30/9	16 - 30/9	16 - 26/9	(134)	Yes
Central	1 - 15/9	1 - 15/9	10 - 12/9	(55)	? Only 3 days
North Sea	16 - 30/9	16 - 30/9	25 - 27/9	(52)	? Only 3 days
	1 - 15/10		1 - 11/10	(98)	Yes
	16 - 31/10		No samples	No	
Southern	16 - 31/12	16 - 31/12	17 - 20/12	(70)	? Only 4 days
North Sea	1 - 15/1	1 - 15/1	4 - 15/1	(117)	Yes
	16 - 31/1		No samples		No

It is clear that reliable LAIs cannot be calculated for the North Sea areas, some time periods having been sampled over only 3 or 4 days. This is especially evident considering that hauls taken within 3 day periods are averaged prior to the calculation of the indices. Moreover, the time periods with the poorest coverages are generally those required to calculate the reduced LAIs defined in Anon. (1990a). No LAIs are, therefore, available this year. Values for the years 1972-1989 are given in Table 2.5.4.

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 1990 are presented by divisions and quarters in Table 2.6.1.

It seems that the mean weight is at the same level as in 1989, and the declining trend in mean weight observed in Divisions IVa and IVb during 1986-1989 has stopped (Table 2.6.2). The small differences in the mean weight can be caused by a poor sampling (see Section 2.2.2).

The following text table provides a convenient comparison of the changes in third quarter mean weight at age in the catch from Divisions IVa and IVb for the years 1986-1990. In this quarter, most fish will be at or approaching their peak weights just prior to spawning.

Age (WR.)	Mean weights (g) at age in the catch: Third qrt. (Divisions IVa and IVb) 1986	1987	1988	1989	1990	Acoustic survey (July 1990)
1	78	54	58	42	58	64
2	146	134	124	126	128	128
3	190	182	178	179	180	186
4	224	219	217	207	208	207
5	248	248	239	244	228	232
6	282	265	261	274	256	257
7	288	286	283	288	267	282
8	327	310	283	296	272	278
9+	364	342	296	350	295	318

2.6.2 Maturity ogive

The percentage of 2- and 3-ringers likely to mature in 1990 was estimated from the acoustic survey made by the research vessels in July 1990

The proportions likely to have spawned in 1990 (maturity stage 3 and above) compared to the two previous years were as follows:

	1988	1989	1990
2-ring	65.6%	78.7%	72.6%
3-ring	89.7%	93.9%	97.0%
older	100.0%	100.0%	100.0%

2.7 State of the Stocks

2.7.1 Total North Sea

2.7.1.1 Description of assessment method

Time series of spawning stock indices from larvae surveys, acoustic surveys and IYFS are shown in Table 2.7.1. The two previous Working Group meetings have considered the RCRTINX2 program a useful tool for combining these indices. The method regresses each time series independently on the converged VPA estimates of spawning stock, and average predictions for the unconverged years are then estimated by weighting each individual prediction by the inverse of its variance. The VPA has been fitted to these weighted average predictions by choosing the input fishing mortality giving the minimum squared residuals. In its 1990 report (Anon., 1990b), the Working Group gave arguments for using the above procedure instead of the tuning module (based on age-disaggregated data) contained in the ST-VPA program. The present Working Group could not see any argument for changing the assessment procedure. The importance of being consistent was stressed. It was, however, decided that the tapered time weighting option in the program should not be used. Instead, the larvae estimates prior to 1978 were taken out. Former Working Groups had used tricubic tapering over 10 years.

Some trial VPA runs were made to inspect the convergence. It was considered sufficiently converged for the year 1987 for which a 20% change in spawning

stock estimate was observed when changing input F by a factor of 2. This year was, therefore, included in the regressions by the RCRTINX2 program. Figures 2.7.1 - 2.7.3 show the converged VPA values plotted against survey values. The slope of the resulting regressions were 1.4 for the larvae surveys, 1.5 for the acoustics and 0.8 for the IYFS (Table 2.7.2). The back-transformed regressions are shown in Figures 2.7.1 -2.7.3. As the regressions are in log scale, a slope different from 1 means a curved relationship between the survey estimates and the VPA estimates. A slope greater than 1 involves a large risk of overestimating stock size when predicting from survey values considerably larger than the values in the regression range. This risk is particularly large when predicting from the 1990 acoustic estimate which is 2.1 times larger than the largest estimate in the regression.

The Working Group could not find any logical reason for having a curved relationship between acoustic estimates and VPA estimates, while in the case of the larvae estimate, one could theoretically expect a slope greater than one (for a log/log regression) if the egg mortality increases with increasing stock size. For the IYFS it is conceivable to have a slope different from 1.

Based on the above arguments, the Working Group decided to accept the RCRTINX2 regressions using the larvae surveys and the IYFS data. For the acoustic surveys the log/log linear "calibration regression" used in RCRTINX2 was replaced by a log/log regression with a slope fixed to 1. The estimated standard error of prediction was taken as constant as the slope is fixed. The estimated intercept, predictions and standard error of predictions are shown in Table 2.7.2. Also shown are the weighting factors for making weighted average predictions, when the new acoustic regression replaces the one calculated by RCRTINX2. The new weighted average predictions are also shown. The regression line is shown on the scatter plot (Figure 2.7.2).

The VPA was then tuned to give the minimum sum of squared residuals from these new weighted average predictions. Sum of squared residuals are plotted as function of input fishing mortality in Figure 2.7.4.

The input catch in number at age is shown in Table 2.7.3. These catches include juvenile North Sea autumn spawners taken in Division IIIa during the years 1980-1989. The lack of catch at age data for Division IIIa in 1990 was not considered serious for the VPA estimates of spawning stock. The consequences for the estimates of juvenile stock are discussed in Sections 2.3 and 2.9 Mean weight at age and proportion of maturity are shown in Table 2.7.4. The 1990 values in that table are estimated from the summer acoustic survey. Weight at age in catch is shown in Table 2.7.5. The selection pattern in 1990 and F on the oldest true age group were estimated by separable VPA. A series of separable VPAs were run with different reference Fs on reference age 4 and terminal S = 1.0.

The matrix of residuals and the resulting selection pattern is shown in Table 2.7.6. The best fit was obtained at a reference F of 0.365 (Figure 2.7.4).

2.7.1.2 Estimates of the total stocks in recent years

The results of the best VPA fit are shown in Table 2.7.7 (fishing mortalities) and 2.7.8 (stock size) and in Figure 2.8A and B. The spawning stock estimate in 1990 (1.4 million t) is 30% below the acoustic estimate, which is at the edge of the likely lower confidence limit of the acoustic survey. Figure 2.7.5 shows the present VPA together with the time series of survey estimates. The VPA does not closely match either the absolute levels of the survey values or their trends in recent years. Figure 2.7.6 shows larvae estimates plotted against acoustic estimates. A curved fit of these points is as good as the one of larvae estimates on converged VPA estimates. This might indicate that errors in the VPA caused by errors in landing estimates and age compositions may be at a level comparable to

errors of survey estimates. The poor fit between survey estimates for the predicted years and VPA is also illustrated in Figure 2.7.4 which shows that the squared residuals are not very sensitive to the input F. As a consequence, the estimate of 1.4 million t of spawners in 1990 has to be considered rather uncertain.

The present assessment shows a 23% increase in the 1989 spawning stock compared to the previous assessment. The present estimate of the 1990 stock is also 23% above the value predicted last year, assuming a catch close to the 1990 catch figure (the status quo option).

At the present stock size, the 1990 catch represents a drop in fishing mortality from 0.44 in 1989 to 0.33.

2.7.2 Southern North Sea (Divisions IVc, VIId)

The southern North Sea is considered a separate management unit within the North Sea, because the population spawning in this area is clearly separated from the other North Sea components for a large part of the year (October-February). Historically, this population has always been exploited at a higher rate than other North Sea populations, probably due to the suitability of the smooth spawning grounds for bottom trawling. Because of the higher vulnerability of this population, attempts have been made to give it special protection in the form of a separate TAC for Divisions IVc and VIId within the overall North Sea TAC.

Assessment of the southern North Sea herring has been hampered by the lack of information concerning the catches taken from this population in summer, when the fish are mixed with other North Sea components. A VPA performed on catches taken in the southern North Sea (Tables 2.7.9-2.7.11) gives a rough estimate of Z in earlier years, but a misleading picture of absolute stock sizes. It cannot be used, therefore, as a starting point for a stock and catch prognosis. An additional problem is that 1-ring recruits to this population cannot be separated from other North Sea recruits, and so a separate recruitment forecast for the southern North Sea cannot be made.

Assessments of this population in previous years have been based on the results of larvae surveys, and on the age composition of catches taken in the southern North Sea. Larvae surveys showed a rapid increase in stock size from 1978 to 1981, but since then the increase in stock size has halted (Tables 2.5.2-2.5.4). The catch composition in the years since 1980 has always shown a low number of fish with more than 3 rings, which, in combination with a constant stock size, indicated a high total mortality (in the order of 1.0).

In the 1989/1990 season, there were signs of a further recovery of the population. The LAI went up by more than 80%, and fishermen reported a sharp increase in herring abundance in the southern North Sea.

It is difficult to judge whether the recovery has continued in the 1990/1991 season. The sampling effort during the larvae survey in December 1990 was too low to allow the calculation of a larvae abundance estimate that can be compared to last year's high value. The other index derived from the larvae surveys, the LPE, shows no large increase in either 1989 or 1990 compared with earlier years. The results from larvae surveys, therefore, are not adequate to demonstrate a further recovery of the stock.

Although fishermen have continued to report larger concentrations of herring in the southern North Sea in 1990, there is not sufficient independent evidence for an increase in stock size.

It should also be noted that most of the spawning is still concentrated in a very restricted area and period (see the distribution of the fishery in November/December 1990, Figures 2.10.1-12). In the years before the collapse of this stock (prior to 1950), spawning grounds used to extend from the banks off the Belgian coast down into the Seine Bay, and the spawning season lasted from November until February. It is clear, therefore, that the stock has not regained the diversity it had in the years before the collapse. The present homogenity of the stock as regards spawning place and time probably increases its susceptability to adverse environmental conditions. It would be advisable, therefore, to provide extra protection to this stock until some of the former spawning grounds have been restored.

2.8 Projection of Catch and Total Stock Size for North Sea Autumn Spawners including Division IIIa

Earlier assessments of the North Sea autumn spawners have been based on catches in the North Sea only. Also the recruitment index from the IYFS has been based on the North Sea standard area. The reasons for not including, in most years, the considerable part of the juvenile age groups growing up in Division IIIa has been complex. One important reason is the problem of separating spring and autumn spawners both in the catches and in survey samples. It has also been argued that the long-term average effect of the supply to the North Sea of surviving recruits from Division IIIa is incorporated when regressing North Sea recruitment indices against VPA estimates of recruits. An additional problem with including the recruitment from Division IIIa is that it involves prediction of catches in that area. This means that catch predictions and TAC advice on the stock has to cover two different management areas.

In recent years, the Working Group has (gradually) made more use of data on Division IIIa juveniles in their assessment. The IKMT 0-ringer index has been based on sampling in both areas, and acoustic estimates of autumn spawners from both areas have been combined. The catch of 1-ringers in Division IIIa has also been taken into account when projecting acoustic 1-ringer estimates forward to estimate 2-ringers at the beginning of the following year. The 1990 Working Group provided estimates of autumn spawners taken in the Division IIIa fishery during the years 1980-1989 and presented a VPA based on the sum of these catches and the North Sea catches. The resulting VPA estimates of the total year classes as 0- and 1-ringers gave an improved fit to the IYFS recruitment indices. This means that the Working Group has some basis for assessing the total juvenile stock and predicting recruiting year classes taking into account the components growing up in Division IIIa.

Unfortunately, major parts of the Division IIIa catches in 1990 were not sampled and could not be split into age groups and spawning components. Therefore, the assessment has to be based on North Sea catches alone in 1990, while total catches were applied for earlier years. As the missing catches are likely to contain mainly 0- and 1-ringers, the likely effect on the VPA is underestimation of the 1989 and 1988 year classes. In the predictions, these year classes are estimated from survey data. The 1989 year class was estimated by applying the 1991 IYFS 1-ringer index on the regression of IYFS 1-ringer index/VPA 1-ringer estimate (Section 2.3). This gives an estimate of 16.1 billion 1-ringers at 1 January 1991. The 1990 year class was estimated from the 1991 IKMT index giving 21.0 billion 0-ringers. To have an estimate of 1-ringers in 1992, this was projected 1 year forward applying a natural mortality = 1.0 and a fishing mortality = 0.15 (1987-1989 average) giving 6.65 billion. 1-ringer recruitment at 1 January 1993 was set to 15.0 billion (average of the 1980-1984 year classes).

The number of 2-ringers at 1 January 1991 (the 1988 year class) was estimated by projecting forward the 1-ringer estimate derived from the 1990 IYFS (13.9 billion) and the estimate derived from the 1990 acoustic survey (6.3 billion). A

natural mortality = 1.0 and a fishing mortality = 0.44 (1987-1989 average) were applied for a whole year to the IYFS estimate giving 3.3 billion, and for half a year to the July acoustic survey giving 3.1 billion. The average value (3.2 billion) was used in the predictions. The stock size in number for older ages at 1 January 1991 was taken from the VPA (Table 2.7.8). The value for 3-ringers (1987 year class) could be an underestimate (compared to the older age groups) caused by not including an unknown catch of 2-ringers in Division IIIa in 1990. The 1990 acoustic survey, however, supports the pattern shown in the VPA of an equal abundance of 2-, 3- and 4-ringers in 1990.

All the prediction input values are shown in Table 2.8.1. As discussed in Section 2.6, the mean weight at age in catch and stock and the proportions of maturity did not show drastic changes in 1990. The 1990 values were applied in the predictions. The selection pattern was taken from the separable VPA (Table 2.7.6) smoothed by setting selection = 1.0 for 4-ringers and older. The reference F represents the unweighted mean of 2-6 ringers.

The Working Group was asked to give options for the present year. In addition to the option based on the (preliminary) agreed TAC (obtained at F_{2-6} = 0.21) and the status quo option (F_{2-6} = 0.33), options are given for F_{2-6} = 0.3 and 0.4. For 1992, the option for $F_{0.1}$ (F_{2-6} = 0.12) is given in addition to status quo and F = 0.3 and 0.4. Catches and stock sizes corresponding to these options are given in Tables 2.8.2 and 2.8.3 and Figures 2.8D and E. The spawning stock predictions for 1993 assumes the 1992 fishing mortalities continued to spawning time in 1993 (2/3 of the year).

When comparing the results of these predictions with last year's predictions, one should bear in mind that the present prediction is based on an exploitation pattern reflecting the total exploitation of 1-ringers from this stock, both in the North Sea and Division IIIa during earlier years. 1-ringers, therefore, represent a large percentage of the total predicted catches. For each of the successive years, the percentages by number are 49, 27 and 50 and the percentages by weight 24, 11 and 24.

A GLM analysis on IYFS data (including Division IIIa survey data) shows a lower recruitment of the 1988 and 1989 year classes in 1991 than that used in the prediction (Table 2.3.5).

The prediction assumes an unchanged exploitation of 0-ringers in 1991 and later years. The resulting catches of 0-ringers, however, have not been included in the projected catch figure. A reduction of F on 0-ringers in 1991 and later years would increase the spawning stock from 1993 onwards.

2.9 Management Considerations

2.9.1 TAC advice for the total North Sea stock

The present management objective for the total North Sea stock is to increase spawning stock size to a level of 1.5-2.2 million t in order to buffer the annual TAC against fluctuation caused by variations in recruitment.

It is not clear whether this level has yet been reached. Although the acoustic survey in 1990 provided a stock estimate of 2 million t, the outcome of the present assessment, using all available survey indices, plus information on age composition of catches, is a spawning stock size of 1.4 million t in 1990. From the description of the assessment method, and the results presented in the previous sections, it is obvious that the estimated stock size in 1990 has fairly wide confidence limits.

In previous reports of the Working Group, the advice has been given to exploit

the adult North Sea herring at F = 0.30. Given average levels of recruitment, this level of fishing mortality will result in an average stock size in the desirable range indicated above (given further restrictions on the juvenile fishery) and a stabilisation of TACs.

The present prediction (Table 2.8.2) shows that a fishing mortality of 0.30 will indeed result in a stabilization of the TAC (for adult herring) although stock size is expected to stay below 1.5 million t, and even decrease from 1992 to 1993. The development of the stock after 1992, however, is very uncertain as the present prediction is partly based on a very provisional estimate of the 1990 year class.

An F of 0.30 in 1991 would lead to a catch of 503,000 t in that year, and a continuation of this F in 1992 would result in a catch of 447,000 t. It should be pointed out that this prediction, contrary to earlier ones, is based on a stock assessment that also includes catches of North Sea autumn spawners in Division IIIa. The expected catches of autumn spawners in Division IIIa should therefore be deducted from the above figures in order to arrive at an area TAC for the North Sea.

The figure of 503,000 t for 1991 is composed of 120,000 t 1-ringers and 383,000 t 2-ringers and older. The 2-ringers and older will be caught mainly in the North Sea, but a large proportion of the 1-ringers may be taken in Division IIIa.

The Working Group is unable to predict the proportion of the 1-ringer catch that will be taken in Division IIIa. The text table below illustrates the wide fluctuations in the proportions of the catch of this age group, taken in the North Sea and in Division IIIa:

Catches of 1-ringed North Sea autumn spawners (billions).

Year	North Sea	Division IIIa
1986	1.76	2.96
1987	3.52	3.15
1988	1.97	5.79
1989	1.90	1.04
1990	1.48	.?..

The proportion of 1-ringers taken in each of the two areas depends not only on the distribution of the year class in a particular year, but also on the relative abundance of spring spawners in Division IIIa, the size of the mixed clupeoid. TAC for Division IIIa, and the enforcement of the existing conservation measures for juvenile herring in both areas.

It should be pointed out that a catch of 383,000 t of adult herring in 1991 corresponds to a recommended target fishing mortality (F = 0.30). The projected catch of 120,000 t of 1-ringers, however, does not correspond to a management objective, but it is merely the result of the assumption, used in the prediction, that the exploitation pattern in 1991 will not be different from that in recent years. It thus implies that no further progress will be made in the restriction of juvenile catches, and that managers will accept the loss of a considerable amount of adult catch in future years. The approximate magnitude of this loss might be estimated from the conversion factors presented in the 1989 Working Group report (Anon., 1989a); no new estimates have become available since then.

The Working Group would like to stress again that an increase in catches of

adult North Sea herring above the current level of 300,000-400,000 t, given average levels of recruitment, can only be achieved by a further reduction of juvenile catches, both in the North Sea and in Division IIIa.

The projections for 1992 are provisional since they are based on a very uncertain estimate for year class 1990. Assuming an F = 0.30 on adults in 1991, and an unchanged exploitation pattern and level of F, the total catch of North Sea autumn spawners in 1992 would be 447,000 t, consisting of 50,000 t 1-ringers (year class 1990) and 396,000 t of 2-ringers and older. The catch of adult herring would thus remain nearly the same in 1992 as it was in 1991.

The TAC estimates presented above refer to the total North Sea stock of autumn spawners. To arrive at an area TAC for the North Sea (Sub-area IV + Division VIId), the catches of autumn spawners allocated to be taken in Division IIIa should be deducted from these figures, and the catch of Division IIIa spring spawners allocated to be taken in the North Sea should be added (this allocation is based on the estimates provided by the Working Group on the Assessment of Pelagic Stocks in the Baltic). The TAC for Divisions IVa,b is obtained by subtracting the area TAC for Divisions IVc, VIId (see next Section) from the area TAC for Sub-area IV + Division VIId.

A similar prediction defining the stock as age 2+ is shown in Tables 2.8.4 and 2.8.5.

2.9.2 Management advice for the southern North Sea (Divisions IVc, VIId)

The difficulties in making an assessment and catch prediction for this area were set out in Section 2.7.2. In the absence of a precise catch prediction for this area, ACFM has in recent years recommended a safe catch level of 30,000 t. The TAC should be maintained at this level until there is evidence of an increase in stock size and a decrease in F.

Although the available information suggests a possible increase in stock size in the last two years, the evidence is considered to be too weak for a revision of the recommended safe catch level. The considerations about the extra vulnerability of the stock, due to the very restricted spawning area and season, are an additional argument for not increasing the recommended TAC at this moment.

The Working Group also draws attention to the fact that actual catches in the southern North Sea (including estimates of discards and unreported landings) have greatly exceeded the agreed TAC in recent years (Table 2.1.5). It is obvious, therefore, that enforcement of the TAC for this area is inadequate. The lack of enforcement mainly arises from reporting catches taken in this area as coming from Division IVb. Another cause of the discrepancy between agreed TAC and actual catches is the high amount of discarding in the roe fishery.

The Working Group, therefore, recommends that action be taken against the misreporting of catches in this area, and the introduction of measures to prevent discarding (Section 8).

The TAC set for Divisions IVc, VIId is part of the TAC for the total North Sea stock.

2.9.3 Management of juvenile fisheries

The Working Group endorses the recommendations given to ACFM last year, (a) to reduce the TAC for mixed clupeoids in Division IIIa to zero, and (b) to maintain the sprat box closures, the 20 cm minimum landing size, the mesh size regulation, and the by-catch regulations in the North Sea.

Catches of juvenile herring in the North Sea could also be reduced by measures aimed at minimising discards in the trawl fishery (see Section 8).

2.9.4 Additional conservation measures

The Working Group recommends the continuation of the spawning ground closures in the central North Sea.

2.10 Requests from the Multispecies Working Group

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

The Multispecies 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 1990 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 VPA estimates of total biomass

In order to have most realistic estimates of total stock size the VPA outputs also show total stock biomass at 1 September. The estimates for the beginning of the year are incorrect because of the application of the weights at age of the third quarter to the numbers at age at 1 January (Table 2.7.8).

2.10.3 Geographical distribution of the catches in the North Sea 1990

Data on the geographical distribution of catches in the North Sea (Sub-areas IV and Division VIId) in 1990 were available from Denmark, the Netherlands, Norway and the UK (Scotland and England). The data represent 84% of the total catch, and include both juveniles and adults. Figures 2.10-1 - 2.10.12 show the catch by ICES rectangles for each month, and the cumulative catch by month for the total North Sea is shown in Figure 2.10.13.

2.11 Future Research Requirements

The need for increased sampling of commercial catches by some countries and in certain areas was discussed in Section 2.2.2.

During the present meeting, results from the IYFS became available only at a very late stage. It was not possible, therefore, to use them in an optimal way for recruitment prediction, and for tuning the VPA. The Working Group recommends that in future all participants in the IYFS submit the herring age/length data well before the Working Group meeting, and that the ICES Secretariat have the necessary extractions prepared for the three most recent years before the start of the meeting.

Further comparative experiments should be conducted in February 1992 with IKMT and MIK in order to establish conversion factors for the old series of indices.

For the splitting of North Sea catches into spring and autumn spawners, new data are required concerning meristic characters of the pure stock components by year class.

It is proposed that otolith exchange programmes are initiated in each of the major fishing areas in order to check the quality of the age determination in the various national laboratories.

3 DIVISION IIIA HERRING

3.1 Stock Composition

3.1.1 Baltic and Division IIIa spring spawners in the North Sea

Details on the separation of the catches of spring spawners in the North Sea are given in Section 2.2.3.

The transferred spring-spawning herring totalled about 8,400 t. Catch-at-age data with corresponding mean weights at age are shown in Table 3.1.1.

3.1.2 Stock composition in Division IIIa

The herring fishery in Division IIIa traditionally exploits local spring spawners and 0- to 2-group autumn-spawned herring from the North Sea. Available data suggest no changes in this fishing pattern in 1990. Insufficient biological sampling of a large part of the total landings, as described in Section 3.2.4, however, prevents the allocation of catches to age groups. Hence, it is not possible at present to separate the catches of the different stocks in the 1990 herring fishery. The scattered data indicate, however, that the catches of 0-and 1-groups in 1990 were dominated by autumn spawners as in previous years. A gradually decreasing proportion of 2-group autumn spawners in the catches is also indicated. The catches of adult herring were totally dominated by local spring spawners.

3.2 The Fishery

3.2.1 ACFM advice and management applicable to 1990 and 1991

1990

ACFM recommended a TAC in 1990 of 67,000 t for the spring spawners in Division IIIa and not more than 60,000 t to be caught in the small-meshed clupeoid fishery.

The agreed TAC for the directed herring fishery in Division IIIa in 1990 was 120,000 t. A further TAC of 65,000 t was set for mixed clupeoids (sprat and young herring) caught by small-meshed gear. The latter was a reduction of 15,000 t from the agreed TAC of 80,000 t in 1989.

Assuming that all 65,000 t of mixed clupeoids taken are herring, the total TAC for Division IIIa in 1990 was 185,000 t. The preliminary estimate of the total herring landings from Division IIIa in 1990 of 202,000 t thus represents an excess of 9% over the agreed TACs. In 1988, the excess of landings amounted to 53% while the 1989 landings - revised to 192,000 t at the present meeting - represented an 88% utilization of the agreed TACs. It thus appears that the agreed

TACs and the actual landings in Division IIIa have converged considerably in the last two years.

1991

The recommended TACs for the herring fisheries in Division IIIa are:

- Spring spawners ..... 91,000 t
- Mixed clupeoids ..... 0 t

The agreed TACs for 1991 are:

- Directed herring fishery ..... 104,000 t
- Mixed fishery ..... 50,000 t

The total agreed TAC for 1991 of 154,000 t represents a reduction of 31,000 t or about 17% from the TAC in 1990. It should be noted that from a management point of view the agreed TACs are regarded as area TACs (see Section 3.5.3).

3.2.2 Landings

The landings from Division IIIa by countries are shown in Table 3.2.1. The preliminary figures for 1990 show a total catch of 202,000 t. The landings for 1989 were corrected and the final figures are about 20,000 t higher than those given in last year's report. With a total of about 192,000 t in 1989, the increase in 1990 is only 10,000 t or about 5%. In the Skagerrak and the Kattegat taken separately, changes are more pronounced. The Skagerrak landings increased by 28% while those from the Kattegat show a decline of about 18%. Danish landings declined by 6%, while Swedish landings increased by 19%. The Danish herring landings from the small-mesh clupeoid fishery amounted to 51,000 t. This is about 25% of the landings, and about the same as in 1989.

3.2.3 Catch in numbers at age

The biological sampling in Division IIIa deteriorated to a level in 1990 that made it impossible to convert a major part of the landings in weight into number caught at age.

Biological sampling covered only the Norwegian landings in the Skagerrak and the Swedish landings for human consumption in Division IIIa except for the second quarter in the Skagerrak, for which the age distribution from the first quarter was applied. Danish consumption landings in all quarters were converted to numbers by use of the Swedish age distributions on the assumption that the Danish and Swedish fisheries with 32 mm mesh are carried out in approximately the same areas.

The results are shown in Table 3.2.2. It should be stressed that the figures only refer to landings for the human consumption market. They represent 82,345 t or only about 41% of the total landings.

3.2.4 Quality of catch and biological sampling data

The species composition in the Danish small-mesh fishery for industrial purposes was adequately sampled in 1990 due to a reorganization and increase of the fisheries inspection organization. Landing statistics for herring to the consumption market were of good quality and the only significant uncertainty concerns the landings of trash fish from the Swedish herring fishery which is mainly carried out with 32 mm mesh. Discards are not known to occur in Division

IIIa.

While the landing figures thus seem quite reliable, the biological sampling is, however, totally insufficient except perhaps for Norwegian and Swedish human consumption landings. Table 3.2.3 shows for 1990 the number of age readings by country, sub-division, landing category and quarter. It is evident that while some combined estimate may be obtained in the case of the consumption landings, this is not possible for the industrial part. There are two main problems involved in connection with the latter. Firstly, it is not valid to apply samples from the mixed clupeoid fishery to trash herring from the fisheries with 32 mm mesh and vice versa. Secondly, the ratio between trash herring and herring from the mixed fishery in the Swedish industrial landings is not well documented.

The effects of the insufficient sampling in Division IIIa are quite serious for the assessment of the Division IIIa/Western Baltic spring-spawning stock. It will not be possible to include 1990 in the VPA and any prognosis will contain a large measure of uncertainty. Also, the assessment of the North Sea autumn spawners will be affected as no estimate can be made of the component of young North Sea herring caught in Division IIIa. At last year's meeting, the Working Group succeeded in including this component in a North Sea VPA in order to get a more realistic esimate of recruitment. This endeavour is, of course, discontinued for the time being.

The deterioration of the biological sampling seems mainly to be due to reorganization of institutes and lower priority to sampling work because of restrictions in manpower and budgets. A certain unwillingness amongst fishermen to allow biological sampling of the landings has also played an important role.

It should be stressed that unless immediate steps are taken in order to remedy the sampling deficiencies in 1991 it will not be possible to furnish any reliable advice on the herring stock in Division IIIa/Western Baltic and the advice on the North Sea autumn spawning stock may also be impaired.

3.3 Acoustic Survey

The acoustic survey of the spring spawning herring in summer 1990 covered the distribution area in the North Sea in July and Division IIIa in August. Details of the survey are given in the Report of the Planning Group on Acoustic Surveys in Sub-area IV and Division IIIa (Anon., 1991b).

The combined result of the spring-spawning herring by age groups, derived as the sum of spring spawners found in the July survey in Sub-area IV and the August estimate of the same stock in Division IIIa are shown in Table 3.3.1.

While the estimated stock in number shows a small increase from, 2.290 million in the 1989 survey to 2.470 million in 1990, the biomass estimate decreased by about 7% to 236,000 t. The estimated adult stock 3-group and older is 114,000 t or 952 million fish in 1990, which represents a small reduction by number but a decrease of about 40% in biomass compared to the 1989 estimate. The reduction of adult biomass is mainly due to much lower mean weights in 1990. The results of the two coverages in the eastern North Sea indicates a change in migration pattern in 1990 compared to the situation in 1988-1989. In 1990, a major part of the spring-spawning stock appears to have already left the North Sea by early August and during the second survey most of the adult herring was found in eastern Skagerrak and in Kattegat. The possibility that some concentrations of herring could have been double-counted as a result of migration in the two week period between the two surveys could, therefore, not be totally ruled out. The abundance of adult herring in the Kattegat could indicate that some herring have migrated out of the survey area into the Baltic-Belt Sea region. Corrections for double counting and areas not covered have not been applied. The observed

differences in mean weight at age of the spring spawners found in the North Sea and in the Skagerrak-Kattegat do not support the suggestion that double counting is a major source of error, but the combined estimate in 1990 could overestimate the stock.

The results of a November survey are given in Section 2.4.2.

3.4 Recruitment

3.4.1 General remarks on the 1991 survey

The 1991 survey was carried out in February as in previous years and a total of 43 hauls were made. All standard stations were sampled and the weather situation was good. Surface temperature varied between 1-2^{0}C and bottom temperature about 5-6^{0}C. A well developed thermocline at 10-15 m separated surface and bottom water masses.

3.4.2 Abundance of 1-group herring

The final index of 1-group herring in 1991 was 3,588 which is about the same as in 1990 and very much lower than the mean (Table 3.4.1). A modal length frequency analysis was used to separate different components but the mean vertebral counts showed that the separation could not be verified for the major components as shown in the text table below.

Stratum (m)	Mean length	Mean VS	Proportion
1. 10-34	14.6	56.2	0.76
	18.4	56.5	0.24
2. 34-44	11.2	55.9	0.03
	14.6	56.2	0.76
	18.0	56.5	0.21
3-4. >45	11.8	55.9	0.02
	14.6	56.2	0.19
	16.9	56.4	0.79

The vertebral counts, however, indicate an increased proportion of spring spawners in 1991 compared to 1990.

3.4.3 Abundance of 2-group herring

The total index of 2-group in 1991 was 3,749, which is very close to the index in 1990 and slightly above the mean value since 1980. The 2-group index is normally dominated by the spring spawners and the separations have been verified with vertebral counts. In 1991, the mean vertebral counts per length class indicate that spring and autumn spawners are mixed over the total length frequency distribution. The mean length, vertebral counts and proportion of the separated components are given in the text table below.

Stratum (m)	Mean length	Mean VS	Proportion
1. 10-34	19.9	56.0	0.13
	22.8	56.3	0.87
2. 34-44	17.5	56.2	0.20
	21.5	56.3	0.80
3-4. >45	21.6	56.3	0.86
	24.1	56.4	0.14

The separation indicates a dominance of autumn spawners from the North Sea in the 2-group. Assuming that the components with mean length less than 20 cm are spring spawners, a tentative split could be made. The result is shown in Table 3.4.1.

3.5 State of the Stock and Management Considerations

3.5.1 General remarks

The assessment of the combined Division IIIa and Sub-divisions 22-24 herring is performed by the Working Group on the Assessment of Pelagic Stocks in the Baltic. The results of the 1991 assessment, insofar as an assessment is possible considering the insufficient data from the fisheries in Division IIIa, will be provided by that Working Group.

3.5.2 Management of the juvenile fisheries

The juvenile fisheries in Division IIIa mainly exploit the North Sea autumn spawners and the management of this fishery is discussed in Section 2.9.3.

3.5.3 Management in relation to stock components

The spring-spawning herring in Division IIIa and Sub-division 22-24 consists of a group of spring- and winter-spawning populations that cannot be separated appropriately and thus are treated as unit stock from an assessment point of view. The spring spawning populations are the major part of this stock.

Numerous spawning sites are located in inshore shallow waters along the coast and at shallow banks in the open Kattegat. Monitoring of spawning activities are only undertaken in the Baltic area, e.g., around the Rügen in former German Democratic Republic, and the proportional contribution from the different spawning areas to the total spawning are not well known. The distribution of 0-group herring, however, indicates that at present the main spawning areas are located in the Baltic.

A general distribution and migration pattern of spring-spawning stock has been established based on tagging experiments, meristic characters from surveys such as the IYFS and acoustic surveys and from commercial samples as well as from studies of Anisakis simplex infestation rate. The juvenile herring appear to concentrate mainly in the Baltic-Belt Sea area and gradually, with increasing age, move into the Division IIIa. As 2-group herring, the spring spawners are distributed over a large area and some have joined the adult population in feeding migration to the eastern parts of the North Sea and are found during the summer mainly in the Norwegian Deep. The migrating spring spawners seem to appear in this area in early May. The present information indicates that the

main concentration of spring spawners is found east of 3^0E, but individual samples show that the distribution could extend further west between 2-3^0E in the North Sea. The northern boundary of the main distribution area appears to be at least as far as 62^0N but samples indicate an even futher northerly migration along the Norwegian coast in some years. The "transfer area" used by this Working Group is shown in Figure 2.2.1. In the past, a portion of the landings from an area of the North Sea has been subtracted from North Sea totals and added into the Division IIIa - Sub-divisions 22-24 assessment.

The time of the migration back to Division IIIa varies from year to year. In 1988, and particularly in 1989, the results of the acoustic survey and data from the fisheries showed that the migration took place later than September. The late migration was corroborated by reports from the fishery in Skagerrak-Kattegat that year, when large herring were scarce in catches in August-September but showed an increase later in the autumn.

In 1990, a reduction of spring spawners was seen between the two acoustic surveys that covered the transfer area in July and in August. The reduction of spring spawners in that area by early August seems early in comparison to acoustic resultsefrom previous years. The August survey also showed a relatively low abundance of adult herring in the western parts of Skagerrak and the main concentration was found in eastern parts and in the Kattegat. The change in distribution is also supported by the fishing pattern in 1990, when the Swedish fleet was mainly fishing in the eastern Skagerrak by early August and left the area for the Kattegat in October; this is more than a month earlier than in 1988-1989.

The main overwintering areas for the spring spawners are known to be in shallow waters in the southern Kattegat and particularly in Sub-divisions 22-24. The peak spawning occurs in March-April but components are known to spawn in February and in May.

The migration pattern of the spring-spawning stock in Division IIIa-southwestern Baltic has resulted in exploitation of the stock in three different management units:

a) Eastern North Sea in the second and third quarters. The yearly transferred catches of spring spawners have varied between 7,000 to 23,000 t, with a mean of 16,000 t in 1983-1990.

b) Division IIIa catches all through the year but the main catches are taken in the second half. The catches in 1983-1989 have varied between 51,000 and 144,0000 t with a mean of 102,000 t.

c) Southwestern Baltic, Sub-divisions 22-24, where the adult stock is exploited predominantly in the first half of the year. The total catches in 1983-1989 have been very stable with a mean of 104,000 t.

The assessment of the combined Division IIIa and Sub-divisions 22-24 herring only includes catches only of spring spawners in the areas listed above. Catches of autumn spawners in the transfer area and in Division IIIa are not included. Prior to the 1990 assessment, only catches of 2-group and older herring were used in the Division IIIa-southwest Baltic assessment but in the 1990 assessment, catches at age of all age groups were included. The fisheries-independent data series (acoustic estimates, IYFS indices of 2-group in Division IIIa and recruitment indices from Sub-divisions 22-24) used to estimate recruitment and tune the VPA are based on spring spawners only. The assessment, the recommended TAC and prognosis apply to the total distribution area of the spring spawner stock, i.e., eastern North Sea, Division IIIa and Sub-divisions 22-24.

In the catch options the likely catches of spring spawners in Division IIIa and

in the southwestern Baltic are partitioned based on historical proportions of the fishing mortality generated in these areas. A separate catch forecast for the likely catches in the eastern North Sea is not given and the catches of spring spawners in this area are at present incorrectly counted against the TAC set for the autumn spawners.

A very large proportion of the total catches taken in Division IIIa is made up of 0- ,1- and 2-group herring from the North Sea stock. The majority of the 0-group catches and a substantial part of 1-group catches are generated in the small mesh fishery with 16 mm full mesh size that is managed under the "Mixed Quota Concept". These mixed quotas are set on the basis of socio-economic considerations and not on the assessment and catch options for the North Sea stock. In recent years an increasing proportion of the total catches of North Sea herring in Division IIIa is taken as unavoidable by-catches in the 32 mm mesh consumption fishery.

The present situation is not satisfactory from a biological or management point of view and it appears that the final advice hitherto offered by ACFM concerning herring fisheries in Division IIIa has caused some confusion and uncertainty among fisheries managers and administrators. This stems from the fact, that the TAC options offered are applicable to a stock TAC, but at the same time a split between Division IIIa and Sub-divisions 22-24 is recommended. This has obviously led to the assumption that the recommended stock TAC for the spring spawners in Division IIIa is an area TAC. From the biological point of view, all catches of one stock should be included in the assessment and counted against the TAC set for that stock.

As the present Working Group is responsible for estimating the catches of the two stock components in the two management areas, it also feels partly responsible for the construction of the advice. The Working Group has, therefore, made the following suggestions which could apply as long as the assessment work and the management consideration concerning Division IIIa are split between two assessment Working Groups:

- The Baltic Pelagic Working Group would assess the spring spawners, give stock TAC options and advise on a TAC split between Sub-divisions 22-24, Division IIIa and Sub-area IV (likely by-catches in the North Sea herring fisheries).

- The present Working Group would assess the North Sea autumn spawners, give stock TAC options and give advice on the split between the North Sea and Division IIIa (likely by-catches of North Sea herring in Division IIIa fisheries including an eventual TAC on mixed clupeoids).

- ACFM would then produce area TAC options for the North Sea, Division IIIa and/or Sub-divisions 22-24 by combining the catch options for the two stock components according to the information provided by the two Working Groups.

At present, there are no methods developed to forecast the likely by-catches of spring spawners in the North Sea or likely by-catches of autumn spawners in Division IIIa fisheries. To forecast by-catches of the different components, assumptions may have to be made concerning a constant migration pattern and fishing pattern between years. The by-catches will also be dependent on the stock structure and development of both stocks. The time available at this meeting did not allow an evaluation of possible tools, such as larvae indices, acoustic estimates of juveniles or IYFS indices, that might be used to make prognoses in advance of the fishery.

The Working Group, therefore, recommends that a Workshop is set up in conjunction with the Working Group on Pelagic Stocks in the Baltic, with the objective being to evaluate methods to forecast by-catches of spring spawners in the North Sea fishery and by-catches of North Sea autumn spawners in the Divi-

sion IIIa fishery. The Workshop should be held prior to the 1992 meetings of the Assessment Groups.

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 that, although the management unit covers all of Divisions VIIg,h,j and k and the southern part of Division VIIa, all of the catches in recent years have come from the southern part of Division VIIa and from Divisions VIIg and j.

4.2 The Fishery in 1990-1991

4.2.1 Advice and management applicable to 1990 and 1991

The preliminary reported landing figure for 1990 was about 17,100 t while the figure for the 1990/1991 season (1 April - 31 March) was also about 17,100 t.

The TAC recommended by ACFM for this area for 1990 was 15,000 t. The figure subsequently agreed and adopted by the EC was 17,500 t.

The management of the fishery by Ireland, which in recent years has taken about 90% of the attributable catches, was conducted along similar lines as in 1989. The Irish fishery, carried out on a seasonal basis, was not opened until mid-October 1990 but was closed again at 1 December because the yearly quota had been reached. The fishery was re-opened on 1 January 1991 but was again closed on 1 February in order to retain the balance of the 1991 quota for the autumn season. The TAC for 1991 has been set at 15,000 t, and the preliminary reported landings for the first quarter have been estimated at about 6,000 t.

The system whereby selected spawning grounds are closed in rotation, and which was first introduced in 1988, was continued during the 1990/1991 season. The spawning grounds thus closed were the important ones in the eastern part of the Celtic Sea where fishing was prohibited from 15-31 January 1991. Although some illegal catches were taken during this period the main fleet observed the closure and transferred their effort to Division VIIg.

The total Irish quota was, as in recent years, divided into weekly quotas and further subdivided into nightly boat quotas. All boats participating in the fishery are required to carry licenses and the number of boats which took part in the main fishery was about 80 which was a slight increase on the figure for 1989/1990. As in the previous season, a number of vessels were forced to leave the fishery for breaches of licensing regulations. Although considerable effort has been spent in recent years on the management of this fishery, it has still proved difficult to obtain accurate estimates of both the legitimate landings and the landings which are made during the closed seasons.

4.2.2 Catch data

The reported 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 catch taken during 1990-1991 was 17,100 t compared with 16,900 t during 1989-1990. This reported catch does not include any estimates of herring which were dis-

carded at sea.

The Working Group has commented in recent years about the possibility of under-reporting of catches from this fishery. This possibility was considered because of difficulties in interpreting the spawning stock biomasses estimated from VPAs which were carried out using a range of values of input F. An independent estimate of the yearly catches may be obtained by examining the production of roe from the fishery for the Japanese market. If a roe yield of 6.5% is assumed, it is possible to back-calculate the total catch which must have been landed. As the fishery in this area for the last four seasons has been almost totally dependent on the roe market, these estimates are considered to be a more realistic estimate of what the total landings must have been.

When the figures are compared to the reported landings it would appear that some landings must be raised by an average factor of 1.5 to correspond to the likely landings. The method used in revising the catches is described in a working document (Molloy). As the likely under-reporting began with the re-opening of the fishery in 1982, which corresponded with the introduction of the boat quota system of management, the catches from this period have all been raised by the appropriate factor for each season.

The problem of discards and the reasons for discarding in this fishery were discussed in the 1990 Working Group report. This problem is also discussed in Section 8 of this report. There are no estimates of discards from this fishery although it is likely that the problem in 1990 was not as serious as it was in earlier years. This is because 1) fishermen are becoming more skilful in identifying traces of "ripe" herring; 2) the opening of the season does not take place until as late as possible; and 3) fishermen avoid areas in which young fish are found. The 1990 Working Group assumed a level of discards of 20% of the total catch for each season since 1983/1984. This figure was selected on the grounds that it would result in a better assessment than if the problem was ignored. Since the overall level of discarding during 1990/1991 seems not to have been as high as in recent years, the Working Group decided to assume a level of discarding of 10% for this season.

The catches taken from the fishery per statistical rectangle are shown per quarter in Figure 4.2.1. When the 1990/1991 season was re-opened in October, the main fishery took place in the northern part of Division VIIj off the south west of Ireland. Considerable catches were taken at this time from an area which straddled the boundary between Division VIIj and Division VIIb. The fishery in this area has developed considerably in recent years. At the same time landings were also recorded by boats fishing in Division VIIg and Division VIIa. During the first quarter of 1991 fishing took place in the traditional areas off the south coast but catches were also recorded by boats fishing in Division VIIj, again adjacent to the boundary with Division VIIb. Considerable difficulty was experienced in allocating the catches, both from the autumn and winter fisheries, to the proper stock unit.

Quarterly length compositions of Irish catches in 1990 are shown in Table 4.2.3.

4.2.3 Quality of catch and biological data

As mentioned earlier, despite considerable effort in the management of this fishery, there still remains a large degree of uncertainty about the actual reported catches. The Working Group could therefore no longer place any confidence in the recent reported landings. However, biological sampling of the landings throughout the season remains very good. The sampling data are shown in Table 4.2.4.

4.2.4 Catches in numbers at age

The total catches in numbers at age including discards and revised catches, are shown in Table 4.2.5. The percentage age distributions of catches in recent years are shown in Table 4.2.6. The total catches include a level of 20% discards from 1983/1984 - 1989/1990 and 10% for 1990/1991.

The catches in numbers at age for 1990/1991 are based entirely on samples obtained from the Irish fishery. The overall age distribution of the catches in 1990/1991 is dominated by the 1987/1988 year class (35%). However, the catches, particularly those taken in the western part of the fishery in Division VIIj, are dominated by the 1985/1986 year class. This year class is also very well represented in the catches in Division VIIa South and Division VIIg. As the season progressed there was a gradual increase in the 1987/1988 year class in the catches from Division VIIa South suggesting that recruitment from this area may come from the Irish Sea. The percentage age distribution of the overall catches indicates a continuous increase in the relative amounts of older fish present in recent years.

4.3 Mean Weights at Age

The entire catch from this fishery in 1990/1991 has been taken from the spawning fishery. The mean weights at age in the catch have, therefore, been considered as in recent years to be the same as the mean weights of the stock at spawning time. The mean weights (g), based on samples for the Irish fishery, are shown below compared with those for the previous seasons.

Season	1	2	3	4	5	6	7	8
1986/1987	119	155	172	187	215	248	236	284
1987/1988	96	138	186	192	204	231	255	267
1988/1989	97	132	168	203	209	215	237	257
1989/1990	106	129	151	169	184	199	210	221
1990/1991	99	137	153	167	188	208	209	229

Although the mean weights of 1990/1991 are similar to those of 1989/1990, they are, however, still considerably lower than those of the three previous seasons. The reason for this decline, which is also evident in the mean weights from Divisions VIa South/VIIb, is not apparent.

4.4 Stock Assessment

4.4.1 Larval surveys

Previous Working Groups have used a series of larval surveys as the main method of stock assessment in this area. However, the surveys were discontinued in 1985. The most recent comprehensive survey was carried out during the 1988/1989 season, but it has not been possible to carry out a complete survey during 1990/1991. The larval surveys carried out in 1989/1990 gave a very high estimate of SSB for that year. This estimate was not used in the assessment by the Working Group since it was considered unrealistically high. It was, however, used qualitatively to indicate that the stock was at a high level.

4.4.2 Larval survey 1991

A limited larval survey was carried out in February 1991 (see Section 4.8) in order to evaluate the effectiveness of the closure of the spawning Box C. Although the survey could not be used to determine spawning stock biomass, the numbers of larvae recorded in the limited area surveyed (see Figure 4.8.1) were very high and the peak value was higher than any recorded in the area during the series of larval surveys from 1978 to 1985.

4.4.3 Acoustic surveys

Acoustic surveys in the Celtic Sea and Division VIIj were undertaken in October 1990 and January/February 1991. The surveys were carried out from the R/V "Lough Foyle" using a 38 kHz echosounder. In October, the survey covered the coastal area (within 6 nm of the coast) from Loop Head on the west coast (52^0 10'N) around to the east coast (52^0 30'N). The objective was to assess the size of the autumn-spawning component in October and the winter-spawning component in January/February. The results of the surveys were presented in a working document (Nash and Molloy).

The surveys were undertaken after the fishery was opened in October. As the time of spawning for this fishery is considered as 1 October, catches taken prior to the commencement of the survey in October had to be added to the acoustic estimate of the autumn component. Similarly, all catches taken between 1 January and the end of January were added to the winter spawning estimate. Examination of the maturity stages of fish from trawl samples obtained indicated that the two surveys examined the two different spawning components. The results of the two surveys were, therefore, combined to give an overall estimate of the biomass.

The survey carried out in October gave an estimate of about 45,000 t of autumn-spawning herring. A lack of trawl samples from the western area presented a problem in interpreting the data. However, the data were split on the basis of the paper trace records. The stock was distributed over both the Celtic Sea and Division VIIj; 52% occurred on the southwest coast (north of the Fastnet Rock) while 48% occurred on the south coast.

The survey carried out in January/February covered only the southern area but this area was in fact covered twice. The two estimates of stock were 51,000 t and 41,000 t giving an average estimate of 46,000 t. 20% occurred in the Bantry Bay/Stags area and 80 % in the area between Cork Harbour and the Tuskar Rock.

The survey carried out during January/February did not include the area around the western coast where boats carried out a fishery for spawning fish at this time.

The acoustic survey, therefore, gave an estimate of spawning stock biomass of around 91,000 t. Within the overall estimate, both the autumn spawners and winter spawners appeared to be at about the same level. This was the situation when the stocks were last assessed separately by the Working Group and ACFM in 1986 when the overall stock was considered to be somewhere around 100,000 t.

Because of the difficulties encountered in carrying out acoustic surveys in the area, and because the 1990/1991 survey was only the first comprehensive acoustic survey undertaken for this stock, the Working Group was reluctant to accept the value of 91,000 t obtained as an absolute estimate of spawning stock biomass. It is, however, clear that acoustic surveys should continue in this area if accurate estimates of spawning stock biomass are to be obtained.

4.5 Recruitment

There are no independent indices of recruitment to this stock. An examination of the age distribution during 1990/1991 would suggest that the 1987/1988 year class is stronger than the 1986/1987 year class but no quantitative information is available.

4.6 Estimates of Stock Size

The Working Group considered the acoustic surveys and the larval surveys as a means of tuning the VPA. The acoustic surveys have only been carried out for one year and are not considered reliable enough yet to give an absolute estimate of spawning stock. The larval index for 1988/90 gave an unrealistically high estimate and the surveys were not repeated in 1990/91. The acoustic survey was, therefore, only used to give an approximate or likely stock size. A VPA was, therefore, carried out to provide some estimates of the size of the spawning stock over a historic period and then to decide how the present stock might be in relation to the historical level. The results of a separable VPA assuming terrminal F = 0.5 on age 2 and terminal S = 1 and of the VPA based on the terminal populations from the separable VPA are shown in Tables 4.4.4 -4.4.6.

The results from the VPA indicate that the spawning stock was at a low level during the 1976-1980 period, at which time the fishery in the Celtic Sea, but not Division VIIj, was closed. In this period. SSB averaged about 30,000 t. Since 1980, it has consistently increased and for 1983-1986 it was estimated to have been around 86,000 t. Results from VPA carried out over the 1958-1970 period showed the spawning stock biomass during 1965-1970 averaged about 96,000 t. The Working Group considered that 86,000 t was the last reliable estimate of spawning stock.

The results of the acoustic surveys in 1990/1991 and the larval surveys in 1989/1990 indicate that the present spawning stock is at least as high as that estimated in 1986, and possibly higher because of the recruitment of the very strong 1985/1986 year class which entered the fishery in 1988. The estimate of the high stock level at present is consistent with observations and reports from fishermen who have taken part in the fishery for a number of years.

4.7 Management Advice

The Working Group has been asked by ACFM to consider a request to review the 1991 advice for the TAC for this area. The response to this request is contained in this section together with the advice for 1992.

As there has been no analytical assessment carried out on the stock, the Working Group has been unable to make a precise catch and stock prediction. It was decided to assume that the present stock level was around 86,000 t. An appropriate fishing level for this stock is considered to be around F = 0.30. This fishing mortality would generate annual catches of around 21,000 t.

The Working Group considers that, if the estimate of present stock level is correct, catches of around 21,000 t could be maintained. This catch level is, therefore, recommended for 1991 and for 1992. The Working Group also recommends that the level of discards in the fishery should be reduced to a minimum and that adequate acoustic surveys be continued in order to provide reliable estimates of stock size.

4.8 Management Considerations about Closures of Spawning Areas

The system of rotating closures of selected spawning areas was first introduced during the 1988/1989 season and was continued during 1989/1990 and 1990/1991. In an effort to evaluate the effectiveness of these spawning bed closures, ACFM suggested in May 1989 that larval surveys and controlled trial fishing should be carried out during the closed seasons and that an analysis of past maturity and catch data should be undertaken. The 1990 Working Group was unable to make a complete evaluation of the effectiveness of these closures and it was suggested that the subject be reviewed at the 1991 meeting, before the system is reintroduced in 1991. The EC has agreed that Box A (see Figure 4.8.1) should again be closed for fishing from 15-31 October 1991.

Evaluation of Box C. The important spawning grounds (Box C) were closed from 15-31 January 1991. During that time experimental fishing using two chartered commercial vessels was carried out. The vessels, using a paired mid-water trawl, were limited to what they could land and were only allowed one night's fishing in each week. On both occasions, considerable shoals of herring were observed and samples obtained. These fish were in a spawning condition (Stage VI). Following the experimental fishing, the acoustic survey was carried out using the R/V "Lough Foyle" which again located herring in the area. A larval survey was subsequently carried out in this area and also in the adjacent area of Cork Harbour from the 11-16 February. The object of this survey, during which 50 plankton samples were taken, was to determine whether larvae had hatched from the herring observed spawning during the closed period. Considerable numbers of larvae were located at those stations adjacent to where the trial fishing had taken place. The numbers/m^2 are shown in Figure 4.8.1. The highest number (552/m^2) is higher than any observed during the series of surveys carried out in this area during 1978-1985. It was, therefore, concluded that the closure of Box C had been implemented in the correct place and at the correct time.

During the closed period in Box C, fishing was permitted in the adjacent area. Samples indicated that these herring spawned at a later date than those in Box C. The larval survey carried out in this area located only small quantities of herring.

Evaluation of Box A. The area which is scheduled for closure in October 1991, Box A, was also surveyed for larvae by the R/V "Lough Foyle" during October and November 1990. The highest numbers of small larvae (<10 mm) were located from 21-25 November in areas were intense fishing had earlier taken place. Although only two surveys were carried out in this area, it would appear that the main spawning would have taken place during the early part of November. Fishing for spawning herring in this area during 1990 continued right up to the end of November. It would appear, therefore, that in order to prohibit fishing during peak spawning, the closure in Box A would need to be moved to the first fortnight of November.

Evaluation of Box B. The closure in Box B is timed for the 1-16 November. During recent years there has been very little fishing activity in this area during November and December because of the shift in the main fishery towards the southwest. However, shoals were observed in this area by the R/V "Lough Foyle" during late October 1990 and the maturity data from samples obtained from commerical vessels fishing in the area suggested that they would spawn early in November. It would appear, therefore, that the closure in this area would also be at the appropriate time. It must also be emphasized that considerable fishing on spawning herring has also taken place in this area in recent years during January and February.

In general, therefore, it would appear that the closures for Boxes B and C are appropriate both in time and position. It is proposed to carry out a larval survey in Box A during October/November 1991 to try to determine the period of

peak spawning in this area.

Effectiveness of closures. It has not been possible to evaluate the effectiveness of these closures in terms of determining increases in spawning stock biomass directly as a result of their introduction.

5 WEST OF SCOTLAND HERRING

5.1 Division VIa (North)

5.1.1 ACFM advice applicable to 1990 and 1991

The ACFM recommended TAC for 1990 was 61,000 t, corresponding to a fishing mortality at $F_{0.1}$. The agreed TAC was 75,000 t. On the assumption that the agreed TAC would be taken in 1990, ACFM recommended a TAC of 57,000 t in 1991, once again corresponding to a fishing mortality at $F_{0.1}$. Given average recruitment, maintaining F at this level should stabilise spawning stock biomass and hence stabilise catches. The agreed TAC for 1991 is 62,000 t.

5.1.2 The fishery

The catches reported for each country are given in Table 5.1.1. The total catch in 1990 was 69,959 t compared with the TAC of 75,000 t. This is the third year in succession where the TAC was not reached, with 53,039 t taken in 1989 compared with the TAC of 58,000 t and 47,354 t taken in 1988 compared with the TAC of 49,800 t.

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.

5.1.3 Catch in numbers at age

Age composition data for 1990 were available from Scotland and the Netherlands. Unallocated catches, discards and catches by Ireland, France, Germany, Norway, England and the Faroe Islands in the last two quarters were converted to numbers at age using the Dutch catch at age data, since the Scottish figures include catches from the Minch fishery which is not prosecuted by the other fleets. Scottish catch at age data were used only for the first two quarters, when there were no Dutch landings. The sampling effort used to derive the catch in numbers is summarized in Table 5.1.2.

The estimated catch in numbers at age for the years 1970 - 1990 are given in Table 5.1.3.

5.1.4 Larvae surveys

Owing to the reduction in effort invested in the larvae surveys, sample coverage was much poorer than in recent years. Given this reduction in effort, the survey in this area was designed to give priority to the calculation of the Larvae Abundance Index (LAI) rather than the Larval Production Estimate (LPE). This affects the reliability of the results (see Section 2.5). Coverage in 1990 is considered sufficient to calculate a satisfactory LAI, with a value of 6525, but no LPE value is available (Table 5.1.4). The 1990 LAI is about 50% higher than the 1989 value, but only about 10% higher than the 1988 value.

5.1.5 Acoustic survey

Acoustic surveys have been carried out in Division VIa(N) during November in 1983 and in 1985 - 1987, and during December 1988 and during January 1990. The 1983 survey did not cover the whole area and so cannot be used as an estimate of SSB. The other survey estimates of SSB are given in the following table:

Year	Estimated SSB (t)
1985	225,000
1986	297,000
1987	364,000
1988	326,000
1990	No estimate

Of these, only the 1987 survey was considered to give a good estimate of SSB. The other surveys were all curtailed by bad weather to greater or lesser degrees, and it was impossible to calculate any estimate from the 1990 survey. The winter surveys have now been abandoned, so no acoustic estimate is available for the assessment in 1991. It is intended to carry out future acoustic surveys in this area concurrently with the North Sea summer acoustic surveys. This will allow a coordinated survey of a continuous area from the west of Scotland to the central North Sea.

5.1.6 Recruitment

It is hoped that carrying out summer acoustic surveys in the area will in future provide good estimates of recruitment. In the meantime, the only information available on recruitment is an index based on the bottom trawl survey carried out by Scotland in March each year. This index is calculated as the mean catch rate of 2-ringers in statistical rectangles 46E4-E6, 47E4-E6, 44E3-E4 and 45E3-E4.

The series of indices and the number of hauls used in their calculation are shown in Table 5.1.5. Figure 5.1.1 shows the relationship between the natural logarithm of the indices and the corresponding VPA estimates of 2-ringer abundance for the years 1981 - 1989. Clearly the relationship cannot be used to provide quantitative estimates of recruitment, though the index may be of use as qualitative evidence of an unusually strong year class. The 1991 index does not suggest that the 1988 year class is exceptional, and on this basis the likely level of recruitment in 1991 - 1993 was assumed to be the geometric mean of the abundance of 2 ringers over the years 1980 - 1988, calculated from the final VPA from this year's assessment.

5.1.7 Mean weight at age

Weight at age data from the 1990 fishery were available from Scotland and the Netherlands and are shown in Table 5.1.6. The SOP for 1990 is 1% more than the reported catch. The mean weights at age in the stock, also shown in the table, are those used in previous years.

5.1.8 Description of the assesment method

Acoustic estimates have been unavailable for this stock for the last 3 years, so the assessment has been based on the larvae surveys. This year, the LPE could not be calculated because of the reduction in the sample coverage during the

larvae survey, so the LAI is the only index available. This is itself based on a reduced temporal coverage of the survey area, undermining its reliability.

The series of LPEs and LAIs from 1973 to 1986 were regressed with estimates of SSB from last year's assessment using the RCRTINX2 program. The LPEs from 1987 to 1989 and the LAIs from 1987 to 1990 were included in RCRTINX2 to give weighted average predictions of SSB from 1987 - 1990. No time weighting was used, and the final estimates were shrunk towards the mean. The input F chosen for 1990 was that which minimised the weighted sum of squared residuals between the predicted SSBs and those from the VPA for these four years. The weights used were the inverses of the squared standard errors of the predicted SSBs.

Individual plots of LAI and LPE against SSB from the VPA are shown in Figures 5.1.2 and 5.1.3. The fitted lines are based on the regressions calculated by RCRTINX2. The outlying LPE point for 1986 is probably because the long-term mean Z/K value was not appropriate for that year, the rate of transport of larvae from Division VIa to the North Sea being very variable. The point does not seem to unduly influence the regression over the range of LPE values more usually observed; this is an advantage of using the log-transformation to establish the relationship.

5.1.9 Results of the assessment

Separable VPAs were run to examine the catch data, with all years prior to 1983 down-weighted to 0.001. With a reference age of 3, SVPAs were run with terminal S values of 0.8, 1.0 and 1.2. As in previous years it was found that in each case the anomalies in the catch at age data for 7 and 8 ringers in 1985/1986 produced a dip in the expoitation pattern at age 7. Down-weighting the years 1985 and 1986 produced a more reasonable exploitation pattern than down-weighting the ages. Table 5.1.7 shows the results of the separable VPA using weights of 0.001 for all years prior to 1983 and for 1985 and 1986, a reference age of 3 and a terminal S of 1.

The separable VPA was run using a range of fishing mortalities and the fishing mortalities based on the terminal populations were used to run a series of VPAs. The weighted sum of squared residuals between the SSBs estimated by the VPA and those predicted by RCRTINX2 was minimised at F = 0.24 (Figure 5.1.4). However, the minimum is not particularly well defined, so the stock size estimates for the most recent years cannot be considered very reliable. Figure 5.1.5 shows the trend in SSB from 1970 - 1990 estimated by the VPA. Also shown are the trends produced by VPAs with input Fs of 0.18 and 0.30, illustrating that there is fairly rapid convergence, with the stock estimates largely independent of input F by about 1986.

The results of the RCRTINX2 analysis are given in Table 5.1.8. As would be expected from an examination of Figures 5.1.2 and 5.1.3, the LAI is given much more weight in all predicted years. The predicted SSB in 1990 is based only on the LAI, and consequently is associated with a relatively high standard error. The SSB estimates for the years 1987-1990 are summarised in the text table below:

Year	VPA estimate (1990 assessment)	Weighted average prediction	SE	VPA estimate (F=.24)
1987	252	279	.34	219
1988	444	364	.51	354
1989	449	327	.45	350
1990	-	318	.73	361

Figures 5.1.6 and 5.1.7 show the relation between the LAI and LPE indices and spawning stock biomass as estimated by this year's assessment.

Detailed results of the assessment are given in Tables 5.1.9 and 5.1.10 and in Figures 5.1.8A and B. Mean fishing mortality over ages 3 - 6 is estimated at 0.246. Spawning stock biomass in 1990 is estimated at 361,000 t, compared to the 515,000 t predicted by last year's assessment. Moreover, the estimate for 1987 is now 219,000 t compared with the previous estimate of 252,000 t, itself a downward revision from the preceding assessment. The present assessment is inconsistent with the 1987 acoustic survey estimate of 364,000 t, even though this is thought to be the best survey estimate of the series.

These inconsistencies need to be resolved. One possibility is that part of the stock estimated during the acoustic surveys is unavailable at the time of the fisheries in Division VIa (N) because of migrations between Division VIa (N) and the North Sea. This might also mean that some of the catches of the Division VIa stock are allocated to the North Sea. It may also be the case that the larvae surveys are unreliable at current stock sizes, or that the reduction in the effort invested in the surveys in recent years has detracted from their performance. It is hoped that acoustic surveys undertaken concurrently in the North Sea and in Division VIa (N) will help clarify this.

5.1.10 Projection

As in previous years, the catches of one ringers are not thought to be reliable indicators of year class strength in this area. One ringers are, therefore, excluded from the projection. Recruitment of 2 ringers in 1991, 1992 and 1993 was assumed to be the geometric mean of 2 ringer abundance from 1980 - 1988. Using the present assessment this is estimated to be 623 million.

The parameters used in the projection are given in Table 5.1.11. From the yield per recruit calculations, $F_{0.1}$ was estimated at 0.171. From the plot of stock and recruitment (Figure 5.1.9), F_{med} was estimated at 0.40.

Selected management options are given in the text tables below and in Figure 5.1.8D. F values refer to the mean F over ages 3 - 6.

1) Assuming status quo in the current year:

1991				1992					1993	
Stock biom. (2+)	SSB	F	Catch (2+)	Management option	Stock biom. (2+)	SSB	F	Catch	Stock biom. (2+)	SSB
457	350	0.25	73	$F_{0.1}$	450	356	0.17	48	455	368
				$F_{92}=F_{90}$		340	0.25	68	432	332
				F_{med}		310	0.40	103	390	272

2) Assuming the catch would correspond to the agreed TAC of 62,000 t:

1991				1992					1993	
Stock biom. (2+)	SSB	F	Catch (2+)	Management option	Stock biom. (2+)	SSB	F	Catch	Stock biom. (2+)	SSB
457	359	0.21	62	$F_{0.1}$	453	367	0.17	50	465	376
				$Catch_{92}=TAC_{91}$		357	0.22	62	451	355
				$F_{92}=F_{90}$		350	0.25	70	441	340
				F_{med}		319	0.40	107	397	278

The status quo F does not differ greatly from that generated from a catch of 62,000 t, but given that the TAC has not been reached in recent years, the second of the above tables is considered the more relevent. A detailed output assuming the TAC will be taken in 1991 and F(92) = F(90) is shown in Table 5.1.12.

The results suggest that SSB in 1992 will be about the same as in 1991 given average recruitment. This SSB will be maintained in 1992 and 1993 if catches are kept at their current level of around 62,000 t, corresponding to a fishing mortality of about 0.22.

5.1.11 Management considerations

Recent levels of fishing mortality have been moderate, and the assessment still indicates an overall trend of increasing stock size. Although the TACs have not been reached in recent years, this is not thought to be because of a scarcity of fish. Maintaining fishing mortalities around their current levels should ensure stable catches in 1992 and 1993.

5.1.12 Research and data requirements

While there is, therefore, no immediate cause for concern, the substantial revisions to the estimates of stock size in successive assessments emphasise the need for confirmation of stock size by fishery independent methods. As well as the continuation of the larvae surveys, co-ordinated acoustic surveys in Division VIa (N) and the North Sea are highly desirable. These would also provide better recruitment estimates. The catch at age data for this stock are generally satisfactory, though estimates of discards are available for only one fleet.

5.2 Clyde Herring

5.2.1 Advice and management applicable to 1990 and 1991

ACFM recommended a TAC of 2,600 t for 1990 and a closure of herring fishing from 1 January-15 April to protect the indigenous spring-spawning stock. These recommendations were accepted by the management body subject to a small allowance within the TAC for unavoidable by-catches in fisheries for roundfish and Nephrops during the closure period. In 1990, the main fishery was opened in June under boat quota control, and continued until the end of the year.

For 1991, ACFM recommended a TAC of 2,900 t and a continuation of the closed period. These have been adopted by the management body. Of the TAC, 200 t may be taken in the closed period and this is being used by the national authority as a by-catch allowance in other fisheries.

As an additional national measure, the spawning grounds at Ballantrae Bank are closed to all forms of active fishing (including scallop dredging) from 1 February-30 April to prevent disturbance to pre-spawning and spawning shoals and to protect the spawn beds themselves.

5.2.2 The fishery in 1990

Annual landings and catches are given in Table 5.2.1. The reported landings in 1990 were 2,184 t against a TAC of 2,600 t. Allowing for overweight boxes, the total landings in 1990 are estimated to be 2,259 t. There were no reports of discarding in 1990. Of the total catch, an estimated 2,046 t was taken by the pair trawl fleet almost entirely during the period June-December. Small by-catches were landed throughout the year by bottom trawlers fishing for roundfish and Nephrops.

Catches in numbers at age were estimated from monthly samples and it is assumed that there was no discarding (Table 5.2.2). The catch in number series from 1970 to 1990 is given in Table 5.2.3. Estimated numbers at length in the landings are given in Table 5.2.4.

The number of days absence from port by pair trawlers in 1990 is given in Table 5.2.5. To provide an index of total effort, these were raised by the ratio of total to pair trawl landings. Effort in 1990 was at a lower level than in 1989.

5.2.3 Weight at age and stock composition

Weights at age in the catch and stock are given in Table 5.2.6. There were no marked differences compared with previous years except that those of 2- and 3-ringers were higher than in 1989.

Monthly maturity data indicate that spring spawners predominated in the landings, as in 1989 (Table 5.2.7). Over the year as a whole it is estimated that around 60-75% of the 3-ringers and older were spring-spawners. The uncertainty arises because of the difficulty of allocating fish at maturity stage VIII in March and April, and maturity stages III and IV in July-September. However, vertebral counts made on the acoustic survey in July indicate that fish at stages III-IV were probably mostly autumn-spawners (mean vs 56.49), whereas recovering spents (stage VIII) were spring spawners (mean vs 57.03).

5.2.4 Acoustic survey

The sixth in a series of acoustic surveys was carried out in July 1990 and the results are given for each of the surveys in Table 5.2.8 (from Walsh and Armstrong, working document). The surveys in 1985 and 1986, however, were carried out in June and may not be comparable with the more recent ones carried out in July. The estimated biomass in 1990 (11,900 t) was 6,500 t less than in 1989, owing mainly to the much lower estimate of the predominant 1986 year class (80.3 million in 1989 cf. 33.3 million in 1990).The abundance of 1-ringers was higher than in 1989, but not nearly as high as in 1987. From the vertebral counts and maturity composition of herring sampled during the survey, spring-spawners predominated among adults (ie., fish at stages III-VIII). The immature fish, however, had low vertebral counts and were almost certainly autumn-spawners. This indicates that the year classes of spring-spawners have all been weak since that of 1986. This is supported by the age compositions of fish sampled on the spawning grounds in March-April 1990 (see Section 5.2.5) and of fish sampled in the Clyde in January and February 1991. In each of these cases, the 1986 year class constituted over 90% of the fish sampled.

5.2.5 Egg surveys

Grab surveys to obtain egg abundance estimates were carried out from 26 March-6 April and from 16-26 April 1990. From the development stages of eggs sampled, spawning probably occurred around 14 April on Ballantrae Bank and on 5 April on another spawning ground close to the south coast of Arran. The latter site is close to an area where spawn deposition had been recorded in 1937.

Samples of spawning herring from both areas were dominated by the 1986 year class (97.6%). The spawning patch at Ballantrae covered an area of 291.3 x 10^3 m^2 compared with 436.0 x 10^3 m^2 in 1989. That at South Arran covered an area of 162.9 x 10^3 m^2. From the mean depth of the egg layer, a mean fecundity based on herring sampled in September-December 1989, and the mean weight of spawning fish, the following stock estimates were obtained.

		Ballantrae Bank	Arran	Total
Total no. (millions)		28.7	11.2	39.9
Spawning stock biomass (t)		4,843	1,887	6,730
No. per year class (10^3)	1984	(6 ringers)		120
	1985	(5 ringers)		482
	1986	(4 ringers)		38,860
	1987	(3 ringers)		362

The possibility of earlier spawning cannot be entirely ruled out. However, larval surveys carried out over the period 14 February-23 May 1983-1987 provided no evidence of any larval production (i.e., hatching) prior to mid-April.

The estimate of the number of spawners in 1990 (39.9 million) compares with 39.4 million at Ballantrae alone in 1989. No survey was carried out at Arran in 1989, however. The 1990 estimate for both areas combined compares with an acoustic estimate in July of 47 million 3-ringers and older of which about 59% (28 million) were estimated to be spring spawners.

5.2.6 Stock assessment

The catches of herring in the Firth of Clyde contain two components, local spring spawners which spawn in the Clyde, and immigrant autumn spawners which spawn elsewhere (Bailey et al., 1986). The spring spawners spawn in March-April and are exploited in the Clyde throughout the year. It is not known if there is a partial emigration and return between spawning seasons. The autumn spawners caught in the Clyde have been shown by tagging to belong to a mixture of the surrounding stocks including those in the Irish Sea, northwest of Ireland, and Division VIa (North) (Bailey et al., 1986; J.A. Morrison, pers. comm.). Earlier tagging experiments showed, however, that autumn-spawned herring tagged in the Clyde were recaptured there in subsequent seasons and that relatively few were caught in other fisheries. On the basis of this partial fidelity to the Clyde, the Working Group has assessed the Clyde population as a separate unit since 1978. It has also been treated as a unit for management purposes. Since the size of the local stock of spring spawners is small in relation to herring stocks in adjacent areas, it is appropriate to continue the management of the Clyde fishery as a separate unit.

Strictly, it would be more appropriate to assess the spring- and autumn-spawning components separately. This is not possible, however, because of the uncertainties in allocating monthly catches in number to the two components (Section 5.2.3). At previous Working Group meetings, a combined VPA has been carried out on the total catches. At the present meeting, this procedure was discontinued for the following reasons:

a) the acoustic survey results in 1989 and 1990 gave very different estimates of the biomass and especially the size of the 1986 year class, and it was impossible to reconcile this with VPA (Figure 5.2.1);

b) a VPA run using the Laurec-Shepherd tuning package indicated a strong increasing trend in catchability in most age groups over the period 1983-1988 and this could be due to a change in the immigration of autumn spawners. This indicates that one of the fundamental tenets of VPA, that the catches are taken from a unit stock, may no longer be valid.

In spite of this problem, it is clear that there is a considerable amount of information about the population of herring in the Clyde. The Working Group, therefore, decided to use the survey results and catch data in a more direct way to provide management options. This was done using the acoustic survey and egg survey estimates projected to 1 January 1991 as a starting point for a prediction.

It is not clear whether the large change in stock size estimates between July 1989 and July 1990 is due to sampling error in one or both of the two years, to a real change in stock size (either spring or autumn spawners or both), or to a change in immigration and emigration. The 1990 acoustic survey estimate of 41.3 million 3-ringers and older, however, (which includes both spring and autumn spawners) compares with an egg survey estimate of 39.9 million spawners in April 1990. The acoustic survey estimate includes an estimated 41% (16.9 million) autumn spawners and 59% (24.4 million) spring spawners. This latter figure compares with the egg survey estimate of 39.9 million spawners in April 1990. After correction for catches and natural mortality between April and July, the mean of these two estimates was used as an estimate of the number of spring spawners and this was raised to account for the estimated percentage of autumn spawners in the population in July. The numbers at age were calculated from the proportion of each age group on the acoustic survey. To give estimates of numbers at age at 1 January 1991, the figures were corrected for catches and natural mortality in the last half of 1990. The resulting stock in numbers is given in Table 5.2.9.

The fishing mortality and exploitation pattern in 1990 were estimated by applying the catches in number at age to the stock estimates at 1 January 1991 (Table 5.2.9).

The results of the assessment described above indicate that mean F_{2-6} in 1990 was 0.16 with a concentration of fishing on the strong 1986 year class F = 0.21). They also indicate that the spawning stock in 1990 was considerably lower than predicted in last year's assessment. This change is mainly due to the much lower acoustic survey estimate in 1990 than in 1989.

The above assessment is rather uncertain, but the acoustic survey estimate in 1990 is in reasonable agreement with the egg survey estimate. The stock in numbers at age and fishing pattern given in Table 5.2.9 were, therefore, accepted as the basis for a prediction.

5.2.7 Projection

The input parameters for the projection are given in Table 5.2.10. Recruitment of 1-ringers in 1991, 1992 and 1993 was assumed to be at the geometric mean of the acoustic survey estimates over the period 1987-1990 (14.91 million). Mean weights at age in the catch and stock were taken as the mean over the years 1988-1990. The reference F is the unweighted mean on 2-6 ringers. The predictions are based on the assumption that no discarding will take place in 1991, 1992 or 1993.

The TAC for 1991 is 2,900 t. However, the TAC has not been taken in any of the most recent years and taking the TAC in 1991 would imply an increase in F from 0.16 to 0.28. In view of the uncertainty about the catch likely to be taken in 1991, predictions were also run on the alternative assumption that the TAC will not be taken and that F will remain at its 1990 level in 1991. The results of the predictions are given in the text tables below in thousand tonnes.

a) Catch in 1991 = TAC of 2,900 t.

1991				1992					1993	
Stock biomass (1+)	SSB	F	Catch (1+)	Mgmt Opt	Stock biomass (1+)	SSB	F	Catch (1+)	Stock biomass (1+)	SSB
14.4	10.3	0.28	2.9	$F_{92}=F_{90}$	11.5	8.8	0.16	1.4	10.2	7.6
				$F_{92}=0.8F_{91}$	11.5	8.8	0.22	1.9	9.7	7.1
				$F_{92}=F_{91}$	11.5	8.8	0.28	2.3	9.3	6.7
b) $F_{1991} = F_{1990}$										
14.4	10.3	0.16	1.8	$F_{92}=F_{90}$	12.6	9.9	0.16	1.6	11.1	8.4
				$F_{92}=0.24$	12.6	9.9	0.24	2.3	10.4	7.8
				$F_{92}=0.30$	12.6	9.9	0.30	2.7	10.0	7.3

5.2.8 Management considerations

This year's assessment indicates that the stock assessment and predictions given in last year's report were over-optimistic. To take the TAC of 2,900 t in 1991 would require a large increase in fishing mortality rate and by 1992 the spawning stock biomass would be only half that predicted last year.

The increase in spawning stock of the local spring spawners resulting from the recruitment of the strong 1986 year class is not expected to continue. More recent year classes all appear to be below average or poor. The future development of this stock depends on recruitment. While there is no evidence at present that recruitment depends on the size of the spawning stock, it would be prudent to provide the spawning stock with as much protection as possible. This can be achieved by keeping the fishing mortality rate at a relatively low level and by giving the spring-spawning stock additional protection.

The effectiveness of the closure of the herring fishery from 1 January-15 April in protecting the spring-spawners depends on the racial composition of the landings at different times of year. Research is currently in progress to improve the identification of spring and autumn-spawners, and it is hoped that this will improve the basis for the assessment and management of Clyde herring. In the meantime, maturity stage analysis indicates that the proportion of autumn-spawners in the landings may increase in the summer and decrease in the autumn and winter (Table 5.2.7). It, therefore, seems likely that the existing closure provides some protection to the spring-spawners over and above that provided by the TAC regulation. Furthermore, in view of the fact that spawning in 1990 was estimated to have occurred up to 15 April, it would be appropriate to extend the period of closure to 30 April.

5.2.9 Future research requirements

In view of the need to assess the spring- and autumn-spawning components separately, the Working Group stresses the need to provide a method of stock separation. It, therefore, recommends that the analysis of monthly maturation stages and gonadosomatic index values should be completed as soon as possible.

The assessment of the Clyde population is dependent on the provision of survey estimates of stock size. It is, therefore, recommended that the egg survey and acoustic survey should be continued.

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

6.1 The Fishery

6.1.1 Advice and management applicable to 1990

The TAC set for this area for 1990 was 27,500 t. The catch level recommended by ACFM was between 25,000 and 27,000 t. The total catch estimated to have been taken during the year was nearly 44,000 t, which was nearly 15,000 t or over 50% higher than in 1989. This total catch from the area was, as it has been every year since 1982, nearly twice the recommended level.

The main catches attributable to any nation were again taken by Ireland. The catches taken by this fleet were regulated by weekly boat quotas and the Irish fishery was closed on 1 December. Nearly 14,000 t were placed in the "unallocated" category and over 10,000 t were believed to have been taken in Division VIa (South) but were reported as having been taken in Division VIa (North).

6.1.2 Catch data

The catches taken by each country fishing in this area from 1981-1989 are shown in Table 6.1.1, together with the preliminary estimates for 1990. Estimates of herring caught but discarded have been included for 1990 for the Dutch fleet. There are no estimates available for discards for the Irish fleet but the quan-

tities are believed to be small (see Section 8). It has not been found necessary to make any revisions to the 1989 catch data.

In general the location and distribution of the main fishery was similar to that of recent years. However, considerable catches were taken during October and November by Irish vessels which developed a new roe fishery for spawning herring along the Irish coast in Donegal Bay. It was noticeable that spawning was much later than usual in this area. The distribution of the Irish and Netherlands catches per quarter are shown in Figure 4.2.1.

6.1.3 Catches in numbers at age

The catches in numbers at age for this fishery since 1979 are shown in Table 6.1.2. No revisions have been made to the 1990 data. The catches in numbers at age have been based mainly on samples from the Irish fishery throughout the year together with a small number of samples from the Dutch fishery during the third and fourth quarters. The age compositions of both the Irish and Dutch catches were heavily dominated by 4 w.ring fish (i.e., the 1985 year class) which constituted over 56% of the catches. This age class was well represented in all areas and it was also a feature of the catches taken in the adjoining areas Divisions VIa (North) and VIIj. In comparison to the 1985 year class, the 1986 year class appears to be rather weak (7%). The 1987 year class increased in abundance as the year progressed and represented 17% of the catches taken during December. The 1981 year class, which had dominated the catches for a considerable period, now constitutes only 3% as 8 w.ring fish.

6.1.4 Quality of catch and biological data

Although there are still considerable quantities of unallocated and misreported landings from this area, there appears to be reasonable confidence in the overall estimate of the total catch and landing figure. The level of biological sampling from the area appears to be satisfactory. The number of samples and biological data are shown in Table 6.1.3 and the length distribution of catches of the Irish fleet per quarter are shown in Table 6.1.4.

6.2 Mean Weights at Age

The mean weights at age in the catches are based on a combination of Irish and Dutch data and are shown below compared with those for 1989. Both sets of data are very similar and the 1990 values have been used to update the VPA data set.

Year	1	2	3	4	5	6	7	8
1989	80	130	141	164	174	183	192	193
1990	94	138	148	160	176	189	194	208

The mean weights of the stock at spawning time are based on Irish samples taken from the spawning fishery during September to November. The mean weights at spawning time calculated for 1989 had shown a decrease of about 20% on the values for the previous year. No satisfactory explanation is apparent for such a significant decrease. The values estimated for 1990 are nearly indentical to those of 1989 and are shown below. Again there appears to be no obvious explanation for this sudden drop in mean weight.

Year	2	3	4	5	6	7	8	>8
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

The 1990 values have been used to update the VPA.

6.3 Larval Surveys

No larval surveys have been carried out in this area since 1989.

6.4 Stock Assessment

6.4.1 Assessment

Recent working groups have had extreme difficulties in carrying out an assessment for the stock in this area. The larval surveys have been discontinued and no other surveys of any kind have taken place. In 1989 and 1990, the Working Group either used catch curves to select an F value for VPA or assumed an F value based on a period from the VPA time series when the catches were at about the same level as in recent years. This assumed that the same catch level would generate the same level of fishing mortality. ACFM accepted the assessment but emphasized that it was very uncertain and stressed that the prognosis was very unreliable. ACFM also pointed out that without survey information it would be unlikely to improve the reliability of its advice. The advice subsequently given was for a catch level of below 26,000 t which took into account the low mean weights of the stock, the anticipated low recruitment of the 1986 year class and the uncertainties of the assessment.

In the absence of any survey data in recent years it was decided that, a VPA could not be carried out which could be used as the basis for an analytical assessment or for prediction purposes. However, it was decided that some useful information could be carried out by looking at the historical data from that period of a VPA when values had converged. VPAs were, therefore, carried out using an input F value in 1990 of 0.50. This high value of F was selected in order to reflect the increase in catches which took place in 1990 and which, it was felt occurred because of the development of the roe fishery. However, it must be emphasized that the results of the VPA for recent years cannot be used for any analytical purposes. A separable VPA was carried out on ages 2-8, using the updated mean weights at age and a terminal F of 0.50 on age 4 and a terminal S of 1.0. The results of this separable VPA are shown in Table 6.4.1. The exploitation pattern is flat topped from ages 4-8 and very similar to exploitation patterns observed in recent years. The results of a conventional VPA using this exploitation pattern are shown in Tables 6.4.2 and 6.4.3.

6.5 Results from VPA

The results of the VPA suggest that, in the period 1980-1986, when convergence was reasonable, the spawning stock biomass averaged about 133,000 t. The average catch in this period was about 27,000 t which generated F levels of about .27. The spawning stock appears to have increased considerably since 1986 mainly because of the recruitment of the very strong 1985 year class which boosted the stock in 1988. However, it must be stressed that the VPA cannot be used to give any indication of either the actual size of the spawning stock in recent years or of recent values of fishing mortality. The effects of different assumptions

of terminal F on F and SSB are shown in Figures 6.1 and 6.2.

6.6 Stock and Catch Prediction

The last accurate estimate of the spawning stock biomass is that obtained from the VPA for 1985-1986. At this time it has been estimated to be at about 163,000 t. The Working Group has not been able to evaluate how the stock has developed since then. However, a number of factors should be considered - mainly the high catches taken in 1987 and 1989; the development of the roe fishery in 1989; and the influx of the strong 1985 year class which entered the stock in 1988. Bearing these in mind, and in the absence of any other information, the Working Group assumed the present stock to be at about the average level of that during the 1980-1986 period. It is thus estimated to be around 133,000 t.

Because of the uncertainty about the stock and the absence of an analytical assessment the Working group has been unable to carry out a precise catch prediction. However, three options were considered as catch options for 1992.

1) Fishing at F = 0.30. This level of F, which is the level recommended by ACFM in 1990 for this stock, would generate catches of around 34,500 t in 1992; this is a reduction of 22% on the 1990 catch.

2) Fishing at F = 0.27. This level of F corresponds to the average F during the 1980-1986 period. The corresponding catch level would be about 32,000 t in 1992, i.e., a reduction of about 27% on the 1990 catch.

3) Fishing at F = 0.20. This level of F was considered to represent a more cautious approach to the fishery, because of the lack of information on stock size and the recent high catch in 1990 caused by the development of the roe fishery. The corresponding catch level would be about 24,000 t, i.e., a reduction of 45% on the 1990 catch.

A continuation of catches in 1992 at the same level as those of 1990 would generate an F = 0.40.

It must be emphasized that all the above catch figures have been calculated on the assumption of an SSB of 133,000 t. There is little information to support this assumption, apart from observations and reports from fishermen about the increased abundance of herring in the area.

The Working Group was unable to agree as to which option was the most appropriate to adopt for the fishery. It was agreed that a continuation of the fishery at a level whereby F was greater than 0.30 was not advisable and that the present catches should, therefore, be reduced. It was not, however, agreed as to what level they should be reduced to. On the one hand, it was argued that a reduction to the level of F = 0.27 would be sufficient in view of the possibility that the stock in this area, as suggested by ACFM in 1989, had been consistently underestimated. On the other hand, a more cautious approach was advocated in view of the recent development of the fishery and the lack of information on stock size. An F of 0.20 would, therefore, be appropriate in this case.

6.7 Management Considerations

6.7.1 General considerations

As has been pointed out in the previous section, the Working Group has had considerable difficulties in carrying out an assessment in this area and in making precise catch predictions. It is not known whether the present catch levels are producing an adverse effect on the stock or whether the present TACs are appropriate or indeed underestimated. It is clear, however, that the present uncertainty about stock sizes and realistic TACs will continue until such time as adequate research and surveys are carried out in this area. The Working Group would, therefore, stress that the TACs recommended for this stock in the past may have been inappropriate. The responsibility for improving this situation lies with the management authorities.

6.7.2 Roe fishery

The Working Group has pointed out the possibility of the development of a roe fishery in this area. As can be seen from other areas, roe fisheries for herring present specific problems which must be considered by management. The main problem arises because a roe fishery can generate rapid increases in fishing mortality because very high catches can be taken in a very short period of time and also because discarding of unsuitable herring at sea may take place. It is, therefore, essential that a roe fishery should be effectively managed and tightly controlled from the start if the recommended catches are not to be exceeded. Consideration should also be given to introducing measures which would ensure that a proportion of the spawning population should be allowed to spawn each year without being subjected to fishing. This could be achieved by the introduction of "closed areas" similar to those recently introduced in the Celtic Sea fishery. In order to do this, however, sufficient information must be available about the location of the spawning beds and the timing of the main spawning season.

6.7.3 Misreporting

The Working Group is also concerned about the possibility of large scale misreporting of catches for this area, particularly of catches from the boundaries between Divisions VIIb and VIIj and also between Division VIa (South) and Division VIa (North). Accurate information about these catches are required if reasonable assessments are to be made.

7 IRISH SEA HERRING (DIVISION VIIa)

7.1 The Fishery

7.1.1 Advice and management applicable to 1990

The 1989 assessment of the stock indicated that the SSB would show a slight decline if catches were held at 7,000 t. ACFM recommended a TAC of 5,700 t and the EC subsequently adopted a TAC of 7,000 t. This was partitioned as a 5,180 t quota to the UK and a 1,820 t quota to the Republic of Ireland. In the UK, sectoral qutas were allocated as follows: Anglo-North Irish Fish Producers Organisation (ANIFPO) 736 t; Northern Ireland Fish Producers Organisation (NIFPO) 2,440 t; Scottish Fishermen's Organisation (SFO) 455 t; Fish Producers' Organisation (FPO) 736 t. In addition, 294 t were allocated to the non-sectoral industry (Manx and Scottish) and 518 t to the Mourne fishery. In October and November reallocations were undertaken to give the following: ANIFPO 865 t; NIFPO 2,869 t; SFO 38 t; FPO 865 t; non-sector 124 t; and Mourne remained at 518 t.

The UK fishery opened in the second week of June. The closed areas around the Manx spawning grounds and along the Mourne shore were in operation from the 21 September to the end of the year. Fishing from the Republic of Ireland was regulated on a weekly vessel quota basis within the period of the second week in August to the end of September.

7.1.2 The fishery in 1990

The catches reported by each country fishing in Division VIIa (N) from 1979-1990 are given in Table 7.1.1. The total catch in 1990 of 6,312 t was within the TAC of 7,000 t agreed by the EC. The UK fishery continued in to December. There was a switch in timing of the main landings this year with 1,574 t occurring in the fourth quarter of the year. Much of these landings were to a lugger based in the Irish Sea. The UK under-shot its quota by 567 t, and the Republic of Ireland by 121 t. This was once again due to a lack of market demand rather than due to a lack of fish. In addition, several of the larger vessels were absent from the area for extended periods during the 1990 season. This resulted in a reduction of effort in 1990 when compared with 1989. The extent of discarding, especially early in the season (June) when the catches are primarily for the kipper industry, is still an unknown quantity.

The catches were not split into Manx and Mourne components due to the problems associated with separation of the two stocks early in the season. Landings from UK vessels in September 1990 were primarily from the Douglas Bank area and this amounted to approximately 1,800 t (i.e. 29% of the total landings). Furthermore, the fishery after September was primarily on spent fish; this amounted to approximately 25% of the total landings. The reported landings are less than the TAC but make no allowance for under-reporting, discards or slippage.

7.1.3 Quality of catch and biological data

We have very little verification of landings data for this fishery and there is concern that some under-reporting is occurring. Similarly there are no data on discards. In general, there is good biological sampling of landings from this fishery (Table 7.1.2), but unfortunately there were no samples from the fourth quarter in 1990.

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 1990. In 1990 the dominant groups were the 2 to 4 ringers (1987 to 1985 year classes). The strong 1985 year class was very evident in the catches. The catch in numbers at length is given in Table 7.1.4 for the years 1988 to 1990. The modal length in 1990 was similar to 1989 which was to be expected with the strong 1985 year class in the catches.

7.2 Mean Length, Weight, and Maturity at Age

Mean lengths at age were calculated for August using the Northern Irish and Republic of Ireland data and are given in Table 7.2.1 for the years 1985 to 1990. Little variation was observed in the mean length at age data during this period.

Mean weight at age is given in Table 7.2.2 for the years 1976-1983 and 1984 to 1990. In general, mean weights in 1990 are similar to those over the last 5 years.

The maturity ogive, expressed as a proportion of the sampled population at stage 3+, has remained similar over the last few years, and the 1990 ogive very closely resembles that used in 1989. Therefore, the maturity ogive used in 1989 was used again for 1990 (0.08 for age 1, 0.85 for age 2 and 1.00 for ages 3-8+).

7.3 Acoustic Surveys

An acoustic survey was again undertaken in September 1990 on the Manx spawning stock. The area surveyed was east of the Isle of Man on the Douglas Bank spawning ground. A rectangular grid with one nautical mile spacing was again used in the area where spawning is known to occur. This survey was only conducted at night on 26 and 27 September.

A total of nine crossings were made over the shoal using a 50 kHz echosounder which gave a single estimate of the shoal. All data were subjected to echosquare integration. The shoal was found to be approximately 2 km south-west of its position in 1989. The aggregation was contained in an area approximately 2.67 km^2 as opposed to 2.44 km^2 in 1989. The dimensions and location of the shoal was relatively stable over the two nights of survey. A trawl sample from the shoal was used to provide the length frequency, mean length (25.86 cm) and mean weight (0.174 kg). The length frequency of herring was used to give the mean target strength. The data were converted to numbers of individuals and then converted into total biomass. The target strength used was for 38 kHz, once again a 2.5% adjustment was made for 50 kHz to give an estimated SSB of 27,000 t. This can be compared with 18,000 t in 1989.

Once again this estimate makes no allowance for the Mourne component of the stock and we have no idea how large it is. Therefore, this estimate represents a lower bound estimate for Division VIIa (N) spawning stock. This estimate is higher than seen or predicted in 1989.

In addition to the above survey, an acoustic survey was carried out to assess the total North Irish Sea herring stock in August 1990 which was not presented to the Working Group. It is hoped, however, that difficulties with these data will be overcome and a full assessment, with the results from a further survey scheduled for 1991, will be available for the 1992 Working Group.

7.4 Stock Assessment

7.4.1 Estimation of fishing mortality

There are very few data for this stock. The effort data are sparse and catch per unit effort are probably independent of stock size. Therefore, the only data were an acoustic assessment of the Douglas Bank spawning population (Manx stock only). The 1989 and 1990 acoustic estimates of the Manx component were used to initiate the VPA. No account has been taken of the the Mourne component. F values were examined which would give a stock size over the years 1989 and 1990 to minimize the difference between the VPA and the two acoustic estimates (i.e., 23,044 in 1989 and 22,203 t in 1990). A number of trial VPAs indicated that the most plausible $F_{(2-7,u)}$ value was 0.22. In general, input Fs of 0.15 to 0.3 indicated a relatively stable stock over the most recent years (Figure 7.4.1).

7.4.2 Exploitation pattern

A separable VPA was run with a reference age of 2, a terminal S of 1 and an F_{90} of 0.195. The output of the separable VPA is given in Table 7.4.1. These analyses suggest a flat-topped selection pattern with 0.083 on 1-ringers and approximately 1.0 on ages 2-7. There was no evidence of a change in the exploi-

tation pattern of this fishery.

7.4.3 Results of VPA

For the VPA, natural mortality was assumed to be the same as in previous years, namely 1.0 on 1-ringers, 0.3 on 2-ringers, 0.2 on 3-ringers and 0.1 on 4-8 ringers. F on the oldest age group was taken from the separable VPA and terminal populations were used to determine Fs (Table 7.4.2).

The results of the VPA are shown in Tables 7.4.2 and 7.4.3 and Figures 7.4.3A and B. Recruitment seems to have fluctuated since 1980 with low recruitment in 1984 and 1985 and again in 1988. The spawning stock biomass appears to have been remarkably stable since 1983. The average fishing mortality on ages 2-7 appears to have fluctuated from 0.14 in 1984 to 0.35 in 1988.

7.5 Recruitment

There are no independent estimators of recruitment for this stock.

Last year, future recruitment was estimated as the geometric mean from the VPA over the period 1984-1988 as 184 million. Given the uncertainty of recruitment for this stock, projected recruitment was estimated this year as the geometric mean of VPA values for the years 1984-1989 as 192 million. This value is slightly higher than projected in 1989. There is still a need for some independent estimate of recruitment levels for this stock.

7.6 Stock and Catch Projections

Stock and catch predictions were run using the stock numbers at 1 January 1991 calculated from VPA (Table 7.4.3). The fishing pattern was taken from the separable VPA selection at age. The recruitment was assumed to be 192 million 1-ring fish, the geometric mean level over the period 1984-1989. The assumption was made that the catch in 1991 would be the agreed TAC of 6,000 t.

The input to the yield-per-recruit and predictions are given in Table 7.6.1 and the results plotted in Figures 7.4.3C and D. Catch levels have been assumed for 1992 at levels of $F_{0.1}$ = 0.19, F_{low} = 0.25 and F(92) = F(90) = 0.22. The results for the various options are summarized in the text table below.

1991				1992					1983	
Stock biom.	SSB	F	Catch	Management option	Stock biom.	SSB	F	Catch	Stock biom.	SSB
50.3	24.2	0.21	6.0	$F_{92}=F_{0.1}$	51.1	25.3	0.19	5.9	52.0	26.0
				$F_{92}=F_{90}$		24.8	0.22	6.6	51.4	25.1
				$F_{92}=F_{low}$		24.1	0.25	7.4	50.6	23.7

Weight in '000 t, stock biomass at 1 January, SSB at spawning time.

The results of the predictions show that fishing mortalities of $F_{0.1}$ and F = 0.22 (status quo) will result in a slight increase in SSB over the 1991 level. Catches in 1992 of 7,400 t ($F(92) = F_{low}$) will result in a slight decrease in spawning stock. It must be stressed again, however, that there are considerable uncertainties concerning the current level of stock size and recruitment. Detailed output for the option assuming status quo F in 1992 is given in Table 7.6.2.

7.7 Management Considerations

7.7.1 Recommended catch levels

It should be stressed that the analysis of this stock is based on acoustic surveys of only a part of the stock (Manx component), and there are no survey data on recruitment.

In 1990, ACFM recommended a reduction of fishing mortality of 20% for 1991 corresponding to a TAC of 5,600 t. The EC subsequently adopted a TAC of 6,000 t for 1991. This has been allocated as 1,560 t to the Republic of Ireland and 4,400 t to the UK. Spawning closures were retained for 1991.

The VPA indicates that the stock in the Irish Sea has been stable over the last 7-8 years with an average catch level of about 7,000 t. Unless there is poor recruitment or fishing mortality increases above the present level, the SSB is expected to increase gradually. This increase is likely to be enhanced by maintaining fishing mortality at about the current level. The Working Group suggests that there is no significant difference between catches at a target F of 0.2 and catches of 6,000 t. Therefore, a TAC for 1992 at the present level of 6,000 t would both stabilise catches and guard against uncertainties about the stock size. Of the TAC, 400-500 t may be allocated to the Mourne gillnet fishery that takes place in the closed period.

7.7.2 Spawning and nursery area closures

Due to a continued uncertainty about the size of this stock and the fact that a large portion of the stock aggregates in one small area for spawning (at least on Douglas Bank for the Manx stock), the spawning and nursery area closures should be maintained in 1992.

7.8 Research and Data Requirements

The Working Group expressed concern at the lack of samples from the commercial catches in the fourth quarter and hopes that this situation will be rectified in 1991. It firmly supports the continuation of acoustic surveys on the Manx spawning stock and on the total stock in the summer months, and an extension to include the Mourne spawning stock. Recruitment indices are also required for this area.

The Working Group also recommends the establishment of an otolith exchange programme for 1991, to evaluate the possibility of errors arising from age determinations made by different laboratories dealing with stocks to the west of the British Isles.

8 THE DISCARD PROBLEM

8.1 Existing Information on Discarding

Only a few countries have so far tried to collect data on discarding in herring fisheries. The reason is that such data are very hard to obtain. One should either send observers along on board commercial vessels, or else rely upon information that is voluntarily provided by certain fishermen.

The first option is costly, and it is not certain whether the presence of an observer on board would affect the behaviour of the fishermen. Also, it is not clear whether the fishing skippers that would allow an observer on board, are representative of all skippers in the fleet. This last problem applies even more

in the case of information that is voluntarily provided by fishing skippers. It can be expected that skippers would be quite willing to supply information concerning trips when discarding has been low, but that they will hold back information about trips when discarding has been high.

Of all countries fishing for herring in the area reviewed by this Working Group, only two have attempted to obtain estimates of discards in recent years (e.g., Working Document by Molloy). For the reasons mentioned above, their figures are likely to be underestimates. For all other countries, no information was available, and discards have been assumed to be zero. The estimates for discards presented in the catch tables for the various stocks must, therefore, be only a fraction of the real amounts discarded at sea.

Based on the limited sources of information described above, it is possible to broadly identify some areas where discarding is likely to occur on a significant scale:

Roe fisheries

Discarding in these fisheries may occur when the fish are not in the proper maturity stage, or when the fish are too small and the percentage roe is below a certain pre-set criterion (6 or 7%). In last year's report, an arbitrary figure of 20% discards was used for the roe fishery in the Celtic Sea. A recent estimate for discards in the roe fishery in the English Channel amounted to 16%. This can probably be considered as a lower limit for the real amount of discards. In recent years, there have been attempts to separate males from females, either manually or automatically, and discard the males. It is unknown whether these attempts have been successful.

Fisheries exploiting mixtures of adult and juvenile herring

This situation may occur in summer in the central North Sea. Vessels use their regular sorting machines to separate the smaller-sized fish from the rest of the catch, and discard them. No accurate data are available on this type of discarding. The amount may vary strongly from one year to another, depending on the size of the recruiting year class, and on the distribution pattern of the various age groups. In extreme cases, fishermen are reported to have discarded as much as 50% of their catches.

Fisheries aimed at mackerel or horse mackerel

After the herring quotas have been taken, boats may continue to fish for other pelagic species such as mackerel or horse mackerel. Any by-catch of herring has then to be discarded. This problem arises for instance in the waters west of Ireland, where continental trawlers only have small quotas for herring, but larger quotas for mackerel and horse mackerel. By-catches of herring in the fishery for horse mackerel may also be discarded because the herring have been damaged by the spines of the horse mackerel, and are not then marketable. Discards of this type west of Ireland are estimated at several thousand tonnes per year.

Fisheries limited by individual quotas per day or week

If a fisherman is given a quota for a certain period, he will not be able to adjust his last catch in such a way that he has precisely filled the quota. Normally, there will be some excess catch that has to be discarded or passed on to another fisherman. When the quota is divided into many daily or weekly quotas, this problem will recur at the end of each quota period. Therefore, the problem only occurs in areas where the fishery is controlled by short-term individual quotas. There are no estimates concerning the magnitude of these discards. In certain fisheries, however, where the overall capacity of the entire

fleet far exceeds the daily market requirements, the quantities of fish discarded for this reason may be very significant.

Fisheries aimed at dense concentrations of herring

When fishing dense concentrations of (spawning) herring, the catch may be so big that either the net will burst, or the vessel is unable to take all the catch on board. There is ample anecdotical information that this situation sometimes occurs in the fisheries for spawning herring in the central North Sea, English Channel, and Celtic Sea. A quantification of these discards, however, is not available.

8.2 Possible Measures to Reduce Discarding in the Herring Fishery

Discarding may occur in three different situations:

a) Non-deliberate discarding because of bursting nets.

b) Deliberate discarding after quotas have been filled.

c) Deliberate discarding before quotas have been filled.

Discarding of type (a) is something the fishermen themselves will try to avoid. It could possibly be reduced by stimulating the introduction of sensors in the net that measure the amount of fish in the net (subsidy scheme).

Discarding of type (b) is particularly serious when working with individual quotas. The extent of this discarding could be reduced by changing from weekly individual quotas to a seasonal individual quotas, or from personal quotas to group quotas or fleet quotas.

Discarding of type (c) is something that occurs in situations when a large fleet is allowed only a small quota. In order to obtain the maximum economic value for the quotas, only the fish of the highest market values are retained on board, and the remainder of the catch is discarded. Sometimes the entire catch is slipped if it consists of low quality fish. If the quotas are further reduced to compensate for the discarding, the problem only gets worse.

This type of discarding is a serious problem because it makes the TAC regulation ineffective. Any TAC is meant to be a restriction on catches and not on landings. If the TAC and quotas are only applied to landings, and the fishermen discard a large part of their catch at sea, then the total amount of fish removed from the stock will be much higher than intended. Therefore, if management through TACs is to achieve its objectives, the TACs and quotas should be applied to catches and not just to landings.

A reduction of deliberate discarding might be achieved through several types of measures, some of which should probably be introduced in conjunction: (a) a legal obligation to count discarded fish against existing quotas; (b) closures of areas and periods when major discarding is occurring, or is likely to occur; (c) restrictions on the use of sorting machines, and (d) a reduction of fishing capacity. The by-catch of small herring might also be reduced by an increase in mesh size. This possibility is further discussed in Section 9.

a. Counting of discarded fish against the quotas

Whereas there is an official regulation in Norway against discarding, no such regulation exists in EC waters. In this area, the TACs and quotas only apply to

the actual landings of the vessels, and the fishermen are free to discard any proportion of their catch.

As stated in the previous section, the TACs advised by ACFM apply to catches, and the amounts of fish discarded at sea should thus be counted against the existing quotas. However, fishery managers in the EC have been reluctant to introduce this regulation because they fear that it cannot be enforced. In general, this is true. One cannot send inspectors along on each fishing vessel and each fishing trip, and when there is no inspector on board, fishing skippers will be inclined to underestimate the amount of discards in their logbooks.

Yet in the present situation within EC, there is no legal possibility at all to stop fishermen from large-scale discarding. This situation is unsatisfactory. It is very difficult to explain to fishermen the logic of a regulation that severely restricts the amounts they are allowed to land, but at the same time allows them to kill an unlimited amount of fish.

An official rule to count discards against quotas (or forcing the fishermen to land all their catches) would not stop small-scale discarding, but it would allow inspection in areas and periods when discarding is suspected to be a problem. A regulation against discarding might also refrain shipowners or fish buyers from openly instructing fishing skippers to discard certain categories of lower value.

A negative effect of an official rule against discarding would be the reduced possibilities of scientists to obtain unbiassed information on discard levels.

b. Closures of fishing areas

Discarding appears to be a problem mainly in certain areas and at certain times of the year. The problem is that such areas and periods are hard to specify in advance. In the roe fishery, the amount of discarding may vary significantly from one week to another, depending on how quickly fish are progressing from maturity stage V to stage VI. In the summer fishery in the North Sea, high by-catches of juveniles may occur in one year, and not in the next one. Also the areas where adults and juveniles are mixed may vary from one year to another.

Closing of the fishery in certain areas and periods because of extensive discarding can only be done on an ad hoc basis. This means that the power to introduce such closures should be delegated to local authorities, which can use real-time information from research vessels or from the industry itself.

c. Restrictions on the use of sorting machines

The availability on board of sorting machines facilitates the grading of larger amounts of fish and discarding of smaller size categories. A ban on the use of sorting machines would thus reduce the discarding of smaller fish. However, the sorting machines are also used to grade the fish on board into different market categories, and unsorted catches might not be marketable.

d. Reducing fishing capacity

The main reason for discarding is that catching capacity of the fleet is larger than the amount of fish they are allowed to land. Discarding could thus be limited by reducing the catching capacity of the fleet. This could be done by either reducing the fishing power of individual vessels (limitations to engine power, size of gear or efficiency of gear), reducing the time each vessel is allowed to spend fishing (limited number of fishing days), or by reducing the numbers of vessels engaged in the fishery. The choice of such regulations will depend very much on social, economical and political considerations.

9 EFFECTS OF DIFFERENT MESH SIZES IN HERRING TRAWLS

The protection of young fish by using nets with mesh sizes so large that the young fish can penetrate the net and avoid capture is a concept of very long standing in fisheries management.

The measure has been applied especially in the demersal fisheries, and a large number of mesh selection experiments have been carried out.

In the case of pelagic species the use of mesh regulation is comparatively new. The first experiments took place in the early 1960s following a proposal for the introduction of a minimum mesh size of 55 mm in the North Sea herring fisheries. These early experiments were reported in 1961-1964 and covered mesh sizes from 48 to 68 mm and materials like cotton, manilla and polyamide. The results showed that the selection factor (ratio between 50% retention length and mesh size) varied from 3.7 to 4.6 with an average of about 4.25 and a selection range of about 3 cm. The experiments showed that mesh sizes above 50 mm often result in very serious meshing problems and that the meshing factor (ratio between modal length of meshed fish and mesh size) was about 4.5.

Applying these results to a 40 mm mesh size gives the following results:

25% retention length	15.5 cm
50% retention length	17.0 cm
75% retention length	18.5 cm
Meshed modal length	18.0 cm

The 40 mm mesh would thus appear to give effective protection to the 0-ringers and to a major part of the 1-ringers, especially in the first half of the year. In its 1981 report, ACFM stated that "under the current practice of fishing for adult herring, most countries are utilising a 40 mm mesh size. Accordingly, ACFM considers that in directed herring fisheries the appropriate mesh size would be 40 mm in Sub-areas IV, VI and VII".

ACFM (loc. cit.) also recommended an increase to 40 mm in herring trawls in Division IIIa with the intention of reducing the catches and subsequent discarding of juvenile herring which was stated to be a serious problem at that time. Today catches are still taking place but discarding is not known to occur in Division IIIa. The recommendation for an increase led to a mesh selection experiment in Division IIIa comparing the 32 mm mesh in use with the 40 mm mesh proposed (Clausson, 1984). In contrast to the earlier experiments in the North Sea, this experiment showed a rate of meshing in the 40 mm mesh that made its use unacceptable in practice. The reason for this difference is probably that young and adult herring show a much higher mixing rate within small areas in Division IIIa than in the North Sea.

More recent experiments have been undertaken in the Baltic but all with mesh sizes smaller than 40 mm. Järvik and Suuronen (1990) measured selection parameters using 32 mm and Suuronen (1990) compared selection characteristics of square mesh and diamond mesh codends of 36 mm. These experiments indicated the same selection indices as the earlier experiments described above in the case of diamond mesh codends, while the square mesh appeared to have a steeper selection curve (smaller selection range) and a somewhat higher selection factor. The greatest difference between the two shapes was, however, in the lower end of the selection range, indicating that the square mesh codend releases the smallest juveniles more effectively than the equivalent diamond mesh codend. Further experiments appear to be necessary before more definite conclusions on the merits of the square mesh codend can be drawn.

A vital question is, of course, whether the survival rate of herring having passed through the meshes of a trawl is sufficiently high to motivate a change

to existing mesh regulations. Very little work has been published on this topic. Treshcev et al. (1975) kept trawl-caught herring in cages and measured death rates and biochemical effects of the capture. The experiment indicated a survival rate as high as 97%. Suuronen (1990) made TV-observations on escapement of herring from trawl meshes. Very few damaged herring were observed and the escapees apparently did not lose scales.

With the present state of knowledge the Working Group concluded that the use of meshes larger than 40 mm is probably unrealistic because of meshing problems and that an increase to 40 mm might reduce discarding in some areas but that its universal introduction is questionable. In the North Sea herring fisheries the introduction of larger meshes will not solve the discard problems which mostly concerns adult herring.

10 A REVIEW OF STOCK ASSESSMENT METHODS USED IN NORTH ATLANTIC HERRING FISHERIES

The Working Group has been particularly conscious of the need for consistency where possible among its assessments and between years. In addition to discussions during each assessment, the Working Group devoted some time to consideration of general assessment methods and approaches. The Working Group compiled a summary of the assessment approach and tuning procedures used in all Atlantic herring assessments.

Atlantic herring is divided into approximately 28 assessment/management units (Table 10.1). These units span a great range in size, stock structure (e.g., number of spawning groups), timing of spawning, as well as in type and intensity of fishing pressure. Biological status is assessed by three working groups of ICES, the Pelagic Sub-committee of the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) and the USA National Marine Fisheries Service Stock Asssessment Workshop (US SAW). Understandably, the diversity in assessment unit characteristics and the relative independence of ICES, CAFSAC and the US SAW processes have resulted in differences in assessment methods and techniques. These have been summarized from the following recent assessment documents:

CAFSAC, 1990. Advice on the management of herring stocks on the Atlantic coast of Canada for 1991. CAFSAC Advisory Doc. 90/40.

ICES, 1991a. Report of the Atlanto-Scandian Herring and Capelin Working Group (15-19 October 1990). ICES Doc. C.M.1991/Assess:6.

ICES, 1990b. Report of the Herring Assessment Working Group for the Area South of 62°N (27 March-6 April 1990). ICES Doc. C.M.1990/Assess:14.

ICES, 1990c. Report of the Working Group on Assessment of Pelagic Stocks in the Baltic (17-27 April 1990). ICES Doc. C.M.1990/Assess:18.

NMFS, 1989. Report of the Fall 1989 NEFC Stock Assessment Workshop (Ninth SAW). Northeast Fisheries Center Reference Document 89-08.

A Summary of Atlantic Herring Assessments

Twenty seven herring assessments summarized in Table 10.2 were considered by the various working groups in the most recent reports. In five cases no analytical assessment was possible (units 2, 4, 23, 25, 27) because they were not discrete units or due to insufficient data. In one case (Newfoundland group; units 17-21) an assessment was based on absolute abundance from acoustic surveys. The remaining 21 were analytical assessments involving a virtual or sequential population analysis (VPA/SPA) of some sort. Eight of the analytical assessments were "untuned"; and the VPA was initiated by Fs from SVPA or by acoustic biomass in one year. The remaining 13 were "tuned" assessments (although one (24a) was in-

complete in 1990 due to poor indices in that year) which utilized the following tuning methods:

ICES tuning module	1, 8a, 11
RCRTINX2	8b, 9, 10
Ad hoc	1-5, 15, 28, 16
ADAPT	22, 24, 26

The assessments differ in the number and type of abundance indices available. Sixteen (of 22) assessments were based on a single type of abundance index, although some of these had more than one of each type (e.g., two acoustic surveys in unit 16). Four assessments had two indices and two (9 and 26) had three.

Number of abundance indices in 1990 assessments

One	Two	Three
1-5, 1, 3, 5, 6, 7, 8a, 8b, 10, 12, 14, 15, 16, 22, 24b, 28	11, 17-21, 22 24a	9, 26

Commercial CPUE was used in 8 cases, and five fishery-independent indices were used; acoustics (11 assessments), larval abundance (4), IYFS (2), Research (Index) gillnet (2) and Bottom trawl surveys (2).

Distribution of the use of abundance indices

Abundance index	Assessment unit
Fishery dependent	
Commercial CPUE	1, 5, 6, 7, 11, 22, 24a, 24b
Fishery independent	
Acoustic	1-5, 3, 8a, 9, 11, 14, 15, 16, 17-21, 24a, 26
IYFS	8b, 9
Larvae	9, 10, 12, 26
Index (research) gillnet	17-21, 22
Research bottom trawl	26, 28

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Anon. 1989a. Report of the Herring Assessment Working Group foir the Area South of 62^{0}N. ICES, Doc. C.M.1989/Assess:15.

Anon. 1989b. Report of the Multispecies Assessment Working Group. ICES, Doc. C.M.1989/Assess:20.

Anon. 1990a. Report of the Working Group on Herring Larvae Surveys South of 62^{0}N. ICES, Doc. C.M.1990/H:32.

Anon. 1990b. Report of the Herring Assessment Working Group for the Area South of 62^0N. ICES, Doc. C.M.1991/Assess:14.

Anon. 1991a. Report of the Multispecies Assessment Working Group. ICES, Doc. C.M.1991/Assess:7.

Anon. 1991b. Report of the Planning Group on Acoustic Surveys in Sub-area IV and Division IIIa. ICES, Doc. C.M.1991/H:40.

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Nash, R.D.M. VIIa (N) acoustic surveys for herring.

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Walsh, M. and Armstrong, F. Results of an acoustic survey for herring and sprat in the Firth of Clyde during July 1990.

Table 2.1.1 HERRING. Catch in tonnes, 1979-1990, North Sea, Sub-area IV, and Division VIId by country. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1979	1980	1981	1982	1983	1984
Belgium	-	-	-	9,700	5,969	5,080
Denmark	10,546	4,431	21,146	67,851	10,467	38,777
Faroe Islands	10	-	-	-	-	-
France	2,560	5,527	15,099	15,310	16,353	20,320
Germany, Fed.Rep.	10	147	2,300	349	1,837	11,609
Netherlands	-	509	7,700	22,300	40,045	44,308
Norway[4]	2,367	2,165	-	-	32,512	98,706
Sweden	-	-	-	-	284	886
UK (England)	2,253	77	303	3,703	111	1,689
UK (Scotland)	-	610	45	1,780	17,260	31,393
USSR	162	-	-	-	-	-
Unallocated landings	-	47,528	94,309	114,252	181,116	64,487
Total landings	17,908	60,994	140,902	235,245	305,954	317,255
Discards[3]	-	-	-	-	-	-
Total catch	17,908	60,994	140,902	235,245	305,954	317,255
Catches of spring spawners (included above)						
IIIa type	-	-	-	-	-	6,958
Coastal type	-	-	-	-	-	520

Country	1985	1986	1987	1988	1989	1990[1]
Belgium	3,482	414	39	4	434	180
Denmark	129,305	121,631	138,596	263,006	210,315[2]	159,280[2]
Faroe Islands	-	623	2,228	810	1,916	633
France	14,400	9,729	7,266	8,384	29,085	23,480
Germany, Fed.Rep.	8,930	3,934	5,552	13,824	38,707	43,191
Netherlands	79,335	85,998	91,478	82,267	84,178	69,828
Norway[4]	159,947	223,058	241,765	222,719	221,891[2]	157,850[2]
Sweden	2,442	1,872	1,725	1,819	4,774	3,754
UK (England)	5,564	1,404	873	8,097	7,980	8,333
UK (Scotland)	55,795	77,459	76,413	64,108	68,106	56,812
USSR	-	-	-	-	-	-
Unallocated landings	74,220	21,089	58,972	33,411	26,749[2]	21,081
Total landings	533,420	547,191	624,907	698,449	694,135[2]	544,422
Discards[3]	-	-	-	-	4,000[3]	8,660[3]
Total catch	533,420	547,191	624,907	698,449	698,135[2]	553,082
Catches of spring spawners (included above)						
IIIa type	17,386	19,654	14,207	23,306	19,869	8,357
Coastal type	905	490	250	250	2,283	1,136

[1] Preliminary.
[2] Working Group estimates.
[3] In previous years any discard estimates were included in unallocated landings.
[4] Catches of Atlanto-Scandian spring spawners removed (taken under a separate TAC).

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	1981	1982	1983	1984	1985
Denmark	11,357	3,155	4,282	26,786	77,788
Faroe Islands	-	-	-	-	-
France	1,851	1,970	680	1,408	2,075
Germany, Fed.Rep.	-	-	1,542	12,092	4,790
Netherlands[2]	-	-	15,745	19,143	49,965
Norway	-	-	16,971	21,305[1]	10,507[1]
Sweden	-	-	213	-[1]	-[1]
UK (England)	-	-	-	-	-
UK (Scotland)	2	1,706	16,136	24,634	52,100
Unallocated landings	6,492	300	3,955	24,030	4,249
Total landings	19,702	7,179	61,738	129,398	197,225
Total catch	19,702	7,179	61,738	129,298	201,474

Country	1986	1987	1988	1989	1990[4]
Denmark	48,590	50,184	25,268	29,298	9,037
Faroe Islands	275	102	810	1,916[1]	633
France	462	285	266	-[1]	2,581
Germany, Fed.Rep.	2,510	3,250	9,308	26,528	20,422
Netherlands[2]	42,900	44,358	32,639	24,600	29,729
Norway	63,848[1]	55,311	30,657	41,768	24,239
Sweden	-[1]	768	1,197	742	-
UK (England)	-	4,820	4,820	5,104	3,337
UK (Scotland)	71,285	66,774	48,791	58,455	46,431
Unallocated landings	-	16,092	-	3,173	4,621
Total landings	229,870	221,032	153,751	191,584	141,030
Discards[3]	-	-	-	900	750
Total catch	229,870	237,124	153,751	192,484	141,780

[1] Included in Division IVb.
[2] Netherlands discard estimates included in "unallocated" from 1980-1988.
[3] Any discards prior to 1989 would have been included in unallocated.
[4] Preliminary.

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	1981	1982	1983	1984	1985
Denmark	-	491	-	126	-
Faroe Islands	-	-	-	-	-
France	-	-	-	-	-
Netherlands	-	-	-	-	-
Norway[1]	-	-	-	51,581	109,975
Sweden	-	-	-	-	-
UK (Scotland)	-	-	257	74	-
Unallocated landings	937	-	431		-
Total landings	937	491	688	51,781	109,975
Total catch	937	491	688	51,781	109,975

Country	1986	1987	1988	1989	1990[3]
Denmark	4,540	7,101	47,183	44,269	44,364
Faroe Islands	-	2,126	-	-	-
France	-	159	45	-	892
Netherlands	-	-	200	-	-
Norway[1]	118,408	145,843	153,496	168,365	121,405
Sweden	-	957	622	612	2,482
UK (Scotland)	-	-	-	-	-
Germany, Fed. Rep.	-	-	-	-	5,604
Unallocated landings	-	-	-	-	-
Total landings	122,348	156,186	201,546	213,246	174,747
Discards[2]	-	-	-	-	-
Total catch	122,948	156,186	201,546	213,246	174,747

[1] Catches of Atlanto-Scandian herring removed (taken under a separate TAC).
[2] Any discards prior to 1989 would have been included in unallocated.
[3] Preliminary.

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	1981	1982	1983	1984	1985
Denmark	9,689	64,205	6,050	13,808	51,517
France	524	561	705	2,299	1,037
Faroe Islands	-	-	-	-	-
Germany, Fed.Rep.	2,300	118	-	2	4,139
Netherlands[4]	-	219	300	4,600	-[3]
Norway	-	-	14,156	25,820	39,465
Sweden	-	-	71	884	2,442[2]
UK (England)	13	3,128	40	1,956	5,214
UK (Scotland)	43	74	867	2,477	2,894
Unallocated landings	65,811	90,262	159,124	41,294	47,799
Total landings	78,380	158,567	181,313	93,140	154,507
Total catch	78,380	158,567	181,313	93,140	154,507

Country	1986	1987	1988	1989	1990[6]
Denmark	67,966	81,280	190,555	136,239	105,614
France	605	387	617	14,415[5]	10,289
Faroe Islands	348	-	-	-	-
Germany, Fed.Rep.	1,424	2,302	4,516	11,880	17,165
Netherlands[4]	21,101	31,371	37,192	47,388	28,402
Norway	40,682	40,111	38,566	11,758	12,207
Sweden	1,872[2]	-	-	3,420	1,276
UK (England)	1,101[1]	329	2,011	957	3,200
UK (Scotland)	6,057	9,639	15,317	9,651	10,381
Unallocated landings	1,594	20,829	1,969	-23,947[7]	-15,616[7]
Total landings	142,750	186,248	290,743	211,711	172,914
Discards[4]	-	-	-	1,900	2,560
Total catch	142,750	186,248	290,743	213,611	175,474

[1] Includes catches misreported from Division IVc.
[2] Includes Division IVa catches.
[3] Included in Division IVa.
[4] Netherlands discard estimates included in "unallocated" from 1980-1988.
[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	1981	1982	1983	1984	1985
Belgium	-	9,700	5,969	5,080	3,482
Denmark	100	-	135	53	-
France	12,724	12,799	14,968	16,613	11,288
Germany, Fed.Rep.	-	183	295	-	-
Netherlands	7,700	22,081	24,000	21,922	32,370
Norway	-	-	1,385	-	-
UK (England)	290	602	71	571	350
UK (Scotland)	-	-	-	-	799
Unallocated landings	21,069	23,307	17,606	1,788	21,595
Total landings	-	-	-	-	69,884
Discards[1]	-	-	-	-	-
Total catch	41,883	68,652	64,430	46,027	69,884
Coastal spring spawners included above	-	-	-	-	905

Country	1986	1987	1988	1989	1990[2]
Belgium	414	39	4	434	180
Denmark	535	31	-	509	265
France	8,662	6,435	7,456	14,670	9,718
Germany, Fed.Rep.	-	-	-	299	-
Netherlands	21,997	15,749	12,236	12,240	11,697
Norway	-	-	-	-	-
UK (England)	303	544	1,266	1,919	1,796
UK (Scotland)	117	-	-	-	-
Unallocated	19,495	22,051	31,442	47,523	32,076
Total landings	51,523	44,849	52,404	77,594	55,732
Discards[1]	-	-	-	1,200	5,350
Total catch	51,523	44,849	52,404	78,794	61,082
Coastal spring spawners included above	496	250	250	2,283	1,136

[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 (w.r.), division and and quarter.

Catches in: 1990.0

Division	Quarter	0 1989	1 1988	2 1987	3 1986	4 1985	5 1984	6 1983	7 1982	8 1981	9 1980	Total	0 + 1 ring
	I	0.0	0.0	0.3	11.4	14.8	7.9	1.1	0.0	0.1	0.0	35.8	0.0
IVa West	II	0.0	0.0	33.3	35.0	26.8	16.3	2.9	3.0	1.8	0.7	119.7	0.0
(W of 2 E)	III	0.2	6.1	59.4	145.8	173.3	70.1	16.9	11.2	9.1	3.7	495.8	6.3
	IV	0.0	1.8	33.8	40.6	23.4	5.1	1.1	1.2	0.0	0.0	107.0	1.8
	Total	0.2	7.9	126.9	232.8	238.3	99.3	22.0	15.4	11.1	4.5	758.3	8.1
	I	0.0	0.0	25.4	79.1	110.5	55.6	7.3	7.1	3.9	0.3	289.1	0.0
IVa East	II	0.0	0.4	25.7	35.5	56.8	22.3	6.6	4.5	1.5	0.5	153.8	0.4
(E of 2 E)	III	7.5	0.4	5.4	26.7	62.8	34.7	11.7	8.3	3.4	2.2	162.9	7.9
	IV	3.6	54.3	52.7	161.3	133.9	56.5	13.4	8.3	4.0	0.5	488.4	57.9
	Total	11.1	55.0	109.2	302.5	363.9	169.1	39.0	28.2	12.8	3.4	1094.3	66.1
	I	0.0	298.1	61.5	16.1	0.4	0.0	0.0	0.0	0.0	0.0	376.1	298.1
IVb	II	0.0	102.0	45.8	9.8	5.7	1.9	0.9	0.0	0.0	0.0	166.0	102.0
	III	606.1	687.9	76.3	90.1	128.7	45.4	10.3	6.0	3.2	3.3	1657.3	1294.0
	IV	236.5	315.6	33.8	16.6	3.0	0.6	0.0	0.0	0.0	0.0	606.2	552.1
	Total	842.6	1403.6	217.4	132.6	137.8	47.9	11.1	6.0	3.2	3.3	2805.7	2246.2
	I	0.0	0.1	1.5	8.5	12.3	7.6	1.0	0.3	0.0	0.0	31.4	0.1
IVc + VIId	II	0.0	0.0	0.4	0.2	0.8	0.5	0.3	0.1	0.0	0.1	2.4	0.0
	III	0.0	0.0	0.7	0.6	0.7	0.7	0.4	0.0	0.0	0.1	3.1	0.0
	IV	0.0	10.8	136.7	86.1	95.3	50.7	6.3	4.3	1.3	0.4	391.9	10.8
	Total	0.0	10.9	139.3	95.4	109.1	59.6	7.9	4.7	1.3	0.6	428.8	10.9
	I	0.0	298.2	88.8	115.0	138.1	71.1	9.4	7.5	4.1	0.3	732.3	298.2
Total	II	0.0	102.3	105.3	80.5	90.1	41.0	10.6	7.6	3.3	1.2	442.0	102.3
North Sea	III	613.8	694.4	141.8	263.2	365.4	150.9	39.3	25.6	15.8	9.3	2319.3	1308.2
	IV	240.1	382.5	257.1	304.6	255.6	112.9	20.8	13.7	5.3	0.9	1593.6	622.6
	Total	853.9	1477.4	592.8	763.3	849.1	375.9	80.1	54.4	28.4	11.8	5087.1	2331.3

Spring spawners transferred to Division IIIa not included.

Table 2.2.2 Millions of HERRING caught annually per age group (winter rings) in the North Sea, 1970-1990.

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

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

Year	0-r	1-r	2-r
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	1,003	1,039	563
1990[1]	?	?	?

[1] No estimate for the last year.

Table 2.2.4 Percentage age composition of North Sea HERRING (2-ring and older) in the catch.
Catches in: 1990

Division	Quarter	2 1987	3 1986	Older	Total (million
IVa West	I	1.0	32.0	67.1	35.8
	II	27.8	29.2	43.0	119.7
	III	12.1	29.8	58.1	489.6
	IV	32.1	38.6	29.3	105.2
	Total	16.9	31.0	52.1	750.2
IVa East	I	8.8	27.3	63.9	289.1
	II	16.7	23.2	60.1	153.4
	III	3.5	17.2	79.3	155.1
	IV	12.3	37.5	50.3	430.5
	Total	10.6	29.4	60.0	1028.1
IVb	I	78.9	20.6	0.5	78.0
	II	71.5	15.2	13.3	64.1
	III	21.0	24.8	54.2	363.3
	IV	62.5	30.8	6.7	54.1
	Total	38.9	23.7	37.4	559.5
IVc + VIId	I	4.9	27.1	68.0	31.3
	II	18.1	10.3	71.6	2.4
	III	21.9	17.8	60.2	3.1
	IV	35.9	22.6	41.5	381.2
	Total	33.3	22.8	43.8	418.0
IVa + IVb	I	21.6	26.4	51.9	402.9
	II	31.1	23.8	45.1	337.2
	III	14.0	26.1	59.9	1008.0
	IV	20.4	37.0	42.5	589.8
	Total	19.4	28.6	52.0	2337.9
Total North Sea	I	20.4	26.5	53.1	434.1
	II	31.0	23.7	45.3	339.6
	III	14.0	26.0	59.9	1011.1
	IV	26.5	31.4	42.2	971.0
	Total	21.5	27.7	50.8	2755.8

Spring spawners transferred to Division IIIa not included.

Table 2.2.5 HERRING NORTH SEA 1990.
Sampling intensity of commercial catches.

Country	Landings[1]	No. of samples	No. of age-readings	No. of fish measured	Estimates of discards	Catches to which the age compositions were applied
Belgium	180	0	0	0	No	-
Denmark	159,280	65	2,676	2,676	No	67,393
Faroe Islands	633	0	0	0	No	-
France	23,480	16	376	3,152	No	21,240
Germany	43,191	-	-	-	No	-
Netherlands	69,828	94	2,350	14,100	Yes	134,490
Norway	157,850	105	3,691	8,400	No	198,288
Sweden	3,754	-	-	-	-	-
UK (England)	8,333	1	?	?	No	2,542
UK (Scotland)	56,812	96	3,361	16,073	No	56,811
Catches split by survey samples						76,320

[1] Working Group estimates.

Table 2.2.6 Transfer of Division IIIa spring spawners taken in the North Sea catches in 1986-1990. Catch in numbers ('000) and mean weight (g) at age with SOPs in tonnes.

		Quarters 2 and 3 Divisions IVa (e) and IVb								Total
Rings		2	3	4	5	6	7	8	9+	
Year:										
1986	No	-	52,782	42,013	14,617	2,751	1,938	602	651	115,354
	w	-	156.8	171.7	194.5	210.1	216.6	210.6	283.1	
	SOP	-	8,276	7,214	2,843	578	420	128	184	19,642
1987	No	35,500	35,000	25,000	8,900	2,800	700	100	100	108,100
	w	94	124	147	177	195	216	278	283	
	SOP									14,207
1988	No	44,561	108,915	19,532	8,168	2,203	391	-	-	183,770
	w	94	131	154	171	176	212	-	-	
	SOP	4,206	14,221	3,015	1,393	399	83	-	-	23,306
1989	No	27,313	52,687	38,325	11,615	8,651	3,811	1,700	224	144,326
	w	91	120	164	180	178	191	202	209	
	SOP	2,488	6,337	6,298	2,090	1,537	729	344	47	19,869
1990	No	12,431	14,703	21,812	3,573	2,986	2,088	746	352	58,691
	w	103	113	134	166	161	184	190	236	
	SOP	1,079	1,668	2,932	1,588	482	384	142	83	8,358

Table 2.2.7 Southern North Sea (Divisions IVc, VIId), age composition of spring spawners (sampled by the Netherlands).

Quarter		0	1	2	3	4	5	6	7	8	9+	Catch (t)*
I	No								279			
	W								255			
	SOP	0	0	0	0	0	0	0	71.145	0	0	70
II	No											
	W											
	SOP	0	0	0	0	0	0	0	0	0	0	
III	No											
	W											
	SOP	0	0	0	0	0	0	0	0	0	0	
IV	No			847	847	2963	423	0	423			
	W			110	113	154	163	0	156			
	SOP	0	0	93.17	95.711	456.302	68.949	0	65.988	0	0	780
Total	No	0	0	847	847	2963	423	0	702	0	0	
	W			110	113	154	163		195.3462			
	SOP	0	0	93.17	95.711	456.302	68.949	0	137.133	0	0	850

* : Catch for which an age composition was available.

Table 2.3.1 Recruitment indices for 1- and 2-ringed herring from International Young Fish Surveys. Indices given are means of all rectangle means either in 1-ringer standard area or in total North Sea.

Year class	Standard area	Total North Sea	VPA estimate (billions)	
	1-ringers	2-ringers	1-ringers	2-ringers
1974	452	-	0.93	-
1975	342	-	0.90	-
1976	575	-	1.48	-
1977	139	-	1.67	-
1978	535	-	3.60	-
1979	551	-	5.45	-
1980	1,293	106	8.63	2.54
1981	1,797	149	17.14	4.91
1982	2,663	712	15.68	4.77
1983	3,416	648	16.10	4.10
1984	3,667	853	29.00	7.98
1985	5,717	3,962	35.90	9.43
1986	4,192	816	27.93	5.95
1987	3,468	443	12.75	3.04
1988	2,146	858[1]	9.93	-
1989	2,485[1]	-	-	-

[1] Preliminary.

Table 2.3.2 Abundance indices of 0-ringed herring from IKMT sampling during International Young Fish Surveys. Catches corrected for haul duration and water depth.

Area	North west	North east	Central west	Central east	South west	South east	Division IIIa	Southern Bight	IKMT index
Area factor	27	11	28	33	12	30	10	10	
Year class									
1976	16.2	4.2	36.5	1.5	2.4	0.7	0.5	4.9	1,658
1977	7.1	7.1	15.1	4.4	16.7	3.8	1.8	10.2	1,273
1978	52.7	9.3	108.3	6.0	3.0	1.5	22.3	0.0	5,061
1979	18.4	58.4	78.7	122.4	67.7	43.0	29.8	16.0	9,821
1980	15.6	0.2	43.4	34.6	26.7	101.6	74.5	56.1	7,455
1981	59.1	0.1	86.8	59.6	64.4	193.5	32.7	10.7	13,016
1982	7.6	3.3	20.4	74.4	87.0	92.6	140.9	42.1	8,918
1983	5.7	2.0	34.3	80.4	81.2	142.0	101.7	113.2	11,173
1984	25.0	5.7	90.8	77.7	298.7	215.4	83.1	89.5	17,617
1985	34.8	17.2	126.3	103.1	139.2	233.2	25.5	25.3	17,242
1986	95.1	8.7	218.9	167.0	249.0	279.8	14.3	73.2	26,331
1987	23.3	9.3	125.0	94.3	47.8	185.5	144.9	148.4	16,415
1988	10.7	6.1	28.5	28.8	45.2	123.2	54.4	4.8	6,935
1989	24.9[1]	8.9[1]	11.9	28.1	4.0	10.6	12.3	0.0	2,520
1990	22.6	16.0	43.9	35.3	16.05	38.1	13.6	41.5	5,072

[1] Estimated from other cruises.

Table 2.3.3 IKMT index and VPA estimates of 0-group, and parameters of fitted regression lines for assessments of North Sea and Division IIIa combined.

Year class	IKMT new index	VPA 0-ringers (billions)
		North Sea + Division IIIa
1976	1,658	4.43
1977	1,273	4.74
1978	5,061	10.63
1979	9,821	16.79
1980	7,455	37.95
1981	13,016	65.00
1982	8,918	62.99
1983	11,173	54.12
1984	17,617	85.38
1985	17,242	103.34
1986	26,331	88.48
1987	16,415	39.55
1988	6,935	31.62[1]
1989	2,520	19.10[1]
1990	5,072	-

[1] Not used in regression.

Regression of VPA on IKMT index:

i) North Sea and Division IIIa VPA

r^2 = 0.694
a = 3.35
b = 0.00392 (s.e. 0.000823, df 10)

ii) North Sea and Division IIIa VPA
(regression forced through origin)

r^2 = 0.691
b = 0.00414 (s.e. 0.000414, df 11)

Table 2.3.4 Relative proportions of 1-ringed herring in North Sea and Division IIIa. Number in each area calculated as (mean number per square) x (number of squares sampled).

Survey year	North Sea	Division IIIa	% in Division IIIa
1983	153,439	38,024	19.9
1984	163,482	31,633	16.2
1985	250,805	78,113	23.7
1986	229,255	224,370	49.5
1987	446,615	114,483	20.4
1988	259,193	661,089	71.8
1989	264,714	170,275	39.1
1990	129,486	34,583	21.1
1991	Not available		

Table 2.3.5 Relation between IYFS indices and VPA stock numbers of 1-group herring in the North Sea.

Year class	Standard index	GLM	GLM incl. Div. IIIa	VPA
1980	1,293	3,138	3,886	8,632
1981	1,797	6,420	7,511	17,142
1982	2,663	4,355	5,980	15,676
1983	3,416	5,666	7,511	16,097
1984	3,667	7,466	9,369	28,993
1985	5,717	14,460	17,003	35,896
1986	4,192	5,147	7,304	27,931
1987	3,468	5,075	6,382	12,752
1988	2,087	2,103	2,666	9,931
1989	2,485[1]	3,308	4,201	-

Regressions (log scale) between indices and VPA (year classes 1980-1986):

R^2	0.81	0.88	0.91
a	-3.89	-5.37	-4.75
b	0.86	0.97	0.92

Predicted year-class strength in millions:

1987	22,463	12,250	10,587
1988	13,900	4,965	4,099
1989	16,096	7,921	6,721

Table 2.3.6 GLM-indices for IYFS 2-ringers, 2+-ringers, and 3+-ringers as well as VPA 2-ringer stock numbers at 1 January and VPA/SSB at spawning time.

Year	VPA/SSB	2-ringers VPA	GLM-2	GLM-2+	GLM-3+
1981	205	1,182	-	-	-
1982	289	1,509	269	522	68
1983	446	2,538	563	1,222	205
1984	743	4,910	862	1,334	175
1985	780	4,771	2,723	4,931	683
1986	844	4,098	728	1,381	367
1987	991	7,981	2,143	3,203	340
1988	1,242	9,425	12,609	17,340	2,216
1989	1,549[1]	5,952[1]	2,552	5,355	1,606
1990	1,411[1]	3,040[1]	1,569	4,249	1,509
1991	-	-	710	2,898	1,159

Regression of GLM on VPA (log-log-regressions):

	[2]	[3]	[4]
r^2	0.77	0.68	0.78
a	-12.15	-9.32	-8.99
b	1.76	1.90	1.63

[1] Not used in regression.
[2] VPA 2-ringers vs. GLM-2.
[3] VPA SSB vs. GLM-2+.
[4] VPA SSB vs. GLM-3+ the following year.

Table 2.4.1 Estimated numbers of herring at age (millions) per spawning stock and area. N = numbers; B = biomass ('000 t); I = immatured; M = mature; SS = spawning stock; TS = total stock.

Age winter rings	IVa W	IVa E		IVb W	IVb E		SKAGERRAK		KATTEGAT		TOTAL	
	au	sp	au	au	sp	au	sp	au	sp	au	sp	au
0	0	0	0	7	0	2526	15	16	17	29	31	2579
1	853	0	640	828	0	3199	0	430	135	300	135	6249
2I	154	233	141	188	115	258	586	72	418	0	1352	813
2M	1024		492	555		87		0		0	0	2158
3I	87	220	17	3	0	2	219	0	82	0	521	108
3M	2538		540	334		10		0		0	0	3422
4	2462	246	808	99	0	2	53	0	21	0	320	3370
5	973	49	359	17	0	0	24	0	3	0	76	1349
6	266	18	128	0	0	0	4	0	1	0	23	395
7	144	5	66	0	0	0	3	0	1	0	9	211
8	70	1	57	7	0	0	1	0	0	0	2	134
9+	23	1	20	0	0	0	0	0	0	0	1	43
TSN	8593	772	3267	2038	115	6084	907	518	676	329	2470	20829
SSN	7500	-	2470	1012	-	99	-	0	-	0	-	11080
TSB	1610	93	557	227	10	259	87	39	46	16	236	2707
SSB	1525	-	483	154	-	12	-	0	-	0	-	2174

Table 2.4.2 Mean weight at age (g) per spawning stock and area. I = immature; M = mature.

Age winter rings	IVa W	IVa E		IVb W	IVb E		SKAGERRAK		KATTEGAT		MEAN	
	au	sp	au	au	sp	au	sp	au	sp	au	sp	au
0	-	-	-	17	-	16	17	17	19	20	18	16
1	59	-	89	62	-	61	-	74	50	49	50	64
2I	117	94	104	107	84	92	91	-	71	-	85	94
2M	151	-	148	135	-	122	-	-	-	-	-	145
3I	193	119	118	129	-	110	104	-	87	-	108	178
3M	189	-	185	169	-	154	-	-	-	-	-	186
4	210	136	202	186	-	95	114	-	101	-	130	208
5	238	153	219	211	-	-	132	-	87	-	144	232
6	266	164	237	250	-	-	129	-	155	-	157	257
7	298	192	248	-	-	-	132	-	127	-	164	282
8	294	182	267	205	-	-	145	-	-	-	162	278
9+	324	220	312	-	-	-	-	-	-	-	220	318

Table 2.4.3 Estimates of North Sea autumn spawners (millions) at age from acoustic surveys, 1984-1990. 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 1990 estimates are from the summer survey in Divisions IVa,b, and IIIa excluding estimates of Division IIIa/Baltic spring spawners.

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

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 1980-1990. 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	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*
Mean	0.37		0.36	0.37	0.64
90z/k	0.31		0.35	0.37	0.58
89z/k	0.31		0.37	0.35	

90z/k: Mortality rates used in the 1990 HAWG Report (Anon., 1990b).
89z/k: Mortality rates used in the 1989 HAWG Report (Anon., 1989a).

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/Sh	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

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

Table 2.5.4 Larvae abundance indices (LAI) by area and for the total North Sea.

Year	Ork-Shet.	Buchan	Central North Sea	IVc+VIId	North Sea
1972	5,779	7	112	171	6,405
1973	2,387	10	734	133	5,466
1974	1,284	379	635	25	4,228
1975	439	441	59	25	1,141
1976	655	1	76	18	978
1977	1,321	228	174	23	2,268
1978	3,705	363	462	111	6,027
1979	5,649	200	188	403	7,004
1980	3,982	18	214	1,193	6,049
1981	3,939	20	3,364	4,855	22,270
1982	3,795	1,002	338	3,709	9,858
1983	3,346	4,483	661	2,354	12,827
1984	3,538	4,296	1,055	2,267	14,321
1985	10,487	4,351	3,802	4,065	34,111
1986	5,500	3,780	2,027	4,780	22,168
1987	9,596	3,308	1,970	3,317	24,101
1988	16,502	12,319	2,946	3,907	44,512
1989	17,424	6,940	2,205	7,861	41,045
1990[1]	-	-	-	-	-

[1] No LAI could be calculated for 1990.

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

Catches in: 1990

Division	Quarter	0 1989	1 1988	2 1987	3 1986	4 1985	5 1984	6 1983	7 1982	8 1981	9 1980
	I			92	117	135	157	162	180	164	180
IVa West	II			119	152	187	206	276	260	296	306
(W of 2 E)	III	17	67	139	186	215	239	270	286	287	307
	IV		85	120	141	163	181	197	213	215	302
	Total	17	71	128	170	202	224	262	275	287	306
	I			86	113	136	149	166	186	196	162
IVa East	II		80	119	132	154	188	257	243	267	299
(E of 2 E)	III	17	97	155	204	212	215	233	237	243	301
	IV	22	105	126	147	163	174	192	191	208	252
	Total	19	104	116	141	161	176	211	211	220	281
	I		26	49	62	125	164	172			
IVb	II		49	103	118	139	149	156	290		
	III	17	58	137	164	197	222	258	272	259	277
	IV	24	68	119	139	196	196	184	231		
	Total	19	53	102	145	194	219	250	272	259	277
	I		57	83	95	113	119	142	140	207	
IVc + VIId	II		67	120	154	172	186	196	210	208	285
	III		93	113	138	164	199	193	210		190
	IV		85	119	135	156	178	203	221	208	233
	Total		85	118	131	152	171	195	216	208	231
IVa	Total	19	100	123	154	177	194	229	234	251	295
	I		26	60	106	135	150	165	186	195	163
IVa + IVb	II		49	112	139	163	194	253	249	283	303
	III	17	58	139	180	208	228	256	266	272	294
	IV	24	73	122	145	163	175	193	194	208	255
	Total	19	55	113	152	181	198	232	238	252	290
	I		47	74	101	125	137	155	166	201	163
Total	II		60	116	147	167	190	228	231	251	294
North	III	17	80	127	162	189	215	229	242	272	253
Sea	IV	24	80	120	140	160	177	198	208	208	245
Total N.S.	Total	19	55	114	149	177	193	229	236	250	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 1985-1990.

Division	Year	Age 2	3	4	5	6	7	8	9 +
	Pre- 1985	137	170	199	216	235	263	270	293
	1986	123	158	183	209	222	246	253	263
IVa	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
	Pre- 1985	123	177	202	216	223	250	267	291
	1986	120	157	191	219	232	220	207	237
IVb	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
	Pre- 1985	126	176	211	243	256	267	271	271
	1985	133	171	200	216	233	261	270	293
IVa + IVb	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
	pre- 1985	117	141	170	192	221	224	216	208
	1985	113	124	148	170	168	212	207	193
IVc + VIId	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
	pre- 1985	125	166	204	228	253	266	271	270
	1985	128	164	194	211	220	258	270	292
Total	1986	121	153	182	207	221	238	252	262
North Sea	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

Spring spawners transferred to Division IIIa are not included.

Table 2.7.1 Time series of relative estimates of spawning stock, and the spawning stock for the converged part of the VPA ('000 t).

Year	SSB VPA	SSB LPE	SSB Acoustic	LAI	IYFS 2+ Total Area
1972	289	146	-	6,405	-
1973	235	116	-	5,466	-
1974	166	77	-	4,228	-
1975	83	61	-	1,141	-
1976	80	20	-	978	-
1977	52	-	-	2,268	-
1978	71	108	-	6,027	-
1979	114	224	-	7,004	-
1980	140	365	-	6,049	35.4
1981	205	636	305	22,270	863.0
1982	289	480	402	9,858	201.5
1983	447	635	440	12,827	270.8
1984	744	871	807	14,321	377.1
1985	783	1,022	697	34,111	1,166.5
1986	850	1,244	942	22,168	1,204.7
1987	1,003	699	667[1]	24,101	1,705.3
1988	-	1,249	801[2]	44,512	4,760.1
1989	-	1,328	1,490[3]	40,707	1,296.5
1990	-	1,547	2,009[4]	-	1,050.4

[1] Reduced by 150,000 t [catches of spawners between 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].

Table 2.7.2

Analysis by RCRTINX2 of data from file SUR-IND-4
PRediction of SSB from LPE, Acoustics, IYFS 2+, Total North Sea.

Data for 3 surveys over 13 years
REGRESSION TYPE = C
TAPERED TIME WEIGHTING NOT APPLIED
PRIOR 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 5 POINTS USED FOR REGRESSION

Yearclass = 1988

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight	New weights
LPE SS	7.1309	1.409	-3.002	.8209	10	7.0458	.46816	.52514	.23017	.216
ACOUST	6.6871	1.585	-3.763	.8565	7	6.8357	.27048	.30349	.68914	0
IYFS 2	8.4682	.768	1.441	.5635	8	7.9412	.69686	.88690	.08069	.076
ACOUST	6.6871	1.000	-0.051			6.6315		.29000	.	.708
MEAN						5.8013	.94482	.94482	.00000	

Yearclass = 1989

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight	
LPE SS	7.1922	1.409	-3.002	.8209	10	7.1321	.46816	.52986	.29969	.208
ACOUST	7.3072	1.585	-3.763	.8565	7	7.8186	.27048	.38798	.55894	0
IYFS 2	7.1682	.768	1.441	.5635	8	6.9433	.69686	.77146	.14137	.098
ACOUST	7.3072	1.000	-0.051			7.2522		.2900		.694
MEAN						5.8013	.94482	.94482	.00000	

Yearclass = 1990

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight	
LPE SS	7.3447	1.409	-3.002	.8209	10	7.3471	.46816	.54276	.33398	.200
ACOUST	7.6059	1.585	-3.763	.8565	7	8.2920	.27048	.44549	.49574	0
IYFS 2	6.9579	.768	1.441	.5635	8	6.7819	.69686	.76013	.17028	.102
ACOUST	7.6059	1.000	-0.051			7.5466		.2900		.699
MEAN						5.8013	.94482	.94482	.00000	

Yearclass		Weighted Average Prediction	Internal Standard Error	External Standard Error	Virtual Population Analysis	Ext.SE/ Int.SE
1988	6.97	1067.74	.25	.21		.84
1989	7.49	1788.50	.29	.27		.92
1990	7.72	2251.33	.31	.42		1.35

NEW PREDICTIONS

1988	6.82	916
1989	7.20	1335
1990	7.43	1684

Table 2.7.3 SUM OF PRODUCTS CHECK. North Sea HERRING (Fishing Area IV) including Division IIIa juvenile catches

Category: Total

CATCH IN NUMBERS UNIT: millions

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	898	684	750	289	996	264	238	257	130	542	1263	9520
1	1196	4379	3341	2368	846	2461	127	144	169	159	245	872
2	2003	1147	1441	1344	773	542	902	45	5	34	134	284
3	884	663	344	659	362	260	117	186	6	10	92	57
4	125	208	131	150	126	141	52	11	5	10	32	40
5	50	27	33	59	56	57	35	7	0	2	22	29
6	61	31	5	31	22	16	6	4	0	0	2	23
7	8	27	0	4	5	9	4	2	0	1	1	19
8	12	0	1	1	2	3	1	1	0	1	0	6
9+	12	12	0	1	1	1	0	0	0	0	0	1
TOTAL	5249	7177	6046	4907	3189	3753	1482	656	315	759	1792	10849

	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	11957	13297	6662	4179	3664	8036	3123	2959	854
1	1116	2449	1737	3228	4723	6675	7763	2938	1477
2	299	574	1095	1316	1246	2124	2248	1490	593
3	230	216	422	1173	827	687	1185	1384	763
4	34	105	193	366	458	482	398	828	849
5	14	26	78	124	128	249	261	218	376
6	7	23	22	43	61	76	129	129	80
7	8	13	24	20	20	24	38	63	54
8	4	11	11	13	13	8	15	21	28
9+	1	12	18	16	15	8	8	9	12
TOTAL	13670	16726	10260	10478	11156	18367	15167	10039	5087

Table 2.7.4 Herring in the total North Sea (Sub-area IV). Weight at age (g) in the stock at time of spawning and proportions of maturity by years, applied in the VPA.

Age	Weight at age							Proportions of maturity age								
	1947-1984	1985	1986	1987	1988	1989	1990	1947-1955	1956-1971	1972-1984	1985	1986	1987	1988	1989	1990
0	15	9	6	6	7	12	16	-	-	-	-	-	-	-	-	-
1	50	64	78	49	43	51	64	-	-	-	-	-	-	-	-	-
2	155	141	146	133	122	140	145	0.70	1.00	0.82	70	0.75	0.63	0.66	0.79	0.73
3	187	193	190	183	163	178	186	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.94	0.97
4	223	228	224	220	215	211	208	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	239	248	248	247	239	254	232	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	276	258	281	263	270	283	257	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	299	300	287	285	277	288	282	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	306	318	328	310	297	316	278	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9+	312	316	364	342	310	362	318	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

(Values for 1985-1990 derived from acoustic survey data.)

Table 2.7.5 North Sea HERRING (Fishing area IV).SOP.

MEAN WEIGHT AT AGE IN THE CATCH UNIT: gram

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000	7.000
1	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000	49.000
2	126.000	126.000	126.000	126.000	126.000	126.000	126.000	126.000	126.000	126.000	126.000	118.000
3	176.000	176.000	176.000	176.000	176.000	176.000	176.000	176.000	176.000	176.000	176.000	142.000
4	211.000	211.000	211.000	211.000	211.000	211.000	211.000	211.000	211.000	211.000	211.000	189.000
5	243.000	243.000	243.000	243.000	243.000	243.000	243.000	243.000	243.000	243.000	243.000	211.000
6	251.000	251.000	251.000	251.000	251.000	251.000	251.000	251.000	251.000	251.000	251.000	222.000
7	267.000	267.000	267.000	267.000	267.000	267.000	267.000	267.000	267.000	267.000	267.000	267.000
8	271.000	271.000	271.000	271.000	271.000	271.000	271.000	271.000	271.000	271.000	271.000	271.000
9+	271.000	271.000	271.000	271.000	271.000	271.000	271.000	271.000	271.000	271.000	271.000	271.000

	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	10.000	10.000	10.000	9.000	6.000	11.000	11.000	17.000	19.000
1	59.000	59.000	59.000	36.000	67.000	35.000	55.000	43.000	55.000
2	118.000	118.000	118.000	128.000	121.000	99.000	111.000	115.000	114.000
3	149.000	149.000	149.000	164.000	153.000	150.000	145.000	153.000	149.000
4	179.000	179.000	179.000	194.000	182.000	180.000	174.000	173.000	177.000
5	217.000	217.000	217.000	211.000	208.000	211.000	197.000	208.000	193.000
6	238.000	238.000	238.000	220.000	221.000	234.000	216.000	231.000	229.000
7	265.000	265.000	265.000	258.000	238.000	258.000	237.000	247.000	236.000
8	274.000	274.000	274.000	270.000	252.000	277.000	253.000	265.000	250.000
9+	275.000	275.000	275.000	292.000	262.000	299.000	263.000	259.000	287.000

Table 2.7.6 North Sea HERRING (Fishing area IV) including Division IIIa juvenile catches.

from 70 to 90 on ages 0 to 8
with Terminal F of .365 on age 4 and Terminal S of 1.000

Initial sum of squared residuals was 229.918 and
final sum of squared residuals is 100.653 after 105 iterations

Matrix of Residuals

Years Ages	70/71	71/72	72/73	73/74	74/75	75/76	76/77	77/78	78/79	79/80		
0/ 1	-1.661	-2.319	-.776	-1.222	-.725	.404	-.082	-1.771	.136	1.842		
1/ 2	-1.435	-1.058	.048	-.394	-.752	-.915	-1.140	-.208	.898	.170		
2/ 3	.267	-.280	.547	.446	.508	.254	.066	-.810	-.752	-.345		
3/ 4	.488	.043	.531	.693	.239	.144	.704	.697	-.568	-.497		
4/ 5	.372	.039	.326	-.178	-.117	-.317	.058	.441	.744	-.221		
5/ 6	-.648	-.104	-.376	-.168	.358	.536	.203	.433	.297	.467		
6/ 7	-.373	3.178	-.197	.614	-.035	-.447	-.575	-.179	-1.567	-1.453		
7/ 8	3.324	1.516	-2.310	-.431	-.406	.630	.039	-1.000	-1.140	1.319		
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		
WTS	.001	.001	.001	.001	.001	.001	.001	.001	.010	.010		
Years Ages	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90		WTS
0/ 1	.898	1.778	1.924	2.275	1.042	-.195	-.512	.081	.064	.472	.000	.196
1/ 2	-.738	-.467	-.105	-.091	-.564	-.324	-.294	-.051	.472	.211	.000	.444
2/ 3	.911	-.656	.206	.065	-.265	-.153	.155	.098	-.037	-.056	.000	.571
3/ 4	.896	-.347	.673	-.129	-.071	.298	.082	.040	-.182	-.241	.000	.583
4/ 5	.032	-.020	.000	-.089	.077	.246	-.007	-.051	-.098	-.096	.000	1.000
5/ 6	-.120	.420	-.697	-.185	.232	-.086	-.079	.011	.017	.133	.000	.726
6/ 7	-2.232	-.012	-.934	-.497	-.333	-.090	.284	-.019	-.037	-.070	.000	.242
7/ 8	-1.370	.715	-.507	-.114	.345	-.307	.418	-.117	.001	.011	.000	.215
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	-3.993	
WTS	.010	.010	.010	.010	.010	1.000	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	70
F-values	1.1303

	71	72	73	74	75	76	77	78	79	80
F-values	1.2892	.6590	1.0487	1.0314	1.6336	1.6961	1.2293	.1247	.1401	.3395

	81	82	83	84	85	86	87	88	89	90
F-values	.5278	.3243	.4019	.4636	.6058	.5340	.5502	.5440	.5103	.3650

Selection-at-age (S)

	0	1	2	3	4	5	6	7	8
S-values	.1997	.7174	.6958	.8498	1.0000	.9920	.9988	.9322	1.0000

Table 2.7.7 VPA.

NORTH SEA HERRING (FISHING AREA IV) including Division IIIa juvenile catches.

FISHING MORTALITY COEFFICIENT UNIT: Year-1 VARIABLE NATURAL MORTALITY COEFFICIENT

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	.035	.034	.058	.046	.075	.151	.142	.095	.044	.084	.125	.481
1	.268	.602	.577	.674	.450	.685	.237	.285	.195	.161	.113	.284
2	.973	.883	.812	1.019	1.028	1.298	1.325	.211	.023	.092	.349	.323
3	1.266	1.215	.802	1.331	.964	1.503	1.380	1.355	.039	.063	.403	.260
4	1.321	1.222	.800	.989	.987	1.333	1.730	.393	.096	.087	.280	.287
5	.867	1.059	.545	.952	1.192	1.827	1.415	1.182	.015	.048	.242	.380
6	1.064	2.449	.492	1.350	1.080	1.297	.964	.531	.075	.011	.061	.379
7	3.951	2.443	.081	.732	.732	2.042	1.612	.584	.039	.419	.091	.831
8	1.130	1.289	.659	1.049	1.031	1.634	1.696	1.229	.125	.140	.339	.528
9+	1.130	1.289	.659	1.049	1.031	1.634	1.696	1.229	.125	.140	.339	.528
(2- 6)U	1.098	1.366	.690	1.128	1.050	1.451	1.363	.734	.050	.060	.267	.326
(2- 6)W	1.057	1.022	.803	1.100	1.014	1.377	1.346	.763	.037	.080	.334	.316

	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	.333	.391	.212	.080	.057	.153	.132	.158	.073
1	.224	.250	.189	.368	.290	.337	.546	.434	.262
2	.259	.301	.296	.380	.428	.364	.320	.339	.254
3	.507	.322	.404	.642	.469	.478	.380	.356	.310
4	.230	.434	.500	.697	.530	.523	.536	.473	.365
5	.144	.251	.584	.616	.494	.543	.529	.561	.362
6	.130	.316	.301	.672	.626	.542	.531	.482	.365
7	.193	.341	.567	.444	.682	.468	.508	.480	.340
8	.324	.402	.464	.606	.534	.550	.544	.510	.365
9+	.324	.402	.464	.606	.534	.550	.544	.510	.365
(2- 6)U	.254	.325	.417	.602	.509	.490	.459	.442	.331
(2- 6)W	.312	.315	.339	.501	.461	.411	.363	.378	.317

Table 2.7.8 VIRTUAL POPULATION ANALYSIS

NORTH SEA HERRING (FISHING AREA IV) including Division IIIa juvenile catches.

STOCK SIZE IN NUMBERS UNIT: millions

BIOMASS TOTALS UNIT: tonnes

ALL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING STOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE USED: PROPORTION OF ANNUAL F BEFORE SPAWNING: .670
PROPORTION OF ANNUAL M BEFORE SPAWNING: .670

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	41086	32346	20861	10142	21756	2946	2814	4433	4738	10626	16791	37952
1	7873	14594	11502	7240	3563	7427	932	898	1482	1668	3596	5450
2	3640	2215	2941	2376	1358	836	1377	271	248	449	522	1182
3	1330	1019	679	968	635	360	169	271	162	180	303	273
4	178	307	248	249	209	198	66	35	57	128	138	166
5	91	43	82	101	84	71	47	11	21	47	106	94
6	97	34	13	43	35	23	10	10	3	19	41	75
7	8	30	3	7	10	11	6	4	6	2	17	35
8	18	0	2	2	3	4	1	1	2	5	1	14
9+	19	18	1	1	2	2	1	0	3	1	0	3
TOTAL NO	54340	50607	36332	21129	27656	11878	5423	5933	6723	13124	21516	45243
SPS NO	2227	1563	1694	1344	909	459	483	292	384	613	724	1119
TOT.BIOM	1924871	1851745	1551095	1158001	914769	685010	364872	218598	235763	393405	642295	1171811
SPS BIOM	377720	267848	289090	234591	163166	83355	80382	51654	70617	114246	139813	205328
TOT.B.[1]	852664	758882	681235	454480	403929	230462	131934	106565	141880	232132	331516	529408

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	65007	62992	54115	85380	103344	88478	39550	31616	19103	0
1	8632	17142	15676	16097	28993	35896	27931	12752	9931	6533
2	1509	2538	4910	4771	4098	7981	9425	5952	3040	2812
3	633	863	1392	2705	2417	1979	4108	5071	3142	1747
4	172	313	512	761	1166	1237	1004	2300	2909	1886
5	113	124	183	281	343	621	664	532	1296	1827
6	58	88	87	92	137	189	327	354	275	817
7	47	46	58	58	43	66	100	174	198	173
8	14	35	30	30	34	20	38	54	97	127
9+	4	38	50	37	37	20	21	23	40	87
TOTAL NO	76189	84179	77013	110213	140612	136488	83168	58826	40031	
SPS NO	1581	2470	4246	4414	4581	5891	8023	8666	7227	
TOT.BIOM	1859958	2516802	2841038	3299209	4360680	4220596	3805407	3561749	3038490	
SPS BIOM	288730	446444	742853	780021	844173	991148	1242269	1549055	1410974	
TOT.B[1]	842709	1157017	1450508	1590981	2073321	2050402	1997761	2262222	2511743	

[1] At spawning time.

Table 2.7.9 VIRTUAL POPULATION ANALYSIS

HERRING IN THE SOUTHERN NORTH SEA (FISHING AREAS IVC AND VIID)

CATCH IN NUMBERS UNIT: millions

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	4	22	5	2	4	24	22	1	0	0	23	7
2	82	131	135	43	24	127	94	6	3	22	99	223
3	84	42	29	115	20	40	42	3	4	9	84	40
4	5	31	9	55	8	5	4	1	1	6	30	19
5	2	1	5	7	1	2	1	0	0	1	18	7
6	1	0	0	2	0	0	0	0	0	0	2	3
7	0	1	0	1	0	0	0	0	0	0	1	1
8	0	0	0	0	0	0	0	0	0	0	0	0
9+	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	178	227	184	226	58	198	163	11	8	37	257	300

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	21	25	14	13	11	20	4	13	11
2	201	252	173	314	108	161	112	106	139
3	221	105	117	169	194	77	213	205	95
4	27	65	33	44	46	81	45	182	109
5	7	11	23	12	14	14	33	32	60
6	2	3	2	8	9	7	6	20	8
7	2	1	1	1	2	0	1	3	5
8	1	1	0	0	0	0	1	1	1
9+	0	0	0	0	0	1	0	0	1
TOTAL	481	462	361	563	383	360	414	562	429

Table 2.7.10 VIRTUAL POPULATION ANALYSIS

HERRING IN THE SOUTHERN NORTH SEA (FISHING AREAS IVC AND VIID)

FISHING MORTALITY COEFFICIENT UNIT: Year-1 VARIABLE NATURAL MORTALITY COEFFICIENT

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	.008	.037	.031	.014	.011	.111	.168	.006	.001	.001	.018	.009
2	.703	.729	.608	.806	.362	1.195	2.122	.112	.038	.132	.612	.412
3	1.040	1.108	.375	2.292	1.367	2.293	3.168	.376	.100	.174	1.186	.589
4	1.540	1.573	.760	3.701	1.480	2.228	2.651	.619	.240	.188	1.332	.958
5	1.466	.752	1.143	3.999	3.107	1.621	2.002	1.811	.014	.163	1.368	1.155
6	.910	1.177	.018	2.215	1.664	.224	1.382	.155	.337	.165	.799	.874
7	2.233	3.451	.087	3.737	2.910	.648	.325	.118	.205	.583	3.471	.649
8	1.987	2.515	.849	3.927	2.435	3.163	4.246	.551	.148	.289	2.003	1.201
9+	1.987	2.515	.849	3.927	2.435	3.163	4.246	.551	.148	.289	2.003	1.201
(2- 6)U	1.132	1.068	.581	2.603	1.596	1.512	2.265	.615	.146	.164	1.059	.798
(3- 6)U	1.239	1.152	.574	3.052	1.905	1.592	2.301	.740	.173	.172	1.171	.894

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.021	.025	.009	.019	.006	.013	.005	.011	.008
2	.638	.682	.421	.506	.364	.195	.165	.294	.265
3	1.044	.919	.879	1.063	.740	.522	.453	.546	.504
4	.949	.993	.809	.977	.920	.761	.632	.847	.600
5	.982	1.310	1.071	.720	.823	.703	.711	1.124	.659
6	1.543	1.662	.779	1.536	1.994	1.133	.643	1.155	.867
7	1.204	2.505	1.546	2.329	2.363	.168	.340	.874	.874
8	1.796	1.929	1.392	1.691	1.334	.834	.699	1.101	.900
9+	1.796	1.929	1.392	1.691	1.334	.834	.699	1.101	.900
(2- 6)U	1.031	1.113	.792	.960	.968	.663	.521	.793	.579
(3- 6)U	1.130	1.221	.884	1.074	1.119	.780	.610	.918	.657

Table 2.7.11 VIRTUAL POPULATION ANALYSIS

HERRING IN THE SOUTHERN NORTH SEA (FISHING AREAS IVC AND VIID)

STOCK SIZE IN NUMBERS UNIT: millions

BIOMASS TOTALS UNIT: thousand tonnes

ALL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING STOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE USED: PROPORTION OF ANNUAL F BEFORE SPAWNING: 1.000
PROPORTION OF ANNUAL M BEFORE SPAWNING: 1.000

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	788	954	249	251	564	359	224	238	547	672	2090	1332
2	184	287	338	89	91	205	118	70	87	201	247	755
3	141	67	103	136	29	47	46	10	46	62	131	99
4	7	41	18	58	11	6	4	2	6	34	43	33
5	2	1	8	8	1	2	1	0	1	4	26	10
6	2	0	1	2	0	0	0	0	0	1	3	6
7	0	1	0	1	0	0	0	0	0	0	1	1
8	0	0	0	0	0	0	0	0	0	0	0	0
9+	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL NO	1124	1352	717	544	697	620	393	320	688	974	2540	2237
SPS NO	111	129	205	42	55	51	13	53	101	203	149	433
TOT.BIOM	121	143	87	70	71	68	44	33	70	105	259	244
SPS BIOM	16	18	29	6	7	7	2	7	14	29	21	57

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	1608	1605	2479	1120	2868	2339	1307	1892	2099	0
2	486	579	576	904	404	1049	849	478	689	766
3	371	190	217	280	404	208	639	533	264	391
4	45	107	62	74	79	158	101	333	253	131
5	11	16	36	25	25	29	67	49	129	126
6	3	4	4	11	11	10	13	30	14	60
7	2	1	1	2	2	1	3	6	8	5
8	1	1	0	0	0	0	1	2	2	3
9+	0	0	1	0	1	1	0	0	1	1
TOTAL NO	2526	2502	3375	2416	3794	3795	2979	3322	3459	
SPS NO	318	319	392	522	406	824	953	671	718	
TOT.BIOM	281	276	356	256	359	266	307	359	364	
SPS BIOM	45	45	55	64	55	102	113	89	97	

Table 2.8.1
List of input variables for the ICES prediction program.

HERRING TOTAL NORTH SEA INCLUDING IIIA JUVENILES
The reference F is the mean F (non-weighted) for the age group range from 2 to 6

The number of recruits per year is as follows:

Year	Recruitment
1991	16100.0
1992	6650.0
1993	15000.0

Proportion of F (fishing mortality) effective before spawning: .6700
Proportion of M (natural mortality) effective before spawning: .6700

Data are printed in the following units:

Number of fish:	millions
Weight by age group in the catch:	gram
Weight by age group in the stock:	gram
Stock biomass:	tonnes
Catch weight:	tonnes

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
1	16100.0	.72	1.00	.00	55.000	64.000
2	3200.0	.70	.30	.73	114.000	145.000
3	1747.0	.85	.20	.97	149.000	186.000
4	1886.0	1.00	.10	1.00	177.000	208.000
5	1827.0	1.00	.10	1.00	193.000	232.000
6	817.0	1.00	.10	1.00	229.000	257.000
7	173.0	1.00	.10	1.00	236.000	282.000
8	127.0	1.00	.10	1.00	250.000	278.000
9+	87.0	1.00	.10	1.00	287.000	318.000

For data that can be entered by file or manually by screen the following table gives the method of input by age group. The identifiers in the table are to be interpreted as:

space: not defined or set by the program
M : manual input by screen
F : data read from a file

age	F at age	M at age	maturity ogive	weight in the catch	weight in the stock
1	M	F	F	F	F
2	M	F	F	F	F
3	M	F	F	F	F
4	M	F	F	F	F
5	M	F	F	F	F
6	M	F	F	F	F
7	M	F	F	F	F
8	M	F	F	F	F
9+	M	F	F	F	F

proportion of F before spawning: M
proportion of M before spawning: M

The data from the files were selected as follows:

M at age:	year 1990 from file NATMOR
Maturity ogive:	year 1990 from file MORPROP
Catch weight:	year 1990 from file WECA
Stock weight:	year 1990 from file WEST

Table 2.8.2

Effects of different levels of fishing mortality on catch, stock biomass and spawning stock biomass.

HERRING TOTAL NORTH SEA INCLUDING IIIA JUVENILES

Year 1991					Year 1992					Year 1993	
factor	ref. F	stock biomass	sp.stock biomass	catch	factor	ref. F	stock biomass	sp.stock biomass	catch	stock biomass	sp.stock biomass
.2 TAC	.21	2957	1399	372	$F_{0.1}$ .1	.12	2667	1676	214	3194	1771
					.3	.30		1491	481	2853	1328
					.4	.33		1461	523	2799	1263
					.4	.40		1395	614	2684	1129
.3	.30	2957	1320	503	$F_{0.1}$ .1	.12	2495	1544	198	3047	1648
					.3	.30		1374	447	2730	1237
					.4	.33		1346	486	2679	1176
					.4	.40		1286	570	2572	1052
.4 F_{90}	.33	2957	1292	548	$F_{0.1}$ .1	.12	2436	1500	193	2997	1607
					.3	.30		1335	435	2688	1206
					.4	.33		1308	474	2639	1147
					.4	.40		1249	556	2534	1026
.4	.40	2957	1233	643	$F_{0.1}$ .1	.12	2312	1405	182	2891	1518
					.3	.30		1251	411	2599	1140
					.4	.33		1225	447	2552	1085
					.4	.40		1171	524	2453	970

The data unit of the biomass and the catch is 1000 tonnes.
The spawning stock biomass is given for the time of spawning.
The spawning stock biomass for 1993 has been calculated with the same fishing mortality as for 1992.
The reference F is the mean F (non-weighted) for the age group range from 2 to 6

Table 2.8.3
HERRING TOTAL NORTH SEA INCLUDING IIIA JUVENILES

****
* Year 1991. F-factor .329 and reference F .2994 *
****

						at 1 January		at spawning time	
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass	sp.stock size	sp.stock biomass
1	.2369	2188.31	120356	16100.0	1030400	.00	0	.00	0
2	.2303	571.96	65203	3200.0	464000	2336.00	338720	1637.45	237430
3	.2797	388.07	57822	1747.0	324942	1694.59	315193	1228.85	228565
4	.3290	504.55	89305	1886.0	392288	1886.00	392288	1414.86	294290
5	.3290	488.77	94332	1827.0	423864	1827.00	423864	1370.60	317978
6	.3290	218.57	50052	817.0	209969	817.00	209969	612.90	157516
7	.3290	46.28	10922	173.0	48786	173.00	48786	129.78	36598
8	.3290	33.98	8493	127.0	35306	127.00	35306	95.27	26486
9+	.3290	23.27	6679	87.0	27666	87.00	27666	65.27	20754
Total		4463.76	503169	25964.0	2957221	8947.59	1791792	6554.97	1319619

****
* Year 1992. F-factor .329 and reference F .2994 *
****

						at 1 January		at spawning time	
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass	sp.stock size	sp.stock biomass
1	.2369	903.87	49712	6650.0	425600	.00	0	.00	0
2	.2303	835.36	95230	4673.6	677678	3411.76	494705	2391.52	346769
3	.2797	418.27	62322	1883.0	350232	1826.48	339725	1324.49	246354
4	.3290	289.30	51206	1081.4	224929	1081.39	224929	811.25	168739
5	.3290	328.54	63409	1228.1	284916	1228.09	284916	921.30	213741
6	.3290	318.27	72883	1189.7	305745	1189.67	305745	892.48	229366
7	.3290	142.32	33588	532.0	150023	532.00	150023	399.10	112545
8	.3290	30.14	7534	112.7	31316	112.65	31316	84.51	23493
9+	.3290	37.28	10699	139.3	44312	139.35	44312	104.54	33242
Total		3303.35	446586	17489.8	2494755	9521.39	1875675	6929.17	1374254

****
* Year 1993. F-factor .329 and reference F .2994 *
****

						at 1 January		at spawning time	
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass	sp.stock size	sp.stock biomass
1	.2369	2038.80	112133	15000.0	960000	.00	0	.00	0
2	.2303	345.04	39334	1930.4	279910	1409.21	204334	987.80	143231
3	.2797	610.89	91022	2750.1	511519	2667.60	496174	1934.43	359804
4	.3290	311.82	55191	1165.6	242436	1165.56	242436	874.39	181873
5	.3290	188.38	36357	704.2	163365	704.16	163365	528.25	122554
6	.3290	213.94	48991	799.7	205518	799.68	205518	599.91	154177
7	.3290	207.24	48909	774.7	218455	774.66	218455	581.15	163882
8	.3290	92.67	23168	346.4	96303	346.42	96303	259.88	72245
9+	.3290	43.90	12598	164.1	52181	164.09	52181	123.10	39145
Total		4052.68	467708	23635.1	2729689	8031.38	1678768	5888.91	1236915

Table 2.8.4 North Sea including juvenile catches in Division IIIa.

The reference F is the mean F (non-weighted) for the age group range from 2 to 6

The number of recruits per year is as follows:

Year	Recruitment
1991	16100.0
1992	6650.0
1993	15000.0

Proportion of F (fishing mortality) effective before spawning: .6700
Proportion of M (natural mortality) effective before spawning: .6700

Data are printed in the following units:

Number of fish: millions
Weight by age group in the catch: gram
Weight by age group in the stock: gram
Stock biomass: tonnes
Catch weight: tonnes

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
1	16100.0	.72	1.00	.00	55.000	64.000
2	3200.0	.70	.30	1.00	114.000	145.000
3	1747.0	.85	.20	1.00	149.000	186.000
4	1886.0	1.00	.10	1.00	177.000	208.000
5	1827.0	1.00	.10	1.00	193.000	232.000
6	817.0	1.00	.10	1.00	229.000	257.000
7	173.0	1.00	.10	1.00	236.000	282.000
8	127.0	1.00	.10	1.00	250.000	278.000
9+	87.0	1.00	.10	1.00	287.000	318.000

For data that can be entered by file or manually by screen the following table gives the method of input by age group. The identifiers in the table are to be interpreted as:

space: not defined or set by the program
M : manual input by screen
F : data read from a file

age	F at age	M at age	maturity ogive	weight in the catch	weight in the stock
1	M	F	F	F	F
2	M	F	M	F	F
3	M	F	M	F	F
4	M	F	F	F	F
5	M	F	F	F	F
6	M	F	F	F	F
7	M	F	F	F	F
8	M	F	F	F	F
9+	M	F	F	F	F

proportion of F before spawning: M
proportion of M before spawning: M

The data from the files were selected as follows:

M at age: year 1990 from file NATMOR
Maturity ogive: year 1990 from file MORPROP
Catch weight: year 1990 from file WECA
Stock weight: year 1990 from file WEST

Table 2.8.5 North Sea including juvenile catches in Division IIIa.
Effects of different levels of fishing mortality on catch, stock biomass and spawning stock biomass.

Year 1991					Year 1992					Year 1993	
fac-tor	ref. F	stock biomass	sp.stock biomass	catch	fac-tor	ref. F	stock biomass	sp.stock biomass	catch	stock biomass	sp.stock biomass
.2	.21	2957	1499	372	.1	.12	2667	1835	214	3194	1853
					.3	.30		1636	481	2853	1393
					.4	.33		1604	523	2799	1325
					.4	.40		1534	614	2684	1186
.3	.30	2957	1415	503	.1	.12	2495	1693	198	3047	1729
					.3	.30		1510	447	2730	1301
					.4	.33		1480	486	2679	1238
					.4	.40		1415	570	2572	1108
.4	.33	2957	1386	548	.1	.12	2436	1645	193	2997	1687
					.3	.30		1467	435	2688	1270
					.4	.33		1438	474	2639	1208
					.4	.40		1375	556	2534	1082
.4	.40	2957	1323	643	.1	.12	2312	1543	182	2891	1598
					.3	.30		1376	411	2599	1204
					.4	.33		1349	447	2552	1145
					.4	.40		1290	524	2453	1026

The data unit of the biomass and the catch is 1000 tonnes.
The spawning stock biomass is given for the time of spawning.
The spawning stock biomass for 1993 has been calculated with the same fishing mortality as for 1992.
The reference F is the mean F (non-weighted) for the age group range from 2 to 6

Table 2.10.1 HERRING Total North Sea, 1990.
Numbers (millions) and weight (g) at age (winter rings) and year class of herring caught in each quarter (spring-spawner transfers to Division IIIa excluded).

Catches in:		1990			Total North Sea							
		0	1	2	3	4	5	6	7	8	9	Total	SOP
Quarter		1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	no	('000t)
I	No	0.0	298.2	88.8	115.0	138.1	71.1	9.4	7.5	4.1	0.3	732.3	57.9
	w		26	61	105	133	147	163	184	195	163		
II	No	0.0	102.3	105.3	80.5	90.1	41.0	10.6	7.6	3.3	1.2	442.0	56.5
	w		49	112	139	163	194	252	249	282	302		
III	No	613.8	694.4	141.8	263.2	365.4	150.9	39.3	25.6	15.8	9.3	2319.3	251.9
	w	17	58	138	180	208	228	255	266	272	293		
IV	No	240.1	382.5	257.1	304.6	255.6	112.9	20.8	13.7	5.3	0.9	1593.6	177.3
	w	24	73	120	142	161	176	196	202	208	245		
Total	No	853.9	1477.4	592.8	763.3	849.1	375.9	80.1	54.4	28.4	11.8	5087.1	543.6
Year	w	19	55	114	149	177	193	229	236	250	287		
Stock weights *)		16	64	128	186	207	232	257	282	278	318		

*) These stock weights derive from the acoustic survey samples taken in July from Divisions IVa,b and used in the 1991 SSVPA
For the 2 and 3 ringers the stock weights are combined of the one of immature and mature fish displayed above.

Age (Immature/Mature)	:	2I	2M	3I	3M
Mean weight	:	81	142	179	186

Table 3.1.1 Transfer of Division IIIa spring spawners taken in the North Sea catches in 1986-1990. Catch in numbers ('000) and mean weight (g) at age with SOPs in tonnes.

Year		Quarters 2 and 3 Divisions IVa (e) and IVb								Total
		2	3	4	5	6	7	8	9+	
1986	No	-	52,782	42,013	14,617	2,751	1,938	602	651	115,354
	w	-	156.8	171.7	194.5	210.1	216.6	210.6	283.1	
	SOP	-	8,276	7,214	2,843	578	420	128	184	19,642
1987	No	35,500	35,000	25,000	8,900	2,800	700	100	100	108,100
	w	94	124	147	177	195	216	278	283	
	SOP									14,207
1988	No	44,561	108,915	19,532	8,168	2,203	391	-	-	183,770
	w	94	131	154	171	176	212	-	-	
	SOP	4,206	14,221	3,015	1,393	399	83	-	-	23,306
1989	No	27,313	52,687	38,325	11,615	8,651	3,811	1,700	224	144,326
	w	91	120	164	180	178	191	202	209	
	SOP	2,488	6,337	6,298	2,090	1,537	729	344	47	19,869
1990	No	12,431	14,703	21,812	3,573	2,986	2,088	746	352	58,691
	w	103	113	134	166	161	184	190	236	
	SOP	1,079	1,668	2,932	1,588	482	384	142	83	8,358

Table 3.2.1 HERRING in Division IIIa.
Landings in tonnes, 1983-1990. (Data provided by Working Group members 1990.)

Country	1983	1984	1985	1986	1987	1988	1989	1990[1]
				Skagerrak				
Denmark	54,102	64,621	88,192	94,014	105,017	144,421	47,393	62,349
Faroe Islands	1,980	891	455	520	-	-	-	-
Germany, Fed.Rep.	40	-	-	11	-	-	-	-
Norway (Open sea)	500	-	2,752	677	-	2,982	242	4,056
Norway (Fjords)	2,834	1,494	1,673	860	1,209	2,692	1,363	1,542
Sweden	35,176	59,195	40,349	42,996	51,184	57,159	47,900	56,503
Total	94,632	126,201	133,421	139,078	157,410	207,254	96,898	124,450
				Kattegat				
Denmark	62,901	71,359	69,235	37,419	46,603	76,175	57,130	32,224
Sweden	40,463	35,027	39,829	35,852	29,844	49,653	37,869	45,288
Total	103,364	106,386	109,064	73,271	76,447	125,828	94,999	77,512
Div. IIIa total	197,996	232,587	242,485	212,349	233,931	333,082	191,897	201,962

[1] Preliminary.

Table 3.2.2 HERRING Division IIIa, 1990.
Numbers (millions) at age (winter rings) of herring landed for human consumption only (41% of total landings). Landings in tonnes.

Quarter		0	1	2	3	4	5	6	7	8	9+	Total landings
	Skagerrak	-	5.8	57.4	14.9	9.1	3.0	0.8	0.6	0.3	+	6,752
I	Kattegat	-	16.6	55.7	16.0	12.4	3.0	0.8	0.4	0.2	-	6,740
	Div. IIIa	-	22.4	113.1	30.9	21.5	6.0	1.6	1.0	0.5	+	13,492
II	Skagerrak	-	5.1	39.2	11.2	7.2	1.9	0.5	0.4	0.2	+	5,017
	Kattegat	-	0.2	4.0	8,6	13.0	2.6	0.5	0.6	-	-	2,292
	Div. IIIa	-	3.9	40.9	17.7	18.9	4.5	1.0	1.0	0.2	+	7,209
III	Skagerrak	-	58.1	102.0	41.1	38.6	13.8	2.6	11.4	+	0.1	29,617
	Kattegat	-	4.6	36.2	17.8	13.0	2.2	0.8	0.4	0.1	-	7,201
	Div. IIIa	-	57.2	131.7	52.4	47.9	15.6	3.0	11.7	0.1	0.1	36,818
IV	Skagerrak	-	2.5	77.1	22.6	5.0	4.1	0.8	0.1	0.1	+	9,676
	Kattegat	0.8	75.1	66.9	15.9	11.2	1.5	0.2	-	0.2	-	15,050
	Div. IIIa	0.8	75.5	142.8	36.5	15.2	5.4	1.0	0.1	0.3	+	24,726
Total	Skagerrak	-	71.5	275.7	89.8	59.9	22.8	4.7	12.5	0.6	0.2	51,062
year	Kattegat	0.8	96.5	162.8	58.3	49.6	9.3	2.3	1.4	0.5	-	31,283
	Div. IIIa	0.8	168.0	438.5	148.1	109.5	32.1	7.0	13.9	1.1	0.2	82,345

Table 3.2.3 HERRING in Division IIIa.
Samples of commercial catches by quarter and area for 1990 available to the Working Group.

Country	Quarter	Consumption		Industrial	
		Catch (t)	No. aged	Catch (t)	No. aged
		Skagerrak			
Denmark	1	4,125	0	8,326	1,007
	2	3,009	0	3,423	295
	3	19,547	655	15,304	0
	4	2,809	0	5,806	0
Sweden	1	2,627	1,930	1,061	207
	2	1,334	0	15,268	0
	3	7,500	1,801	18,328	570
	4	6,055	2,583	4,329	186
Total		47,006	6,969	71,845	2,265
		Kattegat			
Denmark	1	2,643	296	7,643	2,532
	2	1,286	0	1,018	667
	3	4,922	255	4,201	191
	4	5,312	301	5,298	59
Sweden	1	4,096	1,725	7,312	1,129
	2	1,006	2,243	4,639	1,792
	3	2,279	1,858	5,444	1,056
	4	9,837	2,082	10,675	1,487
Total		31,282	8,760	46,230	8,912

Table 3.3.1 Total estimate of Division IIIa spring-spawning herring in Division IIIa and the eastern part of the Sub-area IV in 1987 - 1990 and mean weight at age in 1988 - 1990 (from acoustic surveys).

Age group	1987	1988	$\bar{w}$(g)	1989	$\bar{w}$(g)	1990	$\bar{w}$(g)
0	-	-	-	-	-	31	18
1	-	-	-	-	-	135	50
2	958	1,511.6	65	1,105	78	1,352	85
3	665	761.4	118	714	117	521	108
4	310	86.7	160	317	171	320	130
5	114	74.2	166	81	198	76	144
6	43	18.0	181	54	211	23	157
7	3	1.0	241	16	215	9	164
8+	-	1.2	175	4.2	226	3	181
Total (millions)	2,093	2,454	-	2,289	-	2,470	-
Biomass (t)	252,459	217,997	-	255,500	-	236,000	-

Table 3.4.1 Recruitment indices for 1- and 2-group herring from International Young Fish Survey in Division IIIa. Indices are given for North Sea autumn and spring spawners based on modal length analysis and vertebral counts.

Year	Index					
	Total		Spring spawners		Autumn spawners	
	1-gr	2-gr	1-gr	2-gr	1-gr	2-gr
1980	2,311	387	1,607	307	704	80
1981	3,246	1,393	9,660	1,318	2,250	75
1982	2,560	549	1,408	445	1,152	104
1983	5,419	1,063	1,522	946	3,897	117
1984	6,035	1,947	2,793	1,419	3,242	528
1985	7,994	2,473	-[1]	1,867	-[1]	606
1986	21,489	2,738	-[1]	1,562	-[1]	1,175
1987	11,733	3,671	-[1]	2,921	-[1]	949
1988	67,753	10,095	-[1]	7,834	-[1]	2,161
1989	17,451	4,976	-[1]	0	-[1]	4,976
1990	3,544	3,876	0	3,192	3,544	684
1991	3,588	3,749	-[1]	480	-[1]	3,269

[1] Separation not valid.

Table 4.2.1 Celtic Sea and Division VIIj HERRING landings by calendar year (t), 1977-1990. (Data provided by by Working Group members.)

Year	France	Germany, Fed.Rep.	Ireland	Netherlands	U.K.	Unallocated	Discards	Total
1977	106	96	5,533	1,455	-	-	-	7,190
1978	8	220	6,249	1,002	-	850	-	8,329
1979	584	20	7,019	850	-	3,708	-	12,181
1980	9	2	8,849	393	-	-	-	9,253
1981	123	-	15,562	1,150	-	-	-	16,835
1982	+	-	9,501	-	-	6,900	-	16,401
1983	495	-	10,000	1,500	-	15,500	5,200	32,695
1984	680	-	7,000	890	-	14,800	4,200	27,570
1985	622	-	11,000	-	-	11,000	4,300	26,922
1986	-	-	13,338	+	-	13,900	5,300	32,538
1987	820	-	15,500	1,453	-	13,500	5,900	37,173
1988	-	-	16,766	-	-	9,100	3,700	29,566
1989	10	-	15,880	1,942	-	9,200	5,000	32,032
1990[1]	+	-	15,900	1,040	170	8,800	2,500	28,410

[1] Provisional.

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

Year	France	Germany, Fed.Rep.	Ireland	Netherlands	U.K.	Unallocated	Discards	Total
1977/1978	95	96	6,264	1,378	-	-	-	7,833
1978/1979	8	220	8,239	1,002	-	-	-	7,559
1979/1980	584	20	7,932	850	-	935	-	10,321
1980/1981	9	2	9,024	292	-	3,803	-	13,130
1981/1982	123	-	15,830	1,150	-	-	-	17,103
1982/1983	+	-	13,042	-	-	-	-	10,942
1983/1984	495	-	10,000	1,500	-	14,586	4,897	31,378
1984/1985	680	-	7,000	890	-	17,709	4,942	31,221
1985/1986	622	-	11,995	-	-	10,909	4,581	28,107
1986/1987	-	-	14,725	1	-	13,898	5,725	34,349
1987/1988	820	-	15,500	1,453	-	12,644	5,629	36,046
1988/1989	-	-	17,047	-	-	9,100	5,229	31,376
1989/1990	10	-	15,000	1,942	-	10,502	5,100	32,554
1990/1991[1]	+	-	15,900	1,040	170	8,402	2,551	28,063

[1] Provisional.

Table 4.2.3 Celtic Sea/Division VIIj.
Length distribution of Irish catches per quarter (thousands).

Length	VIIaS		VIIG		VIIJ	
	4Q 1990	1Q 1991	4Q 1990	1Q 1991	4Q 1990	1Q 1991
16.	-	-	8	-	-	-
16.5	-	-	-	-	-	-
17	-	-	-	-	-	-
17.5	-	-	-	-	-	-
18	-	-	-	-	-	-
18.5	-	-	-	-	-	-
19	-	-	-	-	-	-
19.5	-	-	-	-	-	-
20	6	-	8	-	-	-
20.5	-	-	8	9	5	-
21	23	37	8	19	5	-
21.5	11	102	16	65	9	-
22	23	92	-	74	19	-
22.5	64	139	103	169	47	-
23	169	407	103	463	80	-
23.5	495	804	238	362	146	-
24	990	1,395	309	686	315	61
24.5	1,817	2,023	745	1,010	565	183
25	2,440	1,940	1,371	1,409	1,116	670
25.5	2,311	2,347	2,155	2,670	1,935	1,643
26	2,102	2,375	2,203	4,097	2,482	2,496
26.5	1,776	2,153	1,689	5,061	3,263	1,887
27	972	1,719	1,521	4,848	3,772	852
27.5	652	1,099	1,196	3,235	3,216	852
28	373	582	618	1,780	2,053	548
28.5	309	536	348	918	1,342	609
29	134	203	246	510	1,059	121
29.5	99	147	127	287	927	61
30	23	83	87	158	669	61
30.5	-	28	48	37	513	-
31	11	-	24	28	165	-
31.5	6	-	-	9	52	-
32	-	-	-	-	24	-
32.5	-	-	-	-	-	-
Tonnes	2,200	2,600	2,100	4,000	4,200	1,650

Table 4.2.4 Celtic Sea, Division VIIj - 1990.
Sampling intensity of commercial catches.

Country	Catch (t)	No. of samples	No. of age readings	No. of fish measured	Estimates of discards
Ireland	15,000	67	1,926	8,748	-
Netherlands	1,040	-	-	-	-

Table 4.2.5 SUM OF PRODUCTS CHECK

Herring South and South West of Ireland (Fishing Areas VIIg-j)
CATEGORY: HUMAN CONSUMPTION

CATCH IN NUMBERS UNIT: thousands

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	1319	12658	8422	23547	5507	12768	13317	8159	2800	11335	7162	39361
2	37260	23313	137690	38133	42808	15429	11113	12516	13385	13913	30093	21285
3	50087	37563	17855	55805	17184	17783	7286	8610	11948	12399	11726	21861
4	26481	41904	15842	7012	22530	7333	7011	5280	5583	8636	6585	5505
5	18763	18759	14531	9651	4225	9006	2872	1585	1580	2889	2812	4438
6	7853	10443	4645	5323	3737	3520	4785	1898	1476	1316	2204	3436
7	6351	4276	3012	3352	2978	1644	1980	1043	540	1283	1184	795
8	2175	4942	2374	2332	903	1136	1243	383	858	551	1262	313
9+	3367	2239	1020	1209	827	1194	1769	470	482	635	565	866
TOTAL	153656	156097	205391	146364	100699	69813	51376	39944	38652	52957	63593	97860
TONNES	31700	31400	32200	26900	19900	15000	9200	7200	7600	10300	13100	17100
SOP	96	94	93	95	99	114	99	104	92	103	109	103

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	23469	16939	22525	24690	5740	8255	3533	11564	4015
2	65369	128698	107210	78623	78311	92569	125606	59378	62044
3	13353	33770	47460	49964	59176	59512	47411	95758	36604
4	7370	4034	18515	22092	45444	31796	14390	27441	51616
5	2290	2329	2828	3178	12131	19789	9131	11486	12059
6	2893	408	1252	314	1555	3753	4666	5373	5658
7	2555	464	434	116	136	1624	1331	3625	2482
8	513	1166	267	239	40	409	455	1074	1031
9+	912	385	208	182	17	640	132	955	689
TOTAL	118724	188193	200699	179398	202550	218347	206655	216654	176198
TONNES	19900	31400	31200	28100	34300	36000	31400	32600	28100
SOP	95	93	100	102	100	99	101	102	102

Table 4.2.6 Celtic Sea, Division VIIj.
Percentage age distributions 1977/1978-1990/1991.

Winter rings	Season						
	1977-1978	1978-1979	1979-1980	1980-1981	1981-1982	1982-1983	1983-1984
1	20.4	7.3	21.4	11.3	40.2	19.8	9.0
2	31.3	34.6	26.3	47.3	21.8	55.1	68.4
3	21.5	30.9	23.4	18.4	22.3	11.2	17.9
4	13.2	14.5	16.3	10.4	5.6	6.2	2.1
5	4.0	4.1	5.5	4.4	4.5	1.9	1.2
6	4.8	3.8	2.5	3.5	3.5	2.4	0.2
7	2.6	1.4	2.4	1.9	0.8	2.2	0.2
8	1.0	2.2	1.0	2.0	0.3	0.4	0.6
9+	1.2	1.2	1.2	0.9	0.9	0.8	0.2
Catch ('000 t)	7.8	7.6	10.3	13.1	17.1	10.9	31.4

Winter rings	Season						
	1984-1985	1985-1986	1986-1987	1987-1988	1988-1989	1989-1990	1990-1991
1	11.2	13.8	2.8	3.8	1.7	5.3	2.2
2	53.4	43.8	38.7	42.4	60.8	27.4	35.1
3	23.6	27.9	29.2	27.3	22.9	44.2	20.7
4	9.2	12.3	22.4	14.6	7.0	12.7	23.6
5	1.4	1.8	6.0	9.1	4.4	5.3	6.8
6	0.6	0.2	0.8	1.7	2.3	2.5	3.2
7	0.2	+	+	0.7	0.6	1.7	1.4
8	0.1	0.1	+	0.2	0.2	0.5	0.6
9+	0.1	0.1	+	0.3	0.1	0.4	0.4
Catch ('000 t)	31.2	28.1	34.3	36.0	31.4	32.6	28.1

Table 4.4.4

Title : Herring South and South West of Ireland (Fishing Areas VIIg-j)
At 15.14.10 25 APRIL 1991
from 70 to 90 on ages 1 to 8
with Terminal F of .500 on age 2 and Terminal S of 1.000

Initial sum of squared residuals was 187.882 and
final sum of squared residuals is 40.583 after 80 iterations

Matrix of Residuals

Years / Ages	70/71	71/72	72/73	73/74	74/75	75/76	76/77	77/78	78/79	79/80
1/ 2	-.490	-.454	.524	1.297	.887	2.015	1.773	1.459	.684	1.165
2/ 3	-.086	-.360	.377	.105	.227	.074	-.540	-.428	-.060	-.176
3/ 4	-.036	.066	.237	.034	.026	.089	-.616	-.157	.069	.142
4/ 5	.019	.129	-.335	-.505	-.044	-.037	.425	.510	.298	.514
5/ 6	.011	.208	-.075	-.318	-1.035	-.605	-.931	-.910	-.445	-.596
6/ 7	.265	.334	-.474	-.394	-.113	-.389	.426	.487	-.275	-.518
7/ 8	.183	-.022	-.248	.641	.330	-.385	.841	-.296	-.163	-.323
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
WTS	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001

Years / Ages	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90		WTS
1/ 2	1.004	1.537	-.030	.337	.219	.892	-.389	-.910	-.421	.290	.000	.331
2/ 3	-.126	-.086	-.293	.628	-.373	-.123	.140	-.111	.208	-.075	.000	.979
3/ 4	.145	.347	.052	.058	-.550	-.440	.300	.383	.295	-.099	.000	1.000
4/ 5	-.344	-.003	-.141	-.318	.302	-.046	.395	.022	-.193	-.021	.000	.933
5/ 6	-1.188	-.690	.165	-.289	.453	-.205	.489	-.065	-.144	-.396	.000	.582
6/ 7	.302	-.524	.579	-.694	.930	.142	-.487	-.207	-.193	-.070	.000	.619
7/ 8	.904	-.081	-.150	.212	-.535	.651	-1.265	.332	.046	.709	.000	.522
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	5.221	
WTS	.001	.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	70
F-values	.3601

	71	72	73	74	75	76	77	78	79	80
F-values	.5508	.5375	.5947	.5667	.5475	.4961	.3582	.3231	.4251	.5013

	81	82	83	84	85	86	87	88	89	90
F-values	.5857	.6795	.5065	.6707	.3870	.3960	.5638	.3692	.5023	.5000

Selection-at-age (S)

	1	2	3	4	5	6	7	8
S-values	.0547	1.0000	1.3115	1.5199	1.5742	1.1672	.9559	1.0000

Table 4.4.5 VIRTUAL POPULATION ANALYSIS

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

FISHING MORTALITY COEFFICIENT UNIT: Year-1 VARIABLE NATURAL MORTALITY COEFFICIENT

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	.009	.023	.050	.125	.064	.138	.100	.073	.032	.073	.068	.123
2	.309	.364	.692	.608	.652	.457	.296	.220	.284	.383	.502	.533
3	.466	.632	.568	.740	.667	.681	.436	.421	.360	.495	.702	.937
4	.567	.862	.571	.432	.730	.642	.598	.619	.505	.455	.507	.817
5	.612	.907	.743	.729	.447	.644	.495	.230	.335	.471	.233	.675
6	.502	.731	.520	.593	.615	.728	.757	.629	.309	.455	.705	.436
7	.382	.498	.422	.781	.692	.533	1.092	.320	.323	.427	.846	.525
8	.360	.510	.505	.596	.436	.547	.884	.553	.419	.562	.859	.494
9+	.360	.510	.505	.596	.436	.547	.884	.553	.419	.562	.859	.494
(1- 7)U	.407	.574	.509	.573	.552	.546	.539	.359	.307	.394	.509	.578
(2- 7)U	.473	.666	.586	.647	.634	.614	.612	.407	.353	.448	.582	.654

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.045	.029	.046	.058	.015	.014	.013	.034	.027
2	.565	.683	.448	.396	.473	.583	.427	.492	.460
3	.838	.705	.631	.416	.635	.835	.595	.632	.702
4	.950	.626	1.064	.651	.790	.814	.430	.732	.809
5	.870	.809	1.111	.449	.812	.865	.511	.641	.743
6	1.178	.321	1.335	.290	.367	.560	.446	.568	.672
7	.596	.511	.587	.341	.176	.713	.350	.657	.495
8	.678	.529	.552	.664	.169	1.007	.390	.467	.347
9+	.678	.529	.552	.664	.169	1.007	.390	.467	.347
(1- 7)U	.720	.526	.746	.372	.467	.626	.396	.537	.558
(2- 7)U	.833	.609	.863	.424	.542	.729	.460	.620	.647

Table 4.4.6 VIRTUAL POPULATION ANALYSIS

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

STOCK SIZE IN NUMBERS UNIT: thousands

BIOMASS TOTALS UNIT: tonnes

ALL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING STOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE USED: PROPORTION OF ANNUAL F BEFORE SPAWNING: .200
PROPORTION OF ANNUAL M BEFORE SPAWNING: .500

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	240105	872702	272761	313564	139527	155376	218975	182108	140820	254647	171324	531573
2	160977	87563	313696	95462	101789	48141	49812	72869	62274	50179	87122	58882
3	147301	87550	45058	116320	38508	39286	22583	27442	43309	34737	25356	39056
4	63971	75702	38100	20912	45434	16175	16280	11955	14744	24730	17331	10289
5	42858	32822	28936	19482	12278	19816	7700	8097	5822	8055	14196	9447
6	20822	21030	11994	12450	8506	7107	9412	4248	5822	3770	4552	10176
7	20950	11404	9159	6455	6228	4162	3104	3995	2048	3868	2165	2035
8	7543	12937	6270	5433	2674	2820	2209	943	2626	1341	2285	841
9+	11677	5861	2694	2817	2449	2964	3144	1157	1475	1546	1023	2327
TOTAL NO	716205	1207571	728667	592894	357395	295847	333219	312814	278941	382873	325353	664626
SPS NO	468155	533219	435444	313272	213974	159115	158933	163585	158019	182147	174947	261648
TOT.BIOM	127698	172745	119072	93812	60443	47512	48865	46811	44077	55712	50250	88263
SPS BIOM	91796	88708	77956	56472	40138	29271	26957	27929	28313	30710	30576	39473

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	841604	950436	784622	685055	604486	853757	394033	541795	235061	0
2	172877	296001	339811	275587	237717	219042	378234	174746	192604	84143
3	25608	72794	110767	160823	137402	109737	110604	223232	79155	90086
4	12529	9068	29445	48260	86847	59597	43095	55220	97161	32121
5	4111	4383	4389	9191	22775	35652	23895	25360	24030	39162
6	4352	1558	1766	1307	5306	9150	13577	12976	12083	10348
7	5953	1213	1023	420	885	3327	4727	7865	6656	5583
8	1089	2969	658	515	270	671	1475	3015	3688	3672
9+	1936	980	513	392	115	1051	428	2681	2465	3937
TOTAL NO	1070057	1339402	1272994	1181550	1095803	1291984	970068	1046890	652904	
SPS NO	429390	583010	620640	608971	573201	647651	631265	566616	403917	
TOT.BIOM	139608	181067	149913	149687	150994	154755	125011	133476	87836	
SPS BIOM	62219	87826	82565	85352	86796	87347	87970	78251	58639	

Table 5.1.1 Nominal catch (t), Division VIa (North) HERRING, 1981-1990, as reported to the Working Group.

Country	1981	1982	1983	1984	1985
Denmark	1,580	-	-	96	-
Faroes	-	74	834	954	104
France	1,243	2,069	1,313	-	20
Germany, Fed. Rep.	3,029	8,453	6,283	5,564	5,937
Ireland	-	-	-	-	-
Netherlands	5,602	11,317	20,200	7,729	5,500
Norway	3,850	13,018	7,336	6,669	4,690
UK (England)	1,094	90	-	-	-
UK (Scotland)	30,389	38,381	31,616	37,554	28,065
USSR	-	-	-	-	-
Unallocated	4,633	18,958	-4,059	16,588	502
Discards	-	-	-	-	-
Total	51,420	92,360	63,523	75,154	43,814

Country	1986	1987	1988	1989	1990[1]
Denmark	-	-	-	-	-
Faroes	400	-	-	-	326
France	18	136	44	1,342	1,287
Germany, Fed. Rep.	2,188	1,711	1,860	4,290	7,096
Ireland	6,000	6,800	6,740	8,000	10,000
Netherlands	5,160[2]	5,212[2]	6,131	5,860	7,693
Norway	4,799	4,300	456	-[3]	1,607[3]
UK (England)	-	-	1,892	1,977	2,376
UK (Scotland)	25,294	26,810	25,002	27,897	35,877
USSR	-	-	-	-	-
Unallocated	37,840[2]	18,038[2]	5,229[2]	2,123	2,397
Discards	-	-	-	1,550	1,300
Total	81,699	63,007	47,354	53,039	69,959

[1] Preliminary.
[2] Including discards.
[3] Working Group estimate.

Table 5.1.2 HERRING in Division VIa (North), 1990. Sampling intensity of commercial catches.

Country	Catch in tonnes	No. of samples	No. of age readings	No. of fish measured	Estimate of discards
Faroes	326	0	0	0	No
France	1,557	0	0	0	No
Germany, Fed. Rep.	7,096	0	0	0	No
Ireland	10,000	0	0	0	No
Netherlands	7,693	11	275	1,700	Yes
Norway	1,607	0	0	0	No
UK (England)	2,376	0	0	0	No
UK (Scotland)	35,877	66	2,884	11,470	No

Table 5.1.3 VIRTUAL POPULATION ANALYSIS.

Herring in the Northern part of VIA

CATCH IN NUMBERS UNIT: millions

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	239	170	802	51	309	173	69	35	23	0	13	37
2	205	373	804	236	125	202	320	48	46	0	1	78
3	360	560	220	808	151	89	102	96	21	0	0	106
4	140	358	63	131	519	64	36	22	41	0	0	61
5	53	113	86	63	82	188	25	10	7	0	0	21
6	203	55	37	55	50	31	76	12	4	0	0	13
7	29	182	13	18	35	12	11	21	2	0	0	12
8	33	18	101	7	22	13	4	3	6	0	0	1
9+	31	36	20	32	21	14	12	1	2	0	0	1
TOTAL	1293	1865	2146	1401	1314	786	654	248	151	1	15	330

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	13	82	3	46	39	28	2	10	22
2	250	78	253	77	179	94	159	57	75
3	72	93	67	166	99	65	56	171	64
4	94	29	47	19	137	45	38	29	116
5	58	43	20	17	22	71	26	28	42
6	24	27	15	7	21	12	38	12	21
7	12	15	12	8	3	10	4	23	15
8	14	8	6	4	16	5	3	3	34
9+	4	8	3	2	2	8	3	5	9
TOTAL	540	383	426	346	518	338	329	339	398

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

Year	LAI	Z/K	LPE		
			Larvae	Fecundity	SSB
1973	2,442	0.74	318	(1.39)	229
1974	1,186	0.42	238	(1.39)	171
1975	878	0.46	157	1.46	108
1976	189	-	60	1.23	49
1977	787	-	223	1.49	150
1978	332	-	132	1.37	109
1979	1,071	-	118	1.49	79
1980	1,436	0.39	287	2.04	141
1981	2,154	0.34	448	2.12	211
1982	1,890	0.39	267	1.95	137
1983	668	-	112	1.88	60
1984	2,133	0.57	253	1.75	145
1985	2,710	0.37	418	(1.86)	225
1986	3,037	0.24	907	(1.86)	488
1987	4,119	0.53	423	(1.86)	227
1988	5,947	0.47	781	(1.86)	420
1989	4,320	0.40	752	(1.86)	404
1990	6,525	-	-	-	-

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

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
1	90	90	69	113	73	80	82	79
2	164	140	103	145	143	112	142	129
3	208	175	134	173	183	157	145	173
4	233	205	161	196	211	177	191	182
5	246	231	182	215	220	203	190	209
6	252	253	199	230	238	194	213	224
7	258	270	213	242	241	240	216	228
8	269	284	223	251	253	213	204	237
9	292	295	231	258	256	228	243	247

Table 5.1.7 HERRING in the northern part of Division VIa.

At 17.28.10 05 APRIL 1991
from 70 to 90 on ages 1 to 8
with Terminal F of .240 on age 3 and Terminal S of 1.000

Initial sum of squared residuals was 557.039 and
final sum of squared residuals is 95.789 after 77 iterations

Matrix of Residuals

Years	70/71	71/72	72/73	73/74	74/75	75/76	76/77	77/78	78/79	79/80		
Ages												
1/ 2	2.515	.317	3.708	1.789	2.690	1.729	2.445	1.793	.953	1.921		
2/ 3	-.646	-.298	-.114	.455	-.184	.217	.440	.170	-.264	.146		
3/ 4	-.164	.721	-.148	-.113	-.305	-.201	.071	-.459	-.315	-.305		
4/ 5	.303	.277	-.370	.177	.127	.078	.097	.150	1.120	.035		
5/ 6	-.281	-.474	-.296	-.425	-.321	-.368	-.891	-.483	-.545	-.333		
6/ 7	.056	.071	.183	.007	.328	.002	-.063	.559	-.336	-.627		
7/ 8	.274	-.931	.025	-.811	-.267	-.049	-.156	-.171	.113	1.254		
	.000	.000	.000	.000	.000	.000	.000	.001	.001	.001		
WTS	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001		
Years	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90		WTS
Ages												
1/ 2	4.311	.919	.468	1.131	-1.259	1.397	1.303	.345	-.910	.666	.000	.198
2/ 3	.540	.386	.637	-.139	-.079	.040	.708	.173	-.161	.203	.000	.768
3/ 4	-.440	-.082	-.016	-.157	.209	-.012	-.055	-.322	.057	.216	.000	1.000
4/ 5	.294	.131	.173	-.154	.298	-.024	.135	.012	.037	-.197	.000	.933
5/ 6	-.875	-.367	-.246	.110	-.106	-.457	-.302	-.279	.184	.097	.000	.982
6/ 7	-.974	.020	-.312	.086	-.203	.857	.009	.321	.073	-.276	.000	.681
7/ 8	.982	-.404	-.643	.040	.154	-.958	-1.371	.387	-.044	-.535	.000	.426
	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	21.355	
WTS	.001	.001	.001	1.000	1.000	.001	.001	1.000	1.000	1.000		

Fishing Mortalities (F)

	70
F-values	.4631

	71	72	73	74	75	76	77	78	79	80
F-values	.9188	.5608	.6430	.9849	1.0056	1.1548	.9686	.7693	.0016	.0029

	81	82	83	84	85	86	87	88	89	90
F-values	.3768	.6068	.5251	.4568	.2923	.4139	.3198	.2197	.1868	.2400

Selection-at-age (S)

	1	2	3	4	5	6	7	8
S-values	.0245	.6148	1.0000	.9407	1.1720	1.0343	1.1073	1.0000

Table 5.1.8

Analysis by RCRTINX2 of data from file RTINX
HERRING IN VI (NORTH)

Data for 2 surveys over 18 years
REGRESSION TYPE = C
TAPERED TIME WEIGHTING NOT APPLIED
PRIOR WEIGHTING NOT APPLIED
FINAL ESTIMATES 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 5 POINTS USED FOR REGRESSION

Yearclass = 1987

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
LAI	8.3236	.857	-1.019	.6005	14	6.1109	.45856	.51364	.42118
LPE	5.4293	1.470	-2.224	.3878	14	5.7599	.70636	.74926	.19794
MEAN						5.0350	.54014	.54014	.38088

Yearclass = 1988

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
LAI	8.6908	.857	-1.019	.6005	14	6.4255	.45856	.53820	.41230
LPE	6.0426	1.470	-2.224	.3878	14	6.6617	.70636	.81828	.17836
MEAN						5.0350	.54014	.54014	.40934

Yearclass = 1989

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
LAI	8.3712	.857	-1.019	.6005	14	6.1517	.45856	.51653	.43130
LPE	6.0039	1.470	-2.224	.3878	14	6.6047	.70636	.81258	.17428
MEAN						5.0350	.54014	.54014	.39443

Yearclass = 1990

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
LAI	8.7836	.857	-1.019	.6005	14	6.5049	.45856	.54518	.49535
LPE									
MEAN						5.0350	.54014	.54014	.50465

Yearclass		Weighted Average Prediction	Internal Standard Error	External Standard Error	Virtual Population Analysis	Ext.SE/ Int.SE
1987	5.63	279.12	.33	.34		1.03
1988	5.90	364.47	.35	.51		1.48
1989	5.79	327.08	.34	.45		1.31
1990	5.76	318.35	.38	.73		1.92

Table 5.1.9 VIRTUAL POPULATION ANALYSIS.

Herring in the Northern part of VIA

FISHING MORTALITY COEFFICIENT UNIT: Year-1 VARIABLE NATURAL MORTALITY COEFFICIENT

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	.106	.027	.504	.078	.333	.141	.188	.087	.037	.000	.022	.032
2	.181	.424	.297	.501	.494	.733	.807	.337	.276	.001	.003	.306
3	.419	1.156	.513	.590	.770	.878	1.198	.660	.253	.001	.002	.359
4	.461	.921	.342	.633	.920	.849	1.067	.899	.625	.001	.003	.365
5	.447	.744	.515	.598	.943	.928	.878	.914	.696	.000	.001	.282
6	.406	1.007	.515	.641	1.233	1.028	1.151	1.386	.987	.002	.001	.290
7	.600	.679	.639	.452	.986	1.095	1.227	1.072	.849	.003	.007	.408
8	.462	.824	.905	.655	1.479	1.213	1.201	1.121	1.010	.001	.002	.303
9+	.462	.824	.905	.655	1.479	1.213	1.201	1.121	1.010	.001	.002	.303
(3- 6)U	.433	.957	.471	.615	.966	.921	1.073	.965	.640	.001	.002	.324

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.023	.035	.003	.041	.041	.011	.003	.007	.006
2	.582	.306	.247	.186	.388	.222	.128	.141	.123
3	.555	.476	.504	.271	.413	.251	.211	.210	.245
4	.590	.434	.448	.250	.355	.320	.216	.157	.205
5	.621	.518	.530	.257	.435	.281	.275	.222	.306
6	.501	.589	.314	.337	.501	.404	.213	.172	.227
7	.413	.595	.520	.232	.196	.445	.222	.176	.315
8	1.077	.535	.451	.255	.917	.509	.195	.175	.364
9+	1.077	.535	.451	.255	.917	.509	.195	.175	.364
(3- 6)U	.567	.504	.449	.279	.426	.314	.229	.190	.246

Table 5.1.10 VIRTUAL POPULATION ANALYSIS.

Herring in the Northern part of VIA

STOCK SIZE IN NUMBERS UNIT: millions

BIOMASS TOTALS UNIT: thousand tonnes

ALL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING STOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE USED: PROPORTION OF ANNUAL F BEFORE SPAWNING: .670
PROPORTION OF ANNUAL M BEFORE SPAWNING: .670

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	3729	10055	3074	1077	1678	2050	628	655	980	1413	943	1816
2	1432	1234	3600	683	367	442	655	191	221	347	520	340
3	1151	885	598	1983	306	166	157	216	101	124	257	384
4	396	620	228	293	900	116	56	39	92	64	102	210
5	155	226	223	147	141	325	45	18	14	44	58	92
6	639	90	97	121	73	50	116	17	6	6	40	53
7	68	385	30	52	58	19	16	33	4	2	6	36
8	93	34	177	14	30	19	6	4	10	1	2	5
9+	87	68	36	70	28	20	18	2	3	0	1	5
TOTAL NO	7749	13596	8064	4440	3581	3208	1697	1176	1431	2004	1928	2941
SPS NO	2798	1883	3293	1999	978	575	489	300	301	504	843	789
TOT.BIOM	1169	1642	1190	794	569	427	261	163	176	238	274	396
SPS BIOM	578	388	599	415	212	120	93	59	58	96	163	164

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	942	3742	1426	1803	1534	4176	1366	2054	6045	0
2	647	339	1329	523	637	542	1520	501	750	2211
3	185	268	185	769	322	320	321	991	322	491
4	219	87	136	91	480	174	204	213	657	206
5	132	110	51	79	64	304	114	149	165	484
6	63	64	59	27	55	38	208	79	108	110
7	36	34	32	39	18	30	23	152	60	78
8	22	21	17	17	28	13	18	17	115	40
9+	6	21	8	11	4	22	19	36	30	91
TOTAL NO	2252	4687	3243	3360	3141	5620	3793	4190	8252	
SPS NO	770	620	1247	1147	1081	1057	1856	1660	1703	
TOT.BIOM	346	532	459	474	464	674	583	633	1010	
SPS BIOM	155	128	227	230	221	219	354	350	361	

Table 5.1.11

List of input variables for the ICES prediction program.

HERRING - VIA NORTH
The reference F is the mean F (non-weighted) for the age group range from 3 to 6

The number of recruits per year is as follows:

Year	Recruitment
1991	623.0
1992	623.0
1993	623.0

Proportion of F (fishing mortality) effective before spawning: .6700
Proportion of M (natural mortality) effective before spawning: .6700

Data are printed in the following units:

Number of fish:	millions
Weight by age group in the catch:	kilogram
Weight by age group in the stock:	kilogram
Stock biomass:	thousand tonnes
Catch weight:	thousand tonnes

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
2	623.0	.61	.30	1.00	.129	.164
3	491.0	1.00	.20	1.00	.173	.208
4	206.0	.94	.10	1.00	.182	.233
5	484.0	1.17	.10	1.00	.209	.246
6	110.0	1.03	.10	1.00	.224	.252
7	78.0	1.11	.10	1.00	.228	.258
8	40.0	1.00	.10	1.00	.237	.269
9+	91.0	1.00	.10	1.00	.247	.292

For data that can be entered by file or manually by screen the following table gives the method of input by age group. The identifiers in the table are to be interpreted as:

space: not defined or set by the program
M : manual input by screen
F : data read from a file

age	F at age	M at age	maturity ogive	weight in the catch	weight in the stock
2	M	F	F	F	F
3	M	F	F	F	F
4	M	F	F	F	F
5	M	F	F	F	F
6	M	F	F	F	F
7	M	F	F	F	F
8	M	F	F	F	F
9+	M	F	F	F	F

proportion of F before spawning: F
proportion of M before spawning: F

The data from the files were selected as follows:

M at age:	year 1990 from file NATMOR
Maturity ogive:	year 1990 from file MORPROP
Catch weight:	year 1990 from file WECA
Stock weight:	year 1990 from file WEST
Proportions of F and M:	from file MORPROP

Table 5.1.12 HERRING - VIA NORTH.

```
**********************************************************
* Year 1991. F-factor    .201 and reference F    .2088 *
*--------------------------------------------------------*
* Run depending on a TAC value                           *
**********************************************************
```

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January: sp.stock size	at 1 January: sp.stock biomass	at spawning time: sp.stock size	at spawning time: sp.stock biomass
2	.1238	62.865	8.1096	623.00	102.172	623.00	102.172	469.00	76.916
3	.2014	81.435	14.0882	491.00	102.128	491.00	102.128	375.23	78.047
4	.1894	33.881	6.1664	206.00	47.998	206.00	47.998	169.69	39.537
5	.2360	97.012	20.2755	484.00	119.064	484.00	119.064	386.44	95.064
6	.2083	19.715	4.4161	110.00	27.720	110.00	27.720	89.47	22.547
7	.2230	14.862	3.3886	78.00	20.124	78.00	20.124	62.82	16.208
8	.2014	6.954	1.6481	40.00	10.760	40.00	10.760	32.69	8.793
9+	.2014	15.820	3.9076	91.00	26.572	91.00	26.572	74.36	21.714
Total		332.544	62.0000	2123.00	456.538	2123.00	456.538	1659.70	358.827

```
**********************************************************
* Year 1992. F-factor    .240 and reference F    .2488 *
**********************************************************
```

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January: sp.stock size	at 1 January: sp.stock biomass	at spawning time: sp.stock size	at spawning time: sp.stock biomass
2	.1476	74.108	9.5600	623.00	102.172	623.00	102.172	461.59	75.701
3	.2400	79.177	13.6977	407.79	84.820	407.79	84.820	303.67	63.164
4	.2258	63.331	11.5262	328.68	76.583	328.68	76.583	264.23	61.566
5	.2813	36.070	7.5386	154.23	37.941	154.23	37.941	119.46	29.388
6	.2482	72.503	16.2408	345.88	87.162	345.88	87.162	273.90	69.024
7	.2658	17.988	4.1015	80.82	20.851	80.82	20.851	63.25	16.320
8	.2400	11.490	2.7230	56.47	15.191	56.47	15.191	44.97	12.096
9+	.2400	19.718	4.8704	96.92	28.299	96.92	28.299	77.17	22.534
Total		374.386	70.2579	2093.79	453.019	2093.79	453.019	1608.26	349.793

```
**********************************************************
* Year 1993. F-factor    .240 and reference F    .2488 *
**********************************************************
```

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January: sp.stock size	at 1 January: sp.stock biomass	at spawning time: sp.stock size	at spawning time: sp.stock biomass
2	.1476	74.108	9.5600	623.00	102.172	623.00	102.172	461.59	75.701
3	.2400	77.318	13.3761	398.22	82.829	398.22	82.829	296.54	61.681
4	.2258	50.604	9.2100	262.63	61.193	262.63	61.193	211.13	49.194
5	.2813	55.497	11.5988	237.30	58.375	237.30	58.375	183.80	45.215
6	.2482	22.081	4.9461	105.34	26.545	105.34	26.545	83.42	21.021
7	.2658	54.345	12.3908	244.17	62.996	244.17	62.996	191.10	49.304
8	.2400	11.406	2.7033	56.06	15.081	56.06	15.081	44.64	12.009
9+	.2400	22.213	5.4865	109.18	31.880	109.18	31.880	86.94	25.385
Total		367.573	69.2716	2035.89	441.071	2035.89	441.071	1559.17	339.511

Table 5.2.1 Catches (t) of HERRING from the Firth of Clyde.

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Reported landings:										
UK (Scotland)	2,135	2,506	2,530	2,991	3,001	3,395	2,895	1,568	2,135	2,184
UK (N. Ireland + Isle of Man)	-	-	273	247	22	-	-	-	-	-
Additional landings[1]	274	262	293	224	433	576	278	110	208	75
Discards	-[5]	1,253	1,265	2,308[3]	1,344[3]	679[3]	439[4]	245[4]	-[2]	-[2]
Catch used by Working Group	2,409	4,021	4,361	5,770	4,800	4,650	3,612	1,923	2,343	2,259

[1] Calculated from estimates of weight per box and, in some years, estimated by-catch in sprat fishery.
[2] Reported to be at a low level; assumed to be zero.
[3] Based on sampling.
[4] Estimated assuming same discarding rate as in 1986.
[5] No estimates available.

Table 5.2.2 Sampling levels of Clyde HERRING 1988-1990.

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	" "

Table 5.2.3 Clyde HERRING . SOP.

CATCH IN NUMBERS UNIT: thousands

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	5008	2207	1351	9139	5308	12694	6194	1041	14123	507	333	312
2	7551	6503	8983	5258	8841	1876	10480	7524	1796	4859	5633	2372
3	10338	1976	3181	4548	2817	2483	913	6976	2259	807	1592	2785
4	8745	4355	1684	1811	2559	1024	1049	1062	2724	930	567	1622
5	2306	3432	3007	918	1140	1072	526	1112	634	888	341	1158
6	741	1090	1114	1525	494	451	638	574	606	341	204	433
7	760	501	656	659	700	175	261	489	330	289	125	486
8	753	352	282	307	253	356	138	251	298	156	48	407
9	227	225	177	132	87	130	178	146	174	119	56	74
10+	117	181	132	114	59	67	100	192	236	154	68	18
TOTAL	36546	20822	20567	24411	22258	20328	20477	19367	23180	9050	8967	9667

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	220	314	4156	1639	678	508	0	845	716
2	11311	10109	11829	2951	4574	1376	1062	1523	1004
3	4079	5232	5774	4420	4431	3669	1724	9293	839
4	2440	1747	3406	4592	4622	4379	2506	876	7533
5	1028	963	1509	2806	2679	3408	2014	452	576
6	663	555	587	2654	1847	1983	1319	252	359
7	145	415	489	917	644	1427	510	146	329
8	222	189	375	681	287	680	234	29	119
9	63	85	74	457	251	308	66	16	49
10+	53	38	80	240	79	175	16	5	16
TOTAL	20224	19647	28278	21357	20092	17913	9451	13437	11523

Table 5.2.4 Clyde HERRING. Numbers ('000) landed in half cm length groups.

Length (cm)	1988	1989	1990
13		3	
		3	
14		3	
15		3	
16			
17		7	
18			
19		2	
20	+	5	3
			1
21		12	4
	+	13	5
22	+	61	46
	2	78	92
23	3	169	54
	10	186	94
24	31	235	127
	59	304	138
25	99	422	230
	185	883	204
26	172	1,494	443
	171	2,128	632
27	229	2,196	1,164
	376	1,529	1,761
28	620	815	2,064
	348	484	1,878
29	977	421	1,120
	923	315	530
30	889	158	382
	697	112	194
31	514	80	148
	305	72	115
32	146	20	51
	102	22	26
33	43	2	12
	6	1	14
34	7	+	4
	+	+	4
35	+		
	2		

+ Less than 500.

Table 5.2.5 Number of days absent from port by pair trawlers in the Firth of Clyde, 1974-1990, 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

Table 5.2.6 CLYDE HERRING. Mean weight at age in the catch and stock.

Age (rings)	Mean weight in catch							Mean weight in stock		
	1970-1981	1982-1985	1986	1987	1988	1989	1990	1970-1981	1982-1986	1987-1990
2	.225	.149	.166	.149	.156	.149	.170	.225	.176	↓
3	.270	.187	.199	.194	.194	.174	.186	.270	.207	↓
4	.290	.228	.224	.203	.207	.203	.202	.290	.254	↓
5	.310	.253	.253	.217	.211	.221	.216	.310	.260	As mean
6	.328	.272	.265	.225	.222	.227	.237	.328	.306	weight
7	.340	.307	.297	.236	.230	.235	.234	.340	.313	in catch
8	.345	.291	.298	.247	.225	.237	.234	.345	.300	↓
9	.350	.300	.298	.255	.244	.219	.257	.350	.272	↓
10+	.350	.300	.321	.258	.230	.254	.272	.350	.330	↓

Table 5.2.7 Estimated percentages of herring (2-ringers and older) at each maturity stage in each month of 1990.

Month	Maturity stages: Immature I-II	Developing III	Developing IV-V	Spawning/spent VI-VII	Recovering spents VIII
Jan	10.7	3.7	69.2	0.3	16.2
Feb	4.4	1.2	76.5	2.5	15.3
Mar	13.2	14.2	6.9	3.1	62.5
Apr	9.6	0.1	2.2	5.6	82.6
May	2.4	0	0	23.4	74.2
Jun	4.0	25.1	2.5	2.0	66.4
Jul	6.2	40.3	15.8	0	37.7
Aug	3.5	49.0	20.5	0	27.0
Sept	1.7	38.1	57.5	0.7	1.9
Oct	4.0	15.7	60.9	1.2	18.2
Nov	0.3	6.2	43.6	0	14.0
Dec	1.3	8.1	73.7	0.5	16.3

Table 5.2.8 Estimated numbers (millions) of HERRING (≥ 1-ringers) from Clyde acoustic surveys, 1985-1990, and mean weight at age in 1990

Year	Dates	Rings: 1	2	3	4	5	6	7	8	≥9	Total	Biomass ($tx10^{-3}$): Total	≥2
1985	17/5-1/6	1.1	3.2	9.9	10.6	3.0	3.2	0.8	0.7	0.3	33.1	6.6	6.5
1986	4-14/6	1.6	20.5	12.5	9.3	3.4	3.2	1.2	-	0.2	52.0	9.0	9.0
1987	8-14/7	148.2	11.5	9.2	11.5	5.7	3.0	1.2	0.7	0.4	191.4	16.1	8.7
1988	7-18/7	1.6	67.4	6.2	4.8	5.5	3.6	2.8	1.5	0.4	93.8	12.4	12.3
1989	3-18/7	1.2	9.5	80.3	6.7	2.4	1.8	1.1	0.3	0.1	103.4	18.4	18.3
1990	9-21/7	19.9	7.1	5.5	33.3	4.0	2.5	0.7	0.6	0.2	74.2	11.9	10.6
Mean weight at age (g) in 1990		70	157	181	197	216	249	284	271	292	161		

Table 5.2.9 Calculation of stock in number at age at 1 January 1991 from acoustic survey, egg survey and catches in numbers at age (millions).

	Acoustic survey		Catches	Egg survey		Mean egg + acoustic survey		Catch		Catch	F
Age	July 1990	Estimated spring spawners	April-June	April	Corrected to 1 July	Spring spawners	Revised for total spring and autumn	Jul-Dec	Stock at 1 Jan. 1991	1990	1990
1	19.9						(23.4)	0.72	14.91[1]	0.72	0.030
2	7.1						(8.3)	0.95	13.63	1.00	0.128
3	5.5	3.2	0.03	4.7	4.2	3.71	6.33	0.79	6.26	0.84	0.141
4	33.3	19.5	0.49	28.4	26.5	23.02	39.26	6.80	4.98	7.53	0.209
5	4.0	2.3	0.08	3.3	3.06	2.68	4.57	0.48	30.71	0.58	
6	2.5	1.5	0.06	2.2	2.03	1.77	3.02	0.29	3.88	0.36	
7	0.7	0.4	0.07	0.6	0.50	0.45	0.77	0.24	2.59	0.33	0.162
8	0.6	0.4	0.03	0.6	0.54	0.47	0.80	0.08	0.50	0.12	
≥9	0.2	0.117	0.01	0.17	0.15	0.13	0.22	0.05	0.84	0.06	
Σ	73.8	27.4		39.9		32.33	54.97			Mean F_{2-6} = 0.160	

[1] Geometric mean of 1987-1990 acoustic survey estimates corrected for M in first half of year.

Table 5.2.10

List of input variables for the ICES prediction program.

CLYDE HERRING PREDICTION 1991
The reference F is the mean F (non-weighted) for the age group range from 2 to 6

The number of recruits per year is as follows:

Year	Recruitment
1991	14910.0
1992	14910.0
1993	14910.0

Proportion of F (fishing mortality) effective before spawning: .0000
Proportion of M (natural mortality) effective before spawning: .2500

Data are printed in the following units:

Number of fish:	thousands
Weight by age group in the catch:	kilogram
Weight by age group in the stock:	kilogram
Stock biomass:	tonnes
Catch weight:	tonnes

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
1	14910.0	.03	1.00	.00	.108	.108
2	13630.0	.13	.30	.00	.158	.158
3	6260.0	.14	.20	1.00	.185	.185
4	4980.0	.21	.10	1.00	.204	.204
5	30710.0	.16	.10	1.00	.216	.216
6	3880.0	.16	.10	1.00	.229	.229
7	2590.0	.16	.10	1.00	.233	.235
8	500.0	.16	.10	1.00	.232	.232
9+	840.0	.16	.10	1.00	.240	.240

Table 6.1.1 Estimated HERRING catches in tonnes in Divisions VIa (South) and VIIb,c, 1981-1990.

Country	1981	1982	1983	1984	1985
France	-	353	19	-	-
Germany, Fed. Rep.	2,687	265	-	-	-
Ireland	19,443	16,856	15,000	10,000	13,900
Netherlands	2,790	1,735	5,000	6,400	1,270
UK (N. Ireland)	2	-	-	-	-
UK (England + Wales)	-	-	-	-	-
Unallocated	-	-	13,000	11,000	-
Total landings	24,922	19,209	33,019	27,400	23,374
Discards	-	-	-	-	-
Total catch	24,922	19,209	33,019	27,400	23,374

Country	1986	1987	1988	1989	1990[1]
France	-	-	-	-	+
Germany, Fed. Rep.	-	-	-	-	-
Ireland	15,450	15,000	15,000	18,200	25,000
Netherlands	1,550	1,550	300	2,900	2,533
UK (N. Ireland)	-	5	-	-	80
UK (England + Wales)	-	51	-	-	-
UK (Scotland)	-	-	-	+	-
Unallocated	11,785	31,994	13,800	7,100	13,826
Total landings	28,785	48,600	29,100	28,200	41,439
Discards	-	-	-	1,000	2,530
Total catch	28,785	48,600	29,100	29,200	43,969

[1] Provisional.

Table 6.1.2 SUM OF PRODUCTS CHECK

Herring West of Ireland & Porcupine Bank & lower part of VIa (Fishing Areas VIIb,c & part of VIa)
CATEGORY: TOTAL

CATCH IN NUMBERS UNIT: thousands

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	135	883	1001	6423	3374	7360	16613	4485	10170	5919	2856	1620
2	35114	6177	28786	40390	29406	41308	29011	44512	40320	50071	40058	22265
3	26007	7038	20534	47389	41116	25117	37512	13396	27079	19161	64946	41794
4	13243	10856	6191	16863	44579	29192	26544	17176	13308	19969	25140	31460
5	3895	8826	11145	7432	17857	23718	25317	12209	10685	9349	22126	12812
6	40181	3938	10057	12383	8882	10703	15000	9924	5356	8422	7748	12746
7	2982	40553	4243	9191	10901	5909	5208	5534	4270	5443	6946	3461
8	1667	2286	47182	1969	10272	9378	3596	1360	3638	4423	4344	2735
9+	1911	2160	4305	50980	30549	32029	15703	4150	3324	4090	5334	5220
TOTAL	125135	82717	133444	193020	196936	184714	174504	112746	118150	126847	179498	134113
NOM	20306	15044	23474	36719	36589	38764	32767	20567	19715	22608	30124	24922
SOP%	90	87	90	102	98	112	105	108	102	107	96	103

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	748	1517	2794	9606	918	12149	0	2241	878
2	18136	43688	81481	15143	27110	44160	29135	6919	24977
3	17004	49534	28660	67355	24818	80213	46300	78842	19500
4	28220	25316	17854	12756	66383	41504	41008	26149	151978
5	18280	31782	7190	11241	14644	99222	23381	21481	24362
6	8121	18320	12836	7638	7988	15226	45692	15008	20164
7	4089	6695	5974	9185	5696	12639	6946	24917	16314
8	3249	3329	2008	7587	5422	6082	2482	4213	8184
9+	2875	4251	4020	2168	2127	10187	1964	3036	1130
TOTAL	100722	184432	162817	142679	155106	321382	196908	182806	267487
	19209	32988	27450	23343	28785	48600	29100	29210	43969
	103	100	97	98	100	95	100	100	100

Table 6.1.3 HERRING in Divisions VIa (S) and VIIb.
Sampling intensity of commercial catches.

Country	Catch in tonnes	No. of Samples	No. of age readings	No. of fish measured	Estimate of discards
Ireland	25,000	36	1,495	8,168	No
Netherlands	2,500	-	-		Yes

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

Length	1.Q	2.Q	3.Q	4.Q	Total
18	-	21	-	-	21
	-	-	-	-	-
19	-	-	-	-	-
	-	-	-	-	-
20	15	21	-	-	36
	15	42	37	-	94
21	59	21	37	-	117
	104	42	37	-	183
22	119	231	-	75	425
	74	189	55	25	343
23	104	484	-	125	713
	74	1,409	165	498	2,146
24	133	1,325	312	996	2,766
	252	1,768	349	2,291	4,660
25	786	2,040	569	3,163	6,558
	2,076	5,238	844	4,283	12,441
26	4,107	10,770	2,073	7,098	24,048
	3,884	17,901	3,670	15,565	41,020
27	2,076	15,840	4,660	17,183	39,759
	1,453	10,539	4,293	11,879	28 164
28	1,186	6,500	2,459	6,002	16,147
	1,245	4,880	2,458	4,159	12,742
29	1,334	3,955	2,899	2,864	11,052
	756	2,503	3,302	2,814	9,375
30	563	989	2,037	1,967	5,556
	193	442	1,138	1,071	2,844
31	59	189	349	448	1,045
	30	-	202	274	506
32	15	-	74	25	114
	-	-	-	-	-
33	-	-	19	25	44
Total Tonnes	20,711	87,339	32,034	82,829	222,913

Table 6.4.1

Title : Herring West of Ireland & Porcupine Bank & lower part of VIa (Fishing Areas VIIb,c & part of VIa)

from 70 to 90 on ages 1 to 8
with Terminal F of .500 on age 4 and Terminal S of 1.000

Initial sum of squared residuals was 377.756 and
final sum of squared residuals is 52.014 after 77 iterations

Matrix of Residuals

Years	70/71	71/72	72/73	73/74	74/75	75/76	76/77	77/78	78/79	79/80		
Ages												
1/ 2	-1.371	-.550	-.844	1.404	.082	1.311	1.111	.139	1.016	.954		
2/ 3	2.009	-.330	.262	.767	.571	.581	.701	.717	1.250	.472		
3/ 4	.592	.316	.250	.107	-.026	-.365	-.097	-.516	.087	-.276		
4/ 5	.087	.123	-.177	-.070	.192	-.244	-.177	-.104	.083	-.165		
5/ 6	-.370	-.023	-.147	-.247	.008	.003	-.085	.191	-.083	.070		
6/ 7	-.347	.052	.060	.059	-.103	.253	-.030	.217	-.328	.077		
7/ 8	-.417	-.360	.409	-.496	-.684	-.287	-.032	-.547	-.680	-.210		
	.002	.002	.001	.001	.001	.001	.002	.002	.002	.001		
WTS	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001		
Years	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90		WTS
Ages												
1/ 2	.244	-.091	-1.042	-2.048	.823	1.583	-.611	1.313	-3.675	.566	.000	.127
2/ 3	.121	.494	-.104	.248	.633	.057	.053	.004	-.543	-.212	.000	.296
3/ 4	.126	-.114	-.220	.094	.554	-.130	-.092	-.048	.292	-.577	.000	.546
4/ 5	.012	-.016	.005	.274	.164	-.325	-.032	-.209	.314	.089	.000	.970
5/ 6	-.169	-.154	.069	-.133	-.403	.111	.279	-.068	.058	.023	.000	1.000
6/ 7	.088	.537	.269	.089	.009	.080	-.137	-.057	.228	-.126	.000	.833
7/ 8	-.127	-.879	-.036	-.181	-.906	-.025	-.054	.442	-.212	.759	.000	.397
	.001	.001	.000	.000	.000	.000	.000	.000	.000	.000	3.146	
WTS	.001	.001	.001	.001	1.000	1.000	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	70
F-values	.1814

	71	72	73	74	75	76	77	78	79	80
F-values	.1592	.2286	.3073	.4547	.4822	.5714	.3645	.2909	.3066	.4254

	81	82	83	84	85	86	87	88	89	90
F-values	.3293	.2588	.4209	.2230	.2097	.2200	.4561	.3158	.3185	.5000

Selection-at-age (S)

	1	2	3	4	5	6	7	8
S-values	.0130	.3527	.8534	1.0000	1.0936	1.1652	1.2892	1.0000

Table 6.4.2 VIRTUAL POPULATION ANALYSIS

Herring West of Ireland & Porcupine Bank & lower part of VIa (Fishing Areas VIIb,c & part of VIa)

FISHING MORTALITY COEFFICIENT UNIT: Year-1 VARIABLE NATURAL MORTALITY COEFFICIENT

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	.001	.002	.002	.019	.009	.027	.041	.013	.015	.010	.009	.004
2	.373	.050	.114	.182	.189	.254	.242	.253	.262	.156	.147	.153
3	.223	.125	.246	.296	.302	.260	.411	.178	.255	.203	.331	.240
4	.160	.129	.146	.310	.474	.345	.454	.317	.256	.288	.420	.251
5	.182	.137	.170	.234	.553	.441	.502	.346	.297	.256	.523	.349
6	.116	.251	.204	.259	.428	.670	.489	.332	.224	.358	.311	.576
7	.160	.148	.415	.260	.338	.499	.720	.298	.208	.331	.497	.199
8	.181	.159	.229	.307	.455	.482	.571	.364	.291	.307	.425	.329
9+	.181	.159	.229	.307	.455	.482	.571	.364	.291	.307	.425	.329
(2- 7)U	.202	.140	.216	.257	.381	.411	.470	.287	.250	.265	.372	.294
(3- 7)U	.168	.158	.236	.272	.419	.443	.515	.294	.248	.287	.416	.323

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.002	.001	.006	.015	.002	.009	.000	.007	.007
2	.102	.246	.143	.064	.092	.205	.042	.092	.176
3	.178	.469	.268	.179	.150	.451	.365	.162	.427
4	.240	.411	.291	.174	.254	.378	.416	.344	.500
5	.202	.411	.174	.268	.276	.647	.337	.355	.547
6	.346	.285	.258	.253	.276	.453	.622	.334	.583
7	.324	.471	.127	.264	.271	.808	.342	.733	.645
8	.259	.421	.223	.210	.220	.456	.316	.319	.500
9+	.259	.421	.223	.210	.220	.456	.316	.319	.500
(2- 7)U	.232	.382	.210	.200	.220	.490	.354	.337	.480
(3- 7)U	.258	.410	.224	.228	.245	.548	.416	.386	.540

Table 6.4.3 VIRTUAL POPULATION ANALYSIS

Herring West of Ireland & Porcupine Bank & lower part of VIa (Fishing Areas VIIb,c & part of VIa)

STOCK SIZE IN NUMBERS UNIT: thousands

BIOMASS TOTALS UNIT: tonnes

ALL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING STOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE USED: PROPORTION OF ANNUAL F BEFORE SPAWNING: .670
PROPORTION OF ANNUAL M BEFORE SPAWNING: .670

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	399504	836756	763309	544478	582100	433762	649738	554342	1101325	925440	495349	590574
2	129400	146891	307311	280223	196570	212180	155298	229389	201323	399243	337009	180568
3	143261	66029	103529	203049	173116	120526	121989	90321	132006	114794	252997	215439
4	93916	93886	47716	66289	123644	104780	76087	66221	61883	83720	76735	148790
5	24616	72404	74640	37296	43988	69657	67131	43702	43631	43367	56811	45612
6	384535	18576	57131	56955	26694	22901	40559	36770	27968	29344	30370	30458
7	21165	309773	13072	42148	39786	15738	10601	22494	23861	20224	18568	20132
8	10564	16320	241783	7807	29417	25664	8645	4670	15105	17537	13138	10223
9+	12111	15420	22061	202138	87487	87652	37752	14250	13801	16217	16132	19512
TOTAL NO	1219073	1576055	1630552	1440382	1302802	1092860	1167800	1062159	1620903	1649887	1297109	1261308
SPS NO	658906	615348	679829	666491	506882	462165	349392	369609	381849	542909	574659	503284
TOT.BIOM	246075	282118	291884	270250	233018	200153	192996	173222	242706	257285	224537	216353
SPS BIOM	161880	151932	158034	153393	114402	103621	77231	78208	82142	109936	117795	109268

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	628724	1919850	771530	987816	748402	2240641	247274	488376	199006	0
2	216318	230859	705391	282205	357814	274788	817220	90967	178360	72700
3	114749	144740	133791	452946	196098	241882	165893	580455	61471	110809
4	138782	78634	74103	83764	310177	138189	126118	94250	404207	32837
5	104780	98796	47161	50116	63682	217673	85699	75259	60488	221834
6	29124	77456	59278	35847	34683	43729	103117	55374	47732	31673
7	15498	18653	52707	41458	25188	23804	25145	50082	35874	24109
8	14931	10145	10537	42017	28799	17387	9601	16166	21767	17031
9+	13212	12955	21095	12007	11297	29123	7597	11650	3005	13595
TOTAL NO	1276116	2592089	1875593	1988176	1776140	3227217	1587663	1462578	1011910	
SPS NO	505842	467458	835677	786128	803477	659775	1011882	741993	548213	
TOT.BIOM	216674	377239	310040	294989	293338	432181	283401	241486	169171	
SPS BIOM	110649	102616	165827	154441	172291	142688	193314	131892	98448	

Table 7.1.1 HERRING.
Total catches (t) in North Irish Sea (Division VIIa), 1979-1990 as reported to the Working Group.

Country	1979	1980	1981	1982	1983	1984
France	455	1	-	-	48	-
Ireland	1,805	1,340	283	300	860	1,084
Netherlands	-	-	-	-	-	-
UK	10,078	9,272	4,094	3,375	3,025	2,982
Unallocated	-	-	-	1,180	-	-
Total	12,338	10,613	4,377	4,855	3,933	4,066

Country	1985	1986	1987	1988	1989	1990
France	-	-	-	-	-	-
Ireland	1,000	1,640	1,200	2,579	1,430	1,699
Netherlands	-	-	-	-	-	-
UK	4,077	4,376	3,290	7,593	3,532	4,613
Unallocated	4,110	1,424	1,333	-	-	-
Total	9,187	7,440	5,823	10,172	4,962	6,312

Table 7.1.2 HERRING. Sampling intensity of commercial catches for Division VIIa (N) in 1990.

	Country	Landings (t)	No. samples	No. fish measured	No. fish aged	Estimation of discards
	Ireland	0	-	-	-	-
	UK (N. Ireland)	17	1	169	50	No
Q2	UK (Isle of Man)	73	1	211	50	No
	UK (Scotland)	1[2]	0	0	0	No
	UK (offshore)[1]	0	-	-	-	-

	Country	Landings (t)	No. samples	No. fish measured	No. fish aged	Estimation of discards
	Ireland	1,599	44	5,176	1,022	No
	UK (N. Ireland)	2,109	37	9,141	1,850	No
Q3	UK (Isle of Man)	469	17	5,065	847	No
	UK (Scotland)	1[3]	0	0	0	No
	UK (offshore)[1]	378[3]	0	0	0	No

	Country	Landings (t)	No. samples	No. fish measured	No. fish aged	Estimation of discards
	Ireland	100[4]	0	0	0	No
	UK (N. Ireland)	196[4]	0	0	0	No
Q4	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (offshore)[1]	1,192[4]	0	0	0	No

[1] UK offshore denotes landings to offshore vessels.
[2] N. Ireland and Isle of Man sample data applied to this catch.
[3] Ireland, N. Ireland and Isle of Man sample data applied to this catch.
[4] Last N. Ireland sample data in Q3 applied to these catches.

Table 7.1.3 SUM OF PRODUCTS CHECK.

Herring in the North Irish Sea (Manx plus Mourne herring)
CATEGORY: TOTAL

CATCH IN NUMBERS UNIT: thousands

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	40640	42150	43250	33330	34740	30280	15540	11770	5840	5050	5100	1305
2	46660	32740	109550	48240	56160	39040	36950	38270	25760	15790	16030	12162
3	26950	38240	39750	39410	20780	22690	13410	23490	19510	3200	5670	5598
4	13180	11490	24510	10840	15220	6750	6780	4250	8520	2790	2150	2820
5	13750	6920	10650	7870	4580	4520	1740	2200	1980	2300	330	445
6	6760	5070	4990	4210	2810	1460	1340	1050	910	330	1110	484
7	2660	2590	5150	2090	2420	910	670	400	360	290	140	255
8+	1670	2600	1630	1640	1270	1120	350	290	230	240	380	59
TOTAL	152270	141800	239480	147630	137980	106770	76780	81720	63110	29990	30910	23128

	1984	1985	1986	1987	1988	1989	1990
1	1168	2429	4491	2225	2607	1156	2313
2	8424	10050	15266	12981	21250	6385	12835
3	7237	17336	7462	6146	13343	12039	5726
4	3841	13287	8550	2998	7159	4708	9697
5	2221	7206	4528	4180	4610	1876	3598
6	380	2651	3198	2777	5084	1255	1661
7	229	667	1464	2328	3232	1559	1042
8+	479	724	877	1671	4213	1956	1615
TOTAL	23979	54350	45836	35306	61498	30934	38487

Table 7.1.4 HERRING in Division VIIa (North). Catch at length for 1988-1990. Numbers of fish in thousands.

Length	1988	1989	1990
14	1		
	1		
15	1		
	10		
16	13		6
	16		6
17	29		50
	44	24	7
18	46	44	224
	85	43	165
19	247	116	656
	306	214	318
20	385	226	791
	265	244	472
21	482	320	735
	530	401	447
22	763	453	935
	1,205	497	581
23	2,101	612	2,400
	3,573	814	1,908
24	5,046	1,183	3,474
	5,447	1,656	2,818
25	5,276	2,206	4,803
	4,634	2,720	3,688
26	4,082	3,555	4,845
	4,570	3,293	3,015
27	4,689	2,847	3,014
	4,124	2,018	1,134
28	3,406	1,947	993
	2,916	1,586	582
29	2,659	1,268	302
	1,740	997	144
30	1,335	801	146
	685	557	57
31	563	238	54
	144	128	31
32	80	57	29
	7	7	
33	2	5	
	1	6	
34		0	
		5	

Table 7.2.1 HERRING in Division VIIa (North).

Lengths at age (cm)								
Year	Age							
	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

Table 7.2.2 HERRING in Division VIIa (North).

Mean weights at age (g)								
Year	Age							
	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

Table 7.4.1

Title : Herring in the North Irish Sea (Manx plus Mourne herring)
At 15.25.34 10 APRIL 1991
from 72 to 90 on ages 1 to 7
with Terminal F of .195 on age 2 and Terminal S of 1.000

Initial sum of squared residuals was 123.140 and
final sum of squared residuals is 19.368 after 115 iterations

Matrix of Residuals

Years	72/73	73/74	74/75	75/76	76/77	77/78	78/79	79/80
Ages								
1/ 2	1.604	1.037	1.187	.980	1.198	1.070	.537	.683
2/ 3	-.627	-.400	-.088	-.025	-.216	-.067	-.452	-.220
3/ 4	-.006	.192	.105	.004	-.090	-.010	.174	.044
4/ 5	-.502	-.416	-.336	-.344	-.274	-.143	-.119	-.470
5/ 6	.278	.232	-.068	.278	.137	.194	-.287	.103
6/ 7	.034	-.295	-.339	-.400	-.091	-.457	.212	.087
	.000	.000	.000	.000	.000	.000	.000	.000
WTS	.001	.001	.001	.001	.001	.001	.001	.001

Years	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90		WTS
Ages												
1/ 2	-.237	.088	.300	-.258	.384	-.373	.279	-.039	.136	-.524	.000	.265
2/ 3	.479	.168	.196	.154	-.165	-.303	.220	.186	-.461	.006	.000	.567
3/ 4	.282	-.458	-.139	.041	-.032	.113	.238	.075	.025	.137	.000	1.000
4/ 5	-.677	.975	.428	-.402	-.334	.183	-.264	-.486	.010	-.108	.000	.423
5/ 6	.293	-.028	-1.144	-.113	.478	.311	-.105	.116	.369	.115	.000	.462
6/ 7	-.584	-.104	.508	.280	-.096	-.108	-.477	-.030	.045	-.016	.000	.581
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	3.181	
WTS	.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	72	73	74	75	76	77	78	79	80
F-values	.5664	.4821	.8858	.7991	.9291	.8860	.7679	.7906	.8637

	81	82	83	84	85	86	87	88	89	90
F-values	.3797	.2499	.1445	.1278	.3113	.2555	.1783	.3175	.1619	.1950

Selection-at-age (S)

	1	2	3	4	5	6	7
S-values	.0834	1.0000	1.1707	1.3036	1.0064	1.1067	1.0000

Table 7.4.2 VIRTUAL POPULATION ANALYSIS.

Herring in the North Irish Sea (Manx plus Mourne herring)

FISHING MORTALITY COEFFICIENT UNIT: Year-1 VARIABLE NATURAL MORTALITY COEFFICIENT

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	.167	.104	.214	.152	.229	.155	.103	.141	.058	.036	.032	.008
2	.362	.345	.823	.751	.788	.853	.522	.749	1.044	.389	.264	.168
3	.532	.614	1.019	.903	.974	.983	.912	.822	1.308	.357	.249	.147
4	.543	.431	1.004	.837	1.088	.988	.882	.807	.781	.610	.409	.179
5	.623	.542	.798	.952	.945	1.038	.658	.710	1.015	.437	.117	.123
6	.637	.435	.848	.763	.988	.809	.911	.965	.641	.394	.346	.224
7	.565	.475	.940	.961	1.290	.927	.996	.677	.955	.381	.257	.111
8+	.565	.475	.940	.961	1.290	.927	.996	.677	.955	.381	.257	.111
(2- 7)U	.544	.474	.906	.861	1.012	.933	.814	.788	.957	.428	.274	.159

	1984	1985	1986	1987	1988	1989	1990
1	.013	.022	.031	.011	.030	.009	.016
2	.111	.244	.325	.203	.242	.159	.234
3	.151	.371	.308	.223	.352	.223	.222
4	.135	.426	.300	.185	.414	.191	.267
5	.188	.355	.224	.209	.423	.161	.196
6	.132	.317	.235	.186	.375	.173	.188
7	.141	.319	.259	.239	.305	.168	.190
8+	.141	.319	.259	.239	.305	.168	.190
(2- 7)U	.143	.339	.275	.208	.352	.179	.216

Table 7.4.3 VIRTUAL POPULATION ANALYSIS.

Herring in the North Irish Sea (Manx plus Mourne herring)

STOCK SIZE IN NUMBERS UNIT: thousands

BIOMASS TOTALS UNIT: tonnes

ALL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING STOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE USED: PROPORTION OF ANNUAL F BEFORE SPAWNING: .900
PROPORTION OF ANNUAL M BEFORE SPAWNING: .750

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	413226	668285	349267	369880	263645	329449	248569	140371	161979	223945	255129	253371
2	176366	128686	221526	103752	116913	77145	103797	82476	44868	56206	79454	90896
3	71461	91003	67498	72051	36253	39378	24365	45617	28883	11704	28229	45206
4	32913	34376	40312	19947	23912	11206	12069	8014	16413	6391	6709	18011
5	31003	17305	20218	13361	7812	7293	3774	4521	3237	6802	3144	4033
6	14992	15046	9108	8234	4665	2748	2337	1769	2011	1062	3976	2531
7	6448	7171	8811	3530	3473	1571	1107	850	610	959	648	2545
8+	4048	7199	2789	2770	1822	1933	578	616	390	793	1759	589
TOTAL NO	750456	969070	719529	593524	458495	470722	396597	284234	258391	307862	379047	417182
SPS NO	186846	181704	138631	95790	74880	58709	70416	59169	35555	51918	82712	118785
TOT.BIOM	92803	106316	92198	68718	54323	49794	43786	35705	29689	31278	40552	47989
SPS BIOM	33261	32137	24084	16567	12581	9540	11225	10091	6066	8419	13784	20639

	1984	1985	1986	1987	1988	1989	1990	1991
1	146765	175361	228617	312985	139913	194577	226612	0
2	92451	53313	63101	81497	113847	49958	70909	82021
3	56952	61286	30930	33761	49299	66228	31556	41588
4	31967	40108	34612	18617	22110	28380	43388	20683
5	13620	25277	23702	23209	13999	13222	21210	30059
6	3227	10215	16040	17149	17033	8299	10183	15776
7	1831	2559	6729	11479	12880	10593	6317	7637
8+	3829	2777	4031	8239	16790	13290	9791	12053
TOTAL NO	350641	370895	407761	506935	385871	384546	419965	
SPS NO	149290	126534	122993	142229	153412	141726	138398	
TOT.BIOM	47020	47528	47643	49900	48076	47856	50706	
SPS BIOM	26297	20666	21680	22601	23916	23044	22203	

Table 7.6.1

List of input variables for the ICES prediction program.

North Irish Sea (VIIa) - 1991
The reference F is the mean F (non-weighted) for the age group range from 2 to 7

The number of recruits per year is as follows:

Year	Recruitment
1991	192000.0
1992	192000.0
1993	192000.0

Proportion of F (fishing mortality) effective before spawning: .9000
Proportion of M (natural mortality) effective before spawning: .7500

Data are printed in the following units:

Number of fish:	thousands
Weight by age group in the catch:	kilogram
Weight by age group in the stock:	kilogram
Stock biomass:	tonnes
Catch weight:	tonnes

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
1	192000.0	.08	1.00	.08	.096	.086
2	82021.0	1.00	.30	.85	.140	.130
3	41588.0	1.17	.20	1.00	.166	.157
4	20683.0	1.30	.10	1.00	.175	.175
5	30059.0	1.01	.10	1.00	.187	.186
6	15776.0	1.11	.10	1.00	.195	.198
7	7637.0	1.00	.10	1.00	.207	.210
8+	12053.0	1.00	.10	1.00	.218	.221

For data that can be entered by file or manually by screen the following table gives the method of input by age group. The identifiers in the table are to be interpreted as:

space: not defined or set by the program
M : manual input by screen
F : data read from a file

age	F at age	M at age	maturity ogive	weight in the catch	weight in the stock
1	M	F	F	F	F
2	M	F	F	F	F
3	M	F	F	F	F
4	M	F	F	F	F
5	M	F	F	F	F
6	M	F	F	F	F
7	M	F	F	F	F
8+	M	F	F	F	F

proportion of F before spawning: F
proportion of M before spawning: F

The data from the files were selected as follows:

M at age:	year 1990 from file NATMOR
Maturity ogive:	year 1990 from file MORPROP
Catch weight:	year 1990 from file WECA
Stock weight:	year 1990 from file WEST
Proportions of F and M:	from file MORPROP

Table 7.6.2 North Irish Sea (Division VIIa) 1991. Results.

****
* Year 1991. F-factor .187 and reference F .2053 *
****

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January: sp.stock size	at 1 January: sp.stock biomass	at spawning time: sp.stock size	at spawning time: sp.stock biomass
1	.0156	1880.5	180.53	192000	16512.0	15360	1321.0	7154	615.3
2	.1870	12142.3	1699.92	82021	10662.7	69717	9063.3	47047	6116.2
3	.2189	7438.0	1234.72	41588	6529.3	41588	6529.3	29393	4614.8
4	.2438	4266.6	746.66	20683	3619.5	20683	3619.5	15408	2696.5
5	.1882	4914.8	919.07	30059	5591.0	30059	5591.0	23541	4378.8
6	.2070	2811.4	548.22	15776	3123.6	15776	3123.6	12148	2405.5
7	.1870	1241.5	256.98	7637	1603.8	7637	1603.8	5987	1257.4
8+	.1870	1959.3	427.13	12053	2663.7	12053	2663.7	9449	2088.4
Total		36654.5	6013.23	401817	50305.7	212873	33515.2	150132	24172.9

****
* Year 1992. F-factor .197 and reference F .2163 *
****

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January: sp.stock size	at 1 January: sp.stock biomass	at spawning time: sp.stock size	at spawning time: sp.stock biomass
1	.0164	1980.4	190.12	192000	16512.0	15360	1321.0	7149	614.8
2	.1970	10795.4	1511.35	69539	9040.2	59108	7684.1	39530	5139.0
3	.2306	9444.4	1567.78	50399	7912.7	50399	7912.7	35248	5533.9
4	.2568	5908.3	1033.96	27354	4787.1	27354	4787.1	20141	3524.7
5	.1983	2514.2	470.15	14666	2727.9	14666	2727.9	11382	2117.2
6	.2180	4208.0	820.57	22532	4461.5	22532	4461.5	17180	3401.6
7	.1970	1978.1	409.48	11606	2437.3	11606	2437.3	9018	1893.8
8+	.1970	2518.7	549.07	14777	3265.8	14777	3265.8	11482	2537.6
Total		39347.6	6552.47	402876	51144.4	215805	34597.4	151132	24762.7

****
* Year 1993. F-factor .197 and reference F .2163 *
****

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January: sp.stock size	at 1 January: sp.stock biomass	at spawning time: sp.stock size	at spawning time: sp.stock biomass
1	.0164	1980.4	190.12	192000	16512.0	15360	1321.0	7149	614.8
2	.1970	10786.4	1510.09	69481	9032.6	59059	7677.7	39497	5134.7
3	.2306	7927.6	1315.98	42304	6641.8	42304	6641.8	29586	4645.2
4	.2568	7076.8	1238.44	32764	5733.8	32764	5733.8	24124	4221.8
5	.1983	3282.1	613.75	19145	3561.1	19145	3561.1	14859	2763.9
6	.2180	2032.6	396.35	10883	2155.0	10883	2155.0	8298	1643.1
7	.1970	2794.3	578.41	16394	3442.8	16394	3442.8	12738	2675.1
8+	.1970	3341.3	728.41	19604	4332.5	19604	4332.5	15232	3366.4
Total		39221.5	6571.56	402579	51411.8	215517	34865.9	151487	25065.0

Table 10.1 Herring assessment units (1990).

Assessment unit	Statistical unit	Assessment forum[1]
Baltic		
1 South Central Baltic	25, 26, 27	ICES PB
2 Central Baltic	28, 29s	"
3 Gulf of Riga	Gulf of Riga (28)	"
4 Lower Gulf of Bothnia	29N, 30	"
5 Gulf of Finland	32	"
6 Bothnian Sea	30	"
7 Bothnian Bay	31	"
8 Skagerrak-Kattegat	IIIa, 22, 23, 24	"
East Atlantic		
9 North Sea[3]	IVa,b,c, VIId	ICES S-62
10 West of Scotland	VIa(north)-Clyde	"
11 Clyde	VIa	"
12 West of Ireland	VIa(south), VIIb	"
13 Celtic Sea	VIIk,j,g, VIIa(south)	"
14 Irish Sea	VIIa	"
15 Iceland	Va	ICES S-62/A-S[2]
16 Norwegian spring-spawning		ICES A-S
West Atlantic: E+SE Newfoundland		
17 White Bay - Notre Dame Bay	3K	CAFSAC Pel
18 Bonavista Bay-Trinity Bay	3L	"
19 Conception Bay-Southern Shore	3L	"
20 St. Mary's Bay-Placentia Bay	3Ps	"
21 Fortune Bay	3Ps	"
W. Atlantic Gulf of St Lawrence		
22 West coast Newfoundland	4R	"
23 Northern Gulf St Lawrence	4S	"
24 Southern Gulf of St Lawrence	4T	"

cont'd.

Table 10.1 cont'd.

Assessment unit	Statistical unit	Assessment forum[1]
W. Atlantic		
Scotian Shelf and Gulf of Maine		
25 Sydney Bight	4Vn	"
26 Bay of Fundy/ Scotian Shelf	4Wx	"
27 Georges Bank	5Z 6	CAFSAC/NMFS
28 Gulf of Maine	5Y	NMFS SAW

[1] ICES PB=ICES Working Group for Pelagic Stocks in the Baltic.
ICES S-62=ICES Herring Assessment Working Group for the Area South of 62^0N.
ICES A-S=ICES Atlanto-Scandian Herring and Capelin Working Group.
CAFSAC Pel=CAFSAC Pelagic Sub-committee.
NMFS SAW=NMFS Stock Assessment Workshop.
[2] Transferred to the ICES A-S Working Group in 1988.
[3] The southern North Sea (Divisions IVc, VIId), is considered a separate management unit but was not assessed in 1990.

Table 10.2 Summary of herring assessment structure (1990 assessments).

Assessment unit		Assessment type	Abundance indices	Tuning method	Notes
1-5	Baltic (aggregated)	VPA (tuned)	Acoustic series (82-89)	"ad hoc"	
1	South Central Baltic	VPA (tuned)	CPUE (76-89)	ICES module	Laurec-Shepherd
2	Central Baltic	None			Not a discrete unit. Contains fish from other areas. Combined in 1990 with Baltic aggregate
3	Gulf of Riga	VPA (untuned)	Acoustic (88, 89)		Input Fs from acoustic biomass using SVPA
4	Lower Gulf of Bothnia	None			Absorbed in Baltic aggregate
5	Gulf of Finland	VPA (untuned)	CPUE (82-89) (four fisheries)		Input Fs from CPUE in SVPA
6	Bothnian Sea	VPA (untuned)	CPUE		Input Fs from CPUE
7	Bothnian Bay	VPA (untuned)	CPUE		Input Fs from CPUE
8	Skagerrak-Kattegat				A comparison of an ad hoc tuning method of fixing 2+ numbers from recent acoustic surveys gave similar result to ICES modele
(a)	(IIIa, 22, 23, 24)	VPA (tuned)	Acoustic (3-yr series)	ICES module	
(b)	(22 + 24)	VPA	IYFS + German Dem.Rep. surveys	RCRTINX2	Predicted strength of two year classes from young fish surveys
9	North Sea	VPA (tuned)	Acoustic (since 81) LPE (since 72) IYFS (since 70)	RCRTINX2	3 series regressed with converged part of VPA, then used to predict recent years
10	Westh of Scotland	VPA (tuned)	Larvae surveys	RCRTINX2	Minimizing sum of squared residual in recent years
11	Clyde	VPA (tuned)	CPUE (since 74) Acoustic (since 85)	ICES module	

Table 10.2 (cont'd)

Assessment unit		Assessment type	Abundance indices	Tuning method	Notes
12	West of Ireland	VPA (untuned)	Larvae (81-88) but not in recent years		Input Fs from SVPA
13	Celtic Sea	VPA (untuned)			Input Fs from SVPA
14	Irish Sea	VPA (untuned)	Acoustic (single survey 89)		VPA initiated with 1989 biomass from acoustic survey
15	Iceland	VPA (tuned)	Acoustic (since 73)	Ad hoc	Best 1:1 relationship between VPA and 13 acoustic estimates
16	Norwegian Spring	VPA (tuned)	Acoustic (2) (since 82)	Ad hoc	Terminal F which minimized squared residuals between VPA and acoustic estimates of mature year classes (1983 year class and older) in 1988, 1989 and 1990.
17-21	E + SE Newfoundland	Acoustic biomass estimate	Acoustic surveys Research gillnet CPUE		- Biomass estimates for two areas from acoustic survey - Research gillnet catch rates at age used to examine relative year-class strength
22	W Newfoundland	SPA (tuned)	CPUE Commercial gillnet CPUE Research gillnet	ADAPT	1990 SPA rejected because of unrealistically low Fs and lack of convergence
23	N. Gulf of St Lawrence	None			Lack of abundance indices preclude analytical assessment
24	S. Gulf of St Lawrence	SPA (tuned) (none in 1990)	CPUE (gillnet)	ADAPT	1990 SPA not possible due to incomplete acoustic coverage and suspected bias in catch rates
(a)	Spring spawners				

Table 10.2 (cont'd)

Assessment unit		Assessment type	Abundance indices	Tuning method	Notes
(b)	Autumn spawners	SPA (tuned)	CPUE (gillnet)	ADAPT	
25	Sydney Bight	None			Not a discrete stock. Therefore, no analytical assessment
26	Bay of Fundy/ Scotian Shelf	SPA (tuned)	Larval abundance (since 1972) Acoustic survey (since 1984) Research bottom-trawl (since 1978)	ADAPT	1990 SPA tuned with all three abundance indices using ADAPT was rejected because of high CUs, low Fs and non-convergence
27	Georges Bank	None	Larval abundance Research bottom-trawl		Recovering from collapse of late 1970s; no analytical assessment
28	Coastal Gulf of Maine	VPA (tuned)	Research bottom-trawl; spring (since 1968) and fall (since 1963)	Ad hoc	VPA calibrated with spring bottom-trawl series

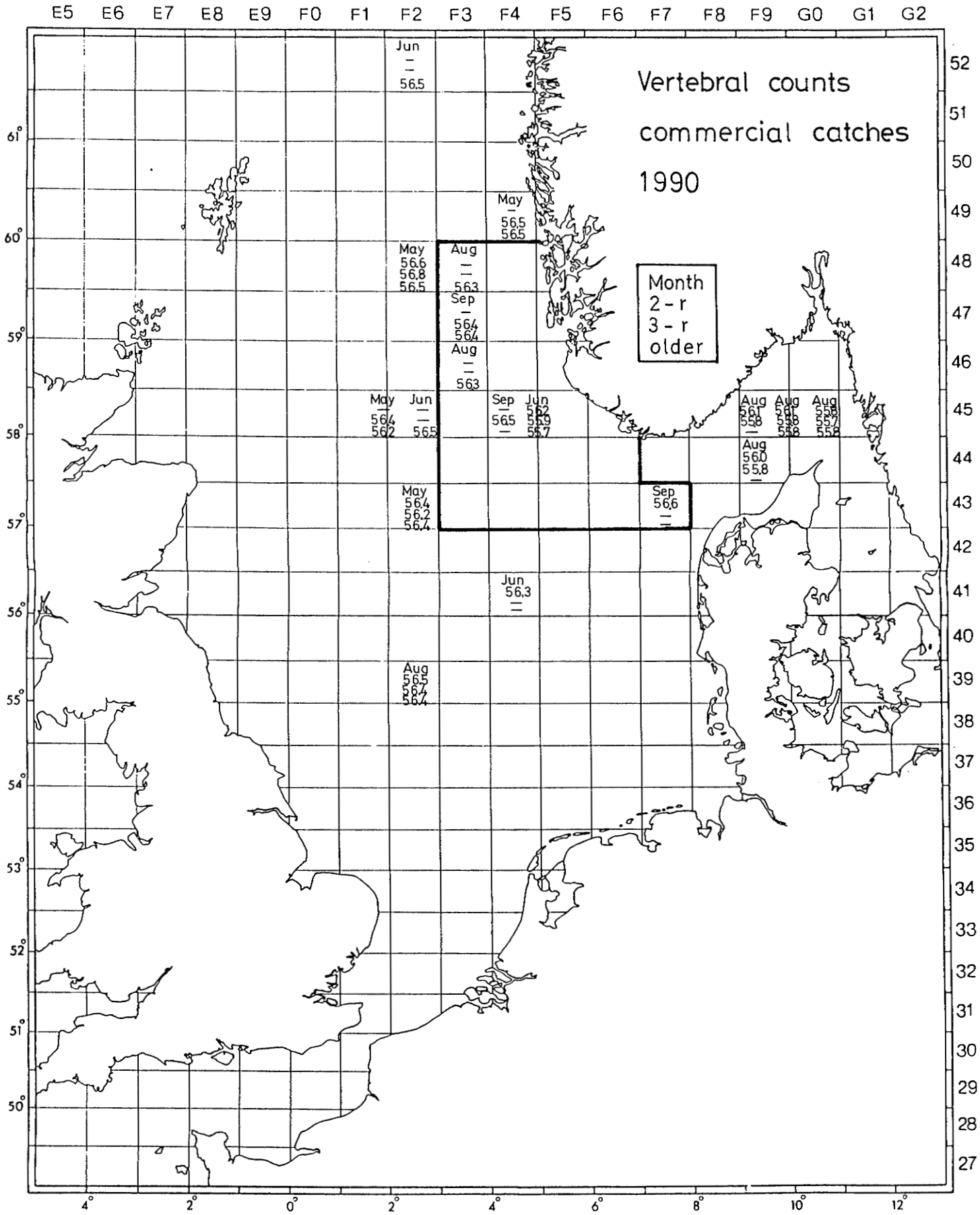


Figure 2.2.1 Mean vertebral counts from commercial catches in 1990.

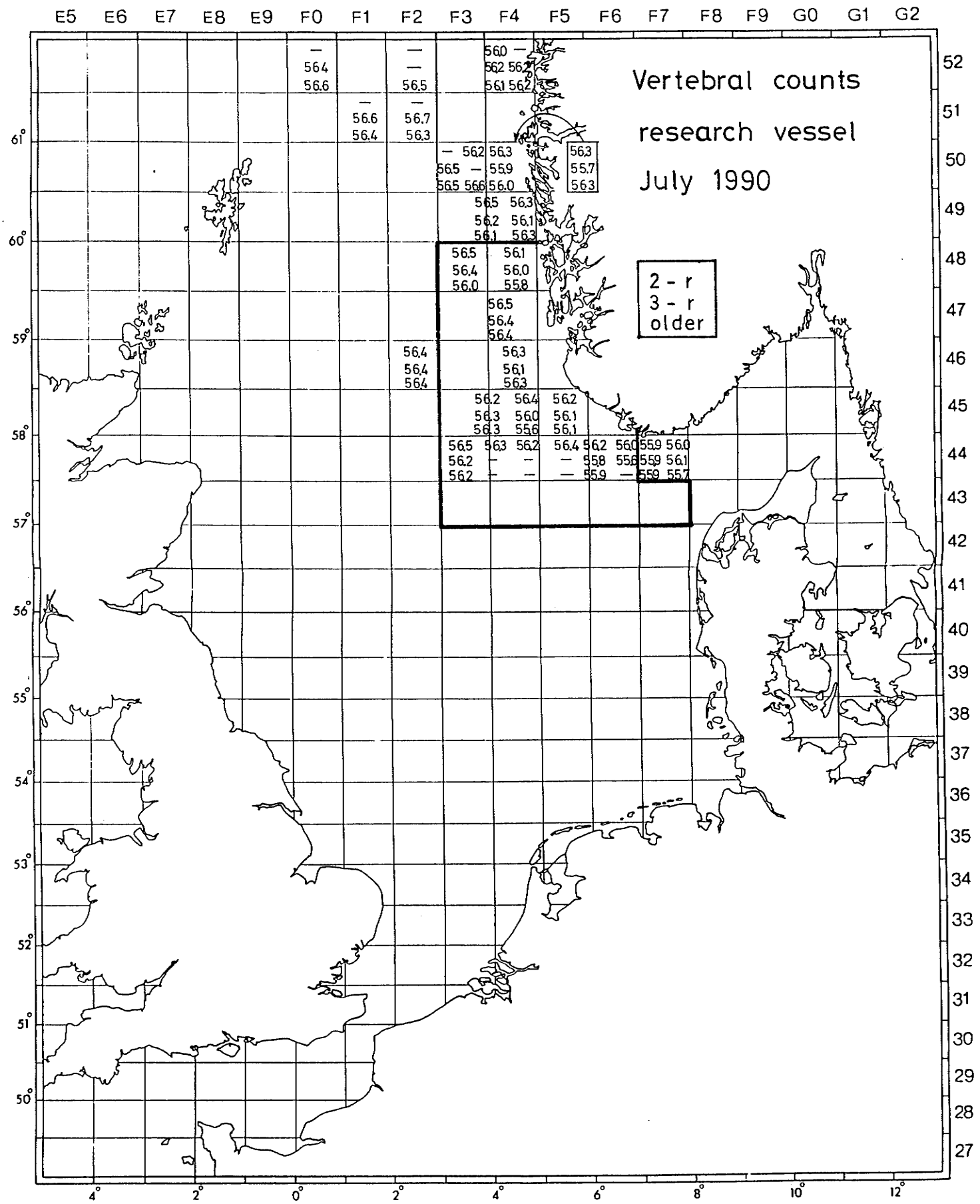


Figure 2.2.2 Mean vertebral counts from research vessel samples in July 1990.

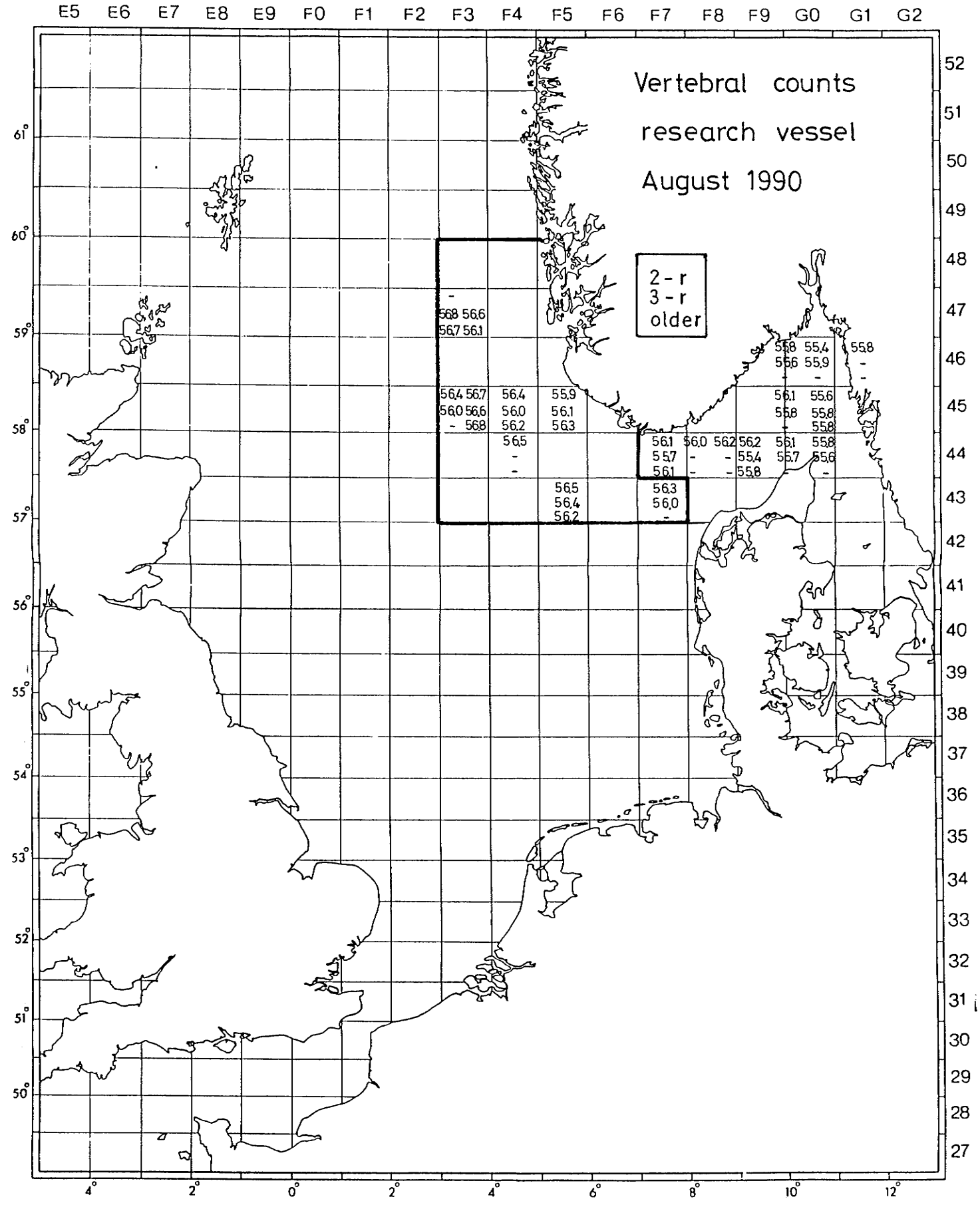


Figure 2.2.3 Mean vertebral counts from research vessel samples in August 1990.

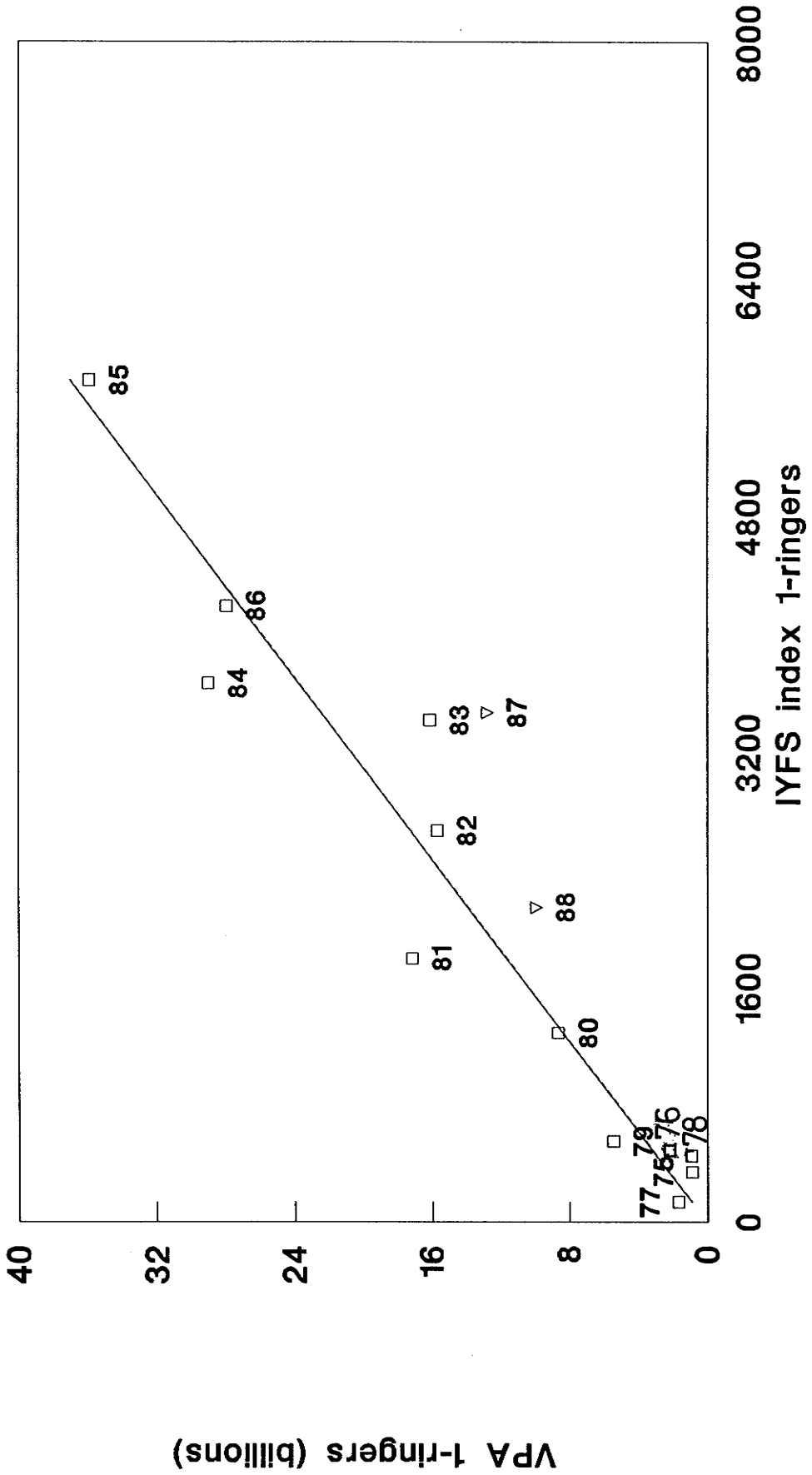


Figure 2.3.1 Relation between IYFS 1-ringers index and 1-ringer abundance from ther VPA.

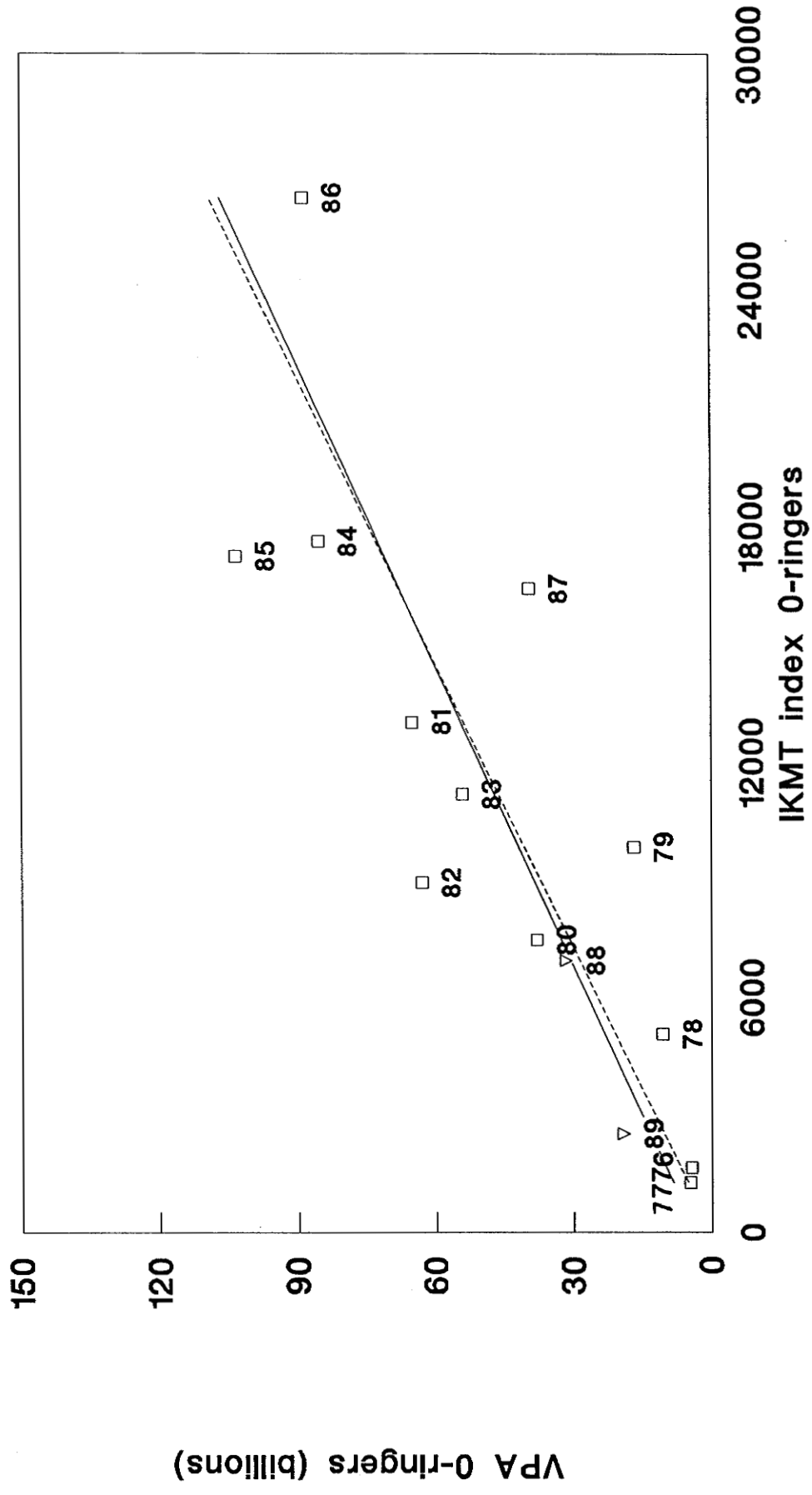


Figure 2.3.2 Relation between IKMT 0-ringer index and 0-ringer abundance from the VPA.

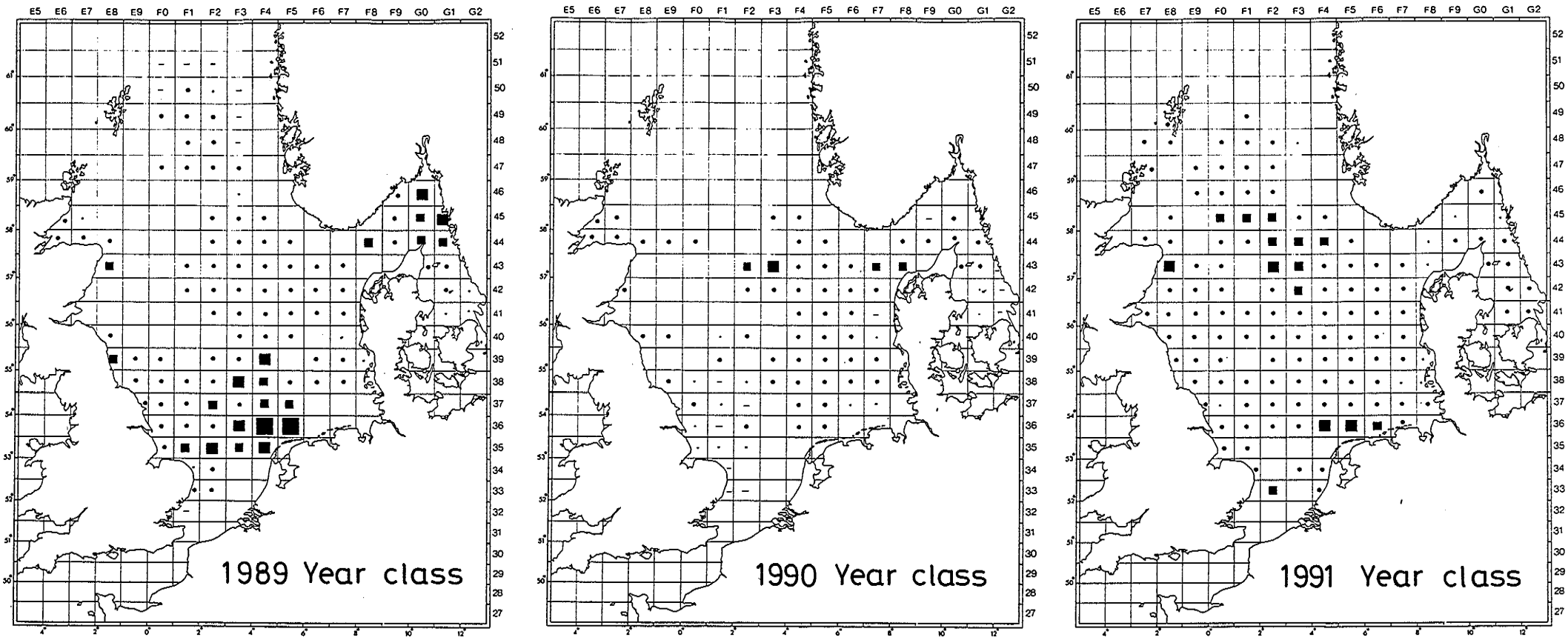
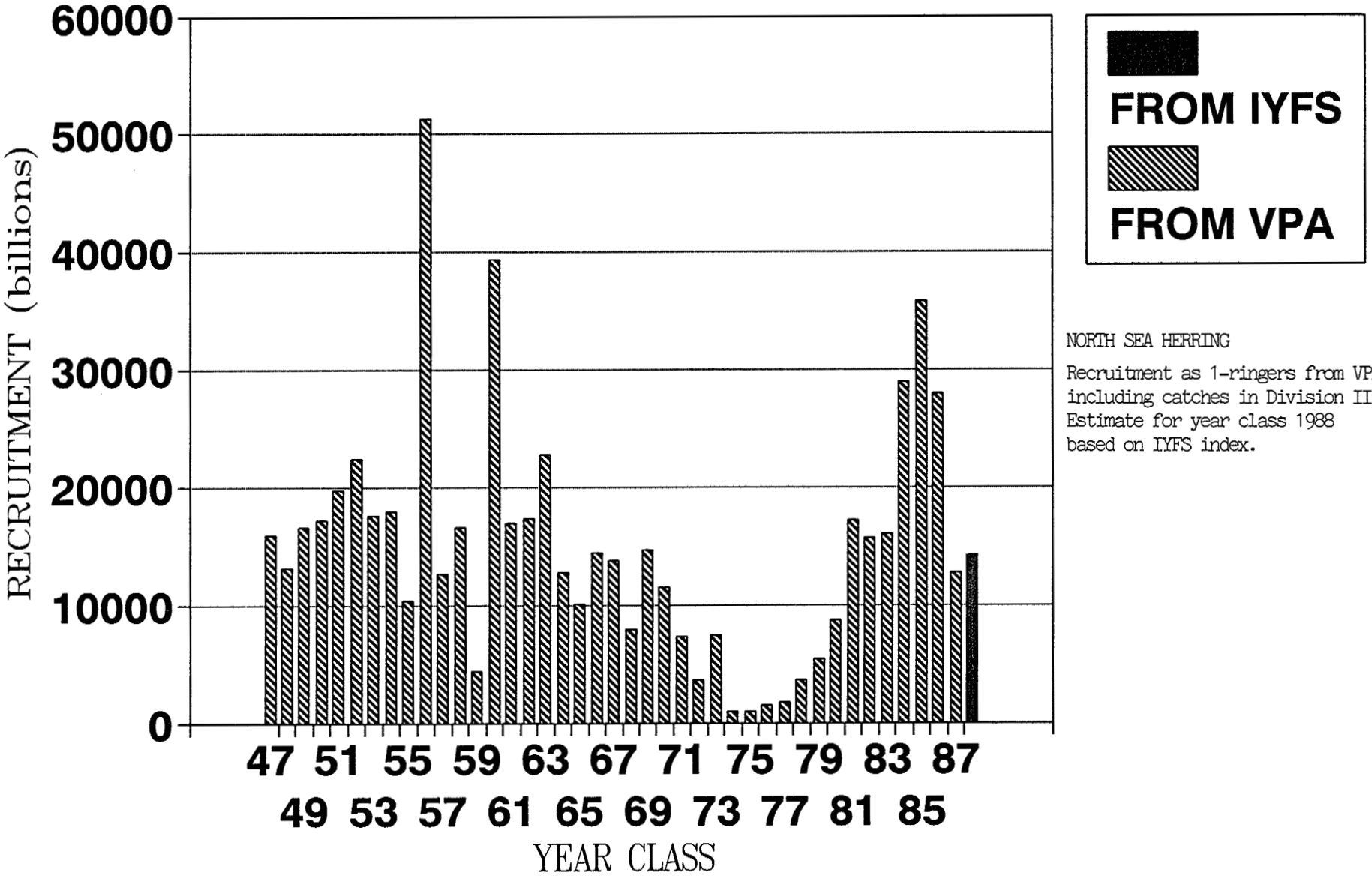


Figure 2.3.3 0-group HERRING sampled by MIK and IKMT in 1989-1991. Mean numbers per haul per rectangle.

Fig. 2.3.4 RECRUITMENT AS 1-RINGERS.

Herring - Total North Sea



NORTH SEA HERRING

Recruitment as 1-ringers from VPA including catches in Division IIIa. Estimate for year class 1988 based on IYFS index.

Figure 2.7.1 Plot of SSB from the VPA on LPE values.

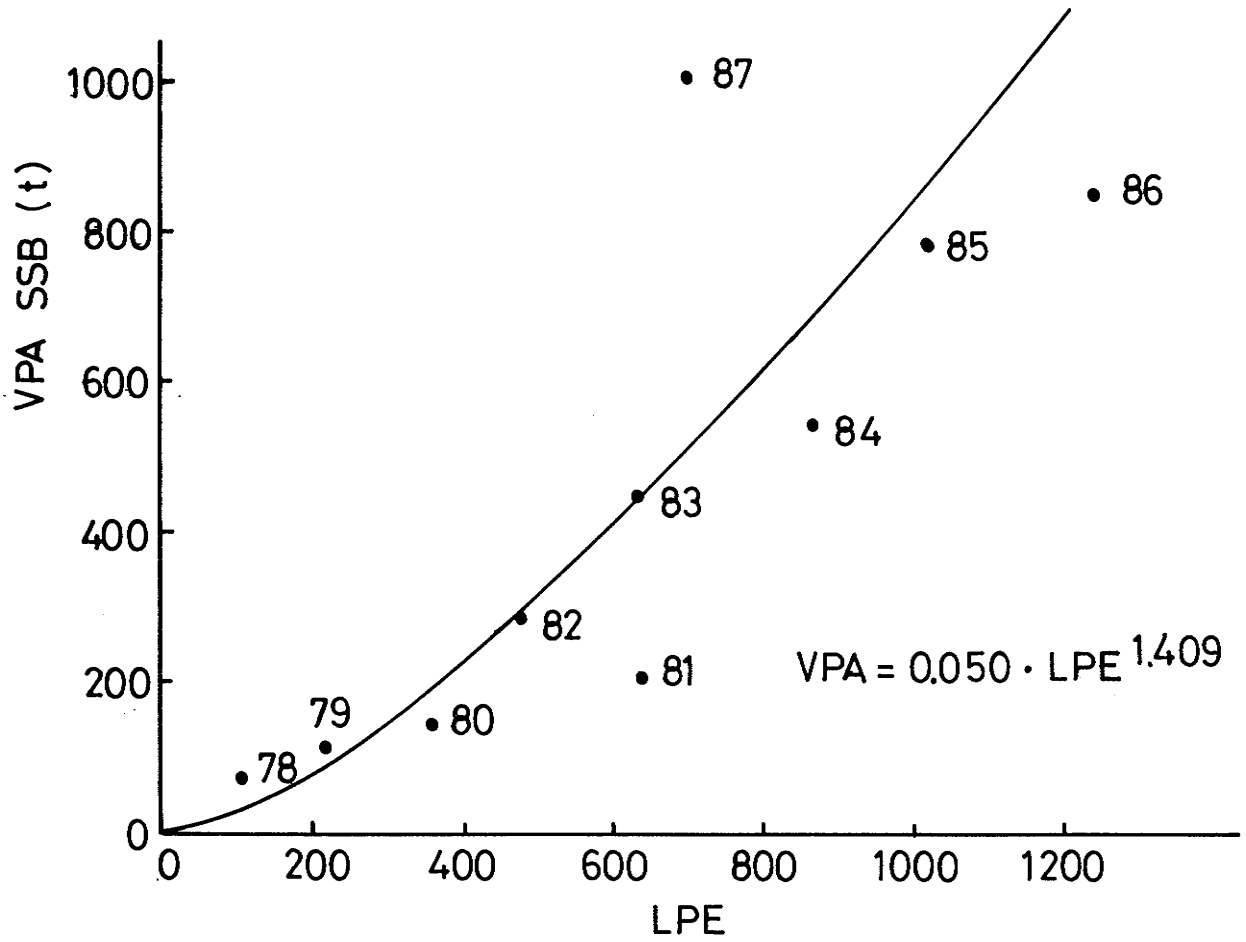


Figure 2.7.2 Plot of SSB from the VPA on SSB as estimated by acoustic surveys. For details of regression lines, see text.

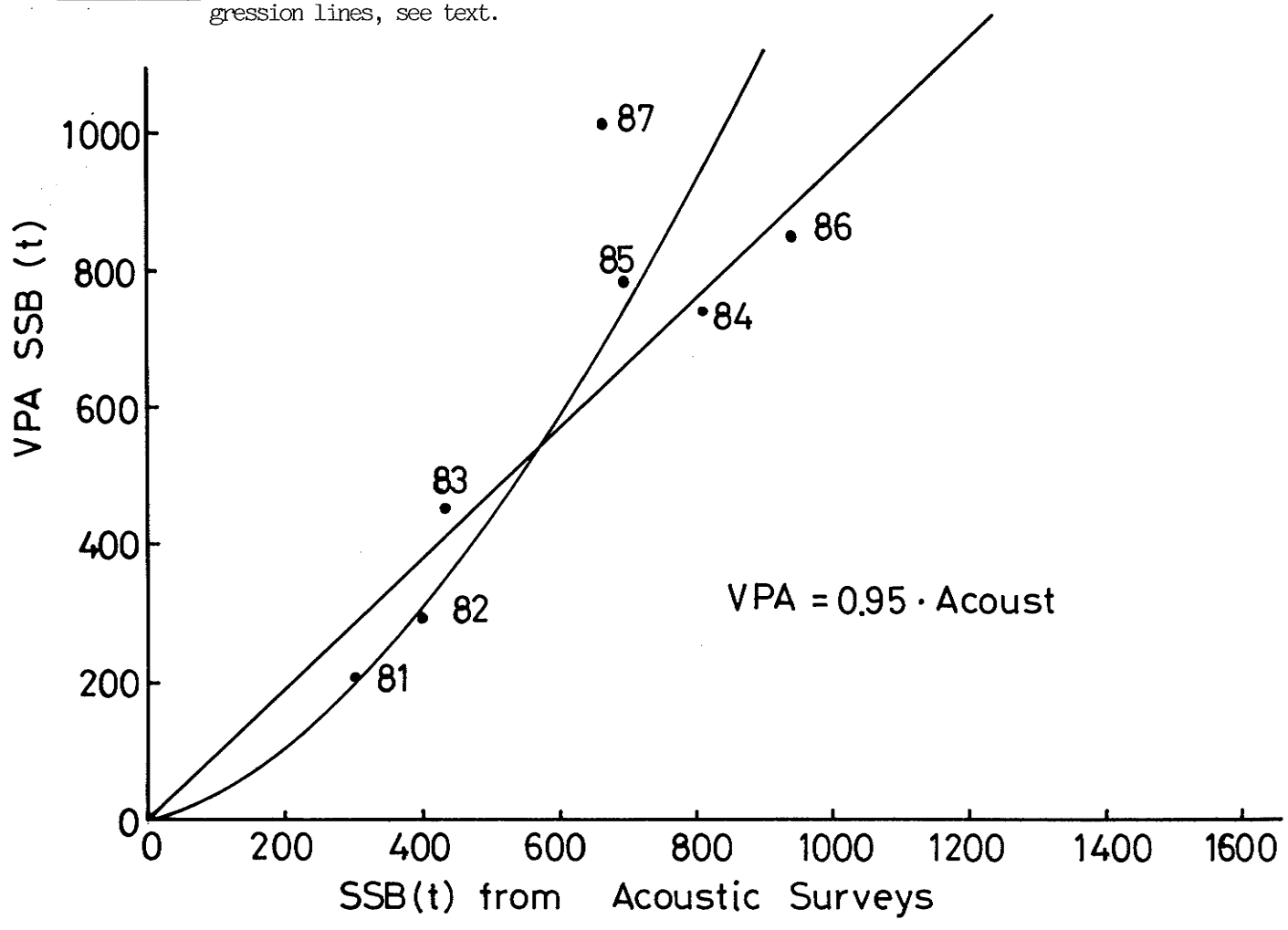
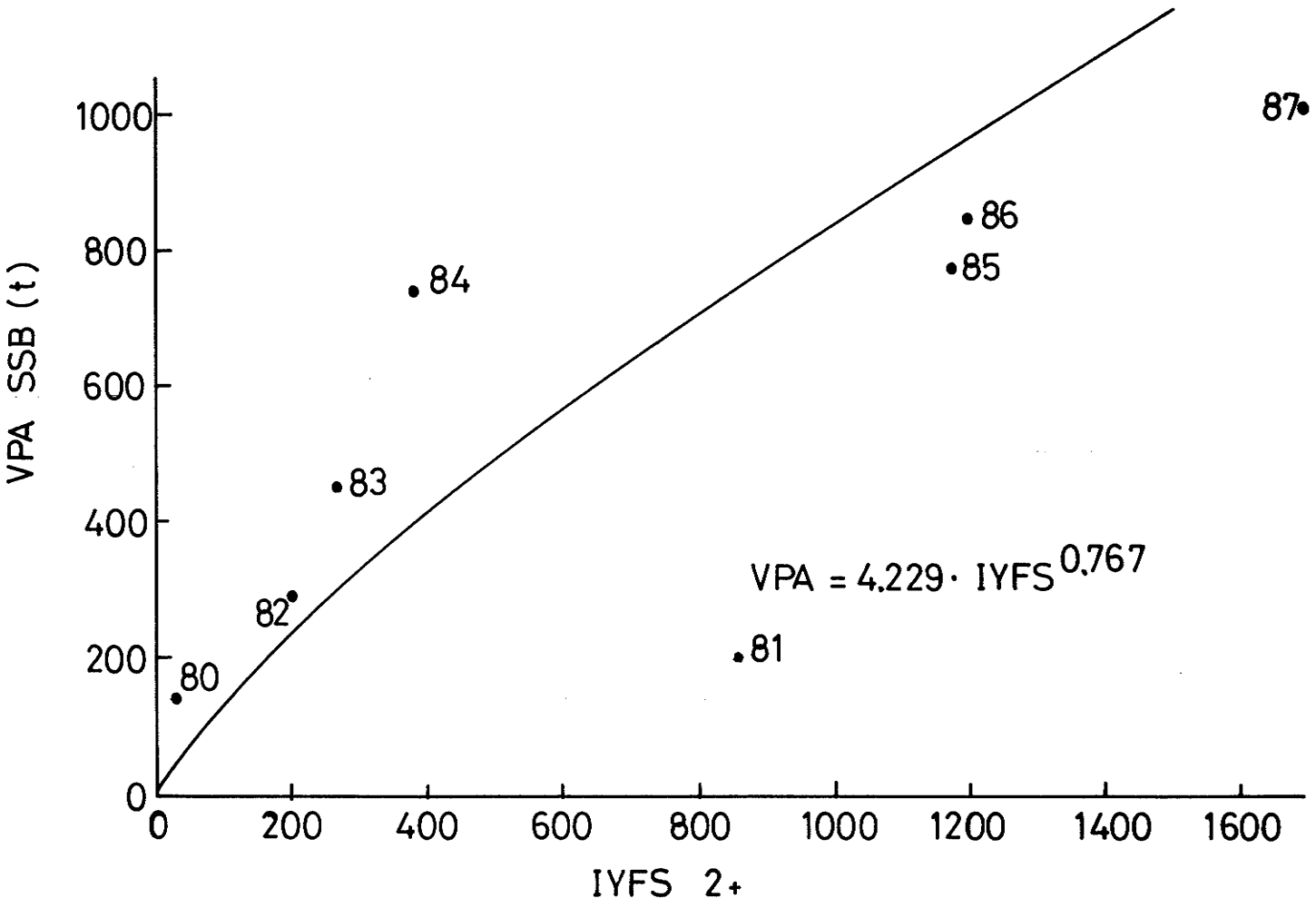


Figure 2.7.3 Plot of SSB from the VPA on the IYFS 2 age 2+ index.



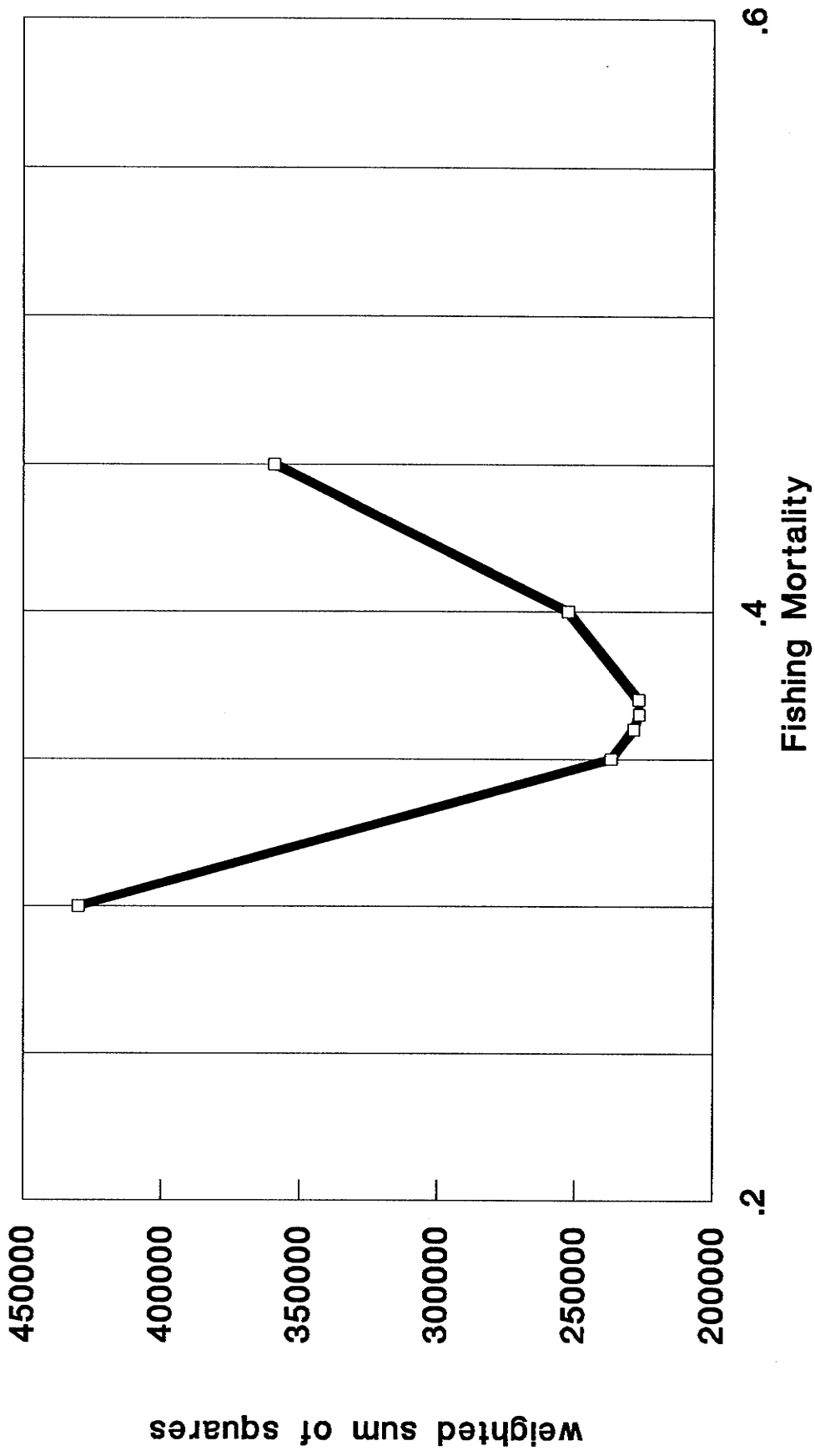


Figure 2.7.4 Plot of sum of squares of residuals between SSB estimate from VPA and as predicted from larval, acoustic and IYFS survey data on fishing mortality in 1990.

Figure 2.7.5 SSB from the VPA in relation to survey indices.

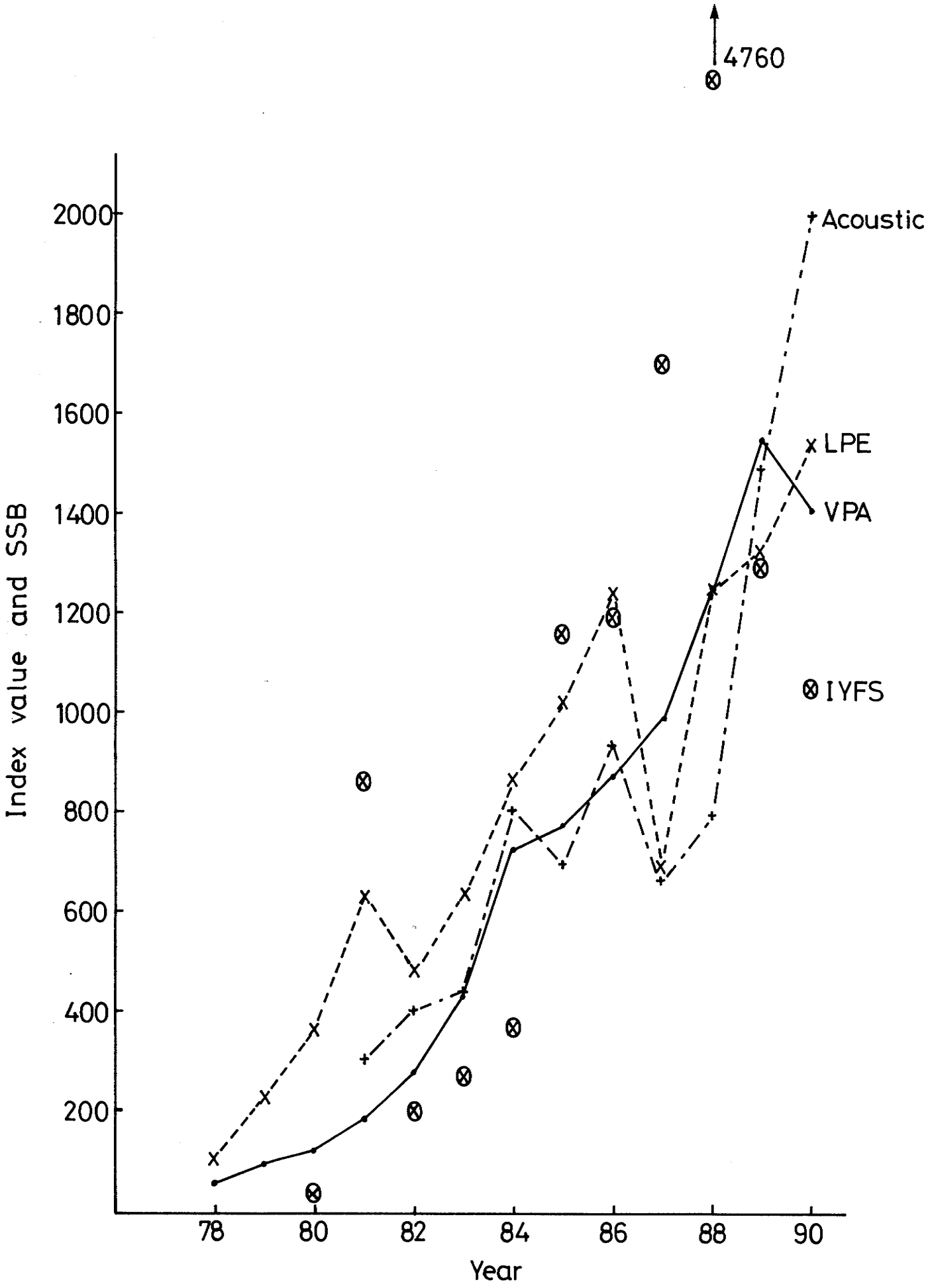


Figure 2.7.6 North Sea HERRING. Relation between acoustic estimates of SSB and LPE values.

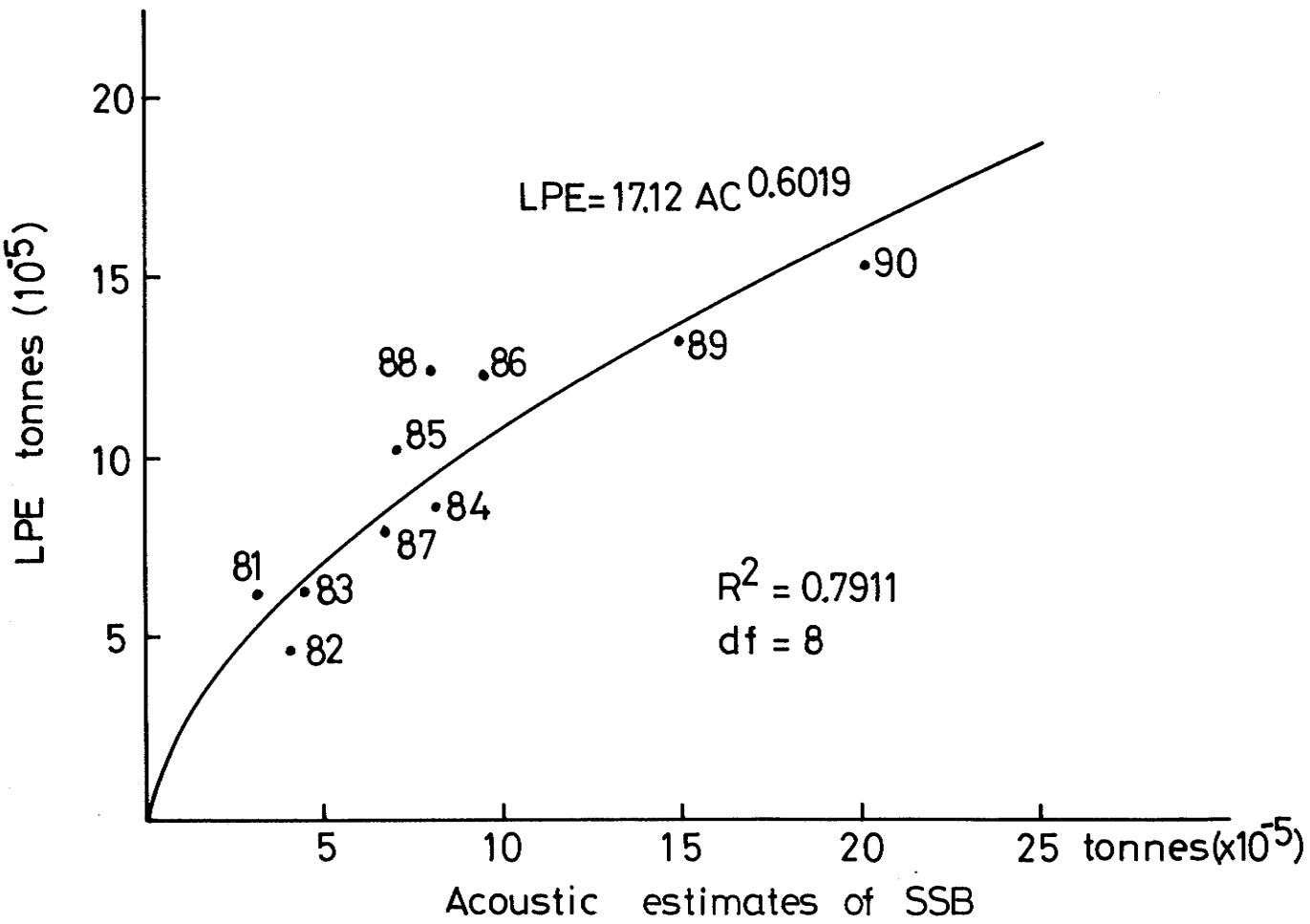
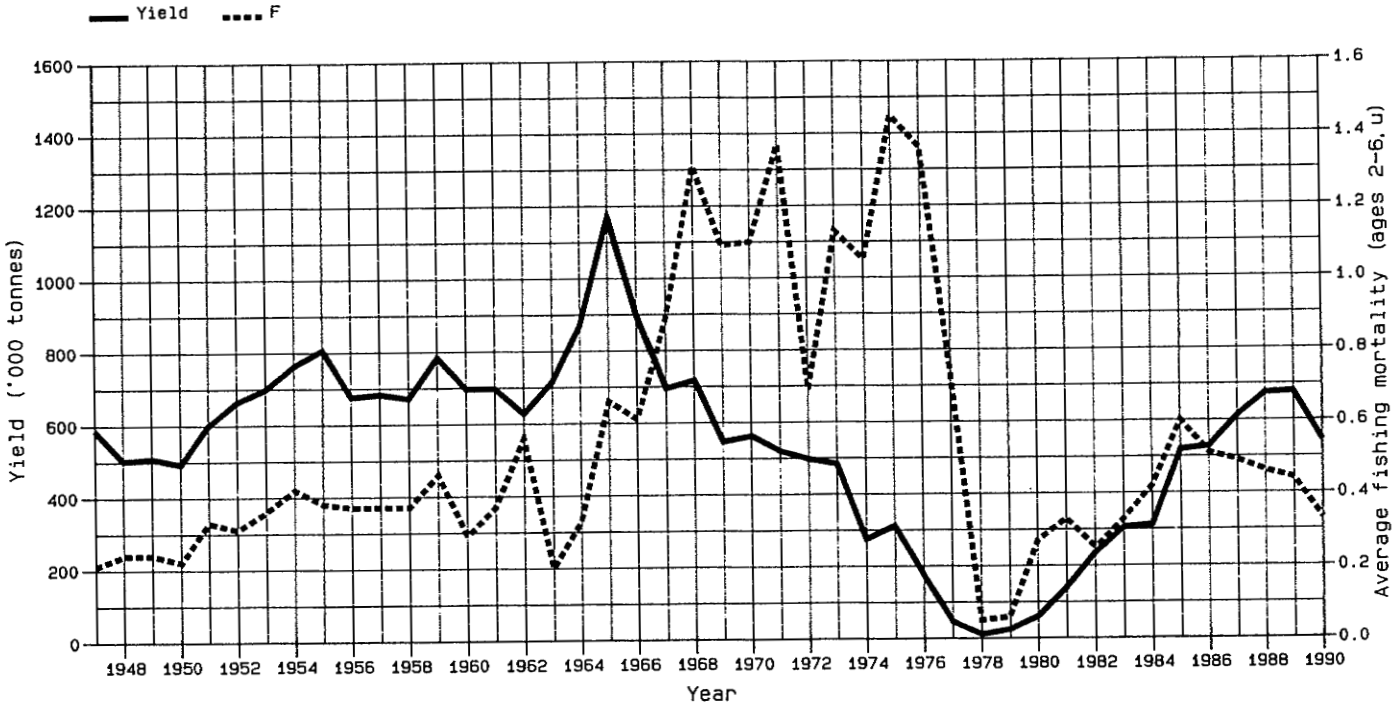


Figure 2.8

FISH STOCK SUMMARY
STOCK: North Sea Herring including IIIa juveniles
29-05-1990

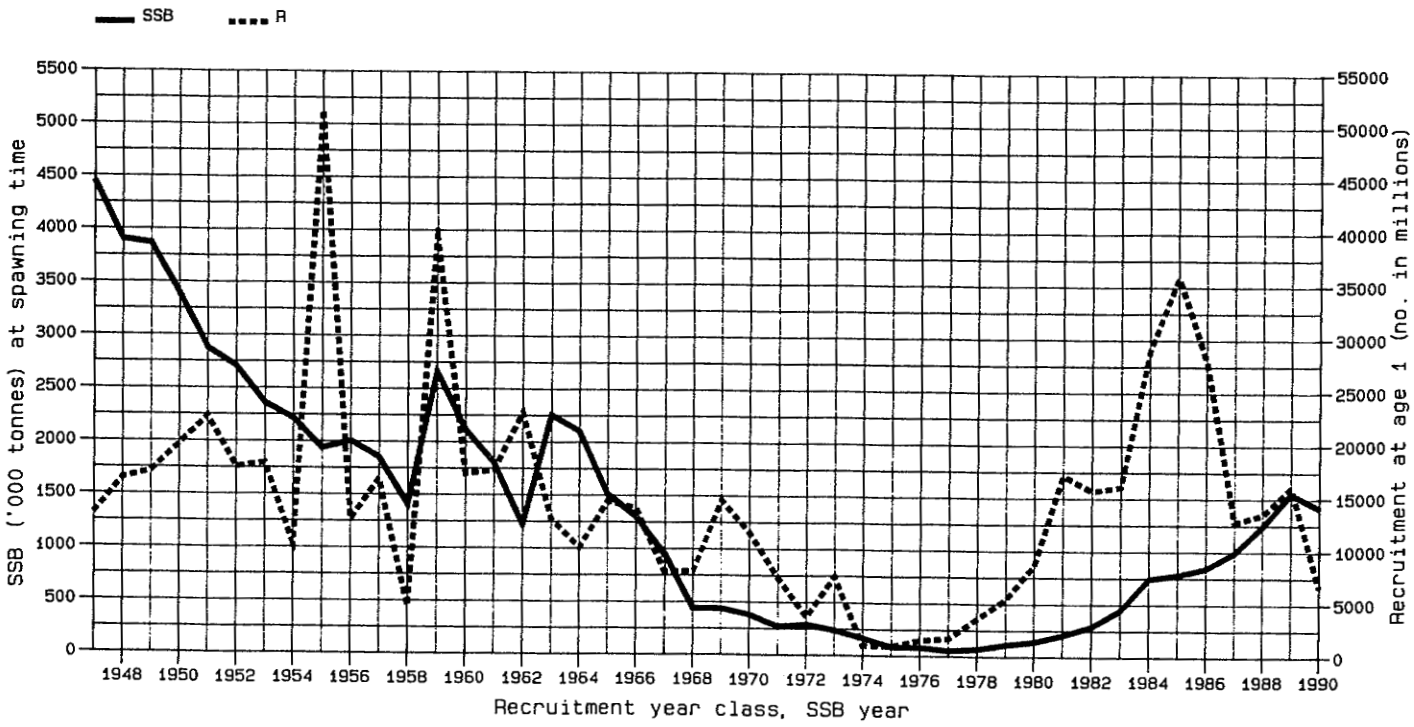
Trends in yield and fishing mortality (F)



A

FISH STOCK SUMMARY
STOCK: North Sea Herring including IIIa juveniles
29-05-1990

Trends in spawning stock biomass (SSB)
and recruitment (R)



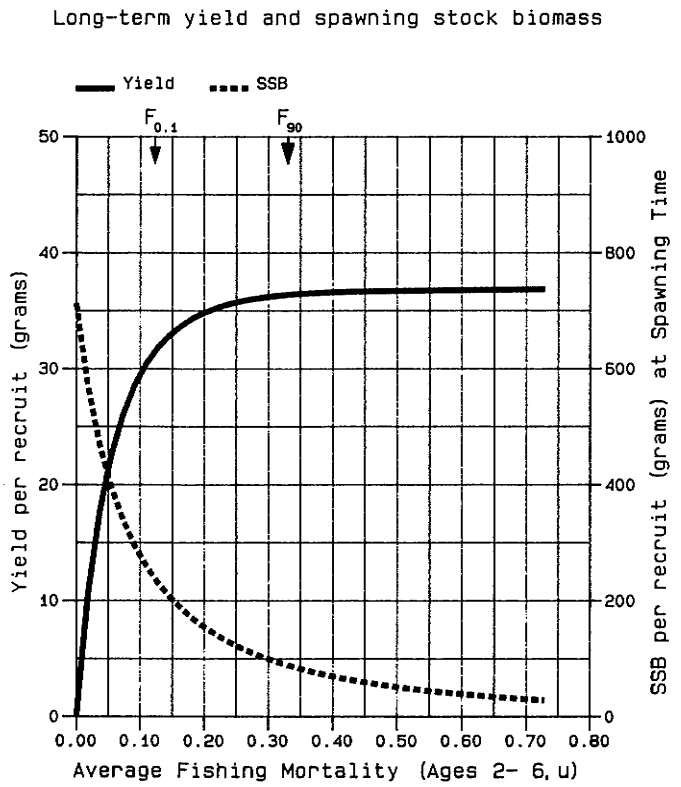
B

Figure 2.8 cont'd.

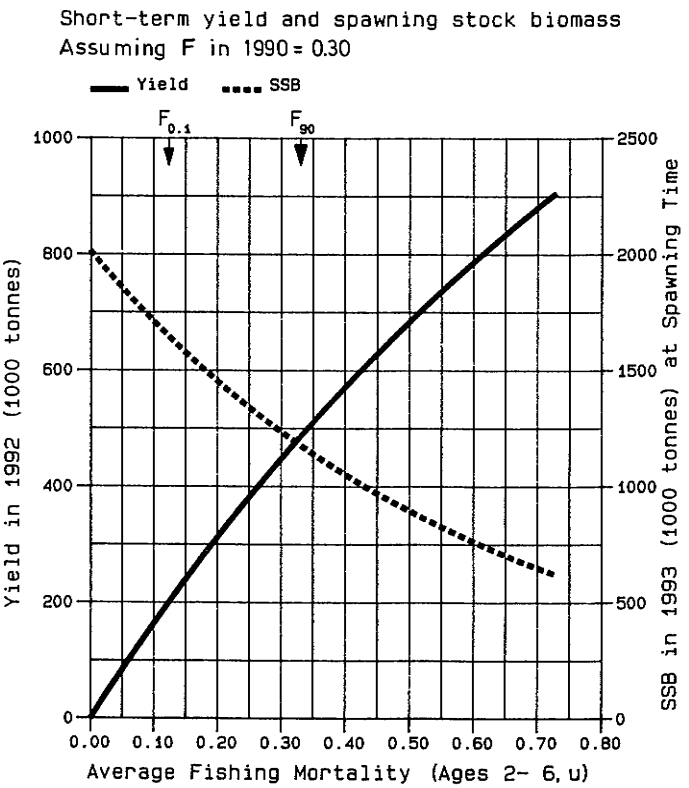
FISH STOCK SUMMARY

STOCK: North Sea Herring including IIIa juveniles

24-04-1991



C



D

Figure 2.10.1 North Sea catches, January 1990, 19,575 tonnes.

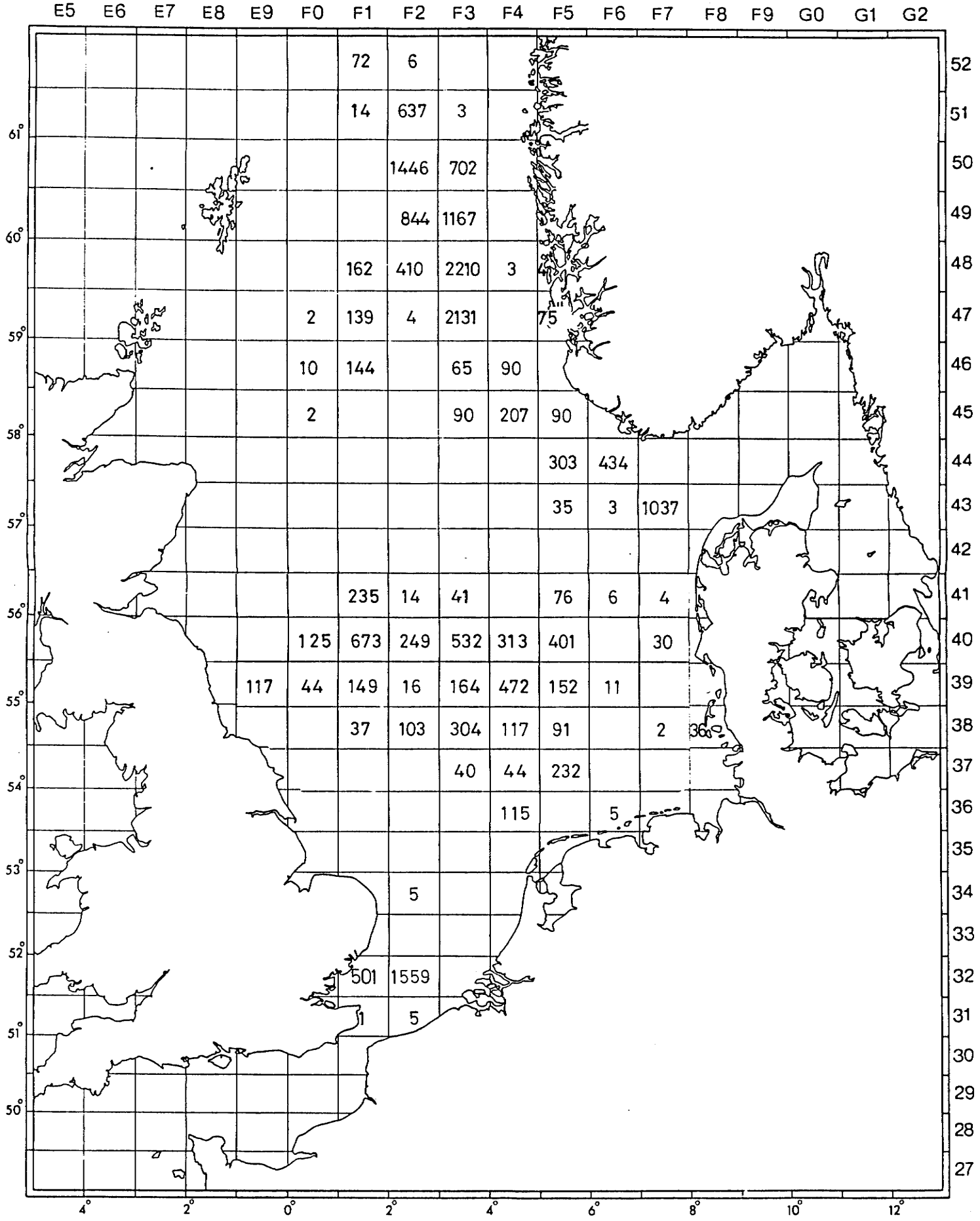


Figure 2.10.2 North Sea catches, February 1990, 26,187 tonnes.

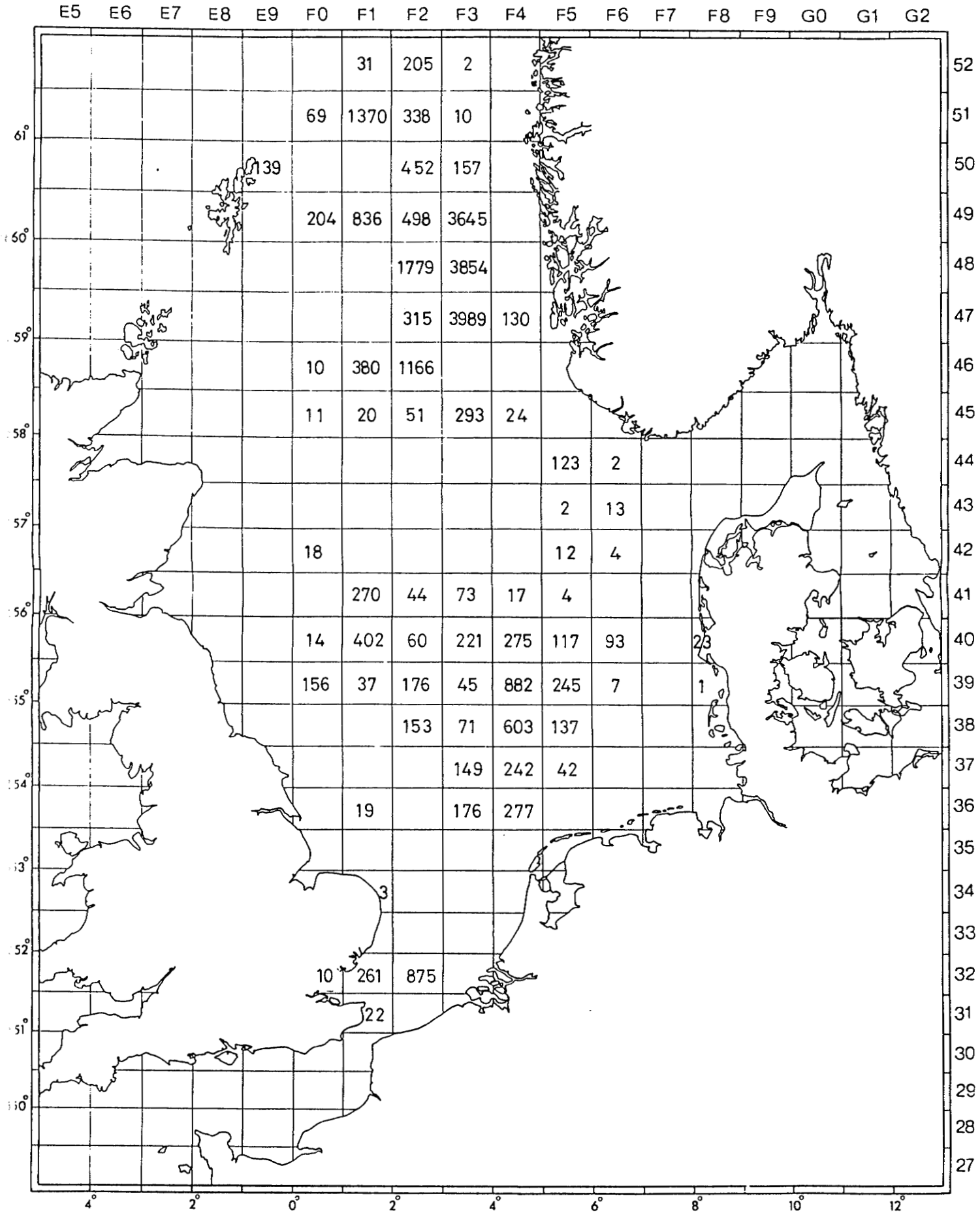


Figure 2.10.3 North Sea catches, March 1990, 7,580 tonnes.

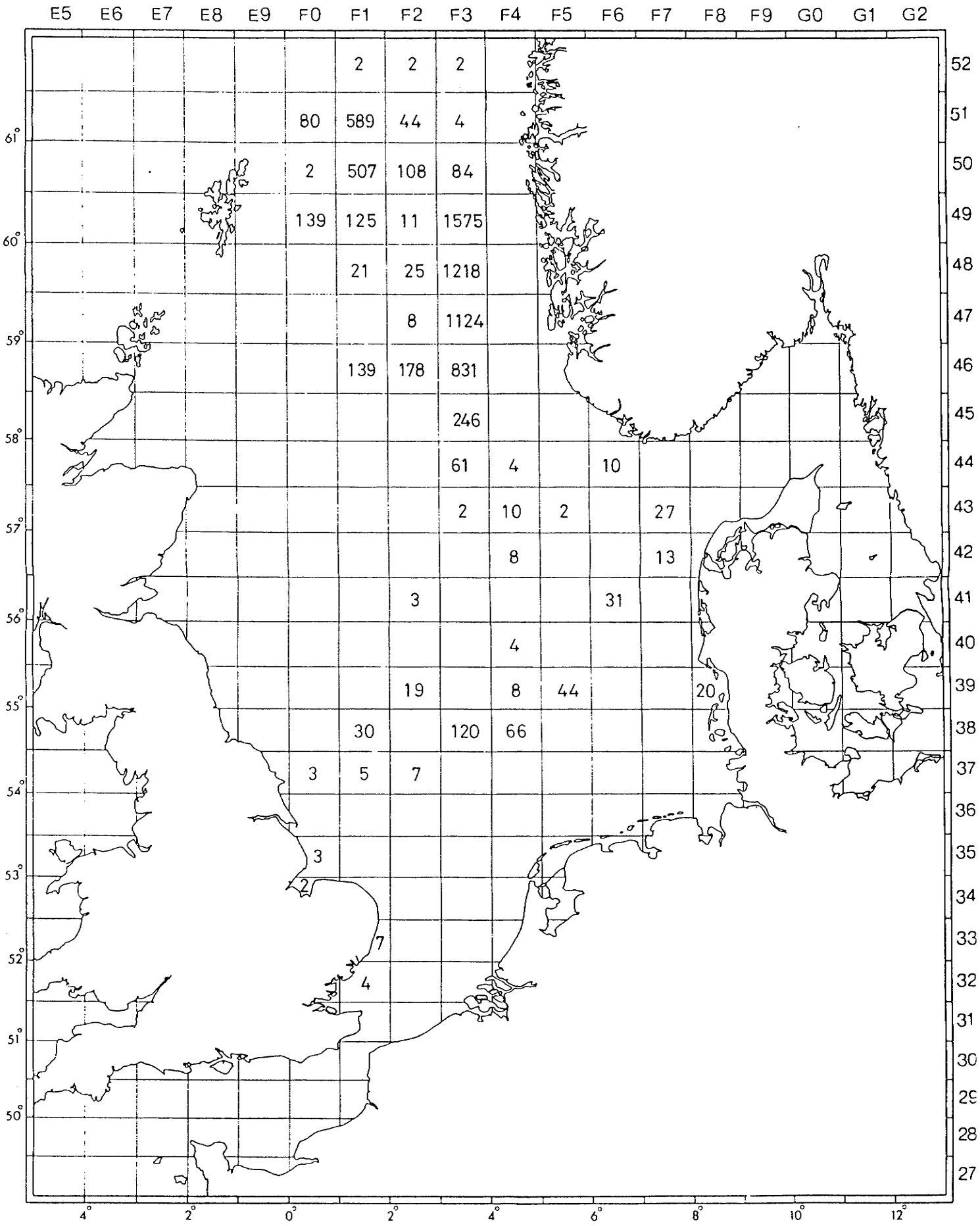


Figure 2.10.4 North Sea catches, April 1990, 2,760 tonnes.

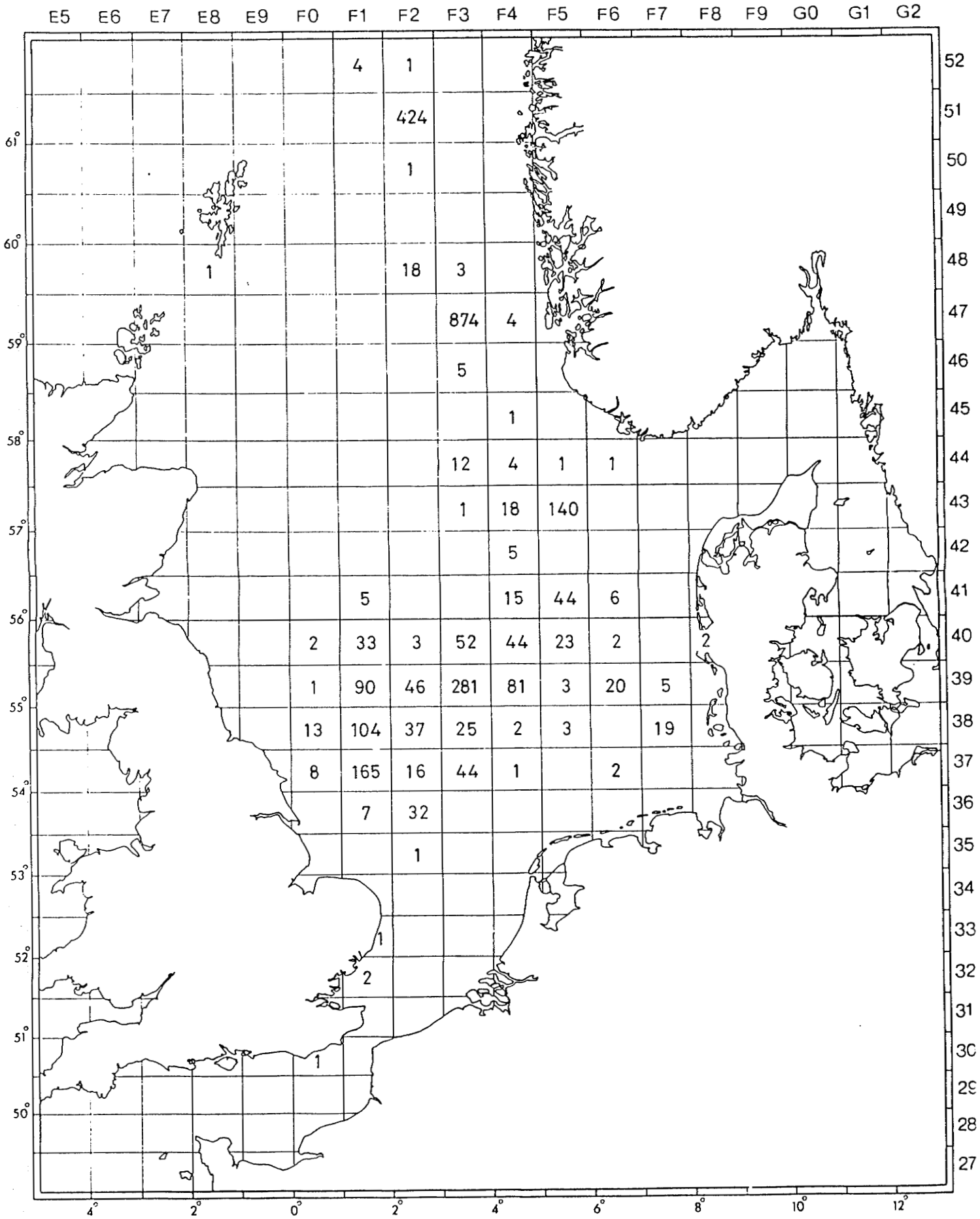


Figure 2.10.5 North Sea catches, May 1990, 11,609 tonnes.

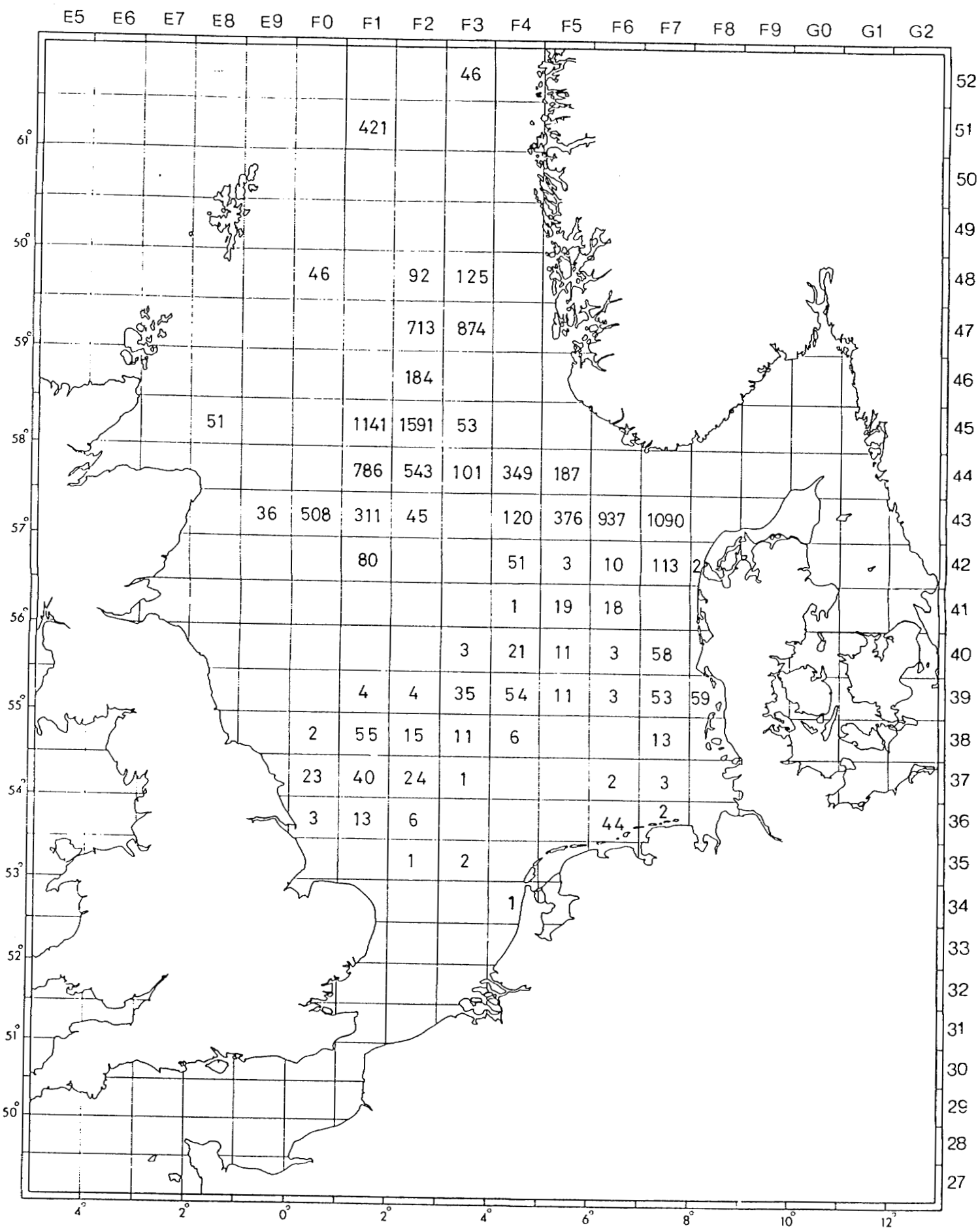


Figure 2.10.6 North Sea catches, June 1990, 33,406 tonnes.

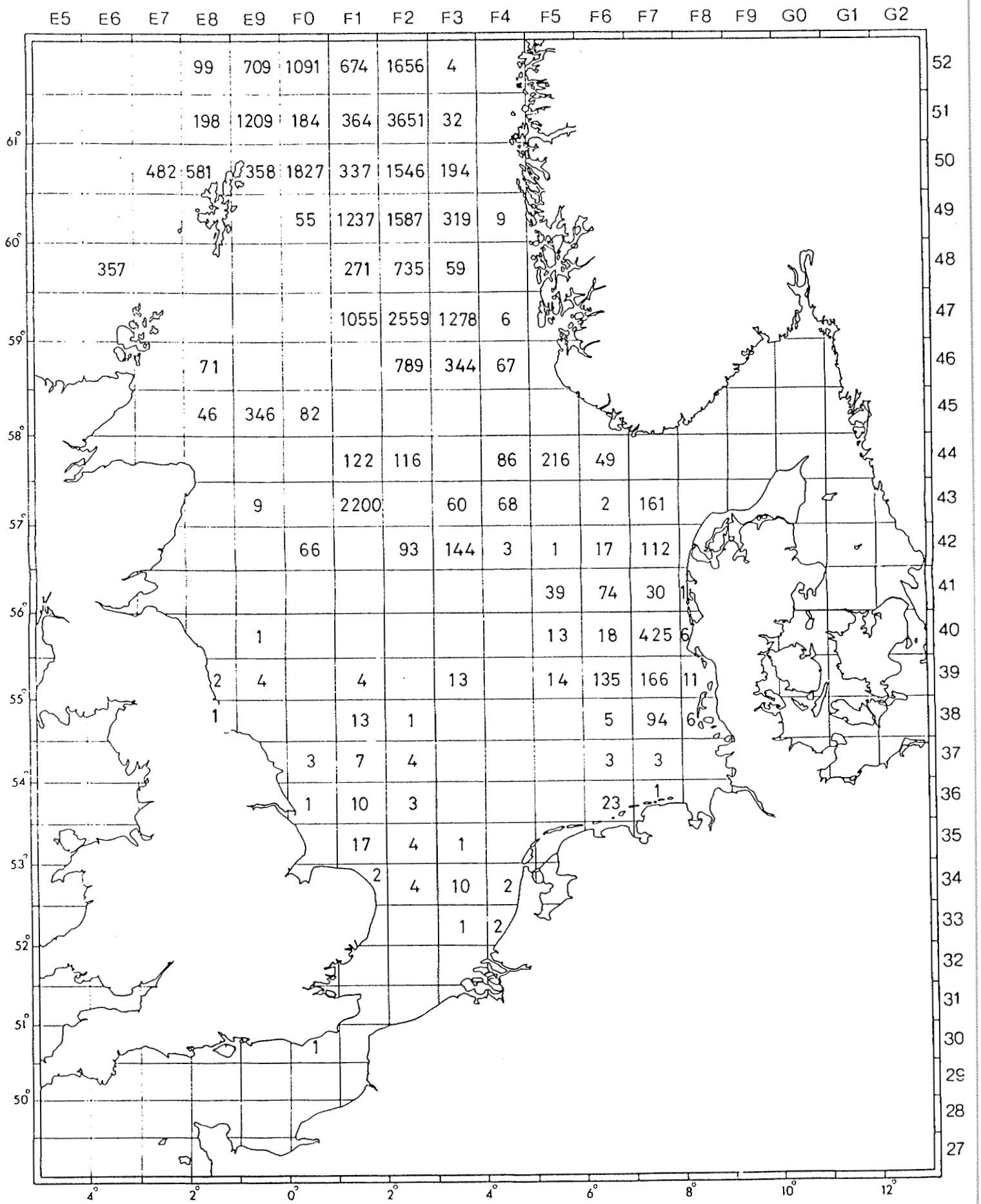


Figure 2.10.7 North Sea catches, July 1990, 72,124 tonnes.

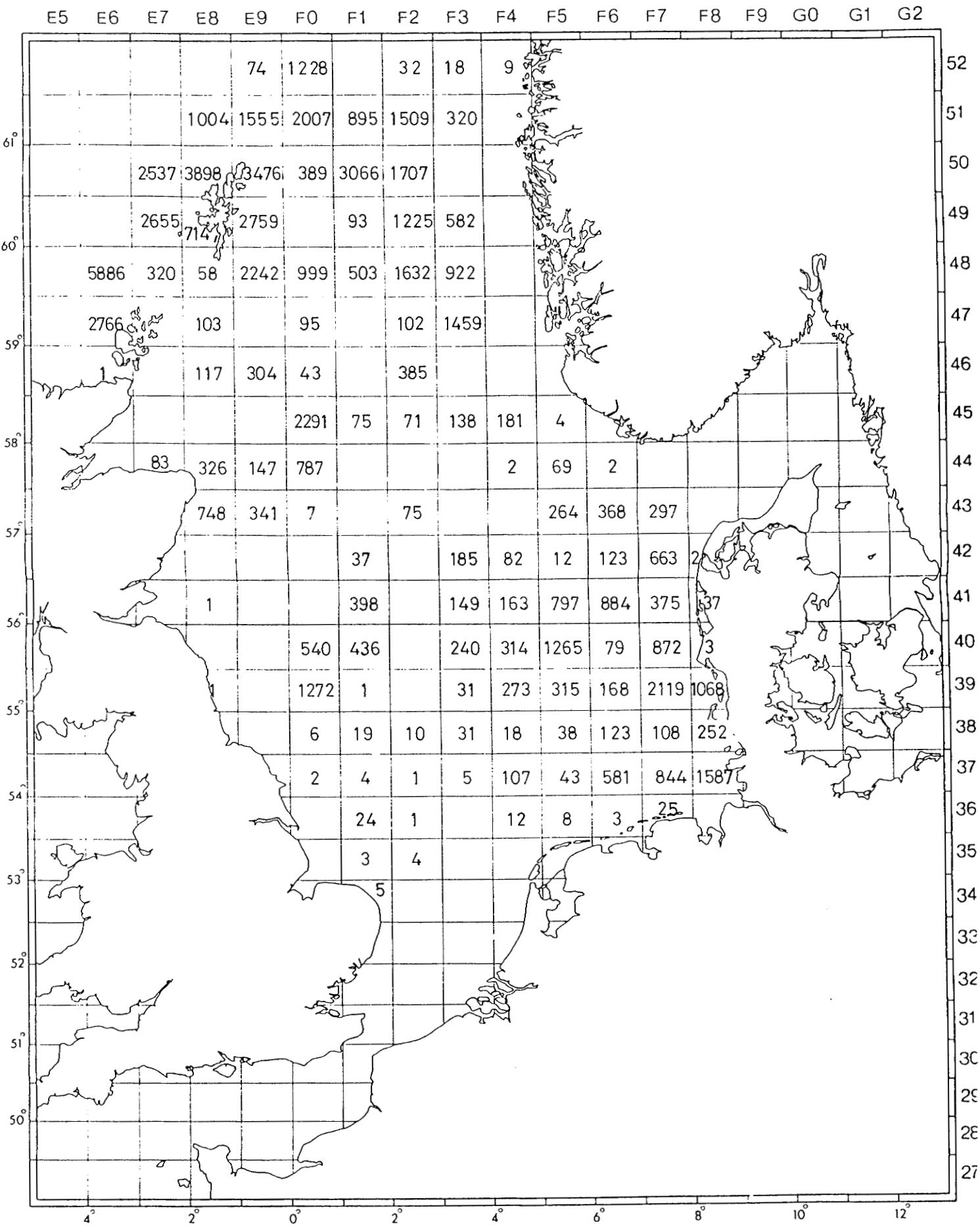


Figure 2.10.8 North Sea catches, August 1990, 101,470 tonnes.

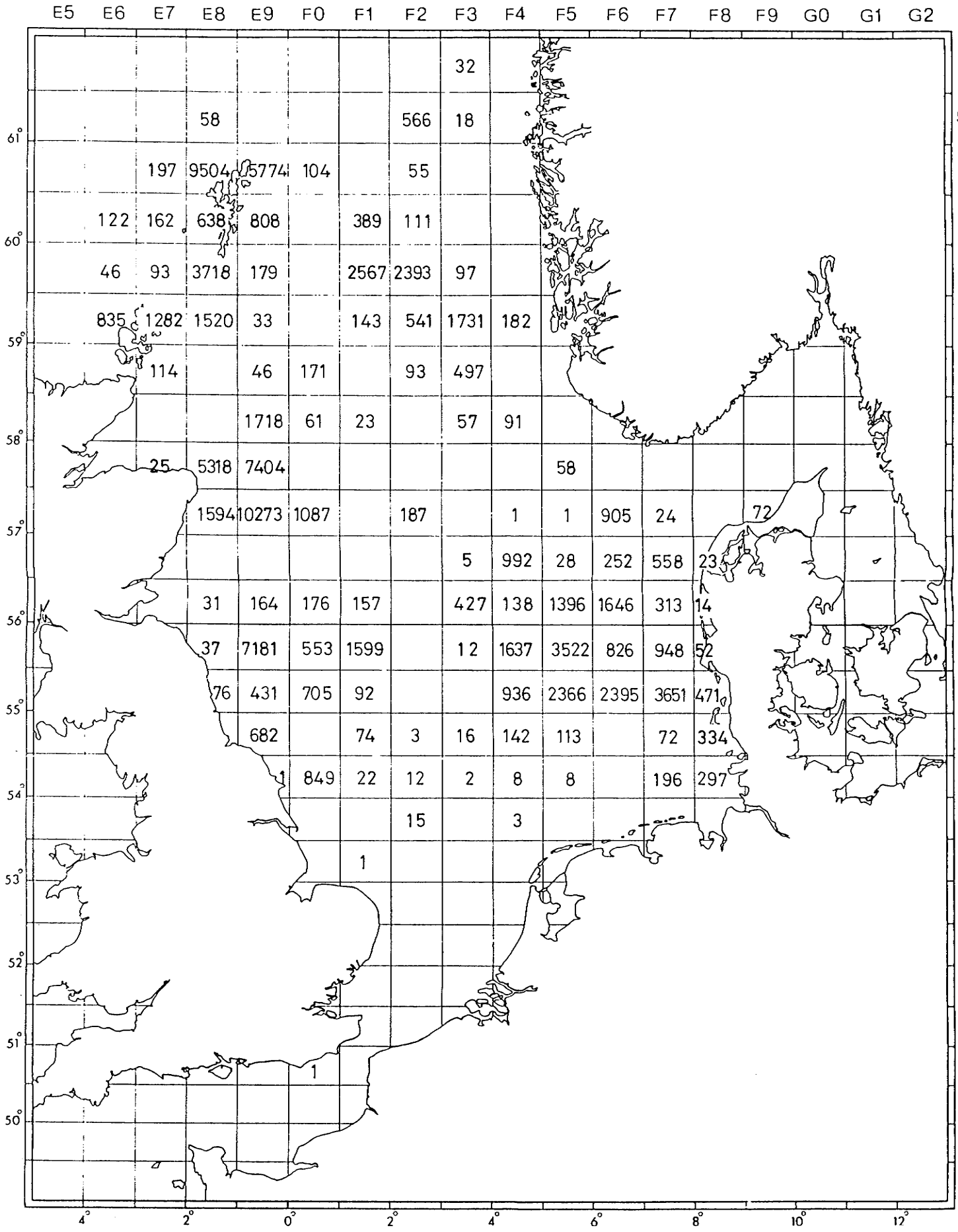


Figure 2.10.9 North Sea catches, September 1990, 44,236 tonnes.

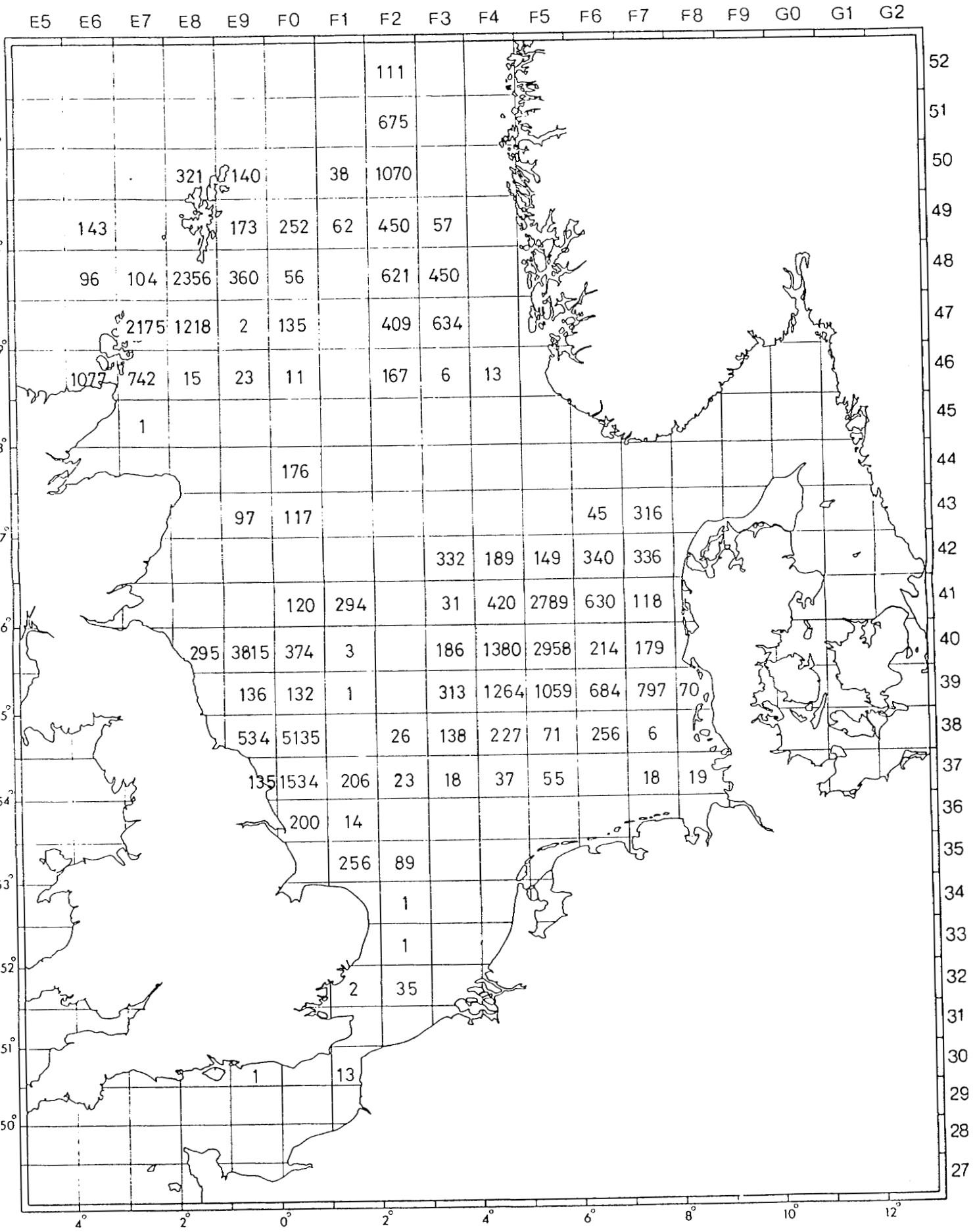


Figure 2.10.10 North Sea catches, October 1990, 26,060 tonnes.

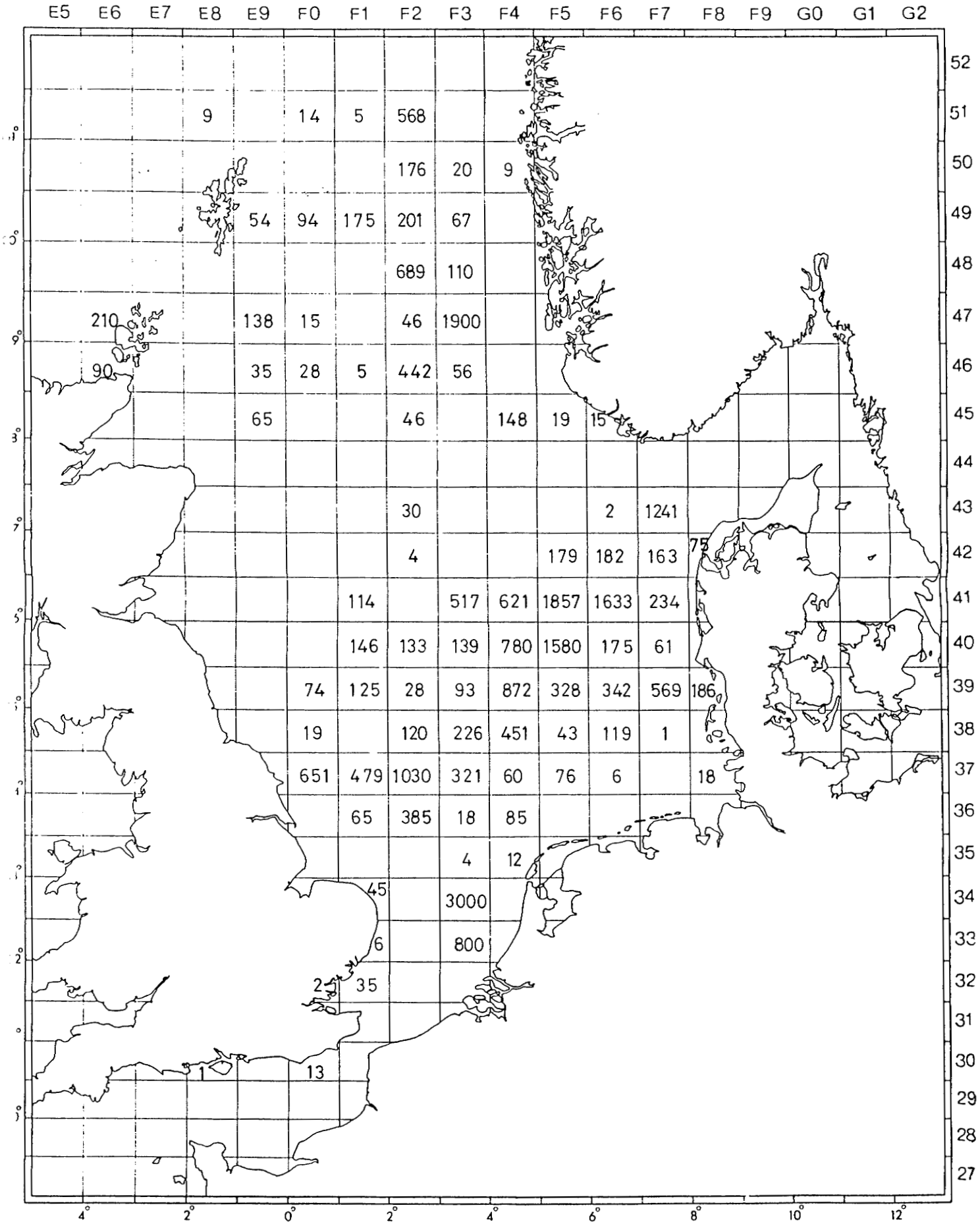


Figure 2.10.11 North Sea catches, November 1990, 66,591 tonnes.

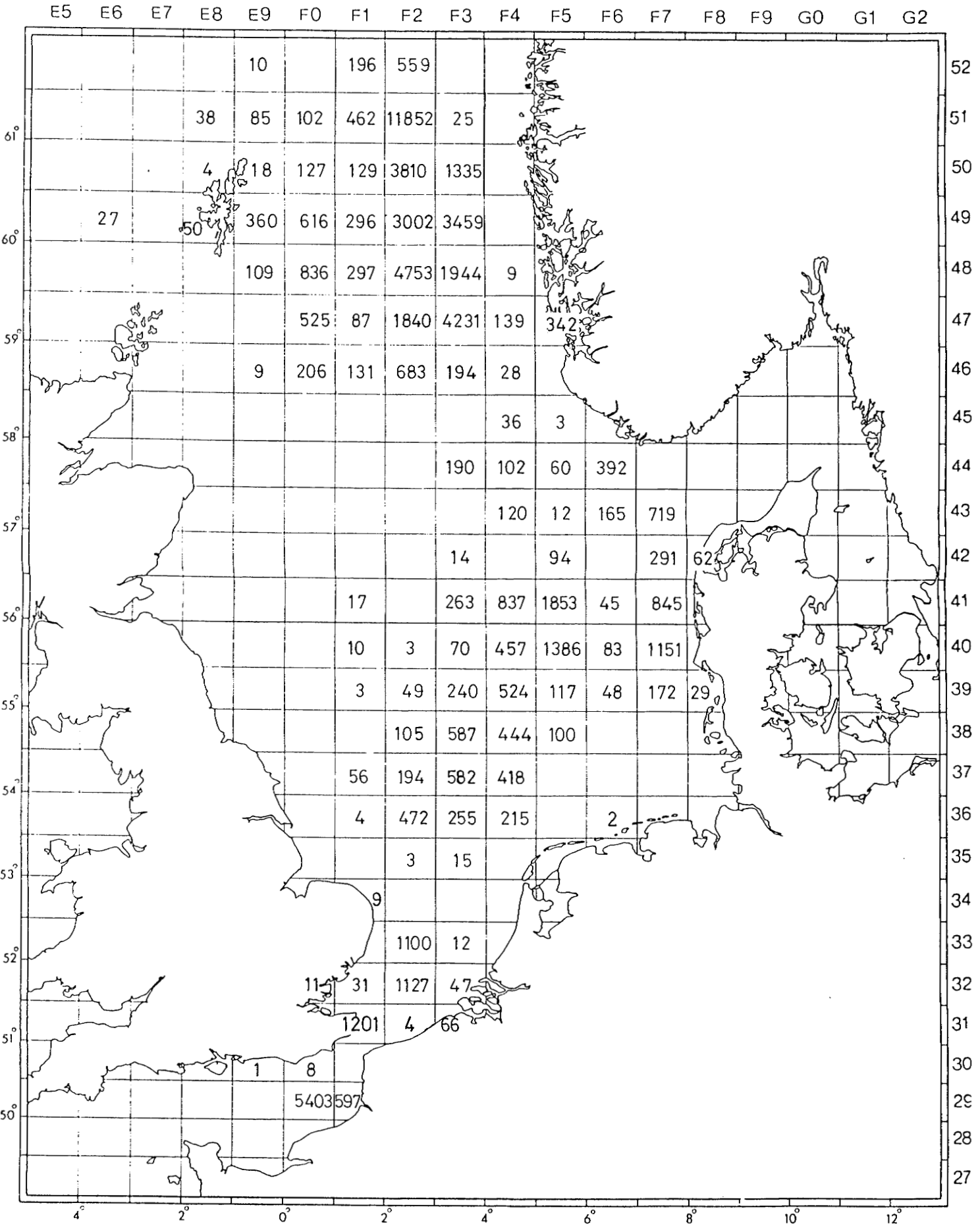


Figure 2.10.12 North Sea catches, December 1990, 56,034 tonnes.

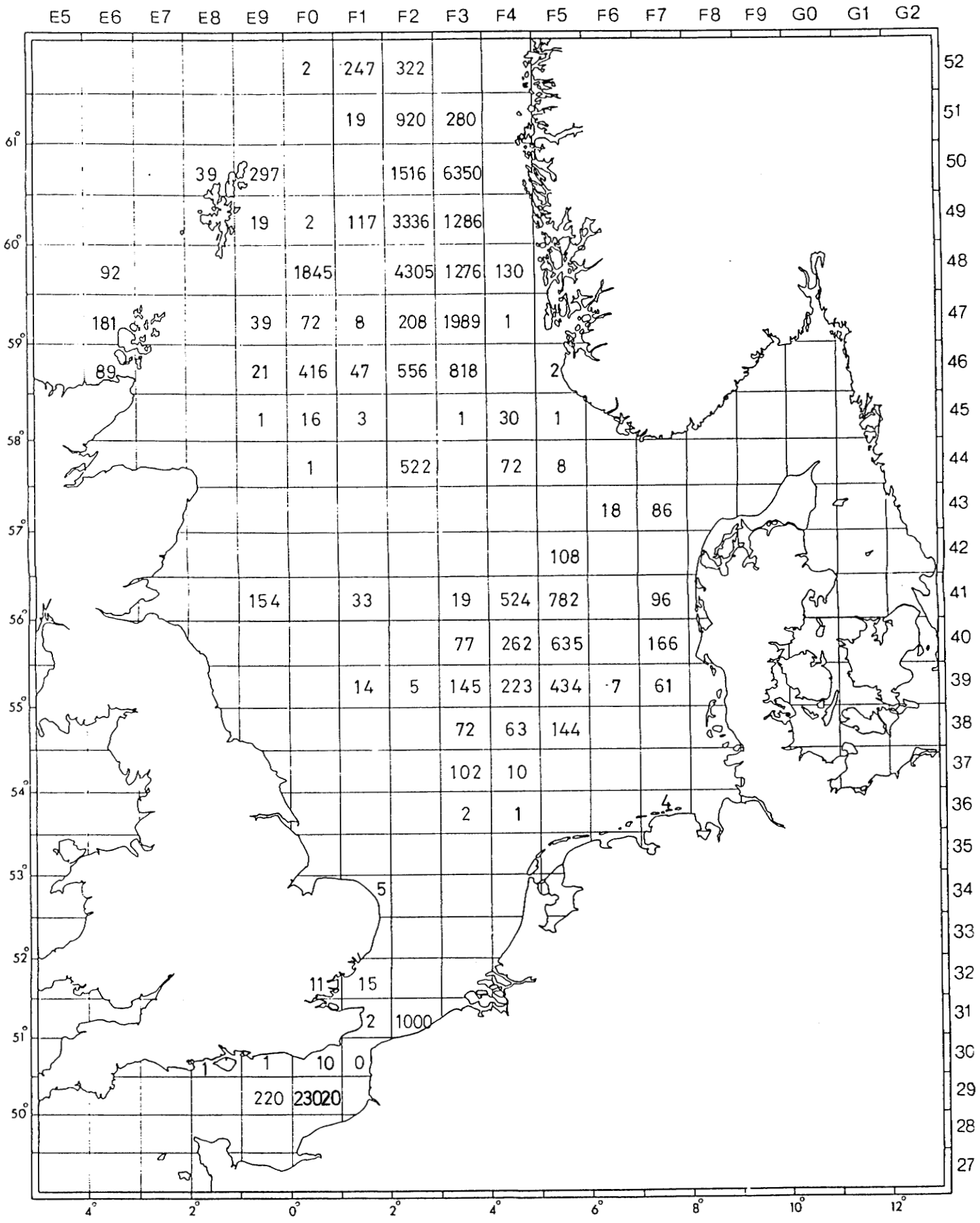


Figure 2.10.13 Cumulative catch by month in the North Sea

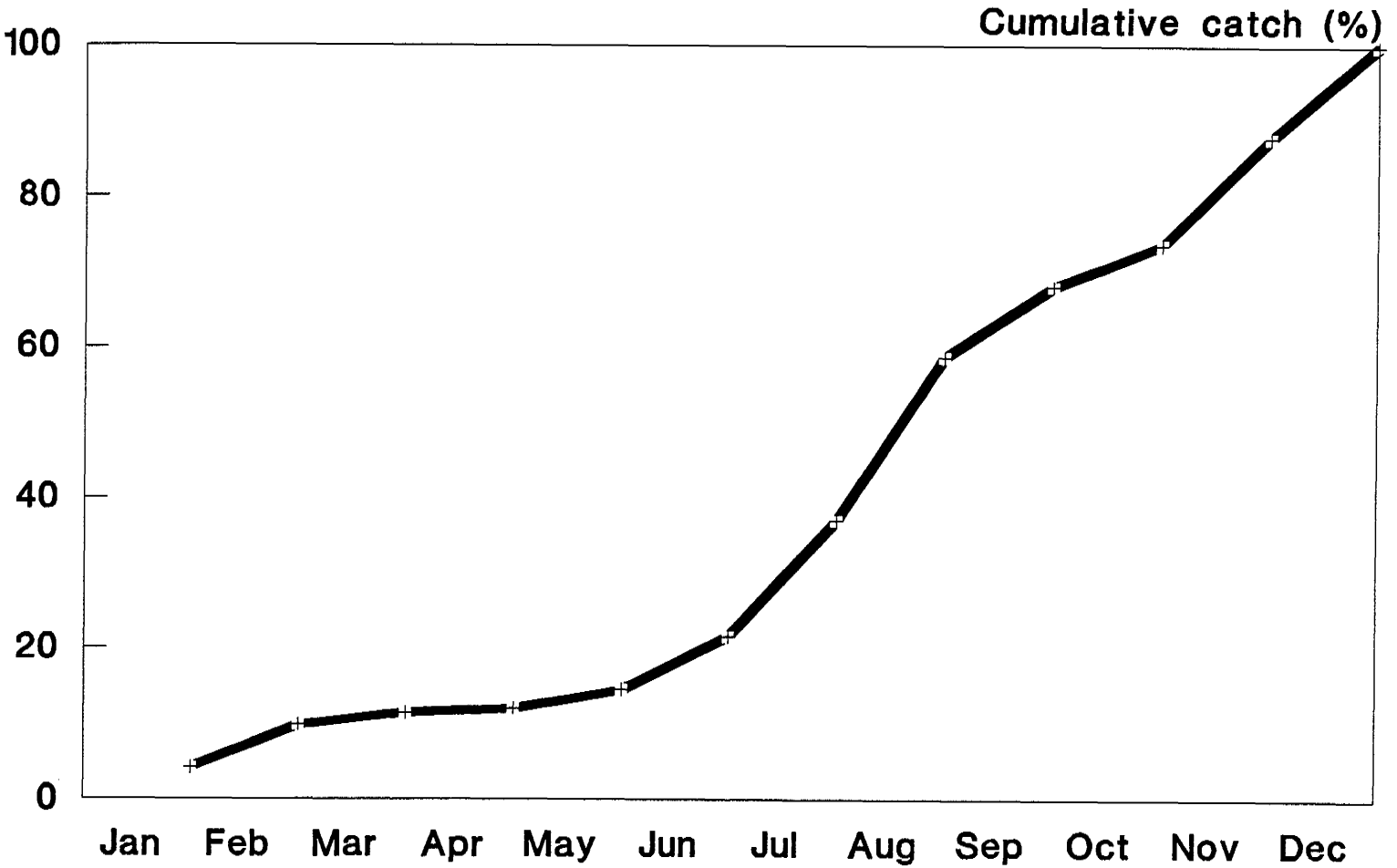


Figure 4.1.1 The assessment covers the area Divisions VIIj and VIIg and that part of Division VIIa below 52°30. TAC is set by EC for Divisions VIIg-k and that section of Division VIIa below 52°30.

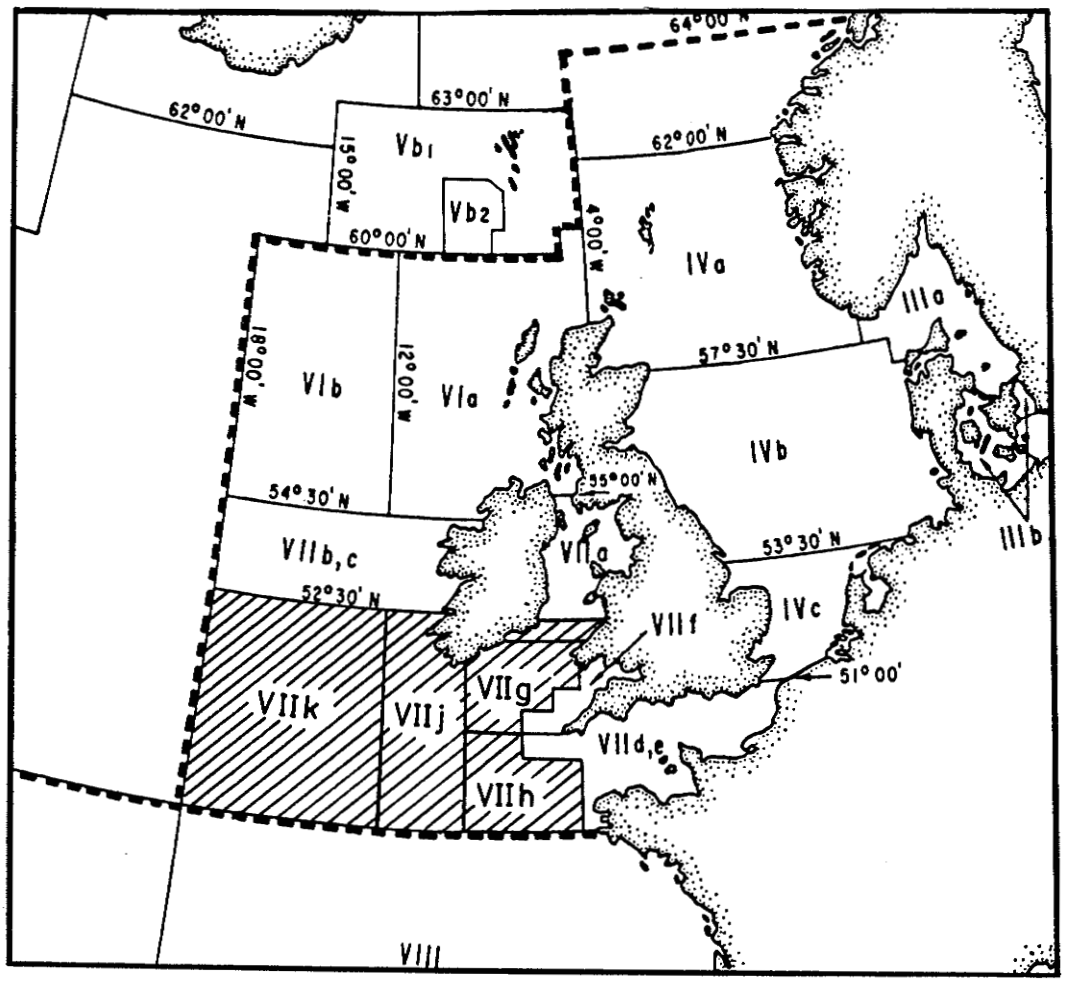


Figure 4.2.1A Distribution of Irish and Netherlands catches.
1st Quarter 1990.

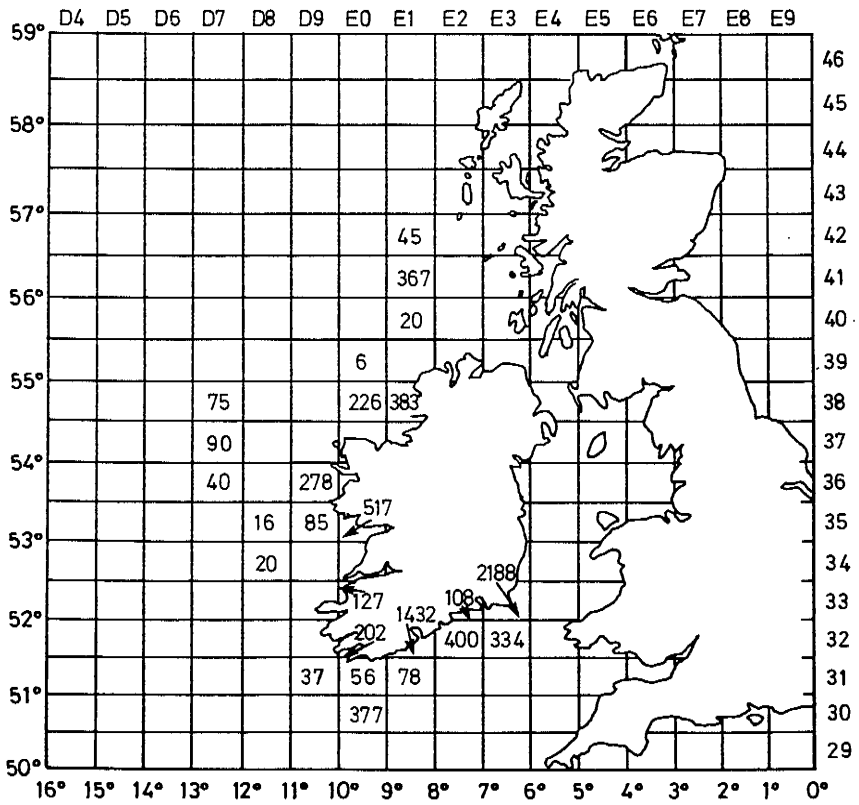


Figure 4.2.1B Distribution of Irish and Netherlands catches.
2nd Quarter 1990.

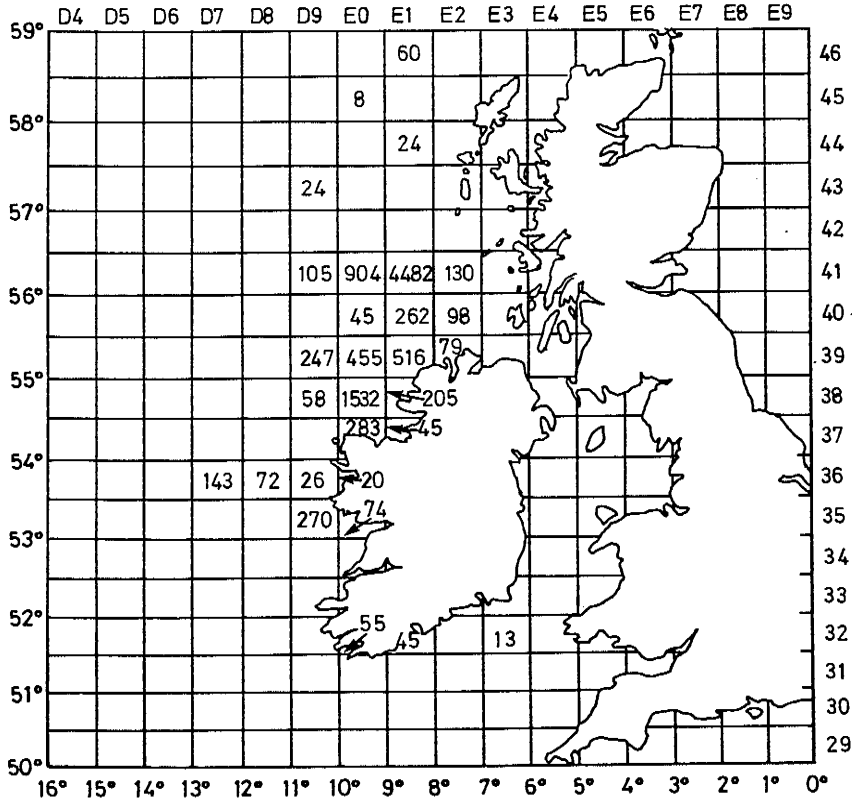


Figure 4.2.1C Distribution of Irish and Netherlands catches.
3rd Quarter 1990.

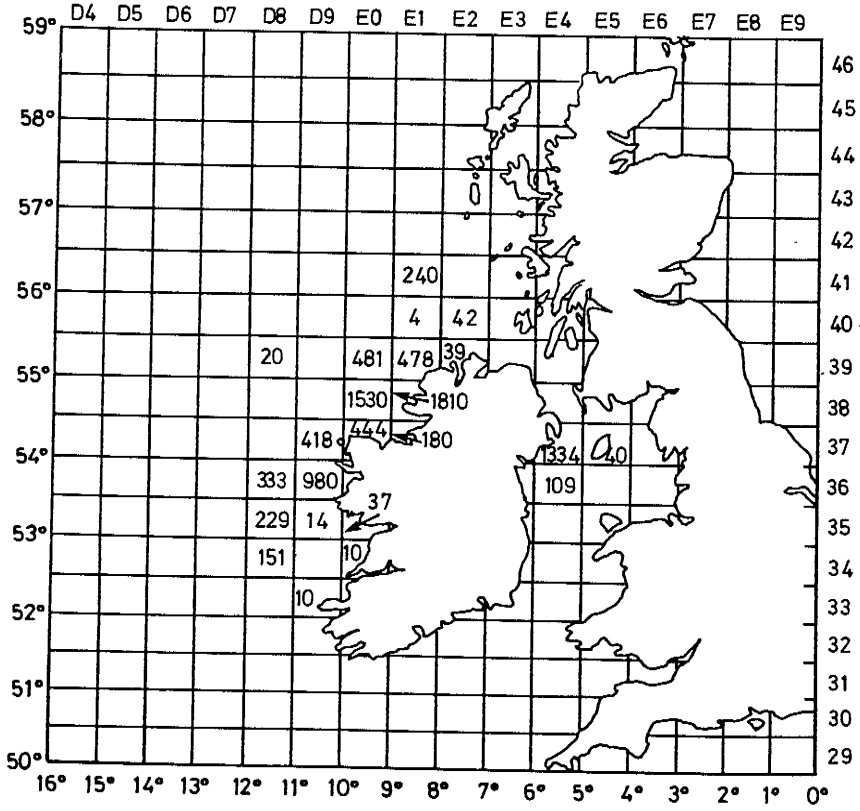


Figure 4.2.1D Distribution of Irish and Netherlands catches.
4th Quarter 1990.

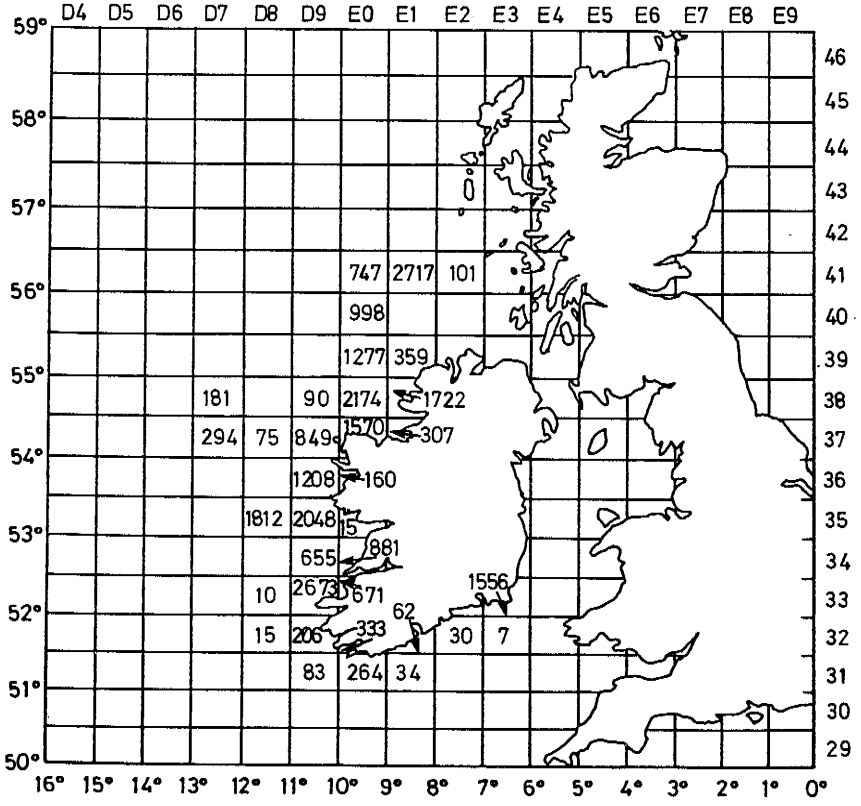
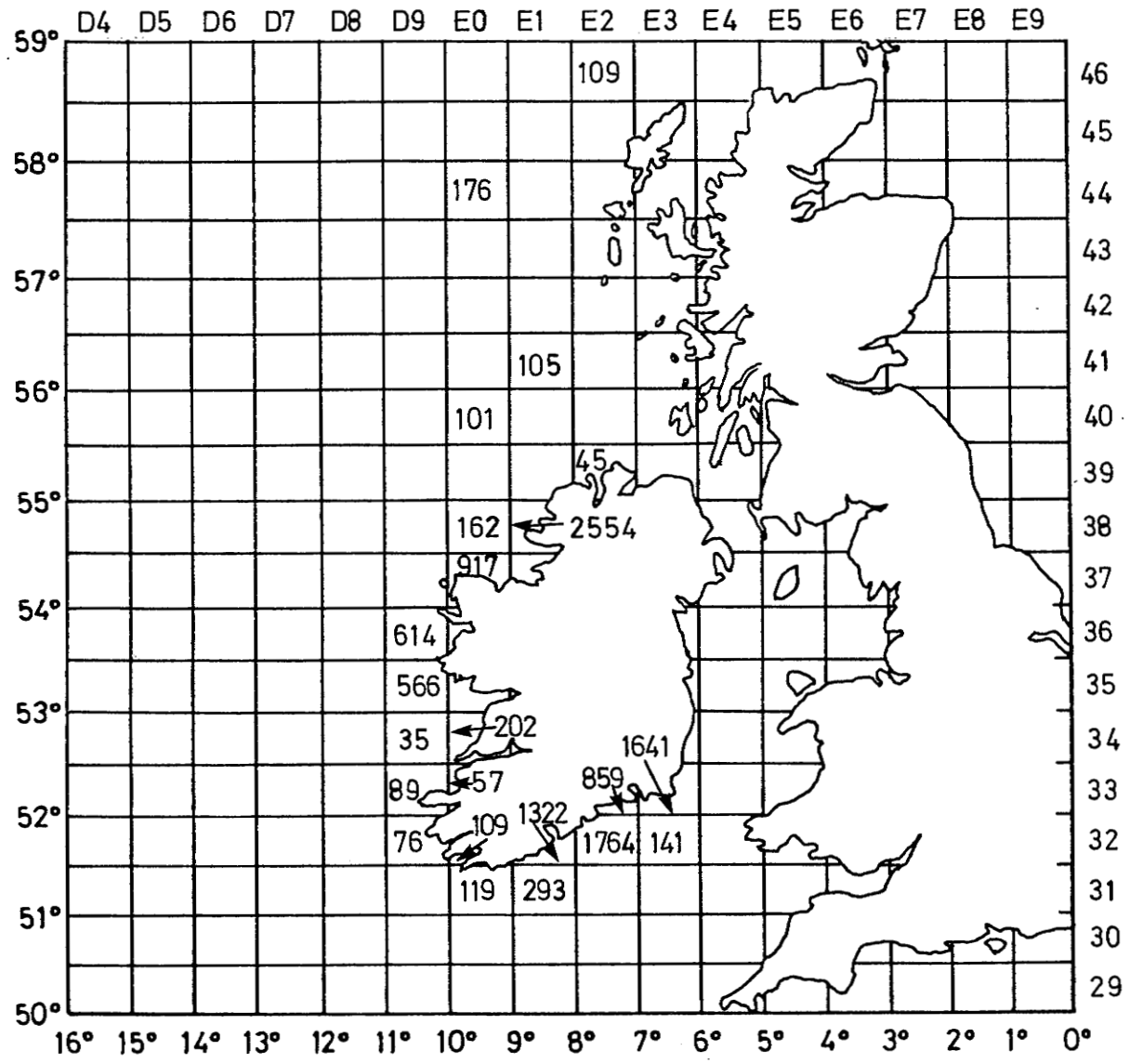


Figure 4.2.1E Distribution of Irish and Netherlands catches.
1st Quarter 1991.



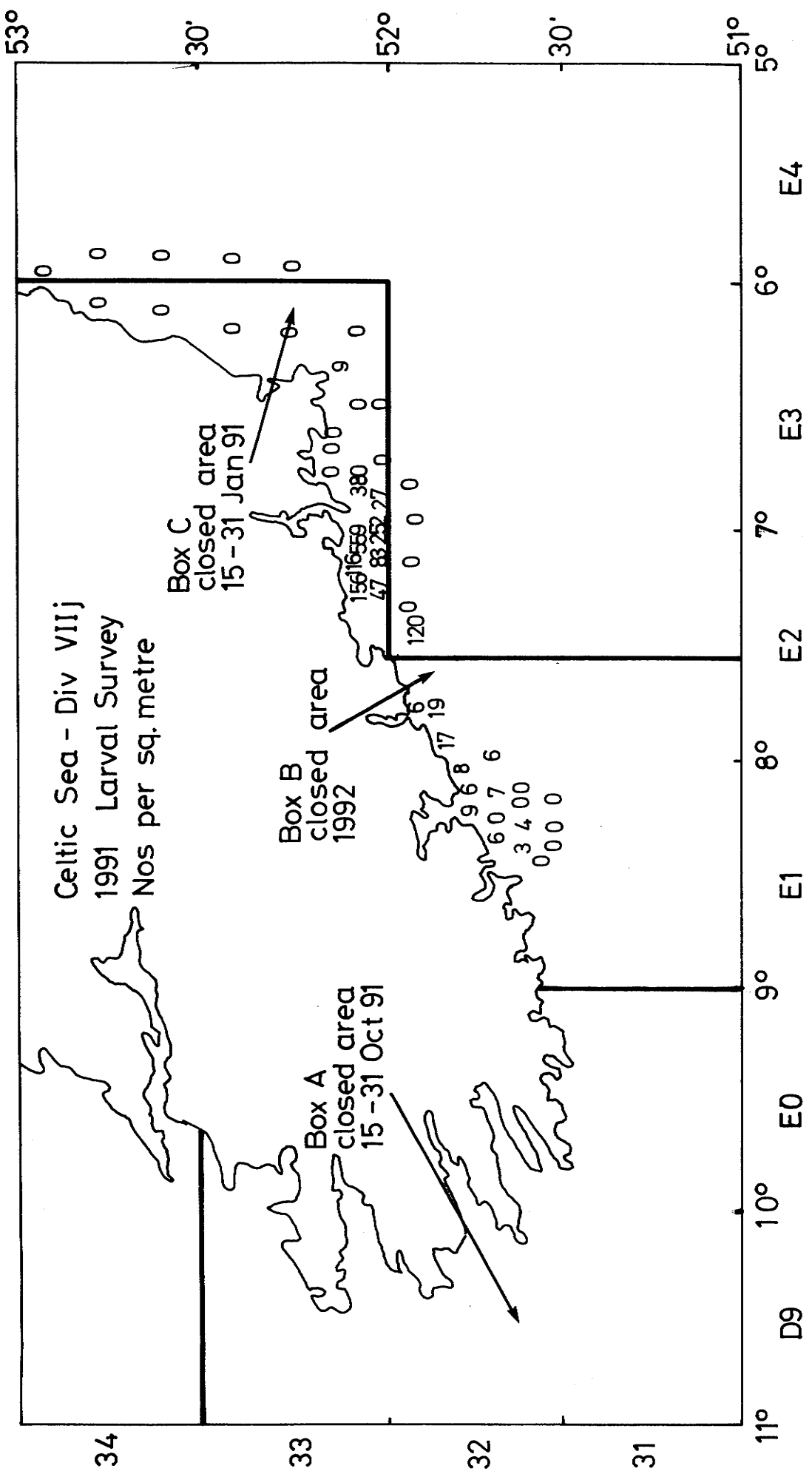
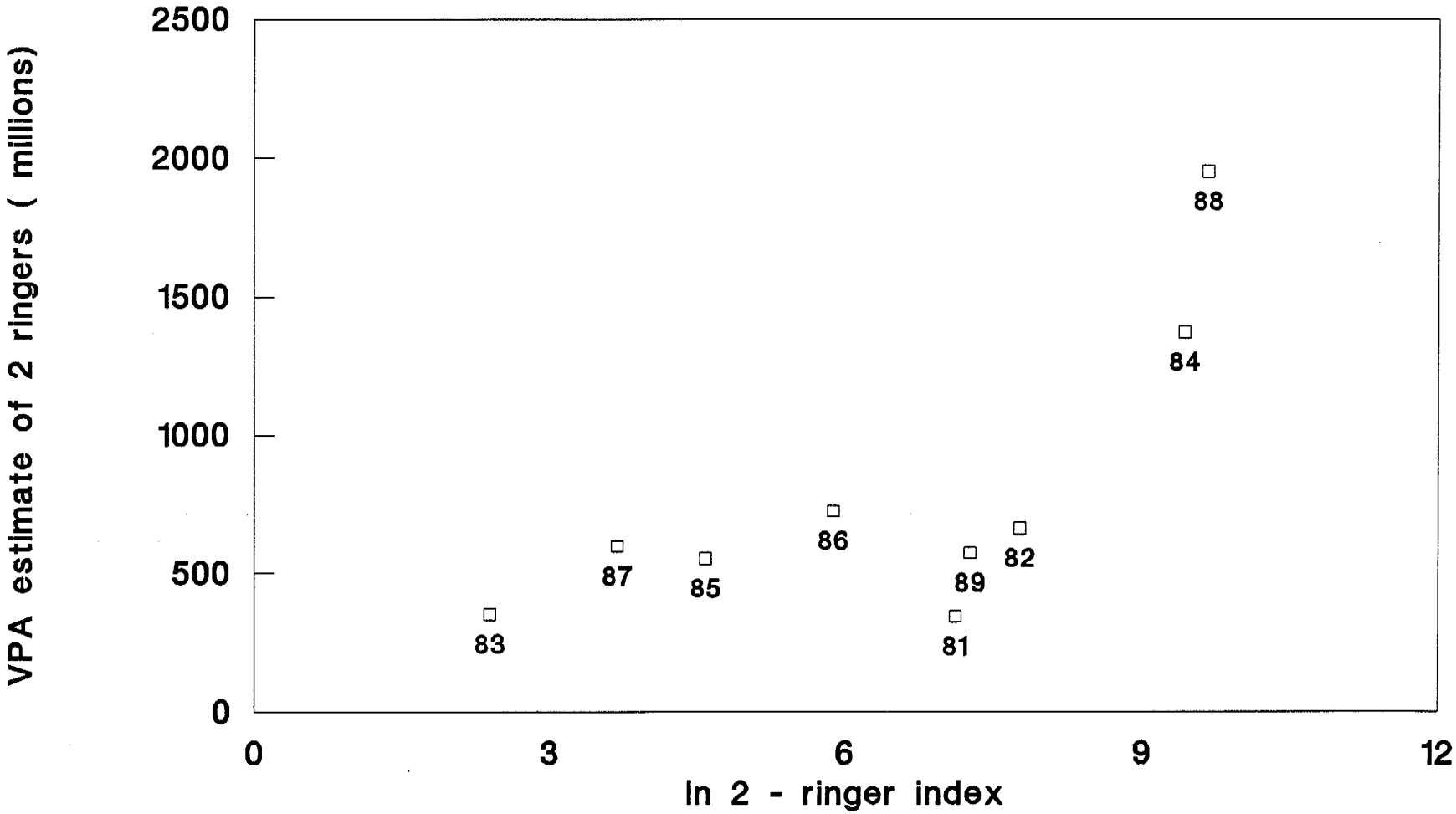


Figure 4.8.1 HERRING in the Celtic Sea and Division VIIj. Abundances (n/m^2) of <10 mm larvae observed during the February 1991 survey and the Boxes closed to fishing for specific periods.

Figure 5.1.1 The natural logarithms of the mean catch rates of 2 ringers in statistical rectangles 46E4-E6, 47E4-E6, 44E3-E4 and 45E3-E4 during the March bottom-trawl surveys, plotted against VPA estimates of 2-ringer abundance.



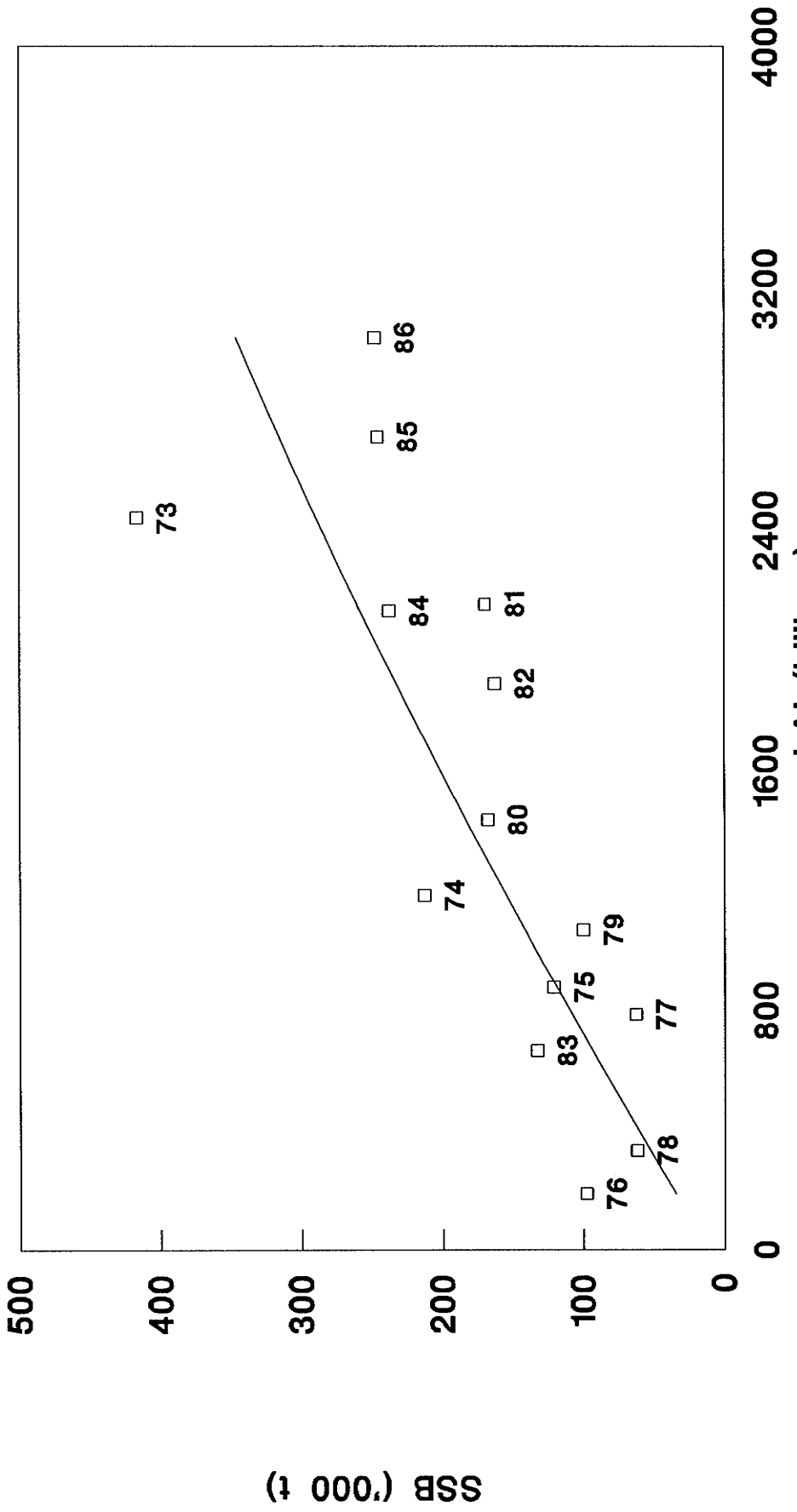


Figure 5.1.2 The relationship between LAI and SSB from 1973-1986 estimated by the 1989 assessment. The line is based on the regression fitted by RCRTINX2 (SSB = 0.361 x $LAI^{0.857}$).

Figure 5.1.3 The relation between PLE and SSB from 1973-1986 estimated by the 1989 assessment. The line is based on the regression fitted by RCRTINX2 (SSB = 0.108 x $LPE^{1.47}$).

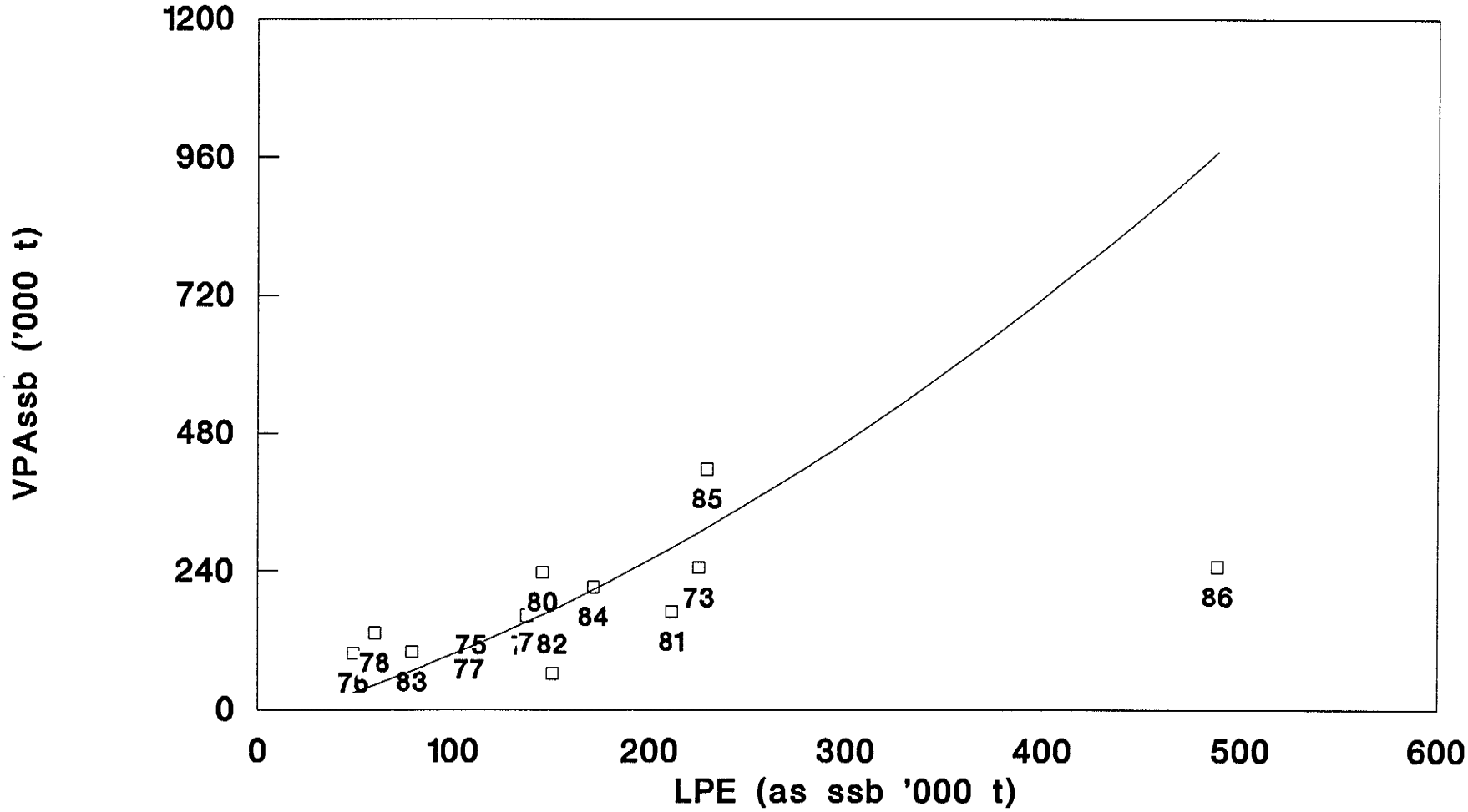
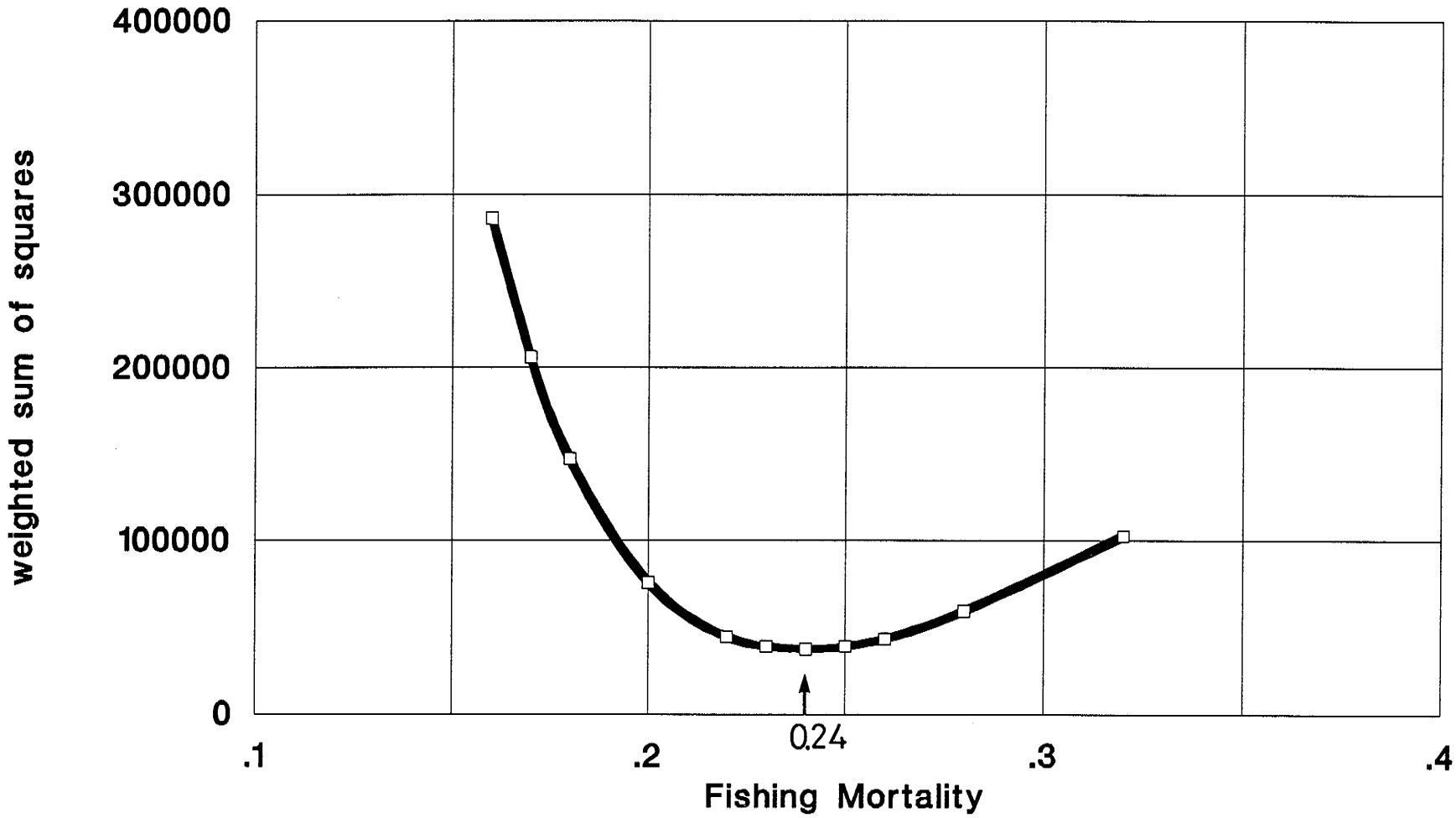


Figure 5.1.4 The weighted sum of squared residuals between the SSB estimates predicted by RCRTINX2 for the years 1987-1990 and those estimated by VPA at a range of input Fs.



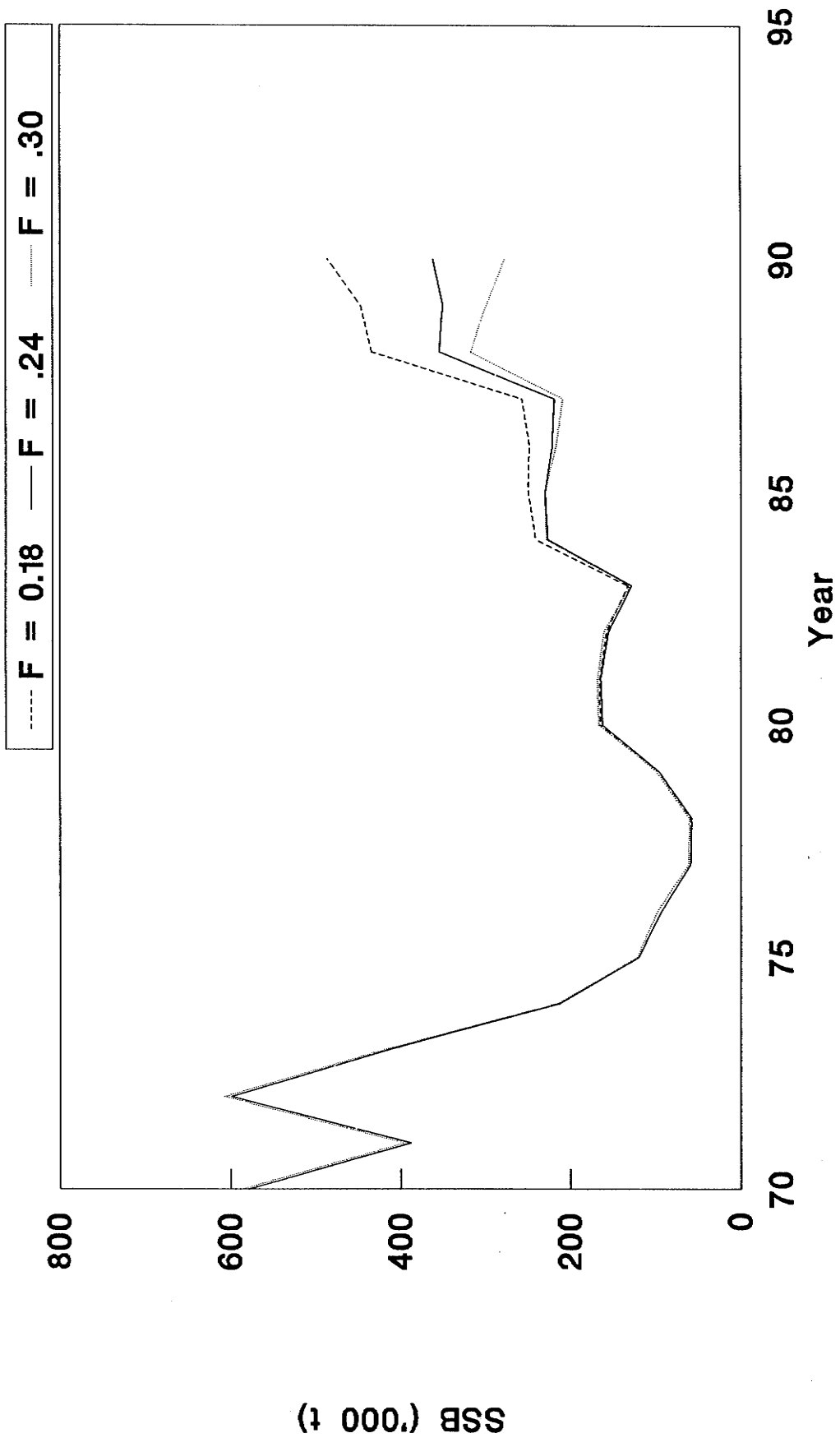


Figure 5.1.5 Trends in SSB estimated by VPA. The present assessment corresponds to the line for F = 0.24.

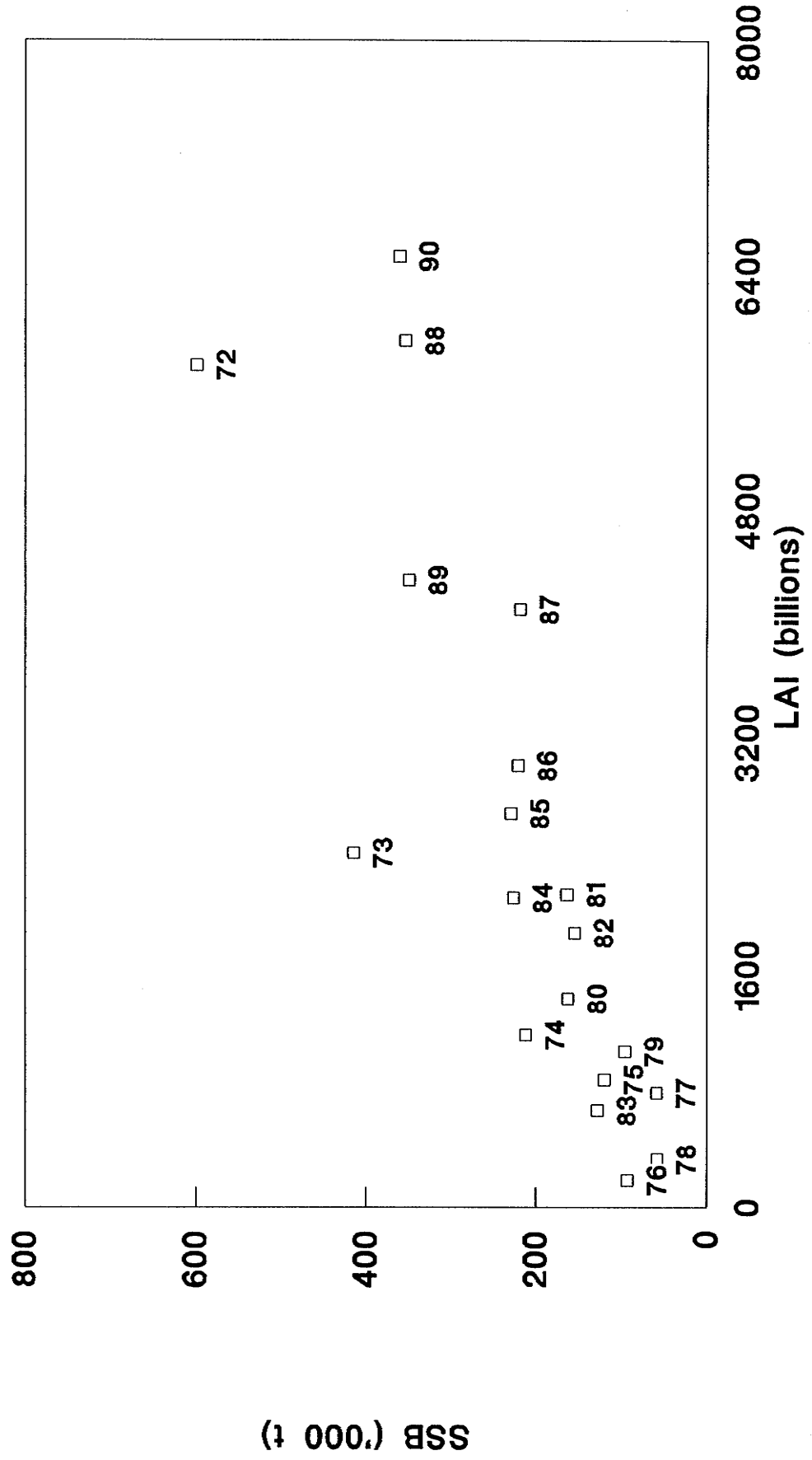


Figure 5.1.6 Scatter plot at the series of LAIs against SSB estimates from the 1990 assessment.

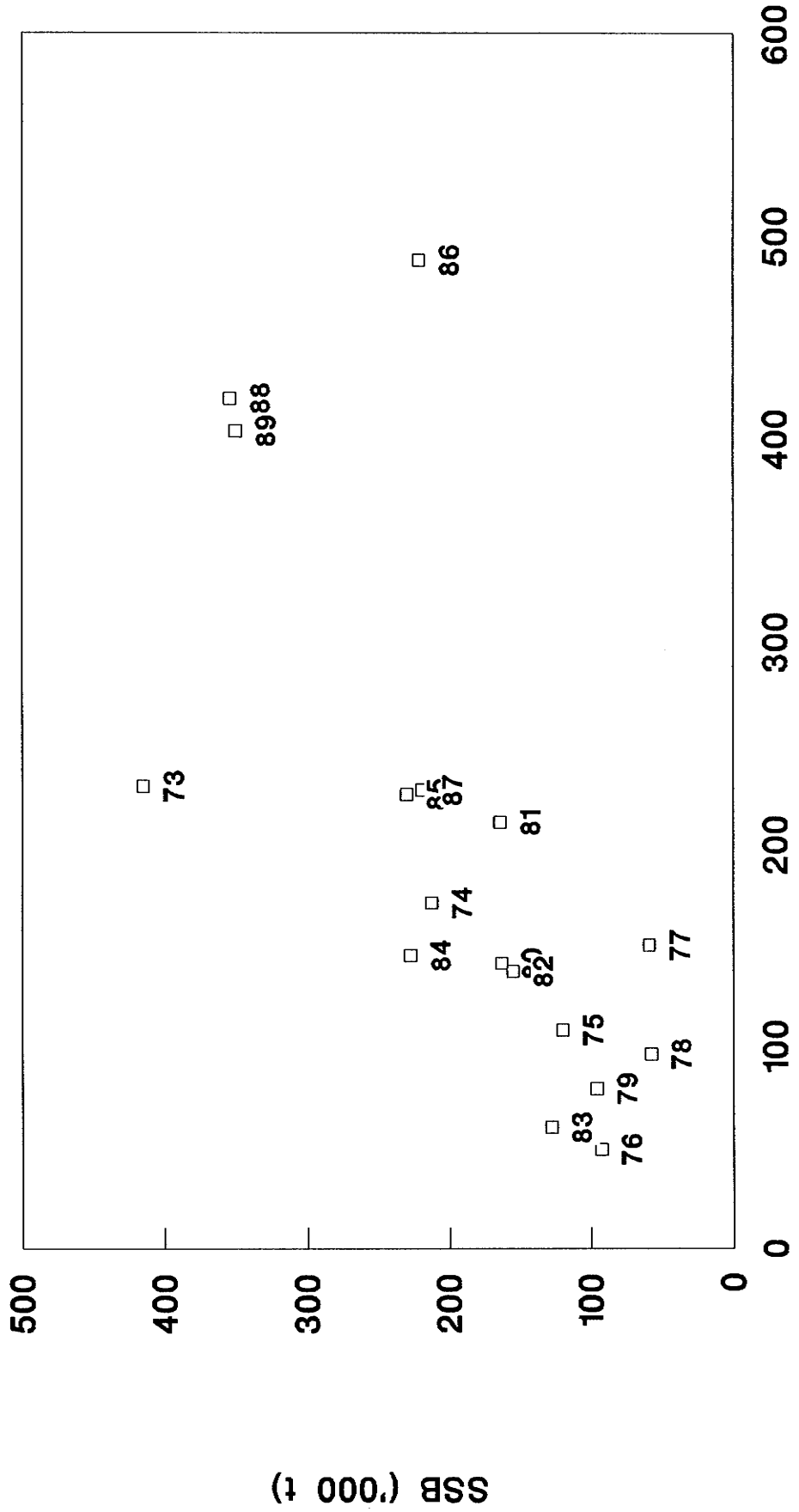
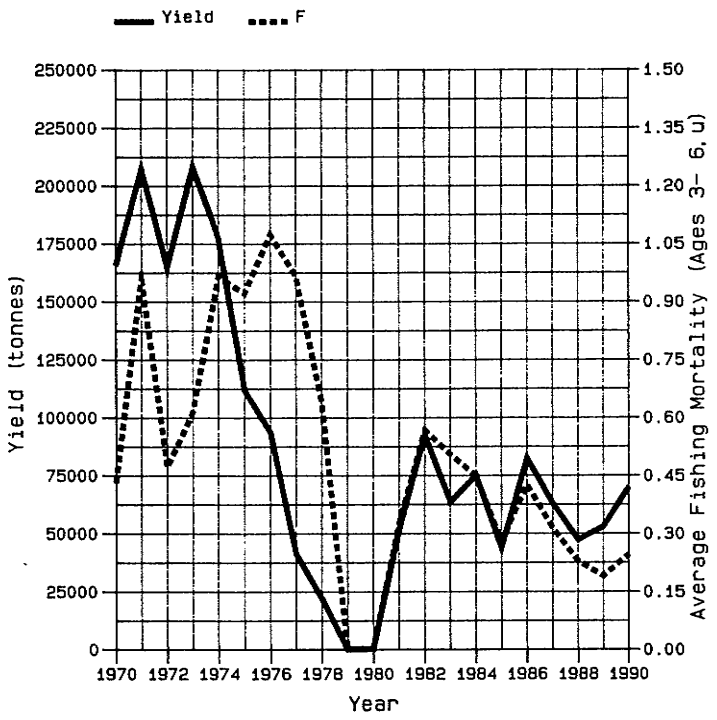


Figure 5.1.7 Scatter plot of the series of LPEs against SSB estimates from the 1990 assessment.

Figure 5.1.8

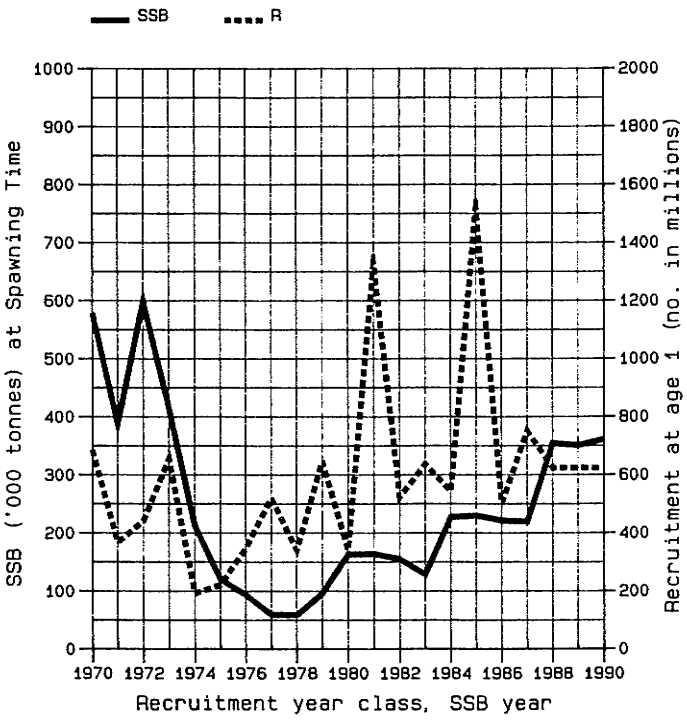
FISH STOCK SUMMARY
Herring in the Northern part of VIA
29-04-1991

Trends in yield and fishing mortality (F)



A

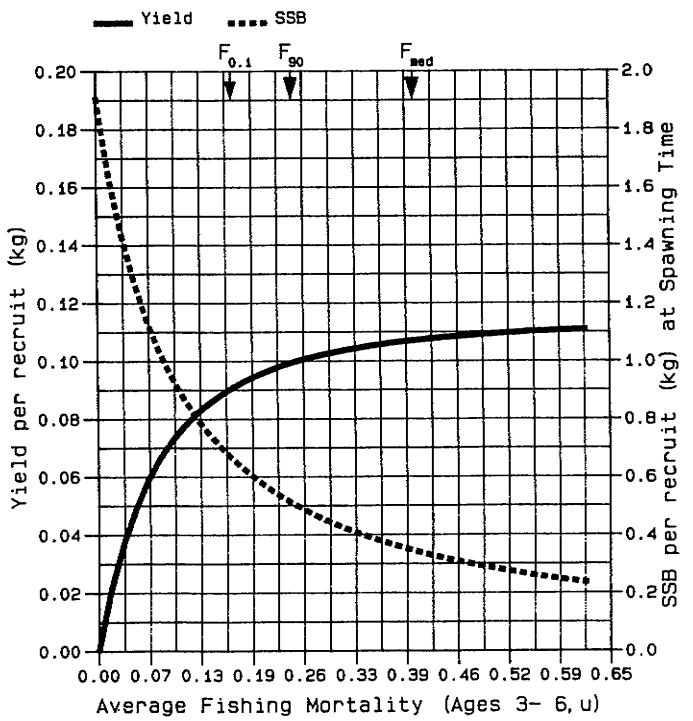
Trends in spawning stock biomass (SSB) and recruitment (R)



B

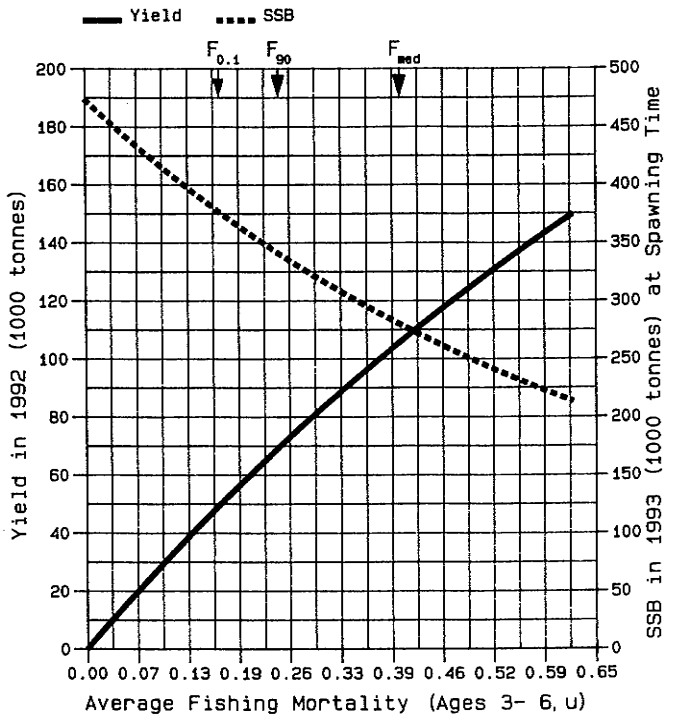
FISH STOCK SUMMARY
Herring in the Northern part of VIA
29-04-1991

Long-term yield and spawning stock biomass



C

Short-term yield and spawning stock biomass



D

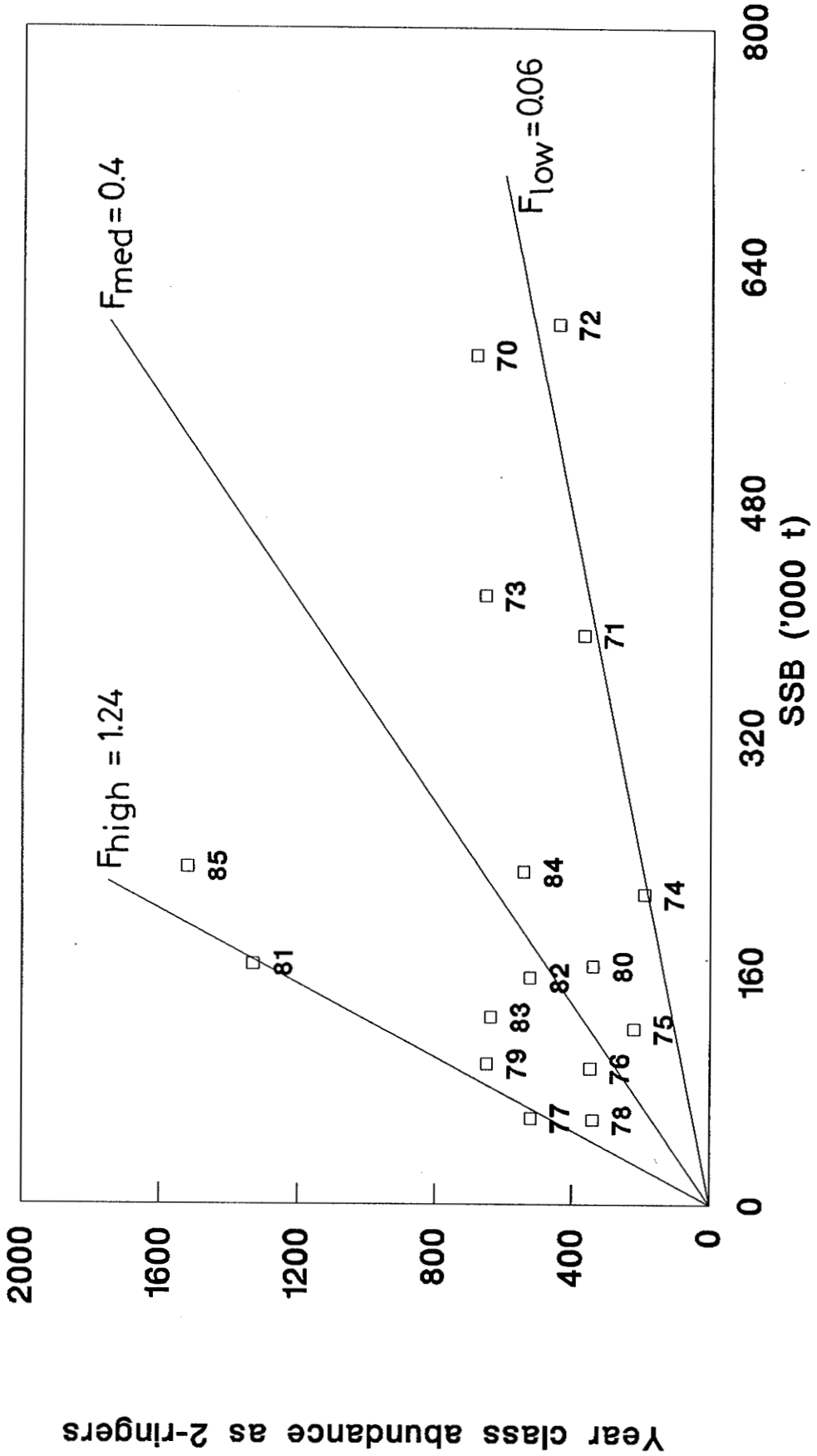
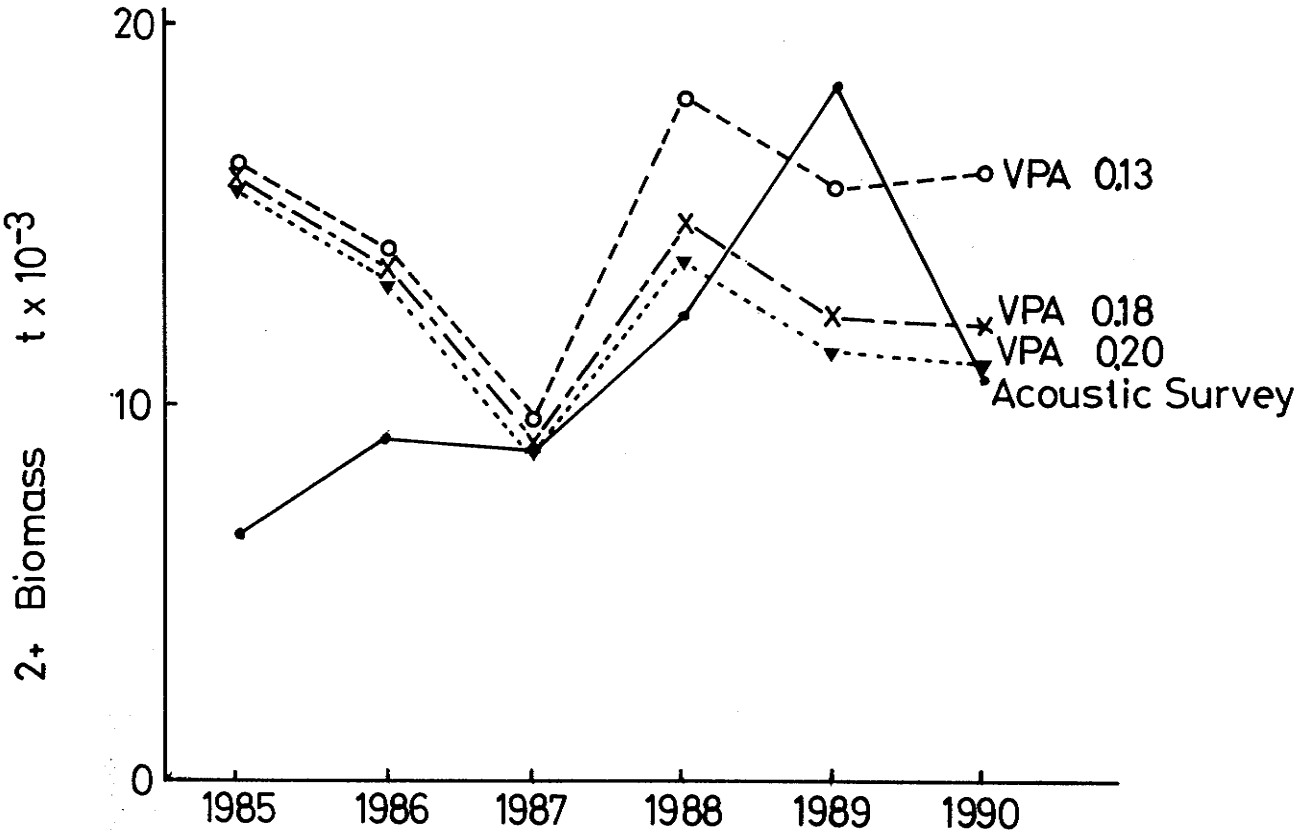

Year class abundance as 2-ringers
SSB ('000 t)
0
160
320
480
640
800
0
400
800
1200
1600
2000
F_{high} = 1.24
F_{med} = 0.4
F_{low} = 0.06
85
81
84
82
83
79
77
78
76
80
75
74
73
71
70
72

Figure 5.1.9

Figure 5.2.1 Estimates of biomass (2 ringers and older) from acoustic survey and a VPA using different values of input F.



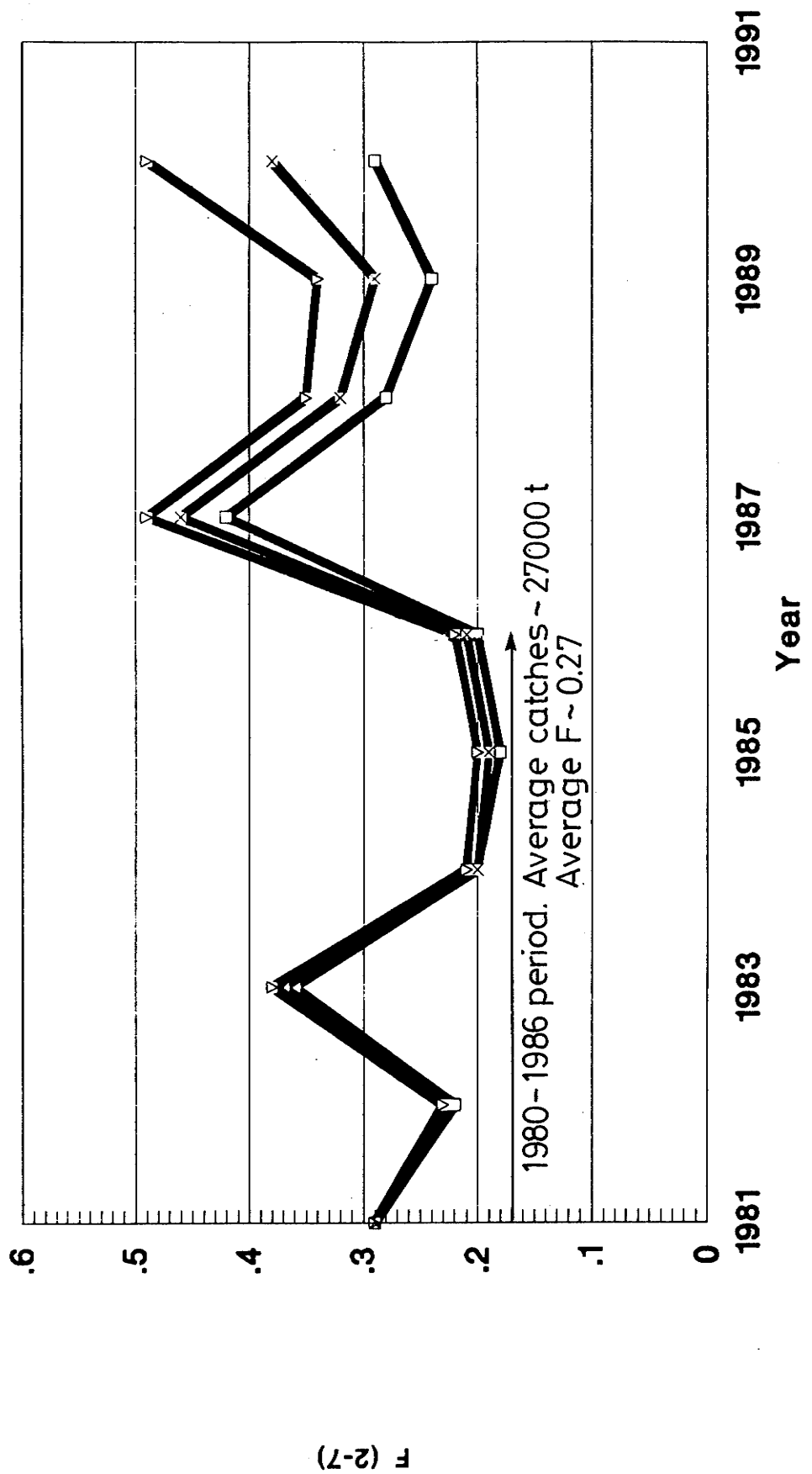


Figure 6.1 HERRING in Divisions VIa (S) and VIIb.
Annual estimates of F using different input values in 1990.

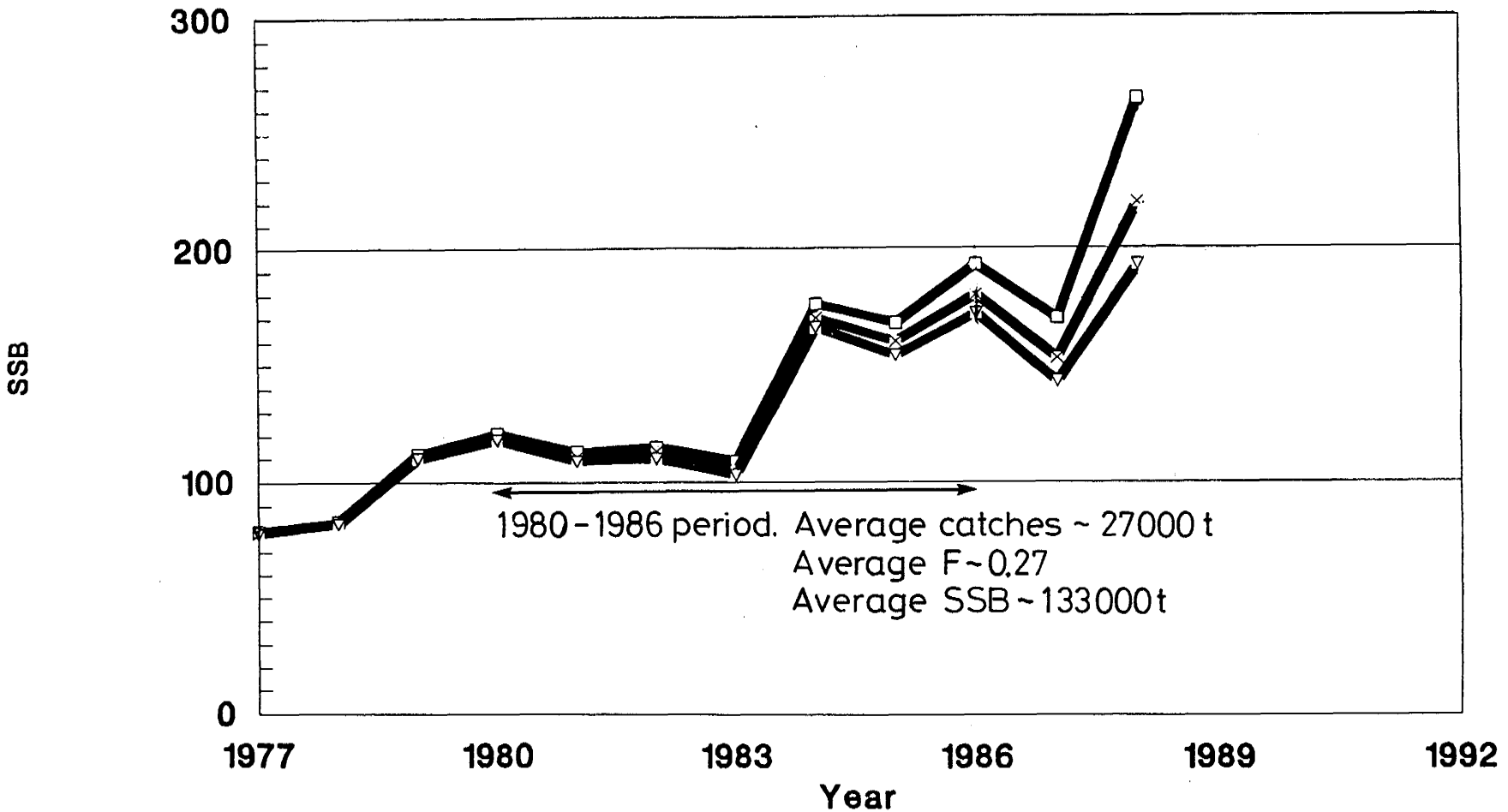


Figure 6.2 HERRING in Divisions VIa (S) and VIIb.
Annual estimates of SSB using input F values in 1990 of 0.5, 0.4, 0.3.

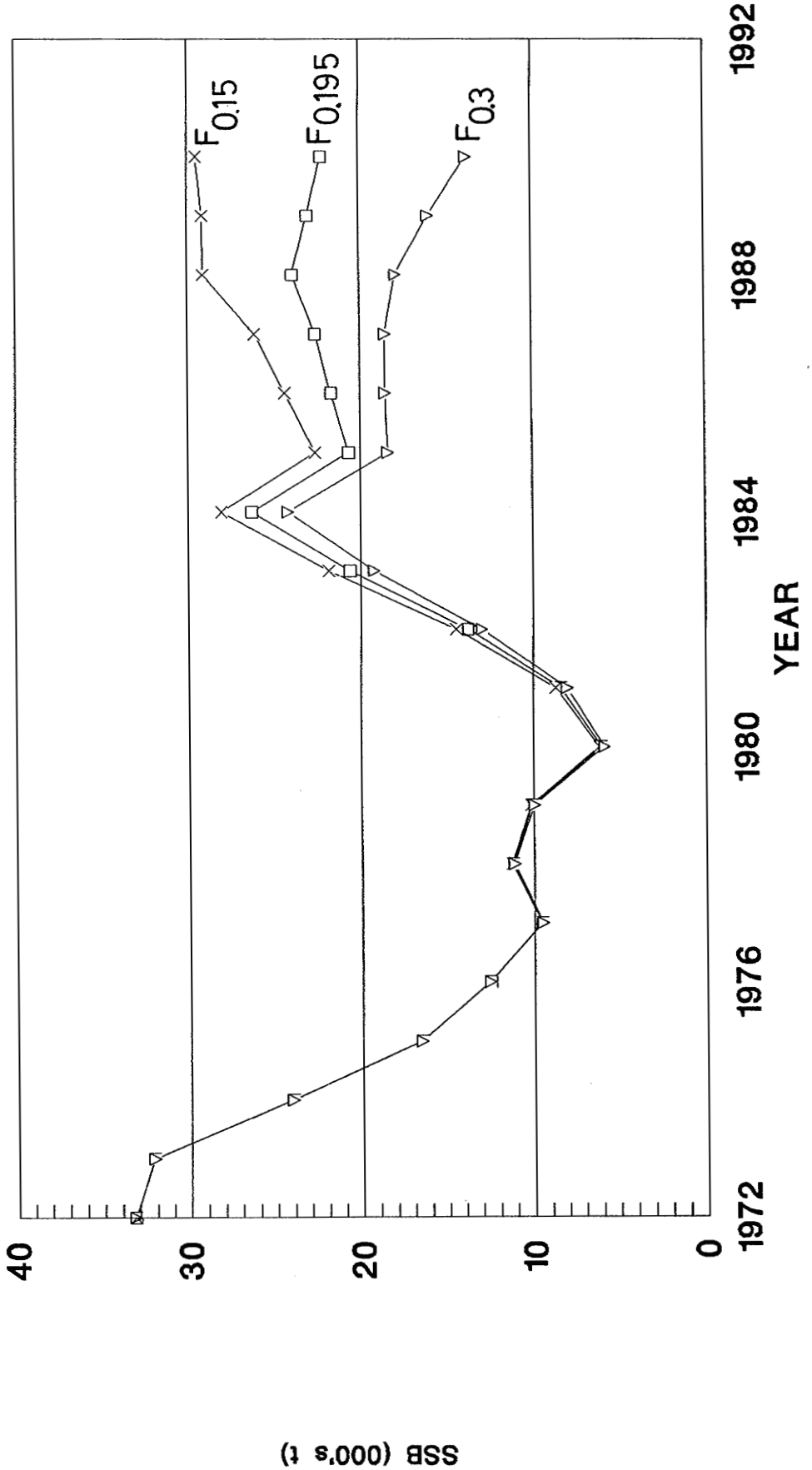


Figure 7.4.1. Spawning stock biomass from VPA with a number of input Fs.

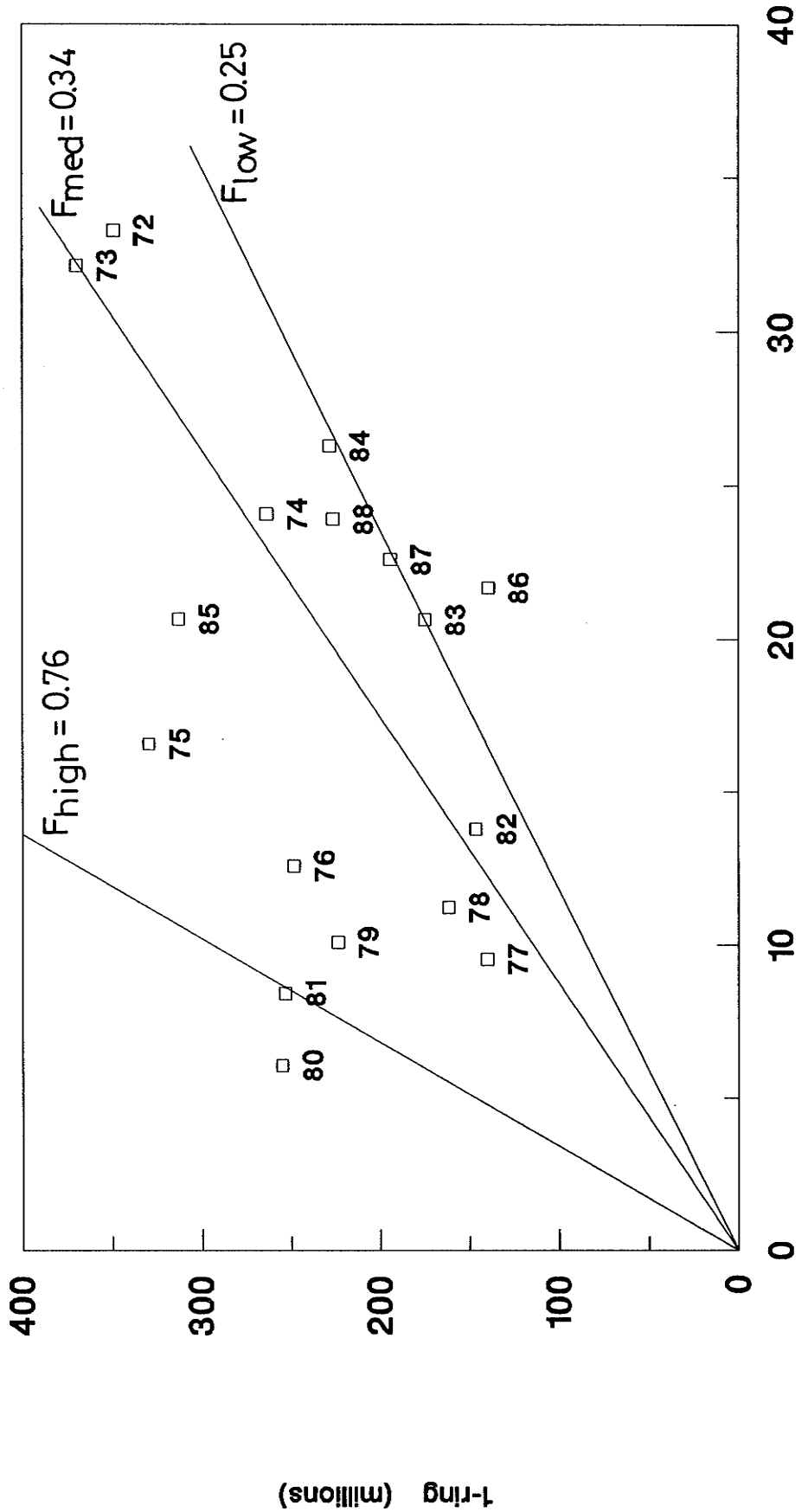
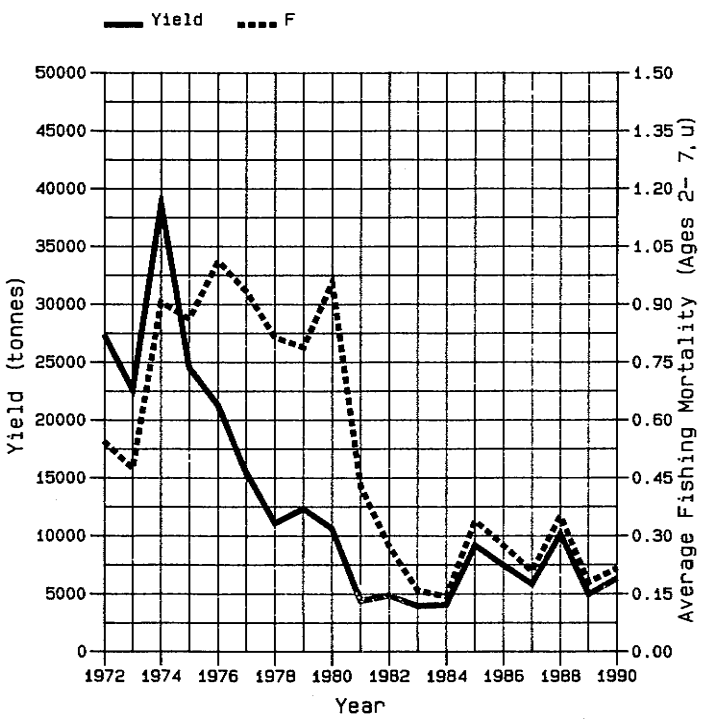


Figure 7.4.2. North Irish Sea HERRING (Division VIIa).

Figure 7.4.3

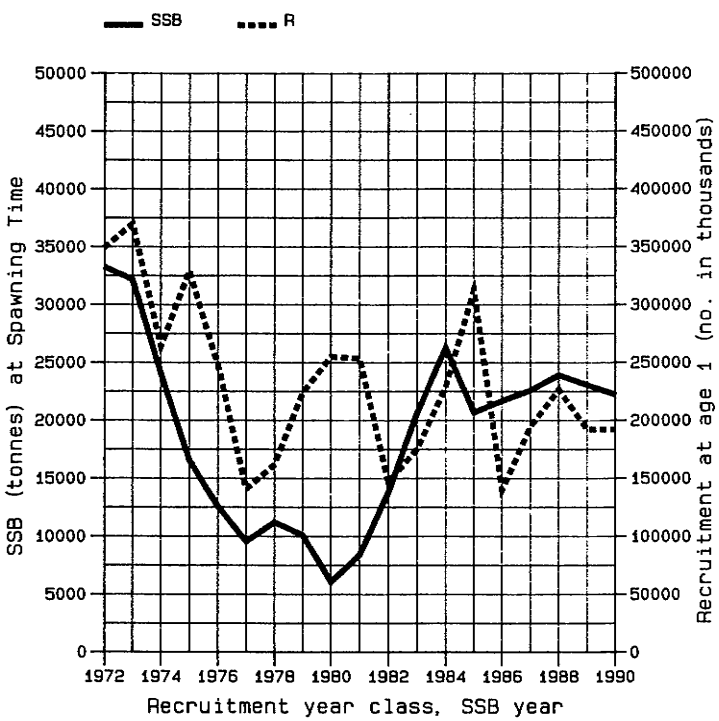
FISH STOCK SUMMARY
Herring in the North Irish Sea
29-04-1991

Trends in yield and fishing mortality (F)



A

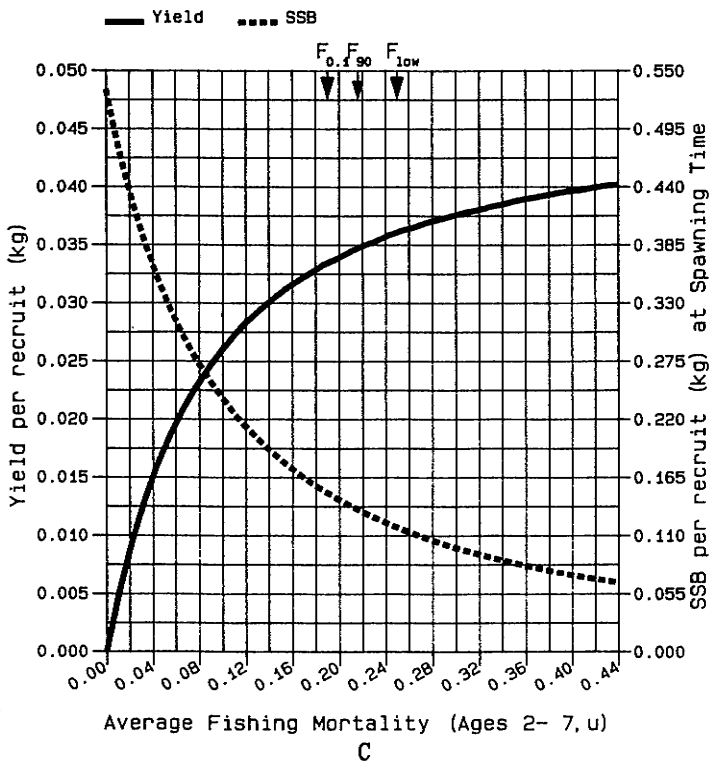
Trends in spawning stock biomass (SSB) and recruitment (R)



B

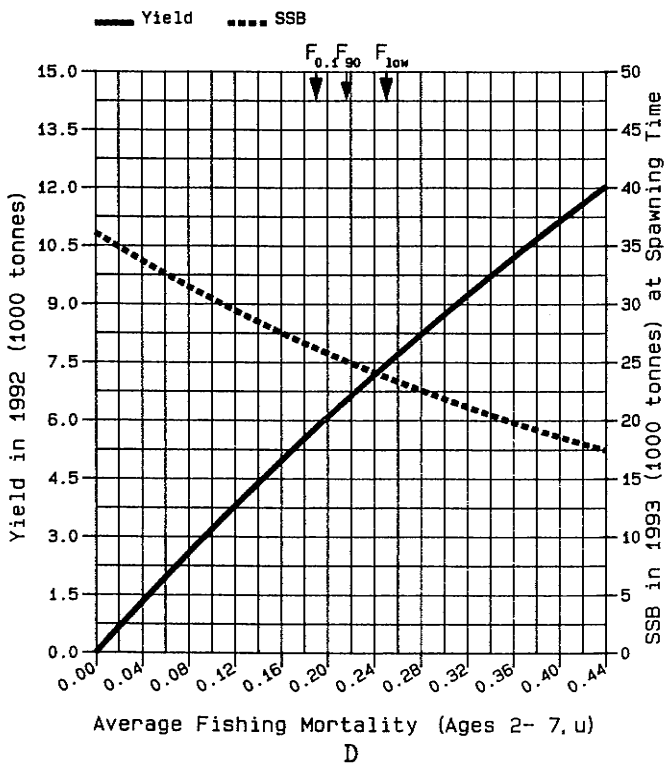
FISH STOCK SUMMARY
Herring in the North Irish Sea
29-04-1991

Long-term yield and spawning stock biomass



C

Short-term yield and spawning stock biomass



D