International Council for the
Exploration of the Sea

C.M.1992/Assess:11

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

Copenhagen, 31 March - 10 April 1992



*General Secretary
ICES
Palægade 2-4
DK-1261 Copenhagen K
DENMARK

## TABLE OF CONTENTS

# 1 INTRODUCTION

## 1.1 Participants

| | |
|---|---|
| Aglen, A. | Norway |
| Armstrong, M. | UK (Northern Ireland) |
| Bailey, R. | UK (Scotland) |
| Corten, A. | Netherlands |
| Dalskov, J. | Denmark |
| Hagström, O. (Chairman) | Sweden |
| Hopkins, P. | UK (Scotland) |
| Kirkegaard, E. | Denmark |
| Lorance, P. | France |
| Melvin, G. | Canada |
| Molloy, J. | Ireland |
| Munk, P. | Denmark |
| Nash, R. | UK (Isle of Man) |
| Sjöstrand, B. (part-time) | Sweden |
| Winters, G. (part-time) | Canada |

## 1.2 Terms of Reference

The Working Group met at ICES Headquarters from 31 March - 10 April 1992 with the following terms of reference (C.Res.1991/2:7:7):

a) assess the status of and provide catch options for 1993 and, where appropriate, 1994 within safe biological limits for the North Sea autumn-spawning herring stock in Division IIIa, Sub-area IV, and Division VIId (separately, if possible, for Divisions IVc and VIId) and the herring stocks in Division VIa and Sub-area VII;

b) provide data to the Working Group on the Assessment of Pelagic Stocks in the Baltic on stock composition of herring catches in Division IIIa and adjacent areas of Sub-area IV in 1991;

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

d) prepare for the transfer of its work to area-based Working Groups, advise how this might be best achieved, and consider what difficulties might arise and how these could be overcome.

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

e) to provide advice on the biological justification for a SSB of 2.2 million tonnes as a management objective for the North Sea herring;

f) to make an evaluation of the structure (including catch composition) and implications of the mixed clupeoid fishery in Division IIIa, with particular reference to its impact on the yield from the North Sea herring stock.

## 1.3 Workshop on Methods of Forecasting Herring Catches in Division IIIa and the North Sea

A Workshop was held in Lysekil from 10 - 13 March 1992 and the draft report was available to the Working Group (C.M.1992/H:5).

In 1991, the Working Group had not been able to allocate predicted catches of North Sea autumn spawners to the North Sea and Division IIIa management areas and ACFM had adopted an *ad hoc* method based on the distribution of catches by age group in recent years. The Workshop considered this to be an inappropriate procedure for long-term use because of changes in fishing pattern in the two areas. As an alternative the Workshop explored the possibility of predicting the actual stock of North Sea autumn spawners in Division IIIa at the beginning of the year, thereby making a choice of options available to managers.This is discussed further in Section 2.8.2.

The Workshop also revised the catch data for Division IIIa for 1989 and 1990. For 1990, however, they concluded that the level of sampling of major sections of the catch was grossly inadequate. To enable assessments involving Division IIIa data to continue, the Workshop made the best use of the few data available but stressed that this new analysis can in no way make up for the lack of samples. They further state that: "... the reliability of assessments using these data is thus permanently impaired".

A further section of the report evaluates the methods of stock separation with particular reference to Division IIIa and the eastern North Sea. A number of promising methods are discussed, notably morphometric analysis and the analysis of daily growth ring patterns in the otolith nucleus but the Workshop concluded that further research is needed before these methods can be put into operational use.

The present Working Group endorsed the conclusions of the Workshop.

## 1.4 Evaluation of the Working Group on Pathology and Diseases of Marine Organisms (WGPDMO) concerning the Impact of Fungus on Affected Herring Stocks

In the summer of 1991, the parasitic fungus *Ichthyophonus* spp. was shown to occur in herring stocks in parts of the North Sea, Norwegian Sea and in the southwestern Baltic. Available data from June 1991 - February 1992 suggest occurrence of the disease in the following

stocks: the North Sea autumn-spawners, Division IIIa-southwestern Baltic spring spawner and the Norwegian spring spawner.

Two areas with high levels of infection can be identified north of 60°N between Shetland and Norway and in Kattegat-southwestern Baltic. Uninfected areas are recognized in the Baltic proper, west of the British Isles, Faroe Islands and Iceland. New information provided by the this Working Group indicated a very low prevalence (< 1%) in commercial catches in the southern North Sea and the Channel area during the 1991/1992 fishing season.

The disease is assumed to be lethal for herring but lack of precise information of prevalence in the infected stocks as well as lack of knowledge of its temporal dynamics prevented the WGPDMO to estimate the mortality caused by the infection.

Based on data from infection on a plaice stock, different levels of additional mortality were calculated by the WGPDMO. This approach was considered justified as available information suggests that the disease is lethal for both species.

With a survival time of 100 days, annual mortality rates ranged from about 20% to 55% with a prevalence of 5-15%. The mortality rates were about half with 200 days' survival.

The WGPDMO reports that studies are currently in progress to determine more accurate prevalence levels and mortality rates. It is recommended that a special meeting be arranged involving stock assessment and disease specialists. The recommendation is endorsed by this Group. It is recommended that this meeting should be held prior to the ACFM meeting in November in order to have the opportunity, if needed, to revise the stock estimate and prognosis before 1993.

### 1.5 Evaluation of the Draft Report of the Study Group on Age Units in Herring

A draft report was presented by the Study Group on Age Units in Herring. This report described the problems that were related to the use of rings instead of years when defining the age of herring.

The convention of defining herring age rings instead of years was introduced in various ICES working groups around 1970. The main argument to do so was the uncertainty about the racial identity of the herring in some areas. A herring with one winter ring is classified as 2-years-old if it is an autumn spawner, and one-year-old if it is a spring spawner. Recording the age of the herring in rings instead of in years allowed scientists to postpone the decision on year of birth until a later date when they might have obtained more information on the racial identity of the herring.

The use of winter rings in ICES working groups has introduced a certain amount of confusion and errors. In specifying the age of the herring, people always have to state explicitly whether they are talking about rings or years, and whether the herring are autumn- or spring spawners. These details tend to get lost in working group reports, which can make these reports confusing for outsiders, and even for herring experts themselves. As the age of all other fish species (and of herring in other parts of the world) is expressed in years, one could question the justification of treating West-European herring in a special way. Especially with the present trend towards multispecies assessment and integration of ICES working groups, there might be a case for a uniform system of age definition throughout all ICES working groups.

However, the change from rings to years would create a number of practical problems. Data files in national laboratories and at ICES would have to be adapted, which would involve extra costs and manpower. People that had not been aware of the change might be confused when comparing new data with data form old working group reports. Finally, in some areas (notably Division IIIa), the distinction between spring- and autumn spawners is still hard to make, and scientists preferred to continue using rings instead of years.

The Working Group discussed at length the various consequences of a change from rings to years. The majority of the Group felt that the advantages of such a change did not outweigh the disadvantages, and it was decided to stick to the present system for the time being.

It was agreed that in the introduction of each working group report, there should be a statement that the ages used throughout the report were based on rings and not on years. The use of the names of 0-group, 1-group, etc. should be discouraged, as this could give rise to further confusion.

## 2 NORTH SEA HERRING

### 2.1 The Fishery

#### 2.1.1 ACFM advice applicable for 1991

The 1990 ACFM meeting recommended for the total North Sea and Divisions VIId a TAC of 327,000 t to 372,000 t in 1991, depending on the level of the catches in 1990.

The agreed TACs adopted by the management bodies in December 1990 were: Divisions IVa,b: 342,000 t; Divi-

sions IVc and VIId: 30,000 t. In May 1991, ACFM provided a new advice for the total TAC of 503,000 t, including a TAC of 50,000 to 60,000 t for Divisions IVc and VIId.

The agreed TACs were revised in July 1991 and were set at 370,000 t for Divisions IVa,b and 50,000 t for Divisions IVc and VIId.

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

### 2.1.2 Catches in 1991

Total landings for 1991 are shown 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 1991, at 566,000 t is very close to the one of 1990, and lower than in the years 1987-1989 (674,000 t on average). However, the 1991 catch still represents a 147,000 t overshot of the total TAC.

As in previous years, Norwegian catches of Norwegian spring spawners in the North Sea were removed.

Like in recent years, catches of autumn-spawning herring have been reported by the Faroese fleet in Division Vb. These catches amounted to 5,334 t in 1990 and 16,000 t in 1991. Based on length-at-age data, these fish look very similar to North Sea herring. However, it is not quite clear whether they belong to the North Sea stock or to the Division VIa North stock. So, as in previous years, these catches were not included in the North Sea assessment.

The Netherlands catches included an additional estimate for discards. Discards are recorded separately (Tables 2.1.1-2.1.5). The total amount of North Sea herring discarded at sea is probably underestimated. However, a Danish experiment presented at the meeting, and other information collected since the previous meeting show that the current level of discards might not exceed 15% of the landings.

In Divisions IVc and VIId, the estimated catch of 60,685 t remains at the same level as in 1990. This catch still constitutes an overshot of the revised TAC for that area (50,000 t). It includes an estimated discard of 2,262 t and a catch of 252 t of spring spawners (in the Thames area fishery). The total catch of spring spawners in that area is likely to be higher as French trawlers catch some hundred tonnes of stages IV-VI fish in Division VIId, and Dutch trawlers some in Division IVc. However, a correct estimate of those catches would require a sampling effort disproportionate to their level and impact in the assessment.

## 2.2 Catch Composition

### 2.2.1 Catch in number and weights at age

Quarterly and annual catches in numbers and mean weights at age were compiled for each Division and for the total North Sea. Table 2.2.1 provides a breakdown of numbers caught by age group for each division on a quarterly and annual basis. Table 2.2.2 presents a comparison of total North Sea catches in numbers at age over the years 1971-1991.

The numbers of 0-, 1- and 2-ringer North Sea autumn spawners caught in Division IIIa were estimated for 1990 and 1991. [The 1990 estimate was not available at the 1991 meeting (see Sections 1.3 and 3.2.3)]. Therefore, Table 2.2.3 was updated and the assessment includes Division IIIa catches of North Sea autumn spawners.

The total catch in number in the North Sea in 1991 of 5.5 billions was 8% higher than in 1990. The mean for the year 1987, 1988 and 1989 was 7.9 billions against 5.3 billions, as an average for the two last years (Table 2.2.2).

The contribution to the catch in numbers of young herring was much higher than in 1990. The number of 0-ringers is close to the average figure for the years 1987-1988, but the number of 1-ringers is the lowest since 1985, probably due to the weakness of the 1989 year class. 0- and 1-ringers account together for 52% of the catch in number.

The 1985 year class has become less dominant in the catches. However, the catch in number of 5-ringers was the highest recorded since 1970 (Table 2.2.2), and it accounted for 9% of the total catch in number compared to an average of 4% for the years 1987-1990.

The bulk of the juvenile fish was caught in Division IVb in the quarters 3 and 4. Among adult fish, the highest proportion of 2-ringers was also taken in Division IVb (Table 2.2.4).

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

Because of improved sampling of industrial catches, separate age compositions have now been calculated for the human consumption fishery and the small-mesh industrial fishery. The results of this are presented in Table 2.2.6.

### 2.2.2 Quality of catch and biological data

Table 2.2.7 shows a breakdown of the sampling schemes of landings by divisions. As in 1990, there are some gaps in the biological data; however, some improvements have been achieved, and the problem of access to the landed fish seems to have been reduced. Nevertheless, the sampling of some countries in some quarters has still been very low.

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. The data of some countries have been used to estimate the age composition of unsampled landings of a similar order of magnitude than their own landings.The bias so introduced in the catch-at-age data is not thought to be very serious, however, some enhancement is still required and some international coordination might allow a better allocation of sampling effort. The Working Group still requests all countries whose annual landings are not negligible, to schedule sampling of commercial landings in the current year.

In some countries independent estimates of catches are made by fisheries scientists and these figures have been used in this report; however, in other countries no independent estimates are available and official landing figures are used.

### 2.2.3 Treatment of spring-spawning herring in the North Sea

Norwegian spring spawners are taken close to the Norwegian coast under a separate TAC. These catches are not included in the catch tables. Coastal spring spawners in the southern North Sea are caught in small quantities most years. These catches are given in Tables 2.1.1 and 2.1.5. With the exception of 1990, these catches are included in the assessment of North Sea autumn spawners.

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

The 1991 Working Group estimated the fraction of spring spawners fsp (56.50-$\bar{v}$)/0.7, where $\bar{v}$ is the mean vertebral count of the (mixed) sample. The method requires that the two components have mean counts close to 56.50 and 55.80, respectively, in all samples. The method is quite sensitive to within-stock variations (like between year classes) of mean vertebral counts, and severe reservations against the method were expressed during the 1991 Working Group meeting.

Several meristic samples from the 1991 summer acoustic survey were split by using this simple formulae, by modal length analysis and by splitting the vertebral count distribution. The latter methods are reviewed by Anon., (1992). The results are shown in Table 2.2.8. As the various meristic samples were available to the Working Group in different formats, applying the simple formulae was the only way of making use of all the samples. As Table 2.2.8 shows, there is a reasonable agreement between the methods, and the simple procedure was accepted.

Figures 2.2.1-2.2.3 show mean vertebral counts by age group and by rectangle during May, June and July 1991. The transfer area defined from meristic samples in previous years is indicated. The presence of spring spawners in the south eastern part of the transfer area is evident from the low vertebral counts. None of the samples indicated any spring spawners among the 0- and 1-ringers in any month.

In July, spring spawners seem to occur somewhat north of the transfer area. When comparing the distribution of catches during these months (Figures 2.10.5-2.10.7), it seems reasonable to apply the same transfer area for all months. The meristic sampling in August and September was too scarce to verify the presence of spring spawners in the most important rectangles of the transfer area. In previous years the sampling has indicated that these spring spawners leave the North Sea during late September.

All meristic samples within the transfer area each month were combined. The resulting proportion of spring spawners and the monthly catches in the transfer area are as follows:

| | Proportion (%) | | | | No. of rectangles sampled | Catch in transfer area (t) |
|---|---|---|---|---|---|---|
| Month | 2-ring | 3-ring | 4-ring | 5+ring | | |
| May | 38 | 24 | 46 | 70 | 4 | 4,858 |
| Jun | 14 | 52 | 67 | 62 | 7 | 5,190 |
| Jul | 24 | 75 | 82 | 67 | 12 | 2,883 |
| Aug | 57 | 96 | 99 | 100 | 1 | 1,286 |
| Sep | - | - | - | - | 0 | 2,385 |
| Q2 | 26 | 38 | 57 | 66 | 11 | 10,048 |
| Q3 | 34 | 81 | 87 | 77 | 13 | 6,554 |

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

The quarterly age distributions in Sub-division IVa East as applied to the catches in the part of the transfer area belonging to that Sub-division (4,731 t in quarter 2 and 2,563 t in quarter 3). Number of spring spawners by age were obtained by applying the estimated proportion by age.

The quarterly age distributions for the total Division IVb, were not considered representative for the southern part of the transfer area. In this case, research vessel samples from late June were used for the catches in quarter 2 (4,317 t) and research vessel samples from late July for catches in quarter 3 (3,991 t).

The resulting catch in number of spring spawners by age is shown in Table 3.1.1. The total amount of spring spawners transferred is 7,894 t.

## 2.3 Recruitment

### 2.3.1 Relationship between IYFS indices and VPA

In last year's report mention was made of the possible application of the General Linear Model (GLM) analysis to the IYFS data. Whereas this approach was further pursued this year (Section 2.3.8), some problems remained, and it was decided for this year to base the recruitment predictions on the traditional regressions.

The traditional regression of VPA estimates of 1-ringers on IYFS indices of the same year classes was updated (Table 2.3.1), using the 12 most recent years for which reliable VPA estimates were available (1977-1988). Year classes prior to 1977 have been disregarded because of possible time trends in efficiency of the survey gear. The scatter plot and fitted regression line are shown in Figure 2.3.1. For prediction purposes, the equation is forced through the origin:

$$y = 0.0064x$$

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

Indices for 2-ringers from the IYFS have not been used so far in predicting recruitment. The reason for this is the strong variation in catchability of 2-ringers during the surveys, as demonstrated in the 1989 report of this Working Group (*Anon.*, 1989a).

The use of IYFS indices for 3-ringers and older to estimate the spawning stock size is discussed in Section 2.7.

### 2.3.2 Relationship between MIK indices and VPA

In 1992, most countries in the IYFS deployed the recommended Methot Isaacs-Kidd (MIK) trawl instead of the traditional IKMT. The MIK has a fixed opening and a sampling efficiency close to 100% (P. Munk, pers. comm.). This sampling gear thus allows an absolute estimate of abundance to be made. The results of the MIK sampling are converted into a total abundance of herring larvae, expressed in billions, for North Sea and Division IIIa combined.

Comparative fishing experiments with MIK and IKMT indicated that the IKMT catch rates, given in numbers/min., are approximately equivalent to numbers/cubic meter x 300. This factor has been used to convert the historic series of IKMT indices into absolute abundance estimates. The new series for various sub-areas of the North Sea and Division IIIa is shown in Table 2.3.2, and the combined series for the whole survey area is compared with VPA estimates of 0-ringers in Table 2.3.3.

A new regression was calculated for the new series of abundance estimates, covering year classes 1976-1988. The scatterplot and regression line are shown in Figure 2.3.2. The slope is different from 1, probably due to underestimation of 0-ringer mortality in the VPA calculations. For predictive purposes, the regression line is forced through the origin:

$$y = 0.422\ x$$

The scatter of points around the regression line is rather wide, and the predicted values have wide confidence limits.

### 2.3.3 Recruitment forecast for the 1989 year class

The final IYFS for this year class as 1-ringers was 2433. In last year's report a preliminary index of 2485 was used. The predicted VPA estimate of 1-ringers based on the final index is 15.57 billion (compared to a provisional estimate of 16.1 billion used last year).

The acoustic survey in July 1991 also provided an estimate of 1-ringer abundance in the North Sea and in Division IIIa. However, this survey was aimed at adult herring, and most of the distribution area of 1-ringers was poorly sampled. It was decided, therefore, not to use the acoustic estimate of 1-ringers in 1991 for prediction purposes.

### 2.3.4 Recruitment forecast for the 1990 year class

The preliminary index of 1-ringers in the standard area during the 1992 IYFS is 2339. This index is based on length data from all participating countries, and age/length keys from 4 countries. Using the new regression, this year class is estimated at 14.97 billion.

The previous estimate for this year class, based on the IKMT index in 1991, was 21.0 billion as 0-ringers.

Using the new estimate for 1-ringers in February 1992, and applying to this the catches of 0-ringers in 1991 (2.3066 billion), the revised estimate for this year class as 0-ringers is 44.52 billion. Fishing mortality on this age group in 1991 is estimated at 0.09.

### 2.3.5 Recruitment for the 1991 year class

The MIK index for this year class (200.7) is the second highest in the revised historical series (Table 2.3.2). Using the new regression, the size of the year class as 0-ringers in the VPA is estimated at 84.70 billion. As the MIK index is near the limit of the range of values used in the regression, the confidence limits on the predicted value are very wide and the estimate should be regarded as uncertain.

### 2.3.6 Trends in recruitment

The distribution as 0-ringers of the three most recent year classes is shown in Figure 2.3.3.

The time series of 1-ringer recruitment from 1970 to the present is shown in Figure 2.3.4.

### 2.3.7 Projection of recruitment in the North Sea and Division IIIa

To provide a means of estimating the number of 1-ringers in the North Sea and Division IIIa, respectively, the IYFS data for each of these two areas have been treated in the same way. The mean number in each rectangle sampled was multiplied by the proportion of sea area in that rectangle and the values for all sampled rectangles summed. This value was then raised to the total sea area (including unsampled rectangles). The comparable estimates are given for 1983-1992 in Table 2.3.4. These show that the proportion of the total population of 1-ringers in Division IIIa increased during the 1980s and that it has now decreased to a lower level (25% in 1992). In Section 2.8, the proportions have been applied to the VPA estimates of 1-ringers to obtain estimates of the number of 1-ring autumn spawners in the two management areas.

It should be noted that IYFS catches of 1-ringers in Division IIIa contain a proportion of Baltic spring spawners. The proportion was estimated by previous Working Groups to be 28% in 1983 and 46% in 1984, but the stock separation procedure proved to be unreliable for 1-ringers over the years 1985-1989. In 1990, the whole 1-ringer index was allocated to autumn spawners. However, mean vertebral counts in 1991 indicated that the IYFS index in Division IIIa included an increased proportion of spring spawners compared with 1990. For 1992, the split is unreliable and it has been assumed that the 1-ringers are autumn spawners (Section 3.4.2). The proportion of 1-ringers in Division IIIa in Table 2.3.4 must, therefore, be considered as overestimates for some years. In recent years it is likely that most were autumn spawners, however.

### 2.3.8 GLM-analysis of IYFS data

At last year's meeting, the use of the GLM-analysis on herring catches from IYFS was discussed and described in the 1991 Working Group report. The regression of GLM-indices to VPA differed from the regressions where the standard index was used, and their predictions of the 1987-1989 year classes were very different.

Last year's analysis indicated that the major cause of the discrepancy between the two indices was the log-transformation of the data for use in the GLM-analysis. Analysis of the distribution of sizes of the catch has shown that a log-transformation of data is appropriate. This aspect has been investigated further at the present meeting.

A comparison is made between an index based on the standard method (mean of catches within rectangles and the mean of these) with data untransformed and log-transformed. This is done for the standard area and for the total area sampled (Table 2.3.5).

These four indices, and the GLM-index, are then used in regressions to the VPA, either linear or on a log-log scale (Figure 2.3.5 and Table 2.3.6). From the results it is obvious that the log-transformation of catch data has significant influence on regressions and predictions. Except for the "untransformed" standard index, a log-log regression resulted in higher R-squares. The predictions, when using log-transformed data, were in general lower than with the untransformed data, but it is not clear to what extent this is due to a bias introduced by the transformation. The Working Group recommends that this should be investigated by the Workshop on the Analysis of Trawl Survey Data.

## 2.4 Acoustic Surveys

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

The 1991 acoustic survey of the North Sea and Division VIa was carried out by vessels from Norway, the Netherlands and Scotland over the period 13 June - 1 August (Simmonds *et al.*, Working Paper, 1992). In addition, a survey of Division IIIa was carried out by Denmark from 23 July to 11 August. This survey extended into the eastern North Sea. However, since it was carried out rather later than the other surveys, only the results for Division IIIa was used by the Working Group (see Section 3.3).

The coverage of the survey in 1991 was reasonably complete and no especial difficulties were experienced in allocating the echointegral to species. An area of the North Sea covered by more than one vessel gave estimates of herring biomass differing by only 7% between vessels for the total overlap area, and 17% and 23% for two different halves of the overlap area.

The results of the survey are given in Table 2.4.1 for autumn spawners and in Table 2.4.2 for Baltic/Division IIIa spring spawning, respectively. The total estimate of 1.87 million t for Divisions IVa and IVb combined compare with an estimate of 2.17 million t in 1990 (Table 2.4.3).

The proportion of 2- and 3-ringers mature on the 1991 surveys were 79% and 98%, respectively, which is rather close to the proportions in 1990. The average survey date in the main area of distribution was about 15 July.

To make the spawning stock estimate from the acoustic survey comparable to the estimate from the VPA, the catches of mature autumn spawners taken between the average survey date (15 July) and the date when 67% of the annual fishing mortality is reached should be deducted. In the VPA run it is assumed that 67% of the annual fishing mortality is reached prior to spawning. According to Figure 2.10.13, the 67% catch date is about 15 September and 35% of the annual catch is taken between 15 July and 15 September. The catch taken in this period is 194,174 t, from which an estimated catch of 4,720 t of spring spawners (Section 2.2.3, text table) is deducted, giving a total catch of 189,454 t. The adult part of this catch in the third quarter is 69.3% by weight (Table 2.2.5) or about 131,000 t. Applying this value to the acoustic figure, the spawning stock estimate is reduced to 1,743,000 t.

### 2.4.2 Acoustic winter survey in Division IVb (east of 3°E) and Division IIIa

During 23 November - 6 December FRV "G.O. Sars" covered these areas. Table 2.4.4 shows estimates of herring and sprat by age group and area. The very low estimates in Skagerrak are likely to be an underestimate due to the lack of trawl samples along the Danish coast. Based on the trawl catch composition, herring and sprat represented 75% of the echo integrator values of fish in Division IVb, 2% in the Skagerrak and 68% in the Kattegat. The sprat estimates are somewhat higher than during previous years.

Estimates of 0- and 1-ringed herring are compared to earlier years in the text table below. The 0-ringer estimate in Division IVb is the highest in the time series, while that in Division IIIa is the second lowest. The 1-ringer estimate in Division IIIa is very low.

| Survey year | Division IVb (E of 2°E) | | Division 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 |
| 1991 | 6,405 | 715 | 287 | 65 | 6,692 | 780 |

## 2.5 Herring Larvae Surveys

### 2.5.1 Herring larvae surveys in 1991/92

The results of the herring larvae surveys were presented in a working document (Hopkins, Working Document, 1992). The Netherlands, Scotland and Germany participated in the surveys in 1991/1992. The decrease in effort continued, as 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 |
| 1991/1992 | 931 |

Of the 931 samples taken in 1991/92, 738 were taken in the North Sea areas.

### 2.5.2 Larvae production estimates

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

| Area | Recommended period | Available samples | (n) |
|---|---|---|---|
| Buchan | 15/09 - 07/10 | 18/09 - 23/09 | (58) |
| Orkney/ Shetland | 10/09 - 30/09 | 12/09 - 23/09 | (115) |
| | | 10/09 - 12/09 | (62) |
| | | 16/09 - 25/09 | (76) |
| Central North Sea | 01/10 - 20/10 | 01/10 - 15/10 | (101) |
| | | 09/12 - 19/12 | (130) |
| Southern North Sea | 01/01 - 15/01 | 04/01 - 15/01 | (196) |

This distribution of sampling effort is considered adequate to calculate estimates of larval production for all areas. However, the problem remains that larval production is implicitly assumed to be zero in hatching periods for which there are no back-calculated estimates. Gaps in temporal coverage of can, therefore, lead to an underestimation of larval production. Further work is needed on methods of estimation for unsampled production periods.

The LPEs were calculated as described in *Anon.*(1987). Z/K values were estimated for each area based on the slope of the log mean abundance of larvae against length over the range 8 - 16 mm (or 10 - 16 mm in the case of the southern North Sea). These were used to calculate the mean Z/K over the years 1980-1991 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 shown in Table 2.5.2. In Table 2.5.3, the LPEs are expressed in units of spawning stock biomass by dividing by estimated fecundity. 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.* (1990) which could be calculated over core areas and time periods.

| Area | Time period required for | | Samples available | | Adequate? |
|---|---|---|---|---|---|
| | Full index | Reduced index | | | |
| Buchan | 01-15/09 | 01-15/09 | No samples | | No |
| | 16-30/09 | 16-30/09 | 18-23/09 | 58 | Only 6 days |
| Orkney/ Shetland | 01-16/09 | 01-16/09 | 12-15/09 | 56 | Only 4 |
| | 16-30/09 | 16-30/09 | 16-23/09 | 59 | days |
| Central North Sea | 01-15/09 | 01-15/09 | 10-12/09 | 62 | Only 3 days |
| | 16-30/09 | 16-30/09 | 16,17, 23-25/09 | 76 | Only 5 days |
| | 01-15/10 | | 01-10/10 | 101 | Yes |
| | 16-31/10 | | No samples | | No |
| Southern North Sea | 16-31/12 | 16-31/12 | 09-19/12 | 130 | Yes |
| | 01-15/01 | 01-15/01 | 04-15/01 | 196 | Yes |
| | 16-31/01 | | No samples | | No |

From the above table it is clear that LAIs cannot be calculated for most of the North Sea areas. An index was, however, calculated for the southern North Sea, with the larval abundance during the period 16 - 31/1 estimated as the mean contribution of that time period to the index values for the years 1985 -1989 (20%).

The updated series of LAIs for the North Sea areas are shown 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 1991 are presented by divisions and quarters in Table 2.6.1.

The observation made in last year's report that the declining trend in mean weight observed in Division IVa and IVb during 1986-1989 has stopped, can now be confirmed this year (Table 2.6.2). In Divisions IVa, IVb and IVc + VIId the mean weight of 2-and 3-ringers are the highest since 1985. In Divisions IVc and VIId this applies also to 4- and 5-ringers. The mean weights in the stock obtained from the summer acoustic survey show a similar pattern.

Table 2.6.3 provides a convenient comparison of the changes in the third quarter mean weights at age in the catch from Divisions IVa and IVb for the years 1986-1991. In this quarter, most fish will be at or approaching their peak weights just prior to spawning. The mean weights in the stock obtained from the summer acoustic survey show a more marked increase than the weights in the catches. The increase seems to apply to all age groups.

### 2.6.2 Maturity ogive

The percentage of 2- and 3-ringers likely to mature in 1991 was estimated from the acoustic survey made by the research vessels in July 1991.

The proportions likely to have spawned in 1991 (maturity stage 3 and above) compared to the three previous years were as follows:

| | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|
| 2-ring | 65.6% | 78.7% | 72.6% | 63.8% |
| 3-ring | 87,7% | 93.9% | 97.0% | 97.1% |
| older | 100.0% | 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

Table 2.7.1 shows time series of spawning stock indices from larvae surveys, acoustic surveys and IYFS. Earlier Working Groups have considered the IYFS index for 2-ringers and older for the total area to be a useful index of spawning stock, under the assumption that it was based on data from the North Sea only. It is, however, evident that the figures used are also based on the sampling in Division IIIa, which means that variable proportions of spring spawners have been contributing. New figures were presented for the North Sea area only. 2-ringed North Sea autumn spawners have in some years been abundant in Division IIIa (Table 3.4.1), while older North Sea herring rarely occur in Division IIIa during the IYFS.

The best IYFS index for the spawning stock of North Sea herring is therefore considered to be the index for 3-ringers and older in the North Sea, in the beginning of the year after spawning. This index for the spawning stock in the years 1981-1991 (survey year 1982-1992) is presented. Both the larvae production estimate (LPE) and the IYFS indicate a considerable reduction (40-50%) of the spawning stock in 1991 compared to the two previous years, while the acoustic estimate is at the same level as the two previous years.

The apparent discrepancy between the 1991 indices was discussed. No major difference in survey methods or survey conditions compared to earlier years seem to give reasons to reject any of the indices. Some doubts were expressed due to the reduced effort in the larvae surveys.

A VPA was tuned by the method described in the 1991 Working Group report. By use of the program "RCT3" each series of indices was regressed with the VPA estimates of spawning stock for the converged year (log-log regression). The regression for the acoustic estimates was replaced by a log-log regression with slope fixed to 1. Predictions of spawning stock in the unconverted years were calculated from these regressions by making a weighted average. The weighting factor was $1/SE^2$, where SE is the estimated standard error of the individual predictions.

On the basis of some trial VPAs the spawning stock estimates were considered reasonably converged for 1988 and earlier years; increasing the relative fishing mortality in 1991 by a factor of 2 caused a 20% decrease in estimated stock.

The output from "RCT3" is shown in Table 2.7.2. Concerning the slope of the regressions the pattern described in the 1991 Working Group report is repeated; the LPE and acoustic estimates causes slopes well above 1 and the IYFS gets a slope somewhat below 1. This implies a curve linear relationship between the non-logged indices and the VPA. A linear relationship was used between acoustic estimates and VPA and, therefore, the slope was fixed to 1 for the log-log regression as in last year's assessment.

Increasing egg mortality at increasing stock size would result in a curved relationship in the direction observed for the LPE and that regression was thus accepted.

Possible reasons for a non-linearity between IYFS and VPA were discussed. Increasing trawl efficiency during a period of increasing stock size was mentioned, but the point was not strongly supported. Anyhow, it was considered reasonable to allow for non-linear relationships as long as no strong reasons for a strict linear relationship was evident.

Table 2.7.2 contains the regression parameters, predicted values with standard errors and the weighting factors obtained when applying the acoustic regression with fixed slope. Predictions from IYFS have a relatively low standard error. Those values therefore get about 50% of the weighting when making the average predictions.

For all years in the VPA an annual natural mortality of 1.0 for 0- and 1-ringers, 0.3 for 2-ringers, 0.2 for 3-ringers and 0.1 for older fish was applied. These values are smoothed values from the most recent multispecies assessment. A number of separable VPAs were made with different fishing mortalities in 1991. The selection pattern based on the years 1986-1991 and fishing mortality of oldest true age group by year is shown in Table 2.7.7. All other input values are shown in Tables 2.7.3 - 2.7.6. The 1991 values for weights at age in the stock and proportions of maturity are derived from the summer acoustic surveys.

The VPA with 0.42 as reference fishing mortality for 1991 was the one giving the minimum sum of squared residuals relative to average predicted values. This VPA was therefore considered as the best fit to the survey data. The outputs of this VPA are shown in Tables 2.7.8 to 2.7.10. Table 2.7.8 shows an average fishing mortality in 1991 of 0.39 for 2-6 ringed fish. This is close to the value for 1990.

#### 2.7.1.2 Estimates of total stock size in recent years.

The VPA estimate of present stock size has to be considered rather uncertain. It is based on survey indices with fairly large variance. There are partly conflicting

trends in the different series of indices as well. The observed fungus disease brings additional uncertainties to the natural mortality applied for 1991 relative to earlier years. The effects on the 1991 VPA estimate caused by any increased mortality might have been incorporated in the assessment since survey data from as late as February 1992 is used. In that case the stock size in 1990 and 1989 could have been underestimated by the present VPA.

It seems noteworthy that for all the three latest years the VPA estimates are 30-40% below the acoustic estimates, which is at the likely lower confidence limit of the acoustic surveys. This cannot be resolved from available information but could be due to error in both the survey and VPA estimates.

In spite of these uncertainties the present VPA estimate of the spawning stock in 1991 is quite close to the prediction from last year's assessment even when taking into account the overshooting of the agreed quotas. The present stock estimates for 1989 and 1990 are 13% down relative to last year's assessment.

### 2.7.2 Southern North Sea (Divisions IVc and VIId) stock

Estimates of stock abundance are available only from herring larvae surveys. Because of the increased sampling intensity in this area in 1991/1992, both the larval abundance index (LAI) and the larval production estimate (LPE) can be calculated.

The LAI in 1991/1992 is considerably higher than the corresponding values for the seasons up till 1989/1990 (no value is available for 1990/1991). It should be noted, however, that the figure for 1991/1992 is largely driven by one large haul in December 1991 (Hopkins, Working Document 1992). The high LAI for 1991/1992, therefore, must have wide confidence limits, and it cannot be considered as a strong evidence for an increase in stock size.

The LPE for 1991/92 should be considered more accurate, as it depends equally on the survey results for December and January. The LPE value for this season is at the same level of the preceding three seasons. In earlier years, the LPE shows more variation from year to year. Considering the time series from 1981 onward, there is no increasing trend over time.

The catch-at-age table (Table 2.7.11) shows an increasing proportion of old fish in the catch. This could indicate an increase in stock size or reduced recruitment.

The monthly distribution of commercial catches (Figures 2.10.11 and 2.10.12) show that catches during the spawning season (November/December) are largely confined to a single statistical rectangle. This confirms earlier reports about the limited spatial (and temporal) extent of the spawning.

### 2.7.3 Historical review of assessment quality

From the Working Group reports since 1972, average fishing mortalities, recruitment and spawning stock estimates are tabulated in Tables 2.7.12-2.7.14. The tables are similar to the ACFM quality diagrams. For practical purposes, columns and rows are interchanged. When reading the tables, the following comments are useful:

| Date of assessment | Comments |
|---|---|
| 1972 | The first VPA for total North Sea for the years 1947-1971 M =0.1. |
| 1972-1975 | No estimates of SSB, only numbers by age and total biomass. |
| 1976 | Predicts SSB for the years 1976-1980 assuming zero catches of adults, *status quo* F on juveniles and recruitment estimate from R/SSB relationship. |
| 1977 | Predicts SSB for 1977-1979 assuming no adult catch since early 1977, and reduced F on juveniles. |
| 1978 | No new VPA, prognosis based on previous VPA and International Young Herring Survey estimates of recruitment, assuming no directed herring fishery. |
| 1979 | No new VPA. |
| 1980 | An "extension" of age the 1977 VPA given with reservations. |
| 1981 | No new VPA. |
| 1982 | VPA presented for total North Sea and southern North Sea. Doubts about catch figures. |
| 1983 | VPA for each sub-division and total North Sea. |
| 1984 | M =1.0 for 0-ring, 0.8 for 1-ring, 0.1 for older. VPA for each sub-division and total North Sea. SSB at time of spawning for total North Sea calculated as sum of the divisions. |
| 1987 | M = 1.0 for 0- and 1-ring, 0.3 for 2-ring, 0.2 for 3-ring, 0.1 for older. Prognosis only for Divisions IVa+b, 150,000 t added in Table 2.7.14. |
| 1990 | F-old created by separable VPA. (Most previous assessments have been based on F-old from "file"). |
| 1991 | Catches of North Sea autumn spawners in Division IIIa included. |

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

The starting point for the prediction is the stock of the North Sea autumn spawners in the North Sea and Division IIIa combined at 1 January 1992. For 3-ringers and older the VPA estimate (Table 2.7.9) is used. For 2-ringers of 1 January 1992 the estimate is based on the IYFS 1-ringer estimate (15.57 billion) one year earlier, taking into account the catch in 1991 of 2,067 million. The starting value for 1-ringers is the 1992 IYFS estimate (14.97 billion) and for 0-ringers the MIK-estimate from the 1992 survey (84.7 billion). The recruitment section (2.3) describes how these year classes (1989, 1990 and 1991) are estimated. 0-ringers at 1 January 1993 are set to 68 billion (1982-1989 average).

For the total stock mean weights at age, maturity at age, natural mortalities and proportions of F and M before spawning are all taken from the VPA input for the year 1991 (Section 2.7). The fishing pattern for the total stock is taken from the separable output (Table 2.7.7).

Catch predictions for 1992 and 1993 were made for five different fleets:

a) other fisheries in the North Sea;
b) small-mesh fisheries in the North Sea;
c) human consumption landings in Division IIIa;
d) mixed clupeoid landings in Division IIIa;
e) other industrial landings in Division IIIa.

Mean weights at age in the 1991 catches by the same fleets were applied for the predictions.

The proportion of each year class in Division IIIa is likely to vary between years for each of the age groups 0, 1 and 2 (winter rings). For the 1-ringers this is reflected in the IYFS results presented in Table 2.3.4. For this reason, it was assumed that the most realistic predictions would be obtained if the proportion (or abundance) in each area could be estimated for each age group at the beginning of each prediction year.

3-ringers and older were assumed to be exclusively in the North Sea. The Workshop on Methods of Forecasting Herring Catches in Division IIIa and the North Sea (*Anon.*, 1992) suggests a procedure for estimating the abundance of 1-ringers in Division IIIa. The proportion of 1-ringers in Division IIIa estimated during the IYFS (Table 2.3.4) is applied to the VPA estimate of the total year class (Table 2.7.9) giving a time series of 1-ringer abundance in Division IIIa. This is regressed with survey indices thought to be related to it. Table 2.8.1 shows the time series and the regression results. All these survey indices are fairly well correlated to the abundance. However, only the MIK index predicts abundance of 1-ringers in Division IIIa more than one year ahead. The 1992 MIK index was, therefore, used to estimate the 1-ringer abundance in Division IIIa on 1 January 1993. The result is 12.7 billion. At 1 January 1992 the IYFS proportion observed in Division IIIa (25%) was directly applied to the total estimate of the year class (14.97 billion)) giving 3.75 billion.

The fishing mortalities by age calculated by fleet for the 1991 catches formed the bases for a *status quo* prediction ($F = F_{91}$) for 1992. For age groups 1 and 2 (winter rings), adjustments between the North Sea and Division IIIa fleets were made to fit the (expected) change in distribution of 1- and 2-ringers relative to 1991.

Another option with TAC constraints on "other fisheries in the North Sea" (A) and *status quo* on the remaining fleets (B,C,D,E) was considered realistic. This is because most catches from them are not counted against the TAC in the North Sea. The first option (Table 2.8.2), however, shows a catch by "fleet A" quite close to the TAC for the North Sea (430,000 t, including 10,000 t of spring spawners) and thus covers both cases.

A *status quo* option for 1993 was made in the same manner as the one for 1992. In addition, one option with 20% increase and one with 20% decrease in fishing mortality caused by "other fisheries in the North Sea (A) were made keeping *status quo* fishing mortality for remaining fleets (B,C,D,E). Similar options (± 20%) for the small-mesh fleet in the North Sea were made, keeping *status quo* for remaining fleets. A final option was made based on no mixed clupeoid fishery in Division IIIa keeping *status quo* on remaining fleets.

The option of $F_{2\text{-}6} = 0.30$ for the "other fisheries in the North Sea" keeping *status quo* on remaining fleets was planned. This would, however, be close to the option of 20% reduction in " the "A" fleet.

The various options are presented in Tables 2.8.2-2.8.8. The consequences for the spawning stock in 1994 is not shown for any of the options. One reason for this is the uncertainties regarding the assessment of the present stock size (Section 2.7.1.2). New information on stock size (acoustic estimate in 1992) and likely increases in mortality due to the fungus disease will be presented at a meeting planned for the early autumn 1992. For this reason, the predictions given in this report should be considered preliminary, and a new prediction may be needed for 1993. Tables 2.7.12-2.7.14 show that for different reasons 3-year-ahead predictions from earlier assessments have not been particularly realistic.

All options presented for 1992 and 1993 show fairly stable spawning biomass, while the catches vary considerably between years and between options for the fleets exploiting the younger age groups. This because the 1991 year class is estimated to be above average thus

contributing strongly as 1-ringers in Division IIIa fisheries in 1993.

In predicting the stock of 1-ringers in Division IIIa using the method described above, it must be stressed that the relationship between VPA estimates of 0-group and the MIK index has wide confidence limits. The estimate of the total size of the year class is thus very uncertain. In addition, moreover, the same index is used to predict the quantity of the year class that will be in Division IIIa (and, by subtraction, the quantity in the North Sea). Any imprecision in the predicted values from the regressions will have a major effect on the reliability of the estimates of the stock in the North Sea and Division IIIa.

## 2.9 Management Considerations

### 2.9.1 TAC advice for the total North Sea stock

The TAC advice depends on the management objectives set by fisheries managers. Until now, this objective has been to increase the spawning stock size to a level of 1.5-2.2 million t. The Working Group in recent years has advised that this objective could be achieved by fixing F on 2-ringers and older at 0.30, and by reducing the exploitation of 0- and 1-ringers. The subject of management objectives is further discussed in Section 2.9.5.

The latest assessment of the stock shows that F in recent years has exceeded the level of 0.30 (Section 2.7). This is largely due to the constant overshooting of TACs.

The TAC advice provided by ACFM in recent years was composed of a component of adult catch, taken mainly in the directed herring fisheries, and a component of juvenile catch, taken mainly in the industrial small-mesh fishery. However, the total TAC advice has been applied in practice to the directed herring fishery. The actual catches of adult herring, therefore, were always higher than the projections on which the TAC advice was based.

Most of the juvenile catches taken in the industrial fisheries were not counted against national quotas. This has resulted in total catches (adults and juveniles) that were considerably above the internationally agreed TACs.

In this year's report, separate projections have been made for the catches in the directed herring fishery and for the by-catch of herring in the industrial small-meshed fishery. It is advised that these fisheries are managed separately, and that the TAC for the directed fishery is only based on the projected catches for that fishery.

The industrial fisheries should be managed under a different set of regulations. Under the assumption of a *status quo* F, the projected catch of herring in this small-mesh fishery, including mixed clupeoid fishery in 1993 is 304,000 t in the North Sea and Division IIIa. Section 2.8 describes how this catch is expected to be distributed between the North Sea and Division IIIa. It should be emphasised that this prediction is very uncertain in view of the wide confidence limits on the predicted strength of the 1991 year class. It is also uncertain whether the 2-ringed herring in 1993 will be distributed in the same way between North Sea and Division IIIa as they were as 1-ringers in 1992.

As shown in Section 2.9.3, the exploitation of juvenile herring by the small-mesh industrial fishery, including mixed clupeoid fishery, reduces the potential yield from the herring stock up to 10%. The reduction in adult catch ($\geq$ 2-ringers) is about 30%. Spawning stock biomass is reduced by about 30%. These yield calculations are, however, based on the fishing pattern and mean weights at age in the catches in 1991 which are very different from those in previous years (see Section 3.2.7). As a result, the relative changes in yield are different from those given in *Anon.*(1989) and can only be considered as uncertain estimates.

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

The population spawning in the southern North Sea is part of the total North Sea stock, and the catches taken in this area are part of the total North Sea TAC. The southern North Sea population has historically shown to be rather susceptible to high fishing pressure, presumably due to the suitability of its spawning grounds to bottom trawling. Whereas the population was very large up till the early 1950s, it was reduced to a very low level in subsequent years, and became nearly extinct in the 1970s. During the period of closure (1977-1981), the population rapidly increased to a level of about 200,000 t, and it has apparently stayed at that level since the reopening of the fishery.

The population is exploited in summer in the central and northern North Sea, and in autumn and winter on its spawning grounds in the southern North Sea and English Channel. Management regulations in recent years have allowed only a certain part of the total North Sea TAC to be taken in Divisions IVc, VIId in order to provide the southern North Sea population some protection during its period of spawning. Contrary to the situation in the central North Sea, the spawning grounds in the southern North Sea are not closed for fishing during the spawning period.

In 1989 and 1990, the TAC advice for the southern North Sea (30,000 t) was based on a policy to increase the size of this population above the present level. Such an increase would buffer the population against short-term reductions in recruitment, and it might result in an extension of its spawning grounds and season. It should

be noted that this population spawns at the southernmost border of the herring distribution area. The population is, therefore, expected to be rather sensitive to environmental variation. An extension of spawning grounds and season would make recruitment less susceptible to chance occurrence of adverse hydrographic conditions.

In 1991, the TAC was increased to 50,000 t, following ACFM's conclusion that catches in this order of magnitude had kept the stock at a stable level throughout the 1980s.

The level of the TAC in future years depends on the management choice whether the present stock level is satisfactory, or whether one should try to further rebuild this population. The first option would allow a continuation of the present catch level of 50,000 t, but it contains a risk of future reductions in catch due to falling recruitment. To allow for some growth in the stock, a reduction of catches below 50,000 t would be required.

### 2.9.3 Management of the juvenile fishery

#### 2.9.3.1 Improving the exploitation pattern in the North Sea

Juvenile North Sea herring of the 0- and 1-ringer groups are caught in both the North Sea and Division IIIa. Details of the fisheries are discussed in Sections 2.2.1 and 3.3.2. The harvesting of these age groups are known to reduce the potential stock yield. In an attempt to estimate the percent reduction of total yield resulting from exploitation of these fish, we employed a standard yield per recruit model with input parameters for these age groups by quarter. Four scenarios of preventing the catch of juveniles were evaluated as follows:

1) For both the North Sea and Division IIIa;
2) Division IIIa;
3) The North Sea;
4) Mixed clupeoid fishery in Division IIIa.

For each scenario, except 4), the result of removing fishing mortality on 0-ringers and 1-ringers were evaluated. In scenario 4) it was not considered reasonable to separate the 0-, 1- or 2-ringers because of the nature of the fishery. Fishing mortality on all three groups were removed and the input parameter adjusted accordingly.

#### 2.9.3.2 Input parameters

All input parameters were estimated from the 1991 assessment data with the exception of natural mortality rates for 0- and 1-ringers. These natural mortalities by quarters were scaled to 1991 values using the mean 1980-1985 quarterly results of the 1989 MSVPA key run (*Anon.*, 1989b). Values for M for age groups 2-9 were the same as those used in the 1991 SSVPA. Input parameters for each simulation are presented in Tables 2.9.1 and 2.9.2.

The weights at age used in the catch were:

- Weight at age by quarters in the total North Sea (Table 2.6.1).
- Weight at age by quarter and by "fleet" in the Kattegat and Skagerrak.

The weight in the catch for the total stock (North Sea and Division IIIa) is the mean weighted by number caught in the North Sea, Kattegat and Skagerrak. For each simulation the weight in the catch was recomputed in order to take into account the catch assumed to be taken by area (Table 2.9.2).

The weights in the stock are those from the July 1991 acoustic survey in the North Sea which were used in the assessment and prediction. As these weights in the stock are used for the calculation of the spawning biomass, the weights of the Division IIIa juveniles can be ignored. The fishing pattern is derived from the separable VPA used in the prediction.

In order to obtain a fishing mortality coefficient by quarter and by area, the SVPA values were split according to catch by area and quarter. The split by area gives exact fishing mortality by area, but the split by quarter gives a biased estimate. Unbiased ones would have to be computed through a quarterly VPA. However, the error is expected to be very low and has, therefore, been ignored.

#### 2.9.3.3 Yield per recruit prediction

The net increase for each simulation is presented in the following text table:

| Preventing catch of juveniles in: | Age | Relative Increase | |
|---|---|---|---|
| | | Net Yield | SS Biomass |
| North Sea + Division IIIa | 0 | 1.4% | 6.7% |
| | 1 | 9.3% | 42.9% |
| Division IIIa | 0 | 0.0% | 2.0% |
| | 0,1 | 3.5% | 14.6% |
| North Sea | 0 | 4.0% | 4.7% |
| | 0,1 | 7.9% | 24.8% |
| Mixed Clupeoids Division IIIa | 0,1,2 | 1.4% | 9.8% |

The net gain in catch and SSB ranged from 0 to 9.3% and from 2.0 to 42.9%, respectively, according to the age group and approach taken.

### 2.9.4 Additional conservation measure

No new information was available on the spawning area in the central North Sea, and the Working Group considers that it would be appropriate to continue the closure in that area to protect the spawning stocks.

### 2.9.5 Biological justification for a target spawning stock biomass of 2.2 million t for North Sea herring

In response to a request from the EC the Working Group considered the background of the figure of 2.2 million t, which has been used as a management objective for North Sea herring SSB in recent years.

The figure of 2.2 million t first appeared in the Agreed Record of Conclusions of Fisheries Consultations between the European Economic Community and Norway in Brussels, 26-28 November 1986. This document states that: "The Parties agreed that the target level for the spawning stock biomass should be about 2.2 million tonnes. The Parties will manage the North Sea herring stock in a way designed to reach this objective". The record does not specify how the figure of 2.2 million t was arrived at.

The target SSB of 2.2 million t does not correspond to a specific biological reference point. It is merely an indication of what the average stock level might be under a regime of low fishing mortality (0.30) and average recruitment (see below). A target stock in this order of magnitude would buffer the TAC against short-term reductions in recruitment.

However, the idea of a buffer stock is to let the stock change in order to keep the TAC relatively stable. If one tries to maintain the stock at a specific target level of 2.2 million t, the TAC will fluctuate considerably (reflecting all fluctuations in recruitment). It may be more practical, therefore, to use a specific fishing mortality as management objective, rather than a specific stock biomass, as long as the spawning stock does not approach the minimum biologically acceptable level.

In 1987, the Working Group discussed the pros and cons of various management strategies, such as aiming for a specific SSB, fixing the TAC at a certain level, or stabilizing fishing mortality (*Anon.*, 1987). From the discussion presented by this Group, and also from studies made by other authors (Skagen, 1991; Corten, 1990), the following conclusions can be drawn regarding the choice of management objectives:

a) Management objectives should be set by managers and not by scientists.

b) The choice of management objectives necessarily contains an arbitrary element. None of the "biological reference points"can be used as an ideal management objective. Moreover, the biological reference points will vary over time.

c) A management policy of fixing F at a relatively low level is probably the best method of securing stability in TACs, maximizing yield over a longer period, and avoiding the risk of the SSB dropping below the minimum level of 800,000 t required for average recruitment.

d) The exact choice of target F depends not only on considerations of stock/recruitment and stability of TACs, but also on aspects like density dependant growth, market demand for specific size categories, multispecies effects, and ecosystem effects.

e) Management objectives, once defined, should be adhered to over a longer period. It will take several years before the full results of a certain management strategy become apparent. If management objectives are changed too frequently, it will not be possible to evaluate the results of a certain management regime.

In recent years, the Working Group has interpreted the stated management objective of 2.2 million t SSB for North Sea herring as an approximate long-term goal. They have suggested to fix F at a level of 0.30, which would eventually result in an average SSB above 2 million t (Skagen, 1991). The precise level of SSB in future years will depend on the exploitation level for juvenile herring, and also on the strength of new year classes.

It is expected that SSB (and TACs) will continue to fluctuate under a regime of constant F. In order to illustrate the possible long-term effects of such a management policy, the results of a simple simulation of catch and SSB are shown in Figure 2.9.1. In this simulation the F on 1-ringers and older has been fixed at 0.30. Recruitment is allowed to vary according to the cyclic pattern observed in the period 1980-1989 (Figure 2.3.4). Under these conditions, the TAC would vary between 500,000 - 800,000 t, whereas SSB would show fluctuations between 1.2 and 2.2 million t. A comparison with historic data (Figure 2.9.2) shows that fluctuations within this range were indeed common during the period when fishing mortality was relatively stable within the range 0.20 - 0.40 (in 1952 - 1964).

It should be noted that the results presented in Figure 2.9.1 are merely meant as an example. If managers want to know the full implications of various management strategies, more elaborate risk analyses (such as presented by Skagen (1991) are required.

## 2.10 Requests from the Multispecies Working Group

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

The Multispecies Assessment Working Group has requested annual provision of quarterly catch-at-age data, together with quarterly weights at age in the catch and in the stock at spawning time for North Sea herring. The data for 1991 are provided in Table 2.10.1.

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

A comparable breakdown of catches of spring spawners taken in the North Sea and transferred to Division IIIa is shown in Table 3.1.1.

### 2.10.2 Geographical distribution of the catches in the North Sea in 1991

Data on the geographical distribution of catches in the North Sea (Sub-areas IV and Division VIId) in 1991 were available from Denmark, the Netherlands, Norway, Sweden and the UK (Scotland and England). The data represent 87% of the total catch, and include both juveniles and adults. Figures 2.10.1 - 2.10.12 show the catch by ICES rectangles for each month. The total catches by month were also available for France and Germany. Therefore, the cumulative catch by month for the total North Sea, shown in Figure 2.10.13, includes 99% of the catch in the North Sea.

# 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 7,900 t in 1991. Catch in numbers and mean weight at age are given 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-ring autumn-spawning herring from the North Sea. The catches of herring in the area were allocated to their respective spawning stocks using a combination of modal length analysis and vertebral counts. The methods and problems are described in *Anon.*(1992).

The analysis was carried out on the catch-at-age data for 1990 and 1991. Annotated with these allocations are type of fishery (see Section 3.2.2). The results are summarized in the text tables below:

| 1990 | Quarter | 0-ringers | | 1-ringers | | 2-ringers | |
|---|---|---|---|---|---|---|---|
| Area | | AS | SS | AS | SS | AS | SS |
| Skagerrak | 1 | 1.0 | 0.0 | 1.0 | 0.0 | 1.0 | 0.0 |
| | 2 | 1.0 | 0.0 | 1.0 | 0.0 | 1.0 | 0.0 |
| | 3 | 1.0 | 0.0 | 1.0 | 0.0 | 0.0 ind. .22 con. | 1.0 ind. .78 con. |
| | 4 | 1.0 | 0.0 | 1.0 | 0.0 | 0.0 ind. .17 con. | 1.0 ind. .83 con. |
| Kattegat | 1 | 1.0 | 0.0 | 1.0 | 0.0 | 0.0 | 1.0 |
| | 2 | 1.0 | 0.0 | 1.0 | 0.0 | 0.0 | 1.0 |
| | 3 | 1.0 | 0.0 | .54 | .46 | 0.0 | 1.0 |
| | 4 | 1.0 | 0.0 | .36 | .64 | 0.0 | 1.0 |

Proportions by stock of catches taken in Division IIIa in 1990. SS = Spring spawning herring. AS = Autumn spawning herring. Ind. = Landings for industrial purposes. Con. = Landings for human consumption.

As pointed out in last year's report (*Anon.*, 1991) the biological sampling of the catches taken in Division IIIa in 1990 was at a very low level. As a consequence the number of herring measured for vertebral count was low and the estimated stock proportions are considered to be uncertain. The separation is based mainly on data from the Swedish catches taken in the 32-mm fishery. This procedure could add to the uncertainties as the proposition of stocks in 32-mm fishery could differ from the proportions in the small-mesh fishery.

| 1991 | Quarter | 0-ringers | | 1-ringers | | 2-ringers | |
|---|---|---|---|---|---|---|---|
| Area | | AS | SS | AS | SS | AS | SS |
| Skagerrak | 1 | 1.0 | 0.0 | 1.0 | 0.0 | 1.0 | 0.0 |
| | 2 | 1.0 | 0.0 | 1.0 | 0.0 | 1.0 | 0.0 |
| | 3 | 1.0 | 0.0 | 1.0 | 0.0 | .30 | .70 |
| | 4 | 1.0 | 0.0 | 1.0 | 0.0 | .71 | .29 |
| Kattegat | 1 | 1.0 | 0.0 | 1.0 | 0.0 | 0.0 ind. .31 con. | 1.0 ind. .69 con. |
| | 2 | 1.0 | 0.0 | 1.0 | 0.0 | .03 ind. .49 con. | .97 ind. .51 con. |
| | 3 | 1.0 | 0.0 | 1.0 | 0.0 | 0.0 ind. .07 con. | 1.0 ind. .93 con. |
| | 4 | .66 ind. 1.0 con. | .34 ind. 0.0 con. | 0.0 ind. .46 con. | 1.0 ind. .64 con. | 0.0 | 1.0 |

Above is given the proportions by stock of catches taken in Division IIIa in 1991. SS = Spring spawning herring. AS = Autumn spawning herring. Ind. = Landings for industrial purposes. Con. = Landings for human consumption.

## 3.2 The Fishery

### 3.2.1 ACFM advice and management applicable to 1991 and 1992

1991

In 1990 ACFM recommended a TAC of 178,000 t in Sub-divisions 22-24 and Division IIIa (87,000 t in Sub-divisions 22-24 and 91,000 t in Division IIIa) and zero catch in the mixed clupeoid fishery (sprat TAC). At its May 1991 meeting ACFM predicted the likely catch of North Sea autumn spawners in Division IIIa to be 80,000 t in 1991, and indicated that it would be appropriate to add it to the TAC for spring spawners.

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

1992

In 1991 ACFM did not recommend any TAC for 1992 but preferred a fishing mortality for the spring-spawning herring in Division IIIa and Sub-divisions 22-24 below the expected level in 1990. ACFM indicated that this could be achieved with a catch of about 180,000 t in 1992 of which 90,000 t could be taken in Division IIIa, 10,000 t in the North Sea and 80,000 t in Sub-divisions 22-24. The TAC for the mixed clupeoid fishery was recommended to be reduced to zero.

To calculate an area TAC for herring in Division IIIa, ACFM found it appropriate to add to the TAC of spring spawners an allowance for the quantity of 1-ringed and older North Sea autumn spawners expected to be taken in Division IIIa. This amount was estimated to be 41,000 t for 1992.

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

### 3.2.2 Landings

The landings from the fishery in Division IIIa by countries are shown in Table 3.2.1. As shown in the table, the landings amount a total of 188,000 t, which are 12,000 t lower than the landings in 1990. The landings from Skagerrak in 1990 and 1991 were 123,000 t and 121,000 t, respectively. The landings in the Kattegat have decreased over the last four years from 126,000 t in 1988 to 66,000 t in 1991.
The fishery in Division IIIa is carried out by Denmark, Norway and Sweden. The catches of herring are mainly taken in the following types of fishery.

- The directed fishery for herring is carried out by purse seiners and trawlers. The trawlers are using 32 mm mesh size. Because of a mixed occurrence of young and adult herring in the area, the landing for human consumption, where the legal landing size is 18 cm, contains varying amounts of unavoidable by-catch of young immature herring. These are mainly landed for reduction.

- The "mixed fishery" is carried out by Denmark, Norway and Sweden under a special "Sprat TAC". In the years before 1991, the Danish fishery was carried out using a mesh size less than 32 mm. On 1 January 1991, Denmark set the legal minimum mesh size to 32 mm. The Swedish fishery including purse seiners fishing for sprat and trawlers with a mesh size under 32 mm is counted against this quota. The Norwegian fishery is a purse seine fishery for sprat landed to the canning industry.

- By-catch in other fisheries: Catches of herring occur in the Norway pout and sandeel fishery, but in relation to the total landings, these landings are small.

It is not possible to allocate the landings to the above mentioned types of fisheries as the landings for reduction, except for the catches taken in the Danish mixed clupeoid fishery, cannot be separated by fishery. In the text table below the landings by categories are shown for 1990 and 1991. The landings in the HC column are those taken in purse seine and 32 mm trawl fisheries and used for human consumptions purposes. Danish landings under the mixed clupeoid TAC are listed under the column MIXED. The last column L.f.I.P (Landings for industrial purposes) are landings of herring taken in 32 mm human consumption trawl fishery and used for reduction plus herring taken as by-catch in small-mesh fisheries. The Swedish landings counted against the mixed TAC could not be separated from other landings used for industrial purposes.

For the years 1990 and 1991 it has also been possible to split the landings from the different landings categories in autumn and spring spawners.

| Year | Autumn spawners | | | Spring spawners | | |
|---|---|---|---|---|---|---|
| | HC | Mixed | L.f.I.P. | HC | Mixed | L.f.I.P. |
| 1990 | 21,891 | 12,681 | 43,685 | 61,638 | 8,053 | 53,647 |
| 1991 | 26,117 | 13,142 | 37,934 | 68,370 | 4,995 | 40,393 |

The landings of spring spawners in Division IIIa in 1991 of about 114,000 t (Tables 3.2.3-3.2.4) were at the same level as in 1990. 68,000 t were landed for human consumption and 46,000 t for reduction, of which only about 5,000 t were caught in the "mixed fishery" (Table 3.2.5-3.2.6).

The landings of autumn spawners in Division IIIa in 1991 were 77,000 t of which about 26,000 t was landed for human consumption and 51,000 t for reduction. Approximately 13,000 t was taken in the "mixed fishery".

The estimated landings overshot the TAC (174,000 t) by about 15,000 t. The catch of herring in the "mixed clupeoid" fishery 18,000 t, excluding a minor catch which could not be separated from the catch in the directed 32 mm trawl fishery), comprises about 40% of the agreed TAC of 50,000 t. Both in 1990 and in 1991 the species composition in this fishery shows that the catches consist of a large number of species, Norway pout, whiting and herring dominating the catches. The low proportion of herring in the catches may partly be due to the relative low abundance of juvenile herring in Division IIIa in 1990 and 1991.

### 3.2.3 Catch in numbers and mean weight at age

The total landings in numbers and mean weight at age for the year 1991 are given in Table 3.2.2. The landings in numbers at age by fishery and split in spring/autumn spawners by area (Skagerrak and Kattegat) are shown in Tables 3.2.3 - 3.2.6.

The revised landings in numbers and mean weight at age for 1990 are shown in Table 3.2.7.

The landings of spring spawners caught in Division IIIa and the North Sea and autumn spawners in Division IIIa are given in number and mean weight at age by stock for the period 1987 to 1991 in Tables 3.2.8 and 3.2.9. A revision of the 1989 and 1990 data was made by the Workshop on Methods of Forecasting Herring Catches in Division IIIa and the North Sea (*Anon.*, 1992). The revised figures are included in Tables 3.2.8 and 3.2.9.

### 3.2.4 Quality of catch and biological sampling data

The number of fish aged by country, area and quarter are shown in Table 3.2.10. The sampling in 1991 was generally at a higher level than the very poor sampling in 1990. At this Working Group meeting the 1991 landings were given by fishery.

The landings statistics for herring to the human consumption market were of good quality. There is still a large uncertainty about the landings for reduction purposes taken in the 32 mm fishery for human consumption. A major part of the Swedish Skagerrak landings for industrial purposes are not adequately sampled in 1991 as was the case in 1990. These landings in 1991 amounted to about 31,000 t (Table 3.2.10). This is serious for the assessment of the autumn-spawner stock and particularly for the spring-spawner stock for which the catches in Division IIIa are dominating. The number of samples from the Danish "mixed fishery" was at a fairly good level in 1991.

Discards occur in Division IIIa, but it only amounts at the most to 10% of the total human consumption landing (Kirkegaard, Working Document 1992). There are no discard data included in the landings statistics (see Section 8).

The Working Group strongly recommends adequate sampling in all fisheries in Division IIIa where herring are caught.

## 3.3 Acoustic Survey

The acoustic survey of the spring-spawning herring in the summer of 1991 covered the distribution area in the North Sea in July and Division IIIa in August (see Section 2.4.1).

The combined result of spring-spawning herring by age, derived as the sum of spring spawners found in the July survey in the North Sea and the August estimate of the same stock in Division IIIa, is shown in Table 3.3.1.

The estimated number of 2-ringers and older is about 5,200 millions, an increase of more than 100% compared to the number found during the 1990 survey. The highest concentrations were found in the eastern part of the Skagerrak indicating a relatively eastern distribution in 1991.

The possibility that some herring could have been double-counted as a result of migration in the two-week period between the two surveys cannot be ruled out. The number of spring spawners found in the North Sea was, however, only 954 millions and even if all these fish had been counted twice it cannot explain the dramatic increase in number observed from 1990 to 1991.

### 3.4 Recruitment

#### 3.4.1 General remarks on the 1992 survey

The 1992 survey was carried out in February as in previous years and a total of 44 hauls were made. All standard stations were sampled and the weather situation was good. The water temperature in 1992 was much above the long-term mean.

#### 3.4.2 Abundance of 1-ringed herring

The final index of 1-ringed herring in 1992 was 5,057 which is about 40% higher than in 1991 but much lower than the mean (Table 3.4.1). The length frequency distribution was bimodal. A modal length frequency analysis was used to separate the observed cohorts but the mean vertebral counts showed values from 56.3 to 56.5. All 1-ringed herring were, therefore, assigned to North Sea autumn spawners.

#### 3.4.3 Abundance of 2-ringed herring

The total index of 2-ring herring in 1992 was 1,934 which is well below the mean value since 1980. The 2-ring index has normally been dominated by the spring spawners. It has generally been possible to verify the separation with vertebral counts. The results of a modal length analysis of the 1992 data presented as mean length, vertebral counts and proportion of the separated components are shown in the text table below:

| | Stratum (m) | Mean length | Mean VS | Proportion |
|---|---|---|---|---|
| 1 | 10-34 | 20.0 | 55.98 | 0.36 |
| | | 22.2 | 56.30 | 0.25 |
| | | 24.6 | 56.40 | 0.39 |
| 2 | 34-44 | 20.3 | 55.78 | 1.00 |
| 3 | 45-65 | 20.2 | 55.90 | 0.95 |
| | | 22.5 | 56.30 | 0.05 |
| 4 | >65 | 22.3 | 56.48 | 1.00 |

Cohorts with VS in the range 55.7-55.9 are similar to VS of adult spring-spawning herring and the autumn spawner component is identified by VS values of 56.3-56.5. The separation was accepted and the corresponding indices are shown in Table 3.4.1. The trend in indices by stock indicates a shift in dominance since 1989 with increasing proportion of autumn spawners.

### 3.5 State of the Stock and Management Considerations

#### 3.5.1 General remarks

The assessment of the Division IIIa and Sub-divisions 22 - 24 herring is performed by the Working Group on the Assessment of Pelagic Stocks in the Baltic.

#### 3.5.2 Management of the juvenile fisheries

The juvenile fisheries in Division IIIa mainly exploit the North Sea autumn spawners. For the first time the species and age composition of the majority of the catches taken under the "mixed quota" concept was made available to the Working Group. In 1990 and 1991, about 50% of the catches of 0-ring and 20% of the catches of 1-ring herring were generated in this fishery. The majority of the remaining catch of juveniles was caught as by-catch in the 32 mm mesh consumption fishery and as by-catch in the small-mesh fishery for Norway pout and sandeel. The management of the juvenile fisheries is discussed in Section 2.9.3.

## 4 CELTIC SEA AND DIVISION VIIJ HERRING

### 4.1 Introduction

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

### 4.2 The Fishery in 1991-1992

#### 4.2.1 Advice and management applicable to 1991 and 1992

The TAC recommended by ACFM for 1991 for this area was originally 15,000 t. However, this figure was revised by ACFM during the year and subsequently increased by the EC to 21,000 t. The TAC recommended by ACFM for 1992 was 27,000 t, while the figure agreed by the EC was 21,000 t.The preliminary reported landing figure for 1991 was about 21,300 t, while the figure for the 1991/1992 season (1 April - 31 March) was about 23,300 t. The catches and landing figures are shown in Tables 4.2.1 and 4.2.2.

The major portion of the catches (over 95%) from this area has in recent years been taken by Ireland. The fishery is managed on a seasonal basis which usually lasts from mid-October until March. During 1991/1992, the fishery was partly opened on 6 October and was closed in mid-March. Only the western part of the area, i.e., Division VIIj, was opened at the beginning of the season as the result of an experimental fishery carried out in Division VIIa (south) had indicated that the herring in that area at the beginning of October were not suitable for the roe market. The opening of the season in that area was, therefore, delayed until the end of the month.

The total Irish quota was again divided into weekly quotas in order to ensure a continuation of the fishery over the entire spawning season. The weekly quota was further sub-divided into boat quotas/night. The number of boats participating in the fishery was about the same as in the previous season although the number of the large tank (R.S.W.) boats decreased from eight to two. All boats participating in the fishery are regulated by licence which restrict landings to specific ports and during specific periods. As has been pointed out in the previous report of the Working Group, considerable effort has been spent in recent years on the management of this fishery. Although it is still difficult to monitor catches, particularly illegal catches taken out of season, the management authorities are confident that the accuracy of the reported catches has improved considerably in recent seasons.

The system whereby selected spawning grounds are closed in rotation, and which was first introduced in 1988, was continued during the 1991/1992 season. The spawning grounds closed to fishing were those situated in Division VIIj, the closure lasting from 1-15 November.

### 4.2.2 Description of the fishery in recent years

In response to a request by ACFM (cf. Minutes of ACFM Meeting, May 1991), the following brief description of the fishery is given.

The catches by the Dutch fleet, which in recent years have been very small, are taken by pelagic freezer trawlers which fish during summer on the offshore feeding shoals.

The Irish fleet exploit the spawning shoals which move inshore to spawn during the months October to February. The pattern of fishing has remained remarkably constant for at least 20 years. The fleet is mainly composed of small dry hold boats from 60'-80' length which use paired midwater trawls. There is a small number of tank (R.S.W.) boats, about 90' long which also use midwater trawls. Most of the spawning grounds are situated within a few hours' steaming from the adjacent port so that most vessels make daily or nightly trips. The fleet is highly efficient and fishing now takes place by day and by night. In recent years, the stated management policy for the fishery is designed to cater for the Japanese roe market. Markets for herring other than those suitable for the roe fishery are extremely limited while the roe market itself in 1991/1992 was restricted.

Attempts have been made in recent years to reduce the amounts of herring discarded at sea by the introduction of a number of means, e.g., experimental fishing prior to opening of the season and closed periods. These measures are believed to have a certain degree of success. In addition, skippers have become more skilful in identifying areas where unsuitable herring are concentrated and claim to be able to identify different types of herring echo-traces, e.g., "hard" herring or "ripe" herring on their echo-sounders.

### 4.2.3 The fishery in 1991/1992

Initial catches during October 1991 were taken from the northern part of Division VIIj and also from the southern part of Division VIIb. The fishery continued in this area until the closed period was introduced in November. An experimental fishery was carried out in the southern part of Division VIIa (south) during late September and early October. Substantial quantities of herring were located in this area and spawned in early October. Shoals were located on the spawning grounds in Division VIIg during late October and the main catches were taken from this area and from Division VIIa (south) during the November-February period. Small catches were made in Division VIIj during January-March.

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

### 4.2.4 Catch data

The estimated catches from the combined areas by year and by season (1 April - 31 March) are given in Tables 4.2.1 and 4.2.2, respectively. The reported landings, including estimates of discards and unallocated catches taken during 1991/1992, was 25,100 t compared with 18,600 t during 1990-1991.

There has been considerable concern about the possibility of under-reporting of the landings from this fishery. This concern arose because of difficulties in interpreting the trends in spawning stock biomasses, estimated by VPAs during the 1983-1990 period. The 1991 Working Group, therefore, calculated the theoretical catches which could have been taken from the fishery during 1983-1990, using the roe production figures and a roe yield of 6.5%. The recalculated catches indicated that

the original catches from the roe fishery could have been underestimated by as much as 50%. The appropriate catches from 1982-1991 were, therefore, raised accordingly. ACFM was concerned at such a major revision of catch data but considered that as the stock was in a healthy state and that, if the revised figures were correct, then the fishery should be stabilized at the catch level of recent years. On this basis, a TAC of 27,000 t for 1992 was recommended.

The Working Group has now been informed that the roe production figures used in the revision of the catches were inappropriate. This is because the figures included considerable quantities of roe obtained from other fisheries around Ireland and the UK. Therefore, the Working Group had to revert to the catch figures presented at the 1990 meeting. As pointed out in the section on management of the fishery, the management authorities are confident that the accuracy of the catch statistics has improved considerably in recent years.

Discards. The problem of discards in this fishery has been discussed at length both in the 1990 and 1991 reports of the Working Group. There are, however, still no estimates of discards for the roe fishery. It is felt that the problem is reducing as fishermen become more skilled in identifying shoals which are suitable for the Japanese market. It was, therefore, decided to continue to assume a level of discarding in the roe fishery of 10% which is the same as that agreed for the previous year. This figure does not seem unrealistic compared with discard figures from other fisheries mentioned in this report.

### 4.2.5 Quality of catch and biological data

The sampling programme carried out on this fishery throughout the season is very intensive and adequate biological data are available. The sampling data are shown in Table 4.2.3. The quarterly length distribution of the catches from the Irish fleet are shown in Table 4.2.4.

### 4.2.6 Catches in numbers at age

The total catches in numbers at age, including discards, are shown in Table 4.2.5. The percentage age distribution of catches in recent seasons is shown in Table 4.2.6. These catches include discards mainly taken during the roe fishery and which have been assumed to be 20% of the landings during 1983/1984 - 1989/1990 and 10% during 1990/1991 and 1991/1992.

The catches in numbers at age for 1991/1992 are mainly based on samples obtained from the Irish fishery. One sample, obtained from the Dutch fishery, has been used to convert both the German and Dutch catches to numbers at age. The age distribution is dominated by 2-winter-ring fish, i.e., incoming year class of 1988/1989. 5-winter-ring fish (i.e., the 1985/1986 year class) are also well represented (18%). This year class is particularly well represented in the fishery in Division VIIj. The age distribution of the catches shows a gradual increase of older fish in recent years. There has been a noticeable decrease in the number of 1-winter-ring fish taken in the catches which first became apparent in 1986/1987.

## 4.3 Mean Weights at Age

The major portion of the catch from this fishery is taken from the spawning fishery. Therefore, the mean weights of the catches have been taken as the mean weight of the stock at spawning time (1 October). The mean weight (g) of all samples are shown below compared with those for recent 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 |
| 1991/1992 | 92 | 128 | 168 | 182 | 190 | 206 | 229 | 237 |

## 4.4 Stock Assessment

### 4.4.1 Larval surveys

No larval surveys were carried out on the stock in the area during the 1991/1992 season.

### 4.4.2 Acoustic surveys

Acoustic surveys have been carried out on the stock for the last three seasons. The spawning stock biomass estimated by the 1989/1990 survey was only 18,000 t, but this estimate was considered to be unrealistically low *Anon.* (1990). The SSB estimated by the 1990/1991 surveys was 90,000 t. This estimate was not accepted by the Working Group as an absolute level of stock size but was considered as an indication that the stock was in a healthy state and possibly a minimum estimate. The results of the 1991 surveys, again carried out by the R/V "Lough Foyle", were presented in a Working Document by Reid and Simmonds (Mar. Lab., Aberdeen) and discussed in a Working Document (Molloy, 1992a). The biomass of adult herring estimated for both surveys was about 100,000 t, and, allowing for catches taken, a total spawning stock at about 110,000 t was calculated. Because of the intensive nature of the grid system the

precision of the stock estimates, although not calculated, is likely to be high.

It was felt however, that the first of the surveys, designed to estimate the size of the autumn-spawning component, had in fact been carried out after the major portion of this component had completed spawning and migrated out of the area. This first survey included a substantial number of herring which appeared by their maturity stages and vertebral counts to be winter/spring spawners and, therefore, may possibly have been double counted during the second survey. The biomass of those herring which may have been double counted was, therefore, removed and a revised spawning stock of about 77,000 t was calculated. The removal of these herring which may have been double counted may result in an under-estimate of the spawning stock.

The Working Group considered that this was a minimum spawning stock estimate and did not include the major portion of the autumn component. It has been indicated by the 1990/1991 surveys that the autumn and winter spawning components were at about equal size. This was also the position during the mid-eighties after the stocks had recovered. It is therefore likely that the acoustic surveys, if they had been carried out at the correct time, would have indicated an SSB equal to, if not greater than, that of 90,000 t suggested by the 1990/1991 surveys.

### 4.5 Result from Tagging Experiments

The results of a tagging experiment carried out during 1991 were presented in a Working Document (Molloy, 1992b). Approximately 10,000 herring were tagged on the west coast of the Isle of Man. Over 160 fish have been recaptured to date. Approximately 32% of the recovered tags were taken in the main Celtic Sea fishery during the December-February period. Tagged herring first became apparent in the catches during December and became more numerous as the season progressed, suggesting a gradual influx of herring from the Irish Sea. The biological data of those herring recovered from the Celtic Sea indicated that over 95% were 2-winter-ring fish in stage VI maturity stage, i.e., probably first-time spawners. The maturity stages indicate that these herring belong to a winter-spawning component. As there is no evidence of any significant winter spawning of herring in the northern Irish Sea, it is most likely that these fish must originally have been born in the Celtic Sea and transported into the Irish Sea as larvae.

The implication of these results for stock assessment warrant further investigation because it is clear that catches of young herring taken west of the Isle of Man will have an effect on the mortality of 2-winter-ring herring in the Celtic Sea. The results should also be considered in relation to the acoustic estimates of 1- and 2- winter ring herring in the Celtic Sea.

### 4.6 State of the Stock

Recent meetings in the working group have been unable to produce estimates the size of the stock in this area because of difficulties in interpreting the larval surveys, doubts about the catch data, lack of recruitment indices, and the absence of a series of acoustic surveys. The 1991 Working Group did not carry out an analytical assessment of the stock because of the poor data. It did, however, conclude that, on the basis of the age distribution of the catches in recent years, the results of the 1990/1991 acoustic surveys and the recent larval surveys, the stock was in a healthy condition. The acoustic survey carried out during 1990/1991 gave an estimate of the spawning stock of about 90,000 t.

The present Working Group is again faced with extreme difficulties in carrying out an assessment of the stock. The available information can be summarized as follows.

1. The acoustic surveys carried out during 1991/1992 gave a minimum spawning stock estimate of about 77,000 t. This estimate does not include a large proportion of the autumn-spawning component.

2. The average age composition of the catches has continued to improve in recent years and shows a greater survival of older fish.

3. The fishing effort of the fleet in the area has remained very constant in recent years and has probably decreased slightly in 1991/1992 because of the absence of a number of the larger tank vessels, and the closure of the fishery on a number of occasions.

4. Reports and observations from fishermen again suggest a high stock level in the area.

The available information, therefore, suggests that the current stock size is at least as high as that indicated by the acoustic surveys of 1990/1991 and may be around 90,000 t.

### 4.7 Management Considerations

The stock in this area can be defined according to the ACFM criterion as a stock whose state of exploitation cannot be precisely assessed. No stock size or recruitment estimates are available on which to make forecasts although the spawning stock is considered to be in a healthy state and around 90,000 t. The Working Group is unable to calculate any advised catch levels because of the uncertainty about the stock size. However, it appears desirable that the catch level should be stabilized until more precise information is available. A precautionary

TAC in line with that recommended by ACFM in 1991, but based on the revised catches is therefore suggested. The average catches during the last 5 years was about 22,700 t and this may be an appropriate level.

The Working Group considers that it is extremely important to continue to carry out acoustic surveys in this area, particularly in view of the history of the stock and the fluctuations that appear to have taken place. It is also important to obtain more information about stock distribution in view of the results suggested by the tagging experiment.

### 4.8 Evaluation of the Effects on Stock Size of Closures of Spawning Areas

The 1991 Working Group described the operation of the rotating box closure system of the spawning beds throughout the area. ACFM questioned the benefits that might arise from this measure and whether it was possible to evaluate them in terms of increases in spawning stock sizes.

The spawning box closure system was first introduced during the 1988/1989 season and continued for three seasons. The system was again introduced following a review by the Working Group and the area defined as Box A was closed from 1-15 November during the 1991/1992 season. Box B is scheduled to be closed from 1-15 November during the 1992/1993 season, while Box C is due to be closed during the 1993/1994 season.

Although some illegal fishing has taken place within the closed area during closed periods, fishermen have generally respected the regulations and consider them as a necessary method of conservation. They associate the closed box system with the increase which they claim has taken place in recent years in stock size in this area.

The Working Group was unable to quantify the effects that these measures may have had on the stock size in the area. This might have been possible if the whole area had been closed for fishing for a season and some estimates of likely decreases in fishing mortality could have been estimated. However, under the present system this does not appear possible because the effort previously exerted on a closed area may be changed to an alternate area.

The original aim of the spawning box closure system was to ensure that a portion of the total stock would be able to spawn each year without being subjected to fishing. The Working Group considers that the measures should be retained until after the 1993/1994 season.

A larval survey, planned to take place during November in Box A, did not take place because of bad weather. However, the results of the commercial sampling did suggest that spawning would have taken place in the area during the closed period. The maturity distribution of samples obtained from catches taken from Division VIIg during October and November 1991 would suggest that the closure dates (1-15 November 1992) are appropriate for that area.

## 5 WEST OF SCOTLAND HERRING

### 5.1 Division VIa (North)

#### 5.1.1 ACFM advice applicable to 1991 and 1992

The ACFM recommended TAC for 1991 was 57,000 t and the agreed TAC was 62,000 t, corresponding to a fishing mortality of 0.25. No long term gains in yield can be expected from higher levels of F. On the assumption that the agreed TAC would be taken in 1991, ACFM recommended a TAC in 1992 of 62,000 tonnes.

#### 5.1.2 The fishery

The catches reported for each country are given in Table 5.1.1. The total catch in 1991 was 50,606 t compared with the TAC of 62,000 tonnes. This is the fourth year in succession where the TAC was not reached, but there is no evidence that this reflects any difficulties encountered by the fleets in reaching their quotas.

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

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

In addition to the catches shown in Table 5.1.1, the Faroese fishery in Area V caught approximately 6700 t of herring in 1990 and approximately 16000 t in 1991. The stock identity of these fish is unknown, but they may belong to the VIa(north) stock.

#### 5.1.3 Catch in numbers at age

Age composition data for 1991 were available from Scotland and the Netherlands. In previous years only the Dutch data were used to convert unsampled catches to numbers at age, because the Scottish figures include catches from the Minch fishery which is not exploited by other fleets. However, this year Dutch data were available only for quarter 3, so unallocated catches and catches by Ireland, Germany, France, Norway, England & Wales and the Faroe Islands were converted to numbers at age using the combined Dutch and Scottish data, covering quarters 1, 3 and 4. For unsampled catches during quarter 2, the combined catches at age for quar-

ters 1 and 3 were used to estimate numbers at age. The catches by quarter and the percentages for which age composition data were available are shown in the text table below.

| Quarter | Catch ('000 t) | % sampled |
|---|---|---|
| 1 | 3,152 | 98.5 |
| 2 | 2,087 | 0.0 |
| 3 | 33,139 | 79.0 |
| 4 | 12,229 | 51.9 |

The sampling effort used to derive the catch in numbers is summarised in Table 5.1.2. The estimated catch in numbers at age for the years 1970-1991 are given in Table 5.1.3.

### 5.1.4 Larvae surveys

A total of 193 samples were taken in Division VIa(N) in 1991 compared with 367 samples in 1990. This is largely the result of poor weather during the survey period, although the overall effort invested in the larvae surveys continues to decrease (see Section 2.5).

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

| Recommended period | Available samples | n |
|---|---|---|
| 15/09 - 07/10 | 06 - 14/09 | 100 |
| | 15 - 17/09 | 24 |
| | 13 - 19/10 | 69 |

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

| Time periods required for | | Available samples | n |
|---|---|---|---|
| Full index | Reduced index | | |
| 01 - 30/09 | 01 - 30/09 | 06 - 17/09 | 124 |
| 01 - 31/10 | | 13 - 19/10 | 69 |

Last year, sampling is considered insufficient to calculate a reliable LPE and only the LAI was used to tune the assessment. Both the LPE and LAI estimates have deteriorated in quality this year. The acoustic survey estimate for this area also needs to be treated with caution (see Section 5.1.5). In the absence of more reliable information, it was decided to use both the LPE and LAI for the assessment this year, including the LPE estimate from the 1990/91 survey.

The updated series of indices are shown in Table 5.1.4.

### 5.1.5 Acoustic survey

Acoustic surveys were carried out in Division VIa(N) during November in 1985-1987, during December in 1988 and during January in 1990. These surveys were often severely disrupted by poor weather, and only the result of the 1987 survey was considered reliable. However, the 1991 Working Group found that the results of its assessment were inconsistent with the biomass estimated from the 1987 survey, and speculated that one reason might be a migration of adult herring between VIa(N) and the North Sea. In 1991 the survey period was changed to July, both to avoid disruption by poor weather and to allow concurrent estimates of stock size in the North Sea and VIa(N).

The acoustic survey was carried out by FRV "Clupea" from 13 - 26 July and covered the area between 56°N and 60°N and between 04°W and 10°W. Echotraces were allocated to the categories "definitely herring", "probably herring" and "other fish species", but fishing operations were unsuccessful in providing samples to confirm these. In the absence of trawl samples, herring biomass was calculated using length composition and weight relationships obtained from the trawl samples taken by FRV "Scotia" south west of Orkney in the same month during the acoustic survey of the North Sea (Simmonds *et al.*, Working Document 1992).

Clearly the biomass estimates must be treated with caution. First, the allocations of echotraces to species were not verified. Secondly, the length distributions in VIa(N) may have differed from those in Orkney/Shetland, generating errors in the estimates of mean target strength. Length - weight relationships may also have differed between the areas, though this is unlikely to be a major source of error. Estimates of age composition would be even more tentative. They are used only to subtract the estimated biomass of 1-ringers and immature 2-ringers in order to estimate the spawning stock biomass (SSB).

The total biomass estimate from the "Clupea" survey is 475,000 tonnes, of which 80% were in the "definitely herring" category and 20% in the "probably herring" category. Combining the results with the FRV "Scotia" survey in the area of overlap, the total biomass estimate in Division VIa(N) is 517,000 tonnes and the SSB estimate is 446,000 tonnes.

The series of survey estimates of biomass are given in the following table:

| Year | Month | Estimated SSB (t) |
|---|---|---|
| 1985 | November | 225,000 |
| 1986 | November | 297,000 |
| 1987 | November | 364,000 |
| 1988 | December | 326,000 |
| 1990 | January | No estimate |
| 1991 | July | 446,000 |

These are estimates of biomass at the time of the survey. The November surveys can be considered estimates of SSB at spawning time, but for the July survey an adjustment must be made. This was done by assuming an annual natural mortality rate of 0.1 over the period 1 August - 1 October and subtracting the catch over the same period, assumed to be two thirds of the catch in the third quarter. For simplicity the catch was assumed to have been taken in the middle of the period 1 August - 1 October. The final acoustic estimate of SSB at spawning time in 1991 is 417,000 tonnes.

### 5.1.6 Recruitment

For the reasons stated in Section 5.1.5, the acoustic survey results cannot be used to provide estimates of recruitment. As was the case for last year's assessment, the only information available on recruitment is the index based on the mean catch rate of 2-ringers in statistical rectangles 46E4-E6, 47E4-E6, 44E3-E4 and 45E3-E4 during the bottom trawl survey carried out by Scotland in March each year.

The 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 - 1990. This relationship is poor and can be used only to provide an indication of very good recruitment.

### 5.1.7 Mean weight at age

Weight at age data from the 1991 fishery were available from Scotland and the Netherlands and are shown in Table 5.1.6. The mean weights at age in the stock, also shown in Table 5.1.6., are those used in previous years.

### 5.1.8 Description of the assessment method

Last year, the tuning procedure used the relation between VPA estimates of SSB and the two series of larvae indices to predict SSB for the most recent 3 years using the RCRTINX2 program.

This procedure was repeated this year. The series of LPEs and LAIs from 1973 to 1987 were regressed with estimates of SSB from last year's assessment using the RCT3 program, and the LPEs and LAIs for 1988 - 1991 were used to predict weighted average predictions of SSB from 1988 - 1991.

Individual plots of LAI and LPE against SSB are shown in Figures 5.1.2 and 5.1.3. The fitted lines are based on the regressions calculated by RCT3. The outlying LPE point for 1986 is likely to be because the long term mean Z/K value was not appropriate for that year, the rate of transport of larvae from Division VIa(north) to the North Sea being very variable. This point was included in the analysis, but does not seem to unduly affect the regression over the range of values more commonly observed.

The series of acoustic survey estimates were not included in the RCT3 analysis because the estimates are too recent to establish any relationship with the converged part of the VPA. In any case the LPE and LAI indices are not independent, so that the larvae surveys would be implicitly given extra weight if included with the acoustic series. Instead, the acoustic survey estimates of SSB in 1987 and 1991 were used directly. The other acoustic surveys were considered to have been too disrupted by poor weather to provide useful estimates and were rejected. A disadvantage of this approach is that the acoustic estimates are treated as absolute estimates of SSB without any verification by comparison with a converged VPA.

The input F chosen for 1991 was the one which minimised the sum of squared residuals between the survey estimates of SSB and those derived from the VPA for 1987 - 1991. Two methods were compared. The first method was identical to that used for last year's assessment and used only the estimates of SSB from the larvae surveys, with the residuals weighted by the squared standard errors of the predicted SSBs from RCT3. The second method used the SSB estimates from both the larvae surveys and acoustic surveys. However, the standard errors of the acoustic survey estimates of SSB are unknown, so the unweighted residuals were used to calculate the sum of squares.

As stated in Section 5.1.2, catches by the Faroese fishery in area V were significant in 1990 and 1991. Since these may be fish belonging to the VIa(north) stock, the above tuning procedures were carried out using catch in number data both including and excluding these catches.

### 5.1.9 Results of the assessment

Separable VPAs were run to examine the catch data with all years prior to 1986 downweighted to 0.001. With a reference age of 3, SVPAs were run with terminal S values of 0.8, 1.0 and 1.2. Each case produced a dip in the exploitation pattern at age 7. From an examination of

the residuals from the SVPA (Table 5.1.7) this seems to be due to the anomalous catches of the 1978 year class (as 7 ringers) in 1986 and (as 8 ringers) in 1987, and of the 1979 year class in 1987 and 1988 (Table 5.1.3). This may indicate a problem in ageing the fish, particularly as similar anomalies are evident in some of the earlier years. The SVPA with a terminal S of 1 was accepted.

The results of the RCT3 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 for all the estimates of SSB. The SSB estimates used in the tuning procedure are summarised in the text table below:

| Year | 1991 VPA | Pred. SSB | SE | Acoust.SSB |
|---|---|---|---|---|
| 1987 | 219 | - | - | 364 |
| 1988 | 354 | 323 | .49 | - |
| 1989 | 350 | 292 | .43 | - |
| 1990 | 361 | 285 | .43 | - |
| 1991 | - | 284 | .39 | 417 |

Separable VPAs were run over a range of terminal fishing mortalities. In each case the fishing mortalities based on the terminal populations were used to run a series of VPAs. The weighted sum of squared residuals between the SSBs estimated by the VPA and those predicted using RCT3 was minimised at F=0.25. The unweighted sum of squares using the SSB estimates from both RCT3 and the acoustic surveys was minimised at F = 0.20. The behaviour of both types of sum over the range of fishing mortalities 0.17 - 0.30 is shown in Figure 5.1.4.

Including the Faroese catches in area V in 1990 and 1991, the residuals were minimised at F = 0.34 using only the larvae surveys and at F = 0.27 using both the larvae and acoustic surveys.

The trends in SSB using the fishing mortalities in 1991 estimated by each of the tuning methods on each set of catch data are shown in figure 5.1.5. The effect of including or excluding the acoustic survey estimates of SSB in 1987 and 1991 on the VPA estimates of SSB in the most recent years is much greater than the effect of including or excluding the Faroese catches in 1990 and 1991.

Although all the tuning options suggest that stock size may be decreasing, this is simply a consequence of using the same tuning information and should not therefore be taken as evidence of a reliable result. The larvae indices are thought to be of poor quality because of the very large reduction in sampling effort, and the acoustic survey estimate in 1991 is thought to be unreliable because of the failure of trawling operations during the cruise. The identity of the Faroese catches seems to be of relatively minor importance.

Detailed results of the assessment are given in Tables 5.1.9 - 5.1.11 and in Figures 5.1.6A and B. These are arbitrarily based on a terminal F of 0.20 and catches which exclude the Faroese catches in area V.

### 5.1.10 Projection

The parameters used in the projections are given in Table 5.1.12. From the yield per recruit calculations $F_{0.1}$ was estimated at 0.15. From the plot of stock and recruitment (Figure 5.1.7), $F_{med}$ was estimated at 0.38.

In view of the uncertainties in the assessment, projections have been made only for 1993, assuming status quo fishing mortalities ($F_{sq}$)over a range of possible stock sizes in 1991. The status quo fishing mortalities were defined as the mean fishing mortality of 3- to 6-ringers ($F_{3-6}$) over the years 1989 -1991. Recruitment was assumed to be the geometric mean of 2-ringer abundance over the years 1980 - 1989. As in previous years 1-ringers were excluded from the projection. This is because 1-ringers are partly exploited in the North Sea, so the catches do not reflect year class strength.

Assuming that the agreed TAC of 62,000 t would be taken in 1992, the catches in 1993 corresponding to the status quo fishing mortalities are summarised in the text table below.

| 1991 | | | 1992 | | | 1993 | | |
|---|---|---|---|---|---|---|---|---|
| Terminal F | SSB | $F_{3-6}$ | SSB | $F_{3-6}$ | Catch | $F_{sq}$ | SSB | Catch |
| 0.20 | 295 | .201 | 328 | .225 | 62 | .200 | 322 | 54 |
| 0.25 | 234 | .260 | 269 | .270 | 62 | .241 | 266 | 54 |
| 0.27 | 284 | .279 | 314 | .232 | 62 | .229 | 307 | 58 |
| 0.34 | 222 | .352 | 253 | .288 | 62 | .277 | 249 | 57 |

Note that the VPA runs with F in 1991 of 0.27 and 0.34 were carried out using the catch in number raised by the Faroese landings in Area V, but the assumed catches in 1992 do not include any estimate of catches in Area V.

Regardless of the tuning procedure adopted, the catches corresponding to the status quo fishing mortalities are within the range 54 - 58 thousand tonnes. However, this assumes average recruitment for the years 1991 - 1993 even though there is some evidence from the bottom trawl index, albeit rather weak, that recruitment in 1991 may be below average (Section 5.1.6).

A detailed output assuming the TAC will be taken in 1992 and $F_{sq}$ in 1993 is shown in Table 5.1.13.

### 5.1.11 Management considerations

The assessment carried out by the Working Group in 1991 suggested that the stock size was increasing. This year's assessment suggests that the stock size is decreasing. This reflects the deterioration in the quality of the fishery independent information used to tune the assessment. Despite these limitations, the available evidence suggests that the stock is not in any immediate danger if current catch levels are maintained.

### 5.1.12 Research and data requirements

Although there is no immediate cause for concern, the substantial revisions to the estimates of stock size, and even to trends in stock size, in successive assessments emphasise the need for improved fishery independent information. The larvae surveys have performed well when sampling effort was adequate and they should be continued. Despite the problems encountered during the acoustic survey in VIa(north) in 1991, the acoustic surveys in July can potentially provide valuable estimates of biomass in VIa(north) at the same time as in the North Sea, as well as providing an estimate of recruitment as 2-ringers.

## 5.2 Clyde Herring

### 5.2.1 Advice and management applicable to 1991 and 1992

The herring exploited in the Firth of Clyde consist of a mixture of stocks: the indigenous spring-spawning stock which spawns on two known spawning grounds in March-April; immigrant autumn-spawning herring from adjacent areas (Divisions VIaS+ VIIb,c; Division VIIa; Division VIa N) which do not spawn in the Clyde. During certain parts of the year, the spring and autumn-spawning stocks cannot be reliably distinguished on the available biological criteria and the assessment and management of Clyde herring is therefore based on the spring and autumn-spawning stocks combined. The TAC given by ACFM thus relates to the combined stocks. ACFM recommended a TAC of 2,900 t for 1991 and this was adopted by the management body. Directed fisheries for herring were closed from 1 January-15 April with an allowance of 200 t within the closure period.

For 1992 ACFM gave a range of options from 1,600-2,700 t and indicated a preference for a TAC of 1,600 t based on *status quo* fishing mortality. The management body adopted a TAC of 2,300 t and extended the closure period up to 30 April in line with advice from ACFM. Once again, there was an allowance of 200 t within the closure period.

As an additional measure under national legislation, the spawning grounds at Ballantrae Bank were 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 1991

Landings in 1991 decreased to their lowest recorded level (Table 5.2.1). The total landings are estimated to be 731 t. There were no reports of discarding in 1991. Of the total landings, 474 t were taken by pair trawlers in a directed herring fishery from July-December, and 239 t as by-catch in demersal trawl fisheries in all months except May and June.

Monthly samples were taken mostly from the demersal trawl by-catches (Table 5.2.2). Assuming that there was no discarding in 1991, the catches in number at age of spring- and autumn-spawners combined over the period 1970-1991 are given in Table 5.2.3. Five ring herring were the most abundant age group in the landings, making up 46%. The contribution of this year class, however, was 69% in 1989 and 65% in 1990. Estimated numbers in each 1/2 cm length group are given for 1988-1991 in Table 5.2.4.

The number of days absence from port by pair trawlers is given in Table 5.2.5. An index of total effort directed at herring was obtained by raising the days absence by pair trawlers by the ratio of total to pair trawl landings. Effort decreased to its lowest recorded level in 1991.

### 5.2.3 Weight at age and stock composition

Weights at age in the catch are given in Table 5.2.6. They were unusually low for all age groups in 1991 and this may have been partly due to a low condition factor.

The mean weights at age in the stock given in last year's report were assumed to be the same as the weights in the catch. In this report the stock mean weights at age refer only to the indigenous spring-spawning stock at spawning time (March). However, the weights in the catch in March 1991 are not appropriate because the samples contained a proportion of fish at maturity stage VIII (i.e. recovering spents). The mean weights in the stock given in Table 5.2.6 are those for February, in which month the samples contained almost entirely fish at stages IV, V and VI. For comparison, mean weights are also given for a research vessel sample taken on the spawning grounds in March 1991. However, this sample contained very small numbers of age groups other than 5-ringers, so the mean weights of other age groups in this sample are very poorly estimated.

Monthly maturity data for 1991 are given in Table 5.2.7. Using the race/maturity key given in Table 5.2.8, the percentages of spring spawners in the catches in each month are given in Table 5.2.9. While spring spawners predominated in January and February, the percentages are much less certain for the rest of the year, largely because of the uncertainties about the racial identity of some maturity stages in some months. Overall, however, the analysis indicates that spring spawners predominated in most months, with spring spawners constituting somewhere between 54.5 and 93.0% over all months combined.

Further quantitative information on the racial composition of the landings can be obtained from the monthly age compositions (Table 5.2.9). In February, when fish at maturity stages IV-VI (i.e. spring spawners) made up 95% of the catch in number, 5-ringers made up 93% of the catch of 3-ringers and older. Research vessel samples taken on the spawning grounds in March, moreover, contained 90.5-95.5% of this age group (Gibb, working document). Over the period March-December this age group contributed 53% to the catches in number. This implies that the mean percentage of spring spawners in the catches was considerably less than in February. The percentage of spring spawners cannot be reliably calculated using age data alone, however, because the origin of the autumn spawners in the Clyde is not known. The age composition in the Clyde catches in 1991 is compared with that in adjacent stocks in Table 5.2.10. From this it is clear that 5-ringers (the 1985 year class of autumn spawners) were also predominant in Divisions VIa S and VIIb,c and prominent in Divisions VIa N and VIIa. The decrease in percentage of 5-ringers in the Clyde catches could thus be due to a wide range of alternative possibilities.

To provide a very rough estimate of the number of spring spawners caught in 1991 it has been assumed that the decrease in percentage contribution of 5-ringers between February and the rest of the year is entirely due to dilution by a stock with equal number of each age group. By comparison with the contribution of this year class in February, the mean proportion of spring spawners in the catches is estimated to be 0.53/0.93 = 0.58. For the reasons given above, this may be an overestimate of the true proportions. However, the maturity data suggest that the proportion of spring spawners cannot have been very much less than 55%.

### 5.2.4 Surveys

No further acoustic surveys of Clyde herring were carried out in 1991.

Grab surveys of the two known spawning grounds (Ballantrae Bank and Brown Head (South Arran)) were carried out over the period 8-26 April 1991. From the development stages of eggs sampled spawning was estimated to have started around 3 April at Ballantrae Bank and around 10 April at Brown Head. Length and age compositions of herring sampled in both areas are given in Table 5.2.11. As in 1990, the 1986 year class predominated in both areas and there was no evidence of any significant recruitment to the spawning population since that of the 1986 year class.

From the areas covered by the egg mats and the mean number of eggs per $m^2$, the estimated numbers of eggs spawned in each area were:

362 (+/-14) x $10^9$ at Ballantrae Bank
490 (+/-32) x $10^9$ at Brown Head

Total = 852 x $10^9$ in both areas combined.

Using length-weighted fecundities obtained in September-December 1989 and a weight/length relationship obtained in March 1991, and assuming a 1:1 sex ratio, the spawning biomass in 1991 is estimated to have been: 2984 t at Ballantrae Bank, 3976 t at Brown Head and 6,960 t for both areas combined. This compares with an estimate of 6,730 t in 1990. Estimated numbers at age in 1990 and 1991 are given in Table 5.2.12. The total number of spawners in 1991 is estimated to have been 32.3 million, which compares with 39.9 million in 1990.

Since the egg survey estimates take no account of egg predation and since spawning in other parts of the Clyde, and at other times of the spring, cannot be ruled out, these estimates are likely to be conservative. However, from the historic distribution of spawning in the Clyde, it is not thought likely that there is major spawning other than at Ballantrae Bank and Brown Head. The presence of stage VI fish in commercial samples in February and March (Table 5.2.7) indicates that some spawning occurred prior to the egg survey, but the amount of this appears to be small in relation to spawning in April when the egg surveys were carried out.

### 5.2.5 Stock assessment

The egg survey estimates have been used to provide a stock size in number for the spring-spawning stock at 1 April 1991 (Table 5.2.13). Accurate estimates of the catch in number of this stock are not available. However, assuming that the catch in number of spring spawners was 58% of the total catch in numbers (see Section 5.2.3), the catch in number at age can be estimated very approximately by allocating the total by the age composition in the spawning area at spawning time. Using values of M of 0.15 for age 3 and 0.075 for older herring and catches for the period April-December, fishing mortalities and the numbers at age surviving at 1 January 1992 are given in Table 5.2.13. In confirmation

of the predicted age composition in 1992 a single sample taken on the spawning grounds in March 1992 contained predominantly fish around 28-29 cm. The age composition of this sample is not yet available, but from the length composition it clearly contained a negligible proportion of recruiting 3-ringers. The number of 3-ringers in 1992 has therefore been assumed to be the same as in 1991, i.e. 250 thousand.

On the basis of this assessment, the spawning stock is estimated to be about 6,000 t at 1 January 1992, and the fishing mortality to be about 0.064 in 1991.

### 5.2.6 Stock and catch projections

The estimated stock size of spring spawners at 1 January 1992 is given in Table 5.2.14. These estimates are very uncertain, and there is no firm basis on which to predict the catches of this stock in 1992. The Working Group has therefore made no catch prediction for 1993. However, the stock is at present composed almost entirely of the 1986 year class and there appears to have been no significant recruitment in 1992. Stock projections have therefore been carried out to indicate the expected decrease in spawning stock at different levels of fishing mortality. These are given in the text table below:

| Year | $F=0$ | $F=F_{1991}=0.064$ | $F=0.15\approx F_{1990}$[1] |
|---|---|---|---|
| | SSB | SSB | SSB |
| 1992 | 5,800 | 5,800 | 5,800 |
| 1993 | 5,850 | 5,490 | 5,040 |
| 1994 | 5,360 | 4,720 | 3,980 |
| 1995 | 4,900 | 4,060 | 3,150 |

[1]1991 ACFM report gives 0.16.

This shows the predicted changes in catch and spawning stock size if recruitment continues at its recent low level. In all scenarios, including a total ban on fishing, the stock is expected to decrease, the rate depending on the level of fishing mortality.

Prediction of the catch of autumn spawners in the Clyde in 1992 is problematic. These fish belong to a mixture of stocks from other areas, autumn spawning in the Clyde is negligible and the level of immigration probably varies considerably from year to year.

In the last few years, the percentage contribution of autumn spawners in the total catch in number has been very approximately estimated by previous working groups to be:

| | | |
|---|---|---|
| 1988 | ca 50% | |
| 1989 | 27% | |
| 1990 | 25-40% | |
| 1991 | 7-45% | (42% assumed). |

### 5.2.7 Management considerations

In the historic past the herring stocks in the Clyde were much larger and supported an annual catch averaging 8,000 t from 1955-1974. The prospects for a recovery to these levels are not known. However, recent recruitment to the spring-spawning stock has been at a very low level and good year classes have been both infrequent and unpredictable. Studies on the spawning grounds have shown that survival of eggs has been low as a result of disturbance of the spawn and substrate by storms (Morrison *et al.*, 1990) and, in one case, as a result of mass mortality caused by settlement of floc from decaying diatom blooms on the spawn beds (Morrison *et al.*, 1991). It thus appears that the timing of spawning may be critical to egg survival. However, if an improvement in the conditions for egg and larval survival occurs, then the chances of recovery based on better recruitment may depend on the spawning by the surviving members of the 1986 year class.If the recent poor recruitment continues, then it is clear that the stock will decline, and that the rate of decline will depend on the fishing mortality.

In recent years the fishery has been dependent on a mixture of both spring and autumn spawners. There is no basis on which to estimate the catch of autumn spawners in 1993.

In addition to controls on catch, some protection of the spring spawning stock can be achieved by restricting directed herring fishing in the Clyde during the period 1 January-30 April when spring spawners assemble for spawning. Closure of the spawning grounds themselves to all active forms of fishing also provides protection to the beds of spawn and to the spawning shoals.

### 5.2.8 Future research requirements

If the management of the Clyde herring fishery is to be put on a firmer basis it is necessary to have:

1. Fishery independent surveys of the spring-spawning stock and if possible the total exploitable stock each year. The egg surveys in the last two years have given fairly precise estimates of the population spawning on the two main spawning grounds, and it would seem appropriate to maintain these.

2. Research into stock separation of herring in the catches. This would make it possible to assess and predict the spring- and autumn-spawning components independently. In this connection, examination of the

daily growth ring structure of the otoliths may be worth investigating as pointed out in the Report of the Workshop on Methods Forecasting herring catches in Division IIIa and the North Sea (*Anon.*, 1992 ).

# 6 HERRING IN DIVISIONS VIA (SOUTH) AND VIIb,c

## 6.1 The Fishery

### 6.1.1 Advice and management applicable in 1991

The TAC set for this area for 1991 was 27,500 t which was the same as for 1990. The total catch estimated to have been taken in 1991 was about 37,600 t which was 6,400 t (14%) less than in 1990. This total catch was, as it has been every year since 1982, considerably higher than the recommended level. In general, the agreed TACs for this fishery in recent years have been in close agreement with the recommended figures.

The main catches attributable to any nation was again taken by Ireland. The catches taken by the Irish fleet were regulated by weekly boat quotas and no fishing was permitted from mid-June to 1 August. Over 11,000 t were placed in the "unallocated" category and, as in recent years, considerable quantities of herring (estimated to be over 8,400 t) were believed to have been taken in Division VIa (South) but were reported as having been taken in Division VIa (North). These catches have been included in the catches in numbers at age for Division VIa (south) and Division VIIb,c.

### 6.1.2 Catch data

The catches taken by each country fishing in this area from 1982-1990 are shown in Table 6.1.1, together with the preliminary figures for 1991. It has not been found necessary to make any revision to the 1990 catch data. Estimates of herring caught but discarded at sea have been included for 1991 but are only available for the Dutch Fleet. The quantities of herring discarded by the Irish Fleet are not known but are believed to be small.

The location and distribution of the main fisheries, both by the Irish and Dutch fleets, were similar to those of recent years. The landings from the "roe" fishery which was developed in 1990 by the Irish Fleet were not as substantial during 1991 as in the previous year - mainly because of a poor demand on the Japanese market. The fishery for spawning (stage VI) herring, however, extended well into December and it appeared that spawning may have been spread out over a longer period than usual. The distribution of the Irish and Netherlands catches per quarter together with the unallocated catches are shown in Figure 4.2.1a-d. The composition and fishing pattern of the Irish fleet has remained very stable in recent years and the fishery in general has been considerably restricted by lack of markets.

### 6.1.3 Catches in numbers at age

The catches in numbers at age for this fishery since 1970 are shown in Table 6.1.2. No revisions have been 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 quarter. The age compositions of both the Irish and Dutch catches were dominated by the 1985 year class, which constituted over 44% of the total number caught. This year class has been well represented in all areas throughout the year and is also a feature of the catches from Divisions VIa (North) and Division VIIj. The 1986 year class (5.5%) appears to have been a comparatively weak one, but the 1987 and 1988 year classes both appear to be well represented. In general, the age composition of the catches would appear to represent a stock which is in a healthy state.

### 6.1.4 Quality of catch and biological data

Although there are considerable quantities of unallocated and misreported catches, there appears to be reasonable confidence in the overall estimate for the total landing figure. The total amounts of discards is not known but is not believed to be significant. The level of biological sampling from the area appears to be satisfactory, although no samples were obtained from the Irish catches taken during December 1991 when over 6,000 t were landed. The number of samples and biological data are shown in Table 6.1.3 and the length distributions of the catches taken by the Irish fleet per quarter are shown in Table 6.1.4.

## 6.2 Mean Weights at Age

The mean weights (g) at age in the catches are based on a combination of Irish and Dutch data and are shown below compared with those for 1989 and 1990:

| Year | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1988 | - | 88 | 133 | 153 | 166 | 171 | 183 | 191 |
| 1989 | 80 | 130 | 141 | 164 | 174 | 183 | 192 | 193 |
| 1990 | 94 | 138 | 148 | 160 | 176 | 189 | 194 | 208 |
| 1991 | 89 | 134 | 145 | 157 | 167 | 185 | 199 | 207 |

There appears to have been little change in the mean weights in recent years and the 1991 values have been used to update the VPA data set.

The mean weights for the stock at spawning time are based on Irish samples taken from the fishery for spawning fish during September to November. As has previously been pointed out (*Anon.*, 1991), the mean weights at spawning time calculated for 1989 had shown a sudden decrease of approximately 20% on the values for the previous year. The values obtained for 1991, which are shown below together with those from 1988 - 1990 are very consistent with those obtained for 1989 and 1990. There does not yet appear to be any satisfactory explanation for the sudden decrease which occurred between 1988 and 1989.

| Year | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 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 |
| 1991 | 149 | 174 | 190 | 195 | 206 | 226 | 236 | 249 |

### 6.3 Larval Surveys

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

### 6.4 Young Fish Surveys

Young fish surveys were carried out in Divisions VIa(S) and VIIb from 1981-1988. No surveys were carried out during 1989, but the series was resumed in 1990 and continued in 1991. The original surveys, which were designed to obtain an index of recruitment for herring and mackerel, have been extended to provide an index for abundance for demersal fish. The results from the surveys have been very difficult to analyze, mainly because they have been carried out by a number of commercial vessels using a variety of gears. The 1991 survey was, however, carried out by the R/V "Lough Foyle" using a rock hopper trawl with a small mesh cod-end liner. 27 stations were fished before bad weather brought a premature end to the survey.

A comparison of the results based on the average catches from a small number of standard herring stations is shown in Table 6.5.1. The results have been compared with the number of recruits from VPAs but do not appear to give any indication for recruitment patterns - although the strong 1985 year class did show up as high numbers of 1-winter-ring fish in 1987.

Nevertheless, it is felt that these surveys should be continued because it is now likely that future surveys will be carried out using the R/V "Lough Foyle" and with standardized gear.

### 6.5 Results from Tagging Experiments

The results of the tagging experiment have been presented in a Working Document (Molloy, 1992b). Even though some further recoveries may yet be made the majority of the tags recovered to-date were from the extreme south of Division VIa and extreme north of Division VIIb. A small number of tags were recovered from the southern part of Division VIIb while a further small number were recovered from the northern part of Division VIIj. The results so far would, therefore, indicate some movement of fish in a southerly direction and a certain degree of mixture between herring from Divisions VIa (south), VIIb and VIIj. However, it is not yet possible to decide to what extent this mixing should be taken into consideration when the assessments of the relevant populations are made.

### 6.6 Stock Assessment

In the absence of any fishery-independent data, recent working groups have been unable to carry out any analytical assessment of this stock. The 1991 Working Group did, however, carry out a VPA in order to study historical trends during the period in which convergence had occurred. The VPA was also used to obtain some indication of F for different levels of catches. It was suggested that the F level during the last period when it could be estimated with any confidence (i.e., the 1985-1986 period) was around 0.2. At that time the SSB appeared to be around 177,000 t. The Working Group was unable to determine with any degree of confidence how the stock had developed since then, although it was assumed that the SSB level in 1991 may have been around the average level of that between 1980-1986, i.e., around 133,000 t.

The present Working Group has no additional data on which to make any further assessment of the stock. A VPA was carried out to update the historical data but has not been included in the report. Apart from the age distribution of the catches, which indicate that the stock is in a healthy state, there is no other information to indicate how the stock has developed in recent years.

### 6.7 Management Considerations

In 1991 ACFM did not consider that there were sufficient data available on which to make an assessment on this stock. Predictions were, therefore, not carried out. Instead, ACFM recommended that the catch levels for 1992 should be stabilized at the average level of catches taken during 1988 and 1989, i.e., about 29,000 t. It was decided that the high catches taken during 1990 (43,000 t) should not be included because this high catch had been the result of a rapid development of a "roe" fishery.

The present Working Group is faced with the same situation as that of last year and is, therefore, unable to carry out any meaningful assessment. However, the available biological information (e.g., age compositions) would suggest that the stock is in a healthy condition and reports from fishermen indicate substantial concentrations in the area in recent years.

According to the categories defined by ACFM in November 1991, the stock could be classified as 3B, i.e., one in which the state of exploitation cannot be precisely assessed. It is, therefore, difficult to formulate any management advice based on the state of the stock. A VPA carried out to obtain some information on the historical development of the stock suggested that the spawning stock from 1981-1987 averaged around 132,000 t. The development of the stock since then is not known but presumably it increased in 1988 because of the recruitment of the very strong 1985 year class.

The Working Group has previously drawn attention to the high catching power of the fleet in this area and also the potential for a roe fishery if market conditions improve. In these conditions and in the absence of adequate biological data on current stock size and recruitment, the Working Group would suggest that the TAC should be stabilized at the level recommended by ACFM in 1991, i.e., 29,000 t.

### 6.8 Future Research Requirements

The Working Group would again express their concern about the lack of data on the stock in this area. It is imperative, if assessments are required, that adequate fishery-independent surveys on the adult stock and on recruitment strengths are available.

## 7 IRISH SEA HERRING (DIVISION VIIA, NORTH)

### 7.1 The Fishery

#### 7.1.1 Advice and management applicable to 1991

The 1990 assessment, based on analysis of data up to 1989, indicated that the SSB of the combined Manx and Mourne stocks would show a small decrease in 1991 if catches were held at approximately 7,000 t. ACFM recommended a TAC of 5,600 t to reduce fishing mortality by 20 percent, and the EC subsequently adopted a TAC of 6,000 t for the 1991 fishing season. This was partitioned as 1,560 t to the Republic of Ireland and 4,400 t to the UK. The quotas were partitioned as follows: Anglo-North Irish Fish Producers Organisation (ANIFPO) 828 t; Northern Ireland Fish Producers Organisation (NIFPO) 2,316 t; Scottish Fishermen's Organisation (SFO) 190 t; Fish Producers' Organisation (FPO) 420 t. In addition 237 t were allocated to the non-sectoral industry and 449 t to the Mourne skiff (gill net) fishery. Of the non-sectoral allocation 201 t appears to have been transferred to FPO. The spawning closures were retained for this year.

The UK fishery opened in the third week of June. The closed area to the east of the Isle of Man (encompassing the Douglas Bank spawning ground) closed on the 21st September until the end of the year. The Mourne shore fishery (skiff fishery) opened on 2nd September and closed on 15th October. 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 1991

The catches reported from each country fishing for herring in Division VIIa (North) from 1980-1991 are given in Table 7.1.1. The reported landings make no allowance for under-reporting, discards or slippage. The total catch of 4,398 t in 1991 was below the TAC of 6,000 t agreed by the EC for Division VIIa (North), because the Republic of Ireland took only 5% of their quota. The reason was given as a lack of fish in the area at the beginning of August resulting in vessels moving elsewhere. The vessels did not return later in the year when herring were apparently more available. The extent of discarding throughout this fishery is still unknown.

The fishery remained open through December but the non-sector fishery was closed in September. The majority of landings in 1991 were in the third quarter (81%) which is the normal pattern for this fishery. Approximately 16% of the landings were in the fourth quarter, a lower figure than in the previous year. In 1991 approximately 9% of the landings were to offshore vessels. The catch taken prior to spawning was 3,671 t in 1991 compared with 4,645 t in 1990. The distribution of catches by quarter of the UK, Northern Irish and Republic of Ireland fleets are shown in Figure 4.2.1a-d.

#### 7.1.3 Quality of catch and biological data

One incidence of over-reporting was recognised in 1991 and corrected at source. Under-reporting is suspected to have been high in some years, and there are still no estimates of quantities of herring discarded. There is good biological sampling of landings from this fishery (Table 7.1.2), and in 1991 there was one sample per 32 t landed and one fish aged per 7,000 fish landed. The absence of samples from 1st quarter landings, 2nd quarter landings into Northern Ireland and landings to offshore vessels in quarters 3 and 4 will have had relatively little effect on the accuracy of the estimated length- and age-compositions of the overall landings.

### 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 1991. In 1991 the dominant groups were the 2,3 and 5 ringers (year classes produced in the autumns of 1988, 1987 and 1985). The above-average 1985 year class was still prominent in the catches. The catch in numbers at length is given in Table 7.1.4 for the years 1988 to 1991. The modal length was at 26 cm which is consistent with the presence of the strong 1985 year class. Over the period 1988 to 1991 large herring of 30 cm and greater have become more poorly represented in the catches, possibly as a consequence of the presence of the strong 1985 year class or of an overall decline in growth rate.

## 7.2 Mean Length, Weight, and Maturity at age

Mean lengths at age were calculated for the third quarter using the data from Northern Ireland and are given in Table 7.2.1 for the years 1985 to 1991. In general, mean length at age have remained fairly stable except for 5-ring and older herring, for which there has been a decline in mean length since 1985.

Mean weight at age in the stock is given in Table 7.2.2 for the years 1976-83 and 1984 to 1991. The mean weight at age is lower in 1991 than any previous year for all age classes above 1-ringers. There is a general trend of decreasing weight at age. Mean weight at age for the years 1989 and 1990 were modified in the WEST (weight at age in the stock) files to represent estimates from commercial catch data in the third quarter rather than estimates from research surveys, in order to maintain consistency with previous data. It is recognised that the mean weights of 1-ringers in the stock computed from commercial data may not reflect the true mean weight of this group.

The maturity ogive, expressed as a proportion of the sampled population at stage 3+ appears to have remained stable over the last few years and the 1991 ogive is similar to the one used previously. Therefore, the ogive used in 1989 and 1990 was adopted again (0.08 for 1-ringers, 0.85 for 2-ringers and 1.00 for 3+-ringers).

## 7.3 Research Surveys

### 7.3.1 Acoustic surveys

The acoustic survey of the spawning stock of Manx herring in September, which provided SSB estimates of 18,000 t in September 1989 and 27,000 t in 1990, could not be carried out in 1991 because of a change-over of research vessels at Port Erin Marine Laboratory. An attempt to survey the spawning grounds of the Mourne stock in October 1991 (Armstrong, 1992a, Working Document) resulted in a failure to detect any adult herring. An area of known herring concentration could not be surveyed because of the presence of a fleet of gillnetters over the fish.

An acoustic survey of the mixed stocks of herring in the northern Irish Sea was carried out from 26 July to 8 August 1991 on board R.V. "Lough Foyle" (Armstrong, 1992a, Working Document). An initial, exploratory, survey of this nature had been carried out in August 1990. A towed 38 kHz transducer was employed, and acoustic data were processed by means of the HADAS echo-integration software (Lindem Associates). The survey grid and the distribution of detected herring are shown in Figure 7.3.1. Although insufficient time was available to survey the region east of the Isle of Man, it was expected that the majority of the Manx stock would be present to the west and south of the Isle of Man, as known within the fishery and observed during the 1990 survey. A total of 16 trawl hauls provided data for estimation of species compositions, length- and age-frequencies, and target strengths.

The total biomass of herring was estimated to be 17,800 t, of which 10,300 t comprised potential spawners according to the maturity ogive adopted by the Working Group. The estimate for the total stock occurring in the inshore strata along the Irish Coast was 6,900 t, whilst the estimate for the Manx coast was 10,300 t. The bulk of the estimate for the Irish Coast was attributable to herring-like targets for which the species composition could not be verified.

These estimates of total biomass of herring are within the range of approximately 10,000 - 30,000 t (depending on assumptions regarding target identification) estimated during the August 1990 survey. Errors in allocation of species compositions during the 1991 survey will have been greatest off the Irish Coast where sprats were abundant. The total biomass of sprats was estimated to be 66,000 t. A negative bias of unknown magnitude will be present in the estimate for herring because of incomplete coverage of the range of the Manx and Mourne stocks, and because of the tendency for some herring to migrate into the acoustic dead-zone close to the seabed. Groundfish surveys conducted in June and September 1991 showed herring to be more widespread than shown in Figure 7.3.1, indicating a strong likelihood of non-detection of herring in some areas during the acoustic survey. Hence, the acoustic estimates are not expected to be comparable in an absolute sense with the VPA estimates.

### 7.3.2 Tagging studies

Approximately 10,000 herring were tagged off the west coast of the Isle of Man in 1991 (Molloy, 1992b, Working Document), as described in Section 4 of this report

(Celtic Sea and Division VIIj herring). Thirty percent of the tag returns comprised spawning 2-ring fish taken in the Celtic Sea fishery in the following December - February, supporting earlier suggestions that Division VIIa (North) is one of the nursery areas for Celtic Sea juvenile herring. The migration out of Division VIIa (North) appeared to take place in the fourth quarter of 1991, after the main period of the Division VIIa fishery. The results of VPA on numbers-at-age in the herring landings in Division VIIa (see Section 7.4) indicate that 1-ring and 2-ring herring experience 7% and 85% of the full rate of fishing mortality, respectively. Hence, the possibility that the Division VIIa fishery could inflict a significant fishing mortality on Celtic Sea 2-ringers warrants further investigation and possibly a re-evaluation of the basis for treating these stocks independently.

## 7.4 Stock Assessment

### 7.4.1 Estimation of fishing mortality and trends in abundance

The only data available for inclusion in an analytical assessment of Division VIIa (North) herring are from annual catches at age of the commercial fleet. No time-series of abundance indices were available to the Working Group for tuning the recent-year Fs, and the acoustic estimates of biomass that have been made are few in number and contain biases of unknown magnitude.

Data on the monthly proportion of landings of the Northern Ireland *Nephrops* trawl fleet that contained herring during the years 1982 to 1990 showed low values in 1982 and 1983 followed by a period of stable but larger values (Armstrong, 1992b, Working Document). This may reflect an increase in the spatial and temporal distribution of herring following the increase in abundance of adult fish in 1984 shown in *Anon.* (1991). The 70 mm diamond mesh employed by Northern Ireland *Nephrops* vessels would retain mostly adult herring. A very high proportion of landings in 1990 contained herring, although the average quantity of herring in each landing during the months July to December was a factor of ten lower than the mean for the years 1984 to 1989. These data, together with anecdotal information from the herring fleet of an increase in abundance of herring in recent years, indicate that the biomass of adult herring has either been comparatively stable, or has increased, since the mid-1980s.

The effect of choice of terminal fishing mortality on the estimated recent trend in abundance of Division VIIa (North) herring was explored by running a series of conventional VPAs, as carried out by the 1991 Working Group. Terminal fishing mortalities ($F_{(2-6)}$) for the different age-classes in the most recent year (1991) were obtained from initial runs of separable VPA. Values of input $F_{(2-6)}$ of 0.1, 0.15, 0.20 and 0.30 were tried. As at the previous Working Group, natural mortality was assumed to be 1.0 on 1-ringers, 0.3 on 2-ringers, 0.2 on 3-ringers and 0.1 on all older ages.

### 7.4.2 Exploitation pattern

The age class containing 3-ring herring was chosen as reference age for the exploitation pattern generated by separable VPA, and unweighted mean Fs were computed for age classes 2 - 6. This procedure differed from the one adopted by the 1991 Working Group, who chose 2-ring herring as reference age and averaged F over age classes 2 - 7. The output of separable VPA at a terminal F of 0.15 is shown in Table 7.4.1. Setting terminal selectivities at 1.0 generated a flat-topped selectivity curve for the most recent six years of data, with no anomalous values for any age classes. Although there was some tendency for a temporal trend in positive residuals associated with catches of the strong 1985 year class, the results of the separable VPA runs were accepted for initiation of conventional VPA.

### 7.4.3 Results of VPA

Trends in fishing mortality, landings, SSB and recruitment are shown in Figure 7.4.1 . The output for terminal $F_{(2-6)}$ of 0.15 is given in Tables 7.4.2 to 7.4.4. This run is illustrated as it is the most compatible with the output presented by the 1991 Working Group (*Anon.*, 1991), who anticipated that the mean F would be 0.21 in 1991 if the TAC of 6,000 t was taken in full. The predicted mean F for 1991 would have been closer to 0.15 for the catch that was eventually taken in that year.

Terminal $F_{(2-6)}$ values of 0.15 and 0.2 gave stable or slightly increasing estimates of SSB over the 1984 - 1991 period, whereas a terminal $F_{(2-6)}$ of 0.10 gave estimates of SSB increasing substantially over time (Figure 7.4.2). A terminal $F_{(2-6)}$ of 0.3 showed a downward trend in SSB that, together with very low absolute values of SSB, seems less plausible in view of the data from the commercial *Nephrops* fishery and from the acoustic surveys of the Manx spawning stock in 1989 and 1990. Recruitment in 1987 of 1-ring fish spawned in the autumn of 1985 was the strongest since 1977, whilst the recruitment in 1988 was the weakest in the time series commencing 1972.

## 7.5 Recruitment

There continue to be no independent time series of recruitment indices for this stock. Catch rates in groundfish surveys carried out by the Republic of Ireland and UK could not be obtained in time for evaluation at the meeting. Values of recruitment for use in stock predictions were computed as the geometric mean of VPA estimates for the years 1984 to 1990.

## 7.6 Stock and Catch projections

Evaluation of the most appropriate of the VPA results shown in Figure 7.4.2 can be guided only very loosely by the crude index of abundance obtained from the incidence of herring landings by Northern Irish *Nephrops* trawlers, and by the general levels of biomass estimated from the small number of acoustic surveys of the Manx spawning stock that have been carried out. Until suitable time series of abundance indices are available for this stock to allow objective estimation of current levels of fishing mortality, the Working Group is unable to provide any advice on TAC levels other than that based on *status quo* fishing mortalities ($F_{sq}$). The sensitivity of $F_{sq}$ catch predictions to the choice of terminal $F_{(2-6)}$ in the VPA was examined as described below.

Stock and catch projections were run for a range of terminal F values using the stock numbers at 1 January 1992 calculated from the appropriate VPAs and the smoothed selectivity patterns generated from the initial separable VPA runs (Table 7.6.1). Recruitment in each case was assumed to be the geometric mean (GM) numbers of 1-ring fish over the period 1984 - 1990. The very imprecise VPA estimates of numbers of 1-ringers at 1 January 1991 were discarded in favour of the GM estimates to improve the stability of the stock predictions. It was assumed that the catch in 1992 would be the agreed TAC of 7,000 t. The value of $F_{sq}$ for 1993 was taken as the mean of the $F_{(2-6)}$ estimates for 1989 and 1990. The value of $F_{(2-6)}$ for 1991 was considered inappropriate for inclusion in the mean because of the unusual withdrawal of the Republic of Ireland fleet from the herring fishery in that year.

The input data for the stock predictions are given in Table 7.6.1. An example of the predictions by age class is given in Table 7.6.2 for the option using VPA estimates from the run with terminal $F_{(2-6)} = 0.15$.

The results of the various options are summarized in the text table below.

| | 1992 | | | | 1993 | |
|---|---|---|---|---|---|---|
| $F_t$ (1991) | F | SSB | Catch | $F_{sq}$ | SSB | Catch |
| 0.10 | 0.144 | 42.3 | 7.0 | 0.148 | 43.2 | 7.4 |
| 0.15 | 0.220 | 26.8 | 7.0 | 0.205 | 27.2 | 6.6 |
| 0.20 | 0.300 | 19.1 | 7.0 | 0.253 | 19.4 | 5.9 |
| 0.30 | 0.466 | 11.4 | 7.0 | 0.333 | 11.8 | 4.9 |

(Weight in '000 t, SSB at spawning time, F's = means for 2-6 ring fish)

The results show the expected result that the $F_{sq}$ catches are much less sensitive to choice of terminal fishing mortality in the VPA than are the SSB estimates. In each case, a very slight increase in SSB is predicted for 1993. The 1993 catches for the options $1.2*F_{sq}$ and $0.8*F_{sq}$ (not shown in text table) are predicted to be 6,900 t and 4,800 t respectively for estimates of stock from VPA with terminal $F_{(2-6)}$ of 0.20. For most of the options examined, the fishing mortality in 1992 is expected to be greater than the mean value for 1989 and 1990 adopted as $F_{sq}$, if the TAC of 7,000 t is taken in full. In these cases a slight increase in the $F_{sq}$ catch in 1993 would be expected if the fishing mortality in 1992 is also *status quo*.

For completeness, SSB vs numbers of 1-ringers are given in Figure 7.4.3 for a terminal F of 0.15. The $F_{low}$ (0.26), $F_{med}$ (0.37) were estimated from this graph. The yield-per-recruit calculations estimated $F_{0.1}$ as 0.165.

## 7.7 Management Considerations

### 7.7.1 Recommended catch levels

The 1991 Working Group explored 1992 TAC options on the basis of predictions from VPAs that had been calibrated against the results of acoustic surveys of the Manx spawning stock. An $F_{sq}$ TAC of 6,600 t was estimated and was subsequently recommended by ACFM. The EC adopted a TAC of 7,000 t for 1992. This has been allocated as 1,820 t to the Republic of Ireland and 5,180 t to the UK. Spawning closures were retained for 1992.

Although the trend in biomass of herring in Division VIIa (North) is very poorly estimated, the information available to the 1992 Working Group has indicated that the stock is unlikely to have declined under recent levels of catch. The *status quo* catch for 1993 (i.e., the predicted catch if $F_{(2-6)}$ in 1993 is maintained at the average level recorded in 1989 and 1990) is in the range 6,000 t to 7,000 t. For the prediction based on VPA with terminal $F_{(2-6)}$ of 0.20, a catch of 7,000 t in 1993 would correspond to $1.2*F_{sq}$. This would result in a very slight reduction in SSB in 1993, whereas the $F_{sq}$ catches resulted in a slight increase in SSB in all cases examined. These predictions are based on an assumption of average recruitment in 1991, 1992 and 1993. It is emphasized that it is not possible to accurately assess the value of current fishing mortality relative to the standard reference $F_s$.

### 7.7.2 Spawning 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 the

Douglas Bank for the Manx stock), the spawning area closures should be maintained in 1993.

### 7.8 Research and Data Requirements

The Working Group expressed some concerns over the lack of samples taken from the landings to the offshore vessels and hopes this will be rectified. It continues to firmly support the acoustic surveys on the whole Division VIIa area, Douglas Bank spawning aggregations and the Mourne spawning aggregations. Recruitment indices are still needed for this area, and the Working Group encouraged the collation of existing data from groundfish surveys that have been carried out by Republic of Ireland and UK research vessels in Division VIIa (North). It was recommended that further investigations of the mixing of Celtic Sea and Division VIIa (North) juveniles in the northern Irish Sea be carried out, and encouragement was given to repeat the valuable tagging studies carried out in 1991 by the Working Group representative from the Republic of Ireland.

The Working Group encourages the establishment of an otolith exchange programme in 1992 to evaluate the precision of ageing by the three main laboratories collecting data in this area.

## 8 REPORT ON DISCARDS IN THE NORTH SEA AND SKAGERRAK FISHERY

As pointed out in last year report (*Anon.*, 1991) only a few countries collect discard data on a routine basis, and except for one country, discards are not included in the catch figures.

Compared to last year, new information on discards was available for the Danish purse seine and pelagic trawl fisheries for herring in 1991 in the North Sea and Skagerrak. The information was collected as part of an EC founded programme to investigate discards in pelagic fisheries.

The results indicate very large variations in discards between fishing trips with a mean level of 10 to 15% of the total catch of herring in weight. Four main reasons for discards were identified:

1. waste of fish in connection with loading operations;
2. the catch exceeds the individual boat quota or the carrying capacity of the vessel;
3. the length composition of the catch is unwanted (undersized fish or economical not optimal size composition) or the quality of the fish is too poor;
4. all or some of the fish caught escapes because the net is damaged.

The results were supported by Dutch investigations carried out under the same programme.

The above-mentioned investigations indicate that discards of herring in 1991 in most fisheries were at a relatively low level with exception of the row fishery. The abundance of juveniles were, however, relatively low in 1991 compared to the situation in the second half of the 1980s, and the discards of undersized herring may have been lower than in years of high abundance of juveniles.

The study on discards in the Danish and Dutch fisheries in the North Sea and Skagerrak may not be considered as representative for all fisheries and the Working Group stresses the importance of studies of discards in all fisheries for herring.

Except for one country, for which discards have been included in the catch figures for several years the Working Group decided not to include new estimates of discards for other countries in the assessment. The reason for this decision was that the information indicates that discard is at a relatively low level and including discards for single years will affect the relationship between survey indices and VPA.

## 9 TRANSFER OF HERRING ASSESSMENTS TO AREA-BASED WORKING GROUPS

### 9.1 General Comments

Traditionally herring stocks have been assessed separately or together with other pelagic species as sprat but normally not together with demersal stocks. The main reasons for this separation beside pure historical motives, have been limited technical interactions, different methods applied in the assessments, and that pelagic species show large migration patterns compared to demersal species.

The fleets exploiting herring stocks are mainly purse seiners and pelagic trawlers. By-catches of other species than pelagic species are small or negligible. The boats operates in a very selective manor and target at specific pelagic species in different well-defined seasons. When changing target species the majority turn to other pelagic species as mackerel, horse mackerel, blue whiting. Characteristic for a major part of the pelagic fleet is also an extended operation area depending on season and target species such as North Sea, west of the British Isles to the Norwegian Sea. Exception from this general strategy occurs in some areas and in some fleets. These exceptions will be discussed in relation to each stock.

Pelagic species generally undertake large seasonal migration over extensive areas. Merging pelagic species with the suggested area-based assessment units will create problems with stocks and fleets moving between areas. The present boundary between areas-based Working Groups is not optimum for the pelagic species and this has to be considered more in detail to minimise boundary problems.

Although similar assessment methods are used for both pelagic and demersal species there are also characteristic differences. While CPUE data from the fisheries are commonly used in tuning procedure for demersal species, these data series cannot be used when assessing pelagic species. In assessment of pelagic species fishery, independent data such as larvae abundance, larvae production estimates and acoustic estimates are used for tuning purpose. Evaluation of the fishery independent data and technical discussion of methods are generally important parts of the assessment work in pelagic assessment working groups. These discussion may not be of common interest in area-based working groups,which could lead to fragmentation into sub-groups. Synergistic effects are not guarantied by mixing different assessment techniques into one large working group.

Biological interactions between pelagic and demersal species are well documented and the need to consider these interactions in both short- and long-term are important.

The consequences of transfer to area-based assessments groups are considered by stock in the following sections.

## 9.2 The North Sea Stock

Description of fishing fleets

Herring fisheries in the North Sea are conducted mainly by vessels specialised in pelagic fisheries. These include the purse seiners from Norway, Scotland and Denmark, and the freezer trawlers from the Netherlands, Germany and the UK. These vessels fish for pelagic species such as herring, mackerel and horse mackerel throughout the year. Their operations are not restricted to the North Sea, but may extend to the west of Scotland and Ireland, and into the Celtic Sea.

A minor fraction of the herring catch in the North Sea is taken by pair trawlers. These vessels may switch to roundfish or flatfish at other times of the year.

A certain amount of juvenile herring is taken by industrial trawlers as a by-catch in the sprat fishery.

Description of herring migrations

There are several connections between herring in the North Sea and in adjacent regions. Some of the North Sea herring spawn outside the North Sea in Division VIId (English Channel). Juvenile North Sea herring grow up in Division IIIa and then re-enter the North Sea as 1- or 2-ringers. Adult herring from the North Sea stock migrates north towards the Faroe Islands. Spring-spawning herring from the Baltic and Division IIIa enter the North Sea as adult herring on their annual feeding migration along the edge of the Norwegian Trench. Larvae from the herring stock in Division VIa drift into the North Sea, metamorphose into juveniles, and return to Division VIa after one or two years.

Possibilities to transfer herring assessment to other working groups

There is very little that the herring fisheries in the North Sea have in common with the demersal fisheries in that region. A transfer of the herring assessment to the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak would not offer much benefits in terms of fleet interactions or multispecies aspects. Disconnecting assessment of North Sea herring from the assessment of herring stocks in Divisions IIIa and VIa would fragmentize the information on fishing operations by the same fleet, and migrations by the same herring stocks.

## 9.3 Division IIIa SW Baltic Stock

The spring spawning herring in Division IIIa-SW Baltic is known to undertake seasonal migration between this area and the North Sea. A review of the general distribution and migration pattern are given in the 1991 report of this Working Group (*Anon.*, 1991).

In the North Sea area the stock is exploited in directed herring fishery mainly by the purse seiner fleet and in Division IIIa by pelagic pair trawlers and, to a lesser extent, by purse seines. A minor part of the catches are at present generated in the small-mesh mixed fishery, which also exploit demersal species. About half of the fishing mortality is generated in the North Sea and Division IIIa. A more detailed description of the different fisheries that take herring in Division IIIa are given in the report of the Workshop on Methods of Forecasting Herring Catches in Division IIIa and the North Sea (*Anon.*, 1992).The other half of the fishing mortality is generated by the pelagic trawler fleet in the southwestern Baltic, i.e Sub-divisions 22-24. By-catches in this fishery are mainly sprat.

While the purse seine fleet is fishing for pelagic species all through the year the trawler fleets changes between herring, demersal species as cod and shellfish as

*Nephrops* or shrimp. The cod fishery in the Baltic have been an important alternative fishery for the pelagic trawler fleets during the past decade.

With the present arrangement of working groups the stocks in Division IIIa are divided between the North Sea area working group and the Baltic working groups. There are no common biological border line for all stocks. At present, this Working Group prepares data and the assessment is carried out by the Working Group on the Assessment of Pelagic Stocks in the Baltic. If the assessment of the herring stock should be transferred to an area working group, the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak seems to be the most logical choice. Any border line in Division IIIa or between this area and southwestern Baltic will cut through the distribution area of this herring stock. The most logical border for this stock seems to be in the Baltic at Bornholm.

The main disadvantage is the size and the large number of stocks to be assessed by the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak.

An alternative solution could be to create a Division IIIa-Southwestern Baltic area group. The disadvantage is disconnecting the assessment from the North Sea area. If there are strong reasons to change the present arrangement, it is recommended that the herring stock in this area should be included in the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak.

### 9.4 Implications for Herring Stocks in Sub-area VII and Division VIIa(S)

The herring fisheries in this area are assessed and managed in three units:

**Divisions VIIa South, VIIg-k**, i.e., Celtic Sea and Division VIIj.

**Divisions VIa South and VIIb-c**, i.e., West and Northwest Ireland.

**Division VIIa North (Irish Sea)**, i.e., Manx and Mourne stocks.

#### 9.4.1 Biological interactions between stocks between each unit

Divisions VIIa (South), VIIg-k

The stock in the Celtic Sea and Division VIIj is also composed of different spawning components - mainly autumn and winter components which spawn inshore along the Irish coast, but which migrate during spring and summer to deeper water south and southwest of Ireland, e.g. Labadie and Jones Banks. The larvae originating from the spawning grounds in the eastern Celtic Sea, i.e. Division VIIa (South), appear to be transported into the Irish Sea (Division VIIa (North)) where they remain for two years before returning to the Celtic Sea as potential recruits. The main spawning grounds off the southwestern Irish coast are situated along or very near the boundary between Division VIIj and Division VIIb and there has always been difficulties in allocating catches from this area to the appropriate management unit. Herrings tagged in the northern part of Division VIIb have also been recovered from Division VIIj indicating some biological links between the two units.

Division VIa (South), VIIb-c

The stock in Division VIa (South), which is mainly composed of an autumn spawning component, was separated from that in Division VIa (North) during the early 1980s for assessment and management purposes. The separation was justified at that time on the basis of biological data and on the location of the fisheries. Nevertheless, there are similarities between the stocks from both units. In addition, herring tagged in the Clyde have also been recovered in some years from catches taken off the northwest coast of Ireland. Larval surveys carried out in this area would suggest that larvae are transported along the Irish coast in a north-easterly direction toward the Scottish coast.

Division VIIa (North)

The stock in the Irish Sea (Division VIIa (North)) is also composed of two spawning components - the Manx and the Mourne - which are exploited together in a mixed fishery prior to spawning but which have separate and discrete spawning areas. Recent tagging experiments have shown that potential recruits to the Celtic Sea stock are present in this area during summer and there is, therefore, a biological link between the stocks in Division VIIa (North) and the stock in the Celtic Sea.

Conclusion

There appears to be considerable biological interaction between the stocks in this area. This would suggest that it would be advisable to transfer all the stocks rather than one or two to an area-based working group, if it is considered necessary.

#### 9.4.2 Technical Interactions: Fleets

The pelagic fisheries throughout Division VIa and Subarea VII are in general exploited by the same fleets. The greatest portion of the herring catches in recent years have been taken by the Irish and Northern Irish fleets. Smaller catches are taken by Dutch, German, French,

Scottish and Isle of Man vessels. The Dutch fleet is composed of large pelagic freezer trawlers which fish mainly for mackerel and horse mackerel and whose herring catch can now be considered as a by-catch.

The Irish and Northern Irish herring fleets may be broadly classified into five main types. Many of these vessels exploit the same fisheries and compete with each other.

Large factory ships. These ships (two large and one small) are pelagic trawlers. Although they concentrate mainly on mackerel throughout Sub-areas IV, VI and VII, they also fish herring in Divisions VIa (South) and VII b during summer and early autumn.

Large RSW trawlers and purse-seiners. These vessels which number about 14, again mainly exploit mackerel and horse mackerel over a large area. However, they also catch substantial quantities of herring during summer and early autumn throughout Divisions VIa (South) and VIIb.

Small RSW trawlers. These vessels, approximately 30, use pair mid-water trawls and concentrate on herring throughout the year. They exploit all the stocks and rapidly switch their effort from one area to another.

Dry hold boats. These vessels, approximately 80-90, only fish herring in Sub-area VII. They also use mid-water trawls and their fishing activities are confined to the main autumn and winter fisheries. During the remainder of the year they fish *Nephrops* and various inshore and offshore fisheries and also take part in the demersal fisheries. This fleet does not include those Northern Irish boats which use twin-rigged nets for demersal fish throughout the year. These vessels also occasionally fish sprat in the Celtic Sea.

Small boat drift netters. These boats are now confined to the drift net fishery operating on the Mourne spawning grounds off the east North Irish coast (in the Irish Sea).

In general, there appears to be considerable interaction between the various fleets operating in the different areas.

By-catch. As the target species for most of these pelagic trawlers are mainly mackerel, horse mackerel or herring, there is little by-catch of other species.

## 9.5 Division VIa (North)

### 9.5.1 Biological considerations

The herring in Division VIa (North) is assessed as a single autumn spawning stock. Spawning occurs to the northwest of Scotland and in particular to the west of the Hebrides. A significant proportion of the larvae are thought to be transported to nursery areas in the North Sea, returning as juveniles and adults. The return migration can extend over several years, so that a component of the stock is subject to fishing mortality in the North Sea. However, it is generally assumed that the return migration is sufficiently complete as 2-ringers and that this component of F can be ignored. There may be further movements of adults between Division Va (North) and the North Sea, and between Division VIa (North) and Division VIa (South), but again no attempt is made to estimate the extent to which the catches are of mixed stocks. The relation between herring in Division VIa (North) and herring in Sub-area V is unknown.

The natural mortality estimates for the stock in Division VIa (North) are based on the results of the multispecies VPA in the North Sea. In the absence of more appropriate estimates this is reasonable, but it would be preferable to have estimates of the predation mortalities in Division VIa (North) itself. In this respect, any attempt by the Working Group on the Assessment of Northern Shelf Demersal Stocks to adopt a multispecies approach would be relevant for this stock.

### 9.5.2 Technical interactions

This stock is mainly exploited by Scotland and the Netherlands. The bulk of the Scottish catch is taken by pair trawlers and purse seiners which also fish for mackerel. The same vessels also fish other areas including the North Sea. The Dutch fleet comprises large freezer trawlers, again exploiting both herring and mackerel over a wide geographical area. There is relatively little technical interaction between the exploitation of the pelagic and demersal stocks.

### 9.5.3 Clyde herring

The herring exploited in the Clyde consist of more than one stock. The total spring-spawning stock spawns in the Clyde and its total distribution at that time of year is not certain. According to tag returns, autumn-spawners migrate into the Clyde from all the adjacent stocks, including Divisions VIIa, VIa (South) + VIIb,c, and VIa (North). To maintain coherence it is appropriate for this stock to be assessed by the working group that assess these other stocks.

The directed herring fishery is carried out by pair-trawlers which switch, according to market demand, between demersal trawling for roundfish and *Nephrops* and herring. Whatever the ultimate destination of the assessment of this stock, the data on effort and fleet structure should be made available to the Working Group on the Assessment of Northern Shelf Demersal Stocks. However, the assessment of the indigenous stock is a self-contained problem and there is no reason for

merging with an area-bound group for assessment and prediction purposes.

## 10 REFERENCES


Anon. 1987. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES, Doc. C.M.1987/Assess:19.

Anon. 1989a. Report of the Herring Assessment Working Group for the Area South of 62°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. 1990. Report of the Working Group on Herring Larvae Surveys South of 62°N. ICES, Doc. C.M.1990/H:32.

Anon. 1991. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES, Doc. C.M.1989/Assess:15.

Anon. 1992. Report of the Workshop on Methods of Forecasting Herring Catches in Division IIIa and the North Sea (Draft). ICES, C.M.1992/H:5.

Anon. 1992. Draft Report of the Working Group on Pathology and Diseases of Marine Organisms.

Corten, A. 1990. The choice of target fishing mortality in herring fisheries. ICES, Doc. C.M.1990/H:21.

Morrison, J.A., Gamble, J.C., Shand, C., and Napier, I.R. 1990. Mass mortality of spring-spawning herring eggs in Scottish waters. ICES, C.M. 1990/L:60.

Skagen, D.W. 1991. Stock prediction using stochastic recruitment numbers with empirical stock dependent distributions. ICES, Doc. C.M.1991/H:28.


## 11 WORKING DOCUMENTS


Aglen, A. 1992, Historical Review of Assessment Quality, Herring total North Sea.

Armstrong, M. 1992a. Research Surveys of Irish Sea Herring and Sprat in 1991.

Armstrong, M. 1992b. Frequency of Occurrence of Herring Landings in the Northern Ireland Otter-Trawl Fishery.

Gibb, I. 1992. Clyde Herring Egg Surveys 1991.

Hopkins, P. 1992. Results of the Herring Larvae Surveys in 1991/1992.

Kirkegaard, E. 1991. Discard Sampling Programme for the North Sea. Danish Participation (part 2).

Molloy, J. 1992a. Results of the acoustic surveys for herring in the Celtic Sea and Division VIIj, 1991-1992.

Molloy, J. 1992b. Preliminary report of the results of the 1991 herring tagging programme.

Reid, D.G., and Simmonds, E.J. 1992. Celtic Sea Acoustic Survey Report.

Simmonds, J. *et al.* 1992. ICES Coordinated Acoustic Survey in ICES Divisions IVa, IVb, and VIa. (Draft).

**Table 2.1.1** HERRING. Catch in tonnes, 1980-1991, 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 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|
| Belgium | - | - | 9,700 | 5,969 | 5,080 | 3,482 |
| Denmark | 4,431 | 21,146 | 67,851 | 10,467 | 38,777 | 129,305 |
| Faroe Islands | - | - | - | - | - | - |
| France | 5,527 | 15,099 | 15,310 | 16,353 | 20,320 | 14,400 |
| Germany, Fed.Rep. | 147 | 2,300 | 349 | 1,837 | 11,609 | 8,930 |
| Netherlands | 509 | 7,700 | 22,300 | 40,045 | 44,308 | 79,335 |
| Norway[4] | 2,165 | - | - | 32,512 | 98,706 | 159,947 |
| Sweden | - | - | - | 284 | 886 | 2,442 |
| UK (England) | 77 | 303 | 3,703 | 111 | 1,689 | 5,564 |
| UK (Scotland) | 610 | 45 | 1,780 | 17,260 | 31,393 | 55,795 |
| UK (N.Ireland) | - | - | - | - | - | - |
| Unallocated landings | 47,528 | 94,309 | 114,252 | 181,116 | 64,487 | 74,220 |
| Total landings | 60,994 | 140,902 | 235,245 | 305,954 | 317,255 | 533,420 |
| Discards[3] | - | - | - | - | - | - |
| Total catch | 60,994 | 140,902 | 235,245 | 305,954 | 317,255 | 533,420 |
| Catches of spring spawners (included above) | | | | | | |
| IIIa type | - | - | - | - | 6,958 | 17,386 |
| Coastal type | - | - | - | - | 520 | 905 |

| Country | 1986 | 1987 | 1988 | 1989 | 1990 | 1991[1] |
|---|---|---|---|---|---|---|
| Belgium | 414 | 39 | 4 | 434 | 180 | 163 |
| Denmark | 121,631 | 138,596 | 263,006 | 210,315[2] | 159,280[2] | 194,358[2] |
| Faroe Islands | 623 | 2,228 | 810 | 1,916 | 633 | 334 |
| France | 9,729 | 7,266 | 8,384 | 29,085 | 23,480 | 24,625 |
| Germany, Fed.Rep. | 3,934 | 5,552 | 13,824 | 38,707 | 43,191 | 41,791 |
| Netherlands | 85,998 | 91,478 | 82,267 | 84,178 | 69,828 | 75,135 |
| Norway[4] | 223,058 | 241,765 | 222,719 | 221,891[2] | 157,850[2] | 124,991[2] |
| Sweden | 1,872 | 1,725 | 1,819 | 4,774 | 3,754 | 5,866 |
| UK (England) | 1,404 | 873 | 8,097 | 7,980 | 8,333 | 11,548 |
| UK (Scotland) | 77,459 | 76,413 | 64,108 | 68,106 | 56,812 | 57,572 |
| UK (N.Ireland) | - | - | - | - | - | 92 |
| Unallocated landings | 21,089 | 58,972 | 33,411 | 26,749[2] | 21,081 | 24,435 |
| Total landings | 547,211 | 624,907 | 698,449 | 694,135[2] | 544,422 | 560,910 |
| Discards[3] | - | - | - | 4,000 | 8,660 | 4,617 |
| Total catch | 547,211 | 624,907 | 698,449 | 698,135 | 553,082 | 565,527 |
| Catches of spring spawners (included above) | | | | | | |
| IIIa type | 19,654 | 14,207 | 23,306 | 19,869 | 8,357 | 7,894 |
| Coastal type | 490 | 250 | 250 | 2,283 | 1,136 | 252[5] |

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

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

| Country | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|
| Denmark | 3,155 | 4,282 | 26,786 | 77,788 | 48,590 |
| Faroe Islands | - | - | - | - | 275 |
| France | 1,970 | 680 | 1,408 | 2,075 | 462 |
| Germany, Fed.Rep. | - | 1,542 | 12,092 | 4,790 | 2,510 |
| Netherlands | - | 15,745 | 19,143 | 49,965 | 42,900 |
| Norway | - | 16,971 | 21,305 | 10,507 | 63,848 |
| Sweden | - | 213 | -[1] | -[1] | -[1] |
| UK (England) | - | - | - | - | - |
| UK (Scotland) | 1,706 | 16,136 | 24,634 | 52,100 | 71,285 |
| Unallocated landings | 300 | 3,955 | 24,030 | 4,249 | - |
| Total Landings | 7,179 | 61,738 | 129,398 | 197,225 | 229,870 |
| Total catch | 7,179 | 61,738 | 129,298 | 201,474 | 229,870 |

| Country | 1987 | 1988 | 1989 | 1990 | 1991[3] |
|---|---|---|---|---|---|
| Denmark | 50,184 | 25,268 | 29,298 | 9,037 | 5,980 |
| Faroe Islands | 102 | 810 | 1,916 | 633 | 334 |
| France | 285 | 266 | -[1] | 2,581 | 3,393 |
| Germany, Fed.Rep. | 3,250 | 9,308 | 26,528 | 20,422 | 20,608 |
| Netherlands | 44,358 | 32,639 | 24,600 | 29,729 | 29,563 |
| Norway | 55,311 | 30,657 | 41,768 | 24,239 | 37,674 |
| Sweden | 768 | 1,197 | 742 | - | 1,130 |
| UK (N.Ireland) | - | - | - | - | 92 |
| UK (England) | 4,820 | 4,820 | 5,104 | 3,337 | 4,873 |
| UK (Scotland) | 66,774 | 48,791 | 58,455 | 46,431 | 42,745 |
| Unallocated landings | 16,092 | - | 3,173 | 4,621 | 5,492 |
| Total Landings | 221,032 | 153,751 | 191,584 | 141,030 | 151,884 |
| Discards[2] | - | - | 900 | 750 | 883 |
| Total catch | 237,124 | 153,751 | 192,484 | 141,780 | 152,767 |

[1]Included in Division IVb.
[2]Any discards prior to 1989 were included in unallocated.
[3]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 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|
| Denmark | 491 | - | 126 | - | 4,540 |
| Faroe Islands | - | - | - | - | - |
| France | - | - | - | - | - |
| Netherlands | - | - | - | - | - |
| Norway[1] | - | - | 51,581 | 109,975 | 118,408 |
| Sweden | - | - | - | - | - |
| UK (Scotland) | - | 257 | 74 | - | - |
| Unallocated landings | - | 431 | - | - | - |
| Total landings | 491 | 688 | 51,781 | 109,975 | 122,348 |
| Total catch | 491 | 688 | 51,781 | 109,975 | 122,948 |

| Country | 1987 | 1988 | 1989 | 1990 | 1991[3] |
|---|---|---|---|---|---|
| Denmark | 7,101 | 47,183 | 44,269 | 44,364 | 48,875 |
| Faroe Islands | 2,126 | - | - | - | - |
| France | 159 | 45 | - | 892 | - |
| Netherlands | - | 200 | - | - | - |
| Norway[1] | 145,843 | 153,496 | 168,365 | 121,405 | 77,465 |
| Sweden | 957 | 622 | 612 | 2,482 | 114 |
| UK (Scotland) | - | - | - | - | 173 |
| Germany, Fed.Rep. | - | - | - | 5,604 | [4] |
| Unallocated landings | - | - | - | - | - |
| Total landings | 156,186 | 201,546 | 213,246 | 174,747 | 126,627 |
| Discards[2] | - | - | - | - | - |
| Total catch | 156,186 | 201,546 | 213,246 | 174,747 | 126,627 |

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

**Table 2.1.4** HERRING, catch in tonnes in Division IVb. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

| Country | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|
| Denmark | 64,205 | 6,050 | 13,808 | 51,517 | 67,966 |
| France | 561 | 705 | 2,299 | 1,037 | 605 |
| Faroe Islands | - | - | - | - | 348 |
| Germany, Fed.Rep. | 118 | - | 2 | 4,139 | 1,424 |
| Netherlands[4] | 219 | 300 | 4,600 | -[3] | 21,101 |
| Norway | - | 14,156 | 25,820 | 39,465 | 40,682 |
| Sweden | - | 71 | 884 | 2,442[2] | 1,872[2] |
| UK (England) | 3,128 | 40 | 1,956 | 5,214 | 1,101[1] |
| UK (Scotland) | 74 | 867 | 2,477 | 2,894 | 6,057 |
| Unallocated landings | 90,262 | 159,124 | 41,294 | 47,799 | 1,594 |
| Total landings | 158,567 | 181,313 | 93,140 | 154,507 | 142,750 |
| Total catch | 158,567 | 181,313 | 93,140 | 154,507 | 142,750 |

| Country | 1987 | 1988 | 1989 | 1990 | 1991[6] |
|---|---|---|---|---|---|
| Denmark | 81,280 | 190,555 | 136,239 | 105,614 | 138,555 |
| France | 387 | 617 | 14,415[5] | 10,289 | 4,120 |
| Faroe Islands | - | - | - | - | - |
| Germany, Fed.Rep. | 2,302 | 4,516 | 11,880 | 17,165 | 20,479 |
| Netherlands[4] | 31,371 | 37,192 | 47,388 | 28,402 | 26,266 |
| Norway | 40,111 | 38,566 | 11,758 | 12,207 | 9,852 |
| Sweden | - | - | 3,420 | 1,276 | 4,622 |
| UK (England) | 329 | 2,011 | 957 | 3,200 | 2,715 |
| UK (Scotland) | 9,639 | 15,317 | 9,651 | 10,381 | 14,587 |
| Unallocated landings | 20,829 | 1,969 | -23,947[7] | -15,616[7] | 3,180 |
| Total landings | 186,248 | 290,743 | 211,711 | 172,914 | 224,376 |
| Discards[4] | - | - | 1,900 | 2,560 | 1,072 |
| Total catch | 186,248 | 290,743 | 213,611 | 175,474 | 225,448 |

[1]Includes catches misreported from Division IVc.
[2]Includes Division IVa catches.
[3]Included in Division IVa.
[4]Any discards prior to 1989 were included in unallocated.
[5]Includes catch in Division IVa.
[6]Preliminary.
[7]Negative unallocated catches due to misreporting from other areas.

**Table 2.1.5** HERRING, catch in tonnes in Divisions IVc and VIId. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

| Country | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|
| Belgium | 9,700 | 5,969 | 5,080 | 3,482 | 414 |
| Denmark | - | 135 | 53 | - | 535 |
| France | 12,799 | 14,968 | 16,613 | 11,288 | 8,662 |
| Germany, Fed.Rep. | 183 | 295 | - | - | - |
| Netherlands | 22,081 | 24,000 | 21,922 | 32,370 | 21,997 |
| Norway | - | 1,385 | - | - | - |
| UK (England) | 602 | 71 | 571 | 350 | 303 |
| UK (Scotland) | - | - | - | 799 | 117 |
| Unallocated landings | 23,307 | 17,606 | 1,788 | 21,595 | 19,495 |
| Total landings | - | - | - | 69,884 | 51,523 |
| Discards[1] | - | - | - | - | - |
| Total catch | 68,652 | 64,430 | 46,027 | 69,884 | 51,523 |
| Coastal spring spawners included above | - | - | - | 905 | 496 |

| Country | 1987 | 1988 | 1989 | 1990[2] | 1991[2] |
|---|---|---|---|---|---|
| Belgium | 39 | 4 | 434 | 180 | 163 |
| Denmark | 31 | - | 509 | 265 | 948 |
| France | 6,435 | 7,456 | 14,670 | 9,718 | 17,112 |
| Germany, Fed.Rep. | - | - | 299 | - | 704 |
| Netherlands | 15,749 | 12,236 | 12,240 | 11,697 | 19,306 |
| Norway | - | - | - | - | - |
| UK (England) | 544 | 1,266 | 1,919 | 1,796 | 3,960 |
| UK (Scotland) | - | - | - | - | 67 |
| Unallocated landings | 22,051 | 31,442 | 47,523 | 32,076 | 15,763 |
| Total landings | 44,849 | 52,404 | 77,594 | 55,732 | 58,023 |
| Discards[1] | - | - | 1,200 | 5,350 | 2,662 |
| Total catch | 44,849 | 52,404 | 78,794 | 61,082 | 60,685 |
| Coastal spring spawners included above | 250 | 250 | 2,283 | 1,136 | 252 |

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

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

Catches in: 1991

| Division | Quarter | 0<br>1990 | 1<br>1989 | 2<br>1988 | 3<br>1987 | 4<br>1986 | 5<br>1985 | 6<br>1984 | 7<br>1983 | 8<br>1982 | 9<br>1981 | Total | 0 + 1 ring |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | 0.0 | 0.1 | 8.9 | 2.3 | 2.0 | 2.4 | 0.8 | 0.4 | 0.6 | 0.3 | 17.7 | 0.1 |
| | II | 0.0 | 1.4 | 34.7 | 31.1 | 45.8 | 52.9 | 15.1 | 2.7 | 3.0 | 2.8 | 189.3 | 1.4 |
| (West of 2E) | III | 0.0 | 0.1 | 74.5 | 100.8 | 121.8 | 113.8 | 38.1 | 8.3 | 7.0 | 3.5 | 467.9 | 0.1 |
| | IV | 0.0 | 0.0 | 5.8 | 11.3 | 27.1 | 14.4 | 5.2 | 1.1 | 0.7 | 0.3 | 65.8 | 0.0 |
| | Total | 0.0 | 1.5 | 123.9 | 145.5 | 196.6 | 183.5 | 59.2 | 12.5 | 11.2 | 6.9 | 740.8 | 1.5 |
| | I | 0.0 | 0.1 | 46.0 | 70.7 | 102.3 | 86.2 | 24.2 | 7.9 | 3.1 | 0.7 | 341.2 | 0.1 |
| | II | 0.0 | 2.6 | 41.4 | 26.6 | 27.7 | 16.5 | 6.7 | 0.7 | 0.5 | 0.1 | 122.8 | 2.6 |
| (East of 2E) | III | 11.9 | 1.2 | 8.1 | 7.3 | 8.2 | 9.2 | 2.4 | 1.0 | 0.3 | 0.1 | 49.8 | 13.1 |
| | IV | 40.5 | 14.8 | 75.2 | 54.1 | 56.2 | 50.9 | 26.4 | 6.4 | 2.3 | 1.6 | 328.4 | 55.2 |
| | Total | 52.3 | 18.7 | 170.8 | 158.7 | 194.4 | 162.9 | 59.8 | 16.1 | 6.2 | 2.4 | 842.2 | 71.0 |
| | I | 0.0 | 20.5 | 43.2 | 1.9 | 1.3 | 0.9 | 0.2 | 0.1 | 0.0 | 0.0 | 68.2 | 20.5 |
| | II | 0.0 | 187.9 | 141.7 | 33.5 | 13.5 | 10.3 | 9.8 | 0.1 | 1.2 | 0.3 | 398.3 | 187.9 |
| Vb | III | 1128.6 | 625.0 | 171.3 | 63.8 | 65.9 | 69.0 | 32.6 | 5.0 | 2.7 | 2.6 | 2166.6 | 1753.7 |
| | IV | 409.7 | 371.3 | 41.3 | 29.5 | 18.0 | 17.3 | 6.5 | 1.5 | 0.2 | 0.3 | 895.6 | 781.1 |
| | Total | 1538.4 | 1204.8 | 397.5 | 128.8 | 98.7 | 97.5 | 49.1 | 6.6 | 4.1 | 3.2 | 3528.7 | 2743.2 |
| | I | 0.0 | 3.8 | 12.1 | 15.7 | 8.5 | 7.4 | 5.1 | 1.0 | 0.1 | 0.0 | 53.8 | 3.8 |
| | II | 0.0 | 2.6 | 1.5 | 0.8 | 0.6 | 0.5 | 0.3 | 0.2 | 0.1 | 0.0 | 6.5 | 2.6 |
| IVc + VIId | III | 0.0 | 0.9 | 1.5 | 5.6 | 1.3 | 0.8 | 1.0 | 0.3 | 0.1 | 0.0 | 11.5 | 0.9 |
| | IV | 3.6 | 12.2 | 63.9 | 98.5 | 49.0 | 41.3 | 27.1 | 2.0 | 3.1 | 0.0 | 300.8 | 15.8 |
| | Total | 3.6 | 19.5 | 79.1 | 120.6 | 59.3 | 50.1 | 33.5 | 3.6 | 3.4 | 0.0 | 372.7 | 23.1 |
| | I | 0.0 | 24.5 | 110.2 | 90.6 | 114.0 | 97.0 | 30.3 | 9.4 | 3.8 | 1.0 | 480.9 | 24.5 |
| Total | II | 0.0 | 194.4 | 219.3 | 92.0 | 87.5 | 80.1 | 31.9 | 3.7 | 4.8 | 3.2 | 717.0 | 194.4 |
| North | III | 1140.5 | 627.2 | 255.5 | 177.5 | 197.2 | 192.9 | 74.1 | 14.7 | 10.1 | 6.2 | 2695.8 | 1767.7 |
| Sea | IV | 453.8 | 398.3 | 186.3 | 193.4 | 150.2 | 123.9 | 65.2 | 11.0 | 6.3 | 2.2 | 1590.6 | 852.1 |
| | Total | 1594.3 | 1244.4 | 771.4 | 553.5 | 548.9 | 493.9 | 201.6 | 38.8 | 25.0 | 12.6 | 5484.3 | 2838.7 |

Spring spawners transferred to Division IIIa and North Sea autumn spawners caught in IIIa are 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 |
| 1991 | 1594.3 | 1244.4 | 771.2 | 553.1 | 548.5 | 493.5 | 201.4 | 38.8 | 25.0 | 12.6 | 5482.7 |

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

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

Table 2.2.4 Percentage age composition of North Sea HERRING (2-ringers and olders) in the catch.
Catches in : 1991

| age in W. Rings | | 2 | 3 | Older | Total |
|---|---|---|---|---|---|
| Division | Quarter | 1988 | 1987 | >=1986 | (millions) |
| | I | 50.6 | 13.0 | 36.4 | 17.6 |
| IVa West | II | 18.5 | 16.5 | 65.0 | 188.0 |
| | III | 15.9 | 21.6 | 62.5 | 467.8 |
| | IV | 8.8 | 17.1 | 74.1 | 65.8 |
| | Total | 16.8 | 19.7 | 63.6 | 739.3 |
| | I | 13.5 | 20.7 | 65.8 | 341.1 |
| IVa East | II | 34.5 | 22.1 | 43.4 | 120.2 |
| | III | 22.2 | 19.8 | 58.0 | 36.7 |
| | IV | 27.5 | 19.8 | 52.7 | 273.2 |
| | Total | 22.1 | 20.6 | 57.3 | 771.2 |
| | I | 90.6 | 4.1 | 5.3 | 47.6 |
| IVb | II | 67.3 | 15.9 | 16.7 | 210.4 |
| | III | 41.5 | 15.5 | 43.1 | 413.0 |
| | IV | 36.1 | 25.8 | 38.1 | 114.5 |
| | Total | 50.6 | 16.4 | 33.0 | 785.5 |
| | I | 24.3 | 31.4 | 44.3 | 50.0 |
| IVc + VIId | II | 38.3 | 19.2 | 42.5 | 3.9 |
| | III | 14.2 | 52.4 | 33.4 | 10.6 |
| | IV | 22.4 | 34.6 | 43.0 | 285.0 |
| | Total | 22.6 | 34.5 | 42.9 | 349.6 |
| | I | 24.1 | 18.4 | 57.4 | 406.4 |
| IVa + IVb | II | 42.0 | 17.6 | 40.4 | 518.6 |
| | III | 27.7 | 18.7 | 53.6 | 917.5 |
| | IV | 27.0 | 20.9 | 52.1 | 453.5 |
| | Total | 30.1 | 18.9 | 51.0 | 2296.0 |
| | I | 24.1 | 19.9 | 56.0 | 456.4 |
| Total | II | 42.0 | 17.6 | 40.4 | 522.5 |
| North | III | 27.5 | 19.1 | 53.3 | 928.1 |
| Sea | IV | 25.2 | 26.2 | 48.6 | 738.5 |
| | Total | 29.2 | 20.9 | 49.9 | 2645.6 |

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

**Table 2.2.5** Catches (SOP, t) of North Sea Herring by Quarter and Division.

Catches in: 1991

| Quarter | Division | 0<br>1990 | 1<br>1989 | 2<br>1988 | 3<br>1987 | 4<br>1986 | 5<br>1985 | 6<br>1984 | 7<br>1983 | 8<br>1982 | 9<br>1981 | SOP<br>Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | IVaW | 0 | 2 | 839 | 255 | 255 | 365 | 132 | 71 | 113 | 75 | 2106 |
| | IVaE | 0 | 5 | 4549 | 8228 | 13493 | 12437 | 3805 | 1394 | 622 | 123 | 44654 |
| | IVB | 0 | 653 | 2073 | 203 | 162 | 130 | 35 | 11 | 7 | 2 | 3274 |
| | IVC | 0 | 129 | 598 | 1433 | 902 | 913 | 687 | 137 | 17 | 0 | 4815 |
| | Total | 0 | 788 | 8058 | 10119 | 14811 | 13845 | 4659 | 1613 | 758 | 199 | 54850 |
| 2 | IVaW | 0 | 119 | 5422 | 5604 | 9380 | 11975 | 3618 | 701 | 863 | 801 | 38482 |
| | IVaE | 0 | 241 | 6417 | 4639 | 5156 | 3303 | 1329 | 146 | 128 | 17 | 21377 |
| | IVB | 0 | 5491 | 10394 | 4211 | 1996 | 1605 | 1605 | 20 | 227 | 68 | 25619 |
| | IVC | 0 | 65 | 77 | 84 | 73 | 76 | 47 | 36 | 12 | 3 | 474 |
| | Total | 0 | 5916 | 22309 | 14539 | 16605 | 16959 | 6599 | 903 | 1231 | 888 | 85951 |
| 3 | IVaW | 0 | 4 | 12070 | 18955 | 26008 | 26302 | 9595 | 2312 | 2099 | 1072 | 98417 |
| | IVaE | 204 | 116 | 1189 | 1078 | 1269 | 1631 | 498 | 231 | 88 | 28 | 6333 |
| | IVB | 18735 | 45600 | 28409 | 12417 | 13766 | 16029 | 7940 | 1421 | 782 | 696 | 145797 |
| | IVC | 0 | 70 | 143 | 644 | 197 | 143 | 177 | 62 | 19 | 4 | 1459 |
| | Total | 18939 | 45790 | 41812 | 33095 | 41241 | 44105 | 18210 | 4026 | 2988 | 1800 | 252005 |
| 4 | IVaW | 0 | 1 | 901 | 1904 | 4942 | 2848 | 1077 | 250 | 153 | 67 | 12143 |
| | IVaE | 668 | 1257 | 11717 | 9269 | 10189 | 9820 | 5458 | 1495 | 540 | 380 | 50793 |
| | IVB | 7194 | 17396 | 6560 | 5396 | 3455 | 3722 | 1458 | 379 | 35 | 73 | 45667 |
| | IVC | 65 | 937 | 8943 | 17694 | 9771 | 8867 | 6201 | 464 | 765 | 0 | 53708 |
| | Total | 7926 | 19592 | 28121 | 34263 | 28358 | 25256 | 14194 | 2588 | 1493 | 520 | 162310 |
| Total North Sea, 1991 | | 26865 | 72086 | 100300 | 92016 | 101015 | 100165 | 43661 | 9130 | 6470 | 3407 | 0 555116 |

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

**Table 2.2.6** Catch in numbers (millions) and mean weight (g), by fleets in the total North Sea 1991.

| 1. QUARTER | TOTAL | | HUMAN CONSUMPTION | | SMALL MESHED FISHERY | |
|---|---|---|---|---|---|---|
| | N | W | N | W | N | W |
| 0 | | | | | | |
| 1 | 24.3 | 32.2 | | | 24.3 | 32.2 |
| 2 | 110.2 | 73.0 | 46.9 | 96.7 | 63.3 | 55.5 |
| 3 | 90.6 | 112.0 | 75.1 | 111.5 | 15.5 | 114.3 |
| 4 | 114.0 | 130.0 | 92.7 | 129.9 | 21.3 | 130.6 |
| 5 | 97.0 | 143.0 | 79.2 | 143.1 | 17.8 | 142.7 |
| 6 | 30.3 | 154.0 | 25.8 | 153.9 | 4.5 | 154.6 |
| 7 | 9.4 | 171.0 | 8.0 | 170.0 | 1.4 | 176.6 |
| 8 | 3.8 | 200.0 | 3.1 | 201.9 | 0.7 | 192.1 |
| 9+ | 1.0 | 194.0 | 0.6 | 202.0 | 0.4 | 180.4 |
| TOTAL | 480.6 | 114.2 | 331.3 | 127.8 | 149.3 | 84.1 |
| LAND./SOP | | 54893.9 | | 42341.3 | | 12552.6 |
| 2. QUARTER | N | W | N | W | N | W |
| 0 | | | | | | |
| 1 | 194.4 | 30.0 | 54.4 | 42.1 | 140.0 | 25.3 |
| 2 | 219.3 | 102.0 | 105.7 | 153.5 | 113.6 | 54.1 |
| 3 | 92.0 | 158.0 | 63.8 | 199.7 | 28.2 | 63.7 |
| 4 | 87.5 | 190.0 | 83.9 | 192.1 | 3.6 | 140.7 |
| 5 | 80.0 | 212.0 | 77.2 | 213.2 | 2.8 | 179.3 |
| 6 | 31.9 | 207.0 | 30.4 | 207.8 | 1.6 | 191.6 |
| 7 | 3.7 | 246.0 | 3.1 | 255.9 | 0.6 | 195.0 |
| 8 | 4.8 | 257.0 | 4.7 | 257.6 | 0.1 | 216.4 |
| 9+ | 3.2 | 277.0 | 3.2 | 277.7 | 0.0 | 229.0 |
| TOTAL | 716.8 | 119.9 | 426.4 | 171.3 | 290.4 | 44.5 |
| LAND./SOP | | 85955.1 | | 73031.9 | | 12923.2 |
| 3. QUARTER | N | W | N | W | N | W |
| 0 | 1140.0 | 16.6 | | | 1140.0 | 16.6 |
| 1 | 627.2 | 73.0 | 17.8 | 73.3 | 609.4 | 73.0 |
| 2 | 255.3 | 164.0 | 173.6 | 168.3 | 81.7 | 154.9 |
| 3 | 177.0 | 186.0 | 167.5 | 187.7 | 9.5 | 156.2 |
| 4 | 196.7 | 209.0 | 188.9 | 211.8 | 7.8 | 140.8 |
| 5 | 192.5 | 229.0 | 188.9 | 229.8 | 3.6 | 189.0 |
| 6 | 74.0 | 246.0 | 69.4 | 249.3 | 4.6 | 195.0 |
| 7 | 14.6 | 275.0 | 14.4 | 275.5 | 0.2 | 227.8 |
| 8 | 10.1 | 295.0 | 10.1 | 295.0 | 0.0 | 291.0 |
| 9+ | 6.1 | 293.0 | 6.1 | 293.1 | 0.0 | 241.0 |
| TOTAL | 2693.5 | 93.4 | 836.7 | 204.9 | 1856.8 | 43.2 |
| LAND./SOP | | 251686.4 | | 171413.5 | | 80272.9 |
| 4. QUARTER | N | W | N | W | N | W |
| 0 | 454.0 | 17.5 | | | 454.0 | 17.5 |
| 1 | 398.3 | 49.0 | 24.6 | 86.5 | 373.7 | 46.5 |
| 2 | 186.3 | 151.0 | 180.2 | 151.3 | 6.1 | 140.7 |
| 3 | 193.4 | 177.0 | 189.3 | 177.7 | 4.2 | 146.2 |
| 4 | 150.2 | 189.0 | 145.6 | 190.2 | 4.6 | 151.3 |
| 5 | 123.9 | 204.0 | 121.4 | 204.7 | 2.5 | 168.2 |
| 6 | 65.2 | 218.0 | 64.3 | 218.1 | 0.9 | 212.3 |
| 7 | 11.0 | 235.0 | 10.8 | 235.0 | 0.2 | 233.8 |
| 8 | 6.3 | 237.0 | 6.2 | 237.0 | 0.1 | 233.0 |
| 9+ | 2.2 | 239.0 | 2.2 | 239.1 | 0.0 | 229.4 |
| TOTAL | 1590.8 | 102.0 | 744.5 | 180.1 | 846.3 | 33.3 |
| LAND./SOP | | 162291.0 | | 134123.3 | | 28167.7 |
| TOTAL YEAR | N | W | N | W | N | W |
| 0 | 1594.0 | 16.9 | | | 1594.0 | 16.9 |
| 1 | 1244.2 | 57.8 | 96.9 | 59.1 | 1147.3 | 57.7 |
| 2 | 771.1 | 130.2 | 506.4 | 152.5 | 264.7 | 87.5 |
| 3 | 553.0 | 166.1 | 495.7 | 173.9 | 57.3 | 98.6 |
| 4 | 548.4 | 184.1 | 511.1 | 187.6 | 37.3 | 136.3 |
| 5 | 493.4 | 203.1 | 466.7 | 205.8 | 26.7 | 155.2 |
| 6 | 201.4 | 216.9 | 189.8 | 219.2 | 11.6 | 180.2 |
| 7 | 38.7 | 235.6 | 36.3 | 238.6 | 2.4 | 189.5 |
| 8 | 25.0 | 258.6 | 24.1 | 260.8 | 0.9 | 200.4 |
| 9+ | 12.5 | 271.5 | 12.0 | 274.6 | 0.5 | 189.7 |
| TOTAL | 5481.7 | 101.2 | 2339.0 | 180.0 | 3142.8 | 42.6 |
| LAND./SOP | | 554826.3 | | 420910.0 | | 133916.3 |

**Table 2.2.7** North Sea Herring sampling intensity of commercial catches.

DIVISION IVa

| Country | Total Landings ('000 t) | No of Samples | No of Age-readings | No of fish measured | Estimates of discards | Catches to which the age compositions were applied ('000 t) |
|---|---|---|---|---|---|---|
| Denmark | 54855 | 28 | 3280 | 3280 | no | 54224 |
| Faroe Islands | 334 | - | - | - | - | - |
| France | 3393 | - | - | - | - | - |
| Germany | 20608 | - | - | - | - | - |
| Netherlands | 35495 | 28 | 700 | 7000 | yes | 62345 |
| Norway | 115139 | 160 | 2300 | 8800 | no | 121055 |
| Sweden | 1244 | | | | - | |
| UK (Scotland) | 42919 | 53 | n/a | 8302 | no | 45477 |
| UK (England) | 4873 | - | - | - | - | - |
| Catches split by survey samples | | | | | | 208 |

DIVISION IVb

| Country | Total Landings ('000 t) | No of Samples | No of Age-readings | No of fish measured | Estimates of discards | Catches to which the age compositions were applied ('000 t) |
|---|---|---|---|---|---|---|
| Denmark | 138549 | 35 | 2760 | 2760 | no | 143372 (1) |
| France | 4120 | - | - | - | - | - |
| Germany | 20479 | | | | - | 16097 |
| Netherlands | 29923 | 37 | 925 | 3700 | yes | 69199 |
| Norway | 9852 | 7 | 560 | 560 | no | 9852 |
| Sweden | 4622 | | | | - | |
| UK (Scotland) | 14588 | 16 | n/a | 2900 | no | 17097 |
| UK (England) | 2715 | - | - | - | - | - |
| Catches split by survey samples | | | | | | 0 |

(1) : including IVc+VIId catches

DIVISIONS IVc+VIId

| Country | Total Landings ('000 t) | No of Samples | No of Age-readings | No of fish measured | Estimates of discards | Catches to which the age compositions were applied ('000 t) |
|---|---|---|---|---|---|---|
| Belgium | 163 | - | - | - | - | - |
| Denmark | 948 | - | - | - | - | - |
| France | 18212 | 18 | 1378 | 3776 | no | 22402 |
| Germany | 704 | - | - | - | - | - |
| Netherlands | 36631 | 19 | 475 | 1900 | yes | 37335 |
| UK (Scotland) | 67 | - | - | - | - | - |
| UK (England) | 3960 | - | - | - | - | - |
| Catches split by survey samples | | | | | | 0 |

**Table 2.2.8** Proportion of Division IIIa/Baltic spring spawners estimated by modal length analysis, by the formulae: (56.5-$\breve{v}$)/0.7 and by analysis of vertebral count distributions. $\breve{v}$ is mean vertebral count of mixed samples.

| Time | Area (rectangle) | Winter rings | $\breve{v}$ | Proportion of spring spawners % | | |
|---|---|---|---|---|---|---|
| | | | | Modal length analysis | Formulae | Analysis of vert. count distribution |
| July | 45F3 | 2 | 56.66 | 0 | 0 | 0 |
| July | 45F3 | 5+ | 56.49 | 0 | 0 | 0 |
| July | 49F4 | 4 | 56.15 | 63 | 50 | 60 |
| July | 45F4 | 5+ | 56.19 | 61 | 44 | 61 |
| July | 45F4 | 2 | 56.25 | 35 | 35 | 35 |
| July | 45F4 | 3 | 55.90 | 69 | 86 | 100 |
| July | 45F4 | 4 | 55.87 | 100 | 90 | 100 |
| July | 45F4 | 5+ | 56.02 | 10 | 69 | 71 |
| July | 43F6 | 2 | 56.21 | 25 | 41 | 40 |
| Q1 | Skagerrak | 1 | 56.24 | 16 | 37 | - |
| Q4 | Skagerrak | 2 | 56.22 | 29 | 40 | - |
| Q1 | Kattegat | 2 | 56.28 | 69 | 31 | - |
| Q2 | Kattegat | 2 | 56.05 | 51 | 64 | - |
| Q2 | Kattegat | 2 | 55.89 | 97 | 87 | - |
| Q3 | Kattegat | 2 | 55.89 | 93 | 87 | - |
| Q4 | Kattegat | 1 | 55.98 | 90 | 74 | - |

**Table 2.3.1** Recruitment index for 1-ringed herring from International Young Fish Surveys. Indices given are means of all rectangle means in 1-ringer standard area.

| Year class | IYFS 1-ringer index | VPA estimate of 1-ringers (billions) |
|---|---|---|
| 1974 | 452 | 0.81 |
| 1975 | 342 | 0.81 |
| 1976 | 575 | 1.43 |
| 1977 | 139 | 1.65 |
| 1978 | 535 | 3.59 |
| 1979 | 551 | 5.42 |
| 1980 | 1,293 | 8.56 |
| 1981 | 1,797 | 16.98 |
| 1982 | 2,663 | 15.34 |
| 1983 | 3,416 | 15.82 |
| 1984 | 3,667 | 27.59 |
| 1985 | 5,717 | 33.52 |
| 1986 | 4,192 | 27.83 |
| 1987 | 3,468 | 15.29 |
| 1988 | 2,146 | 17.68 |
| 1989 | 2,433 | 11.94 |
| 1990 | 2,339[1] | - |

[1]Preliminary

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

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

**Table 2.3.3** MIK index and VPA estimates of 0-ringers for North Sea and Division IIIa combined. MIK index represents absolute estimates of abundance of herring larvae in billions.

| Year class | MIK-index | VPA 0-ringers (billions) |
|---|---|---|
| 1976 | 17.1 | 4.29 |
| 1977 | 13.1 | 4.69 |
| 1978 | 52.1 | 10.62 |
| 1979 | 101.1 | 16.70 |
| 1980 | 76.7 | 37.75 |
| 1981 | 133.9 | 64.55 |
| 1982 | 91.8 | 62.07 |
| 1983 | 115.0 | 53.36 |
| 1984 | 181.3 | 81.56 |
| 1985 | 177.4 | 96.89 |
| 1986 | 270.9 | 88.22 |
| 1987 | 168.9 | 46.46 |
| 1988 | 71.4 | 52.76 |
| 1989 | 25.9 | - |
| 1990 | 69.9 | - |
| 1991 | 200.7 | - |

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

**Table 2.3.4** Calculated abundance of 1-ringed HERRING in North Sea 1983-1992 based on IYFS results.

| Year | North Sea | Division IIIa | Sum | Prop. in Div. IIIa |
|---|---|---|---|---|
| 1983 | 132075 | 64282 | 196357 | 0.33 |
| 1984 | 156197 | 85436 | 242633 | 0.35 |
| 1985 | 231535 | 124225 | 355760 | 0.35 |
| 1986 | 219136 | 234623 | 453759 | 0.52 |
| 1987 | 388807 | 224115 | 612922 | 0.37 |
| 1988 | 247205 | 545006 | 792211 | 0.69 |
| 1989 | 223244 | 113088 | 336332 | 0.34 |
| 1990 | 130396 | 36807 | 167203 | 0.22 |
| 1991 | 154454 | 27186 | 181640 | 0.15 |
| 1992 | 144114 | 46812 | 190926 | 0.25 |

**Table 2.3.5** VPA-estimate and indices of 1-ringer abundance based on IYFS

| Year class | VPA estimate millions | Standard area | Standard area log-transf. | Total area | Total area log-tranf. | GLM 5230-5830 log-tranf. |
|---|---|---|---|---|---|---|
| 1980 | 8630 | 1308 | 79.2 | 853 | 37.5 | 1.33 |
| 1981 | 17140 | 1777 | 310.4 | 1834 | 125.7 | 1.52 |
| 1982 | 15168 | 2456 | 204.1 | 2018 | 109.4 | 1.09 |
| 1983 | 16100 | 3195 | 209.9 | 2938 | 115.2 | 1.27 |
| 1984 | 29000 | 3546 | 390.3 | 4007 | 145.9 | 1.76 |
| 1985 | 35900 | 6223 | 796.7 | 4895 | 298.4 | 3.39 |
| 1986 | 27930 | 4227 | 250.6 | 6906 | 113.5 | 1.22 |
| 1987 | 12750 | 3422 | 170.1 | 3272 | 110.2 | 1.19 |
| 1988 | 9930 | 2248 | 82.0 | 1494 | 52.2 | 0.59 |
| 1989 | - | 2464 | 149.0 | 1831 | 57.5 | 1.00 |

**Table 2.3.6** Regression to VPA and prediction by indices.

| | | Standard area | Standard area log trans. | Total area | Total area log trans | GLM 5230-5830 log trans. |
|---|---|---|---|---|---|---|
| Log-Log regression | intercept | -3.9 | -0.53 | -2.3 | -0.56 | 2.65 |
| | slope | 0.84 | 0.63 | 0.65 | 0.73 | 0.85 |
| | R-square | 0.66 | 0.86 | 0.74 | 0.78 | 0.74 |
| Linear regression | intercept | 1.86 | 8.71 | 6.62 | 5.89 | 5.50 |
| | slope | 0.005 | 0.03 | 0.004 | 0.11 | 9.65 |
| | R-square | 0.74 | 0.77 | 0.65 | 0.72 | 0.71 |
| Prediction log-log r. | 1988 Y.c. | 13236 | 9452 | 11600 | 10249 | 9039 |
| | 1989 Y.c. | 14297 | 13770 | 13240 | 10990 | 14154 |

**Table 2.4.1** Estimated numbers of autumn-spawning herring by age, maturity, and area. Acoustic surveys 13 June to 12 August 1991.

| AGE RINGS | NUMBERS (MILLIONS) VIa | IVa | IVb | SKAGER | KATTEGAT | TOTAL | BIOMASS ('000 TONNES) VIa | IVa | IVb | SKAGER | KATTEGAT | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | 1237 | 60 | 934 | 2231 | | | 5 | + | 5 | 10 |
| 1 | 449 | 341 | 1990 | 539 | 312 | 3631 | 42 | 30 | 122 | 51 | 29 | 274 |
| 2 IMMATURE | 217 | 347 | 163 | 515 | | 1242 | 27 | 43 | 20 | 67 | | 157 |
| 2 MATURE | 770 | 1232 | 577 | | | 2579 | 134 | 209 | 96 | | | 439 |
| 3 IMMATURE | 12 | 28 | 4 | | | 44 | 2 | 4 | 1 | | | 7 |
| 3 MATURE | 583 | 1359 | 200 | | | 2142 | 119 | 272 | 40 | | | 431 |
| 4 | 441 | 2054 | 48 | | | 2543 | 98 | 462 | 10 | | | 570 |
| 5 | 290 | 1928 | 56 | | | 2274 | 70 | 456 | 12 | | | 538 |
| 6 | 74 | 697 | 51 | | | 822 | 20 | 183 | 12 | | | 215 |
| 7 | 11 | 240 | 22 | | | 273 | 3 | 67 | 5 | | | 75 |
| 8 | 0 | 79 | 33 | | | 112 | 0 | 25 | 8 | | | 33 |
| 9+ | 9 | 56 | 0 | | | 65 | 2 | 18 | 0 | | | 20 |
| TOTAL IMMATURE | 678 | 716 | 3394 | 1114 | 1246 | 7148 | 71 | 77 | 147 | 118 | 34 | 447 |
| TOTAL SPAWNERS | 2178 | 7644 | 987 | 0 | 0 | 10809 | 446 | 1691 | 183 | 0 | 0 | 2320 |
| TOTAL | 2856 | 8360 | 4382 | 1114 | 1246 | 17958 | 517 | 1768 | 330 | 118 | 34 | 2767 |

| AGE RINGS | MEAN WEIGHT (GRAM) VIa | IVa | IVb | SKAGER | KATTEGAT |
|---|---|---|---|---|---|
| 0 | | | 4 | 6.0 | 14 |
| 1 | 93 | 89 | 61 | 94.0 | 55 |
| 2 IMMATURE | 126 | 123 | 121 | 131.0 | |
| 2 MATURE | 174 | 169 | 167 | | |
| 3 IMMATURE | 132 | 129 | 128 | | |
| 3 MATURE | 204 | 200 | 198 | | |
| 4 | 222 | 225 | 206 | | |
| 5 | 241 | 237 | 217 | | |
| 6 | 271 | 262 | 233 | | |
| 7 | 294 | 277 | 248 | | |
| 8 | 345 | 322 | 240 | | |
| 9+ | 252 | 317 | 261 | | |
| TOTAL IMMATURE | | | | | |
| TOTAL SPAWNERS | | | | | |
| TOTAL | 181 | 211 | 111 | 106 | 24 |

**Table 2.4.2** Estimated numbers of autumn-spawning herring (IIIa/Baltic) by age, maturity, and area. Acoustic surveys 13 June to 12 August 1991.

| AGE RINGS | NUMBERS (MILLIONS) IV | SKAGER. | KATTEGAT | TOTAL | BIOMASS ('000 TONNES) IV | SKAGER. | KATTEGAT | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | |
| 1 | | | | | | | | |
| 2 | 119 | 795 | 950 | 1864 | 12 | 83 | 82 | 177 |
| 3 | 360 | 925 | 642 | 1927 | 45 | 109 | 67 | 221 |
| 4 | 322 | 342 | 202 | 866 | 44 | 45 | 27 | 116 |
| 5 | 105 | 150 | 95 | 350 | 15 | 21 | 15 | 51 |
| 6 | 35 | 24 | 29 | 88 | 7 | 5 | 7 | 19 |
| 7 | 11 | 29 | 32 | 72 | 2 | 5 | 6 | 13 |
| 8 | 2 | 8 | | 10 | 0 | 2 | | 2 |
| 9+ | | | | | | | | |
| TOTAL | 954 | 2273 | 1950 | 5177 | 125 | 270 | 204 | 599 |

| AGE RINGS | MEAN WEIGHT (GRAM) IV | SKAGER. | KATTEGAT |
|---|---|---|---|
| 0 | | | |
| 1 | | | |
| 2 | 103 | 105 | 86 |
| 3 | 124 | 118 | 104 |
| 4 | 138 | 133 | 134 |
| 5 | 143 | 143 | 156 |
| 6 | 193 | 191 | 237 |
| 7 | 209 | 164 | 188 |
| 8 | 164 | 205 | |
| 9+ | | | |
| TOTAL | 131 | 119 | 105 |

**Table 2.4.3** Estimates of North Sea autumn spawners (millions) at age from acoustic surveys, 1984-1991. 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.

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

SSB defined as all fish > maturity stage III.

**Table 2.4.4** Herring and sprat estimates from winter acoustic survey. Number in millions, biomass in '000 t.

| **Herring** | w-rings | IVb,east | Skagerrak | Kattegat |
|---|---|---|---|---|
| | 0 | 6405 | 0 | 287 |
| | 1 | 715 | 3 | 62 |
| | 2 | 14 | 0 | 13 |
| | 3 | 7 | 2 | 8 |
| | 4+ | 7 | 6 | 14 |
| | Biomass | 151.2 | 1.4 | 14.1 |
| **Sprat** | Age | | | |
| | 0 | 7825 | 83 | 1528 |
| | 1 | 798 | 0 | 166 |
| | 2 | 52 | 0 | 2 |
| | Biomass | 41.2 | 0.6 | 15.0 |

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

| Year | Orkney-Shetland | Div. VIa (N) + Ork./Shet. | Buchan | Central North Sea | Divs.IVc + VIId |
|---|---|---|---|---|---|
| 1980 | - | 0.29* | - | - | 0.33** |
| 1981 | 0.29 | 0.34 | - | - | - |
| 1982 | 0.25* | 0.26* | - | 0.40 | 0.80** |
| 1983 | 0.27* | 0.26* | 0.43 | 0.34 | - |
| 1984 | 0.20 | 0.24 | 0.42 | - | 0.54** |
| 1985 | 0.25* | 0.29* | - | 0.33* | 0.56** |
| 1986 | 0.28* | 0.22* | 0.27* | - | 0.48** |
| 1987 | 0.37* | 0.36 | 0.37* | 0.35* | 0.64** |
| 1988 | 0.53* | 0.56 | 0.38 | 0.31 | 0.71** |
| 1989 | 0.39* | 0.41 | 0.22 | 0.46 | - |
| 1990 | 0.36 | - | 0.40* | 0.38 | 1.07* |
| 1991 | 0.39 | - | 0.29 | 0.39 | 0.90* |
| Mean | 0.33 | - | 0.35 | 0.37 | 0.67 |
| 91z/k | 0.37 | | 0.36 | 0.37 | 0.64 |
| 90z/k | 0.31 | | 0.35 | 0.37 | 0.58 |

91z/k: Mortality rates used in the 1991 HAWG Report (*Anon.*, 1991).
90z/k: Mortality rates used in the 1990 HAWG Report (*Anon.*, 1990).

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

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

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

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

**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] | - | - | - | - | - |
| 1991[1] | - | - | - | - | - |

[1]No LAI could be calculated for 1990 or 1991.

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

Catches in: 1991

| Division | Quarter | 0 1990 | 1 1989 | 2 1988 | 3 1987 | 4 1986 | 5 1985 | 6 1984 | 7 1983 | 8 1982 | 9 1981 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | | 45 | 94 | 111 | 130 | 153 | 172 | 182 | 196 | 215 |
| | II | | 87 | 156 | 180 | 205 | 227 | 239 | 264 | 288 | 287 |
| (W of 2 E) | III | | 53 | 162 | 188 | 214 | 231 | 252 | 277 | 300 | 310 |
| | IV | | 130 | 156 | 169 | 183 | 197 | 208 | 221 | 232 | 220 |
| | Total | | 84 | 155 | 184 | 206 | 226 | 244 | 266 | 287 | 292 |
| | I | | 47 | 99 | 116 | 132 | 144 | 157 | 176 | 202 | 183 |
| | II | | 93 | 155 | 174 | 186 | 201 | 198 | 212 | 236 | 269 |
| (E of 2 E) | III | 17 | 95 | 146 | 148 | 155 | 177 | 204 | 220 | 305 | 250 |
| | IV | 17 | 85 | 156 | 171 | 181 | 193 | 207 | 233 | 231 | 239 |
| | Total | 17 | 87 | 140 | 146 | 155 | 167 | 185 | 203 | 221 | 225 |
| | I | | 32 | 48 | 105 | 124 | 141 | 158 | 176 | 211 | 177 |
| | II | | 29 | 73 | 126 | 148 | 156 | 164 | 187 | 194 | 201 |
| IVb | III | 17 | 73 | 166 | 195 | 209 | 232 | 244 | 286 | 285 | 272 |
| | IV | 18 | 47 | 159 | 183 | 192 | 216 | 224 | 256 | 226 | 258 |
| | Total | 17 | 57 | 119 | 173 | 196 | 220 | 225 | 277 | 257 | 263 |
| | I | | 34 | 49 | 91 | 106 | 123 | 134 | 132 | 159 | |
| | II | | 25 | 51 | 111 | 133 | 147 | 161 | 158 | 163 | 163 |
| IVc + VIId | III | | 79 | 95 | 116 | 150 | 172 | 184 | 201 | 186 | 160 |
| | IV | 18 | 77 | 140 | 180 | 199 | 215 | 229 | 232 | 243 | |
| | Total | 18 | 62 | 123 | 165 | 184 | 200 | 212 | 196 | 237 | 161 |
| IVa | Total | 17 | 87 | 146 | 164 | 181 | 198 | 214 | 231 | 263 | 275 |
| | I | | 32 | 76 | 116 | 132 | 144 | 157 | 176 | 201 | 194 |
| IVa + IVb | II | | 30 | 102 | 158 | 190 | 212 | 207 | 251 | 259 | 278 |
| | III | 17 | 73 | 164 | 189 | 210 | 229 | 246 | 276 | 296 | 293 |
| | IV | 17 | 48 | 157 | 175 | 184 | 198 | 210 | 235 | 231 | 239 |
| | Total | 17 | 58 | 131 | 167 | 184 | 203 | 217 | 239 | 262 | 272 |
| | I | | 32 | 73 | 112 | 130 | 143 | 154 | 171 | 200 | 194 |
| Total | II | | 30 | 102 | 158 | 190 | 212 | 207 | 246 | 257 | 277 |
| North | III | 17 | 73 | 164 | 186 | 209 | 229 | 246 | 275 | 295 | 293 |
| Sea | IV | 17 | 49 | 151 | 177 | 189 | 204 | 218 | 235 | 237 | 239 |
| | Total | 17 | 58 | 130 | 166 | 184 | 203 | 217 | 235 | 259 | 271 |

Spring spawners transferred to Division IIIa and North Sea Autumn spawners caught in division IIIa are not included

Table 2.6.2. Comparison between mean weights (g) at age (w.r.) in catch of North Sea Herring (adult) from earlier years and 1985-1991

| Division | Year | age in winter rings 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9+ |
|---|---|---|---|---|---|---|---|---|---|
| IVa | 1985 | 137 | 170 | 199 | 216 | 235 | 263 | 270 | 293 |
| | 1986 | 123 | 158 | 183 | 209 | 222 | 246 | 253 | 263 |
| | 1987 | 118 | 157 | 186 | 214 | 237 | 260 | 278 | 304 |
| | 1988 | 126 | 150 | 176 | 200 | 218 | 237 | 260 | 263 |
| | 1989 | 129 | 157 | 175 | 210 | 233 | 246 | 268 | 256 |
| | 1990 | 123 | 154 | 177 | 194 | 229 | 234 | 251 | 295 |
| | 1991 | 146 | 164 | 181 | 198 | 214 | 231 | 263 | 275 |
| IVb | 1985 | 123 | 177 | 202 | 216 | 223 | 250 | 267 | 291 |
| | 1986 | 120 | 157 | 191 | 219 | 232 | 220 | 207 | 237 |
| | 1987 | 70 | 131 | 179 | 215 | 233 | 225 | 273 | 244 |
| | 1988 | 98 | 136 | 175 | 195 | 208 | 244 | 228 | 205 |
| | 1989 | 93 | 162 | 199 | 225 | 280 | 276 | 273 | 333 |
| | 1990 | 102 | 145 | 194 | 219 | 250 | 272 | 259 | 277 |
| | 1991 | 119 | 173 | 196 | 220 | 225 | 277 | 257 | 263 |
| IVa+ IVb | Pre- 1985 | 126 | 176 | 211 | 243 | 256 | 267 | 271 | 271 |
| | 1985 | 133 | 171 | 200 | 216 | 233 | 261 | 270 | 293 |
| | 1986 | 122 | 158 | 184 | 210 | 223 | 245 | 253 | 263 |
| | 1987 | 99 | 152 | 186 | 214 | 237 | 259 | 278 | 304 |
| | 1988 | 112 | 147 | 176 | 199 | 217 | 238 | 257 | 263 |
| | 1989 | 116 | 158 | 179 | 212 | 237 | 250 | 269 | 259 |
| | 1990 | 113 | 152 | 181 | 198 | 232 | 238 | 252 | 290 |
| | 1991 | 131 | 167 | 184 | 203 | 217 | 239 | 262 | 272 |
| IVc+ VIId | pre- 1985 | 117 | 141 | 170 | 192 | 221 | 224 | 216 | 208 |
| | 1985 | 113 | 124 | 148 | 170 | 168 | 212 | 207 | 193 |
| | 1986 | 108 | 139 | 164 | 185 | 208 | 174 | 202 | 232 |
| | 1987 | 105 | 128 | 148 | 164 | 198 | 211 | 197 | 234 |
| | 1988 | 103 | 132 | 156 | 178 | 197 | 185 | 165 | |
| | 1989 | 110 | 127 | 151 | 182 | 198 | 201 | 198 | 179 |
| | 1990 | 118 | 131 | 152 | 171 | 195 | 216 | 208 | 231 |
| | 1991 | 123 | 165 | 184 | 200 | 212 | 196 | 237 | 161 |
| Total North Sea | pre- 1985 | 125 | 166 | 204 | 228 | 253 | 266 | 271 | 270 |
| | 1985 | 128 | 164 | 194 | 211 | 220 | 258 | 270 | 292 |
| | 1986 | 121 | 153 | 182 | 207 | 221 | 238 | 252 | 262 |
| | 1987 | 99 | 149 | 180 | 211 | 234 | 258 | 278 | 295 |
| | 1988 | 111 | 145 | 174 | 197 | 216 | 237 | 253 | 263 |
| | 1989 | 115 | 153 | 173 | 208 | 231 | 247 | 265 | 259 |
| | 1990 | 114 | 149 | 177 | 193 | 229 | 236 | 250 | 287 |
| | 1991 | 130 | 166 | 184 | 203 | 217 | 235 | 259 | 271 |

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

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

| Age (WR.) | Mean weights (g) at age in the catch | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Third quarter (Divisions IVa and IVb) | | | | | | July Acoustic Survey | |
| | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1990 | 1991 |
| 1 | 78 | 54 | 58 | 42 | 58 | 73 | 64 | 65 |
| 2 | 146 | 134 | 124 | 126 | 128 | 164 | 128 | 158 |
| 3 | 190 | 182 | 178 | 179 | 180 | 189 | 186 | 198 |
| 4 | 214 | 219 | 217 | 207 | 208 | 210 | 207 | 224 |
| 5 | 248 | 248 | 239 | 244 | 228 | 229 | 232 | 236 |
| 6 | 282 | 265 | 261 | 274 | 256 | 246 | 257 | 260 |
| 7 | 288 | 286 | 283 | 288 | 267 | 276 | 282 | 275 |
| 8 | 327 | 310 | 283 | 296 | 272 | 296 | 278 | 298 |
| 9+ | 364 | 342 | 296 | 350 | 295 | 293 | 318 | 317 |

**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 3+ Total North Sea |
|---|---|---|---|---|---|
| 1972 | 289 | 146 | - | 6,405 | - |
| 1973 | 233 | 116 | - | 5,466 | - |
| 1974 | 161 | 77 | - | 4,228 | - |
| 1975 | 79 | 61 | - | 1,141 | - |
| 1976 | 75 | 20 | - | 978 | - |
| 1977 | 41 | - | - | 2,268 | - |
| 1978 | 52 | 108 | - | 6,027 | - |
| 1979 | 100 | 224 | - | 7,004 | - |
| 1980 | 126 | 365 | - | 6,049 | - |
| 1981 | 191 | 636 | 305 | 22,270 | 41.8 |
| 1982 | 276 | 480 | 402 | 9,858 | 73.4 |
| 1983 | 428 | 635 | 440 | 12,827 | 93.4 |
| 1984 | 726 | 871 | 807 | 14,321 | 247.8 |
| 1985 | 764 | 1,022 | 697 | 34,111 | 300.6 |
| 1986 | 818 | 1,244 | 942 | 22,168 | 182.6 |
| 1987 | 935 | 699 | 667[1] | 24,101 | 508.6 |
| 1988 | 1123 | 1,249 | 801[2] | 44,512 | 374.0 |
| 1989 | - | 1,328 | 1,490[3] | 40,707 | 566.4 |
| 1990 | - | 1,547 | 2,009[4] | - | 554.3 |
| 1991 | - | 849 | 1,743[5] | - | 281.3 |

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

## Table 2.7.2

```
Analysis by RCT3 ver3.1 of data from file :

J:\scratch\wg_114\her_nsea\ind-4.rci

PRediction of SSB from LPE, Acoustics, IYFS 3+, Total North Sea.

Data for   3 surveys over   14 years :  1978 - 1991

Regression type = C
Tapered time weighting not applied
Survey weighting not applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean
+                                                    included
Minimum S.E. for any survey taken as    .20
Minimum of   5 points used for regression

Forecast/Hindcast variance correction used.

Year      =   1989

          I----------Regression----------I  I----------Prediction---------I

Survey/   Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP      Net
Series           cept    Error         Pts  Value   Value    Error  Weights  weights

LPE SS    1.47  -3.45     .43   .860     11   7.19    7.11     .531    .168    .139
ACOUST    1.69  -4.45     .27   .867      8   7.31    7.90     .421    .268    .000
IYFS 3     .76   2.42     .21   .911      8   6.34    7.25     .290    .564    .465
                                           7.31    7.27     .314             .396
Acoust    1.00  -0.04                  VPA Mean =    5.84    1.022    .000

Year      =   1990

          I----------Regression----------I  I----------Prediction---------I

Survey/   Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept    Error         Pts  Value   Value    Error  Weights

LPE SS    1.47  -3.45     .43   .860     11   7.34    7.34     .542    .173    .133
ACOUST    1.69  -4.45     .27   .867      8   7.61    8.40     .481    .220    .000
IYFS 3     .76   2.42     .21   .911      8   6.32    7.23     .289    .608    .469
                                           7.61    7.57     .314             .397
Acoust    1.00  -0.04                  VPA Mean =    5.84    1.022    .000

Year      =   1991

          I----------Regression----------I  I----------Prediction---------I

Survey/   Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
Series           cept    Error         Pts  Value   Value    Error  Weights

LPE SS    1.47  -3.45     .43   .860     11   6.79    6.52     .511    .166    .136
ACOUST    1.69  -4.45     .27   .867      8   7.43    8.11     .445    .220    .000
IYFS 3     .76   2.42     .21   .911      8   5.64    6.72     .266    .614    .503
                                           7.43    7.42     .314             .361
Acoust    1.00  -0.04                  VPA Mean =    5.84    1.022    .000
```

| Year | Weighted Average Prediction | Log WAP | Int Std Error | Ext Std Error | Var Ratio | VPA | Log VPA |
|---|---|---|---|---|---|---|---|
| 1989 | 1636 | 7.40 | .22 | .22 | .98 | | |
| 1990 | 1822 | 7.51 | .23 | .34 | 2.24 | | |
| 1991 | 1085 | 6.99 | .21 | .42 | 4.09 | | |

Net weighted average predictions

| | |
|---|---|
| 1989 | 1,392 |
| 1990 | 1,603 |
| 1991 | 1,038 |

## Table 2.7.3

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (r At 7/04/1992 19:36
Traditional vpa Terminal populations from weighted Separable populations

Catch numbers at age Numbers*10**-4

| YEAR | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | | | |
| 0 | 89810 | 68400 | 75040 | 28940 | 99610 | 26380 | 23820 | 25680 | 13000 | 54200 | 126270 | 951970 |
| 1 | 119620 | 437850 | 334060 | 236800 | 84610 | 246050 | 12660 | 14430 | 16860 | 15920 | 24510 | 87200 |
| 2 | 200280 | 114680 | 144050 | 134420 | 77260 | 54170 | 90150 | 4470 | 490 | 3410 | 13400 | 28430 |
| 3 | 88360 | 66250 | 34380 | 65920 | 36200 | 25960 | 11730 | 18640 | 570 | 1000 | 9180 | 5690 |
| 4 | 12520 | 20830 | 13060 | 15020 | 12600 | 14050 | 5200 | 1080 | 500 | 1010 | 3220 | 3950 |
| 5 | 5030 | 2690 | 3290 | 5930 | 5610 | 5720 | 3450 | 700 | 30 | 210 | 2170 | 2850 |
| 6 | 6100 | 3050 | 500 | 3060 | 2230 | 1610 | 610 | 410 | 20 | 20 | 230 | 2270 |
| 7 | 790 | 2680 | 20 | 370 | 500 | 910 | 440 | 150 | 20 | 80 | 140 | 1870 |
| 8 | 1200 | 10 | 110 | 140 | 200 | 340 | 100 | 70 | 20 | 60 | 40 | 550 |
| +gp | 1220 | 1240 | 40 | 60 | 110 | 140 | 40 | 0 | 30 | 10 | 10 | 110 |
| TOTALNUM | 524930 | 717680 | 604550 | 490660 | 318930 | 375330 | 148200 | 65630 | 31540 | 75920 | 179170 | 1084890 |
| TONSLAND | 563100 | 520100 | 497500 | 484000 | 275100 | 312800 | 174800 | 46000 | 11000 | 25100 | 61000 | 140972 |
| SOPCOF % | 104 | 93 | 109 | 104 | 103 | 107 | 105 | 83 | 82 | 99 | 79 | 80 |

Catch numbers at age Numbers*10**-4

| YEAR | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 0 | 1195670 | 1329690 | 666190 | 417890 | 366400 | 803550 | 312290 | 298400 | 124600 | 230660 |
| 1 | 111640 | 244860 | 173720 | 322820 | 472320 | 667530 | 776280 | 307100 | 285500 | 206710 |
| 2 | 29940 | 57380 | 109500 | 131620 | 124610 | 212370 | 224750 | 158300 | 87700 | 110160 |
| 3 | 23010 | 21640 | 42170 | 117340 | 82710 | 68710 | 118510 | 138358 | 76330 | 55350 |
| 4 | 3370 | 10510 | 19250 | 36570 | 45830 | 48150 | 39810 | 82812 | 84910 | 54890 |
| 5 | 1440 | 2620 | 7750 | 12360 | 12770 | 24880 | 26060 | 21834 | 37590 | 49390 |
| 6 | 680 | 2280 | 2160 | 4330 | 6110 | 7570 | 12860 | 12940 | 8010 | 20160 |
| 7 | 780 | 1280 | 2410 | 2000 | 2020 | 2370 | 3790 | 6327 | 5440 | 3880 |
| 8 | 360 | 1100 | 1060 | 1300 | 1340 | 790 | 1510 | 2073 | 2840 | 2500 |
| +gp | 110 | 1210 | 1780 | 1600 | 1460 | 800 | 840 | 866 | 1180 | 1260 |
| TOTALNUM | 1367000 | 1672570 | 1025990 | 1047830 | 1115570 | 1836720 | 1516700 | 1029009 | 714100 | 734960 |
| TONSLAND | 235925 | 305954 | 312436 | 519474 | 527995 | 612087 | 675143 | 679080 | 543589 | 558646 |
| SOPCOF % | 88 | 73 | 72 | 82 | 70 | 76 | 65 | 83 | 82 | 85 |

## Table 2.7.4

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (r
Traditional vpa Terminal populations from weighted Separable populations

Catch weights at age (kg)

| YEAR | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | | | |
| 0 | .0150 | .0150 | .0150 | .0150 | .0150 | .0150 | .0150 | .0150 | .0150 | .0150 | .0150 | .0070 |
| 1 | .0500 | .0500 | .0500 | .0500 | .0500 | .0500 | .0500 | .0500 | .0500 | .0500 | .0500 | .0490 |
| 2 | .1260 | .1260 | .1260 | .1260 | .1260 | .1260 | .1260 | .1260 | .1260 | .1260 | .1260 | .1180 |
| 3 | .1760 | .1760 | .1760 | .1760 | .1760 | .1760 | .1760 | .1760 | .1760 | .1760 | .1760 | .1420 |
| 4 | .2110 | .2110 | .2110 | .2110 | .2110 | .2110 | .2110 | .2110 | .2110 | .2110 | .2110 | .1890 |
| 5 | .2430 | .2430 | .2430 | .2430 | .2430 | .2430 | .2430 | .2430 | .2430 | .2430 | .2430 | .2110 |
| 6 | .2510 | .2510 | .2510 | .2510 | .2510 | .2510 | .2510 | .2510 | .2510 | .2510 | .2510 | .2220 |
| 7 | .2670 | .2670 | .2670 | .2670 | .2670 | .2670 | .2670 | .2670 | .2670 | .2670 | .2670 | .2670 |
| 8 | .2710 | .2710 | .2710 | .2710 | .2710 | .2710 | .2710 | .2710 | .2710 | .2710 | .2710 | .2710 |
| +gp | .2710 | .2710 | .2710 | .2710 | .2710 | .2710 | .2710 | .2710 | .2710 | .2710 | .2710 | .2710 |
| SOPCOFAC | 1.0356 | .9305 | 1.0873 | 1.0444 | 1.0331 | 1.0703 | 1.0494 | .8348 | .8229 | .9944 | .7882 | .7996 |

Catch weights at age (kg)

| YEAR | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 0 | .0100 | .0100 | .0100 | .0090 | .0060 | .0110 | .0110 | .0170 | .0190 | .0170 |
| 1 | .0590 | .0590 | .0590 | .0360 | .0670 | .0350 | .0550 | .0430 | .0550 | .0580 |
| 2 | .1180 | .1180 | .1180 | .1280 | .1210 | .0990 | .1110 | .1150 | .1140 | .1300 |
| 3 | .1490 | .1490 | .1490 | .1640 | .1530 | .1500 | .1450 | .1530 | .1490 | .1660 |
| 4 | .1790 | .1790 | .1790 | .1940 | .1820 | .1800 | .1740 | .1730 | .1770 | .1840 |
| 5 | .2170 | .2170 | .2170 | .2110 | .2080 | .2110 | .1970 | .2080 | .1930 | .2030 |
| 6 | .2380 | .2380 | .2380 | .2200 | .2210 | .2340 | .2160 | .2310 | .2290 | .2170 |
| 7 | .2650 | .2650 | .2650 | .2580 | .2380 | .2580 | .2370 | .2470 | .2360 | .2350 |
| 8 | .2740 | .2740 | .2740 | .2700 | .2520 | .2770 | .2530 | .2650 | .2500 | .2590 |
| +gp | .2750 | .2750 | .2750 | .2920 | .2620 | .2990 | .2630 | .2590 | .2870 | .2710 |
| SOPCOFAC | .8765 | .7336 | .7236 | .8185 | .7028 | .7623 | .6454 | .8297 | .8250 | .8487 |

## Table 2.7.5

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (r At 7/04/1992 19:36
Traditional vpa Terminal populations from weighted Separable populations

Table 3 Stock weights at age (kg)

| YEAR | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | | | |
| 0 | .0150 | .0150 | .0150 | .0150 | .0150 | .0150 | .0150 | .0150 | .0150 | .0150 | .0150 | .0150 |
| 1 | .0500 | .0500 | .0500 | .0500 | .0500 | .0500 | .0500 | .0500 | .0500 | .0500 | .0500 | .0500 |
| 2 | .1550 | .1550 | .1550 | .1550 | .1550 | .1550 | .1550 | .1550 | .1550 | .1550 | .1550 | .1550 |
| 3 | .1870 | .1870 | .1870 | .1870 | .1870 | .1870 | .1870 | .1870 | .1870 | .1870 | .1870 | .1870 |
| 4 | .2230 | .2230 | .2230 | .2230 | .2230 | .2230 | .2230 | .2230 | .2230 | .2230 | .2230 | .2230 |
| 5 | .2390 | .2390 | .2390 | .2390 | .2390 | .2390 | .2390 | .2390 | .2390 | .2390 | .2390 | .2390 |
| 6 | .2760 | .2760 | .2760 | .2760 | .2760 | .2760 | .2760 | .2760 | .2760 | .2760 | .2760 | .2760 |
| 7 | .2990 | .2990 | .2990 | .2990 | .2990 | .2990 | .2990 | .2990 | .2990 | .2990 | .2990 | .2990 |
| 8 | .3060 | .3060 | .3060 | .3060 | .3060 | .3060 | .3060 | .3060 | .3060 | .3060 | .3060 | .3060 |
| +gp | .3120 | .3120 | .3120 | .3120 | .3120 | .3120 | .3120 | .3120 | .3120 | .3120 | .3120 | .3120 |

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (r At 7/04/1992 19:36
Traditional vpa Terminal populations from weighted Separable populations

Table 3 Stock weights at age (kg)

| YEAR | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 0 | .0150 | .0150 | .0150 | .0090 | .0060 | .0060 | .0070 | .0120 | .0160 | .0170 |
| 1 | .0500 | .0500 | .0500 | .0640 | .0780 | .0490 | .0430 | .0510 | .0640 | .0650 |
| 2 | .1550 | .1550 | .1550 | .1410 | .1460 | .1330 | .1220 | .1400 | .1450 | .1580 |
| 3 | .1870 | .1870 | .1870 | .1930 | .1900 | .1830 | .1630 | .1780 | .1860 | .1980 |
| 4 | .2230 | .2230 | .2230 | .2280 | .2240 | .2200 | .2150 | .2110 | .2080 | .2240 |
| 5 | .2390 | .2390 | .2390 | .2480 | .2480 | .2470 | .2390 | .2540 | .2320 | .2360 |
| 6 | .2760 | .2760 | .2760 | .2580 | .2810 | .2630 | .2700 | .2830 | .2570 | .2600 |
| 7 | .2990 | .2990 | .2990 | .3000 | .2870 | .2850 | .2770 | .2880 | .2820 | .2750 |
| 8 | .3060 | .3060 | .3060 | .3180 | .3280 | .3100 | .2970 | .3160 | .2780 | .2980 |
| +gp | .3120 | .3120 | .3120 | .3160 | .3640 | .3420 | .3100 | .3620 | .3180 | .3170 |

## Table 2.7.6

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (r At 7/04/1992 19:36
Traditional vpa Terminal populations from weighted Separable populations

Table 5 Proportion mature at age

| YEAR | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | | | |
| 0 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 |
| 1 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 |
| 2 | 1.0000 | 1.0000 | .8200 | .8200 | .8200 | .8200 | .8200 | .8200 | .8200 | .8200 | .8200 | .8200 |
| 3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 4 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 5 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 7 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 8 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| +gp | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |

Run title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (r At 7/04/1992 19:36
Traditional vpa Terminal populations from weighted Separable populations

Table 5 Proportion mature at age

| YEAR | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 0 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 |
| 1 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 | .0000 |
| 2 | .8200 | .8200 | .8200 | .7000 | .7500 | .6300 | .6600 | .7900 | .7300 | .6400 |
| 3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | .9000 | .9400 | .9700 | .9700 |
| 4 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 5 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 7 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 8 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| +gp | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |

## Table 2.7.7

Title : Herring in the North Sea Area (Fishing Areas IV and IIIA) (r At 8/04/1992 10:34

Separable analysis
from 1970 to 1991 on ages 0 to 8
With Terminal F of .365 on age 4 and Terminal S of 1.050

Initial sum of squared residuals was 235.419 and
final sum of squared residuals is 101.889 after 114 iterations

Matrix of Residuals

| Years Ages | 1970/71 | 1971/72 | 1972/73 | 1973/74 | 1974/75 | 1975/76 | 1976/77 | 1977/78 | 1978/79 | 1979/80 | 1980/81 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0/ 1 | -1.423 | -2.095 | -.566 | -.998 | -.492 | .661 | .196 | -1.529 | .290 | 2.008 | 1.104 |
| 1/ 2 | -1.367 | -1.004 | .090 | -.339 | -.690 | -.833 | -1.047 | -.161 | .890 | .174 | -.700 |
| 2/ 3 | .247 | -.327 | .505 | .412 | .489 | .245 | .058 | -.873 | -.854 | -.431 | .860 |
| 3/ 4 | .602 | .147 | .613 | .795 | .345 | .279 | .842 | .789 | -.543 | -.461 | .966 |
| 4/ 5 | .421 | .088 | .365 | -.132 | -.079 | -.275 | .106 | .487 | .771 | -.191 | .083 |
| 5/ 6 | -.725 | -.185 | -.436 | -.240 | .273 | .419 | .089 | .355 | .260 | .431 | -.148 |
| 6/ 7 | -.485 | 3.060 | -.283 | .508 | -.153 | -.611 | -.736 | -.293 | -1.618 | -1.504 | -2.278 |
| 7/ 8 | 3.158 | 1.330 | -2.452 | -.595 | -.572 | .418 | -.177 | -1.194 | -1.270 | 1.195 | -1.484 |
| | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| WTS | .001 | | | | | | | | | | |

| WTS | .001 | .001 | .001 | .001 | .001 | .001 | .001 | .001 | .001 | .001 |
|---|---|---|---|---|---|---|---|---|---|---|

| Years Ages | 1981/82 | 1982/83 | 1983/84 | 1984/85 | 1985/86 | 1986/87 | 1987/88 | 1988/89 | 1989/90 | 1990/91 | | WTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0/ 1 | 1.968 | 2.116 | 2.465 | 1.239 | .008 | -.312 | .279 | .220 | .075 | -.266 | .000 | .197 |
| 1/ 2 | -.449 | -.080 | -.069 | -.537 | -.292 | -.263 | -.023 | .442 | -.051 | -.099 | .000 | .468 |
| 2/ 3 | -.733 | .140 | -.005 | -.327 | -.214 | .095 | .035 | -.099 | -.005 | -.025 | .000 | .549 |
| 3/ 4 | -.292 | .732 | -.073 | -.010 | .366 | .147 | .104 | -.115 | -.122 | -.020 | .000 | .553 |
| 4/ 5 | .015 | .044 | -.053 | .113 | .286 | .033 | -.013 | -.056 | .004 | .031 | .000 | 1.000 |
| 5/ 6 | .370 | -.728 | -.229 | .182 | -.137 | -.128 | -.041 | -.029 | .148 | .050 | .000 | .729 |
| 6/ 7 | -.084 | -.984 | -.561 | -.404 | -.165 | .213 | -.093 | -.105 | -.075 | .066 | .000 | .243 |
| 7/ 8 | .569 | -.629 | -.248 | .208 | -.450 | .279 | -.259 | -.136 | -.068 | .187 | .000 | .214 |
| | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | -4.352 | |

| WTS | .001 | .001 | .001 | .001 | .001 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
|---|---|---|---|---|---|---|---|---|---|---|

Fishing Mortalities (F)

| | 1970 | 1971 |
|---|---|---|
| F-values | 1.1259 | 1.2970 |

| | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|
| F-values | .6618 | 1.0466 | 1.0266 | 1.6282 | 1.7181 | 1.3201 | .1385 | .1501 | .3548 | .5587 |

| | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| F-values | .3406 | .4208 | .4816 | .6276 | .5536 | .5701 | .5617 | .5255 | .3984 | .3650 |

Selection-at-age (S)

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| S-values | .1586 | .6884 | .6911 | .7943 | 1.0000 | 1.0753 | 1.1104 | 1.0504 | 1.0500 |

Table 2.7.8

Herring in the North Sea Area (Fishing Areas IV and IIIA) (r At 8/04/1992 10:58
Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

| YEAR | 1970 | 1971 |
|---|---|---|
| AGE | | |
| 0 | .0351 | .0340 |
| 1 | .2681 | .6024 |
| 2 | .9728 | .8831 |
| 3 | 1.2664 | 1.2145 |
| 4 | 1.3354 | 1.2248 |
| 5 | .8704 | 1.0981 |
| 6 | 1.0335 | 2.5147 |
| 7 | 3.2714 | 2.0612 |
| 8 | 1.1628 | .4488 |
| +gp | 1.1628 | .4488 |
| FBAR 2- 6 | 1.0957 | 1.3870 |

Table 8 Fishing mortality (F) at age

| YEAR | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 0 | .0583 | .0467 | .0751 | .1715 | .1567 | .0987 | .0447 | .0836 | .1260 | .4839 |
| 1 | .5789 | .6738 | .4582 | .6897 | .2770 | .3225 | .2028 | .1633 | .1131 | .2861 |
| 2 | .8129 | 1.0249 | 1.0280 | 1.3597 | 1.3486 | .2585 | .0267 | .0962 | .3543 | .3236 |
| 3 | .8024 | 1.3373 | .9801 | 1.5011 | 1.6696 | 1.4514 | .0499 | .0737 | .4280 | .2657 |
| 4 | .7991 | .9909 | 1.0022 | 1.4073 | 1.7198 | .6377 | .1102 | .1114 | .3371 | .3127 |
| 5 | .5478 | .9501 | 1.1973 | 1.9586 | 1.8005 | 1.1545 | .0279 | .0556 | .3277 | .4969 |
| 6 | .5317 | 1.3665 | 1.0743 | 1.3182 | 1.2775 | 1.0998 | .0717 | .0211 | .0717 | .5929 |
| 7 | .0876 | .8498 | .7552 | 1.9921 | 1.7374 | 1.2159 | .1153 | .3972 | .1798 | 1.0862 |
| 8 | .3783 | 1.2098 | 1.5868 | 1.8379 | 1.4773 | 1.7336 | .4338 | .5172 | .3142 | 1.8585 |
| +gp | .3783 | 1.2098 | 1.5868 | 1.8379 | 1.4773 | 1.7336 | .4338 | .5172 | .3142 | 1.8585 |
| FBAR 2- 6 | .6988 | 1.1339 | 1.0564 | 1.5090 | 1.5632 | .9204 | .0573 | .0716 | .3037 | .3984 |

: Herring in the North Sea Area (Fishing Areas IV and IIIA) (r At 8/04/1992 10:58
Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

| YEAR | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 0 | .3357 | .3977 | .2157 | .0839 | .0614 | .1535 | .1113 | .0930 | .0587 | .0682 |
| 1 | .2263 | .2530 | .1940 | .3756 | .3067 | .3650 | .5484 | .3687 | .2870 | .3105 |
| 2 | .2613 | .3044 | .3003 | .3923 | .4414 | .3944 | .3584 | .3665 | .2997 | .3000 |
| 3 | .5072 | .3258 | .4106 | .6566 | .4928 | .5020 | .4279 | .4187 | .3226 | .3345 |
| 4 | .2360 | .4349 | .5093 | .7188 | .5523 | .5671 | .5816 | .5712 | .4658 | .3844 |
| 5 | .1603 | .2596 | .5860 | .6363 | .5219 | .5837 | .6093 | .6500 | .4890 | .4801 |
| 6 | .1865 | .3620 | .3147 | .6765 | .6651 | .5953 | .6028 | .6171 | .4648 | .4682 |
| 7 | .3680 | .5537 | .7095 | .4747 | .6901 | .5200 | .5982 | .5975 | .5058 | .3812 |
| 8 | .5438 | 1.1673 | 1.1208 | .9536 | .5967 | .5622 | .6533 | .6823 | .5206 | .4074 |
| +gp | .5438 | 1.1673 | 1.1208 | .9536 | .5967 | .5622 | .6533 | .6823 | .5206 | .4074 |
| FBAR 2- 6 | .2703 | .3374 | .4242 | .6161 | .5347 | .5285 | .5160 | .5247 | .4084 | .3935 |

## Table 2.7.9

Herring in the North Sea Area (Fishing Areas IV and IIIA) (r At 8/04/1992 10:58
Traditional vpa Terminal populations from weighted Separable populations

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

| YEAR | 1970 | 1971 |
|---|---|---|
| AGE | | |
| 0 | 410609 | 322800 |
| 1 | 78722 | 145842 |
| 2 | 36398 | 22149 |
| 3 | 13300 | 10194 |
| 4 | 1766 | 3069 |
| 5 | 903 | 420 |
| 6 | 987 | 342 |
| 7 | 84 | 318 |
| 8 | 182 | 3 |
| +gp | 185 | 359 |
| TOTAL | 543136 | 505496 |

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

| YEAR | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 0 | 208636 | 99956 | 216609 | 26114 | 25649 | 42882 | 46882 | 106203 | 167027 | 377543 |
| 1 | 114781 | 72406 | 35094 | 73924 | 8093 | 8067 | 14293 | 16493 | 35937 | 54173 |
| 2 | 29374 | 23668 | 13579 | 8165 | 13644 | 2257 | 2150 | 4293 | 5153 | 11807 |
| 3 | 6785 | 9653 | 6292 | 3599 | 1553 | 2624 | 1291 | 1551 | 2889 | 2679 |
| 4 | 2478 | 2490 | 2075 | 1933 | 657 | 239 | 503 | 1006 | 1179 | 1542 |
| 5 | 816 | 1008 | 836 | 689 | 428 | 106 | 115 | 408 | 814 | 762 |
| 6 | 127 | 427 | 353 | 229 | 88 | 64 | 30 | 101 | 349 | 531 |
| 7 | 25 | 67 | 99 | 109 | 55 | 22 | 19 | 26 | 89 | 294 |
| 8 | 37 | 21 | 26 | 42 | 13 | 9 | 6 | 16 | 16 | 67 |
| +gp | 13 | 9 | 14 | 17 | 5 | 0 | 9 | 3 | 4 | 13 |
| TOTAL | 363072 | 209705 | 274977 | 114821 | 50186 | 56271 | 65298 | 130098 | 213457 | 449410 |

: Herring in the North Sea Area (Fishing Areas IV and IIIA) (r At 8/04/1992 10:58
Traditional vpa Terminal populations from weighted Separable populations

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

| YEAR | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | | |
| 0 | 645537 | 620730 | 533622 | 815588 | 968895 | 882151 | 464632 | 527579 | 344330 | 550692 | 0 |
| 1 | 85610 | 169767 | 153421 | 158214 | 275885 | 335217 | 278343 | 152919 | 176851 | 119454 | 189239 |
| 2 | 14971 | 25116 | 48494 | 46489 | 39980 | 74682 | 85605 | 59170 | 38909 | 48828 | 32215 |
| 3 | 6329 | 8540 | 13723 | 26606 | 23263 | 19049 | 37292 | 44317 | 30383 | 21360 | 26797 |
| 4 | 1681 | 3120 | 5048 | 7452 | 11297 | 11635 | 9440 | 19903 | 23871 | 18017 | 12516 |
| 5 | 1020 | 1202 | 1828 | 2745 | 3286 | 5884 | 5971 | 4775 | 10172 | 13557 | 11100 |
| 6 | 419 | 786 | 839 | 920 | 1314 | 1764 | 2970 | 2938 | 2256 | 5644 | 7590 |
| 7 | 265 | 315 | 495 | 554 | 423 | 612 | 880 | 1471 | 1434 | 1282 | 3198 |
| 8 | 90 | 166 | 164 | 221 | 312 | 192 | 329 | 438 | 732 | 783 | 792 |
| +gp | 27 | 183 | 275 | 271 | 340 | 195 | 183 | 183 | 304 | 394 | 709 |
| TOTAL | 755950 | 829925 | 757909 | 1059061 | 1324996 | 1331381 | 885647 | 813692 | 629243 | 780013 | 284155 |

## Table 2.7.10

Herring in the North Sea Area (Fishing Areas IV and IIIA) (r At 8/04/1992 10:59
Traditional vpa Terminal populations from weighted Separable populations

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

| YEAR | 1970 | 1971 |
|---|---|---|
| AGE | | |
| 0 | 0 | 0 |
| 1 | 0 | 0 |
| 2 | 240475 | 155393 |
| 3 | 93112 | 73891 |
| 4 | 15053 | 28173 |
| 5 | 11265 | 4502 |
| 6 | 12741 | 1638 |
| 7 | 263 | 2232 |
| 8 | 2386 | 61 |
| +gp | 2473 | 7755 |
| TOTSPBIO | 377769 | 273646 |

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

| YEAR | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 177129 | 123821 | 70892 | 34133 | 57464 | 19730 | 21951 | 41843 | 42250 | 98818 |
| 3 | 64819 | 64441 | 53359 | 21527 | 8298 | 16229 | 20421 | 24136 | 35466 | 36664 |
| 4 | 30249 | 26735 | 22110 | 15702 | 4326 | 3257 | 9748 | 19463 | 19622 | 26073 |
| 5 | 12635 | 11923 | 8382 | 4147 | 2864 | 1097 | 2512 | 8782 | 14607 | 12204 |
| 6 | 2293 | 4411 | 4433 | 2439 | 965 | 791 | 747 | 2564 | 8587 | 9208 |
| 7 | 660 | 1067 | 1661 | 802 | 483 | 275 | 499 | 548 | 2213 | 3971 |
| 8 | 812 | 264 | 258 | 350 | 143 | 79 | 127 | 315 | 360 | 556 |
| +gp | 301 | 115 | 145 | 147 | 58 | 0 | 195 | 53 | 92 | 113 |
| TOTSPBIO | 288899 | 232777 | 161239 | 79246 | 74602 | 41458 | 56199 | 97704 | 123197 | 187607 |

Herring in the North Sea Area (Fishing Areas IV and IIIA) (r At 8/04/1992 10:59
Traditional vpa Terminal populations from weighted Separable populations

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

| YEAR | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 130634 | 212921 | 412246 | 288544 | 266398 | 392951 | 443433 | 418711 | 275579 | 330304 |
| 3 | 73687 | 112279 | 170459 | 289262 | 277862 | 217795 | 359200 | 489885 | 386250 | 286757 |
| 4 | 29936 | 48625 | 74838 | 98166 | 163467 | 163720 | 128554 | 267843 | 339877 | 291744 |
| 5 | 20483 | 22568 | 27586 | 41564 | 53726 | 91931 | 88730 | 73378 | 159037 | 216912 |
| 6 | 9553 | 15928 | 17531 | 14114 | 22122 | 29123 | 50078 | 51420 | 39704 | 100283 |
| 7 | 5800 | 6076 | 8613 | 11308 | 7157 | 11506 | 15274 | 26546 | 26950 | 25542 |
| 8 | 1785 | 2176 | 2212 | 3462 | 6413 | 3822 | 5899 | 8193 | 13431 | 16599 |
| +gp | 556 | 2441 | 3787 | 4234 | 7754 | 4270 | 3425 | 3919 | 6383 | 8899 |
| TOTSPBIO | 272433 | 423014 | 717271 | 750654 | 804900 | 915117 | 1094593 | 1339895 | 1247212 | 1277039 |

Table 2.7.11 Herring in the southern North Sea (fishing areas IVc and VIId).

Catch numbers at age Numbers*10**-3

| YEAR | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 |
|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | |
| 1 | 21300 | 400 | 3600 | 3600 | 6000 | 5500 | 4200 | 21800 |
| 2 | 22300 | 25500 | 54800 | 42400 | 22900 | 161800 | 81600 | 130800 |
| 3 | 78500 | 60500 | 9900 | 15400 | 19900 | 8800 | 83800 | 41700 |
| 4 | 700 | 32600 | 1200 | 4900 | 9700 | 5300 | 5400 | 31100 |
| 5 | 5900 | 2100 | 3100 | 2200 | 1500 | 1900 | 1600 | 700 |
| 6 | 10 | 2400 | 10 | 100 | 3000 | 400 | 1000 | 300 |
| 7 | 10 | 500 | 10 | 10 | 600 | 400 | 100 | 600 |
| 8 | 10 | 10 | 10 | 10 | 10 | 10 | 400 | 10 |
| +gp | 10 | 30 | 10 | 10 | 10 | 20 | 100 | 300 |
| TOTALNUM | 128740 | 124040 | 72640 | 68630 | 63620 | 184130 | 178200 | 227310 |
| TONSLAND | 56572 | 21777 | 11623 | 11446 | 9610 | 24322 | 27086 | 23451 |
| SOPCOF % | 316 | 114 | 123 | 124 | 104 | 104 | 113 | 93 |

Catch numbers at age Numbers*10**-3

| YEAR | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 4800 | 2200 | 3900 | 24100 | 22200 | 900 | 400 | 400 | 23400 | 7300 |
| 2 | 135100 | 43300 | 24100 | 127200 | 94400 | 6400 | 2800 | 21600 | 99100 | 222600 |
| 3 | 29300 | 115100 | 20300 | 39600 | 41800 | 3000 | 4000 | 9000 | 83800 | 40400 |
| 4 | 9300 | 55000 | 8400 | 5300 | 3500 | 700 | 1200 | 5600 | 30200 | 19300 |
| 5 | 5000 | 7400 | 1200 | 1800 | 500 | 200 | 10 | 600 | 18400 | 6700 |
| 6 | 10 | 1900 | 100 | 10 | 300 | 10 | 10 | 100 | 1700 | 3300 |
| 7 | 10 | 500 | 200 | 10 | 10 | 10 | 10 | 10 | 500 | 600 |
| 8 | 10 | 100 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| +gp | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| TOTALNUM | 183540 | 225510 | 58220 | 198040 | 162730 | 11240 | 8450 | 37330 | 257120 | 300220 |
| TONSLAND | 23004 | 30163 | 7383 | 25527 | 17526 | 1446 | 1591 | 6552 | 43086 | 41883 |
| SOPCOF % | 101 | 90 | 99 | 101 | 101 | 101 | 105 | 101 | 99 | 103 |

Catch numbers at age Numbers*10**-3

| YEAR | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 20900 | 25100 | 13700 | 13100 | 10800 | 19700 | 4400 | 12600 | 10858 | 19500 |
| 2 | 201200 | 251700 | 172600 | 314100 | 107600 | 161400 | 112000 | 106100 | 139347 | 79100 |
| 3 | 221400 | 105100 | 116600 | 169000 | 193700 | 77400 | 212800 | 205400 | 95411 | 120600 |
| 4 | 26500 | 64500 | 33000 | 44100 | 45700 | 80500 | 45300 | 182000 | 109117 | 59300 |
| 5 | 6800 | 11100 | 22600 | 12300 | 13500 | 13800 | 32500 | 31500 | 59573 | 50100 |
| 6 | 2200 | 3000 | 2000 | 8400 | 9200 | 6500 | 5800 | 19500 | 7931 | 33500 |
| 7 | 1500 | 500 | 500 | 1400 | 1900 | 200 | 800 | 3400 | 4717 | 3600 |
| 8 | 500 | 500 | 30 | 100 | 100 | 100 | 500 | 1200 | 1307 | 3400 |
| +gp | 100 | 100 | 400 | 200 | 400 | 600 | 0 | 40 | 581 | 0 |
| TOTALNUM | 481100 | 461600 | 361430 | 562700 | 382900 | 360200 | 414100 | 561740 | 428842 | 369100 |
| TONSLAND | 68652 | 64430 | 45643 | 68979 | 51290 | 44598 | 52404 | 78794 | 61082 | 60685 |
| SOPCOF % | 109 | 103 | 99 | 102 | 100 | 100 | 97 | 103 | 102 | 101 |

**Table 2.7.12** Assessment quality diagram, herring total North Sea. Average FISHING MORTALITY for 2-ringers and older. Unweighted average except for the period 1982-1985.

| | Date of assessment | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | Year |
| 1969 | .89 | .88 | .90 | .90 | .89 | .91 | .91 | | | | .90 | .91 | | | 1.06 | 1.03 | 1.09 | 1.03 | | | | 1969 |
| 1970 | 1.05 | 1.05 | 1.13 | 1.14 | 1.13 | 1.15 | 1.15 | | | | 1.14 | 1.15 | | 1.15 | 1.31 | 1.10 | 1.13 | 1.10 | 1.10 | 1.10 | 1.10 | 1970 |
| 1971 | 1.00 | ? | 1.09 | 1.12 | 1.11 | 1.12 | 1.12 | | | | 1.12 | 1.12 | | 1.12 | 1.39 | 1.36 | 1.48 | 1.36 | 1.41 | 1.37 | 1.39 | 1971 |
| 1972 | | .70 | ? | .89 | .86 | .88 | .88 | | | | .87 | .87 | | .88 | .71 | .69 | .65 | .69 | .70 | .69 | .70 | 1972 |
| 1973 | | | .70 | ? | 1.12 | 1.17 | 1.17 | | | | 1.14 | 1.14 | | 1.18 | 1.14 | 1.11 | 1.13 | 1.11 | 1.14 | 1.13 | 1.13 | 1973 |
| 1974 | | | | 1.00 | .94 | 1.03 | 1.03 | | | | 1.02 | 1.02 | 1.04 | 1.08 | 1.07 | 1.04 | 1.04 | 1.04 | 1.06 | 1.05 | 1.06 | 1974 |
| 1975 | | | | | .90 | 1.27 | 1.27 | | | | 1.18 | 1.09 | 1.30 | 1.42 | 1.45 | 1.41 | 1.46 | 1.41 | 1.52 | 1.45 | 1.51 | 1975 |
| 1976 | | | | | | .80 | .80 | | | | .83 | .99 | 1.28 | 1.43 | 1.31 | 1.27 | 1.26 | 1.27 | 1.59 | 1.36 | 1.56 | 1976 |
| 1977 | | | | | | | .18 | | | | .24 | .36 | .61 | .79 | .69 | .67 | .79 | .67 | .97 | .73 | .92 | 1977 |
| 1978 | | | | | | | | | .02 | | .01 | .02 | .03 | .04 | .05 | .05 | .05 | .05 | .06 | .05 | .06 | 1978 |
| 1979 | | | | | | | | | .02 | | .03 | .05 | .08 | .08 | .06 | .06 | .05 | .06 | .07 | .06 | .07 | 1979 |
| 1980 | | | | | | | | | | | .15 | .20 | .29 | .32 | .25 | .24 | .23 | .24 | .29 | .27 | .30 | 1980 |
| 1981 | | | | | | | | | | | .15 | .20 | .28 | .32 | .30 | .30 | .30 | .30 | .39 | .33 | .40 | 1981 |
| 1982 | | | | | | | | | | | | .19 | .25 | .29 | .23 | .24 | .25 | .24 | .26 | .25 | .27 | 1982 |
| 1983 | | | | | | | | | | | | | .25 | .29 | .28 | .31 | .33 | .32 | .32 | .33 | .34 | 1983 |
| 1984 | | | | | | | | | | | | | | .32 | .33 | .38 | .45 | .41 | .41 | .42 | .42 | 1984 |
| 1985 | | | | | | | | | | | | | | | .39 | .54 | .67 | .61 | .58 | .60 | .62 | 1985 |
| 1986 | | | | | | | | | | | | | | | | .45 | .55 | .53 | .49 | .51 | .53 | 1986 |
| 1987 | | | | | | | | | | | | | | | | | .55 | .55 | .49 | .49 | .52 | 1987 |
| 1988 | | | | | | | | | | | | | | | | | | .58 | .47 | .46 | .52 | 1988 |
| 1989 | | | | | | | | | | | | | | | | | | | .47 | .44 | .52 | 1989 |
| 1990 | | | | | | | | | | | | | | | | | | | | .33 | .41 | 1990 |
| 1991 | | | | | | | | | | | | | | | | | | | | | .39 | 1991 |
| 1992 | | | | | | | | | | | | | | | | | | | | | | 1992 |
| 1993 | | | | | | | | | | | | | | | | | | | | | | 1993 |
| 1994 | | | | | | | | | | | | | | | | | | | | | | 1994 |

**Table 2.7.13** Assessment quality diagram, herring total North Sea. RECRUITMENT as 2-ringers (billions). Figures below the indicated "diagonal" are prognosis.

| | Date of assessment | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | Year |
| 1969 | 3.40 | 3.40 | 3.38 | 3.35 | 3.39 | 3.36 | 3.36 | | | | 3.36 | 3.36 | | | 3.36 | 3.94 | 3.94 | 3.94 | | | | 1969 |
| 1970 | 3.32 | 3.32 | 3.16 | 3.15 | 3.19 | 3.15 | 3.15 | | | | 3.15 | 3.15 | | 3.15 | 3.15 | 3.64 | 3.64 | 3.64 | 3.64 | 3.64 | 3.64 | 1970 |
| 1971 | 3.33 | ? | 1.93 | 1.90 | 1.92 | 1.90 | 1.90 | | | | 1.90 | 1.90 | | 1.90 | 1.90 | 2.22 | 2.22 | 2.22 | 2.22 | 2.22 | 2.21 | 1971 |
| 1972 | 5.40 | ? | ? | 2.49 | 2.58 | 2.52 | 2.52 | | | | 2.53 | 2.53 | | 2.52 | 2.52 | 2.94 | 2.94 | 2.94 | 2.94 | 2.94 | 2.94 | 1972 |
| 1973 | | 3.10 | ? | ? | 2.13 | 2.08 | 2.08 | | | | 2.11 | 2.11 | | 2.06 | 2.06 | 2.38 | 2.38 | 2.38 | 2.37 | 2.38 | 2.37 | 1973 |
| 1974 | | | 2.20 | ? | 1.31 | 1.22 | 1.22 | | | | 1.20 | 1.20 | 1.19 | 1.18 | 1.18 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1974 |
| 1975 | | | | 1.22 | ? | .78 | .78 | | | | .84 | .91 | .77 | .76 | .76 | .86 | .86 | .86 | .82 | .84 | .82 | 1975 |
| 1976 | | | | | | ? | ? | | | | 1.64 | 1.39 | 1.26 | 1.22 | 1.22 | 1.38 | 1.38 | 1.38 | 1.36 | 1.38 | 1.36 | 1976 |
| 1977 | | | | | | | .54 | | | | .49 | .29 | .24 | .23 | .23 | .29 | .29 | .29 | .23 | .27 | .23 | 1977 |
| 1978 | | | | | | | .63 | | .63 | | .43 | .25 | .21 | .21 | .21 | .26 | .26 | .26 | .22 | .25 | .22 | 1978 |
| 1979 | | | | | | | | | 1.26 | | .62 | .49 | .37 | .37 | .37 | .46 | .46 | .46 | .44 | .45 | .43 | 1979 |
| 1980 | | | | | | | | | .24 | | .46 | .47 | .39 | .36 | .40 | .50 | .50 | .50 | .49 | .52 | .52 | 1980 |
| 1981 | | | | | | | | | | | 1.53 | 1.50 | 1.15 | 1.02 | .99 | 1.19 | 1.16 | 1.16 | 1.17 | 1.18 | 1.18 | 1981 |
| 1982 | | | | | | | | | | | | 1.70 | 1.41 | 1.31 | 1.30 | 1.54 | 1.46 | 1.46 | 1.49 | 1.51 | 1.50 | 1982 |
| 1983 | | | | | | | | | | | | | 2.57 | 2.31 | 2.46 | 2.53 | 2.50 | 2.48 | 2.52 | 2.54 | 2.51 | 1983 |
| 1984 | | | | | | | | | | | | | 4.10 | 3.95 | 5.11 | 4.96 | 4.76 | 4.71 | 4.77 | 4.91 | 4.85 | 1984 |
| 1985 | | | | | | | | | | | | | | 5.30 | 4.81 | 4.66 | 4.59 | 4.54 | 4.63 | 4.77 | 4.65 | 1985 |
| 1986 | | | | | | | | | | | | | | | 6.03 | 4.49 | 3.72 | 3.84 | 4.07 | 4.10 | 4.00 | 1986 |
| 1987 | | | | | | | | | | | | | | | | 5.43 | 6.70 | 6.12 | 7.34 | 7.98 | 7.47 | 1987 |
| 1988 | | | | | | | | | | | | | | | | | 8.00 | 6.09 | 7.68 | 9.43 | 8.56 | 1988 |
| 1989 | | | | | | | | | | | | | | | | | | 6.18 | 4.56 | 5.95 | 5.92 | 1989 |
| 1990 | | | | | | | | | | | | | | | | | | | 3.95 | 3.04 | 3.89 | 1990 |
| 1991 | | | | | | | | | | | | | | | | | | | | 3.20 | 4.88 | 1991 |
| 1992 | | | | | | | | | | | | | | | | | | | | | 4.45 | 1992 |
| 1993 | | | | | | | | | | | | | | | | | | | | | | 1993 |
| 1994 | | | | | | | | | | | | | | | | | | | | | | 1994 |

**Table 2.7.14** Assessment quality diagram, herring total North Sea. SPAWNING STOCK. Figures given with decimal point are number in billions, the remaining table is biomass in thousand tonnes. Figures below the indicated "diagonal" are prognosis.

| | Date of assessment | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | Year |
| 1969 | 4.69 | 4.71 | 4.63 | 4.62 | 4.67 | 4.61 | 4.61 | | | | 359 | | | | 409 | 436 | 434 | 434 | | | | 1969 |
| 1970 | 5.07 | 5.12 | 4.87 | 4.85 | 4.90 | 4.81 | 4.81 | | | | 318 | | | 361 | 361 | 382 | 381 | 381 | 378 | 378 | 378 | 1970 |
| 1971 | 4.92 | ? | 3.37 | 3.30 | 3.36 | 3.29 | 3.29 | | | | 219 | | | 251 | 251 | 267 | 266 | 266 | 265 | 268 | 274 | 1971 |
| 1972 | 7.28 | ? | ? | 3.47 | 3.60 | 3.49 | 3.49 | | | | 269 | 263 | | 310 | 274 | 291 | 290 | 290 | 327 | 289 | 289 | 1972 |
| 1973 | | 4.91 | ? | ? | 3.52 | 3.40 | 3.40 | | | | 228 | 225 | | 250 | 225 | 237 | 236 | 236 | 260 | 235 | 233 | 1973 |
| 1974 | | | 4.04 | ? | 2.35 | 2.18 | 2.18 | | | | 166 | 173 | 164 | 173 | 159 | 165 | 165 | 165 | 176 | 163 | 161 | 1974 |
| 1975 | | | | 1.97 | 146 | 1.48 | 1.48 | | | | 107 | 111 | 96 | 93 | 85 | 88 | 88 | 88 | 86 | 83 | 79 | 1975 |
| 1976 | | | | | 249 | 155 | | | 155 | | 160 | 129 | 98 | 93 | 80 | 85 | 85 | 85 | 87 | 80 | 75 | 1976 |
| 1977 | | | | | 351 | 185 | 180 | | 180 | | 172 | 114 | 72 | 59 | 54 | 58 | 58 | 58 | 45 | 52 | 41 | 1977 |
| 1978 | | | | | 494 | 289 | 275 | | 271 | | 231 | 150 | 99 | 80 | 75 | 79 | 79 | 79 | 61 | 71 | 56 | 1978 |
| 1979 | | | | | 696 | 400 | 435 | | 442 | | 311 | 174 | 131 | 129 | 120 | 123 | 123 | 123 | 109 | 114 | 98 | 1979 |
| 1980 | | | | | 930 | | | | 508 | | 345 | 197 | 153 | 149 | 146 | 148 | 148 | 148 | 133 | 140 | 123 | 1980 |
| 1981 | | | | | | | | | | | 482 | 313 | 237 | 234 | 214 | 218 | 214 | 214 | 212 | 205 | 188 | 1981 |
| 1982 | | | | | | | | | | | | 433 | 344 | 338 | 308 | 306 | 293 | 293 | 278 | 289 | 272 | 1982 |
| 1983 | | | | | | | | | | | | | 563 | 555 | 521 | 471 | 452 | 451 | 434 | 446 | 423 | 1983 |
| 1984 | | | | | | | | | | | | | 797 | 837 | 968 | 782 | 741 | 733 | 732 | 743 | 717 | 1984 |
| 1985 | | | | | | | | | | | | | 1162 | 1180 | 1196 | 839 | 770 | 757 | 777 | 780 | 751 | 1985 |
| 1986 | | | | | | | | | | | | | | 1800 | 1314 | 941 | 805 | 801 | 847 | 844 | 805 | 1986 |
| 1987 | | | | | | | | | | | | | | 2000 | 1680 | 1060 | 862 | 821 | 964 | 991 | 915 | 1987 |
| 1988 | | | | | | | | | | | | | | | 1790 | 1540 | 1171 | 822 | 1102 | 1242 | 1095 | 1988 |
| 1989 | | | | | | | | | | | | | | | | 1700 | 1466 | 961 | 1256 | 1549 | 1340 | 1989 |
| 1990 | | | | | | | | | | | | | | | | | 1559 | 1178 | 1262 | 1411 | 1247 | 1990 |
| 1991 | | | | | | | | | | | | | | | | | | 1212 | 1282 | 1320 | 1277 | 1991 |
| 1992 | | | | | | | | | | | | | | | | | | | 1080 | 1374 | | 1992 |
| 1993 | | | | | | | | | | | | | | | | | | | | 1237 | | 1993 |
| 1994 | | | | | | | | | | | | | | | | | | | | | | 1994 |

**Table 2.8.1** Proportion and abundance of each year class as 1-ringers in Division IIIa and survey indices related to that abundance.

| Year class (aut. sp.) | Proportion in IIIa (1 ringers) | No. of 1-ringers IIIa (millions) | MIK index N.S. + IIIa | Acoustic estimates | |
|---|---|---|---|---|---|
| | | | | 0-ringers August IIIa | 0-ringers November IIIa |
| 1981 | 0.33 | 5,602 | 133.9 | 3,394 | - |
| 1982 | 0.35 | 5,369 | 91.8 | 783 | - |
| 1983 | 0.35 | 5,537 | 115.0 | 552 | - |
| 1984 | 0.52 | 14,346 | 181.3 | 3,583 | 5,814 |
| 1985 | 0.37 | 12,403 | 177.4 | 8,187 | 6,513 |
| 1986 | 0.69 | 19,206 | 270.9 | 11,548 | 10,192 |
| 1987 | 0.34 | 5,199 | 168.9 | 3,706 | 2,527 |
| 1988 | 0.22 | 3,890 | 71.4 | 1,058 | 224 |
| 1989 | 0.15 | 1,792 | 25.9 | 77 | 463 |
| 1990 | 0.25 | - | 69,9 | 994 | 287 |
| 1991 | - | - | 200.7 | - | - |

Regressions: No of 1-ringers in Division IIIa (millions) =

| | | |
|---|---|---|
| $72.1 \cdot MIK - 1759$ | $r^2 = 0.786$ | or $61.8 \cdot MIK$ |
| $1.3 \cdot ACO_A + 3397$ | $r^2 = 0.728$ | or $1.8 \cdot ACO_A$ |
| $1.7 \cdot ACO_N + 2116$ | $r^2 = 0.943$ | or $2.0 \cdot ACO_N$ |

Proportion in IIIa =

| | | |
|---|---|---|
| $2.02 \cdot 10^{-3} \cdot MIK + 0.09$ | $r^2 = 0.835$ | or $2.55 \cdot 10\text{-}3 \cdot MIK$ |
| $3.2 \cdot 10^{-5} \cdot ACO_A + 0.025$ | $r^2 = 0.553$ | or $6.6 \cdot 10\text{-}5 \cdot ACO_A$ |
| $4.7 \cdot 10^{-5} \cdot ACO_N + 0.178$ | $r^2 = 0.846$ | or $7.2 \cdot 10\text{-}5 \cdot ACO_N$ |

Table 2.8.2. Predicted catch and biomass of North Sea autumn spawning herring in 1992. Status quo F for 3+ and 0-ringer and catch of 1- and 2-ringers estimated based on relative abundance and unchanged effort.

| AGE | STOCK SIZE | ABSOLUTE F | YIELD NS OTHER | YIELD NS SM. M. | YIELD NS TOTAL | YIELD 3A HC | YIELD 3A MIXED | YIELD 3A IND. L. | YIELD 3A TOTAL | YIELD TOTAL AS | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 84700 | 0.07 | 0 | 40370 | 40370 | 110 | 11704 | 13739 | 25553 | 65923 | 0 | 0 |
| 1 | 14970 | 0.28 | 1369 | 56575 | 57944 | 19054 | 6646 | 28614 | 54313 | 112257 | 0 | 0 |
| 2 | 4550 | 0.29 | 79114 | 23441 | 102555 | 9564 | 471 | 6310 | 16345 | 118901 | 2239 | 353755 |
| 3 | 2680 | 0.33 | 108774 | 6877 | 115650 | 0 | 0 | 0 | 0 | 115650 | 1817 | 359762 |
| 4 | 1252 | 0.42 | 71856 | 3913 | 75768 | 0 | 0 | 0 | 0 | 75768 | 883 | 197786 |
| 5 | 1110 | 0.45 | 75574 | 2993 | 78567 | 0 | 0 | 0 | 0 | 78567 | 766 | 180865 |
| 6 | 759 | 0.47 | 56353 | 2438 | 58791 | 0 | 0 | 0 | 0 | 58791 | 519 | 134905 |
| 7 | 320 | 0.44 | 24809 | 1038 | 25847 | 0 | 0 | 0 | 0 | 25847 | 222 | 61187 |
| 8 | 79 | 0.44 | 6687 | 270 | 6957 | 0 | 0 | 0 | 0 | 6957 | 55 | 16370 |
| 9 | 71 | 0.44 | 6333 | 230 | 6563 | 0 | 0 | 0 | 0 | 6563 | 49 | 15650 |
| TOTAL | 110491 | | 430869 | 138144 | 569013 | 28728 | 18820 | 48663 | 96212 | 665225 | 6551 | 1320279 |

| AGE | STOCK SIZE | ABSOLUTE F | CATCH NS OTHER | CATCH NS SM. M. | CATCH NS TOTAL | CATCH 3A HC | CATCH 3A MIXED | CATCH 3A IND. L. | CATCH 3A TOTAL | CATCH TOTAL AS | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 84700 | 0.07 | 0 | 2375 | 2375 | 3 | 509 | 509 | 1021 | 3395 | 0 | 0 |
| 1 | 14970 | 0.28 | 81 | 975 | 1056 | 224 | 277 | 818 | 1319 | 2375 | 0 | 0 |
| 2 | 4550 | 0.29 | 517 | 266 | 783 | 99 | 12 | 99 | 209 | 993 | 2239 | 353755 |
| 3 | 2680 | 0.33 | 625 | 69 | 695 | 0 | 0 | 0 | 0 | 695 | 1817 | 359762 |
| 4 | 1252 | 0.42 | 382 | 29 | 411 | 0 | 0 | 0 | 0 | 411 | 883 | 197786 |
| 5 | 1110 | 0.45 | 367 | 19 | 386 | 0 | 0 | 0 | 0 | 386 | 766 | 180865 |
| 6 | 759 | 0.47 | 257 | 14 | 271 | 0 | 0 | 0 | 0 | 271 | 519 | 134905 |
| 7 | 320 | 0.44 | 104 | 5 | 109 | 0 | 0 | 0 | 0 | 109 | 222 | 61187 |
| 8 | 79 | 0.44 | 26 | 1 | 27 | 0 | 0 | 0 | 0 | 27 | 55 | 16370 |
| 9 | 71 | 0.44 | 23 | 1 | 24 | 0 | 0 | 0 | 0 | 24 | 49 | 15650 |
| TOTAL | 110491 | | 2382 | 3756 | 6137 | 326 | 798 | 1425 | 2549 | 8686 | 6551 | 1320279 |

| AGE | STOCK SIZE | ABSOLUTE F | F NS OTHER | F NS SM. M. | F 3A HC | F 3A MIXED | F 3A IND. L. | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 84700 | 0.07 | 0.00 | 0.05 | 0.00 | 0.01 | 0.01 | 0 | 0 |
| 1 | 14970 | 0.28 | 0.01 | 0.12 | 0.03 | 0.03 | 0.10 | 0 | 0 |
| 2 | 4550 | 0.29 | 0.15 | 0.08 | 0.03 | 0.00 | 0.03 | 2239 | 353755 |
| 3 | 2680 | 0.33 | 0.30 | 0.03 | 0.00 | 0.00 | 0.00 | 1817 | 359762 |
| 4 | 1252 | 0.42 | 0.39 | 0.03 | 0.00 | 0.00 | 0.00 | 883 | 197786 |
| 5 | 1110 | 0.45 | 0.43 | 0.02 | 0.00 | 0.00 | 0.00 | 766 | 180865 |
| 6 | 759 | 0.47 | 0.44 | 0.02 | 0.00 | 0.00 | 0.00 | 519 | 134905 |
| 7 | 320 | 0.44 | 0.42 | 0.02 | 0.00 | 0.00 | 0.00 | 222 | 61187 |
| 8 | 79 | 0.44 | 0.42 | 0.02 | 0.00 | 0.00 | 0.00 | 55 | 16370 |
| 9 | 71 | 0.44 | 0.42 | 0.02 | 0.00 | 0.00 | 0.00 | 49 | 15650 |
| TOTAL | 110491 | | | | | | | 6551 | 1320279 |

Yield = Catch in t. Catch = Catch in number (mill.).
NS SM. M. = Small meshed fisheries in the North Sea
NS OTHER = Other fisheries in the North Sea
3A HC = Human consumption landings in Division IIIa
3A MIXED = Mixed clupeoid landings in Division IIIa
3A IND. L. = Other industrial landings in Division IIIa

Table 2.8.3. Predicted catch and biomass of North Sea autumn spawning herring in 1993. Status quo F for 3+ and 0-ringer and catch of 1- and 2-ringers estimated based on relative abundance and unchanged effort.

| AGE | STOCK SIZE | ABSOLUTE F | YIELD NS OTHER | YIELD NS SM. M. | YIELD NS TOTAL | YIELD 3A HC | YIELD 3A MIXED | YIELD 3A IND. L. | YIELD 3A TOTAL | YIELD TOTAL AS | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.07 | 0 | 33813 | 33813 | 92 | 9803 | 11508 | 21403 | 55216 | 0 | 0 |
| 1 | 29194 | 0.38 | 7196 | 84526 | 91722 | 63146 | 22025 | 94829 | 180000 | 271722 | 0 | 0 |
| 2 | 4156 | 0.32 | 65936 | 19537 | 85472 | 15250 | 751 | 10062 | 26063 | 111535 | 2005 | 316813 |
| 3 | 2526 | 0.33 | 102479 | 6479 | 108958 | 0 | 0 | 0 | 0 | 108958 | 1712 | 339052 |
| 4 | 1570 | 0.38 | 83644 | 4554 | 88199 | 0 | 0 | 0 | 0 | 88199 | 1135 | 254249 |
| 5 | 743 | 0.48 | 53000 | 2099 | 55099 | 0 | 0 | 0 | 0 | 55099 | 504 | 118950 |
| 6 | 639 | 0.47 | 47451 | 2053 | 49504 | 0 | 0 | 0 | 0 | 49504 | 436 | 113460 |
| 7 | 430 | 0.38 | 29557 | 1237 | 30794 | 0 | 0 | 0 | 0 | 30794 | 312 | 85705 |
| 8 | 186 | 0.41 | 14738 | 594 | 15333 | 0 | 0 | 0 | 0 | 15333 | 132 | 39461 |
| 9 | 87 | 0.41 | 7280 | 265 | 7545 | 0 | 0 | 0 | 0 | 7545 | 62 | 19678 |
| TOTAL | 107532 | | 411282 | 155156 | 566438 | 78488 | 32579 | 116398 | 227465 | 793904 | 6299 | 1287369 |

| AGE | STOCK SIZE | ABSOLUTE F | CATCH NS OTHER | CATCH NS SM. M. | CATCH NS TOTAL | CATCH 3A HC | CATCH 3A MIXED | CATCH 3A IND. L. | CATCH 3A TOTAL | CATCH TOTAL AS | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.07 | 0 | 1989 | 1989 | 3 | 426 | 426 | 855 | 2844 | 0 | 0 |
| 1 | 29194 | 0.38 | 122 | 1457 | 1579 | 743 | 918 | 2709 | 4370 | 5949 | 0 | 0 |
| 2 | 4156 | 0.32 | 431 | 222 | 653 | 157 | 19 | 157 | 334 | 987 | 2005 | 316813 |
| 3 | 2526 | 0.33 | 589 | 65 | 654 | 0 | 0 | 0 | 0 | 654 | 1712 | 339052 |
| 4 | 1570 | 0.38 | 445 | 33 | 478 | 0 | 0 | 0 | 0 | 478 | 1135 | 254249 |
| 5 | 743 | 0.48 | 257 | 14 | 271 | 0 | 0 | 0 | 0 | 271 | 504 | 118950 |
| 6 | 639 | 0.47 | 217 | 11 | 228 | 0 | 0 | 0 | 0 | 228 | 436 | 113460 |
| 7 | 430 | 0.38 | 124 | 7 | 130 | 0 | 0 | 0 | 0 | 130 | 312 | 85705 |
| 8 | 186 | 0.41 | 56 | 3 | 59 | 0 | 0 | 0 | 0 | 59 | 132 | 39461 |
| 9 | 87 | 0.41 | 26 | 1 | 28 | 0 | 0 | 0 | 0 | 28 | 62 | 19678 |
| TOTAL | 107532 | | 2267 | 3803 | 6070 | 903 | 1363 | 3293 | 5559 | 11629 | 6299 | 1287369 |

| AGE | STOCK SIZE | ABSOLUTE F | F NS OTHER | F NS SM. M. | F 3A HC | F 3A MIXED | F 3A IND. L. | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.07 | 0.00 | 0.05 | 0.00 | 0.01 | 0.01 | 0 | 0 |
| 1 | 29194 | 0.38 | 0.01 | 0.09 | 0.05 | 0.06 | 0.17 | 0 | 0 |
| 2 | 4156 | 0.32 | 0.14 | 0.07 | 0.05 | 0.01 | 0.05 | 2005 | 316813 |
| 3 | 2526 | 0.33 | 0.30 | 0.03 | 0.00 | 0.00 | 0.00 | 1712 | 339052 |
| 4 | 1570 | 0.38 | 0.36 | 0.03 | 0.00 | 0.00 | 0.00 | 1135 | 254249 |
| 5 | 743 | 0.48 | 0.46 | 0.02 | 0.00 | 0.00 | 0.00 | 504 | 118950 |
| 6 | 639 | 0.47 | 0.44 | 0.02 | 0.00 | 0.00 | 0.00 | 436 | 113460 |
| 7 | 430 | 0.38 | 0.36 | 0.02 | 0.00 | 0.00 | 0.00 | 312 | 85705 |
| 8 | 186 | 0.41 | 0.39 | 0.02 | 0.00 | 0.00 | 0.00 | 132 | 39461 |
| 9 | 87 | 0.41 | 0.39 | 0.02 | 0.00 | 0.00 | 0.00 | 62 | 19678 |
| TOTAL | 107532 | | | | | | | 6299 | 1287369 |

Yield = Catch in t. Catch = Catch in number (mill.).
NS SM. M. = Small meshed fisheries in the North Sea
NS OTHER = Other fisheries in the North Sea
3A HC = Human consumption landings in Division IIIa
3A MIXED = Mixed clupeoid landings in Division IIIa
3A IND. L. = Other industrial landings in Division IIIa

Table 2.8.4. Predicted catch and biomass of North Sea autumn spawning herring in 1993. 20% decrease in "NS OTHER" F. Status quo F for 3+ and 0-ringer. in other fisheries. Catch of 1- and 2-ringers in IIIa estimated based on relative abundance and unchanged effort.

| AGE | STOCK SIZE | ABSOLUTE F | YIELD NS OTHER | YIELD NS SM. M. | YIELD NS TOTAL | YIELD 3A HC | YIELD 3A MIXED | YIELD 3A IND. L. | YIELD 3A TOTAL | YIELD TOTAL AS | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.07 | 0 | 33813 | 33813 | 92 | 9803 | 11508 | 21403 | 55216 | 0 | 0 |
| 1 | 29194 | 0.37 | 7106 | 83464 | 90570 | 63178 | 22036 | 94877 | 180091 | 270661 | 0 | 0 |
| 2 | 4156 | 0.29 | 53435 | 19791 | 73226 | 15314 | 754 | 10104 | 26173 | 99399 | 2044 | 322973 |
| 3 | 2526 | 0.27 | 84277 | 6660 | 90936 | 0 | 0 | 0 | 0 | 90936 | 1783 | 353009 |
| 4 | 1570 | 0.31 | 69166 | 4708 | 73874 | 0 | 0 | 0 | 0 | 73874 | 1191 | 266725 |
| 5 | 743 | 0.39 | 44200 | 2188 | 46388 | 0 | 0 | 0 | 0 | 46388 | 536 | 126447 |
| 6 | 639 | 0.38 | 39534 | 2138 | 41672 | 0 | 0 | 0 | 0 | 41672 | 463 | 120428 |
| 7 | 430 | 0.31 | 24452 | 1279 | 25731 | 0 | 0 | 0 | 0 | 25731 | 327 | 89967 |
| 8 | 186 | 0.33 | 12219 | 616 | 12835 | 0 | 0 | 0 | 0 | 12835 | 139 | 41561 |
| 9 | 87 | 0.33 | 6035 | 274 | 6310 | 0 | 0 | 0 | 0 | 6310 | 65 | 20726 |
| TOTAL | 107532 | | 340424 | 154931 | 495355 | 78585 | 32593 | 116489 | 227666 | 723021 | 6549 | 1341836 |

| AGE | STOCK SIZE | ABSOLUTE F | CATCH NS OTHER | CATCH NS SM. M. | CATCH NS TOTAL | CATCH 3A HC | CATCH 3A MIXED | CATCH 3A IND. L. | CATCH 3A TOTAL | CATCH TOTAL AS | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.07 | 0 | 1989 | 1989 | 3 | 426 | 426 | 855 | 2844 | 0 | 0 |
| 1 | 29194 | 0.37 | 120 | 1439 | 1559 | 743 | 918 | 2711 | 4372 | 5932 | 0 | 0 |
| 2 | 4156 | 0.29 | 349 | 225 | 574 | 158 | 19 | 158 | 335 | 909 | 2044 | 322973 |
| 3 | 2526 | 0.27 | 484 | 67 | 552 | 0 | 0 | 0 | 0 | 552 | 1783 | 353009 |
| 4 | 1570 | 0.31 | 368 | 35 | 403 | 0 | 0 | 0 | 0 | 403 | 1191 | 266725 |
| 5 | 743 | 0.39 | 215 | 14 | 229 | 0 | 0 | 0 | 0 | 229 | 536 | 126447 |
| 6 | 639 | 0.38 | 181 | 12 | 192 | 0 | 0 | 0 | 0 | 192 | 463 | 120428 |
| 7 | 430 | 0.31 | 102 | 7 | 109 | 0 | 0 | 0 | 0 | 109 | 327 | 89967 |
| 8 | 186 | 0.33 | 47 | 3 | 50 | 0 | 0 | 0 | 0 | 50 | 139 | 41561 |
| 9 | 87 | 0.33 | 22 | 1 | 23 | 0 | 0 | 0 | 0 | 23 | 65 | 20726 |
| TOTAL | 107532 | | 1888 | 3792 | 5680 | 904 | 1364 | 3295 | 5562 | 11242 | 6549 | 1341836 |

| AGE | STOCK SIZE | ABSOLUTE F | F NS OTHER | F NS SM. M. | F 3A HC | F 3A MIXED | F 3A IND. L. | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.07 | 0.00 | 0.05 | 0.00 | 0.01 | 0.01 | 0 | 0 |
| 1 | 29194 | 0.37 | 0.01 | 0.09 | 0.05 | 0.06 | 0.17 | 0 | 0 |
| 2 | 4156 | 0.29 | 0.11 | 0.07 | 0.05 | 0.01 | 0.05 | 2044 | 322973 |
| 3 | 2526 | 0.27 | 0.24 | 0.03 | 0.00 | 0.00 | 0.00 | 1783 | 353009 |
| 4 | 1570 | 0.31 | 0.29 | 0.03 | 0.00 | 0.00 | 0.00 | 1191 | 266725 |
| 5 | 743 | 0.39 | 0.36 | 0.02 | 0.00 | 0.00 | 0.00 | 536 | 126447 |
| 6 | 639 | 0.38 | 0.36 | 0.02 | 0.00 | 0.00 | 0.00 | 463 | 120428 |
| 7 | 430 | 0.31 | 0.29 | 0.02 | 0.00 | 0.00 | 0.00 | 327 | 89967 |
| 8 | 186 | 0.33 | 0.31 | 0.02 | 0.00 | 0.00 | 0.00 | 139 | 41561 |
| 9 | 87 | 0.33 | 0.31 | 0.02 | 0.00 | 0.00 | 0.00 | 65 | 20726 |
| TOTAL | 107532 | | | | | | | 6549 | 1341836 |

Yield = Catch in t. Catch = Catch in number (mill.).
NS SM. M. = Small meshed fisheries in the North Sea
NS OTHER = Other fisheries in the North Sea
3A HC = Human consumption landings in Division IIIa
3A MIXED = Mixed clupeoid landings in Division IIIa
3A IND. L. = Other industrial landings in Division IIIa

Table 2.8.5. Predicted catch and biomass of North Sea autumn spawning herring in 1993. 20% increase in "NS OTHER" F. Status quo F for 3+ and 0-ringer. in other fisheries. Catch of 1- and 2-ringers in IIIa estimated based on relative abundance and unchanged effort.

| AGE | STOCK SIZE | ABSOLUTE F | YIELD NS OTHER | YIELD NS SM. M. | YIELD NS TOTAL | YIELD 3A HC | YIELD 3A MIXED | YIELD 3A IND. L. | YIELD 3A TOTAL | YIELD TOTAL AS | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.07 | 0 | 33813 | 33813 | 92 | 9803 | 11508 | 21403 | 55216 | 0 | 0 |
| 1 | 29194 | 0.37 | 7106 | 83464 | 90570 | 63178 | 22036 | 94877 | 180091 | 270661 | 0 | 0 |
| 2 | 4156 | 0.35 | 78079 | 19279 | 97358 | 15311 | 754 | 10102 | 26166 | 123524 | 1966 | 310577 |
| 3 | 2526 | 0.39 | 119665 | 6304 | 125969 | 0 | 0 | 0 | 0 | 125969 | 1645 | 325647 |
| 4 | 1570 | 0.46 | 97148 | 4408 | 101556 | 0 | 0 | 0 | 0 | 101556 | 1082 | 242357 |
| 5 | 743 | 0.57 | 61053 | 2015 | 63067 | 0 | 0 | 0 | 0 | 63067 | 474 | 111898 |
| 6 | 639 | 0.56 | 54710 | 1972 | 56682 | 0 | 0 | 0 | 0 | 56682 | 411 | 106895 |
| 7 | 430 | 0.45 | 34313 | 1196 | 35510 | 0 | 0 | 0 | 0 | 35510 | 297 | 81646 |
| 8 | 186 | 0.48 | 17074 | 574 | 17648 | 0 | 0 | 0 | 0 | 17648 | 126 | 37466 |
| 9 | 87 | 0.48 | 8434 | 256 | 8689 | 0 | 0 | 0 | 0 | 8689 | 59 | 18684 |
| TOTAL | 107532 | | 477581 | 153281 | 630863 | 78581 | 32593 | 116486 | 227660 | 858523 | 6059 | 1235169 |

| AGE | STOCK SIZE | ABSOLUTE F | CATCH NS OTHER | CATCH NS SM. M. | CATCH NS TOTAL | CATCH 3A HC | CATCH 3A MIXED | CATCH 3A IND. L. | CATCH 3A TOTAL | CATCH TOTAL AS | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.07 | 0 | 1989 | 1989 | 3 | 426 | 426 | 855 | 2844 | 0 | 0 |
| 1 | 29194 | 0.37 | 120 | 1439 | 1559 | 743 | 918 | 2711 | 4372 | 5932 | 0 | 0 |
| 2 | 4156 | 0.35 | 510 | 219 | 729 | 158 | 19 | 158 | 335 | 1064 | 1966 | 310577 |
| 3 | 2526 | 0.39 | 688 | 64 | 751 | 0 | 0 | 0 | 0 | 751 | 1645 | 325647 |
| 4 | 1570 | 0.46 | 517 | 32 | 549 | 0 | 0 | 0 | 0 | 549 | 1082 | 242357 |
| 5 | 743 | 0.57 | 296 | 13 | 309 | 0 | 0 | 0 | 0 | 309 | 474 | 111898 |
| 6 | 639 | 0.56 | 250 | 11 | 261 | 0 | 0 | 0 | 0 | 261 | 411 | 106895 |
| 7 | 430 | 0.45 | 144 | 6 | 150 | 0 | 0 | 0 | 0 | 150 | 297 | 81646 |
| 8 | 186 | 0.48 | 65 | 3 | 68 | 0 | 0 | 0 | 0 | 68 | 126 | 37466 |
| 9 | 87 | 0.48 | 31 | 1 | 32 | 0 | 0 | 0 | 0 | 32 | 59 | 18684 |
| TOTAL | 107532 | | 2621 | 3778 | 6399 | 904 | 1364 | 3295 | 5562 | 11961 | 6059 | 1235169 |

| AGE | STOCK SIZE | ABSOLUTE F | F NS OTHER | F NS SM. M. | F 3A HC | F 3A MIXED | F 3A IND. L. | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.07 | 0.00 | 0.05 | 0.00 | 0.01 | 0.01 | 0 | 0 |
| 1 | 29194 | 0.37 | 0.01 | 0.09 | 0.05 | 0.06 | 0.17 | 0 | 0 |
| 2 | 4156 | 0.35 | 0.17 | 0.07 | 0.05 | 0.01 | 0.05 | 1966 | 310577 |
| 3 | 2526 | 0.39 | 0.36 | 0.03 | 0.00 | 0.00 | 0.00 | 1645 | 325647 |
| 4 | 1570 | 0.46 | 0.43 | 0.03 | 0.00 | 0.00 | 0.00 | 1082 | 242357 |
| 5 | 743 | 0.57 | 0.55 | 0.02 | 0.00 | 0.00 | 0.00 | 474 | 111898 |
| 6 | 639 | 0.56 | 0.53 | 0.02 | 0.00 | 0.00 | 0.00 | 411 | 106895 |
| 7 | 430 | 0.45 | 0.43 | 0.02 | 0.00 | 0.00 | 0.00 | 297 | 81646 |
| 8 | 186 | 0.48 | 0.46 | 0.02 | 0.00 | 0.00 | 0.00 | 126 | 37466 |
| 9 | 87 | 0.48 | 0.46 | 0.02 | 0.00 | 0.00 | 0.00 | 59 | 18684 |
| TOTAL | 107532 | | | | | | | 6059 | 1235169 |

Yield = Catch in t. Catch = Catch in number (mill.).
NS SM. M. = Small meshed fisheries in the North Sea
NS OTHER = Other fisheries in the North Sea
3A HC = Human consumption landings in Division IIIa
3A MIXED = Mixed clupeoid landings in Division IIIa
3A IND. L. = Other industrial landings in Division IIIa

Table 2.8.6. Predicted catch and biomass of North Sea autumn spawning herring in 1993. 20% increase in "NS SM. M." F. Status quo F for 3+ and 0-ringer. in other fisheries. Catch of 1- and 2-ringers in IIIa estimated based on relative abundance and unchanged effort.

| AGE | STOCK SIZE | ABSOLUTE F | YIELD NS OTHER | YIELD NS SM. M. | YIELD NS TOTAL | YIELD 3A HC | YIELD 3A MIXED | YIELD 3A IND. L. | YIELD 3A TOTAL | YIELD TOTAL AS | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.08 | 0 | 40417 | 40417 | 92 | 9765 | 11463 | 21319 | 61736 | 0 | 0 |
| 1 | 29194 | 0.39 | 7051 | 99378 | 106429 | 63139 | 22022 | 94817 | 179978 | 286407 | 0 | 0 |
| 2 | 4156 | 0.33 | 65473 | 23279 | 88752 | 15341 | 755 | 10122 | 26217 | 114969 | 1984 | 313493 |
| 3 | 2526 | 0.34 | 102168 | 7751 | 109918 | 0 | 0 | 0 | 0 | 109918 | 1705 | 337536 |
| 4 | 1570 | 0.39 | 83438 | 5452 | 88890 | 0 | 0 | 0 | 0 | 88890 | 1131 | 253334 |
| 5 | 743 | 0.48 | 52885 | 2513 | 55399 | 0 | 0 | 0 | 0 | 55399 | 502 | 118568 |
| 6 | 639 | 0.47 | 47350 | 2458 | 49808 | 0 | 0 | 0 | 0 | 49808 | 435 | 113104 |
| 7 | 430 | 0.39 | 29505 | 1481 | 30986 | 0 | 0 | 0 | 0 | 30986 | 311 | 85487 |
| 8 | 186 | 0.41 | 14711 | 712 | 15423 | 0 | 0 | 0 | 0 | 15423 | 132 | 39353 |
| 9 | 87 | 0.41 | 7266 | 317 | 7583 | 0 | 0 | 0 | 0 | 7583 | 62 | 19625 |
| TOTAL | 107532 | | 409847 | 183758 | 593605 | 78571 | 32542 | 116402 | 227515 | 821120 | 6262 | 1280500 |

| AGE | STOCK SIZE | ABSOLUTE F | CATCH NS OTHER | CATCH NS SM. M. | CATCH NS TOTAL | CATCH 3A HC | CATCH 3A MIXED | CATCH 3A IND. L. | CATCH 3A TOTAL | CATCH TOTAL AS | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.08 | 0 | 2377 | 2377 | 3 | 425 | 425 | 852 | 3229 | 0 | 0 |
| 1 | 29194 | 0.39 | 120 | 1713 | 1833 | 743 | 918 | 2709 | 4369 | 6202 | 0 | 0 |
| 2 | 4156 | 0.33 | 428 | 265 | 692 | 158 | 19 | 158 | 336 | 1028 | 1984 | 313493 |
| 3 | 2526 | 0.34 | 587 | 78 | 665 | 0 | 0 | 0 | 0 | 665 | 1705 | 337536 |
| 4 | 1570 | 0.39 | 444 | 40 | 484 | 0 | 0 | 0 | 0 | 484 | 1131 | 253334 |
| 5 | 743 | 0.48 | 257 | 16 | 273 | 0 | 0 | 0 | 0 | 273 | 502 | 118568 |
| 6 | 639 | 0.47 | 216 | 14 | 230 | 0 | 0 | 0 | 0 | 230 | 435 | 113104 |
| 7 | 430 | 0.39 | 123 | 8 | 131 | 0 | 0 | 0 | 0 | 131 | 311 | 85487 |
| 8 | 186 | 0.41 | 56 | 4 | 60 | 0 | 0 | 0 | 0 | 60 | 132 | 39353 |
| 9 | 87 | 0.41 | 26 | 2 | 28 | 0 | 0 | 0 | 0 | 28 | 62 | 19625 |
| TOTAL | 107532 | | 2258 | 4517 | 6774 | 904 | 1362 | 3292 | 5557 | 12331 | 6262 | 1280500 |

| AGE | STOCK SIZE | ABSOLUTE F | F NS OTHER | F NS SM. M. | F 3A HC | F 3A MIXED | F 3A IND. L. | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.08 | 0.00 | 0.06 | 0.00 | 0.01 | 0.01 | 0 | 0 |
| 1 | 29194 | 0.39 | 0.01 | 0.11 | 0.05 | 0.06 | 0.17 | 0 | 0 |
| 2 | 4156 | 0.33 | 0.14 | 0.09 | 0.05 | 0.01 | 0.05 | 1984 | 313493 |
| 3 | 2526 | 0.34 | 0.30 | 0.04 | 0.00 | 0.00 | 0.00 | 1705 | 337536 |
| 4 | 1570 | 0.39 | 0.36 | 0.03 | 0.00 | 0.00 | 0.00 | 1131 | 253334 |
| 5 | 743 | 0.48 | 0.46 | 0.03 | 0.00 | 0.00 | 0.00 | 502 | 118568 |
| 6 | 639 | 0.47 | 0.44 | 0.03 | 0.00 | 0.00 | 0.00 | 435 | 113104 |
| 7 | 430 | 0.39 | 0.36 | 0.02 | 0.00 | 0.00 | 0.00 | 311 | 85487 |
| 8 | 186 | 0.41 | 0.39 | 0.02 | 0.00 | 0.00 | 0.00 | 132 | 39353 |
| 9 | 87 | 0.41 | 0.39 | 0.02 | 0.00 | 0.00 | 0.00 | 62 | 19625 |
| TOTAL | 107532 | | | | | | | 6262 | 1280500 |

Yield = Catch in t. Catch = Catch in number (mill.).
NS SM. M. = Small meshed fisheries in the North Sea
NS OTHER = Other fisheries in the North Sea
3A HC = Human consumption landings in Division IIIa
3A MIXED = Mixed clupeoid landings in Division IIIa
3A IND. L. = Other industrial landings in Division IIIa

Table 2.8.7. Predicted catch and biomass of North Sea autumn spawning herring in 1993. 20% decrease in "NS SM. M." F. Status quo F for 3+ and 0-ringer. in other fisheries. Catch of 1- and 2-ringers in IIIa estimated based on relative abundance and unchanged effort.

| AGE | STOCK SIZE | ABSOLUTE F | YIELD NS OTHER | YIELD NS SM. M. | YIELD NS TOTAL | YIELD 3A HC | YIELD 3A MIXED | YIELD 3A IND. L. | YIELD 3A TOTAL | YIELD TOTAL AS | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.06 | 0 | 27157 | 27157 | 92 | 9842 | 11553 | 21487 | 48645 | 0 | 0 |
| 1 | 29194 | 0.35 | 7163 | 67305 | 74468 | 63152 | 22027 | 94837 | 180016 | 254484 | 0 | 0 |
| 2 | 4156 | 0.30 | 66367 | 15731 | 82099 | 15323 | 754 | 10110 | 26188 | 108286 | 2025 | 319908 |
| 3 | 2526 | 0.33 | 102793 | 5199 | 107991 | 0 | 0 | 0 | 0 | 107991 | 1720 | 340575 |
| 4 | 1570 | 0.38 | 83852 | 3653 | 87504 | 0 | 0 | 0 | 0 | 87504 | 1139 | 255168 |
| 5 | 743 | 0.48 | 53115 | 1683 | 54798 | 0 | 0 | 0 | 0 | 54798 | 506 | 119334 |
| 6 | 639 | 0.46 | 47552 | 1646 | 49197 | 0 | 0 | 0 | 0 | 49197 | 438 | 113816 |
| 7 | 430 | 0.38 | 29609 | 991 | 30600 | 0 | 0 | 0 | 0 | 30600 | 312 | 85924 |
| 8 | 186 | 0.40 | 14766 | 476 | 15242 | 0 | 0 | 0 | 0 | 15242 | 133 | 39568 |
| 9 | 87 | 0.40 | 7293 | 212 | 7506 | 0 | 0 | 0 | 0 | 7506 | 62 | 19732 |
| TOTAL | 107532 | | 412509 | 124053 | 536562 | 78568 | 32623 | 116501 | 227691 | 764254 | 6335 | 1294026 |

| AGE | STOCK SIZE | ABSOLUTE F | CATCH NS OTHER | CATCH NS SM. M. | CATCH NS TOTAL | CATCH 3A HC | CATCH 3A MIXED | CATCH 3A IND. L. | CATCH 3A TOTAL | CATCH TOTAL AS | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.06 | 0 | 1597 | 1597 | 3 | 428 | 428 | 858 | 2456 | 0 | 0 |
| 1 | 29194 | 0.35 | 121 | 1160 | 1282 | 743 | 918 | 2710 | 4370 | 5652 | 0 | 0 |
| 2 | 4156 | 0.30 | 434 | 179 | 613 | 158 | 19 | 158 | 335 | 948 | 2025 | 319908 |
| 3 | 2526 | 0.33 | 591 | 53 | 643 | 0 | 0 | 0 | 0 | 643 | 1720 | 340575 |
| 4 | 1570 | 0.38 | 446 | 27 | 473 | 0 | 0 | 0 | 0 | 473 | 1139 | 255168 |
| 5 | 743 | 0.48 | 258 | 11 | 269 | 0 | 0 | 0 | 0 | 269 | 506 | 119334 |
| 6 | 639 | 0.46 | 217 | 9 | 226 | 0 | 0 | 0 | 0 | 226 | 438 | 113816 |
| 7 | 430 | 0.38 | 124 | 5 | 129 | 0 | 0 | 0 | 0 | 129 | 312 | 85924 |
| 8 | 186 | 0.40 | 57 | 2 | 59 | 0 | 0 | 0 | 0 | 59 | 133 | 39568 |
| 9 | 87 | 0.40 | 27 | 1 | 28 | 0 | 0 | 0 | 0 | 28 | 62 | 19732 |
| TOTAL | 107532 | | 2274 | 3045 | 5319 | 904 | 1365 | 3296 | 5564 | 10883 | 6335 | 1294026 |

| AGE | STOCK SIZE | ABSOLUTE F | F NS OTHER | F NS SM. M. | F 3A HC | F 3A MIXED | F 3A IND. L. | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.06 | 0.00 | 0.04 | 0.00 | 0.01 | 0.01 | 0 | 0 |
| 1 | 29194 | 0.35 | 0.01 | 0.07 | 0.05 | 0.06 | 0.17 | 0 | 0 |
| 2 | 4156 | 0.30 | 0.14 | 0.06 | 0.05 | 0.01 | 0.05 | 2025 | 319908 |
| 3 | 2526 | 0.33 | 0.30 | 0.03 | 0.00 | 0.00 | 0.00 | 1720 | 340575 |
| 4 | 1570 | 0.38 | 0.36 | 0.02 | 0.00 | 0.00 | 0.00 | 1139 | 255168 |
| 5 | 743 | 0.48 | 0.46 | 0.02 | 0.00 | 0.00 | 0.00 | 506 | 119334 |
| 6 | 639 | 0.46 | 0.44 | 0.02 | 0.00 | 0.00 | 0.00 | 438 | 113816 |
| 7 | 430 | 0.38 | 0.36 | 0.02 | 0.00 | 0.00 | 0.00 | 312 | 85924 |
| 8 | 186 | 0.40 | 0.39 | 0.02 | 0.00 | 0.00 | 0.00 | 133 | 39568 |
| 9 | 87 | 0.40 | 0.39 | 0.02 | 0.00 | 0.00 | 0.00 | 62 | 19732 |
| TOTAL | 107532 | | | | | | | 6335 | 1294026 |

Yield = Catch in t. Catch = Catch in number (mill.).
NS SM. M. = Small meshed fisheries in the North Sea
NS OTHER = Other fisheries in the North Sea
3A HC = Human consumption landings in Division IIIa
3A MIXED = Mixed clupeoid landings in Division IIIa
3A IND. L. = Other industrial landings in Division IIIa

Table 2.8.8. Predicted catch and biomass of North Sea autumn spawning herring in 1993. Status quo F for 0– and 3+ – ringers in "NS OTHER", "3A MIXED" closed and catch of 1– and 2–ringers in The North Sea estimated based on relative abundance and unchanged effort.

| AGE | STOCK SIZE | ABSOLUTE F | YIELD NS OTHER | YIELD NS SM. M. | YIELD NS TOTAL | YIELD 3A HC | YIELD 3A MIXED | YIELD 3A IND. L. | YIELD 3A TOTAL | YIELD TOTAL AS | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.06 | 0 | 33956 | 33956 | 92 | 0 | 11556 | 11649 | 45605 | 0 | 0 |
| 1 | 29194 | 0.31 | 2073 | 84508 | 86582 | 64119 | 0 | 96289 | 160408 | 246990 | 0 | 0 |
| 2 | 4156 | 0.31 | 66180 | 19609 | 85788 | 15291 | 0 | 10089 | 25380 | 111169 | 2013 | 318089 |
| 3 | 2526 | 0.33 | 102479 | 6479 | 108958 | 0 | 0 | 0 | 0 | 108958 | 1712 | 339052 |
| 4 | 1570 | 0.38 | 83644 | 4554 | 88199 | 0 | 0 | 0 | 0 | 88199 | 1135 | 254249 |
| 5 | 743 | 0.48 | 53000 | 2099 | 55099 | 0 | 0 | 0 | 0 | 55099 | 504 | 118950 |
| 6 | 639 | 0.47 | 47451 | 2053 | 49504 | 0 | 0 | 0 | 0 | 49504 | 436 | 113460 |
| 7 | 430 | 0.38 | 29557 | 1237 | 30794 | 0 | 0 | 0 | 0 | 30794 | 312 | 85705 |
| 8 | 186 | 0.41 | 14738 | 594 | 15333 | 0 | 0 | 0 | 0 | 15333 | 132 | 39461 |
| 9 | 87 | 0.41 | 7280 | 265 | 7545 | 0 | 0 | 0 | 0 | 7545 | 62 | 19678 |
| TOTAL | 107532 | | 406402 | 155354 | 561756 | 79503 | 0 | 117935 | 197438 | 759194 | 6307 | 1288645 |

| AGE | STOCK SIZE | ABSOLUTE F | CATCH NS OTHER | CATCH NS SM. M. | CATCH NS TOTAL | CATCH 3A HC | CATCH 3A MIXED | CATCH 3A IND. L. | CATCH 3A TOTAL | CATCH TOTAL AS | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.06 | 0 | 1997 | 1997 | 3 | 0 | 428 | 431 | 2428 | 0 | 0 |
| 1 | 29194 | 0.31 | 122 | 1457 | 1579 | 754 | 0 | 2751 | 3505 | 5084 | 0 | 0 |
| 2 | 4156 | 0.31 | 433 | 223 | 655 | 158 | 0 | 158 | 315 | 971 | 2013 | 318089 |
| 3 | 2526 | 0.33 | 589 | 65 | 654 | 0 | 0 | 0 | 0 | 654 | 1712 | 339052 |
| 4 | 1570 | 0.38 | 445 | 33 | 478 | 0 | 0 | 0 | 0 | 478 | 1135 | 254249 |
| 5 | 743 | 0.48 | 257 | 14 | 271 | 0 | 0 | 0 | 0 | 271 | 504 | 118950 |
| 6 | 639 | 0.47 | 217 | 11 | 228 | 0 | 0 | 0 | 0 | 228 | 436 | 113460 |
| 7 | 430 | 0.38 | 124 | 7 | 130 | 0 | 0 | 0 | 0 | 130 | 312 | 85705 |
| 8 | 186 | 0.41 | 56 | 3 | 59 | 0 | 0 | 0 | 0 | 59 | 132 | 39461 |
| 9 | 87 | 0.41 | 26 | 1 | 28 | 0 | 0 | 0 | 0 | 28 | 62 | 19678 |
| TOTAL | 107532 | | 2269 | 3812 | 6081 | 915 | 0 | 3337 | 4251 | 10332 | 6307 | 1288645 |

| AGE | STOCK SIZE | ABSOLUTE F | F NS OTHER | F NS SM. M. | F 3A HC | F 3A MIXED | F 3A IND. L. | SP STOCK NUMBER | SP STOCK BIOMASS |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 68000 | 0.06 | 0.00 | 0.05 | 0.00 | 0.00 | 0.01 | 0 | 0 |
| 1 | 29194 | 0.31 | 0.01 | 0.09 | 0.05 | 0.00 | 0.17 | 0 | 0 |
| 2 | 4156 | 0.31 | 0.14 | 0.07 | 0.05 | 0.00 | 0.05 | 2013 | 318089 |
| 3 | 2526 | 0.33 | 0.30 | 0.03 | 0.00 | 0.00 | 0.00 | 1712 | 339052 |
| 4 | 1570 | 0.38 | 0.36 | 0.03 | 0.00 | 0.00 | 0.00 | 1135 | 254249 |
| 5 | 743 | 0.48 | 0.46 | 0.02 | 0.00 | 0.00 | 0.00 | 504 | 118950 |
| 6 | 639 | 0.47 | 0.44 | 0.02 | 0.00 | 0.00 | 0.00 | 436 | 113460 |
| 7 | 430 | 0.38 | 0.36 | 0.02 | 0.00 | 0.00 | 0.00 | 312 | 85705 |
| 8 | 186 | 0.41 | 0.39 | 0.02 | 0.00 | 0.00 | 0.00 | 132 | 39461 |
| 9 | 87 | 0.41 | 0.39 | 0.02 | 0.00 | 0.00 | 0.00 | 62 | 19678 |
| TOTAL | 107532 | | | | | | | 6307 | 1288645 |

Yield = Catch in t. Catch = Catch in number (mill.).
NS SM. M. = Small meshed fisheries in the North Sea
NS OTHER = Other fisheries in the North Sea
3A HC = Human consumption landings in Division IIIa
3A MIXED = Mixed clupeoid landings in Division IIIa
3A IND. L. = Other industrial landings in Division IIIa

Table 2.9.1 Yield per recruit input parameters (North Sea + Div. IIIa)

| Age (w.r.) Quarter | fishing pattern | natural mortality | Maturity ogive | Prop. of F and M before spawning | Weight in the catch | weight in the stock |
|---|---|---|---|---|---|---|
| 0 qua.3 | 0.0396 | 0.2106 | 0 | 0 | 17.9 | 17 |
| 0 qua.4 | 0.0255 | 0.3759 | 0 | 0 | 22 | 17 |
| 1 qua.1 | 0.0356 | 0.3409 | 0 | 0 | 25.8 | 27 |
| 1 qua.2 | 0.0771 | 0.1212 | 0 | 0 | 30 | 31 |
| 1 qua.3 | 0.1159 | 0.4652 | 0 | 0 | 71.7 | 73 |
| 1 qua.4 | 0.0614 | 0.0932 | 0 | 0 | 52.3 | 48 |
| 2 | 0.2911 | 0.3 | 0.638 | 0.67 | 114.3 | 158 |
| 3 | 0.3346 | 0.2 | 0.971 | 0.67 | 166 | 198 |
| 4 | 0.4215 | 0.1 | 1 | 0.67 | 184 | 224 |
| 5 | 0.4529 | 0.1 | 1 | 0.67 | 203 | 236 |
| 6 | 0.4677 | 0.1 | 1 | 0.67 | 217 | 260 |
| 7 | 0.4424 | 0.1 | 1 | 0.67 | 235 | 275 |
| 8 | 0.4423 | 0.1 | 1 | 0.67 | 259 | 298 |
| 9+ | 0.4423 | 0.1 | 1 | 0.67 | 271 | 317 |

Table 2.9.2. Catch at age and fishing pattern used when removing the catch of juveniles

| SCENARIO | 1 | | 2 | | 3 | | 4 | |
|---|---|---|---|---|---|---|---|---|
| AGE (w. r.) | Fishing Pattern | Weight in catch | Fishing Pattern | Weight in catch | Fishing Pattern | Weight in catch | Fishing Pattern | Weight in catch |
| 0 qua.3 | 0 | 0 | 0.0322 | 17 | 0.0074 | 22 | 0.0325 | 17.1 |
| 0 qua.4 | 0 | 0 | 0.0128 | 17 | 0.0127 | 27.1 | 0.0226 | 21.5 |
| 1 qua.1 | 0 | 0 | 0.0034 | 27 | 0.032 | 25.7 | 0.0152 | 30.5 |
| 1 qua.2 | 0 | 0 | 0.0273 | 31 | 0.05 | 29.4 | 0.0738 | 30.2 |
| 1 qua.3 | 0 | 0 | 0.088 | 73 | 0.0279 | 67.5 | 0.1153 | 71.8 |
| 1 qua.4 | 0 | 0 | 0.0559 | 48 | 0.056 | 95.1 | 0.0612 | 52.2 |
| 2 | 0.2911 | 114.3 | | | | | 0.2857 | 115.8 |

Example : in scenario 2 (preventing the catch of juveniles in IIIa),the fishing mortality and the weight at age of 0 ringers in quarter 3 are set to .0322 and 17g when catch of 0 ringers are prevented in IIIa

**Table 2.10.1** HERRING Total North Sea, 1991.
Numbers (millions) and weights (g) at age (winter rings) and year class of herring caught in each quarter. Spring spawners transferred to Division IIIa, and North Sea autumn spawners caught in Division III are not included.

| Catches in: | | 1991 | | | Total North Sea | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Total | SOP |
| Quarter | | 1990 | 1989 | 1988 | 1987 | 1986 | 1985 | 1984 | 1983 | 1982 | 1981 | no | ('000t) |
| I | No | 0.0 | 24.5 | 110.2 | 90.6 | 114.0 | 97.0 | 30.3 | 9.4 | 3.8 | 1.0 | 480.9 | 54.8 |
| | W | | 32 | 73 | 112 | 130 | 143 | 154 | 171 | 200 | 194 | | |
| II | No | 0.0 | 194.4 | 219.3 | 92.0 | 87.5 | 80.1 | 31.9 | 3.7 | 4.8 | 3.2 | 717.0 | 86.0 |
| | W | | 30 | 102 | 158 | 190 | 212 | 207 | 246 | 257 | 277 | | |
| III | No | 1140.5 | 627.2 | 255.5 | 177.5 | 197.2 | 192.9 | 74.1 | 14.7 | 10.1 | 6.2 | 2695.8 | 252.0 |
| | W | 17 | 73 | 164 | 186 | 209 | 229 | 246 | 275 | 295 | 293 | | |
| IV | No | 453.8 | 398.3 | 186.3 | 193.4 | 150.2 | 123.9 | 65.2 | 11.0 | 6.3 | 2.2 | 1590.6 | 162.3 |
| | W | 17 | 49 | 151 | 177 | 189 | 204 | 218 | 235 | 237 | 239 | | |
| Total | No | 1594.3 | 1244.4 | 771.4 | 553.5 | 548.9 | 493.9 | 201.6 | 38.8 | 25.0 | 12.6 | 5484.3 | 555.1 |
| Year | W | 17 | 58 | 130 | 166 | 184 | 203 | 217 | 235 | 259 | 271 | | |
| Stock weights (1) | | | 65 | 158 | 198 | 224 | 236 | 260 | 275 | 298 | 317 | | |

(1) These stock weights derive from acoustic survey samples taken in july from divisions IVa,b and used in the 1992 SSVPA

For the 2 and 3 ringers the stock weights are combined of the ones of immature and mature fish displayed above

| Age (W.R.) : | 2 | 2 | 3 | 3 |
|---|---|---|---|---|
| Mature/Immature : | I | M | I | M |
| Mean weight : | 122 | 168 | 129 | 200 |

**Table 3.1.1** Transfer of Division IIIa spring spawners taken in the North Sea catches in 1987-1991. Catch in numbers ('000) and mean weight (g) at age with SOPs in tonnes.

| | | Quarters 2 and 3 Divisions IVa (e) and IVb | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Rings | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9+ | Total |
| Year | | | | | | | | | | |
| 1987 | No | 35,500 | 35,000 | 25,000 | 8,900 | 2,800 | 700 | 100 | 100 | 108,100 |
| | $\bar{w}$ | 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 |
| | $\bar{w}$ | 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 |
| | $\bar{w}$ | 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 |
| | $\bar{w}$ | 103 | 113 | 134 | 166 | 161 | 184 | 190 | 236 | |
| | SOP | 1,079 | 1,668 | 2,932 | 1,588 | 482 | 384 | 142 | 83 | 8,358 |
| 1991 | No | 6,650 | 15,074 | 18,007 | 9,145 | 3,050 | 821 | 289 | - | 52,747 |
| | $\bar{w}$ | 115 | 136 | 148 | 168 | 205 | 216 | 221 | - | |
| | SOP | 762 | 2,054 | 2,670 | 1,541 | 626 | 177 | 64 | - | 7,894 |

**Table 3.2.1** HERRING in Division IIIa. Landings in tonnes, 1984-1991. (Data provided by Working Group members 1991.)

| Country | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991[1] |
|---|---|---|---|---|---|---|---|---|
| | | | | Skagerrak | | | | |
| Denmark | 64,621 | 88,192 | 94,014 | 105,017 | 144,421 | 47,393 | 62,349 | 58,658 |
| Faroe Islands | 891 | 455 | 520 | - | - | - | - | - |
| Germany, Fed.Rep. | - | - | 11 | - | - | - | - | - |
| Norway (Open sea) | - | 2,752 | 677 | - | 2,982 | 242 | 4,056 | 6,546 |
| Norway (Fjords) | 1,494 | 1,673 | 860 | 1,209 | 2,692 | 1,363 | 1,542 | 1,581 |
| Sweden | 59,195 | 40,349 | 42,996 | 51,184 | 57,159 | 47,900 | 56,503 | 54,679 |
| Total | 126,201 | 133,421 | 139,078 | 157,410 | 207,254 | 96,898 | 124,450 | 121,464 |
| | | | | Kattegat | | | | |
| Denmark | 71,359 | 69,235 | 37,419 | 46,603 | 76,175 | 57,130 | 32,224 | 29,653 |
| Sweden | 35,027 | 39,829 | 35,852 | 29,844 | 49,653 | 37,869 | 45,228 | 36,732 |
| Total | 106,386 | 109,064 | 73,271 | 76,447 | 125,828 | 94,999 | 77,512 | 66,385 |
| Div. IIIa total | 232,587 | 242,485 | 212,349 | 233,931 | 333,082 | 191,897 | 201,962 | 187,849 |

[1]Preliminary.

Table 3.2.2 HERRING Division IIIa, 1991.

Numbers (millions) at age (winter rings) and landings in tonnes.

| Quarter | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ | Total Landings |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Skagerrak | | 69.6 | 78.0 | 14.0 | 7.3 | 4.6 | 1.2 | 0.4 | 0.2 | 9476 |
| | Kattegat | | 159.4 | 247.1 | 93.1 | 12.2 | 0.1 | 0.0 | | | 25072 |
| | Div. IIIa | 0 | 229.0 | 317.1 | 107.1 | 19.5 | 12.7 | 2.0 | 0.4 | 0.2 | 34748 |
| 2 | Skagerrak | | 331.9 | 130.1 | 111.1 | 54.2 | 23.6 | 7.2 | 2.8 | 1.4 | 48149 |
| | Kattegat | | 23.4 | 54.1 | 93.6 | 17.7 | 10.3 | 1.5 | 0.4 | 0.3 | 10292 |
| | Div. IIIa | 0 | 355.3 | 192.2 | 166.7 | 71.9 | 33.9 | 8.7 | 3.2 | 1.7 | 58441 |
| 3 | Skagerrak | 45.2 | 134.6 | 83.4 | 84.2 | 43.9 | 36.4 | 6.8 | 2.8 | 0.3 | 40133 |
| | Kattegat | 217.5 | 64.1 | 29.3 | 21.9 | 6.1 | 5.8 | 0.5 | 0.5 | 0.4 | 15739 |
| | Div. IIIa | 262.7 | 198.7 | 112.7 | 116.1 | 50.0 | 41.4 | 6.5 | 2.5 | 0.7 | 54872 |
| 4 | Skagerrak | 322.1 | 24.3 | 24.8 | 24.2 | 11.6 | 8.8 | 1.5 | 0.7 | 0.4 | 22986 |
| | Kattegat | 192.3 | 58.4 | 28.8 | 18.8 | 3.7 | 2.8 | 0.4 | 0.1 | | 15282 |
| | Div. IIIa | 514.4 | 82.7 | 53.7 | 42.2 | 15.3 | 11.6 | 1.9 | 0.8 | 0.4 | 37788 |
| Total Year | Skagerrak | 367.3 | 560.4 | 316.4 | 243.5 | 117.0 | 73.6 | 15.9 | 5.9 | 2.3 | 121464 |
| | Kattegat | 409.8 | 305.3 | 359.3 | 188.6 | 39.7 | 28.8 | 3.2 | 1.0 | 0.7 | 66385 |
| | Div. IIIa | 777.1 | 865.7 | 673.7 | 432.1 | 156.7 | 99.6 | 19.1 | 6.9 | 3.0 | 187849 |

Mean weight at age by quarter.

| Quarter | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Skagerrak | | 25.0 | 66.2 | 96.1 | 130.0 | 139.2 | 145.3 | 143.0 | 169.0 |
| | Kattegat | | 25.5 | 48.8 | 74.7 | 89.7 | 95.0 | 100.1 | | |
| | Div. IIIa | 0.0 | 25.6 | 52.6 | 77.5 | 107.8 | 111.6 | 130.4 | 143.0 | 169.0 |
| 2 | Skagerrak | | 29.2 | 86.5 | 93.3 | 133.0 | 126.6 | 147.0 | 152.0 | 182.1 |
| | Kattegat | | 32.4 | 59.3 | 67.5 | 81.3 | 92.9 | 107.4 | 107.5 | 114.2 |
| | Div. IIIa | 0.0 | 29.4 | 78.0 | 84.7 | 121.0 | 116.4 | 140.2 | 146.4 | 178.1 |
| 3 | Skagerrak | 22.7 | 73.6 | 127.3 | 130.0 | 150.9 | 178.9 | 179.4 | 191.0 | 190.1 |
| | Kattegat | 21.9 | 69.9 | 90.3 | 106.5 | 150.7 | 156.4 | 206.3 | 205.2 | 207.0 |
| | Div. IIIa | 22.0 | 71.1 | 115.1 | 132.7 | 150.0 | 176.2 | 181.5 | 206.5 | 199.7 |
| 4 | Skagerrak | 24.5 | 109.6 | 132.6 | 150.0 | 164.2 | 180.4 | 217.5 | 236.6 | 287.0 |
| | Kattegat | 33.7 | 63.6 | 79.6 | 97.0 | 113.4 | 132.3 | 138.6 | 210.0 | |
| | Div. IIIa | 27.0 | 77.1 | 104.2 | 132.3 | 153.4 | 169.6 | 200.0 | 233.2 | 286.0 |
| Total Year | Skagerrak | 24.3 | 42.0 | 96.4 | 117.5 | 143.7 | 159.8 | 165.7 | 174.0 | 200.2 |
| | Kattegat | 27.4 | 41.0 | 55.4 | 78.5 | 97.5 | 110.0 | 126.0 | 194.6 | 167.2 |
| | Div. IIIa | 25.0 | 42.5 | 74.6 | 100.5 | 132.0 | 146.0 | 159.2 | 178.1 | 192.5 |

Table 3.2.3 Skagerrak 1991. Spring spawning herring. Catch in numbers (millions) and mean weight (g) at age.

| | TOTAL | | LANDINGS FOR HUMAN CONSUMPT. | | MIXED CLUPEOID | | LANDINGS FOR INDUST. PURPOSES | |
|---|---|---|---|---|---|---|---|---|
| 1. QUARTER | N | W | N | W | N | W | N | W |
| 2 | | | | | | | | |
| 3 | 14.0 | 96.1 | 12.6 | 98.6 | | | 1.3 | 72.3 |
| 4 | 7.3 | 138.0 | 6.9 | 136.9 | 0.4 | 158.0 | | |
| 5 | 4.6 | 139.2 | 4.6 | 139.2 | | | | |
| 6 | 1.2 | 145.3 | 1.2 | 145.3 | | | | |
| 7 | 0.4 | 143.0 | 0.4 | 143.0 | | | | |
| 8 | | | | | | | | |
| 9+ | 0.2 | 169.0 | 0.2 | 169.0 | | | | |
| TOTAL | 27.7 | 117.6 | 25.9 | | 0.4 | 158.0 | 1.3 | 72.3 |
| LAND./SOP | | 3252.4 | | 3090.7 | | 64.8 | | 96.9 |
| 2. QUARTER | N | W | N | W | N | W | N | W |
| 2 | | | | | | | | |
| 3 | 111.1 | 93.3 | 49.0 | 116.0 | 0.9 | 92.2 | 61.3 | 75.2 |
| 4 | 54.2 | 113.9 | 29.5 | 129.2 | 0.3 | 104.7 | 24.4 | 95.5 |
| 5 | 23.6 | 126.6 | 16.7 | 135.1 | 0.1 | 112.5 | 6.9 | 106.0 |
| 6 | 7.3 | 146.8 | 6.2 | 152.9 | | | 1.1 | 112.5 |
| 7 | 2.8 | 152.0 | 2.8 | 152.0 | | | | |
| 8 | 0.4 | 168.8 | 0.4 | 168.8 | | | | |
| 9+ | 1.0 | 187.4 | 1.0 | 187.4 | | | | |
| TOTAL | 200.4 | 106.2 | 105.5 | | 1.2 | 96.0 | 93.7 | 83.2 |
| LAND./SOP | | 21270.0 | | 13356.7 | | 112.3 | | 7801.0 |
| 3. QUARTER | N | W | N | W | N | W | N | W |
| 2 | 68.0 | 125.1 | 42.4 | 128.0 | 0.6 | 112.0 | 25.0 | 120.5 |
| 3 | 94.2 | 138.8 | 57.3 | 128.4 | 3.0 | 120.5 | 33.9 | 158.1 |
| 4 | 43.9 | 150.9 | 24.0 | 131.4 | 2.4 | 141.3 | 17.6 | 178.7 |
| 5 | 36.4 | 178.9 | 11.2 | 153.9 | 0.4 | 168.0 | 24.9 | 190.3 |
| 6 | 6.0 | 179.4 | 4.4 | 155.1 | | | 1.6 | 244.0 |
| 7 | 2.0 | 191.8 | 0.8 | 146.3 | | | 1.1 | 224.5 |
| 8 | 0.3 | 190.1 | 0.3 | 190.1 | | | | |
| 9+ | | | | | | | | |
| TOTAL | 250.7 | 144.5 | 140.3 | | 6.3 | 130.1 | 104.1 | 162.3 |
| LAND./SOP | | 36224.8 | | 18499.8 | | 822.5 | | 16902.5 |
| 4. QUARTER | N | W | N | W | N | W | N | W |
| 2 | 10.0 | 95.4 | 4.3 | 0.0 | 0.4 | 167.1 | 5.3 | 168.6 |
| 3 | 24.2 | 158.0 | 18.2 | 152.4 | 0.2 | 175.1 | 5.7 | 175.2 |
| 4 | 11.6 | 166.2 | 11.6 | 166.2 | | | | |
| 5 | 9.0 | 180.4 | 9.0 | 180.4 | | | | |
| 6 | 1.5 | 217.5 | 1.5 | 217.5 | | | | |
| 7 | 0.7 | 236.6 | 0.7 | 236.6 | | | | |
| 8 | 0.4 | 287.0 | 0.4 | 287.0 | | | | |
| 9+ | | | | | | | | |
| TOTAL | 57.4 | 155.7 | 45.8 | | 0.6 | 170.0 | 11.0 | 172.0 |
| LAND./SOP | | 8936.2 | | 6943.7 | | 108.8 | | 1883.7 |
| TOTAL YEAR | N | W | N | W | N | W | N | W |
| 2 | 78.0 | 121.3 | 46.7 | 116.1 | 1.0 | 133.9 | 30.3 | 128.9 |
| 3 | 243.5 | 117.5 | 137.2 | 124.4 | 4.1 | 117.7 | 102.2 | 108.2 |
| 4 | 117.0 | 134.5 | 72.0 | 136.6 | 3.0 | 140.3 | 42.0 | 130.3 |
| 5 | 73.7 | 159.8 | 41.5 | 150.4 | 0.4 | 161.2 | 31.8 | 172.0 |
| 6 | 16.0 | 165.7 | 13.3 | 160.4 | | | 2.7 | 191.2 |
| 7 | 5.8 | 175.3 | 4.7 | 163.3 | | | 1.1 | 224.5 |
| 8 | 1.0 | 216.5 | 1.0 | 216.5 | | | | |
| 9+ | 1.1 | 184.8 | 1.1 | 184.8 | | | | |
| TOTAL | 536.2 | 130.0 | 317.5 | 131.9 | 8.5 | 129.8 | 210.2 | 127.0 |
| LAND./SOP | | 69683.3 | | 41890.9 | | 1108.3 | | 26684.1 |

Table 3.2.4 Kattegat 1991. Spring spawning herring. Catch in numbers (millions) and mean weight (g) at age.

| | TOTAL | | LANDINGS FOR HUMAN CONSUMPT. | | MIXED CLUPEOID | | LANDINGS FOR INDUST. PURPOSES | |
|---|---|---|---|---|---|---|---|---|
| 1. QUARTER | N | W | N | W | N | W | N | W |
| 0 | 0.0 | | | | | | | |
| 1 | 0.0 | | | | | | | |
| 2 | 163.1 | 59.8 | 73.0 | 70.7 | 26.7 | 45.2 | 63.5 | 53.4 |
| 3 | 93.1 | 74.7 | 57.2 | 82.4 | 8.6 | 74.7 | 27.2 | 58.6 |
| 4 | 12.2 | 89.7 | 9.5 | 94.9 | 0.0 | 0.0 | 2.7 | 71.7 |
| 5 | 8.1 | 95.9 | 7.2 | 96.7 | 0.2 | 139.0 | 0.7 | 79.2 |
| 6 | 0.8 | 108.1 | 0.8 | 108.1 | | | | |
| 7 | 0.0 | | | | | | | |
| 8 | 0.0 | | | | | | | |
| 9+ | 0.0 | | | | | | | |
| TOTAL | 277.3 | 67.3 | 147.7 | | 35.4 | 52.8 | 94.2 | 55.6 |
| LAND./SOP | | 18664.3 | | 11554.7 | | 1867.9 | | 5241.8 |
| 2. QUARTER | N | W | N | W | N | W | N | W |
| 0 | | | | | | | | |
| 1 | | | | | | | | |
| 2 | 47.2 | 57.6 | 5.2 | 76.5 | 14.1 | 53.6 | 27.9 | 56.2 |
| 3 | 55.6 | 67.5 | 18.4 | 78.0 | 4.2 | 61.8 | 33.0 | 62.3 |
| 4 | 17.7 | 81.3 | 9.2 | 87.9 | 1.3 | 85.1 | 7.2 | 72.0 |
| 5 | 10.3 | 92.9 | 8.1 | 95.0 | 0.5 | 118.4 | 1.8 | 77.3 |
| 6 | 1.5 | 107.4 | 1.5 | 107.4 | | | | |
| 7 | 0.4 | 107.5 | 0.3 | 111.0 | | | 0.1 | 97.8 |
| 8 | 0.3 | 114.2 | 0.3 | 114.2 | | | | |
| 9+ | | | | | | | | |
| TOTAL | 133.0 | 68.5 | 43.0 | 84.6 | 20.1 | 58.9 | 69.9 | 61.3 |
| LAND./SOP | | 9105.9 | | 3639.9 | | 1181.8 | | 4284.3 |
| 3. QUARTER | N | W | N | W | N | W | N | W |
| 0 | | | | | | | | |
| 1 | | | | | | | | |
| 2 | 28.2 | 80.3 | 16.9 | 83.6 | | | 11.4 | 75.3 |
| 3 | 21.9 | 106.5 | 17.4 | 112.4 | 1.1 | 100.0 | 3.4 | 79.1 |
| 4 | 6.1 | 150.7 | 5.4 | 159.2 | | | 0.7 | 85.9 |
| 5 | 5.0 | 156.4 | 4.9 | 157.5 | | | 0.1 | 104.5 |
| 6 | 0.5 | 206.3 | 0.5 | 206.3 | | | | |
| 7 | 0.5 | 265.2 | 0.5 | 265.2 | | | | |
| 8 | 0.4 | 207.0 | 0.4 | 207.0 | | | | |
| 9+ | | | | | | | | |
| TOTAL | 62.8 | 105.9 | 46.0 | 115.9 | 1.1 | 100.0 | 15.6 | 76.8 |
| LAND./SOP | | 6644.9 | | 5334.5 | | 110.0 | | 1200.4 |
| 4. QUARTER | N | W | N | W | N | W | N | W |
| 0 | 64.8 | 33.7 | | | 21.8 | 28.9 | 43.0 | 36.1 |
| 1 | 43.0 | 60.5 | 18.6 | 73.3 | 1.1 | 49.0 | 23.3 | 50.8 |
| 2 | 28.8 | 79.6 | 25.1 | 82.2 | 0.3 | 142.1 | 3.5 | 55.5 |
| 3 | 18.0 | 97.8 | 17.2 | 99.4 | 0.0 | 158.0 | 0.7 | 55.5 |
| 4 | 3.7 | 113.4 | 3.5 | 116.8 | | | 0.2 | 57.6 |
| 5 | 2.6 | 132.3 | 2.6 | 132.3 | | | | |
| 6 | 0.4 | 138.6 | 0.4 | 138.6 | | | | |
| 7 | 0.1 | 210.0 | 0.1 | 210.0 | | | | |
| 8 | | | | | | | | |
| 9+ | | | | | | | | |
| TOTAL | 161.3 | 59.9 | 67.4 | 88.3 | 23.2 | 31.4 | 70.7 | 42.2 |
| LAND./SOP | | 9659.9 | | 5950.0 | | 727.6 | | 2982.3 |
| TOTAL YEAR | N | W | N | W | N | W | N | W |
| 0 | 64.8 | 33.7 | | | 21.8 | 28.9 | 43.0 | 36.1 |
| 1 | 43.0 | 60.5 | 18.6 | 73.3 | 1.1 | 49.0 | 23.3 | 50.8 |
| 2 | 267.4 | 63.7 | 120.0 | 75.2 | 41.1 | 48.8 | 106.3 | 56.6 |
| 3 | 188.5 | 78.5 | 110.3 | 89.0 | 13.9 | 73.1 | 64.4 | 61.6 |
| 4 | 39.7 | 97.5 | 27.6 | 107.9 | 1.3 | 85.1 | 10.8 | 72.6 |
| 5 | 26.0 | 110.0 | 22.8 | 113.3 | 0.6 | 123.6 | 2.6 | 78.9 |
| 6 | 3.3 | 127.6 | 3.3 | 127.6 | | | | |
| 7 | 1.0 | 197.1 | 0.9 | 209.5 | | | 0.1 | 97.8 |
| 8 | 0.7 | 168.9 | 0.7 | 168.9 | | | | |
| 9+ | | | | | | | | |
| TOTAL | 634.3 | 69.5 | 304.1 | 87.1 | 79.8 | 48.7 | 250.5 | 54.7 |
| LAND./SOP | | 44075.1 | | 26479.0 | | 3887.2 | | 13708.8 |

Table 3.2.5 Skagerrak 1991. Autumn spawning herring. Catch in numbers (millions) and mean weight (g) at age

| | TOTAL | | LANDINGS FOR HUMAN CONSUMPT. | | MIXED CLUPEOID | | LANDINGS FOR INDUST. PURPOSES | |
|---|---|---|---|---|---|---|---|---|
| 1. QUARTER | N | W | N | W | N | W | N | W |
| 0 | 0.0 | 0.0 | | | | | | |
| 1 | 69.6 | 26.1 | 0.7 | 69.0 | 49.5 | 23.2 | 19.4 | 32.1 |
| 2 | 70.0 | 67.0 | 35.3 | 85.6 | 18.3 | 35.5 | 16.4 | 62.0 |
| TOTAL | 139.5 | 46.6 | 36.0 | 85.3 | 67.7 | 26.5 | 35.8 | |
| LAND./SOP | | 6505.9 | | 3070.8 | | 1796.2 | | 1638.9 |
| 2. QUARTER | N | W | N | W | N | W | N | W |
| 0 | 0.0 | 0.0 | | | | | | |
| 1 | 331.9 | 29.2 | 15.2 | 73.2 | 6.9 | 27.1 | 309.8 | 27.1 |
| 2 | 138.1 | 79.3 | 48.9 | 101.8 | 1.9 | 66.9 | 87.2 | 66.9 |
| TOTAL | 470.0 | 43.9 | 64.1 | 95.0 | 8.8 | 35.8 | 397.1 | |
| LAND./SOP | | 20640.7 | | 6092.4 | | 315.3 | | 14233.0 |
| 3. QUARTER | N | W | N | W | N | W | N | W |
| 0 | 45.2 | 22.7 | | | 33.8 | 20.4 | 11.4 | 29.5 |
| 1 | 134.6 | 68.2 | 67.3 | 85.9 | 0.7 | 51.0 | 66.6 | 50.5 |
| 2 | 15.4 | 126.9 | 15.4 | 126.9 | | | | |
| TOTAL | 195.2 | 62.3 | 82.6 | 93.5 | 34.6 | 21.1 | 78.0 | |
| LAND./SOP | | 12156.9 | | 7729.2 | | 728.1 | | 3699.6 |
| 4. QUARTER | N | W | N | W | N | W | N | W |
| 0 | 322.1 | 24.5 | 0.2 | 114.7 | 61.7 | 24.8 | 260.1 | 24.4 |
| 1 | 24.3 | 109.6 | 12.1 | 130.0 | 1.6 | 60.6 | 10.6 | 93.5 |
| 2 | 14.8 | 167.3 | 10.9 | 166.4 | | | 3.9 | 170.0 |
| TOTAL | 361.1 | 36.1 | 23.3 | 146.9 | 63.3 | 25.7 | 274.5 | |
| LAND./SOP | | 13043.8 | | 3423.7 | | 1626.4 | | 7993.8 |
| TOTAL YEAR | N | W | N | W | N | W | N | W |
| 0 | 367.3 | 24.3 | 0.2 | 114.7 | 95.6 | 23.2 | 271.5 | 24.6 |
| 1 | 560.4 | 41.7 | 95.3 | 89.4 | 58.7 | 25.0 | 406.4 | 32.9 |
| 2 | 238.2 | 84.2 | 110.5 | 106.5 | 20.2 | 38.5 | 107.5 | 69.9 |
| TOTAL | 1165.9 | 44.9 | 206.1 | 98.6 | 174.4 | 25.6 | 785.4 | 35.1 |
| LAND./SOP | | 52347.3 | | 20316.1 | | 4465.9 | | 27565.3 |

Table 3.2.6 Kattegat 1991. Autumn spawning herring. Catch in numbers (millions) and mean weight (g) at age.

| | TOTAL | | LANDINGS FOR HUMAN CONSUMPT. | | MIXED CLUPEOID | | LANDINGS FOR INDUST. PURPOSES | |
|---|---|---|---|---|---|---|---|---|
| 1. QUARTER | N | W | N | W | N | W | N | W |
| 0 | | | | | | | | |
| 1 | 159.4 | 25.5 | 3.6 | 44.1 | 95.7 | 21.9 | 60.1 | 30.1 |
| 2 | 84.0 | 60.1 | 32.7 | 70.7 | | | 51.3 | 53.4 |
| TOTAL | 243.4 | 37.5 | 36.3 | 68.1 | 95.7 | 21.9 | 111.4 | 40.8 |
| LAND./SOP | | 9115.8 | | 2472.3 | | 2096.3 | | 4547.2 |
| 2. QUARTER | N | W | N | W | N | W | N | W |
| 0 | | | | | | | | |
| 1 | 23.4 | 32.4 | 1.1 | 58.5 | 16.7 | 24.8 | 5.7 | 49.7 |
| 2 | 6.9 | 70.6 | 5.0 | 76.5 | 0.4 | 53.6 | 1.5 | 56.2 |
| TOTAL | 30.3 | 41.1 | 6.0 | 73.3 | 17.1 | 25.5 | 7.2 | 51.0 |
| LAND./SOP | | 1245.0 | | 441.5 | | 436.5 | | 367.0 |
| 3. QUARTER | N | W | N | W | N | W | N | W |
| 0 | 217.5 | 21.9 | | | 216.3 | 21.9 | 1.2 | 19.8 |
| 1 | 64.1 | 65.9 | 20.3 | 80.0 | 3.5 | 51.3 | 40.2 | 60.1 |
| 2 | 1.1 | 79.7 | 1.1 | 79.7 | | | | |
| TOTAL | 282.7 | 32.1 | 21.4 | 80.0 | 219.8 | 22.4 | 41.4 | 58.9 |
| LAND./SOP | | 9074.8 | | 1714.5 | | 4918.6 | | 2441.8 |
| 4. QUARTER | N | W | N | W | N | W | N | W |
| 0 | 127.5 | 33.7 | 1.7 | 36.0 | 42.4 | 28.9 | 83.5 | 36.1 |
| 1 | 15.4 | 72.1 | 15.4 | 72.1 | | | | |
| 2 | | | | | | | | |
| TOTAL | 142.9 | 37.9 | 17.1 | 68.6 | 42.4 | 28.9 | 83.5 | 36.1 |
| LAND./SOP | | 5410.6 | | 1172.5 | | 1224.8 | | 3013.3 |
| TOTAL YEAR | N | W | N | W | N | W | N | W |
| 0 | 345.0 | 26.3 | 1.7 | 36.0 | 258.7 | 23.0 | 84.7 | 35.9 |
| 1 | 262.3 | 38.7 | 40.4 | 73.2 | 115.9 | 23.2 | 106.0 | 42.5 |
| 2 | 92.0 | 61.2 | 38.8 | 71.7 | 0.4 | 53.6 | 52.8 | 53.5 |
| TOTAL | 699.4 | 35.5 | 80.9 | 71.7 | 375.0 | 23.1 | 243.5 | 42.6 |
| LAND./SOP | | 24846.2 | | 5800.7 | | 8676.1 | | 10369.3 |

Table 3.2.7 HERRING Division IIIa, 1990.

Numbers (millions) at age (winter rings) and landings in tonnes.

| Quarter | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ | Total Landings |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Skagerrak | | 162.4 | 166.9 | 25.5 | 11.0 | 3.4 | 0.9 | 0.7 | 0.3 | 16139 |
| | Kattegat | | 231.6 | 284.2 | 32.9 | 15.9 | 5.6 | 0.8 | 0.4 | 0.2 | 21695 |
| | Div. IIIa | 0 | 394.0 | 451.1 | 58.4 | 26.9 | 9.0 | 1.7 | 1.1 | 0.5 | 37834 |
| 2 | Skagerrak | | 660.5 | 125.0 | 17.8 | 16.7 | 2.0 | 0.5 | 0.4 | 0.2 | 23708 |
| | Kattegat | 5.1 | 46.2 | 98.6 | 16.2 | 16.3 | 2.8 | 0.5 | 0.6 | 0.0 | 7949 |
| | Div. IIIa | 5.1 | 706.7 | 223.6 | 34.0 | 33.0 | 4.8 | 1.0 | 1.0 | 0.2 | 31657 |
| 3 | Skagerrak | 0.0 | 125.3 | 302.6 | 74.9 | 75.1 | 36.6 | 2.3 | 14.2 | 0.1 | 63249 |
| | Kattegat | 2.1 | 74.2 | 112.9 | 32.6 | 17.7 | 2.5 | 0.8 | 0.4 | 0.1 | 16846 |
| | Div. IIIa | 2.1 | 199.5 | 415.5 | 107.5 | 92.8 | 39.1 | 3.1 | 14.6 | 0.2 | 80095 |
| 4 | Skagerrak | 310.2 | 19.8 | 77.1 | 22.6 | 5.0 | 4.1 | 0.8 | 0.1 | 0 | 19811 |
| | Kattegat | 80.5 | 245.2 | 110.2 | 22.7 | 12.7 | 1.5 | 0.4 | 0.2 | 0.2 | 31023 |
| | Div. IIIa | 390.7 | 265.0 | 187.3 | 45.3 | 17.7 | 5.6 | 1.2 | 0.3 | 0.2 | 50834 |
| Total Year | Skagerrak | 310.2 | 968.0 | 671.6 | 140.8 | 107.8 | 46.1 | 4.5 | 15.4 | 0.6 | 122907 |
| | Kattegat | 87.7 | 597.2 | 605.9 | 104.4 | 62.6 | 12.4 | 2.5 | 1.6 | 0.5 | 77513 |
| | Div. IIIa | 397.9 | 1565.2 | 1277.5 | 245.2 | 170.4 | 58.5 | 7.0 | 17.0 | 1.1 | 200420 |

Mean weight at age by quarter.

| Quarter | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Skagerrak | | 28.8 | 52.5 | 75.9 | 90.0 | 96.4 | 151.9 | 170.3 | 188.2 |
| | Kattegat | | 21.8 | 43.3 | 69.3 | 83.1 | 102.4 | 123.8 | 124.1 | 161.7 |
| | Div. IIIa | 0.0 | 24.7 | 46.7 | 72.2 | 85.9 | 100.1 | 138.7 | 153.5 | 177.6 |
| 2 | Skagerrak | | 20.8 | 51.6 | 83.7 | 100.6 | 96.4 | 151.9 | 170.3 | 188.2 |
| | Kattegat | 5.5 | 28.7 | 39.5 | 64.4 | 79.5 | 88.1 | 92.0 | 91.0 | 0.0 |
| | Div. IIIa | 5.5 | 21.3 | 46.3 | 74.5 | 90.2 | 91.6 | 121.9 | 122.7 | 188.1 |
| 3 | Skagerrak | 0.0 | 82.6 | 87.0 | 109.2 | 145.4 | 127.1 | 201.4 | 161.1 | 233.7 |
| | Kattegat | 24.6 | 51.9 | 69.5 | 86.8 | 95.1 | 117.9 | 122.6 | 132.3 | 173.3 |
| | Div. IIIa | 24.6 | 71.2 | 82.2 | 102.4 | 135.8 | 126.5 | 181.1 | 160.3 | 203.4 |
| 4 | Skagerrak | 30.5 | 45.0 | 87.3 | 98.3 | 101.0 | 112.3 | 152.7 | 200.0 | 0.0 |
| | Kattegat | 33.0 | 65.6 | 80.2 | 88.1 | 101.3 | 99.8 | 128.5 | 201.9 | 91.7 |
| | Div. IIIa | 31.0 | 64.1 | 83.1 | 93.2 | 101.2 | 108.9 | 144.6 | 201.2 | 91.7 |
| Total Year | Skagerrak | 30.5 | 30.6 | 71.9 | 98.2 | 130.7 | 122.2 | 177.3 | 162.0 | 195.8 |
| | Kattegat | 31.2 | 44.1 | 54.3 | 78.1 | 89.2 | 102.0 | 117.8 | 123.5 | 136.0 |
| | Div. IIIa | 30.7 | 35.8 | 63.5 | 89.6 | 115.5 | 117.9 | 156.1 | 158.4 | 168.6 |

Table 3.2.8 Total catch in numbers (mill) and mean weight (g), SOP (tonnes) of spring spawners in Div. IIIa and the North Sea in the years 1987 – 1991.

| Rings / Year | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8+ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1987 | No | | | 767.00 | 168.10 | 82.90 | 27.70 | 9.30 | 1.20 | 0.20 | 1056.40 |
| | Mean w. | | | 57.0 | 85.0 | 105.6 | 145.3 | 154.6 | 201.2 | 280.4 | |
| | SOP | | | 43705.0 | 14290.4 | 8756.5 | 4023.8 | 1437.6 | 241.4 | 56.1 | 72511 |
| 1988 | No | | | 2075.00 | 563.00 | 62.00 | 8.00 | 2.00 | 0.50 | 0.50 | 2711 |
| | Mean w. | | | 47.3 | 77.0 | 138.3 | 156.0 | 166.0 | 149.0 | 209.0 | |
| | SOP | | | 98147.5 | 43351.0 | 8574.6 | 1248.0 | 332.0 | 74.5 | 104.5 | 151832 |
| 1989 | No | | | 497.69 | 503.66 | 115.23 | 29.96 | 13.68 | 5.35 | 2.34 | 1167.91 |
| | Mean w. | | | 56.5 | 79.9 | 125.5 | 151.6 | 167.3 | 189.2 | 204.8 | |
| | SOP | | | 28119.5 | 40242.4 | 14461.4 | 4541.9 | 2288.7 | 1012.2 | 479.2 | 91145 |
| 1990 | No | | 140.90 | 1006.23 | 259.90 | 192.21 | 62.07 | 9.99 | 19.09 | 2.20 | 1692.59 |
| | Mean w. | | 56.6 | 65.0 | 84.6 | 102.4 | 111.1 | 109.3 | 141.0 | 84.3 | |
| | SOP | | 7974.9 | 65445.2 | 21980.2 | 19673.4 | 6898.2 | 1092.4 | 2692.4 | 185.5 | 125942 |
| 1991 | No | 64.80 | 43.00 | 352.05 | 447.07 | 174.71 | 108.85 | 22.35 | 7.62 | 3.09 | 1223.54 |
| | Mean w. | 33.7 | 60.5 | 77.4 | 101.7 | 127.5 | 148.6 | 165.4 | 182.5 | 194.9 | |
| | SOP | 2183.8 | 2601.5 | 27259.5 | 45458.0 | 22272.7 | 16174.5 | 3697.5 | 1391.0 | 602.1 | 121640.6 |

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

Table 3.2.9 HERRING Division IIIa, 1987 – 1991.
Transfers of juvenile autumn spawners from Div. IIIa to the North Sea
Numbers (mill), mean weight (g) per age group (wr). SOP in tonnes

| YEAR | 0–WR | | 1–WR | | 2–WR | | TOTAL SOP |
|---|---|---|---|---|---|---|---|
| | Numbers | Mean w. | Numbers | Mean w. | Numbers | Mean w. | |
| 1987 | 6238.0 | 8.0 | 3153.0 | 33.0 | 117.0 | 63.0 | 161324 |
| 1988 | 1830.0 | 12.0 | 5792.0 | 28.0 | 292.0 | 57.0 | 200780 |
| 1989 | 1028.2 | 16.2 | 1170.5 | 33.4 | 654.8 | 53.3 | 90652 |
| 1990 | 397.9 | 31.0 | 1424.3 | 34.1 | 283.7 | 55.4 | 76621 |
| 1991 | 712.3 | 25.3 | 822.7 | 40.7 | 330.2 | 77.8 | 77195 |

There are minor corrections for the years previous to 1991.

**Table 3.2.10** HERRING in Division IIIa. Samples of commercial catches by quarter and area for 1991 available to the Working Group.

| Country | Quarter | Landings for consumption | | Landings for industrial purposes | |
|---|---|---|---|---|---|
| | | Catch (t) | No. aged | Catch (t) | No. aged |
| | | **Skagerrak** | | | |
| Denmark | 1 | 1,651 | - | 3,072 | 168 |
| | 2 | 11,864 | 491 | 10,622 | 376 |
| | 3 | 13,594 | 190 | 5,787 | 330 |
| | 4 | 6,374 | 228 | 5,694 | 999 |
| Total | | 33,483 | 909 | 26,175 | 1,873 |
| Sweden | 1 | 3,405 | 536 | 516 | 209 |
| | 2 | 5,667 | 0 | 9,073 | 0 |
| | 3 | 9,984 | 534 | 16,061 | 123 |
| | 4 | 4,055 | 620 | 5,918 | 0 |
| Total | | 23,111 | 1,690 | 31,568 | 332 |
| Norway | 1 | 1,032 | 196 | 0 | |
| | 2 | 2,923 | 192[1] | 0 | |
| | 3 | 3,707 | 559[1] | 0 | |
| | 4 | 465 | 100 | 0 | |
| Total | | 8,127 | 1,047 | 0 | |
| | | **Kattegat** | | | |
| Denmark | 1 | 4,437 | 143 | 5,322 | 413 |
| | 2 | 1,377 | - | 2,103 | 250 |
| | 3 | 5,108 | 114 | 5,072 | 185 |
| | 4 | 4,125 | 420 | 2,109 | 1,235 |
| Total | | 15,047 | 677 | 14,606 | 2,083 |
| Sweden | 1 | 9,626 | 664 | 5,687 | 553 |
| | 2 | 2,694 | 1,018 | 4,118 | 456 |
| | 3 | 1,948 | 642 | 3,611 | 325 |
| | 4 | 3,215 | 799 | 5,833 | 374 |
| Total | | 17,483 | 3,123 | 19,249 | 1,708 |

[1]Research vessel samples.

**Table 3.3.1** Total estimate in numbers (millions) and mean weight (g) at age of spring-spawning herring in Division IIIa and the eastern part the Sub-area IV in 1987-1991 (from acoustic surveys).

| Age rings | 1987 | | 1988 | | 1989 | | 1990 | | 1991 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | W | N | W | N | W | N | W | N | W |
| 0 | | | | | | | 31 | 18 | | |
| 1 | | | | | | | 135 | 50 | | |
| 2 | 958 | | 1512 | 65 | 1105 | 78 | 1352 | 85 | 1864 | 95 |
| 3 | 665 | | 761 | 118 | 714 | 117 | 521 | 108 | 1927 | 114 |
| 4 | 310 | | 87 | 160 | 317 | 171 | 320 | 130 | 866 | 134 |
| 5 | 114 | | 74 | 166 | 81 | 198 | 76 | 144 | 350 | 146 |
| 6 | 43 | | 18 | 181 | 54 | 211 | 23 | 157 | 88 | 216 |
| 7 | 3 | | 1 | 241 | 16 | 215 | 9 | 164 | 72 | 181 |
| 8+ | | | 1 | 175 | 4 | 226 | 3 | 181 | 10 | 200 |
| Total no. | 2093 | | 2454 | | 2291 | | 2470 | | 5177 | |
| Biomass (t) | 252459 | | 217997 | | 255500 | | 236000 | | 597942 | |

**Table 3.4.1** Recruitment indices for 1- and 2-ringed herring from the International Young Fish Survey in Division IIIa. Indices are given for autumn and spring spawners based on modal length analysis and vertebral counts. The indices are weighted by the areas of four depth strata.

| Year | Index | | | | | |
|---|---|---|---|---|---|---|
| | Total | | Spring spawners | | Autumn spawners | |
| | 1-ring | 2-ring | 1-ring | 2-ring | 1-ring | 2-ring |
| 1980 | 2,311 | 387 | 1,607 | 307 | 704 | 80 |
| 1981 | 3,246 | 1,393 | 996 | 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 |
| 1992 | 5,057 | 1,934 | 0 | 771 | 5,057 | 1,163 |

[1]Separation not valid.

**Table 4.2.1** Celtic Sea and Division VIIj HERRING landings by calendar year (t), 1977-1991. (Data provided by Working Group members.)

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

[1]Provisional.

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

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

[1]Provisional.

**Table 4.2.3** Celtic Sea, Division VIIj (1991 - 1992). Sampling intensity of commercial catches.

| Country | Catch (t) | No. of samples | No. of age readings | No. of fish measured | Estimates of discards |
|---|---|---|---|---|---|
| Ireland | 19,400 | 117 | 2,388 | 16,245 | No |
| Netherlands | 1,770 | 1 | 25 | 100 | Yes |

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

| Length | Q3 (1991) | Q4 (1991) | Q1 (1992) |
|---|---|---|---|
| 14.0 | - | - | - |
| 14.5 | - | 7 | - |
| 15.0 | - | - | - |
| 15.5 | - | - | - |
| 16.0 | - | - | - |
| 16.5 | - | 29 | - |
| 17.0 | - | 7 | - |
| 17.5 | - | 15 | - |
| 18.0 | - | 15 | - |
| 18.5 | - | - | - |
| 19.0 | - | 7 | - |
| 19.5 | - | - | - |
| 20.0 | - | 7 | 25 |
| 20.5 | 3 | 15 | 38 |
| 21.0 | 2 | 22 | 89 |
| 21.5 | 10 | 37 | 266 |
| 22.0 | 30 | 44 | 393 |
| 22.5 | 38 | 110 | 520 |
| 23.0 | 43 | 468 | 1,674 |
| 23.5 | 49 | 1,023 | 3,614 |
| 24.0 | 83 | 1,842 | 6,074 |
| 24.5 | 106 | 3,041 | 7,064 |
| 25.0 | 168 | 3,860 | 5,770 |
| 25.5 | 226 | 5,226 | 5,314 |
| 26.0 | 267 | 6,575 | 6,074 |
| 26.5 | 403 | 8,626 | 5,656 |
| 27.0 | 429 | 10,373 | 7,025 |
| 27.5 | 463 | 10,066 | 6,036 |
| 28.0 | 330 | 7,586 | 4,591 |
| 28.5 | 163 | 4,379 | 2,638 |
| 29.0 | 78 | 2,259 | 1,065 |
| 29.5 | 66 | 1,396 | 457 |
| 30.0 | 54 | 870 | 203 |
| 30.5 | 28 | 402 | 76 |
| 31.0 | 14 | 234 | 25 |
| 31.5 | - | 44 | - |
| 32.0 | 2 | 7 | - |
| 32.5 | - | 7 | - |
| 33.0 | - | - | - |
| Total | 3,054 | 68,595 | 64,688 |

Table 4.2.5.

16:14 Sunday, May 10, 1992

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

Catch in Numbers (Thousands)

(CANUM)

| Year | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 | Age 7 | Age 8 | Age 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1970 | 1319 | 37260 | 50087 | 26481 | 18763 | 7853 | 6351 | 2175 | 3367 |
| 1971 | 12658 | 23313 | 37563 | 41904 | 18759 | 10443 | 4276 | 4942 | 2239 |
| 1972 | 8422 | 137690 | 17855 | 15842 | 14531 | 4645 | 3012 | 2374 | 1020 |
| 1973 | 23547 | 38133 | 55805 | 7012 | 9651 | 5323 | 3352 | 2332 | 1209 |
| 1974 | 5507 | 42808 | 17184 | 22530 | 4225 | 3737 | 2978 | 903 | 827 |
| 1975 | 12768 | 15429 | 17783 | 7333 | 9006 | 3520 | 1644 | 1136 | 1194 |
| 1976 | 13317 | 11113 | 7286 | 7011 | 2872 | 4785 | 1980 | 1243 | 1769 |
| 1977 | 8159 | 12516 | 8610 | 5280 | 1585 | 1898 | 1043 | 383 | 470 |
| 1978 | 2800 | 13385 | 11948 | 5583 | 1580 | 1476 | 540 | 858 | 482 |
| 1979 | 11335 | 13913 | 12399 | 8636 | 2889 | 1316 | 1283 | 551 | 635 |
| 1980 | 7162 | 30093 | 11726 | 6585 | 2812 | 2204 | 1184 | 1262 | 565 |
| 1981 | 39361 | 21285 | 21861 | 5505 | 4438 | 3436 | 795 | 313 | 866 |
| 1982 | 15339 | 42725 | 8728 | 4817 | 1497 | 1891 | 1670 | 335 | 596 |
| 1983 | 13540 | 102871 | 26993 | 3225 | 1862 | 327 | 372 | 932 | 308 |
| 1984 | 19517 | 92892 | 41121 | 16043 | 2450 | 1085 | 376 | 231 | 180 |
| 1985 | 17916 | 57054 | 36258 | 16032 | 2306 | 228 | 85 | 173 | 132 |
| 1986 | 4159 | 56747 | 42881 | 32930 | 8790 | 1127 | 98 | 29 | 12 |
| 1987 | 5976 | 67000 | 43075 | 23014 | 14323 | 2716 | 1175 | 296 | 464 |
| 1988 | 2307 | 82027 | 30962 | 9398 | 5963 | 3047 | 869 | 297 | 86 |
| 1989 | 8260 | 42413 | 68399 | 19601 | 8205 | 3837 | 2589 | 767 | 682 |
| 1990 | 2702 | 41756 | 24634 | 35258 | 8116 | 3808 | 1671 | 695 | 462 |
| 1991 | 1861 | 62306 | 37753 | 16590 | 27904 | 4786 | 2569 | 945 | 589 |

**Table 4.2.6** Celtic Sea, Divison VIIj. Percentage age distributions 1977/1978 - 1991/1992.

| Winter rings | Season | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1977-1978 | 1978-1979 | 1979-1980 | 1980-1981 | 1981-1982 | 1982-1983 | 1983-1984 | 1984-1985 | 1985-1986 | 1986-1987 | 1987-1988 | 1988-1989 | 1989-1990 | 1990-1991 | 1991-1992 |
| 1 | 20.4 | 7.3 | 21.4 | 11.3 | 40.2 | 19.8 | 9.0 | 11.2 | 13.8 | 2.8 | 3.8 | 1.7 | 5.3 | 2.2 | 1.2 |
| 2 | 31.3 | 34.6 | 26.3 | 47.3 | 21.8 | 55.1 | 68.4 | 53.4 | 43.8 | 38.7 | 42.4 | 60.8 | 27.4 | 35.1 | 40.1 |
| 3 | 21.5 | 30.9 | 23.4 | 18.4 | 22.3 | 11.2 | 17.9 | 23.6 | 27.9 | 29.2 | 27.3 | 22.9 | 44.2 | 20.7 | 24.3 |
| 4 | 13.2 | 14.5 | 16.3 | 10.4 | 5.6 | 6.2 | 2.1 | 9.2 | 12.3 | 22.4 | 14.6 | 7.0 | 12.7 | 23.6 | 10.7 |
| 5 | 4.0 | 4.1 | 5.5 | 4.4 | 4.5 | 1.9 | 1.2 | 1.4 | 1.8 | 6.0 | 9.1 | 4.4 | 5.3 | 6.8 | 18.0 |
| 6 | 4.8 | 3.8 | 2.5 | 3.5 | 3.5 | 2.4 | 0.2 | 0.6 | 0.2 | 0.8 | 1.7 | 2.3 | 2.5 | 3.2 | 3.1 |
| 7 | 2.6 | 1.4 | 2.4 | 1.9 | 0.8 | 2.2 | 0.2 | 0.2 | + | + | 0.7 | 0.6 | 1.7 | 1.4 | 1.6 |
| 8 | 1.0 | 2.2 | 1.0 | 2.0 | 0.3 | 0.4 | 0.2 | 0.1 | 0.1 | + | 0.2 | 0.2 | 0.5 | 0.6 | 0.6 |
| 9+ | 1.2 | 1.2 | 1.2 | 0.9 | 0.9 | 0.8 | 0.2 | 0.1 | 0.1 | + | 0.3 | 0.1 | 0.4 | 0.4 | 0.4 |

**Table 5.1.1** Nominal catch (t), Division VIa (North) HERRING, 1982-1991, as reported to the Working Group.

| Country | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|
| Denmark | - | - | 96 | - | - |
| Faroes | 74 | 834 | 954 | 104 | 400 |
| France | 2,069 | 1,313 | - | 20 | 18 |
| Germany,Fed.Rep | 8,453 | 6,283 | 5,564 | 5,937 | 2,188 |
| Ireland | - | - | - | - | 6,000 |
| Netherlands | 11,317 | 20,200 | 7,729 | 5,500 | 5,160[2] |
| Norway | 13,018 | 7,336 | 6,669 | 4,690 | 4,799 |
| UK (England) | 90 | - | - | - | - |
| UK (Scotland) | 38,381 | 31,616 | 37,554 | 28,065 | 25,294 |
| Unallocated | 18,958 | -4,059 | 16,588 | 502 | 37,840[2] |
| Discards | - | - | - | - | - |
| Total | 92,360 | 63,523 | 75,154 | 43,814 | 81,699 |

| Country | 1987 | 1988 | 1989 | 1990 | 1991[1] |
|---|---|---|---|---|---|
| Denmark | - | - | - | - | - |
| Faroes | - | - | - | 326 | 482 |
| France | 136 | 44 | 1,342 | 1,287 | 1,168 |
| Germany,Fed.Rep | 1,711 | 1,860 | 4,290 | 7,096 | 6,450 |
| Ireland | 6,800 | 6,740 | 8,000 | 10,000 | 8,000 |
| Netherlands | 5,212[2] | 6,131 | 5,860 | 7,693 | 7,979 |
| Norwaylands | 4,300 | 456 | - | 1,607 | 3,318 |
| UK (England) | - | 1,892 | 1,977 | 2,376 | 2,998 |
| UK (Scotland) | 26,810 | 25,002 | 27,897 | 35,877 | 29,630 |
| Unallocated | 18,038[2] | 5,229[2] | 2,123 | 2,397 | -10,597 |
| Discards | - | - | 1,550 | 1,300 | 1,180 |
| Total | 63,007 | 47,354 | 53,039 | 69,959 | 50,606 |

[1]Preliminary.
[2]Including discards.

**Table 5.1.2** HERRING in Division VIa (North), 1991. Sampling intensity of commercial catches.

| Country | Catch in tonnes | No. of samples | No. of age readings | No. of fish measured | Estimate of discards |
|---|---|---|---|---|---|
| Faroes | 482 | 0 | 0 | 0 | No |
| France | 1,168 | 0 | 0 | 0 | No |
| Germany | 6,450 | 0 | 0 | 0 | No |
| Ireland | 8,000 | 0 | 0 | 0 | No |
| Netherlands | 7,979 | 0 | 0 | 0 | Yes |
| Norway | 3,318 | 0 | 0 | 0 | No |
| UK (England) | 2,996 | 0 | 0 | 0 | No |
| UK (Scotland) | 29,630 | 0 | 0 | 12,035 | No |

## Table 5.1.3

Run title : Herring in the Northern part of VIa (run name: HERRING VIA(N

| Table 1 Catch numbers at age Numbers*10**-3 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
| AGE | | | | | | | | | | | | |
| 1 | 238738 | 169947 | 801663 | 51170 | 309016 | 172879 | 69053 | 34836 | 22525 | 392 | 12867 | 36740 |
| 2 | 205454 | 372615 | 804097 | 235627 | 124944 | 202087 | 319604 | 47739 | 46284 | 225 | 1335 | 77961 |
| 3 | 359711 | 560348 | 219502 | 808267 | 151025 | 89066 | 101548 | 95834 | 20587 | 122 | 452 | 105600 |
| 4 | 139718 | 357745 | 63069 | 131484 | 519178 | 63701 | 35502 | 22117 | 40692 | 31 | 246 | 61341 |
| 5 | 53320 | 113391 | 85920 | 63071 | 82466 | 188202 | 25195 | 10083 | 6879 | 21 | 62 | 21473 |
| 6 | 203462 | 54571 | 37341 | 54642 | 49683 | 30601 | 76289 | 12211 | 3833 | 12 | 43 | 12623 |
| 7 | 29141 | 181592 | 13377 | 18242 | 34629 | 12297 | 10918 | 20992 | 2100 | 7 | 40 | 11583 |
| 8 | 32860 | 18042 | 100938 | 6506 | 22470 | 13121 | 3914 | 2758 | 6278 | 2 | 3 | 1309 |
| +gp | 30651 | 36395 | 20465 | 32223 | 21042 | 13698 | 12014 | 1486 | 1544 | 0 | 1 | 1326 |
| TOTALNUM | 1293055 | 1864646 | 2146372 | 1401232 | 1314453 | 785652 | 654037 | 248056 | 150722 | 812 | 15049 | 329956 |
| TONSLAND | 165930 | 207167 | 164756 | 208270 | 177458 | 111922 | 93642 | 41341 | 22176 | 60 | 306 | 51420 |
| SOPCOF % | 83 | 70 | 61 | 95 | 89 | 97 | 100 | 109 | 100 | 63 | 21 | 103 |

| Table 1 Catch numbers at age Numbers*10**-3 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
| AGE | | | | | | | | | | |
| 1 | 13304 | 81923 | 2961 | 45663 | 38943 | 27645 | 2273 | 9690 | 22374 | 46052 |
| 2 | 250010 | 77810 | 253291 | 77063 | 178714 | 93679 | 158832 | 57305 | 75241 | 40086 |
| 3 | 72179 | 92743 | 66857 | 166112 | 99264 | 64575 | 55529 | 170687 | 63832 | 44635 |
| 4 | 93544 | 29262 | 46963 | 19269 | 137077 | 45488 | 37815 | 29497 | 116270 | 50070 |
| 5 | 58452 | 42535 | 20057 | 17027 | 21723 | 71188 | 26292 | 28228 | 41512 | 66459 |
| 6 | 23580 | 27318 | 15250 | 7422 | 20759 | 11973 | 37993 | 11830 | 20826 | 24005 |
| 7 | 11516 | 14709 | 12478 | 7731 | 2973 | 10378 | 4327 | 23400 | 15463 | 13441 |
| 8 | 13814 | 8437 | 5940 | 3720 | 16177 | 4982 | 2956 | 2529 | 33585 | 12228 |
| +gp | 4027 | 8484 | 2629 | 2450 | 2273 | 8498 | 3140 | 5463 | 8644 | 7901 |
| TOTALNUM | 540426 | 383221 | 426426 | 346457 | 517903 | 338406 | 329157 | 338629 | 397747 | 304877 |
| TONSLAND | 92361 | 63523 | 75154 | 43814 | 82280 | 63007 | 47354 | 53039 | 69959 | 50606 |
| SOPCOF % | 97 | 97 | 105 | 99 | 92 | 103 | 94 | 98 | 99 | 94 |

**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 | 0.64 | 426 | (1.86) | 229 |
| 1991 | 4,430 | 0.60 | 632 | (1.86) | 340 |

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

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

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

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

## Table 5.1.7

Title : Herring in the Northern part of VIa (run name: HERRING VIA(N At 5/04/1992 10:47

Separable analysis
from 1970 to 1991 on ages 1 to 8
with Terminal F of .200 on age 3 and Terminal S of 1.000

Initial sum of squared residuals was 558.450 and
final sum of squared residuals is 72.000 after 97 iterations

Matrix of Residuals

| Years | 1970/71 |
|---|---|
| Ages | |
| 1/ 2 | 1.801 |
| 2/ 3 | -.950 |
| 3/ 4 | -.092 |
| 4/ 5 | .267 |
| 5/ 6 | -.168 |
| 6/ 7 | .102 |
| 7/ 8 | .674 |
| | .000 |
| WTS | .001 |

| Years | 1971/72 | 1972/73 | 1973/74 | 1974/75 | 1975/76 | 1976/77 | 1977/78 | 1978/79 | 1979/80 | 1980/81 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ages | | | | | | | | | | |
| 1/ 2 | -.387 | 3.029 | 1.070 | 1.945 | .961 | 1.670 | 1.022 | .269 | 1.358 | 4.297 |
| 2/ 3 | -.653 | -.415 | .132 | -.563 | -.170 | .038 | -.202 | -.599 | -.070 | .292 |
| 3/ 4 | .809 | -.057 | -.037 | -.238 | -.139 | .145 | -.377 | -.212 | -.195 | -.366 |
| 4/ 5 | .230 | -.404 | .145 | .081 | .034 | .055 | .110 | 1.050 | -.014 | .236 |
| 5/ 6 | -.328 | -.172 | -.289 | -.166 | -.210 | -.716 | -.327 | -.431 | -.272 | -.824 |
| 6/ 7 | .128 | .226 | .078 | .419 | .102 | .039 | .627 | -.353 | -.683 | -1.018 |
| 7/ 8 | -.447 | .456 | -.378 | .214 | .431 | .357 | .312 | .569 | 1.619 | 1.316 |
| | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| WTS | .001 | .001 | .001 | .001 | .001 | .001 | .001 | .001 | .001 | .001 |

| Years | 1981/82 | 1982/83 | 1983/84 | 1984/85 | 1985/86 | 1986/87 | 1987/88 | 1988/89 | 1989/90 | 1990/91 | | WTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ages | | | | | | | | | | | | |
| 1/ 2 | .240 | -.231 | .442 | -1.925 | .754 | .657 | -.281 | -1.520 | .064 | 1.064 | .000 | .190 |
| 2/ 3 | .109 | .327 | -.439 | -.368 | -.211 | .438 | -.088 | -.410 | -.038 | .102 | .000 | .735 |
| 3/ 4 | .010 | .077 | -.065 | .304 | .097 | .053 | -.217 | .159 | .321 | -.316 | .000 | .958 |
| 4/ 5 | .100 | .133 | -.196 | .250 | -.049 | .101 | -.031 | -.009 | -.236 | .173 | .000 | .954 |
| 5/ 6 | -.258 | -.124 | .222 | -.006 | -.349 | -.191 | -.185 | .266 | .184 | -.070 | .000 | 1.000 |
| 6/ 7 | .043 | -.284 | .101 | -.210 | .868 | .017 | .307 | .048 | -.292 | -.080 | .000 | .641 |
| 7/ 8 | -.001 | -.208 | .462 | .566 | -.553 | -.951 | .790 | .343 | -.147 | -.040 | .000 | .435 |
| | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | 15.406 | |
| WTS | .001 | .001 | .001 | .001 | .001 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | | |

Fishing Mortalities (F)

| | 1970 | 1971 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| F-values | .4210 | .8348 | | | | | | | | |
| | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
| F-values | .5085 | .5977 | .9277 | .9402 | 1.0443 | .8180 | .5888 | .0012 | .0024 | .3149 |
| | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
| F-values | .5058 | .4264 | .3628 | .2312 | .3344 | .2634 | .1880 | .1689 | .2333 | .2000 |

Selection-at-age (S)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| S-values | .0633 | .8316 | 1.0000 | .9631 | 1.0484 | .9025 | .8383 | 1.0000 |

## Table 5.1.8

Analysis by RCT3 ver3.1 of data from file :

rct3.dat

Herring in VIa(north)

Data for 2 surveys over 19 years : 1973 - 1991

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

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .00
Minimum of 5 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1988

| | I----------Regression---------I | | | | I----------Prediction---------I | | | |
|---|---|---|---|---|---|---|---|---|
| Survey/ Series | Slope | Inter- cept | Std Error | Rsquare | No. Pts | Index Value | Predicted Value | Std Error | WAP Weights |
| LAI | .83 | -.89 | .47 | .586 | 15 | 8.69 | 6.29 | .573 | .389 |
| LPE | 1.50 | -2.42 | .71 | .379 | 15 | 6.04 | 6.62 | .876 | .167 |
| | | | | | VPA Mean = | | 5.02 | .537 | .444 |

Yearclass = 1989

| | I----------Regression---------I | | | | I----------Prediction---------I | | | |
|---|---|---|---|---|---|---|---|---|
| Survey/ Series | Slope | Inter- cept | Std Error | Rsquare | No. Pts | Index Value | Predicted Value | Std Error | WAP Weights |
| LAI | .83 | -.89 | .47 | .586 | 15 | 8.37 | 6.02 | .554 | .405 |
| LPE | 1.50 | -2.42 | .71 | .379 | 15 | 6.00 | 6.57 | .870 | .164 |
| | | | | | VPA Mean = | | 5.02 | .537 | .431 |

Yearclass = 1990

| | I----------Regression---------I | | | | I----------Prediction---------I | | | |
|---|---|---|---|---|---|---|---|---|
| Survey/ Series | Slope | Inter- cept | Std Error | Rsquare | No. Pts | Index Value | Predicted Value | Std Error | WAP Weights |
| LAI | .83 | -.89 | .47 | .586 | 15 | 8.78 | 6.37 | .579 | .373 |
| LPE | 1.50 | -2.42 | .71 | .379 | 15 | 5.44 | 5.72 | .807 | .192 |
| | | | | | VPA Mean = | | 5.02 | .537 | .435 |

Yearclass = 1991

| | I----------Regression---------I | | | | I----------Prediction---------I | | | |
|---|---|---|---|---|---|---|---|---|
| Survey/ Series | Slope | Inter- cept | Std Error | Rsquare | No. Pts | Index Value | Predicted Value | Std Error | WAP Weights |
| LAI | .83 | -.89 | .47 | .586 | 15 | 8.40 | 6.05 | .555 | .400 |
| LPE | 1.50 | -2.42 | .71 | .379 | 15 | 5.83 | 6.31 | .846 | .172 |
| | | | | | VPA Mean = | | 5.02 | .537 | .428 |

| Year Class | Weighted Average Prediction | Log WAP | Int Std Error | Ext Std Error | Var Ratio | VPA | Log VPA |
|---|---|---|---|---|---|---|---|
| 1988 | 323 | 5.78 | .36 | .49 | 1.87 | | |
| 1989 | 292 | 5.68 | .35 | .43 | 1.47 | | |
| 1990 | 285 | 5.65 | .35 | .43 | 1.46 | | |
| 1991 | 284 | 5.65 | .35 | .39 | 1.25 | | |

## Table 5.1.9

Run title : Herring in the Northern part of VIa (run name: HERRING VIA(N At 5/04/1992
Traditional vpa Terminal populations from weighted Separable populations

| Table 8 Fishing mortality (F) at age | | |
|---|---|---|
| YEAR | 1970 | 1971 |
| AGE | | |
| 1 | .1054 | .0269 |
| 2 | .1801 | .4224 |
| 3 | .4146 | 1.1477 |
| 4 | .4503 | .9018 |
| 5 | .4227 | .7115 |
| 6 | .3644 | .8985 |
| 7 | .5253 | .5673 |
| 8 | .4203 | .6393 |
| +gp | .4202 | .6393 |
| FBAR 3- 6 | .4130 | .9149 |
| FBARS | .2602 | .4818 |
| FBARS | .2602 | .4818 |

| Table 8 Fishing mortality (F) at age | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
| AGE | | | | | | | | | | |
| 1 | .5016 | .0769 | .3298 | .1389 | .1981 | .0837 | .0344 | .0004 | .0211 | .0311 |
| 2 | .2952 | .4971 | .4877 | .7190 | .7848 | .3617 | .2624 | .0007 | .0026 | .2955 |
| 3 | .5095 | .5852 | .7571 | .8565 | 1.1393 | .6237 | .2782 | .0010 | .0018 | .3050 |
| 4 | .3370 | .6246 | .9056 | .8178 | .9996 | .7870 | .5622 | .0006 | .0024 | .3350 |
| 5 | .4941 | .5835 | .9159 | .8923 | .8058 | .7764 | .5314 | .0004 | .0012 | .2640 |
| 6 | .4750 | .5955 | 1.1604 | .9535 | 1.0350 | 1.0844 | .6802 | .0014 | .0010 | .3291 |
| 7 | .5037 | .3982 | .8416 | .9175 | .9905 | .8051 | .4683 | .0020 | .0050 | .3437 |
| 8 | .6326 | .4341 | 1.0856 | .8052 | .7538 | .6422 | .5272 | .0006 | .0009 | .2006 |
| +gp | .6326 | .4341 | 1.0856 | .8052 | .7538 | .6422 | .5272 | .0006 | .0009 | .2006 |
| FBAR 3- 6 | .4539 | .5972 | .9347 | .8800 | .9949 | .8179 | .5130 | .0008 | .0016 | .3083 |
| FBARS | .3204 | .3328 | .5924 | .5433 | .5840 | .4665 | .3119 | .0006 | .0015 | .1809 |
| FBARS | .3204 | .3328 | .5924 | .5433 | .5840 | .4665 | .3119 | .0006 | .0015 | .1809 |

Run title : Herring in the Northern part of VIa (run name: HERRING VIA(N At 5/04/1992
Traditional vpa Terminal populations from weighted Separable populations

| Table 8 Fishing mortality (F) at age | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
| AGE | | | | | | | | | | |
| 1 | .0213 | .0331 | .0029 | .0387 | .0372 | .0113 | .0024 | .0120 | .0324 | .0127 |
| 2 | .5491 | .2869 | .2311 | .1648 | .3643 | .1997 | .1391 | .1297 | .2044 | .1247 |
| 3 | .5259 | .4331 | .4575 | .2481 | .3516 | .2299 | .1850 | .2311 | .2211 | .1905 |
| 4 | .4587 | .3977 | .3865 | .2177 | .3157 | .2555 | .1942 | .1345 | .2312 | .2564 |
| 5 | .5420 | .3464 | .4616 | .2099 | .3605 | .2397 | .2058 | .1945 | .2532 | .1796 |
| 6 | .4559 | .4649 | .1794 | .2748 | .3772 | .3072 | .1742 | .1207 | .1925 | .2036 |
| 7 | .4982 | .5076 | .3553 | .1167 | .1510 | .2921 | .1553 | .1388 | .2048 | .1642 |
| 8 | .7736 | .7378 | .3503 | .1518 | .3366 | .3586 | .1131 | .1149 | .2690 | .2214 |
| +gp | .7736 | .7378 | .3503 | .1518 | .3366 | .3586 | .1131 | .1149 | .2690 | .2214 |
| FBAR 3- 6 | .4956 | .4105 | .3712 | .2376 | .3512 | .2581 | .1898 | .1702 | .2245 | .2075 |
| FBARS | .3642 | .3163 | .2220 | .1242 | .2069 | .1804 | .1023 | .0942 | .1476 | .1263 |
| FBARS | .3642 | .3163 | .2220 | .1242 | .2069 | .1804 | .1023 | .0942 | .1476 | .1263 |

## Table 5.1.10

Run title : Herring in the Northern part of VIa (run name: HERRING VIA(N At 5/04/1992
Traditional vpa Terminal populations from weighted Separable populations

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

| YEAR | 1970 | 1971 |
|---|---|---|
| AGE | | |
| 1 | 374202 | 1009483 |
| 2 | 143674 | 123886 |
| 3 | 116127 | 88898 |
| 4 | 40344 | 62806 |
| 5 | 16196 | 23269 |
| 6 | 69797 | 9602 |
| 7 | 7461 | 43868 |
| 8 | 10029 | 3993 |
| +gp | 9355 | 8054 |
| TOTAL | 787184 | 1373858 |

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

| YEAR | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 308753 | 108681 | 169416 | 208437 | 59800 | 68165 | 105005 | 162309 | 97213 | 189456 |
| 2 | 361498 | 68779 | 37022 | 44816 | 66732 | 18045 | 23063 | 37322 | 59688 | 35015 |
| 3 | 60159 | 199358 | 30995 | 16841 | 16176 | 22554 | 9311 | 13142 | 27629 | 44103 |
| 4 | 23098 | 29592 | 90909 | 11903 | 5855 | 4239 | 9897 | 5772 | 10749 | 22580 |
| 5 | 23064 | 14920 | 14338 | 33258 | 4754 | 1950 | 1746 | 5104 | 5220 | 9703 |
| 6 | 10336 | 12733 | 7532 | 5191 | 12329 | 1922 | 812 | 929 | 4617 | 4717 |
| 7 | 3538 | 5816 | 6351 | 2136 | 1810 | 3963 | 588 | 372 | 839 | 4173 |
| 8 | 22508 | 1934 | 3534 | 2477 | 772 | 608 | 1603 | 333 | 336 | 755 |
| +gp | 4563 | 9581 | 3309 | 2586 | 2370 | 328 | 394 | 0 | 112 | 765 |
| TOTAL | 817518 | 451394 | 363408 | 327646 | 170599 | 121773 | 152419 | 225283 | 206403 | 311269 |

Run title : Herring in the Northern part of VIa (run name: HERRING VIA(N At 5/04/1992
Traditional vpa Terminal populations from weighted Separable populations

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

| YEAR | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | | |
| 1 | 99575 | 397001 | 159392 | 189721 | 168143 | 387762 | 148127 | 128919 | 110772 | 578573 | 0 |
| 2 | 67564 | 35858 | 141293 | 58465 | 67145 | 59597 | 141042 | 54361 | 46863 | 39452 | 210167 |
| 3 | 19304 | 28904 | 19940 | 83078 | 36731 | 34556 | 36157 | 90914 | 35373 | 28298 | 25800 |
| 4 | 26618 | 9341 | 15347 | 10332 | 53075 | 21158 | 22481 | 24602 | 59075 | 23216 | 19149 |
| 5 | 14615 | 15224 | 5679 | 9435 | 7520 | 35024 | 14829 | 16752 | 19460 | 42419 | 16256 |
| 6 | 6742 | 7691 | 9742 | 3239 | 6921 | 4745 | 24936 | 10922 | 12478 | 13669 | 32072 |
| 7 | 3071 | 3867 | 4372 | 7367 | 2226 | 4295 | 3158 | 18956 | 8759 | 9314 | 10090 |
| 8 | 2678 | 1689 | 2106 | 2773 | 5932 | 1732 | 2902 | 2446 | 14930 | 6458 | 7151 |
| +gp | 781 | 1698 | 932 | 1826 | 833 | 2955 | 3082 | 5284 | 3843 | 4173 | 7708 |
| TOTAL | 240947 | 501274 | 358804 | 366236 | 348526 | 551823 | 396714 | 353157 | 311552 | 745570 | 328394 |

## Table 5.1.11

Run title : Herring in the Northern part of VIa (run name: HERRING VIA(N At 5/04/1992

Table 16 Summary (without SOP correction)
Traditional vpa Terminal populations from weighted Separable populations

| | RECRUITS | TOTALBIO | EXPLTBIO | TOTSPBIO | LANDINGS | FBAR 3- 6 | FBARS | FBARS |
|---|---|---|---|---|---|---|---|---|
| 1970 | 3742016 | 1197225 | 484331 | 603745 | 165930 | .4130 | | |
| 1971 | 10094825 | 1671829 | 323148 | 413848 | 207167 | .9149 | | |
| 1972 | 3087528 | 1215468 | 592516 | 622981 | 164756 | .4539 | | |
| 1973 | 1086806 | 811201 | 367491 | 430881 | 208270 | .5972 | | |
| 1974 | 1694162 | 579289 | 214518 | 221155 | 177458 | .9347 | | |
| 1975 | 2084372 | 438478 | 130936 | 128464 | 111922 | .8800 | | |
| 1976 | 598003 | 266981 | 93973 | 101381 | 93642 | .9949 | | |
| 1977 | 681646 | 170188 | 46269 | 63473 | 41341 | .8179 | | |
| 1978 | 1050045 | 188076 | 43434 | 63456 | 22176 | .5130 | | |
| 1979 | 1623094 | 264823 | 112994 | 102163 | 60 | .0008 | | |
| 1980 | 972133 | 295764 | 909055 | 179549 | 306 | .0016 | | |
| 1981 | 1894564 | 423071 | 161769 | 182352 | 51420 | .3083 | | |
| 1982 | 995747 | 372944 | 192814 | 175754 | 92361 | .4956 | | |
| 1983 | 3970014 | 574304 | 159034 | 147725 | 63523 | .4105 | | |
| 1984 | 1593924 | 510595 | 192183 | 259320 | 75154 | .3712 | | |
| 1985 | 1897212 | 526678 | 185464 | 270123 | 43814 | .2376 | | |
| 1986 | 1681429 | 521585 | 253870 | 261799 | 82280 | .3512 | | |
| 1987 | 3877622 | 690383 | 237441 | 258682 | 63007 | .2581 | | |
| 1988 | 1481267 | 616481 | 264005 | 376917 | 47354 | .1898 | | |
| 1989 | 1289195 | 591253 | 317812 | 375804 | 53039 | .1702 | | |
| 1990 | 1107717 | 541065 | 314642 | 342736 | 69959 | .2245 | | |
| 1991 | 5785727 | 890751 | 259862 | 295180 | 50606 | .2075 | | |
| Units | (Thousands) | (Tonnes) | (Tonnes) | (Tonnes) | (Tonnes) | | | |

**Table 5.1.12** List of input variables for prediction.

Herring in Division VIa(north)

List of input variables:

Reference F is the mean f (unweighted) for the age group range from 3 to 6.

The number of recruits per year is as follows for each VPA terminal F option.

Geometric mean recruitment (1980-1989) for VPA terminal Fs:

| Year | F=0.20 | F=0.25 | F=0.27 | F=0.34 |
|---|---|---|---|---|
| 1992 | 646,890 | 613,620 | 653,400 | 620,340 |
| 1993 | 646,890 | 613,620 | 653,400 | 620,340 |

Proportion of F (fishing mortality) effective before spawning: .67
Proportion of M (natural mortality) effective before spawning: .67

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 in weight: | tonnes |

| | | | | All gears | | |
|---|---|---|---|---|---|---|
| age | stock size | natural[1] mortality | maturity[2] ogive | fishing pattern | weight in[3] the catch | weight in[4] the stock |
| 2 | 646890 | .30 | 1.00 | .83 | .118 | .164 |
| 3 | 282980 | .20 | 1.00 | 1.00 | .160 | .208 |
| 4 | 232160 | .10 | 1.00 | .96 | .203 | .233 |
| 5 | 424190 | .10 | 1.00 | 1.05 | .211 | .246 |
| 6 | 136690 | .10 | 1.00 | .90 | .229 | .252 |
| 7 | 93140 | .10 | 1.00 | .84 | .236 | .258 |
| 8 | 64580 | .10 | 1.00 | 1.00 | .261 | .269 |
| 9 | 41730 | .10 | 1.00 | 1.00 | .271 | .292 |

[1] Year 1991 from file NATMOR
[2] Year 1991 from file MORPROP
[3] Year 1991 from file WECA
[4] Year 1991 from file WEST

**Table 5.1.12 (cont.)**

Stock size and fishing pattern for each VPA terminal F option. Stock sizes in thousands of fish on 1st January 1992.

| | F=0.20 | | F=0.25 | | F=0.27 | | F=0.34 | |
|---|---|---|---|---|---|---|---|---|
| Age | Stock size | fishing pattern | Stock size | fishing pattern | Stock size | Fishing pattern | Stock size | Fishing pattern |
| 2 | 646,890 | 0.83 | 613,620 | 0.83 | 653,400 | 0.83 | 620,340 | 0.83 |
| 3 | 404,110 | 1.00 | 369,250 | 1.00 | 386,700 | 1.00 | 346,380 | 1.00 |
| 4 | 188,740 | 0.96 | 147,500 | 0.96 | 177,690 | 0.96 | 135,580 | 0.96 |
| 5 | 172,430 | 1.05 | 136,820 | 1.05 | 166,100 | 1.05 | 129,330 | 1.05 |
| 6 | 309,590 | 0.90 | 239,870 | 0.90 | 288,690 | 0.90 | 217,850 | 0.90 |
| 7 | 102,790 | 0.84 | 80,790 | 0.84 | 98,110 | 0.84 | 75,570 | 0.84 |
| 8 | 70,970 | 1.00 | 55,740 | 1.00 | 67,570 | 1.00 | 52,000 | 1.00 |
| 9+ | 78,360 | 1.00 | 61,720 | 1.00 | 74,540 | 1.00 | 57,440 | 1.00 |

Table 5.1.13

Herring in VIa(north)

* Species: Herring Year 1991. F-factor .2000 and ref. F .1955 *

| 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 | .1701 | 87813.9 | 10362.04 | 646890. | 106090.0 | 646890.0 | 106090.0 | 472092.9 | 77423.2 |
| 3 | .2050 | 47701.2 | 7632.19 | 282980. | 58859.8 | 282980.0 | 58859.8 | 215729.7 | 44871.8 |
| 4 | .1968 | 39532.7 | 8025.13 | 232160. | 54093.3 | 232160.0 | 54093.3 | 190294.1 | 44338.5 |
| 5 | .2152 | 78315.0 | 16524.46 | 424190. | 104350.7 | 424190.0 | 104350.7 | 343423.4 | 84482.1 |
| 6 | .1845 | 21949.2 | 5026.36 | 136690. | 34445.9 | 136690.0 | 34445.9 | 112967.5 | 28467.8 |
| 7 | .1722 | 14041.1 | 3313.70 | 93140. | 24030.1 | 93140.0 | 24030.1 | 77612.6 | 20024.0 |
| 8 | .2050 | 11410.5 | 2978.14 | 64580. | 17372.0 | 64580.0 | 17372.0 | 52644.1 | 14161.3 |
| 9+ | .2050 | 7373.2 | 1998.13 | 41730. | 12185.2 | 41730.0 | 12185.2 | 34017.3 | 9933.1 |
| Total | | 308136.7 | 55860.14 | 1922360. | 411427.0 | 1922360.0 | 411427.0 | 1498782.0 | 323701.9 |

* Species: Herring Year 1992. F-factor .2300 and ref. F .2248 *

| 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 | .1909 | 97586.7 | 11515.23 | 646890. | 106090.0 | 646890.0 | 106090.0 | 465575.0 | 76354.3 |
| 3 | .2300 | 74633.7 | 11941.40 | 399245. | 83043.0 | 399245.4 | 83043.0 | 299308.9 | 62256.3 |
| 4 | .2208 | 35119.7 | 7129.30 | 185931. | 43321.9 | 185931.1 | 43321.9 | 149970.8 | 34943.2 |
| 5 | .2415 | 34794.0 | 7341.54 | 170073. | 41837.9 | 170072.8 | 41837.9 | 135290.2 | 33281.4 |
| 6 | .2070 | 54302.4 | 12435.26 | 304655. | 76773.2 | 304655.5 | 76773.2 | 248015.6 | 62499.9 |
| 7 | .1932 | 16990.7 | 4009.80 | 101465. | 26178.0 | 101465.2 | 26178.0 | 83368.6 | 21509.1 |
| 8 | .2300 | 13724.2 | 3582.02 | 70057. | 18845.2 | 70056.6 | 18845.2 | 56159.9 | 15107.0 |
| 9+ | .2300 | 15123.0 | 4098.33 | 77197. | 22541.5 | 77196.9 | 22541.5 | 61883.9 | 18070.1 |
| Total | | 342274.5 | 62052.88 | 1955514. | 418630.8 | 1955514.0 | 418630.8 | 1499573.0 | 324021.3 |

* Species: Herring Year 1993. F-factor .2000 and ref. F .1955 *

| 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 | .1660 | 85836.2 | 10128.67 | 646890. | 106090.0 | 646890.0 | 106090.0 | 473407.4 | 77638.8 |
| 3 | .2000 | 64193.1 | 10270.90 | 389427. | 81000.8 | 389426.9 | 81000.8 | 297875.7 | 61958.1 |
| 4 | .1920 | 42388.0 | 8604.77 | 254570. | 59314.8 | 254570.1 | 59314.8 | 209335.1 | 48775.1 |
| 5 | .2100 | 23896.4 | 5042.15 | 132340. | 32555.7 | 132340.3 | 32555.7 | 107519.9 | 26449.9 |
| 6 | .1800 | 18582.0 | 4255.28 | 118360. | 29826.6 | 118359.5 | 29826.6 | 98113.7 | 24724.7 |
| 7 | .1680 | 32439.6 | 7655.75 | 220122. | 56791.5 | 220121.9 | 56791.5 | 183942.2 | 47457.1 |
| 8 | .2000 | 12858.8 | 3356.13 | 74419. | 20018.8 | 74419.3 | 20018.8 | 60868.5 | 16373.6 |
| 9+ | .2000 | 17929.8 | 4858.98 | 103768. | 30300.2 | 103767.8 | 30300.2 | 84873.0 | 24782.9 |
| Total | | 298124.0 | 54172.64 | 1939896. | 415898.4 | 1939896.0 | 415898.4 | 1515936.0 | 328160.2 |

**Table 5.2.1** Catches (t) of HERRING from the Firth of Clyde (spring and autumn-spawners combined).

| | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| Reported landings: | | | | | | | | | | |
| UK (Scotland) | 2,506 | 2,530 | 2,991 | 3,001 | 3,395 | 2,895 | 1,568 | 2,135 | 2,184 | 713 |
| UK (N.Ireland + Isle of Man) | - | 273 | 247 | 22 | - | - | - | - | - | - |
| Additional landings[1] | 262 | 293 | 224 | 433 | 576 | 278 | 110 | 208 | 75 | 18 |
| Discards | 1,253 | 1,265 | 2,308[3] | 1,344[3] | 679[3] | 439[4] | 245[4] | -[2] | -[2] | -[2] |
| Catch used by Working Group | 4,021 | 4,361 | 5,770 | 4,800 | 4,650 | 3,612 | 1,923 | 2,343 | 2,259 | 731 |

[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.

Table 5.2.2 Sampling levels of Clyde HERRING 1988-1991.

| Year | Reported landings (t) | No. of samples | No. of fish measured | No. of fish aged | Estimates of discards |
|---|---|---|---|---|---|
| 1988 | 1,568 | 41 | 5,955 | 2,574 | Based on |
| 1989 | 2,135 | 45 | 8,368 | 4,152 | local reports |
| 1990 | 2,184 | 37 | 5,926 | 3,803 | " " |
| 1991 | 713 | 29 | 4,312 | 2,992 | " " |

**Table 5.2.3** Clyde HERRING (spring and autumn spawners combined).

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 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 220 | 314 | 4156 | 1639 | 678 | 508 | 0 | 845 | 716 | 42 |
| 2 | 11311 | 10109 | 11829 | 2951 | 4574 | 1376 | 1062 | 1523 | 1004 | 615 |
| 3 | 4079 | 5232 | 5774 | 4420 | 4431 | 3669 | 1724 | 9293 | 839 | 472 |
| 4 | 2440 | 1747 | 3406 | 4592 | 4622 | 4379 | 2506 | 876 | 7533 | 703 |
| 5 | 1028 | 963 | 1509 | 2806 | 2679 | 3408 | 2014 | 452 | 576 | 1908 |
| 6 | 663 | 555 | 587 | 2654 | 1847 | 1983 | 1319 | 252 | 359 | 169 |
| 7 | 145 | 415 | 489 | 917 | 644 | 1427 | 510 | 146 | 329 | 92 |
| 8 | 222 | 189 | 375 | 681 | 287 | 680 | 234 | 29 | 119 | 113 |
| 9 | 63 | 85 | 74 | 457 | 251 | 308 | 66 | 16 | 49 | 22 |
| 10+ | 53 | 38 | 80 | 240 | 79 | 175 | 16 | 5 | 16 | 9 |
| TOTAL | 20224 | 19647 | 28278 | 21357 | 20092 | 17913 | 9451 | 13437 | 11523 | 4145 |

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

| Length (cm) | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|
| 13.0 | | 3 | | |
| 13.5 | | 3 | | |
| 14.0 | | 3 | | |
| 14.5 | | | | |
| 15.0 | | 3 | | |
| 15.5 | | | | |
| 16.0 | | | | |
| 16.5 | | | | |
| 17.0 | | 7 | | |
| 17.5 | | | | |
| 18.0 | | | | |
| 18.5 | | | | |
| 19.0 | | 2 | | |
| 19.5 | | | | 1 |
| 20.0 | + | 5 | 3 | 1 |
| 20.5 | | | 1 | 2 |
| 21.0 | | 12 | 4 | + |
| 21.5 | + | 13 | 5 | 7 |
| 22.0 | + | 61 | 46 | 14 |
| 22.5 | 2 | 78 | 92 | 10 |
| 23.0 | 3 | 169 | 54 | 34 |
| 23.5 | 10 | 186 | 94 | 25 |
| 24.0 | 31 | 235 | 127 | 51 |
| 24.5 | 59 | 304 | 138 | 85 |
| 25.0 | 99 | 422 | 230 | 143 |
| 25.5 | 185 | 883 | 204 | 149 |
| 26.0 | 172 | 1,494 | 443 | 243 |
| 26.5 | 171 | 2,128 | 632 | 294 |
| 27.0 | 229 | 2,196 | 1,164 | 437 |
| 27.5 | 376 | 1,529 | 1,761 | 393 |
| 28.0 | 620 | 815 | 2,064 | 601 |
| 28.5 | 348 | 484 | 1,878 | 636 |
| 29.0 | 977 | 421 | 1,120 | 495 |
| 29.5 | 923 | 315 | 530 | 226 |
| 30.0 | 889 | 158 | 382 | 148 |
| 30.5 | 697 | 112 | 194 | 50 |
| 31.0 | 514 | 80 | 148 | 42 |
| 31.5 | 305 | 72 | 115 | 21 |
| 32.0 | 146 | 20 | 51 | 20 |
| 32.5 | 102 | 22 | 26 | 3 |
| 33.0 | 43 | 2 | 12 | 3 |
| 33.5 | 6 | 1 | 14 | 10 |
| 34.0 | 7 | + | 4 | |
| 34.5 | + | + | 4 | |
| 35.0 | + | | | |
| 35.5 | 2 | | | |

+Less than 500.

**Table 5.2.5** Number of days absent from port by pair trawlers in the Firth of Clyde, 1974-1991, and estimated total effort in pair trawl units.

| Year | Days absent (pair trawl) | Raised to total landings |
|---|---|---|
| 1974 | 3,376 | 3,376 |
| 1975 | 3,209 | 3,209 |
| 1976 | 3,016 | 3,016 |
| 1977 | 4,186 | 4,186 |
| 1978 | 4,379 | 4,379 |
| 1979 | 2,933 | 2,933 |
| 1980 | 1,982 | 1,982 |
| 1981 | 1,529 | 1,529 |
| 1982 | 1,755 | 1,755 |
| 1983 | 1,644 | 1,644 |
| 1984 | 1,401 | 1,401 |
| 1985 | 1,688 | 1,688 |
| 1986 | 1,375 | 1,375 |
| 1987 | 850 | 998 |
| 1988 | 540 | 626 |
| 1989 | 582 | 639 |
| 1990 | 388 | 429 |
| 1991 | 169 | 254 |

**Table 5.2.6** CLYDE HERRING. Mean weight at age (kg) in the catch and stock.

| Age (rings) | Mean weight in catch (spring and autumn-spawners combined) | | | | | | | | Mean weight in stock (spring spawners only) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1970-1981 | 1982-1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | Feb[1] 1991 | Mar[2] 1991 |
| 2 | .225 | .149 | .166 | .149 | .156 | .149 | .170 | .143 | - | - |
| 3 | .270 | .187 | .199 | .194 | .194 | .174 | .186 | .163 | .171 | .173 |
| 4 | .290 | .228 | .224 | .203 | .207 | .203 | .202 | .188 | .195 | .218 |
| 5 | .310 | .253 | .253 | .217 | .211 | .221 | .216 | .192 | .210 | .215 |
| 6 | .328 | .272 | .265 | .225 | .222 | .227 | .237 | .198 | .210 | .245 |
| 7 | .340 | .307 | .297 | .236 | .230 | .235 | .234 | .210 | .234 | - |
| 8 | .345 | .291 | .298 | .247 | .225 | .237 | .234 | .222 | - | - |
| 9 | .350 | .300 | .298 | .255 | .244 | .219 | .257 | .200 | - | - |
| 10+ | .350 | .300 | .321 | .258 | .230 | .254 | .272 | .203 | - | - |

[1]Based on commercial samples of herring mostly at stages IV, V and VI.
[2]Based on one sample taken on the spawning grounds.

**Table 5.2.7** Estimated percentages of herring (2-ringers and older at each maturity stage in each month of 1991.

| Month | Maturity stages | | | | |
|---|---|---|---|---|---|
| | Immature I-II | Developing III | Developing IV-V | Spawning/spent VI-VII | Recovering spents VIII |
| Jan | 5.7 | 2.2 | 75.2 | 0 | 16.8 |
| Feb | 0 | 0.4 | 66.5 | 28.5 | 4.6 |
| Mar | 4.3 | 0.3 | 42.7 | 7.2 | 45.5 |
| Apr | 24.8 | 0.4 | 1.6 | 7.7 | 65.6 |
| May | 2.8 | 0 | 0.6 | 3.1 | 93.6 |
| Jun | 2.3 | 2.6 | 0.3 | 7.2 | 87.7 |
| Jul | 10.2 | 44.8 | 12.3 | 0 | 32.8 |
| Aug | 2.2 | 26.7 | 34.7 | 0.5 | 35.8 |
| Sept | 0.6 | 41.8 | 44.2 | 0 | 13.3 |
| Oct | 0.5 | 23.2 | 63.1 | 0 | 13.2 |
| Nov | 12.5 | 9.1 | 53.9 | 0 | 24.4 |
| Dec | 1.5 | 3.8 | 63.5 | 0 | 31.2 |

Table 5.2.8 Race/maturity key used in estimating percentage of spring- and autumn-spawners in the catch

| | MATURITY STAGE | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | VII | VIII |
| January | ? | ? | S | S | S | S | ? | A |
| February | ? | ? | ? | S | S | S | S | A |
| March | ? | ? | ? | S | S | S | S | ? |
| April | ? | ? | ? | ? | S | S | S | ? |
| | | | | | | | | |
| July | ? | ? | ? | ? | A | A | ? | ? |
| August | ? | ? | ? | ? | A | A | A | S |
| September | ? | ? | S | ? | A | A | A | S |
| October | ? | ? | S | S | A | A | A | ? |
| November | ? | ? | S | S | A | A | A | ? |
| December | ? | ? | S | S | S | A | A | A |

**Table 5.2.9** Monthly percentage of spring-spawners and estimated numbers (thousands) and percentages of 5-ringers in catches of 3-ringers and older in 1991.

| Month | Estimated number | | % of 5-ringers | % of spring-spawners based on maturity data |
|---|---|---|---|---|
| | 5-ringers | 3-ringers & older | | |
| January | 17.4 | 20.2 | 85.8 | 81.6 - 82.1 |
| February | 86.9 | 94.0 | 92.5 | 95.3 |
| March | 35.4 | 50.7 | 69.9 | 51.1 - 100 |
| April | 48.5 | 125.7 | 38.5 | 9.8 - 100 |
| July | 259.7 | 570.9 | 45.5 | 0.0 - 100 |
| August | 116.8 | 301.9 | 38.7 | 35.8 - 97.6 |
| September | 346.7 | 581.3 | 59.6 | 56.0 - 82.7 |
| October | 589.6 | 1027.3 | 57.4 | 81.2 - 97.0 |
| November | 217.7 | 398.7 | 54.6 | 68.5 - 99.7 |
| December | 142.4 | 230.9 | 61.6 | 66.7 - 67.1 |

**Table 5.2.10** Percentage age compositions (3-ringers and older) in landings from Clyde (spring and autumn spawners combined) and adjacent areas in 1991.

| Age in rings | Clyde | | VIa N | VIIa | VIa S + VIIb,c |
|---|---|---|---|---|---|
| | Jan-Feb. | Mar.-Dec. | | | |
| 3 | 2.3 | 13.9 | 20.4 | 38.2 | 14.1 |
| 4 | 4.2 | 20.7 | 22.9 | 16.0 | 6.4 |
| 5 | 91.3 | 53.4 | 30.4 | 28.7 | 52.2 |
| 6 | 1.4 | 5.0 | 11.0 | 8.4 | 9.3 |
| 7 | 0.7 | 2.7 | 6.1 | 4.1 | 7.7 |
| ≥8 | 0.1 | 4.3 | 9.2 | 4.6 | 9.9 |

**Table 5.2.11** Length and age compositions of herring sampled on the spawning grounds in the Clyde, March 1991.

| | | % Frequency | | |
|---|---|---|---|---|
| Length (cm) | | Brown Head | Ballantrae Bank | |
| 25.0 | | 0.5 | | |
| 25.5 | | 0.5 | 0.5 | |
| 26.0 | | | | |
| 26.5 | | | 0.5 | |
| 27.0 | | | 2.5 | |
| 27.5 | | 5.0 | 6.5 | |
| 28.0 | | 12.0 | 19.9 | |
| 28.5 | | 16.0 | 21.9 | |
| 29.0 | | 36.5 | 21.4 | |
| 29.5 | | 16.5 | 12.4 | |
| 30.0 | | 9.5 | 11.0 | |
| 30.5 | | 1.0 | 0.5 | |
| 31.0 | | 1.5 | 1.5 | |
| 31.5 | | 1.0 | 0.5 | |
| 32.0 | | | 0.5 | |
| 32.5 | | | 0.5 | |
| Age (rings) | Year class | | | Combined |
| 2 | 1989 | | 0.5 | 0.2 |
| 3 | 1988 | 1.0 | 0.5 | 0.8 |
| 4 | 1987 | 2.5 | 5.5 | 4.0 |
| 5 | 1986 | 95.5 | 90.6 | 93.0 |
| 6 | 1985 | 1.0 | 2.5 | 1.8 |
| 7 | 1984 | | 0.5 | 0.2 |

**Table 5.2.12** Estimated numbers at age (thousands) in the spawning population in the Clyde in 1991, with 1990 for comparison.

| | 1991 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Age (rings) & Year Class | | | | | | Total |
| | 2 | 3 | 4 | 5 | 6 | 7 | |
| | 1989 | 1988 | 1987 | 1986 | 1985 | 1984 | |
| Brown Head | - | 184 | 461 | 17,645 | 185 | - | 18,475 |
| Ballantrae Bank | 69 | 69 | 759 | 12,560 | 344 | 69 | 13,870 |
| Combined | 69 | 253 | 1,220 | 30,205 | 529 | 69 | 32,345 |

| | 1990 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Age (rings) & Year Class | | | | | | Total |
| | 2 | 3 | 4 | 5 | 6 | 7 | |
| | 1988 | 1987 | 1986 | 1985 | 1984 | 1983 | |
| Combined | - | 362 | 38,860 | 428 | 120 | - | 39,824 |

**Table 5.2.13** Calculation of fishing mortality in 1991 and stock in number of spring spawners at 1 January 1992 from egg survey and catches in numbers at age (thousands).

| Age (rings) | No at 1.4.91 | Catch Apr-Dec 1991[1] | M | F | No at 1.1.92 |
|---|---|---|---|---|---|
| 3 | 253 | 15 | 0.15 | 0.066 | (250) |
| 4 | 1,220 | 73 | 0.075 | 0.064 | 204 |
| 5 | 30,205 | 1,815 | 0.075 | 0.064 | 1,062 |
| 6 | 529 | 32 | 0.075 | 0.064 | 26,285 |
| =/>7 | 69 | 4 | 0.075 | 0.064 | 520 |

[1]58% of total catch in number assumed to be spring spawners allocated to age in proportion to numbers in stock.

**Table 5.2.14** Input for prediction of Clyde spring spawning herring.

| Age (rings) | No at 1.1.92 (thousands) | M | F pattern | Maturity 0give | $W_c$[1] | $W_s$[2] |
|---|---|---|---|---|---|---|
| 3 | 250 | 0.2 | 1 | 1 | .174 | .171 |
| 4 | 204 | 0.1 | 1 | 1 | .198 | .195 |
| 5 | 1,062 | 0.1 | 1 | 1 | .210 | .210 |
| 6 | 26,285 | 0.1 | 1 | 1 | .221 | .210 |
| =/>7 | 520 | 0.1 | 1 | 1 | .229 | .234 |

[1]Weight in catch = mean over 1989-1991.
[2]$W_s$ weight in stock is from samples from the spawning grounds in February 1991.
Recruitment in 1993 and 1994: 250 assumed.

**Table 6.1.1** Estimated HERRING catches in tonnes in Divisions VIa (South) and VIIb,c, 1982-1991.

| Country | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|
| France | 353 | 19 | - | - | - |
| Germany, Fed.Rep. | 265 | - | - | - | - |
| Ireland | 16,856 | 15,000 | 10,000 | 13,900 | 15,540 |
| Netherlands | 1,735 | 5,000 | 6,400 | 1,270 | 1,550 |
| UK (N.Ireland) | - | - | - | - | - |
| UK (England + Wales) | - | - | - | - | - |
| UK Scotland | - | - | - | - | - |
| Unallocated | - | 13,000 | 11,000 | - | 11,785 |
| Total landings | 19,209 | 33,019 | 27,400 | 23,374 | 28,785 |
| Discards | - | - | - | - | - |
| Total catch | 19,209 | 33,019 | 27,400 | 23,374 | 28,785 |

| Country | 1987 | 1988 | 1989 | 1990 | 1991[1] |
|---|---|---|---|---|---|
| France | - | - | - | + | - |
| Germany, Fed.Rep. | - | - | - | - | - |
| Ireland | 15,000 | 15,000 | 18,200 | 25,000 | 22,500 |
| Netherlands | 1,550 | 300 | 2,900 | 2,533 | 600 |
| UK (N.Ireland) | 5 | - | - | 80 | - |
| UK (England + Wales) | 51 | - | - | - | - |
| UK (Scotland) | - | - | + | - | + |
| Unallocated | 31,994 | 13,800 | 7,100 | 13,826 | 11,200 |
| Total landings | 48,600 | 29,100 | 28,200 | 41,439 | 34,300 |
| Discards | - | - | 1,000 | 2,530 | 3,400 |
| Total catch | 48,600 | 29,100 | 29,200 | 43,969 | 37,700 |

[1]Provisional

**Table 6.1.2** Herring West of Ireland & Porcupine Bank & lower part of VIa (Fishing Areas VIIb,c & of VIa).

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 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 748 | 1517 | 2794 | 9606 | 918 | 12149 | 0 | 2241 | 878 | 675 |
| 2 | 18136 | 43688 | 81481 | 15143 | 27110 | 44160 | 29135 | 6919 | 24977 | 34437 |
| 3 | 17004 | 49534 | 28660 | 67355 | 24818 | 80213 | 46300 | 78842 | 19500 | 27810 |
| 4 | 28220 | 25316 | 17854 | 12756 | 66383 | 41504 | 41008 | 26149 | 151978 | 12420 |
| 5 | 18280 | 31782 | 7190 | 11241 | 14644 | 99222 | 23381 | 21481 | 24362 | 100444 |
| 6 | 8121 | 18320 | 12836 | 7638 | 7988 | 15226 | 45692 | 15008 | 20164 | 17921 |
| 7 | 4089 | 6695 | 5974 | 9185 | 5696 | 12639 | 6946 | 24917 | 16314 | 14865 |
| 8 | 3249 | 3329 | 2008 | 7587 | 5422 | 6082 | 2482 | 4213 | 8184 | 11311 |
| 9+ | 2875 | 4251 | 4020 | 2168 | 2127 | 10187 | 1964 | 3036 | 1130 | 7660 |
| TOTAL | 100722 | 184432 | 162817 | 142679 | 155106 | 321382 | 196908 | 182806 | 267487 | 227543 |
| | 19209 | 32988 | 27450 | 23343 | 28785 | 48600 | 29100 | 29210 | 43969 | 37700 |
| | 103 | 100 | 97 | 98 | 100 | 95 | 100 | 100 | 100 | 100 |

**Table 6.1.3** Sampling intensity of commercial catches.

| Country | Catch (t) | No. of samples | No. of age readings | No. of fish measured | Estimates of discards |
|---|---|---|---|---|---|
| Ireland | 22,000 | 45 | 1,958 | 9,464 | No |
| Netherlands | 600 | 4 | 100 | 400 | Yes |

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

| Length | 1st quarter | 2 quarter | 3 quarter | 4 quarter |
|---|---|---|---|---|
| 16.0 | 13 | | | |
| 16.5 | 25 | | | |
| 17.0 | 13 | | | |
| 17.5 | 25 | | | |
| 18.0 | 25 | | | |
| 18.5 | - | | | |
| 19.0 | 13 | | | |
| 19.5 | - | | | |
| 20.0 | 63 | | 17 | |
| 20.5 | 241 | 33 | 17 | 34 |
| 21.0 | 266 | 33 | 76 | - |
| 21.5 | 431 | 263 | 110 | 34 |
| 22.0 | 494 | 493 | 202 | - |
| 22.5 | 507 | 362 | 185 | 135 |
| 23.0 | 481 | 117 | 194 | 270 |
| 23.5 | 456 | 920 | 211 | 641 |
| 24.0 | 785 | 920 | 514 | 2429 |
| 24.5 | 1495 | 1150 | 801 | 4251 |
| 25.0 | 1695 | 920 | 666 | 5701 |
| 25.5 | 2597 | 2366 | 514 | 5634 |
| 26.0 | 4383 | 3516 | 430 | 6275 |
| 26.5 | 10084 | 4502 | 531 | 8029 |
| 27.0 | 10793 | 6047 | 565 | 12651 |
| 27.5 | 8259 | 4009 | 590 | 17609 |
| 28.0 | 4788 | 2498 | 480 | 15113 |
| 28.5 | 3230 | 1479 | 219 | 10222 |
| 29.0 | 2736 | 1052 | 236 | 5735 |
| 29.5 | 1812 | 657 | 118 | 4419 |
| 30.0 | 1064 | 230 | 126 | 2496 |
| 30.5 | 583 | 66 | 101 | 1451 |
| 31.0 | 279 | 66 | 67 | 405 |
| 31.5 | 89 | - | 8 | 236 |
| 32.0 | 13 | - | 8 | 67 |
| 32.5 | 13 | 33 | - | |
| 33.0 | | | 8 | |
| 33.5 | | | 8 | |
| 34.0 | | | | |
| Total | 57753 | 32372 | 7004 | 103666 |

**Table 6.1.5** Irish young fish surveys. Catch of herring per hour.

| Year | 0-w.r. | 1-w.r | No. of stations | Type of trawl |
|---|---|---|---|---|
| 1981 | 628 | 455 | 10 | 3 briddle butterfly trawl |
| 1982 | 1,599 | 861 | 10 | 1 whitefish bottom trawl |
| 1983 | 238 | 661 | 10 | and sprat bag |
| 1984 | 2,398 | 64 | 10 | " |
| 1985 | 7 | 77 | 10 | Pelagic trawl and sprat bag |
| 1986 | 24 | 0 | 6 | Whitefish bottom trawl and sprat bag |
| 1987 | 1,065 | 3,661 | 8 | Star trawl and sprat bag |
| 1988 | 4,432 | 45 | 13 | Star trawl and rock hopper |
| 1989 | | | No survey | |
| 1990 | 17 | 4 | 8 | Rock hopper and sprat bag |
| 1991 | 61 | 3 | 6 | Rock hopper and sprat bag |

**Table 7.1.1** HERRING. Total catches (t) in North Irish Sea (Division VIIa, North), 1980-1991 as reported to the Working Group.

| Country | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|
| France | 1 | - | - | 48 | - | - |
| Ireland | 1,340 | 283 | 300 | 860 | 1,084 | 1,000 |
| Netherlands | - | - | - | - | - | - |
| UK | 9,272 | 4,094 | 3,375 | 3,025 | 2,982 | 4,077 |
| Unallocated | - | - | 1,180 | - | - | 4,110 |
| Total | 10,613 | 4,377 | 4,855 | 3,933 | 4,066 | 9,187 |

| Country | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|
| France | - | - | - | - | - | |
| Ireland | 1,640 | 1,200 | 2,579 | 1,430 | 1,699 | |
| Netherlands | - | - | - | - | - | |
| UK | 4,376 | 3,290 | 7,593 | 3,532 | 4,613 | |
| Unallocated | 1,424 | 1,333 | - | - | - | |
| Total | 7,440 | 5,823 | 10,172 | 4,962 | 6,312 | |

**Table 7.1.2** HERRING.
Sampling intensity of commercial landings for Division VIIa (North) in 1991.

| Quarter | Country | Landings (t) | No. samples | No. fish measured | No. fish aged | Estimation of discards |
|---|---|---|---|---|---|---|
| Q1 | Ireland | 0 | - | - | - | - |
| | UK (N.Ireland) | 2[2] | 0 | 0 | 0 | No |
| | UK (Isle of Man) | 0 | - | - | - | - |
| | UK (Scotland) | 0 | - | - | - | - |
| | UK (Offshore) | 0 | - | - | - | - |
| Q2 | Ireland | 0 | - | - | - | - |
| | UK (N.Ireland) | 7[2] | 0 | 0 | 0 | No |
| | UK (Isle of Man) | 98 | 5 | 1,597 | 246 | No |
| | UK (Scotland) | + | 0 | 0 | 0 | No |
| | UK (Offshore)[1] | 0 | - | - | - | - |
| Q3 | Ireland | 80 | 5 | 1,255 | 247 | No |
| | UK (N.Ireland) | 2,859 | 98 | 15,729 | 2,434 | No |
| | UK (Isle of Man) | 531 | 23 | 6,683 | 1,146 | No |
| | UK (Scotland) | + | 0 | 0 | 0 | No |
| | UK (Offshore)[1] | 96[2] | 0 | 0 | 0 | No |
| Q4 | Ireland | 0 | - | - | - | - |
| | Uk (N.Ireland) | 430 | 7 | 995 | 50 | No |
| | UK (Isle of Man) | 0 | - | - | - | - |
| | UK (Scotland) | 0 | - | - | - | - |
| | UK (Offshore)[1] | 295[3] | 0 | 0 | 0 | No |

[1]UK offshore denotes landings to offshore vessels + < 1t.
[2]Mean weight at age data for Q3 (N. Ireland) applied to these catches.
[3]Mean weight-at-age data for Q4 (N. Ireland) applied to these catches.
+ = landings < 1t.

**Table 7.1.3** HERRING in the North Irish Sea (Manx plus Mourne herring, Division VIIa (North)).

Run title : Herring in the North Irish Sea (Manx plus Mourne herring) (r At 5/04/1992 16:12
Traditional vpa Terminal populations from weighted Separable populations

Catch numbers at age Numbers*10**-3

| YEAR | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 40640 | 42150 | 43250 | 33330 | 34740 | 30280 | 15540 | 11770 | 5840 | 5050 |
| 2 | 46660 | 32740 | 109550 | 48240 | 56160 | 39040 | 36950 | 38270 | 25760 | 15790 |
| 3 | 26950 | 38240 | 39750 | 39410 | 20780 | 22690 | 13410 | 23490 | 19510 | 3200 |
| 4 | 13180 | 11490 | 24510 | 10840 | 15220 | 6750 | 6780 | 4250 | 8520 | 2790 |
| 5 | 13750 | 6920 | 10650 | 7870 | 4580 | 4520 | 1740 | 2200 | 1980 | 2300 |
| 6 | 6760 | 5070 | 4990 | 4210 | 2810 | 1460 | 1340 | 1050 | 910 | 330 |
| 7 | 2660 | 2590 | 5150 | 2090 | 2420 | 910 | 670 | 400 | 360 | 290 |
| +gp | 1670 | 2600 | 1630 | 1640 | 1270 | 1120 | 350 | 290 | 230 | 240 |
| TOTALNUM | 152270 | 141800 | 239480 | 147630 | 137980 | 106770 | 76780 | 81720 | 63110 | 29990 |
| TONSLAND | 27350 | 22600 | 38640 | 24500 | 21250 | 15410 | 11080 | 12338 | 10613 | 4377 |
| SOPCOF % | 112 | 101 | 100 | 103 | 99 | 95 | 92 | 93 | 97 | 91 |

Catch numbers at age Numbers*10**-3

| YEAR | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 5100 | 1305 | 1168 | 2429 | 4491 | 2225 | 2607 | 1156 | 2313 | 1999 |
| 2 | 16030 | 12162 | 8424 | 10050 | 15266 | 12981 | 21250 | 6385 | 12835 | 9754 |
| 3 | 5670 | 5598 | 7237 | 17336 | 7462 | 6146 | 13343 | 12039 | 5726 | 6743 |
| 4 | 2150 | 2820 | 3841 | 13287 | 8550 | 2998 | 7159 | 4708 | 9697 | 2833 |
| 5 | 330 | 445 | 2221 | 7206 | 4528 | 4180 | 4610 | 1876 | 3598 | 5068 |
| 6 | 1110 | 484 | 380 | 2651 | 3198 | 2777 | 5084 | 1255 | 1661 | 1493 |
| 7 | 140 | 255 | 229 | 667 | 1464 | 2328 | 3232 | 1559 | 1042 | 719 |
| +gp | 380 | 59 | 479 | 724 | 877 | 1671 | 4213 | 1956 | 1615 | 815 |
| TOTALNUM | 30910 | 23128 | 23979 | 54350 | 45836 | 35306 | 61498 | 30934 | 38487 | 29424 |
| TONSLAND | 4855 | 3933 | 4066 | 9187 | 7440 | 5823 | 10172 | 4949 | 6312 | 4398 |
| SOPCOF % | 98 | 98 | 96 | 102 | 98 | 104 | 105 | 100 | 101 | 100 |

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

| Length (cm) | 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).

| Year | Lengths at age (cm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Age (rings) | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1985 | 22.1 | 24.3 | 26.1 | 27.6 | 28.3 | 28.6 | 29.5 | 30.1 |
| 1986 | 19.7 | 24.3 | 25.8 | 26.9 | 28.0 | 28.8 | 28.8 | 29.8 |
| 1987 | 20.0 | 24.1 | 26.3 | 27.3 | 28.0 | 29.2 | 29.4 | 30.1 |
| 1988 | 20.2 | 23.5 | 25.7 | 26.3 | 27.2 | 27.7 | 28.7 | 29.6 |
| 1989 | 20.9 | 23.8 | 25.8 | 26.8 | 27.8 | 28.2 | 28.0 | 29.5 |
| 1990 | 20.1 | 24.2 | 25.6 | 26.2 | 27.7 | 28.3 | 28.3 | 29.0 |
| 1991 | 20.5 | 23.8 | 25.4 | 26.1 | 26.8 | 27.3 | 27.7 | 28.7 |

**Table 7.2.2** HERRING in Division VIIa (North).

| Year | Weights at age (g) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Age (rings) | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1976-1983 | 74 | 155 | 195 | 219 | 232 | 251 | 258 | 278 |
| 1984 | 76 | 142 | 187 | 213 | 221 | 243 | 240 | 273 |
| 1985 | 87 | 125 | 157 | 186 | 202 | 209 | 222 | 258 |
| 1986 | 68 | 143 | 167 | 188 | 215 | 229 | 239 | 254 |
| 1987 | 58 | 130 | 160 | 175 | 194 | 210 | 218 | 229 |
| 1988 | 70 | 124 | 160 | 170 | 180 | 198 | 212 | 232 |
| 1989 | 81 | 128 | 155 | 174 | 184 | 195 | 205 | 218 |
| 1990 | 77 | 135 | 163 | 175 | 188 | 196 | 207 | 217 |
| 1991 | 70 | 121 | 153 | 167 | 180 | 189 | 195 | 214 |

**Table 7.4.1** HERRING in the North Irish Sea (Manx plus Mourne herring, Division VIIa (North)).

At 6/04/1992 12:44

Separable analysis
from 1972 to 1991 on ages 1 to 7
with Terminal F of .150 on age 3 and Terminal S of 1.000

Initial sum of squared residuals was 129.351 and
final sum of squared residuals is 20.140 after 128 iterations

Matrix of Residuals

| Years | 1972/73 | 1973/74 | 1974/75 | 1975/76 | 1976/77 | 1977/78 | 1978/79 | 1979/80 | 1980/81 |
|---|---|---|---|---|---|---|---|---|---|
| Ages | | | | | | | | | |
| 1/ 2 | 1.672 | 1.108 | 1.260 | 1.052 | 1.274 | 1.142 | .613 | .764 | -.161 |
| 2/ 3 | -.592 | -.368 | -.048 | .012 | -.173 | -.029 | -.411 | -.179 | .511 |
| 3/ 4 | -.084 | .130 | .040 | -.057 | -.150 | -.078 | .111 | -.017 | .186 |
| 4/ 5 | -.254 | -.200 | -.083 | -.107 | -.020 | .109 | .127 | -.228 | -.411 |
| 5/ 6 | .094 | .050 | -.291 | .062 | -.090 | -.031 | -.494 | -.109 | .068 |
| 6/ 7 | .103 | -.251 | -.300 | -.368 | -.056 | -.418 | .257 | .126 | -.527 |
| | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| WTS | .001 | .001 | .001 | .001 | .001 | .001 | .001 | .001 | .001 |

| Years | 1981/82 | 1982/83 | 1983/84 | 1984/85 | 1985/86 | 1986/87 | 1987/88 | 1988/89 | 1989/90 | 1990/91 | | WTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ages | | | | | | | | | | | | |
| 1/ 2 | .149 | .360 | -.204 | .441 | -.313 | .334 | .017 | .193 | -.472 | -.081 | .000 | .262 |
| 2/ 3 | .188 | .218 | .172 | -.146 | -.281 | .237 | .205 | -.438 | .024 | -.027 | .000 | .585 |
| 3/ 4 | -.561 | -.242 | -.065 | -.127 | .013 | .132 | -.021 | -.078 | .034 | -.066 | .000 | 1.000 |
| 4/ 5 | 1.212 | .670 | -.168 | -.114 | .419 | -.029 | -.263 | .255 | .122 | -.086 | .000 | .431 |
| 5/ 6 | -.202 | -1.298 | -.260 | .330 | .146 | -.266 | -.037 | .207 | -.036 | .134 | .000 | .469 |
| 6/ 7 | -.027 | .601 | .375 | -.014 | -.027 | -.392 | .049 | .135 | .072 | .136 | .000 | .564 |
| | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | 5.524 | |
| WTS | .001 | .001 | .001 | .001 | .001 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | | |

Fishing Mortalities (F)

| | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|
| F-values | .6688 | .5690 | 1.0442 | .9424 | 1.0941 | 1.0466 | .9074 | .9415 | 1.0486 | .4681 |
| | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
| F-values | .3085 | .1784 | .1568 | .3807 | .3123 | .2163 | .3829 | .1943 | .2312 | .1500 |

Selection-at-age (S)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| S-values | .0650 | .8287 | 1.0000 | 1.0092 | 1.0007 | .9787 | 1.0000 |

**Table 7.4.2** HERRING in the North Irish Sea (Manx plus Mourne herring, Division VIIa (North)).

Fishing mortality (F) at age

| YEAR | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | .1669 | .1043 | .2141 | .1527 | .2294 | .1573 | .1029 | .1416 | .0608 | .0363 |
| 2 | .3625 | .3459 | .8244 | .7529 | .7959 | .8560 | .5332 | .7453 | 1.0577 | .4084 |
| 3 | .5357 | .6164 | 1.0230 | .9062 | .9784 | 1.0061 | .9209 | .8573 | 1.2889 | .3659 |
| 4 | .5513 | .4359 | 1.0125 | .8456 | 1.0982 | 1.0003 | .9373 | .8253 | .8593 | .5876 |
| 5 | .6530 | .5565 | .8163 | .9732 | .9679 | 1.0675 | .6754 | .8154 | 1.0759 | .5230 |
| 6 | .6898 | .4715 | .8959 | .8017 | 1.0477 | .8571 | .9824 | 1.0262 | .8576 | .4429 |
| 7 | .6660 | .5466 | 1.1172 | 1.1083 | 1.4997 | 1.0855 | 1.1592 | .8031 | 1.1327 | .6519 |
| +gp | .6660 | .5466 | 1.1172 | 1.1083 | 1.4997 | 1.0855 | 1.1592 | .8031 | 1.1327 | .6519 |
| FBAR 2- 6 | .5584 | .4853 | .9144 | .8559 | .9776 | .9574 | .8099 | .8539 | 1.0279 | .4656 |

Fishing mortality (F) at age

| YEAR | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | .0340 | .0083 | .0130 | .0229 | .0331 | .0108 | .0296 | .0083 | .0142 | .0097 |
| 2 | .2648 | .1787 | .1133 | .2520 | .3395 | .2142 | .2288 | .1581 | .2013 | .1279 |
| 3 | .2671 | .1471 | .1626 | .3806 | .3203 | .2361 | .3792 | .2080 | .2203 | .1638 |
| 4 | .4249 | .1956 | .1354 | .4727 | .3102 | .1949 | .4478 | .2109 | .2446 | .1533 |
| 5 | .1109 | .1294 | .2082 | .3568 | .2587 | .2190 | .4540 | .1791 | .2210 | .1746 |
| 6 | .4568 | .2106 | .1397 | .3638 | .2364 | .2234 | .3984 | .1903 | .2130 | .1205 |
| 7 | .3032 | .1594 | .1308 | .3431 | .3119 | .2414 | .3879 | .1817 | .2135 | .1207 |
| +gp | .3032 | .1594 | .1308 | .3431 | .3119 | .2414 | .3879 | .1817 | .2135 | .1207 |
| FBAR 2- 6 | .3049 | .1723 | .1519 | .3652 | .2930 | .2175 | .3816 | .1893 | .2200 | .1480 |

**Table 7.4.3** HERRING in the North Irish Sea (Manx plus Mourne herring, Division VIIa (North)). Traditional VPA terminal populations from weighted separable population.

Stock number at age (start of year) Numbers*10**-3

| YEAR | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 1 | 412653 | 667683 | 348898 | 367806 | 263083 | 324905 | 249393 | 139421 | 155876 | 223359 |
| 2 | 176045 | 128475 | 221305 | 103618 | 116151 | 76940 | 102129 | 82778 | 44519 | 53961 |
| 3 | 71062 | 90766 | 67343 | 71890 | 36156 | 38823 | 24217 | 44390 | 29104 | 11453 |
| 4 | 32530 | 34050 | 40119 | 19822 | 23782 | 11128 | 11622 | 7895 | 15420 | 6566 |
| 5 | 29972 | 16959 | 19924 | 13188 | 7700 | 7176 | 3703 | 4119 | 3130 | 5909 |
| 6 | 14175 | 14116 | 8796 | 7970 | 4509 | 2647 | 2233 | 1705 | 1649 | 966 |
| 7 | 5717 | 6435 | 7971 | 3249 | 3235 | 1431 | 1016 | 756 | 553 | 633 |
| +gp | 3589 | 6460 | 2523 | 2550 | 1697 | 1761 | 531 | 548 | 353 | 524 |
| TOTAL | 745744 | 964944 | 716879 | 590092 | 456314 | 464811 | 394844 | 281613 | 250604 | 303370 |

Stock number at age (start of year) Numbers*10**-3

| YEAR | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | | |
| 1 | 240845 | 248816 | 142920 | 169301 | 217806 | 328591 | 140963 | 222211 | 258554 | 325744 | 0 |
| 2 | 79239 | 85642 | 90775 | 51898 | 60871 | 77519 | 119588 | 50344 | 81075 | 93772 | 118672 |
| 3 | 26572 | 45046 | 53063 | 60045 | 29883 | 32114 | 46356 | 70475 | 31842 | 49111 | 61131 |
| 4 | 6503 | 16656 | 31836 | 36924 | 33599 | 17761 | 20763 | 25975 | 46862 | 20916 | 34134 |
| 5 | 3302 | 3847 | 12394 | 25159 | 20826 | 22293 | 13225 | 12005 | 19035 | 33201 | 16236 |
| 6 | 3169 | 2674 | 3059 | 9107 | 15933 | 14548 | 16204 | 7600 | 9081 | 13809 | 25230 |
| 7 | 561 | 1816 | 1960 | 2407 | 5727 | 11382 | 10528 | 9844 | 5685 | 6641 | 11076 |
| +gp | 1523 | 420 | 4100 | 2612 | 3431 | 8170 | 13724 | 12351 | 8811 | 7527 | 11363 |
| TOTAL | 361714 | 404918 | 340107 | 357452 | 388076 | 512378 | 381350 | 410804 | 460946 | 550721 | 277841 |

**Table 7.4.4** HERRING in the North Irish Sea (Manx plus Mourne herring, Division VIIa (North)).

Summary (with SOP correction)
Traditional vpa Terminal populations from weighted Separable populations

| | RECRUITS | TOTALBIO | EXPLTBIO | TOTSPBIO | LANDINGS | SOPCOFAC | FBAR 2- 6 | FBAR 2- 6 |
|---|---|---|---|---|---|---|---|---|
| 1972 | 412653 | 102808 | 48975 | 36251 | 27350 | 1.1200 | .5584 | |
| 1973 | 667683 | 106183 | 46572 | 31572 | 22600 | 1.0073 | .4853 | |
| 1974 | 348898 | 91238 | 42256 | 23477 | 38640 | .9958 | .9144 | |
| 1975 | 367806 | 70016 | 28624 | 16687 | 24500 | 1.0260 | .8559 | |
| 1976 | 263083 | 53561 | 21737 | 12210 | 21250 | .9927 | .9776 | |
| 1977 | 324905 | 46894 | 16096 | 8837 | 15410 | .9538 | .9574 | |
| 1978 | 249393 | 40099 | 13681 | 10036 | 11080 | .9243 | .8099 | |
| 1979 | 139421 | 32783 | 14449 | 9058 | 12338 | .9296 | .8539 | |
| 1980 | 155876 | 28006 | 10325 | 5541 | 10613 | .9701 | 1.0279 | |
| 1981 | 223359 | 27718 | 9402 | 7100 | 4377 | .9092 | .4656 | |
| 1982 | 240845 | 38207 | 15924 | 12949 | 4855 | .9837 | .3049 | |
| 1983 | 248816 | 45518 | 22831 | 19229 | 3933 | .9838 | .1723 | |
| 1984 | 142920 | 43811 | 26776 | 24326 | 4066 | .9623 | .1519 | |
| 1985 | 169301 | 46627 | 25158 | 19889 | 9187 | 1.0202 | .3652 | |
| 1986 | 217806 | 44137 | 25391 | 19677 | 7440 | .9767 | .2930 | |
| 1987 | 328591 | 50990 | 26769 | 22021 | 5823 | 1.0382 | .2175 | |
| 1988 | 140963 | 49077 | 26653 | 23538 | 10172 | 1.0521 | .3816 | |
| 1989 | 222211 | 48454 | 26148 | 22424 | 4949 | 1.0034 | .1893 | |
| 1990 | 258554 | 53378 | 28687 | 23460 | 6312 | 1.0130 | .2200 | |
| 1991 | 325744 | 56680 | 29716 | 25466 | 4398 | 1.0006 | .1480 | |
| Units | (Thousands) | (Tonnes) | (Tonnes) | (Tonnes) | (Tonnes) | | | |

**Table 7.6.1** List of input variables for prediction.

Herring in the North Irish Sea (VIIa)

List of input variables:

Reference F is the mean f (unweighted) for the age group range from 2 to 6.

The number of recruits per year is as follows for each VPA terminal F option.

Geometric mean recruitment (1984-1990) for VPA terminal Fs:

| Year | F=0.10 | F=0.15 | F=0.20 | F=0.30 |
|---|---|---|---|---|
| 1992 | 251,876 | 202,628 | 176,900 | 149,934 |
| 1993 | 251,876 | 202,628 | 176,900 | 149,934 |

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 in weight: | tonnes |

| | | | | All gears | | |
|---|---|---|---|---|---|---|
| age | stock size | natural[1] mortality | maturity[2] ogive | fishing pattern | weight in[3] the catch | weight in[4] the stock |
| 1 | 202630.0 | 1.00 | .08 | .07 | .076 | .071 |
| 2 | 73381.0 | .30 | .85 | .83 | .129 | .128 |
| 3 | 61131.0 | .20 | 1.00 | 1.00 | .159 | .158 |
| 4 | 34134.0 | .10 | 1.00 | 1.01 | .173 | .172 |
| 5 | 16236.0 | .10 | 1.00 | 1.00 | .185 | .185 |
| 6 | 25230.0 | .10 | 1.00 | .98 | .198 | .198 |
| 7 | 11076.0 | .10 | 1.00 | 1.00 | .208 | .207 |
| 8 | 11363.0 | .10 | 1.00 | 1.00 | .223 | .222 |

[1] Year 1991 from file NATMOR
[2] Year 1991 from file MORPROP
[3] Mean for years 1987-1991 from file WECA
[4] Mean for years 1987-1991 from file WEST

**Table 7.6.1 (cont.)**

Stock size and fishing pattern for each VPA terminal F option. Stock sizes in thousands of fish on 1st January 1992.

| | F=0.10 | | F=0.15 | | F=0.20 | | F=0.30 | |
|---|---|---|---|---|---|---|---|---|
| Age / Ring | Stock size | fishing pattern | Stock size | fishing pattern | Stock size | Fishing pattern | Stock size | Fishing pattern |
| 1 | 251,876 | 0.06 | 202,628 | 0.07 | 176,900 | 0.07 | 149,934 | 0.07 |
| 2 | 91,495 | 0.83 | 73,381 | 0.83 | 63,917 | 0.83 | 53,995 | 0.84 |
| 3 | 93,940 | 1.00 | 61,131 | 1.00 | 44,860 | 1.00 | 28,722 | 1.00 |
| 4 | 52,600 | 1.01 | 34,134 | 1.01 | 24933 | 1.01 | 15,774 | 1.01 |
| 5 | 24,984 | 1.00 | 16,236 | 1.00 | 11,859 | 1.00 | 7,487 | 1.00 |
| 6 | 38,932 | 0.98 | 25,230 | 0.98 | 18,385 | 0.98 | 11,564 | 0.98 |
| 7 | 17,065 | 1.00 | 11,076 | 1.00 | 8,084 | 1.00 | 5,101 | 1.00 |
| 8+ | 17,499 | 1.00 | 11,363 | 1.00 | 8,297 | 1.00 | 5,241 | 1.00 |

Numbers of 2-ring fish obtained by replacing VPA estimate of 1-ring fish in 1991 with a geometric mean value.

**Table 7.6.2 Results of prediction based on VPA with terminal F = 0.15.**

Herring in the North Irish Sea (VIIa)

**********
* Species: Herring Year 1992. All gears F-factor .2282 and ref. F .2200 *
**********

| | All gears | | | | 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 | .0160 | 2032.4 | 154.47 | 202628. | 14386.6 | 16210.2 | 1150.9 | 7547.9 | 535.9 |
| 2 | .1894 | 10990.8 | 1417.81 | 73381. | 9392.8 | 62373.9 | 7983.9 | 42000.5 | 5376.1 |
| 3 | .2282 | 11347.7 | 1804.28 | 61131. | 9658.7 | 61131.0 | 9658.7 | 42847.1 | 6769.8 |
| 4 | .2305 | 6699.4 | 1159.00 | 34134. | 5871.0 | 34134.0 | 5871.0 | 25735.2 | 4426.5 |
| 5 | .2282 | 3158.5 | 584.31 | 16236. | 3003.7 | 16236.0 | 3003.7 | 12266.2 | 2269.3 |
| 6 | .2236 | 4820.3 | 954.42 | 25230. | 4995.5 | 25230.0 | 4995.5 | 19139.6 | 3789.6 |
| 7 | .2282 | 2154.7 | 448.17 | 11076. | 2292.7 | 11076.0 | 2292.7 | 8367.9 | 1732.2 |
| 8+ | .2282 | 2210.5 | 492.94 | 11363. | 2522.6 | 11363.0 | 2522.6 | 8584.7 | 1905.8 |
| Total | | 43414.3 | 7015.40 | 435179. | 52123.6 | 237754.1 | 37479.0 | 166489.2 | 26805.1 |

**********
* Species: Herring Year 1993. All gears F-factor .2124 and ref. F .2048 *
**********

| | All gears | | | | 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 | .0149 | 1892.6 | 143.84 | 202628. | 14386.6 | 16210.2 | 1150.9 | 7555.4 | 536.4 |
| 2 | .1763 | 10289.0 | 1327.28 | 73361. | 9390.3 | 62357.2 | 7981.7 | 42487.8 | 5438.4 |
| 3 | .2124 | 7829.1 | 1244.83 | 44982. | 7107.1 | 44981.8 | 7107.1 | 31979.6 | 5052.8 |
| 4 | .2145 | 7332.7 | 1268.55 | 39838. | 6852.1 | 39837.9 | 6852.1 | 30470.1 | 5240.9 |
| 5 | .2124 | 4474.5 | 827.78 | 24528. | 4537.7 | 24527.9 | 4537.7 | 18796.1 | 3477.3 |
| 6 | .2082 | 2094.7 | 414.76 | 11693. | 2315.3 | 11693.5 | 2315.3 | 8995.2 | 1781.1 |
| 7 | .2124 | 3330.0 | 692.64 | 18254. | 3778.6 | 18254.2 | 3778.6 | 13988.5 | 2895.6 |
| 8+ | .2124 | 2948.2 | 657.44 | 16161. | 3587.7 | 16161.0 | 3587.7 | 12384.4 | 2749.3 |
| Total | | 40190.8 | 6577.12 | 431446. | 51955.4 | 234023.8 | 37311.2 | 166657.3 | 27171.8 |

**Figure 2.3.1** Relation between IYFS 1-ringer index and estimates of 1-ringers from VPA. Regression based on year classes 1977-1988.

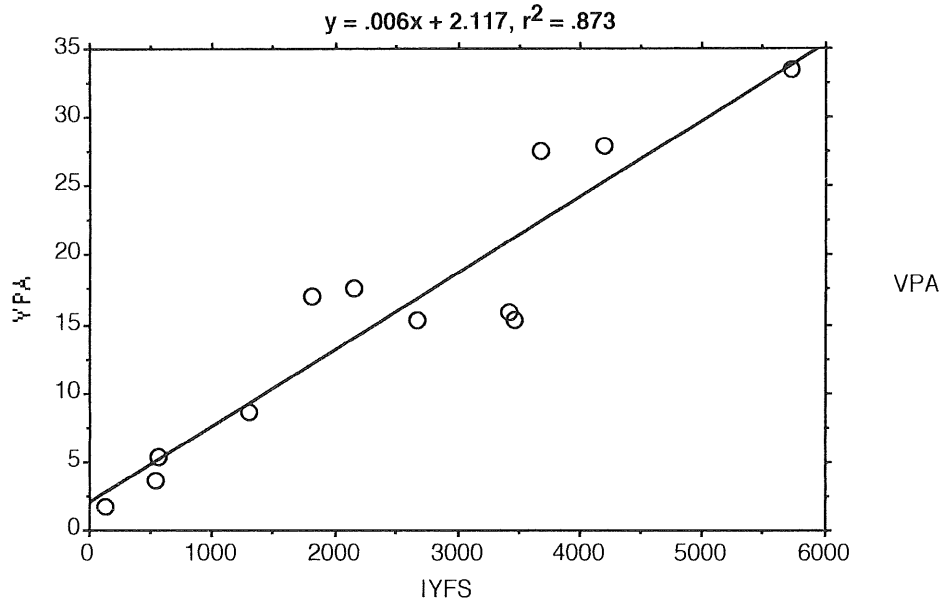



**Figure 2.3.2** Relation between MIK 0-ringer index and estimates of 0-ringers from VPA. Regression based on year classes 1976-1988.

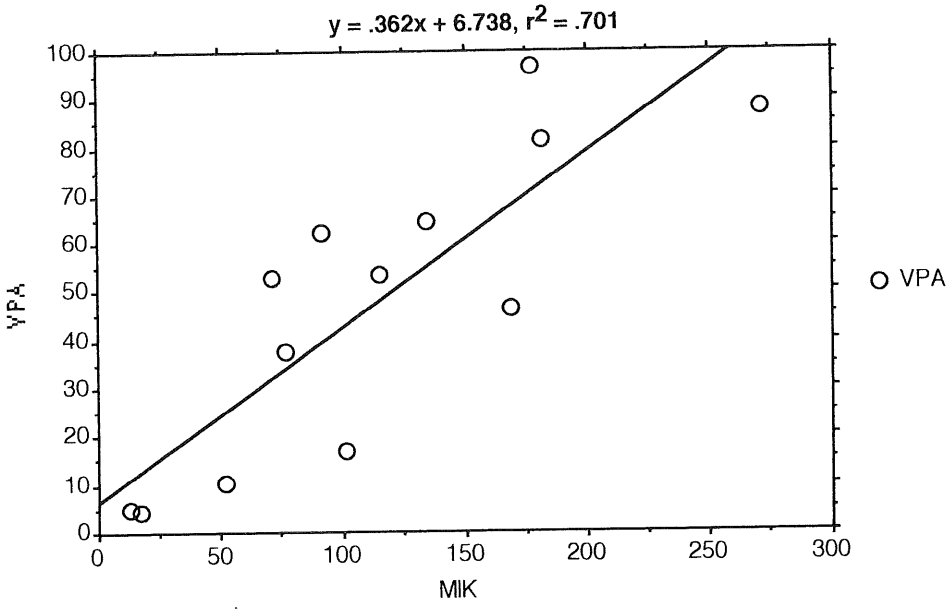


**Figure 2.3.3** Distribution of 0-ringers, year classes 1989-1991. Density of 0-ringers within statistical rectangles, estimated from catches with either IKMT or MIK during the IYFS in February. Area of filled circles represents densities in no. $m^{-2}$, the area of circles that extends to the borders of a statistical rectangle represents 1.8 $m^{-2}$.

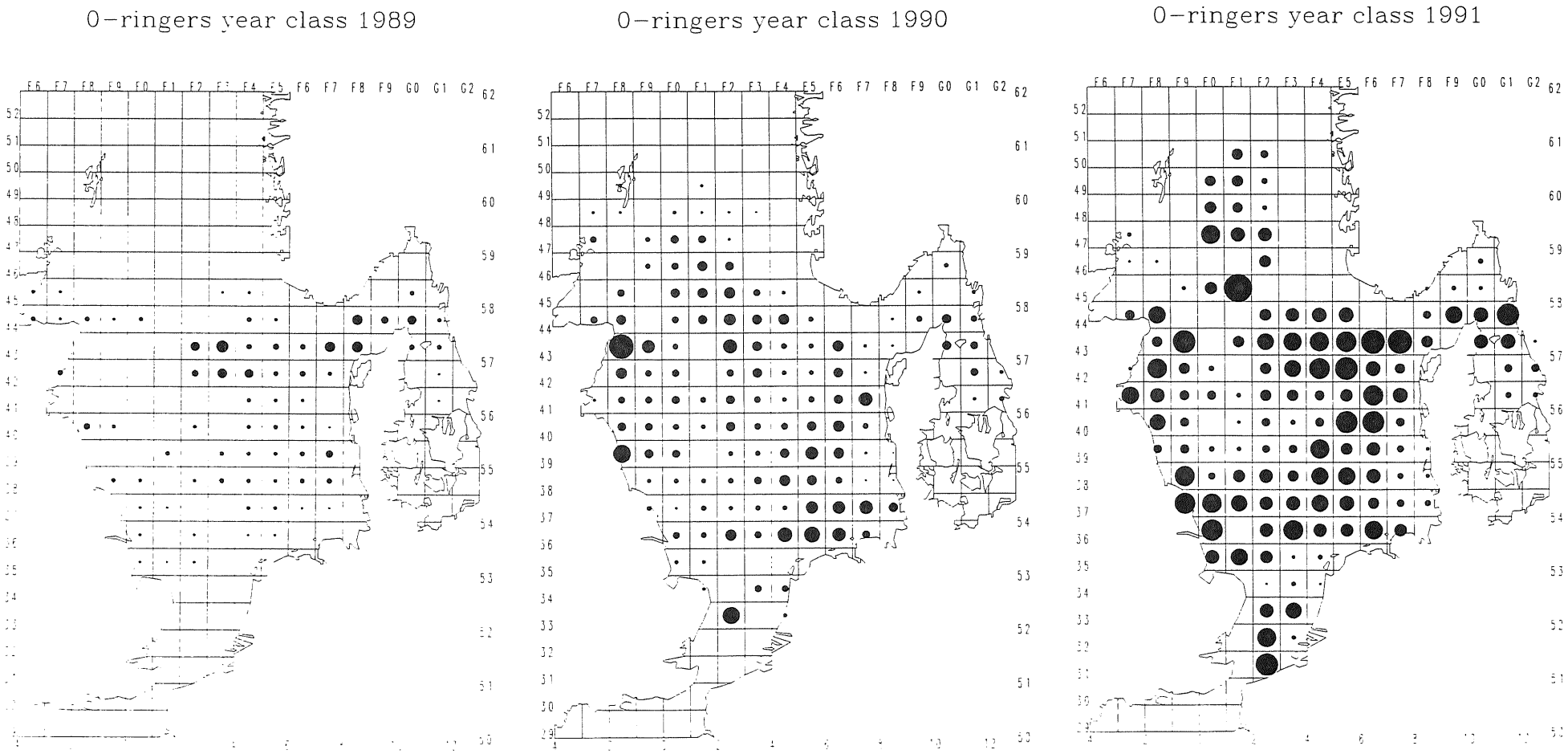


Figure 2.3.4 Trends in recruitment of 1-ringed North Sea autumn spawners

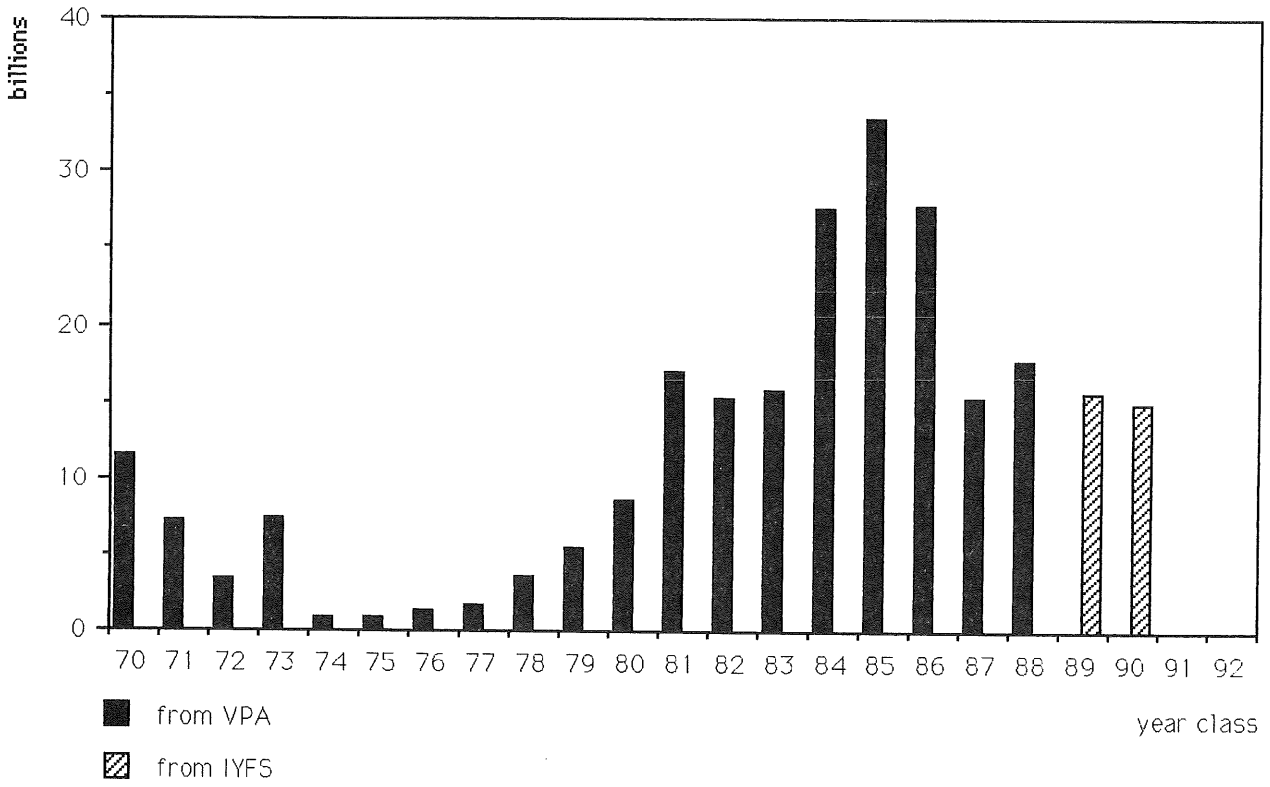
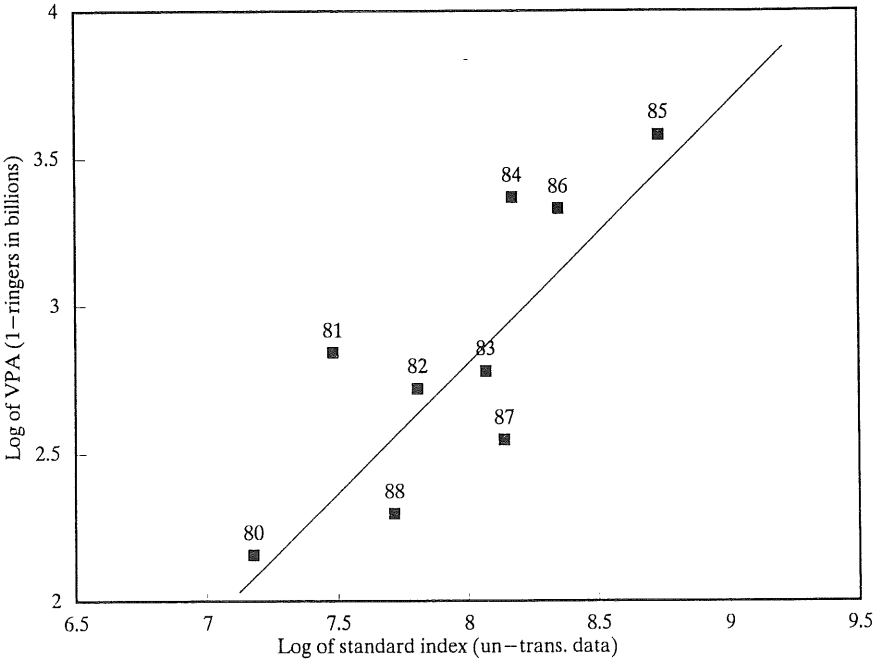
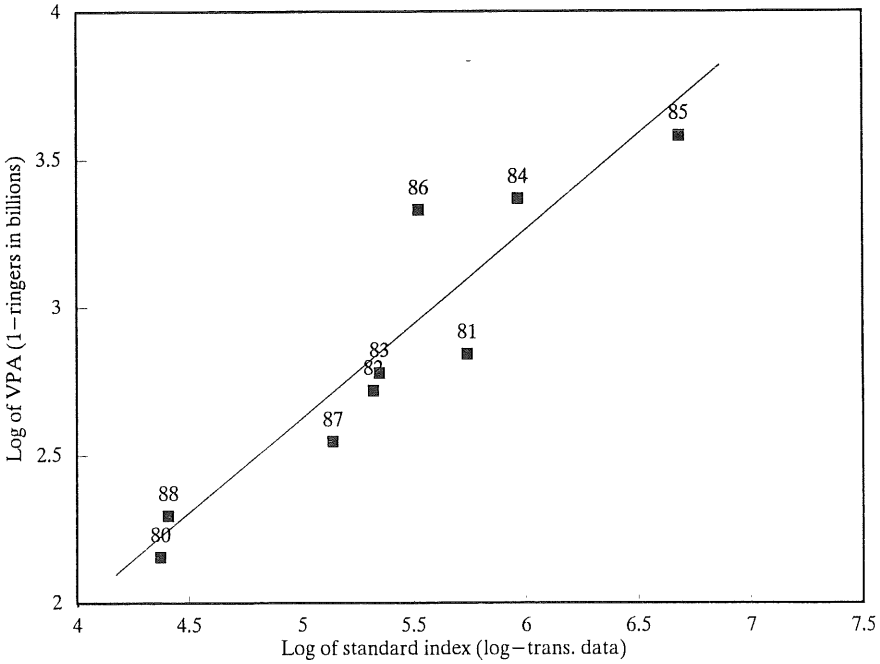


**Figure 2.3.5** The logarithm of the VPA estimate of 1-ringers, regressed against the logarithm of either 1) the standard index based on untransformed data, 2) the "standard" index based on log-transformed catch data, or 3) the GLM-index which also uses log-transformed catch data.



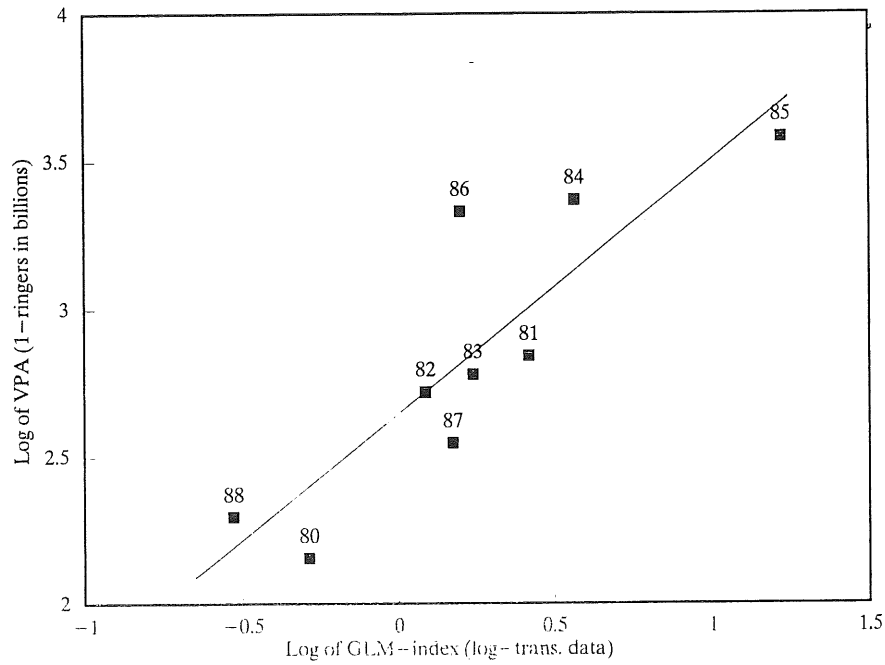



Figure 2.7.1

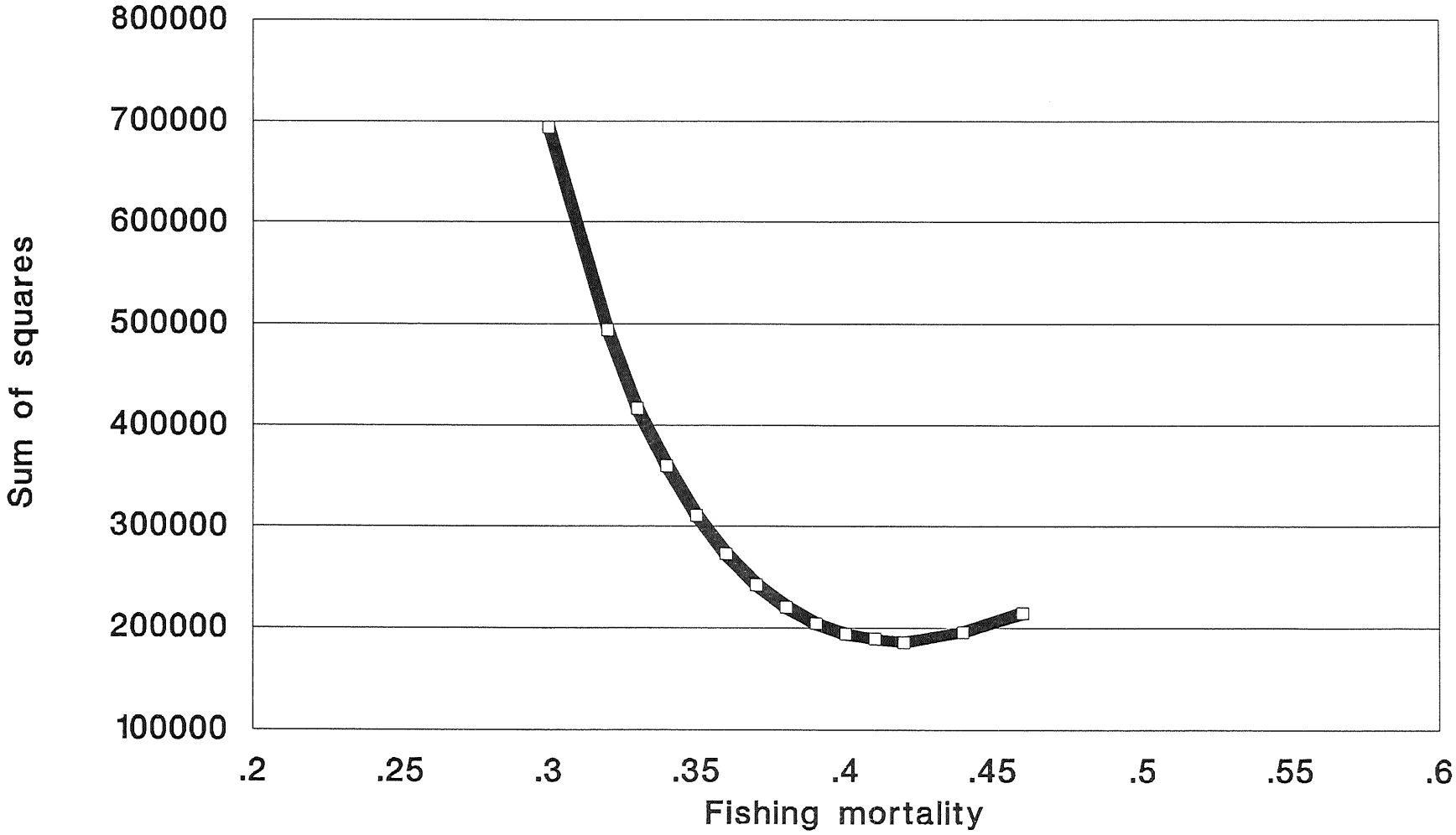
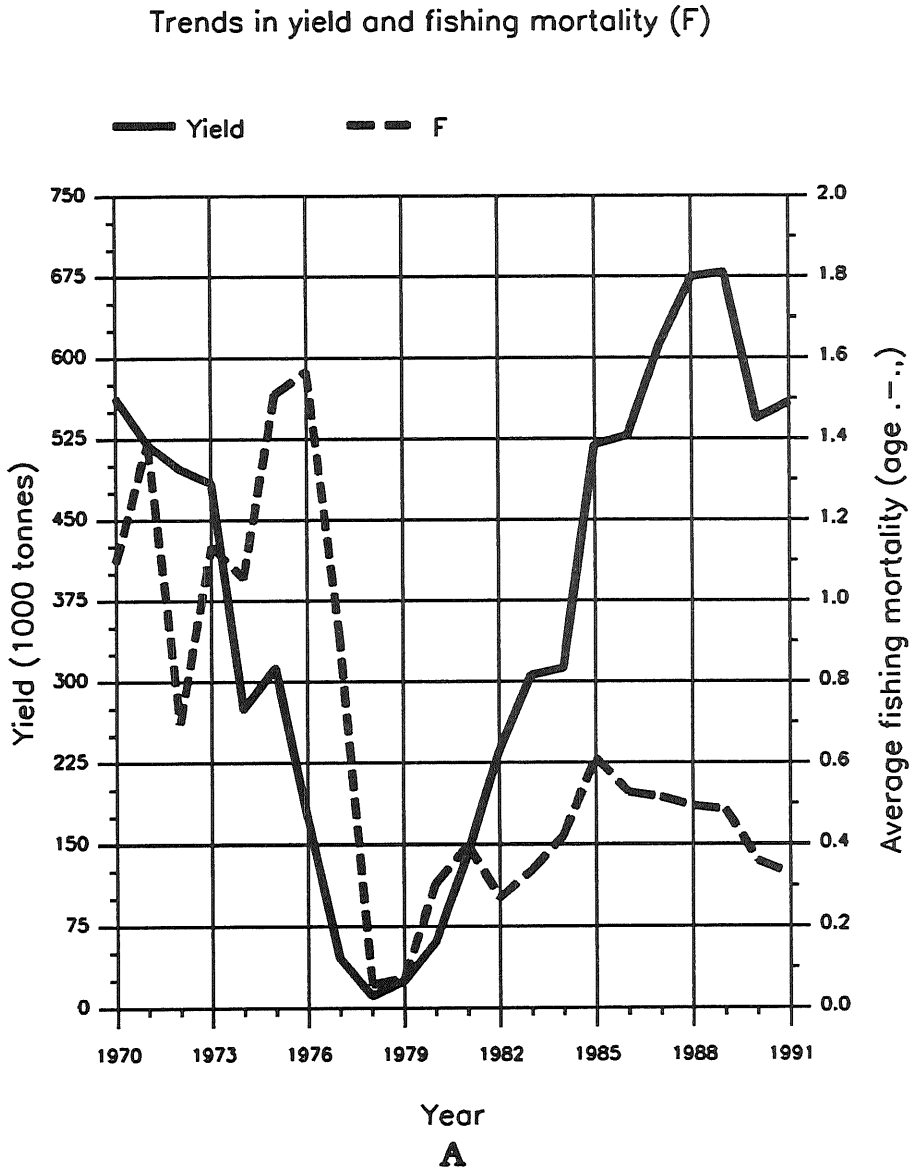

800000
700000
600000
500000
400000
300000
200000
100000
Sum of squares
.2
.25
.3
.35
.4
.45
.5
.55
.6
Fishing mortality

Figure 2.7.8

# FISH STOCK SUMMARY
## STOCK: Herring in the North Sea Area (Fishing Areas IV and IIIA)
## 7–4–1992



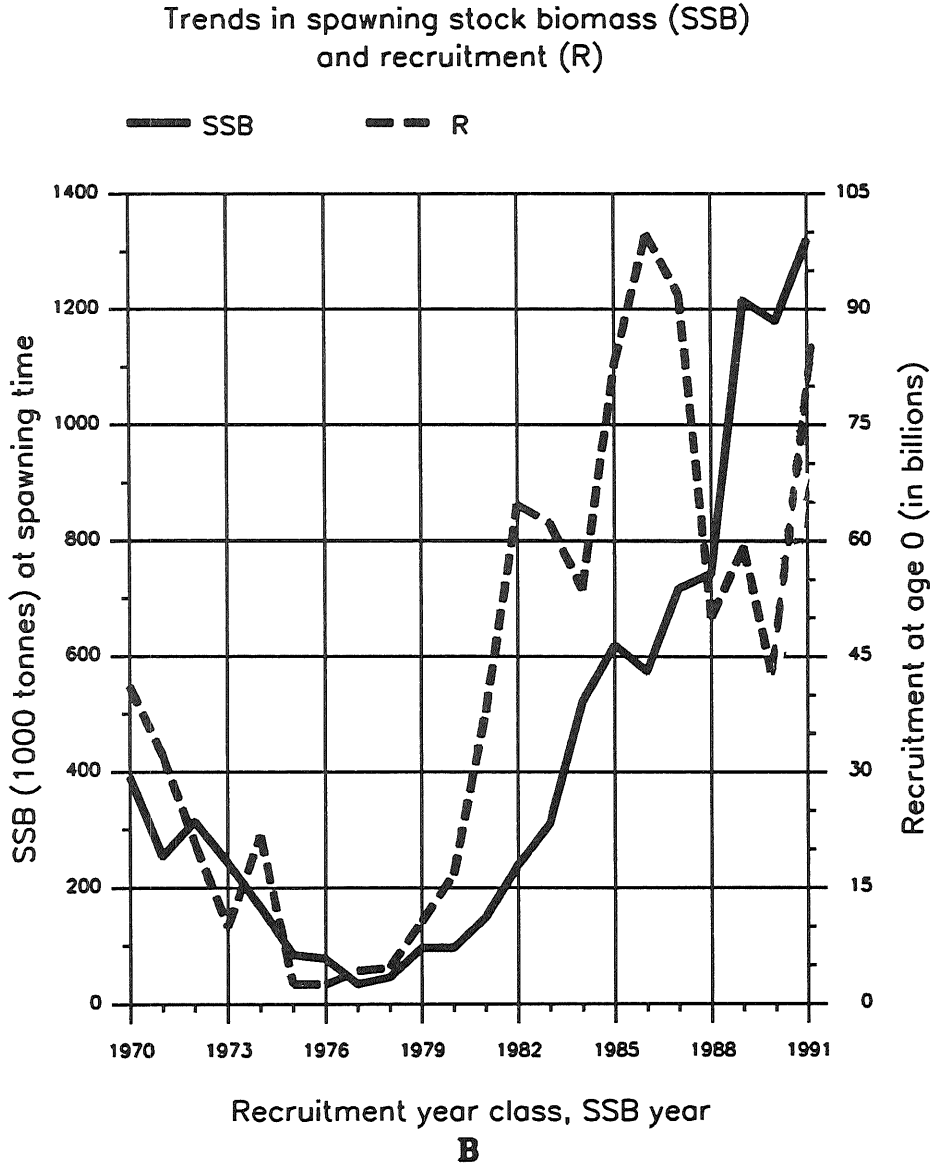



**Figure 2.9.1** Simulated catches and SSB under a regime of constant F=0.30 on 1-ringers and older. Recruitment for 1980-1989 used as input for the periods 1991-2000 and 2001-2010.

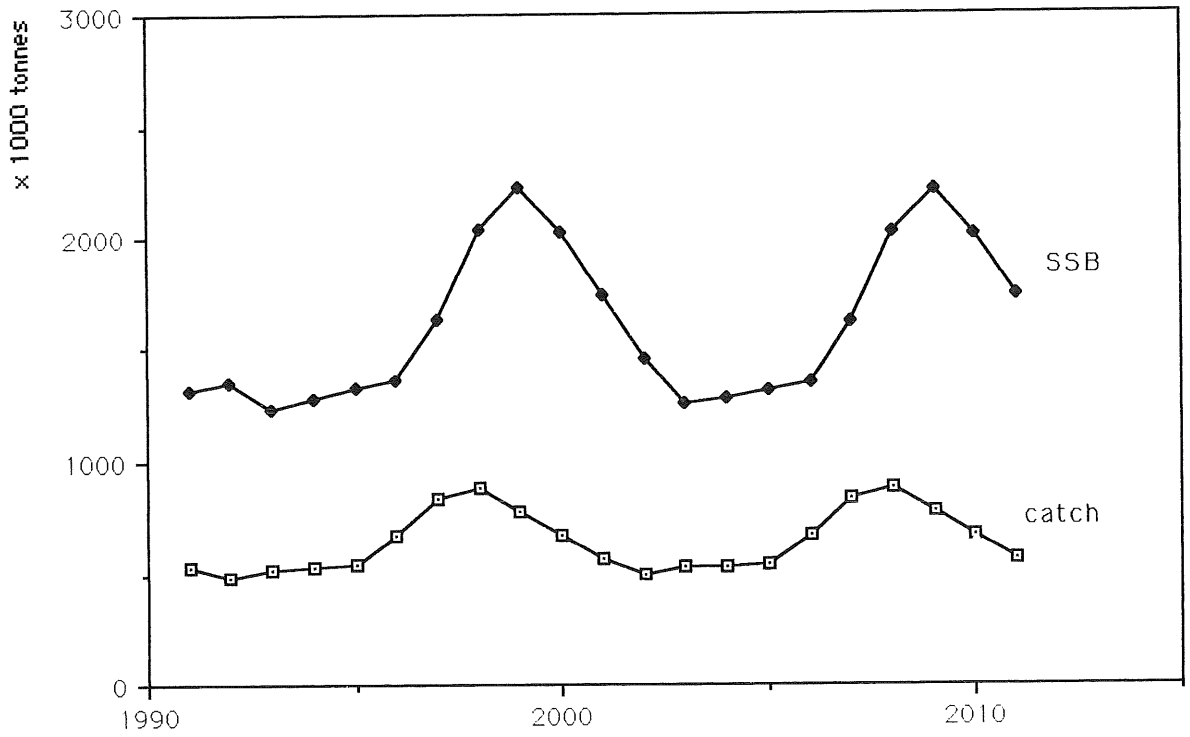
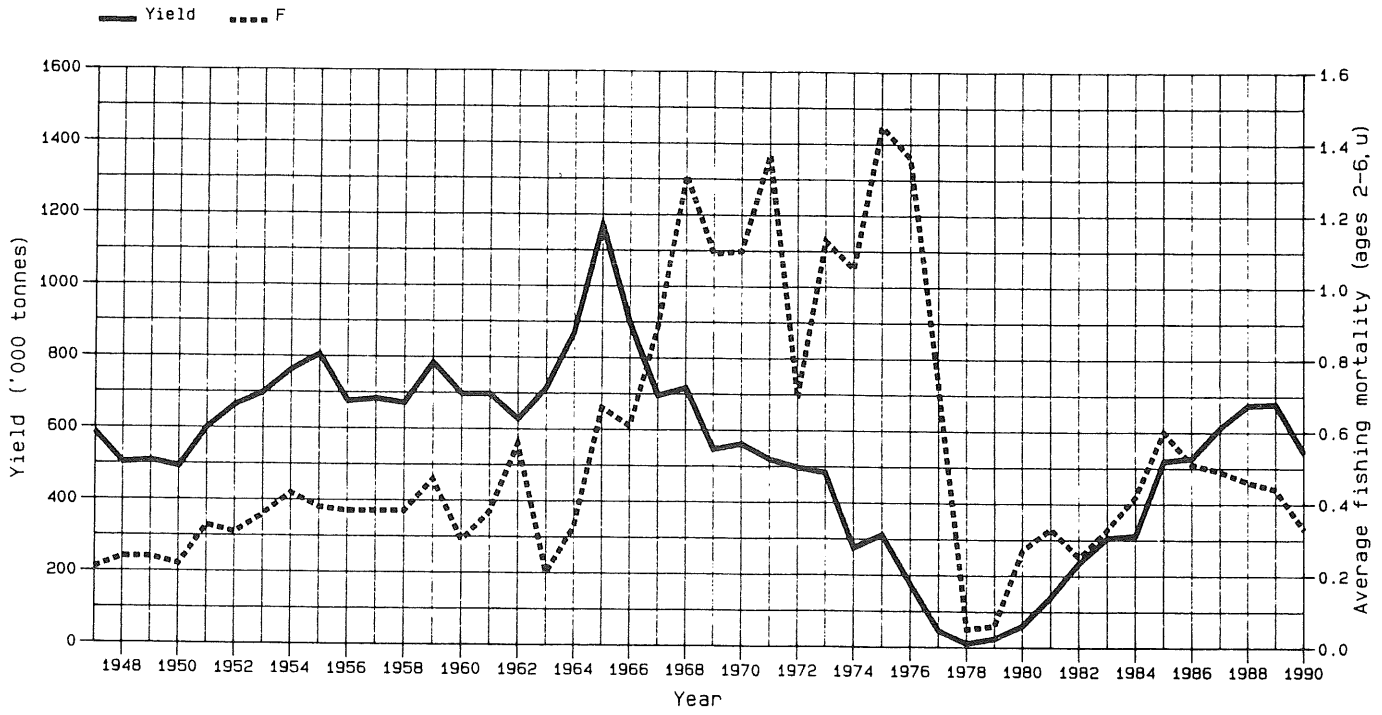
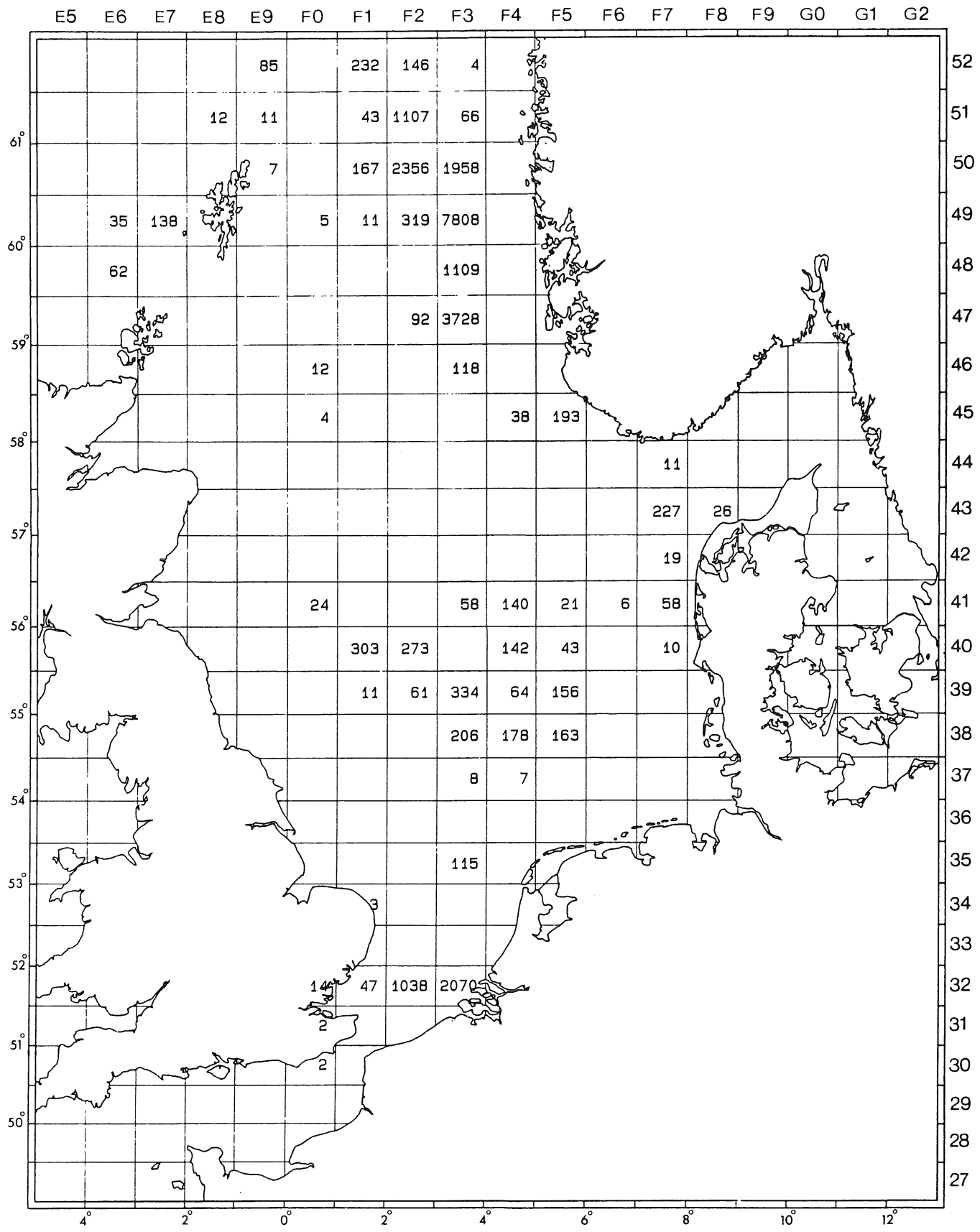


Figure 2.9.2 North Sea herring. Yield and F by year from Anon. (1990).

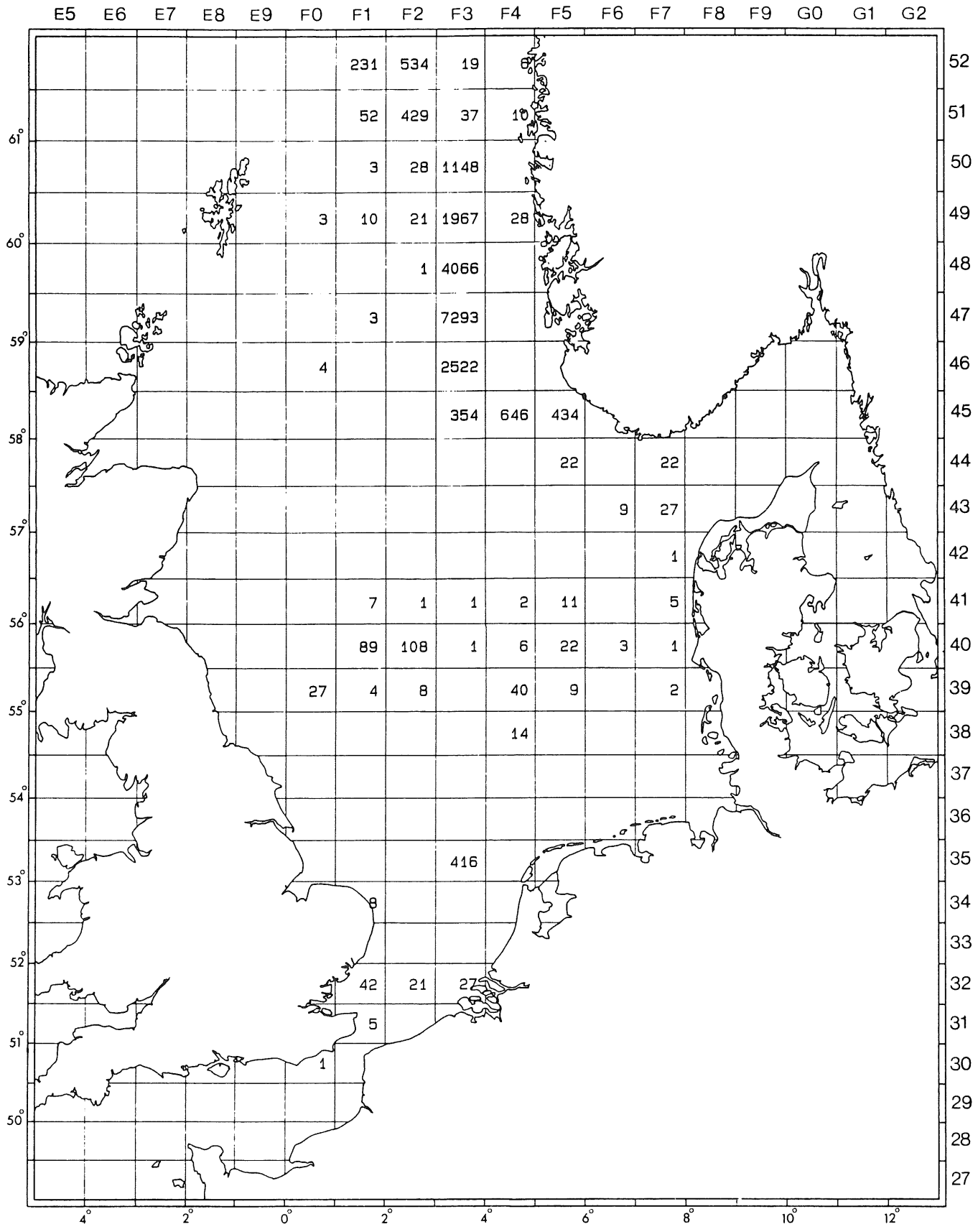


# Figure 2.10.1 North Sea catches.



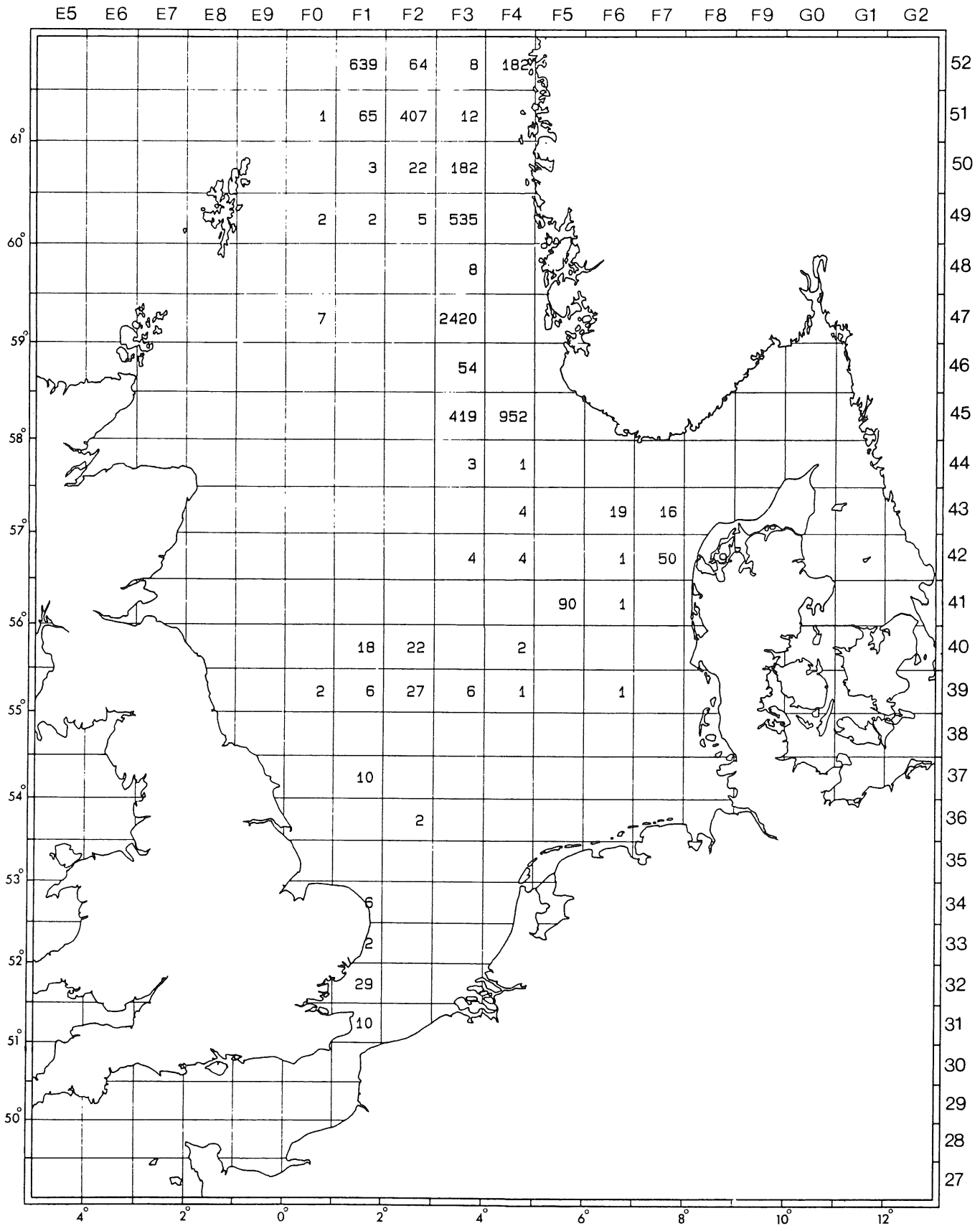

January 1991 - 25 706 tonnes.

Figure 2.10.2 North Sea catches.



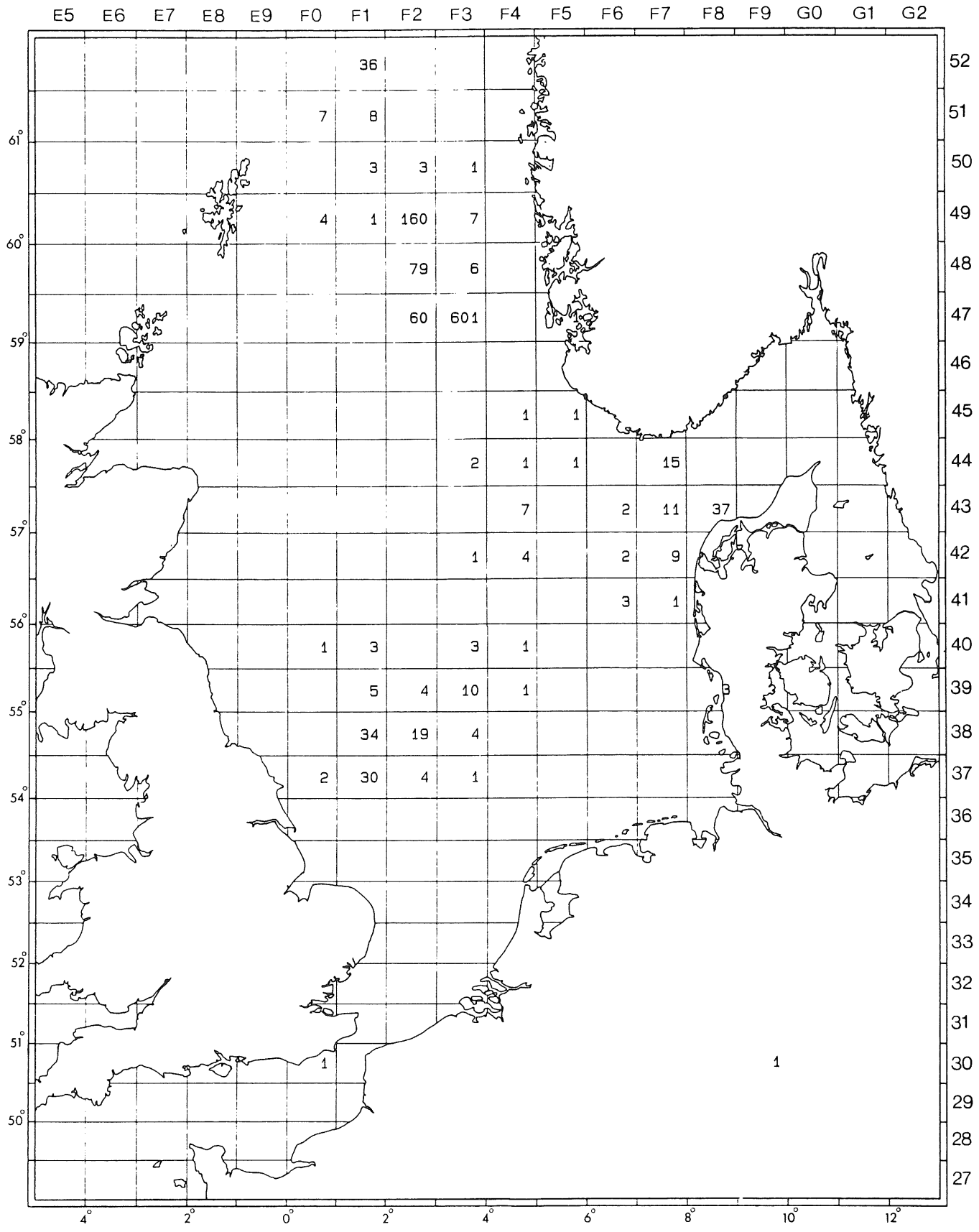

February 1991 - 20 811 tonnes.

# Figure 2.10.3 North Sea catches.



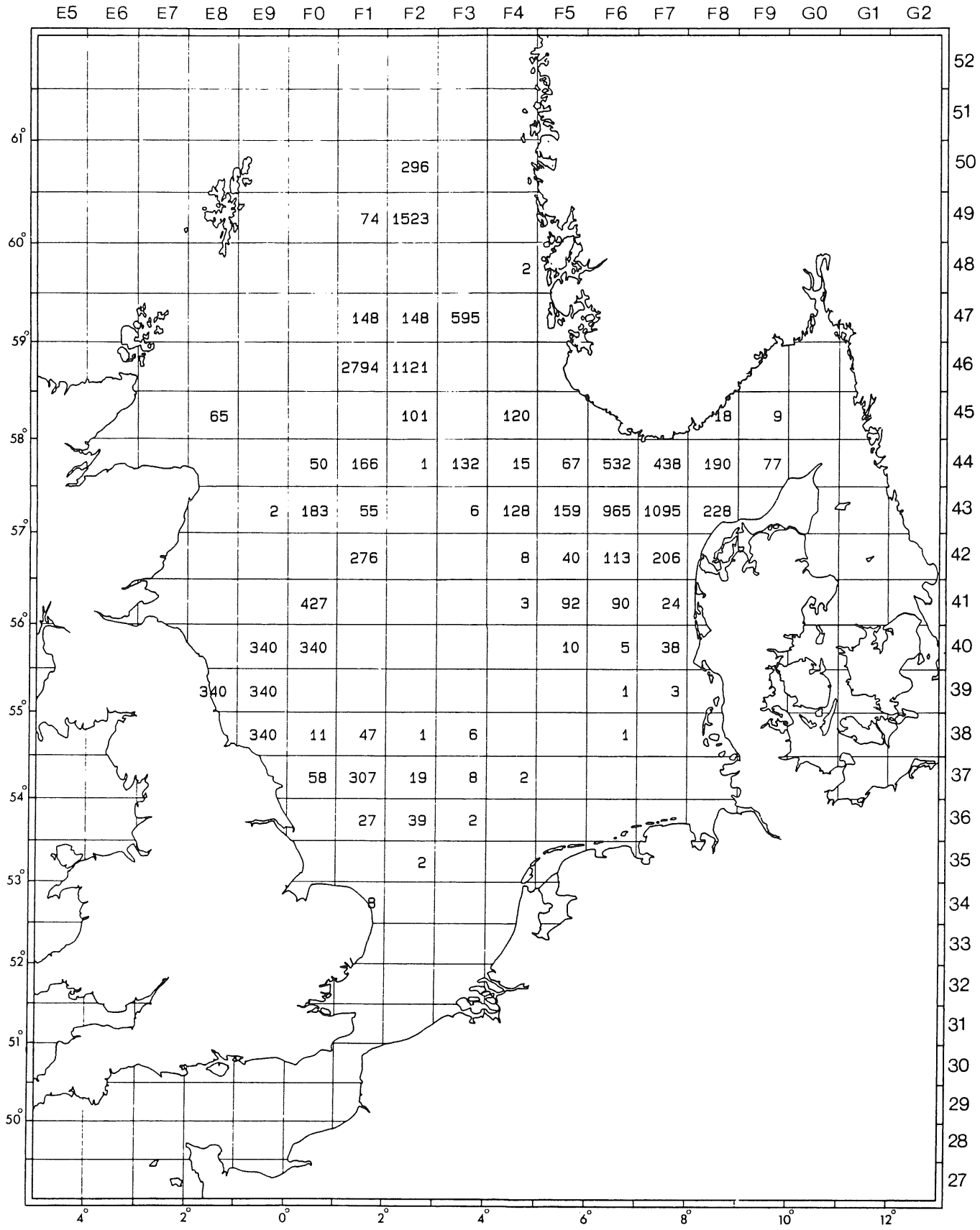

March 1991 - 6 335 tonnes.

Figure 2.10.4 North Sea catches.



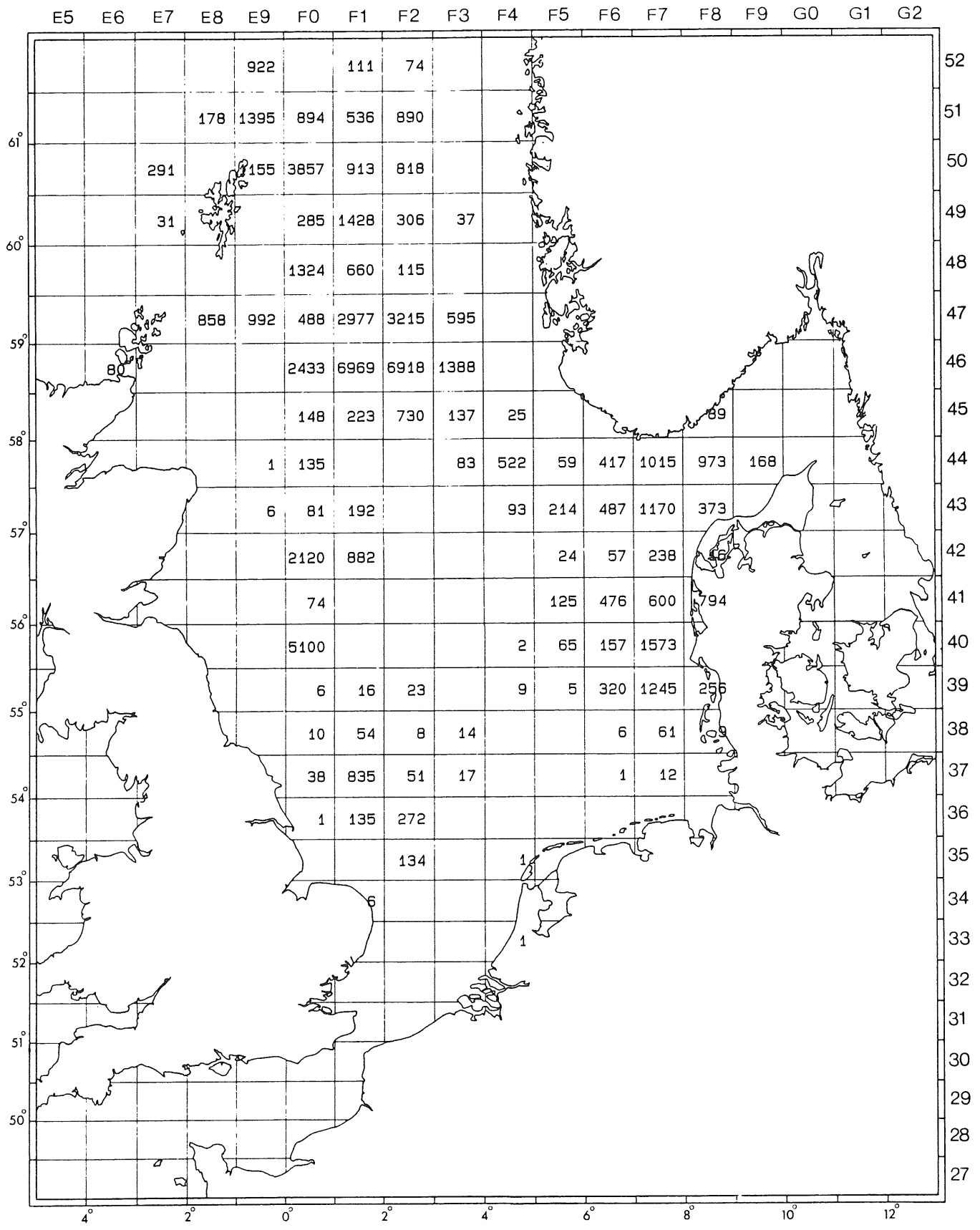

April 1991 - 1 202 tonnes.

# Figure 2.10.5 North Sea catches.



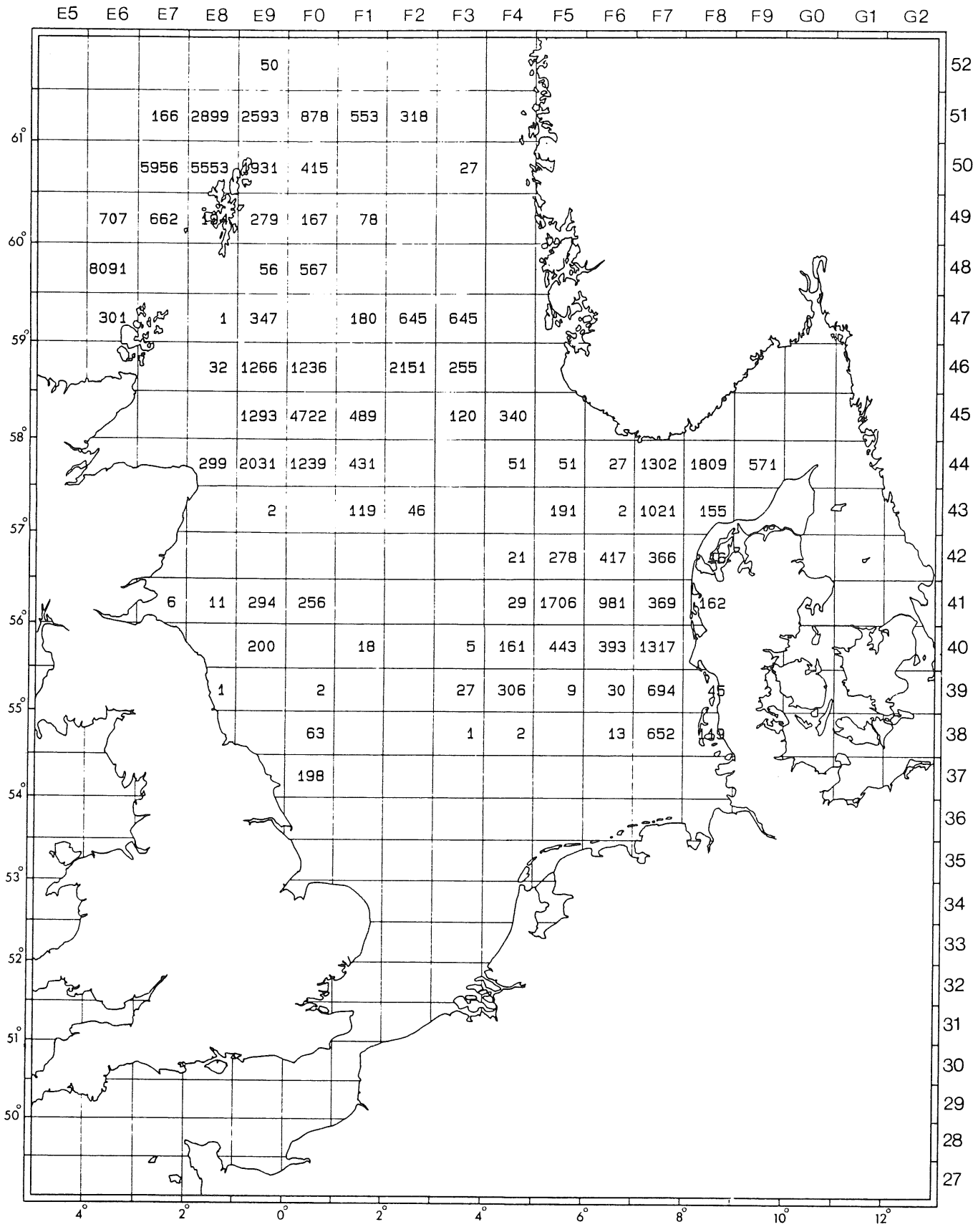

May 1991 - 14 991 tonnes.

# Figure 2.10.6 North Sea catches.



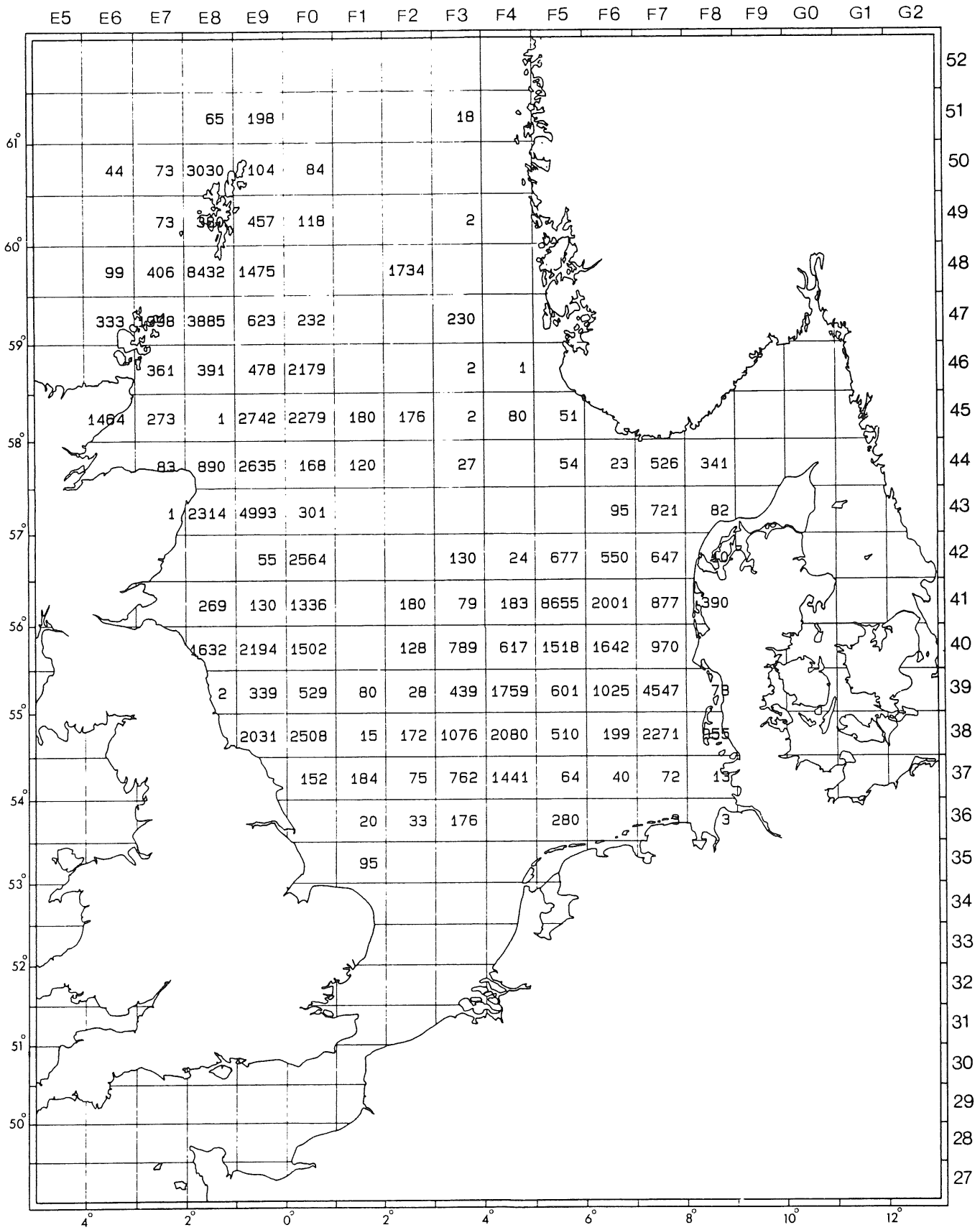

June 1991 - 66 323 tonnes.

# Figure 2.10.7 North Sea catches.



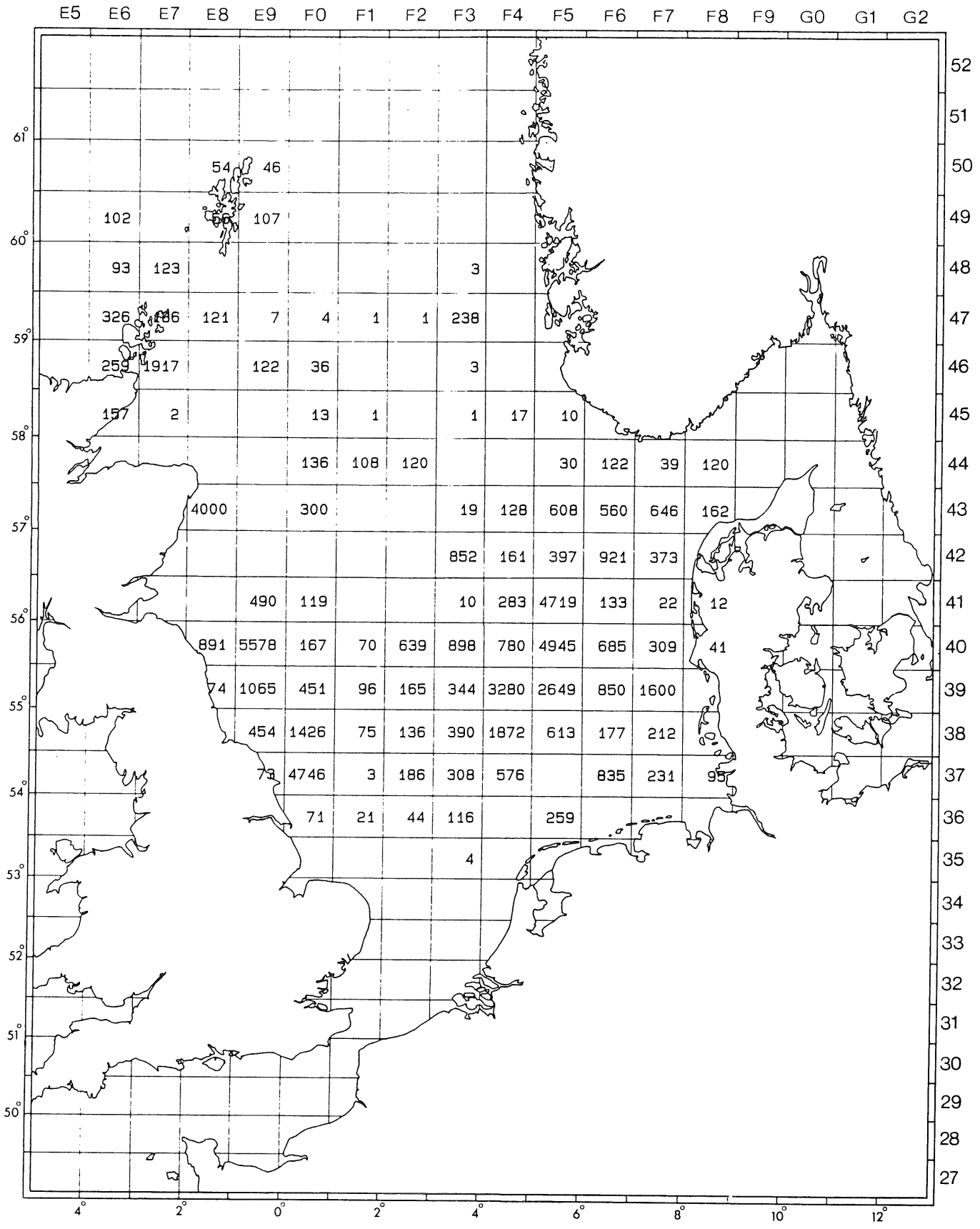

July 1991 - 65 121 tonnes.

# Figure 2.10.8 North Sea catches.



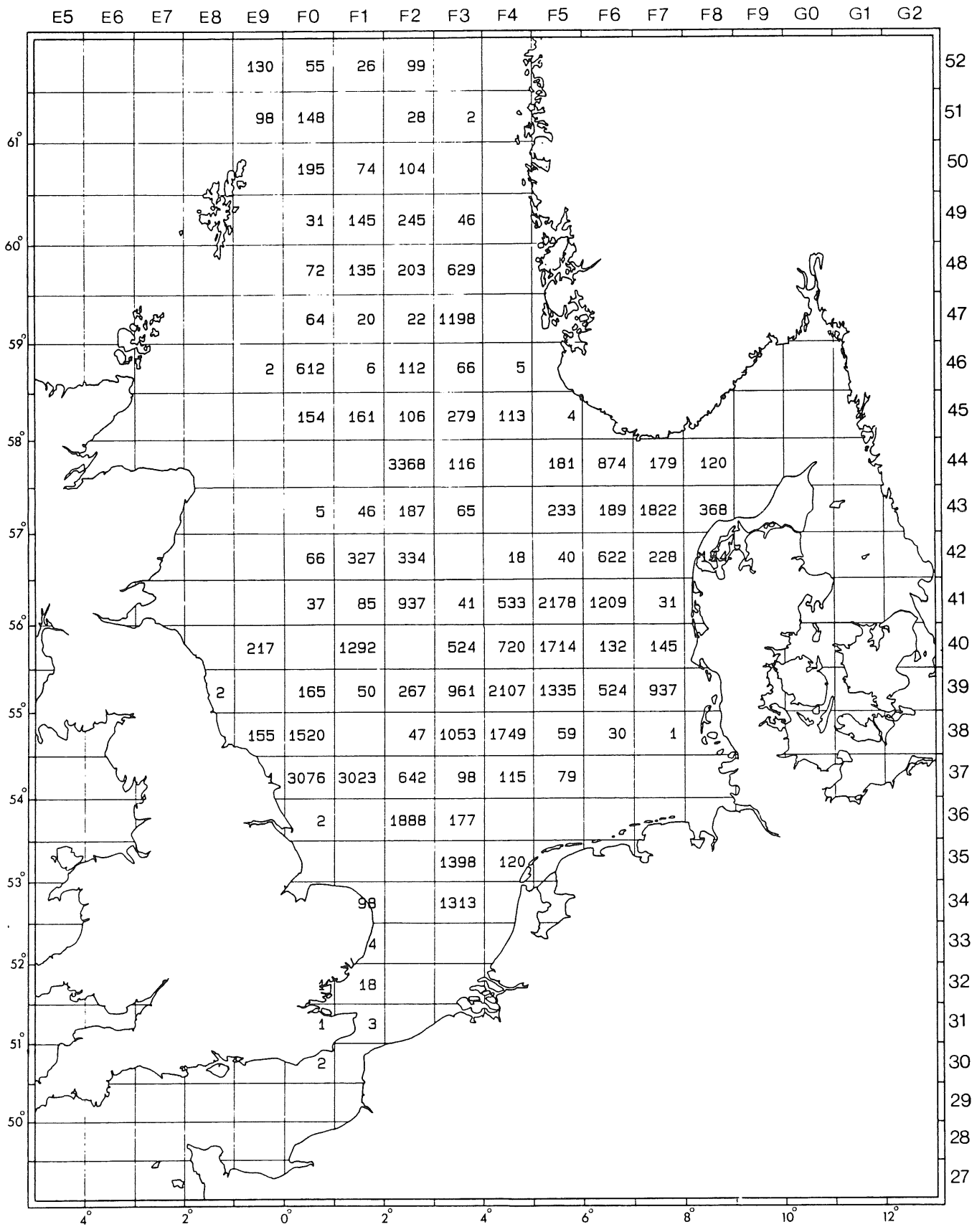

August 1991 - 101 833 tonnes.

Figure 2.10.9 North Sea catches.



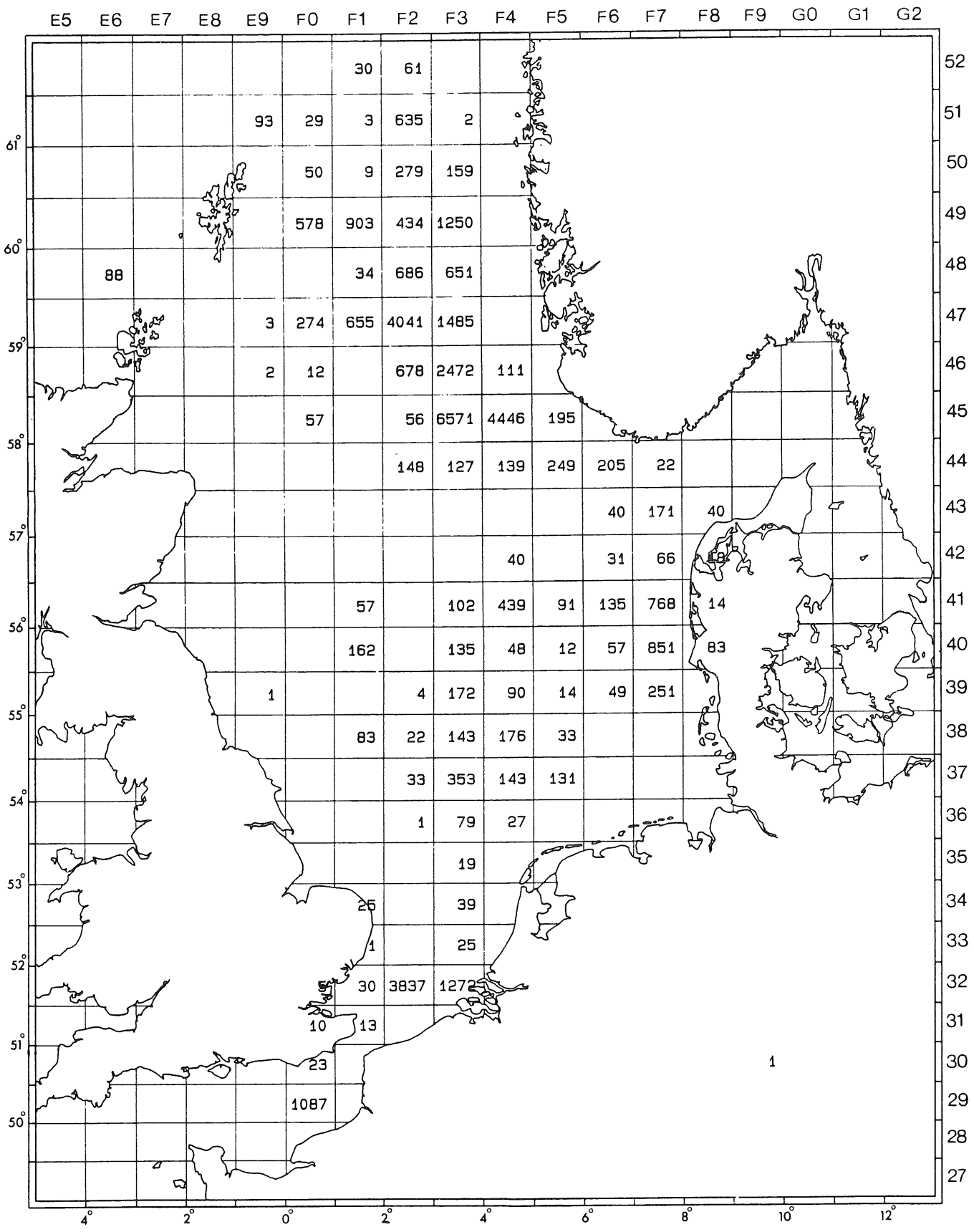

September 1991 - 58 096 tonnes.

# Figure 2.10.10 North Sea catches.



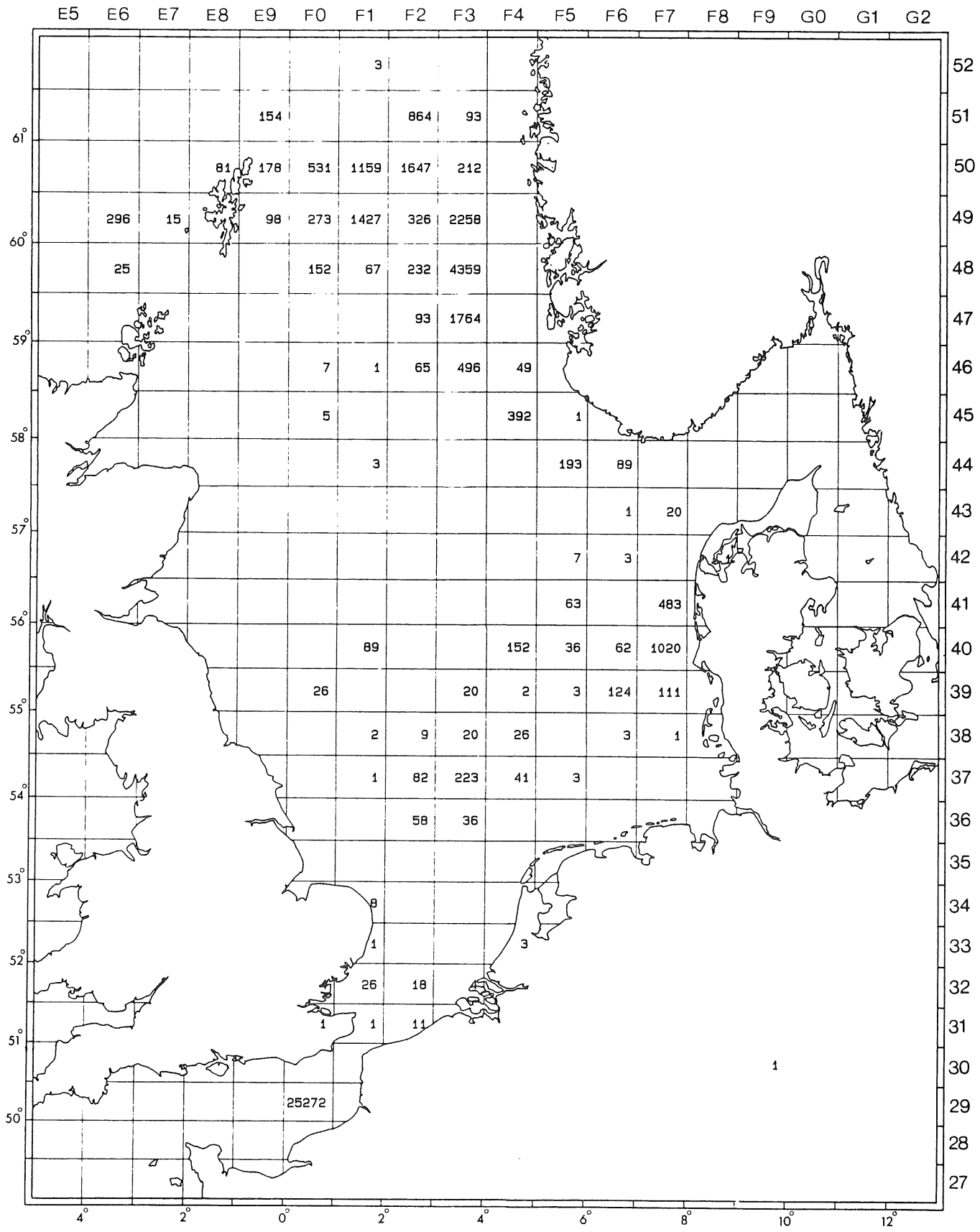

October 1991 - 47 727 tonnes.

Figure 2.10.11 North Sea catches.




November 1991 - 39 474 tonnes.

# Figure 2.10.12 North Sea catches.




December 1991 - 45 686 tonnes.

# FIGURE 2.10.13 NORTH SEA HERRING

Cumulative catch by month

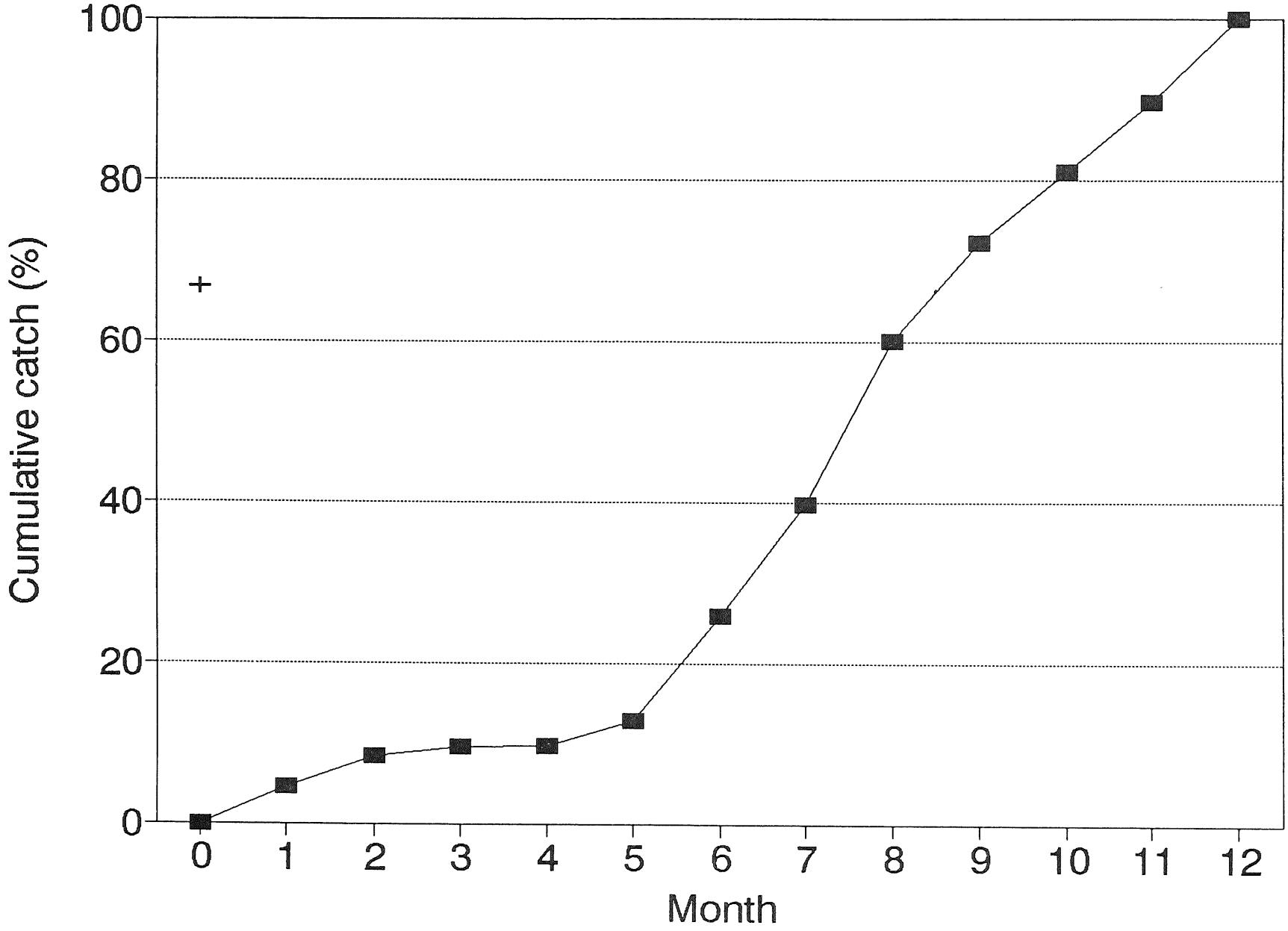
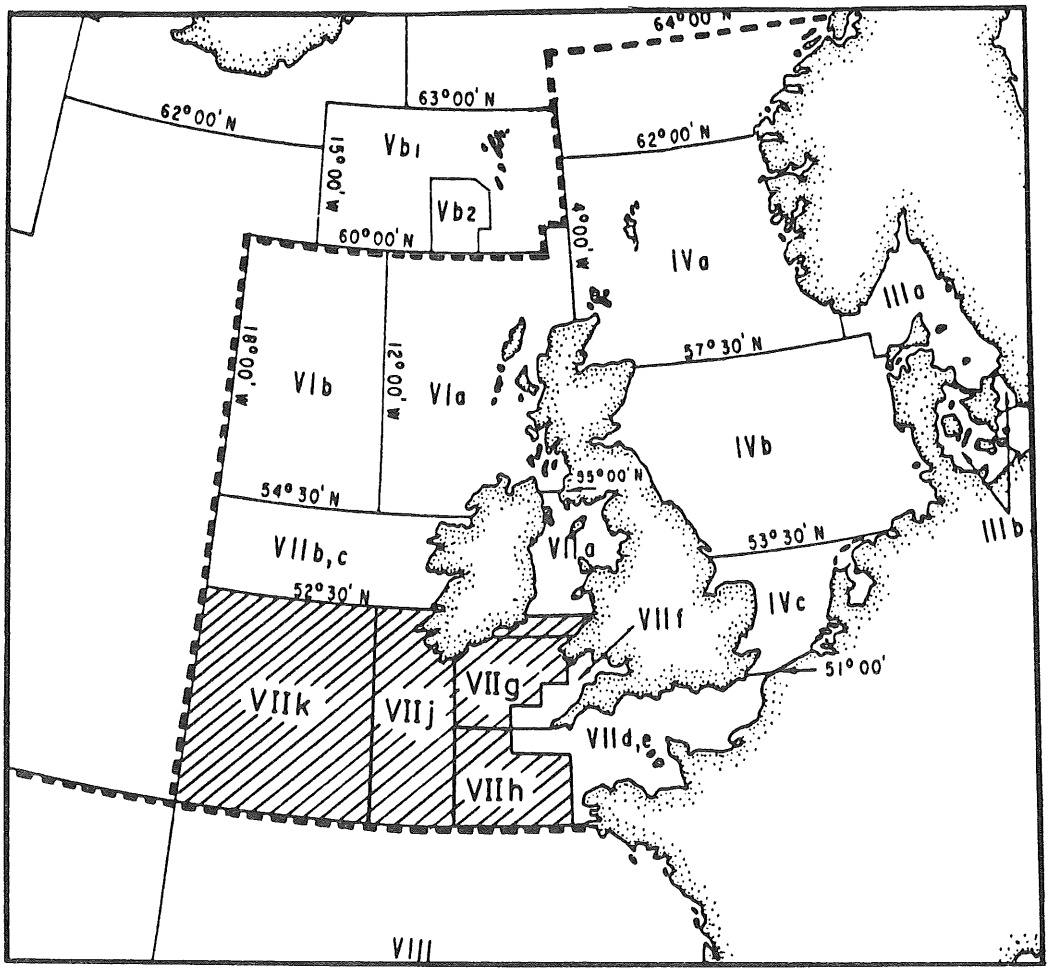


Figure 4.1.1 The assessment covers the area Divisions VIIj and VIIg and that part of Division VIIa below 52°30. TAC is set by EC for Divisions VIIg-k and that section of Division VIIa below 52°30.



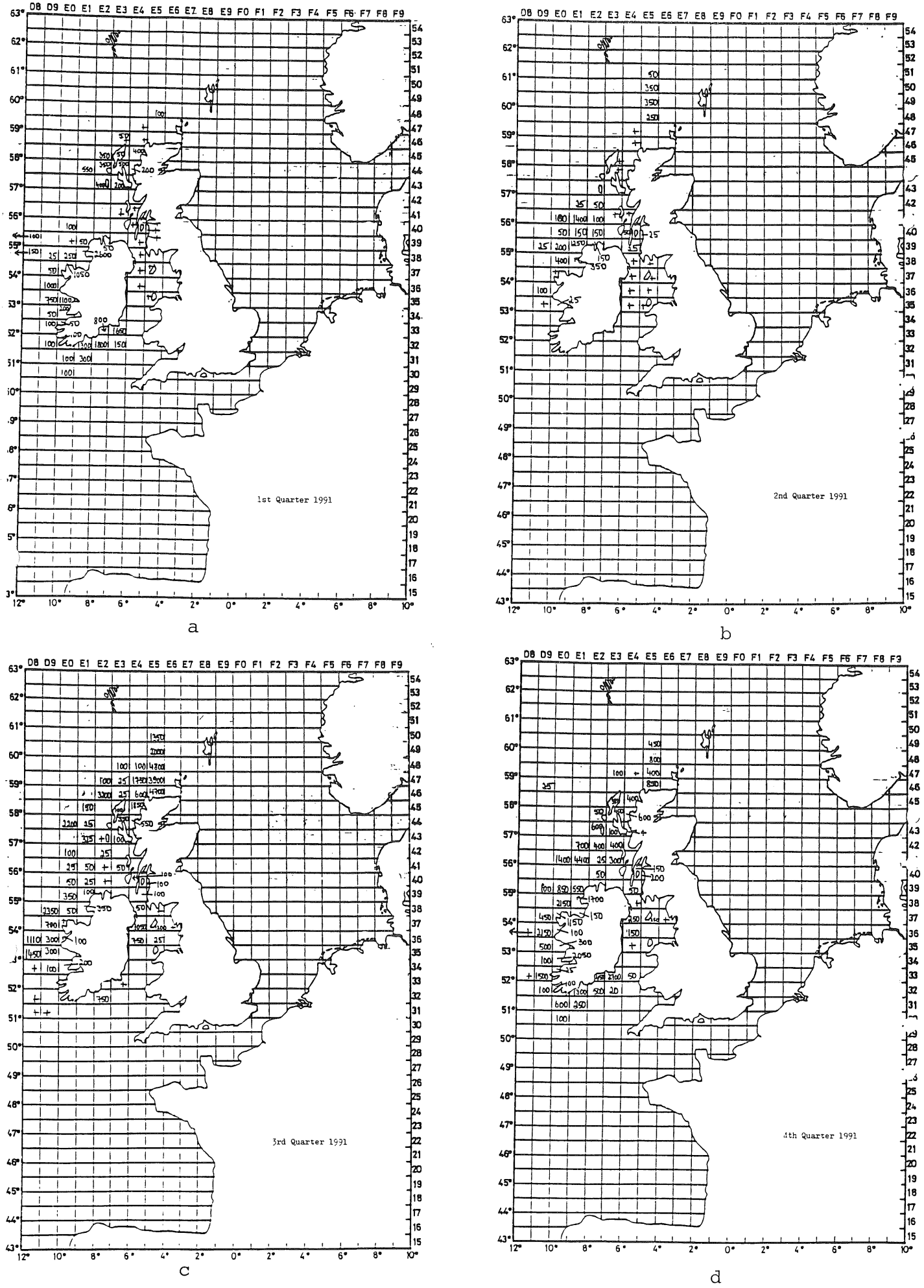



**Figure 4.2.1a-d** Reported distribution of catches by quarter for 1991 based on data from Ireland, the Netherlands, Norway, and the UK.

**Figure 5.1.1** The natural logarithms of the mean-catch rate of 2-ringers in statistical rectangles 46E4-E6, 47E4-E6, 44E3-E4 during the March bottom-trawl survey, plotted against VPA estimates of 2-ringer abundance. Years refer to year classes.

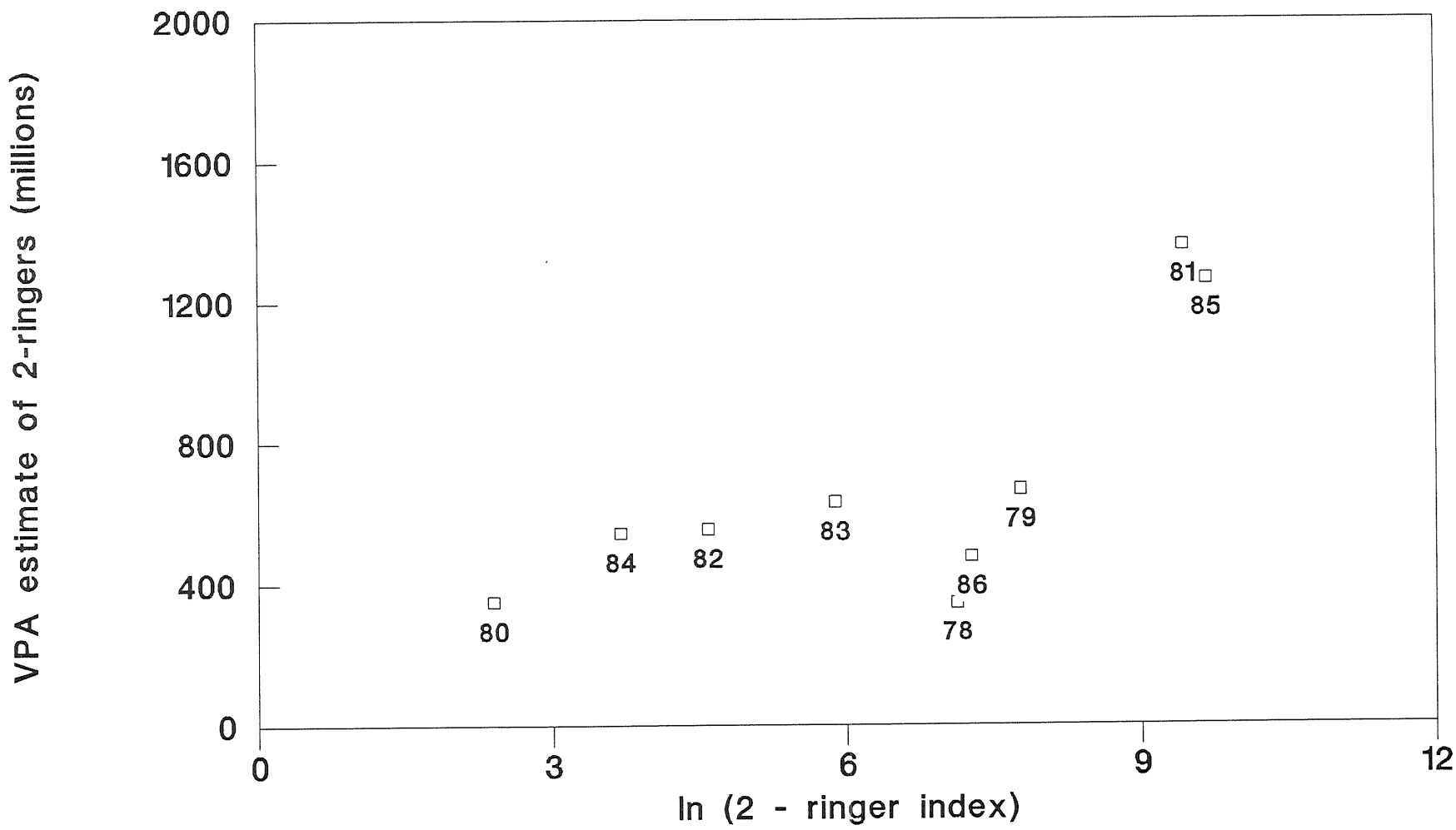


**Figure 5.1.2** The relation between LAI and SSB from 1973-1987. The line is based on the regression fitted by RCT3.

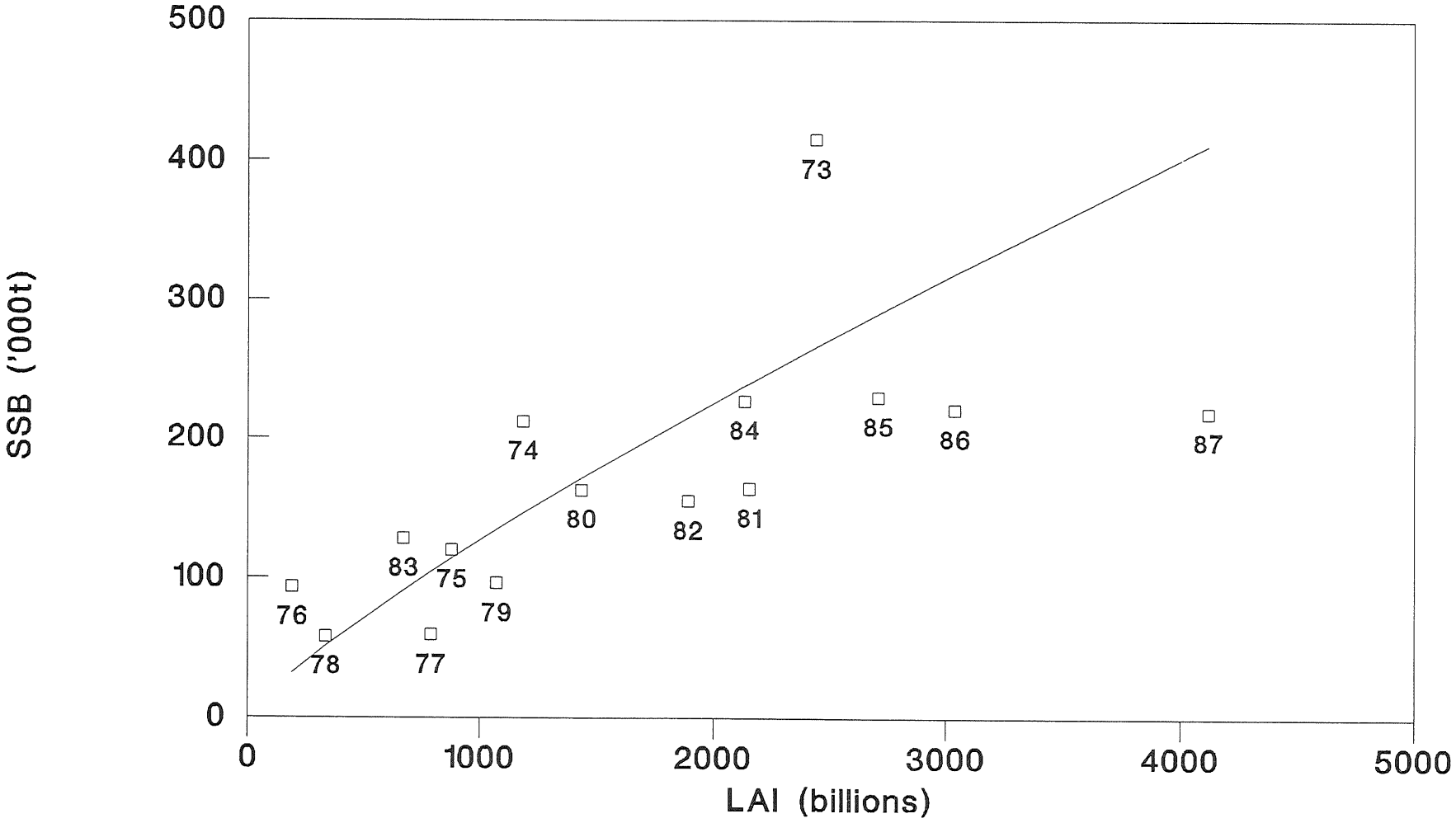


**Figure 5.1.3** The relation between LPE and SSB from 1973-1987. The line is based on the regression fitted by RCT3.

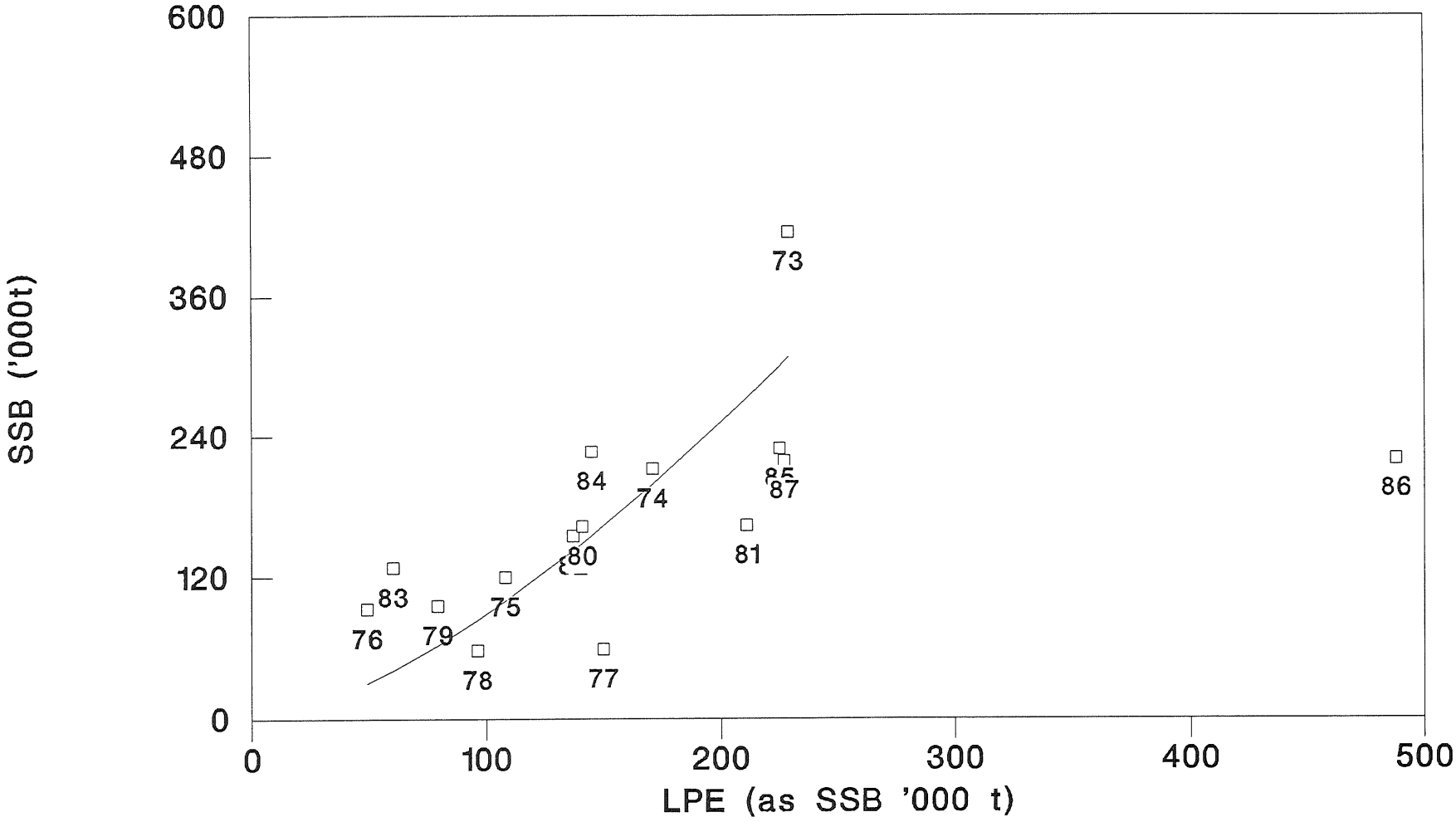


**Figure 5.1.4** Sum of squared residuals between VPA estimates of SSB and fishery-independent estimates of SSB at a range of terminal F values.

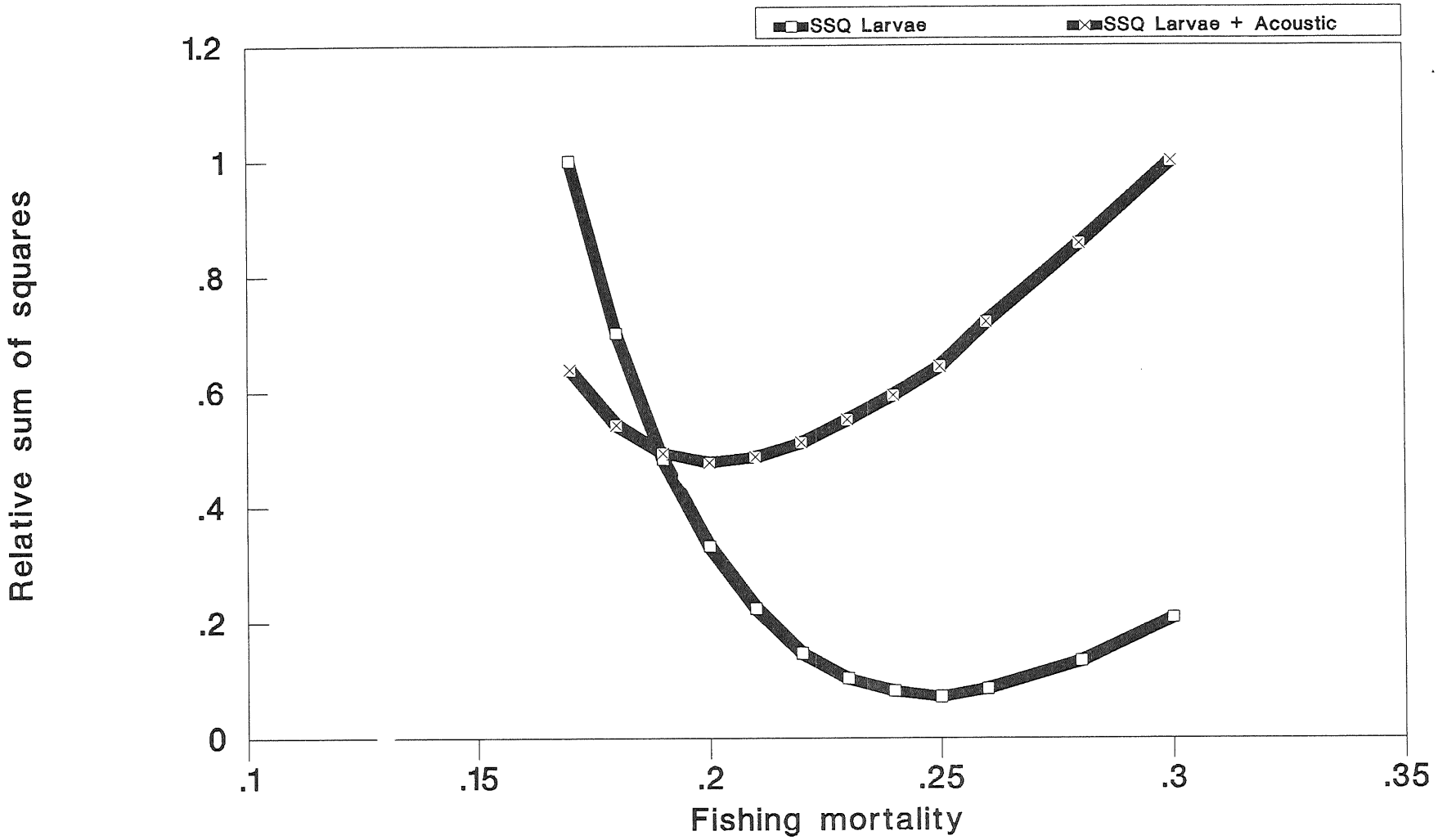


**Figure 5.1.5** Trend in SSB estimated by VPA.
A = Terminal F of 0.2 excluding Faroese catches
B = Terminal F of 0.25 excluding Faroese catches
C = Terminal F of 0.27 including Faroese catches
D = Terminal F of 0.34 including Faroese catches.

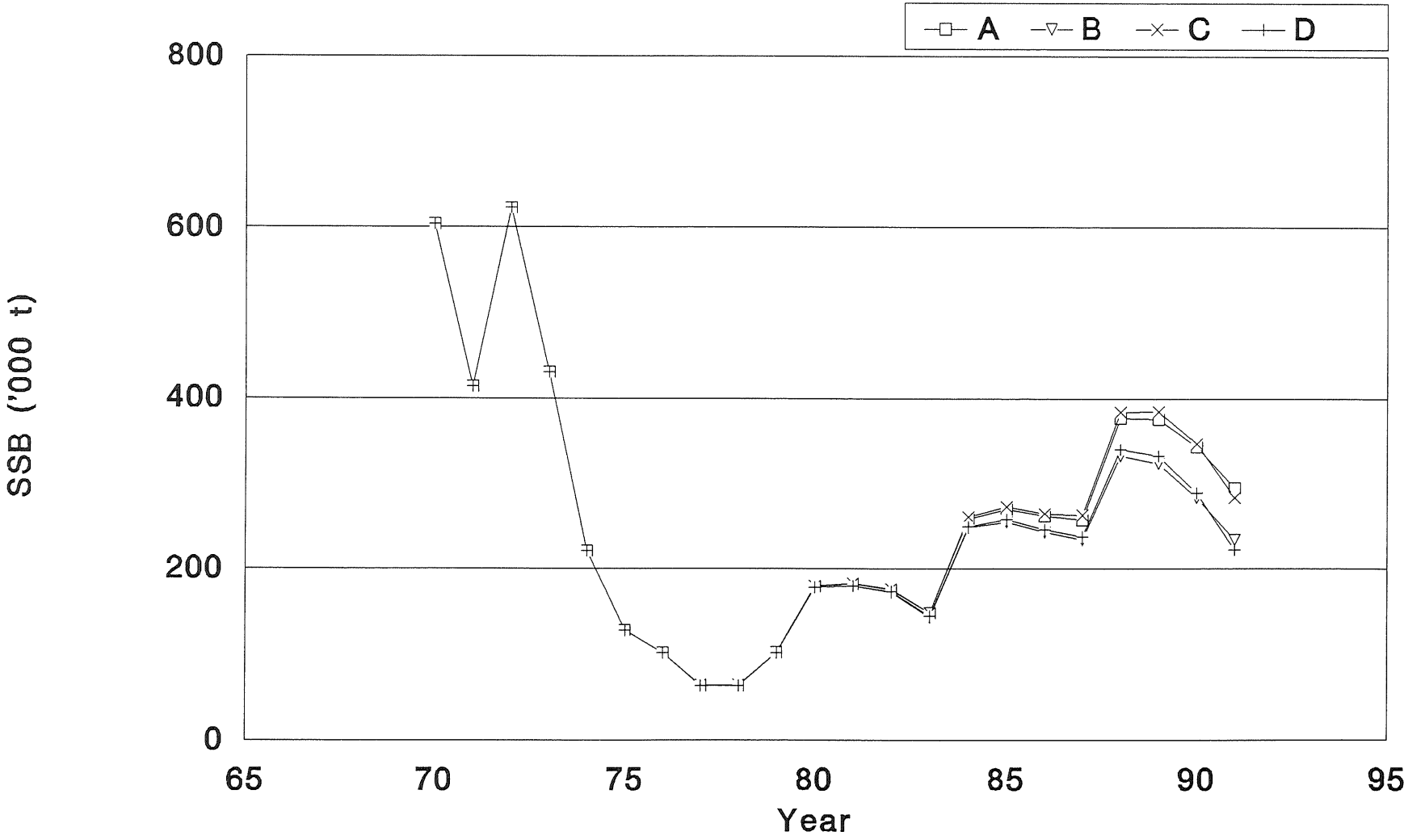
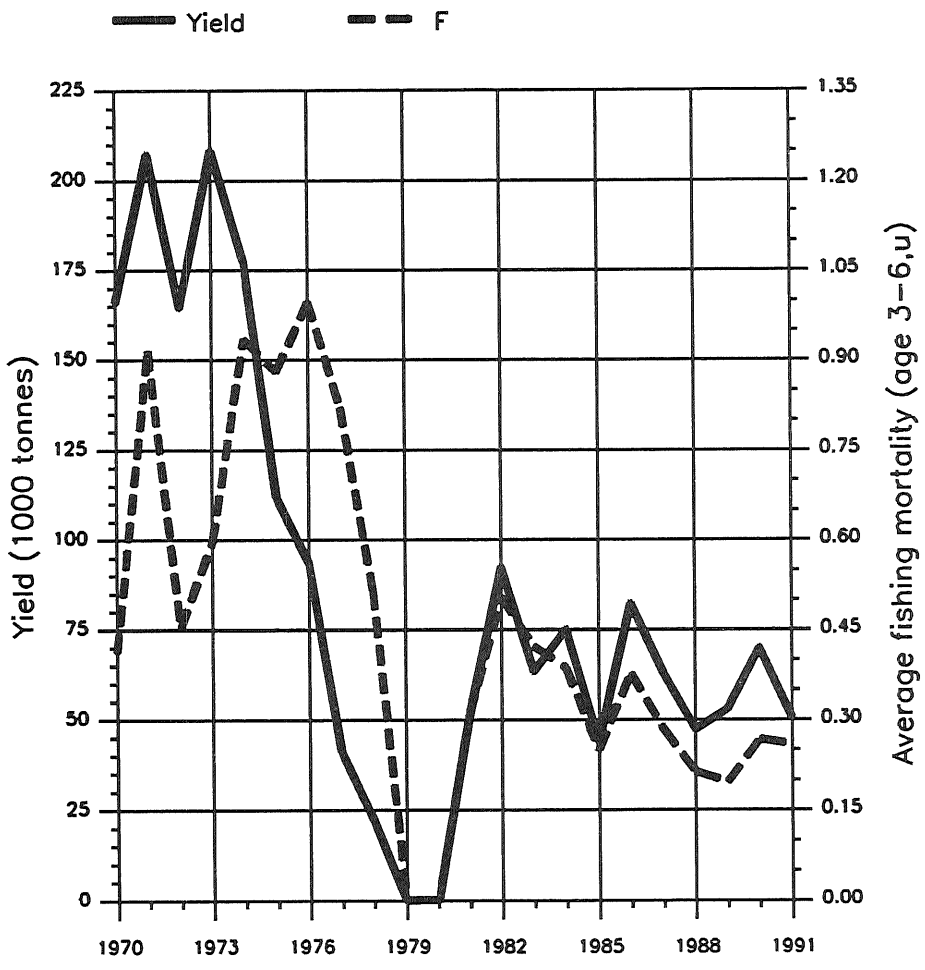


Figure 5.1.6

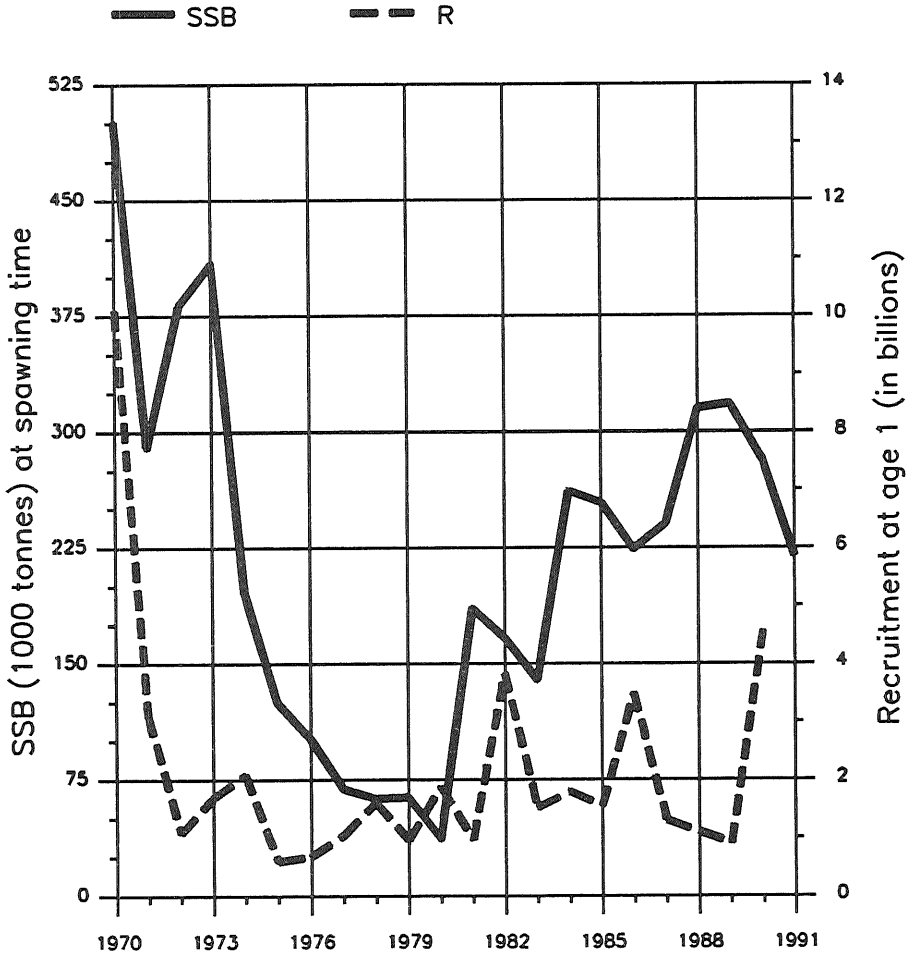
# FISH STOCK SUMMARY
## STOCK: Herring in the Northern part of VIa
## 3–4–1992

Trends in yield and fishing mortality (F)



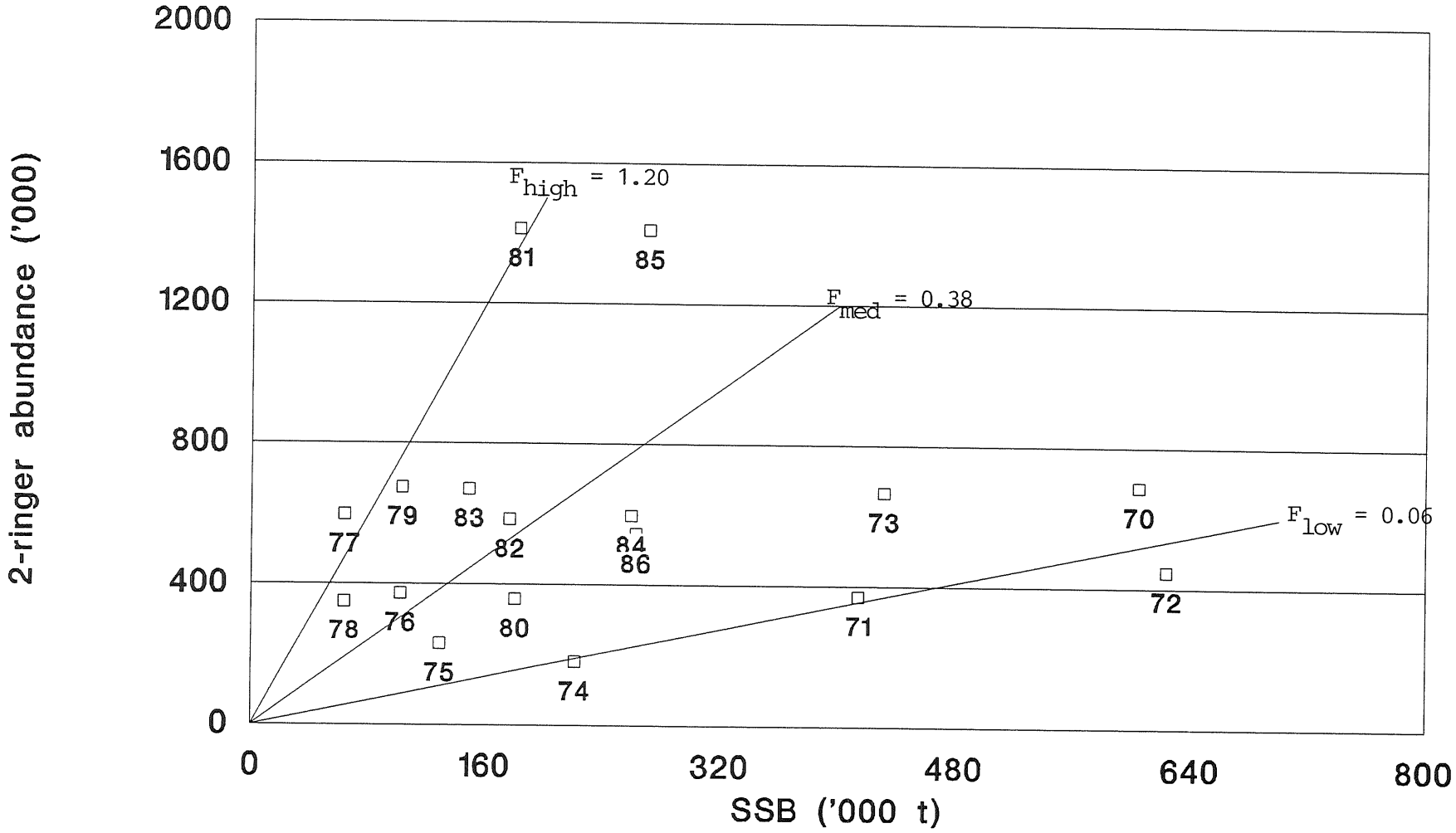

A

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




B

**Figure 5.1.7**


2000
1600
1200
800
400
0
2-ringer abundance ('000)
0
160
320
480
640
800
SSB ('000 t)
F high = 1.20
F med = 0.38
F low = 0.06
81
85
77
79
83
82
84
86
73
70
78
76
80
71
72
75
74

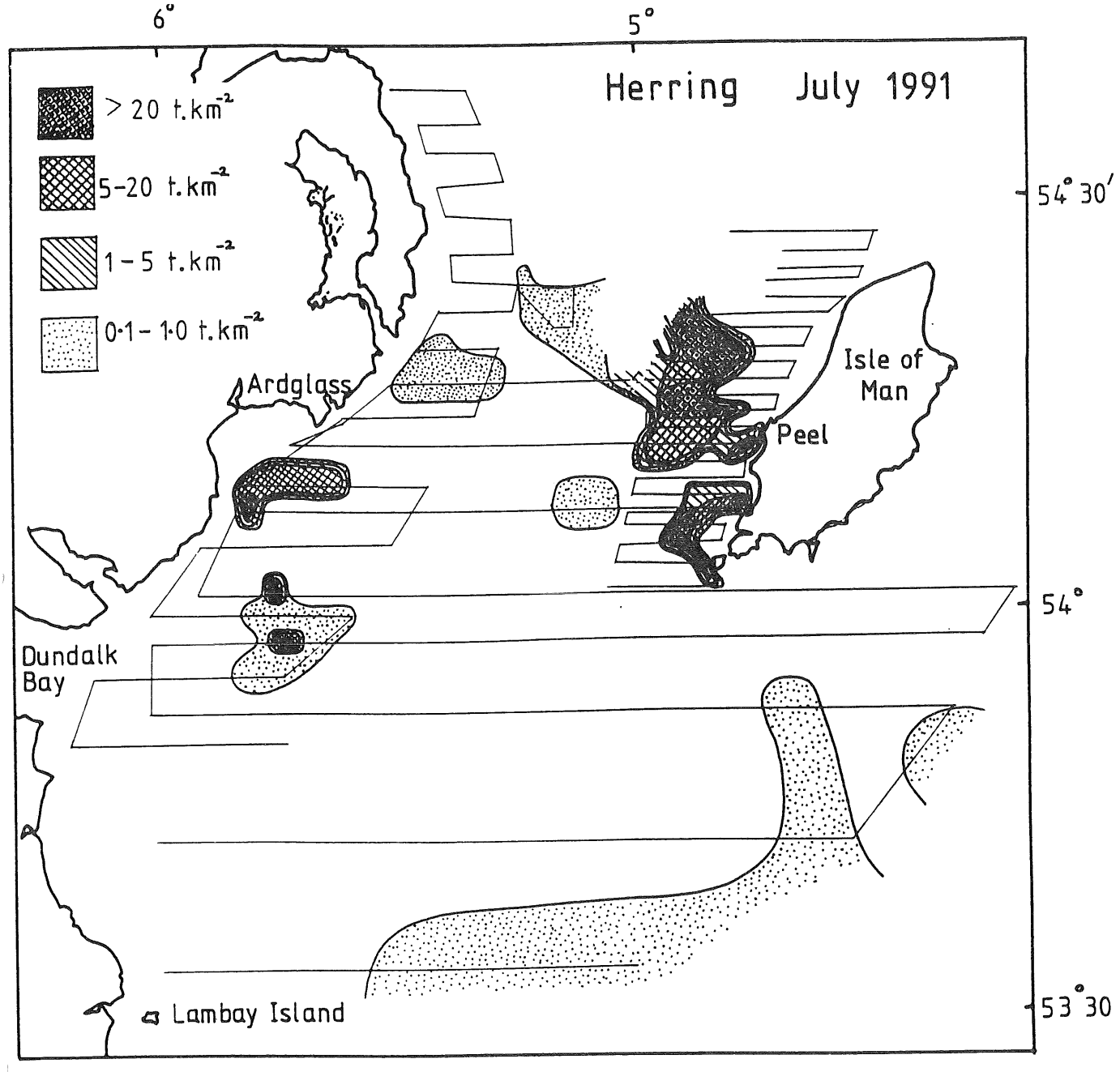
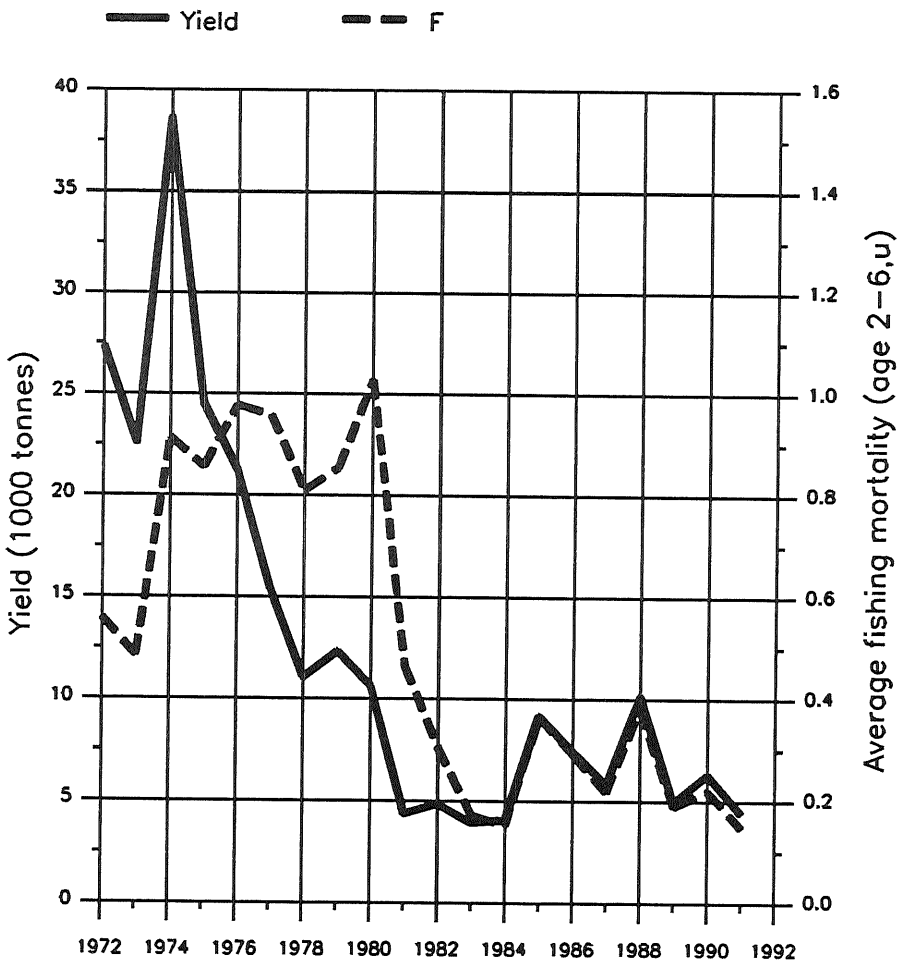



Figure 7.3.1 Density distribution of herring in Division VIIa (North) during the July 1991 acoustic survey.

Figure 7.4.1

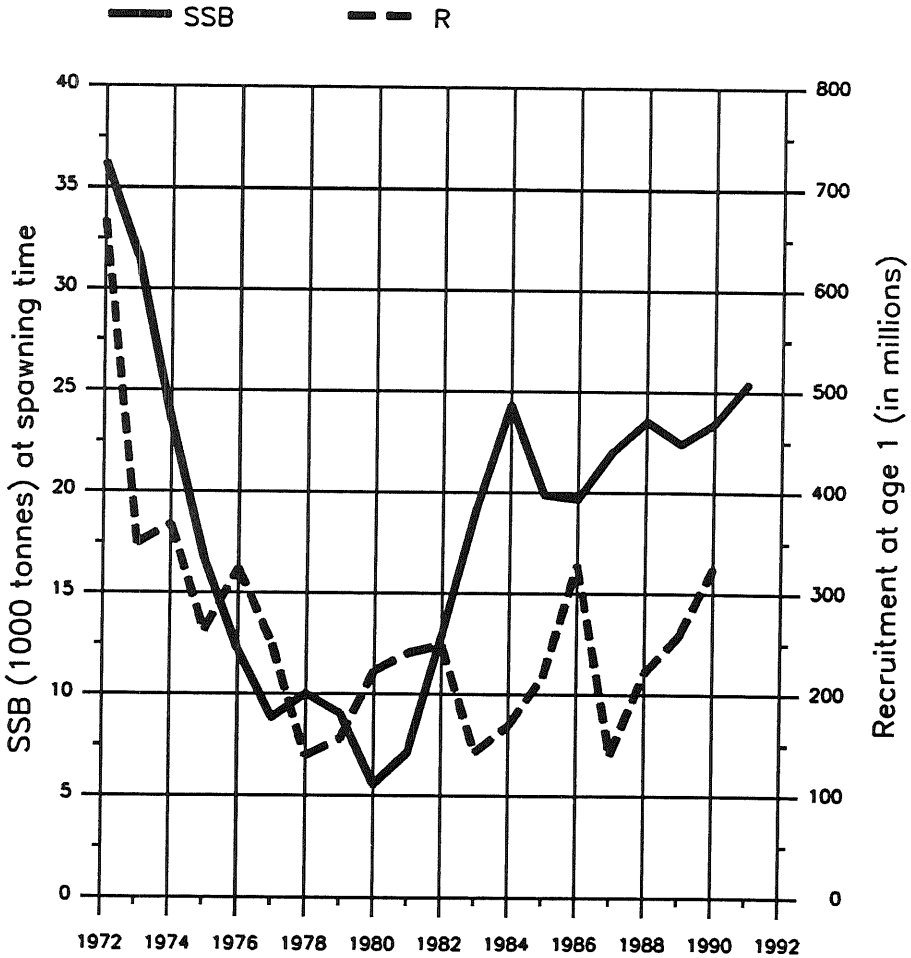
# FISH STOCK SUMMARY
## STOCK: Herring in the North Irish Sea (Manx plus Mourne herring)
## 5–4–1992

Trends in yield and fishing mortality (F)




A

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




B

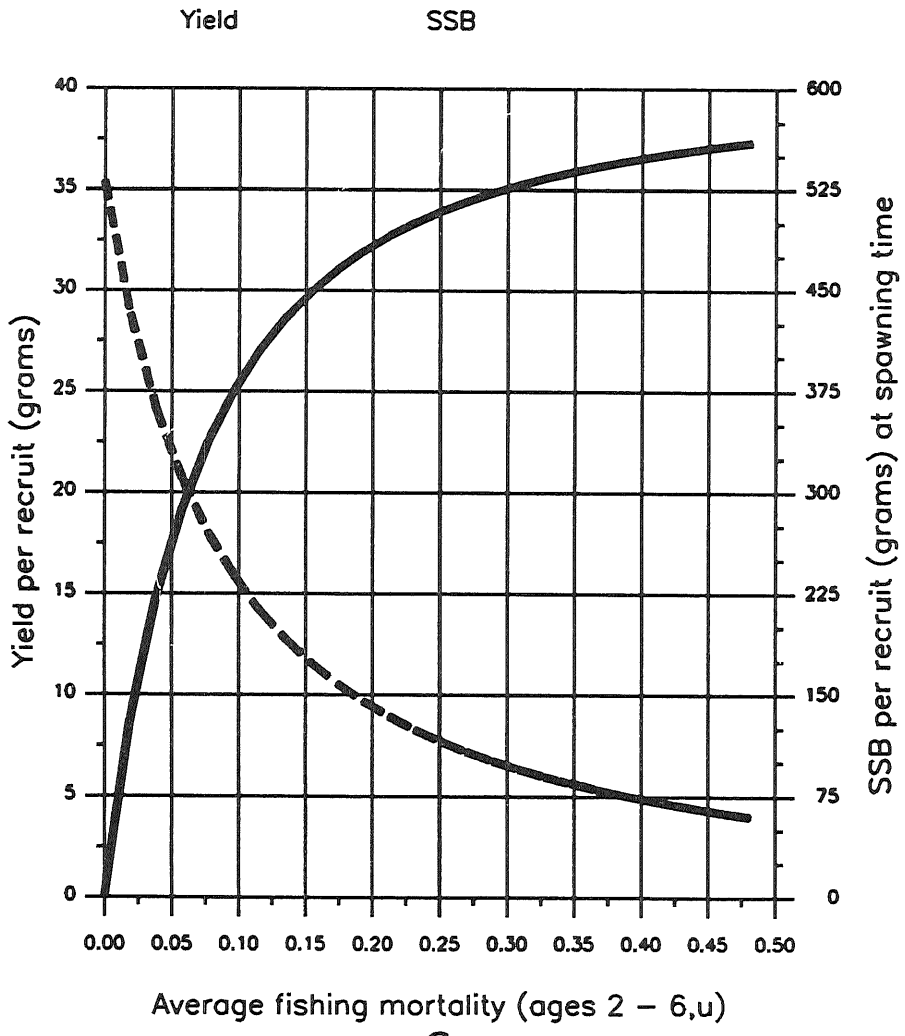
Figure 7.4.1 (cont'd)

# FISH STOCK SUMMARY

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

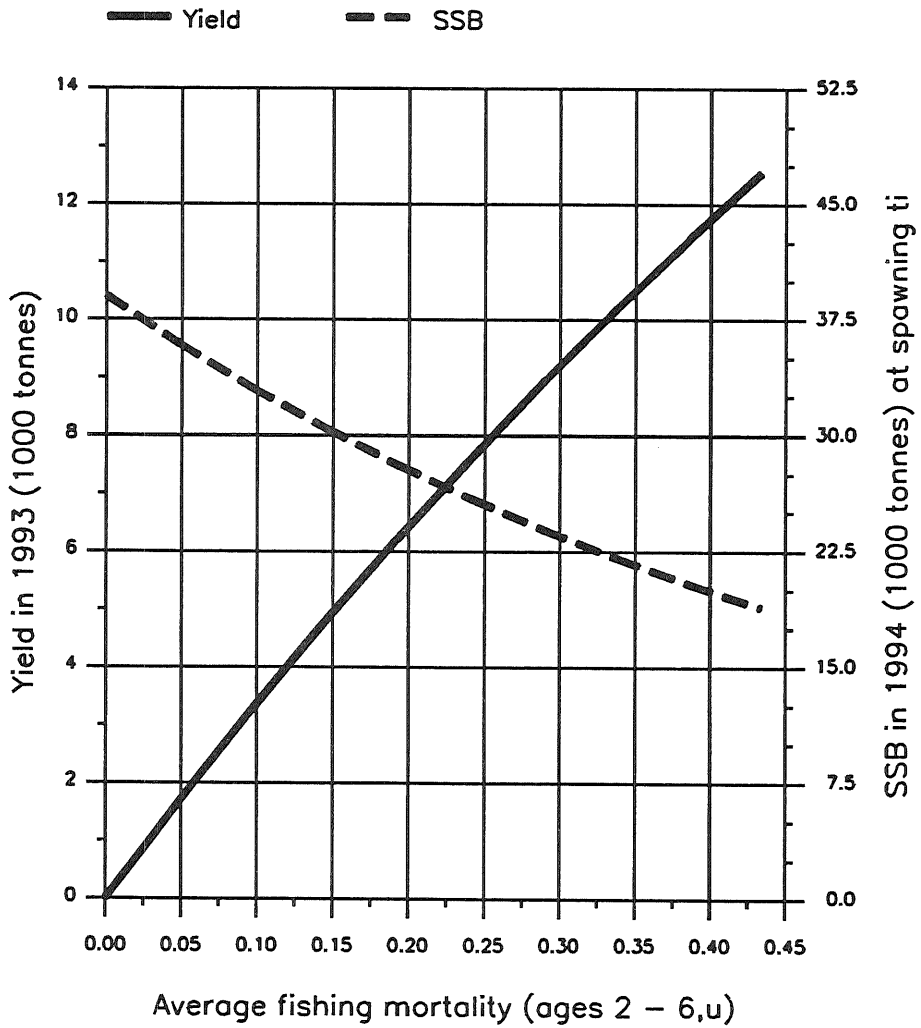
## 5–4–1992

Long term yield and spawning stock biomass




C

Short–term yield and spawning stock biomass




D

**Figure 7.4.2** Spawning stock biomass from VPA with a number of terminal Fs.

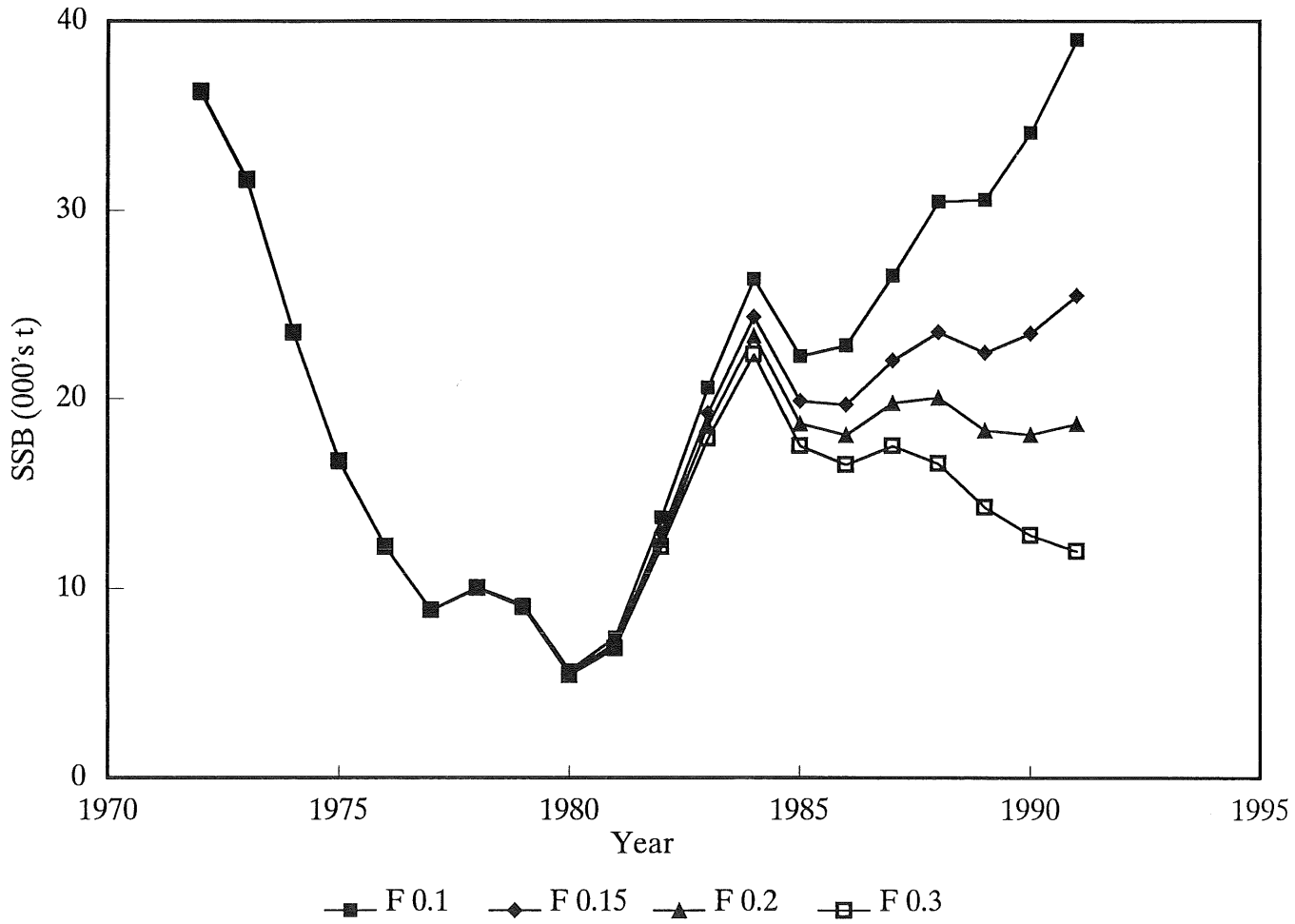


**Figure 7.4.3** North Irish Sea HERRING (Division VIIa (N).