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International Council for the Exploration of the Sea

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PART 1

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

Copenhagen, 4 - 14 April 1989

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TABLE OF CONTENTS

1 INTRODUCTION

1.1 Participants

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Dr E.D. Anderson, ICES Statistician, attended the meeting when necessary and provided statistical assistance.

1.2 Terms of Reference

In accordance with C.Res. 1988/2:4:9 the Herring Assessment Working Group for the Area South of 62°N met at ICES Headquarters from 4-14 April 1989 to:

a) consider the report of the Multispecies Assessment Working Group;

b) assess the status of and provide catch options for 1990 within safe biological limits for the herring stocks in Division IIIa, Sub-area IV (separately, if possible, for Divisions IVa,b and Divisions IVc and VIId), Division VIa, and Sub-area VII;

c) provide quarterly catch-at-age and catch and stock mean weight-at-age data and information on the relative distribution at different ages by quarter for North Sea herring for 1988 as input for the multispecies VPA;

d) provide data on the stock composition of herring catches in Division IIIa;

e) evaluate the impact of the rotating seasonal closures of spawning areas for the Celtic Sea and Division VIIj herring stock;

f) evaluate all available survey data and comment on their applicability in the assessments of the herring stocks.

1.3 Evaluation of Multispecies Assessment Working Group Report

The Herring Assessment Working Group considered the report of the Multispecies Assessment Working Group (MSWG). They were not in a position at the meeting to explain the discrepancies between the quarterly catch data on North Sea herring provided for the MSVPA and those used in the Herring Working Group.

The Working Group noted the changes in values of M at age in the new key run of the MSVPA. They are compared with the values used in the single species VPA (SSVPA) in the text table below:

Age (rings)	1974-76	1977-79	1980-82	1983-85	1986-87	Overall mean 1974-87	SSVPA
0	0.65	0.63	0.67	0.50	0.77	0.64	1.0
1	1.13	1.12	1.20	0.86	0.90	1.05	1.0
2	0.39	0.45	0.50	0.42	0.42	0.44	0.3
3	0.32	0.31	0.33	0.28	0.28	0.31	0.2
4	0.18	0.17	0.17	0.16	0.16	0.17	0.1
5	0.13	0.13	0.13	0.12	0.12	0.13	0.1
6	0.26	0.20	0.21	0.18	0.20	0.21	0.1
≥7	0.1	0.1	0.1	0.1	0.1	0.1	0.1

The total M values from MSVPA are higher than those used by the Herring Working Group in ages 2-6. Following guidelines from the MSWG, the Working Group nevertheless retained the existing values to preserve consistency in TAC estimation on the grounds that the new values are not very different from those previously estimated by the MSVPA.

1.4 Use of More Up-to-date Information For Management

Last year the Working Group suggested that ACFM consider the possibility of shifting the time of the Working Group meeting towards the end of the year. In that case, the Working Group would be able to use the results of the summer acoustic surveys, and the first estimates from the autumn larvae surveys.

ACFM considered this request, but they were unable to comply with it, because of the present excess in meetings of other working groups at the end of the year.

Given the fact that the time of the Herring Working Group meeting cannot be shifted towards the end of the year, the Working Group would like to suggest another procedure for utilising more recent survey data. The main source of additional information that becomes available after the time of the present Working Group meeting is the acoustic survey in the North Sea in summer. Preliminary results of this survey can be ready by September, and they could be made available to ACFM as a working document for the November meeting. If the results of this survey are very different from the projected stock size (say by more than 30%), and there are no reasons to assume that the survey results are biassed, then ACFM could consider the need to adjust the earlier advice given during the May meeting. The Working Group, therefore, suggests that ACFM keeps the option of amending the North Sea herring advice later in the year by including this stock on the agenda for their November meeting.

1.5 Spawning Ground Closures

Spawning ground closures have been common in management of herring fisheries and are now used in four of the management units of this Working Group.

In the past, spawning fish were not in particular demand by the fisheries and closures of spawning grounds could be implemented relatively easily as an auxiliary management measure. Since the development of herring roe markets, however, spawning fish have become valuable. Recently there has been an increasing interest in exploitation of herring on their spawning grounds. Closure of spawning grounds now means that fishermen are prevented from taking the herring at the time when they are most valuable. If such closures are to be maintained or initiated, there has to be a strong justification for this particular kind of management measure.

The Working Group discussed general aspects of spawning ground closures with a view to developing a consistent approach. The reasons for closing spawning grounds in the past were:

1) Concentration of effort on spawning groups may increase vulnerability. Particularly where there is more than one spawning unit within a management area, there could be disproportional allocation of effort to that unit.

2) In addition to fishing pressure, there may be additional negative impact on spawning caused by disturbance of spawning aggregation and damage to the eggs already deposited on the spawning grounds.

3) Potential excessive mortality caused by fishing dense aggregations, including catches in excess of trip limits, losses from split nets, etc.

Situations in which closures of spawning grounds should be recommended

In general, the Working Group recognizes that it should refrain from recommending a closure of spawning grounds; however, there are a number of specific situations in which the disadvantages of fishing on spawning grounds are so great that a (partial) closure of spawning grounds is justified. These situations include:

a) A management unit, which is controlled by an overall TAC, is composed of several discrete spawning stocks, and the spawning grounds of some stocks are more vulnerable than others. In this case, closure of the more vulnerable spawning grounds will prevent an uneven distribution of fishing effort, and a possible extinction of some of the more vulnerable stocks.

b) If a stock is managed by a precautionary TAC which is above the recommended level, it is wise to introduce a closed spawning season as an extra precaution. This will prevent the stock from being decimated in case an unexpected drop in recruitment occurs, and the TAC appears to have been too high.

c) If excessive discarding is known to occur in the spawning fishery.

d) If a fishery is managed by quotas, but enforcement is inadequate, the total catch will tend to exceed the TAC. In this case a closure of spawning grounds is required as a back-up measure, to make sure that at least a certain proportion of the stock gets a chance to spawn.

The following points should be considered in applying spawning area closures:

1) Closures should be long enough in time and large enough in area to ensure protection of the spawning unit. (Because of annual variation in spawning time a 2-week closure, for example, is perhaps not enough.)

2) Consideration should be given to the resulting pressure on neighbouring units to ensure that closure of one area does not result in negative impact on a neighbouring unit (disproportional effort, premature fisheries leading to slippage, etc.).

3) Complimentary management measures should be considered, including controlled openings, enforcement of closures and restriction of other fisheries which may affect spawning herring and the spawning beds.

4) Closed areas should be monitored to assess the impacts of closures.

1.6 Biological Reference Points and Management Strategies

The Working Group discussed a proposal for simplifying the choice of target Fs by considering only a limited number of rounded standard values for each stock.

According to this proposal, the range of F from 0.20-0.30 could be considered as the safe biological range for all herring stocks dealt with at present. Within this range, only 3 standard options would be considered for each stock (0.20, 0.25 and 0.30), assuming that biological data generally are insufficient to justify a more precise definition of optimum target F. Depending on the biological characteristics and exploitation level of each individual stock, one of these 3 standard options would be recommended as optimum target F.

Although the idea of more uniformity in the choice of target Fs did look attractive, the majority of the Working Group felt that the above limitation of the number of management options would unnecessarily restrict the freedom of choice for fishery managers, and that it would also tend to ignore small but significant differences in biological characteristics between the stocks.

Some concern was expressed about the use of F_{med} as a possible management objective. Although F_{med} corresponds to an exploitation level that has generally been balanced by recruitment in the past, it does not necessarily reflect the optimum exploitation level from a Y/R point of view. For this reason, F_{med} should not be considered as the optimum level from a Y/R and buffer stock point of view, but rather as the possible upper limit of the safe biological range.

1.7 Changes in Growth Rate

Recent herring assessments have identified apparent changes in growth rates, manifested as changes in mean length or weight at age. A summary of last year's Working Group report indicates a decrease in growth in five of the assessments. The coincidence of changes in growth rates (some of which are very large) among a number of stocks and at a time of changing (generally increasing) stock size raises a number of questions, including:

1) Is it related to stock size (i.e., indicative of density-dependence)?

2) Is there geographical coincidence (perhaps indicative of an environmental effect)?

3) What are the implications for assessment?

The Working Group concluded that it would be valuable to compare growth rate information to determine if there are patterns in the change of growth within and between stocks. Since only fishery-derived weight at age data were readily available the Working Group recommended:

> "that data be compiled to allow a review of growth rates at the next Working Group meeting".

The following points should be considered:

1) The North Sea should be considered in sub-units, as preliminary analysis (V. Christensen, unpubl.) indicates a confounding effect due to the relative contribution of young herring from different areas with different growth rates.

2) The comparison should focus on standardized growth increments (rather than simply size at age) to avoid the effect of differences in size.

3) Care should be taken in selecting historical data to avoid the impact of selectivity of commercial gear and apparent size at age.

4) Growth in length should receive primary attention because of the confounding influence of length and condition on weight.

The Working Group proposed that historical growth rates be calculated at least for both young rapidly growing (1-ring) and fully recruited (3-ring) herring from each stock and initial comparisons made as outlined in the working paper on changes in growth rate (Stephenson, Working Document).

2 NORTH SEA HERRING

2.1 The Fishery

2.1.1 ACFM advice applicable to 1988 and 1989

1988

At its 1987 meeting ACFM advised the following TACs for 1988:

Divisions IVa,b: 500,000 t(including an estimated 81,000 t of 1-ringers).

Divisions IVc, VIId: 20,000 t (this to be reduced to 15,000 t if the agreed TAC of 40,000 t is taken in 1987).

The TACs adopted by the management bodies were:

Divisions IVa,b: 500,000 t,

Divisions IVc, VIId: 30,000 t.

In addition ACFM recommended that:

a) Existing regulations designed to protect 0-group and small 1-ring herring should be maintained (sprat box closures, 20 cm minimum landing size, 10% by-catch regulation).

b) Spawning ground closures in the western part of Division IVb should be maintained to protect vulnerable spawning shoals.

1989

The 1988 ACFM meeting recommended the following TACs for 1989:

Divisions IVa,b: 484,000 t (including 35,000 t of 1-ring herring.

Divisions IVc, VIId: 30,000 t.

The agreed TAC adopted by the management bodies were:

Divisions IVa,b: 484,000 t,

Divisions IVc, VIId: 30,000 t.

It was additionally recommended that existing reulations designed to protect juvenile and spawning herring be maintained (as in 1988).

2.1.2 Catches in 1988

Official and unofficially reported landings for 1988 are shown by countries in Table 2.1.1 for the total North Sea and for each division in Tables 2.1.2-2.1.5. The total provisional catch was 698,449 t an increase of 72,155 t on that recorded in 1987. Unallocated catches amounted to 33,411 t (4.8% of the total) compared with 35,000 t (5.6% of the total) in 1987.

The Netherlands catches included an additional estimate for discards, these were incorporated in the unallocated catches.

There has been a slight change in the catch figures reported by Norway for the years 1984-1987 in Division IVa E. These changes are relatively small (<1% of the total North Sea catch) and the Working Group felt that they would affect the final results only marginally. Therefore, the catch in number at age figures have not been adjusted for these years.

Adult herring catches (2-ring and older)

A breakdown of adult herring catches (2-ring and older) by ICES divisions and quarters is presented in the following text table. These tonnages were derived from the sums of products of estimated numbers and mean weights at age provided by Working Group members.

Adult herring catches (2-ring and older)

Division	Quarter 1988 I	II	III	IV	Total
IVa[2] (W of 2°E)	18.0	23.7	110.1	30.0	181.8
IVa[1] (E of 2°E)	71.4	29.6	17.6	67.0	185.6
IVb[1]	10.4	10.4	68.5	41.7	131.0
IVc + VIId	2.3	0.2	0.1	51.3	53.9
Total	102.1	63.9	196.3	190.0	552.3

Weights in '000 t.
[1] Catches of spring spawners (23,306 t). transferred to Division IIIa from IVa,b excluded.
[2] Catches made in S. Buchan area of Division IVb are not included in those for Division IVa (W of 2°E).

This table excludes catches of spring spawning herring amounting to 23,306 t transferred to Division IIIa, which were taken in the eastern parts of Divisions IVa E and IVb during the second and third quarters.

The proportion of these in the North Sea catches was estimated using the modal length and vertebral count separation method (see Section 3.1.1).

Most of the adult herring were caught in purse seine and trawl fisheries using a minimum mesh of 32 mm.

The total catch of 2-ring and older herring in Divisions IVa + IVb was thus estimated at 498,400 t, which, with the addition of a similarly estimated 1-ring catch of 108,900 t for these divisions (see following Section), gave a total of 607,300 t. This compares with the ACFM recommended and agreed TAC of 500,000 t (including 81,000 t 1-ringers) for Divisions IVa + IVb.

In Divisions IVc and VIId, the estimated catch of 53,900 t adult herring was considerably in excess of the recommended 15,000 t and the agreed TAC of 30,000 t.

Juvenile herring catches (0- and 1-ring)

The catch breakdown by divisions and quarters for 0- and 1-ring juvenile herring is provided in the text table below, these catches are also estimated from data supplied by Working Group members.

		Quarter 1988				
Division	Age group	I	II	III	IV	Total
IVa (W of 2^0E)	0	-	-	-	-	-
	1	-	0.3	+	0.9	1.2
IVa (E of 2^0E)	0	-	-	0.1	0.1	0.2
	1	+	0.1	0.8	2.7	3.6
IVb	0	-	-	11.0	3.6	14.6
	1	2.2	7.8	73.7	20.4	104.1
IVc + VIId	0	-	-	-	-	-
	1	-	-	-	0.4	0.4
Total	0	-	-	11.1	3.7	14.8
	1	2.2	8.2	74.5	24.4	109.3

Weights in '000 t.
+ Less than 50 t.

The total catch of juvenile herring was thus estimated as 124,100 t and this was 18,300 t less than that for 1987. This decrease is evident in both the 0- and 1-ring catches, with reductions of 4,200 t and 14,100 t, respectively.

Most of the juvenile landings were reported from the eastern half of Division IVb, during the third and fourth quarters, amounting to 14,600 t of 0-group (98.6% of total 0-groups) and 94,100 t of 1-ringers (86% of their total). Small amounts of larger 1-ring fish were also taken in catches from Division IVa during the last quarter of the year.

Most of the 0- and smaller 1-ring fish are caught in shallow water coastal fisheries by vessels using small mesh (16 mm) bottom trawls. Larger 1-ring fish are taken in more offshore deeper water areas during the second half of the year by larger industrial trawlers using both 32 mm and smaller mesh trawls and also by purse seiners. Juvenile catches are mainly utilised for reduction purposes.

2.1.3 Quality of catch and biological sampling data

A comprehensive discussion was held by members of the Working Group to evaluate the general quality of national catch and biological sampling data submitted for the 1988 assessment.

In many fisheries, information on landings was largely provided by vessel logbooks, but in some areas alternative sources such as fisheries inspectors, meal plant controllers, processors, sales dockets, fisheries producer organisations etc., were also instrumental in providing catch data.

A possible problem area involved landings of herring made in countries other than those of the vessels' registered origin. Some doubts were expressed concerning the accuracy of returns made on these landings, and such operations could also provide opportunities for misreporting the species concerned. These landings were also not covered by biological sampling on a routine basis.

Checks on transhipment operations now seemed better controlled in most areas, with less opportunity for under-reporting catches landed directly to the klondykers.

A major problem involved the estimation of unrecorded amounts of fish discarded, slipped, or lost through burst nets, particularly when vessels fished on dense spawning aggregations for the roe market. This information was generally lacking for most countries, although the Netherlands had made adjustments to its catch figures to allow for discards.

The collection, measuring, and biological analysis of samples was largely the responsibility of the fisheries institutes concerned, generally operating through market sampling programmes, although supplementary assistance was often provided by fisheries inspectorate staff, and through cooperation of the processors.

It was concluded that although these systems operated reasonably well, there were some areas where improvements could be made in both more accurate determination of actual catches made and improved levels of biological sampling in some fisheries.

2.1.4 Catch in number at age

Quarterly and annual catches in numbers and mean weights at age were compiled for each division and the total North Sea using data submitted by the main countries fishing herring in the North Sea during 1988.

In the case of countries where only catch data was provided, conversions to equivalent age distributions were made by raising to the most appropriate fisheries in time and area for which full information was available.

Table 2.1.6 provides a detailed breakdown on numbers caught by age group for each division, quarter and the annual total, whilst a comparison of total North Sea catches in numbers at age over the years 1970-1988 is presented in Table 2.1.7.

Additional information on estimated catches of 0- and 1-ring fish of North Sea origin taken in Division IIIa fisheries is provided in Section 3.1.2.

An analysis of the percentage contributions by number of 2-ring, 3-ring, and older fish (excluding 0- and 1-ringers) by division, quarter, and annual is shown in Table 2.1.8.

Compared with landings in 1987, there was a considerable reduction in the catch in number of 1-ringers, these contributing about 27% by number and 16% by weight to the total North Sea catch in 1988 (excluding spring spawner transfers to Sub-area III), whereas in 1987 the catch of 1-ringers represented about 40% by number and 20% by weight of the North Sea total catch. These differences were largely contributed to by heavier exploitation of 1-ringers earlier in the year 1987, when 54% by number of the 1-ring catch were taken in the first half of the year, compared with only 17% in 1988, also reflected in differences in the annual mean weights in the catch (35 g in 1987, 55 g in 1988).

The representation of age groups in the adult (2-ring and older) catches, (Table 2.1.8), shows that the recruiting 1985 year class, predicted as an exceptionally strong one, progressively increased its representation in the catches through the year in all divisions except Division IVb. Here it was the predominant age group in catches made during the first two quarters (82-89%), and reduced to around 70% in the last two quarters following an influx of older fish. It was also less well represented in the Divisions IVc and VIId fishery (about 27%). Overall it contributed about 49% by number and 39% by weight to the total North Sea adult catch in 1988. This compares with overall values of 57% by number and 42% by weight contributed by the recruiting year class (1984) in 1987, which also exhibited very similar changes in its pattern of representation through the year in different divisions, although relatively much more strongly represented in the Divisions IVc and VIId fishery (see Table 2.8.1 in last year's Working Group report).

2.2 Natural Mortality

The latest estimates of total natural mortalfity, M, for different age groups of herring presented in the 1988 report of the Multispecies Assessment Working Group were discussed by the Working Group. However, it was concluded that the difference between the values currently in use for the SSVPA and those arising from the MSVPA key runs (averaged over the period 1980-1985) were not sufficiently great to warrent any changes at present (see Table 2.8.4 in the 1988 report of that Working Group) and guideline comments in para. 2 of the recommendations).

The values used for the 1988 assessment are listed in Section 1.3.

2.3 Recruitment

2.3.1 IYFS indices

An updated series of indices of 1-ring herring from the IYFS is given in Table 2.3.1. The regression of VPA estimates of 1-ringers on IYFS indices of the same year classes was updated using the new VPA given in Section 2.8. As in 1988, indices obtained prior to the standardization of the survey gear in 1976 were excluded. The scatter plot and fitted regression line are given in Figure 2.3.1. The intercept is not significantly different from zero and for prediction purposes the regression has been forced through the origin. The resulting equation is identical to last year's, i.e.,

$$y = 0.0053 x$$

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

The 1985 and 1986 year classes are also plotted in Figure 2.3.1, but were not used in the regression. The provisional VPA estimates and predicted values from IYFS are in reasonable agreement.

Indices of 2-ringer abundance from the IYFS are also given in Table 2.3.1. An evaluation of the usefulness of this index as an estimator of 2-ringer abundance is not yet possible because insufficient years are available. However, the very high index of the 1985 year class from the 1988 survey does not correspond to the relative size of this year class in VPA or as 1-ringers in the IYFS (see Table 2.3.1 and Section 2.7).

2.3.2 IKMT indices

An updated series of IKMT indices from the IYFS is given in Table 2.3.2, and the area breakdown is shown in Figure 2.3.2 in the 1988 report (C.M.1988/Assess:17). The updated scatter plot and regression of 0-ringer abundance from VPA on the IKMT index values is given in Figure 2.3.2 based on the values in Table 2.3.3. As pointed out in the 1988 report, the regression is based on an increasing trend of stock size and it will not be clear whether the IKMT index is a reliable predictor of 0-group abundance until a weak year class is observed. The low index of the 1988 year class may provide a useful test of the predictive value of the index.

2.3.3 Recruitment forecast 1986 year class

The preliminary index of the 1986 year class as 1-ringers used in the 1988 report was 4,178 per hour giving a predicted recruitment of 22.14 billion. The final index is 4,192 giving a year class strength of 22.22 billion at 1 January 1988. It should be noted, however, that a high proportion of this year class was present outside the standard area and in particular in Division IIIa (Table 2.3.4).

A further estimate of this year class in 1988 is available from the July/August acoustic survey of the North Sea and Division IIIa. The estimate of 1-ringers is 13.05 billion, all of which were assumed to be North Sea autumn spawners. To estimate the number alive at 1 January 1988, this figure has been corrected by the catches in the first half of the year in the North Sea (0.33 billion) and in Division IIIa (3.33 billion) and an assumed natural mortality of 0.5 (half the annual figure for 1-ringers). The estimated number alive at 1 January is 26.13 billion, which is not inconsistent with the IYFS estimate considering the higher proportion in Division IIIa in 1988.

Projecting forward from this estimate, based on the acoustic survey, to 1 January 1989 using the annual catch of 1-ringers in the North Sea (1.97 billion) and Division IIIa (5.79 billion) using an M of 1.0 gives an estimated 5.31 billion 2-ringers at 1 January 1989. The corresponding fishing mortality rate on 1-ringers in 1988 is 0.59.

The projected estimate of 2-ringers at 1 January 1989 from the 1988 IYFS and 1988 catches of 1-ringers in the North Sea is 7.04 billion.

2.3.4 Recruitment forecast 1987 year class

The preliminary index of 1-ringers in the standard area during the 1989 IYFS was 3,471 from which a year-class strength of 18.40 billion is predicted. This is roughly the same level as the 1984 and 1985 year classes as estimated by VPA, and above the long-term mean since 1947. Comparison of the numbers caught during the IYFS in the North Sea and Division IIIa indicates that this year class was concentrated in Division IIIa (63%) but not to the same extent as the 1986 year class (72%) (Table 2.3.4).

2.3.5 Recruitment forecast 1988 year class

The IKMT sampling on the 1989 IYFS gave an index of 7,097 which is the lowest value since 1978 (Table 2.3.3.). As pointed out in Section 2.3.2. the significance of this low value is not yet known, but since the larvae came from a relatively large spawning stock, it may be an indication of a poorer year class than has been seen in the last few years. Using the regression equation given in Figure 2.3.2, the predicted number of 0-group at 1 July 1989 is 24.6 billion. The mean over the period 1960-1987 from VPA is 35.2 billion.

The distribution of 0-group in the 1989 IYFS is shown in Figure 2.3.3..

2.3.6 Trends in recruitment

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

2.4 Acoustic Surveys

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

An acoustic survey of the North Sea and Division IIIa was carried out between 53°30'N and 62°N over the period 24 June-19 August by vessels from four countries. Details of the survey are given in the report of the Planning Group for Acoustic Surveys in Sub-area IV and Division IIIa (Anon.,1989).

The estimated numbers at age for the total area covered in the Norh Sea are given in Table 2.4.1. In 1988, the percentage of each age group expected to spawn (maturity III and above) was 65.6% of 2-ringers, 89.7% of 3-ringers and 100% of the older age groups. The estimated biomass of fish expected to spawn was 897,000 t of which 661,000 t was in Division IVa W, 175,000 t in Division IVa E and 61,000 t in Division IVb. Mean weights at age in the 1988 survey are also given in Table 2.4.1.

2.4.2 Eastern part of central North Sea

A Norwegian vessel surveyed Division IIIa and Division IVb east of 3°E from 11 November - 11 December 1988. The estimated numbers at age in millions are compared with those at the same time in previous years in the text table below;

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	2,257	2,803	3,752	3,100

The estimates of 0- and 1-ring herring in 1988 are lower than those of the same age groups in 1987.

2.5 Herring Larvae Surveys

2.5.1 Herring larvae surveys in 1988/1989

The sampling intensity in 1988/1989 was at a level slightly below that in the preceding years. A total of approximately 85 days at sea was used for the surveys in Sub-area IV and Division VIId.

The Orkney-Shetland area was surveyed once by the Federal Republic of Germany in the first half of September and once by Denmark and by Scotland in the second half of September. Very high concentrations of small larvae were found in the area.

The Buchan area was sampled once by Scotland in early September and once by Denmark in the second half of September. Very high abundances of larvae were found in the Turbot Bank area.

In the Central North Sea, the Netherlands made surveys through four periods of September while England sampled in early October and the Netherlands again in late October.

The Southern North Sea and Eastern Channel was surveyed by the Netherlands once in both the first and second half of December. England made a survey in the first half of January, and the Federal Republic of Germany sampled in the period 12-30 January.

The data from the surveys were collected and processed at the DAFS Marine Laboratory, Aberdeen.

2.5.2 Larvae production estimates (LPE)

Calculations of LPEs were made available to the Working Group by DIFMAR, Hirtshals. The estimates were calculated as described in the 1987 Herring Assessment Working Group report (Anon., 1987).

As discussed in the IHLS (Anon., 1987b), a bias in the LPE is likely to occur for Division VIa(N) and the Orkney-Shetland area.

This is due to the fact that large and most likely variable amounts of larvae drift from Division VIa (N) into the Orkney-Shetland area every year. By combining Division VIa (N) and Orkney-Shetland in the analysis of larval mortality and production, more reliable estimates should be obtained. This has been tried in the present analysis. However, no way is known to separate the LPEs for the two standard areas. Therefore, the combination poses problems for management purposes, where separate estimates of stock size for the two areas are needed.

The production estimates are based on estimates of mortality rates (z/k) calculated from the larvae data. In Table 2.5.1 the results for the years since 1981 are given for the four standard areas in Sub-area IV, as well as for the combined Division VIa (N) and Orkney-Shetland area. For each area, the average mortality rate over the years 1980-1988 was used as the area-specific mortality rate for all years from 1972-1988. As can be seen from Table 2.5.1, only very slight changes have been made to the area-specific mortality rates due to the new 1988 data.

In the analysis the growth rates are assumed to be 0.35 mm/day for all the standard areas. In a working document presented to the Working Group, Christensen and Munk estimated larval growth rates from the IHLS data base and found the average growth rates for the areas VIa (N), Orkney-Shetland, Buchan, and the Central North Sea to be in the range 0.27 to 0.30 mm. This places some confidence in the growth rate used in the calculation of the LPEs. Thus, the IHLS Working Group has shown (Anon., 1987b) that the LPE estimates are not very sensitive to changes in growth rates in the range of 0.25 to 0.35 mm/day.

The LPE values for the four standard areas, as well as for the combined Division VIa (N) and Orkney-Shetland area, are given in Table 2.5.2. The LPEs for 1988 show no dramatic changes in any of the areas compared to the average over the years since 1983. The spawning stock must, therefore, be judged to be quite stable.

The LPE estimates were 'corrected' for differences in fecundity in Table 2.5.3. No new fecundity data were available to the Working Group for this year.

2.5.3 Indices based on small larvae (LAI)

Calculations of larvae abundance indices were made available to the Working Group by the DAFS Marine Laboratorty, Aberdeen. The estimates were calculated as described by Saville and Rankine (1985). The LAIs for 1972-1987 are given in Table 2.5.2 together with the LPE resulrs.

The LAIs showed marked increases from 1987 to 1988, especially in the Orkney-Shetland and the Buchan areas, where the new indices are by far the largest on record. In the Central North Sea, the Southern North Sea, and the Eastern Channel the larvae abundance has been rather stable over the last five years.

The LAI values for Divisions IVa,b and for the total North Sea were calculated as follows: the sum of the Orkney-Shetland LAI and the Buchan LAI was added to four times the LAI for the Central North Sea to give the LAI for Divisions IVa,b. The LAI for the Central North Sea was multiplied by four as it is reported as the mean of the four half-month periods that are included. The LAI for Divisions IVc and VIId were added to the LAI for Divisions IVa,b to give the LAI for the total North Sea.

2.5.4 Development of individual stocks

Based on the larvae production estimates it is possible to monitor the development of individual stocks. This is illustrated in Figure 2.5.1, where the indices of spawning stock biomass for 1972-1988 are plotted. As can be seen, the Orkney-Shetland herring were dominating in the years prior to the start of the recovery. The recovery started in the late 1970s and became especially apparent after a good recruitment to the Divisions IVc/VIId stocks in 1981. Since then, the Buchan and Central North Sea herring stocks have built up from virtually nil to being the dominating stocks in the North Sea.

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 catch during 1988 are shown by divisions and quarters in Table 2.6.1. A decrease in annual mean weights at age was first noted in 1985 (1986 Herring Assessment Working Group report) and a continuing downward trend has since become evident. In the 1988 HAWG report it was noted that care must be exercised in interpreting these data since they can be influenced by variation in the quarterly distributions of catch between years, and within quarter comparisons between years should provide a better indication of changes.

Mean weights at age for the years 1986-1988 are thus summarized on a quarterly basis for Divisions IVa+b and Divisions IVc + VIId in Table 2.6.2.

The mean weights at age of fish taken in the Divisions IVc + VIId fisheries show no consistent trends of changes in mean weight between years in any quarter. This contrasts with those in the Divisions IVa+b fisheries which do register fairly consistent trends of decreasing mean weight for age in all age groups and quarters except the first.

The following text table provides a comparison for the years 1986, 1987 and 1988 of mean weights at age in the catch in the third quarter, for Divisions IVa + IVb.

Mean weights (g) at age in the Catch

Third Quarter (Divisions IVa + IVb)			
Age (w.r.)	1986	1987	1988
1	78	54	58
2	146	134	124
3	190	182	178
4	224	219	217
5	248	248	239
6	282	265	261
7	288	286	283
8	327	310	283
9+	364	342	296

Mean weight at age in the 1988 summer acoustic surveys were again close to those recorded in the third quarter catches (as in 1987), and the survey values were used in the VPA as stock weights at age (see Table 2.7.5).

2.6.2 Maturity ogive

Estimates of the percentage of 2- and 3-ringers likely to mature in 1988 were derived from research vessels samples taken on the July survey, which provided a very comprehensive cover for the whole herring population in Divisions IVa,b.

The proportions expected to spawn (stage 3 maturity and above) were as follows:

2-ring 65.6%
3-ring 89.7%
Older 100.0%

2.7 State of the Stocks

2.7.1 Total North Sea (Sub-area IV and Division VIId)

As in 1988 the Working Group did not have sufficient data to make a separate assessment for the separate divisions.

Relative estimates for the spawning stock in the total North Sea were available from acoustic surveys (Section 2.4) and from larvae surveys (Section 2.5). In addition the average catch rates of 2-ringed and older herring in the total area in the IYFS were presented for the time series 1980-1988. All these relative estimates were considered to contain valuable information on the development of the spawning stock. The time series are shown in Table 2.7.1.

The acoustic estimates for 1987 and 1988 are adjusted for the catches of spawners taken between the time of the surveys and the time when 67% of the annual catch was taken. The reasoning for this is as follows: the VPA program applies the same proportion of F and M before spawning for all years. For 3 of the 4 years examined (1985-1988, Figure 2.7.1), 67% of the annual catch was reached in early September. This corresponds to the time of spawning (and also to the time of the surveys in 1981-1986). Thus for the VPA a value of 0.67 was used as the proportion of F and M before spawning. When the F for the spawners are much larger than M, the VPA will estimate the spawning stock at the time when 67% of the annual catch is reached. This means that the VPA estimate for the exceptional year 1987 represents early November. The dates and corrections are summarized in the text table below (details are given in Table 2.7.10):

Year	1981-1986	1987	1988
Average survey date	about 1 Sep	15 Jul	15 Jul
Date of 67% annual catch	about 1 Sep	1 Nov	1 Sep
Catch of spawners ('000 t) between survey and 67% data, to be deleted from acoustic spawning stock estimate.	0	150	94

The RCRTINX(2) - program was taken as a useful tool for weighting the estimates from the IYFS, acoustic and larvae surveys relative to their precision. The estimates were regressed against the spawning stock for the last 10 years of the converged part of the VPA (up to 1985) thereby giving weighted predictions for the years 1986, 1987 and 1988. The output is shown in Table 2.7.2. The predicted values are mostly based on the acoustic estimates (71% weight) and the larvae production estimation (16% weight).

As both the acoustic surveys and the IYFS give relative estimates for several age groups, they can be used for estimating mortalities by age. This was done through the tuning option in the ST-VPA program. To take into account the variable proportion of F before the time of the survey (Figure 2.7.1), the acoustic estimates were back-calculated to 1 January. This also makes them more comparable to the IYFS carried out in February. The input file for "fleet" data is shown in Table 2.7.3 and the catch in numbers in Table 2.7.4. Table 2.7.5 shows mean weight at age and proportions of maturity. The values for 1988 were obtained during the acoustic survey. For the years 1985-1987, the weight at age in the third quarter catches was used as the weight at age in stock at the time of spawning. These have shown to be quite close to the values in the acoustic survey both for 1988 (Tables 2.10.1 and 2.4.1) and for 1987 (Table 2.7.3 in the 1988 Working Group report). The values from the acoustic surveys were considered best because estimates from the fishery could be biased.

The output from the report file of the tuning program is shown in Table 2.7.6. The pattern of the q values by age group is plotted in Figure 2.7.2. This output indicates that the data are reasonably good for the age groups 2, 3, and 4 in the acoustic surveys, and for age group 1 in the IYFS. The resulting estimates of terminal F should be considered rather precise. With some smoothing on the older age groups poorly sampled in the surveys, this was considered as the best available estimate of the exploitation pattern. This is compared to the pattern resulting from a separable VPA (Table 2.7.7) .

Age group	Exploitation pattern: Tuning program	Separable VPA	Applied
0	-	0.060	0.060
1	0.179	0.257	0.179
2	0.750	0.631	0.750
3	1.000	0.885	1.000
4	0.998	1.000	1.000
5	0.893	0.956	1.000
6	0.686	0.960	1.000
7	0.998	0.966	1.000
8	0.929	1.000	1.000

The exploitation pattern was considered to be better reflected by the surveys than by the mean pattern obtained from separable VPA, because in earlier years rather large changes have occurred between years (Table 2.7.8).

In the tuning program only two of the time series of survey estimates were used (acoustic surveys and IYFS) as these were the only ones giving age compositions. It is likely that a better estimate of average F in 1988 would be obtained by applying the data from the larvae surveys as well. Therefore the VPA was tuned to give the best fit (minimum sum of residuals) to the biomass values predicted by the RCRTINX2-program for the years 1986-1988. The VPA output for the best fit is given in Tables 2.7.8 and 2.7.9.

The average fishing mortality for age groups 2 to 6 appears to have remained at a stable, high level of 0.5 to 0.6 since 1985. The spawning stock size has not changed much since 1984 in spite of good recruitment. This means that the catches of spawners have been at the same level as the contributions from the year classes recruiting to the spawning stock.

The predictions made by the 1988 Working Group assumed catches at the level of the agreed TAC for 1988. The predicted spawning stock for 1988 was 1,171,000 t compared to 821,000 t from the present assessment. This difference is partly explained by the 184,000 t taken in excess of the TAC, partly by the recruitment of 2-ringers being lower than expected, and partly by a reduced estimate of older age groups at 1 January 1988. There was also a further decrease in the mean weight at age in the spawning stock (Table 2.7.5). The 1988 Working Group already pointed out that the stock at 1 January was likely to be overestimated (Section 2.8.1 and Section 2.10.1 in the 1988 Working Group report). The reason for this warning was that the assessment had not taken into account that an exceptionally large proportion of the catches in 1987 was taken after the time of spawning.

2.7.2 Development of individual stocks in the North Sea

Herring larvae surveys (Section 2.5) are of special importance in providing an indication of changes in individual spawning stocks within the North Sea.

The relative contributions to total North Sea larvae production from different spawning areas is provided by the LPE values in Figure 2.5.1. These show that since 1983 the Orkney Shetland area has produced an average of 21% of total larvae production, the Buchan area 34%, central North Sea 29%, and southern North Sea - eastern Channel 16%. The Divisions IVa and IVb production thus amounted to 84% of the total.

There were no obvious trends in levels of production evident over this relatively short period, except possibly in the case of the Buchan area. Here the average level in 1986-1988 was about 43% greater than that over the previous years, but considering the high variability it is of doubtful significance.

The results of the 1988 larvae surveys show when the LPE indices are compared with those for 1987, a major increase in production from the Buchan area (x 3.6), a marked increase from the central North Sea spawning grounds (x 1.7), and lesser increases from the Southern North Sea (x 1.3) and Orkney-Shetland (x 1.2).

The proportions of the total North Sea larvae production contributed by each of these areas in 1988 were as follows:

Buchan 35.7%; Central North Sea 29.3%; Orkney-Shetland 21.3%, and Southern North Sea/Channel 11.9%; these values are similar to the 1983-1988 period means. The Working Group noted that the smallest increases in larvae production between 1987 and 1988 were observed in those areas (Orkney-Shetland and Divisions IVc, VIId) where spawning fisheries take place.

Divisions IVc, and VIId

In the report of the 1988 HAWG, the problems encountered in attempting to carry out an analytical assessment for Divisions IVc and VIId were discussed and summarised.

A trial VPA was run in 1988 using an arbitrary input F (0.65), which suggested very high levels of fishing mortality (around 1.0) over the years 1980-1985.

Results from acoustic surveys over the years 1980-1985 indicated spawning stock sizes in the range 96,000-150,000 t and Figure 2.5.1 shows no trend in the LPE estimate of SSB since this fishery reopened in 1981.

A VPA was not run in 1989, although a catch in number (Table 2.7.11) is provided. The generally poor representation of older age groups (5-ring and older) is evident, and in 1988 2- and 3-ring fish made up about 79% of the catch.

It has been a general feature of this fishery that apparently a strong recruitment has appeared in a number of seasons, but these year classes have faded out within a year or so, and there has been no progressive build-up of an old stock. It is largely a spawning ground fishery, with consequent vulnerability of the fish resulting in high fishing mortality. It is also strongly suspected that fish from this stock are taken in fisheries elsewhere in the North Sea during their summer feeding period, and as commented upon in previous Working Group reports, this has had to be allowed for in considering management strategy (see Section 2.9.2).

2.7.3 Stock recruitment

Figure 2.7.3 shows the stock/recruitment plot. The recruitment of 1-ringers in the early 1980s is consistently higher than the recruitment in the 1970s at the same spawning stock size. Figure 2.7.4 shows this shift in "recruitment success" more clearly. Here the VPA results are used to present the number of 0-group produced per kg spawning stock. Before 1977, the reproductive success stayed at a rather low level, while it increased by a factor of 5 during the period 1977-1981. Since 1983, it has fluctuated at an intermediate level.

If we trust the larval production estimate (Section 2.5), the number of larvae per unit of spawning stock is a measure of hatching success. This shows a trend quite similar to the one in reproduction success (Figure 2.7.5), which means that the hatching success is rather determinant for the year-class strength.

The ratio between the "year-class strength" estimated as 0-group in the VPA and as larvae in the LPE has, however, been surprisingly stable since 1978 (Figure 2.7.6). In fact, for the whole time series since 1972, the LPE is stronger correlated to the resulting year-class strength than the spawning stock biomass. Only looking at correlation coefficients, the LPE is even a better predictor of year-class strength than the IKMT indices.

These findings conflict evidences of high variability in larval survival for other stocks. One cannot trust that the stability of the larval survival indicated in the present material will continue in the future.

2.8 Projection of Catch and Stock Size - Total North Sea

The input data for the prediction are given in Table 2.8.1. The input maturity ogive, mean weight at age in stock, and proportion of F and M before spawning were the same as used for the year 1988 in the VPA. The input recruitment of 1-ringer in 1989 is the figure estimated from the IYFS 1989 (18.40 billion). For the 2-ringers the input for 1989 was 6.176 billion, which is the average of the estimate from the IYFS 1988 and from the acoustic survey 1988, both projected forward to 1 January 1989 (Section 2.3.3).

The regression between IKMT indices and VPA estimates of 0-group was used to estimate the 0-group in 1989 from the 1989 IKMT index (Section 2.3.2). This was projected forward to estimate 1 ringers 1 January 1990 by assuming the average 0-group mortality from the VPA for the years 1984-1987. The resulting value (8.65 billions) was taken as input value for the prediction. This is the first time that the IKMT index has been used by the Working Group for catch preciction. The average of the 1981 to 1984 year classes (15.1 billion) was used for the 1-ringers in 1991.

The exploitation pattern for the predictions were taken equal to the one used for the year 1988 in the present VPA, except for the 1-ringers where the value is taken from the separable VPA.

Table 2.8.2 gives the prediction for several catch options. The agreed TAC for 1989 corresponds to an average fishing mortality for age groups 2-6 of 0.42, which is a slight reduction compared to those for 1985-1988.

The resulting spawning stock (961,000 t) represents a 17% increase compared to 1988.

The previous Working Groups advocated a fishing mortality at about 0.3 on the basis that this is the level which the stock historically had been able to sustain. Input F_{2-6} = 0.30 gives a catch in 1990 of 403,000 t. A full output for this option is shown in Table 2.8.3. This allows for some increase in the spawning stock in 1990 and 1991.

The table also shows the consequences of continuing the same high fishing mortality as in recent years. This will bring the spawning stock below the present level in 1991.

Only catching at or below $F_{0.1}$ (~0.14) in 1990 and 1991 can bring the spawning stock biomass to the lower limit of the buffer range discussed by the 1987 and 1988 Working Groups.

Table 2.8.4 shows the predictions for the 2+ stock for the same catch options.

2.9 Management Considerations

2.9.1 Management advice for total North Sea

In previous reports the Working Group has advised to increase the North Sea spawning stock to a level of 1.5-2.0 million t, in order to buffer the annual TAC against recruitment fluctuations. Management bodies have set an even higher target of 2.2 million t for the North Sea spawning stock (consultations between Norway and EEC in 1986).

Results of the present assessment show that management in recent years has failed to achieve the objective of a buffer stock. Over the last three years (1986-1988), there has been no significant increase in spawning stock size, despite the recruitment of a series of good year classes. The growth of spawning stock size has been halted at a level around 800,000 t, which is supposedly the minimum level required to produce average recruitment (Anon., 1976).

The lack of success in building up a buffer stock is primarily due to overshooting of TACs in 1987 and 1988. Due to inadequate enforcement in some parts of the North Sea, the landings have exceeded the TAC by 26,000 t in 1987, and by 184,000 t in 1988.

A second cause for the lack of growth in the North Sea spawning stock is the removal of a large proportion of potential recruits by the fishery in Division IIIa. Juvenile North Sea autumn spawners are taken in Division IIIa both in the industrial fishery for mixed clupeoids, and in the directed consumption fishery. The total amount of juvenile North Sea herring taken by this fishery in Division IIIa in 1988 was estimated at 200,000 t Considering the effects of juvenile catches on potential yield and spawning stock biomass (Section 2.9.3), the high level of juvenile catches in Division IIIa is bound to have a depressing effect on North Sea spawning stock size.

Finally, the growth in the North Sea stock may also be reduced by high levels of discarding in recent years. Although no quantitative estimates of discards are available for most fisheries, incidental reports do suggest that the rate of discarding may be as high as 50% at certain times and in certain areas. With increasing quota and market restraints on the landings, fishermen tend to select the most valuable fish from their catches, and dump the rest. This practice is known to occur in the fisheries for spawning herring, and also in areas where mixtures of adult and juvenile herring occur. There is also a risk of slipping catches above trip quotas, especially in the purse seine fishery. It should be pointed out that some management bodies interpret TACs as total allowable landings instead of total allowable catches. This interpretation may eventually undermine the basis for the present TAC management system. If an increasing amount of the actual catch is discarded at sea, either the discards should be counted against the TAC, or the TAC should be reduced by the amount of fish that is expected to be discarded.

Advice for 1990

With the present relatively low stock size, there is hardly any buffer against a possible drop in recruitment in future years. If the stock is kept at the present level, a drastic cut in TAC will be required as soon as recruitment drops, in order to keep the stock above the minimum level of 800,000 t. In this respect it should be noted that the first indications for the 1988 year class are not very promising (Section 2.3.5). The advice for 1990 is, therefore, to try and build up a reasonable buffer stock while there is still good recruitment to the stock. This could be achieved by:

a) reduction of F to 0.30, which corresponds to a TAC of 403,000 t;

b) Introducing measures to reduce discarding, for instance by closing certain areas during certain seasons;

c) Changing the exploitation pattern by reducing the exploitation of 0- and 1-ringed autumn spawners in Division IIIa, and the exploitation of 1-ringed herring in the North Sea during the first half of the year. This could be achieved by a reduction of the mixed clupeoid TAC in Division IIIa, a better enforcement of quotas for consumption fisheries in Division IIIa, and a better enforcement of the 20 cm minimum landing size in the North Sea;

d) Strengthening enforcement in areas where overshooting of national quotas or misreporting of catches are likely to occur.

2.9.2 Special management measures for Divisions IVc and VIId

The component of North Sea herring spawning in Divisions IVc and VIId has shown very high mortality rates since the fishery was reopened in 1981, and there are no signs yet that this situation has improved. Despite reports of high abundance of herring on the spawning grounds in 1988, the larvae surveys in this area do not show a major increase in larval abundance in 1988. This indicates that the stock which was left to spawn after the fishery had taken its catch, had not significantly increased since 1987.

The Working Group, therefore, recommends that the herring stock spawning in this area should continue to receive special protection measures. Not more than 30,000 t of the total North Sea TAC should be allowed to be taken in Divisions IVc, VIId and this area TAC should be more rigidly enforced than in 1988. Since the fishery in this area has now partly changed into a roe fishery, special measures should be taken to minimise the amount of slipping and discarding.

2.9.3 Management of the juvenile fishery

2.9.3.1 Improving the exploitation pattern in the North Sea

The present exploitation pattern for herring in the North Sea is rather far from being optimal. Especially the large catch of 0- and 1-group herring is expected to reduce the potential yield from the stock. The following is an attempt to estimate the reduction in the total yield from the stock due to the juvenile fishery.

Unfortunately the juvenile fishery is not well defined with respect to a specific fleet and a specific fishing pattern. It is not possible at present to apply a certain array of fishing mortalities to this juvenile fishery. Therefore, the approach used here is of the kind that "if the 0-and 1-group catch is prevented, and herring are caught as 2-groups or older what would be the gain in the total yield from a given cohort".

This problem can for instance be handled by applying the standard yield per recruit program to different arrays of fishing mortalities: one with the present exploitation pattern, a second one with an exploitation pattern where the fishing mortality on 0-groups is set to zero, a third one where the fishing mortalities on 0- and 1-group are set to zero, a fourth one where the fishing mortality on 0-, 1-, and 2-groups equal zero etc. The relation between the outcome of these analyses can then be compared and the relative difference between the yield per recruit is a measure of the relative gain in yield by preventing the 0-group fishery, the 0- and 1-group fishery, the 0-, 1-, and 2-group fishery, etc.

Input data for this analysis are the exploitation pattern, natural mortality, maturity ogive, and weight in the catch as used in the yield per recruit calculations by Anon.(1988) (Table 2.10.3.1). The F level used is 0.33 for age 3 and older, because this is close to F_{max} for the first four exploitation pattern analyzed. For the rest of the exploitation patterns, no F_{max} could be found (F_{max} probably infinite).

The results are given in Table 2.9.3.2. The first two analyses indicate that a loss of a catch of 0-groups equal to .5641 g per recruit, by preventing the 0-group fishery, will increase the total yield by (12.8591-12.3871) = 0.4720 g. If both the 0- and 1-group fisheries are prevented the gain will be (13.4199-12.3871) = 1.0328 g. If both the 0-, 1-, and 2- groups are prevented from being caught the gain will be (13.9276+12.3871) =

1.5405 g. If both the 0-, 1-, 2-, and 3- groups are prevented from been caught the gain will be (14.0146-12.3871) = 1.6275 g per. If also the 4-group is prevented from being caught the total yield will decrease again.

The prevention of catches of juvenile herring will of course also have the effect of increasing the spawning stock biomass. The following table shows the relative increase in spawning stock biomass at spawning time for the various scenarios above compared to the present situation with a fishery on all ages:

Preventing catch of	Relative increase in spawning stock biomass
0-groups	9%
0- and 1-groups	22%
0-,1-, and 2-groups	55%
0-,1-,2-, and 3- groups	100%

In other words, there seems to be possibilities for improving the exploitation pattern for herring in the North Sea and not only the total yield would benefit from such an improved exploitation pattern (and level) but also total spawning stock biomass will increase which will make it more easy to meet the management option of a spawning stock size of 1.5 million t.

2.9.3.2 The juvenile fishery in Division IIIa

In the above analysis, no account was taken of the catch in Division IIIa of juvenile herring belonging to the North Sea herring stock. The following is an attempt to assess the impact this catch has on the total yield from the North Sea stock.

The juvenile fishery of herring in Division IIIa can be divided into several types of fishery or groups of vessels. A certain fraction of the catch is taken by small vessels less than 25 m in length. These vessels have licenses to catch herring/sprat amounting to 80,000 t per year with small-meshed trawls. The main part of these catches are herring. Another fraction of the juvenile herring catch is taken by both large and small vessels as a by-catch in the herring fishery for human consumption (the juvenile herring are used for fish meal and oil). The last fraction is caught by large vessels which instead of catching herring for consumption direct their fishery towards both small and large herring for reduction. At present, this is profitable because the price on consumption herring is low and the price on industrial herring relatively high.

The fishery of the first and the last group of vessels described above can be prevented by new regulations and a stronger enforcement of the present ones. The catch of the second group of vessels cannot be prevented because the juvenile herring in this fishery are an unavoidable by-catch. However, because data on their catch are not available this catch cannot be treated separately in the present analysis.

The catch in 1988 of North Sea herring in Division IIIa is given in Table 3.2.4 by age and quarter of the year. If it is assumed that the catch of 0- and 1-groups in Division IIIa is prevented, the purpose of this analysis is to estimate the gain in the North Sea catches. The catches of 2-groups and older North Sea herring in Division IIIa are ignored, because they are rather small. The gain in this catch if the 0- and 1-group fishery is prevented is also ignored. It is further assumed that the North Sea herring from Division IIIa returns to the North Sea in a "knife-edge" way at 1 January when they become 2- groups. The same input parameters are used as in 2.9.3.1 for 2-groups and older in the North Sea except that the actual fishing mortalities from 1987 are used instead of the ones corresponding to F_{max}. The natural mortalities are taken from the MSVPA key run (Anon., 1988) and mean quarterly values over 1980-1985 are applied. These are:

Quarter	Age	Natural mortality
3	0	0.2106
4	0	0.3759
1	1	0.3414
2	1	0.1217
3	1	0.4657
4	1	0.0932
1-4	2	0.4553
1-4	3	0.3055
1-4	4	0.1676
1-4	5	0.1263
1-4	6	0.1963
1-4	7-9	0.1000

The additional yield in the North Sea if the 0- and 1-group catch is prevented in Division IIIa is calculated to be 36,000 t from the survival of the 0-groups and 285,000 t from the survival of the 1-groups. In this estimation it is assumed that all the 0-and 1-groups in Division IIIa are North Sea herring except the 1-groups in Kattegat in the third and fourth quarters, which are assumed to be spring spawners. If the lost catch of 0- and 1-groups in Division IIIa is subtracted from this we get a net gain from the stock of 137,000 t. The lost catch of sprat and other by-catch species in Division IIIa which is unavoidable if the catch of 0- and 1-groups are prevented, should of course be subtracted from this net gain. Data on this by-catch are not available to the present Working Group but are expected to be about 20%. If this fraction is subtracted the net gain will be reduced to 100,000 t. The lost catch of 2-groups and older herring also taken in this fishery can probably be ignored because they will migrate to the North Sea and some of them will be caught there.

The results are very sensitive to the assumption about natural mortality. If for instance the natural mortalities for 2-groups and older are taken as those used in the North Sea herring VPA in the present report, the gain will be 174,000 t. If the residual mortality for herring in the MSVPA is set to 0.2 like for the rest of the species in the MSVPA, the gain will only be 19,000 t.

2.9.3.3 Conversion factors for the effect of juvenile fishery

The following is an estimation of conversion factors which can be used if the effect of a catch of a certain amount of 0- and 1-group herring in a certain quarter should be estimated. The conversion factors are given in the form that "if the catch of 1 million of say 1-groups in the third quarter of the year are prevented in Division IIIa or the North Sea, to what extent will this increase the total yield from the North Sea herring stock".

In Division IIIa, the mean weights for 1988 from Table 3.2.4 are used and for the North Sea area data from Divisions IVa,b, 1988 from Table 2.6.2 are used. Natural mortalities from the text table in Section 2.9.3.2 are used, and the other parameters are taken from Table 2.9.3.1.

It is assumed that a prevention of a certain catch of juveniles will mean that these survivors will not be caught before they are 2-groups.

DIVISION IIIa

Quarter	Age	Reduced catch of juveniles in numbers	W in g	Reduced catch of juveniles in t	Gain of 2+-groups in t	Net gain
3	0	1 000 000	10	10	17.7	7.7
4	0	"	19	19	23.7	4.7
1	1	"	16	16	33.9	17.9
2	1	"	20	20	42.7	22.7
3	1	"	36	36	57.3	21.3
4	1	"	54	54	75.8	21.8

NORTH SEA

Quarter	Age	Reduced Catch of juveniles in numbers	W in g	Reduced catch of juveniles in t	Gain of 2+-groups in t	Net gain
3	0	1 000 000	11	11	17.7	6.7
4	0	"	12	12	23.7	11.7
1	1	"	14	14	33.9	19.9
2	1	"	45	45	42.7	-2.3
3	1	"	58	58	57.3	-0.7
4	1	"	69	69	75.8	6.8

The relative gain in yield is highest for the 0-groups, and for the 1-groups in the first quarter of the year, and in Division IIIa also in the second quarter. It is apparently profitable to catch 1-groups in the second and third quarter of the year in the North Sea. The gain is, however, very small and probably due to variation in the parameters, but at least the gain seems to level off from the second quarter for 1-group in the North Sea. This seems contradictary to the results obtained in Section 2.9.3.1, but is due to the different natural mortalities used. In that section, natural mortalities were taken from the North Sea herring VPA from the present report, but as these are not given on a quarterly basis, they cannot be used in this section.

The difference in gain between the Division IIIa and the North Sea for 1-groups in the second and fourth quarter of the year can be explained by the difference in mean weights used for these 1-groups. In Division IIIa, the mean weights are less than in the North Sea for 1-groups in these quarters. As the mean weights used for Division IIIa are very uncertain (see Section 3.2.2), the estimates of the net gain are equally uncertain.

Another problem relates to the natural mortalities used in Division IIIa. No MSVPA exists for this area and, therefore, the natural mortalities from the North Sea MSVPA have been applied to Division IIIa as well. Whether this is correct is very uncertain, but investigations made along the Danish North Sea coast and in Skagerrak and Kattegat in August 1986 and 1987 indicate that juvenile herring are subject to heavy predation by mackerel, scad, and whiting in this area. Whether this is also true in other parts of the year is unknown. As the 1-group herring in Division IIIa seems to be smaller than in the North Sea, this could indicate a higher natural mortality on this group than in the North Sea, because, generally, in marine ecosystems the predation mortality seems to increase with decrease in prey size.

As mentioned above several times, the results presented here are very uncertain and should be considered with caution. However, it can probably be concluded from these analyses that the juvenile fishery reduces the potential yield from the North Sea herring stock and if the management objective is to get the maximum yield in terms of weight the juvenile fishery should be reduced as much as possible. Whether a 1-group fishery in the North Sea in the second half of the year is harmful in this respect is questionable. A reduced juvenile fishery will also result in a faster building up of the spawning stock biomass.

In this context it should be mentioned that a complete prevention of the juvenile catch is not possible from a practical point of view. It is unavoidable to get some small herring as a *by*-catch in the fishery for consumption herring as well as in the industrial fishery for sprat, sandeel, and Norway pout.

2.10 Requests from the Multispecies Working Group

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

In response to a request from the Multispecies Working Group (1.2 Terms of Reference, Item c, HAWG, 1989) for provision of quarterly catch-at-age data, together with weight at age in the catch and in the stock at spawning time for North Sea herring in 1988, these data are provided in Table 2.10.1. The only mean weight at age data available for the stock at spawning time were those provided by samples taken during the July acoustic surveys, which covered Divisions IVa and IVb, and these mean weights at age are shown in the last line of Table 2.10.1.

Catches of spring spawners transferred to Division IIIa are given in Table 3.1.1.

2.10.2 Geographical distribution of the catches in the North Sea in 1988

Data on geographical distribution of catches in the North Sea in 1988 were availabe from Denmark, the Netherlands, Norway, the UK (England), and the UK (Scotland). The data represent about 70% of the total catch of herring in 1988.

Figures 2.10.1 - 2.10.12 show the catch of the four countries by ICES rectangles for each month in 1988 and include both juvenile and adult catches. The cummulative catch by month is shown in Figure 2.7.1.

3 DIVISION IIIA HERRING

3.1 Stock Composition

3.1.1 Baltic and Division IIIa spring spawners in the North Sea

It was shown in the 1987 and 1988 reports that spring-spawning herring migrate from Division III into the eastern part of the North Sea in Division IVa E and IVb where they dominate the catches of 3-group and older and constitute a part of the 2-group catches in the second and third quarters. These catches of spring-spawning herring should from an assessment point of view be included in Sub-area III, and counted on the TAC set for this stock. Based on vertebral counts in both commercial and research vessel samples, transfer areas and time periods were defined and total catches of 19,654 t and 14,207 t were transferred in 1986 and 1987, respectively.

Figure 3.1.1 shows mean vertebral counts of age groups 1-, 2-, and 3+ in research vessel and commercial samples in May-September 1988. In these samples, all 0- and 1-group herring are autumn spawners and the majority of 3+ group and older are spring spawners. The 2-group herring appear to be a mixture of both autumn spawners and spring spawners. A modal length analysis of the 2-group sampled during the acoustic survey in the beginning of August estimated that the spring spawners made up 30% of this age group in Division IVa E up to 59^{0}N.

A detailed analysis of the distributiion of acoustic biomass in July-August indicates decreasing or very low abundance of herring west of 3^{0}E. No catches have been reported in July-August north of 60^{0}N which indicates that the distribution of spring spawners could be limited by the latitude 60^{0}N. The southern limit of the distribution area is based on the acoustic surveys and only one commercial sample in Division IVb. The distribution area of the spring spawners seems to be restricted to the slope of the Norwegian Deep in the northern part of Division IVb.

On this basis, the Working Group decided to transfer all 3-group and older herring and 30% of 2-group herring caught in the period May-September in the area indicated in Figure 3.1.1 to the Sub-area III stock.

The transferred spring spawning herring, in total 23,306 t, and number at age with mean weights at age from acoustic survey are given in Table 3.1.1.

3.1.2 Stock composition in Division IIIa

Vertebral counts of 0- and 1-group herring in all quarters and over the total area showed that the catch was totally dominated by North Sea autumn spawners. The good year class 1986 was shown in the IYFS 1988 to be very abundant in Division IIIa. This year class has been dominating in the catches all through the year even in the Kattegat in contrast to previous years when the proportion of 1-group spring spawners normally increases in the third and fourth quarters.

In the case of the 2-group herring, vertebral counts indicate a mixture of autumn spawners and spring spawners in the catches. Aggregated length frequencies were only available from the Swedish catches. The results of a modal length analysis, verified by mean vertebral counts, were applied to the total catch.

The result of the analysis of the 2-group herring are summarized below:

Quarter	Mean VS	Proportion	
		NS	SSP
1	55.88		0.43
	56.23	0.57	
2	55.89		0.98
	56.31	0.02	
3	55.90		1.0
4	55.92		1.0

NS = North Sea autumn spawners.
SSP = Division IIIa spring spawners.

The separation gave components that could be assigned to either stock based on the criteria that spring spawners should have mean vs of 56.00 or less and autumn spawners 56.20 or more. The proportions found in the first quarter are supported by the estimated proportions in IYFS 1988.

The vertebral counts of 3-groups and older in all samples confirm that these age groups in the catches are only spring spawners from Division IIIa stocks. This is in good agreement with the situation in previous years.

3.2 The Fishery

3.2.1 Landings

Landings from Division IIIa by countries are shown in Table 3.2.1. Preliminary data provided by Working Group members indicate a total catch in 1988 of 333,000 t being the highest figure on record apart from the large Bohuslän period in the previous century. From the 1987 landings of about 234,000 t, the 1988 figure represents an increase of 42%. While landings in the Skagerrak and the Kattegat both increased by 50,000 t, the relative increase in the Kattegat was about twice the increase in the Skagerrak being 68% and 32%, respectively.

A major part of the landings was used for industrial purposes in three different categories:

i) Directly from the TAC on small mixed clupeids;

ii) As by-catch from the human consumption fishery or as herring refused for that purpose;

iii) As by-catch in other industrial landings of, e.g., blue whiting and Norway pout.

There are no sufficient data to divide the industrial landings into the three categories above. In case of the Danish fishery the structure was the following:

The special small mixed clupoids TAC was only allowed to be used by vessels <22 metres. The fishery was carried out with 32 mm meshes except for November-December, when 16 mm could be legally used. Total landings from this fishery and from by-catch in other industrial landings by small vessels amounted to about 97,300 t of herring. The remaining 123,000 t of the Danish Division IIIa herring catch were caught by vessels >22 metre either in a herring fishery for consumption using 32 mm meshes or as by-catch in a fishery directed at other species than herring.

The Swedish catches could not be separated into the same categories, but the major part was taken in a 32 mm fishery directed at herring.

3.2.2 Catch in numbers at age

Sampling of the Division IIIa herring catches was carried out by Denmark concerning the landings of small clupeoids by vessels less than 22 metres, while Sweden covered landings made by the larger vessels fishing for consumption herring. The small clupeoid fishery was adequately covered by sampling as were the Swedish landings of herring used for consumption. Less adequate was the sampling of the trash herring from the consumption fishery which constitutes the major part of the total herring catch in Division IIIa. This was especially the case in the first two quarters when about 57,000 of trash herring from the consumption fishery had to be transferred into numbers on the basis of a few hundred specimens. It was consequently decided to apply average weights for 1-groups taken in the period 1984-1986.

The results obtained in this way are shown in Table 3.2.2. It includes all herring caught in Division IIIa, i.e., also young herring of North Sea origin but not the spring spawners caught in the adjacent parts of the North Sea.

In Table 3.2.3, the estimated catches in numbers at age are presented for the component assumed to be spring-spawning herring caught in the North Sea and in Division IIIa. These figures, together with data on the herring landings from the western Baltic, will form the basis for the assessment carried out in the Baltic Pelagic Working Group. Table 3.2.4 shows the number of North Sea autumn spawners caught in Division IIIa.

3.2.3 Advice and management applicable to 1988

In 1988, an agreed TAC for the mixed sprat/juvenile herring fishery was set at 80,000 t, while the TAC for herring was set at 138,000 t as in 1987. Assuming that all 80,000 t of mixed clupeoids taken are herring, the total agreed TAC for Division IIIa in 1988 was 218,000 t. The preliminary estimate of the total herring landings from Division IIIa in 1988 of 333,000 t thus represents an excess of 53% over the agreed TAC.

As stated in Section 3.2.1, the catch of 97,000 t by vessels below 22 metres represents all herring caught in the mixed clupeoid fishery plus some by-catch from other fisheries in which these smaller vessels have been engaged. The maximum excess over the TAC in this fishery is thus about 20% which means, that the major violation of the agreed catch limits in 1988 took place in the fishery for human consumption and may amount to about 70%.

3.3 Acoustic Surveys

3.3.1 Eastern North Sea and Division IIIa

An acoustic survey of the Northern and Central parts of the North Sea and Division IIIa was carried out during the period 24 June - 19 August by vessels from four countries. Details and the total result of the survey are given in the report of the Planning Group for Acoustic Surveys in Sub-area IV and Division IIIa (Anon., 1989).

On the basis of a modal length analysis and vertebral counts, the component of Division IIIa spring spawners was separated from the North Sea autumn spawners in the surveyed area. The resulting estimates of Division IIIa stock in 1988 and in 1987 are shown in Table 3.3.1. The estimate stock was 2,450 million herring or about 218,000 t. All 0- and 1-group herring in Division IIIa were autumn spawners from the North Sea stock and these age groups were estimated to be 3,700 million and 6,600 million, respectively. The total biomass of 0- and 1-group was 251,000 t.

3.3.2 Eastern part of the central North Sea and Division IIIa

A Norwegian vessel surveyed Division IIIa and Division IVb E in November-December 1988 as in previous years. The estimates are dominated by 0- and 1-group North Sea autumn spawners and the result is given in Section 2.4.2.

3.4 Recruitment

3.4.1 General remarks on the 1989 IYFS

The 1989 IYFS was carried out in February and a total of 44 hauls were made. In 1989, almost all standard stations could be worked and in addition some new stations were sampled in previously unsampled areas of the Western Kattegat.

3.4.2 Abundance of 1-group herring

Very large catches in a number of hauls were obtained in the southern part of Kattegat as in previous years. The total index in 1989 was 17,451 which is still very high but only 26% of the 1988 index. Indices from IYFS 1980-1989 are given in Table 3.4.1. In 1988, the vertebral counts indicate that all 1-group herring could be assigned to be North Sea autumn spawners. The vertebral counts of the aggregated 1-group herring per depth stratum in 1989 indicate that spring spawners and autumn spawners were mixed, at least in stratum 1 and 4, as shown in the text table below:

Stratum (m)	Mean length (cm)	Mean VS
1. 10-34	14.3	56.15
2. 35-44	16.0	56.30
3. 45-65	16.3	56.34
4. 66-150	14.9	56.20

A modal length analysis was applied but the resulting components could not be verified by vertebral counts.

3.4.3 Abundance of 2-group herring

The 2-group index of herring in 1989 was 4,976 (Table 3.4.1). The index is the second highest since 1980 but only about 50% of the 1988 index.

The total index is normally a mixture of spring spawners and autumn spawners from the North Sea, with the largest contribution of the spring spawners.

In 1989, the vertebral counts indicate that all the 2-group herring are autumn spawners as shown in the text table below:

Stratum (m)	Mean length (cm)	Mean VS
1. 10-34	20.0	56.36
2. 35-44	20.4	56.41
3. 45-65	20.9	56.37
4. 66-150	21.0	56.38

The dominance of autumn spawners in IYFS 1989 is supported by an equal dominance as 1-group in the commercial catches in the fourth quarter in 1988 (see Section 3.1.2). The index series shows an increasing abundance of 2-group herring in the area and that North Sea herring have prolonged the time period spent in Division IIIa in recent years.

3.5 State of Stock and Management Considerations

3.5.1 General remarks

The assessment of the combined Division IIIa and Southwestern Baltic herring stock has, since 1985, been the task of the Working Group on Pelagic Stocks in the Baltic. The results of the 1989 assessment, management considerations, predictions, and state of the stock will be given by that working group.

3.5.2 Management of juvenile fisheries

The juvenile fisheries in Division IIIa are known to exploit mainly autumn spawners from the North Sea stock, and management of this problems 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, those areas have been combined since 1982. The area for which the assessment is now made together with the area for which the TAC is set by the EC are shown in Figure 4.1.1. It should be noted that, although the management unit covers all of Divisions VIIg,h,j and k and the southern part of Division VIIa, all of the catches in recent years have come from the southern part of Division VIIa and from Divisions VIIg,j.

4.2 The Fishery in 1988-1989

4.2.1 Catch data

The reported catches from the combined areas by year and by season (1 April - 31 March) are given in Tables 4.2.1 and 4.2.2, respectively. The reported catch taken during the 1988-1989 season was 17,000 t, compared with 22,200 t taken during 1987-1988. The reported catch does not include what are believed to be substantial quantities of fish which were caught but later "slipped" and discarded at sea - either because fish were considered unsuitable for the Japanese "roe" market or because the boat catch had exceeded the vessel's weekly quota.

All the catch taken from the fishery in 1988/1989 is reported to have been taken by Irish boats which have been fishing the spawning concentrations along the Irish coast during the October to February period. No catches during 1988/1989 were placed in the "unallocated" category. Again, as in recent years, the fishery was almost totally dependent on the Japanese roe market.

It was found necessary to revise the provisional catch data reported for 1986 and for the 1986/1987 season. This revision had the effect of increasing the total catch by over 6,000 t (i.e., over 28%) and, as a result, the "unallocated" catches rose dramatically.

It should be pointed out by the Working Group that considerable doubts must be expressed about the total reported landings and the actual catches taken from this area. The total landings may have been under-reported prior to 1988. It was felt, however, that increased surveillance and tighter management during 1988/89 has improved the accuracy of the most recent reported landings but that the figures reported for 1986 and 1987 must be treated with caution. There is, in addition, no information available about the quantities of herring which have been caught but discarded at sea. Although previous working groups and ACFM at its 1988 meeting have requested additional information about the rate of discarding, no data has been made available.

4.2.2 Advice and management applicable to 1988 and 1989

The preliminary catch figure for the 1988/1989 season was about 17,000 t and for the year 1988 16,800 t.

The TAC recommended by ACFM in 1987 for this area for 1988 was 13,000 t.However, the basis for this advice was reviewed by the 1988 Working Group, and STCF subsequently recommended that the 1988 catch should not exceed 18,000 t. This figure was subsequently adopted by the EC. This level was based on the long-term biologically advised catch level of 15,000 - 20,000 t per annum.

Apart from restriction on the total catch, the fishery in 1988/ 1989 was also regulated by way of seasonal and area closures. The Irish fishery was completely closed from 1 April to 12 October. In addition, the system whereby selected spawning grounds are closed on a rotating basis was initiated in October 1988. This EC measure was introduced in an effort to allow a certain proportion of the total stock to spawn each year without being subjected to fishing activity during spawning. A further closure of the main winter spawning grounds in the eastern Celtic Sea was introduced by Ireland in January 1989. This closure, which lasted for the remainder of the season, was introduced to prevent the discarding of large amounts of small unmarketable herring which were present in the catches from that area. Although trial fishing was carried out on a number of occasions, the area was not re-opened.

The total quota was divided into weekly quotas and further divided into boat quotas per week. All boats participating in the fishery were required to carry licenses. During the January/February period, about 75 boats actively participated in the fishery compared with about 55 during the previous two seasons.

The TAC set for 1989 is 20,000 t which is the figure recommended by ACFM. The total catch taken during the January-March period 1989 was about 7,200 t. The Irish fishery which will not re-open until October 1989 will be managed along the same lines as in 1988. The spawning grounds in the second of the selected areas will be closed during the period 1-16 November. ACFM have also advised that the management of the fishery should be improved and efforts be made to collect information on discards.

4.2.3 Catches in numbers at age

The total catches in numbers at age are shown in Table 4.2.3. These catches do not include any herring which have been slipped or discarded. No changes have been made to the catches taken during the 1987/1988 season, but the 1986/1987 data have been altered to include the additional catches now reported for that year.

The catches during 1988/1989 were dominated by the incoming 1985-1986 year class. This year class constituted over 60% of the total landings and was consistently distributed throughout the fishery in all areas.

4.3 Mean Weights at Age

In this fishery, most of the catch in recent years has been taken during the spawning season. The mean weights at age of the spawning stock are, therefore, considered to be the same as the mean weights at age in the catch.

The mean weights (g) for the recent seasons which are shown in the text table below do not appear to show any consistent changes in recent years.

	Winter rings								
Season	1	2	3	4	5	6	7	8	>8
1986/1987	119	155	172	187	215	248	236	284	332
1987/1988	96	138	186	192	204	231	255	267	283
1988/1989	97	132	168	203	209	215	237	257	283

4.4 Stock Assessment

The total landings taken from this area during 1988 were slightly less than the recommended level. The total reported landings have not, however, included discards and so the TAC, as it was in 1987/1988, may have been exceeded. It could be suggested that this might indicate that the fleet had experienced some difficulty in landing the permitted amount and that this, therefore, may have indicated a decline in stock size. However, in the absence of any data to indicate the actual stock size it is not possible to draw any firm conclusions. Alternatively, the decrease may in fact have been caused by a reduction in effort, either because of the decline in fishing effort by foreign fleets and/or because of the restricted fishing by the Irish fleet on the spawning grounds. It is considered, however, more likely to have been a consequence of the management strategy adopted for the fishery in which the quota is divided over the season on a weekly basis according to market requirements.

Since the larval surveys in this area were discontinued in 1985 there has been no fishery-independent method of monitoring changes in stock abundance. No assessment on this stock has, therefore, been carried out since that by ACFM in 1987. The Working Group considered the possibility of carrying out a VPA but it was concluded that the results from such an assessment would not give any accurate estimate of the present stock size. There is no method of determining a value of F for the most recent seasons and there are grave doubts about the actual catches and data prior to 1987, mainly as a result of the unquantifiable amounts of discards. It is not possible to meaure changes in effort because of the effects of the closures on the spawning grounds in recent years and because of the boat quotas imposed on the fleet.

It must, therefore, again be pointed out, as it has been by each working group since 1986, that it will not be possible to do any stock assessments or consequently to provide realistic management advice for this area until information about the stock size is obtained.

The Working Group is, however, concerned about the age composition of the catch in number table shown in Table 4.2.3. This shows a scarcity of fish older than 3 winter rings in 1988/89 and a rapid disappearance of very strong year classes which recruited to the fishery during 1982 to 1984. The percentage age compositions are shown in Table 4.4.1 for the period 1977 - 1988/89. As is always the case with percentage age compositions, it is difficult to decide whether the absence of old fish is due to high fishing intensity or due to a strong recruiting year class. However, in an effort to detect any changes in Z in recent years a series of catch curves were constructed based on these age compositions. The data were grouped into four periods and value of Z estimated. The results were as follows:

Period	Average Landings	Values of Z
1977-1979	8,600	.58
1980-1982	14,400	.62
1983-1985	20,300	.81
1986-1988	20,000	.98

Similar catch curves have been constructed for this fishery by the 1981 and 1986 working group for data extending back to 1958. The results, given below, all show high values of F even for periods when the fishery was considered to be relatively lightly exploited. While the results from catch curve analysis may not always be accepted as true values of Z the trend of increasing values from the above data should be noted as an indication of an increasing fishing intensity and a possible decrease in stock size.

Period	Average Landings	Values of Z
1958-1964	17,600	.31
1965-1969	29,800	.44
1970-1973	32,000	.54
1974-1981	12,700	.56
1982-1986	18,900	1.04

4.5 Stock Projection

For reasons outlined in the previous section and because of the absence of any information on recruitment, no projection for this stock was carried out. This situation will remain for a number of years until reliable stock estimates are available.

4.6 Management Considerations

4.6.1 Management considerations about closures of spawning areas

In recent years, the fishery in this area has become highly dependent on the Japanese roe market and as such can be considered as a "roe fishery". The management of this type of fishery on spawning grounds is discussed in Section 1.5. Because of this the fishery required specific management strategies. This in itself, however, presents a conflict between two objectives:

1) The desire to afford a degree of protection to herring shoals during the process of spawning.

2) The need to conduct the fishery at a time when the financial returns to the industry are at a maximum i.e. when the shoals are just about to spawn.

In consideration of the first point the 1987 Working Group suggested that, because of the inadequate data about the stock size and because of concern about the possibility of high mortality rates being generated by intensive fisheries during the spawning season, fishing should be prohibited on one of the main spawning grounds each season. This suggestion was endorsed by both ACFM and STCF in 1988 and regulatory measures along these lines were introduced during the 1988/1989 season. ACFM had, however, some reservations about the results of these measures and their possible effect on the overall fishing intensity. The Working Group was, therefore, asked to evaluate the impact of the rotating seasonal closures of spawning areas for the Celtic Sea and Division VIIj herring stock. A working document on the background to these measures and their application during the 1988/1989 season was available (Molloy, 1989). A brief summary of the discussion was as follows:

The overall aim of the rotating spawning area closures was to give some protection to a proportion of the total spawning stock so that it could spawn without being subjected to fishing during this process. It was felt that herring shoals are particularly vulnerable during spawning and high fishing mortality rates can be quickly generated. This may be particularly so in this fishery which is dependent on the Japanese roe market and in which unsuitable catches are discarded at sea. It was suggested that the duration of the closures may not be sufficiently long to have any protective value because a shift in the peak of spawning activity may in fact render the closure largely ineffective. It is important, therefore, to establish if in fact spawning takes place during the closed period. A detailed examination of maturity data over a number of years should help to estimate more accurately the appropriate time for closing an area. This analysis which should be carried out in time for the 1990 meeting of the working group will help to determine whether the areas are, in fact, closed at the correct time.

There was some evidence to suggest that, as anticipated by ACFM, some diversion of effort to adjacent spawning grounds did in fact take place. Some large catches were taken from the area east of the closed area in Division VIIj during October. This could, therefore, mean that the overall F, while remaining unchanged, may have been spread over two areas instead of three. However, the fact that the weekly catches are restricted to market requirements of about 1,000 t may prevent this diversion. It was expected that the timing of the closures in each area should have eliminated this problem but the fact that it may have occured would suggest that the timing may not have been correct. Finally, it was concluded that it was not possible to evaluate in a quantitative measure the effects of this measure in its first year of operation. However, it is apparent that more detailed information about e.g., weekly catches and their origin, together with the relevant biological material should be made available if any sort of evaluation be possible.

It is also essential that trial fishing should be carried out during the closed season in the appropriate area to investigate the occurence and extent of spawning and to obtain biological samples. The occurence of spawning could be verified either from larval surveys or from an egg-bed survey.

It was considered that because of the degree of uncertainty about the size of the adult stock and the consequent need to ensure a certain amount of protection that these spawning closures should be retained. However, they should again be reviewed in 1990 in the light of the suggestions above and the results of the 1989/1990 closure. It was also suggested that the spawning area scheduled for closure in November 1989 should be extended so that the eastern boundary is 7^0 30'W rather than 8^0W as recommended. The area will, therefore, include some additional spawning areas and will prevent misreporting of catches. It is also important that landings at any port in a closed area should be prohibited during the closed season.

In addition to the closed area introduced by the EC in 1988, an additional spawning area was closed by Ireland during January-March 1989. The area closed was that section of the Celtic Sea which lies east of $7^0$30'W and which contains important spawning beds usually frequented by winter spawning fish. This closure was introduced because of the presence in the catches of large amounts of small 2-winter-ring fish with a low roe yield. These fish were not marketable and considerable amounts were being discarded. The measure, therefore, was taken to prevent the discarding and dumping of these fish at sea. It seems apparent that this type of closure will be introduced more readily in this fishery in the future. Consideration should, therefore, be given to establishing some guidelines along those regarding the quality of herring which should be available before a fishery is opened. These guidelines could be based on length distributions or roe yields or a combination of both.

In the light of the above discussion the Working Group would suggest that:

1) This system of rotational closures of spawning grounds should be retained for the next two seasons.

2) The efectiveness of the system should be re-examined by the Working Group in the light of results of the 1989/1990 closure.

3) To enable this re-examination to be made, a comprehensive series of a) maturity data to select the appropriate time of closure and b) catch data to study possible diversion of effort should be made available.

4) Consideration be given to extending the length of the closed season.

5) Trial fishing and spawning surveys during the closed season should be carried out to determine the extent of spawning.

6) The eastern boundary of the closed area for 1989 should be changed to $7^{0}30'$W.

7) No ports in a closed area should be "open" for herring landing during a closed season.

In addition, the Working Group welcomed the additional measures that have been taken by Ireland in recent years to prevent discarding. It is suggested that:

1) Trial fishing should continue to be carried out each season before the fishery is opened.

2) Consideration should be given to establishing some standards whether based on length and/or roe yield on which to base the opening or closure of a fishery.

4.6.2 Catch levels and TAC advice

Recent working groups have pointed out the difficulties in providing management advice for a stock when its size is not known with any degree of certainty. Because of this, ACFM and STCF have suggested that, in the absence of any estimates of stock size, the fishery should be managed in such a way that catches should not exceed 15,000-20,000 t per annum. This catch level was based on historical yield/biomass ratios and estimates of maximum sustainable yields. The catch level 15,000-20,000 t assumes that the stock is about 100,000 t and that recruitment has remained at an average level. Obviously the further one gets from the last estimate of stock size, the greater the degree of uncertainty becomes about the present level. Even though the reported catches in recent years (1985-1988) have averaged about <u>19,000 t</u>, there is no estimate of the amount of herring caught but discarded. If this has been considerable, the stock size may have decreased without being noticed. In addition, there has been no method of determining the level of recruitment. It should be noted that it was a rapid decrease in recruitment, which was not detected, that accelerated the collapse of this stock in the early 1970s.

4.7 Management Advice

In the absence of any stock assessment, the advice that has been given in recent years for this stock is based on a long-term yield/biomass ratio in which the spawning stock was at a historical level about 100,000 t. This suggested that the annual catches - <u>including discards</u> - should not exceed the range 15,000-20,000 t. The analysis of the present age composition indicates an increasing fishing intensity, and the most recent values of F may well be above the desired level. If this is the case, the catches in the immediate future should be set at the lower end of the range suggested by the yield/biomass ratio, i.e., 15,000 t. A reduction of the catches - including discards -

to this level would hopefully bring about a gradual improvement in the age composition of the stock, an increase in roe yield, and a resulting increase in TAC.

4.8 Management Requirements

It has been pointed out in recent working groups and by ACFM that it will not be possible to make any assessments of this stock until fishery-independent surveys are carried out. It is important, therefore, that larval and acoustic surveys should be initiated immediately. A resumption of surveys would enable any increase in stock size to be detected at an early date.

5 WEST OF SCOTLAND HERRING

5.1 Division VIa (North)

5.1.1 ACFM advice applicable to 1988 and 1989

The agreed TAC for 1988 was 49,800 t. The ACFM advice for this stock has been to stabilize stock size at its present level. The projection from the 1988 assessment indicated that this could be achieved by fishing at or around $F_{0.1}$, corresponding to a catch in 1989 of 58,000 t. This has been adopted as the agreed TAC for 1989.

5.1.2 The fishery

The catches reported for each country are given in Table 5.1.1. The preliminary total catch for 1988 is 47,354 t, compared with 63,007 t in 1987 and 81,699 t in 1986. The reductions in the catches are accounted for by the reductions in unallocated catches from 37,840 t in 1986 to 5,224 t in 1988, reflecting much stricter enforcement of the TAC regulations.

5.1.3 Catch in numbers at age

The estimated catch in numbers at age for the years 1970-1988 are given in Table 5.1.2. For 1988, age composition data were available from Scotland, Norway and the Netherlands. Unallocated catches and landings by France, UK (England and Wales), the Federal Republic of Germany, and Ireland were converted to numbers at age using the Norwegian and Dutch catch-at-age data, the Scottish data being excluded because of the fishing activity in the Minch. Catches of 1-ringers in the Moray Firth have previously been included, but since 1985 these have been negligible.

5.1.4 Larval surveys

Both the larval abundance indices (LAI) and larval production estimates (LPE) were available to the Working Group (Table 5.1.3). The calculation of these indices are described in Anon., 1987.

The LAI values for 1988 and 1987 are the highest and second highest on record. The LPE index for 1988 is second only to the

1986 value, which was extremely high due to an anomalously low mortality figure in 1986 (Table 5.1.3). Both indices, therefore, indicate an increase in stock size in 1988. It should be noted, however, that the calculation of LPE values for Division VIa (North) is problematic due to larval transport to the Orkney/ Shetland area (see Section 2.5).

5.1.5 Acoustic survey

An acoustic survey of Division VIa (North) was carried out by R/V "Scotia" during December 1988, repeating similar surveys in November 1983, 1985, 1986, and 1987 (Hopkins, Working Document).

The survey coverage in 1988 was severely curtailed by bad weather, and over much of the area that was covered the performance of the integrator was suspect due to aeration of the water below the transducer. The survey estimate cannot, therefore, be considered to be a good one and is likely to be an underestimate of stock size. Biological sampling was also limited by the weather conditions, so that the age composition data are also suspect.

The survey estimate of spawning stock biomass (2-ringers and older) was 326,000 t. Previously the survey has also been used to estimate 1-ring recruitment, but no 1-ring fish were found during the 1988 survey.

5.1.6 Recruitment

An index of recruitment was calculated from the Scottish bottom trawl survey carried out in March 1989. As in previous years, this was calculated as the mean of the catch rates of 2-ringers per hour in each of two sub-areas, namely the northern coast of Scotland (statistical rectangles 46E4-E6, 47E4-E6) and the Minch (statistical rectangles 44E3-E4, 45E3-E4). For the 1989 survey, age composition was estimated using length data from the North Sea IYFS and so the index value is preliminary.

The series of indices and the numbers of hauls used in their calculation are shown in Table 5.1.4. The indices are highly variable and in previous years have been used as qualitative supporting evidence of recruitment strength estimated from the acoustic survey, but for 1989 they provide the only estimate of recruitment. The index suggest an intermediate recruitment in 1989 and for the purposes of projecting catches and stock sizes in 1990 and 1991, the likely level of recruitment of 2-ringers in 1989 and 1990 was assumed to be the geometric mean of the number of 2-ringers from the VPA over the years 1973-1986 (555 million).

5.1.7 Mean weight at age

Weight-at-age data from the 1988 fishery were available from Scotland, the Netherlands and Norway, and are shown in Table 5.1.5. The SOP for 1988 is 2.4% more than the reported catch. The mean weights at age in the stock are as used in previous years (Table 5.1.5).

5.1.8 Spawning stock biomass and fishing mortality in 1988

Last year's assessment was based on the SSB estimate from the 1987 acoustic survey, having rejected the use of the series of larval abundance indices on the grounds that their values were well outside the previously observed range. The LAI for 1988 is even further beyond the previously observed range (Table 5.1.3) so that tuning the assessment using this index would involve an unacceptable degree of extrapolation beyond data used for the regression with converged SSB estimates from the VPA (Figure 5.1.1). The LPE estimates are better in this respect (Table 5.1.3) but show a much poorer relationship with the VPA values of SSB (Figure 5.1.2).

The 1988 acoustic survey estimate of SSB is not considered reliable (see Section 5.1.5) and cannot, therefore, be used to estimate F in 1988.

Two approaches were considered;

a) Use of both the LAI and LPE indices to predict SSB in 1988 by regressing against SSB values for the years 1973-1986 taken from last year's VPA using the RCRTINX2 program. The results are summarized in the text table below.

Year	Weighted average prediction	VPA estimate	External:internal standard error
1981	311	202	0.97
1982	225	205	0.54
1983	109	184	0.62
1984	224	321	0.66
1985	289	349	0.98
1986	356	360	1.42
1987	332	-	0.97
1988	423	-	1.25

Using this approach, a spawning stock biomass of 423,000 t in 1988 was predicted. However, the text table suggests that the prediction is rather unreliable. Tuning to this estimate in 1988 would produce an an SSB in 1987 of 280,000, about 90,000 t less than was estimated by the 1987 acoustic survey.

b) Tuning the 1988 VPA to the 1987 acoustic survey.

This was considered preferable on the grounds that the 1987 survey was thought to be reliable and is the best recent estimate of spawning stock size, i.e., 364,000 t. This approach is consistent with that of the 1988 Assessment Working Group.

5.1.9 Results of the assessment

The catch-at-age data were examined using separable VPA. As in last year's assessment, using S values of 1 at ages 3 and 8, the analysis indicated a dip in the exploitation pattern at age 7. This highlights an apparent sampling or ageing problem in 1986 and 1987, where the catches in numbers of 7- and 8-ringers are anomalous (Table 5.1.2). Down-weighting years 1985/1986 and

1986/1987 and re-running the SVPA indicated an approximately flat exploitation pattern from ages 3-8 (Table 5.1.6).

Unlike previous years, the exploitation pattern from the SVPA suggests that 2-ringers are more lightly exploited than older age groups. However, the Working Group was reluctant to accept this for a number of reasons. First, because the years 1986 and 1987 were down-weighted, the exploitation pattern from the SVPA is effectively based on the years 1981-1985. Also, the number of 2-ringers in the catches may depend on the timing of the recruitment migration from the North Sea, so that the exploitation of this age group might be expected to be variable; this is supported by the widely fluctuating residuals for 2/3-ringers in the SVPA (Table 5.1.6). Both the November 1987 acoustic survey and the March 1988 west coast recruit survey indicated a high abundance of this year class (Table 5.1.4), suggesting that it was in the area early in 1988 and hence available to exploitation. Given these uncertainties, the SVPA values were used only for F on the oldest ages, and a completely flat exploitation pattern on ages 2-8 was assumed for the latest year.

The results of the assessment are given in Tables 5.1.7 and 5.1.8 and in Figure 5.1.3. The decrease in F in 1988 reflects the lower catch and continuing increase in stock size. The assessment indicates that the 1985 year class is very strong, and this accounts for the much larger SSB in 1988 than that predicted by the 1987 Working Group, which assumed a recruitment of average strength.

5.1.10 Projection

As in previous years, the catches of 1-ringers in this area are not thought to reflect year-class strength, and this is indicated by the variable F values in the VPA (Table 5.1.7). This age group is, therefore, excluded from the projection.

The projections were made on the assumption that the catch in 1989 will be the agreed TAC of 58,000 t. The parameters used in the projections are given in Table 5.1.9, and the results are shown in Figure 5.1.3. $F_{0.1}$ was estimated to be 0.16, with F_{high} and F_{med} estimated at 0.90 and 0.35, respectively (Figure 5.1.4). Selected management options are given in the text table below.

1989				1990					1991	
Stock biom. (2+)	SSB	F	Catch (2+)	Management option	Stock biom. (2+)	SSB	F	Catch	Stock biom. (2+)	SSB
595	490	0.15	58	$F_{90} = F_{88}$	570	477	0.12	48	565	472
				$F_{0.1}$		465	0.16	61	548	447
				F_{med}		410	0.35	122	470	336

Weights in '000 t.
Stock biomass calculated at 1 January = SSB at 1 January.
SSB calculated at spawning time, i.e., 1 September.

The results indicate that the stock will remain stable at its present level given present catches and average recruitment, and that increasing fishing mortality to $F_{0.1}$ will result in only a slight reduction in stock size in 1990. The detailed prediction assuming $F_{0.1}$ in 1990 is given in Table 5.1.10.

5.1.11 Management considerations

Since the closure of the fishery in 1978, when the stock was at an all time minimum of around 70,000 t, the stock has recovered rapidly and is now at a size comparable to that in the early 1970s (Table 5.1.8) Recent levels of fishing mortality have been around $F_{0.1}$, and in 1988 less than $F_{0.1}$. These levels are considerably less than F_{med}, so that fishing mortalities higher than $F_{0.1}$ are likely to be within safe biological limits. However, given that the increase in yield per recruit obtained by fishing mortalities in excess of F0.1 are marginal, the present low levels of fishing mortality are preferable so that a buffer is maintained against recruitment fluctuations.

5.1.12 Research and data requirements

Catch and biological data for this stock are generally of high quality. However, some anomalies in the catch in numbers at age are apparent for 7- and 8-year olds in 1986 and 1987 (see Section 5.1.8) and should be investigated further.

The larvae surveys have provided a good record of trends in stock size, and despite the present difficulties of using them to predict the rapidly increasing stock size they should be continued. New fecundity data should be collected in order to improve the performance of the larvae production estimates.

Although weather conditions limited the usefulness of the 1988 survey, the acoustic surveys in Division VIa (North) can provide useful estimates of stock size and of recruitment and should be continued. These surveys will provide the only estimate of stock size in the latest year until values of the larval abundance indices fall within the range of the regression with converged VPA values.

5.2 Clyde Herring

5.2.1 Management of the fishery

The Firth of Clyde has been treated as a separate management unit for herring since 1978. Within the Clyde there is an indigenous stock of spring spawners which spawns within the firth and a population of autumn spawners. The latter are of unknown, but probably mixed origin and appear to spawn predominantly, if not entirely, outside the Clyde. The contribution of the two spawning groups to the catches in each month is not known.

Historically, there was a pre-spawning and spawning fishery targetted on spring spawners which has not taken place for many years. The main fishery in most years begins in late spring or summer and continues until the TAC is taken. National management of the TAC is by weekly vessel quotas.

The TAC advised and agreed for 1988 was 3,200 t. For 1989, ACFM recommended that "landings should be stabilized at recent levels (2,900 - 3,400 t)". The TAC adopted is 3,200 t. In view of the fact that the indigenous spring-spawning stock has shown no sign of recovery in recent years, ACFM also recommended for both 1988 and 1989 that no fishing for herring should take place during the prespawning and spawning periods. For 1988, this was January-March inclusive, but in 1988 ACFM advised a closure from January-mid-April because new evidence showed that spawning continues into April. For 1989, this advice has been adopted as part of the TAC regulation and fishing for herring is banned up to 15 April.

5.2.2 The fishery in 1988

The directed pair-trawl fishery in 1988 was opened on 3 July. Prior to this, small by-catches of herring were landed mainly by *Nephrops* trawlers from March onwards. For much of the year the vessels experienced difficulty in locating herring. Partly for this reason and partly because quality (fat content) was variable, the fishery failed to take the TAC for the second year in succession, and fishing continued until 19 December.

Landings by month are given in Table 5.2.1. The reported landings for the year were 1,568 t of which 1,337 t were taken in the directed pair-trawl fishery. Making an allowance for overweight boxes the total landings were estimated to be 1,678 t.

No information is available on discarding in 1988.

Monthly landings in numbers at age are given in Table 5.2.2. In the absence of discard sampling, it has been assumed that the percentage discarded at each age was the same as in 1986.

The number of days absent from port by pair-trawlers in 1988 is given in Table 5.2.3. As in the previous year, the effort was raised by the ratio of total to pair-trawl landings to give an estimate of total effort. From the figures available there was a considerable decrease in effort in 1988 to a level less than half that in 1986.

5.2.3 Weight at age and stock composition

Monthly weights at age in the landings for 1988 are given in Table 5.2.4. Although the change was not uniform across age groups, mean weights at age appear to have been slightly lower than in 1987 and considerably lower than in 1985-1986. Condition factors were again low in 1988.

The percentages of herring at each maturity stage in each month are given in Table 5.2.5.

The existence of developing fish and recovered spents in the landings in the months October-March indicated that there was almost certainly a mixture of spring and autumn spawners in the Clyde over this period. From April-September, the fish progresses from stage VII-VIII in April and May to stages III-V in August-September, but the basis for a split on maturity stages is weak because the difference in timing of the onset of maturation in the spring and autumn spawners is not known.

To investigate racial composition a vertebral count was made on a sample of herring in each month and, for the same fish, the otoliths were independently categorized as "spring" and "autumn spawned", using the nucleus character and otolith shape as criteria. The results given in Table 5.2.6 indicate that there was probably a mixture of the two spawning groups both in the early summer and autumn-winter. The data also indicate some differences in VS between maturity stages and in general support the racial analysis based on maturity stage alone. Using the proportions of each maturity stage in each month and the meristic evidence, it appears that approximately equal numbers of spring and autumn spawners were caught over the year as a whole.

Further samples taken on the acoustic survey in July (Table 5.2.7) supported the above analysis in showing that developing fish among 3-ringers and older had low VS characteristic of autumn spawners, while recovered spents had high VS characteristic of spring spawners. These research vessel samples also provided data on 2-ringers largely missing from the commercial landings. These were fish in maturity stages I-III which had high VS and were probably predominantly spring-spawned fish.

5.2.4 Acoustic survey

An acoustic survey was carried out from 7-18 July. Estimates of biomass and numbers and mean weights at age representative of the population are given in Table 5.2.8, together with comparable estimates of numbers and biomass from previous surveys.

The estimated biomass in 1988 was 12,400 t of which 2-ringers contributed an estimated 7,100 t. The relatively high abundance of this age group in 1988 is consistent with the abundance of 1-ringers in 1987. If the survey provides an indication of recruitment, the survey results might indicate a poor 1987 year class of spring spawners.

5.2.5 Egg surveys of Ballantrae Bank spawning ground

A patch of herring eggs was found on Ballantrae Bank in the period 13 April - 1 May 1987. Sampling by grab was insufficient to make a reliable estimate of total egg deposition. A further survey was carried out from 11-29 April 1988. The exact location and extent of the egg patch was determined from grab samples. The area over which spawn was deposited was estimated to be 84,750 m^2. This compares with a mean of 420,000 m^2 in the period 1965-1972. The density of eggs over the patch varied and the total area was stratified to obtain an estimate of total deposition (94.1×10^9). Assuming a mean fecundity of 63,800, an estimated mean weight of fish of 256.5 g and an equal sex ratio, the biomass required to produce these eggs is estimated to be about 760 t.

The 1988 egg estimate covered the main spawning ground of the Clyde spring-spawning stock. Historically, spawning also occurred in an area to the south of Arran. This has been searched but no sign of spawning has been found. In the period 1958-1972, the main peak of hatching occurred in March (Bailey *et al.*, 1986). Whether spawning occurred in February or March in 1988 is not known for certain. However, larval surveys have been carried out over Ballantrae Bank in recent years and no larvae have been found in what was the main hatching period up to 1972. Details of the surveys are as follows:

14 Mar - 28 Mar 1983	No larvae
14 Feb - 15 Mar 1984	No larvae
10 Mar - 4 Apr 1985	No larvae
19 Mar - 24 Apr 1986	Larvae found 18-24 Apr (21-24 Apr at Ballantrae Bank)
14 Apr - 28 Apr 1987	Larvae found 22-28 Apr.
11 May - 23 May 1987	No larvae

These indicate that very little hatching has occurred earlier than the beginning of April in recent years. It, therefore, seems likely that the population spawning in 1988 was at a very low level.

The age compositions of samples of herring taken in the area of Ballantrae Bank in recent years are given in Table 5.2.9. These indicate that these herring recruit to the spawning stock at three years at age (3-ringers).

5.2.6 Stock assessment

The acoustic survey in July 1988 provided an estimate of stock in numbers at age. In addition, a VPA on 2-ringers and older was carried out. For tuning purposes both CPUE data and the estimates from the acoustic survey over the past few years were used (Table 5.2.10). Separable VPA was not used for this stock because a trial run indicated very variable residuals on the youngest ages (Table 5.2.11). The outputs from the tuning module are given in Table 5.2.12. The results of a VPA based on the outputs is given in Tables 5.2.13-5.2.15. These indicate a stock biomass at 1 January 1988 of 12,400 t, which compares with the acoustic survey estimate of 12,400 t at 1 July. The age composition is very different, however. In the acoustic survey, 72% by number were estimated to be 2-ringers, while in the VPA the corresponding figure was 36%. An incorrect assumption about the discarding rate on the young age groups in 1988 could in part be responsible.

In view of the reasonable agreement between the two estimates of stock size in 1988, the VPA outputs in Table 5.2.15 were used as the basis for a prediction.

5.2.7 Projections

The input data for catch and stock projections are given in Table 5.2.16. Recruitment of 2-ringers in 1989 and 1990 was assumed to be the geometric mean over the period 1970-1987 (23 million). Since the exploitation pattern appears to have been variable in recent years, the pattern used in the prediction was taken from mean values given by the separable VPA (Table 5.2.11). The 1988 weights at age were used. The reference F is defined as the unweighted mean on ages 2-6.The calculated value of $F_{0.1}$ is 0.132.

The landings in 1989 are difficult to predict because in both of the last two years the TAC has not been reached. For this reason the projections are run on two alternative catch levels - that the TAC of 3,200 t will be taken, and that the F will remain the same as in 1988 (0.21).

Projections for two levels of F are given (in tonnes) in the text table below. The detailed outputs for option 4 are given in Table 5.2.17.

	1989			1990				1991
	Stock biom. 2+ 1 Jan	Catch	F	Stock biom. 2+ 1 Jan	Managem. option	F	Catch	Stock biom. 2+ 1 Jan
1.	13,200	TAC=3,200	0.29	12,500	$F_{0.1}$	0.13	1,440	13,500
2.	13,200	TAC=3,200	0.29	12,500	F_{88}	0.21	2,170	12,800
3.	13,200	F_{88}=2,360	0.21	13,300	$F_{0.1}$	0.13	1,560	14,200
4.	13,200	F_{88}=2,360	0.21	13,300	F_{88}	0.21	2,350	13,400

5.2.8 Management considerations

Until the racial composition of the landings in the Clyde is better understood, it is not possible to evaluate the effect of different catch options on the indigenous stock of spring spawners. The catch options have been carried out for the combined population in the Clyde based on the best estimates of total stock size available. The evidence available, however, indicates that the spring-spawning stock is at a low level and that it needs the maximum protection possible. This can be achieved by a combination of measures. Firstly, the closure of herring fisheries in the pre-spawning and spawning periods (1 January -15 April) should be continued. Secondly, the fishing mortality should be set at a low level. The appropriate level of F cannot be defined objectively, but the Working Group recommended that it should be set at the 1988 level (0.21). This level corresponds to a TAC in 1990 of 2,400 t.

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

6.1 The Fishery

6.1.1 Advice and management applicable to 1988 and 1989

The TAC set by EC for this area for 1988 was 14,000 t. The advised catch level by ACFM was 11,000 - 18,000 t. The total catch taken was 29,100 t. Although the Irish fishery was closed in the area at the end of June the total catch by all nations was over twice the TAC.

The TAC for 1989 has been set at 20,000 t, which is within the range advised by ACFM. For the first time it appears that a serious attempt is being made to manage the fishery properly. Irish boats participating in the fishery will be regulated by licenses and the national quota has also been divided into monthly quotas in an effort to spread the TAC according to the yearly demand. The monthly quota has also been further sub-divided into boat quotas per month.

6.1.2 Catch data

The catches by each country fishing in these areas from 1979-1987 and the preliminary catch figures for 1988 are shown in Table 6.1.1. These figures have been supplied by Working Group members. The 1987 catches have been revised and the resulting total has increased considerably. The total catch for that year is now estimated to have been over 48,000 t, which is by far the highest recorded catch taken from this fishery. Unallocated catches account for about 66% of the total. The preliminary reported catch for 1988 is 29,100 t which is a decrease on the 1987 figure and about the same as that taken in 1986.

The main catches by the Irish fleet in 1988 were taken in the first and second quarters by boats fishing mainly off the northwest coast of Ireland in the southern part of Division VIa. Small unreported catches were subsequently taken as a by-catch in the horse mackerel fishery during late summer. There also appeared to have been a considerable drop in fishing activity by the Dutch fleet. The major revision of the catch data which was found necessary for 1987 has cast doubts about the accuracy of the catch statistics for the years immediately prior to this. However, the 1988 are thought to be reliable and no major revision is expected.

6.1.3 Catches in numbers at age

The catches in numbers at age for this fishery from 1977 are shown in Table 6.1.2. The 1987 data has been revised because of the changes in the catch data. The 1988 catch-at-age data have been based mainly on Irish data and in general good sampling coverage of the fishery was obtained. However, inadequate sampling was carried out on the species composition of the by-catches in the scad fishery during summer and autumn.

As has been the case since it entered the fishery in 1984, the 1981 year class dominated the catches throughout most of the year and still constitutes over 23% of the total. The 1984 year class, which only constituted 14% of the catch in 1987, increased in proportion and in 1988 amounted to 23% as 3-winter-ring fish. In comparison with other stocks around Ireland, the age composition contains substantial numbers of old fish. No 1-winter-ring fish (1986 year class) were present in the catches, probably because the Irish fishery was closed in June before these young fish would have recruited to the adult stocks. 2-winter-ring fish (1985 year class) were also relatively scarce in the catches. However, data on the composition of the first quarter for 1989 indicate that they constitute over 60% of the catches suggesting that the major recruitment occurred in the second and third quarters of 1988.

6.2 Weights at Age

The mean weights at age in the catches were recalculated for 1987 because of the catch revisions for that year. The 1988 mean weights at age were approximately 9% lower than those of 1987 because of the change in timing of the fishery whereby nearly 75% of all the total catch was taken in the first and second quarter. The mean weights at spawning time (1 October) and in the catch used in the prediction were the same as those used in 1988 (see Table 6.6.1).

6.3 Larval Surveys

Larval surveys in this area in 1988 were again carried out by Ireland during October and November. Scottish surveys in the southern part of Division VIa have not been carried out since 1986. Three Irish surveys were carried out at fortnightly intervals and good coverage of the area was obtained. In line with suggestions made by the 1987 Working Group, some additional stations were included both to the northeast of the area and to the south. These additional stations were intended to locate larger larvae which have been conspicuously absent from the surveys in this area and also to cover some additional spawning areas on the boundary of Division VIIj. The results from these stations have not, however, been included in the indices from the standard area. At the 1988 Working Group the difficulties in interpreting the results from the surveys in this area were discussed at length. It was suggested that new indices based on the average results of the individual Irish surveys including the additional stations should be examined. Accordingly, the LA1 and LPE indices calculated for both areas are presented below.

Larvae production estimates (LPE) and Larvae abundance estimates (LAI) for Divisions VIa S and VIIb. SSB is calculated from LPE/fecundity.

Year	LAI (old area)	LAI (new area)	LPE (old area)	Fec.	SSB (LPE/fec.)
1981	58	60	27	1.42	190
1982	76	40	21	1.44	146
1983	68	61	20	1.41	143
1984	36	47	9	1.43	59
1985	26	24	9	1.43	63
1986	62	54	13	1.43	92
1987	40	55	12	1.43	83
1988	139	169	20	1.43	136

1988 surveys

The first survey (3-12 October) indicated large quantities of small larvae in the southern part of Division VIa and also some medium-sized larvae in the northern part of the survey area. Large larvae were not found.

The second survey (17-26 October) again indicated large concentrations of small larvae in the southern part of Division VIa and on the boundary of the Clyde area, and very high concentrations in Division VIIb.

Medium-sized larvae were well distributed throughout Division VIa S. Again, very few large larvae were found.

In <u>the third survey</u> (31 October-9 November), the highest concentrations of small larvae were found in Division VIIb. Some small larvae were found in the stations on the boundary with Division VIIj. Medium sized larvae were again scattered throughout the survey area and large larvae were again absent.

The LAIs calculated for 1988 show a dramatic increase on any other values obtained since these surveys began. The increase is evident in both series of data. It was noted that dramatic increases in 1988 LAIs were also recorded from the larval surveys in Division VIa N and in the Orkney-Shetland area.

The values obtained by calculating the indices in the new way do not differ very much from the original data but probably give a better estimate over the whole area. The LPE index also increased during 1988 but not to the same degree as the LAI and may perhaps be a better reflection of changes in SSB. The LPE values are slightly different fromn those shown in 1987 because they have been calculated using different values of Z.

6.4 <u>Stock Assessment</u>

Recent working groups have had extreme difficulty in carrying out an assessment on the stock in this area. The difficulties have arisen because there appears to be no relationship between the results from the larval surveys and the spawning stock biomasses calculated from VPAs. The main cause for this appears to be the very low larval indices which were calculated for the 1984 and 1985 surveys. However, during this time the SSB estimated from VPAs shows a dramatic increase because of the recruitment of the very strong 1981 year class. The larval surveys in 1986 and 1987 appeared to show a recovery of the stock but no input value of F in 1987 could create a similar recovery while at the same time indicate low levels in 1984 and 1985. The 1988 Working Group, therefore, did not use the larval surveys to give an indication of stock size to determine a value of input F. An assessment was subsequently carried out, using an input F value for 1987 which was based on the F value generated in a period when catches were similar to what they were in 1987. This value was F = 0.35. ACFM accepted this assessment with reservations, and noted the irregularities that exist in the larval data and the fact that the stock appears to be surviving quite satisfactorily in spite of the fact that the recommended TACs have been grossly exceeded for the last ten years.

The situation regarding an assessment based on the results of the 1988 fishery and the larval results appears to be even more complex. The difficulties are further compounded by the very high larval indices and the revised 1987 catch figures. The revised catch figures would suggest that the F calculated for that year of 0.35 should in fact have been at a higher level.

A comparision was made using the RCRTINX2 programme between the indices from the LAIs and the LPE and the spawning stock estimated from VPA over the 1981-1985 period derived from using two values of F in 1988 - 0.3 and 0.4. An analysis of the results show clearly that neither the LAIs or the LPE can be used to predict SSB. The two series of data produce external standard error to internal standard error ratios of 1.69 and 1.66 and these values indicate that the larval surveys cannot be used to calculate spawning stock.

It is, therefore, again difficult to select an appropriate F value for 1988. The revised catches for 1987 would suggest that the F value of 0.35, used by the 1988 Working Group, may in fact have been an underestimate. On the other hand, the substantial reduction of the 1988 catch because of the early closure of the Irish fishery would indicate a decrease in fishing effort from 1987 to 1988. Only 6,000 t were caught in the third and fourth quarters in 1988 out of a total catch of 30,000 t. In the absence of any fishery-independent data, it was decided to use the same approach as that of the 1988 Working Group. It was, therefore, assumed that the average F generated by the catches in the 1986-1988 period (35,000 t) would be approximately similar to that generated by similar catches during the 1973-1976 period (36,000 t). This would suggest that the F in recent years would have averaged about 0.4. As this is an <u>average</u> value over the 1986-1988 period the <u>actual</u> 1988 value might be lower. In order to check the accuracy of the value of 0.40 in recent years, catch curves were constructed for the average age compositions for the periods 1973 to 1976 and 1986 to 1988. The resultant values of Z calculated over the years 3-8 were 0.37 and 0.44, respectively. This would suggest that the value of F for 1988 might be reasonable but a little conservative. However, the Working Group considered that 1) because of the doubts about the catches, 2) the uncertainty about the stock in general, and 3) the very significant increase in catching power of the fleet in general, it would be better to select a conservative value of F. An F = 0.40 was, therefore, considered appropriate.

A separable VPA was carried out on ages 2-8 and a terminal F of 0.40 on age 4 and a terminal S of 1.0 were selected. The results of this separable VPA are shown in Table 6.4.1. The S values show a different selection pattern than that of the previous year. The exploitation pattern was flat-topped for 4-winter-ring fish older, with 3-winter-ring and 2-winter-ring fish being subjected to a mortality of 0.88 and 0.45, respectively. In 1987, 3-winter-ring fish were considered to be fully exploited. The difference is probably explained by the closure of the Irish fishery in June 1988. An ordinary VPA was then carried out on fish of 2-winter-ring and older fish, using an input F = 0.40 and the exploitation pattern derived from the SVPA.

6.4.1 <u>Results from VPA</u>

The results from VPA are shown in Tables 6.4.2 and 6.4.3. The estimates of spawning stock biomass and recruitment have been considerably affected by the large revision of the 1987 catch. This has had the effect of increasing the SSB in recent years but there appears to have been a considerable decline from the high level recorded in 1984-1986. The present level is estimated to be about 149,600 t. The values of $F_{(2-7)u}$ which have been remarkably consistent up to 1986, averaging 0.25 from 1982-1986, increased to 0.51 in 1987. This high level, however, as has been mentioned earlier, may be overestimated. The age composition shows a very strong recruitment in 1984 of the 1981 year class. Again as mentioned earlier the estimates of 2-winter-ring fish in 1988 cannot be taken as an indication of recruitment strength of the 1985 year class because of the closure of the fishery in the second part of the year.

As has been explained earlier, the numbers of 2-winter-ring fish present (29 million) in the catches in 1988 are unrealistically low because of the closure of the fishery in June. This means that the stock numbers for 2-winter-ring fish calculated for 1988 and projected forward to 1989 are not realistic. The estimated numbers which would have been caught if the fishery had remained open as in previous years were, therefore, recalculated on the basis that the fishery represented 40% of the annual mortality. The recalculated stock numbers were 511 million fish. If this number was subjected to full fishing, the numbers of 3-winter-ring fish calculated to be in the stock at 1 January 1989 would have been 316 million. This number was used in the catch prediction (Section 6.6).

The recalculated stock numbers of 2-winter-ring fish in 1988 also means that the spawning stock at spawning time must also be recalculated. The spawning stock biomass at age was calculated from VPA and the value for 2-winter-ring fish at 1 January was then raised by the ratio of the new numbers calculated above. This gave a new total biomass which was then used to calculate a new spawning stock biomass at spawning time using the ratio of the previous values. This gave a new spawning stock biomass of 149,600 t. These new values have been inserted in the VPA tables.

6.5 Recruitment

Very strong year classes enter the fishery at intervals and subsequently dominate the catches for a number of years, e.g., the recent catches have been dominated for a number of years by the 1981 year class. The average recruitment level, excluding the strong year classes, however, appears to remain at a very steady level. The results of Irish young fish surveys, shown in Table 6.5.1, do not appear to give an indication of year class strength, and have not been used for predictive purposes. Recent working groups have calculated the recruitment level to be used in the prediction based on the geometric mean of the 2-winter-ring fish from 1980, but excluding the value of the strong 1981 year class. The value used by the 1988 Working Group was 235 million fish. The young fish surveys in 1987 (Molloy, discussion paper, 1988) suggested that the 1985 year class is a strong one. This year class is very strongly represented in the catch data for the first quarter of 1989 with over 60% of the age composition. The 1985 year class also appears to be a very strong one in adjacent areas and in the North Sea. It was considered realistic to select the recruitment level for the prediction using the geometric mean over the period 1980-1987 but including the value of the strong 1981 year class. The resultant value was 293 million fish and this value was used for predictive purposes.

6.6 Stock and Catch Projections

Stock and catch projections were made using the stock numbers at 1 January 1989 calculated from VPA. The level of recruitment was assumed to be 293 million 2-winter-ring fish. The predictions were based on two catch levels for 1989, a) a catch of 20,000 t which is equal to the agreed TAC and b) a catch of about 30,000 t which is approximately the same as that of 1988. Catch options have been assumed for 1990 at levels of $F_{0.1}$ = 0.156; F_{med} = 0.24, and F_{90} = F_{88}, i.e., 0.38 taken from the VPA. The input parameters and the results of these predictions are shown in Tables 6.6.1-6.6.3 and Figure 6.6.1. The detailed results of the projection (F_{med}-option) are given in Table 6.6.4.

The results of the predictions show that if the catch in 1989 is controlled at 20,000 t then the SSB will increase to 154,000 t. If F in 1989 is set a F_{med} = 0.24 then the subsequent catch will be 27,000 t and the SSB will remain stable.

If the 1989 catch is about the same level as 1988, i.e., 30,000 t, the SSB will decrease to 144,000 t. If F in 1990 is set at F_{med} = 0.24, then the catch will yield 25,000 t but the SSB will decline to 147,000 t from the level estimated for 1988.

6.7 Management Considerations

As pointed out earlier, the Working Group continue to have difficulties in making a proper analytical assessment for this area. This is mainly because of difficulties in interpreting the results of the larval and young fish surveys. As discussed by the 1988 Working Group, the management unit may not cover the entire distribution of the stock throughout its life span. However, one of the features of the assessments is that the spawning stock is periodically boosted by the recruitment of very strong year classes which then dominate the stock for a number of years until they disappear. During this period the spawning stock gradually declines. Since 1970, the spawning stock has been boosted in this way by the 1970, 1976, and 1981 year classes. Preliminary evidence indicates that the 1985 year class will also be strong. However, even though there are serious doubts about the size of the stock in the area, it appears that at present it is in a relatively healthy state because of the recent strong recruitment in 1984 and the likelihood of the strong 1985 year class. It does, however, appear that catch levels of 30,000 t will produce a declining spawning stock as the strong year classes decrease with age. Considerably more information is required about the composition and distribution of the stock in this area before accurate catch levels can be advised. In the absence of this it is considered that in the immediate future the fishery should be stabilized at the F_{med} level, which corresdponds to a TAC of 25,000 t in 1990.

7 IRISH SEA HERRING (Division VIIa)

7.1 The Fishery

7.1.1 The fishery 1988

The catches reported by each country fishing in Division VIIa from 1979-1988 are given in Table 7.1.1. For 1988, the total catch of 10,172 t was within the TAC of 10,500 t agreed by the EC. Because of the higher TAC there was little discarding even early in the season (June) and the UK fishery continued into late November, being closed as a result of falling catch per unit effort rather than exhausted quota. The UK undershot its quota of 7,770 t by 177 t as a result.

Once again catches were not split into Manx/Mourne components. However, landings by UK vessels in September 1988 were mainly from the Douglas Bank Manx fishery and these amounted to more than 3,500 t. Although the total catch appears to be below the TAC there are serious concerns that considerable underreporting of catch may have taken place by certain fleets. However, the extent of this could not be estimated and could not, therefore, be considered in the report.

7.1.2 Catches in number at age

Catches in numbers at age are given in Table 7.1.2 for the years 1972-1988. 2-ring fish once again dominated catches in 1988 though with a significant proportion of 3-rings being taken. Catch in numbers at length are shown in Table 7.1.3 and Figure 7.1.3. Length intervals are 0.5 cm.

7.1.3 Advice and management applicable to 1988

The 1987 assessment of this stock indicated that SSB would continue to rise slowly if 1988 catches were between 7,200 and 10,500 t. The EEC subsequently adopted a TAC of 10,500 t, the UK quota of which was 7,770 t. In the UK, sectoral quotas were allocated as follows: Anglo-North Irish Fish Producers Organisation 2,165 t; Northern Ireland Fish Producers Organisation 3,852 t; Scottish Fishermens Organisation 700 t. In addition, 453 t were allocated to the non-sectoral industry (Manx and Scottish) and 600 t to the Mourne Skiff fishery.

The UK fishery opened in the second week of June and the usual closed area around the Manx spawning grounds and along the Mourne shore was in operation from 21 September to the end of the year. Ireland was allocated 2,730 t, and fishing was regulated on a vessel quota basis within a period 1 August to 5 September.

Following the 1988 Working Group report, ACFM expressed concern about the reliability of assessments for the Irish Sea herring stock based on fishery-dependent sources alone. ACFM recommended a reduction of TAC for 1988 to 5,600 t with a TAC for 1989 of 5,500 t. The EEC has set the 1989 TAC at 6,000 t (allocated as 1,560 t for Ireland and 4,440 t for the UK); spawning closures were retained as for 1988.

7.2 Mean Length, Weight, and Maturity at Age

Mean lengths at age in August, calculated from Northern Ireland, Ireland, and Isle of Man samples, are given in the text table below. There does appear to have been a drop in the mean length of Irish Sea herring over this period.

Lengths at age (cm)

Year	Age							
	1	2	3	4	5	6	7	8
1985	22.1	24.3	26.1	27.6	28.3	28.6	29.5	30.1
1986	19.7	24.3	25.8	26.9	28.0	28.8	28.8	29.8
1987	20.0	24.1	26.3	27.3	28.0	29.2	29.4	30.1
1988	20.2	23.5	25.7	26.3	27.2	27.7	28.7	29.6

Mean weight at age in the catch are given in the table below. Although mean weight at age appeared to fall over the period 1985-1987, the rate of this decrease appears to have slowed.

Mean weights at age (kg)

Year	Age							
	1	2	3	4	5	6	7	8
1976-1983	0.074	0.155	0.195	0.219	0.232	0.251	0.258	0.278
1984	0.076	0.142	0.187	0.213	0.221	0.243	0.240	0.273
1985	0.087	0.125	0.157	0.186	0.202	0.209	0.222	0.258
1986	0.068	0.143	0.167	0.188	0.215	0.229	0.239	0.254
1987	0.058	0.130	0.160	0.175	0.194	0.210	0.218	0.229
1988	0.070	0.124	0.160	0.170	0.180	0.198	0.212	0.232

The maturity ogive expressed as proportions of sampled population at stage 3+ has changed little in the last few years, and the 1988 ogive was similar to previous estimates. Therefore, the ogive was unchanged at 0.08, 0.85, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00 on ages 1-8+.

7.3 Stock Assessment

7.3.1 Estimation of fishing mortality rate

There were no data independent of the fishery available for this year. In addition, following the concern shown by the 1988 Working Group, it was felt that effort data could not be used to tune the VPA. In the absence of any reliable information about the fishery that would allow an estimate of F to be made, a full analytical assessment was not performed. However, trial VPAs were run to investigate the age structure and exploitation patterns of this stock.

7.3.2 Exploitation pattern

Separable VPAs were performed with reference age 2 and terminal S 1.0 and with F on 1988 of 0.2-0.66. The output from the S-VPA with F = 0.3 is shown in Table 7.3.2. These analyses indicated a selection pattern of 0.085 on 1-ringers and 1.0 on ages 2-7 and there was no evidence of changing exploitation pattern in this fishery.

7.3.3 Results of VPA

As previously stated a full analytical assessment was not performed for this stock. Nevertheless, the proportion of fish of age 3+ in the stock at spawning time was investigated by running VPAs with input F on the final year of 0.3, 0.4, and 0.66. For these analyses the natural mortality was assumed to be the same as was used by the Working Group in 1988, namely 1.0 on age 1, 0.3 on age 2, 0.2 on age 3, and 0.1 on ages 4-8. F on the oldest fish was taken from the separable VPA results for 1981-1988 and from previous Working Group reports for 1972-1980.

The 1988 assessment implied a fishing mortality of 0.66 if 10,500 t were caught in 1988. The results of the VPA with F = 0.66 are shown in Table 7.3.3 and analyzed in Figure 7.3.3, along with the proportion of 3+ fish in the catch. Following the high fishing effort in 1985 the proportion of older (spawning) fish in the stock dropped and is now increasing slowly once again. It must be noted that the percentage of spawning stock number refers to numbers of old fish at spawning time as a percentage of all fish present at 1 January and, therefore, effectively predicts the numbers of old fish surviving to the next year. This analysis appears to indicate that the age composition is stabilizing.

7.4 Recruitment

The Irish young fish survey was discontinued in 1989, and there are no other estimates of recruitment in 1989 for this stock.

7.5 Stock and Catch Projections

The results of yield-per-recruit and SSB-per-recruit analyses are shown in Figure 7.5.1. There is no F_{max} and $F_{0.1}$= 0.163.

Although an analytical prediction was not possible, the effect of the 6,000 t TAC in 1989 was investigated for F88 = 0.3 and 0.66. The latter figure was derived from the 1988 Working Group report assuming catch in 1988 = 10.500 t. The stock size in 1989 was calculated from the VPA analyses described under 7.3.3 above and the number of 1-ring recruits was taken from the geometric mean of the 10 years 1976-1985 from the VPAs. The results are shown in Table 7.5.1 from which it can be seen that SSB should not decrease if catches of 6,000 t are maintained for the years 1989-1991.

7.6 Management Considerations

7.6.1 Catch limits

As discussed above, recommendations for catch limits cannot be made from an analytical review of this fishery. However, several comments may be made concerning the present levels of exploitation.

Figure 7.3.3 indicates that catch and stock composition may be stabilising. Impressions of the fishery in 1988 indicated that although the TAC was not caught this was a result of market forces rather than a scarcity of fish.

In the absence of any evidence to the contrary, the Working Group recommends a precautionary TAC of 5,700 t based on the mean catch level 1981-1987, until firm evidence is available to perform analytical assessments on the stock. Catches at this level should not dammage the stock. Provision of reliable fishery-independent data is not expected until the 1990s.

7.6.2 Spawning and nursery area closures

Given the present state of uncertainty about the size of this stock and a recommended precautionary TAC, the spawning and nursery area closures presently in force should be maintained in 1990.

8 RESEARCH REQUIREMENTS

In 1988, the Working Group reviewed the surveys and abundance indices available for each assessment and summarized their use in recent years (Anon., 1988, Tables 9.1 and 9.2).

This year, the Working Group again discussed the use of survey data and, as requested by ACFM, attempted to evaluate the relative applicability of the various surveys to the assessments.

The use of survey data in each assessment is summarized as follows:

North Sea

Three surveys provide potential estimates of spawning stock size - acoustic surveys (1981 - present), larval surveys (LPE and LAI since 1972), and catch rates of 2-ring and older herring in the IYFS survey. The IYFS (since 1976) provide potential recruitment estimates.

The relative ability of these series to predict SSB was assessed using the modified RCRTINX2 program and a converged portion of the VPA matrix (see Section 2.7). The result (expressed as relative weighting given each survey) indicates the relative merit of the acoustic series (given approximately 70% weighting), followed by LPE (approximately 15%), LAI (~ 3%), and IYFS 2+ (~2%).

Since both acoustic and IYFS surveys give age-structured estimates, they were used (combined and weighted) in tuning the VPA.

Recruitment values for 1- and 2-ringers were based on results from the IYFS survey and, for the first time, an estimate of 0-group was based upon the results from IKMT (see Section 2.3).

Larvae surveys were used to assess the relative performance of spawning units within the North Sea assessment area (see Section 2.7.2).

Celtic Sea

No survey indices available since 1985. Larval surveys prior to 1985. However, the 1988 Working Groyup suggested, having examined the relationship between LAI and SSB prior to 1985, that useful information could be obtained by a resumptiom of the surveys.

West of Scotland

Three series are available: larval surveys (1973-present), acoustic surveys (1983 - present), and Scottish bottom trawl surveys.

The 1988 acoustic survey results had been compromised by bad weather and were not used in the assessment. The 1988 larval values were the highest on record and were again rejected for calibration on the basis that they lay outside the predictive historical regression with SSB and due to a potentially variable loss of larvae from the assessment area into the Orkney/Shetland area.

Tuning of the VPA was conducted using the 1987 acoustic survey (see Section 5.1.8).

The Scottish bottom trawl survey results were used as indicator of recruitment index.

Clyde

Egg bed (benthic grab) and acoustic (July) surveys have been undertaken since 1987. Egg estimates indicated a small spawning biomass in 1988. Acoustic survey results were used to estimate total biomass and the relative recruitment of 1- and 2-ringers.

West of Ireland

Larval survey series (LAI and LPE) are available since 1981. The applicability of these series to predict SSB was assessed using the RCRTINX2 program (over the period 1981-1985). Results indicate poor predictive power and the series was not used in calibration of the assessment.

Irish Sea

A young fish survey which has not been of use has been discontinued. No survey indices are available in 1989.

Discussion

The Working Group discussed the relative advantages and disadvantages of the major surveys.

Larval surveys reflect the general state of the stocks. They are generally our longest series and have been very useful in the past in indicating general stock size at low levels when other surveys are not as effective. The larval survey has been useful this year as an indication of the relative performance of sub-units of the North Sea stock.

On the other hand, larval indices are not precise as point estimates of stock size. In recent years of high stock size this has been confounded by points outside the documented range of the historical regression. There are additional problems caused by larval movement across assessment area boundaries (west of Scotland, for example). Some of this may be able to be resolved by re-aggregation of survey data.

Acoustic surveys appear to be of increasing value. The comparisons undertaken in the North Sea assessment this year indicate the relative advantage over other surveys. These surveys are advantageous also in allowing collection of age-structured abundance data.

A minor disadvantage noted this year was the negative impact of weather and fish disaggregation on acoustic estimates; west of Scotland in particular - but also in the North Sea.

The IYFS is proving valuable as a source of recruitment estimates. Coverage appears to be sufficient to account for major changes in juvenile distribution. Results from the more recent IKMT series (O-group) have been used for the first time.

Recommendation

In view of the difficulty experienced by the Working Group in utilizing the results of larval surveys in some of their assessments, the Working Group recommends that the Herring Larvae Survey Working Group should meet to consider the underlying basis of the assumptions used in calculating LPE and LAI, and in relating larval production to spawning stock size.

In addition, in view of the likelihood of a reduction in effort on the larval surveys, the Herring Larval Survey Working Group should be asked to consider the possibility of producing estimates of LPE and larval abundance indices from shorter survey periods.

9 REFERENCES

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9.1 Working Documents

Jørgensen, T. Preliminary Results of a Multivariate Analysis of Morphometric and Meristic Characters as a Basis for Studying the Stock Structure of Herring in the Skagerrak-Kattegat and Adjacent Waters.

Molloy, J. Seasonal Closures of Spawning Areas for the Celtic Sea and Division VIIj Herring Stock.

Rankine, P. and Christensen, V. Results from the ICES International Herring Larvae Surveys South of 62^0N, 1988/1989.

Stephenson, R. Discussion Paper on Apparent Changes in Growth Rate.

Table 2.1.1 HERRING. Catch in tonnes, 1978-1988, 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	1978	1979	1980	1981	1982
Belgium	-	-	-	-	9,700
Denmark	4,359	10,546	4,431	21,146	67,851
Faroe Islands	40	10	-	-	-
France	2,119	2,560	5,527	15,099	15,310
Germany, Fed.Rep.	24	10	147	2,300	349
Netherlands	18	-	509	7,700	22,300
Norway	1,189	3,617	2,165	70	680
Sweden	-	-	-	-	-
UK (England)	2,843	2,253	77	303	3,703
UK (Scotland)[2]	437	-	610	45	1,780
USSR	4	162	-	-	-
Total North Sea	11,033	19,158	13,466	46,663	122,056
Total including unallocated catches	-	-	60,994	140,972	235,925

Country	1983	1984	1985	1986	1987	1988[1]
Belgium	5,969	5,080	3,482	414	39	4
Denmark	10,467	38,777	129,305[1]	121,631	138,596	263,006
Faroe Islands	-	-	-	623	2,228	810
France	16,353	20,320	14,400	9,729	7,266	8,384
Germany, Fed.Rep.	1,837	11,609	8,930	3,934	5,552	13,824
Netherlands	40,045	44,308	79,335[1]	85,998	91,478	82,267
Norway	32,512	100,845	163,387	223,496	243,152	222,719
Sweden	284	886	2,442	1,872	1,725	1,819
UK (England)	111	1,689	5,564	1,404	873	8,097
UK (Scotland)[2]	17,260	31,393	55,795	77,459	76,413	64,108
USSR	-	-	-	-	-	-
Total North Sea	124,838	254,907	462,640	526,560	591,294	665,038
Total including unallocated catches	305,954	319,394[3]	536,860[3]	547,649[3]	626,294[3]	698,449[3]

[1] Preliminary.
[2] Catches of juveniles from Moray Firth not included.
[3] Includes catches of Division IIIa spring spawners (1984-6,958 t; 1985 - 17,386 t; 1986 - 19,654 t; 1987 - 14,207 t; 1988 - 23,306 t).

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	1980	1981	1982	1983	1984	1985	1986	1987	1988
Denmark	687	11,357	3,155	4,282	26,786	77,788	48,590	50,184	25,268
Faroe Islands	-	-	-	-	-	-	275	102	810
France	651	1,851	1,970	680	1,408	2,075	462	285	266
Germany, Fed.Rep.	-	-	-	1,542	12,092	4,790	2,510	3,250	9,308
Netherlands[2]	-	-	-	15,745	19,143	49,965	42,900	44,358	32,639
Norway	-	-	-	16,971	21,305	10,507	63,848	55,311	30,657
Sweden	-	-	-	213	-[1]	-[1]	-[1]	768	1,197
UK (England)	-	-	-	-	-	-	-	4,820	4,820
UK (Scotland)	18	2	1,706	16,136	24,634	52,100	71,285	66,774	48,791
Unallocated	1,762	6,492	300	3,955	24,030	4,249	-	16,092	-
Total	3,118	19,702	7,179	61,738	129,398	201,474	229,870	237,124	153,751

[1]Included in Division IVb.
[2]Netherlands discard estimates included in "unallocated".

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	1980	1981	1982	1983	1984	1985	1986	1987	1988
Denmark	-	-	491	-	126	-	4,540	7,101	47,183
Faroe Islands	-	-	-	-	-	-	-	2,126	-
France	-	-	-	-	-	-	-	159	45
Netherlands	-	-	-	-	-	-	-	-	200
Norway	21	70	680	-	53,720	113,415	118,966	147,730	153,496
Sweden	-	-	-	-	-	-	-	957	622
UK (Scotland)	-	-	-	257	74	-	-	-	-
Unallocated	2,476	937	-	431	-	-	-	-	-
Total	2,497	1,007	1,171	688	53,920	113,415	123,506	158,073	201,546

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	1980	1981	1982	1983	1984	1985	1986	1987	1988
Denmark	3,733	9,689	64,205	6,050	13,808	51,517	67,966	81,280	190,555
France	176	524	561	705	2,299	1,037	605	387	617
Faroe Islands	-	-	-	-	-	-	348	-	-
Germany, Fed.Rep.	147	2,300	118	-	2	4,139	1,424	2,302	4,516
Netherlands[4]	35	-	219	300	4,600	-[3]	21,101	31,371	37,192
Norway	1,607	-	-	14,156	25,820[2]	39,465[2]	40,682[2]	40,111	38,566
Sweden	-	-	-	71	884[2]	2,442[2]	1,872[2]	-	-
UK (England)	76	13	3,128	40	1,956[1]	5,214	1,101[1]	329	2,011
UK (Scotland)	592	43	74	867	2,477	2,894	6,057	9,639	15,317
Unallocated	9,258	65,811	90,262	159,124	41,294	47,799	1,594	20,829	1,969
Total	15,624	78,380	158,567	181,313	93,140	154,507	142,750	186,248	290,743

[1] Includes catches misreported from Division IVc.
[2] Includes Division IVa catches.
[3] Included in Division IVa.
[4] Netherlands discard estimates included in "unallocated".

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	1980	1981	1982	1983	1984	1985	1986	1987	1988
Belgium	-	-	9,700	5,969	5,080	3,482	414	39	4
Denmark	11	100	-	135	53	-	535	31	-
France	4,700	12,724	12,799	14,968	16,613	11,288	8,662	6,435	7,456
Germany, Fed.Rep.	-	-	183	295	-	-	-	-	-
Netherlands	474	7,700	22,081	24,000	21,922	32,370	21,997[4]	15,749	12,236
Norway	482	-	-	1,385	-	-	-	-	-
UK (England)	1	290	602	71	571[1]	350	303[5]	544[6]	1,266[7]
UK (Scotland)	-	-	-	-	-	799	117	-	-
Unallocated	37,418	21,069	23,307	17,606	1,788	21,595	19,495	22,051	31,442
Total	43,086	41,883	68,652	64,430	46,027	69,884[3]	51,523	44,849	52,404

[1] Includes 520 tonnes coastal spring-spawning herring.
[2] Includes 269 tonnes coastal spring-spawning herring.
[3] Includes 905 tonnes coastal spring-spawning herring.
[4] Includes 263 tonnes coastal spring-spawning herring.
[5] Includes 233 tonnes coastal spring spawning herring.
[6] Includes 250 tonnes coastal spring-spawning herring.
[7] Includes 250 tonnes coastal spring-spawning herring.

Table 2.1.6 North Sea Herring. Millions caught by age group (w.r.), year class, division, and quarter.

Catches in: 1988

Division	Quarter	0 1987	1 1986	2 1985	3 1984	4 1983	5 1982	6 1981	7 1980	8 1979	9+ 1978<	Total	0 + 1 ring
	I	0.0	0.0	20.7	66.5	28.1	16.9	6.3	3.1	0.3	0.3	142.2	0.0
IVa(W of 2°E)	II	0.0	4.8	88.1	37.3	16.0	13.8	3.7	3.9	0.9	0.6	169.0	4.8
	III	0.0	0.7	284.5	200.4	52.9	38.1	26.9	7.6	4.5	2.2	617.9	0.7
	IV	0.0	10.1	133.6	56.6	10.4	8.6	4.4	0.8	0.8	0.6	225.8	10.1
	Total	0.0	15.6	526.9	360.8	107.4	77.4	41.2	15.5	6.5	3.7	1155.0	15.6
	I	0.0	0.5	44.7	167.7	108.9	90.6	44.9	13.7	4.0	3.2	478.1	0.5
IVa(E of 2°E)	II	0.0	1.1	51.4	76.2	37.5	16.8	10.9	1.2	0.9	0.3	196.2	1.1
	III	5.2	9.3	54.6	30.4	10.0	9.5	3.3	0.6	1.2	0.3	124.4	14.5
	IV	6.2	28.1	265.2	141.1	36.4	17.5	8.2	3.5	0.4	0.9	507.5	34.2
	Total	11.4	38.9	415.9	415.4	192.8	134.3	67.3	18.9	6.5	4.7	1306.3	50.3
	I	0.0	151.7	155.0	16.0	1.6	0.1	0.0	0.0	0.0	0.0	324.4	151.7
IV b	II	0.0	176.3	93.7	10.6	5.5	2.7	1.1	0.0	0.2	0.0	290.1	176.3
	III	970.4	1272.1	390.4	75.8	31.6	12.3	9.5	2.4	1.2	0.0	2765.7	2242.5
	IV	311.1	311.8	261.5	93.7	13.9	1.2	3.6	0.3	0.0	0.0	997.2	622.9
	Total	1281.5	1911.8	900.7	196.0	52.6	16.3	14.3	2.7	1.5	0.0	4377.4	3193.3
	I	0.0	0.0	0.5	13.2	3.0	4.0	0.1	0.3	0.5	0.0	21.6	0.0
IVc+VIId	II	0.0	0.0	0.0	0.3	0.5	0.3	0.1	0.0	0.0	0.0	1.3	0.0
	III	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.3	0.0
	IV	0.0	4.4	111.4	199.3	41.8	28.0	5.5	0.5	0.0	0.0	391.0	4.4
	Total	0.0	4.4	112.0	212.8	45.3	32.5	5.8	0.8	0.5	0.0	414.1	4.4
	I	0	152	221	263	142	112	51	17	5	3	966	152
Total North Sea.	II	0	182	233	124	59	34	16	5	2	1	657	182
	III	976	1282	729	307	95	60	40	11	7	3	3508	2258
	IV	317	354	772	491	103	55	22	5	1	1	2122	672
	Total	1292.9	1970.8	1955.5	1185.1	398.1	260.6	128.6	37.9	15.1	8.4	7252.8	3264

Catches made in the South Buchan Area of Division IVb are included in those for Division IVa (W of 2°E).
Spring spawners transferred to Division IIIa not included.

Table 2.1.7 Millions of HERRING caught annually per age group (winter rings) in the North Sea, 1970-1988.

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

Table 2.1.8 Percentage age composition of North Sea HERRING (2-ring and older) in the catch in 1988.

Division	Quarter	2 1985	3 1984	Older	Total (millions)
IVa(W of 2°E)	I	14.5	46.8	38.7	142.2
	II	53.6	22.7	23.7	164.2
	III	46.1	32.5	21.4	617.2
	IV	61.9	26.2	11.9	215.8
	Total	46.2	31.7	22.1	1139.4
IVa(E of 2°E)	I	9.4	35.1	55.5	477.7
	II	26.3	39.1	34.6	195.1
	III	49.7	27.7	22.6	109.9
	IV	56.0	29.8	14.1	473.3
	Total	33.1	33.1	33.8	1255.9
IV b	I	89.7	9.3	1.0	172.8
	II	82.4	9.3	8.4	113.8
	III	74.6	14.5	10.9	523.2
	IV	69.9	25.0	5.1	374.3
	Total	76.1	16.6	7.4	1184.1
IVc+VIId	I	2.5	61.2	36.3	21.6
	II	3.3	21.7	75.1	1.3
	III	0.9	10.5	88.6	0.3
	IV	28.8	51.6	19.6	386.6
	Total	27.3	51.9	20.7	409.7
IVa + IVb	I	27.8	31.6	40.6	792.6
	II	49.3	26.2	24.5	473.2
	III	58.3	24.5	17.1	1250.2
	IV	62.1	27.4	10.5	1063.4
	Total	51.5	27.2	21.3	3579.4
Total North Sea	I	27.1	32.3	40.5	814.2
	II	49.2	26.2	24.6	474.4
	III	58.3	24.5	17.1	1250.6
	IV	53.2	33.8	12.9	1450.0
	Total	49.0	29.7	21.3	3989.2

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

Year class	1-ringers standard area	2-ringers total North Sea	VPA estimate 1-ringer (billions)
1974	452		1.00
1975	342		0.93
1976	575		1.50
1977	139		1.61
1978	535		3.40
1979	551		4.68
1980	1,293	106	8.04
1981	1,797	149	14.59
1982	2,663	712	13.23
1983	3,416	648	12.96
1984	3,667	853	19.40
1985	5,717	3,962	22.00[2]
1986	4,192	821[1]	29.92[2]
1987	3,471[1]	-	-

[1] Preliminary.
[2] Estimate still inaccurate.

Table 2.3.2 Abundance indices of 0-ringed herring from IKMT sampling during International Young Fish Surveys. Catches corrected for haul duration and water depth. Area divisions are shown in Figure 2.3.4.

Area	North west	North east	Central west	Central east	South west	South east	Division IIIa	Southern Bight	IKMT index
Area factor	27	11	28	33	12	30	10	10	
Year class									
1976	16.2	4.2	36.5	1.5	2.4	0.7	0.5	4.9	1,658
1977	7.1	7.1	15.1	4.4	16.7	3.8	1.8	10.2	1,273
1978	52.7	9.3	108.3	6.0	3.0	1.5	22.3	0.0	5,061
1979	18.4	58.4	78.7	122.4	67.7	43.0	29.8	16.0	9,821
1980	15.6	0.2	43.4	34.6	26.7	101.6	74.5	56.1	7,455
1981	59.1	0.1	86.8	59.6	64.4	193.5	32.7	10.7	13,016
1982	7.6	3.3	20.4	74.4	87.0	92.6	140.9	42.1	8,918
1983	5.7	2.0	34.3	80.4	81.2	142.0	101.7	113.2	11,173
1984	25.0	5.7	90.8	77.7	298.7	215.4	83.1	89.5	17,617
1985	34.8	17.2	126.3	103.1	139.2	233.2	25.5	25.3	17,242
1986	95.1	8.7	218.9	167.0	249.0	279.8	14.3	73.2	26,331
1987	23.3	9.3	125.0	94.3	47.8	185.5	144.9	148.4	16,415
1988	10.7	6.1	28.5	28.8	45.2	128.6	54.4	4.8	7,097

Table 2.3.3 IKMT index and VPA estimates of 0-group, and parameters of fitted regression line.

Year class	IKMT new index	VPA 0-ringers (billions)
1976	1,658	4.48
1977	1,273	4.58
1978	5,061	10.08
1979	9,821	13.97
1980	7,455	33.90
1981	13,016	54.40
1982	8,918	51.37
1983	11,173	38.66
1984	17,617	54.76
1985	17,242	60.92
1986	26,331	84.17[1]
1987	16,415	56.14[1]
1988	7.097	-

Regression of VPA on IKMT index: r^2 = 0.77
a = 0.46
b = 0.00346

[1]Not used in regression.

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

Survey year	North Sea	Division IIIa	% in Division IIIa
1983	153,439	73,710	32.5
1984	163,482	73,897	31.1
1985	250,805	104,189	29.4
1986	229,255	278,162	54.8
1987	446,615	285,269	39.0
1988	262,467	689,426	72.4
1989	262,615	446,124	62.9

Table 2.4.1 Total North Sea estimates of numbers (millions) at age from acoustic surveys, 1984-1988, and mean weights at age in 1988.

Age (rings)	Numbers (millions)					$\bar{w}$ (g)		
	Year					1988		
	1984	1985	1986	1987[1]	1988[1]	Imm	Spawners	Total
1	551	726	1,639	13,736	6,431	54	-	54
2	3,194	2,789	3,206	4,303	4,202	100	134	122
3	1,005	1,433	1,637	955	1,732	119	168	163
4	394	323	833	657	528	-	215	215
5	158	113	135	368	349	-	240	240
6	44	41	36	77	174	-	270	270
7	52	17	24	38	43	-	277	277
8	39	23	6	11	23	-	297	297
≥9	41	19	8	20	14	-	310	310
SSB ('000 t)	807	697	942	817	897			

[1] 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 and 1988 estimates are from the summer survey in Divisions IVa,b, excluding estimates of spring spawner immigrants from Division IIIa and the western Baltic.

Table 2.5.1 ICES International herring larvae surveys. Estimated mortality rates rates (z/k) per mm for the standard areas over the years 1980-1988. 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**
Mean	0.31	0.31	0.37	0.35	0.58
88z k	0.27		0.37	0.36	0.56
87z k	0.26		0.37	0.36	0.54

88z/k: Mortality rates used in the 1988 HAWG Report.
87z/k: Mortality rates used in the 1987 HAWG Report.

Table 2.5.2 Larvae production estimates (LPE * 10'E11 larvae) calculated using area-specific natural mortality rates (z/k) and larvae abundance indices. IVa is the sum of Orkney-Shetland and Buchan LPE's. VIa(N)+Orkney/Shetland is combined LPE's for Orkney-Shetland and VIa(N).

YEAR	Ork-Shet LPE	Ork-Shet LAI	Buchan LPE	Buchan LAI	IVa LPE	VIa(N) +OR/SH	C.N.Sea LPE	C.N.Sea LAI	IVc+VIId LPE	IVc+VIId LAI
1972	174	5779		7	174		23	112	20	171
1973	95	2387		10	95	229	80	734	10	133
1974	78	1284		379	78	153	45	635	2	25
1975	54	439		441	54	147	46	59	1	25
1976	20	655		1	20	55	10	76	1	18
1977	-	1321		228	-	151	67	174	-	23
1978	102	3705		363	102	198	73	462	3	111
1979	299	5649		200	299	517	57	188	11	403
1980	332	3982		18	332	586	103	214	127	1193
1981	225	3939		20	225	457	187	3364	406	4855
1982	336	3795	92	1002	428	554	76	338	190	3709
1983	282	3346	277	4483	559	396	64	661	258	2354
1984	213	3538	433	4296	646	391	523	1055	178	2267
1985	314	10487	477	4351	791	575	633	3802	206	4065
1986	218	5500	831	3780	1049	789	451	2027	359	4780
1987	359	9596	200	3308	559	597	331	1970	175	3317
1988	413	16502	727	12319	1140	803	568	2946	231	3907

Table 2.5.3. The LPE index of SSB ('000 tonnes) estimated from larvae production estimates (LPE * 10E11 larvae), and Fec, i.e. number of eggs (* 10E5) per kg SSB; compared to LAI (*10E9 larvae). 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 year where an estimate was available.

YEAR	IVa (inc.Buch) LPE	Fec.	SSB	IVb LPE	Fec.	SSB	IVa+IVb SSB	LAI	IVc+VIId LPE	Fec.	SSB	North Sea SSB	LAI
1972	174	1.56 *	112	23	1.79 *	13	124	6234	20	0.94	21	146	6405
1973	95	1.56 *	61	80	1.79 *	45	106	5333	10	0.93	11	116	5466
1974	78	1.56 *	50	45	1.79 *	25	75	4203	2	0.87	2	77	4228
1975	54	1.59	34	46	1.79 *	26	60	1116	1	1.01	1	61	1141
1976	20	1.52	13	10	1.79 *	6	19	960	1	0.74	1	20	978
1977	-	1.57	0	67	1.79 *	37	-	2245	2	1.02	2	-	2268
1978	102	1.57	65	73	1.79 *	41	106	5916	3	1.18	3	108	6027
1979	299	1.64	182	57	1.79 *	32	214	6601	11	1.07	10	224	7004
1980	332	1.69	196	103	1.79 *	58	254	4856	127	1.14	111	365	6049
1981	225	1.51	149	187	1.79 *	104	253	17415	406	1.06	383	636	22270
1982	428	1.60	268	76	1.83 *	42	309	6149	190	1.11	171	480	9858
1983	559	1.53	365	64	1.82 *	35	401	10473	258	1.1	235	635	12827
1984	646	1.67	387	523	1.67	313	700	12054	178	1.04	171	871	14321
1985	791	1.60 *	494	633	1.88	337	831	30046	206	1.08	191	1022	34111
1986	1049	1.60 *	656	451	1.76 *	256	912	17388	359	1.08 *	332	1244	22168
1987	559	1.60 *	349	331	1.76 *	188	537	20784	175	1.08 *	162	699	24101
1988	1140	1.60 *	713	568	1.76 *	323	1035	40605	231	1.08 *	214	1249	44512

Table 2.6.1 North Sea herring, 1988.

Mean weight (g) at age (w.r.) and year class weighted by numbers caught.

Division	Quarter	0 1987	1 1986	2 1985	3 1984	4 1983	5 1982	6 1981	7 1980	8 1979	9+ 1978<
	I			74	115	148	169	180	197	199	249
IVa(W of 2 E)	II		68	108	147	200	223	255	262	325	340
	III		59	140	183	230	254	272	295	313	299
	IV		93	124	152	170	201	204	195	201	250
	Total		84	128	162	198	224	249	262	295	294
	I		15	86	125	157	180	192	216	232	231
IVa(E of 2 E)	II		88	120	148	164	193	211	221	199	272
	III	14	86	136	160	198	215	252	263	213	283
	IV	17	96	127	149	175	190	196	216	235	239
	Total	16	92	122	140	164	186	199	218	225	238
	I		14	57	81	107	160				
IV b	II		44	88	87	126	130	151	279	167	
	III	11	58	111	172	201	210	232	248	239	194
	IV	12	65	105	122	142	191	162	208	200	238
	Total	11	54	98	136	175	195	208	244	228	205
	I			98	96	118	134	181	145	160	
IVc+VIId	II			102	142	176	192	201	197	206	
	III			131	184	208	220	227	238	234	
	IV		80	103	135	159	184	197	203		
	Total		80	103	132	156	178	197	185	165	
IVa	Total	16	90	126	150	176	200	218	237	260	263
IVa + IVb	Total	11	55	112	147	176	199	217	238	257	263
North Sea	Total	11	55	111	145	174	197	216	237	253	263

Table 2.6.2 Mean weight of herring (g) by quarter and areas, 1986-1988.
Spring Spawners transferred to IIIa are not included.

AREA	YEAR QUARTER	WINTER RINGS									
		0	1	2	3	4	5	6	7	8	9
IVc+VIId	1986 I	12	18	70	95	118	145	167	200	202	
	1987 I			74	100	126	150	166	240	232	
	1988 I			98	96	118	134	181	145	160	
	1986 II	2	25	83	104	129	153	163	198	202	
	1987 II			82	109	136	157	171	184		
	1988 II			102	142	176	192	201	197	206	
	1986 III	20	80	113	152	174	214	220	170		232
	1987 III	6	49	110	170	200	207	207	237		
	1988 III			131	184	208	220	227	238	234	
	1986 IV	20	80	113	152	174	214	220	170		232
	1987 IV	27	101	105	142	167	178	206	186	174	234
	1988 IV		80	103	135	159	184	197	203		
	1986 Total	19	59	108	139	164	185	209	174	202	232
	1987 Total	20	100	104	128	148	164	198	210	197	234
	1988 Total		80	103	132	156	178	197	185	165	
IVa + IVb	1986 I		14	77	118	150	177	187	226	229	250
	1987 I		14	49	123	161	184	209	231	271	257
	1988 I		14	65	119	155	178	191	212	230	232
	1986 II	2	30	130	167	196	224	225	259	259	284
	1987 II		15	104	162	192	220	245	255	268	290
	1988 II		45	102	143	170	200	217	252	253	315
	1986 III	6	78	146	190	224	248	282	288	327	364
	1987 III	10	54	134	182	219	248	265	286	310	342
	1988 III	11	58	124	178	217	239	261	283	283	296
	1986 IV	20	79	129	167	183	198	216	227	271	262
	1987 IV	11	61	104	147	172	197	214	230	261	264
	1988 IV	12	69	117	141	166	194	191	212	213	243
	1986 Total	6	67	122	158	184	210	223	245	253	263
	1987 Total	11	35	97	150	185	213	237	259	269	304
	1988 Total	11	55	112	147	176	199	217	238	257	263
Total N S	1986 Total	6	67	121	153	182	208	221	238	253	262
	1987 Total	11	35	98	147	179	210	234	258	269	299
	1988 Total	11	55	111	145	174	197	216	237	253	263

Table 2.7.1 Time series of relative estimates of spawning stock, and the spawning stock for the converged part of the VPA.

Year	SSB VPA	SSB LPE	SSB Acoustic	LAI	IYFS 2+ Total Area
1972	290	146	-	6,405	-
1973	236	116	-	5,466	-
1974	164	77	-	4,228	-
1975	88	61	-	1,141	-
1976	85	20	-	978	-
1977	58	-	-	2,268	-
1978	79	108	-	6,027	-
1979	123	224	-	7,004	-
1980	148	365	-	6,049	35.4
1981	214	636	305	22,270	863.0
1982	293	480	402	9,858	201.5
1983	451	635	440	12,827	270.8
1984	734	871	807	14,321	377.1
1985	759	1022	697	34,111	1,166.5
1986	-	1244	942	22,168	1,204.7
1987	-	699	667[1]	24,101	1,705.3
1988	-	1249	801[2]	44,512	4,760.1

[1] Reduced by 150,000 t (catches of spawners between time of the survey [15 July] and 1 November).
[2] Reduced by 94,000 t (catches of spawners between time of the survey [15 July] and 1 September).

Table 2.7.2

Analysis by RCRTINX2 of data from file survey-ind-1
Prediction of SSB from LPE, Acoustics, LAI, IYFS 2+, Total North Sea.

Data for 4 surveys over 17 years
REGRESSION TYPE = C
TAPERED TIME WEIGHTING APPLIED
POWER = 3 OVER 10 YEARS
PRIOR WEIGHTING NOT APPLIED
FINAL ESTIMATES SHRUNK TOWARDS MEAN
ESTIMATES WITH S.E.'S GREATER THAN THAT OF MEAN INCLUDED
MINIMUM S.E. FOR ANY SURVEY TAKEN AS .20
MINIMUM OF 5 POINTS USED FOR REGRESSION

Yearclass = 1986

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
LPE SS	7.1269	1.359	-2.769	.7938	13	6.9195	.43835	.53338	.14477
ACOUST	6.8491	1.428	-2.786	.9303	5	6.9926	.17646	.23996	.71531
LAI	10.0065	1.598	-9.354	.5410	14	6.6403	.82353	.93074	.04754
IYFS 2	7.0948	.936	.538	.3593	6	7.1750	.98751	1.19529	.02883
MEAN						5.7751	.80509	.80509	.06354

Yearclass = 1987

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
LPE SS	6.5511	1.522	-3.832	.8189	13	6.1385	.39137	.42970	.17507
ACOUST	6.5043	1.422	-2.747	.9272	5	6.4997	.18306	.21207	.71874
LAI	10.0900	1.748	-10.806	.4581	14	6.8350	.91600	1.06515	.02849
IYFS 2	7.4421	.975	.297	.3488	6	7.5563	1.01550	1.33054	.01826
MEAN						5.9243	.73745	.73745	.05944

Yearclass = 1988

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
LPE SS	7.1309	1.696	-4.979	.8180	13	7.1140	.37751	.51237	.16496
ACOUST	6.6871	1.412	-2.687	.9222	5	6.7573	.19555	.24771	.70579
LAI	10.7035	1.799	-11.306	.3823	14	7.9523	1.01733	1.49439	.01939
IYFS 2	8.4682	1.023	.003	.3360	6	8.6684	1.05854	1.84544	.01272
MEAN						6.0693	.66768	.66768	.09714

Yearclass		Weighted Average Prediction	Internal Standard Error	External Standard Error	Virtual Population Analysis	Ext.SE/ Int.SE
1986	6.89	985.48	.20	.15		.75
1987	6.43	620.85	.18	.12		.69
1988	6.80	894.94	.21	.19		.90

Table 2.7.3 Input file for the VPA tuning program ("Fleet Data") total North Sea.

```
Acoustic Survey Data 1984-1987 and IYFS Data 1984-1989
102
Combined Acoustic Survey
1984 1988
1  1
2  8
1 4179.5  1315.4   513.7   207.5    54.7    65.4    44.3
1 3548.3  2233.8   556.1   194.7    68.4    29.6    32.7
1 4120.3  2060.4   951.2   176.4    49.9    33.7     6.3
1 5695.1  1387.0   946.9   516.1   114.1    50.0    16.4
1 5369.2  2321.8   751.0   515.8   254.7    68.0    31.2
IYFS 2+
1984 1989
1 1
1 4
1 1447  266   77  28
1 2152  805  295  39
1 2967  790  319  75
1 4382 1400  174  85
1 4957 3962  714  56
1 1917  821  391  86
```

File name: (Herring-NSEA) IYFS-Acoust:Symb

Table 2.7.4 VIRTUAL POPULATION ANALYSIS

NORTH SEA HERRING (FISHING AREA IV + VIId)

CATCH IN NUMBERS UNIT: millions

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	195	1269	142	443	497	157	375	645	839	112	898	684
1	2393	336	2147	1262	2972	3209	1383	1674	2425	2503	1196	4379
2	1142	1889	270	2961	1548	2218	2570	1172	1795	1883	2003	1147
3	1967	480	797	177	2243	1325	741	1365	1494	296	884	663
4	166	1456	335	158	148	2039	450	372	621	133	125	208
5	168	124	1082	81	149	145	890	298	157	191	50	27
6	113	158	127	230	95	152	45	393	145	50	61	31
7	126	61	145	22	256	118	65	68	163	43	8	27
8	129	56	86	42	26	413	96	82	14	27	12	0
9+	142	88	87	51	58	78	236	173	92	25	12	12
TOTAL	6539	5917	5218	5427	7992	9854	6850	6241	7746	5264	5249	7177

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	750	289	996	264	238	257	130	542	792	7889	9557	10030
1	3341	2368	846	2461	127	144	169	159	161	447	840	1147
2	1441	1344	773	542	902	45	5	34	108	264	268	545
3	344	659	362	260	117	186	6	10	92	57	230	216
4	131	150	126	141	52	11	5	10	32	40	34	105
5	33	59	56	57	35	7	0	2	22	29	14	26
6	5	31	22	16	6	4	0	0	2	23	7	23
7	0	4	5	9	4	2	0	1	1	19	8	13
8	1	1	2	3	1	1	0	1	0	6	4	11
9+	0	1	1	1	0	0	0	0	0	1	1	12
TOTAL	6046	4907	3189	3753	1482	656	315	759	1211	8773	10963	12128

	1984	1985	1986	1987	1988
0	2190	1293	704	1798	1293
1	560	1620	1763	3522	1971
2	976	1223	1155	2007	1956
3	422	1173	827	687	1185
4	193	366	458	482	398
5	78	124	128	249	261
6	22	43	61	76	129
7	24	20	20	24	38
8	11	13	13	8	15
9+	18	16	15	8	8
TOTAL	4492	5891	5145	8859	7253

Table 2.7.5 Herring in the total North Sea (Sub-area IV). Weight at age (g) in the stock at time of spawning and proportions of maturity by years.

Age	Weight at age					Proportions of maturity						
	1947-1984	1985	1986	1987	1988	1947-1955	1956-1971	1972-1984	1985	1986	1987	1988
0	15	9	6	6	7	-	-	-	-	-	-	-
1	50	64	78	49	43	-	-	-	-	-	-	-
2	155	141	146	133	122	0.70	1.00	0.82	70	0.75	0.63	0.66
3	187	193	190	183	163	1.00	1.00	1.00	1.00	1.00	1.00	0.90
4	223	228	224	220	215	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	239	248	248	247	239	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	278	258	281	263	270	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	299	300	287	285	271	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	305	318	328	310	297	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9+	312	316	364	342	310	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 2.7.6

Module run at 14.06.22 12 APRIL 1989
DISAGGREGATED Qs
LOG TRANSFORMATION
NO explanatory variate (Mean used)
Fleet 1 ,Combined Acoustic Su, has terminal q estimated as the mean
Fleet 2 ,IYFS 2+ , has terminal q estimated as the mean
FLEETS COMBINED BY ** VARIANCE **

Regression weights
, 1.000, 1.000, 1.000, 1.000, 1.000,
Oldest age F = 1.000*average of 5 younger ages. Fleets combined by variance of predictions
Fishing mortalities

Age,	84,	85,	86,	87,	88,
1,	.066,	.212,	.148,	.269,	.100,
2,	.256,	.353,	.410,	.449,	.423,
3,	.408,	.599,	.460,	.492,	.564,
4,	.497,	.711,	.469,	.506,	.563,
5,	.574,	.610,	.512,	.445,	.501,
6,	.302,	.652,	.614,	.575,	.387,
7,	.566,	.447,	.643,	.453,	.563,
8,	.469,	.604,	.540,	.494,	.515,

Log catchability estimates

Age 1

Fleet,	84,	85,	86,	87,	88
1 ,	No data for this fleet at this age				
2 ,	-1.76,	-1.27,	-1.39,	-1.09,	-1.38

SUMMARY STATISTICS

Fleet ,	Pred. q ,	SE(q),	Partial F ,	Raised, F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1 ,	No data for this fleet at this age							
2 ,	-1.38 ,	.268,	.2519 ,	.1002,	.000E+00,	.000E+00,	-1.379,	.110

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.100	.268	0.000	.268	0.000

Age 2

Fleet,	84,	85,	86,	87,	88
1 ,	.09,	.02,	.38,	.24,	.15
2 ,	-2.66,	-1.46,	-1.27,	-1.16,	-.15

SUMMARY STATISTICS

Fleet ,	Pred. q ,	SE(q),	Partial F ,	Raised, F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1 ,	.18 ,	.152,	1.1947 ,	.4351,	.000E+00,	.000E+00,	.178,	.062
2 ,	-1.34 ,	.980,	.2615 ,	.1291,	.000E+00,	.000E+00,	-1.341,	.400

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.423	.150	.184	.184	1.501

Age 3

Fleet,	84,	85,	86,	87,	88
1 ,	.24,	.13,	.14,	-.01,	.10
2 ,	-2.60,	-1.89,	-1.73,	-2.08,	-1.08

SUMMARY STATISTICS

Fleet ,	Pred. q ,	SE(q),	Partial F ,	Raised, F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1 ,	.12 ,	.097,	1.1282 ,	.5759,	.000E+00,	.000E+00,	.121,	.040
2 ,	-1.88 ,	.605,	.1532 ,	.2543,	.000E+00,	.000E+00,	-1.876,	.247

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.564	.259E-01	.123	.128	1.790

contd.

Table 2.7.6 cont'd.

Age 4

Fleet,	84,	85,	86,	87,	88
1 ,	.28,	.08,	-.03,	.00,	.06
2 ,	-2.63,	-2.58,	-2.57,	-2.42,	-2.54

SUMMARY STATISTICS

Fleet ,	Pred. q ,	SE(q),	Partial F ,	Raised, F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1 ,	.08 ,	.134,	1.0809 ,	.5730,	.000E+00,	.000E+00,	.078,	.055
2 ,	-2.54 ,	.087,	.0785 ,	.5579,	.000E+00,	.000E+00,	-2.545,	.036

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.562	.730E-01	.122E-01	.730E-01	.028

Age 5

Fleet,	84,	85,	86,	87,	88
1 ,	.43,	-.04,	-.35,	-.08,	-.01
2 ,	No data for this fleet at this age				

SUMMARY STATISTICS

Fleet ,	Pred. q ,	SE(q),	Partial F ,	Raised, F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1 ,	-.01 ,	.307,	.9911 ,	.5008,	.000E+00,	.000E+00,	-.009,	.125
2 ,	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.501	.307	0.000	.307	0.000

Age 6

Fleet,	84,	85,	86,	87,	88
1 ,	-.27,	.03,	-.69,	-.14,	-.27
2 ,	No data for this fleet at this age				

SUMMARY STATISTICS

Fleet ,	Pred. q ,	SE(q),	Partial F ,	Raised, F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1 ,	-.27 ,	.291,	.7652 ,	.3864,	.000E+00,	.000E+00,	-.268,	.119
2 ,	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.386	.291	0.000	.291	0.000

Age 7

Fleet,	84,	85,	86,	87,	88
1 ,	.43,	-.41,	.07,	-.05,	.01
2 ,	No data for this fleet at this age				

SUMMARY STATISTICS

Fleet ,	Pred. q ,	SE(q),	Partial F ,	Raised, F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1 ,	.01 ,	.329,	1.0097 ,	.5628,	.000E+00,	.000E+00,	.010,	.134
2 ,	No data for this fleet at this age							

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.563	.329	0.000	.329	0.000

Table 2.7.7 Separable - VPA.

Title : NORTH SEA HERRING (FISHING AREA IV)
At 17.31.56 19 APRIL 1989
from 78 to 88 on ages 0 to 8
with Terminal F of .600 on age 4 and Terminal S of 1.000

Initial sum of squared residuals was 94.232 and
final sum of squared residuals is 61.822 after 93 iterations

Matrix of Residuals

Years	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88		WTS
Ages												
0/ 1	.353	2.357	1.470	2.099	2.725	3.370	.963	-.060	-1.169	.254	.000	.209
1/ 2	1.852	1.192	-.004	-.020	.663	.254	-.545	.156	-.118	.503	.000	.424
2/ 3	-.636	-.390	.864	-.680	.199	.081	-.243	-.109	.224	.128	.000	.642
3/ 4	-.640	-.729	.867	-.515	.578	-.260	-.134	.203	.017	-.086	.000	.576
4/ 5	.678	-.442	.021	-.175	-.081	-.204	.035	.172	-.050	-.157	.000	1.000
5/ 6	.269	.284	-.089	.313	-.735	-.257	.235	-.111	-.076	-.048	.000	.918
6/ 7	-1.521	-1.570	-2.140	-.052	-.908	-.505	-.271	-.054	.348	-.017	.000	.358
7/ 8	-1.210	1.091	-1.395	.548	-.600	-.242	.286	-.399	.356	-.241	.000	.382
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	6.120	
WTS	.001	.001	.001	.001	.001	.001	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	78
F-values	.1590

	79	80	81	82	83	84	85	86	87	88
F-values	.1794	.3720	.6242	.3641	.4469	.4905	.6545	.5772	.6172	.6000

Selection-at-age (S)

	0	1	2	3	4	5	6	7	8
S-values	.0597	.2571	.6311	.8846	1.0000	.9558	.9598	.9662	1.0000

Table 2.7.8 VIRTUAL POPULATION ANALYSIS

NORTH SEA HERRING (FISHING AREA IV)

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

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	.03	.02	.00	.01	.01	.01	.02	.03	.03	.01	.04	.03
1	.25	.13	.09	.12	.31	.25	.19	.30	.30	.33	.27	.60
2	.43	.61	.25	.30	.39	.77	.59	.42	1.33	.78	.97	.88
3	.32	.35	.62	.27	.41	.74	.70	.80	1.87	.91	1.26	1.21
4	.32	.39	.42	.22	.36	.77	.57	.91	1.07	.87	1.32	1.21
5	.26	.37	.49	.15	.30	.63	.82	.81	1.17	1.05	.87	1.06
6	.26	.37	.71	.16	.23	.49	.37	.98	1.12	1.53	1.08	2.43
7	.42	.19	.59	.23	.24	.44	.36	1.30	1.43	1.11	1.00	2.69
8	.30	.30	.40	.30	.40	.67	.69	.90	.90	.90	1.00	.00
9+	.30	.30	.40	.30	.40	.67	.69	.90	.90	.90	1.00	.00
(2- 6)U	.32	.42	.50	.22	.34	.68	.61	.79	1.31	1.03	1.10	1.36
(3- 6)U	.29	.37	.56	.20	.33	.66	.61	.88	1.31	1.09	1.13	1.48

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	.06	.05	.07	.14	.14	.09	.05	.09	.09	.44	.32	.36
1	.58	.67	.44	.68	.22	.27	.19	.17	.08	.16	.18	.13
2	.81	1.02	1.03	1.24	1.32	.19	.02	.09	.28	.30	.24	.29
3	.80	1.33	.96	1.50	1.17	1.34	.04	.06	.40	.25	.51	.32
4	.80	.99	.98	1.30	1.71	.27	.09	.08	.26	.28	.22	.44
5	.53	.94	1.18	1.79	1.27	1.14	.01	.05	.21	.35	.14	.24
6	.49	1.26	1.05	1.26	.89	.42	.07	.01	.06	.32	.12	.30
7	.08	.72	.61	1.82	1.42	.50	.03	.38	.06	.79	.15	.30
8	1.00	1.00	1.00	1.00	1.00	.80	.10	.10	.30	.30	.30	.30
9+	1.00	1.00	1.00	1.00	1.00	.80	.10	.10	.30	.30	.30	.30
(2- 6)U	.69	1.11	1.04	1.41	1.27	.67	.05	.06	.24	.30	.24	.32
(3- 6)U	.65	1.13	1.04	1.46	1.26	.79	.05	.05	.23	.30	.25	.33

	1984	1985	1986	1987	1988
0	.09	.04	.02	.03	.04
1	.07	.22	.15	.28	.11
2	.27	.37	.42	.47	.46
3	.41	.66	.49	.52	.61
4	.51	.72	.55	.57	.61
5	.59	.63	.53	.59	.61
6	.28	.69	.65	.60	.61
7	.53	.41	.71	.50	.61
8	.38	.54	.47	.60	.61
9+	.38	.54	.47	.60	.61
(2- 6)U	.41	.61	.53	.55	.58
(3- 6)U	.45	.67	.56	.57	.61

Table 2.7.9 VIRTUAL POPULATION ANALYSIS

NORTH SEA HERRING (FISHING AREA IV)

STOCK SIZE IN NUMBERS   UNIT: millions

BIOMASS TOTALS   UNIT: tonnes

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

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	12211	109038	46365	47742	62789	34905	27868	40286	38705	21584	41093	32382
1	16517	4379	39375	16974	17306	22810	12750	10035	14446	13752	7875	14596
2	3718	4712	1418	13245	5517	4680	6561	3897	2740	3937	3641	2216
3	7963	1786	1895	820	7292	2773	1601	2689	1893	539	1333	1020
4	636	4752	1031	838	512	3957	1088	649	985	239	178	309
5	773	418	2920	615	608	323	1654	559	237	305	91	43
6	524	541	261	1618	480	409	155	656	224	66	96	35
7	382	367	339	116	1246	344	226	97	223	66	13	30
8	520	226	274	170	84	884	200	143	24	48	20	0
9+	574	354	276	206	183	168	495	304	161	44	20	0
TOTAL NO	43819	126573	94154	82345	96017	71253	52598	59315	59639	40581	54360	50631
SPS NO	10517	8671	5534	12414	10729	7308	6760	4993	2219	2526	2238	1559
TOT.BIOM	3998290	4517200	4509452	4702708	4873246	4406394	3336030	2840008	2544078	1915247	1927755	1847338
SPS BIOM	2111987	1802300	1217193	2255122	2101324	1509984	1299187	945204	436423	434313	380681	266093
SPS BIOM (2+)	2111987	1802300	1217193	2255122	2101324	1509984	1299187	945204	436423	434313	380681	266093

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	20864	10304	21776	3123	2910	4482	4583	10079	13971	33899	54403	51373
1	11516	7241	3623	7435	997	933	1501	1610	3395	4682	8040	14593
2	2942	2380	1358	858	1379	294	261	455	501	1156	1466	2476
3	679	968	639	360	185	273	180	189	308	279	631	857
4	248	250	210	201	66	47	59	142	146	170	177	311
5	84	101	84	71	50	11	32	48	119	102	116	129
6	14	44	36	23	11	13	3	29	42	87	65	92
7	3	8	11	11	6	4	8	3	26	36	57	52
8	2	2	3	6	2	1	2	7	2	22	15	44
9+	1	1	2	2	1	0	3	1	0	4	4	49
TOTAL NO	36352	21300	27742	12090	5606	6059	6632	12564	18510	40437	64975	69975
SPS NO	1697	1351	916	482	504	325	423	652	758	1151	1593	2469
TOT.BIOM	1552408	1162074	919568	692966	373889	228751	243572	392146	595561	1079021	1671532	2214016
SPS BIOM	289626	236016	164638	87608	84664	57924	78524	123041	148193	214148	293438	450644
SPS BIOM (2+)	328613	263529	180204	96155	97664	63832	84398	132823	157642	235648	321983	497114

	1984	1985	1986	1987	1988	1989
0	38661	54765	60915	84174	56138	0
1	13228	12958	19397	22000	29923	19902
2	4708	4542	3841	6122	6090	9871
3	1370	2657	2326	1865	2835	2854
4	507	743	1127	1163	911	1261
5	182	277	327	586	597	448
6	91	91	133	175	294	293
7	61	62	41	63	87	145
8	35	33	37	18	35	43
9+	59	40	41	19	19	26
TOTAL NO	58904	76168	88184	116185	96929	
SPS NO	4172	4270	4337	4745	5109	
TOT.BIOM	2456562	2778722	3290971	3215120	3343062	
SPS BIOM	733283	756884	801143	820647	821630	
SPS BIOM (2+)	822810	879579	887538	1000499	1000510	

Table 2.7.10 Calculation of catches ('000 t) of spawners between date of acoustic survey and the date when 67% annual catch was reached.

	0	1	2	3	4+	Total
1987						
Catches by age Q.3[1]	4.6	16.1	54.9	31.9	54.1	162
Maturity ogive	-	-	0.63	1.0	1.0	
Catch of spawners Q.3	-	-	34.6	31.9	54.1	121

Spawners relative to total catch % by weight = 74%

Monthly catches:[3] July: 52.1, Aug: 76.7, Sep: 43.6
Oct: 41.6, Nov: 161.5

Total catch 15 July-3 Nov (incl. 50% from July, 10% from Nov.)	204
Catch of spawners 15 July-3 Nov.	150

	0	1	2	3	4+	Total
1988						
Catches by age Q.3[2]	11.0	74.6	90.8	54.7	51.0	282
Maturity ogive	-	-	0.66	0.90	1.0	
Catches of spawners Q.3	-	-	59.9	49.2	52.0	160

Spawners relative to total catch (% by weight) = 57%

Monthly catches[4] July: 70.3, Aug: 133.5

Total catch 15 July-1 Sep (incl. 50% from July)	167
Catch of spawners 15 July-1 Sep.	96

[1] Calculated from Tables 2.1.6 and 2.7.1 in the 1988 Working Group report.
[2] Calculated from Tables 2.1.6 and 2.6.1 in the present report.
[3] Taken from Figures 2.11.7-2.11.11 in the 1988 Working Group report and raised by the ratio between total annual catch of autumn spawners (612) and the annual total shown in Figure 2.11.1-2.11.12 (509).
[4] Taken from Figures 2.10.7-2.10.8 in the present report and raised by the same method as in footnote 3 (factor = 675/492).

Table 2.7.11 VIRTUAL POPULATION ANALYSIS

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

CATCH IN NUMBERS   UNIT: millions

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
1	0	4	4	6	6	4	22	5	2	4	24	22
2	26	55	42	23	162	82	131	135	43	24	127	94
3	61	10	15	20	9	84	42	29	115	20	40	42
4	33	1	5	10	5	5	31	9	55	8	5	4
5	2	3	2	2	2	2	1	5	7	1	2	1
6	2	0	0	3	0	1	0	0	2	0	0	0
7	1	0	0	1	0	0	1	0	1	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9+	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	124	73	69	64	184	178	227	184	226	58	198	163

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	1	0	0	23	7	21	25	14	13	11	20	4
2	6	3	22	99	223	201	252	173	314	108	161	112
3	3	4	9	84	40	221	105	117	169	194	77	213
4	1	1	6	30	19	27	65	33	44	46	81	45
5	0	0	1	18	7	7	11	23	12	14	14	33
6	0	0	0	2	3	2	3	2	8	9	7	6
7	0	0	0	1	1	2	1	1	1	2	0	1
8	0	0	0	0	0	1	1	0	0	0	0	1
9+	0	0	0	0	0	0	0	0	0	0	1	0
TOTAL	11	8	37	257	300	481	462	361	563	383	360	414

Table 2.8.1

List of input variables for the ICES prediction program.

HERRING - TOTAL NORTH SEA (SSB CALCULATED USING THE MATURITY OGIVE FOR 1988)
The reference F is the mean F for the age group range from 2 to 6

The number of recruits per year is as follows:

Year	Recruitment
1989	18400.0
1990	8650.0
1991	15100.0

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

Data are printed in the following units:

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

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
1	18400.0	.16	1.00	.00	55.000	43.000
2	6176.0	.46	.30	.66	111.000	122.000
3	2854.0	.61	.20	.90	145.000	163.000
4	1261.0	.61	.10	1.00	174.000	215.000
5	448.0	.61	.10	1.00	197.000	239.000
6	293.0	.61	.10	1.00	216.000	270.000
7	145.0	.61	.10	1.00	237.000	277.000
8	43.0	.61	.10	1.00	253.000	297.000
9+	26.0	.61	.10	1.00	263.000	310.000

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

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

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

The data from the files were selected as follows:

F at age:	year 1988 from file FNEWMOR
M at age:	year 1988 from file NATMOR
Maturity ogive:	year 1988 from file MORPROP
Catch weight:	year 1988 from file WECA
Stock weight:	year 1988 from file WEST

Table 2.8.2

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

HERRING - TOTAL NORTH SEA (SSB CALCULATED USING THE MATURITY OGIVE FOR 1988)

Year 1989					Year 1990					Year 1991	
factor	ref. F	stock biomass	sp.stock biomass	catch	factor	ref. F	stock biomass	sp.stock biomass	catch	stock biomass	sp.stock biomass
.7	.42	2528	961	514	.2	.14	2302	1311	197	2746	1562
					.5	.30		1178	403	2482	1212
					.8	.45		1069	566	2274	964
					1.0	.58		981	693	2113	790
1.0	.58	2528	865	672	.2	.14	2102	1161	177	2568	1415
					.5	.30		1044	362	2331	1101
					.8	.45		948	508	2144	878
					1.0	.58		871	623	1999	721

The data unit of the biomass and the catch is 1000 tonnes.
The spawning stock biomass is given for the time of spawning.
The spawning stock biomass for 1991 has been calculated with the same fishing mortality as for 1990.
The reference F is the mean F for the age group range from 2 to 6

Table 2.8.3

13.34.34 14 APRIL 1989
HERRING - TOTAL NORTH SEA (SSB CALCULATED USING THE MATURITY OGIVE FOR 1988)

* Year 1989. F-factor .719 and reference F .4168 *

* Run depending on a TAC value *

						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	.1128	1252.05	68862	18400.0	791200	.00	0	.00	0
2	.3291	1508.51	167444	6176.0	753472	4076.16	497291	2674.25	326258
3	.4388	925.44	134189	2854.0	465202	2568.60	418681	1674.27	272906
4	.4388	427.77	74431	1261.0	271115	1261.00	271115	878.91	188964
5	.4388	151.97	29938	448.0	107072	448.00	107072	312.25	74628
6	.4388	99.39	21469	293.0	79110	293.00	79110	204.22	55138
7	.4388	49.19	11657	145.0	40165	145.00	40165	101.06	27994
8	.4388	14.59	3690	43.0	12771	43.00	12771	29.97	8901
9+	.4388	8.82	2319	26.0	8060	26.00	8060	18.12	5617
Total		4437.74	514004	29646.0	2528167	8860.76	1434266	5893.05	960410

* Year 1990. F-factor .518 and reference F .3000 *

						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	.0812	429.16	23603	8650.0	371950	.00	0	.00	0
2	.2368	1108.25	123015	6047.0	737734	3991.02	486904	2785.31	339807
3	.3158	812.28	117780	3292.3	536644	2963.07	482980	2097.28	341856
4	.3158	389.29	67737	1506.7	323947	1506.73	323947	1140.38	245180
5	.3158	190.09	37448	735.7	175842	735.74	175842	556.85	133087
6	.3158	67.54	14587	261.4	70575	261.39	70575	197.83	53415
7	.3158	44.17	10468	171.0	47354	170.95	47354	129.39	35840
8	.3158	21.86	5530	84.6	25126	84.60	25126	64.03	19017
9+	.3158	10.40	2735	40.3	12480	40.26	12480	30.47	9445
Total		3073.04	402907	20789.0	2301654	9753.77	1625210	7001.54	1177651

* Year 1991. F-factor .518 and reference F .3000 *

						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	.0812	749.16	41204	15100.0	649300	.00	0	.00	0
2	.2368	537.73	59688	2934.1	357954	1936.47	236249	1351.45	164877
3	.3158	872.16	126463	3535.0	576206	3181.51	518585	2251.89	367058
4	.3158	507.85	88365	1965.6	422600	1965.58	422600	1487.66	319847
5	.3158	256.86	50601	994.2	237604	994.16	237604	752.44	179832
6	.3158	125.43	27092	485.5	131072	485.45	131072	367.42	99202
7	.3158	44.56	10560	172.5	47773	172.47	47773	130.53	36157
8	.3158	29.14	7373	112.8	33500	112.80	33500	85.37	25355
9+	.3158	21.29	5598	82.4	25539	82.38	25539	62.35	19329
Total		3144.19	416947	25381.9	2481552	8930.83	1652926	6489.12	1211660

Table 2.8.4

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

HERRING - TOTAL NORTH SEA (SSB DEFINED AS 2+ STOCK)

Year 1989					Year 1990					Year 1991	
factor	ref. F	stock biomass	sp.stock biomass	catch	factor	ref. F	stock biomass	sp.stock biomass	catch	stock biomass	sp.stock biomass
.7	.42	2528	1159	514	.2	.14	2302	1544	197	2746	1711
					.5	.30		1391	403	2482	1338
					.8	.45		1265	566	2274	1072
					1.0	.58		1164	693	2113	884
1.0	.58	2528	1046	672	.2	.14	2102	1381	177	2568	1562
					.5	.30		1245	362	2331	1225
					.8	.45		1133	508	2144	985
					1.0	.58		1042	623	1999	814

The data unit of the biomass and the catch is 1000 tonnes.
The spawning stock biomass is given for the time of spawning.
The spawning stock biomass for 1991 has been calculated with the same fishing mortality as for 1990.
The reference F is the mean F for the age group range from 2 to 6

Table 2.9.3.1

List of input variables for the ICES prediction program.

YIELD PER RECRUIT
The reference F is the maximum value in the F at age array (age 9).

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

Data are printed in the following units:

Total yield and weight by age group in the catch: gram
Total biomass and weight by age group in the stock: gram

age	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
0	.00	1.00	.00	11.000	6.000
1	.00	1.00	.00	35.000	49.000
2	.42	.30	.63	99.000	133.000
3	.55	.20	1.00	150.000	183.000
4	.55	.10	1.00	180.000	220.000
5	.55	.10	1.00	211.000	247.000
6	.55	.10	1.00	234.000	263.000
7	.55	.10	1.00	258.000	285.000
8	.55	.10	1.00	277.000	310.000
9+	.55	.10	1.00	299.000	342.000

Table 2.9.3.2

16.45.36 20 APRIL 1989
YIELD PER RECRUIT

Range of age groups in the catch: 0-9 w.r.

****

* F-factor .600 and reference F .3300 *

****

						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
0	.0840	.0513	.5641	1.0000	6.0000	.0000	.0000	.0000	.0000
1	.1140	.0233	.8138	.3382	16.5738	.0000	.0000	.0000	.0000
2	.2520	.0215	2.1286	.1110	14.7663	.0699	9.3028	.0483	6.4268
3	.3300	.0164	2.4563	.0639	11.6988	.0639	11.6988	.0448	8.2021
4	.3300	.0101	1.8166	.0376	8.2782	.0376	8.2782	.0282	6.2061
5	.3300	.0066	1.3853	.0245	6.0459	.0245	6.0459	.0184	4.5326
6	.3300	.0043	.9994	.0159	4.1877	.0159	4.1877	.0119	3.1395
7	.3300	.0028	.7168	.0104	2.9520	.0104	2.9520	.0078	2.2131
8	.3300	.0018	.5006	.0067	2.0888	.0067	2.0888	.0051	1.5659
9+	.3300	.0034	1.0058	.0125	4.2892	.0125	4.2892	.0094	3.2155
Total		.1413	12.3871	1.6209	76.8807	.2415	48.8434	.1739	35.5015

$$
$$

Slope of the yield curve at the origin based on a single recruit: 137.109
F-0.1 given by an F factor of .224, resulting in a reference F of .123
F-max given by an F factor of .497, resulting in a reference F of .273

$$
$$

cont'd.

Table 2.9.3.2 cont'd.

16.48.28 20 APRIL 1989
YIELD PER RECRUIT

Range of age groups in the catch: 1-9 w.r.

****
* F-factor .600 and reference F .3300 *
****

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
0	.0000	.0000	.0000	1.0000	6.0000	.0000	.0000	.0000	.0000
1	.1140	.0253	.8851	.3679	18.0261	.0000	.0000	.0000	.0000
2	.2520	.0234	2.3151	.1208	16.0603	.0761	10.1180	.0526	6.9900
3	.3300	.0178	2.6715	.0695	12.7240	.0695	12.7240	.0487	8.9208
4	.3300	.0110	1.9758	.0409	9.0036	.0409	9.0036	.0307	6.7499
5	.3300	.0071	1.5066	.0266	6.5757	.0266	6.5757	.0200	4.9298
6	.3300	.0046	1.0869	.0173	4.5547	.0173	4.5547	.0130	3.4146
7	.3300	.0030	.7796	.0113	3.2107	.0113	3.2107	.0084	2.4070
8	.3300	.0020	.5445	.0073	2.2718	.0073	2.2718	.0055	1.7031
9+	.3300	.0037	1.0939	.0136	4.6650	.0136	4.6650	.0102	3.4973
Total		.0979	12.8591	1.6753	83.0919	.2627	53.1235	.1891	38.6124

$$$

Slope of the yield curve at the origin based on a single recruit: 136.135
F-0.1 given by an F factor of .233, resulting in a reference F of .128
F-max given by an F factor of .561, resulting in a reference F of .309

$$

cont'd.

Table 2.9.3.2 cont'd.

16.49.34 20 APRIL 1989
YIELD PER RECRUIT

Range of age groups in the catch: 2-9 w.r.

* F-factor .600 and reference F .3300 *

						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
0	.0000	.0000	.0000	1.0000	6.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.3679	18.0261	.0000	.0000	.0000	.0000
2	.2520	.0262	2.5947	.1353	17.9996	.0853	11.3397	.0589	7.8340
3	.3300	.0200	2.9941	.0779	14.2604	.0779	14.2604	.0546	9.9980
4	.3300	.0123	2.2144	.0459	10.0908	.0459	10.0908	.0344	7.5650
5	.3300	.0080	1.6886	.0298	7.3698	.0298	7.3698	.0224	5.5250
6	.3300	.0052	1.2182	.0194	5.1047	.0194	5.1047	.0146	3.8269
7	.3300	.0034	.8737	.0126	3.5984	.0126	3.5984	.0095	2.6977
8	.3300	.0022	.6102	.0082	2.5461	.0082	2.5461	.0062	1.9088
9+	.3300	.0041	1.2260	.0153	5.2283	.0153	5.2283	.0115	3.9196
Total		.0814	13.4199	1.7124	90.2242	.2944	59.5383	.2119	43.2750

Slope of the yield curve at the origin based on a single recruit: 134.589
F-0.1 given by an F factor of .246, resulting in a reference F of .135
F-max given by an F factor of .690, resulting in a reference F of .379

cont'd.

Table 2.9.3.2 cont'd.

16.50.23 20 APRIL 1989
YIELD PER RECRUIT

Range of age groups in the catch: 3-9 w.r.

****
* F-factor .600 and reference F .3300 *
****

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
0	.0000	.0000	.0000	1.0000	6.000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.3679	18.026	.0000	.0000	.0000	.0000
2	.0000	.0000	.0000	.1353	18.000	.0853	11.3397	.0697	9.2749
3	.3300	.0257	3.8522	.1003	18.347	.1003	18.3474	.0703	12.8634
4	.3300	.0158	2.8491	.0590	12.983	.0590	12.9828	.0442	9.7331
5	.3300	.0103	2.1725	.0384	9.482	.0384	9.4819	.0288	7.1085
6	.3300	.0067	1.5673	.0250	6.568	.0250	6.5676	.0187	4.9237
7	.3300	.0044	1.1241	.0162	4.630	.0162	4.6297	.0122	3.4708
8	.3300	.0028	.7851	.0106	3.276	.0106	3.2758	.0079	2.4558
9+	.3300	.0053	1.5774	.0197	6.727	.0197	6.7267	.0147	5.0429
Total		.0710	13.9276	1.7723	104.038	.3544	73.3518	.2666	54.8731

$$
$$

Slope of the yield curve at the origin based on a single recruit: 129.727
F-0.1 given by an F factor of .267, resulting in a reference F of .147
F-max can't be calculated or is not present

$$$
$$$

cont'd.

Table 2.9.3.2 cont'd.

16.51.04 20 APRIL 1989
YIELD PER RECRUIT

Range of age groups in the catch: 4-9 w.r.

****

* F-factor .600 and reference F .3300 *

****

						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
0	.0000	.0000	.0000	1.0000	6.000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.3679	18.026	.0000	.0000	.0000	.0000
2	.0000	.0000	.0000	.1353	18.000	.0853	11.3397	.0697	9.2749
3	.0000	.0000	.0000	.1003	18.347	.1003	18.3474	.0877	16.0464
4	.3300	.0220	3.9629	.0821	18.059	.0821	18.0587	.0615	13.5384
5	.3300	.0143	3.0219	.0534	13.189	.0534	13.1891	.0400	9.8877
6	.3300	.0093	2.1801	.0347	9.135	.0347	9.1354	.0260	6.8487
7	.3300	.0061	1.5636	.0226	6.440	.0226	6.4397	.0169	4.8278
8	.3300	.0039	1.0920	.0147	4.557	.0147	4.5566	.0110	3.4160
9+	.3300	.0073	2.1941	.0274	9.357	.0274	9.3567	.0205	7.0146
Total		.0630	14.0146	1.8383	121.109	.4204	90.4232	.3335	70.8544

$$$

Slope of the yield curve at the origin based on a single recruit: 122.230
F-0.1 given by an F factor of .291, resulting in a reference F of .160
F-max can't be calculated or is not present

$$

cont'd.

Table 2.9.3.2 cont'd.

16.51.49 20 APRIL 1989
YIELD PER RECRUIT

Range of age groups in the catch: 5-9 w.r.

****

* F-factor .600 and reference F .3300 *

****

						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
0	.0000	.0000	.0000	1.0000	6.000	.0000	.000	.0000	.0000
1	.0000	.0000	.0000	.3679	18.026	.0000	.000	.0000	.0000
2	.0000	.0000	.0000	.1353	18.000	.0853	11.340	.0697	9.2749
3	.0000	.0000	.0000	.1003	18.347	.1003	18.347	.0877	16.0464
4	.0000	.0000	.0000	.0821	18.059	.0821	18.059	.0768	16.8884
5	.3300	.0199	4.2034	.0743	18.346	.0743	18.346	.0557	13.7534
6	.3300	.0130	3.0324	.0483	12.707	.0483	12.707	.0362	9.5263
7	.3300	.0084	2.1749	.0314	8.957	.0314	8.957	.0236	6.7153
8	.3300	.0055	1.5190	.0204	6.338	.0204	6.338	.0153	4.7516
9+	.3300	.0102	3.0519	.0381	13.015	.0381	13.015	.0285	9.7570
Total		.0570	13.9815	1.8981	137.795	.4801	107.109	.3935	86.7133

$$$
$$$

Slope of the yield curve at the origin based on a single recruit: 114.497
F-0.1 given by an F factor of .316, resulting in a reference F of .174
F-max can't be calculated or is not present

$$
$$

Table 2.10.1

HERRING Total North Sea, 1988
Numbers (millions) and weights (g) at age (w.r) and
year-class of herring caught in each quarter year,
(excluding spring-spawner transfers to Division IIIa).

Catches in: 1988 Total North Sea

Quarter		0 1987	1 1986	2 1985	3 1984	4 1983	5 1982	6 1981	7 1980	8 1979	9+ 1978<	Total no	SOP ('000t)
I	No	0.0	152.1	221.0	263.4	141.6	111.6	51.3	17.1	4.9	3.4	966.4	104.4
	w		14	65	118	154	177	191	211	223	232		
II	No	0.0	182.2	233.2	124.3	59.4	33.6	15.9	5.1	2.0	0.9	656.6	72.2
	w		45	102	143	170	200	217	252	252	315		
III	No	975.6	1282.1	729.5	306.7	94.6	60.0	39.7	10.6	6.9	2.6	3508.3	282.0
	w	11	58	124	178	217	239	261	283	283	296		
IV	No	317.2	354.4	771.8	490.7	102.5	55.3	21.7	5.1	1.2	1.5	2121.6	218.2
	w	12	69	115	138	163	189	192	211	213	243		
Total Year	No	1292.9	1970.8	1955.5	1185.1	398.1	260.6	128.6	37.9	15.1	8.4	7252.8	676.6
	w	11	55	111	145	174	197	216	237	253	263		
[1]Stock wts (July)		-	54	122	163	215	240	270	277	297	310		

[1]These stock weights were used in the 1989 SSVPA and derive from acoustic survey samples taken in July from Divisions IVa and IVb.

Table 3.1.1 Catch in numbers ('000) and mean weight (g) at age and year class of HERRING in Divisions IVa,b which were transferred to the Division IIIa herring stock. SOP in tonnes.

YEAR: 1988

QUAR-TER		2 1985	3 1984	4 1983	5 1982	6 1981	7 1980	Total Number	Total weight
II	No	19982	42465	9487	2994	806	-0	75734	
	W	92	127	150	165	166	..		
	SOP	1841	5392	1424	494	134	-0		9285
III	No	24579	66450	10045	5174	1397	391	108036	
	W	96	133	158	174	182	212		
	SOP	2365	8829	1591	899	255	83		14022
Total year	No	44561	108915	19532	8168	2203	391	183770	
	W	94	131	154	171	176	212		
	SOP	4206	14221	3015	1393	388	83		23306

Table 3.2.1 HERRING in Division IIIa. Landings in tonnes, 1978-1988 (Data mainly provided by Working Group Members).

Country	1978	1979	1980	1981	1982
Skagerrak					
Denmark	7,753	8,729	22,811	45,525	43,328
Faroe Islands	1,041	817	526	900	715
Germany, Fed.Rep.	28	181	-	199	43
Norway (Open sea)	1,860	2,460	1,350	6,330	10,140
Norway (Fjords)	2,271	2,259	2,795	900	1,560
Sweden	11,551	8,140	10,701	30,274	24,859
Total	24,504	22,586	38,183	83,768	80,645
Kattegat					
Denmark	29,241	21,337	25,380	48,922	38,609
Sweden	35,193	25,272	18,260	38.871	38,892
Total	64,434	46,609	43,640	87,833	77,501
Division IIIa total	88,938	69,195	81,823	171,601	158,146

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

[1]Preliminary.

Table 3.2.2 HERRING Division IIIa, 1988
Numbers (millions) and weights (g) at age (w.r) and year-class of herring caught in each quarter year, SOP in tonnes.

Catches in: 1988 Division IIIa

Quarter		0 1987	1 1986	2 1985	3 1984	4 1983	5 1982	6 1981	7 1980	8 1979	9 1978	Total no	SOP
I	No	0.0	1240.2	491.6	187.0	16.6	13.0	4.3	0.9	0.0	0.0	1953.6	
	W		16	42	57	64	125	156	170	208	220		
	SOP		19223	20663	10702	1067	1630	671	156	2	2		54118
II	No	111.1	2087.1	524.8	113.3	12.6	2.2	0.5	0.2	0.0	0.0	2851.8	
	W	2	20	36	56	85	94	127	144				
	SOP	200	41327	18849	6359	1069	204	57	32				68097
III	No	1194.0	1814.1	1050.2	89.8	6.5	3.5	0.4	0.0	0.4	0.0	4158.9	
	W	10	36	50	76	100	134	157		148	197		
	SOP	11367	65175	52696	6795	647	473	59		55	2		137269
IV	No	525.2	650.6	254.6	64.6	7.0	5.6	0.4	0.3	0.0	0.0	1508.4	
	W	19	54	72	81	112	130	162	173				
	SOP	10098	35418	18405	5246	790	726	72	48				70803
Total Year	No	1830.3	5792.1	2321.3	454.6	42.7	24.3	5.6	1.4	0.4	0.0	10472.6	
	W	12	28	48	64	84	125	155	166	149	209		
	SOP	21665	161144	110612	29103	3573	3033	860	236	57	4		330286

Spring spawners transferred from Division IV to Division III are not included.

Table 3.2.3. HERRING Division IIIa, 1988 estimated catch in numbers (millions) and weights (g) at age (w.r) and year-class of spring-spawning herring caught by quarter in Div. IIIa and adjacent parts of the North Sea. SOP in tonnes.

Catches in: 1988 Division IIIa

Quarter		2 1985	3 1984	4 1983	5 1982	6 1981	7 1980	8 1979	9 1978	Total no	SOP (tons)
I	No	211	187	17	13	4	1	<1	<1	433	
	w	23	57	64	125	156	170	208	220		
	SOP	4798	10702	1067	1630	671	156	2	2		19029
II	No	534	156	22	5	1	0			719	
	w	37	75	113	135	152	144				
	SOP	19842	11752	2492	698	191	32				35007
III	No	1075	156	17	9	2	0	<1	<1	1259	
	w	51	100	135	158	177	212	148	197		
	SOP	55061	15624	2238	1372	314	83	55	2		74749
IV	No	255	65	7	6	0	0			333	
	w	72	81	112	130	162	173				
	SOP	18405	5246	790	726	72	48				25287
Total Year	No	2075	563	62	32	8	2	<1	<1	2743	
	w	47.3	77.0	105.3	138.3	156	166	149	209		
	SOP	98106	43324	6588	4426	1248	319	57	4		154072

Table 3.2.4 HERRING Division IIIa, 1985 - 1988 Estimated numbers (millions) at age by quarter of North Sea autumn spawners caught in Division IIIa. SOP in tonnes.

		YEAR OF CATCH										
		1985		1986		1987			1988			
Quarter/Ringers:		0	1	0	1	0	1	2	0	1	2	Total
I	No		760				1107	35	0	1240	281	1521
	w						13	61		16	56	23
	SOP	0	0	0	0	0	14834	2103	0	19223	15865	35088
II	No	630	170			9	617	82	111	2087	11	2209
	w					5	18	63	2	20	79	19
	SOP	0	0	0	0	45	11110	5205	200	41327	848	42375
III	No	296	153			4077	898		1194	1814	0	3008
	w					7	51		10	36	0	25
	SOP	0	0	0	0	27965	45613	0	11367	65175	0	76542
IV	No	319	125			2153	515		525	651	0	1176
	w					10	60		19	54	0	39
	SOP	0	0	0	0	21957	31042	0	10098	35418	0	45516
Total	No	1245	1208	0	0	6238	3137	117	1830	5792	292	7914
Year	w	0	0			8	33	63	12	28	57	25
	SOP	0	0	0	0	49966	102599	7308	21665	161144	16713	199522

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

Age group	1987	1988	$\bar{W}$(g)
0	-	-	-
1	-	-	-
2	958	1,511.6	65
3	665	761.4	118
4	310	86.7	160
5	114	74.2	166
6	43	18.0	181
7	3	1.0	241
8	-	1.2	175
Total (millions)	2,093	2,454	-
Biomass (t)	252,459	217,997	-

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

	Index					
	Total		Spring Spawners		Autumn-spawners	
Year	1-gr	2-gr	1-gr	2-gr	1-gr	2-gr
1980	2,311	387	1,607	307	704	80
1981	3,246	1,393	9660	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

[1] Separation not valid.

Table 4.2.1 Celtic Sea and Division VIIj HERRING landings by calendar year (t), 1977-1988. (Data provided by Working Group members.)

Year	France	Germany Fed.Rep.	Ireland	Nether-lands	Un-allocated	Total
1977	106	96	5,533	1,455	-	7,190
1978	8	220	6,249	1,002	850	15,519
1979	584	20	7,019	850	3,705	12,178
1980	9	2	8,849	393	-	9,253
1981	123	-	15,562	1,150	-	16,835
1982	+	-	9,501	-	-	9,501
1983	495	-	10,000	1,500	10,187	22,187
1984	680	-	7,000	890	11,148	19,718
1985	622	-	11,000	-	4,601	16,223
1986	-	-	13,338	+	6,098	19,436
1987	820	-	15,500	1,453	5,310	23,083
1988[1]	-	-	16,766	-	-	16,766

[1] Provisional.

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

Year	France	Germany Fed.Rep.	Ireland	Nether-lands	Un-allocated	Total
1977/1978	95	96	6,264	1,378	-	7,833
1978/1979	8	220	8,239	1,002	-	7,559
1979/1980	584	20	7,932	850	935	-
1980/1981	9	2	9,024	292	3,803	13,130
1981/1982	123	-	15,830	1,150	-	17,103
1982/1983	+	-	13,042	-	-	-
1983/1984	495	-	10,000	1,500	9,186	21,181
1984/1985	680	-	7,000	890	14,009	22,579
1985/1986	622	-	11,995	-	4,509	-
1986/1987	-	-	14,725	1	6,098	20,824
1987/1988	820	-	15,500	1,453	4,444	22,217
1988/1989	-	-	17,047	-	-	17,047

[1] Provisional.

Table 4.2.3 SUM OF PRODUCTS CHECK 11.03.39 21 APRIL 1989

HERRING SOUTH AND SOUTH WEST OF IRELAND (FISH AREAS VIIG-J)
CATEGORY: TOTAL

CATCH IN NUMBERS UNIT: thousands

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	2800	11335	7162	39361	15339	11484	16456	15018	3466	5064	1924
2	13385	13913	30093	21285	42725	87253	78324	47824	47289	56780	68413
3	11948	12399	11726	21861	8728	22895	34672	30392	35734	36504	25823
4	5583	8636	6585	5505	4817	2735	13527	13438	27442	19503	7838
5	1580	2889	2812	4438	1497	1579	2066	1933	7325	12138	4973
6	1476	1316	2204	3436	1891	277	915	191	939	2302	2541
7	540	1283	1184	795	1670	315	317	71	82	996	725
8	858	551	1262	313	335	790	195	145	24	251	248
9+	482	635	565	866	596	261	152	111	10	393	72
TOTAL	38652	52957	63593	97860	77598	127589	146624	109123	122311	133931	112557
Catch in t.	7559	10321	13130	17103	13042	21181	22579	17126	20824	22217	17047

Table 4.4.1 Celtic Sea, Division VIIj. Percentage age distribution 1977/1978-1988-1989.

W. rings	Season							
	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
1	20.4	7.3	21.4	11.3	40.2	19.8	9.0	11.2
2	31.3	34.6	26.3	47.3	21.8	55.1	68.4	53.4
3	21.5	30.9	23.4	18.4	22.3	11.2	17.9	23.6
4	13.2	14.5	16.3	10.4	5.6	6.2	2.1	9.2
5	4.0	4.1	5.5	4.4	4.5	1.9	1.2	1.4
6	4.8	3.8	2.5	3.5	3.5	2.4	0.2	0.6
7	2.6	1.4	2.4	1.9	0.8	2.2	0.2	0.2
8	1.0	2.2	1.0	2.0	0.3	0.4	0.6	0.1
9+	1.2	1.2	1.2	0.9	0.9	0.8	0.2	0.1
Catch ('000 t)	7.8	7.6	10.3	13.1	17.1	13.0	21.2	22.6

W. rings	Season			
	1985/86	1986/87	1987/88	1988/89
1	13.8	2.8	3.8	1.7
2	43.8	38.7	42.4	60.8
3	27.9	29.2	27.3	22.9
4	12.3	22.4	14.6	7.0
5	1.8	6.0	9.1	4.4
6	0.2	0.8	1.7	2.3
7	+	+	0.7	0.6
8	0.1	+	0.2	0.2
9+	0.1	+	0.3	0.1
Catch ('000 t)	17.1	20.8	22.2	17.0

Table 5.1.1 Catch in weight, (t) Division VIa (North) HERRING, 1979-1988.

Country	1979	1980	1981	1982	1983
Denmark	-	-	1,580	-	-
Faroes	-	-	-	74	834
France	3	-	1,243	2,069	1,313
German Dem. Rep.	-	2	-	-	-
Germany, Fed. Rep.	-	-	3,029	8,453	6,283
Iceland	-	256	-	-	-
Ireland	-	-	-	-	-
Netherlands	-	-	5,602	11,317	20,200
Norway	-	-	3,850	13,018	7,336
UK (England)	54	-	1,094	90	-
UK (Scotland)	3	33	30,389	38,381	31,616
USSR	-	15	-	-	-
Unallocated	-	-	4,633	18,958	-4,059
Total	60	306	51,420	92,360	63,523

Country	1984	1985	1986	1987	1988[1]
Denmark	96	-	-	-	-
Faroes	954	104	400	-	-
France	-	20	18	136	44
German Dem. Rep.	-	-	-	-	-
Germany, Fed. Rep.	5,564	5,937	2,188	1,711	1,860
Iceland	-	-	-	-	-
Ireland	-	-	6,000[2]	6,800[2]	6,740
Netherlands	7,729	5,500	5,160[2]	5,212[2]	6,131
Norway	6,669	4,690	4,799	4,300	456
UK (England)	-	-	-	-	1,892
UK (Scotland)	37,554	28,065	25,294	26,810	25,002
USSR	-	-	-	-	-
Unallocated	16,588	502	37,840[2]	18,038[2]	5,229[2]
Total	75,154	43,814	81,699	63,007	47,354

[1] Preliminary.
[2] Including discards.

Table 5.1.2 SUM OF PRODUCTS CHECK

HERRING IN THE NORTHERN PART OF VIA
CATEGORY: TOTAL

CATCH IN NUMBERS UNIT: thousands

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	16299	209598	24941	267872	536119	82676	8225	11508	108199	1614	0	3003
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
9+	30651	36395	20465	32223	21042	13698	12014	1486	1544	0	1	1326
TOTAL	1309354	2074244	2171313	1669104	1850572	868328	662262	259564	258921	2426	15049	332959

	1982	1983	1984	1985	1986	1987	1988
0	219	144	0	372	1971	2	0
1	13304	81923	2961	45663	38943	27645	2273
2	250010	77810	253291	77063	178714	93679	158832
3	72179	92743	66857	166112	99264	64575	55529
4	93544	29262	46963	19269	137077	45488	37815
5	58452	42535	20057	17027	21723	71188	26292
6	23580	27318	15250	7422	20759	11973	37993
7	11516	14709	12478	7731	2973	10378	4327
8	13814	8437	5940	3720	16177	4982	2956
9+	4027	8484	2629	2450	2273	8498	3140
TOTAL	540645	383365	426426	346829	519874	338408	329157

Table 5.1.3 HERRING in Division VIa (North). Larvae abundance indices (numbers in billions), larvae mortality rates (Z/K), fecundity estimate (10^5 eggs/g), spawning stock biomass ('000 t, age 2+ at spawning time).

Year	LAI	Z/K	LPE			Spawning stock biomass from		
			Larvae	Fecundity	SSB	LPE[1]	LAI[2]	VPA
1973	2,442	0.74	318	(1.39)	229	219	282	431
1974	1,186	0.42	238	(1.39)	171	164	137	222
1975	878	0.46	157	1.46	108	108	101	129
1976	189	-	60	1.23	49	41	22	104
1977	787	-	223	1.49	150	154	91	67
1978	332	-	132	1.37	109	91	38	67
1979	1,071	-	118	1.49	79	81	124	105
1980	1,436	0.39	287	2.04	141	198	166	176
1981	2,154	0.34	448	2.12	211	309	245	179
1982	1,890	0.39	267	1.95	137	184	218	174
1983	668	-	112	1.88	60	77	77	147
1984	2,133	0.57	253	1.75	145	175	246	281
1985	2,710	0.37	418	(1.86)	225	288	313	314
1986	3,037	0.24	907	(1.86)	488	626	351	330
1987	4,119	0.53	423	(1.86)	227	292	475	361
1988	5,947	0.47	781	(1.86)	420	539	687	492

[1] Predicted from (1973-1987) regression:
SSB = 0.69 x LPE (r = 0.62).

[2] Predicted from (1973-1987) regression:
SSB = 0.116 x LAI (r = 0.85).

Table 5.1.4 HERRING in Division VIa (North). Scottish bottom trawl survey indices of 2-ringed herring catch rates in January-March and acoustic survey indices of the same year class in the preceding November.

Trawl survey year	Year class	Number of GOV hauls	2-ringer index (millions)	Acoustic estimate no. of 1-ringers (millions)
1981	1978	9	1,237	-
1982	1979	10	2,361	-
1983	1980	12	11	-
1984	1981	12	12,456	28.1
1985	1982	17	98	-
1986	1983	12	359	1,039.0
1987	1984	15	40	85.6
1988	1985	19	15,770	249.1
1989	1986	15	2,174[1]	-

[1] Preliminary estimate

Table 5.1.5 HERRING in Division VIa (North). Mean weights at age (kg).

Age (rings)	Weight in the stock	Weight in the catch				
		1982-1984	1985	1986	1987	1988
1	0.090	0.090	0.069	0.113	0.073	0.080
2	0.164	0.140	0.103	0.145	0.143	0.112
3	0.208	0.175	0.134	0.173	0.183	0.157
4	0.233	0.205	0.161	0.196	0.211	0.177
5	0.246	0.231	0.182	0.215	0.220	0.203
6	0.252	0.253	0.199	0.230	0.238	0.194
7	0.258	0.270	0.213	0.242	0.241	0.240
8	0.269	0.284	0.223	0.251	0.253	0.213
9	0.292	0.295	0.231	0.258	0.256	0.228

Table 5.1.6

Title : HERRING IN THE NORTHERN PART OF VIA
At 12.11.30 21 APRIL 1989
from 70 to 88 on ages 1 to 8
with Terminal F of .125 on age 3 and Terminal S of 1.000

Initial sum of squared residuals was 528.928 and
final sum of squared residuals is 77.249 after 84 iterations

Matrix of Residuals

Years	70/71	71/72	72/73	73/74	74/75	75/76	76/77	77/78
Ages								
1/ 2	2.200	.011	3.410	1.477	2.358	1.385	2.107	1.439
2/ 3	-.839	-.520	-.309	.260	-.417	-.015	.214	-.057
3/ 4	-.104	.796	-.078	-.042	-.243	-.136	.164	-.378
4/ 5	.225	.183	-.456	.110	.043	.004	.038	.075
5/ 6	-.112	-.260	-.114	-.230	-.108	-.148	-.630	-.252
6/ 7	.072	.092	.201	.036	.350	.032	-.008	.597
7/ 8	.358	-.823	.118	-.710	-.164	.060	-.016	-.051
	.000	.000	.000	.000	.000	.000	.001	.001
WTS	.001	.001	.001	.001	.001	.001	.001	.001

Years	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88		WTS
Ages												
1/ 2	.649	1.694	4.305	.617	.140	.783	-1.591	1.087	.964	.027	.000	.166
2/ 3	-.475	.005	.410	.210	.433	-.356	-.280	-.129	.517	-.006	.000	.594
3/ 4	-.218	-.215	-.345	-.004	.059	-.100	.281	.075	.028	-.234	.000	.822
4/ 5	1.010	-.062	.230	.057	.084	-.262	.196	-.098	.047	-.077	.000	.767
5/ 6	-.330	-.181	-.709	-.189	-.055	.277	.069	-.277	-.117	-.099	.000	1.000
6/ 7	-.314	-.614	-.941	.047	-.290	.089	-.191	.888	.035	.345	.000	.535
7/ 8	.230	1.341	1.082	-.307	-.544	.119	.244	-.856	-1.269	.488	.000	.337
	.001	.001	.000	.000	.000	.000	.000	.000	.000	.000	18.621	
WTS	.001	.001	.001	1.000	1.000	1.000	1.000	.001	.001	1.000		

Fishing Mortalities (F)

	70	71	72	73	74	75	76	77	78	
F-values	.4373	.8656	.5274	.6086	.9403	.9488	1.0571	.8533	.6289	
	79	80	81	82	83	84	85	86	87	88
F-values	.0013	.0025	.3277	.5183	.4262	.3414	.2044	.2731	.1934	.1250

Selection-at-age (S)

	1	2	3	4	5	6	7	8
S-values	.0390	.7435	1.0000	.9799	1.0547	1.0320	1.0656	1.0000

Table 5.1.7 VIRTUAL POPULATION ANALYSIS 21.27.16 26 APRIL 1989

HERRING IN THE NORTHERN PART OF VIA

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

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	.106	.027	.503	.077	.334	.136	.190	.085	.035	.000	.021	.031
2	.180	.424	.296	.500	.489	.735	.757	.342	.266	.001	.003	.286
3	.417	1.153	.512	.588	.765	.860	1.205	.581	.258	.001	.002	.335
4	.457	.914	.340	.629	.913	.838	1.009	.915	.497	.001	.002	.338
5	.438	.731	.507	.592	.932	.912	.852	.793	.724	.000	.001	.269
6	.395	.965	.499	.624	1.203	.996	1.096	1.265	.712	.002	.001	.298
7	.572	.647	.582	.430	.930	1.017	1.117	.933	.665	.002	.008	.285
8	.437	.750	.816	.553	1.296	1.026	.971	.855	.714	.001	.001	.324
9+	.437	.750	.816	.553	1.296	1.026	.971	.855	.714	.001	.001	.324
(3- 6)U	.427	.941	.465	.608	.953	.901	1.041	.889	.548	.001	.002	.310

	1982	1983	1984	1985	1986	1987	1988
1	.020	.029	.002	.030	.028	.010	.005
2	.556	.273	.202	.127	.274	.143	.125
3	.501	.442	.426	.210	.255	.159	.125
4	.528	.368	.399	.197	.254	.169	.125
5	.549	.430	.411	.219	.317	.182	.125
6	.469	.475	.240	.234	.399	.258	.125
7	.430	.532	.367	.165	.124	.317	.125
8	.569	.569	.377	.158	.534	.280	.125
9+	.569	.569	.377	.158	.534	.280	.125
(3- 6)U	.512	.429	.369	.215	.306	.192	.125

Table 5.1.8 VIRTUAL POPULATION ANALYSIS 21.27.16 26 APRIL 1989

HERRING IN THE NORTHERN PART OF VIA

STOCK SIZE IN NUMBERS UNIT: thousands

BIOMASS TOTALS UNIT: tonnes

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

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	3734493	10072764	3078795	1085395	1675825	2129079	621297	673222	1043202	1499309	999583	1876859
2	1433773	1236100	3606876	684640	369702	441473	683743	188994	227531	370701	551337	360250
3	1154834	886780	599556	1987587	307633	168031	156871	237529	99421	129133	274429	407296
4	398662	622801	229223	294267	904207	117148	58241	38476	108729	62882	105615	224275
5	157418	228379	225918	147610	141895	328192	45847	19218	13942	59850	56868	95331
6	653576	91923	99477	123066	73886	50577	119345	17695	7865	6114	54135	51398
7	69944	398554	31696	54652	59666	20073	16903	36094	4519	3493	5520	48942
8	97183	35711	188883	16021	32168	21312	6568	5008	12852	2103	3154	4957
9+	90650	72038	38296	79350	30124	22249	20159	2698	3161	0	1051	5021
TOTAL NO	7790532	13645050	8098720	4472588	3595106	3298135	1728972	1218934	1521221	2133584	2051692	3074328
SPS NO	2831831	1913706	3322412	2022180	993941	586707	523896	322886	326281	541599	901234	854322
TOT.BIOM	1178420	1651646	1197549	800854	572492	437154	267617	170590	188174	254974	292282	416802
SPS BIOM	586657	396143	606496	421213	215931	123251	99521	64137	64088	103448	174883	178173

	1982	1983	1984	1985	1986	1987	1988	1989
1	1038880	4464538	2023869	2405328	2264384	4283508	720671	0
2	669131	374453	1594848	742817	858362	810408	1559739	263798
3	200503	284252	211132	965387	484421	483685	520323	1019710
4	238602	99495	149560	112892	640859	307322	337829	375948
5	144770	127339	62289	90821	83857	449810	234885	269762
6	65887	75667	74921	37355	66018	55276	339419	187560
7	34534	37284	42594	53320	26757	40062	38656	271032
8	33297	20337	19811	26712	40905	21387	26408	30868
9+	9707	20450	8768	17593	5748	36481	28052	43487
TOTAL NO	2435311	5503814	4187793	4452224	4471312	6487938	3805982	
SPS NO	849503	703840	1540990	1569090	1611345	1730358	2456327	
TOT.BIOM	373454	616980	575548	623240	651496	841960	676182	
SPS BIOM	172593	145760	280349	313087	329669	360802	492153	

Table 5.1.9

List of input variables for the ICES prediction program.

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

The number of recruits per year is as follows:

Year	Recruitment
1989	555000.0
1990	555000.0
1991	555000.0

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

Data are printed in the following units:

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

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
2	555000.0	.12	.30	1.00	.112	.164
3	1019710.0	.12	.20	1.00	.157	.208
4	375948.0	.12	.10	1.00	.177	.233
5	269762.0	.12	.10	1.00	.203	.246
6	187560.0	.12	.10	1.00	.194	.252
7	271032.0	.12	.10	1.00	.240	.258
8	30868.0	.12	.10	1.00	.213	.269
9+	43487.0	.12	.10	1.00	.228	.292

Table 5.1.10
HERRING - VIA NORTH

* Year 1989. F-factor 1.167 and reference F .1459 *

* Run depending on a TAC value *

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January sp.stock size	at 1 January sp.stock biomass	at spawning time sp.stock size	at spawning time sp.stock biomass
2	.1459	65323	7316.2	555000	91020	555000	91020	411671	67514
3	.1459	125758	19744.0	1019710	212099	1019710	212099	808784	168227
4	.1459	48621	8606.1	375948	87595	375948	87595	318846	74291
5	.1459	34888	7082.4	269762	66361	269762	66361	228788	56282
6	.1459	24257	4705.9	187560	47265	187560	47265	159072	40086
7	.1459	35052	8412.7	271032	69926	271032	69926	229865	59305
8	.1459	3992	850.3	30868	8303	30868	8303	26179	7042
9+	.1459	5624	1282.3	43487	12698	43487	12698	36881	10769
Total		343518	58000.0	2753367	595270	2753367	595270	2220091	483517

* Year 1990. F-factor 1.300 and reference F .1625 *

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	.1625	72207	8087.2	555000	91020	555000	91020	407113	66766
3	.1625	48435	7604.3	355343	73911	355343	73911	278720	57973
4	.1625	103124	18253.0	721542	168119	721542	168119	605173	141005
5	.1625	42018	8529.8	293996	72323	293996	72323	246581	60659
6	.1625	30150	5849.2	210957	53161	210957	53161	176935	44587
7	.1625	20962	5031.1	146674	37842	146674	37842	123019	31738
8	.1625	30292	6452.3	211950	57014	211950	57014	177767	47819
9+	.1625	8310	1894.8	58146	16978	58146	16978	48768	14240
Total		355501	61701.6	2553612	570371	2553612	570371	2064081	464791

* Year 1991. F-factor 1.300 and reference F .1625 *

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	.1625	72207	8087.2	555000	91020	555000	91020	407113	66766
3	.1625	47637	7479.0	349487	72693	349487	72693	274127	57018
4	.1625	35343	6255.9	247295	57619	247295	57619	207412	48327
5	.1625	79315	16101.0	554957	136519	554957	136519	465455	114501
6	.1625	32317	6269.6	226120	56982	226120	56982	189652	47792
7	.1625	23189	5565.5	162253	41861	162253	41861	136085	35110
8	.1625	16123	3434.2	112811	30346	112811	30346	94617	25452
9+	.1625	29690	6769.4	207739	60659	207739	60659	174235	50876
Total		335824	59961.9	2415664	547702	2415664	547702	1948700	445845

Table 5.2.1 Reported landings (tonnes) of HERRING from the Firth of Clyde (all fishing methods combined).

Month	1977	1978	1979	1980	1981	1982
January	-[1]	4[1]	4[1]	6[1]	15[1]	2[1]
February	-[1]	6[1]	8[1]	3[1]	15[1]	16[1]
March	-[1]	7[1]	13[1]	8[1]	14[1]	1[1]
April	530	246	12[1]	4[1]	32[1]	2[1]
May	44	245	4[1]	2[1]	25[1]	615
June	640	238	336	114	429	850
July	494	376	466	656	982	757
August	601	587	450	645	511	262
September	559	581	374	559	106	-[1]
October	556	653	263	79	-[1]	-[1]
November	560	647	1[1]	3[1]	2[1]	-[1]
December	328	272	-[1]	2[1]	4[1]	1[1]
Not known	35	-	-	-	-	-
Total	4,847	3,862	1,951	2,081	2,135	2,506

Month	1983	1984	1985	1986	1987	1988
January	+[1]	-[1]	-[1]	-[1]	-[1]	+[1]
February	1[1]	-[1]	-[1]	-[1]	-[1]	-[1]
March	1[1]	-[1]	-[1]	-[1]	-[1]	3[1]
April	-[1]	-[1]	-[1]	-[1]	+[1]	16[1]
May	1[1]	554	527	272[1]	112[1]	13[1]
June	265	847	831	724	289	19[1]
July	519	944	815	763	189	270
August	681	276	661	786	323	533
September	604	246	187	555	961	402
October	457	124	1[1]	218[1]	571	176
November	1[1]	-[1]	-[1]	77[1]	379	108
December	-[1]	-[1]	-[1]	-[1]	71	28
Not known	273[2]	247[2]	-	-	-	-
Total	2,803	3,238	3,022	3,395	2,895	1,568

[1] Subject to closure of directed fishery for whole or part of the month.
[2] Landed in Northern Ireland and Isle of Man.
+ Less than 1 t.

Table 5.2.2 Monthly landings of Clyde herring in number at age (thousands), 1988 with estimate of numbers discarded.

Age (rings)	Jan	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total landings	Estimated discards[1]	Estimated catch
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-	?	-
2	2	-	1	-	+	10	81	182	125	112	40	553	458	1,011
3	+	2	8	8	12	113	269	532	213	126	36	1,319	303	1,622
4	+	3	19	19	25	351	440	620	300	174	40	1,991	358	2,349
5	+	4	18	18	29	289	546	483	223	98	19	1,727	106	1,833
6	+	3	29	13	18	317	339	274	89	43	13	1,138	52	1,190
7	+	3	13	13	9	130	149	68	45	10	4	444	9	453
8	+	2	6	6	6	49	72	35	11	12	2	202	4	206
9	-	1	2	1	1	22	19	12	1	1	1	61	1	62
≥10	+	+	1	2	2	-	4	3	2	-	-	14	+	4

[1]Assuming percentage of each age discarded the same as in 1986.
+Less than 500 fish.

Table 5.2.3 Number of days absent from port by pair trawlers in the Firth of Clyde, 1974-1988, 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

Table 5.2.4 Weights at age (g) in landings of Clyde herring, 1988.

Age (rings)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Whole year[1]
2	88	106	-	69	-	92	142	138	146	136	138	142	140
3	146	128	133	131	145	155	192	190	191	185	183	182	188
4	163	149	152	156	146	174	216	201	208	205	202	194	205
5	181	163	150	162	159	181	222	206	214	207	206	203	210
6	196	173	173	171	165	184	238	223	225	229	221	214	225
7	206	184	175	171	167	187	249	236	245	248	237	219	237
8	211	184	179	181	177	191	241	226	240	261	236	215	230
9	224	196	180	206	215	222	255	258	269	270	247	220	254
≥10	233	206	185	196	208	204	-	242	266	284	-	-	240

[1]Weighted by numbers landed in each month.

Table 5.2.5 Estimated percentages of Clyde herring (2-ringers and older) at each maturity stage in commercial landings in each month of 1988.

Month	Maturity stage							Estimated no. landed (10^3)
	II	III	IV	V	VI	VII	VIII	
Jan	1.1	10.6	30.6	0.2	0.6	0.1	56.8	2
Feb	2.7	9.9	15.8	3.0	0.6	4.9	63.2	+
Mar	0.2	0.1	5.5	12.6	7.8	14.6	58.9	18
Apr	1.3	-	-	-	-	7.2	91.5	97
May	1.1	1.4	-	-	0.4	7.7	89.4	81
Jun	1.0	14.4	0.3	-	1.1	-	83.2	102
Jul	3.8	43.8	38.6	-	-	-	13.8	1,281
Aug	1.1	21.7	58.4	12.0	1.2	-	5.6	1,919
Sep	1.6	27.0	52.5	17.3	0.2	-	1.4	2,209
Oct	1.3	11.5	46.3	17.1	0.4	4.5	18.8	1,009
Nov	0.7	8.0	42.4	30.6	0.5	0.5	17.4	576
Dec	0.7	6.1	41.3	18.5	3.0	3.8	26.7	155

Table 5.2.6 Mean vertebral counts (vs) of samples of Clyde herring in 1988 subdivided by otolith type and maturity stage. Statistics based on samples of fewer than 10 fish excluded.

Month	Otolith type						Maturity									
	Spring		Autumn		Total (including unclassified)		2		3		4		5		8	
	vs	n	vs	n	vs	n	vs	n	vs	n	vs	n	vs	n	vs	n
Jun	57.0	45	56.5	128	56.7	211	-	-	56.4	32	-	-	-	-	56.7	172
Jul	57.2	88	56.6	98	56.9	196	56.2	61	56.4	47	56.2	15	-	-	57.1	32
Aug	-	-	56.6	61	56.7	76	-	-	56.9	13	56.7	33	56.4	25	-	-
Sep	-	-	56.7	48	56.8	62	-	-	56.9	12	56.6	30	56.9	19	-	-
Oct	56.9	125	56.5	57	56.8	204	-	-	56.9	41	56.9	122	-	-	56.5	40
Nov	56.9	107	56.7	49	56.9	185	-	-	-	-	57.0	112	56.8	31	56.7	34
Dec	56.6	92	56.4	38	56.6	145	-	-	56.7	16	56.7	81	-	-	56.4	45

Table 5.2.7 Mean vertebral counts (vs) of Clyde herring by maturity stage and age in different samples taken by research vessel in July 1988.

Sample	Age (rings)	Maturity stage	Mean vs	n
1	2	I- II	57.04	50
2	2	I-III	57.28	46
3	2	I-III	56.92	49
4	$\geq$3	III-V	56.32	25
		VIII	57.23	17
5	$\geq$3	III-V	56.39	31
		VIII	57.08	13

Table 5.2.8 Estimated numbers (millions) and mean weight (g) at age of herring (> 1-ringers) from Clyde acoustic surveys, 1985-1988.

Year	Dates	Rings										Biomass
		1	2	3	4	5	6	7	8	>9	Total	($x10^{-3}$)
1985	17/5-1/6	1.1	3.2	9.9	10.6	3.0	3.2	0.8	0.7	0.3	33.1	6.6
1986	4-14/6	1.6	20.5	12.5	9.3	3.4	3.2	1.2	-	0.2	52.0	9.0
1987	8-14/7	148.2	11.5	9.2	11.5	5.7	3.0	1.2	0.7	0.4	191.4	16.1
1988	7-18/7	1.6	67.4	6.2	4.8	5.5	3.6	2.8	1.5	0.4	93.8	12.4
Mean weight at age (g) in 1988		69	106	179	206	209	228	225	247	250	133	

Table 5.2.9 Percentage age composition and mean length at age (cm) of samples of herring taken at Ballantrae Bank, Clyde, 1985-1988.

Age (rings)	March 1985		March 1986		March 1987		March 1988	
	%	$\bar{l}$	%	$\bar{l}$	%	$\bar{l}$	%	$\bar{l}$
0	-	-	-	-	-	-	-	-
1	5.8	18.0	11.3	14.9	10.4	17.7	-	-
2	7.9	25.2	3.3	22.2	18.8	23.3	0.7	23.8
3	31.8	26.1	36.1	27.2	32.7	27.3	23.5	28.4
4	25.4	29.4	24.0	29.3	12.9	29.7	35.6	29.8
5	14.6	30.9	16.3	30.8	7.0	30.8	16.4	30.5
6	5.9	32.0	3.6	30.4	7.2	31.4	10.7	30.6
7	4.3	32.7	2.5	32.4	3.7	31.9	7.8	30.6
8	2.9	33.5	1.9	32.7	4.1	32.0	4.0	31.3
9	0.7	33.0	0.8	33.6	1.4	32.6	1.0	32.7
10	0.5	34.4	0.3	34.2	1.2	33.3	-	-
>11	0.2	31.2	-	-	0.6	31.8	0.2	32.7
No. sampled	556		363		489		421	

<u>Table 5.2.10</u> Clyde herring - inputs for tuning VPA. Fleet 1. effort, catch in number at ages 2-9. Fleet 2. acoustic survey estimates of numbers at ages 2-8.

```
clyde-tuning
102
cpue
1974 1988
1 1
2 9
3376 8841 2817 2559 1140 494 700 253 87
3209 1876 2483 1024 1072 451 175 356 130
3016 10480 913 1049 526 638 261 138 178
4186 7524 6976 1062 1112 574 489 251 146
4379 1796 2259 2724 634 606 330 298 174
2933 4859 807 930 888 341 289 156 119
1982 5633 1592 567 341 204 125 48 56
1529 2372 2785 1622 1158 433 486 407 74
1755 11311 4079 2440 1028 663 145 222 63
1644 10109 5232 1747 963 555 415 189 85
1401 11829 5774 3406 1509 587 489 375 74
1688 2951 4420 4592 2806 2654 917 681 457
1375 4574 4431 4622 2679 1847 644 287 251
998 1376 3669 4379 3408 1983 1427 680 308
626 1011 1622 2349 1833 1190 453 206 62
acoustic survey
1985 1988
1 1
2 8
1 3200 9900 10600 3000 3200 800 700
1 20500 12500 9300 3400 3200 1200 0
1 11500 9200 11500 5700 3000 1200 700
1 67400 6200 4800 5500 3600 2800 1500
```

Table 5.2.11 Clyde herring - separable VPA.

Title : CLYDE HERRING
At 10.48.57 22 APRIL 1989
from 70 to 88 on ages 2 to 9
with Terminal F of .206 on age 4 and Terminal S of 1.400

Initial sum of squared residuals was 53.533 and
final sum of squared residuals is 23.734 after 102 iterations

Matrix of Residuals

Years	70/71	71/72	72/73	73/74	74/75	75/76	76/77	77/78
Ages								
2/ 3	.833	.432	.365	.250	.646	.336	.635	.891
3/ 4	.329	-.144	.222	.176	.383	.496	.080	.609
4/ 5	.155	-.166	.029	-.175	.012	.097	-.031	-.047
5/ 6	-.001	.622	.131	.013	.119	.017	-.012	.080
6/ 7	-.639	-.261	-.293	-.100	-.034	-.189	.111	-.239
7/ 8	-.286	-.215	-.082	.056	-.407	-.497	-.125	-.316
8/ 9	-.109	-.352	-.334	.105	-.683	-.297	-.451	-.697
	.000	.000	.000	.000	.000	.000	.000	.000
WTS	.001	.001	.001	.001	.001	.001	.001	.001

Years	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88		WTS
Ages												
2/ 3	.230	.190	1.360	-.949	.311	.368	1.269	-.804	.267	-1.105	.000	.276
3/ 4	.313	-.538	.665	-.262	.419	.278	.538	-.425	.070	-.465	.000	.494
4/ 5	.320	-.086	-.211	-.147	.305	-.188	.315	-.046	.163	-.244	.000	1.000
5/ 6	-.131	.466	.332	.016	.068	.243	-.377	-.101	.217	.017	.000	.822
6/ 7	-.271	-.232	-.502	.312	-.306	-.335	-.473	.661	-.054	.204	.000	.591
7/ 8	-.274	.571	-.809	.000	-1.032	-.348	-.355	.406	-.370	.671	.000	.432
8/ 9	-.369	-.469	-.288	.826	-.064	.237	-.455	-.013	-.625	.859	.000	.412
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.808	
WTS	.001	.001	.001	.001	.001	1.000	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	70	71	72	73	74	75	76	77	78
F-values	.6328	.5401	.5658	.5810	.5616	.3975	.3321	.5392	.5440

	79	80	81	82	83	84	85	86	87	88
F-values	.4052	.1876	.4304	.3585	.2684	.2543	.4075	.3378	.4430	.2060

Selection-at-age (S)

	2	3	4	5	6	7	8	9
S-values	.5663	.7537	1.0000	1.0976	1.3713	1.4577	1.6202	1.4000

Table 5.2.12 Clyde herring - outputs from tuning module.
Module run at 10.30.45 22 APRIL 1989
DISAGGREGATED Qs
LOG TRANSFORMATION
NO explanatory variate (Mean used)
Fleet 1 ,cpue , has terminal q estimated as the mean
Fleet 2 ,acoustic survey , has terminal q estimated as the mean
FLEETS COMBINED BY ** VARIANCE **

Regression weights
, 1.000, 1.000, 1.000, 1.000,
Oldest age F = 1.000*average of 5 younger ages. Fleets combined by variance of predictions
Fishing mortalities

Age,	85,	86,	87,	88,
2,	.093,	.258,	.093,	.049,
3,	.229,	.208,	.363,	.160,
4,	.361,	.375,	.308,	.395,
5,	.408,	.329,	.463,	.183,
6,	.857,	.455,	.384,	.259,
7,	.580,	.454,	.677,	.126,
8,	.580,	.318,	1.097,	.168,
9,	.557,	.386,	.586,	.226,

Log catchability estimates

Age 2

Fleet,	85,	86,	87,	88
1 ,	-9.81,	-8.58,	-9.28,	-9.45
2 ,	-2.30,	.15,	-.25,	1.19

SUMMARY STATISTICS

Fleet ,	Pred. q ,	SE(q),	Partial F ,	Raised F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1 ,	-9.28 ,	.577,	.0584 ,	.0584,	.000E+00,	.000E+00,	-9.280,	.258
2 ,	-.30 ,	1.634,	.7382 ,	.0111,	.000E+00,	.000E+00,	-.304,	.731

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.049	.544	.522	.544	.920

Age 3

Fleet,	85,	86,	87,	88
1 ,	-8.91,	-8.80,	-7.92,	-8.27
2 ,	-.67,	-.54,	-.10,	-.49

SUMMARY STATISTICS

Fleet ,	Pred. q ,	SE(q),	Partial F ,	Raised F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1 ,	-8.47 ,	.516,	.1307 ,	.1307,	.000E+00,	.000E+00,	-8.474,	.231
2 ,	-.45 ,	.276,	.6392 ,	.1672,	.000E+00,	.000E+00,	-.448,	.123

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.158	.243	.102	.243	.177

Age 4

Fleet,	85,	86,	87,	88
1 ,	-8.45,	-8.21,	-8.08,	-7.37
2 ,	-.18,	-.28,	-.21,	-.21

SUMMARY STATISTICS

Fleet ,	Pred. q ,	SE(q),	Partial F ,	Raised F ,	SLOPE ,	SE Slope ,	INTRCPT,	SE Intrcpt
1 ,	-8.03 ,	.520,	.2045 ,	.2045,	.000E+00,	.000E+00,	-8.026,	.232
2 ,	-.22 ,	.047,	.8011 ,	.3920,	.000E+00,	.000E+00,	-.222,	.021

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.390	.468E-01	.584E-01	.584E-01	1.555

...Continued..

Table 5.2.12 Continued

Age 5

Fleet	85	86	87	88
1	-8.33	-8.34	-7.68	-8.14
2	-.83	-.87	-.26	-.60

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-8.12	.347	.1864	.1864	.000E+00	.000E+00	-8.119	.155
2	-.64	.316	.5277	.1759	.000E+00	.000E+00	-.639	.141

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.181	.234	.288E-01	.234	.015

Age 6

Fleet	85	86	87	88
1	-7.59	-8.01	-7.86	-7.79
2	.03	-.24	-.54	-.25

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-7.81	.198	.2531	.2531	.000E+00	.000E+00	-7.813	.089
2	-.25	.263	.7801	.2579	.000E+00	.000E+00	-.248	.117

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.255	.158	.901E-02	.158	.003

Age 7

Fleet	85	86	87	88
1	-7.98	-8.02	-7.30	-8.51
2	-.68	-.17	-.56	-.25

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-7.95	.557	.2208	.2208	.000E+00	.000E+00	-7.950	.249
2	-.42	.275	.6600	.1068	.000E+00	.000E+00	-.416	.123

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.123	.247	.288	.288	1.367

Age 8

Fleet	85	86	87	88
1	-7.98	-8.37	-6.81	-8.22
2	-.52	-1.86	.12	.20

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-7.85	.791	.2451	.2451	.000E+00	.000E+00	-7.845	.354
2	-.51	1.068	.5982	.0822	.000E+00	.000E+00	-.514	.478

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.166	.636	.523	.636	.676

Table 5.2.13 VIRTUAL POPULATION ANALYSIS

CLYDE HERRING

CATCH IN NUMBERS   UNIT: thousands

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
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	31538	18615	19216	15272	16950	7634	14283	18326	9057	8543	8634	9355

	1982	1983	1984	1985	1986	1987	1988
2	11311	10109	11829	2951	4574	1376	1011
3	4079	5232	5774	4420	4431	3669	1622
4	2440	1747	3406	4592	4622	4379	2349
5	1028	963	1509	2806	2679	3408	1833
6	663	555	587	2654	1847	1983	1190
7	145	415	489	917	644	1427	453
8	222	189	375	681	287	680	206
9	63	85	74	457	251	308	62
10+	53	38	80	240	79	175	4
TOTAL	20004	19333	24122	19718	19414	17405	8730

Table 5.2.14 VIRTUAL POPULATION ANALYSIS

CLYDE HERRING

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

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
2	.599	.442	.464	.458	.686	.265	.473	.713	.176	.347	.335	.119
3	.548	.327	.433	.488	.514	.446	.211	.730	.519	.118	.194	.293
4	.797	.445	.485	.446	.534	.337	.325	.384	.676	.397	.108	.292
5	.606	.753	.558	.471	.496	.396	.258	.595	.369	.428	.221	.298
6	.448	.572	.517	.542	.443	.330	.385	.438	.672	.309	.146	.424
7	.621	.549	.718	.583	.454	.247	.288	.506	.430	.703	.159	.533
8	.846	.581	.607	.784	.410	.391	.279	.438	.586	.329	.208	.954
9	.664	.580	.577	.565	.468	.340	.307	.472	.546	.433	.168	.501
10+	.664	.580	.577	.565	.468	.340	.307	.472	.546	.433	.168	.501
(2- 6)U	.600	.508	.491	.481	.535	.355	.330	.572	.482	.320	.201	.285

	1982	1983	1984	1985	1986	1987	1988
2	.363	.287	.352	.092	.256	.092	.049
3	.327	.303	.281	.228	.206	.359	.158
4	.426	.215	.313	.358	.373	.305	.390
5	.272	.264	.260	.406	.325	.459	.181
6	.248	.206	.228	.857	.453	.377	.255
7	.218	.216	.252	.580	.454	.671	.123
8	.440	.431	.276	.580	.318	1.097	.166
9	.321	.267	.267	.557	.386	.586	.226
10+	.321	.267	.267	.557	.386	.586	.226
(2- 6)U	.327	.255	.287	.388	.323	.318	.206

Table 5.2.15 VIRTUAL POPULATION ANALYSIS

CLYDE HERRING

STOCK SIZE IN NUMBERS   UNIT: thousands

BIOMASS TOTALS   UNIT: tonnes

ALL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING STOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE USED: PROPORTION OF ANNUAL F BEFORE SPAWNING: .900
PROPORTION OF ANNUAL M BEFORE SPAWNING: .670

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
2	19105	20831	27672	16363	20270	9265	31811	16792	12841	19001	22735	24375
3	26807	7774	9917	12885	7665	7562	5266	14684	6100	7980	9946	12052
4	16619	12693	4589	5266	6474	3752	3965	3490	5796	2971	5806	6709
5	5304	6777	7359	2558	3049	3436	2424	2593	2151	2669	1807	4715
6	2147	2618	2889	3813	1445	1680	2093	1694	1294	1345	1574	1312
7	1717	1240	1337	1559	2007	839	1092	1289	989	598	894	1230
8	1377	835	648	590	787	1153	593	741	703	582	268	690
9	489	535	422	320	244	472	706	406	432	354	379	197
10+	252	430	315	276	165	244	396	534	586	458	460	48
TOTAL NO	73817	53732	55148	43630	42105	28403	48346	42222	30894	35959	43868	51328
SPS NO	37137	30850	30831	24641	21645	18287	28756	20496	18963	23454	30275	36175
TOT.BIOM	20023	14474	14400	11674	11024	7764	12129	11137	8244	9249	11251	13318
SPS BIOM	10101	8314	8080	6618	5788	5019	7357	5508	4991	6075	7904	9323

	1982	1983	1984	1985	1986	1987	1988	1989
2	42650	46546	45785	38766	23254	18044	24664	0
3	16030	21984	25875	23864	26194	13330	12190	17405
4	7364	9459	13296	15994	15560	17457	7619	8519
5	4532	4352	6901	8800	10118	9698	11642	4668
6	3168	3126	3024	4813	5304	6615	5547	8794
7	776	2237	2301	2179	1849	3049	4106	3890
8	653	565	1630	1619	1104	1063	1410	3285
9	240	380	332	1119	820	726	321	1080
10+	202	170	358	588	258	413	21	247
TOTAL NO	75616	88819	99503	97741	84462	70396	67520	
SPS NO	47310	59450	65068	67896	57538	47393	51785	
TOT.BIOM	15414	18263	20929	21252	18939	13685	12384	
SPS BIOM	9774	12397	13904	14462	12882	9093	9483	

Table 5.2.16

List of input variables for the ICES prediction program.

CLYDE HERRING PREDICTION

The reference F is the mean F for the age group range from 2 to 6

The number of recruits per year is as follows:

Year	Recruitment
1989	23000.0
1990	23000.0
1991	23000.0

Proportion of F (fishing mortality) effective before spawning: .9000
Proportion of M (natural mortality) effective before spawning: .6700

Data are printed in the following units:

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

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
2	23000.0	.57	.30	1.00	.140	.140
3	17405.0	.75	.20	1.00	.188	.188
4	8519.0	1.00	.10	1.00	.205	.205
5	4668.0	1.10	.10	1.00	.210	.210
6	8794.0	1.37	.10	1.00	.255	.225
7	3890.0	1.46	.10	1.00	.237	.237
8	3285.0	1.62	.10	1.00	.230	.230
9	1080.0	1.40	.10	1.00	.254	.254
10+	247.0	1.40	.10	1.00	.240	.240

Table 5.2.17

11.12.57 22 APRIL 1989
CLYDE HERRING PREDICTION

Numbers in thousands, catch and biomass in tonnes.

* Year 1989. F-factor .215 and reference F .2060 *

						at 1 January		at spawning time	
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass	sp.stock size	sp.stock biomass
2	.1226	2298.9	321.84	23000.0	3220.0	23000.0	3220.0	16847.4	2358.64
3	.1612	2355.5	442.84	17405.0	3272.1	17405.0	3272.1	13165.9	2475.19
4	.2150	1571.2	322.09	8519.0	1746.4	8519.0	1746.4	6565.3	1345.89
5	.2365	937.4	196.86	4668.0	980.3	4668.0	980.3	3528.5	740.99
6	.2946	2140.3	545.79	8794.0	1978.6	8794.0	1978.6	6309.0	1419.52
7	.3139	999.9	236.98	3890.0	921.9	3890.0	921.9	2742.6	649.99
8	.3483	922.1	212.08	3285.0	755.5	3285.0	755.5	2245.4	516.45
9	.3010	267.8	68.02	1080.0	274.3	1080.0	274.3	770.3	195.66
10+	.3010	61.2	14.70	247.0	59.3	247.0	59.3	176.2	42.28
Total		11554.4	2361.19	70888.0	13208.5	70888.0	13208.5	52350.7	9744.63

* Year 1990. F-factor .215 and reference F .2060 *

						at 1 January		at spawning time	
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass	sp.stock size	sp.stock biomass
2	.1226	2298.9	321.84	23000.0	3220.0	23000.0	3220.0	16847.4	2358.64
3	.1612	2040.0	383.52	15073.6	2833.8	15073.6	2833.8	11402.3	2143.64
4	.2150	2236.7	458.53	12127.9	2486.2	12127.9	2486.2	9346.6	1916.04
5	.2365	1248.5	262.19	6217.1	1305.6	6217.1	1305.6	4699.5	986.89
6	.2946	811.5	206.93	3334.2	750.2	3334.2	750.2	2392.0	538.20
7	.3139	1523.5	361.07	5927.0	1404.7	5927.0	1404.7	4178.7	990.36
8	.3483	721.8	166.02	2571.6	591.5	2571.6	591.5	1757.8	404.28
9	.3010	520.3	132.15	2098.2	532.9	2098.2	532.9	1496.6	380.13
10+	.3010	220.4	52.88	888.6	213.3	888.6	213.3	633.8	152.12
Total		11621.6	2345.14	71238.1	13338.2	71238.1	13338.2	52754.7	9870.31

* Year 1991. F-factor .215 and reference F .2060 *

						at 1 January		at spawning time	
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass	sp.stock size	sp.stock biomass
2	.1226	2298.9	321.84	23000.0	3220.0	23000.0	3220.0	16847.4	2358.64
3	.1612	2040.0	383.52	15073.6	2833.8	15073.6	2833.8	11402.3	2143.64
4	.2150	1937.1	397.11	10503.3	2153.2	10503.3	2153.2	8094.6	1659.39
5	.2365	1777.4	373.26	8850.8	1858.7	8850.8	1858.7	6690.3	1404.96
6	.2946	1080.8	275.60	4440.6	999.1	4440.6	999.1	3185.8	716.81
7	.3139	577.6	136.90	2247.2	532.6	2247.2	532.6	1584.3	375.49
8	.3483	1099.8	252.96	3918.2	901.2	3918.2	901.2	2678.2	615.99
9	.3010	407.3	103.45	1642.5	417.2	1642.5	417.2	1171.5	297.57
10+	.3010	496.0	119.03	2000.1	480.0	2000.1	480.0	1426.6	342.39
Total		11714.9	2363.67	71676.3	13395.8	71676.3	13395.8	53081.2	9914.87

Table 6.1.1 Estimated HERRING catches in tonnes in Divisions VIa (South) and VIIb,c, 1979-1988.

Country	1979	1980	1981	1982	1983
France	-	-	-	353	19
Germany, Fed. Rep.	5	-	2,687	265	-
Ireland	18,910	27,499	19,443	16,856	15,000
Netherlands	1,939	1,514	2,790	1,735	5,000
UK (N. Ireland)	2	1	2	-	-
UK (England + Wales)	-	-	-	-	-
Unallocated	1,752	1,110	-	-	13,000
Total	22,608	30,124	24,922	19,209	33,019

Country	1984	1985	1986	1987	1988[1]
France	-	-	-	-	-
Germany, Fed. Rep.	-	-	-	-	-
Ireland	10,000	13,900	15,450	15,000	15,000
Netherlands	6,400	1,270	1,550	1,550	300
UK (N. Ireland)	-	-	-	5	-
UK (England + Wales)	-	-	-	51	-
Unallocated	11,000	8,204	11,785	31,994	13,800
Total	27,400	23,374	28,785	48,600	29,100

[1] Provisional.

Table 6.1.2 SUM OF PRODUCTS CHECK

HERRING IN FISHING AREAS VIIB,C AND LOWER VIA (W. COAST OF IRELAND, PORCUPINE BANK)
CATEGORY: TOTAL

CATCH IN NUMBERS UNIT: thousands

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

	1982	1983	1984	1985	1986	1987	1988
1	748	1517	2794	9606	918	12149	0
2	18136	43688	81481	15143	27110	44160	29135
3	17004	49534	28660	67355	24818	80213	46300
4	28220	25316	17854	12756	66383	41504	41008
5	18280	31782	7190	11241	14644	99222	23381
6	8121	18320	12836	7638	7988	15226	45692
7	4089	6695	5974	9185	5696	12639	6946
8	3249	3329	2008	7587	5422	6082	2482
9+	2875	4251	4020	2168	2127	10187	1964
TOTAL	100722	184432	162817	142679	155106	321382	196908

Table 6.4.1

Title : HERRING IN FISHING AREAS VIIB,C AND LOWER VIA (W. COAST OF IRELAND, PORCUPINE BANK)
At 13.53.23 22 APRIL 1989
from 70 to 88 on ages 2 to 8
with Terminal F of .400 on age 4 and Terminal S of 1.000

Initial sum of squared residuals was 36.865 and
final sum of squared residuals is 11.823 after 94 iterations

Matrix of Residuals

Years	70/71	71/72	72/73	73/74	74/75	75/76	76/77	77/78
Ages								
2/ 3	1.726	-.556	.027	.581	.322	.402	.494	.529
3/ 4	.498	.282	.213	.128	-.057	-.320	-.079	-.496
4/ 5	.017	.115	-.185	-.017	.196	-.161	-.121	-.053
5/ 6	-.416	-.007	-.130	-.168	.040	.115	.001	.270
6/ 7	-.560	-.094	-.078	-.004	-.212	.231	-.094	.140
7/ 8	-.286	-.170	.605	-.230	-.450	.031	.272	-.274
	.000	.000	.000	.000	.000	.000	.000	.000
WTS	.001	.001	.001	.001	.001	.001	.001	.001

Years	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88		WTS
Ages												
2/ 3	1.046	.304	-.098	.297	-.326	-.047	.423	-.062	-.150	-.140	.000	.250
3/ 4	.085	-.241	.111	-.113	-.248	-.003	.537	-.057	-.107	-.008	.000	.497
4/ 5	.111	-.099	.028	.013	.004	.206	.174	-.227	-.023	-.146	.000	1.000
5/ 6	-.029	.161	-.127	-.101	.090	-.176	-.369	.233	.308	.015	.000	.662
6/ 7	-.428	.023	-.024	.431	.145	-.118	-.120	.040	-.249	-.129	.000	.578
7/ 8	-.439	.070	.118	-.633	.171	-.022	-.691	.277	.160	.738	.000	.337
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	2.582	
WTS	.001	.001	.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	70	71	72	73	74	75	76	77	78	
F-values	.1784	.1465	.2072	.2706	.4084	.4138	.5004	.3204	.2618	
	79	80	81	82	83	84	85	86	87	88
F-values	.2781	.4057	.3169	.2571	.4211	.2090	.1978	.2312	.5019	.4000

Selection-at-age (S)

	2	3	4	5	6	7	8
S-values	.4500	.8814	1.0000	1.0808	1.1647	1.0868	1.0000

Table 6.4.2 VIRTUAL POPULATION ANALYSIS

HERRING IN FISHING AREAS VIIB,C AND LOWER VIA (W. COAST OF IRELAND, PORCUPINE BANK)

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

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
2	.33	.05	.11	.18	.19	.25	.24	.25	.26	.15	.15	.16
3	.19	.11	.24	.29	.29	.26	.41	.18	.26	.20	.33	.24
4	.14	.11	.12	.31	.45	.33	.45	.32	.26	.29	.41	.25
5	.18	.11	.14	.19	.54	.41	.48	.34	.29	.26	.52	.34
6	.15	.26	.17	.21	.33	.64	.43	.31	.22	.35	.31	.58
7	.28	.19	.43	.20	.25	.34	.67	.25	.19	.32	.49	.20
8	.32	.32	.32	.32	.32	.32	.32	.32	.23	.27	.40	.32
9+	.32	.32	.32	.32	.32	.32	.32	.32	.23	.27	.40	.32
(2- 7)U	.21	.14	.20	.23	.34	.37	.45	.27	.25	.26	.37	.29
(3- 7)U	.19	.16	.22	.24	.37	.40	.49	.28	.24	.28	.41	.32

	1982	1983	1984	1985	1986	1987	1988
2	.10	.26	.13	.07	.09	.20	.18
3	.18	.48	.29	.16	.17	.44	.35
4	.24	.42	.30	.19	.23	.45	.40
5	.20	.42	.18	.28	.31	.54	.43
6	.34	.28	.26	.27	.30	.53	.46
7	.32	.45	.12	.27	.29	.92	.43
8	.26	.42	.21	.20	.23	.50	.40
9+	.26	.42	.21	.20	.23	.50	.40
(2- 7)U	.23	.38	.21	.21	.23	.51	.38
(3- 7)U	.26	.41	.23	.23	.26	.58	.41

Table 6.4.3 VIRTUAL POPULATION ANALYSIS

HERRING IN FISHING AREAS VIIB,C AND LOWER VIA (W. COAST OF IRELAND, PORCUPINE BANK)

STOCK SIZE IN NUMBERS UNIT: thousands

BIOMASS TOTALS UNIT: tonnes

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

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
2	142067	148222	315900	285323	198209	212787	155174	229438	202768	403917	334236	177576
3	161934	75385	104516	209409	176892	121739	122437	90228	132042	115863	256458	213386
4	108692	109163	55374	67096	128844	107867	77079	66586	61808	83749	77609	151618
5	24249	85771	88462	44224	44718	74353	69922	44599	43961	43299	56838	46402
6	309739	18243	69225	69459	32960	23560	44802	39291	28778	29643	30308	30482
7	12795	242104	12771	53088	51096	21401	11195	26327	26140	20956	18837	20076
8	6380	8749	180568	7535	39311	35890	13762	5205	18571	19599	13800	10467
9+	7313	8266	16475	195103	116913	122577	60096	15882	16968	18123	16945	19977
TOTAL NO	773169	695904	843291	931238	788943	720174	554467	517556	531035	735149	805032	669984
SPS NO	612899	573836	655991	698696	571142	520022	384084	378804	392456	552359	577905	503077
TOT.BIOM	182166	167423	191158	213451	182143	165494	125485	109420	113675	148687	166059	145620
SPS BIOM	146441	138368	149202	161229	132311	120112	87196	80776	85056	112139	118725	109486

	1982	1983	1984	1985	1986	1987	1988	1989
2	212043	221156	759204	253637	364698	283015	(511144)*	0
3	112534	141574	126614	492793	174937	246980	171982	316287*
4	137104	76821	71522	77896	342786	120871	130277	99225
5	107337	97278	45524	47782	58373	247165	70051	79017
6	29839	79769	57907	34365	32572	38930	129725	41232
7	15519	19299	54799	40218	23848	21896	20811	74100
8	14880	10165	11120	43909	27677	16176	7885	12249
9+	13167	12980	22263	12547	10857	27094	6239	8567
TOTAL NO	642423	659043	1148952	1003148	1035749	1002126	740774	
SPS NO	501828	456322	871786	789716	811506	673526	522867	
TOT.BIOM	140482	144557	224741	197823	221721	217798	162154	
SPS BIOM	110065	100673	171662	155988	174051	145345	149600*	

*Recalculated (see Section 6.4.1)

Table 6.5.1 Irish Young Fish Surveys. Catch of herring per hour.

Year	0 w.ring	1 w.ring	Number of Stations	Numbers of 2 w.ring fish from VPA (millions)
1981	628	455	10	178
1982	1,599	861	10	212
1983	238	661	10	221
1984	2,398	64	10	759
1985	7	77	6	254
1986	24	-	6	365
1987	1,065	3,661	8	283
1988	4,432	45	13	511

Table 6.6.1

List of input variables for the ICES prediction program.

HERRING IN DIVISION VIA (SOUTH) AND VIIB

The reference F is the mean F for the age group range from 2 to 7

The number of recruits per year is as follows:

Year	Recruitment
1989	293000.0
1990	293000.0
1991	293000.0

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

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

Data are printed in the following units:

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

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
2	293000.0	.18	.30	1.00	.115	.164
3	316287.0	.35	.20	1.00	.151	.206
4	99225.0	.40	.10	1.00	.171	.233
5	79017.0	.43	.10	1.00	.177	.252
6	41232.0	.46	.10	1.00	.194	.271
7	74100.0	.43	.10	1.00	.202	.280
8	12249.0	.40	.10	1.00	.214	.296
9+	8567.0	.40	.10	1.00	.220	.317

Table 6.6.2

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

HERRING IN DIVISION VIA (SOUTH) AND VIIB

Year 1989					Year 1990						Year 1991	
factor	ref. F	stock biomass	sp.stock biomass	catch	factor	ref. F	stock biomass	sp.stock biomass	catch	stock biomass	sp.stock biomass
.5	.19	195	154	20	.4	.16	203	165	18	215	175
					.6	.24		156	27	202	155
					1.0	.38		144	40	185	131

The data unit of the biomass and the catch is 1000 tonnes.
The spawning stock biomass is given for the time of spawning.
The spawning stock biomass for 1991 has been calculated with the same fishing mortality as for 1990.
The reference F is the mean F for the age group range from 2 to 7

Table 6.6.3

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

HERRING IN DIVISION VIA (SOUTH) AND VIIB

Year 1989					Year 1990					Year 1991	
factor	ref. F	stock biomass	sp.stock biomass	catch	factor	ref. F	stock biomass	sp.stock biomass	catch	stock biomass	sp.stock biomass
.8	.29	195	144	30	.4	.16	189	153	17	204	165
					.6	.24		145	25	192	147
					1.0	.38		134	36	176	125

The data unit of the biomass and the catch is 1000 tonnes.
The spawning stock biomass is given for the time of spawning.
The spawning stock biomass for 1991 has been calculated with the same fishing mortality as for 1990.
The reference F is the mean F for the age group range from 2 to 7

Table 6.6.4

09.20.25 13 APRIL 1989
HERRING IN DIVISION VIA (SOUTH) AND VIIB

* Year 1989. F-factor .784 and reference F .2938 *
* Run depending on a TAC value *

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January sp.stock size	at 1 January sp.stock biomass	at spawning time sp.stock size	at spawning time sp.stock biomass
2	.1410	33416	3842.9	293000	48052	293000	48052	218038	35758
3	.2743	69073	10430.1	316287	65155	316287	65155	230189	47418
4	.3134	25472	4355.9	99225	23119	99225	23119	75218	17525
5	.3369	21569	3817.8	79017	19912	79017	19912	58963	14858
6	.3604	11910	2310.6	41232	11173	41232	11173	30286	8207
7	.3369	20227	4085.9	74100	20747	74100	20747	55294	15482
8	.3134	3144	672.9	12249	3625	12249	3625	9285	2748
9+	.3134	2199	483.8	8567	2715	8567	2715	6494	2058
Total		187014	30000.0	923677	194502	923677	194502	683769	144059

* Year 1990. F-factor 1.000 and reference F .3750 *

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	.1800	41886	4816.9	293000	48052	293000	48052	212421	34837
3	.3500	50748	7663.0	188505	38832	188505	38832	130402	26862
4	.4000	61960	10595.3	196841	45864	196841	45864	140808	32808
5	.4300	21903	3877.0	65625	16537	65625	16537	46009	11594
6	.4600	17979	3488.0	51045	13833	51045	13833	35076	9505
7	.4300	8683	1754.2	26017	7284	26017	7284	18240	5107
8	.4000	15068	3224.6	47869	14169	47869	14169	34242	10135
9+	.4000	4333	953.4	13767	4364	13767	4364	9848	3121
Total		222564	36372.3	882672	188937	882672	188937	627050	133973

* Year 1991. F-factor 1.000 and reference F .3750 *

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	.1800	41886	4816.9	293000	48052	293000	48052	212421	34837
3	.3500	48809	7370.2	181303	37348	181303	37348	125420	25836
4	.4000	34234	5854.1	108758	25340	108758	25340	77798	18127
5	.4300	39849	7053.3	119390	30086	119390	30086	83704	21093
6	.4600	13605	2639.4	38627	10467	38627	10467	26542	7193
7	.4300	9732	1965.9	29157	8164	29157	8164	20442	5723
8	.4000	4820	1031.6	15314	4532	15314	4532	10954	3242
9+	.4000	11767	2588.9	37384	11850	37384	11850	26742	8477
Total		204705	33320.4	822935	175843	822935	175843	584028	124531

Table 7.1.1 HERRING.
Total catches (t) in North Irish Sea
(Division VIIa), 1979-1988.

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

Country	1984	1985	1986	1987	1988
France	-	-	-	-	-
Ireland	1,084	1,000	1,640	1,200	2,579
Netherlands	-	-	-	-	-
UK	2,982	4,077	4,376	3,290	7,593
Unallocated	-	4,110	1,424	1,333	-
Total	4,066	9,187	7,440	5,823	10,172

Table 7.1.2 VIRTUAL POPULATION ANALYSIS

HERRING IN THE NORTHERN IRISH SEA (MANX PLUS MOURNE HERRING)

CATCH IN NUMBERS UNIT: thousands

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

	1984	1985	1986	1987	1988
1	1168	2429	4491	2225	2607
2	8424	10050	15266	12981	21250
3	7237	17336	7462	6146	13343
4	3841	13287	8550	2998	7159
5	2221	7206	4528	4180	4610
6	380	2651	3198	2777	5084
7	229	667	1464	2328	3232
8+	479	724	877	1671	4213
TOTAL	23979	54350	45836	35306	61498

Table 7.1.3 Herring in Division VIIa. Catch at length.

No fish at length 1988
(thousands)

LENGTH (cm) CM	NUMBER OF FISH (thousands) TOTAL (thousands)
13	0
	1
14	1
	1
15	10
	13
16	16
	29
17	44
	46
18	85
	247
19	306
	385
20	265
	482
21	530
	763
22	1205
	2101
23	3573
	5046
24	5447
	5276
25	4634
	4082
26	4570
	4689
27	4124
	3406
28	2916
	2659
29	1740
	1335
30	685
	563
31	144
	80
32	7
	2
33	1
	0
34	0
TOTALS	61509

Table 7.3.2

Title : HERRING IN THE NORTHERN IRISH SEA (MANX PLUS MOURNE HERRING)
At 14.01.37 19 APRIL 1989
from 72 to 88 on ages 1 to 7
with Terminal F of .300 on age 2 and Terminal S of 1.000

Initial sum of squared residuals was 106.889 and
final sum of squared residuals is 18.244 after 113 iterations

Matrix of Residuals

Years / Ages	72/73	73/74	74/75	75/76	76/77	77/78
1/ 2	1.543	.973	1.120	.911	1.129	1.000
2/ 3	-.704	-.469	-.172	-.105	-.299	-.152
3/ 4	.015	.216	.133	.030	-.060	.018
4/ 5	-.518	-.424	-.345	-.353	-.280	-.153
5/ 6	.343	.292	-.002	.341	.204	.260
6/ 7	.020	-.312	-.367	-.428	-.120	-.485
	.000	.000	.000	.000	.000	.000
WTS	.001	.001	.001	.001	.001	.001

Years / Ages	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88		WTS
1/ 2	.475	.615	-.303	.029	.248	-.305	.328	-.427	.218	-.098	.000	.293
2/ 3	-.522	-.294	.396	.097	.131	.093	-.228	-.364	.150	.123	.000	.596
3/ 4	.210	.077	.313	-.435	-.115	.064	-.013	.142	.258	.098	.000	1.000
4/ 5	-.118	-.473	-.686	.960	.415	-.416	-.351	.176	-.282	-.500	.000	.427
5/ 6	-.213	.173	.369	.041	-1.072	-.041	.541	.385	-.039	.182	.000	.474
6/ 7	.197	.066	-.599	-.105	.515	.291	-.094	-.101	-.476	-.028	.000	.572
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	2.480	
WTS	.001	.001	.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	72	73	74	75	76	77	78
F-values	.5933	.5042	.9279	.8367	.9711	.9242	.7950

	79	80	81	82	83	84	85	86	87	88
F-values	.8184	.8869	.3847	.2506	.1444	.1277	.3078	.2504	.1719	.3000

Selection-at-age (S)

	1	2	3	4	5	6	7
S-values	.0874	1.0000	1.0963	1.2370	.9331	1.0959	1.0000

Table 7.3.3 VPA results.

HERRING IN THE NORTHERN IRISH SEA (MANX PLUS MOURNE HERRING)

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

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	.166	.104	.214	.152	.229	.156	.104	.144	.063	.040	.037	.009
2	.362	.344	.825	.752	.790	.856	.528	.758	1.088	.424	.299	.199
3	.522	.614	1.012	.907	.976	.988	.920	.840	1.355	.387	.282	.172
4	.532	.418	1.004	.823	1.101	.995	.895	.823	.819	.666	.462	.210
5	.610	.524	.754	.953	.907	1.075	.667	.734	1.069	.477	.133	.145
6	.631	.420	.794	.678	.990	.737	1.001	.997	.684	.437	.395	.261
7	.535	.467	.878	.823	.953	.930	.803	.841	1.043	.426	.298	.132
8+	.535	.467	.878	.823	.953	.930	.803	.841	1.043	.426	.298	.132
(2- 7)U	.532	.465	.878	.823	.953	.930	.802	.832	1.010	.470	.311	.186

	1984	1985	1986	1987	1988
1	.015	.027	.046	.025	.056
2	.129	.290	.409	.312	.660
3	.185	.452	.387	.305	.660
4	.162	.566	.399	.251	.660
5	.227	.452	.339	.308	.660
6	.159	.408	.329	.320	.660
7	.170	.406	.368	.377	.660
8+	.170	.406	.368	.377	.660
(2- 7)U	.172	.429	.372	.312	.660

VIRTUAL POPULATION ANALYSIS

HERRING IN THE NORTHERN IRISH SEA (MANX PLUS MOURNE HERRING)

STOCK SIZE IN NUMBERS UNIT: thousands

BIOMASS TOTALS UNIT: tonnes

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

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	414234	667532	349067	369352	263143	327124	246731	137469	151326	201412	219340	220177
2	176360	129055	221250	103679	116719	76961	102943	81800	43802	52288	71166	77731
3	72523	90997	67771	71851	36200	39237	24233	44989	28389	10936	25338	39078
4	33404	35241	40307	20167	23751	11164	11955	7907	15905	5998	6082	15647
5	31474	17748	21000	13357	8010	7148	3735	4418	3141	6345	2789	3466
6	15097	15470	9508	8938	4661	2925	2208	1735	1919	976	3563	2210
7	6717	7266	9194	3889	4107	1567	1267	734	579	876	570	2172
8+	4217	7294	2910	3052	2155	1929	662	532	370	725	1548	502
TOTAL NO	754024	970605	721007	594285	458746	468055	393734	279584	245430	279556	330395	360984
SPS NO	189208	183718	140265	97021	75638	58355	69613	57630	33276	46718	71664	99863
TOT.BIOM	93443	106766	92607	69024	54511	49565	43489	35154	28469	28600	35653	41447
SPS BIOM	33779	32593	24492	16897	12804	9489	11106	9801	5677	7575	11950	17341

	1984	1985	1986	1987	1988	1989
1	126738	145541	158201	139663	75382	0
2	80240	45945	52131	55595	50087	26221
3	47208	52243	25481	25661	30141	19178
4	26952	32133	27229	14165	15486	12754
5	11481	20740	16500	16535	9972	7242
6	2714	8281	11940	10637	10997	4664
7	1541	2095	4981	7771	6991	5143
8+	3223	2274	2984	5578	9113	7532
TOTAL NO	300095	309252	299447	275606	208170	
SPS NO	123897	98195	88174	88771	62724	
TOT.BIOM	40041	39556	35817	30326	26512	
SPS BIOM	21727	15879	15404	14298	10034	

Table 7.5.1

$F_{88} = 0.3$

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
1	223000.0	.08	1.00	.08	.070	.070
2	58621.0	1.00	.30	.85	.124	.124
3	51696.0	1.00	.20	1.00	.160	.160
4	34280.0	1.00	.10	1.00	.170	.170
5	19408.0	1.00	.10	1.00	.180	.180
6	12498.0	1.00	.10	1.00	.198	.198
7	13783.0	1.00	.10	1.00	.212	.212
8+	20183.0	1.00	.10	1.00	.232	.232

14.27.23 08 APRIL 1989
NIRISH F88=.3

							at 1 January		at spawning time	
Year/ TAC=X	F factor	reference F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass	sp.stock size	sp.stock biomass
1989/X	.199	.1990	37269.2	6000.00	433469	50550.5	219515	35098.9	156435	25703.5
1990/X	.189	.1886	37684.1	5999.95	448201	52436.0	230942	36574.5	165660	26989.6
1991/X	.179	.1788	37470.1	5999.95	458989	54366.6	241719	38503.8	174767	28619.3

$F_{88} = 0.66$

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
1	195000.0	.08	1.00	.08	.070	.070
2	26221.0	1.00	.30	.85	.124	.124
3	19178.0	1.00	.20	1.00	.160	.160
4	12754.0	1.00	.10	1.00	.170	.170
5	7242.0	1.00	.10	1.00	.180	.180
6	4664.0	1.00	.10	1.00	.198	.198
7	5143.0	1.00	.10	1.00	.212	.212
8+	7532.0	1.00	.10	1.00	.232	.232

14.29.33 08 APRIL 1989
NIRISH F88=.66

							at 1 January		at spawning time	
Year/ TAC=X	F factor	reference F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass	sp.stock size	sp.stock biomass
1989/X	.586	.5864	39839.6	5999.95	277734	27202.8	94400	14157.1	47717.5	7311.98
1990/X	.510	.5104	43590.8	5999.95	301586	29182.7	111949	15355.2	58356.2	8194.21
1991/X	.450	.4499	43433.9	6000.00	314300	30990.1	124597	17154.4	68181.4	9597.22

D l o

International Council for the Exploration of the Sea

C.M.1989/Assess:15

PART 2

REPORT OF THE HERRING ASSESSMENT WORKING GROUP FOR THE AREA SOUTH OF 62^{0}N

Copenhagen, 4 - 14 April 1989

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

Figure 2.3.1 Regression of VPA 1-ringers on IYFS indices. **Recent year** classes indicated by asterix have not been used in calculating the regression. The dotted line represents line forced through the origin.

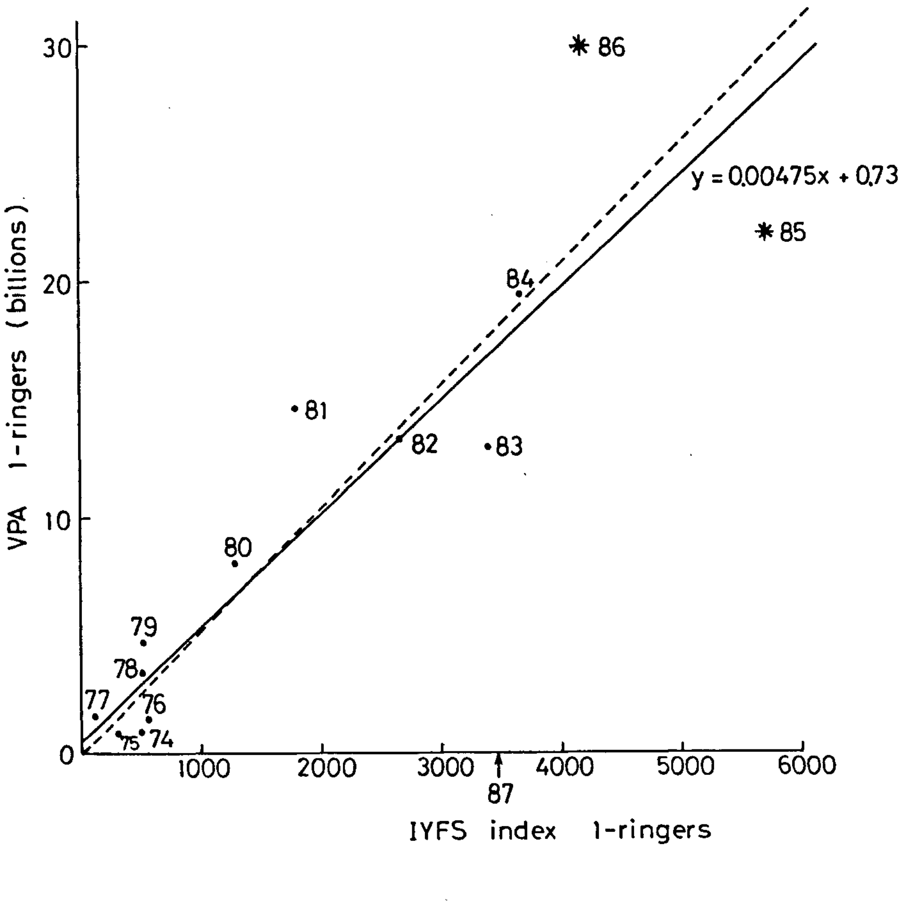


Figure 2.3.2 Plot of IKMT indices in VPA estimates of 0-ring herring at 1 July. Year classes indicated by asterix have not been used in calculating regression.

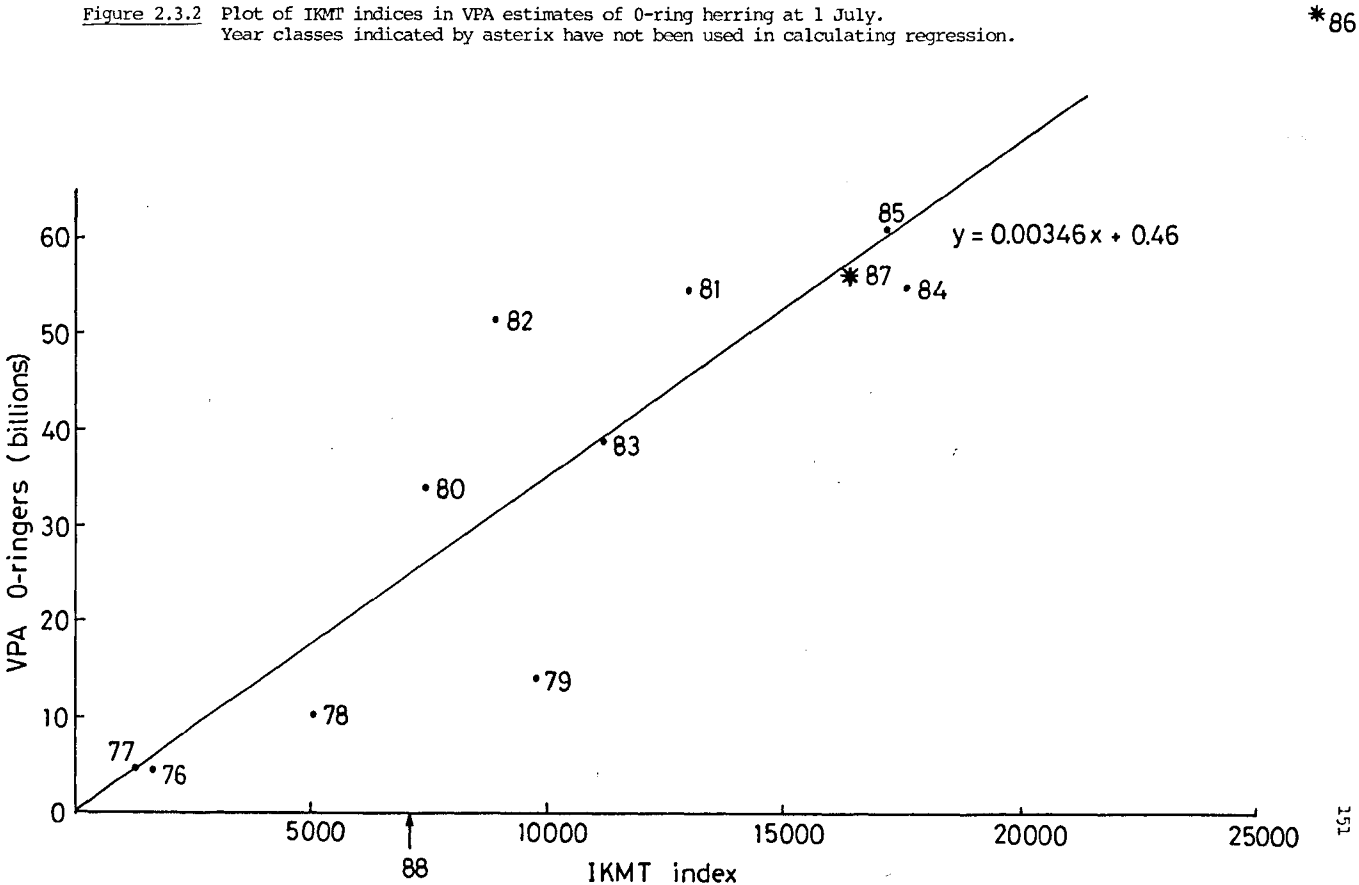


Figure 2.3.3 0-group herring sampled by IKMT during the International Young Fish Surveys in 1987-1989.

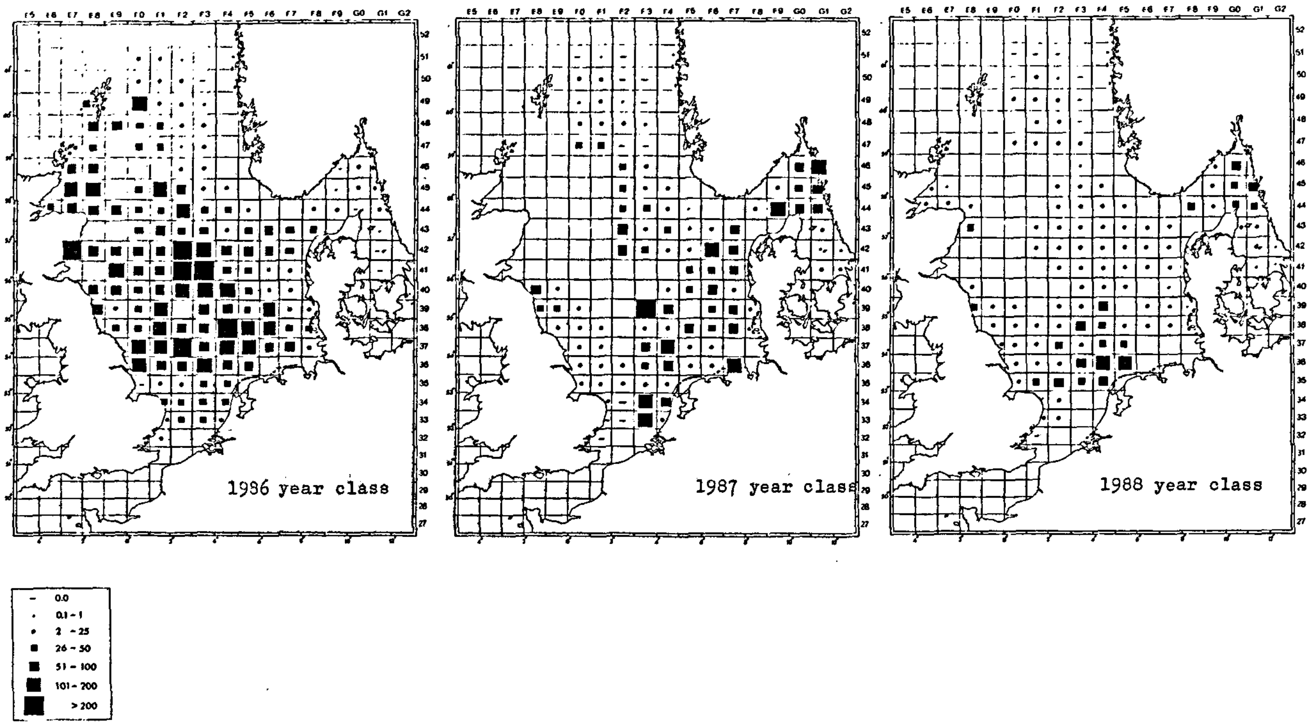


Fig. 2.3.4. RECRUITMENT AS 1–RINGERS

Herring – Total North Sea

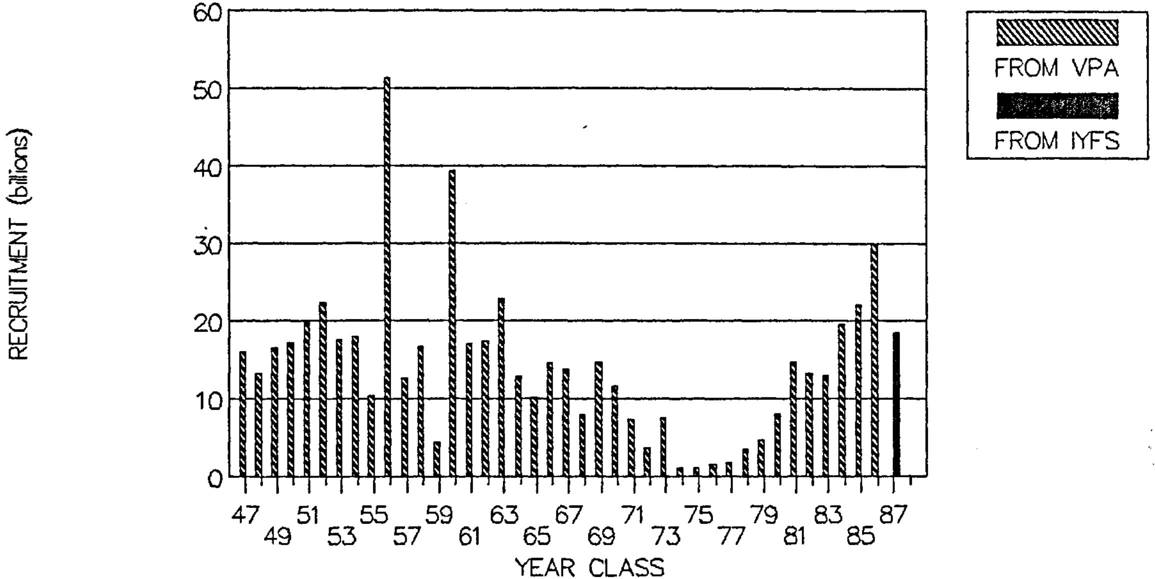


Fig. 2.5.1 DEVELOPMENT OF STOCKS
LPE – NORTH SEA DIVISIONS

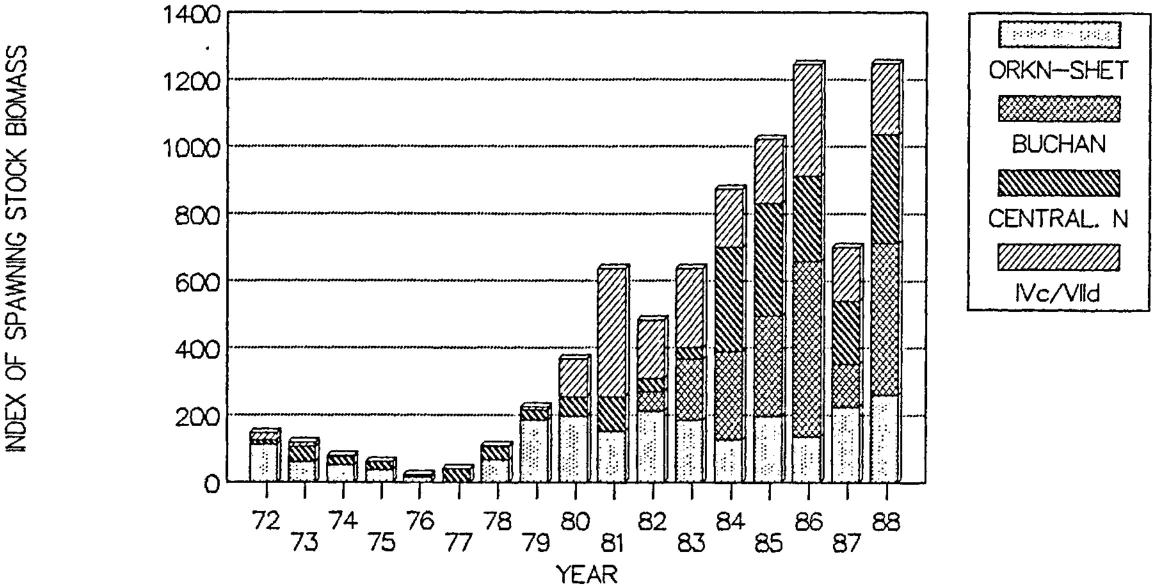


Figure 2.7.1 Cumulative catch by month in the North Sea.

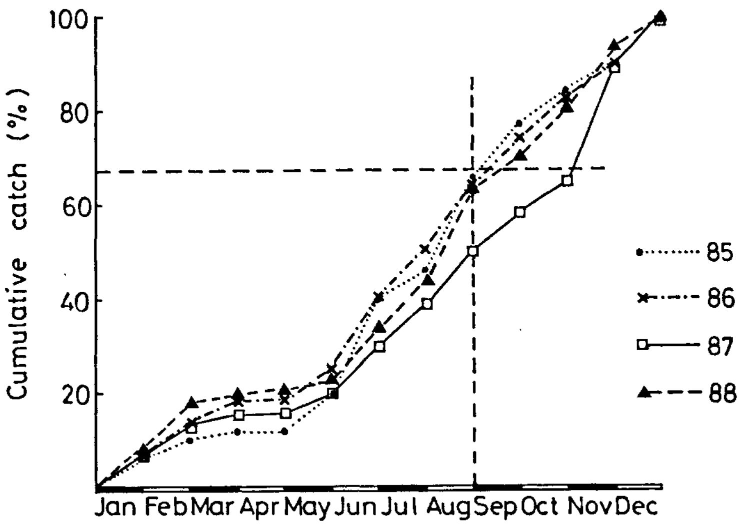


Figure 2.7.2 Catchability pattern by age group from the VPA tuning.

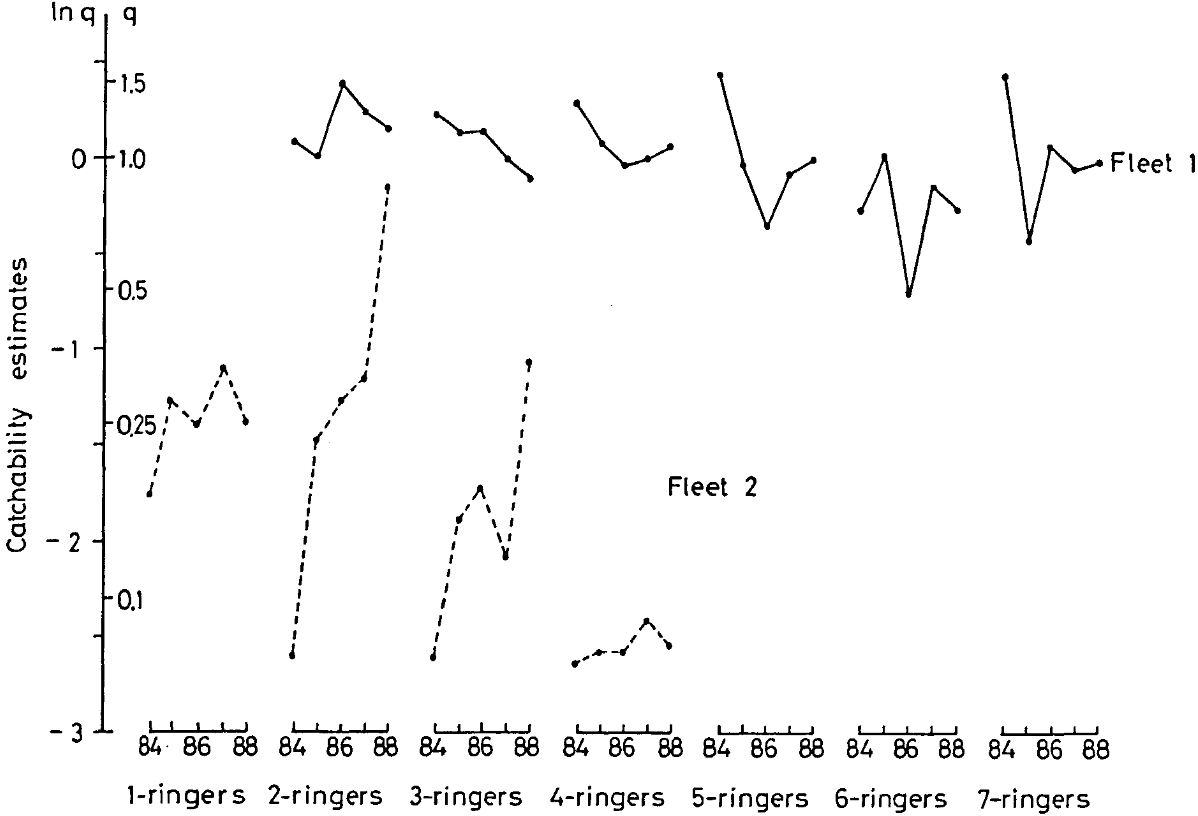


Fig. 2.7.3 STOCK-RECRUITMENT

North Sea Herring VPA 1-ringers

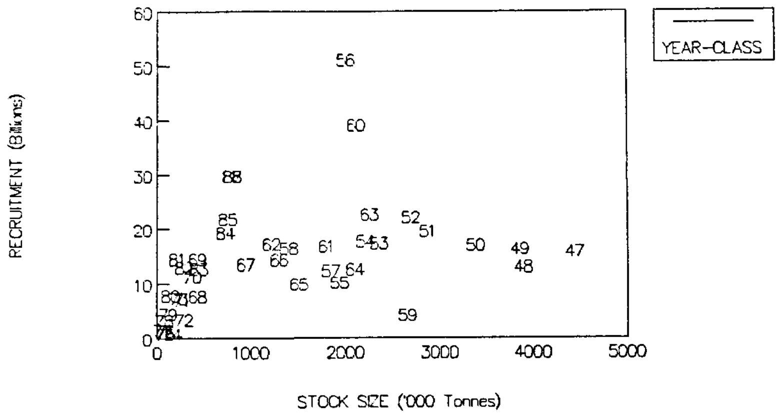


Fig 2.7.4 RECRUITMENT SUCCESS

Herring – Total North Sea

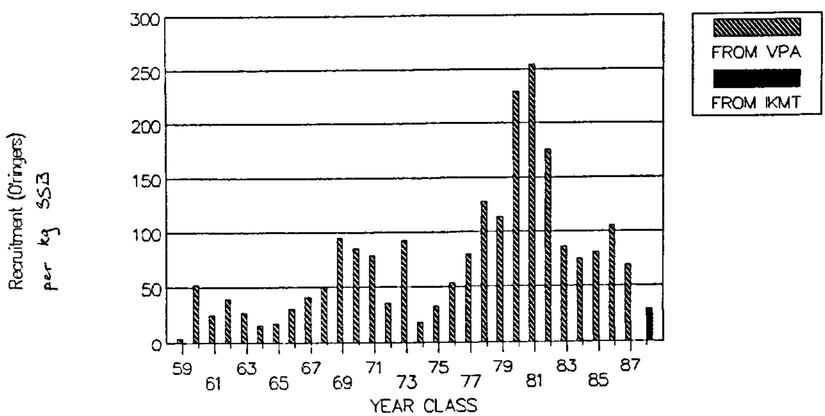


Fig 2.7.5 Larvae per gramme SSB

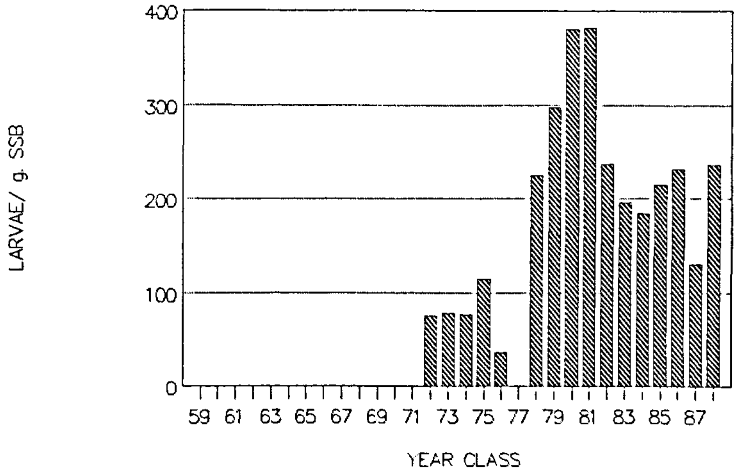


Fig 2.7.6 0 group – Number per 1000 larvae

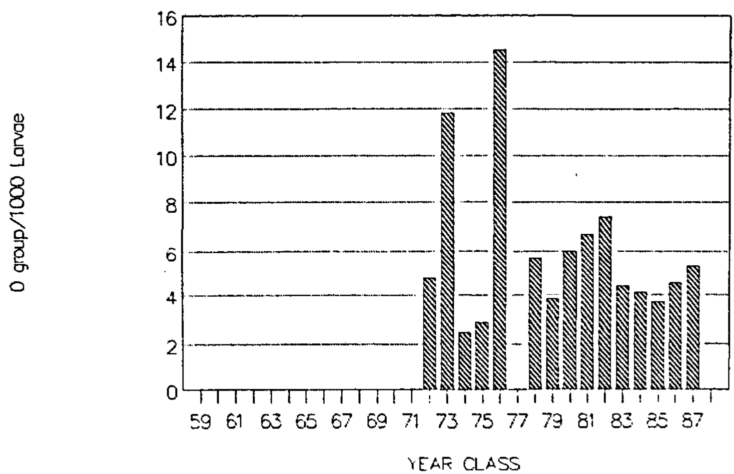
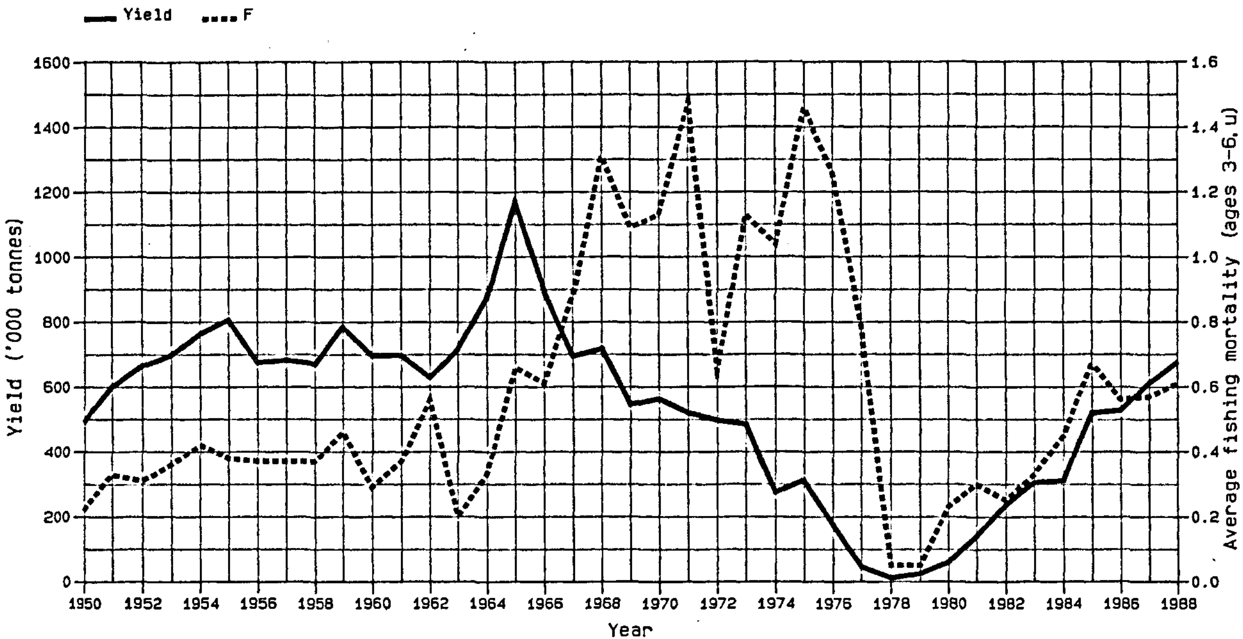


Figure 2.8.1

FISH STOCK SUMMARY
STOCK: Herring - Total North Sea
20-04-1989

Trends in yield and fishing mortality (F)

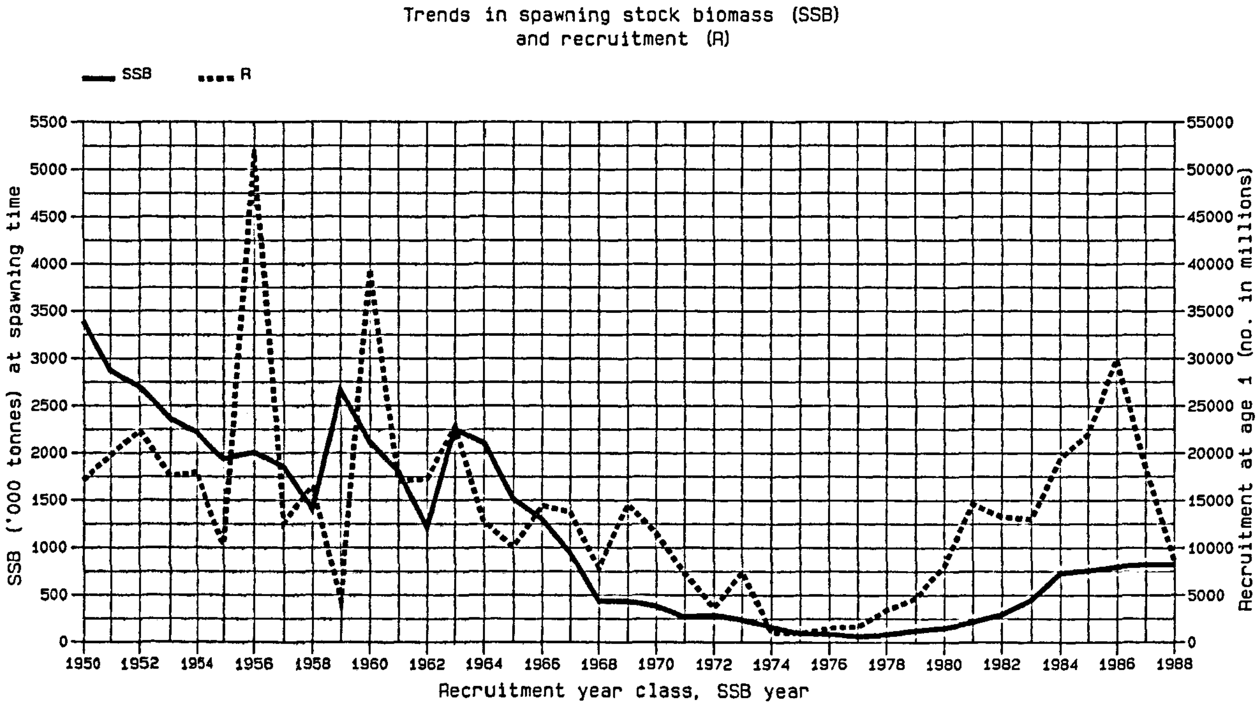


A

cont'd.

Figure 2.8.1 cont'd.

FISH STOCK SUMMARY
STOCK: Herring - Total North Sea
20-04-1989



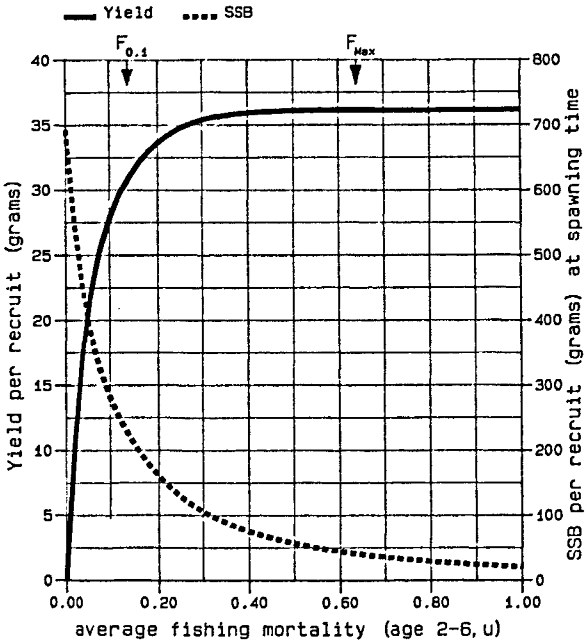
B

cont'd.

Figure 2.8.1 cont'd.

FISH STOCK SUMMARY
STOCK: Herring - Total North Sea
24-04-1989

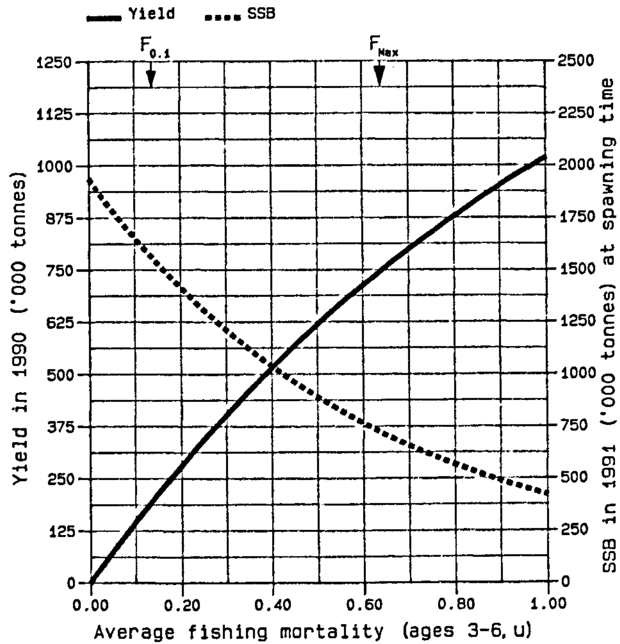
Long-term yield and spawning stock biomass



C

Short-term yield and spawning stock biomass

Assuming catch of 514,000 t in 1989



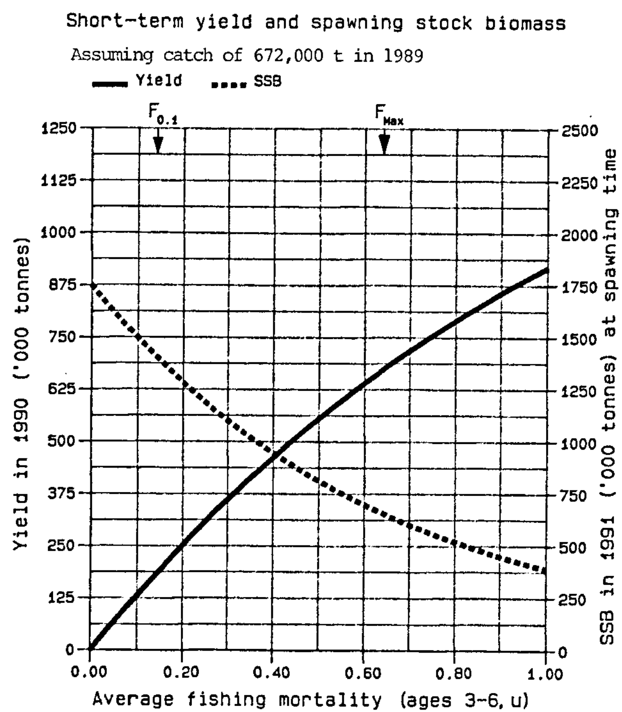
D

cont'd.

FISH STOCK SUMMARY

Figure 2.8.1 cont'd. STOCK: Herring - Total North Sea

24-04-1989



D

Figure 2.10.1 North Sea herring 1988. Total catch January, 41,301 t.

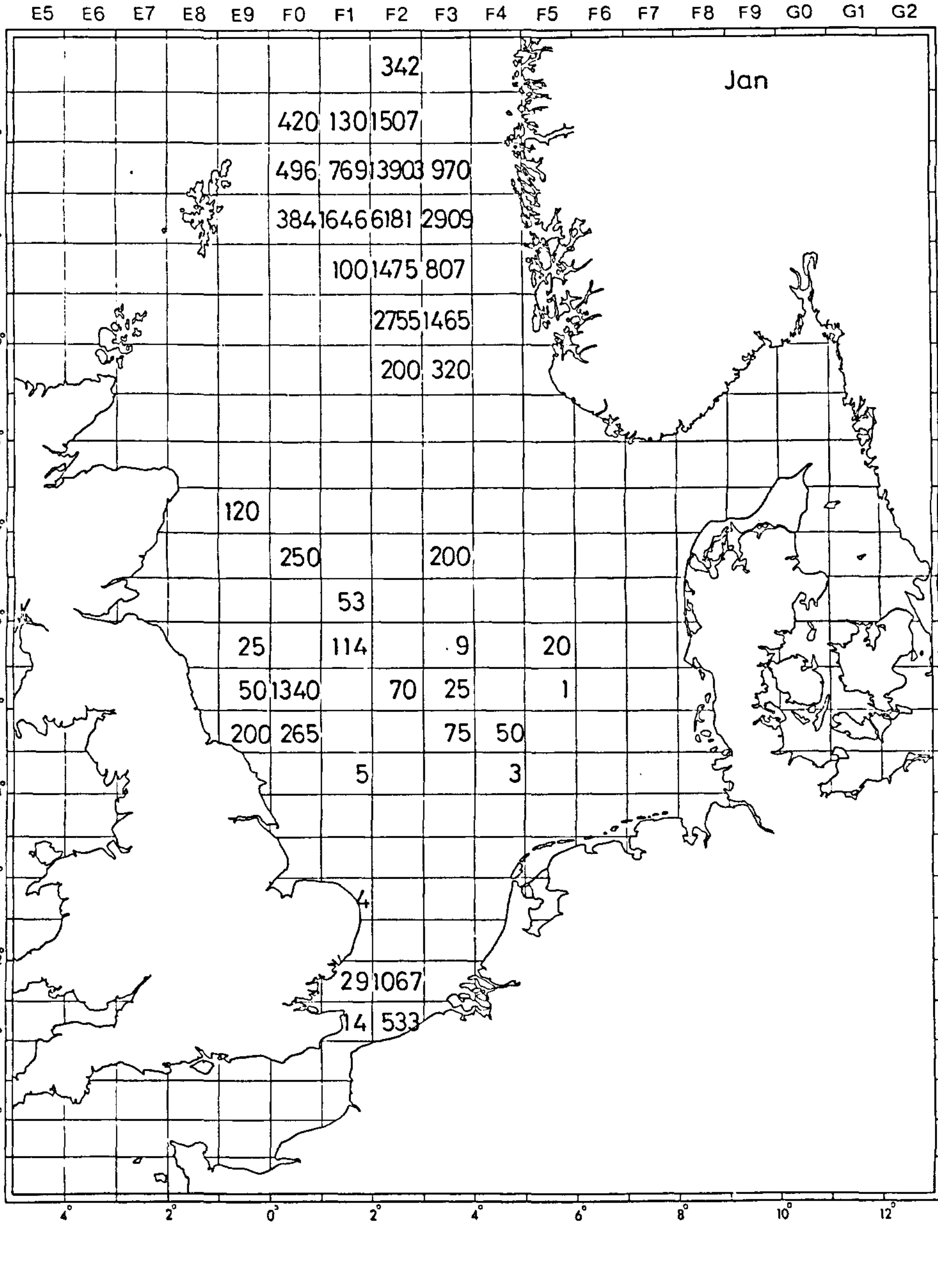


Figure 2.10.2 North Sea herring, 1988. Total catch February 47,966 t.

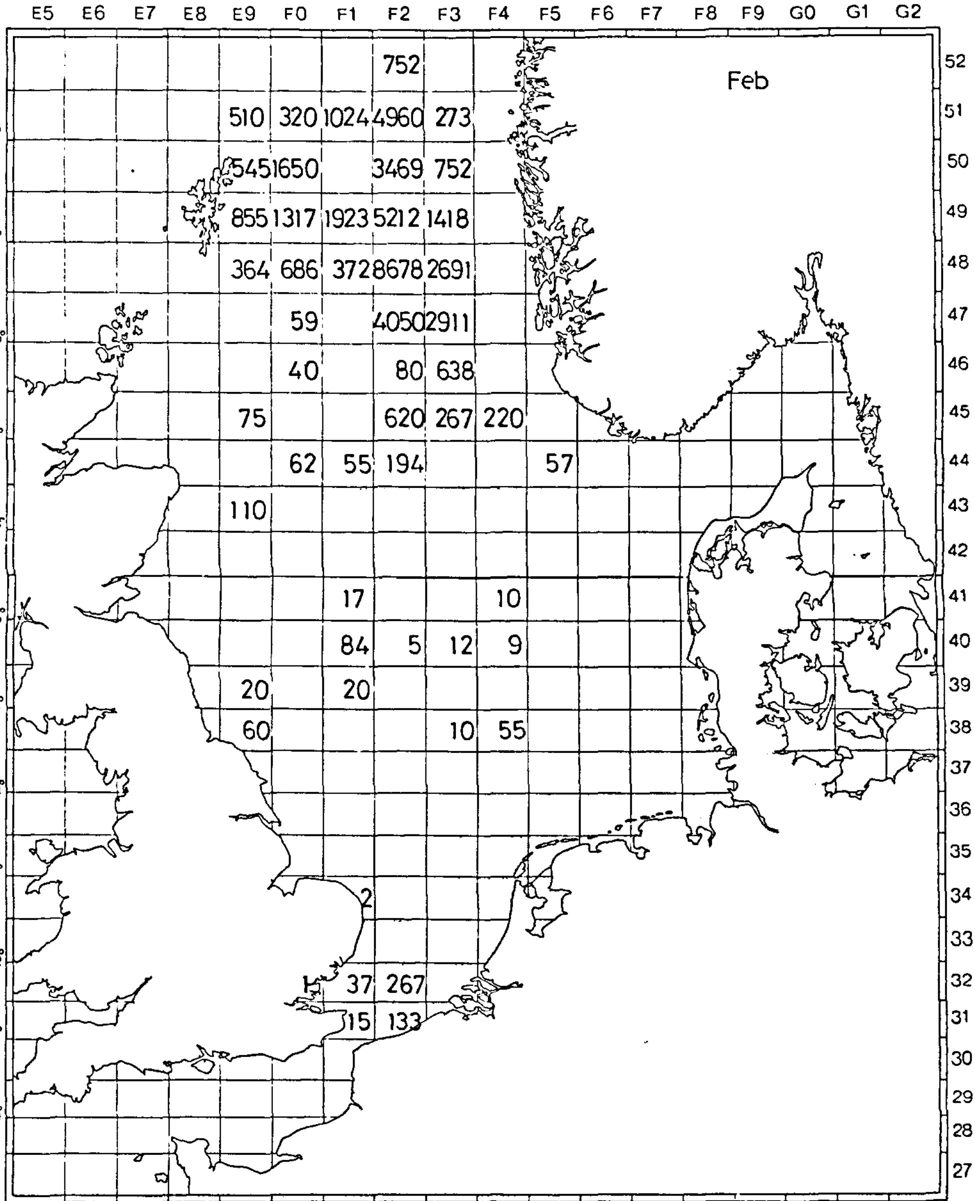


Figure 2.10.3 North Sea herring, 1988. Total catch March 8,354 t.

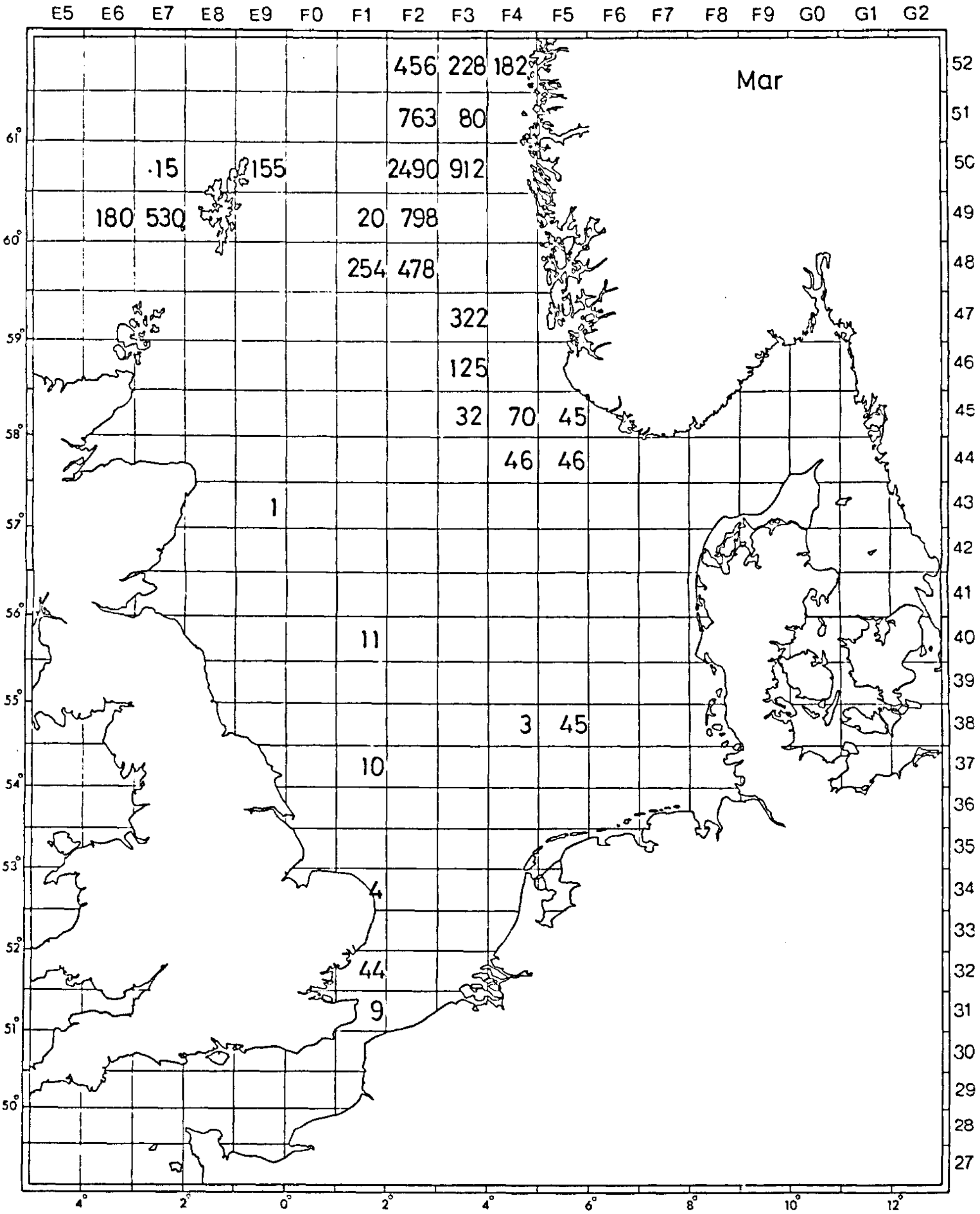


Figure 2.10.4 North Sea herring, 1988. Total catch April 3,183 t.

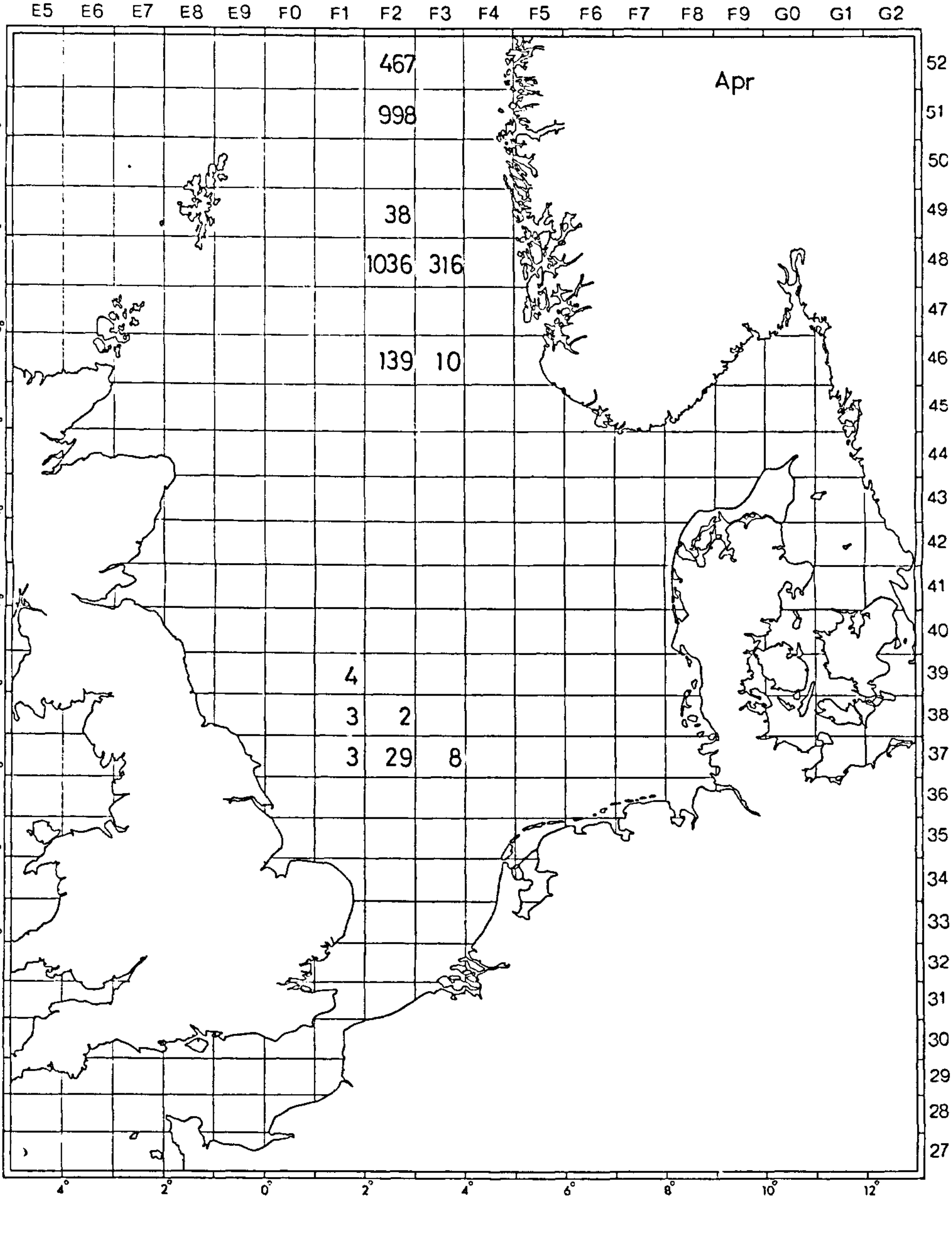


Figure 2.10.5 North Sea herring, 1988. Total catch May 15,652 t.

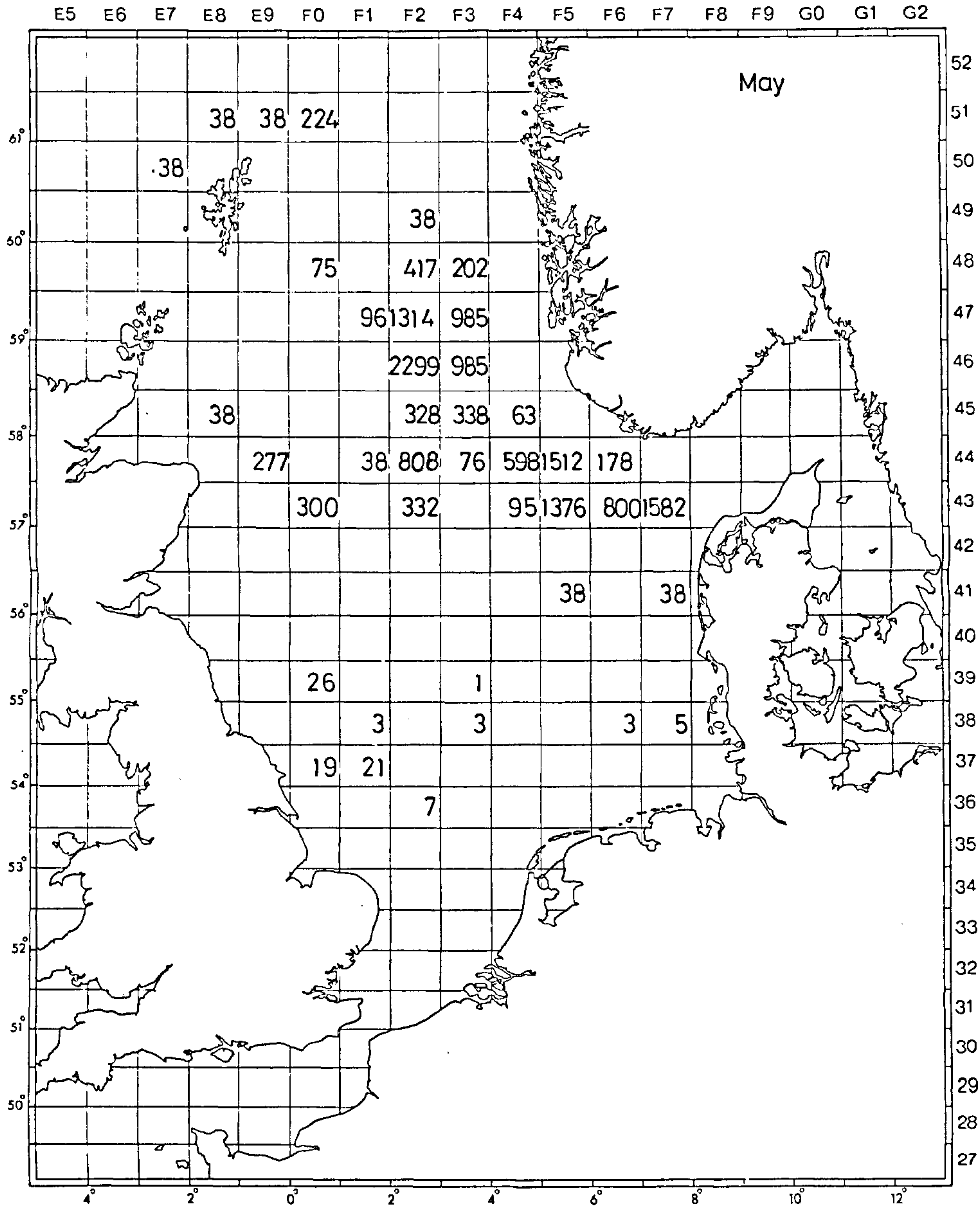


Figure 2.10.6 North Sea herring, 1988. Total catch June 50,426 t.

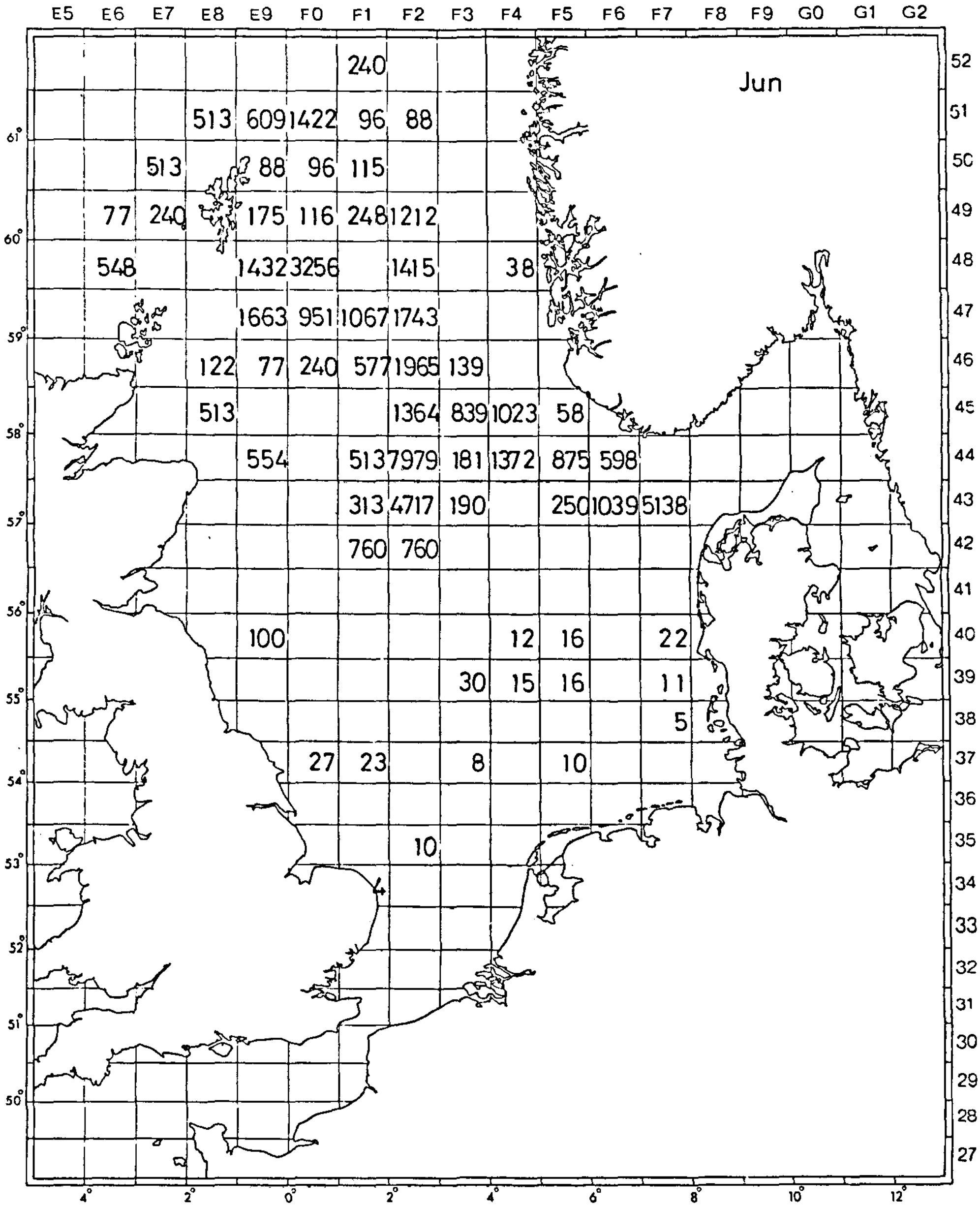


Figure 2.10.7 North Sea herring, 1988. Total catch July 51,221 t.

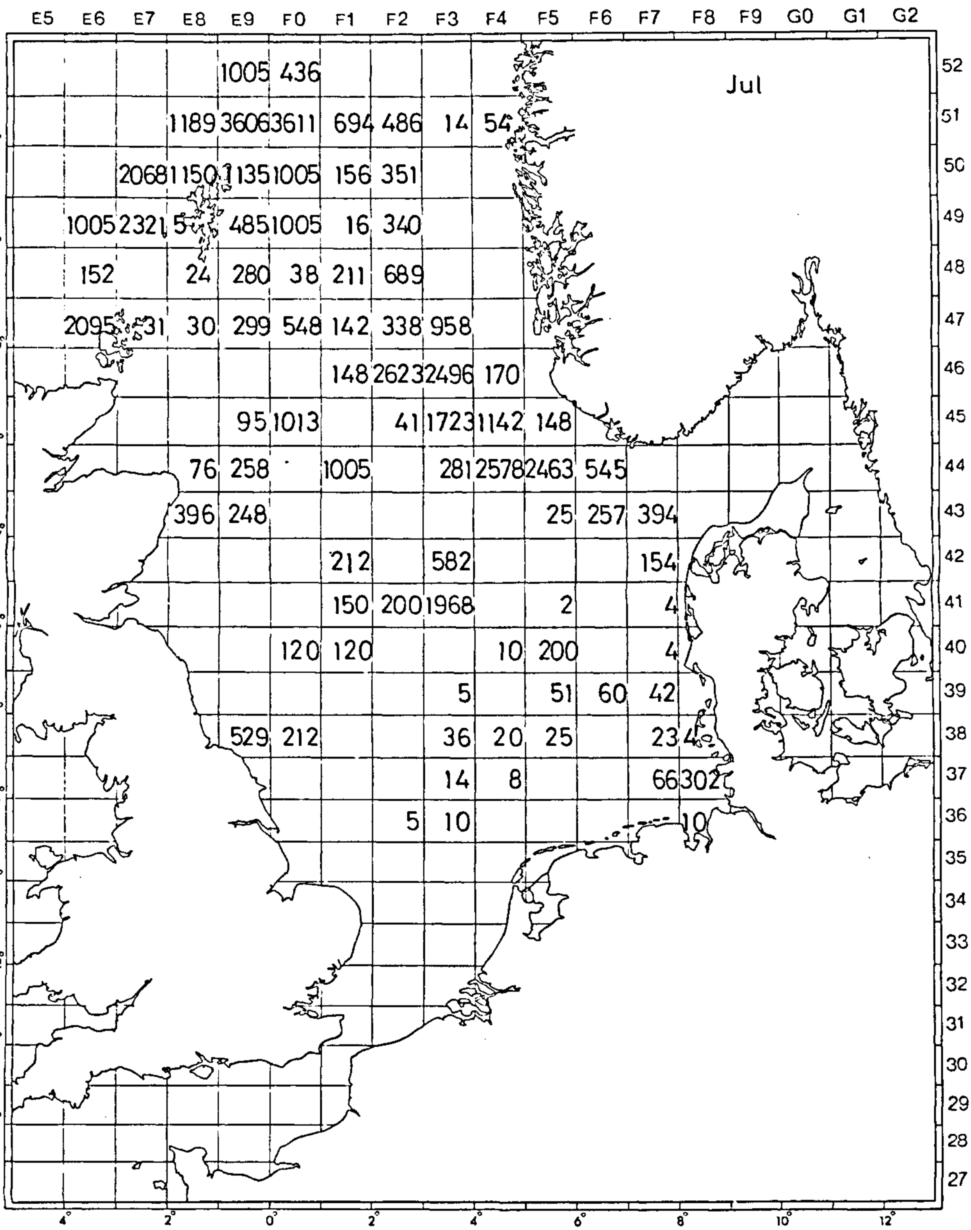


Figure 2.10.8 North Sea herring, 1988. Total catch August 97,192 t.

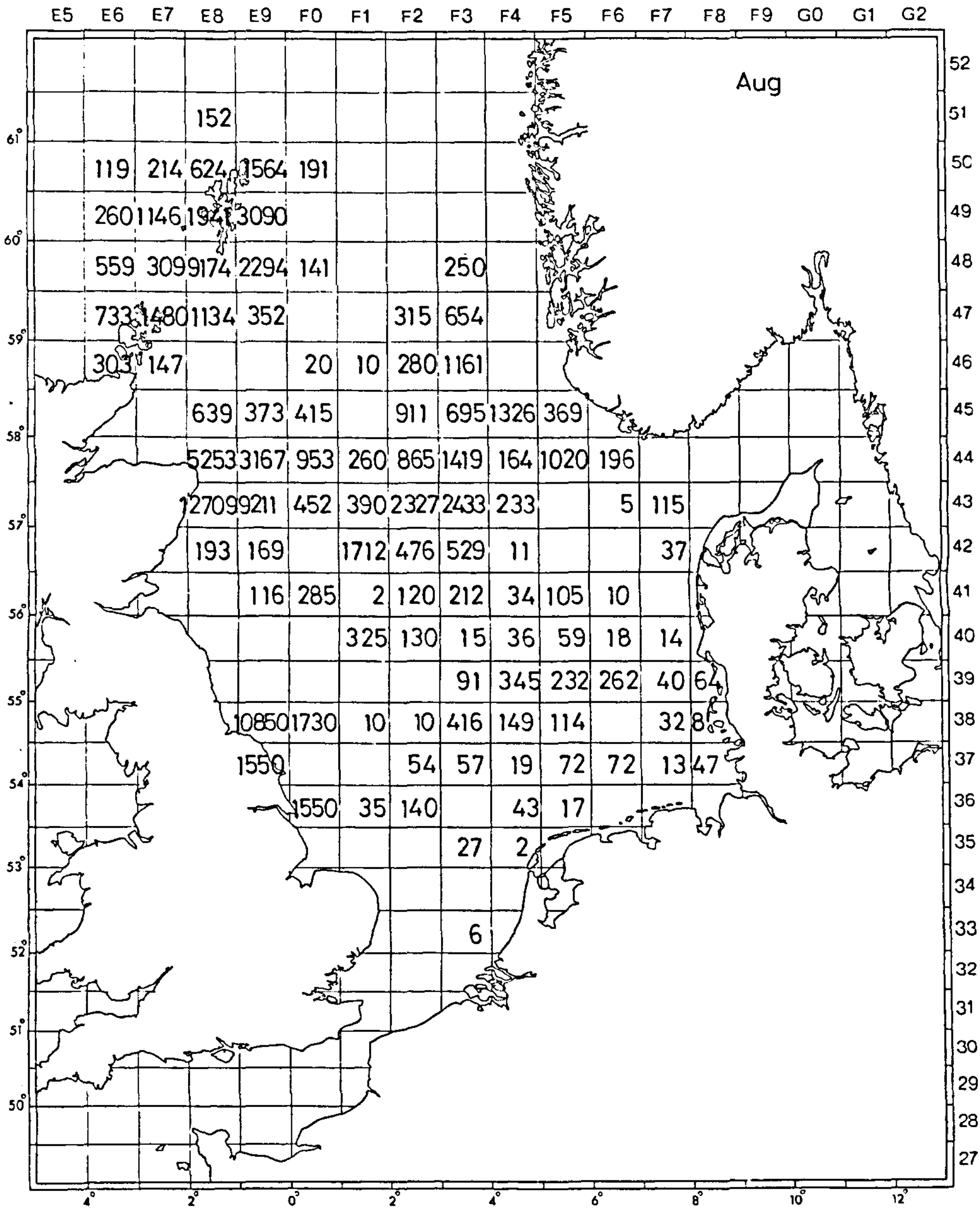


Figure 2.10.9 North Sea herring, 1988. Total catch September 34,426 t.

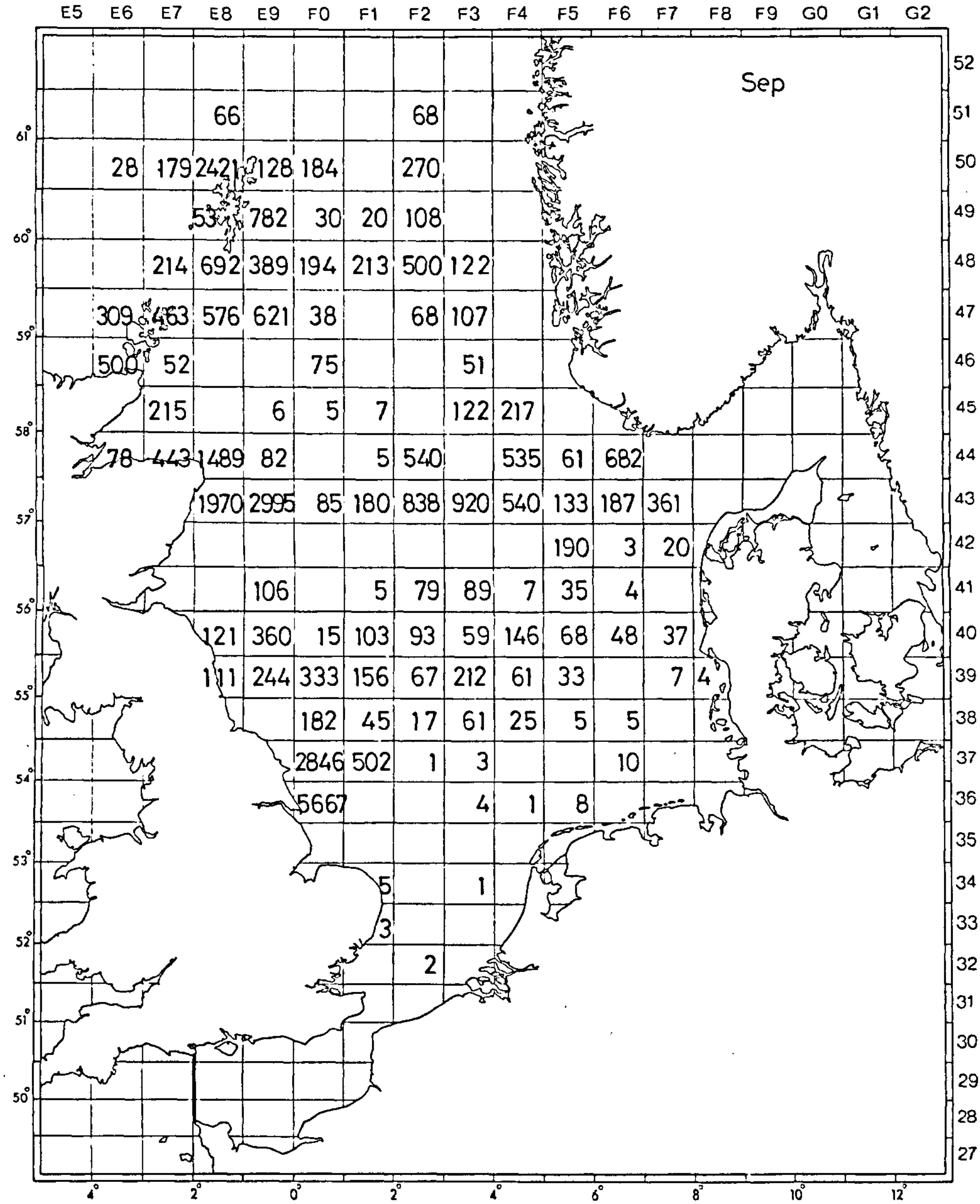


Figure 2.10.10 North Sea herring, 1988. Total catch October 47,898 t.

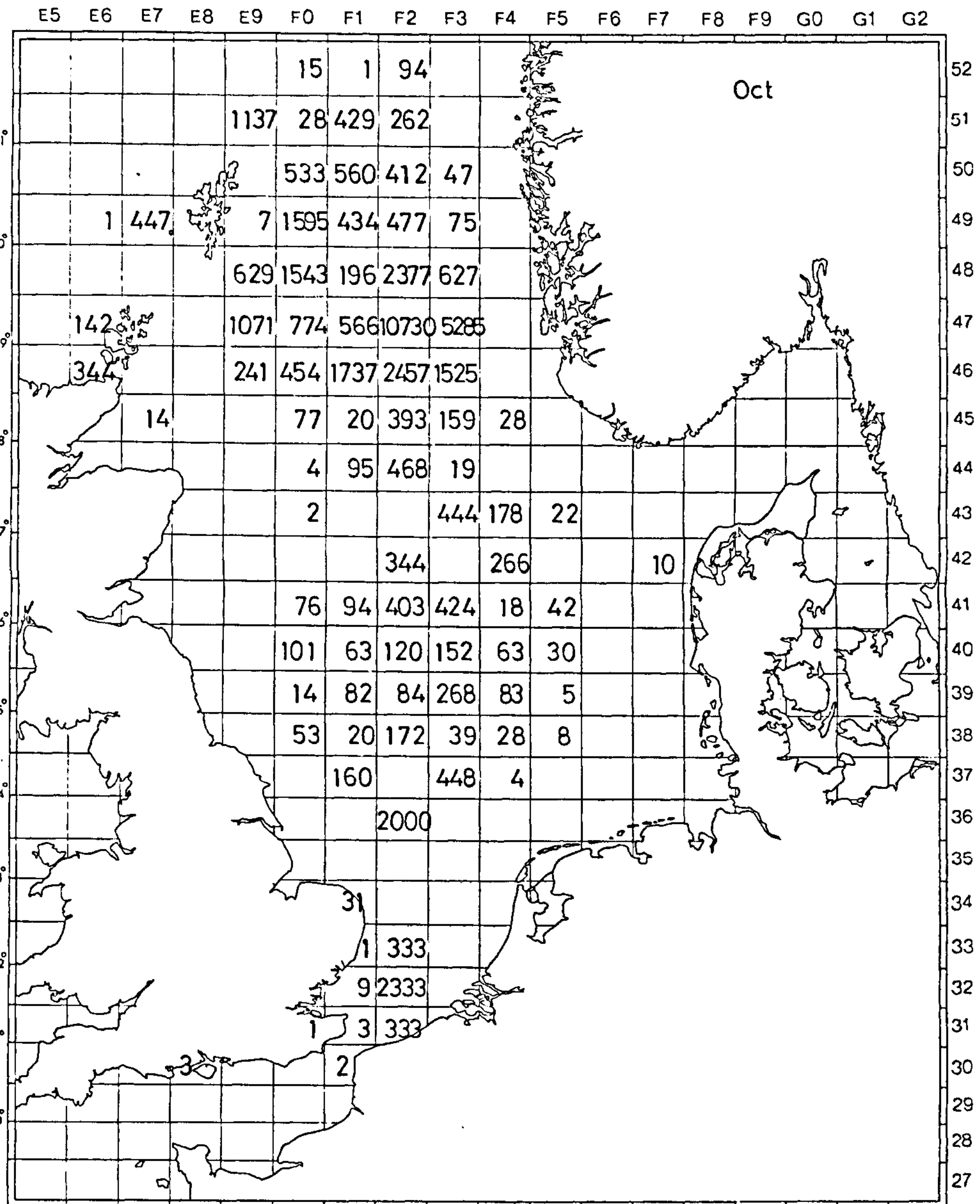


Figure 2.10.11 North Sea herring, 1988. Total catch November 64,288 t.

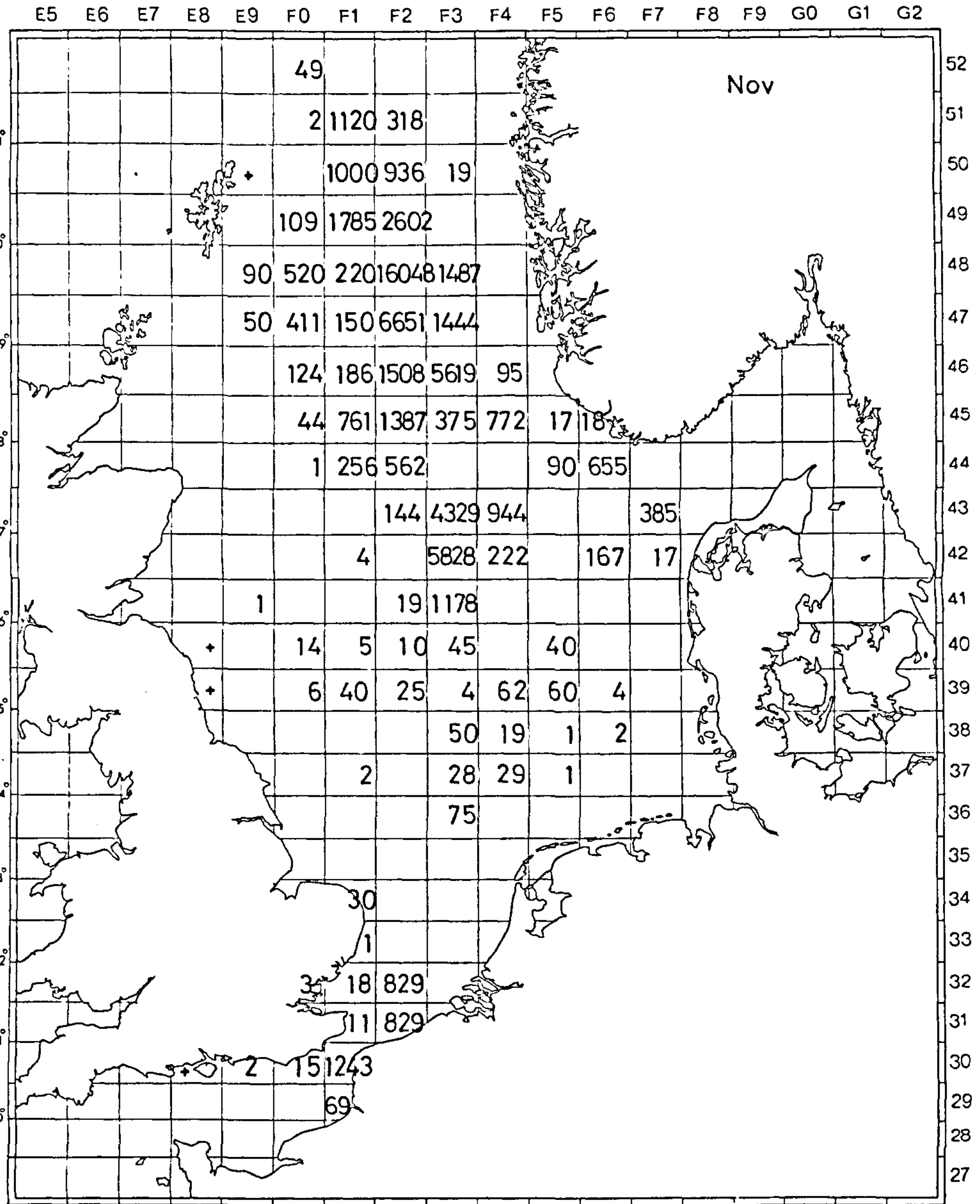


Figure 2.10.12 North Sea herring, 1988. Total catch December 29,639 t.

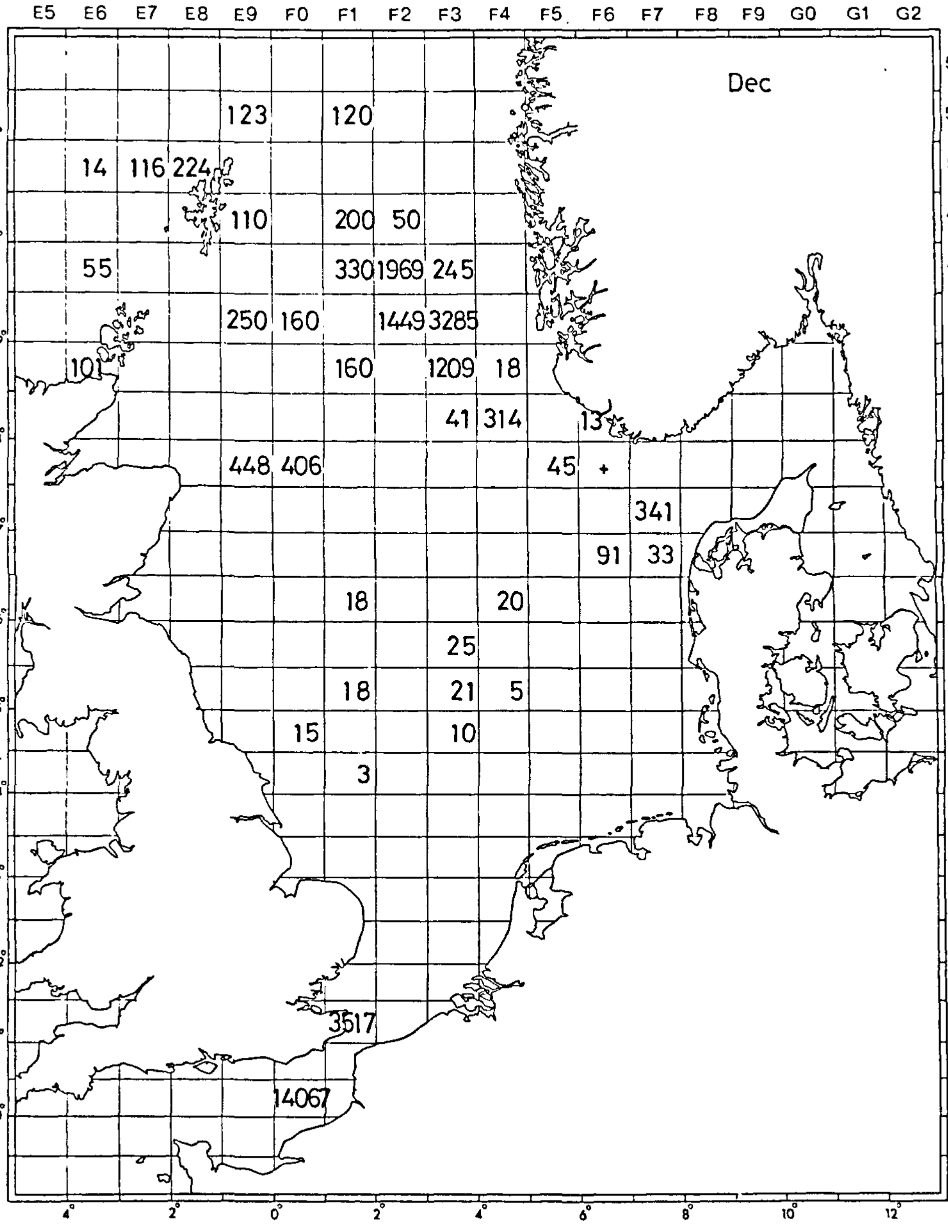
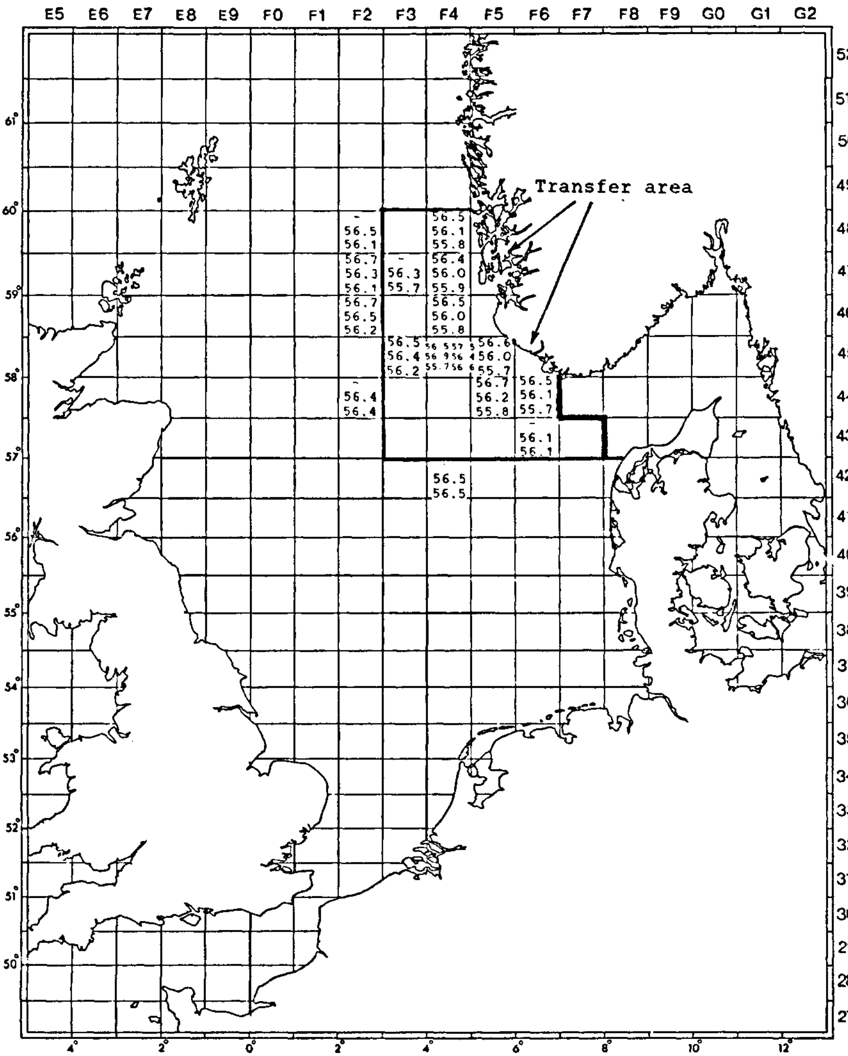


Figure 3.1.1 Area from where catches of 3+-group and parts of 2-group have been transferred in May-September. Vertebral counts of 1-, 2- and 3+-group herring in commercial and research vessel samples in May-September 1988: Upper figure: 1-group. Middle figure: 2-group. Lower figure: 3+-group.



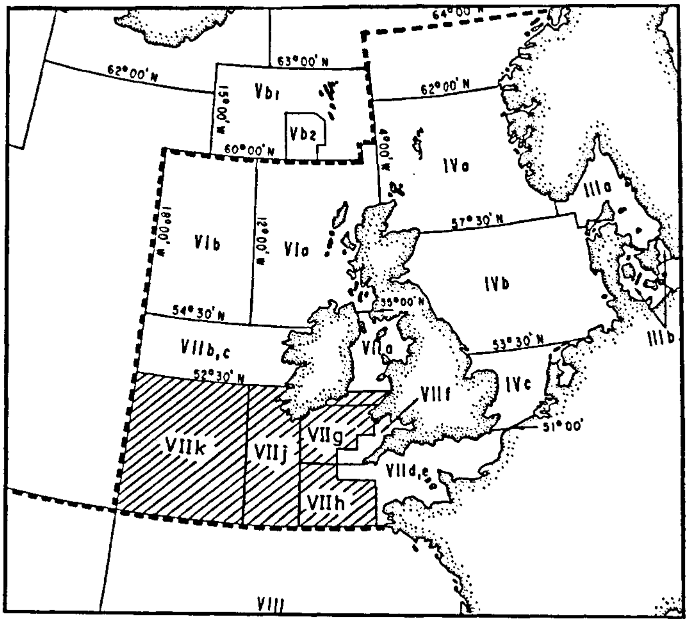


Figure 4.1.1 The assessment covers the area Divisions VIIj and VIIg and that part of Division VIIa below 52°30. TAC is set by EC for Divisions VIIg-k and that section of Division VIIa below 52°30.

Figure 5.1.1 Herring in Division VIa North. Larval abundance indices plotted against SSB estimates from VPA.

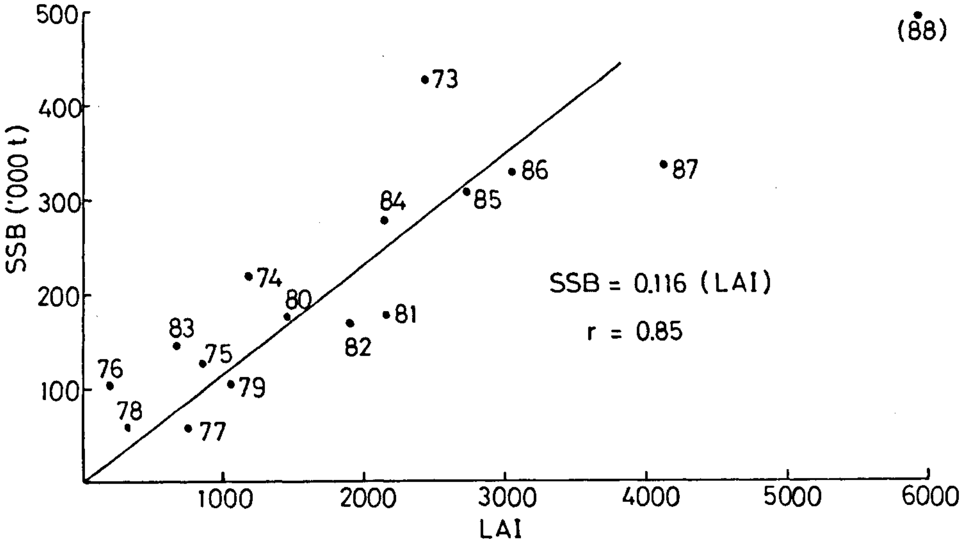
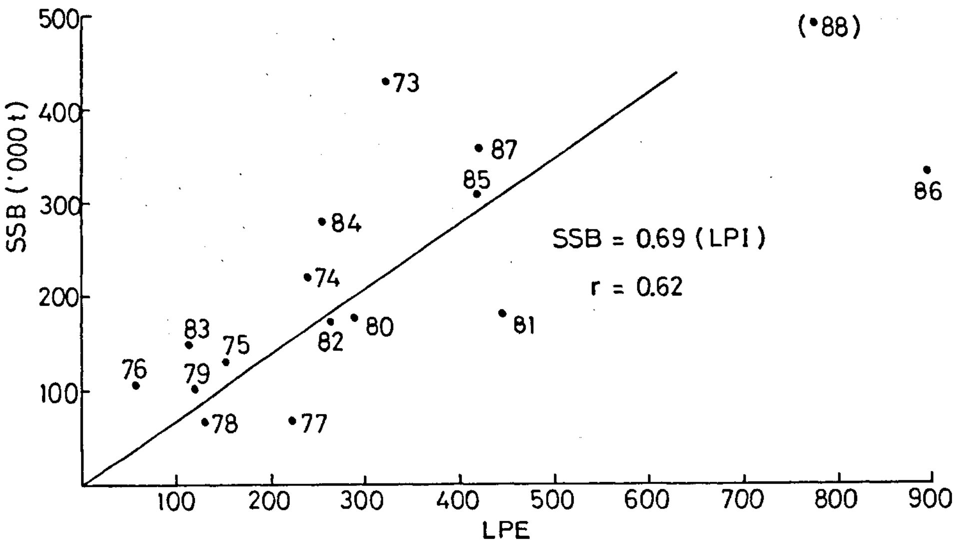
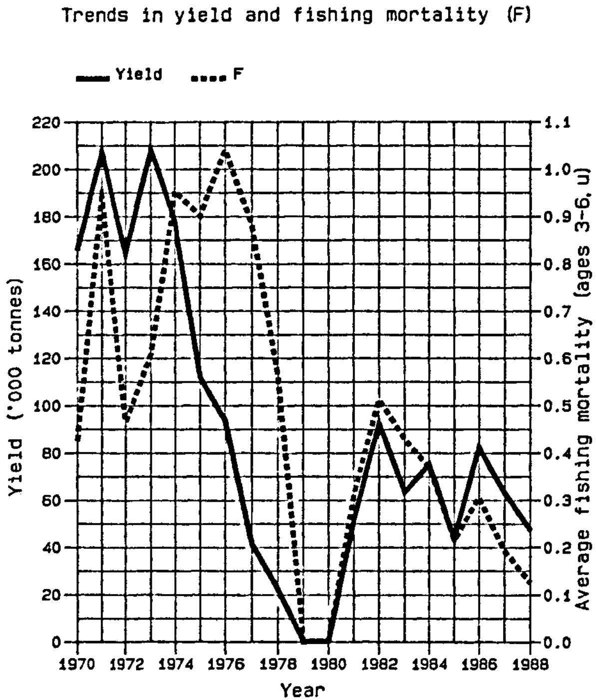


Figure 5.1.2 Herring in Division VIa North. Larval production estimates plotted against SSB estimates from VPA.

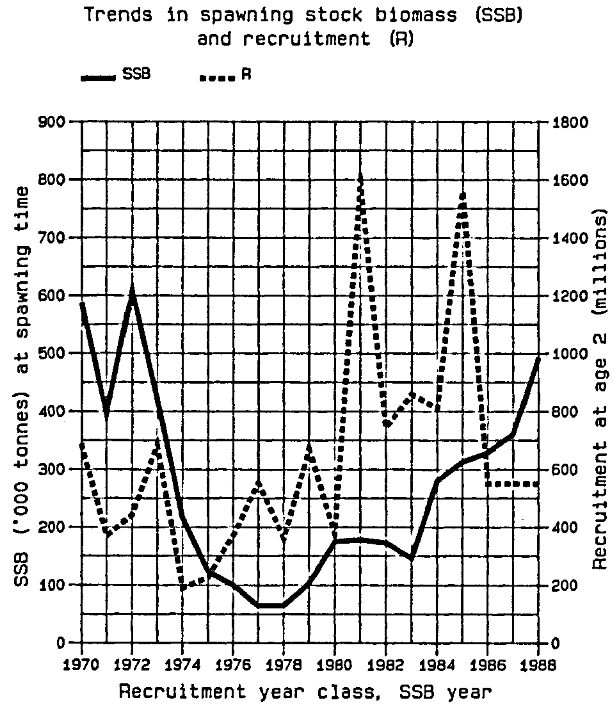


FISH STOCK SUMMARY
STOCK: Herring - IVa North
24-04-1989

Figure 5.1.3



A



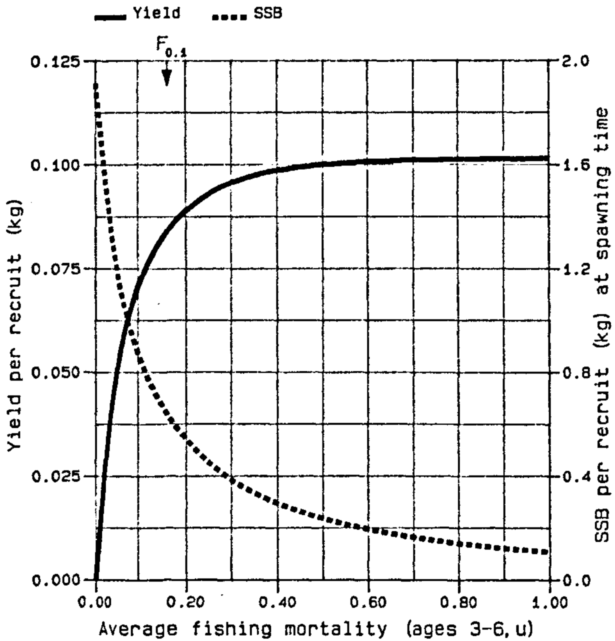
B

cont'd.

Figure 5.1.3 cont'd.

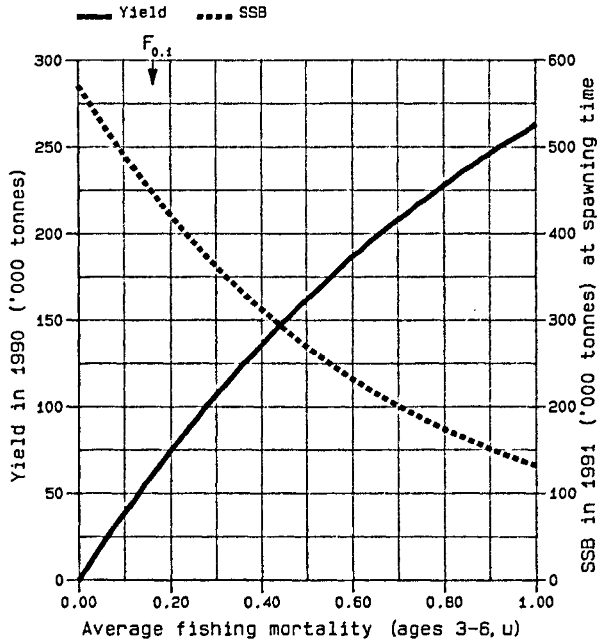
FISH STOCK SUMMARY
STOCK: Herring - IVa North
24-04-1989

Long-term yield and spawning stock biomass



C

Short-term yield and spawning stock biomass



D

Figure 5.1.4 Herring in Division VIa North. Stock recruitment plot with biological reference lines.

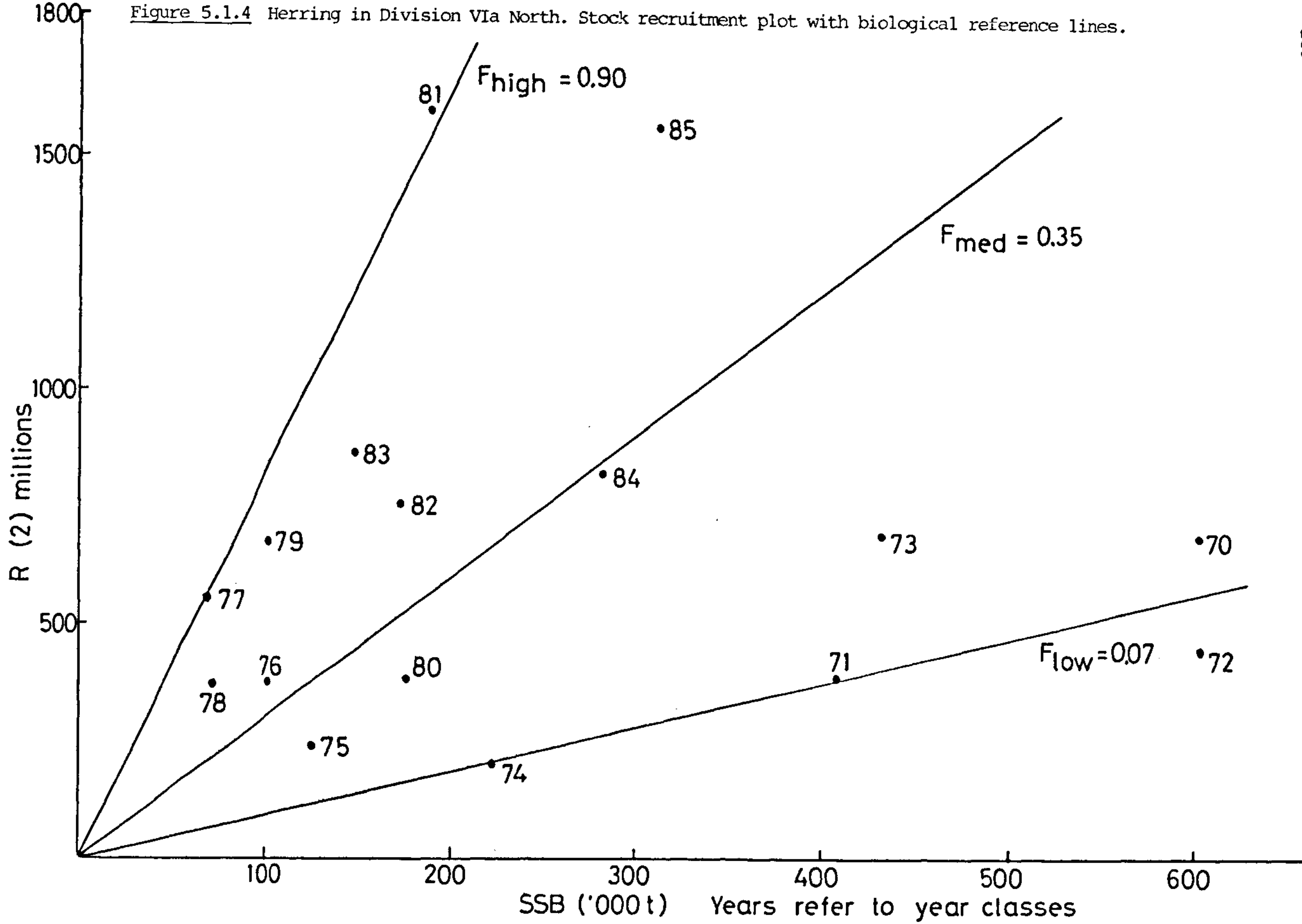
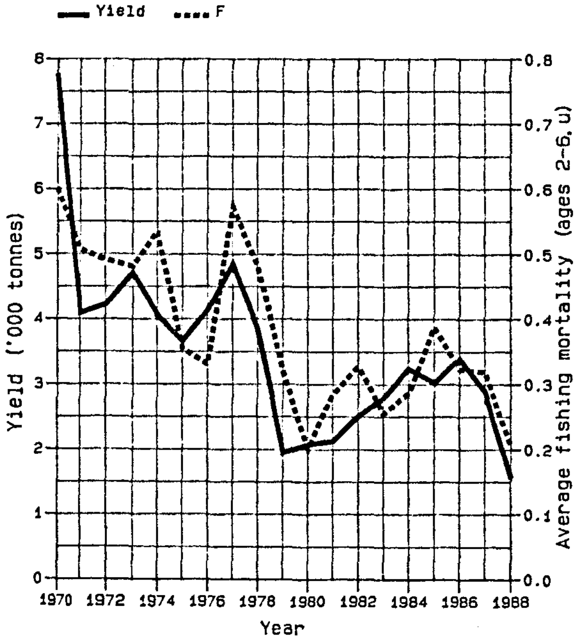


Figure 5.2.7.1

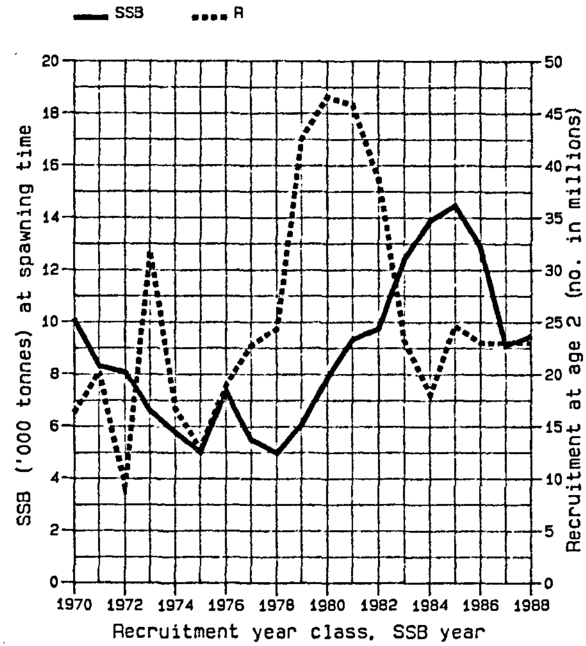
FISH STOCK SUMMARY
STOCK: Clyde Herring
24-04-1989

Trends in yield and fishing mortality (F)



A

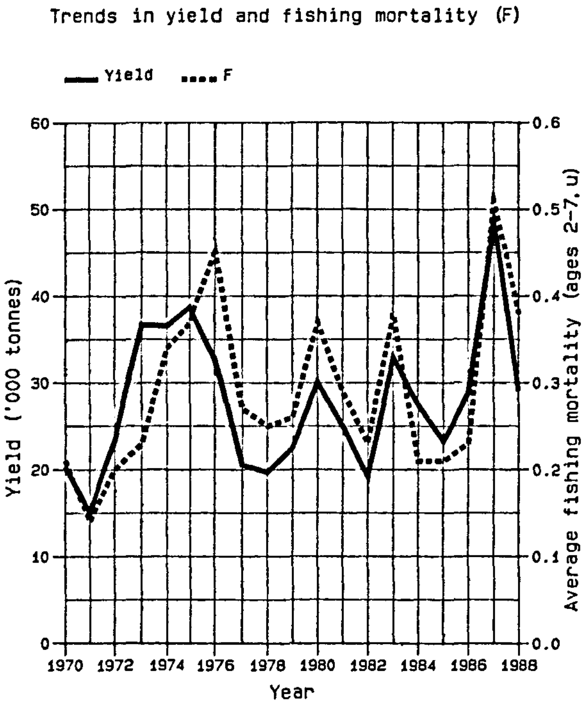
Trends in spawning stock biomass (SSB) and recruitment (R)



B

Figure 6.6.1

FISH STOCK SUMMARY
STOCK: Herring - VIa (South) and VIIb,c
24-04-1989



A

B

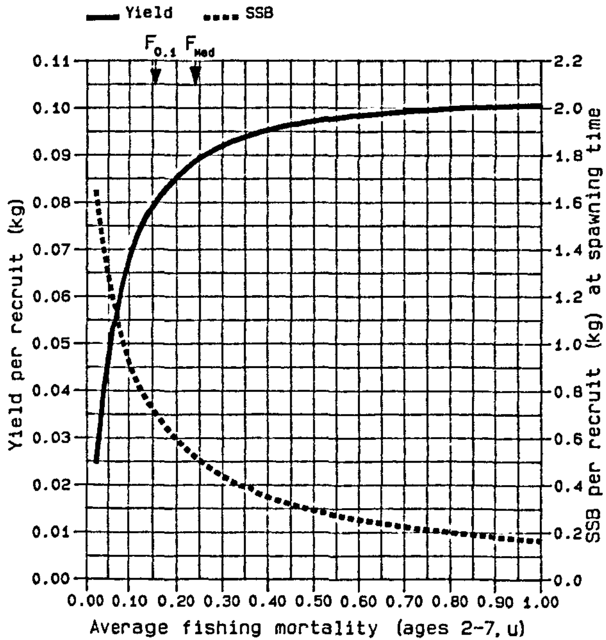
cont'd.

FISH STOCK SUMMARY

Figure 6.6.1 cont'd. STOCK: Herring - VIa (South) and VIIb,c

24-04-1989

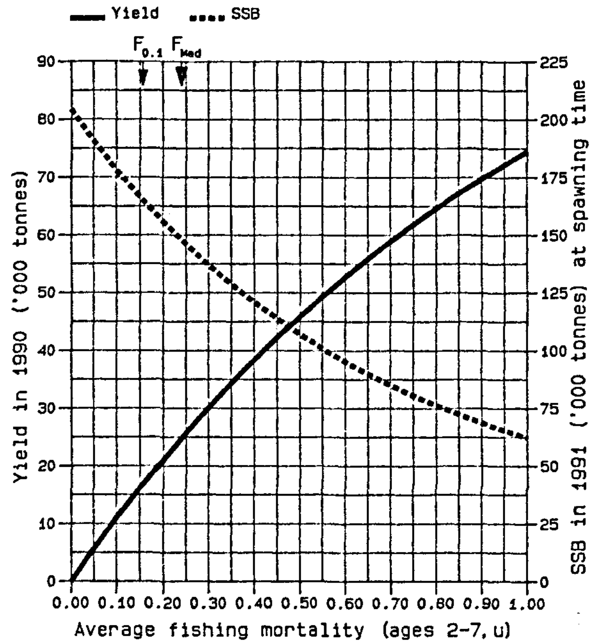
Long-term yield and spawning stock biomass



C

Short-term yield and spawning stock biomass

Assuming catch of 30,000 t in 1989



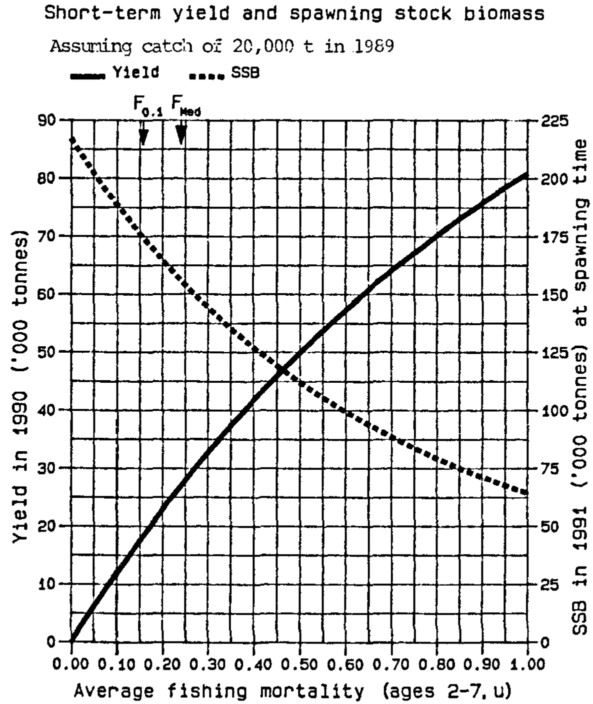
D

cont'd.

FISH STOCK SUMMARY

Figure 6.6.1 cont'd. STOCK: Herring - VIa (South) and VIIb,c

24-04-1989



D

Figure 6.7.1 Divisions VIa S, VIIb. Stock-recruitment scatter plot.

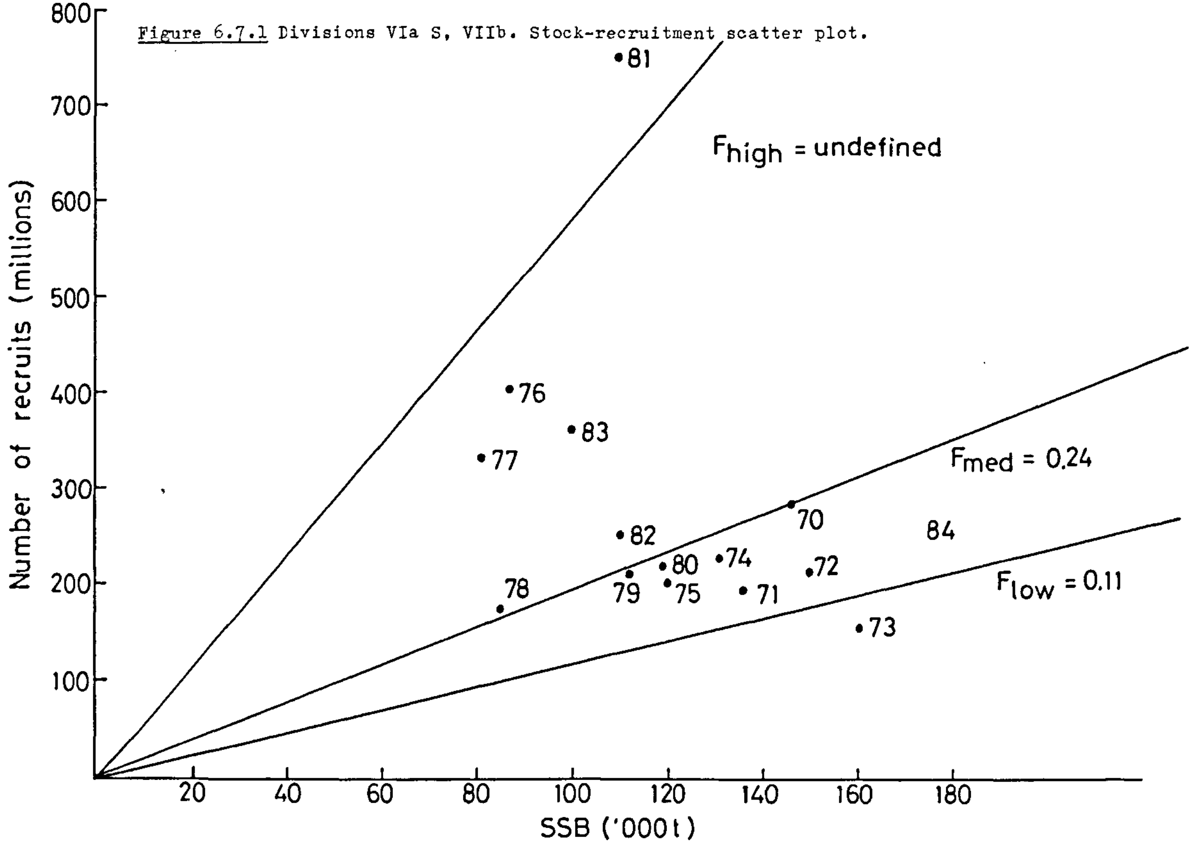


Figure 7.1.3 Herring in Division VIIa. Catch at length 1988.

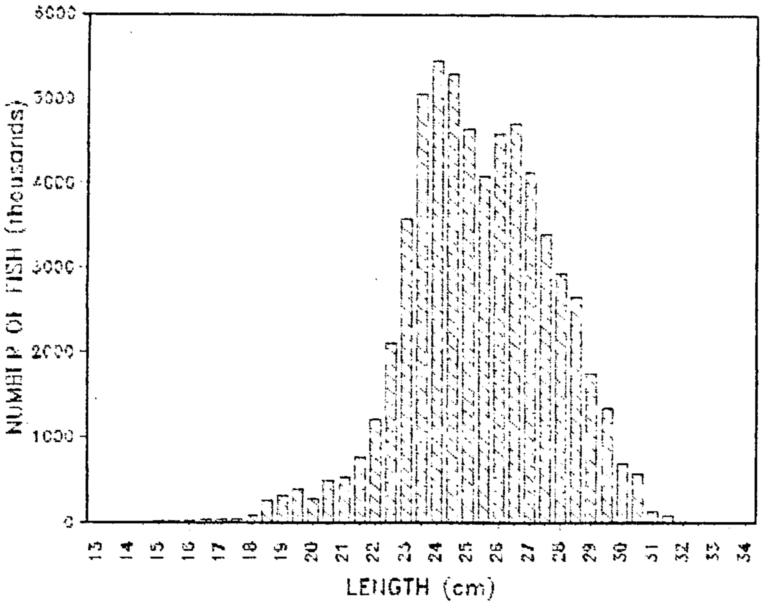
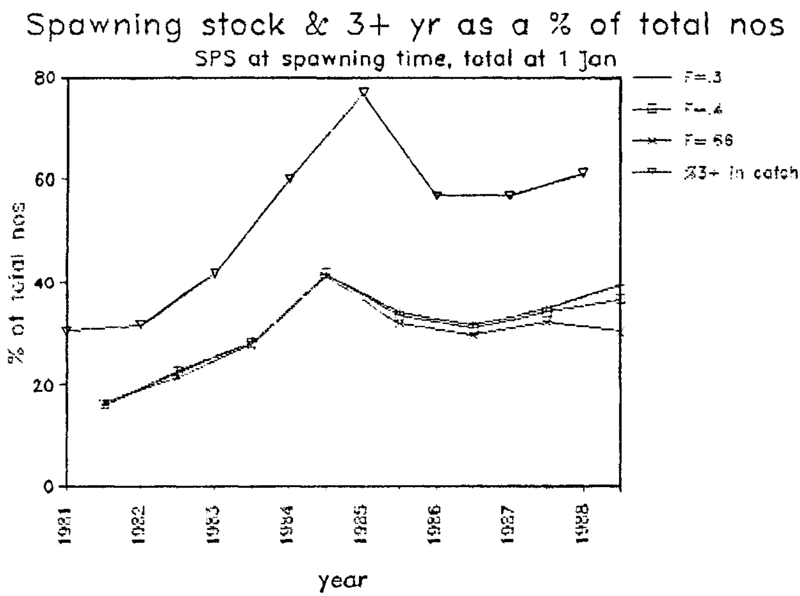


Figure 7.3.3



SPS numbers at spawning time were extracted from VPAs run with F = 0.3-0.66 and expressed as a % of total numbers at the start of the year. The values obtained are, therefore, a measure of the survival rate of 2 and a half + ring fish through the year which is not as dependent on input F as fishing mortality etc. This is compared in the figure with the proportion of 3+ fish in the catch.