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Exploration of the Sea

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

Copenhagen, 9 - 18 March 1983

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1. INTRODUCTION

1.1 Participants

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Mr Kjartan Hoydal attended as ICES Statistician.

1.2 Terms of Reference

The Herring Assessment Working Group for the Area South of 62°N met at ICES headquarters from 9 to 18 March 1983, in accordance with C.Res.1982/2:5:6:

"It was decided that the Herring Assessment Working Group for the Area South of 62°N (Chairman: Mr Ø Ulltang) should meet at ICES headquarters from 9 to 18 March 1983 to:

(i) assess the state of the herring stocks in Division IIIa, Sub-area IV, Divisions Va and VIa and Sub-area VII, and to provide management options for 1983 inside safe biological limits,

(ii) evaluate any new data available on stock components in Division IIIa herring,

(iii) review which data are available in the Working Group files for evaluating density dependence in the parameters of the models used in fish stock assessment,

(iv) specify deficiencies in data required for assessments.

2. NORTH SEA HERRING

2.1 The Fishery

2.1.1 Catch data

In 1982, a ban on directed herring fishing was in principle in force in the northern and central North Sea (Divisions IVa and IVb). Legal fishing for herring was restricted to the southern North Sea and was

regulated by TAC and seasonal closure. A TAC of 72 000 tonnes was set for the period 1 October 1982 - 25 February 1983, whereas ACFM suggested that the fishing mortality should not increase above the $F_{0.1}$ level, which would have resulted in an overall catch of 60 000 tonnes.

The landing figures as reported by Working Group members include legal directed catches in Divisions IVc - VIId, estimated by-catches, catches taken in excess of national quotas, and substantial catches taken illegally in Divisions IVa and IVb including some misreported as being taken in Division IVc. Due to this confusion and the difficulties involved in presenting the catch figures on a national basis, it was agreed to modify the lay-out of the catch tables. Thus, after the standard table giving herring catches for the last 10 years for Sub-area IV and Division VIId (Table 2.1), reported catches by country are presented for each area, with an overall estimate, supplied by Working Group members, of unreported catches representing the sum of illegal catches and/or those reported for the incorrect area.

In these circumstances, the total North Sea catch in 1982 is estimated at 171 481 tonnes, of which about 55 000 tonnes were not officially reported (Table 2.1). The Working Group reiterates its warning on the vital need to have accurate catch statistics for meaningful analysis of the situation and for assessments of the various stocks.

The estimated catches by area are given in Tables 2.2.1 to 2.2.4.

In Division IVa, the overall catch seems to have decreased mainly owing to a reduction of fishing in the western area (west of 2°E), where catches fell from 19 700 tonnes in 1981 to 4 330 tonnes in 1982, whereas in the eastern area catches remained of the same order (about 1 000 tonnes) during the last 2 years.

In Division IVb, catches of adult herring were about 5 000 tonnes, resulting mainly from illegal directed fishing. The main event in this Division concerns the dramatic increase in juvenile catches which reached over 89 000 tonnes in the first three quarters of the year. This drastic increase must be considered in relation to previous years: about 15 000 tonnes in 1979 and 1980 and 78 000 tonnes (revised figure) for 1981. As mentioned in the report of the Industrial Fisheries Working Group (Doc. C.M.1983/Assess:7), catches at the level of the last two years (1981 and 1982) can hardly be considered as by-catches in a sprat fishery but rather as a result of a directed fishery on 0-group herring.

In Divisions IVc and VIId, the overall estimated catch is 71 596 tonnes which represents an increase of about 40% compared to 1981. The apparent coincidence between this catch and the agreed TAC for the season 1982-83 (72 000 tonnes) must nevertheless be considered with caution and certainly does not reflect the effectiveness of fleet monitoring and landing control. It results, in fact, from the summation of some catches far in excess of the national allowed quotas and of others far below. In addition, re-opening the fishery in that area gave the opportunity to misreport catches taken in other areas (Divisions IVa and IVb). It must be pointed out that in 1982 about a quarter of the catch in this area (mainly Division IVc) was taken during the first quarter of the year, indicating the revival of the traditional fishery for spent herring off the Belgian and Dutch coasts.

2.1.2 Catch in numbers

Numbers of herring caught by age and area are given in Tables 2.3 and 2.4 and are summarized in the following text table for the past 5 years (with the revised figures for 1981):

Millions of herring caught by age group
(winter rings)

Year	0	1	2	3	4	5 and older	Total
1978	130	169	5	6	5	1	316
1979	542	159	34	10	10	4	759
1980	792	161	108	92	32	26	1 211
1981	7 889	447	264	57	40	77	8 774
1982x)	8 269	403	216	275	44	34	9 241

x) Preliminary

In 1978, the lowest catch in number of juvenile fish was recorded since the beginning of industrial fishing for herring. Since then, there has been a rapid escalation of these catches, which reached 7 900 and 8 300 million of 0-ringed fish in 1981 and 1982, respectively, the latter value corresponding to the catch of only the first three quarters of the year. The 1981 juvenile catch figures have been comprehensively revised. In last year's Working Group, a regression was used to evaluate 0- and 1-ring herring from the correlation between the IYFS index and the corresponding catch in number of each year class as 0- and 1-ringer in Division IVb. Results of a very limited sampling were at that time disregarded because they were very different from any other value observed in the past (about 6 times the 1961 value). The improved sampling carried out in 1982, which confirmed the dramatic increase of of 0-group catches, gave some support to the 1981 figure, which nevertheless must be considered with caution.

The contribution of 0- and 1-ringed fish as a percentage of the total reached the extreme levels of 92% and 94% for the last two years in the overall catch of North Sea herring. Considering catches in Division IVb, these catches of 0- and 1-ringed fish constitute practically 100% of the herring catch.

2.2 Age Composition

Age composition data were available from various sources and derived from an increase in sampling effort covering both the acoustic surveys carried out in the various areas and the commercial landings. The main results are summarized in the text table below.

In Division IVa, sampling of directed commercial catches covered only the first two months of the year, although the by-catches originating from this area were spread over the whole year. The most abundant year classes are those of 1974, 1973 and 1976. The recruiting 1979 year class was represented in the samples from the acoustic survey carried out in July 1982 (see Section 2.4.1) and represents 53% of the total, the 1976 and 1973 year classes amounting to almost 10% each.

Year class	W.R.	Division IVa/W		Division IVb		Divisions IVc + VIId		
		Jan-Feb C	July R	August R	December C	1st Quarter VIId/IVc C	1st Quarter 4c North C	4th Quarter IV+VIId C
1981	0				0.4			
1980	1		2.0		65.6		1.9	3
1979	2		52.6	62.2	24.0	9.7	39.5	33
1978	3	3.9	15.9	18.6	5.9	62.4	50.9	52
1977	4	4.8	4.4	6.9	0.9	19.2	5.9	8
1976	5	22.6	9.9	2.6	1.0	5.2	1.6	2
1975	6	12.8	2.5	1.5	0.5		0.1	1
1974	7	29.1	4.0	5.3	1.3	3.4		1
1973	8	23.9	8.2	1.3	0.2		0.2	+
	8+	2.9	0.5	1.6	0.2			+

R: from acoustic survey
C: from commercial catches

In Division IVb, the 1979 year class constituted the major part of the spawning stock in the samples obtained during the acoustic survey (62.2%). This fits with the dominant year class in the adult component of purse-seine catches taken in December. In the overall age composition of these catches, the 1980 year class, which will recruit to the adult stock in 1983, constituted over 65% indicating the possibility of continued improvement of recruitment in 1983, at least in the central North Sea.

In Divisions IVc and VIId, the 1978 year class still contributed over 50% to the catches. The recruiting year class accounted for 33% in the catches made on the spawning grounds in the last quarter of 1982. The differences between the two age compositions obtained during the first quarter are due to the different location of the fisheries. The highest percentage of the 1979 year class (39.5%) originated from samples taken in catches made off the Dutch coast in the northern part of Division IVc, the lowest value (9.7%) from catches from the Southern Bight.

2.3 Recruitment

2.3.1 Length frequency distributions for International Young Fish Surveys

Length frequency distributions have now been computed for all International Young Fish Surveys up to 1982. The distributions, representing total numbers of 1-group herring caught in the North Sea, excluding those in the Moray Firth, are presented in Figure 2.1 for the year classes 1969-80.

It is seen that the mean length over the whole period is somewhere around 16.0 cm. In some years there is a very marked component of small fish, with a mode between 10.0 and 14.0 cm. This occurred in year class 1969, and more recently, in year classes 1978 and 1980. It is likely that these small fish represent mainly Downs recruits.

2.3.2 Year class 1979

From the data on catches per age group in Divisions IVc, VIId (Table 2.3), it appears that year class 1979 has recruited in smaller numbers to the Downs stock than its predecessor. In the central and northern North Sea, on the other hand, recruitment of year class 1979 was better than in the six preceding years (Sections 2.6.1 and 2.6.2).

In the previous report of this Working Group, the opinion was expressed that year class 1979 would contain a high proportion of Downs herring. This expectation was based on a limited study of otolith characteristics of 1-group herring, abundance of pre-metamorphosis larvae in Dutch coastal waters, and a high component of the 1979 year class in Dutch catches in the southern North Sea in early 1982.

It is now clear that the previous prediction was incorrect, and that the criteria on which this prediction was based were of limited value in assigning juvenile herring to specific sub-populations.

The length distribution of the 1979 year class as 1-group fish, which only now has become available, would have been far more useful in predicting the racial composition of the year class. It is obvious from Figure 2.1, that the year class contained relatively few small fish, and a high component of Downs fish was, therefore, not to be expected.

It is interesting to note that the 1979 year class was the first one that showed up in reasonable numbers as big larvae in the eastern North Sea during the IKMT Survey (Section 2.3.4). Now that this year class has also been the first one in several years to recruit in reasonable numbers to the northern and central North Sea, it seems possible that the abundance and distribution of the larvae during the IKMT Survey may indeed be related to the final strength of the year class on the spawning grounds in central and northern North Sea.

2.3.3 Year class 1980

The final abundance of this year class from the 1982 International Young Fish Survey was 1 293 fish per hour. At the previous meeting of the Working Group, a provisional index of 1 314 fish/hour was used. Substituting the final index of 1 293 into the usual formula

$$Y = 0.0031 x - 0.21$$

results in a year class strength of 3.80×10^9 instead of 3.86×10^9 as used previously.

From catch at age data in the industrial fishery in Division IVb, it appears that 7.9×10^9 individuals of this year class had already been caught as 0-group in the summer of 1981. Starting from the IYFS value of 3.80×10^9 in February 1982, and taking into account a catch of 7.9×10^9 in the summer of 1981, the original strength of the year class is calculated at 12.4×10^9 as 0-group, which is about 150% of the mean for the year classes 1951-70. These calculations are based on a natural mortality of 0.1 on the 0-group. If the natural mortality on 0-group is higher, the estimated relative strength of the 1980 year class compared to year classes 1954-70 would be somewhat lower.

The length composition of the fish sampled in February 1982 shows a pronounced component of small fish with a modal length of 13.0 cm (Figure 2.1). This suggests that a high proportion of this year class will recruit to the southern North Sea. At the same time, it must be born in mind that large numbers of this year class were caught in the German Bight and Skagerrak during the IKMT Survey. This could mean that

survival of larvae from the northern North Sea had been good up to the age of ½ year. If sufficient numbers of these fish have survived the subsequent attack by the industrial fishery, there could again be a reasonable recruitment to the northern population in 1983.

2.3.4 Year class 1981

From the IYFS in February 1983, a preliminary index of 1 910 fish per hour was obtained for the herring standard area. Substituting this index in the formula mentioned in the previous section, the strength of the year class as 1-ringers is estimated at 5.71 x 10^9. This year class is, therefore, the strongest one sampled in the IYFS since year class 1969.

Year class	Abundance index IYFS	Year class strength as 1-ringers (x 10^{-9}) estimated from VPA	Year class strength as 1-ringers (x 10^{-9}) predicted from regression formula
1968	822	3.35	
1969	2 647	7.35	
1970	1 629	5.79	
1971	827	3.82	
1972	1 195	1.75	
1973	1 592	4.39	
1974	452	0.73	
1975	342	-	0.85
1976	575	-	1.57
1977	139	-	0.43 x)
1978	535	-	1.45
1979	551	-	1.50
1980	1 293	-	3.80
1981	1 910	-	5.71

x) Ignoring constant in regression formula.

Catch at age data in the industrial fishery in Division IVb show that 8.3 x 10^9 individuals of this year class had already been caught as 0-group in the summer of 1982. Starting from the IYFS value of 5.7 x 10^9 in February 1983, and taking into account a catch of 8.3 x 10^9 individuals in the summer of 1982, the original strength of the year class is calculated at 14.9 x 10^9 as 0-group, which is about 180% of the mean for year classes 1951-70. The same reservations apply to these calculations as expressed in Section 2.3.3.

The distribution of 1-ringers during the 1983 IYFS is shown in Figure 2.2. The fish showed a more offshore distribution than in the previous year; relatively high catches were made in the central and northern parts of the survey area. Also in the western part of the North Sea some very high catches were made.

At the time of the Working Group meeting, few length distributions had yet been exchanged, but the data available indicated a mean length above that of the preceding year class.

Both the spatial distribution of 1-ringers and their mean length indicate a predominance of central and/or northern North Sea recruits in the 1981 year class.

2.3.5 Year class 1982

Result of IKMT sampling during IYFS

Figure 2.2 in last year's report shows the distribution of larvae in each of the years 1977-82. The Figure shows a very low abundance of larvae in the years 1977-79. The year 1980-82 all show large abundances of herring larvae, although the area distributions are different each year. In 1980, large concentrations exist in the northeastern part of the North Sea, while herring larvae in 1981 were abundant in a band from the German Bight to Skagerrak. In 1982, the larvae were mainly distributed in the central North Sea. In broad terms, the distribution pattern in 1983 (Figure 2.3) could be described as the sum of the distribution in 1981 and 1982. Herring larvae are abundant in the central North Sea, the German Bight, and in the Skagerrak and Kattegat. Figure 2.2 is based on preliminary data available at the Working Group meeting. Moreover, it should be noted that the northwestern part of the North Sea was not sampled by IKMT hauls in the IYFS 1983. Herring larvae in significant quantities have earlier (1980) been found in this area, and, thus, the 1983 survey may underestimate the overall distribution.

2.4 Acoustic Surveys

2.4.1 The 1982 acoustic survey in the Orkney-Shetland area

A report on the ICES-coordinated survey in the Orkney-Shetland area was presented at the 1982 Statutory Meeting (Doc. C.M.1982/H:47), and an evaluation of it was carried out at a meeting of the Acoustic Survey Planning Group held in Aberdeen, United Kingdom, from 14-17 February 1983.

To convert echo-integration values to biomass, the target strength values given in the last report of the Working Group were used (see also Doc. C.M.1982/H:4). Using the results of trawl hauls to identify echo-traces in each area, two estimates of herring biomass were obtained:

	Ship	Dates	No. of quarter statistical rectangles surveyed	Estimated herring biomass (tonnes)
a	"G O Sars"	9-18 July	32	166 800
b	"G O Sars"	9-18 July	Raised to 59 rectangles[x)]	215 900
c	"Scotia"	7-26 July	59	233 000

x) Raised by proportion of stock in additional area on "Scotia" survey.

Mean of b and c: 224 450

To compare the biomass estimates in 1981 and 1982, the Norwegian estimate of biomass in July 1981 was corrected to take account of a revision in calibration procedures. This correction resulted in a 29% increase compared with estimates given in the 1982 report of the Working Group. The corrected biomass in July 1981 is 140 000 tonnes, which consisted mainly of large herring. At the same time, the Dutch research vessel "Tridens" recorded herring echo-traces in the Moray Firth and these were again recorded by "Scotia" during August. An estimate of biomass of these herring, which consisted primarily of 2-ringers, was 57 000 tonnes, so the estimate of the total biomass in 1981 is 197 000 tonnes. In view of the likely error in the two years' estimate, the Working Group concluded that there was no evidence of a significant change in biomass between 1981 and 1982 from the acoustic survey results. More doubt was cast on the absolute level of the estimates because of conflicting evidence on the target strength of herring.

From the results of the trawl sampling, the herring biomass estimates obtained in both 1981 and 1982 have been allocated to their respective age distributions (Table 2.5). In 1981, the overall age composition showed a strong contribution of 2-, 4- and 7-ringers. In 1982, 2-ringers were predominant (53%), indicating increased recruitment from the 1979 year class compared to the immediately preceding year classes. Within the older age groups, the relative proportions of year classes corresponded closely to that in 1981, with the exception of the 1973 and 1974 year classes. However, comparison of age compositions obtained on the Scottish and Norwegian surveys indicates a probable discrepancy in age determination of these older herring. On the assumption that the Norwegian age readings are correct, the relative proportions of these age groups have been changed in Table 2.5 accordingly.

2.4.2 Division IVb stock (Bank)

An echo survey was carried out during the first half of July 1982 by the Netherlands. Concentrations of herring were located off the northeast coasts of England and Scotland, and the overall age composition of adult herring taken in sample trawl hauls contained a high proportion (46%) of the recruiting 1979 year class. This year class included 39% full herring in maturity stages IV and V, which were considered to be central North Sea spawners. The percentage of full herring in all adult year classes combined was 36%.

An acoustic survey was made by England during the second half of August between the Farne Islands and Flamborough Head. Two concentrations of herring, which were spawning, were located and acoustic biomass estimates obtained for each one: 26 000 tonnes for the first to the east of the Farne Islands and 32 000 tonnes for the second off the Yorkshire coast. These estimates were based on the target strength values, which were recommended by the 1982 Planning Group on ICES Coordinated Herring and Sprat Acoustic Surveys. In addition to the above estimates, a further estimated 5 000 tonnes was obtained for herring in maturity stage V off Whitby and 11 000 tonnes for unidentified pelagic fish off Flamborough Head, which were considered likely to be later central North Sea spawners (a larval survey in October indicated that a substantial spawning occurred off the Yorkshire coast in mid-September). The total acoustic biomass estimate for all these concentrations combined was therefore 74 000 tonnes. This must be considered to be an underestimate of the whole of the adult spawning stock in Division IVb in 1982, as the substantial larval production which occurred off the Scottish coast within this Division indicated that an important component of the stock had spawned in August outside the area, which was surveyed acoustically.

2.4.3 Divisions IVc and VIId (Downs)

Three acoustic surveys were carried out by England during 1982. The first in early February concerned a substantial part of the spent herring population then in the Southern Bight, and the distribution of these was ideal for echo-integration. A combined echo- and larval survey made a few days earlier indicated that some herring were also distributed over a total 4 300 km^2 outside the acoustic survey area. A correction was made for this area by applying the mean biomass value per km^2 from the acoustic survey. A further adjustment was also made for a component of immature herring. A total acoustic biomass estimate of 143 000 tonnes was then derived for adult herring, which at that time were virtually all in a spent condition.

A second acoustic survey was carried out in late November, but this was seriously restricted by the severe weather conditions, which prevailed at that time. A biomass estimate of 46 000 tonnes was, however, obtained

from an area in the Eastern Channel, where small herring larvae were very abundant 2-3 weeks afterwards. A biomass estimate of 70 000 tonnes was also obtained from a restricted area of 4 049 km^2 within the Southern Bight.

The final survey was conducted early in December. Weather conditions were reasonable, and a good coverage was achieved both within the Southern Bight and Eastern Channel. A total acoustic biomass estimate of 145 000 tonnes was obtained for adult herring from the area which was surveyed. Herring were, however, reported to have been present in coastal areas, which were not covered by the survey. It is, therefore, possible that the acoustic biomass estimate is an underestimate of the total spawning stock, but there is no objective method to correct for this.

During the two surveys in November and December 1982, herring were generally very widely dispersed, and no dense concentrations were encountered. The only substantial spawning concentration to be surveyed (northeast of Dieppe on 2 December) produced a biomass estimate of only 9 064 tonnes.

The results of the acoustic surveys indicate that the size of the spawning stock during the winters 1981/82 and 1982/83 were substantially the same.

2.5 Herring Larval Surveys

In general, as in 1981, the data available were satisfactory in 1982 in all areas in terms of sampling intensity and distribution over the hatching period. There was only one minor exception to this, i.e. in Division IVb, where some interpolation was required. This is discussed in Section 2.5.2.

2.5.1 Division IVa

Surveys in this area were carried out by the Netherlands and the Federal Republic of Germany in early September and by Denmark and Scotland in late September. The coverage in both periods was satisfactory.

The indices of abundance of larvae less than 10 mm long are: 1st half of September: 2 885; 2nd half of September: 967. The index for the first half of September is considerably lower than in 1981, but that for the second half is very much higher. The resulting mean for 1982 of 1 926 is, however, slightly lower than in 1981, and inserted on the regression equation given in last year's report gives a spawning stock biomass estimate for 1982 of 202 000 tonnes. In the light of the likely confidence limits of these estimates, this would suggest that the spawning stock biomass in this area has remained stable over the period 1980-82.

In the text table below, the larval indices and the resulting estimates of spawning stock biomass are given for 1979-82.

	1979	1980	1981	1982
Larval index	3 325	2 074	2 341	1 926
SSB (tonnes)	314 000	214 000	236 000	202 000

2.5.2 Division IVb

In the Buchan area one survey was carried out by Scotland in early September and one by Denmark in late September. They gave estimates of abundance of early larvae of 248 and 216 x 10^9, respectively. These are very much higher than corresponding values in this area in recent years.

In the central North Sea, surveys were done by the Netherlands in early and late September and by England in early October. Unfortunately, due to the late withdrawal of the country which in recent years has surveyed this area in late October, no survey was done at this time, which necessitated some interpolation. The Dutch surveys in early and late September gave estimates of abundance of early larvae of 96.77 and 73.98 x 10^9, respectively; these are low compared with those of 1981 at these times. The English survey in early October, however, gave an estimate of 1 038 x 10^9, which is extremely high compared with the corresponding estimate in 1981. Because the area was not surveyed in late October, it was necessary to interpolate a value for this period. This was done by taking the mean ratio of late to early October surveys in previous years, when the area was adequately sampled in both periods. This gave a mean value of 0.32 by which the abundance from the English survey was multiplied to give an abundance for late October.

The resulting index for Division IVb, estimated in the same way as in previous years, is 617.1 x 10^9. Inserting this value into the spawning stock biomass-larval index regression given in last year's report gives an estimate of spawning stock biomass in 1982 of 72 000 tonnes. It should be noted, however, that the larval index for 1982 is somewhat higher than the highest value used in calculating the regression.

	1979	1980	1981	1982
Larval abundance x 10^{-11}	2.26	0.59	3.44	6.17
SSB (tonnes)	32 000	15 000	43 000	72 000

2.5.3 Divisions IVc and VIId

Surveys were carried out by the Netherlands, England, the Federal Republic of Germany, and France. The coverage of both the distributional area of the larvae, and their distribution in time, in 1982-83 was satisfactory. The resulting values of abundance of all size groups of larvae were: 2 361 x 10^9 for early December, 581 x 10^9 for late December, 756 x 10^9 for early January, and 260 x 10^9 for late January, giving an overall mean of 990 x 10^9. This value is somewhat lower than that of 1981-82, but is still well beyond the range used in calculating the regression previously used for this area. Accordingly, as in 1981, these larval data cannot be used in estimating the absolute size of the spawning stock in this area. They are, however, still useful in a non-quantitative way in giving a relative index of changes in spawning stock size from year to year.

	1979/80	1980/81	1981/82	1982/83
Larval index	147.3	363.7	1531.0	990

Acoustic surveys at spawning time in this area in 1981 and 1982 have indicated that although possibly half of the Downs stock has spawned in the Eastern Channel during these years, a major proportion of all small larvae taken in larval surveys in Divisions IVc and VIId have, in fact, hatched in the Eastern Channel in December. This could affect the relationship between spawning stock biomass and larval abundance compared with earlier years.

2.6 State of the Stocks

2.6.1 Division IVa

Estimates of spawning stock size in Division IVa are available from acoustic and larval surveys. The estimates from acoustic surveys given in Section 2.4.1 are slightly inflated by the existence of a component

of immature fish in the total biomass estimate. In 1981 and 1982, the proportion of 2-ringers that were immature was estimated to be 16% and 25%, respectively.

Estimates of spawning stock size in Division IVa in 1981 and 1982 from larval surveys, using the equation referred to in Section 2.5.1, and acoustic surveys, are as follows:

	Larval survey	Acoustic survey Total	Adjusted to exclude immature 2-ringers
	(tonnes)	(tonnes)	(tonnes)
1981	236 000	197 000	191 000
1982	202 000	224 000	202 000

Taking into account the likely confidence limits of these estimates, there is no evidence of a change in spawning stock size between the two years from either of the surveys. Trawl samples taken during the acoustic survey indicate a strong contribution by the recruiting 1979 year class in 1982, which is difficult to reconcile with the apparent lack of increase in spawning stock size. If these estimates of relative stock size and age composition are correct, then one inference is that there must have been a considerable mortality or loss of 2-ringers and older between July 1981 and July 1982. Taking the acoustic survey results at face value, the estimate of Z for these age groups is 0.45, which is equivalent to a total loss of 71 000 tonnes of herring, and, assuming a natural mortality coefficient of 0.1, a catch of 55 000 tonnes. Even if the total catches in Division IVa in 1981 and 1982 combined were taken in the relevant period (July 1981 - July 1982), the total recorded catch does not amount to more than 25 000 tonnes.

This discrepancy could be explained in several ways:

a) the age composition recorded on the acoustic surveys was biassed (i.e., the real percentage of 2-ringers in 1982 was much lower);

b) the results of both the larval and acoustic surveys in one or both years are incorrect;

c) catches in Division IVa have been underestimated;

d) there was an emigration of fish or a higher natural mortality between the two years.

The Working Group was not able to determine the most probable explanation or combination of explanations.

Although it was appreciated that running a VPA would not resolve the problem referred to earlier regarding the conflict between stable stock sizes in 1981 and 1982 taken in conjunction with a considerable recruitment in the latter year, it was decided to run a VPA for Division IVa to illustrate the problems this raises in assessing the current state of this stock.

This was done using the catch in numbers per age group given in in Table 2.4 for Division IVa W and IVa E combined, for age groups 2-ringers and older in the years 1972-82. The input Fs for each age group in 1982 were estimated from the catch of that age group in that year, and the estimate of the numbers of that age group in the stock derived from the acoustic survey. The outputs are given in Tables 2.6-2.8. There are features of this VPA, which require some comments:

a) The output spawning stock biomass in 1982 is somewhat smaller than the estimate of 202 000 tonnes given by the acoustic survey. This is due to the fact that the latter value is based on the mean weight at age found in the samples taken during that survey. In the VPA estimate, the same mean weights at age have been used throughout the entire period, based on those used by the Working Group in the past for this stock.

b) The output spawning stock biomass in 1981 is only 64% of that for 1982. This is compatible with the increment to stock in 1982 provided by the stronger 1979 year class, but is not compatible with the acoustic survey results in that year, which gave an almost identical estimate to that of 1982.

c) The outputs of spawning stock biomass, derived from this VPA, are not compatible with the indices of larval abundance, which have been used in the past for predicting spawning stock size in this area. The larval indices are plotted against the spawning stock biomasses from this VPA in Figure 2.4. It is apparent that there is no linear relationship between these data, and, if one accepts the outputs of this VPA, larval abundance cannot be used to predict spawning stock biomass in this area. It should be noted, however, that the output spawning stock biomasses of this VPA are extremely sensitive to rather small changes in assumed stock size in 1982 and its age composition, even back to 1975. In an alternative VPA run with relatively minor changes in input Fs, the spawning stock biomass in 1975 was over 40% higher than that given in Table 2.8. This is in part due to the lack of any appreciable convergence in this VPA in the years 1977 to 1981, when catches were extremely small.

From these analyses of the available data it is clear that there are major inconsistencies between the various sources of information on the current state of this stock. These may be due to one or more of the factors a) to d) mentioned earlier in this section (p.11). The result of these inconsistencies, however, is that there is currently no firm basis on which to make an assessment of the present state of this stock or any prediction of catches in 1983.

2.6.2 Division IVb (Bank stock)

Two estimates of spawning stock size in Division IVb in 1982 are available.

	Larval survey	Acoustic survey
1982	72 000 tonnes	74 000 tonnes

Both of these are likely to be underestimates. The acoustic survey estimate for the reason discussed in Section 2.4.2, and the larval survey estimate because few, if any, larvae were derived from the August spawning, which took place off the Yorkshire coast. This was most unusual, because this particular spawning concentration has now been surveyed acoustically each year since 1979, and previously considerable numbers of small larvae have always been taken in the same locality some 3 weeks later. The possible explanation might lie in the fact that as many of the spawning shoals in 1982 were exceptionally dense, the egg layer deposited on the sea-bed was abnormally thick, and this resulted in a high egg mortality.

The estimated size of the spawning stock in Division IVb in 1981 was 43 000 tonnes (from larval survey data), so it is quite clear that a substantial recovery of this stock took place in 1982, as a result of comparatively strong recruitment by the 1979 year class. This can be

seen from the following age distributions (a) from research vessel catches of spawning herring in August and (b) from commercial purse-seine catches of spent herring in December.

Rings	2	3	4	5	6	7	8	9	10	11
Year class	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970
% (a)	62.2	18.6	6.9	2.6	1.5	5.3	1.3	0.9	0.6	0.1
% (b)	65.9	20.0	3.1	3.4	1.7	4.3	0.6	0.6	0.4	-

A further indication of the change in spawning stock size in 1982 may be made from the series of acoustic survey estimates of herring spawning biomass in the concentration off the Yorkshire coast during late August 1979, 1981 and 1982 (the 1980 survey was not carried out at the correct time to obtain a valid estimate).

25-28 August 1979	Acoustic biomass estimate	12 000 tonnes
22-23 August 1981	" "	10 000 tonnes
26-27 August 1982	" "	32 000 tonnes

These values suggest a substantial increase in the spawning stock biomass in 1982. It was decided that the acoustic estimate of 74 000 tonnes for the spawning area off the northeast English coast should be accepted as the best available estimate for that area. No acoustic survey, however, was made in the spawning area in Division IVb off the east coast of Scotland, where a substantial larval production took place in 1982 (see Section 2.5.2).

The increment to the total Division IVb larval index provided by the Buchan area can be converted to a biomass estimate. This was used to raise the 74 000 tonnes from the acoustic survey to the total area of larval production. This would give a total estimate of spawning stock biomass of 117 000 tonnes. In view of some of the uncertainties surrounding this estimate, however, it seemed reasonable for assessment purposes to take a value of about 100 000 tonnes.

Results from VPA

A VPA was run for 2-9+ ringers, using F values in 1982 as given for Division IVb in Section 2.7. The catch in number data are given in Table 2.9 and were derived by subtracting the estimated catches from the Downs stock (Table 2.12) and catches in Division IVa from the totals for the North Sea (Table 2.4). The mean weights used were catch weights at age given in the 1978 Working Group report (Section 2.5). For all years, 100% of fish in all age groups were assumed to be mature except for 2-ringers in 1982, of which only 81% were taken as mature reflecting the catch sample data for that year.

Because of the very low catches in recent years, the results (Tables 2.9 to 2.11 and Figure 2.5) should be treated with caution, though the trends are probably realistic. Fishing mortality of 2-7 ringers dropped from very high values of 1-2 between 1972 and 1976 to 0.2 or less since 1978. The decline in recruitment (as 2-ringers) from year classes 1972-75 was reversed with the 1978 year class. Recruitment from the 1979 year class was

appreciably stronger than recruitment from the immediate preceding 6 year classes. Spawning stock biomass fell from a peak of about 70 000 tonnes in 1974 to remain at about 20 000 tonnes between 1976 and 1980. Improved recruitment subsequently brought about a rapid increase. The spawning stock biomasses in the recent past compare closely with the estimates made by previous Working Groups.

2.6.3 Divisions IVc and VIId (Downs stock)

The fishery in 1982

1/5th of the 1982 catch of 72 000 tonnes was taken in January and February as spents in the continental coastal areas and as spents and immature 2-ringers off the Dutch coast. In the 1982 IYFS, the highest density of 2-ringers in the North Sea occurred in that area at a level of 22 times the mean density (Figure 2.6), which is where the Dutch fishery took place.

During the main seasonal fishery in October to December, a major part of the catch was taken in coastal grounds off the Netherlands, Belgium and France.

Estimates of spawning stock

Though larval abundance indices are available for recent years, they cannot be used to derive spawning stock biomass values by the reasons explained in the 1982 report (Section 2.5.3). The 1982/83 larval index for this stock of 990 x 10^9 was based, as normally, on four separate surveys, these being in the two halves of the months of December and January. The 1981/82 index of 1 531 x 10^9 was only derived from two surveys due to inadequate coverage. The comparable larval index from 1982/83 to that of 1981/82 is 1 260 x 10^9. This is about four times the 1980/81 index and about eight times the 1979/80 index.

The results from the larval surveys indicate that one major spawning took place about mid-November in the Eastern English Channel, with some spawning also in the Southern Bight. Further spawning took place in the Southern Bight early in December.

Biomass estimates from English acoustic surveys are available for December 1981, and February, November and December 1982. (See Section 2.4.3.)

The Working Group accepted the February 1982 survey as the best estimate of spawning stock for the reasons given in Section 2.4.3

Recruitment indices

To make a projection for 1983, some estimate of the Downs contribution is required. Two methods have been employed. The length frequency distribution obtained from the IYFS in 1982 in Sub-area IV was made available to the Working Group. The total distribution was split into a number of normal frequency distributions, using a method (and a computer program) by MacDonald (MacDonald and Pitcher, 1979). The length components with a mean length less than 14 cm was regarded as Downs herring. They made up about 60% of the total number of fish.

A second method, using the distribution of mean length per statistical area in the IYFS, was derived. Centres of abundance characterized by fish with mean lengths of 12.1 cm, 14.4 cm and 18.2 cm were identified and were used to proportion the catches in other areas to these populations. The results gave a similar estimate to that derived above.

The Working Group decided to reduce this proportion and assign 50% of the IYFS recruitment estimate to the Downs stock in view of the known occurrence of North Sea herring in the Skagerrak.

Spawning stock biomass in 1982

The text table below sets out the calculation of the spawning stock biomass as at 1 January 1982.

	1	2	3	4	5	6	7	8+	Σ	Biomass	
$\bar{w}$ (in kg)	.095	.123	.150	.170	.205	.233	.260	.288			
% age comp. Feb.82		12.7	61.3	13.6	6.2	4.9	1.1	0.3			Derived from Dec.1981
% age comp.			70.1	15.6	7.1	5.6	1.3	0.3			In acoustic survey carried out Feb.1982
Stock in number Feb.82			726.2	161.6	73.6	58.0	13.5	3.1	1 036		Calculated from acoustic survey biomass: 143 000 t/.138 kg (mean weight in survey)
Stock in number Jan.82		475.7 [1)]	767.7	166.5	74.9	58.9	13.7	3.1	1 084	236 670 t	Taking into account Jan.82 catches. 1) Applying $F_{2rg}=F_{3rg}$ to 2 rg catch
F in 82		.456 [1)]	.456	.312	.151	.104	.148	.270			Derived from stock in number and catch
Catch in number in 1982		166.4	268.4	42.6	10.0	5.5	1.8	0.7			
Stock in number, end of 1982		272.8	440.4	110.3	58.3	47.4	10.9	2.1		146 000 t	
Stock in number, Jan.83	2) 1 528									360 000 t	Including 50% of year class 1980 estimated at 3.8×10^9 as 1-ringer from IYFS reduced by M

2) Revised

Results of VPA

The results of the VPA are given in Tables 2.12-2.14 and are summarised in Figure 2.7.A and 2.7.B.

In this section, which describes past development of the fishing mortality, average fishing mortality refers to mean F over the age groups 2-8 weighted by numbers at age in the stock. However, these weighted means cannot be directly related to the fishing mortality used in the catch projection and in the calculation of the Y/R curve. For this purpose, fishing mortality has to be expressed as unweighted mean and, therefore, these values are also given in the VPA table of fishing mortality.

Fishing mortality fluctuated around a level of about 1.0 up to 1975. After an increase to a level of about 2.4 in 1976, it decreased considerably by 1977 and remained at comparatively low levels up to 1979 as a result of the ban on directed herring fishery in the North Sea. As a consequence of fishing in 1980, when the fishery was not officially re-opened, fishing mortality increased to 0.4. With the progressing recovery of the Downs stock and about the same amount of catch as in 1980, the fishing mortality decreased somewhat to a level of 0.2 in 1981 and reached again 0.4 in 1982 due to a higher catch level in that year.

The spawning stock biomass at spawning time (i.e., the end of the year) increased continuously from the very low level in 1976 of about 3 000 tonnes to 61 000 tonnes in 1980. A further increase to about 150 000 tonnes in 1981 took place as a result of the contribution to the spawning stock biomass by the strong 1978 year class, which recruited predominantly yo the Downs stock. Since the Downs component of the 1979 year class was relatively small, no further increase in spawning stock biomass was observed by the end of 1982.

The positive development of the spawning stock since 1978 must obviously have resulted from the protection of the Downs herring in the years 1977-79. The quick reaction of the Downs stock to the ban on directed herring fishing compared to the central and northern North Sea may be explained by a lower level of exploitation of juvenile herring of this stock in the mixed fisheries.

Projection of catch and spawning stock size for 1983

Catches and the corresponding spawning stock biomass for different levels of fishing mortality in 1983 have been calculated, using the data given in Table 2.15.

Recruitment at age 2 in 1983 (year class 1980) was derived from IYFS results, indicating a very strong year class. Based on an analysis of the length composition of IYFS catches, the Downs component was estimated to be about 50% of that year class, i.e., about 1 900 million 1-ringers in 1982. To estimate the number of 2-ringers, 50% of the total catch of 1-ringed fish in 1982 was assumed to be Downs herring. These catches and natural mortality (M = 0.1) were applied resulting in 1 528 million recruits at the beginning of 1983.

The fishery in 1982 was concentrated mainly on the three youngest age groups in the population, and this fishing pattern is expected to continue in 1983. Therefore, the exploitation pattern of 1982 was used in the catch projection.

The detailed results of the catch projection are given in Figure 2.7.D, and some selected management options in the following text table.

Downs herring ICES Divs. IVc and VIId

1982				Management option for 1983	1983			
Stock biom. (2+)	$\bar{F}_{(2-8)}$	Catch	Spawn. stock biom. (2+)		Stock biom. (2+)	$\bar{F}_{(2-8)}$	Catch	Spawn. stock biom. (2+)
237	.271	72	146	$F_{0.1}$	360	.125	55	273
				$F_{83}=F_{82}$		.271	107	224

Weights in thousand tonnes.
Stock biomass refers to the beginning of the year.
Spawning stock biomass refers to spawning time (end of the year).
Fishing mortality refers to the average F on age groups 2-8 not weighted by stock numbers.

In the 1982 Working Group report it was suggested that the catches should be taken solely in Divisions IVc and VIId in the period 1 October to 28 February the following year, as it is only in that area, and during that time period, that one can be sure of catching only the Downs population.

This suggestion was made with reference to the expected continuation of the ban on directed herring fishing on the central and northern North Sea herring stock and was subsequently submitted by ACFM to the managers as a recommendation.

If the herring fishery will not be re-opened on the central and northern North Sea stocks in 1983, then the considerations given in last year's Working Group report still apply.

2.7 VPA - Total North Sea

Estimates of the spawning stock biomass of the components of the North Sea herring are available from acoustic surveys or larval surveys. The estimates are summarized in the text table below:

Area	Spawning stock	Date	Source
Div. IVa	200 000 tonnes	1.8.1982	Larval/Acoustic
Div. IVb	100 000 tonnes	1.9.1982	Larval/Acoustic
Divs.IVc+VIId	146 000 tonnes	31.12.1982	Acoustic

Using the catch numbers for 1982, the input Fs to the VPA were calculated to give a spawning stock size as estimated above. However, because of different age distributions and different spawning times, it is necessary to calculate the spawning stock in numbers for each component at spawning time. Taking account of the catch of the component in the period from 1 January 1982 up to spawning time, the spawning stock of each component is back-traced to 1 January 1982. Adding each component, we get an estimate of the total North Sea stock in numbers of herring at 1 January 1982.

Division IVa

Winter Rings	Stock 1.8.82	Catch 1982	Stock 1.1.82	F
2	589.2	10.2	630.8	0.017
3	178.1	1.5	189.7	0.008
4	49.0	0.9	52.5	0.018
5	111.1	3.9	120.2	0.035
6	27.5	2.2	30.5	0.079
7	44.2	4.2	49.5	0.093
8	92.0	3.0	99.4	0.032
8+	6.0	0.9	6.9	0.147

The age distribution of the spawning stock is based on trawl samples made during the acoustic survey.

Division IVb

W/R	Age Distribution Mature Fish %	Average Weight (g)	Stock 1.9.82⌘)	Catch 1982	Stock 1.1.82	F
2	65.9	126	530.7	39.1	595.2	0.072
3	20.0	176	130.2	5.3	142.9	0.040
4	3.0	211	19.6	0.5	21.3	0.025
5	3.4	243	22.4	0.5	24.3	0.022
6	1.7	251	11.2	0.2	12.1	0.017
7	4.3	267	28.0	0.5	30.3	0.017
8	0.6	271	4.2	0.1	4.6	0.022
8+	1.1	271	7.0	0.1	7.6	0.014

⌘) The number of 2-ringers has been adjusted upwards, because the samples showed 19% immature 2-ringers.

The calculations are based on samples from commercial catches of spent herring.

Spawning stock 1.1.82 - Total North Sea

W/R \ Division	IVa	IVb	IVc + VIId⌘)	Total
2	630.8	595.2	475.7	1 701.7
3	189.7	142.9	767.7	1 100.3
4	52.5	21.3	166.5	240.3
5	120.2	24.3	74.9	219.4
6	30.5	12.1	58.2	100.8
7	49.5	30.3	13.7	93.5
8	99.4	4.6	3.1	107.1
8+	6.9	7.6	-	14.5

⌘) The basis of these calculations are described in Section 2.6.3.

As the first step, the stock in numbers at spawning time is calculated. Secondly, the fishing mortalities on each stock are calculated to meet two requirements:

a) The catch of the age group should be the value of the catch in the relevant area.

b) The stock in number of the age group at spawning time should match the value of the age group in the estimated spawning stock.

The fishing mortalities are thus found solving the equation:

$$C = N_s \cdot e^{(F+M).S} \cdot \frac{F}{F+M} (1 - e^{-(F+M)s})$$

where N_s is the stock size at the date when the fraction s of the year was gone, i.e., $N_{7/12}$ is the number as at 1 August.

The input Fs for the last year in the VPA are now selected to give a stock size at 1.1.1982 as given in the text table on p.18.

For age groups 0 and 1, the inputs F are chosen to produce stock sizes as estimated in the IYFS in 1982 and 1983, respectively.

The catch in numbers is given in Table 2.16, and the fishing mortalities in Table 2.17. The stock in numbers, together with the total biomass, is shown in Table 2.18. It should be noted that the weights at age used for this calculation are the stock weights in Doc. C.M.1978/H:3, although different sets of weight at age have been used for the individual components in the calculation of the spawning stock in numbers.

2.8 North Sea Herring - Management Considerations

In last year's report of this Working Group, it was concluded that the population spawning in Division IVc and Division VIId had shown a very marked recovery, while in Division IVa and Division IVb the recovery had been very small. It was further concluded that Divisions IVc+VIId spawning stock would increase further to a level of 300 000 - 400 000 tonnes at the end of 1982, due to good recruitment from the 1979 year class, the exact increase depending on the fishing mortality and on what part of the 1979 year class would recruit to the southern areas.

The present assessment shows that the expected further large increase in Divisions IVc and VIId spawning stock did not occur. It seems clear that a larger part than expected of the 1979 year class recruited to the spawning stocks in Divisions IVb and IVa in 1982. This resulted in a large increase in the spawning stock in Division IVb from about 40 000 tonnes in 1981 to about 100 000 tonnes in 1982.

The situation in the northern North Sea is more unclear. While neither larval surveys nor acoustic surveys indicated a substantial increase in spawning stock in Division IVa from 1981 to 1982, age compositions collected during the acoustic surveys indicated a substantial relative contribution to the spawning stock in 1982 from the recruiting 1979 year class. As discussed in Section 2.6.1, this discrepancy could have several explanations. If estimates of present stock size are correct, then either the spawning stock estimates from the larval surveys have overestimated the stock in the years 1978-81, and that some increase occurred in fact in 1982, or that non-reported and unknown catches from the stock in 1981/82 have generated a significant mortality on the age groups, which had already recruited to the spawning stock in 1981.

It has only been possible to carry out a stock projection for 1983 for the stock in Divisions IVc and VIId. Assuming 50% of the 1980 year class will recruit to this stock, a further substantial increase in the spawning stock is expected at the end of 1983.

If the part of the year class, which recruits to Divisions IVb and IVa is not fished as 2-ringers prior to the spawning season, the year class is expected to contribute approximately 200 000 tonnes to the spawning stock in these areas in 1983. Thus, a further increase in the spawning stock in Divisions IVb-IVa combined is expected in 1983, but it is not possible to calculate how this increase will be divided between the two Divisions.

Based on IYFS, year class 1981 seems to be even stronger than the 1980 year class as 1-group. If not fished to any significant extent as 1-ringers and as 2-ringers before it recruits to the spawning stocks, this year class could contribute approximately 600 000 tonnes to the total North Sea spawning stock in 1984, if the IYFS estimate is correct. It ha not been possible to make any estimate of how this contribution would b divided between the three stocks.

It is thus clear that a significant rebuilding is taking place in the total North Sea spawning stocks, although difficulties are experienced in making projections on a stock basis. It is, however, also clear that the rebuilding is being seriously delayed by illegal, directed young herring fisheries.

At its 1982 meeting, the Working Group had to use indirect methods to estimate the 0- and 1-group catch in 1982. Data, which have now been presented to the Group, show that the catches of 0-ringers in Division IVb in 1981 and in 1982 are the highest ever recorded for this fishery. They are, in fact, of the same order of magnitude as an average year class from the period 1954-70.

For several years the recruitment to the North Sea stock was at a low level probably due to stock/recruitment failure. This is no longer the case. The North Sea herring have recently (1980-81) produced at least two strong year classes, which could have brought the North Sea herring stock to its former state of highly productive resource.

The 0-group fishery, which took place in Division IVb in 1981 and 1982, will, however, seriously delay a further recovery of the total stock. In this context it must also be noted that a large 0-group fishery also takes place in Division IIIa. This fishery is mainly based on 0-group fish of North Sea origin. It is, therefore, concluded that not only are the young herring industrial catches in Divisions IVb and IIIa a serious threat to the recruitment of the North Sea herring but they are also contrary to any rational exploitation of this potentially largest fish resource in the North Sea.

Concerning the fishing of 0-group herring along the Danish coast, ACFM at its April meeting in 1982 recommended a closure of the sprat fishery in ICES statistical squares 41 F7 and 42 F7 from 1 July to 31 October. The last two years' fishing indicates, that this area should be extended southwards and include ICES statistical square 40 F7 as well as the fishery taking place very close to the shore. The Working Group suggests that the area be defined as: from the shoreline to 7°E longitude, and between 55°30'N and 57°N latitude.

The Working Group is concerned about the failure to implement the already existing regulations to prevent catches of young herring.

At its 1980 meeting, the Working Group agreed that before re-opening fisheries on the North Sea herring stock certain criteria should be met, i.e., that there should be evidence that the spawning stock would recover to about 800 000 tonnes, even under a limited fishery, and that there should also be evidence of improved recruitment. If the 1980 year class will not be fished further before it recruits to the spawning stock in 1983, the total North Sea herring stock will probably reach the target of 800 000 tonnes that year.

As discussed above, there is firm evidence of improved recruitment. It is concluded that the criteria will probably be met in 1983, if one considers the total North Sea stock as one unit. However, it should be kept in mind that three main components of the stock have recovered at a different rate.

The Working Group would stress the need for continued protection of the spawning stocks in Divisions IVa and IVb to ensure further rebuilding in these areas. If a re-opening of the adult herring fishery in the North Sea outside Divisions IVc-VIId is considered, only very moderate fishing mortalities should be allowed on these stocks.

Area TACs combined with closure during the spawning seasons would probably be the safest method for preventing that a large fishing effort is concentrated on either Division IVa or Division IVb stocks.

Considering a fishery in Division IVb in early summer, when the Downs and the Bank stocks are mixed in that area, the Working Group refers to what was said in last year's report about the mixing of these stocks.

3. DIVISION IIIa HERRING

3.1 Stock Composition

In late January 1983, a Workshop on Stocks Components undertook a trial of separating Division IIIa herring into spring- and autumn-spawned components, using length distributions and meristic characters. The Workshop found that more than three components could be separated in Division IIIa on the basis of length frequency distributions. Of these, at least one could be referred to autumn spawners and one or more to spring spawners. Kattegat spring spawners, Skagerrak spring spawners, and North Sea autumn spawners have different pure stock characteristics and can be identified by these means. The Workshop was unable, however, to separate the Kattegat spring spawners from those in the western Baltic and the Belt Seas.

The Workshop considered four different methods of separating length distributions into components that are normally distributed. It reached the conclusion, that before an attempt to estimate the relative proportions of the length components can be made, an integrated method of analysing length frequencies must be applied to all presently available and future data.

For the time being, the broad outlines indicate that the major proportion in the catches of 0-groups in July-December and of 1-groups in January-March are referrable to North Sea autumn spawners. 1-groups in July-December seem to be dominated by spring spawners, which are almost the sole component amongts 2-ringers and older fish.

3.2 The Fishery

3.2.1 Catch data

The landings of herring during the last decade are given in Table 3.1. Preliminary figures for 1982, partly based upon official figures, amounted to about 111 500 tonnes, which is slightly less than the

revised figure for 1981. An increase of 6% in the Skagerrak was counterbalanced by an 11% decrease in the Kattegat.

In last year's report, Denmark was not able to produce reliable data for the second half of 1981, and an indirect method was applied in order to estimate the likely level of this part of the landings. At the present meeting, figures based on a restricted number of samples were presented to the Working Group, and Table 3.1 was revised accordingly. The main change occurs in the unallocated landings, which increased by 11 000 tonnes to 57 000 tonnes. In 1982, this part of the landings declined to about 35 300 tonnes.

The total estimated landings thus show a decline from about 171 000 tonnes in 1981 to about 147 000 tonnes in 1982.

3.2.2 Catch in numbers at age

Catch in numbers at age data were available for the major fisheries in 1982 and for those landings in 1981, for which no data were available in last year's report. The revised data for 1981 and new data for 1982 are given in Table 3.2, together with the years 1974-80. It should be kept in mind that the apparent exactitude with which the catch of immatures are stated grossly exagerates the actual precision of these estimates. In both 1981 and 1982, the figures indicate, however, the largest catches of 0-group herring on record in Division IIIa and amount to over 60% of the total catch in number. Most of these would probably be of North Sea origin (see Section 3.1).

3.3 Biomass Estimates from Acoustic Surveys

The yearly acoustic survey in August-September was carried out by the Danish and Swedish research vessels "Dana" and "Argos". The preliminary results were presented to the ACFM meeting in November 1982.

The 38-kHz equipment was calibrated against a standard copper sphere. The recorded mm-deflections were corrected for deviation between measured TVG-amplification and the theoretical values as well as for the actual sound absorption and sound velocity.

The corrected mm-deflections were converted to biomass, using the following length-dependent target strength:

Herring: $\overline{TS}_{md} = 21.7 \log L - 75.5$ dB (Haldorsson and Reynisson, 1982)

Gadoids: $\overline{TS}_{md} = 21.8 \log L - 37.3$ dB (Dalén and Smedstad, 1982)

Mean target strength per individual for all species was converted to corresponding target strength per kg by length and weight data from the catches. A total of 36 pelagic trawl hauls were used to split the total fish biomass on species. The material was grouped by quarters of ICES rectangles.

The estimated herring stock in number per age group and total biomass at 1 September 1982 are presented in the text table below:

Age group	Number x 10^{-6}
0	6 171
1	2 349
2	989
3	221
4	31
5	8
6	1
7	+
Total	9 770
Biomass in tonnes	340 000

3.4 Recruitment

The annual young fish survey was carried out in Division IIIa during 31 January - 18 February 1983. A total of 35 hauls, covering 14 squares, were made with the GOV trawl.

The index of the 1-group herring, calculated as the geometric mean of the arithmetic means of seven standard squares, was 3 255, which is more than twice the index of 1982 and the highest recorded.

The 1-group herring had a wider distribution over the surveyed area, compared with previous years, and high numbers were also caught in the eastern part of the Skagerrak.

It was not possible during the Working Group meeting to split the index on local and North Sea components.

The abundance indices for 1972-83 (year classes 1970/71 - 1981/82) are given in the text table below:

Year	Index of 1-group
1972	78
1973	181
1974	726
1975	455
1976	1 339
1977	204
1978	575
1979	3
1980	504
1981	544
1982	1 647
1983	3 255

The IKMT sampling during the survey covered 13 squares and 52 hauls were made. The abundance of autumn-spawned larvae was higher than in the preceding 5 years.

3.5 Virtual Population Analysis

A VPA was done on the basis of the 9 years' catch at age data, which are available up to now. When considering the results, two points should be kept in mind:

(i) a major part of the 0- and some of the 1-group fish probably belongs to the North Sea herring and cannot be regarded as potential recruits to Division IIIa stocks,

(ii) part of the adolescent and adult stock (i.e., ≥ 2-ringers) probably belongs to the spring-spawning communities in the Belt Seas and in the western Baltic. Fishing mortality inflicted upon that component in these adjacent areas will be added to the fishing mortality generated in the Skagerrak-Kattegat.

The results of the VPA (Tables 3.3 and 3.4) are consequently of restricted value in respect to the management of Division IIIa stocks. They show, however, the trend of development in the late decade and permit comparisons with results from acoustic surveys and trends in other areas.

The input figures are partly the catch in numbers at age, which have already been commented upon in Section 3.2.2. They are shown in Table 3.2. A knife-edge maturity ogive at 3 years of age (3-ringers) was assumed. Input fishing mortalities were estimated from

the acoustic stock in number estimate in September 1982, and the catches in number for the period January-September 1982. By this means, estimates of the fishing mortality of the 0-group, 1-group and the group of 2 years and older fish were obtained.

Weight at age data were not included in the present VPA run, as the stock in numbers was the main object of the exercise. For the sake of recording they are, however, shown in the text table below (in g):

	WR.	0	1	2	3	4	5	6	7	8
In catch	1974-80	12	65	79	140	196	218	241	265	285
	1981-82	12	40	79	140	196	218	241	265	285
In stock		-	26	60	116	175	205	225	255	275

The stock in numbers, calculated by the VPA and shown in Table 3.4, permits comparisons with year class fluctuations in adjacent areas. In Figure 3.1 is shown the relation between the numbers of 2-groups calculated by the present VPA for Division IIIa, and those calculated by VPA in Sub-divisions 22 and 24 (C.M.1982/Assess:16). The correlation between these two sets of figures is highly significant.

In Figure 3.2, the catch of 3-ringers in Sub-divisions 22 and 24 is plotted against the catch of 2-groups in Division IIIa in the year before. Again, a high correlation is found.

Another comparison can be made between the results of acoustic surveys carried out in Sub-divisions 22+24 in October and in Division IIIa in August-September. The data are shown in the text table below, together with catches of 2-groups in Division IIIa.

Year class	Acoustic surveys			Catch
	Baltic (0-gr.)	Baltic (1-gr.)	Div.IIIa (2-gr.)	Div.IIIa (2-gr.)
1978	1 048	217	434	253
1979	5 846	663	1 260	656
1980	4 020	550	989	314

Even though the time-series is very restricted, there is an apparent conformity between the three acoustic estimates of year class strength. The catch in numbers of 2-groups in 1982 seems, however, to be somewhat lower than would be expected from the acoustic estimates.

3.6 Management Considerations

3.6.1 General

The difficulties mentioned in the preceding section and indeed in several earlier reports dealing with the Division IIIa herring fisheries have made it impossible to make an assessment from which a meaningful prognosis can be obtained. The Working Group considers, however, that the attention of ACFM should, in the first place, be drawn to the continuing and apparently increasing catches of young herring and

secondly, to the appropriateness of assessing indigenous herring stocks in Division IIIa and herring in Sub-divisions 22+24 as one unit.

3.6.2 The catch of 0-group herring

According to the catch at age figures presented in Table 3.2, the catch of 0-group herring reached the highest level on record in 1981-82. This may not reflect an increase in fishing effort on young herring but could be an indication of an increase in abundance in these year classes compared with earlier year classes in the restricted period for which age data are available. Even then, these catches undoubtedly reduce the recruitment to the herring stocks mainly in the North Sea and could - together with the 0-group catches in the North Sea proper - equal the major part of an average year class.

ACFM has already proposed a number of restrictions which, if enforced, would effectively cut 0-group catches, and it is difficult to imagine which further restrictions could be suggested. The real problem in Division IIIa thus appears to be the lack of enforcement of existing regulations and the failure to accept the additional proposals recommended by ACFM in November 1982. No improvement can be expected from any additional restrictions without effective enforcement.

3.6.3 Management of adult herring

The borderline between Division IIIa and Sub-divisions 22 and 23 cuts through a more or less continuous series of spawning sites, which also extends along the western Baltic coast in Sub-division 24. In Section 3.5, the close relationship between the herring stocks in these areas was pointed out, and the Working Group finds that there are good arguments for considering these stocks as one unit. At present, partial assessments are carried out in two Working Groups (the present for Division IIIa and the Working Group on Pelagic Stocks in the Baltic, for Sub-divisions 22-24). It is felt that ACFM should consider the pratical possibilities and eventual virtues of a joint assessment in the future. The situation may, however, be more complex in the future, as it should be born in mind that North Sea adult herring were fished in winter in Division IIIa in the years prior to 1967, and there was also a fishery on adult autumn-spawning Kobbergrund herring in that period.

With no reliable indication of the 2-group strength in 1983 and with some doubts about the strength of the 3-group, no reliable prognosis can be made.

4. CELTIC SEA AND DIVISION VIIj HERRING

4.1 Introduction

The herring stocks in the Celtic Sea and in Division VIIj were assessed separately by the 1982 Working Group. However, the Working Group examined the biological data of the stocks in both areas and the location of the fisheries and concluded that consideration should be given to managing both areas as one unit. Accordingly, a combined assessment was carried out and presented to the July meeting of ACFM. ACFM considered this assessment and recommended that no catches should be allowed during 1982/83 from the combined areas. A modified version of this assessment was subsequently used by the November meeting of ACFM in making predictions about the effects of various catch levels on the stock size. Catches of 8 100 tonnes were permitted by the EEC from the area for the period October 1982 to March 1983.

4.2 The Fishery in 1982/83

4.2.1 Catch data

The total catches from the combined areas per year and per season are shown in Tables 4.1 and 4.2. The total catch taken during the whole of the 1982/83 season amounted to approximately 13 000 tonnes, which was over 4 000 tonnes less than that taken in 1981/82. The catches were again taken almost exclusively by Irish pelagic trawlers and drifters. Over 70% of the total catch was taken in the third and fourth quarters of the season by boats fishing during the main spawning season. As in recent years, lack of markets greatly curtailed catches throughout the season, and boats were obliged to fish under severe nightly quota restrictions.

Quantities of herring were also discarded at sea by boats, whose catch had exceeded their nightly quota. It was not possible, however to quantify the amounts discarded in this way.

4.2.2 Catch in number per age group

The total catch in number per age group is given in Table 4.4. The catches throughout the season were dominated by the 1979 year class, which during the third and fourth quarters constituted approximately 60% of the total. This year class had been noticeably abundant during 1981/82 as 1-winter-ring fish. Older fish were relatively more abundant during the first and second quarters, while 1-winter-ring fish (i.e., the 1980 year class) became increasingly more plentyful as the season progressed.

4.3 Spawning Stock

4.3.1 Larval surveys

Larval surveys were conducted for the fifth successive season. Because the Celtic Sea and Division VIIj were amalgamated for assessment in 1982, it was planned to extend the survey grid westward during the autumn to 10°13'W so as to cover the Bantry Bay area, where it was suspected from commercial catch samples that spawning occurred. Unfortunately, due to severe weather conditions coverage extended this far west on only one cruise and then virtually no larvae were taken. A change in sampling distribution was also made to winter (December-February) cruises when sampling in 1982/83 did not extend further west than 8°31'W, because in previous years small class larvae were very rare in that region. In addition, winter coverage was extended northwards on the eastern end of the grid to see, if many larvae were drifting into the Irish Sea. Again, virtually no larvae were taken at these new stations. Coverage on time was very satisfactory with surveys roughly every 14 days. An additional cruise was undertaken at the end of the season, because some spawning herring were still caught in early February, which was later than in previous years.

In the 1982/83 season, small class larvae were most abundant west of Cork Harbour in the autumn and again in late February and also off Baginbun Bay in February. Medium and large class larvae were less abundant than in any of the previous seasons.

Following suggestions made at the 1982 meeting of this Working Group, a new means of calculating the larval index was used, and this is described in an Appendix to Doc. C.M.1982/Assess:7 and in Grainger et al. (Doc. C.M.1982/H:38). Briefly, for each cruise the total abundance of small class larvae was calculated, as before, by multiplying the numbers per m^2 by the area represented by each station (see Table 4.3). The mean abundance of <10 mm larvae prior to 15 December gave the autumn index and the mean abundance of <11 mm

larvae after 15 December gave the winter index. The winter index was then multiplied by 1.465, to compensate for the lower fecundity of winter spawners (Molloy, 1979) and added to the autumn index to give an index for the whole season. The indices for the last five seasons are given in the following text table (number of cruises in brackets):

	Autumn	Winter x 1.465	Total
1978/79	7 163 (3)	122 (3)	7 284
1979/80	9 503 (5)	3 374 (5)	12 877
1980/81	7 601 (4)	8 932 (4)	16 533
1981/82	16 285 (5)	1 510 (5)	17 795
1982/83	14 557 (5)	5 164 (6)	19 721

4.4 Estimates of Fishing Mortality

It has not been possible to calculate F for the 1982/83 season from cpue data, because, as in the last few years, boats were working to nightly quotas. There is, however, indirect evidence, that F was substantially lower than in the previous season. In 1982/83, market demand was lower resulting in lower nightly quotas than in the previous season. For a period of about six weeks in October/November 1982, there was virtually no fishing because of a protest by fishermen and severe weather conditions. Because of the poor demand, several vessels left the fishery before the end of the season. Catches fell from 17 100 tonnes in 1981/82 to 13 000 tonnes in 1982/83.

Several runs of VPA were carried out with different input values, and an increasing trend in spawning stock biomass over the last five years was shown with $F_{82/83} = 0.6$ or less. There has been a continuous increase in the larval index during the same period. In order to determine which rate of increase in spawning stock biomass best matched the increase in the larval index, the ratio of the mean spawning stock biomass of the last two seasons to the mean of the two previous seasons was found for each input F. The equivalent ratio of the two-year means for the larval indices was also found. The ratios are given in the text table below:

	Mean SSB			Larval index
Input F	0.4	0.5	0.6	
A) 1979/80 - 1980/81	27 350	26 080	25 240	14 705
B) 1981/82 - 1982/83	35 490	30 190	26 650	18 758
B/A	1.30	1.16	1.06	1.28

The increase in spawning stock biomass best matching the increase in the larval index is derived from $F_{82/83} = 0.4$, and this was taken as the appropriate F for 1982/83.

4.5 Recruitment

No method is available to predict recruitment to the stock in this new area. Examination of the numbers of 1-winter-ring fish in the stock from VPA from 1968-81 indicates that apart from the strong 1969 and 1979 year classes recruitment has varied between 49 and 97 million fish each year at 1 April. Although 1-winter-ring fish were again abundant in the catches taken during 1982/83, it is not possible to draw any definite conclusion about the strength of the 1980/81 year class. However, if F adult in 1982/83 = 0.4 (se Section 4.4) and F on 1-winter-ring fish is 40% of that on adults, then the estimated strength of the 1980/81 year class is about 109 million at 1 April 1982. This is higher than the average level of 65 million produced by the stock during the 1974-80 period, when it was at a very low level.

4.6 Results from VPA

The results from VPA, assuming F adult = 0.4 in 1982/83, are shown in Figure 4.1 and Tables 4.5 and 4.6. The exploitation pattern assumed that F on 1-winter-ring fish was 40% of that on adults. The mean weights per age class are the same as those used in the assessment presented to ACFM in July, and the mean weights per age class of the stock at spawning time are the same as those in the catches, because all catches are now taken during spawning time. The VPA has been run back to 1958, and it must be emphasized that over this period considerable changes in stock sizes and composition have taken place. From 1958 to 1970 approximately, the fishery mainly exploited a winter spawning component, but in the early 1970s an autumn-spawning component emerged and has since then dominated the catches and the total stock, as reflected in the larval surveys.

The spawning stock biomass has slowly increased in recent years from its lowest level of 23 500 tonnes in 1976 and was estimated to be about 39 000 tonnes at spawning time in 1982. Fishing mortality decreased from high levels in the early 1970s (F = 0.70) to about 0.45 during the years 1975-79 and has since increased slightly to about 0.50 from 1980-82. Recruitment of 1-winter-ring fish from 1974 to 1980 averaged about 65 million, with the lowest level of about 49 million. The 1979 year class (173 million) appears to be the strongest one to enter the fishery since that of 1969, while preliminary evidence indicates that the 1980 year class will be above the average recorded during the 1974-1980 period.

It should be pointed out, that the results obtained from VPA, assuming F = 0.4 in 1982/83, give estimates of spawning stock and recruitment in 1982 and F values in 1981/82, which confirm the assessment carried out by ACFM in November 1982.

4.7 State of the Stocks

The spawning stock biomass at spawning time in 1983 is estimated to be about 40 000 tonnes. The highest level recorded was during 1965-69, when it averaged about 106 000 tonnes, and the lowest level was in the mid-1970s when it averaged about 25 000 tonnes.

4.7.1 Estimate of target spawning stock biomass

The preliminary assessment of the stocks in the combined Celtic Sea/ Division VIIj area was presented to ACFM in July 1982. The desired minimum target spawning stock biomass was, however, not estimated. ACFM examined this aspect and concluded that it was not possible to determine any period since 1958, when F values were consistently low and the stock could be considered to be lightly exploited. It was

difficult, therefore, to determine the level to which the stock should be rebuilt. It was apparent, however, that prior to the increase that took place in the total stock around 1965, the spawning stock was stable at about 80 000 tonnes from 1958-64. Yields during this period were also stable at around 20 000 tonnes, and F values varied between 0.3 and 0.5.

The Working Group was therefore asked to examine the question of an appropriate target stock biomass for the area. Two aspects were therefore examined:

1) stock/recruitment relationship

2) yield/biomass ratio.

4.7.2 Stock/recruitment relationship

The relationship between the spawning stock biomass and the numbers of recruits as 1 winter-ring fish produced two years later is shown in Figure 4.2. This covers the period 1958-80, during which considerable changes in stock composition took place from mainly winter spawners to autumn spawners. There does not appear to be any clear relationship over the whole time period, but the points fall into two well defined groups each of which corresponds to different phases of the fishery. There is a period from 1973-80, when, with the exception of the 1979 year class, recruitment was low and stock was low. Recruitment during this period averaged 89 million fish. A second period from 1958-72 contained fluctuating stock sizes, which produced several good year classes which averaged 162 million fish. The probability that the present spawning stock biomass will produce very strong year classes is considered to be low.

4.7.3 Yield/biomass ratio

The relationship between yield and spawning stock biomass was also examined for 1958-82 to determine a desired stock level (Figure 4.3). Four periods can be identified:

1) 1958-64 Stable stock - mainly winter spawners

2) 1965-69 High stock - mainly winter spawners

3) 1970-76 Declining stock - mixed autumn and winter spawners

4) 1977-82 Low stock - mainly autumn spawners.

The average yield in each period has been expressed as a percentage of the spawning stock biomass and is 20%, 28%, 48% and 40%, respectively. The stock, therefore, was able to expand after the 1958-64 period during which yields were about 20% of the spawning stock biomass. During the period 1965-69, the yields increased to 28% of the biomass. The stock declined rapidly when yields averaged 48% during the period 1970-76. In the latest period, from 1977-82, the yield is approximately 40% of the biomass, and the stock cannot produce sufficiently good year classes to effect a rapid recovery.

Therefore, to ensure rebuilding of the stock, the yield should never exceed 20% of the spawning stock biomass. It seems that if the yields are consistently allowed to exceed about 30% of the biomass, then the stock will be in danger of collapsing.

4.7.4 Stock predictions and management considerations

Stock predictions were made with a selection of fishing mortalities in 1983-84 and 1984-85, assuming 40% adult F on the 1-ringers. The starting stock in numbers for 1 April 1983 was from the VPA, assuming

$F_{82/83}$ = 0.4, with the number of 1-ringers taken as 50 million fish (roughly the minimum value since 1958). Recruitment in 1984-85 was also taken as 50 million 1-ringers. The input parameters for stock predictions are given in Table 4.7. The results are given in Figure 4.1, and in the following text table (SSB in tonnes at spawning time):

1982/83			1983/84			1984/85		
SSB	$\bar{F}_{2-9+}$	Catch	SSB	$\bar{F}_{2-9+}$	Catch	SSB	$\bar{F}_{2-9+}$	Catch
39 000	0.4	13 000	41 800	0	0	49 900	0	0
			40 600	$0.16(=F_{0.1})$	6 100	42 200	$0.16(=F_{0.1})$	6 400
			38 700	$0.4(=F_{82/83})$	13 700	33 100	$0.4(=F_{82/83})$	11 700

For rebuilding the stock, the catch/spawning stock biomass ratio should not exceed 0.2 (see Section 4.7.3).

5. WEST OF SCOTLAND HERRING

5.1 Assessment Procedure

The assessments in this area were done on the same sub-divisions as in 1982. The limits of these are given in Figure 5.1.

5.2 Division VIa North

5.2.1 Catch data

The catches reported by each country from this area in 1973-81, and the preliminary estimates of the catches in 1982 are given in Table 5.1. The preliminary total catch of 49 100 tonnes in 1981, given in the previous report, has been increased by about 2 000 tonnes in the revised figure for that year. The preliminary total catch for 1982 is about 92 000 tonnes. This is considerably in excess of the catch in that year given as the preferred level by ACFM in its advice on management of this stock in April 1982.

5.2.2 Catch in numbers at age

The estimated numbers at age caught in this area in each of the years 1973-82, and including the by-catches of herring in the Moray Firth sprat fishery, are given in Table 5.2. The sampling of national catches was much more satisfactory than in 1981, with all countries which had taken appreciable catches in the area supplying catch at age data.

The age composition of the catch in numbers in 1982 is in general agreement with the prediction made last year, with 2-ringers (1979 year class) being the predominant age group. The 1980 year class was taken in considerably smaller numbers in 1982 than was the 1979 year class in 1981. This, however, was due to the almost complete absence of a sprat fishery in the Moray Firth in 1982. The catches of these year classes as 1-ringers in the directed herring fisheries in Division VIa (north) were of almost identical size in the two years. This might suggest that the 1980 year class will also be a strong one, when it recruits more fully to the herring fishery in 1983.

5.2.3 Larval surveys

Larval surveys were carried out in this area throughout September and October by the Federal Republic of Germany and Scotland, resulting in satisfactory sampling coverage in 1982, both in space and time. The 1982 index of abundance for the smallest size category of herring larvae was only slightly higher than in 1981 (Table 5.5). Using the 1982 larval index in the regression equation of larval abundance and spawning stock biomass given in Table 5.5, based on a preliminary VPA, provided an estimate of spawning stock biomass in 1982 of 380 897 tonnes. This value was used to initiate a VPA.

5.2.4 VPA outputs

From the VPA outputs obtained in 1982 it appeared that the exploitation pattern on this stock was full recruitment to the fishery of fish older than 2-group and 0.8 on 2-group. This, however, was based on the results from the fishing pattern prior to the closure of the fishery and might not be applicable to the changed situation since the fishery was re-opened in 1981. It is not possible, with so few data points subsequent to the re-opening of the fishery, to resolve this problem reliably. But the preliminary VPA run, based on the assumption of the exploitation pattern used in last year's prediction, suggested that the 2-group fish were fully recruited to the fishery in 1981. A new input F for 1982 was, therefore, estimated from the spawning stock biomass on the assumption that recruitment to the fishery was complete at 2-rings. The final VPA was run on this basis.

The relevant data are given in Table 5.5. The points are plotted and the new regression line is shown in Figure 5.2.

The outputs of fishing mortalities, stock in numbers at age and spawning stock biomasses at spawning time are given in Table 5.3 and Table 5.4. As would be expected from the high level of catch taken in 1982, the fishing mortality in that year was about 30% above the preferred level of 0.15 advised by ACFM. The size of the 1979 year class at 1 January 1982 is in close agreement with that predicted in last year's report. The number of all other age groups, however, are somewhat lower than predicted due to the somewhat higher fishing mortality rate in 1981 than was estimated last year.

5.3 Recruitment

In last year's report on this stock, recruitment as 2-group in 1982 was estimated based on Scottish research vessel surveys carried out in February-March 1981 and 1982. In these years the indices of abundance were of comparable size, and the method used appears, from the 1982 catch data, to have given a rather good estimate of recruitment in that year. A similar survey was carried out in February-March 1983, and the results would suggest that the 1980 year class is a much weaker one than either the 1978 or 1979 year classes. However, with only three data points from these surveys, it would be very dangerous to assume that the relationship between the index of abundance and stock size is a linear one over a very wide range of indices. Under these circumstances all that can be inferred from the 1983 survey is that the 1980 year class is a weak one. For prediction purposes, this year class has been set at 205 x 10^6 fish, which is the lowest value at this age given in the VPA over the period since 1970.

5.4 Management Considerations

The results of the assessments mentioned above were used to predict yields and spawning stock biomasses in 1983 and 1984. The parameters used are given in Table 5.6. The outputs of the predictions over a

range of fishing mortality rates are shown in Figure 5.3. Yield per recruit and spawning stock biomass per recruit curves are shown in Figure 5.3. The Y/R curve has no maximum. The yields at $F_{0.1}$ and some adjacent values in 1983 and 1984 are given in the text table below. These assumptions made throughout these predictions are

a) that the same fishing mortality rate will be maintained in both years, and

b) that recruitment will be at the same level in both years.

1982			1983			1984		
Catch	$\bar{F}_{2-7}$	Spawn. stock	Catch	$\bar{F}_{2-7}$	Spawn. stock	Catch	$\bar{F}_{2-7}$	Spawn. stock
92 417	.201	380 000	38 437	0.10	370 900	36 739	0.10	354 521
			57 996	$F_{0.1}$=.1549	357 500	52 653	0.1549	324 567
			73 277	0.20	346 865	63 783	0.20	301 926
			104 859	0.30	324 386	83 172	0.30	257 296

The predicted catches in 1983 are somewhat lower than those predicted last year at the same F values. This is principally due to the low recruitment value assumed in this prediction as compared to that assumed for 1983 in the previous prediction.

5.5 Clyde Herring

5.5.1 The fishery in 1982

Landings in the years 1973-82 by Scottish and a few Northern Irish vessels are given in Table 5.7. The landings in 1982 of 2 506 tonnes were almost exactly the recommended TAC for that year, but sampling suggests that approximately 10% more may have been landed due to overweight boxes. In addition, there were reports of discarding of immature fish as well as reports of illegal landings from this fishery, but no data are available to quantify this aspect. In addition, an estimated 11 tonnes were caught as by-catch in the sprat fishery. Reports of the fishery indicated that fishermen experienced difficulty achieving their quotas both at the beginning of the season in May and June and also at the end of August, while quotas were more readily achieved during July and early August.

Catch in numbers (spring- and autumn-spawners combined) for the period 1967-82 is given in Table 5.8. The data for 1982 have been raised to take account of the percentage overweight boxes on a monthly basis. In 1982, 2-ringed herring made up approximately 50% of the total landed, with 3-5-ringed herring making up another 30%. In addition, there were reports of discarding of small herring.

5.5.2 Tagging experiments

The updated recapture data for the tagging experiment carried out in the Clyde in May-June 1980, in which approximately 7 000 externally tagged herring herring were liberated, are given in Table 5.9. Only a few further returns of tagged herring were received in 1982, and these were all recaptured within the Clyde, apart from one taken off the Donegal coast in June.

5.5.3 Basis for stock assessment

The 1982 returns of tagged herring liberated in the Clyde in 1980 are too few to draw firm conclusions about the rate of emigration. Only one out of 29 tags, however, was returned from outside the Clyde, which supports the earlier conclusions that most of the fishing mortality on the Clyde population takes place within the Firth of Clyde itself. On this basis, a VPA was carried out to estimate recent changes in F.

5.5.4 VPA

As in the previous report, the VPA was carried out using a natural mortality of 0.1. The exploitation pattern was derived from a trial analysis, which showed that full exploitation appears to be reached at an age of 2, while that on 1-ringers was approximately 7% of that on older fish in the years 1979-81. Since catches of 0-group are entirely due to a small sprat fishery, and since sampling of this fishery was very poor, it is not possible to determine the proportional F on this age group. In all runs of the VPA, the value of F on the oldest age group was assumed to be 0.5 in all years. Estimates of F on 2-ringers and older are shown in Figure 5.4 for input values of 0.1, 0.2, 0.4 and 0.6 in 1982. All runs show a progressive decrease in F from a peak in 1977 to 1980. For 1981 and 1982, the results of the VPA itself are equivocal. Low values of input F indicate a small decrease of F in 1981 and 1982, whereas high values of input F suggest that F has increased. No independent information is available to indicate the most likely value of input F. If it is assumed that fishing mortality has neither increased nor decreased over the period 1980-82, an input F of 0.3 is appropriate. The results of a VPA, using this input value of F, are given in Tables 5.10 and 5.11.

Since discarding of small herring, particularly 1-ringers, is difficult to estimate, it is appropriate to consider recruitment values for 2-ringers. An input F of 0.3 would suggest a slightly higher recruitment than average in 1982.

5.6 State of the stock and management considerations

The VPA analysis summarized in the previous section indicates that fishing mortality was reduced when a TAC regulation was introduced in 1979. Estimation of the fishing mortality in 1982 is impossible without some independent evidence, but in the absence of any indications of changes in fishing effort, it is likely to be around 0.3. If this is correct, and if recruitment remains at approximately the same level as in the past few years, then the TAC of 2 500 tonnes advised by ACFM for 1983 will result in a slight decrease in fishing mortality rate to about 0.27. As stated in the previous report, it is likely that a continuation of this level of TAC will result in a stable level of fishing mortality.

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

6.1 Catch Data

The catches of each country fishing in this area in the years 1973-81, and the preliminary estimates of catches in 1982, are given in Table 6.1. The revision to the preliminary 1981 catches given in the 1982 report amounted to a reduction of about 1 000 tonnes. The preliminary total catch figure for 1982 is 18 000 tonnes, very predominantly taken by Ireland. This is the lowest catch taken from this area since 1971, partly reflecting the reduced stock size commented on in last year's report, and partly due to some reduction in fishing effort in 1982.

6.2 Catch in Numbers at Age

The estimated numbers at age caught in this area in each of the years 1973-82 are given in Table 6.2. There has been some minor revision of the data presented in last year's report for 1981, arising from the revised catch in weight data for that year. All countries fishing in this area in 1982 supplied catch at age data from this fishery. The largest contribution to the catch in 1982 was made by the 1977 year class, reflecting the rather moderate recruitment to this stock in recent years. The catch of 1-ringers in 1982 was again very low compared to previous years.

6.3 Larval Surveys

Although the larval surveys in 1982 again extended south to Galway Bay and covered a longer time period, the time-series of comparable data on this basis is as yet too short to be used in predicting stock size. Accordingly, the index of larval abundance in 1982 has been estimated on the same basis as in the past. The sampling coverage in 1982 in the standard area, which has been used to date for spawning stock biomass estimation, was again very satisfactory both in space and time. In 1982, comparative fishing was done between Irish and Scottish vessels engaged in these larval surveys. This suggested that, although there was no significant difference in the total number of larvae caught by the two vessels, the Scottish vessels were catching 1.8 times more larvae in the size category used in the index. The reason for this will be investigated, but, for the moment, this value was applied as an adjustment factor to the Irish 1982 data. The effect on the final index was less than 5%.

The resulting larval indices are given in Table 6.5. The index for 1982 is somewhat higher than for 1981 but is again low compared to earlier years.

6.4 VPA

It will be noted that the spawning stock biomass estimates given in Table 6.5 are somewhat different from those given in the corresponding table in last year's report even for the earlier years, when they are unaffected by the terminal F value used to initiate the VPA. This is because it was discovered, that the spawning stock biomasses used in 1982 were calculated with the wrong mean weight at age. To initiate the VPA, it was, therefore, necessary to recalculate the spawning stock biomasses derived from last year's VPA, and a new regression equation between spawning stock biomass and larval abundance. This was then used to estimate the spawning stock biomass in 1982, which, in turn, was used to estimate the input F value for 1982 to start the VPA. The input data for this, the predictive regression equation,using the data up to 1981, and the revised spawning stock biomasses derived from the final run of the VPA are all listed in Table 6.5. The revised regression equation using the final outputs is also given in this table and shown in Figure 6.1.

In this stock, recruitment to the fishery is complete at age 2, and an F of 0.208 gave a satisfactory fit to the larval data. The Fs at age, stock in numbers at age and spawning stock biomasses at the time of spawning are given in Tables 6.3 and 6.4, respectively. The data given in Table 6.3 would suggest a reduction of about 20% in F in 1982 compared with 1981. The VPA output (Table 6.4), however, would suggest a slight reduction in spawning stock biomass in 1982, compared with 1981, due to the reduced recruitment to the population in the last two years.

6.5 Recruitment

In this area, there are no satisfactory data available to give a fishery-independent index of recruitment to the stock in 1983. Young herring surveys, designed to identify nursery grounds in this area and to provide indices of recruitment, were carried out in 1981 and 1982 and will be continued in subsequent years. The surveys carried out to date indicate Galway and Donegal Bays as nursery areas. The time-series of data is as yet too short to measure year class strengths quantitatively.

The only data which can give any indication of this are the catches of 1-ringers in 1982. As mentioned in Section 6.2, these were very low in that year. The problem in estimating the stock of this age group at 1 January 1982 from the catch data in that year is, that there is no objective way of estimating the F in that year on that age group. If one takes the ratio of the F on 1-group to the mean F on fully recruited age groups in the years 1979-81 and takes the means of these ratios as applying to 1982, an estimate of F on 1-ringers in 1982 of 0.018 would be obtained. This, however, would estimate this year class as only 44 x 10^6 fish at 1 January 1982. This would be by far the poorest year class ever recorded in this stock. The Scottish recruit survey in Division VIa does not sample this area very well, but the results of it would indicate that this 1980 year class in 1983 is only slightly less abundant than was the 1978 year class in 1981. On this basis, an F of 0.010 would seem an appropriate compromise, resulting in an estimate of 2-ringers in 1983 of 70 x 10^6.

6.6 Management Considerations

The results of the assessments given above were used to predict yields in 1983 and 1984. The parameters used are given in Table 6.6. The outputs of the predictions over a range of fishing mortality rates, in terms of yields and spawning stock biomasses, are shown in Figure 6.2. Yield per recruit and spawning stock biomass per recruit curves for this stock are shown in Figure 6.2 C-D. The yield per recruit curve is flat-topped, and, therefore, F_{max} is not relevant. The yields, at $F_{0.1}$ and some adjacent values, in 1983 and 1984 are given in the text table below.

1982			1983			1984		
Catch	$\bar{F}_{2-7}$	Spawn. stock	Catch	$\bar{F}_{2-7}$	Spawn. stock	Catch	$\bar{F}_{2-7}$	Spawn. stock
18 079	.208	77 345	7 822	0.10	75 475	7 798	0.10	75 248
			11 772	$F_{0.1}$=.1545	72 769	11 180	$F_{0.1}$=.1545	69 107
			14 911	0.20	70 584	13 601	0.20	64 381
			21 338	0.30	66 010	17 824	0.30	55 139

These predictions for 1983 are reasonably consistent with those given for that year in the 1982 report.

7. IRISH SEA HERRING (DIVISION VIIa)

7.1 Introduction

The TAC for the North Irish Sea for 1982 was set at 3 800 tonnes, the same as in 1981. The reported catch from the North Irish Sea was 4 855 tonnes (Table 7.1). Actual catches were probably greater than this, because many small fish were dumped at sea, boxes often overweight, and some catches may not have been reported. Nominal catches were allocated to Manx or Mourne stock on the basis of vertebral counts, gonad condition, and location of capture as described in Doc. C.M.1979/H:6. 3 097 tonnes were allocated to Manx stock, and 1 758 tonnes to Mourne stock (Table 7.2). The two stocks are considered separately below, and general recommendations for the North Irish Sea are given in Section 7.4.

7.2 Manx Stock

7.2.1 The fishery in 1982

The fishing pattern was similar to that in 1981. Daily quotas per boat were recommended by a representative port committee; a short week of four fishing days was worked; unfilled quotas could be carried over up to the end of the week but not longer. Effort data are not available, but reports and observations suggest that the effort was similar to that in 1981. The TAC was taken by 2 September.

Some fishing took place after the TAC was taken. There were persistent reports of discarding at sea of small herring; these reports were supported by the difference in length frequency distribution between samples of sorted and unsorted boxes of herring landed, but it was not possible to quantify the amount of young fish discarded.

7.2.2 Estimates of fishing mortality and stock size

The number of fish at each age in the nominal catch is given in Table 7.3. VPAs were applied to these data, with a range of input F for 1982. There is no independent evidence on which to base a choice of input F. In view of the similarities between the fisheries of 1981 and 1982, the Working Group used the same reasoning to choose an input F in 1982 as was used in 1981.

Most of the fishing took place to the west of the Isle of Man, and most of the fish were caught before September; it is likely that the fishing mortality on the 2-ringed fish was higher than on the older fish, which tend to appear in quantity late in the season. The TAC was taken early without difficulty by a relatively small fleet. The Working Group considered that F on the fully recruited fish would be much less than in 1980, and an F of 0.4 on 2-ringed fish and of 0.3 on 3-ringed fish and older seemed appropriate. Actual catch in numbers of 1-ringed fish could not be estimated because of discards at sea. This year class is derived from the low spawning stock of 1980 and is likely to be poor. An F on 1-ringed fish of 0.07 gave a stock in number of this age in 1982 of about 30×10^6, equivalent to that of 1965, the lowest given by VPAs carried out by the Working Group. This value of F was used for the VPA. Results of VPA with F (age 1) = 0.07, F (age 2) = 0.40 and F (age 3 to 8+) = 0.30 are given in Tables 7.4 and 7.5. The results indicate a spawning stock biomass at spawning time in 1982 of 8 400 tonnes, a modest increase on that indicated for the previous two years.

7.2.3 State of the stock

Figures 7.1.A and 7.1.B show that the decline in spawning stock biomass associated with high F which started in 1971 and continued until 1980, has possibly been halted. Estimates from VPA of stock size in 1981 and 1982 must be treated with caution, but it appears that a

recovery may have started. Continuing recovery will depend on the recruitment (which is likely to be low, since the spawning stock is relatively low) and a very modest catch to generate an F of less than 0.4. The text-table below gives projections based on an assumed recruitment of 30 x 10^{-6} 1-ringed fish in 1983 and 1984, with an F on 1-ringed fish of 0.07, and fishing mortality on fish 2-ringed and more equal at all ages and equal in 1983 and 1984.

Manx Herring — Div. VIIa N.Irish Sea

1982					1983				1984		
Stock biom. 1 Jan.	Spawn. stock biom. at sp. time	F Age	F	Catch	Option (F_{2-8})	Stock biom. 1 Jan.	Spawn. stock biom. at sp. time	Catch	Stock biom. 1 Jan.	Spawn. stock biom. at sp. time	Catch
16.3	8.4	1 2 >2	0.07 0.4 0.3	3.1	$F_{(0.1)} = F_{0.15}$	17.2	10.9	1.8	19.9	13.1	2.1
					0	17.2	12.7	0	21.9	17.1	0
					0.1	17.2	11.5	1.2	20.5	14.3	1.5
					0.2	17.2	10.4	2.3	19.2	11.9	2.7
					0.3	17.2	9.4	3.3	18.1	10.0	3.5
					0.4	17.2	8.5	4.2	17.0	8.4	4.2

$F_{1984} = F_{1983}$

Catch and biomass in tonnes x 10^{-3}.
Stock biomass = Σ weight of stock at age 1 to 8+.
Spawning stock biomass = Σ weight of stock age 2 to 8+ at spawning time.
Weight at age in catch and in stock as given in 1982 Working Group report, based on mean values from Manx samples over 10 years.

7.3 Mourne Stock

7.3.1 The fishery in 1982

The total nominal catch of the Mourne stock in 1982 was 1 758 tonnes, made up of 490 tonnes selectively fished by gill nets over the Mourne spawning grounds and 1 260 tonnes taken as a component of the Isle of Man fishery outside the 12-mile Irish coast limit (Table 7.2).The comparable data for 1981 were 1 146 tonnes in the mixed fishery and 295 tonnes selectively fished over the spawning grounds. There was, therefore, an increase of about 22% in the catch in 1982. However, as the Republic of Ireland did not participate in the Mourne gill-net fishery in 1982, their allocation of 200 tonnes was not taken. Accordingly, in 1982, the selective gill-net fishery did not take up the whole 600 tonnes allocation.

7.3.2 Catch in numbers by age

The total catch in numbers of fish per age group in each of the years 1972-82 are given in Table 7.6. This has been estimated by using data from samples of the catch landed in Northern Ireland, the Republic of Ireland and the Isle of Man. From sample data in the mixed fishery, it was estimated that at least one-half of the 1-group herring caught in 1982 were discarded at sea by vessels participating in the Isle of Man fishery.

Thus, the catch in numbers of 1-ringers was doubled to give the catch in numbers shown in Table 7.6. It may be seen from Table 7.6 that the catch is heavily dependent on 1- and 2-group fish; 2-ringers made up 46% of the catch in 1982 as opposed to 43% in 1981. Mean weights at age used to calculate the stock sizes were based on the 1982 sample data and were as follows:

Age (w.r.)	0	1	2	3	4	5	6	7	8	9+
Weight (g)	26	108	165	204	226	244	258	279	281	305

7.3.3 North Irish Sea - Young herring survey

A young herring survey, similar to those carried out in 1979-82, was carried out in the northwestern Irish Sea in February 1983. The results, although not yet completely analyzed, indicate that the 1981 year class will be at about the same level of abundance as that of 1980.

7.3.4 VPA

A first VPA was carried out with F = 0.2 on age groups 2 and over, as this was the value adopted by the previous Working Group for the 1981 season. This VPA gave a value of F = 0.31 for 1981. Thus, a further trial run was made with input F = 0.3. This increased F_{81} to 0.43. As in previous years, the Working Group had little evidence on which to select as the most appropriate value of input F in 1982. However, given that there was no increase in the number of boats participating in the fishery in 1982, only a moderate demand for herring, and the low TAC, it was assumed that the fishing mortality rate in 1982 was probably lower than that in 1981.

Hence, input F = 0.3 was chosen as the most appropriate value for age groups 2 and over in 1982. The input value for 1-group fish in 1982 was then adjusted to produce a recruitment of 26 x 10^6 (a value equal to the number of 1-ringers in 1981)(1979 year class). This was congruent with the results of last year's young herring survey, which indicated that the abundance of the 1980 year class was similar to that of the 1979 year class. This generated an F of 0.13 on age group 1. The input value of F for the oldest age group in 1981 and earlier years was taken as those given by mean weighted F for age groups 2-7.

The exploitation pattern on the Mourne stock is rather different from that used in the Manx stock assessment (see Section 7.2.2). The reason for this is that the fishery, which mainly took place to the west of the Isle of Man is considered to have exploited all age groups of Mourne stock to the same extent, while mainly younger age groups of the Manx stock are taken in this area.

The results of the VPA, with the input values discussed above, are summarized in Tables 7.7 and 7.8, which give fishing mortality at age, stock in numbers at age age, and spawning stock biomass at spawning time. The results indicate a spawning stock biomass at spawning time of 5 000 tonnes and were consistent with the conclusion reached by the Working Group in 1982, i.e., that the spawning stock biomass is increasing.

7.3.5 State of the stock

The Y/R and spawning stock biomass per recruit curves, dependent on the 1982 exploitation pattern, are shown in Figure 7.2.

In making a prediction, the Working Group assumed that the geometric mean of 1-ringers from the VPA in the period 1974-79, i.e., 32×10^6 1-group fish, was appropriate for 1-ringers in 1983 and 1984.

Although the young herring survey (Section 7.3.3) cannot yet be used to measure the size of these year classes, the results would support the assumptions that the 1981 year class was at least as strong as the 1980 year class, and that both year classes were stronger than year class 1979.

Predictions were carried out with the above-mentioned assumptions, and the 1982 stock (2-9+) generated by the VPA with an input F_{82} on age 2 and over of 0.3. Stock changes and yields indicated by the projections are given in the text-table below.

The resulting catches and spawning stock biomasses over a full range of Fs are illustrated in Figure 7.2.

Mourne Herring — Div. VIIa North Irish Sea

1982 (from VPA)				Management option for 1983	1983			1984		
Stock biom.	Spawn. stock biom.	F	Catch		Stock biom.	Spawn. stock biom.	Catch	Stock biom.	Spawn. stock biom.	Catch
9.1	5.1	Age 1 =0.13 Age 2-9+ = 0.3	1.7	F = 0.1		8.1	0.9	15.9	11.6	1.2
				F = 0.15	11.8	7.8	1.3	15.4	10.7	1.8
				F = 0.20		7.4	1.7	15.0	9.8	2.3
				F = 0.30		6.8	2.4	14.1	8.3	3.0

$F_{1983} = F_{1984}$

Units: tonnes x 10^{-3}

It must be noted, that the stock in both years is heavily dependent on assumed values of initial strengths for year classes 1980, 1981 and 1982. Thus, the predictions for 1984 must be considered as somewhat uncertain.

7.4 Management Considerations

7.4.1 TAC

The fishery in the North Irish Sea exploits a mixture of Manx and Mourne herring in the area west and southwest of the Isle of Man for a large part of the fishing season. Catches in this area cannot be allocated to stock until all relevant biological and statistical data are available after the end of the fishing season. The Working Group, therefore, recommends that a single TAC be set for herring in the North Irish Sea, rather than separate TACs for Manx and Mourne stocks.

The impact on each stock will depend on the seasonal and spatial distribution of the fishing effort; it is important that the effort applied to take the TAC should not be concentrated on either the Mourne or the Manx stock. If the fishing was concentrated on the early part of the season, it would exploit the Manx stock and the Mourne stock with a more or less equal F. If major part of the TAC was taken late in the season, the impact on Manx fish would be greater, and that on Mourne fish less.

In 1982, ACFM considered that, subject to the examination of data from the 1982 fishery, the TAC for 1983 should be the same as that set for 1982, i.e., 3 800 tonnes, of which 600 tonnes could be allocated to a selective directed herring fishery over the Mourne spawning ground in 1982 and 1983.

The Working Group considers that it is undesirable to increase the catch on this spawning ground until the impact of the fishery, which was resumed in 1980, can be reliably assessed. A TAC of 3 800 tonnes, of which 600 tonnes were taken on the Mourne ground, would leave a balance of 3 200 tonnes to be taken between the mixed fishery and the fishery on Manx herring as they approach their spawning ground east of the Isle of Man. In 1981 and 1982 about 70% of the catch other than that on the Mourne spawning ground was made up of Manx stock and 30% of Mourne stock. If this pattern was followed in 1983, about 2 240 tonnes of Manx fish would be taken and 1 560 tonnes of Mourne fish (960 tonnes from the mixed fishery, and 600 tonnes from the spawning ground). Projections made in Sections 7.2.3 and 7.3.5, illustrated in Figures 7.1 and 7.2, suggest that the fishing would generate an F of about 0.2 on Manx fish and 0.18 on Mourne fish. It should be remembered, that the projections were made with F in 1982 and recruitment in 1982 and 1983, based on qualitative evidence only. Nevertheless, they were made with caution and they indicate that a TAC of 3 800 tonnes in 1983 would represent a cautious management. The same TAC in 1981 and 1982 appears to have allowed the biomass of both Manx and Mourne stocks to increase.

It would be prudent to examine data from the 1983 fishery before considering management for 1984. If, however, it is essential to make a provisional recommendation, it is suggested that the TAC for 1984 should be the same as that for 1983. In each year, the part of the TAC allocated to the selective directed herring fishery over the Mourne spawning ground should be clearly stated.

7.4.2 Other conservation measures

Management of the North Irish Sea fishery in the past has included measures to reduce fishing mortality on the spawning stock by closure of the fishery from the Saturday nearest to 21 September until the Monday nearest to 16 November, except for a small directed gill-net fishery on the Mourne spawning ground, prohibition of directed herring fishery in the nursery areas, and a minimum size regulation. These measures should be continued in 1983 and 1984.

8. THE ICELANDIC SPRING- AND SUMMER-SPAWNING HERRING

8.1 The fishery

No signs of recovery of the Icelandic spring-spawning herring were observed, and the fishery in 1982 was entirely based (99.8%) on Icelandic summer spawners.

The landings of summer-spawning herring from 1973-82 are given in Table 8.1. The 1982 landings were about 53 900 tonnes. Of these, about 14 500 tonnes were taken by drift nets, 1 900 tonnes by set nets and 37 500 tonnes by purse-seines. The fishery took place during the last

four months of the year. The text-table below gives the catches, the TACs set and the TACs recommended during the last four years for this fishery.

Landings and TACs (in tonnes x 10^{-3}) of Icelandic summer-spawning herring in 1979-82

Year	Landings	TACs	Rec. TACs
1979	45.1	35.0	35.0
1980	53.3	50.0	45.0
1981	39.5	42.5	40.0
1982	53.9	50.0	50.0

8.2 Catch in Numbers, Weight at Age and Age Distribution

The catch in numbers by age for the Icelandic summer spawners are given in Table 8.2 for the period 1969-82. During the period 1975-77, the catches were predominated by one year class, i.e., the 1971 year class. In 1979, two new strong year classes had recruited to the fishery, i.e., the 1974 and 1975 year classes, which predominated in the catches until 1981. However, the catches in 1982 are based on a much wider range of age groups, especially those belonging to the 1979-1974 year classes. It should be noted that about 8% of the catches are still coming from the 1971 year class. Out of 210 million herring caught in 1982, 20.6 million were immature or just about 10% by numbers. This corresponds to about 5% immatures by weight. The weight at age for each year is given in Table 8.3.

8.3 The Maturity at Age

The division between immatures and the adult part of the stock is based on a new maturity ogive, which has been re-calculated from all samples of herring taken during the last four months each year by non-selective gears, i.e., purse-seines or pelagic trawls (Table 8.4). During the period 1969-73 of low stock abundance and low recruitment, there was a sharp increase (from 0.08-0.64) in the proportion of 2-ringers, which matured and spawned at that age. There was a reversal of this trend in 1974, when the strong 1971 year class recruited to the stock. During the period 1977-82, only a very small fraction (about 0.05) of the 2-ringers became mature and spawned at that age. Similarly, the proportion of the 3-ringers, which matured, fell from 1 to about 0.7 in the period 1973-79.

8.4 Acoustic Abundance Surveys in 1982 and in January 1983

The state of the Icelandic summer-spawning herring has been monitored by acoustic abundance surveys since 1973. It has been shown (Jakobsson, 1982) that the acoustic estimates are correlated with the subsequent VPA outputs.

As discussed in the report of the Atlanto-Scandian Herring and Capelin Working Group 1982 (Doc. C.M.1982/Assess:12), the summer-spawning herring assembled at the beginning of 1982 on new wintering grounds near southwest Iceland at the mouths of two big rivers. During the period 9-10 January 1982, acoustic abundance estimates were obtained under excellent weather conditions. Based on the mean weights at age from the sampling of these wintering concentrations and length-dependent TS (Haldorsson & Reynisson,1982). the biomass on the wintering ground was about 200 000 tonnes of herring. The age distribution of the samples showed that the immature part of the stock was, to a large extent, absent

from these wintering concentrations. Despite a considerable effort in December 1982 and in January 1983, an acoustic estimate of the adult stock could not be obtained, either because the herring were too close to the coast, or due to long periods of very bad weather, especially in January 1983, which prevented the work at sea. However, the 3-ringers, i.e., the 1979 year class, had assembled in January 1983 in one fjord at the east coast and two almost identical acoustic estimates were obtained. In the absence of a new acoustic estimate for the adult stock, it was decided to use the results of the January 1982 acoustic survey and the catches taken in 1982 to calculate the fishing mortality for the adult herring (4-ringers and older). On this basis the fishing mortality was $F_{4+} = 0.25$. The fishing mortality for 3-ringers was taken to be about half of the adult F, but the fishing mortality for 2-ringers in 1982 of $F_2 = 0.05$ was calculated from the new acoustic estimate of the 1979 year class and the catches taken in 1982. The data used in these calculations are given in Table 8.5.

8.5 VPA Outputs

Using the catch at age data given in Table 8.2, and input Fs as described above, a VPA was run. The outputs of fishing mortality at age, stock in numbers at age and spawning stock biomass at 1 July are given in Tables 8.6 and 8.7, respectively. The results are similar to those given in the 1982 report of the Atlanto-Scandian Herring and Capelin Working Group (C.M.1982/Assess:12). The fishery for this stock was re-opened in 1975, and according to this assessment, the fishing mortality for 4-ringers and older herring was about 0.15 during the first three years of exploitation. During the period 1977-82, the fishing mortality has been around, or just above, 0.2.

As shown in Table 8.7, the 1971 year class is estimated to have been about 470 million as 1-ringers. The 1972 and 1973 year classes are both poor (144 million and 184 million, respectively), while the 1974 and the 1975 year classes are estimated to have been 721 million and 518 million as 1-ringers, respectively. The 1976 year class is poor or only about 176 million. The 1977 year class was estimated as very strong (620 million as 2-ringers) in the 1980 acoustic survey. The new estimate of about 272 million in this assessment is based on the assumption that the year class had fully recruited as 4-ringers in 1982, and, therefore, this low estimate is based on the input fishing mortality of $F_{4+} = 0.25$. The strength of the 1978 year class was acoustically estimated as 500 million 1-ringers (Jakobsson, 1982). On that basis, the fishing mortality of 3-ringers in 1982 would only have been 0.06 or 0.25 of the adult F. Inspection of Table 8.6 indicates, however, that this is probably not realistic, and, therefore, a more conservative estimate of $F_3 = 0.12$ was chosen, which is about half the value of the adult F. This input fishing mortality reduces the estimate of the 1978 year class to 311 million 1-ringers. The strength of the 1979 year class of 437 million 1-ringers is based on an acoustic estimate obtained in January 1983.

The spawning stock biomass (Table 8.7) increased from about 11 000 tonnes in 1972 to about 200 000 tonnes in 1978. During the 4-year period 1979-82, the spawning stock biomass has been about 250 000 tonnes.

8.6 Management Considerations

According to the present assessment, the spawning stock biomass has remained stable at a level of about 250 000 tonnes during the last four years. In 1983 it is expected to increase somewhat (265 000 tonnes). This level of stock abundance is within the range of spawning stock biomass during the 1954-63 period of high and steady recruitment. Catches

have been calculated, over a range of Fs, for 1983, using the starting parameters given in Table 8.8. The stock in numbers data are derived from Table 8.7 apart from the 1- and 2-ringers, which are assumed to be 400 million as 1-ringers. These age groups are a very small proportion of the catch. The weight at age for the catch are rounded mean weights from the previous few years. The exploitation pattern is the same as in 1982. The resulting catches and spawning stock biomasses over a range of Fs are illustrated in Figure 8.1. For this population, the yield per recruit and spawning stock biomass per recruit are also shown in Figure 8.1.

Projections of stock abundance and catches in thousand tonnes for a range of values of F are given in the text-table below.

1982			1983		1984
Catch	F_{4+}	Spawning stock	F_{4+}	Catch	Spawning stock in 1984
53.8	0.25	248.6	0.1	27.8	301
			0.22	49.7	276
			0.3	65.5	260

During the last five years (1977-82), the fishing mortality in the adult component of this stock has been about, or just above, 0.2. Since the stock abundance has also been at a steady level and its abundance is within the target range of spawning biomass (200 000 - 300 000 tonnes), which during the period 1954-63 gave high and steady recruitment, it would seem appropriate that the exploitation of this stock should be continued at about the F = 0.2 level.

9. MINIMUM SIZE OF HERRING

At present, the minimum size limit for herring in most areas is 20 cm (at this length the herring have not yet spawned). Under the EEC marketing arrangements, fishermen are allowed compensation for herring which they cannot sell, and in the present situation of depressed prices for herring, considerable quantities of small herring ($\approx$ 20 cm) can nowbe landed legally and will subsequently be dumped.

Although this may be considered as a marketing problem, it has serious biological implications. The Working Group would, therefore, point out the dangers of encouraging the landings of small immature herring by the present marketing arrangements within the EEC.

It should further be considered to increase the minimum landing size.

10. DENSITY-DEPENDENT POPULATION PARAMETERS

The only data presented to the Working Group on density-dependent population parameters concerned the Icelandic summer-spawning herring. Here, the proportion of herring spawning as 2-ringers increased from 8% to 64% during the period 1969-73, when stock abundance was low. There was a reversal of this trend in 1974, when the strong 1971 year class recruited to the stock. During the period 1977-82, only a very small fraction (about 5%) of the 2-ringers spawned at that age.

For the other herring stocks with which the Working Group is concerned, long data series exist at the various national laboratories, but these data had not been worked up for the present meeting. It was agreed that various members of the Working Group would attempt to extract the relevant information from their data files at home, and present the results in working documents to the 1984 meeting of this Working Group. The following division of labour between laboratories was proposed:

England:	central and southern North Sea stocks
Scotland:	Divisions IVa and VIa north stocks
Ireland:	Celtic Sea stock, and herring in Division VIa south and Divisions VIIb,c
Isle of Man:	Manx stock
Iceland:	Icelandic summer spawners.

The Canadian representative offered to produce a working document for the next meeting of this Working Group on density-dependent growth of herring in the Northwest Atlantic.

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Table 2.1 HERRING. Catch in tonnes 1973 - 1982 North Sea (Sub-area IV and Division VIId) by country

(National catches as officially reported. Unallocated catches provided by Working Group members.)

Country \ Year	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*
Belgium	2 160 [a]	603	2 451	2 451	57	-	-	-	-	10 306
Denmark	174 254 [a]	61 728 [b]	115 616	34 841	12 769	4 359	10 546	4 431	21 146	72 116
Faroe Islands	54 935 [b]	26 161 [b]	25 854	14 378	8 070	40	10	-	-	-
Finland	-	-	-	1 034	-	-	-	-	-	-
France	22 235	12 548	20 391	14 468	1 613	2 119	2 560	5 527	15 099	15 616
German Dem. Rep.	1 728 [c]	3 268	2 689	2 624	2	-	-	-	-	-
Germany, Fed. Rep.	10 634 [d]	12 470	6 953	1 654	221	24	10	147	2 300 [c]	349 [c]
Iceland	23 742	29 017	16 286	9 412	-	-	-	-	-	-
Netherlands	34 070	35 106	38 416	20 146	4 134	18	-	509	7 700	11 967
Norway	99 739	40 975	34 183	27 386	4 065	1 189	3 617	2 165	70	680
Poland	5 738 [e]	9 850	7 069	7 072	2	-	-	-	-	-
Sweden	4 222	3 561	6 858	4 777	3 616	-	-	-	-	-
U.K. (England)	2 268	5 699	6 475	9 662	3 224	2 843	2 253	77	303	3 730
U.K. (Scotland) [f]	16 012	15 034	8 904	15 015	8 159	437	-	610	45	1 780
USSR	30 735	18 096	20 653	10 935	78	4	162	-	-	-
Total North Sea	484 012	275 116	312 798	174 834	46 010	11 033	19 158	13 466	46 663	116 544
Total including unallocated catches							25 148	60 994	140 972	171 481

*)Preliminary

a) Total includes 2 107 t for human consumption unspecified to area

b) Supplied by Fiskirannsóknarstovan

c) From Federal Republic of Germany national statistics compiled by Federal Research Board for Fisheries, Hamburg

d) Excludes 15 938 t caught on Skagerrak border and allocated to that area on the basis of age analysis

e) Swedish catches in Danish ports reported by area (North Sea, Skagerrak) used for area allocation of Swedish landings reported as Skagerrak and North Sea in Swedish Statistics

f) Catches from Moray Firth not included

Table 2.2.1 HERRING, catch in tonnes in Division IVa West

YEAR	1978	1979	1980	1981	1982
BELGIUM	-	-	-	-	-
DENMARK	-	437	687	11 357	300
FRANCE	486	493	651	1 851	2 276
Fed. Rep. GERMANY	4	10	-	-	48
NETHERLANDS	-	-	-	-	-
NORWAY	27	-	-	-	-
UK (England)	-	-	-	-	-
UK (Scotland)	-	6	18	2	-
Unallocated	0	0	1 762	6 492	1 706
TOTAL	517	946	3 118	19 702	4 330

Table 2.2.2 HERRING, catch in tonnes in Division IVa East

YEAR	1978	1979	1980	1981	1982
BELGIUM	-	-	-	-	-
DENMARK	-	-	-	-	500
FRANCE	-	68	-	-	-
FED.REP. GERMANY	-	-	-	-	-
NETHERLANDS	-	-	-	-	-
NORWAY	1 033	1 250	21	70	680
UK (England)	-	-	-	-	-
UK (Scotland)	-	-	-	-	-
Unallocated	0	0	2 476	937	0
TOTAL	1 033	1 318	2 497	1 007	1 180

Table 2.2.3 HERRING, catch in tonnes in Division IVb

YEAR	1978		1979		1980		1981		1982	
	Juv.	Adult	Juv.	Adult	Juv.	Adult	Juv.	Adult	Juv.	Adult
BELGIUM	-	-	-	-	-	-	-	-	-	-
DENMARK	4 359	-	10 107	-	3 733	-	9 689	-	64 205	-
FRANCE	-	302	-	448	-	176	-	524	-	561
GERMANY FED.REP.	1	-	-	-	147	-	2 300	-	118	-
NETHERLANDS	-	-	-	-	35	-	-	-	-	-
NORWAY	129	-	2 367	-	1 607	-	-	-	-	-
UK (England)	2 620	-	2 252		76	-	-	13	-	-
UK (Scotland)	437	-	156	-	592	-	33	10	74	-
Unallocated	0	236	1 030		9 258		65 811	0	24 795*	4 622
TOTAL	7 546	538	16 360		15 624		77 833	547	89 192	5 183

* for the first 3 quarters of 1982 only

Table 2.2.4 HERRING, catch in tonnes in Divisions IVc and VIId

YEAR	1978	1979	1980	1981	1982
BELGIUM	-	-	-	-	10 306
DENMARK	-	-	11	100	7 111
FRANCE	1 331	1 551	4 700	12 724	12 779
GERMANY FED.REP.	-	-	-	-	183
NETHERLANDS	18	-	474	7 700	11 967
NORWAY	-	-	482	-	-
UK (England)	223	1	1	290	602
UK (Scotland)	-	-	-	-	-
Unallocated	0	5 000	37 418	21 069	28 648
TOTAL	1 572	6 552	43 086	41 883	71 596

Table 2.3. HERRING. North Sea catch in millions of fish by age.

Year	Area	Age in winter rings										Total
		0	1	2	3	4	5	6	7	8	>8	
1972	IVaW of 2°E	-	338.9	830.1	176.8	88.6	19.3	4.1	-	0.5	0.4	1 458.7
	IVaE of 2°E	-	75.1	91.0	17.8	5.8	0.7	0.1	-	-	-	190.5
	IVb	-	25.2	46.4	98.8	20.5	6.7	0.6	0.2	0.6	-	199.0
	IVbYH	750.4	2 896.6	337.9	21.1	6.4	1.2	0.2	-	-	-	4 013.8
	IVc+VIId,e	-	4.8	135.1	29.3	9.3	5.0	-	-	-	-	183.5
	Total NS	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	IVaW of 2°E	-	52.5	742.1	452.6	58.0	39.5	20.3	2.6	0.5	0.6	1 368.7
	IVaE of 2°E	-	0.3	16.2	23.1	6.3	7.2	1.0	0.3	0.8	-	55.2
	IVb	-	242.5	180.1	39.0	28.3	4.7	7.2	-	-	-	501.8
	IVbYH	289.4	2 070.5	362.5	29.4	2.6	0.5	0.2	0.3	-	-	2 755.4
	IVc+VIId,e	-	2.2	43.3	115.1	55.0	7.4	1.9	0.5	0.1	0.0	225.5
	Total NS	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	IVaW of 2°E	65.3	162.9	98.5	112.9	97.1	36.0	18.6	4.5	1.5	1.0	598.3
	IVaE of 2°E	5.7	131.8	24.2	10.8	1.0	-	-	-	0.1	-	173.6
	IVb (adult)	-	54.0	493.7	212.3	19.5	18.9	3.6	0.3	0.4	0.1	802.8
	IVbYH	925.1	493.5	132.1	5.7	-	-	-	-	-	-	1 556.4
	IVc+VIId		3.9	24.1	20.3	8.4	1.2	0.1	0.2	-	-	58.2
	Total NS	996.1	846.1	772.6	362.0	126.0	56.1	22.3	5.0	2.0	1.1	3 189.3
1975	IVaW of 2°E	-	267.0	120.0	69.0	49.0	40.2	9.8	6.3	2.9	1.1	565.3
	IVaE of 2°E	-	82.5	8.2	7.0	2.4	0.4	0.1	-	-	-	100.7
	IVb (adult)		268.8	147.1	124.2	81.2	14.8	5.8	2.7	0.5	0.3	645.4
	IVbYH	262.8	1 818.1	139.2	19.8	2.6	-	0.4				2 242.9
	IVc+VIId	1.0	24.1	127.2	39.6	5.3	1.8					199.0
	Total NS	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	IVaW of 2°E	-	19.4	572.9	56.3	17.9	13.2	3.6	2.6	0.5	0.3	686.7
	IVaE of 2°E	-	-	10.6	1.1	0.5	0.5	0.4	-	-	-	13.1
	IVb (adult)	0.9	35.5	205.9	17.6	28.4	20.3	1.8	1.8	0.5	0.1	312.8
	IVbYH	237.3	49.5	17.7	0.5	1.7	-	-	-	-	-	306.7
	IVc+VIId	-	22.2	94.4	41.8	3.5	0.5	0.3	-	-	-	162.7
	Total NS	238.2	126.6	901.5	117.3	52.0	34.5	6.1	4.4	1.0	0.4	1 482.0
1977	IVaW of 2°E	2.6	2.7	9.3	171.7	8.6	3.8	2.1	0.9	0.2		201.9
	IVaE of 2°E	0.4	3.3	+	4.9	1.2	1.1	1.0	0.6	0.5	+	13.0
	IVb (adult)	-	1.1	25.9	6.8	0.3	1.9	1.0	-	+	-	37.0
	IVbYH	253.8	136.3	3.1	-	-	-	-	-	-	-	393.2
	IVc+VIId	-	0.9	6.4	3.0	0.7	0.2	+	+	-	-	11.2
	Total NS	256.8	144.3	44.7	186.4	10.8	7.0	4.1	1.5	0.7		656.3
1978	IVaW of 2°E			0.1	0.1	1.5	0.2	0.1	+	+	+	2.0
	IVaE of 2°E				0.2	1.2	-	+	0.2	0.2	0.3	2.1
	IVb (adult)		0.2	0.6	1.4	1.1	0.1	0.1	+			3.5
	IVb (indust.)	130.0	168.0	1.4								299.4
	IVc+VIId		0.4	2.8	4.0	1.2	+	+				8.4
	Total NS	130.0	168.6	4.9	5.7	5.0	0.3	0.2	0.2	0.2	0.3	315.4
1979	IVaW of 2°E		1.9	0.4	0.3	2.2	0.5	+	+	+		5.3
	IVaE of 2°E		-	2.4	0.3	+	+	+				2.7
	IVb (adult)		0.5	2.1	0.4	2.2	0.9	0.1	0.4	0.3		6.9
	IVb (indust.)	542.0	156.4	7.6	-	0.1	0.1	+	0.4	0.3	0.1	707.0
	IVc+VIId		0.4	21.6	9.0	5.6	0.6	0.1				37.3
	Total NS	542.0	159.2	34.1	10.0	10.1	2.1	0.2	0.8	0.6	0.1	759.2
1980	IVaW of 2°E		+	2.2	6.5	1.2	2.7	0.6	0.8	0.4	0.1	14.5
	IVaE of 2°E	166.8	-	+	0.1	0.1	0.1	+	+	+		167.1
	IVb (adult)		0.4	0.7	0.4	0.1	0.2	+	+	+	+	1.8
	IVb (indust.)	624.9	137.3	6.0	1.0	0.6	0.3	+	0.1	+		770.2
	IVc+VIId	+	23.4	99.1	83.8	30.2	18.4	1.7	0.5	+	+	257.1
	Total NS	791.7	161.1	108.0	91.8	32.2	21.7	2.3	1.4	0.4	0.1	1 210.7
1981	IVaW of 2°E	20.0	3.7	0.7	7.6	17.7	20.1	17.9	18.0	5.4	1.1	112.1
	IVaE of 2°E	-	0.1	0.1	0.4	1.1	1.5	1.1	0.1	-	-	4.5
	IVb (adult)	-	-	0.8	0.4	0.3	0.3	0.4	+	+	+	2.4
	IVb (indust.)	7 868.7	435.9	40.0	8.0	1.0	-	-	-	-	-	8 353.6
	IVc+VIId	-	7.3	222.6	40.4	19.3	6.7	3.3	0.6	-	-	300.4
	Total NS	7 888.7	447.0	264.3	56.9	39.5	28.5	22.7	18.7	5.5	1.1	8 773.1
1982	IVaW of 2°E		0.1	3.2	1.5	0.9	3.9	2.2	4.2	3.0	0.9	19.9
	IVaE of 2°E		4.3	7.0								11.3
	IVb (adult)	0.1	28.6	12.1	3.3	0.5	0.5	0.2	0.5	0.1	0.1	46.0
	IVb (indust.)	8 269.1	352.1	27.0	2.0							8 650.2
	IVc+VIId		17.6	166.4	268.2	42.6	10.0	5.5	1.8	0.6	0.1	512.8
	Total NS	8 269.2	402.7	215.7	275.0	44.0	14.4	7.9	6.5	3.7	1.1	9 240.2

Table 2.4. Millions of HERRING caught annually per age group (winter rings) in the North Sea 1970-1982.

Year \ Winter rings	0	1	2	3	4	5	6	7	8	> 8	Total
1970	898.1	1 196.2	2 002.8	883.6	125.2	50.3	61.0	7.9	12.0	12.2	5 249.3
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	7888.7	447.0	264.3	56.9	39.5	28.5	22.7	18.7	5.5	1.1	8 772.9
1982	8269.2	402.7	215.7	275.0	44.0	14.4	7.9	6.5	3.7	1.1	9 240.2

Table 2.5. Estimated numbers at age (x 10^{-6}) from acoustic surveys in July-August 1981 and July 1982 in the northwestern North Sea.

Age	Year class	1981			1982		
		G O Sars July	Scotia Moray Firth - Aug.	Total	Age	Year class	"Scotia" July
0	1980	-	-		0	1981	-
1	1979	1.9	3.2	5.1	1	1980	22.7
2	1978	1.9	255.0	256.9	2	1979	589.2
3	1977	18.3	33.8	52.1	3	1978	178.1
4	1976	162.2	20.3	182.5	4	1977	49.0
5	1975	52.6	5.5	58.1	5	1976	111.1
6	1974	36.7	1.0	37.7	6	1975	27.5
7	1973	198.9	3.2	202.1	7	1974	44.2 x)
8	1972	10.1	-	10.1	8	1973	92.0 x)
					≥8	p 1973	6.0
Biomass (tonnes)		140 000	57 000	197 000			233 000
$\bar{W}$ (g)		290	177				208

x) Proportions of these two age groups were corrected to correspond to the proportions found by "G O Sars" in appropriate areas.

Table 2.6. HERRING IN THE NORTHERN NORTH SEA (FISHING AREA IVA)

VIRTUAL POPULATION ANALYSIS **** VPA ****

CATCH IN NUMBERS UNIT: MILLIONS

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	921.1	758.3	122.7	126.2	583.5	9.3	0.1	2.8	2.2	0.8	10.2
3	194.6	475.7	123.7	76.0	57.4	176.6	0.3	0.6	6.6	8.0	1.5
4	94.4	64.3	96.1	51.4	16.4	9.8	2.7	2.2	1.3	16.8	0.9
5	20.0	46.7	36.0	40.6	13.7	4.9	0.2	0.5	2.8	21.6	3.9
6	4.2	21.3	13.6	9.9	4.6	3.1	0.1	0.0	0.6	19.0	2.2
7	0.0	2.9	4.5	6.4	2.6	1.5	0.2	0.0	0.8	18.1	4.2
8	0.5	1.3	1.6	2.9	0.5	0.7	0.2	0.0	0.4	5.4	3.0
9+	0.4	0.6	1.0	1.1	0.3	0.0	0.3	0.0	0.1	1.1	0.9
TOTAL	1235.2	1371.1	406.2	316.5	684.4	205.9	4.1	6.1	14.8	92.8	26.6

Table 2.7. HERRING IN THE NORTHERN NORTH SEA (FISHING AREA IVA)

VIRTUAL POPULATION ANALYSIS **** VPA ****

UNIT: Year-1
FISHING MORTALITY COEFFICIENT NATURAL MORTALITY COEEFICIENT = 0.10

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	0.788	1.312	0.612	0.659	0.939	0.079	0.001	0.015	0.031	0.004	0.017
3	0.887	1.145	0.676	0.860	0.620	0.738	0.003	0.009	0.041	0.134	0.008
4	0.752	0.739	0.674	0.587	0.456	0.178	0.019	0.024	0.022	0.140	0.018
5	0.412	0.946	1.121	0.580	0.269	0.187	0.004	0.004	0.035	0.514	0.035
6	0.473	0.910	1.179	0.993	0.090	0.081	0.005	0.000	0.005	0.310	0.079
7	0.000	0.617	0.428	1.910	0.682	0.040	0.006	0.000	0.022	0.189	0.093
8	0.802	1.223	0.734	0.478	0.696	0.345	0.006	0.000	0.023	0.179	0.039
9+	0.802	1.223	0.734	0.478	0.696	0.345	0.006	0.000	0.023	0.179	0.039
(2- 7)U	0.552	0.945	0.782	0.932	0.509	0.217	0.006	0.009	0.026	0.215	0.042
(2- 7)W	0.787	1.193	0.696	0.700	0.823	0.445	0.009	0.011	0.027	0.153	0.023

Table 2.8. HERRING IN THE NORTHERN NORTH SEA (FISHING AREA IVA)

VIRTUAL POPULATION ANALYSIS **** VPA ****

STOCK SIZE IN NUMBERS UNIT: MILLIONS
---------- BIOMASS UNIT: TONNES

TOTAL STOCK 1 JANUARY * SPAWNING STOCK AT SPAWNING TIME
PROP.OF ANNUAL F 0.670 PROP.OF ANNUAL M 0.670

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	1764	1079	260	278	999	128	78	196	76	219	636	********
3	345	726	263	137	130	353	107	71	174	67	198	566
4	187	129	209	121	53	63	153	97	63	151	53	178
5	62	80	56	96	61	30	48	136	86	56	119	47
6	12	37	28	16	49	42	23	43	122	75	30	104
7	2	7	14	8	5	40	35	20	39	110	50	25
8	1	2	3	8	1	3	35	0	18	35	82	41
9+	1	1	2	3	1	0	53	0	5	7	25	93
TOTAL NO	2374	2060	855	668	1298	660	532	562	584	720	1193	
SSB NO.	1312	871	504	394	709	469	495	522	536	610	1098	
TOT.BIOM	341456	322134	151282	117317	188798	121074	111522	106789	121855	144475	204974	
SSB BIOM	189735	139521	87989	69262	107972	86633	103702	99179	112043	119952	188098	

Table 2.9. HERRING IN THE CENTRAL NORTH SEA (FISHING AREA IVB)

VIRTUAL POPULATION ANALYSIS **** VPA ****

CATCH IN NUMBERS UNIT: MILLIONS

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	378.7	443.3	427.7	268.7	176.2	22.5	1.8	9.2	6.6	40.9	39.1
3	108.0	47.0	152.2	129.1	14.1	5.1	1.0	0.3	1.3	8.5	5.3
4	24.4	15.3	13.5	74.1	23.6	0.2	0.8	1.7	0.7	1.4	0.5
5	7.2	2.7	13.0	13.0	15.6	1.4	0.1	0.8	0.4	0.2	0.5
6	0.7	3.5	2.8	4.5	1.4	0.7	0.1	0.1	0.0	0.4	0.2
7	0.2	0.3	0.2	1.9	1.5	0.0	0.0	0.7	0.1	0.0	0.5
8	0.5	0.0	0.3	0.4	0.4	0.0	0.0	0.5	0.0	0.1	0.1
9+	0.0	0.0	0.1	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.1
TOTAL	519.7	512.1	609.8	492.0	232.9	29.9	3.8	13.3	9.1	51.5	46.3

Table 2.10. HERRING IN THE CENTRAL NORTH SEA (FISHING AREA IVB)

VIRTUAL POPULATION ANALYSIS **** VPA ****

UNIT: Year-1
FISHING MORTALITY COEFFICIENT NATURAL MORTALITY COEEFICIENT = 0.10

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	1.625	0.927	1.133	2.434	2.466	0.352	0.090	0.238	0.177	0.242	0.072
3	1.210	0.827	0.867	1.209	0.941	0.431	0.021	0.017	0.043	0.321	0.040
4	1.235	0.463	0.527	1.346	0.648	0.025	0.098	0.041	0.046	0.054	0.025
5	0.910	0.357	0.803	1.322	1.088	0.062	0.014	0.121	0.011	0.015	0.022
6	0.553	1.578	0.674	0.638	0.400	0.104	0.005	0.016	0.000	0.012	0.017
7	0.553	0.431	0.262	1.265	0.400	0.000	0.000	0.040	0.018	0.000	0.017
8	1.000	0.000	0.900	1.250	0.900	0.000	0.000	0.100	0.000	0.020	0.022
9+	1.000	0.000	0.900	1.250	0.900	0.000	0.000	0.100	0.000	0.020	0.022
(2- 7)W	1.494	0.893	1.027	1.816	1.870	0.274	0.036	0.104	0.072	0.193	0.061
(3- 7)W	1.190	0.710	0.823	1.242	0.790	0.163	0.023	0.041	0.027	0.109	0.032

Table 2.11. HERRING IN THE CENTRAL NORTH SEA (FISHING AREA IVB)

VIRTUAL POPULATION ANALYSIS **** VPA ****

STOCK SIZE IN NUMBERS UNIT: MILLIONS.
BIOMASS UNIT: TONNES

TOTAL STOCK 1 JANUARY * SPAWNING STOCK AT SPAWNING TIME
PROP.OF ANNUAL F 0.667 PROP.OF ANNUAL M 0.667

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	489	765	657	304	199	79	22	46	43	200	591	********
3	160	87	274	192	24	15	51	18	32	32	142	498
4	36	43	34	104	52	9	9	45	16	28	21	123
5	13	9	25	18	25	24	8	7	39	14	24	19
6	2	5	6	10	4	7	21	7	6	35	12	21
7	0	1	1	3	5	0	6	19	6	5	31	11
8	1	0	1	1	1	0	0	6	0	5	5	28
9+	0	0	0	0	0	0	0	0	0	0	5	9
TOTAL NO	701	910	997	632	309	135	116	147	142	320	832	
SSB NO.	245	471	473	191	98	106	106	128	127	264	647	
TOT.BIOM	101213	124521	146147	101953	48766	22325	22254	28376	27059	51836	123892	
SSB BIOM	36417	65358	70922	33204	17804	17929	20408	25127	24424	43646	99097	

Table 2.12. HERRING IN THE SOUTHERN NORTH SEA (FISHING AREAS IVC AND VIID)

VIRTUAL POPULATION ANALYSIS **** VPA ****

CATCH IN NUMBERS UNIT: MILLIONS

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	140.7	142.4	177.2	144.8	141.8	12.9	3.0	22.1	99.3	222.6	100.4
3	41.2	136.5	86.1	54.5	45.8	4.7	4.4	9.1	83.9	40.4	268.2
4	11.8	70.6	14.4	15.0	10.0	0.8	1.5	6.2	30.2	19.3	42.6
5	5.7	9.9	7.1	3.6	5.2	0.7	0.0	0.8	18.5	6.7	10.0
6	0.1	5.8	0.9	1.7	0.7	0.3	0.0	0.1	1.7	3.3	5.5
7	0.0	0.5	0.3	0.8	0.3	0.0	0.0	0.1	0.5	0.6	1.8
8	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.6
9+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
TOTAL	199.5	365.8	286.1	220.6	208.9	19.4	8.9	38.5	234.1	292.9	495.2

Table 2.13. HERRING IN THE SOUTHERN NORTH SEA (FISHING AREAS IVC AND VIID)

VIRTUAL POPULATION ANALYSIS **** VPA ****

UNIT: Year-1
FISHING MORTALITY COEFFICIENT NATURAL MORTALITY COEEFICIENT = 0.10

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	0.596	0.772	1.227	1.328	2.261	0.184	0.021	0.099	0.348	0.243	0.456
3	0.382	1.993	1.467	1.699	3.183	0.365	0.079	0.075	0.571	0.207	0.456
4	0.638	2.041	1.356	1.081	2.322	0.606	0.181	0.138	0.336	0.219	0.312
5	0.597	1.715	1.380	1.585	1.366	1.260	0.012	0.125	0.662	0.103	0.151
6	0.062	2.371	0.619	1.543	1.784	0.208	0.041	0.138	0.573	0.205	0.104
7	0.109	1.218	0.782	1.801	1.269	0.083	0.009	0.619	1.659	0.194	0.148
8	1.000	1.000	1.000	1.000	1.000	0.100	0.100	0.100	0.100	0.100	0.270
9+	1.000	1.000	1.000	1.000	1.000	0.100	0.100	0.100	0.100	0.100	0.270
(2- 8)U	0.483	1.587	1.122	1.434	1.884	0.404	0.063	0.185	0.578	0.182	0.271
(2- 8)W	0.539	1.377	1.307	1.400	2.426	0.234	0.044	0.097	0.428	0.229	0.410

Table 2.14. HERRING IN THE SOUTHERN NORTH SEA (FISHING AREAS IVC AND VIID)

VIRTUAL POPULATION ANALYSIS **** VPA ****

STOCK SIZE IN NUMBERS UNIT: MILLIONS
BIOMASS UNIT: THOUSAND TONNES

TOTAL STOCK 1 JANUARY * SPAWNING STOCK AT SPAWNING TIME
PROP.OF ANNUAL F 1.000 PROP.OF ANNUAL M 1.000

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	328	276	261	205	163	80	149	246	354	1081	476	********
3	136	164	116	69	49	15	61	132	202	226	767	273
4	26	84	20	24	11	2	9	51	111	103	167	440
5	13	13	10	5	7	1	1	7	40	72	75	110
6	1	7	2	2	1	2	0	1	6	19	58	58
7	0	1	1	1	0	0	1	0	1	4	14	48
8	0	0	0	0	0	0	0	1	0	0	3	11
9+	0	0	0	0	0	0	0	0	0	0	0	2
TOTAL NO	504	544	409	306	233	101	222	438	713	1504	1559	
SSB NO.	267	148	101	69	29	13	192	360	424	1083	942	
TOT.BIOM	68	78	56	42	31	13	30	61	103	205	237	
SSB BIOM	37	20	14	9	3	9	26	50	61	149	146	

Table 2.15. LIST OF INPUT VARIABLES FOR THE ICES PREDICTION PROGRAM

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

PROPORTION OF F BEFORE THE SPAWNING SEASON: 1.0000
PROPORTION OF M BEFORE THE SPAWNING SEASON: 1.0000

LIST OF INPUT VARIABLES BY AGE GROUP:

AGE	STOCK SIZE	F-PATTERN	M	MATURITY OGIVE	WEIGHT IN THE CATCH	WEIGHT IN THE STOCK
2	1528.00	1.6950	0.100	1.0000	0.1230	0.1230
3	273.00	1.6950	0.100	1.0000	0.1500	0.1500
4	440.00	1.1420	0.100	1.0000	0.1780	0.1780
5	110.00	0.5530	0.100	1.0000	0.2050	0.2050
6	58.00	0.3680	0.100	1.0000	0.2330	0.2330
7	48.00	0.5530	0.100	1.0000	0.2600	0.2600
8	11.00	0.9950	0.100	1.0000	0.2880	0.2880
9+	2.00	0.9950	0.100	1.0000	0.3150	0.3150

Table 2.16. NORTH SEA HERRING (FISHING AREA IV)

VIRTUAL POPULATION ANALYSIS **** VPA ****

CATCH IN NUMBERS UNIT: MILLIONS

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	194.6	1269.2	141.8	442.8	496.9	157.1	374.5	645.4	839.3	112.0	898.1	664.0
1	2392.7	336.0	2146.9	1262.2	2971.7	2209.3	1383.1	1674.3	2425.0	2503.3	1196.2	4378.5
2	1142.3	1889.4	269.0	2961.2	1547.5	2217.6	2569.7	1171.5	1795.2	1282.0	2002.8	1146.8
3	1966.7	479.9	797.4	177.2	2243.1	1324.6	741.2	1364.7	1494.3	296.3	883.6	662.5
4	135.9	1455.9	335.1	158.3	148.4	2039.4	459.1	371.5	621.4	133.1	125.2	208.3
5	167.7	124.0	1081.3	86.0	149.0	145.1	389.8	297.8	157.1	190.8	50.3	26.9
6	112.9	157.9	126.9	229.7	95.0	151.9	45.3	393.1	145.0	49.9	61.0	30.5
7	125.8	61.4	145.1	22.4	256.3	117.0	64.8	67.9	163.4	42.7	7.9	26.8
8	123.6	56.0	36.3	42.0	26.3	413.0	95.5	31.6	13.7	27.4	12.0	0.0
9+	142.0	87.5	86.3	51.0	57.7	78.4	236.3	172.3	91.8	25.1	12.2	12.4
TOTAL	6539.2	5917.2	5217.7	5427.4	7991.9	9854.0	6859.3	6240.6	7746.2	5263.6	5249.3	7176.7

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	750.4	289.4	996.1	203.3	238.2	256.8	130.0	542.0	791.7	7888.7	8269.2
1	3340.6	2368.0	846.1	2460.5	126.6	144.3	168.6	159.2	161.1	447.0	402.7
2	1440.5	1344.2	772.6	541.7	901.5	44.7	4.9	34.1	108.0	264.3	215.7
3	343.8	659.2	362.0	259.6	117.3	186.4	5.7	10.0	91.8	56.9	275.0
4	130.6	150.2	126.0	140.5	52.0	10.8	5.0	10.1	32.2	39.5	44.0
5	32.9	59.3	56.1	57.2	34.5	7.0	0.3	2.1	21.7	28.5	14.4
6	5.0	30.0	22.3	10.1	0.1	4.1	0.2	0.2	2.3	22.7	7.9
7	0.2	3.7	5.0	9.1	4.4	1.5	0.2	0.8	1.4	18.7	6.5
8	1.1	1.4	2.0	3.4	1.0	0.7	0.2	0.6	0.4	5.5	3.7
9+	0.4	0.6	1.1	1.4	0.4	0.0	0.3	0.1	0.1	1.1	1.1
TOTAL	6045.5	4906.0	3189.3	3755.3	1482.0	656.3	315.4	759.2	1210.7	8772.9	9240.2

Table 2.17.

NORTH SEA HERRING (FISHING AREA IV)

VIRTUAL POPULATION ANALYSIS **** VPA ****

UNIT: Year-1
FISHING MORTALITY COEFFICIENT NATURAL MORTALITY COEFFICIENT = 0.10

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	0.110	0.083	0.021	0.055	0.049	0.029	0.077	0.094	0.123	0.031	0.110	0.106
1	0.456	0.252	0.177	0.237	0.537	0.443	0.341	0.503	0.521	0.561	0.468	0.967
2	0.506	0.701	0.293	0.349	0.449	0.877	0.677	0.478	1.467	0.880	1.085	0.993
3	0.331	0.366	0.642	0.284	0.430	0.765	0.732	0.837	1.924	0.944	1.308	1.256
4	0.320	0.387	0.416	0.221	0.362	0.772	0.565	0.909	1.071	0.868	1.314	1.210
5	0.258	0.372	0.491	0.140	0.297	0.634	0.824	0.809	1.174	1.053	0.662	1.043
6	0.256	0.365	0.711	0.161	0.253	0.492	0.366	0.979	1.104	1.526	1.076	2.372
7	0.423	0.193	0.592	0.227	0.243	0.442	0.350	1.296	1.432	1.068	1.000	2.634
8	0.300	0.300	0.400	0.300	0.400	0.670	0.690	0.900	0.900	0.900	0.900	0.000
9+	0.300	0.300	0.400	0.300	0.400	0.670	0.690	0.900	0.900	0.900	0.900	0.000
(2- 7)U	0.349	0.397	0.524	0.232	0.335	0.664	0.587	0.885	1.362	1.056	1.107	1.586
(2- 7)W	0.367	0.482	0.499	0.308	0.404	0.763	0.665	0.708	1.514	0.911	1.147	1.121

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	0.172	0.135	0.207	0.442	0.425	0.292	0.165	0.249	0.278	1.084	0.860
1	0.914	1.053	0.629	0.980	0.350	0.438	0.282	0.277	0.097	0.223	0.118
2	0.900	1.089	1.117	0.962	1.118	0.179	0.021	0.076	0.274	0.205	0.143
3	0.830	1.330	0.887	1.433	0.492	0.040	0.028	0.049	0.266	0.203	0.303
4	0.796	0.977	0.890	0.947	1.230	0.067	0.027	0.057	0.196	0.157	0.213
5	0.539	0.941	1.148	1.268	0.561	0.450	0.002	0.013	0.150	0.238	0.071
6	0.477	1.306	1.047	1.149	0.361	0.104	0.018	0.002	0.016	0.208	0.086
7	0.074	0.691	0.670	1.767	1.053	0.126	0.006	0.085	0.012	0.154	0.076
8	0.900	0.900	0.900	1.250	0.900	0.400	0.020	0.020	0.050	0.055	0.037
9+	0.900	0.900	0.900	1.250	0.900	0.400	0.020	0.020	0.050	0.055	0.037
(2- 7)U	0.603	1.056	0.960	1.254	0.802	0.261	0.047	0.047	0.152	0.194	0.149
(2- 7)W	0.869	1.144	1.024	1.086	0.985	0.360	0.020	0.051	0.201	0.198	0.191

Table 2.18. NORTH SEA HERRING (FISHING AREA IV)

VIRTUAL POPULATION ANALYSIS **** VPA ****

STOCK SIZE IN NUMBERS UNIT: MILLIONS
---------- BIOMASS UNIT: TONNES

1 JANUARY (TOTAL AND SPAWNING STOCK)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	1954	16686	7085	8740	10907	5709	5239	7581	7023	3820	9081	7146
1	6836	1583	13892	6276	7458	9397	5017	4430	6246	6101	3350	7563
2	3010	3919	1114	10532	4481	3962	3462	3228	2423	3356	3151	1899
3	7313	1642	1760	752	6722	2588	1491	2513	1611	506	1259	964
4	636	4752	1031	838	512	3957	1090	649	985	239	178	508
5	773	418	2920	615	608	323	1654	561	257	305	91	43
6	524	541	261	1618	430	409	155	656	226	66	96	35
7	382	367	339	116	1246	344	226	97	223	68	13	30
8	520	226	274	170	34	384	200	143	24	48	21	0
9+	574	354	276	206	183	108	495	304	161	44	21	0
TOTAL NO	22523	30489	28952	29863	32711	27742	21031	20162	19960	14554	17262	17787
SSB NO.	13733	12220	7975	14647	14316	12036	10775	8151	6090	4633	4831	3278
TOT.BIOM	2889762	2607620	2483171	2769604	3067051	2903336	2200710	1769162	1482578	1056023	1021221	976357
SSB BIOM	2518634	2278169	1682280	2324724	2529068	2347853	1870529	1433960	1055910	896283	717495	500998

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	4975	2398	5583	773	720	1064	899	2582	3423	12414	14958	*********
1	5816	3789	1895	4106	449	426	719	690	1822	2347	3796	5727
2	2532	2110	1196	914	1394	287	249	491	473	1496	1699	3054
3	636	932	642	354	516	412	217	220	412	326	1103	1333
4	248	251	223	239	76	175	197	191	190	285	241	737
5	83	101	86	83	84	20	148	173	163	141	221	176
6	14	44	36	25	21	43	12	134	155	127	101	186
7	3	8	11	11	7	13	35	10	121	136	93	84
8	2	2	4	5	2	2	11	32	9	108	107	78
9+	1	1	2	2	1	0	16	5	2	22	32	121
TOTAL NO	14310	9636	9670	6512	3071	2443	2501	4528	6770	17403	22352	
SSB NO.	3519	3449	2199	1633	1902	953	864	1256	1524	2642	3596	
TOT.BIOM	873944	746832	553	476140	309003	202801	215973	302558	4 91	747611	1014617	
SSB BIOM	508521	521427	344870	259249	275738	165554	166541	229335	2 17	444063	600336	

Table 3.1 HERRING in Division IIIa. Landings in tonnes 1972-1982.
(Data mainly provided by Working Group members)

	Country/Year	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981[x)]	1982[xx)]
SKAGERRAK	Denmark	34 900	42 098	35 732	29 997	7 326	19 889	6 425	5 153	5 180	18 001	22 881
	Faroe Islands	4 115	5 265	7 132	8 053	1 553	10 064	1 041	817	526	990	715
	Germany,Fed.Rep.	-	-	36	108	6	32	28	181	-	199	43
	Iceland	7 317	15 938	231	1 209	123	-	-	-	-	-	-
	Norway (Open Sea)	1 045	836	698	196	-	-	1 860	2 460	1 350	6 330	10 140
	Norway (Fjords)	4 222	1 680	1 720	1 459	2 304	1 837	2 271	2 259	2 795	950	1 560
	Sweden	19 644	20 429	11 683	12 348	6 505	8 109	11 551	8 104	10 701	30 274	24 859
	Total	71 243	86 246	57 232	53 370	17 817	39 931	23 176	18 974	20 552	56 744	60 198
KATTEGAT	Denmark	52 755	78 125	54 540	48 974	41 749	38 205	29 241	21 337	25 380	18 721	12 366
	Sweden	39 972	40 418	39 779	23 769	30 263	37 160	35 193	25 272	18 260	38 871	38 892
	Total	92 727	118 543	94 319	72 743	72 012	75 365	64 434	46 609	43 640	57 592	51 258
Division IIIa Total		163 970	204 789	151 551	126 113	89 829	115 296	87 610	65 583	64 192	114 336	111 456
Unallocated									8 117	20 053	57 000	35 344
GRAND TOTAL									73 700	84 245	171 336	146 800

x) Revised
xx) Preliminary

Table 3.2. HERRING IN FISHING AREA IIIA (KATTEGAT AND SKAGERRAK)

VIRTUAL POPULATION ANALYSIS **** VPA ****

CATCH IN NUMBERS UNIT: MILLIONS

	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	2499.2	2005.7	433.4	955.0	147.2	457.2	662.1	3024.0	3334.6
1	909.5	1470.8	1473.6	1436.5	370.3	168.5	466.7	966.0	935.0
2	375.0	149.3	325.0	328.6	454.5	582.7	252.5	656.0	314.0
3	155.2	59.9	28.4	61.4	64.7	69.5	139.5	178.3	240.6
4	47.2	57.0	4.2	12.0	9.9	13.4	30.1	67.7	26.0
5	25.9	15.4	2.5	5.8	1.3	3.9	4.3	8.0	10.4
6	9.1	6.2	1.1	4.2	0.6	0.5	1.5	1.7	3.0
7	3.1	0.9	1.0	1.5	0.3	0.2	0.1	0.2	0.6
8+	1.4	0.7	0.5	0.1	0.2	0.0	0.1	0.2	0.4
TOTAL	4025.6	3765.9	2269.8	2785.8	1555.1	1295.9	1082.5	5502.1	4927.0

Table 3.3. HERRING IN FISHING AREA IIIA (KATTEGAT AND SKAGERRAK)

VIRTUAL POPULATION ANALYSIS **** VPA ****

UNIT: Year-1
FISHING MORTALITY COEFFICIENT NATURAL MORTALITY COEFFICIENT = 0.30

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1974-80
0	0.67	0.57	0.14	0.30	0.13	0.15	0.23	0.58	0.42	0.31
1	1.52	1.33	1.31	1.07	0.55	0.23	1.24	0.67	0.33	0.89
2	1.68	1.35	1.50	1.42	1.42	0.95	0.58	0.65	0.50	1.27
3	1.06	1.71	1.03	1.49	1.29	0.83	0.90	1.23	0.50	1.19
4	1.18	2.02	0.44	1.32	0.94	0.92	0.96	0.96	0.50	1.19
5	1.33	1.66	0.39	1.86	1.00	1.14	0.76	0.67	0.50	1.16
6	2.09	1.34	0.42	2.09	1.02	1.20	1.55	0.70	0.50	1.39
7	1.50	1.50	0.70	1.50	1.00	1.00	1.00	1.00	0.50	1.17
8+	1.50	1.50	0.70	1.50	1.00	1.00	1.00	1.00	0.50	1.17
(2- 8)U	1.48	1.58	0.74	1.67	1.09	1.01	0.97	0.88	0.50	
(2- 8)W	1.46	1.55	1.40	1.45	1.39	0.94	0.72	0.75	0.50	

Table 3.4. HERRING IN FISHING AREA IIIA (KATTEGAT AND SKAGERRAK)

VIRTUAL POPULATION ANALYSIS **** VPA ****

STOCK SIZE IN NUMBERS UNIT: MILLIONS
---------- BIOMASS UNIT: TONNES

1 JANUARY (TOTAL AND SPAWNING STOCK)

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1974-80
0	5811	5290	5765	4179	1421	3331	3752	9445	11136	********	4007
1	1276	2197	2225	2419	2391	927	2448	2198	5934	5420	1970
2	495	217	451	468	647	1029	574	1493	873	2202	555
3	216	76	46	82	93	126	325	262	640	434	136
4	71	68	12	15	17	23	50	119	69	351	37
5	37	20	8	7	2	6	6	17	44	38	13
6	11	9	3	5	1	1	2	4	8	24	4
7	4	1	2	2	1	0	0	0	2	4	2
8+	2	1	1	0	0	0	0	0	1	1	1
TOTAL NO	7923	7879	6512	7178	4482	5946	7159	13543	18706		
SSB NO.	340	174	72	112	114	153	345	402	763		
TOT.BIOM	111858	97417	95599	106275	113268	106264	146745	202678	252437		
SSB BIOM	43935	27251	10769	15299	14653	20405	48662	55670	97707		

Table 4.1. Annual Celtic Sea and Division VIIj HERRING catches 1973-82.
(Data provided by Working Group members.)

Year	France	German Dem.Rep.	Germany Fed.Rep.	Ireland	Netherlands	Poland	United Kingdom	USSR	Unallocated	Total
1973	5 553	7	294	17 068	5 834	1 125	-	334	-	30 215[a]
1974	2 261	-	433	16 276	2 105	954	-	-	-	22 029
1975	1 924	-	361	10 587	2 825	512	24	1 054	-	17 287
1976	1 919	147	28	5 986	1 627	324	-	826	-	10 857
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

Table 4.2. Celtic Sea and Division VIIj HERRING by season (1 April to 31 March).
(Data provided by Working Group members.)

Season	France	German Dem.Rep.	Germany Fed.Rep.	Ireland	Netherlands	Poland	United Kingdom	USSR	Unallocated	Total
1973/74	4 143	7	294	15 185	5 834	1 139	-	334	-	26 936[a]
1974/75	2 150	-	435	13 939	2 462	954	-	-	-	19 940
1975/76	2 451	-	399	8 640	2 441	579	24	1 054	-	15 588
1976/77	1 317	147	36	5 864	1 324	257	-	826	-	9 771
1977/78	95	-	96	6 264	1 378	-	-	-	-	7 833
1978/79	8	-	220	8 239	1 002	-	-	-	-	7 559
1979/80	584	-	20	7 932	850	-	-	-	935	10 321
1980/81	9	-	2	9 024	292	-	-	-	3 803	13 130
1981/82	123	-	-	15 830	1 150	-	-	-	-	17 103
1982/83[*]	+	-	-	13 042	-	-	-	-	-	13 042

[*] Provisional
a) Including 123 tonnes for Bulgaria.

Table 4.3. Larval abundances in the 1982/83 season.

Cruise Mid-date	Abundance ($\times 10^{-6}$)		
	<10 mm	10-15 mm	>15 mm
13.10.82 ⁎	25 645	1 169	225
27.10.82	8 852	2 550	0
10.11.82	36 245	14 510	0
24.11.82	2 043	3 477	519
9.12.82	0	3 660	1 658
	<11 mm	11-16 mm	>16 mm
19.12.82	348	1 287	927
7.1.83	0	415	709
19.1.83	3 605	0	314
2.2.83	942	0	1 788
16.2.83	5 363	367	253
28.2.83	10 890	5 650	0

⁎) Monthly cruises - inefficient estimate.

Table 4.4. HERRING SOUTH AND SOUTH WEST OF IRELAND (FISH AREAS VIIG-J)

VIRTUAL POPULATION ANALYSIS **** VPA ****

CATCH IN NUMBERS UNIT: THOUSANDS

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	8422	23547	9507	12766	13517	8159	2800	11335	7162	39361	15539
2	137690	38133	42808	15429	11114	12516	13345	13913	30092	21285	42725
3	17835	55805	17134	17783	7236	3810	11948	12399	11726	21861	8726
4	15842	7012	22530	7335	7011	5280	5585	8026	6545	5575	4817
5	14551	9651	4225	9446	2872	1565	1550	2539	2812	4458	1497
6	4645	5323	1737	3520	4785	1198	1476	1516	2204	3436	1391
7	3012	3352	2976	1644	1980	1043	540	1263	1164	795	1070
8	2374	2332	903	1136	1243	383	353	551	1202	513	335
9+	1020	1209	627	1194	1759	476	462	635	565	656	596
TOTAL	205391	146364	100699	69813	51576	39944	38652	52957	63593	97860	77598

Table 4.5. HERRING SOUTH AND SOUTH WEST OF IRELAND (FISH AREAS VIIG-J)

VIRTUAL POPULATION ANALYSIS **** VPA ****

UNIT: Year-1
FISHING MORTALITY COEFFICIENT NATURAL MORTALITY COEFFICIENT = 0.10

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1972-79
1	0.096	0.230	0.127	0.267	0.203	0.139	0.082	0.133	0.121	0.243	0.160	0.157
2	0.736	0.693	0.738	0.541	0.349	0.267	0.314	0.432	0.541	0.546	0.400	0.514
3	0.551	0.767	0.638	0.681	0.468	0.441	0.243	0.474	0.697	0.354	0.400	0.561
4	0.537	0.419	0.722	0.550	0.554	0.643	0.500	0.476	0.440	0.739	0.400	0.562
5	0.755	0.649	0.425	0.631	0.479	0.205	0.360	0.472	0.248	0.530	0.400	0.497
6	0.550	0.611	0.497	0.667	0.727	0.594	0.267	0.589	0.712	0.478	0.400	0.556
7	0.464	0.982	0.755	0.576	0.488	0.299	0.295	0.347	1.008	0.535	0.400	0.548
8	0.725	0.702	0.690	0.610	0.450	0.367	0.380	0.439	0.579	0.518	0.400	0.555
9+	0.725	0.702	0.690	0.610	0.450	0.367	0.380	0.439	0.579	0.518	0.400	0.555
(1- 7)U	0.606	0.547	0.576	0.502	0.357	0.275	0.274	0.310	0.484	0.406	0.314	
(2- 7)W	0.724	0.700	0.689	0.609	0.476	0.356	0.361	0.435	0.539	0.453	0.400	

Table 4.6. HERRING SOUTH AND SOUTH WEST OF IRELAND (FISH AREAS VIIG-J)

VIRTUAL POPULATION ANALYSIS **** VPA ****

STOCK SIZE IN NUMBERS UNIT: THOUSANDS
BIOMASS UNIT: TONNES

TOTAL STOCK 1 JANUARY + SPAWNING STOCK AT SPAWNING TIME
PROP.OF ANNUAL F 0.200 PROP.OF ANNUAL M 0.500

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	96947	120089	48550	57120	75954	66058	46861	95210	65993	191245	169240	********
2	264057	79720	86315	34699	39571	56028	52023	41551	75364	52910	135732	136562
3	42392	108849	36061	37641	20411	25209	33876	34378	24415	39724	27727	82325
4	39915	21462	45702	16401	17245	11568	14707	23653	19304	11006	15503	16818
5	28636	21120	12776	20112	7904	8968	5473	8021	13403	11282	4756	9282
6	11631	12180	9982	7557	9679	4451	6616	3454	4522	9466	6687	2885
7	8491	5586	5985	5494	3509	4235	2214	4581	1330	2005	5305	3644
8	4809	4830	1893	2601	3413	1306	2643	1491	2928	535	1064	3218
9+	2066	2504	1734	2734	4857	1603	1597	1718	1511	1618	1893	1794
TOTAL NO	498345	376341	249077	186357	182545	179526	173264	214257	209199	319877	367029	
SSB NO.	375660	266492	138729	136292	126893	131109	132937	147458	152949	193992	252576	
TOT.BIOM	89024	67236	46892	34689	31594	30535	31024	35780	36332	48396	57302	
SSB BIOM	69457	50476	30879	26034	23523	23799	25104	26624	28005	31981	42300	

Table 4.7. Input parameters for stock prediction. Celtic Sea HERRING.

PROPORTION OF F BEFORE THE SPAWNING SEASON: 0.2000
PROPORTION OF M BEFORE THE SPAWNING SEASON: 0.5000

LIST OF INPUT VARIABLES BY AGE GROUP:

AGE	STOCK SIZE	F-PATTERN	M	MATURITY OGIVE	WEIGHT IN THE CATCH	WEIGHT IN THE STOCK
1	50000.00	0.4000	0.100	0.5000	0.1150	0.1150
2	83945.00	1.0000	0.100	1.0000	0.1740	0.1740
3	82325.00	1.0000	0.100	1.0000	0.2110	0.2110
4	16818.00	1.0000	0.100	1.0000	0.2290	0.2290
5	9282.00	1.0000	0.100	1.0000	0.2440	0.2440
6	2885.00	1.0000	0.100	1.0000	0.2570	0.2570
7	3644.00	1.0000	0.100	1.0000	0.2600	0.2600
8	3218.00	1.0000	0.100	1.0000	0.2630	0.2630
9+	1794.00	1.0000	0.100	1.0000	0.2660	0.2660

Table 5.1 Catch in Weight, Division VIa (North) 1973-1982

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*
Denmark	932	-	374	249	626	128	-	-	1 580	-
Faroes	10 003	5 371	3 895	4 017	3 564	-	-	-	-	-
France	2 441	411	1 244	1 481	1 548	1 435	3	2	1 243	2 084
G.D.R.	251	200	600	279	-	-	-	-	-	-
Germany, Fed.Rep.	9 663	8 687	5 582	4 084	-	26	-	256	3 029	8 569
Ireland	2 532	9 566	2 633	3 273	-	-	-	-	-	-
Netherlands	27 892	17 461	12 024	16 573	8 705	5 874	-		5 602	30 275
Norway	32 557	26 218	509	5 183	1 098	4 462	-		3 850	13 018
Poland	2 062	334	376	390	-	-	-		-	-
Sweden	-	-	-	2 206	261	-	-		-	-
UK (Engl)	-	45	125	20	301	134	54	33	1 094	90
UK (Scot)	120 800	107 475	85 395	53 351	25 238	10 097	3	15	30 389	38 381
USSR	1 137	2 392	1 244	2 536	-	-	-	-	-	-
Unallocated	-	-	-	-	-	-	-	-	4 633	-
TOTAL	208 270	178 164	114 001	93 642	41 341	22 176	60	306	51 420	92 417

* Preliminary

Table 5.2. HERRING IN THE NORTHERN PART OF VIA

VIRTUAL POPULATION ANALYSIS **** VPA ****

CATCH IN NUMBERS UNIT: THOUSANDS

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	267872	536119	82076	8225	11508	103199	1614	0	3003	240
1	51170	309616	172479	69653	54636	22525	392	12367	36740	13383
2	235627	124944	202047	319604	47759	46284	225	1335	77961	250222
3	80382	151025	89066	101548	95834	20567	122	452	105008	72306
4	131484	519178	63701	35502	22117	40662	31	246	61341	93729
5	65071	82466	163202	25195	10065	6879	21	62	21473	56697
6	54642	49683	30601	70289	12211	3925	12	43	12623	23800
7	16242	34629	12297	10918	26992	2166	7	40	11563	11744
8	6536	22470	13121	3914	2759	6278	2	3	1309	14041
9+	32225	21042	13696	12014	1456	1544	0	1	1326	4259
TOTAL	1869104	1850572	863528	662262	259564	258921	2426	15049	332959	542481

Table 5.3. HERRING IN THE NORTHERN PART OF VIA

VIRTUAL POPULATION ANALYSIS **** VPA ****

UNIT: Year-1
FISHING MORTALITY COEFFICIENT NATURAL MORTALITY COEFFICIENT = 0.10

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	0.293	0.441	0.233	0.022	0.018	0.112	0.002	0.000	0.019	0.030
1	0.148	0.568	0.221	0.277	0.110	0.039	0.000	0.022	0.024	0.100
2	0.575	0.561	0.801	0.693	0.279	0.188	0.000	0.002	0.163	0.201
3	0.600	0.797	0.493	1.140	0.409	0.167	0.001	0.001	0.170	0.201
4	0.619	0.874	0.336	1.009	0.720	0.271	0.000	0.001	0.159	0.201
5	0.592	0.900	0.821	0.852	0.793	0.452	0.000	0.001	0.159	0.201
6	0.603	1.205	0.912	0.645	1.265	0.712	0.001	0.000	0.163	0.201
7	0.359	0.864	1.023	0.235	0.519	0.665	0.002	0.004	0.128	0.201
8	0.597	0.879	0.855	0.985	0.508	0.255	0.001	0.001	0.160	0.201
9+	0.597	0.879	0.855	0.985	0.508	0.255	0.001	0.001	0.160	0.201
(3- 7)W	0.596	0.876	0.853	0.980	0.506	0.254	0.000	0.001	0.160	0.201

Table 5.4. HERRING IN THE NORTHERN PART OF VIA

VIRTUAL POPULATION ANALYSIS **** VPA ****

STOCK SIZE IN NUMBERS UNIT: THOUSANDS
BIOMASS UNIT: TONNES

TOTAL STOCK 1 JANUARY + SPAWNING STOCK AT SPAWNING TIME
PROP.OF ANNUAL F 0.670 PROP.OF ANNUAL M 0.670

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	1105517	1573343	417564	595944	692766	1070939	679357	1803465	166243	8551	********
1	390240	746227	915720	299567	350446	615906	860243	613173	1631843	147659	7491
2	563707	304503	382765	864499	205370	284003	535679	783436	542590	1441626	120893
3	1872201	287136	157278	155452	299118	140540	213037	434669	707613	416929	1066915
4	297701	929302	117143	58240	44995	179339	107616	192648	438117	540009	306560
5	147531	144989	350734	45847	19219	19308	124121	97347	174081	338176	399649
6	12e1e4	73815	53356	139611	17695	7865	11407	112289	86024	137121	250277
7	63414	62461	20011	19398	54239	4519	5493	10310	101563	67662	101480
8	15133	40086	23323	6512	7246	29248	2103	3154	9291	80896	50075
9+	74953	37539	24871	19938	3904	7193	0	1051	9412	24538	78029
TOTAL NO	4656621	4199405	2463269	1604656	1695047	2359854	2543257	4101543	3868676	3203145	
SSB NO.	1988138	1014851	604010	605910	458905	541729	932727	1574278	1738602	2490474	
TOT.BIOM	549732	400913	269753	193512	140005	168634	228758	322735	479498	477703	
SSB BIOM	316839	169512	97611	87483	70353	81972	134631	233143	278099	379525	

Table 5.5 Predicted regression between larval indices (numbers x 10^{-9}) and spawning stock biomass (t x 10^{-3}, age 2 and older) in Division VIa (North). Regression based on data from 1972-1979.

Year	Larval index	Spawning stock biomass
1972	2 871 30	448 713
1973	1 913 30	316 889
1974	1 094 80	169 512
1975	1 039 30	97 611
1976	374 85	86 114
1977	1 039 95	67 769
1978	648 95	77 431
1979	1 290 13	125 809
1980	2 184 60	
1981	2 484 00	
1982	2 533 18	(380 897)[1]

Regression between larval indices and spawning stock biomass using values 1973-1979

$$Y = - 38.9661 + 0.1656 \times (r = 0.9441)$$

1) Predicted from regression equation

Table 5.6. Input parameters used in catch predictions for Division VIa (North) in 1983 and 1984.

Age	Stock size ($x10^{-3}$)	F-pattern	Mean weight in the catch and stock (g)
2	205000.00	1.0000	0.1210
3	1066915.00	1.0000	0.1580
4	308560.00	1.0000	0.1750
5	399649.00	1.0000	0.1860
6	250277.00	1.0000	0.2060
7	101480.00	1.0000	0.2180
8	50075.00	1.0000	0.2240
9+	75029.00	1.0000	0.2240

Recruitment in 1984: 205 000 x 10^{-3}

Table 5.7 Monthly landings (tonnes) of HERRING from the Firth of Clyde (all fishing methods combined). (Data provided by the Working Group)

Month	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
January	*	*	*	*	*	4*	4*	6*	15*	2*
February	71*	91*	68*	7*	*	6*	8*	3*	15*	16*
March	36*	168*	85	69*	*	7*	13*	8*	14*	1*
April	316	398	369	521	530	246	12*	4*	32*	2*
May	385	280	283	436	544	245	4*	2*	25*	615
June	468	607	203	281	640	238	336	114	429	850
July	688	690	354	332	494	376	466	656	982	757
August	593	543	240	473	601	587	450	645	511	262
September	668	310	515	541	559	581	374	559	106	-*
October	711	451	811	598	556	653	263	79	-*	-*
November	464	245	571	595	560	647	1*	3*	2*	-*
December	248	91	120	236	328	272	-*	2*	4*	1*
Not known	67	189	44	50	35					
Total	4 715	4 053	3 663	4 139	4 847	3 862	1 951	2 081	2 135	2 506

* Subject to closure of directed fishery

Table 5.8 Catch in numbers x 10^{-3} in the Firth of Clyde, 1967 - 1982
(Races combined)

Year	Age (winter rings)											Total
	0	1	2	3	4	5	6	7	8	9	≥10	
1967	-	10 109	24 797	3 950	1 828	8 151	4 775	526	106	63	109	54 414
1968	4	5 354	27 811	11 721	3 145	767	5 218	4 542	412	326	220	59 520
1969	-	3 106	24 336	19 936	6 256	1 282	1 042	1 429	990	89	38	58 504
1970	6	5 008	7 551	10 338	8 745	2 306	741	760	753	227	117	36 552
1971	6	2 207	6 503	1 976	4 355	3 432	1 090	501	352	225	181	20 828
1972	-	1 351	8 983	3 181	1 684	3 007	1 114	656	282	177	132	20 567
1973	-	9 139	5 258	4 548	1 811	918	1 525	659	307	132	114	24 411
1974	86	5 308	8 841	2 817	2 559	1 140	494	700	253	87	59	22 344
1975	-	12 694	1 876	2 483	1 024	1 072	451	175	356	130	67	20 328
1976	-	6 194	10 480	913	1 049	526	638	261	138	178	100	20 477
1977	-	1 041	7 524	6 976	1 062	1 112	574	489	251	146	192	19 367
1978	-	14 123	1 796	2 259	2 724	634	606	330	298	174	236	23 180
1979	-	507	4 859	807	930	888	341	289	156	119	154	9 050
1980	380*	333	5 633	1 592	567	341	204	125	48	56	68	9 347
1981		312*	2 372	2 785	1 622	1 158	433	486	407	74	18	9 667
1982	427*	197	5 619	1 953	1 559	956	621	137	203	60	46	11 778

* Including sprat by-catch.

Table 5.9 Number of recapture by month and area of HERRING tagged in the Clyde in May-June 1980

Age of Recovery	Clyde	Irish Sea	N W Ireland	S W Ireland	S Minch	?
1980 May-June	30	-	-	-	-	-
July	192	2	-	-	-	-
August	155	1	-	-	-	-
September	152	3	3	-	-	-
October	32	2	1	-	-	-
November	21	-	-	-	-	-
December	1	1	-	-	-	-
1981 January	5	1	-	-	-	-
February	4	-	-	-	-	-
March	6	2	1	-	-	-
April	8	1	2	-	-	1
May	3	-	1	-	-	-
June	58	-	2	-	-	-
July	49	-	3	-	-	1
August	51	-	-	-	-	-
September	13	-	-	-	-	-
October	2	-	-	-	-	-
November	-	-	-	1	1	-
December	-	1	-	-	1	-
1982 January						
February						
March	-	-	-	-	-	1
April						
May	2					
June	4		1			
July	11					
August	11					
Date unknown	10	-	1	-	-	-
	825	14	15	1	2	3

Table 5.10. CLYDE HERRING

VIRTUAL POPULATION ANALYSIS **** VPA ****

UNIT: Year-1
FISHING MORTALITY COEFFICIENT NATURAL MORTALITY COEEFICIENT = 0.10

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.014	0.000
1	0.247	0.089	0.095	0.413	0.524	0.375	0.356	0.105	0.662	0.028	0.028	0.013
2	0.695	0.512	0.541	0.557	0.787	0.314	0.537	0.849	0.237	0.442	0.432	0.251
3	0.585	0.344	0.449	0.514	0.583	0.466	0.222	0.737	0.588	0.143	0.226	0.350
4	0.813	0.463	0.489	0.441	0.541	0.383	0.325	0.383	0.636	0.454	0.127	0.335
5	0.609	0.786	0.595	0.477	0.487	0.404	0.308	0.595	0.369	0.387	0.265	0.363
6	0.438	0.577	0.560	0.609	0.453	0.321	0.397	0.570	0.672	0.308	0.128	0.554
7	0.593	0.527	0.730	0.675	0.554	0.254	0.277	0.531	0.669	0.703	0.158	0.445
8	0.783	0.535	0.565	0.812	0.526	0.538	0.291	0.415	0.637	0.688	0.208	0.949
9	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
10+	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
(2-10)W	0.666	0.516	0.532	0.535	0.652	0.388	0.451	0.710	0.465	0.376	0.308	0.340

	1982
0	0.001
1	0.021
2	0.300
3	0.300
4	0.300
5	0.300
6	0.300
7	0.300
8	0.300
9	0.300
10+	0.300
(2-10)W	0.300

VIRTUAL POPULATION ANALYSIS **** VPA ****

STOCK SIZE IN NUMBERS UNIT: THOUSANDS
BIOMASS UNIT: TONNES

1 JANUARY

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	30034	17295	31276	15044	47037	23934	12116	33691	21138	14087	28518	11007
1	24017	27170	15644	28300	13012	42479	21656	10963	30485	19126	12746	25443
2	15747	16979	22488	12671	16946	7291	26404	13723	8931	14228	16824	11217
3	24411	7110	9206	11844	6670	6981	4818	13971	5313	6377	8271	9886
4	16406	12306	4560	5317	6411	3369	3965	3493	6049	2670	5004	5973
5	5286	6585	7010	2531	3095	3379	2078	2593	2154	2897	1535	3989
6	2189	2601	2716	3498	1421	1721	2041	1382	1294	1348	1779	1065
7	1777	1279	1322	1404	1722	818	1129	1242	707	598	897	1416
8	1448	889	683	576	647	896	574	774	661	328	268	693
9	604	598	471	351	231	346	473	388	463	316	149	197
10+	311	481	351	303	157	178	266	511	628	410	181	48
TOTAL NO	122230	93294	95726	82038	97950	91392	75523	82732	77822	62384	76171	70934
SSB NO.	68179	48828	48807	38695	37300	24979	41750	38078	26200	29171	34907	34483
TOT.BIOM	22815	17843	15720	15151	12491	13921	14133	12225	12230	10809	11366	13498
SSB BIOM	18672	13323	12904	10473	9843	6885	10546	10134	7141	7608	9042	9317

	1982	1983
0		
1	9960	
2	22725	8825
3	7899	15233
4	6305	5295
5	3866	4226
6	2512	2592
7	554	1684
8	821	371
9	243	550
10+	166	287
TOTAL NO	503997	
SSB NO.	45110	
TOT.BIOM	17801	
SSB BIOM	11718	

Table 6.1. Estimated catches in weight in Divisions VIa (south) and VIIb,c, 1973-1982.

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*)
Belgium	-	-	-	12	-	-	-	-	-	-
France	-	145	68	47	-	-	-	-	-	353
German Dem.Rep.	2 256	1 833	1 394	890	-	-	-	-	-	-
Germany, Fed.Rep.	7 785	5 667	4 431	924	221	100	5	-	2 687	265
Ireland	16 912	16 395	12 465	10 895	15 916	19 128	18 910	27 499	19 443	15 726
Netherlands	5 228	2 225	15 208	16 546	4 423	481	1 939	1 514	2 790	1 735
Poland	3 623	6 034	2 558	2 778	6	-	-	-	-	-
U.K. (N.Ireland)	-	28	6	1	1	6	2	1	2	-
USSR	915	4 262	2 634	674	-	-	-	-	-	-
Unspecified	-	-	-	-	-	-	1 752	1 110	-	-
Total	36 719	36 589	38 764	32 767	20 567	19 715	22 608	30 124	24 922	18 079

*) Provisional data.

Table 6.2. HERRING IN FISHING AREAS VIIB,C AND LOWER VIA (W. COAST OF IRELAND)

VIRTUAL POPULATION ANALYSIS **** VPA ****

CATCH IN NUMBERS UNIT: THOUSANDS

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	46	0	194	823	0	82	4	0	0	0
1	6423	3374	7360	16613	4485	10170	5919	2856	1620	743
2	40390	29406	41308	29011	44512	40320	50071	40058	22265	17017
3	47369	41116	25117	37512	13396	27079	19161	16943	41794	15163
4	16863	44579	29192	26544	17176	13308	19969	25140	31460	25870
5	7432	17857	23718	25317	12209	10685	9349	22126	12612	17018
6	12383	8882	10703	15000	9924	5356	8422	7748	12746	7239
7	9191	10901	5909	5208	5534	4270	5443	6946	3461	3653
8	1969	10272	9378	3596	1360	3638	4423	4344	2735	3050
9+	50980	30549	32029	15703	4150	3324	4090	5334	5220	2701
TOTAL	193066	196936	184908	175527	112746	118232	126851	131495	134113	92454

Table 6.3. HERRING IN FISHING AREAS VIIB,C AND LOWER VIA (W. COAST OF IRELAND)

VIRTUAL POPULATION ANALYSIS **** VPA ****

UNIT: Year-1
FISHING MORTALITY COEFFICIENT NATURAL MORTALITY COEEFICIENT = 0.10

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	0.000	0.000	0.001	0.004	0.000	0.000	0.000	0.000	0.000	0.000
1	0.035	0.018	0.054	0.080	0.024	0.039	0.021	0.023	0.016	0.010
2	0.207	0.200	0.296	0.278	0.265	0.276	0.246	0.171	0.223	0.208
3	0.302	0.299	0.235	0.412	0.179	0.250	0.183	0.110	0.243	0.208
4	0.298	0.456	0.320	0.370	0.299	0.242	0.264	0.344	0.273	0.208
5	0.209	0.520	0.415	0.443	0.258	0.274	0.238	0.460	0.263	0.208
6	0.211	0.367	0.601	0.445	0.261	0.154	0.320	0.283	0.465	0.208
7	0.207	0.259	0.394	0.586	0.260	0.168	0.207	0.421	0.176	0.208
8	0.244	0.333	0.330	0.393	0.262	0.243	0.235	0.227	0.259	0.208
9+	0.244	0.333	0.330	0.393	0.262	0.243	0.235	0.227	0.259	0.208
(2- 7)W	0.245	0.3[illegible]	0.319	0.381	0.262	0.248	0.237	0.22	0.259	0.208

Table 6.4. HERRING IN FISHING AREAS VIIB,C AND LOWER VIA (W. COAST OF IRELAND)

VIRTUAL POPULATION ANALYSIS **** VPA ****

STOCK SIZE IN NUMBERS UNIT: THOUSANDS
---------- BIOMASS UNIT: TONNES

TOTAL STOCK 1 JANUARY * SPAWNING STOCK AT SPAWNING TIME
PROP.OF ANNUAL F 0.670 PROP.OF ANNUAL M 0.670

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	213921	161686	249642	219972	305494	333049	146179	117984	86713		0********
1	194504	193520	146299	225761	198256	276764	301276	132204	106757	78461	0
2	226417	169889	171696	125582	138437	175126	240778	266980	116962	95057	70286
3	190601	166532	125404	116555	85929	128281	120210	170352	203559	84701	69859
4	66577	127517	111666	90000	69735	65033	90576	90579	138045	144516	62246
5	41234	46056	73154	73575	56273	45808	46216	62852	58124	95063	106203
6	68326	30301	24767	43716	42416	39334	32217	32946	35694	40437	69665
7	51644	50072	13998	12294	25548	23960	20505	21164	22461	20406	29718
8	9537	38006	34965	11590	8167	17665	22150	22436	12509	17037	14996
9+	246927	113029	119416	50612	18879	16159	20482	27549	23988	15088	23609
TOTAL NO	1311742	1096609	1076633	968969	997549	1127219	1050392	945086	805053	590761	
SSB NO.	717139	559143	513228	379242	387819	409995	481286	561599	481111	416776	
TOT.BIOM	194757	160820	145696	122412	109721	123246	136805	132869	121714	103703	
SSB BIOM	135950	103215	94902	66621	66613	71174	81545	93717	85576	77345	

Table 6.5. Predictive regression between larval indices (numbers x 10^{-9}) and spawning stock biomass (t, age 2 and older) in Division VIa (south) and Division VIIb,c. Regression based on data from 1973-79.

Year	Larval Index	Spawning Stock Biomass
1973	716.60	135 930
1974	767.30	103 215
1975	386.35	94 962
1976	56.30	68 621
1977	162.10	66 613
1978	338.84	71 174
1979	349.78	81 543
1980	327.46	
1981	197.45	
1982	250.96	177 030[1)]

Regression between larval indices and spawning stock biomass using values 1973-79

$$y = 56658.204 + 81.1770x \quad (r = 0.8576)$$

1) Predicted from regression equation.

Table 6.6. Parameters predicting yield and spawning stock biomass in Divisions VIa (south) and VIIb,c in 1983 and 1984.

Age	Stock Size	F-Pattern	Weight in the Catch and Stock
2	70288.00	1.0000	0.1290
3	69859.00	1.0000	0.1650
4	62248.00	1.0000	0.1910
5	106203.00	1.0000	0.2090
6	69863.00	1.0000	0.2220
7	29718.00	1.0000	0.2310
8	14996.00	1.0000	0.2370
9+	23609.00	1.0000	0.2410

Recruitment in 1984 (age 2) = 70 288

Table 7.1. HERRING.
Total catches (tonnes) in North Irish Sea (Division VIIa), 1971-82 (includes industrial catch).

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*)
France	1 815	1 224	254	3 194	813	651	85	174	455[2]	1	-	-
Ireland	3 131	2 529	3 614	5 894	4 790	3 205	3 331	2 371	1 805	1 340	283	300
Netherlands	-	260	143	1 116	630	989	500	98	-	-	-	-
U.K.	21 861	23 337	18 587	27 489	18 244	16 401	11 498	8 432[1]	10 078[3]	9 272	4 094	3 375
USSR	-	-	-	945	26	-	-	-	-	-	-	1 180[4]
Total	26 807	27 350	22 598	38 638	24 503	21 246	15 414	11 075	12 338	10 613	4 377	4 855

*) Preliminary. 1) Includes 68.5 tonnes of spring-spawned herring. 2) No data basis for allocation to stock.
3) Additional unrecorded catch of 106 tonnes estimated. 4) Unallocated.

Table 7.2. HERRING.
Total catch by stock in North Irish Sea, 1972-82.

Country	1972		1973		1974		1975		1976		1977		1978		1979		1980		1981		1982*)	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
France	1 224	-	254	-	3 194	-	813	-	651	-	85	-	87	87	-	-	1	-	-	-	-	-
Ireland	-	2 529	-	3 614	1 783	4 111	2 406	2 384	1 816	1 389	2 009	1 322	610	1 761	748	1 054	762	578	100	183	198	102
Netherlands	260	-	-	143	1 116	-	630	-	989	-	500	-	98	-	-	-	-	-	-	-	-	-
U.K.	19 308	4 029	13 071	5 516	23 639	3 850	15 408	2 836	12 831	3 570	9 837	1 661	7 663	700	9 382	696	7 897	1 375	2 837	1 257	2 120	1 255
Unallocated	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	779	401
Total Manx	20 792		13 325		29 732		19 257		16 287		12 431		8 458		10 130		8 660		2 937		3 097	
Total Mourne	6 558		9 273		7 961		5 220		4 959		2 983		2 548		1 750		1 953		1 440		1 758	

1 - Manx stock; 2 = Mourne stock. *) Preliminary

Table 7.3 Manx stock HERRING. Catch in number x 10^{-6}.

Year	Rings									
	1	2	3	4	5	6	7	8 and 8+	Total 2 to 8+	Mean age excl. 1-ring
1971	4.98	54.36	21.91	18.68	9.67	3.41	1.74	1.16	110.93	3.060
1972	3.64	41.76	26.05	11.28	13.15	6.46	1.96	1.27	101.93	2.327
1973	1.75	18.74	22.74	10.69	5.52	4.07	2.09	1.40	65.28	3.468
1974	12.95	95.95	32.55	19.41	9.65	4.09	4.55	1.03	167.23	2.871
1975	5.63	38.94	36.61	9.44	6.17	4.11	1.89	1.34	98.50	3.005
1976	9.34	47.46	17.38	13.62	3.88	2.41	2.32	1.07	88.14	2.952
1977	13.98	33.04	20.29	5.85	3.92	1.16	0.81	1.02	66.09	2.856
1978	3.64	32.41	11.41	6.18	1.44	1.24	0.57	0.35	53.60	2.709
1979	3.66	35.37	21.29	3.55	1.90	0.85	0.30	0.19	67.11	2.632
1980	0.66	22.82	17.41	7.27	1.54	0.63	0.21	0.12	50.00	2.817
1981	2.02	11.67	2.34	2.05	1.70	0.24	0.22	0.13	18.35	2.783
1982	1.99	10.84	4.43	1.31	0.89	0.73	0.10	0.28	18.58	2.759

Table 7.4.

MANX HERRING

VIRTUAL POPULATION ANALYSIS **** VPA ****

UNIT: Year-1

FISHING MORTALITY COEFFICIENT NATURAL MORTALITY COEEFICIENT = 0.10

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.043	0.010	0.158	0.061	0.149	0.164	0.052	0.100	0.019	0.054	0.070
2	0.510	0.288	0.906	0.831	0.866	0.975	0.607	0.851	1.277	0.480	0.400
3	0.559	0.512	1.017	0.971	1.016	1.050	0.993	0.927	1.301	0.350	0.300
4	0.548	0.416	0.989	0.835	1.121	1.064	0.983	0.880	0.859	0.432	0.300
5	0.674	0.502	0.720	0.900	0.897	1.073	0.729	0.841	1.124	0.435	0.300
6	0.672	0.400	0.760	0.686	0.994	0.656	1.117	1.197	0.861	0.446	0.300
7	0.580	0.420	0.930	0.870	0.950	1.000	0.700	0.800	1.000	0.450	0.300
8+	0.580	0.420	0.930	0.870	0.950	1.000	0.700	0.800	1.000	0.450	0.300
(2- 7)W	0.556	0.400	0.920	0.879	0.937	1.004	0.722	0.881	1.194	0.449	0.353

Table 7.5. MANX HERRING

VIRTUAL POPULATION ANALYSIS **** VPA ****

STOCK SIZE IN NUMBERS UNIT: MILLIONS
---------- BIOMASS UNIT: THOUSAND TONNES

TOTAL STOCK 1 JANUARY + SPAWNING STOCK AT SPAWNING TIME
PROP.OF ANNUAL F 1.000 PROP.OF ANNUAL M 0.750

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	90.5	187.5	93.2	100.4	70.9	97.0	75.0	40.2	36.1	46.2	30.9	********
2	109.3	78.4	168.0	72.0	65.5	55.3	74.5	64.4	32.9	32.0	34.4	26.1
3	63.6	59.4	53.2	61.4	28.4	32.5	18.9	36.7	24.9	8.3	17.9	20.9
4	28.0	32.9	32.2	17.4	21.0	9.3	10.3	6.3	13.2	6.1	5.3	12.0
5	28.0	14.6	19.6	10.8	6.8	6.2	2.9	3.5	2.4	5.0	3.6	3.6
6	13.8	12.9	8.0	8.7	4.0	2.5	1.9	1.3	1.4	0.7	3.0	2.4
7	4.7	6.4	7.8	3.4	3.9	1.3	1.2	0.6	0.3	0.6	0.4	2.0
8+	3.0	4.3	1.8	2.4	1.8	1.7	0.7	0.4	0.2	0.4	1.1	1.0
TOTAL NO	340.9	396.4	383.8	276.5	222.4	205.9	185.4	153.4	111.3	93.4	96.7	
SSB NO.	133.4	130.4	107.8	68.1	55.3	37.1	50.5	43.6	21.5	31.5	42.9	
TOT.BIOM	60.7	64.4	66.8	46.7	37.5	32.4	29.3	25.9	18.8	14.9	16.3	
SSB BIOM	26.5	26.3	20.8	13.5	10.6	7.2	9.2	8.1	4.3	6.0	8.4	

VIRTUAL POPULATION ANALYSIS **** VPA ****

CATCH IN NUMBERS UNIT: MILLIONS

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	78.4	50.2	57.9	20.3	10.4	26.4	20.8	0.0	0.0	0.0	0.0
1	37.0	40.4	30.3	27.7	25.4	16.3	11.9	8.1	5.2	3.0	3.1
2	14.9	14.0	13.6	9.3	8.7	6.0	4.5	2.9	2.9	4.1	5.2
3	0.9	15.5	7.2	2.8	3.4	2.4	2.0	2.2	2.1	0.9	1.2
4	1.9	0.8	5.1	1.4	1.6	0.9	0.6	0.7	1.2	0.7	0.8
5	0.6	1.4	1.0	1.7	0.7	0.6	0.3	0.3	0.4	0.6	0.4
6	0.3	1.0	0.9	0.1	0.4	0.3	0.1	0.2	0.3	0.1	0.4
7	0.7	0.5	0.6	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.0
8	0.1	1.0	0.2	0.2	0.1	0.1	0.0	0.1	0.1	0.1	0.1
9+	0.3	0.2	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	135.1	125.0	117.2	63.8	50.9	53.1	40.3	14.6	12.4	9.6	11.3

Table 7.7. MOURNE HERRING

VIRTUAL POPULATION ANALYSIS **** VPA ****

UNIT: Year-1
FISHING MORTALITY COEFFICIENT NATURAL MORTALITY COEEFICIENT = 0.10

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1972-79
0	0.757	0.667	0.803	0.409	0.282	0.754	0.751	0.000	0.000	0.000	0.000	0.553
1	0.831	1.032	0.997	1.051	1.188	0.826	0.822	0.658	0.404	0.128	0.130	0.926
2	0.449	0.780	1.114	0.868	1.059	0.908	0.499	0.422	0.469	0.575	0.300	0.760
3	0.289	1.045	1.109	0.630	0.818	0.817	0.789	0.430	0.545	0.215	0.300	0.741
4	0.471	0.399	1.103	0.577	0.805	0.465	0.431	0.626	0.411	0.332	0.300	0.610
5	0.231	0.673	1.117	1.370	0.564	0.720	0.246	0.354	0.925	0.315	0.300	0.659
6	0.284	0.646	1.137	0.260	1.440	0.445	0.217	0.230	0.574	0.423	0.300	0.583
7	0.315	0.924	0.919	0.737	0.397	2.170	0.232	0.312	0.242	0.242	0.300	0.751
8	0.420	0.870	1.110	0.810	0.920	0.770	0.000	0.340	0.390	0.200	0.300	0.655
9+	0.420	0.870	1.110	0.810	0.920	0.770	0.000	0.340	0.390	0.200	0.300	0.655
(2- 7)W	0.420	0.865	1.108	0.814	0.927	0.806	0.515	0.425	0.491	0.422	0.300	

Table 7.8. MOURNE HERRING

VIRTUAL POPULATION ANALYSIS **** VPA ****

STOCK SIZE IN NUMBERS UNIT: MILLIONS
BIOMASS UNIT: TONNES

TOTAL STOCK 1 JANUARY + SPAWNING STOCK AT SPAWNING TIME
PROP.OF ANNUAL F 0.950 PROP.OF ANNUAL M 0.750

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	154	108	109	63	44	52	41	18	29	30	0********	
1	68	65	50	44	38	30	22	18	16	26	27	0
2	43	27	21	17	14	10	12	9	8	10	21	21
3	4	25	11	6	6	4	4	7	5	5	5	14
4	5	3	8	3	3	3	2	2	4	3	3	3
5	3	3	2	2	2	1	1	1	1	2	2	2
6	1	2	1	0	1	1	1	1	1	0	2	1
7	3	1	1	0	0	0	1	0	1	0	0	1
8	0	2	0	0	0	0	0	0	0	1	0	0
9+	1	0	1	0	0	0	0	0	0	0	0	0
TOTAL NO	283	236	205	138	109	102	83	55	65	77	60	
SSB NO.	47	33	21	16	14	13	15	15	15	20	31	
TOT.BIOM	22562	22038	16990	12126	10244	8391	7229	6244	6458	7696	9140	
SSB BIOM	8225	5934	3541	3098	2428	2188	2569	2763	2709	3448	5149	

Table 8.1 Landings of Icelandic summer spawning herring 1973-1982 in tonnes x 10^{-3}

1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0.2	1.2	12.8	17.8	28.7	37.3	45.1	53.3	39.5	53.8

Table 8.2 Catch in number, millions, Icelandic Summer Spawners 1969-1982.

AGE	1969	1970	1971	1972	1973	1974	1975
1	4,520	2,003	8,774	0,176	0,001	0,001	1,465
2	78,410	22,344	13,071	0,385	0,172	3,681	1,977
3	8,274	33,965	5,439	0,157	0,734	0,814	30,855
4	5,178	4,500	13,688	0,195	0,113	0,972	6,266
5	10,015	2,734	3,040	0,316	0,018	0,090	7,628
6	2,841	4,419	1,563	0,056	0,014	0,045	0,833
7	1,389	1,145	3,276	0,033	0,006	0,002	0,427
8	1,179	0,531	0,748	0,029	0,006	0,001	0,333
9	0,609	0,604	0,250	0,016	0,003	0,001	0,110
10	0,424	0,195	0,103	0,011	0,003	0,001	0,004
11	0,286	0,103	0,120	0,004	0,001	0,001	0,001
12	0,139	0,076	0,001	0,001	0,001	0,001	0,001
13	0,109	0,061	0,001	0,004	0,001	0,001	0,001
14	0,074	0,051	0,001	0,001	0,001	0,001	0,001
JUVENILE	78,943	23,167	16,899	0,449	0,070	3,215	3,834
ADULT	34,504	49,564	33,176	0,935	1,004	2,396	46,068
TOTAL	113,447	72,731	50,075	1,384	1,074	5,612	49,902

AGE	1976	1977	1978	1979	1980	1981	1982
1	0,632	0,683	2,607	0,919	3,239	2,279	0,431
2	10,136	18,266	22,318	14,932	14,768	4,622	18,245
3	4,022	23,400	50,469	47,038	21,370	16,745	26,729
4	35,142	10,080	13,703	68,968	62,509	12,107	36,400
5	7,214	44,913	8,648	16,270	67,245	36,813	15,807
6	5,641	6,525	39,085	7,915	11,879	41,851	36,427
7	1,076	5,252	7,178	25,753	9,557	7,288	41,621
8	0,451	1,352	6,288	3,016	20,012	4,855	6,479
9	0,305	0,508	1,599	1,848	1,849	13,395	6,307
10	0,138	0,351	0,916	0,489	1,507	1,030	9,943
11	0,095	0,026	0,396	0,434	0,718	0,883	2,238
12	0,001	0,124	0,017	0,032	0,001	0,759	0,565
13	0,001	0,001	0,025	0,053	0,113	0,101	0,071
14	0,001	0,001	0,050	0,006	0,081	0,062	0,201
JUVENILE	9,853	21,626	35,135	32,648	18,978	12,744	21,764
ADULT	55,002	89,856	118,164	155,025	195,870	130,046	179,700
TOTAL	64,855	111,482	153,299	187,673	214,848	142,790	201,464

Table 8.3 Weight at age, in grammes. Icelandic summer spawners 1969-1982.

AGE	1969	1970	1971	1972	1973	1974	1975
1	82.0	85.0	88.0	96.0	90.0	80.0	110.0
2	157.0	169.0	165.0	177.0	199.0	189.0	179.0
3	195.0	216.0	237.0	278.0	257.0	262.0	241.0
4	264.0	263.0	273.0	332.0	278.0	297.0	291.0
5	284.0	312.0	301.0	358.0	337.0	340.0	319.0
6	304.0	329.0	324.0	379.0	381.0	332.0	339.0
7	339.0	338.0	346.0	410.0	380.0	379.0	365.0
8	372.0	357.0	368.0	419.0	397.0	356.0	364.0
9	379.0	378.0	390.0	470.0	385.0	407.0	407.0
10	390.0	396.0	409.0	500.0	450.0	410.0	389.0
11	376.0	408.0	412.0	500.0	450.0	410.0	430.0
12	401.0	425.0	420.0	500.0	450.0	423.0	416.0
13	409.0	430.0	442.0	500.0	450.0	423.0	416.0
14	414.0	450.0	450.0	500.0	450.0	423.0	416.0

AGE	1976	1977	1978	1979	1980	1981	1982
1	103.0	84.0	73.0	75.3	68.9	60.8	65.0
2	189.0	157.0	128.0	145.3	115.3	140.9	141.0
3	243.0	217.0	196.0	182.4	202.0	190.5	186.1
4	281.0	261.0	247.0	230.9	232.5	245.5	217.3
5	305.0	285.0	295.0	284.7	268.9	268.6	273.7
6	335.0	313.0	314.0	315.7	316.7	297.6	293.3
7	351.0	326.0	339.0	333.7	351.6	329.8	323.0
8	355.0	347.0	359.0	350.4	360.4	355.7	353.8
9	395.0	364.0	360.0	366.7	379.9	368.3	384.6
10	363.0	362.0	376.0	368.3	382.9	405.4	388.7
11	396.0	358.0	380.0	370.6	392.7	381.5	400.4
12	396.0	355.0	425.0	350.0	390.0	400.0	393.5
13	396.0	400.0	425.0	350.0	390.0	400.0	390.3
14	396.0	420.0	425.0	450.0	390.0	400.0	419.5

Table 8.4

Proportion of mature herring in each group. Based on samples taken in Sept. - Oct. by purse seine and pelagic trawls. The number of herring analysed are given in the brackets.

Rings	1960	1961	1962	1963	1964	1965
2	0.28 (254)	0.13 (128)	0.04 (78)	0.54 (13)	0 (90)	0.05 (141)
3	0.79 (179)	0.79 (229)	0.46 (82)	0.96 (45)	0.85 (114)	0.75 (177)
4	0.99 (81)	0.97 (179)	0.83 (117)	0.97 (69)	0.99 (78)	1.0 (122)
5			0.96 (85)		0.98 (58)	
Rings	1966	1967	1968	1969	1970	1971
2	0.05 (279)	0.02 (121)	0.02 (139)	0.08 (1595)	0.22 (970)	0.38 (436)
3	0.52 (195)	0.41 (472)	0.67 (141)	0.73 (165)	0.89 (1271)	0.98 (318)
4	0.95 (170)	0.84 (136)	0.97 (328)	0.99 (104)	1	1
Rings	1972	1973	1974	1975	1976	1977
2	0.29 (157)	0.64 (74)	0.14 (662)	0.27 (163)	0.13 (611)	0.02 (948)
3	1.0 (5)	0.99 (132)	0.94 (86)	0.97 (2053)	0.90 (143)	0.87 (263)
4	1	1	1	1	1 (1018)	1 (121)
Rings	1978	1979	1980	1981	1982	
2	0.04 (714)	0.07 (366)	0.05 (417)	0.03 (185)	0.05 (718)	
3	0.78 (1012)	0.65 (835)	0.92 (290)	0.65 (390)	0.85 (342)	
4	1.0 (174)	0.90 (907)	1.0 (808)	0.99 (178)	1.00 (466)	

Table 8.5

Stock abundance and catches by age groups x 10^{-6} 1982.

Rings	Acoustic estimates	Catches	F_{82}
1		0.4	
2	393[1)]	18.2	0.05
3	448[2)]	26.7	0.06 (0.12)
4	206	36.4	0.19
5	54	15.8	0.36
6	157	36.4	0.28
7	205	41.6	0.24
8	30	6.4	0.25
9	10	6.3	1.07
10	57	9.9	0.2
10+	12	3.0	0.3
	N_{4+} = 731	C_{4+} = 155.8	F_{4+} = 0.25

1) Based on acoustic estimate Jan. 1983.

2) Based on acoustic estimate Dec. 1980.

Table 8.6 Icelandic summer spawners (herring in Division Va.)
Fishing mortalities.

AGE	1969	1970	1971	1972	1973	1974	1975
1	0.104	0.063	0.130	0.002	0.000	0.000	0.008
2	0.844	0.897	0.625	0.007	0.002	0.009	0.016
3	0.568	1.005	0.497	0.012	0.014	0.012	0.089
4	0.655	0.614	1.463	0.026	0.009	0.021	0.107
5	0.715	0.775	0.999	0.090	0.003	0.008	0.207
6	0.827	0.713	1.331	0.036	0.005	0.007	0.089
7	0.920	0.850	1.858	0.068	0.004	0.001	0.082
8	0.901	1.015	3.066	0.055	0.014	0.001	0.144
9	0.857	1.727	2.373	0.677	0.007	0.003	0.102
10	1.149	0.655	2.038	0.652	0.225	0.002	0.012
11	1.219	0.867	0.989	0.343	0.097	0.097	0.003
12	1.110	1.204	0.015	0.016	0.120	0.120	0.120
13	0.799	3.564	0.035	0.069	0.018	0.152	0.152
14	0.700	1.000	1.000	0.040	0.020	0.020	0.200
AVERAGE WEIGHTED BY STOCK IN NUMBERS							
AVE 4-14	0.750	0.744	1.474	0.049	0.007	0.017	0.138

AGE	1976	1977	1978	1979	1980	1981	1982
1	0.001	0.001	0.016	0.004	0.011	0.005	0.001
2	0.066	0.030	0.051	0.105	0.065	0.018	0.050
3	0.037	0.193	0.097	0.131	0.193	0.088	0.120
4	0.124	0.110	0.148	0.167	0.230	0.143	0.250
5	0.155	0.207	0.117	0.234	0.218	0.184	0.250
6	0.209	0.184	0.249	0.135	0.240	0.183	0.250
7	0.143	0.273	0.281	0.231	0.213	0.203	0.250
8	0.105	0.240	0.534	0.164	0.252	0.143	0.250
9	0.170	0.148	0.437	0.261	0.129	0.239	0.250
10	0.161	0.269	0.381	0.205	0.313	0.088	0.250
11	0.371	0.037	0.484	0.278	0.461	0.272	0.250
12	0.003	1.034	0.028	0.057	0.001	1.139	0.250
13	0.152	0.003	0.520	0.102	0.261	0.096	0.250
14	0.200	0.200	0.200	0.200	0.200	0.200	0.250
AVERAGE WEIGHTED BY STOCK IN NUMBERS							
AVE 4-14	0.135	0.186	0.215	0.183	0.226	0.183	0.250

Table 8.7. Icelandic summer spawners (HERRING in Division Va), VPA stock size in numbers (x 10^{-6}) and spawning stock biomass at 1 July.

AGE	1969	1970	1971	1972	1973	1974	1975
1	48,245	34,586	75,713	88,797	470,135	144,066	184,483
2	143,544	39,360	29,391	60,174	80,179	425,440	130,346
3	19,980	55,845	14,525	14,230	54,082	72,386	381,455
4	11,264	10,249	18,499	7,992	12,726	48,238	64,724
5	20,474	5,295	5,016	3,876	7,046	11,408	42,723
6	5,271	9,059	2,208	1,672	3,207	6,359	10,237
7	2,408	2,086	4,020	0,528	1,460	2,888	5,711
8	2,071	0,868	0,806	0,567	0,446	1,315	2,611
9	1,104	0,761	0,285	0,034	0,486	0,398	1,189
10	0,646	0,424	0,123	0,024	0,016	0,437	0,359
11	0,422	0,185	0,199	0,014	0,011	0,011	0,394
12	0,216	0,113	0,071	0,067	0,009	0,009	0,009
13	0,207	0,064	0,031	0,063	0,060	0,007	0,007
14	0,154	0,084	0,002	0,027	0,053	0,053	0,006
JUVENILE	185,813	71,430	93,469	131,521	499,541	514,288	291,079
Sp.stock biomass	16 798	20 153	13 824	11 688	30 527	48 835	128 647

AGE	1976	1977	1978	1979	1980	1981	1982
1	721,447	517,770	176,396	272,520	311,851	436,673	453,132
2	165,535	652,189	467,850	157,131	245,712	279,094	392,952
3	116,062	140,150	572,761	402,117	127,993	208,295	248,141
4	315,839	101,194	104,599	470,307	319,174	95,526	172,563
5	52,612	252,403	81,989	81,632	360,066	229,478	74,937
6	31,417	40,755	185,752	65,972	58,423	261,978	172,691
7	8,471	23,073	30,682	130,989	52,176	41,591	197,315
8	4,762	6,643	15,895	20,953	94,084	38,140	30,715
9	2,047	3,880	4,728	8,430	16,095	66,143	29,900
10	0,971	1,562	3,028	2,763	5,874	12,807	47,137
11	0,321	0,748	1,081	1,872	2,036	3,886	10,610
12	0,356	0,201	0,652	0,603	1,282	1,162	2,679
13	0,007	0,321	0,065	0,574	0,515	1,159	0,337
14	0,006	0,006	0,289	0,035	0,469	0,359	0,953
JUVENILE	877,068	1175,134	751,539	568,799	555,517	781,253	854,594
Sp.stock biomass	143 512	144 477	207 457	243 558	263 523	237 029	248 770

Table 8.8.

Input parameters used in Catch Prediction for the Icelandic summer spawning Div. Va herring

Rings	Stock in number at 1/1 1982	Proportional F	Mean weight in catch and in spawning stock
1	400 000	0.004	65
2	341 299	0.2	140
3	338 216	0.48	190
4	199 138	1.0	240
5	121 603	-	280
6	52 807	-	300
7	121 694	-	330
8	139 045	-	360
9	21 070	-	380
10	33 217	-	400
11	33 217	-	-
12	7 477	-	-
13	1 888	-	-
14	237	-	-

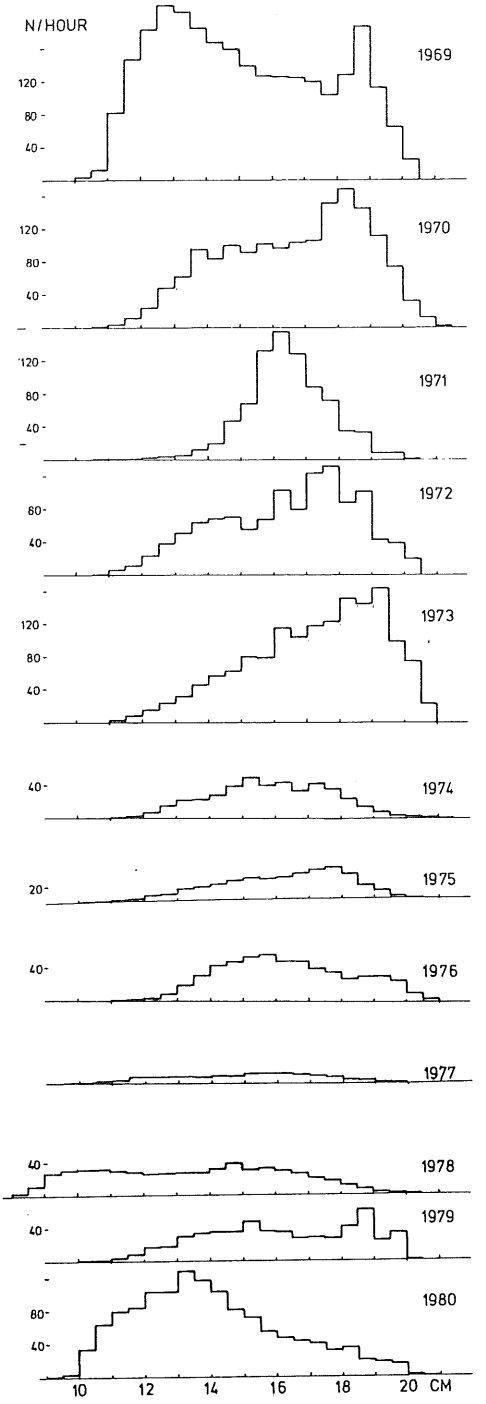


Figure 2.1.

Length distributions in number per hour of one year old HERRING in the North Sea without Moray Firth and Skagerrak.

Data from from IYFS.

Figure 2.2. International Young Fish Survey, February 1983.
One-ringed HERRING in numbers per hour, preliminary data.

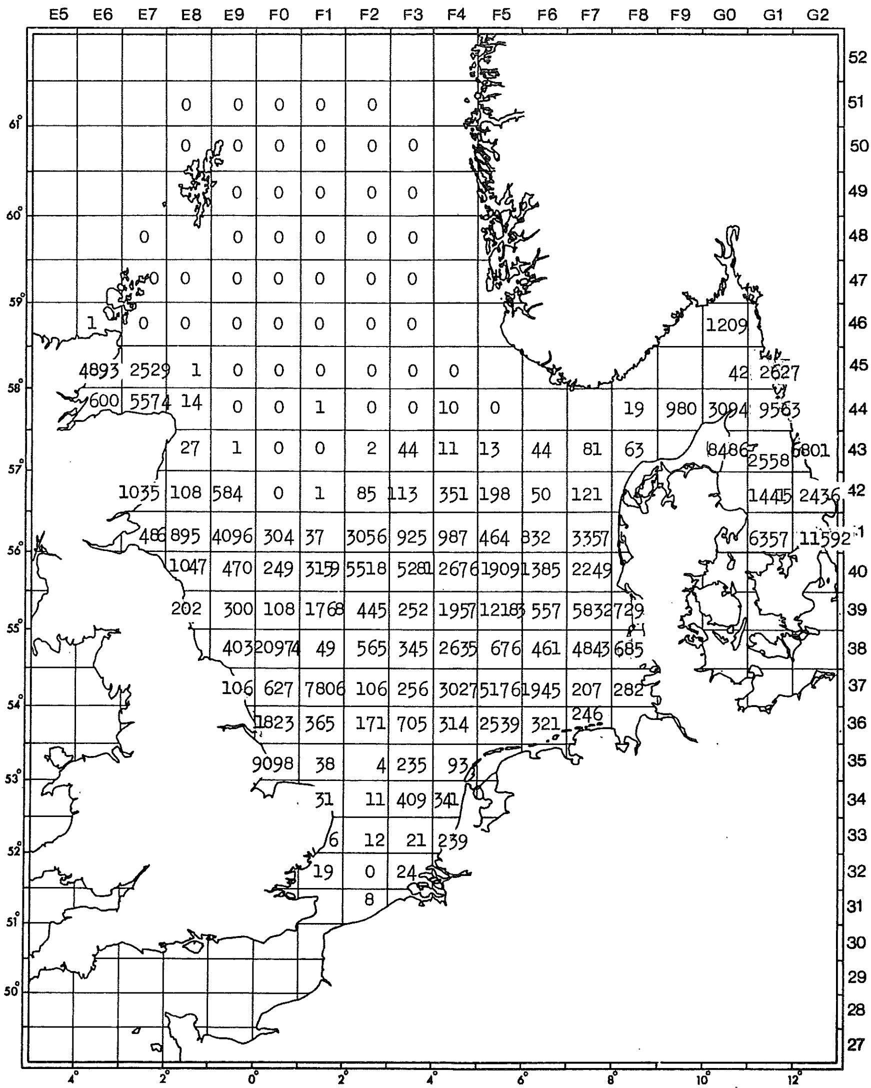


Figure 2.3. HERRING larvae sampled by IKMT during IYFS 1983.
No. larvae per haul.

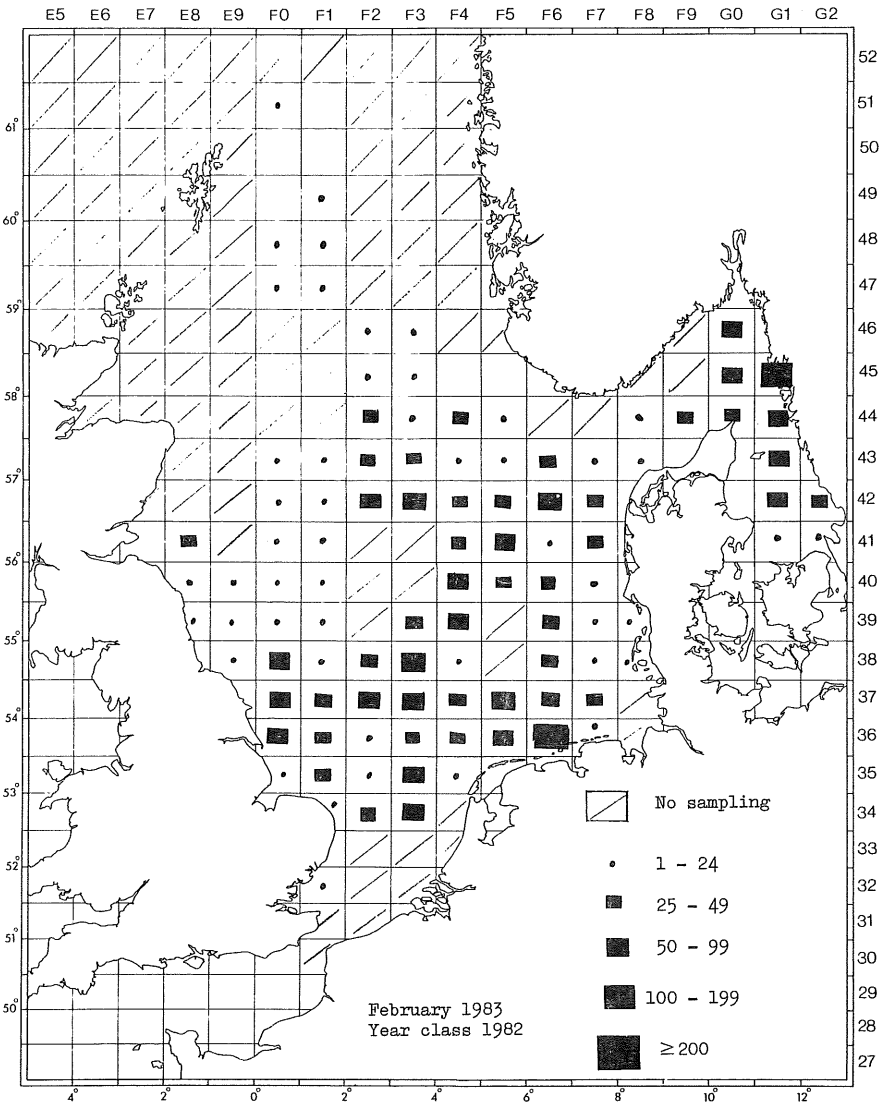


Figure 2.4. Larval abundance indices and spawning stock biomasses in Division IVa. Spawning stock biomasses derived from VPA using 1982 acoustic survey biomass estimate.

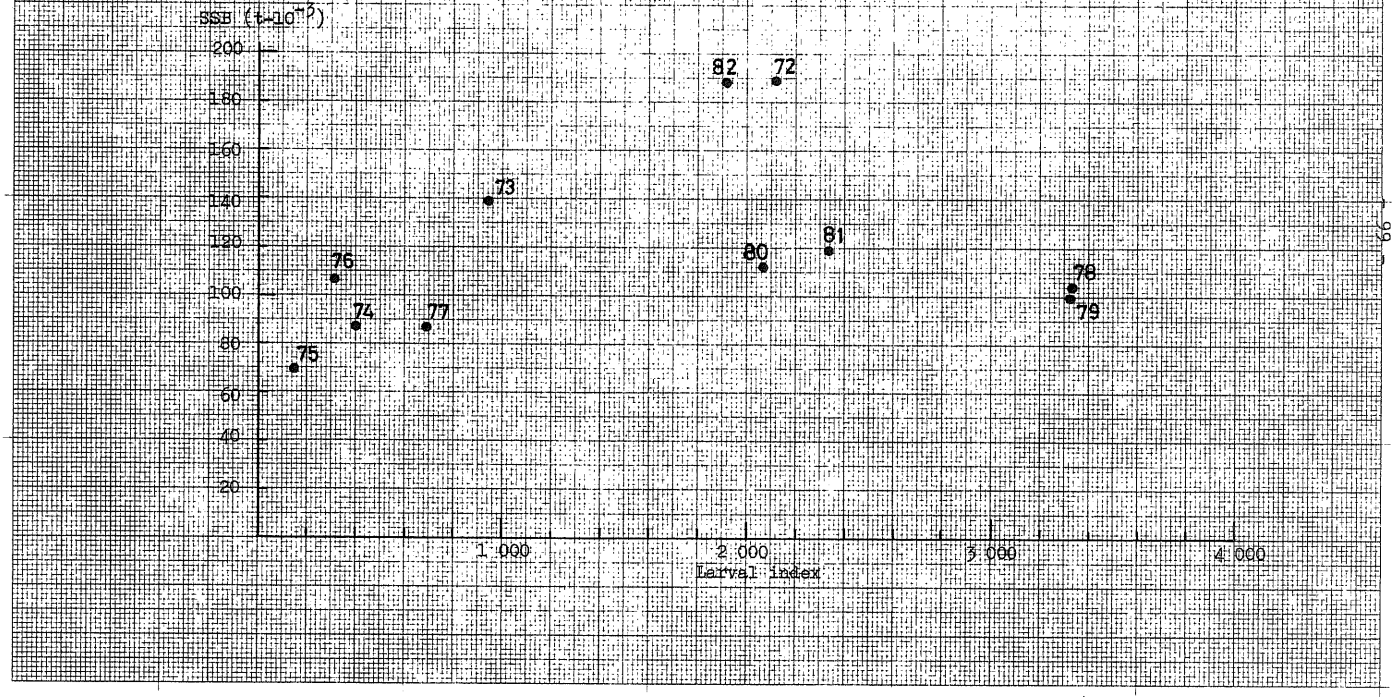
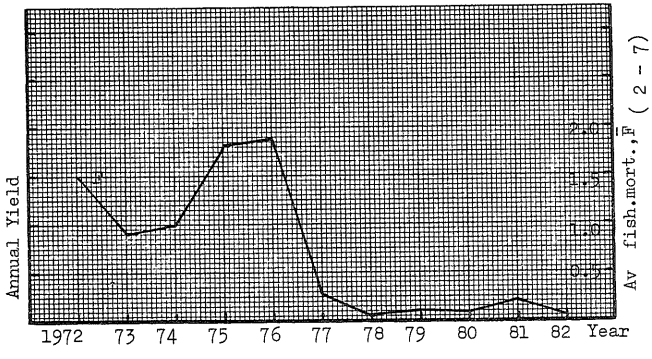


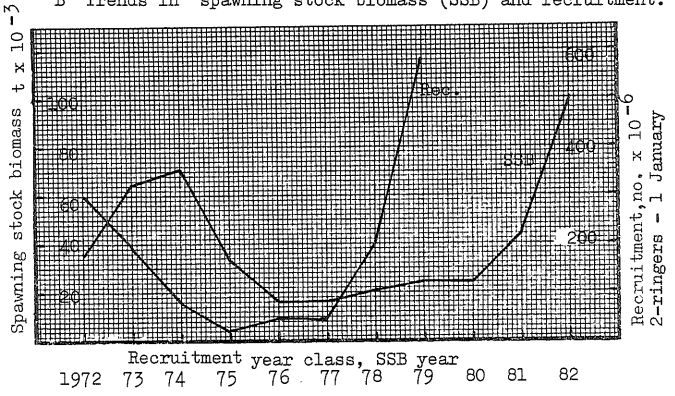
Figure 2.5. F I S H S T O C K S U M M A R Y

Division IVb - HERRING
(stock)

A Trends in Yield and fishing mortality ($\bar{F}$)



B Trends in spawning stock biomass (SSB) and recruitment.



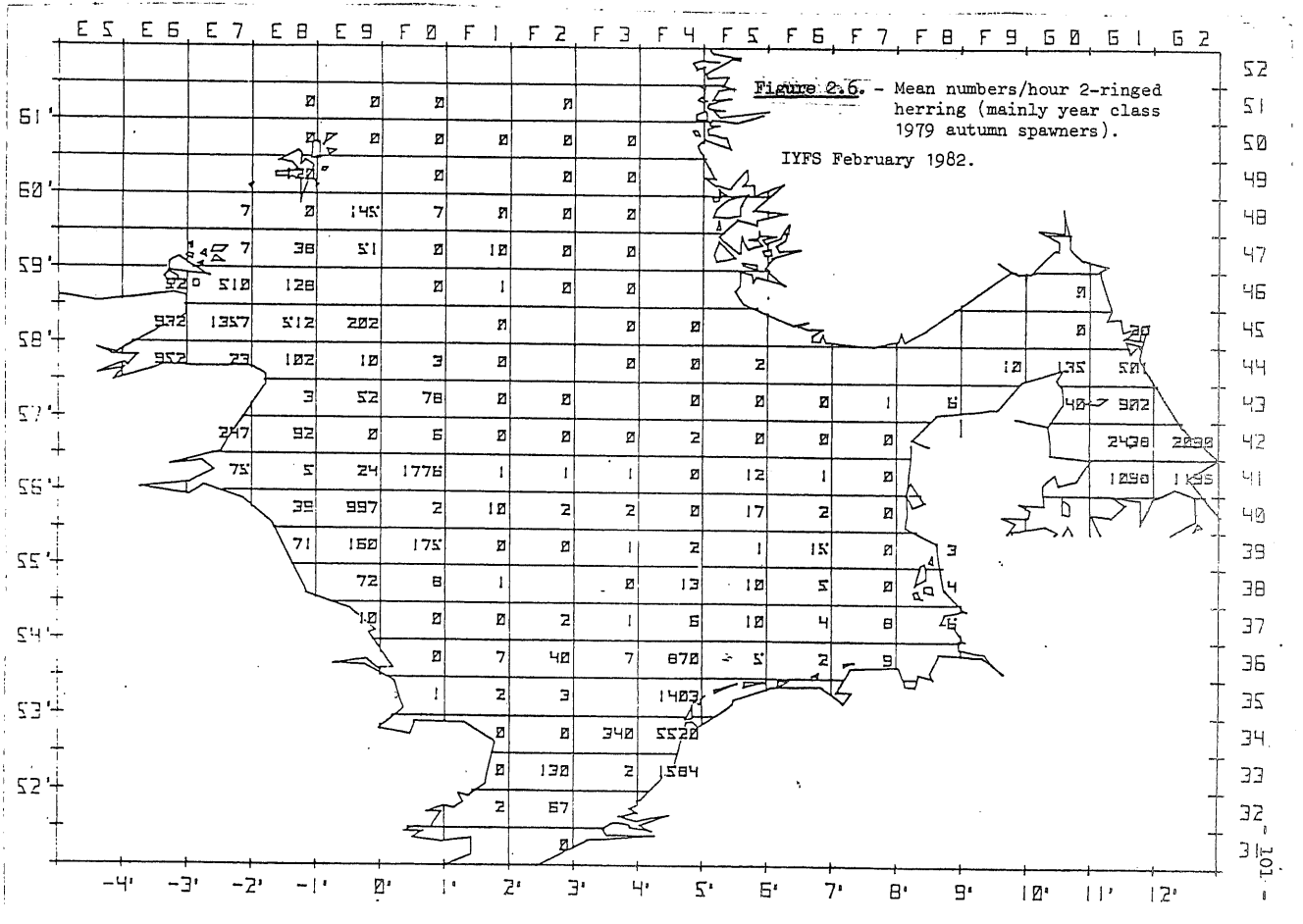
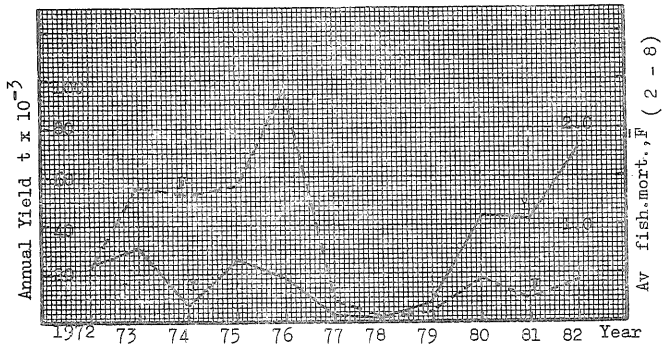


Figure 2.6. - Mean numbers/hour 2-ringed herring (mainly year class 1979 autumn spawners).

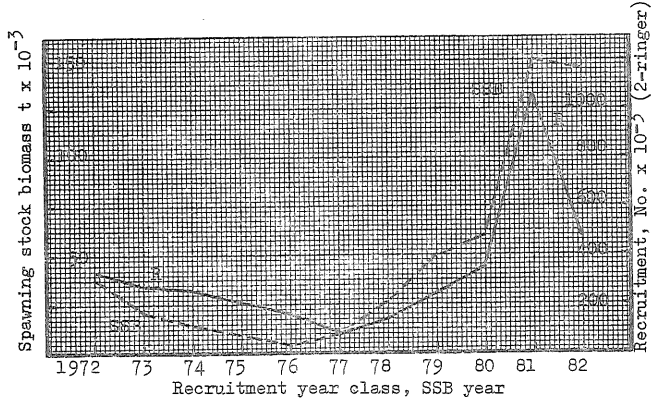
IYFS February 1982.

Figure 2.7. FISH STOCK SUMMARY Downs HERRING, ICES Divs. IVc and VIId. (stock)

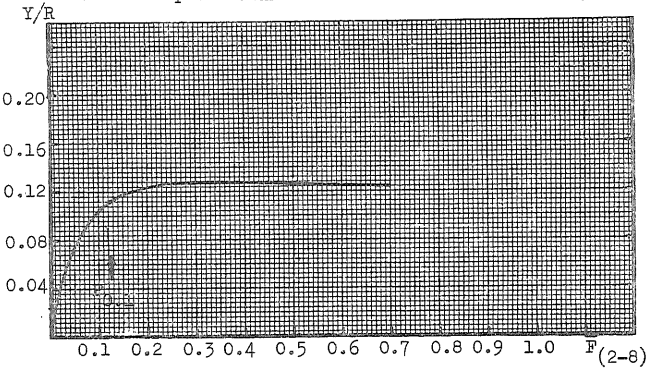
A Trends in Yield and fishing mortality ($\bar{F}$)



B Trends in spawning stock biomass (SSB) and recruitment.



C Yield per recruit



D Catch in 1983 and spawning stock biomass at the end of 1983 for different levels of fishing mortality in 1983

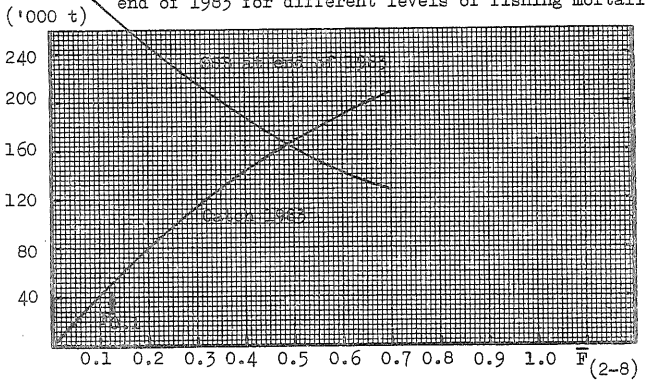


Figure 3.1. Relation between VPA estimates of 2-wr.cod stock in numbers in Division IIIa and IV Sub-Divisions 22-24.

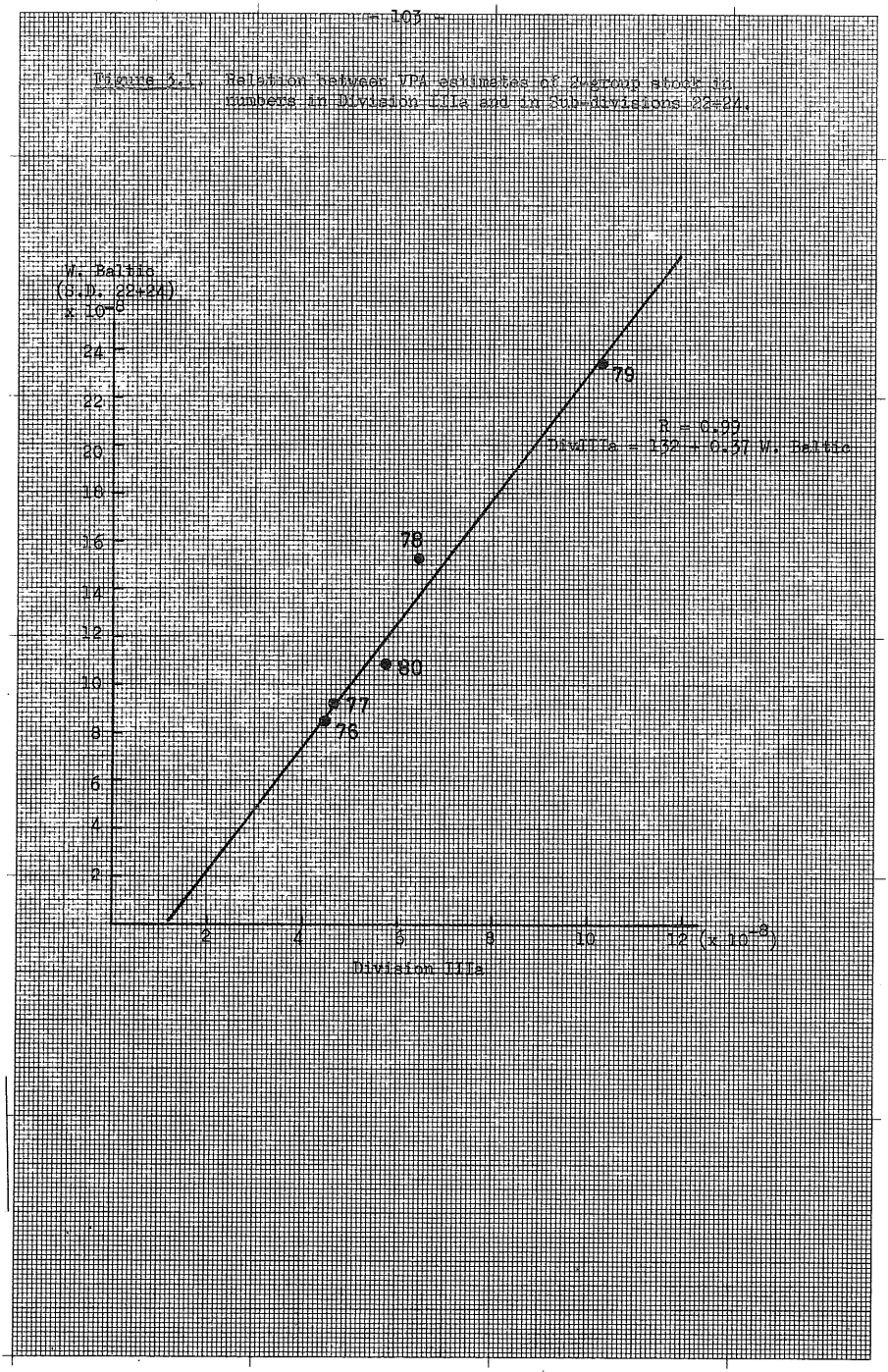


Figure 4.2. Relationship between the number of 2-ringers caught in Skagerrak-Kattegat in one year and the number of 3-ringers caught the following year in the western Baltic (Areas 22 - 24).

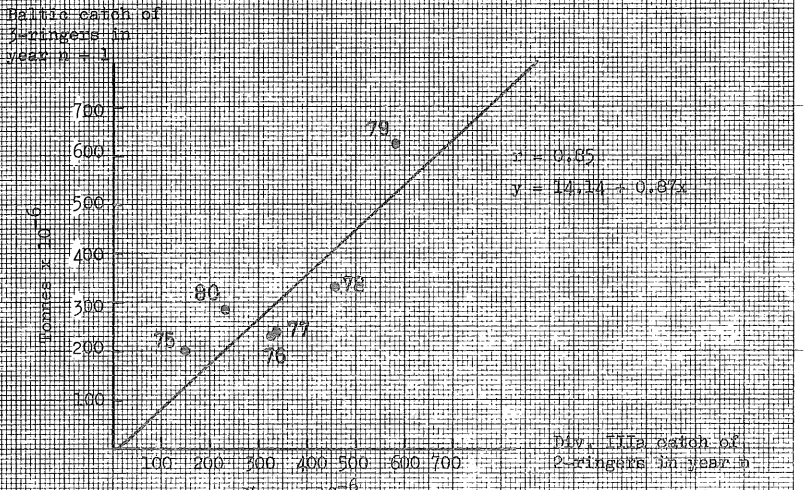
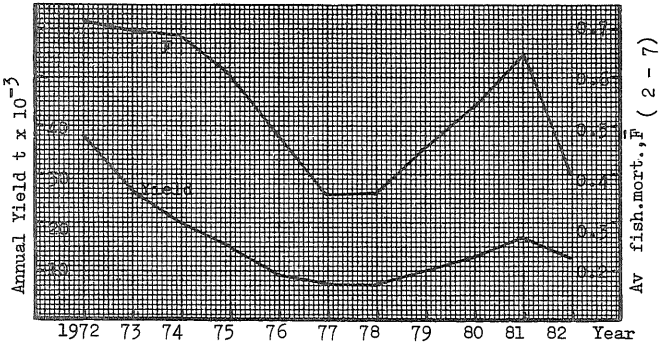


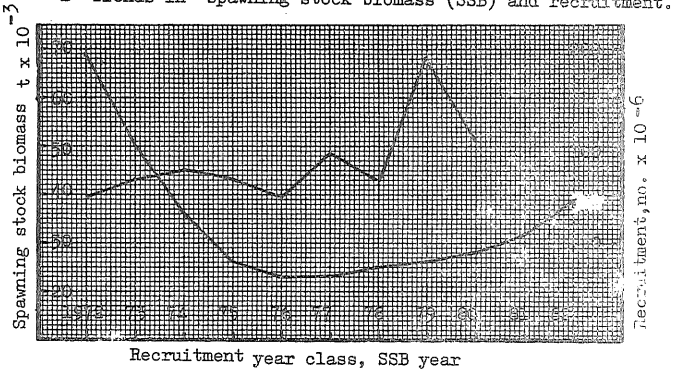
Figure 4.1. F I S H S T O C K S U M M A R Y

HERRING -Celtic Sea and Division VIIj
(stock)

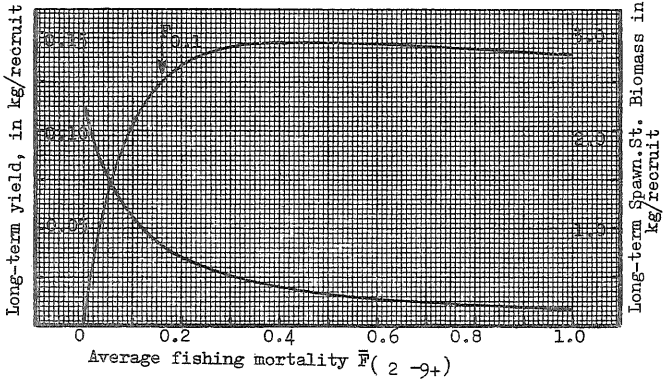
A Trends in Yield and fishing mortality ($\bar{F}$)



B Trends in spawning stock biomass (SSB) and recruitment.



C Long-term yield and spawning stock biomass
(indicate biological reference points)



D Short-term yield and spawning stock biomass
(indicate biological reference points)

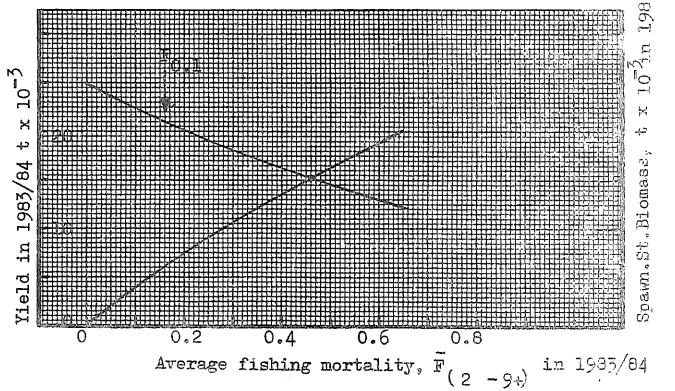


Figure 4.2. Celtic Sea HERRING in Division VIIg. Stock and recruitment.

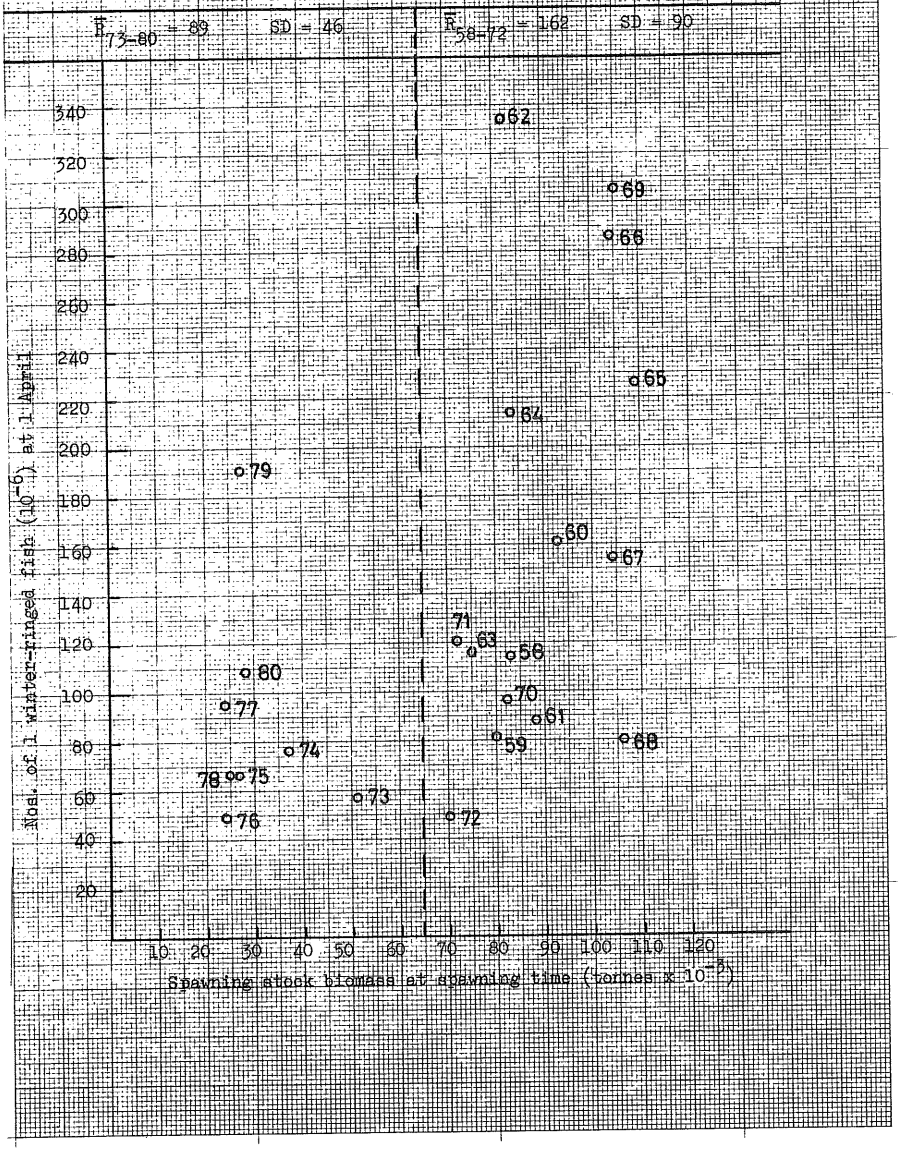
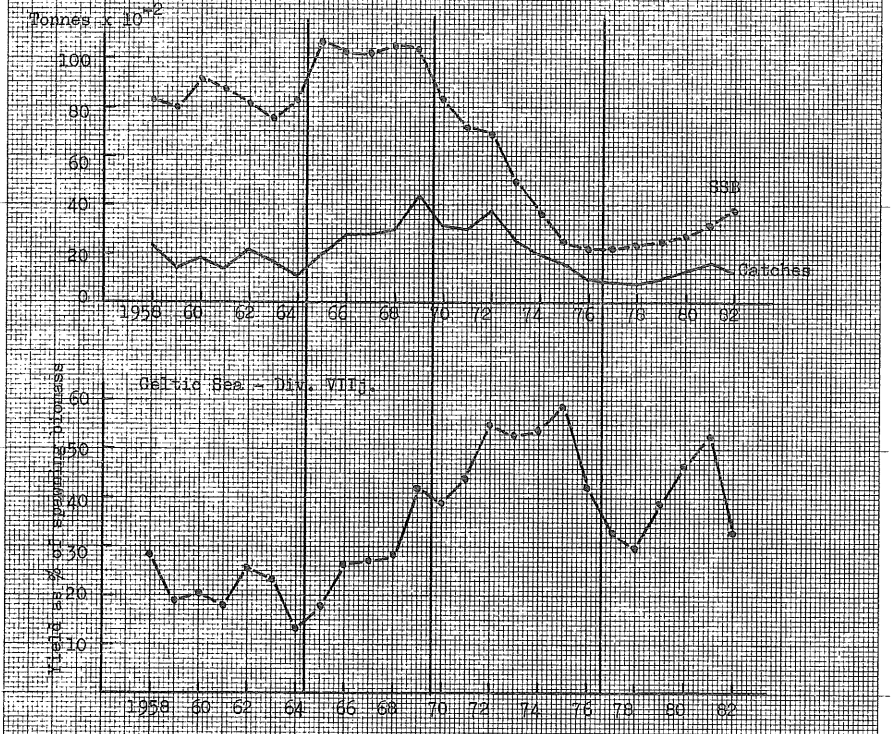


Figure 4.1: Celtic Sea HERRING.
Trend in spawning stock biomass, catches and yield as % of SSB.



Period	SSB	Yield	%	
1958-64	93 000	17 000	20	Stable stock (winter sp.)
1965-69	106 000	30 000	29	High stock (winter sp.)
1970-76	51 500	24 800	48	Declining stock (mixture)
1977-82	29 000	11 500	40	Low stock (mainly autumn)

Figure 5.1. Boundaries of new HERRING unit stocks west of Scotland and Ireland.

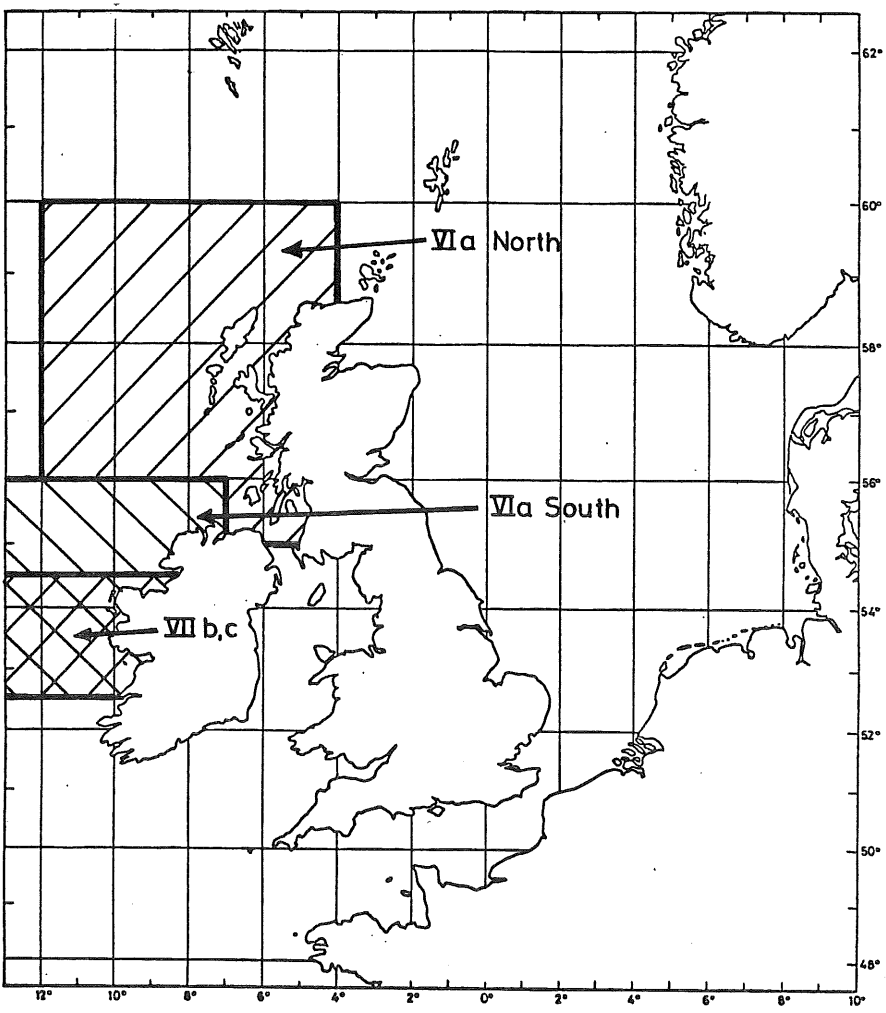


Figure 5.2: Larval abundance indices and spawning stock biomasses in Division VIa (North). Points are labelled by year.

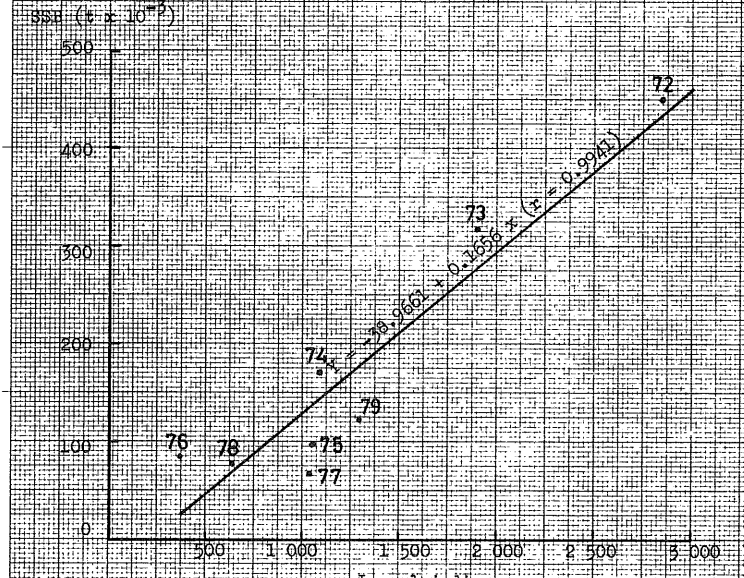
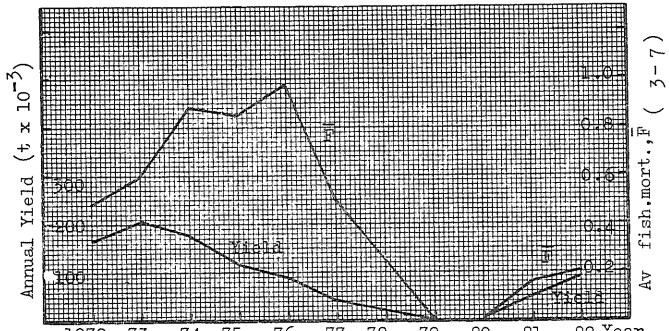
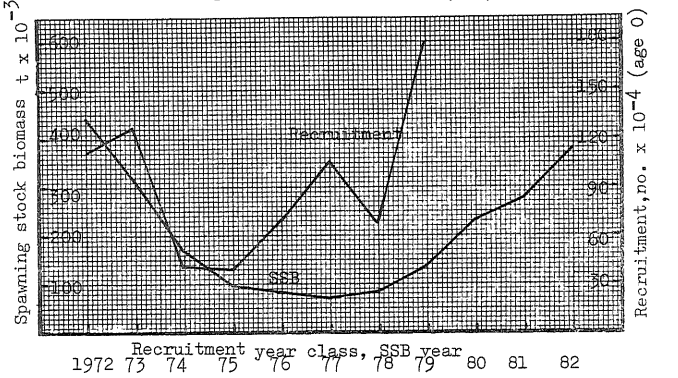


Figure 5.3. F I S H S T O C K S U M M A R Y ...Herring in Div.VIa (North)...
(stock)

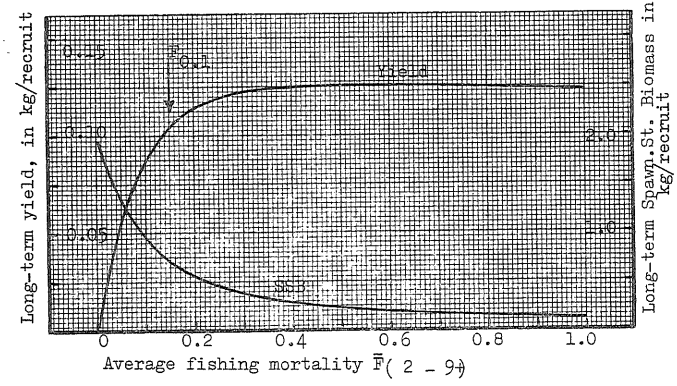
A Trends in Yield and fishing mortality ($\bar{F}$)



B Trends in spawning stock biomass (SSB) and recruitment.



C Long-term yield and spawning stock biomass
(indicate biological reference points)



D Short-term yield and spawning stock biomass
(indicate biological reference points)

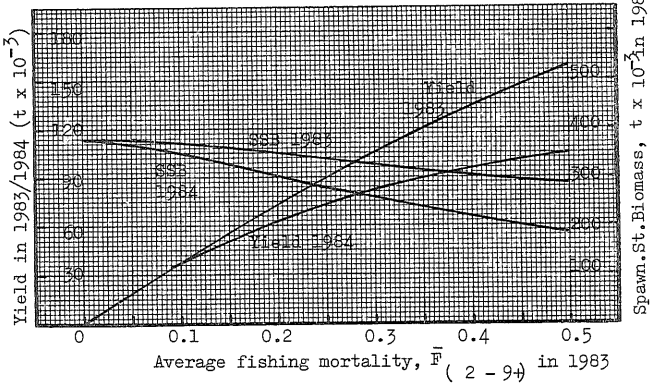


Figure 5.4. Weighted mean values of F on 2-ringers and older using different values of input F. Clyde HERRING.

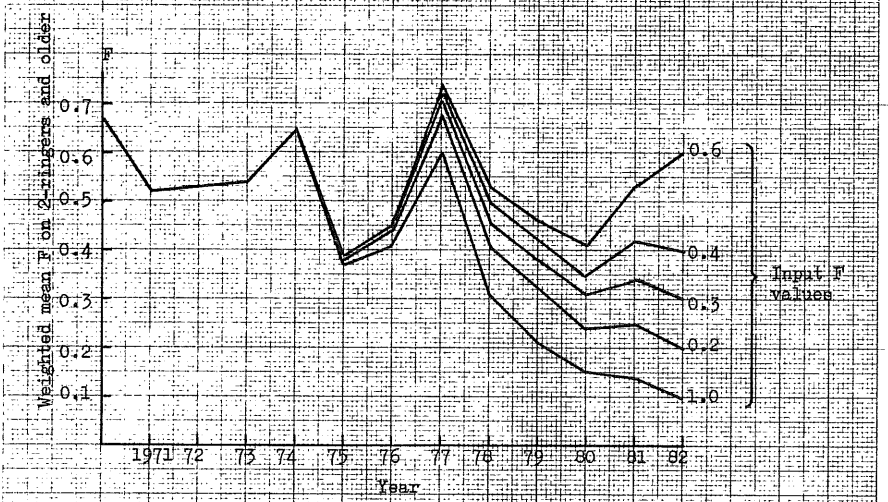
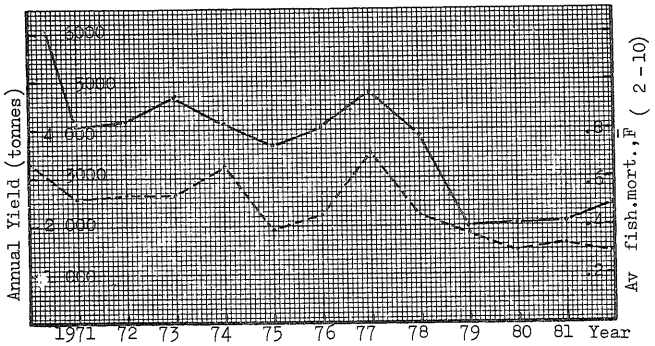


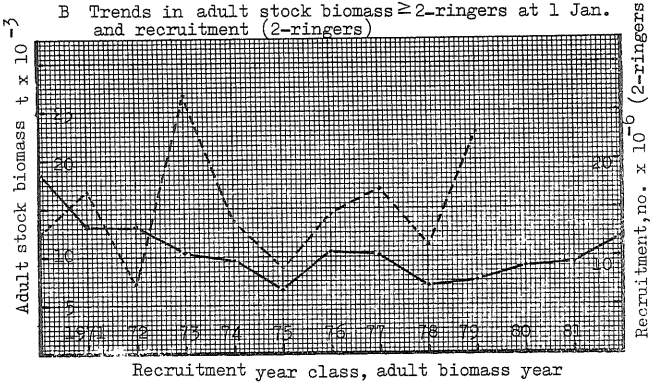
Figure 5.5. F I S H S T O C K S U M M A R Y

Clyde Herring
(stock)

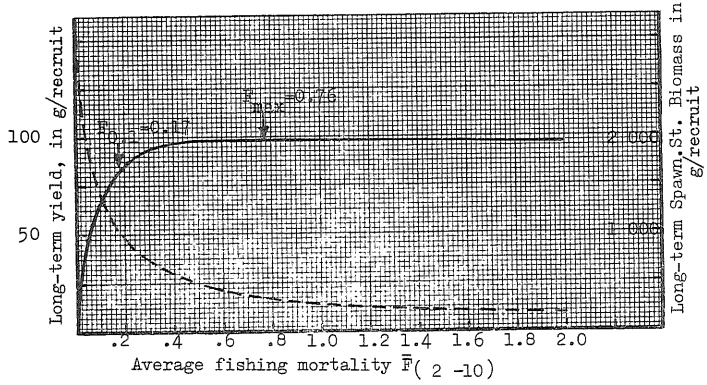
A Trends in Yield and fishing mortality ($\bar{F}$)



B Trends in adult stock biomass ≥ 2-ringers at 1 Jan. and recruitment (2-ringers)



C Long-term yield and adult stock biomass (≥2-ringers) (indicate biological reference points) at 1 January



D Short-term yield and spawning stock biomass (indicate biological reference points)

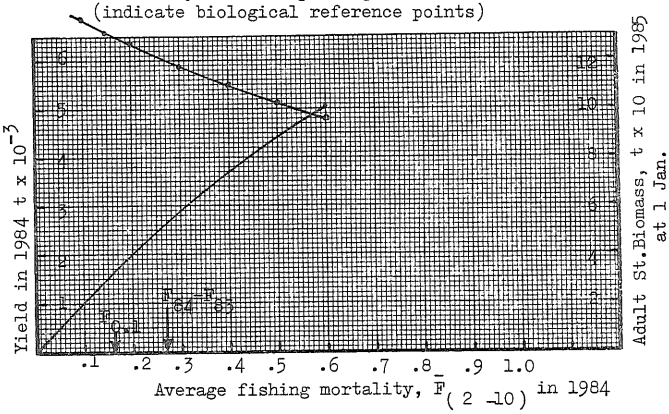


Figure 6.1. Larval abundance indices and spawning stock biomasses in Division VIa (south) and Division VIIb,c. Points are labelled by year.

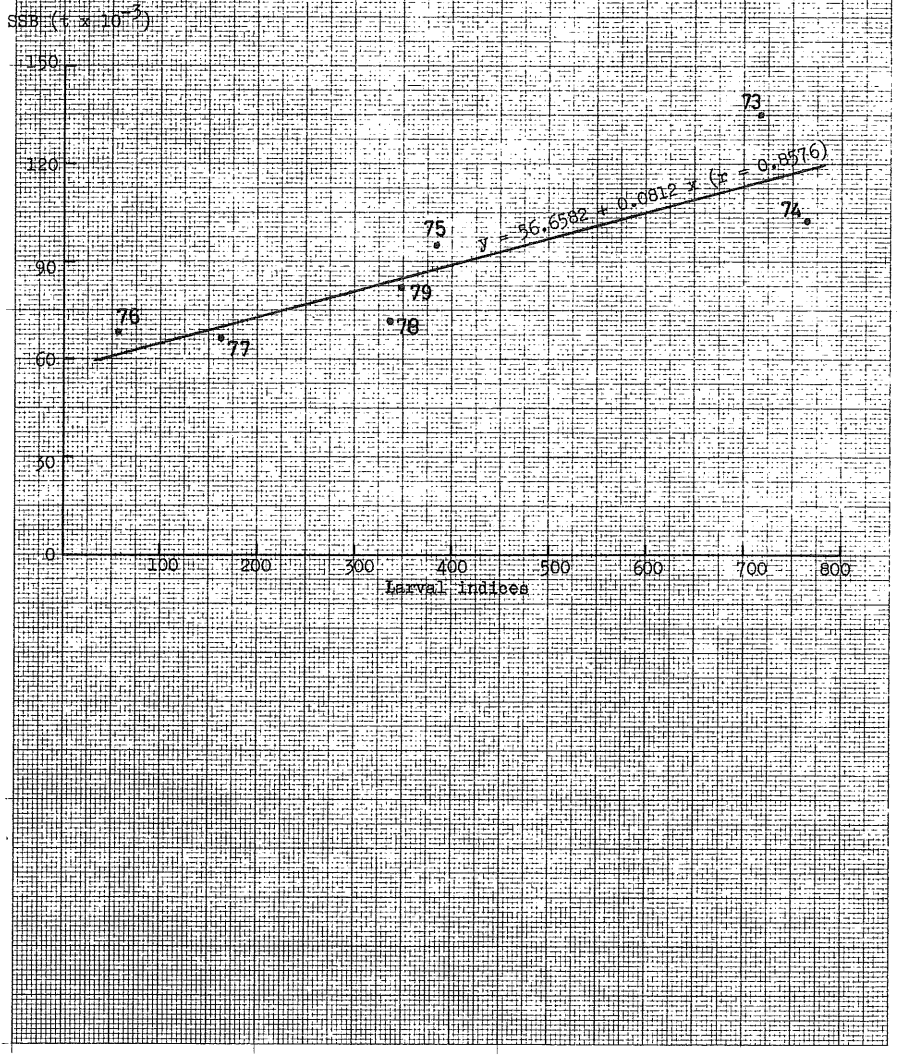
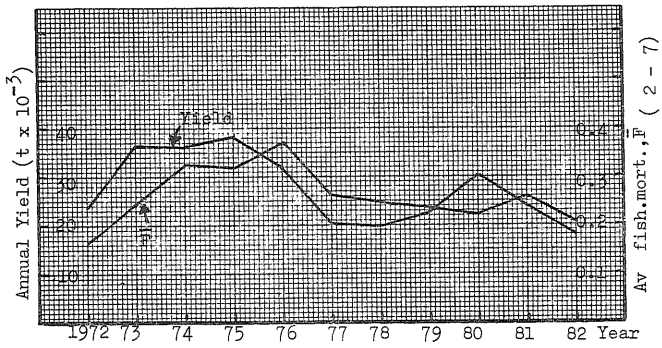


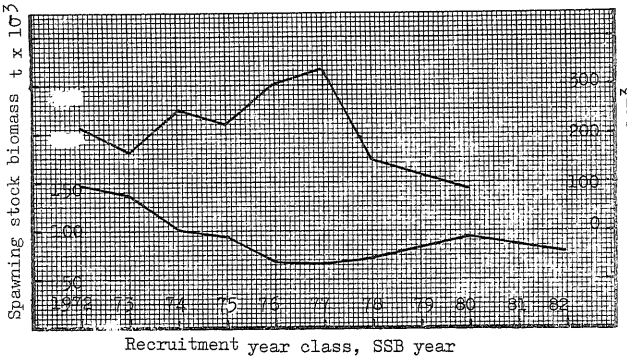
Figure 6.2. F I S H S T O C K S U M M A R Y

Herring in Divs. VIa(south) and VIIb,c
(stock)

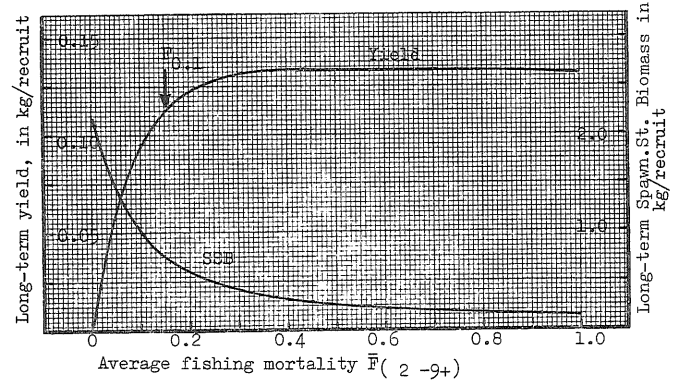
A Trends in Yield and fishing mortality ($\bar{F}$)



B Trends in spawning stock biomass (SSB) and recruitment.



C Long-term yield and spawning stock biomass
(indicate biological reference points)



D Short-term yield and spawning stock biomass
(indicate biological reference points)

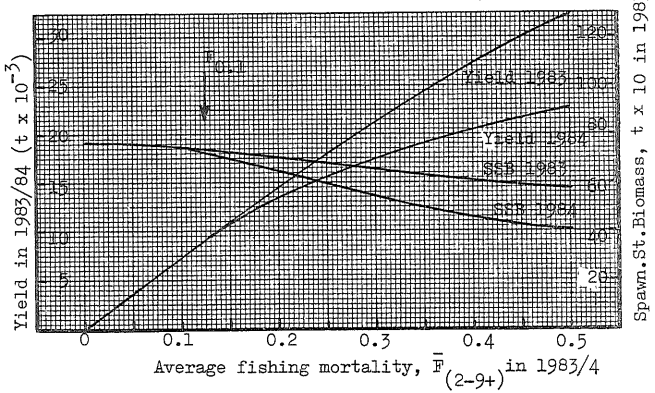
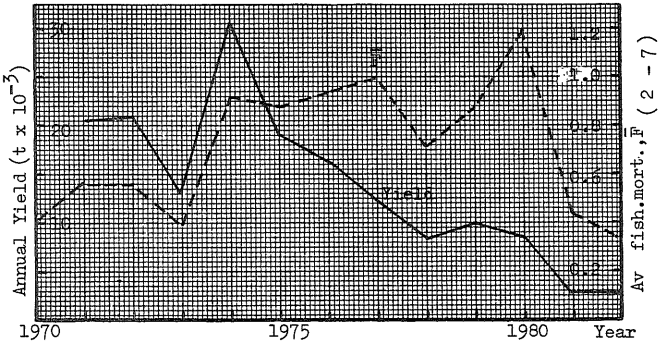


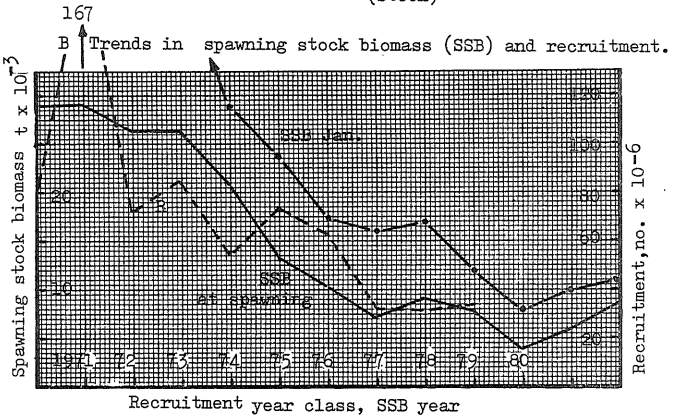
Figure 7.1. F I S H S T O C K S U M M A R Y

Manx Herring in Div. VIIa
(stock)

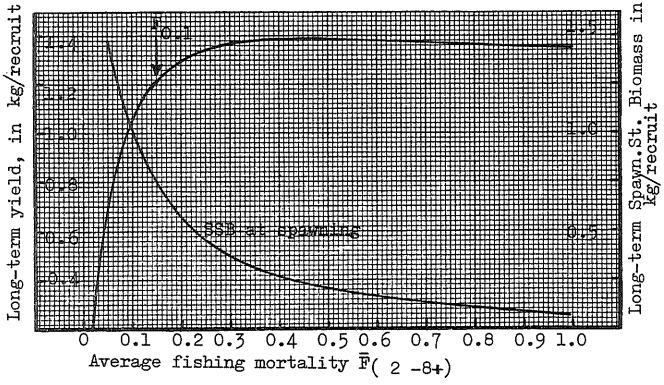
A Trends in Yield and fishing mortality ($\bar{F}$)



B Trends in spawning stock biomass (SSB) and recruitment.



C Long-term yield and spawning stock biomass
(indicate biological reference points)



D Short-term yield and spawning stock biomass
(indicate biological reference points)

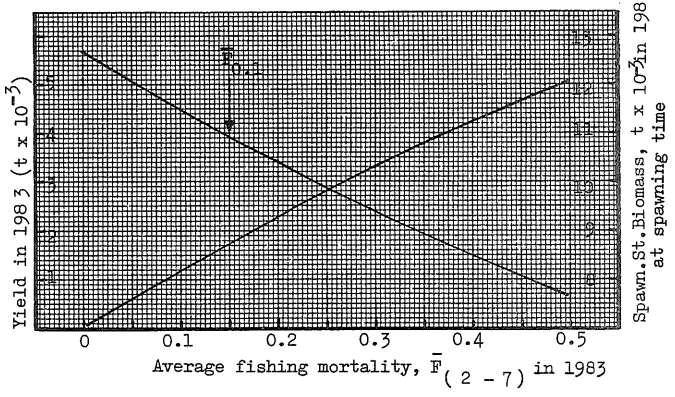
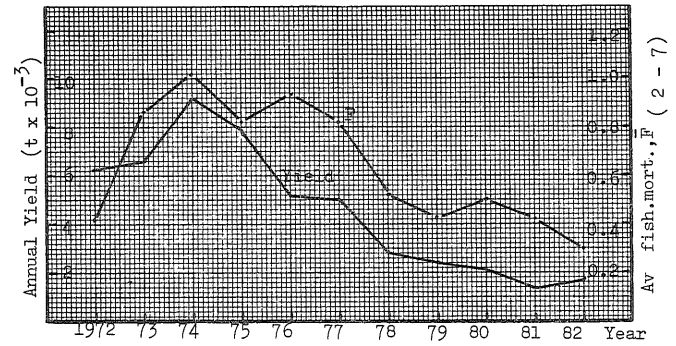


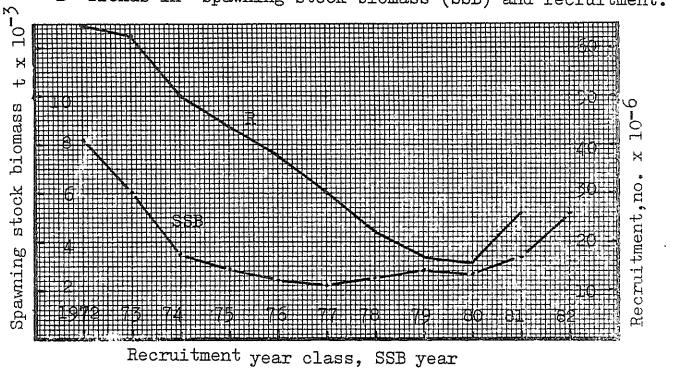
Figure 7.2. F I S H S T O C K S U M M A R Y

Mourne Herring - Div.VIIa
(stock)

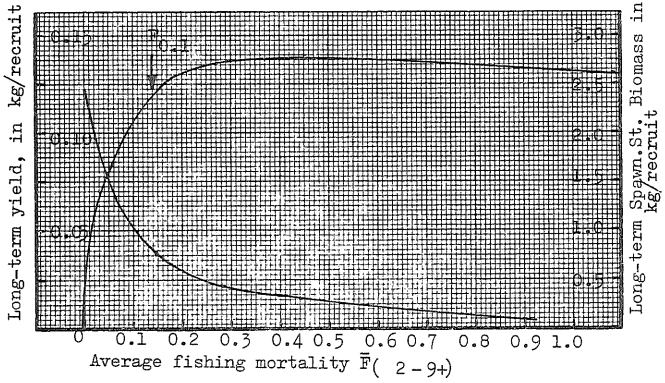
A Trends in Yield and fishing mortality ($\bar{F}$)



B Trends in spawning stock biomass (SSB) and recruitment.



C Long-term yield and spawning stock biomass
(indicate biological reference points)



D Short-term yield and spawning stock biomass
(indicate biological reference points)

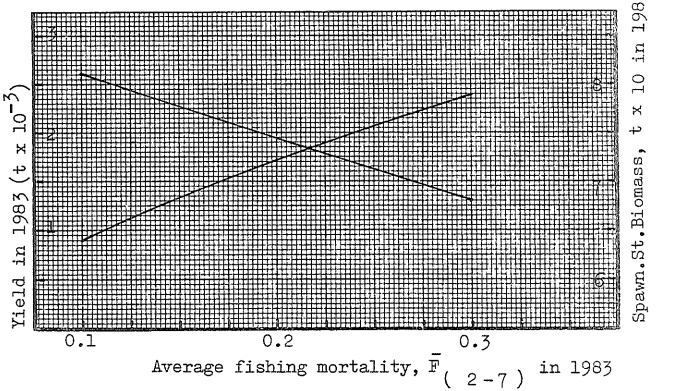
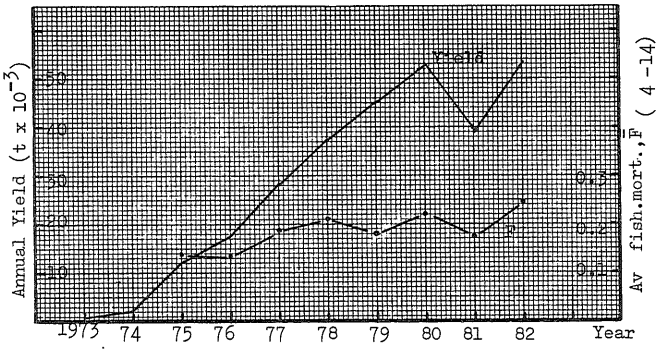


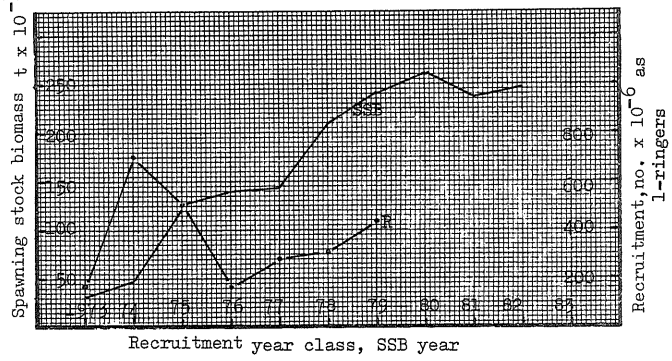
Figure 8.1. F I S H S T O C K S U M M A R Y

Icelandic Summer Spawning Herring
(stock)

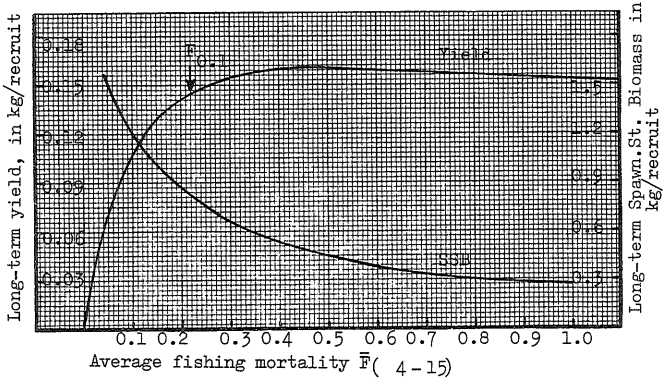
A Trends in Yield and fishing mortality ($\bar{F}$)



B Trends in spawning stock biomass (SSB) and recruitment.



C Long-term yield and spawning stock biomass
(indicate biological reference points)



D Short-term yield and spawning stock biomass
(indicate biological reference points)