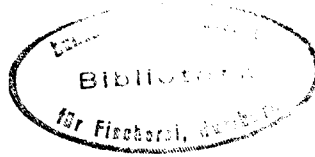


International Council for the
Exploration of the Sea

C.M.1975/H:2

Pelagic Fish (Northern) Committee



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REPORT OF THE HERRING ASSESSMENT WORKING GROUP FOR

THE AREA SOUTH OF 62°N

27 February - 7 March 1975, Charlottenlund

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Report of the Herring Assessment Working Group for the Area South of 62°N

1. Introduction and Participation

1.1 The Herring Assessment Working Group for the Area South of 62°N met at Charlottenlund over the period 27 February - 7 March 1975 to report to the Liaison Committee's mid-term meeting on the following subjects:

- a) the appropriate levels of TAC for the North Sea and Skagerak herring in 1975 and in 1976;
- b) the appropriate level of TAC for Division VIa herring in 1976;
- c) the TAC level for Celtic Sea herring in the period 1 March 1976 - 28 February 1977;
- d) the state of the North Sea sprat population and what regulatory measures are desirable, including a TAC level if this is considered appropriate.

1.2 Member countries were represented by the following scientists:

Mr E Bakken	Norway
Dr R S Bailey	U.K. (Scotland)
Mr A C Burd	U.K. (England)
Mr A Corten	Netherlands
Mr J Jakobsson	Iceland
Mr K Popp Madsen	Denmark
M A Maucorps	France
Mr J Molloy	Ireland
Mrs E Nielsen	Denmark
Dr G Rauck	Germany, Federal Republic of
Mr A Saville (Chairman)	U.K. (Scotland)
Dr H Schultz	German Democratic Republic
Dr A Schumacher	Germany, Federal Republic of
Mr B Sjöstrand	Sweden
Mr G Speiser	Germany, Federal Republic of
Mr Ø Ulltang	Norway
Mr O J Østvedt	Norway

All meetings were attended by Mr D de G Griffith in his capacity of Secretary to the Liaison Committee and of Statistician to ICES.

The absence of representatives from Poland and U.S.S.R. was noted with regret.

1.3 The members of the Working Group felt that inadequate notice had been given of the requirement for advice on sprat. With less than a month's forewarning of this requirement, at a time when they were fully occupied assembling national data for the herring objectives, the collation of national sprat data could not be given the attention which was desirable.

2. The North Sea

2.1 The fishery in 1974

2.1.1 In Table 2.1 catch data for the years 1970-74 are given (preliminary for 1974). In contrast with 1973, information on total national catches for 1974 was received from all countries. The total North Sea catch in 1974,

excluding Skagerak, amounted to 252 690 tons which is 245 000 tons less than in 1973 and the second lowest on record (Figure 1). It is only slightly above the 1941 catch of 251 000 tons, but it is below any of the other catches taken during World War II and any of those taken during the years 1914-18.

2.1.2 In previous years the preliminary estimates have increased by about 10% when the final catch data became available. Even with such an increase, the final catch for 1974 will be well below 300 000 tons, the lowest for the North Sea with the exception of 1915-17 and 1941-42. The Skagerak catch decreased from 84 566 in 1973 to 54 835 in 1974 (Table 2.2).

2.1.3 Tables 2.3 to 2.7 give the catch data for the sub-divisions of the area used in the previous Reports. In Division IVaE the catch in 1974 remained on the same level as in 1973, while there was a sharp decrease in all other areas. It should, however, be noted that in Division IVb the catches taken in the adult fisheries continued to increase, whereas the catches in weight in the young herring fisheries showed a further decline.

2.1.4 The numbers of herring at each age in the catches in each area are given in Table 2.8 and those for the total North Sea are summarised below:

Millions of herring caught per age group (winter rings)

Age Year	0	1	2	3	4	5 and older	Total
1968	839	2 425	1 795	1 494	621	571	7 746
1969	112	2 503	1 883	296	133	336	5 246
1970	890	1 196	2 003	884	125	143	5 249
1971	684	4 378	1 147	662	208	97	7 177
1972	750	3 341	1 441	344	131	40	6 047
1973	289	2 368	1 344	659	150	96	4 906
1974	992	838	718	327	114	79	3 069

2.1.5 The catches of 0-group herring have escalated beyond the level of the previous 3-4 years and are in fact one of the highest on record, while there has been a sharp decrease of the catch of all other age groups, especially 1-4 ringers.

2.1.6 The catch in numbers for 1974 was also calculated for the Skagerak as shown in Table 2.9. In this area, 0-group fish also made up a high proportion of the total number of fish caught, but the figures may not be very precise because of the difficulties in separating catches made on the boundary of the Skagerak and Kattegat.

2.1.7 The Working Group recommends that consideration be given at the next Council Meeting to the alteration of the present IIIa/IVa boundaries.

2.2 Input data for VPA

2.2.1 Catch composition in numbers per age for the years 1971 to 1974 are given in Table 2.8. The composition of the 1974 catch was calculated during the meeting and that of 1973 given in the previous Report (C.M.1974/H:4) was raised in accordance with revised catch data.

2.2.2 The fishing mortality on adult herring (2-ringers and older) was taken as 1.0, based on the estimate given in C.M.1974/H:4 averaged over the years 1967-71.

- 2.2.3 New abundance indices of I-group herring in the Danish industrial fishery have been calculated, taking into account the increased fishing power in this fishery. The new abundance indices show a good correlation with stock sizes calculated from VPA. Using this regression, the stock size in numbers of 1-ringers in 1974 is estimated as 2.7×10^9 and using the actual catch in numbers in 1974 the fishing mortality on this age group is estimated at 0.50.
- 2.2.4 Two other sources of information on the 1972 year class are available: the catches as 0- and 1-ringers, and the estimate from the Young Herring Surveys (YHS). The YHS in 1974 estimated the year class to be 5.6×10^9 as 1-ringers (83% of average). Comparing this year class size with the catch of 838×10^6 in 1974, fishing mortality in this year would have been only 0.17 which obviously is much too low and therefore this estimate from the YHS is an overestimate.
- 2.2.5 However, if we assume a fishing mortality of 0.70 on 1-ringers in 1974 the stock size as 1-ringers would have been only 1.739×10^9 (28% of average). This is probably an underestimate, since some of the effort usually directed to young herring was in 1974 directed at sprat. The Working Group decided to use the estimate of $F = 0.5$ derived above.
- 2.2.6 Fishing mortality of 0-group (year class 1973) was taken as 0.20. This estimate was based both on an estimate from the YHS in 1975 and on effort data from the Danish industrial fishery.
- 2.2.7 Preliminary data from the YHS in 1975 indicate an average abundance of 1 383 for the standard area of 53 squares defined in Doc. C.M.1974/H:6.
- 2.2.8 Using the regression equation given in Doc. C.M.1974/H:6, the stock of 1-ringers is estimated at 5.9×10^9 at 1st January 1975. However, the strengths of the year classes 1971 and probably 1972 have been seriously overestimated by using this regression, and because the regression line has a large intercept on the Y-axis, small year classes are bound to be overestimated.
- 2.2.9 Considering that there may have been a gradual increase in efficiency during the YHSs from 1960 onwards, the correlation between VPA-values and YHS-estimates was calculated for the five most recent years only. A significant correlation was obtained and the intercept of the regression line on the Y-axis was considerably reduced. Using this regression equation, the stock size of 1-ringers (1973 year class) is estimated at 4.5×10^9 . This figure seems to be the best estimate for this year class available at present. With a catch of 993×10^6 0-ringers in 1974, fishing mortality on this age group would be around 0.20. As 0-ringers the strength of this year class was subsequently estimated at 6.0×10^9 , or 75% of the strength of an average year class. The same figure of 0.20 is also obtained from independent estimates of fishing effort in the Danish industrial fishery. Abundance indices from this fishery indicate year class 1973 to be of comparable strength to the year classes 1970 and 1971, or somewhat below average.
- 2.3 Results from VPA
- 2.3.1 Calculated fishing mortalities and stock sizes for the period 1965-72 are given in Tables 2.10 and 2.11. It should be noted that estimates for the years 1971 and 1972 are to some extent dependent on the choice of the input F for 1974.
- 2.3.2 Fishing mortality on 1-ringers in 1971 and 1972 was calculated at 0.98 and 0.95 respectively. These figures represent a considerable increase compared with the period 1965-70 (approx. 0.50).

- 2.3.3 Fishing mortality on adult fish in 1972 was slightly below the level of the previous two years, but at 0.89 it was still approximately twice the level required for MSY.
- 2.3.4 Fishing mortalities for all age groups in 1971 and 1970 are slightly higher than those given in the previous Report (C.M.1974/H:4), due to a higher input F for adult fish in 1974 than in 1973. Minor changes in F in older age groups in previous years were caused by a different input F on 8-ringers in 1967, 1969 and 1970.
- 2.3.5 Calculated stock size and biomass for 1971 and previous years have been slightly reduced compared to the figures given in C.M.1974/H:4), due to the high input F on adult fish in 1974. Year classes 1970 and 1971 are now estimated at 9.03×10^9 and 7.00×10^9 as 0-ringers respectively.
- 2.3.6 Year class 1972 has now been estimated for the first time from VPA. The figure of 4.96×10^9 still depends to some degree on the input F in 1974, but it indicates the 1972 year class to be approximately 30% below the long-term mean. The continued decline in stock biomass should be noted. In 1972 it was rather less than one quarter of the 1965 level.
- 2.3.7 Figure 2 shows the weighted fishing mortalities of adults (≥ 2 -ringers) since 1947, based on the VPA (Table 2.10). Additional points for 1973 and 1974 have been added, derived from the Working Group's best estimate of the likely fishing mortality rate in these years. These values demonstrate a very sharp increase in fishing mortalities since 1963 resulting in a sharp decline in catches and biomass since 1965 (Figures 1 and 3).

2.4 Mean weight by age in catch

The Working Group decided to reconsider the mean weights by age which have been used in the catch prognoses in previous reports. For this purpose data from the period 1971-74 were used. For each area an annual mean weight by age in catch was calculated from monthly mean weights, assuming a seasonal distribution of the catch of the different age groups similar to that in 1970-71. The annual mean weights for the different areas were then combined to give an annual mean weight in catch for the whole North Sea, using as weighting factor the catch in number by age in the different areas in 1970-71. These results are compared with the previous ones (C.M.1972/H:13) in the table below. The difference between the two sets of data is negligible except for the 5-year old and older herring which get a little higher weight using the data from the recent years. Most of the older herring have been caught in Division IVaW in later years and the weight by age in this area is higher than in other parts of the North Sea. It was decided to use the new set of mean weights in the catch prognoses.

Age (Winter rings)	Biomass 1 January ^{x)}	Mean Weight in Catch ^{x)}
0	0	15 (17)
1	25 (25)	50 (50)
2	75 (75)	126 (125)
3		176 (182)
4	↑	211 (207)
5	as in	243 (226)
6	catch	251 (240)
7	↓	267 (249)
8		271 (256)

x) Previous figures in brackets.

2.5 TAC's for 1975 and 1976

- 2.5.1 The TAC for the season 1974/75 adopted by NEAFC was 488 000 tons, covering catches from both the North Sea and Skagerak. In addition, if countries had observed the ban on fishing in the spring of 1974, they could take additional quotas which depend on the size categories of herring in the catches. The effective TAC could thus rise to about 500 000 tons.
- 2.5.2 The catches taken from 1 July 1974, when the quota year commenced, up to 31 December amounted to about 240 000 tons (including Skagerak). Thus in the remaining period to 1 July 1975 there is the possibility that catches of up to 250 000 tons could be taken within the TAC agreed.
- 2.5.3 This TAC agreed by NEAFC was 90 000 - 132 000 tons greater than that proposed by the Liaison Committee for the North Sea alone. With the data now available, it is clear that the Liaison Committee's recommendation was a serious overestimate of the desirable TAC level. This largely arose from an overestimate of the strength of the 1972 year class. The resulting discrepancy illustrates the dangers of catch prediction in the situation where a major part of the yield is taken from very young fish, for which prediction of year class strength has very wide confidence limits.
- 2.5.4 The estimated age composition at 1 January is given below:

<u>Age in rings</u>									
	0	1	2	3	4	5	6	7	8
No. x 10 ⁻⁹	6.6	4.26	1.22	0.44	0.20	0.069	0.031	0.13	0.003

This represents a stock biomass of 346 000 tons, of which the adult stock comprises 241 000 tons. The recruit year class has been set at 6.6×10^9 which is the mean recruitment over the period 1963-74. In previous Reports the long-term mean of 7.9 has been used, but in the past 12 years this value has been exceeded only three times, and in the 3 most recent years has averaged 4.5.

- 2.5.5 On the basis of this age composition the Working Group has made a calculation of the catch in 1975 corresponding to that obtainable at the fishing mortality on adults giving MSY and allowing for a catch of 1-ringed fish. These levels are $F = 0.40$ for adults and $F = 0.20$ for 1-ringers. The fishing mortality on 0-ringers has been set at 0.04. This implies a TAC for the whole of 1975 of not more than 140 000 tons for the North Sea and Skagerak, of which the total catch of juvenile herring should not be greater than 40 000 tons (including the by-catch which will be inevitable in the industrial fisheries for other species).
- 2.5.6 The age composition of the Skagerak catches in 1974 (Table 2.9) indicates that most of these were juvenile herring. These catches may well have the effect of further reducing the recruitment to the North Sea stocks and delaying the recovery of the spawning stock. In the absence of suitable data for assessing the effect of the fishery in the Skagerak, it is recommended that no increase in the TAC should be made to take account of that area.
- 2.5.7 In view of the present extremely low level of adult stock, the Working Group considered that the level of TAC (140 000 tons) should be continued for 1976. There are indications of reduced recruitment in recent years and with the low level of spawning stock the danger of recruitment failure has undoubtedly increased. The present spawning stock size is only of the order of 200 000 tons and it should be the aim of the regulation to return it to a level of about 2 000 000 tons as quickly as possible (Figure 3). This was the level of the stock during the period 1955-60 when it was exploited at adult MSY levels of fishing mortality, with total annual catches of the order of 700 000 tons.

- 2.5.8 Any excess catch in 1975 over the recommended TAC of 140 000 tons must be deducted from the 140 000 tons recommended as the TAC for 1976. In view of the remaining quantity of the 1974/75 TAC (about 250 000 tons), the necessity of closing the fishery in the latter half of 1975 and operating with an extremely low TAC in 1976 is a distinct possibility.

2.6 The effects of a closed season

- 2.6.1 In the Report from the North Sea Herring Assessment Working Group in September 1973 (Doc. C.M.1973/H:27), the increase in yield resulting from a closed season 1 February - 15 June was said to be 5% and 23% in the adult and juvenile fisheries respectively, compared with the yield generated by the same annual fishing mortalities when there is no seasonal restriction.
- 2.6.2 The 0-group herring are caught only in autumn. Taking the total juvenile TAC in the autumn will thus result in a proportional increase in 0-group mortality when compared with an equivalent juvenile TAC spread over the whole year.
- 2.6.3 The Working Group therefore concluded that there is no justification for allowing an increase in quotas when the catch is taken only during the second half of the year.

3. Celtic Sea

3.1 Catch data

The herring catches for the period 1969-74 from the Celtic Sea are shown in Table 3.1. The figures for 1974 are provisional. The figures for each season are given in Table 3.2. The 1973 figures which were estimated in the previous Reports were examined but no change was found necessary. The total annual catch has continued to decline since 1969 and is now down to 19 738 tons. This decline was particularly apparent in the 1974 figures from the Netherlands and French fleets, but this may have been due to a decreased effort by these fleets in the area.

3.2 Stock and mortality estimates

- 3.2.1 The age composition of the total catch in 1974/75 was calculated from Irish and Dutch age data (1 000 and 200 otoliths respectively). No changes had to be made in the catch composition for previous seasons.
- 3.2.2 Stock size and fishing mortalities for previous seasons were then calculated by cohort analyses. For the oldest age group a fishing mortality of 0.70 was assumed. For the fishing season 1974/75, however, a fishing mortality of 0.55 on adults and 0.06 on 1-ringers was chosen, based on mortality estimates from Irish catch/effort. Also, the relatively low proportion of French and Dutch catches in the overall catch indicates a reduced effort from foreign trawlers during the 1974/75 season. Results of the cohort analyses are given in Tables 3.4 and 3.5.
- 3.2.3 The estimated stock size at 1st March 1974 is very low, which is mainly due to a succession of poor year classes and a continuing high level of fishing mortality. Recruitment of 2-ringers (year class 1971/72) is below average, and from the scarce information available at present, year class 1972/73 seems to be even poorer.

3.3 Variability of recruitment and its effect on catch prediction

- 3.3.1 Advice on TACs has been based on the establishment of the MSY of the yield per recruit curve at a fishing mortality of the order of 0.45 - 0.50, and the estimate of recruitment. The variation in annual recruitment is shown in Figure 4, where it is seen that the extreme variation in recruitment is over 10 times, while it commonly varies by 3 times. The table below gives the levels of MSY for different periods of recruitment estimates:

Levels of MSY for different mean recruitment levels, as 1-ringed fish

Years	Recruitment (10^{-6})	MSY (tons)
1957-1962	125.5	12 - 15 000
1957-1968	161.8	22 000
1965/66-1969/70	240.2	30 000

- 3.3.2 The ICES Working Group on Celtic Sea Herring Assessment (Doc. C.M.1973/H:2) reviewed the data available to 1973 and concluded that with levels of fishing mortality between 0.3 and 0.4 the maintenance of the then current catch levels (35 000 tons) depended on continuation of that level of recruitment. The NEAFC ad hoc Working Group proposed a TAC for 1974/75 of 25 000 tons on the basis that recruitment could not be forecast and there was the possibility that recruitment would fall to a lower level. With two poor year classes entering the fishery as 1-ringed fish in 1973/74 and 1974/75, and a reduced adult stock consequent upon the higher fishing mortalities of 1971-73, the actual catch in the season 1974/75 only reached about 18 000 tons.
- 3.3.3 The Liaison Committee has recommended a TAC of 19 000 tons for the 1975/76 season. In arriving at this TAC recruitment was assumed to be 166×10^6 fish which was the mean over the period 1957/58 to 1972/73. The Working Group has reconsidered the problem of estimation of possible recruitment and has revised the stock estimates made by the Working Group in October 1974 (Doc. C.M.1975/H:5).
- 3.3.4 For forecasting incoming recruitment, it is necessary to rely on the historic record to estimate the most probable level of recruitment. This is best estimated by the modal value, not by the mean. In the case of a species with widely fluctuating recruitment the mean and mode may differ considerably. In the case of the Celtic Sea herring the modal value of recruitment is about 100×10^6 which can be compared with the mean for the comparable period of 166×10^6 .

3.4 Estimates of fishing mortality

Table 3.6 gives the weighted F values from 2-8 year-old fish from the cohort analysis and the instantaneous fishing mortality estimates derived from Irish pair trawl catches. In both cases natural mortality has been taken as $M = 0.1$. Figure 5 shows the regression of cohort F on catch per effort F. From this regression a calculated cohort F for the 1974/75 season has been obtained of 0.51 which is close to the value of 0.55 used in the calculation of the stock sizes for the 1974/75 catch.

3.5 TACs for 1975/76 and 1976/77

- 3.5.1 With the new data available the age composition of the stock on 1 March 1974 has been revised. In addition, the data on mean weight for age have also been re-examined and a revised set is presented. These data are

derived from the Irish catches which comprise a major part of the total catch. The revised age compositions for 1974/75 and 1975/76 together with the new weight data are given below.

Mean weights and calculated stock figures at 1st March (in millions)

Age	Mean weight (g)	1974	1975	1976	
				$F_{75/76} = 1.1$	$F_{75/76} = 0.7$
1	128.4	68.82	100.00*	100.00*	100.00*
2	170.4	98.22	58.06	79.45	83.53
3	210.6	39.58	53.37	17.45	26.09
4	238.9	50.97	21.51	16.07	23.98
5	257.4	9.72	27.69	6.48	9.67
6	267.0	8.49	5.28	8.34	12.44
7	269.7	6.84	4.61	1.59	2.37
8	277.8	2.07	3.72	1.39	2.07
>8	277.8	1.91	2.16	1.77	2.64
Biomass in tcns		54 000	50 500	39 000	46 000

* estimated

3.5.2 A TAC of 25 000 tcns for 1975/76 has been adopted by NEAFC. This would imply an escalation of fishing mortality from 0.51 in 1974/75 to 1.1 in 1975/76. Using this value the stock size as at 1st March 1976 has been calculated. This is also given in the table above. With the tendency towards reduced recruitment in recent years, it may be unrealistic to suppose that the TAC could be reached. However, some increased effort would be expected in the Celtic Sea; the resulting F has been taken as 0.7 which is close to the recent mean. Stock size at 1st March 1976 calculated on this basis is also given in the table above.

3.5.3 Under the present TAC agreement for 1975/76 it is likely that the fishing mortality will exceed that giving the MSY. The Working Group calculated the TACs for 1976/77 on the basis of a return to the level of fishing mortality at the MSY. The various TACs proposed and adopted are:

Levels of TAC proposed (tcns)

	1974/75	1975/76	1976/77	
			$F_{75/76} = 1.1$	$F_{75/76} = 0.7$
Original advice	25 000	19 000		
NEAFC agreement	32 000	25 000		
TAC at $F = 0.45$	16 000	13 800	10 000	12 000
Actual catch	17 318			

3.5.4 The TACs suggested for 1976/77 are rather small and are dependent on the catch in 1975/76. If NEAFC were to reconsider its TAC for 1975/76 and set it at the level of the MSY, it would be possible to have a higher TAC for 1976/77. The TACs for 1975/76 and 1976/77 would then be 13 800 and 14 000 tons respectively. This would increase the biomass at 1st March 1976 to 51 700 tcns.

4. Herring in Division VIa

4.1 Interrelationship of herring caught in Divisions VIa and VIIb

- 4.1.1 In this Report and in previous Reports dealing with the herring population in Division VIa, the catch statistics given and the resulting tables of numbers of fish caught per age group and stock in numbers per age group have included catches and age data from the Irish fishery in Donegal Bay. The fishery in this area takes place almost entirely in statistical Division VIIb, but the catch statistics are reported in "Bulletin Statistique" as from Division VIa because they are landed at a port lying within the southern boundary of VIa.
- 4.1.2 Doubts have been expressed as to whether the population fished in Division VIIb should be treated as part of the same stock management unit as the population in Division VIa, or whether it should be considered as a separate management unit. The Working Group did not have time to make a detailed analysis of the data relevant to this subject. The mortality rates of the Donegal Bay population have been calculated from the catch per unit effort and age compositions of the Irish fishery. A comparison was made between the mortality data derived from the Irish data and those from the VPA over the period 1968-1973. There was little similarity between the yearly values and the Irish data showed no increasing trend in the recent seasons. However, the means of the values over the period were virtually identical at 0.47 for Irish data and 0.50 for the VPA data (Table 4.1). Certainly in recent years there have been differences in the year class strengths of recruits to the two fisheries. Although the 1963 year class was a very strong one in both areas, the 1969 year class which was also very strong in Division VIa has not played any appreciable part in the Irish catches, whilst the 1970 year class shows some evidence of being stronger in Division VIIb than in VIa. A preliminary examination of length at age data suggests that the Donegal Bay fish are somewhat larger in all age groups than those taken entirely within Division VIa.
- 4.1.3 In the light of the inconclusiveness of the evidence the Working Group decided that in 1975 its assessment should continue to be done treating as one unit VIa and the herring taken in VIIb but reported from VIa. It would stress, however, the importance of obtaining more conclusive evidence on the inter-relationships of the populations in the two areas and would suggest tagging experiments as the most profitable approach to solving the problem, together with more extensive sampling of catches taken by fleets fishing in the southern parts of Division VIa.

4.2 Total catches and the fisheries in Division VIa

The total catch taken by each country in Division VIa, for each of the years 1968-73 is given in Table 4.2 together with preliminary estimates of the catches taken in 1974. Estimates of the weight of herring taken in each year in the Moray Firth young herring and sprat fisheries are also given. The final figure of total catch in Division VIa in 1973 shows an increase of about 7 000 tons over the preliminary figure for that year in the last Report of the Working Group. The total for 1974 (205 000 tons) may well be appreciably higher as the Norwegian and Netherlands catches have only been estimated for the last four months of the year. The preliminary 1974 figure shows a decrease of about 42 000 tons compared with the final 1973 figure. Even if the total given in Table 4.2 for 1974 is not revised upwards, it is still at a very high level, having been exceeded only twice in the recorded history of the fishery. The major changes in national catches in 1974 were a decrease to about half the 1973 level in that taken by the Faroes, to

about 20% of the 1973 level for the French catch and to about 65% of the 1973 level for the Netherlands catch. The Icelandic catch in contrast increased by almost four times, and Poland also showed some increase over their 1973 catch level.

4.3 Catch in numbers in Division VIa

- 4.3.1 Estimates of the numbers of autumn spawning herring per age group caught in Division VIa in each of the years 1957-74 are given in Table 4.3, and in the Moray Firth in Table 4.4. The estimates for the period 1957-72 are taken from Saville and Morrisson (1973), and from unpublished Scottish data on the catch in number in the Moray Firth fishery.
- 4.3.2 Estimates of the numbers of autumn spawning herring for 1973 have been corrected according to the revised catch figures. The numbers per age group for 1974 are compiled from national reports. Catches in numbers per age group of the Faroes, Federal Republic of Germany, and Polish fisheries, for which no age composition data were available, have been raised by using age data from the Icelandic and Dutch fisheries. This raising was done taking into account the different gears and the different seasonality of the fisheries.
- 4.3.3 As in 1973, the 1969 year class provided a substantial component of the fish accounting in 1974 for about 40% of the numbers caught in Division VIa. In contrast, in the Irish fishery in Donegal Bay the 1971 year class dominated the catch in numbers in 1974, followed by the 1970 year class.
- 4.3.4 In previous Reports on the herring population in Division VIa, the catch in numbers per age group in each year has been given in a single table in which the catches taken in VIa have been combined with those taken in the Scottish winter fishery in Moray Firth. The Working Group decided that this procedure could be misleading and accordingly in this Report the catches in numbers per age group for the two areas are given separately in Tables 4.3 and 4.4. The catches in numbers per age group from the Moray Firth in 1973 and 1974 must be treated with some reserve.

4.4 Stock and mortality estimates

- 4.4.1 The estimated fishing mortalities, and stock in numbers, per age group in the period 1965-1973 calculated by VPA are given in Tables 4.5 and 4.6. The new values of the weighted mean fishing mortality rate on the fully recruited age groups in 1971 and 1972 are rather higher than those given in Doc.C.M.1974/H:4. The new value of the mean mortality rate in 1973 is 0.59 which is appreciably above the MSY value for the stock.
- 4.4.2 The stock in number data would suggest that the recruitment of the 1970 year class as 1-ringers in 1971 was appreciably higher than given in the previous Report, but the 1971 year class, however, is very much weaker than the 1970 year class. In older age groups there are only minor differences in numbers between the previous estimate of the stock in 1971 and that given here. The total adult stock in numbers increased by about 50% between 1971 and 1972, because of the recruitment of the strong 1969 year class to the adult stock in 1972.

4.5 Catch prognosis for 1975 and 1976

- 4.5.1 A prediction has been made of the catch which could be taken in 1976 at a level of fishing mortality corresponding to that giving the MSY. The basic age composition at 1 January 1975 was calculated from the catch in numbers per age group in 1974, by using an $F = 0.7$ in 1974. The average weight per age group used in making this prognosis is given on page 11:

Age (rings)	Numbers per age group $\times 10^{-6}$	Average weight per age group in grammes
1	650.0	88
2	831.2	124
3	142.9	163
4	189.4	171
5	507.7	190
6	83.6	212
7	41.8	218
8	39.5	220
9	17.5	220
≥ 10	36.9	220

4.5.2. There have been changes in the basic parameters used to predict future catches. The average weight per age group has been revised on the basis of new data from the 1974 fishery. The assumptions about recruitment have also been changed. In contrast to the previous practice of assuming average recruitment ($1\ 400 \times 10^6$) the Working Group decided to use the most frequent recruitment (modal recruitment) level in the catch prediction (650×10^6). This will decrease the probability of overestimating the stock size at the beginning of a year. If the changes made in this Report had been made for the TAC recommended by the Liaison Committee for 1975, the predicted catch would have been reduced from 156 000 tons to 120 000 tons.

4.5.3. Predicted catch figures together with the corresponding values for F and the biomass of the adult component of the stock are given in the table below:

1974	1975			1976			1977
Biomass	Biomass	F	Catch	Biomass	F	Catch	Biomass
402	303	1.0	205	159	0.45	66	158

5.4. The prediction has been made assuming that the TAC in 1975 will be taken, which implies a fishing mortality of 1.0 in that year. In that case, the remaining adult stock will be reduced by 60% from the level at the beginning of 1974.

4.5.5. If in 1976 the fishery is managed in such a way that the fishing mortality will be reduced to that giving MSY ($F = 0.45$) then the decline in stock size would only be arrested, but the stock size would not be increased. At the MSY level the TAC in 1976 would be not more than 66 000 tons.

4.5.6. In recent years there has been an increase in effort in Division VIa, attracted by an increased stock between 1966 and 1973, resulting from a period of good recruitment. There are indications, however, that the year classes 1970-72 are well below average size, and therefore even with fishing on the MSY level the stock size will fall back to the original level of the period 1965 and earlier (see Figure 6). The comparatively low TAC recommended for 1976 is partly due to this decline in expected recruitment, and partly due to the increased exploitation rate in recent years.

5. North Sea Sprat

5.1 General biology of sprat in the North Sea

- 5.1.1 The sprat is a small clupeoid fish, widely distributed in the North Sea. In winter it concentrates in coastal areas where it is exploited by a number of fisheries. In spring it disperses offshore to spawn over a wide area, with the spawning season extending from January to August in the area as a whole, and generally somewhat earlier in the south and later in the north. There is little information available on stock sub-divisions of the North Sea sprat population, and it is therefore difficult to determine what are realistic unit stocks for assessment and management purposes.
- 5.1.2 Few fish over five years of age occur in the catches even in unexploited stocks or in stocks with a low level of exploitation. This would suggest a high rate of natural mortality; but the mean annual rate, and how it varies over the lifespan, is not known with any precision. Recruitment to the fisheries occurs at an age of one year, and the catches are largely dependent on the recruiting year class. There would therefore seem to be, for this species, little likelihood that recruitment can be predicted in sufficient time for it to be utilised for management purposes.
- 5.1.3 Sprat become sexually mature at an age of two years, and because of the high level of natural mortality, this age group is likely to make a major contribution to the spawning potential of the population, even at low levels of exploitation.
- 5.1.4 Because of difficulties in obtaining representative samples of the sprat population, as distinct from the catches, current estimates of the growth parameters are not very reliable.

5.2 Total catches and the fisheries

- 5.2.1 According to the figures published in "Bulletin Statistique", landings of sprat in the North Sea have increased from around 20-30 000 metric tons in the early 1960s to 210 000 tons in 1973, most of the recent increase coming from the central North Sea. The published totals, however, do not contain an important component of sprat landed by the Danish industrial fisheries, figures for which are now available from 1965 onwards. The revised total catch in 1973 from the North Sea is 271 000 tons (Table 5.1). Preliminary sprat catch statistics for 1974 given in Table 5.1 were provided by members of the Working Group and by the ICES Statistician. Unfortunately no data were available for that year from U.S.S.R., and an estimate was made by the Working Group.* The "Bulletin Statistique" figures fail to discriminate between the different sprat fisheries, which take place in discrete and well defined areas, but from a knowledge of the fisheries and from the statistics available to the Working Group, the landings have been tentatively divided into those from the eastern and western parts of each sub-division of the North Sea (see Table 5.1). The salient features of the trends are summarised for each area below.

* The information was subsequently received from the U.S.S.R. after the meeting of the Working Group (see Table 5.1, footnote b).

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5.2.2 IVa - west of 2°E

Until 1974, landings from this area were almost entirely from the Scottish winter coastal fisheries, which began in 1964-65. Catches have since fluctuated considerably, being higher than average in 1973 and 1974.

5.2.3 IVa - east of 2°E

Landings in this area are entirely from the Norwegian summer fjord fishery, and are probably dependent for recruitment on the stock spawning in the Skagerak and Kattegat. The landings from this fishery have shown only minor fluctuations over the last ten years.

5.2.4 IVb - west of 3°E

Landings from the Scottish and English winter coastal fisheries fluctuated around a fairly low level until 1971. In that year the landings from the fishery off northeast England increased due to increased effort. Landings from this area rose by a factor of two in 1973 to over 100 000 tons, largely due to the entry of other countries and appear to have increased in 1974. Part of this increase was undoubtedly due to a diversion of effort resulting from the closure of the North Sea herring fisheries from February to May in 1973 and 1974.

5.2.5 IVb - east of 3°E

Landings were fairly constant until 1973 when there was a large increase. The increase in Danish catch did not appear to be accompanied by a commensurate increase in effort directed at clupeoid fish.

5.2.6 IVc

The winter coastal fisheries in this area have shown a general decline in all parts of the area, although there is some evidence from echo-surveys that the stock size has not fallen by the same magnitude.

5.3 Fishing effort

5.3.1 The Danish industrial fishery exploits sprat over all areas of Division IVb. The catches per unit effort from this fishery are the only data which can be used to get any impression of the total effort exerted on the sprat. Table 5.2 gives these effort estimates as thousands of hours fishing by pair trawl. They have been corrected by a power factor taking 1963 as the base year. The corrected effort shows an increase of 2 to 3 times since 1965 with, in the most recent years, an increased catch per unit effort.

5.3.2 This increased catch per unit effort is partly due to a direction of effort onto the dense winter concentrations off North Shields but may also reflect an increase in stock over the central North Sea as a whole. As the Working Group did not have time to break down the catch and effort data between IVb east and west, the relative changes between the two areas could not be compared.

5.4 Catch composition

5.4.1 Using data on age and length of sprat sampled from the fisheries, the Working Group estimated the annual age composition of the landings in some sub-divisions of the North Sea. The results from IVb east and IVb west are given in Table 5.3.

5.4.2 There is an indication of a recent change in the mean age of the stock in IVb. Up to 1972, fish two years of age and older contributed at least 60-70% of the catch in the eastern area, and in most years more than 20% in the west. In the east, the percentage dropped to 16% in 1973 and 8% in

1974, while in the western area it dropped to 2% over the 1973-74 season. Without data from at least one subsequent year the Working Group could not determine whether these changes are due to an increase in exploitation, or to an increase in recruitment in 1973 and 1974.

- 5.4.3 Although the Working Group could not make accurate estimates of mortalities, a preliminary estimate can be obtained from the average age composition over the past seven years (Figure 7). This suggests that in IVb west the total annual mortality rate, averaged over the last seven years, may lie between 60% and 70% ($Z = 1.0$). By this technique one cannot estimate the current total mortality rate in this area, but in view of the increased effort in the last two years it is likely to have been somewhat higher.

5.5 Management of North Sea sprat

- 5.5.1 Because of the high level of natural mortality the sprat is a short lived species, in which a year class only effectively contributes to the commercial fishery over two or three years. Few fish over five years old are found. Because of this feature the stock biomass is very dependent on the strength of recruiting year classes. The successes and failures of the fisheries in some areas have been almost entirely dependent on the occurrence of good or bad year classes.
- 5.5.2 In the absence of any reliable estimate of the natural mortality rate it is not possible to apportion the estimate of total mortality given in paragraph 5.4.3 between the components due to natural causes and to fishing. Using the possible range of natural mortality rate, however, it is clear that the yield per recruit is unlikely to decline with increasing fishing effort. Therefore the objective of management should be to maintain the spawning stock at a level which will permit, on average, the maximum recruitment. At present little is known, for sprat, about the relationship between spawning stock biomass and recruitment level, and no estimates are available of the absolute level of recruitment. However, unlimited escalation of fishing effort must eventually reduce the spawning stock to a level at which recruitment declines. Because sprat recruit to the fishery within their first year of life, and contribute an appreciable part of the spawning potential at 2 years of age, the decline in recruitment, and in total stock size, would proceed very rapidly with little prospect of it being possible to take management action quickly enough to rectify the situation.
- 5.5.3 Because of these features of the population dynamics of sprat the Working Group is not in a position to define a Total Allowable Catch on any precise basis. Although the available age, catch, and catch per unit effort data have been examined for a number of fisheries it has not been possible to determine whether the high levels of catch in 1973 and 1974 were due to increased stock size, increased fishing effort, or greater availability of the stock to the fishery.
- 5.5.4 However, because further escalation of catch and fishing effort might have the effect of reducing recruitment and bringing about a collapse of the fisheries before this could be identified and appropriate conservation action taken, it would be prudent to introduce a precautionary total allowable catch regulation. In 1976 this should not be set higher than 300 000 tons for the total North Sea excluding the Norwegian fjords. This is approximately the level of catch taken in 1974, and would prevent further escalation.
- 5.5.5 As shown in Table 5.3, in recent years 0-group sprat have contributed a rather high proportion of the catch in Division IVb. Some protection of the recruiting year class could be gained by introducing a minimum mesh size for clupeoid fisheries. The table on top of page 15 shows that there is only a

small overlap of the length distribution of the youngest age group and that of older sprat. The table also shows that the number caught will be reduced drastically by avoiding capture of fish below 7-8 cm length.

Percentage length distribution by age and numbers per kg by length groups. North Shields, November-December 1973.

Age cm	0	1	2	3	Nos. per kg
14			7.4	38.9	40
13		0.4	55.6	16.7	51
12		7.0	37.0	44.4	68
11		32.5			93
10		41.9			129
9	0.4	17.7			187
8	7.7	0.6			270
7	19.5				405
6	31.9				675
5	35.8				1 060
4	4.6				1 850
Nos. measured	1 877	1 261	54	18	-

- 5.5.6 Unpublished Danish selection experiments on small sprat and herring indicate that meshing is unlikely to become a problem as long as the selection range is below 12-13 cm.

The same experiment gave the following selection factors for sprat:

	Summer	Winter
NEAFC Gauge	4.2	4.7
ICES Gauge	3.5	3.9

- 5.5.7 An appropriate 50% retention length would appear to be about 9 cm for sprat corresponding to a mesh size of 20 mm for trawls

6. Trial Run of ICES FISHDAT System

- 6.1 The Working Group had before it the Report of the January 1975 meeting of the ADP Working Group (C.M.1975/D:2), including an analysis of the output of the trial run based on 1972 North Sea herring material.
- 6.2 The Working Group felt that the results of the trial run showed considerable promise, considering the poor quality of some of the input data. Even with material of this quality, the system gives access to data not previously available in that extent of detail.
- 6.3 The Working Group expressed the hope that the 1975 North Sea herring data would be made available in the same format as in the trial run for any assessment that has to be made early in 1976. To achieve this, it will be necessary for member countries to report their monthly biological and statistical data before the end of the second month after that to which the data apply. The Working Group urged that all countries participating in the North Sea herring fishery should comply with this request, in order to ensure maximum utilisation of the system.

7. Summary

- 7.1 The most recent data on North Sea herring show a further serious decline in the size of the adult stock, and in the catches for 1974, particularly in the northwestern North Sea. The Working Group has concluded that if the adult stock is to be increased to a level where it is in less danger of extinction due to recruitment failure, the level of catch to be taken in each of the calendar years 1975 and 1976 should not exceed 140 000 tons. If more than 140 000 tons are taken in the remainder of the 1974-75 quota year, it will be necessary to close the fishery in the latter part of 1975, and to make the appropriate adjustment in the 1976 TAC.
- 7.2 It is recommended that the North Sea TACs for 1975 and 1976 should not be increased to take account of the Skagerak catches.
- 7.3 There is no justification for allowing an increase in quotas when the catch is taken only during the second half of the year.
- 7.4 The TAC for the Celtic Sea herring stock set by NEAFC for 1975/76 is almost twice that giving the MSY. If the appropriate level of 13 800 tons were applied, this would allow a TAC of 14 000 tons in 1976/77. If the full TAC presently agreed for 1975/76 is taken, the TAC in 1976/77 will be at a considerably lower level.
- 7.5 In Division VIa the stock biomass is declining due to reduced recruitment and the higher exploitation rates in recent years. As a result, if the TAC adopted by NEAFC for 1975 is taken, the TAC for 1976 at the MSY point will be only 66 000 tons.
- 7.6 Because of the nature of the sprat fisheries and the population dynamics of sprat the Working Group was not able to make any precise assessment of the state of the sprat stock in the North Sea. In view of the very rapid increase in sprat catches in 1972 and 1973 and the maintenance of a high level of catch in 1974, the Group recommends that as a precautionary measure a TAC of 300 000 tons should be set for 1976.
- 7.7 In view of the large numbers of small sprats taken in the last two years, it is also recommended that a minimum mesh size of 20 mm should be introduced for towed gears used in clupeoid fisheries.
- 7.8 The Working Group recommends that consideration be given to the alteration of the present IIIa/IVa boundaries.
- 7.9 The results of the trial run of the ICES FISHDAT system showed considerable promise, and the Working Group recommends that steps be taken to make 1975 monthly data available in similar format for possible use in 1976.

Table 2.1 Herring

Catch in tons 1970-1973 and preliminary figures for 1974.
North Sea (Sub-Area IV and Divisions VIIId and e), and
Skagerak, by country.

Year Country	1970	1971	1972	1973	1974
Belgium	1 200	681	1 337	2 160	603
Denmark	133 331	185 393	213 739	174 254 ^{a)}	61 728
Faroe Isl.	58 365	45 524	48 444	54 935 ^{b)}	26 161 ^{b)}
Finland	-	-	-	1 540	-
France	11 482	11 408	12 901	22 235	13 157
German Dem.Rep.	290	475	127	1 728	3 268
F.R. Germany	7 150	3 570	3 065	10 634 ^{c)}	12 306 ^{c)}
Iceland	22 951	37 171	31 998	23 742 ^{d)}	29 017
Netherlands	46 218	32 479	24 829	34 070	28 900 ^{e)}
Norway	193 102	125 842	117 501	99 739	40 100
Poland	5 057	2 031	2 235	5 738	7 401
Sweden	34 670	36 880	7 366	4 222 ^{f)}	3 561
U.K(England)	9 702	4 113	650	2 893	5 755
U.K.(Scotland) ^{g)}	21 885	25 073	17 227	16 012	14 978
U.S.S.R.	18 078	9 500	16 386	30 735	5 755
Total North Sea	563 481	520 140	497 804	484 637	252 690
Skagerak	71 071	61 570	67 021	84 566	54 835
Grand Total	634 552	581 710	564 825	569 203	307 525

Footnotes: a) Total includes 2 107 tons for human consumption unspecified to area.

b) Supplied by Fiskirannsóknarstofnun.

c) From Fed. Rep. of Germany national statistics compiled by Federal Research Board of Fisheries, Hamburg.

d) Excludes 15 938 tons caught on Skagerak border and allocated to that area on the basis of age analysis.

e) Supplied by Dutch Ministry of Agriculture and Fisheries.

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

g) Catches from Moray Firth not included.

Table 2.2. Herring.
Total catch in tons. Skagerak (Division IIIa excluding Kattegat)

Year	Denmark	Faroe Islands	German Dem. Rep.	Iceland	Norway	Sweden	Total
1970	30 107	-	-	6 453	7 581	26 930	71 071
1971	26 985	5 636	-	3 066	6 120	19 763	61 570
1972	34 906	4 115	-	7 317	1 045	19 644	67 021
1973	42 098	5 265 ^{a)}	-	15 938 ^{a)}	836	20 429 ^{a)}	84 566
1974	35 732	7 132	36	231	21	11 683	54 835

a) see Table 2.1. footnote under relevant country.

Table 2.3. Herring.
Total catch in tons. North Sea, Northeast (Division IVa east of 2°E).

Year	Belgium	Denmark	Faroe Islands	France	German Dem. Rep.	Germany F.R.	Iceland	Netherlands	Norway	Poland	U.K. Scotland	Sweden	USSR	Total
1970	50	1 800	5 898	48	-	10	1 220	281	3 501	123	1 929	5 560	1 012	21 432
1971	-	6 219	239	-	-	-	-	167	10 720	-	-	-	-	17 345
1972	-	19 711	979	-	-	9	1 943	40	50	-	-	-	-	22 732
1973	-	686	12 776 ^{a)}	-	637	-	-	331	236	-	-	-	-	14 666
1974	-	12 284	532	-	55	-	2 460	21	-	-	-	-	-	15 352

a) see Table 2.1. footnote under relevant country.

Table 2.4. Herring.
Total catch in tons. North Sea. Northwest (Division IVa west of 2°E).

Year	Denmark	Faroe Islands	Finland	France	German Dem. Rep.	Germany F.R.	Iceland	Netherlands	Norway	Poland	U.K. (England)	U.K. (Scotland)	Sweden	USSR	Total
1970	61 423	40 884	-	818	-	177	20 587	177	160 784	2 069	-	17 767	4 470	17 066	326 932 ^{a)}
1971	44 500	45 095	-	514	-	389	36 992	5 755	115 108	1 288	-	24 711	4 954	9 500	288 806
1972	29 711	37 004	-	888	-	100	29 721	1 967	100 408	1 620	74	17 227	-	16 386	235 106
1973	41 341	42 159 ^{b)}	1 540	209	1 057	2 624	23 742	4 615	70 476	5 547	-	15 430	4 222	30 735	247 697
1974	3 475	16 676	-	415	40	1 292	22 421	2 285 ^{c)}	15 604	7 030 ^{d)}	-	10 459	-	-	79 697

a) total includes 750 tons from Belgium. b) see footnote under relevant country. c) estimated from biological statistics. d) total catch for IVa allocated to IVaW

Table 2.5 Herring.
Total catch in tons. North Sea, Central (Division IVb). Adult herring fisheries.

Year	Belgium	Denmark	Faroe Islands	France	German Dem. Rep.	Germany F.R.	Iceland	Netherlands	Norway	Poland	U.K. (England)	U.K. (Scotland)	Sweden	Total
1970	-	-	11 623	2 433	-	6 005	1 144	28 815	28 817	2 836	8 731	2 189	24 640	117 233
1971	8	2 488	429	4 734	-	-	179	10 172	14	743	4 113	362	1 926	25 168
1972	-	1 589	10 460	2 014	-	21	334	11 372	17 043 ^{a)}	615	271	-	4 068	47 787
1973	-	-	-	8 259	34	115	-	17 370	29 027	191	2 175	582	-	57 753
1974	-	2 067	8 953	8 457	3 173	3 825	4 136	31 090 ^{a)}	24 496	370	5 502	4 519	2 416	99 004

a) estimated from biological statistics.

Table 2.6. Herring.
Total catch in tons. North Sea, Central (Division IVb)

Year	Young Herring Fisheries				Total Young and Adult Fisheries (Tables 2.5. and 2.6.)
	Denmark	Germany F.R.	Sweden	Total	
1970	70 108	400	-	70 508	187 741
1971	132 161	3 055	30 000	165 216	190 209
1972	162 671	2 823	3 298	168 792	216 579
1973	129 988	5 638	-	135 626	193 379
1974	43 866	6 760	1 145	51 771	150 775

Table 2.7.

Herring.

Total catch in tons. North Sea, South and English Channel, East and West
(Divisions IVc and VIId and e)

Year	Belgium	Denmark	France	Germany F.R.	Netherlands	Poland	U.K. (England)	Total
1970	400	-	8 183	558	16 945	29	971	27 086
1971	673	25	6 160	126	16 385	-	-	23 369
1972	1 337	57	9 999	112	11 450	-	305	23 260
1973	2 160	132	13 767	2 257	11 754	-	718	30 788
1974	603	36	4 285	429	1 706 ^{a)}	1	253	7 313

a) estimated from biological statistics.

Table 2.8. 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	
1971	IVaW of 2°E	136.7	818.3	516.9	488.3	154.2	24.1	28.8	25.1	-	9.8	2 202.2
	IVaE of 2°E	14.0	95.4	54.5	38.5	10.5	2.1	1.4	1.1	-	0.2	217.6
	IVb	-	2.1	140.3	54.4	12.6	-	-	-	-	2.1	211.5
	IVbYH	533.0	3 440.9	304.3	39.6	-	-	-	-	-	-	4 317.8
	IVc+VIId,e	0.3	21.8	130.8	41.7	31.1	0.7	0.3	0.6	-	0.3	227.6
	Total NS	684.0	4 378.5	1 146.8	662.5	208.3	26.9	30.5	26.8	-	12.4	7 176.7
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	61.8	154.2	93.3	106.9	91.9	34.1	17.6	4.3	1.4	1.0	566.5
	IVaE of 2°E	5.7	131.6	24.1	10.8	1.0	-	-	-	0.1	-	173.3
	IVb	-	51.9	421.0	173.7	12.1	15.2	3.0	0.2	0.2	0.1	677.4
	IVbYH	925.1	493.5	132.1	5.7	-	-	-	-	-	-	1 556.4
	IVc+VIId,e	-	3.8	23.8	20.1	8.3	1.2	0.1	0.2	-	-	57.5
	unspecified ¹⁾	-	2.9	23.7	9.8	0.7	0.8	0.2	-	-	-	38.1
	Total NS	992.6	837.9	718.0	327.0	114.0	51.3	20.9	4.7	1.7	1.1	3 069.2

¹⁾ Soviet catches split according to age composition of adults in IVb

Table 2.9. Skagerak catch in millions of fish by age

Age in winter rings	0	1	2	3	4	5	6	7	8	> 8	Total
1974	624.5	288.7	91.0	45.8	14.3	5.7	1.1	0.8	-	-	1 071.9

Table 2.10 Total North Sea. Calculated fishing mortality.

Years Winter Rings	1965	1966	1967	1968	1969	1970	1971	1972
0	0.03	0.08	0.09	0.12	0.03	0.11	0.11	0.17
1	0.44	0.34	0.50	0.52	0.56	0.47	0.98	0.95
2	0.86	0.68	0.48	1.47	0.88	1.09	0.99	0.93
3	0.76	0.71	0.84	1.92	0.95	1.32	1.26	0.83
4	0.77	0.56	0.84	1.07	0.86	1.33	1.25	0.80
5	0.63	0.82	0.80	0.96	1.05	0.85	1.09	0.57
6	0.49	0.37	0.90	1.06	0.83	1.07	2.23	0.52
7	0.44	0.36	1.30	1.31	0.96	0.26	2.48	0.06
8	0.67	0.69	0.90	0.90	0.70	0.70	0.70	0.70
$\bar{F}_w \geq 2$	0.77	0.68	0.70	1.49	0.90	1.14	1.12	0.89

Table 2.11 Total North Sea. Calculated stock in numbers $\times 10^{-9}$ and stock biomass

Years Winter Rings	1965	1966	1967	1968	1969	1970	1971	1972
0	5.71	5.29	7.58	7.62	3.82	9.03	7.00	4.96
1	9.40	5.02	4.43	6.24	6.10	3.35	7.31	5.69
2	4.00	5.46	3.23	2.42	3.35	3.15	1.90	2.49
3	2.60	1.53	2.51	1.81	0.50	1.26	0.96	0.64
4	3.97	1.10	0.68	0.99	0.24	0.18	0.30	0.25
5	0.32	1.67	0.57	0.27	0.31	0.09	0.04	0.08
6	0.41	0.16	0.67	0.23	0.09	0.10	0.04	0.01
7	0.34	0.23	0.10	0.23	0.07	0.04	0.03	0.00
8	0.88	0.20	0.14	0.02	0.06	0.03	0.03	0.00
\sum Juveniles 0 + 1	15.11	10.31	12.01	13.86	9.92	12.38	14.31	10.65
\sum Adults 2 - 8	12.52	10.35	7.90	5.97	4.62	4.85	3.30	3.47
Biomass (tons $\times 10^{-3}$)	2 340	1 598	1 310	1 055	675	646	593	516

Table 3.1. Herring catches in Celtic Sea (metric tons)

Year	France	Germany F.R.	Ireland	Netherlands	Poland	England	USSR	Total
1969	7 038	5 906	18 712	16 256	252	-	-	48 164
1970	3 629	1 481	24 702	7 015	1 191	220	-	38 236
1971	3 393	974	12 602	9 672	881	65	-	27 587
1972	7 327	393	20 109	6 758	751	-	618	35 956
1973	5 553	294	13 105	5 834	1 125	-	334	26 245
1974*)	1 523	433	14 154	2 128	954	-	-	19 192

Table 3.2. Total catch by seasons in Celtic Sea (metric tons)

Season	Mar/May	Jun/Aug.	Sep/Nov.	Dec/Feb.	Total Metric Tons
1969/70	1 136	9 783	13 818	16 263	41 000
1970/71	1 703	3 789	8 879	18 348	32 719
1971/72	1 755	4 742	7 240	19 625	33 362
1972/73	2 039	2 936	7 668	17 720	30 363
1973/74*)	3 581	2 326	5 571	12 111	23 589
1974/75*)	515	1 296	8 204	7 273	17 318

Table 3.3. Catch in numbers per age group $\times 10^{-3}$

Season	1	2	3	4	5	6	7	8	>8	Total
1968/69	13 463	61 022	44 213	12 897	25 646	5 223	4 563	1 440	5 303	173 770
1969/70	7 353	86 869	51 438	30 517	11 219	16 303	4 355	2 011	3 228	213 293
1970/71	701	34 546	53 348	28 409	20 011	7 771	6 299	2 108	3 498	156 691
1971/72	11 543	25 254	38 675	45 597	20 753	11 032	4 251	5 451	2 411	164 967
1972/73	6 352	108 514	14 767	12 057	11 932	3 779	2 316	1 835	654	161 206
1973/74*)	22 670	34 890	46 178	6 410	8 437	4 760	3 282	2 010	730	129 367
1974/75*)	4 423	37 498	15 110	19 456	3 704	3 243	2 613	789	727	87 563

Table 3.4. Calculated stock size in numbers ($\times 10^{-6}$) by age and year (M = 0.1) at 1 March

Season Winter rings	1968	1969	1970	1971	1972	1973
1	287.0	141.1	71.8	262.4	92.8	126.3
2	205.0	246.9	120.7	64.3	226.5	78.0
3	133.1	127.5	140.8	76.3	34.2	101.7
4	48.0	78.4	66.4	76.6	32.3	16.9
5	63.8	31.1	41.9	33.1	26.0	17.7
6	20.0	33.3	17.5	18.9	10.2	12.1
7	16.0	13.1	14.6	8.5	6.6	5.6
8	8.9	10.1	7.7	7.2	3.6	3.8
> 8	-	6.7	7.3	5.0	1.4	1.5
Total adult stock	494.8	547.1	416.9	289.9	340.8	237.3

*) preliminary

Table 3.5. Fishing mortalities from VPA and weighted mean values of F

Seasons Winter rings	1968/69	1969/70	1970/71	1971/72	1972/73	1973/74
1	0.05	0.06	0.01	0.05	0.07	0.20
2	0.46	0.38	0.36	0.53	0.70	0.64
3	0.43	0.55	0.51	0.76	0.61	0.65
4	0.33	0.53	0.60	0.98	0.50	0.51
5	0.55	0.48	0.70	1.08	0.66	0.69
6	0.32	0.72	0.63	0.95	0.50	0.53
7	0.36	0.43	0.60	0.75	0.46	0.96
8	0.19	0.23	0.34	1.57	0.77	0.82
Weighted F (adults)	0.44	0.47	0.50	0.83	0.66	0.64

Table 3.6. Values of F derived from cohort analysis and from Irish catch per effort data

Season	F from Cohort analysis	From Irish cpe
1968 - 1969	0.44	0.32
1969 - 1970	0.47	0.50
1970 - 1971	0.50	0.34
1971 - 1972	0.84	0.82
1972 - 1973	0.66	0.65
1973 - 1974	0.64	0.82
1974 - 1975		0.44

Table 4.1 Mortality rates in Donegal Bay and in Division VIa

Year	Total mortality from Irish catch/effort ≥ 3 years	Total mortality in VIa from VPA ≥ 3 years
1968	0.41	0.29
1969	0.97	0.33
1970	+	0.43
1971	0.09	0.69
1972	0.89	0.45
1973	0.43	0.80
Mean 1968 - 73	0.47	0.50

Table 4.2 Total catches of herring (metric tons) in Division VIa, 1966-1974

Country	1966	1967	1968	1969	1970	1971	1972	1973	1974 ^{x)}
Belgium	23	-	-	-	-	-	-	-	-
England	1	-	3	-	-	-	-	-	45
Faroes ^{a)}	-	-	-	-	15 100	8 100	8 094	10 003	5 371
France	1	379	1 124	966	1 293	2 055	680	2 441	547
German Dem. Rep.	412	177	3	416	207	330	935	2 507	2 037
Germany, Fed.Rep.of	14 634	17 318	14 874	15 805	16 548	7 700	4 108	17 443	13 686
Netherlands	251	4 576	2 957	1 514	1 102	9 252	23 370	32 715	21 000 ^{b)}
Iceland	-	-	-	-	5 595	5 416	2 066	2 532	9 566
Ireland ^{c)}	7 759	12 290	13 390	11 895	11 716	12 161	17 308	14 668	12 381
N.Ireland	-	-	4	3	1	-	-	-	-
Norway	-	-	-	-	20 199	76 720	17 400	36 302	27 000 ^{b)}
Poland	-	727	2 791	3 188	3 709	-	-	5 685	6 368
Scotland	69 363	67 404	65 180	90 222	103 530	99 537	107 638	120 800	107 357
USSR	-	-	-	-	3	-	?	2 052	-
Total	92 444	102 871	100 326	124 009	179 003	221 271	174 873	247 148	205 358
Scottish Juvenile Herring and Sprat Fisheries in Moray Firth	20 734	6 507	4 985	3 100	1 385	5 666	10 242	7 219	

x) Preliminary figures

a) Figures supplied by Fiskirannsóknarstovan

b) September to December estimated

c) Catches mainly taken in Division VIIb and landed in VIa

Table 4.3 Herring autumn spawners. Catch in number $\times 10^{-3}$, Division VIa

Year	Age	1	2	3	4	5	6	7	8	9	10	11	11+ ¹⁾
	Rings	0	1	2	3	4	5	6	7	8	9	10	10+
1957	-	-	-	60 802	64 533	26 882	38 989	21 541	9 643	1 658	2 606	578	1 633
1958	-	-	11 187	32 973	152 781	43 895	28 108	32 025	19 986	10 795	3 725	2 592	2 570
1959	-	-	53 216	74 568	38 547	124 307	27 898	18 942	18 833	8 158	4 629	2 971	1 764
1960	-	-	2 135	101 389	65 462	25 340	50 558	12 196	11 096	6 770	3 029	1 558	269
1961	-	-	4 041	50 602	72 896	38 321	24 455	14 296	5 791	5 370	1 741	767	379
1962	-	-	20 738	99 061	27 189	76 706	49 002	22 707	27 787	7 614	5 676	2 097	662
1963	-	-	10 005	82 643	57 688	13 310	42 796	28 698	10 171	14 585	3 915	3 239	731
1964	-	-	3 633	81 919	74 309	29 583	8 857	27 075	21 347	10 109	11 956	4 028	1 671
1965	-	-	31 886	19 675	71 511	67 768	24 525	7 001	28 806	21 475	7 500	11 609	4 406
1966	-	-	6 299	251 086	33 526	70 449	38 471	22 691	12 656	20 790	17 005	7 418	8 752
1967	-	-	30 944	22 374	263 880	49 150	48 320	36 143	15 226	10 397	15 068	10 962	7 937
1968	-	-	58 215	90 027	26 031	243 304	19 679	28 436	17 699	7 275	4 493	5 326	4 570
1969	-	-	14 077	106 022	84 565	27 604	264 558	25 795	45 908	27 932	11 003	5 197	13 058
1970	-	-	158 085	107 037	272 693	124 498	42 623	185 380	24 821	29 920	14 276	5 156	6 903
1971	-	-	53 113	283 962	346 206	261 891	94 206	25 876	166 165	16 425	16 286	8 038	5 578
1972	147	-	35 047	647 919	208 367	72 885	83 361	37 428	13 445	94 577	8 154	5 855	5 377
1973	-	-	17 654	271 166	990 183	155 828	66 476	68 522	26 512	8 037	53 767	-	-
1974	-	-	57 769	142 068	203 356	544 547	89 818	45 026	42 367	18 747	43 644	-	-

1) Age 10 and older

Table 4.4 Catch in numbers $\times 10^{-3}$, Moray Firth

Year	Age in rings				
	0	1	2	3	4
1957		6 496	20 015	1 561	
1958	12 931	4 508	643	20	
1959	39 729	847	47	-	
1960	21	1 805	14 112	241	48
1961	-	10 432	207	18	
1962	-	34 540	106	-	
1963	-	1 885	206	-	
1964	2 781	22 976	5 733	-	
1965	46 891	267 815	3 676	574	
1966	211 639	205 376	266 530	11 791	344
1967	186 598	177 003	6 274	9 843	605
1968	71 425	162 655	15 321	-	
1969	192 368	25 083	1 167	-	
1970	16 299	80 346	1 835	-	
1971	209 598	116 667	2 186	-	
1972	24 794	286 492	105 436	1 876	
1973	267 872	33 083	2 617		
1974	385 826	250 736	11 191		

Table 4.5 Herring in VIa (Moray Firth included). Fishing mortalities by year and by age

Age \ Year	1965	1966	1967	1968	1969	1970	1971	1972
1	0.08	0.19	0.11	0.07	0.13	0.00	0.16	0.04
2	0.11	0.58	0.26	0.17	0.04	0.21	0.05	0.34
3	0.08	0.24	0.13	0.18	0.10	0.15	0.36	0.27
4	0.19	0.19	0.17	0.14	0.19	0.37	0.80	0.43
5	0.29	0.26	0.29	0.20	0.20	0.42	0.64	0.34
6	0.25	0.23	0.25	0.16	0.32	0.47	0.57	0.38
7	0.14	0.34	0.32	0.20	0.29	0.34	0.52	0.41
8	0.42	0.34	0.36	0.23	0.51	0.45	0.51	0.50
9	0.39	0.53	0.47	0.26	0.58	0.66	0.53	0.54
10	0.38	0.54	0.83	0.33	0.68	0.59	0.82	0.48
Mean $F_w \geq 3$	0.26	0.28	0.22	0.20	0.30	0.39	0.65	0.43

Table 4.6 Herring in VIa (Moray Firth included). Stock in numbers at beginning of year

Age	1965	1966	1967	1968
1	606 167	1 288 640	1 835 130	1 146 800
2	3 138 400	503 928	965 096	1 483 240
3	328 045	2 555 020	255 667	675 953
4	438 492	274 639	1 820 690	204 126
5	285 547	328 331	205 483	1 387 540
6	116 572	194 090	229 917	138 735
7	57 744	82 208	139 112	162 189
8	88 333	45 600	52 871	91 598
9	69 943	52 632	29 261	33 405
10	24 871	42 934	27 943	16 629
11	24 093	15 395	22 750	11 054

Age	1969	1970	1971	1972
1	1 692 140	4 262 500	1 512 030	679 100
2	969 794	1 348 390	3 841 370	1 169 110
3	1 132 380	840 285	993 757	3 314 450
4	511 608	922 787	656 928	627 920
5	159 979	382 642	576 483	267 385
6	1 024 550	118 552	228 261	273 930
7	106 846	676 157	66 901	117 383
8	119 762	72 211	436 042	36 036
9	66 084	64 899	41 826	237 217
10	23 324	33 365	30 429	22 296
11	10 786	10 701	16 682	12 151

Table 5.1. Sprat catches in the North Sea ('000 metric tons) 1965 - 1974.

Country	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974 ^{a)}
<u>Iva West</u>										
Denmark	-	-	-	-	-	-	-	-	-	8.6
France	-	-	+	-	-	-	-	-	-	-
Germany, Federal	-	-	+	-	-	-	-	-	+	-
Republic of	-	-	-	-	-	-	-	-	-	-
Netherlands	+	-	-	+	+	+	+	+	+	+
Norway	-	-	-	-	-	-	0.9	2.2	-	-
Poland	+	-	+	-	-	-	-	-	+	-
Sweden	-	-	-	-	-	-	-	-	1.0	-
U.K. (England)	+	+	-	-	-	-	+	-	0.2	-
U.K. (Scotland)	26.4	65.1	19.1	13.0	12.4	3.8	15.0	29.8	49.4	37.7
Total	26.4	65.1	19.1	13.0	12.4	3.8	15.9	32.0	50.6	46.3
<u>Iva East (Norwegian west coast fjords)</u>										
Norway	7.6	10.7	10.2	6.3	11.8	6.4	4.4	6.9	8.8	4.7
<u>IVb West</u>										
Denmark	...	...	...	...	...	8.6	9.9	14.4	47.0	55.4
Faroe Islands	-	-	-	-	-	-	-	-	-	4.0
France	-	-	-	1.0	-	-	-	-	-	-
German Democratic	-	+	+	-	-	-	-	-	-	1.7
Republic	-	-	-	-	-	-	-	-	-	-
Netherlands	0.1	+	+	+	2.0	+	+	+	-	-
Norway	-	-	-	-	-	-	-	4.1	3.4	9.8
Poland	0.1	+	+	+	-	-	-	+	-	-
U.K. (England)	+	0.9	11.9	2.6	3.3	11.2	25.5	21.8	34.6	23.2
U.K. (Scotland)	20.2	6.0	7.4	13.4	22.0	9.5	7.2	3.6	2.9	11.7
U.S.S.R.	-	-	-	-	-	-	1.2	0.8	17.9	25.0 ^{b)}
Total	20.4	6.9	19.3	17.0	27.3	29.3	43.8	44.7	105.8	130.8
<u>IVb East</u>										
Denmark	17.6	24.5	17.4	18.1	18.5	16.2	19.9	28.8	93.9	103.3
Germany, Federal	6.0	8.5	11.5	16.7	6.3	7.6	5.1	1.7	11.0	11.1
Republic of	-	-	-	-	-	-	-	-	-	-
Total	23.6	33.0	28.9	34.8	24.8	23.8	25.0	30.5	104.9	114.4
<u>IVc</u>										
Belgium	1.2	1.4	0.4	0.4	0.4	0.6	0.1	0.1	0.2	+
Denmark	-	-	-	-	-	-	-	-	-	0.9
France	+	+	-	+	0.1	+	+	-	+	+
Germany, Federal	-	-	-	-	-	+	-	+	-	-
Republic of	-	-	-	-	-	-	-	-	-	-
Netherlands	3.3	1.5	0.2	1.0	1.6	1.5	1.0	0.4	+	+
U.K. (England)	8.1	5.7	3.2	6.2	4.2	3.9	0.2	+	0.8	0.1
Total	12.6	8.6	3.8	7.6	6.3	6.0	1.3	0.5	1.0	1.0
<u>Total North Sea</u>										
Belgium	1.2	1.4	0.4	0.4	0.4	0.6	0.1	0.1	0.2	+
Denmark	17.6	24.5	17.4	18.1	18.5	24.8	29.8	43.2	140.9	168.2
Faroe Islands	-	-	-	-	-	-	-	-	-	4.0
France	+	+	+	1.0	0.1	+	+	-	+	+
German Democratic	-	+	+	-	-	-	-	-	-	1.7
Republic	-	-	-	-	-	-	-	-	-	-
Germany, Federal	6.0	8.5	11.5	16.7	6.3	7.6	5.1	1.7	11.0	11.1
Republic of	-	-	-	-	-	-	-	-	-	-
Netherlands	3.4	1.5	0.2	1.0	3.6	1.5	1.0	0.4	+	+
Norway	7.6	10.7	10.2	6.3	11.8	6.4	5.3	13.2	12.2	14.5
Poland	0.1	+	+	+	-	-	-	+	+	-
Sweden	-	-	-	-	-	-	-	-	1.0	-
U.K. (England)	8.1	6.6	15.1	8.8	7.5	15.1	25.7	21.8	35.6	23.3
U.K. (Scotland)	46.6	71.1	26.5	26.4	34.4	13.3	22.2	33.4	52.3	49.4
U.S.S.R.	-	-	-	-	-	-	1.2	0.8	17.9	25.0 ^{b)}
Total	90.6	124.3	81.3	78.7	82.6	69.3	90.4	114.6	271.1	297.2

+ = Less than 0.1

... = No data available

- = Magnitude known to be nil

a) Preliminary figures as reported

b) Estimated by the Working Group.
 A telegram received from Moscow on
 12 March 1975 gave the USSR sprat
 catch in the North Sea in 1974 as
 30 612 tons.

Table 5.2. Catch and effort for the Danish industrial fishery in the North Sea (Clupeoid catches).

Year	Effort (['] 000 hours, pair trawl)		Uncorrected Effort (Total)	Fishing Power Correction	Corrected Effort (['] 000 hours, pair trawl)	Danish Catch of Sprat (['] 000 tons)	kg/hr
	Spring	Autumn					
1965	17.57	41.05	58.62	1.25	73.3	17.6	240
1966	7.72	25.52	33.24	1.37	45.5	24.5	539
1967	25.86	20.61	46.47	1.50	69.7	17.4	250
1968	20.65	35.85	56.50	1.62	91.5	18.1	198
1969	42.44	29.04	71.48	1.75	125.1	18.5	148
1970	17.60	23.83	41.43	1.87	77.5	25.8	333
1971	36.75	28.58	65.33	2.00	130.7	29.8	228
1972	34.14	57.18	91.32	2.12	193.6	43.2	223
1973	37.57	42.67	80.24	2.25	180.5	140.9	781
1974	14.90	73.59	87.80	2.37	208.1	167.1	803

Table 5.3. Percentage age compositions of landings 1967 - 1974.

Area IVb - west of 3°E

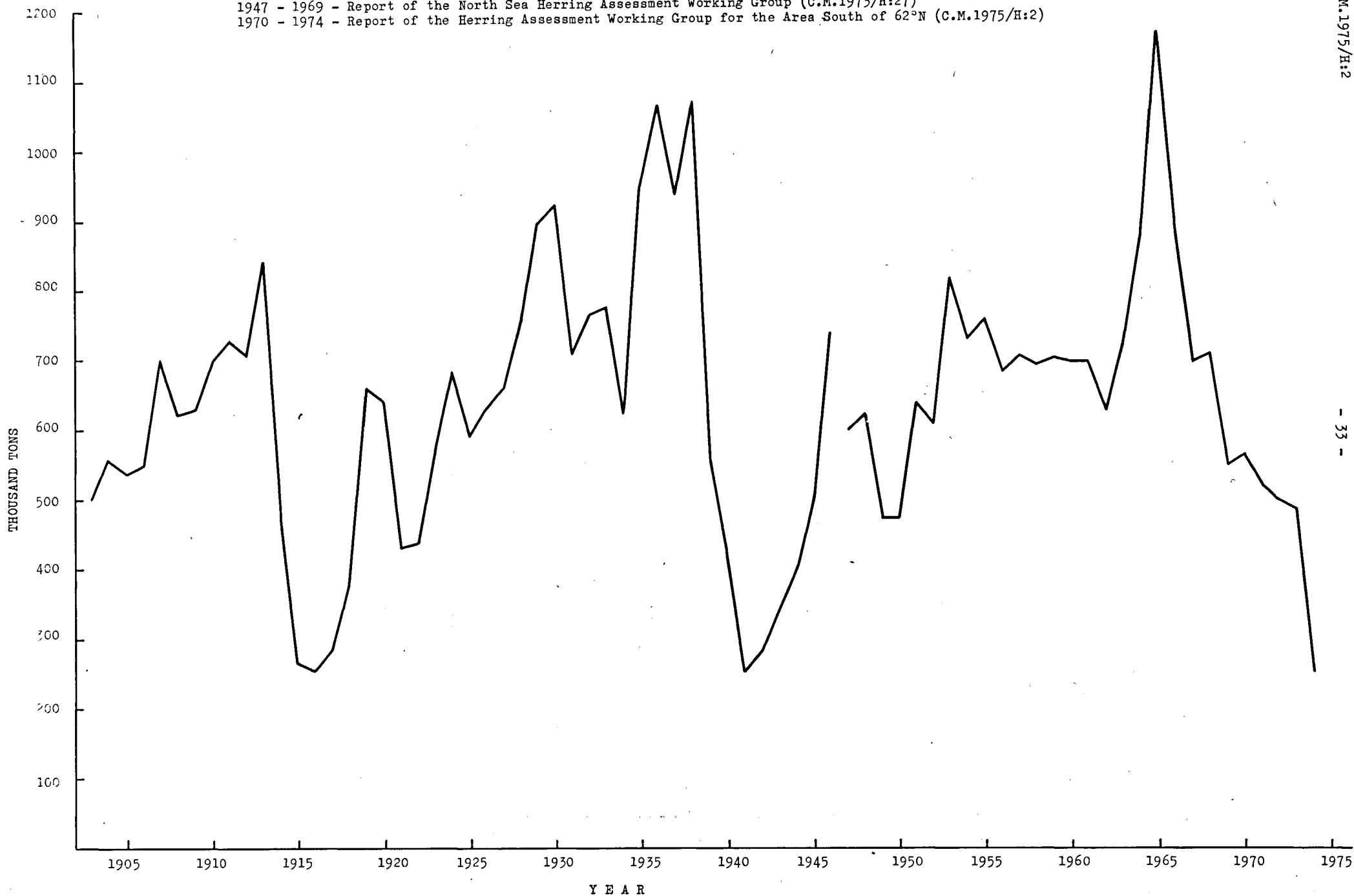
Fishing Season	Age Group					
	0	1	2	3	4	5
1967-68	17.1	53.8	16.9	11.1	1.2	
1968-69	3.0	37.5	43.1	11.7	4.3	0.3
1969-70	89.5	4.9	2.2	2.9	0.5	0.1
1970-71	40.9	25.3	22.8	8.3	2.8	
1971-72	8.8	77.9	8.6	4.2	0.4	
1972-73	33.7	44.2	17.9	2.9	1.1	0.2
1973-74	58.5	39.3	1.7	0.6		

Area IVb - east of 3°E

Fishing Season	Age Group				
	0	1	2	3	>3
1967		10	76	14	
1968		9	57	27	5
1969		1	41	39	20
1970	0.3	33	33	22	12
1971		23	40	20	17
1972	4	1	76	16	2
1973	15	69	11	4	1
1974	0.3	91.5	8	0.2	+

Figure 1. Annual catch of North Sea herring ('000 tons), 1903 - 1974.

1903 - 1946 - Bulletin Statistique Vols. 1 - 31 (1903 - 1931 "North Sea"; 1932 - 1946 IV + VIId,e)
1947 - 1969 - Report of the North Sea Herring Assessment Working Group (C.M.1973/H:27)
1970 - 1974 - Report of the Herring Assessment Working Group for the Area South of 62°N (C.M.1975/H:2)



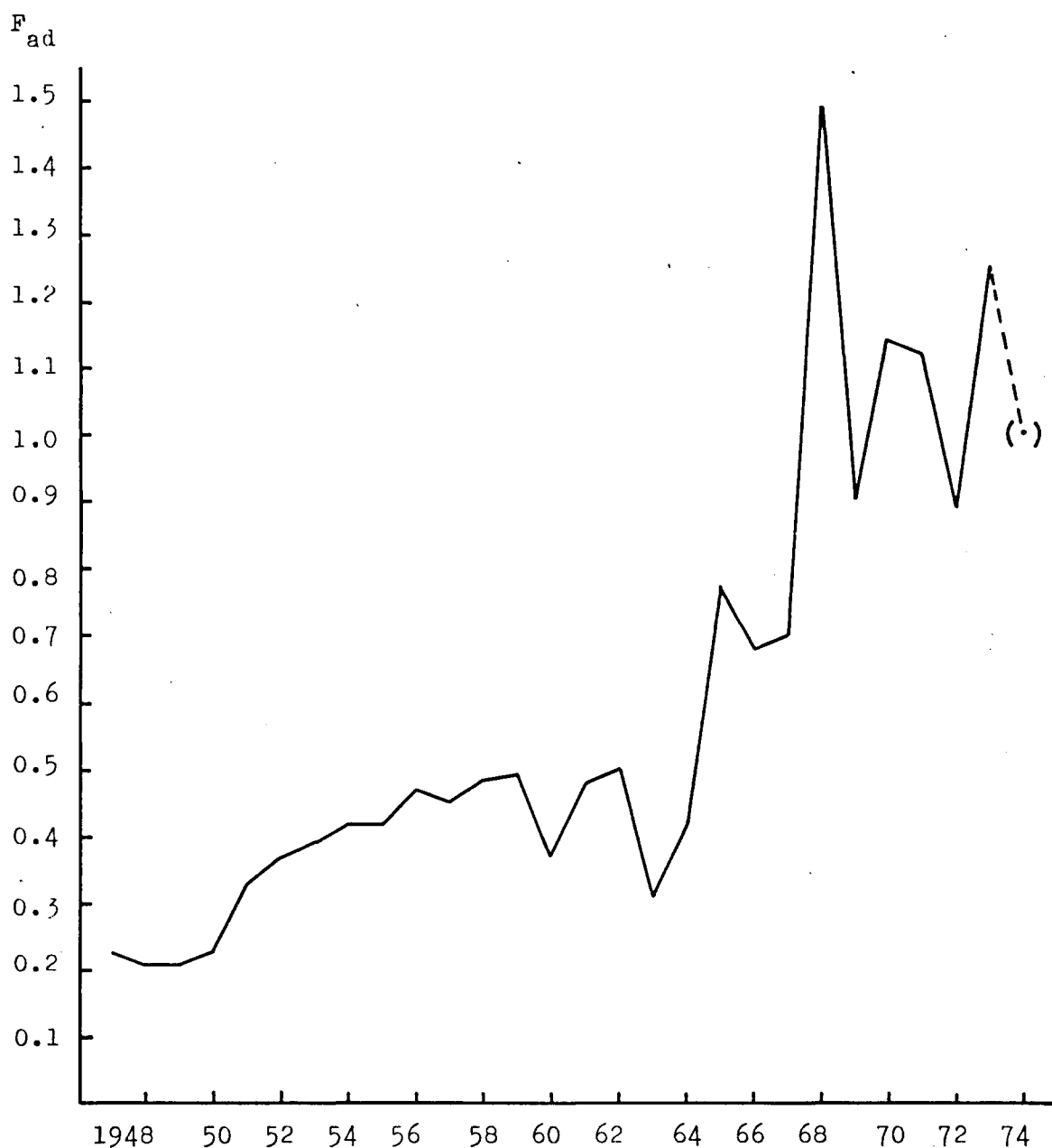


Figure 2. Fishing mortalities for the adults (≥ 2 -ringers) since 1947 in the North Sea (value for 1974 assumed).

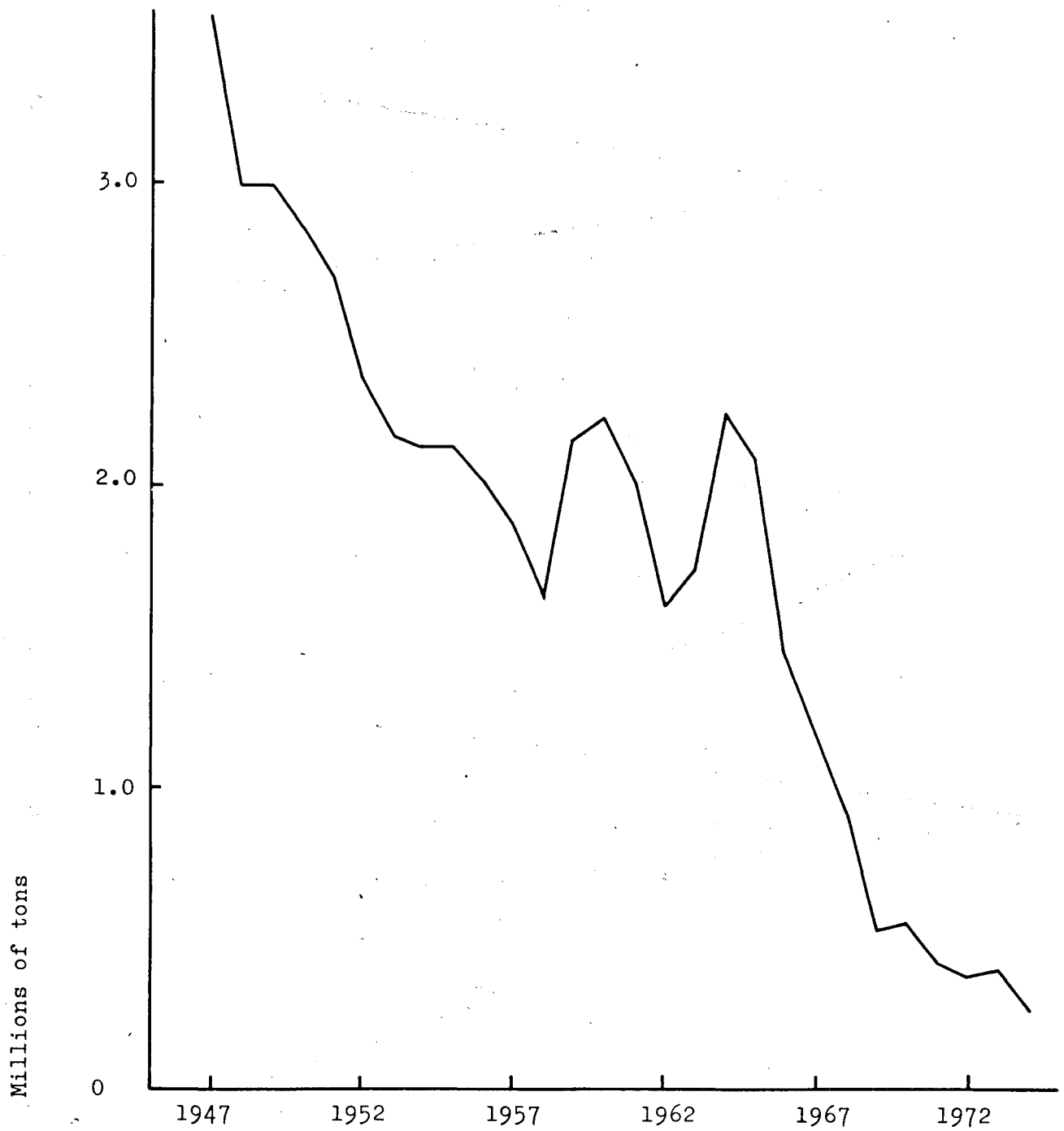


Figure 3. North Sea herring. Adult stock biomass (2-8 ringers) at 1 January).

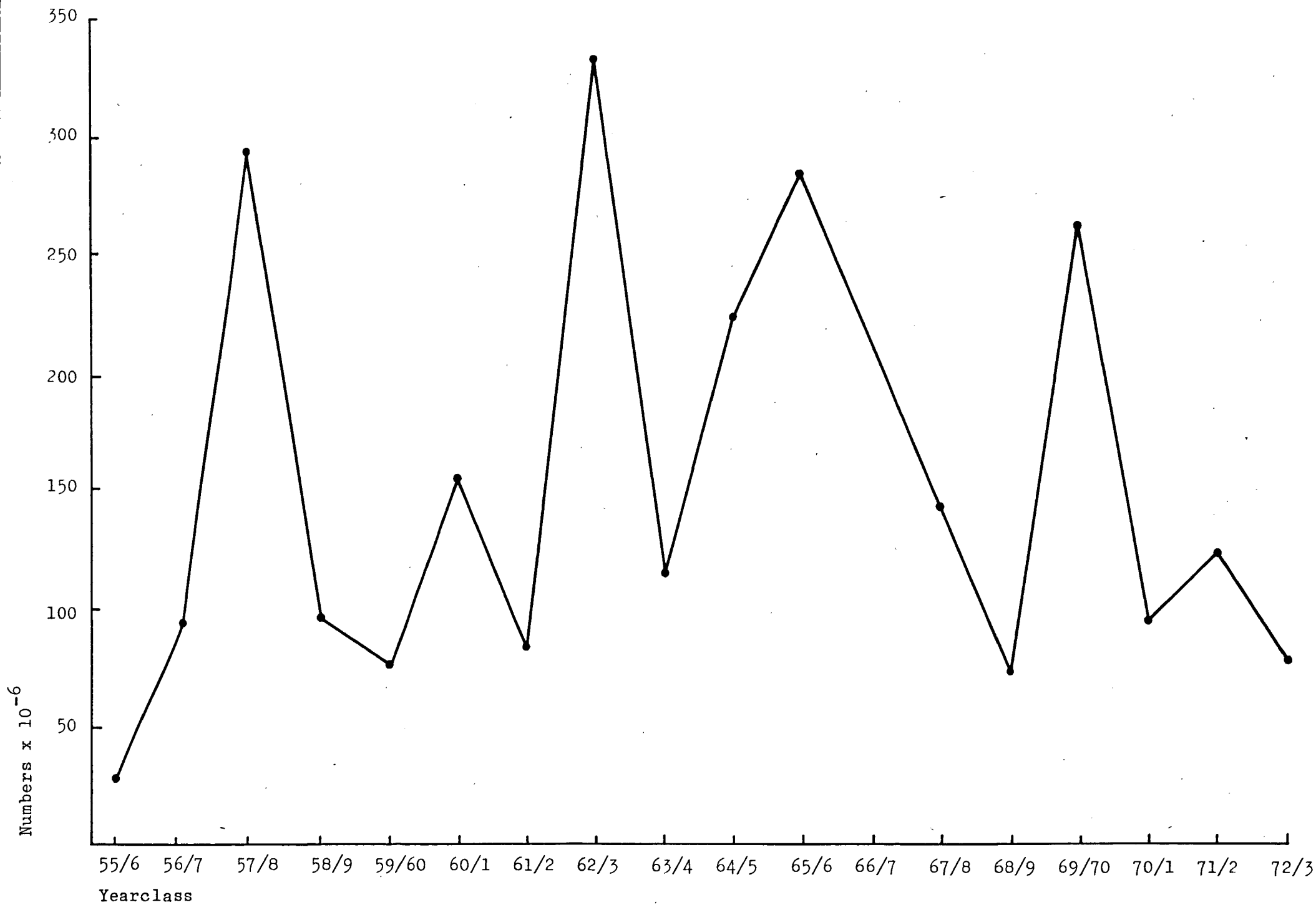


Figure 4. Celtic Sea. Recruitment of 1-winter ring fish per season. Values from 1957-1967 taken from Q.M.1973/H:2.

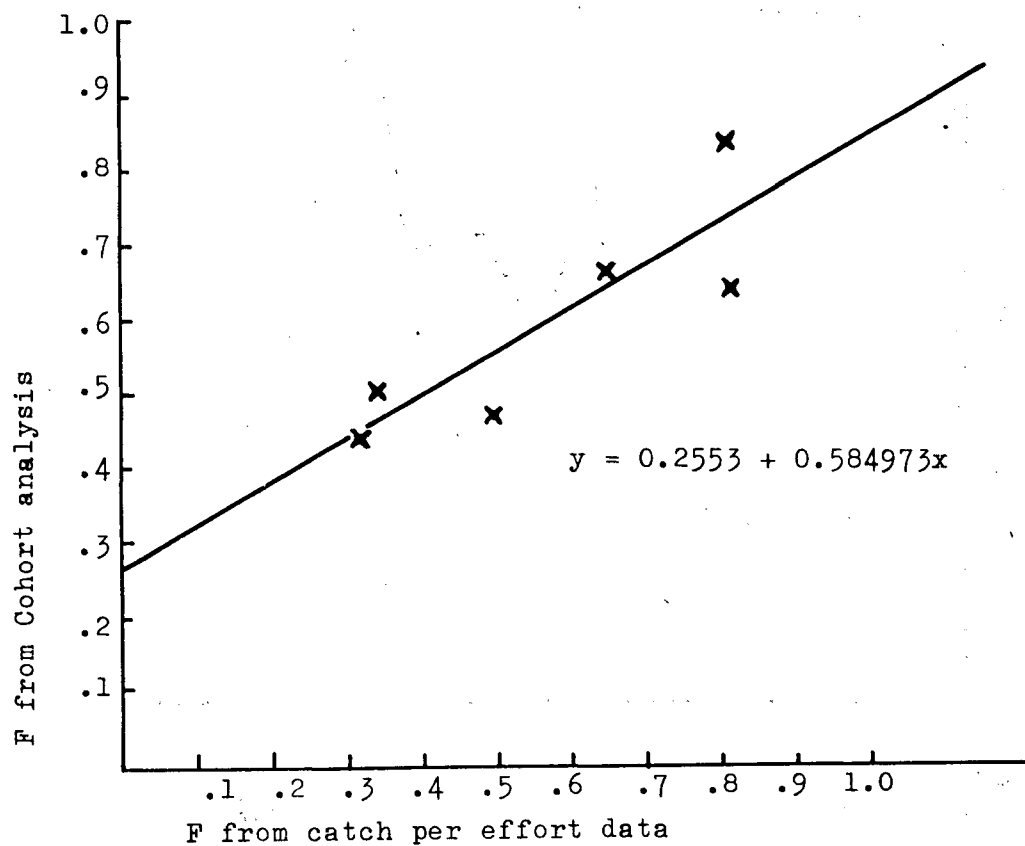


Figure 5. Values of F derived from Cohort analysis and from Irish catch per effort data.

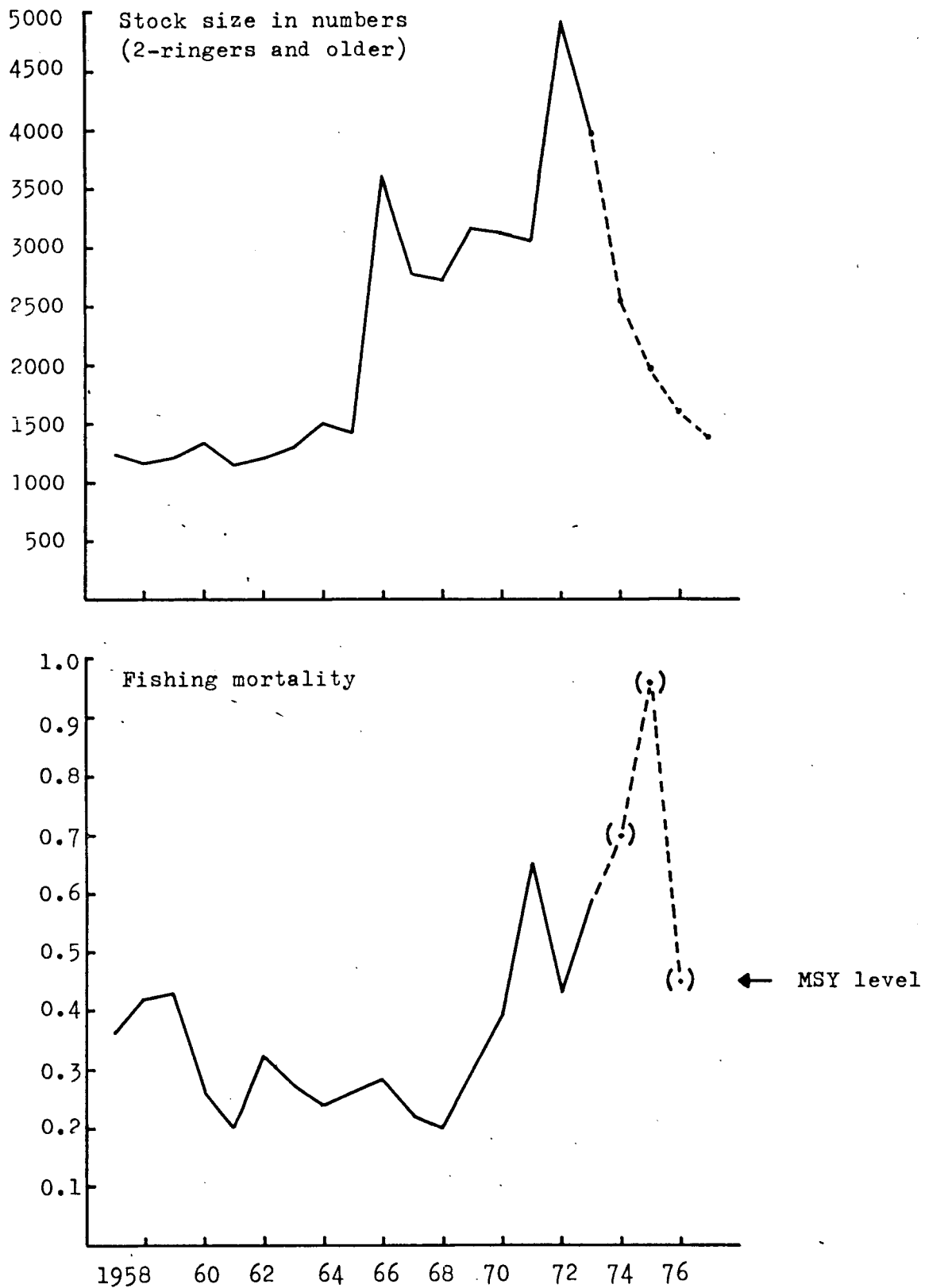


Figure 6. Stock size and fishing mortality in VIa herring.

\log_e mean percentage
age composition,
(excluding 0-group)

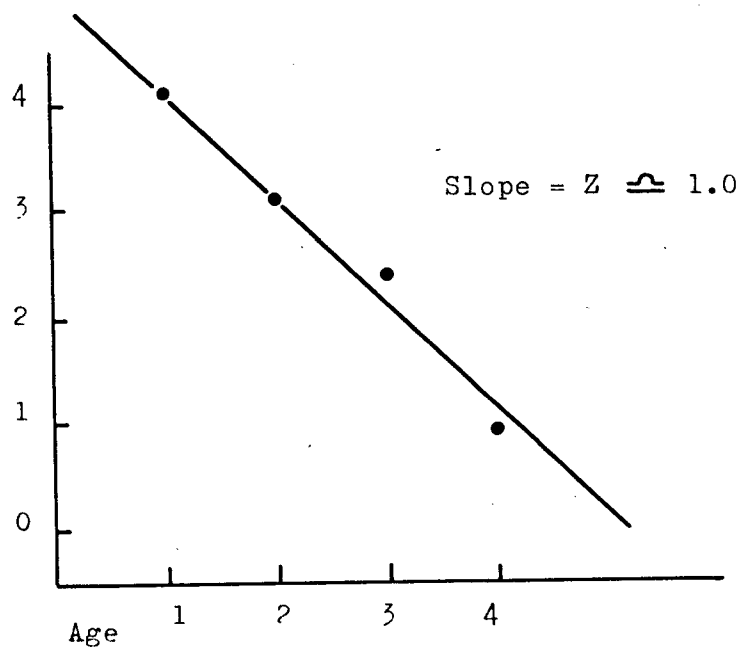


Figure 7. Mortality rate from catch-curve for area IVb west.