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ASSESSMENT OF HERRING STOCKS SOUTH OF 62°N

1973 to 1975

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International Council for the Exploration of the Sea
Charlottenlund Slot, DK-2920 Charlottenlund
Denmark

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INTRODUCTION

In this volume the report resulting from the meeting of "The North Sea Herring Assessment Working Group" in 1973 and those from the meetings in 1974 and 1975 of the new group set up to succeed it - "The Herring Assessment Working Group for the Area South of 62°North - are presented. The purpose of each of these meetings was to provide the Liaison Committee of ICES with advice, for transmission to the North-East Atlantic Fisheries Commission on the state of, and suggested management action for, pelagic stocks in the area south of 62°N. The increase in the number of stocks which these Working Groups have been required to assess in succeeding years illustrates the expansion which has taken place in recent years in the exploitation of pelagic resources in the area within which NEAFC is responsible for fish stock management. The reader of these reports will be able to form his own judgment of how effectively that management function has been discharged.

In an earlier report of the North Sea Herring Assessment Working Group (C.M.1972/H:13) cohort analysis was first applied to North Sea herring. Because of the major role which this technique plays in current assessments, and because the basic input data of catch and catch in numbers per age group have been revised for the most recent years at each succeeding assessment, the complete set of data, covering the period 1947-74, are given in Appendix Tables 1-9. These are the most accurate data for that period currently available. Those for 1973 and 1974 may require some revision in future, as new data become available; it is unlikely that any further revision will be possible in the data for the earlier years.

In Appendix Tables 10 and 11 the output from the cohort analysis, using the data of Tables 1-9, of fishing mortalities on each age group, and the stock in numbers of each age group, in each year are given. These data are frequently referred to in the reports published here, and it was considered more convenient to append them as single tables rather than to produce them in full in each report. It is also hoped that these Appendix Tables will be a convenient source of data for anyone who wishes to apply a new approach to, or to extend, the assessments reported in this volume.

It should be noted that the "Explanatory Notes to Tables 1-8" given on pages 18-19 of the 1973 report apply equally to Appendix Tables 1-8.

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REPORT OF THE NORTH SEA HERRING ASSESSMENT WORKING GROUP

Charlottenlund, 3 - 7 September 1973

1. Introduction

1.1 A description is given of the changes in the state of the North Sea herring stocks since the second World War in terms of total catch, stock size, fishing mortality, spawning potential and recruitment. It is concluded that the high fishing intensity exerted on the stock during the last decade has reduced the spawning potential at a rate of about 20% per year. The decrease in biomass has led to a decline in the total North Sea herring catch which at present is based upon a few young year classes.

1.2 Based on the assumption that future year classes will be of average strength, a prognosis of future catch and biomass is given for different combinations of fishing mortalities for juvenile and adult herring. Total allowable catch levels are deduced from this prognosis.

1.3 The existence of a stock/recruitment relationship for the total North Sea stock has not yet been demonstrated. The possibility that such a relation could arise by further reduction of the spawning potential is pointed out. This could lead to a rapid collapse of the stocks and the fisheries.

2. Terms of Reference

2.1 At its Eleventh Annual Meeting in May 1973, NEAFC agreed that an extraordinary meeting of the Commission should be held in December 1973 in order to recommend conservation measures - especially quota regulations - to improve the state of the herring stocks and fisheries. The Commission also agreed that a NEAFC Working Group of administrators and scientists should meet in London in late October in order to prepare basic material for this extraordinary meeting.

2.2 The terms of reference for the NEAFC Working Group were:-

> "To assemble and evaluate for presentation to a Special Meeting of the Commission information on measures for regulating catch with relation to herring stocks in the North and Celtic Seas.
>
> To consider and evaluate scientific data on the state of stocks of North Sea herring, including an assessment of the total allowable catch provided by the Liaison Committee of ICES.
>
> To consider and report to the Special Meeting on what further measures of conservation, if any, other than regulation of catch may be required for North Sea and Celtic Sea herring".

2.3 The North Sea Herring Assessment Working Group consequently met at ICES headquarters, Charlottenlund, Denmark, in the period 3-7 September 1973. It had already met in February 1973 with two objectives: to revise its last report (Anon., 1972) for publication in ICES Cooperative Research Reports series* and to report to the Liaison Committee on the preliminary data on the herring stocks and fisheries in 1972. A statement is included in the Liaison Committee's subsequent Report (Anon., 1973).

3. Participation

The following members of the Working Group took part in the meeting:

A C Burd	United Kingdom
A Corten	Netherlands
J Jakobsson	Iceland
H Lassen	Denmark
A Maucorps	France
K Popp Madsen (Chairman)	Denmark
K Postuma	Netherlands
A Saville	United Kingdom
A Schumacher	Federal Republic of Germany
Ø Ulltang	Norway
G Wagner	Federal Republic of Germany
O J Østvedt	Norway

The ICES Statistician, Mr D de G Griffith, also took part in the meeting. The absence of members from Poland, Sweden and U.S.S.R. was noted with regret.

4. The Development of the Fishery in 1972

4.1 A review of the development of the North Sea herring fishery in the period 1947-71 is given in the Report of the North Sea Herring Assessment Working Group (Anon., 1972).

4.2 The final figures for the catch taken in 1972 show a total of 491 100 tons for the North Sea and 66 900 tons for the Skagerrak. The overall total of 558 000 tons is thus about the same as in 1971 (Table 1). As in 1971 a large part of the catch (40%) was taken in the northwestern area (Table 5). The landings from the young herring fisheries in the central North Sea increased from 165 200 tons in 1971 to 184 900 tons in 1972 (Table 7).**

4.3 As in recent years the landings were mainly composed of 0, 1 and 2-ringed fish as shown in the table below.

Millions of herring caught per age group (winter rings)

Year/Age	0	1	2	3	4	5 and older	Total
1968	839	2425	1795	1494	621	571	7746
1969	112	2503	1883	296	133	336	5246
1970	890	1196	2003	884	125	143	5249
1971	684	4378	1147	662	208	97	7177
1972	750	3341	1441	344	131	40	6047

* The report has not been published in that series.

** These preliminary catch figures for 1972 were subsequently amended at later meetings of the Working Group, see Appendix Table 2.

4.4 Considering that about half of the catch of the 2-ringed fish is taken before spawning about 80% of the total North Sea catch in numbers in 1971-72 consisted of juveniles and first time pre-spawners.

5. Spawning Potential

5.1 Using the estimates of each age group of the adult stock for the total North Sea derived from the Cohort Analysis (Appendix Tables 10 and 11) the spawning potential of the stock was calculated from fecundity data for northern North Sea herring (Figure 1):-

Fecundity per age group (From Baxter, 1959)

Rings	2	3	4	5	>5
No. of eggs ($x 10^{-3}$)	45	67	87	96	101

Spawning potential

(Number of adult females x Mean number of eggs per age group $x 10^{-12}$)

Year	Sp.pot.	Year	Sp.pot.	Year	Sp.pot.
1947	730	1955	459	1963	431
1948	622	1956	435	1964	481
1949	627	1957	405	1965	453
1950	585	1958	336	1966	338
1951	557	1959	520	1967	266
1952	500	1960	452	1968	197
1953	465	1961	434	1969	131
1954	460	1962	322	1970	146

5.2 The high spawning potential in 1947 is obviously a result of an accumulation during the war period of older fish having high fecundity.

5.3 From 1947 to 1958 the spawning potential declined in the course of 11 years by about 50%. This decline is associated with an increase in fishing mortality on adults from 0.24 in 1947 to 0.45 in 1958.

5.4 In the following period 1959 to 1965 the spawning potential fluctuated by about 25% around an average of 440×10^{12}. The fishing mortality during this period fluctuated in a similar way between values of 0.3 and 0.48. Within this range a remarkable increase in spawning potential was observed in 1959 and in 1963-64 as a result of the recruitment to the spawning stock of the outstanding year classes 1956 and 1960.

5.5 In the course of the 5 year period after 1965 the spawning potential declined to 30% of the level of the preceding period. This decline is associated with a sharp increase in fishing mortality from the previous level of 0.45 up to a level of 1.0 and even higher.

5.6 As mentioned above and as shown in Figure 1 the two very good year classes 1956 and 1960 increased the spawning potential considerably and temporarily counteracted the rapid decline of the spawning potential caused by fishing (Figure 2). The good year class 1963, which was about 40% above the long-term average, did not lead to an increase in spawning potential. This was due to the increasing exploitation of the juvenile component, and leads to the conclusion that at the present high level of exploitation of juveniles, even a good year class can hardly contribute significantly to the spawning potential.

6. Fishing Mortality from Cohort Analyses and Catch per Unit Effort Data

6.1 Fishing mortality rates calculated for each age group, in each year, over the period 1947-70, are given in Appendix Tables 11 and 12 for the total North Sea stock.

6.2 For the adult stock the changes in the fishing mortality rates can most easily be followed from the value $\bar{F}_{w \geq 2}$. This value which was about 0.2 prior to 1951, fluctuated between 0.31 - 0.48, with a mean of 0.4, in the period 1952-64; and thereafter increased very much to a mean of 0.71 in 1965-67 and to 1.13 in 1968-70.

6.3 In the early 1950s when the Bløden fishery started, the calculated fishing mortalities for the 1-ringers were low, at a value of 0.1. From 1954 to 1963 this mortality fluctuated without trend in the range 0.18 - 0.46, with a mean value of 0.3. In the period 1964-69 the fishing mortality rate was appreciably higher in the range 0.36 - 0.54 with a mean of 0.5.

6.4 The catch data indicate that subsequent to 1970 the fishing mortality in the young herring fishery has increased even further. For several alternative values of F on 2-ringers in 1972, the value of F on 1-ringers in 1971 was calculated applying cohort analysis. The results indicate that at present the fishing mortality rate on 1-ringers is at the same level or even higher than that of the adults i.e. about 0.7.

6.5 From the Bløden Herring Tagging Experiment estimates were made of the fishing mortality of the 1967 and 1968 year classes as 1-ringed fish (Anon., 1975). The values derived are in close agreement with those obtained from the cohort analysis.

6.6 In the table below are given total mortality rates calculated from catch per unit effort and age composition data for the northwestern, central and southern North Sea adult stocks separately. As these are rather variable from year to year they are presented as mean values for 4-year periods. The values in this table up to 1969 are taken from Table 22 of Anon. (1971); those subsequent to 1969 have been calculated during this meeting (see table on page 6).

6.7 In the northwestern area the total mortality rates in the period to 1965 were in the range 0.4 - 0.6 but subsequent to 1965 they increased to about 0.7. In the central North Sea these total mortality rates were at about the same level as in the northwestern area prior to 1961 and then rose more sharply. In the southern North Sea the total mortality rate was quite high at 0.8 even in the earliest period considered here, and increased progressively up to 1965 to a level of 1.5.

Period	Northwestern North Sea[1)]	Central North Sea[2)]	Southern North Sea[3)]
1952-57	0.39	0.44	0.81
1957-61	0.58	0.60	1.13
1961-65	0.42	0.83	1.55
1965-69	0.73	1.01	1.33
1969-72	0.67	0.89	1.22

1) Derived from Scottish drift net catch per unit effort in May-July.

2) Derived from Netherlands trawl catch per unit effort in August-September.

3) Derived from Netherlands trawl catch per unit effort in November-December.

6.8 The mortality rates from catch per unit effort data can only be compared with those derived from the cohort analysis by weighting these area estimates by the relative stock sizes in each area to get an overall mean. Data on the sizes of the adult stock in the three areas have been taken from Burd (1973). When this is done and 0.1 subtracted to get an F value, the resulting values are given in the text table below with the cohort analysis values for comparison.

Period	Fishing mortalities derived from:	
	Catch per unit effort	VPA
1952-57	0.41	0.38
1957-61	0.49	0.44
1961-65	0.44	0.49
1965-69	0.67	0.89
1969-72	0.64	?

6.9 The close agreement up to 1965 gives some confidence in the catch per unit effort estimates for the period 1969-72 when no efficient estimate of F can be obtained from the cohort analysis. The value of 0.64 for this period derived from catch per unit effort is very close to the value of 0.7 used in the prognosis for the input value of the adult stock.

7. Recent Recruitment Estimates

7.1 The magnitude of any regulatory measures to be taken in order to restore the North Sea spawning stocks is partly dependent upon the level of current recruitment to these stocks. The 1969 year class is the last one for which some estimate can be made from the adult North Sea fisheries. In the central North Sea fisheries the abundance was low as it also was in the spawning fishery in the Southern Bight. This year class made a major contribution to the fishery in the northwestern North Sea around the Orkneys and Shetlands, and in catches in Division VIa. The recent year class abundances for both areas from Scottish catch per unit effort at

Shetland and from cohort analysis for Division VIa are given below:

Scottish estimates of recruitment of recent year classes

Year class	Division IVa W tons/drifter landings (May-July) as 2-ringers	Division VIa Stock in 10^9 as 0-group
1967	3.06	1.01
1968	1.68	1.53
1969	1.50	2.30
1970	1.41	1.58

This text table indicates that the 1969 year class was particularly strong in Division VIa while in Division IVa it was about the same strength as the 1968 and 1970 year classes, in contrast to the situation in other North Sea adult fisheries.

7.2 Estimates of the strength of these year classes were available as juvenile fish. The text table below gives the abundances in the English 0-group surveys, the ICES Young Herring Surveys and the Danish industrial fishery.

Estimates of recruitment as juvenile fish

Year class	English 0-group 1)	ICES Young Herring Surveys 2)		Danish industr.fishery 3)	
		I	II	I(spring)	II(autumn)
1967	1 799	455	87	1 082	318
1968	1 259	442	73	305	173
1969	2 793	1 241	354	1 006	455
1970	1 245	844	57	1 278	307
1971	907	411			

1) Numbers per hour per station.

2) Numbers per hour per rectangle.

3) Weighted average number per unit effort.

The 1969 year class is dominant in each series except in spring 1971 in the Danish fishery. The 1970 year class was also above average in the ICES Young Herring Surveys and the Danish fishery. The 1967 year class, which was much stronger in the northwestern North Sea than in Division VIa, also appears as above average strength in the juvenile estimates. From the few data available the 1971 year class as juvenile fish appears to be about average strength.

The interpretation of the juvenile abundance estimates in relation to the North Sea spawning stocks is problematic. While the 1969 year class appeared abundant from the juvenile assessments it recruited poorly in the North Sea, except in the northwestern area. It was also abundant in Division VIa, and the possibility exists that a part of that year class of juvenile herring in the North Sea were recruits to the stock in Division VIa.

7.3 A number of returns from the Bløden Tagging Experiment can be ascribed to fishing position. These are mostly returns from Norwegian and Scottish meal plants. Figure 3 shows the returns reported from the July/August fishery in 1970 and 1973. It appears that some fish of the year classes 1967 and 1968 tagged on the Bløden south of 55°30' migrated to the west of the Shetlands and Orkneys and even into the Minch.

7.4 The abundances of larvae in the North Sea surveys over the period 1946-72 are summarised in Table 13. This table is a complete revision of that previously reported (Anon., 1972). In recent years in the Downs area there has been some improvement from the very low levels in 1963-68. In the central North Sea the major production in recent years has been centred on the Yorkshire coast and Longstone spawning grounds, while on the Dogger there has been no appreciable production since 1966. In the Buchan area some larval production occurred in 1971 and 1972 after the low levels in 1967-70. The abundance of larvae in the Orkney/Shetland area seems to be very variable from year to year. If these larvae, or even older larvae from areas further west, are drifted into the North Sea and as juveniles eventually exploited in the young herring fisheries, a component of variability is introduced which causes difficulty in making forecasts of recruitment from these.

7.5 In the prognosis the recruitment of the incoming 1971, 1972 and subsequent year classes has been put at average.

8. Stock/Recruitment Relationship

Although no stock/recruitment relationship for the herring stock of the North Sea has so far been established, a continuation of the steady decrease in spawning potential during the past years makes it likely that such a relationship could become effective. In that case the result would be that the protection measures discussed in the present report will be over-optimistic.

If very severe protection measures are not then taken immediately, a complete breakdown of the North Sea herring stock will be evident within a couple of years.

9. Prognosis

9.1 A new prognosis (Table 14) has been made for the catches in 1973 and changes in catch and biomass in subsequent years, using final catch figures for 1972. The assumptions used for the new prognosis differ in some respects from those used in the previous Report (Anon., 1972). Both sets of assumptions are given in paragraph 9.2 for comparison:

9.2

Assumptions used in:	This report	The previous report
Year class 1971	Average (7.9×10^9)	Average (7.9×10^9)
Year class 1972	Average (7.9×10^9)	Average (7.9×10^9)
Natural mortality	0.1	0.1
Fishing mortality, 0-group, 1972	0.14*	0.05**
Fishing mortality, 1-group, 1972	0.70	0.5
Fishing mortality, adults, 1972	0.70	1.0

* $F_{0-gr} = 0.2 \times F_{1-gr}$ ** $F_{0-gr} = 0.1 \times F_{1-gr}$

9.3 The estimated age composition of the stock as at 1 January 1973 is given below:

Age	0	1	2	3	4	5	6	7	8	Biomass in tons
Nos $\times 10^{-9}$	7.9	6.2	3.1	1.34	0.32	0.12	0.031	0.005	0	0.77×10^6

The changes in fishing mortalities for adult and juvenile herring were based on the catch in numbers for 1972. Assuming year classes 1969 and 1970 to be not far above average strength, the high numbers of these year classes caught as juveniles can only be explained by an increased fishing mortality on juvenile herring. The numbers of adult herring caught were lower than would have been expected at F = 1.0. Therefore, the fishing mortality on adult herring has been reduced to 0.70.

10. Total Allowable Catch

10.1 The objective of introducing a total allowable catch regulation is either to prevent a reduction of the current stock size, and hence of the future catch, or to allow an increase in stock size and future yields from it. With the size and age composition of the stock at their present levels the fishery is very largely dependent on the youngest age groups. A succession of poor year classes, whether naturally induced or due to a stock/recruitment relationship, would effectively eliminate the North Sea herring fisheries very quickly. The objective therefore must be to bring about an appreciable increase in stock size over a fairly short time period. Table 14 gives the forecast catches in 1973, and the increases expected by 1976 in catch and stock size, at various levels of fishing mortality on the juvenile and the adult components of the stock.

10.2 This prognosis is based on the catch figures of 1972, assumed F's on adults and 1-ringers of 0.7, and average recruitment. The provisional catch figures for 1973 (Table 9) suggest that the F values in that year are likely to remain at about the same level.

The prognosis shows that there is little change in stock biomass at these levels of F and therefore the values in Table 14 for 1973 can be taken as equally valid for 1974. Similarly the values for 1976 are valid for 1977. To illustrate the options which are available two levels of increase in stock size, of 100% and of 200%, have been selected and the various strategies which will achieve these by 1977, given average recruitment, are shown in the text tables below.

10.3 If the objective is to increase the stock biomass by 100%, from the current level of 770 000 tons to about 1.5 million tons, Table 14 shows that this can be achieved by any of seven combinations of adult and juvenile fishing mortalities. These are given in the text table below with their effects on total allowable catch in 1974, and with the maintenance of these F's in the ensuing years, on the catch in 1977.

100% increase in stock biomass by 1977 (in '000 tons)

Juvenile F		0.0	0.1	0.2	0.3	0.4	0.6	0.8
Adult F		0.8	0.7	0.6	0.5	0.4	0.3	0.2
Allowable catch in 1974	Juveniles	-	30	60	80	110	150	180
	Adult	390	350	310	280	230	180	130
	Total	390	380	370	360	340	330	310
Allowable catch in 1977	Juveniles	-	30	60	80	110	150	180
	Adult	820	730	640	560	470	350	240
	Total	820	760	700	640	580	500	420

10.4 The smaller the juvenile F selected the higher will be the catch which can be taken in 1974; and the catch in 1977 will be very appreciably higher, increasing in the extreme case from 420 000 to 820 000 tons. If the greatest yield is the objective, then this would be achieved by completely stopping the juvenile fishery and retaining the exploitation rate of the adult fish at about the current level. The total allowable catch in 1974 would then be set at 390 000 tons. Retention of these levels of F to 1977 would give a total allowable catch in that year of 820 000 tons.

10.5 If the aim is to increase the stock size over the period 1974 to 1977 by 200% (to 2-3 million tons) only four combinations of adult and juvenile F's listed in Table 14 will obtain the objective. These are shown on page 11, and they give a small range of 210 000 - 240 000 tons in the total allowable catch in 1974. With the retention of these F values the levels of catch which can be taken in 1977 are, however, very different, with a major increase in catch with decreasing F's in the juvenile fishery.

200% increase in stock biomass by 1977 (in '000 tons)

Juvenile F Adult F		0.0 0.4	0.2 0.3	0.25* 0.25	0.3 0.2	0.6 0.1
Allowable catch in 1974	Juveniles Adult	0 230	60 180	70 160	80 130	150 70
	Total	230	240	230	210	220
Allowable catch in 1977	Juveniles Adult	0 700	60 510	70 410	80 380	150 170
	Total	700	570	480	460	320

* interpolated.

10.6 It must be stressed that if a total allowable catch is set without differentiating between adult and juvenile herring, the 1977 catch will be very much lower than that obtainable by a proportionally greater decrease in the juvenile than in the adult fishery.

With a stock size increase of 200% by 1977 the maximum sustainable yield thereafter would be taken by not exploiting the stock until the fish are 2-ringers and applying a fishing mortality rate of 0.4. The annual yield, assuming stable recruitment, would then be about 825 000 tons.

The expected long-term developments in catches and stock biomass are shown in Figure 4A and Figure 4B, respectively. It should be noted that the MSY for North Sea herring would be obtained at a fishing mortality rate of 0.4 for adults with no fishing for the 0 and 1 groups.

11. Additional Regulatory Measures

11.1 Minimum mesh size

The effectiveness of mesh size regulations in herring fisheries is very doubtful as fish which have escaped through the meshes may not be viable.

11.2 Minimum size

The introduction of a size limit in herring fisheries would have its effect through increased recruitment to the adult stock. Because of the difficulties in applying minimum mesh sizes, the direct effect would be to prohibit fishing on grounds where small herring are dominant. The length dividing the immature from the adult herring lies roughly between 20-23 cm.

11.3 Area closures

Closure of certain areas can be used for protecting specific components of the stocks e.g. by closing spawning grounds or nursery areas.

11.4 Seasonal closures

Because of the increase in weight of the herring from spring to summer and autumn, some increases in yield would be obtained by reducing the fishery in the first half of the year. A closed season from 1 February to 15 June increases the theoretical yield in the juvenile and adult fisheries by about 23% and 5% respectively, compared with the yield generated by the same annual fishing mortalities when there are no seasonal restrictions (Ulltang, 1972). The same quota in weight could thus theoretically be obtained with a reduced catch in number by seasonal restrictions.

11.5 Other conservation measures were discussed in the former reports of the Working Group (Anon., 1971 and 1972).

12. Discussion

12.1 The data in Tables 1-8 and in Appendix Tables 1-8 refer solely to herring catches in the North Sea and Skagerrak, while in "Bulletin Statistique" no distinction is made between catches derived from the Skagerrak and Kattegat. It is also known that some of the "so-called" herring catches in "Bulletin Statistique" contain varying quantities of other species. The total annual catch figures given in the present report are about 30-40% less than the official figures in "Bulletin Statistique".

12.2 It is stressed that the total allowable catch levels for North Sea autumn spawners given in the present report are based on the catch data presented here, which are the better estimates of North Sea herring catches.

12.3 The final catch figures for 1972 differ little from the preliminary ones given in the Liaison Committee Report (Anon., 1973) and at 558 000 tons the total catch is close to that in 1971. The catch composition, however, shows a further increase in the proportion of young fish.

12.4 The preliminary catch figures for the first seven months of 1973 already amount to 264 000 tons despite the closure in force from 1 February to 15 June. This catch represents about half the expected annual catch if fishing mortalities had remained at the levels of 1972. The major part of this catch was taken after 15 June.

12.5 Prognoses of future catches have been made on the basis of the 1972 age composition and on certain assumptions, including that of average recruitment levels being maintained after the 1971 year class entered the stock.

12.6 The assumption of average recruitment would be invalid if a stock/recruitment relationship exists. Total North Sea estimates of recruitment have remained high despite a reduction of spawning potential of about 80% since 1947. The catches from the juvenile fisheries have remained high and have even increased. There is evidence to suggest that the apparent sustained abundance of juveniles in the North Sea may be supported by an increased influx of progeny from stocks north and west of Scotland. As these fish may not contribute to the adult North Sea stocks, they could be masking a decline in North Sea recruits, and the existence of a stock/recruitment relationship. Although the critical level to which spawning potential can be reduced before recruitment is effected is not known, any further reduction from the present level must be regarded with concern.

12.7 With maintenance of the present mortalities on juveniles and adults little change is expected by 1976 in biomass or catch if recruitment remains constant. However, because of the dependence of the fishery and of the stock biomass on the recruit brood the occurrence of a single poor year class would result in an immediate drop in total catch and a subsequent decline in spawning potential. For this reason alone it would be beneficial for the fisheries to be based on a stock of higher average age and biomass.

12.8 The stock biomass can only be increased by a reduction in fishing mortality. In view of the errors inherent in the catch statistics on herring and on the assumption of future recruitment, it is necessary to aim at an increase of at least 100% over the 1972 biomass in the course of 3-4 years.

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Table 1. Herring. Catch in tons 1969-1972.
North Sea (Sub-area IV and Divisions VIId and e) by country.
Skagerrak and Kattegat (Division IIIa) total catch.

Country \ Year	1969	1970	1971	1972
Belgium	468	1 200	681	1 337
Denmark	180 260	133 331	185 393	213 738
England	6 666	9 702	4 113	650
Faroe Isl.	40 640	58 405	25 635	48 444
France	15 307	11 482	11 408	12 901
Germany(F.R.)	12 798	7 150	3 952	3 065
Iceland	19 997	22 951	36 992	31 998
Netherlands	29 769	49 416	32 479	24 829
Norway	114 938	177 341	122 570	110 969
Poland	9 221	5 057	2 031	2 235
Scotland	22 053	21 885	25 073	17 227
Sweden	33 109	34 670	36 880	7 366
U.S.S.R.	61 549	18 078	9 500	16 386
Total N.Sea	546 775	550 668	496 707	491 145
Skagerrak	113 279	70 527	61 411	66 962
Kattegat	59 300	74 300	90 200	107 519
Grand Total	719 354	695 745	648 318	665 626
Non-member countries	?	250	?	?

Table 2. Herring. Total catch in thousands of tons in the North Sea and Skagerrak.

Year	Area							Total
	Northwest	Northeast	Central	South	Industr.fishery (IVb)	Total N.Sea	Skagerrak	
1969	213.1	148.1	40.0	24.3	121.2	546.7	113.3	660.0
1970	312.6	21.3	111.7	27.1	74.8	550.7	70.5	621.2
1971	279.0	17.5	26.6	21.5	165.2	496.7	64.2	560.9
1972	229.5	22.7	30.7	23.3	184.9	491.1	66.9	558.0

Table 3. Herring. Total catch in tons.
Skagerrak (Division IIIa excl. Kattegat).

Year	Denmark	Faroe Islands	Germany (F.R.)	Iceland	Netherlands	Norway	Poland	Sweden	U.S.S.R.	Total
1969	57 965	-	-	-	-	13 957	-	41 357	-	113 279
1970	30 107	-	-	6 453	-	7 037	-	26 930	-	70 527
1971	26 985	5 636	-	3 066	-	5 961	-	19 763	-	61 411
1972	34 900	4 115	-	7 317	-	986	-	19 644	-	66 962

Table 4. Herring. Total catch in tons.
North Sea. Northeast (Division IVa east of 2°E).

Year	Belgium	Denmark	England	Faroe Isls.	France	Germany (F.R.)	Iceland	Nether-lands	Norway	Poland	Scotland	Sweden	USSR	Total
1969	32	55 550	-	12 805	278	16	6 300	2 084	15 618	166	9 785	26 035	19 392	148.061
1970	50	1 800	-	5 898	48	10	1 220	281	3 331	123	1 929	5 560	1 012	21 262
1971	-	6 219	-	239	-	-	-	167	10 442	-	-	-	-	17 067
1972		19 711	-	979		9	1 943	40	50				-	22 732

Table 5. Herring. Total catch in tons.
North Sea. Northwest (Division IVa west of 2°E).

Year	Belgium	Denmark	England	Faroe Isls.	France	Germany (F.R.)	Iceland	Nether-lands	Norway	Poland	Scotland	Sweden	USSR	Total
1969	68	11 360	-	27 835	605	448	13 697	474	99 316	362	10 051	6 765	42 157	213 138
1970	750	61 423	-	40 884	818	177	20 587	177	146 397	2 069	17 767	4 470	17 066	312 585
1971	-	44 500	-	25 142	514	389	36 992	5 755	112 114	1 288	24 711	4 954	9 500	265 580
1972	-	29 711	74	37 004	888	100	29 721	1 967	94 825	1 620	17 227	-	16 386	229 523

Table 6. Herring. Total catch in tons.
North Sea, Central (Division IVb). Adult herring fisheries.

Year	Belgium	Denmark	England	Faroe Isls.	France	Germany (F.R.)	Iceland	Nether-lands	Norway	Poland	Scotland	Sweden	Total
1969	-	-	5 964	-	3 362	3 528	-	16 542	4	8 077	2 217	309	40 003
1970	-	-	8 731	11 623	2 433	6 005	1 144	28 815	27 613	2 836	2 189	24 640	116 029
1971	8	2 488	4 113	254	4 734	-	179	10 172	14	743	362	1 926	24 993
1972	-	1 589	271	10 460	2 014	21	334	11 372	-	615	-	4 068	30 744

Table 7. Herring. Total catch in tons.
North Sea, Central (Division IVb).
Young herring fisheries.

Year	Young herring fisheries					
	Denmark	Germany (F.R.)	Sweden	Norway	Total	Total young and adult fisheries (Tables 6 and 7)
1969	113 350	7 900	0	-	121 250	161 253
1970	70 108	400	0	-	70 508	186 537
1971	132 161	3 055	30 000	-	165 216	190 209
1972	162 671	2 823	3 298	16 094	184 886	215 514

Table 8. Herring. Total catch in tons.
North Sea, South and English Channel, East and West
(Divisions IVc and VIId and e).

Year	Belgium	Denmark	England	France	Germany (F.R.)	Nether-lands	Poland	Total
1969	367	-	702	11 062	906	10 669	616	24 322
1970	400	-	971	8 183	558	16 945	29	27 086
1971	673	25	-	6 160	126	16 385	-	23 369
1972	1 337	57	305	9 999	112	11 450	-	23 260

Explanatory Notes to Tables 1-8 and to Appendix Tables 1-8

Table 1

Data derived as listed below under each country. The Kattegat catches are according to Danish national statistics and information from the Swedish Laboratory at Lysekil.

Table 2

1947-54. Catches for northwest and northeast are derived from Statistical News Letters 11A and 11B. The national distributions of catch by area in some cases refer to all catches and in others to a large sub-sample of the catches.

Catches for central and south are taken from Cushing and Bridger (1966), Appendix 4. The catches for the south refer to the seasonal winter fishery and not the calendar year.

Catches for the industrial fishery are derived from Coop.Res.Rep., Ser.B, 1965, Annex II, Table 12.

The catches for the Skagerrak for some countries also include Kattegat catches (Bull.Stat.). Taking the catches ascribed to areas for the North Sea, their total covers an average of 98% of the annual catches given in Table 1 for the period 1947-54.

1955-59. Catches for the northwest, northeast and central are based on data in Cushing and Bridger (1966). The Swedish catch from Division IVa (Bull.Stat.) was regarded as taken in the northeastern area.

Catches for the south and the industrial fisheries are derived from Coop.Res.Rep., Ser.B, 1965, Annex II, Tables 11 and 12.

1960-68. Data from Coop.Res.Rep., Ser.A, No.26.

Industrial Fishery: These data refer only to the juvenile herring catches in Division IVb by Denmark and the Federal Republic of Germany, and also Norway and Sweden for 1971 and 1972. A separation into industrial and consumption catches was not possible for any other area.

Skagerrak: 1955-72 data from Danish national statistics and from the Fisheries Laboratory at Lysekil.

Belgium

All data derived from "Bulletin Statistique". Catches from Division IVa for 1960-68 are ascribed to Division IVa west of 2°E.

Denmark

All data used in the tables are based upon Danish national statistics (Popp Madsen). Catches from Division IVa are ascribed to IVa east of 2°E for 1960-68. Catches from Division IVb (Young Herring Fishery) have been reduced for content of other species (1960 to spring 1965 by 5%, autumn 1965-1971 by estimates from individual years; Popp Madsen). Catches from the Kattegat for 1972 have been derived by subtracting the catch figure for the Skagerrak (supplied by Popp Madsen) from the total 1972 catch for Division IIIa (Kattegat + Skagerrak) given in Bulletin Statistique.

England

All data derived from "Bulletin Statistique". Separation of catches in Division IVa east and west of 2°E according to national statistics.

Faroe Islands

Catches only from Division IVa according to "Bulletin Statistique". Ascribed to IVa west for 1960-68. From 1969-71 the distribution of catches to fishing areas are based on landings in Danish ports. Landings for 1972 have been supplied by the Faroese statistics reporting agency.

France

The data given have been supplied by the "Institut des Pêches", Boulogne s/Mer.

Federal Republic of Germany

All data are according to German national statistics (Schumacher). They are compiled by "Bundesforschungsanstalt für Fischerei", Hamburg, according to log books.

Iceland

All data derived from "Bulletin Statistique". Separation of catches in Division IVa east and west of 2°E are according to Icelandic statistics for 1960-69, 1971 and 1972, and according to landings in Danish ports for 1970.

Netherlands

All data derived from "Bulletin Statistique". Separation of catches in Division IVa east and west of 2°E are according to Dutch national statistics.

Norway

The data are according to reports from "Noregs Sildesalslag". Catches in inshore waters are not included.

Poland

All data according to "Bulletin Statistique". Separation of catches in Division IVa east and west of 2°E up to 1971 is according to Polish national statistics. The 1972 catch in Division IVa has been allocated to Division IVa west.

Scotland

All data are according to "Bulletin Statistique". Separation of catches in Division IVa east and west of 2°E is according to Scottish national statistics. Catches from the Moray Firth are not included.

Sweden

Data according to Swedish national statistics (Ackefors). Division IIIa: Data obtained from proportion of Skagerrak catches in Swedish landings in Danish ports applied to total Swedish landings. Separation of catches in Division IVa east and west of 2°E (up to 1971) according to Swedish national statistics, but is supposed to be rather unreliable. A greater part of the landings presumably comes from Division IVa, west of 2°E. Allocation by area for the North Sea catch for 1972 was not possible, and was separated only into industrial and consumption herring landed in Sweden and abroad. Total consumption catch was supplied for the North Sea as a whole, and constituted 9% of the consumption catch from all areas. This catch was allocated to the Central Division IVb, and by applying the proportion to the grand total of industrial and consumption herring landed in Sweden and abroad, the industrial and consumption catch from Division IVb was derived.

U.S.S.R.

All data according to "Bulletin Statistique". Separation of catches in Division IIIa Skagerrak, IVa east and IVa west of 2°E up to 1971 are according to Soviet national statistics. For 1972, the total IVa catch has been allocated to Division IVa west.

Table 9. Preliminary catch for 1973.

Country	Period	Total North Sea	Div. IIIa	North Sea + Skagerrak	West of 4°W
Belgium					
Denmark	1/1 - 30/7	92 056	13 077	105 133	
Faroe Isl.*	1/1 - 1/8	16 100	4 185	20 285	
France	1/1 - 1/7	355	-	355	
Germany (F.R.)					
Iceland	1/5 - 1/8	13 621	389	14 010	
Netherlands	1/1 - 1/7	4 456		4 456	
Norway**	1/1 - 31/8	85 900		85 900	44 600
Poland					
Sweden*		2 106	6 336	8 442	
UK England	1/7 - 1/9	1 000		1 000	
UK Scotland	1/5 - 18/8	8 686		8 686	
U.S.S.R.					
Total		224 280	23 987	248 267	

* Landed in Danish harbours.

** A national catch quota of about 66 000 tons set on herring landed for industrial purposes is expected to be reached early September.

Table 10. North Sea catch in millions of fish by age.

Year	Area	Age in winter rings										
		0	1	2	3	4	5	6	7	8	>8	Total
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	10.4	2.1	1.4	1.1	-	0.2	217.6
	IVb	-	2.1	140.3	54.4	12.6	-	-	-	-	2.1	211.5
	IVb YH	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
	IVb YH	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

Table 11. Total North Sea: calculated stock in number x 10^{-9}

Winter rings \ Year	1967	1968	1969	1970
0	7.64	7.83	5.57	7.66
1	4.44	6.30	6.29	4.93
2	3.27	2.43	3.40	3.32
3	2.54	1.85	0.51	1.30
4	0.64	1.01	0.27	0.18
5	0.56	0.23	0.33	0.12
6	0.68	0.22	0.06	0.12
7	0.11	0.24	0.12	0.01
8	0.25	0.04	0.02	0.07
Juvenile, 0+1	12.08	14.13	11.86	12.59
Adult, 2-8	8.05	6.02	4.71	5.12

Table 12. Total North Sea: calculated fishing mortality.

Winter rings \ Year	1967	1968	1969	1970
0	0.09	0.12	0.02	0.13
1	0.50	0.52	0.54	0.29
2	0.47	1.45	0.86	0.99
3	0.82	1.81	0.92	1.23
4	0.92	1.02	0.71	1.22
5	0.81	1.21	0.92	0.56
6	0.93	1.12	1.74	0.76
7	1.01	1.23	1.11	1.74
8	0.40	0.50	0.60	1.00
$F_W \geq 2$	0.69	1.46	0.88	1.05

Table 13. Larval abundance in the North Sea.
Number x 10^{-9} (- = no observations)
(+ = <0.5 x 10^{-9}).

Year	Southern North Sea[1]	Central North Sea		Northwestern North Sea[4]		
		Dogger[2]	Total[3]	Buchan	Orkney-Shetland	Total
1946	1 193	-	-	-	-	-
1947	1 134	-	-	-	-	-
1948	-	-	-	-	-	-
1949	-	-	-	-	-	-
1950	281	-	-	-	-	-
1951	686	-	-	2 205	1 029	3 234
1952	-	-	-	2 180	245	2 425
1953	-	-	-	5 170	2 303	7 473
1954	-	-	-	2 132	1 715	3 847
1955	183	-	-	32	1 715	1 747
1956	165	-	-	-	-	-
1957	36	232	-	735	-	-
1958	139	252	-	539	6 860	7 399
1959	12	97	-	735	2 107	2 842
1960	147	138	-	1 078	1 568	2 646
1961	187	86	-	931	12 103	13 034
1962	>30	66	-	980	1 764	2 744
1963	22	-	-	1 078	1 421	2 499
1964	9	52	>63	2 254	2 156	4 410
1965	13	275	>490	172	5 439	5 611
1966	+	3	>142	25	1 666	1 691
1967	26	0	599	+	854	854
1968	16	0	137	0	222	222
1969	108	0	14	+	493	493
1970	126	0	387	2	230	232
1971	7	+	177	143	711	854
1972	67	+	112	25	2 803	2 828

1) Larval abundance (all size groups) in Downs area in December-January.

2) Abundance of larvae <11 mm in October on western and southern slopes of Dogger Bank.

3) Abundance of larvae <10 mm in September-October in central area of the North Sea.

4) Abundance of larvae <10 mm in September in the northwestern North Sea (north of 56°N).

Table 14. Initial catch levels (1973) and percentage increase in catch and biomass 1973-76 at different combinations of mortalities for juvenile and adult North Sea autumn spawning herring.

Juvenile mortalities (0- and 1-ringers)

Adult mortalities (2-ringers and older) F	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
0.0	0.0 100.0 496.3	30.6 0 445.5	58.6 0 400.3	84.1 0 359.9	107.4 0 323.9	128.7 0 291.8	148.2 0 263.1	166.1 0 237.5	182.4 0 214.6
0.1	66.5 333.3 391.6	97.1 206.3 348.3	125.0 144.1 309.6	150.6 107.1 275.2	173.9 82.4 244.4	195.2 64.7 217.0	214.7 51.4 192.6	232.6 40.9 170.8	248.9 32.4 151.3
0.2	126.7 279.4 312.4	157.3 199.8 275.0	185.3 150.0 241.6	210.8 115.9 211.9	234.1 91.1 185.4	255.4 72.3 161.8	274.9 57.6 140.8	292.8 45.7 122.0	309.2 36.0 105.2
0.3	181.3 235.9 251.7	212.0 176.7 219.1	239.9 135.8 190.1	265.4 106.0 164.2	288.7 83.4 141.1	310.1 65.7 120.6	329.6 51.5 102.2	347.4 39.9 85.9	363.8 30.3 71.3
0.4	230.8 200.6 204.7	261.5 152.9 176.0	289.4 118.2 150.5	314.9 92.1 127.7	338.3 71.6 107.5	359.6 55.3 89.4	379.1 42.1 73.3	396.9 31.1 58.9	413.3 21.9 46.1
0.5	275.7 171.8 168.0	306.4 131.5 142.5	334.3 101.4 119.8	359.8 78.0 99.6	383.1 59.5 81.6	404.5 44.5 65.5	424.0 32.2 51.2	441.8 22.0 38.5	458.2 13.3 27.1
0.6	316.4 148.1 138.9	347.1 113.1 116.0	375.0 86.3 95.7	400.5 65.3 77.6	423.9 48.4 61.4	445.2 34.5 47.1	464.7 23.1 34.3	482.5 13.5 22.8	498.9 5.4 12.6
0.7	353.4 128.5 115.6	384.0 97.4 95.0	411.9 73.3 76.6	437.5 54.0 60.2	460.8 38.5 45.6	482.1 25.7 32.6	501.6 15.0 21.0	519.4 6.0 10.7	535.8 -1.6 1.5
0.8	386.8 112.1 96.8	417.5 84.1 78.0	445.4 62.1 61.2	470.9 44.4 46.3	494.3 29.9 33.0	515.6 18.0 21.1	535.1 8.0 10.5	552.9 -0.5 1.1	569.3 -7.7 -7.3
0.9	417.2 98.5 81.5	447.8 72.8 64.2	475.8 52.5 48.8	501.3 36.1 35.0	524.6 22.6 22.8	545.9 11.4 11.9	565.4 2.0 2.2	583.3 -6.0 -6.5	599.7 -12.9 -14.2
1.0	444.8 87.0 68.9	475.4 63.3 52.8	503.3 44.3 38.5	528.9 28.9 25.8	552.2 16.3 14.5	573.5 5.7 4.4	593.0 -3.2 -4.6	610.8 -10.8 -12.6	627.2 -17.3 -19.8

Upper figure: catch in 1973 (1 000 tons)

Middle figure: increase in catch in 1976 as a percentage of that in 1973

Lower figure: increase in biomass as at the beginning of 1977 (% in weight).

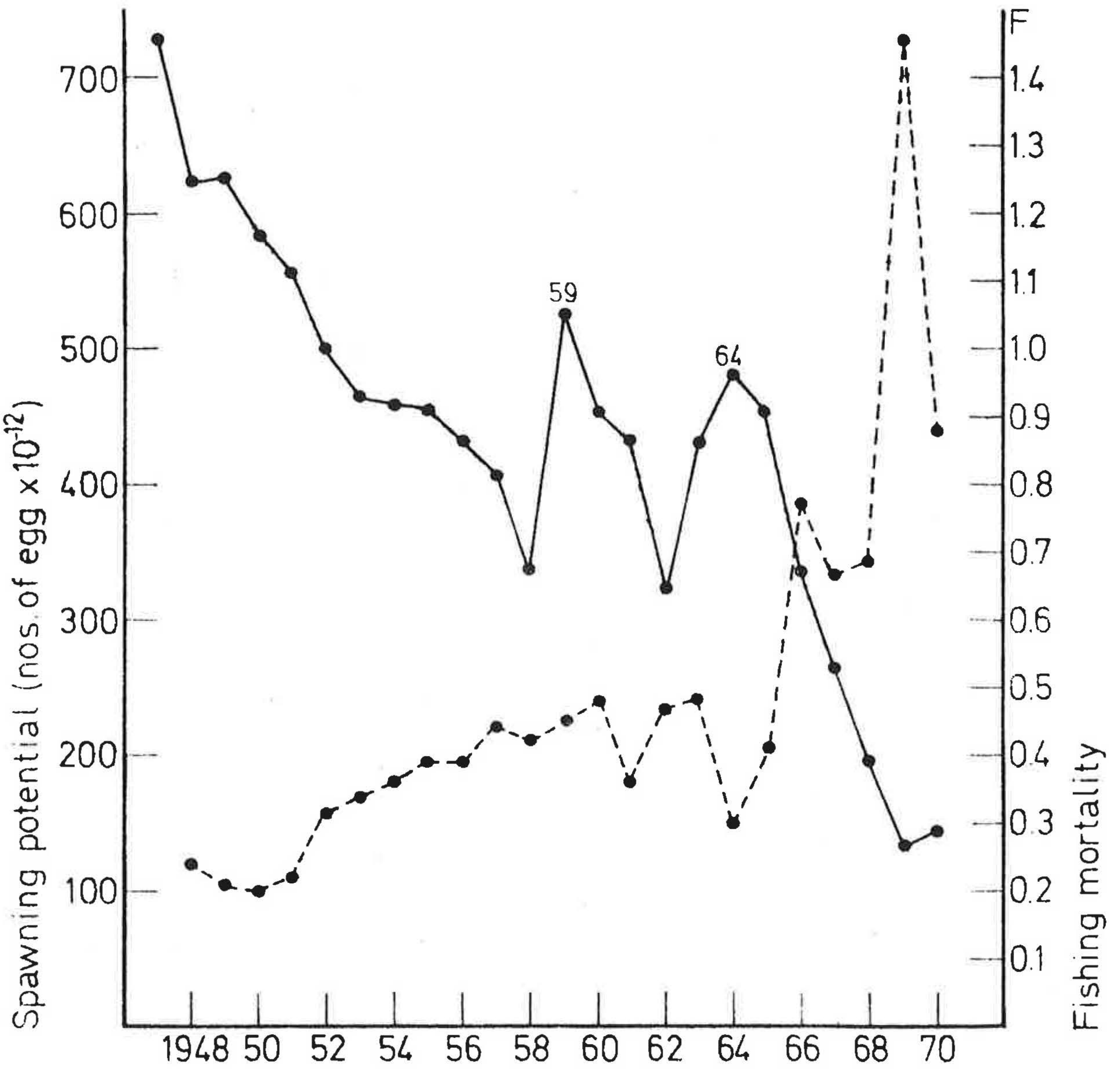

Figure 1. The spawning potential of the total North Sea herring stock 1947-1970 (full line) compared with the fishing mortality in the preceding year (hatched line).

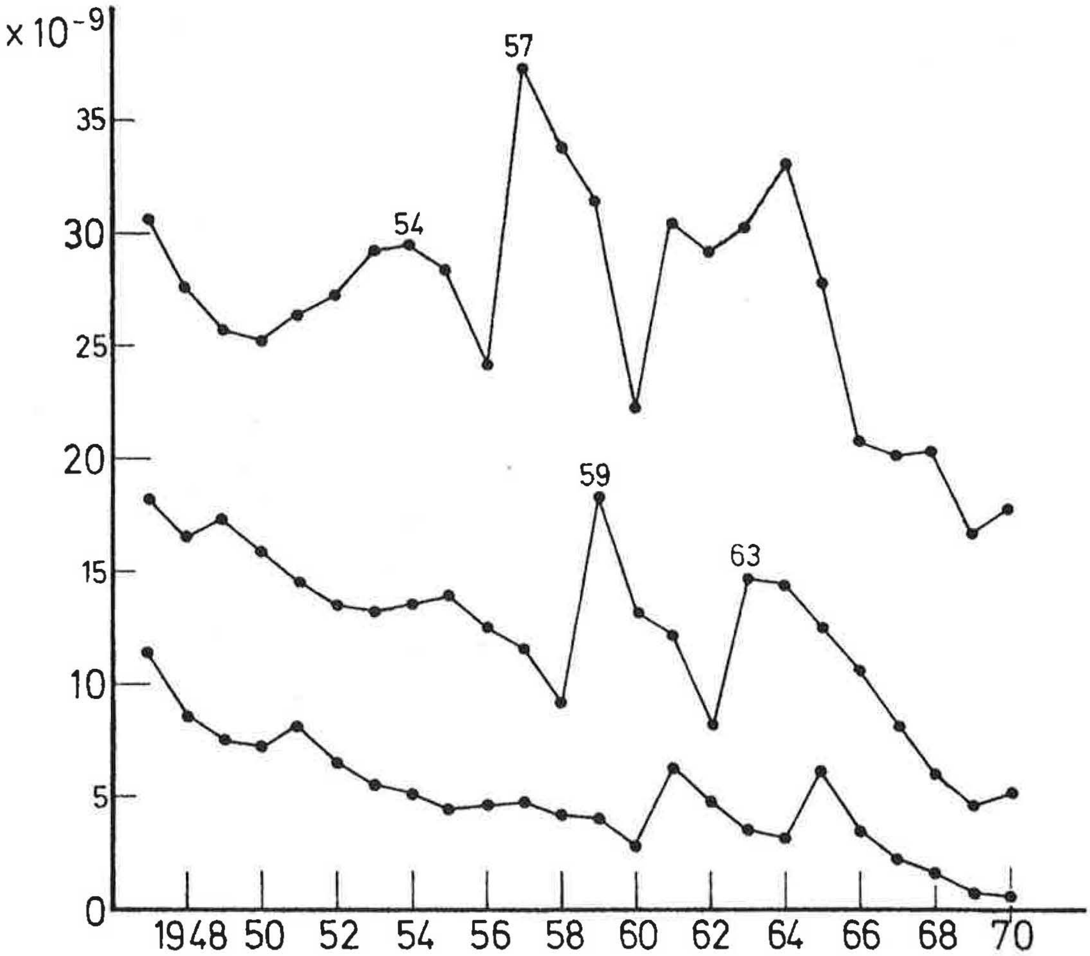

Figure 2. The North Sea herring stock in numbers (x 10^{-9}).

Upper curve: total stock
Middle curve: adults as 2-ringers and older
Lower curve: adults as 4-ringers and older.

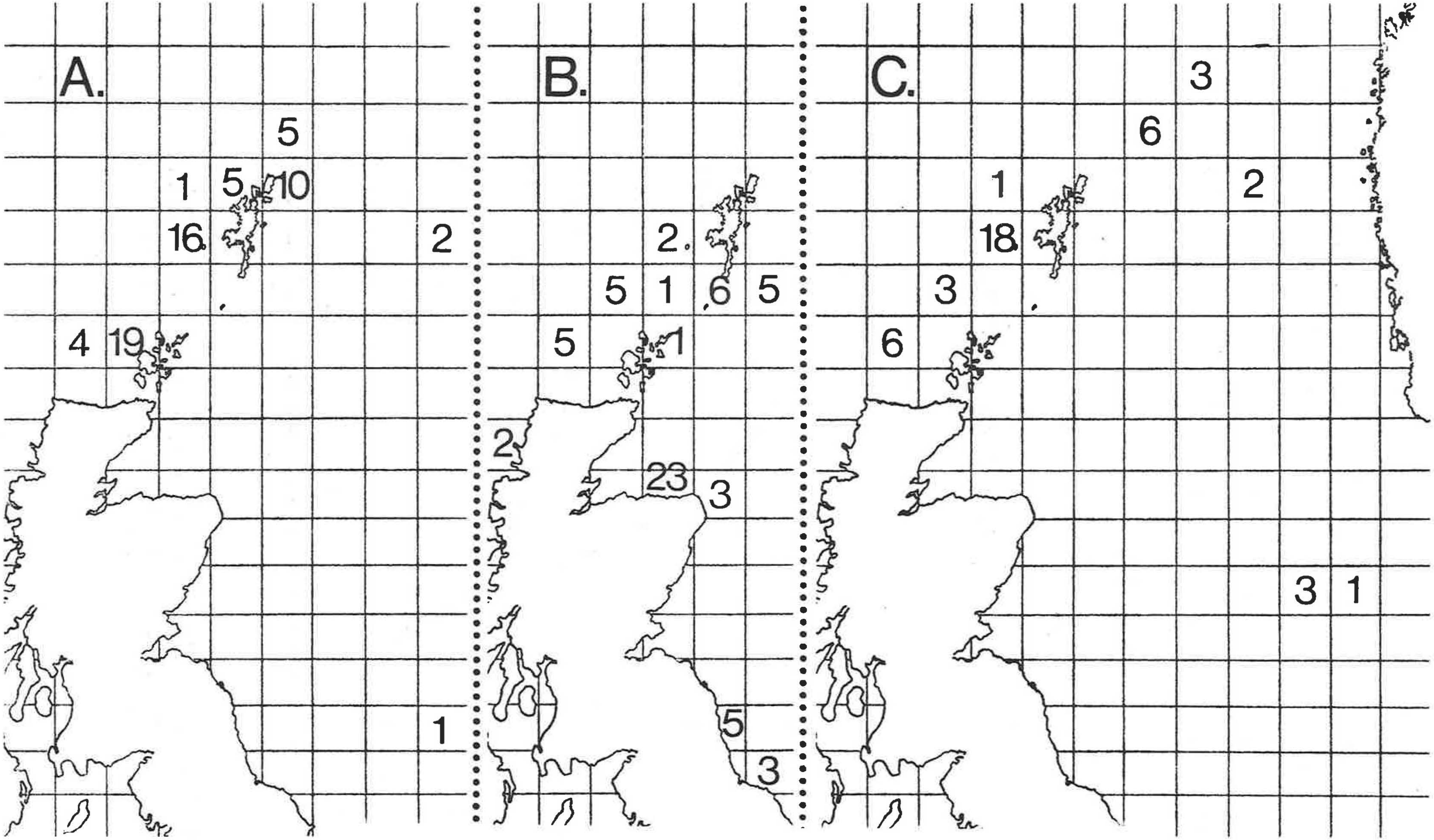

Figure 3. Number of recaptures with specified catch position. ICES Bløden Herring Tagging Experiment 1969.

A. Norwegian recaptures in July-August 1970.
B. Scottish recaptures in July-August 1970.
C. Norwegian recaptures in July 1973.

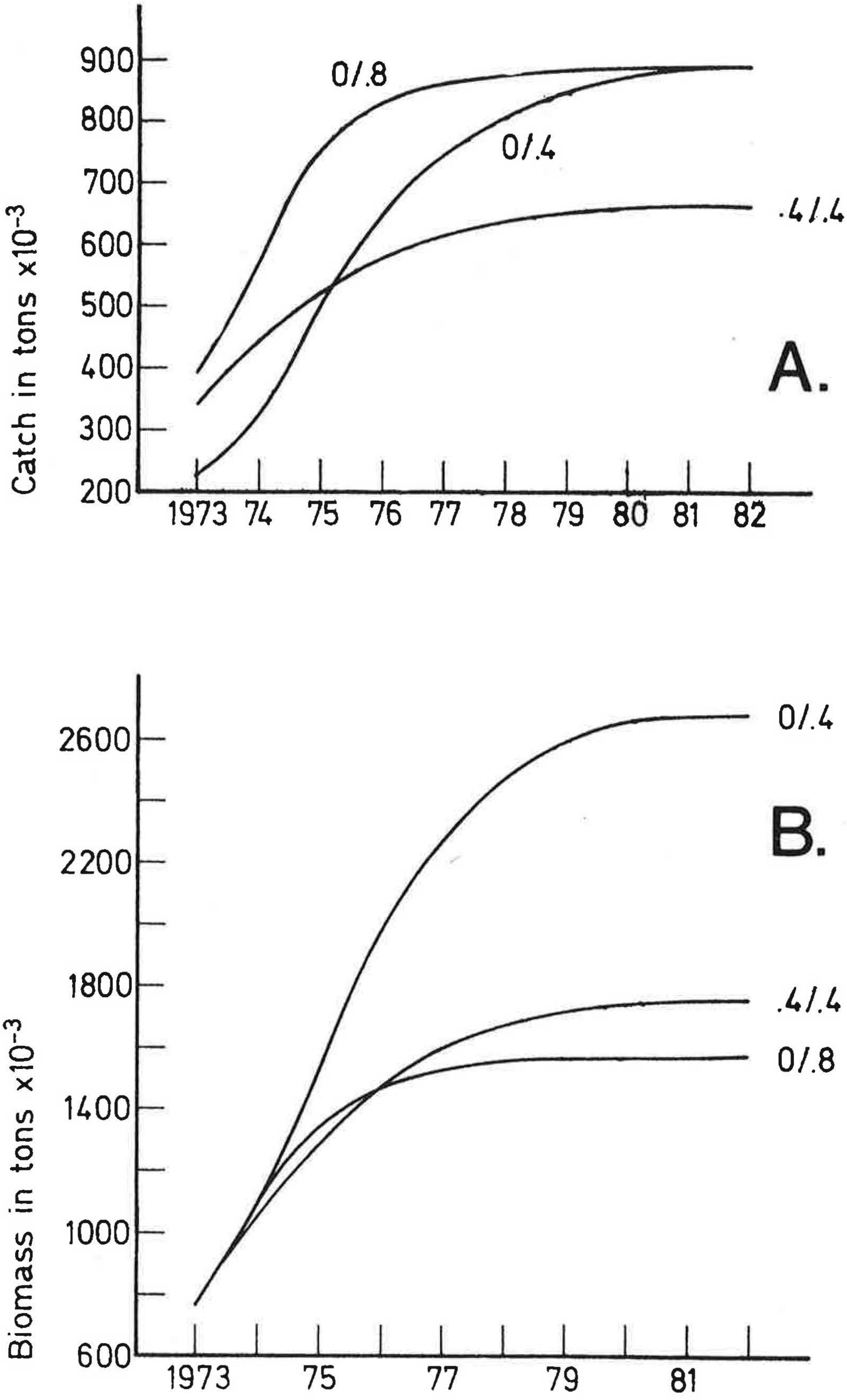

Figure 4. Forecast long-term development in catch (A) and total biomass (B) at three combinations of juvenile and adult fishing mortalities (juv./adult). Assumptions: see Section 9 (p.8).

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

Charlottenlund, 18 - 22 February 1974

1. Introduction and Participation

1.1 The International Council for the Exploration of the Sea, at its Statutory Meeting in September 1973, decided to disband the Celtic Sea Herring Assessment Working Group and the North Sea Herring Assessment Working Group. To replace these it established a new "Herring Assessment Working Group for the Area South of 62°N". This Group was asked to meet in Charlottenlund on 18 February 1974 for five days to report to the Liaison Committee's mid-term meeting on herring stocks west of 4°W and, if necessary, on the North Sea and Celtic Sea stocks. The Group decided that although its major task should be to make an assessment of the herring stock in the area west of 4°W, it was advisable to review the new data available on the North Sea and Celtic Sea stocks to examine whether these had introduced appreciable changes in the last assessments of these stocks.

1.2 Member countries were represented by the following scientists:

A C Burd	United Kingdom (England)
A Corten	Netherlands
J Jakobsson	Iceland
H Lassen	Denmark
A Lindquist	Sweden
K Popp Madsen	Denmark
A Maucorps	France
J Molloy	Ireland
E Nielsen (Mrs)	Denmark
A Saville (Chairman)	United Kingdom (Scotland)
A Schumacher	Federal Republic of Germany
B Sjöstrand	Sweden
Ø Ulltang	Norway
O J Østvedt	Norway

Mr Corten and Mr Jakobsson were not present on the last two days of the meeting.

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 Working Group during this meeting also considered the output required, and the input data necessary to achieve this output, from the trial run of the ICES ADP system using North Sea herring data.

2. North Sea Herring

2.1 The fishery in 1973

2.1.1 In the last Report of the North Sea Herring Assessment Working Group (pp. 1-28 of this volume) a preliminary estimate of 264 000 tons was given as the catch in the first seven months of 1973, despite the closure in force from 1 February to 15 June. This catch represents about half the expected annual catch if fishing mortalities had remained at the levels of 1972. The major part of this catch was taken after 15 June.

2.1.2 From preliminary catch data for the whole of 1973 the total North Sea catch, excluding Skagerrak, was estimated to be about 450 000 tons. No information was available for one country and its catch has been estimated on the basis of those of previous years (Table 2.1).

In previous years the preliminary estimates have been increased by about 10% when the final catch data became available. It would seem, therefore, that the final annual catch will be rather similar to those of 1971 and 1972. The Skagerrak catch increased in 1973, but this increase is in part due to the inclusion of Icelandic catches taken in the border area. Biological samples indicated that these fish were spring spawners (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 IVb the adult catch increased in 1973, while the IVc and VIId,e catch remained at about the level of the three previous years. In all other areas, including the Division IVb juvenile fishery, the catches declined.[1)]

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)

Year/Age	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	5 263
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	2 400	1 221	552	132	84	4 677

* Preliminary. (These figures were subsequently slightly amended. See Appendix Table 9).

There has been an apparent decrease in the catches of juvenile herring, while the catch of older fish has remained at the same level.

2.2 Fishing mortality

2.2.1 Using the 1973 preliminary catch in number, the fishing mortalities and stock sizes have been recalculated by cohort analysis. Tables 2.9 and 2.10 give the stock sizes and fishing mortality estimated for the period 1965-71. Those for earlier years are given in Appendix Tables 10 and 11.

2.2.2 In the previous Report some estimates of mortality from catch and effort data were presented (this volume, previous report, paragraphs 6.6 - 6.8). No further additions could be made to this

1) These conclusions have been somewhat amended in the light of the revised catch data for 1973 given in Appendix Tables 4-8.

series. From Table 2.9 and the previous report mean fishing mortalities based on 2-ringed fish and older for various periods are given as follows:

Fishing mortality from:

Catch per unit effort		Cohort analysis	
Period	F	Period	F
1952-57	0.41	1952-57	0.38
1957-61	0.49	1957-61	0.44
1961-65	0.44	1961-65	0.49
1965-69	0.67	1965-69	0.89
1969-72	0.64	1969-71	1.04

2.2.3 A considerable number of herring tagged during the Bløden Tagging Experiment have been recovered from the adult fisheries. The total number of tags returned during 1971 to 1973 which can be ascribed to a month of recapture are given below:

	1971	1972	1973
Total tags	1 063	280	92

These data can be used to calculate total mortalities. For the period 1971-73 the annual total mortality was 1.1. Assuming natural mortality to be 0.1, then the fishing mortality is appreciably higher than the value chosen from other information for the calculation of the stock size in 1974.

2.2.4 The fishing mortalities of 1-ringed fish, as estimated by cohort analysis for recent years are: 1970 - 0.46, 1971 - 0.91, 1972 - 0.81. The values for 1971 and 1972 are rather higher than those used in the prognosis for this age group; but their accuracy is not very high.

2.3 Stock and recruitment

2.3.1 The annual stock sizes given in Table 2.10, using the 1973 catch as the starting point in the cohort analysis, give almost identical values to those in the previous report up to 1969 (this volume, Table 11). The main change in the stock size in 1969 is caused by a lower estimated value for the 1968 year class (0-group). Table 2.10 shows that this year class was about half the long-term average strength.

2.3.2 The estimated stock size for 1970 shows that the 1969 year class was well above average strength, which is in conformity with the estimates from the Young Herring Surveys (text table, para. 2.3.4). The calculated stock size in numbers for 1971 shows that the year class 1970 was of about average strength.

2.3.3 In Table 2.10 the estimated total stock biomass is also given for the years 1965-71. Over this period, the biomass declined from about 2 300 000 tons to 600 000 tons. The low biomass in 1971 is largely due to the poor 1968 year class. The apparent increase in the estimated biomass of the stock in 1973 and 1974 (paragraph 2.4.1) is partly due to the strong 1969 year class and partly to the assumption of average recruitment for subsequent year classes.

2.3.4 In the previous report it was suggested that the 1971 year class might be of about average strength. Some additional confirmatory evidence is now available from preliminary estimates of this year class from the Danish industrial fishery. These estimates are comparable to those for the 1967 year class, which proved to be of average strength.

Estimates of recruitment as juvenile fish

Year class	English O-Group 1)	ICES Young Herring Survey 2)		Danish industrial fishery	
		I-Group	II-Group	I (spring) 3)	I (autumn)
1967	1 799	455	87	1 082	318
1968	1 259	442	73	305	173
1969	2 793	1 241	354	1 006	455
1970	1 245	844	57	1 278	307
1971	907	411		931 4)	321
1972	654				

1) Numbers per hour per station.
2) Numbers per hour per rectangle.
3) Weighted average number per unit effort (Feb-Mar).
4) Based only on January figures.

2.3.5 The estimate of recruitment of the 1971 year class is 6.2×10^9 * which is about 20% lower than the long-term mean (7.9×10^9), but the 1971 year class estimate is rather suspect (see paragraph 2.2.4). Few data are yet available for the 1972 year class because the ICES Young Herring Survey was still underway at the time of the meeting. The only information is the estimate from English O-Group Surveys, which is well below average.

2.4 Prognosis and total allowable catch

2.4.1 From the data of Table 2.8 the age composition of the stock as at 1 January 1974 has been calculated. This is given below with the comparable figures calculated at 1 January 1973 for comparison.

Stock No. x 10^{-9}	Age									Biomass in tons
	0	1	2	3	4	5	6	7	8	
1973 estimate	7.9	6.2	3.1	1.34	0.32	0.12	.031	.005	0	$.77 \times 10^6$
1974 estimate	7.9	6.2	2.2	1.14	0.51	0.12	.047	.026	0	$.72 \times 10^6$

2.4.2 The assumptions used in calculating the age composition of the stock at 1 January 1974 are the same as those used in the previous report with respect to 1973. The difference in the age compositions between

* Subsequent data suggest that the 1971 year class is considerably weaker than this initial estimate, see Appendix Table 10.

the stocks in the two years is principally due to the lower estimate for 2-ringers in 1974 which is derived from the lower catches of the 1971 year class in 1973. This value is also dependent on the assumption that the F on 1-ringers in 1973 remained at 0.7. The estimates of F on this age group given in paragraph 2.2.4 show a higher value of 0.8 - 0.9. These however, are rather inaccurate estimates and it has been considered safer to retain the same value used in the previous prognosis. The total estimated biomass of the stock in 1974 is some 50 000 tons less than that previously estimated.

2.4.3 Catches, and changes in biomass by 1977, have been calculated. The options of fishing mortalities on juveniles and adults which allow a 100% increase in biomass by 1 January 1978 are presented in the text table below:

		100% increase in stock biomass by 1978						
	Juvenile F Adult F	0.0 0.8	0.1 0.7	0.2 0.6	0.3 0.5	0.4 0.4	0.6 0.3	0.8 0.2
Allowable catch in 1974	Juveniles Adults	- 340	30 310	60 270	80 240	110 200	150 160	180 110
	Total	340	340	330	320	310	310	290
Allowable catch in 1977	Juveniles Adults	- 810	30 720	60 630	80 550	110 460	150 340	180 230
	Total	810	750	690	630	570	490	410

2.4.4 The allowable catches of adults in 1974 to achieve this objective are 30 - 40 000 tons less than in the previous prognosis. By 1977 the allowable catch of adults is about 10 000 tons less for all values of fishing mortalities. No differences occur in the juvenile catches because recruitment is assumed to be constant.

The recruitment level of the 1972 year class cannot yet be assessed. If this, or subsequent year classes are below average, then these estimates of allowable catches will be too high.

3. Celtic Sea Herring

3.1 Catches

The total catches from the Celtic Sea for the last five years are given in Table 3.1. The catch figures for 1972 have been revised and preliminary figures are given for 1973. The highest catches were recorded in 1969 and since then there has been a major decline, with the 1973 catch the lowest since 1965. The total catch by season is given in Table 3.2.

3.2 Stock and recruitment estimates

3.2.1 The percentage age distributions of the Dutch and Irish catches are given in Table 3.3. The Dutch data refer to the fishery in May to December immediately preceeding the Irish fishery in November to February. The proportions of fish in each winter-ring group refer to the same year class. The two series show the same trends.

3.2.2 As mentioned in previous reports, because of the changes in fishing gear, fishing area and timing of the fishery, over the long term abundance indices from catches per unit effort may not be completely reliable. However, Irish pair-trawl abundance indices for the past 6 seasons have been used to indicate the relative strength of annual recruitment (Table 3.4). These data provide indices of recruitment for the 1969/70 and 1970/71 year classes, the first of which is not estimated efficiently by cohort analysis, the second of which cannot yet be estimated in this way. The 1968/69 and 1970/71 year classes are seen to be very poor.

3.2.3 In the previous report on the Celtic Sea herring (Anon., 1973) the levels of stock size and fishing mortalities were calculated by cohort analysis. This method can only give reliable estimates up to the 1970/71 season. In order to get some indication of stock size and fishing mortality in the most recent years, the following procedure was followed:

If the stock composition at the beginning of a year is known and also the catch in numbers during that year, an average F (for all age groups) can be calculated which comes most closely to producing the actually observed catch. By applying this calculated F to the initial stock, the stock composition at the beginning of the next year can be calculated, except for the recruiting age group. This recruitment can be found by repeating the above procedure for the next year, and calculating the average F for all age groups. By applying this average F to the number of recruits caught, the number of recruits at the beginning of the year can be backcalculated. Starting from the stock composition as at 1 March 1969 (Anon., 1973), fishing mortalities and recruitment for subsequent years have been calculated in this way (Table 3.5). The dependence of catch on the size of the recruitment is seen.

A comparison of these recruit year class strengths with those from catch per unit effort data is shown in Table 3.4.

3.3 Fishing mortality

In Table 3.6 fishing mortalities estimated from catch per unit effort and from cohort analyses are given. There is a considerable degree of agreement between the two series. In the two most recent years the value of F has exceeded that at which the maximum sustainable yield per recruit is obtained (F = 0.45).

3.4 Conclusion

Total mortality rates for Celtic Sea herring have remained high in recent years, causing a depletion of older age groups and an increasing dependence of the fishery on the recruiting year class. This was demonstrated both in 1971 and 1973 when catches dropped to 27 500 and 26 000 tons respectively, due to the poor recruitment of year classes 1968/69 and 1970/71.

In order to stabilise the stock, the total mortality rate should be reduced. This can only be achieved in the present state of the stock by a temporary reduction of the catch below the 1973 level.

4. Herring in Division VIa

4.1 General biology of stocks in Division VIa

4.1.1 The spawning areas, and times of spawning, as shown by the distribution of small herring larvae on surveys carried out in 1965, 1971 and 1972 are shown in Figure 5. There would appear to be two distinct major spawning areas, one to the north and west of the Outer Hebrides in late August - September and another approximately one month later to the northwest of Ireland. Within each of these major sub-divisions of the total spawning area there may also be two or more distinct spawning grounds.

4.1.2 The drift of the larvae from the spawning areas is not clearly established. However, there is some evidence that, particularly from the areas to the west and north of the Hebrides, the larvae are drifted along the north coast of Scotland and into the northern North Sea. These larvae are likely to be the main source of the recruits to Division VIa from the juvenile herring populations in the Moray Firth and in the central North Sea. Nothing is known of the drift of larvae from the spawning grounds off the northwest of Ireland, but these may be the main source of juvenile herring which are found in the coastal zone to the west of Scotland.

Juvenile herring are caught in a herring fishery, and as by-catch of a sprat fishery, by Scottish vessels in the Moray Firth. There is good evidence from the growth characteristics and year class strength of these fish that they are predominantly recruits to the VIa stocks and not to any of the North Sea herring stocks (Saville, 1971). Returns from the fisheries in Division VIa of herring tagged in the Bløden Experiment provide conclusive evidence that recruits to the VIa stock are also spread over a wide area of the central North Sea during their juvenile stages.

4.1.3 The exact timing of the return migration of these recruits to Division VIa is not known, but it would appear that the majority of them have returned by their third birthday, when most of the VIa population spawn for the first time.

The distribution of the adult component of the stock can be seen from Figure 6, which shows the distribution, in space and time, of the fisheries in Division VIa by different countries. From this it can be deduced that the adult stock, during the spring and summer fishing season, is distributed over a wide area extending from N.Rona, and perhaps even further east to the west coasts of Orkney and Shetland, along the west coast of the Hebrides and south to Donegal. Within this broad area there are major centres of abundance at N.Rona, St Kilda, Stanton Bank and around Tory Island. Figure 6 also shows that there would appear to be two over-wintering areas for this herring population, one in the Minch where the major Scottish fishery on the adult stock takes place in the period November-February and another in the Donegal Bay area in the same months.

4.2 Stock structure of herring in Division VIa

4.2.1 The age compositions of the catches from adjacent areas are compared with those in the various fishing regions of Division VIa in Tables 4.1 and 4.2. These data show that there is an increasing percentage of older fish from east of Shetland westwards to the Minch, and to the fishing area north of Ireland. In 1970 and 1971 the 1963 year class was particularly strong in the South Minch, west of the Hebrides, and northwest of Ireland. This could suggest that the main influx of older fish to the South Minch in the winter period comes from west of the Hebrides and northwest of Ireland. The age composition data given in Tables 4.1 and 4.2 also show that the Minch can be regarded as a nursery area for the western stocks.

The data given in Table 4.3 show fairly consistent differences in mean l_1 values within year classes between the South Minch, the North Minch and the west of Shetland with a general tendency for the lowest values in the South Minch, intermediate ones in the North Minch and the highest values west of Shetland.

4.2.2 Norwegian and Scottish recaptures from the Bløden Tagging Experiment show that some of the young herring tagged in the Bløden area migrated to the area west of 4°W and to the Minch (Table 4.4).

4.2.3 To study the migrations and mixing of herring from east and west of 4°W tagging experiments have been carried out in 1972 and 1973 by Scotland and Iceland. So far only a few recaptures have been reported for which definite areas of capture are obtainable.

As however, the recaptures reported at Stornoway (Hebrides) and at Lerwick (Shetland) refer almost exclusively to catches taken in the Minch and Shetland areas respectively, these data give some indication of the mixing rate. In Table 4.5 recaptures at Stornoway and Lerwick are given from fish tagged west of 4°W, west of Orkney, and at Foula (east of 4°W) in 1972. The recaptures are given as number per 1 000 fish tagged per ton processed.

Although the number of recaptures are few, the data indicate that fish tagged west of 4°W (Rona) and immediately east of 4°W (west of Orkney) were, in 1973, recaptured at the same rates between experiments in the Minch and at Shetland, but at a lower rate in the Shetland area than in the Minch. Recaptures from the tagging experiment immediately west of Shetland (Foula) were at a higher rate in the Shetland area than in the Minch.

4.2.4 The data at present available do not permit any firm statement about the stock structure in Division VIa. Data from tagging experiments show some migration of fish between the area west of Shetland (east of 4°W) and the North Minch. The stability of the age composition and l_1 data within these areas would suggest that the mixing between these areas is at a fairly constant rate from year to year.

Only age composition data are available to relate the population to the northwest of Ireland with those in the other areas. These might suggest some migration from the northwest of Ireland to the South Minch in the winter period.

4.3 Total catches and the fisheries in Division VIa

4.3.1 The total catch taken by each country in Division VIa for each of the years 1957-73 is given in Table 4.6, together with the estimated quantity of herring taken in each year in the Moray Firth young herring and sprat fisheries. The annual total catch taken in Division VIa in the period 1957-65 fluctuated, without trend, in the range 46 000 to 69 000 tons, increased sharply in 1966 to 92 000 tons, and showed a fairly regular increase each year thereafter to attain over 220 000 tons in 1971. In 1972 the total catch was appreciably lower than in 1971 at 174 000 tons, but in 1973 increased again to somewhat above the 1971 level.

The large increase in total catch in 1973 compared to 1972 was due to an increase in the Scottish, Norwegian and German (F.R.) catches by about 13 000 tons; the Dutch catches by about 7 000 tons, and the Faroese fisheries by about 8 000 tons.

4.3.2 Detailed information on the catch per month and area is given in Table 4.7. For many countries the information is less detailed but the main fishing areas could be identified.

The distribution of the catch according to areas was as follows:

	Tons	%
W Shetland	47 808	20.2
Hebrides	33 755	14.2
N and NW Ireland	34 684	14.6
N Minch	65 969	27.8
S Minch	54 827	23.1

4.3.3 The Scottish and Irish fisheries are carried out mainly during autumn and winter. The fisheries by other countries, on the more offshore grounds, mainly take place during summer and autumn.

4.4 Catch in numbers in Division VIa

4.4.1 Estimates of the number of autumn spawning herring per age group caught in Division VIa in each of the years 1957-73 are given in Table 4.8. The estimates for the period 1957-72 are taken from Saville and Morrison (1973).

4.4.2 Estimates of the number of herring per age group in 1973 were derived from German (F.R.), Netherlands, Scottish and Norwegian age composition data. The calculations were done on a monthly basis when possible, or for small groups of months when the catches were small.

4.4.3 4 year old fish of the 1969 year class were dominant in all areas in 1973 and accounted for about 60% of the numbers caught in Division VIa. In the absence of data on the age composition of the catches in the Moray Firth young herring fishery, the figures in 1973 for the 0, 1 and 2-ringers given in Table 4.8 do not represent the total catch of these age groups in 1973. In 1972 the total catch of 1-ringers amounted to 320 x 10^6 herring.

4.5 Mortality in 1973

4.5.1 The total mortality for the year 1973 has been estimated on the basis of catch per landing data for the years 1972 and 73 from the Scottish pair-trawling fishery in the North Minch during November and December. There are no wide fluctuations in the resulting values (see below) over the groups 2-5 which made the major contribution to the catches. The average total mortality, weighted by year class abundance indices, for these age groups was 0.70.

Age (winter rings)	2	3	4	5	6	7
Z	.78	.64	.68	1.07	.20	.62

4.6 Recruitment of the 1971 year class in Division VIa

4.6.1 During the winter season (November - February) a substantial part of the Division VIa herring population is aggregated in the Minch. Therefore, biological parameters obtained from Scottish pair-trawl fisheries in that area can be considered as representative of the VIa herring stock.

As no catch figures for January and February 1974 were available, the estimate of the recruitment of the 1971 year class was calculated only from the number per landing of 1-ringers caught in November and December by the North Minch pair-trawl fishery.

4.6.2 A regression has been made between the number of 1-ringers caught in this fishery in each year for the period when age composition data are available and the estimated number of 1-ringers from cohort analysis for the corresponding year class (i.e. 1964-70), (Saville and Morrison, 1973).

4.6.3 The regression of the values obtained which is shown in Figure 7 is quite homogeneous and the regression is of the form:

$$y = 960.87 + 0.02\ x$$

The recruitment of the 1971 year class as 1-ringers to the VIa stock is, in this way, estimated as 1 000 x 10^6 fish which is about 30% below the 10 year average. Applying the estimated F on 1-ringers in 1973 of 0.25 this means that 705 x 10^6 of this year class will survive to 1 January 1974.

4.7 Mortalities and stock size

4.7.1 Mean fishing mortality rates derived from cohort analysis for 2-ringed and older fish showed a fairly constant level up to and including 1969 (Table 4.9). There was a small increase in 1970 and a sharp one in 1971. The fishing mortality rates on these age groups can be summarised as follows:

	Mean
1957-69	0.25
1970	0.33
1971	0.59
1972	0.35
1973	0.60*

* from catch per effort data.

4.7.2 The higher mortality rates after 1969 in all fully exploited year classes is probably caused by an increase in fishing effort. The generally higher mortality rates in the 0 and 1 group after 1965 coincides with the general development of the fishery in Division VIa and particularly with that of the Scottish sprat fishery in the Moray Firth.

4.7.3 The stock size in numbers at age 3 years and older remained on a fairly constant level of about 1.2 x 10^9 in the period 1957-63. In 1964 there was a minor increase and in 1966 the figure was more than doubled at 3.6 x 10^9. Thereafter the stock numbers remained at a rather high level of 2.6 - 3.0 x 10^9, due to a sustained high level of recruitment (Table 4.10). The total stock biomass was at a fairly constant level of about 200 - 250 000 tons in the period 1957-64. It rose sharply in 1965 to close on 500 000 tons, with the recruitment of the strong 1963 year class, and has since remained in the 5 - 600 000 ton level due to a sustained high level of recruitment.

4.8 Catch prognosis for 1974

4.8.1 A prediction has been made of the catches which could be taken in 1974 at various levels of mortality on juveniles (1-ringers) and adults, and is given in Table 4.11.

The basic age composition at 1 January 1974 and the average weight per age group used in making this prognosis are given below:

Age (rings)	Numbers per age group x 10^{-9}	Average weight per age group in grammes
1	(1.4)*	112.7
2	0.705	148.1
3	0.312	186.2
4	1.119	226.7
5	0.176	234.2
6	0.075	243.4
7	0.077	257.7
8	0.029	261.7
9	0.009	264.6
>9	0.060	266.0

* Average recruitment as 1-ringers 1960-70 year class from cohort analysis.

Longer term prognosis for this stock would be liable to major errors because of the large variation in annual recruitment levels.

4.9 Total allowable catch (TAC)

4.9.1 The catch prediction (Table 4.11) shows that if the fishing mortality rates estimated for 1973 (F = 0.25 for 2 year old herring and F = 0.60 for adult herring) were maintained in 1974, the resulting catch would be 260 000 metric tons, that is about 10% higher than in 1973. The corresponding position on the yield per recruit curve (Figure 8) is beyond the F giving the maximum sustainable yield per recruit. The yield curve shows that at an age of first capture of 2 years old, the maximum sustainable yield per recruit would be obtained at F = 0.4 and would result in a catch in 1974 of about 210 000 metric tons. The yield curve implies that the 2 year old fish would also be exploited at an F of 0.4. If, however, the present pattern of fishing were maintained, the number of 2 year old fish removed from the sea would be less than anticipated in the catch prediction. If this difference in numbers was taken from the adult part of the stock, a higher catch in weight, up to about 230 000 metric tons in 1974, might be allowed without departing from the maximum sustainable yield level.

5. Discussion

5.1 The most recent data on North Sea herring indicate a continuation of the undesirable features shown in previous reports of the

North Sea Herring Assessment Working Group of high levels of mortality on juveniles and adults.

The 1973 data incorporated in the present assessment of the North Sea stock have largely confirmed the previous assessment and the prognosis derived from it. The previous recommendation of a reduction in the fishing mortality rates on both juveniles and adults to the levels giving at least an increase of 100% on the 1972-73 biomass in the course of 3-4 years, is still valid. Equally the warnings issued in that report of the serious effects of a single poor year class on the immediate catch, and the spawning potential of the stock, must be reiterated.

5.2 In the previous report attention was drawn to the recapture of fish tagged on the Bløden Ground at Shetland, west of 4°W, and in the Minch. The presence of juvenile herring in the North Sea, which might have originated from spawning grounds outside the North Sea, was discussed in a previous report by the North Sea Young Herring Working Group (Anon., 1969). Evidence of the drift of larvae from areas west of Shetland into the North Sea has been discussed by Wood (1971), Schnack (1973), Zijlstra (1972), and Saville and McKay (Coop.Res.Rep., No.41, 1974). Saville (1971) has suggested that juveniles in the Moray Firth originate from Division VIa spawning grounds. There is thus evidence of drift of larvae into the North Sea, their presence there as juveniles and evidence of subsequent emigration as adults.

5.3 From a cohort analysis on the herring catches in Division VIa, the average level of 0-group abundance in 1957-70 was 1.28 x 10^9 compared with 8.59 x 10^9 in the North Sea stock over the same period. Because of the disparity in the relative sizes of the recruitments, the effects of incursion of VIa recruits into the North Sea would not be expected to have a major effect on the estimation of North Sea recruitment or juvenile fishing mortality. On the other hand, the high level of fishing mortality on juveniles in the North Sea could considerably reduce recruitment to VIa. Any regulatory action taken to reduce the juvenile catch in the North Sea will also have a beneficial effect on the stock in VIa, provided action is also taken to control fishing effort in VIa to prevent a major diversion of fishing effort to that area.

5.4 The most recent data on Celtic Sea herring examined by the Working Group has reinforced the conclusions of the last meeting of the Celtic Sea Herring Assessment Working Group (C.M.1973/H:2). It had pointed out that exceptional levels of recruitment had occurred for a number of years and that these had supported the greatly increased catches since 1966. As a consequence of the increased recruitment the total catch corresponding to the fishing mortality rate giving the MSY per recruit (F = 0.45) had also increased from about 20 000 tons to 30 000 tons.

5.5 It had been recommended that fishing mortality should be reduced, partly because the fishery has become highly dependent on the recruit year class. The occurrence of a poor recruit brood could cause an escalation in fishing mortality on the older fish if the present levels of fishing effort were to continue. In the absence of any indication of recruitment failure, NEAFC agreed a catch limit for the 1974-75 season of 32 000 tons. At the changed level of recruitment shown by more recent data available to this Working Group, it is recommended that this catch limit should be reduced to 25 000 tons.

5.6 Previous reports of the North Sea Herring Assessment Working Group have drawn attention to the problems raised in assessment of this population by uncertainties regarding the stock affinities of the fish caught in certain areas of the North Sea. This applied in particular to the herring caught in the area to the west of Orkney and Shetland which in recent years has contributed a major part of the total adult catch from the North Sea (Anon., 1972). This problem has been further highlighted in the assessment of the VIa population where the major increase in catch in recent years has again been taken close to the 4°W boundary between Divisions VIa and IVa.

Recent work to help clarify this problem, chiefly by tagging on either side of the 4°W boundary, has suggested that no sharp boundary can be drawn between the stocks in this area. The data available would point to this area containing a mixture of the North Sea and VIa populations with a tendency for the proportion of VIa fish to increase from east to west. The Herring Assessment Working Group for the Area South of 62°N accepted the 4°W boundary, as the catch statistics are available only on that basis.This problem must, however, be investigated further, particularly by more extensive and intensive tagging experiments. Future work of this Herring Assessment Working Group would be facilitated by more complete catch statistics and biological data on a statistical rectangle basis for this area.

5.7 The stock in Division VIa is in a relatively better state than that of the North Sea. However, since 1970 the fishing mortality rate on it has been somewhat above that giving the MSY per recruit and the current high levels of catch from VIa are dependent on the current high level of recruitment to this stock. The data suggest that in the past three years there has been a rapid increase in fishing effort on this stock and this is likely to escalate further, in the light of restrictions on herring fishing projected in neighbouring areas. It is recommended,therefore, that action should be taken to control fishing on this herring population at the value giving the MSY per recruit. This would mean in 1974 a TAC of 210 000 tons. Longer term prognosis for this stock is not possible at this stage because of the major variations in year class strengths and the current lack of technique for earlier assessment of year class strengths.

5.8 Prognoses of the TAC for any herring stock are dependent on a method of forecasting recruitment with an acceptable level of precision. In the case of the North Sea population the absence of precise recruitment forecasts is less serious because year class strengths have been relatively stable over the past decade. In the Celtic Sea and VIa populations recruitment has varied widely in recent years and prognoses of the TAC even one year in advance are liable to considerable inaccuracies for this reason. More facilities to investigate methods of forecasting recruitment in these areas are a major priority.

6. References

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Table 2.1 Herring.
Catch in tons 1970-72 and preliminary figures for 1973. North Sea (Sub-area IV and Divisions VIId and e) by country. Skagerrak and Kattegat (Division IIIa) Total catch. Estimated catches in brackets.

Country \ Year	1970	1971	1972	1973
Belgium	1 200	681	1 337	(933)[a]
Denmark	133 331	185 393	213 738	174 254[b]
Faroe Isl.	58 365	45 524[c]	48 444	54 935[c]
Finland	-	-	-	1 050
France	11 482	11 408	12 901	21 052
Germany (F.R.)	7 150	3 570	3 065	10 606[d]
Iceland	22 951	37 171	31 998	23 742[e]
Netherlands	46 218	32 479	24 829	30 713[f]
Norway	193 102	125 842	117 501	96 985
Poland	5 057	2 031	2 235	5 700
Sweden	34 670	36 880	7 366	4 222[g]
U.K. (England)	9 702	4 113	650	2 785
U.K. (Scotland)	21 885	25 073	17 227	15 529[h]
U.S.S.R.	18 078	9 500	16 386	30 100
Total North Sea	563 191	519 665	497 677	472 606
Skagerrak	71 071	61 570	67 021	84 566
Kattegat	74 300	90 200	107 519	
Grand Total	708 562	671 435	672 217	
Non-member countries	250	481	?	?

a. Sub-area IV catch taken as 1970-72 mean.

b. Total includes 2 107 tons for human consumption unspecified to area.

c. Figure supplied by Fiskirannsóknarstovan.

d. From Federal Republic of Germany national statistics compiled by Federal Research Board of Fisheries, Hamburg.

e. Includes 15 938 tons caught on Skagerrak border and allocated to that area on the basis of age analysis.

f. Catch January-October raised to 12 months on basis of 1972 catch ratio.

g. 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.

h. Catches from Moray Firth not included.

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

Year	Denmark	Faroe Isl.	Germany (F.R.)	Iceland	Netherlands	Norway	Poland	Sweden	USSR	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	34 900	4 115	-	7 317	-	1 045	-	19 644	-	67 021
1973	42 098	5 265[a]	-	15 938[b]	-	836	-	20 429[b]	-	84 566

a. Catches by Faroese vessels landed in Danish ports. b. 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 Isl.	France	Germany (F.R.)	Iceland	Netherlands	Norway	Poland	U.K. (Scotl.)	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]	-	-	-	331	236	-	-	-	-	14 029

a. Allocation based on landings in Denmark.

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

Year	Bel-gium	Denmark	Faroe Isl.	Fin-land	France	Germany (F.R.)	Iceland	Nether-lands	Norway	Poland	U.K. (Engl.)	U.K. (Scotl.)	Sweden	USSR	Total
1970	750	61 423	40 884	-	818	177	20 587	177	160 784	2 069	-	17 767	4 470	17 066	326 932
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	17 228	-	16 386	235 106
1973	-	41 341	42 159[a]	1 050	209	2 624	23 742	5 162	58 747	4 100	-	15 202	4 222	30 100	228 658

a. Allocation based on landings in Denmark.

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

Year	Belgium	Denmark	Faroe Isl.	France	Iceland	Germany (F.R.)	Nether-lands	Norway	Poland	U.K. (Engl.)	U.K. (Scotl.)	Sweden	Total
1970	-	-	11 623	2 433	1 144	6 005	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	334	21	11 372	17 043[a]	615	271	-	4 068	47 787
1973	-	-	-	8 288	-	115	16 917	38 002	1 600	2 781	327	-	68 030

a. Reallocated to Division IVb from IVb Young Herring (Table 7, previous report, this volume).

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	Norway	Total	
1970	70 108	400	0	-	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	203 656

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	933	132	12 555	2 229	8 303	-	4	24 156

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
	IVb YH	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
	IVb YH	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	-	42.1	596.0	363.1	46.5	31.7	16.3	2.1	0.4	0.5	1 098.7
	IVaE of 2°E	-	0.3	16.2	23.1	6.3	7.2	1.0	0.3	0.8	-	55.2
	IVb	-	285.5	212.1	45.9	33.3	5.6	8.5	-	-	-	590.9
	IVb YH	289.4	2 070.5	362.5	29.4	2.6	0.5	0.2	0.3	-	-	2 755.4
	IVc+VIId,e	-	1.7	34.0	90.3	43.2	5.8	1.5	0.4	0.1	0.0	177.0
	Total NS	289.4	2 400.1	1 220.8	551.8	131.9	50.8	27.5	3.1	1.3	0.5	4 677.2

* Preliminary.

Table 2.9 Total North Sea. Calculated fishing mortality.

Winter rings	Years						
	1965	1966	1967	1968	1969	1970	1971
0	0.03	0.08	0.09	0.12	0.03	0.11	0.07
1	0.44	0.34	0.50	0.52	0.56	0.46	0.91
2	0.86	0.68	0.48	1.47	0.87	1.08	0.97
3	0.77	0.71	0.84	1.92	0.95	1.27	1.24
4	0.77	0.57	0.84	1.07	0.87	1.34	1.10
5	0.63	0.83	0.81	0.96	1.05	0.86	1.12
6	0.56	0.36	0.99	1.12	0.83	1.07	2.30
7	0.44	0.44	1.29	1.50	1.11	0.26	2.48
8	0.67	0.69	1.40	0.88	1.05	1.00	0.70
$\bar{F}_w \geq 2$	0.77	0.69	0.70	1.50	0.90	1.13	1.09

Table 2.10 Total North Sea. Calculated stock in number ($x\ 10^{-9}$), and stock biomass.

Winter rings	Years						
	1965	1966	1967	1968	1969	1970	1971
0	5.71	5.29	7.61	7.63	3.86	9.37	7.46
1	9.40	5.02	4.43	6.27	6.11	3.38	7.63
2	4.00	5.46	3.23	2.42	3.38	3.16	1.93
3	2.59	1.53	2.51	1.81	0.50	1.28	0.97
4	3.95	1.09	0.68	0.99	0.24	0.18	0.33
5	0.32	1.65	0.56	0.27	0.31	0.09	0.04
6	0.37	0.16	0.65	0.22	0.09	0.10	0.04
7	0.34	0.19	0.10	0.22	0.07	0.04	0.03
8	0.88	0.20	0.11	0.02	0.04	0.02	0.03
Juveniles Σ_{0+1}	15.11	10.31	12.04	13.9	9.97	12.75	15.09
Adult Σ_{2-8}	12.45	10.28	7.84	5.95	4.63	4.87	3.37
Biomass (1 000 tons)	2 295	1 549	1 286	1 046	666	651	614

Table 3.1 Annual herring catches in the Celtic Sea (metric tons).

Year	France	Germany (F.R.)	Ireland	Nether-lands	Poland	England	USSR	Total
1969	7 038	5 906	18 712	16 256	252	-	-	48 164
1970	3 627	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*	6 173	294	13 105	5 834	1 000	-	500	26 906

* Preliminary figures for 1973.

Table 3.2 Total catch by seasons in the 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*	3 123	3 463	5 942	12 817	25 345

*Preliminary figures for 1973.

Table 3.3 Percentage age distributions of Celtic Sea catches.

Year class	1970	1969	1968	1967	1966	1965	1964	1963 and older
Dutch 1971	1.3	15.7	28.1	27.9	10.9	6.7	1.7	7.7
Irish 1971/72	9.8	18.0	21.3	26.2	10.7	6.6	3.3	4.1
Dutch 1972	4.0	62.3	7.9	8.6	10.7	2.9	1.9	2.0
Irish 1972/73	3.8	68.7	9.8	7.4	6.1	1.8	1.2	1.2
Dutch 1973	31.5	19.7	31.7	3.7	6.3	4.0	1.7	1.5

Dutch trawl fishery - May to December

Irish pair-trawl fishery - November to February.

Table 3.4 Estimates of recruit strength as 2 winter-ring fish.

Year class	Irish c.p.u.e. Tons/Pr. trawler landing	VPA x 10^{-6}
1965-66	7.1	234.30
1966-67	9.4	212.40
1967-68	7.4	149.22
1968-69	2.2	51.32
1969-70	11.2	210.65
1970-71	2.6*	

* Preliminary estimate.

Table 3.5 Calculated stock size in millions. Celtic Sea.

Rings	1968-69		1969-70		1970-71		1971-72		1972-73		1973-74
	Stock	Catch	Stock	Catch	Stock	Catch	Stock	Catch	Stock	Catch	Stock
1	346.7	13.46	173.37	7.35		0.70		11.54		5.30	
2	234.3	61.02	212.40	86.87	149.22	34.55	51.32	25.25	210.65	94.16	
3	146.8	44.21	143.54	51.44	116.57	53.35	86.09	38.68	22.60	17.64	101.51
4	54.7	12.90	89.93	30.52	78.78	28.41	67.26	45.60	37.92	14.15	10.89
5	73.3	25.65	33.51	11.22	49.35	20.01	45.45	20.75	29.62	12.10	18.27
6	17.4	5.22	44.91	16.30	18.39	7.77	28.47	11.03	20.02	4.32	14.27
7	10.7	4.56	10.66	4.36	24.68	6.30	10.61	4.25	12.54	2.47	9.65
8	3.8	1.44	6.56	2.01	5.85	2.11	14.24	5.45	4.67	2.15	6.04
>8		5.30	2.33	3.23	4.88	3.50	6.20	2.41	9.00	0.96	2.25
Calculated F		0.39		0.50		0.45		0.72		0.63	

Table 3.6 Total mortality rates of Celtic Sea herring from c.p.u.e. and from cohort analysis.

Year	Irish* pelagic trawl	Cohort analysis estimates
1968/69 - 69/70	0.66	0.60
1969/70 - 70/71	0.39	0.55
1970/71 - 71/72	0.79	0.82
1971/72 - 72/73	0.89	0.73
1972/73 - 73/74		

* November-February.

Table 4.1 Percentage age composition in different areas of Division VIa in 1970/71.

		Year classes									
		1968	1967	1966	1965	1964	1963	1962	1961	1960+	n
1970 Apr-Aug	East of Orkney and Shetland	-	79.9	15.5	2.0	0.4	1.0	0.5	0.4	0.5	2 017
	4°W - West of Orkney-Shetland	-	54.2	31.2	5.0	1.1	3.4	0.7	0.8	0.7	760
	West of 4°W	-	41.2	43.3	4.3	3.5	6.0	0.6	1.0	0.2	840
1970/1 Oct-Mar	North Minch	31.8	20.5	17.8	7.9	2.3	16.1	0.9	1.5	1.0	755
	South Minch	25.0	12.5	23.6	9.6	3.5	19.4	1.8	2.7	1.6	2 927
1970 Nov	Hebrides	-	10.3	35.8	12.8	6.9	29.0	2.1	1.0	2.1	290
1970 Aug-Nov	Northwest Ireland	-	27.0	22.3	10.7	2.4	35.6	1.0	-	0.9	-

Table 4.2 Percentage age composition in different areas of Division VIa in 1971/72.

		Year classes									
		1969	1968	1967	1966	1965	1964	1963	1962	1961+	n
1971 Apr-Aug	East of Orkney and Shetland	10.4	36.1	41.0	10.2	0.7	0.2	0.8	0.3	0.3	1 709
	4°W - West of Orkney-Shetland	-	12.1	45.2	29.0	6.1	2.7	2.8	1.1	1.0	1 018
	West of 4°W	0.3	15.6	49.9	22.7	4.4	3.2	2.2	0.7	1.0	956
1971/72 Oct-Mar	North Minch	42.2	32.8	9.4	7.4	2.5	0.8	3.3	0.3	1.0	2 759
	South Minch	19.1	24.8	8.7	16.7	6.7	2.7	15.1	1.6	2.4	1 664
1971 Nov	Hebrides	-	9.0	19.1	24.1	10.7	4.3	24.1	1.0	7.7	299
1971 Aug-Nov	Northwest Ireland	1.1	19.9	17.3	19.1	11.2	2.2	22.7	1.6	4.9	-

Table 4.3 Mean l_1 for different year classes in South Minch, North Minch and Shetland east of 4°W.

Year class	Age (winter rings)		
	2	3	4
1961		12.8 (177) 13.9 (279)	13.1 (160) 13.6 (280) 13.7 (25)
1962		12.2 (27) 13.1 (151) 12.3 (49)	13.6 (15) 13.0 (82) 13.3 (19)
1963	14.4 (557) 15.4 (391) 15.9 (94)	14.0 (413) 15.2 (440) 14.0 (94)	14.5 (570) 14.9 (124) 14.5 (62)
1964	13.6 (15) 12.9 (57) 15.1 (47)	13.5 (69) 13.9 (24) 15.9 (23)	13.3 (50) 14.0 (45)
1965	13.5 (193) 14.0 (69) 15.5 (22)	13.3 (174) 13.1 (160)	13.3 (222) 13.7 (71) 14.3 (11)
1966	14.3 (243) 14.5 (356)	14.9 (491) 15.2 (161) 15.9 (84)	14.6 (759) 14.7 (185) 17.0 (17)
1967	14.3 (169) 16.1 (70) 17.6 (151)	15.0 (435) 15.5 (202) 16.7 (58)	

Upper figure: South Minch.
Middle figure: North Minch.
Lower figure: West of Shetland.
In brackets: Number of observations.

Table 4.4 Recaptures by Scotland and Norway from the Bløden Tagging Experiment.

	Area of recapture	1970	1971	1972	1973
Scotland	Shetland	19	28	19	9
	East of Orkney	1	0	1	1
	West of Orkney	5	3	0	0
	West coast (Minch)	12	12	12	1
Norway	Between Shetland and 4°W	107	162	56	19
	West of 4°W	15	110	13	5

Table 4.5 Returns by factories from Scottish and Icelandic tagging experiments 1972 east and west of 4°W.

			Recaptures at factories				
			Stornoway			Lerwick	
Year of tagging	Area	No. tagged	Year	No. of recaptures	No. per 1 000 fish tagged per ton processed	No. of recaptures	No. per 1 000 fish tagged per ton processed
1972	West of 4°W (Rona)	3 000	1972 1973	7 23	0.21 0.44	6 6	0.14 0.16
	West of Orkney	810	1972 1973	1 5	- 0.36	2 2	0.17 0.20
	Foula	600	1972 1973	0 1	- 0.10	4 2	0.46 0.27

Table 4.6 Total catches of herring (metric tons) in Division VIa, and in Scottish juvenile herring and sprat fisheries in the Moray Firth 1957-1973.

	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973*
Belgium	-	192	24	40	-	-	1	-	-	23	-	-	-	-	-	-	-
England	99	201	16	36	52	85	58	26	28	1	-	3	-	-	-	-	340
Faroes[a)]	-	-	-	-	-	-	-	-	-	-	-	-	-	15 100	8 100	8 094	15 800
France	-	-	-	154	353	489	1 121	1 023	610	1	379	1 124	966	1 293	2 055	680	2 417
Germany (F.R.)	-	8 592	2 509	5 311	1 816	11 279	4 739	5 387	5 066	14 634	17 318	14 874	15 805	16 548	7 700	4 108	17 754
Netherlands	-	-	-	-	-	-	-	68	330	251	4 576	2 957	1 514	1 102	9 252	23 370	30 328
Iceland	-	-	-	-	-	-	-	-	-	-	-	-	-	5 595	5 416	2 066	3 545
Ireland	5 069	4 049	4 449	3 768	5 637	4 015	3 633	4 540	6 440	7 759	12 290	13 390	11 895	11 716	12 161	17 308	13 452
N. Ireland	1	6	-	-	-	-	3	1	-	-	-	4	3	1	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	20 199	76 720	17 400	30 557
Poland	-	-	-	-	-	-	-	-	-	-	727	2 791	3 188	3 709	-	-	2 500
Scotland	41 636	52 250	60 986	58 921	44 083	47 831	44 394	58 673	53 909	69 363	67 404	65 180	90 222	103 530	99 537	107 638	120 800
U.S.S.R.	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	?	2 500
Total	46 805	65 290	67 984	68 230	51 941	63 699	53 949	69 718	66 383	92 032	102 694	100 323	123 593	178 796	220 941	173 938	239 993
Scottish juvenile herring and sprat fisheries in Moray Firth	1 703	1 164	2 451	906	585	1 842	118	660	10 278	20 734	6 507	4 985	3 100	1 385	5 666	10 242	7 219

* Preliminary figures.

a) Figures supplied by Fiskirannsóknarstovan

Table 4.7 Catches of herring in Division VIa in 1973 by countries, fishing grounds and months (preliminary figures).

Country	Area	Months												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Nether-lands	06 NW Ireland					110	1 980	1 708	2 195	2 992	1 662			10 647
	01 Hebrides							5 947	3 528	4 691	4 789			18 955
	02 W.Shetland							726						726
	Total					110	1 980	8 381	5 723	7 683	6 451			30 328
Germany (F.R.)*	VIa_1 N.Ireland						58	471	117	361	4 244	2 577		7 828
	VIa_2 Hebrides						470	2 874	949	1 788	2 671	1 048		9 800
	Total						528	3 345	1 066	2 149	6 915	3 625		17 628
Scotland	N.Minch	12 878	13 488	8 156	849		4	570	1 136	1 601	8 825	12 277	6 185	65 969
	S.Minch	12 928	9 982	5 095	1 923	704	756	981	1 834	1 221	2 568	9 297	7 541	54 827
England	NW.Ireland													340
Faroes	W.Shetland													15 800
France	NW.Ireland													2 417
Iceland	W.Shetland						803	1 852			890			3 545
Ireland	NW. Ireland													13 452
Norway	W.Shetland						16 763	13 076	623	95				30 557
Poland	Hebrides													2 500
U.S.S.R.	Hebrides													2 500
GRAND TOTAL														239 862

* Excluding 126 tons from the German lugger fishery.

Table 4.8 Herring autumn spawners.
Catch in number x 10^{-3}, Division VIa + Moray Firth.

Year	Age	1	2	3	4	5	6	7	8	9	10	11	11+
	Rings	0	1	2	3	4	5	6	7	8	9	10	10+
1957		-	6 496	80 817	66 094	26 882	38 989	21 541	9 643	1 658	2 606	578	1 633
1958		-	15 695	33 616	152 801	43 895	28 108	32 025	19 986	10 795	3 725	2 592	2 570
1959		-	54 063	74 615	38 547	124 307	27 898	18 942	18 833	8 158	4 629	2 971	1 764
1960		21	3 940	115 501	65 703	25 388	50 558	12 196	11 096	6 770	3 029	1 558	269
1961		-	14 473	50 809	72 914	38 321	24 455	14 296	5 791	5 370	1 741	767	379
1962		-	55 278	99 167	27 189	76 706	49 002	22 707	27 787	7 614	5 676	2 097	662
1963		-	11 890	82 849	57 688	13 310	42 796	28 698	10 171	14 585	3 915	3 239	731
1964		2 781	26 609	87 652	74 309	29 583	8 857	27 075	21 347	10 109	11 956	4 028	1 671
1965		46 891	299 701	23 351	72 085	67 768	24 525	7 001	28 806	21 475	7 500	11 609	4 406
1966		211 639	211 675	517 616	45 317	70 793	38 471	22 691	12 656	20 790	17 005	7 418	8 752
1967		186 598	207 947	28 648	273 723	49 755	48 320	36 143	15 226	10 397	15 068	10 962	7 937
1968		71 425	220 870	105 348	26 031	243 304	19 679	28 436	17 699	7 275	4 493	5 326	4 570
1969		192 368	39 160	107 189	84 565	27 604	264 558	25 795	45 908	27 932	11 003	5 197	13 058
1970		16 299	238 431	108 872	272 693	124 498	42 623	185 380	24 821	29 920	14 276	5 156	6 903
1971		209 598	169 780	286 148	346 206	261 891	94 206	25 876	166 165	16 425	16 286	8 038	5 578
1972		24 941	321 539	753 355	210 243	72 885	83 361	37 428	13 445	94 577	8 154	5 855	5 377
1973*		-	17 654	270 715	971 883	152 713	65 131	66 469	25 494	7 882	52 081**		

* Catches from Moray Firth not included.

** Age 10 and older.

Table 4.9 Calculated fishing mortalities by age and year in Division VIa population.

Age (rings) \ Year	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.19	0.11	0.07	0.13	0.00	0.07
1	0.02	0.03	0.09	0.02	0.04	0.10	0.02	0.07	0.11	0.58	0.26	0.17	0.05	0.21	0.05
2	0.13	0.14	0.17	0.25	0.30	0.33	0.18	0.17	0.08	0.24	0.13	0.18	0.11	0.16	0.38
3	0.37	0.36	0.21	0.21	0.22	0.24	0.29	0.22	0.19	0.19	0.17	0.15	0.19	0.38	0.86
4	0.24	0.41	0.48	0.18	0.16	0.33	0.16	0.21	0.28	0.25	0.30	0.20	0.20	0.43	0.67
5	0.41	0.38	0.43	0.33	0.24	0.28	0.28	0.13	0.24	0.23	0.25	0.16	0.31	0.48	0.59
6	0.44	0.61	0.42	0.30	0.13	0.33	0.23	0.25	0.13	0.33	0.31	0.20	0.30	0.34	0.53
7	0.36	0.85	0.78	0.41	0.21	0.35	0.21	0.24	0.41	0.33	0.35	0.22	0.50	0.46	0.51
8	0.13	0.77	0.92	0.64	0.32	0.41	0.28	0.31	0.37	0.51	0.44	0.25	0.56	0.63	0.55
9	0.34	0.41	0.79	0.96	0.29	0.49	0.33	0.35	0.35	0.49	0.77	0.30	0.63	0.59	0.76
$\bar{F}_w \geq 2$	0.23	0.35	0.32	0.25	0.21	0.32	0.23	0.21	0.27	0.25	0.20	0.19	0.23	0.33	0.59

Table 4.10 Calculated stock size in numbers (x 10^{-6}) by age and year.

Age (rings) \ Year	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	614.4	741.0	252.9	467.3	706.8	721.9	429.2	3476.4	603.6	1277.0	1809.6	1074.9	1636.6	4072.7	937.3
1	309.2	555.9	670.5	228.9	422.8	639.6	653.2	388.3	3142.9	501.6	954.5	1460.1	904.8	1298.2	3669.6
2	675.5	273.6	488.1	555.3	203.3	368.8	526.2	579.8	326.1	2559.1	253.6	666.4	1111.5	781.4	948.3
3	221.5	534.5	215.6	370.8	392.8	135.8	239.7	397.5	441.4	272.9	1824.4	202.3	503.0	903.8	603.7
4	131.5	137.7	338.8	158.5	273.2	286.3	97.1	162.2	289.1	330.9	203.9	1390.9	158.3	374.8	559.4
5	122.1	93.5	83.0	188.8	119.3	210.8	186.3	75.2	118.6	197.3	232.3	137.3	1027.6	117.0	221.2
6	62.9	73.6	57.9	48.7	122.9	84.8	144.2	128.0	59.6	84.1	142.0	164.3	105.5	678.9	65.5
7	33.3	36.5	36.3	34.5	32.5	97.6	55.2	103.3	90.1	47.3	54.6	94.2	121.7	71.0	438.5
8	14.5	21.0	14.2	15.0	20.7	23.9	62.0	40.3	73.2	54.2	30.8	34.9	68.5	66.6	40.8
≥9	10.7	17.5	15.7	8.7	9.0	18.5	21.9	51.6	53.8	63.1	54.8	30.4	36.8	47.5	50.6
Σ Adult 2>8	1272.0	1187.9	1249.6	1380.4	1173.7	1226.4	1332.6	1537.7	1451.9	3608.9	2796.4	2720.7	3132.8	3041.2	2928.0
Stock biomass	192 746	213 975	223 696	204 359	209 061	234 679	238 167	279 556	461 198	484 773	480 963	523 143	524 268	577 730	709 178

Table 4.11 Prognosis of catch in Division VIa in 1974 at various levels of juvenile and adult fishing mortalities (thousand ton units).

Adults	F juvenile (1 ringers)						
	0.0	0.1	0.2	0.3	0.4	0.5	0.6
0.1	47.4	61.8	74.7	86.4	97.1	106.7	115.5
0.2	90.2	104.6	117.5	129.2	139.9	149.5	158.3
0.3	129.3	143.7	156.6	168.3	179.0	188.6	197.4
0.4	163.8	178.2	191.1	202.8	213.5	223.1	231.9
0.5	196.1	210.5	223.4	235.1	245.8	255.4	264.2
0.6	224.8	239.2	252.1	263.8	274.5	284.1	292.9
0.7	251.3	265.7	278.6	290.3	301.0	310.6	319.4
0.8	274.8	289.2	302.1	313.8	324.5	334.1	342.9
0.9	297.7	312.1	325.0	336.7	347.4	357.0	365.8
1.0	316.0	330.4	343.3	355.0	365.7	375.3	384.1

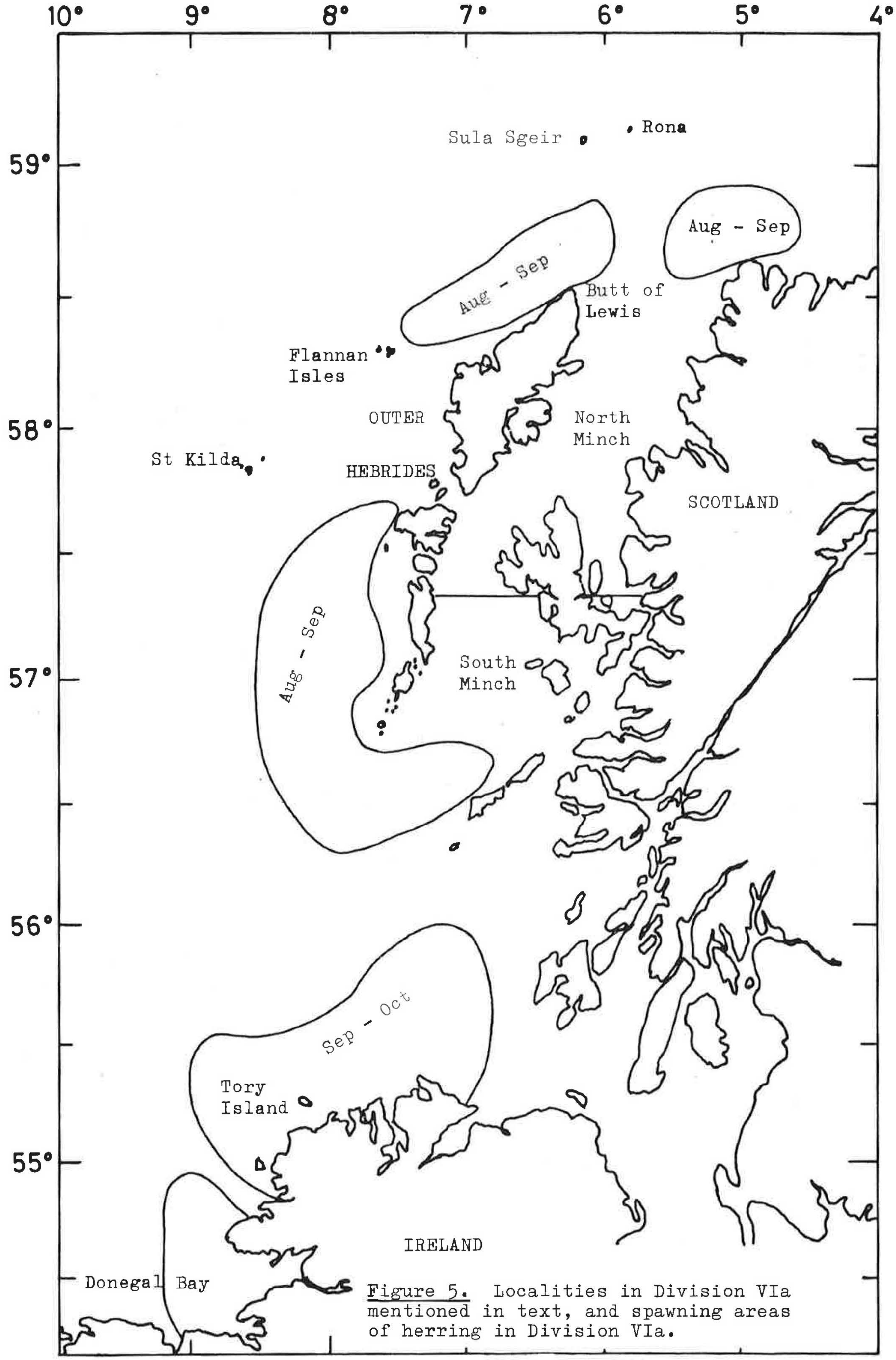

Figure 5. Localities in Division VIa mentioned in text, and spawning areas of herring in Division VIa.

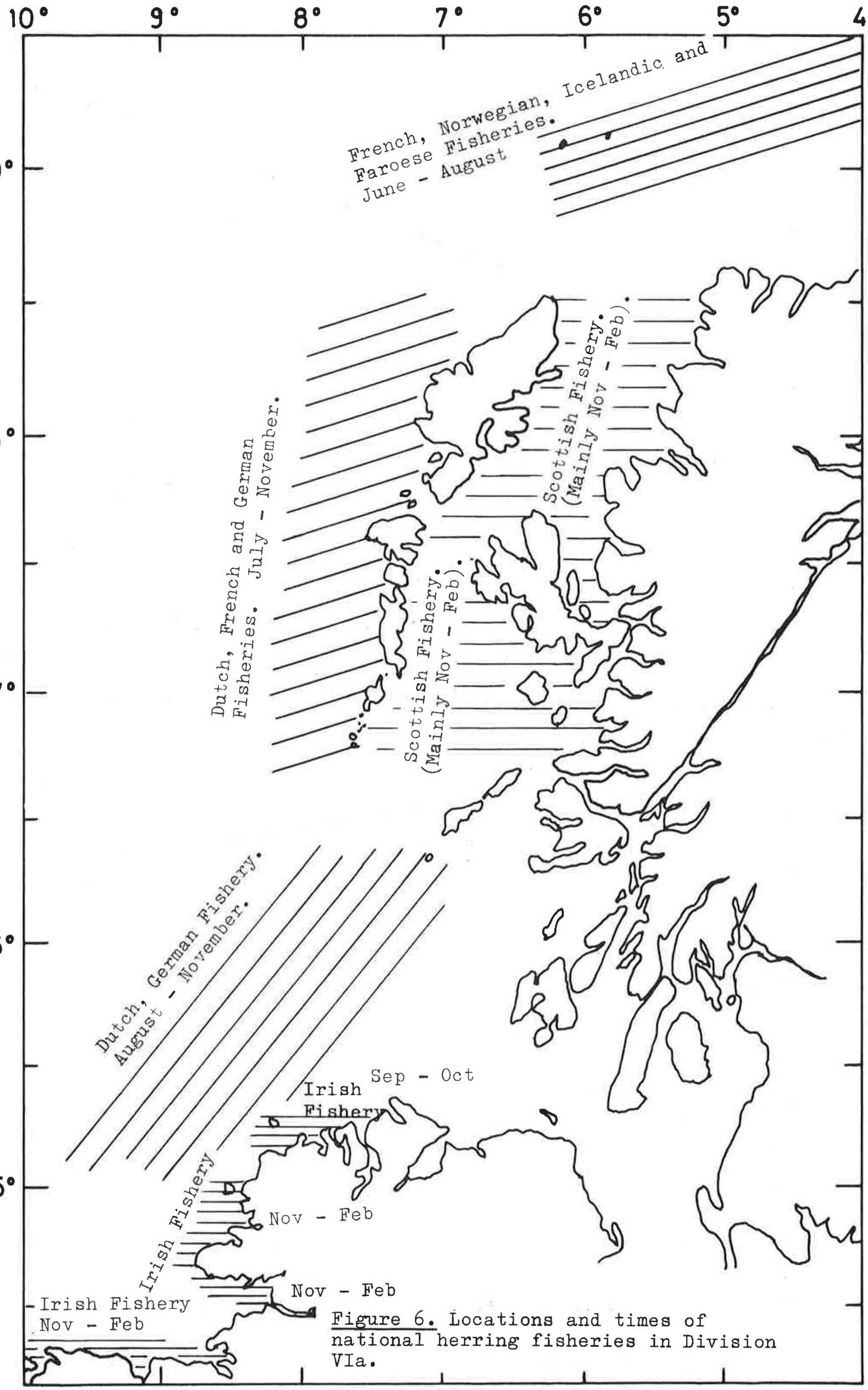

Figure 6. Locations and times of national herring fisheries in Division VIa.

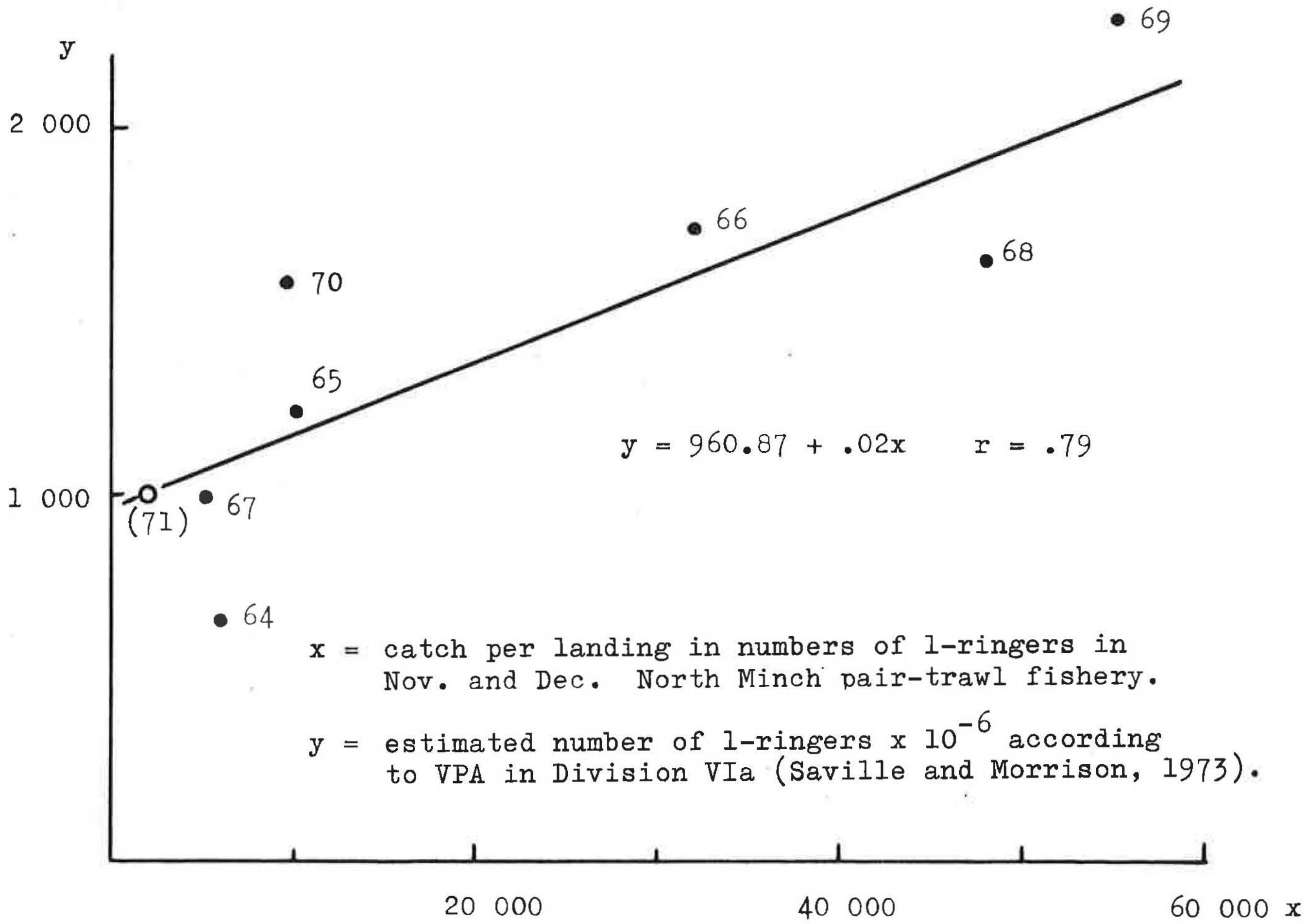

Figure 7. Estimation of number of 1-ringers of the 1971 year class.

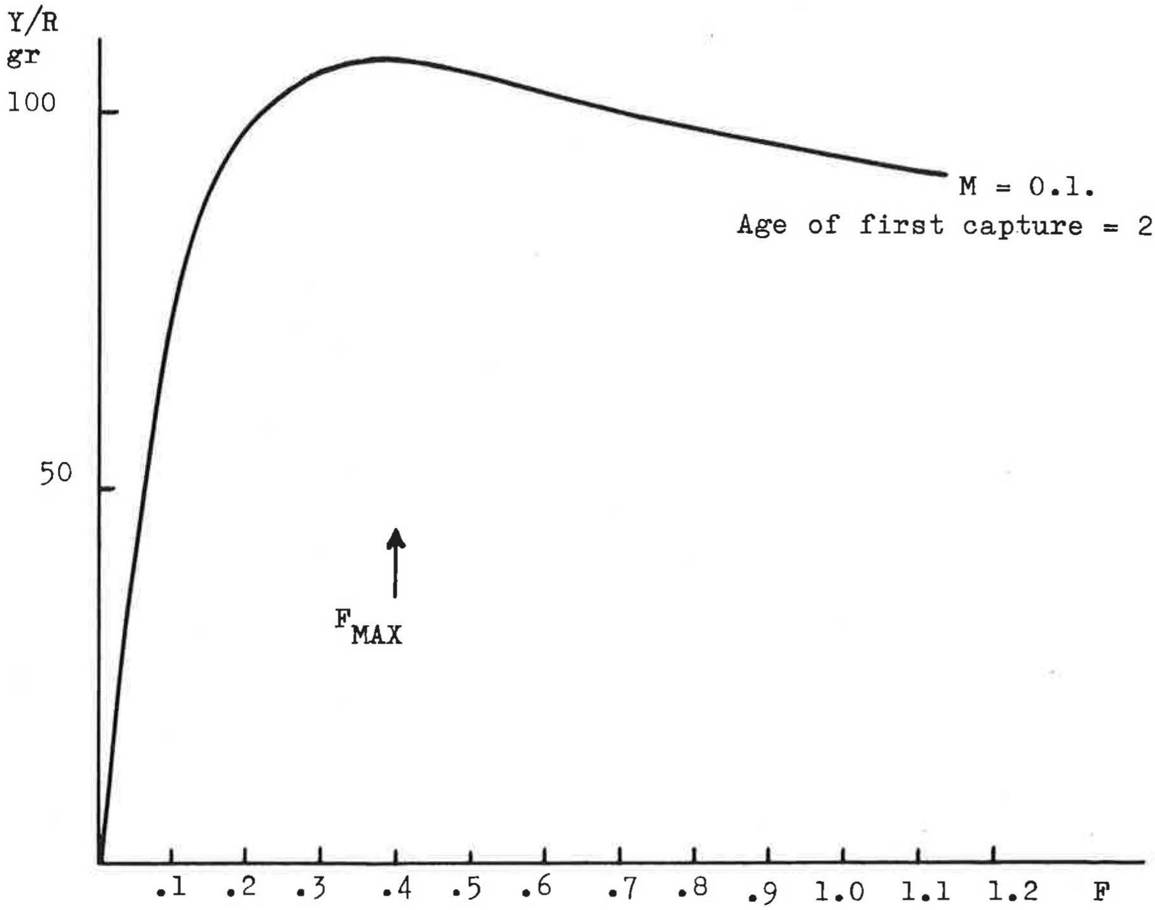

Figure 8. The yield per recruit curve for the Division VIa herring population.

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

Charlottenlund, 27 February - 7 March 1975

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 Skagerrak 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 - 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:

E Bakken	Norway
R S Bailey	United Kingdom (Scotland)
A C Burd	United Kingdom (England)
A Corten	Netherlands
J Jakobsson	Iceland
K Popp Madsen	Denmark
A Maucorps	France
J Molloy	Ireland
E Nielsen (Ms)	Denmark
G Rauck	Federal Republic of Germany
A Saville (Chairman)	United Kingdom (Scotland)
H Schultz	German Democratic Republic
A Schumacher	Federal Republic of Germany
B Sjöstrand	Sweden
G Speiser	Federal Republic of Germany
Ø Ulltang	Norway
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 Skagerrak, amounted to 252 690 tons which is 245 000 tons less than in 1973 and the second lowest on record (Figure 9). 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 Skagerrak catch decreased from 84 566 tons in 1973 to 54 835 tons 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 IVa E 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)

Year	Age						Total
	0	1	2	3	4	5 and older	
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 increased 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 number for 1974 was also calculated for the Skagerrak 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 Skagerrak 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 cohort analysis

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 (this volume) 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 the previous report averaged over the years 1967-71.

2.2.3 New abundance indices of I-group herring (1972 year class) 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 cohort analysis. 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 International 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 estimate with the catch of 838×10^6 in 1974, fishing mortality in this year would have been only 0.17 which is obviously much too low. Therefore this estimate from the YHS must be an overestimate.

2.2.5 However, if one assumes 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 Cooperative Research Report, No.52, p.65.

2.2.8 Using the regression equation given in that report 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 likely to be overestimated.

2.2.9 Considering that there may have been a gradual increase from 1960 onwards in efficiency during the YHSs the correlation between cohort analysis 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. On this basis the strength of this year class as 0-ringers is estimated at 6.0×10^9, or 75% of the strength of an average year class. The same figure for the fishery mortality on this age group of 0.20 was also obtained from independent estimates of fishing effort in the Danish industrial fishery (paragraph 2.2.6). Abundance indices from this fishery indicate that the year class 1973 is of comparable strength to the year classes 1970 and 1971, or somewhat below average.

2.3 Results from cohort analysis

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 is estimated 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 to give the maximum yield per recruit.

2.3.4 The estimated fishing mortalities for all age groups in 1971 and 1970 are slightly higher than those given in the previous report (this volume), due to a higher input F for adult fish in 1974 than in 1973. Minor changes in F in older age groups in preceding years are caused by a different input F on 8-ringers in 1967, 1969 and 1970.

2.3.5 Calculated stock sizes and biomasses for 1971 and preceding years have been slightly reduced compared to the figures given in the previous report, 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 cohort analysis. The figure of 4.96×10^9 still depends to some degree on the input F in 1974, but it indicates that the 1972 year class is 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 10 shows the weighted fishing mortalities of adults ($\geq$ 2-ringers) since 1974, based on the cohort analysis (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 9 and 11).

2.4 Mean weight by age in catch

The Working Group decided to reconsider the mean weights at age which have been used in the catch prognosis 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 (Doc. 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 have a somewhat higher weight using the data from recent years. Most of the older herring have been caught in Division IVaW in these years and the weight at 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 prognosis.

Age (Winter rings)	Biomass 1 January*	Mean weight in catch*
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)

* Previous figures in brackets.

2.5 Total allowable catches (TACs) 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 Skagerrak. In addition, if countries had observed the ban on fishing in the spring of 1974, they were allowed to take additional quotas which depended 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 Skagerrak). 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 The 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 1975 is given below:

Age in rings

	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	0.013	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 x 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 the MSY per recruit 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 Skagerrak, 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 Skagerrak 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 Skagerrak 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 this 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 11). 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 (this volume), 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 given in Table 3.1. The figures for 1974 are provisional. The catches for each season are given in Table 3.2. The 1973 figures which were estimated in the previous report 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 catches of the Netherlands and French fleets, but this may have been due to a decreased effort in the area by these fleets.

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 sizes and fishing mortalities for previous seasons were calculated by cohort analysis. For the oldest age groups 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 estimated based on mortality estimates from Irish catch per unit effort data. The relatively low proportion of French and Dutch catches in the overall catch also indicates a reduced effort by trawlers of these countries during the 1974/75 season. Results of the cohort analysis are given in Tables 3.4 and 3.5.

3.2.3 The estimated stock size at 1 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 little information available at present the 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 fishing mortality corresponding to the maximum of the yield per recruit curve (0.45 - 0.50), and an estimate of recruitment. The variation in annual recruitment is shown in Figure 12, where it is seen that, at the extreme, recruitment can vary over 10 times, while it commonly varies by 3 times. The table below gives the levels of MSY for periods of differing estimates of recruitment.

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

Years	Recruitment ($x\ 10^{-6}$)	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 (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 catch levels then current (35 000 tons) depended on continuation of the level of recruitment of the 1965-69 period. 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 it 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 x 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 (C.M.1975/H:5).

3.3.4 For forecasting future 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 x 10^6 compared with the mean for the same period of 166 x 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 13 shows the regression of cohort F on catch per unit 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 from the 1974/75 catch.

3.5 Total allowable catches (TACs) for 1975/76 and 1976/77

3.5.1 With the new data available the age composition of the stock at 1 March 1974 has been revised. In addition, the data on mean weight for age have also been re-examined. The revised data are given in the text table below. The weight data are derived from the Irish catches which comprise a major part of the total catch.

Mean weights at age and calculated stock sizes at 1 March (x 10^{-6})

Age	Mean weight (g)	1974	1975	1976	
				$F_{75/76}$ = 1.1	$F_{75/76}$ = 0.7
1	128.4	68.82	100.0*	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 tons		54 000	50 500	39 000	46 000

* estimated.

3.5.2 A TAC of 25 000 tons for 1975/76 has been adopted by NEAFC. This would imply a sharp increase in fishing mortality from 0.51 in 1974/75 to 1.1 in 1975/76. Using this value the stock size at 1 March 1976 has been calculated. This is also given in the table above. With the trend of reduced recruitment in recent years, it may be unrealistic to assume that this TAC could be taken. However, some increased effort can be expected in the Celtic Sea; an F of 0.7, which is close to the recent mean, has been used as a likely alternative value in 1975/76. The stock size at 1 March 1976 calculated on this basis is also given in the table above.

3.5.3 Under the present TAC agreement it is likely that the fishing mortality in 1975/76 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 per recruit. The various TACs proposed and adopted are:

Levels of TACs proposed (tons)

	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 of 10 - 12 000 tons suggested for 1976/77 are small and vary inversely with the catch which will be taken in 1975/76. If NEAFC were to reconsider its TAC for 1975/76 and set it at the level corresponding to the F giving the MSY per recruit it would be possible to have a higher TAC in 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 1 March 1976 to 51 700 tons.

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, although 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 Division 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 cohort analysis over the period 1968/73. 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). In recent years there have certainly 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. The 1970 year class however shows some evidence of being stronger in Division VIIb than in Division 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 the herring taken in Division VIa and those taken in Division VIIb but reported from Division VIa. It would stress, however, the importance of obtaining more conclusive evidence on the inter-relations of the populations in the two areas and would suggest tagging experiments as the most profitable approach to solving the problem. More extensive sampling of catches taken by fleets fishing in the southern parts of Division VIa would also be of value in this context.

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 preliminary total for 1974 (205 000 tons) may well be an appreciable underestimate as the Norwegian and Netherlands catches have had to be estimated for the last four months of the year. This preliminary 1974 figure shows a decrease of about 42 000 tons compared with the final 1973 figure. Even if the total for 1974 given in Table 4.2 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 per age group of autumn spawning herring 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 Morrison (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 caught in 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 estimated 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 fishery in 1974, accounting for about 40% of the numbers caught in Division VIa. By contrast, in the Irish fishery in Donegal Bay the 1971 year class dominated in 1974, with the 1970 year class second in importance.

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 Division VIa have been combined with those taken in the Scottish winter fishery in the Moray Firth. The Working Group decided that this procedure could be misleading and accordingly in this report the catches in number per age group for the two areas are given separately in Tables 4.3 and 4.4. The estimates of the catches in numbers per age group in 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 cohort analysis 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 the previous report (this volume). The new value of the mean mortality rate in 1973 is 0.59 which is appreciably above the value giving the maximum sustainable yield per recruit 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. 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 per recruit. 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 on the fully recruited age groups in 1974. The average weight per age group used in making this prognosis is given in the text table below together with the estimated stock in number at 1 January 1975.

Age (rings)	Numbers per age group ($x 10^{-6}$) at 1 January 1975	Average weight per age group (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

4.5.4 The prediction has been made on the assumption that the TAC agreed for 1975 (205 000 tons) will be taken. This 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 is reduced to that giving the MSY per recruit (F = 0.45) then the decline in stock size would 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 high recruitment. There are indications, however, that the year classes 1970-72 are well below average size.

Therefore even with fishing on the MSY level the stock size will decline to the level of the period 1965 and earlier (see Figure 14). 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. The spawning season extends from January to August in the area as a whole, and is generally somewhat earlier in the south and later in the north. There is little information available on stock sub-division 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 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 within the first year of life, and the catches are largely dependent on the recruiting year class. There would therefore seem to be little likelihood for this species 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. 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 has been taken in the central North Sea. The published totals, however, do not contain an important component of the sprat catch 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. 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 feature of the trends are summarised for each area below.

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

5.2.2 Division IVa - west of 2°E

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 Division 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 Skagerrak and Kattegat. The landings from this fishery have shown only minor fluctuations over the last ten years.

5.2.4 Division IVb - west of 3°E

Landings from this area by 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 into the fishery and appear to have increased again 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 1973 and 1974.

5.2.5 Division IVb - east of 3°E

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

5.2.6 Division 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 to the same extent.

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 give 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 on to the dense winter concentrations off North Shields but may also reflect an increase in stock in the central North Sea as a whole. As the Working Group did not have time to allocate the catch and effort data between Division IVb east and Division IVb 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 samples 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 Division 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 Division 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, this percentage dropped to 16% in 1973 and to 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 were 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 15). This suggests that in Division 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 contributes effectively 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 strong or weak year classes.

5.5.2 In the absence of a 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 likely 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 increase 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, and the inadequacies of the available data, 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 a further rapid increase 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 achieved by introducing a minimum mesh size for clupeoid fisheries. The text table below 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 of the youngest age group caught would be reduced very markedly by avoiding capture of fish below 7-8 cm in length.

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

cm \ Age	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				1 085
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 be a problem as long as the selection range is below 12-13 cm.

The same experiments 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 this 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 catch 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 to 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 Skagerrak 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 set by NEAFC for 1975/76 for the Celtic Sea herring stock is almost twice that corresponding to the MSY per recruit. If the appropriate level of 13 800 tons were applied in 1975/76, 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 per recruit 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 this 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 sprat 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 boundary between Divisions IIIa and IVa.

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.

8. References

ANON., 1972. Report of the North Sea Herring Assessment Working Group Meeting, Charlottenlund Slot, 13-22 June 1972". Doc. C.M.1972/H:13 (mimeo.).

ANON., 1975. I. Report of a Meeting to Consider Young Fish Surveys, Bergen, 6-9 May 1974; II. Report of the Working Group on North Sea Young Herring Surveys, IJmuiden, 19 April - 3 May 1974. ICES, Coop.Res.Rep., No.52.

SAVILLE, A and MORRISON, J A, 1973. A re-assessment of the herring stocks to the west of Scotland. ICES, Doc. C.M.1973/H:24 (mimeo.).

Table 2.1 Herring.
Catch in tons 1970-73 and preliminary figures for 1974.
North Sea (Sub-Area IV and Divisions VIId and e) by country, and annual totals for Skagerrak.

Country	Year				
	1970	1971	1972	1973	1974
Belgium	1 200	681	1 337	2 160	603
Denmark	133 331	185 393	213 738	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
Germany (F.R.)	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
Skagerrak	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 Fiskirannsóknarstovan.

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

d) Excludes 15 938 tons caught on Skagerrak 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, Skagerrak) used for area allocation of Swedish landings reported as Skagerrak and North Sea in Swedish statistics.

g) Catches from Moray Firth not included.

Table 2.2 Herring.
Total catch in tons. Skagerrak (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	34 900	4 115	-	7 317	1 045	19 644	67 021
1973	42 098	5 265	-	15 938	836	20 429	84 566
1974	35 732	7 132	36	231	21	11 683	54 835

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

Year	Belgium	Denmark	Faroe Isl.	France	German Dem.Rep.	Germany (F.R.)	Iceland	Nether-lands	Norway	Poland	U.K. Scotland	Sweden	U.S.S.R.	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 Isl.	Finland	France	German Dem.Rep.	Germany (F.R.)	Iceland	Nether-lands	Norway	Poland	U.K. England	U.K. Scotland	Sweden	U.S.S.R.	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 Table 2.1 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 Isl.	France	German Dem.Rep.	Germany (F.R.)	Iceland	Nether-lands	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	UK (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 1)	-	3.8	23.8	20.1	8.3	1.2	0.1	0.2	-	-	57.5
	unspecified	-	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 Skagerrak catches 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 mortalities.

Winter rings	Years							
	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 at 1 January.

Winter rings	Years							
	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
Σ Juveniles 0 + 1	15.11	10.31	12.01	13.86	9.92	12.38	14.31	10.65
Σ 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 the Celtic Sea (metric tons).

Year	France	Germany (F.R.)	Ireland	Netherlands	Poland	England	U.S.S.R.	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

* Preliminary.

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

Season	Mar/May	Jun/Aug	Sep/Nov	Dec/Feb	Total
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

* Preliminary.

Table 3.3 Catch in numbers per age group (x 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

* Preliminary

<u>Table 3.4</u> Calculated stock size in numbers ($x 10^{-6}$) (M = 0.1) at 1 March.

Winter rings	Year					
	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 in numbers	494.8	547.1	416.9	289.9	340.8	237.3

<u>Table 3.5</u> Fishing mortalities from cohort analysis and weighted mean values of F.

Winter rings	Seasons					
	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 unit effort data.

Season	F from cohort analysis	From Irish cpue
1968-69	0.44	0.32
1969-70	0.47	0.50
1970-71	0.50	0.34
1971-72	0.84	0.82
1972-73	0.66	0.65
1973-74	0.64	0.82
1974-75		0.44

Table 4.1 Mortality rates in Donegal Bay and in Division VIa.

Year	Total mortality from Irish catch/effort $\geq$ 3 years	Total mortality in VIa from cohort analysis $\geq$ 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, and in Scottish juvenile herring and sprat fisheries in the Moray Firth.

Country	1966	1967	1968	1969	1970	1971	1972	1973	1974*
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 (F.R.)	14 634	17 318	14 805	15 805	16 548	7 700	4 108	17 443	13 686[b)]
Netherlands	251	4 576	2 957	1 514	1 102	9 252	23 370	32 715	21 000
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
U.S.S.R.	-	-	-	-	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	

* Preliminary figures.

a) Figures supplied by Fiskirannsóknarstovan.

b) September to December estimated.

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

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

Year	Age	1	2	3	4	5	6	7	8	9	10	11	11+
	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	-	-

Table 4.4 Catch in numbers x 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 Division VIa (Moray Firth included). Fishing mortalities by year and age.

Age (rings)	Year							
	1965	1966	1967	1968	1969	1970	1971	1972
0	0.08	0.19	0.11	0.07	0.13	0.00	0.16	0.04
1	0.11	0.58	0.26	0.17	0.04	0.21	0.05	0.34
2	0.08	0.24	0.13	0.18	0.10	0.15	0.36	0.27
3	0.19	0.19	0.17	0.14	0.19	0.37	0.80	0.43
4	0.29	0.26	0.29	0.20	0.20	0.42	0.64	0.34
5	0.25	0.23	0.25	0.16	0.32	0.47	0.57	0.38
6	0.14	0.34	0.32	0.20	0.29	0.34	0.52	0.41
7	0.42	0.34	0.36	0.23	0.51	0.45	0.51	0.50
8	0.39	0.53	0.47	0.26	0.58	0.66	0.53	0.54
9	0.38	0.54	0.83	0.33	0.68	0.59	0.82	0.48
Mean $F_{w} \geq 2$	0.26	0.28	0.22	0.20	0.30	0.39	0.65	0.43

Table 4.6 Herring in Division VIa (Moray Firth included).
Stock in numbers at beginning of year (x 10^{-3})

Age (rings)	Year							
	1965	1966	1967	1968	1969	1970	1971	1972
0	606 167	1 288 640	1 835 130	1 146 800	1 692 140	4 262 500	1 512 030	679 100
1	3 138 400	503 928	965 096	1 483 240	969 794	1 348 390	3 841 370	1 169 110
2	328 045	2 555 020	255 667	675 953	1 132 380	840 285	993 757	3 314 450
3	438 492	274 639	1 820 690	204 126	511 608	922 787	656 928	627 920
4	285 547	328 331	205 483	1 387 540	159 979	382 642	576 483	267 385
5	116 572	194 090	229 917	138 735	1 024 550	118 552	228 261	273 930
6	57 744	82 208	139 112	162 189	106 846	676 157	66 901	117 383
7	88 333	45 600	52 871	91 598	119 762	72 211	436 042	36 036
8	69 943	52 632	29 261	33 405	66 084	64 899	41 826	237 217
9	24 871	42 934	27 943	16 629	23 324	33 365	30 429	22 296
10	24 093	15 395	22 750	11 054	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	1974a)
IVa West										
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
IVa East (Norwegian west coast fjords)										
Norway	7.6	10.7	10.2	6.3	11.8	6.4	4.4	6.9	8.8	4.7
IVb West										
Denmark	...	...	...	...	...	8.6	9.9	14.4	47.0	55.4
Faroe Islands	-	-	-	-	-	-	-	-	-	4.0
France	-	-	-	1.0	-	-	-	-	-	-
German Democratic Republic	-	+	+	-	-	-	-	-	-	1.7
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	25.0b)
Total	20.4	6.9	19.3	17.0	27.3	29.3	43.8	44.7	105.8	130.8
IVb East										
Denmark	17.6	24.5	17.4	18.1	18.5	16.2	19.9	28.8	93.9	103.3
Germany, Federal Republic of	6.0	8.5	11.5	16.7	6.3	7.6	5.1	1.7	11.0	11.1
Total	23.6	33.0	28.9	34.8	24.8	23.8	25.0	30.5	104.9	114.4
IVc										
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
Total North Sea										
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 Republic	-	+	+	-	-	-	-	-	-	1.7
Germany, Federal Republic of	6.0	8.5	11.5	16.7	6.3	7.6	5.1	1.7	11.0	11.1
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	25.0b)
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

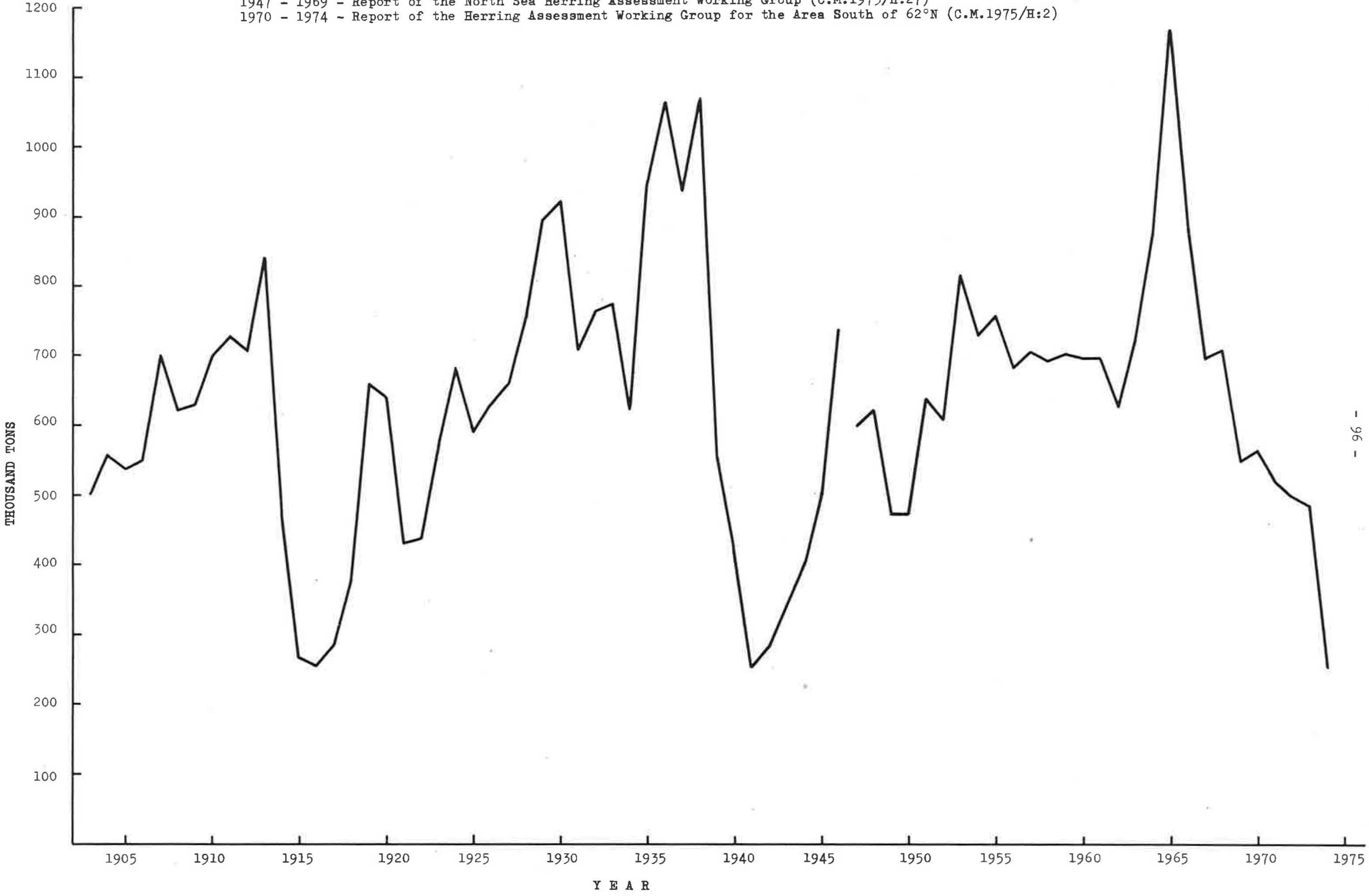
Fishing season	Age group					
	0	1	2	3	4	5
1967-68	17.1	53.8	16.9	11.1	1.2	
1968-69	3.0	37.5	43.1	11.7	4.3	0.3
1969-70	89.5	4.9	2.2	2.9	0.5	0.1
1970-71	40.9	25.3	22.8	8.3	2.8	
1971-72	8.8	77.9	8.6	4.2	0.4	
1972-73	33.7	44.2	17.9	2.9	1.1	0.2
1973-74	58.5	39.3	1.7	0.6		

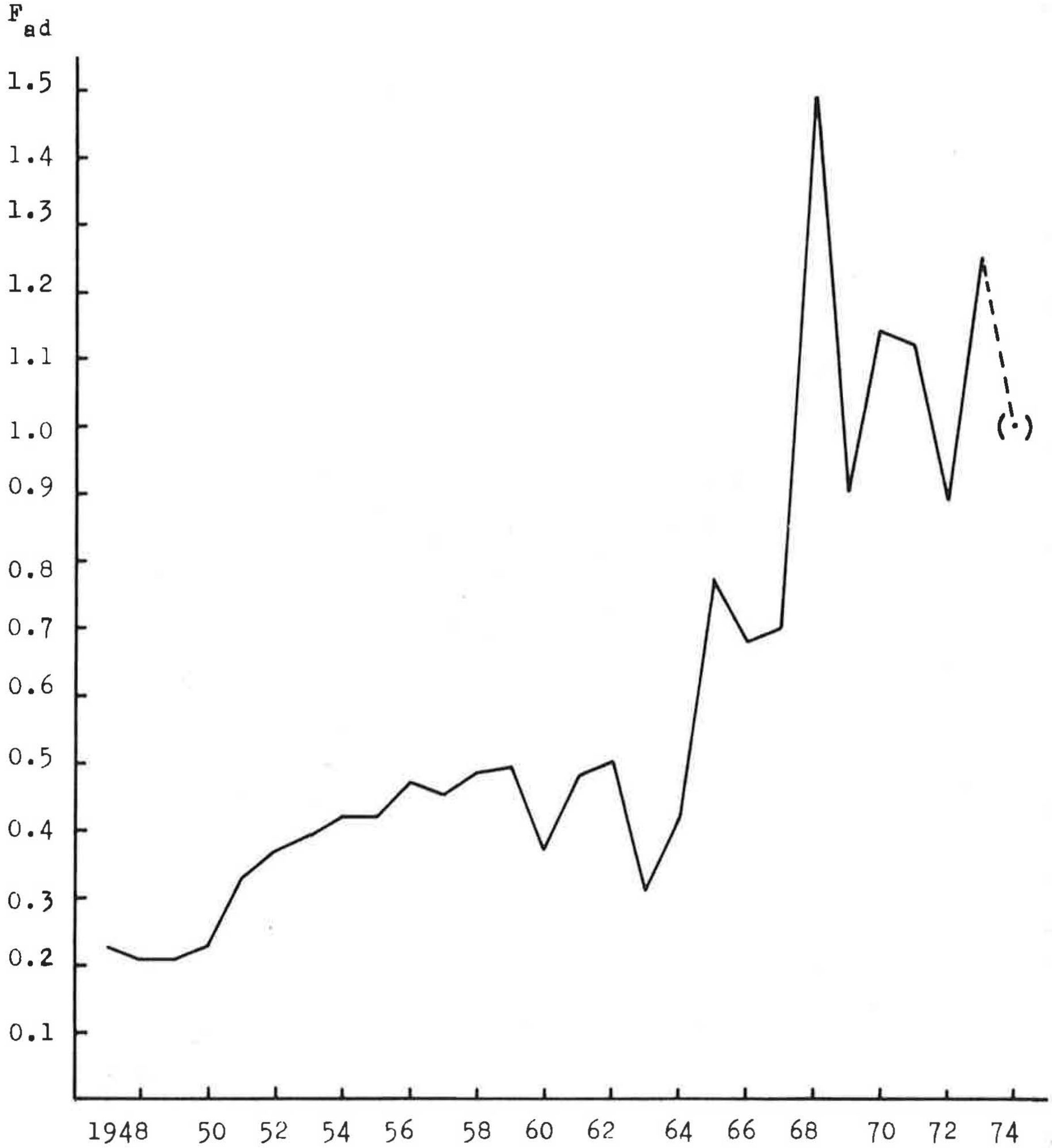
Area IVb - east of 3°E

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 9. 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)





<u>Figure 10.</u> Fishing mortalities for adults (≥ 2-ringers) since 1947 in the North Sea (value for 1974 assumed).

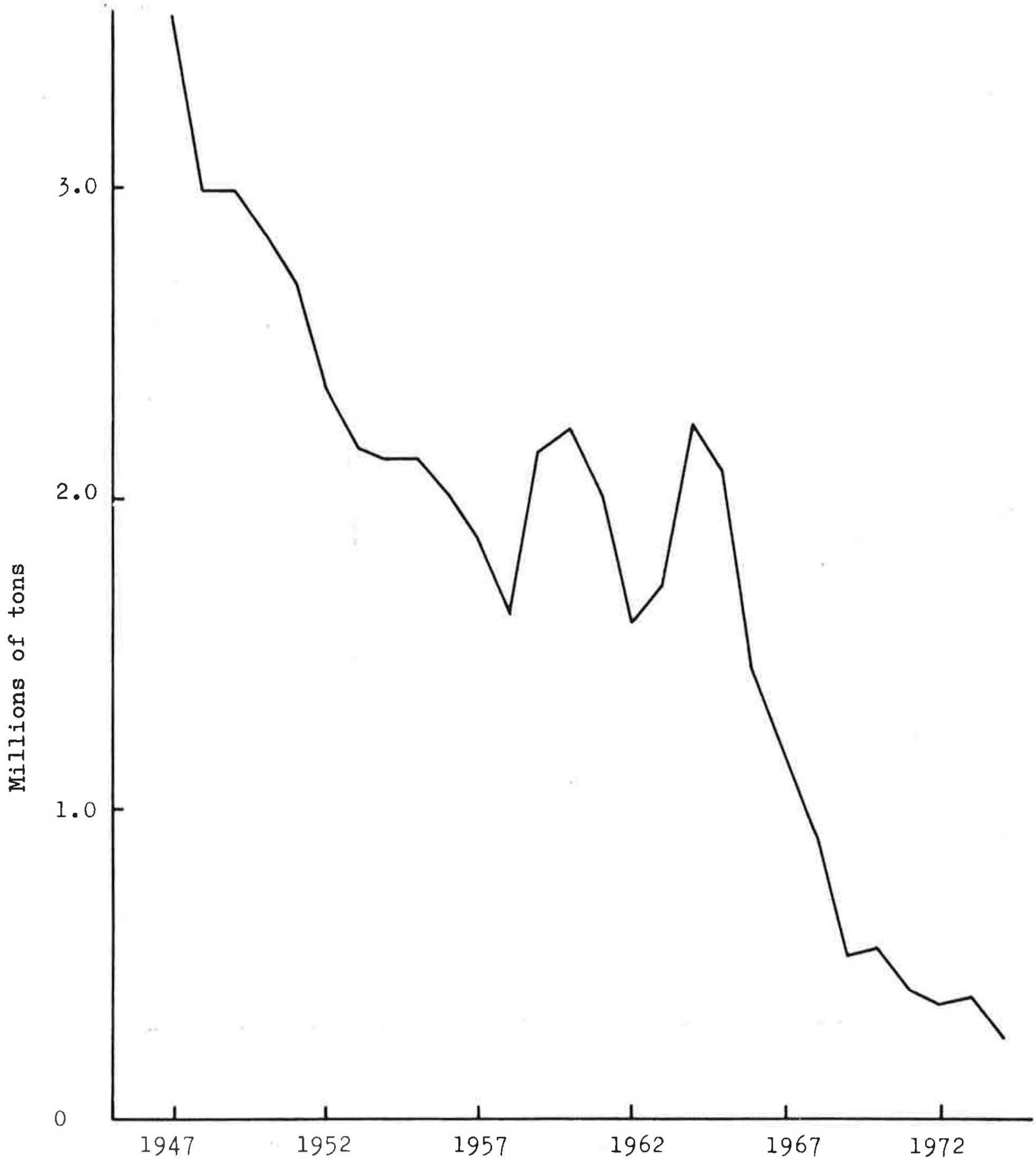


Figure 11. North Sea hering. Adult stock biomass (2-8 ringers) at 1 January.

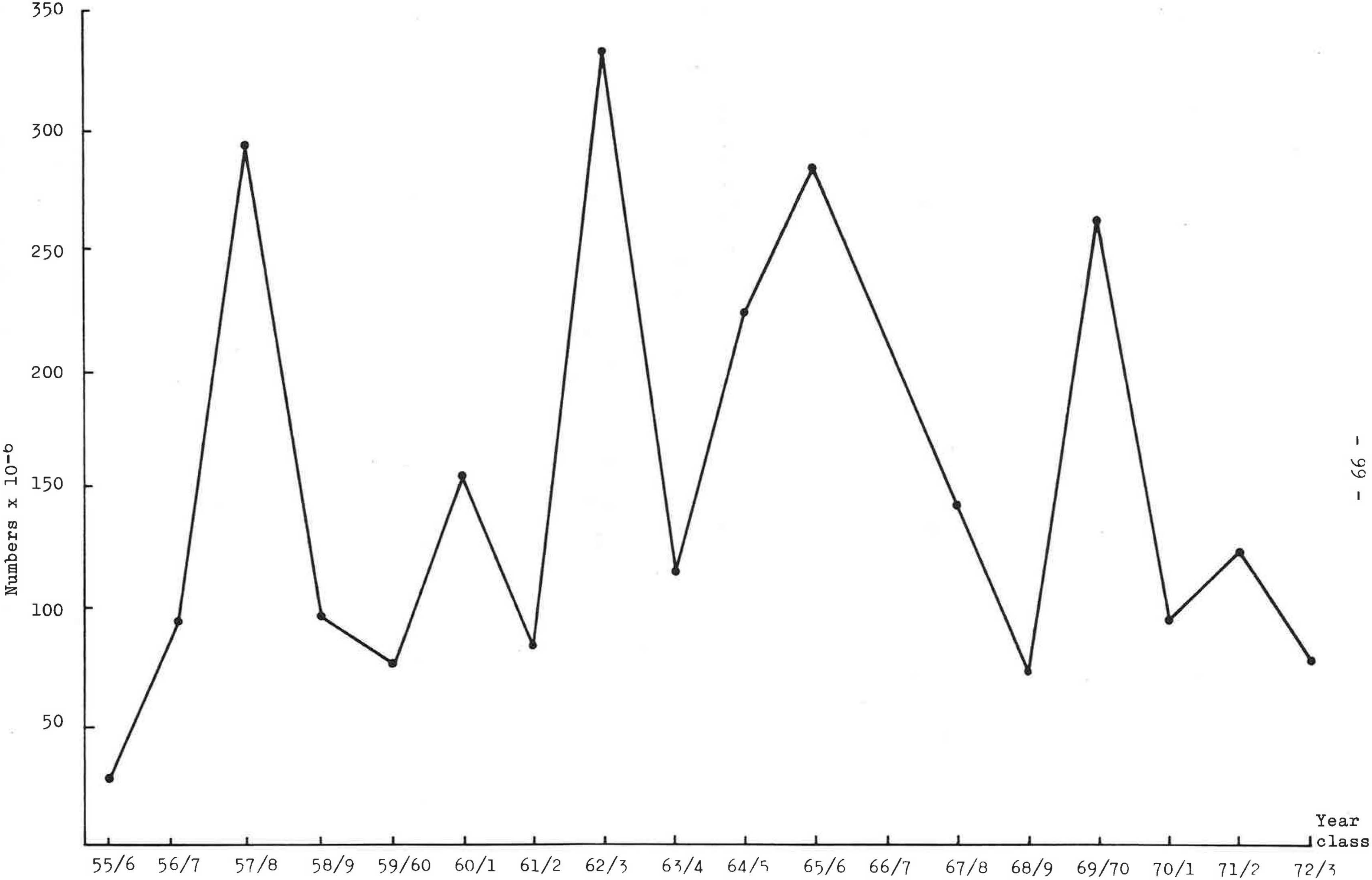


Figure 12. Celtic Sea. Recruitment of 1-winter ring fish per season. Values from 1957-67 taken from C.M.1973/H:2.

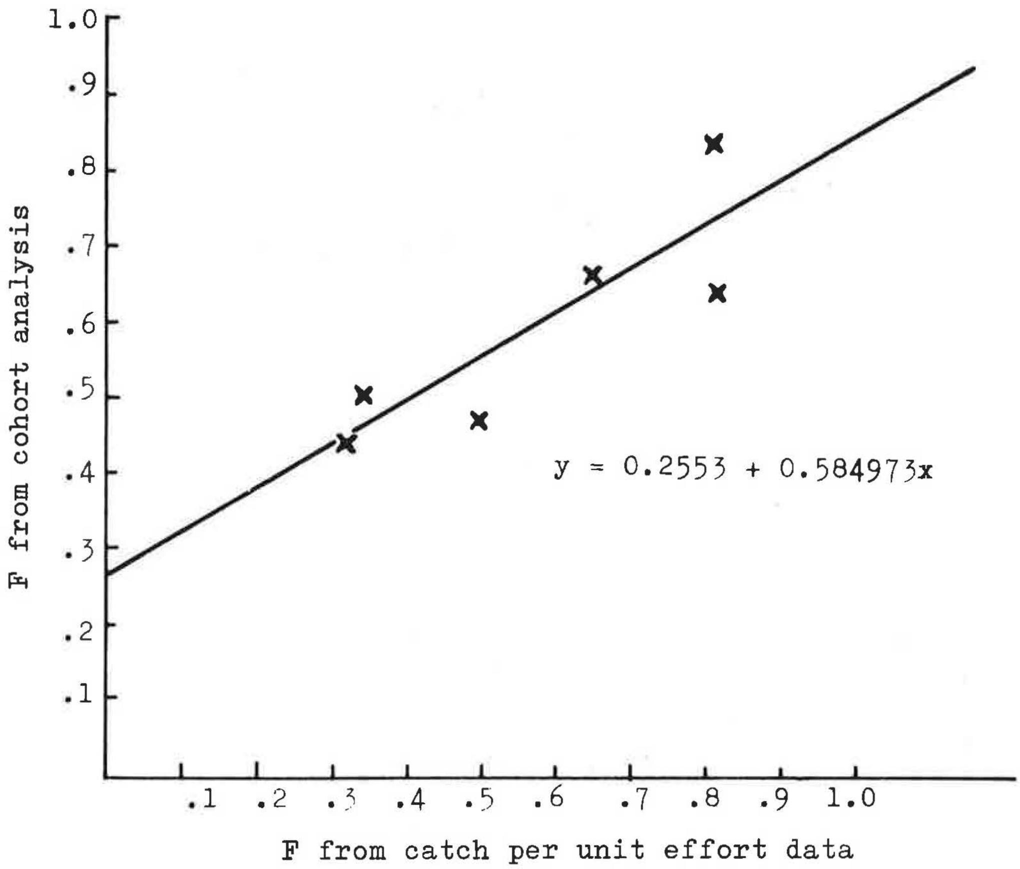


Figure 13. Values of F derived from cohort analysis and from Irish catch per unit effort data.

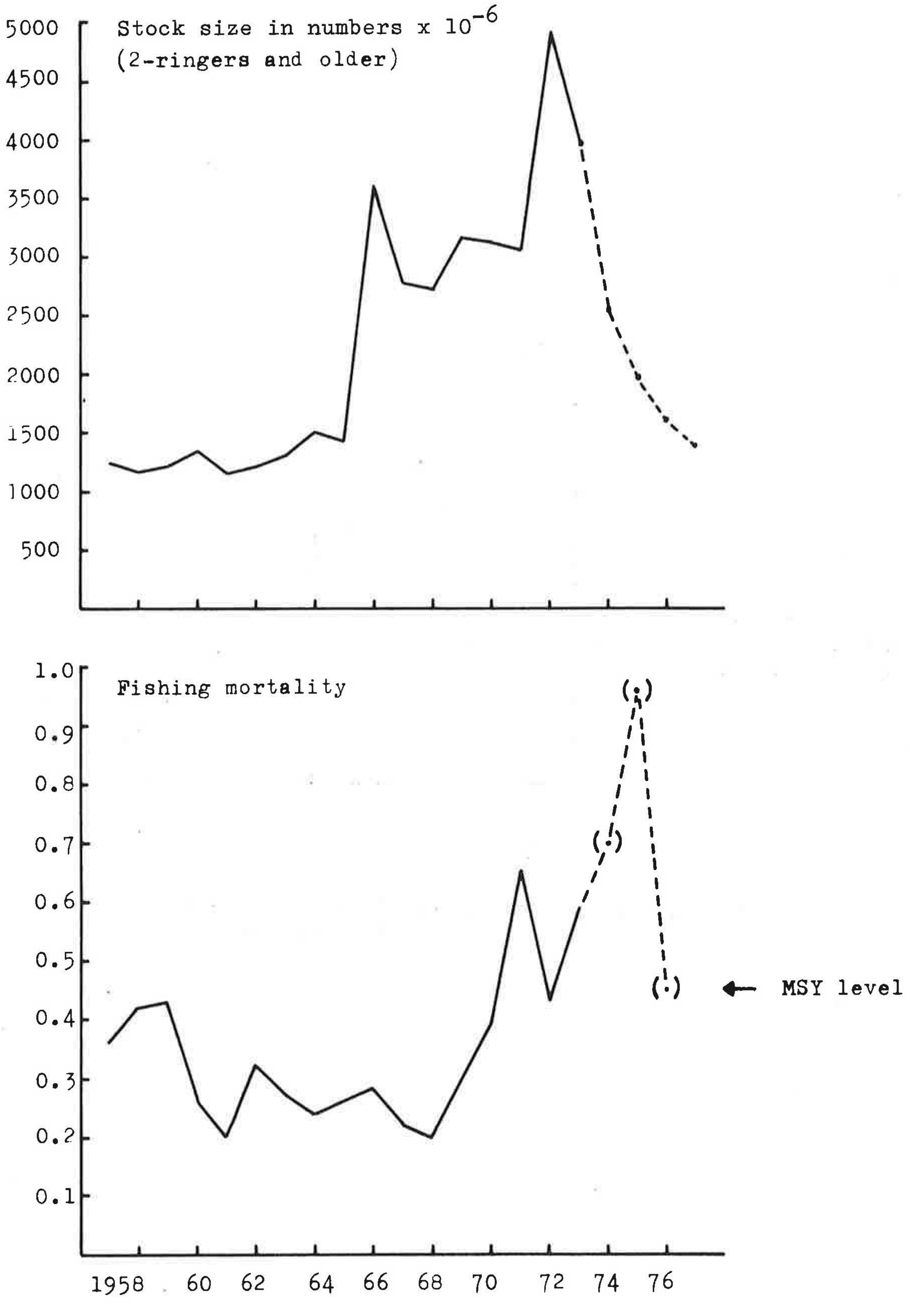
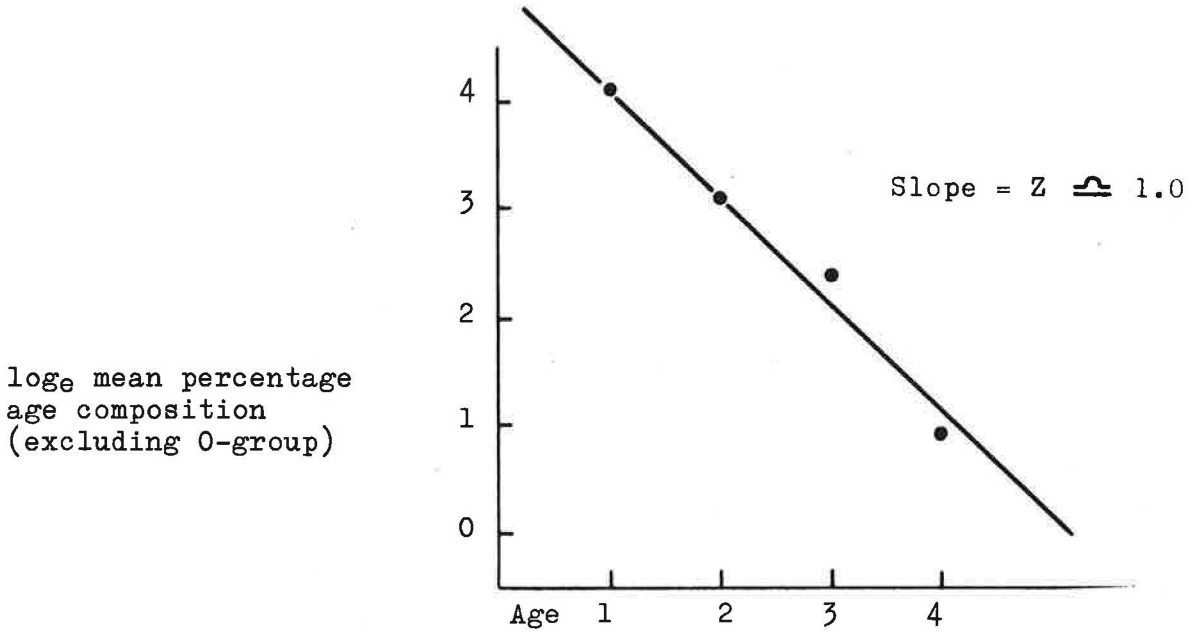


Figure 14. Stock size and fishing mortality in Division VIa herring.



<u>Figure 15.</u> North Sea sprat mortality rate from catch curve for Division IVb west.

Appendix Table 1a *

Herring. Catch in '000 tons 1947-59

North Sea (Sub-area IV & Divisions VIId and e) by country. Skagerrak & Kattegat (Division IIIa) total catch

Country \ Year	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Belgium	36	23	17	10	8	13	16	18	16	6	2	2	3
Denmark	9	7	5	8	34	33	50	58	66	83	88	134	145
England	101	114	71	75	73	66	71	61	39	36	32	22	21
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-
France	77	77	60	61	125	65	76	54	59	45	34	34	35
Germany (F.R.)	110	117	107	117	177	158	297	263	268	217	237	200	147
Iceland	-	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	155	163	131	133	149	158	186	174	148	136	129	127	118
Norway	4	6	3	4	1	2	2	3	5	5	8	8	17
Poland	-	-	-	-	-	-	-	-	39	46	49	56	71
Scotland	81	90	53	37	42	77	82	59	69	43	41	30	48
Sweden	25	26	25	27	31	37	37	39	47	38	49	50	57
U.S.S.R.	-	-	-	-	-	-	-	-	2	28	37	29	40
Total North Sea	598	623	472	472	640	609	817	729	758	683	706	692	702
Total Skagerrak and Kattegat	53	81	79	91	104	139	137	99	113	123	158	216	205
Grand total	651	704	551	563	744	748	954	828	871	806	864	908	907

* The explanatory notes to Tables 1-8 (this volume, p.18) also refer to Appendix Tables 1-8.

Appendix Table 1b

Herring. Catch in tons 1960 - 74

North Sea (Sub area IV & Divisions VIId and e) by country. Skagerrak & Kattegat (Division IIIa) total catch

Country \ Year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974*
Belgium	3 642	3 146	1 117	1 843	1 607	776	391	410	134	468	1 200	681	1 337	2 160	603
Denmark	119 400	138 800	126 000	117 600	141 600	158 700	105 900	135 000	163 100	180 260	133 331	185 393	213 738	174 254	61 728
England	16 354	17 849	11 994	22 821	16 533	11 494	10 716	8 215	5 128	6 666	9 702	4 113	650	2 893	5 755
Faroe Islands	-	-	-	-	973	3 111	1 491	35 993	49 995	40 640	58 365	45 524	48 444	54 935	26 161
France	11 137	23 042	12 271	18 062	23 295	16 480	10 711	11 478	12 852	15 307	11 482	11 408	12 901	22 235	13 157
German D.R.											290	475	127	1 728	3 268
Germany(F.R.)	148 388	100 944	89 056	93 815	86 586	77 032	54 157	32 312	21 216	12 798	7 150	3 570	3 065	10 634	12 306
Iceland	-	-	-	-	-	1 757	1 047	5 684	44 489	19 997	22 951	37 171	31 998	23 742	29 017
Netherlands	125 713	129 841	87 521	126 487	116 226	80 320	56 668	37 270	22 306	29 769	46 218	32 479	24 829	34 070	28 900
Norway	138 93	10 440	7 461	21 448	103 752	520 890	424 462	240 032	211 904	114 938	193 102	125 842	117 501	99 739	40 100
Poland	77 304	78 082	59 331	72 462	89 691	98 130	74 071	37 816	11 954	9 221	5 057	2 031	2 235	5 738	7 401
Scotland	29 006	23 038	22 416	34 571	21 125	20 569	17 557	18 138	16 477	22 053	21 885	25 073	17 227	16 012	14 978
Sweden	89 289	103 744	110 353	140 012	130 132	132 182	121 970	121 591	88 061	33 109	34 670	36 880	7 366	4 222	3 561
U.S.S.R.	63 105	67 722	100 265	75 965	139 637	47 322	16 442	11 660	70 029	61 549	18 078	9 500	16 386	30 735	5 755
Total North Sea	696 231	696 648	627 785	725 086	871 157	1 168 763	895 583	695 599	717 645	546 775	563 481	520 140	497 804	484 637	252 690
Skagerrak	75 820	85 291	104 246	163 228	309 804	256 742	144 655	279 744	280 036	113 279	71 071	61 570	67 021	84 566	54 835
Kattegat	31 000	41 100	51 600	64 200	79 300	81 400	75 300	72 000	108 900	59 300	74 300	90 200			
Grand total	803 051	823 039	783 631	952 514	1 260 261	1 506 905	1 115 538	1 047 343	1 106 581	719 354	708 562	671 435			
Non-member countries	36 000	?	?	?	?	67 700	30 600	27 700	?	?	?	?			

* Preliminary data

Appendix Table 2

Herring. Total catch in '000 tons 1947-74. North Sea and Skagerrak.

Year	Area							Total
	Northwest	Northeast	Central	South	Industrial fishery (IVb)	Total North Sea	Skagerrak	
1947	211.3	0.3	214.4	160.6	-	586.6	40.9*	627.5*
1948	169.4	1.9	168.0	162.5	0.3	502.1	54.9*	557.0*
1949	134.2	2.0	178.8	193.3	0.2	508.5	52.4*	560.9*
1950	125.1	1.6	181.3	178.3	5.4	491.7	51.3*	543.0*
1951	123.0	1.2	266.0	165.6	44.6	600.4	46.7*	647.1*
1952	168.4	6.6	203.1	236.1	50.2	664.4	61.1*	725.5*
1953	178.8	7.5	224.6	209.2	78.4	698.5	47.9*	746.4*
1954	168.0	4.3	218.4	276.9	95.3	762.9	99.1*	862.0*
1955	287.8	67.4	170.3	168.4	112.5	806.4	89.0	895.4
1956	194.5	79.1	163.9	134.0	103.7	675.2	82.0	757.2
1957	209.0	97.3	150.7	122.7	103.2	682.9	90.5	773.4
1958	164.7	98.2	156.1	92.6	158.9	670.5	131.0	801.5
1959	259.6	144.2	147.1	77.2	156.4	784.5	139.0	923.5
1960	101.1	264.0	166.3	64.9	99.9	696.2	75.8	772.0
1961	61.0	274.8	168.9	98.2	93.8	696.7	85.3	782.0
1962	37.6	291.8	143.3	54.7	100.4	627.8	104.2	732.0
1963	73.1	301.3	228.2	45.7	67.7	716.0	163.2	879.2
1964	66.1	444.0	187.9	56.6	116.6	871.2	309.8	1 181.0
1965	298.3	580.8	132.9	21.8	135.0	1 168.8	256.7	1 425.5
1966	278.6	424.0	114.1	11.6	67.2	895.5	144.7	1 040.2
1967	117.3	373.7	107.9	11.4	85.2	695.5	279.7	975.2
1968	286.7	256.8	57.8	9.6	106.9	717.8	280.0	997.8
1969	213.1	148.1	40.0	24.3	121.2	546.7	113.3	660.0
1970	326.9	21.4	117.2	27.1	70.5	563.1	71.1	634.2
1971	288.8	17.3	25.2	23.4	165.2	519.9	61.6	581.5
1972	235.1	22.7	47.8	23.3	168.8	497.7	67.0	564.7
1973	247.7	14.7	57.8	30.8	135.6	486.6	84.6	571.2
1974 1)	79.7	15.4	99.0	7.3	51.8	253.2	54.8	308.0

* Data include some Kattegat catches

1) Preliminary data

Appendix Table 3

Herring. Total catch in tons

Skagerrak (Division IIIa excl. Kattegat)

Year	Denmark	Faroe Islands	Germany (F.R.)	Iceland	Netherlands	Norway	Poland	Sweden	U.S.S.R.	Total
1960	43 200	-	42	-	-	2 578	-	30 000	-	75 820
1961	56 700	-	7	-	-	4 584	-	24 000	-	85 291
1962	70 600	-	3	-	-	5 049	594	28 000	-	104 246
1963	105 100	-	828	-	-	10 971	329	46 000	-	163 228
1964	129 500	-	6 064	-	-	85 916	4 324	84 000	-	309 804
1965	95 300	-	4 248	-	-	83 864	4 330	68 000	-	256 742
1966	75 200	-	432	-	74	30 438	511	38 000	-	144 655
1967	100 400	-	466	2 151	-	95 039	127	66 000	15 561	279 744
1968	143 600	-	2	695	36	71 865	42	45 000	18 796	280 036
1969	57 965	-	-	-	-	13 957	-	41 357	-	113 279
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	34 900	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[1]	35 732	7 132	36[b]	231	-	21	-	11 683	-	54 835

1) Preliminary data

a) See footnote to relevant country in Table 2.2 of 1974 Report (p.44)

b) German Democratic Republic in 1974

Appendix Table 4

Herring. Total catch in tons

North Sea, Northeast (Division IVa east of 2^{o}E)

Year	Belgium	Denmark	England	Faroe Islands	France	German Dem.Rep.	Germany (F.R.)	Iceland	Nether-lands	Norway	Poland	Scotland	Sweden	U.S.S.R.	Total
1960	-	41 800	-	-	-	-	29 455	-	15 442	9 005	15 749	1 598	87 825	63 105	263 979
1961	-	61 500	-	-	-	-	14 043	-	6 318	7 630	11 020	3 877	102 676	67 722	274 786
1962	-	49 600	3	-	-	-	8 913	-	6 990	5 793	5 036	4 899	110 287	100 265	291 786
1963	-	58 900	4	-	-	-	10 069	-	8 448	18 255	3 335	-	135 350	75 965	301 326
1974	-	53 100	-	-	-	-	9 972	-	9 313	91 006	12 949	627	127 425	139 637	444 029
1965	-	49 700	-	-	-	-	23 428	1 757	6 912	323 361	16 200	-	132 182	27 227	580 767
1966	-	51 400	6	-	-	-	12 329	1 047	4 555	205 239	11 690	186	121 141	16 442	424 035
1967	-	51 600	-	-	-	-	2 558	5 684	1 709	176 628	2 986	-	120 838	11 660	373 663
1968	-	57 100	-	-	-	-	2 487	9 355	1 022	66 046	1 880	-	88 061	30 799	356 750
1969	32	55 550	-	12 805	278	-	16	6 300	2 084	15 618	166	9 785	26 035	19 392	148 061
1970	50	1 800	-	5 898	48	-	10	1 220	281	3 501	123	1 929	5 560	1 012	21 262
1971	-	6 219	-	239	-	-	-	-	167	10 720	-	-	-	-	17 067
1972	-	19 711	-	979	-	-	9	1 943	40	50	-	-	-	-	22 732
1973	-	686	-	12 776	-	637	-	-	331	236	-	-	-	-	14 666
1974[1]	-	12 284	-	532	-	55	-	2 460	21	-	-	-	-	-	15 352

1) Preliminary data

Appendix Table 5

Herring. Total catch in tons

North Sea, Northwest (Division IVa west of 2^{o}E)

Year	Belgium	Denmark	England	Faroe Islands	France	German Dem.Rep.	Germany (F.R.)	Iceland	Nether-lands	Norway	Poland	Scotland	Sweden	U.S.S.R.	Total
1960	122	-	163	-	1 151	-	45 746	-	19 863	3 343	7 000	22 292	1 464	-	101 144
1961	120	-	8	-	5 796	-	19 146	-	8 414	2 173	7 271	16 954	1 068	-	60 950
1962	125	-	11	-	3 757	-	7 125	-	4 659	837	3 807	17 191	66	-	37 578
1963	343	-	13	-	5 121	-	11 377	-	9 495	2 641	12 511	26 945	4 662	-	73 108
1964	155	-	8	973	6 405	-	7 319	-	11 420	4 350	15 962	16 753	2 707	-	66 052
1965	227	-	-	3 111	7 303	-	4 489	-	11 515	196 488	35 878	19 239	-	20 095	298 345
1966	178	-	34	1 491	2 628	-	7 069	-	3 414	219 233	27 199	16 548	829	-	278 613
1967	200	-	15	35 993	1 515	-	7 941	-	3 418	41 664	8 454	17 359	753	-	117 312
1968	23	-	-	49 995	1 349	-	7 150	35 134	3 072	131 598	2 806	16 324	-	39 230	286 681
1969	68	11 360	-	27 835	605	-	448	13 697	474	99 316	362	10 051	6 765	42 157	213 318
1970	750	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	74	37 004	888	-	100	29 721	1 967	100 408	1 620	17 227	-	16 386	235 106
1973	-	41 341	-	42 159[b]	209	1 057	2 624	23 742	4 615	70 476	5 547	15 430	4 222	30 735	247 697
1974[1]	-	3 475	-	16 676	415	40	1 292	22 421	2 285[c]	15 604	7 030[d]	10 459	-	-	79 697

1) Preliminary data

a) Total including 750 tons from Belgium

b) See footnote to relevant country in Table 2.4 of 1974 Report (p. 45)

c) estimated from biological statistics

d) total catch from IVa allocated to IVa W

Appendix Table 6

Herring. Total catch in tons

North Sea, Central (Division IVb)

Adult Herring Fisheries

Year	Belgium	Denmark	Faroe Islands	England	Iceland	France	Germany (F.R.)	Nether-lands	Norway	Poland	Scotland	Sweden	Total
1960	115	-	-	9 816	-	369	39 326	61 540	1 545	48 479	5 116	-	166 306
1961	121	-	-	8 579	-	2 535	35 402	70 336	637	49 064	2 207	-	168 881
1962	124	-	-	6 076	-	2 886	40 772	47 255	831	45 030	326	-	143 300
1963	558	-	-	14 465	-	8 296	60 818	81 524	552	54 370	7 626	-	228 209
1964	351	-	-	9 235	-	7 750	36 361	63 314	8 396	58 726	3 745	-	187 878
1965	47	-	-	8 524	-	7 037	22 520	47 551	1 041	44 815	1 330	-	132 865
1966	69	-	-	9 646	-	6 261	21 183	42 008	-	34 085	823	-	114 075
1967	5	-	-	6 809	-	6 540	18 917	26 769	21 740	26 370	779	-	107 929
1968	13	-	-	4 170	-	8 196	10 439	13 285	14 260	7 241	153	-	57 757
1969	-	-	-	5 964	-	3 362	3 528	16 542	4	8 077	2 217	309	40 003
1970	-	-	11 623	8 731	1 144	2 433	6 005	28 815	28 817	2 836	2 189	24 640	117 233
1971	8	2 488	254	4 113	179	4 734	-	10 172	14	743	362	1 926	25 168
1972	-	1 589	10 460	271	334	2 014	21	11 372	17 043[a]	615	-	4 068	47 787
1973	-	-	-	2 175	-	8 259	115	17 370	29 027	191	582	-	57 753
1974[1]	-	2 067	8 953	5 502	4 136	8 457	3 825	31 090	24 496	370	4 519	2 416	99 004

1) Preliminary data a) estimated from biological statistics

Appendix Table 7

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

Year	Young Herring Fisheries				
	Denmark	Germany (F.R.)	Sweden	Total	Total young and adult fisheries (Tables 6 and 7)
1960	77 600	22 322	-	99 922	266 228
1961	77 300	16 549	-	93 849	262 730
1962	76 400	23 975	-	100 375	243 675
1963	58 700	9 017	-	67 717	295 926
1964	88 500	28 126	-	116 626	304 504
1965	109 000	26 009	-	135 009	267 874
1966	54 500	12 737	-	67 237	181 312
1967	83 400	1 849	0	85 249	193 178
1968	106 000	847	0	106 847	164 604
1969	113 350	7 900	0	121 250	161 253
1970	70 108	400	0	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 1)	43 866	6 760	1 145	51 771	150 775

1) Preliminary data

Appendix Table 8

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

Year	Belgium	Denmark	England	France	Germany (F.R.)	Netherlands	Poland	Total
1960	3 405	-	6 375	9 617	11 539	28 868	5 076	64 880
1961	2 905	-	9 262	14 711	15 804	44 773	10 727	98 182
1962	868	-	5 904	5 628	8 271	28 617	5 458	54 746
1963	942	-	8 339	4 645	2 534	27 020	2 246	45 726
1964	1 101	-	7 290	9 140	4 808	32 179	2 054	56 572
1965	502	-	2 970	2 140	586	14 342	1 237	21 777
1966	144	-	1 030	1 822	839	6 691	1 097	11 623
1967	205	-	1 391	3 423	1 047	5 374	6	11 446
9168	98	-	958	3 307	293	4 927	27	9 610
1969	367	-	702	11 062	906	10 669	616	24 322
1970	400	-	971	8 183	558	16 945	29	27 086
1971	673	25	-	6 160	126	16 385	-	23 369
1972	1 337	57	305	9 999	112	11 450	-	23 260
1973	2 160	132	718	13 767	2 257	11 754	-	30 788
1974 1)	603	36	253	4 285	429	1 706a)	1	7 313

1) Preliminary data   a) estimated from biological statistics

Appendix Table 9

North Sea catch in millions of fish by age

Year	Area	Age in winter rings										
		0	1	2	3	4	5	6	7	8	>8	Total
1947	IVaW of 2°E	-	-	233.9	182.7	216.7	175.1	217.8	121.2	112.8	107.3	1 367.5
	IVaE of 2°E	-	-	0.1	0.1	0.1	0.2	0.3	0.2	0.2	0.2	1.4
	IVb	-	-	80.1	94.4	190.9	234.4	431.0	259.3	273.3	244.9	1 808.3
	IVb YH	-	-	-	-	-	-	-	-	-	-	-
	IVc + VIId,e	-	-	179.9	138.3	229.9	116.4	106.7	50.4	240.3	331.7	1 393.6
	Total North Sea	-	-	494.0	415.5	637.6	526.1	755.8	431.1	626.6	684.1	4 570.8
1948	IVaW of 2°E	-	-	93.2	256.4	126.1	202.6	131.2	104.6	72.5	93.6	1 080.2
	IVaE of 2°E	-	-	0.0	1.7	1.1	1.8	1.3	1.3	1.0	1.3	9.5
	IVb	-	-	27.0	229.1	104.4	155.7	182.4	148.7	87.4	186.3	1 121.0
	IVb YH	-	-	-	-	-	-	-	-	-	-	-
	IVc + VIId,e	-	3.4	126.5	184.9	96.3	240.9	172.0	145.8	90.7	383.7	1 444.2
	Total North Sea	-	3.4	246.7	672.1	327.9	601.0	486.9	400.4	251.6	664.9	3 654.9
1949	IVaW of 2°E	-	-	120.5	97.6	98.1	89.2	121.3	123.8	111.9	74.8	837.2
	IVaE of 2°E	-	-	0.1	0.3	1.1	1.2	1.8	2.0	1.9	1.3	9.7
	IVb	-	-	77.8	149.0	165.5	106.1	256.7	112.7	169.0	162.9	1 199.7
	IVb YH	-	-	-	-	-	-	-	-	-	-	-
	IVc + VIId,e	-	-	280.0	397.0	131.3	90.2	272.0	223.1	131.2	384.3	1 909.1
	Total North Sea	-	-	478.4	643.9	396.0	286.7	651.8	461.6	414.0	623.3	3 955.7
1950	IVaW of 2°E	-	-	121.8	301.4	96.8	63.3	60.9	100.1	51.8	49.9	846.0
	IVaE of 2°E	-	-	1.4	2.9	0.7	0.6	0.7	1.3	0.6	0.6	8.8
	IVb	-	-	138.2	370.7	222.0	90.7	82.5	63.9	51.4	166.3	1 185.7
	IVb YH	-	-	-	-	-	-	-	-	-	-	-
	IVc + VIId,e	-	-	273.6	363.5	297.1	135.4	109.5	165.3	91.2	184.9	1 620.5
	Total North Sea	-	-	535.0	1 038.5	616.6	290.0	253.6	330.6	195.0	401.7	3 661.0
1951	IVaW of 2°E	-	-	43.8	131.6	217.7	124.6	78.7	50.0	42.7	79.6	768.7
	IVaE of 2°E	-	-	0.2	0.7	1.4	1.0	0.6	0.4	0.3	0.7	5.3
	IVb	-	-	73.3	362.9	685.7	280.6	79.5	49.2	108.2	132.3	1 771.7
	IVb YH	-	452.8	240.6	49.5	-	-	-	-	-	-	742.9
	IVc + VIId,e	-	8.8	302.4	413.8	350.2	223.8	103.3	42.5	54.4	26.8	1 526.0
	Total North Sea	-	461.6	660.3	958.5	1 255.0	630.0	262.1	142.1	205.6	239.4	4 814.6
1952	IVaW of 2°E	-	-	189.3	125.1	118.0	157.5	90.4	78.2	55.5	149.3	963.3
	IVaE of 2°E	-	-	0.6	1.7	1.5	4.4	3.2	3.6	2.7	7.8	25.5
	IVb	-	-	212.8	188.2	191.5	248.3	178.7	61.2	58.5	122.9	1 262.1
	IVb YH	-	699.3	189.7	12.5	-	-	-	-	-	-	901.5
	IVc + VIId,e	-	22.5	753.3	248.8	299.1	241.7	191.8	93.2	48.8	108.3	2 007.5
	Total North Sea	-	721.8	1 345.7	576.3	610.1	651.9	464.1	236.2	165.5	388.3	5 159.9
1953	IVaW of 2°E	-	-	262.3	255.6	109.4	95.1	100.8	44.7	50.3	88.5	1 006.7
	IVaE of 2°E	-	-	5.3	7.1	3.6	3.3	3.7	1.6	2.2	4.0	30.8
	IVb	-	9.4	307.2	311.3	160.5	109.0	183.6	97.1	30.0	127.2	1 335.3
	IVb YH	150.0	1 008.7	236.2	38.3	-	-	-	-	-	-	1 433.2
	IVc + VIId,e	-	5.1	511.4	391.0	200.2	178.6	184.6	134.5	35.3	54.9	1 695.6
	Total North Sea	150.0	1 023.2	1 322.4	1 003.3	473.7	386.0	472.7	277.9	117.8	274.6	5 501.6

continued

Appendix Table 9 (ctd.)

Year	Area	Age in winter rings										
		0	1	2	3	4	5	6	7	8	>8	Total
1954	IVaW of 2°E	-	26.5	415.5	238.2	111.6	52.8	62.2	52.7	33.6	37.6	1 030.7
	IVaE of 2°E	-	0.9	4.7	5.3	2.6	1.3	1.7	1.5	1.0	1.0	20.0
	IVb	-	20.2	185.9	344.7	223.2	119.5	91.9	130.2	51.8	172.9	1 340.3
	IVb YH	218.5	1 387.8	180.9	23.9	-	-	-	-	-	-	1 811.1
	IVc + VIId,e	-	15.3	706.3	499.1	253.7	187.5	173.7	194.1	108.0	105.4	2 243.1
	Total North Sea	218.5	1 450.7	1 493.3	1 111.2	591.1	361.1	329.5	378.5	194.4	316.9	6 445.2
1955	IVaW of 2°E	-	4.2	697.6	385.8	144.9	149.0	138.6	28.1	42.4	41.1	1 631.7
	IVaE of 2°E	0.1	20.2	125.3	82.4	54.6	20.1	16.0	23.2	12.6	14.2	368.7
	IVb	-	87.1	610.8	216.5	108.8	84.7	39.9	30.2	16.9	10.9	1 205.8
	IVb YH	164.2	1 960.6	162.2	25.5	-	-	-	-	-	-	2 312.5
	IVc	-	-	335.3	321.5	170.8	82.8	37.1	38.2	37.1	39.3	1 062.1
	Total North Sea	164.3	2 072.1	1 931.2	1 031.7	479.1	336.6	231.6	119.7	109.0	105.5	6 580.8
1956	IVaW of 2°E	-	0.6	248.7	543.5	214.2	89.9	62.8	42.3	30.6	41.0	1 273.6
	IVaE of 2°E	-	-	15.6	148.9	98.7	45.2	55.1	11.9	8.6	27.6	411.6
	IVb	-	22.5	607.9	341.7	92.7	33.1	39.7	29.1	49.0	106.0	1 321.7
	IVb YH	95.9	1 667.7	432.5	33.4	-	-	-	-	-	-	2 229.5
	IVc	-	6.0	555.3	153.7	110.1	80.3	36.7	20.8	15.9	12.9	991.7
	Total North Sea	95.9	1 696.8	1 860.0	1 221.2	515.7	248.5	194.3	104.1	104.1	187.5	6 228.1
1957	IVaW of 2°E	-	-	216.5	287.5	261.4	195.7	84.4	43.8	39.0	69.6	1 197.9
	IVaE of 2°E	-	-	19.6	37.4	124.8	51.0	70.8	63.8	37.5	24.8	429.7
	IVb	-	14.1	421.9	143.3	219.0	70.7	37.3	30.3	20.2	53.5	921.3
	IVb YH	278.7	1 461.1	400.6	37.0	-	-	-	-	-	-	2 177.4
	IVc + VIId,e	-	7.4	585.3	231.0	38.7	26.7	14.7	9.2	2.8	5.5	1 010.3
	Total North Sea	278.7	1 482.6	1 643.9	736.2	643.9	344.1	207.2	147.1	99.5	153.4	5 736.6
1958	IVaW of 2°E	-	29.9	41.8	326.8	139.7	233.3	81.4	41.9	27.1	19.3	941.2
	IVaE of 2°E	-	-	43.5	247.8	64.3	85.5	28.5	17.1	9.3	22.9	518.9
	IVb	-	218.5	413.0	207.6	59.0	125.6	25.1	7.6	7.6	28.4	1 092.4
	IVb YH	97.1	4 028.7	265.0	26.5	-	-	-	-	-	-	4 417.3
	IVc + VIId,e	-	1.7	266.1	190.6	58.9	16.7	11.7	6.7	1.7	1.7	555.8
	Total North Sea	97.1	4 278.8	1 029.4	999.3	321.9	461.1	146.7	73.3	45.7	72.3	7 525.6
1959	IVaW of 2°E	-	13.5	1 488.9	128.1	173.6	74.8	99.8	46.5	23.0	26.0	2 074.2
	IVaE of 2°E	-	-	182.5	78.7	210.0	115.9	111.2	60.5	52.1	163.1	974.0
	IVb	-	85.1	929.5	140.1	60.2	24.9	34.0	9.2	5.2	24.9	1 313.1
	IVb YH	-	1 500.2	1 847.9	61.4	-	-	-	-	-	-	3 409.5
	IVc + VIId,e	-	10.6	485.1	79.2	53.5	17.8	4.0	3.3	2.0	4.6	660.1
	Total North Sea	-	1 609.4	4 933.9	487.5	497.3	233.4	249.0	119.5	82.3	218.6	8 430.9
1960	IVaW of 2°E	-	-	174.3	339.3	17.6	35.4	22.5	18.0	8.5	6.8	622.4
	IVaE of 2°E	-	78.8	179.9	854.1	84.9	91.5	77.4	76.7	110.1	131.1	1 684.5
	IVb	-	25.1	238.8	604.1	47.1	35.2	12.1	31.1	10.0	4.1	1 007.6
	IVb YH	194.6	2 275.3	260.2	27.8	-	-	-	-	-	-	2 757.9
	IVc + VIId,e	-	13.5	289.1	141.4	16.3	5.6	0.9	-	-	-	466.8
	Total North Sea	194.6	2 392.7	1 142.3	1 966.7	165.9	167.7	112.9	125.8	128.6	142.0	6 539.2

continued

Appendix Table 9 (ctd.)

Year	Area	Age in winter rings										
		0	1	2	3	4	5	6	7	8	>8	Total
1961	IVaW of 2°E	-	2.0	21.8	66.0	188.0	12.4	18.8	5.9	11.5	5.7	332.1
	IVaE of 2°E	1.2	68.6	96.3	227.6	942.2	97.8	139.1	55.5	44.5	81.8	1 754.6
	IVb	-	29.4	560.0	96.1	287.4	8.8	-	-	-	-	981.7
	IVb YH	1 268.0	235.3	625.6	10.8	-	-	-	-	-	-	2 139.7
	IVc + VIId,e	-	0.7	585.7	79.4	38.3	5.0	-	-	-	-	709.1
	Total North Sea	1 269.2	336.0	1 889.4	479.9	1 435.9	124.0	157.9	61.4	56.0	87.5	5 917.2
1962	IVaW of 2°E	-	0.6	22.3	14.9	29.5	114.2	6.8	15.6	7.2	10.1	221.2
	IVaE of 2°E	-	127.9	136.8	171.8	208.3	802.8	105.7	124.2	74.9	74.6	1 827.0
	IVb	-	48.9	66.6	358.4	68.8	151.9	13.7	5.0	4.2	2.1	719.6
	IVb YH	141.8	1 958.2	2.8	15.1	-	-	-	-	-	-	2 117.9
	IVc + VIId,e	-	11.3	41.1	237.2	28.5	12.9	0.7	0.3	-	-	332.0
	Total North Sea	141.8	2 146.9	269.6	797.4	335.1	1 081.8	126.9	145.1	86.3	86.8	5 217.7
1963	IVaW of 2°E	-	0.6	135.7	3.0	4.5	3.7	17.1	0.9	4.2	2.2	171.9
	IVaE of 2°E	-	69.6	1 414.6	101.1	75.9	74.4	212.3	21.5	37.8	48.8	2 055.4
	IVb	-	36.3	1 080.5	62.5	55.0	-	-	-	-	-	1 234.3
	IVb YH	442.8	1 154.1	55.4	-	-	-	-	-	-	-	1 652.3
	IVc + VIId,e	-	2.2	275.0	10.6	22.9	2.5	0.3	-	-	-	313.5
	Total North Sea	442.8	1 262.2	2 961.2	177.2	158.3	80.6	229.7	22.4	42.0	51.0	5 427.4
1964	IVaW of 2°E	-	0.8	107.7	182.2	6.7	6.9	7.2	40.1	2.5	6.6	360.7
	IVaE of 2°E	4.6	28.6	830.3	1 581.5	128.4	109.0	79.6	190.0	23.8	51.1	3 026.9
	IVb	-	42.6	395.0	395.0	12.6	27.2	8.2	26.2	-	-	906.8
	IVb YH	492.3	2 878.4	192.2	5.9	-	-	-	-	-	-	3 568.8
	IVc + VIId,e	-	21.3	22.3	78.5	0.7	5.9	-	-	-	-	128.7
	Total North Sea	496.9	2 971.7	1 547.5	2 243.1	148.4	149.0	95.0	256.3	26.3	57.7	7 991.9
1965	IVaW of 2°E	-	52.9	613.2	367.2	571.7	21.9	23.2	28.6	108.2	24.9	1 811.8
	IVaE of 2°E	2.6	456.4	542.9	771.9	1 336.8	112.5	118.4	84.9	277.5	34.1	3 738.0
	IVb	-	55.3	432.2	84.9	98.3	8.6	7.9	3.6	27.3	18.1	736.2
	IVb YH	154.5	2 644.3	603.8	40.1	-	-	-	-	-	-	3 442.7
	IVc + VIId,e	-	0.4	25.5	60.5	32.6	2.1	2.4	0.5	-	0.03	125.3
	Total North Sea	157.1	3 209.3	2 217.6	1 324.6	2 039.4	145.1	151.9	117.6	413.0	78.4	9 854.0
1966	IVaW of 2°E	-	12.2	693.5	249.2	156.8	328.5	8.7	9.1	32.2	93.2	1 583.4
	IVa E of 2°E	2.7	357.1	1 102.9	383.7	276.2	534.7	36.6	54.4	60.6	141.8	2 950.7
	IVb	-	1.3	539.4	91.6	15.9	23.5	-	1.3	2.7	1.3	677.0
	IVb YH	371.8	1 008.9	179.1	6.8	-	-	-	-	-	-	1 566.6
	IVc + VIId,e	-	3.6	54.8	9.9	1.2	3.1	-	-	-	-	72.6
	Total North Sea	374.5	1 383.1	2 569.7	741.2	450.1	889.8	45.3	64.8	95.5	236.3	6 850.3
1967	IVaW of 2°E	-	12.2	119.1	315.6	67.7	51.5	71.4	4.7	4.1	33.8	680.1
	IVaE of 2°E	0.7	402.6	444.6	741.0	245.8	237.3	307.5	63.2	77.5	139.0	2 659.2
	IVb	-	24.3	209.4	257.4	53.1	6.8	14.1	-	-	-	565.1
	IVb YH	644.7	1 231.6	356.0	35.3	-	-	-	-	-	-	2 267.6
	IVc + VIId,e	-	3.6	42.4	15.4	4.9	2.2	0.1	-	-	-	68.6
	Total North Sea	645.4	1 674.3	1 171.5	1 364.7	371.5	297.8	393.1	67.9	81.6	172.8	6 240.6

continued

Appendix Table 9 (ctd.)

Year	Area	Age in winter rings										
		0	1	2	3	4	5	6	7	8	>8	Total
1968	IVaW of 2°E	-	83.1	577.7	231.5	372.1	83.5	86.8	89.9	10.6	63.5	1 598.6
	IVaE of 2°E	-	579.7	781.7	1 201.0	179.7	59.5	51.6	67.6	3.1	28.3	2 952.2
	IVb	-	9.0	166.8	40.6	59.9	12.6	3.6	5.4	-	-	297.9
	IVb YH	839.3	1 747.2	246.1	1.3	-	-	-	-	-	-	2 833.9
	IVc + VIId,e	-	6.0	22.9	19.9	9.7	1.5	3.0	0.6	-	-	63.6
	Total North Sea	839.3	2 425.0	1 795.2	1 494.3	621.4	157.1	145.0	163.4	13.7	91.8	7 746.2
1969	IVaW of 2°E	-	101.1	736.2	109.4	52.4	103.9	17.2	14.7	10.3	4.5	1 149.7
	IVaE of 2°E	-	128.2	559.3	136.0	61.9	66.9	29.3	27.4	16.9	20.4	1 046.3
	IVb	-	44.8	154.6	29.1	13.5	18.1	3.0	0.2	0.2	-	263.5
	IVb YH	112.0	2 223.7	271.1	13.0	-	-	-	-	-	-	2 619.8
	IVc + VIId,e	-	5.5	161.8	8.8	5.3	1.9	0.4	0.4	-	0.02	184.3
	Total North Sea	112.0	2 503.3	1 883.0	296.3	133.1	190.8	49.9	42.7	27.4	25.1	5 263.6
1970	IVaW of 2°E	-	13.0	930.9	695.3	98.7	39.4	49.3	5.7	10.0	4.0	1 846.3
	IVaE of 2°E	-	32.6	68.7	23.5	9.6	5.4	4.1	1.2	1.2	8.1	154.4
	IVb	-	27.7	203.5	63.4	9.3	3.3	6.6	0.9	0.4	-	315.1
	IVb YH	898.1	1 118.7	718.1	17.6	2.2	0.6	-	-	-	-	2 755.3
	IVc + VIId,e	-	4.2	81.6	83.8	5.4	1.6	1.0	0.1	0.4	0.1	178.2
	Total North Sea	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	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
	IVb YH	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 North Sea	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
	IVb YH	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 North Sea	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
	IVb YH	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	9.4	1.9	0.5	0.1	-	225.5
	Total North Sea	280.4	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
	IVb YH	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 North Sea	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 Division IVb.

Appendix Table 10

Total North Sea: Calculated stock in number x 10^{-9}

Winter rings \ Year	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
0	7.26	4.72	4.10	5.68	6.90	7.69	9.10	8.07	7.70	4.76	21.37	5.64	7.82
1	5.22	6.57	4.27	3.71	5.14	6.24	6.96	8.09	7.10	6.81	4.22	19.07	5.01
2	3.80	4.73	5.99	3.86	3.34	4.22	3.98	5.32	5.93	4.46	4.56	2.41	13.19
3	2.85	3.05	3.96	4.97	3.04	2.53	2.76	3.03	3.37	3.53	2.27	2.57	1.21
4	3.56	2.10	2.07	2.87	3.50	1.99	1.74	1.64	1.66	2.07	2.04	1.36	1.38
5	2.13	2.57	1.55	1.41	2.03	2.06	1.29	1.21	0.96	1.04	1.39	1.24	0.93
6	2.67	1.43	1.78	1.12	1.00	1.30	1.22	0.90	0.85	0.55	0.71	0.93	0.68
7	1.35	1.69	0.86	1.11	0.81	0.68	0.78	0.74	0.59	0.55	0.31	0.44	0.70
8	1.76	0.81	1.22	0.52	0.77	0.60	0.43	0.52	0.44	0.42	0.40	0.15	0.33
Juvenile, 0+1	12.48	11.29	8.37	9.39	12.04	13.93	16.06	16.16	14.80	11.57	25.59	24.71	12.83
Adult, 2 - 8	18.12	16.38	17.43	15.86	14.49	13.38	13.20	13.36	13.80	12.62	11.68	9.10	18.42

Winter rings \ Year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1968	1970	1971	1972
0	1.98	16.72	7.33	8.73	10.95	5.71	5.29	7.58	7.62	3.82	9.03	7.00	4.96
1	7.07	1.63	13.92	6.50	7.48	9.40	5.02	4.43	6.24	6.10	3.35	7.31	5.69
2	3.01	4.13	1.14	10.56	4.68	4.00	5.46	3.23	2.42	3.35	3.15	1.90	2.49
3	7.27	1.64	1.95	0.77	6.75	2.60	1.58	2.51	1.81	0.50	1.26	0.96	0.64
4	0.63	4.71	1.03	1.01	0.53	3.97	1.10	0.68	0.99	0.24	0.18	0.30	0.25
5	0.77	0.41	2.88	0.61	0.77	0.32	1.67	0.57	0.27	0.31	0.09	0.04	0.08
6	0.62	0.54	0.26	1.58	0.48	0.41	0.16	0.67	0.23	0.09	0.10	0.04	0.01
7	0.38	0.45	0.34	0.11	1.22	0.34	0.23	0.10	0.23	0.07	0.04	0.03	0.00
8	0.52	0.23	0.35	0.17	0.08	0.88	0.20	0.14	0.02	0.06	0.03	0.03	0.00
Juvenile, 0+1	9.05	18.35	21.25	15.23	18.43	15.11	10.31	12.01	13.86	9.92	12.38	14.31	10.65
Adult, 2 - 8	13.20	12.11	7.95	14.81	14.51	12.52	10.35	7.90	5.97	4.62	4.85	3.30	3.47

Appendix Table 11

Total North Sea: Calculated fishing mortality

Winter rings \ Year	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
0							0.02	0.03	0.02	0.02	0.01	0.02	
1					0.09	0.13	0.17	0.21	0.37	0.30	0.46	0.27	0.41
2	0.12	0.08	0.08	0.14	0.18	0.32	0.40	0.36	0.42	0.57	0.47	0.59	0.50
3	0.20	0.29	0.22	0.25	0.32	0.27	0.42	0.50	0.39	0.45	0.41	0.52	0.55
4	0.22	0.20	0.28	0.25	0.43	0.33	0.26	0.44	0.36	0.30	0.40	0.29	0.48
5	0.29	0.27	0.23	0.24	0.35	0.43	0.27	0.25	0.46	0.29	0.30	0.49	0.31
6	0.36	0.41	0.37	0.22	0.28	0.41	0.39	0.31	0.33	0.46	0.37	0.18	0.48
7	0.41	0.22	0.40	0.26	0.20	0.35	0.29	0.42	0.24	0.22	0.67	0.19	0.20
8	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.40	0.30
$F_{w \geq 2}$	0.24	0.21	0.20	0.22	0.31	0.34	0.36	0.39	0.39	0.44	0.42	0.45	0.48

Winter rings \ Year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
0	0.11	0.08	0.02	0.06	0.05	0.03	0.08	0.09	0.12	0.03	0.11	0.11	0.17
1	0.43	0.25	0.18	0.23	0.54	0.44	0.34	0.50	0.52	0.56	0.47	0.98	0.95
2	0.51	0.65	0.29	0.35	0.49	0.86	0.68	0.48	1.47	0.88	1.09	0.99	0.93
3	0.33	0.37	0.56	0.28	0.43	0.76	0.71	0.84	1.92	0.95	1.32	1.26	0.83
4	0.32	0.39	0.42	0.18	0.35	0.77	0.56	0.84	1.07	0.86	1.33	1.25	0.80
5	0.26	0.38	0.49	0.15	0.23	0.63	0.82	0.80	0.96	1.05	0.85	1.09	0.57
6	0.21	0.37	0.73	0.16	0.23	0.49	0.37	0.90	1.06	0.83	1.07	2.23	0.52
7	0.42	0.15	0.59	0.23	0.25	0.44	0.36	1.30	1.31	0.96	0.26	2.48	0.06
8	0.30	0.30	0.30	0.30	0.40	0.67	0.69	0.90	0.90	0.70	0.70	0.70	0.70
$F_{w \geq 2}$	0.36	0.47	0.48	0.30	0.41	0.77	0.68	0.70	1.49	0.90	1.14	1.12	0.89