International Council for the
Exploration of the Sea

C.M.1979/H:6
Pelagic Fish Committee

ERRATA SHEET

Due to new information on the results of the North Sea sprat acoustic survey (Scotia 1979) referred to in Section 7, the following corrections are needed:

Page 29, Section 7.5, 2nd paragraph: delete last sentence.

Page 29, Section 7.6: delete 2nd paragraph.

Page 70, Table 7.5: the correct figures in the 2nd column under "Scotia" are 222 and 572, instead of 86 and 174.

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

Charlottenlund, 30 April - 5 May 1979

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CONTENTS

Page

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Page

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Page

- o - o -

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

Charlottenlund, 30 April - 5 May 1979

1. PARTICIPANTS AND TERMS OF REFERENCE

1.1. Participants

R.S. Bailey	United Kingdom
E. Bakken	Norway
A.B. Bowers	United Kingdom
A.C. Burd	United Kingdom
A. Corten	Netherlands
H. Dornheim	Federal Republic of Germany
R. Grainger	Ireland
O. Hagström	Sweden
J. Jakobsson (Chairman)	Iceland
A. Maucorps	France
J. Molloy	Ireland
J. Morrison	United Kingdom
N.A. Nielsen	Denmark
K. Popp Madsen	Denmark
R. Rosenberg	Sweden
Ø. Ulltang	Norway
R.J. Wood	United Kingdom
O.J. Østvedt	Norway

V. Nikolaev attended part of the meeting as the ICES Statistician.

1.2. Terms of Reference

The Herring Assessment Working Group for the Area South of 62°N met at Charlottenlund from 30 April to 5 May 1979 in accordance with C.Res.1978/2:45 to re-assess the state and appropriate levels of TACs in 1979 and 1980 for:

a) North Sea herring;
b) Celtic Sea herring;
c) Division VIa and Division VIIb,c herring;
d) Northern Irish Sea herring (Division VIIa);
e) North Sea sprat; and
f) Division IIIa herring.

2. NORTH SEA AND SKAGERRAK HERRING

2.1. The Fishery in 1978

2.1.1. Catch data

Catch data for the years 1969 to 1977 are given in Table 2.1 with a preliminary estimation for the year 1978.

Previous Working Group reports have advised a ban on directed fishing for herring in the North Sea and a reduction of by-catches in other fisheries. These measures were enforced in 1978 without exception throughout the year so the catches reported in the official statistics must all be considered as by-catches.

The total North Sea catch, excluding Skagerrak, amounted to 9 138 tonnes (see Table 2.1) as compared with 46 010 tonnes which is the revised catch figure for 1977. The main difference between the preliminary and the revised 1977 figures, which is about 4 700 tonnes, comes from three countries.

The preliminary Skagerrak figure amounted to 21 227 tonnes as compared with the revised 1977 figure of 37 618 tonnes (Table 2.2).

Tables 2.3 to 2.7 give the North Sea catch data by Sub-divisions as in the previous reports. The total recorded by-catch is given in Table 2.8 for all fisheries, which represents the overall herring catch in 1978. Of the total catch of 9 138 tonnes, about 6 000 tonnes were taken in the industrial fisheries.

In all Sub-divisions, the by-catch figures have decreased from 1977 to 1978 except in Divisions IVc and VIId and e, where it is likely that part of the reported catches were in fact the consequence of directed fishery for herring.

The Group expressed doubt as to the reliability of the figures supplied and also its great concern regarding the control of catches, landings and reporting of them.

2.1.2. Catch in numbers by age

Numbers of herring at each age in catches by fishing areas are given in Tables 2.9 and 2.10 and those for the total North Sea are summarised in the text-table below for the past five years (with the revised figures for 1977):

Millions of herring caught per age group (winter-rings)

Year	Age						Total
	0	1	2	3	4	5 and older	
1974	996	846	773	362	126	87	3 190
1975	264	2 461	542	260	141	87	3 755
1976	238	127	901	117	52	46	1 481
1977	257	144	45	186	11	13	656
1978	109	136	4	5	5	1	260

As in 1977 and despite the prohibition of directed fisheries on herring for industrial purposes, the catch of 0-group herring represents over 40% of the total catch in numbers of North Sea herring and the juvenile herring (0+1 groups) about 95%. These were all taken as by-catch in the industrial fisheries.

2.2. Age Composition

Due to the ban on herring fishery in the North Sea, only few samples from research vessels were available to show the age composition of the stocks in Divisions IVa and IVb. Although the material is rather limited, the data (see text-table below) indicate the predominance of of 1-ringed fish.

Percentage Age Distribution

Age in winter rings	Division IVa W (August)		Division IVb			
			(August)		(November)	(October)
	Germany Fed.Rep.of	Scotland	Scotland	Germany Fed.Rep.of	Germany Fed.Rep.of	England
0	-	-	39.1	-	-	-
1	61.5	-	33.0	86.3	92.3	25.5
2	21.8	42.6	10.8	5.8	1.1	12.9
3	16.7	21.8	12.7	6.2	1.1	36.6
4	-	30.9	3.7	1.5	2.2	19.3
5	-	1.6	0.2	-	-	3.5
6	-	1.9	0.5	-	2.2	1.0
7	-	1.0	0.1	+	1.1	1.1
≥8	-	0.3	-	-	-	0
N	78	224	310	497	90	350

In the Eastern Channel, the sampling of some illegal commercial catches indicate the prevailing of the 3-ringed fish (46.4%) followed by the 2-ringed fish (33.1%) and the 4-ringed fish (14.4%).

2.3. Recruitment

2.3.1. Year class 1976

The final figure for this year class during the 1978 Young Herring Survey is 575 fish/hour for the herring standard area. During the previous meeting of the Working Group, a preliminary figure of 498 fish/hour was used.

The regression formula used is that given in the previous report:

$$Y = 0.0031x - 0.21$$

where Y is the absolute size of the year class ($x\ 10^9$) derived from VPA and x is the mean catch per hour of 1-ringers in the herring standard area.

Substituting the new YHS value for year class 1976 into the regression formula, an estimate of 1.57×10^9 1-ringers is obtained. This would correspond to a year class size of 2.00×10^9 as 0-ringers.

2.3.2. Year class 1977

The Young Herring Survey in February 1979 has yielded a preliminary estimate of 144 fish/hour for the herring standard area. This is by far the lowest abundance of any year class in recent times, as is shown by the text-table below. Substituting the value of 144 fish/hour in the regression formula, the absolute size of the year class as 1-ringers is estimated at only 0.24 x 10^9. It should be realised that at this extremely low range of YHS abundances, the intercept of the regression line has a relatively strong effect on the estimate of year class strength in absolute numbers. If the regression line had been drawn through the origin, the year class would be estimated at 0.45 x 10^9. The Working Group decided that this procedure was more appropriate when the IYHS indices are at extremely low levels.

Year class	Mean catch/hour of 1-ringers in herring standard area	Best estimate of year class as 1-ringers from VPA (in billions)
1968	822	3.35
1969	2 647	7.35
1970	1 629	5.79
1971	827	3.82
1972	1 195	1.75
1973	1 592	4.39
1974	452	0.73
1975	342	-
1976	575	-
1977	(144)	-

Although the strength of the 1977 year class appears to be extremely low, there are some indications that the YHS in February 1979 may have underestimated the abundance of this year class to some extent.

The distribution of 1-ringed herring in February 1979 was rather different in comparison to normal years. Very few juveniles were caught in the southeastern North Sea and near the entrance to the Skagerrak, which are normally the areas with the highest concentrations of 1-ringers. On the other hand, several catches of more than 1 000 fish/hour were taken northwest of the Dogger Bank, where in other years only insignificant numbers of 1-ringers were caught. It seems likely therefore that the 1-ringed herring were distributed more to the northwestern part of the central North Sea than in other years. This area is sampled less intensively for juvenile herring than the southeastern part, and most of its squares are not included in the standard area of 57 squares on which the YHS abundance indices are based.

The text-table at the tope of page 5 shows the catches of 0-group herring in the three most recent years, and the estimates of F on 0-group that are obtained by using the YHS values for the same year class as a reference point.

Year	Catch 0-group x 10^{-9}	$F_{0\text{-group}}$	Stock size 1-ringers estimated from YHS x 10^{9}
1976	238	0.24	-
1977	257	0.14	850
1978	109	0.21	1 570
1979	-	-	450

2.4. Estimates of Spawning Stock Biomass from Herring Larval Surveys

The Report of the Working Group on Herring Larval Surveys South of 62°N was available to the Herring Assessment Working Group. Also available were precise estimates of the abundance of herring larvae <10 mm in length for all the surveys which were carried out during 1978 both in the North Sea and adjacent waters. These are given in Table 2.12, together with the results of the comparable surveys which were carried out in 1977.

2.4.1. Northern North Sea

The coverage in this area in 1978 was well below the required level. In the Orkney/Shetland area, surveys were only made during the first half of September, and even then some of the stations to the west of Shetland, which yielded substantial numbers of herring larvae in the previous year, were not worked. An additional complication resulted from the fact that one station worked by the Netherlands to the north of Orkney on 8 September 1978 produced a total of 13 593 herring larvae <10 mm in length beneath 1 square meter of surface. The way in which this station is treated has a major influence on the abundance estimates derived for the northern North Sea in 1978. The Larval Working Group made two estimates of abundance for 1978, one based on the same treatment for this station as all the others and the second based on a reduction to 1/10th of the surface area applicable to the station. A correction was also necessary, due to the fact that no surveys were carried out during the second half of September in the Orkney/Shetland area, in order to arrive at a mean value for the whole of September, which is essential if spawning stock biomass is to be estimated. The ratio of the abundance values during the first and second halves of September from 1974-77 was calculated and applied to the two estimates for the first half of September 1978. All abundance estimates are substantially higher in the northern North Sea than in 1977, and it would appear very probable that herring larval production in 1978 in this area was about double that in 1977.

2.4.2. Central North Sea

There was again a complete coverage of this area in late autumn of 1978 with extensive surveys being made during four separate periods in September and October. The results are directly comparable with those of the previous year, and it is clear that production also doubled in the central North Sea in 1978.

2.4.3. Southern North Sea and Eastern Channel

Only two surveys were made during the winter of 1978/79, but the first was notable for the fact that appreciable production occurred in the Sandettié/Hinder area before the end of 1978 for the first time in five years. The results of the second survey in early January 1979 were much the same as in the previous year, particularly in total larval abundance. It would appear that some recovery of the Downs stock is taking place, but a better coverage with surveys during January is required before any firm conclusions can be arrived at.

2.4.4. Spawning stock size

At the previous meeting of the Herring Assessment Working Group, new functional regressions were calculated of estimated abundances of larvae <10 mm in length on spawning stock biomass for the northern North Sea and the central North Sea separately.

However, the Larval Working Group considered that a modification to the regression for the central North Sea might be justified (Saville, 1979). The VPA for this area from which the spawning stock size has been estimated in the past was based on catches which included the 2-ringed fish taken in the industrial fishery. It was argued that a considerable proportion of these herring might recruit to the spawning stocks in other areas. Saville's adjusted functional regression has the following equation:

$$Y = 7.370x + 24.786$$

where Y = the estimated spawning stock from the regression ($x\ 10^{-3}$ tonnes), and x = the mean survey abundance of herring larvae ($x\ 10^{-11}$).

The size of the spawning stock in the central North Sea in 1977 and 1978 based on this regression is reduced by approximately 6 000 tonnes in both years.

The paper by A. Saville, which was presented to the Larval Working Group, also considered the effect on stock sizes both in the North Sea and in Division VIa resulting from the fact that some juvenile herring originating from Division VIa grow up in the North Sea as immatures. Saville's paper contained estimates of spawning stock size both in Divisions IVa and VIa, estimated by incorporating various emigration rates into the VPA analyses, but there were such major differences between his spawning stock estimates and those previously accepted by the Herring Assessment Working Group, that the members of the Larval Working Group considered a careful examination of the whole paper by the Herring Assessment Working Group was essential before any decision could be reached regarding the validity of his new regressions of larval abundance on spawning stock in Divisions IVa and VIa.

The Herring Assessment Working Group noted that the calculations made by Saville resulted in a larger spawning stock in recent years in Division IVb than in Division IVa. This was not matched, however, by higher larval production in Division IVb despite a similar fecundity in both areas. In fact the opposite was the case with substantially higher larval production in Division IVa. The Herring Assessment Working Group, while acknowledging that emigration from the North Sea to

Division VIa undoubtedly takes place, rejected Saville's contention that his new regression for Division IVa gave more realistic prediction of spawning stock size for larval abundances, than that previously calculated by the Group.

The regressions used to estimate North Sea spawning stock size in 1978 are, therefore, the previous Assessment Working Group regression for Division IVa and Saville's new regression for Division IVb.

The size of the spawning stock in both areas in 1977 and 1978 given below was calculated from the regressions.

	1977 (tonnes)	1978 (tonnes)
Northern North Sea (IVa)	90 000	148 000
Central North Sea (IVb)	41 000	58 000
Combined	131 000	206 000

The increase in spawning stock biomass between 1977 and 1978 is therefore 75 000 tonnes. The increase between 1976 and 1977 based on the same regressions was 36 000 tonnes. It should be noted that the spawning stock biomass in 1978 has been based on the lower of the two estimated larval abundance values for the month of September in Division IVa. Both the Larval and Herring Assessment Working Groups considered this to be the more realistic of the two values which are given in Table 2.12 for this area.

If some allowance is made for the Downs stock spawning in the southern North Sea and eastern Channel a total spawning stock size for the North Sea is not likely to be greater than 230 000 tonnes in 1978, which is somewhat lower than the Herring Assessment Working Group's prognosis made in 1978.

2.5 State of Stock and Advice on TAC

In the previous report (Doc. C.M.1978/H:3) the spawning stock in 1977 as well as prognoses of the stock for 1978 and 1979 were calculated on the basis of catch data and the input fishing mortalities in 1976. In these prognoses, values for the recruiting year classes were those of the IYHS.

At its 1979 meeting, the Working Group agreed not to continue these prognoses due to the risk of errors involved if this was continued for a longer period without direct estimates to check these calculations. At present, the only independent estimate of the spawning stock sizes in the central and northern North Sea are those derived from the herring larval surveys. The results of these surveys are given in Section 2.4. These estimates for the 1978 spawning stock size in the central and northern North Sea are somewhat lower than the prognoses given in the 1978 report. It must be stressed that the larval survey coverage in 1978 in the northern North Sea was far from satisfactory. It was noted with concern that the low level of recruitment, as measured by the IYHS, continued in 1979. Thus, out of the last five most recent year classes (1973-77) the 1973 year class was about 85% of an average year class strength as O-group, while the four most recent year classes have been about or even below 20% of the average O-group abundance.

From an examination of the stock/recruitment relationships published in the 1976 Herring Working Group report and by Saville and Bailey (in press), the Working Group could find no reason to deviate from its previous conclusion that the lower limit of the optimal range of the spawning stock size should be 800 000 tonnes. It would, therefore, reiterate its advice given in previous reports of rebuilding the stock as quickly as possible to at least 800 000 tonnes. A limited fishery should not be allowed before there is evidence of a recovery of the spawning stock size and improved recruitment and that therefore the rebuilding would take place within a fairly short period under such a fishery.

The contribution of the 2 year olds to the spawning stock derived from an average year class would result in the desired level of stock being quickly reached, assuming the 1979 spawning stock size of 230 000 tonnes.

However, the estimated recruitment to the spawning stock in 1980 (1977 year class) will not result in the rapid rebuilding. It is therefore recommended that no fishery should be allowed in 1980.

Three members of the Working Group, Messrs. A Corten, A Maucorps and K Popp Madsen, objected to the above advice of the Working Group, since they were of the opinion that because of the high probability of an improved recruitment after the 1977 year class a very limited quota (of about 20 000 tonnes) for consumption fisheries could be allowed in 1980, provided that management authorities could guarantee a strict enforcement of such a small quota.

The Working Group reiterates its plea for the most stringent measures to be taken to minimise the by-catch of the North Sea herring.

The Working Group stresses the fact that at present the monitoring of the recovery of the North Sea herring is far from satisfactory. Little information on the age compositions of the stock has been obtained for the last two years. This, as well as new direct estimates of the spawning stock sizes are urgently needed.

Following a proposal from the 1978 Statutory Meeting, an ICES coordinated acoustic survey has been planned for 1979 to provide a direct estimate of stock size in the western part of Divisions IVa and IVb. However, support for this survey is totally inadequate to guarantee a stock estimate upon which any reliance can be based.

It was noted that the tagging programme proposed by the Working Group last year could not start in 1979, but that plans were being made for launching the programme in 1980, on a continuing annual basis. The purpose would be to monitor spawning stock sizes in Sub-area IV and Division VIa. The Working Group stresses the need to support this programme.

2.6 Herring in Division IIIa

The fisheries data for this area are presented in the report of the Working Group on Division IIIa Stocks (Doc. C.M.1979/G:9).

2.6.1 Stock composition

The Working Group on Division IIIa Stocks considered data on K_2, VS and average length as possible means by which different components of the juvenile herring could be distinguished.

The two major indigenous spring spawning stocks, i.e., those of Skagerrak and Kattegat, respectively, differ markedly in mean VS. As, however, mean VS of North Sea autumn spawners are intermediate it would be difficult to separate a mixture of indigenous stocks from North Sea autumn spawners on this criterion alone.

Mean K_2 values in Division IIIa show a considerable overlap with those of immature herring caught during the IYHS in the North Sea. In both areas, the K_2 values are, however, well below those of the North Sea spawning stocks. The reason for this is not clear but it throws some doubt on how far one may draw conclusions based on this character.

The mean length of 1-ring herring in the southern Kattegat is in the lower range of mean values derived from the IYHS in the North Sea approaches to the Skagerrak, while mean lengths in the northern Kattegat and Skagerrak are within this range. This may indicate a difference in stock composition between the northern and southern parts of Division IIIa, but could also be the result of separation by depth.

The Working Group concluded that on the evidence at hand it could not rule out the possibility that juvenile herring caught in Division IIIa contain recruits to the North Sea autumn spawning stock.

2.6.2 Future census of the stock composition in Division IIIa

The Working Group recommends that otolith samples should be collected from both spawning and juvenile herring and a workshop set up at an early data and convened by Dr R Rosenberg in Lysekil (Sweden) in order to determine the range of otolith types present in the indigenous stocks, to compare these with otoliths of the North Sea autumn spawners and to report to the 67th Statutory Meeting.

Although the meristic characters available to the Working Group did not provide conclusive evidence as regards the racial composition of herring in Division IIIa, the Working Group considered it useful to initiate or continue the taking of VS and K_2 counts. These characteristics could be particularly useful on substantiating any split in races made on the basis of otolith type or length distribution.

Genetic studies, already commenced in Sweden, may provide a possible further method of differentiating the various herring stocks.

In order to shed further light on the migration through Division IIIa it is recommended that tagging experiments be considered.

2.6.3 Herring fishery regulations in Division IIIa

In 1978 the following restrictions were introduced:

1) Ban on direct landings of herring for industrial purposes was extended to include the Kattegat.
2) A 15% by-catch limit was introduced in the Kattegat for sprat landings and 5% in any other fisheries.
3) TACs of 14 500 and 50 000 tonnes of herring in the Skagerrak and the Kattegat, respectively.
4) Minimum mesh size of 32 mm for directed herring fisheries in the Kattegat.
5) Ban on herring fishing during week-ends in the Kattegat.

In addition, a minimum landing size of 20 cm, and a by-catch percentage of 10% in sprat landings have already been introduced for the Skagerrak.

In 1979, further restrictions were introduced by agreement between Norway, Sweden and EEC:

1) Ban on directed herring fisheries in the Skagerrak in the period from 1 January to 31 March and from 1 October to 31 December 1979.

2) Minimum landing size of 18 mm for the Kattegat.

3) By-catch of herring in sprat landings from the Kattegat reduced to 10%.

4) Ban on the use of trawls with mesh size less than 32 mm within 3 nautical miles from the coast line during the period from 1 July to 15 September in the whole of Division IIIa.

5) Minimum mesh size of 32 mm for the Skagerrak.

6) The use of mesh sizes less than 16 mm only allowed for sand-eel fishing and only from 1 March to 31 July in the Kattegat and from 1 March to 31 October in the Skagerrak.

7) TACs of 10 000 and 35 000 tonnes for Skagerrak and Kattegat, respectively.

8) In directed herring fisheries not more than 10% of undersized herring may be present.

In addition, Denmark has closed its herring fishery in the Skagerrak until 15 June 1979.

2.6.4 Management advice

The Herring Assessment Working Group endorsed the following statement given in the report of the Working Group on Division IIIa Stocks:

"The management of Division IIIa herring present some special problems because of the mixed stock composition and migration in and out of the area. As described in para. 3.1 not all the juvenile herring in the area can be considered as local recruits; some will recruit to herring stocks outside Division IIIa. Management should be directed both at protecting and, if necessary, rebuilding the local spawning stocks, and at protecting the non-native juvenile herring which occur temporarily in the area.

As regards the local spawning stocks, there is not much information available concerning their present size and recent development. Judging from the age composition of the catches, it seems that the spawning stocks are quite small at present. In a previous assessment report on these stocks, the combined total of all spawning stocks in Division IIIa was estimated at approximately 20 000 tonnes (Anon., 1978a).

It seems very unlikely that a spawning stock of this size has been able to produce the high numbers of juvenile herring which have been present in Division IIIa in recent years, particularly when one considers the relationship between spawning stock size and recruitment in other areas such as the North Sea, Division VIa, and the Celtic Sea (Anon., 1978b).

It is not possible to indicate what the minimum size of spawning stocks in this area should be. The age composition of the catches shows that the adult fish in the area are sustaining a high mortality (hardly any fish older than 6 years are encountered) and the local spawning stocks may indeed be below their minimum level for normal recruitment. It seems advisable therefore to reduce the high mortality on the local spawning stocks, and to monitor more precisely the development in each of the major sub-populations. This might be achieved by measuring the catch per unit effort in some selected inshore fisheries based on spawning herring. Also the age composition of the various spawning stocks should be adequately sampled.

The juvenile herring in Division IIIa should be protected as much as possible, no matter whether they will recruit to the local spawning populations or to stocks outside the area. It is appreciated that the consumption fishery in Division IIIa cannot avoid taking some quantities of 1-group herring because of the mixed occurrence of juvenile and adult herring in the area (in contrast to the North Sea for instance), but these by-catches of juvenile herring should be reduced as much as possible. For this reason the Working Group strongly supports the newly introduced minimum landing size of 18 cm in the Kattegat, which should result in an almost total cessation of exploitation of the 0-group and also the 1-group in the first few months of the year. The present mesh size of 32 mm should be increased to correspond more closely to the minimum landing size. In view of the need to avoid the problem of meshing, however, it would be unrealistic to use the formula suggested by ACFM. The appropriate mesh size appears to be that at present in use by part of the fleet in Kattegat, i.e., 36-37 mm".

In addition, the Herring Assessment Working Group makes the following comments:

Based on advice from a Danish-Swedish Study Group a TAC of 45 000 tonnes for Division IIIa was agreed upon by Sweden, Norway and EEC for 1979. For the Skagerrak the TAC should be 10 000 tonnes and for the Kattegat 35 000 tonnes. It seems unlikely that such a TAC will reduce fishing mortality to an acceptable level even if strictly enforced. Lack of data makes it impossible to carry out a realistic prognosis. There is no adequate method of estimating F during 1978, nor is it possible to calculate the exploitation pattern on the basis of historical catch at age data. Exceptionally low catches of 1-ringers during the IYHS in the Skagerrak-Kattegat area in 1979 indicate that the number of 2-ringers may be low in 1980 (Table 2.13). Since regulatory measures have already been taken to reduce the exploitation of 0- and 1-ringers, and since 2-ringers traditionally have dominated in the catches of older herring, it is thus possible that the TAC in 1980 would have to be reduced far below the 1979 level if the fishing mortalities on older fish are to be reduced to an acceptable level.

The Working Group recommends that a survey be carried out in September 1979 in order to monitor further the strength of the 1-group herring. The TAC for 1980 would then have to be considered by the ACFM at the time of the 67th Statutory Meeting.

3. CELTIC SEA HERRING

3.1 The Fishery in the 1978/79 Season

3.1.1 Introduction

The prohibition of herring fishing in the Celtic Sea, which was first recommended by the 1976 Working Group, was introduced in 1977/78. This prohibition was continued during 1978/79, and in 1978 the ACFM recommended that it should be further continued during 1979/80. The

ACFM also recommended that the landing of by-catches of herring from this area should be prohibited.

3.1.2 Catch data

In spite of these recommendations, however, a considerable quantity of herring was removed from the Celtic Sea during the 1978/79 season. This was mainly the result of a directed Irish trawl and drift net fishery and from catches of herring reported as by-catch in the Dutch and the Federal Republic of Germany mackerel fisheries. The total amount involved was nearly 4 000 tonnes. This was 25% more than catches made in similar fisheries during the 1977/78 season. The catch data for the Celtic Sea fishery for the years and seasons since 1967/68 are given in Table 3.1 and Table 3.2. The 1978/79 figures are provisional and some very slight alterations have been made in the 1977/78 figures quoted in the previous report.

3.1.3 Catch in numbers by age

The age composition of the total catch in 1978/79 has been calculated from Irish and Dutch data, using the same procedure as in previous reports. Some slight alterations have been made to the 1977/78 figures because of the revised catch statistics for that year. The age composition of the catches since 1966/67 are given in Table 3.3.

3.2 Estimates of Fishing Mortality

In recent years the only direct mortality estimates for Celtic Sea herring were those derived from Irish catches per unit effort. However, because of the closure of the fishery in 1977/78 and 1978/79, it has not been possible to obtain estimates of F from this source. The Irish catches per unit effort are now severely limited by a quota system and consequently give no valid indication of stock abundance. However, the effort in the Irish trawl and drift net fishery increased substantially in 1978/79, and probably was at least twice the 1977/78 level.

It was therefore decided to make use of the catches in number at age for 1978/79 to estimate the fishing mortality to which the stock has been subjected since the last accurate assessment was made in 1977. Fishing mortalities of 0.2, 0.5 and 0.8 were therefore assumed for 1978/79 and VPA analyses carried out for these values. A comparison of these fishing mortalities with the resulting 1977/78 values indicated that F = 0.8 was the most realistic estimate of F in 1978/79, because this value reflects the increased effort in the Irish fishery during the year. The calculated stock size and weighted values of F are shown in Tables 3.4 and 3.5.

3.3 State of the Stock and Advice on TAC

3.3.1 Herring surveys

During 1977/78, an Irish survey during the spawning season was carried out. The purpose of this survey had been to obtain samples for biological investigations and also to obtain an impression of the amount of herring appearing on the spawning grounds. The amount of illegal fishing that took place during 1978/79 meant that it was not possible to obtain by a similar survey any impression of stock abundance because of the constant disturbance of the shoals. It also meant that catches were available on which to carry out biological analyses. Therefore, no Irish trawling survey was conducted during the season.

3.3.2 Larval survey and fecundity studies

Following a recommendation from the 1978 Herring Assessment Working Group, a herring larval survey was carried out in the Celtic Sea throughout the spawning period of 1978/79. The survey was divided into seven cruises which were started in September and concluded in April. This period covered the complete spawning period, which is very prolonged in the Celtic Sea. Celtic Sea herring have traditionally been considered as winter spawners, but the possible presence of an autumn-spawning component in the area was discussed briefly by the 1975 Working Group. In recent years, this component has appeared to be more abundant than the winter-spawning component in the Irish catches, the majority of which are now taken in the September-November period.

Larval cruises in the Celtic Sea were first carried out by the United Kingdom during 1959 and 1960. These cruises were confined to the January to March period which coincided with peak spawning in those years. The results were briefly discussed by the 1969 Working Group. Recalculated values of the total number of larvae found were 65 (x 10^9) in 1959 and 13 (x 10^9) in 1960 (Ozcan, 1974). The estimated number found during the first six cruises during 1978/89 are shown below.

Cruise	Mid-date	Abundance of larvae			Days from 31 Aug.
		<10 mm(10^9)	10-15 mm(10^9)	>15 mm(10^9)	
18 - 23/9	21/9	.36	0		21
15 - 21/10	18/10	15.83	17.58		48
27 - 29/11	28/11	5.30	13.19	1.62 (poor coverage)	89
15 - 18/12	17/12	0	0.73	1.72	108
23 - 26/1	24/1	0	0	.84 (1 larva)	146
12 - 23/2	5/2	7.91	0	0	168

The distribution of the larvae plotted on time with fitted normal distribution curves are shown in Figure 3.1. These curves show very clearly that there are now two distinct spawning phases during the September to March period and that the autumn-spawning component constitutes the most important part of the Celtic Sea stock.

3.3.3 Spawning potential

Estimates of fecundity of both autumn- and winter-spawning components were obtained during the 1978/79 season. The regressions of fecundity against length for both components are as follows:

Autumn spawners: fecundity = $5.117\ l^3 - 56.59$

Winter spawners: fecundity = $3.485\ l^3 - 35.90$

There is a very significant difference between the mean fecundity indices (fecundity/length^3) for autumn and winter spawners.

These estimates of fecundity were used to calculate the spawning potential of the Celtic Sea stock in the following way. The average mean length/age was calculated and subsequently the fecundity per age calculated from the fecundity/length regressions. This was calculated for both autumn- and winter-spawning components and the results averaged to give a value for the total season. The average fecundity per age was multiplied by half the corresponding stock numbers (taken from VPA analysis used in the 1976 assessment). As expected the spawning potential was at a very high level during the late 1960s but subsequently fell dramatically as the stock size decreased. The decline is very similar to the decrease in spawning stock in weight shown in the 1976 Working Group report (Doc. C.M.1976/H:2, Figure 2). A comparison between the spawning stock biomass and the resulting recruitment of 2 year old fish was made (Figure 2) and it was evident that the reduced spawning potential in recent years has produced a number of very poor year classes.

3.3.4 Recruitment

There is still no method available for estimating the recruitment level in the Celtic Sea stock. Although the numbers of recruiting 3 year old fish (i.e., the 1975/76 year class) were considerably higher in the 1978/79 catches than in any of the previous six years, there is no positive evidence to indicate an increased level of recruitment in either this or the 1976/77 year class. It is also obvious from the VPA that the recruitment of the 1974/75 year class was overestimated by the 1977 Assessment Working Group. There is therefore clearly an urgent need to initiate some programme in the Celtic Sea which will provide adequate information about incoming year class strength. This might be achieved by organising a combined beach seine and sprat weir survey along the south coast of Ireland to estimate the 0-group herring abundance or by re-examining the possibility of conducting trawl surveys for 1-group herring in the Celtic and Irish Seas. The Working Group therefore recommends that investigations into these aspects should be commenced as soon as possible.

3.3.5 Stock assessment

Because there is no direct estimate from fishing mortality in 1977/78 or 1978/79 and no indication of increased recruitment levels in recent years, it is impossible to make any accurate estimate of stock size for the Celtic Sea. The adult stock size estimated at 1 April 1978 by the previous Assessment Group was 10 000 tonnes. However, if one accepts that the fishing mortality in 1978/79 was approximately 0.8 on the fully recruited age groups, then the adult stock size at 1 April 1978 was in fact only about 6 000 tonnes. The 1976 Working Group has previously decided that the minimum stock size necessary to provide adequate recruitment would be at 40 000 tonnes. This was considered to be 1/3 of the adult stock biomass, which was present in a relatively unexploited phase.

It must therefore be considered that the catches during 1977/78 and 1978/79, together with the poor recruitment in both of those years, have prevented the stock from recovering. The adult stock therefore must be considered to be well below the level of 40 000 tonnes, which is the declared management objective, and the stock is still in a very critical state.

The Working Group reviewed the above management objective, and in the light of Figure 2 it is recommended that the stock should be rebuilt to at least 40 000 tonnes.

3.3.6 Management advice

This Working Group can, therefore, only reiterate the advice already given by the 1978 Assessment Group and by the ACFM:

1) a complete prohibition of herring fishing in the Celtic Sea during the 1980/81 season;

2) a complete prohibition on the landing of all by-catches of herring taken during tbe mackerel and sprat fisheries.

4. WEST OF SCOTLAND HERRING (Division VIa)

4.1 The Fishery in 1978

4.1.1 Catch data

The total catches reported by each country in Division VIa (excluding the Firth of Clyde) for the period 1969-76, together with revised catches for 1977 and preliminary estimates of catches taken in 1978 are given in Table 4.1. As in previous reports, estimates are also included of the weight of herring taken as by-catch in the fishery for sprats in the Moray Firth.

The final figure for catch in 1977 is very little higher than the preliminary estimate reported in the previous report.

The preliminary catch in 1978 (32 371 tonnes) is considerably less than that taken in 1977, reflecting the closure of the fishery within British fishery limits from 6 July which was imposed on the advice of ICES. To show the effect of the closure more fully, monthly landings in 1977 and 1978 are compared in Table 4.2. Landings after July were mainly in the area to the northwest of Ireland. In 1978 a higher percentage of the annual total was taken in the first half of the year (59% compared with 32% in 1977) and the catch in this period increased between the two years.

Owing to the strict imposition of quota restrictions on individual Scottish vessels fishing in Division VIa in 1978, there was some evidence of discarding of herring either immediately after catches were made or as a result of enforcement measures of the landing ports. It is impossible to get an estimate of the total quantity discarded or dumped, but records kept at some ports indicate that it was not less than 250 tonnes. These would have been predominantly young fish of the 1975 and 1976 year classes.

4.1.2 Catch in numbers at age

Estimates of the numbers of autumn-spawning herring per age group caught in Division VIa (including the Moray Firth) in each of the years 1969-78 are given in Table 4.3. The figures for 1977 were amended using revised catches.

While the catch in number of most age groups decreased in 1978 4-ringers (1973 year class) still contributed a high percentage of the adult fish. In addition the catch of 0-ringers (1977 year class) was much higher than in the previous two years this being mainly due to increased by-catches of this age group in the Moray Firth sprat fishery.

4.2 Estimates of Fishing Mortality and Stock Size

In previous years the state of and trends in the herring stock in Division VIa have been assessed by carrying out a cohort analysis on the numbers at age caught in the Division VIa fishery and the juveniles caught primarily as a by-catch of the sprat fisheries in the Moray Firth. The latter were included because of the clear evidence that these fish later recruit to adult fisheries west of Scotland rather than to any of the populations spawning in the North Sea. There is additional evidence, from the Bløden Tagging Experiment, that Division VIa also draws its recruits from a much wider area of the North Sea, and in particular from the major nursery area in the eastern part (Bløden). In the absence of any method of quantifying the movement of recruits from the central North Sea to Division VIa, however, the Working Group had no basis on which to include in the Division VIa cohort analysis fish from the Division VIa "stock" which were caught in the North Sea prior to their intended migration to Division VIa.

From a theoretical demonstration by Ulltang (1977) of the dangers of carrying out a VPA on two separate stocks between which there is a one-way migration, it is now clear that major biases can result in the estimates of fishing mortality, stock size and recruitment, particularly in the area receiving the immigration, from a VPA in which no migration factor is incorporated.

The Working Group was presented with a new assessment of recent trends in the Division VIa population based on a VPA of both the North Sea and Div. VIa populations in which emigration factors had been incorporated. This had been made possible by the discovery of a "biological tag" (the parasite Renicola) that has been used to estimate the proportion of herring at each age in Division VIa that had recruited from Scottish coastal areas and the Bløden nursery area in the North Sea (McKenzie and Johnston, 1976). The results of this analysis are described in full in a paper presented to the ICES Pelagic Fish Symposium in 1978 (Saville and Bailey, in press). The infestation rates by Renicola in Division VIa are given for the 1969-74 year classes in Table 4.4 and the values of fishing mortality and emigration factors in Tables 4.5 and 4.6 for Division VIa and the North Sea, respectively. Input Fs for the VPA were derived by iteration to comply with the assumption made by the Working Group in 1978 that fishing effort in Division VIa dropped by 30% between 1976 and 1977.

As would be expected from the theoretical treatment (Ulltang, 1977) estimated fishing mortalities in the North Sea are slightly lower than those derived from conventional VPA. Those in Division VIa, however, are considerably higher. The resulting stock in number estimated for Division VIa and the North Sea are given in Tables 4.7 and 4.8, respectively. In the North Sea, the new population estimates are slightly higher than those estimated by conventional VPA, whereas in Division VIa they are very much lower.

Although the potential dangers of carrying out a conventional VPA on Division VIa catches were recognised, the Working Group was reluctant to accept the emigration model without further research on the validity of the emigration data used and without confirmation of some of the implications of the model. In the first place, the hypothesis implies that there are considerable numbers of Division VIa recruits up to five years of age in the North Sea which do not spawn there. It was agreed that all countries with relevant data on maturities of fish in the northern North Sea should re-examine them in the light of this hypothesis. Furthermore, the assumption made by Saville (1979), resulting from the emigration hypothesis, implies that these potential VIa recruits must be deducted from the northern North Sea population, gave rise to a spawning stock size in Division IVa very much lower than that in Division IVb. From larval production data (Section 2.4) the reverse appeared to be the case. The Working Group was unable to find an explanation for this inconsistency. Nevertheless, it is possible that the potential VIa recruits could spawn in the North Sea prior to their intended migration. The possibility of a net migration of herring from the North Sea to Division VIa cannot be ruled out.

However, the Working Group felt that the sampling of juvenile herring for parasite infestation in all parts of its distribution area was insufficient to conclude that the decrease in infestation rate with age in Division VIa was due entirely to immigration from the North Sea (one sample in the south Minch may have consisted of fish originating in an area to the south of Division VIa). The sampling in Division VIa, furthermore, seemed at present inadequate to quantify the likely emigration rates with the required accuracy. As a result, the Working Group recognised the importance of further tagging experiments both to confirm and to quantify the direction and rate of migration.

As a result of the discussion, the Working Group decided to carry out their assessment of the Division VIa stock using the techniques it had used at previous meetings, but in addition to carry out a prognosis based on the emigration model to determine what effect it would have on the conclusions.

In view of the partial closure of the fishery in the second half of 1978, it seemed likely that the fishing effort dropped from 1977 to 1978. By how much, however, was difficult to estimate, and several runs of the VPA were made until the decrease in fishing mortality between 1976 and 1977 approximated to 30%,the level assumed in the 1978 report. The results of the VPA are given in Tables 4.9 and 4.10. These indicated a value of F on 3-ringers and older in 1978 of 0.6 and the comparable values for 1976 and 1977 were 1.04 and 0.70, repectively, i.e. a little lower than those estimated in 1978. For the analysis, the exploitation pattern was assumed to be the same as in the input values used in the 1978 report.

The estimated decrease in F between 1977 and 1978 is 14%. The spawning stock at 1 January 1978 is estimated to have been 71 000 tonnes compared with 68 000 tonnes calculated at the 1978 Working Group meeting.

The results of larval surveys conducted in Division VIa were available for comparison with VPA estimates of spawning stock size. The survey coverage was not good in 1978, but it appeared that production was at approximately the same level as, or slightly lower than, in 1977. Estimates of the total abundance of larvae less than 10 mm (number x 10^{-9}) in each survey and an overall mean are given in the following:

1977		1978	
8-16 Sep. (N of 56°30'N)	404	1-11 Sep. (whole area)	364
18-26 Sep. (whole area)	1 188	23 Sep.-10 Oct. (whole area)	820
15-24 Oct. (whole area)	335		
Mean	642		592

4.3 State of the Stock and Management Advice

To calculate the most probable future course of events in the Division VIa stock, prognoses have been made both disregarding emigration factors and incorporating them.

4.3.1 Disregarding immigration to Division VIa

Using the estimated stock number and fishing mortality in 1978 from Tables 4.9 and 4.10, the stock in number at 1 January 1979 has been calculated (Table 4.11). This indicates a spawning stock size of more than 78 000 tonnes, or slightly higher than in 1978. On the assumption of zero fishing mortality on 2-ringers and older in 1979 and an F on the 1-ringers of the same level as in 1978, the spawning stock in 1980 will be considerably higher. The exact level will depend upon the assumed recruitment level of the 1977 year class.

The estimated number of 0-group in 1978 in Table 4.10 is probably unrealistic and is in any case dependent on the assumed value of F in the Moray Firth sprat fishery. As a conservative approach a value equal to the lowest estimated by VPA has been used (240×10^6 as 1-ringers). On this assumption the spawning stock at 1 January 1980 is calculated at 107 000 tonnes.

Prognosis beyond 1980 is impossible without some indication of likely recruitment. For this reason a stock/recruitment scatter diagram is given in Figure 4.1. Considering the majority of the points, there is a rather clear relationship. However, exceptionally large year classes (1963 and 1969) have been produced at both low and high levels of stock. The basis for prediction is, therefore, extremely unreliable, but the likelihood is that a stock of 71 000 tonnes in 1978 will produce only poor recruitment.

For a period during the late 1950s and early 1960s a spawning stock of 190 - 280 000 tonnes produced relatively steady recruitment. It therefore seems desirable to allow the stock to increase to a level of 200 000 tonnes as quickly as possible and then to utilise strong year classes to rebuild it further.

The Working Group recommends that no catch should be taken from the stock in 1979, but the decision on whether or not to re-open the Division VIa fishery in 1980 should depend on estimates of the strength of the 1977 year class, possibly by the use of acoustic surveys on the nursery grounds.

4.3.2 Taking immigration into account

Since emigration factors are not available for 1978, an assumption is required about their value. Assuming that they were at the average level estimated for the previous four years, prognoses have been made from the stock in numbers at 1 January 1977 and the fishing mortalities and emigration rates in 1977 given by Saville and Bailey (in press). The stages in the calculation are shown in Table 4.12.

To predict forward to 1 January 1979, the number of 2-ringers at 1 January 1978 is assumed to have been 100×10^6 in Division VIa and 540×10^6 in the North Sea, i.e., the lowest recent values given by Saville and Bailey (loc.cit.).

The calculations given in Table 4.12 are not based on all the age groups in the spawning population. They indicate, however, that the adult stock decreased from 1977 to 1978 but increased fairly sharply in 1979.

For comparison, the stock biomass ($t \times 10^{-3}$) of 2-5 ringers at 1 January are given below ignoring immigration.

	Ignoring immigration	Considering immigration
1 Jan 1977	72.1	46.4
1 Jan 1978	61.5	40.6
1 Jan 1979	70.8	62.3

The quantity in 1979 considering immigration, however, is not the entire spawning stock, because this will also include immigrants still in the North Sea at 1 January. It is, therefore, difficult to make a direct comparison.

4.4 Clyde Herring

4.4.1 The fishery in 1978

Catch data - Catch data for the years 1968-77 are given in Table 4.13 with a preliminary estimate for year 1978. The preliminary catch figure of almost 3 900 tonnes for 1978 decreased by nearly 20% from that of the previous year almost entirely because of the reduction of a nationally set quota for this area.

Catch in numbers - Doubts about the reliability of allocating Clyde herring to race by otolith characteristics were expressed at the Herring Assessment Working Group for the Area South of 62°N, which met in September 1978 to discuss Clyde herring. In response to this, an attempt was made to re-allocate herring into their autumn and spring spawning component using instead maturity stage within age groups on a monthly basis as the criterion of classification. To decide on the requirements for classification into autumn and spring spawning components using this method, representative monthly samples for the period 1973-78 were tabulated by month, maturity stages and VS. High vertebral counts (56.7 - 57.0) associated with maturity stages IV-VII in spring and with maturity stages III-V in the period September-December were allocated to spring spawners, whereas low vertebral counts (56.3 - 56.6) associated with maturity stage VIII in the period April to August and October to December and with stages II-IV in the period April to September were allocated to autumn spawners. However, samples at maturity stage VIII with intermediate vertebral counts in the period April-June were difficult to identify on this basis.

Estimates of autumn and spring spawning herring per age group caught in the Clyde in 1977 and 1978 based on this classification are shown in Tables 4.14 and 4.15, respectively. These figures indicate that spring spawned herring made up to 26% and 11% of the catches by number in 1977 and 1978, respectively. Among the spring spawners, the 1974 year class contributed strongly in both years.

4.4.2 Tagging

The number of recaptures by month and area of tagged herring (external tags) in the Firth of Clyde is shown in Table 4.16. No further taggings were carried out in this area in 1978.

4.4.3 Management advice

At its meeting in September 1978, the Working Group concluded that in the absence of any firm evidence about the origin of autumn spawning herring in the Clyde, the area should be managed as a separate unit. None of the new data available alter this conclusion. Furthermore, the biological data provide no adequate basis on which to make an assessment of the state of the population in this area.

In the autumn spawning component, 1-ringed fish constituted a much higher proportion of the catches in 1978 but it is not clear whether this is due to a change in exploitation pattern or to good recruitment. It therefore seems advisable to continue the advice given in 1978, that the herring fishery in this area should be managed in conformity with those of adjacent areas.

The Working Group recommends that for 1980 a TAC should be set at the same level as for 1979, i.e. 2 000 tonnes for the Firth of Clyde, which for this purpose is defined as that area within a line drawn from Mull of Kintyre to Corsewall Point.

5. WEST OF IRELAND HERRING

5.1 Herring in Division VIIb,c

5.1.1 Nominal catch and catch in numbers at age

Herring catches in Division VIIb,c for the period 1967-77 are given in Table 5.1, together with preliminary catches in 1978. Catches in 1978 were considerably less than in 1977 owing primarily to the decrease in catch by the Netherlands. Catches in numbers at age from 1970-78 are given in Table 5.2.

5.1.2 Relationship between herring stocks in Division VIIb,c and Division VIa

The relationship between herring taken in Division VIa and in Division VIIb,c has already been discussed by previous Working Groups. In the penultimate report of the Herring Assessment Working Group for the Area South of 62°N (Doc. C.M.1978/H:3) there was a recommendation that steps be taken to clarify stock identification and mixing in these two Divisions. In an attempt to examine this problem Spearman rank-correlation coefficients were calculated using paired sets of age composition data of autumn spawners from the Hebrides, South Minch, Northwest of Ireland and West of Ireland. These data were taken from Annales Biologiques, ICES Statistical News Letters and from Working Party data over compatible time periods. The net result of this analysis indicated that a varying degree of association existed between all combinations of areas, but there was no demonstrable relationship between the age structure in the areas off the Hebrides and West of Ireland (Galway). It could be suggested that the South Minch and Northwest of Ireland were areas in which a complex stock mixing takes place, but it was not possible to quantify this further on the present data. The strong associations between age structure in Donegal and Galway further suggested that the boundary betweeen Division VIa and Division VIIb,c was not a realistic biological boundary and this supported previous conclusions based on meristic, fecundity and age composition comparisons (Grainger, 1976; Molloy, 1975).

5.1.3 Management advice

On the basis of the analysis summarised above, it does not at present seem possible to re-define a boundary between Division VIa and Division VIIb,c.

Because of the dangers of overexploitation in Division VIIb,c, the Working Group reiterates its advice given in 1978 and recommends that a precautionary TAC of 7 000 tonnes should be set for 1979 and for 1980 for this area.

5.2 Herring in Division VIIj (southwest Ireland)

Accurate catch statistics of herring from Division VIIj, which is situated west of the Celtic Sea, are not available. This is because all countries report their catches as having been taken in Division VIIg-k. At the present time, however, it would appear that the catches are almost completely taken by Irish vessels. The average landings per year in the 1960-70 period did not exceed 5 000 tonnes. However, in the more recent years the effort in the area has increased considerably because of the closure of the Celtic Sea, and as a result the total Irish catch has increased and in 1978 it exceeded 7 500 tonnes.

Scientific data about these herring are limited and not sufficient to estimate stock size. However, catch per effort data would indicate that the fishery is based on rather small stocks which react quickly to increased effort. The majority of herring in the area are autumn spawners and there is a number of well defined spawning beds along the Irish coast. The age distributions in 1977 and 1978 indicate that the 1974 year class was substantial in the area (as it was in the adjacent Division VIIb,c) and was responsible for over 40% of the catch in both years.

EEC regulations, intended to limit the catch in the area to about 5 000 tonnes, were introduced in 1978. Until more scientific data become available it would seem desirable to stabilise the fishery in the area at about the level of the recent catches, i.e., about 5 - 7 000 tonnes. This would prevent diversifications of effort to the area and the inaccurate reporting of catch statistics.

The Working Group therefore recommends that a precautionary TAC of 6 000 tonnes be set for 1980 for Division VIIj.

6. IRISH SEA HERRING (Division VIIa)

6.1 Introduction

6.1.1 Herring fishing in the North Irish Sea is supported almost exclusively by two autumn spawning stocks called the Mourne and the Manx stock. The location of their spawning grounds and the general biology of these stocks are described in Doc. C.M.1978/H:3, Appendix. Examination of mature fish caught on the Mourne spawning ground and the Manx spawning ground has demonstrated characteristic differences between the stocks:

a) Mourne spawners are approximately 1 cm longer at each age than Manx spawners;

b) There is a substantial recruitment to the Mourne spawning stock of herring aged 1 ring; virtually no Manx herring spawn until they are age 2 rings;

c) In recent years there have been few herring older than age 2 rings on the Mourne spawning ground; Manx spawners include a substantial proportion of herring older than 2 rings;

d) Mourne spawners have a higher mean vertebral count than Manx spawners (Table 6.1). As would be expected, mean vertebral counts vary a little within stocks from one year class to another, but it is clear that there is a substantial difference between the two stocks for all year classes and age groups.

6.1.2 The Working Group first considered the herring stocks in the North Irish Sea in 1976. It was then concluded that the Mourne and the Manx herrings were separate stocks and that separate assessments should be made. It was, therefore, necessary to allocate catches of herring taken in the North Irish Sea to parent stocks. From 1976 onwards catches taken on the Mourne spawning grounds have been assumed to be Mourne stock and those taken in the Manx grounds to be Manx stock. Catches taken outside the spawning grounds have been identified to stock on the basis of vertebral counts of samples. Many catches have easily been ascribed to one stock or the other; when sample data indicated that catches of adult herring were of mixed origin, half the catch was allocated to each stock. This practice has been followed in the assessment for 1978.

6.1.3 The juvenile herring of the Irish industrial fishery show close affinities to the Mourne stock but no discernible affinities to the Manx. Their vertebral counts, given in Table 6.1 by year class and by age, are very similar to those recorded for Mourne spawning herring and year class strengths have been consistent with the premise that the industrial fishery was predominantly exploiting Mourne stock. In 1976 and 1977 the Working Group decided to assume that only 75% of the cohort 0-group recruitment to the industrial fishery in any year was attributable to the Mourne stock. The other 25% was thought to belong to another stock component, possibly Celtic Sea herring. For the 1978 assessment, all of the industrial catch has been included in the total catch of Mourne herring, because a detailed examination of VS by year class and age (Table 6.1) suggests that any Celtic Sea component of the industrial catch would be negligible.

6.2 The Fishery in 1978

6.2.1 Manx stock

Nominal catches are given in Tables 6.2 - 6.3 by country and by stock. The declared catch from the North Irish Sea in 1978 was 11 075 tonnes of which 8 458 tonnes was attributed to Manx stock and 2 548 tonnes was attributed to Mourne stock. A small quantity of spring spawning herring was landed; these fish are not considered further in this report. The quantity of herring caught was controlled by a TAC and a restricted fishing season applied to United Kingdom vessels. Daily catch quotas for vessels operating from Isle of Man were set by a joint committee of catchers and processors in order to spread the catch over a reasonable period.

Catches have fallen progressively since 1974. Conservation measures have been applied either by international agreement to all vessels or nationally to United Kingdom vessels.

Catch in numbers by age

Catch in weight in each month was converted to catch in numbers by means of regular counts of herring in boxes of a declared nominal weight. Age distribution was determined by the application of length/age keys made each month in which there was an appreciable landing in the Isle of Man. The results are given in Table 6.4. Recruit 2 ring fish (1975 year class) made up 60% of the catch; very few 1 ring fish were caught.

6.2.2 Mourne stock

The total nominal catch of herring in the Mourne stock in 1978 was 2 548 tonnes (Table 6.3), made up of 1 809 tonnes consumption and 739 tonnes caught for industrial purposes. The comparable catch data for 1977 were 1 809 tonnes consumption and 1 174 tonnes industrial, giving a total of 2 983 tonnes. Thus, the consumption catch was identical in the two years while the industrisl catch was 435 tonnes lower in 1978.

Catch in numbers by age

Total catches, by weight, of Mourne herring were converted to numbers at each age by the use of data from samples of catch landed in Northern Ireland, Ireland and England. The age composition of the Mourne catch is given in Table 6.5. As in all recent years 0 and 1 ring herring made up the major part of the catch in number, all the 0 ring and 60% of the 1 ring catch being taken in the industrial fishery.

Substantial changes occurred in the seasonal distribution of the catches taken in 1978, because of national measures to limit the fishery. As a result there was a change in mean weight at age. The mean weights at age in the catch taken in 1978 which are different to those given in the previous report (Doc. C.M.1978/H:3) are:

Age (rings)	Mean weight (g)
0	23
1	45
2	158
3	199

No meaningful estimate was possible for the older age groups because of the very small numbers of fish sampled.

6.2.3 The industrial fishery

The industrial fishery carried out in the northwestern part of the Irish Sea continued in 1978. Estimates of the total annual weight of young herring taken as a by-catch, based on samples obtained since 1969, are given below:

Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Tonnes	2 210	3 796	2 715	2 251	1 913	2 190	1 573	779	1 174	739

As in other recent years the major part of the by-catch was taken in the winter months. From January to March the catches consisted mainly of 1 ring fish of the 1976 year class. These migrated offshore during the spring and summer months and were replaced by 0 ring fish of the

1977 year class. The herring by-catch for the remainder of the year consisted almost exclusively of this age group. As discussed above in para. 6.1.3 the immature herring taken in the industrial fishery are considered to be predominantly pre-recruits of the Mourne stock. The total catch expressed as numbers of herring per age group is shown in Table 6.6 for the period 1969-78. In 1978 0-ring herring made up 74% of the total catch in number.

Recent reports of this Group, and also of ACFM in 1978, have all drawn attention to the continuing very high level of the herring catches taken in the industrial fishery. These have continued in spite of both an agreement to prohibit the landing of herring for industrial purposes (subject to a 10% tolerance limit) and the introduction of a 20 cm minimum landing size. Despite the somewhat lower weight of catch taken in 1978, this is still at an unacceptably high level when one considers the very small amount of recruitment to the Mourne spawning stock during recent years.

The Working Group therefore repeats its warning that the Mourne stock is unlikely to survive unless the industrial catch is terminated at once.

6.3 Estimates of Fishing Mortality and Stock Size

6.3.1 Manx stock

In 1976, 1977 and 1978 stock estimates were initiated by cohort analysis with an input F derived from a regression of fishing mortality and fishing effort calculated over the previous 7 to 10 years. This method is inappropriate for the 1978 fishing season because the measure of fishing effort is unlikely to reflect F; a catch quota per boat was decided by a port committee on a day-to-day basis in order to achieve a predetermined weekly and monthly catch pattern within a TAC. The unit of effort recorded is a daily arrival of a fishing boat with a catch, and because of the large number of vessels participating, catch per day per boat was held at a low level. Average catch per day was in fact 2.7 tonnes for vessels based on Isle of Man, about half that in 1977.

In order to obtain a stock estimate, cohort analyses were run with a range of input F at intervals of 0.05; from these analyses a series of estimates for F in earlier years was obtained. For each set the correlation of F with effort for the years 1967 to 1977 was calculated. It was found that the correlation was highest for input F of 0.25 and 0.3 and fell away for lower or higher values; the most relevant parts of the results are given in Table 6.7. As a result of this exercise it was decided to apply an input F_{1978} = 0.30 to the data for a stock estimate from cohort analysis.

The results of the analysis are given in Tables 6.8 and 6.9. The Tables indicate that half the stock is composed of 2-ring fish of the 1975 year class, older fish are mainly of the 1974 and 1973 year classes. It would appear that the steady decline in stock size since 1974 has been stopped by conservation measures and the stock size has increased from the low level of 1977. Fishing mortality appears to be reducing steadily from the high levels of 1974 and 1975 in accordance with ACFM advice that F should be gradually reduced towards $F_{0.1}$. The value of $F_{0.1}$ for Manx stock at the present exploitation pattern and mean weights of age equals 0.16.

6.3.2 Mourne stock

For a first cohort run a mean weighted value of F was calculated for 2-9 ring fish from the estimated stock in numbers of herring at each age on 1 January 1978, which was given in the previous report of the Working Group (Doc. C.M.1978/H:3), and the catch in number for these age groups taken in 1978. This gave F = 0.30 and the cohort was run with this input value for all groups in 1978. The stock in number for 1976, the last reliable year from this cohort, was very similar to that calculated by the previous Working Group. The catches in number taken during 1976 and 1977 were applied to the new cohort stock in number at 1 January 1976 to give a revised estimate of numbers of 2-9 ring fish at 1 January 1978. The 1978 catch applied to those gave a weighted fishing mortality of F = 0.29. A new cohort was run with this input value for all age groups in 1978. Input values of F for the last age group in 1977 and earlier years were taken from the mean weighted value of F for age groups 1-8 years estimated by the first cohort. The new 1979 cohort values of fishing mortality and stock size are given in Tables 6.10 and 6.11. In calculating fishing mortality on 0 and 1 ring herring in 1978 it was assumed that the numbers of 0-group were the same in 1976 and 1977, i.e., 52×10^6, and a value of 45×10^6 was assumed for 1978. This was based on the declining trend of 0 ring abundance shown in Figure 6.1. The catch taken in 1978 would then have generated F = 0.66 on 0 ring and F = 0.81 on the 1 ring herring. Thus, while fishing mortality on the adult component of the Mourne stock was reduced to a moderate level that on the immature and recruit 0 and 1 ring fish remained at a dangerously high rate. In view of the trend shown in Figure 6.1 it may be concluded that year class strength will continue to decline and therefore a value of 40×10^6 0 ring herring has been assumed for 1979. The estimated stock in number at 1 January 1979 for ages 1 ring and older has been calculated from the catch in number per age group in 1978 and the values of fishing mortality discussed above for that year.

Millions of fish at 1 January 1979

Age (rings)

0	1	2	3	4	5	6	7	8	9	10	Total
40.0	21.1	9.0	12.7	5.7	1.8	0.7	0.1	0.3	0.1	0.0	91.5

6.4 State of the Stocks and Advice of TACs

6.4.1 Manx stock

There is no reliable method of forecasting recruitment to the Manx stock. Catch of 1 ring fish is not correlated significantly with subsequent recruitment of age 2 rings. The stock/recruitment plot gives no guidance on recruitment levels. It is, therefore, considered prudent to assume moderate levels of recruitment. The stock is still heavily dependent on the recruiting year class and one poor year class would delay the recovery of the stock that appears to have started with a moderate fishing mortality and a good recruitment in 1978, though it must be remembered that the stock size estimate for 1978 is not very reliable. However, the Working Group considers that, given moderate recruitment, a TAC of 10 000 tonnes in 1979 and 1980 would result in a reduction of F towards $F_{0.1}$ level and allow an increase in stock size.

From 1973 to 1977 fishing for herring in the North Irish Sea was prohibited for six weeks from the end of September and this has almost certainly helped control F. Fishing in September has been concentrated over the spawning beds in recent years and disturbance of spawn has been observed. A crude larval survey carried out 2 to 3 October 1978 (when eggs spawned up to 21 September would have hatched) caught negligible numbers of larvae. A repeat survey conducted on 18 to 20 October caught numbers of larvae comparable with those produced in similar surveys in 1974-75 and 1977, and more than those caught in 1976. This observation is by no means firm evidence that trawling over the spawning beds affects spawning success but it is provocative.

The Working Group recommends that herring fishing in the North Irish Sea be prohibited for 8 weeks from 22 September each year. This is an extension of the period recommended by the Working Group in 1978 and is designed to afford greater protection to the spawning shoals which frequent the spawning beds from early September to mid-November.

6.4.2 Mourne stock

By applying the mean weights at age tabulated in the previous report (Doc. C.M.1978/H:3) the spawning stock size at 1 January 1979 was estimated at 6 353 tonnes. At 1 January 1978 it was 6 058 tonnes. Spawning stock size is based on an estimate that 1/3 of the 1 ring stock spawn at that age. This ratio has been derived from samples taken from June to December during the past five years. It must be noted, however, that the stock in number in both years is heavily dependent on assumed values of initial strength for year classes 1976, 1977 and 1978. For this reason it is considered quite unrealistic to attempt a stock prognosis for future years based on further assumed values. It is quite clear, as stated in earlier reports, that the Mourne stock has declined to a very low level and that all fishing on the stock should be prohibited until a substantial recovery has taken place. The Working Group is unable to advise an optimal spawning stock size for Mourne herring due to the fact that this stock has been in a declining state ever since the first assessment was carried out. In addition, there is no estimate of the size of the spawning stock which produced the most abundant year class measured, i.e., the 1969 year class.

It is recommended that the present prohibition on fishing for herring within 12 miles of the coast of Ireland up to the northern boundary of Division VIIa at latitude 55°00'N should be continued in order to protect the remaining spawning stock; and it is further recommended that directed herring fishing be prohibited in a zone extending 12 miles from the English coast between 53°20'N and 55°N in order to protect the juvenile component of the Manx stock. The Working Group also reaffirms that it is imperative that the industrial catch should be terminated at once.

7. NORTH SEA SPRAT

7.1 Introduction

As in previous assessments the sprat populations have been treated as two separate stocks. The Kattegat,Skagerrak stock (including

Norwegian fjords) has been assessed by the Working Group on Division IIIa Stocks (Doc. C.M.1979/G: 9), and the North Sea stock is assessed here.

7.2 The Fishery in 1978

7.2.1 Catch data

The catches of sprat in the North Sea for the years 1976-78 are shown in Table 7.1. The provisional total catch for 1978 was 378 000 tonnes. That is about 75 000 tonnes more than in 1977, but about 250 000 tonnes less than catches in 1976 and 1975. The 1978 catch was somewhat lower than the TAC recommended by the ACFM (400 000 tonnes) for the year 1978.

In 1978, about the same relative increase in catch was found in the western and eastern part of Division IVb, while catches in Division IVa west were reduced when compared to 1977.

The Danish catch accounted for more than half the total (international) catch as in previous years. A major part of the Danish catch was taken by bottom trawl in Division IVb east in autumn. The Norwegian catch was taken by purse seine in Division IVb, mainly in the western part in the first and fourth quarter of the year. The United Kingdom sprat fisheries have remained rather stable. Most of the catch was taken by trawl in the winter months off the coast of Scotland and England.

7.2.2 Catch in numbers by age

Denmark, Norway and the United Kingdom supplied catches by age group in number and their summed quarterly catches are given in Table 7.2. These catches account for about 95% of the preliminary total catch figure. A feature of the 1978 catches are the relatively low catches in the first quarter of 1978 and the high level of 1-group fish in the third quarter. This catch is similar to the high level of this age group in the third quarter of 1976.

Table 7.3 gives the numbers accumulated by Sub-division in the North Sea. A notable feature is the high catch of 1-group fish in IVb east in 1978.

7.3 Weight at Age

No new data on weight at age were available, and the overall weighted mean weights given in the previous report (Doc. C.M.1978/H:3, Table 7.4) were used for calculations of stock biomass.

7.4 Estimates of Fishing Mortality and Recruitment

With short-lived species like the sprat having a high natural mortality, the information derived from VPA or cohort analysis have a limited value. With fishing mortality being equal to natural mortality, the stock estimate is basically dependent on the value of M assumed. With age data only extending over 5 age groups and the reliability of the oldest age abundances being low (due to sampling), the annual VPA can only give an estimate of the stock of 1 year old fish with any accuracy. The analysis is also somewhat unrealistic in that it does not reflect the large fluctuations in fishing mortality generated between different periods of the year. The estimate of stock size is not so heavily dependent on small changes in F, when the F value is high.

Assuming that natural mortality previously set at 0.8 is generated on all age groups at the same rate throughout the year, then on a quarterly basis M may be set at 0.2. A VPA has been run on the quarterly catch data of Table 7.2. To test the rate of convergence, input F values for the last quarter of 1978 were set at half the value of the input values given in Table 7.7.a of the 1978 Working Group report (Doc. C.M.1978/H:3) and other runs were made increasing the value of F by 50% each time. For the 1974 year class, rate of convergence expressed as a percentage of the initial F value is shown in Figure 7.1 as an example. The input F values were 0.28, 0.42, 0.63. It is seen that by the third quarter of 1977 the difference in these estimates is of the order 15-20%, reducing to 10% by the fourth quarter of 1976. Estimates of stock size in the first quarter of the year of fourth quarter data entry may be calculated, with some degree of reliability, provided the assumption is accepted that M does not vary with age and season.

In these trials varying input Fs were also used to examine the form of the exploitation pattern. F values, incremented in steps of 50%, were used in each successive run. It was apparent that both stock numbers and fishing mortalities derived from the quarters of the years 1974-76 differed little. Taking the F values by age for these years, mean exploitation patterns were calculated. Those derived for the fourth quarter are given below expressed as a ratio of the F value for 1 ringers. The value on 4 ringers is based on the same assumption as was made in 1978.

Mean exploitation pattern in fourth quarter

Age	0	1	2	3	4
	0.12	1	2.07	5.60	(7.21)

No independent data are available which can be used to set the input F values for 1978. Examination of the trial VPA runs showed that the large catch of 1-group in third quarter of 1976 was taken with F = 0.2. A similarly large catch was taken in third quarter of 1978.

Both these quarter 3 catches come from the Danish industrial fishery exclusively. There was no restriction on catch in this quarter and hence there is no indication of any major change in effort between 1976 and 1978.

A VPA was run setting the input F values for quarter 4 which gave an F in quarter 3 approximately to 0.2 on 1 ringers (the value calculated for 1976). The input Fs on other age groups were set using the average exploitation pattern for that quarter given above. The stock sizes and fishing mortalities derived are given in Table 7.4.

Using the mean quarterly weights at age (Doc. C.M.1978/H:3, Table 7.4), biomasses have been calculated and are shown in Figure 7.2. For each year two biomass estimates are shown for quarters 3 and 4. The lower estimates derive from the older fish and are referable directly to the estimates in quarters 1 and 2. The large increases in biomass reflect the major increase in weight for age of these age groups during the year. The higher estimates include the increment due to the new 0-group recruitment entering the stock in the second half of the year.

The only estimate of sprat recruitment, independent of data from the fishery, are those from the Young Herring Surveys. Johnson (Doc. C.M.1978/H:31) has reviewed the recent data collected in those surveys. Johnson grouped the data into 19 sub-areas, 11 of which were sampled in each year of 1976, 1977 and 1978. Mean abundances were calculated for age groups 1 and 2 for these 11 sub-areas and are given in the text table below.

Year class	VPA stock Q 1 x 10^9	IYHS age groups 1 No/hr	2 No/hr
1974	100		3 076.91
1975	159	5 015.36	4 151.82
1976	108	196.82	2 355.45
1977	158	3 413.64	

The time series is too short to allow any conclusions to be drawn.

7.5 Stock Size Estimate

The results from VPA are shown as biomass estimates in Figure 7.2. The new year class as 0-group enter the fishery in quarters 3 and 4 each year. Biomasses are shown separately for the new recruitment and the surviving stock for these quarters. The total North Sea biomass, including recruitment, has averaged about 1 million tonnes over the period 1974-77. It should, however, be noted that the VPA was based on several assumptions which, if wrong, could bias the results.

In the previous report the results of an acoustic survey were presented which suggested that the pelagic biomass was of the order of 795 000 tonnes in the area of distribution of the winter sprat fisheries of the east coasts of England and Scotland. This was interpreted as an estimate of the sprat population in the western half of the North Sea. This survey was later reported at the Statutory Meeting (Doc. C.M.1978/H:55). Unfortunately, it has since been discovered that a computational error occurred and that the biomass is considerably lower.

7.6 Acoustic Surveys

In January or February 1978 and 1979 Scottish and English research vessels have conducted acoustic surveys using integrates over the area of sprat fisheries off the United Kingdom North Sea coasts. The areas covered in each year are indicated in Figure 7.3.

In 1978 transducer difficulties on RV "Corella" and the wide disparity in the estimate from RV "Scotia" rendered the use of the surveys problematical at the time of the Working Group meeting. Revision of both series of data has led to much closer agreement in the two surveys.

The cruise data have been grouped into the three major areas covered. The biomass estimate has been obtained in the same manner as reported in Doc. C.M.1978/H:3, using a target strength of -34 dB kg^{-1}.

In 1979 an intercalibration was undertaken between RV "Corella" and RV "Scotia". Vessels followed parallel courses over an area in which the English sprat fishery was operating. The results of these parallel surveys are also given in Table 7.5. From this it would appear that some confidence may be placed in the reproducability of the technique.

It can, however, only be surmised that these tonnages refer solely to sprat. On the acoustic surveys, the research vessels sampled by trawl in attempts to identify scatterers. In the case of "Corella", much of the catches consisted of 0/1-group sprat, which also occurred in the adjacent fishery. Comparing the biomass estimates for the English northeast coast in the two years, the considerable drop in abundance is consistent with the reduced catch rates in 1979 as compared with 1978. However, how much this reflects a real stock change, and how much might be caused by difficulties for the fishery arising from weather cannot be determined. In the Scottish area the high biomass in 1979 is associated with a high abundance of 0/1-groups, i.e., the 1978 year class.

Even supposing that these estimates referred solely to sprat, it is not possible to interpret them in relation to the total North Sea biomasses. There is no way by which the relative proportions of the North Sea stock which are distributed in the western and in the eastern area may be quantified. It is thus not possible to raise the acoustic abundance to a value representing the total North Sea.

7.7 Catch Prediction and Advice on TAC

At the 1978 Working Group meeting a precautionary TAC was recommended for 1979. This was set at 400 000 tonnes "until a more reliable estimate of stock size can be obtained" (Doc. C.M.1978/H:3). The Working Group also pointed out that, while it was difficult to set a TAC for the year in which the Working Group met, it was even more pointless to try to project a TAC for the following year. This is because the year class entering the fishery which might contribute over half the total biomass was not yet born.

The Working Group must point out that because of this limitation it cannot see a scientifically determined TAC for 1980.

The Working Group reconsidered the recommendation of a TAC of 400 000 tonnes for 1979 and saw no reason to change its former advice.

8. FUTURE RESEARCH REQUIREMENTS

- Great emphasis should be given to the acoustic surveys which will be held in the North Sea and Division VIa for the first time in July 1979. At present the amount of vessel time allocated to this project is inadequate to provide stock estimates with the required level of accuracy. It is strongly recommended that these surveys are repeated in 1980 and that the number of participating vessels is increased.
- Unfortunately, the tagging programme for herring in the North Sea and Division VIa which was recommended by the Working Group last year cannot start until the summer of 1980. This means that the first estimates for the herring stocks derived from this experiment will not be available until 1981. However, these estimates will still be very important at that time, and apart from these stock

estimates, the experiment will also provide very important information on the migration of herring, in particular between the North Sea and Division VIa. It is strongly recommended that the required funds for chartering of vessels and acquisition of tagging equipment are provided through ICES.

- Despite the recommendation made by the Working Group last year, the effort put into larval surveys is still inadequate to obtain a sufficient coverage of the main spawning grounds both in the North Sea and Division VIa. This is also due to the withdrawal from these surveys of Poland and the German Democratic Republic. The Working Group wants to stress the fact that sampling effort should be increased, particularly in Divisions IVa (W) and VIa, if estimates of larval production in these areas are to be produced with a reasonable degree of accuracy.
- The Working Group recommends that Irish trawling surveys during the Celtic Sea herring spawning season should be continued, because it is an important method by which the state of the stock can be monitored.
- Racial studies on juvenile herring in Division IIIa should be intensified in order to establish the origin of these fish. Particular emphasis should be placed on otolith characters, in combination with VS and K_2 counts. The Working Group recommends that a Workshop on otolith typing should be arranged in 1979 in order to refine the methodology for separating spring and autumn spawners.
- Unless more data are provided on the occurrence of adult fish in maturity stage 1 and 2 in Division IVa (W), the Working Group cannot judge whether Saville's emigration model provides a better basis for stock assessment of herring in the North Sea and Division VIa than the methods used by the Working Group so far. The Working Group therefore recommends that all countries screen their available data from Division IVa (west) for adult fish in low maturity stages, preferably in combination with K_2 and VS data.
- The planned acoustic survey on northern North Sea (and Division VIa) herring will give occasion for an extensive sampling and will be the opportunity of getting valuable information on the age distribution and stock composition. The Working Group stresses the importance of full biological sampling, including the determination of the stages of maturity and the counting of VS and K_2. All otoliths taken for are determinations should be retained.
- New programmes should be initiated in order to obtain estimates of recruitment to Division VIa. Because of the total absence of any reliable recruitment estimates for Division VIa, the Working Group was not able to predict the adult stock in this area for 1980 with any degree of accuracy. Recruitment estimates could possibly be obtained from acoustic surveys in the nursery areas during late 1979 or early 1980.
- In view of the necessity to monitor changes in the abundance of North Sea sprat it is recommended that acoustic surveys, e.g., in January, should be coordinated and extended so as to cover the main fishing areas during the period (see Figure 7.3).

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Table 2.1 HERRING. Catch in tonnes 1968–78.
North Sea (Sub-area IV and Divisions VIId and e) by country.
Skagerrak (Division IIIa excl. Kattegat) total catch.

(Data provided by Working Group members)

Country/Year	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978*
Belgium	134	468	1 200	681	1 337	2 160	603	2 451	1 430	57	-
Denmark	163 100	180 260	133 331	185 393	213 738	174 254[a)]	61 728	115 616	34 841	12 769	2 806
Faroe Islands	49 995	40 640	58 365	45 524	48 444	54 935[b)]	26 161[b)]	25 854	14 378	8 070	40
Finland	-	-	-	-	-	-	-	-	1 034	-	-
France	12 852	15 307	11 482	11 408	12 901	22 235	12 548	20 391	14 468	1 613	2 016
German Dem.Rep.	-	-	290	475	127	1 728	3 268	2 689	2 624	2	-
Germany,Fed.Rep.	21 216	12 798	7 150	3 570	3 065	10 634[c)]	12 470	6 953	1 654	221	-
Iceland	44 489	19 997	22 951	37 171	31 998	23 742[d)]	29 017	16 286	9 412	-	-
Netherlands	22 306	29 769	46 218	32 479	24 829	34 070	35 106	38 416	20 146	4 134	-
Norway	211 904	114 938	193 102	125 842	117 501	99 739	40 975	34 183	27 386	4 065	1 189
Poland	11 954	9 221	5 057	2 031	2 235	5 738	9 850	7 069	7 072	2	-
Sweden	88 061	33 109	34 670	36 880	7 366	4 222[e)]	3 561	6 858	4 777	3 616	-
UK(England)	5 128	6 666	9 702	4 113	394	2 268	5 699	6 475	9 662	3 224	2 652
UK(Scotland)[f)]	16 477	22 053	21 885	25 073	17 227	16 012	15 034	8 904	15 015	8 159	431
USSR	70 029	61 549	18 078	9 500	16 386	30 735	18 096	20 653	10 935	78	4
Total North Sea	717 645	546 775	563 481	520 140	497 548	484 012	275 116	312 798	174 834	46 010	9 138
Skagerrak	280 036	113 279	71 071	61 570	67 021	84 566	55 512	51 911	15 550	37 618	21 227
Grand Total	997 681	660 054	634 552	581 710	564 569	568 578	330 628	364 709	190 384	83 628	30 365

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

b) Supplied by Fískirannsóknarstovan.

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

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

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

f) Catches from Moray Firth not included.

*) Preliminary.

Table 2.2. HERRING. Total catch in tonnes.
Skagerrak (Division IIIa excl. Kattegat).

Year	Denmark	Faroe Islands	Germany, Fed.Rep. of	Iceland	Norway	Sweden	Total	Norwegian Fjords[b)]
1969	57 965	-	-	-	13 957	41 357	113 279	
1970	30 107	-	-	6 453	7 581	26 930	71 071	1 830
1971	26 985	5 636	-	3 066	6 120	19 763	61 570	3 166
1972	34 900	4 115	-	7 317	1 045	19 644	67 021	4 222
1973	42 098	5 265[a)]	-	15 938[a)]	836	20 429[a)]	84 566	1 680
1974	35 732	7 132	36	231	698	11 683	55 512	1 720
1975	29 997	8 053	108	1 209	196	12 348	51 911	1 459
1976	7 363	1 553	6	123	-	6 505	15 550	2 304
1977	19 382	10 064	32	-	31	8 109	37 618	2 312
1978*)	6 425	1 041	28	-	2 182	11 551	21 227	2 400

*) Preliminary.
a) See Table 2.1 footnote under relevant country.
b) Not included in total Skagerrak catch.

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

Year	Belgium	Denmark	Faroe Islands	France	German Dem.Rep.	Germany Fed.Rep. of	Iceland	Nether-lands	Norway	Poland	UK Scotland	Sweden	USSR	Total
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	46	-	-	-	-	-	15 377
1975	-	8 036	-	-	-	-	1 539	24	53	-	-	-	-	9 652
1976	-	1 220	-	-	113	-	-	-	-	5	-	919	-	2 257
1977	-	-	-	-	-	-	-	-	1 245	-	-	619	-	1 864
1978*)	-	-	-	-	-	-	-	-	1 033	-	-	-	-	1 033

*) Preliminary.
a) See Table 2.1 footnote under relevant country.

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

Year	Denmark	Faroe Isl.	Finland	France	German Dem.Rep.	Germany Fed.Rep. of	Iceland	Nether-lands	Norway	Poland	UK Eng-land	UK Scot-land	Sweden	USSR	Total
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 159a)	1 540	209	1 057	2 624	23 742	4 615	62 749	5 547	-	15 430	4 222	30 735	247 697
1974	3 475	16 676	-	414	40	1 431	22 421	2 139	14 393	9 187	-	10 473	-	3 525	84 174
1975	14 031	16 124	-	1 266	1 151	1 566	7 868	2 222	26 355	6 310	-	6 674	-	12 194	95 761
1976	14 011	12 446	1 034	4 183	1 614	1 275	9 179	7 421	23 768	6 199	-	11 823	3 858	4 741	101 552
1977	5 515	7 036	-	178	-	-	-	1 240	2 820	-	-	8 137	2 997	-	27 923
1978*)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

*) Preliminary.
a) See Table 2.1 footnote under relevant country.

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

Year	Denmark	Faroe Isl.	France	German Dem.Rep.	Germany Fed.Rep. of	Iceland	Nether-lands	Norway	Poland	UK England	UK Scotland	Sweden	USSR	Total
1972	1 589	10 460	2 014	-	21	334	11 372	17 043	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	8 561	3 173	3 832	4 136	31 229	26 582	662	5 658	41	2 416	14 566	116 396
1975	4 374	9 730	4 963	1 538	2 480	6 879	28 963	7 743	759	6 403	2 230	6 858	8 190	91 110
1976	5 472	499	2 026	896	342	233	9 362	3 618	606	9 361	3 192	-	5 868	41 475
1977	608	1 034	53	-	221	-	2 455	-	-	414	-	-	-	4 785
1978*)	-	-	-	-	-	-	-	-	-	-	-	-	-	-

*) Preliminary.

Table 2.6. HERRING. Total catch in tonnes.
North Sea Central (Division IVb).

Year	Young herring fisheries						Total young and adult fisheries (Tables 2.5 and 2.6)
	Denmark	Germany, Fed.Rep.	Sweden	UK (England)	UK (Scotland)	Total	
1972	162 671	2 823	3 298	-	-	168 792	216 579
1973	129 988	5 638	-	-	-	135 626	193 379
1974	43 866	6 761	1 145	-	-	51 772	168 168
1975	88 191	2 557	-	-	-	90 748	181 858

Table 2.7. HERRING. Total catch in tonnes.
North Sea Southern and English Channel, East and West
(Divisions IVc and VIId and e).

Year	Belgium	Denmark	Faroe Isl.	France	Germany Fed.Rep.	Nether-lands	Norway	Poland	U.K. England	USSR	Total
1971	673	25	-	6 160	126	16 385	-	-	82	-	23 451
1972	1 337	57	-	9 999	112	11 450	-	-	49	-	23 004
1973	2 160	132	-	13 767	2 257	11 754	-	-	93	-	30 163
1974	603	36	-	4 573	432	1 692	-	1	41	5	7 383
1975	2 451	984	-	14 162	350	7 207	32	-	72	269	25 527
1976	1 430	2 351	1 433	8 035	-	3 363	-	262	301	326	17 501[a)]
1977	57	-	-	930	-	397	-	-	-	-	1 384
1978*	-	-	-	-	-	-	-	-	-	-	-

* Preliminary.

a) Included 1 tonne caught by German Democratic Republic.

Table 2.8. HERRING. By-catch (in weight) by areas and countries.

Country	IVa West			IVa East			IVb			IVc + VIId		
	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978
Denmark	4 105	502	-	-	186	-	7 682	5 958	2 806	-	-	-
Faroe Islands	-	-	25	-	-	-	-	-	15	-	-	-
France	100	148	477	11	44	-	88	198	302	25	62	1 237
German Dem.Rep.	-	-	-	-	2	-	-	-		-	-	-
Germany, Fed.Rep. of	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	-	-	-	-	42	-	-	-	-	-	-	-
Norway	-	-	27	-	-	-	-	-	129	-	-	-
Poland	-	-	-	-	2	-	-	-	-	-	-	-
Sweden	-	-	-	-	-	-	-	-	-	-	-	-
UK (England)	-	-	-	-	-	-	165	2 810	2 620	-	-	32
UK (Scotland)	-	-	-	-	-	-	-	22	431	-	-	-
USSR	-	-	-	-	43	4	-	35	-	-	-	-
Total	4 205	650	529	11	319	4	7 915	9 023	6 303	25	62	1 269

Table 2.9. HERRING North Sea catch in millions of fish by age.

Year	Area	Age in winter rings										Total
		0	1	2	3	4	5	6	7	8	>8	
1972	IVaW of 2^{o}E	-	338.9	830.1	176.8	88.6	19.3	4.1	-	0.5	0.4	1 458.7
	IVaE of 2^{o}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^{o}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^{o}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 75[illegible]4
	IVc+VIId,e	-	2.2	43.3	115.1	55.0	7.4	1.9	0.5	0.1	0.0	22[illegible].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^{o}E	65.3	162.9	98.5	112.9	97.1	36.0	18.6	4.5	1.5	1.0	598.3
	IVaE of 2^{o}E	5.7	131.8	24.2	10.8	1.0	-	-	-	0.1	-	173.6
	IVb (adult)	-	54.0	493.7	212.3	19.5	18.9	3.6	0.3	0.4	0.1	802.8
	IVbYH	925.1	493.5	132.1	5.7	-	-	-	-	-	-	1 556.4
	IVc+VIId		3.9	24.1	20.3	8.4	1.2	0.1	0.2	-	-	58.2
	Total NS	996.1	846.1	772.6	362.0	126.0	56.1	22.3	5.0	2.0	1.1	3 189.3
1975	IVaW of 2^{o}E	-	267.0	120.0	69.0	49.0	40.2	9.8	6.3	2.9	1.1	565.3
	IVaE of 2^{o}E	-	82.5	8.2	7.0	2.4	0.4	0.1	0.1	-	-	100.7
	IVb (adult)		268.8	147.1	124.2	81.2	14.8	5.8	2.7	0.5	0.3	645.4
	IVbYH	262.8	1 818.1	139.2	19.8	2.6	-	0.4				2 242.9
	IVc+VIId	1.0	24.1	127.2	39.6	5.3	1.8					199.0
	Total NS	263.8	2 460.5	541.7	259.6	140.5	57.2	16.1	9.1	3.4	1.4	3 753.3
1976	IVaW of 2^{o}E	-	19.4	572.9	56.3	17.9	13.2	3.6	2.6	0.5	0.3	68[illegible]7
	IVaE of 2^{o}E	-	-	10.6	1.1	0.5	0.5	0.4	-	-	-	1[illegible].1
	IVb (adult)	0.9	35.5	205.9	17.6	28.4	20.3	1.8	1.8	0.5	0.1	312.8
	IVbYH	237.3	49.5	17.7	0.5	1.7	-	-	-	-	-	306.7
	IVc+VIId	-	22.2	94.4	41.8	3.5	0.5	0.3	-	-	-	162.7
	Total NS	238.2	126.6	901.5	117.3	52.0	34.5	6.1	4.4	1.0	0.4	1 482.0
1977	IVaW of 2^{o}E	2.6	2.7	9.3	171.7	8.6	3.8	2.1	0.9	0.2		201.9
	IVaE of 2^{o}E	0.4	3.3	+	4.9	1.2	1.1	1.0	0.6	0.5	+	13.0
	IVb (adult)	-	1.1	25.9	6.8	0.3	1.9	1.0	-	+	-	37.0
	IVbYH	253.8	136.3	3.1	-	-	-	-	-	-	-	393.2
	IVc+VIId	-	0.9	6.4	3.0	0.7	0.2	+	+	-	-	11.2
	Total NS	256.8	144.3	44.7	186.4	10.8	7.0	4.1	1.5	0.7		656.3
1978	IVaW of 2^{o}E	-	-	0.1	0.1	1.5	0.2	0.1	+	+	+	2.6
	IVaE of 2^{o}E	-	-	-	0.2	1.2	-	0.1	0.2	0.2	0.3	2.2
	IVb	109.0	135.4	1.5	1.4	1.1	0.1	0.1	+	-	-	248.6
	IVc+VIId	-	0.3	2.3	3.2	1.0	+	+				6.8
		109.0	135.7	3.9	4.9	4.8	0.3	0.3	0.2	0.2	0.3	259.6

Table 2.10. HERRING Skagerrak catch in millions of fish by age.

Age in winter rings	0	1	2	3	4	5	6	7	8	>8	Total
1974	632.2	292.3	92.1	46.4	14.5	5.8	1.1	0.8	-	-	1 085.2
1975	76.2	380.7	38.0	36.2	49.1	13.3	5.4	0.6	0.6	-	600.1
1976	64.6	49.7	63.1	5.1	1.2	0.5	0.2	0.1	-	-	184.4
1977	54.4	118.8	87.6	37.5	8.9	4.5	2.8	0.8	+	-	315.3
1978	41.5	137.8	91.7	19.0	3.5	0.8	0.5	0.3	0.1	-	295.2

Table 2.11 Millions of HERRING caught annually per age group (winter rings) in the North Sea over the last 10 years.

Year / Winter rings	0	1	2	3	4	5	6	7	8	>8	Total
1969	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	898.1	1 196.2	2 002.8	883.6	125.2	50.3	61.0	7.9	12.0	12.2	5 249.3
1971	684.0	4 378.5	1 146.8	662.5	208.3	26.9	30.5	26.8	-	12.4	7 176.7
1972	750.4	3 340.6	1 440.5	343.8	130.6	32.9	5.0	0.2	1.1	0.4	6 045.5
1973	289.4	2 368.0	1 344.2	659.2	150.2	59.3	30.6	3.7	1.4	0.6	4 906.6
1974	996.1	846.1	772.6	362.0	126.0	56.1	22.3	5.0	2.0	1.1	3 189.3
1975	263.8	2 460.5	541.7	259.6	140.5	57.2	16.1	9.1	3.4	1.4	3 753.3
1976	238.2	126.6	901.5	117.3	52.0	34.5	6.1	4.4	1.0	0.4	1 482.0
1977	256.8	144.3	44.7	186.4	10.8	7.0	4.1	1.5	0.7	+	656.3
1978	109.0	135.7	3.9	4.9	4.8	0.3	0.3	0.2	0.2	0.3	259.6

Table 2.12. Estimates of the abundance of herring larvae in the North Sea and Division VIa in 1978/79 and comparable estimates for 1977/78.

Area	1977/78 (x 10^{-9})	1978/79 (x 10^{-9})
Northern North Sea	31 August - 16 September $<$10 mm - 1 582 19 - 29 September $<$10 mm - 354	5 - 14 September $<$10 mm - 5 390*)
Mean survey abundance	968	3 564[a)] 2 363[b)]
Central North Sea	11 - 16 September $<$10 mm - 502 20 - 22 September $<$10 mm - 310 2 - 10 October $<$10 mm - 104 14 - 19 October $<$10 mm - 3	6 - 13 September $<$ 10 mm - 1 484 20 - 27 September $<$ 10 mm - 79 29 September - 11 October $<$ 10 mm - 314 22 - 29 October $<$ 10 mm - 2
Mean survey abundance	230	470
Southern North Sea and Eastern Channel	13 - 16 December $<$11 mm - 1 Total 1 19 - 22 December $<$11 mm - 1 Total 2 2 - 6 January $<$11 mm - 0 Total 8 19 - 23 January $<$11 mm - 3 Total 28	11 - 22 December $<$ 11 mm - 34 Total 49 3 - 10 January $<$ 11 mm - 4 Total 7

/Cont'd.

*) Estimate giving equal weighting to one quite exceptionally high density station.
a) Larval Working Group estimate for the whole of September based on ratio of abundances first half to second half of September 1974-77 and giving equal weighting to high density station.
b) Larval Working Group estimate for the whole of September but with weighting of high density station reduced to normal value.

Table 2.12 (Continued)

Area	1977 (x 10^{-9})	1978 (x 10^{-9})
VIa	8-16 September (N of 56°30' only) <10 mm - 404 18-26 September (whole area) <10 mm - 1 188 15 - 24 October (whole area) <10 mm - 335	1-11 September (whole area) <10 mm - 364 23 September - 10 October (whole are) <10 mm - 820
Mean survey abundance	642	592

Table 2.13. Abundance indices of 1-group herring in Division IIIa, 1972-79 International Young Herring Surveys.

Year	Abundance indices 1-group herring
1972	77.8
1973	180.7
1974	726.2
1975	454.8
1976	1 339.4
1977	203.5
1978	575.0
1979*)	12.0

*)Preliminary index based on herring less than 20 cm, which is an overestimate of abundance.

Table 3.1 Annual Celtic Sea herring catches 1965-78.

(Data provided by Working Group members)

Year	France	German Dem.Rep.	Germany Fed.Rep.	Ireland	Netherlands	Poland	UK	USSR	Total
1965	1 742	-	353	3 980	7 198	-	1 054	-	14 327
1966	5 506	-	1 143	6 891	16 605	112	197	-	31 454
1967	3 825	-	910	11 133	13 184	300	398	-	29 750
1968	2 637	-	1 662	9 480	15 679	130	598	-	30 186
1969	7 038	-	5 906	18 712	16 256	252	400	-	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	7	294	13 105	5 834	1 125	-	334	26 375a)
1974	2 261	-	433	13 991	2 105	954	-	-	19 744
1975	1 924	-	361	8 430	2 825	512	24	1 054	15 130
1976	1 919	147	28	3 705	1 627	324	-	826	8 258
1977	106	-	96	1 394	1 455	-	-	-	3 051
1978*)	4	-	220	2 725	1 002	-	-	-	3 951

* Provisional. a) Including 123 tonnes for Bulgaria.

Table 3.2 Celtic Sea herring catches by season (1 April to 31 March).

(Data provided by Working Group members)

Year	France	German Dem.Rep.	Germany Fed.Rep.	Ireland	Netherlands	Poland	UK	USSR	Total
1965/6	1 742		353	3 482	13 071	-	1 054		19 702
1966/7	5 506		1 143	8 061	11 459	112	197		26 478
1967/8	3 825		910	10 736	10 204	425	398		26 498
1968/9	2 637		1 662	11 996	12 191	130	598		29 214
1969/70	7 038		5 906	16 712	13 111	261	400		43 428
1970/1	3 627		1 481	19 106	4 667	778	220		29 879
1971/2	3 383		974	13 757	10 600	880	65		29 659
1972/3	7 327		393	18 846	6 852	751	-	618	34 878
1973/4	4 143	7	294	11 317	5 834	1 139	-	334	23 191a)
1974/5	2 150	-	435	11 683	2 462	954	-	-	17 684
1975/6	2 451	-	399	6 524	2 441	579	24	1 054	13 472
1976/7	1 371	147	36	2 970	1 324	257	-	826	7 019
1977/8	95	-	96	1 322	1 378	-	-	-	2 891
1978/9*)	3	-	220	2 656	1 002	-	-	-	3 881

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

Table 3.3 Celtic Sea. Catch in numbers x 10^{-3} (1 April - 31 March).

Season/Age	1	2	3	4	5	6	7	8	>8	Total
1965/6	58	70 937	9 456	15 911	3 433	4 584	12 241	1 391	7 566	125 576
1966/7	6 337	19 146	58 633	9 827	13 193	5 585	3 581	8 742	3 839	128 614
1967/8	6 921	36 168	19 486	47 837	8 954	9 334	3 894	6 462	6 684	145 741
1968/9	11 699	53 028	38 421	11 207	22 286	4 538	3 965	1 251	4 608	151 003
1969/70	7 787	91 994	54 473	32 318	11 881	17 265	4 612	2 130	3 418	225 878
1970/1	640	31 540	48 706	25 937	18 270	7 095	5 751	1 925	3 194	143 058
1971/2	10 262	22 451	34 382	40 536	18 449	9 807	3 779	4 846	2 143	146 655
1972/3	7 279	124 357	16 922	13 817	13 674	4 331	2 654	2 103	749	185 886
1973/4	22 171	34 122	45 162	6 269	8 251	4 655	3 209	1 966	714	126 519
1974/5	4 516	38 285	15 427	19 865	3 782	3 311	2 668	806	742	89 402
1975/6	11 452	13 077	15 709	6 898	6 042	3 252	1 268	964	1 022	59 685
1976/7	7 262	9 090	5 202	5 196	2 092	2 669	1 384	1 005	777	34 701
1977/8	3 859	4 095	3 491	1 534	782	547	289	36	55	14 687
1978/9	1 660	10 373	3 890	1 573	450	471	115	260	130	18 922

Table 3.4. Celtic Sea herring. Fishing mortalities from VPA and weighted mean values of F.

Age	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79
1	0.27	0.17	0.49	0.44	0.17	0.15
2	0.77	0.91	0.92	0.81	0.42	0.80
3	0.84	0.87	1.10	1.08	0.75	0.80
4	0.45	1.01	1.14	1.31	0.99	0.80
5	0.60	0.52	0.88	1.23	0.60	0.80
6	0.47	0.46	1.05	1.18	1.21	0.80
7	0.67	0.48	0.28	2.06	0.32	0.80
8	0.70	0.70	0.70	0.70	0.70	0.80
$\bar{F}_{(2-8)}$	0.42	0.84	0.95	1.13	0.60	0.80

Table 3.5. Celtic Sea herring. Calculated stock size in number (10^{-6}) by age and year (M = 0.1) at 1 April.

Age	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79
1	97.3	29.9	30.9	21.4	25.8	12.5
2	66.3	67.0	22.7	17.2	12.4	19.7
3	83.1	27.8	24.5	8.2	6.9	7.4
4	17.3	32.6	10.6	7.4	2.5	3.0
5	19.1	9.7	10.7	3.1	1.8	0.9
6	13.0	9.5	5.2	4.0	0.8	0.9
7	6.9	7.3	5.4	1.6	1.1	0.2
8	5.6	3.2	4.1	3.7	0.2	0.7
Biomass (2-8)	40.5	29.8	16.4	8.7	4.8	5.9

Table 4.1. Total catches of herring (tonnes) in Division VIa, 1969-78. (Data provided by Working Group members)

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978*
Belgium	-	-	-	-	-	-	-	12	-	-
Denmark	-	-	554	150	932	-	374	249	626	-
Faroe Islands[a]	-	15 100	8 100	8 094	10 003	5 371	3 895	4 017	3 564	-
France	966	1 293	2 055	680	2 441	547	1 293	1 528	1 548	1 409
German Dem.Rep.	416	207	330	935	2 507	2 037	1 994	929	-	-
Germany, Fed.Rep.of	15 805	16 548	7 700	4 108	17 443	14 354	9 099	4 980	221	126
Iceland	-	5 595	5 416	2 066	2 532	9 566	2 633	3 273	-	-
Ireland[b]	11 895	11 716	12 161	17 308	14 668	12 557	10 417	8 558	7 189	10 208
Netherlands	1 514	1 102	9 252	23 370	32 715	19 635	19 360	20 812	8 515	5 929
Norway	-	20 199	76 720	17 400	36 302	26 218	512	5 307	1 098	4 462
Poland	3 188	3 709	-	-	5 685	6 368	2 934	3 085	6	-
Sweden	-	-	-	-	-	-	-	2 206	261	-
UK (England)	3	1	-	-	-	45	125	20	301	134
UK (N.Ireland)	3	1	-	-	-	3	6	1	1	6
UK (Scotland)	90 222	103 530	99 537	107 638	120 800	107 475	85 395	53 351	25 238[c]	10 097[c]
USSR	-	3	-	?	2 052	5 388	3 232	3 092	-	-
Total	124 012	179 004	221 825	181 749	248 080	209 564	141 269	111 420	48 568	32 371
Scottish juvenile herring and sprat fisheries in Moray Firth	3 100	1 385	5 666	10 242	7 219	13 003	2 454	313	205	276

*) Preliminary figures.
a) Figures supplied by Fiskirannsoknarstovan.
b) Catches prior to 1976 mainly taken in Division VIIb and landed in Division VIa.
c) Including by-catch in local sprat fishery (16 tonnes in 1977; 157 tonnes in 1978).

Table 4.2. Monthly catches of herring (tonnes) by France, Ireland, the Netherlands, Norway and UK in Division VIa in 1977 and 1978.

	1977	1978
January	5 706	4 176
February	3 591	3 660
March	3 786	2 996
April	200	1 064
May	397	921
June	182	5 999
July	2 501	6 081
August	12 452	2 342
September	3 135	2 451
October	3 635	1 251
November	3 734	820
December	4 224	328
Sub-total: Jan-Jun	13 862	18 816
Sub-total: Jul-Dec	29 681	13 273
Total	43 543	32 089

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

Year \ Age(rings)	0	1	2	3	4	5	6	7	8	9	10	>10
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	249 941	321 539	753 355	210 243	72 885	83 361	37 428	13 445	94 577	8 154	5 855	5 377
1973	267 872	50 737	273 783	990 183	155 828	66 476	68 522	26 512	8 037	53 767 1)	-	-
1974	536 119	312 029	153 833	205 806	553 627	90 584	45 144	43 069	18 504	45 393 1)	-	-
1975	82 698	185 723	257 116	108 284	84 977	228 583	38 929	15 573	20 304	20 689 1)	-	-
1976	8 446	78 894	386 932	123 947	44 430	36 714	87 477	14 208	5 766	13 078 1)	-	-
1977	11 871	38 582	60 563	119 880	25 593	12 506	13 046	20 759	2 948	3 262 1)	-	-
1978*	116 967	35 738	68 146	32 061	47 819	12 285	6 049	3 801	7 531	3 322 1)	-	-

*) Preliminary. 1) Age 9 and older

Table 4.4. Division VIa herring. Infestation rate by Renicola (i.e. percentage of number of fish with parasites) based on sampling in the years 1973-77.

Year class	Age					
	1	2	3	4	5	6
1974	27	18				
1973	50	32	22			
1972	75	45	35	13		
1971	40	31	19	13	8	
1970			36	23	11	
1969				14	9	10

Table 4.5 Fishing mortalities by year and age on the herring population in Division VIa.
(a) taking into account emigration rates from the North Sea, and
(b) from conventional VPA disregarding emigration.

Age (rings)	1972		1973		1974		1975		1976		1977	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
0	0.54	0.41	0.32	0.26	0.56	0.44	0.35	0.28				
1			0.18	0.12	0.67	0.49	0.34	0.24	0.52	0.41		
2					0.85	0.56	1.19	0.85	1.33	0.97	0.78	0.56
3							1.25	0.88	1.90	0.80	1.10	0.80
4									1.33	1.03	1.10	0.80
5											1.10	0.80

Table 4.6 Fishing mortalities (F) and emigration factor s (E) by year and age on the herring population in the North Sea (Sub-area IV):
(a) taking into account emigration rates from the North Sea, and
(b) from conventional VPA disregarding emigration.

Age (rings)		1972		1973		1974		1975		1976		1977	
		(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
0	F	0.17	0.17	0.13	0.15	0.19	0.19	0.03	0.31				
	E												
1	F			0.98	1.04	0.61	0.70	0.82	0.88	0.19	0.20		
	E												
2	F					0.96	1.07	1.06	1.28	0.77	0.80	0.08	-
	E					0.06		0.23		0.12		0.09	
3	F							1.09	1.26	0.76	0.80	0.31	-
	E							0.19		0.12		0.10	
4	F									0.75	0.80	0.13	
	E									0.18		0.32	
5	F											0.17	
	E											0.15	

Table 4.7 Herring stock in number (x 10^{-6}) in Division VIa.
(a) taking into account emigration rates from the North Sea; and
(b) from conventional VPA disregarding emigration.

Age (rings)	1972		1973		1974		1975		1976		1977	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
0	630	780	1 030	1 220	1 310	1 580	290	360				
1			330	470	670	850	680	920	190	250		
2					250	380	300	470	430	660	100	150
3							130	190	140	180	160	230
4									50	70	30	50
5											20	20

Table 4.8 Herring stock in number (x 10^{-6}) in the North Sea.
(a) taking account emigration rates and
(b) from conventional VPA disregarding emigration.

Age (rings)	1972		1973		1974		1975		1976		1977	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
0	5 040	5 010	2 490	2 240	6 040	5 900	1 080	1 040				
1			3 950	3 820	1 940	1 750	4 590	4 390	720	670		
2					1 340	1 220	950	780	1 830	1 650	540	-
3							440	380	240	200	700	-
4									110	90	90	-
5											40	-

Table 4.9. Herring in Division VIa, Moray Firth included.
Fishing mortalities by year and age.

Age (rings)	1969	1970	1971	1972	1973	1974	1975	1976	1977*)	1978*)
0	0.13	0.004	0.16	0.40	0.26	0.43	0.28	0.03	0.03	0.04
1	0.04	0.21	0.05	0.35	0.12	0.48	0.23	0.42	0.16	0.11
2	0.10	0.15	0.37	0.29	0.51	0.55	0.81	0.91	0.57	0.42
3	0.19	0.37	0.84	0.45	0.66	0.80	0.84	1.10	0.70	0.60
4	0.14	0.40	0.65	0.37	0.63	0.85	0.81	0.90	0.62	0.60
5	0.35	0.29	0.54	0.39	0.60	0.83	0.95	0.91	0.61	0.60
6	0.29	0.40	0.25	0.38	0.56	0.94	0.96	1.10	0.88	0.60
7	0.49	0.43	0.66	0.18	0.44	0.74	0.90	1.04	0.75	0.60
8	0.58	0.60	0.50	0.89	0.14	0.57	0.85	0.90	0.54	0.60
≥9	0.30	0.38	0.66	0.45	0.63	0.82	0.89	1.01	0.69	0.60
Mean F_w ≥3	0.30	0.39	0.67	0.45	0.63	0.83	0.89	1.04	0.70	0.60

*) Inefficient estimates.

Table 4.10. Herring in Division VIa, Moray Firth included.
Stock in number x 10^{-6} and biomass of adult stock at the beginning of the year.

Age (rings)	1969	1970	1971	1972	1973	1974	1975	1976	1977*)	1978*)
0	1 661	4 079	1 470	786	1 231	1 604	356	308	401	3 295
1	943	1 320	3 675	1 131	474	859	943	243	270	351
2	1 129	816	968	3 164	719	381	482	677	145	208
3	521	320	635	605	2 149	391	199	193	248	74
4	227	391	574	248	348	1 008	160	78	58	111
5	930	179	236	272	155	167	389	64	29	28
6	109	591	122	125	167	77	66	136	23	14
7	125	74	359	86	77	86	27	23	41	9
8	66	69	43	168	65	45	37	10	7	17
≥9	39	33	34	24	62	51	23	14	4	4
Total ≥2	3 146	3 074	2 971	4 690	3 741	2 206	1 383	1 197	555	466
Biomass ≥2 (tonnes x 10^{-3})	505	507	483	659	596	372	223	177	88	71

*) Inefficient estimates.

Table 4.11. Prognosis of the Division VIa herring, disregarding immigration.

Age	Stock in number (10^6)	F_{1978}	Stock in number (10^6) 1 Jan 1979	$\overline{W}$ (g)	F_{1979}	Stock in number (10^6) 1 Jan 1980
0		0.04				
1	351	0.11	(240)	90	0.11	
2	208	0.42	285	121	zero	195
3	74	0.60	124	158	"	258
4	111	0.60	37	175	"	112
5	28	0.60	55	186	"	33
6	14	0.60	14	206	"	50
7	9	0.60	7	218	"	13
8	17	0.60	4	224	"	6
≥9	4	0.60	10	224	"	13
Biomass (t x 10^{-3})	71.0		78.3			107.5

Table 4.12. Prognosis of Division VIa herring (1978,1979) taking immigration into account.

Age	N_b at 1 Jan 1977 (10^9)	F_b 1977	Survival at 1 Jan 1978	N_a at 1 Jan 1977 (10^9)	F_a 1977	E 1977	No. of emigrants which survive to 1 Jan 1978 *	Hence, N_b at 1 Jan 1978	Hence, N_a at 1 Jan 1978	C_b in 1978	F_b required to generate C_b **	E 1978	Survival of N_b at 1 Jan 1979	Survival of emigrants at 1 Jan 1979	Total N_b at 1 Jan 1979	$\bar{w}$ (g)
0										.117						
1										.036						
2	.10	.78		.54	.08	.09		(.100)	(.540)	.068	.74	.125	(.100)	(.098)	.198	121
3	.16	1.10	.041	.70	.31	.10	.028	.069	.412	.032	.42	.140	.043	.040	.083	158
4	.03	1.10	.048	.09	.13	.32	.030	.078	.420	.048	.49	.250	.045	.048	.093	175
5	.02	1.10	.009	.04	.17	.15	.012	.021	.052	.012	.66	.150	.043	.005	.048	186
6			.006				.003	.009	.026	.0060	1.20	.000	.010	-	.010	206
7													.002	-	.002	218
	From Tables 4.7 and 4.5			From Saville & Bailey (in press)												
Biomass t x 10^{-3}	46.4							42.4							64.8	
Biomass 2-5 ring. only	46.4							40.6							62.3	

N = stock in number, E = instantaneous emigration rate, C = catch in number and subscripts a, b refer to North Sea and VIa respectively.

*) Number of emigrants which survive = $\dfrac{EN_a\,(e^{-Z_b} - e^{-Z_a})}{E + F_a - F_b}$

**) F_b calculated from

$$C_b = \frac{N_b F_b}{Z_b}\left(1 - e^{-Z_b}\right) + \frac{N_a E F_b}{E + F_a - F_b}\left\{\left(\frac{1 - e^{-Z_b}}{Z_b}\right) - \left(\frac{1 - e^{-Z_a}}{Z_a}\right)\right\}$$

Table 4.13. Monthly landings (tonnes) of herring from the Firth of Clyde (all fishing methods combined). (Data provided by members of the Working Group.)

Month	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Jan	506	446	272	*	*	*	*	*	*	4*
Feb	1 820	1 569	491	52*	71*	91*	68*	7*	*	6*
Mar	232	263	495	82*	36*	168*	85	69*	*	7*
Apr	510	526	406	400	316	398	369	521	530	246
May	760	325	305	569	385	280	283	436	544	245
Jun	700	793	111	657	468	607	203	281	640	238
Jul	1 266	1 249	260	416	688	690	354	332	494	376
Aug	960	680	385	700	593	543	240	473	601	586
Sep	894	404	519	263	668	310	515	541	559	581
Oct	1 329	824	461	410	711	451	811	598	556	653
Nov	1 204	283	193	463	464	245	571	595	560	647
Dec	380	342	190	166	248	91	120	236	328	267
NK	33	59		48	67	189	44	50	35	
Total	10 594	7 763	4 088	4 226	4 715	4 063	3 663	4 139	4 847	3 857

*) Subject to closure of directed herring fishery.

Table 4.14. Catch in numbers x 10^{-3} autumn spawners in the Firth of Clyde, 1977 and 1978

Year	0	1	2	3	4	5	6	7	8	9	9+	Total
1977	-	1 034.1	6 119.7	4 067.5	831.3	912.8	442.0	398.6	229.7	101.5	182.5	14 319.7
1978	-	13 913.7	1 416.6	1 695.1	1 710.8	561.8	541.4	291.0	244.9	156.2	198.5	20 730.0

Table 4.15. Catch in numbers x 10^{-3} spring spawners in the Firth of Clyde, 1977 and 1978

Year	0	1	2	3	4	5	6	7	8	9	9+	Total
1977	-	6.7	1 404.6	2 908.9	230.4	198.8	132.3	90.4	21.2	44.5	9.8	5 047.6
1978	-	209.1	379.5	563.9	1 013.6	72.1	64.9	38.6	72.7	17.9	37.5	2 469.8

Table 4.16. Number of recaptures by month and area of herring released in the Firth of Clyde.

	(1) Released October 1976 No. recaptured					(2) Released July 1977 No. recaptured				
	Clyde	Irish Sea	N.W. Ireland	Minch	Unknown	Clyde	Irish Sea	N.W. Ireland	Minch	Unknown
1976 Oct.	10									
Nov.	108				1					
Dec.	10									
Total	128				1					
1977 Jan.	10									
Feb.	2				1					
Mar.	6	1								
Apr.	25									
May	30									
June	17		1							
Jul.	25					22				1
Aug.	14				1	57	2			
Sep.	13					56	1			1
Oct.	27				1	65	1			3
Nov.	24				1	42	1		2	1
Dec.	13		1			16				
Total	206	1	2		4	258	5		2	6
1978 Jan.	0					2				
Feb.	0					1				
Mar.	1					1				
Apr.	1					5				2
May	2					1				1
June	2					4				
Jul.	1					-				
Aug.	1					1				
Sep.	-					2				
Oct.	-					8				
Nov.	-					-				
Dec.	1				1	-				
Total	9				1	31				3
Grand Total	343	1	2		6	289	5		2	9

Table 5.1. Herring in Division VIIb,c. Nominal catches (tonnes) 1967-78. (Data for 1967-75 from Bulletin Statistique.)

Year	France	German Dem.Rep.	Germany Fed.Rep.	Ireland	Nether-lands	Poland	UK	USSR	Total
1967				108					108
1968	713			30	525				1 268
1969			71	145	355				571
1970	733		180	1 518	179			2	2 612
1971	42		52	1 646	61				1 801
1972	312		23	3 154	71			347	3 907
1973			5	5 036	200				5 241
1974	10		-	4 412	51		25	1 266	5 764
1975	20		914	5 576	9 815			646	16 971
1976		240	28	5 537	12 306	83		118	18 312
1977*				8 727	4 194			-	12 921
1978*				7 057	475				7 532

* Provisional.

Table 5.2. Catch in number x 10^{-3}, Division VIIb,c Herring.

Year	Winter rings									
	0	1	2	3	4	5	6	7	8	>8
1970	-	60	456	803	1 237	511	9 015	972	408	393
1971	-	387	124	429	532	602	404	6 077	605	316
1972	-	351	4 671	276	1 054	1 143	1 127	626	11 724	1 278
1973	44	4 972	5 270	3 782	1 932	1 117	870	824	729	14 084
1974	-	320	7 394	8 535	3 557	1 789	1 369	1 706	3 620	7 314
1975	962	10 105	15 279	24 409	16 874	11 194	3 911	5 040	5 058	14 877
1976	62	7 717	14 688	16 823	19 733	15 171	5 136	2 624	2 362	10 050
1977	-	2 220	30 016	7 646	9 835	7 415	6 241	3 893	722	1 957
1978	-	1 965	15 829	14 229	4 068	3 678	2 208	1 782	704	1 267

Table 6.1 Irish Sea Herring (Division VIIa). Mean vertebral count by stock, year class and age of fish (no. of fish in samples in brackets). Spawning fish caught on spawning grounds and Irish Sea industrial fishery.

Age / Year class	Mourne stock				Manx stock				Industrial fishery		
	1	2	3	4	1	2	3	4	0	1	2
1969	56.64 (285)	56.63 (263)	56.65 (161)	56.56 (97)	No 1 ring spawners	56.21 (424)	56.22 (231)	56.39 (217)	56.59 (118)	56.60 (10)	56.71 (7)
1970	56.84 (87)	56.71 (216)	56.72 (98)	56.92 (36)		56.15 (208)	56.21 (175)	56.30 (174)	56.74 (500)	56.81 (229)	- (0)
1971	56.79 (87)	56.65 (190)	56.68 (37)	56.65 (20)		56.37 (577)	56.34 (383)	56.35 (188)	56.72 (619)	56.70 (257)	56.89 (9)
1972	56.77 (172)	56.71 (86)	56.73 (44)	56.89 (9)		56.26 (363)	56.27 (173)	56.25 (112)	56.69 (303)	56.80 (125)	- (0)
1973	56.70 (92)	56.83 (106)	56.73 (26)	56.87 (38)		56.31 (542)	56.27 (229)	56.46 (70)	56.81 (246)	56.71 (217)	56.67 (6)
1974	56.75 (84)	56.76 (88)	56.75 (171)			56.13 (384)	56.29 (118)		56.71 (217)	56.75 (314)	- (0)
1975	56.67 (18)	56.59 (323)	Not yet recruited			56.27 (239)	Not yet recruited		56.70 (109)	56.75 (173)	- (0)
1976	56.56 (153)								- (0)	56.36 (25)	- (0)
1977									56.82 (34)	56.60 (25)	- (0)

Table 6.2. Herring. Total catches in North Irish Sea (Division VIIa), 1967-78 (includes industrial catch).

Country	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978*)
France	-	-	-	558	1 815	1 224	254	3 194	813	651	85	174
Ireland	118	68	2 328	3 933	3 131	2 529	3 614	5 894	4 790	3 205	3 331	2 371
Netherlands	-	-	-	-	-	260	143	1 116	630	989	500	98 1)
UK	7 145	8 389	9 821	17 912	21 861	23 337	18 587	27 489	18 244	16 401	11 498	8 432
USSR	-	-	-	-	-	-	-	945	26	-	-	
Total	7 263	8 457	12 149	22 403	26 807	27 350	22 598	38 638	24 503	21 246	15 414	11 075

*) Preliminary. 1) Includes 68.5 tonnes of spring-spawned herring.

Table 6.3. Herring. Total catch by stock in North Irish Sea, 1967-78.

Country	1967		1968		1969		1970		1971		1972	
	1	2	1	2	1	2	1	2	1	2	1	2
France	-	-	-	-	-	-	558	-	1 815	-	1 224	-
Ireland	-	118	-	68	-	2 328	-	3 933	-	3 131	-	2 529
Netherlands	-	-	-	-	-	-	-	-	-	-	260	-
UK	5 885	1 260	7 645	744	9 139	682	15 629	2 283	18 758	3 103	19 308	4 029
USSR	-	-	-	-	-	-	-	-	-	-	-	-
Total Manx	5 885		7 645		9 139		16 187		20 573		20 792	
Total Mourne	1 378		812		3 010		6 216		6 234		6 558	

(ctd.)

Country	1973		1974		1975		1976		1977		1978*)	
	1	2	1	2	1	2	1	2	1	2	1	2
France	254	-	3 194	-	813	-	651	-	85	-	87	87
Ireland	-	3 614	1 783	4 111	2 406	2 384	1 816	1 389	2 009	1 322	610	1 761
Netherlands	-	143	1 116	-	630	-	989	-	500	-	98	-
UK	13 071	5 516	23 639	3 850	15 408	2 836	12 831	3 570	9 837	1 661	7 663	700
USSR	-	-	945	-	26	-	-	-	-	-	-	-
Total Manx	13 325		30 677		19 283		16 287		12 431		8 458	
Total Mourne	9 273		7 961		5 220		4 959		2 983		2 548	

Note

1 = Manx stock
2 = Mourne stock
*) Preliminary

Table 6.4. Manx stock herring. Catch in number x 10^{-6}.

Year \ Rings	1	2	3	4	5	6	7	8 and 8+	Total 2 to 8+
1965	0.31	20.78	6.78	1.03	0.46	0.63	0.41	0.39	30.48
1966	0.18	3.89	7.91	1.88	0.33	0.27	0.18	0.07	14.53
1967	1.02	17.82	4.79	7.61	1.80	0.38	0.20	0.40	33.00
1968	0.44	24.46	11.29	2.68	4.33	0.70	0.06	0.29	43.81
1969	0.19	22.84	14.25	6.24	2.47	1.97	0.42	0.02	48.21
1970	0.75	25.24	27.89	13.24	9.42	2.88	2.66	0.31	81.64
1971	4.98	54.36	21.91	18.68	9.67	3.41	1.74	1.16	110.93
1972	3.64	41.76	26.05	11.28	13.15	6.46	1.96	1.27	101.93
1973	1.75	18.74	22.74	10.69	5.52	4.07	2.09	1.40	65.28
1974	12.95	95.95	32.55	19.41	9.65	4.09	4.55	1.03	167.23
1975	5.63	38.94	36.61	9.44	6.17	4.11	1.89	1.34	98.50
1976	9.34	47.46	17.38	13.62	3.88	2.41	2.32	1.07	88.14
1977	13.98	33.04	20.29	5.85	3.92	1.16	0.81	1.02	66.09
1978	3.64	32.41	11.41	6.18	1.44	1.24	0.57	0.35	53.60

Table 6.5. Mourne stock herring. Catch in number x 10^{-6}.

Year \ Rings	0	1	2	3	4	5	6	7	8	8+
1969	48.1	18.2	7.7	1.0	0.0	0.0	0.0	0.0	0.0	0.0
1970	161.5	23.7	3.6	1.4	0.0	0.0	0.0	0.0	0.0	0.0
1971	100.3	47.4	33.1	12.9	1.1	0.4	0.5	0.2	0.2	0.03
1972	78.4	37.0	14.9	0.9	1.9	0.6	0.3	0.7	0.1	0.3
1973	50.2	40.4	14.0	15.5	0.8	1.4	1.0	0.5	1.0	0.2
1974	57.9	30.3	13.6	7.2	5.1	1.0	0.9	0.6	0.2	0.4
1975	20.3	27.7	9.3	2.8	1.4	1.7	0.1	0.2	0.2	0.1
1976	10.4	25.4	8.7	3.4	1.6	0.7	0.4	0.1	0.1	0.1
1977	26.4	16.3	6.0	2.4	0.9	0.6	0.3	0.1	0.1	0.0
1978	20.8	11.9	4.5	2.0	0.6	0.3	0.1	0.1	0.0	0.0

Table 6.6. North Irish Sea. Catch of herring in number (10^{-6}) by year and by age in the industrial fishery.

Age (rings) \ Year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
0	48.1	161.5	100.3	78.4	50.2	57.9	20.3	10.4	26.4	20.8
1	18.2	23.7	30.3	28.8	29.7	19.0	21.6	11.7	13.3	7.1
2	7.7	3.6	3.5	1.8	0.6	2.3	1.5	0.1	0.3	0.2
3	1.0	1.4	0.4	0.3	0.5	0.8	0.6	-	-	-
Total	75.0	190.2	134.5	109.3	81.0	80.0	44.0	22.2	40.0	28.1
Total in tons	2 210	3 796	2 715	2 251	1 913	2 190	1 573	779	1 174	739
N/kg	33.9	50.1	49.5	48.6	42.3	36.5	28.0	28.5	34.0	38.0

Table 6.7. Manx stock herring. Estimates of F from VPA, 1967 to 1977, with various input F for 1978.

Input year	F						Effort
1978	0.20	0.25	0.30	0.35	0.40	0.45	
1977	0.41	0.49	0.55	0.61	0.66	0.70	2 208
1976	0.63	0.69	0.73	0.77	0.80	0.82	2 471
1975	0.76	0.79	0.81	0.82	0.84	0.84	2 770
1974	0.87	0.89	0.90	0.90	0.91	0.91	4 083
1973	0.40	0.41	0.41	0.41	0.41	0.41	1 362
1972	0.58	0.58	0.58	0.58	0.58	0.58	1 958
1971	0.58	0.58	0.58	0.58	0.58	0.58	2 699
1970	0.45	0.45	0.45	0.45	0.45	0.45	1 455
1969	0.27	0.27	0.27	0.27	0.27	0.27	1 151
1968	0.34	0.34	0.34	0.34	0.34	0.34	1 395
1967	0.37	0.37	0.37	0.37	0.37	0.37	851
Correlation r^2	0.8300	0.8555	0.8544	0.8381	0.8189	0.8010	
r	0.911	0.925	0.924	0.915	0.905	0.895	
N		11	11	11	11	11	
Intercept		0.1412	0.1393				
Slope		0.000192	0.000199				

Table 6.8 Manx Stock herring. Fishing mortalities by year and by age (from VPA, M = 0.10)

		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Age (rings)	2	0.34	0.34	0.23	0.37	0.59	0.51	0.28	0.87	0.77	0.65	0.52	[0.3]
	3	0.28	0.33	0.30	0.43	0.56	0.56	0.51	0.97	0.87	0.84	0.57	[0.3]
	4	0.47	0.22	0.28	0.46	0.52	0.55	0.42	0.99	0.74	0.85	0.67	[0.3]
	5	0.70	0.47	0.29	0.75	0.62	0.74	0.51	0.73	0.90	0.68	0.56	[0.3]
	6	1.56	0.57	0.36	0.58	0.60	1.02	0.47	0.77	0.71	0.98	0.39	[0.3]
	7	0.41	1.08	0.72	1.04	0.74	0.73	1.01	1.35	0.91	1.04	0.97	[0.3]
	8+	[0.37]	[0.34]	[0.26]	[0.46]	[0.57]	[0.58]	[0.41]	[0.90]	[0.81]	[0.73]	[0.55]	[0.3]
$\bar{F}_W$ (2-7)		0.37	0.34	0.27	0.45	0.58	0.58	0.41	0.90	0.81	0.73	0.55	

[input values in square brackets]

Table 6.9 Manx Stock Herring. Stock size in numbers (x 10^{-6})
(Input F_2^8 1978 = 0.30)

		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Age	1	98.81	128.15	95.04	140.92	126.06	93.08	194.07	98.16	120.85	104.57	159.56	(79.13)
	2	64.86	88.44	115.54	85.82	126.79	110.03	80.76	173.94	76.50	103.99	85.73	131.10
	3	20.52	41.79	56.83	82.87	53.73	63.65	59.84	55.25	66.11	32.18	48.95	46.15
	4	21.27	14.02	27.11	37.91	48.56	28.02	32.82	32.50	19.03	25.0	12.59	24.99
	5	3.74	12.04	10.14	18.61	21.76	26.43	14.62	19.53	10.96	8.24	9.66	5.82
	6	.50	1.68	6.79	6.84	7.94	10.61	11.40	7.98	8.49	4.04	3.77	5.01
	7	.63	.09	.86	4.28	3.46	3.99	3.46	6.45	3.33	3.77	1.37	2.31
	8+	.51	.38	.03	.38	1.36	1.49	1.74	1.14	1.51	1.22	1.21	0.47
Size age ≥2		112.02	158.44	217.30	236.69	263.59	244.22	204.62	296.79	185.93	178.44	163.28	215.85

Table 6.10. Mourne stock herring. Fishing mortalities by year and by age.

Age (rings) \ Year	1969	1970	1971	1972	1973	1974	1975	1976	1977*)	Mean 1971-76
0	0.51	0.94	0.87	0.76	0.67	0.79	0.36	0.23	0.75	0.61
1	?	0.46	0.71	0.83	1.05	1.02	1.01	0.93	0.60	0.93
2	?	?	2.25	0.44	0.79	1.18	0.92	0.93	0.52	1.09
3	?	?	1.21	0.29	1.02	1.14	0.71	0.92	0.63	0.88
4	?	?	0.29	0.46	0.41	1.06	0.64	1.01	0.61	0.65
5	?	?	0.23	0.25	0.68	1.16	1.21	0.60	1.31	0.69
6	?	?	0.18	0.26	0.69	1.10	0.22	0.84	0.42	0.55
7	?	?	0.27	0.31	0.79	1.06	0.52	0.57	0.69	0.59
8	?	?	0.33	0.12	0.86	0.99	0.82	1.07	1.26	0.70
$\bar{F}_w$ (0-8 rings)	?	?	0.98	0.70	0.82	0.92	0.67	0.63	0.66	
$\bar{F}_w$ (1-8 rings)	?	?	1.09	0.64	0.96	1.08	0.96	0.92	0.59	

Table 6.11. Mourne stock herring. Stock size in numbers ($\times 10^{-6}$) (from Cohort analysis).

Age (rings) \ Year	1969	1970	1971	1972	1973	1974	1975	1976	1977*)	1978*)
0	126	278	181	154	108	111	70	52	52	?
1	?	68	98	69	65	50	46	44	38	23
2	?	?	39	44	27	21	16	15	16	20
3	?	?	19	4	25	11	6	6	5	9
4	?	?	4	5	3	8	3	3	2	3
5	?	?	2	3	3	2	3	2	1	1
6	?	?	3	1	2	1	0	1	1	0
7	?	?	1	3	1	1	0	0	0	0
8	?	?	1	0	2	0	0	0	0	0
Total stock in numbers (0-8 rings)	?	?	348	283	236	205	144	123	115	?
Total stock in numbers (1-8 rings)	?	?	167	129	128	94	74	71	63	56
Total stock biomass (tonnes) (1-8 rings)	?	?	18 433	14 824	15 716	11 245	7 867	7 599	6 742	7 215

*) Inefficient estimates

Table 7.1. Sprat catches in the North Sea ('000 tonnes), 1968-1978.
(Data provided by Working Group members.)

Country	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978a)
					IVa West						
Denmark	–	–	–	–	–	–	5.3	0.5	0.6	0.1	–
Faroe Islands	–	–	–	–	–	–	0.2	12.9	2.5	0.4	–
France	–	–	–	–	–	–	–	–	–	+	–
German Dem.Rep.	–	–	–	–	–	–	–	–	–	+	–
Germany, Fed.Rep. of	–	–	–	–	–	+	–	–	+	0.6	–
Netherlands	+	+	+	+	+	+	+	+	+	+	–
Norway	–	–	–	0.9	2.2	–	–	1.5	29.9	16.0	1.3
Poland	–	–	–	–	+	+	–	0.3	–	–	–
Sweden	–	–	–	–	–	1.0	2.2	11.0	+	0	–
UK (England)	–	–	–	+	–	0.2	–	–	–	0	–
UK (Scotland)	13.0	12.4	3.8	15.0	29.8	49.4	41.2	9.4	12.7	26.9	16.9
USSR	–	–	–	–	–	–	1.0	1.3	1.2	+	–
Total	13.0	12.4	3.8	15.9	32.0	50.6	49.9	36.9	46.9	44.0	18.2
					IVa East (North Sea stock)						
Denmark	–	–	–	–	–	–	–	–	0.2	0.1	–
Norway	–	–	–	–	–	–	–	–	1.9	0.7	0.1
UK (Scotland)	–	–	–	–	–	–	–	–	+	0	–
Total	–	–	–	–	–	–	–	–	2.1	0.8	0.1
					IVb West						
Belgium	–	–	–	–	–	–	–	–	+	0	–
Denmark	...	...	8.6	9.9	14.4	47.0	55.4	106.6	104.4	57.5	44.1
Faroe Islands	–	–	–	–	–	–	4.0	30.0	42.9	1.8	–
France	1.0	–	–	–	–	–	–	–	–	+	–
German Dem.Rep.	–	–	–	–	–	–	1.7	4.5	6.4	0.7	–
Netherlands	+	2.0	+	+	+	–	–	–	–	0	–
Norway	–	–	–	–	4.1	3.4	9.5	145.7	73.0	5.5	56.2
Poland	+	–	–	–	+	–	–	9.1	10.5	0	–
Sweden	–	–	–	–	–	–	–	–	7.9	0	–
UK (England)	2.6	3.3	11.2	25.5	21.8	34.6	25.5	32.5	49.7	51.9	53.9
UK (Scotland)	13.4	22.0	9.5	7.2	3.6	2.9	8.6	4.9	18.1	10.9	14.8
USSR	–	–	–	1.2	0.8	17.9	32.9	47.8	50.4	1.6	–
Total	17.0	27.3	29.3	43.8	44.7	105.8	137.7	381.1	362.3	123.9	169.0

/Cont'd.

a)Preliminary figures as reported. + = less than 0.1. ... = No data available. – = Magnitude known to be nil.

Table 7.1 (Continued).

Country	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978[a]
					IVb East						
Denmark	18.1	18.5	16.2	19.9	28.8	93.9	104.0	215.2	201.1	126.8	161.0
German Dem.Rep.	–	–	–	–	–	–	–	0.4	–	0.7	–
Germany, Fed.Rep.of	16.7	6.3	7.6	5.1	1.7	11.0	17.5	0.5	1.7	4.3	–
Norway	–	–	–	–	–	–	–	–	5.1	0	29.8
Sweden	–	–	–	–	–	–	–	–	–	1.5	–
Total	34.8	24.8	23.8	25.0	30.5	104.9	121.5	216.1	207.9	133.3	190.8
					IVc						
Belgium	0.4	0.4	0.6	0.1	0.1	0.2	+	+	–	0	–
Denmark	–	–	–	–	–	–	0.9	3.9	0.3	1.4	–
France	+	0.1	+	+	–	+	0.3	0.1	–	+	–
German Dem.Rep.	–	–	–	–	–	–	–	–	0.1	+	–
Germany, Fed.Rep.of	–	–	+	–	+	–	–	–	–	0.4	–
Netherlands	1.0	1.6	1.5	1.0	0.4	+	+	0.2	–	0	–
Norway	–	–	–	–	–	–	–	–	–	–	0.2
UK (England)	6.2	4.2	3.9	0.2	+	0.8	3.4	2.9	0.7	0.2	0.0
USSR	–	–	–	–	–	–	+	+	0.2	–	–
Total	7.6	6.3	6.0	1.3	0.5	1.0	4.6	7.1	1.3	2.0	0.2
					Total North Sea						
Belgium	0.4	0.4	0.6	0.1	0.1	0.2	+	+	+	+	+
Denmark	18.1	18.5	24.8	29.8	43.2	140.9	165.6	326.2	306.6	179.9	205.1
Faroe Islands	–	–	–	–	–	–	4.2	42.9	45.4	2.2	–
France	1.0	0.1	+	+	–	+	0.3	0.1	–	+	–
German Dem.Rep.	–	–	–	–	–	–	1.7	4.9	6.5	1.4	–
Germany, Fed.Rep.of	16.7	6.3	7.6	5.1	1.7	11.0	17.5	0.5	1.7	5.3	–
Netherlands	1.0	3.6	1.5	1.0	0.4	+	+	0.2	+	+	–
Norway	–	–	–	0.9	6.3	3.4	9.5	147.2	109.9	22.2	87.6
Poland	+	–	–	–	+	+	–	9.4	10.5	+	–
Sweden	–	–	–	–	–	1.0	2.2	11.0	7.9	1.5	–
UK (England)	8.8	7.5	15.1	25.7	21.8	35.6	28.9	35.4	50.4	52.1	53.9
UK (Scotland)	26.4	34.4	13.3	22.2	33.4	52.3	49.8	14.3	30.8	37.8	31.7
USSR	–	–	–	1.2	0.8	17.9	33.9	49.1	51.8	1.6	–
Total	72.4	70.8	62.9	86.0	107.7	262.3	313.6	641.2	621.5	304.0	378.3

Table 7.2. North Sea sprat catch in 1974-77. Numbers caught per age group x 10^6 in each three-month period.

Year	Months	Age group						
		0	1	2	3	4	5	6
1974	Jan-Mar	-	7 620.0	7 341.8	1 043.2	198.7	40.3	-
	Apr-Jun	-	361.8	2 083.5	148.6	26.1	4.7	-
	Jul-Sep	46.7	4 909.8	1 784.7	36.2	0.9	4.6	-
	Oct-Dec	1 549.3	6 172.9	865.1	74.5	10.6	7.2	-
1975	Jan-Mar	-	4 096.6	14 973.2	3 929.0	233.7	14.1	-
	Apr-Jun	-	446.2	1 163.2	68.9	6.5	-	-
	Jul-Sep	15.0	10 588.1	5 760.0	75.1	3.1	-	-
	Oct-Dec	675.2	6 351.6	6 122.5	660.2	57.3	4.4	-
1976	Jan-Mar	-	9 360.9	9 997.0	6 678.0	373.0	6.2	1.4
	Apr-Jun	-	2 017.2	964.6	740.1	40.9	0.8	-
	Jul-Sep	79.6	16 536.4	599.5	40.1	-	-	-
	Oct-Dec	2 780.4	8 443.7	2 659.4	612.7	37.1	-	-
1977	Jan-Mar	-	4 197.2	11 962.6	962.9	104.7	12.0	-
	Apr-Jun	-	540.3	670.9	52.7	1.5	-	-
	Jul-Sep	57.3	2 803.1	3 248.4	165.9	11.1	-	-
	Oct-Dec	1 060.8	4 705.0	3 049.5	311.2	1.5	-	-
1978	Jan-Mar	-	2 461.9	2 839.3	3 770.1	344.5		
	Apr-Jun	-	1 077.5	123.8	3.2	0		
	Jul-Sep	6.3	17 785.5	216.5	14.7	0.7		
	Oct-Dec	636.8	6 932.7	3 955.8	1 159.0	214.9		
1979	Jan-Mar		2 000	6 000	2 000			

Table 7.3. Total North Sea sprat catch 1974-78. Numbers caught per age group x 10^{-6} in each Division.

Area	Year	Age group 0	1	2	3	4	5	6
IVaW	1974	961.6	2 963.1	693.0	112.0	12.2	-	-
	1975	267.2	2 011.1	1 025.4	363.6	11.1	2.2	-
	1976	938.5	2 777.2	715.0	365.3	26.5	0.3	-
	1977	472.5	3 354.4	1 255.8	212.3	5.9	-	-
	1978	199.0	2 312.2	226.9	175.0	15.7	-	-
IVaE	1976	6.1	46.1	38.0	24.8	1.3	-	-
	1977	1.3	26.1	15.3	7.8	-	-	-
	1978	-	1.3	4.8	0.7	0.1	-	-
IVbW	1974	609.4	6 848.1	6 033.4	1 095.6	220.8	49.5	20.7
	1975	665.4	5 110.0	17 287.0	4 396.0	282.7	17.0	-
	1976	1 004.2	14 903.6	12 280.6	7 586.0	423.0	6.7	1.4
	1977	480.8	3 878.1	8 538.4	1 144.2	112.1	12.0	-
	1978	444.1	3 839.6	4 917.9	439.0	490.6	2.4	-
IVbE	1974	3.3	8 486.7	4 727.9	116.5	1.7	3.9	-
	1975	9.8	13 169.0	9 282.0	149.5	6.3	-	-
	1976	911.2	18 631.4	1 193.1	94.9	0.2	-	0.01
	1977	163.5	4 941.4	8 779.7	108.4	-	-	-
	1978	-	23 179.4	1 977.5	370.1	56.1	-	-
IVc	1974	21.7	766.2	620.8	28.6	1.8	3.3	-
	1975	-	1 182.4	499.1	45.8	1.8	-	-
	1976	-			Negligible			
	1977	-	45.6	342.2	20.0	0.8	-	-
	1978	-	0.2	6.8	10.9	0.2	-	-
Total								
34 401.8	1974	1 596.0	19 064.1	12 075.1	1 352.7	236.5	56.7	20.7
55 784.4	1975	942.4	21 472.5	28 093.5	4 954.9	301.9	19.2	-
61 975.4	1976	2 860.0	36 358.3	14 226.7	8 071.0	451.0	7.0	1.4
33 918.6	1977	1 118.1	12 245.6	18 931.4	1 492.7	118.0	12.0	-
41 543.2	1978	643.1	28 257.6	7 135.4	4 947.0	560.1	-	-

Table 7.4. North Sea sprat. Quarterly stocks and fishing mortality (F). Quarterly M = 0.2.

Year	Quarter \ Age	Stock x 10^9					Total biomass x 10^6 t	F				
		0	1	2	3	4		0	1	2	3	4
1974	1	-	167.8	31.6	2.5	0.3	0.71	-	0.052	0.297	0.614	1.299
	2	-	130.5	19.2	1.1	0.1	0.51	-	0.003	0.128	0.160	0.558
	3	150.5	106.5	13.8	0.8	+	1.37	0.000	0.052	0.154	0.053	0.032
	4	123.2	82.8	9.7	0.6	+	1.23	0.014	0.086	0.104	0.147	0.620
1975	1	-	99.5	62.2	7.2	0.4	0.89	-	0.047	0.309	0.930	0.930
	2	-	77.7	37.4	2.3	0.1	0.58	-	0.006	0.035	0.033	0.054
	3	237.6	63.2	29.5	1.8	0.1	1.48	0.000	0.205	0.243	0.046	0.033
	4	194.5	42.2	19.0	1.4	0.1	1.24	0.004	0.182	0.441	0.711	1.312
1976	1	-	158.6	28.8	10.0	0.6	0.79	-	0.067	0.484	1.341	1.256
	2	-	121.4	14.5	2.1	0.1	0.46	-	0.019	0.076	0.481	0.410
	3	165.6	97.6	11.0	1.1	0.1	1.32	0.001	0.207	0.062	0.042	0.000
	4	135.5	64.9	8.4	0.9	0.1	1.09	0.023	0.155	0.425	1.591	1.118
1977	1	-	108.4	45.5	4.5	0.1	0.72	-	0.044	0.343	0.267	1.693
	2	-	85.0	26.4	2.8	+	0.50	-	0.007	0.028	0.021	0.081
	3	236.5	69.1	21.0	2.3	+	1.42	0.000	0.046	0.187	0.084	1.429
	4	193.5	54.0	14.3	1.7	+	1.26	0.006	0.101	0.269	0.223	0.728
1978	1	-	157.5	40.0	8.9	1.1	0.85	-	0.017	0.082	0.628	0.413
	2	-	126.7	30.2	3.9	0.6	0.66	-	0.009	0.005	0.001	0.000
	3	61.7	102.8	24.6	3.2	0.5	1.17	0.000	0.212	0.010	0.005	0.002
	4	50.5	68.0	19.9	2.6	0.4	1.01	0.014	0.119	0.246	0.666	0.850

Table 7.5. North Sea sprat. Pelagic biomass from acoustic surveys.

	Biomass in thousand tonnes			
Year	1978		1979	
Month	Jan	Feb	Feb	
Ship	Scotia	Corella	Scotia	Corella
Scottish northeast coast	86		133	
English northeast coast	174	194		83
Wash		23	Not surveyed	
Calibration grid			20	23

Fig. 3.1 Celtic Sea Herring. Abundance of larvae< 10 mm with fitted normal curves

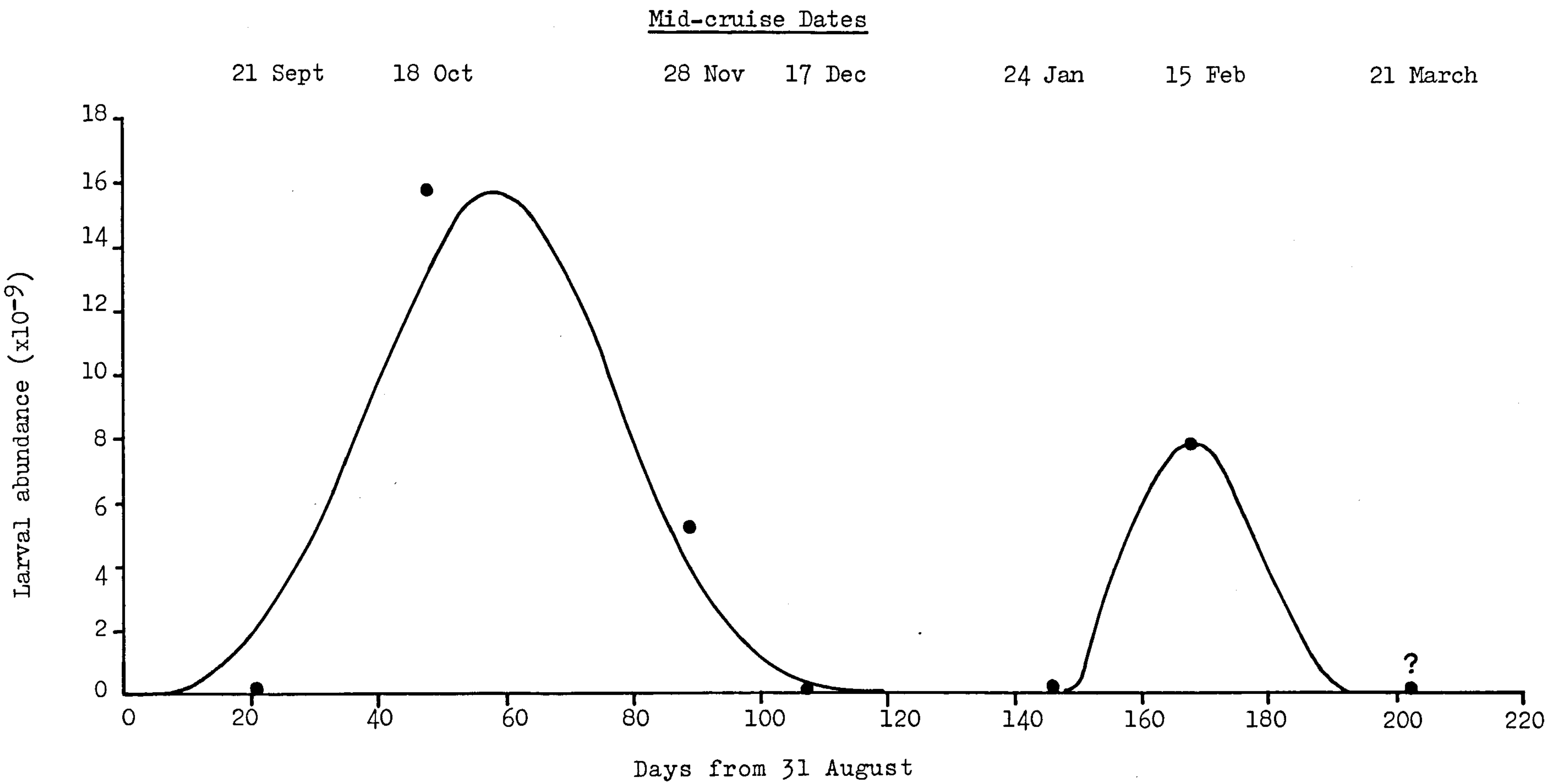


Fig. 3.2 Celtic Sea Herring.
Adult Stock biomass (at 1 April) against
Recruitment numbers (1 ringers two years later)

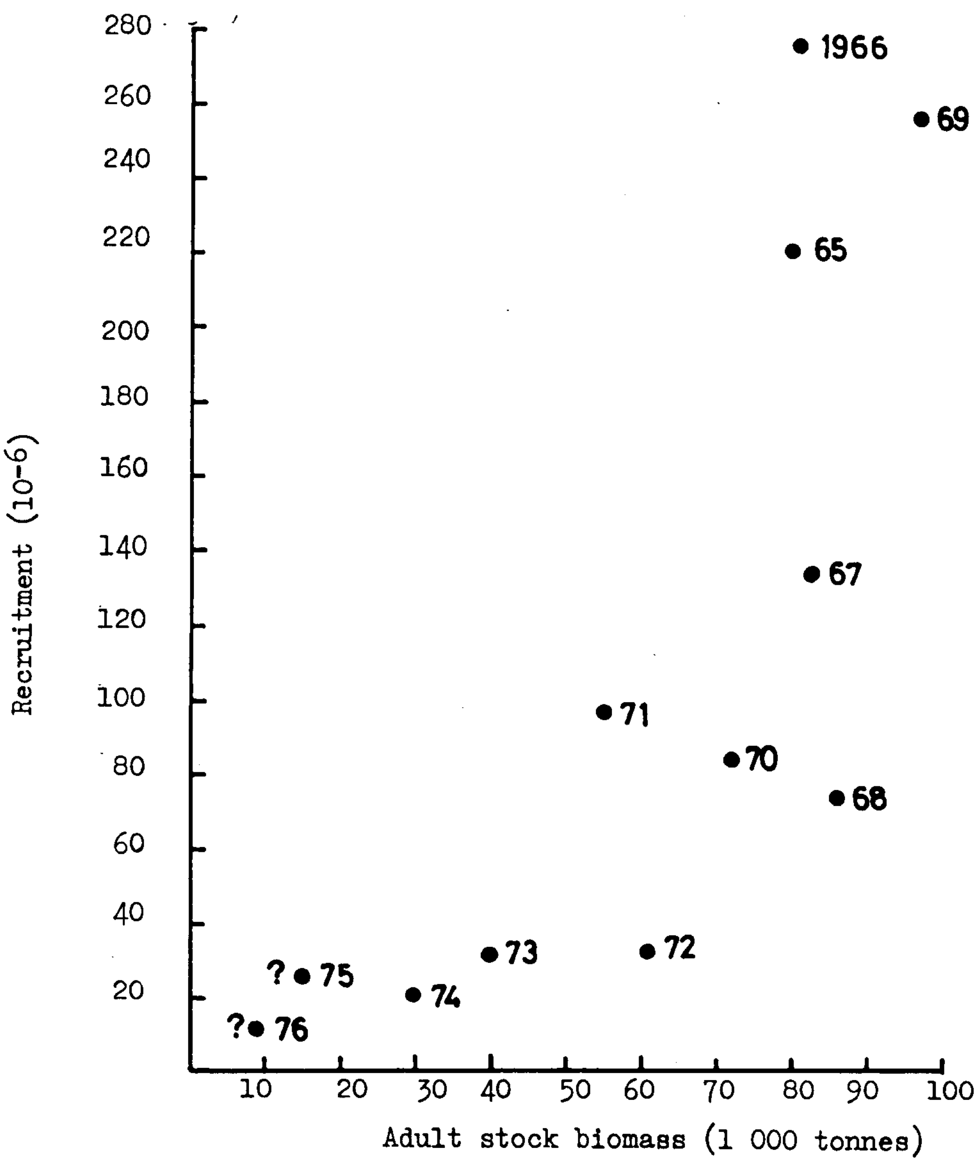


Fig. 4.1 Division VIa Herring
Adult stock biomass against recruitment numbers

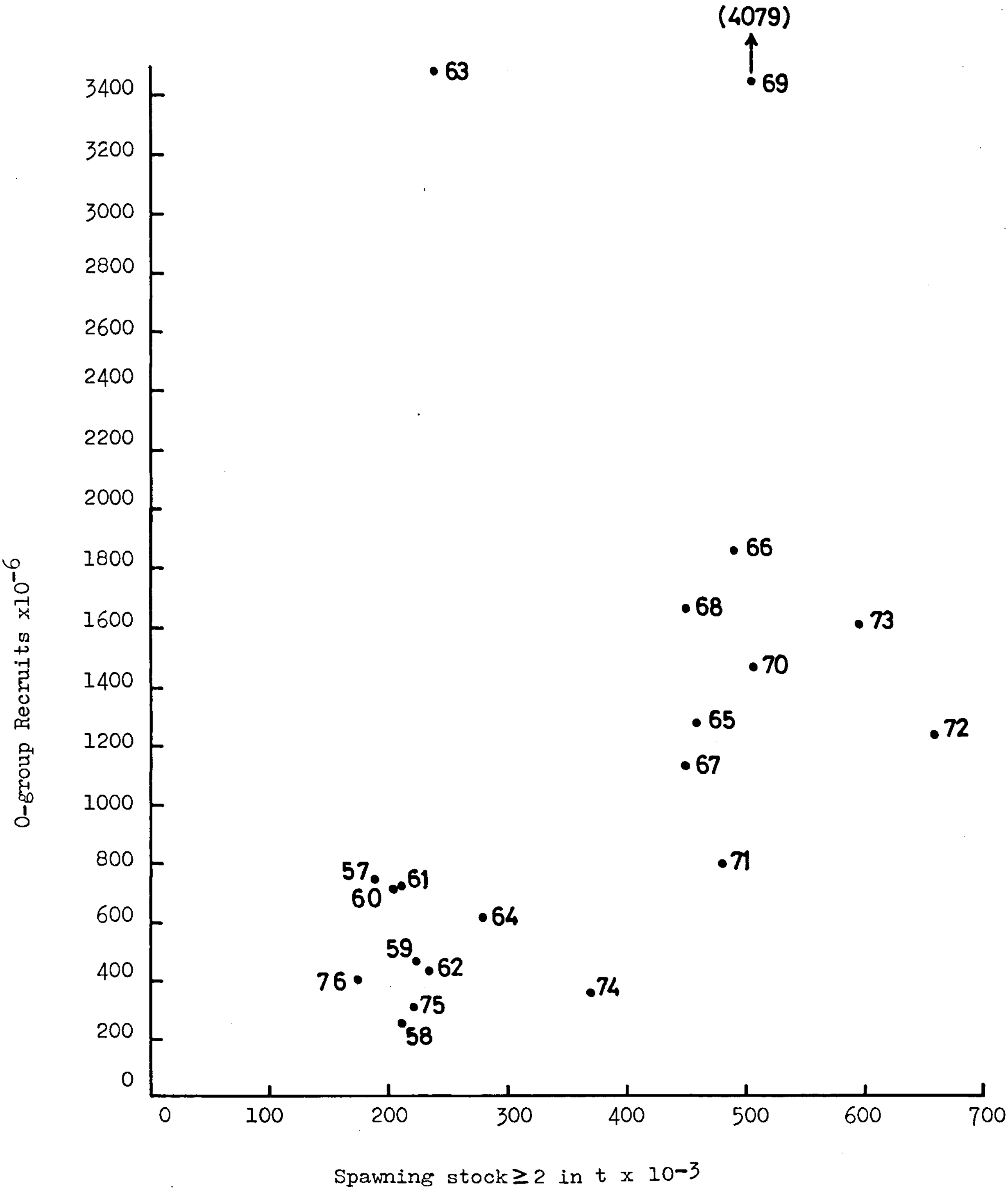


Fig. 6.1 Mourne Stock Decline in O-group Abundance

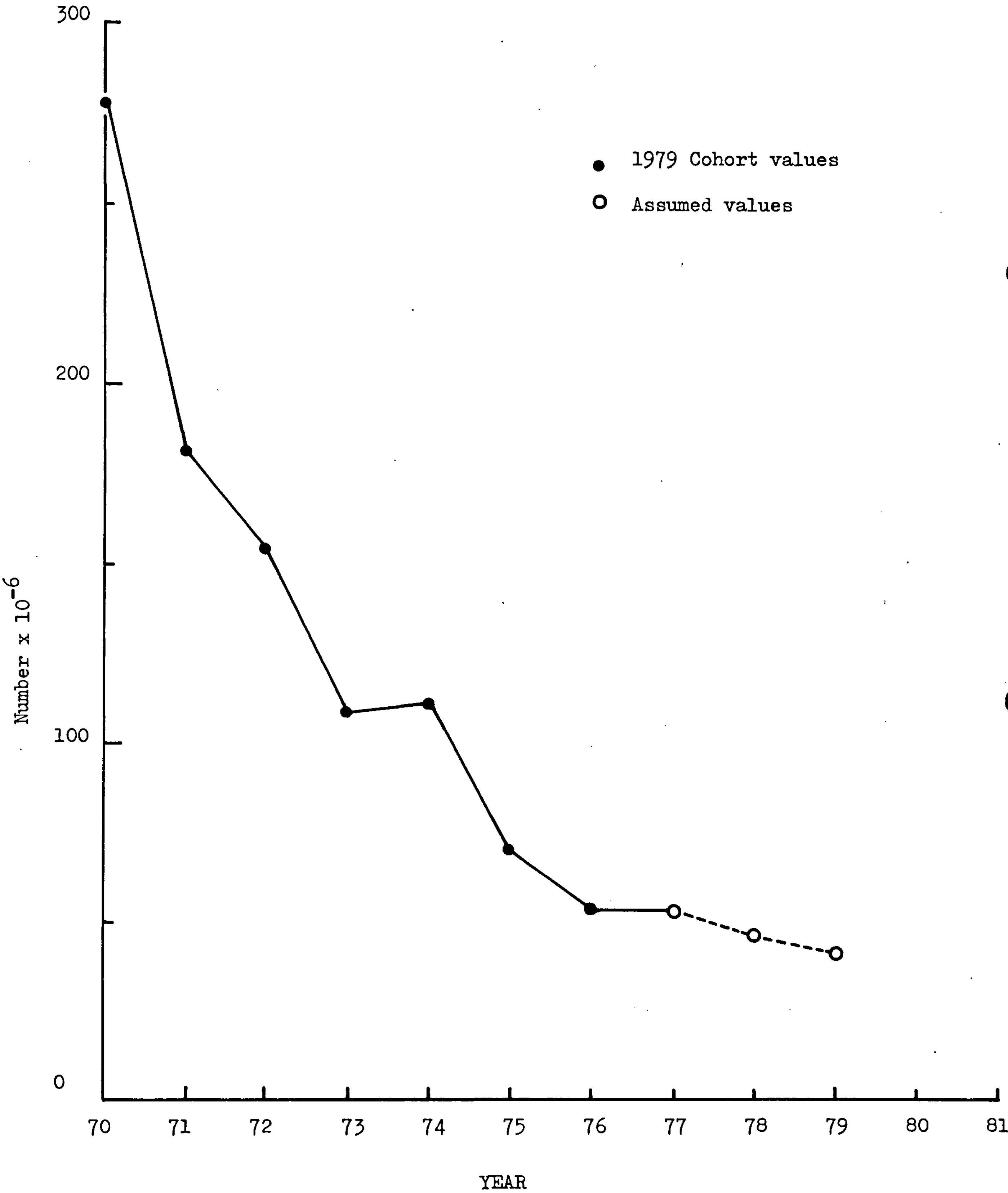


Fig. 7.1 North Sea Sprat.
Quarterly estimates of F for varying input F values as percentage of initial F = 0.28 in 4 ringers quarter 4, 1978.

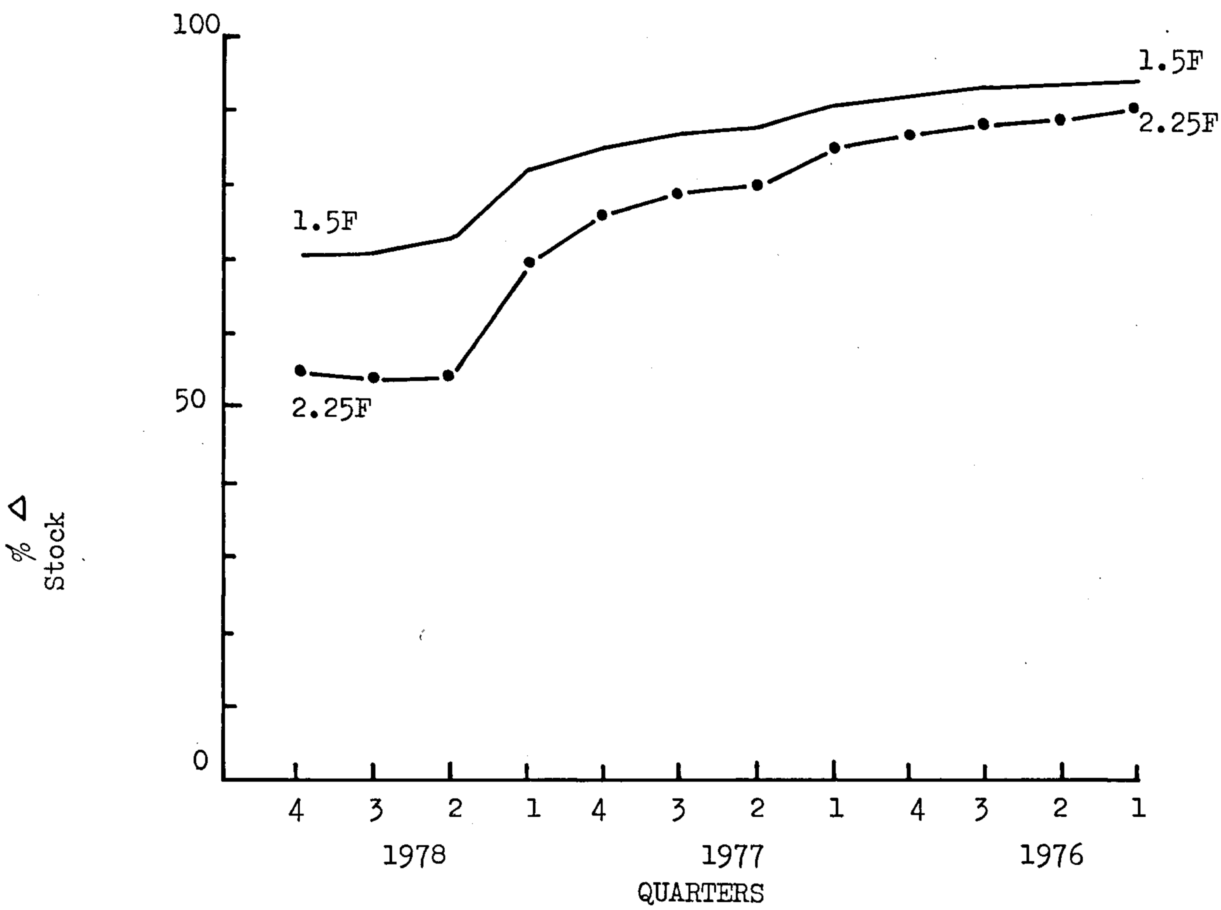
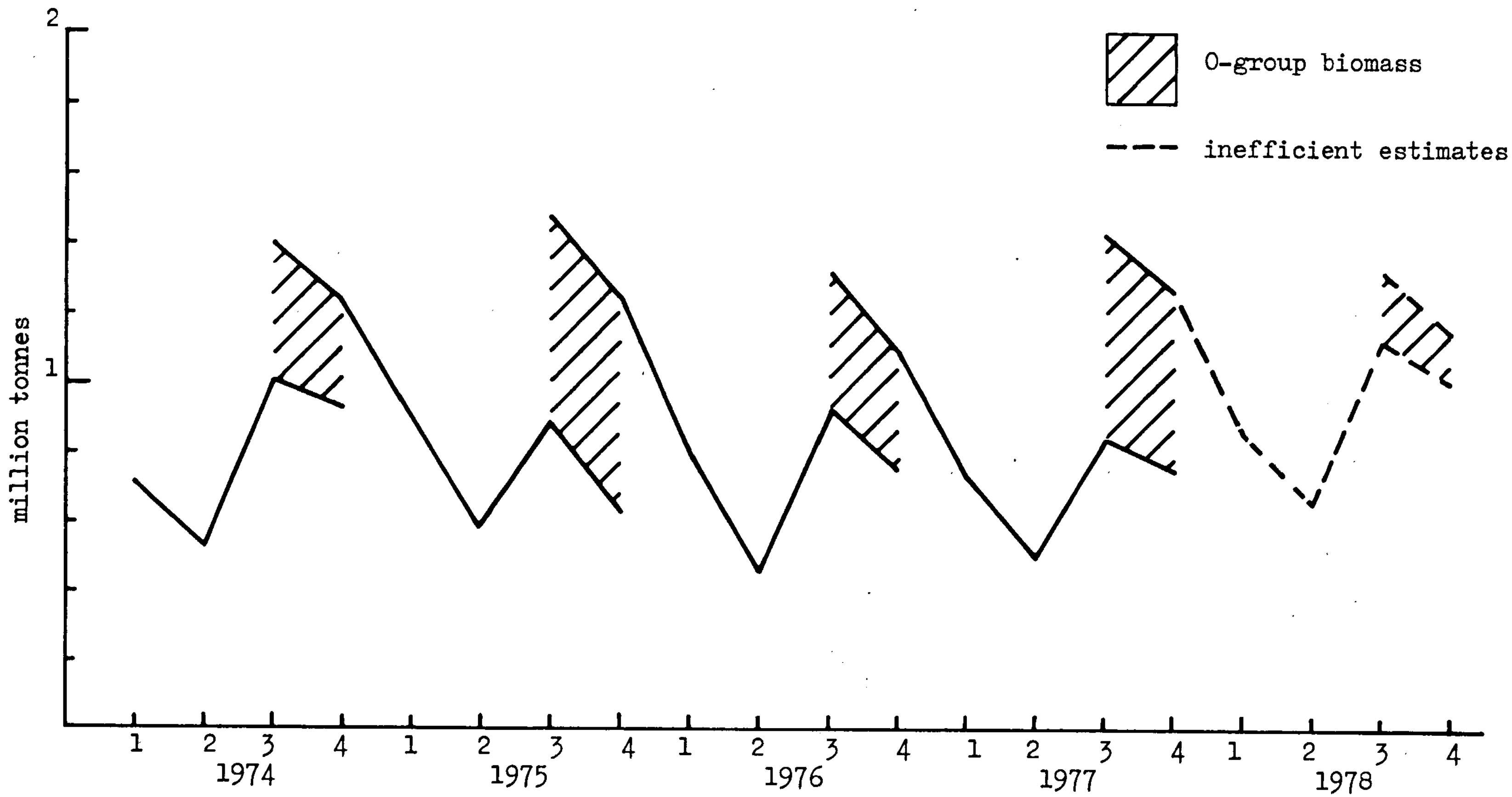


Fig. 7.2   North Sea Sprat. Quarterly Biomass Estimates



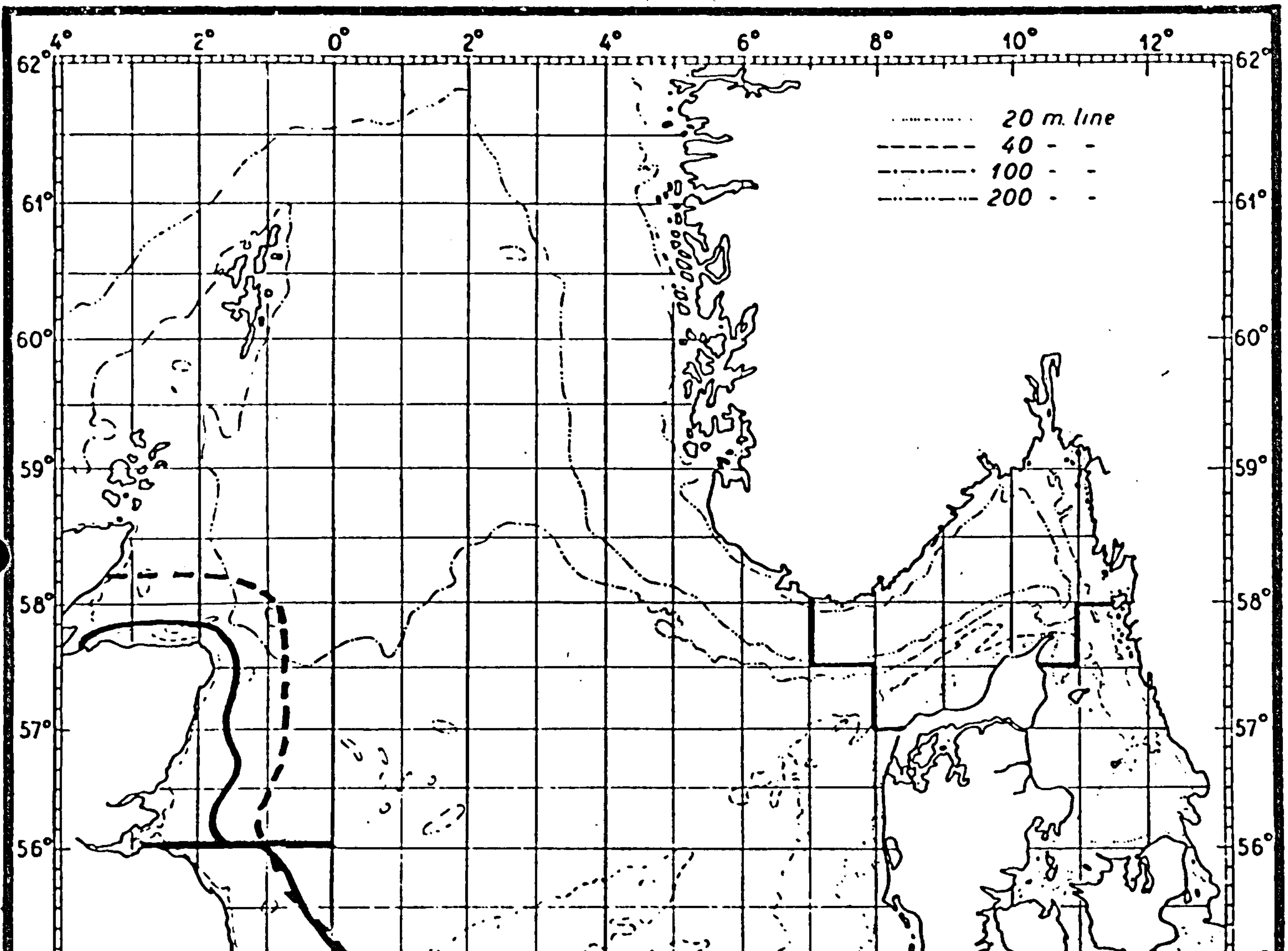


Figure 7.3 North Sea sprat. Area of coverage of United Kingdom acoustic surveys. Cross-hatched area indicates the area of major Danish and Norwegian catches in the same periods.