

This paper not to be cited without prior reference to the Council^{x)}

International Council for the
Exploration of the Sea

C.M.1974/H:4
Pelagic Fish (Northern) Committee

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

18 - 22 February 1974, Charlottenlund, Denmark.

<u>CONTENTS</u>	<u>Page</u>
1. Introduction and Participation	1
2. North Sea Herring	1
2.1. The Fishery in 1973	1
2.2. Fishing Mortality	2
2.3. Stock and Recruitment	3
2.4. Prognosis and Total Allowable Catch	4
3. Celtic Sea Herring	5
3.1. Catches	5
3.2. Stock and Recruitment Estimates	5
3.3. Fishing Mortality	6
3.4. Conclusions	6
4. Herring in Division VIa	6
4.1. General Biology of Stocks in VIa	6
4.2. Stock Structure of Herring in Division VIa	7
4.3. Total Catches and the Fisheries in Division VIa	8
4.4. Catch in Numbers in Division VIa	9
4.5. Mortality in 1973	9
4.6. Recruitment of the 1971 Year Class in VIa	9
4.7. Mortalities and Stock Size	10
4.8. Catch Prognosis for 1974	10
4.9. T.A.C.	11
5. Discussion	11
6. References	13
Appendix A	14
Tables 2.1. - 4.11.	16
Figures 1 - 5	33

^{x)} The General Secretary,
ICES,
Charlottenlund Slot,
2920 Charlottenlund,
DENMARK

1. Introduction and Participation

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

1.2. Member countries were represented by the following scientists:

Mr A.C. Burd	U.K. (England)
Mr A. Corten	Netherlands
Mr J. Jakobsson	Iceland
Mr H. Lassen	Denmark
Dr A. Lindquist	Sweden
Mr K. Popp Madsen	Denmark
Mr A. Maucorps	France
Mr J. Molloy	Ireland
Mrs E. Nielsen	Denmark
Mr A. Saville (Chairman)	U.K. (Scotland)
Dr A. Schumacher	Germany (F.R.)
Mr B. Sjöstrand	Sweden
Mr Ø. Ulltang	Norway
Mr O.J. Østvedt	Norway

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

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

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

The Working Group during this Meeting also considered the output required, and the input data necessary to achieve this output, from the trial run of the ICES A.D.P. system using North Sea herring data. The Working Group's conclusions on this topic are given in Appendix A.

2. North Sea Herring

2.1. The Fishery in 1973

2.1.1. In the last Report of the North Sea Herring Assessment Working Group (C.M.1973/H:27) a preliminary estimate of 264 000 tons was given as the catch in the first seven months of 1973, despite the closure in force from 1 February to 15 June. This catch represents about half the expected annual catch if fishing mortalities had remained at the levels of 1972. The major part of this catch was taken after 15 June.

2.1.2. In Table 2.1. preliminary catch data for the whole of 1973 are given. No information was available for a number of countries, and their catches have been estimated on the basis of those of previous years. The total North Sea catch, excluding Skagerak, was estimated to be about 450 000 tons.

In previous years the preliminary estimates have been increased by about 10% when the final catch data became available. It would seem, therefore, that the final annual catch will be rather similar to those of 1971 and 1972. The Skagerak catch increased in 1973, but this increase is in part due to the inclusion of Icelandic catches taken in the border area. Biological samples indicated that these fish were spring spawners (Table 2.2.).

2.1.3. Tables 2.3. to 2.7. give the catch data for the sub-divisions of the area used in previous reports. In Division IVb the adult catch increased in 1973, while the IVc catch remained at about the level of the three previous years. In all other areas, including the IVb juvenile fishery, the catches declined.

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

Year/Age	0	1	2	3	4	5 and older	Total
1968	839	2 425	1 795	1 494	621	571	7 746
1969	112	2 503	1 883	296	133	336	5 246
1970	890	1 196	2 003	884	125	143	5 249
1971	684	4 378	1 147	662	208	97	7 177
1972	750	3 341	1 441	344	131	40	6 047
1973 ^x)	289	2 400	1 221	552	132	84	4 677

Millions of Herring Caught per Age Group (Winter Rings)

^x) Preliminary.

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

2.2. Fishing Mortality

2.2.1. Using the 1973 preliminary catch in number, the fishing mortalities and stock sizes have been recalculated by virtual population analysis. As the 1972 and 1973 catch data are likely to affect the estimates of stock and mortality for only the most recent years, Tables 2.9. and 2.10. give the stock sizes and fishing mortality estimates only for the period 1965 - 1971.

2.2.2. In the previous Report some estimates of mortality from catch and effort data were presented (C.M.1973/H:27, 6.6. - 6.8.). No further additions could be made to this series. From Table 2.9. and the previous report mean fishing mortalities based on 2-ringed fish and older for various periods are given as follows:

Fishing Mortality from:

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

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

	1971	1972	1973
Total tags	1063	380	92

which can be attributed to month migration

These data can be used to calculate total mortalities. For the period 1971 - 1973 the annual total mortality was ~~0.87~~. Assuming natural mortality to be 0.1, then the fishing mortality is ~~not substantially different from~~ the value chosen from other information for the calculation of the stock size in 1974.

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

2.3. Stock and Recruitment

2.3.1. The annual stock sizes given in Table 2.10. using the 1973 catch as the starting point in the V.P.A. analysis, give almost identical values to those in the previous Report up to 1969 (C.M.1973/H:27, Table 11). The main change in the stock size in 1969 is caused by a lower estimated value for the 1968 year class (0-group). Table 2.10. shows that this year class was about half the long-term average strength.

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

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

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

Estimates of Recruitment as Juvenile Fish

Year Class	English 0-Group ¹⁾	ICES Young Herring Surveys ²⁾		Danish Industrial Fishery	
		I-Group	II-Group	I (Spring) ³⁾	I (Autumn)
1967	1 799	455	87	1 082	318
1968	1 259	442	73	305	173
1969	2 793	1 241	354	1 006	455
1970	1 245	844	57	1 278	307
1971	907	411		931 ⁴⁾	321
1972	654				

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

2.3.5. The VPA estimate of recruitment of the 1971 year class is 6.2×10^9 which is about 20% lower than the long-term mean (7.9×10^9), but the 1971 year class estimate is rather suspect (see paragraph 2.2.4.). Few data are yet available for the 1972 year class because the ICES Young Herring Survey was still underway at the time of the Meeting. The only information is the estimate from English 0-group surveys, which is well below average.

2.4. Prognosis and Total Allowable Catch

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

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

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

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

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

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

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

3. Celtic Sea Herring

3.1. Catches

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

3.2. Stock and Recruitment Estimates

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

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

3.2.3. In the previous Report (C.M.1973/H:2) the levels of stock size and fishing mortalities were calculated by cohort analysis. This method can only give reliable estimates up to the 1970/71 season. In order to get some indication of stock size and fishing mortality in the most recent years, the following procedure was followed:

If the stock composition at the beginning of a year is known and also the catch in numbers during that year, an average F (for all age groups) can be calculated which comes most closely to producing the actually observed catch. By applying this calculated F to the initial stock, the stock composition at the beginning of the next year can be calculated, except for the recruiting age group. This recruitment can be found by repeating the above procedure for the next year, and calculating the average F for all age groups. By applying this average F to the number of recruits caught, the number of recruits at the beginning of the year can be back-calculated. Starting from the stock composition as at 1 March 1969 (C.M.1973/H:2), fishing mortalities and recruitment for subsequent years have been calculated in this way (Table 3.5.). The dependence of catch on the size of the recruitment is seen.

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

3.3. Fishing Mortality

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

3.4. Conclusions

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

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

4. Herring in Division VIa

4.1. General Biology of Stocks in VIa

4.1.1. The spawning areas, and times of spawning, as shown by the distribution of small herring larvae in surveys carried out in 1965, 1971 and 1972 are shown in Figure 1. There would appear to be two distinct major spawning areas, one to the north and west of the Outer Hebrides in late August - September and another approximately one month later to the northwest of Ireland. Within each of these major sub-divisions of the total spawning area there may also be two or more distinct spawning grounds.

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

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

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

The distribution of the adult component of the stock can be seen from Figure 2 which shows the distribution in space and time of the fisheries in Division VIa of different countries. From this it can be deduced that the adult stock during the spring and summer fishing season is distributed over a wide area extending from N. Rona, and perhaps even further east to the west coasts of Orkney and Shetland, along the west coast of the Hebrides and south to Donegal. Within this broad area there are major centres of abundance at N. Rona, St Kilda, Stanton Bank and around Tory Island. Figure 2 also shows that there would appear to be two over-wintering areas for this herring population, one in the Minch where the major Scottish fishery on the adult stock takes place in the period November - February and another in the Donegal Bay area in the same months.

4.2. Stock Structure of Herring in Division VIa.

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

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

- 4.2.2. Norwegian and Scottish recaptures from the Bløden Tagging Experiment show that some of the young herring tagged in the Bløden area migrated to the area west of 4°W and to the Minch (Table 4.4.).
- 4.2.3. To study the migrations and mixing of herring from east and west of 4°W tagging experiments have been carried out in 1972 and 1973 by Scotland and Iceland. So far only a few recaptures have been reported for which definite areas of capture are obtainable.

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

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

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

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

4.3. Total Catches and the Fisheries in Division VIa

4.3.1. The total catch taken by each country in Division VIa for each of the years 1957 - 72 is given in Table 4.6., together with the estimated quantity of herring taken in each year in the Moray Firth young herring and sprat fisheries. The annual total catch taken in Division VIa in the period 1957 - 65 fluctuated, without trend, in the range 46 000 to 69 000 tons, increased sharply in 1966 to 92 000 tons, and showed a fairly regular increase each year thereafter to attain almost 240 000 tons in 1971. In 1972 the total catch was appreciably lower than in 1971 at 174 000 tons, but in 1973 increased again to the 1971 level.

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

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

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

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

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

4.4. Catch in Numbers in Division VIa

- 4.4.1. Estimates of the numbers of autumn spawning herring per age group caught in Division VIa in each of the years 1957 - 73 are given in Table 4.8. The estimates for the period 1957 - 72 are taken from Saville and Morrison (1973).
- 4.4.2. Estimates of the numbers of herring per age group in 1973 were derived from German (F.R.), Netherlands, Scottish and Norwegian age composition data. The calculation was done on a monthly basis when possible, or for small groups of months when the catches were small.
- 4.4.3. The 1969 year class of 4-year-old fish was dominant in all areas and accounted for about 60% of the numbers caught in VIa. In the absence of data on the age composition of the Moray Firth young herring fishery, the figure for the 0, 1 and 2-ringers given in Table 4.8. does not represent the total catch of these age groups in 1973. In 1972 the total catch of 1-ringers amounted to 320×10^6 herring.

4.5. Mortality in 1973

- 4.5.1. The total mortality for the year 1973 has been estimated on the basis of catch per landing data for the years 1972 - 73 from the Scottish pair-trawling fishery in the North Minch during November and December. There are no wide fluctuations in the resulting values (see below) over the age groups 3 - 6 which made the major contribution to the catches. The average mortality, weighted by year class abundance indices, for these age groups was 0.70.

Age (years)	3	4	5	6	7	8
Z	.78	.64	.68	1.07	.20	.62

4.6. Recruitment of the 1971 Year Class in Division VIa

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

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

- 4.6.2. A regression has been made between the number of 1-ringers caught in this fishery in each year for the period when age composition data are available and the number of 1-ringers from the V.P.A. for the corresponding year class (i.e. 1964 - 70), (Saville and Morrison, 1973).
- 4.6.3. The regression of the values obtained which is shown in Figure 3 is quite homogeneous and the regression is of the form:

$$y = 960.87 + 0.02 x$$

The recruitment of the 1971 year class as 1 year olds to the VIa stock is, in this way, estimated as $1\ 000 \times 10^6$ fish which is about 30% below the 10 year average.

4.7. Mortalities and Stock Size

4.7.1. Mean fishing mortality rates derived from VPA for 3 year old and older fish show a fairly constant level up to and including 1969 (Table 4.9.). There was a small increase in 1970 and a sharp one in 1971. The fishing mortality rates can be summarised as follows:

	Mean
1957 - 69	0.25
1970	0.33
1971	0.59
1972	0.35
1973	0.60 ^{x)}

^{x)} from catch per effort data.

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

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

4.8. Catch Prognosis for 1974

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

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

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

1) Average recruitment as 1-ringers 1960 - 70 year class from V.P.A.

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

4.9. T.A.C.

- 4.9.1. The catch prediction (Table 4.11.) shows that if the fishing mortality rates estimated for 1973 ($F = 0.25$ for 2-year-old herring and $F = 0.60$ for adult herring) were maintained in 1974, the resulting catch would be 260 000 metric tons, that is about 10% higher than in 1973. The corresponding position on the yield curve (Figure 4) is beyond the F giving the maximum sustainable yield per recruit. The yield curve shows that at an age of first capture of 2 years old, the maximum sustainable yield per recruit would be obtained at $F = 0.4$ and would result in a catch in 1974 of about 210 000 metric tons. The yield curve implies that the 2-year-old fish would also be exploited at an F of 0.4. If, however, the present pattern of fishing were maintained, the number of 2-year-old fish removed from the sea would be less than anticipated in the catch prediction. If this difference in numbers was taken from the adult part of the stock, a higher catch in weight, up to about 230 000 metric tons in 1974, might be allowed without departing from the maximum sustainable yield level.

5. Discussion

- 5.1. The most recent data on North Sea herring indicate a continuation of the undesirable features shown in previous Reports of the North Sea Herring Assessment Working Group of high levels of mortality on juveniles and adults.

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

2. In the previous Report attention was drawn to the recapture of fish tagged on the Bløden ground at Shetland, west of $4^{\circ}W$, and in the Minch. The presence of juvenile herring in the North Sea, which might have originated from spawning grounds outside the North Sea, was discussed in a previous Report by the North Sea Young Herring Working Group (Coop.Res.Rep.Ser.A., 14). Evidence of the drift of larvae from areas west of Shetland into the North Sea has been discussed by Wood (1971), Schnack (1973), Zijlstra (1972), and Saville and McKay (1973). Saville (1971) has suggested that juveniles of the Moray Firth originate from VIa spawning grounds. There is thus evidence of drift of larvae into the North Sea, their presence there as juveniles and evidence of subsequent emigration as adults.
- 5.3. From a cohort analysis on the herring catches in VIa, the average level of 0-group abundance in 1957 - 70 was 1.09×10^9 compared with 8.59×10^9 in the North Sea stock over the same period. Because of the disparity in the relative sizes of the recruitments, the effects of incursion of VIa recruits into the North Sea would not be expected to have a major effect on the estimation of North Sea recruitment or juvenile fishing mortality. On the other hand, the high level of fishing mortality in the North Sea could considerably reduce recruitment to VIa. Any regulatory action taken to reduce the juvenile catch in the North Sea will also have a beneficial effect on the stock in VIa, provided action is also taken to control fishing effort in VIa to prevent a major diversion of fishing effort to that area.

- 5.4. The most recent data on Celtic Sea herring examined by the Working Group has reinforced the conclusions of the last Meeting of the Celtic Sea Herring Assessment Working Group (C.M.1973/H:2). It had pointed out that exceptional levels of recruitment had occurred for a number of years and that these had supported the greatly increased catches since 1966. As a consequence of the increased recruitment the total catch corresponding to the fishing mortality rate giving the M.S.Y. ($F = 0.45$) had also increased from about 20 000 tons to 30 000 tons.
- 5.5. It had been recommended that fishing mortality should be reduced, partly because the fishery had become highly dependent on the recruit year class. The occurrence of a poor recruit brood could cause an escalation in fishing mortality on the older fish if the present levels of fishing effort were to continue. In the absence of any indication of recruitment failure, NEAFC agreed a catch limit of 32 000 tons. At the changed level of recruitment shown by more recent data available to this Working Group, it is recommended that this catch limit should be reduced to 25 000 tons for 1974.
- 5.6. Previous Reports of the North Sea Herring Assessment Working Group have drawn attention to the problems raised in assessment of this population by uncertainties regarding the stock affinities of the fish caught in certain areas of the North Sea. This applied in particular to the herring caught in the area to the west of Orkney and Shetland which in recent years has contributed a major part of the total adult catch from the North Sea (Anon. 1972). This problem has been further highlighted in the assessment of the VIa population where the major increase in catch in recent years has again been taken close to the $4^{\circ}W$ boundary between Divisions VIa and IVa.
- Recent work to help clarify this problem, chiefly by tagging on either side of the $4^{\circ}W$ boundary, has suggested that no sharp boundary can be drawn between the stocks in this area. The data available would point to this area containing a mixture of the North Sea and VIa populations with a tendency for the proportion of VIa fish to increase from east to west. The Herring Assessment Working Group for the Area South of $62^{\circ}N$ accepted the $4^{\circ}W$ boundary as the catch statistics are available only on that basis. This problem must, however, be investigated further, particularly by more extensive and intensive tagging experiments. Future work of this Herring Assessment Working Group would be facilitated by more complete catch statistics and biological data on a statistical rectangle basis for this area.
- 5.7. The stock in VIa is in a relatively better state than that of the North Sea. However, since 1970 the fishing mortality rate on it has been somewhat above that giving the M.S.Y. and the current high levels of catch from VIa are dependent on the current high level of recruitment to this stock. The data suggest that in the past three years there has been a rapid increase in fishing effort on this stock and this is likely to escalate further, in the light of restrictions on fishing projected in neighbouring areas. It is recommended, therefore, that action should be taken to control fishing on this herring population at the value giving the M.S.Y. This would mean in 1974 a T.A.C. of 210 000 tons. Longer term prognoses for this stock are not possible at this stage because of the major variations in year class strengths and the current lack of a technique for assessing year class strengths earlier.

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

6.

REFERENCES

- SAVILLE, A., 1971. The biology of young herring in the Moray Firth and their recruitment to the adult stocks. Rapp. P.-v. Réun. Cons. int. Explor. Mer, 160: 184-193.
- SAVILLE, A. and MCKAY, D.W., 1973. Report on the international surveys of herring larvae in the North Sea in 1972/73. ICES Coop. Res.Rep., (in preparation).
- SAVILLE, A. and MORRISON, J.A., 1973. A reassessment of the herring stocks to the west of Scotland. ICES C.M.1973/H:24 (mimeo).
- SCHNACK, D., 1973. Report on the international surveys of herring larvae in the North Sea and adjacent waters, 1971 - 1972. ICES Coop.Res.Rep., No. 34 : 1-31.
- WOOD, R.J., 1971. Report on the international surveys of herring larvae in the North Sea and adjacent waters in 1969/70. ICES Coop.Res.Rep., Ser.A, No. 22 : 3-36.
- ZIJLSTRA, J.J., 1972. Report on the international surveys of herring larvae in the North Sea and adjacent waters in 1970/71. ICES Coop.Res.Rep., Ser. A, No. 28 : 1-24.

Establishment of an ICES ADP System for Fisheries Statistics

Discussion of this matter at the 1973 Council Meeting concluded with the proposal of a trial run using North Sea herring data (C.Res.1973/2:16), the aim being to study the feasibility and cost of the full system. It is understood that the cost of the trial run - which will be carried out at the Danish Fisheries and Marine Research Institute in Charlottenlund - will not be more than D.Kr. 2 500 (not including the cost of punching the 5 000 cards involved which will be carried out by ICES).

The Herring Assessment Working Group for the Area South of 62°N considered the output which the trial run should be designed to achieve, and the nature of the input data required for this. On the basis of an output of monthly catch in numbers per age group by statistical rectangles, for each gear type, the following statistical and biological information is required; also shown are the dates which the Working Group feels are both feasible and necessary for the submission of the data to ICES by the countries involved in the North Sea herring fishery:

- (i) Total catch of herring in metric tons, per month, per rectangle. 1 April 1974.
- (ii) Length distribution of the samples, and numbers per kg stating the source (sample or catch). The statistical rectangles to which the data relate should also be stated. 13 May 1974.
- (iii) Weight-length data. 13 May 1974.
- (iv) Age-length data. 13 May 1974.

Items (i) - (iv) should be provided for each of the five years 1969-1973 on ICES Biological Data Forms 1-4 as appropriate. When numbering the statistical rectangles, the system indicated in the chart at the end of this Report (Figure 5) should be used. The northing co-ordinate (93 - 99, 01 onwards) should be stated first. Countries which are not able to give a breakdown by statistical rectangle or by month should supply data with the finest possible area and time breakdown.

Examples of ICES Biological Data Forms 1-4 may be seen in the following publications:

- Data Form 1 Statistical News Letters No. 57 (Demersal Species, Stock Record Data), pages 25-152.
Length distribution and age distribution of catch; catch per effort; sampling levels; by quarters.
- Data Form 2 Statistical News Letters No. 60 (Herring and Mackerel Stock Record Data), Parts I and II.
Age distribution of samples (spring or autumn spawners); total catch (tons); no. per kilo; by months.
- Data Form 3 Statistical News Letters No. 60 (Herring and Mackerel Stock Record Data), page 44.
Length parameters (\bar{x} , s^2) per age group, spring or autumn spawners; by months.
- Data Form 4 As Data Form 3, but for weight parameters.

Data Forms 1 and 2 are available from ICES; Data Forms 3 and 4 are to be reproduced by member countries.

This proposed schedule - which has been condensed into the shortest possible space of time - obviously involves a postponement of the date of the ADP Working Group Meeting, which was to have taken place during the week commencing 22 April 1974. Consequently, the Herring Assessment Working Group for the Area South of 62°N suggests that the earliest date on which the ADP Working Group could meet would be 10 June, when the precise specifications for the trial run as well as the scope and cost-estimate of the full ADP system would be drawn up. The trial run itself would be made after the ADP Working Group meets; an evaluation would be made at the 1974 Council Meeting and presented to that Meeting of the Bureau (and not to the Bureau's mid-term Meeting).

Finally, the Herring Assessment Working Group for the Area South of 62°N is of the opinion that the participation of two or three of its members in the Meeting of the ADP Working Group would be necessary to specify the precise content of both the input and output of the trial run.

Table 2.1. Herring.
Catch in tons 1970-1972 and Preliminary Figures for 1973. North Sea (Sub-Area IV and Divisions VIIId and e) by country. Skagerak and Kattegat (Division IIIa) Total Catch. Estimated Catches in Brackets.

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

- Footnotes:
- a. Sub-area IV catch taken as 1970-72 mean.
 - b. Total includes 2 107 tons for human consumption unspecified to area.
 - c. Figure supplied by Fiskirannsóknarstovan.
 - d. From Federal Republic of Germany national statistics compiled by Federal Research Board of Fisheries, Hamburg.
 - e. Includes 15 938 tons caught on Skagerak border and allocated to that area on the basis of age analysis.
 - f. Catch Jan-Oct raised to 12 months on basis of 1972 catch ratio.
 - g. Swedish catches in Danish ports reported by area (North Sea, Skagerak) used for area allocation of Swedish landings reported as Skagerak and North Sea in Swedish statistics.
 - h. Catches from Moray Firth not included.

Table 2.2. Herring.
Total Catch in Tons. Skagerak. (Division IIIa excluding Kattegat)

Year	Denmark	Faroe Islands	Germany (F.R.)	Iceland	Netherlands	Norway	Poland	Sweden	USSR	Total
1970	30 107	-	-	6 453	-	7 581	-	26 930	-	71 071
1971	26 985	5 636	-	3 066	-	6 120	-	19 763	-	61 570
1972	34 900	4 115	-	7 317	-	1 045	-	19 644	-	67 021
1973	42 098	5 265 ^{a)}	-	15 938 ^{b)}	-	836	-	20 429 ^{b)}	-	84 566

a) Catches by Faroese vessels landed in Danish ports.

b) See Table 2.1. footnote under relevant country.

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

Year	Belgium	Denmark	Faroe Islands	France	Germany (F.R.)	Iceland	Nether-lands	Norway	Poland	U.K. (Scotland)	Sweden	USSR	Total
1970	50	1 800	5 898	48	10	1 220	281	3 501	123	1 929	5 560	1 012	21 432
1971	-	6 219	239	-	-	-	167	10 720	-	-	-	-	17 345
1972	-	19 711	979	-	9	1 943	40	50	-	-	-	-	22 732
1973	-	686	12 776 ^{a)}	-	-	-	331	236	-	-	-	-	14 029

a) Allocation based on landings in Denmark.

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

Year	Belgium	Denmark	Faroe Islands	Finland	France	Germany (F.R.)	Iceland	Nether-lands	Norway	Poland	U.K. (Eng-land)	U.K. (Scot-land)	Sweden	USSR	Total
1970	750	61 423	40 884	-	818	177	20 587	177	160 784	2 069	-	17 767	4 470	17 066	326 932
1971	-	44 500	45 095	-	514	389	36 992	5 755	115 108	1 288	-	24 711	4 954	9 500	288 806
1972	-	29 711	37 004	-	888	100	29 721	1 967	100 408	1 620	74	17 227	-	16 386	235 106
1973	-	41 341	42 159 ^{a)}	1 050	209	2 624	23 742	5 162	58 747	4 100	-	15 202	4 222	30 100	228 658

a) Allocation based on landings in Denmark.

Table 2.5. Herring.
Total Catch in Tons. North Sea, Central (Division IVb). Adult Herring Fisheries.

Year	Belgium	Denmark	Faroe Islands	France	Iceland	Germany (F.R.)	Netherlands	Norway	Poland	U.K. (England)	U.K. (Scotland)	Sweden	Total
1970	-	-	11 623	2 433	1 144	6 005	28 815	28 817	2 836	8 731	2 189	24 640	117 233
1971	8	2 488	429	4 734	179	-	10 172	14	743	4 113	362	1 926	25 168
1972	-	1 589	10 460	2 014	334	21	11 372	17 043 ^{a)}	615	271	-	4 068	47 787
1973	-	-	-	8 288	-	115	16 917	38 002	1 600	2 781	327	-	68 030

a) Re-allocated to Division IVb from IVb YH (Table 7, C.M.1973/H:27).

Table 2.6. Herring.
Total Catch in Tons. North Sea, Central (Division IVb).

Year	Young Herring Fisheries					Total Young and Adult Fisheries (Tables 2.5. and 2.6.)
	Denmark	Germany (F.R.)	Sweden	Norway	Total	
1970	70 108	400	0	-	70 508	187 741
1971	132 161	3 055	30 000	-	165 216	190 209
1972	162 671	2 823	3 298	-	168 792	216 579
1973	129 988	5 638	-	-	135 626	203 656

Table 2.7. Herring.
Total Catch in Tons. North Sea, South and English Channel, East and West (Divisions IVc, and VIIId and e).

Year	Belgium	Denmark	France	Germany (F.R.)	Netherlands	Poland	U.K. (England)	Total
1970	400	-	8 183	558	16 945	29	971	27 086
1971	673	25	6 160	126	16 385	-	-	23 369
1972	1 337	57	9 999	112	11 450	-	305	23 260
1973	933	132	12 555	2 229	8 303	-	4	24 156

Table 2.8. North Sea Catch in Millions of Fish by Age.

Year	Area	Age in Winter Rings										Total	
		0	1	2	3	4	5	6	7	8	>8		
1971	IVaW of 2°E	136.7	818.3	516.9	488.3	154.2	24.1	28.8	25.1	-	-	9.8	2 202.2
	IVaE of 2°E	14.0	95.4	54.5	38.5	10.5	2.1	1.4	1.1	-	-	0.2	217.6
	IVb	-	2.1	140.3	54.4	12.6	-	-	-	-	-	2.1	211.5
	IVbYH	533.0	3 440.9	304.3	39.6	-	-	-	-	-	-	-	4 317.8
	IVc+VIIId,e	0.3	21.8	130.8	41.7	31.1	0.7	0.3	0.6	-	-	0.3	227.6
	Total NS	684.0	4 378.5	1 146.8	662.5	208.3	26.9	30.5	26.8	-	-	12.4	7 176.7
1972	IVaW of 2°E	-	338.9	830.1	176.8	88.6	19.3	4.1	-	0.5	-	0.4	1 458.7
	IVaE of 2°E	-	75.1	91.0	17.8	5.8	0.7	0.1	-	-	-	-	190.5
	IVb	-	25.2	46.4	98.8	20.5	6.7	0.6	0.2	0.6	-	-	199.0
	IVbYH	750.4	2 896.6	337.9	21.1	6.4	1.2	0.2	-	-	-	-	4 013.8
	IVc+VIIId,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	0.4	6 045.5
1973 ^{x)}	IVaW of 2°E	-	42.1	596.0	363.1	46.5	31.7	16.3	2.1	0.4	0.5	0.5	1 098.7
	IVaE of 2°E	-	0.3	16.2	23.1	6.3	7.2	1.0	0.3	0.8	-	-	55.2
	IVb	-	285.5	212.1	45.9	33.3	5.6	8.5	-	-	-	-	590.9
	IVbYH	289.4	2 070.5	362.5	29.4	2.6	0.5	0.2	0.3	-	-	-	2 755.4
	IVc+VIIId,e	-	1.7	34.0	30.3	43.2	5.8	1.5	0.4	0.1	0.1	0.0	177.0
	Total NS	289.4	2 400.1	1 220.8	551.8	131.9	50.8	27.5	3.1	1.3	0.5	0.5	4 677.2

x) Preliminary.

Table 2.9. Total North Sea. Calculated Fishing Mortality.

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

Table 2.10. Total North Sea. Calculated Stock in Number $\times 10^{-9}$, and Stock Biomass.

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

Table 3.1. Herring Catches in Celtic Sea (Metric Tons).

Year	France	Germany (F.R.)	Ireland	Netherlands	Poland	England	USSR	Total
1969	7 038	5 906	18 712	16 256	252	-	-	48 164
1970	3 627	1 481	24 702	7 015	1 191	220	-	38 236
1971	3 393	974	12 602	9 672	881	65	-	27 587
1972	7 327	393	20 109	6 758	751	-	618	35 956
1973 ^{x)}	6 173	294	13 105	5 834	1 000	-	500	26 906

^{x)} Preliminary figures for 1973.

Table 3.2. Total Catch by Seasons in Celtic Sea (Metric Tons)

Season	Mar/May	Jun/Aug.	Sep/Nov.	Dec/Feb.	Total Metric Tons
1969/70	1 136	9 783	13 818	16 263	41 000
1970/71	1 703	3 789	8 879	18 348	32 719
1971/72	1 755	4 742	7 240	19 625	33 362
1972/73	2 039	2 936	7 668	17 720	30 363
1973/74 ^{x)}	3 123	3 463	5 942	12 817	25 345

^{x)} Preliminary figures for 1973.

Table 3.3. Percentage Age Distributions of Celtic Sea Catches.

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

Dutch trawl fishery - May to December.

Irish pair trawl fishery - November to February.

Table 3.4. Estimates of Recruit Strength as 2 Winter-Ring Fish.

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

^{x)} Preliminary estimate.

Table 3.5. Calculated Stock Size in Millions. Celtic Sea.

Rings	1968-9		1969-70		1970-1		1971-2		1972-3		Stock
	Stock	Catch	Stock	Catch	Stock	Catch	Stock	Catch	Stock	Catch	
1	346.7	13.46	173.37	7.35		0.70	11.54			5.30	
2	234.3	61.02	212.40	86.87	149.22	34.55	51.32	25.25	210.65	94.16	
3	146.8	44.21	143.54	51.44	116.57	53.35	86.09	38.68	22.60	17.64	101.51
4	54.7	12.90	89.93	30.52	78.78	28.41	67.26	45.60	37.92	14.15	10.89
5	73.3	25.65	33.51	11.22	49.35	20.01	45.45	20.75	29.62	12.10	18.27
6	17.4	5.22	44.91	16.30	18.39	7.77	28.47	11.03	20.02	4.32	14.27
7	10.7	4.56	10.66	4.36	24.68	6.30	10.61	4.25	12.54	2.47	9.65
8	3.8	1.44	6.56	2.01	5.85	2.11	14.24	5.45	4.67	2.15	6.04
>8		5.30	2.33	3.23	4.88	3.50	6.20	2.41	9.00	0.96	2.25
Calculated F		0.39		0.50		0.45		0.72		0.63	

Table 3.6. Total Mortality Rates of Celtic Sea Herring from VPA and CPE.

Year	Irish ¹⁾ Pelagic Trawl	VPA New Estimates
1968/69 - 69/70	0.66	0.60
1969/70 - 70/71	0.39	0.55
1970/71 - 71/72	0.79	0.82
1971/72 - 72/73	0.89	0.73
1972/73 - 73/74		

¹⁾ November - February.

Table 4.3. Mean l_1 for Different Year Classes in South Minch, North Minch and Shetland East of 4°W.

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

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

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

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

Table 4.5. Returns by Factories from Scottish and Icelandic Tagging Experiments 1972 East and West of 4°W.

			Recaptures at Factories				
			Stornoway			Lerwick	
Year of Tagging	Area	No. Tagged	Year	No. of Recaptures	No. per 1 000 Fish Tagged per Ton Processed	No. of Recaptures	No. per 1 000 Fish Tagged per Ton Processed
1972	West of 4°W (Rona)	3 000	1972	7	0.21	6	0.14
			1973	23	0.44	6	0.16
	West of Orkney	810	1972	1	-	2	0.17
			1973	5	0.36	2	0.20
	Foula	600	1972	0	-	4	0.46
			1973	1	0.10	2	0.27

Table 4.6. Total Catches of Herring (Metric Tons) in Area VIa, 1957 - 1973.

	1957	1958	1959	1960	1961	1962	1963	1964	1965
Belgium	-	192	24	40	-	-	1	-	-
England	99	201	16	36	52	85	58	26	28
Faroes ²⁾	-	-	-	-	-	-	-	-	-
France	-	-	-	154	353	489	1 121	1 023	610
Germany (F.R.)	-	8 592	2 509	5 311	1 816	11 279	4 739	5 387	5 066
Netherlands	-	-	-	-	-	-	-	68	330
Iceland	-	-	-	-	-	-	-	-	-
Ireland	5 069	4 049	4 449	3 768	5 637	4 015	3 633	4 540	6 440
N. Ireland	1	6	-	-	-	-	3	1	-
Norway	-	-	-	-	-	-	-	-	-
Poland	-	-	-	-	-	-	-	-	-
Scotland	41 636	52 250	60 986	58 921	44 083	47 831	44 394	58 673	53 909
USSR	-	-	-	-	-	-	-	-	-
Total	46 805	65 290	67 984	68 230	51 941	63 699	53 949	69 718	66 383
Scottish Juvenile Herring and Sprat Fisheries in Moray Firth	1 703	1 164	2 451	906	585	1 842	118	660	10 278

/Cont'd.

Table 4.6. (Continued).

	1966	1967	1968	1969	1970	1971	1972	1973 ^{x)}
Belgium	23	-	-	-	-	-	-	-
England	1	-	3	-	-	-	-	340
Faroes ^{a)}	-	-	-	-	15 100	8 100	8 094	15 800
France	1	379	1 124	966	1 293	2 055	680	2 417
Germany (F.R.)	14 634	17 318	14 874	15 805	16 548	7 700	4 108	17 754
Netherlands	251	4 576	2 957	1 514	1 102	9 252	23 370	30 328
Iceland	-	-	-	-	5 595	5 416	2 066	3 545
Ireland	7 759	12 290	13 390	11 895	11 716	12 161	17 308	13 452
N. Ireland	-	-	4	3	1	-	-	-
Norway	-	-	-	-	20 199	76 720	17 400	30 557
Poland	-	727	2 791	3 188	3 709	-	-	2 500
Scotland	69 363	67 404	65 180	90 222	103 530	99 537	107 638	120 800
USSR	-	-	-	-	3	-	?	2 500
Total	92 032	102 694	100 323	123 593	178 796	220 941	173 938	239 993
Scottish Juvenile Herring and Sprat Fisheries in Moray Firth	20 734	6 507	4 985	3 100	1 385	5 666	10 242	7 219

x) Preliminary figures.

a) Figures supplied by Fiskirannsóknarstofnan.

Table 4.7. Catches of Herring in Division VIA in 1973 by Countries, Fishing Grounds and Months (Preliminary Figures).

Country	Area	Months												Total		
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
Netherlands	06 NW Ireland					110	1 980	1 708	2 195	2 992	1 662					10 647
	01 Hebrides							5 947	3 528	4 691	4 789					18 955
	02 W. Shetland							726								726
	Total					110	1 980	8 381	5 723	7 683	6 451					30 328
Germany ¹⁾ (F.R.)	Via1 N. Ireland						58	471	117	361	4 244			2 577		7 828
	Via2 Hebrides						470	2 874	949	1 788	2 671			1 048		9 800
	Total						528	3 345	1 066	2 149	6 915			3 625		17 628
Scotland	N. Minch	12 878	13 488	8 156	849		4	570	1 136	1 601	8 825			12 277	6 185	65 969
	S. Minch	12 928	9 982	5 095	1 923	704	756	981	1 834	1 221	2 568			9 297	7 541	54 827
England Faroes France Iceland Ireland Norway Poland USSR	NW Ireland															340
	W. Shetland															15 800
	NW Ireland						803	1 852			890					2 417
	W. Shetland															3 545
	NW Ireland															13 452
	W. Shetland															30 557
	Hebrides															2 500
Hebrides															2 500	
	Grand Total															239 863

1) Excluding 126 tons from the German lugger fishery.

Table 4.8. Herring Autumn Spawners. Catch in Number x 10⁻³, Division VIa + Moray Firth.

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

1) Catches from Moray Firth not included.

2) Age 10 and older.

Table 4.9. Calculated Fishing Mortalities by Age and Year in VIa population

Age(years) \ Year	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.19	0.11	0.07	0.13	0.00	0.07	?
2	0.02	0.03	0.09	0.02	0.04	0.10	0.02	0.07	0.11	0.58	0.26	0.17	0.05	0.21	0.05	0.55
3	0.13	0.14	0.17	0.25	0.30	0.33	0.18	0.17	0.08	0.24	0.13	0.18	0.11	0.16	0.38	0.29
4	0.37	0.36	0.21	0.21	0.22	0.24	0.29	0.22	0.19	0.19	0.17	0.15	0.19	0.38	0.91	0.62
5	0.24	0.41	0.48	0.18	0.16	0.33	0.16	0.21	0.28	0.25	0.30	0.20	0.20	0.43	0.67	0.29
6	0.41	0.38	0.43	0.33	0.24	0.28	0.28	0.13	0.24	0.23	0.25	0.16	0.31	0.48	0.59	0.37
7	0.44	0.61	0.42	0.30	0.13	0.33	0.23	0.25	0.13	0.33	0.31	0.20	0.30	0.34	0.53	0.44
8	0.36	0.85	0.78	0.41	0.21	0.35	0.21	0.24	0.41	0.33	0.35	0.22	0.50	0.46	0.51	0.56
9	0.13	0.77	0.92	0.64	0.32	0.41	0.28	0.31	0.37	0.51	0.44	0.25	0.56	0.63	0.55	0.60
10	0.34	0.41	0.79	0.96	0.29	0.49	0.33	0.35	0.35	0.49	0.77	0.30	0.63	0.55	0.76	0.54
$\bar{F}_w \geq 3$	0.23	0.35	0.32	0.25	0.21	0.32	0.23	0.21	0.27	0.25	0.20	0.19	0.23	0.33	0.59	0.35

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

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

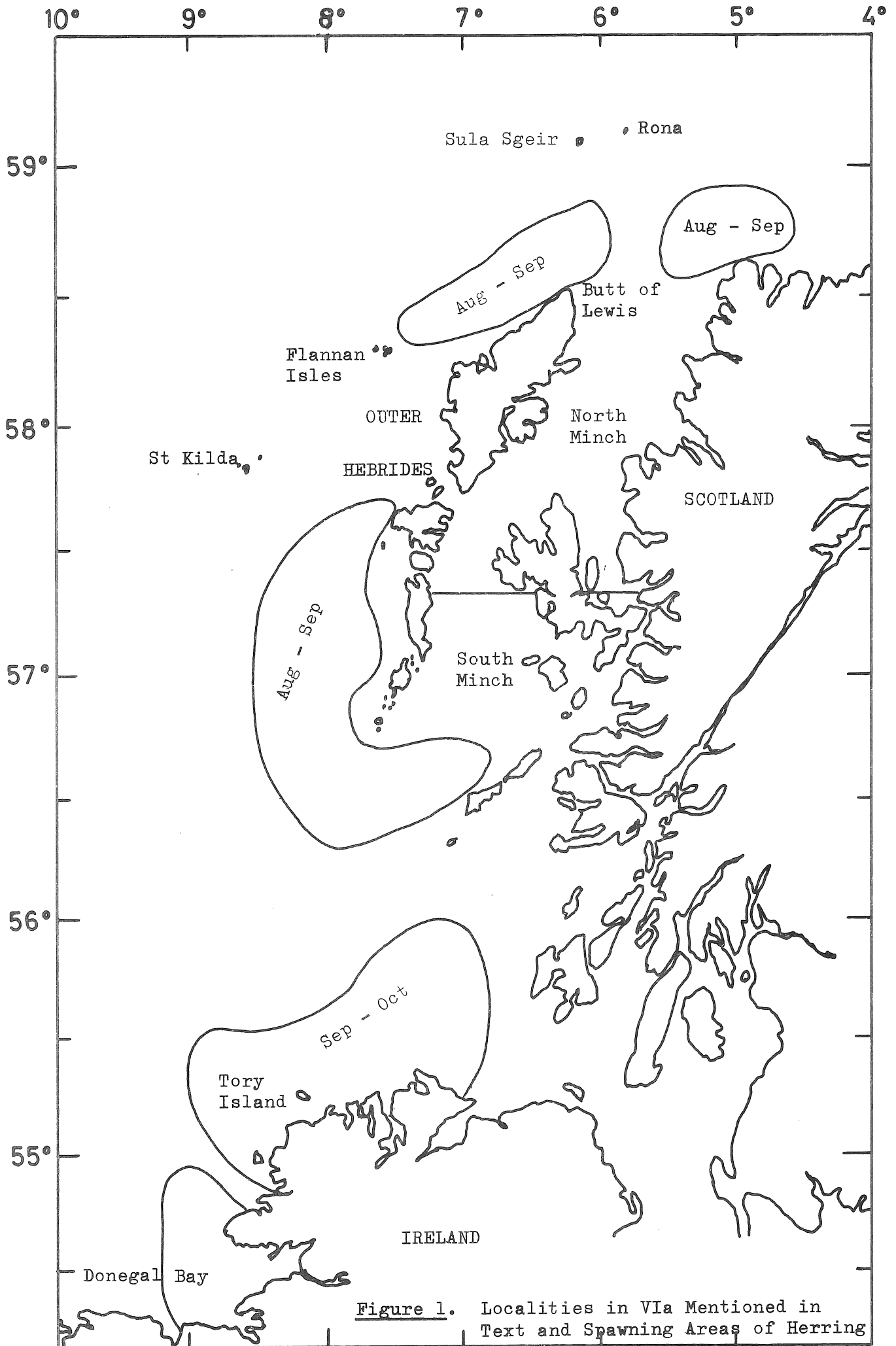


Figure 1. Localities in VIA Mentioned in Text and Spawning Areas of Herring in VIA.

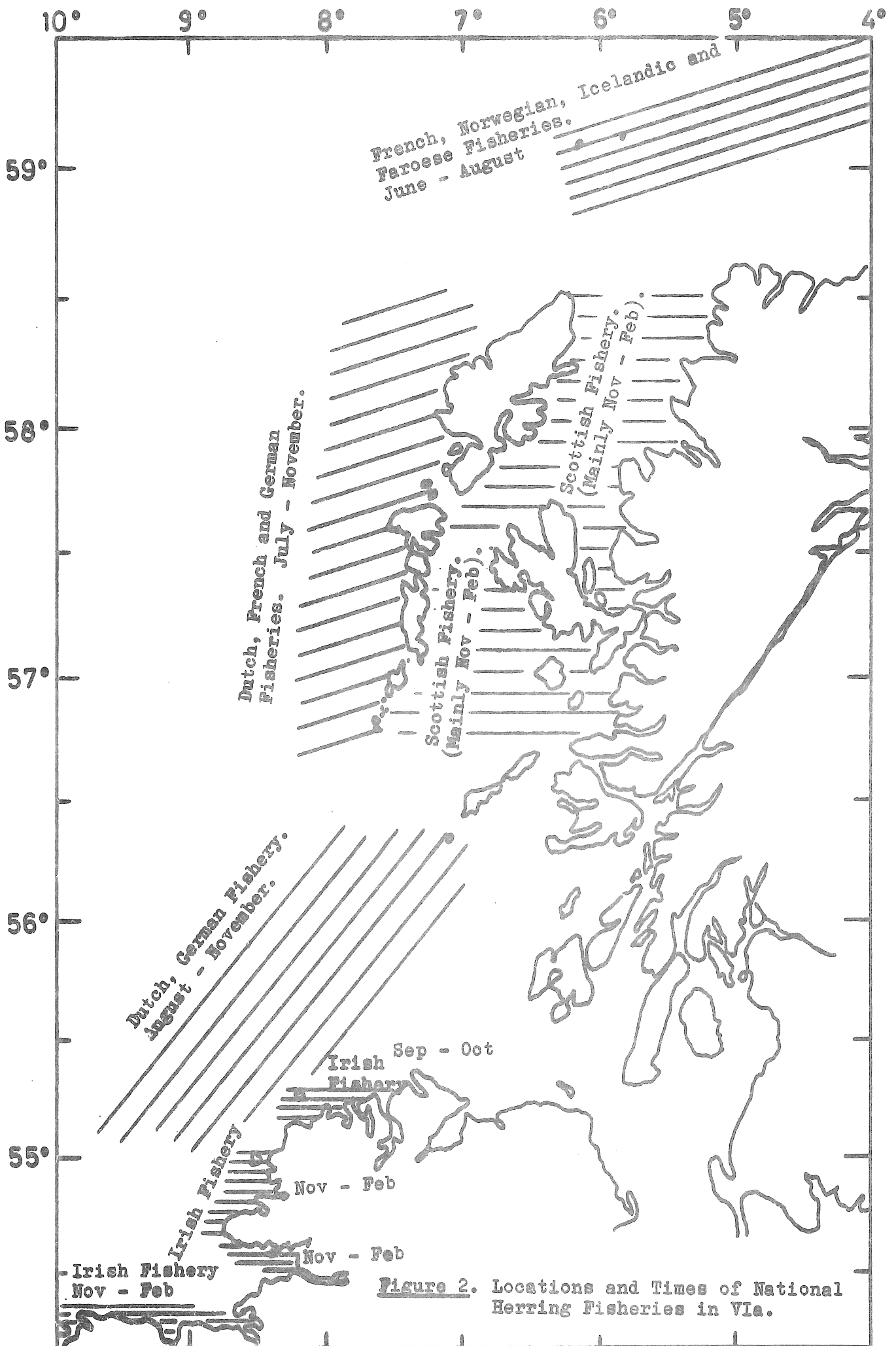


Figure 2. Locations and Times of National Herring Fisheries in Via.

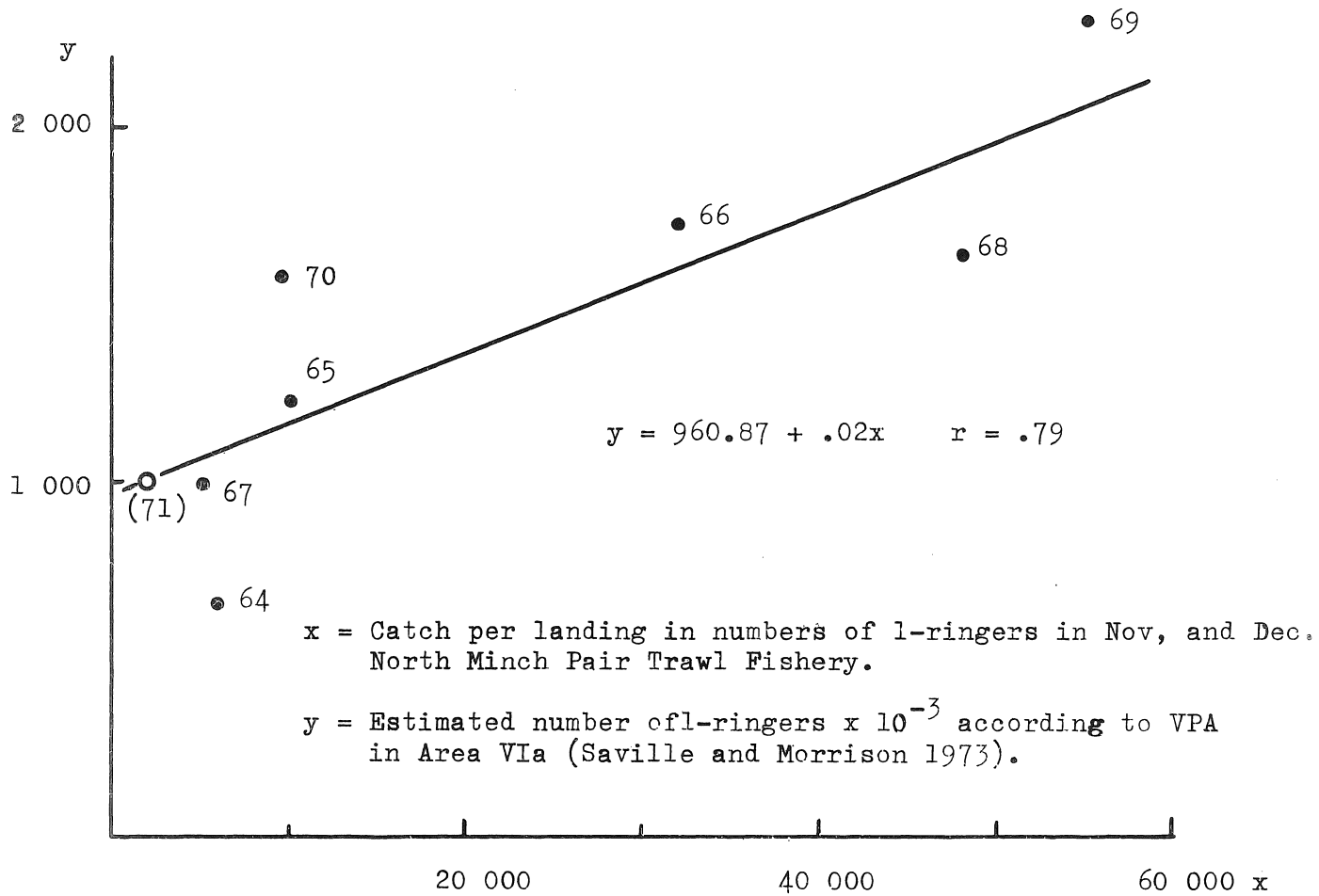


Figure 3. Estimation of Number of 1-Ringers of the 1971 Year Class.

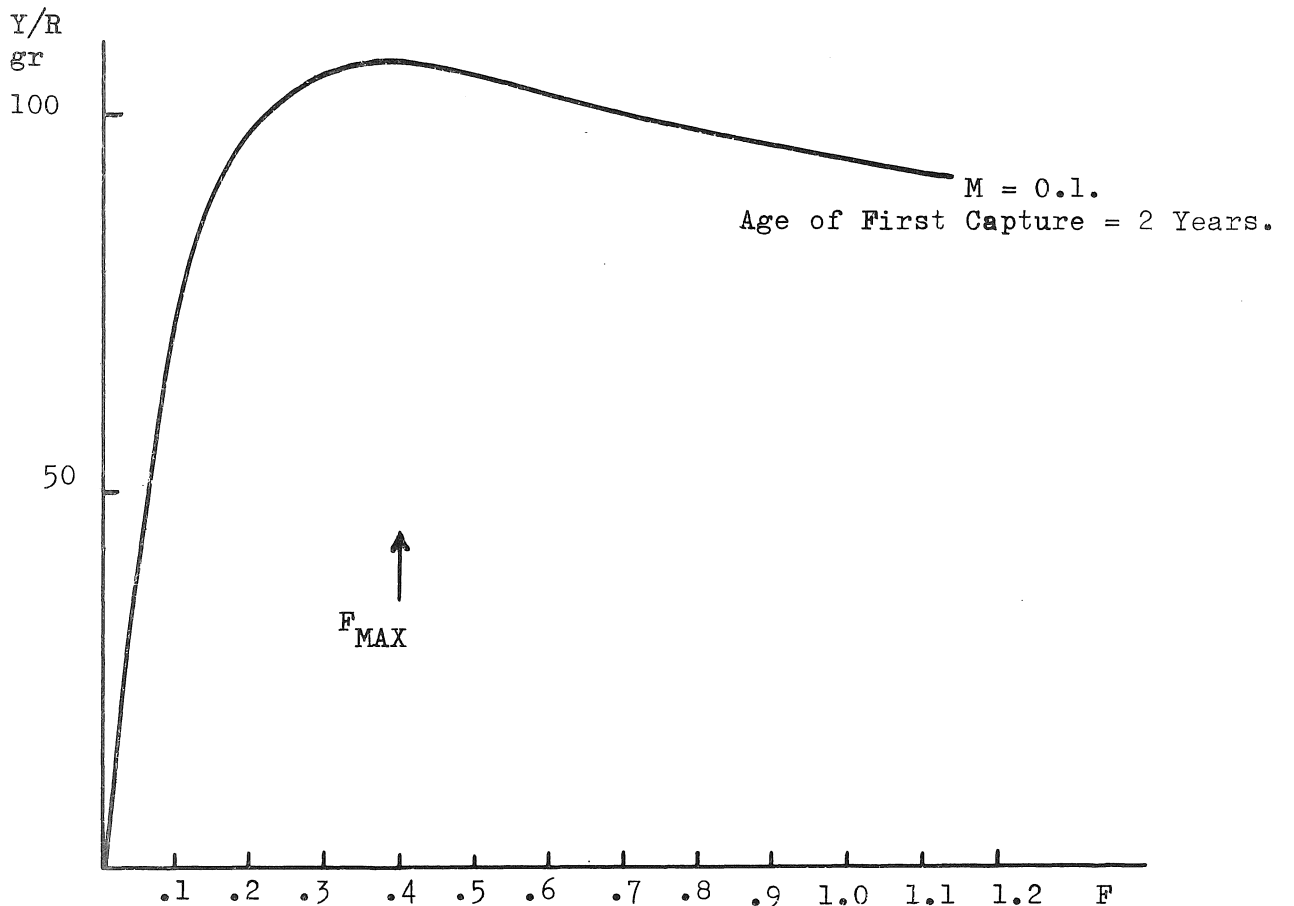


Figure 4. The Yield per Recruit Curve for the VIa Herring Population.

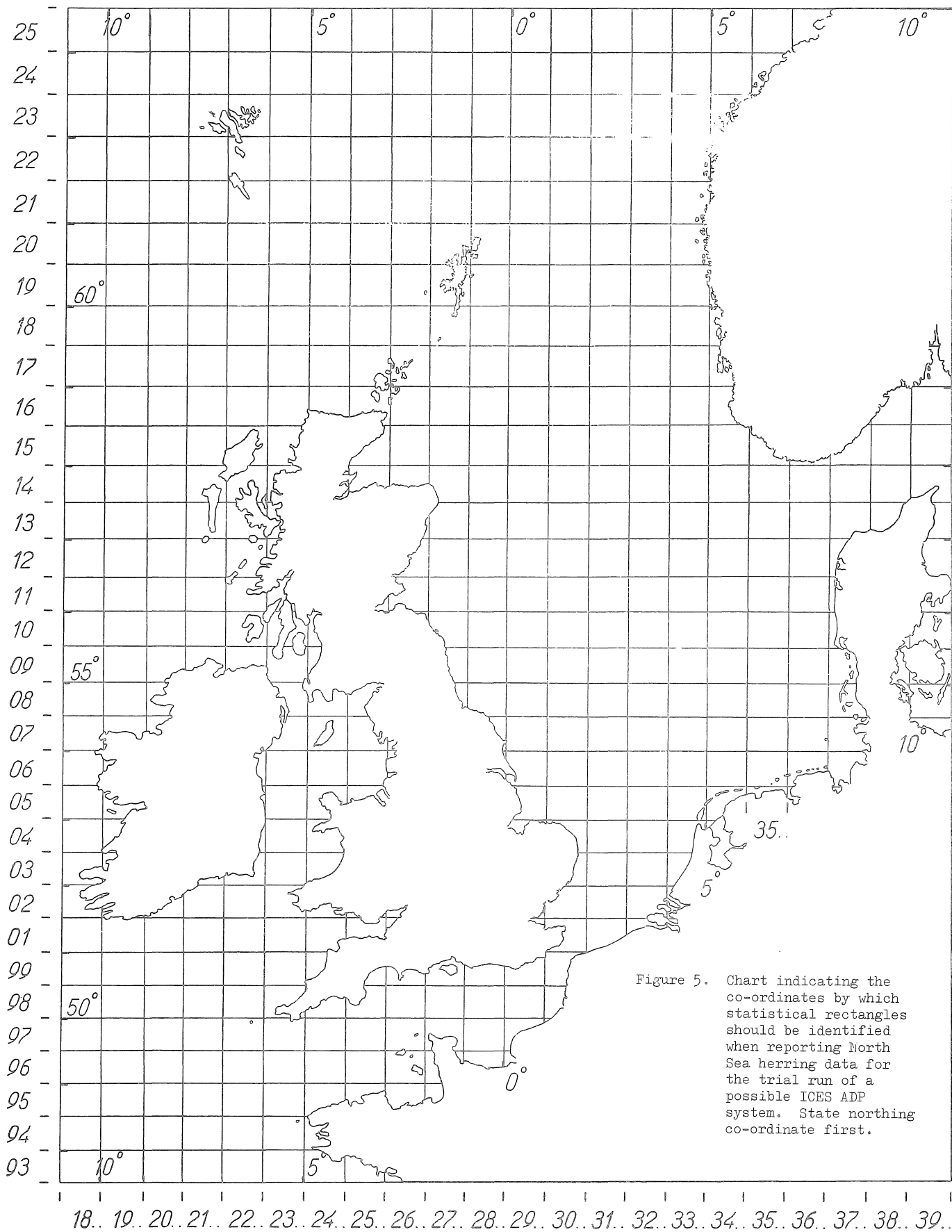


Figure 5. Chart indicating the co-ordinates by which statistical rectangles should be identified when reporting North Sea herring data for the trial run of a possible ICES ADP system. State northing co-ordinate first.

CORRIGENDA

Page 8

Section 4.3.1, line 7: " to almost 230 000 tons"
line 8: " than in 1971 at 197 000 tons"
line 9: " increased again to somewhat above the 1971 ..."

Page 9

Section 4.6.2, line 3: " ... and the number of 1-year-olds from the V.P.A. .."

Page 10

Section 4.7.3, line 2: " ... constant level of about 1.2 x 10⁹ in the"
line 4: " ... more than doubled at 3.6 x 10⁹"
line 5: " ... rather high level of 2.6 x 10⁹ to 3.0 x 10⁹, .."
line 8: " ... recruitment of the strong 1963 year class ..."

Page 35

Figure 3: "y = Estimated number of 1-year-olds x 10⁻⁶ according to V.P.A. ..."