International Council for the
Exploration of the Sea

C.M.1982/Assess:7

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

Copenhagen, 23 March - 1 April 1982

This document is a report of a Working Group of the International
Council for the Exploration of the Sea and does not necessarily
represent the views of the Council. Therefore, it should not be
quoted without consultation with the General Secretary.

---

x) General Secretary,
   ICES,
   Palægade 2-4,
   DK-1261 Copenhagen K,
   Denmark.

TABLE OF CONTENTS

Table of Contents (ctd)

-o-o-o-

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

1.   INTRODUCTION

1.1   Participants

R S Bailey	United Kingdom (Scotland)
A B Bowers	United Kingdom (Isle of Man)
A C Burd	United Kingdom (England)
A Corten	Netherlands
R Grainger	Ireland
D P King	United Kingdom (Northern Ireland)
J Masse	France
J Molloy	Ireland
A Maucorps	France
N A Nielsen	Denmark
K Popp Madsen	Denmark
R Rosenberg	Sweden
A Saville	United Kingdom (Scotland)
A Schumacher	Federal Republic of Germany
B Sjöstrand	Sweden
Ø Ulltang (Chairman)	Norway
R J Wood	United Kingdom (England)
O J Østvedt	Norway

1.2   Terms of Reference

The Herring Assessment Working Group for the Area South of 62°N
(Chairman: Mr Ø Ulltang) met at ICES headquarters from 23 March to
1 April 1982, in accordance with C.Res.1981/2:27:9, to:

   (i)   assess the state of the herring stocks in Sub-areas
          IV and VII and Divisions IIIa and VIa and to provide
          management options for 1983,

   (ii)   collate any new data available on herring by-catch
          in the sprat fisheries by small time and area sub-
          divisions,

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

   (iv)   specify deficiencies in data required for assessments.

1.3   The Use of Reference Points on the Yield per Recruit Curve

For the calculation of yield/recruit curves, the treatment of the oldest
age group as a plus group simulates a continuation of the exploitation
beyond the oldest age in the assessment.

In calculating Y/R curves, Beverton and Holt (1957, p.351) referred to
the "fishable lifespan", using 15 years in case of North Sea plaice.
In this context the interpretation is that the calculation should
not be expanded beyond the age groups which are observed in the catches.

The differences between these two approaches are entirely dependent on
the contribution which the oldest age group makes to the total yield.
The relative contribution to yield per recruit of the oldest age group
decreases with increasing fishing mortality, but it is very high on

very small Fs which are used in calculating the slope of the tangent at the origin of the Y/R curve used to estimate $F_{0.1}$ The implication are that by treating the oldest age group as a plus group the slope is much steeper resulting in smaller $F_{0.1}$ and F_{max} values (Figure 1).

This discussion will have practical importance if management objectives are being defined by reference points on the Y/R curve.

To illustrate the magnitude of the problem, the Downs herring may serve as an example.

	$F_{0.1}$	Corresponding yield in 1982 ('000 tonnes)
Age 9+ group	0.15	53
Age 9 not a plus group	0.27	90

For these reasons, the Working Group did not include reference points on the Y/R curve in the tables giving management options.

The Working Group, therefore, would like to see these questions considered by ACFM, if management strategies should be based on Y/R considerations.

2. NORTH SEA HERRING CATCHES

2.1 The Fishery

2.1.1 Regulation of North Sea herring fisheries

1975 was the last year of unrestricted herring fishing. In 1976 a ban on directed fishing for herring for fish meal was introduced. From that year about all catches of juvenile herring have been taken as by-catches of small-meshed fisheries and, in particular, those directed at sprat.

Except for some limited catches in early summer of 1977 in Division IVb and in November and December in Division VIId, all directed fishing for herring has been banned. Since that date and until the re-opening of Division IVc in October 1981, any herring have been reported as by-catches in trawl and purse-seine fisheries directed at other species.

ACFM recommended in its 1981 report that:

1) a limited fishery could be allowed in Division IVc-VIId stocks, but the TAC should not be more than 20 000 tonnes;

2) it should only be taken in the area south of 53°N in Division IVc t VIId and within the time period October 1981 to March 1982;

3) no herring fishery for 1981 be allowed in Division IVa and IVb.

This recommendation was accepted by the Commission of the European Communities and was an integral part of their EEC/Norwegian fisheries management agreement. Nevertheless, the enforcement of this recommendation was dependent upon national government actions.

2.1.2 The fishery in 1981

Table 2.1 gives the catch data from 1972. For 1981 the table is compiled from official reports to ICES.

Despite the ACFM recommendation directed fisheries took place in areas outside Division IVc and Division VIId both on adult and juvenile fish. Table 2.2 gives the catches by Sub-divisions for directed catches, while Tables 2.3.1 - 2.3.4 show the catches reported as by-catch of both adult and juvenile herring. The data presented in these tables are summarized below:

Year	Reported catches			Reported by-catches [2]
	Herring	Sprat	Herring juveniles	
1975	312.8	651.6	90.7	
1976	176.6	609.7		12.0
1977	45.6	311.1		9.5
1978	7.8	401.7		7.8
1979	7.7	396.4		15.3
1980	15.9	407.6		7.3
1981	46.2[1]	318.0[1]		14.4[1]

1) Preliminary
2) Further updated estimates from C.M.1981/H:8
   and C.M.1982/Assess: 6

From information provided by Working Group members and an attempt at estimating the total quantity of 0 and 1 group fish caught in Division IVb, the total North Sea catch has been estimated to be not less than 95 000 tonnes, of which about 43 000 tonnes do not appear in the official statistics.

The Working Group confirms, once more, its great concern regarding the efficiency of the monitoring of landings and the reporting of them. The present situation was unanimously found unacceptable.

Management bodies must be aware that if a drastic improvement of catch and biological data is not immediately undertaken by countries, no assessment can be made for North Sea herring next year.

2.1.3   Catch in number

Table 2.4 gives the updated catch in number by age for 1980, and those Divisions of the North Sea for which adequate data on age composition and catch are available in 1981. The 10-year summary is given in Table 2.5.

No data are included in Table 2.4 for the industrial catches in Division IVb in 1981. Most of this catch is derived from sprat fisheries of which the following percentages represent that part of the total taken in Division IVb:

	1975	1976	1977	1978	1979	1980
%	94	92	83	94	96	92

Sampling for by-catch presented considerable logistic difficulties. It may be questioned, how realistic are the reported figures in view of the continued high level of sprat catch and the area and timing of the fishery. It might be supposed that subject to unrestricted fishing of sprat, the quantity of herring would be taken simply in proportion to the size of the year class available.

Considering the results of the recent IYFSs and without any information about a drastic reduction in effort, the reported by-catch which in 1981 went to the fishmeal plants would appear to be a serious underestimate. The Working Group therefore decided to make an estimate based upon the historic relation between IYFS and the recorded catches. The following text table gives the abundance index from the IYFS with the corresponding estimates of the catches in number of each year class as 0-and 1-ringers for Division IVb.

IYFS abundance indices and number of 0-and 1-ringed herring caught in Division IVb

IYFS Index		Catch in millions	
Year class	No./hour	0-ringers y'	1-ringers y''
1968	822	112.0	1118.7
1969	2 647	898.1	3440.9
1970	1 629	533.0	2896.6
1971	827	750.4	2070.5
1972	1 195	289.4	493.5
1973	1 529	925.1	1818.1
1974	452	262.8	49.5
1975	342	273.3	136.3
1976	575	253.8	168.0
1977	139	138.0	156.4
1978	535	542.0	137.3
1979	551	624.9	
1980	1 314		

Parameters of functional regression

	x/y'	x/y''
a	88.05	-505.25
b	0.4044	1.6876
r	0.66	0.88
$\bar{x}$	936.92	972.0
s	466.90	1135.07
n	12	11

Projected catches from regression:

	Age (rings):	
	0	1
1980	619.4	424.6
1981	?	1712.3

The functional regressions of catch in IYFS indices are shown in Figure 2.1. The correlation coefficient is less good for the 0-group regression, but it should be noted that the Working Group commented in 1981 that the 0-group estimates, particularly for earlier years, were believed to be underestimates, which might lead to increased variances. It also pointed to an increase in catch of this age group

by a factor of 6 times between 1978 and 1980. Using these regressions, projected catches have been made of the total catches of 0- and 1-group in 1981. These are far in excess of the values reported.

2.2   Age Composition in 1981

The data given in Table 2.4 are basically derived from the following sampling by sub-divisions, but, in addition, some age compositions from commercial sampling by Denmark, Norway and the Netherlands have been included.

Percentage age composition per area

| Age group (w.r.) | Year class | IVa W Echo surveys | | IVb Adult | IVc and VIId | |
		Moray Firth Aug.	Shetlands area Jul.+Aug.	August[1]	November[1]	1)2) December
1	1979	1.0	0.23		0.63	12.7
2	1978	79.2	1.30	33.4	85.06	61.3
3	1977	10.4	6.60	17.2	9.62	13.6
4	1976	6.3	30.60	13.8	3.13	6.2
5	1975	1.7	12.80	14.0	1.45	4.9
6	1974	0.3	10.70	17.4	0.06	1.1
7	1973	1.0	35.97	0.6	0.05[**]	0.3[**]
8	1972		1.70	2.0		
8+	1972			1.6		
No. of fish		168[*]	770[*]	338	3 803	1 461

1) Research ship sampling

2) Landing sampling

[*] Otolith number

[**] Age group 7+ (w.r.)

In Sub-division IVa W (of 2°E) the coordinated acoustic survey carried out on herring in the Shetland area provided age composition from an intensive sampling. In this area, the 1973 and 1976 year classes remain predominant with respectively 35.6% and 30.6%. Since the beginning of this survey in 1979, the sampling has revealed the deficiency of the recruiting year class in that area. Nevertheless, the sampling during the Moray Firth acoustic survey was dominated by 2-ring fish (year class 1979) which, being at stage 4 in August, are expected to recruit in the northern North Sea.

In the central North Sea the sampling made in August during another acoustic survey on spawning concentration indicates a higher proportion of recruiting fish (33.4%) but shows an almost equal representation of the year classes 1974-77.

In the southern North Sea and Eastern Channel samples taken during acoustic surveys and from landings of commercial catches indicate the very high representation of the 1978 year class which recruited to the Downs stock in 1981. The slightly different age structure found in sampling commercial catches in December in the Eastern Channel was

already found during the acoustic survey in November on North-Hinder (southeast of Division IVc). This tends to confirm the arrival of pre-spawners to the Channel spawning grounds in several successive waves.

In order to make some assessment of the likely age structure in the 1981 catch, some estimate of the juvenile herring catch needs to be derived. Data by age groups are available only for the first half of the year.

Assuming the predicted catches from the regression to be valid estimates and knowing the percentage age composition of the second half year in the industrial by-catch, estimates of the total industrial by-catch can be calculated. The age composition of the industrial catch in the second half year expressed relative to the 1-group abundance is as follows:

Winter rings	1	2	3	4
Relative abundance	1.00	.100	0.024	0.004

As 0-group are not sufficiently well sampled, the calculated value will be taken as the best estimate of catch. This will give the following projected age compositions for 1981 (in millions):

Age	IVa W	IVa E	IVb Adult	IVb Juvenile Jan-Jun	IVb Juvenile Jul-Dec	IVc/VIId	Total
0					619.4[1]		619.4
1		0.1		144.7[1]	279.9[1]	6.7	431.4
2	7.7	0.1	0.8	11.9	28.0	210.4	258.9
3	6.2	0.1	0.4	0.6	6.7	38.5	52.5
4	23.4	+	0.3		1.1	18.6	43.4
5	16.6	+	0.3			6.7	23.6
6	11.1	+	0.4			2.8	14.3
7	15.2	+	+			0.5	15.7
8	3.4		+				3.4
>8	1.1		+				1.1

1) From regression estimates

Applying the standard weight at age this would suggest the 1981 catch to be of the order of 95 000 tonnes compared with the present reported level of 23 000 tonnes. The Working Group has used this estimate for assessment, and it believes that in the absence of the proper reporting of data it is a more realistic figure, but perhaps still below the real one.

Numbers of herring caught by age and area, which are given in Tables 2.4 and 2.5, are summarized in the text table below for the past five years with the revised figures for 1980 and those derived above for 1981:

Millions of herring caught per age group (winter rings)

Year	0	1	2	3	4	5 and older	Total
1977	257	144	45	186	11	13	656
1978	130	169	5	6	5	1	316
1979	542	159	34	10	10	4	759
1980	792	161	108	92	32	26	1 211
1981	619	431	259	52	43	58	1 462

2.3 Recruitment

2.3.1 Results of IKMT sampling during International Young Fish Surveys

Now that 6 years of data have been collected from this programme, it is useful to compare the results for the various years and see, whether any conclusions can be drawn as regards recruitment to the North Sea populations. It should be noted that the herring larvae born in the southern North Sea and English Channel are probably not represented in any significant numbers in the IKMT-catches in February. These larvae do not show up in Dutch and English coastal waters until April, when they have reached a length of approximately 30 mm. In February, therefore, most of these larvae are probably not yet available to the IKMT.

Figure 2.2 shows the distribution of larvae in each of the years 1977-82. The picture is very different for the first three years of the programme and the last three years. During the surveys in 1977-79, hardly any larvae were found in the central and southern North Sea, and very few in the Skagerrak. The only significant catches of larvae were taken off the Scottish coast and in the northern North Sea.

Starting from 1980, the situation changed drastically, with major concentrations of larvae appearing in the central North Sea, particularly on the eastern side, and also in the Skagerrak.

Although the general abundance of larvae was high in all the years 1980-82, the actual distribution pattern was rather different. In 1980, the major concentration occurred off the Jutland coast and in the entrance of the Skagerrak. For 1981, the general direction of the larval drift must have been the same, but now the larvae had proceeded further east than in previous years. It is likely that the larval concentrations found in Skagerrak/Kattegat and in the German Bight originated from the same wave of larvae, coming from the direction of Shetland/Orkney, which had already been split into two components. In the most recent year (1982), the main concentration of larvae was found further to the south in the central North Sea. Either this concentration contains Shetland/Orkney larvae that have followed a more southerly course than during the previous 2 years, or this concentration is mainly derived from spawning grounds in the central North Sea.

2.3.2 Possible underestimates of Downs recruits during the IYFS

It should be borne in mind that the regression presently used to predict year class strength from IYFS abundance was based on the years 1958-59 and 1968-74, in which Downs herring constituted a very small proportion of total North Sea recruitment. It is quite possible, therefore, that this regression has not given accurate predictions in recent years, when a large proportion of the overall North Sea recruitment consisted of Downs recruits.

Downs recruits are born later in the year than all other recruits in the North Sea, and they stay in inshore waters for a relatively long period. It is likely that not all 1-ringers belonging to the Downs stock have already migrated towards the open sea in February, in which case the IYFS only samples part of the year class.

2.3.3 Year class 1978

In the previous report of the Working Group, the strength of the 1978 year class as 1-ringers was estimated at 1.45×10^9, which is 21% of an average year class during the period 1951-70.

From the data on catches per age group (Section 2.2) it appears that year class 1978 has recruited predominantly to the Downs stock in 1981. This confirms the expectations expressed in last year's report of the Working Group (Section 2.3.2).

As mentioned in the section above, there is a possibility that the year class was underestimated during the IYFS because it consisted mainly of Downs recruits.

2.3.4 Year class 1979

The final abundance index for this year class from the 1981 International Young Fish Survey was 551 fish per hour. At the previous meeting of the Working Group, a provisional abundance index of 504 fish/hour was used for this year class.

Substituting the final figure for year class 1979 into the usual formula

$$Y = 0.0031x - 0.21$$

results in a year class strength of 1.50×10^9 instead of 1.35×10^9 as used previously. This new figure is 21% of the mean for year classes born in the period 1951-70. The conclusion from last year's report, that year class 1979 is of the same magnitude as its predecessor remains unaltered.

There are some indications as to what sub-populations year class 1979 will predominantly recruit to. In last year's report (Section 2.3.5) it was mentioned that during the 1981 IYFS a high percentage of opaque nucleii was found among year class 1979, suggesting that it contained a high proportion of Downs recruits. Results of the Dutch monitoring programme on pre-metamorphosis larvae in the Wadden Sea pointed in the same direction (Table 2.6).

Further evidence for a substantial proportion of Downs recruits among year class 1979 is provided by the age composition of Dutch commercial catches in the southern North Sea in early 1982. These catches show a high percentage of 2-ringers, most of which are assumed to be Downs recruits because of their southerly distribution, and a high percentage of opaque nucleii.

Percentage age composition - Dutch pair-trawl catches in the
Southern Bight in early 1982

| Month | Year class | | | | | | Total catch (tonnes) |
	1980	1979	1978	1977	1976	1975+	
Jan.	0.0	34.4	57.7	6.1	1.5	0.3	4 700
Feb.	5.3	49.0	38.0	5.7	1.6	0.4	1 500

In last year's report (Section 2.3.3) it is also stated that during
the 1981 IYFS many 1-group herring were taken in the western part of
the North Sea. No conclusions were drawn from this observation, but it
is likely that these westerly distributed herring contain a certain
proportion of Division VIa or IVa recruits.

Attention is also drawn to the results of the IKMT sampling in 1980
(Figure 2.2), which for the first time showed a significant survival of
herring larvae born in the northern parts of the North Sea or Division
VIa. This would also suggest that year class 1979 might contain a
larger proportion of recruits to these northern populations than the
three preceding year classes.

2.3.5 Year class 1980

From the IYFS in February 1982, a preliminary abundance index of
1 314 fish/hour was obtained for the herring standard area. This
indicates the first appearance of a reasonably good year class in the
North Sea since 1973.

Applying the regression formula

$$Y = 0.0031x - 0.21$$

the strength of the year class as 1-ringer is estimated at 3.86×10^9.
This figure is 55% of the mean for year classes born in the period 1951-70.

Year class	Abundance index IYFS	Year class strength as 1-ringers ($\times 10^{-9}$) estimated from VPA	Year class strength as 1-ringers ($\times 10^{-9}$) predicted from regression formula
1968	822	3.35	
1969	2 647	7.35	
1970	1 629	5.79	
1971	827	3.82	
1972	1 195	1.75	
1973	1 592	4.39	
1974	452	0.73	
1975	342	-	0.85
1976	575	-	1.57
1977	139	-	0.43[*]
1978	535	-	1.45
1979	551	-	1.50
1980	1 314	-	3.86

[*]) Ignoring constant in regression formula

The distribution of 1-ringers during the 1982 IYFS is shown in
Figure 2.3. In contrast to the preceding year, the main concentrations
were found in the German Bight, particularly in the coastal waters. The
fish in these areas had a mean length between 11.0 - 14.5 cm, which is
extraordinarily low. Recent experience with year class 1978 confirmed
that a low mean length of 1-group herring during the IYFS indicates a
high proportion of Downs recruits. A great majority of the small
herring had opaque nucleii, which is also characteristic for Downs
recruits.

Further indications of a good recruitment to the Downs stock of the 1980 year class were obtained from the Dutch sampling programme of pre-metamorphosis larvae in the Wadden Sea. As shown in Table 2.6 catches of Downs larvae in April 1981 were the highest ever observed since the beginning of this programme in 1967.

Also the English 0-group surveys in July (Table 2.6) indicate a relatively high recruitment of year class 1980 to the Downs stock, although the year class in these surveys is not as outstanding as in the Dutch data.

Apart from an important Downs component, the year class could also contain a significant proportion of recruits to the northern North Sea population. IKMT-data for February 1981 show that larvae from presumably the northwestern spawning areas had penetrated in high numbers far into Division IIIa and the German Bight.

2.3.6 Year class 1981

For this year class, the only information available yet was derived from the IKMT-sampling during the 1982 IYFS (Figure 2.2). These data still cannot be used for quantitative predictions, but they do show again a high abundance of larvae, this time especially in the central North Sea.

2.4 Acoustic Surveys

2.4.1 The 1981 acoustic survey in the Orkney/Shetland area

A report on the ICES coordinated survey in the Orkney/Shetland area was submitted to the 1981 Statutory Meeting (Doc. C.M.1981/H:50), and an evaluation of it was carried out at a meeting of the Acoustic Survey Planning Group held in Aberdeen, United Kingdom, from 2-5 March 1982.

To convert echointegration values to biomass, a new relationship between target strength per kg and length of fish was used, and the values of target strength for each 2-cm length group are given in the text table below:

Length (cm)	Target strength (dB/kg)
19	-33.3
21	-33.8
23	-34.2
25	-34.6
27	-34.9
29	-35.3
31	-35.6
33	-35.9
35	-36.2

Using this new relationship between target strength per kg and length of fish, four estimates of herring biomass were made in 1981, as given in the text table below:

Ship	Dates	No. of quarter stat. rectangles surveyed	Estimated herring biomass (tonnes)
"G O Sars"	15-20 July	62	110 000
"G O Sars"	26-28 July	21	74 000
"Tridens"	27 Jul - 7 Aug	28	69 000
"Scotia"	12-31 August	65	118 000

Whereas on the first three surveys herring echotraces identifyed by trawl were distinguishable from other traces, in August the proportion of the total biomass contributed by herring was estimated from their proportion in trawl hauls. Since the herring caught in July were mainly mature, and those in August mainly spent, this change in behaviour may have been associated with spawning.

When differences in coverage are taken into account, the estimates of herring biomass in 1981 suggest that the random error in a single estimate is relatively low. The values of target strength used, however, are based on measurements in experimental situations and no allowance is made for the possible reaction of fish to the survey vessel. The biomass estimates are therefore more likely to be too low than too high.

The results of the 1981 survey are compared with those of previous years in Table 2.7. To allow for differences in coverage, the biomass estimates are given for a set of six statistical rectangles in the south Shetland area which has been covered on most surveys, and which contained the major part of the herring population in most cases. The complete surveys of this area in 1980 and 1981 indicate a decrease in biomass between the two years. The estimate of 110 000 tonnes in July 1981 does not include a concentration of recruits recorded in the northern part of the Moray Firth in August (an estimated 57 000 tonnes). Thus, the best available estimate of spawning biomass in July-August 1981 from acoustic surveys is 167 000 tonnes.

The survey carried out in July 1981 by "G O Sars" extended into the northern part of Division VIa. During this period, herring were found in the area southwest of Shetland and in the area around North Rona, but there was no evidence of shoals in the intervening area.

The Working Group considered that the absolute estimates of herring biomass provided by these surveys could not at present be substantiated. They also expressed some reservations about the validity of the change in biomass between the two years. The agreement between survey vessels, however, had improved markedly since the survey began, and they therefore agreed that the survey in this area should be continued. Since the validity of the surveys depends on correct methodology, they further agreed that this aspect should be concentrated on, in particular, to determine the variability to be expected in the estimates. For this reason, it was agreed that the effort on the summer survey should be concentrated in the Orkney/Shetland area.

2.4.2　Acoustic biomass estimates from the southern North Sea and Eastern Channel

Acoustic biomass estimates were available from three surveys, which were carried out in Divisions IVc and VII d during winter 1981/82. Few fish of other species were taken in either research vessel sample hauls or catches from the commercial fishery in the areas which were

surveyed, and allocation of biomass to species did not present any problems. Biomass estimates were based on a target strength value of -34.6 dB/kg for 25 cm herring as recommended by the Acoustic Survey Planning Group.

"Thalassa" surveyed five separate small areas from 5-15 November. The herring were at this time approaching spawning and were mainly in maturity stage V. An acoustic biomass estimate of 64 000 tonnes was derived from this survey. "Clione" again covered the same general area from 2-15 December but found herring to be very dispersed and mainly newly spent, in maturity stage VII. An acoustic biomass estimate of 53 000 tonnes was obtained from this survey.

"Thalassa" and "Clione", from past experience, expected to cover all important areas of herring distribution in the Southern Bight and Eastern Channel. However, subsequent surveys of herring larvae indicated that a substantial part of a very important spawning area in the Eastern Channel had not been covered by either vessel. In addition, "Clione" did not cover a concentration of herring being fished by Dutch pair trawlers near to the Bligh Bank during early December.

An area of diffuse mid-water echo trace in the Southern Bight off the Dutch coast, composed of spent herring with an admixture of immatures, was surveyed at the end of January and beginning of February by "Corella". An acoustic biomass estimate for the adult herring of 144 000 tonnes was derived from this survey.

These surveys are the first ones to have been carried out for herring in the Southern Bight and Eastern Channel. They have demonstrated that acoustic surveys can be made of pre-spawning and spawning concentrations in November-December and of spent herring in January-February giving encouraging results. The biomass estimates which were obtained must all be considered as underestimates of the total stock, the November-December estimates for the reasons given above, and the January-February estimate because spent herring would also have been distributed in the Eastern Channel at that time.

Because of the long duration of the spawning season (November-January) and the fact that part of the stock migrates through the Southern Bight to spawn in the Eastern Channel, while another part remains and spawns within the Southern Bight, arriving at a total acoustic biomass estimate for the whole of the spawning stock will present considerable difficulties. Perhaps in further years with sufficient ship participation it may be possible to survey each spawning concentration in turn and then sum the biomass estimate obtained from them.

2.5   North Sea Herring Larval Surveys

The data available from the larval surveys in 1981/82 were more satisfactory than in previous years in that in all areas the sampling intensity was higher and its distribution over the hatching period resulted in no gap which had to be filled by interpolation except in the southern North Sea. In all areas, the indices of larval abundance were estimated as described in C.M.1981/H:3.

2.5.1   Division IVa

Surveys were carried out by the Netherlands and the Federal Republic of Germany in the first half of September, and by Denmark and Scotland in the second half of September. The resulting indices of

larvae less than 10 mm long are: 1st half of September: 4 444, 2nd half of September: 238, resulting in a mean of 2 341. This value inserted in the regression equation given by McKay (1981) of

$$\hat{Y} = 0.0798X + 48.77$$

where $\hat{Y}$ is the spawning stock biomass in 1 000 tonnes units, and X is the larval index x 10^{-9}, gives an estimated spawning stock size in 1981 of 235 000 tonnes compared with an estimate of 214 000 tonnes in 1980. In the light of the confidence limits on estimates from this technique, this in effect means that there has been no significant change in the size of the spawning stock in this area since 1978. This is supported by the age composition of both research vessel and commercial catches, which would suggest that recruitment to this stock has been low in recent years.

In the text table below the larval indices and the resulting estimates of spawning stock biomasses are given for 1978-81.

	1978	1979	1980	1981
Larval index	3 345	3 325	2 074	2 341
Spawning stock biomass (tonnes)	316 000	314 000	214 000	236 000

2.5.2 Division IVb

One survey was carried out by Scotland in the Buchan area resulting in an index of larvae less than 10 mm of 9 x 10^9. In the central North Sea two surveys by the Netherlands in September gave estimates of 989 x 10^9 in the first half of September and 324 x 10^9 in the second half of September. A survey in early October by England gave an estimate of 27 x 10^9 (after correcting for efficiency), and one by Norway in the second half of October a value of 0 giving a mean, as calculated in Anon. (1981) for use in the regression of 344 x 10^9 larvae.

In a background document to this meeting of the Working Group, the historic spawning stocks in Division IVb were recalculated. This resulted in very small changes in the values used in Anon. (1981), but the regression equation has been re-estimated. The new form is

$$\hat{Y} = 10.179X + 8.698$$

where $\hat{Y}$ is the spawning stock biomass in 1 000 tonnes units, and X is the larval index x 10^{-11}. This results in an estimate of spawning stock size in 1981 of 43 000 tonnes.

The larval indices and resulting spawning stock biomass in this Division for the years 1978-81 are given in the text table below.

	1978	1979	1980	1981
Larval index	2.23	2.26	0.59	3.44
Spawning stock biomass	31 000	32 000	15 000	43 000

These values suggest that the spawning stock in this Division had increased quite dramatically between 1980 and 1981, but as pointed out in last year's report the 1980 estimate was of a somewhat

dubious accuracy because of gaps in the sampling in that year which had to be filled by interpolation. It now seems most likely that the spawning stock was at a fairly stable level from 1978-80 but has increased slightly in 1981. This would be supported by some evidence from research vessel sampling, which suggests that this stock may have had rather better recruitment in 1981.

2.5.3   Divisions IVc and VIId

Surveys were carried out by England, France, the Federal Republic of Germany and the Netherlands. The mean estimates of abundance of all size groups of larvae were $2\ 722 \times 10^9$ in December, and 380×10^9 in January, giving an overall mean of 1531.0×10^9.

A revision of the data input for the VPA for the Downs stock, carried out by the Working Group on Herring Larval Surveys South of 62°N, uncovered a major error in the input catch in number data for one age group in one year. This resulted in quite major discrepancies on the estimated spawning stock estimates and, therefore, in the parameter. of the regression equation between spawning stock and larval abundance. The Working Group made a new VPA for the Downs stock, starting from the year 1981, which is described in para.2.7.1.3. From this, new estimates of spawning stock biomass were made, and a new regression calculated for the spawning seasons 1958/59 to 1978/79. The equation is

$$\hat{Y} = 0.282X + 8.590$$

where $\hat{Y}$ is the spawning stock biomass in tonnes $\times 10^{-3}$, and X is larval index $\times 10^{-9}$. This regression is significant at the 5% level.

Little reliance can be placed on an estimate of spawning stock in 1981-82 from this source. The larval index for 1981-82 is higher, by a factor of over 10, than the largest index used in calculating the regression equation. Under these circumstances, the assumption that the same relationship holds is entirely unlikely.

In the text table below the larval indices for the seasons 78/79 to 1981/82 are given as well as the corresponding estimated spawning stock sizes for the years when these estimates have some reliability.

	1978/79	1979/80	1980/81	1981/82
Larval index	16.4	147.3	363.7	1 531.0
Spawning stock biomass	13 200	50 000	111 000	-

2.6   Effects of By-Catches of Herring

2.6.1   VPA on the total North Sea herring stock

Since it is several years ago since a VPA has been run on the total North Sea herring catches, and since such a VPA would be useful for studying the effects of by-catches on the North Sea herring stock, a VPA was run, using the total North Sea catches for the years 1955-81. The Working Group had serious doubts about the validity of the estimated 1981 catches. It was therefore decided to use an input procedure for the last year, that would not use the catch in 1981.

The input Fs for the last year were based on the following asumptions:

1) Spawning stock 1/9-81   Div. IVa   235 000 tonnes

    Spawning stock 1/9-81   Div. IVb   43 000 tonnes

    Spawning stock 1/9-81   Divs. IVc and VIId 250 000 tonnes

2) No catches of adult herring in 1981 were taken before
    1 September. This assumption might be questioned for
    Division IVb, while it is considered realistic for the
    other areas.

Using the available age composition of the spawning stock, the
spawning stock in numbers in each area were scaled to the assumed
biomass. The weights at age are taken as the values of C.M.1978/H:2.

Using 2/3 of natural mortality, the spawning stock in numbers
were backtraced to the 1 of January 1981. The number of 0-group
as at 1/1-1981 was chosen to give 3.86 x 10^{-9} as 1-group is at
1/1-1982, this being the IYFS estimate in February 1982. The
number of 1-group was chosen as 1.35 x 10^{-9}, this being the IYFS
estimate. Using the above method, the stock as at 1/1-1981 was:

W.r.	0	1	2	3	4	5	6	7	8	8+
No. x 10^{-9}	4.80	1.35	1.53	0.31	0.39	0.28	0.27	0.29	0.07	0.03

The Fs for 1981 were chosen to produce the stock shown in the
text table. The output from the VPA is found in Tables 2.8 - 2.11.

2.6.2   Effects of the by-catch of 0-group and 1-group

In order to illustrate the effects of the fishery of 0-group and
1-group on the spawning stock size, the spawning stock sizes in
the years 1977-81 were calculated, using different assumptions on
the fishing mortality on juvenile herring. The estimated stock
in numbers as at 1/1-1977 (VPA, Table 2.10) was used as a basis
for the prediction. The recruitment in the years 1978-81 was
selected as estimated from the VPA. Using a fishing pattern of
constant mortality on 0- and 1-group and zero mortality on older
fish, a prediction was run:

W.r	0	1	2	3	4	5	6	7	8	8+
Stock in no. x 10^{-9}	1.18	0.62	0.48	0.63	0.12	0.01	0.02	0.01	-	-
Fishing pattern	F_o	F_1	0	0	0	0	0	0	0	0

Predicted spawning stock at 1 September:

$F_0=F_1$ / Years	0	0.1	0.2	0.3
1977	194	194	194	194
1978	285	279	273	268
1979	427	396	372	352
1980	547	496	453	418
1981	829	725	639	568

It is likely that the by-catches have affected the recruitment to Divisions IVb and IVa to a higher extent than to Divisions IVc-VIId. The mean F on 0- and 1-group for the years 1977-81 has been estimated to about 0.25. However, this estimate, or any other estimates from the VPA, do not take into account catches of North Sea herring taken in other areas.

2.7 State of Stocks and Management Considerations

2.7.1 Divisions IVc and VIId Stocks (Downs)

2.7.1.1 The fishery in Divisions IVc and VIId

Over the post-war period catches reached an exceptionally high level of about 280 000 tonnes in 1954, when bottom trawling was carried out extensively on the spawning grounds. This record was followed by a very sharp decrease to about 11 000 tonnes in the years 1966-68. The catches during the period 1969-76 averaged 22 400 tonnes (Figure 2.4).

After a ban on a directed herring fishery had been set in Sub-area IV and Division VIId from 1977, catches fell to a negligible level in Divisions IVc-VIId in 1977 and 1978 when this ban was effectively enforced. But in 1979 and even more in 1980 substantial illegal fisheries directed to herring occurred and reached in 1980 about 45 000 tonnes, of which the major part was taken in the Eastern Channel.

Fishing was carried out chiefly in November and December on the main spawning and pre-spawning concentrations.

In both the 1980/81 and 1981/82 seasons fishing took place on spent herring in January-March. Such a fishery was almost non-existent over the last decade when the stock was at its lowest level.

The overall catch in 1981 amounted to about 40 500 tonnes (including estimate of discarded or dumped fish).

2.7.1.2 Catch in number

The Downs stock is defined as spawning in the southern North Sea and Eastern Channel (ICES Divisions IVc and VIId). However, Wood (1958) and Burd (1962) have pointed out that Downs spawners are also taken in appreciable quantities in Division IVb, particularly prior to the Division IVb spawning season.

Central North Sea and Downs components in Division IVb catches can
be distinguished by differences in fat content, l_1, and mainly
by maturity stages. Downs components have been identified as being
predominantly less mature than stage IV in the period July-September.
Such an analysis, which has been carried out for the years prior to
1977, shows that the percentage of Downs component can vary rather
widely from year to year, depending on the period during which the
main fishery is exerted.

These results for the years 1971-76 are given in the text table below.

Year	1971	1972	1973	1974	1975	1976
Proportion	0.18	0.12	0.55	0.31	0.12	0.23

For the most recent years, where no adequate data were available,
a mean of 25% was applied to the Division IVb adult catches in number
and transferred to the Divisions IVc and IVd catches. The resulting
figures have been used as input catch in number for the VPA carried
out for the Downs stock (Table 2.7.1).

2.7.1.3   Estimate of spawning stock size and fishing mortality in 1981

As explained in Section 2.5 on estimates of spawning stock biomass
from larval surveys, it was possible to estimate the size of the
spawning stock at the end of 1981 based on the 1981/82 larval abundance
index, since this would require extrapolation far beyond the range
of the available observations. Estimates of the spawning stock
biomass at the end of 1981 and the corresponding fishing mortality
in 1981 have been made as follows:

For the 1978 year class, terminal F was estimated based on its
abundance as 1-ringers in the IYFS. It was assumed that this year
class has recruited entirely to the Downs stock and has been
subject to only natural mortality before recruiting to the fishery
as 2-ringers in 1981. Its contribution to the spawning stock at the
end of 1981 was calculated by applying the catch of 2-ringers to it.
The resulting F on that age group for 1981 was 0.185.

Spawning stock biomass at the end of 1980 (year classes 1977 and
older) estimated from the corrected regression of SSB against
larval survey indices (see Section 2.5) was 111 000 tonnes ± 31 000 t.
This estimate was considered reliable, since the larval index for
that year does not require a too large extrapolation beyond the
range of observed data. A VPA with a terminal F of 0.185 and 0.1
for the year classes 1978 and 1977 and older, respectively, resulted
in an estimate for the 1980 SSB of 115 000 tonnes, which is close
to the estimate from the regression. The resulting SSB at the
end of 1981 was 244 000 tonnes. The underlying assumption that
fishing in 1981 was concentrated mainly on the 1978 year class
is not unlikely in view of the fact that this year class was the
dominating one in the stock.

2.7.1.4   Results of VPA

The results of the VPA are given in Table 2.12 and are summarized
in Figure 2.5.

Fishing mortality fluctuated at a level of about 1.0 up to 1975.
After an increase to a level of 2.5 in 1976 it decreased by 1977
and remained at relatively low levels as a result of the ban on
directed herring fishery in the North Sea.

The spawning stock biomass at spawning time (i.e., the end of the year) increased slightly from 1968 onwards to a peak in 1972 of about 40 000 tonnes, followed by a steady decrease to a level as low as about 3 000 tonnes in 1976.

Due to increasing recruitment since 1978, the spawning stock biomass increased rapidly. Although the estimate of the 1981 spawning stock biomass has some uncertainties attached to it, it is quite obvious that the positive development of the spawning stock since 1978 must have resulted from the protection of the Downs herring in the years 1977-79. The quick reaction of the Downs stock to the ban on directed herring fishing compared to the central and northern North Sea may be explained by a lower level of exploitation of juvenile herring of this stock in the mixed fisheries.

2.7.1.5   Projection of catch and spawning stock size for 1982

Catches and the corresponding spawning stock biomass for different levels of fishing mortality in 1982 have been calculated, using the data given in Table 2.12(c).

The estimated age composition of the stock in numbers derived from VPA shows that the 3- and 4-ringers are making up a higher proportion of the stock in 1982 compared to the preceding period. Therefore, the exploitation pattern which was applied in the VPA, assuming that fishing had been concentrated on the good year class 1978 in 1981, had to be changed based on the assumption that fishing mortality is about the same on all age groups $\geq$ 2 in 1982.

Recruitment at age 2 in 1982 (year class 1979) was derived from the IYFS results. As in last year's assessment, it was assumed as a first approach that 50% of the recruits are Downs herring and, after applying natural mortality on 1-ringers, about 680×10^6 are estimated to recruit to the Downs stock as 2-ringers in 1982.

This approach taken in estimating recruitment has to be seen in the light of qualitative information as discussed in Sections 2.3.4 and 2.3.5, indicating that a high proportion of the recruits as estimated from the IYFS for these two year classes might recruit to the Downs stock. It is also possible that the most recent year classes are underestimated in the IYFS. It should also be noted in this context that the assumption made in last year's assessment of the number of recruits of the 1978 year class to the Downs stock (50% of the IYFS estimate for the total North Sea) has to be considered as an underestimate (see Sections 2.3.2 and 2.3.3). These qualitative indications should not be ignored, even if they could not be quantified at present. For these reasons, the Working Group prepared two catch projections under two different assumptions on the recruitment of the 1979 year class to the Downs stock as 2-ringers in 1982.

A.   50% of the IYFS estimate are Downs herring (680×10^6)

B.   Recruits from 1979 year class the same as for the 1978 year class ($1\ 300 \times 10^{-6}$).

Although the 1980 year class in the IYFS appears to be very strong for the total North Sea and might contain a high proportion of Downs recruits (see Section 2.3.5), the Working Group refrained from expanding the projection beyond the end of 1982, since the evaluation of the qualitative information on the proportion of Downs recruits in quantitative terms would contain a too great element of speculation. The detailed results of the catch projection are given in Figure 2.6, and some selected management options in the text table below.

A. Recruitment 1979 year class = 680×10^6

1981				Management option for 1982	1982			
Stock biom. (2+)	$\bar{F}_{(2-9)}$	Catch	Spawn stock biom. (2+)		Stock biom. (2+)	$\bar{F}_{(2-9)}$	Catch	Sp. stock biom. (2+)
311	.154	40.5	243	F = .10	396	.10	36	325
				$F_{82} = F_{81}$		.15	53	310
				F = .20		.20	69	294

B. Recruitment 1979 year class = $1\ 300 \times 10^6$

1981				Management option for 1982	1982			
Stock biom. (2+)	$\bar{F}_{(2-9)}$	Catch	Spawn stock biom. (2+)		Stock biom. (2+)	$\bar{F}_{(2-9)}$	Catch	Sp. stock biom. (2+)
311	.154	40.5	243	F = .10	475	.10	43	390
				$F_{82} = F_{81}$		.15	63	370
				F = .20		.20	82	350

Weights in thousand tonnes.
Stock biomass refers to the beginning of the year.
Spawning stock biomass refers to spawning time (end of the year).

2.7.2   Division IVb Stock (Bank)

Age compositions of the spawning stock in the central North Sea
are given in the text table below for the period 1977-81.   The
figures for earlier years are taken from the previous report, and
those for 1981 from English sampling of research vessel catches
on the spawning grounds at the spawning time.

Year \ Winter-rings	2	3	4	5	6	7	≥8	Total
1977	72.4	19.0	0.7	5.4	2.5	-	-	100
1978	15.7	52.8	17.0	2.2	5.6	6.4	0.3	100
1979	12.8	4.3	40.4	28.7	2.1	5.3	6.4	100
1980	20.9	9.7	1.4	53.2	7.2	0.6	7.0	100
1981	33.4	17.2	13.8	14.0	17.4	0.6	3.6	100

It is clear that this stock had received no appreciable increment
from recruitment in 1978-80.   In 1981, however, the recruit year
class was the largest component, and this would suggest that in
1981 recruitment was somewhat better than in any year since 1977.

The only other source of data on the stock in this area is that
derived from the herring larval surveys given in Section 2.5.
The relevant text table from that is reproduced below:

	1978	1979	1980	1981
Larval index	2.23	2.26	0.59	3.44
Estimate spawning stock (tonnes)	31 000	32 000	15 000[*]	43 000

* Inadequate sampling

The data from the 1980 larval survey, as commented in Section 2.5,
are not very reliable, and the estimate of spawning stock in that
year given above might well be seriously underestimated.   If that
were so, the data given in the text table would be in some con-
formity with those given on stock composition in suggesting a
rather stable spawning stock from 1978-80 but some small
increment in it in 1981.

2.7.3   Division IVa stock

The age composition of the stock in Division IVa, derived from
sampling during research vessel surveys in this area, are given
in the text table below, together with the age compositions of
landings from this area in 1977:

Year \ Winter-rings	1	2	3	4	5	6	7	≥8	Total
1977	1.4	4.7	86.2	4.3	1.9	1.0	0.4	0.1	100
1978	-	42.6	21.8	30.9	1.6	1.9	1.0	0.3	100
1979	27.4	16.6	7.9	28.7	18.6	0.6	0.2	-	100
1980	-	15.9	41.5	14.3	10.2	15.2	1.7	1.2	100
1981	0.2	1.4	6.6	30.6	12.8	10.7	36.0	1.7	100

The age composition data from the acoustic survey in the Orkney/Shetland area are in very close agreement with those of illegal commercial landings from this area in 1981. Sampling by one of the survey vessels in the northern Moray Firth in 1981, however, would suggest that there may have been some addition of recruit spawners to the stock in that area. But the overall conclusion from these data is that over the period 1978-81 the increment to the spawning stock from recruitment has been very small. This conclusion is supported by the larval data, taken from Section 2.5, given in the text table below:

	1978	1979	1980	1981
Larval index	3345	3325	2074	2341
Spawning stock (tonnes)	316 000	314 000	214 000	236 000

There would indeed appear from the larval indices to have been a drop in larval abundance and in spawning stock in the most recent two years, but, bearing in mind the confidence limits on these estimates, it would seem more likely that the situation is one of stability. Acoustic surveys carried out in Division IVa in these years would also tend to suggest that there has been no major changes in the stock size.

2.7.4   Management considerations

It is clear from last year's report of the Herring Assessment Working Group for the Area South of 62°N, and from assessments carried out by this Working Group in 1982, that the reactions of the populations in the different sub-divisions of the North Sea to management regulations have been very different. The population spawning in Divisions IVc and VIId has shown a very marked recovery, in Divisions IVb and IVa the recovery to date has been very small. It is quite clear that the differences in the rates of recovery between the Divisions IVc and VIId populations, and those in the remaining Sub-divisions of Sub-area IV have arisen from the very different levels of recruitment to them in the last two years. The reasons for this difference in recruitment are not yet completely explicable, but it is suggested elsewhere in this report, that the explanation may lie in the differences in their distribution as juveniles, and the concomitant differences in the exploitation to which they are subject during this stage of their life cycle.

Irrespective of the reasons for these differences, however, the fact remains that the populations in Divisions IVc and VIId have recovered very rapidly, whilst those in Divisions IVa and IVb have shown little change. At its meeting in 1981, the Working Group

accepted this difference and advised a re-opening of the fishery in Divisions IVc and VIId on a limited TAC, to be taken in these divisions where the catches would be solely from the population spawning there.

The results of the new data available, and of the analysis of them, carried out during the 1982 meeting, suggest little change in this situation. The population spawning in Divisions IVc and VIId has been increased even further by good recruitment, whilst the population spawning in Division IVb may have increased, but only marginally, in 1981, and that in Division IVa has remained stable over the last four years. The data available on recruitment to these populations would suggest little change in this situation in 1982 and 1983. They suggest that the spawning population in Divisions IVc and VIId will gain a further large recruitment in that year, whilst those in Divisions IVa and IVb can expect only very small increments.

In the light of these new data there is no doubt that the populations spawning in Divisions IVc and VIId could continue to be exploited in 1982 and 1983, whilst the exploitation of those spawning in Division IVa and IVb should, on purely biological considerations, continue to be prohibited. Such a policy is likely to result in a TAC of the order of 60 000 - 80 000 tonnes, to be taken solely in Divisions IVc and VIId in the period 1 October 1982 - 28 February 1983, as it is only in that area, and during that time period, that one can be sure of catching only the Downs population. This may not be the most effective way of utilizing the resource, and, on this basis, consideration should be given to what is known of the distribution of the populations during other periods.

As stated in an earlier section, there is good evidence that the Downs stock, during late spring and summer, are distributed in the central North Sea and, to some extent, also in the southern fringe of Division IVa. In this situation, the Downs stock could be fished in early summer in Division IVb, and in the light of the evidence that the Downs population is about 5-8 times larger than the Division IVb one would be expected to constitute a major component of the catches. The relative proportions of the populations in the catches are, however, not relevant to management considerations - the important factor is the fishing mortality which these catches will cause in the two populations. This cannot be quantified, but the best assumption might be that any catch taken in Division IVb, during early summer, would generate the same mortality rates on the central North Sea and Downs populations. The effects of this fishing mortality rate on the prospects of recovery of the central North Sea population must be the prime consideration in deciding what proportion, if any, of the TAC for the Downs stock in 1982 should be taken in Division IVb. In the light of the current situation in respect of management and enforcement, consideration should also be given to the prospects of any proportion of the TAC for the Downs stock, allocated to Division IVb, being effectively enforced. The evidence for the Downs population being distributed in Division IVa is less firm, but it certainly appears that this population has never penetrated far into this Division.

3. DIVISION IIIa HERRING

3.1 Stock Composition

In Division IIIa three different stocks were identified in 1981: the Kattegat spring spawners (including Danish coastal spawners (VS: 55.8-56.4)), the Skagerrak spring spawners (VS: 56.6-57.3), and the North Sea autumn spawners (VS: 56.3-56.6). In addition,

herring from the western Baltic mix with these stocks. Baltic herring (VS: 55.5-56.2) can at present not be separated from Kattegat spring spawned herring and their proportion in the catches is therefore unknown. North Sea autumn spawned herring occur in Division IIIa predominantly as 0- and 1-group herring.

In the commercial Swedish samples from 1981, herring with meristic characteristics of the Kattegat spring spawners (VS ≈ 56.0) dominated among the 2-group and older herring. In July and August, herring with these characteristics migrated from the North Sea into the Skagerrak and made up the predominant part in samples from purse-seine and pelagic trawl catches in the western Skagerrak during that time.

Separation of 0- and 1-group herring into spring and autumn spawned fish can be made from fish length and otolith length measurements (C.M.1981/H:28), and the identity after such a separation should preferably be checked by the means of VS. A series of length frequency diagrams of 0- and 1-group herring are shown, which, however, indicates that more than one stock were present in Division IIIa in 1981 (Figure 3.1). The results are from the Swedish catches and are given for each quarter for the Kattegat and for the third quarter for the Skagerrak. The numbers of herring landed in this fishery are presented in each graph.

The interpretation of the length frequency diagrams with respect to stock separation must, at this stage, be considered as preliminary.

In the first quarter, the length distribution suggests that 1-group autumn spawned herring dominated in the catches in the Kattegat. In the second quarter, the length distribution is bimodal indicating that both spring (< ~ 15 cm) and autumn (> ~ 15 cm) spawned herring were fished upon.

In the third quarter, the peak of the 1-group consisted of rather small fish suggesting a dominance of spring spawners, part of the autumn spawners had probably left the Kattegat by this time. In this quarter, also the 0-group appeared in the catches in the Kattegat, and these were, based on the length distribution, mainly autumn spawned herring. The stock classification in the third quarter was supported by the samples from the acoustic survey in September. In these samples, the means of VS of the 0-group were about 56.5. The 1-group herring were separated according to length, resulting in that fish smaller than about 20 cm showed a mean VS of either 56.0 or 56.7, i.e., corresponding to Kattegat and Skagerrak spawners, respectively. Larger 1-group herring had means of VS of about 56.5 indicating autumn spawned origin.

In the fourth quarter, the catches of 0- and 1-group seem to have been made up predominantly by autumn and spring spawned herring, respectively.

The Swedish samples from the third quarter in the Skagerrak resulted in bimodal length frequency diagrams for both the 0- and 1-group herring. These peaks are probably made up by spring and autumn spawned herring. If so, a comparison with the samples from the Kattegat from the same quarter suggests that the herring in the Skagerrak had a larger size at that time than in the Kattegat.

The number of 0- and 1-group herring landed in the Swedish fishery in Division IIIa was less than 20% of the total, and the Working Group felt that at the present state, these figures could not be used for an estimation of the numbers of autumn and spring spawners caught in Division IIIa during 1981.

3.2   The Fishery in 1981

3.2.1   Catch data

The landings of herring during the last decade are given in Table 3.1.
The preliminary total landings based upon official figures in 1981
for Division IIIa amounted to approximately 114 000 tonnes, which is
a drastic increase from the official figures in 1980. The increase
is most pronounced in the Skagerrak, where the landings almost
trebled.

Denmark was not able to produce reliable data on the catch composition
of industrial landings for the second half of the year, and in
order to get an indication of the likely level of this part of the
landings, the Working Group made an estimate from a regression of
research vessel data on earlier catches of 0-group herring. This
exercise, which is described in the following section, indicated that
an additional 42 000 tonnes of herring might have been landed in
July-December. This together with another 4 000 tonnes of unallocated
landings would indicate a total catch of some 160 000 tonnes. The
official figures appear, therefore, to be an underestimate of the
catch taken in Division IIIa.

It is stressed that the validity of the indirect estimation depends
upon a number of assumptions, which are not likely to be fulfilled,
and it can never replace a direct estimate based on an efficient
sampling scheme. Without such a sampling scheme and reliable
figures for total landings, one will not have the data base required
for making a proper assessment.

3.2.2   Catch in numbers at age

Catch in numbers at age data were available for all major fisheries
except landings for processing in Danish harbours in the second half
of 1981. In the latter case, percentage age distributions were avail-
able, but reliable data on the actual landings of herring in weight
could not be presented.

In order to obtain an indication of the possible level of catch in
numbers, the Working Group used an indirect method. In the text
table below is given the estimated catch in numbers of 0-group herring
in the years 1975-80 and the corresponding abundance indices obtained
from IYFS in 1976-82.

Year	Catch of 0-group	IYFS index of 1-group
1975	2 006	
1976	433	1 339
1977	934	204
1978	147	575
1979	457	3
1980	682	504
1981	?	544
1982	-	1 647

The regression of catch of 0-group on abundance indices of 1-ringers
of the same year class is shown in Figure 3.2. Inserting the abundance
index obtained from the recent 1982 survey in the regression equation
indicates a catch of 2.4×10^9 0-group herring in 1981.

Table 3.2 shows the age distribution in numbers of the "known"
landings. It also shows the percentage age distribution of Danish
samples in the second half of 1981. By subtracting the known number of
0-ringers from 2.4×10^9 obtained by the regression equation, an

indication of the catch in numbers of older fish could be arrived at by applying the percentage age composition. The results are shown in the same table, together with average weights at age, by which an indication of total weight was obtained. As the unknown landings were calculated by SOP, they were corrected by the ratio of actual catch and SOP of the known landings.

The validity of the estimate depends largely on two assumptions:

    a)   Fishing patterns and effort have not changed over the period 1975-81.

    b)   The age composition applied to the unknown landings in the second half of 1981 is representative.

Neither of these can be evaluated at present.

Catch in number by age for previous years are shown in Table 3.2.

3.3   Biomass Estimates from Acoustic Surveys

An acoustic survey was carried out in September 1981 by the Swedish and Danish research vessels "Argos" and "Dana". Preliminary results were reported to the ACFM at its meeting in November 1981. ACFM expressed doubts about the actual level of biomass arrived at, mainly because of the target strength used (-38.3 dB/kg for a herring of 23.7 cm) and because of insufficient calibration of "Dana's" new equipment. New calibration data were not presented to the Working Group, which, however, expressed its interest in these surveys being continued.

3.4   Recruitment

The annual young fish survey was carried out in Division IIIa during 8-19 February 1982. In the first week of February, ice made trawling impossible. Bottom trawling with the GOV was made on 12 stations in the Kattegat and 11 in the Skagerrak. The index of the 1-group herring, calculated as the geometric mean of the arithmetic means of seven standard squares, was 1 647, which is the highest so far recorded. The number of herring was, as in previous years, higher in the Kattegat than in the Skagerrak. Two stations in the southeastern part of the Kattegat, where herring are normally abundant, could not be trawled because of ice.

The abundance index indicates that year class 1980/81 is strong. No attempt to separate the herring into spring and autumn spawned components has been made yet. However, the international young fish survey conducted in February 1981 indicated, that the amount of North Sea herring larvae drifting into Division IIIa was unusually high (see Section 2.3). This suggests that North Sea autumn spawned herring, at least partly, contribute to the high index. This is also supported by data on mean length (about 16.6 cm) of the fish taken during the survey. The mean length would also suggest that these 1-group fish of North Sea origin are predominantly from the northwestern North Sea or central North Sea spawning grounds.

Abundance indices for 1972-82 (year classes 1970/71 - 1980/81) are given in the following text table:

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

3.5   Management Considerations

The Working Group refrained from doing a stock estimate and trying to produce a prognosis upon which a TAC could be based. There were two main reasons for this decision:

a)   The lack of reliable data on the actual amount of herring landed in 1981 makes it impossible to estimate the number of each age group removed from the stock by the fishery.

b)   There are strong indications that the 2 youngest age groups contain an important, and in some years even a dominant, component of North Sea origin. An estimate of the likely recruitment to the Division IIIa stock cannot, therefore, be made from any index of abundance of immatures, before these can be split into the relevant components.

Even though a VPA is not feasible for these reasons, the age compositions of the landings alone indicate that the fishing mortality is very high, and that the spawning stock must be heavily dependent on one year class, i.e., 3-ringed recruit spawners. The high numbers of 0- and especially 1-group fish show that the fishing pattern is very much like the one observed in the North Sea herring fisheries before they finally collapsed.

Judging from the age composition of the catches, it seems that the local spawning stocks are quite small at present, and it seems highly unlikely that they would be able to produce the high numbers of juvenile herring which have been caught in Division IIIa in recent years. Moreover, tagging experiments show that Baltic herring migrate into Division IIIa, which would also tend to give an overestimate of the amount of local Division IIIa spawners.

The local stocks may indeed be below their minimum level for normal recruitment, and the herring fishery mainly supported by North Sea juveniles and Baltic adults. It is not clear, how big a proportion of North Sea juveniles enter Division IIIa or how big a proportion they form of the juvenile catches in Division IIIa. A large part of the problem in answering these questions could be solved by the meeting of the Workshop recommended in Section 9 and which was in fact recommended in last year's report.

The numbers are, however, of the same order, or even larger, than the recorded landings of juveniles from the North Sea, and even if the North Sea component is only 50% the impact on the rebuilding of the North Sea stocks could be significant. The apparent slower recovery of the stocks in Divisions IVa and IVb as compared with Divisions IVc and VIa could partly be an effect of the juvenile catches in Division IIIa.

The Working Group can consequently only reiterate advice given in earlier reports, both of the present Working Group and the Working Group on Division IIIa stocks, as follows:

a) Fishing mortality on the adult stock should be reduced in order to increase the component of older fish and stabilize the spawning stock.

b) Catches of juvenile herring should be reduced as much as possible in order to increase recruitment both to the North Sea stocks and to Division IIIa itself.

In order to achieve these improvements in the exploitation pattern and hence in the herring fisheries, TACs, minimum landing sizes and mesh sizes, together with by-catch regulations and a ban on direct fisheries for reduction purposes have been recommended and even agreed upon amongst the interested parties. The development in the landings strongly suggests, that the main problem in Division IIIa is a lack of will and/or capability of implementing the agreed measures. It is difficult to imagine what other regulations could be effective as long as the intention to avoid a very possible collapse of the herring stocks in Division IIIa is not stronger than it appears to be at present.

4. CELTIC SEA HERRING

4.1 The Fishery

4.1.1 Catch data

Fishing for herring in the Celtic Sea has now been prohibited since 1977. In spite of this, considerable catches were again made during 1981/82, and the total catch of over 9 000 tonnes was the highest recorded since 1975/76. These catches were again taken mainly by Irish pelagic trawlers and drifters. Total catches by countries per year and per season are shown in Tables 4.1 and 4.2. As in the previous seasons, the lack of markets greatly curtailed catches during 1981/82, and boats were working under a quota system for most of the season.

4.1.2 Catch in number per age

The total catch in numbers of fish per age class is shown in Table 4.3. This has been estimated from Irish and Dutch data. In the Irish catches there are considerable differences betweeen the age distribution of the autumn and winter spawning components. The autumn spawning component, which is mainly exploited during August-October, contain considerably more older herring than the winter spawning component. 1-winter-ring fish were well represented in the catches taken during the early part of the season.

4.2 Spawning Stock

4.2.1 Larval surveys

Larval surveys were conducted in 1981/82 for the fourth successive season, and station coverage was similar to that in 1980/81 (Doc. C.M.1981/H:44).

Sampling coverage, when considered on the time scale, was better than in preceding seasons with a cruise every second week between mid-October and mid-February. The distribution of < 10 mm larvae in October was between Old Head of Kinsale and Mine Head, but in early November it also extended east of Waterford Harbour. Larval production

in late November was restricted to the Mine Head area, but early December
distribution was widespread though the main concentration was offshore
between Mine Head and Waterford Harbour. Abundance of < 10 mm larvae
in late December was very low, and from January onwards none were
sampled. The larval abundances for each cruise are given in Table 4.4
and plotted with data from other seasons in Figure 4.1.

The larval index for the whole season was calculated as described in
the 1981 Herring Larval Survey Working Group Report (C.M.1981/H:3). The
areas under the straight lines joining < 10 mm larval abundance
estimates plotted on time were found for each of the periods before and
after 1 January. Each larval production index for the latter period
was multiplied by 1.465 (to adjust for lower fecundities of winter
spawners) and added to the corresponding autumn index to produce
an index of total spawning stock biomass for each season. These are
as follows:

	Autumn index	Winter index x 1.465	Total
1978/79	702[*]	326[*]	1 028[*]
1979/80	733	75	808
1980/81	655	97	752
1981/82	1 090	1	1 091

[*] Monthly surveys only - not good estimates.

While the autumn index for 1981/82 is high relative to other years,
the winter larval index was practically nil. However, the moderate
abundance of 10-15 mm larvae (mostly from one station) during the
last cruise suggests that some < 10 mm larvae were missed on the previous
cruise (Table 4.4), resulting in an underestimate of the total larval
index for 1981/82. Thus, the larval abundance index for this year
is somewhat higher than in previous seasons.

4.3   Recruitment

There is still no method available to estimate recruitment to the
Celtic Sea stock. Examination of stock numbers from VPA indicates
that recruitment has been low since 1974, with the exception of the
1977 year class. This recruited to the fishery as 1 winter ring fish
in 1979, when it constituted 20% of the total catch. The percentage
of 1 winter ring fish present in 1981/82 was 24% of the total catch
in numbers, and this might suggest that the 1979 year class would
also be above the low values of recent years. There is no evidence
of change in the exploitation pattern in recent years. 1-ring fish
also appeared to be very abundant in the catches taken in the
adjoining Division VIIj during 1981.

4.4   Estimates of Fishing Mortality

As in previous years, it has not been possible to obtain any estimate
of F for the most recent years on the Celtic Sea stock. The 1981
Working Group examined trends in F, estimated from catch curves and
the mean ages of the catches for different periods, when effort was
thought to be different. As a result of this, it has been calculated
that F in the period 1976-80 was about 0.8. This value was, therefore,
used by the 1981 Working Group as an input F on VPA for the 1980/81
catch in numbers data.

It has not been possible to calculate F for the 1981/82 catches from catch per effort data.

VPA was again carried out on the 1981/82 catch in number data, using a range of F values from 0.4 - 1.2. It was found that no input F value on the 1981/82 data generated an F in 1980/81 as high as 0.8. It must, therefore, be concluded that the F = 0.8 for 1980/81 was over-estimated or that the F in 1981/82 was in excess of 1.2. The spawning stock sizes, calculated from the different VPAs, were also compared with the larval indices but no similarities were evident. This was probably because the VPAs were carried out on the catches in age data for both the autumn and winter spawning components of the Celtic Sea combined. More meaningful comparisons might be obtained, if stock sizes for both components were separately cal-culated by VPA. However, the data necessary to enable this separation to be made were not available at this meeting.

4.4.1 Results from VPA

There is, therefore, no method of calculating the appropriate F for 1981/82. The output from the VPA, based on assumed input F adult = 0.8 and 0.4 and F 1-ring = 0.2 and 0.1, respectively, are shown in Tables 4.5-4.8. Both analyses show that the spawning stock size has increased since the initial closure of the fishery in 1977 and at spawning time in 1981 was calculated to be either 26 000 tonnes (F =0.4) or 13 800 tonnes (F = 0.8), compared to 9 000 tonnes in 1976. The VPA also indicates that the 1977/78 year class, which entered the fishery in 1979/80, was the strongest one since 1971, as suggested by the 1981 Working Group. Preliminary data from the 1981 catches indicate that the 1979/80 year class might also be a strong one and even stronger than the 1977/78 year class. This year class also appears to be abundant in the catches from the adjoining Division VIIj. There therefore appears to be some evidence that two good year classes have entered the fishery since 1979. Yield per recruit curves and spawning biomass per recruit curves are shown in Figure 4.2

4.5 State of the Stock and Management Considerations

The prognosis of the stock is shown in the following text table and in Figure 4.3.

Prognosis of Celtic Sea herring

1981/82				1982/83				1983/84			
al k b_ _ass	Spawning stock at spawning time	$\bar{F}_{2-9}$	Catch	Stock biomass 1 April	Spawning stock biomass at spawning time	$\bar{F}_{2-9}$	Catch	Stock biomass 1 April	Spawning stock biomass at spawning time	$\bar{F}_{2-9}$	Catch
36 000	25 600	0.4	9 471	34 300	30 900	0	0	39 300	35 700	0	0
					30 400	0.1	3 400	36 200	32 100	0.1	3 700
					29 800	0.2	6 500	33 400	29 000	0.2	6 400
					29 200	0.3	9 400	30 900	26 100	0.3	8 400
20 400	13 800	0.8	9 471	17 100	14 600	0	0	21 800	19 100	0	0
					14 300	0.1	1 600	18 600	17 400	0.1	1 900
					14 100	0.2	3 000	19 100	15 900	0.2	3 400
					13 800	0.3	4 300	17 900	14 500	0.3	4 500

The stock size, calculated at 1 April 1981, was used to calculate stock sizes at 1 April 1982, using F values of 0.4 and 0.8. The mean weights per age class used were the same as in the 1981 assessment, and a minimal recruitment of 30 million fish was taken for the 1980/81 year class. The stock size has increased considerably due to the influx of the strong 1979/80 year class and is calculated to be either 17 100 tonnes or 34 300 tonnes. The 1982 spawning stock size has been further projected to 1983, using a range of F values of 0.0 $\longrightarrow$ 0.3 on adults and F on 1-ringers to be 0.25 of that on the adults. Recruitment of the 1981/82 year class was again taken as the minimal level of 30 million fish. The resultant very different stock sizes and catches with different levels of F are very clearly shown.

The initial closure of the Celtic Sea herring fishery was recommended by ICES in 1976. It was recommended that the fishery should remain closed "until the spawning stock had recovered to a sufficiently high level". This level was defined as "1/3 of the stock size in a period of light exploitation". The estimated stock size during the period of light exploitation was taken as 120 000 tonnes, and the desired spawning stock level was, therefore, estimated to be 40 000 tonnes. The present Working Group has not been able to find the basis on which the 120 000 tonnes were estimated.

However, it has not been possible by the present Working Group to redefine the desired minimum spawning stock.

The spawning stock size in 1981 is estimated to be somewhere between 14 000 tonnes and 26 000 tonnes.

4.6 Comparison between Herring Stocks in Division VIIj (southwest Ireland) and the Celtic Sea

The fisheries in both these areas have in recent years exploited stocks, which are predominantly autumn spawners. The spawning grounds in the western part of the Celtic Sea and the eastern part of Division VIIj are situated very close to each other, and since spawning occurs at the same time there must be a considerable mixture of the larvae. It has been suggested that the nursery grounds of the herring recruiting to the Celtic Sea may lie in Division VIIj, and similarities have been shown between 2-winter ringed herring belonging to both areas (Molloy, 1968). This Working Group examined the age compositions of the Irish catches from both areas in the most recent years (1980 and 1981) for the months September-November. These months were taken because the catches would almost certainly be composed of autumn spawners.

Comparison of percentage age distribution between catches of Celtic Sea and Division VIIj (autumn spawners).

			Winter rings									
			0	1	2	3	4	5	6	7	8	>8
Sep	1980	Div. VIIj	–	13.4	36.9	16.0	4.9	15.2	5.1	3.5	3.6	1.4
		Celtic Sea		5.2	46.1	22.1	7.0	11.7	3.5	0.9	0.6	2.9
Oct	1980	Div. VIIj	–	10.1	30.6	24.6	8.7	9.4	5.5	4.5	5.9	0.7
		Celtic Sea	–	7.9	41.3	22.2	7.7	13.3	4.3	1.4	1.0	0.9
Sep	1981	Div. VIIj	–	33.9	57.2	8.5	–	–	–	–	–	–
		Celtic Sea	–	7.6	10.0	32.0	10.6	7.3	21.5	3.8	1.6	5.6
Oct	1981	Div. VIIj	–	56.5	11.6	23.9	4.8	1.0	1.8	0.4	–	–
		Celtic Sea	–	49.7	11.6	18.9	5.7	5.4	3.8	2.3	0.5	2.1
Nov	1981	Div. VIIj	–	74.7	12.7	9.8	0.3	0.3	1.6	0.4	–	0.2
		Celtic Sea	2.5	71.8	10.2	11.0	2.3	1.7	0.3	0.2	–	–

The age compositions were strikingly similar in nearly all months. In 1980, both areas were dominated by the 1977 year class, while the 1976 and 1974 year classes were well represented. In 1981, there was a considerable influx of the 1979 year class, while the 1977 year class was also well represented.

As both fisheries are exploited by the same fleets and the herring from both areas are very similar, consideration should be given to managing both areas as one unit.

4.7 Herring Stocks in Division VIIj

4.7.1 Introduction

No previous assessments have been carried out on herring stocks in Division VIIj, because of the inadequacy of the data presented at previous meetings. In 1981, however, the Working Group decided to attempt an assessment at its next meeting and that data should be made available to enable this assessment to be made. ACFM recommended that the catch in the area in 1979-81 should not exceed 6 000 tonnes. The purpose of this recommendation was to stabilize the fishery and to prevent a diversion of effort to the area because of catch restrictions in the adjacent Celtic Sea and Division VIIb,c.

4.7.2 Catches

The total catches from the area (Table 4.9) are taken, as far as can be determined, exclusively by Irish boats. The total catch has increased from 1 500 tonnes in 1971 to over 7 000 tonnes in 1981. It must be pointed out, however, that the collection of accurate catch statistics from this area is extremely difficult, because illegal catches taken in the Celtic Sea are regularly landed in Division VIIj, and herring taken from the northern part of Division VIIj are occasionally landed in Division VIIb,c. In view of this and because of the location of the different spawning grounds along the south coast of Ireland, the boundary defining the western extremity of the Celtic Sea does not seem to be a realistic one. Catches in 1980 and 1981 in Division VIIj may have been limited due to poor markets.

4.7.3 Catches in number per age class

Catches in number per age class, based on Irish data, are only available from 1975-81 and these are shown in Table 4.10. It must be pointed out, that the sampling data from the earlier years of this period are severely restricted. However, it would appear from an examination of the data, that the 1974 year class, which entered the fishery in 1976, was a particularly strong one. Preliminary evidence from the 1981 catches would suggest that the 1979 year class, which also appears to be very abundant in the catches in the Celtic Sea, is also a very strong one.

4.7.4 Effort and catch per effort statistics

Accurate effort and catch per effort figures are not available for the entire fleet fishing in this area. The total effort is very much affected by the situation in the Celtic Sea, the decreased demand for herring, the increased efficiency of the fleet and a change from herring to mackerel fishing. Figures are available for one section of the fleet, which takes approximately 70% of the total catch (Table 4.9). These data would seem to indicate a slight increase in both effort and catch per effort since 1975.

4.7.5 Estimates of Z

The limited catch per effort and age data have been used to calculate Z. The results given in Table 4.9 indicate, although highly variable, that Z has increased in recent years. If M = 0.1, then the $\bar{F}$ from 1979-81 appears to be about 0.4.

4.7.6 VPA

A VPA run with input F = 0.4 (Tables 4.11-4.12). Allowing for some increase in fishing power in the most recent years, separable VPAs indicated that this input F and an S = 0.7 give a historic series of F values in conformity with the trend in effort.

The spawning stock biomass at spawning time in 1981 appears to be about 14 400 tonnes, and this has increased from 6 400 tonnes in 1975. Recruitment from 1975-80 has averaged 36 million fish. The 1974, 1977 and 1979 year classes appear to have been relatively strong ones. Values of $\bar{F}_{2-9+}$ seem to show an increase in recent years.

The mean weights used were as follows:

Rings	1	2	3	4	5	6	7	8	9
Catch (g)	105	150	186	205	218	231	235	232	244
Stock (g)	41	102	141	169	186	198	216	203	229

4.8 State of the Stock and Management Considerations

Predictions were carried out starting with the 1981 stock generated by the VPA with input F = 0.4 for a range of Fs in 1982 and 1983 between 0 to 0.3, and the results are shown in the text table below and in Figure 4.5.

Prognosis of Division VIIj Herring

1981				1982				1983			
Total Stock Biomass 1 January	Spawning Stock Biomass at Spawning Time	F	Catch	Stock Biomass 1 January	Spawning Stock Biomass at Spawning Time	F	Catch	Stock Biomass 1 January	Spawning Stock Biomass at Spawning Time	F	Catch
					29 300	0	0	39 000	36 700	0	0
					28 700	0.1	3 929	35 500	32 700	0.1	4 100
21 600	14 400	0.4	7 176	31 300	28 200	0.2	7 500	32 400	29 200	0.2	7 200
					27 600	0.3	10 700	31 300	26 100	0.3	9 400

Recruitment as 1-ringers in 1982 and 1983 was taken as 22 million, which is the lowest observed. With F = 0.2 in 1982, the total catch would be about 7 500 tonnes (i.e,, the same as in 1981).

5.   WEST OF SCOTLAND HERRING

5.1   Assessment Procedures

In the previous report of the Working Group (C.M.1981/H:8) it was
stated that in 1982 an attempt would be made to allocate catches to
the northern and southern parts of Division VIa, subdivided at 56°N and
west of 7°W (Figure 5.1), and do assessments of the southern part of
Division VIa combined with Divisions VIIb and c, the northern part
as a separate unit, and the whole of Division VIa combined with
VIIb and c.

In doing so, some assumptions had to be made about the allocation of
the catches taken by some countries between the sub-divisions of Division
VIa and of the age distributions of their catches. But these are not
likely to have resulted in major errors in the outputs. The procedure
used in estimating the catches and their age compositions in the
two constituent sub-divisions of Division VIa for the period 1970-80
has resulted in the summed totals for Division VIa as a whole differing
somewhat from the catch in numbers per age group used for this
Division in previous years. This new data set has been used in all
the subsequent assessments carried out during the 1982 meeting of the
Working Group.

The preliminary assessments carried out for each of the areas mentioned
above resulted in VPA outputs which were compatible with the known
history of the fisheries in these areas during the period considered
and gave estimated spawning stock biomasses which related satis-
factorily to the appropriate larval abundance indices for that area.
Logistically, therefore, it would have been possible to have done
assessments and catch predictions for any of the area groupings con-
sidered, but under those circumstances it was considered that the choice
should be made on biological grounds of areas which showed the greatest
homogeneity of stock structure. On this basis it was considered that
the best subdivision was the northern part of Division VIa as one unit
and the southern part of Division VIa combined with Divisions VIIb and
c as a second unit. Such a subdivision also has the advantage that
fisheries in these two areas are rather distinct ones, to a large
extent exploited by different countries, and with rather different
patterns of fishing activity in the last decade.

5.2   Division VIa North

5.2.1 Catch data

The catches reported by each country from this area in the period
1970-80, and the preliminary estimates of catches in 1981, are given
in Table 5.1. It should be noted that these catches do not include
those taken in the Clyde, which has in the past been treated as a
separate unit, but do include herring taken as by-catch in the Moray
Firth sprat fishery. As a result of the re-opening of the Division VIa
fishery in July 1981, the catches increased markedly from 306 tonnes
in 1980 to 49 112 tonnes in 1981.

5.2.2 Catch in numbers at age

The estimated numbers at age caught in this area in each of the years
1970-81 and including the by-catches of herring in the Moray Firth
sprat fishery are given in Table 5.2. Not all countries fishing in
this area in 1981 had carried out adequate sampling of their catches,
and the age compositions of French, English and German catches had
to be estimated by assuming that they corresponded to those of the
Netherlands. The total international catch in numbers at age shows

the features which would have been expected from the assessment
carried out in 1981 with 3- and 4-ringers (1977 and 1976 year classes)
to be strongly represented. The 1979 year class was also taken
in fairly large numbers, considering the very limited fishing activity
for sprat in the Moray Firth, and this might be indicative of this year
class being a fairly strong one when it recruits more fully to the
directed herring fishery in Division VIa (north) in 1982.

5.2.3 Larval surveys

Larval surveys were carried out in this area throughout September and
October by the Federal Republic of Germany and Scottish research vessels
resulting in a very satisfactory sampling coverage both in space and
time. The resulting index of abundance for the smallest size category
of herring larvae was the highest which has been attained since 1972.
An initial VPA was run from 1978 to 1972 to give preliminary estimates
of spawning stock biomass in each year of this period, and a
regression calculated between these estimates and the larval indices.
This regression was highly significant, and using it a preliminary
estimate of spawning stock biomass in 1981 was made from the larval
index of that year to provide an input F for a VPA.

5.2.4 VPA outputs

Using the catch at age data given in Table 5.2 and an input F of 0.12
on fully recruited age groups derived as described above, a VPA was
run. The outputs of fishing mortality at age, stock in numbers at
age, and spawning stock biomass at 1 September are given in Tables 5.3
and 5.4, respectively. These outputs demonstrate the very marked
increase in spawning stock biomass, which took place in this area in
1979 and the very appreciably subsequent increases in 1980 and 1981,
arising from the better recruitment to the stock by the 1976, 1977, and
1978 year classes. Table 5.3 also demonstrates the very high
exploitation rate to which the herring population in this area was
subjected in the period 1971-76, resulting in a heavily depleted
spawning stock in 1977 and the need to close the fishery to give it
an opportunity to recover.

Using the new spawning stock biomasses given in Table 5.4, new
regressions have been calculated between spawning stock and larval
abundance indices from 1972-81. The input data and the resulting
regression parameters are given in Table 5.5, and these data are shown
in Figure 5.2. The correlation coefficient is very high, and the
very close agreements between the VPA estimates of spawning biomass
from the VPA and the predicted values from the regression equation
demonstrate that little would be gained by carrying out further
iterations. It might be considered that using inputs from 1981 in cal-
culating the regression parameters has its dangers, because of the
uncertainty about the stock biomass estimates in that year and in the
immediately preceding years, but it was in fact demonstrated that
it had little effect on the outputs.

5.3 Recruitment

As stated in paragraph 5.2.2, catches of 1-ringers in 1981 were
higher than for several years, and in view of the very limited sprat
fishery in the Moray Firth this might be indicative of better recruit-
ment to the Division VIa fishery in 1982. However, there is no
objective way of fixing an input F for either O-group or 1-group in
this fishery, so the size of the 1979 and 1980 year classes are not
adequately measured from the VPA stock sizes. The only data available

to get some measure of this are trawl surveys carried out by the
Scottish research vessel "Scotia", covering the whole of Division VIa
in February-March 1981 and 1982. These gave mean catches per hour of
2-group fish in the northern part of Division VIa of 1 103 in 1981
and 1 680 in 1982. From VPA the strength of the 1978 year class as
2-ringers is 848 020 x 10^3 and this would suggest that the 1979 year
class in 1982 would be expected to be about 1 290 000 x 10^3. This
value has been used for catch predictions in the absence of any
other objective way of measuring the strength of this year class.

5.4 Management Considerations

As stated earlier, the spawning stock biomass in this area has
now recovered almost to the high level of 1972, and recruitment in
recent years has been at a fairly satisfactory level. TACs have been
calculated, over a range of Fs, for 1982 using the starting parameters
given in Table 5.b. The stock in numbers data are derived from
Table 5.4, apart from the recent year class, which was estimated as
discussed in paragraph 5.3. The weights at age for the catch and
for the spawning stock are the same values as used previously by the
Working Group for the whole of Division VIa. Inspection of Table 5.3
suggests that 2-ringers in this fishery are not fully recruited to
the exploited stock and an exploitation pattern of 0.80 on 2-group
and full exploitation on all older fish was used. The resulting
catches and spawning stock biomasses over a range of Fs are illustrated
in Figure 5.3.

For this population the yield per recruit and spawning stock biomass per
recruit are shown in Figure 5.4. The yield per recruit curve has no
maximum.

Projections of stock size and catches for a range of F values are
given in the text table below.

1981			1982			1983		
Catch	$\bar{F}_{3-10}$	Spawning stock	$\bar{F}_{3-10}$	Catch	Spawning stock	$\bar{F}_{3-10}$	Catch	Spawning stock
44 264	0.12	373 000	0.10	47 300	484 000	0.10	49 300	481 000
			0.20	90 400	455 000	0.20	86 070	412 622
			0.30	129 600	427 000	0.30	112 800	354 000

In estimating TACs for 1983, some assumption has to be made about
recruitment in that year, as there are no data from which it can
be measured. Accordingly, a highly conservative value of the lowest
value (250 x 10^6) recorded in the VPA has been used. This results
in the values given above of catch and spawning stock biomass in
1983, provided the fishing mortality rate is maintained at the same
level in both years.

5.5 Clyde Herring

5.5.1 The fishery in 1981

Landings in the years 1972-81 by Scottish and a few Northern Irish
vessels are given in Table 5.7. The landings in 1981 of 2 135 tonnes
were slightly above the recommended TAC for that year, and sampling

evidence suggests that the landing of overweight boxes may have further increased the actual landings by between 10% and 15%. There were reports of illegal landings from this fishery, but no data are available to quantify this aspect. An additional estimated 7 tonnes were caught as by-catch in the sprat fishery.

Reports of the fishery indicated that fishermen experienced some difficulty in catching their weekly quotas from the opening of the fishery on 15 June until the end of July, but the TAC was taken earlier than expected by 4 September. There were also reports of discarding of small herring during June and July.

Catches in numbers (spring and autumn spawners combined) for the period 1967-81 are given in Table 5.8. The data for 1981 have been raised to take account of the percentage overweight in the boxes on a monthly basis. In 1981, 2- and 3-ringed herring (1978 and 1977 year classes, respectively) predominated in the landings, and 4-ringers (1976 year class) were also well represented. In addition, there were reports of discarding of small herring, but no measure of the extent of this was available.

5.5.2 Tagging experiments

The updated recapture data for the tagging experiment carried out in the Clyde in May-June 1980, in which approximately 7 000 externally tagged herring were liberated, are given in Table 5.9. As can be seen from this table, there were again tag returns in 1981 from the Irish Sea and N.W.Ireland area, although, unlike 1980, none from the former area immediately before and during the spawning season. In addition, there were two returns from the South Minch in the winter and one from southwest of Ireland (from a catch of recently spent fish in November). As was the case in 1980, however, most of the returns from this experiment were from within the Clyde. The recovery of two Clyde tagged herring from the South Minch indicates some interchange with this area, a feature not shown in the two previous years because of the closure of Division VIa to directed herring fisheries. These data coupled with the tag return data for other areas adjacent to the Clyde, suggest a rather complex mixing of stocks within the Firth of Clyde. However, if there are directed fisheries in the Manx and Mourne areas as well as in Divisions VIa and VIIb,c in 1982, a proposed tagging in the Clyde in May-June 1982 may assist in quantifying the various relationships between the stocks in these areas.

5.5.3 Basis for stock assessment

The 1981 returns of herring tagged in the Clyde in 1980 support the earlier conclusion that herring from a number of different spawning stocks are present in the Clyde, and that some emigration takes place. The proportion of tag returns from outside the Clyde increased from 1980-81. The only period of the year with a significant number of returns in both years is July-September, the period of the Clyde fishery. In this period, the proportion of tag returns from outside the Clyde increased from 2.3% in 1980 to 6.5% in 1981. This is consistent with a low level of emigration.

Nevertheless, a year and more after tagging, the majority of tag returns still come from the Clyde itself. If one assumes that the likelihood of a tag being reported is not significantly lower outside the Clyde, then this indicates that most of the fishing mortality on the population of Clyde herring (at least those present at the beginning of the main fishing season) takes place in the Clyde itself, and not when the fish emigrate, either temporarily to spawn or permanently. Hence, although recruitment to the Clyde autumn-spawning population comes from outside the Clyde, the population itself has a degree of continuity. This conclusion is also supported by the consistent recent difference in mean length at age between Clyde herring and those in the adjacent areas, which was the basis for one of the main arguments for managing the Clyde herring as a separate unit, when this question was first considered in 1978 (C.M.1978/H:67, revised).

Since most of the fishing mortality on the Clyde population appears to be generated in the Clyde, the Working Group considered it justifiable to carry out a VPA in order to estimate recent changes in F, and to provide estimates of recruitment to the population for comparison with recruitment fluctuations in neighbouring stocks. Since there was evidence of a change in the proportion of spring- and autumn-spawners in the Clyde around 1969 (C.M.1978/H:67, revised), the VPA was carried out for the years 1970-81. The results are discussed in the next section.

5.5.4   Virtual Population Analysis (VPA)

The VPA on the Clyde herring was carried out with a value of natural mortality of 0.1 in all ages and the following exploitation pattern derived from a trial analysis.

Age	1	2	3	4	5	6	7	8	9
F as a proportion of F on the older age groups	0.6	1.4	1.0	1.0	1.0	1.0	1.0	1.0	1.0

In all runs of the analysis, the value of F on the oldest age group was assumed to be 0.5 in all years.

Using these input parameters a VPA was carried out using values of F in 1981 ranging from 0.2 - 0.8 (where F is defined as F on age groups 3-9). The results are summarized in Tables 5.10 and 5.11, which give, for each value of input F, the weighted mean values of F on 2-10 ringers and estimated numbers of 0-group recruits at 1 January each year.

The Working Group had little evidence on which to select the most appropriate value of input F in 1981. The introduction and enforcement of a TAC in 1979, however, which reduced the catch to 50% of that in the previous year, had probably reduced fishing mortality. In Table 5.10, the largest decrease in F on all age groups from 1978-79 occurred using low values of input F in 1981. High values of input F in 1981, furthermore, indicated a sharp increase in F on 2-ringers between 1980 and 1981, a change which was not supported by any increase in nominal fishing effort. The Working Group, therefore, considered that the fishing mortality rate in 1981 was probably near the lower end of the range of trial values. The results from a final analysis, using an input F of 0.3 in 1981, are given in Tables 5.12 and 5.13.

The estimates of F, given in Table 5.12, fluctuated between 0.36 and 0.67 over the period 1970-78 and decreased to 0.32 in 1979 when the TAC regulation was first introduced.

Estimates of recruitment to the Clyde population given in Table 5.13 indicate a mean level of 26.7 x 10^6 0-ringers over the period 1970-78. Estimates for 1979 and 1980 are likely to be underestimates because they do not include a contribution from discarding of small fish, which was known to have taken place in 1980 and 1981.

The large year classes in the Clyde population were those of 1969, 1971, 1973, and 1976. Tests of correlation between Clyde recruitment estimates and those in adjacent stocks (Manx, Mourne, Division VIa north, Division VIa south and Division VIIb,c) showed no evidence of a clear relationship with any stock in particular.

5.5.5   State of the stock and management considerations.

The results of the VPA given above together with the tag returns in 1980 and 1981 support the earlier conclusion that autumn-spawning herring in the Clyde are drawn from all the adjacent stocks. On the evidence available, the fishing mortality rate in the Clyde is unlikely to be higher than about 0.3 in 1981. If this is correct, then the present level of TAC advised by ICES (2 500 tonnes in 1982) would be at approximately the correct level to stablise the fishing mortality rate on the Clyde herring population.

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

6.1   In the preceding section of this report, the parameters adopted in splitting Division VIa into two sub-areas were explained and the justification for adopting the combination of areas finally chosen. The boundaries of this sub-area are shown in Figure 5.1.

6.1.1   Catch data

The catches of each country allocated to this area in the period 1970-80 and the preliminary estimates of catches in 1981 are given in Table 6.1. The total international catch in 1981 of about 26 000 tonnes was about 4 000 tonnes less than in the preceding year despite the lifting of the closure for the southern part of Division VIa. This resulted from a large drop in Irish catches, which was only partly compensated by the increased catches of Federal Republic of Germany and the Netherlands.

6.1.2   Catch in numbers at age

The estimated numbers at age caught in this area in each of the years 1970-81 are given in Table 6.2. Catches by the Federal Republic of Germany had not been sampled in 1981, and the age composition of these were estimated by assuming they were comparable to those of the Nether- lands. French catches were treated similarly. These catch data show much greater stability during this period than those from Division VIa (north) and in most years show a higher proportion of older fish. As in Division VIa (north), however, the main contribution to the 1981 catches was made by the 1978, 1977 and 1976 year classes. 1-ringed fish were more poorly represented than in any year since 1972.

6.1.3 <u>Larval surveys</u>

In the past, the larval survey data for this area have not been
completely satisfactory in that the surveys have covered only the
northern part of the total distribution of spawning and only the
early part of the total time of hatching. In 1981, Ireland started
to do larval surveys in this area and, as a result, in conjunction
with the Scottish surveys, rather good coverage was obtained of the
total area and time of hatching. This, however, is of no help at
the present time, as the only way to convert these data to estimates
of parental stock size is by a regression technique which demands a
fairly long series of comparable data. It is hoped to continue
these surveys on the 1981 scale for a number of years, at the end
of which a new regression can be utilized in this way. In this one,
the 1981 index was lower than in any year since 1977.

As in Division VIa (north), a preliminary VPA was run for this area
to give a first estimate of spawning stock biomasses, and from these
a regression between larval abundance and spawning stock was estimated.
From this regression, the 1981 larval abundance index was converted
to spawning stock biomass, and this was used to estimate the input F
for a new VPA starting with the 1981 data.

6.1.4 <u>VPA outputs</u>

Using the catch at age data given in Table 6.2 and an input F of 0.34
derived from the 1981 larval index, a VPA was run. The resulting Fs,
stock in numbers and spawning stock biomasses are given in Tables
6.3 and 6.4, respectively. In this area the preliminary VPA outputs
did not suggest that in recent years the F on 2-ringers was lower than
on older fish, so a constant F on all age groups ≥ 2 was input. The
outputs of Tables 6.3 and 6.4 show a rather stable exploitation rate
in this area since the mid-1970s, and a rather stable spawning stock
biomass but at a level of only about a half of that in the early 1970s.

Using the spawning stock biomasses given in Table 6.4, new regressions
were calculated with the larval indices. The larval index for 1972 is
obviously discrepant and the data for that year were omitted. The
parameters and the regression calculations are given in Table 6.5.
The correlation coefficient is not as high as in Division VIa (north),
probably due to the poorer quality of the larval data, but it is
highly significant, and the estimates of spawning stock from the
regression show a satisfactory degree of agreement with those derived
from the VPA, which gives some confidence in the stability of the
regression. It should be noted, however, that a rather high proportion
is contributed by the intercept. This regression is shown in
Figure 6.1. The same comments as made in paragraph 5.2 about the
use of data, starting from 1981 in estimating the regression, also
apply in this case.

6.1.5 <u>Recruitment</u>

As stated earlier, the catches of 1-group fish in this area in 1981
were lower than they had been for several years, and this might
suggest that recruitment as 2-ringers in 1982 will be poor. The
strength of this year class from the VPA is, however, highly dependent
on the input F, which cannot be measured in any objective way. It
was merely chosen to be compatible with levels encountered in other
recent years.

The Scottish research vessel surveys in February-March 1981 and 1982
covered only a small but a constant part of this area in both years.
Since the proportion of this area covered is small, the data from these

surveys cannot be used to measure the size of this year class, but They would support the evidence from the VPA that this year class is likely to be very small in relation to the preceding one.

6.1.6 Management advice

In the previous report of the Working Group, estimates of mean weight at age were given for Divisions VIa (south) and VIIb,c, which suggested that the values were rather higher than in Division VIa (north). The values given in that report fluctuated considerably amongst the older fish, and to get a more rational series these values were used to calculate a smoother series using a von Bertalanffy equation derived from them. These values, which are given in Table 6.6, were used in calculating predicted yields in 1982 and 1983. TACs were calculated over a range of Fs using the parameters given in that table. The stock in numbers data are taken from Table 6.4. Recruitment in 1983 was set at 54 280 x 10^3.

Yield per recruit and a spawning stock biomass per recruit curve were estimated for this stock and are shown in Figure 6.2. The yield per recruit curve has no maximum.

1981			1982			1983		
Catch	$\bar{F}_{2-7}$	Spawning stock	$\bar{F}_{2-7}$	Catch	Spawning stock	$\bar{F}_{2-7}$	Catch	Spawning stock
26 135	.34	70 336	.10	7 211	69 580	.10	7 058	68 111
			.20	13 747	65 071	.20	12 291	58 181
			.30	19 671	60 854	.30	16 079	49 742

7. IRISH SEA HERRING (DIVISION VIIa)

7.1 Introduction

TAC for the North Irish Sea for 1981 was set at 3 800 tonnes. The reported catch from the North Irish Sea was 4 385 tonnes (Table 7.1). Actual catches probably exceeded this because of dumping of small fish at sea, overweight boxes, and unreported catches. Reported catches were allocated to Manx and Mourne stocks on the basis of vertebral counts, gonad condition, and place of capture as described in Doc. C.M.1979/H:6. 2 945 tonnes were allocated to the Manx stock, and 1 440 tonnes to the Mourne stock (Table 7.2). The two stocks are considered separately below, and general recommendations for the North Irish Sea are given in Section 7.4.

7.2 Manx Stock

7.2.1 The fishery in 1981

The number of vessels participating in the fishery showed a marked reduction from 115 in 1980 to 67 in 1981 (provisional figure for 1981).

The fishing pattern was voluntarily regulated by daily quotas per boat recommended by a representative port committee; a short week of four fishing days was worked. The TAC was taken by 15 September, i.e., earlier than the statutory closure of the fishery on 21 September. Some

fishing over the spawning ground was observed in the closed season, but it proved impossible to trace the landings, which were unrecorded. There was discarding at sea of small herring, but this cannot be quantified.

The low TAC in 1981, fluctuating prices and demand, and availability of herring elsewhere, affected the number of boats fishing at different times and the proportion of the total catch taken in different parts of the fishing season. The seasonal change in fishing pattern from 1980 to 1981 is indicated in the text table below.

Percentage of total catch taken in different months

	June/July	August	September and later
1980	24.2	21.0	54.8
1981	29.4	35.0	35.6

7.2.2 Estimates of fishing mortality and stock size

Catch in number of fish at each age is given in Table 7.3. VPAs were applied to these data, with a range of input F for 1981. Fs for terminal ages in earlier years were taken as those given by mean Fs in the VPA adopted in 1981 (C.M.1981/H:8). There is no direct independent evidence available on which to base a choice of input Fs for a VPA. The Working Group considered, however, that the low TAC and catch in 1981, the smaller fishing fleet, and the early closure of the fishery, indicated an appreciably lower F than that for 1980. It was also considered that the change in seasonal fishing pattern was likely to generate an F on age group 2 higher than that on older age groups, which are not fully represented in the early catches. The high proportion of 2-ringed herring in the total catch lends support to this view. VPA with input $F_{age\ 2} = 0.4$ and $F_{age\ 3-8+} = 0.3$ gave results consistent with the conclusions reached by the Working Group in 1981, i.e., that the stock size was low in 1980 and that F_{1980} was similar to that in 1977 (C.M.1981/H:8). VPA with $F_{1981} = 0.3$ is given in Tables 7.4 and 7.5. The results indicate a spawning stock biomass at spawning time of 8 100 tonnes.

7.2.3 Larval survey

A tow-net survey was carried out over the spawning ground and adjacent areas. A relatively large number of larvae was caught in the first week of October. The larvae were all less than 10 mm, nearly all had prominent yolk sacs and were recently hatched. Data from such surveys in recent years (Table 7.6) are very variable. A proposed follow-up survey for older larvae was frustrated by bad weather.

7.2.4 State of the stock

There was a modest increase in estimated spawning stock biomass at spawning time in 1981 compared to that in 1980, but the stock biomass is still low (see text table below) and is heavily dependent on recruitment.

Spawning stock biomass at spawning time (tonnes x 10^{-3})										
1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
29.0	26.5	26.3	20.8	13.5	10.6	7.6	9.8	9.1	5.5[*]	8.1[*]

[*] Inefficient estimates

Recruitment in the next few years will be derived from low levels of spawning stock and is likely to be poor, particularly that of the 1980 year class. Projections made forward to 1983 from present VPA estimates are very uncertain, since they depend on two unknown values for recruitment and on the catch level and pattern in 1982. The projections given in the text table below assume recruitment at 30×10^6 1-ringed fish in 1982 and 1983. This is equal to the lowest level indicated by VPAs carried out by the Working Group, i.e. that for 1-ringed fish 1965. The projections give the possible spawning stock biomass in 1982 and 1983 at different levels of F_{1982}, with $F_{1983} = F_{1982}$.

Manx herring. - Projection for management options.   Div.VIIa N.Irish Sea

1981				1982				1983		
Stock biomass	Spawn. stock biom.	F	Catch	Option	Stock biomass	Spawn. stock biom.	Catch	Stock biom.	Spawn. stock biom.	Catch
		Age 2 =0.4		F=0	16.0	13.2	0	20.5	17.7	0
15.0	8.1	Age 3+ = 0.3	2.9	F=0.1	16.0	11.9	1.3	19.2	14.8	1.6
				F=0.15	16.0	11.35	1.9	18.6	13.5	2.2
				F=0.2	16.0	10.8	2.4	18.0	12.4	2.8
				F=0.3	16.0	9.8	3.5	16.9	10.4	3.7
				F=0.4	16.0	8.8	4.45	15.9	8.7	4./

$F_{1983} = F_{1982}$

Biomass in tonnes x 10^{-3}
Stock biomass = Σ weights of stock ages 1 to 8+
Spawning stock biomass = Σ weights of stock ages 2 to 8+ at spawning
Input data given in Figure 7.1.
A full range of F values is shown in Figure 7.2.

7.3   Mourne Stock

7.3.1   The fishery in 1981

The total nominal catch of the Mourne stock in 1981 was 1 440 tonnes, made up of 295 tonnes selectively fished by gill-nets over the Mourne spawning grounds, and 1 146 tonnes taken as a component of the Isle of Man fishery outside the 12-mile Irish coast limit (Table 7.2). The

total catch was 26% lower than in 1980, largely as a result of the reduction of the North Irish Sea TAC (see Section 7.1) and a general decrease in effort in the Mourne area because of lack of market demands. As a result, in 1981 the selective gill-net fishery on the spawning grounds did not take the whole 400 tonnes allocation.

7.3.2 Catch in numbers by age

Total catches by weight of Mourne herring were converted to numbers at age by using data from samples of the catch landed in Northern Ireland and the Republic of Ireland. The age composition of the catches since 1971 is given in Table 7.7. The predominant age group in 1981 was the 1978 year class.

In 1981 some data on discards at sea of juvenile herring taken as a by-catch in the Northern Ireland Nephrops fishery were collected. From sample data in this fishery it was estimated that approximately 1.9×10^6 0-group herring were discarded at sea by vessels landing at Northern Ireland ports.

As Northern Ireland's by-catch data could not reliably be extrapolated to the Republic of Ireland's Nephrops catch due to differences in mesh size, this figure, therefore, is most probably an underestimate of total 0-group catch. However, in the absence of similar data for earlier years, no 0-group catch was included in the VPA.

The mean weights at age used to calculate the stock sizes are based on Northern Ireland and the Republic of Ireland's data and are given in the text table below.

Age(w.r.)	1	2	3	4	5	6	7	8	9+
Weight(g)	106	169	205	224	249	263	273	280	312

7.3.3 North Irish Sea - Young herring survey

A young herring survey in the northwestern Irish Sea was carried out in February 1982. This survey was similar to those carried out in February 1980 and 1981. The average number of 1-group herring taken per hour haul (based on 35 stations) was 770 compared with 830 in 1981 and 108 in 1980. This would indicate that the abundance of the 1980 year class was similar to that of the 1979 year class. The vertebral counts of these herring were 56.81, which would suggest that they belonged mainly to the Mourne spawning component.

7.3.4 Virtual Population Analysis

Although no direct data on effort are available, there is indirect evidence to suggest a reduction in F between 1980 and 1981. The catch of Mourne herring was reduced from 1 953 tonnes in 1980 to 1 440 tonnes in 1981, there was a marked reduction in market demand for herring owing to availability of supplies from other areas, e.g., Division VIa, and fewer boats participated in the fishery. It was, therefore, concluded that F_{81} would have been significantly lower than $F_{80}(=0.3)$.

Input F = 0.2 was chosen for age groups 2 and over; the input value for 1-group fish in 1981 was adjusted to produce a recruitment for year class 1979 of 45×10^6 (the lowest value from the VPA of the previous Working Group); this gave a value of F = 0.08, which is in accord with last year's conclusion that F on 1-ringers would be approximately 1/3 of F on the older age groups. The input value of F for the oldest age group in 1980 and earlier years was taken from

the mean weighted value of F for age groups 2-6 and estimated from the VPA of the previous Working Group (Table 7.8). Stock sizes and biomass were derived both for 1 January and at spawning time and are given in Table 7.9.

The results of the VPA indicate that spawning stock biomass increased in 1981 for the fourth year in succession (see text table below).

Spawning stock biomass at spawning time, tonnes

1976	1977	1978	1979	1980	1981
3 100	2 800	3 300	3 800	4 300[*]	7 200[*]

[*] Inefficient estimates

7.3.5 State of the stock

The yield per recruit and spawning stock biomass per recruit curves dependent on the 1981 exploitation pattern are shown in Figure 7.3.

In making a prognosis, the Working Group assumed that the mean arithmetic recruitment from the VPA in the period 1974-78, i.e., 63×10^6 0-group fish, was appropriate for the 1980 and 1981 year classes. This value was used as input for projections, together with stock size at 1 January 1981 from the VPA with input F_{81} on age 2 and over of 0.2. Stock changes and yields indicated by the projections are given in the text table below.

It must be stressed, however, that because of the assumptions made for both 1982 and 1983 the predictions for the latter year are extremely tentative. Furthermore, the projections for 1983 were rendered even more uncertain because of possible changes in the exploitation pattern resulting from the re-introduction of a directed selective fishery on the spawning grounds.

Mourne herring. - Projection for management options.   Div.VIIa N.Irish Sea

1981 (from VPA)				Management option for 1982	1982			1983		
Stock biomass	Spawn. stock biom.	F	Catch		Stock biom.	Spawn. stock biom.	Catch	Stock biom.	Spawn. stock biom.	Catch
11.6	7.2	Age 1 =0.08	1.4	F=0.10	19.7	12.2	1.3	27.3	18.9	2.0
		Age 2-9+ = 0.2		F=0.15	19.7	11.9	1.9	26.6	17.6	2.9
				F=0.20	19.7	11.5	2.5	25.9	16.5	3.6
				F=0.30	19.7	10.8	3.6	24.6	14.5	4.9

$$F_{1982} = F_{1983}$$

Biomass in tonnes x 10^{-3}

A full range of F values is given in Figure 7.4

7.4   Management Considerations

7.4.1   TAC

The fishery in the N.Irish Sea exploits a mixture of Manx and Mourne
herring in the area west and southwest of the Isle of Man for a large
part of the fishing season. The Working Group, therefore, recommends
that a single TAC be set for herring in the N.Irish Sea, rather than
separate TACs for Manx and Mourne stocks, because catches cannot be
allocated to stock until all relevant biological and statistical
data are available. It is important that the fishing effort applied
to take the TAC should not be concentrated on either the Manx stock
or the Mourne stock. The impact on each stock will depend on the
seasonal and spatial distribution of the fishery. We take as an
example a TAC of 3 800 tonnes based on the yield from $F = 0.15$
applied on each stock, which would give a theoretical catch of
1 900 tonnes of Manx herring and 1 900 tonnes of Mourne herring.
If about two-thirds of the TAC were taken in the mixed fishery, this
could result in a catch of about 1 300 tonnes of Mourne herring and
1 000 tonnes of Manx herring, since the estimated Mourne stock
biomass (at the beginning of the season) is higher than the Manx
stock biomass. The balance of the TAC could be taken by selective
fishing of 600 tonnes Mourne stock on their spawning grounds off
the Mourne coast, and 900 tonnes of Manx herring taken as they
approach the Manx spawning ground east of the Isle of Man. The
estimated effect on stock sizes is given in the text table below.

Effect of fishing at $F = 0.15$ on stocks in N.Irish Sea

	1982			1983	
	Total stock biom.	Spawn. stock biom.at spawning	Catch	Total stock biom.	Spawning stock biomass at spawning
Manx	16.0	11.35	1.9	18.6	13.5
Mourne	19.7	11.9	1.9	26.6	17.7

The effort available for selective gill-net fishing over the Mourne
spawning ground is limited, and in any case it is considered
undesirable to increase the catch on this spawning ground until
the impact of the resumption of this fishery after the closure between
1978 and 1980 can be fully assessed. If a larger part of a TAC were
taken late in the season as the herring approach their respective
spawning grounds,the effect could be to increase effort and F on the
Manx stock. At $F=0.15$,the expected spawning stock at spawning time
in 1982 would be 11 900 tonnes of Mourne herring, which is near the
peak value in 1972, and 11 350 tonnes of Manx herring, which is
higher than any value since 1975. The effect of management options
which entail fishing at values of F lower and higher than $F = 0.15$
can be seen in the text table in paragraph 7.2.4 for Manx stock
and in the text table in paragraph 7.3.5 for Mourne stock. All
estimates must be treated with extreme caution because of the
uncertainties introduced by assumed levels of recruitment, and
F generated in 1982.

A TAC of 3 800 tonnes is the same as that set for 1981 and represents a relatively cautious management. It would be prudent to examine data from the 1982 fishery before considering management for 1983. If, however, it is essential to make a provisional recommendation, it is considered that the TAC for 1983 should be the same as that for 1982. In each year, the part of the TAC allocated to the selective directed herring fishery over the Mourne spawning ground should be clearly stated.

7.4.2 Other conservation measures

Management of the N.Irish Sea fishery in the past has included measures to reduce fishing mortality on the spawning stock by closure of the fishery from the Saturday nearest to 21 September until the Monday nearest to 16 November, except for a small directed gill-net fishery on the Mourne spawning ground, prohibition of directed herring fishery in nursery areas, and a minimum size regulation. These measures should be continued in 1982 and 1983.

8. NORTH SEA HERRING TAGGING EXPERIMENT

The Working Group took note of the report from the Planning Group (C.M.1982/H:3) and endorsed its proposals. It wishes to stress the importance of obtaining more information on the state of the stock in the northern North Sea. The results of such a tagging experiment should help to check the use of larval abundances, which are presently the only estimate of stock size used, and also to evaluate the acoustic biomass estimates.

It is recommended that this experiment should be implemented in 1983 as envisaged. The problems of developing a system for monitoring commercial catches should be further studied, and the opportunities arising from a tagged herring population in 1983 be used in further development. This should be done with a view to a longer term tagging programme being developed later.

The Working Group also indicated its support for the work being done in the Irish Sea and Clyde. Those countries taking catches of these stocks should be encouraged to monitor catches for microtags in order to improve the estimates of stock mixing, stock size, and fishing mortality.

9. RECOMMENDATION

In view of the importance to the assessment of herring stocks in Division IIIa (and adjacent waters), the Working Group recommends that a workshop on stock components in herring landings from this area be established well in advance of the next meeting of this Working Group and of the Working Group on Division IIIa Stocks. The workshop should attempt a separation of landings into spring- and autumn-spawned components for as many years back as the available material allows.

The workshop should also consider the exchange of stock elements between Division IIIa and the Baltic-Belt Seas, preferably in cooperation with the members from the Working Group on Assessment of Pelagic Stocks in the Baltic.

REFERENCE

Molloy, J P. 1968. Herring investigations on the southwest coast of Ireland, 1967. ICES, C.M.1968/H:14 (mimeo.).

Table 2.1   HERRING. Catch in tonnes 1972 - 1981 North Sea (Sub-area IV and Division VIId) by country

(Data provided by Working Group members 1981 as officially reported)

Year / Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981*
Belgium	1 337	2 160 a)	603	2 451	2 451	57	–	–	–	–
Denmark	213 738	174 254	61 728 b)	115 616	34 841	12 769	4 359	10 546	4 458	21 337
Faroe Islands	48 444	54 935 b)	26 161 b)	25 854	.14 378	8 070	40	10	–	–
Finland	–	–	–	–	1 034	–	–	–	–	–
France	12 901	22 235	12.548	20 391	14 468	1 613	2 119	2 560	3 330	14 396
German Dem. Rep.	127	1 728	3 268	2 689	2 624	2	–	–	–	–
Germany, Fed. Rep.	3 065	10 634 c)	12 470	6 953	1 654	221	24	10	147	2 300 c)
Iceland	31 998	23 742 d)	29 017	16 286	9 412	–	–	–	–	–
Netherlands	24 829	34 070	35 106	38 416	20 146	4 134	18	–	509	7 700
Norway	117 501	99 739	40 975	34 183	27 386	4 065	1 189	3 617	2 110	70
Poland	2 235	5 738 e)	9 850	7 069	7 072	2	–	–	–	–
Sweden	7 366	4 222 e)	3 561	6 858	4 777	3 616	–	–	–	–
U.K. (England) f)	394	2 268	5 699	6 475	9 662	3 224	2 843	2 253	77	303
U.K. (Scotland) f)	17 227	16 012	15 034	8 904	15 015	8 159	437	–	610	45
USSR	16 386	30 735	18 096	20 653	10 935	78	4	162	–	–
Total North Sea	497 548	484 012	275 116	312 798	174 834	46 010	11 033	19 158	11 241	46 151
Total including unallocated catches								25 148	60 994	? g)

*)Preliminary
a) Total includes 2 107 t for human consumption unspecified to area
b) Supplied by Fiskirannsóknarstovan
c) From Federal Republic of Germany national statistics compiled by Federal Research Board for Fisheries, Hamburg
d) Excludes 15 938 t caught on Skagerrak border and allocated to that area on the basis of age analysis
e) Swedish catches in Danish ports reported by area (North Sea, Skagerrak) used for area allocation of Swedish
   landings reported as Skagerrak and North Sea in Swedish Statistics
f) Catches from Moray Firth not included
g) See Section 2.1.2

-47 -

Table 2.2   HERRING, North Sea catches in directed fisheries by area
             (Figures supplied by Working Group members)

Year	IVa W	IVa E	IVb (adult)	IVb (juv.)	IVc + VIId
1972	235 106	22 732	47 787	168 792	23 004
1973	247 697	14 666	57 753	135 626	30 163
1974	84 174	15 377	116 396	51 772	7 383
1975	95 761	9 652	91 110	90 748	25 527
1976	101 552	2 257	41 475	-	17 501
1977	27 923	1 864	4 785	-	1 384
1978	-	1 033	-		-
1979	-	1 250[1]	1 000[2]		5 000[2]
1980	1 698	2 449	9 233		39 704
1981	18 787	-	-		40 127

[1] Including spring spawners: 410 tonnes of autumn spawners assumed
    for calculating catch in number

[2] Rough estimates

Table 2.3.1 HERRING. By-catch (in weight) by countries in Division IVa west of 2^OE

	1977	1978	1979	1980	1981
Denmark	502	-	437	687	-
Faroe Islands	-	25	-	-	-
France	148	486	493	651	1 148
German Dem. Rep.	-	-	-	-	-
Germany, Fed. Rep.	-	4	10	-	-
Netherlands	-	-	-	-	-
Norway	-	27	-	-	-
Poland	-	-	-	-	-
Sweden	-	-	-	-	-
U.K. (England)	-	-	-	-	-
U.K. (Scotland)	-	-	6	18	2
USSR	-	-	-	-	-
Total	650	542	946	1 356	1 150

Table 2.3.2 HERRING. By-catch (in weight) by countries in Division IVa east of 2^OE

	1977	1978	1979	1980	1981
Denmark	186	-	2	27	-
Faroe Islands	-	-	-	-	-
France	44	-	68	-	-
German Dem. Rep.	2	-	-	-	-
Germany, Fed. Rep.	-	-	-	-	-
Netherlands	42	-	-	-	-
Norway	-	-	-	21	70
Poland	2	-	-	-	-
Sweden	-	-	-	-	-
U.K. (England)	-	-	-	-	-
U.K. (Scotland)	-	-	-	-	-
USSR	43	4	-	-	-
Total	319	4	70	48	70

Table 2.3.3 HERRING. By-catch (in weight)
by countries in Division IVb

	1977	1978	1979	1980	1981
Denmark	5 958	4 359	10 107	3 733	9 900
Faroe Islands	-	15	-	-	-
France	198	302	448	176	524
German Dem. Rep.	-	-	-	-	-
Germany, Fed. Rep.	-	1	-	147	2 300
Netherlands	-	-	-	35	-
Norway	-	129	2 367	1 607	-
Poland	-	-	-	-	-
Sweden	-	-	-	-	-
U.K. (England)	2 810	2 620	2 252	76	13
U.K. (Scotland)	22	437	156	592	43
USSR	35	-	-	-	-
Total	9 023	7 863	15 330	6 366	12 780

Table 2.3.4 HERRING. By-catch (in weight)
by countries in Divisions IVc + VIId

	1977	1978	1979	1980	1981
Denmark	-	-	-	11	80
Faroe Islands	-	-	-	-	-
France	62	1 331	1 551	4 700	298
German Dem. Rep.	-	-	-	-	-
Germany, Fed. Rep.	-	19	-	-	-
Netherlands	-	18	-	474	-
Norway	-	-	-	482	-
Poland	-	-	-	-	-
Sweden	-	-	-	-	-
U.K. (England)	-	223	1	1	8
U.K. (Scotland)	-	-	-	-	-
USSR	-	-	-	-	-
Total	62	1 591	1 552	5 668	386

Table 2.4. HERRING. North Sea catch in millions of fish by age.

Year	Area	Age in winter rings										Total
		0	1	2	3	4	5	6	7	8	>8	
1972	IVaW of 2°E	−	338.9	830.1	176.8	88.6	19.3	4.1	−	0.5	0.4	1 458.7
	IVaE of 2°E	−	75.1	91.0	17.8	5.8	0.7	0.1	−	−	−	190.5
	IVb	−	25.2	46.4	98.8	20.5	6.7	0.6	0.2	0.6	−	199.0
	IVbYH	750.4	2 896.6	337.9	21.1	6.4	1.2	0.2	−	−	−	4 013.8
	IVc+VIId,e	−	4.8	135.1	29.3	9.3	5.0	−	−	−	−	183.5
	Total NS	750.4	3 340.6	1 440.5	343.8	130.6	32.9	5.0	0.2	1.1	0.4	6 045.5
1973	IVaW of 2°E	−	52.5	742.1	452.6	58.0	39.5	20.3	2.6	0.5	0.6	1 368.7
	IVaE of 2°E	−	0.3	16.2	23.1	6.3	7.2	1.0	0.3	0.8	−	55.2
	IVb	−	242.5	180.1	39.0	28.3	4.7	7.2	−	−	−	501.8
	IVbYH	289.4	2 070.5	362.5	29.4	2.6	0.5	0.2	0.3	−	−	2 755.4
	IVc+VIId,e	−	2.2	43.3	115.1	55.0	7.4	1.9	0.5	0.1	0.0	225.5
	Total NS	289.4	2 368.0	1 344.2	659.2	150.2	59.3	30.6	3.7	1.4	0.6	4 906.6
1974	IVaW of 2°E	65.3	162.9	98.5	112.9	97.1	36.0	18.6	4.5	1.5	1.0	598.3
	IVaE of 2°E	5.7	131.8	24.2	10.8	1.0	−	−	−	0.1	−	173.6
	IVb (adult)	−	54.0	493.7	212.3	19.5	18.9	3.6	0.3	0.4	0.1	802.8
	IVbYH	925.1	493.5	132.1	5.7	−	−	−	−	−	−	1 556.4
	IVc+VIId	−	3.9	24.1	20.3	8.4	1.2	0.1	0.2	−	−	58.2
	Total NS	996.1	846.1	772.6	362.0	126.0	56.1	22.3	5.0	2.0	1.1	3 189.3
1975	IVaW of 2°E	−	267.0	120.0	69.0	49.0	40.2	9.8	6.3	2.9	1.1	565.3
	IVaE of 2°E	−	82.5	8.2	7.0	2.4	0.4	0.1	0.1	−	−	100.7
	IVb (adult)	−	268.8	147.1	124.2	81.2	14.8	5.8	2.7	0.5	0.3	645.4
	IVbYH	262.8	1 818.1	139.2	19.8	2.6	−	0.4				2 242.9
	IVc+VIId	1.0	24.1	127.2	39.6	5.3	1.8					199.0
	Total NS	263.8	2 460.5	541.7	259.6	140.5	57.2	16.1	9.1	3.4	1.4	3 753.3
1976	IVaW of 2°E	−	19.4	572.9	56.3	17.9	13.2	3.6	2.6	0.5	0.3	686.7
	IVaE of 2°E	−	−	10.6	1.1	0.5	0.5	0.4	−	−	−	13.1
	IVb (adult)	0.9	35.5	205.9	17.6	28.4	20.3	1.8	1.8	0.5	0.1	312.8
	IVbYH	237.3	49.5	17.7	0.5	1.7	−	−	−	−	−	306.7
	IVc+VIId	−	22.2	94.4	41.8	3.5	0.5	0.3	−	−	−	162.7
	Total NS	238.2	126.6	901.5	117.3	52.0	34.5	6.1	4.4	1.0	0.4	1 482.0
1977	IVaW of 2°E	2.6	2.7	9.3	171.7	8.6	3.8	2.1	0.9	0.2		201.9
	IVaE of 2°E	0.4	3.3	+	4.9	1.2	1.1	1.0	0.6	0.5	+	13.0
	IVb (adult)	−	1.1	25.9	6.8	0.3	1.9	1.0	−	+	−	37.0
	IVbYH	253.8	136.3	3.1	−	−	−	−	−	−	−	393.2
	IVc+VIId	−	0.9	6.4	3.0	0.7	0.2	+	+	−	−	11.2
	Total NS	256.8	144.3	44.7	186.4	10.8	7.0	4.1	1.5	0.7		656.3
1978	IVaW of 2°E			0.1	0.1	1.5	0.2	0.1	+	+	+	2.0
	IVaE of 2°E				0.2	1.2	−	+	0.2	0.2	0.3	2.1
	IVb (adult)		0.2	0.6	1.4	1.1	0.1	0.1	+			3.5
	IVb (indust.)	130.0	168.0	1.4								299.4
	IVc+VIId		0.4	2.8	4.0	1.2	+	+				8.4
	Total NS	130.0	168.6	4.9	5.7	5.0	0.3	0.2	0.2	0.2	0.3	315.4
1979	IVaW of 2°E		1.9	0.4	0.3	2.2	0.5	+	+	+		5.3
	IVaE of 2°E		−	2.4	0.3	+	+	+				2.7
	IVb (adult)		0.5	2.1	0.4	2.2	0.9	0.1	0.4	0.3		6.9
	IVb (indust.)	542.0	156.4	7.6	−	0.1	0.1	+	0.4	0.3	0.1	707.0
	IVc+VIId		0.4	21.6	9.0	5.6	0.6	0.1				37.3
	Total NS	542.0	159.2	34.1	10.0	10.1	2.1	0.2	0.8	0.6	0.1	759.2
1980	IVaW of 2°E		+	2.2	6.5	1.2	2.7	0.6	0.8	0.4	0.1	14.5
	IVaE of 2°E	166.8	−	+	0.1	0.1	0.1	+	+	+		167.1
	IVb (adult)		0.4	0.7	0.4	0.1	0.2	+	+	+	+	1.8
	IVb (indust.)	624.9	137.3	6.0	1.0	0.6	0.3	+	0.1	+	+	770.2
	IVc+VIId	+	23.4	99.1	83.8	30.2	18.4	1.7	0.5	+	+	257.1
	Total NS	791.7	161.1	108.0	91.8	32.2	21.7	2.3	1.4	0.4	0.1	1 210.7
1981	IVaW of 2°E	−	+	7.7	6.2	23.4	16.6	11.1	15.1	3.4	1.1	84.6
	IVaE of 2°E	−	0.1	0.1	0.1	+	+	+	+	−	−	0.3
	IVb (adult)	−	−	0.8	0.4	0.3	0.3	0.4	+	+	+	2.2
	IVb (indust.)											
	IVc+VIId	−	6.7	210.4	38.5	18.6	6.7	2.8	0.5	−	−	284.2

Table 2.5   Millions of HERRING caught annually per age group (winter rings)
            in the North Sea 1970-1980.

Year \ Winter rings	0	1	2	3	4	5	6	7	8	> 8	Total
1970	898.1	1 196.2	2 002.8	883.6	125.2	50.3	61.0	7.9	12.0	12.2	5 249.3
1971	684.0	4 378.5	1 146.8	662.5	208.3	26.9	30.5	26.8	-	12.4	7 176.7
1972	750.4	3 340.6	1 440.5	343.8	130.6	32.9	5.0	0.2	1.1	0.4	6 045.5
1973	289.4	2 368.0	1 344.2	659.2	150.2	59.3	30.6	3.7	1.4	0.6	4 906.6
1974	996.1	846.1	772.6	362.0	126.0	56.1	22.3	5.0	2.0	1.1	3 189.3
1975	263.8	2 460.5	541.7	259.6	140.5	57.2	16.1	9.1	3.4	1.4	3 753.3
1976	238.2	126.6	901.5	117.3	52.0	34.5	6.1	4.4	1.0	0.4	1 482.0
1977	256.8	144.3	44.7	186.4	10.8	7.0	4.1	1.5	0.7	+	656.3
1978	130.0	168.6	4.9	5.7	5.0	0.3	0.2	0.2	0.2	0.3	315.4
1979	542.0	159.2	34.1	10.0	10.1	2.1	0.2	0.8	0.6	0.1	759.2
1980	791.7	161.2	108.1	91.8	32.1	21.8	2.3	1.4	0.4	0.2	1 211.0
1981											

Table 2.6   O-group estimates for southern North Sea HERRING.

| Year class | English surveys, East Anglia coast and Thames estuary in July by mid-water trawl | | Dutch sampling in coastal waters by anchored plankton nets in April |
	Number of stations	Mean number per hour fishing	Numbers per 10 000 m^3
1967	12	714	11
1968	12	2 060	55
1969	11	1 406	384
1970	12	2 453	131
1971	12	828	75
1972	12	53	155
1973	12	50	230
1974	12	44	194
1975	11	24	11
1976	12	31	22
1977	11	70	57
1978	12	2 153	174
1979	11	159	796
1980	12	524	931[x]

x) Preliminary

Table 2.7. Biomass estimates of herring in six statistical rectangles (see figure below) around Shetland, standardized to target strengths given in the text (section 2.4.1).

Year	Ship	Dates	No. of rectangles surveyed	Biomass estimate (t)
1979	Thalassa	10-30 July	6	122 500*
	Explorer	7-16 August	6	2 300**
1980	Explorer	10-28 July	6	174 000
	Thalassa	15-25 July	2	11 600
	G O Sars	23-31 July	3	17 000
1981	G O Sars	14-26 July	6	110 000
	G O Sars	26-28 July	$3\frac{1}{4}$	73 000
	Tridens	27 July-7 August	$3\frac{1}{4}$	60 000
	Scotia	12-31 August	$5\frac{1}{2}$	61 000

* Target strength uncertain owing to lack of adequate calibration
** Plume traces only
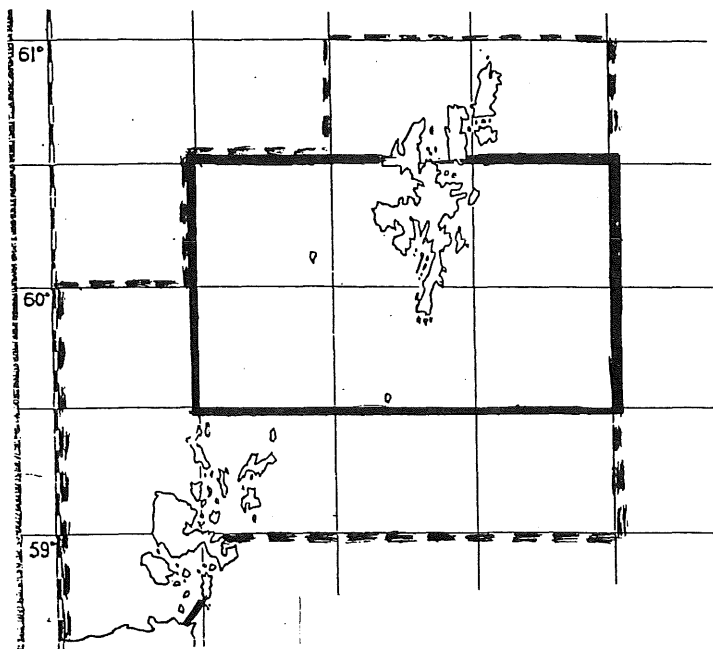
Table 2.8. North Sea HERRING in Sub-area IV and Division VIId.
VPA analysis, catch in numbers x 10^{-6}.

	1955	1956	1957	1958	1959	1960	1961	1962	1963
0	164.3	95.9	278.7	97.1	0.0	194.6	1269.2	141.8	442.8
1	2072.1	1696.8	1482.6	4278.8	1609.4	2392.7	336.0	2146.9	1262.2
2	1931.2	1860.0	1643.9	1029.4	4933.9	1142.3	1889.4	269.6	2961.2
3	1031.7	1221.2	736.2	999.3	487.5	1966.7	479.9	797.4	177.2
4	479.1	515.7	643.9	321.9	497.3	165.9	1455.9	335.1	158.3
5	336.6	248.5	344.1	461.1	233.4	167.7	124.0	1081.8	80.6
6	231.6	194.3	207.2	146.7	249.0	112.9	157.9	126.9	229.7
7	119.7	104.1	147.1	73.3	119.5	125.8	61.4	145.1	22.4
8	109.0	104.1	99.5	45.7	82.3	128.6	56.0	86.3	42.0
9+	105.5	187.5	153.4	72.3	218.6	142.0	87.5	86.8	51.0
TOTAL	6580.8	6228.1	5736.6	7525.6	8430.9	6539.2	5917.2	5217.7	5427.4

	1964	1965	1966	1967	1968	1969	1970	1971	1972
0	496.9	157.1	374.5	645.4	839.3	112.0	898.1	684.0	750.4
1	2971.7	3209.3	1383.1	1674.3	2425.0	2503.3	1196.2	4378.5	3340.6
2	1547.5	2217.6	2569.7	1171.5	1795.2	1883.0	2002.8	1146.8	1440.5
3	2243.1	1324.6	741.2	1364.7	1494.3	296.3	883.6	662.5	343.8
4	148.4	2039.4	450.1	371.5	621.4	133.1	125.2	208.3	130.6
5	149.0	145.1	889.8	297.8	157.1	190.8	50.3	26.9	32.9
6	95.0	151.9	45.3	393.1	145.0	49.9	61.0	30.5	5.0
7	256.3	117.6	64.8	67.9	163.4	42.7	7.9	26.8	0.2
8	26.3	413.0	95.5	81.6	13.7	27.4	12.0	0.0	1.1
9+	57.7	78.4	236.3	172.8	91.8	25.1	12.2	12.4	0.4
TOTAL	7991.9	9854.0	6850.3	6240.6	7746.2	5263.6	5249.3	7176.7	6045.5

	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	289.4	996.1	263.8	238.2	256.8	130.0	542.0	791.7	619.4
1	2368.0	846.1	2460.5	126.6	144.3	168.6	159.2	161.1	431.4
2	1344.2	772.6	541.7	901.5	44.7	4.9	34.1	108.0	258.9
3	659.2	362.0	259.6	117.3	186.4	5.7	10.0	91.8	52.5
4	150.2	126.0	140.5	52.0	10.8	5.0	10.1	32.2	43.4
5	59.3	56.1	57.2	34.5	7.0	0.3	2.1	21.7	23.6
6	30.6	22.3	16.1	6.1	4.1	0.2	0.2	2.3	14.3
7	3.7	5.0	9.1	4.4	1.5	0.2	0.8	1.4	15.7
8	1.4	2.0	3.4	1.0	0.7	0.2	0.6	0.4	3.4
9+	0.6	1.1	1.4	0.4	0.0	0.3	0.1	0.1	1.1
TOTAL	4906.6	3189.3	3753.3	1482.0	656.3	315.4	759.2	1210.7	1463.7

Table 2.9. North Sea HERRING in Sub-area IV and Division VIId.
VPA analysis, fishing mortalities (M = 0.1).

	1955	1956	1957	1958	1959	1960	1961	1962	1963
0	0.02	0.02	0.01	0.02	0.00	0.11	0.08	0.02	0.05
1	0.37	0.30	0.46	0.27	0.41	0.46	0.25	0.18	0.24
2	0.42	0.60	0.47	0.59	0.49	0.51	0.70	0.29	0.35
3	0.39	0.45	0.44	0.52	0.55	0.33	0.37	0.64	0.28
4	0.39	0.30	0.40	0.32	0.48	0.52	0.39	0.42	0.22
5	0.46	0.32	0.30	0.49	0.35	0.26	0.37	0.49	0.15
6	0.33	0.46	0.43	0.18	0.48	0.26	0.37	0.71	0.16
7	0.24	0.22	0.67	0.24	0.20	0.42	0.19	0.59	0.23
8	0.30	0.30	0.30	0.40	0.40	0.30	0.30	0.40	0.30
9+	0.30	0.30	0.30	0.40	0.40	0.30	0.30	0.40	0.30
F(2- 7),W	0.40	0.46	0.44	0.46	0.48	0.37	0.48	0.50	0.31

	1964	1965	1966	1967	1968	1969	1970	1971	1972
0	0.05	0.03	0.08	0.09	0.12	0.03	0.11	0.11	0.17
1	0.53	0.44	0.34	0.50	0.52	0.56	0.47	0.97	0.91
2	0.45	0.86	0.68	0.48	1.47	0.88	1.08	0.99	0.90
3	0.43	0.76	0.71	0.84	1.92	0.94	1.31	1.26	0.83
4	0.36	0.77	0.57	0.84	1.07	0.87	1.31	1.22	0.80
5	0.30	0.63	0.82	0.81	0.96	1.05	0.86	1.04	0.54
6	0.23	0.49	0.37	0.98	1.10	0.83	1.08	2.37	0.48
7	0.24	0.44	0.36	1.30	1.43	1.07	0.26	2.63	0.07
8	0.40	0.67	0.69	0.90	0.90	0.90	0.90	0.00	0.90
9+	0.40	0.67	0.69	0.90	0.90	0.90	0.90	0.00	0.90
F(2- 7),W	0.40	0.78	0.68	0.70	1.50	0.90	1.14	1.12	0.87

	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0.14	0.20	0.32	0.31	0.25	0.17	0.24	0.44	0.143
1	1.05	0.67	0.88	0.22	0.28	0.23	0.28	0.10	0.400
2	1.09	1.12	1.12	0.86	0.10	0.01	0.06	0.28	0.195
3	1.33	0.89	1.43	0.68	0.37	0.02	0.03	0.20	0.205
4	0.98	0.89	0.95	1.23	0.11	0.01	0.03	0.11	0.125
5	0.94	1.15	1.27	0.56	0.45	0.00	0.01	0.08	0.095
6	1.31	1.05	1.15	0.36	0.10	0.02	0.00	0.01	0.059
7	0.69	0.67	1.77	1.05	0.13	0.01	0.08	0.02	0.060
8	0.90	0.90	1.25	0.90	0.40	0.02	0.02	0.05	0.055
9+	0.90	0.90	1.25	0.90	0.40	0.02	0.02	0.05	0.055
F(2- 7),W	1.14	1.02	1.18	0.83	0.24	0.01	0.03	0.15	0.15

Table 2.10. North Sea HERRING in Sub-area IV and Division VIId.
VPA analysis, stock size in numbers x 10^{-6} at 1 January.
Spawning stock as at 1 September ('000 t).

	1955	1956	1957	1958	1959	1960	1961	1962	1963
0	7703	4768	21429	5641	7555	1954	16086	7085	8789
1	6947	6814	4223	19125	5012	6836	1583	13892	6276
2	5929	4321	4556	2417	13246	3010	3919	1114	10532
3	3371	3535	2150	2565	1213	7313	1642	1760	752
4	1548	2072	2042	1248	1375	636	4752	1031	838
5	961	947	1386	1237	824	773	418	2920	615
6	855	551	621	928	683	524	541	261	1618
7	591	554	314	366	700	382	367	339	116
8	441	421	402	145	261	520	226	274	170
9+	427	758	620	230	694	574	354	276	206
TOTAL	28772	24741	37744	33902	31564	22523	30489	28952	29912
SPAWN. ST.	1 821	1 741	1 593	1 236	2 063	1 871	1 601	1 132	1 800

	1964	1965	1966	1967	1968	1969	1970	1971	1972
0	10907	5709	5289	7581	7623	3820	9081	7146	4975
1	7532	9397	5017	4430	6246	6101	3350	7363	5816
2	4481	4002	5462	3228	2423	3356	3151	1899	2532
3	6722	2588	1527	2513	1811	506	1259	964	636
4	512	3957	1090	681	985	239	178	308	248
5	608	323	1654	561	266	305	91	43	83
6	480	409	155	656	226	92	96	35	14
7	1246	344	226	97	223	68	36	30	3
8	84	884	200	143	24	48	21	0	2
9+	183	168	495	304	161	44	21	0	1
TOTAL	32755	27782	21117	20194	19989	14580	17285	17787	14310
SPAWN. ST.	1 829	1 340	1 116	817	390	359	318	219	269

	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	2305	5881	1020	939	1217	883	2628	2344	4879
1	3789	1810	4375	673	623	857	675	1864	1371
2	2110	1196	838	1636	488	427	616	460	1533
3	932	642	354	248	629	399	382	525	514
4	251	223	239	76	113	393	356	336	388
5	101	86	83	84	20	92	351	313	273
6	44	36	25	21	43	12	83	315	262
7	8	11	11	7	13	35	10	75	283
8	2	4	5	2	2	11	32	9	67
9+	1	2	2	1	0	16	5	2	22
TOTAL	9542	9890	6953	3687	3151	3126	5138	6242	9391
SPAWN. ST.	228	166	107	160	172	231	311	345	482

Table 2.11. North Sea HERRING - Sub-area IV and Division VIId.
Catch weight and SOP check.

	1955	1956	1957	1958	1959	1960	1961	1962	1963
A) SOP	862085	860355	794311	789317	1125537	823638	790607	734871	615876
B) NOMINAL	806400	675200	682900	670500	784500	696200	696700	627800	716000
(B/A) IN %	94	78	86	85	70	85	88	85	116

	1964	1965	1966	1967	1968	1969	1970	1971	1972
A) SOP	928370	1343637	958788	817684	900935	528854	543706	558941	457564
B) NOMINAL	871200	1168800	895500	695500	717800	546700	563100	520100	497500
(B/A) IN %	94	87	93	85	80	103	104	93	109

	1973	1974	1975	1976	1977	1978	1979	1980	1981
A) SOP	463442	266297	292242	166578	55105	13368	25242	62849	96615
B) NOMINAL	484000	275100	312800	174800	46000	11000	25100	61000	94775
(B/A) IN %	104	103	107	105	83	82	99	97	98

Table 2.12(a). Downs HERRING.
VPA, catch in numbers x 10^{-6}.

	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	86.40	41.30	208.20	134.50	156.00	140.70	142.40	177.20	144.80
3	69.50	24.40	14.90	100.30	51.50	41.20	136.50	86.10	54.50
4	16.10	16.30	9.40	7.80	33.20	11.80	70.60	14.40	15.00
5	3.60	2.90	5.30	2.50	0.70	5.70	9.90	7.10	3.60
6	3.10	3.40	0.50	2.70	0.30	0.05	5.80	0.90	1.70
7	0.01	1.20	0.45	0.30	0.60	0.02	0.50	0.29	0.80
8	0.01	0.01	0.08	0.50	0.01	0.06	0.10	0.12	0.14
9+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.04
TOTAL	178.72	89.51	238.83	248.60	242.31	199.53	365.80	286.14	220.58

	1976	1977	1978	1979	1980	1981
2	141.80	12.90	3.00	22.10	99.30	210.59
3	45.80	4.70	4.40	9.10	83.90	38.58
4	10.00	0.80	1.50	6.20	30.20	18.66
5	5.20	0.70	0.01	0.80	18.50	6.75
6	0.70	0.30	0.01	0.10	1.70	2.89
7	0.30	0.01	0.01	0.10	0.50	0.52
8	0.09	0.01	0.01	0.10	0.01	0.01
9+	0.02	0.00	0.00	0.00	0.00	0.01
TOTAL	203.91	19.42	8.94	38.50	234.11	278.01

Table 2.12(b). Downs HERRING.
VPA, fishing mortalities (M = 0.1).

	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	1.108	0.903	0.806	0.931	0.735	0.596	0.772	1.227	1.328
3	1.217	1.005	0.881	1.072	1.049	0.382	1.993	1.487	1.699
4	1.567	0.961	1.328	1.672	1.211	0.638	2.041	1.356	1.081
5	0.515	1.408	0.870	1.680	0.567	0.597	1.715	1.380	1.585
6	1.134	1.199	0.894	1.498	0.873	0.062	2.371	0.619	1.543
7	0.454	2.251	0.417	2.887	1.899	0.109	1.218	0.782	1.801
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9+	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
F(2- 9),W	1.165	0.977	0.826	1.017	0.846	0.539	1.377	1.307	1.400
F(6- 7),W	1.150	1.425	0.603	1.613	1.464	0.071	2.255	0.654	1.622

	1976	1977	1978	1979	1980	1981
2	2.093	0.145	0.021	0.064	0.200	0.185
3	3.183	0.307	0.061	0.073	0.327	0.100
4	2.322	0.606	0.135	0.102	0.325	0.100
5	1.366	1.260	0.012	0.089	0.438	0.100
6	1.784	0.208	0.041	0.138	0.248	0.100
7	1.269	0.083	0.009	0.619	1.659	0.100
8	1.000	0.100	0.100	0.100	0.100	0.100
9+	1.000	0.100	0.100	0.100	0.100	0.100
F(2- 9),W	2.305	0.186	0.039	0.072	0.264	0.154
F(6- 7),W	1.613	0.199	0.014	0.243	0.351	0.100

Table 2.12(c). Downs HERRING.
VPA, stock size in numbers at 1 January.

	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	134.31	72.42	392.89	231.52	313.12	327.82	276.57	260.80	204.78
3	102.73	40.12	26.55	158.85	82.57	135.89	163.50	115.53	69.16
4	21.12	27.52	13.29	9.96	49.20	26.17	83.91	20.16	23.64
5	9.37	3.99	9.52	3.19	1.69	13.26	12.52	9.86	4.70
6	4.76	5.07	0.88	3.61	0.54	0.87	6.60	2.04	2.24
7	0.03	1.39	1.38	0.33	0.73	0.20	0.74	0.56	0.99
8	0.02	0.02	0.13	0.82	0.02	0.10	0.16	0.20	0.23
9+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.07
TOTAL	272.33	150.52	444.66	408.28	447.87	504.31	543.81	409.19	305.81
SPAWN. ST.	272.33	150.52	444.66	408.28	447.87	504.31	543.81	409.19	305.81
SSB at the end of the year	12.3	8.3	23.6	19.8	24.8	39.9	20.9	14.7	10.1

	1976	1977	1978	1979	1980	1981	1982
2	167.23	100.31	152.90	371.85	574.61	1308.23**********	
3	49.08	18.66	78.52	135.50	315.46	425.67	983.81
4	11.45	1.84	12.42	66.86	113.96	205.88	348.51
5	7.25	1.02	0.91	9.82	54.61	74.47	168.56
6	0.87	1.67	0.26	0.81	8.12	31.89	60.97
7	0.43	0.13	1.23	0.23	0.64	5.74	26.11
8	0.15	0.11	0.11	1.10	0.11	0.11	4.70
9+	0.03	0.00	0.00	0.00	0.00	0.11	0.18
TOTAL	236.50	123.75	246.35	586.17	1067.51	2052.10	
SPAWN. ST.	236.50	123.75	246.35	586.17	1067.51	2052.10	
SSB at the end of the year	3.4	12.7	31.5	73.7	114.8	243.5	

Table 3.1 HERRING in Division IIIa. Landings in tonnes 1972-1981
(Data mainly provided by Working Group members)

	Country/Year	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981[x]
SKAGERRAK	Denmark	34 900	42 098	35 732	29 997	7 326	19 889	6 425	5 153	5 180	18 001
	Faroe Islands	4 115	5 265	7 132	8 053	1 553	10 064	1 041	817	526	600
	Germany,Fed.Rep.	-	-	36	108	6	32	28	181	-	199
	Iceland	7 317	15 938	231	1 209	123	-	-	-	-	-
	Norway (Open Sea)	1 045	836	698	196	-	-	1 860	2 460	1 350	6 330
	Norway (Fjords)	4 222	1 680	1 720	1 459	2 304	1 837	2 271	2 259	2 795	950
	Sweden	19 644	20 429	11 683	12 348	6 505	8 109	11 551	8 104	10 701	30 274
	Total	71 243	86 246	57 232	53 370	17 817	39 931	23 176	18 974	20 552	56 354
KATTEGAT	Denmark	52 755	78 125	54 540	48 974	41 749	38 205	29 241	21 337	25 380	18 721
	Sweden	39 972	40 418	39 779	23 769	30 263	37 160	35 193	25 272	18 260	38 871
	Total	92 727	118 543	94 319	72 743	72 012	75 365	64 434	46 609	43 640	57 592
	Division IIIa Total	163 970	204 789	151 551	126 113	89 829	115 296	87 610	65 583	64 192	113 946
	Unallocated								8 117	20 053	46 000[xx]
	GRAND TOTAL								73 700	84 245	160 000

x) Preliminary
xx) Indirect estimate (see text)

- 62 -

Table 3.2   Estimation of unreported catches in Division
             IIIa in 1981 (for explanation see para. 3.2.2).

w.r.	"Known" landings nos.x 10^{-6}	"Unknown" landings age comp.	"Unknown" landings nos.x 10^{-6}	Estimated total catch no.x 10^{-6}	$\bar{\bar{w}}$ grammes
0	372	1.0000	2 028	2 400	12
1	579	0.1186	241	820	65
2	580	0.0233	47	627	79
3	169.9	0.0026	5.3	175	140
4	66.0	0.0005	1.0	67	196
5	8.0			8.0	218
6	1.7			1.7	241
7	0.2			0.2	265
8	0.2			0.2	285
SOP (tonnes)	126 900	-	44 652	171 553	-
actual catch	118 173		(41 581)	(159 755)	-

Table 3.3 Catch in number by age, 1974-80.

Age	1974	1975	1976	1977	1978	1979	1980
0	2 499	2 006	433	934	147	457	682
1	910	1 471	1 474	1 437	876	168	467
2	375	149	325	329	455	583	232
3	135	60	28	61	65	70	185
4	47	57	4	12	10	13	30
5	26	15	3	6	1	4	4
6	9	6	1	4	1	0	1
7	3	1	1	2	0	0	0
8	1	1	1	0	0	0	0

Table 4.1   Annual Celtic Sea HERRING catches 1972-1981 (Data provided by Working Group members)

Year	France	German Dem. Rep.	Germany, Fed. Rep.	Ireland	Netherlands	Poland	U.K.	USSR	Unallocated	Total
1972	7 327	-	393	20 109	6 758	751	-	618		35 956 a)
1973	5 553	7	294	13 105	5 834	1 125	-	334		26 375
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	8	-	220	2 725	1 002	-	-	-	850	3 955
1979	584	-	20	2 123	850	-	-	-	3 705	4 427
1980	9	-	2	3 416	393	-	-	-		7 524
1981*	123	-	-	8 386	1 150	-	-	-		

*provisional   a) including 123 tonnes for Bulgaria

Table 4.2   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	U.K.	USSR	Unallocated	Total
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		23 191 a)
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	8	-	220	2 656	1 002	-	-	-		3 886
1979/80	584	-	20	2 920	850	-	-	-	935	5 309
1980/81	9	-	2	3 582	292	-	-	-	3 803	7 788
1981/82 x)	123	-	-	8 476	1 150	-	-	-	-	9 749

x)provisional   a) including 123 tonnes for Bulgaria

Table 4.3   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
1979/80	5 318	8 260	7 946	2 228	1 230	422	305	140	264	26 113
1980/81	2 933	20 520	6 363	4 206	2 147	972	308	151	205	37 805
1981/82	11 292	11 816	13 706	3 489	3 414	1 600	561	169	575	46 622

Table 4.4 Abundance of larvae (x 10^{-6}) in 1981/82 in
the Celtic Sea.

Cruise mid-date	<10 mm	10-15 mm	>15 mm
13.10.81	8 852	5 023	0
28.10.81	8 051	16 471	1 242
11.11.81	30 895	31 331	5 261
25.11.81	6 349	44 707	7 537
09.12.81	27 280	40 784	6 513
22.12.81	1 363	15 983	10 073
05.01.82	0	1 880	2 730
21.01.82	0	252	1 447
07.02.82	0	0	0
17.02.82	0	20 580	0

Table 4.5. HERRING in the Celtic Sea.
VPA, fishing mortalities (M = 0.1).
F adult = 0.4.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.00	0.03	0.03	0.05	0.06	0.01	0.04	0.10	0.27
2	0.30	0.23	0.24	0.34	0.52	0.35	0.46	0.88	0.76
3	0.21	0.38	0.34	0.39	0.61	0.50	0.68	0.66	0.84
4	0.35	0.31	0.53	0.29	0.58	0.59	0.91	0.57	0.48
5	0.22	0.49	0.45	0.45	0.51	0.67	0.99	0.81	0.71
6	0.21	0.57	0.68	0.58	0.67	0.57	0.82	0.58	0.63
7	0.51	0.23	0.88	0.61	0.74	0.43	0.60	0.48	1.03
8	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
9+	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
F(1- 9),W	0.26	0.26	0.28	0.25	0.46	0.42	0.40	0.67	0.61
F(2- 9),W	0.31	0.36	0.40	0.38	0.57	0.49	0.73	0.80	0.77

	1974	1975	1976	1977	1978	1979	1980	1981
1	0.16	0.40	0.27	0.09	0.05	0.07	0.07	0.10
2	0.89	0.82	0.57	0.21	0.32	0.35	0.37	0.40
3	0.85	1.06	0.81	0.40	0.29	0.38	0.43	0.40
4	1.03	1.08	1.18	0.53	0.28	0.24	0.31	0.40
5	0.54	0.92	1.05	0.47	0.26	0.33	0.34	0.40
6	0.62	1.11	1.33	0.77	0.51	0.36	0.42	0.40
7	0.82	0.45	2.90	0.41	0.32	0.65	0.43	0.40
8	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.40
9+	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.40
F(1- 9),W	0.75	0.77	0.64	0.20	0.22	0.20	0.29	0.24
F(2- 9),W	0.87	0.93	0.87	0.53	0.31	0.35	0.37	0.40

Table 4.6. HERRING in the Celtic Sea.
VPA, stock size in numbers at 1 January , spawning stock biomass at spawning time.
F adult = 0.4.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	109825	201997	220471	276424	133274	71338	255286	81383	97916
2	290037	99519	176751	192912	238999	113191	63941	221238	66723
3	52943	195151	71696	125610	124276	129155	72516	36589	82793
4	56034	38929	121004	46397	77241	60917	70743	33108	17104
5	18523	35617	25904	64203	31352	39307	30578	25754	16882
6	25540	13502	19734	14957	36982	17119	18290	10268	10388
7	32241	18578	6932	9031	9232	17137	8775	7287	5192
8	2887	17583	13411	2596	4421	3995	10057	4365	4080
9+	15702	7967	13872	9563	7094	6629	4448	1554	1482
TOTAL	603553	628644	609776	741694	662870	458787	534634	421546	302559
Spawning stock biomass at spawning time	87104	84697	87585	92666	91502	68602	59747	54018	37040

	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	31725	36042	32233	48365	54408	82526	44566	124588	**********
2	67565	24417	27759	22776	40096	29556	69019	37538	102004
3	28131	24999	9743	11086	16270	26443	18912	43542	22768
4	32268	10888	7812	5903	6723	11031	16395	11084	26410
5	9540	10466	3350	2176	2079	4591	7867	10846	6723
6	7476	5051	3768	1059	1228	1454	2988	5083	6578
7	4996	3633	1506	899	442	665	916	1782	5083
8	1673	2001	2086	75	540	291	313	537	1081
9+	1540	2121	1613	114	270	548	425	1827	1434
TOTAL	184913	119617	83871	89953	102054	157105	162001	236827	
Spawning stock biomass at spawning time	24828	14760	9559	9367	12703	16905	21155	25585	

Table 4.7. HERRING in the Celtic Sea.
VPA, fishing mortalities (M = 0.1).
F adult = 0.8.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	0.00	0.03	0.03	0.05	0.06	0.01	0.04	0.10	0.27
2	0.50	0.23	0.24	0.54	0.52	0.35	0.46	0.88	0.76
3	0.21	0.58	0.54	0.59	0.61	0.50	0.68	0.66	0.84
4	0.35	0.31	0.53	0.29	0.58	0.59	0.91	0.57	0.48
5	0.22	0.49	0.45	0.45	0.51	0.67	0.99	0.81	0.71
6	0.21	0.57	0.68	0.58	0.67	0.57	0.82	0.58	0.63
7	0.51	0.23	0.88	0.61	0.74	0.43	0.60	0.48	1.03
8	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
9+	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
F(1- 9),W	0.26	0.26	0.28	0.25	0.46	0.42	0.40	0.67	0.61
F(2- 9),W	0.31	0.36	0.40	0.38	0.57	0.49	0.73	0.80	0.77

	1974	1975	1976	1977	1978	1979	1980	1981
1	0.16	0.42	0.31	0.10	0.06	0.10	0.12	0.20
2	0.89	0.84	0.62	0.25	0.38	0.45	0.56	0.80
3	0.85	1.06	0.86	0.45	0.56	0.50	0.65	0.80
4	1.03	1.08	1.18	0.59	0.34	0.52	0.48	0.80
5	0.54	0.92	1.05	0.47	0.31	0.43	0.51	0.80
6	0.62	1.11	1.33	0.77	0.51	0.46	0.62	0.80
7	0.82	0.45	2.90	0.41	0.32	0.65	0.65	0.80
8	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.80
9+	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.80
F(1- 9),W	0.75	0.79	0.69	0.23	0.27	0.27	0.45	0.50
F(2- 9),W	0.87	0.94	0.91	0.37	0.38	0.45	0.56	0.80

Table 4.8. HERRING in the Celtic Sea.
VPA, stock size in numbers at 1 January ,spawning stock biomass at spawning time.
F adult = 0.8.

	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	109825	201997	220471	276424	135274	71358	255286	81383	97916
2	290037	99319	176751	192912	238999	113191	63941	221238	66723
3	52943	195151	71696	125610	124276	129155	72516	36589	82793
4	56034	38929	121004	46397	77241	60917	70743	35108	17104
5	18523	35617	25904	64703	31352	39307	30578	25754	16882
6	25340	13502	19734	14957	36982	17119	18290	10268	10388
7	32241	18578	6932	9057	9232	17137	8775	7287	5192
8	2887	17583	13411	2596	4421	3995	10057	4365	4080
9+	15702	7967	13872	9563	7094	6629	4448	1554	1482
TOTAL	603533	628044	669776	741694	662870	458787	534654	421546	302559
Spawning stock biomass at spawning time	87104	84697	87585	92666	91502	68602	59747	54018	37040

	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	31280	34718	28840	41815	28353	61041	27835	65552 **********	
2	67565	24015	20564	19208	34169	24077	50180	22400	48414
3	28151	24999	9581	10008	13495	21086	13961	25983	9107
4	32268	10888	7812	3577	5749	8523	11555	6614	10564
5	9540	10466	3350	2176	1786	3710	5599	6472	2689
6	7476	5051	3768	1059	1228	1189	2192	3033	2631
7	4996	3633	1506	899	442	665	676	1064	1233
8	1673	2001	2096	75	540	291	313	320	432
9+	1540	2121	1613	114	270	548	425	1090	573
TOTAL	184468	117892	78921	78950	86029	121129	112736	132329	
Spawning stock biomass at spawning time	24803	14619	9106	8256	10669	13094	14544	13842	

Table 4.9   Division VIIj. Details of total catch, effort and
catch per effort (based on landings of paired pelagic
trawlers)

Year	Catch (tonnes)	Effort (nights fishing)	C.P.U.E.	Z
1971	1 463	206	7.1	
1972	3 195	280	11.4	
1973	3 963	502	7.9	
1974	2 285	313	7.3	
1975	2 157	288	7.5	
1976	2 281	275	8.3	- 0.03
1977	4 139	431	9.6	0.17
1978	3 524	294	12.0	- 0.11
1979	4 896	357	13.7	0.33
1980	5 433	481	11.3	0.58
1981	7 176	454	15.8	0.56

Table 4.10 Southwest coast. Catch in numbers x 10^{-3}.
Division VIIj.

Season/Age	1	2	3	4	5	6	7	8	>8	Total	Tonnes
1975	1 091	2 481	2 084	397	3 076	198	397	99	99	9 922	2 157
1976	4 700	1 409	1 675	2 016	638	2 372	638	267	1 112	14 827	2 281
1977	3 873	8 471	5 246	4 234	761	1 528	772	378	453	25 716	4 139
1978	246	2 671	8 155	4 449	1 179	1 022	420	663	391	19 196	3 524
1979	4 453	5 590	4 800	7 548	1 705	872	920	448	405	26 741	4 896
1980	2 649	9 777	5 984	2 629	427	1 420	1 014	1 279	414	29 437	5 432
1981	24 579	9 872	8 501	2 101	1 068	1 914	244	150	304	48 733	7 176

Table 4.11   Herring in Division VIIj. Calculated F Mortality
M = 0.1

Age winterrings	1975	1976	1977	1978	1979	1980	1981
1	0.05	0.10	0.20	0.01	0.10	0.08	0.10
2	0.18	0.08	0.23	0.19	0.33	0.30	0.40
3	0.19	0.16	0.42	0.32	0.53	0.61	0.40
4	0.09	0.25	0.67	0.67	0.49	0.55	0.40
5	0.46	0.17	0.13	0.35	0.53	0.51	0.40
6	0.12	0.67	0.68	0.22	0.42	1.00	0.40
7	0.52	0.57	0.43	0.36	0.28	1.10	0.40
8	0.70	0.70	0.70	0.70	0.70	0.70	0.40
9+	0.70	0.70	0.70	0.70	0.70	0.70	0.40
F(1-9) w	0.18	0.17	0.31	0.26	0.30	0.33	0.17
F(2-9) w	0.24	0.24	0.34	0.35	0.44	0.46	0.40

Table 4.12   Division VIIj . Stock Size in Numbers at 1 January (10^{-6})
and spawning stock biomass (tonnes) at 1 October

Age winterrings	1975	1976	1977	1978	1979	1980	1981
1	22.3	52.5	22.1	23.4	49.0	37.4	(271.2)
2	15.6	19.1	43.1	16.3	20.9	40.1	31.4
3	12.8	11.8	16.0	30.9	12.2	13.6	27.0
4	5.1	9.6	9.0	9.5	20.2	6.5	6.7
5	8.8	4.2	6.7	4.2	4.4	11.2	3.4
6	1.9	5.1	3.2	5.4	2.7	2.3	6.1
7	1.0	1.5	2.3	1.5	3.9	1.6	0.8
8	0.2	0.6	0.8	1.4	0.9	2.7	0.5
9+	0.2	2.3	0.9	0.8	0.8	0.9	1.0
Total	67.9	106.7	104.2	93.3	115.1	116.3	(347.9)
Spawning Stock Biomass (tonnes) at spawning	6 377	8 185	10 085	9 523	9 490	9 956	14 364

Table 5.1 Catch in Weight Division VIa (North) 1970–1981

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Denmark	–	554	150	932	–	374	249	626	128	–	–	1 580
Faroes	15 100	8 100	8 094	10 003	5 371	3 895	4 017	3 564	–	–	–	–
France	1 293	2 055	680	2 441	411	1 244	1 481	1 548	1 435	3	2	1 243
G.D.R.	52	30	94	251	200	600	279	–	–	–	–	–
Germany, Fed.Rep.	11 716	6 414	3 282	9 663	8 687	5 582	4 084	–	26	–	256	3 029
Ireland	5 595	5 416	2 066	2 532	9 566	2 633	3 273	–	–	–	–	–
Netherlands	464	8 340	22 673	27 892	17 461	12 024	16 573	8 705	5 874	–		4 048
Norway	27 250	76 721	17 400	32 557	26 218	509	5 183	1 098	4 462	–		3 850
Poland	927	–	743	2 062	334	376	390	–	–	–		–
Sweden	–	–	–	–	–	–	2 206	261	–	–		–
UK (Engl.)	–	–	–	–	45	125	20	301	134	54	33	1 094
UK (Scot.)	103 530	99 537	107 638	120 800	107 475	85 395	53 351	25 238	10 097	3	15	30 389
USSR	3	–	1 936	1 137	·2 392	1 244	2 536	–	–	–	–	–
Unallocated	–	–	–	–	–	–	–	–	–	–	–	3 879
TOTAL	165 930	207 167	164 756	208 270	178 164	114 001	93 642	41 341	22 176	60	306	49 112

Table 5.2. HERRING in Division VIa (North).
VPA, catch in numbers ('000).

	1970	1971	1972	1973	1974	1975	1976	1977	1978
0	16299	209598	24941	267872	536119	82676	8225	11508	108199
1	238738	169947	801663	51170	309016	172879	69053	34836	22525
2	205454	372615	804097	235627	124944	202087	319604	47739	46284
3	359711	560348	219502	808267	151025	89066	101548	95834	20587
4	139718	357745	63069	131484	519178	63701	35502	22117	40692
5	53320	113591	85920	63071	82466	188202	25195	10083	6879
6	203462	54571	57341	54642	49685	30601	76289	12211	3833
7	29141	181592	13377	18242	34629	12297	10918	20992	2100
8	32860	18042	100938	6506	22470	13121	3914	2758	6278
9+	30651	36395	20465	32223	21042	13698	12014	1486	1544
TOTAL	1309354	2074244	2171313	1669104	1850572	868328	662262	259564	258921

	1979	1980	1981
0	1614	0	3003
1	392	12867	36703
2	225	1335	76860
3	122	452	103953
4	31	246	57491
5	21	62	18817
6	12	43	12339
7	7	40	10521
8	2	3	492
9+	0	1	1730
TOTAL	2426	15049	321909

Table 5.3. HERRING in Division VIa (North).
VPA, fishing mortalities
M = 0.1

	1970	1971	1972	1973	1974	1975	1976	1977	1978
0	0.005	0.128	0.060	0.296	0.444	0.206	0.022	0.015	0.083
1	0.203	0.054	0.855	0.150	0.578	0.223	0.237	0.110	0.032
2	0.210	0.490	0.343	0.579	0.571	0.830	0.708	0.229	0.187
3	0.434	1.194	0.530	0.606	0.809	0.927	1.259	0.419	0.131
4	0.441	0.904	0.340	0.621	0.891	0.868	1.114	0.938	0.280
5	0.442	0.686	0.497	0.591	0.906	0.857	0.927	1.030	0.767
6	0.528	0.986	0.445	0.601	1.200	0.927	0.935	1.674	1.406
7	0.626	0.483	0.609	0.361	0.857	1.009	0.921	0.637	1.736
8	0.410	0.900	0.480	0.600	0.890	0.840	0.950	0.550	0.350
9+	0.410	0.900	0.480	0.600	0.890	0.840	0.950	0.550	0.350
F(3- 7),W	0.408	0.899	0.480	0.600	0.890	0.885	1.079	0.564	0.253

	1979	1980	1981
0	0.002	0.000	0.030
1	0.000	0.014	0.070
2	0.000	0.001	0.100
3	0.001	0.001	0.120
4	0.000	0.001	0.120
5	0.000	0.001	0.120
6	0.002	0.000	0.120
7	0.006	0.008	0.120
8	0.005	0.003	0.120
9+	0.005	0.003	0.120
F(3- 7),W	0.000	0.001	0.120

Table <u>5.4</u>. HERRING in Division VIa (North).
VPA, stock size in numbers at 1 January.

	1970	1971	1972	1973	1974	1975	1976	1977	1978
0	3754855	1829141	452634	1094697	1565455	465976	396947	835395	1418479
1	1362919	3382035	1455990	385857	736444	908590	343155	351353	744955
2	1140134	1006600	2898670	500536	300544	373933	658048	244970	284824
3	1069043	830625	557945	1860416	284224	153699	147502	293304	176352
4	410113	627048	229354	297049	918670	114533	55026	37889	174585
5	156130	238722	229724	147730	144401	341179	43496	16338	13414
6	761763	90759	108797	126500	73994	52827	131014	15582	5276
7	65513	496340	30650	63069	62764	20170	18924	46561	2642
8	102313	31713	277133	15078	39774	24095	.6655	6820	22275
9+	95435	63973	56188	74677	37246	25155	20427	3674	5478
TOTAL	8918818	8602957	6297091	4625609	4163515	2480159	1821192	1851885	2848281
SPAWN. ST.	3801045	3391780	4388460	3145055	1861617	1105592	1081091	665137	684847
Spawning stock biomass at 1 Sept.	458 450	313 018	447 243	314 558	166 585	93 798	82 624	69 942	82 550

	1979	1980	1981	1982
0	1052412	630123	106747	**********
1	1180685	950727	570159	93734
2	652652	1067955	848020	481023
3	213780	590330	965056	694300
4	140016	193320	533723	774476
5	119570	120663	174689	428322
6	5638	107990	114550	140191
7	1170	5090	97673	91929
8	421	1052	4568	78384
9+	0	351	16061	16554
TOTAL	3366144	3673600	3431245	
SPAWN. ST.	1133047	2092750	2754339	
Spawning stock biomass at 1 Sept.	150 494	283 681	372 688	

Table 5.5 Spawning Biomass – Larval Index Regressions
for Division VIa (North)

Year	Spawning Biomass	Larval indices
1972	447.243	2871.30
1973	314.558	1913.30
1974	166.585	1094.80
1975	93.798	1039.30
1976	82.624	374.85
1977	69.942	1039.95
1978	82.550	648.95
1979	150.494	1290.13
1980	283.681	2184.60
1981	372.688	2484.00

1972–81: $y = -42.800 + 0.167x$
$r = .960$

Estimated from Reg. 72–81

172.4 ± 30.7
321.6 ± 39.6
371.5 ± 47.9

Table 5.6 Input Parameters used in Catch Prediction for
          Division VIa (North) in 1982 and 1983

Age	Stock in Numbers at 1/1-1982 x 10^{-3}	Proportional F	Mean Weight in Catch and in Spawning Stock
2	1 291 635	0.8	121
3	697 083	1.0	158
4	774 476	1.0	175
5	428 323	1.0	186
6	140 191	1.0	206
7	91 929	1.0	218
8	78 384	1.0	224
9+	16 555	1.0	224

Recruitment in 1983 – 250 000 x 10^3

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

Month	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
January	*	*	*	*	*	*	4*	4*	6*	15*
February	52*	71*	91*	68*	7*	*	6*	8*	3*	15*
March	82*	36*	168*	85	69*	*	7*	13*	8*	14*
April	400	316	398	369	521	530	246	12*	4*	32*
May	569	385	280	283	436	544	245	4*	2*	25*
June	657	468	607	203	281	640	238	356	114	429
July	416	688	690	354	332	494	376	466	656	982
August	700	593	543	240	473	601	587	450	645	511
September	263	668	310	515	541	559	581	374	559	106
October	410	711	451	811	598	556	653	263	79	-*
November	463	464	245	571	595	560	647	1*	3*	2*
December	166	248	91	120	236	328	272	-*	2*	4*
Not Known	48	67	189	44	50	35				
Total	4 226	4 715	4 063	3 663	4 139	4 847	3 862	1 951	2 081	2 135

* Subject to closure of directed fishery

- 81 -

Table 5.8 Catch in numbers x 10^{-3} in the Firth of Clyde, 1967 – 1981
(Races combined)

Year	Age (winter rings)											Total
	0	1	2	3	4	5	6	7	8	9	≥10	
1967	–	10 109	24 797	3 950	1 828	8 151	4 775	526	106	63	109	54 414
1968	4	5 354	27 811	11 721	3 145	767	5 218	4 542	412	326	220	59 520
1969	–	3 106	24 336	19 936	6 256	1 282	1 042	1 429	990	89	38	58 504
1970	6	5 008	7 551	10 338	8 745	2 306	741	760	753	227	117	36 552
1971	6	2 207	6 503	1 976	4 355	3 432	1 090	501	352	225	181	20 828
1972	–	1 351	8 983	3 181	1 684	3 007	1 114	656	282	177	132	20 567
1973	–	9 139	5 258	4 548	1 811	918	1 525	659	307	132	114	24 411
1974	86	5 308	8 841	2 817	2 559	1 140	494	700	253	87	59	22 344
1975	–	12 694	1 876	2 483	1 024	1 072	451	175	356	130	67	20 328
1976	–	6 194	10 480	913	1 049	526	638	261	138	178	100	20 477
1977	–	1 041	7 524	6 976	1 062	1 112	574	489	251	146	192	19 367
1978	–	14 123	1 796	2 259	2 724	634	606	330	298	174	236	23 200
1979	–	507	4 859	807	930	888	341	289	156	119	154	9 050
1980	380*	333	5 633	1 592	567	341	204	125	48	56	68	9 347
1981		312*	2 372	2 785	1 622	1 158	433	486	407	74	18	9 629

* Including sprat bycatch

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

Age of Recovery	Clyde	Irish Sea	N W Ireland	S W Ireland	S Minch	?
1980 May – June	30	–	–	–	–	–
July	192	2	–	–	–	–
August	155	1	–	–	–	–
September	152	3	3	–	–	–
October	37	2	1	–	–	–
November	21	–	–	–	–	–
December	1	1	–	–	–	–
1981 January	5	1	–	–	–	–
February	4	–	–	–	–	–
March	6	2	1	–	–	–
April	8	1	2	–	–	1
May	3	–	1	–	–	–
June	58	–	2	–	–	–
July	49	–	3	–	–	1
August	51	–	–	–	–	–
September	13	–	–	–	–	–
October	2	–	–	–	–	–
November	–	–	–	1	1	–
December	–	1	–	–	1	–
Date unknown	10	–	1	–	–	–
Σ	797	14	14	1	2	2

Table 5.10   Results of Virtual Population Analysis on Clyde HERRING

          Estimated values of fishing mortality F (1970-1981). M = 0.1

Input F on 3-9 ringers in last year

Year	0.2	0.4	0.6	0.8	0.2	0.4	0.6	0.8
	Weighted mean F on 2-10 ringers				F on 2 ringers			
1970	0.67	0.67	0.67	0.67	0.70	0.70	0.70	0.70
1971	0.52	0.52	0.52	0.52	0.51	0.51	0.51	0.51
1972	0.53	0.53	0.53	0.53	0.54	0.54	0.54	0.54
1973	0.54	0.54	0.54	0.54	0.56	0.56	0.56	0.56
1974	0.64	0.65	0.65	0.66	0.76	0.78	0.79	0.80
1975	0.34	0.37	0.38	0.39	0.21	0.27	0.29	0.31
1976	0.39	0.44	0.45	0.46	0.48	0.53	0.55	0.56
1977	0.56	0.67	0.72	0.74	0.68	0.81	0.86	0.89
1978	0.31	0.44	0.51	0.55	0.16	0.25	0.30	0.34
1979	0.24	0.38	0.46	0.52	0.32	0.48	0.58	0.65
1980	0.19	0.32	0.42	0.50	0.29	0.47	0.60	0.70
1981	0.20*	0.40*	0.60*	0.80*	0.28*	0.56*	0.84*	1.12*

*Input values

Table 5.11   Results of Virtual Population Analysis on Clyde HERRING:
          Numbers of 0-group recruits at 1 January. M = 0.1

Input F on 3-9 ringers in last year

Year	Year Class	0.2	0.4	0.6	0.8
		No. of recruit x 10^{-6}			
1970	1969	30.0	30.0	30.0	30.0
1971	1970	17.3	17.3	17.3	17.3
1972	1971	31.9	31.4	31.2	31.1
1973	1972	18.8	16.4	15.6	15.2
1974	1973	49.9	47.3	46.4	46.0
1975	1974	26.6	24.5	23.8	23.5
1976	1975	16.6	11.6	10.0	9.2
1977	1976	38.8	32.5	30.4	29.3
1978	1977	29.6	19.7	16.5	14.9
1979	1978	12.8	7.5	5.7	4.9
1980	1979	3.6	2.1	1.6	1.3
1981*	1980	-	-	-	-

*No estimate because no catch of 0-ringers in 1981

Table 5.12 Virtual Populati. Analysis - Clyde herring

$$M = 0.1$$

FISHING MORTALITY

	1970	1971	1972	1973	1974	1975	1976	1977	1978
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.25	0.09	0.10	0.41	0.44	0.36	0.34	0.10	0.64
2	0.70	0.51	0.54	0.56	0.77	0.25	0.51	0.76	0.21
3	0.58	0.34	0.45	0.51	0.58	0.45	0.16	0.68	0.48
4	0.81	0.46	0.49	0.44	0.54	0.38	0.31	0.26	0.54
5	0.61	0.79	0.60	0.48	0.49	0.40	0.31	0.55	0.21
6	0.44	0.58	0.56	0.61	0.45	0.32	0.40	0.57	0.58
7	0.59	0.53	0.73	0.67	0.55	0.25	0.28	0.53	0.67
8	0.78	0.54	0.57	0.81	0.53	0.54	0.29	0.41	0.64
9	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
10+	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
F(2-10),W	0.67	0.52	0.53	0.53	0.65	0.36	0.42	0.63	0.39

	1979	1980	1981	1976-1980
0	0.00	0.17	0.00	0.03
1	0.03	0.04	0.18	0.23
2	0.42	0.39	0.42	0.46
3	0.12	0.21	0.30	0.33
4	0.33	0.11	0.30	0.31
5	0.30	0.17	0.30	0.31
6	0.15	0.09	0.30	0.36
7	0.54	0.07	0.30	0.42
8	0.69	0.14	0.30	0.43
9	0.50	0.50	0.30	0.50
10+	0.50	0.50	0.30	0.50
F(2-10),W	0.32	0.26	0.32	

Table 5.13 Virtual Population Analyses - Clyde herring

STOCK SIZE IN NUMBERS
----

1 JANUARY

	1970	1971	1972	1973	1974	1975	1976	1977	1978
0	30034	17295	31535	17176	48156	25197	13262	34571	22999
1	24017	27170	15644	28532	15541	43492	22799	12000	31281
2	15747	16979	22488	12871	17156	9054	27320	14756	9869
3	24411	7110	9206	11844	6670	7170	6594	14797	6243
4	16406	12306	4560	5317	6411	3369	4136	4919	6793
5	5286	6585	7010	2531	3095	3379	2078	2747	3443
6	2189	2601	2716	3498	1421	1721	2041	1382	1433
7	1777	1279	1372	1404	1722	818	1129	1242	707
8	1448	889	683	576	647	896	574	774	661
9	604	598	471	351	231	346	473	388	463
10+	311	481	351	303	157	178	266	511	628
TOTAL	122230	93294	95983	84405	101208	95599	80473	88088	84521
Spawn.st. (≥ 2)	68179	48828	48807	58695	37510	26910	44412	41517	30240

	1979	1980	1981	1982
0	9233	2595	0**********	
1	20811	8354	1987	0
2	14946	18348	7243	1502
3	7225	8920	11263	4306
4	3509	5771	6560	7550
5	3568	2293	4683	4397
6	2513	2386	1751	3139
7	724	1950	1960	1174
8	328	381	1646	1318
9	316	149	299	1103
10+	410	181	73	249
TOTAL	63583	51530	37472	
Spawn.st. (≥ 2)	33540	40380	35484	

Table 6.1 Estimated catches in weight in Divisions VIa (south) and VIIb,c, 1970-1981

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981[x)]
Belgium	-	-	-	-	-	-	12	-	-	-	-	-
France	733	42	312	-	145	68	47	-	-	-	-	11
German Dem.Rep.	. 155	300	841	2 256	1 833	1 394	890	-	-	-	-	-
Germany, Fed.Rep.	5 012	1 338	849	7 785	5 667	4 431	924	221	100	5	-	2 729
Ireland	10 806	11 515	17 248	16 912	16 395	12 465	10 895	15 916	19 128	18 910	27 499	19 443
Netherlands	816	1 406	915	5 228	2 225	15 208	16 546	4 423	481	1 939	1 514	3 952
Poland	2 782	1 345	2 475	3 623	6 034	2 558	2 778	6	-	-	-	-
U.K. (N.Ireland)	-	-	-	-	28	6	1	1	6	2	1	. 2
USSR	2	-	834	915	4 262	2 634	674	-	-	-	-	-
Unspecified	-	-	-	-	-	-	-	-	-	1 752	1 110	-
Total	20 306	15 044	23 474	36 719	36 589	38 764	32 767	20 567	19 715	22 608	30 124	26 135

x) Provisional data

Table 6.2. HERRING in Divisions VIa (South) and VIIb,c.
VPA, catch in numbers ('000).

	1970	1971	1972	1973	1974	1975	1976	1977	1978
0	0	0	0	46	0	194	823	0	82
1	135	883	1001	6423	3374	7360	16613	4485	10170
2	35114	6177	28786	40390	29406	41308	29011	44512	40320
3	26007	7038	20534	47389	41116	25117	37512	13396	27079
4	13243	10856	6191	16863	44579	29192	26544	17176	13308
5	3895	8826	11145	7432	17857	23718	25317	12209	10685
6	40181	3938	10057	12383	8882	10703	15000	9924	5356
7	2982	40553	4243	9191	10901	5909	5208	5534	4270
8	1667	2286	47182	1969	10272	9378	3596	1360	5638
9+	1911	2160	4305	50980	30549	32029	15703	4150	3324
TOTAL	125135	82717	133444	193066	196936	184908	175327	112746	118232

	1979	1980	1981
0	4	0	0
1	5919	2856	1739
2	50071	40058	21598
3	19161	16943	47345
4	19969	25140	37860
5	9349	22126	17206
6	8422	7748	11991
7	5443	6946	6685
8	4423	4344	3625
9+	4090	5334	5896
TOTAL	126851	131495	153945

Table 6.3. HERRING in Divisions VIa (South) and VIIb,c.
VPA, fishing mortalities
M = 0.1

	1970	1971	1972	1973	1974	1975	1976	1977	1978
0	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.000	0.000
1	0.001	0.003	0.004	0.040	0.018	0.053	0.076	0.023	0.039
2	0.415	0.059	0.135	0.205	0.230	0.288	0.270	0.266	0.266
3	0.206	0.121	0.250	0.303	0.295	0.280	0.408	0.173	0.229
4	0.139	0.112	0.134	0.298	0.459	0.313	0.473	0.294	0.232
5	0.153	0.116	0.144	0.211	0.520	0.419	0.435	0.368	0.268
6	0.088	0.204	0.169	0.211	0.370	0.600	0.452	0.269	0.243
7	0.152	0.109	0.314	0.205	0.259	0.399	0.583	0.266	0.159
8	0.150	0.150	0.160	0.210	0.330	0.330	0.400	0.260	0.250
9+	0.150	0.150	0.160	0.210	0.330	0.330	0.400	0.260	0.250
F(2- 7),W	0.156	0.107	0.165	0.244	0.333	0.330	0.393	0.262	0.243

	1979	1980	1981
0	0.000	0.000	0.000
1	0.024	0.034	0.030
2	0.247	0.200	0.340
3	0.174	0.111	0.340
4	0.236	0.323	0.340
5	0.226	0.393	0.340
6	0.312	0.264	0.340
7	0.369	0.405	0.340
8	0.220	0.500	0.340
9+	0.220	0.500	0.340
F(2- 7),W	0.235	0.227	0.340

Table 6.4. HERRING in Divisions VIa (South) and VIIb,c.
VPA, stock size in numbers at 1 January, spawning stock biomass at spawning time.

	1970	1971	1972	1973	1974	1975	1976	1977	1978
0	294238	280711	190640	215287	165404	263716	227288	305289	290631
1	126265	266237	253998	172498	194756	149663	238436	204877	276237
2	108301	114121	240062	228875	149978	173015	128426	199959	181116
3	146400	64721	97391	189876	168756	107799	117366	88682	138699
4	107179	107781	51877	68639	126861	113697	73714	70649	67524
5	28805	84402	87212	41060	46113	72561	75193	41559	47634
6	498273	22365	67986	68328	30098	24818	43182	44051	26030
7	22165	412678	16498	51967	50072	18814	12330	24863	30444
8	12560	17224	334882	10904	38298	34965	11424	6229	17247
9+	14399	16275	30555	282331	113898	119416	49886	19007	15758
TOTAL	1358585	1586517	1371102	1529767	1084233	1078465	977245	1005164	1091321
Spawning stock biomass at spawning time	148 281	139 501	141 727	134 939	94 608	86 020	61 555	61 521	66 803

	1979	1980	1981	1982
0	99225	68317	0**********	
1	262896	89779	61816	0
2	240283	232251	78520	54280
3	125627	169905	172124	50570
4	99801	95479	137641	110854
5	48469	71354	62553	88646
6	32964	34984	43594	40286
7	18471	21840	24304	28076
8	23493	11553	13179	15652
9+	21724	14187	21435	22293
TOTAL	972951	809648	615166	
Spawning stock biomass at spawning time	77 028	81 327	70 336	

Table 6.5 Regression between larval indices and spawning
          stock biomass in Division VIa (south) and VIIb,c.

	Spawning biomass	Larval index
1972	141 727	17.00
1973	134 909	716.60
1974	94 608	767.30
1975	86 020	386.35
1976	61 555	56.30
1977	61 521	162.10
1978	66 803	338.84
1979	77 028	349.78
1980	81 327	327.46
1981	70 336	197.45

73-81 $y = 46.219 + 0.096x$

$r = .841$

estim. from
    regres. 1973 - 1981

79.1 ± 10.5

77.8 ± 10.6

65.2 ± 13.1

Table 6.6 Parameters in predicting yield and spawning
stock biomass in Divisions VIa (south) and VIIb,c
in 1982 and 1983.

Age	Stock at 1.1.1982	Proportional F	Mean weight in catch and stock
2	54 280	1.0	129
3	50 570	1.0	165
4	110 854	1.0	191
5	88 646	1.0	209
6	40 286	1.0	222
7	28 076	1.0	231
8	15 652	1.0	237
9+	22 293	1.0	241

Recruitment in 1983 = 54 280

Table 7.1   HERRING.   Total catches (tonnes) in North Irish Sea (Division VIIa), 1971-1981 (includes industrial catch)

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

*) preliminary   [1] includes 68.5 tonnes of spring-spawned herring   [2] no data basis for allocation to stock

[3] additional unrecorded catch of 106 tonnes estimated

Table 7.2 HERRING. Total catch by stock in North Irish Sea, 1971-81.

Country	1971		1972		1973		1974		1975		1976		1977		1978		1979		1980		1981*	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
France	1 815	-	1 224	-	254	-	3 194	-	813	-	651	-	85	-	87	87	-	-	1		-	
Ireland	-	3 131	-	2 529	-	3 614	1 783	4 111	2 406	2 384	1 816	1 389	2 009	1 322	610	1 761	748	1 054	762	578	100	183
Netherlands	-	-	260	-	143	-	1 116	-	630	-	989	-	500	-	98	-	-	-	-	-	-	-
U.K.	18 758	3 103	19 308	4 029	13 071	5 516	23 639	3 850	15 408	2 836	12 831	3 570	9 837	1 661	7 663	700	9 382	696	7 897	1 375	2 837	1 257
Total Manx	20 573		20 792		13 325		30 677		19 283		16 287		12 431		8 458		10 130		8 660		2 937	
Total Mourne	6 234		6 558		9 273		7 961		5 220		4 959		2 983		2 548		1 753		1 953		1 440	

Notes 1 - Manx stock, 2 - Mourne stock *) Preliminary

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

Year	Rings								Total 2 to 8+	Mean age excl. 1-ring
	1	2	3	4	5	6	7	8 and 8+		
1971	4.98	54.36	21.91	18.68	9.67	3.41	1.74	1.16	110.93	3.060
1972	3.64	41.76	26.o5	11.28	13.15	6.46	1.96	1.27	101.93	2.327
1973	1.75	18.74	22.74	10.69	5.52	4.07	2.09	1.40	65.28	3.468
1974	12.95	95.95	32.55	19.41	9.65	4.09	4.55	1.03	167.23	2.871
1975	5.63	38.94	36.61	9.44	6.17	4.11	1.89	1.34	98.50	3.005
1976	9.34	47.46	17.38	13.62	3.88	2.41	2.32	1.07	88.14	2.952
1977	13.98	33.04	20.29	5.85	3.92	1.16	0.81	1.02	66.09	2.856
1978	3.64	32.41	11.41	6.18	1.44	1.24	0.57	0.35	53.60	2.709
1979	3.66	35.37	21.29	3.55	1.90	0.85	0.30	0.19	67.11	2.632
1980	0.66	22.82	17.41	7.27	1.54	0.63	0.21	0.12	50.00	2.817
1981	2.02	11.67	2.34	2.05	1.70	0.24	0.22	0.13	18.35	2.783

Table 7.4. Manx HERRING.
VPA, fishing mortalities

M = 0.1

	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	0.04	0.04	0.01	0.16	0.06	0.15	0.16	0.05	0.10
2	0.59	0.51	0.29	0.91	0.83	0.86	0.96	0.58	0.80
3	0.55	0.56	0.51	1.02	0.97	1.02	1.03	0.96	0.84
4	0.49	0.55	0.42	0.99	0.83	1.12	1.06	0.93	0.81
5	0.51	0.67	0.50	0.72	0.90	0.90	1.07	0.73	0.74
6	0.53	0.67	0.40	0.76	0.69	0.99	0.66	1.12	1.20
7	0.58	0.58	0.42	0.93	0.87	0.95	1.00	0.70	0.80
8+	0.58	0.58	0.42	0.93	0.87	0.95	1.00	0.70	0.80
F(2- 7),W	0.56	0.56	0.40	0.92	0.88	0.93	0.99	0.69	0.82

		Input F
	1980	1981
1	0.02	0.06
2	1.19	0.40
3	1.09	0.30
4	0.69	0.30
5	0.92	0.30
6	0.51	0.30
7	1.00	0.30
8+	1.00	0.30
F(2- 7),W	1.04	0.36

Table 7.5. Manx HERRING.
VPA, stock size in numbers at 1 January, spawning stock biomass at spawning time

	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	126.08	90.46	187.46	93.19	100.84	71.40	99.78	77.97	41.65
2	127.15	109.35	78.39	167.96	72.02	85.89	55.74	77.01	67.09
3	53.84	63.61	59.40	53.16	61.42	28.40	32.91	19.26	39.01
4	50.52	27.98	32.91	32.22	17.40	21.04	9.30	10.64	6.67
5	25.37	28.03	14.64	19.64	10.84	6.83	6.21	2.90	3.80
6	8.72	13.80	12.92	8.02	8.65	3.99	2.52	1.92	1.27
7	4.13	4.66	6.38	7.84	3.39	3.94	1.34	1.18	0.57
8+	2.76	3.02	4.27	1.78	2.41	1.82	1.68	0.73	0.36
TOTAL	398.57	340.91	396.38	383.80	276.98	223.31	209.47	191.62	160.41
Spawning stock biomass at spawning time	28.96	26.52	26.31	20.80	13.53	10.63	7.30	9.76	9.11

	1980	1981	1982	1971-1981
1	41.67	36.43	*********	87.90
2	34.21	37.07	31.05	82.90
3	27.30	9.46	22.49	40.71
4	15.19	8.29	6.34	21.11
5	2.68	6.88	5.56	11.62
6	1.64	0.97	4.61	5.86
7	0.35	0.89	0.65	3.15
8+	0.20	0.53	0.95	1.78
TOTAL	123.23	100.52		
Spawning stock biomass at spawning time	5.47	8.09		

Units: Numbers x 10^{-6}
Biomass tonnes x 10^{-3}

Table 7.6   MANX HERRING larvae, 1974-1981

Year	Date	No. of Larvae		No. of stations
		≤10 mm	>10 mm	
1974	3-4 Oct.	11 850	250	10
1975	2-6 Oct.	3 618	28	14
1976	4-8 Oct.	434	46	14
1977	3-4 Oct.	1 617	15	14
	20-21 Oct.	96	3	17
1978	2-3 Oct.	49	21	14
	18-19 Oct.	2 441	101	17
1979	1-2 Oct.	4	61	14
	15-16 Oct.	90	180	14
1980	29-30 Sept.	316	181	13
	15-20 Oct.	710	901	16
1981	1, 5-6 Oct.	73 290	0	16

Table 7.7. Mourne HERRING.
VPA, catch in numbers x 10^{-6}.

	1971	1972	1973	1974	1975	1976	1977	1978	1979
0	100.30	78.40	50.20	57.90	20.30	10.40	26.40	20.80	0.00
1	47.40	37.00	40.40	30.30	27.70	25.40	16.30	11.90	8.10
2	33.10	14.90	14.00	13.60	9.30	8.70	6.00	4.50	2.90
3	12.90	0.90	15.50	7.20	2.80	3.40	2.40	2.00	2.20
4	1.10	1.90	0.80	5.10	1.40	1.60	0.90	0.60	0.70
5	0.40	0.60	1.40	1.00	1.70	0.70	0.60	0.30	0.30
6	0.50	0.30	1.00	0.90	0.10	0.40	0.30	0.10	0.20
7	0.20	0.70	0.50	0.60	0.20	0.10	0.10	0.10	0.10
8	0.20	0.10	1.00	0.20	0.20	0.10	0.10	0.00	0.10
9+	0.03	0.30	0.20	0.40	0.10	0.10	0.00	0.00	0.00
TOTAL	196.13	135.10	125.00	117.20	63.80	50.90	53.10	40.30	14.60

	1980	1981
0	0.00	0.00
1	5.18	3.03
2	2.94	4.12
3	2.10	0.86
4	1.25	0.74
5	0.44	0.60
6	0.28	0.09
7	0.15	0.07
8	0.08	0.09
9+	0.03	0.02
TOTAL	12.45	9.62

Table 7.8. Mourne HERRING.
VPA, fishing mortalities

M = 0.1

	1971	1972	1973	1974	1975	1976	1977	1978	1979
0	0.87	0.76	0.67	0.80	0.41	0.27	0.71	0.74	0.00
1	0.71	0.83	1.03	1.00	1.05	1.16	0.76	0.72	0.64
2	2.23	0.45	0.79	1.10	0.87	1.03	0.86	0.43	0.33
3	1.19	0.29	1.04	1.13	0.62	0.82	0.79	0.70	0.34
4	0.29	0.47	0.40	1.11	0.60	0.77	0.46	0.41	0.49
5	0.26	0.23	0.67	1.15	1.37	0.61	0.65	0.25	0.33
6	0.16	0.28	0.65	1.11	0.27	1.44	0.50	0.19	0.23
7	0.48	0.31	0.92	0.92	0.70	0.43	2.17	0.28	0.26
8	1.64	0.42	0.86	1.10	0.82	0.82	0.89	0.00	0.43
9+	1.64	0.42	0.86	1.10	0.82	0.82	0.89	0.00	0.43
F(2- 7),W	1.63	0.42	0.87	1.11	0.81	0.92	0.77	0.45	0.34

	1980	1981	1971-1978
0	0.00	0.00	0.65
1	0.19	0.08	0.91
2	0.44	0.20	0.97
3	0.38	0.20	0.82
4	0.29	0.20	0.56
5	0.59	0.20	0.65
6	0.50	0.20	0.58
7	0.24	0.20	0.78
8	0.30	0.20	0.82
9+	0.30	0.20	0.82
F(2- 7),W	0.39	0.20	

Table 7.9. Mourne HERRING.
VPA, stock size in numbers at 1 January , spawning stock biomass at spawning time.

	1971	1972	1973	1974	1975	1976	1977	1978	1979
0	180.14	154.30	107.79	109.60	63.75	46.26	54.39	41.56	35.13
1	97.18	68.31	65.53	50.06	44.48	38.45	31.99	24.26	17.95
2	38.31	43.13	26.87	21.20	16.72	14.13	10.86	13.55	10.70
3	19.29	3.73	24.91	11.08	6.37	6.35	4.58	4.16	7.99
4	4.53	5.31	2.52	7.93	3.24	3.12	2.54	1.88	1.88
5	1.83	3.05	3.01	1.52	2.37	1.61	1.51	1.44	1.13
6	3.54	1.27	2.19	1.40	0.44	0.54	0.80	0.62	1.02
7	0.55	2.73	0.87	1.04	0.42	0.30	0.12	0.44	0.46
8	0.26	0.31	1.81	0.31	0.37	0.19	0.18	0.00	0.30
9+	0.04	0.92	0.36	0.62	0.19	0.19	0.00	0.00	0.00
TOTAL	345.68	283.06	235.86	204.78	138.35	111.14	106.76	87.90	76.57
Spawning stock biomass at spawning time	6.81	9.23	7.36	4.64	3.81	3.10	2.79	3.34	3.75

	1980	1981	1982	1971-1978
0	45.74	0.00**********		94.73
1	31.79	41.39	0.00	52.53
2	8.58	23.84	34.57	23.10
3	6.93	4.98	17.66	10.06
4	5.15	4.28	3.69	3.88
5	1.04	3.47	3.17	2.02
6	0.74	0.52	2.57	1.35
7	0.73	0.41	0.39	0.81
8	0.32	0.52	0.30	0.43
9+	0.12	0.12	0.47	0.29
TOTAL	101.14	79.53		
Spawning stock biomass at spawning time	4.32	7.17		

Figure 1. Yield per recruit curve for Downs HERRING treating (a) oldest age group not as a plus group, and (b) treating oldest age group as a plus group.
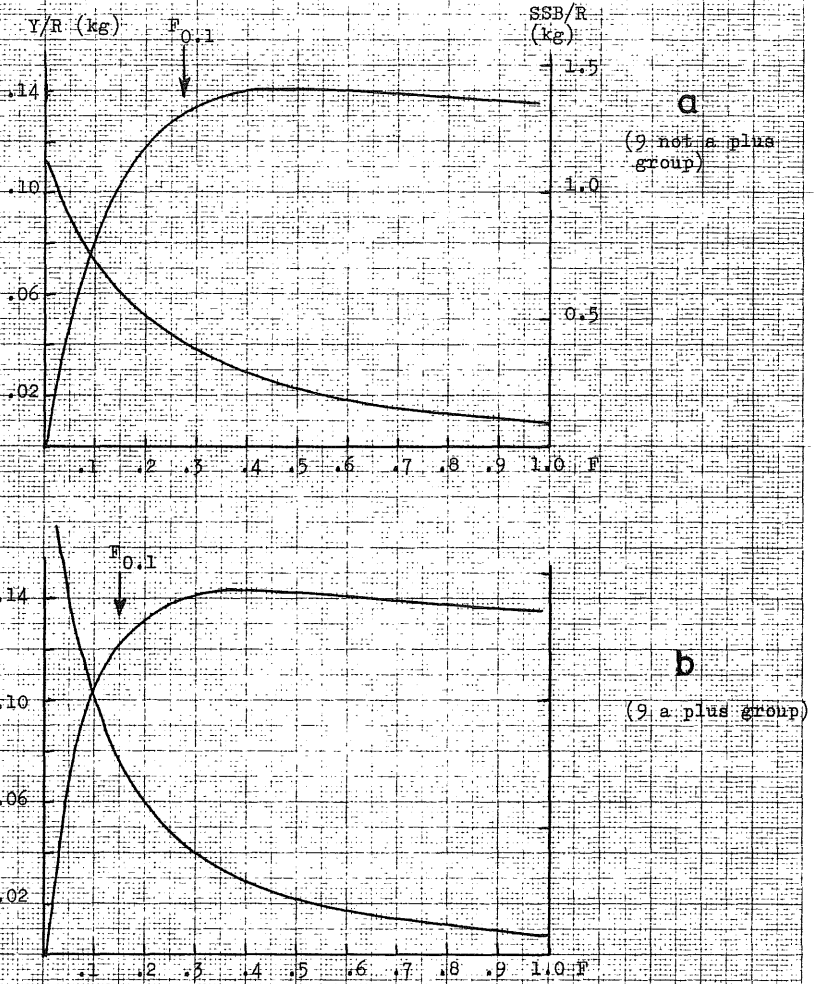
Figure 2.1. HERRING catches in Division IVb on the International Young Fish Survey index.
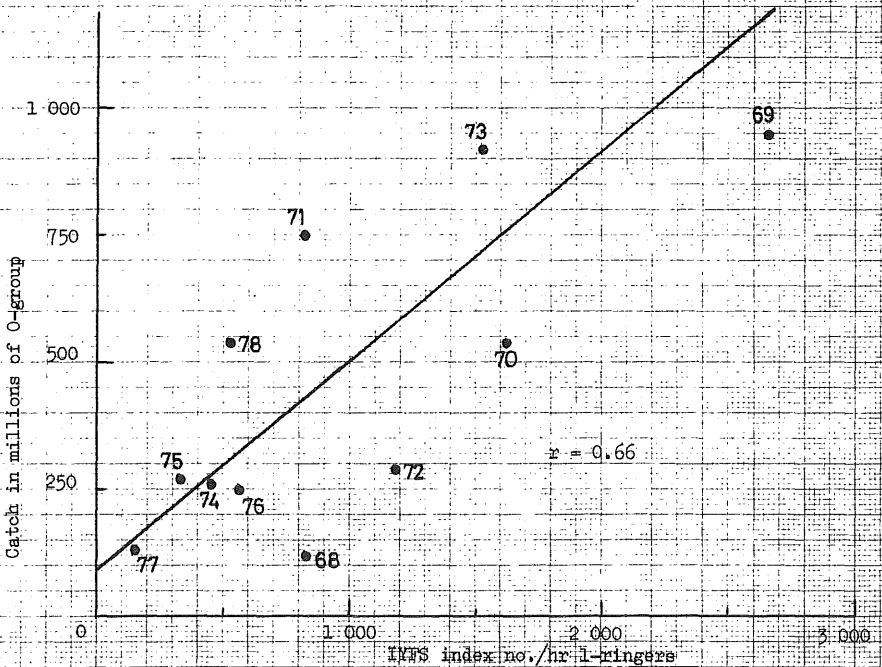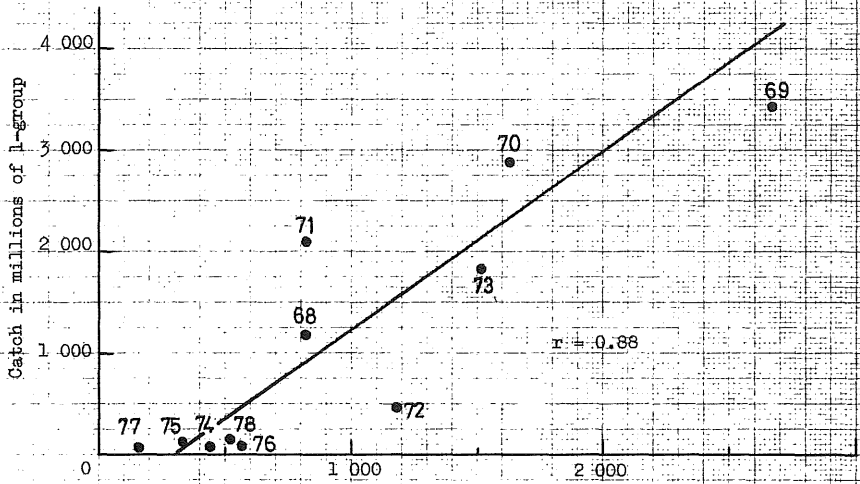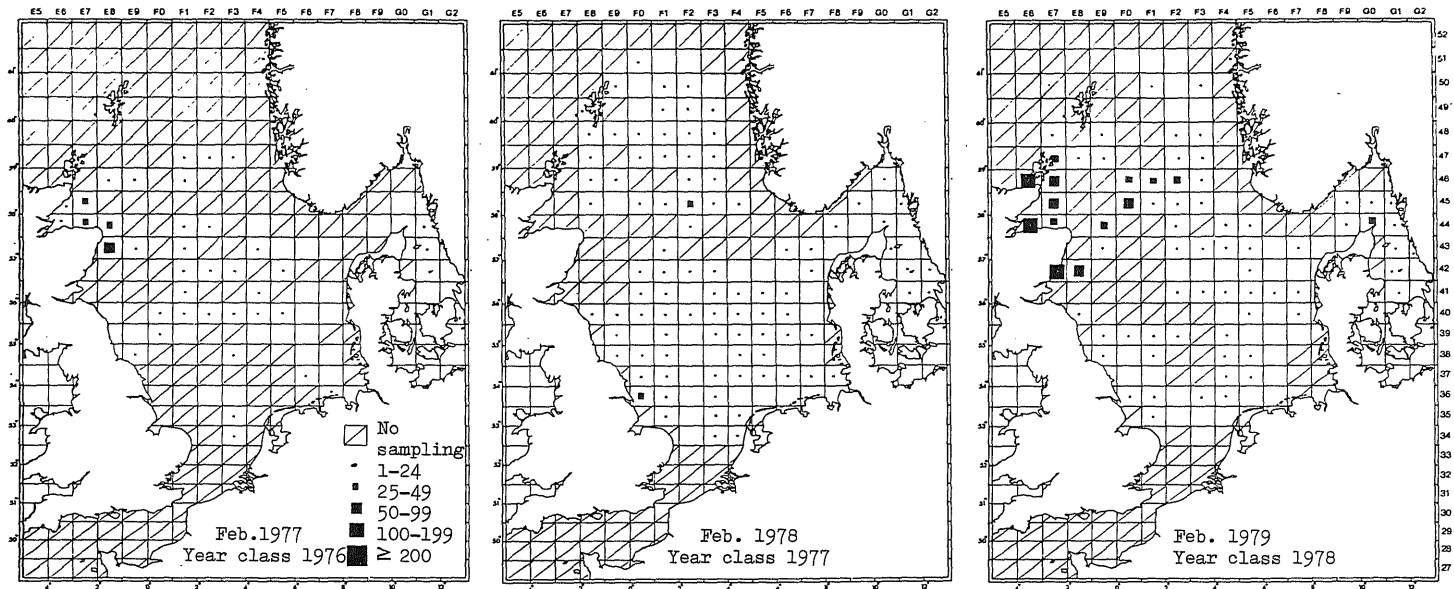
Figure 2.2. HERRING larvae sampled by IKMT during the International Young Fish Surveys 1977-82.
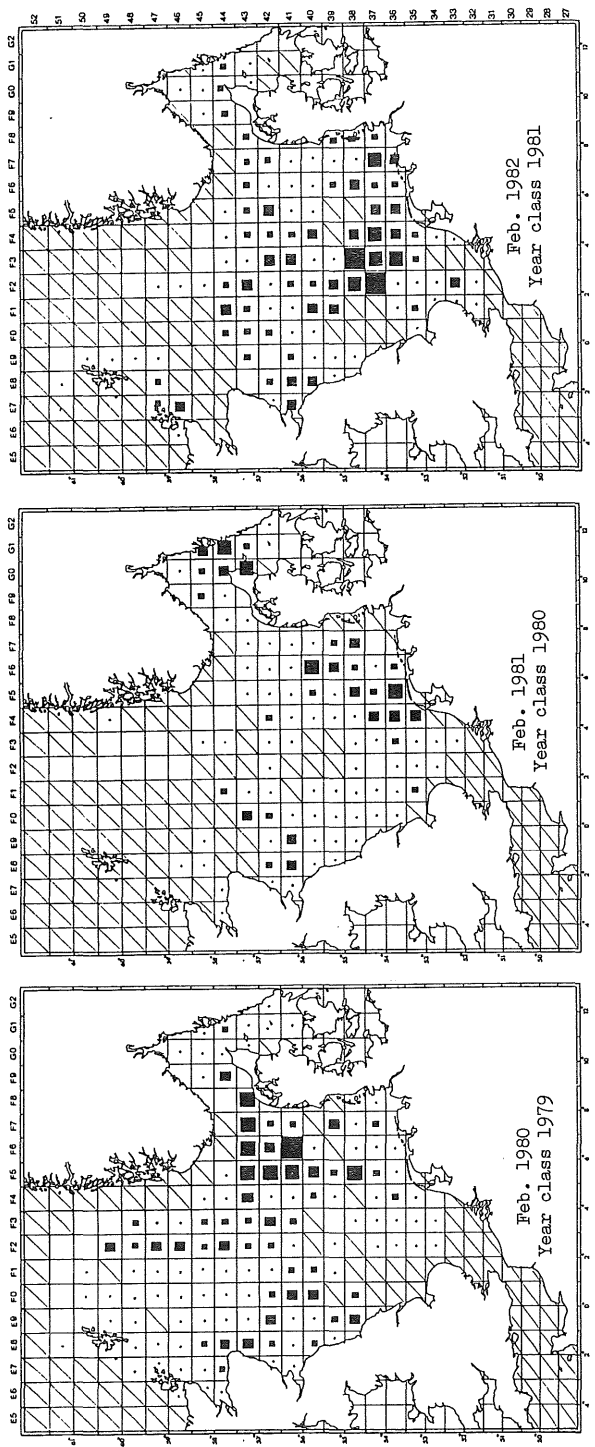
Figure 2.2. (Continued).

<u>Figure 2.3.</u> International Young Fish Survey, February 1982.
1-ringed HERRING in numbers per hour. Preliminary data.

Row	E5	E6	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8	F9	G0	G1	G2
51				0	0	0		0										
50				0	0	0	0	0	0									
49					0	0	0	0	0									
48			1	0	0	0	0	0	0									
47			1	2	3	0	0	0	0									
46		14	74	76	0	0	0	0	0							11		
45		909	1070	430	260	1	0	2	0	0						20	246	
44		2191	291	170	10	0	0	29	0	0	2			605		629	1283	
43				6	58	2	1	2	8	0	0	0	8	42		3076	4938	
42			1770	112	42	0	2	6	8	8	2	9	0			10063		1660
41			131	46	50	677	1	37	60	23	1421	46	19				4156	3507
40				114	400	4	27	175	33	3	1875	1799	11					
39				1897	1266	2278	202	464	4		260	1127	2834	105	364			
38					482	60	31	22	791	1451	2018	1404	158	728				
37				0	0	0	148	1510	2249	6089	524	206	9933					
36						11	1497	2093	663	3691	1242	2696	2870					
35						8	228	4618	36	388								
34							1	0	114	3337								
33								0	8	44	1590							
32							1	0										
31								0										

Figure 2.4   Total catch (1000t) in southern North Sea and Eastern Channel (Divisions IVc and VIId).
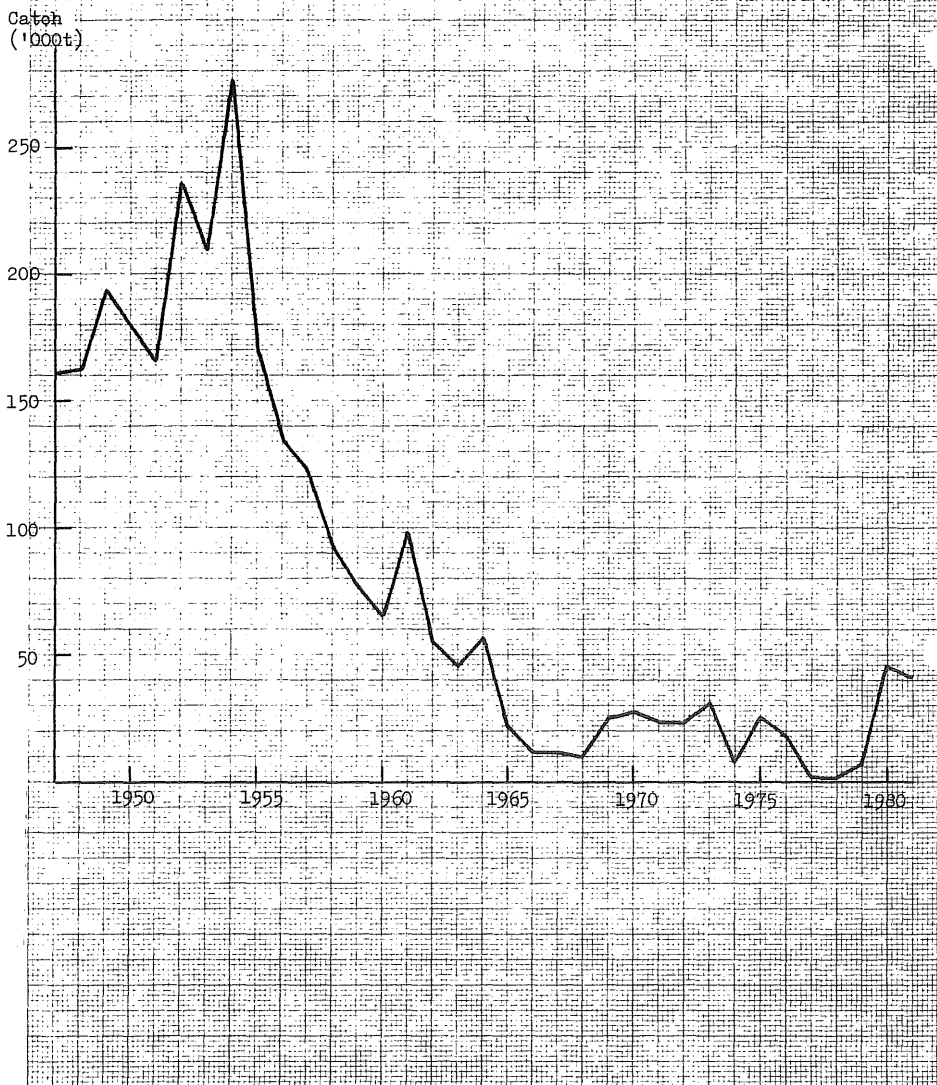
Figure 2.5. Downs HERRING. Fishing mortality, spawning stock biomass and recruitment.
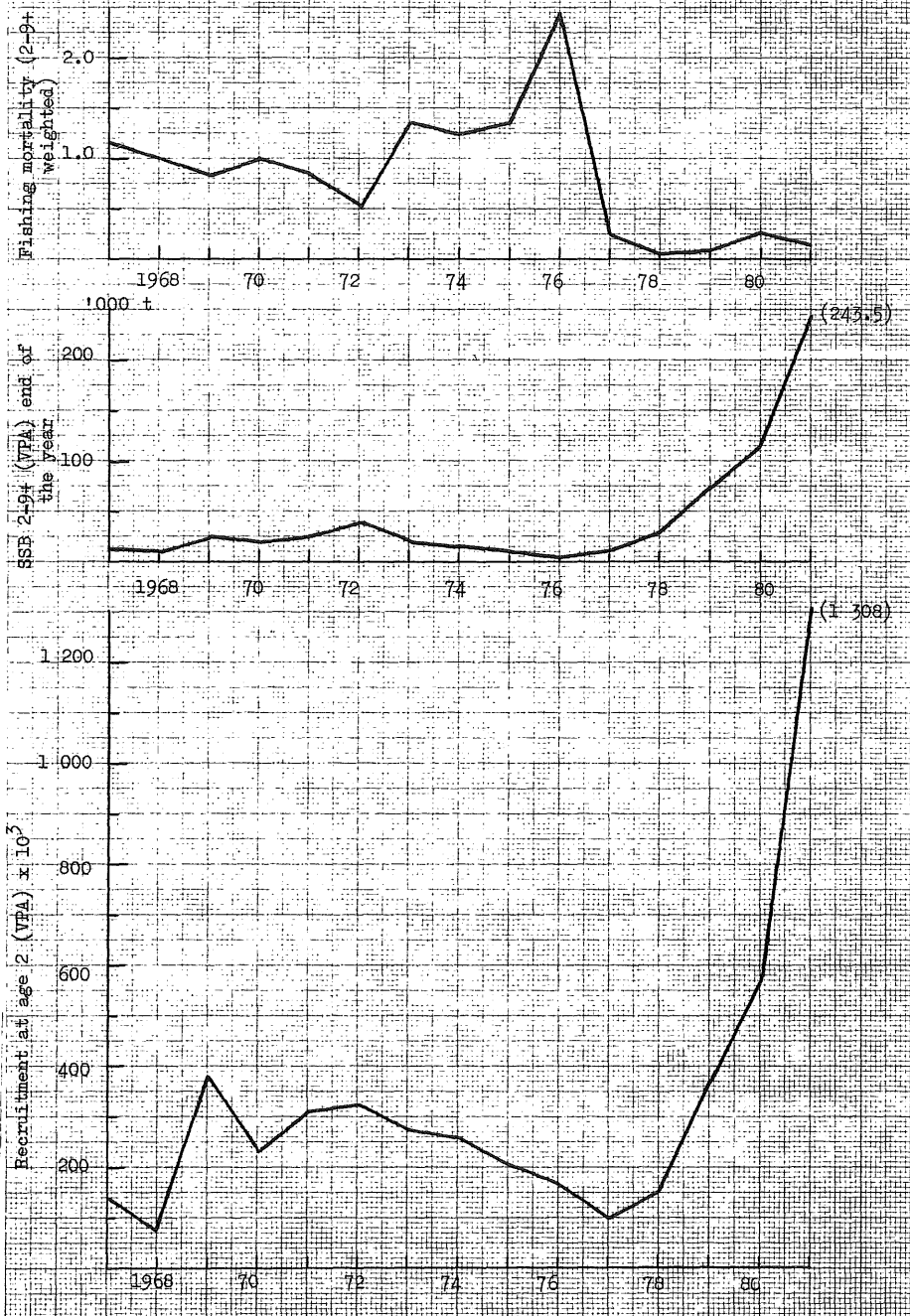
Figure 2.6. Downs HERRING. Catch and spawning stock biomass in 1982 for different levels of fishing mortalities in 1982.

List of input variables by age group:

AGE	STOCK SIZE	F-PATTERN	M	MATURITY OGIVE	WEIGHT IN THE CATCH	WEIGHT IN THE STOCK
2	680.00	1.0000	0.100	1.0000	0.1260	0.1260
3	983.91	1.0000	0.100	1.0000	0.1760	0.1760
4	348.51	1.0000	0.100	1.0000	0.2110	0.2110
5	168.56	1.0000	0.100	1.0000	0.2430	0.2430
6	60.97	1.0000	0.100	1.0000	0.2510	0.2510
7	26.11	1.0000	0.100	1.0000	0.2670	0.2670
8	4.70	1.0000	0.100	1.0000	0.2710	0.2710
9+	0.18	1.0000	0.100	1.0000	0.2710	0.2710

LIST OF INPUT VARIABLES BY AGE GROUP:

AGE	STOCK SIZE	F-PATTERN	M	MATURITY OGIVE	WEIGHT IN THE CATCH	WEIGHT IN THE STOCK
2	1300.00	1.0000	0.100	1.0000	0.1260	0.1260
3	983.91	1.0000	0.100	1.0000	0.1760	0.1760
4	348.51	1.0000	0.100	1.0000	0.2110	0.2110
5	168.56	1.0000	0.100	1.0000	0.2430	0.2430
6	60.97	1.0000	0.100	1.0000	0.2510	0.2510
7	26.11	1.0000	0.100	1.0000	0.2670	0.2670
8	4.70	1.0000	0.100	1.0000	0.2710	0.2710
9+	0.18	1.0000	0.100	1.0000	0.2710	0.2710

Figure 3.1. Length compositions from Swedish commercial samples from Division IIIa in 1981.

Skagerrak 3rd quarter
$$C_1 = 49 \times 10^6$$
$$C_0 = 97 \times 10^6$$
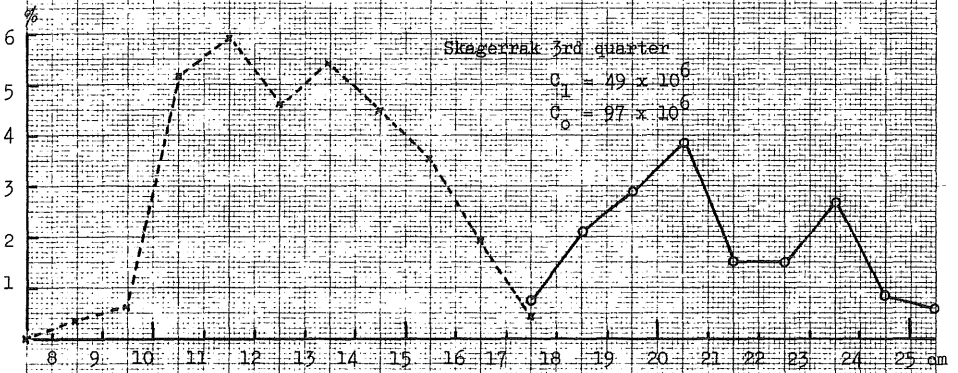
Figure 3.1. (continued)
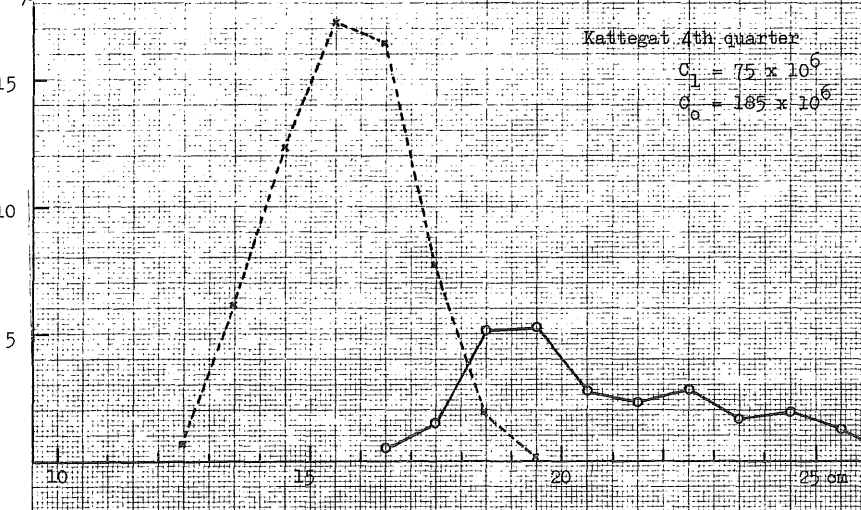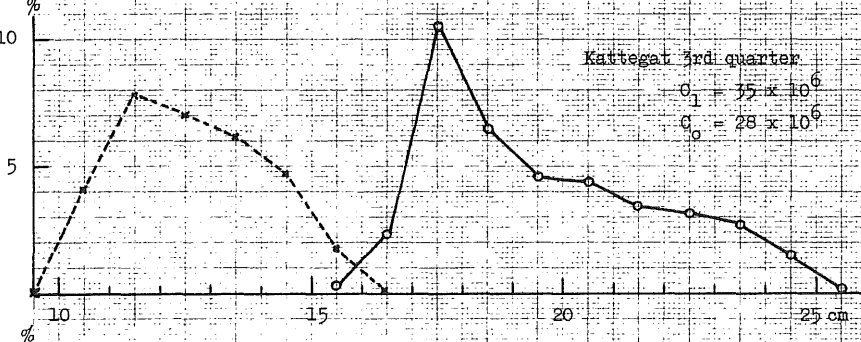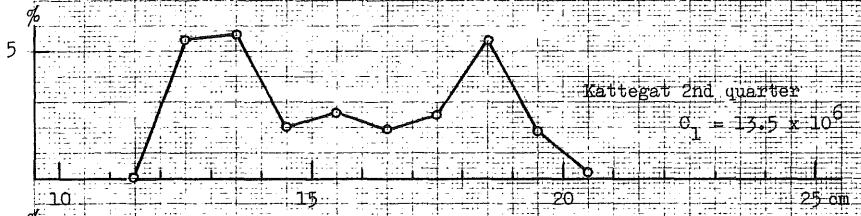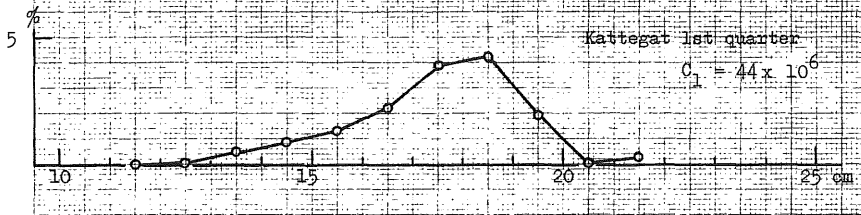
Figure 3.2: Regression of catch of 0-group HERRING on abundance indices of 1-ringers of the same year class in Division IIIa.
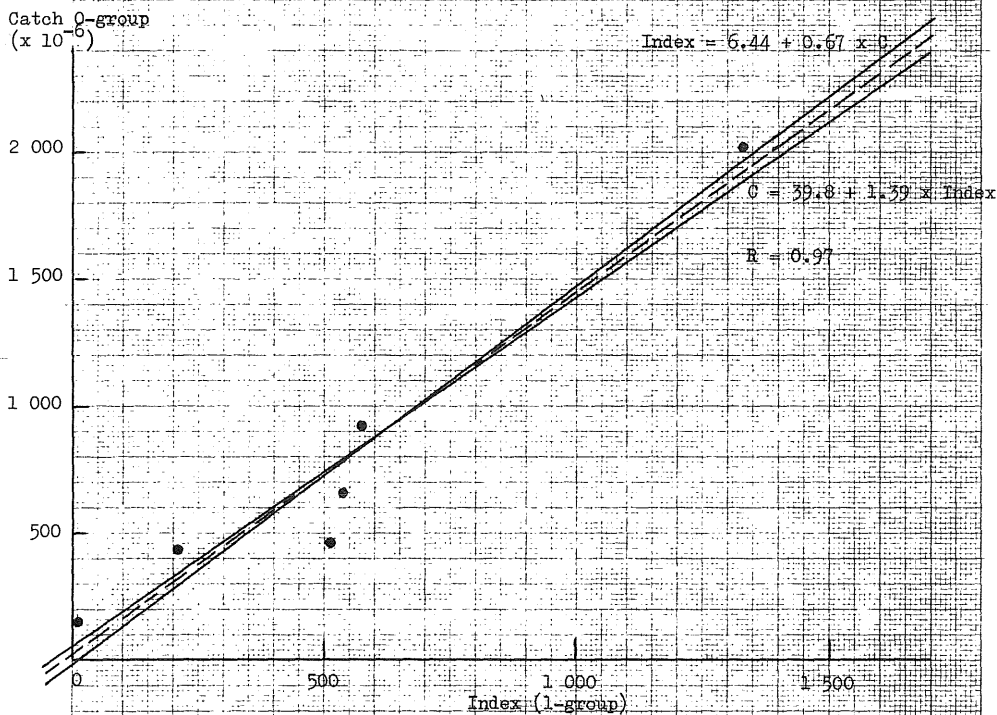
Figure 4.1. Celtic Sea HERRING.
Larval abundance indices plotted against time (cruise and date).
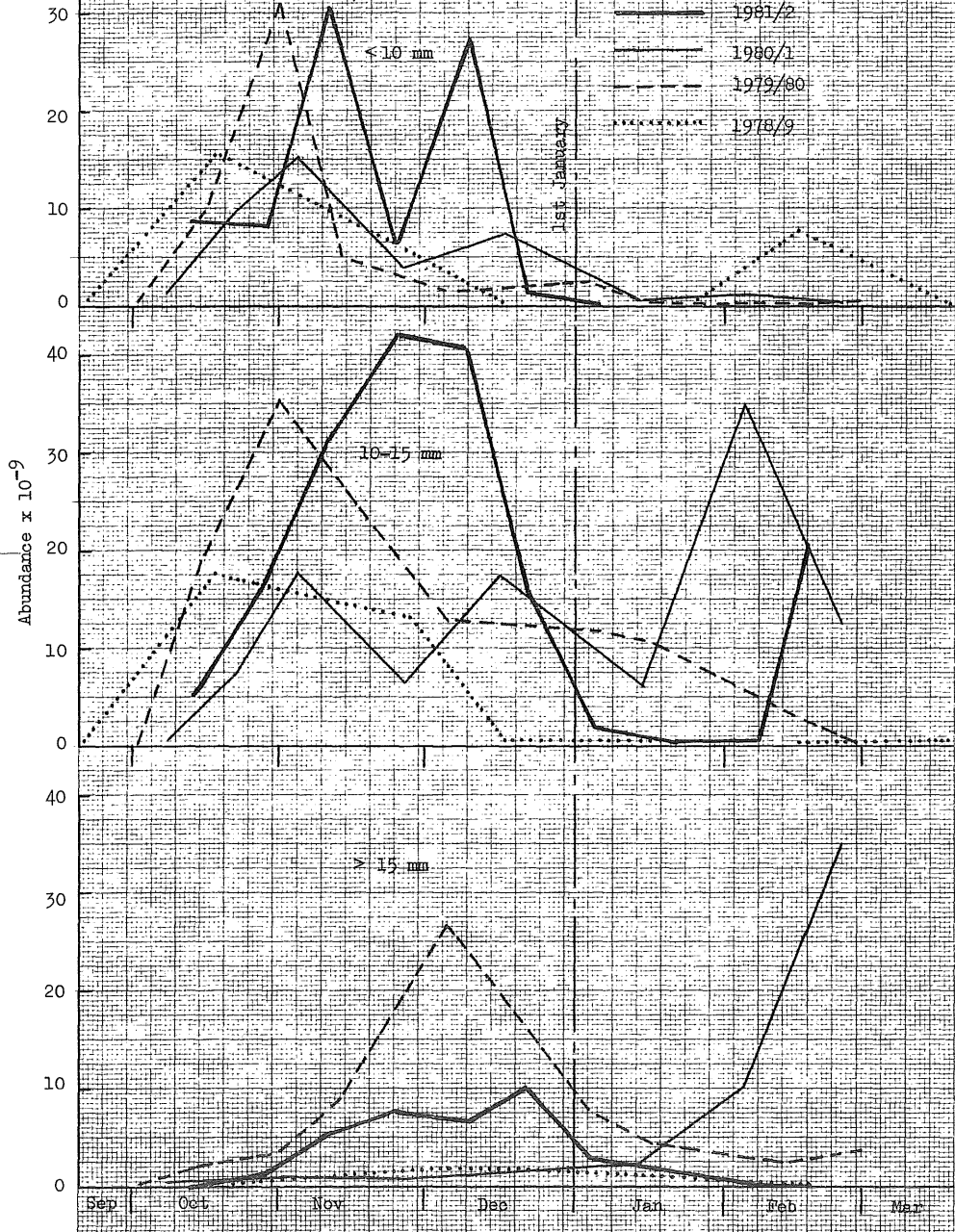
Figure 4.2: Yield per recruit and spawning stock biomass per recruit in the Celtic Sea.
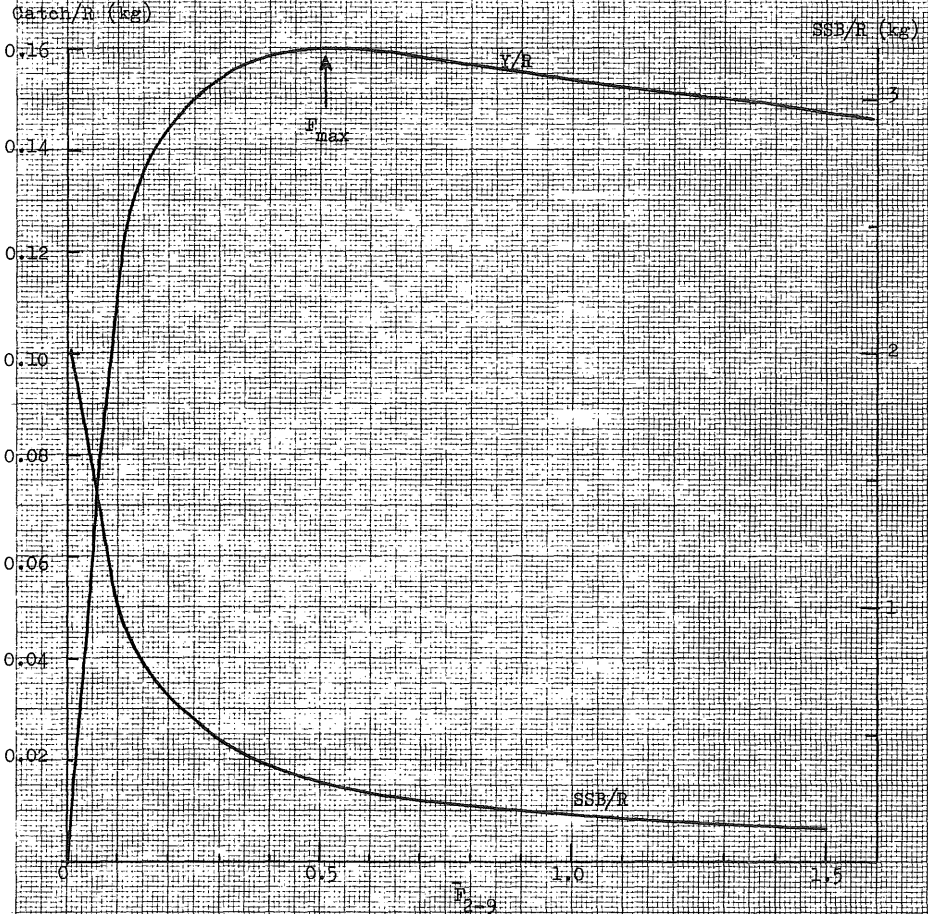
Figure 4.3 Celtic Sea spawning stock biomass at spawning time in 1983 and catch in 1982/83 in relation to F_{2-9} in 1982/83, assuming F_{1981} = 0.8 and 0.4.

Input data

AGE	STOCK SIZE	M	MATURITY OGIVE	WEIGHT IN THE CATCH	WEIGHT IN THE STOCK	F-PATTERN	F-PATTERN
1	65352.00	0.100	0.5000	0.1230	0.1180	0.2000	0.1000
2	22400.00	0.100	1.0000	0.1940	0.1620	0.8000	0.4000
3	25983.00	0.100	1.0000	0.2330	0.1930	0.8000	0.4000
4	6614.00	0.100	1.0000	0.2490	0.2100	0.8000	0.4000
5	6472.00	0.100	1.0000	0.2670	0.2200	0.8000	0.4000
6	3033.00	0.100	1.0000	0.2790	0.2280	0.8000	0.4000
7	1064.00	0.100	1.0000	0.2810	0.2320	0.8000	0.4000
8	320.00	0.100	1.0000	0.2900	0.2350	0.8000	0.4000
9+	1090.00	0.100	1.0000	0.2840	0.2380	0.8000	0.4000
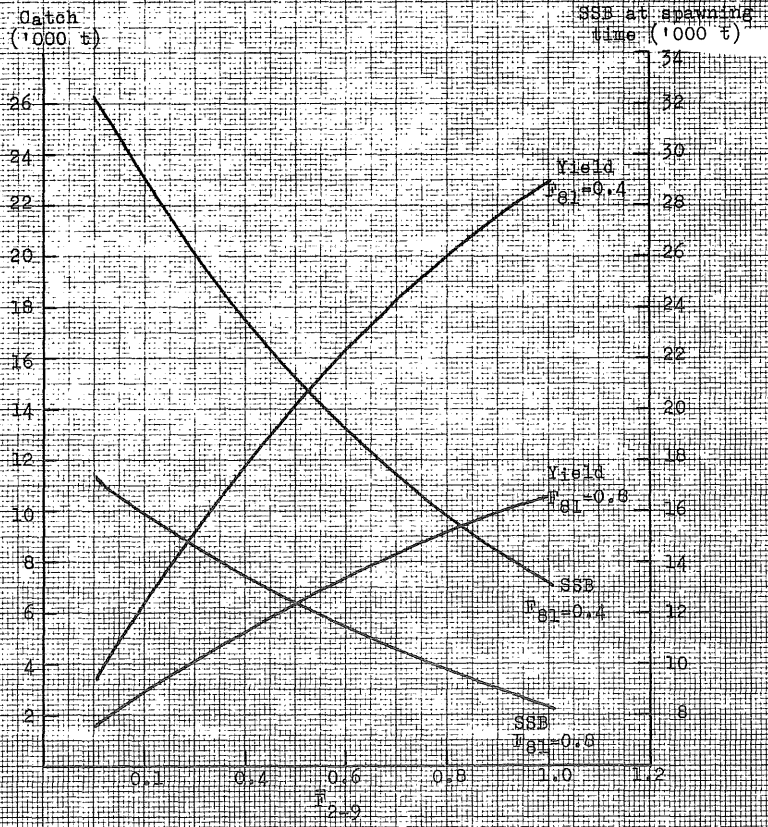
Figure 4.4. Yield per recruit and spawning stock biomass per recruit at spawning time in Division VIIj.
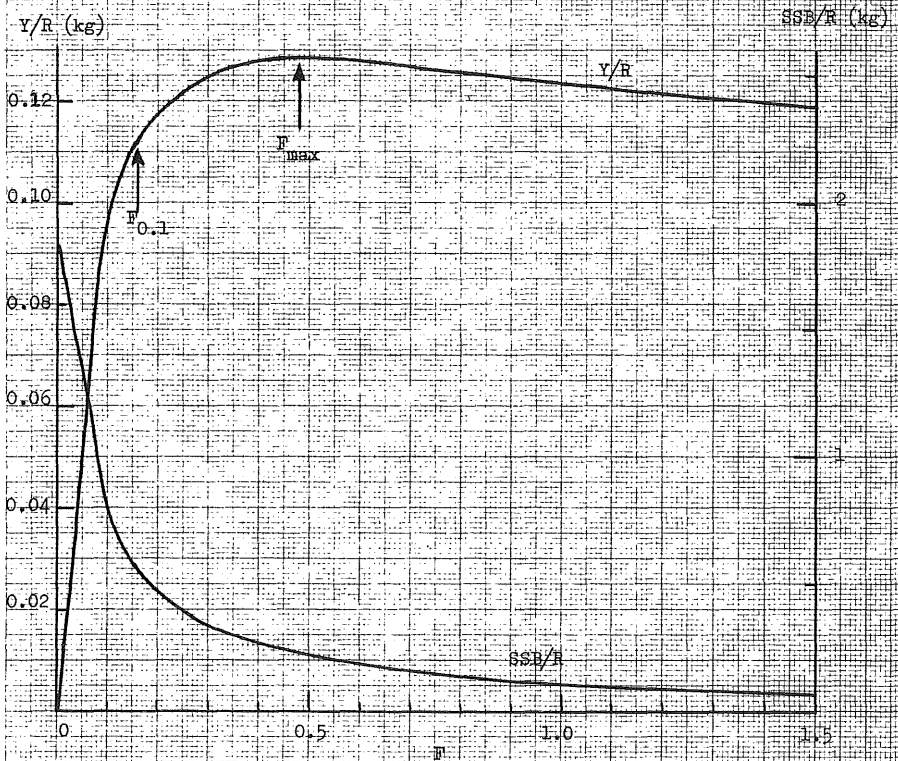
Figure 4.5. Division VII, catch in 1982 and spawning stock biomass at spawning time in 1983 in relation to F_{2-9} in 1982.
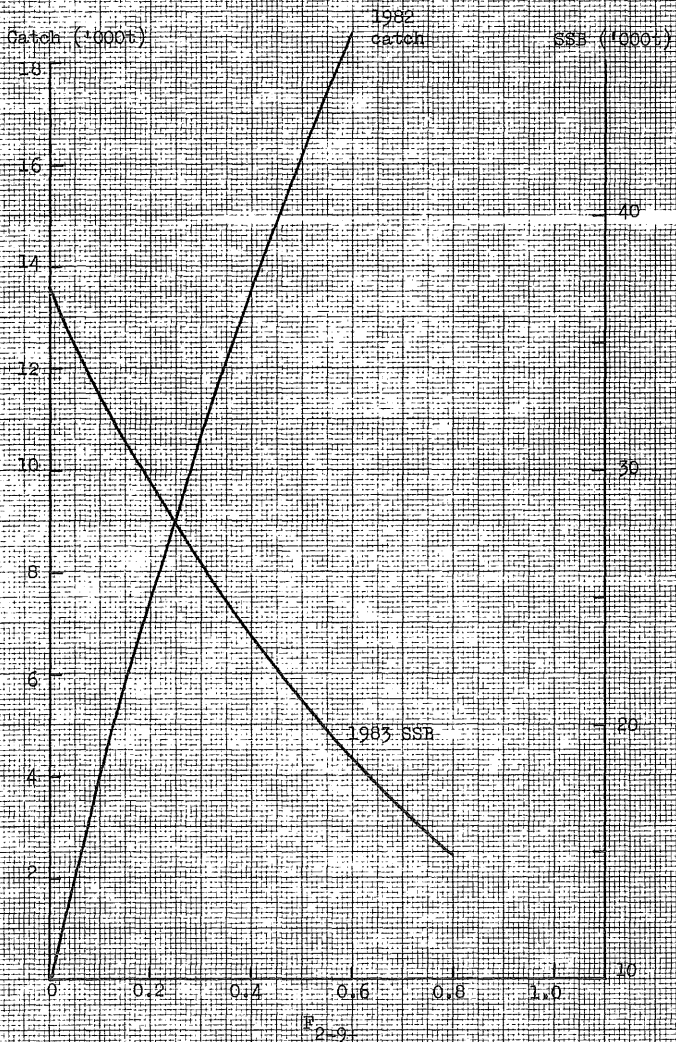
Figure 5.1. Boundaries of new HERRING unit stocks west of Scotland and Ireland.
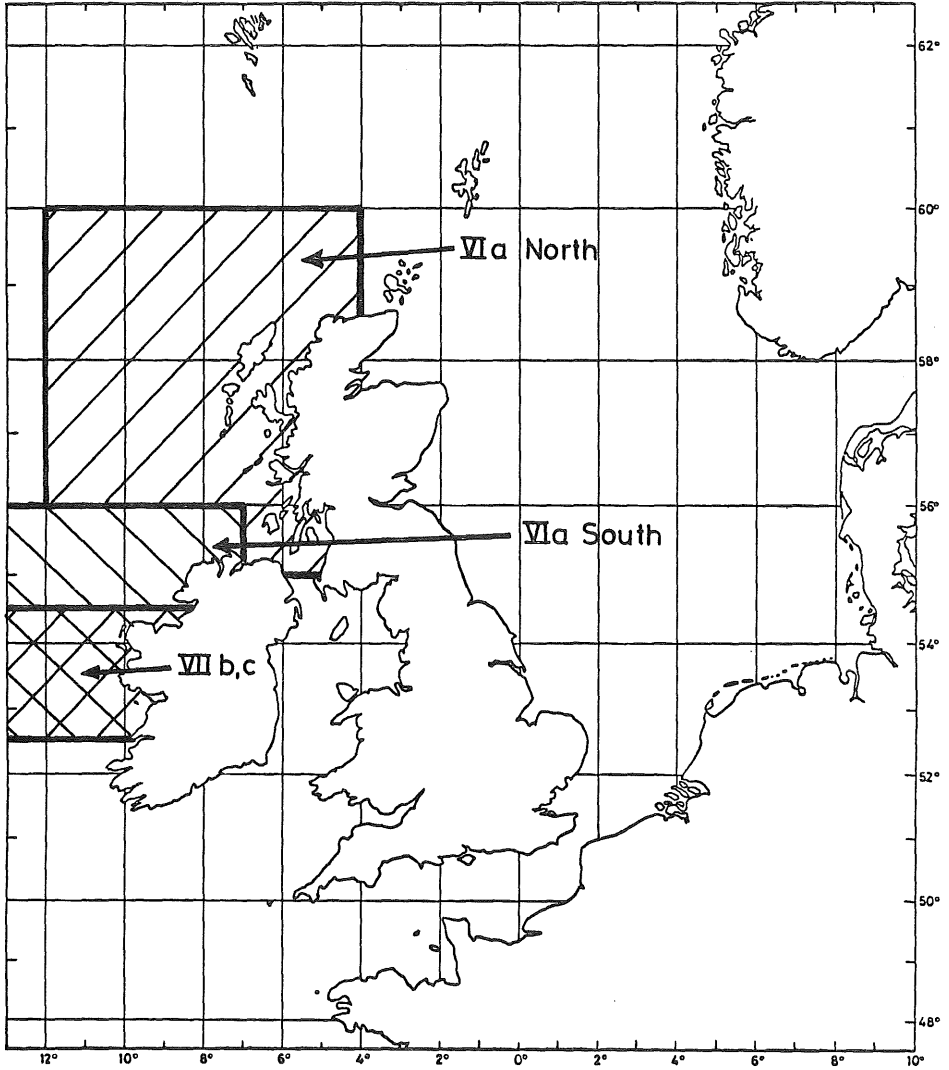
Figure 5.2: Larval abundance indices and spawning stock biomasses in Division VIa (North).
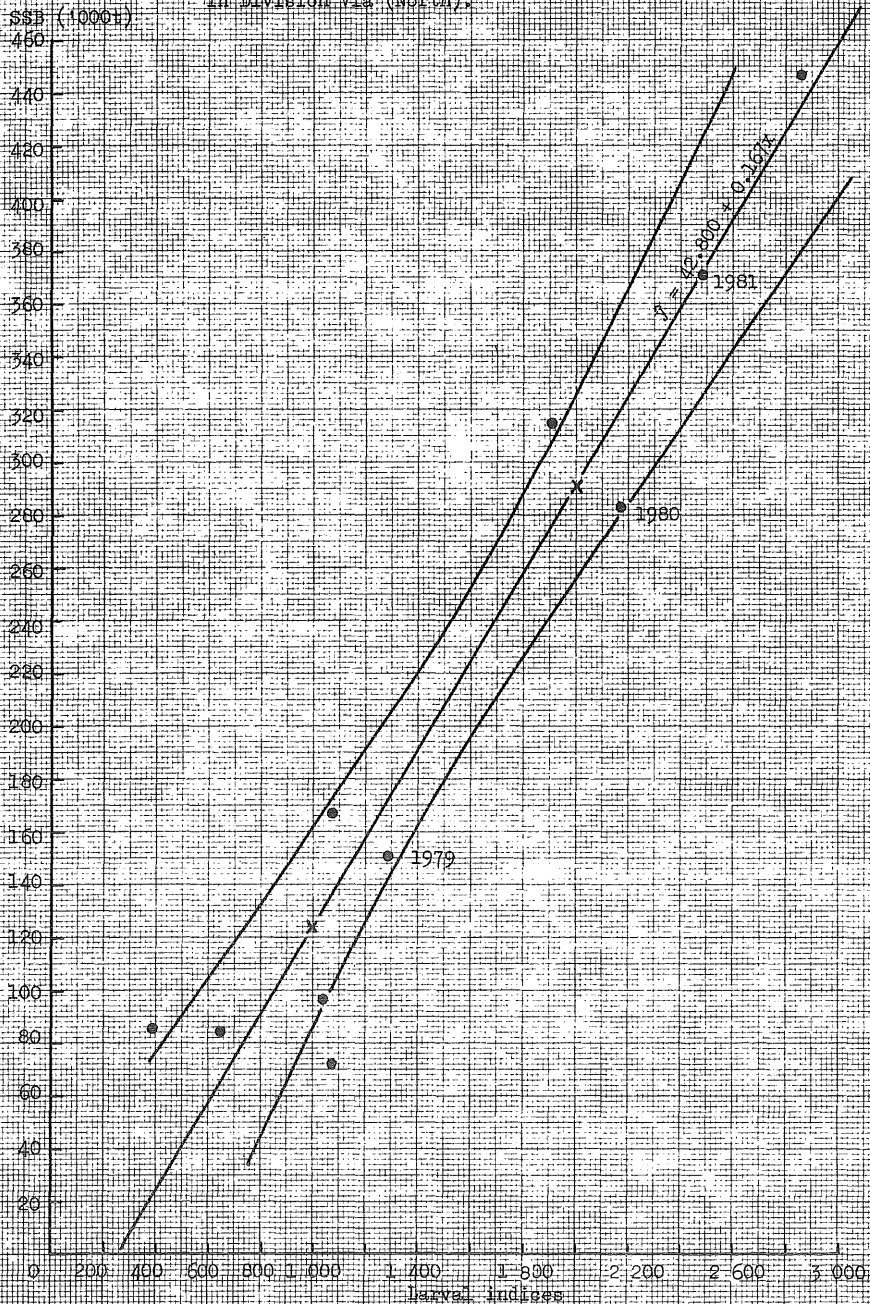
Figure 5.3. Yield and spawning stock biomass at different levels of F in 1982 and 1983 in Division VIa (north).
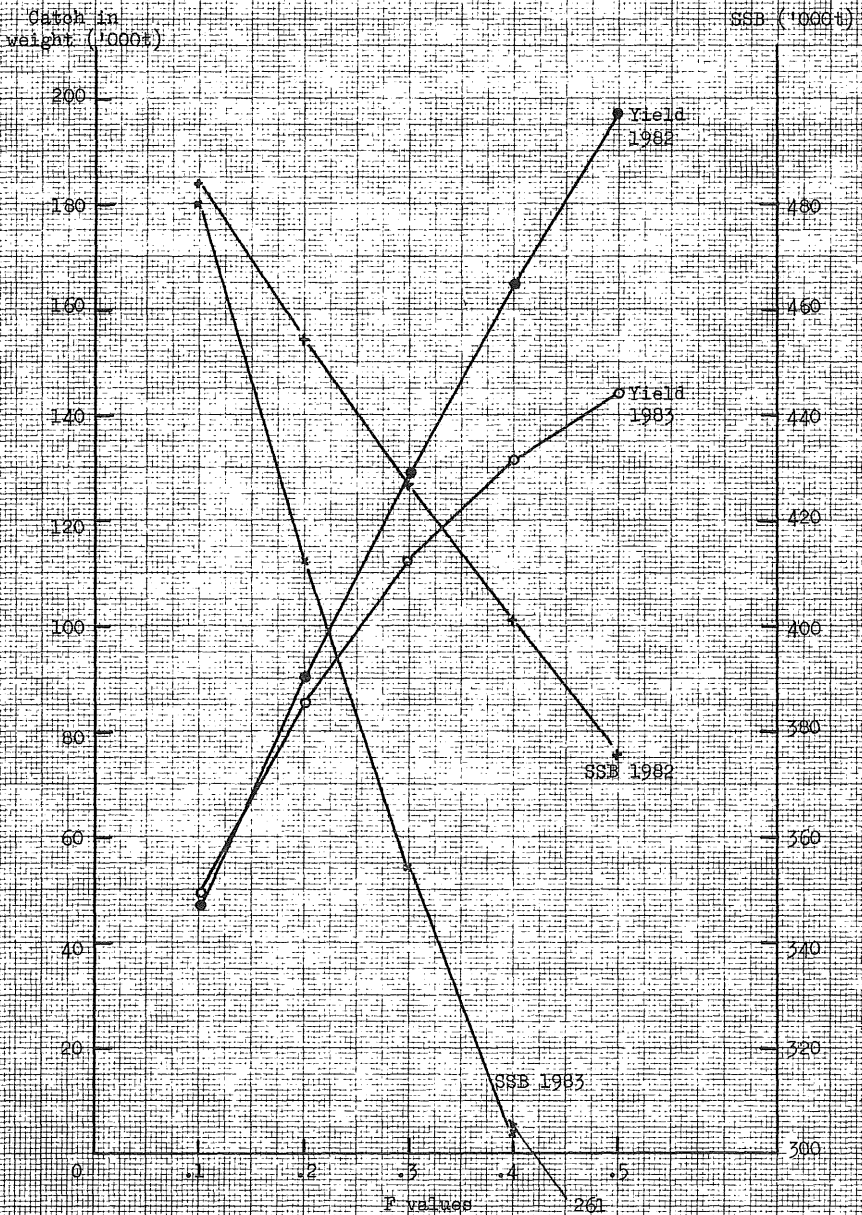
Figure 5.4. Yield per recruit and spawning stock biomass per recruit in Division VIa (North).
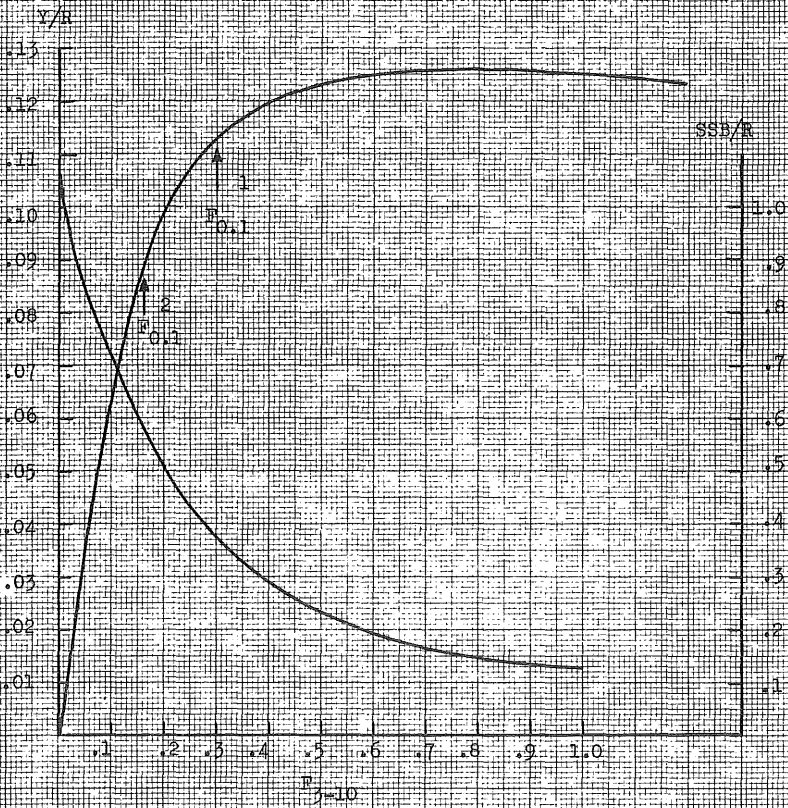
Figure 6.1. Larval abundance indices and spawning stock biomasses in Division VIa (South) and Division VIIb,c.
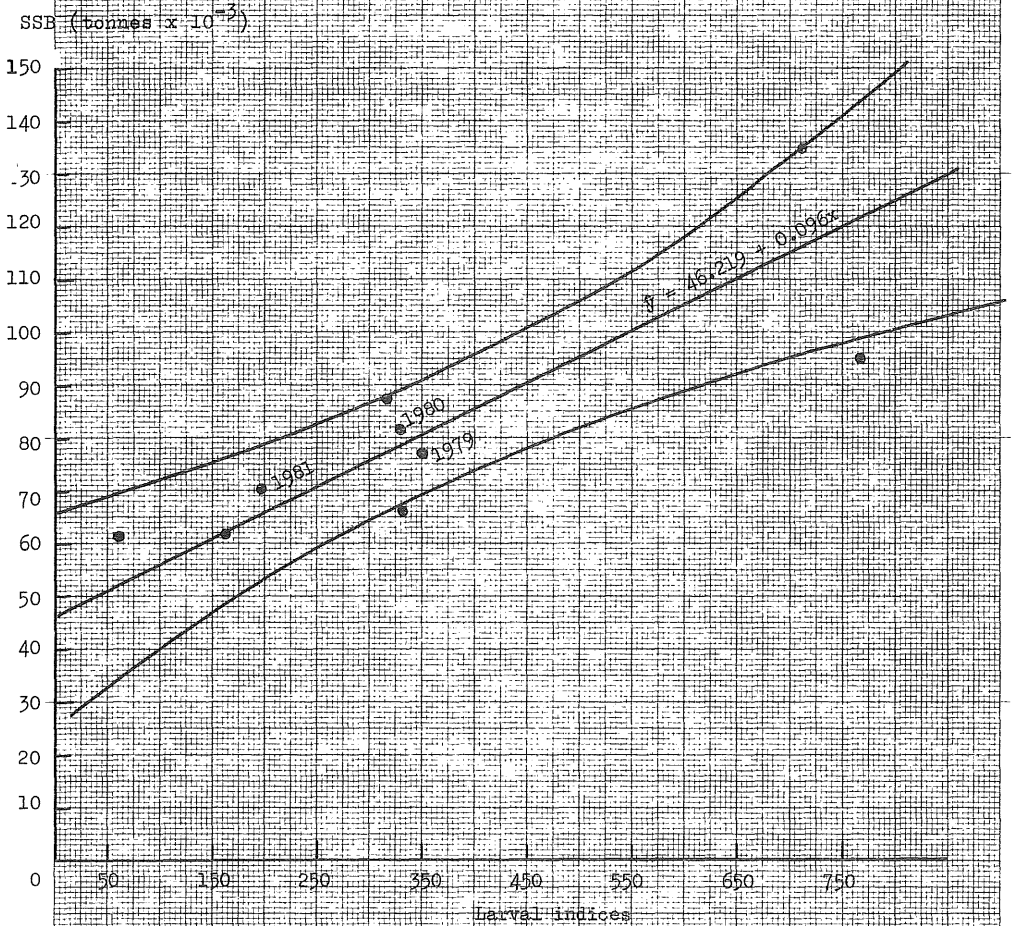
Figure 6.2 HERRING, Divisions VIa (south) and VIb,c.
           Yield per recruit and spawning stock biomass per recruit.

Input Data
Proportion of F before the spawning season: 0.7800
Proportion of M before the spawning season: 0.7500

Age	F-Pattern	M	Maturity ogive	Weight in the catch	Weight in the stock
2	1.0000	0.100	1.0000	0.1290	0.1290
3	1.0000	0.100	1.0000	0.1650	0.1650
4	1.0000	0.100	1.0000	0.1910	0.1910
5	1.0000	0.100	1.0000	0.2090	0.2090
6	1.0000	0.100	1.0000	0.2220	0.2220
7	1.0000	0.100	1.0000	0.2310	0.2310
8	1.0000	0.100	1.0000	0.2370	0.2370
9+	1.0000	0.100	1.0000	0.2410	0.2410
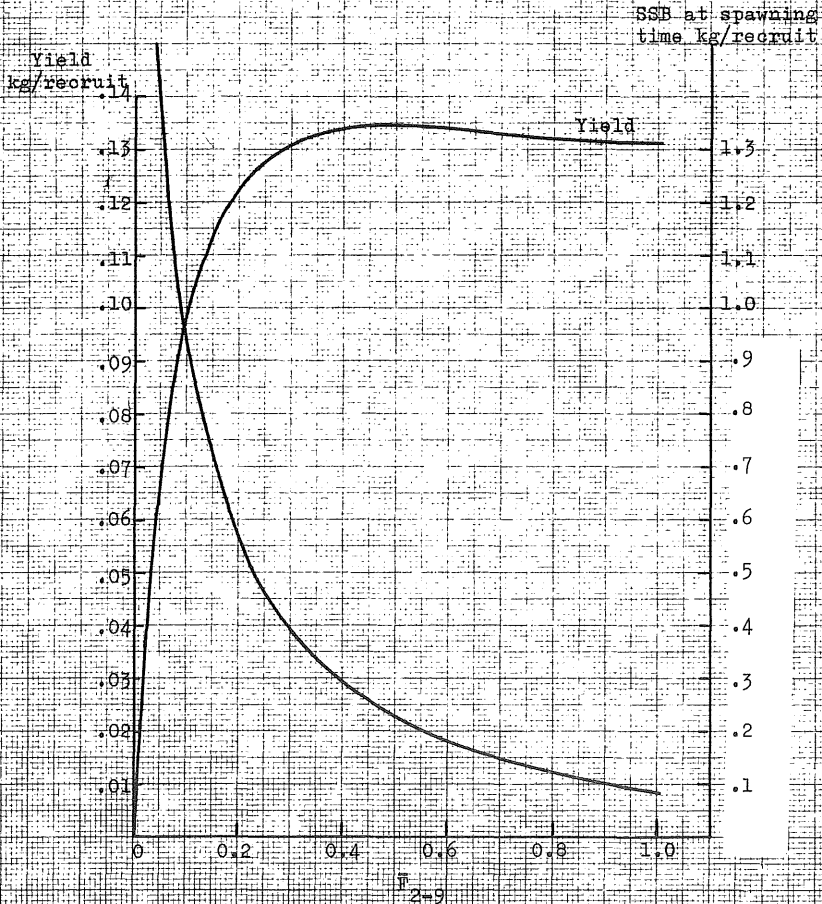
Figure 6.3 Yield and spawning stock biomass at different F levels in 1982 and 1983 in Divisions VIa (south) and VIIb,c, with higher recruitment in 1982.
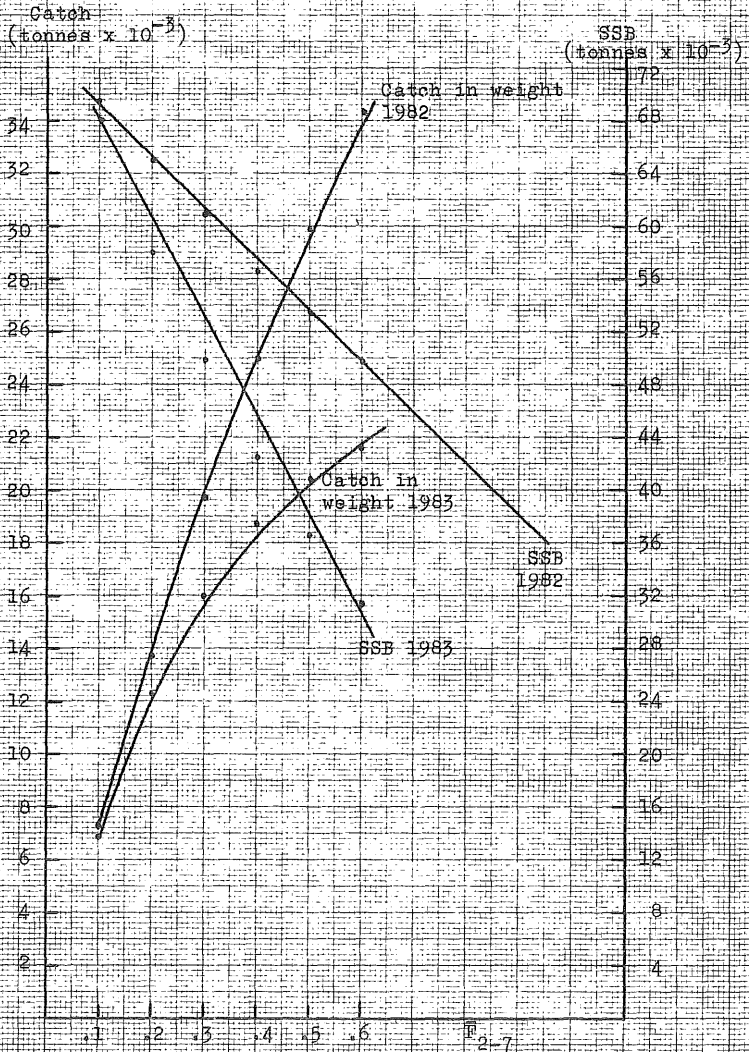
Figure 7.1 Manx HERRING. Yield per recruit. Biomass per recruit. Units: kg.
List of input variables by age group:

Age	F-pattern	Maturity ogive	Weight in the catch	Weight in stock at beginning of fishing season	Weight in stock at spawning
1	0.1600	0.0000	0.0960	0.0960	0.1170
2	1.0000	1.0000	0.1650	0.1580	0.1700
3	1.0000	1.0000	0.1890	0.1870	0.2010
4	1.0000	1.0000	0.2060	0.2080	0.2240
5	1.0000	1.0000	0.2360	0.2210	0.2420
6	1.0000	1.0000	0.2420	0.2330	0.2610
7	1.0000	1.0000	0.2730	0.2500	0.2720
8+	1.0000	1.0000	0.3070	0.2810	0.2860

Proportion of F before spawning season: 1.0000
Proportion of M before spawning season: 0.7500
M = 0.1 for all ages

Yield

Total stock biomass at 1 January

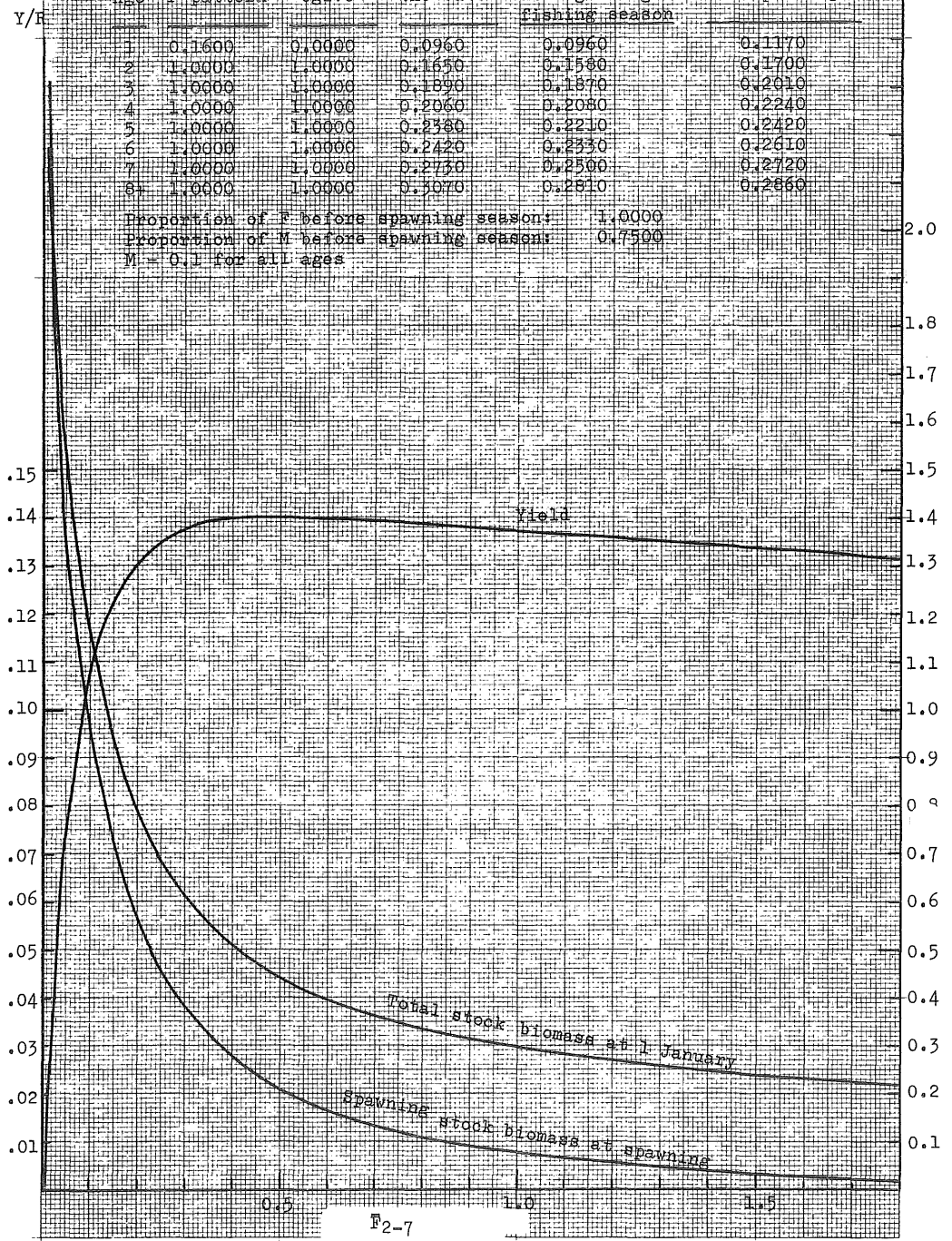Spawning stock biomass at spawning

F_{2-7}

Figure 7.2: Manx HERRING: Catch forecast for 1982 and spawning stock at spawning time.
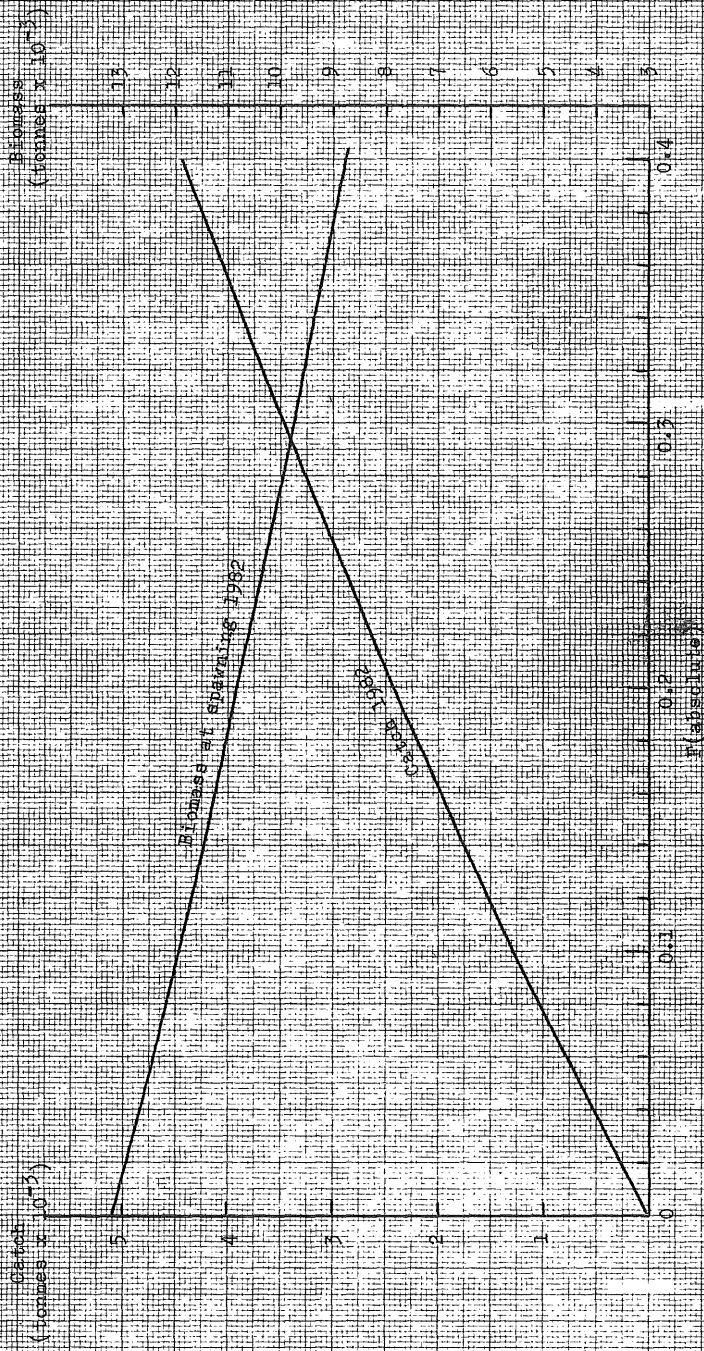
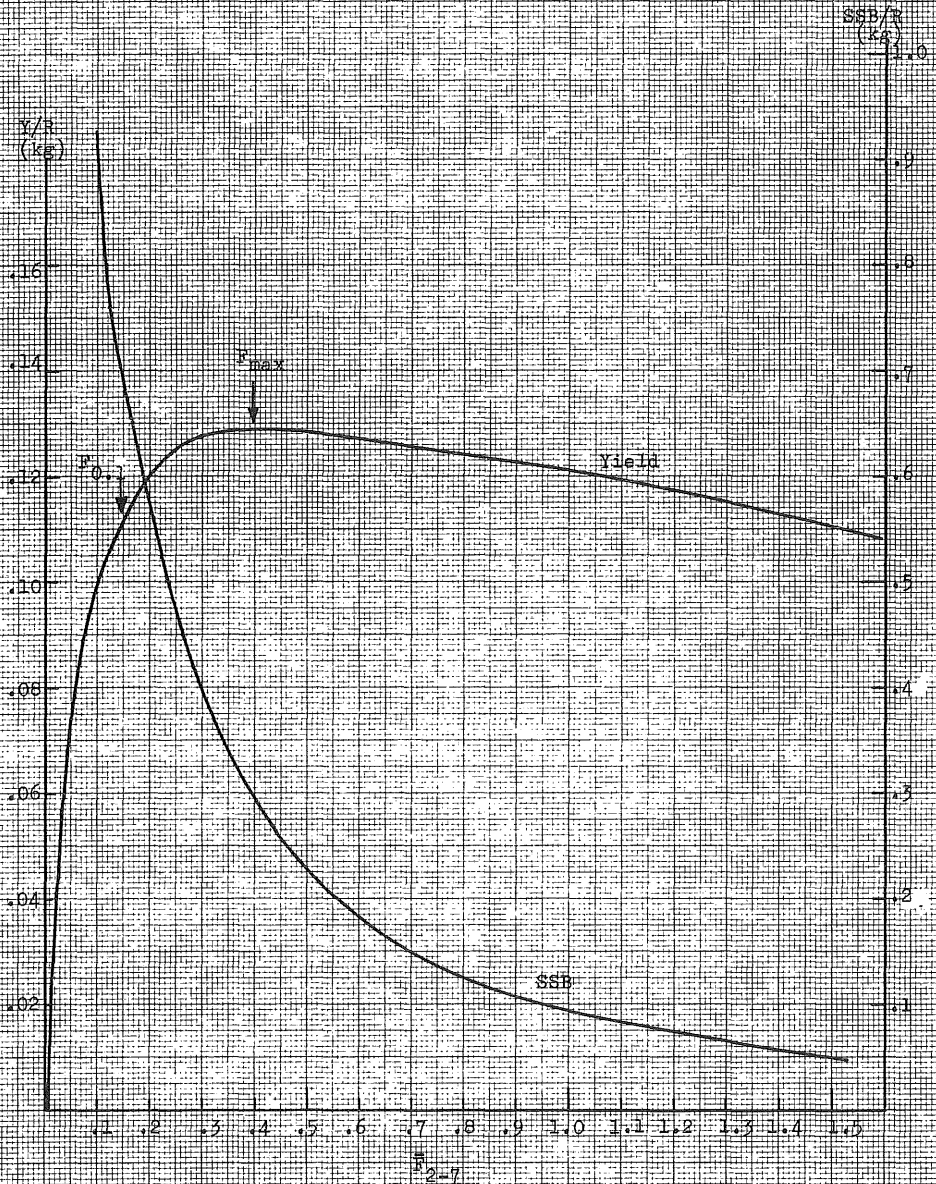Figure 7.3 Mourne stock. Yield and spawning stock biomass per recruit.

Figure 7.4 Mourne HERRING. Catch forecast for 1982 and spawning stock biomass.

Fig. 7