Advisory Committee on Fishery Management

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REPORT OF THE

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

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3 HERRING IN DIVISION IIIA AND SUB-DIVISIONS 22-24

3.1 The Fishery

3.1.1 ACFM advice and management applicable to 1996 and 1997

ACFM stated again in 1996 that the state of the stock is uncertain as available information is conflicting. Results from research surveys indicate intermediate to high levels of mortality.

The management advice was, that if a precautionary TAC was required for Sub-divisions 22-24, the catch levels in that area should not exceed recent catches.

The 1996 agreed herring TAC between the EU, Norway and Sweden to be taken in Division IIIa was 120,000 t. A TAC including all catches of all species taken in the mixed clupeoid fishery and landed unsorted was set at 43,000 t.

In June 1996 the TACs for the area were changed. A 25% reduction in the directed herring fishery was agreed between EU and Norway.

As in previous years no special TAC was set by the International Baltic Sea Fishery Commission (IBSFC) for the stock component in the Western Baltic area in 1996. In the Baltic there is a TAC for all the Sub-divisions 22-32.

Introduction to landing statistics

The landings of herring caught in Division IIIa are a mixture of North Sea autumn spawners and Baltic spring spawners. Spring-spawning herring in the eastern part of the North Sea, Skagerrak, Kattegat and Sub-Divisions 22, 23 and 24 are considered to be one stock. This section gives the landings of both North Sea autumn spawners and Baltic spring spawners, but the stock assessment applies only to the spring spawners.

3.1.2 Total Landings

Landings from 1985 to 1996 are given in Table 3.1.1. In 1996 the total landings decreased to around 173,000 t in Division IIIa and Sub-Divisions 22-24, of which 44,000 t were from the Kattegat, about 71,000 t from the Skagerrak and 57,000 t from Sub-Divisions 22-24. This represents a decrease of 58,000 t compared to 1995 and it is the lowest level in the time series.

There are several reasons for this significant drop in total landings. First of all the 25% reduction in the TAC for human consumption fisheries in Division IIIa and a very restrictive management of the small meshed fishery in Kattegat and Skagerrak. The herring fishing fleet in Sub-divisions. 22-24 changed to fishing for cod and for sprat in the eastern Baltic area.

Misreporting of fishing grounds still occurs. Some of the Danish landings of herring for human consumption reported in Division IIIa may have been taken in the adjacent waters of the North Sea in quarters 1, 2 and 4. These landings are included in the figures for the North Sea.

A substiantial part of Swedish landings has been misreported to be caught in the triangle (an area in southern Kattegat which is a part of the Baltic area, Gilleleje, DK - Kullen, S - Helsingborg, S - Helsingør, DK) were included in the figures for Kattegat and Skagerrak.

No estimates of discards were available to the Working Group. In Denmark a program for monitoring discards in different fisheries is conducted. This program has only been running for one year. The preliminary data show that the amount of discards is negligible or none at all in the herring and sprat fisheries in Kattegat and Sub-Divisions 22 - 24. The magnitude of discarding in Skagerrak may be at a high level, especially in the summer period where there is a special demand for high quality herring to the Dutch market.

The herring catches in Division IIIa are taken mainly in three types of fisheries (see Section 2.15).:

- **A directed fishery for herring (fleet C)** in which trawlers (with 32 mm mesh size) and purse seiners participate.

- The **"Mixed clupeoid fishery" (fleet D)** is carried out under a special "Sprat" TAC for all species caught in this fishery.Danish boats have been obliged to use a 32 mm mesh (since 1 Jan 1991). The Swedish fishery by purse seiners fishing for sprat along the coast. Norwegian purse seine catches of sprat for the canning industry.

- Catches of herring also occur as **by-catches in small meshed fisheries (fleet E) (mesh size<32 mm)**, such as the Norway pout, blue whiting and sandeel fisheries.

Attempts have been made to separate the landings of these fisheries. The category "Mixed clupeoids" only refers to Denmark since it was not possible to separate the Norwegian and Swedish "Mixed" landings from other industrial landings. During the WG meeting is was not possible to separate Norwegian and Swedish herring by-catch landings from trawl fisheries with a mesh size less than 32 mm, therefore, Fleet E landings only refer to Denmark. All Swedish herring landings fished by vessels using 32 mm mesh size are counted under Fleet C. Norwegian herring by-catches from the small meshed fishery are negligible. These landings are counted under Fleet C.

The landings in the different fisheries for the period 1991-1996 in thousands of tonnes are shown in Table 3.1.2. It should be noted, that the fleet definition has been changed and therefore landings by fleet for 1995 are changed and the new fleet definition was used for 1996 (see Section 2.15).

In Sub-Divisions 22-24 most of the catches are taken in a directed fishery for herring and some as by-catch in a directed sprat fishery. All catches from Sub-Div. 22-24 are treated in this section as one fleet.

The landings from this stock could therefore be split into four fleets:

C: Fleet using 32 mm mesh size in Division IIIa.
D: Mixed clupeoid fleet in Division IIIa.
E: Fleet using mesh size less than 32 mm Division IIIa.
F: Landings from Sub-Divisions 22-24.

In the text table below the 1996 landings are given in thousands of tonnes by fleet and quarter.

Quarter/	Fleet C	Fleet D	Fleet E	Fleet F	Total
1	13.9	6.9	5.2	9.3	35.3
2	12.5	0.0	2.2	23.9	38.6
3	46.2	1.0	2.2	10.1	39.5
4	19.4	5.9	2.4	13.5	41.2
Total	92.0	13.8	10.1	56.8	174.6

The landings from fleets C-F are SOP figures.

3.2 Stock Composition

3.2.1 Spring spawners in the North Sea

3.2.2 The mixing of spring and autumn spawners in Division IIIa

Catches of herring in the Kattegat and Skagerrak are taken from a mixture of two main spawning stocks (ICES 1991/Assess: 15): the Baltic spring spawners and the North Sea autumn spawners.

In addition several local stocks have been identified (Jensen, 1957). These are however considered to be less abundant and therefore of minor importance to the herring fisheries (ICES 1991/Assess: 15).

The North Sea autumn spawners (NSAS) enter Skagerrak and Kattegat as larvae and migrate back to the North Sea at an age of 2-3 years (Rosenberg & Palmén, 1982). The Baltic spring spawners (BSS) spawn around the Baltic island Rügen. They enter the Belt Sea, Kattegat and Skagerrack as adults after spawning (Biester, 1979).

The herring stocks in the Kattegat and the Skagerrak have traditionally been separated by the average counts in number of vertebrae in herring samples (Rosenberg & Palmén, 1982; Gröger & Gröhsler, 1995 and 1996). NSAS have a mean number of 56.5 vertebrae while the BSS are represented by a lower mean number, 55.8 vertebrae. The most prominent local spring spawning herring, the Skagerrak spring spawners (SSS), are represented by a higher mean number, 57.0 vertebrae.

Following the tradition from Heinke (1898) several other morphometric and metric variables have been used to separate herring stocks (Rosenberg & Palmén, 1982). The use of most of these variables was evaluated by an ICES study group in 1992 (Anon., 1992). The group concluded that a simple modal length analysis of the relevant 1-2 age groups would be precise enough for routine assessment purposes.

However, modal length analysis has proved to be an imprecise measure requiring a large sampling effort. Experience within the Herring assement working group showed that the separation procedure often failed. The amounts of herring catches that were allocated to the NSAS stock have varied between 30 to 50% of total annual landings during the last 10 years. Errors in the estimate of this withdrawal will clearly affect the quality of the assessment of the BSS stock. A more precise measure is needed.

The diameter of the first winter ring (annuli) on the otoliths of autumn spawners are significantly larger than for spring spawners (Rosenberg & Palmén, 1982). The analysis of otolith annuli has however not been applied on a routine basis in the Kattegat -Skagerrak area, because it is more labour-demanding. New image analysis systems can however remove this obstacle.

Otolith microstructurial otolith analysis has also been tested to separate spring and autumn spawned larvae (Moksness & Fossum, 1991) and adults (Zhang & Moksness, 1993). Otolith growth, which can be inferred from microscopical examination, is significantly slower for autumn spawners. Mosegaard & Popp-Madsen (1996) showed that the processing speed of the method can be accelerated by image analysis and training. The disadvantage of a lower number of measurements is outweighted by a very high precision. Efficient grinding methods opens up the possibility to include ages more than 2 years old in a routine examination.

3.2.3 Treatment of autumn spawning herring in Division IIIa

For 1996 a new method was employed using otolith micro-structure for separating Baltic spring spawners from North Sea autumn spawners (Mosegaard & Popp-Madsen, 1996).

The method allows the stocks to be separated at the individual level for all age classes and will produce proportions directly from the samples taken. Double checking of readings gives an estimated error rate of less than 1% when separating autumn/winter from spring spawners (including possible local populations with similar characteristics) (Mosegaard, W.D.).

For the third and fourth quarters otolith analyses of samples from the Danish surveys were used to calculate proportions of spring spawners by ICES rectangle within Div. IIIa.

For the first quarter herring vertebral counts from the Swedish surveys were applied in the same manner as in previous years, were the fraction of spring spawners by ICES rectangle within Div. IIIa, was calculated as follows:

$$f(sp)=[vs(au)-55.8]/[56.5-55.8]$$

where vs(au) was the sample mean vertebral count (ICES 1992/H:5). The mean proportion of spring spawners for each of the age classes 0, 1, 2, 3, and 4+ within each of the Sub-divisions, Skagerrack and Kattegat, was calculated as the average of the individual proportions over the respective ICES rectangles.

For the second quarter the proportion for each Sub-division was calculated as the average of quarter one and quarter three for each of the age classes 1 to 4+.

The resulting split is summarised below as autumn spawners and spring spawners by age in each quarter:

Quarter	Winter rings	Skagerrak Autumn Spawners	Skagerrak Spring Spawners	Kattegat Autumn Spawners	Kattegat Spring Spawners
1	0				
	1	0,84	0,16	0,88	0,12
	2	0,69	0,31	0,3	0,7
	3	0,57	0,43	0,46	0,54
	4+	0	1	0	1
2	0				
	1	0,87	0,13	0,67	0,33
	2	0,45	0,55	0,19	0,81
	3	0,35	0,65	0,35	0,65
	4+	0	1	0	1
3	0	0,65	0,35	0,83	0,17
	1	0,90	0,1	0,46	0,54
	2	0,21	0,79	0,17	0,83
	3	0,14	0,86	0,24	0,76
	4+	0	1	0	1
4	0	1	0	1	0
	1	0,85	0,15	0,45	0,55
	2	0,01	0,99	0,17	0,83
	3	0,07	0,93	0	1
	4+	0	1	0	1

All landings from Sub-divisions 22-24 are assumed to be Baltic spring spawners.

3.2.4 Estimation of precision in the historical proportion of spring spawners

Earlier estimates of proportion of spring spawners have been based on a combination of a modal splitting of length frequencies confirmed by vertebral counts on resulting length groups (ICES 1992/H:5). The splitting procedure is sensitive to weightings of sampling strata and the initial choice of means and standard deviations, several solutions therefore lead to a high degree of subjectivity. Historically it has been impossible to apply the method when more than two modal groups have emerged. In an exercise the method could not reproduce earlier splitting factors for Kattegat and Skagerrak (Figure 3.2.4.1 and Figures 3.2.4.2 a&b).

The combined data base of Swedish and Danish vertebral counts from 1991 to 1997 and 1984 to 1995 respectively, was used to study variability within Sub-divisions (Kattegat and Skagerrak) by year, quarter, age group, and ICES rectangle. Standard deviation was plotted against mean vertebral count and compared to a simulated pattern (n=1000 runs) from samples of two mixed stocks with mean vs=55.8 and 56.5 respectively and a common sd=0.7, the samples were taken from a similar pattern in sample sizes. A very similar pattern between observed and simulated data suggested that the mix in Division IIIa may very well be composed mainly of the two traditionally expected stocks, North Sea autumn spawners and Baltic spring spawners.

The proportion of spring spawner 2-ringers calculated by vertebral counts was compared to the HAWG's earlier estimated proportions by Sub-division, year, and quarter (Figs. 3.2.4.2a and 3.2.4.2b). The results show substantial deviation between the two estimates as well as a large variation within and among years.

It was therefore concluded that the simulated pattern of symmetrical 95% confidence limits for different median vertebral counts and sample sizes could be used as a measure of the minimum variation in proportion of spring spawners in earlier years of HAWG estimates (see Figure 3.2.4.3).

3.2.5 Estimation of the precition in the split for 1996

The precision using the analysis of otolith microstructure may be calculated from the binomial distribution and depends almost entirely on the observed proportion and the sample size. Analysis of the variation shows a dominating and significant component of between squares variation, therefore the estimated proportion will largely be influenced by sampling stratified by square, age class, and quarter. This consideration may also apply to the method of vertebral counts.

Danish and Swedish samples from 1996 surveys taken during the third quarter were compared by age and ICES rectangle. The difference in the estimated proportion of spring spawners between otolith determined Danish samples and Swedish samples determined by vs-count, were:

2.9% (mean) +/- 30.6% (sd) (n=27 samples)

The greater than 30% in standard deviation is primarily determined by variability in the proportion of BSS determined by vs-counts. Thereby this figure is highly influenced by the low number of herring in some of the age groups from some of the squares.

3.2.6 Estimation of bias in the proportion of spring spawners in the catch

Besides the variation in the estimated proportion of spring spawners due to an overlap in meristic characters, a possible bias may exist when estimating the split in the landings from stock identification of different age classes in the surveys. When plotting vertebral counts in herring from surveys versus the same character from the fisheries by Sub-division, year, quarter, and age class, a bias is noted towards a higher mean vs in herring sampled from the landings. This means that more North Sea herring are taken by the fisheries than is representative for Div. IIIa (Figure 3.2.5). The estimated proportion of autumn spawners in the fisheries was overall **14.6%** higher than in surveys and the difference was statistically significant (2*S.E.=10.9%). The problem is obviously greatest for 2-ringers where the difference was **31.3%** (2*S.E.=20.7%).

3.3 Catch in numbers and mean weights at age

The sampling intensity of the landings in 1996 was at a higher level than in 1995. The Swedish catches from Skagerrak for industrial purposes were sampled in the last three quarters (see Table 3.4.1). The sampling of the human consumption landings were generally acceptable in Skagerrak and Kattegat. Since, the Danish and Swedish sampling intensity in Sub-Division 24 was at a very low level, German samples from the fourth quarter were used to estimate catch in numbers for the third and fourth quarter. The Danish sampling intensity in Sub-Division 22 was at an adequate level for quarter 1 and 2. A few Swedish and Danish commercial samples were taken from Sub-Division 23, the Sound. Samples from Sub-Division 24 were used to calculate catch in numbers and mean weights in this area. The Polish and German landings were sampled in the most important quarters.

Based on these data the total numbers and mean weights at age for herring landed from the Kattegat, Skagerrak and Sub-Division 22 - 24 by the fleets listed in Section 3.1.3. were compiled and shown in Tables 3.3.1 - 3.3.7.

Based on the above proportions, the catches in number and mean weights by age group for spring- and autumn-spawning herring in each of the three fisheries in Division IIIa, are given in Tables 3.3.3 - 3.3.6 The landings of spring spawners taken in Division IIIa and the North Sea in 1996 were thus estimated to be about 74,000 t (Table 3.3.11) compared to about 96,000 t in 1995, 97,000 t in 1994 and 89,000 t in 1993. This reduction in landings is due to the reduction in the TAC for 1996 compared with previous years. The total catch in numbers of BSS in Division IIIa and the North Sea is shown in Table 3.3.8.

The landings of North Sea autumn spawners in Division IIIa amounted to 42,000 tons compared to 70,000 tons in 1995 and to 86,000 t in 1994 (Tables 3.3.9). The 1994-1996 landings represents a significant reduction compared to 1992 and 1993 when 152,000 t and 132,000 t were taken.

The total catch in number and mean weight at age of Division IIIa/Baltic spring spawners in the North Sea, Division IIIa and in Sub-Divisions 22-24 for 1987-1996 are given in Tables 3.3.10 and 3.3.11.

Table 3.3.7 gives the total landings in numbers and mean weight at age by fleet of the Division IIIa/Baltic spring-spawning herring caught in the North Sea, Division IIIa and in Sub-Divisions 22-24 in 1996. The total landings in

1996 were 130,000 t compared with 1995 where total catch were173,000 t and in 1994 164,000 t . This reduction is probably due to a reduction in the TAC's for Division IIIa and in the North Sea for 1996.

Even though, the fleet definition for 1995 was changed, catch in numbers and mean weight for the WB spring spawners in Division IIIa and in Sub-Divisions 22-24 was not changed.

3.4 Quality of catch and biological sampling data

The data on landings have been improved since 1993 and 1994 but is at the same level as in 1995. Danish landings were sampled in all quarters for Skagerrak, Kattegat and in quarter 1 and 2 for Sub-Division 22. No samples were taken from the Sound (Sub-Division 23) and Sub-Division 24. Swedish landings from the human consumption fishery were sampled in all quarters and landings for industrial purposes from Skagerrak and Kattegat have been sampled at highest level ever. From the Norwegian landings from Skagerrak only 2 samples were taken.

Table 3.4.1 shows the number of fish aged by country, area, fishery and quarter. The total landings from Division IIIa, IIIb and IIIc were, 173,000 t, from which 390 samples were taken. A total of 64,000 herring were measured and 15,500 aged. The figures for 1996 are nearly at the same level as in 1995. The sampling intensity by quarter over all landings are acceptable, with a mean of more than one sample per 1000 t landed. The distribution over seasons, areas and fishing fleets needs to be improved.

Sampling of the Danish catches for industrial purposes was at a much higher level than in previous years and are now at an acceptable level. The number of samples and number of fish investigated were considered to be at a reasonable level. Again in 1996 there have been difficulties in getting samples from the Danish directed herring human consumption fishery in Skagerrak.

There is uncertainty about where the Danish catches for human consumption, reported from Division IIIa (quarters 1, 2 and 4), were actually taken. These landings were most likely to have been taken in the North Sea and were therefore transferred to the North Sea.

In 1996 Sweden established a new sampling programme for the industrial landings from Division IIIa. This sampling programme met the requirement of the agreed level of one sample per 1000 t landed. Swedish sampling in Kattegat was adequate but sampling of landings by Swedish vessels in Denmark still needs to be improved (see section 2.15).

The Norwegian and Danish fishery for human consumption takes place in the area around the border line between the North Sea and Skagerrak and misreportings are known to occur.

Due to market conditions, technical regulations and quotas, discarding occurs in the purse seine fleets and in some fleets in the trawl fishery in Division IIIa, especially in June, July and August. Lack of sampling of discards creates problems which need to be resolved for the assessment.

Although the overall sampling meets the recommended level of one sample per 1000 t landed per quarter the coverage of different fisheries, areas and seasons are not adequate.

For reasons discussed in section 2.15 the Working Group recommends that adequate sampling is conducted for all fisheries in Division IIIa and Sub-divisions 22-24.

Each nation should provide information on the level of sampling to determine species composition in all fisheries in which herring are caught.

3.5 Fishery-independent estimates

3.5.1 German bottom trawl surveys in Sub-divisions 22 and 24

The German bottom trawl surveys have been conducted in Sub-divisions 22 and 24 since 1978 by the Institute for Hochseefischerei. Since 1992 the surveys are carried out by the Institute for Baltic Fisheries in Rostock. Depending on the availability of research vessel they were conducted either in November/December or in January/February. The main purpose for these surveys has been to estimate recruitment indices for cod stocks. The survey stations were randomly selected in the first year. After the first year a fixed station grid was used. Sub-division 22 is only covering the Mecklenburger Bucht (20 stations), which is taken as one depth stratum.

Sub-division 24 is divided into four depth strata (31 stations). Trawling is done by the herring bottom trawl 'HG 20/25'. From each station the catch in number at age is estimated (cod, herring, sprat and flounder). In Sub-division 22 the arithmetic mean values at age are used as indices. The calculated indices at age in Sub-division 24 are stratified means weighted by the area of the depth strata.

Details of the survey design and the gear (HG 20/25) as well as some results for the period 1978 to 1985 are given in Schulz and Vaske (1988).

Abundance indices for 0, 1, 2, and 3+ ringed herring from bottom-trawl surveys carried out in November/December of each year in Sub-divisions 24 and 22 are given in Tables 3.5.1 and 3.5.2. Combined estimates for the total area are obtained by weighting the single survey estimate by the survey areas of each Sub-division. The resulting index series is shown in Table 3.5.3.

The 1996 survey shows in both areas relatively low 1996, 1995 and 1994 year classes. In Sub-division 22 the 0-group herring in 1996 is the lowest recorded since 1979. As earlier years the 3+ group in Sub-division 24 seems to be rather high.

Abundance indices for 1 to 8+ ringed herring from bottom-trawl surveys conducted in January/February each year in Sub-division 24 are given in Table 3.5.4. Since the 1987 survey was influenced by a strong winter with a high ice coverage the estimated abundance indices should be used with caution. Compared to the estimates for the period 1979 to about 1990 there is in the last years a general trend with lower indices for 1, 2 and 3 -ringers and higher estimates for the 6, 7 and 8+ -ringers, respectively.

3.5.2 Summer Acoustic survey in Division IIIa

This survey is part of an annual survey covering the North Sea and Division IIIa in July-August. As in previous years the survey was conducted by R/V DANA. The echo integration survey from 19 to 30 July covered the North Sea east of 5^0E between 57^0N and 59^0N, the Skagerrak and the Kattegat. Acoustic data were collected using a Simrad EK400 38 kHz Simrad echosounder with a hull mounted split-beam transducer (type ES 38-29). The echointegration data were stored by the echo analysis system ECHOANN (Degnbol *et al.*, 1990).

Pelagic trawling was carried out using a Fotö trawl (16 mm in the codend), while an Expo trawl (16 mm codend) was used on the bottom. The trawl hauls were performed in the time intervals 12.00-18.00 h and 23.00-5.00 h.
The TS relationships used in this survey were:

Clupeids:	TS = 20 log L (cm) - 71.2
Gadoids:	TS = 20 log L (cm) - 67.5

A total of 36 trawl hauls were carried out. Further details of the survey are given in Simmonds *et al.* (W.D.1997).

The total stock sizes of Western Baltic spring spawning herring in the years 1992 to 1996 were estimated by combining the results from the Danish (Division IIIa) and Norwegian Acoustic Survey (Sub-area IVa and IVb). The result are summarized in Tables 3.5.5-3.5.9. The total stock estimate for 1996 (215,100 t) is about 58 % lower than the estimate for 1995 (506,200 t). During the hours of darkness herring rise close to the surface in Skagerrak and Kattegat, and may not be registered by the hull mounted transducer. Normally a towed-body transducer, which can be deployed close to the surface, is used for echointegration during the Danish surveys. However, in 1996 the towed-body was out of action which could explain the large decrease in biomass observed between 1995 and 1996.

3.5.3 October Acoustic survey in Western Baltic and the Southern Part of Division IIIa (Kattegat)

The cruise carried out with R/V 'Solea' from 2 to 18 October 1996 represents the 9th subsequent joint hydroacoustic survey between the Germany and Denmark since 1987. The survey covered the whole of Sub-divisions 22, 23, 24 and the southern part of the Kattegat. The acoustic equipment used was an echosounder EK500 connected to the Bergen-Integrator BI500. The transducer ES 38-26 was installed in a towed body.

Pelagic trawling was carried out using a 'PSN 480' trawl, while an 'Aalhopser' trawl was used near the bottom.
All investigations were performed at night (18.00 - 06.00 h) as in recent years.

The s_a values for each stratum were converted into fish numbers using the TS-length relationships:

Clupeids: $TS = 20 \log L (cm) - 71.2$
Gadoids: $TS = 20 \log L (cm) - 67.5$

The total number of fish was divided into species and age groups according to the trawl results. A total of 52 trawl hauls were made for biological samples.

The survey results in the years 1992 to 1996 are given in Tables 3.5.5-3.5.9. The total estimated stock size of spring spawning herring in Sub-divisions 22-24 in 1996 (229,200 t) was about the same level as in 1995 (244,200 t).

3.5.4 Acoustic Monitoring in Sub-Division 23 (the Sound)

A base-line study on the migration of herring was initiated in the autumn of 1993. The main purpose of this study is to provide information for the evaluation of possible environmental impacts of the construction of the Sound Bridge between Denmark and Sweden. A description of the survey and the corresponding results concerning the numbers and the biomass in tonnes during the period September 1993 to May 1995 are given in last years Working Group Report (ICES 1996/Assess:10). The estimates for 1996 cannot be presented because they were not available during the meeting.

3.5.5 Larvae surveys

The German herring larvae monitoring started in 1977 and takes place every year from March/April to June in the main spawning grounds of the spring spawning herring in the Western Baltic in the Greifswalder Bodden (area: 510.2 km², volume: 2,960 x 10^6 m³, mean depth: 5.8 m, greatest depth: 13.5 m) and adjacent waters. Since 1977 the same sampling method, sampling strategy and station grid have been used. Usually 35 standard stations are sampled by R/V „Clupea“ in daylight during 10 consecutive cruises. At each station herring larvae samples are taken with a MARMAP-Bongo (diameter: 600 mm, mesh size of both nets: 0.315 mm) by parallel double oblique tows at a speed of 3 knots.

For the calculation of the number of larvae per station and m², the methods of Smith and Richardson (1977) and Klenz (1993) were used and extended to length-classes. To get the index for the estimation of the year-class strength, the number of larvae which have reached the length of TL = 30 mm (larvae after metomorphosis) were calculated taking into consideration growth and mortality.

Further details concerning the surveys and the treatment of the samples are given in Brielmann (1989) and Mueller & Klenz (1994).

The estimated numbers of larvae for the period 1977 to 1995 are summarized in Table 3.5.10.

3.6 Recruitment

3.6.1 Indices of 0-ringers

Indices of 0-ringer abundance are available from larval surveys at Greifswalder Bodden and adjacent waters during March to June (Table 3.5.10), and from German Bottom Trawl Surveys during November-December in Div. 22-24 (Table 3.5.1). The indices for year classes 1980 to 1996 are compared in Figure 3.6.1.

3.6.2 Indices of 1-ringers

Indices of 1-ringer abundance are available from German Bottom Trawl Surveys during November-December in Div. 22-24 (Table 3.5.1) and from German Bottom Trawl Surveys during January-February in Div. 24 (Table 3.5.4). The indices for year classes 1980 to 1995 are compared in Figure 3.6.2.

3.6.3 Trend in recruitment

The indices illustrated in Figures 3.6.1 and 3.6.2 show the following trends: A poor recruitment of year classes 1980-81 was followed by an increase to a high level of recruitment for year classes 1983-88. From year class

1990 the recruitment declined markedly and has been at a low level since. An increase in year classes 1993-1994 is indicated. The present estimate of the 1996 year class is low compared to historical record.

3.7 Data exploration

Catch at age and survey data are presented in Tables 3.3.10, 3.3.11 and 3.5.1 - 3.5.11. The input data are restricted to the period 1987 and onwards. This restriction in time was decided in last years report (ICES 96/Assess:10) by the fact that splitting of spring and autumn spawners in Divisions IIIa and Subarea IVa was not done before 1987. In light of the problems in the splitting methodology it should be emphasised that the basis for any assessment of the stock relies on questionable catch and survey data.

Natural mortality, maturity ogive and proportions of F and M before spawning were all assumed to remain constant between years. M is assumed to be 0.2 per year, F-prop. 0.1 and M-prop. 0.25 for all age groups. The maturity ogive used was the same as that used at last years Working Group meeting:

Age	0	1	2	3	4	5	6	7	8+
Maturity	0	0	.2	.75	.9	1	1	1	1

It was noted that the estimated maturity ogives obtained from acoustic surveys differs between samples taken in the Division IIIa and in the spawning area in Sub-division 22.

Six surveys with age disaggregated data and one larvae survey were available as indices of abundance:

Index 1: IBTS in Div. IIIa, Feb. 1980-1996, 2 and 3+ ringers
Index 2: German bottom trawl survey (GBTS) in SD 22, Nov. 1979-96, 0-3+ ringers
Index 3: German bottom trawl survey (GBTS) in SD 24, Nov. 1978-96, 0-3+ ringers
Index 4: Acoustic. survey in Div IIIa, July 1989-96, 0-8+ ringers
Index 5: Acoustic. survey in SD 22+24, Oct. 1989-96, 0-8+ ringers
Index 6: Larvae survey in SD 24, March-June 1977-1995, 0-group
Index 7: German bottom trawl survey (GBTS) in SD 24, February 1979-96, 1-8+ ringers

The IBTS indicies (Index 1) in February could not be adequately split between spring and autumn spawners (Section 3.2) and only 3+ ringers were used in the analyses. Indices 2 and 3 basically cover the same stock component in the Baltic with the same methodology. All three surveys are undertaken at the time of the extensive migration from and to the spawning areas in the southern Baltic (ICES 1996/Assess:10). The acoustic survey in Division IIIa (Index 4) coincides with a high expectation of a large proportion of the stock in Division IIIa. The acoustic survey in Sub-divison 22 and 24 (Index 5) mainly covers the Baltic component of the stock. The use of the larvae survey (Index 6) as a biomass index is restricted (Section 3.5.5) but has nevertheless been interpreted as an SSB estimate. The updated bottom trawl survey results from the Baltic during February covers both the Baltic stock component and the immigrating Division IIIa stock component.

The estimated yearclass strenght at age 3 varies and is not consistent between surveys (Figure 3.7.1). However, all surveys indicate less abundant yearclasses after 1993 and 1994. Catches indicate a relatively larger 1994 yearclass. The age distribution in the surveys vary, while the age distribution in the catches seems stable. Mean weights at age in the catch varies by quarter according to the migration model (emigration to the Division IIIa in the third quarter of larger individuals). However, there is a conspicuous difference in mean weights between the Baltic and Division IIIa areas indicating that other stock components in the Baltic interfere with the Western Baltic herring (Figure 3.7.2).

Due to the uncertainties in the basic data (stock separation, catch at age) it was agreed not to attempt to make an analytical assessment. The Working Groups has previously explored such attempts in vain. However, simulations with the ICA program was tested in order to elucidate the reliability of input data.

In all ICA runs the following parameters were kept constant:

The weighting factor to all indices (lambda = 1).
The linear catchability model for all indices.
The range of years for separability constraint (=6)
The reference F at age 4 and the selection 1 for oldest age.

Further details on input parameters for the ICA are presented in Table 3.7.1. Input data on the ICA run is shown in Tables 3.7.2 - 3.7.6.

Altogether six runs were made with single indices and one run with multiple indices. The results of the runs were compared by using the estimates and standard deviations of the reference F and the SSB in 1996. The estimates of the comparative runs obtained are given below:

			F and SSB (x 1000 t) in 1996 from ICA			
Run No.	Index No.	Index	Mean F 1996	Lower L.	Upper L.	SSB (x 1000 t) 1996
1	2	GBTS SD 24 Nov	0.08	0.05	0.14	920
2	3	GBTS SD 22 Nov	1.38	0.74	2.57	90
3	4	Acou. Surv.IIIa+IVaE	0.20	0.13	0.31	380
4	5	Acou. Surv. SD 22-24	0.07	0.05	0.09	1060
5	6	Larv. Surv. SD 24	0.59	0.23	1.49	170 [1]
6	7	GBTS SD 24 Feb	0.20	0.14	0.30	390
7	**4/5/7**	**Indices 4, 5 and 7/ 3-8+ ringers**	**0.07**	**0.05**	**0.09**	**990**

[1] 1996 data not yet available

As can be seen, the runs by individual indices estimate both unrealistic and plausible fishing mortalities. The estimated SSB levels also appear very uncertain. The indices and catch at age data appear to give no useful information on absolute stock size. It should be stressed that the results from the ICA run are presented only to illustrate the assessment problems. Consequently, no attempt was made to predict the stock size of herring in Division IIIa and Sub-divisions 22-24.

The two hydroacoustic and the botttom trawl survey in Sub-division 22 and 24 seem to agree in time trends. The additional run was made with only age groups 3 to 8+ included in order to exclude the splitting problem. The result of the run is presented in Tables 3.7.7 - 3.7.16 and Figures 3.7.3 - 3.7.5. This run resulted in an extremly low estimate of reference F (0.07) and a correspondingly large spawning biomass (990,000 t).

3.8 Stock assessment

Despite the failure to contribute to an analytical assessment the survey and catch data provide information on stock development. CPUE values (in weight) or biomass estimates were available for all indices. The larvae survey was assumed to represent changes in biomass levels. An inspection of these relative stock estimates was interpreted as a stable or slight decrease in the stock over the last six years (Figure 3.8.1). However, the IBTS CPUE (only 3+ included) increased dramatically from 1995 to 1996 in both the Skagerrak and the Kattegatt.

A separable VPA was run on ages 3 to 6 (only spring spawners) from 1987 to 1996 with down-weighting to 0.01 from 1987 to 1990. F was assumed to be 0.4 and S was set to 1.0. Results show a random residual pattern. Spawning stock estimates decrease from a peak in 1992 by 1/3 to 1996. There were no obvious trends in fishing mortalities.

The catch data indicates lower exploitation in 1996 compared to previous years. Catch curves (3-6 WR) averaged over three year periods show a downward trend in total mortality: Z=.95 in 1988 to 1991, Z= 0.54 in 1992 to 1993 and Z=0.43 in 1994 to 1996. Similar trends are seen in the acoustic surveys and the Baltic bottom trawl surveys. Assuming equilibrium conditions total mortality calculated for the same three periods drops by 23% to 67%. Total mortality in the IBTS drops from Z=1.15 in 1992 to 1994 to Z=0.92 in 1995 to 1997. These capricious calculations do not give rise to fears of increasing exploitation rates.

The overall results of the 1996 exercises indicate a stable SSB and slightly decreasing fishing mortality from 1987 and onwards. However, the Working Group members feel that both the data on the commercial fishery and on the surveys are questionable. The assessment trials cannot provide an accurate indication about the development of the stock. As a consequence, predictions of the western Baltic herring were not considered.

3.9 Future activities

Since 1993, the Working Group has encountered severe problems in assessing the status of the spring spawners in Division IIIa and Sub-divisions 22, 23 and 24. These problems have repeatedly been described over the past years by the Working Group. The problems can be ascribed to two sources. Firstly, year and age trends are in conflict between survey indices and the commercial catch data. Some of the indices are internally inconsistent, often demonstrating negative mortality. Furthermore, tuning of the catch data by individual surveys has resulted in conflicting estimates of the SSB and fishing mortalities. These incoherent patterns in the input data and in the assessment results were also observed during the 1996 Working Group meeting.

The second cause for concern is the estimate of the proportion of autumn spawners in the total landings in the SW Baltic and Division IIIa. The net transfer of catches of autumn spawners from the Division IIIa to the North Sea stock varies significantly between years.

Division IIIa and Sub-divisions 22-24

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Landings (x 1000 t)	349	308	336	432	286	280	257	311	295	234	231	173
Fraction Spring Spawners (%)	71	60	52	58	65	73	74	54	57	70	75	75

The uncertain and highly questionable basis for the split between spring and autumn spawners in Division IIIa and Sub-area IVa are reviewed in section 3.2. In view of the important consequences the present splitting method should be reviewed and preferably replaced by other methods. Pilot studies indicate that measurements of otolith increment widths are statistically robust and more cost-efficient (Mosegaard and Madsen, 1996).

The underlying biological model should be evaluated. Prior to 1988 annual assessments were made separately for Division IIIa and the Baltic (Sub-divisions 22-24). The present perception of a unit stock is based on the assumption that spring spawning herring in the Baltic migrate northwards into Division IIIa and the North Sea after spawning in April-May. The return migration to the Baltic spawning grounds occurs by the end of the winter season. The theory is supported by tagging results (Biester, 1979) and by seasonal and spatial observations of vertebrae counts (Rosenberg & Palmen, 1981). Results from the acoustic estimates from the Baltic Sound (Sub-division 23) suggest that the migration is substantial and rapid (ICES 1996/Assess:10). Thus, the estimated relative biomass in the Sound remained at 400 t x NM^{-2} from autumn 1993 to April 1994 when the biomass decreased to 20 t x NM^{-2}.

Existing fishery-independent surveys have not been designed to account for the assumed migration patterns. None of the surveys covered the entire distribution of the stock. Thus, changes in the migration rate or timing between years may have violated the validity of the time series of these surveys. The Baltic larval survey at spawning time and the acoustic survey during summer in Division IIIa would be expected to reflect the SSB better than the other surveys. The acoustic surveys are not consistent with the catch at age distributions and the Baltic larval surveys have a very low precision. The Baltic trawl surveys are conducted at times when migration is assumed to occur (IBTS) or when a main part of the stock is assumed to be at least partially absent from the surveyed area (Baltic trawl surveys). From an assessment point of view a call for a coordination or a larger coverage of these surveys may address these problems.

The above problems will be addressed inter-sessionally but it is unlikely that they will be resolved before the next Working Group meeting. An EU funded co-operation will start on June 1996. The objectives are to evaluate present splitting methods in terms of precision and accuracy. Traditional vertebra counts will be compared with otolith macro and microstructure analyses. The three year project will also subsample and analyse historical otoliths from surveys and catches for a full VPA range (10 years). Ongoing acoustic surveys in the transition area between the Baltic and Division IIIa, the Sound will contribute to further knowledge of the migration pattern of spring spawning herring.

In order to make fruitful contributions towards a full analytical assessment of spring spawners in the Division IIIa and Sub-divisions 22 and 24, the Working Group recommends that a Study Group should set up. The group should meet in Lysekil January 12th to 16th, 1998 (Chairman Jorgen Dalskov) with the following terms of reference:

1. to formulate and test a migration model of the Baltic spring spawning herring that is consistent with present knowledge and which can be used on a routine basis for assessment purposes. The model should be linked to the results of an evaluation of the methodology on separation of stocks.

2. to compare the methodologies for stock discrimination by vertebrae counts or otolith analyses and to update the historical split between spring and autum spawning components in Division IIIa.

3. to review and update catch at age and mean weight at age data for all fishing fleets that catch herring in Division IIIa and Sub-divisions 22 and 24. The task should include the possibility of a revised sampling regime of the affected fleets.

4. to review and test the consistency among existing results from research surveys and to adapt future sampling to the needs of an established migration model.

Table 3.1.1 **HERRING in Division IIIa and Sub. Division 22-24. 1986 - 1996**
Landings in thousands of tonnes.
(Data provided by Working Group members 1997).

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996 [1]
Skagerrak												
Denmark	88.2	94.0	105.0	144.4	47.4	62.3	58.7	64.7	87.8	44.9	43.7	28.7
Faroe Islands	0.5	0.5										
Norway	4.5	1.6	1.2	5.7	1.6	5.6	8.1	13.9	24.2	17.7	16.7	9.4
Sweden	40.3	43.0	51.2	57.2	47.9	56.5	54.7	88.0	56.4	66.4	48.5	32.7
Total	133.5	139.1	157.4	207.3	96.9	124.4	121.5	166.6	168.4	129.0	108.9	70.8
Kattegat												
Denmark	69.2	37.4	46.6	76.2	57.1	32.2	29.7	33.5	28.7	23.6	16.9	17.2
Sweden	39.8	35.9	29.8	49.7	37.9	45.2	36.7	26.4	16.7	15.4	30.8	27.0
Total	109.0	73.3	76.4	125.9	95.0	77.4	66.4	59.9	45.4	39.0	47.7	44.2
Sub. Div. 22+24												
Denmark	15.9	14.0	32.5	33.1	21.7	13.6	25.2	26.9	38.0	39.5	36.8	34.4
Germany	54.6	60.0	53.1	54.7	56.4	45.5	15.8	15.6	11.1	11.4	13.4	7.3
Poland	16.7	12.3	8.0	6.6	8.5	9.7	5.6	15.5	11.8	6.3	7.3	6.0
Sweden	11.4	5.9	7.8	4.6	6.3	8.1	19.3	22.3	16.2	7.4	15.8	9.0
Total	98.6	92.2	101.4	99.0	92.9	76.9	65.9	80.3	77.1	64.6	73.3	56.7
Sub. Div. 23												
Denmark	6.8	1.5	0.8	0.1	1.5	1.1	1.7	2.9	3.3	1.5	0.9	0.7
Sweden	1.1	1.4	0.2	0.1	0.1	0.1	2.3	1.7	0.7	0.3	0.2	0.3
Total	7.9	2.9	1.0	0.2	1.6	1.2	4.0	4.6	4.0	1.8	1.1	1.0
Grand Total	349.0	307.5	336.2	432.4	286.4	279.9	257.8	311.4	294.9	234.4	231.0	172.7

Preliminary data.

Table 3.1.2 Landings from Division IIIa by Fleets 1991 - 1996 in '000 tons.

Year	Area	Fleet C	Fleet D	Fleet E	Total
1991	Kattegat	32	13	24	69
	Skagerrak	62	6	54	122
	Total	94	19	78	191
1992	Kattegat	24	11	24	59
	Skagerrak	75	14	79	168
	Total	99	25	103	227
1993	Kattegat	18	12	16	46
	Skagerrak	94	15	60	169
	Total	112	27	76	215
1994	Kattegat	18	8	12	38
	Skagerrak	81	5	43	129
	Total	99	13	55	167
1995	Kattegat	36	5	2	43
	Skagerrak	87	3	19	109
	Total	123	8	21	152
1996	Kattegat	33	9	2	44
	Skagerrak	59	4	8	71
	Total	92	13	10	115

Note: It should be remembered that fleet definition has been changed and the new definition has been used for 1995 and 1996

Table 3.3.1 Skagerrak 1996

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Fleet C		Fleet D		Fleet E		TOTAL	
1. QUARTER Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight
0								
1	16.07	21.6	71.81	17.4	263.35	14.6	351.23	15.5
2	33.32	76.5	2.96	38.5	8.44	44.9	44.72	68.0
3	13.25	124.0	3.12	48.2	0.82	56.8	17.19	107.1
4	4.24	157.0					4.24	157.0
5	1.52	199.9	0.08	150			1.60	197.4
6	0.79	237.6					0.79	237.6
7	0.62	257.5					0.62	257.5
8+	0.54	276.6					0.54	276.6
TOTAL	70.34		77.97		272.61		420.92	
Land. (SOP)(t)		6,003		1,526		4,270		11,799
2. QUARTER Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight
0								
1	20.35	33.7			22.61	33.9	42.96	33.8
2	41.13	84.8			5.31	62.3	46.44	82.3
3	17.53	159.2			0.99	80.0	18.52	155.0
4	9.16	191.6			0.12	68.0	9.28	190.0
5	4.15	160.7					4.15	160.7
6	1.87	190.6					1.87	190.6
7	1.72	200.0					1.72	200.0
8+	2.62	190.1					2.62	190.1
TOTAL	98.53		0.00		29.03		127.56	
Land. (SOP)(t)		10,588		0		1,185		11,772
3. QUARTER Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight
0					64.24	7.3	64.24	7.3
1	51.25	79.8			10.20	61.7	61.45	76.8
2	113.91	123.4			3.95	92.9	117.86	122.4
3	29.11	151.7			1.97	100.8	31.08	148.5
4	20.94	180.0			1.40	116.3	22.34	176.1
5	15.85	191.2			0.25	189.0	16.10	191.1
6	6.58	209.0			0.25	125.0	6.83	205.9
7	2.90	190.4					2.90	190.4
8+	1.60	227.2					1.60	227.2
TOTAL	242.13		0.00		82.26		324.39	
Land. (SOP)(t)		31,657		0		1,905		33,562
4. QUARTER Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight
0			219.34	11.7	36.07	14.0	255.41	12.0
1	62.08	47.9			0.15	83.0	62.23	47.9
2	41.90	96.6			0.15	70.0	42.05	96.5
3	12.52	152.2					12.52	152.2
4	4.67	183.3					4.67	183.3
5	2.22	209.0					2.22	209.0
6	0.76	222.5					0.76	222.5
7	0.11	218.0					0.11	218.0
8+	0.20	211.5					0.20	211.5
TOTAL	124.46		219.34		36.37		380.17	
Land. (SOP)(t)		10,479		2,566		528		13,573
TOTAL YEAR Winter rings	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight	Numbers	Mean Weight
0			219.34	11.7	100.31	9.7	319.65	11.1
1	149.75	54.1	71.81	17.4	296.31	17.7	517.87	28.2
2	230.26	104.9	2.96	38.5	17.85	60.9	251.07	101.0
3	72.40	148.5	3.12	48.2	3.78	85.8	79.30	141.6
4	39.01	180.6			1.52	112.5	40.53	178.1
5	23.74	188.1	0.08	150.0	0.25	189.0	24.07	187.9
6	9.99	208.8			0.25	125.0	10.24	206.8
7	5.34	201.8					5.34	201.8
8+	4.97	212.3					4.97	212.3
TOTAL	535.47		297.31		420.27		1253.05	
Land. (SOP)(t)		58,727		4,092		7,888		70,707

Table 3.3.2 **Kattegat 1996**

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Fleet C		Fleet D		Fleet E		TOTAL	
1. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	23.52	35.6	344.77	14.2	60.95	14.7	429.24	15.4
2	74.86	61.1	6.38	43.8	3.49	33.3	84.73	58.7
3	5.82	140.3	1.77	72.4	0.06	81.0	7.65	124.2
4	5.69	184.1	1.06	110.3	0.06	78.0	6.81	171.7
5	1.28	207.5	0.35	81.0			1.63	180.3
6	1.24	225.8					1.24	225.8
7	0.23	260.5					0.23	260.5
8+	0.10	221.0					0.10	221.0
TOTAL	112.74		354.33		64.56		531.63	
Land. (SOP)(t)		7,905		5,449		1,022		14,375
2. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	4.72	32.7			29.52	15.2	34.24	17.6
2	15.57	63.2			7.11	37.9	22.68	55.2
3	1.92	99.2			2.28	68.8	4.20	82.7
4	1.37	132.2			0.52	93.6	1.89	121.6
5	1.50	134.9					1.50	134.9
6	0.56	150.4			0.36	112.8	0.92	135.7
7	0.31	157.5					0.31	157.5
8+	0.21	170.0					0.21	170.0
TOTAL	26.17		0.00		39.79		65.96	
Land. (SOP)(t)		1,882		0		964		2,846
3. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0					8.77	7.3	8.77	7.3
1	28.81	28.5			1.39	61.7	30.20	30.0
2	193.92	54.9			0.54	92.9	194.46	55.1
3	20.65	85.0			0.27	100.8	20.92	85.2
4	3.53	132.9			0.19	116.3	3.72	132.1
5	2.26	159.8			0.03	189.0	2.29	160.2
6	0.90	177.6			0.03	125.0	0.93	175.9
7	1.10	170.7					1.10	170.7
8+	0.36	186.6					0.36	186.6
TOTAL	251.52		0.00		11.22		262.74	
Land. (SOP)(t)		14,476		0		259		14,734
4. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	9.12	17.4	318.43	10.5	0.07	14.0	327.62	10.7
1	31.88	29.7					31.88	29.7
2	115.51	61.1					115.51	61.1
3	7.05	76.9					7.05	76.9
4	0.58	144.9					0.58	144.9
5	0.51	169.1					0.51	169.1
6	0.26	167.4					0.26	167.4
7								
8+								
TOTAL	164.91		318.43		0.07		483.41	
Land. (SOP)(t)		8,922		3,344		1		12,267
TOTAL YEAR		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	9.12	17.4	318.43	10.5	8.84	7.4	336.39	10.6
1	88.94	31.0	344.77	14.2	91.86	15.6	525.57	17.3
2	399.87	58.2	6.38	43.8	11.14	39.1	417.39	57.5
3	35.45	93.3			2.61	72.4	38.06	91.8
4	11.16	159.5	1.06	110.3	0.77	98.0	12.99	151.9
5	5.54	164.9			0.03	189.0	5.57	165.0
6	2.96	191.7			0.39	113.7	3.35	182.6
7	1.63	180.9					1.63	180.9
8+	0.68	186.4					0.68	186.4
TOTAL	555.35		670.64		115.64		1341.63	
Land. (SOP)(t)		33,184		8,636		2,246		44,066

Table 3.3.3 Skagerrak 1996 North Sea Autumn Spawners

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Fleet C		Fleet D		Fleet E		TOTAL	
1. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	13.50	21.6	60.32	17.4	221.21	14.6	295.03	15.5
2	22.99	76.5	2.04	38.5	5.82	44.9	30.85	68.0
3	7.55	124.0	1.78	48.2	0.47	56.8	9.80	107.1
4								
5								
6								
7								
8+								
TOTAL	44.04		64.14		227.51		335.69	
Land. (SOP)(t)		2,986		1,214		3,518		7,717
2. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	17.71	33.7			19.67	33.9	37.38	33.8
2	18.51	84.8			2.39	62.3	20.90	82.3
3	6.13	159.2			0.35	80.0	6.48	155.0
4								
5								
6								
7								
8+								
TOTAL	42.35		0.00		22.41		64.76	
Land. (SOP)(t)		3,145		0		843		3,988
3. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0					41.76	7.3	41.76	7.3
1	46.12	79.8			9.18	61.7	55.30	76.8
2	23.92	123.4			0.83	92.9	24.75	122.4
3	4.07	151.7			0.28	100.8	4.35	148.5
4								
5								
6								
7								
8+								
TOTAL	74.12		0.00		52.04		126.16	
Land. (SOP)(t)		7,252		0		976		8,228
4. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			219.34	11.7	36.07	14.0	255.41	12.0
1	52.77	47.9			0.13	83.0	52.90	47.9
2	0.42	96.6			0.00	70.0	0.42	96.5
3	0.88	152.2					0.88	152.2
4								
5								
6								
7								
8+								
TOTAL	54.07		219.34		36.20		309.60	
Land. (SOP)(t)		2,699		2,566		516		5,781
TOTAL YEAR		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0			219.34	11.7	77.83	10.4	297.17	11.4
1	130.10	54.5	60.32	17.4	250.19	17.9	440.61	28.6
2	65.84	96.0	2.04	38.5	9.04	53.9	76.93	89.5
3	18.64	143.0	1.78	48.2	1.09	75.3	21.50	131.7
4								
5								
6								
7								
8+								
TOTAL	214.57		283.48		338.15		836.21	
Land. (SOP)(t)		16,081		3,780		5,853		25,715

Table 3.3.4 **Kattegat 1996** **North Sea Autumn Spawners**

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Fleet C		Fleet D		Fleet E		TOTAL	
1. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	20.70	35.6	303.40	14.2	53.64	14.7	377.73	15.4
2	22.46	61.1	1.91	43.8	1.05	33.3	25.42	58.7
3	2.68	140.3	0.81	72.4	0.03	81.0	3.52	124.2
4								
5								
6								
7								
8+								
TOTAL	45.83		306.13		54.71		406.67	
Land. (SOP)(t)		2,486		4,451		826		7,762
2. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	3.16	32.7			19.78	15.2	22.94	17.6
2	2.96	63.2			1.35	37.9	4.31	55.2
3	0.67	99.2			0.80	68.8	1.47	82.7
4								
5								
6								
7								
8+								
TOTAL	6.80		0.00		21.93		28.72	
Land. (SOP)(t)		357		0		407		764
3. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0					7.28	7.3	7.28	7.3
1	13.25	28.5			0.64	61.7	13.89	30.0
2	32.97	54.9			0.09	92.9	33.06	55.1
3	4.96	85.0			0.06	100.8	5.02	85.2
4								
5								
6								
7								
8+								
TOTAL	51.18		0.00		8.08		59.25	
Land. (SOP)(t)		2,611		0		108		2,718
4. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	9.12	17.4	318.43	10.5	0.07	14.0	327.62	10.7
1	14.35	29.7	0.00		0.00		14.35	29.7
2	19.64	61.1	0.00		0.00		19.64	61.1
3								
4								
5								
6								
7								
8+								
TOTAL	43.11		318.43		0.07		361.61	
Land. (SOP)(t)		1,785		3,344		1		5,130
TOTAL YEAR		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	9.12	17.4	318.43	10.5	7.35	7.4	334.90	10.6
1	51.46	31.9	303.40	14.2	74.05	15.2	428.92	16.5
2	78.02	58.6	1.91	43.8	2.49	38.0	82.42	57.6
3	8.31	104.0			0.89	71.5	9.20	100.9
4								
5								
6								
7								
8+								
TOTAL	146.92		623.74		84.78		855.44	
Land. (SOP)(t)		7,238		7,736		1,341		16,315

Table 3.3.5 Skagerrak 1996 Western Baltic Spring Spawners

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Fleet C		Fleet D		Fleet E		TOTAL	
1. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	2.57	21.6	11.49	17.4	42.14	14.6	56.20	15.5
2	10.33	76.5	0.92	38.5	2.62	44.9	13.86	68.0
3	5.70	124.0	1.34	48.2	0.35	56.8	7.39	107.1
4	4.24	157.0					4.24	157.0
5	1.52	199.9	0.08	150.0			1.60	197.4
6	0.79	237.6					0.79	237.6
7	0.62	257.5					0.62	257.5
8+	0.54	276.6					0.54	276.6
TOTAL	26.30		13.83		45.11		85.24	
Land. (SOP)(t)		3,017		312		753		4,082
2. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	2.65	33.7			2.94	33.9	5.58	33.8
2	22.62	84.8			2.92	62.3	25.54	82.3
3	11.39	159.2			0.64	80.0	12.04	155.0
4	9.16	191.6			0.12	68.0	9.28	190.0
5	4.15	160.7					4.15	160.7
6	1.87	190.6					1.87	190.6
7	1.72	200.0					1.72	200.0
8+	2.62	190.1					2.62	190.1
TOTAL	56.18		0.00		6.62		62.80	
Land. (SOP)(t)		7,443		0		341		7,784
3. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0					22.48	7.3	22.48	7.3
1	5.12	79.8			1.02	61.7	6.14	76.8
2	89.99	123.4			3.12	92.9	93.11	122.4
3	25.03	151.7			1.69	100.8	26.73	148.5
4	20.94	180.0			1.40	116.3	22.34	176.1
5	15.85	191.2			0.25	189.0	16.10	191.1
6	6.58	209.0			0.25	125.0	6.83	205.9
7	2.90	190.4					2.90	190.4
8+	1.60	227.2					1.60	227.2
TOTAL	168.01		0.00		30.22		198.23	
Land. (SOP)(t)		24,405		0		929		25,334
4. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	9.31	47.9			0.02	83.0	9.33	47.9
2	41.48	96.6			0.15	70.0	41.62	96.5
3	11.65	152.2					11.65	152.2
4	4.67	183.3					4.67	183.3
5	2.22	209.0					2.22	209.0
6	0.76	222.5					0.76	222.5
7	0.11	218.0					0.11	218.0
8+	0.20	211.5					0.20	211.5
TOTAL	70.39		0.00		0.17		70.56	
Land. (SOP)(t)		7,780		0		12		7,792
TOTAL YEAR		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0					22.48	7.3	22.48	7.3
1	19.65	50.9	11.49	17.4	46.12	16.9	77.26	25.6
2	164.42	108.4	0.92	38.5	8.81	68.1	174.14	106.0
3	53.77	150.5	1.34	48.2	2.69	90.1	57.80	145.3
4	39.01	180.6			1.52	112.5	40.53	178.1
5	23.74	188.1	0.08	150.0	0.25	189.0	24.07	187.9
6	9.99	208.8			0.25	125.0	10.24	206.8
7	5.34	201.8					5.34	201.8
8+	4.97	212.3					4.97	212.3
TOTAL	320.89		13.83		82.12		416.84	
Land. (SOP)(t)		42,645		312		2,035		44,992

Table 3.3.6 **Kattegat 1996** **Western Baltic Spring Spawners**

Catch in numbers (millions) and mean weight (g) at age by fleet.

	Fleet C		Fleet D		Fleet E		TOTAL	
1. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	2.82	35.6	41.37	14.2	7.31	14.7	51.51	15.4
2	52.40	61.1	4.47	43.8	2.44	33.3	59.31	58.7
3	3.14	140.3	0.96	72.4	0.03	81.0	4.13	124.2
4	5.69	184.1	1.06	110.3	0.06	78.0	6.81	171.7
5	1.28	207.5	0.35	81.0		0.0	1.63	180.3
6	1.24	225.8				0.0	1.24	225.8
7	0.23	260.5				0.0	0.23	260.5
8+	0.10	221.0				0.0	0.10	221.0
TOTAL	66.90		48.20		9.85		124.96	
Land. (SOP)(t)		5,419		998		196		6,613
2. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0								
1	1.56	32.7			9.74	15.2	11.30	17.6
2	12.62	63.2			5.76	37.9	18.37	55.2
3	1.25	99.2			1.48	68.8	2.73	82.7
4	1.37	132.2			0.52	93.6	1.89	121.6
5	1.50	134.9			0.00	0.0	1.50	134.9
6	0.56	150.4			0.36	112.8	0.92	135.7
7	0.31	157.5					0.31	157.5
8+	0.21	170.0					0.21	170.0
TOTAL	19.38		0.00		17.86		37.24	
Land. (SOP)(t)		1,525		0		558		2,082
3. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0					1.49	7.3	1.49	7.3
1	15.56	28.5			0.75	61.7	16.31	30.0
2	160.95	54.9			0.45	92.9	161.40	55.1
3	15.70	85.0			0.21	100.8	15.90	85.2
4	3.53	132.9			0.19	116.3	3.72	132.1
5	2.26	159.8			0.03	189.0	2.29	160.2
6	0.90	177.6			0.03	125.0	0.93	175.9
7	1.10	170.7					1.10	170.7
8+	0.36	186.6					0.36	186.6
TOTAL	200.35		0.00		3.14		203.49	
Land. (SOP)(t)		11,865		0		151		12,016
4. QUARTER		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0	0.00	17.4						
1	17.54	29.7					17.54	29.7
2	95.87	61.1					95.87	61.1
3	7.05	76.9					7.05	76.9
4	0.58	144.9					0.58	144.9
5	0.51	169.1					0.51	169.1
6	0.26	167.4					0.26	167.4
7								
8+								
TOTAL	121.80		0.00		0.00		121.80	
Land. (SOP)(t)		7,137		0		0		7,137
TOTAL YEAR		Mean		Mean		Mean		Mean
Winter rings	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
0					1.49	7.3	1.49	7.3
1	37.48	29.8	41.37	14.2	17.81	17.0	96.65	20.7
2	321.85	58.1	4.47	43.8	8.65	39.5	334.96	57.4
3	27.14	90.0	0.96	72.4	1.72	72.8	29.81	88.4
4	11.16	159.5	1.06	110.3	0.77	98.0	12.99	151.9
5	5.54	164.9	0.35	81.0	0.03	189.0	5.92	160.1
6	2.96	191.7			0.39	113.7	3.35	182.6
7	1.63	180.9					1.63	180.9
8+	0.68	186.4					0.68	186.4
TOTAL	408.43		48.20		30.86		487.49	
Land. (SOP)(t)		25,946		998		905		27,848

Table 3.3.7 Western Baltic Spring Spawning Herring

Landings of Herring from the North Sea, Div. IIIa and the Western Baltic area in 1996
Catch in numbers (mill) and mean weight (g) by fleet.

Fleet: A: 32mm fishery in the North Sea; C: 32mm fishery in Div. IIIa; D: Mixed clupeoid fleet in Div IIIa; E: <32mm fishery in Div IIIa; F: Div. 22-24 Fisheries

	Fleet A		Fleet C		Fleet D		Fleet E		Fleet F		Total	
1. Quarter												
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0												
1			5.39	28.94	52.86	14.90	49.45	14.61	125.21	21.68	232.92	18.8
2			62.73	63.65	5.38	42.90	5.06	39.30	26.39	41.12	99.56	55.3
3			8.84	129.8	2.30	58.3	0.39	58.8	24.49	76.2	36.01	88.0
4			9.93	172.5	1.06	110.3	0.06	78.0	19.57	96.3	30.62	121.5
5			2.80	203.4	0.43	93.84			10.34	107.7	13.57	127.0
6			2.03	230.4					2.54	115.5	4.57	166.4
7			0.85	258.3					0.94	105.8	1.79	178.2
8+			0.64	267.9					2.37	116.8	3.01	148.9
Total	0.00		93.21	90.5	62.03	21.11	54.95	17.3	211.85	44.1	422.05	47.5
SOP (t)		0		8,436		1,309		949		9,334		20,029
2. Quarter												
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0												
1			4.20	33.34			12.68	19.53	261.86	22.3	278.74	22.3
2			35.24	77.1			8.68	46.1	31.54	42.1	75.46	58.9
3			12.64	153.3			2.13	72.2	38.02	76.0	52.79	94.3
4			10.53	183.9			0.64	88.8	37.25	92.9	48.42	112.6
5			5.65	153.9					29.08	123.8	34.73	128.7
6			2.43	181.3			0.36	112.8	17.38	151.8	20.17	154.6
7			2.02	193.5					9.44	181.4	11.46	183.6
8+			2.84	188.5					12.23	199.8	15.07	197.7
Total	0.00		75.56	118.7	0.00		24.49	36.7	436.80	54.7	536.85	62.9
SOP (t)		0		8,968		0		899		23,908		33,774
3. Quarter												
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0							23.97	7.30	1.97	12.2	25.95	7.7
1			20.68	41.21			1.77	61.70	9.54	35.6	32.00	40.7
2			250.94	79.5			3.57	92.9	10.18	55.3	264.69	78.8
3	2.80	160.0	40.73	126.0			1.90	100.8	26.12	72.1	71.55	107.0
4	0.80	192.0	24.47	173.3			1.59	116.3	20.44	89.2	47.29	135.3
5	0.40	207.0	18.11	187.2			0.28	189.0	26.19	112.6	44.98	144.0
6	0.10	211.0	7.48	205.2			0.28	125.0	14.32	103.0	22.18	138.2
7	0.10	252.0	3.99	185.0					6.04	110.0	10.14	140.9
8+	0.30	271.0	1.96	219.7					2.24	165.8	4.50	196.3
Total	4.50	180.4	368.36	98.5	0.00		33.36	32.4	117.04	86.2	523.27	92.2
SOP (t)		812		36,270		0		1,080		10,093		48,255
4. Quarter												
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0									3.33	12.1	3.33	12.1
1			26.85	35.97			0.02	83.00	16.48	34.8	43.35	35.6
2			137.35	71.9			0.15	70.0	16.94	51.6	154.44	69.6
3			18.70	123.8					35.69	70.4	54.38	88.8
4			5.25	179.1					27.50	86.6	32.75	101.4
5			2.72	201.6					34.17	112.3	36.89	118.9
6			1.02	208.4					19.00	102.6	20.01	108.0
7			0.11	218.0					7.74	110.0	7.85	111.5
8+			0.20	211.5					2.77	167.4	2.97	170.4
Total	0.00		192.19	77.6	0.00		0.17	71.7	163.62	82.4	355.98	79.8
SOP (t)		0.0		14,917		0		12		13,482		28,411
Total Year												
W. rings	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W	Numbers	Mean-W
0							23.97	7.3	5.30	12.1	29.28	8.2
1			57.13	37.0	52.86	14.9	63.92	16.9	413.09	22.9	587.01	22.9
2			486.26	75.1	5.38	42.9	17.46	53.9	85.05	45.3	594.15	69.9
3	2.80	160.0	80.91	130.2	2.30	58.3	4.41	83.3	124.32	73.6	214.73	96.1
4	0.80	192.0	50.17	176.0	1.06	110.3	2.29	107.6	104.76	91.2	159.08	118.8
5	0.40	207.0	29.28	183.7	0.43	93.8	0.28	189.0	99.79	115.3	130.18	131.0
6	0.10	211.0	12.95	204.9			0.64	118.1	53.24	119.4	66.93	136.1
7	0.10	252.0	6.98	196.9					24.16	137.8	31.23	151.3
8+	0.30	271.0	5.64	209.2					19.60	181.3	25.55	188.5
Total	4.50	180.4	729.32	94.0	62.03	21.11	112.98	26.0	929.31	61.1	1838.14	71.0
SOP (t)		812		68,591		1,309		2,940		56,817		130,470

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Table 3.3.8 Total catch in numbers (mill) and mean weight (g), SOP (tonnes) of spring spawners in Division IIIa and the North Sea in the year 1987 - 1996.

Year	Rings	0	1	2	3	4	5	6	7	8+	Total
	Number			767.00	167.10	82.90	27.70	9.30	1.20	0.20	1,055.40
1987	Mean W.			57.0	85.0	105.6	145.3	154.6	201.2	280.4	
	SOP			43,719	14,204	8,754	4,025	1,438	241	56	72,437
	Number			2075.00	563.00	62.00	8.00	2.00	0.50	0.50	2,711.00
1988	Mean W.			47.3	77.0	138.3	156.0	166.0	149.0	209.0	
	SOP			98,148	43,351	8,575	1,248	332	75	105	151,832
	Number			497.69	503.66	115.23	29.96	13.68	5.35	2.34	1,167.91
1989	Mean W.			56.5	79.9	125.5	151.6	167.3	189.2	204.8	
	SOP			28,119	40,242	14,461	4,542	2,289	1,012	479	91,145
	Number		140.90	1006.23	259.90	192.21	62.07	9.99	19.09	2.20	1,692.59
1990	Mean W.		56.6	65.0	84.6	102.4	111.1	109.3	141.0	84.3	
	SOP		7,975	65,405	21,988	19,682	6,896	1,092	2,692	185	125,915
	Number	64.80	43.00	352.05	447.07	174.71	108.85	22.35	7.62	3.09	1,223.54
1991	Mean W.	33.7	60.5	77.4	101.7	127.5	148.6	165.4	182.5	194.9	
	SOP	2,184	2,602	27,249	45,467	22,276	16,175	3,697	1,391	602	121,641
	Number		66.98	214.33	156.34	128.78	63.88	43.59	12.65	7.76	694.31
1992	Mean W.		53.4	96.2	115.2	138.6	172.9	184.0	201.7	201.3	
	SOP		3,577	20,619	18,010	17,849	11,045	8,021	2,552	1,562	83,234
	Number		52.92	185.91	245.60	101.75	63.05	43.65	23.86	8.88	725.62
1993	Mean W.		60.4	88.6	121.5	147.2	160.3	182.9	195.6	218.2	
	SOP		3,196	16,472	29,840	14,978	10,107	7,984	4,667	1,938	89,181
	Number			157.34	248.54	137.01	80.20	45.92	14.75	8.40	692.16
1994	Mean W.			127.2	120.1	148.6	165.3	190.6	204.1	216.5	
	SOP			20,014	29,850	20,360	13,257	8,752	3,010	1,819	97,061
	Number	84.40	504.27	254.11	132.29	81.25	52.50	16.07	10.14	4.70	1,139.73
1995	Mean W.	17.5	37.8	101.2	148.3	165.5	188.7	213.0	233.1	232.2	
	SOP	1,477	19,061	25,716	19,619	13,447	9,907	3,423	2,364	1,091	96,104
	Number	23.97	173.92	509.10	90.41	54.32	30.39	13.69	7.08	5.94	908.83
1996	Mean W.	7.3	22.9	74.1	127.0	172.0	182.8	200.9	197.7	212.3	
	SOP	175	3,983	37,702	11,481	9,345	5,554	2,751	1,399	1,262	73,653

There may be minor corrections in data from 1987 and 1988.

Table 3.3.9 Herring Division IIIa, 1987 - 1996
Transfers of autumn spawners from Div. IIIa to the North Sea Numbers (mill) and mean weight, SOP in (tonnes).

Year	Rings	0	1	2	3	4	5	6	7	8+	Total
	Number	6238.00	3153.00	117.00							9508.00
1987	Mean W.	8.0	33.0	63.0							
	SOP	49,904	104,049	7,371							161,324
	Number	1830.00	5792.00	292.00							7914.00
1988	Mean W.	12.0	28.0	57.0							
	SOP	21,960	162,176	16,644							200,780
	Number	1,028.20	1,170.50	654.80							2853.50
1989	Mean W.	16.2	33.4	53.3							
	SOP	16,657	39,095	34,901							90,652
	Number	397.90	1,424.30	283.70							2105.90
1990	Mean W.	31.0	34.1	55.4							
	SOP	12,335	48,569	15,717							76,621
	Number	712.30	822.70	330.20							1865.20
1991	Mean W.	25.3	40.7	77.8							
	SOP	18,021	33,484	25,690							77,195
	Number	2407.51	1587.09	283.80	26.79	26.61	15.98	12.33	5.46	1.00	4366.57
1992	Mean W.	12.3	50.6	94.8	164	171.7	184.7	197.5	202.7	219.8	
	SOP	29,612	80,307	26,904	4,394	4,569	2,952	2,435	1,107	220	152,499
	Number	2,956.70	2,351.10	350.01							5,658
1993	Mean W.	12.7	27.5	86.6							
	SOP	37,550	64,655	30,311							132,516
	Number	542.23	1,239.65	305.19							2,087
1994	Mean W.	16.5	42.9	77.3							
	SOP	8,947	53,181	23,591							85,719
	Number	1,722.84	1,069.58	126.37							2,919
1995	Mean W.	12.5	32.8	102.7							
	SOP	21,536	35,082	12,978							69,596
	Number	632.07	869.53	159.35	31.52						1692.47
1996	Mean W.	11.0	22.7	73.0	121.2						
	SOP	6,953	19,738	11,633	3,820						42,144

There are minor corrections for the years previous to 1991.

Table 3.3.10 **Total catch in numbers (mill) and mean weight (g), SOP (tonnes) of spring spawners in Division IIIa and the North Sea + in Sub-Divisions 22-24 in the years 1987 - 1996**

Year	Area	Rings	0	1	2	3	4	5	6	7	8+	Total
	North Sea +Div. IIIa	Number			767.00	167.10	82.90	27.70	9.30	1.20	0.20	1,055.40
1987	Sub-Division 22-24	Number	771.20	1,090.00	221.00	220.00	311.00	97.00	28.00	8.00	4.00	2,750.20
	North Sea +Div. IIIa	Number			2,075.00	563.00	62.00	8.00	2.00	0.50	0.50	2,711.00
1988	Sub-Division 22-24	Number	789.50	861.00	364.00	363.00	142.00	119.00	34.00	10.00	6.00	2,688.50
	North Sea +Div. IIIa	Number			497.69	503.66	115.23	29.96	13.68	5.35	2.34	1,167.91
1989	Sub-Division 22-24	Number	129.70	682.00	285.00	386.00	244.00	59.00	34.00	11.00	4.00	1,834.70
	North Sea +Div. IIIa	Number		140.90	1,006.23	259.90	192.21	62.07	9.99	19.09	2.20	1,692.59
1990	Sub-Division 22-24	Number	160.50	286.30	162.10	215.10	263.90	105.90	27.00	12.30	4.40	1,237.50
	North Sea +Div. IIIa	Number	64.80	43.00	352.05	447.07	174.71	108.85	22.35	7.62	3.09	1,223.54
1991	Sub-Division 22-24	Number	22.34	787.65	179.89	184.82	114.88	67.59	25.97	6.14	1.81	1,391.09
	North Sea +Div. IIIa	Number		66.98	214.33	156.34	128.78	63.88	43.59	12.65	7.76	694.31
1992	Sub-Division 22-24	Number	36.01	210.71	280.77	190.84	179.52	104.87	84.01	34.75	14.04	1,135.52
	North Sea +Div. IIIa	Number		52.92	185.91	245.60	101.75	63.05	43.65	23.86	8.88	725.62
1993	Sub-Division 22-24	Number	44.85	159.21	180.13	196.06	166.87	151.07	61.80	42.21	16.31	1,018.51
	North Sea +Div. IIIa	Number			157.34	248.54	137.01	80.20	45.92	14.75	8.40	692.16
1994	Sub-Division 22-24	Number	202.58	96.29	103.84	161.01	136.06	90.84	74.02	35.11	24.47	924.22
	North Sea +Div. IIIa	Number	84.40	504.27	254.11	132.29	81.25	52.50	16.07	10.14	4.70	1,139.73
1995	Sub-Division 22-24	Number	490.99	1,358.18	233.95	128.88	104.01	53.57	38.82	20.87	13.22	2,442.49
	North Sea +Div. IIIa	Number	23.97	173.92	509.10	90.41	54.32	30.39	13.69	7.08	5.94	908.82
1996	Sub-Division 22-24	Number	5.30	413.09	85.05	124.32	104.76	99.79	53.24	24.16	19.60	929.31

Table 3.3.11 **Mean weight (g) and SOP (tonnes) of spring spawners in Division IIIa and the North Sea + in Sub-Divisions 22-24 in the years 1987 - 1996**

Year	Area	Rings	0	1	2	3	4	5	6	7	8+	SOP
	North Sea +Div. IIIa	Mean weight			57.0	85.0	105.6	145.3	154.6	201.2	280.4	72,437
1987	Sub-Division 22-24	Mean weight	11.7	15.7	34.8	76.7	98.4	121.9	141.4	151.4	163.4	89,954
	North Sea +Div. IIIa	Mean weight			47.3	77.0	138.3	156.0	166.0	149.0	209.0	151,832
1988	Sub-Division 22-24	Mean weight	11.0	16.9	29.1	83.8	108.5	124.8	142.2	143.7	135.8	92,908
	North Sea +Div. IIIa	Mean weight			56.5	79.9	125.5	151.6	167.3	189.2	204.8	91,145
1989	Sub-Division 22-24	Mean weight	13.5	17.5	43.6	70.5	105.9	122.0	125.5	137.8	131.5	91,002
	North Sea +Div. IIIa	Mean weight		56.6	65.0	84.6	102.4	111.1	109.3	141.0	84.3	125,915
1990	Sub-Division 22-24	Mean weight	13.8	24.2	44.5	75.5	95.9	121.1	142.6	138.7	145.8	73,978
	North Sea +Div. IIIa	Mean weight	33.7	60.5	77.4	101.7	127.5	148.6	165.4	182.5	194.9	121,641
1991	Sub-Division 22-24	Mean weight	11.5	31.5	58.5	78.8	98.5	120.9	138.6	152.2	179.0	82,390
	North Sea +Div. IIIa	Mean weight		53.4	96.2	115.2	138.6	172.9	184.0	201.7	201.3	83,234
1992	Sub-Division 22-24	Mean weight	19.1	23.3	44.8	77.4	99.2	123.3	152.9	166.2	184.2	84,874
	North Sea +Div. IIIa	Mean weight		60.4	88.6	121.5	147.2	160.3	182.9	195.6	218.2	89,181
1993	Sub-Division 22-24	Mean weight	16.2	24.5	44.5	73.6	94.1	122.4	149.4	168.5	169.1	80,358
	North Sea +Div. IIIa	Mean weight			127.2	120.1	148.6	165.3	190.6	204.1	216.5	97,061
1994	Sub-Division 22-24	Mean weight	12.9	28.2	54.2	76.4	95.0	117.7	133.6	154.3	173.9	66,425
	North Sea +Div. IIIa	Mean weight	17.5	37.8	101.2	148.3	165.5	188.7	213.0	233.1	232.2	96,102
1995	Sub-Division 22-24	Mean weight	9.3	16.3	42.8	68.3	88.9	125.4	150.4	193.3	207.4	74,157
	North Sea +Div. IIIa	Mean weight	7.3	22.9	74.1	127.0	172.0	182.8	200.9	197.7	212.3	73,653
1996	Sub-Division 22-24	Mean weight	12.1	22.9	45.3	73.6	91.2	115.3	119.4	137.8	181.3	56,817

There may be minor corrections in data from 1987 and 1988.

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Table 3.4.1 **Herring in Division IIIa, IIIb and IIIc.**
Samples of commercial catches by quarter and Sub-Div. for 1996 available to the Working Group.

Area	Country	Quarter	Landings in '000 tons	Number of samples	Number of fish meas.	Number of fish aged
Skagerrak	Denmark	1	7.5	16	1805	1805
		2	1.3	10	162	162
		3	13.7	17	299	291
		4	6.2	9	687	687
		Total	28.7	52	2,953	2,945
	Norway	1	0.0			
		2	5.6	8	301	299
		3	2.7			
		4	1.1	30	388	
			9.4	38	689	299
	Sweden	1	4.3	8	1,730	443
		2	4.9	8	1,669	458
		3	17.2	12	1,556	484
		4	6.4	8	1,317	443
		Total	32.8	36	6,272	1,828
Kattegat	Country	Quarter	Landings in '000 tons	Number of samples	Number of fish meas.	Number of fish aged
	Denmark	1	10.0	17	2003	2003
		2	1.3	2	230	230
		3	1.5	1	150	150
		4	4.4	1	100	100
		Total	17.2	21	2,483	2,483
	Sweden	1	4.4	60	9,863	972
		2	1.6	9	1,972	642
		3	13.2	27	4101	1,291
		4	7.8	14	2,919	851
		Total	27.0	110	18,855	3,756
Sub-Division 22-24	Country	Quarter	Landings in '000 tons	Number of samples	Number of fish meas.	Number of fish aged
	Denmark	1	6.8	3	31	2
		2	10.5	4	390	348
		3	6.7	1	107	107
		4	10.4	0	0	0
		Total	34.4	8	528	457
	Germany	1	0.1	8	3,170	694
		2	6.8	25	7,514	1,381
		3	0.1	0	0	0
		4	0.2	87	21,083	1,265
		Total	7.2	120	31,767	3,340
	Poland	1	0.4	?		
		2	5.2	?		
		3	0.1	?		
		4	0.3	?		
		Total	6.0	0	0	0
	Sweden	1	2.0			
		2	1.2			
		3	3.3	5	332	332
		4	2.6			
		Total	9.1	5	332	332

Table 3.5.1 German Bottom Trawl Survey in Sub-Div. 24.
Young Fish survey in November/December
Mean catch at age in numbers per haul.

Month	Year	Winter rings				Total	Mean catch in kg.
		0	1	2	3+	numbers	Herring
Nov.	1979	8,665.90	240.47	103.36	10.33	9,020.06	89.61
Nov.	1981	332.63	96.79	60.05	21.30	510.77	16.36
Dec.	1982	695.71	108.21	70.63	34.72	909.27	24.57
Dec.	1983	1,995.97	387.11	63.71	46.11	2,492.90	46.68
Nov.	1984	1,581.66	377.15	88.03	24.26	2,071.10	39.79
Nov.	1985	3,085.64	340.92	169.95	74.76	3,671.27	45.99
Dec.	1986	2,984.47	368.35	46.41	69.30	3,468.53	44.42
Nov.	1989	2,881.81	319.38	48.99	55.12	3,305.30	47.76
Nov.	1990	103.92	14.79	21.69	32.90	173.30	7.09
Nov.	1991	117.38	134.20	103.14	144.63	499.35	27.16
Nov.	1992	233.85	88.05	57.15	113.58	492.63	19.86
Nov.	1993	1,744.19	37.10	63.87	544.65	2,389.81	66.46
Nov.	1994	1,020.49	13.21	73.47	583.23	1,690.40	79.34
Nov.	1995	635.09	33.22	47.97	324.98	1,041.27	47.53
Nov.	1996	514.52	36.12	49.04	349.44	949.12	25.82

Table 3.5.2 German Bottom Trawl Survey in Sub-Div. 22.
Young Fish survey in November/December
Mean catch at age in numbers per haul.

Month	Year	Winter rings				Total	Mean catch in kg.
		0	1	2	3+	Numbers	Herring
Nov.	1979	3,561.79	1,358.84	137.11	7.68	5,065.42	86.91
Nov.	1981	1,033.40	118.85	28.35	9.10	1,189.70	17.69
Dec.	1982	354.00	239.45	44.50	26.20	664.15	19.97
Dec.	1983	7,917.00	834.70	80.10	29.50	8,861.30	117.51
Nov.	1984	6,596.32	1,830.32	150.47	40.47	8,617.58	147.45
Nov.	1985	3,506.20	958.80	219.80	25.25	4,710.05	83.38
Nov.	1986	6,863.75	175.35	16.55	5.60	7,061.25	54.18
Nov.	1989	10,587.70	1,444.50	117.75	76.45	12,226.40	176.53
Nov.	1992	572.68	87.68	19.16	17.26	696.78	13.13
Nov.	1993	8,419.70	1,644.05	1,293.70	898.10	12,255.55	301.71
Nov.	1994	2,158.10	317.35	1,588.45	326.35	4,390.25	135.65
Nov.	1995	1,226.63	158.75	29.00	123.31	1,537.69	31.17
Nov.	1996	8.76	193.71	101.24	57.76	361.47	15.23

Table 3.5.3 German Bottom Trawl Survey in Sub-Div. 22 and 24.
Young Fish survey in November/December
Mean catch at age in numbers per haul.

Sum weighted by area of sub-division :

Area of 24 is	2325 sq.nm
Area of 22 is	485 sq.nm
Total	2810 sq.nm

Month	Year	Winter rings				Total	Mean catch in kg.
		0	1	2	3+	Numbers	Herring
Nov.	1979	7784.9	433.5	109.2	9.9	8337.5	89.1
Nov.	1981	453.6	100.6	54.6	19.2	628.0	16.6
Dec.	1982	636.7	130.9	66.1	33.2	867.0	23.8
Dec.	1983	3017.9	464.4	66.5	43.2	3592.1	58.9
Nov.	1984	2447.2	628.0	98.8	27.1	3201.0	58.4
Nov.	1985	3158.2	447.6	178.6	66.2	3850.6	52.4
Nov.	1986	3654.0	335.0	41.3	58.3	4088.6	46.1
Nov.	1989	4211.8	513.6	60.9	58.8	4845.1	70.0
Nov.	1992	292.3	88.0	50.6	97.0	527.9	18.7
Nov.	1993	2896.4	314.5	276.1	605.7	4092.6	107.1
Nov.	1994	1216.8	65.7	335.0	538.9	2156.4	89.1
Nov.	1995	737.2	54.9	44.7	290.2	1126.9	44.7
Nov.	1996	427.2	63.3	58.0	299.1	847.7	24.0

Table 3.5.4 **German Bottom Trawl Survey in January/February in Sub-Div. 24. Mean catch at age in numbers per haul.**

Year	Winter rings							
	1	2	3	4	5	6	7	8+
1979	1597.6	702.2	106.5	23.0	4.9	0.0	0.5	0.0
1981	1038.7	642.8	67.9	54.9	13.0	1.4	0.4	0.6
1984	4865.4	1094.8	153.7	32.0	11.4	0.8	0.6	0.0
1985	3018.3	3253.6	1012.2	307.8	87.9	38.8	8.8	0.8
1986	7585.8	514.0	386.7	85.4	20.0	10.5	3.6	0.9
1987	712.9	338.1	154.7	201.7	51.2	21.2	2.6	0.9
1988	5031.7	2553.0	291.6	31.8	20.9	4.4	1.6	0.2
1989	6654.5	2099.3	612.6	103.7	21.8	6.1	5.7	1.3
1990	4568.5	1393.1	124.4	52.1	4.4	8.5	0.8	0.2
1991	1961.0	636.2	261.4	87.1	34.5	8.8	2.0	2.1
1992	2778.1	820.6	251.2	79.7	26.8	9.7	3.1	1.1
1993	959.9	371.2	94.8	61.3	44.4	13.9	5.6	1.0
1994	996.3	214.9	201.9	329.5	130.6	75.8	30.3	21.0
1995	1949.0	91.7	328.7	131.1	83.6	24.4	27.9	11.3
1996	1221.7	188.9	83.3	87.9	86.7	41.4	33.3	86.7

Table 3.5.5
Acoustic surveys on the Spring-spawning HERRING in the North Sea/Div. IIIa and in Sub-Div. 22-24 in 1992.
(North Sea/Div. IIIa in July and Sub-Div. 22-24 in October)

Numbers in millions			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0	3,853	3,412	7,265
1	277	1,658	1,935
2	2,092	657	2,749
3	1,799	282	2,081
4	1,593	156	1,749
5	556	37	593
6	197	25	222
7	122	4	126
8+	20		20
Total	6,379	6,231	16,740
3+ group	6,359	504	4,791
Biomass ('000 tonnes)			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0	34.3	53.2	87.5
1	26.8	61.3	88.2
2	169.0	39.6	208.6
3	206.3	20.6	226.9
4	204.7	14.4	219.1
5	83.3	4.6	87.9
6	36.6	3.3	39.9
7	24.4	0.7	25.0
8+	5.0		5.0
Total	790.4	197.7	988.1
Mean weight (g)			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0	8.9	15.6	12.0
1	96.8	37.0	45.6
2	80.8	60.2	75.9
3	114.7	73.0	109.0
4	128.5	92.1	125.3
5	149.8	125.6	148.3
6	185.7	132.0	179.7
7	199.7	168.1	198.7
8+	252.0		252.0
Mean weight	123.9	31.7	59.0

Table 3.5.6
Acoustic surveys on the Spring-spawning HERRING in the North Sea/Div. IIIa and in Sub-Div. 22-24 in 1993.
(North Sea/Div. IIIa in July and Sub-Div. 22-24 in October)

Numbers in millions			
	North Sea/Div IIIa	Sub-Div. 22-24	Total
W-rings			
0	372	1,414	1,786
1	103	466	569
2	2,768	393	3,161
3	1,274	518	1,792
4	598	402	1,000
5	434	145	579
6	154	64	218
7	63	31	94
8+	13	16	29
Total	5,779	3,449	9,228
3+ group	2,536	1,176	3,712

Biomass ('000 tonnnes)			
	North Sea/Div IIIa	Sub-Div. 22-24	Total
W-rings			
0	1	21	23
1	7	16	23
2	139	18	157
3	112	34	146
4	69	28	98
5	65	16	81
6	26	9	35
7	16	4	20
8+	2	3	5
Total	438	150	588

Mean weight (g)			
	North Sea/Div IIIa	Sub-Div. 22-24	Total
W-rings			
0	4.0	14.9	12.6
1	66.3	35.2	40.8
2	50.1	45.6	49.5
3	87.9	65.8	81.5
4	116.2	69.7	97.5
5	149.9	111.2	140.2
6	169.6	146.2	162.7
7	256.9	125.4	213.5
8+	164.2	171.3	168.1
Mean weight	75.8	43.4	63.7

Table 3.5.7
Acoustic surveys on the Spring-spawning HERRING in the North Sea/Div. IIIa and in Sub-Div. 22-24 in 1994. (North Sea/Div. IIIa in July and Sub-Div. 22-24 in October)

Numbers in millions			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0	964	6,749	7,713
1	5	457	462
2	413	831	1,244
3	935	525	1,460
4	501	449	950
5	239	195	434
6	186	63	249
7	62	25	87
8+	34	2	36
Total	3,339	9,295	12,634
3+ group	1,957	1,258	3,215
Biomass ('000 tonnnes)			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0	8.7	77.0	85.7
1	0.4	16.0	16.4
2	33.2	38.1	71.3
3	114.7	38.8	153.5
4	76.7	43.2	119.9
5	41.8	24.9	66.8
6	38.1	12.9	51.0
7	13.1	5.0	18.2
8+	7.8	0.0	7.8
Total	334.5	255.9	590.4
Mean weight (g)			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0	9.0	11.4	11.1
1	80.0	34.9	35.4
2	80.3	45.8	57.3
3	122.7	73.8	105.1
4	153.0	96.3	126.2
5	175.1	127.7	153.8
6	205.0	206.3	205.3
7	212.0	204.5	209.9
8+	230.3		217.4
Mean weight	100.2	27.5	46.7

Table 3.5.8
Acoustic surveys on the Spring-spawning HERRING in the North Sea/Div. IIIa and in Sub-Div. 22-24 in 1995.
(North Sea/Div. IIIa in July and Sub-Div. 22-24 in October)

Numbers in millions

W-rings	North Sea/Div. IIIa	Sub-Div. 22-24	Total
0		4,765	4,765
1	2,199	1,315	3,514
2	1,887	353	2,240
3	1,022	354	1,376
4	1,270	375	1,645
5	255	269	524
6	174	133	307
7	39	37	76
8+	21	25	46
Total	6,867	7,626	14,493
3+ group	2,781	1,193	3,974

Biomass ('000 tonnnes)

W-rings	North Sea/Div. IIIa	Sub-Div. 22-24	Total
0		51.5	51.5
1	77.4	44.4	121.8
2	108.9	22.4	131.2
3	102.6	30.6	133.2
4	145.5	41.1	186.7
5	33.9	27.1	61.0
6	27.4	13.9	41.2
7	6.7	7.6	14.4
8+	3.8	5.4	9.2
Total	506.2	244.2	750.4

Mean weight (g)

W-rings	North Sea/Div. IIIa	Sub-Div. 22-24	Total
0		10.8	10.8
1	35.2	33.8	34.7
2	57.7	63.4	58.6
3	100.4	86.6	96.8
4	114.6	109.7	113.5
5	132.9	100.8	116.4
6	157.2	104.4	134.3
7	172.9	206.0	189.0
8+	183.1	217.5	201.9
Mean weight	73.7	32.0	51.8

Table 3.5.9
Acoustic surveys on the Spring-spawning HERRING in the North Sea/Div. IIIa and in Sub-Div. 22-24 in 1996.
(North Sea/Div. IIIa in July and Sub-Div. 22-24 in October)

Numbers in millions			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0		1,841	1,841
1	1,091	1,391	2,482
2	1,005	559	1,564
3	247	430	677
4	141	313	454
5	119	278	397
6	37	119	156
7	20	47	67
8+	13	16	29
Total	2,673	4,994	7,667
3+ group	577	1,203	1,780

Biomass ('000 tonnes)			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0		18.0	18.0
1	52.9	45.6	98.5
2	87.0	40.6	127.6
3	27.6	38.5	66.1
4	17.9	31.5	49.4
5	17.8	29.8	47.5
6	5.8	13.6	19.4
7	3.3	8.9	12.2
8+	2.7	2.7	5.5
Total	215.1	229.2	444.3

Mean weight (g)			
	North Sea/Div. IIIa	Sub-Div. 22-24	Total
W-rings			
0		9.8	9.8
1	48.5	32.8	39.7
2	86.6	72.6	81.6
3	111.9	89.5	97.7
4	126.8	100.6	108.7
5	149.4	107.0	119.7
6	157.3	114.2	124.5
7	166.8	189.4	182.7
8+	212.9	171.4	189.9
Mean weight	80.5	45.9	58.0

Table 3.5.10

Estimation of the herring O-Group (TL>= 30 mm)

Greifswalder Bodden and adjacent waters

(March/April to June)

Year	Number in Millions
1977	2000[1]
1978	100[1]
1979	2200[1]
1980	360[1]
1981	200[1]
1982	180[1]
1983	1760[1]
1984	290[1]
1985	1670[1]
1986	1500[1]
1987	1370[1]
1988	1223[2]
1989	63[2]
1990	57[2]
1991	236[3]
1992	18[3]
1993	199[3]
1994	788[2]
1995	171[2]
1996	not yet available

[1]Brielmann 1989

[2]not yet published

[3]Mueller & Klenz 1994

Table 3.5.11 Mean numbers at ages 1 to 5 from IBTS in February, 1992 to 1997.

Skagerrak, numbers

	WR 1	WR 2	WR 3	WR 4	WR 5
1992	1954	72	12	4	10
1993	47646	639	24	2	3
1994	2782	161	20	4	6
1995	622	52	6	1	1
1996	8079	958	109	36	34
1997	20156	400	54	2	14

Kattegat, numbers

	WR 1	WR 2	WR 3	WR 4	WR 5
1992	6302	1199	307	183	59
1993	25873	3317	321	63	20
1994	11397	3327	1450	139	122
1995	8874	708	224	168	38
1996	13756	6943	1270	302	251
1997	26233	1752	1450	61	170

Table 3.7.1 Input parameters for ICA

/users/fish/ifad/ifapwork/hawg/her_3a22/CANUM.I09
/users/fish/ifad/ifapwork/hawg/her_3a22/WECA.I09
/users/fish/ifad/ifapwork/hawg/her_3a22/WEST.I09
Stock weights in 1997 assumed = stock weights in 1996
/users/fish/ifad/ifapwork/hawg/her_3a22/NATMOR.I09
M in 1997 assumed = M in 1996
/users/fish/ifad/ifapwork/hawg/her_3a22/MATPROP.I09
Ogive in 1997 assumed = ogive in 1996
/users/fish/ifad/ifapwork/hawg/her_3a22/FPROP.I09
/users/fish/ifad/ifapwork/hawg/her_3a22/MPROP.I09
/users/fish/ifad/ifapwork/hawg/her_3a22/FLEET.I09

No indices of spawning biomass to be used.
No of years for separable constraint ? --> 6
Reference age for separable constraint ? --> 4
Constant selection pattern model (Y/N) ? -->y
S to be fixed on last age ? --> 1
First age for calculation of reference F --> 3
Last age for calculation of reference F --> 6
Use default weighting (Y/N) ? --> y
Is the last age of FLT04: Acoustic Surv in DIIIa a plus group ? (Y/N)--> y
Is the last age of FLT05: Acoustic Surv in SD22-24 a plus group ? (Y/N)--> y
Is the last age of FLT11: Germ Bott Trawl Sur SD 24 a plus group ? (Y/N)--> y

You must choose a catchability model for each index.
Models : A Absolute: Index = Abundance + e
L Linear: Index = Q . Abundance + e
P Power: Index = Q . Abundance^K + e
where Q and K are parameters to be estimated, and
e is a lognormally-distributed error.
Model for FLT04: Acoustic Surv in Div IIIa is to be (A/L/P) ?--> l
Model for FLT05: Acoustic Surv in SD 22-24 is to be (A/L/P) ?--> l
Model for FLT11: Ger Bott Tra Su SD 24 Feb is to be (A/L/P) ?--> l

Fit a stock-recruit relationship (Y/N) ? --> n

Enter lowest feasible F --> .05
Enter highest feasible F --> 1

No of years for separable analysis : 6
Age range in the analysis : 3 8
Year range in the analysis : 1987 1996
Number of indices of SSB : 0
Number of age-structured indices : 3
Parameters to estimate : 37
Number of observations : 183

Conventional single selection vector model to be fitted.

Weighting options :
1 - Recalculate all survey weights iteratively.
2 - Enter survey weights by hand.
Enter your choice --> 2
Enter weight for FLT04: Acoustic Survey in IIIa at age 3 --> 1
Enter weight for FLT04: Acoustic Survey in IIIa at age 4 --> 1
Enter weight for FLT04: Acoustic Survey in IIIa at age 5 --> 1
Enter weight for FLT04: Acoustic Survey in IIIa at age 6 --> 1
Enter weight for FLT04: Acoustic Survey in IIIa at age 7 --> 1
Enter weight for FLT04: Acoustic Survey in IIIa at age 8 --> 1
Enter weight for FLT05: Acoustic Surv. in 22-24 at age 3 --> 1
Enter weight for FLT05: Acoustic Surv. in 22-24 at age 4 --> 1
Enter weight for FLT05: Acoustic Surv. in 22-24 at age 5 --> 1
Enter weight for FLT05: Acoustic Surv. in 22-24 at age 6 --> 1
Enter weight for FLT05: Acoustic Surv. in 22-24 at age 7 --> 1
Enter weight for FLT05: Acoustic Surv. in 22-24 at age 8 --> 1
Enter weight for FLT11: Germ Bott T Su SD 24 Feb age 3 --> 1
Enter weight for FLT11: Germ Bott T Su SD 24 Feb age 4 --> 1
Enter weight for FLT11: Germ Bott T Su SD 24 Feb age 5 --> 1
Enter weight for FLT11: Germ Bott T Su SD 24 Feb age 6 --> 1
Enter weight for FLT11: Germ Bott T Su SD 24 Feb age 7 --> 1
Enter weight for FLT11: Germ Bott T Su SD 24 Feb age 8 --> 1

You should enter estimates of the extent to which
errors in each age of the age structured indices
are correlated. These may range from zero
(independence) to 1 (correlated errors) .
Enter value for aged index 1 --> 1
Enter value for aged index 2 --> 1
Enter value for aged index 3 --> 1

Do you want to shrink the final populations ? (Y/N) --> n

Table. 3.7.2 WESTERN BALTIC HERRING. Input to ICA. Mean weight in catch (kilograms)

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1987	0.01178	0.01280	0.05199	0.08029	0.09991	0.12707	0.14462	0.15780	0.16642
1988	0.01100	0.01690	0.04520	0.07170	0.10100	0.12480	0.14440	0.14570	0.13580
1989	0.01350	0.01747	0.05227	0.07642	0.11321	0.13471	0.14179	0.16083	0.16370
1990	0.01380	0.03113	0.06326	0.08396	0.10501	0.12095	0.14662	0.15236	0.15000
1991	0.02816	0.03292	0.07087	0.09482	0.11585	0.13791	0.15095	0.16943	0.18000
1992	0.01910	0.03050	0.06160	0.09100	0.11220	0.13820	0.16000	0.17240	0.18860
1993	0.01621	0.02409	0.07176	0.10019	0.11418	0.13357	0.16324	0.17568	0.18759
1994	0.01290	0.02820	0.09820	0.10290	0.12190	0.14000	0.15540	0.16900	0.18480
1995	0.01050	0.02230	0.07500	0.10720	0.12560	0.15710	0.16960	0.20640	0.21540
1996	0.00820	0.02290	0.06990	0.09610	0.11880	0.13100	0.13610	0.15130	0.18850

Table. 3.7.3 WESTERN BALTIC HERRING. Input to ICA . Mean weight in stock (kilograms)

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1987	0.00010	0.01280	0.05199	0.08029	0.09991	0.12707	0.14462	0.15780	0.16642
1988	0.00010	0.01690	0.04520	0.07170	0.10100	0.12480	0.14440	0.14570	0.13580
1989	0.00010	0.01683	0.04425	0.06780	0.07080	0.10460	0.12230	0.18610	0.13950
1990	0.00010	0.01683	0.04330	0.07218	0.08592	0.10013	0.13868	0.15350	0.13950
1991	0.00010	0.01675	0.05796	0.07837	0.10405	0.11082	0.13702	0.14059	0.14319
1992	0.00010	0.01470	0.04390	0.08230	0.10610	0.12860	0.15910	0.17090	0.18740
1993	0.00010	0.01809	0.03924	0.08342	0.11081	0.13677	0.15842	0.17912	0.18612
1994	0.00010	0.01970	0.04430	0.08400	0.10770	0.13930	0.15660	0.17680	0.20270
1995	0.00010	0.01340	0.04670	0.07450	0.13340	0.16790	0.18930	0.20980	0.23400
1996	0.00010	0.01880	0.05530	0.08800	0.12150	0.12700	0.16640	0.17820	0.14890

Table. 3.7.4 **WESTERN BALTIC HERRING. Input to ICA. AGE - STRUCTURED INDICES. INDEX 1: Acoustic Survey in Div IIIa+IVaE, Ages 3-8+(Catch: Number)**

Age	1989	1990	1991	1992	1993	1994	1995	1996
3	714.3	343.3	1927.0	1799.0	1274.0	935.0	1022.0	247.0
4	317.2	109.4	866.0	1593.0	598.0	501.0	1270.0	141.0
5	80.7	45.3	350.0	556.0	434.0	239.0	255.0	119.0
6	51.4	7.1	88.0	197.0	154.0	186.0	174.0	37.0
7	16.3	7.3	72.0	122.0	63.0	62.0	39.0	20.0
8	4.2	1.9	10.0	20.0	13.0	34.0	21.0	13.0

Table. 3.7.5 **WESTERN BALTIC HERRING. Input to ICA. AGE - STRUCTURED INDICES. INDEX 2: Acoustic Survey in Sub div 22-24, Ages 3-8+ (Catch: Number)**

Age	1989	1990	1991	1992	1993	1994	1995	1996
3	161.0	146.0	1434.0	282.0	518.0	525.0	354.0	430.0
4	102.0	79.0	461.0	156.0	402.0	449.0	375.0	313.0
5	23.0	19.0	174.0	37.0	145.0	195.0	269.0	278.0
6	4.0	8.0	44.0	25.0	64.0	63.0	133.0	119.0
7	3.0	4.0	24.0	4.0	31.0	25.0	37.0	47.0
8	1.0	2.0	21.0	-	16.0	2.0	25.0	16.0

Table. 3.7.6 **WESTERN BALTIC HERRING. Input to ICA. AGE - STRUCTURED INDICES.**
INDEX 3: German Bottom Trawl Survey in Sub-division 24 (February), Ages 3-8+ (Catch: Number)

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
3	155.00	292.00	613.00	124.00	261.00	251.00	95.00	202.00	329.00	83.00
4	202.00	32.00	104.00	52.00	87.00	80.00	61.00	330.00	131.00	88.00
5	51.00	21.00	22.00	4.00	35.00	27.00	44.00	131.00	84.00	87.00
6	21.00	4.00	6.00	9.00	9.00	10.00	14.00	76.00	24.00	41.00
7	3.00	2.00	6.00	1.00	2.00	3.00	6.00	30.00	28.00	33.00
8	1.00	-	1.00	-	2.00	1.00	1.00	21.00	11.00	87.00

Table. 3.7.7 **WESTERN BALTIC HERRING. Output from ICA. FISHING MORTALITY**

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
3	.40527	.50814	.36327	.21644	.16453	.21290	.18817	.15819	.08368	.08331
4	.56732	.38944	.37562	.30233	.13328	.17246	.15242	.12814	.06779	.06748
5	.61625	.44705	.28702	.30280	.15612	.20201	.17854	.15010	.07940	.07904
6	.63738	.41919	.23115	.18802	.13688	.17712	.15655	.13161	.06962	.06931
7	.57134	.39308	.28191	.24797	.13328	.17246	.15242	.12814	.06779	.06748
8	.57134	.39308	.28191	.24797	.13328	.17246	.15242	.12814	.06779	.06748

Table. 3.7.8 **WESTERN BALTIC HERRING. Output from ICA. NUMBERS AT AGE (Millions)- 1 January**

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	199
3	1276.2	2548.6	3370.8	2683.2	3417.1	2825.3	3258.7	3661.6	3106.3	2327.9	1619.8
4	994.7	696.7	1255.3	1919.1	1769.2	2373.3	1869.6	2210.4	2559.2	2339.0	1753.6
5	296.8	461.8	386.4	705.9	1161.3	1267.8	1635.3	1314.3	1592.0	1958.0	1790.1
6	85.7	131.2	241.8	237.4	427.0	813.4	848.1	1119.9	926.1	1204.0	1481.2
7	23.9	37.1	70.6	157.1	161.1	304.9	557.8	593.8	803.8	707.2	919.7
8	9.8	20.2	26.8	33.0	43.2	152.8	174.1	300.9	313.3	431.5	871.5

Table. 3.7.9 **WESTERN BALTIC HERRING. Output from ICA. STOCK SUMMARY**

Year	Recruits Age 3 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield/ SSB ratio	Mean F Ages 3- 6	SoP (%)
1987	1276170	257073	200048	174700	.8733	.5566	53
1988	2548560	338646	259575	251000	.9670	.4410	45
1989	3370750	405302	311723	185700	.5957	.3143	71
1990	2683150	490645	394657	203900	.5167	.2524	58
1991	3417110	666829	545212	191500	.3512	.1477	67
1992	2825280	856810	722252	168000	.2326	.1911	74
1993	3258700	968268	823047	171000	.2078	.1689	79
1994	3661610	1070985	910067	164000	.1802	.1420	80
1995	3106250	1257950	1100743	173187	.1573	.0751	51
1996	2327920	1128921	990754	130470	.1317	.0748	57

Table. 3.7.10 WESTERN BALTIC HERRING. Output from ICA. PARAMETER ESTIMATES

Parm No.		Maximum Likelih. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. distrib.
Separable Model: Reference F by year								
1	1991	.1333	22	.0864	.2057	.1068	.1663	.1366
2	1992	.1725	21	.1124	.2645	.1386	.2145	.1766
3	1993	.1524	21	.0995	.2334	.1226	.1895	.1561
4	1994	.1281	22	.0828	.1984	.1025	.1602	.1314
5	1995	.0678	23	.0432	.1065	.0538	.0853	.0696
6	1996	.0675	24	.0421	.1083	.0530	.0859	.0695
Separable Model: Selection (S) by age								
7	3	1.2345	19	.8462	1.8010	1.0182	1.4968	1.2576
	4	1.0000			Fixed : Reference age			
8	5	1.1713	17	.8334	1.6463	.9846	1.3935	1.1891
9	6	1.0270	17	.7306	1.4437	.8633	1.2219	1.0427
	7	1.0000			Fixed : last true age			
Separable Model: Populations in year 1996								
10	3	2327925	35	1163550	4657501	1634195	3316151	2478304
11	4	2339021	26	1391620	3931406	1794635	3048542	2422565
12	5	1958000	23	1244692	3080090	1553923	2467151	2011008
13	6	1203961	21	787255	1841237	969351	1495353	1232576
14	7	707202	21	467733	1069274	572715	873270	723110
Separable Model: Populations at age 7								
15	1991	161075	32	84468	307158	115878	223900	170051
16	1992	304853	25	183480	506515	235282	394995	315255
17	1993	557828	23	352867	881842	441597	704653	573265
18	1994	593758	22	383064	920337	474786	742541	608789
19	1995	803848	21	528337	1223028	648907	995784	822488

Table. 3.7.11 WESTERN BALTIC HERRING. Output from ICA. Age-structured index catchabilities

```
FLT04: Acoustic Survey in Div IIIa+IVaE
Linear model fitted. Slopes at age:
   20   3  Q  .3512E-03  31 .2589E-03 .8993E-03 .3512E-03 .6629E-03 .5075E-03
   21   4  Q  .3008E-03  31 .2221E-03 .7658E-03 .3008E-03 .5656E-03 .4335E-03
   22   5  Q  .2203E-03  31 .1625E-03 .5635E-03 .2203E-03 .4156E-03 .3182E-03
   23   6  Q  .1536E-03  32 .1128E-03 .3979E-03 .1536E-03 .2922E-03 .2231E-03
   24   7  Q  .1440E-03  32 .1052E-03 .3798E-03 .1440E-03 .2773E-03 .2108E-03
   25   8  Q  .1139E-03  32 .8342E-04 .2971E-03 .1139E-03 .2177E-03 .1659E-03
FLT05: Acoustic Survey in Sub div 22-24
Linear model fitted. Slopes at age:
   26   3  Q  .1672E-03  31 .1231E-03 .4292E-03 .1672E-03 .3161E-03 .2419E-03
   27   4  Q  .1647E-03  31 .1216E-03 .4201E-03 .1647E-03 .3101E-03 .2376E-03
   28   5  Q  .1122E-03  31 .8266E-04 .2878E-03 .1122E-03 .2120E-03 .1623E-03
   29   6  Q  .7470E-04  32 .5481E-04 .1941E-03 .7470E-04 .1424E-03 .1086E-03
   30   7  Q  .5908E-04  32 .4310E-04 .1562E-03 .5908E-04 .1140E-03 .8660E-04
   31   8  Q  .7584E-04  34 .5459E-04 .2090E-03 .7584E-04 .1504E-03 .1133E-03
FLT11: German Bottom Trawl Survey in SD 24 February
Linear model fitted. Slopes at age:
   32   3  Q  .7802E-04  27 .5970E-04 .1780E-03 .7802E-04 .1362E-03 .1072E-03
   33   4  Q  .5957E-04  27 .4562E-04 .1355E-03 .5957E-04 .1038E-03 .8173E-04
   34   5  Q  .4220E-04  27 .3230E-04 .9619E-04 .4220E-04 .7363E-04 .5794E-04
   35   6  Q  .3536E-04  28 .2699E-04 .8130E-04 .3536E-04 .6206E-04 .4874E-04
   36   7  Q  .3039E-04  28 .2310E-04 .7081E-04 .3039E-04 .5382E-04 .4213E-04
   37   8  Q  .3854E-04  32 .2832E-04 .9969E-04 .3854E-04 .7325E-04 .5594E-04
```

Table. 3.7.12 **WESTERN BALTIC HERRING. Output from ICA.**
RESIDUALS ABOUT THE MODEL FIT Separable Model Residuals
(log(Observed Catch)-log(Expected Catch))

Age	1991	1992	1993	1994	1995	1996
3	.2936	-.3134	-.1404	-.1729	.1219	.2402
4	.3675	-.0725	.1113	.1230	.2404	.1386
5	.1454	-.1934	-.1268	.0273	-.0315	-.0367
6	-.0269	.0830	-.0572	-.0449	-.0165	-.0889
7	-.2799	.0956	-.0812	-.2630	-.3980	-.2933

Table. 3.7.13 **WESTERN BALTIC HERRING. Output from ICA.**
Aged Index Residuals: log(Observed Index) - log(Expected Index)

FLT04: Acoustic Survey in Div IIIa+IVaE

Age	1989	1990	1991	1992	1993	1994	1995	1996
3	-.153	-.750	.701	.853	.350	-.095	.112	-1.020
4	.185	-1.349	.695	1.035	.282	-.078	.668	-1.440
5	.251	-.920	.536	.940	.423	.027	-.144	-1.113
6	.594	-1.397	.505	.691	.390	.285	.370	-1.441
7	.773	-.850	1.341	1.255	-.023	-.116	-.921	-1.461
8	.620	-.382	.917	.372	-.202	.197	-.362	-1.162

FLT05: Acoustic Survey in Sub div 22-24

Age	1989	1990	1991	1992	1993	1994	1995	1996
3	-.802	-.789	1.212	-.185	.260	.133	-.156	.326
4	-.246	-.985	.725	-.621	.549	.472	.097	.006
5	-.244	-1.025	.574	-1.025	.067	.560	.633	.459
6	-1.163	-.486	.591	-.586	.295	-.018	.869	.495
7	.056	-.483	1.192	-1.207	.221	-.076	-.035	.332
8	-.325	.134	2.124	-1.000	.474	-2.172	.265	-.502

Table. 3.7.13 continued

FLT11: German Bottom Trawl Survey in SD 24 (February)

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
3	.518	.473	.917	-.472	.024	.182	-.936	-.302	.341	-.748
4	1.322	-.186	.402	-.725	-.150	-.523	-.558	.960	-.118	-.426
5	1.506	.156	.360	-1.945	-.292	-.634	-.403	.903	.258	.087
6	2.040	-.071	-.300	.118	-.475	-1.009	-.717	.693	-.277	-.004
7	1.517	.647	1.088	-1.507	-.853	-1.081	-.995	.549	.170	.462
8	1.071	-1.000	.027	-1.000	.224	-1.726	-1.860	.635	-.060	1.688

Table. 3.7.14 WESTERN BALTIC HERRING. Output from ICA.
PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1991 to 1996

Variance	:	.0962
Skewness test statistic	:	-.7138
Kurtosis test statistic	:	-.6555
Partial chi-square	:	.0907
Significance in fit	:	.0000
Degrees of freedom	:	11

Table. 3.7.15 **WESTERN BALTIC HERRING. Output from ICA.**
PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

Linear catchability relationship assumed for all indices.

DISTRIBUTION STATISTICS FOR FLT04: Acoustic Survey in Div IIIa+IVaE

Age	:	3	4	5	6	7	8
Variance	:	.0712	.1433	.0838	.1305	.1830	.0731
Skewness test stat.	:	-.3013	-.8125	-.5380	-1.2500	.0517	-.3720
Kurtosis test stat.	:	-.6024	-.5572	-.5568	-.4136	-.8050	-.3901
Partial chi-square	:	.0751	.1606	.1097	.2240	.3789	.2830
Significance in fit	:	.0000	.0000	.0000	.0000	.0002	.0001
Number of data	:	8	8	8	8	8	8
Degrees of freedom	:	7	7	7	7	7	7
Weight in analysis	:	.1667	.1667	.1667	.1667	.1667	.1667

DISTRIBUTION STATISTICS FOR FLT05: Acoustic Survey in Sub div 22-24

Age	:	3	4	5	6	7	8
Variance	:	.0711	.0589	.0814	.0802	.0781	.2749
Skewness test stat.	:	.5172	-.4663	-.7512	-.4629	-.0718	-.0643
Kurtosis test stat.	:	-.1895	-.5938	-.6957	-.6086	.0751	.0288
Partial chi-square	:	.0838	.0759	.1283	.1817	.2422	1.1833
Significance in fit	:	.0000	.0000	.0000	.0000	.0000	.0223
Number of data	:	8	8	8	8	8	7
Degrees of freedom	:	7	7	7	7	7	6
Weight in analysis	:	.1667	.1667	.1667	.1667	.1667	.1667

DISTRIBUTION STATISTICS FOR FLT11: German Bottom Trawl Survey in SD 24 (February)

Age	:	3	4	5	6	7	8
Variance	:	.0598	.0777	.1434	.1220	.1779	.2594
Skewness test stat.	:	-.2172	1.1765	-.6587	1.7564	-.1336	-.4791
Kurtosis test stat.	:	-.7119	-.3163	.2523	.8784	-.8842	-.5469
Partial chi-square	:	.1014	.1594	.4189	.8165	3.2341	.9976
Significance in fit	:	.0000	.0000	.0000	.0002	.0457	.0051
Number of data	:	10	10	10	10	10	8
Degrees of freedom	:	9	9	9	9	9	7
Weight in analysis	:	.1667	.1667	.1667	.1667	.1667	.1667

Table. 3.7.16 WESTERN BALTIC HERRING. Output from ICA. ANALYSIS OF VARIANCE TABLE

Unweighted Statistics

	SSQ	Data	Params	d.f.	
Variance					
Total for Model	97.5093	183	37	146	.6679
Catches at Age	1.0579	30	19	11	.0962
Aged Indices					
FLT04: Acoustic Survey in Div IIIa+IVaE	28.7672	48	6	42	.6849
FLT05: Acoustic Survey in Sub div 22-24	25.4266	47	6	41	.6202
FLT11: Germ. Bott. Tra. Sur. SD 24 Feb.	42.2577	58	6	52	.8126

Weighted Statistics

	SSQ	Data	Params	d.f.	
Variance					
Total for Model	3.7371	183	37	146	.0256
Catches at Age	1.0579	30	19	11	.0962
Aged Indices					
FLT04: Acoustic Survey in Div IIIa+IVaE	.7991	48	6	42	.0190
FLT05: Acoustic Survey in Sub div 22-24	.7063	47	6	41	.0172
FLT11: Germ. Bott. Tra. Sur. Sd 24 Feb.	1.1738	58	6	52	.0226

Figure 3.2.4.1 Spring spawning component according to modal length analysis by quarter 1991 to 1997.

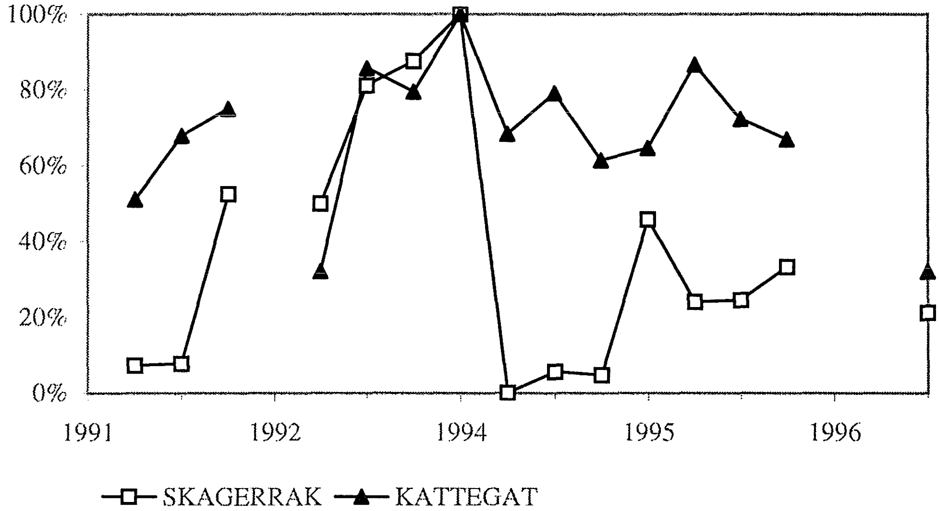
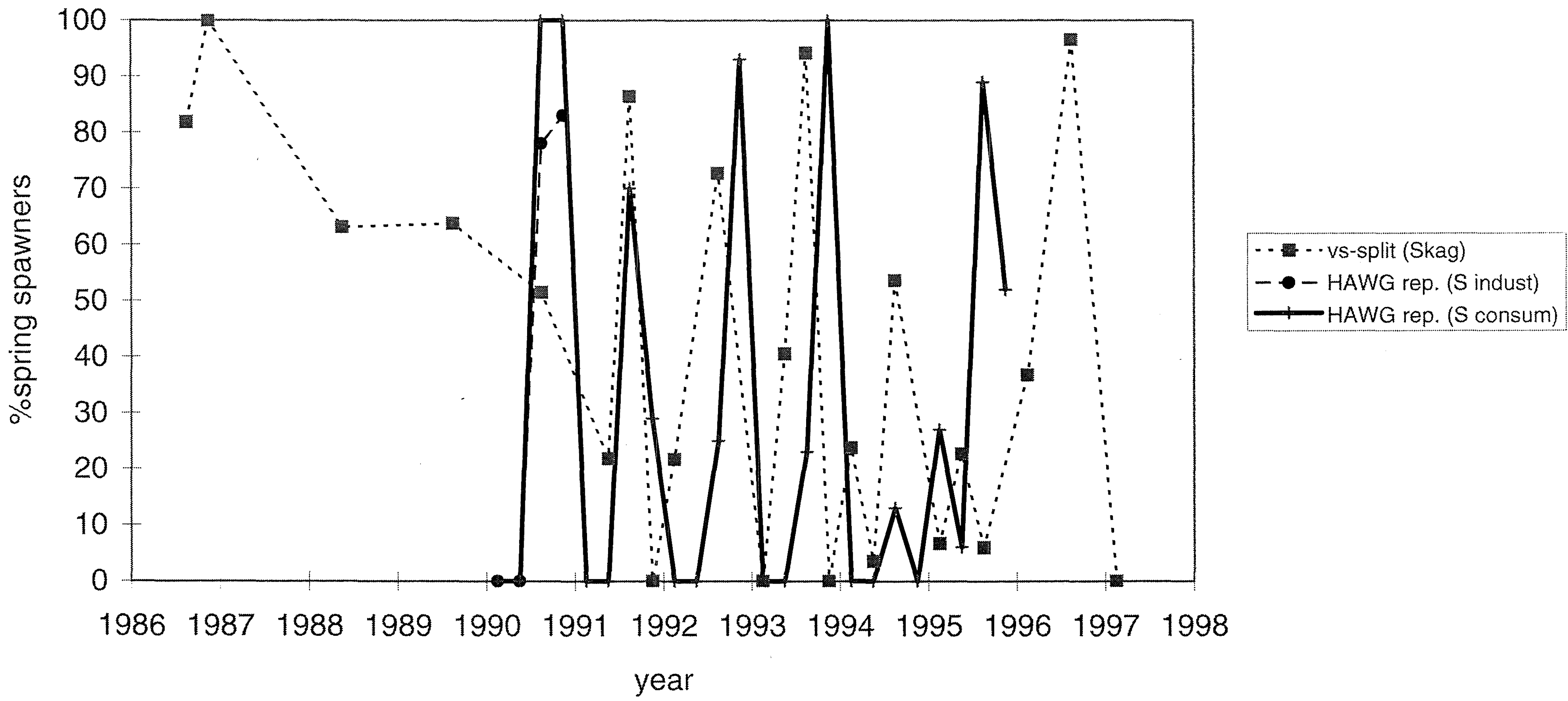


Figure 3.2.4.2a Proportion of spring spawners in Skagerrak from HAWG reports and estimated anew by vs counts



e:\acfm\hawg97\F-3242a.xls

Figure 3.2.4.2b Proportion of spring spawners in Kattegat from HAWG reports and estimated anew by vs counts

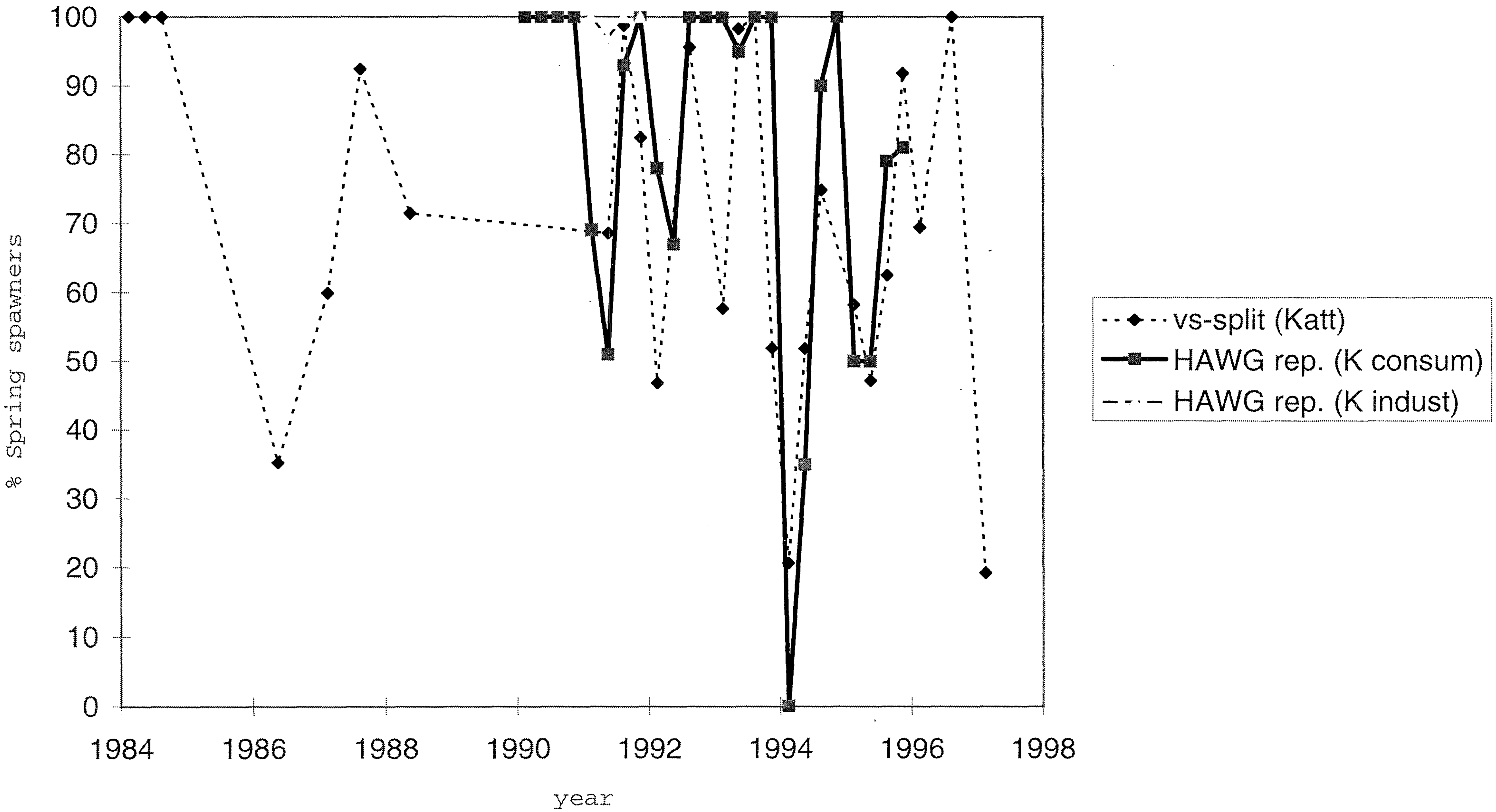


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Figure 3.2.4.3 Estimated % ssp +/- 95% confidence limits from n vertebral counts for proportion

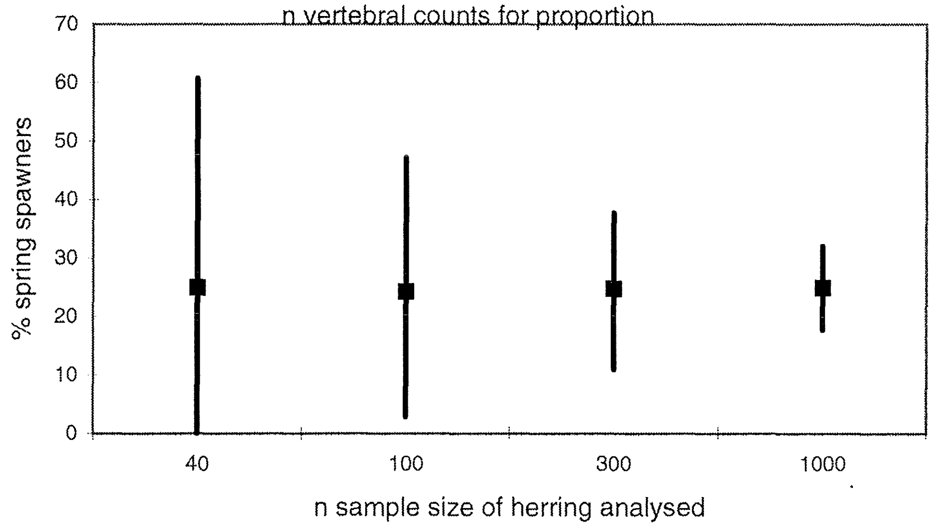
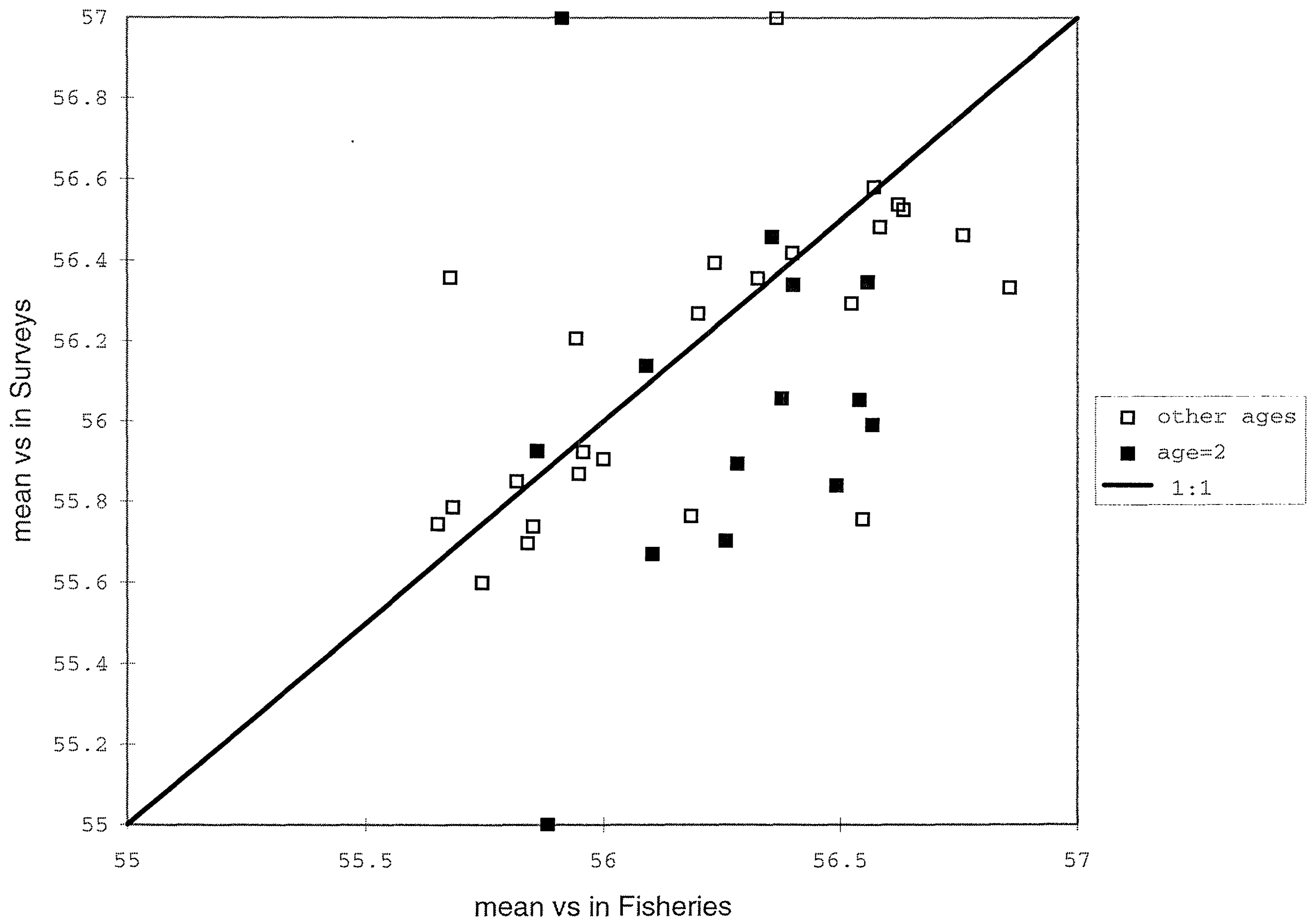


Figure 3.2.5: Comparison of mean vertebral counts in Div.IIIa herring from two sources



e:\acfm\hawg97\F-3-2-5.xls

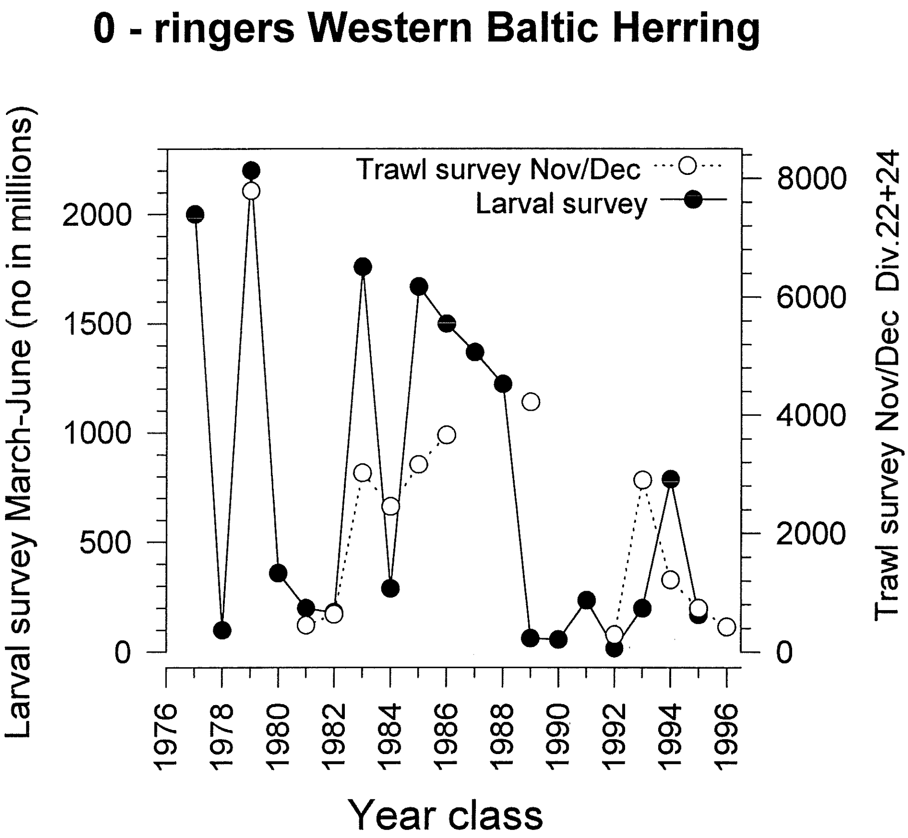


Figure 3.6.1. 0-ringer indices of recruitment from either larval surveys or trawl surveys

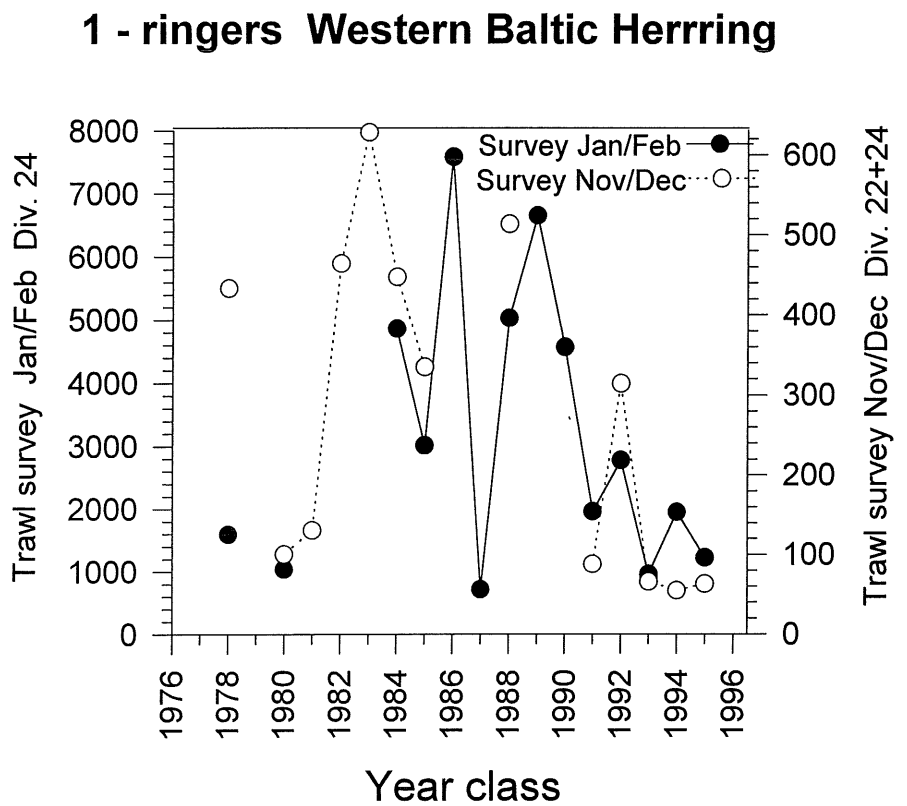


Figure 3.6.2. 1-ringer indices of recruitment from two trawl surveys

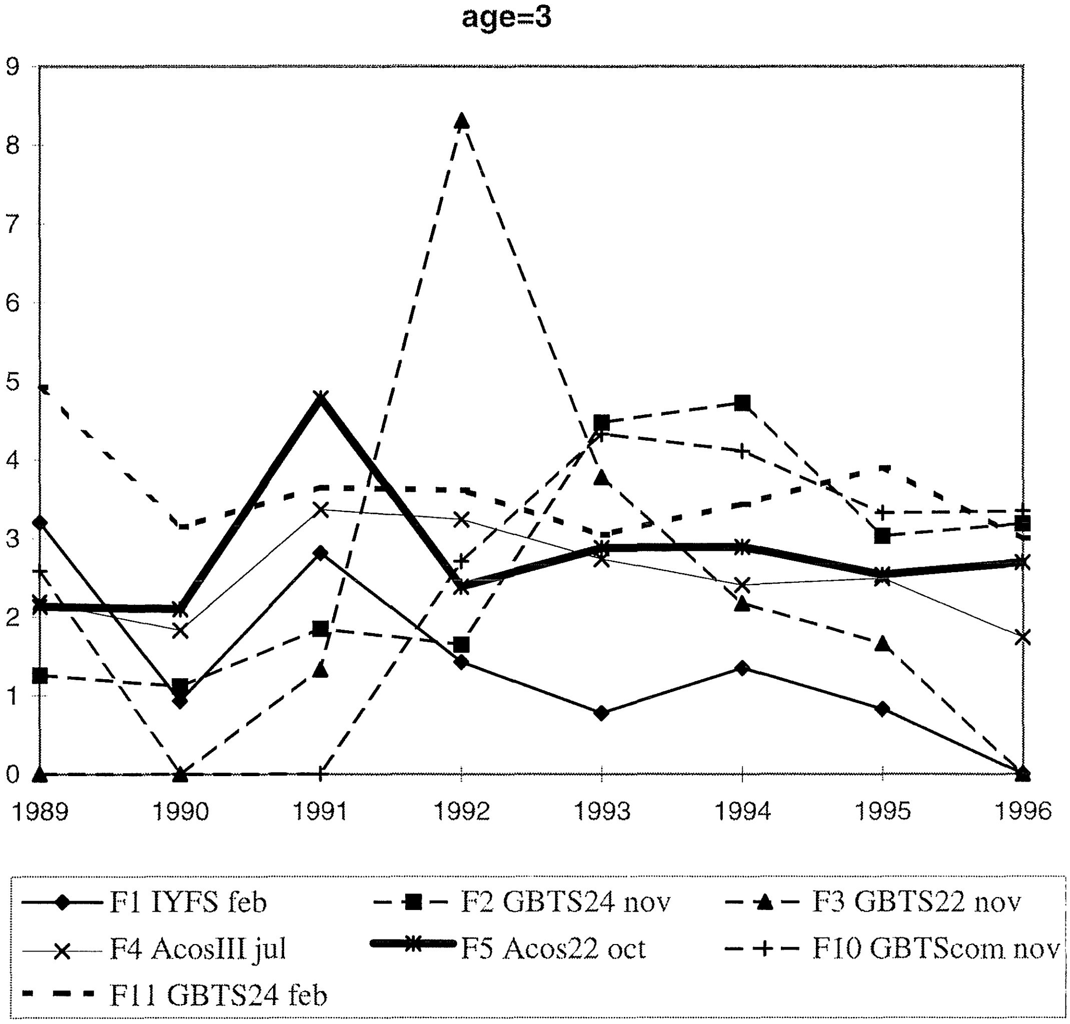
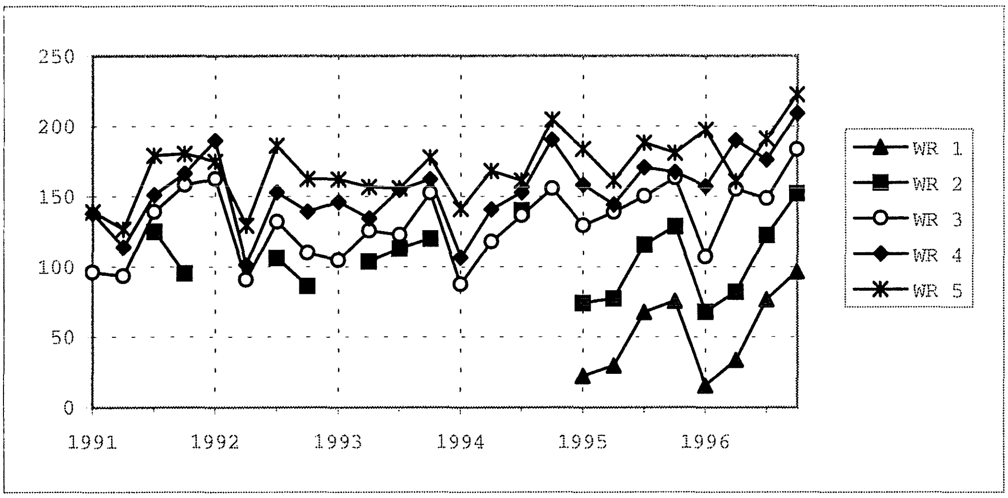
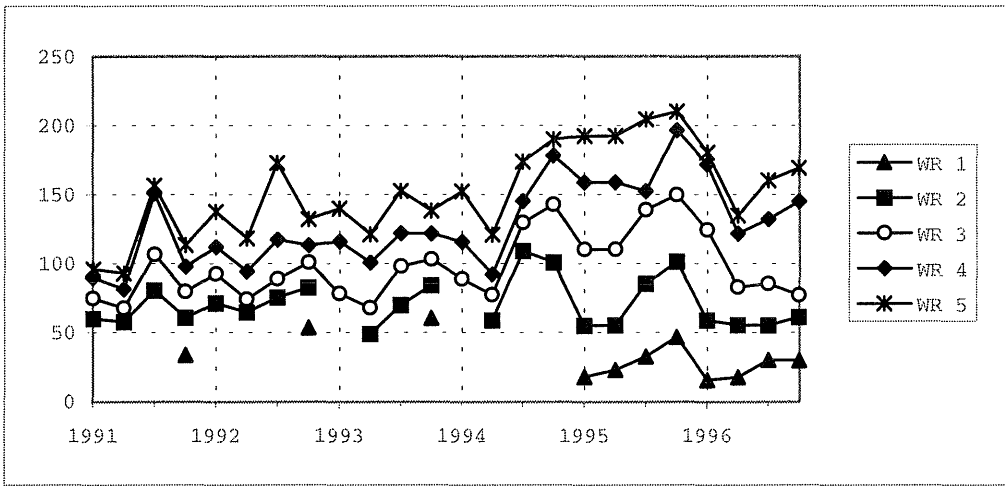


Figure 3.7.1 Yearclass abundance in numbers at age 3 from research surveys 1989 to 1996. All series are normalized by their means.

Skagerrak



Kattegat



Sub-division 22 and 24.

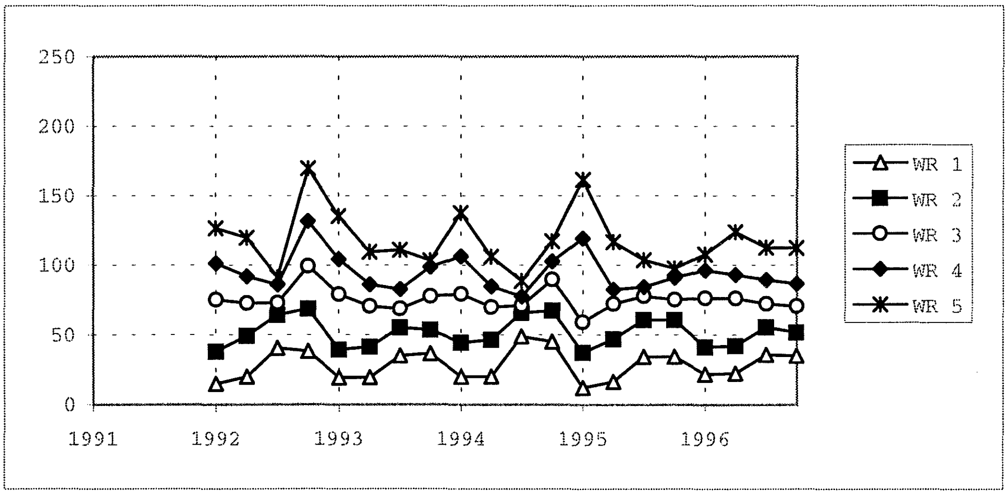


Fig 3.7.2 Mean weights at age (g) in the catches of Baltic herring by quarter 1991-1997.

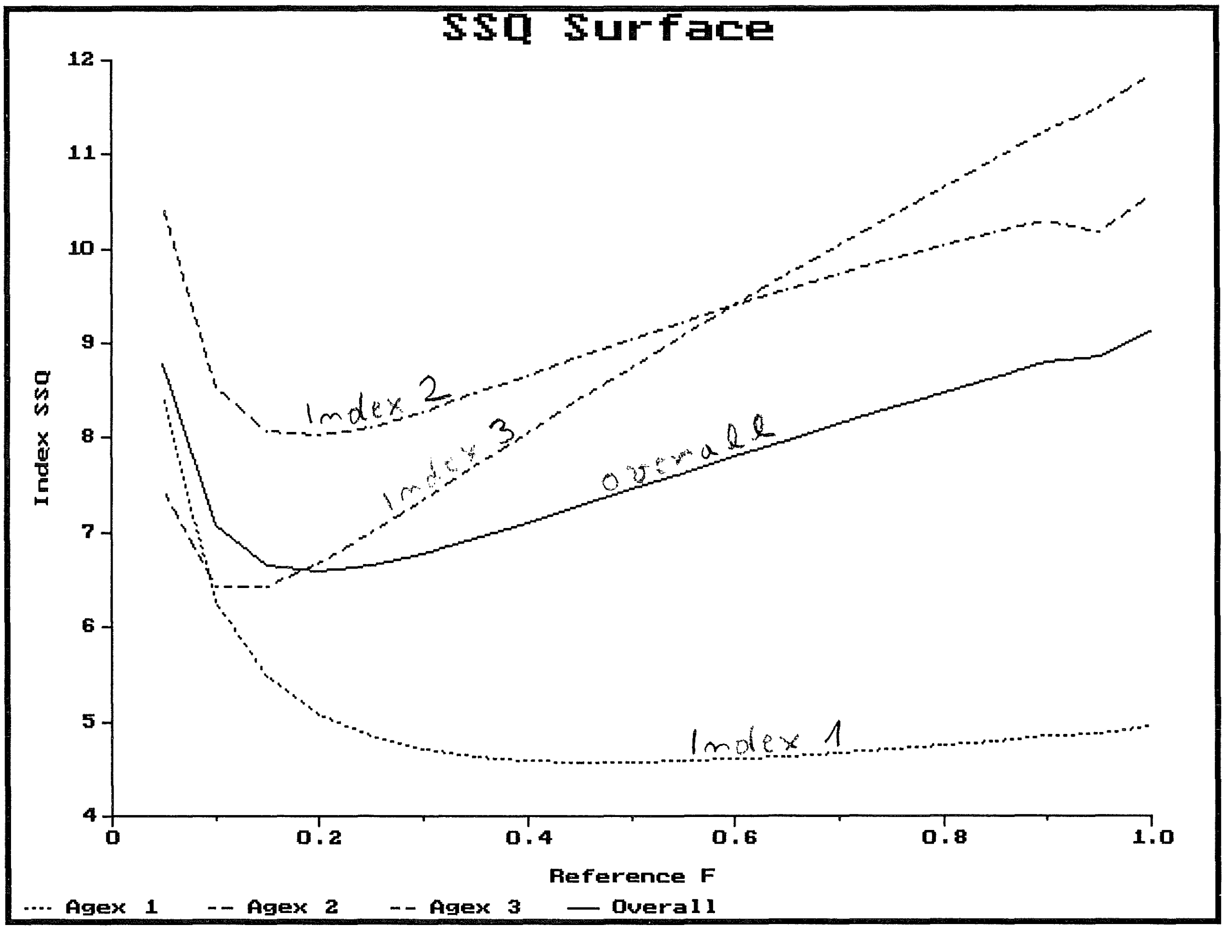


Figure 3.7.3 ***Western Baltic Herring. Output from ICA.***
Index sum of squares of deviations between model and observations

(survey index) as a function of the reference F in 1994
INDEX 1: 1989-96: Acoustic survey in IIIa+IVaE, Age groups 3-8+.
INDEX 2: 1989-96: Acoustic survey in Sub.Div 22-24, Age groups 3-8+.
INDEX 3: 1989-96: Germ. Bott.Trawl Surv. in Sub.Div. 24, Feb., Age groups 3-8+.

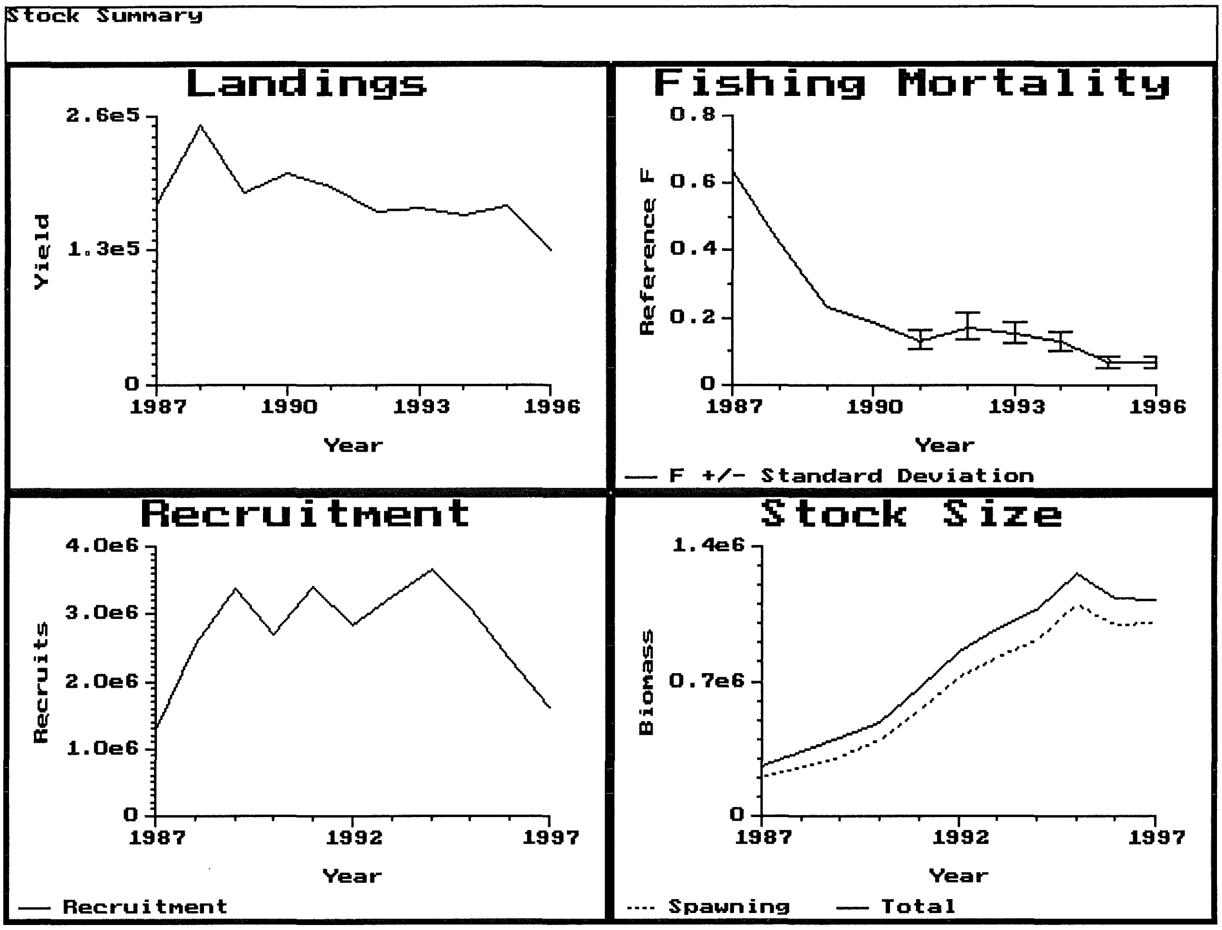


Figure 3.7.4 *Western Baltic Herring. Output from ICA. Stock summary*

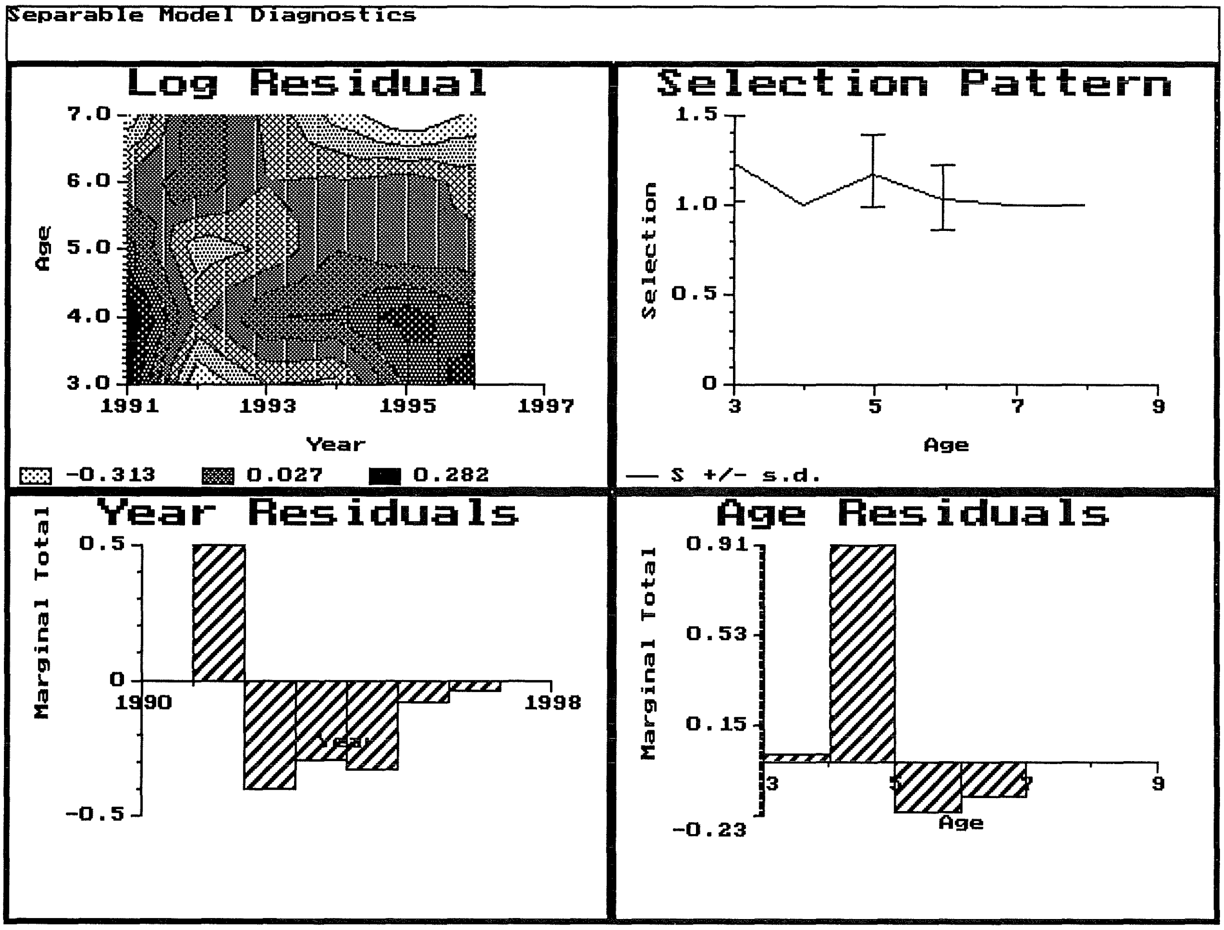


Figure 3.7.5 *Western Baltic Herring. Separable model diagnostics.*

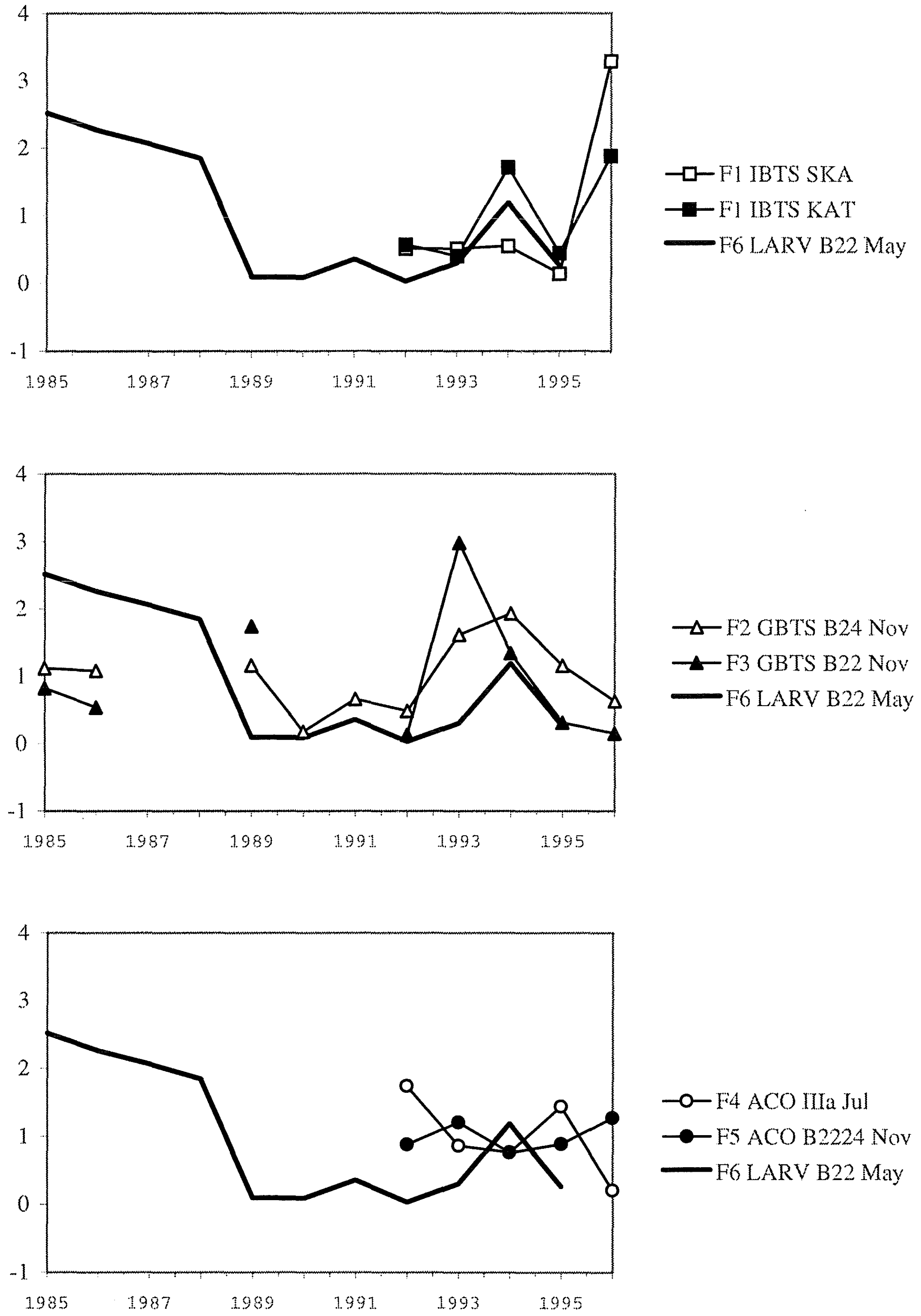


Figure 3.8.1 Relative CPUE (in weight) or abundance indices for Div. IIIa and Sub-div. 22 and 24. All series normalised by their average. The larvae survey series are shown in all figures as reference.

4 CELTIC SEA AND DIVISION VIIJ HERRING

4.1 Introduction

The herring fisheries to the south of Ireland in the Celtic Sea and in Division VIIj have been considered to exploit the same stock. For the purpose of stock assessment and management these areas have been combined since 1982. The areas for which the assessments are now made, together with the area for which the TAC is set by the EU is shown in Figure 4.1.1. It should be noted that, although the management unit covers all of Divisions VIIg,h,j and k and the southern part of Division VIIa, the total Irish catch which constitutes over 95% of the catch from this entire management unit is taken from the inshore waters along the Irish coast.

4.2 The Fishery in 1996–1997

4.2.1 Advice and management applicable to 1996 and 1997

In 1995 ACFM reacted to the apparent decrease in stock in the area and recommended that F should be reduced in 1996 by 60% of the 1994 value, corresponding to a catch of only 9,800 t. The EU subsequently introduced a TAC for 1996 of 16,500 t. This was subsequently increased to 21,000 t by the EU following the results of the May 1996 meeting of ACFM.

ACFM did not give specific advice for the fishery for 1997 as the stock was considered to be within safe biological limits. The TAC set by the EU for 1997 was for a catch of 22,000 t.

The spawning box closure system,which was first introduced in the late eighties and which is described in ICES (CM1989/Assess:15) was again continued during the 1996/97 season - the box closed being that in Division VIIaS. This was closed for a forthnight in January 1997. The entire Irish fishery was again closed from mid-February 1996 through to early October 1997.

The total Irish quota was subdivided into boat quotas on a week by week basis. All vessels were again regulated by licences which restrict landings to specific ports and to specific times.

4.2.2 The fishery in 1996/1997

As has been the case for a number of years the major portion of the catches in this area was taken by the Irish fishery during the spawning season which normally lasts from October to February. This fishery is directed to the Japanese roe market.

During the period October 1996 to December 1996 shoals appeared to be very abundant throughout all areas particularly on the inshore spawning grounds. Unusually large shoals were also reported during January and early February on the important spawning grounds in Division VIIa (South). Shoals were also abundant in Dingle Bay (Division VIIj) in January and early February. It has been pointed out by recent Working Groups that there appears to have been a continued increase in the abundance of fish from this area i.e. Division VIIj at this time in recent years. The Irish fishery was closed early in February 1997 because of difficulties in disposing of the catch. For this reason the final catch figures for the season were lower than those of recent seasons.

The maximum number of Irish vessels participating in the 1996/1997 fishery was 70 which was an increase on the numbers (approximately 65) which participated from 1993 to 1995.

The distribution of the total international herring catches (t) in Sub-areas VI and VII per quarter per statistical rectangle, based on the logbooks and not corrected for misreporting is shown in Figure 4.2.1 a–d.

4.2.3 The catch data

The estimated national catches from 1987–1996 for the combined areas by year and by season (1 April–31 March) are given in Tables 4.2.1 and 4.2.2 respectively. The total catches for the fishery over the longer period from 1958 to 1996 are shown in Figure 4.4.2. The reported catch including the estimates of discards and unallocated landings, taken during the 1996/1997 season was over 17,000 t compared with 23,300 t during the previous season. The decrease was mainly due to marketing difficulties during early 1997 and a reduced level of discards. Landings from this fishery have been stable for a number of years and have averaged about 19,000 t since 1985. Nearly 2,000 t were reported as having been taken in this area during 1996 but were in fact taken in the other areas.

Discards

The level of discards in this fishery is believed to have decreased in recent years as fishermen have become more expert in identifying suitable shoals for the Japanese roe market and in controlling the amounts of fish in their nets. Nevertheless, discards may on occasions reach a high level particularly if the fishery is allowed to remain open despite marketing difficulties. During the first quarter of 1997 the landings from Division VIIa(South) and Division VIIg were raised by 10% to include discards as in previous years. The level of discards for the remainder of the season is not believed to have been significant.

The results of an EU funded project (EU Project BIOECO/93/17) indicate that the overall discard rate of 10%–20% used by previous Working Groups is realistic.

4.2.4 Quality of catch and biological data

Management authorities are confident that the accuracy of the landing statistics from this fishery has increased considerably in recent years. There have, however, been persistent but unconfirmed reports that the overall catch figure may be considerably underestimated. Misreporting of catches from Division VIIj to Division VIIb, which had been a problem, has decreased in recent years. However as mentioned above there has been an increase in the amounts of catches misreported from other areas. Biological sampling of the catches throughout the area continues to be satisfactory and at a high level. Details of the sampling data per quarter are shown in Table 4.2.3, while the length distributions of the catches taken by the Irish fleet per quarter are shown in Table 4.2.4.

4.2.5 Catches in numbers at age

The total catches in numbers at age, including discards, per season from 1958 to 1996 are shown in Table 4.2.5. The catch during 1996/1997 was dominated by 2.w.ring fish (the 1993/1994 year class). The 1992/93 year class, which dominated the catches during 1995/96 season was again well represented. The 1990/91 year class which was considered to be a strong year class still represents over 12% of the total catch.

4.3 Mean weights at age

As the major portion of the catch from this fishery continues to be taken during the spawning season the mean weights at age in the catches have traditionally been taken as the mean weights in the stock at spawning time (1 October). The mean weights from 1958 to 1996. are shown in Table 4.3.1. The mean weights appear to be reasonably stable although there has been a decrease of approximately 10% in the values of the 1 - 3 w. ring fish in recent years.

4.4 Stock assessments

4.4.1 Acoustic surveys

Acoustic surveys have been carried out on this stock each season since 1989/1990. Two surveys have been carried out each season and the surveys were designed to estimate the size of the autumn and winter spawning components separately The total stock has been considered to be the sum of the stocks estimated from both surveys - the different components being separated on the basis of maturity stages. It was again intended to carry out two surveys in 1996/97 but due to unforeseen circumstances it was not possible to carry out the January 1997 survey.

The survey, carried out in October 1996, the results of which were presented in a working document (Molloy, and Fernandes, W.D.1997), was severely disrupted by abnormally bad weather. The survey did not therefore cover the important areas in Division VIIj in which considerable catches were taken in the commercial fishery. It was originally intended that the transects in this survey should extend out as far as 50 miles offshore because of the occurrence of offshore concentrations evident during the 1996 surveys. However, this was not achieved because of time restraints and most of the transects extended only to 20 miles off shore. During this survey unusually large concentrations of herring were located on the spawning grounds along the Irish coast. These concentrations were positively identified as herring from fishing trawls and by the commercial fleet. Considerable confidence is therefore attached to the estimates obtained during the survey. The shoals were dominated by fish from the 1993/94 year class as also were the catches taken from the commercial fishery.

The total stock size estimated to be in this areas at the time of the survey was 150,000 t which was the highest estimate recorded since these surveys were commenced in 1989. The total spawning stock was estimated to be 143,000 t. Although the stock size as estimated from the acoustic survey is the highest recorded it may be even higher because no coverage was possible in Division VIIj. The high stock size is consistent with reports from fishermen who have suggested that there has been a very large increase in this stock in recent years.

The age disaggregated data for this stock, estimated at the time of the survey, and including a small amount of commercial catch (1,500 t) taken prior to the survey is shown in Table 4.4.1 and is compared with similar data for the previous surveys. The age distribution indicates that the 1993/94 year class is the strongest one to enter the fishery since 1990. It is also clear that the numbers of two year old fish is higher than the numbers of one year olds in the preceding year in all cases except for 1994 indicating that some recruitment is coming from outside the survey area. Again there is a considerable reduction in the numbers of 0-group fish in recent years because of the inadequate coverage in Division VIIj.

4.4.2 Results of Assessments

The integrated catch analysis program (See Section 1.5) has been used since 1994 to estimate the fishing mortality and the size of the stock. In these analyses the age-disaggregated data from the acoustic surveys from 1990 to 1996 have been used as the only tuning index available. The 0 and 1-ring fish are excluded from the analyses as they are not believed to be fully recruited to the Celtic Sea from Division VIIa (North). The analyses carried out at the 1994 Working Group meeting indicated that using the acoustic surveys as a proportional index of stock abundance provided the best fit to the ICA model. This approach has again been adopted and the results of this run are shown in Table 4.4.2 and the diagnostics from the ICA model are shown in Figures 4.4.1, to 4.4.11.

The spawning stock biomass estimated by the ICA model for 1996 is 67,500 t compared with 71,400 t for 1995. The value of F estimated for 1996 is 0.38 which is the lowest value for this stock since 1979 and may be explained by the low catch in 1996/97. The ICA model indicates that the recruitment of the 1992/93 year class, while strong, is not as strong as either the 1992 or 1990 year class. A comparison between the estimates of SSB obtained from the ICAs carried out since 1994 and the SSBs obtained from the acoustic surveys is shown below.

Season	Acoustic surveys	ICA in 1994	ICA in 1995	ICA in 1996	ICA in 1997
1990	91000	65300	57500	65000	66000
1991	77000	55000	45600	55700	56800
1992	71000	61600	44800	57300	59600
1993	90000	62500	41200	55200	58200
1994	50600	59100*	45000	67800	67900
1995	114000	59700*	42700*	86000	71400
1996	142000	60000*	35000*	93000*	67500
1997					

*predicted values

The SSBs estimated from the acoustic surveys suggest that the stock has increased considerably in recent years. The overall trend from the most recent ICA suggest that the stock has been stable but at a lower level than that indicated from the acoustic surveys.

Despite these considerable differences, the diagnostics from the ICA model suggest that there is a good fit between the acoustic age-disaggregated data and the catch at age data although there is evidence to suggest that in 1996 the acoustic survey overestimated the abundance of the 1993/94 year class in comparison with the abundance suggested from the numbers of that year class in the catches. This year class represented 60% of the stock as estimated from the acoustic survey but only 48% of the numbers in the catches. An examination of the age distribution of the catches did not indicate any change in the exploitation pattern in the 1996/97 season and there was no evidence to show that the restrictions in the January fishery or the premature closing of the fishery in February due to marketing difficulties resulted in a decreased proportion of the 1993/94 year class in the overall catches.

The effects of the low stock estimate obtained from the 1994/95 survey on the overall development of the stock was investigated by rerunning the ICA model but omitting the results from this survey. However the differences were not substantial. It was therefore decided to accept the assessment using the full data set.

4.5 Recruitment estimates

There are no recruitment indices available for this stock which can be used for predictive purposes. The numbers of 1-ring fish derived from the 1997 ICA model are shown in Figure 4.4.2. There has been no apparent trend in recent years and recruitment has fluctuated considerably The geometric mean value over the period 1983–1995 was taken as the most realistic value to use for predictive purposes. The value for the 1993 year class was not included as it is based on limited data. The resultant value was 543 million, compared with values of 535 million and 517 million used in the prediction carried out in 1995 and 1996.

4.6 Short-term Projections

Short-term projections were carried out for the following two scenarios:

1. A total catch in 1997 of 22,000 t i.e. the agreed TAC. A range of F factors is then presented for 1998.

   The input data for the predictions are shown in Table 4.6.1.and the results are shown in Tables 4.6.2.

2. A total catch in 1997 of 22,000 t followed by continuation of fishing in 1998 and 1999 at an F level in both years equal to that of 1996 i.e. =0.375.

The results of this projection is shown in Table 4.6.3 and the detailed output is shown in Table 4.6.4. The yield/ recruit curve is shown in Fig 4.6.1.

The total SSB estimated by the ICA for 1996 was 67,500 t and this was predicted to be at the same level in 1997. If a similar catch level is maintained in 1997 the SSB will decrease slightly to 64,000 t and the F level will be about 0.48.

A continuation of F in 1998 and 1999 at the same level of 1996 will generate catches on between 18,000 t and 19,000 t and the SSB will be about 69,000 t in both years.

The general conclusions from the short term projection indicate that catches during 1997 to 1999 in the range of 18,000 t - 22,000 t will result in a maintenance of the SSB at about the present level.

The results of the projections show stock sizes that are lower than those estimated in the previous assessment when the predicted stock sizes were 90,000 t. They are also considerably lower than those indicated by the trend in the results from the acoustic surveys in 1995 and 1996. The differences in the ICA estimates are as a result of the low numbers of 2.w.ring fish (the 1994/95 year class) in the population estimates for1997 compared with the numbers of 2 w. ring fish in the population in 1996. These numbers in 1997 were generated by the catches of this year class in the 1996/97 season and they may not have been fully represented as the fishery was prematurely closed. It is therefore not possible to say anything about the relative abundance of this year class.If it is assumed however to have been at the average recruitment level of 534 million fish then it would have appeared in the population at 1 January 1997 at around 198 million fish instead of 168 million as estimated for the prediction.This would produce an increase in the predicted SSB for 1998 from 66,700 t to 69,600 t, assuming a continuation of an F level of that in 1996 (i.e = 0.375).

4.7 Medium Term Predictions and Safe biological limits

The MBAL and the stock recruitment relationship for this stock were investigated in detail by the 1996 Working Group. The MBAL was defined at about 40,000 t i.e 1/3 of the stock level in a period when it was relatively lightly exploited. For this stock it must again be emphasised that there is no period over the timespan 1958 - 1997 when F values were lowere than about .35 for more than a few years continuously. To study the future development of the stock a prediction was carried out for the period 1997 - 2007, assuming average recruitment and catches of about 20,000 t. The results show that over this period the stock remains at about the present level while the fishing level also remains at about the 1996 level(=.39). It, therefore seems reasonable to assume that a catch level of 20,000 t per annum is a safe level for this stock. The results of this prediction are shown in Table 4.6.5.

4.8 Management Considerations

The present assessment indicates that this stock is in a stable condition and should be able to sustain the present catch level. The development of the stock in the immediate future is largely dependent on the strength of the 1994/95 and 1993/94 year classes. The 1994/95 year class appears to be relatively low, based on the age distribution of the 1996/97 catches, while on the other hand the 1993/94 year class appears to have been very strong, based on the results of the acoustic survey. There is therefore considerable uncertainty on the development of the stock in the immediate future and this would suggest a cautious management of the fishery.

The major fleet which exploits this stock is capable of generating a very high fishing mortality - particularly as the main fishery takes place for spawning shoals on the spawning beds. The catching power of this fleet is extremely high in relation to the TAC and consideration should be given to reducing the number of vessels that participate in the fishery.

It is extremely important that the fishery should continue to be effectively monitored. This can not be done without adequate survey data and in this respect it is recommended that sufficient resources be made available to enable the acoustic surveys to be maintained.

Table 4.2.1 Celtic Sea and Division VIIj HERRING landings by calendar year (t), 1987–1996. (Data provided by Working Group members.)

These figures may not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	France	Germany	Ireland	Netherlands	U.K.	Unallocated	Discards	Total
1987	800	-	15,500	1,500	-	5,300	4,200	27,300
1988	-	-	16,800	-	-	-	2,400	19,200
1989	+	-	16,000	1,900	-	1,300	3,500	22,700
1990	+	-	15,800	1,000	200	700	2,500	20,200
1991	+	100	19,400	1,600	-	600	1,900	23,600
1992	500	-	18,000	100	+	2,300	2,100	23,000
1993	-	-	19,000	1,300	+	-1,100	1,900	21,100
1994	+	200	17,400	1,300	+	-1,500	1,700	19,100
1995	200	200	18,000	100	+	-200	700	19,000
1996[1]	1,000	0	18,600	1,000	-	-1,800	3,000	21,800

[1]Preliminary

Table 4.2.2 Celtic Sea and Division VIIj herring landings (t) by season (1 April–31 March) 1987/1988-1996/1997. (Data provided by Working Group members).

These figures may not in all cases correspond to the offical statistics and cannot be used for management purposes.

Year	France	Germany	Ireland	Netherlands	U.K.	Unallocated	Discards	Total
1987/1988	800	-	15,500	1,500	-	4,400	4,000	26,200
1988/1989	-	-	17,000	-	-	-	3,400	20,400
1989/1990	+	-	15,000	1,900	-	2,600	3,600	23,100
1990/1991	+	-	15,000	1,000	200	700	1,700	18,600
1991/1992	500	100	21,400	1,600	-	-100	2,100	25,600
1992/1993	-	-	18,000	1,300	-	-100	2,000	21,200
1993/1994	-	-	16,600	1,300	+	-1,100	1,800	18,600
1994/1995	+	200	17,400	1,300	+	-1,500	1,900	19,300
1995/1996	200	200	20,000	100	+	-200	3,000	23,300
1996/1997	1,000	-	16,600	1,000	-	-1,800	600	17,400

Table 4.2.3 Celtic Sea, Division VIIj (1996–1997). Sampling intensity of commercial catches.

Country		Catch (t)	No. of samples	No. of age readings	No. of fish measured	Aged per 1000 t	Estimates of discards
Ireland	Q 4	10250	60	2314	9619	220	Yes
	Q 1	6900	25	878	5814	127	Yes
Netherlands	Q 3	986	-	-	-	-	-
Germany	Q 4	0	-	-	-	-	-
France	Q3	1021	-	-	-	-	-

Table 4.2.4 Celtic Sea and Division VIIj. Length distribution (including discards) of Irish catches/quarter (thousands).

Length	Division VIIa South		Division VIIg		Division VIIj	
	Q4 96	Q1 97	Q4 96	Q1 97	Q4 96	Q1 97
18						
19						
	13					
20	51		50		5	3
	133		129			
21	234	18	109		37	
	278	28	278		28	
22	494	193	527	21	96	19
	367	396	745	439	133	3
23	684	1,170	1,660	1,087	188	44
	842	1,373	2,067	920	238	86
24	1,626	2,183	3,280	2,468	371	321
	1,734	2,451	2,806	1,924	371	381
25	2,563	3,040	4,930	2,593	523	765
	2,234	2,791	4,214	2,322	578	695
26	2,126	3,225	4,383	2,949	793	1,016
	1,291	2,322	2,723	1,861	853	724
27	1,050	1,760	2,167	1,777	1,380	727
	728	1,271	1,719	1,108	1,403	429
28	651	1,207	1,729	1,255	1,605	492
	449	544	1,670	565	1,233	390
29	348	378	1,163	314	1,178	349
	171	92	477	84	1,004	178
30	69	55	209	42	747	76
	70		99		325	16
31	44		30		96	3
			10		46	
32			-		36	
Total	18,252	24,498	38,175	21,727	13,268	6,717
Tonnes	2,500	3,100	5,380	2,800	2,400	1,000

Table 4.2.5

HER-IRLS: Herring South and South West of Ireland (Celtic Sea + VIIj)

CANUM: Catch in Numbers (Thousands)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1958	1642	3742	33094	25746	12551	23949	16093	9384	5584
1959	1203	25717	2274	19262	11015	5830	17821	3745	7352
1960	2840	72246	24658	3779	13698	4431	6096	4379	4151
1961	2129	16058	32044	5631	2034	5067	2825	1524	4947
1962	772	18567	19909	48061	8075	3584	8593	3805	5322
1963	297	51935	13033	4179	20694	2686	1392	2488	2787
1964	7529	15058	17250	6658	1719	8716	1304	577	2193
1965	57	70248	9365	15757	3399	4539	12127	1377	7493
1966	7093	19559	59893	9924	13211	5602	3586	8746	3842
1967	7599	39991	20062	49113	9218	9444	3939	6510	6757
1968	12197	54790	39604	11544	22599	4929	4170	1310	4936
1969	9472	93279	55039	33145	12217	17837	4762	2174	3469
1970	1319	37260	50087	26481	18763	7853	6351	2175	3367
1971	12658	23313	37563	41904	18759	10443	4276	4942	2239
1972	8422	137690	17855	15842	14531	4645	3012	2374	1020
1973	23547	38133	55805	7012	9651	5323	3352	2332	1209
1974	5507	42808	17184	22530	4225	3737	2978	903	827
1975	12768	15429	17783	7333	9006	3520	1644	1136	1194
1976	13317	11113	7286	7011	2872	4785	1980	1243	1769
1977	8159	12516	8610	5280	1585	1898	1043	383	470
1978	2800	13385	11948	5583	1580	1476	540	858	482
1979	11335	13913	12399	8636	2889	1316	1283	551	635
1980	7162	30093	11726	6585	2812	2204	1184	1262	565
1981	39361	21285	21861	5505	4438	3436	795	313	866
1982	15339	42725	8728	4817	1497	1891	1670	335	596
1983	13540	102871	26993	3225	1862	327	372	932	308
1984	19517	92892	41121	16043	2450	1085	376	231	180
1985	17916	57054	36258	16032	2306	228	85	173	132
1986	4159	56747	42881	32930	8790	1127	98	29	12
1987	5976	67000	43075	23014	14323	2716	1175	296	464
1988	2307	82027	30962	9398	5963	3047	869	297	86
1989	8260	42413	68399	19601	8205	3837	2589	767	682
1990	2702	41756	24634	35258	8116	3808	1671	695	462
1991	1912	63854	38342	16916	28405	4869	2588	954	593
1992	10410	26752	35019	27591	10139	18061	3021	6285	689
1993	1608	94061	9372	10221	4491	2790	5932	855	508
1994	12130	35768	61737	3289	3025	4773	1713	1705	474
1995	9450	79159	22591	36541	3686	3420	2651	1859	842
1996	3464	57263	35366	7345	14901	1921	1467	1394	948

Table 4.3.1

HER-IRLS: Herring South and South West of Ireland (Celtic Sea + VIIj)

WEST: Mean Weight in Stock (Kilograms)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1958	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1959	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1960	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1961	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1962	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1963	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1964	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1965	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1966	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1967	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1968	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1969	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1970	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1971	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1972	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1973	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1974	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1975	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1976	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1977	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1978	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1979	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1980	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1981	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1982	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1983	0.115	0.174	0.211	0.229	0.244	0.257	0.260	0.263	0.266
1984	0.093	0.142	0.185	0.213	0.213	0.245	0.246	0.263	0.262
1985	0.104	0.140	0.170	0.201	0.234	0.248	0.256	0.260	0.263
1986	0.112	0.155	0.172	0.187	0.215	0.248	0.276	0.284	0.332
1987	0.096	0.138	0.186	0.192	0.204	0.231	0.255	0.267	0.284
1988	0.097	0.132	0.168	0.203	0.209	0.215	0.237	0.257	0.283
1989	0.106	0.129	0.151	0.169	0.194	0.199	0.210	0.221	0.240
1990	0.099	0.137	0.153	0.167	0.188	0.208	0.209	0.229	0.251
1991	0.092	0.128	0.168	0.182	0.190	0.206	0.229	0.236	0.251
1992	0.096	0.123	0.150	0.177	0.191	0.194	0.212	0.228	0.248
1993	0.092	0.129	0.155	0.180	0.201	0.204	0.210	0.225	0.240
1994	0.097	0.135	0.168	0.179	0.190	0.210	0.218	0.217	0.227
1995	0.088	0.126	0.151	0.178	0.188	0.198	0.207	0.227	0.227
1996	0.088	0.118	0.147	0.159	0.185	0.196	0.207	0.219	0.231

Table 4.4.1 Total stock numbers at age (10^6) estimated using acoustic surveys estimates.

W.Rs	1990/1991	1991/1992	1992/1993	1993/1994	1994/1995	1995/1996	1996/1997
0	204.8	213.8	141.8	258.8	41.3	5.1	2.8
1	131.6	62.6	426.9	217.1	38.0	279.5	133.6
2	249.0	195.2	117.0	437.9	127.2	550.7	757.0
3	108.6	94.7	87.8	58.7	160.3	138.4	249.9
4	152.5	54.0	49.6	63.4	10.5	93.5	50.6
5	32.4	84.8	22.2	26.0	10.6	7.9	41.9
6	14.9	22.1	24.2	16.3	6.5	9.2	1.1
7	6.1	5.3	9.6	24.6	1.6	8.4	14.2
8	2.5	6.1	1.8	2.3	2.6	9.2	0.5
9+	1.5	-	1.1	1.7	0.5	4.7	1.8
Total	903.9	738.6	882.0	1,106.8	399.1	1106.5	1,253.4
TSB (000't)	103.0	84.4	88.5	104.0	51.8	134.6	151.3
SSB (000't)	91.0	77.0	71.0	90.0	50.6	114.0	145.8

Table 4.4.2

Output Generated by ICA version 1.3

Herring Celtic VIIj (run: ICAJM10/I10)

Catch in number

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	2.80	11.34	7.16	39.36	15.34	13.54	19.52	17.92	4.16	5.98	2.31	8.26	2.70	1.91	10.41
2	13.39	13.91	30.09	21.29	42.73	102.87	92.89	57.05	56.75	67.00	82.03	42.41	41.76	63.85	26.75
3	11.95	12.40	11.73	21.86	8.73	26.99	41.12	36.26	42.88	43.08	30.96	68.40	24.63	38.34	35.02
4	5.58	8.64	6.59	5.51	4.82	3.23	16.04	16.03	32.93	23.01	9.40	19.60	35.26	16.92	27.59
5	1.58	2.89	2.81	4.44	1.50	1.86	2.45	2.31	8.79	14.32	5.96	8.21	8.12	28.41	10.14
6	1.48	1.32	2.20	3.44	1.89	.33	1.09	.23	1.13	2.72	3.05	3.84	3.81	4.87	18.06
7	.54	1.28	1.18	.80	1.67	.37	.38	.09	.10	1.18	.87	2.59	1.67	2.59	3.02
8	.86	.55	1.26	.31	.34	.93	.23	.17	.03	.30	.30	.77	.69	.95	6.29
9	.48	.64	.56	.87	.60	.31	.18	.13	.01	.46	.09	.68	.46	.59	.69

Thousands

Catch in number

Age	1993	1994	1995	1996
1	1.61	12.13	9.45	3.46
2	94.06	35.77	79.16	57.26
3	9.37	61.74	22.59	35.37
4	10.22	3.29	36.54	7.35
5	4.49	3.03	3.69	14.90
6	2.79	4.77	3.42	1.92
7	5.93	1.71	2.65	1.47
8	.86	1.71	1.86	1.39
9	.51	.47	.84	.95

Thousands

Table 4.4.2 ctd

Predicted Catch in Number

Age	1990	1991	1992	1993	1994	1995	1996
1	3215.	2019.	14316.	2680.	6720.	5911.	3464.
2	46206.	48521.	33335.	88062.	32874.	81357.	60014.
3	24532.	36995.	39215.	8905.	56545.	20649.	42836.
4	30786.	16443.	24849.	8368.	4763.	29540.	9018.
5	6554.	22030.	11969.	5762.	4777.	2659.	13762.
6	4508.	5764.	19493.	3497.	4064.	3295.	1538.
7	1669.	3066.	3960.	4233.	1896.	2153.	1457.
8	737.	1433.	2643.	1124.	2914.	1276.	1215.

Units

Weights at age in the catches (Kg)

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.11500	.11500	.11500	.11500	.11500	.11500	.09300	.10400	.11200	.09600	.09700	.10600	.09900	.09200	.09600
2	.17400	.17400	.17400	.17400	.17400	.17400	.14200	.14000	.15500	.13800	.13200	.12900	.13700	.12800	.12300
3	.21100	.21100	.21100	.21100	.21100	.21100	.18500	.17000	.17200	.18600	.16800	.15100	.15300	.16800	.15000
4	.22900	.22900	.22900	.22900	.22900	.22900	.21300	.20100	.18700	.19200	.20300	.16900	.16700	.18200	.17700
5	.24400	.24400	.24400	.24400	.24400	.24400	.21300	.23400	.21500	.20400	.20900	.19400	.18800	.19000	.19100
6	.25700	.25700	.25700	.25700	.25700	.25700	.24500	.24800	.24800	.23100	.21500	.19900	.20800	.20600	.19400
7	.26000	.26000	.26000	.26000	.26000	.26000	.24600	.25600	.27600	.25500	.23700	.21000	.20900	.22900	.21200
8	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26000	.28400	.26700	.25700	.22100	.22900	.23600	.22800
9	.26600	.26600	.26600	.26600	.26600	.26600	.26200	.26300	.33200	.28400	.28300	.24000	.25100	.25100	.24800

Units

Weights at age in the catches (Kg)

Age	1993	1994	1995	1996
1	.09200	.09700	.08800	.08800
2	.12900	.13500	.12600	.11800
3	.15500	.16800	.15100	.14700
4	.18000	.17900	.17800	.15900
5	.20100	.19000	.18800	.18500
6	.20400	.21000	.19800	.19600
7	.21000	.21800	.20700	.20700
8	.22500	.21700	.22700	.21900
9	.24000	.22700	.22700	.23100

Units

Table 4.4.2 ctd

Weights at age in the stock (Kg)

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.11500	.11500	.11500	.11500	.11500	.11500	.09300	.10400	.11200	.09600	.09700	.10600	.09900	.09200	.09600
2	.17400	.17400	.17400	.17400	.17400	.17400	.14200	.14000	.15500	.13800	.13200	.12900	.13700	.12800	.12300
3	.21100	.21100	.21100	.21100	.21100	.21100	.18500	.17000	.17200	.18600	.16800	.15100	.15300	.16800	.15000
4	.22900	.22900	.22900	.22900	.22900	.22900	.21300	.20100	.18700	.19200	.20300	.16900	.16700	.18200	.17700
5	.24400	.24400	.24400	.24400	.24400	.24400	.21300	.23400	.21500	.20400	.20900	.19400	.18800	.19000	.19100
6	.25700	.25700	.25700	.25700	.25700	.25700	.24500	.24800	.24800	.23100	.21500	.19900	.20800	.20600	.19400
7	.26000	.26000	.26000	.26000	.26000	.26000	.24600	.25600	.27600	.25500	.23700	.21000	.20900	.22900	.21200
8	.26300	.26300	.26300	.26300	.26300	.26300	.26300	.26000	.28400	.26700	.25700	.22100	.22900	.23600	.22800
9	.26600	.26600	.26600	.26600	.26600	.26600	.26200	.26300	.33200	.28400	.28300	.24000	.25100	.25100	.24800

Units

Weights at age in the stock (Kg)

Age	1993	1994	1995	1996
1	.09200	.09700	.08800	.08800
2	.12900	.13500	.12600	.11800
3	.15500	.16800	.15100	.14700
4	.18000	.17900	.17800	.15900
5	.20100	.19000	.18800	.18500
6	.20400	.21000	.19800	.19600
7	.21000	.21800	.20700	.20700
8	.22500	.21700	.22700	.21900
9	.24000	.22700	.22700	.23100

Units

Natural Mortality (per year)

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000	.3000
3	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000	.2000
4	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
5	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
6	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
7	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
8	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
9	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000

Units

Table 4.4.2 ctd

Natural Mortality (per year)

Age	1993	1994	1995	1996
1	1.0000	1.0000	1.0000	1.0000
2	.3000	.3000	.3000	.3000
3	.2000	.2000	.2000	.2000
4	.1000	.1000	.1000	.1000
5	.1000	.1000	.1000	.1000
6	.1000	.1000	.1000	.1000
7	.1000	.1000	.1000	.1000
8	.1000	.1000	.1000	.1000
9	.1000	.1000	.1000	.1000

Units

Proportion of fish spawning

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Units

Proportion of fish spawning

Age	1993	1994	1995	1996
1	.5000	.5000	.5000	.5000
2	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000

Units

Table 4.4.2 ctd

AGE - STRUCTURED INDICES

ACC: celtic combined acc data (Catch: Mi

Age	1990	1991	1992	1993	1994	1995	1996
2	249.00	195.20	117.00	437.90	127.20	550.70	*******
3	108.60	94.70	87.80	58.70	160.30	138.40	*******
4	152.50	54.00	49.60	63.40	10.50	93.50	*******
5	32.40	84.80	22.20	26.00	10.60	7.90	*******
6	14.90	22.10	24.20	16.30	6.50	9.20	*******
7	6.10	5.30	9.60	24.60	1.60	8.40	*******
8	2.50	6.10	1.80	2.30	2.60	9.20	*******
9	1.50	1.00	1.10	1.70	.50	4.70	*******

Units

Fishing Mortality (per year)

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0332	.0780	.0805	.1628	.0373	.0296	.0549	.0536	.0121	.0096	.0085	.0257	.0120	.0157	.0254
2	.3009	.4025	.5541	.6746	.4816	.6926	.5201	.3949	.4225	.4894	.3022	.3725	.3393	.4444	.7168
3	.3984	.5410	.7679	1.1665	.7149	.6994	.7266	.4226	.6312	.7191	.4732	.4755	.4106	.5377	.8675
4	.5377	.5318	.5892	1.0044	.8519	.6011	1.2080	.6684	.8114	.8017	.3142	.5924	.3860	.5056	.8157
5	.3653	.5231	.2919	.9070	.7363	.8539	1.1674	.4700	.8568	.9184	.4355	.4397	.3556	.4658	.7514
6	.2944	.5199	.8622	.6098	1.1840	.3061	1.9752	.2605	.3920	.6232	.4390	.4909	.4086	.5352	.8634
7	.3108	.3983	1.1230	.7893	.6001	.6830	.6049	.7817	.1525	.8010	.3660	.7263	.3639	.4767	.7689
8	.4004	.5282	.7559	.9336	.8201	.7068	1.1092	.5496	.5934	.7923	.4216	.5628	.4106	.5377	.8675
9	.4004	.5282	.7559	.9336	.8201	.7068	1.1092	.5496	.5934	.7923	.4216	.5628	.4106	.5377	.8675

Units

Fishing Mortality (per year)

Age	1993	1994	1995	1996
1	.0132	.0137	.0142	.0119
2	.3738	.3885	.4007	.3371
3	.4524	.4701	.4849	.4080
4	.4253	.4420	.4560	.3836
5	.3918	.4072	.4201	.3534
6	.4502	.4679	.4827	.4061
7	.4010	.4167	.4299	.3616
8	.4524	.4701	.4849	.4080
9	.4524	.4701	.4849	.4080

Units

Table 4.4.2 ctd

Population Abundance (1 January)

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	135.21	237.35	145.49	409.01	660.91	732.86	575.56	540.98	544.72	991.61	428.82	514.10	425.94	204.57	902.75
2	59.18	48.12	80.76	49.38	127.86	234.24	261.74	200.43	188.63	197.97	361.32	156.41	184.33	154.83	74.08
3	39.85	32.45	23.83	34.38	18.63	58.52	86.81	115.27	100.04	91.59	89.90	197.86	79.84	97.27	73.55
4	14.04	21.90	15.47	9.05	8.77	7.46	23.81	34.37	61.85	43.57	36.54	45.86	100.69	43.36	46.51
5	5.41	7.42	11.64	7.76	3.00	3.38	3.70	6.44	15.94	24.86	17.68	24.15	22.95	61.93	23.66
6	6.07	3.40	3.98	7.87	2.84	1.30	1.30	1.04	3.64	6.12	8.98	10.35	14.08	14.55	35.17
7	2.12	4.09	1.83	1.52	3.87	.79	.87	.16	.73	2.23	2.97	5.24	5.73	8.46	7.71
8	2.72	1.40	2.48	.54	.62	1.92	.36	.43	.07	.56	.90	1.86	2.29	3.61	4.75
9	1.53	1.62	1.11	1.49	1.11	.63	.28	.33	.03	.89	.26	1.66	1.44	1.49	1.24

Thousands

Population Abundance (1 January)

Age	1993	1994	1995	1996	1997
1	322.48	778.23	663.63	461.84	476.44
2	323.79	117.08	282.39	240.70	167.89
3	26.80	165.05	58.81	140.13	127.28
4	25.29	13.96	84.45	29.65	76.29
5	18.62	14.96	8.12	48.43	18.28
6	10.10	11.38	9.01	4.83	30.78
7	13.42	5.83	6.45	5.03	2.91
8	3.23	8.13	3.47	3.80	3.17
9	1.46	1.32	2.29	2.96	4.07

Thousands

Weighting factors for the catches in number

Age	1990	1991	1992	1993	1994	1995	1996
1	.1000	.1000	.1000	.1000	.1000	.1000	.1000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Units

Table 4.4.2.ctd

Predicted Age-Structured Index Values

ACC: celtic combined acc data (Catch: MiPredicted

Age	1990	1991	1992	1993	1994	1995	1996
2	287.64	217.50	79.25	488.12	173.93	414.39	*******
3	127.92	137.23	74.62	41.18	249.18	87.48	*******
4	144.07	55.04	43.31	34.79	18.88	112.67	*******
5	28.10	67.94	19.51	21.99	17.40	9.32	*******
6	16.07	14.64	25.49	11.06	12.25	9.55	*******
7	5.80	7.64	5.20	13.07	5.59	6.11	*******
8	2.25	3.12	2.96	3.05	7.53	3.17	*******
9	1.48	1.35	.81	1.44	1.28	2.19	*******

Units

Fitted Selection Pattern

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	.0834	.1442	.1048	.1396	.0522	.0423	.0755	.1268	.0192	.0133	.0180	.0540	.0292	.0292	.0292
2	.7552	.7440	.7216	.5784	.6736	.9904	.7158	.9346	.6693	.6806	.6386	.7834	.8264	.8264	.8264
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.3496	.9831	.7673	.8611	1.1917	.8595	1.6626	1.5818	1.2855	1.1149	.6639	1.2458	.9403	.9403	.9403
5	.9169	.9668	.3801	.7776	1.0300	1.2209	1.6067	1.1123	1.3574	1.2773	.9203	.9248	.8662	.8662	.8662
6	.7389	.9609	1.1228	.5228	1.6562	.4376	2.7186	.6165	.6210	.8667	.9276	1.0324	.9953	.9953	.9953
7	.7801	.7363	1.4623	.6767	.8395	.9767	.8326	1.8499	.2417	1.1139	.7733	1.5275	.8864	.8864	.8864
8	1.0050	.9764	.9843	.8003	1.1471	1.0106	1.5267	1.3006	.9401	1.1019	.8909	1.1835	1.0000	1.0000	1.0000
9	1.0050	.9764	.9843	.8003	1.1471	1.0106	1.5267	1.3006	.9401	1.1019	.8909	1.1835	1.0000	1.0000	1.0000

Units

Fitted Selection Pattern

Age	1993	1994	1995	1996
1	.0292	.0292	.0292	.0292
2	.8264	.8264	.8264	.8264
3	1.0000	1.0000	1.0000	1.0000
4	.9403	.9403	.9403	.9403
5	.8662	.8662	.8662	.8662
6	.9953	.9953	.9953	.9953
7	.8864	.8864	.8864	.8864
8	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000

Units

Table 4.4.2.ctd

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield/ SSB ratio	Mean F Ages 2- 7	SoP (%)
1978	135200	42023	26845	7559	.2816	.3679	101
1979	237340	52076	28566	10321	.3613	.4861	96
1980	145490	44643	27221	13130	.4823	.6981	92
1981	409000	69804	31031	17103	.5512	.8586	96
1982	660910	107119	47331	13000	.2747	.7615	105
1983	732850	141131	68793	24981	.3631	.6393	107
1984	575560	113314	62346	26779	.4295	1.0337	100
1985	540980	112830	62980	20426	.3243	.4997	97
1986	544710	123578	68409	25024	.3658	.5444	99
1987	991610	155372	76253	26200	.3436	.7255	100
1988	428810	118446	76088	20447	.2687	.3883	99
1989	514090	120952	71141	23254	.3269	.5162	99
1990	425940	105777	66279	18404	.2777	.3773	100
1991	204570	80797	56840	25562	.4497	.4942	98
1992	902750	129409	59595	21127	.3545	.7973	104
1993	322480	89842	58238	18618	.3197	.4158	99
1994	778220	130088	67893	19300	.2843	.4320	100
1995	663620	123847	71443	23305	.3262	.4457	99
1996	461830	106820	67500	17432	.2582	.3750	99

IFAP run code: I10

No of years for separable analysis : 7
Age range in the analysis : 1 9
Year range in the analysis : 1978 1996
Number of indices of SSB : 0
Number of age-structured indices : 1
Parameters to estimate : 35
Number of observations : 104

Conventional single selection vector model to be fitted.

Table 4.4.2.ctd

PARAMETER ESTIMATES

Parm No.		Maximum Likelih. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. distrib.
Separable Model: Reference F by year								
1	1990	.4106	18	.2872	.5869	.3421	.4927	.4174
2	1991	.5377	16	.3855	.7501	.4538	.6373	.5456
3	1992	.8675	15	.6413	1.1734	.7436	1.0120	.8778
4	1993	.4524	18	.3151	.6494	.3762	.5440	.4601
5	1994	.4701	19	.3192	.6923	.3858	.5727	.4793
6	1995	.4849	23	.3036	.7745	.3819	.6158	.4990
7	1996	.4080	35	.2041	.8154	.2866	.5809	.4343
Separable Model: Selection (S) by age								
8	1	.0292	48	.0112	.0760	.0179	.0476	.0329
9	2	.8264	19	.5662	1.2061	.6814	1.0022	.8419
	3	1.0000			Fixed : Reference age			
10	4	.9403	17	.6669	1.3257	.7891	1.1204	.9548
11	5	.8662	16	.6256	1.1994	.7337	1.0226	.8782
12	6	.9953	15	.7341	1.3494	.8521	1.1625	1.0074
13	7	.8864	16	.6477	1.2131	.7553	1.0403	.8978
	8	1.0000			Fixed : last true age			
Separable Model: Populations in year 1996								
14	1	461838	127	37785	5644916	128769	1656408	1044010
15	2	240697	45	98508	588124	152585	379690	267047
16	3	140124	31	75327	260663	102089	192330	147330
17	4	29647	28	16930	51918	22276	39458	30884
18	5	48433	27	28455	82438	36922	63532	50249
19	6	4824	26	2893	8045	3716	6262	4991
20	7	5028	27	2921	8653	3811	6633	5224
21	8	3797	29	2143	6726	2836	5083	3962
Separable Model: Populations at age 8								
22	1990	2291	32	1205	4353	1651	3179	2417
23	1991	3604	26	2155	6025	2772	4684	3730
24	1992	4753	23	2990	7557	3752	6022	4888
25	1993	3231	24	1986	5258	2520	4143	3333
26	1994	8131	23	5125	12900	6425	10290	8360
27	1995	3473	24	2144	5626	2715	4442	3580
Age-structured index catchabilities								
					ACC: celtic combined acc data (Catch: Mi			
Linear model fitted. Slopes at age:								
28	2 Q	.2957E-02	23	.2371E-02	.5846E-02	.2957E-02	.4687E-02	.3823E-02
29	3 Q	.2950E-02	23	.2360E-02	.5875E-02	.2950E-02	.4699E-02	.3826E-02
30	4 Q	.2326E-02	23	.1859E-02	.4644E-02	.2326E-02	.3711E-02	.3020E-02
31	5 Q	.1932E-02	23	.1539E-02	.3893E-02	.1932E-02	.3102E-02	.2517E-02
32	6 Q	.1899E-02	25	.1493E-02	.3988E-02	.1899E-02	.3135E-02	.2518E-02
33	7 Q	.1607E-02	28	.1228E-02	.3683E-02	.1607E-02	.2815E-02	.2212E-02
34	8 Q	.1637E-02	31	.1209E-02	.4170E-02	.1637E-02	.3079E-02	.2360E-02
35	9 Q	.1717E-02	27	.1321E-02	.3849E-02	.1717E-02	.2962E-02	.2341E-02

Table 4.4.2.ctd

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1990	1991	1992	1993	1994	1995	1996
1	-.1738	-.0546	-.3186	-.5110	.5905	.4692	.0000
2	-.1013	.2746	-.2200	.0659	.0844	-.0274	-.0469
3	.0041	.0358	-.1132	.0511	.0879	.0899	-.1916
4	.1356	.0284	.1047	.2000	-.3702	.2127	-.2052
5	.2138	.2542	-.1659	-.2492	-.4568	.3267	.0796
6	-.1688	-.1687	-.0763	-.2259	.1608	.0374	.2225
7	.0009	-.1694	-.2708	.3374	-.1013	.2081	.0070
8	-.0587	-.4071	.8663	-.2732	-.5359	.3765	.1375

Units

AGE - STRUCTURED INDEX RESIDUALS

ACC: celtic combined acc data (Catch: Mi

Age	1990	1991	1992	1993	1994	1995	1996
2	-.144	-.108	.390	-.109	-.313	.284	-1.000
3	-.164	-.371	.163	.354	-.441	.459	-1.000
4	.057	-.019	.136	.600	-.587	-.187	-1.000
5	.142	.222	.129	.168	-.495	-.165	-1.000
6	-.076	.412	-.052	.388	-.634	-.038	-1.000
7	.051	-.366	.614	.632	-1.250	.319	-1.000
8	.104	.671	-.497	-.281	-1.063	1.066	-1.000
9	.013	-.303	.308	.163	-.943	.762	-1.000

Units

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1990 to 1996

Variance	:	.1046
Skewness test statistic	:	1.7087
Kurtosis test statistic	:	3.1424
Partial chi-square	:	.3692
Significance in fit	:	.0000
Degrees of freedom	:	29

Table 4.4.2.ctd

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR ACC: celtic combined acc data (Catch: Mi

Linear catchability relationship assumed.

Age :	2	3	4	5	6	7	8	9
Variance :	.0422	.0812	.0856	.0435	.0823	.2900	.3434	.1894
Skewness test stat. :	.4902	.0164	.0372	-1.0732	-.4988	-.8798	.0766	-.4386
Kurtosis test stat. :	-.6489	-.8184	-.2067	-.2003	-.3065	-.2481	-.5866	-.2857
Partial chi-square :	.0421	.0876	.1303	.0735	.1629	.7967	1.2668	2.8784
Significance in fit :	.0000	.0001	.0003	.0001	.0005	.0228	.0617	.2813
Number of data :	6	6	6	6	6	6	6	6
Degrees of freedom :	5	5	5	5	5	5	5	5
Weight in analysis :	.5625	.5625	.5625	.5625	.5625	.5625	.5625	.5625

ANALYSIS OF VARIANCE TABLE

Unweighted Statistics

		SSQ	Data	Params	d.f.	
Variance						
	Total for Model	14.1911	104	35	69	.2057
	Catches at Age	3.9008	56	27	29	.1345
Aged Indices						
ACC: celtic combined acc data (Catch: M		10.2903	48	8	40	.2573

Weighted Statistics

		SSQ	Data	Params	d.f.	
Variance						
	Total for Model	6.2885	104	35	69	.0911
	Catches at Age	3.0325	56	27	29	.1046
Aged Indices						
ACC: celtic combined acc data (Catch: M		3.2559	48	8	40	.0814

Table 4.6.1

Herring South and South West of Ireland (Celtic Sea + VIIj)

Prediction with management option table: Input data

Year: 1997								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	476.440	1.0000	0.5000	0.2000	0.5000	91.000	0.0119	91.000
2	167.890	0.3000	1.0000	0.2000	0.5000	126.000	0.3372	126.000
3	127.280	0.2000	1.0000	0.2000	0.5000	155.000	0.4080	155.000
4	76.290	0.1000	1.0000	0.2000	0.5000	172.000	0.3836	172.000
5	18.280	0.1000	1.0000	0.2000	0.5000	188.000	0.3534	188.000
6	30.780	0.1000	1.0000	0.2000	0.5000	201.000	0.4061	201.000
7	2.910	0.1000	1.0000	0.2000	0.5000	211.000	0.3617	211.000
8	3.170	0.1000	1.0000	0.2000	0.5000	221.000	0.4080	221.000
9+	4.070	0.1000	1.0000	0.2000	0.5000	228.000	0.4080	228.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 1998								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	543.000	1.0000	0.5000	0.2000	0.5000	91.000	0.0119	91.000
2	.	0.3000	1.0000	0.2000	0.5000	126.000	0.3372	126.000
3	.	0.2000	1.0000	0.2000	0.5000	155.000	0.4080	155.000
4	.	0.1000	1.0000	0.2000	0.5000	172.000	0.3836	172.000
5	.	0.1000	1.0000	0.2000	0.5000	188.000	0.3534	188.000
6	.	0.1000	1.0000	0.2000	0.5000	201.000	0.4061	201.000
7	.	0.1000	1.0000	0.2000	0.5000	211.000	0.3617	211.000
8	.	0.1000	1.0000	0.2000	0.5000	221.000	0.4080	221.000
9+	.	0.1000	1.0000	0.2000	0.5000	228.000	0.4080	228.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 1999								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	543.000	1.0000	0.5000	0.2000	0.5000	91.000	0.0119	91.000
2	.	0.3000	1.0000	0.2000	0.5000	126.000	0.3372	126.000
3	.	0.2000	1.0000	0.2000	0.5000	155.000	0.4080	155.000
4	.	0.1000	1.0000	0.2000	0.5000	172.000	0.3836	172.000
5	.	0.1000	1.0000	0.2000	0.5000	188.000	0.3534	188.000
6	.	0.1000	1.0000	0.2000	0.5000	201.000	0.4061	201.000
7	.	0.1000	1.0000	0.2000	0.5000	211.000	0.3617	211.000
8	.	0.1000	1.0000	0.2000	0.5000	221.000	0.4080	221.000
9+	.	0.1000	1.0000	0.2000	0.5000	228.000	0.4080	228.000
Unit	Millions	-	-	-	-	Grams	-	Grams

Notes: Run name : MANJM01
Date and time: 17MAR97:13:31

Table 4.6.2

Herring South and South West of Ireland (Celtic Sea + VIIj)

Prediction with management option table

Year: 1997					Year: 1998					Year: 1999	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.1760	0.4410	109226	67854	22000	0.5000	0.1875	110660	68638	9603	122120	78664
.	.	.	.	.	0.6000	0.2250	.	68240	11329	120368	76624
.	.	.	.	.	0.7000	0.2625	.	67845	12995	118678	74666
.	.	.	.	.	0.8000	0.3000	.	67453	14605	117049	72789
.	.	.	.	.	0.9000	0.3375	.	67063	16159	115478	70988
.	.	.	.	.	1.0000	0.3750	.	66677	17660	113963	69259
.	.	.	.	.	1.1000	0.4125	.	66293	19109	112501	67601
.	.	.	.	.	1.2000	0.4500	.	65912	20509	111092	66009
.	.	.	.	.	1.3000	0.4875	.	65534	21861	109733	64481
.	.	.	.	.	1.4000	0.5250	.	65159	23168	108422	63014
.	.	.	.	.	1.5000	0.5625	.	64787	24429	107158	61606
.	.	.	.	.	1.6000	0.6000	.	64417	25648	105938	60254
.	.	.	.	.	1.7000	0.6375	.	64050	26826	104762	58955
.	.	.	.	.	1.8000	0.6750	.	63686	27964	103627	57708
.	.	.	.	.	1.9000	0.7125	.	63324	29064	102533	56509
.	.	.	.	.	2.0000	0.7500	.	62965	30127	101477	55358
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANJM01
Date and time : 17MAR97:13:31
Computation of ref. F: Simple mean, age 2 - 7
Basis for 1997 : TAC constraints

Table 4.6.3

Herring South and South West of Ireland (Celtic Sea + VIIj)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1997	1.1760	0.4410	143603	21937	972000	114960	700500	90254	518607	69407
1998	1.0000	0.3750	120921	18361	965130	113511	693630	88804	517413	68955
1999	1.0000	0.3750	125504	19190	978159	115816	706659	91109	527733	70799
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRJM01
Date and time : 16MAR97:18:19
Computation of ref. F: Simple mean, age 2 - 7
Prediction basis : F factors

Table 4.6.4

Herring South and South West of Ireland (Celtic Sea + VIIj)

Single option prediction: Detailed tables

Year: 1997 F-factor: 1.1760 Reference F: 0.4410

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0140	4775	435	543000	49413	271500	24707	164213	14943
2	0.3965	47984	6046	168000	21168	168000	21168	133574	16830
3	0.4798	44216	6854	127000	19685	127000	19685	104400	16182
4	0.4511	26358	4534	76000	13072	76000	13072	66057	11362
5	0.4156	5845	1099	18000	3384	18000	3384	15756	2962
6	0.4776	10883	2188	30000	6030	30000	6030	25937	5213
7	0.4254	993	209	3000	633	3000	633	2621	553
8	0.4798	1092	241	3000	663	3000	663	2593	573
9+	0.4798	1456	332	4000	912	4000	912	3457	788
Total		143603	21937	972000	114960	700500	90254	518607	69407
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1998 F-factor: 1.0000 Reference F: 0.3750

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0119	4064	370	543000	49413	271500	24707	164282	14950
2	0.3372	49121	6189	196983	24820	196983	24820	158487	19969
3	0.4080	25592	3967	83715	12976	83715	12976	69813	10821
4	0.3836	19573	3367	64353	11069	64353	11069	56693	9751
5	0.3534	12445	2340	43799	8234	43799	8234	38820	7298
6	0.4061	3425	689	10749	2160	10749	2160	9427	1895
7	0.3617	4878	1029	16838	3553	16838	3553	14899	3144
8	0.4080	568	125	1774	392	1774	392	1555	344
9+	0.4080	1254	286	3920	894	3920	894	3437	784
Total		120921	18361	965130	113511	693630	88804	517413	68955
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1999 F-factor: 1.0000 Reference F: 0.3750

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0119	4064	370	543000	49413	271500	24707	164282	14950
2	0.3372	49224	6202	197395	24872	197395	24872	158820	20011
3	0.4080	31842	4935	104159	16145	104159	16145	86862	13464
4	0.3836	13863	2384	45578	7839	45578	7839	40153	6906
5	0.3534	11274	2119	39677	7459	39677	7459	35167	6611
6	0.4061	8870	1783	27833	5594	27833	5594	24410	4906
7	0.3617	1877	396	6480	1367	6480	1367	5734	1210
8	0.4080	3395	750	10611	2345	10611	2345	9303	2056
9+	0.4080	1096	250	3426	781	3426	781	3004	685
Total		125504	19190	978159	115816	706659	91109	527733	70799
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRJM01
Date and time : 16MAR97:18:19
Computation of ref. F: Simple mean, age 2 - 7
Prediction basis : F factors

Table 4.6.5

Herring South and South West of Ireland (Celtic Sea + VIIj)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1997	1.0506	0.3940	130496	20000	905000	108938	667000	87280	501797	68159
1998	1.1220	0.4208	130032	20000	951957	112420	680457	87713	504411	67724
1999	1.1048	0.4143	130854	20000	961563	113280	690063	88573	511186	68267
2000	1.0928	0.4098	131181	20000	965976	113808	694476	89102	514737	68683
2001	1.0849	0.4068	131248	20000	968676	114185	697176	89478	517292	69041
2002	1.0764	0.4037	131149	20000	970963	114568	699463	89861	519501	69407
2003	1.0689	0.4008	131056	20000	973041	114928	701541	90221	521506	69752
2004	1.0623	0.3984	130953	20000	974930	115272	703430	90565	523335	70081
2005	1.0555	0.3958	130804	20000	976667	115606	705167	90899	525030	70400
2006	1.0490	0.3934	130656	20000	978311	115926	706811	91219	526634	70705
2007	1.0429	0.3911	130520	20000	979869	116228	708369	91521	528155	70994
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRJM02
Date and time : 18MAR97:19:54
Computation of ref. F: Simple mean, age 2 - 7
Prediction basis : TAC constraints

Table 4.6.6

Herring South and South West of Ireland (Celtic Sea + VIIj)

Yield per recruit: Summary table

						1 January		Spawning time	
F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0.000	0.000	3.985	684.832	3.485	639.332	3.097	586.312
0.1000	0.0375	0.079	15.292	3.220	514.254	2.720	468.754	2.353	421.030
0.2000	0.0750	0.125	23.137	2.795	420.882	2.295	375.382	1.940	330.628
0.3000	0.1125	0.154	27.742	2.524	362.178	2.024	316.678	1.676	273.832
0.4000	0.1500	0.176	30.684	2.335	321.986	1.835	276.486	1.492	234.969
0.5000	0.1875	0.192	32.682	2.196	292.825	1.696	247.325	1.357	206.783
0.6000	0.2250	0.205	34.102	2.089	270.758	1.589	225.258	1.252	185.458
0.7000	0.2625	0.216	35.152	2.004	253.515	1.504	208.015	1.169	168.794
0.8000	0.3000	0.225	35.953	1.935	239.697	1.435	194.197	1.101	155.437
0.9000	0.3375	0.233	36.582	1.878	228.396	1.378	182.896	1.045	144.506
1.0000	0.3750	0.240	37.089	1.830	218.996	1.330	173.496	0.997	135.406
1.1000	0.4125	0.246	37.506	1.788	211.064	1.288	165.564	0.956	127.721
1.2000	0.4500	0.251	37.857	1.753	204.290	1.253	158.790	0.920	121.148
1.3000	0.4875	0.256	38.159	1.722	198.443	1.222	152.943	0.889	115.466
1.4000	0.5250	0.261	38.421	1.694	193.350	1.194	147.850	0.862	110.508
1.5000	0.5625	0.265	38.653	1.670	188.877	1.170	143.377	0.837	106.144
1.6000	0.6000	0.269	38.862	1.648	184.921	1.148	139.421	0.815	102.275
1.7000	0.6375	0.273	39.050	1.628	181.398	1.128	135.898	0.795	98.822
1.8000	0.6750	0.276	39.223	1.611	178.243	1.111	132.743	0.777	95.720
1.9000	0.7125	0.279	39.383	1.595	175.402	1.095	129.902	0.761	92.919
2.0000	0.7500	0.283	39.532	1.580	172.832	1.080	127.332	0.746	90.377
2.1000	0.7875	0.285	39.671	1.567	170.497	1.067	124.997	0.732	88.059
2.2000	0.8250	0.288	39.803	1.554	168.366	1.054	122.866	0.719	85.936
2.3000	0.8625	0.291	39.928	1.543	166.415	1.043	120.915	0.707	83.984
2.4000	0.9000	0.293	40.047	1.533	164.621	1.033	119.121	0.696	82.183
2.5000	0.9375	0.295	40.160	1.523	162.968	1.023	117.468	0.686	80.516
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDJM04
Date and time : 17MAR97:19:51
Computation of ref. F: Simple mean, age 2 - 7
F-0.1 factor : 0.4199
F-max factor : Not found
F-0.1 reference F : 0.1575
F-max reference F : Not found
Recruitment : Single recruit

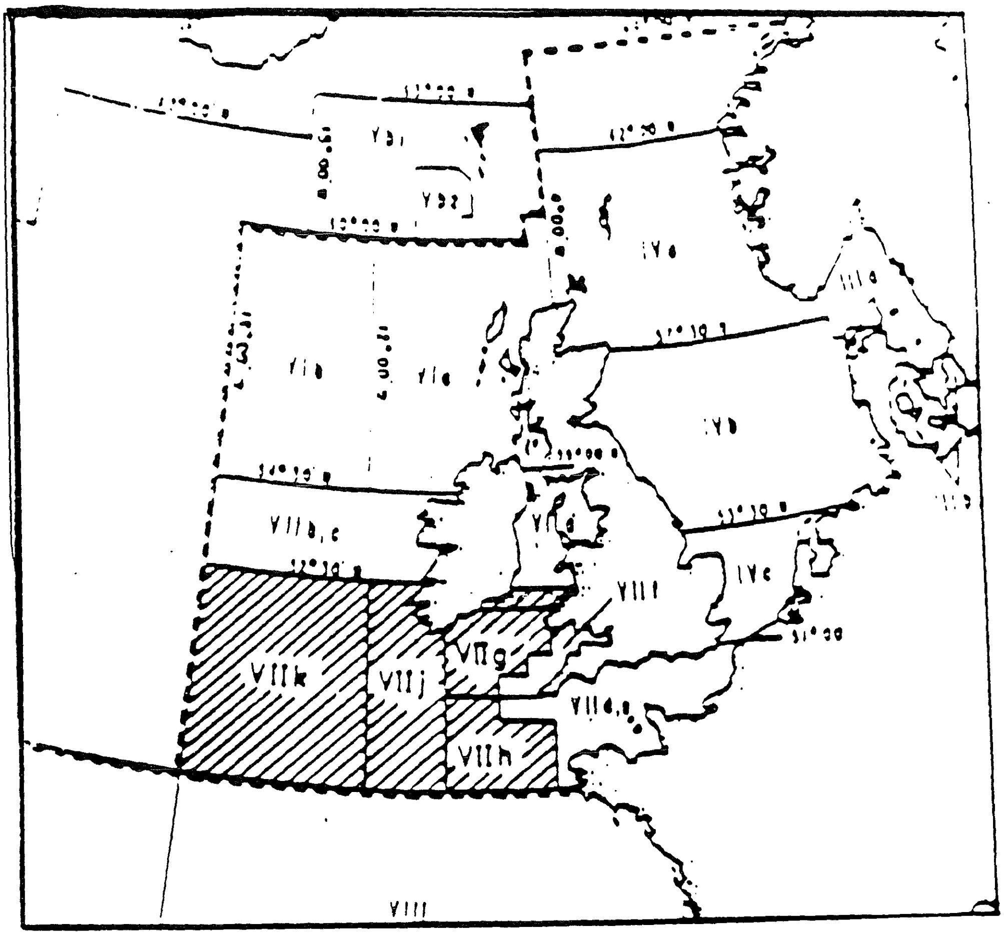


Figure 4.1.1 The assessment cover the area Divisions VIIj and VIIg and that part of Division VIIa below 52°30. TAC is set by EC for Divisions VIIg-k and that section of Division VIIa below 52°30.

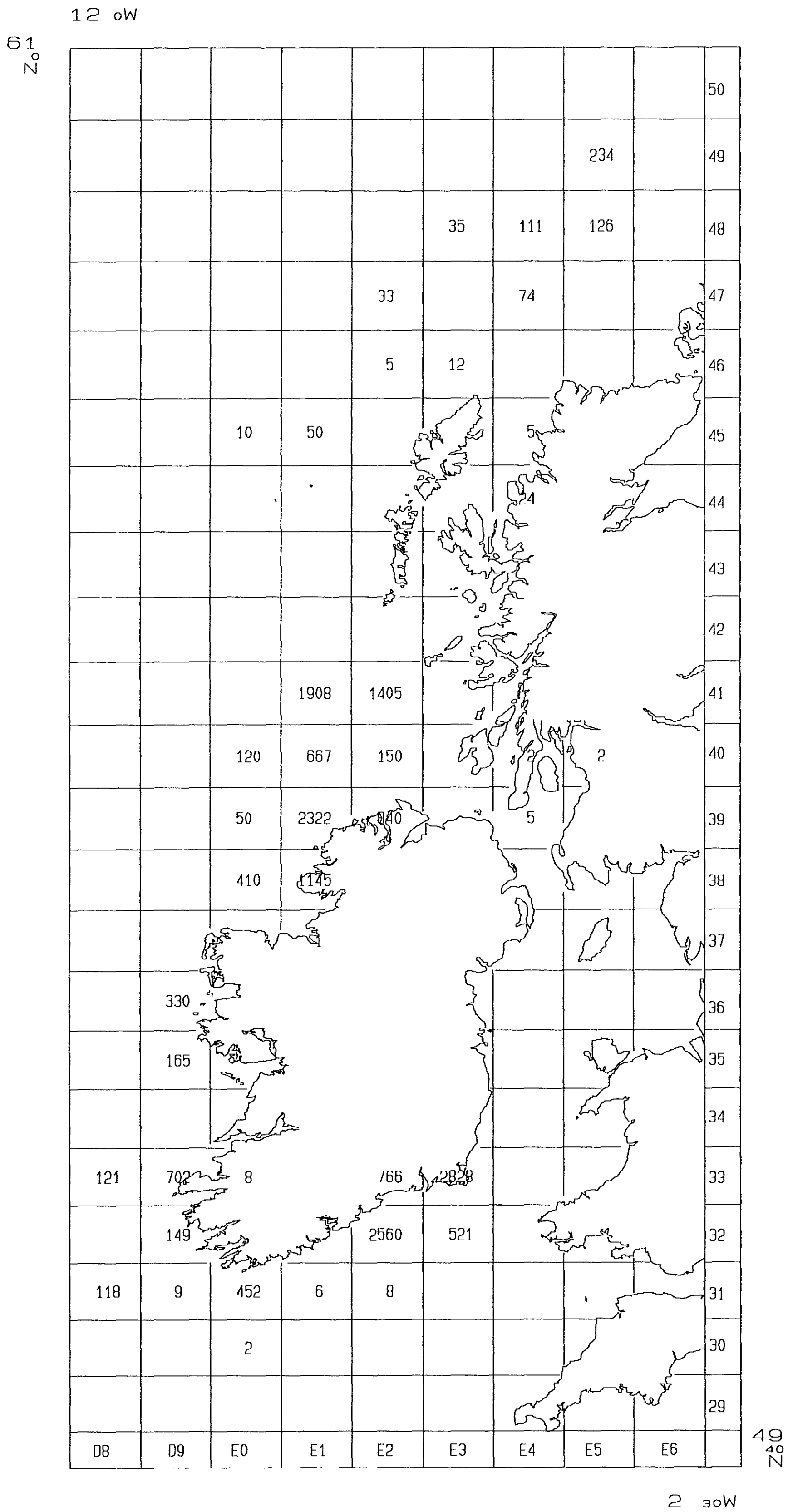


Figure 4.2.1a : Distribution of herring - 1 Quarter 1996.

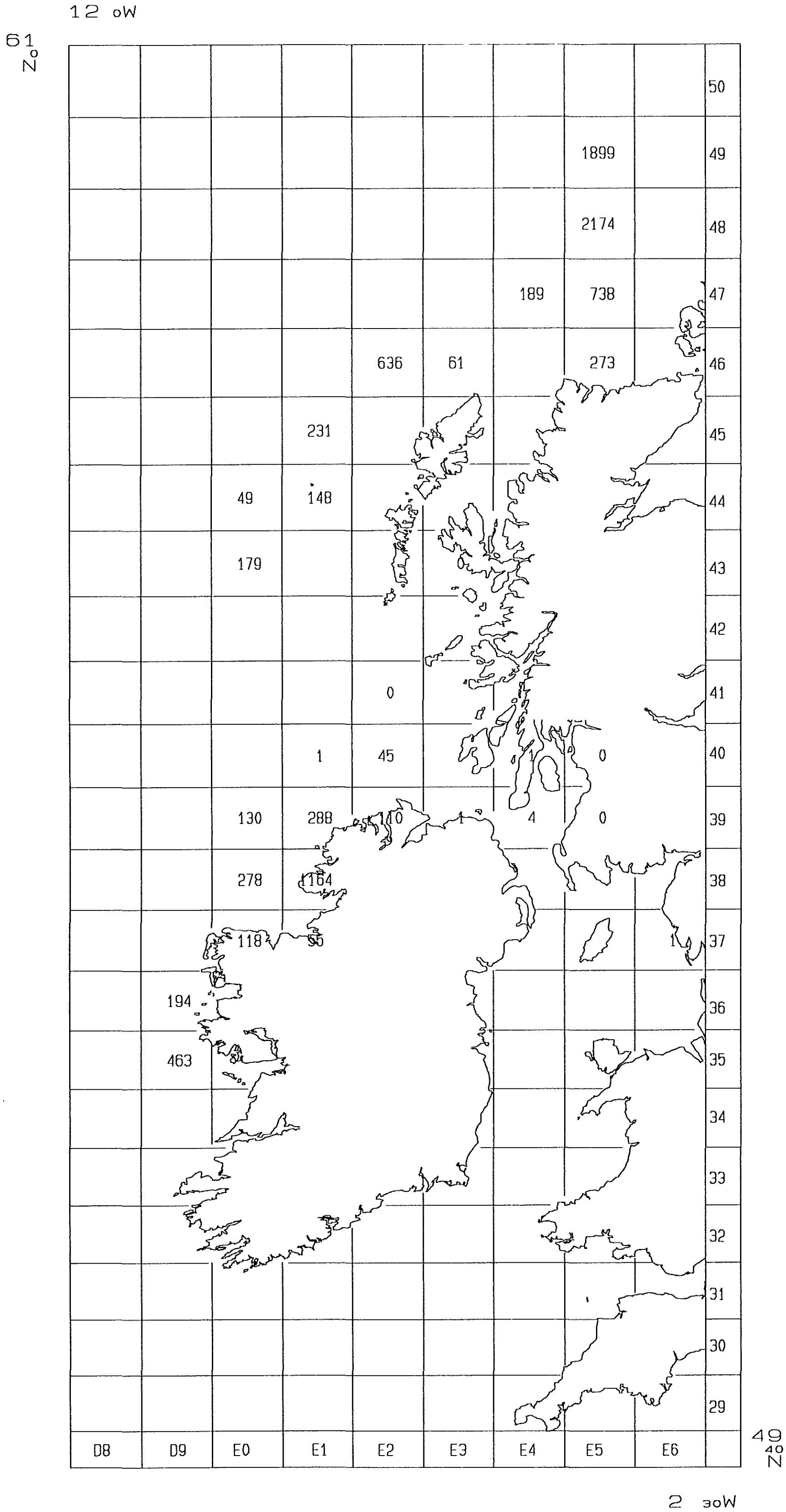


Figure 4.2.1b : Distribution of herring - 2 Quarter 1996.

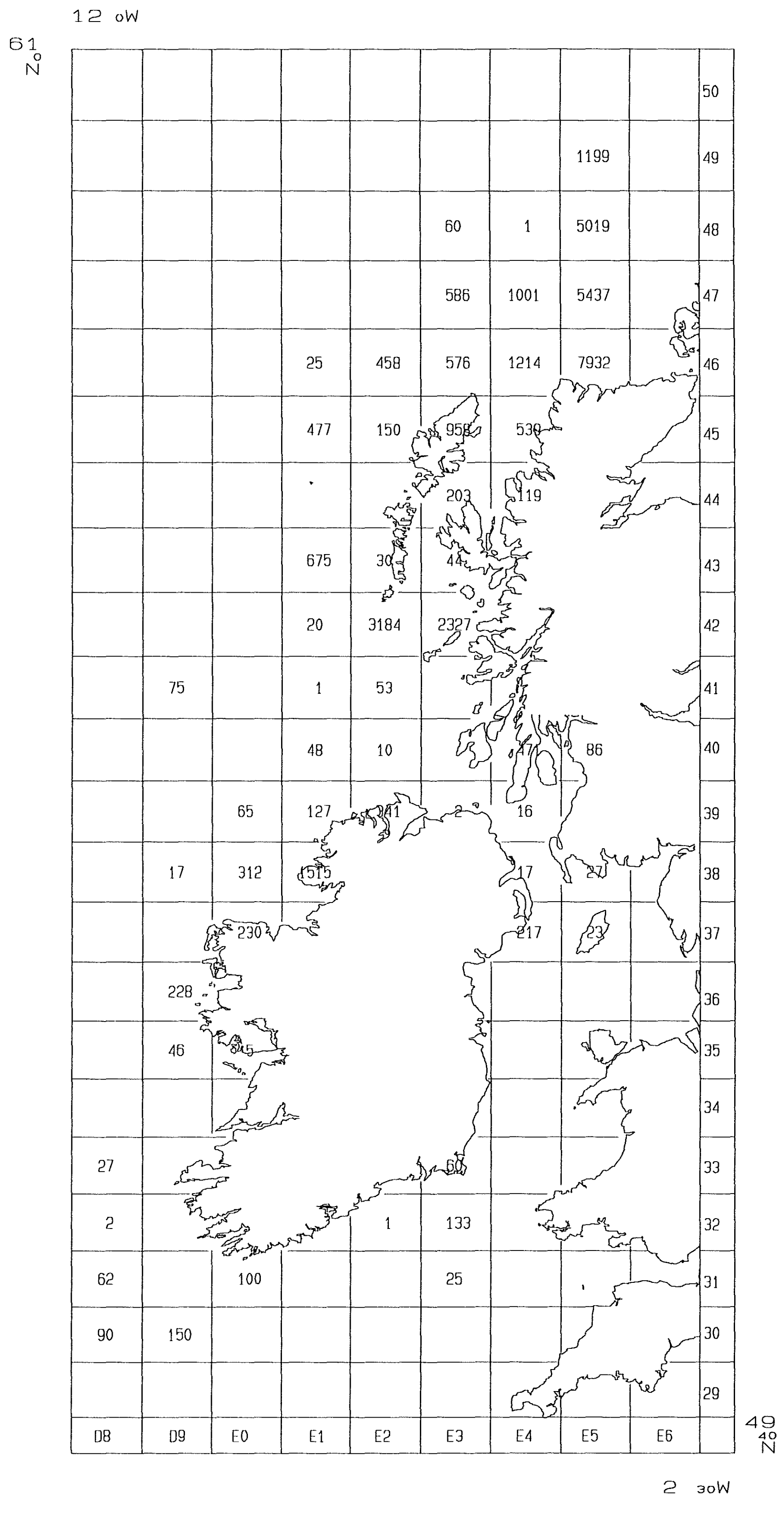


Figure 4.2.1c : Distribution of herring - 3 Quarter 1996.

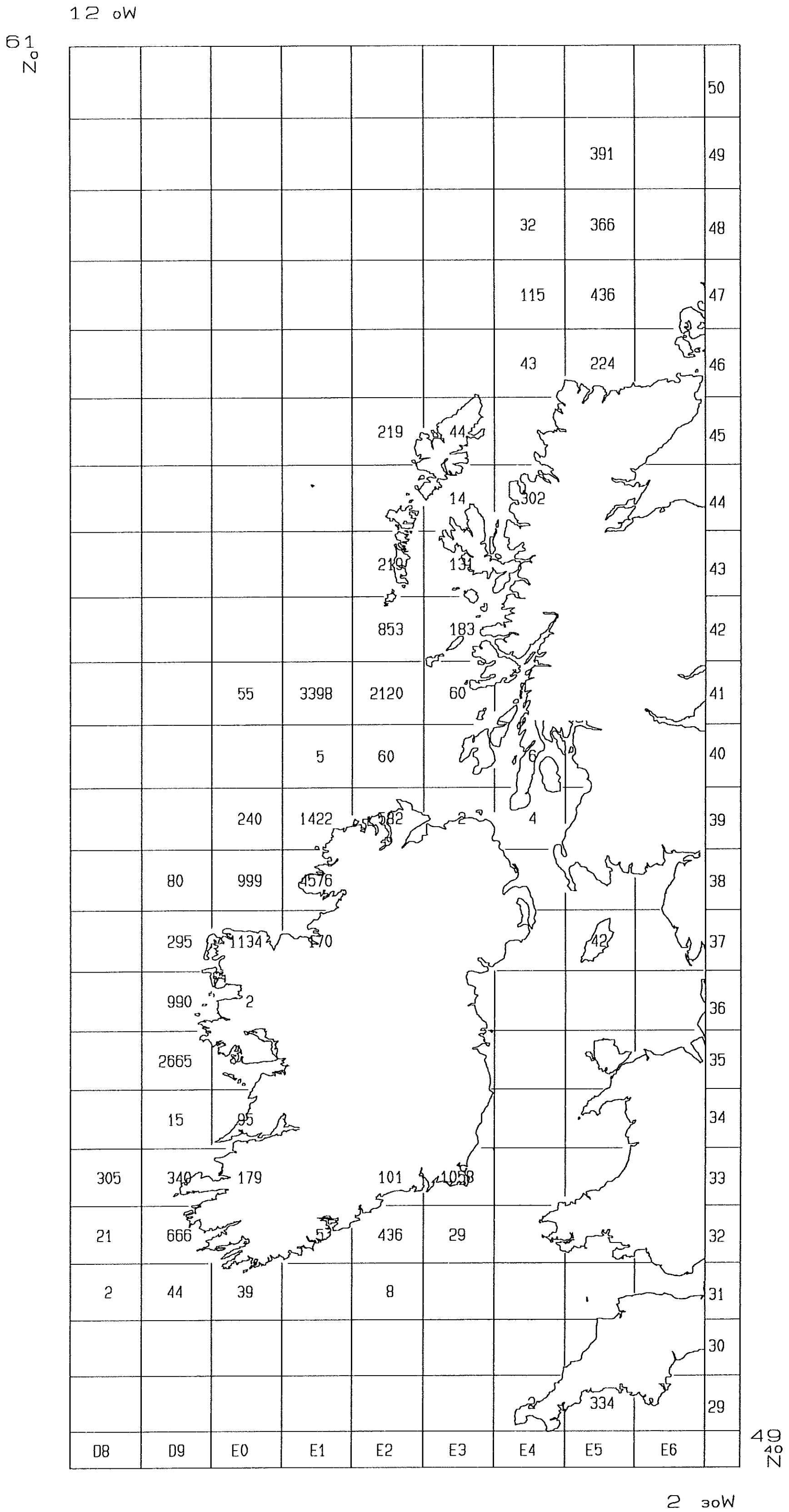


Figure 4.2.1d : Distribution of herring - 4 Quarter 1996.

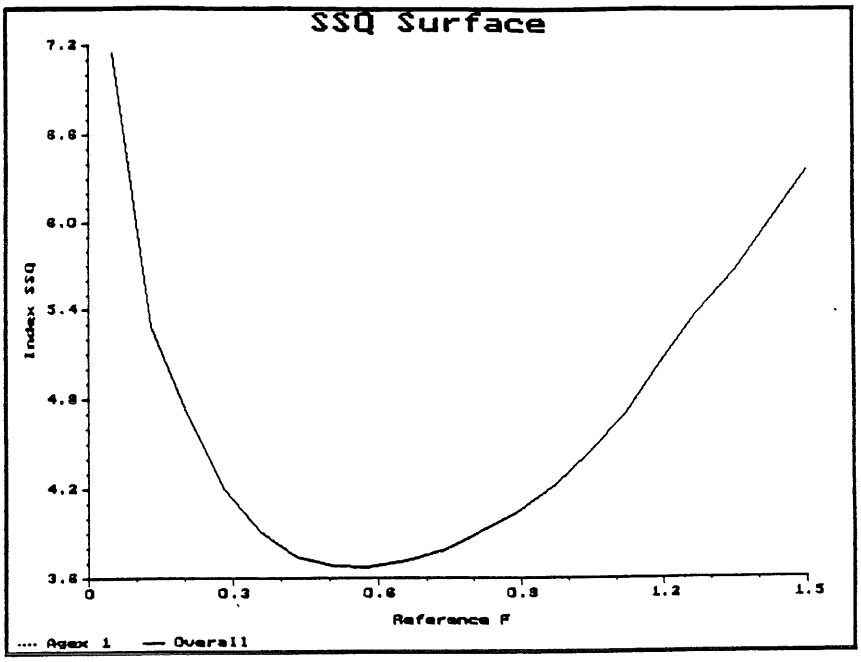


Figure 4.4.1. Herring in Celtic Sea and Division VIIj. SSQ surface for the baseline assessment.

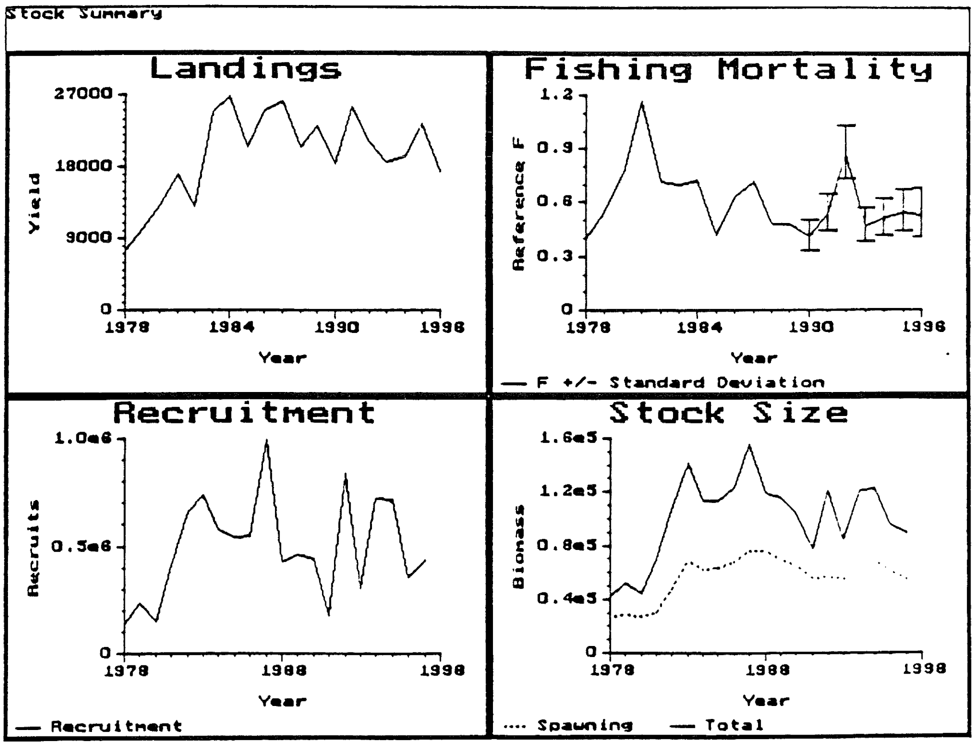


Figure 4.4.2. Herring in Celtic Sea and Division VIIj. Results of baseline assessment. Summary of estimates of landings, fishing mortality at age 3, recruitment at age 1, stock size on 1 January and spawning stock size at spawning time.

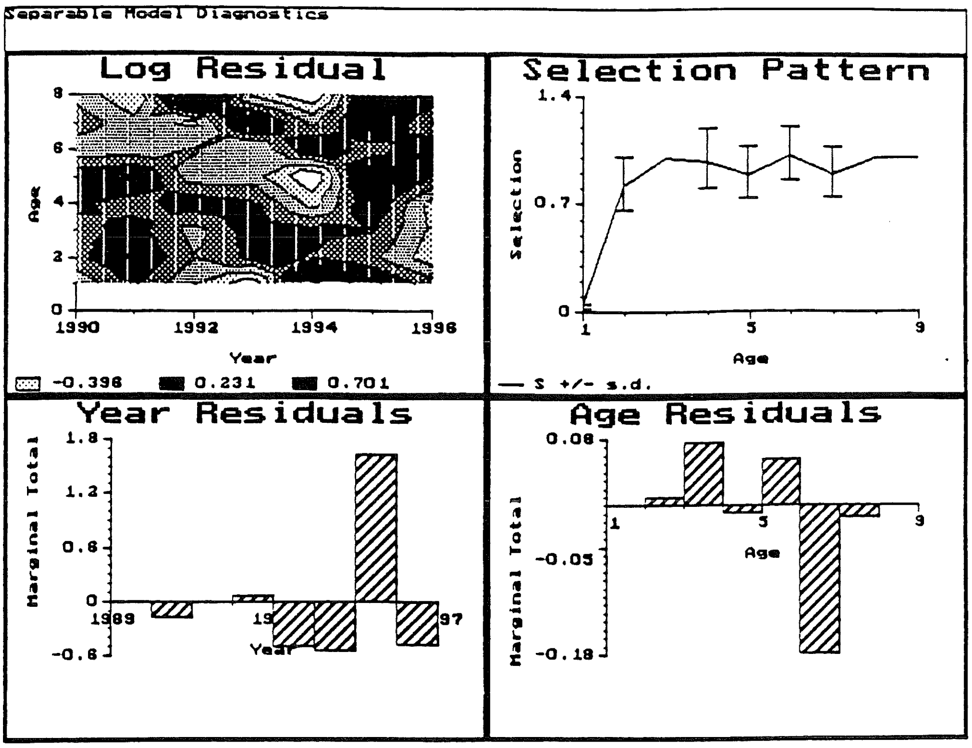


Figure 4.4.3. Herring in Celtic Sea and Division VIIj. Results of baseline assessment. Selection pattern diagnostics. Top left, contour plot of selection pattern residuals. Top right, estimated selection (relative to age 3) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

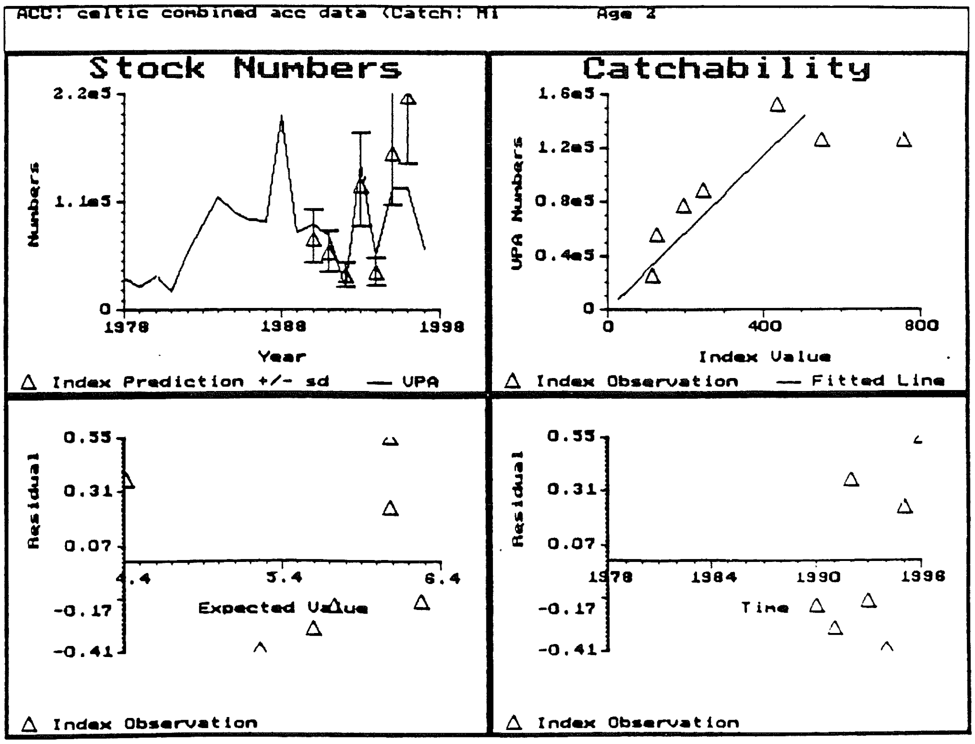


Figure 4.4.4. Herring in Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 2 against the estimated populations at age 2. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

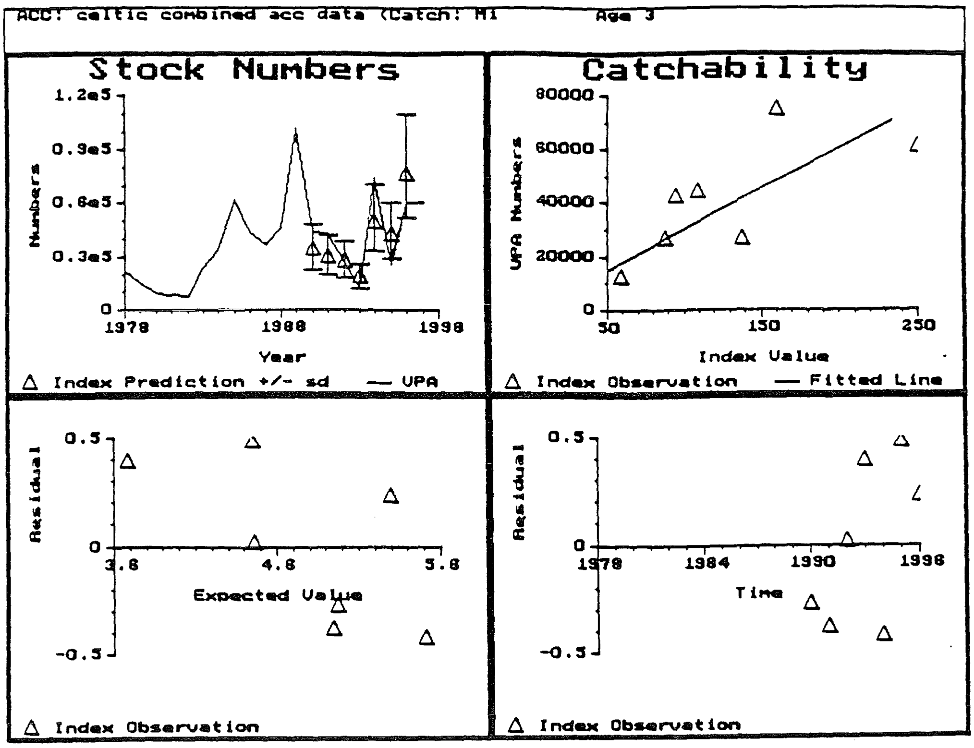


Figure 4.4.5. Herring in Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 3 against the estimated populations at age 3. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

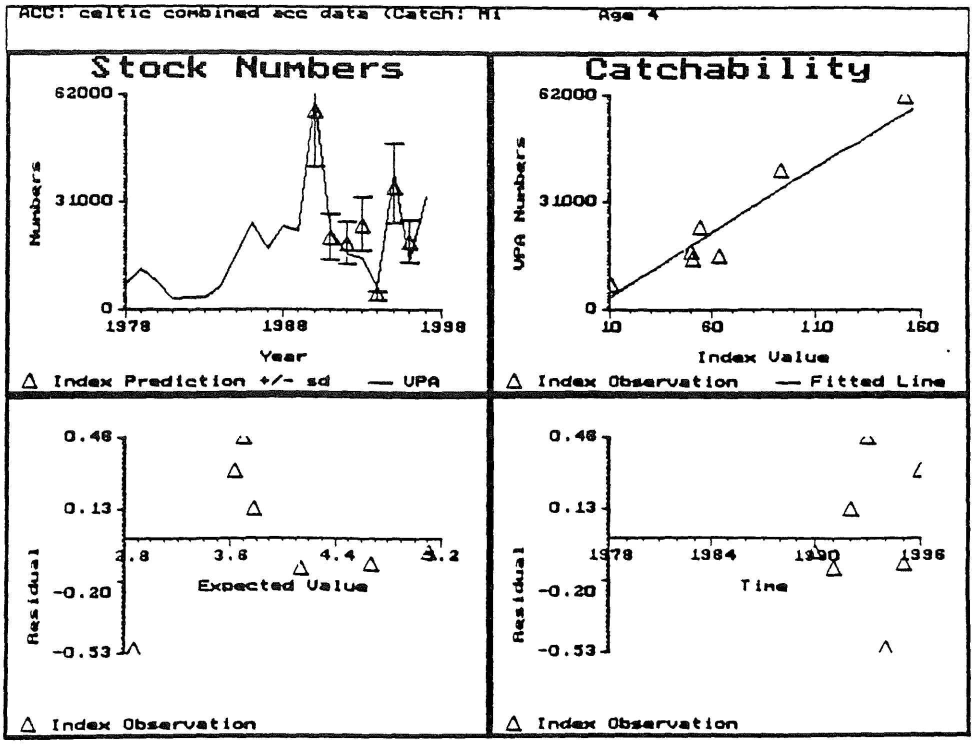


Figure 4.4.6. Herring in Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 4 against the estimated populations at age 4. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

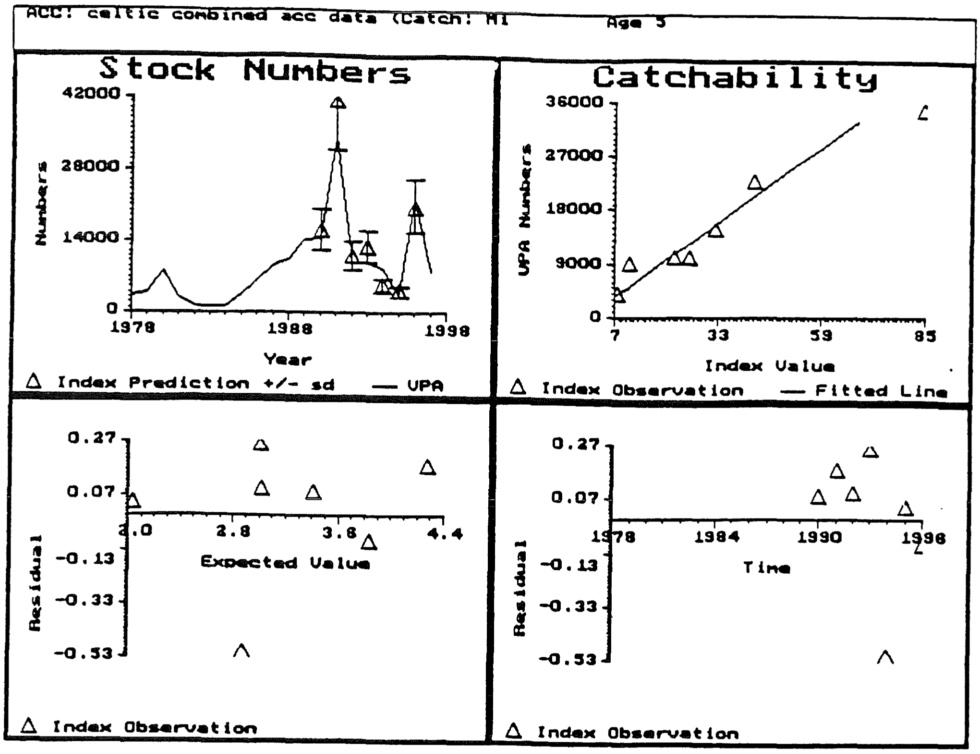


Figure 4.4.7. Herring in Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 5 against the estimated populations at age 5. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

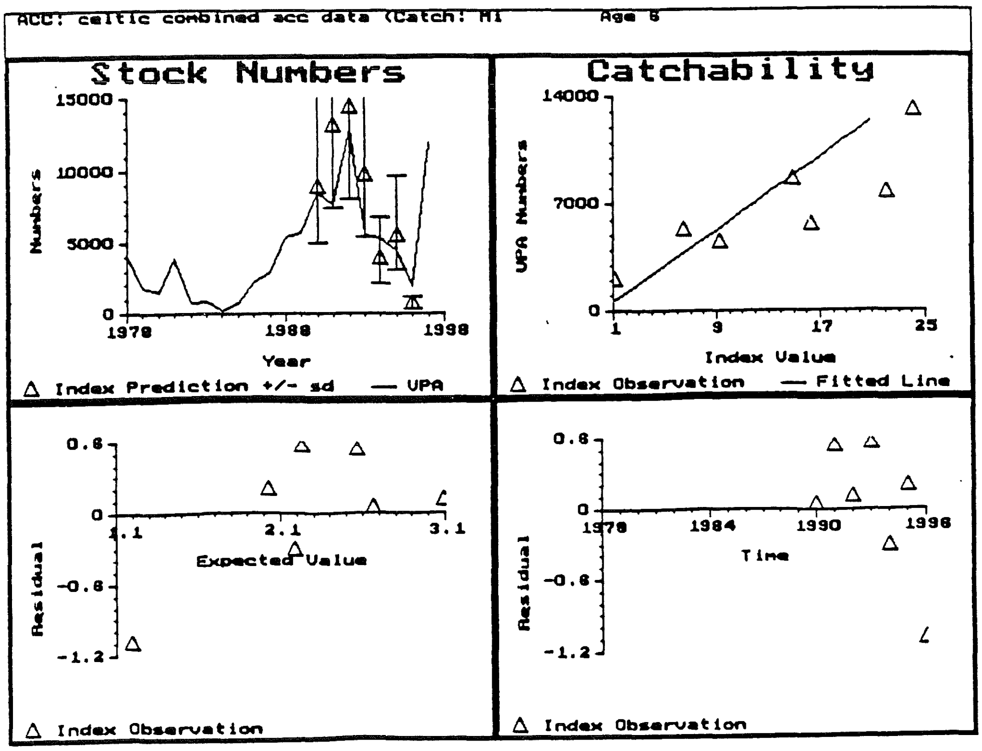


Figure 4.4.8. Herring in Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 6 against the estimated populations at age 6. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

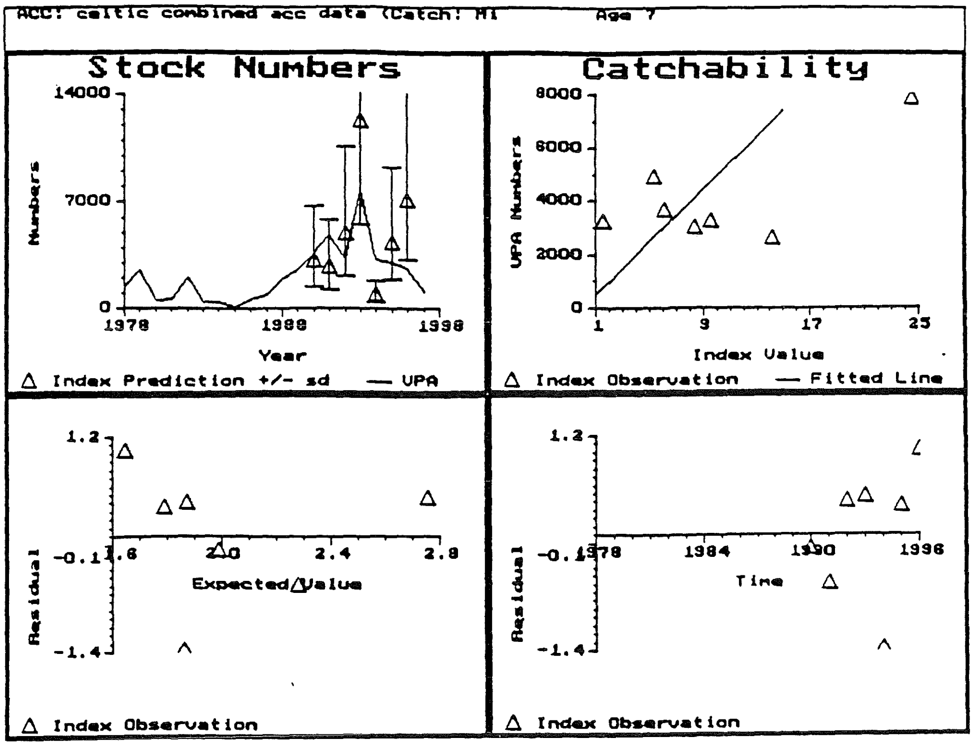


Figure 4.4.9. Herring in Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 7 against the estimated populations at age 7. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

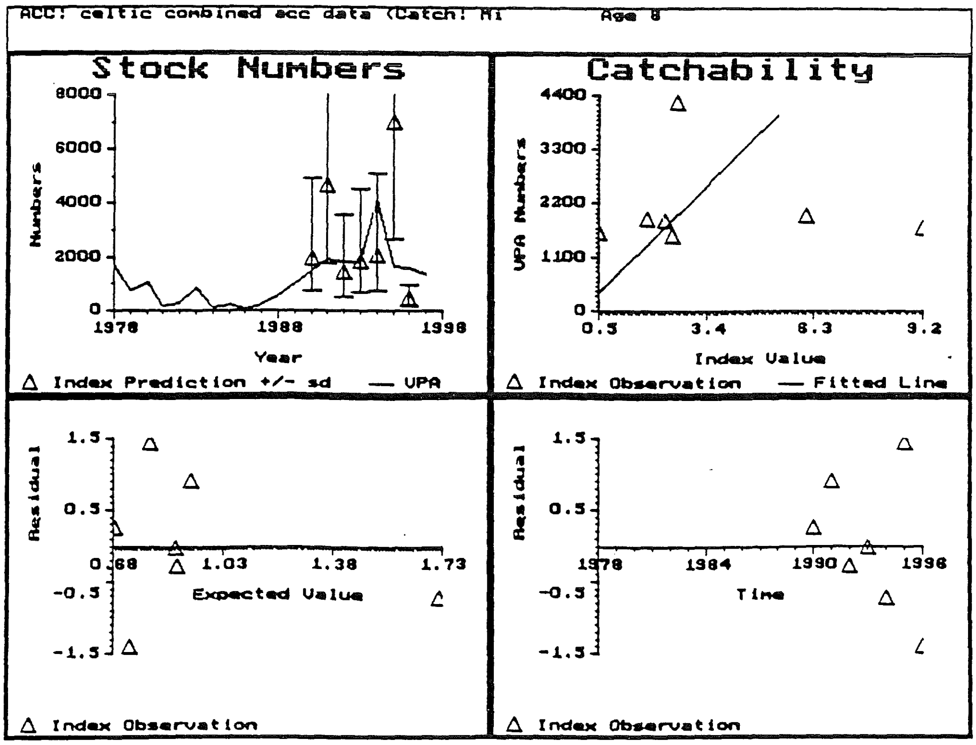


Figure 4.4.10. Herring in Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 8 against the estimated populations at age 8. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

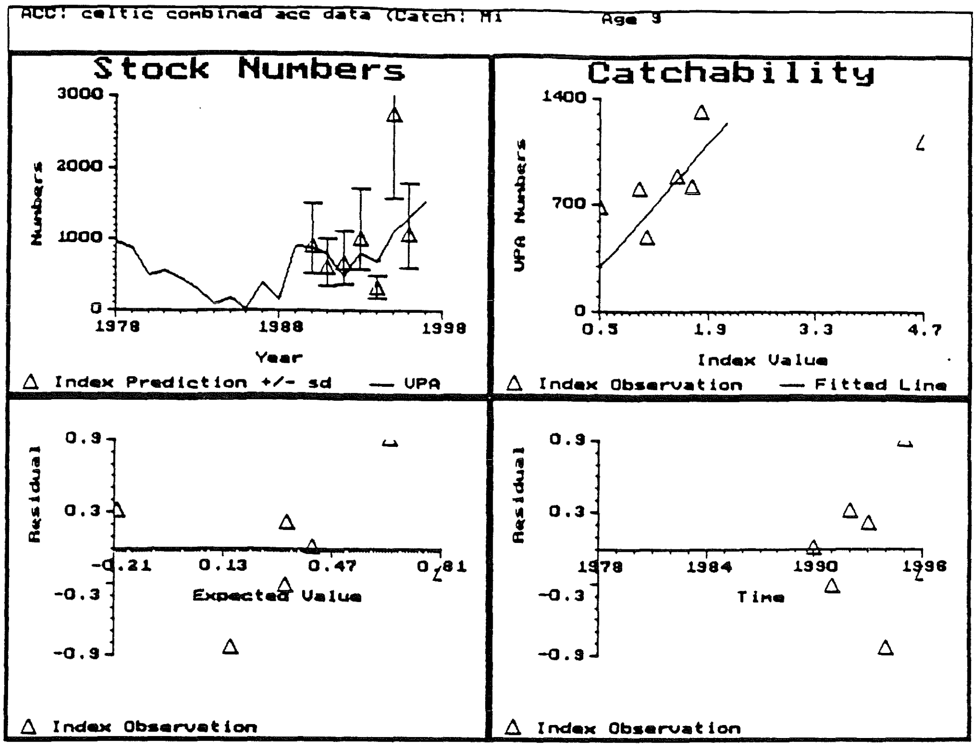


Figure 4.4.11. Herring in Celtic Sea and Division VIIj. Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 9 against the estimated populations at age 9. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

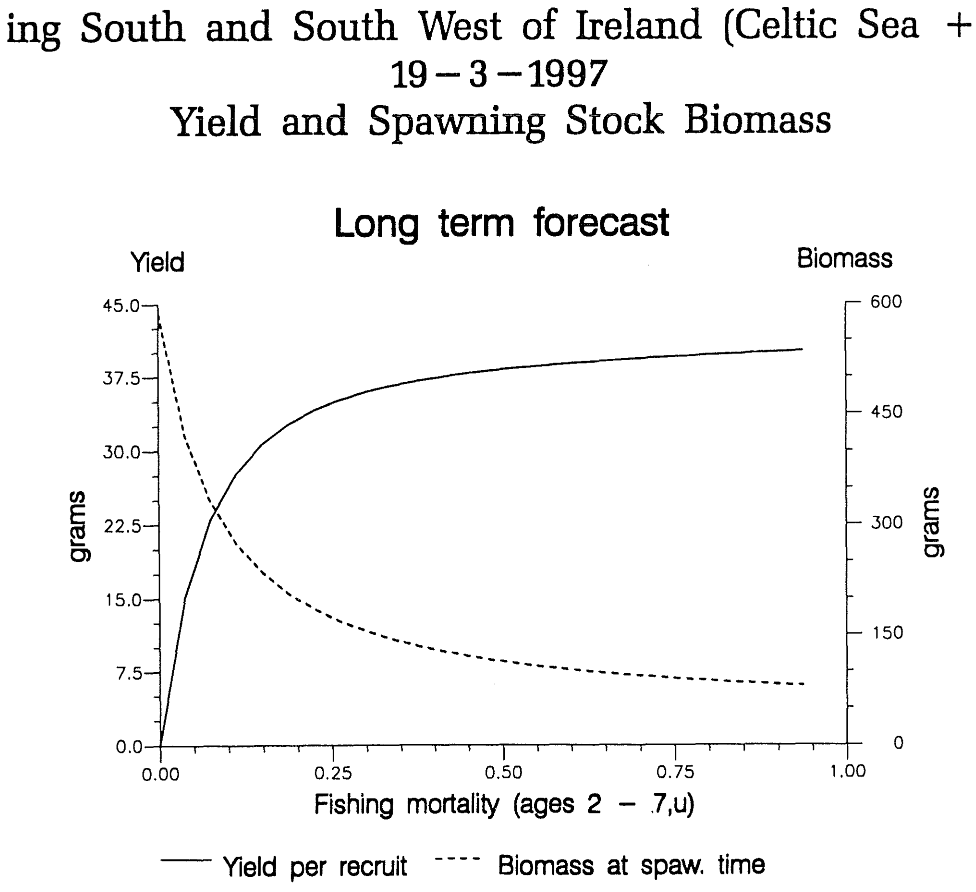


Figure 4.6.1 (I.C.A. run 10)

5 WEST OF SCOTLAND HERRING

5.1 Division VIa (North)

5.1.1 ACFM Advice applicable to 1996 and 1997

ACFM advice in 1996 recommended a precautionary TAC based on the expected catch levels to discourage misreporting from other areas. The agreed precautionary TACs were 83 570 t in 1996 and 83 570 t in 1997.

5.1.2 The fishery

Estimated catches by participating nations for 1996 are given in Table 5.1.1. Reported catches were 82 112 t compared with the agreed TAC of 83 570 t. This is the eighth year in succession in which the TAC was not reached, but the TACs have been increased for the last two years.

Continued difficulties with catch reporting exist, with many examples of vessels operating and landing herring catches distant from Division VIa(N) but reporting catches from that area. The problem is particularly acute during the peak months of the herring fishery around Shetland (August to October). The level of misreporting was assessed to be approximately 68% of the total catch, leading to an estimated catch of 26 105 t for Division VIa(N). Some misreported catches were reallocated to Division VIa(S) and all catches from east of 5°W were assigned to Division IVa.

The herring fishery in Division VIa(N) takes place in two main areas. Certain vessels fish inshore for smaller younger herring, whilst other vessels fish offshore in deeper waters where the fish are larger and older. The distribution of the total international herring catches (t) in Sub-areas VI and VII per quarter per statistical rectangle, based on the logbooks, and not corrected for misreporting is shown in Figure 4.2.1 a–d.

5.1.3 Catch in numbers at age

Age composition data of commercial catches, for 1996, were available primarily from Scotland (quarters 1, 3 and 4), Germany (quarters 1 and 3) and Ireland (quarter 3) with two additional samples from Northern Ireland and The Netherlands (Table 5.1.2). The German sample data provided extensive age information but did not include any mean weights at age, the Netherlands data provided age and mean weights but from only 25 fish. Both the German and the Netherlands' samples included a higher proportion of older fish and a reduced proportion of younger fish compared with the Scottish samples.

So as to consider the effect of the different age at length data on the stock estimation procedure, two estimates of catch at age were made. The first estimate used the Scottish age-length and mean weight at age data on the entire catch. The second estimate used the Scottish data on the Scottish catches, and the Netherlands' and German age-length data and the Netherlands' mean weight at age data on all other catches. Due to the patchy nature of sampling, certain assumptions were made for the second estimate:

- the mean weight at age data from the Netherlands' sample (taken from 25 fish in the third quarter) were used to infer weight at age estimates for catches in the other quarters, assuming the same proportional change in weight as found in the Scottish data
- the mean weights from the Netherlands' sample were then applied to the German age data

The estimates are shown in Table 5.1.3. The inclusion of the German age and Netherlands' age data substantially increased the proportion of age 9+ fish in the catch. Following the comparisons described in section 5.1.8, it was decided to use the second estimate as the final catch at age estimate. It is important in the future, that additional weight information be collected from the offshore catches. The estimated catches in numbers at age back to 1970 (including misreporting) are given in Table 5.1.4.

5.1.4 Larvae surveys

Larvae surveys for this stock have been discontinued and no new information is available since 1994. As the larval survey indices of abundance will again be used in the assessment the available information has been reproduced in

Table 5.1.5 for convenience. Details of the survey are given in the 1994 report of the Working Group (ICES 1994/Assess: 13).

5.1.5 Acoustic survey

Historical acoustic survey information documented in the 1995 Working Group report have been used. The time series has been updated to include information from the most recent survey (Table 5.1.6).

An acoustic survey of Division VIa (N) was completed from 13 to 30 July 1996 using a chartered fishing vessel. Prior to 1994, a single unstratified transect design was used for the surveys. In 1994, this was changed to a two-level stratified design, in order to reflect perceptions of fish aggregation observed in previous years. In 1996 three levels of stratification were used (Transect spacing = 4, 7.5 or 15 nautical mile as in 1995), and chosen to reflect perceptions of historical stock abundance in the area from 1992 to 1995. Prior analyses have shown that the stock size estimate is highly sensitive to a small number of observations of very dense shoals. Survey precision should therefore be improved substantially if more survey effort can be allocated to areas of high fish abundance.

Thirty nine trawl hauls were shot on the echo traces, of which 21 captured more than 100 herring. The age structure was dominated by 3-ring herring with an apparent shortage of 2-ring fish. The age-structure of the stock is consistent with that observed in the 1992 - 1996 surveys. Some problems in identification were noted and it is possible that some traces that contained herring were not included in the estimate. Echo-traces were allocated among the following categories, where the percentage in brackets indicates the contribution by number of each category to the biomass estimate.

1. Herring (82% of estimate)
2. Likely to be herring (11% of estimate)
3. Herring found in mixtures(7% of estimate)
4. Unlikely to be herring (would add 80% to stock estimate if included)
5. Known not be herring (not calculated)

The spawning biomass of the stock was estimated to be 370,300 t compared with 452,000 t in 1995. The value in 1993 was substantially greater. It is thought that the 1993 survey returned an exceptionally high stock estimate, possibly on account of a strongly contagious distribution. The spatial distribution of the herring stock found in the survey is shown in Figures 2.4.1. and 2.4.2.

In fitting the age-structured models to the survey data it was again assumed that 40% of annual mortality had been incurred before the surveys. This figure was calculated by assuming that natural mortality is constant throughout the year, and that fishing mortality can be apportioned in the ratio of seasonal catches in 1993.

5.1.6 Mean weight at age

Weight at age data from the 1996 fishery were available from Scotland, The Netherlands and Ireland. Mean estimates weighted by the reported catches in number are given in Table 5.1.7, together with comparable historic information. Mean weights at age of the five years of acoustic surveys are also given in of Table 5.1.7.

5.1.7 Maturity ogive

Historically, a value of 1 was used as the proportion of mature 2 and 3 ringers. The last five years of acoustic surveys of Division VIa (N) highlighted that a value of 1 was too high for both 2 and 3 ringers. As a result, in the present assessment, the proportion of mature fish back to 1992 was determined by data from the acoustic surveys (Table 5.1.8). The mean proportion of mature fish from 1992-1996 was used for years prior to 1992 (0.57 for 2 and 0.96 for 3 ringers).

5.1.8 Data exploration and preliminary modelling

As in 1995, the reported catches were thought to contain large amounts of misreported data. Discussions with industry representatives and with pelagic fishery enforcement officers lend credence to the belief that by excluding these catch reports, a much better representation of the true catches is likely to be achieved. However, by the very nature of the problem, it is not possible to define a reliable criterion for reallocating misreported catches. Hence whilst all the assessments were carried out using the estimated catches for Division VIa(N), a large degree of uncertainty still exists about the reliability of the results.

A range of different models were fitted separately in order to examine the effect of the two estimates of catch at age, and the sensitivity of the fitted population parameters on prior assumptions about survey catchability. All models used the following components with equal weighting:

1. acoustic surveys as proportional linear estimates of stock size
2. larvae abundance indices as power indices of stock size

The survey data and models tested were:

1. catch at age and mean weight at age data with the Scottish samples applied to all catches
2. gradual change in the selection pattern (separable constraint) for 1992-1996
3. the acoustic survey from 1993 removed as part of the acoustic index
4. catch at age and mean weight at age data from a combination of Scottish, German and Netherlands' samples applied to catches by fishing area.

The first run used the catch at age and mean weights from only the Scottish catches, which where well sampled throughout the year and contributed more than 50% of the estimated catch. Examination of the diagnostics indicated a number of problems; the three indices had minima in the reference F ranging from 0.7 to 0.2, there was a high peak in the selection pattern at 2 ring and a change in residuals at 2 ring over the period 1991 to 1996.

It was noted that the acoustic survey in 1993 showed a very high positive residual and that the age structure changes observed in the series from 1992 to 1994 did not support this change. In order to examine the impact of this point it was removed from the time series and run 3 was carried out. There was no appreciable difference in F or the SSB when this point was included or removed. Therefore the value was included in the series.

Examination of the diagnostics showed a peak in the selection pattern at 2, dropping to 1 at age 4 (the reference age) and flat from 5 to 9+. The map of residuals showed changing residuals with time for 2 ring herring. The fishery is known to consist of a Scottish fleet catching predominantly 2 and 3 ring fish and a shelf edge fleet catching older fish. These factors indicate that a changing selection pattern may be more appropriate and a gradual changing selection pattern was allowed within the ICA. The resulting run showed; little improvement in the residuals, elevated 2 ring herring in 1996 (which was not supported by the surveys) and also produced an unreasonable recruitment of 1 ring herring in 1996. The relaxation of the constraint was considered to give unreliable results and therefore excluded from the assessment.

In 1995 the stock recruit relationship was examined in detail (ICES 1996/Assess:10) and it was concluded that "neither stock recruit relationship (Ricker or Beverton and Holt) fitted better to the observations than a simple geometric mean recruitment". On this basis no stock recruit relationship was included.

The incorporation of the sample data from the shelf edge catches by the German and Netherlands' fleets reduced the overall sum of squares in the model fit and improved the alignment between the minima in the different tuning indices in the ICA. On this basis it was assumed that these samples should be included despite their poorly estimated mean weight at age, and this model has been used for reference purposes.

A comparison of the F and SSB for the last 7 years for these four options described above can be seen in Figures 5.1.1 and 5.1.2 respectively.

5.1.9 Stock Assessment

The second model tested was used as the 'baseline' assessment and has been used as the reference model for the calculation of short- and medium-term projections. The following variables are defined as:

a,y -	age and year subscripts
C	Catch in number at age and year
C'	Catch in number at age and year predicted by the structural model
SSB	Spawning stock size in the structural model
LAI	Larval abundance index

ACOUST	Acoustic survey estimates of abundance at age
N	Population abundance in the structural model
SSB	Spawning stock biomass in the structural model
Q_{LAI}	Coefficient of proportionality for larvae survey estimates of stock abundance
Q_{ACU}	Coefficient of proportionality for acoustic survey estimates of stock abundance
K	Power coefficient for the LAI estimate of stock abundance
λ	Weighting factor = 0.1 for age 1 and 1 for all other ages.

The assessment model was fitted by a least-squares minimisation of:

$$\Sigma_{a,y}(\log(C_{a,y}) - \log(C'_{a,y}))^2 +$$
$$\Sigma_y(\log(Q_{LAI}\,SSB_y^K\ ) - \log(LAI_y))^2 +$$
$$\lambda_a\,\Sigma_{a,y}(\log(Q_{ACU,a}\,N^*_{a,y}) - \log(ACOUST_{a,y}))^2$$

This is the same assessment model as that used by the Working Group in 1994 and in 1995. Except that a stock recruit model was excluded. Detailed results of this assessment are given in Table 5.1.9. and in Figures 5.1.3-5.1.15.

Salient points of the assessment are:

1. Fishing mortality in 1996 was low, and in the range 0.05 to 0.21 (parameter 95% C.I.s)
2. Incidence of 2 ringers in the acoustic survey were unusually low in 1996.
3. 1-ringers are still highly variable in the acoustic index.
4. Assumptions of log-normality in the index observations are not demonstrably violated.
5. Fishing mortality is estimated to have stopped declining or may now be slightly increasing following a declining trend from 1986 to 1994.
6. The assumption of a fixed selection pattern over the last 6 years is not supported by the catch data.
7. The estimate of the absolute level of the SSB poorly established.

The assessment merits further comment. There was a large catch of 2-ringers included in the catch at age matrix for 1995, and this translated into a perception of increased selection at this age which was of concern last year. However, the acoustic survey has confirmed an unusually abundant 1992 year class which supports the sample reallocation (section 5.1.3). It is possible that due to the misreporting problem there has been some confusion about the origin of samples and it is likely that in some cases a North Sea age-structure has been used to allocate catches to age for the Division VIa(N) stock. Therefore, the apparent change in selection may be due to sampling problems or a change in the relative proportions of the Scottish and shelf edge fisheries.

In the present assessment, the estimated fishing mortality is below the assumed natural mortality for ages 1, 2 & 3 and similar to that for 4 to 9+. This means the assessment is very strongly dependent on the assumed value of M, and provides only limited information on the state of the stock. It is suggested that the assessment be treated as an indication that the stock is lightly exploited. Quantitative estimates of fishing mortality provided here are likely to be of limited value. Summaries of F, yield, recruitment and SSB are shown in Figure 5.1.16.

5.1.10 Short-term projections

Conventional short term catch projections were calculated on the following basis:

- Fishing mortality in 1997 = Fishing mortality in 1996
- Starting populations on 1 January 1997 = Population model estimates, except for age 2 for which a geometric mean of population abundance from 1985 to 1995; also used for 1998 and 1999 recruitment.
- Historic mean weights at age from 1993 to 1996 were used for both the stock weights and the catch weights.
- The exploitation pattern used for the projections was that estimated by the population model, and fishing mortality in 1996 was used as a reference value for the projections.

Input data for the projections are given in Table 5.1.10, and the consequences of fishing at different levels of fishing mortality (in terms of catch and spawning biomass) are given in Table 5.1.11.

At present there is no reason to suspect major changes in F, therefore at recent levels of fishing mortality ($F_{(96)}$), *status quo* catches (Table 5.1.12) are predicted to be of the order of 30,000 t. At this level of fishing mortality the SSB should gradually increase.

5.1.11 MBAL and Stock-Recruit considerations

Considerations of an appropriate level for the minimum biologically acceptable level (MBAL) of spawning stock size was explored in ICES (1996/Assess:10). This year because the assessment was carried out with a different maturity ogive, derived from measured maturity in the population, MBAL was re-calculated using a precautionary measure which defines the MBAL as one-third of the unexploited stock size.

Unexploited stock size cannot be calculated directly but was approximated by calculating the equilibrium stock size for zero fishing mortality under the following conditions:

- Expected recruitment is calculated as $R\exp(\sigma^2/2)$ where R represents the geometric mean recruitment from 1976 to 1995 and σ^2 represents the variance of ln(recruitment).
- Arithmetic mean weights at age in the stock, 1990 to 1996
- Assumed values of maturity and natural mortality as used by the Working Group.

This calculation (using ages 1 to 9) leads to an estimate of unexploited equilibrium stock size of some 430,000 t. Taking one-third of this level (see section 5.1.11; ICES (1996/Assess: 10) and rounding appropriately leads to an indicative MBAL of 140,000 t. For comparison, estimates of historical stock size range from 53,000 t to 245,000 t. The SSB in 1996 is estimated to be 194,000 t. Despite being below the MBAL for about nine years in the mid 1970s to the mid 1980s there was no apparent adverse effect on recruitment. Further work to address the problem of setting an appropriate MBAL for this stock is required.

5.1.12 Medium-term projections

A medium-term projection indicates a low risk for the stock if fishing continues at recent levels with only a 29% chance of falling below the 140,000 t in 2004.

The method used to calculate medium-term projections is as described by ICES (1996/Assess:7). A Monte-Carlo method was used, with a conventional stock projection being used for each iteration. Projections were F-constrained. The generation of pseudo-data sets for the projections was performed separately for the population parameters derived from the stock assessment and for the generation of future recruitments.

Population parameters (vector of abundance at age in 1996, fishing mortality at reference age in 1996, selection at age) were drawn from a multivariate normal distribution with mean equal to the values estimated in the stock assessment model (Section 5.1.9), and with covariance as estimated in the same model fit. Pseudo-recruitments for subsequent years were generated by calculating a simple geometric mean recruitment because of the failure to identify a usable stock-recruit relationship and resampling randomly from the residuals according to a conventional non-parametric bootstrap method.

The 'ICP3' program was used to implement the calculations.

Weights at age in the catch and in the stock, maturity ogives and natural mortality were as given in Section 5.1.10. Only one scenario was examined: Exploitation at recent levels of fishing mortality. The fishing mortality in 1997 was constrained at its estimated value for 1996. This projection indicates very little change in stock size for fishing at the 1996 fishing mortality (Figure 5.1.17).

5.1.13 Consistency of Assessments

It is not possible to calculate an informative retrospective analysis for this stock, as the assessments are heavily dependent on a short time-series of acoustic survey data. Thus, deleting recent data leaves a data set which is too small for a comparable analysis to be calculated. A summary of estimates of fishing mortality made in recent assessments shows that there has been a marked downwards revision in the fishing mortality estimate Figure 5.1.1. This is clearly due to the new perception that catches from this stock in recent years have probably been about half of the reported levels. In addition there is a reduction in the SSB over the full time series from last years assessment due to the inclusion of a maturity ogive of 57% at 2 ring and 96% at 3 ring compared with 100% for both age groups for the previous assessments. The perception is that the stock dynamics are not strongly dependant on the model structure. However, the recent changes in the selection pattern are a concern.

5.1.14 Management Considerations

The assessment calculation presented here indicates that this is a lightly exploited stock. The modelling approaches used indicate that continued fishing at recent levels is likely to result in catches around 30,000 t, and to present little risk of a stock decline.

5.2 Clyde Herring

5.2.1 Advice and management applicable to 1996 and 1997

Management of herring in the Clyde is complicated by the presence of two virtually indistinguishable stocks; a resident spring-spawning population and the immigrant autumn-spawning component. In recent years management strategies have been directed towards rebuilding the highly depleted spring-spawning component to historical levels.

The measures which remain in force in order to protect the indigenous spring-spawning stock are;

- A complete ban on herring fishing from 1 January to 30 April.
- A complete ban on all forms of active fishing from 1 February to 1 April, on the Ballantrae Bank spawning grounds, to protect the demersal spawn and prevent disturbance of the spawning shoals.
- The TAC in 1996 was maintained at the same level as in recent years (1,000 tonnes).

5.2.2 The fishery in 1996

Annual landings from 1955 to 1996 are presented in Table 5.2.1. Landings in 1996 were 881 t which is more than double the recorded landing in the previous year. Landings by the local fleet increased from 392 t in 1995 to 598 t in 1996. A total of 283 t was taken by Northern Ireland vessels landing into either Northern Ireland or the Isle of Man. This is the first time since 1985 that landings by UK vessels, other than those from Scotland, have been reported from this area. Most of the landings were in the third quarter of the year with more than half (568 t) taken by Scottish pair trawlers. In 1995 this directed fishery took place later, during October and November. The proportions of spring and autumn spawners in these landings could not be estimated.

Sampling levels in the local fishery have been reduced to almost half the levels of recent years but are still well above recommended levels (Table 5.2.2). Samples were taken from both the Scottish and the Northern Ireland fleet landings.

An index of effort (E), based solely on the Scottish pair trawler fleet, has been calculated for comparison with previous years as follows;

$$E = E_p \,.\, L / L_p$$

where E_p = days absent by Scottish pair trawlers.

L = total landings in tonnes.
L_p = landings by pair trawlers in tonnes.

This shows a big increase in effort, by the pair trawler fleet, in 1996 and a small increase in the catch per unit effort over the previous year. (Table 5.2.3).

5.2.3 Weight at age and stock composition

The catch in numbers at age for the period 1970 to 1996 is given in Table 5.2.4. In 1995 the catch of 2 ringers was the highest since 1989 which suggested an improved recruitment of the 1993 year class. The indication from the 1996 catches is that this year class is good with the highest number of 3 ringers in the catch since 1989. The 1991 year class, which appeared to be above average in 1993 and 1994 but not in 1995, has again appeared in the catches as a good year class in 1996. It is still not possible to tell whether these improved year classes come from either the spring spawning or autumn spawning components.

Weights at age are given in Table 5.2.5. Mean weights in the stock have not been available from research vessel surveys since 1991, therefore the weights in the stock used are the weights at age in the catches. Weights at age in previous years are as used by the Working Group in 1994.

Once again no attempt has been made to apportion catches between spring and autumn-spawning stocks for 1996. The landings data show that the Scottish fishery was earlier this year and therefore not necessarily directed at aggregations of autumn-spawning fish as in 1995. Only the Northern Ireland vessels made significant landings (55 t) in the autumn . The small landings in the first half of the year (12 t) are mainly taken as by-catch in the demersal trawl fishery.

5.2.4 Surveys

No demersal egg surveys on the Ballantrae Bank and Brown Head spawning sites, no acoustic surveys in the Clyde and no spring trawl surveys were carried out in 1996. Historical estimates from these surveys are tabulated in (ICES 1995 Assess:13).

5.2.5 Stock Assessment

The structure of the stock in the Clyde remains uncertain. No survey data are available from recent years therefore no analytical assessment could be attempted.

5.2.6 Stock and catch projections

In the absence of an analytical assessment no stock projections can be provided.

5.2.7 Management considerations

The management of this fishery is made difficult by the presence of a mixture of a severely depleted spring-spawning component and autumn spawners from Division VIa south. The management objectives for these two components are necessarily distinct. The absence of fishery independent data from surveys further compounds the problem.

Historically the spring spawning stock supported a fishery with catches up to 15,000 tonnes per year in the 1960's. Landings generally began to decline through the 1970's and 1980's with a rapid decline in effort during the late 1980's up to the present time. A TAC was first set in 1984 (3,000 t.) increasing to a maximum of 3,500 tonnes in 1987 subsequently decreasing to 1,000 tonnes by 1993. Estimated catches, including discards, exceeded the TAC for the first four years. This was followed by a decline in catches to 1990. In 1991 there was a dramatic drop in both landings and effort and since then landings have fluctuated at below 1,000 tonnes. In 1996 the effort remained at a low level but there was a marked increase in catch per unit effort in the Scottish pair trawl fleet.

In the absence of surveys and no stock separation of the catches, nothing is currently known about the state of the spring spawning stock or the origins of the improved year classes of 1991 and 1993. All the management measures, currently in force, need to remain. Catches should be reduced to as low a level as possible and an attempt should be made to apportion those catches to spring and autumn spawning components.

5.2.8 Future research requirements

Provision of some fishery independent survey data for this area is necessary before an analytical assessment of the stock can be attempted. In a similar, but smaller stock, in the Thames estuary, a single pelagic trawl survey each year provides an index of recruitment and a measure of the mixture of spring and autumn spawners in the area. That survey now provides a ten year time series and together with landings data and biological sampling is sufficient for an analytical assessment of the state of this stock.

Further research is required to improve the understanding of the stock structure in the Clyde and in particular to attempt to apportion landings to spring and autumn spawners. If current management advice is required for the spring spawning stock, the otolith structure technique, described by Mosegaard (WD,1996) for separating spring-spawners from autumn spawners in the Baltic, should be investigated.

There is evidence in adjacent stocks in Divisions VIa (North) and VIa (South) that there is a general increase in the spring spawning components of these stocks. Further research would be necessary to verify this in the Clyde.

Table 5.1.1. HERRING in Division VIa (North). Catch in tonnes by country, 1981-1995. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1982	1983	1984	1985	1986	1987
Denmark	-	-	96	-	-	-
Faroes	74	834	954	104	400	-
France	2 069	1 313	-	20	18	136
Germany	8 453	6 283	5 564	5 937	2 188	1 711
Ireland	-	-	-	-	6 000	6 800
Netherlands	11 317	20 200	7 729	5 500	5 160	5 212
Norway	10 018	7 336	6 669	4 690	4 799	4 300
UK England	90	-	-	-	-	-
UK Scotland	38 381	31 616	37 554	28 065	25 294	26 810
Unallocated	18 958	-4 059	16 588	502	37 840	18 038
Discards	-	-	-	-	-	-
Misreported(*)			19 142	4 672	10 935	18 647
Total	92 360	63 523	63 864	38 994	71 078	44 105

Country	1988	1989	1990	1991	1992	1993
Denmark	-	-	-	-	-	-
Faroes	-	-	326	482	-	-
France	44	1342	1287	1168	119	818
Germany	1 860	4 290	7 096	6 450	5 640	4 693
Ireland	6 740	8 000	10 000	8 000	7 985	8 236
Netherlands	6 131	5 680	7 693	7 979	8 000	6 132
Norway	456	-	1 607	3 318	2 389	7 447
UK Eng. & Wales	1 892	1 977	2 376	2 998	3 327	2 965
UK Scotland	25 002	27 897	35 877	29 630	29 403	29 637
Unallocated	5 229	2 123	2 397	-10 597	-5 485	-3 753
Discards	-	1 550	1 300	1 180	200	820
Misreported(*)	11 763	19 013	25 266	22 079	22 593	24 397
Total	35 516	33 945	44 774	32 388	28 888	32 020

Country	1994	1995	1996
Denmark	0	0	0
Faroes	0	0	0
France	274	3 672	2297
Germany	5 087	3 733	7836
Ireland	7 938	3 548	9721
Netherlands	6 093	7 808	9396
Norway	8 183	4 840	6223
UK Eng, Wales & NI	3 511	5 375	5051
UK Scotland	27 165	37 286	41588
Unallocated	-3 587	- 4 541	
Discards	700		
Misreported(*)	30 234	36 687	56 007
Total	24 619	33 794	26105

Discards are included in national catches.

(*) Catches assumed misreported are catches reported from the area between 4°W and 5°W. They are not included in the catch totals, but are included in the catches by country.

Table 5.1.2 HERRING in Division VIa (N), 1996. Sampling intensity of commercial catches.

Country	No of samples	No of age readings	No of fish measured	Estimate of discards
France	0	0	0	No
Germany	22	667	8386	No
Ireland	8	348	2012	No
Netherlands	1	25	25	Yes
Norway	0	0	0	No
UK (England & Wales)	0	0	0	No
UK (Scotland)	19	1165	4003	No
UK (N. Ireland)	1	25	212	No

Table 5.1.3 Comparison of estimates of numbers in catch, mean weights and biomass at age by quater for VIa(N), using only Scottish biological sampling and using Scottish, German and 'Netherlands biological sampling.

Estimates from the Scottish sampling.

Numbers (millions)						Mean Weights at Age (g)						Biomass (tonnes)					
Age	q1	q2	q3	q4	Total	Age	q1	q2	q3	q4	Total	Age	q1	q2	q3	q4	Total
1.0	22.3	78.3	717.3	625.1	1442.9	1.0	19.0	90.9	85.7	73.5	79.7	1.0	0.4	7.1	61.5	45.9	115.0
2.0	1567.2	10868.9	50234.2	18656.3	81326.6	2.0	69.8	137.3	136.9	123.4	132.6	2.0	109.4	1492.3	6877.1	2302.2	10780.9
3.0	2472.3	1913.6	28918.4	13010.7	46315.0	3.0	111.7	180.4	179.1	155.6	169.0	3.0	276.2	345.2	5179.3	2024.5	7825.1
4.0	510.5	199.9	8142.4	3136.4	11989.2	4.0	133.1	212.1	211.0	177.7	199.0	4.0	67.9	42.4	1718.0	557.3	2385.7
5.0	95.9	31.6	4835.5	2867.3	7830.3	5.0	154.9	230.8	212.3	189.0	203.1	5.0	14.8	7.3	1026.6	541.9	1590.7
6.0	22.3	6.7	1259.8	1014.3	2303.1	6.0	174.8	251.5	226.2	191.0	210.3	6.0	3.9	1.7	285.0	193.7	484.3
7.0	0.0	0.0	2671.7	714.0	3385.7	7.0	127.3	199.9	236.8	204.2	229.9	7.0	0.0	0.0	632.6	145.8	778.5
8.0	0.0	0.0	3058.7	547.2	3605.9	8.0	131.7	206.9	247.9	213.4	242.7	8.0	0.0	0.0	758.2	116.8	875.0
9.0	22.3	0.0	4041.5	856.4	4920.2	9.0	194.6	212.0	265.7	222.8	257.9	9.0	4.3	0.0	1073.7	190.8	1268.9
Totals	4712.7	13099.0	103879.4	41427.8	163118.9							Totals	477.0	1896.0	17612.0	6119.0	26104.0

Estimates from the Scottish, German and Netherlands sampling.

Numbers (millions)						Mean Weights at Age (g)						Biomass (tonnes)					
Age	q1	q2	q3	q4	Total	Age	q1	q2	q3	q4	Total	Age	q1	q2	q3	q4	Total
1.0	2.5	4.0	1249.9	695.4	1951.8	1.0	19.0	90.9	85.7	73.5	81.3	1.0	0.0	0.4	107.1	51.1	158.6
2.0	177.4	556.1	29029.2	8091.3	37854.0	2.0	69.8	137.3	136.9	123.4	133.7	2.0	12.4	76.3	3974.1	998.5	5061.3
3.0	1360.5	2973.2	19595.8	6969.3	30898.9	3.0	121.5	201.7	179.4	156.3	173.8	3.0	165.3	599.6	3514.5	1089.6	5369.0
4.0	611.6	1482.6	5396.5	1727.8	9218.5	4.0	148.7	241.9	211.3	178.6	205.9	4.0	90.9	358.6	1140.2	308.6	1898.3
5.0	681.4	1799.2	3512.8	1514.2	7507.6	5.0	187.0	280.2	212.9	190.3	222.1	5.0	127.5	504.1	747.8	288.2	1667.5
6.0	170.6	451.4	1226.0	652.4	2500.5	6.0	194.0	280.0	226.9	192.1	225.1	6.0	33.1	126.4	278.1	125.3	563.0
7.0	123.0	330.7	3086.1	1160.2	4700.0	7.0	127.3	258.3	239.2	214.8	231.6	7.0	15.7	85.4	738.3	249.2	1088.6
8.0	240.4	646.3	5332.1	2239.3	8458.0	8.0	131.7	224.5	249.3	220.3	236.3	8.0	31.7	145.1	1329.1	493.2	1999.0
9.0	2.5		20992.3	10113.4	31108.2	9.0	194.6		275.5	248.7	266.8	9.0	0.5	0.0	5782.8	2515.3	8298.5
Totals	3370.0	8243.5	89420.8	33163.2	134197.5							Totals	477.0	1896.0	17612.0	6119.0	26104.0

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Table 5.1.4. Estimated catches at age of herring in Area VIa(N).

Rings	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	238738	169947	801663	51170	309016	172879	69053	34836	22525	247
2	205454	372615	804097	235627	124944	202087	319604	47739	46284	142
3	359711	560348	219502	808267	151025	89066	101548	95834	20587	77
4	139718	357745	63069	131484	519178	63701	35502	22117	40692	19
5	53320	113391	85920	63071	82466	188202	25195	10083	6879	13
6	203462	54571	37341	54642	49683	30601	76289	12211	3833	8
7	29141	181592	13377	18242	34629	12297	10918	20992	2100	4
8	32860	18042	100938	6506	22470	13121	3914	2758	6278	1
9+	30651	36395	20465	32223	21042	13698	12014	1486	1544	0

Rings	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	2692	36740	13304	81923	2961	45663	38943	27645	2273	9690
2	279	77961	250010	77810	253291	77063	178714	93679	158832	57305
3	95	105600	72179	92743	66857	166112	99264	64575	55529	170687
4	51	61341	93544	29262	46963	19269	137077	45488	37815	29497
5	13	21473	58452	42535	20057	17027	21723	71188	26292	28228
6	9	12623	23580	27318	15250	7422	20759	11973	37993	11830
7	8	11583	11516	14709	12478	7731	2973	10378	4327	23400
8	1	1309	13814	8437	5940	3720	16177	4982	2956	2529
9+	0	1326	4027	8484	2629	2450	2273	8498	3140	5463

Rings	1990	1991	1992	1993	1994	1995	1996
1	22374	46826	9346	17719	1728	266	1952
2	75241	40824	43538	95288	36554	82176	37854
3	63832	44755	44344	18710	40193	30398	30899
4	116270	50048	42228	10978	6007	21272	9219
5	41512	66554	38818	13269	7433	5376	7508
6	20826	24007	60262	14801	8101	4205	2501
7	15463	13449	11301	19186	10515	8805	4700
8	33585	12226	7681	4711	12158	7971	8458
9+	8644	7904	9805	3740	10206	9787	31108

Table 5.1.5. HERRING in Division VIa (North). Larvae abundance indices (Numbers in billions), larvae mortality rates (Z/K), fecundity estimate (10^5 eggs/g). LPE Biomass estimate in thousands of tonnes.

Year	LAI	10% Trim LAI	Z/K	LPE		
				Larvae	Fecundity	SSB
1973	2 442	46.49	0.74	318	(1.39)	229
1974	1 186	17.44	0.42	238	(1.39)	171
1975	878	22	0.46	157	1.46	108
1976	189	11.04	-	60	1.23	49
1977	787	25	-	223	1.49	150
1978	332	32.8	-	132	1.37	109
1979	1 071	26.94		118	1.49	79
1980	1 436	26.33	0.39	287	2.04	141
1981	2 154	35.61	0.34	448	2.12	211
1982	1 890	32.58	0.39	267	1.95	137
1983	668	24.55	-	112	1.88	60
1984	2 133	45.99	0.57	253	1.75	145
1985	2 710	50.03	0.37	418	(1.86)	225
1986	3 037	45.36	0.24	907	(1.86)	488
1987	4 119	45.47	0.53	423	(1.86)	227
1988	5 947	75.13	0.47	781	(1.86)	420
1989	4 320	82.68	0.40	752	(1.86)	404
1990	6 525	86.2	0.64	426	(1.86)	229
1991	4 430	63.06	0.60	632	(1.86)	340
1992	12 252	41.79	0.66	463	(1.86)	248
1993	2 941	65.01	0.56	538	(1.86)	289

Table 5.1.6. HERRING in Division VIa (North). Estimates of abundance from Scottish acoustic surveys. Thousands of fish at age, and spawning biomass (SSB, tonnes).

Age	1987	1991	1992	1993	1994	1995	1996
1	249 100	338 312	74 310	2 760	494 150	441 240	41 220
2	578 400	294 484	503 430	750 270	542 080	1103 400	576 460
3	551 100	327 902	210 980	681 170	607 720	473 220	802 530
4	353 100	367 830	258 090	653 050	285 610	450 270	329 110
5	752 600	488 288	414 750	544 000	306 760	152 970	95 360
6	111 600	176 348	240 110	865 150	268 130	187 100	60 600
7	48 100	98 741	105 670	284 110	406 840	169 080	77 380
8	15 900	89 830	56 710	151 730	173 740	236 540	78 190
9+	6 500	58 043	63 440	156 180	131 880	201 500	114 810
SSB:	273 000*	452 000	351 460	866 190	533 740	452 120	370300

* - Biomass of 2+ ringers in November.

Table 5.1.7. HERRING in Division VIa (North). Mean weights at age (g).

Age	Weight in the catch												
(Age, Rings)	1982-1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	90	69	113	73	80	82	79	84	91	89	83	105	81
2	140	103	145	143	112	142	129	118	122	128	142	142	134
3	175	134	173	183	157	145	173	160	172	158	167	180	178
4	205	161	196	211	177	191	182	203	194	197	190	191	210
5	231	182	215	220	203	190	209	211	216	206	195	198	230
6	253	199	230	238	194	213	224	229	224	228	201	213	233
7	270	213	242	241	240	216	228	236	236	223	244	207	262
8	284	223	251	253	213	204	237	261	251	262	234	227	247
9+	295	231	258	256	228	243	247	271	258	263	266	277	291

Weight in the stock from Acoustic surveys

Age	Historical	1992	1993	1994	1995	1996
1	90	68	75	52	45	45
2	164	152	162	150	144	140
3	208	186	196	192	191	180
4	233	206	206	220	202	209
5	246	232	226	221	225	219
6	252	252	234	233	226	222
7	258	271	254	241	247	229
8	269	296	260	270	260	242
9+	292	305	276	296	293	263

Table 5.1.8 HERRING in Division Via (N), new maturity ogive used in estimates of spawning stock biomass taken from acoustic surveys. The historical series is the values used in the assessment where no data are available

Year \Age (W ring)	2	3	>3
Historical	0.57	0.96	1.00
1992	0.47	1.00	1.00
1993	0.93	0.96	1.00
1994	0.48	0.92	1.00
1995	0.19	0.98	1.00
1996	0.76	0.94	1.00

Table 5.1.9 HERRING in Division VIa(N). Results of baseline assesment.

Output Generated by ICA version 1.3

Herring North VIa (run: ICAMDC27/I27)

Catch in number

Age	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	69.05	34.84	22.53	.25	2.69	36.74	13.30	81.92	2.21	40.79	33.77	19.46	1.71	6.22	14.29
2	319.60	47.74	46.28	.14	.28	77.96	250.01	77.81	188.78	68.85	154.96	65.95	119.38	36.76	40.87
3	101.55	95.83	20.59	.08	.10	105.60	72.18	92.74	49.83	148.40	86.07	45.46	41.74	109.50	40.78
4	35.50	22.12	40.69	.02	.05	61.34	93.54	29.26	35.00	17.21	118.86	32.03	28.42	18.92	74.28
5	25.20	10.08	6.88	.01	.01	21.47	58.45	42.54	14.95	15.21	18.84	50.12	19.76	18.11	26.52
6	76.29	12.21	3.83	.01	.01	12.62	23.58	27.32	11.37	6.63	18.00	8.43	28.56	7.59	13.31
7	10.92	20.99	2.10	.00	.01	11.58	11.52	14.71	9.30	6.91	2.58	7.31	3.25	15.01	9.88
8	3.91	2.76	6.28	.00	.00	1.31	13.81	8.44	4.43	3.32	1.43	3.51	2.22	1.62	21.46
9	12.01	1.49	1.54	.00	.00	1.33	4.03	8.48	1.96	2.19	1.97	5.98	2.36	3.51	5.52

Thousands

Catch in number, cont.

Age	1991	1992	1993	1994	1995	1996
1	26.40	5.25	17.72	1.73	.27	1.95
2	23.01	24.47	95.29	36.55	82.18	37.85
3	25.23	24.92	18.71	40.19	30.40	30.90
4	28.21	23.73	10.98	6.01	21.27	9.22
5	37.52	21.82	13.27	7.43	5.38	7.51
6	13.53	33.87	14.80	8.10	4.21	2.50
7	7.58	6.35	19.19	10.52	8.81	4.70
8	6.89	4.32	4.71	12.16	7.97	8.46
9	4.46	5.51	3.74	10.21	9.79	31.11

Thousands

INDICES OF SPAWNING BIOMASS

INDEX1

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	189.0	787.0	332.0	1071.0	1436.0	2154.0	1890.0	668.0	2133.0	2710.0	3037.0	4119.0	5947.0	4320.0	6525.0

	1991	1992	1993
1	4430.0	*******	2941.0

Table 5.1.9 HERRING in Division VIa(N). Results of baseline assesment, cont.

AGE - STRUCTURED INDICES

ACOUS: West Scotland Summer Acoustic Sur

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	249.1	1.0	1.0	1.0	338.3	74.3	2.8	494.2	460.6	41.2
2	578.4	1.0	1.0	1.0	294.5	503.4	750.3	542.1	1085.1	576.5
3	551.1	1.0	1.0	1.0	327.9	211.0	681.2	607.7	472.7	802.5
4	353.1	1.0	1.0	1.0	367.8	258.1	653.0	285.6	450.2	329.1
5	752.6	1.0	1.0	1.0	488.3	414.8	544.0	306.8	153.0	95.4
6	111.6	1.0	1.0	1.0	176.3	240.1	865.2	268.1	187.1	60.6
7	48.1	1.0	1.0	1.0	98.7	105.7	284.1	406.8	169.2	77.4
8	15.9	1.0	1.0	1.0	89.8	56.7	151.7	173.7	236.6	78.2
9	6.5	1.0	1.0	1.0	58.0	63.4	156.2	131.9	201.5	114.8

Thousands

Fishing Mortality (per year)

Age	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.1899	.0900	.0390	.0003	.0046	.0348	.0264	.0397	.0028	.0490	.0504	.0117	.0020	.0095	.0356
2	.7500	.3420	.2863	.0005	.0007	.3089	.6400	.3692	.2047	.1868	.4725	.2240	.1550	.0895	.1328
3	1.1899	.5706	.2577	.0007	.0004	.4252	.5630	.5633	.4597	.2612	.4000	.2609	.2291	.2205	.1434
4	1.0547	.8827	.4814	.0003	.0006	.3893	.7903	.4440	.4066	.2689	.3266	.2406	.2450	.1464	.2169
5	.8773	.8870	.6696	.0002	.0002	.2956	.6931	.9273	.3794	.2761	.4661	.1986	.2052	.2176	.2796
6	1.0433	1.3835	.9155	.0012	.0002	.2967	.5388	.7263	.6021	.2567	.5360	.3480	.1490	.1018	.2199
7	1.0718	.8211	.8450	.0017	.0014	.2719	.4275	.6766	.5146	.8071	.1346	.3836	.1957	.0980	.1673
8	.8729	.7711	.5477	.0007	.0005	.2828	.5294	.5647	.3893	.3095	.3348	.2439	.1713	.1269	.1775
9	.8729	.7711	.5477	.0007	.0005	.2828	.5294	.5647	.3893	.3095	.3348	.2439	.1713	.1269	.1775

Units

Fishing Mortality (per year), cont.

Age	1991	1992	1993	1994	1995	1996
1	.0134	.0109	.0120	.0075	.0080	.0092
2	.3195	.2585	.2854	.1775	.1892	.2181
3	.2473	.2001	.2209	.1374	.1464	.1688
4	.1539	.1246	.1375	.0855	.0911	.1051
5	.1447	.1171	.1293	.0804	.0857	.0988
6	.1416	.1146	.1265	.0787	.0838	.0967
7	.1629	.1318	.1455	.0905	.0964	.1112
8	.1539	.1246	.1375	.0855	.0911	.1051
9	.1539	.1246	.1375	.0855	.0911	.1051

Units

Table 5.1.9 HERRING in Division VIa(N). Results of baseline assesment, cont.

Numbers at age (thousands) (1 January)

Age	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	621.8	635.5	929.3	1227.0	920.1	1695.9	806.8	3322.1	1269.1	1344.1	1081.5	2637.3	1350.9	1040.2	644.7
2	688.3	189.2	213.7	328.8	451.2	336.9	602.6	289.1	1174.6	465.6	470.8	378.3	958.9	496.0	379.0
3	158.0	240.9	99.5	118.9	243.5	334.0	183.3	235.4	148.0	709.1	286.2	217.5	224.0	608.4	336.0
4	56.8	39.4	111.5	63.0	97.3	199.3	178.8	85.4	109.7	76.5	447.1	157.1	137.1	145.9	399.6
5	45.0	17.9	14.7	62.3	57.0	88.0	122.2	73.4	49.6	66.1	52.9	291.8	111.7	97.1	114.0
6	122.7	16.9	6.7	6.8	56.4	51.5	59.2	55.3	26.3	30.7	45.4	30.0	216.5	82.3	70.7
7	17.3	39.1	3.8	2.4	6.2	51.0	34.7	31.3	24.2	13.0	21.5	24.0	19.2	168.8	67.3
8	7.0	5.4	15.6	1.5	2.2	5.6	35.2	20.5	14.4	13.1	5.3	17.0	14.8	14.3	138.5
9	21.5	2.9	3.8	10.2	10.5	5.6	10.3	20.6	6.4	8.6	7.3	29.0	15.7	30.9	35.6

Age	1991	1992	1993	1994	1995	1996	1997
1	615.6	1095.7	989.0	845.5	195.5	336.9	885.9
2	228.9	223.4	398.7	359.5	308.7	71.4	122.8
3	245.9	123.2	127.8	222.0	223.0	189.3	42.5
4	238.3	157.2	82.6	83.9	158.5	157.7	130.9
5	291.0	184.9	125.6	65.1	69.7	130.9	128.5
6	78.0	227.9	148.8	99.9	54.4	57.9	107.3
7	51.3	61.3	183.8	118.6	83.5	45.2	47.6
8	51.5	39.5	48.6	143.8	98.1	68.6	36.6
9	32.8	49.4	30.6	130.7	118.0	327.4	322.6

STOCK SUMMARY

Year	Recruits Age 1 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield/ SSB ratio	Mean F Ages 3- 6	SoP (%)
1976	621760	269559	76796	93642	1.2194	1.0413	99
1977	635490	168536	55520	41341	.7446	.9309	91
1978	929340	176960	52684	22176	.4209	.5811	100
1979	1226990	224797	79275	60	.0008	.0006	100
1980	920130	263594	129476	306	.0024	.0003	100
1981	1695940	374730	137518	51420	.3739	.3517	96
1982	806810	317578	116733	92361	.7912	.6463	103
1983	3322090	466822	88513	63523	.7177	.6652	102
1984	1269130	394002	136751	56012	.4096	.4620	94
1985	1344070	396051	174445	39142	.2244	.2657	100
1986	1081530	371785	166494	71345	.4285	.4322	103
1987	2637270	479825	165128	44360	.2686	.2621	97
1988	1350880	452959	204789	35591	.1738	.2071	102
1989	1040180	436524	242796	34026	.1401	.1716	101
1990	644720	394035	245302	44693	.1822	.2149	98
1991	615600	327532	205702	28527	.1387	.1719	106
1992	1095720	341253	187081	28992	.1550	.1391	100
1993	988990	311790	185062	31778	.1717	.1536	99
1994	845500	302757	193410	24474	.1265	.0955	99
1995	195540	235977	163020	29575	.1814	.1018	100
1996	336920	246775	193985	26105	.1346	.1173	104

Table 5.1.9 HERRING in Division VIa(N). Results of baseline assesment, cont.

PARAMETER ESTIMATES

Parm No.		Maximum Likelih. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. distrib.
Separable Model: Reference F by year								
1	1991	.1539	26	.0920	.2576	.1184	.2002	.1594
2	1992	.1246	26	.0745	.2081	.0959	.1619	.1289
3	1993	.1375	26	.0819	.2308	.1056	.1791	.1424
4	1994	.0855	27	.0496	.1476	.0648	.1130	.0889
5	1995	.0911	30	.0505	.1645	.0674	.1232	.0954
6	1996	.1051	34	.0535	.2065	.0744	.1483	.1115
Separable Model: Selection (S) by age								
7	1	.0874	31	.0467	.1633	.0635	.1202	.0919
8	2	2.0755	26	1.2230	3.5223	1.5847	2.7184	2.1525
9	3	1.6064	25	.9780	2.6385	1.2471	2.0692	1.6587
	4	1.0000			Fixed : Reference age			
10	5	.9402	22	.6047	1.4618	.7506	1.1776	.9643
11	6	.9199	22	.5969	1.4177	.7377	1.1470	.9426
12	7	1.0578	22	.6811	1.6430	.8450	1.3243	1.0849
	8	1.0000			Fixed : last true age			
Separable Model: Populations in year 1996								
13	1	336925	65	94230	1204697	175879	645435	416194
14	2	71366	47	28352	179640	44560	114298	79737
15	3	189288	42	81863	437684	123421	290307	207415
16	4	157706	37	75074	331285	107989	230311	169429
17	5	130881	32	69029	248154	94432	181399	138042
18	6	57884	30	31557	106176	42476	78883	60725
19	7	45231	29	25491	80256	33758	60603	47209
20	8	68618	28	39442	119378	51730	91020	71412
Separable Model: Populations at age 8								
21	1991	51504	46	20853	127204	32471	81692	57286
22	1992	39472	37	19107	81544	27260	57155	42271
23	1993	48580	32	25920	91050	35259	66935	51141
24	1994	143827	27	84160	245795	109421	189052	149304
25	1995	98057	27	57242	167975	74510	129047	101826
SSB Index catchabilities								
INDEX1								
26	1 Q	6.442	22	5.220	12.59	6.476	10.15	8.315
27	1 K	.5406E-06	22	.5190E-05	.1252E-04	.6439E-05	.1009E-04	.9019E-05
Age-structured index catchabilities								
ACOUS: West Scotland Summer Acoustic Sur								
Linear model fitted. Slopes at age:								
28	1 Q	.2237	155	.5031E-01	22.28	.2237	5.010	3.543
29	2 Q	2.873	52	1.731	13.72	2.873	8.261	5.601
30	3 Q	3.024	52	1.827	14.31	3.024	8.642	5.867
31	4 Q	2.907	51	1.766	13.52	2.907	8.213	5.591
32	5 Q	2.488	51	1.520	11.38	2.488	6.951	4.745
33	6 Q	2.675	51	1.634	12.23	2.675	7.469	5.099
34	7 Q	2.205	51	1.342	10.18	2.205	6.198	4.225
35	8 Q	1.733	52	1.048	8.168	1.733	4.940	3.356
36	9 Q	1.172	52	.7091	5.521	1.172	3.340	2.269

Table 5.1.9 HERRING in Division VIa(N). Results of baseline assesment, cont.

RESIDUALS ABOUT THE MODEL FIT
Separable Model Residuals

Age	1991	1992	1993	1994	1995	1996
1	1.624	-.356	.863	-.835	-1.305	.002
2	-.862	-.593	.101	-.328	.576	1.137
3	-.664	.204	-.209	.440	.097	.145
4	-.138	.302	.083	-.087	.481	-.486
5	.004	.114	-.089	.439	-.014	-.446
6	.322	.366	-.129	.119	.010	-.709
7	.031	-.126	-.212	.073	.186	.036
8	-.016	-.020	-.233	.080	-.020	.260

Units

SPAWNING BIOMASS INDEX RESIDUALS
INDEX1

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	-1.282	.748	-.017	.393	-.228	.066	.240	-.284	.066	-.148	.053	.373	.339	-.297	.096

	1991	1992	1993
1	.037	-1.000	-.176

AGE - STRUCTURED INDEX RESIDUALS
ACOUS: West Scotland Summer Acoustic Sur

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	-.458	-1.000	-1.000	-1.000	1.304	-.789	-3.979	1.363	2.757	-.200
2	-.421	-1.000	-1.000	-1.000	-.556	-.020	-.189	-.454	.397	1.241
3	.008	-1.000	-1.000	-1.000	-.640	-.408	.735	.035	-.217	.486
4	-.121	-1.000	-1.000	-1.000	-.532	-.482	1.096	.232	.054	-.249
5	.155	-1.000	-1.000	-1.000	-.296	-.017	.646	.710	-.051	-1.149
6	.507	-1.000	-1.000	-1.000	-.071	-.846	.867	.075	.325	-.859
7	.097	-1.000	-1.000	-1.000	-.031	-.153	-.257	.518	-.006	-.169
8	-.479	-1.000	-1.000	-1.000	.108	-.098	.684	-.287	.407	-.337
9	-1.517	-1.000	-1.000	-1.000	.514	.181	1.568	-.076	.453	-1.125

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE
Separable model fitted from 1991 to 1996
Variance : .5002
Skewness test statistic : 1.2012
Kurtosis test statistic : 2.9904
Partial chi-square : 1.3091
Significance in fit : .0000
Degrees of freedom : 23

Table 5.1.9 HERRING in Division VIa(N). Results of baseline assesment, cont.

PARAMETERS OF THE DISTRIBUTION OF THE SSB INDICES
DISTRIBUTION STATISTICS FOR INDEX1
Power catchability relationship assumed.
Last age is a plus-group.

Variance	:	.1978
Skewness test statistic	:	-2.1612
Kurtosis test statistic	:	2.5060
Partial chi-square	:	.4476
Significance in fit	:	.0000
Number of observations	:	17
Degrees of freedom	:	15
Weight in the analysis	:	1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES
DISTRIBUTION STATISTICS FOR ACOUS: West Scotland Summer Acoustic Sur

Linear catchability relationship assumed.

Age	:	1	2	3	4	5	6	7	8	9
Variance	:	.0516	.0449	.0259	.0342	.0436	.0478	.0073	.0200	.1210
Skewness test stat.	:	-.7360	1.2308	.2959	1.1935	-.7191	-.2914	1.3090	.5497	-.1411
Kurtosis test stat.	:	-.0854	.0287	-.5694	.1306	-.1369	-.6546	.2485	-.5870	-.4641
Partial chi-square	:	.0272	.0215	.0120	.0164	.0210	.0231	.0036	.0107	.0672
Significance in fit	:	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
Number of data	:	7	7	7	7	7	7	7	7	7
Degrees of freedom	:	6	6	6	6	6	6	6	6	6
Weight in analysis	:	.0111	.1111	.1111	.1111	.1111	.1111	.1111	.1111	.1111

ANALYSIS OF VARIANCE TABLE
Unweighted Statistics

		SSQ	Data	Params	d.f.	
Variance						
	Total for Model	60.9598	128	36	92	.6626
	Catches at Age	11.5036	48	25	23	.5002
SSB Indices						
INDEX1		2.9674	17	2	15	.1978
Aged Indices						
ACOUS: West Scotland Summer Acoustic Su		46.4889	63	9	54	.8609

Weighted Statistics

		SSQ	Data	Params	d.f.	
Variance						
	Total for Model	14.7043	128	36	92	.1598
	Catches at Age	11.5036	48	25	23	.5002
SSB Indices						
INDEX1		2.9674	17	2	15	.1978
Aged Indices						
ACOUS: West Scotland Summer Acoustic Su		.2333	63	9	54	.0043

Table 5.1.10 Herring in Division VIa(N). Input data for short-term deterministic predictions.

Herring in the Northern part of VIa

Prediction with management option table: Input data

Year: 1997								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	392250.00	0.3000	0.7600	0.6700	0.6700	0.149	0.2181	0.137
3	42500.000	0.2000	0.9400	0.6700	0.6700	0.190	0.1688	0.171
4	130900.00	0.1000	1.0000	0.6700	0.6700	0.209	0.1051	0.197
5	128500.00	0.1000	1.0000	0.6700	0.6700	0.223	0.0988	0.207
6	107300.00	0.1000	1.0000	0.6700	0.6700	0.229	0.0967	0.219
7	47600.000	0.1000	1.0000	0.6700	0.6700	0.243	0.1112	0.234
8	36600.000	0.1000	1.0000	0.6700	0.6700	0.258	0.1051	0.243
9+	322600.00	0.1000	1.0000	0.6700	0.6700	0.282	0.1051	0.274
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1998								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	392250.00	0.3000	0.7600	0.6700	0.6700	0.149	0.2181	0.137
3	.	0.2000	0.9400	0.6700	0.6700	0.190	0.1688	0.171
4	.	0.1000	1.0000	0.6700	0.6700	0.209	0.1051	0.197
5	.	0.1000	1.0000	0.6700	0.6700	0.223	0.0988	0.207
6	.	0.1000	1.0000	0.6700	0.6700	0.229	0.0967	0.219
7	.	0.1000	1.0000	0.6700	0.6700	0.243	0.1112	0.234
8	.	0.1000	1.0000	0.6700	0.6700	0.258	0.1051	0.243
9+	.	0.1000	1.0000	0.6700	0.6700	0.282	0.1051	0.274
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1999								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	.	0.3000	0.7600	0.6700	0.6700	0.149	0.2181	0.137
3	.	0.2000	0.9400	0.6700	0.6700	0.190	0.1688	0.171
4	.	0.1000	1.0000	0.6700	0.6700	0.209	0.1051	0.197
5	.	0.1000	1.0000	0.6700	0.6700	0.223	0.0988	0.207
6	.	0.1000	1.0000	0.6700	0.6700	0.229	0.0967	0.219
7	.	0.1000	1.0000	0.6700	0.6700	0.243	0.1112	0.234
8	.	0.1000	1.0000	0.6700	0.6700	0.258	0.1051	0.243
9+	.	0.1000	1.0000	0.6700	0.6700	0.282	0.1051	0.274
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANMDC03
Date and time: 18MAR97:20:59

Table 5.1.11 Herring in Division VIa(N). Management option table. Estimated effect on stock biomass at different levels of catches and fishing mortality in the stock.

Herring in the Northern part of VIa

Prediction with management option table

Year: 1997					Year: 1998					Year: 1999	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.1173	259088	205349	27430	0.5000	0.0587	270751	219927	15502	234605	205601
.	.	.	.	.	0.6000	0.0704	.	217998	18469	231390	201255
.	.	.	.	.	0.7000	0.0821	.	216088	21393	228225	197009
.	.	.	.	.	0.8000	0.0939	.	214197	24275	225108	192859
.	.	.	.	.	0.9000	0.1056	.	212324	27116	222039	188804
.	.	.	.	.	1.0000	0.1173	.	210469	29915	219016	184840
.	.	.	.	.	1.1000	0.1291	.	208633	32675	216039	180967
.	.	.	.	.	1.2000	0.1408	.	206814	35395	213108	177181
.	.	.	.	.	1.3000	0.1526	.	205012	38077	210221	173480
.	.	.	.	.	1.4000	0.1643	.	203228	40720	207377	169863
.	.	.	.	.	1.5000	0.1760	.	201461	43326	204576	166327
.	.	.	.	.	1.6000	0.1878	.	199712	45895	201818	162870
.	.	.	.	.	1.7000	0.1995	.	197979	48427	199101	159490
.	.	.	.	.	1.8000	0.2112	.	196262	50924	196425	156186
.	.	.	.	.	1.9000	0.2230	.	194562	53385	193789	152956
.	.	.	.	.	2.0000	0.2347	.	192879	55811	191192	149797
.	.	.	.	.	2.1000	0.2464	.	191212	58204	188635	146709
.	.	.	.	.	2.2000	0.2582	.	189560	60563	186115	143689
.	.	.	.	.	2.3000	0.2699	.	187924	62889	183633	140736
.	.	.	.	.	2.4000	0.2816	.	186304	65182	181188	137848
.	.	.	.	.	2.5000	0.2934	.	184700	67443	178779	135024
.	.	.	.	.	2.6000	0.3051	.	183111	69673	176406	132262
.	.	.	.	.	2.7000	0.3168	.	181536	71872	174068	129560
.	.	.	.	.	2.8000	0.3286	.	179977	74040	171764	126918
.	.	.	.	.	2.9000	0.3403	.	178433	76178	169494	124333
.	.	.	.	.	3.0000	0.3520	.	176903	78286	167258	121805
.	.	.	.	.	3.1000	0.3638	.	175388	80366	165055	119332
.	.	.	.	.	3.2000	0.3755	.	173887	82417	162884	116913
.	.	.	.	.	3.3000	0.3873	.	172400	84439	160745	114546
.	.	.	.	.	3.4000	0.3990	.	170928	86434	158636	112231
.	.	.	.	.	3.5000	0.4107	.	169469	88401	156559	109965
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANMDC03
Date and time : 18MAR97:20:59
Computation of ref. F: Simple mean, age 3 - 6
Basis for 1997 : F factors

Table 5.1.12 Herring in Division VIa(N). Estimated catches at maintaining F_{sq} for 1997 to 1999.

The SAS System 20:56 Tuesday, March 18, 1997

Herring in the Northern part of VIa

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1997	1.0000	0.1173	145007	27425	1208250	259088	1111560	244577	916921	205352
1998	1.0000	0.1173	161614	29911	1286545	270757	1178385	254067	958662	210477
1999	1.0000	0.1173	165978	30632	1326480	277472	1218320	260781	993083	216243
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRMDC01
Date and time : 18MAR97:20:58
Computation of ref. F: Simple mean, age 3 - 6
Prediction basis : F factors

Table 5.2.1 Catches of HERRING from the Firth of Clyde. Spring and autumn-spawners combined. Catch in tonnes by country, 1955–1995.

Country	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Scotland											
Other UK											
Unallocated[1]											
Discards											
Agreed TAC											
Total	4,050	4,848	5,915	4,926	10,530	15,680	10,848	3,989	7,073	14,509	15,096

Country	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Scotland											
Other UK											
Unallocated[1]											
Discards											
Agreed TAC											
Total	9,807	7,929	9,433	10,594	7,763	4,088	4,226	4,715	4,061	3,664	4,139

Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Scotland						2,506	2,530	2,991	3,001	3,395	2,895
Other UK						-	273	247	22	-	-
Unallocated[1]						262	293	224	433	576	278
Discards						1,253	1,265	2,308[3]	1,344[3]	679[3]	439[4]
Agreed TAC								3,000	3,000	3,100	3,500
Total	4,847	3,862	1,951	2,081	2,135	4,021	4,361	5,770	4,800	4,650	3,612

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996
Scotland	1,568	2,135	2,184	713	929	852	608	392	598
Other UK	-	-	-	-	-	-	-	-	283
Unallocated[1]	110	208	75	18	-	-	-	-	-
Discards	245[4]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-
Agreed TAC	3,200	3,200	2,600	2,900	2,300	1,000	1,000	1,000	1,000
Total	1,923	2,343	2,259	731	929	852	608	392	881

[1]Calculated from estimates of weight per box and in some years estimated by-catch in the sprat fishery
[2]Reported to be at a low level, assumed to be zero.
[3]Based on sampling.
[4]Estimated assuming the same discarding rate as in 1986.

Table 5.2.2 Sampling levels of Clyde HERRING 1988-1995.

Year	Reported catch (tonnes)	No. of samples	No. of fish measured	No. of fish aged	Discards
1988	1,568	41	5,955	2,574	Based on local
1989	2,135	45	8,368	4,152	reports
1990	2,184	37	5,926	3,803	" "
1991	713	29	4,312	2,992	" "
1992	929	23	4,604	1,579	No information
1993	852	16	3,408	798	No information
1994	608	16	3,903	1,388	No information
1995	392	16	2,727	1,073	No information
1996	881	9	1,915	679	No information

Table 5.2.3 Effort on Clyde HERRING. Number of days' absence from port by pair trawlers in the Firth of Clyde, 1974 to 1995, and estimated total effort in pair trawl units .

Year	Days absent (pair trawl) Days	Raised to total Landings Effort	CPUE
1974	3,376	3,376	1.2
1975	3,209	3,209	1.1
1976	3,016	3,016	1.4
1977	4,186	4,186	1.2
1978	4,379	4,379	0.9
1979	2,933	2,933	0.7
1980	1,982	1,982	1.0
1981	1,529	1,529	1.4
1982	1,755	1,755	2.3
1983	1,644	1,644	2.7
1984	1,401	1,401	4.1
1985	1,688	1,688	2.8
1986	1,375	1,375	3.4
1987	850	998	3.1
1988	540	626	2.6
1989	582	639	3.3
1990	388	429	4.8
1991	169	254	1.9
1992	137	165	4.7
1993	194	224	3.3
1994	104	111	5.1
1995	79	89	3.9
1996	82	127	4.5

Table 5.2.4 Clyde HERRING catch in numbers at age. Spring- and autumn-spawners combined. Thousands of fish.

Age(Rings)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	5008	2207	1351	9139	5308	12694	6194	1041	14123	507
2	7551	6503	8983	5258	8841	1876	10480	7524	1796	4859
3	10338	1976	3181	4548	2817	2483	913	6976	2259	807
4	8745	4355	1684	1811	2559	1024	1049	1062	2724	930
5	2306	3432	3007	918	1140	1072	526	1112	634	888
6	741	1090	1114	1525	494	451	638	574	606	341
7	760	501	656	659	700	175	261	409	330	289
8	753	352	282	307	253	356	138	251	298	156
9	227	225	177	132	87	130	178	146	174	119
9+	117	181	132	114	59	67	100	192	236	154

Age(Rings)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	333	312	220	314	4156	1639	678	508	0	845
2	5633	2372	11311	10109	11829	2951	4574	1376	1062	1523
3	1592	2785	4079	5232	5774	4420	4431	3669	1724	9239
4	567	1622	2440	1747	3406	4592	4622	4379	2506	876
5	341	1158	1028	963	1509	2806	2679	3400	2014	452
6	204	433	663	555	587	2654	1847	1983	1319	252
7	125	486	145	415	489	917	644	1427	510	146
8	48	407	222	189	375	681	287	680	234	29
9	56	74	63	85	74	457	251	308	66	16
9+	68	18	53	38	80	240	79	175	16	5

Age(Rings)

	1990	1991	1992	1993	1994	1995	1996
1	716	42	145	3	399	118	494
2	1004	615	411	418	964	1425	1962
3	839	472	493	261	964	186	1189
4	7533	703	385	268	358	189	273
5	576	1908	1947	1305	534	149	544
6	359	169	333	327	319	130	183
7	329	92	91	78	76	66	208
8	119	113	69	111	57	35	127
9	49	22	32	38	16	15	52
9+	16	9	10	0	17	1	9

Table 5.2.5 HERRING in the Firth of Clyde. Mean weights at age in the catch and stock (g).

Age (rings)	Weight in the stock (Spr spawn)		Weight in the catch												
			1970-81	1982-85	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	-	-	-	-	-	-	-	-	-	-	-	-	-	102	90
2	-	-	225	149	166	149	156	149	170	143	141	141	92	151	146
3	171	173	270	187	199	194	194	174	186	163	187	174	157	174	184
4	195	218	290	228	224	203	207	203	202	188	188	198	184	201	203
5	210	215	310	253	253	217	211	221	216	192	216	213	212	226	233
6	210	245	328	272	265	225	222	227	237	198	227	216	249	241	255
7	234	-	340	307	297	236	230	235	234	210	206	229	248	249	257
8	-	-	345	291	298	247	225	237	234	222	218	261	240	252	255
9	-	-	350	300	298	255	244	219	257	200	201	233	249	242	284
10+	-	-	350	300	321	258	230	254	272	203	221	254	294	270	239

Figure 5.1.1 Comparison of F for 4 ICA runs for Division VIa(N) Herring

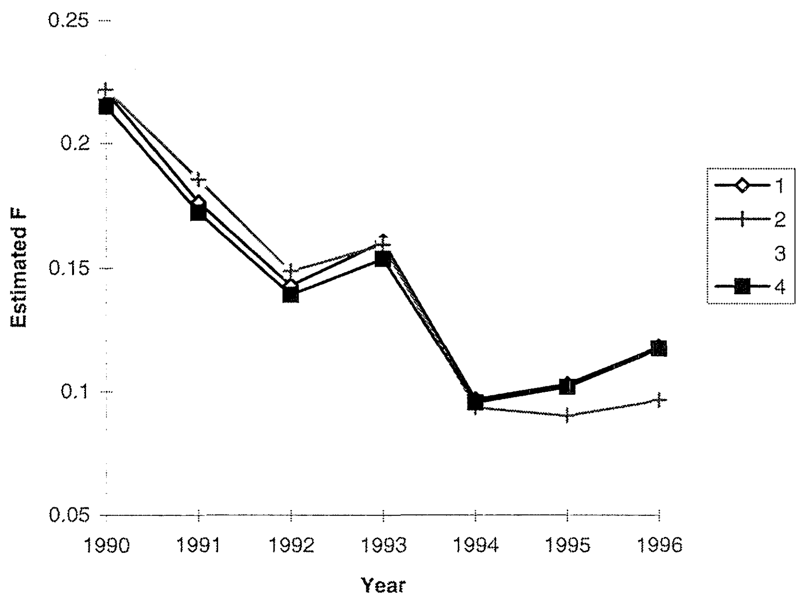
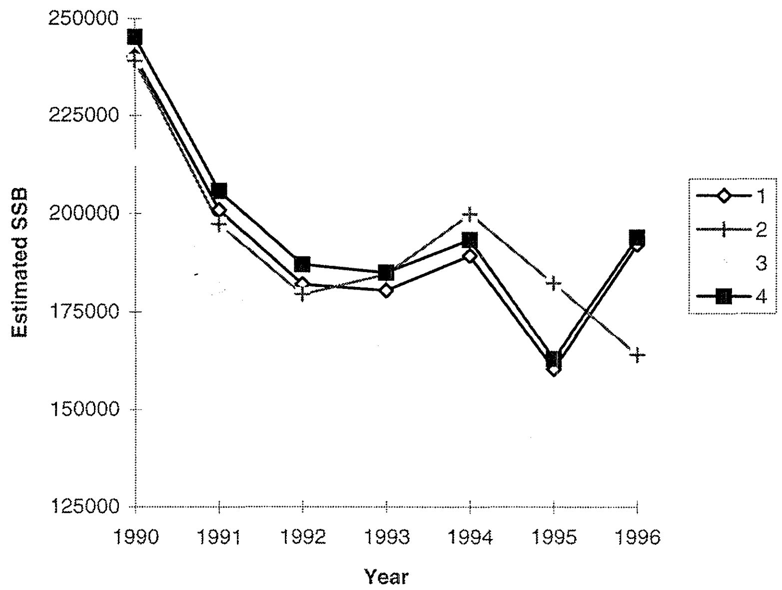


Figure 5.1.2 Comparison of SSB for 4 ICA runs for Division VIa(N) Herring



Figures 5.1.1 and 5.1.2 shows the influence of the use of four main combinations of data and model on the reference $F_{(3\text{-}6)}$ and on the SSB with reference to the baseline assessment (4).

1 shows the influence of the removal of a single outlying year (1993) from the acoustic time series, the results are indistingushable from line 4.
2 shows the results of excluding the limited age data on the shelf edge fishery and replacing it with Scottish age and mean weight at age data.
3 shows the influence of allowing a gradual change in the seprable constraint, this results in unreasonable recruitment to 1 ring herring.
4 is the final baseline assessment using all the age and mean weight data with a seperable constraint of 6 years

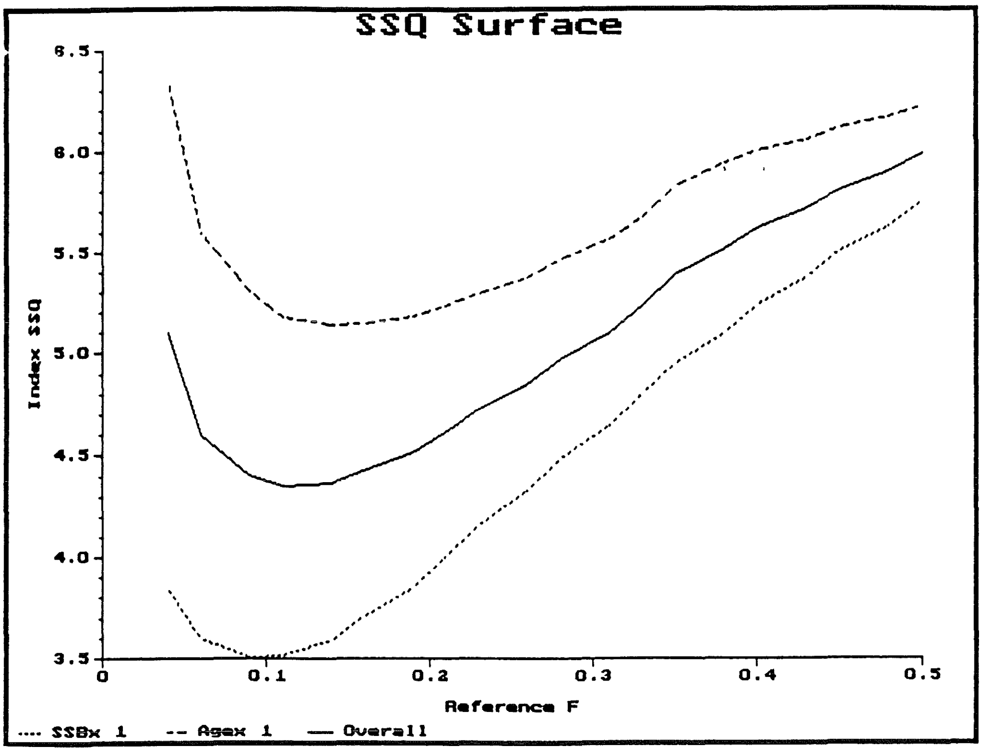


Figure 5.1.3 HERRING in Division VIa (N). SSq surface for the baseline assessment.

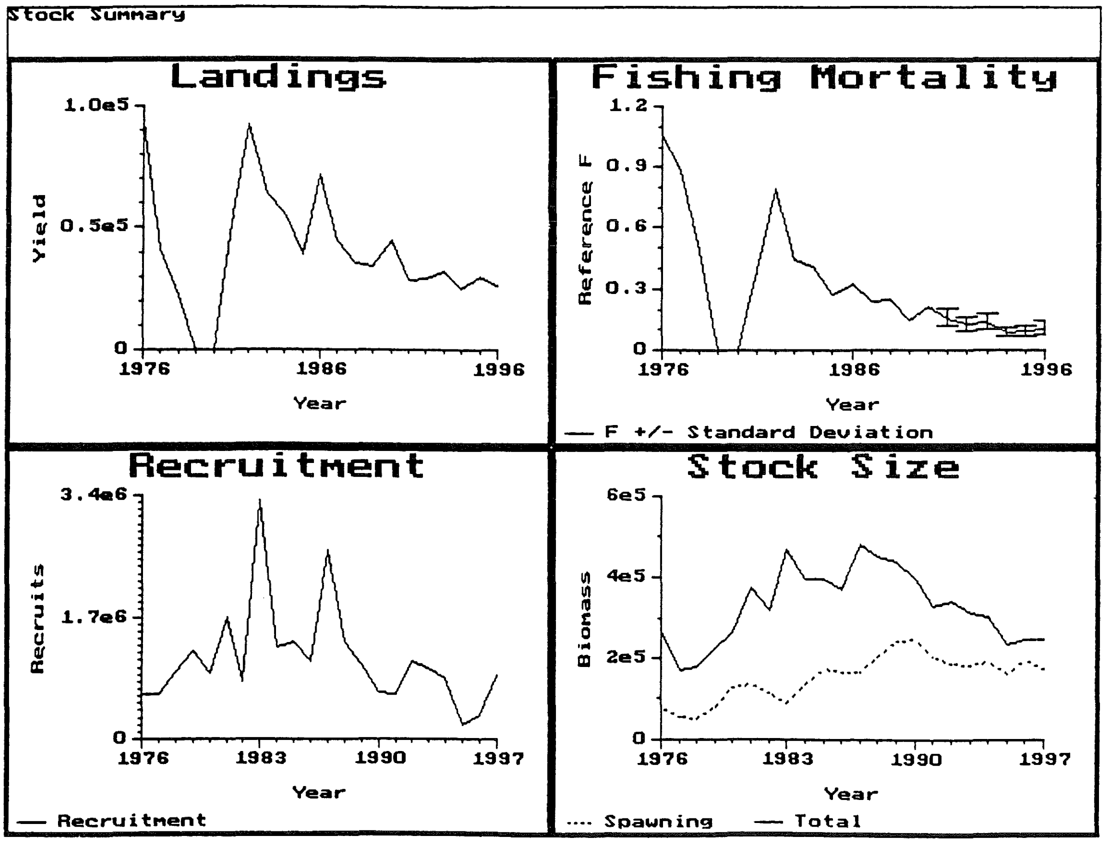


Figure 5.1.4. Herring in VIa(N). Results of baseline assessment. Summary of estimates of landings, fishing mortality at age 3, recruitment at age 1, stock size on 1 January and spawning stock size at spawning time.

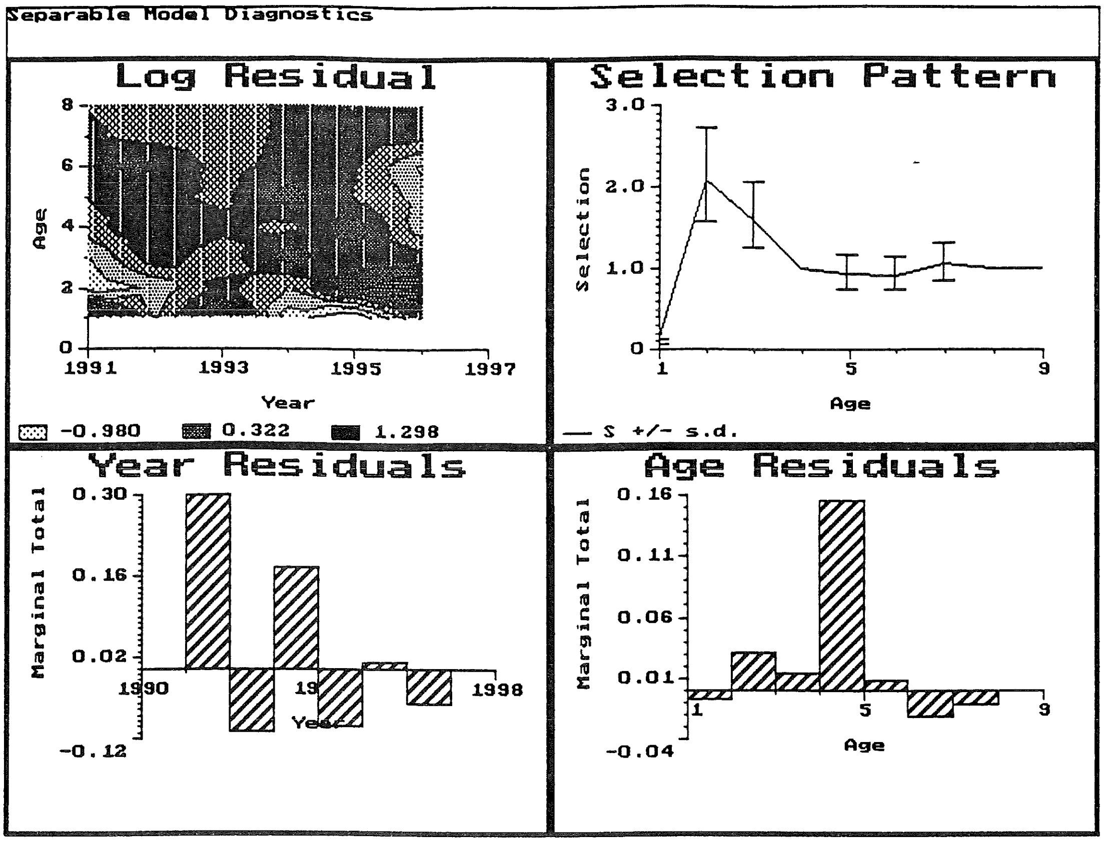


Figure 5.1.5. Herring in VIa(N). Results of baseline assessment. Selection pattern diagnostics. Top left, contour plot of selection pattern residuals. Top right, estimated selection (relative to age 3) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

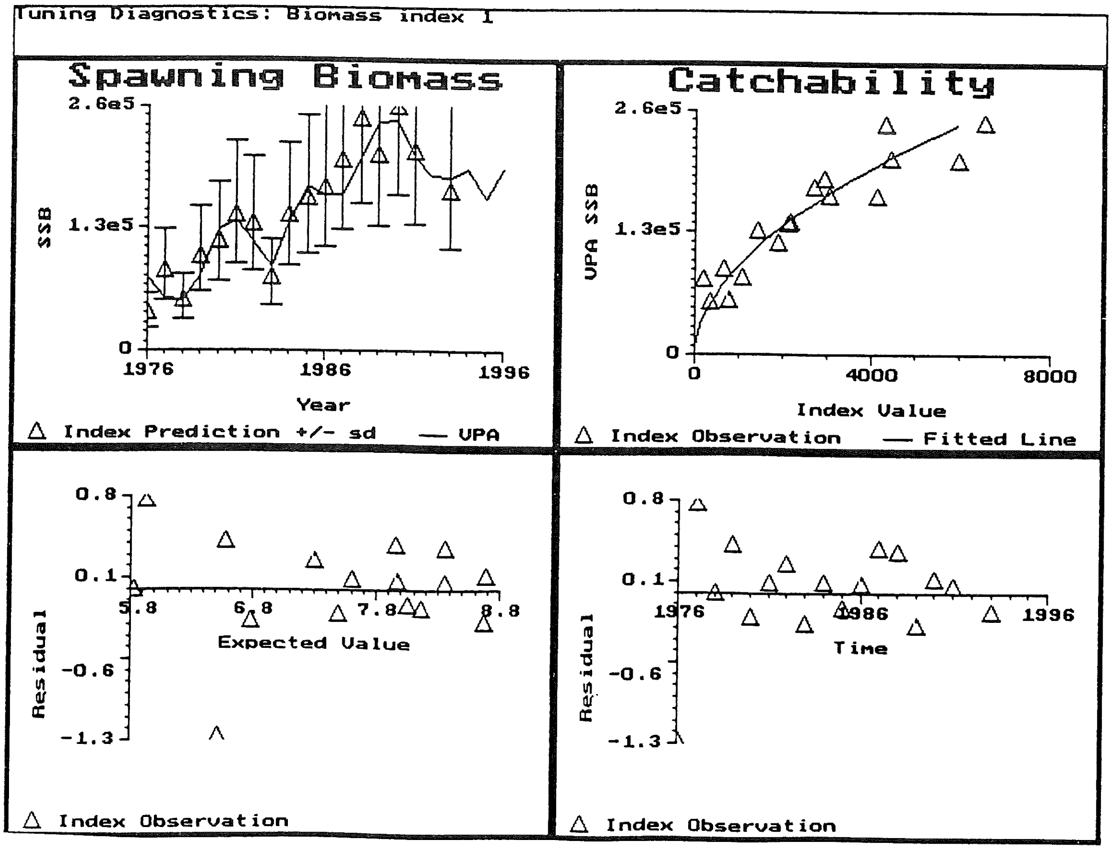


Figure 5.1.6. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the larval abundance index against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of spawning biomass from the fitted populations and larval survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

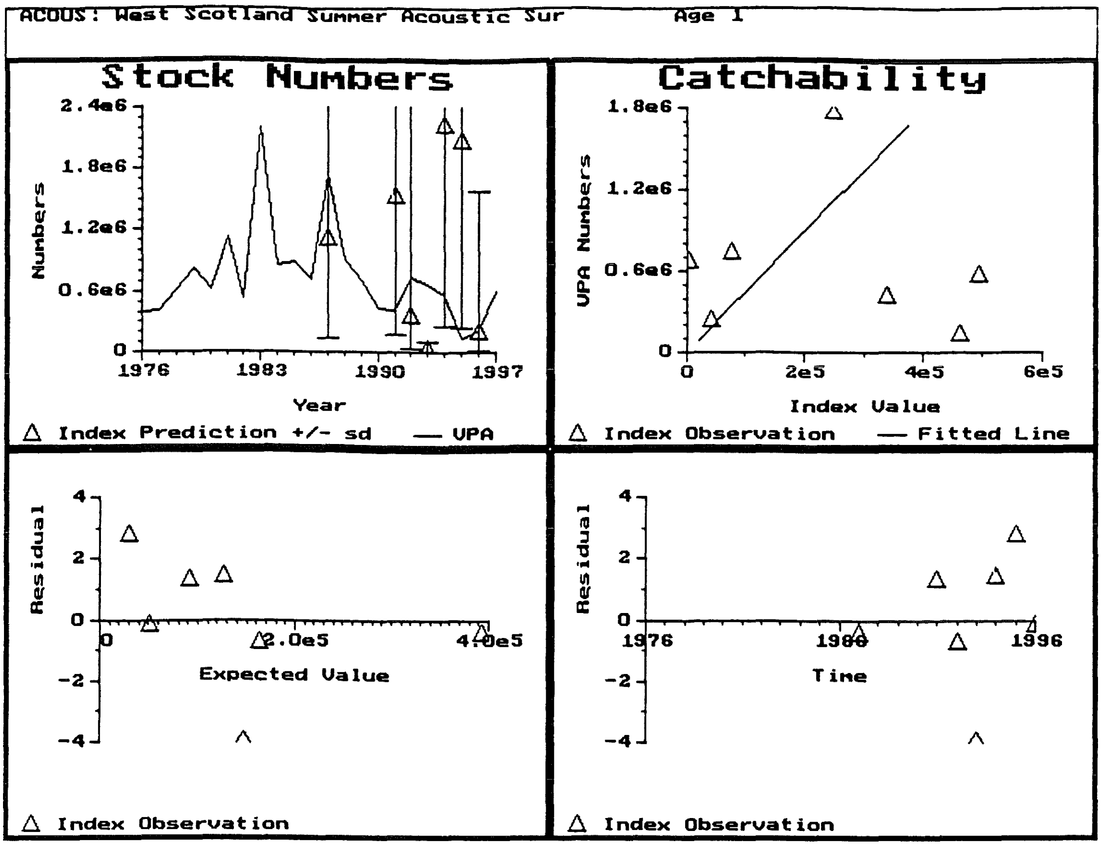


Figure 5.1.7. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 1 against the estimated populations at age 1. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

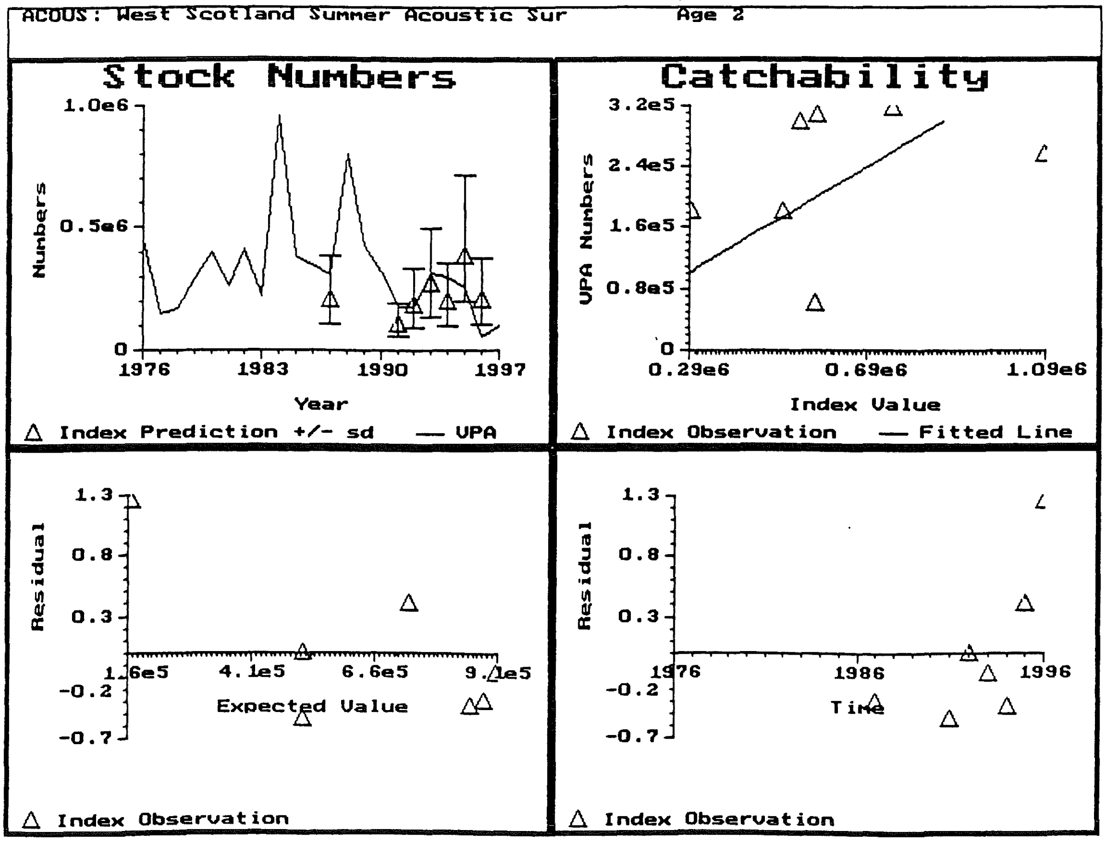


Figure 5.1.8. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 2 against the estimated populations at age 2. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

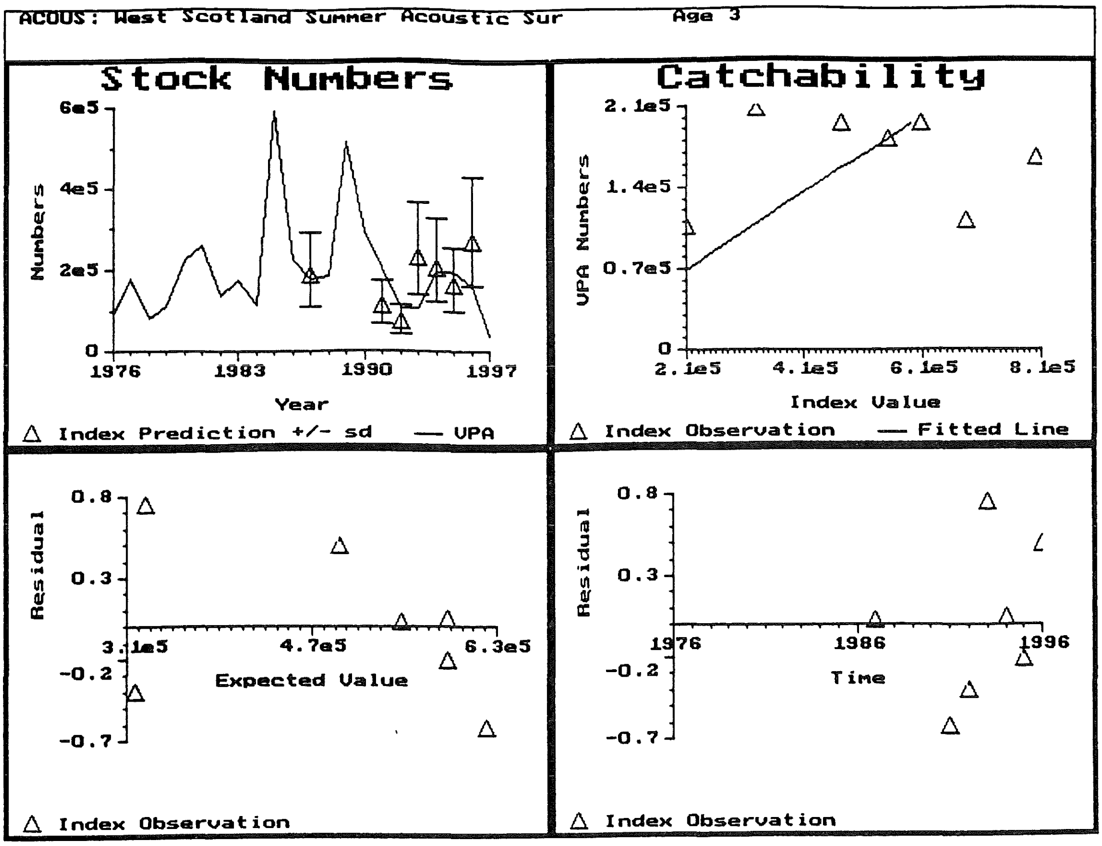


Figure 5.1.9. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 3 against the estimated populations at age 3. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

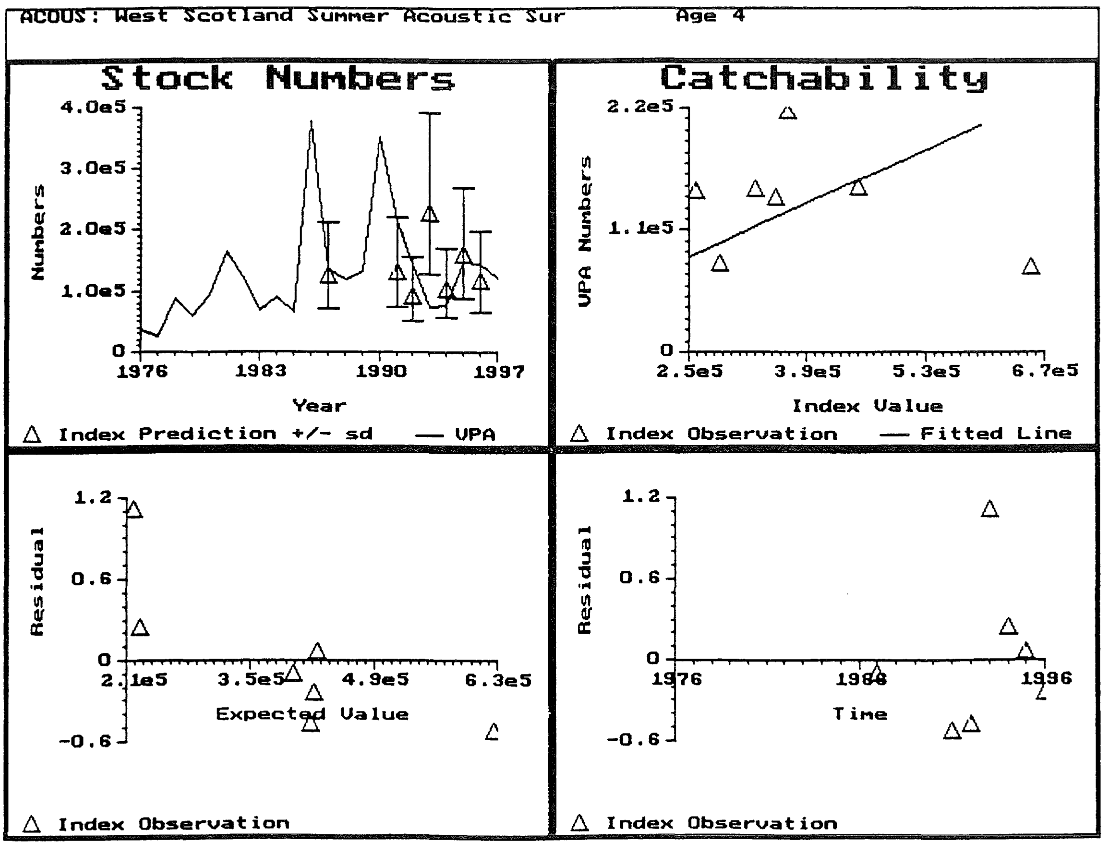


Figure 5.1.10. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 4 against the estimated populations at age 4. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

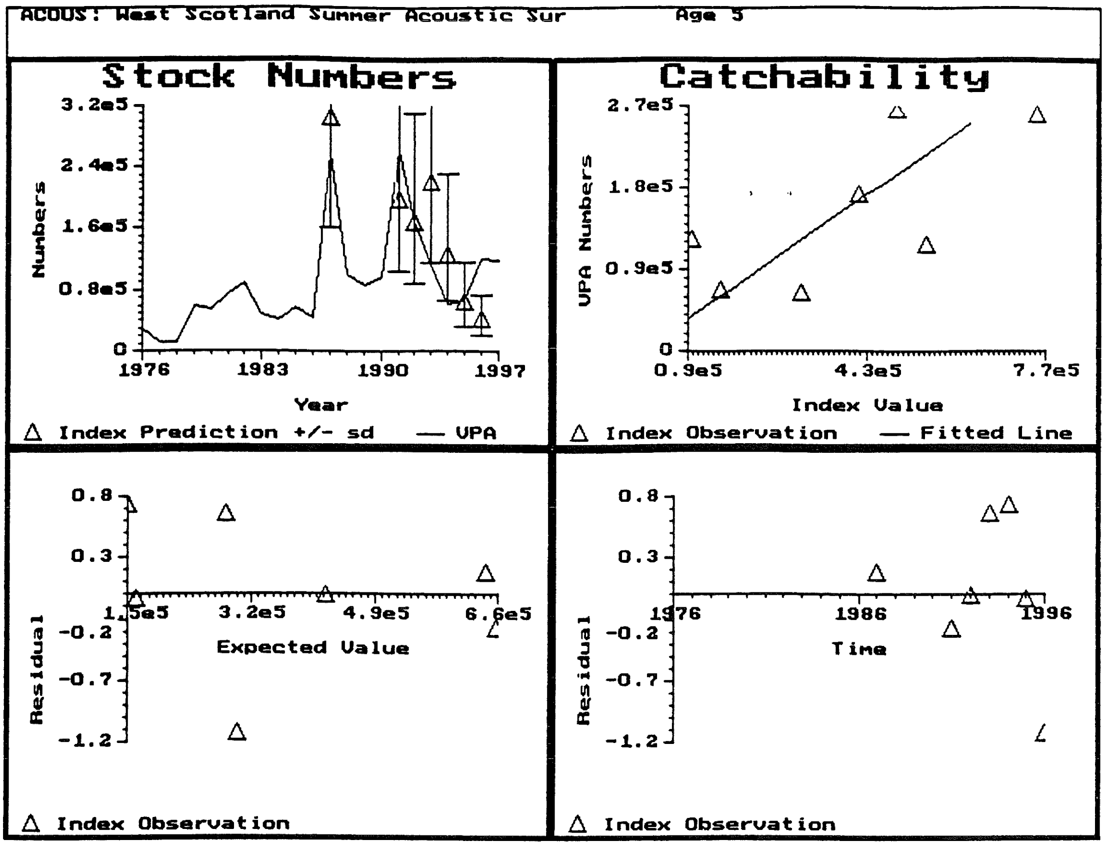


Figure 5.1.11. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 5 against the estimated populations at age 5. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

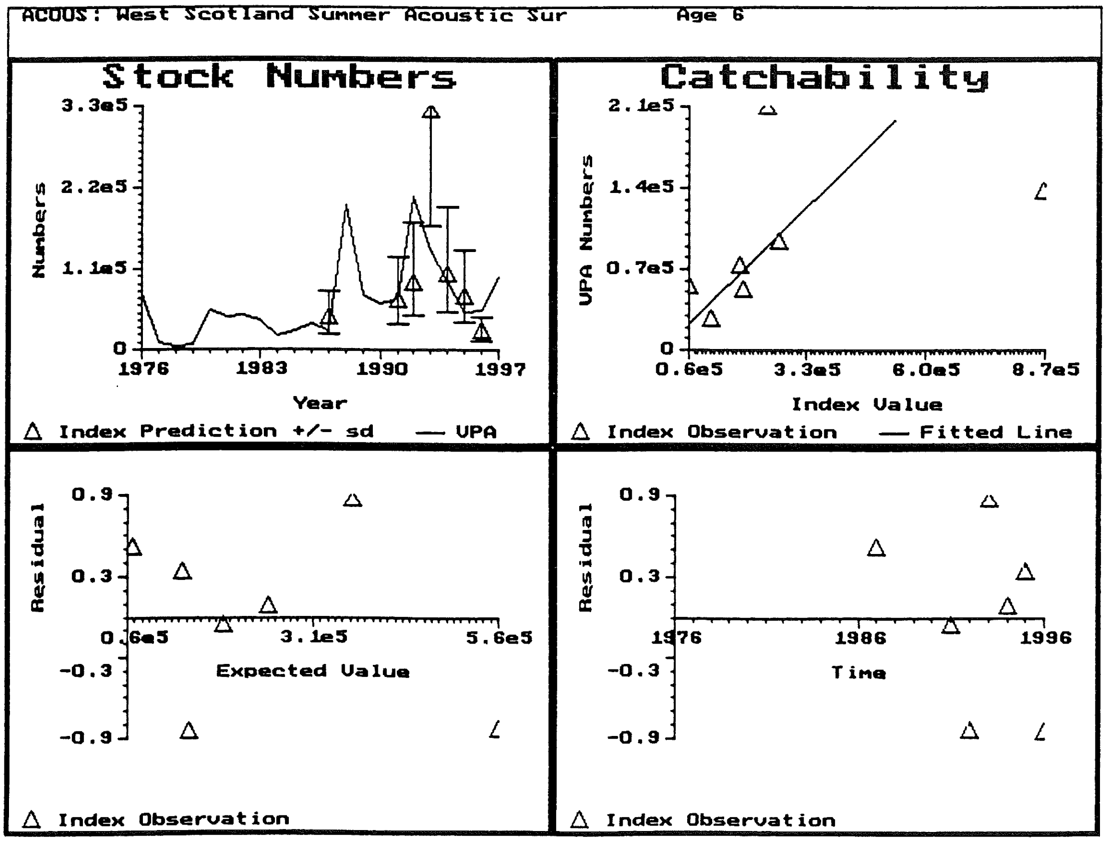


Figure 5.1.12. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 6 against the estimated populations at age 6. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

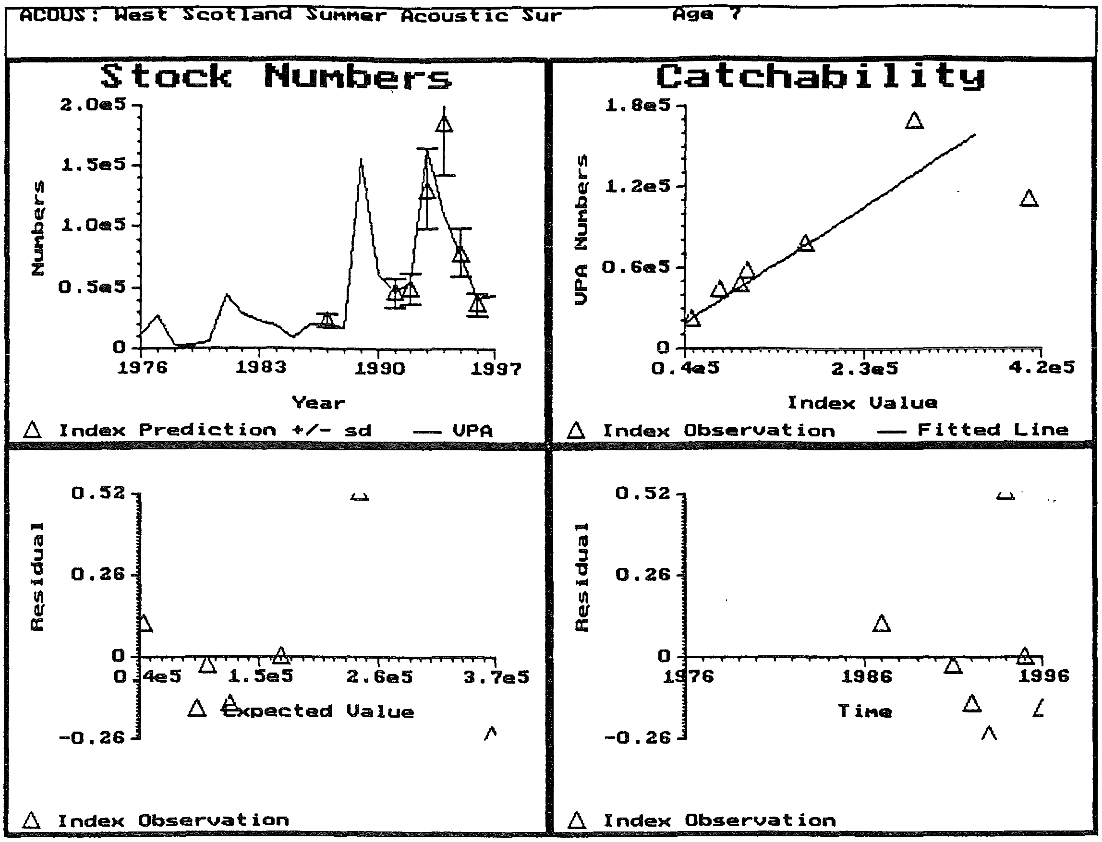


Figure 5.1.13. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 7 against the estimated populations at age 7. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

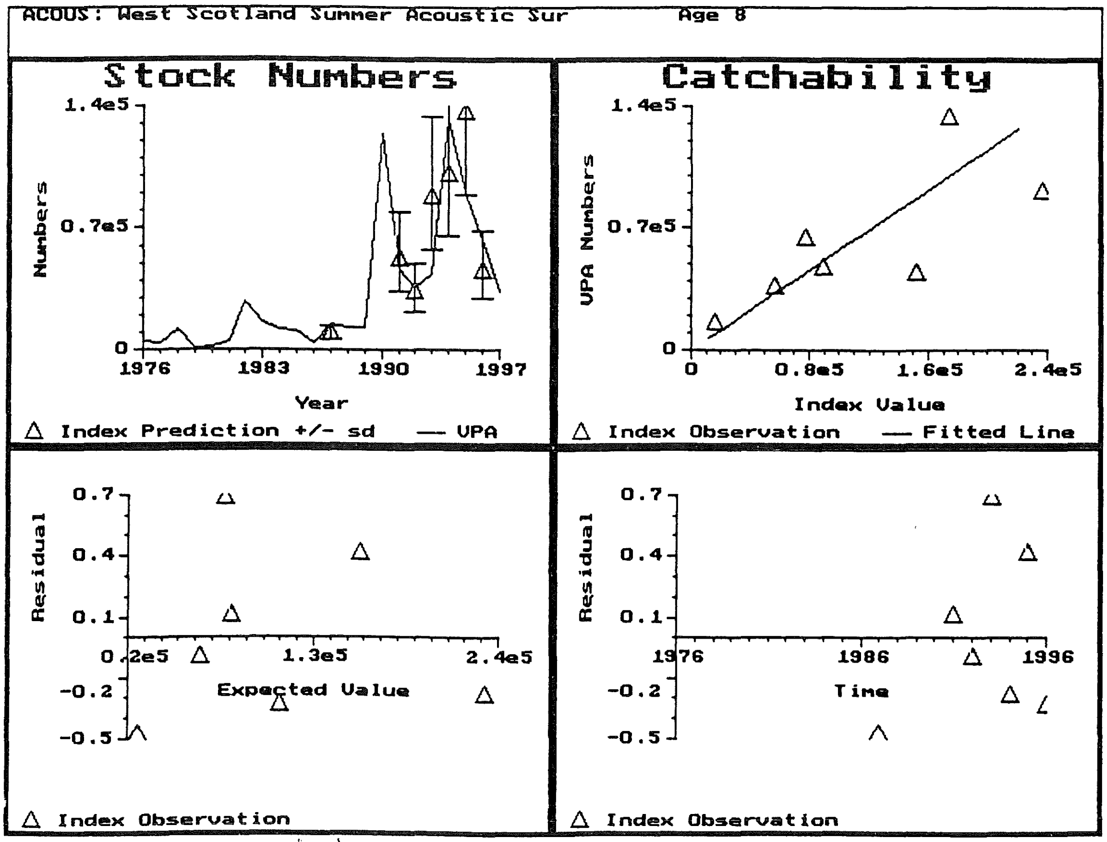


Figure 5.1.14. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 8 against the estimated populations at age 8. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

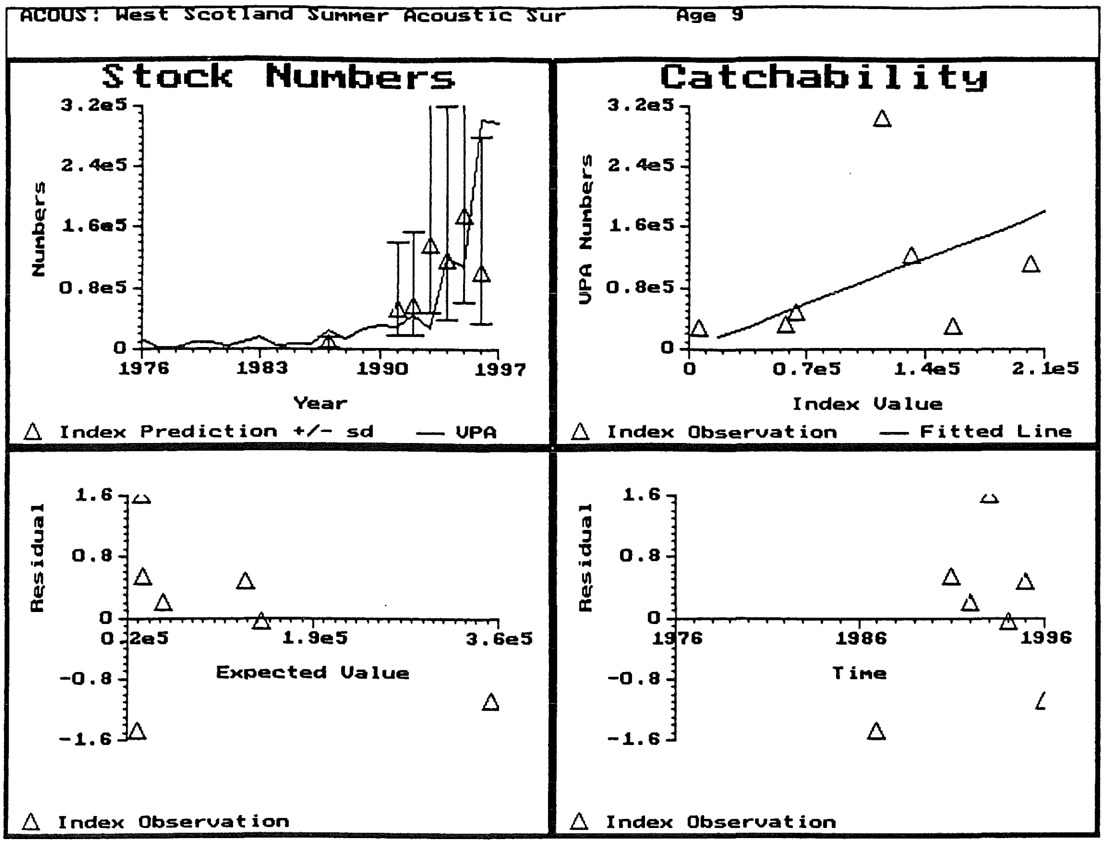


Figure 5.1.15. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 9 against the estimated populations at age 9. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

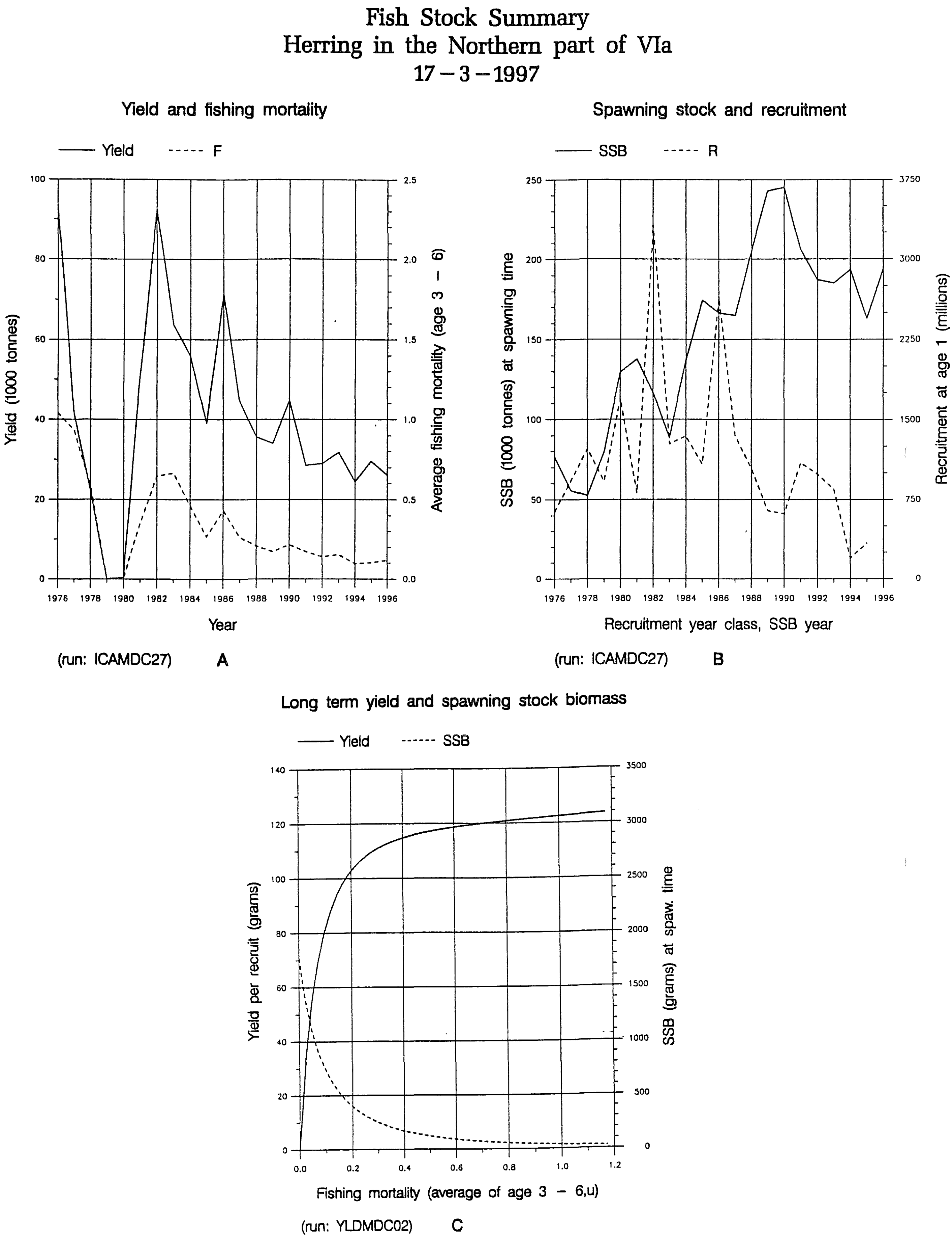


Figure 5.1.16 Herring in VIa(N). Summaries of F, recruitment, yield and SSB

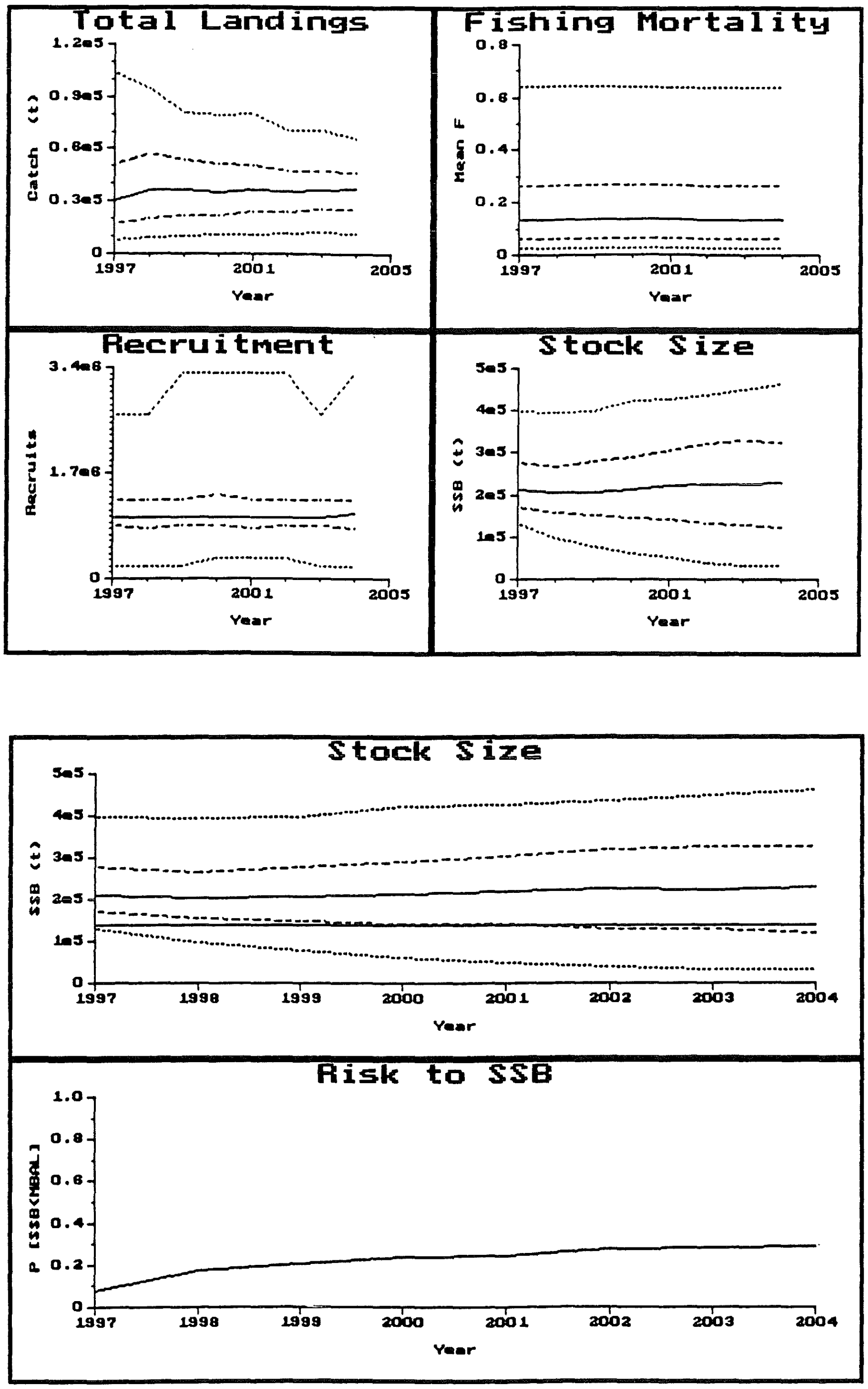


Figure 5.1.17 Herring in VIa(N). Summary results of medium-term projections for fishing mortality from 1997 to 2004 constrained equal to the fishing mortality estimate for 1996. **Upper panel:** landings, fishing mortality (mean over ages 3 to 6), recruitment, and stock size. **Lower panel:** Stock size and the probability that the stock may fall below the MBAL level of 140 000t. Solid line, 50th percentile. dashed lines, 25th and 75th percentiles. Dotted line, 5th and 95th percentiles.

6 HERRING IN DIVISIONS VIA (SOUTH) AND VIIB,C

6.1 The fishery

6.1.1 Advice and management applicable to 1996 and 1997

The TAC for this area for 1996 was 28,000 t. This was a precautionary TAC and was the same as that set each year since 1992. The total catch estimated by the Working Group to have been taken from the stock during 1996 was approximately 32,500 t. This was approximately 4,000 t higher than that recorded for 1995 and at about the same level as that from 1992 - 1995.There is considerable misreporting of catches in this area and the total catch recorded from the area is considerably lower than the actual catch taken from the stock.

Recent Working Groups have not carried out any analytical assessments for this stock but have suggested that the stock has declined in recent years and that the state of the stock is not known. The 1996 Working Group stated that, because of the extremely high catching power of the pelagic fleet in this area and because of it's ability to quickly change their target species, a cautious management should be adopted for this fishery. Therefore it was concluded that catches should not be allowed to rise above the 1995 level until more information on the stock became available. ACFM, in 1996, in the absence of an assessment, did not carry out a forecast for the stock but advised that a precautionary TAC, if required, should be set at a level so that the resulting catches did not exceed 25,000 t. The subsequent TAC agreed by the EU for 1996 was again set at 28,000 t.

6.1.2 Catch data

The main landings in 1996 from this fishery were again taken by Ireland who took over 95% of the total allocated catches. (Table 6.1.1.)

The total amount of unallocated catches in 1996 was over 8,600 t which was considerably higher than that recorded for 1995. This unallocated catch is mainly composed of catches which were made in Division VIa (South) but which were reported as having been taken in Division VIa (North)) The total international catches, from Sub-areas VI and VII per statistical rectangle, based on log book data, and not corrected for "misreporting" are shown in Figures 4.2.1 a-d.

The catches and landings taken by each country fishing in this area from 1987-1996 are shown in Table 6.1.1 and the total catches from 1970 are shown in Figure 6.1.1. There were no estimates of discards reported from 1996 and there are no indications that discarding is a major problem in this fishery even though substantial catches from this fishery in recent years have been taken in a "roe" fishery. Reports, however, have been received of quantities of discarded herring taken by bottom trawlers fishing in the areas adjacent to known spawning grounds but it has not been possible to quantify the amounts.

The catches for 1996 are preliminary. It has not been found necessary to make any alterations to the 1995 data.

6.1.3 The fishery in 1996

Reports from the Irish fishery throughout most of 1996 as in 1995 suggested that herring shoals were very scarce, particularly in Division VIIb. As has been the pattern in recent years catches from the first quarter taken from Division VIa(South) contained substantial amounts of full and spawning fish. In 1996 these fish amounted to over 90% of the total catch in the first quarter and had a typical winter/spring vertebral count of 56.87, compared with a vertebral count of 56.51 for full and spawning fish during Quarter 4. Recent Herring Working Groups have commented on the increasing numbers of winter/spring spawning fish which have appeared in the catches from this area in recent years and this pattern has been maintained in the early part of 1997. Herring shoals again appeared to be very scarce on the traditional autumn spawning grounds in Division VIIb in 1996. The main landings by the Irish fleet were taken during Quarter 4. Landings in this quarter increased in 1996 because of additional effort in the fishery due to the participation of the large pelagic trawlers who changed from fishing for mackerel and horsemackerel to fishing for herring.

Landings by the Irish fleet in 1996 were again regulated by weekly quotas and a closed season was introduced during June and July. This closed season is designed to prevent landings of herrings at a time when marketing difficulties are usually experienced.

6.1.4 Catch in numbers at age

The catches at age for this fishery since 1970 are shown in Table 6.1.2. In recent years the catches in numbers at age are derived mainly from Irish sampling data. The catches during 1996 were mainly dominated by 3 w.ring fish i.e.the 1992 year class which constituted over 38% of the total number. This year class was well represented in all areas. Older herring, mainly from the very strong 1985 year class, were taken in Quarter 3 in Div.VIIb where they constituted 28% of the total number.

6.1.5 Quality of the catch and biological data

Management authorities are confident about the accuracy of catch statistics from this area. However there may still be some under-reporting although , the extent of this cannot be quantified. Since 1994 the scarcity of herring throughout the year has not put pressure on skippers to under-report to any great extent. Misreporting of substantial catches taken in Division VIa (North) to the adjoining Division VIa (South) continued in 1996 but it was possible to re-allocate these catches based on information from fishermen.

The numbers of samples and the biological data, together with the length distribution of the catches taken per quarter by the Irish fleet, are shown in Tables 6.1.3 and 6.1.4 respectively. Sampling of catches throughout 1996 improved on the 1995 level and was considered satisfactory.

6.2 Mean Weights at Age

The mean weights (g) at age in the catches in 1996 are based mainly on Irish samples, together with one Dutch sample. The mean weights from 1970-1996 are shown in Table 6.2.1. The mean weights have increased in recent years because of the increasing amount of catches of full fish taken during the first quarter.

The 1996 mean weights at age for the stock at spawning time (1 October) are based on Irish samples of full fish taken during the fourth Quarter. The mean weights from 1970-1996 are shown in Table 6.2.2. and have been very similar in recent years.

6.3 Ground fish Surveys

Ground fish surveys have been carried out during November along the west coast of Ireland from 1993 to 1996. Over 60 stations have been sampled each year with a bottom trawl fitted with fine mesh liner. Although these surveys are designed to obtain an abundance index for demersal fish it is hoped that they will also provide recruitment indices for herring. The series, however, has not yet been established long enough to provide useful information.

6.4 Acoustic surveys

Acoustic surveys were initiated in this area in 1994, and are designed to provide an estimate of the total stock size. The third survey, again using the **R.V. Lough Foyle**, was carried out in July 1996 and covered the same areas as those in previous years. The results were presented in a working paper (Molloy and Fernandes, 1997. W.D.) and were also included in the report of the 1997 Co-ordinated Acoustic Survey (Simmonds *et al.*, 1997 W.D.).

Considerable difficulties were experienced with the acoustic equipment throughout the 1996 survey. These difficulties were associated with the calibration equipment, the transducer cable and unidentified faults in the E.K.500. Despite intensive investigations it was not possible to identify the reasons for the very low SA values recorded during the survey which resulted in a very low estimate of stock size. The total stock sizes estimated in 1996 were unrealisticand were not used as a basis for any assessment. The total stock estimated for 1995 and 1996 were 354,000 t and 135,000 t respectively.

It is important, however, that acoustic surveys should be continued in this area because there is at present no other method of assessing the stock size and no basis for providing accurate management advice. Herring fisheries are extremely important to the local communities along the Irish coast and there is an extremely high catching capacity of the fleet in the area. The stock appears to have seriously declined in recent years and catches may need to be substantially reduced. Consideration should be given to changing the timing of the surveys in the area because of the difficulties in locating concentrations during the summer. The increasing importance of the winter/spring herring in the area would suggest that acoustic surveys should be carried out during the winter in the southern part of Division VIa (South).

6.5 State of the Stock

Analytical assessments have not been carried out on this stock for a number of years because of the absence of survey data. Recent Working Groups have therefore only carried out VPA analyses to study the development of the stock and no stock projections have been made. The results of those analyses have indicated that the stock has decreased in recent years from a high level in 1988. This high level was as a result of the recruitment of the exceptionally strong 1985 year class which dominated the catches in this area for a long period.

The only additional data available to the present Working Group are the indications of a low stock size from the 1996 acoustic survey and reports from fishermen, both of which indicate a serious decline in stock size. In an attempt to demonstrate possible rates of decline it was again decided to run a series of VPAs with different input F values as has been done by recent working groups. A separable VPA was therefore carried out using the updated catch data and a terminal S value of 1.0 and down weighted prior to 1990 to 0.001. Age 4 was taken as reference age and the resultant exploitation pattern appears to be reasonably flat topped. The results of the separable VPA are shown in Table 6.5.1. The terminal populations from the separable VPA were then used to carry out traditional VPAs using input F values = 0.3, 0.4, 0.5 and 0.6.

The results from the traditional VPA using F in 1996=0.6 are shown in Tables 6.5.2 and 6.5.3. These indicate that over the period 1970–1996 the spawning stock was at its maximum level in 1988 and has since declined steadily each year. The estimated SSB levels, obtained from using the different F values in 1996 are shown in Figure 6.5.1. The present SSB level is between 14% and 25% of the level in 1998 and may be between 50,000 t and 105,000 t depending on the input F level. The recruitment of the exceptionally strong 1985 year class had a dramatic effect on the spawning stock in 1988. Since 1985 there have been no other outstanding year classes but there were indications in 1996 that the 1992 year class may have been above average size This, however has not been confirmed.

6.6 Stock Forecasts and Catch Predictions

As there is no method of obtaining a recruitment index for this stock and no estimates of stock size from survey data it has not been possible to carry out any stock forecasts or catch predictions.

6.7 Management Considerations

The results of these non analytical assessments indicate that the spawning stock has declined considerably in recent years and is now at a comparatively low level. This is consistent with observations from fishermen who in recent years have expressed alarm at the scarcity of herring in this area. There has been no substantial recruitment to the stock in recent years and the very strong 1985 year class has now reached the end of it's natural lifespan. The scarcity of herring may be due to a combination of the decline in stock accentuated by a more northerly distribution of the stock in recent years. It is also interesting to note the increasing importance of winter/spring spawning fish in this area. The old traditional fisheries in this area, which were extremely important in the early part of the century, were all based on winter/spring spawning herring.

As no analytical assessments have been carried out on this stock in recent years the TACs have been set on the average catch level recorded for Divisions VIa (South) and VIIb. The actual catch taken from the stock has consistently exceeded these recommended TACs because of the amounts taken in this area but misreported to Division VIa (North). Because of the decline in the stock and the importance of the fishery to the local communities serious attempts should be made to bring about an actual substantial and realistic decrease in the total catches. Until such time as it is possible to make an improved assessment of the stock and there is evidence of improved recruitment the catches should be stabilised at a level considerably below those recorded in recent years.

6.8 Medium Term Projections and Consideration of MBAL

Medium term projections and the MBAL for this stock were considered by the 1996 working group but it was not possible to carry out any projections because of the absence of sufficient data. The situation has not altered in 1997 and in the absence of information about current recruitment levels and because of the uncertainty about the current stock size no projections were carried out. An examination of the spawning stock/recruitment relationship (Figure 6.8.1) suggests that there is little evidence of any relationship between spawning stock and recruitment over the range of SSB and recruitment encountered.

An examination of the historical data series (1970-1995) did not suggest any period when the stock was subjected to a low fishing effort i.e F below 0.1. The lowest F values were recorded during the period 1984 to 1986 when the mean F was about 0.21 and the average SSB was about 180,000 t. At that time the average catches were about 26,500 t. Therefore it might be suggested that if the stock was at this level the fishery might then be able to sustain catches of about 26,000 t. The present analyses suggests that the spawning stock has seriously declined in recent years and, even though the exact size is not known, it would appear to be well below 180,000 t. This in turn would suggest that the present catches are far too high. It has not been possible with the present data to calculate the MBAL for this stock.

Table 6.1.1 Estimated Herring catches in tonnes in Divisions VIa (South) and VIIb,c, 1986–1996. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1986	1987	1988	1989	1990
France	-	-	-	-	+
Germany, Fed.Rep.	-	-	-	-	-
Ireland	15,540	15,000	15,000	18,200	25,000
Netherlands	1,550	1,550	300	2,900	2,533
UK (N.Ireland)	-	5	-	-	80
UK (England + Wales)	-	51	-	-	-
UK Scotland	-	-	-	+	-
Unallocated	11,785	31,994	13,800	7,100	13,826
Total landings	28,785	48,600	29,100	28,200	41,439
Discards	-	-	-	1,000	2,530
Total catch	28,785	48,600	29,100	29,200	43,969

Country	1991	1992	1993	1994	1995	1996[1]
France	-	-	-	-	-	-
Germany, Fed.Rep.	-	250	-	-	11	-
Ireland	22,500	26,000	27,600	24,400	25,450	23,800
Netherlands	600	900	2,500	2,500	1,207	1,800
UK (N.Ireland)	-	-	-	-	-	-
UK (England + Wales)	-	-	-	50	24	-
UK (Scotland)	+	-	200	-	-	-
Unallocated	11,200	4,600	6,250	6,250	1,100	6,900
Total landings	34,300	31,750	36,550	33,200	27,792	32,500
Discards	3,400	100	250	700	-	-
Total catch	37,700	31,850	36,800	33,900	27,792	32,500

[1]Provisional

Table 6.1.2 HER-IRLW: Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

CANUM: Catch in Numbers (Thousands)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1970	0	135	35114	26007	13243	3895	40181	2982	1667	1911
1971	0	883	6177	7038	10856	8826	3938	40553	2286	2160
1972	0	1001	28786	20534	6191	11145	10057	4243	47182	4305
1973	46	6423	40390	47389	16863	7432	12383	9191	1969	50980
1974	0	3374	29406	41116	44579	17857	8882	10901	10272	30549
1975	194	7360	41308	25117	29192	23718	10703	5909	9378	32029
1976	823	16613	29011	37512	26544	25317	15000	5208	3596	15703
1977	0	4485	44512	13396	17176	12209	9924	5534	1360	4150
1978	82	10170	40320	27079	13308	10685	5356	4270	3638	3324
1979	4	5919	50071	19161	19969	9349	8422	5443	4423	4090
1980	0	2856	40058	64946	25140	22126	7748	6946	4344	5334
1981	0	1620	22265	41794	31460	12812	12746	3461	2735	5220
1982	0	748	18136	17004	28220	18280	8121	4089	3249	2875
1983	0	1517	43688	49534	25316	31782	18320	6695	3329	4251
1984	0	2794	81481	28660	17854	7190	12836	5974	2008	4020
1985	0	9606	15143	67355	12756	11241	7638	9185	7587	2168
1986	0	918	27110	24818	66383	14644	7988	5696	5422	2127
1987	0	12149	44160	80213	41504	99222	15226	12639	6082	10187
1988	0	0	29135	46300	41008	23381	45692	6946	2482	1964
1989	0	2241	6919	78842	26149	21481	15008	24917	4213	3036
1990	0	878	24977	19500	151978	24362	20164	16314	8184	1130
1991	0	675	34437	27810	12420	100444	17921	14865	11311	7660
1992	0	2592	15519	42532	26839	12565	73307	8535	8203	6286
1993	0	191	20562	22666	41967	23379	13547	67265	7671	6013
1994	0	11709	56156	31225	16877	21772	13644	8597	31729	10093
1995	0	284	34471	35414	18617	19133	16081	5749	8585	14215
1996	43	4776	24424	69307	31128	9842	15314	8158	12463	6472

Table 6.1.3 Divisions VIa (South) and VIIb. Sampling intensity of catches in 1996.

Country	Q	Catch[1]	No. of samples	No. of age readings	No. of fish measured	Aged per 1000 t.	Estimate of discards
Ireland	1	9,500	13	448	2,348	47	No
	2	2,800	12	591	1,743	211	No
	3	2,800	17	775	3,158	276	No
	4	17,200	12	448	2,928	26	No
Netherlands	3	100	1	25	129	250	Yes

[1]including Division VIa (North).

Table 6.1.4 Divisions VIa and VIIb. Length distributions of Irish catches (pelagic trawlers) per quarter (10^3) in 1996.

Length	1st quarter	2nd quarter	3rd quarter	4th quarter
18.0			5	30
18.5		11	10	
19.0			57	
19.5			162	
20.0			348	
20.5		11	334	59
21.0		32	429	355
21.5		43	353	415
22.0		151	262	563
22.5		140	105	592
23.0	145	270	157	1,185
23.5	121	313	210	1,007
24.0	217	518	376	1,303
24.5	797	400	391	1,806
25.0	2,559	626	600	3,139
25.5	4,610	1,069	600	2,873
26.0	8,424	1,674	767	3,820
26.5	7,241	2,020	810	3,879
27.0	7,483	1,901	1,072	8,025
27.5	4,707	1,566	1,196	6,722
28.0	5,021	1,642	1,372	8,647
28.5	4,007	2,020	1,091	7,818
29.0	4,731	1,836	1,163	9,684
29.5	3,041	1,393	1,144	8,914
30.0	2,052	961	1,105	8,914
30.5	724	173	567	4,205
31.0	314	32	272	1,629
31.5	193	22	48	681
32.0	72		33	267
32.5	72		10	148
33.0	121			30
33.5	24			
34.0				
34.5				
35.0				
Total	56,675	18,825	15,048	86,709
Tonnes	9,000	2,800	2,800	17,238

Table 6.2.1 HER-IRLW: Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

WECA: Mean Weight in Catch (Kilograms)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1970	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1971	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1972	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1973	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1974	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1975	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1976	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1977	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1978	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1979	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1980	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1981	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1982	0.010	0.110	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1983	-1.000	0.090	0.129	0.165	0.191	0.209	0.222	0.231	0.237	0.241
1984	-1.000	0.106	0.141	0.181	0.210	0.226	0.237	0.243	0.247	0.248
1985	-1.000	0.077	0.122	0.161	0.184	0.196	0.206	0.212	0.225	0.230
1986	-1.000	0.095	0.138	0.164	0.194	0.212	0.225	0.239	0.208	0.288
1987	-1.000	0.085	0.102	0.150	0.169	0.177	0.193	0.205	0.215	0.220
1988	-1.000	-1.000	0.098	0.133	0.153	0.166	0.171	0.183	0.191	0.201
1989	-1.000	0.080	0.130	0.141	0.164	0.174	0.183	0.192	0.193	0.203
1990	-1.000	0.094	0.138	0.148	0.160	0.176	0.189	0.194	0.208	0.216
1991	-1.000	0.089	0.134	0.145	0.157	0.167	0.185	0.199	0.207	0.230
1992	-1.000	0.095	0.141	0.147	0.157	0.165	0.171	0.180	0.194	0.219
1993	-1.000	0.112	0.138	0.153	0.170	0.181	0.184	0.196	0.229	0.236
1994	-1.000	0.081	0.141	0.164	0.177	0.189	0.187	0.191	0.204	0.220
1995	-1.000	0.080	0.140	0.161	0.173	0.182	0.198	0.194	0.206	0.217
1996	0.034	0.085	0.135	0.172	0.182	0.199	0.209	0.220	0.233	0.237

Table 6.2.2

HER-IRLW: Herring West of Ireland & Porcupine Bank (Fishing Area VIa South)

WEST: Mean Weight in Stock (Kilograms)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1970	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1971	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1972	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1973	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1974	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1975	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1976	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1977	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1978	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1979	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1980	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1981	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1982	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1983	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1984	0.010	0.120	0.169	0.210	0.236	0.260	0.273	0.283	0.290	0.296
1985	-1.000	0.100	0.150	0.196	0.227	0.238	0.251	0.252	0.269	0.284
1986	-1.000	0.098	0.169	0.209	0.238	0.256	0.276	0.280	0.287	0.312
1987	-1.000	0.097	0.164	0.206	0.233	0.252	0.271	0.280	0.296	0.317
1988	-1.000	0.097	0.164	0.206	0.233	0.252	0.271	0.280	0.296	0.317
1989	-1.000	0.138	0.157	0.168	0.182	0.200	0.217	0.227	0.238	0.245
1990	-1.000	0.113	0.152	0.170	0.180	0.200	0.217	0.225	0.233	0.255
1991	-1.000	0.102	0.149	0.174	0.190	0.195	0.206	0.226	0.236	0.248
1992	-1.000	0.102	0.144	0.167	0.182	0.194	0.197	0.214	0.218	0.242
1993	-1.000	0.118	0.166	0.196	0.205	0.214	0.220	0.223	0.242	0.258
1994	-1.000	0.098	0.156	0.192	0.209	0.216	0.223	0.226	0.230	0.247
1995	-1.000	0.090	0.144	0.181	0.203	0.217	0.226	0.227	0.239	0.246
1996	0.034	0.086	0.137	0.186	0.206	0.219	0.234	0.233	0.249	0.253

Table 6.5.1

Title : Herring VIa South (run: SEPJM24/S24)

At 15-Mar-97 15:51:28

Separable analysis
from 1970 to 1996 on ages 0 to 8
with Terminal F of .600 on age 4 and Terminal S of 1.000

Initial sum of squared residuals was 2910.224 and
final sum of squared residuals is 1235.700 after 150 iterations

Matrix of Residuals

Years, Ages	1970/71,	1971/72,	1972/73,	1973/74,	1974/75,	1975/76,
0/ 1,	-6.731,	-6.103,	-8.147,	-2.738,	-8.482,	-3.129,
1/ 2,	-.862,	.215,	-.197,	1.979,	.768,	1.876,
2/ 3,	1.612,	-.463,	.012,	.459,	.378,	.276,
3/ 4,	.476,	.466,	.288,	.100,	.102,	-.346,
4/ 5,	-.039,	.265,	-.144,	-.077,	.325,	-.217,
5/ 6,	-.446,	.169,	-.062,	-.198,	.202,	.092,
6/ 7,	-.771,	-.092,	-.179,	-.196,	-.206,	.053,
7/ 8,	-.073,	.245,	.919,	-.012,	-.029,	.267,
TOT ,	.000,	.000,	.000,	.000,	.000,	.000,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,

Years,	1976/77,	1977/78,	1978/79,	1979/80,	1980/81,	1981/82,	1982/83,	1983/84,	1984/85,	1985/86,
0/ 1,	-1.099,	-9.086,	-3.109,	-5.080,	-7.382,	-6.531,	-6.538,	-8.289,	-8.872,	-6.415,
1/ 2,	1.580,	.838,	1.556,	1.547,	.852,	.576,	-.392,	-1.427,	1.519,	2.278,
2/ 3,	.296,	.544,	.917,	.216,	-.121,	.297,	-.299,	.008,	.454,	-.125,
3/ 4,	-.162,	-.369,	.063,	-.211,	.224,	.013,	-.098,	.192,	.679,	-.010,
4/ 5,	-.232,	.046,	.061,	-.093,	.120,	.114,	.133,	.380,	.288,	-.207,
5/ 6,	-.074,	.401,	-.047,	.203,	.004,	.037,	.257,	.036,	-.223,	.284,
6/ 7,	-.338,	.099,	-.622,	-.107,	-.065,	.392,	.137,	-.080,	-.154,	-.089,
7/ 8,	.462,	.104,	-.217,	.346,	.491,	-.257,	.564,	.436,	-.310,	.561,
TOT ,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years,	1986/87,	1987/88,	1988/89,	1989/90,	1990/91,	1991/92,	1992/93,	1993/94,	1994/95,	1995/96,	TOT,	WTS,
0/ 1,	-8.350,	.644,	-7.326,	-6.122,	-6.181,	-7.461,	-4.615,	-8.938,	-5.289,	-7.600,	-34.028,	.100,
1/ 2,	.064,	1.758,	-6.467,	1.135,	-.446,	.150,	1.435,	-2.393,	2.137,	-.781,	.558,	.100,
2/ 3,	-.119,	-.397,	-.662,	-.461,	.130,	.085,	.119,	-.162,	.632,	-.119,	.558,	1.000,
3/ 4,	.047,	-.102,	.503,	-.488,	.270,	-.089,	.081,	.102,	.231,	.232,	.558,	1.000,
4/ 5,	.112,	-.252,	.532,	.190,	.181,	-.189,	.151,	.401,	-.476,	.670,	.558,	1.000,
5/ 6,	.482,	-.043,	.338,	.190,	.079,	.142,	-.061,	.282,	-.051,	.244,	.558,	1.000,
6/ 7,	-.249,	-.362,	.178,	-.273,	-.241,	.253,	-.207,	-.109,	.204,	.420,	.558,	1.000,
7/ 8,	.555,	.915,	.491,	1.341,	.245,	.530,	.235,	.619,	-.224,	-.609,	.558,	1.000,
TOT ,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	*******,	
WTS ,	.001,	.001,	.001,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)

,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
F-values,	.1438,	.1102,	.1795,	.2430,	.3360,	.3731,	.4074,

,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
F-values,	.2154,	.1806,	.1694,	.2189,	.1606,	.1273,	.2035,	.1039,	.1019,	.1114,

,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
F-values,	.2328,	.1290,	.1385,	.1941,	.1972,	.2139,	.2947,	.3299,	.3444,	.6000,

Selection-at-age (S)

,	0,	1,	2,	3,	4,	5,	6,	7,	8,
S-values,	.0010,	.0092,	.4758,	.8711,	1.0000,	1.0527,	1.1285,	.8652,	1.0000,

Table 6.5.1 cont'd

Run title : Herring VIa South (run: SEPJM24/S24)

At 15-Mar-97 15:51:32

Traditional vpa Terminal populations from weighted Separable populations

Fishing mortality residuals

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE							
0,	-.0001,	-.0001,	-.0002,	-.0002,	-.0003,	-.0002,	.0003,
1,	-.0009,	.0006,	.0003,	.0149,	.0047,	.0207,	.0281,
2,	.2733,	-.0078,	.0222,	.0554,	.0109,	.0340,	.0185,
3,	.0811,	.0157,	.0602,	.0631,	-.0127,	-.0961,	-.0329,
4,	-.0005,	.0081,	-.0504,	.0199,	.0894,	-.0620,	-.0268,
5,	-.0238,	.0044,	-.0353,	-.0541,	.0795,	-.0191,	.0012,
6,	-.0590,	.0405,	-.0269,	-.0463,	-.0297,	.0237,	-.0790,
7,	-.0046,	.0340,	.0847,	.0053,	-.0043,	.0446,	.0063,
8,	.0000,	.0038,	.0159,	-.0931,	.0161,	.0052,	-.0527,

Fishing mortality residuals

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
0,	-.0002,	-.0001,	-.0002,	-.0002,	-.0002,	-.0001,	-.0002,	-.0001,	-.0001,	-.0001,
1,	.0077,	.0107,	.0058,	.0048,	.0016,	.0002,	-.0010,	.0031,	.0110,	.0005,
2,	.0864,	.1056,	.0491,	.0009,	.0355,	.0110,	.0784,	.0493,	-.0042,	.0165,
3,	-.0358,	.0207,	-.0090,	.0718,	.0211,	.0128,	.1235,	.0861,	.0282,	.0034,
4,	.0115,	.0298,	.0137,	.0384,	.0253,	.0204,	.0555,	.0558,	.0037,	.0422,
5,	.0419,	.0025,	.0223,	.0517,	.0117,	.0066,	.0065,	-.0119,	.0213,	.0351,
6,	.0222,	-.0417,	.0134,	-.0196,	.0515,	.0058,	-.0467,	-.0004,	.0131,	-.0117,
7,	.0233,	.0000,	.0734,	.0424,	-.0041,	-.0125,	-.0172,	-.0148,	.0151,	.0231,
8,	-.0822,	.0053,	.0457,	.0257,	-.0400,	.0348,	-.1067,	-.0451,	.0141,	-.0377,

Run title : Herring VIa South (run: SEPJM24/S24)

At 15-Mar-97 15:51:32

Traditional vpa Terminal populations from weighted Separable populations

Fishing mortality residuals

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
0,	-.0002,	-.0001,	-.0001,	-.0002,	-.0002,	-.0002,	-.0003,	-.0003,	-.0003,	.0000,
1,	.0033,	-.0012,	.0036,	-.0002,	.0003,	.0076,	-.0023,	.0236,	-.0005,	.2103,
2,	.0422,	-.0352,	-.0238,	.0218,	.0405,	.0018,	.0238,	.1642,	.0080,	.3052,
3,	.1160,	.1399,	-.0237,	.0000,	.0184,	.0727,	-.0275,	.1390,	.0681,	.1348,
4,	-.0029,	.1246,	.0710,	.0646,	-.0502,	.0544,	.1203,	-.0769,	.1177,	.0078,
5,	.0749,	.0397,	.0372,	.0698,	.0354,	-.0304,	.0408,	.0024,	.0840,	-.2112,
6,	-.0533,	.0677,	-.0099,	.0144,	.0737,	.0094,	-.0368,	-.0558,	.0292,	.0099,
7,	.0354,	.0134,	.0350,	.0418,	.0705,	.0153,	.0860,	-.0091,	-.1073,	-.1753,
8,	-.0706,	-.0692,	-.0449,	-.1314,	-.0001,	-.0319,	-.0458,	-.0916,	.0876,	.0955,

Table 6.5.2

Run title : Herring VIa South (run: SEPJM24/S24)

At 15-Mar-97 15:51:46

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE							
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0001,	.0007,
1,	.0005,	.0016,	.0020,	.0171,	.0078,	.0242,	.0319,
2,	.3417,	.0446,	.1076,	.1710,	.1707,	.2116,	.2123,
3,	.2064,	.1118,	.2165,	.2748,	.2800,	.2290,	.3220,
4,	.1433,	.1183,	.1291,	.2630,	.4253,	.3112,	.3805,
5,	.1276,	.1204,	.1537,	.2018,	.4331,	.3737,	.4300,
6,	.1033,	.1649,	.1757,	.2280,	.3494,	.4448,	.3808,
7,	.1198,	.1294,	.2400,	.2156,	.2864,	.3674,	.3588,
8,	.1438,	.1141,	.1954,	.1499,	.3521,	.3784,	.3547,
+gp,	.1438,	.1141,	.1954,	.1499,	.3521,	.3784,	.3547,
FBAR 2- 6,	.1845,	.1120,	.1565,	.2277,	.3317,	.3140,	.3451,

Table 8 Fishing mortality (F) at age

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0097,	.0124,	.0074,	.0068,	.0031,	.0014,	.0009,	.0040,	.0119,	.0015,
2,	.1889,	.1915,	.1297,	.1050,	.1119,	.0715,	.1752,	.0987,	.0443,	.0695,
3,	.1519,	.1780,	.1386,	.2625,	.1609,	.1238,	.3008,	.1766,	.1170,	.1004,
4,	.2269,	.2103,	.1831,	.2573,	.1858,	.1477,	.2590,	.1598,	.1056,	.1536,
5,	.2687,	.1926,	.2006,	.2822,	.1808,	.1406,	.2207,	.0975,	.1285,	.1523,
6,	.2654,	.1620,	.2046,	.2274,	.2327,	.1495,	.1830,	.1169,	.1281,	.1140,
7,	.2097,	.1562,	.2200,	.2318,	.1348,	.0976,	.1589,	.0752,	.1032,	.1195,
8,	.1333,	.1858,	.2150,	.2446,	.1206,	.1622,	.0968,	.0588,	.1160,	.0736,
+gp,	.1333,	.1858,	.2150,	.2446,	.1206,	.1622,	.0968,	.0588,	.1160,	.0736,
FBAR 2- 6,	.2203,	.1869,	.1713,	.2269,	.1744,	.1266,	.2277,	.1299	.1047	[illegible]

Run title : Herring VIa South (run: SEPJM24/S24)

At 15-Mar-97 15:51:46

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	FBAR 94-96
AGE											
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0006,	.0002,
1,	.0054,	.0000,	.0049,	.0016,	.0022,	.0096,	.0005,	.0267,	.0026,	.2159,	.0817,
2,	.1530,	.0262,	.0421,	.1141,	.1343,	.1036,	.1640,	.3212,	.1718,	.5906,	.3612,
3,	.3188,	.2523,	.0969,	.1691,	.1901,	.2590,	.2292,	.4264,	.3681,	.6575,	.4840,
4,	.2299,	.2536,	.2095,	.2588,	.1470,	.2683,	.4150,	.2530,	.4620,	.6078,	.4409,
5,	.3200,	.1755,	.1830,	.2742,	.2430,	.1948,	.3511,	.3497,	.4465,	.4205,	.4055,
6,	.2094,	.2133,	.1463,	.2335,	.2963,	.2509,	.2958,	.3166,	.4178,	.6870,	.4738,
7,	.2368,	.1250,	.1548,	.2098,	.2412,	.2004,	.3410,	.2763,	.1907,	.3438,	.2703,
8,	.1622,	.0598,	.0935,	.0627,	.1971,	.1820,	.2489,	.2383,	.4320,	.6955,	.4553,
+gp,	.1622,	.0598,	.0935,	.0627,	.1971,	.1820,	.2489,	.2383,	.4320,	.6955,	
FBAR 2- 6,	.2462,	.1842,	.1356,	.2099,	.2021,	.2153,	.2910,	.3334,	.3732,	.5927,	

Table 6.5.2 cont'd

Run title : Herring VIa South (run: SEPJM24/S24)

At 15-Mar-97 15:51:46

Traditional vpa Terminal populations from weighted Separable populations

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE							
0,	241002,	219262,	162359,	185761,	132212,	227312,	198977,
1,	44515,	88660,	80662,	59729,	68335,	48638,	83612,
2,	13923,	16368,	32565,	29616,	21600,	24943,	17465,
3,	15335,	7329,	11597,	21663,	18491,	13491,	14955,
4,	10414,	10214,	5366,	7646,	13475,	11442,	8785,
5,	3412,	8166,	8210,	4267,	5319,	7969,	7585,
6,	42992,	2718,	6550,	6371,	3156,	3121,	4962,
7,	2773,	35084,	2085,	4972,	4589,	2013,	1810,
8,	1307,	2226,	27893,	1484,	3627,	3119,	1262,
+gp,	1498,	2103,	2545,	38426,	10785,	10651,	5509,
TOTAL,	377171,	392129,	339833,	359935,	281589,	352699,	344922,

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
0,	355317,	345314,	180636,	224980,	231761,	740239,	299628,	348917,	265584,	968250,
1,	73152,	130714,	127029,	66452,	82765,	85260,	272319,	110227,	128360,	97703,
2,	29795,	26650,	47496,	46387,	24280,	30354,	31322,	100092,	40388,	46662,
3,	10464,	18274,	16302,	30906,	30938,	16083,	20934,	19474,	67181,	28623,
4,	8873,	7360,	12522,	11620,	19462,	21565,	11635,	12687,	13363,	48930,
5,	5433,	6399,	5397,	9435,	8129,	14624,	16833,	8126,	9784,	10879,
6,	4465,	3758,	4775,	3996,	6438,	6139,	11496,	12215,	6670,	7786,
7,	3068,	3098,	2892,	3522,	2880,	4616,	4784,	8663,	9833,	5309,
8,	1144,	2251,	2398,	2100,	2527,	2277,	3788,	3693,	7271,	8025,
+gp,	3491,	2057,	2217,	2578,	4824,	2015,	4837,	7393,	2078,	3148,
TOTAL,	495202,	545874,	401664,	401975,	414005,	923172,	677575,	631486,	550509,	1225314,

Run title : Herring VIa South (run: SEPJM24/S24)

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Traditional vpa Terminal populations from weighted Separable populations

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	GMST
AGE												
0,	143464,	198451,	233964,	134822,	116916,	173524,	190967,	46277,	10392,	11458,	0,	2197
1,	356199,	52778,	73006,	86070,	49598,	43011,	63836,	70253,	17024,	3823,	4213,	840
2,	35890,	130331,	19416,	26727,	31613,	18207,	15672,	23473,	25165,	6246,	1133,	299
3,	32248,	22815,	94055,	13791,	17664,	20476,	12161,	9854,	12612,	15699,	2563,	194
4,	21196,	19195,	14515,	69896,	9534,	11958,	12939,	7917,	5267,	7146,	6660,	132
5,	37970,	15240,	13477,	10651,	48825,	7448,	8274,	7731,	5562,	3002,	3521,	93
6,	8453,	24947,	11570,	10155,	7327,	34647,	5546,	5270,	4931,	3220,	1784,	73
7,	6286,	6204,	18236,	9044,	7275,	4930,	24394,	3733,	3475,	2938,	1466,	52
8,	4263,	4488,	4953,	14135,	6635,	5172,	3650,	15695,	2563,	2598,	1885,	37
+gp,	7140,	3552,	3570,	1952,	4493,	3964,	2861,	4993,	4243,	1349,	1782,	
TOTAL,	653109,	478001,	486762,	377243,	299879,	323336,	340300,	195196,	91233,	57481,	25008,	

Table 6.5.3

Run title : Herring VIa South (run: SEPJM24/S24)

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Table 17 Summary (with SOP correction)

Traditional vpa Terminal populations from weighted Separable populations

,	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 2- 6,
1970,	2410017,	269153,	165465,	20306,	.1227,	.8968,	.1845,
1971,	2192617,	292643,	153188,	15044,	.0982,	.8707,	.1120,
1972,	1623596,	303914,	162702,	23474,	.1443,	.8975,	.1565,
1973,	1857606,	370327,	221531,	36719,	.1658,	1.0161,	.2277,
1974,	1322122,	273555,	131369,	36589,	.2785,	.9762,	.3317,
1975,	2273120,	285496,	141895,	38764,	.2732,	1.1236,	.3140,
1976,	1989771,	272453,	104939,	32767,	.3122,	1.0469,	.3451,
1977,	3553168,	285871,	118320,	20567,	.1738,	1.0778,	.2203,
1978,	3453142,	345933,	118259,	19715,	.1667,	1.0161,	.1869,
1979,	1806360,	387436,	161633,	22608,	.1399,	1.0664,	.1713,
1980,	2249795,	319983,	169180,	30124,	.1781,	.9636,	.2269,
1981,	2317605,	353593,	182784,	24922,	.1363,	1.0312,	.1744,
1982,	7402393,	404522,	184195,	19209,	.1043,	1.0301,	.1266,
1983,	2996277,	597586,	187127,	32988,	.1763,	1.0042,	.2277,
1984,	3489174,	502562,	275997,	27450,	.0995,	.9688,	.1299,
1985,	2655842,	434421,	255023,	23343,	.0915,	.9846,	.1047,
1986,	9682492,	448013,	293002,	28785,	.0982,	1.0002,	.1179,
1987,	1434642,	656209,	250877,	48600,	.1937,	.9488,	.2462,
1988,	1984505,	504209,	365236,	29100,	.0797,	.9992,	.1842,
1989,	2339637,	430072,	272009,	29210,	.1074,	1.0010,	.1356,
1990,	1348223,	388981,	232896,	43969,	.1888,	1.0006,	.2099,
1991,	1169156,	299232,	195947,	37700,	.1924,	.9971,	.2021,
1992,	1735237,	238987,	153111,	31856,	.2081,	.9951,	.2153,
1993,	1909669,	253728,	132276,	36763,	.2779,	1.0060,	.2910,
1994,	462771,	225796,	115825,	33908,	.2928,	.9980,	.3334,
1995,	103922,	139711,	88082,	27792,	.3155,	1.0525,	.3732,
1996,	114583,	86217,	50059,	32534,	.6499,	.9955,	.5927,
Arith. Mean ,	2439905,	347059,	180849,	29808,	.1950		.2275,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Fig. 6.1.1 Herring: Landings from Division VIa(S) and VIIb for the period 1970 to 1996

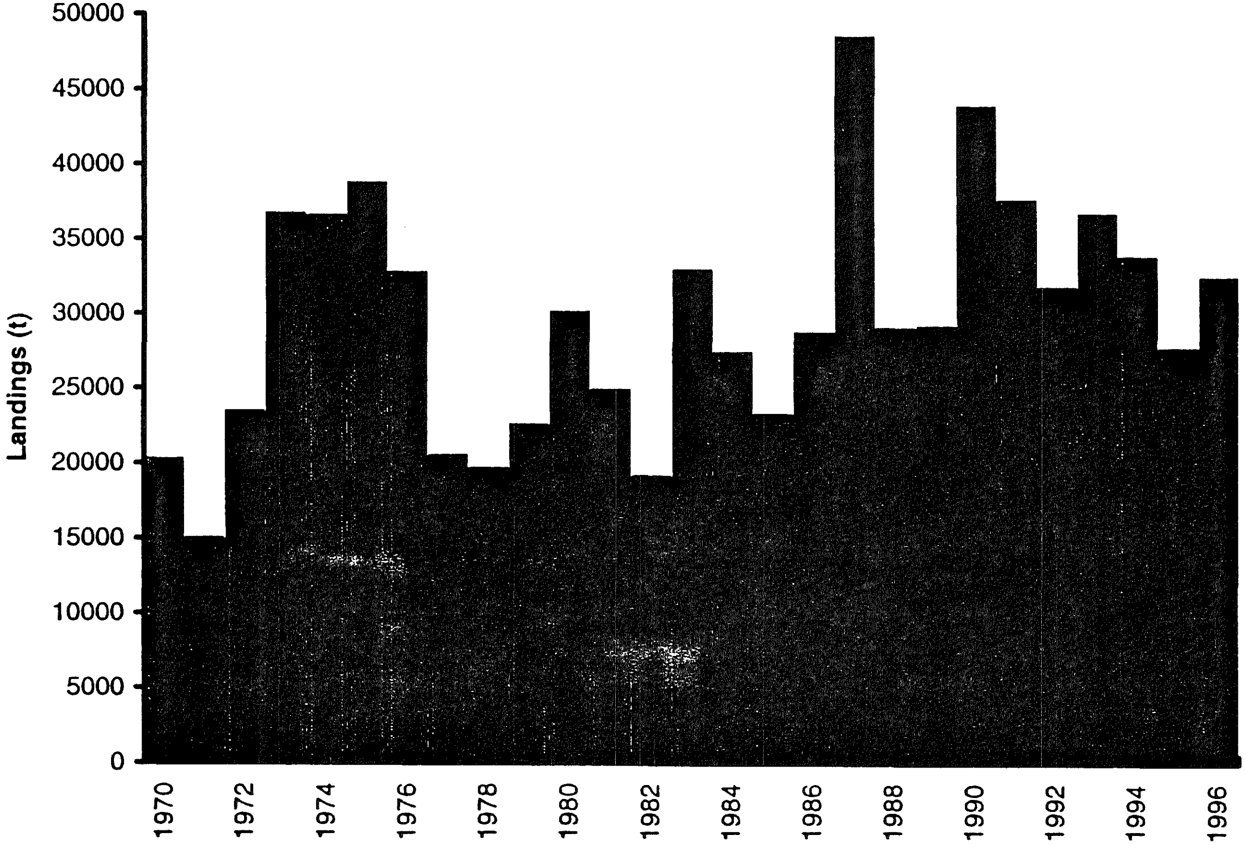

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Fig. 6.5.1 Division VIa(S) and VIIb SSB levels arising from different input levels of F for 1996

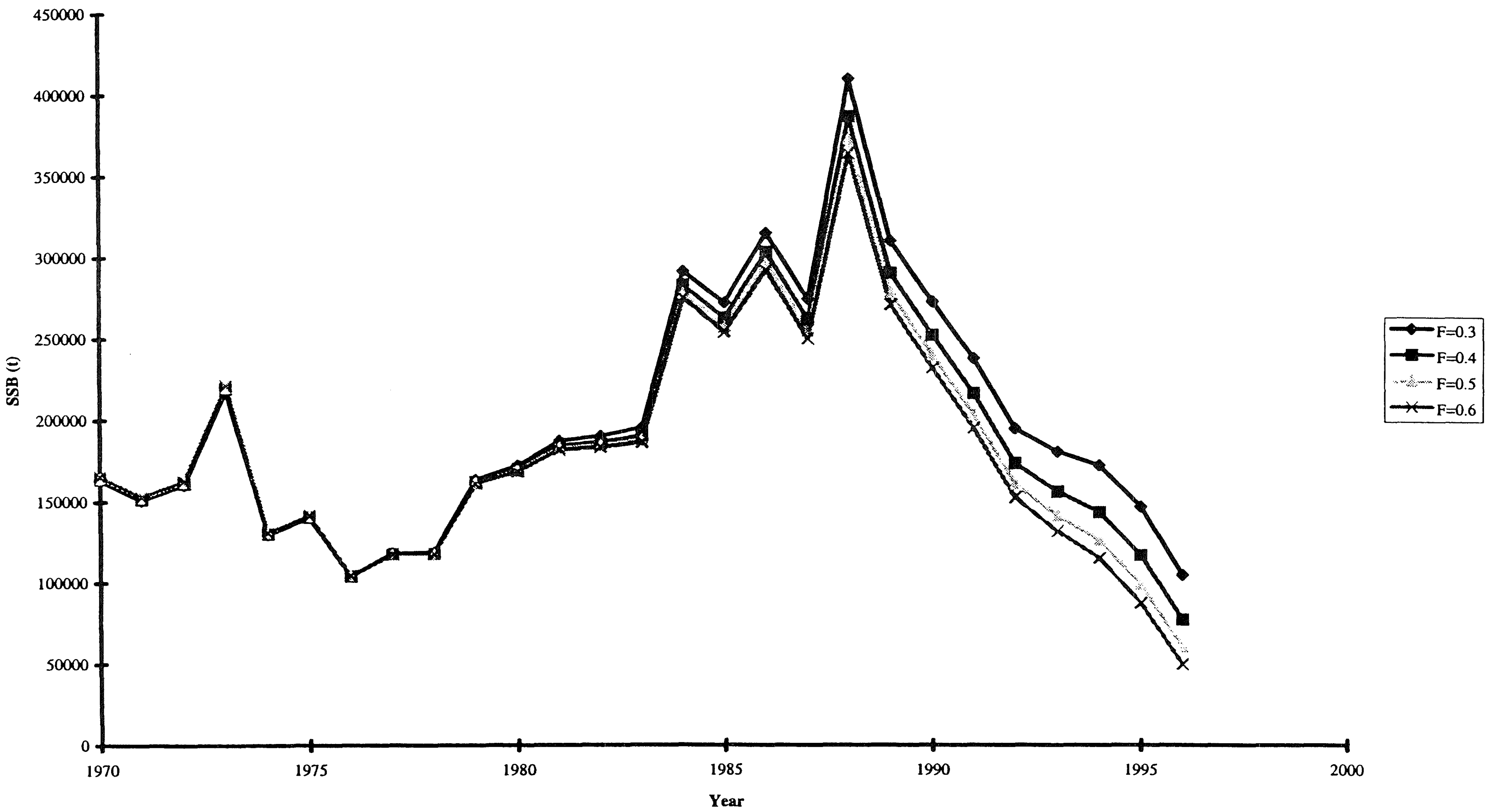
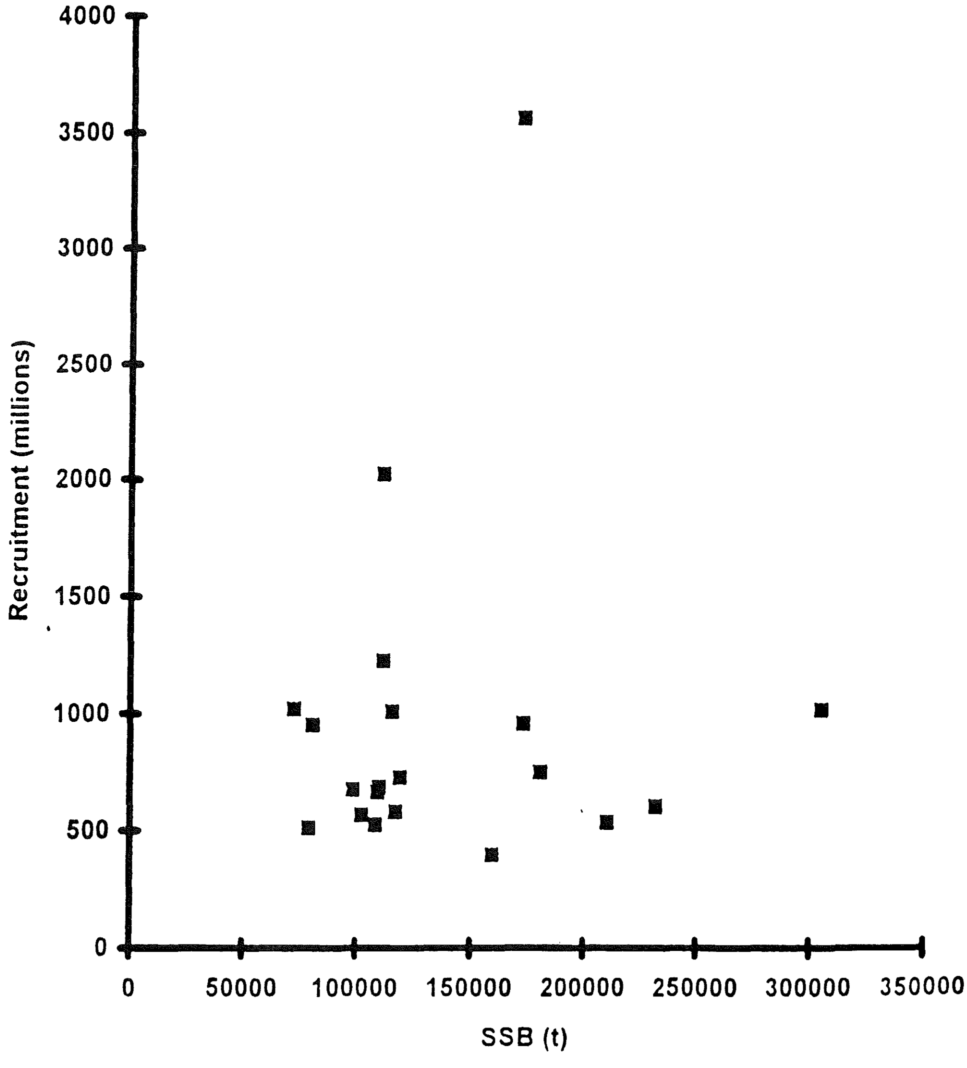


Fig. 6.8.1 Herring in VIa(S) + VIIb. Relationship between stock and recruitment for the years 1970 to 1989



7 IRISH SEA HERRING (DIVISION VIIA, NORTH)

7.1 The Fishery

7.1.1 Advice and management applicable to 1996 and 1997

In 1995 no analytical assessment of this stock was undertaken due to continued uncertainty about the fishing mortality and level of SSB. ACFM concluded that the present state of the stock was not known. Consequently the ACFM advice was that if a precautionary TAC is required for 1995 it should not exceed the recent catch levels of 5,000 t. A TAC of 7,000 t was subsequently adopted for 1996 and partitioned as 1,820 t to Ireland and 5,180 t to the UK.

In 1996 the UK fishery opened in the third week in June. The Irish fishery opened in the second week of August with one pair of vessels taking a small catch in September, and took no further participation in this fishery. Closed areas for herring fishing in the Irish Sea along the east coast of Ireland and within 12 nautical miles of the west coast of Britain were maintained throughout the year. The Mourne gillnet fishery, which has a derogation to fish within the Irish closed box, opened in September and closed in November. The area to the east of the Isle of Man (encompassing the Douglas Bank spawning ground) was closed from 21 September to 31 December.

In 1996 an analytical assessment was undertaken and ACFM concluded that the stock was within safe biological limits although the precision of the scientific assessment was comparatively low due to the short time series of catch-independent data. ACFM suggested that continued exploitation at 7,000 t would not be detrimental to the stock. A TAC of 9,000 t was adopted for 1997 and partitioned as 2,340 t to the Republic of Ireland and 6,660 t to the UK.

7.1.2 The fishery in 1996

The catches reported from each country, for the period 1983 to 1996 are given in Table 7.1.1 and from 1972 to 1996 in Figure 7.1.2. Again there has been no estimate of discarding or slipping. The total catch of 5,302t was again below the recommended TAC of 7,000 t. As in 1993 to 1995, this was mainly due to the Republic of Ireland not taking substantial quantities of herring from Division VIIa(N). In 1996, 59% of the total catch was taken in the 3rd quarter. There did not appear to be any landings from the Mourne gillnet fishery.

7.1.3 Quality of catch and biological data

There are still no estimates of discarding or slippage of herring in the Irish Sea fisheries. Landing statistics are assumed to be accurate.

Biological sampling in this fishery remains fairly high with approximately one sample per 100 t landed (Table 7.1.2). However, there were no samples taken in the 1st, 2nd and 4th quarters; this meant that 1,246t (approximately 24%) landed were not sampled and third quarter biological data needed to be applied to these catches.

7.1.4 Catch in number at age

Catches in numbers at age are given in Table 7.1.3 for the years 1972 to 1996. The predominant year class in 1996 was the 2-ringers (1993 year class). The 1992 year class, which was numerically the most abundant year class in the 1995 catches was still abundant in the 1996 catches. The 1990 year class was also still abundant. The catch in numbers at length is given in Table 7.1.4 for 1988 to 1996. Over this time period there has been a slight reduction of lengths of the predominant numbers of fish in the catches. The distribution of lengths in 1996 was similar to that in the preceding years with a low abundance of fish over 30cm compared with 1988 and 1989, during which the strong 1979 and 1980 year classes were abundant in the catches (see Table 7.1.3).

7.2 Mean length, weight, maturity and natural mortality at age

Mean lengths at age were calculated for the 3rd quarter using the Northern Ireland data and are given for the years 1985 to 1996 in Table 7.2.1. In general, mean lengths at age have remained fairly stable since 1988.

Mean weights at age in the stock are given in Table 7.2.2. Mean weights at age in 1996 were, in general, comparable to the mean weights in 1995. Mean weights at age in the third-quarter catches have been used as estimates of stock weights at spawning time.

The maturity ogive used in 1994 (ICES 1994/ Assess:13) was used again since there was no evidence to suggest a change: 0.08 for 1-ringers, 0.85 for 2-ringers and 1.00 for 3+-ringers.

As in previous years, natural mortality per year was assumed to be 1.0 on 1-ringers, 0.3 on 2-ringers, 0.2 on 3-ringers and 0.1 on all older age classes.

7.3 Research surveys

7.3.1 Acoustic surveys

The information on the time series of acoustic surveys in the Irish Sea is given in Table 7.3.1. No acoustic survey was undertaken on Douglas Bank in 1996 as a result of equipment failure and poor weather conditions.

An acoustic survey was undertaken over the whole northern Irish Sea (Division VIIa(N)) between 2 and 12 September 1996 by Northern Ireland as part of a time series that commenced in 1994. The survey is described in detail by Armstrong and Burns (WD 1997). The survey was carried out using a Simrad EK500 echosounder with a towed 38 kHz split-beam transducer. The survey was stratified to allow variable sampling intensity according to the expected distribution of herring. Targets were identified where possible by midwater trawling. The general spatial distribution of pelagic fish targets in 1996 was similar to that observed in 1994 and 1995, although more adult fish were found over the Douglas Bank spawning ground (Figure 7.3.1). Herring classified as 0 ringers were most abundant off the NW of the Isle of Man, the Solway Firth and the Irish coast. Herring classified as 1 ringers were scarce in the trawl catches. No fish aggregations were found in Liverpool Bay and off the North Wales coast.

In 1994 and 1995 the estimates of biomass were given as fish 1-ring and older. The biomass recorded was adjusted by a factor of 0.6 (the mean proportion of SSB to 1+ fish) to obtain an estimate of SSB. The estimates of biomass from 1994, 1995 and 1996 were re-analysed (Armstrong & Burns WD 1997) using age length keys and mean weight at age from fish sampled in each survey, to give a survey specific 1-ringer and older to SSB ratio (Table 7.3.1). As a result, the SSB estimates for 1994 and 1995 have been increased, and the large number of 1-ringers in the 1995 survey, compared to 1994 and 1996, taken into account.

A further acoustic survey (using a Simrad EK500 echosounder with a towed 120 kHz split-beam transducer) was carried out in the closed box along the English and Welsh coast in December 1996 (Armstrong WD 1997) to investigate the winter distribution of adult and juvenile herring.

7.3.2 Larvae surveys

Larvae surveys were undertaken by Northern Ireland (whole of Division VIIa(N)) and the Isle of Man (north-eastern Irish Sea). Due to poor weather, no survey took place on the Douglas Bank and both the north-eastern Irish Sea survey and the VIIa (N) survey were much reduced. The north-eastern Irish Sea survey (the 4th in the series) was undertaken on the 26 November 1996 (see Nash & Hughes WD 1997). The numbers of larvae at 6mm length and the estimated larval production were the lowest on record (Table 7.3.2). The distribution of spawning dates, back-calculated from the length at capture, suggested that the majority of the larvae were spawned between 22-30 October 1996.

The 4th Northern Irish larvae survey of Division VIIa(N) was undertaken between 17 and 20 November 1996 (Dickey-Collas WD 1997). The poor weather resulted in only 7 stations being sampled in the western Irish Sea. As in 1995, no Mourne larvae were caught. Manx larvae were distributed across the north east of the Irish Sea, in a similar pattern to other years. Using the larval lengths, spawning was estimated to be in the last 3 weeks of October, a similar estimate to the north-eastern Irish Sea survey. The estimate of total larval production in 1996 (3.9×10^{11}) was much lower than in previous years (Table 7.3.2). Both the Douglas Bank larval survey and the Division VIIa(N) survey show similar interannual variations in estimated larval production (Table 7.3.2).

7.3.3 Groundfish surveys of Area VIIa(N).

Groundfish surveys, carried out by Northern Ireland since 1991 in the western Irish Sea, were used by the 1996 Herring Assessment Working Group to obtain indices for 0 group and 1-ringer herring in the Irish Sea. They indicated a strong 1992 year class. These data have since been re-analysed to cover the whole Irish Sea (Figure 7.3.2) and combined with new 1996 data (Burns & Armstrong WD 1997). The strong 1992 year class is still evident although the large 1990 year class found in the catch at age data is not apparent (Table 7.4.1).

7.4 Data exploration and preliminary modelling

In 1996 an analytical assessment of this stock was undertaken. Western Irish Sea groundfish indices for 1-ringers, acoustic estimates of SSB and Douglas Bank larvae indices of SSB were used as tuning files. This year all the groundfish indices were reworked to reflect the whole Irish Sea (see section 7.3.3) rather than just the western Irish Sea and the acoustic estimates were corrected to reflect the true estimates of SSB (see section 7.3.1). This year, the survey indices were used to initiate an analytical assessment using an integrated catch-at-age analysis (ICA) including a separable constraint (Deriso *et al.* 1985). The Integrated Catch Analysis (ICA) (see section 1.5) was used. The following short survey series were available for inclusion in an assessment using the ICA package:

1. Larval production estimates from Douglas Bank surveys to provide an SSB index: 1989 - 1995 (**DBL**)
2. Larval production estimates from Douglas Bank surveys to provide a recruitment index: 1989 - 1995 (**LPER1**)
3. Age-aggregated acoustic estimates of Manx herring spawning aggregations in 1989, 1990 and 1994 (**AC_DB**)
4. Age-aggregated acoustic estimates for the SSB of herring in Division VIIa(N) in September 1994 - 1996 (**AC_VIIa(N)**)
5. Age-disaggregated acoustic estimates for the SSB of herring in Division VIIa(N) in September 1994 - 1996 (**ACAGE**)
6. Irish Sea groundfish survey indices of 0-ring herring in September 1991 - 1996 (**GFS0S**)
7. Irish Sea groundfish survey indices of 1-ring herring in March 1992 - 1996 (**GFS1M**)
8. Irish Sea groundfish survey indices of 1-ring herring in June 1991 - 1994 (**GFS1J**)
9. Irish Sea groundfish survey indices of 1-ring herring in September 1991 - 1996 (**GFS1S**)

The different indices are given in Tables 7.4.1 and 7.4.2. As in this stock 1-ringers are used as the youngest age class the data for O-ringers in the September groundfish surveys (Table 7.4.1) have been assigned to the year that they will be used as a 1-ringer index. Although individual CVs of the GFS series were comparatively high, similar overall trends were apparent in the four series, with the 1992 year class being strongest in each series. Larval production on the Douglas Bank was also high in 1992. In 1996 it was decided to treat this series as SSB indices in accordance with practices for other herring stocks, however, this year they were also examined as recruitment indices.

The ICA model was fitted using each series in turn (the acoustic survey data were analysed together (SSBA) because of the shortness of the AC_DB and AC_VIIa(N) series). The following input values were used:

- Separable constraint over last 6 years (weighting = 1.0 for each year)
- Reference age = 4
- Constant selection pattern model
- Selectivity on oldest age = 1.0
- First age for calculation of reference age = 2
- Last age for calculation of reference age = 6
- Weighting on 1-ringers = 0.1; all other age classes = 1.0
- Weighting for all years = 1.0
- All indices treated as linear
- No S/R relationship fitted
- Lowest and highest feasible F = 0.05 and 1.0
- All survey weights fitted by hand i.e. 1.0
- Correlated errors assumed i.e. = 1.0
- No shrinkage applied

It was again decided not to treat the Division VIIa(N) acoustic survey estimates as absolute because of discrepancies between acoustic estimates and tuned SSB estimates seen in other stocks. No solution could be found using series GFS1M, GFS1J and GFS1S. There was a solution with the GFS0S series but this gave an unacceptably high reference F (15.46) and was not used. The failure of the GFS data to provide good indices could be because they only provide 1 ringer indices and it is known that Celtic Sea juveniles do occur in Division VIIa(N). Estimates of F(96) for the reference age class 4 from the other tuning series are shown in Figure 7.4.1 together with $\pm$ 1 SD intervals. Mean values ranged from <0.1 to 0.30. Precision was generally poor. In an attempt to explore the performance of these tuning indices the LPER1 was combined with ACAGE and LPER1 with SSBA. Both are also given in Figure 7.4.1. In view of the limited data available and the variability in perceptions of reference F it was decided to only present the ranges in F over the time series and variability in perceived SSB for this range of terminal Fs.

7.5 Stock assessment

The variation in F(2-6) generated from using the various tuning indices is given in Figure 7.5.1. It is obvious that the Douglas Bank larvae survey (DBL) presents questionably low levels of fishing mortality. All other tuning indices show variation in fishing mortality after 1985 with a generally slow decrease over the years. This is consistent with the reported landings remaining relatively stable at approximately 5,000 t from 1991 to the present.

The consequences of these variations in fishing mortality on SSB are shown in Figure 7.5.2. The range in SSB for 1996, from the tuning indices (excluding DBL(SSB)), is between 11,000 and 44,000 t. The lowest estimate came from using the acoustic data as age disaggregated indices, primarily for age structure in the population. The highest estimate came from using the acoustic series as SSB indices.

The assessment in 1996 suggested an SSB in 1995 of 38,000 t, which is not dissimilar to the estimate of SSB for 1995 this year (approximately 33,000 t) from the acoustic SSB tuning indices (SSBA). However, three of the tuning series used in 1996 were not used this year (GFS1M, GFS1S and DBL) and one was converted from SSB indices to recruitment indices (LPER1). Unfortunately, there is no objective way to determine which tuning series or combination of tuning series will provide the most likely SSB in the current year since in most cases the series are short and in many cases they are noisy.

Therefore, the Working Group decided not to undertake an analytical assessment of herring in Division VIIa(N) this year.

7.6 Stock and Catch Projection

No short-term predictions were undertaken for this stock due to the uncertainty of the size of the SSB. The Working Group noted that the TAC for 1997 has been raised from 7,000 to 9,000 t. In the recent past the Irish fleet has not taken substantial catches from Division VIIa(N) but the UK has recorded landings close to its quota. There is no reason to suspect this will not happen in 1997 with the increased quota. Therefore, it is anticipated that landings in 1997 will increase from approximately 5,000 to at least 6,500 t. The consequences of this on levels of SSB are, at present, unknown.

7.7 MBAL, limit and target reference points

In 1996 (ICES 1996/Assess: 10) an attempt was made to estimate MBAL for this stock. The conclusion was that 20,000 t was a sensible level for this stock. However, the Working Group stated that further analyses should be done to verify a reasonable level for MBAL. In light of the present analyses the level of MBAL will need to be re-examined once the level of SSB in VIIa(N) has been determined with an appropriate degree of certainty.

In regard to F_{lim} and target Fs, again due to uncertainties in an assessment of this stock neither can be calculated with any precision.

7.8 Medium-term predictions of stock size

Due to uncertainties in present fishing mortalities and SSB, medium-term predictions were not undertaken.

7.9 Management considerations

7.9.1 Precision of the assessment

The current time-series of survey data are very short and, as seen here, prone to providing variable perceptions of stock development. Assessments will be possible with longer time-series of abundance indices, especially from acoustic and larvae surveys which are now established in the area.

All indices show an increase in SSB from 1994 to the present, the degree of increase is uncertain. The perceived increase in SSB is primarily due to three relatively strong year classes (1990, 1992 and 1994) within the population. Therefore, maintaining the present catch level, in the short-term, of approximately 5,000 t should not be detrimental to the stock. The consequences of catches above 5,000 t on SSB are at present unknown.

7.9.2 Spawning and Juvenile Fishing Area Closures

The present arrangement of closed boxes in Division VIIa(N) are discussed in detail in ICES (1996/Assess: 10). The closed areas consist of: all year juvenile closures along the east coast of Ireland, and the west coast of Scotland, England and Wales; spawning closures along the east coast of the Isle of Man, and along the east coast of Ireland.

In view of the uncertainties in the size of the stock in Division VIIa(N) the Working Group recommends that any alterations to the present closures are considered carefully, in the context of this report, to ensure protection for all components of this stock.

Table 7.1.1. Irish Sea HERRING (Division VIIa(N)). Catch in tonnes by country, 1982-1995. These figures do not in all cases correspond to the official statistics and cannot be used for mangement purposes.

Country	1983	1984	1985	1986	1987	1988	1989
France	48	-	-	-	-	-	-
Ireland	860	1,084	1,000	1,640	1,200	2,579	1,430
UK	3,025	2,982	4,077	4,376	3,290	7,593	3,532
Unallocated	-	-	4,110	1,424	1,333	-	-
Total	3,933	4,066	9,187	7,440	5,823	10,172	4,962

Country	1990	1991	1992	1993	1994	1995	1996
France	-	-	-	-	-	-	-
Ireland	1,699	80	406	0	0	0	100
UK	4,613	4,318	4,864	4,408	4,828	5,076	5,180
Unallocated	-	-	-	-	-	-	22
Total	6,312	4,398	5,270	4,408	4,828	5,076	5,302

Table 7.1.2 Irish Sea HERRING. Sampling intensity of commercial landings for Division VIIa (N) in 1996.

Quarter	Country	Landings (t)	No. samples	No. fish measured	No. fish aged	Estimation of discards
	Ireland	0	-	-	-	-
	UK (N. Ireland)	+	0	0	0	No
1	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
	Ireland	0	-	-	-	-
	UK (N. Ireland)	+	0	0	0	No
2	UK (Isle of Man)	24	0	0	0	No
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-
	Ireland	100	1	537	55	No
	UK (N. Ireland)	3113	45	4813	1050	No
3	UK (Isle of Man)	513	5	997	228	No
	UK (Scotland)	82	0	0	0	No
	UK (England & Wales)	247	0	0	0	No
	Ireland	0	-	-	-	-
	UK (N. Ireland)	1222	0	0	0	No
4	UK (Isle of Man)	0	-	-	-	-
	UK (Scotland)	0	-	-	-	-
	UK (England & Wales)	0	-	-	-	-

+ < 1t

Table 7.1.3 Herring in the North Irish Sea (Manx plus Mourne VIIa(N)). Catch in numbers (thousands) by year.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1972	40640	46660	26950	13180	13750	6760	2660	1670
1973	42150	32740	38240	11490	6920	5070	2590	2600
1974	43250	109550	39750	24510	10650	4990	5150	1630
1975	33330	48240	39410	10840	7870	4210	2090	1640
1976	34740	56160	20780	15220	4580	2810	2420	1270
1977	30280	39040	22690	6750	4520	1460	910	1120
1978	15540	36950	13410	6780	1740	1340	670	350
1979	11770	38270	23490	4250	2200	1050	400	290
1980	5840	25760	19510	8520	1980	910	360	230
1981	5050	15790	3200	2790	2300	330	290	240
1982	5100	16030	5670	2150	330	1110	140	380
1983	1305	12162	5598	2820	445	484	255	59
1984	1168	8424	7237	3841	2221	380	229	479
1985	2429	10050	17336	13287	7206	2651	667	724
1986	4491	15266	7462	8550	4528	3198	1464	877
1987	2225	12981	6146	2998	4180	2777	2328	1671
1988	2607	21250	13343	7159	4610	5084	3232	4213
1989	1156	6385	12039	4708	1876	1255	1559	1956
1990	2313	12835	5726	9697	3598	1661	1042	1615
1991	1999	9754	6743	2833	5068	1493	719	815
1992	12145	6885	6744	6690	3256	5122	1036	392
1993	646	14636	3008	3017	2903	1606	2181	848
1994	1970	7002	12165	1826	2566	2104	1278	1991
1995	3204	21330	3391	5269	1199	1154	926	1452
1996	5335	17529	9761	1160	3603	780	961	1364

Table 7.1.4 HERRING in Division VIIa (North). Catch at length for 1988-1996. Numbers of fish in thousands

Length	1988	1989	1990	1991	1992	1993	1994	1995	1996
14	1								
	1								
15	1				95				
	10				169				
16	13		6		343			21	21
	16		6	2	275			55	51
17	29		50	1	779		84	139	127
	44	24	7	4	1,106		59	148	200
18	46	44	224	31	1,263		69	300	173
	85	43	165	56	1,662		89	280	415
19	247	116	656	168	1,767	39	226	310	554
	306	214	318	174	1,189	75	241	305	652
20	385	226	791	454	1,268	75	253	326	749
	265	244	472	341	705	57	270	404	867
21	482	320	735	469	705	130	400	468	8[illegible]
	530	401	447	296	597	263	308	782	1,25[illegible]
22	763	453	935	438	664	610	700	1,509	1,530
	1,205	497	581	782	927	1,224	785	2,541	2,190
23	2,101	612	2,400	1,790	1,653	2,016	1,035	4,198	2,362
	3,573	814	1,908	1,974	1,156	2,368	1,473	4,547	2,917
24	5,046	1,183	3,474	2,842	1,575	2,895	2,126	4,416	3,649
	5,447	1,656	2,818	2,311	2,412	2,616	2,564	3,391	4,077
25	5,276	2,206	4,803	2,734	2,792	2,207	3,315	3,100	4,015
	4,634	2,720	3,688	2,596	3,268	2,198	3,382	2,358	3,668
26	4,082	3,555	4,845	3,278	3,865	2,216	3,480	2,334	2,480
	4,570	3,293	3,015	2,862	3,908	2,176	2,617	1,807	2,177
27	4,689	2,847	3,014	2,412	3,389	2,299	2,391	1,622	1,949
	4,124	2,018	1,134	1,449	2,203	2,047	1,777	990	1,267
28	3,406	1,947	993	922	1,440	1,538	1,294	834	906
	2,916	1,586	582	423	569	944	900	123	564
29	2,659	1,268	302	293	278	473	417	248	210
	1,740	997	144	129	96	160	165	56	79
30	1,335	801	146	82	70	83	9	40	32
	685	557	57	36	36	15	27	5	[illegible]
31	563	238	54	12	2	4		1	
	144	128	31	3					
32	80	57	29						
	7	7							
33	2	5							
	1	6							
34		0							
		5							

Table 7.2.1 HERRING in Division VIIa (North). Mean length at age.

Year	Lengths at age (cm)							
	Age (rings)							
	1	2	3	4	5	6	7	8
1985	22.1	24.3	26.1	27.6	28.3	28.6	29.5	30.1
1986	19.7	24.3	25.8	26.9	28.0	28.8	28.8	29.8
1987	20.0	24.1	26.3	27.3	28.0	29.2	29.4	30.1
1988	20.2	23.5	25.7	26.3	27.2	27.7	28.7	29.6
1989	20.9	23.8	25.8	26.8	27.8	28.2	28.0	29.5
1990	20.1	24.2	25.6	26.2	27.7	28.3	28.3	29.0
1991	20.5	23.8	25.4	26.1	26.8	27.3	27.7	28.7
1992	19.0	23.7	25.3	26.2	26.7	27.2	27.9	29.4
1993	21.6	24.1	25.9	26.7	27.2	27.6	28.0	28.7
1994	20.1	23.9	25.5	26.5	27.0	27.4	27.9	28.4
1995	20.4	23.6	25.2	26.3	26.8	27.0	27.6	28.3
1996	19.8	23.5	25.3	26.0	26.6	27.6	27.6	28.2

Table 7.2.2 HERRING in Division VIIa (North). Mean weights at age.

Year	Weights at age (g)							
	Age (rings)							
	1	2	3	4	5	6	7	8
1985	87	125	157	186	202	209	222	258
1986	68	143	167	188	215	229	239	254
1987	58	130	160	175	194	210	218	229
1988	70	124	160	170	180	198	212	232
1989	81	128	155	174	184	195	205	218
1990	77	135	163	175	188	196	207	217
1991	70	121	153	167	180	189	195	214
1992	61	111	136	151	159	171	179	191
1993	88	126	157	171	183	191	198	214
1994	73	126	154	174	181	190	203	214
1995	72	120	147	168	180	185	197	212
1996	67	116	148	162	177	199	200	214

Table 7.3.1 Herring: Summary of acoustic survey information for Division VIIa(N) for the period 1989-1996. Small clupeoids include sprat and 0-ring herring unless otherwise stated. CVs are approximate. Biomass in t. All surveys carried out at 38kHz except December 1996, which was at 120kHz.

Year	Area	Dates	herring biomass (1+ years)	CV	herring biomass SSB	CV	small clupeoids biomass	CV
1989	Douglas Bank	25-26 Sept			18000	-	-	-
1990	Douglas Bank	26-27 Sept			26600	-	-	-
1991	Western Irish Sea	26 July - 8 Aug	12760	0.23			66000[1]	0.20
1992	Western Irish Sea + IOM east coast	20 - 31 July	17490	0.19			43200	0.25
1994	Area VIIa(N)	28 Aug - 8 Sep	31400	0.36	26190	-	68600	0.10
	Douglas Bank	22-26 Sept			28200	-	-	-
1995	Area VIIa(N)	11-22 Sept	53200	0.32	34040	-	344700	0.13
	Douglas Bank	10-11 Oct		-	9840	-	-	-
	Douglas Bank	23-24 Oct			1750	0.51	-	-
1996	Area VIIa(N)	2-12 Sept	24500	0.24	23390	0.25	49120	0.13
	Eastern Irish Sea (closed box)	9-12 Dec	12800	0.49	11880	0.49	6810	0.13

[1] sprat only

Table 7.3.2 Irish Sea HERRING larval production (10^{11}) indices for the Manx component of Division VIIa(N)

Year	Douglas Bank	North east of the Isle of Man	
		Northern Ireland	Isle of Man
1989	3.39		
1990	1.92		
1991	1.56		
1992	15.64		128.86
1993	4.81	34.7	1.10
1994	7.30	52.5	12.50
1995	1.58	15.4	-[1]
1996	-[1]	3.9	0.30

[1]No assessment

Table 7.4.1 Tuning indices used for the Irish Sea (VIIa(N)) herring assessment. Values and approximate CVs are given. na = not available. GFS0S = Groundfish survey, 0-ring herring, September; GFS1J = Groundfish survey, 1-ring herring, June; GFS1M = Groundfish survey, 1-ring herring, March; GFS1S = Groundfish survey, 1-ring herring, September; SSBA = Spawning stock biomass by acoustic techniques (AC_DB = Douglas Bank acoustic surveys covering only the spawning stock, AC_VIIa(N) = Irish Sea acoustic surveys covering 2+ ringers); DBL = larvae production on Douglas Bank.

Year	GFS0S[1]	GFS1J[1]	GFS1M[1]	GFS1S[1]	SSBA		DBL[4]
					AC_DB[2]	AC_VIIa(N)[3]	
1989					18000 (na)	-	3.39 (0.49)
1990					26000 (na)	-	1.92 (0.24)
1991					-	-	1.56 (0.22)
1992		154 (0.35)	190 (0.41)	21 (0.38)	-	-	15.64 (0.55)
1993	177 (0.38)	170 (0.38)	681 (0.32)	44 (0.52)	-	-	4.81 (0.18)
1994	412 (0.38)	397 (0.40)	923 (0.69)	176 (0.27)	28200 (na)	26190 (na)	7.30 (0.58)
1995	194 (0.28)	-	480 (0.49)	55 (0.38)	-	34040 (na)	1.58 (0.42)
1996	37 (na)	-	487 (0.47)	11 (0.45)	-	23390 (0.25)	-
1997	117 (0.43)						

1. Numbers per 3 nautical miles, northern Irish Sea only
2. Biomass of spawning aggregation, t
3. Biomass of SSB, t.
4. Numbers of larvae at 6mm x 10^{-11}

Table 7.4.2 Age structure of herring in Division VIIa(N) from the Northern Ireland Acoustic surveys in September.

Age (rings)	1994	1995	1996
1	66830	313869	11340
2	68290	133802	42372
3	73529	21637	67473
4	11860	54804	8954
5	9299	8551	26469
6	7550	6588	4171
7	3867	9174	5911
8+	10118	12716	5815

Fig. 7.1.2 Herring in Division VIIa(N); Landings (t)

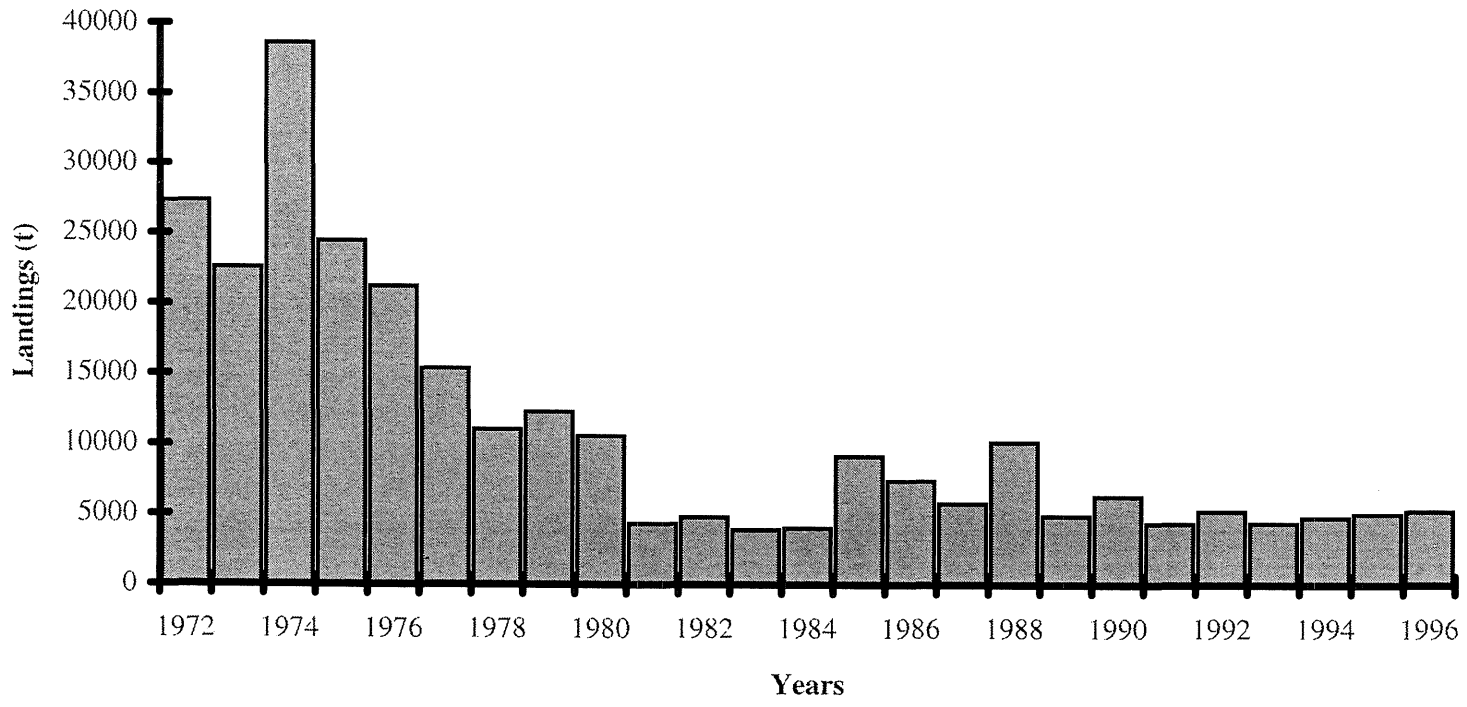


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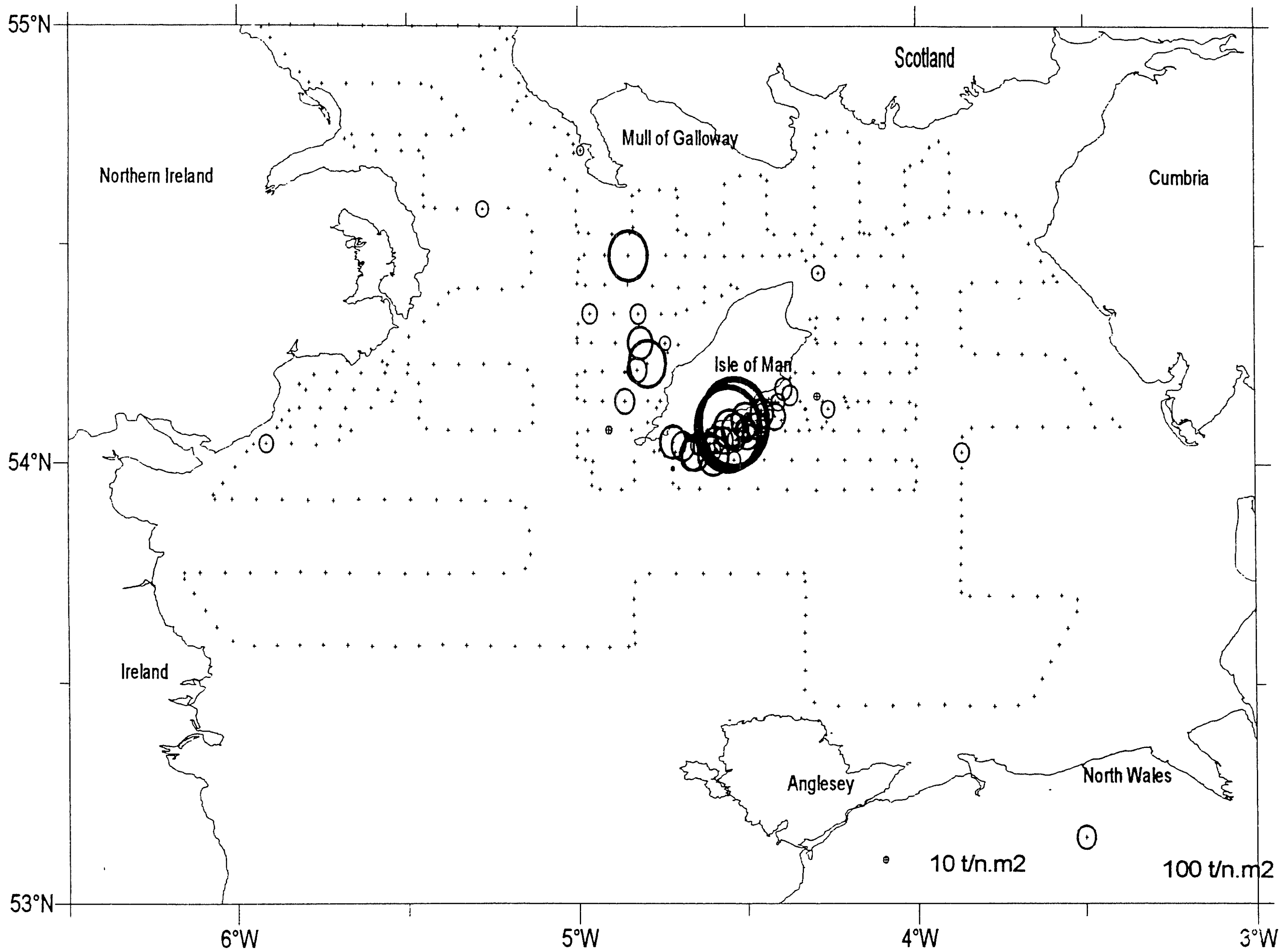
Fig. 7.3.1 Distribution of targets considered to be herring of 2-rings and older during the DANI acoustic survey in September 1997.



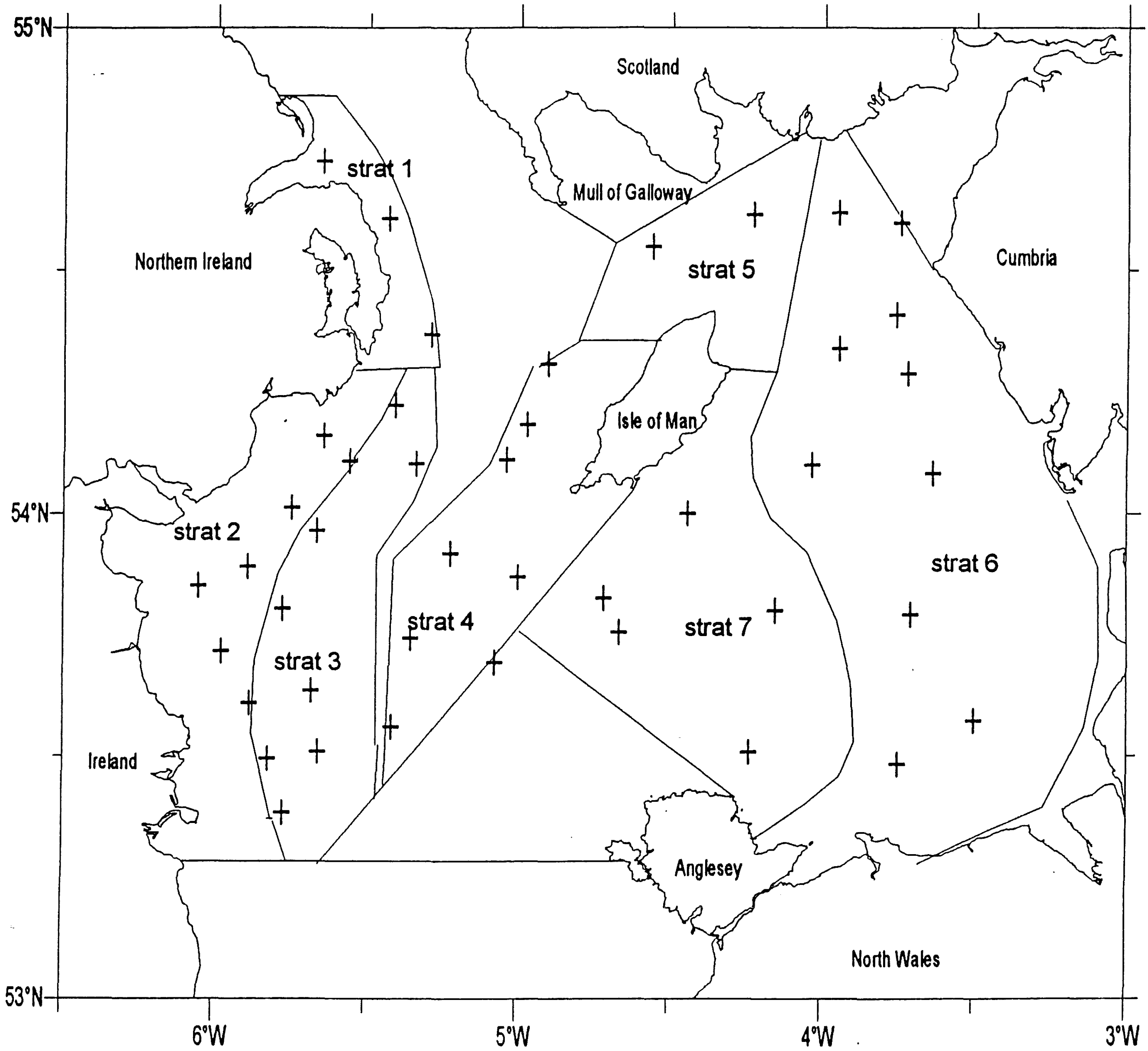


Fig. 7.3.2 Trawl survey stations and survey strata for RV Lough Foyle groundfish surveys of the Irish Sea: 1992-1996.

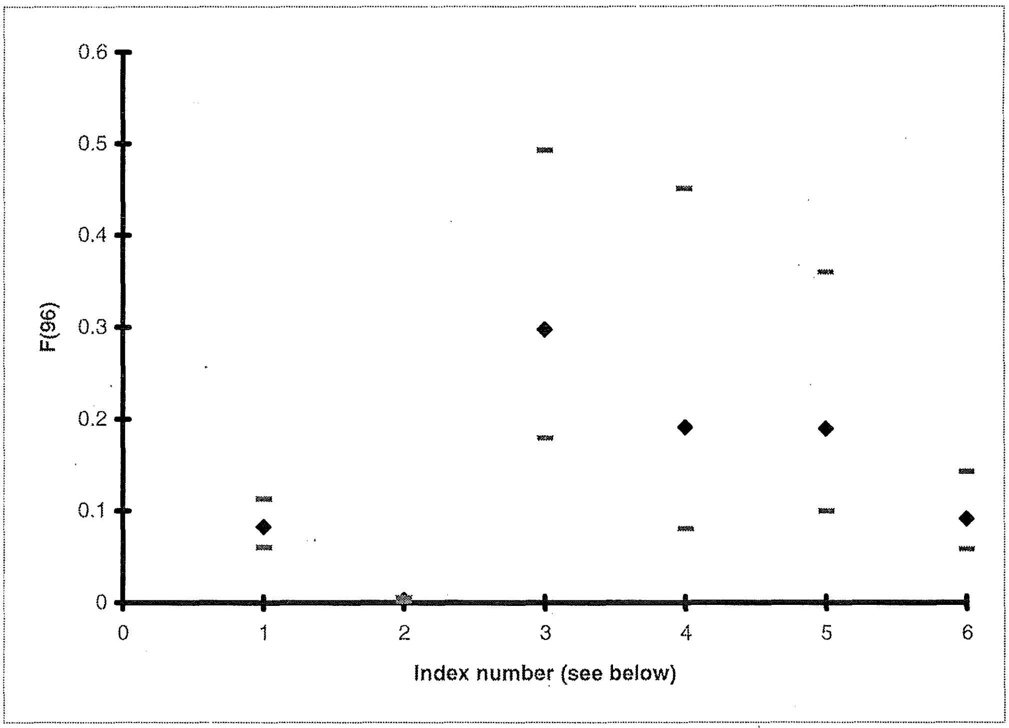


Figure 7.4.1 Estimates of reference F in 1996 with 1 SD error bars from separate fits of ICA model to the six tuning sets for Irish Sea herring.

	F(96)
1. AC_(SSB)	0.083
2. DBL (SSB)	0.003
3. ACAGE	0.298
4. LPER1	0.191
5. ACAGE+LPER1	0.190
6. AC_(SSB)+LPER1	0.091

Fig. 7.5.1 Variation in mean F(2-6) for Division VIIa(N) herring depending on the tuning indices used in ICA

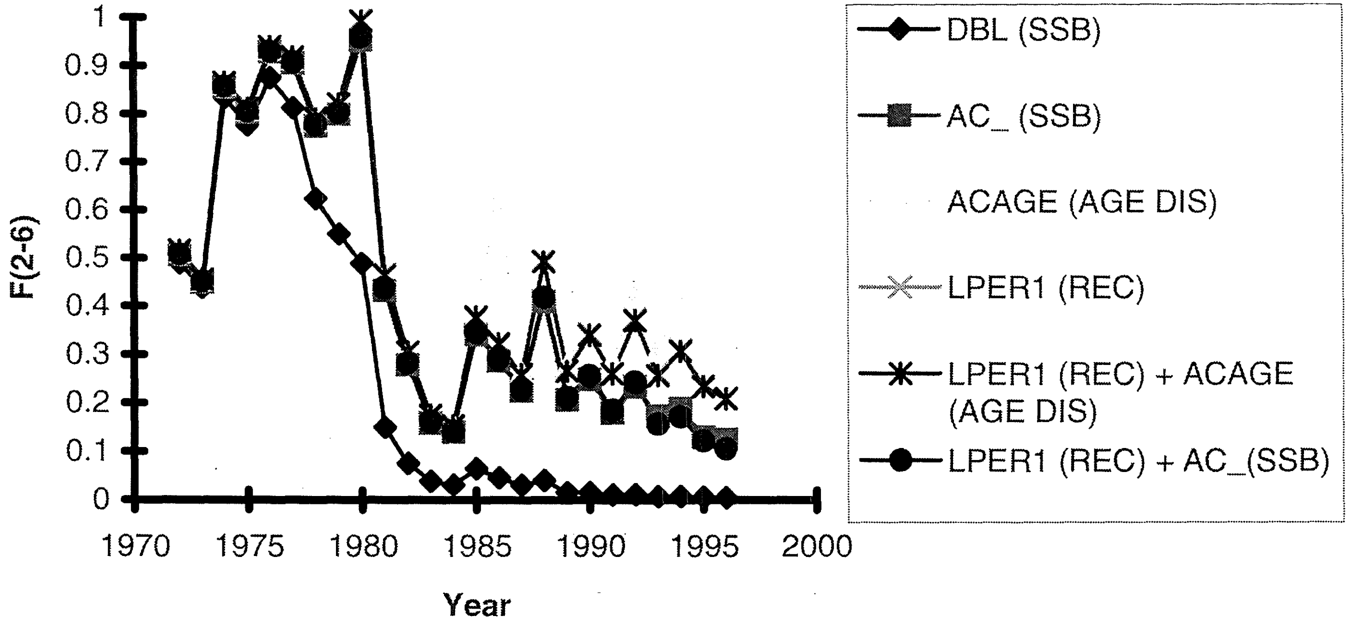


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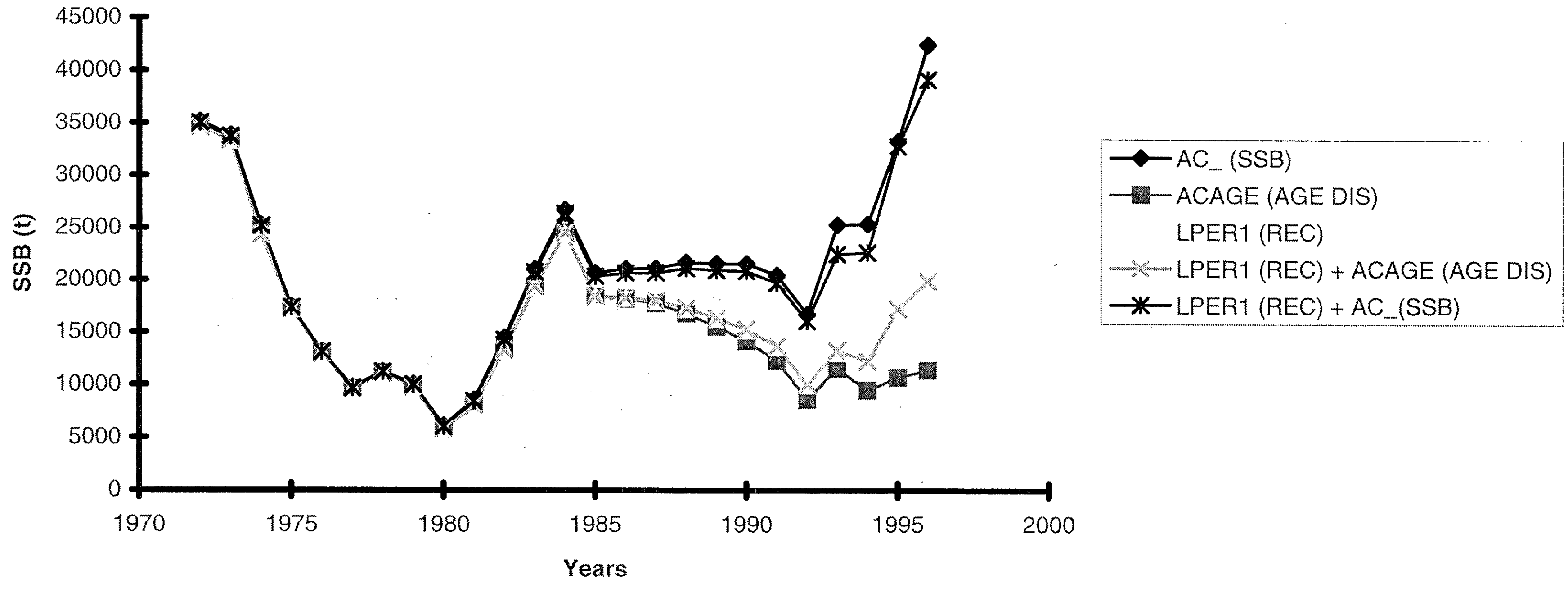
Fig. 7.5.2 Variation of SSB in Division VIIa(N) herring depending on tuning indices used in the ICA.



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8 SPRAT IN THE NORTH SEA

8.1 The Fishery

8.1.1 ACFM advice applicable for 1996 and 1997

No ACFM advice on sprat TAC has been given in recent years. The TAC set by the management bodies was 175,000 t for 1995 [Subarea IV(EU zone) + Division IIa (EU zone)] and 200,000 t for 1996. The agreed TAC for 1997 is 150,000 t

8.1.2 Catches in 1996

Landing statistics for sprat for the North Sea by area and country are presented in Table 8.1.1 for 1983-1996. As in previous years, sprat from the fjords of western Norway were not included in the landings for the North Sea. Landings from the fjords are presented separately because the uncertainty concerning their stock identity. Norwegian catches in the western fjords for 1983-1996, are presented in Table 8.1.2.

The monthly and annual distributions of catches by rectangle for Sub-area IV are shown in Figures 8.1.1-8.1.13. The catches reported in the rectangles 41F3-42F4 are unuasual and may be misreportings from other rectangles in Division IVb.

Landing figures for Denmark, Sweden, Norway and UK indicate that 136,600 t sprat were harvested from the North Sea in 1996, which was a decline in landings of about 60 % compared with 1995. Nearly 60% of the landings were taken in January. After considerable increases in landings from about 10,000 t in 1986 to a peak of 320,600 t in 1995, the Danish landings decreased to 81,000 t in 1996. During the last years, 60-70% of the Danish sprat landings have been reported from the third quarter. To reduce the herring by-catches in the small-meshed fishery, Denmark banned sprat fishing from 1 July to 15 August. In 1996 the Danish landings in third quarter made up for less than 10% of their landings. The Norwegian landings were 53,000 t, the highest recorded for the period. UK catches continued to be at a very low level. Catches by Norway in the western fjords were at the same level as in 1995 with 3,300 t.

Landings by area and quarter are shown in Table 8.1.3. Again, most of the landings were reported from Division IVb, predominantly Division IVbE. In 1996 landings from this division were mainly from the first (January) and fourth quarter (October-December).

8.1.3 Fleets

The sprat is mainly taken in a directed sprat purse seine fishery and in the fleet B fishery as defined in the North Sea herring assessment (see Section 2.10 and Section 2.15 *ad* 1.3 a).

8.2 Catch Composition

8.2.1 Catches in number

Uncertainties in the reliability and/or absence of quarterly aged samples have prevented the IFWG and later the HAWG, from running a VPA since 1984. A historical perspective of the problems associated with estimates of catch in numbers at age by previous groups up to 1992, is described in the report of the Herring Working Group for 1993 (ICES 1993/Assess:15).

The estimated quarterly catch-at-age in numbers is presented in Table 8.2.1. Age composition data for commercial landings for 1996 were provided by Denmark and Norway. There is a difference in age composition in the Danish and the Norwegian landings in the first quarter. This might be a result of the different gears used in the two fisheries with the Danish using bottom trawl and the Norwegian purse seiners.

8.2.2 Mean Weight at age

The mean weights (g) at age in catches taken in 1994 - 1996 are presented by quarter in Table 8.2.2. Weights were estimated from Danish and Norwegian commercial data as provided by Working Group members.

8.2.3 Quality of catch and biological data

The sampling intensity for biological samples,i.e age and weight at age, is given in Table 8.2.3. The number of samples has improved but is still below the recommended level.

The sampling of Danish landings for industrial purposes continued with the intensity and coverage largely unchanged compared to the previous years. From the Danish landings 32 samples were used to estimate age composition and weight at age of sprat and 36 samples from the Norwegian landings. No sprat were reported in the landings from the Norwegian small meshed fishery targeted at sandeel and Norway pout. Sampling intensity for species compositions is presented in Section 2.15.

8.3 Recruitment

8.3.1 Abundance

The IBTS(February) sprat indices, no per hour, are used as an index of abundance. The historical data were revised by the Working Group in 1995 (ICES 1995/Asses:13). The IBTS-indices are presented in Table 8.3.1 for age groups 1-4, 5+ and total, along with the number of rectangles sampled and the number of hauls considered.

Table 8.3.1 indicates an increase in the 1-group index, but the index is still below the average of 1-group index 1981-1996. It also indicates a strong decrease in the 3- group. The 1993-year class which was observed to be strong as 3-group in 1996, were in 1997 at a level normal for the 4-group. The total 1997-abundance index increased from 1996 but was below the values for 1992-1995.

The IBTS data are provided by rectangle in Figure 8.3.1 for age groups 1, 2 and 3+. Age 1-group were found to be concentrated in the central-eastern areas of Division IVb and IVc. The mean lengths in mm of age-group 1 by rectangle are presented in Figure. 8.3.2.

8.4 Acoustic Survey

Sprat abundance was estimated from the ICES Coordinated Herring Acoustic survey in June-July 1996 (WD Simmonds *et al*, 1997b). The sprat were mainly found in the western North Sea, west of 2° E. The survey area coverage in the eastern and central part of Sub-division IVb does not include the whole area where sprat normally is distributed. Total stock estimates by number and biomass were:

	Numbers (mill)	Biomass ('000 t)
1996	20042	213

In the western area, unfortunately, weights of the sprat samples were not properly taken during the survey. The mean weight per size-class was derived from sprat taken during the IBTS-survey in January and February 1997. Samples for ageing were either not available or there were some difficulties in interpreting the otoliths.

8.5 State of the Stock

8.5.1 Catch-Survey Data Analysis

The IBTS surveys have difficulties following strong and weak cohorts for sprat, which has also been demonstrated by the last years Working Groups (see 1996). The 1-group:2-group ratio varies among 0.32 (1981 year class) and 7.57 (1988 year class).

Combined with the ageing problems, this implies that the available indices do not adequately reflect the dynamics of the stock.

8.6 Projections of Catch and Stock

Prior to 1997 the data have not permitted projections of either catches or stock sizes. As discussed in the 1995 Herring Working Group report (ICES 1995/Asses:13), the 1989 IBTS index continues to be an outlier in a regression of total landings and IBTS-indices. The regression was also highly affected by the 1994 observation.

Regression of the total catches and the IBTS indices for 1981-1996 shows as in previous years the 1989 index to be an outlier and this value was deleted in the subsequent analysis. The 1997(February) index was applied to a regression excluding the 1989-index (r^2=0.81) and this predicted a yield for 1997 of 110,000 tons, see Figure 8.6.1. Other regressions using log-log relationship gave similar prediction for 1997.

ACFM in May 1996 commented that "it is wrong to regress numbers on yield". The HAWG does not think it is wrong but of course that the slope has the dimension of tons per number. It may well be that the biomass IBTS index would be a worse predictor than the number index if the mean weight at age measured in February is a highly variable predictor of the mean weight at age at the time of the catch. The procedure was recommended by ACFM in 1993 in its comments to the assessment at that time.

An attempt to improve the analysis was performed by including a model for stock development, The Biomass dynamic model. This model was fitted using the CEDA program, see ICES (1993/Assess:15). The data were total catch and IBTS(February) abundance indices for 1978 to 1996. The initial state of the stock in 1978 was assumed to be that the biomass was 0.25 of the carrying capacity K. The 1989 observation was again considered as an outlier. A new run was done excluding the 1989-index. The model suggests that the biomass is currently at a very low level, Figure 8.6.2a. The log residuals on the abundance IBTS indices are considerable,Figure 8.6.2b.

SHOT estimates (Shepherd, 1991) were provided by the IFWG, but as demonstrated in their report of 1992 (ICES 1992/Assess:9), little confidence was put in the estimates. At that time the analysis was driven by the very strong 1989-index. With more data available, the Herring Assessment Working Group decided to undertake a new SHOT-estimate for the North Sea sprat. The estimated landings for 1997 using the total IBTS-indices was found around 100 000 tonnes, Table 8.6.1. Other runs using the 1-group indices and the combined 1-and 2-group indices gave similar estimates for the 1997 yield.

8.7 Management Considerations

The stock shows signs of heavy exploitation as both catch and biomass appear to be decreasing. There is no signs of a good year class recruiting to the 1997 fishery. Therefore, catches should be reduced to the lowest possible level until there are signs of increased recruitment.

8.8 Research Recommendations

The Working Group considered the research required to improve the quality of the sprat assessment and recommends the following to be addressed before the next meeting of the Working Group:

- **Data from the acoustic survey in 1996 indicate that sprat abundance estimates can be obtained from this survey. The work deriving these estimates for 1995 and earlier years should be continued.**

- **The improvement of the biological sampling intensity in the last three years should be continued.**

Table 8.1.1 Sprat catches in the North Sea ('000 t) 1983-1996. Catch in fjords of western Norway excluded (Data provided by Working Group members except where indicated). These figures do not in all cases correspond to the offical statistics and cannot be used for management purposes.

Country	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Division IVa West														
Denmark	-	-	0.9	0.6	0.2	0.1	+	-		0.26	0.6	-	-	-
Germany	-	-	-	-	-	-	-	-		-	-	-	-	-
Netherlands	-	-	6.7	-	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-
UK (Scotland)	-	+	6.1	+	+	-	-	+	-	-	-	0.1	+	-
Total	-	+	13.7	0.6	0.2	0.1	+	+	0.1	0.26	0.6	0.1	+	-
Division IVa East (North Sea) stock														
Denmark	-	-	+	0.2	+	+	+	-	-	-	+	+	+	0.3
Norway	-	-	-	-	-	-	-	-	-	0.54	2.5	+	+	-
Sweden	-	-	-	-	-	-	-	+	2.5	-	-	-	-	-
Total	-	-	+	0.2	+	+	+	+	2.5	0.64	2.5	+	+	0.3
Division IVb West														
Denmark	32.6	5.6	1.8	0.4	3.4	1.4	2.0	10.0	9.4	19.9	13.0	19.0	26.0	1.8
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	0.9	0.5	-	-	-	3.5	0.1	1.2	4.4	18.4	16.8	12.6	21.0	1.9
UK (England & Wales)	-	+	-	-	-	-	-	-	-	0.48	0.5	-	+	+
UK (Scotland)	+	+	-	-	0.1	-	-	-	-	-	0.5	-	-	-
Total	33.5	6.1	1.8	0.4	3.5	4.9	2.1	11.2	13.8	38.26	30.5	31.6	47.0	3.7
Division IVb East														
Denmark	39.2	62.1	36.6	10.3	28.0	80.7	59.2	59.2	67.0	66.56	136.2	251.7	283.2	74.7
Germany	-	0.6	0.6	0.6[3]	-	-	-	-	-	-	-	-	-	-
Norway	10.8	3.1	-	-	-	0.6	-	0.6	25.1	9.5	24.1	19.1	14.7	50.9
Sweden	-	-	-	-	-	-	-	+[2]	+[2]	-	-	-	0.2	0.5
Total	50.0	65.8	37.2	10.9	28.0	81.3	59.2	59.8	92.1	76.49	160.3	270.8	298.1	125.9
Division IVc														
Belgium	-	-	+	+	+	-	+[2]	+[2]	+[2]	-	-	-	-	-
Denmark	1.0	0.5	+	0.1	+	0.1	0.5	1.5	1.7	2.49	3.5	-	11.4	3.9
France	-	-	-	+	-	-	+[2]	-	+[2]	-	+	+	+	-
Netherlands	-	0.1	-	-	-	0.4	0.4[2,3]	-	+[2,3]	-	-	-	-	-
Norway	0.5	3.4	-	-	-	-	-	-	-	-	0.4	4.6	0.4	-
UK (England and Wales)	3.6	0.9	3.4	4.1	0.7	0.6	0.9	0.2	1.8	6.12[1]	2.0	2.9	0.2	2.6
Total	5.1	4.9	3.4	4.3	0.7	1.1	1.8	1.7	3.5	8.61	5.9	21.2	12.0	6.5
Total North Sea														
Belgium	-	-	+	+	+	-	+	+[2]	+[2]	-	-	-	-	-
Denmark	72.6	68.1	39.5	11.7	31.7	82.3	61.9	69.2	78.1	89.1	153.3	284.4	320.6	80.7
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-
France	-	-	-	+	-	-	+	-	+[2,3]	-	+	-	+	-
Germany	-	0.6	-	0.6	-	-	-	-	-	-	-	-	-	-
Netherlands	-	0.1	0.6	-	0.5	0.4	0.4	-	+[2,3]	-	-	-	-	-
Norway	12.0	7.0	6.1	-	-	4.1	0.1	1.8	29.6	28.5	43.8	36.3	36.2	52.8
Sweden	-	-	-	-	-	-	-	+[2]	+[2]	-	0.1	-	0.2	0.5
UK (England and Wales)	3.6	0.9	3.4	4.1	0.7	0.6	0.9	0.2	1.8	6.6	2.6	2.9	0.2	2.6
UK (Scotland)	+	+	-	+	0.2	-	-	+	-	-	0.5	0.1	+	-
Total	88.4	76.7	49.6	16.4	33.1	87.4	63.3	71.2	109.5	124.2	200.3	323.7	357.2	136.6

[1]Preliminary.
[2]Official statistics.
[3]Includes Division IV a-c.

Table 8.1.2 Sprat catches ('000 t) in the fjords of western Norway, 1983–1996.

1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996[1]
3.2	4.4	7.1	2.2	8.3	5.3	2.4	2.7	3.2	3.8	1.9	5.3	3.7	3.3

[1]Preliminary.

Table 8.1.3. Sprat catches (tonnes) in the North Sea by quarter[1]. Catches in fjords of Western Norway excluded.

Year	Quarter	Area					Total
		IVaW	IVaE	IVbW	IVbE	IVc	
1994	1	0	42	2616	17227	16091	35976
	2	0	0	242	10857	2	11101
	3	0	0	10479	184747	3572	198798
	4	97	0	18224	57959	1325	77605
Total		97	42	31561	270790	20990	323480
1995	1	0	0	17752	16900	7324	41976
	2	0	0	1138	5752	1	6891
	3	0	86	25305	183500	6	208897
	4	0	5	2826	92054	4693	99578
Total		0	91	47021	298206	12024	357342
1996	1	0	459	2471	81020	6103	90053
	2	0	0	615	2102	18	2735
	3	0	0	242	6259	0	6501
	4	0	353	411	36273	386	37360
Total		0	812	3739	125654	6507	136649

[1] 1994 Data from Denmark and Norway
1995-1996 data from Denmark, Sweden, Norway and the UK.

Table 8.2.1 North Sea Sprat. Catch in numbers (millions) taken by quarter in 1994 and 1995 (Denmark and Norway) and 1996 (Denmark, Norway and UK-England).

Country	Fishing area	Quarter	Age 0	1	2	3	4	5+
1994								
Denmark	IVa	4	0.54	2.13	0.61	0.06		0
Denmark	IVb	1		485.02	670.18	268.1		
		2		2983.51	15	0		
		3		24541.41	272.95	0		
		4	887.11	4528.93	1289.6	144.85	2.97	5.38
Norway	IVb	1			794.57	172.58	12.82	
Denmark	IVc	1		22.74	673.41	150.43	27.99	
		2		0.27	0			
		4	1.26	85.25	23.6	4.12	0.23	
1995								
Denmark	IVa	4		0.23	0.17	0.02		
Denmark	IVb	1		5.78	1133.81	360.51		
		2		2.17	552.92	169.57		
		3	513.23	11686.05	7402.48	138.18		
		4		4327.87	3179.02	361.97		
Norway	IVb	1			1278.16	518.37	43.56	
		3			315.84	115.49	3.22	
Denmark	IVc	1			537.11	98.77	9.68	
		2			0.08	0.01		
		3		0.26	0.16	0.02		
		4		206.66	125.95	15.31		
1996								
Denmark	IVa	1		0.01	0.07	0.02		
		4		8.44	7.59	2.41		
Denmark	IVb	1		285.02	2278.78	634.29	63.97	8.73
		2		1.92	239.9	32.46	15.41	0.26
		3		400.52	100.72	22.94	0.33	
		4		1167.75	1050.05	333.66	5.41	
Norway	IVb	1		38.96	1984.32	1891.40	241.29	1.50
Denmark	IVc	1		33.55	268.22	74.66	7.53	1.03
		2		0.01	1.59	0.21	0.1	
		3						
		4		10.28	9.25	2.94	0.05	
UK(England)	IVc	1		167.2	84	21.49	3.63	
		4		4.21	2.12	0.54	0.09	

Table 8.2.2. North Sea Sprat. Quarterly mean weight (g) at age in the landings in 1994-1996. Weight were estimated from data provided by Working Group members.

Quarter	Age					
1994	0	1	2	3	4	5+
1		1.8	9.6	12.8	17.4	
2		3.7	8.0			
3		7.0	10.8			
4	8.4	10.4	13.7	18.5	24.7	
Total	8.4	7.1	11.0	13.9	18.1	
1995						
1		3.0	9.4	12.9	19.4	
2		3.0	8.4	10.3		
3	2.4	7.6	13.9	16.4	20.7	
4		10.5	13.9	16.2		
Total	2.4	8.4	12.8	14.0	19.5	
1996						
1		3.9	9.3	14.9	15.3	16.1
2		6.9	8.4	11.6	20.0	15.2
3		11.6	14.2	18.2	21.5	
4		12.1	15.9	17.2	20.5	
Total		10.6	10.6	15.2	15.6	16.0

Table 8.2.3 North Sea Sprat. Sampling commercial landings for biological samples in 1996.

Country	Quarter	Landings 000t	No samples	No fish meas.	No fish aged
Denmark					
	1	34.2	13	2635	743
	2	2.7	11	109	
	3	6.5	5	115	
	4	37.3	3	314	337*
	Total	80.7	32	3,173	743
Norway	1	55.8	36	3459	2774
	2	0			
	3	0			
	4	0			
	Total	55.8	36	3,459	2,774
Total North Sea		136.5	68	6632	3517

* Incl. aged fish from research surveys

Table 8.3.1 North Sea Sprat. Abundance indices by age group from IBTS(February), 1981-1997, in the standard sprat area (Div. IVb).

Year	No rect.	No hauls	Age					
			1	2	3	4	5+	Total
1981	70	146	957.28	1414.02	341.79	4.11	0.31	2717.51
1982	67	155	245.91	510.86	125.42	5.64	0.19	888.02
1983	79	211	201.21	764.08	192.43	8.26	0.85	1166.83
1984	80	251	383.63	393.57	47.43	6.66	0.41	831.70
1985	79	289	675.49	305.00	38.22	4.32	0.90	1023.93
1986	78	285	68.22	104.77	29.38	1.31	0.26	203.94
1987	78	299	758.28	74.68	24.80	3.61	0.21	861.58
1988	78	208	152.29	1410.52	109.66	8.78	0.00	1681.25
1989	79	236	4293.66	445.72	318.65	4.10	13.44	5075.57
1990	78	192	115.16	567.46	149.83	30.79	0.59	863.83
1991	78	179	834.45	104.89	27.84	2.63	1.17	970.98
1992	79	185	1562.20	344.08	38.25	5.51	0.45	1950.49
1993	79	181	1732.54	602.01	84.12	4.35	0.06	2423.08
1994	78	173	4084.89	1397.77	129.96	2.79	0.67	5616.08
1995	79	166	1059.30	2643.93	134.01	3.23	1.12	3841.59
1996	78	146	346.37	483.45	141.96	23.64	0.56	995.98
1997	79	159	887.43	389.35	33.8	3.42	0.15	1314.17

Table 8.6.1. North Sea Sprat. SHOT forecast of landings in 1997 using total landings and the total IBTS-indices as input data.

```
North Sea Sprat                          SHOT forecast spreadsheet version 7
Total Index                                                     Mars 1997

running recruitment weights
      older    0.00                              G-M =  0.00
      central  1.00                             exp(d)  1.00
      younger  0.00                           exp(d/2)  1.00
```

Year	Land -ings	Recrt Index	W'td Index	Y/B Ratio	Hang -over	Act'l Prodn	Est'd Prodn	Est'd SQC.	Act'l Expl Biom	Est'd Expl Biom	Est'd Land -ings
1981	209	2718		0.77	0.23				271		
1982	154	888	888	0.77	0.23	138			200		
1983	88	1167	1167	0.77	0.23	68	362	314	114		
1984	77	832	832	0.77	0.23	74	125	117	100		
1985	50	1024	1024	0.77	0.23	42	99	94	65	122	94
1986	16	204	204	0.77	0.23	6	17	24	21	32	24
1987	33	862	862	0.77	0.23	38	69	56	43	73	56
1988	87	1681	1681	0.77	0.23	103	123	103	113	133	103
1989	63	5076	5076	0.77	0.23	56	357	295	82	383	295
1990	71	864	864	0.77	0.23	73	39	44	92	57	44
1991	110	971	971	0.77	0.23	122	46	52	143	67	52
1992	125	1950	1950	0.77	0.23	129	103	105	162	136	105
1993	200	2423	2423	0.77	0.23	222	133	131	260	170	131
1994	324	5616	5616	0.77	0.23	361	335	304	421	395	304
1995	357	3842	3842	0.77	0.23	367	234	254	464	330	254
1996	137	996	996	0.77	0.23	71	65	132	178	172	132
1997		1314	1314	0.77	0.23		87	98	0	127	98

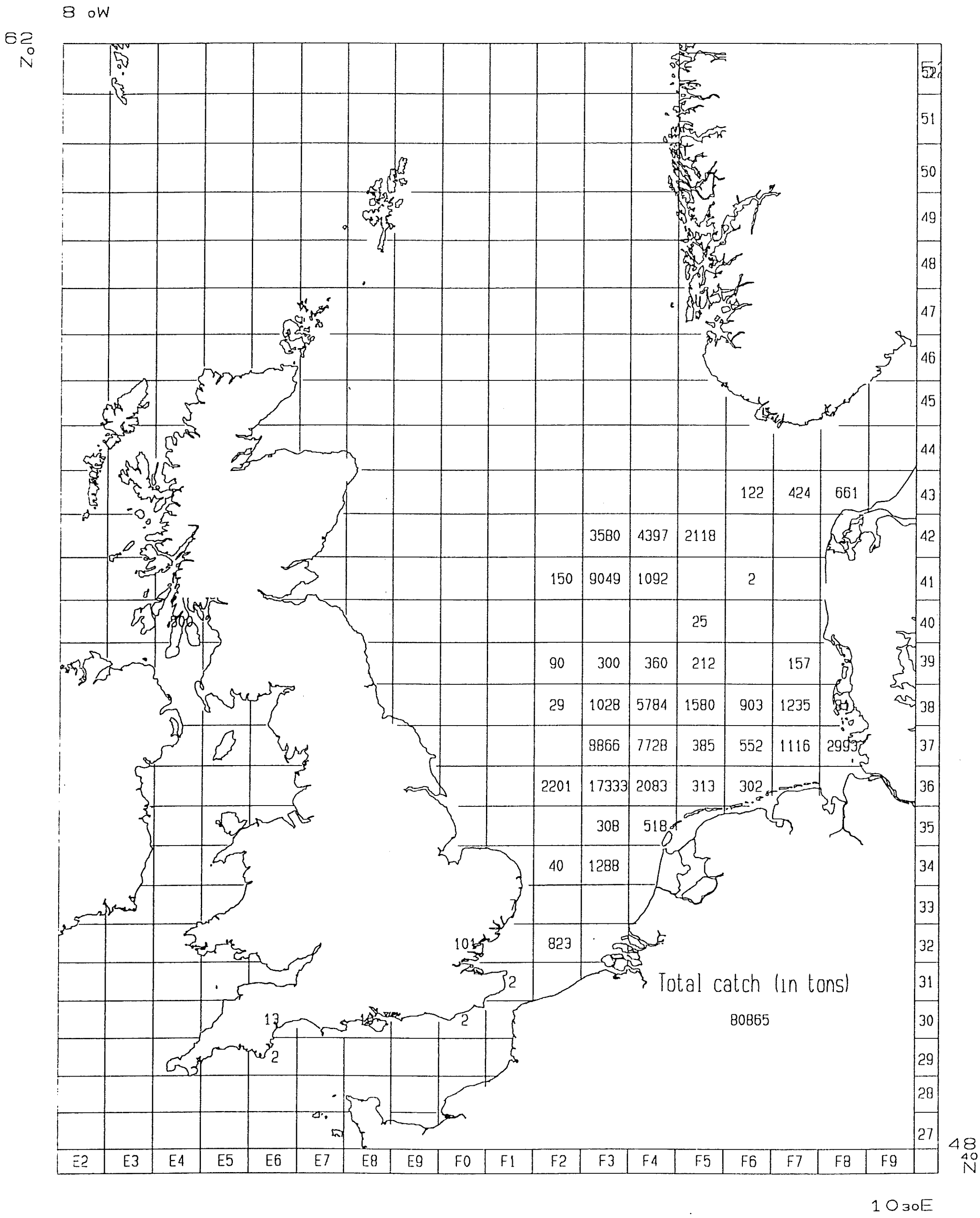


Figure 8.1.1. North Sea and Division VIId,e sprat catches in tonnes, January 1996.

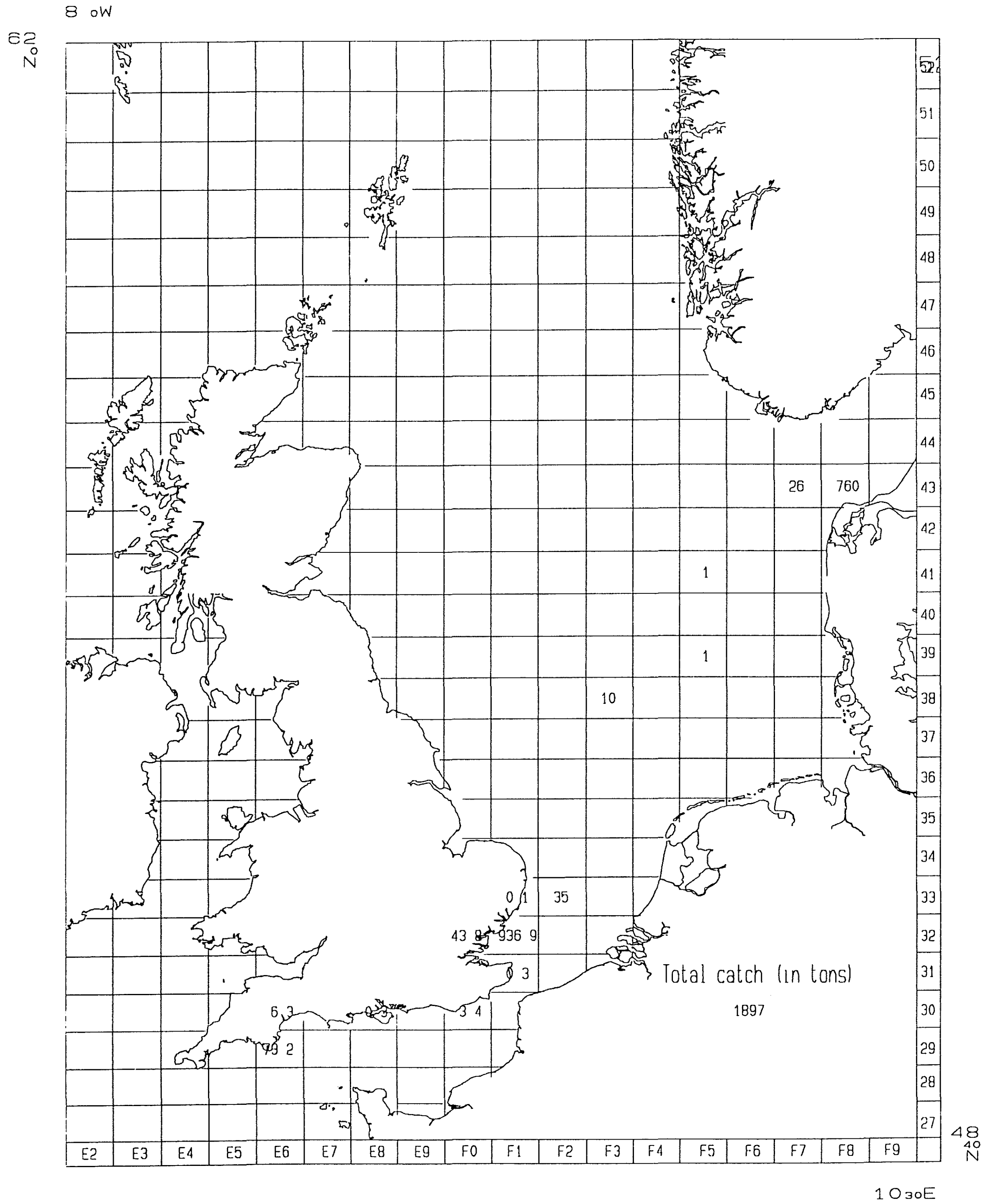


Figure 8.1.2. North Sea and Division VIId,e sprat catches in tonnes, February 1996.

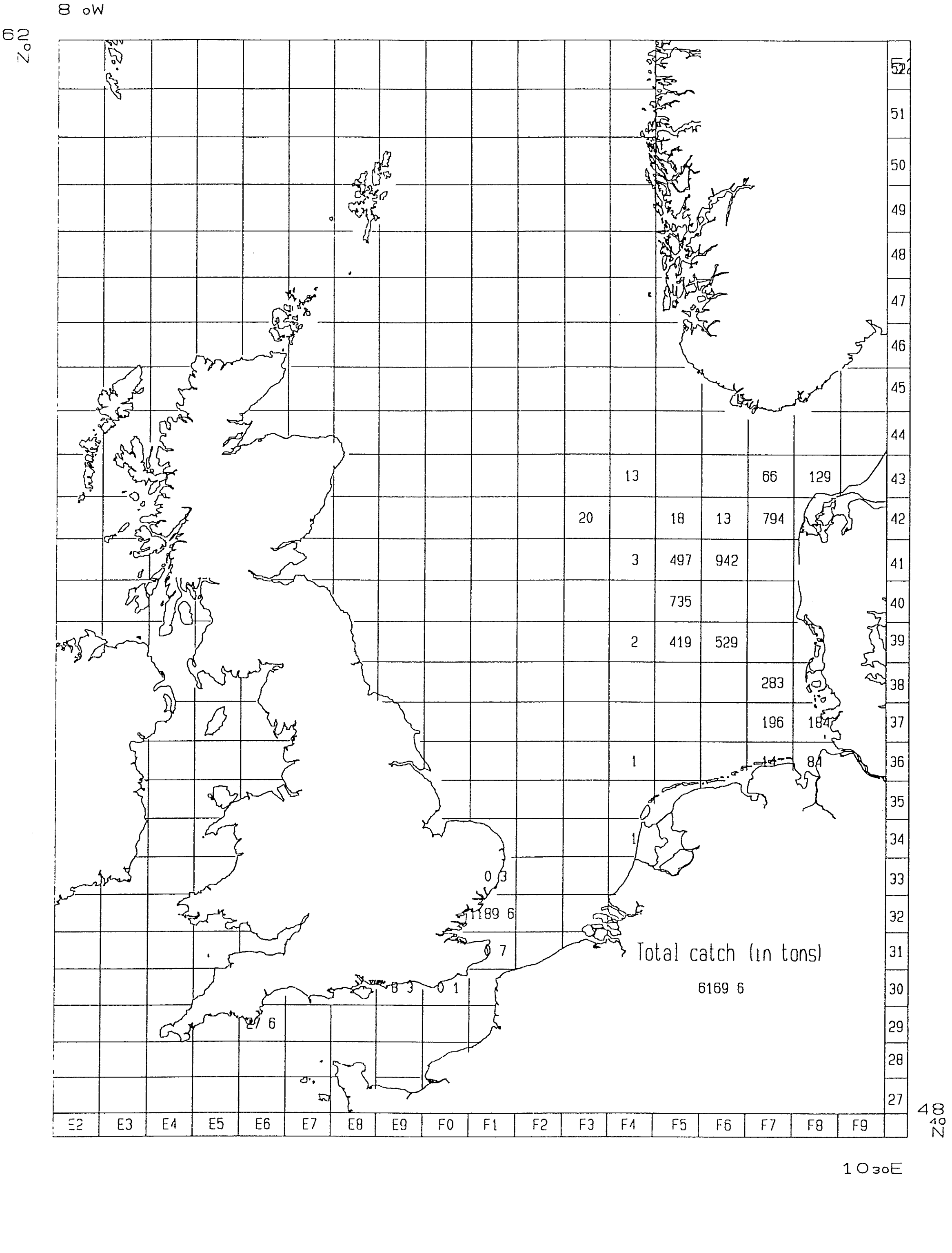


Figure 8.1.3 North Sea and Divisions VIId,e sprat catches in tonnes, March 1996.

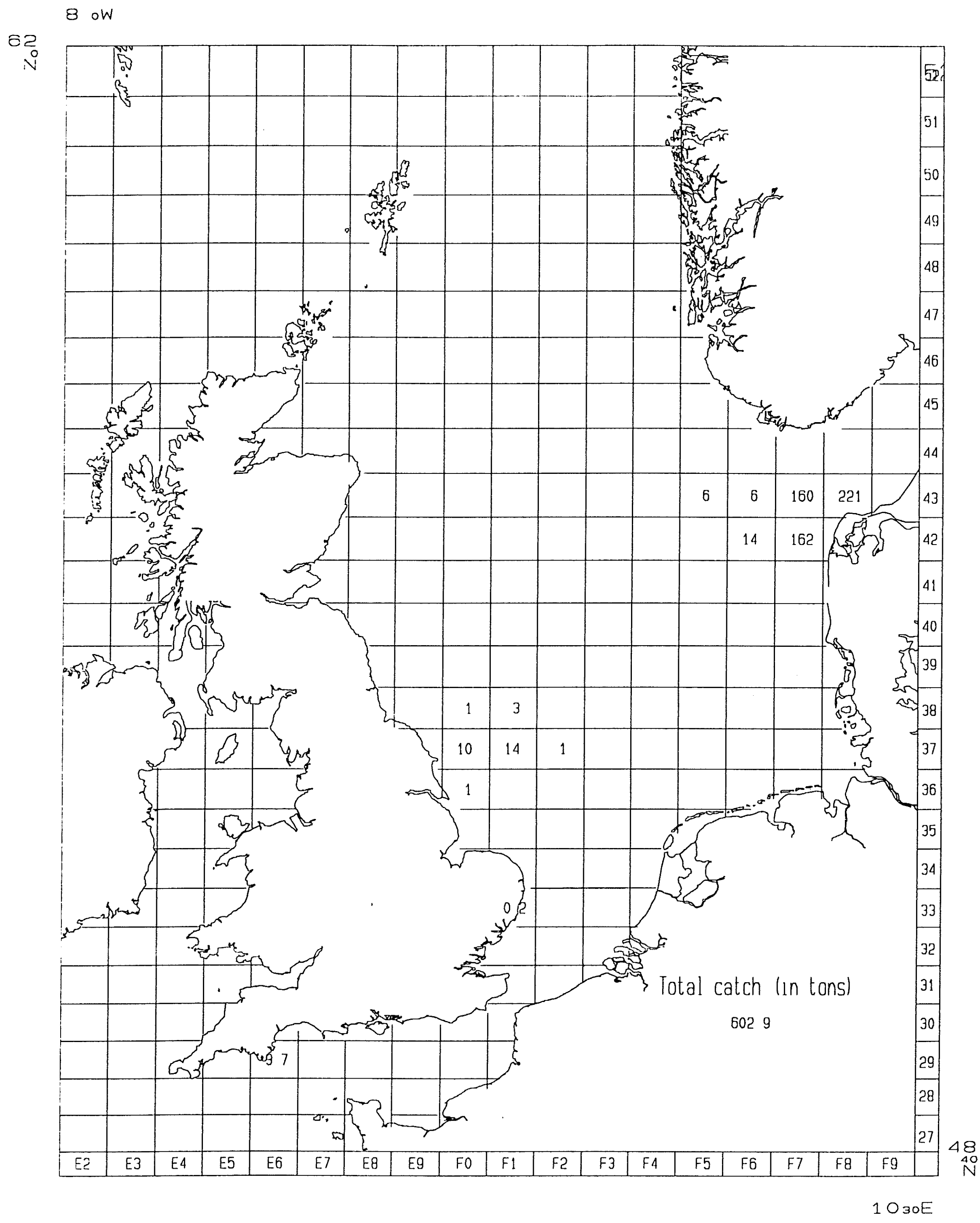


Figure 8.1.4. North Sea and Division VIId,e sprat catches in tonnes, April 1996.

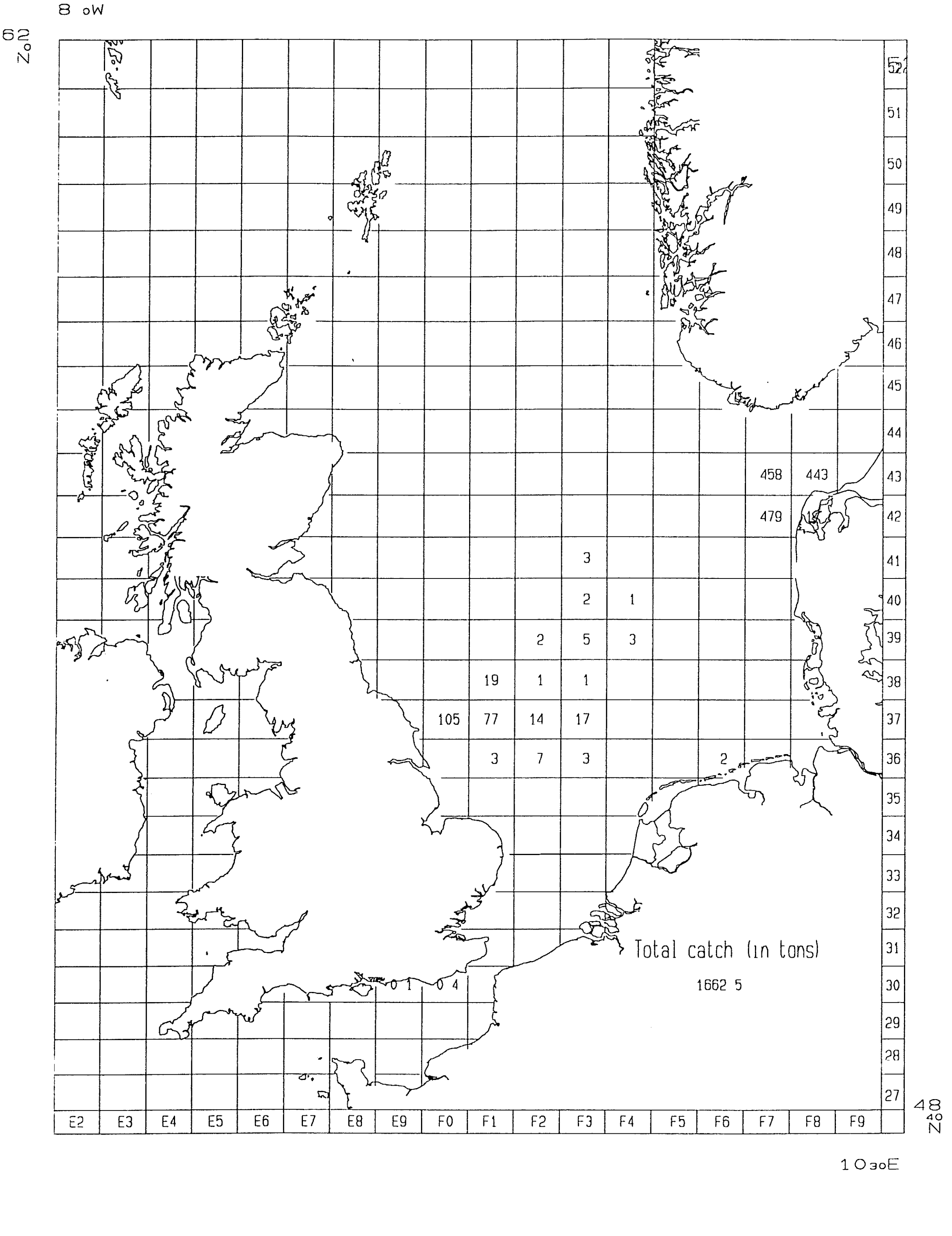


Figure 8.1.5. North Sea and Division VIId,e sprat catches in tonnes, May 1996.

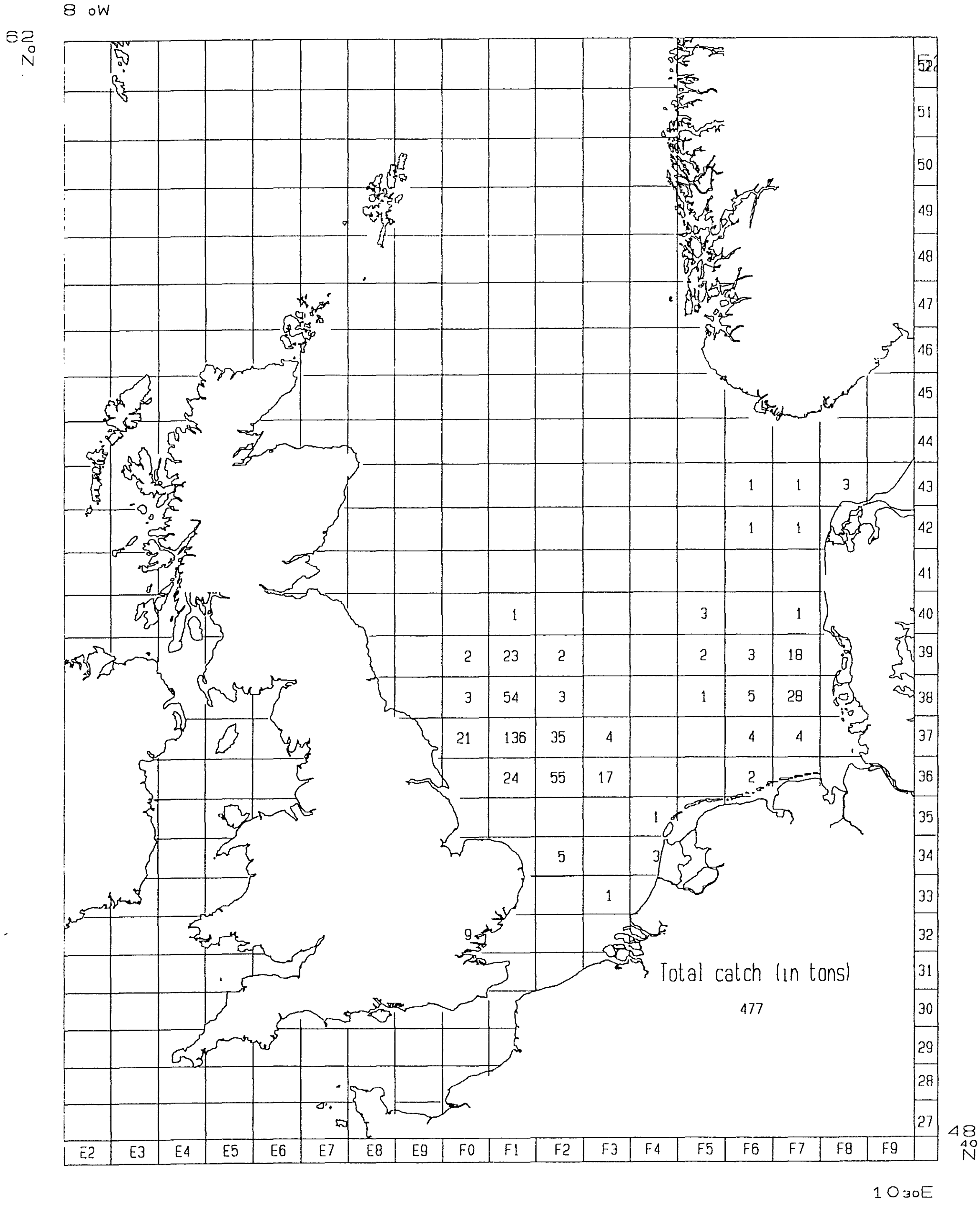


Figure 8.1.6. North Sea and Division VIId,e sprat catches in tonnes, June 1996.

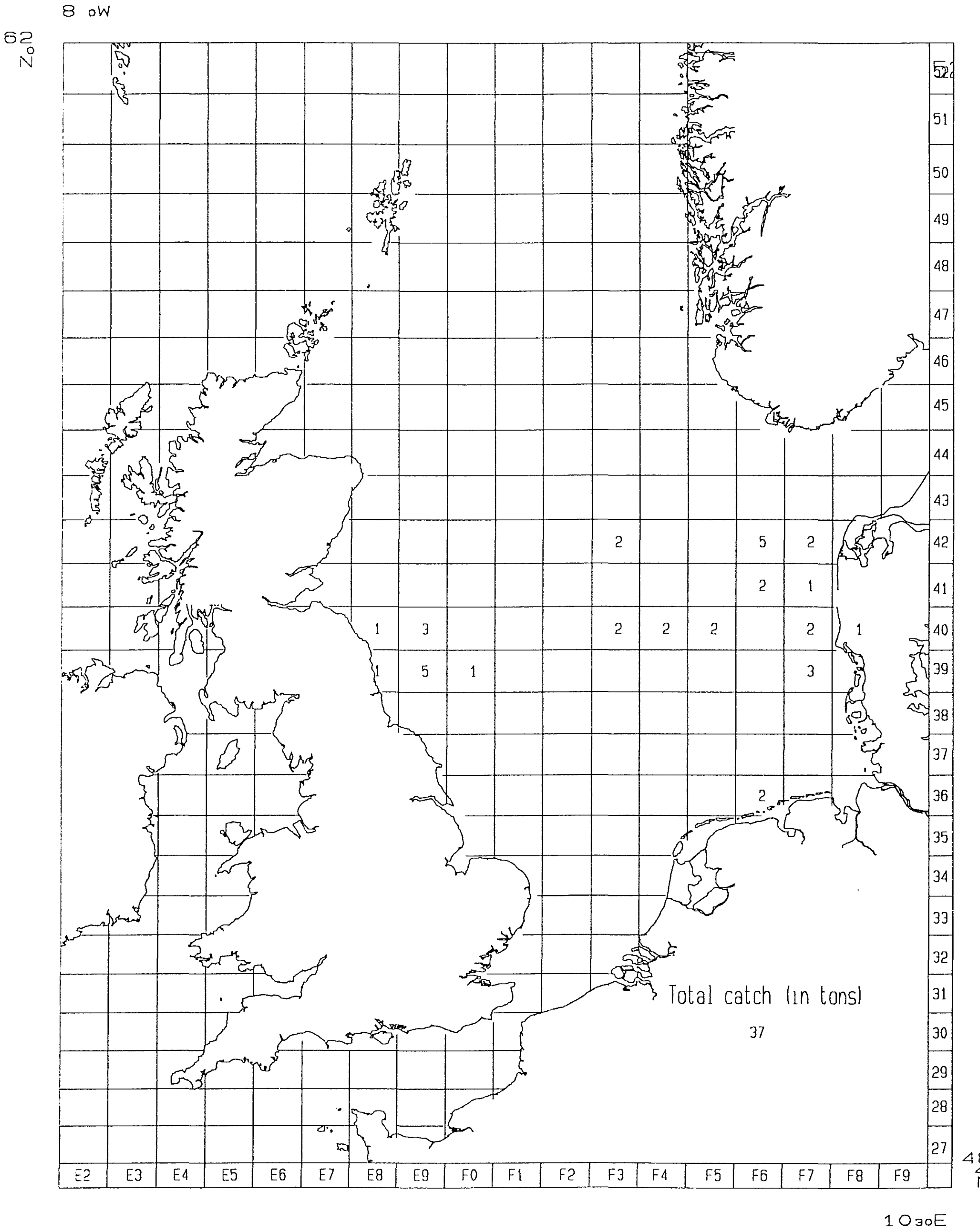


Figure 8.1.7. North Sea and Divisions VIId,e sprat catches in tonnes, July 1996.

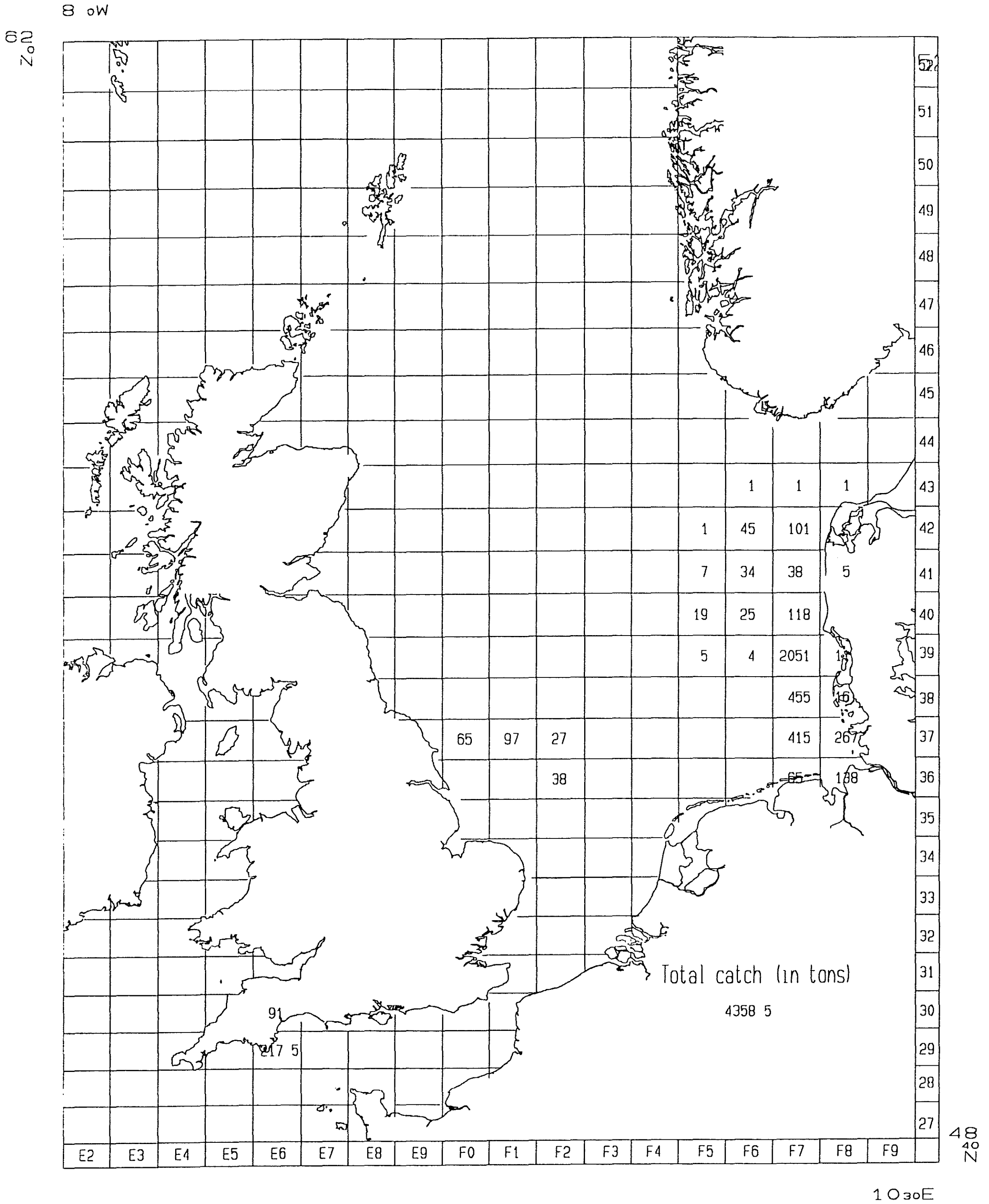


Figure 8.1.8. North Sea and Division VIId,e sprat catches in tonnes, August 1996.

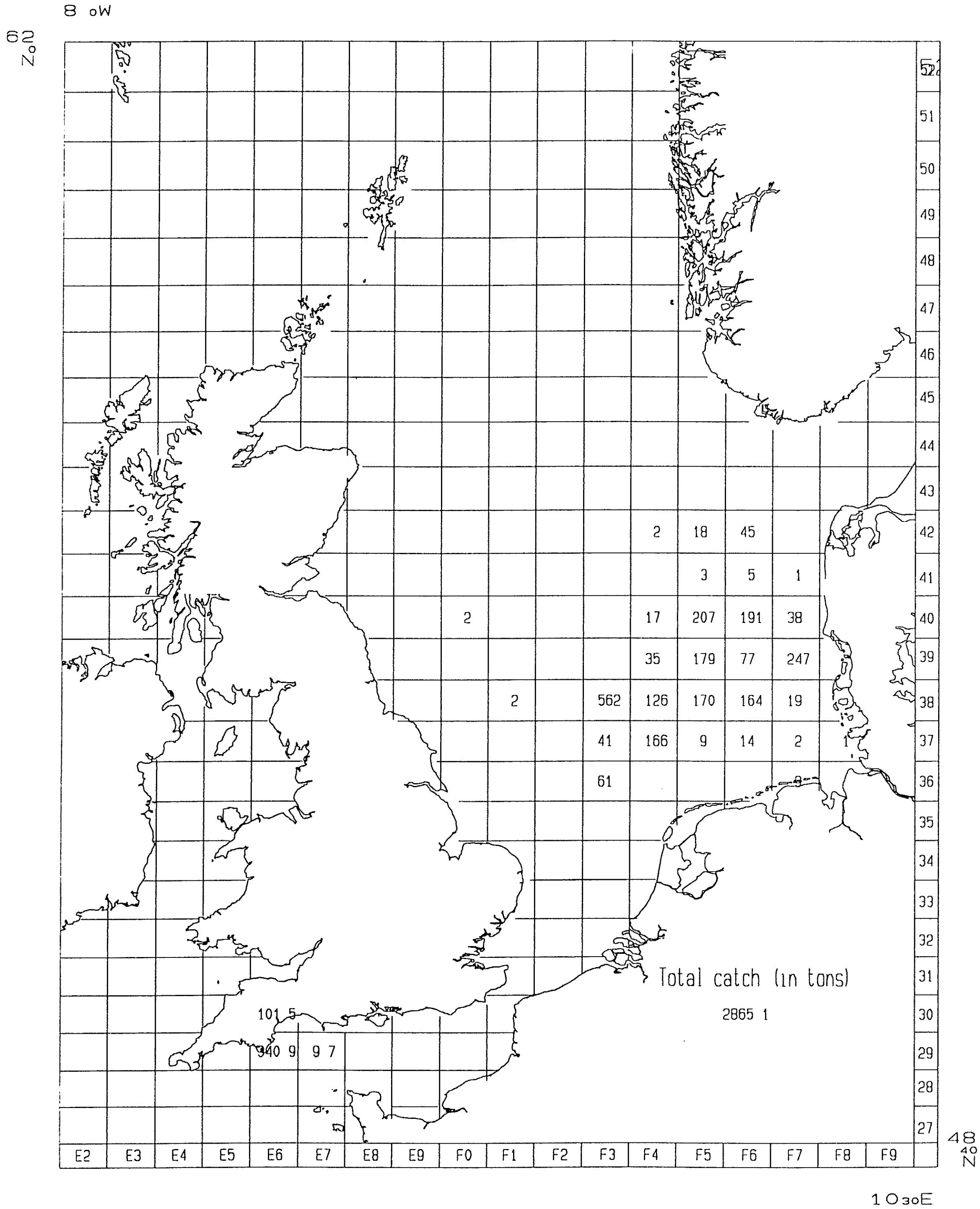


Figure 8.1.9. North Sea and Division VIId,e sprat catches in tonnes, September 1996.

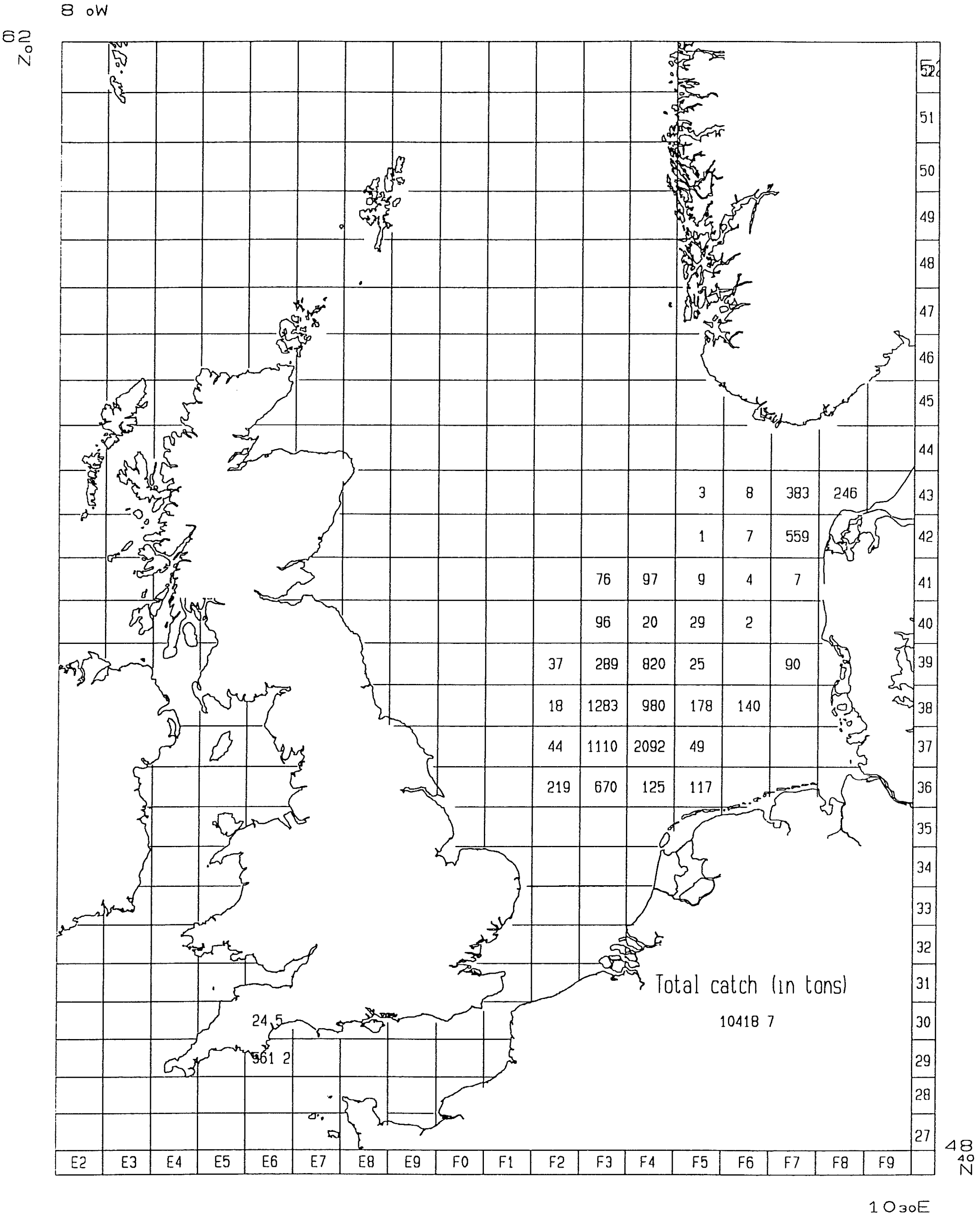


Figure 8.1.10. North Sea and Division VIId,e sprat catches in tonnes, October 1996.

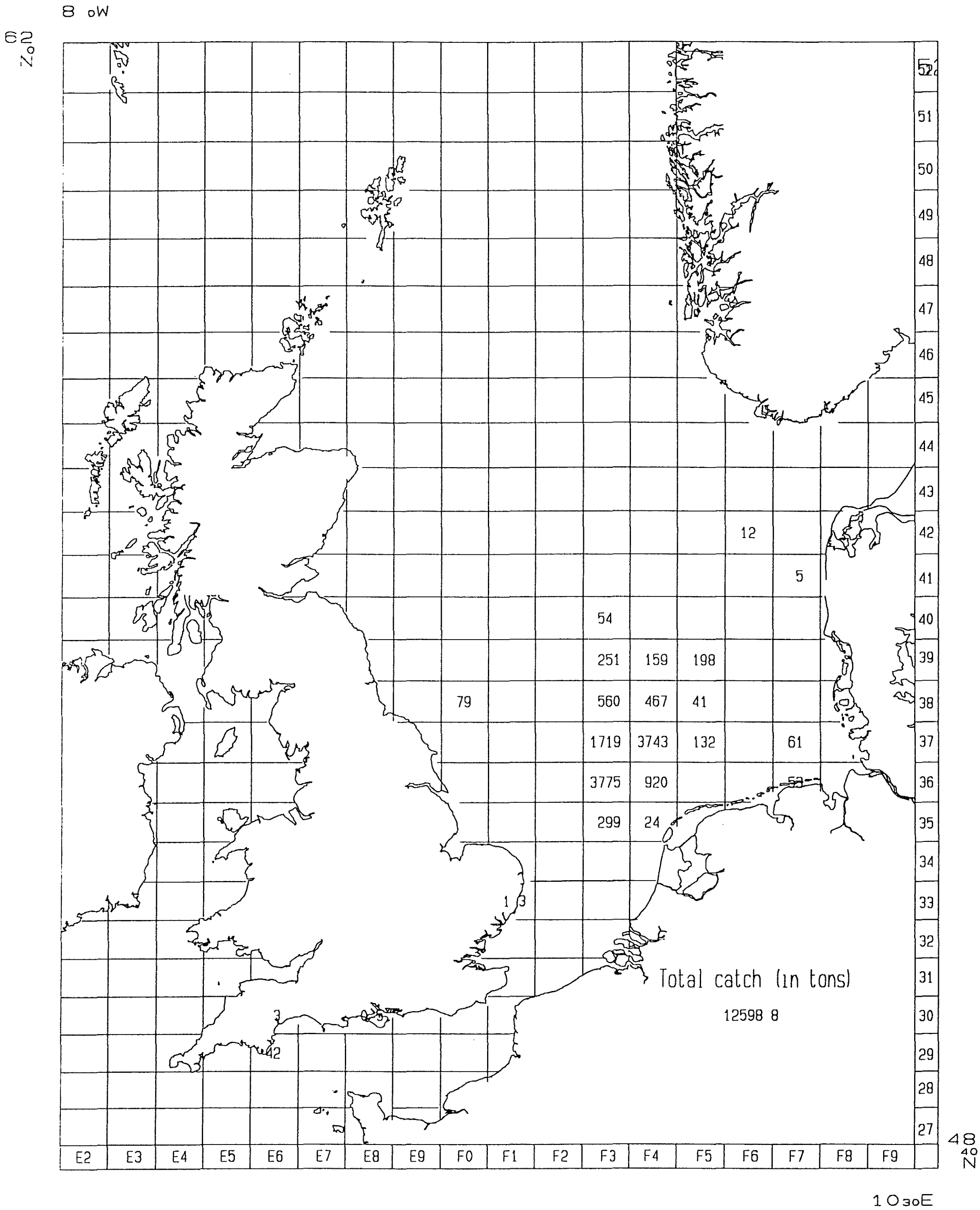


Figure 8.1.11. North Sea and Divisions VIId,e sprat catches in tonnes, November 1996.

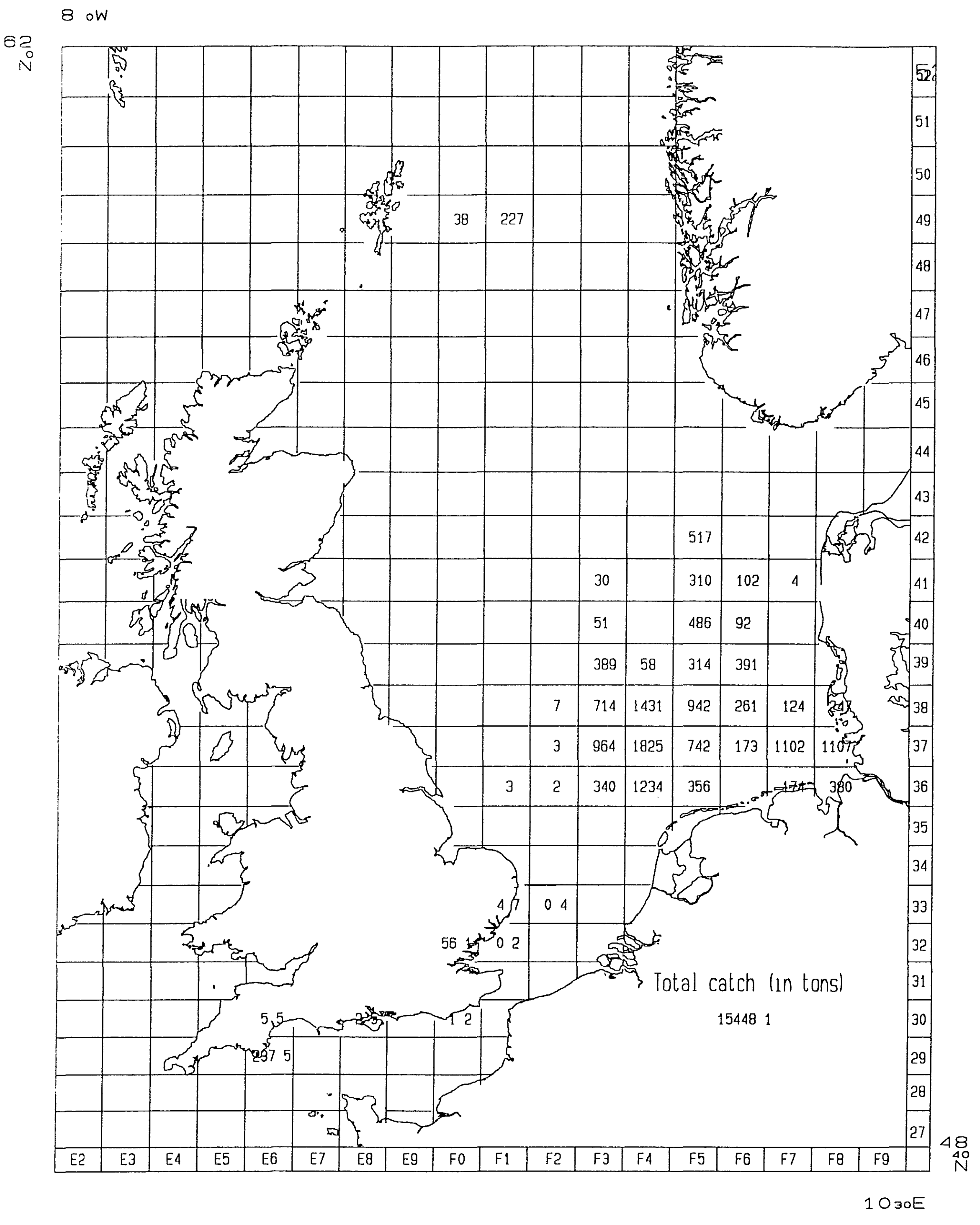


Figure 8.1.12. North Sea and Division VIId,e sprat catches in tonnes, December 1996.

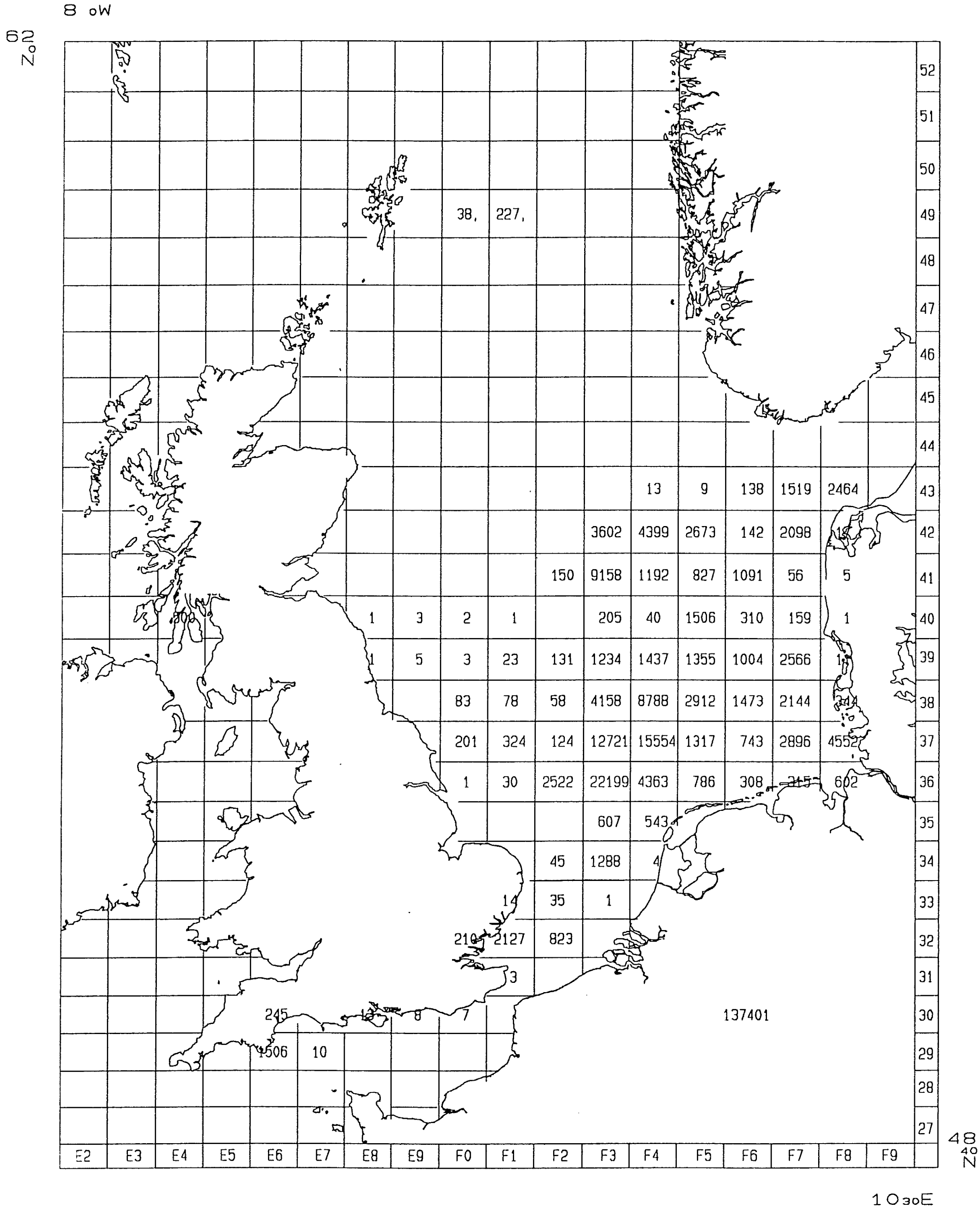
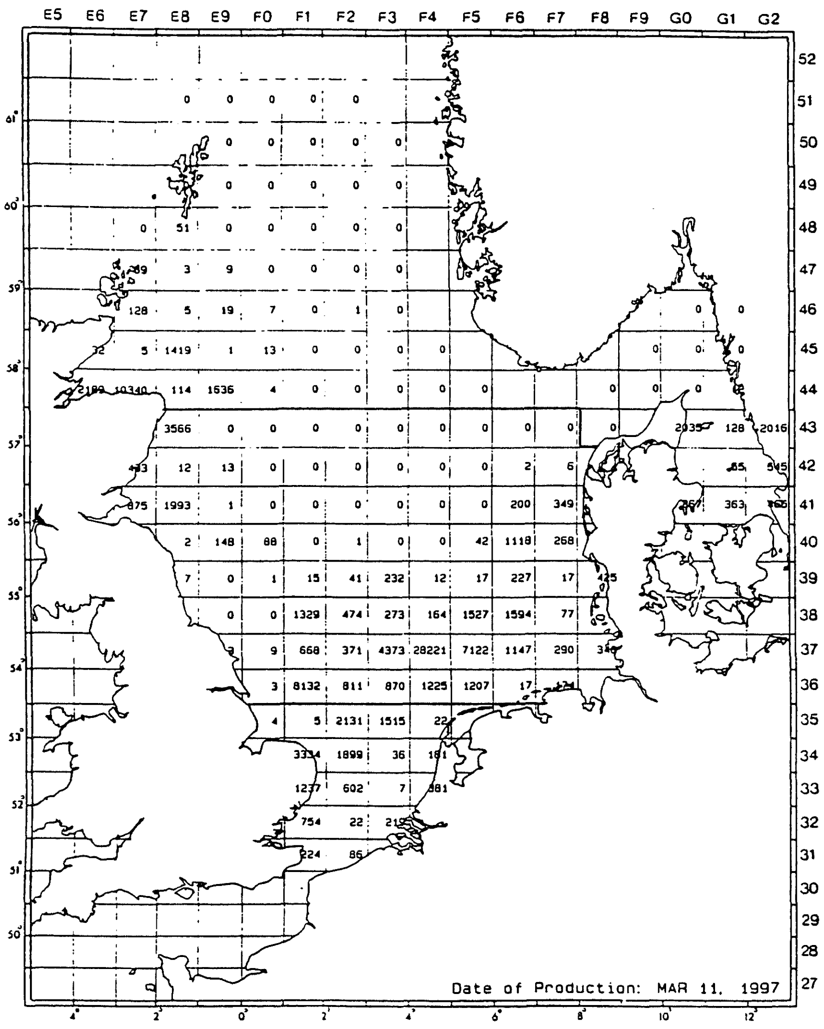
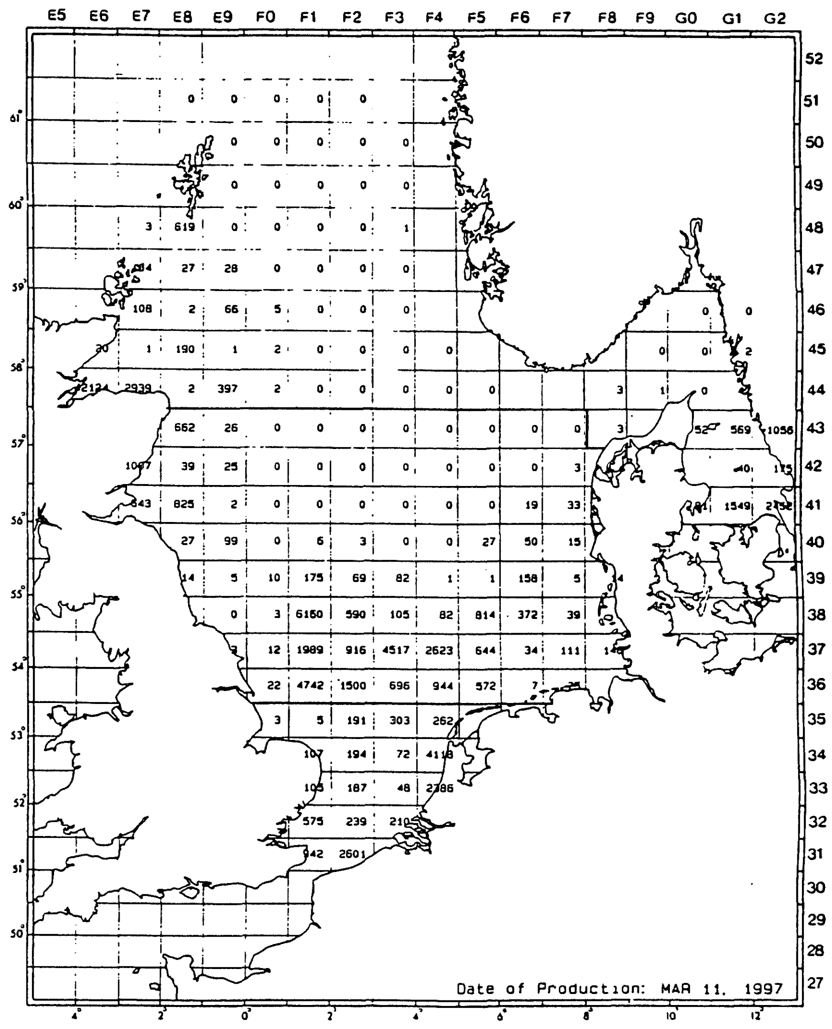


Figure 8.1.13. North Sea and Division VIId,e sprat catches in tonnes, 1996.

Year 1996



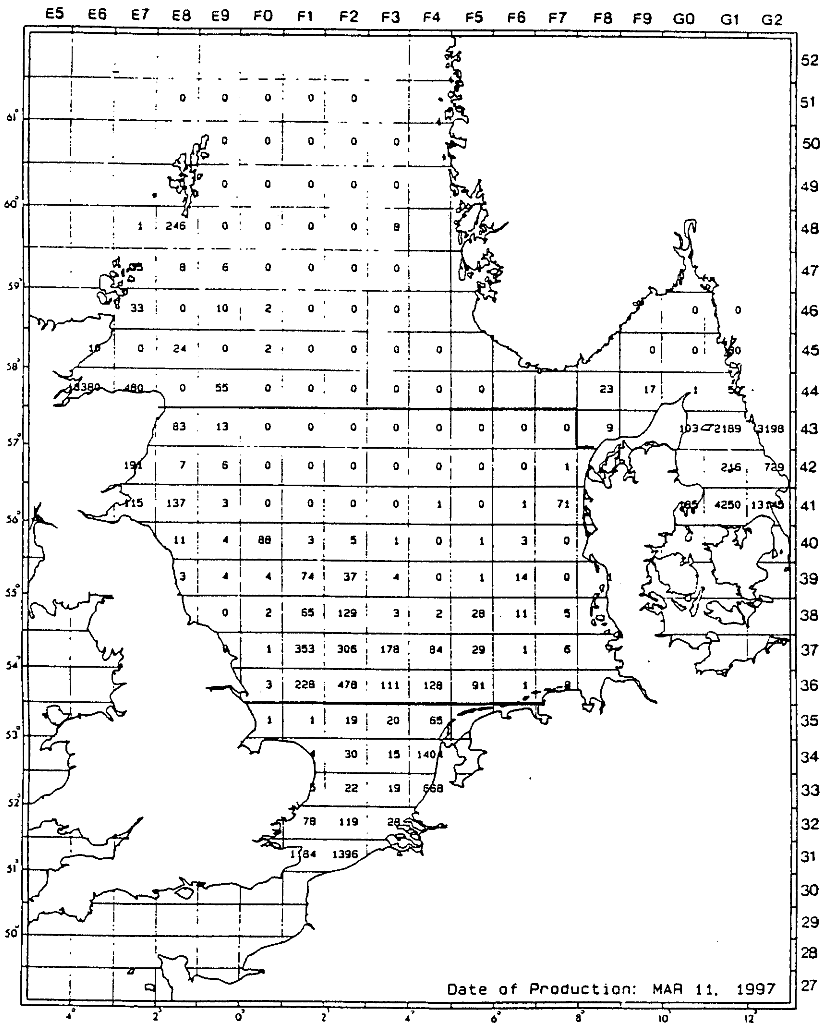
Sprat, SPRA SPR
Number per Hour , Age Group 1.



Sprat, SPRA SPR
Number per Hour , Age Group 2.

Figure 8.3.1. SPRAT. Distribution by age groups in the IBTS(February) 1996, in the North Sea and Division IIIa.

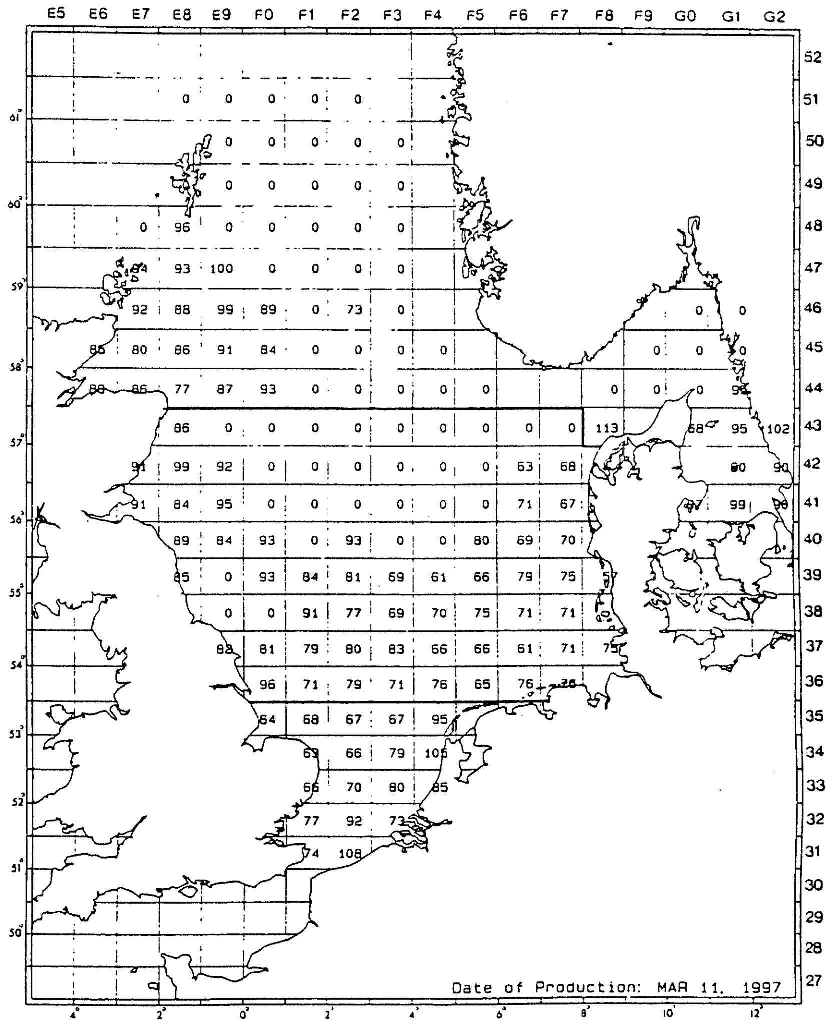
International Young Fish Survey 1997



Sprat. SPRA SPR
Number per Hour . Age Group 3+.

Figure 8.3.1. (continued).

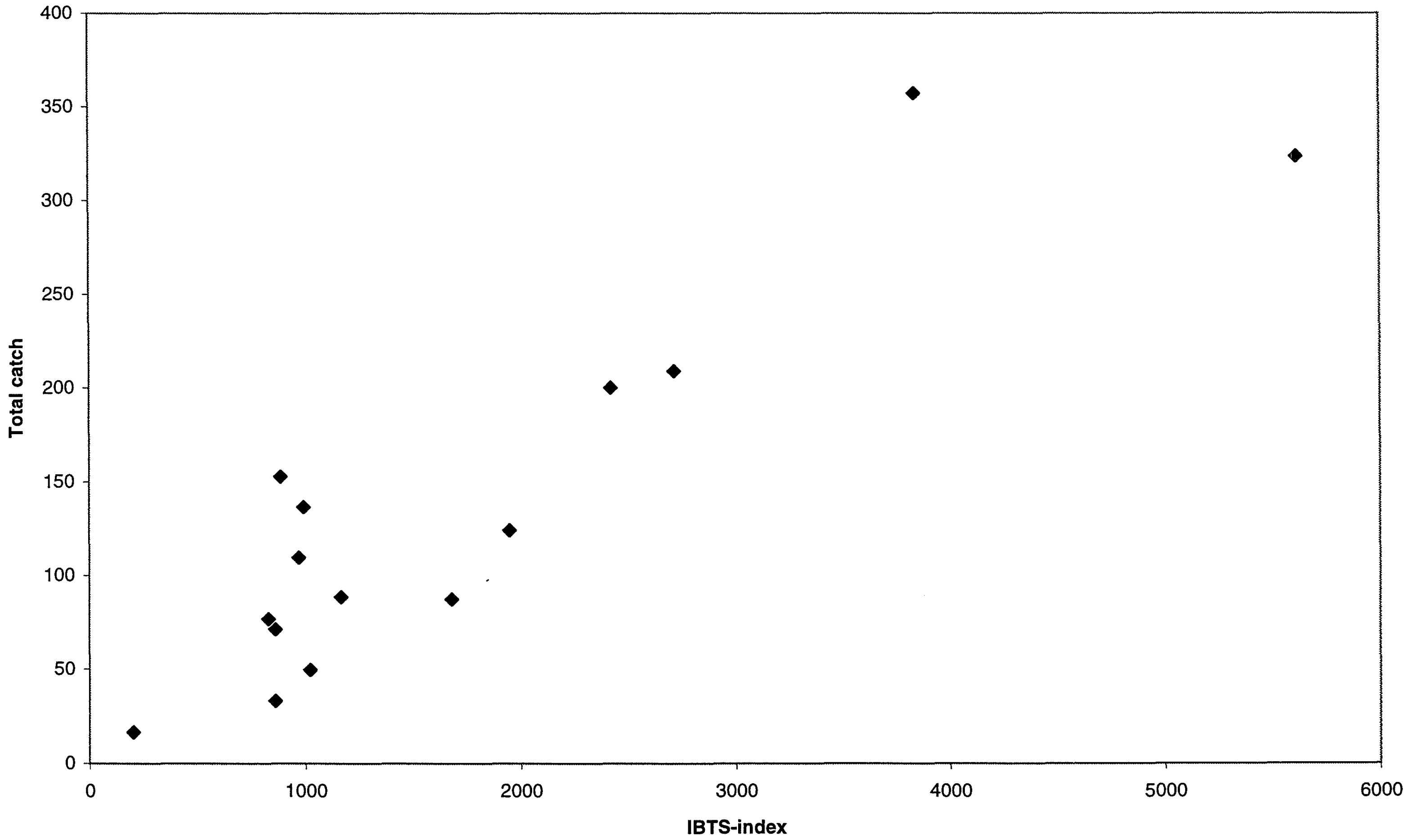
International Young Fish Survey 1997



Sprat. SPRA SPR
Mean Length. Age Group 1.

Figure 8.3.2. SPRAT. Mean length (mm) of age group 1 in the IBTS(February) 1996, in tl North Sea and Division IIIa.

Fig.8.6.1. North Sea Sprat. IBTS indices vs total catches in 1981-1996, excl.1989-index. (rsq=0,81)



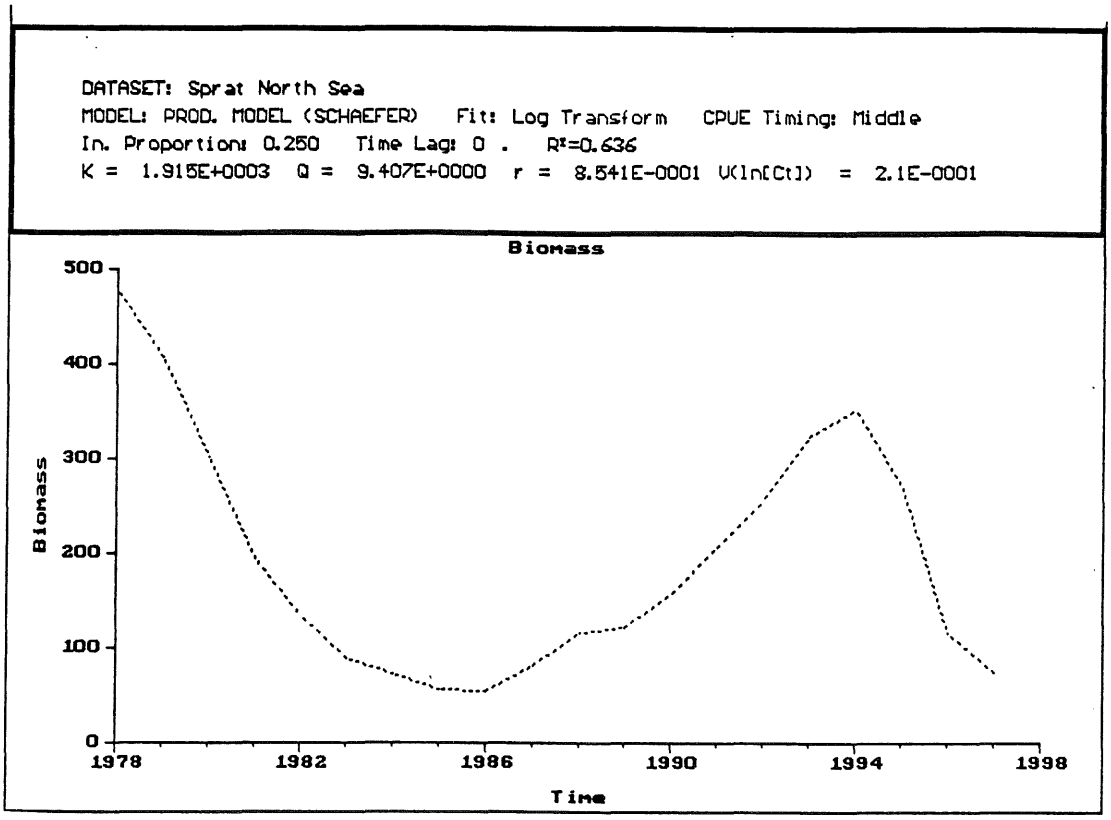


Figure 8.6.2a. Biomass *vs*. year for the North Sea sprat, 1978-1997, excluding the 1989-IBTS index.

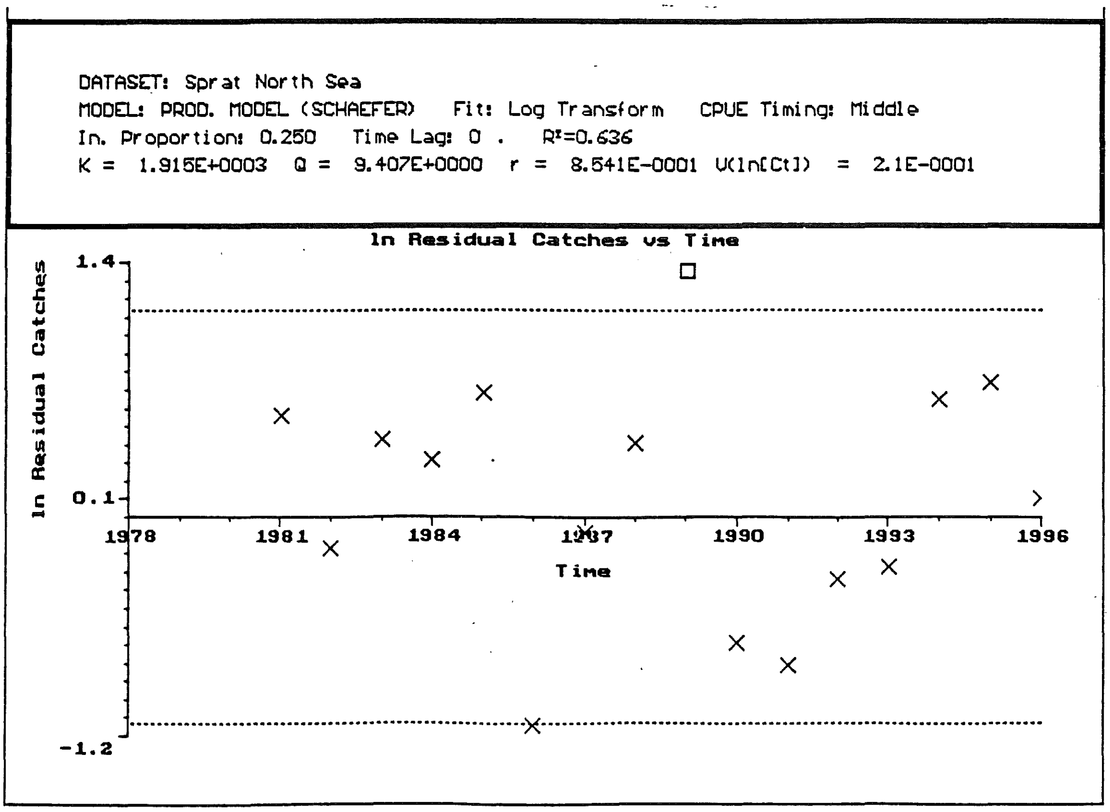


Figure 8.6.2b. Log residuals on the abundance IBTS indices 1978-1997, excluding the 1989-IBTS index.

9 SPRAT IN DIVISION VIID,E

9.1 The fishery

9.1.1 ACFM advice applicable for 1997

The TAC for this fishery was set to 12 000 t for 1997. No ACFM advice has been provided in recent years.

9.1.2 Catches in 1997

Table 9.1.1 shows the nominal landings in 1983-1997. The landings in 1997, as reported by UK(England&Wales), were at the same low level as in the last years. Monthly catches for the Lyme Bay sprat fishery are shown in Table 9.1.2. Monthly and annual distributions of catches by rectangle are shown in Figures 8.1.1-8.1.13.

9.2 Catch Composition

Data on catch composition and mean weights were available for the Working Group for April, October and December (three samples). Catch compositions and the mean weights for 1991-1997 are given in Table 9.2.1 and Table 9.2.2.

Table 9.1.1 Nominal catch of sprat (t) in Divisions VIId,e, 1983-1996.

Country	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996[1]
Belgium	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Denmark	638	1,417	-	15	250	2,529	2,092	608	-	-	-	-	-	-
France	60	47	14	-	23	2	10	-	-	35	2	1	+	-
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	1,454	589	-	-	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (Engl.& Wales)	4,756	2,402	3,771	1,163	2,441	2,944	1,319	1,508	2,567	1,790	1,798	3,177	1,515	1,789
Total	6,911	4,455	3,785	1,178	2,714	5,475	3,421	2,116	2,567	1,825	1,800	3,177	1,515	1,789

[1]Preliminary

Table 9.1.2 Lyme Bay sprat fishery. Monthly catches, (t). (UK vessels only).

Season	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1991/92	0	0	205	450	952	60	358	258	109	51	0
1992/93	0	0	302	472	189	294	248	284	158	78	0
1993/94	8	0	156	82	302	529	208	417	134	53	0
1994/95	0	0	299	834	545	608	232	112	68	0	0
1995/96	0	0	154	409	301	307	151	15	80	28	4

Table 9.2.1. Lyme Bay sprat fishery. Number caught by age group (millions).

Season		0/1	1/2	2/3	3/4	4/5	5/6
1991/92		1.7	56.03	44.69	16.24	0.57	0.03
1992/93[1]		0.22	28.23	48.61	12.94	1.56	0
1993/94[2]		0	0.83	44.81	15.7	1.95	0.58
1994/95				No data			
	0	1	2	3	4	5	6
1995[3]		0.33	5.2	2.31	0.23	0.03	
1996	0.72	12.60	71.35	22.00	1.24	0.20	

1 August to December only (samples in August and December only, so these are best estimates

2 August to December only (samples in August, September and November only, so these are best estimates

3 Only September (one sample)

Table 9.2.2 Lyme Bay area SPRAT. 1991–1995 mean weight (g) at age.

		Age						
Season	Quarter	0/1	1/2	2/3	3/4	4/5	5/6	Overall mean
1991/91	3	4.7	16.6	22.6	25.4	29.2	34.6	20.7
	4	6.6	17.1	23	26.3	30.9		21.0
	1	5.7	13.3	17.5	20.2	24.1		14.4
1992/93	3	4.2	12.1	22.8	24.6	32.4		21.8
	4		15.8	20.0	23.8	24.8		21.0
	1		13.2	17.1	21.2			14.2
1993/94	3			19.1	22.2	20.8		19.8
	4[1]		14.2	18.9	24.5	28.1	25.5	20.6

		Age							
Season	Quarter	0	1	2	3	4	5	6	Overall mean
1995	3[2]	-	-	12.0	17.0	19.0	21.0	29.0	-
1996	1			8.0	11.0	13.0	13.0		-
	4	8.0	15.0	19.0	23.0	28.0			-

[1]Based on November samples only.
[2]Based on September sample only.

10 SPRAT IN DIVISION IIIA

10.1 Fishery

10.1.1 ACFM advice applicable for 1996 and 1997

ACFM advice on a sprat TAC has not been provided in recent years. Sprat is landed under the TAC for the mixed clupeoid fishery, including all catches of all species taken in this fishery (see Section 2.15 a).

The proportion of sprat in the mixed clupeoid fishery increased substantially between 1993 and 1994. In 1994 and in 1995 there was, for the first time in several years, a directed sprat fishery for industrial purposes in Skagerrak and the northern part of Kattegat. The high sprat catches were not seen in 1996. The TACs for this fishery, as adopted by the management bodies, were 43,000 t in 1994, 1995 and 1996. The TAC set for 1997 was 40,000 t, with a restriction in by- catches of herring not to exceed 12,000 t.

10.1.2 Catches in 1996

The total annual landings for Division IIIa by area and country in 1974-1996 are given in Table 10.1.1. The Norwegian and Swedish catches include the coastal and the fjord fisheries. The total landings in 1996, as estimated by the Working Group, were 18,000 t. This was a reduction of nearly 70% from 1995. Decreases were reported in both the Danish and Swedish industrial landings. Of the total landings about 14 % were taken for human consumption, 1,000 t by Norway and 1,450 t by Sweden, mainly in Skagerrak.

Landings by quarter for all three countries are shown in Table. 10.1.2. About 50 % of the total landings were taken in the first quarter, and about 25 % in each of the quarters 2 and 4. Small landings were reported by the industrial fisheries in third quarter. There was a total ban on the directed Danish sprat fishery (mixed clupeoid) from 16 March to 30 September. The Norwegian landings for human consumption were taken in the third and fourth quarter, the Swedish mainly in the first quarter

The composition of sprat and herring in the mixed-clupeoid fishery in the last two years, are given in Table 10.1.3.

10.1.3 Fleet

The sprat fishery in Division IIIa is conducted by fleets from Denmark, Norway and Sweden. The Danish landings are taken by two fleet categories: 1) a directed sprat (mixed clupeoid) trawl fishery using minimum mesh size of 32 mm (see herring fleet D defined in section 2.10) and 2) by catches from the small mesh (16 mm) fisheries for Norway pout, blue whiting and sandeel. The landings are for reduction purposes.

The Swedish sprat fishery can be divided into three categories: 1) directed herring trawl fishery with minimum mesh size of 32 mm and by purse seines, mainly for human consumption (see herring fleet C defined in section 2.10), 2) directed sprat fishery for human consumption carried out by purse seines (see herring fleet D) and 3) a directed sprat (mixed clupeoid) trawl fishery with mainly 16, 18 or 22 mm mesh size, for human consumption and for reduction purposes, (see herring fleet D).

The Norwegian sprat fishery in Division IIIa is an inshore purse seine fishery for human consumption.

10.2 Catch composition

10.2.1 Catches in number and weight at age

No weight-at-age data in the catches were available for 1983- 1991. For 1992-1993 data were supplied by Denmark, in 1994 and 1995 by Denmark and Sweden, and in 1996 only by Denmark.

The numbers and the mean weight by age in the industrial landings in 1992-1996 are presented in Tables 10.2.1 and Table 10.2.2, respectively. For 1996 the number by age group represents about 67 % of the total industrial sprat landings in Div. IIIa. Low mean weight in age group 1 (4,5 g) in fourth quarter, indicate that there might be problems in the ageing.

10.2.2 Quality of catch and biological data

Denmark introduced an improved monitoring system for management and scientific purposes in 1996 (see Section 2.15). Samples used for estimation of sprat age and mean weight at age, were provided by Demark for the industrial/"mixed clupeoid" fisheries. The amount of sampling has improved and is considered as adequate. As in previous years, no samples of sprat were taken from the fisheries for human consumption. Details on the sampling for biological data are shown in Table 10.2.3.

10.3 Recruitment

10.3.1 Abundance of 1-group and older sprat from IBTS

The IBTS(February) indices for 1984-1995, were revised by the 1995 Herring Working Group (ICES 1995/Assess:13). The indices, calculated as mean cpue (no./hr) weighted by the area with water depths between 10 and 150 m of the rectangle, are presented in Table 10.3.1. The IBTS data are provided by rectangle in Figure 8.3.1 for age groups 1,2 and 3+, and the mean length (mm) of 1-gr sprat in Figure 8.3.2.

The 1997 IBTS indices indicate a continuation of the reduction in the 2-group and 1-group index which is at the same low level as last year. The index of 3-group appears to be high, following a high 2-group index in 1996. The total 1997 sprat index for Division IIIa was one of the lowest recorded in the period 1984-1996.

The age structure of sprat from the survey is rather variable, with difficulties in following strong and weak cohorts from year to year. The ratio 1-gr/2-gr has varied between 0.27 and 2.91 (see ICES 1996/Assess:10).

10.4 Acoustic Survey

Acoustic estimates of sprat were estimated from the ICES Coordinated Herring Acoustic survey in June-July 1996 (WD Simmonds *et al.* 1997b). The total number of sprat was 7.9 x 10^8 or 14,267 tonnes. The main densities of sprat were found in the inner area, with 95 % of the biomass in Kattegat. The majority of the sprat were between 1 and 3 years old and 12 and 14 cm.

10.5 State of the Stock

No assessments of the sprat stock in Division IIIa have been presented since 1985 and this year is no exception. The Working Group concluded that the data available do not allow any assessment which could be helpful for management.

10.6 Projection of Catch and Stock

IBTS(February) index plotted vs the catch in the same year (r^2=0.05) is shown in Figure 10.6.1. The 1994 and 1995 observations are anomously high.

SHOT estimates (Shepherd, 1991) were provided by the IFWG, but as demonstrated in their report of 1992 (ICES 1992/Assess:9), little confidence was put in the estimates. With more data available, the Herring Assessment Working Group decided to undertake a new SHOT-estimate for the Div.IIIa sprat. The estimated landings for 1997 using the total IBTS-indices was found around 10,000 tonnes, Table 10.6.1. Other runs using the 1-group indices and the combined 1-and 2-group indices gave similar estimates for the 1997 yield.

10.7 Management Considerations

The recruitment between years does not appear to be driven directly by fishing effort. The sprat stock has in recent years been mainly fished together with herring, except from 1994 and 1995 when a directed sprat fishery was implemented. The human consumption fishery is only a minor part of the total catch. The natural variability in the stock is high.

10.8 Research Recommendations

The Working Group considered the research required to improve the quality of the sprat assessment and recommends the following to be addressed before the next meeting of the Working Group:

Data from the acoustic survey in 1996 indicate that sprat abundance estimates can be obtained from this survey. The work deriving these estimates for 1995 and earlier years should be continued.

The improvement of the biological sampling intensity in the last three years should be continued.

Table 10.1.1 Landings of SPRAT in Division IIIa Catch (in tonnes 10^{-3}). (Data provided by Working Group members). These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	Skagerrak				Kattegat			Div. IIIa total
	Denmark	Sweden	Norway	Total	Denmark	Sweden	Total	
1974	17.9	2.0	1.2	21.1	31.6	18.6	50.2	71.3
1975	15.0	2.1	1.9	19.0	60.7	20.9	81.6	100.6
1976	12.8	2.6	2.0	17.4	27.9	13.5	41.4	58.8
1977	7.1	2.2	1.2	10.5	47.1	9.8	56.9	67.4
1978	26.6	2.2	2.7	31.5	37.0	9.4	46.4	77.9
1979	33.5	8.1	1.8	43.4	45.8	6.4	52.2	95.6
1980	31.7	4.0	3.4	39.1	35.8	9.0	44.8	83.9
1981	26.4	6.3	4.6	37.3	23.0	16.0	39.0	76.3

Year	Skagerrak			Kattegat		Div. IIIa	Division IIIa Total
	Denmark	Sweden	Norway	Denmark	Sweden	Sweden	
1982	10.5	-	1.9	21.4	-	5.9	39.7
1983	3.4	-	1.9	9.1	-	13.0	26.4
1984	13.2	-	1.8	10.9	-	10.2	36.1
1985	1.3	-	2.5	4.6	-	11.3	19.7
1986	0.4	-	1.1	0.9	-	8.4	10.8
1987	1.4	-	0.4	1.4	-	11.2	14.4
1988	1.7	-	0.3	1.3	-	5.4	8.7
1989	0.9	-	1.1	3.0	-	4.8	9.8
1990	1.3	-	1.3	1.1	-	6.0	9.7
1991	4.2	-	1.0	2.2	-	6.6	14.0
1992	1.1	-	0.6	2.2	-	6.6	10.5
1993	0.6	4.7	1.3	0.8	1.7	-	9.1
1994	47.7	32.2	1.8	11.7	2.6	-	96.0
1995	29.1	9.7	0.5	11.7	4.6	-	55.6
1996[1]	7.0	3.5	1.0	3.4	3.1	-	18.0

[1]Preliminary.

Table 10.1.2. Div. IIIa Sprat. Landings of sprat ('ooo t) by quarter by the three countries. (Data provided by the Working Group members)

Quarter		Denmark	Norway	Sweden	Total
1994	1	0.3	0.0	0.5	0.8
	2	6.0	0.0	0.3	6.3
	3	37.0	0.1	23.0	60.1
	4	16.1	1.7	11.0	28.8
Total		59.4	1.8	34.8	96.0
1995					
	1	4.8	0.1	4.8	9.7
	2	10.4	0.0	0.9	11.3
	3	19.3	0.0	2.3	21.6
	4	6.3	0.4	6.3	13.0
Total		40.8	0.5	14.3	55.6
1996					
	1	5.6	+	4.2	9.8
	2	3.4		0.2	3.6
	3	+	0.4	+	0.4
	4	1.4	0.6	2.2	4.2
Total		10.4	1.0	6.6	18.0

Table 10.1.3. Species composition in the Mixed clupeoide fishery in Div. IIIa.Landings in tonnes.[1]
(Data provided by Working Group members)

KATTEGAT	Sprat	Herring	Cod	Haddock	Whiting	Norway pout	Sandeel	Blue whithing	Others	Total
1995	7750	4937	238	184	2597	341	1	0	628	16676
1996	3380	8767	99	107	1203	225	2	0	369	14152
SKAGERRAK										
1995	3840	3192	110	385	1494	1262	1	0	350	10634
1996	1057	4093	44	203	424	572	437	1	209	7040
DIV.IIIa										
1995	11590	8129	348	569	4091	1603	2	0	978	27310
1996	4437	12860	143	310	1627	797	439	1	578	21192

[1] 1995-1996 Danish landings

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Table 10.2.1 Division IIIA Sprat. Landed numbers (millions) of sprat by age groups in 1994-1996.

Country	Fishing area	Quarter	Age					
1994			0	1	2	3	4	5+
Denmark	Skagerrak	1		16.28				
		2		1191.33				
		3		4221.72	21.21			
		4	16.47	874.75	23.79			
Denmark	Kattegat	1		5.02	7.39	3.48	0.31	
		2		0.92	36.53	6.30		
		3	3.69	632.38	5024.00	42.11		
		4	5.73	287.74	42.28	21.50		
Sweden	Skagerrak	1						
		2						
		3	18.49	2135.32	37.64	8.21	2.08	6.53
		4	1.51	911.44	7.30	7.10	0.32	
Total Div.IIIa		1	0.00	21.30	7.39	3.48	0.31	0.00
		2	0.00	1192.25	36.53	6.30	0.00	0.00
		3	22.18	6989.42	5082.85	50.32	2.08	6.53
		4	23.71	2073.93	73.37	28.60	0.32	0.00
1995								
Denmark	Skagerrak	1		66.07	199.32	8.77		
		2		1026.38	758.87	34.58		
		3		1304.54	108.83			
		4		255.41	2.32			
Denmark	Kattegat	1		205.54	194.92	32.79	21.25	7.38
		2		124.37	117.94	19.84	12.86	4.48
		3		315.11	16.64	13.31		
		4		277.62	19.66		0.60	
Sweden	Div.IIIa	1		21.54	342.64	8.70	4.39	1.08
		2		22.37	56.35	2.94	1.46	
		3						
		4		315.08	109.50	28.14	9.34	
TOTAL	Div. IIIa	1		293.15	736.88	50.26	25.64	8.46
		2		1173.12	933.16	57.36	14.32	4.48
		3		1619.65	125.47	13.31	0.00	0.00
		4		848.11	131.48	28.14	9.94	0.00
1996								
Denmark	Skagerrak	1		125.22	128.11	7.88	1.31	0.00
		2		0.00	232.44	23.83	0.00	0.00
		3		0.20	1.04	0.17	0.01	0.00
		4		11.15	59.22	9.78	0.73	0.00
Denmark	Kattegat	1		40.54	185.99	27.82	7.68	2.91
		2		0.51	5.55	0.74	0.41	0.04
		3		0.00	0.00	0.00	0.00	0.00
		4		6.77	35.98	5.94	0.44	0.00
TOTAL	Div.IIIa	1		165.76	314.10	35.69	9.00	2.91
		2		0.51	237.99	24.57	0.41	0.04
		3		0.20	1.04	0.17	0.01	0.00
		4		17.92	95.20	15.72	1.17	0.00

Table 10.2.2. Div. IIIa Sprat. Quarterly mean weight (g) at age in the landings in 1994-1996 . (1994-1995 Danish and Swedish data, 1996 Danish data)

Quarter	Age					
1994	0	1	2	3	4	5+
1		4.5	18.3	20.3	24.7	
2		4.3	20.0	22.8		
3	7.8	8.1	17.4	21.6	22.1	17.6
4	4.2	11.2	17.1	22.3	31.0	
Total	6.0	8.4	17.8	21.9	27.2	17.6
1995						
1		2.3	8.9	18.8	22.9	26.1
2		2.9	7.3	12.4	23.7	27.0
3		10.5	18.4	15.5		
4		11.5	15.6		18.2	
Total		7.8	9.2	15.3	22.2	26.4
1996						
1		9.2	10.6	14.2	17.4	17.7
2		8.6	12.5	15.1	17.4	17.0
3		4.2	10.9	15.5	21.0	
4		4.2	10.9	15.5	21.0	
Total		8.7	7.6	14.8	19.6	17.7

Table 10.2.3 Division IIIa Sprat. Sampling commersial landings for biological samples 1996

Country	Quarter	Landings ('000 t)	No. samples	No. meas.	No. aged
1996					
Denmark					
Skagerrak	1	2.8	15	1206	199
	2	3.3	4	312	172
	3		5	13	
	4	0.9	5	251	
Total		7.0	29	1,782	371
Kattegat	1	2.7	17	1,533	562
	2	0.1	2	196	196
	3		1	116	116
	4	0.5	1	24	24
Total		3.3	21	1,869	898
Denmark		10.3	50	3651	1269
Norway		1	0	0	0
Sweden		6.6	0	0	0
Total		18	50	3651	1269

Table 10.3.1. Div. IIIa Sprat. Revised indices of sprat per age group from IBTS(February) 1984-1997. (Mean number per hour per rectangle weighted by area. Only hauls taken in depths of 10-150 m are included).

Year	No Rect	No hauls	Age Group					
			1	2	3	4	5+	Total
1984	15	38	5779.73	854.30	207.60	80.09	61.47	6983.19
1985	14	38	2397.24	2395.15	368.76	128.50	49.11	5338.76
1986	15	38	664.99	1918.53	1786.59	116.20	31.91	4518.22
1987	16	38	2244.33	2501.38	2224.94	1655.66	78.69	8705.00
1988	13	38	939.91	5461.23	1519.15	2130.02	459.41	10509.72
1989	14	38	437.60	994.37	1077.13	603.41	147.86	3260.37
1990	15	38	502.83	237.76	69.90	65.65	49.04	925.18
1991	14	38	636.17	456.74	493.57	86.03	215.58	1888.09
1992	16	38	6016.26	605.99	272.13	215.45	79.26	7189.09
1993	16	38	1789.73	4623.70	996.75	218.97	260.08	7889.23
1994	16	38	1546.88	614.35	961.44	299.48	67.58	3489.73
1995	17	38	2282.92	1828.84	37.24	47.86	4.53	4201.39
1996	15	38	176.15	5800.45	794.23	135.95	228.51	7135.29
1997	16	41	200.80	409.84	1307.35	147.36	144.17	2209.52

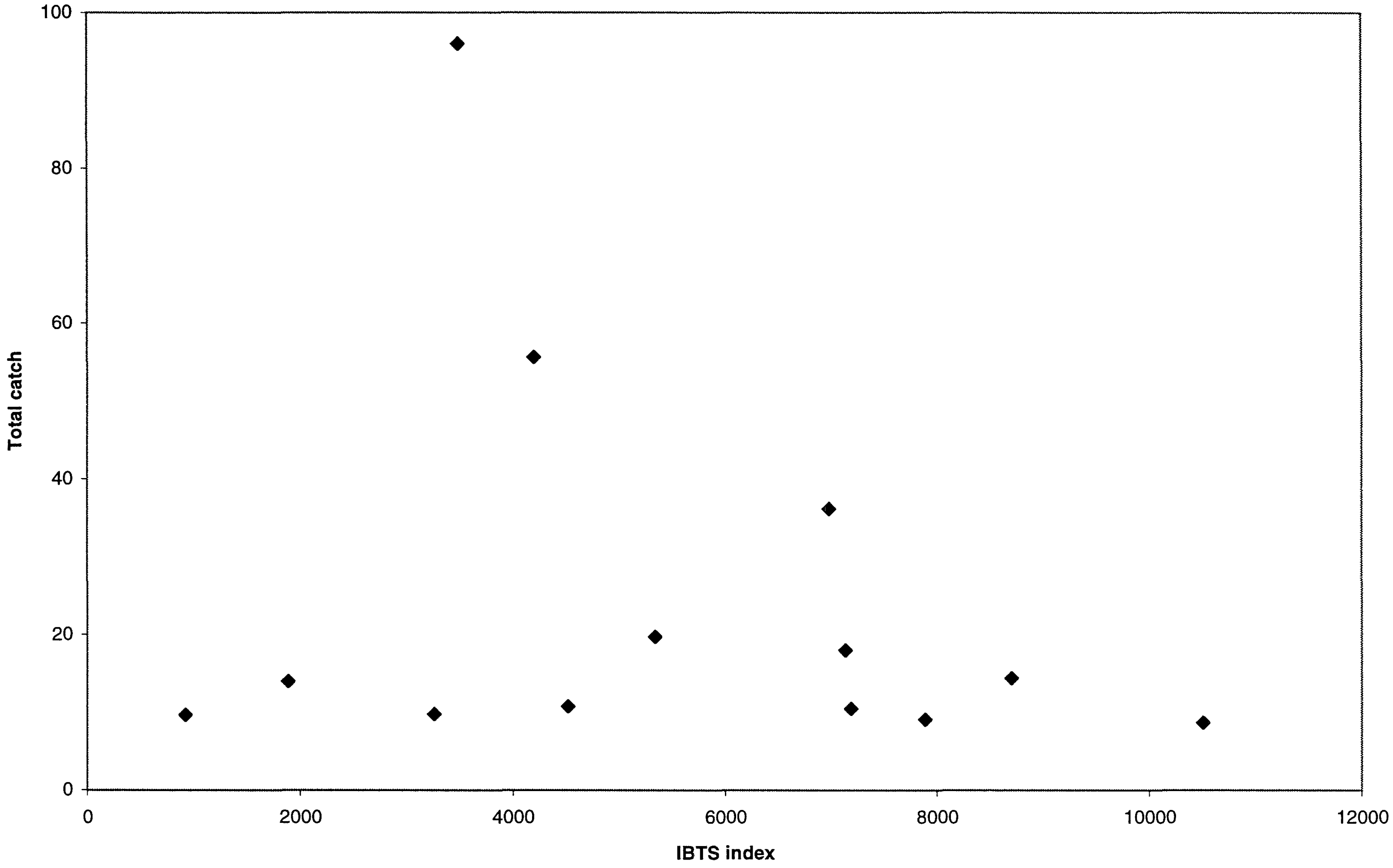
Table 10.6.1. SPRAT Div. IIIa. SHOT forecast of landings in 1997 using total landings and the total IBTS(February) indices as input data.

```
Div.IIIa sprat                         SHOT forecast spreadsheet version 6
Total   index                                         Mars 1997

running recruitment weights
      older      0.00                          G-M =  0.00
      central    1.00                         exp(d)  1.00
      younger    0.00                       exp(d/2)  1.00
```

Year	Land -ings	Recrt Index	W'td Index	Y/B Ratio	Hang -over	Act'l Prodn	Est'd Prodn	Est'd SQC.	Act'l Expl Biom	Est'd Expl Biom	Est'd Land -ings
1984	36	6983		0.77	0.23				47		
1985	20	5339	5339	0.77	0.23	15			26		
1986	11	4518	4518	0.77	0.23	8	26	24	14		
1987	14	8705	8705	0.77	0.23	15	31	27	18		
1988	9	10509	10509	0.77	0.23	8	22	20	12	26	20
1989	10	3260	3260	0.77	0.23	10	5	6	13	8	6
1990	10	925	925	0.77	0.23	10	2	4	13	5	4
1991	14	1888	1888	0.77	0.23	15	4	5	18	7	5
1992	11	7189	7189	0.77	0.23	10	17	16	14	21	16
1993	9	7889	7889	0.77	0.23	8	17	16	12	20	16
1994	96	3490	3490	0.77	0.23	122	7	7	125	10	7
1995	56	4201	4201	0.77	0.23	44	17	35	73	46	35
1996	18	7135	7135	0.77	0.23	7	33	38	23	49	38
1997		2210	2210	0.77	0.23		9	11	0	15	11

Figure 10.6.1.Div.IIIa sprat. IBTS total indices vs total catches in 1984-1997. (rsq=0,05)



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