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Pelagic Fish Commitee

Report on Herring Acoustic Surveys in the North Sea, Skagerrak and Kattegat during Summer 1988

E. Kirkegaard[1], A. Aglen[2], R.S. Bailey[3], S.T. Forbes[3] and O. Hagström[4].

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ABSTRACT

Four herring acoustic surveys coordinated by ICES were carried out by Scottish, Norwegian, Swedish and Danish vessels during the period 24 June to 19 August 1988. The reports on the individual surveys, giving a short description of the survey, and a presentation of the results, are collected in this paper.

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Four herring acoustic surveys coordinated by ICES were carried out by Scottish, Norwegian, Swedish and Danish vessels during the period 24 June to 19 August 1988. The reports on the individual surveys, giving a short description of the survey, and a presentation of the results, are collected in this paper.

Introduction

Four acoustic surveys on herring were carried out by Scotland, Norway, Sweden and Denmark during the period 24 June to 19 August in the North Sea, Skagerrak and Kattegat. The Surveys were coordinated through ICES.

A short description and the combined results for herring of these surveys are given in Anon. (1989).

This paper contains the report on each survey including a detailed description of the survey and a presentation of the results.

REPORT ON THE 1988 HERRING ACOUSTIC SURVEY BY FRV SCOTIA IN THE NORTHERN NORTH SEA

by

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As part of an ICES-coordinated acoustic survey of the North Sea, "Scotia" surveyed the northwestern North Sea from 6-23 July 1988. The cruise track together with midwater trawl haul positions is shown in Figure 1.

The survey was carried out using a Simrad EK400 38 kHz sounder interfaced to an Aberdeen echointegrator. Table 1 shows the equipment settings and the results of calibrations carried out during the survey.

For operational reasons changes had to be made to the survey design during the cruise and track spacing was therefore not uniform. Within each part of the area covered, however, the exact position of each east-west track was selected randomly within certain constraints. The ends of each track were then designed to give approximately equal length of track within each quarter statistical rectangle. Trawl hauls were carried out where required to identify echotraces. The species composition of each haul was determined (Table 2) and herring sampled from every haul for length, age and maturity. From each haul otoliths were taken as follows: Five per ½ cm $\leq$ 26.5 cm; 10 per ½ cm > 26.5 cm. In addition separate samples were taken for determination of

weight-length relationship, fecundity and vertebral count.

Data from the echointegrator were summed over quarter hour periods (2.5 nautical miles at 10 knots). By inspection of echotraces combined with the results of trawl hauls, the data were allocated into three categories: traces judged to be herring; traces that were probably herring, and traces that were probably not herring. Compared with the 1987 survey, this classification was not easy in some areas.

To calculate integrator conversion factors, the target strength was estimated using the TS/length relationship recommended by the acoustic survey planning group (Anon, 1982):

$$Ts = 20 \log_{10} L - 71.2 \text{ dB per individual}$$

The weight length relationship over the survey as a whole was:

$$W(g) = 0.0022315\ L^{3.413} \quad (L \text{ in cm})$$

To convert the echointegration data to numbers of herring, data from each haul were examined to determine areas within which similar length compositions were found (Table 3). On this basis, the survey area was divided into two subareas as shown in Figure 2. Within each subarea the mean length distribution in all hauls from that subarea was used to calculate the mean target strength per individual.

Results

The estimated numbers and biomass of herring in each quarter statistical rectangle are given in Figures 3 and 4 respectively. They are also summarised by area in Table 4 which in addition gives mean lengths and weights at age.

In the survey area as a whole, the population was dominated by 2-ring herring which formed an estimated 62% of the total. The percentages mature at each age were 66% of 2-ringers, 81% og 3-ringers and all fish older than 3-ringers.

A large proportion of the herring found during the survey were in the northern and western parts of the survey area. Unlike previous years herring distribution extended into deep water along the edge of the Continental Shelf and it was in these areas that the highest percentage of large herring was found. A concentration of traces southwest of Orkney thought to be herring was not sampled.

The estimated number of herring in the area surveyed by Scotia was 3,022 million, the biomass being 466,600 tonnes of which 377,200 tonnes were mature.

RESULTS FROM A HERRING ACOUSTIC SURVEY WITH R/V "ELDJARN"
24 June - 16 July 1988.

by

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Figure 5 shows survey grid and trawl positions. The data were worked out within the sub-areas shown in Figure 6.

About 5 days of the scheduled time were lost in the beginning of the survey. Therefore the coverage could not be as complete as planned. The integrator did not operate during the last four days of the survey. Herring recorded during that period were given integrator values equal to the values obtained on similar recordings earlier during the survey. The rectangles covered without integrator are indicated in Figure 7 (parts of subareas B and D).

Within the area covered the herring distribution seemed some different from earlier years. Surprisingly large amounths of herring were recorded in the area north of 61°N. It might even have continued north of the covered area. In addition some amounts were found along the western edge of the Norwegian Trench between N 58°30' and N 60°00. In both of these areas the herring were found in small schools at 15-40 m depth, mainly in areas of 150-250m bottom depth. The schools were difficult to catch. Another consentration was found along bottom in the Fladen area (110-140m bottom depth), as in earlier years. Surprisingly little adult herring were recorded in the covered part of IVb. Some schools were recorded at various depths in the Devils hole /Gut - area.

Some O-group herring were recorded along the Brittish coast and some sprat were recorded in the southwestern part of the area covered.

The integrator values were allocated to the cathegories: herring (1+), 0-group herring, sprat, fish in mixed pelagic recordings, fish in mixed recordings along bottom, and plankton. In the Fladen area values for herring were split out from the values of fish in mixed recordings along bottom according to the proportion of herring in bottom trawl catches.

The results are presented in Figures 7 and 8 and Tables 5-8. The results are based on TS = 20 log L -71.2 dB ref 1 herring of L cm and TS=-8.7 log L -19.6 dB ref 1 kg sprat of L cm. The average length distributions (Table 5) and age-length keys within sub-areas were used to calculate number of fish per age group (Table 6). Fish at maturity stages 3-5 were considered as spawners. For the whole survey the average percentage of spawners was 72 for 2-ringers and 96 for 3-ringers. The percentage was highest in the northern sub-areas, where also the size of 2- and 3-ringers was largest. Mean weight at age is listed in Table 7. Seperate mean

weights for mature and immature fish were calculated by assuming that the ratio between mean weight of mature and immature fish was 1.51 for 2-ringers and 1.22 for 3-ringers. These ratios are average values from the survey carried out by "Scotia" in the Shetland area in summer 1987.

An estimate of 2870 million spawners (499 000 tonnes) were obtained in the covered part of IVa (sub-areas A-C), and an estimate of 486 million spawners (60 000 tonnes) were obtained in the covered part of IVb (sub-areas D-G). Compared to the results in 1987 it is a large increase in the covered part of IVa and a large decrease in the covered part of IVb.

Some uncertainities about the results have to be mentioned. Firstly some rectangles along the boarders of the most important areas were not properly covered. Therefore the observations in the north-western rectangle of subarea A were taken to represent only one quarter rectangle and the observations in three of the rectangles in subarea C were taken to represent only half the rectangle. Then the uncovered (deepest) parts of the rectangles are excluded In neighbour rectangles the herring densities tended to decrease sharply when entering deeper waters. If the observations in those partly covered rectangles are applied for the whole rectangles it will increase the biomass by about 200 thousand tonnes.

In the northern part of the Fladen area small herring schools were partly masked by heavy plankton recordings and in the whole Fladen area herring was mixed with Norway pout on the bottom. Therefore the allocation of integrator values was difficult in this area.

During the period when the integrator was out of order about 25 quite small schools and 5 og 6 larger schools were recorded. The values given for those schools are thought to be on the "conservative" side. The errors made by this procedure might have some impact on the estimate of sub-area D, but compared to the total survey estimate this error is small.

During daytime the sonar was watched. Some school countings and videorecords were made. Those observations gave some additional information on the herring distribution. This will hopefully be reported later. Herring schools were recorded on the sonar in at least two of the rectangles where no herring were recorded on the echo sounder.

REPORT ON THE 1988 ACOUSTIC SURVEY By R/V "ARGOS" IN NORTHEASTERN NORTH SEA, SKAGERRAK AND KATTEGAT

by

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The Swedish survey was carried out by R/V "Argos" during the period 1-19 August 1988. The areas covered by the survey are shown in Figure 9. The integration was carried out using a Simrak EK 400 38 kHz sounder and a Nord 10 computer with the same integration program as used in the Norwegian survey. The methods and stratification used are the same as used in the Danish survey. The strata are shown in fig. 10. A total of 46 pelagic hauls were made during the survey. The survey statistics are given in table 9.

Vertical counts showed that two main components of herring, autumn spawners from the North Sea and spring spawners from Division IIIa, Southwestern Baltic, were mixed in the surveyed area. The two components were separated using a modal length analysis and results were verified with vertebral counts for each component. The result of the split is shown in Table 10.

Results

The estimated numbers, mean weights and biomass at age of herring in each stratum are given in table 11 - 13. The estimated biomass per stratum of sprat, cod, haddock, whiting, blue whiting, mackerel, saith, horse mackerel, norway pout and dogfish are given in table 14.

Spring spawners dominated the 3-group and older herring in all of the surveyed area up to about 60° 20′ N. The 2-group herring found in the North Sea part was mixed from the entrance of the Skagerrak up to about 59° N. The separation indicated that 71% of the 2-group were autumn spawners. This should be regarded as a minimum value as the VS count indicates that the separation is not complete.

All the 0- and 1-group herring in the survey area could be allocated to the North Sea autumn spawners.

Sonar observations during the survey showed that herring shoals were close to the surface both during day and night, especially in deeper waters. Avoidance reactions were frequently observed and the estimate of age group 3 and older herring could be too low.

REPORT ON THE ACOUSTIC SURVEY by "RV DANA" IN THE EASTERN NORTH SEA JULY - AUGUST 1988

by

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During the period 21 July - 4 August an acoustic survey primarily targeted at herring was carried out by "RV DANA" in the eastern North Sea. The cruise track and positions of trawl hauls are shown in fig. 11.

The survey was carried out using a simrad EK400 38kHz sounder and a QD integrator. During the survey 18 pelagic and 7 demersal trawl hauls were taken. The species composition per trawl haul are shown in table 15.

The stratification used in the calculations is based on total depth within larger geographical units (subareas). Each subarea is divided in up to six strata based on bottom depth: 1. 0-20 m; 2. 20-40 m; 3. 40-60 m; 4. 60-100 m; 5. 100-300 m; 6. > 300 m. The subareas are shown in fig. 10.

For each stratum a mean TS value per fish is estimated using species and length compositions of the trawl hauls taken in the stratum and published TS-length relationships. The total number of fish is then estimated using the mean area back scattering values, the area of the stratum and the mean TS value. The number of fish is then allocated to species and length group using the composition of the trawl hauls. The TS-length relationships used are given in table 16.

Due to technical problems with the integrator the first three days of the survey, no acoustic data are available for strata A, B, I, P and O.

Results

As shown in table 1, herring and mackerel caunted for more than 70% of the total catches. Compared with previous years surveys, the catch of horse mackerel was very low.

The estimated numbers, mean weight and biomass at age of herring and mackerel in each subarea are given in table 17-22. The estimated number of herring was 9.557 million (350.000 t). 1-ring fish dominated (60% in number), while the abundance of 0-ring herring was found to be very low compared with previous years.

The estimated numbers and biomass at length of cod, whiting, haddock, sprat and horse mackerel are given in table 23-32.

Table 1

Specifications, settings and calibration results of the acoustic equipment on FRV Scotia.

Echo sounder	EK400
Frequency	38 kHz
Receiver gain	-10 dB
TVG	20 log R + 2 ÁR
Á	0.008 dB/m
Pulse length	1.0 ms
Bandwidth	3.3 kHz
Range	150/200 m(changed during survey according to depth of water column)
Transducer	15 by 30 cm
Equivalent beam angle	-17.75 dB/Strn (measured)
Integrator	Aberdeen
Threshold (effective)	20 mV

Source level and voltage response referred to one metre on the TVG function measured once for 38 kHz system using 38.1 mm tungsten carbide ball.

19 - 20 July 53.75 dB//1_{Vrms}

VR + SL used for the survey = +53.80 dB//1_{Vrms}

Table 2

Trawl hauls by FRV Scotia, position, date, time and number of fish caught in each haul

Haul No	Position		Date	Time (BST)	Duration (h.m)	Numbers caught								Comments
	Latitude	Longitude				Herring	Sprat	Whiting	Haddock	Norway Pout	Mackerel		Others	
185	59°54'N	01°13'W	8 July	1220	0.30	-	-	1	1	-	1	6	Sabastes viviparus	0-group N pout meshed
186	59°43.8'N	00°44.2'W	8 July	1950	0.35	874	-	-	15	3	-	1	Gurnard	-
187	59°43.8'N	00°41.5'W	8 July	2105	0.35	-	-	-	-	-	-	-		-
188	59°26.4'N	01°39.4'W	9 July	0725	0.30	-	-	-	-	-	-	-		0-group N pout meshed
189	59°26'N	01°05.6'W	9 July	1105	0.45	361	-	30	1	-	85	2	Gurnard	-
190	59°37'N	01°11'W	9 July	1440	1.20	2	-	30	-	-	8	1	Gurnard	-
191	60°26.1'N	01°49.5'W	10 July	1102	1.00	3361	19	33	20	5	-	10	Argentina sphyraena	-
192	60°39.4'N	01°36.4'W	10 July	1725	1.00	1685	-	1	1	-	3	-		-
193	60°57'N	00°42.1'W	11 July	1003	0.30	-	-	-	-	-	-	-		0-group N pout meshed
194	59°26.1'N	03°36.8'W	14 July	0721	0.36	239	2	3	1	1	24	1	Squalus acanthias	-
195	59°22.8'N	03°36.4'W	14 July	0844	0.56	6	-	-	-	-	2	1	S. viviparus	-
196	59°28.4'N	03°02'W	14 July	1250	1.00	1	-	5	52	-	18	-		0-group N pout and sandeels meshed
197	59°32.0'N	03°47.1'W	14 July	1938	0.39	2154	-	20	12	100	-	2	Horse mackerel	-
												84	Hyperoplus lanceolatus	
												4	A. sphyraena	
												4	Trisopterus minutus	
												4	Phycis blennoides	
												9	Hyperoplus immaculatus	
198	59°53.5'N	03°20'W	15 July	1340	1.30	88	-	-	3	278	-	1	Cod, 1 Lumpsucker	0-group N pout meshed
199	60°01.4'N	02°13.1'W	15 July	1945	1.11	94	-	1	9	3	-	1	S. acanthias	0-group N pout meshed
												1	Saithe, 2 Gurnard	
200	60°27'N	02°17'W	16 July	0800	0.38	3030	-	32	6	122	3	3	Saithe, 96 H Mackerel	-
												3	Lumpsucker	
201	60°50'N	01°11.5'W	16 July	1500	1.00	4908	-	6	18	-	312	6	Horse Mackerel	-
202	61°12.4'N	01°22.9'W	17 July	0955	0.46	998	-	-	3	-	-	86	Argentina silus	-
												2	A. sphyraena	
203	61°17'N	00°22'W	17 July	1255	0.20	-	-	-	-	-	-	-		Maurolicus muelleri meshed, gear damaged

Table 2 (continued)

Haul No	Position: Latitude	Position: Longitude	Date	Time (BST)	Duration (h.m)	Numbers caught: Herring	Sprat	Whiting	Haddock	Norway Pout	Mackerel	Others	Comments
204	60°55.2'N	00°22.3'W	17 July	1835	0.55	-	-	-	-	-	-	-	0-group N pout meshed
205	60°04.5'N	01°06.5'W	18 July	1450	0.40	-	-	17	2	-	-	-	0-group N pout meshed
206	59°17.2'N	00°34.6'W	19 July	0926	1.09	6834	-	-	-	-	17	1 Lumpsucker	Small mackerel meshed
207	58°50.1'N	01°31'W	20 July	0942	0.44	3877	-	12	18	35	-	-	-
208	58°43'N	00°12'W	20 July	1525	1.00	2145	-	-	-	2	-	-	-
209	58°03.8'N	01°09.6'W	1 July	1525	0.45	4482	-	45	-	-	-	2 Lumpsucker	0-group herring and 0-group whiting meshed
210	57°38.7'N	00°47'W	22 July	1155	1.00	3339	5	5	15	-	-	- -	0-group herring meshed

Table 3

Percentage length composition of herring by trawl haul and by area showing number caught, mean length, mean weight and mean target strength

	Area I			Area II														
½ cm below	200	202	mean	186	189	191	192	194	197	198	199	201	206	207	208	209	210	mean
15.5																	0.4	0.0
16.0																		
16.5																		
17.0																		
17.5									0.2									0.0
18.0								0.4										0.0
18.5								0.4						0.7				0.1
19.0								0.4										0.0
19.5								1.7									0.4	0.1
20.0								1.3	0.2							0.2		0.1
20.5								2.5	0.2							0.2		0.2
21.0						0.4		4.6	0.2							1.2	0.4	0.5
21.5				1.4	0.3	1.7		4.6	2.2			0.2		1.1	0.4	0.4		0.9
22.0	0.7		0.3	2.7	2.5	0.8		6.3	3.9			0.2		5.1		3.7	0.4	1.8
22.5				7.8	5.8	3.7	2.5	6.3	5.8	1.1		0.7	0.5	7.9		5.3	2.1	3.6
23.0				5.9	11.1	5.4	3.3	9.2	5.6	2.3	2.1	2.7	2.2	10.5	2.5	7.2	5.5	5.4
23.5	3.0	0.2	1.6	15.1	20.2	3.7	12.9	11.3	6.1	10.2	9.6	4.9	5.2	11.9	3.8	8.0	8.4	9.4
24.0	2.3	1.1	1.7	10.5	18.3	29.2	17.4	13.0	10.5	15.9	12.8	6.8	5.7	15.9	9.2	8.0	16.4	13.5
24.5	3.6	2.3	3.0	21.5	14.1	17.9	17.9	10.5	13.4	17.0	14.9	11.0	10.2	19.5	13.0	15.6	15.9	15.2
25.0	5.6	2.7	4.2	9.2	9.4	16.2	14.5	6.7	4.9	13.6	12.8	13.0	10.9	10.1	18.0	13.2	19.3	12.3
25.5	7.3	2.5	4.9	5.5	5.3	12.1	13.7	6.3	7.1	11.4	9.6	12.2	12.2	7.6	13.4	10.7	12.6	10.0
26.0	5.0	3.4	4.2	0.9	2.8	4.2	7.9	4.2	5.6	10.2	10.6	7.6	6.7	4.3	13.0	6.0	6.3	6.5
26.5	4.6	1.1	2.9	3.0	2.8	1.7	4.6	2.1	5.1	5.7	5.3	6.6	8.5	2.5	8.4	5.6	3.8	4.7
27.0	5.0	1.4	3.2	1.8	1.7	0.8	1.1	1.7	2.9	2.3	6.4	4.9	4.2	0.4	7.6	2.5	1.5	2.8
27.5	6.3	5.1	5.7	3.7	3.0	1.1	1.4		5.1	3.4	5.3	6.1	6.2	0.6	2.8	2.9	1.0	3.0
28.0	4.0	6.3	5.1	0.5	0.8	0.1	0.5	2.1	1.2	1.1	1.1	6.6	4.2	0.5	2.3	2.7	1.5	1.8
28.5	7.9	5.1	6.5	3.4			0.4	1.3	2.3	3.4		6.4	6.0	0.2	2.0	3.5	0.8	2.1
29.0	8.9	8.7	8.8	1.8	0.3	0.6	0.1	0.8	2.8		4.3	3.2	4.2	0.5	1.1	1.2	0.8	1.6
29.5	5.6	7.8	6.7	1.6	0.6	0.1	0.5	0.4	2.3	1.1	1.1	1.3	6.0	0.2	0.7	0.4	0.4	1.2
30.0	6.3	9.6	7.9	1.4	0.6		0.2	1.3	4.7		4.3	2.0	1.5	0.4	0.7	0.6	0.6	1.3

Table 3 (continued)

	Area I			Area II														
½ cm below	200	202	mean	186	189	191	192	194	197	198	199	201	206	207	208	209	210	mean
30.5	7.6	10.5	9.1	0.9			0.1		1.9			1.0	2.0	0.1	0.5	0.6	0.4	0.5
31.0	5.9	11.4	8.7		0.3	0.1	0.2		1.5			0.7	1.5		0.2	0.2		0.3
31.5	4.3	8.1	6.2	0.9	0.3		0.5		0.8	1.1		0.9	1.0	0.1	0.1		0.2	0.4
32.0	2.3	7.2	4.8	0.2			0.1	0.4	1.8			0.7	0.7		0.2			0.3
32.5	2.6	2.3	2.5	0.2			0.1		0.5								0.6	0.1
33.0	0.3	0.7	0.5					0.4	0.5			0.1	0.2					0.1
33.5	1.0	1.1	1.0				0.1		0.3								0.2	0.0
34.0		0.5	0.3				0.1					0.1						0.0
34.5		0.2	0.1						0.2									0.0
35.0		0.5	0.3															
35.5																		
36.0																		
Number	3,030	998		874	361	3,361	1,685	239	2,154	88	94	4,908	6,834	3,877	2,145	4,374	3,339	
mean length	28.4	29.7	29.1	25.1	24.6	24.7	25.1	24.1	25.9	25.4	25.8	26.4	26.7	24.4	25.8	25.2	25.1	25.3
mean weight	210	243	227	137	126	128	135	121	156	142	150	162	169	123	149	138	137	141
TS/ind	-42.1	-41.7	-41.9	-43.2	-43.4	-43.3	-43.2	-43.5	-42.9	-43.1	-42.9	-42.7	-42.6	-43.4	-42.9	-43.2	-43.2	-43.1
TS/kg	-35.3	-35.6	-35.5	-34.6	-34.4	-34.4	-34.5	-34.3	-34.8	-34.6	-34.7	-34.8	-34.9	-34.3	-34.7	-34.6	-34.5	-34.6

Table 4

Number of herring, mean length, mean weight and total biomass at age for two subareas (see Fig. 2) and total area

Age breakdown of the stock in subarea I

Age (ring)	Number	Mean length	Mean weight	Biomass ($t \times 10^{-3}$)
1 All	0.00			0.00
2 Immature	22.10	24.51	128.53	2.84
2 Mature	70.80	25.40	144.60	10.24
3 Immature	3.42	24.53	127.97	0.44
3 Mature	126.41	28.27	208.25	26.33
4 All	90.86	29.57	242.58	22.04
5 All	71.40	30.67	273.53	19.53
6 All	65.62	30.94	281.64	18.48
7 All	10.58	31.90	313.05	3.31
8 All	8.67	31.89	312.72	2.71
9+	5.92	32.09	321.85	1.91
Total	475.80	28.81	226.62	107.83

Age breakdown of the stock in subarea II

Age (ring)	Number	Mean length	Mean weight	Biomass ($t \times 10^{-3}$)
1 All	11.84	20.28	70.15	0.83
2 Immature	617.80	23.50	111.74	69.03
2 Mature	1170.86	24.76	132.68	155.35
3 Immature	133.51	24.13	121.76	16.26
3 Mature	445.94	26.71	172.43	76.89
4 All	90.22	28.91	224.11	20.22
5 All	42.32	29.69	245.69	10.40
6 All	26.64	30.90	280.64	7.48
7 All	4.88	31.47	299.59	1.46
8 All	1.53	32.30	325.21	0.50
9+	0.99	33.01	349.92	0.35
Total	2546.54	25.05	140.88	358.76

Table 4 (continued)

Age breakdown of the stock in total survey area

Age (ring)	Number	Mean length	Mean weight	Biomass ($t \times 10^{-3}$)
1 All	11.84	20.28	70.15	0.83
2 Immature	639.90	23.54	112.32	71.87
2 Mature	1241.66	24.79	133.36	165.58
3 Immature	136.93	24.14	121.92	16.69
3 Mature	572.35	27.05	180.34	103.22
4 All	181.09	29.24	233.38	42.26
5 All	113.72	30.30	263.17	29.93
6 All	92.26	30.92	281.35	25.96
7 All	15.46	31.76	308.81	4.77
8 All	10.20	31.95	314.60	3.21
9+	6.91	32.22	325.87	2.25
Total	3022.34	25.65	154.38	466.58

Table 5 Average length distributions (°/oo) of 1 ringed and older herring within sub-areas. Nm=number measured, catches=number of catches with more than 50 herring. N.key = number of fish in the applied age-length key. TS = average target strength (dB ref 1 fish)

Length	SUB - AREA						
(cm)	A	B	C*	D	E	F	G
13							8
14					4		30
15					102		47
16					302		36
17				7	241	23	97
18		1		22	192	34	147
19		5	1	56	57	174	274
20		8		77	57	219	200
21		33	15	115	24	214	102
22		87	70	223	12	140	37
23	9	180	105	253	8	107	15
24	54	301	160	141		56	2
25	254	224	176	64		17	1
26	225	79	137	22		17	
27	128	40	113	9			2
28	116	28	97	9			1
29	81	5	66	2			
30	60	8	24				
31	48		29				
32	21	1	6				
33	3		1				
34	2						
Nm	579	794	791	845	245	178	944
N.key	426	611	279	446	185	185	267
Catches	3	7	10	4	2	1	3
-TS	42.4	43.3	42.8	44.0	46.2	44.6	45.4

* Includes samples from 8 commercial purse seine catches and one trawl catch from R/V "M.Sars" from the same area and time period.

Table 6 Estimated number of herring (millions) per age group within the sub-area shown in Figure 2. N = number (millions), B - biomass (thousand tonnes), m-2r = Percentage mature 2-ringer, m-3r = percentage mature 3-ringers. Eldjarn 24/6 - 16/7 1988, (REVISED 21 Feb 89)

Age (winter rings)	SUB - AREA							
	A	B	C	D	E	F	G	TOTAL
0				667.0	2736.0		1248.0	4651
1		7.2	1.9	81.2	185.3	90.6	193.1	559
2	488.3	453.4	242.9	441.5	20.2	121.6	41.7	1810
3	681.3	213.2	233.5	94.1	.2	12.3	20.2	1255
4	280.0	50.1	48.9	10.8		1.0	3.2	394
5	193.7	34.2	54.3	6.2		.7	.1	289
6	75.0	4.8	32.5	1.5			.5	114
7	22.3	4.8	5.1	.8				33
8	12.7	.2	.9					14
9+	7.4							7
Total N	1761	768	620	1303	2942	226	1507	9127
Total B	318	103	105	69	17	20	20	652
m-2r	93	74	67	66	31	31	41	72
m-3r	99	93	93	99	50	50	44	96
Spawning N	1720	628	522	404	6	46	30	3356
Spawning B	314	90	95	51	1	6	3	560

Table 7 . Mean weight at age (g) within sub-areas. Eldjarn 24/6-16/7 1988.

Age (winter rings)	SUB-AREA							TOTAL
	A	B	C	D	E	F	G	
0				2	3		2	2
1		65	83	60	45	72	56	55
2-imm	94	89	97	77	66	83	70	88
2-mat	142	134	146	117	99	126	106	133
2	138	122	130	104	76	97	85	120
3-imm	136	118	142	110	108	144	82	131
3-mat	166	144	173	134	132	176	100	160
3	166	142	171	134	120	139	126	159
4	211	169	213	178		160	212	204
5	237	183	243	188		165	121	231
6	260	222	255	190			212	255
7	275	183	239	199				254
8	283	296	304					284
9+	296							296

Table 8 Estimated number (N,millions), biomass (B '000 tonnes), mean length ($\bar{l}$,cm) and mean weight (w,grams) of sprat and 0-group herring by sub-area. R/V "Eldjarn" 24 June - 16 July 1988.

Sub-area		D	E	F	G	TOTAL
0-GROUP HERRING	N	667	2736	0	1248	4651
	B	1.3	7.1	0	2.9	11.3
	$\bar{l}$	7.5	7.8	-	7.3	
	$\bar{w}$	2.0	2.6	-	2.3	
	$-TS_{ind}$	53.7	53.3	-	53.9	
SPRAT	N	52	270	189	450	963
	B	.7	4.6	3.7	6.4	15.4
	$\bar{l}$	12.3	13.0	13.3	12.3	
	$\bar{w}$	13.5	17.0	19.5	14.3	
	$-TS_{kg}$	29.1	29.3	29.4	29.1	

Table 9

Survey statistics . R/V Argos

Area	Stratum	Area sq.mile	No of mile integrated	No of trawl hauls
N. North Sea	AA	1800	66	1
	AB	900	27	1 *
	AC	1841	131	2
	Z	3682	199	4
	Total:	8223	423	7
S. North Sea	AD	954	22	2 *
	T	2836	130	3
	O	3790	264	5
	P	3894	265	6
	I	3894	244	2
	U	1947	36	1 *
	Total:	17315	961	16
Skagerrak	A1	339	34	2 *
	A2	191	20	2 *
	A3	212	18	2
	A4	523	14	1
	A5	655	64	1
	B0	539	14	1 *
	B1	324	50	1
	B2	156	16	1 *
	B3	278	8	1
	B4	490	44	2
	B5	1124	84	2 *
	C2	29	10	1 *
	C3	200	24	1
	C4	476	49	2
	C5	127	10	2 *
	D0	136	6	1 *
	D1	71	19	1 *
	D2	169	50	1
	D3	433	54	1
	D4	733	127	4
	D5	295	22	4 *
	Total:	7500	737	17
Kattegat	E0	3493	60	3 *
	E1	1216	216	3
	E2	382	100	2
	E3	137	34	1
	Total:	5228	410	6

* = Trawl data from other area

Area		Age group 1	2	3	4	5
IVa E North	% autumn sp.	100	100			
	VS	56,46	56,21			
	mean length	215,00	245,28			
	% spring sp.			100	100	100
	VS			55,89	55,77	55,81
	mean length			250,65	277,95	281,71

Area		Age group 1	2	3	4	5
IVa E South	% autumn sp.	100	71			
	VS	56,57	56,34			
	mean length	209,84	245,34			
	% spring sp.		29	100	100	100
	VS		56,07	56,13	56,14	55,83
	mean length		208,24	258,89	277,88	285,43

Area		Age group 1	2	3	4	5
Skagerrak	% autumn sp.	100				
	VS	56,37				
	mean length	177,41				
	% spring sp.		100	100	100	100
	VS		56,03	55,80	55,68	55,66
	mean length		211,29	238,12	259,34	274,69

Area		Age group 1	2	3	4	5
Kattegat	% autumn sp.	100				
	VS	56,46				
	mean length	161,67				
	% spring sp.		100	100	100	100
	VS		55,89	55,77	56,00	55,60
	mean length		198,29	225,89	233,57	254,00

Table 10. The % autumn and spring spawners per age group and area, based on vertebral count. R/V "Argos"

Table 11

Estimated number of herring by age group and strata. Numbers in thousands. (R/V "Argos")

	Stratum	Number	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8
N.North Sea	AA	19164	0	0	11518	4159	1744	1514	172		
	AB	223773	0	7161	39160	132473	19245	21930	2014	0	895
	AC	312034	0	8752	107144	133913	21162	32306	6508	987	262
	Z	54708	0	0	29771	11830	5837	4234	467		
	Autumn sp.	203506		15913	187593						
	Spring sp.	401652				282375	47988	59984	9161	987	1157
S.North Sea	AD	27577	0	7225	19056	938	138	55	55		
	T	248173	0	26516	143682	71609	3653	1222	663		
	O	404256	0	76754	212038	105004	5817	2098	929		
	P	348581	0	23704	267013	49499	4531	1743	1394		
	I	65376	0	32230	22555	7780	1504	1111			
	Autumn sp.	638113		166429	471684						
	Spring sp.	452403			192660	234830	15643	6229	3041		
Skagerrak	A1	137784	23148	110778	3445	138					
	A2	152364	25597	122500	3809	152					
	A3	114883	19300	92366	2872	115					
	A4	14764	0	3440	3543	4902	1565	812	443	30	
	A5	448689	0	223447	149413	53843	9871	5384	5384		
	B2	170916	139980	24954	5127	513					
	B3	140504	115073	20514	4215	422					
	B4	93851	0	15767	51430	24401	1971				
	B5	137326	0	23071	75255	35705	2884				
	C2	199518	191937	6983	399						
	C3	811962	781108	28419	1624						
	C4	484382	484	385084	72657	23250	1453				
	C5	67788	68	53892	10168	3254	203				
	D0	231186	95018	125303	9016	1156					
	D1	156125	64168	84620	6089	781					
	D2	403402	165798	218644	15733	2017					
	D3	1059247	239390	484076	309300	21185	2118				
	D4	1024758	198803	713232	100426	10248					
	D5	192931	37429	134280	18907	1929					
	Autumn sp.	4968671	2097301	2871370							
	Spring sp.	1059557			843428	184011	20065	6196	5827	30	
Kattegat	E0	3327963	542458	2452709	309501	16640					
	E1	1046097	170514	770973	97287	5230					
	E2	598652	17361	510051	63457	5987					
	E3	901671	878228	12623	3607	2705	0	1803			
	Autumn sp.	5354917	1608561	3746356							
	Spring sp.	506217			473852	30562		1803			

Table 12

Mean weight of herring by age group and strata. Mean weights by age. (R/V "Argos")

	Stratum	Mean weight	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8
N.North Sea	AA	151,64			139,55	156,02	192,96	185,75	187,00		
	AB	133,80		86,63	125,12	130,92	162,08	158,10	175,20		175,00
	AC	135,75		97,92	130,85	128,19	163,25	168,95	172,23	241,22	
	Z	151,70			139,62	155,07	184,24	184,24	186,01		
S.North Sea	AD	68,66		65,88	67,57	98,67	149,84	151,32	150,85	166,00	175,00
	T	118,52		85,17	119,28	125,32	182,96	200,22	195,72		
	O	107,55		81,42	110,15	116,67	180,41	190,24	188,50		
	P	129,57		99,91	127,80	146,25	173,09	200,65	215,37	229,32	262,57
	I	90,31		75,61	96,03	113,79	151,75	168,67			
Skagerrak	A1	39,01	9,84	44,48	60,98	72,00					
	A2	39,01	9,84	44,48	60,98	72,00					
	A3	39,01	9,84	44,48	60,98	72,00					
	A4	87,16		56,29	77,80	94,03	102,05	143,18	169,98	182,88	
	A5	78,35		63,59	79,18	107,71	146,86	164,09	182,47		
	B2	19,78	13,28	47,19	58,99	81,40					
	B3	19,78	13,28	47,19	58,99	81,40					
	B4	81,32		72,97	74,27	99,38	120,02	149,00			
	B5	81,32		72,97	74,27	99,38	120,02	149,00			
	C2	10,21	9,55	26,53	46,00						
	C3	10,21	9,55	26,53	46,00						
	C4	43,99	10,00	36,12	68,52	95,77	129,86	136,00			
	C5	43,99	10,00	36,12	68,52	95,77	129,86	136,00			
	D0	21,85	10,96	27,34	50,96	107,69					
	D1	21,85	10,96	27,34	50,96	107,69					
	D2	21,85	10,96	27,34	50,96	107,69					
	D3	39,25	13,52	39,76	54,99	84,44	140,00				
	D4	33,89	9,38	36,68	58,18	84,48					
	D5	33,89	9,38	36,68	58,18	84,48					
Kattegat	E0	26,31	12,23	27,34	41,37	64,56	68,37				
	E1	26,31	12,23	27,34	41,37	64,56	68,37				
	E2	34,20	10,51	33,25	44,07	89,73	77,92	138,02	138,19		
	E3	6,30	5,49	24,77	51,50	50,67		122,00			

Table 13

Estimated biomass in metric tonnes by age group and strata. (R/V "Argos").

	Stratum	Biomass	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8
N.North Sea	AA	2906			1607	649	337	281	32		
	AB	29959		620	4900	17343	3119	3467	352		156
	AC	42360		857	14020	17166	3455	5458	1121	238	46
	Z	7933			4157	1834	1075	781	87		
	Autumn sp.	26161		1477	24684						
	Spring sp.	56907				36992	7986	9987	1592	238	202
S.North Sea	AD	1893		476	1288	93	21	8	8		
	T	29414		2258	17138	8974	668	245	130		
	O	43480		6249	23355	12251	1049	399	175		
	P	45167		2368	34125	7239	785	349	300		
	I	5904		2437	2166	885	228	188			
	Autumn sp.	69219		13788	55431						
	Spring sp.	56636			22641	29442	2751	1189	613		
Skagerrak	A1	5375	228	4927	210	10					
	A2	5944	252	5449	232	11					
	A3	4482	190	4108	175	8					
	A4	1287	0	194	276	461	160	116	75	5	
	A5	35154	0	14209	11830	5799	1450	884	982		
	B2	3380	1859	1177	302	42					
	B3	2779	1528	968	249	34					
	B4	7632	0	1151	3820	2425	237				
	B5	11167	0	1684	5589	3548	346				
	C2	2038	1834	185	18						
	C3	8292	7463	754	75						
	C4	21308	5	13909	4979	2227	189				
	C5	2982	1	1947	697	312	26				
	D0	5050	1041	3425	460	124					
	D1	3411	703	2313	310	84					
	D2	8812	1817	5977	802	217					
	D3	41576	3236	19246	17009	1789	297				
	D4	34732	1864	26160	5843	866					
	D5	6539	351	4925	1100	163					
	Autumn sp.	135080	22372	112708							
	Spring sp.	76863			53976	18120	2705	1000	1057	5	
Kattegat	E0	87572	6636	67059	12803	1074					
	E1	27527	2086	21079	4024	338					
	E2	20477	182	16960	2797	537					
	E3	5677	4821	313	186	137	0	220			
	Autumn sp.	119136	13725	105411							
	Spring sp.	22116			19810	2086		220			

Table 14. Estimated biomass (tonnes) by species and strata.

Stratum	Sprat	Cod	Haddock	Whiting	Blue Whiting	Mackerel	Saithe	Horse Mackerel	Norway Pout	Dogfish
AA				41763			206400			
AB				34174		21939956		8389605		
AC				9984		6651093		2503764		
Z				105660	13247202	1125654	5563052	247102		206745
Total				191581	13247202	29716703	5769452	11140471		206745

AD				4928	7385664	6305786				19008
T		11550	402940	633596	562608	297143	1822800		44268	
O			18400	591086	11427482	8991837	3109401	7191	1229480	27108
P			3158124	4473861	4156494	4431550	18438594	151800	436919	
I				66945	16073483		33863817		962862	
U				2272550						
Total		11550	3579464	8042966	39605731	20026316	57234612	158991	2673529	46116

A		4200	61500	2108866	6368914					1330
B		4777	30961	116478	10408783	97059045	186300	6239	93	
C				4998	686550	1808732		198437	2863	
D	186000		15500	1099142	23664	1463604		274434	1854057	
E	17507605	17500		245080		36200		44885		
Total	17693605	26477	107961	3574564	17487911	100367581	186300	523995	1857031	1330

STATION	SPECIES						TOTAL CATCH
	COD	H.M	HAD	HER	WHI	MAC	
58°04' 08°52'	.	.	.	2	.	30	161
57°17' 08°10'	.	3	.	26	1	4	140
58°17' 05°36'	.	5	.	292	.	.	1027
58°13' 05°34'	.	.	.	562	.	153	1683
58°28' 04°56'	.	.	.	108	0	19	535
58°28' 04°41'	.	.	.	0	0	1	46
57°02' 06°09'	.	1	.	.	.	728	737
57°07' 06°43'	.	8	.	1	.	163	172
56°38' 07°52'	4	5	.	1944	6	3	2190
56°34' 07°14'	.	47	.	76	1	164	290
56°36' 06°40'	.	86	.	865	.	3049	4000
56°25' 03°39'	2	.	2	.	0	4	26
56°18' 04°42'	.	1	.	0	.	177	182
56°18' 05°07'	.	2	.	2	.	1307	1312
56°14' 07°43'	3	5	.	109	94	1	408
55°49' 07°25'	.	95	.	349	0	325	862
55°50' 07°13'	.	300	.	1462	4	494	2488
55°45' 05°13'	17	.	.	1329	32	0	1427
55°45' 03°38'	.	.	.	.	.	110	110
55°41' 03°01'	.	38	.	.	.	392	435
55°18' 05°40'	26	.	1	355	192	38	632
55°02' 07°09'	.	87	.	.	.	96	365
54°51' 03°40'	33	.	1	11	135	.	604
55°20' 04°42'	.	0	.	1675	.	5	1680
total	85	683	4	9168	465	7263	21512

Table 15. Catch in kg of cod, horse mackerel (H.M), haddock (HAD), herring (HER), whiting (WHI) and mackerel (MAC).

Table 16. The species included in the calculations and the used target strength - length relationship. RV "Dana".

Herring	TS = 20.0*log(L)-71.2	(Anon. 1983)
Sprat	TS = 20.0*log(L)-71.2	1)
Horse Mackerel	TS = 20.0*log(L)-71.2	1)
Mackerel	TS = 20.0*log(L)-77.2	2)
Gadoids	TS = 20.0*log(L)-67.5	(Foote, 1986)

1) The herring TS-length relationship.
2) 6 dB below the herring relationship.

Table 17. Mean weight (gram) of Herring by age group and strata.

Strata	age (winter rings)				
	0	1	2	3	4
K	8.43	34.75	58.26	.	.
L	9.38	48.78	86.48	124.18	.
Q	.	60.19	115.83	152.52	199.96
R	.	60.00	92.99	.	.
S	11.02	58.80	91.11	.	.
X	11.02	53.52	96.25	.	.
Mean	8.92	53.31	88.29	150.00	199.96

Table 18. Estimated number (millions) of Herring per age group and strata.

Strata	age (winter rings)					
	0	1	2	3	4	total
K	1806	1365	26	.	.	3198
L	1853	172	1	0	.	2025
Q	.	1763	22	1	2	1789
R	.	1320	23	.	.	1342
S	9	936	16	.	.	961
X	14	225	3	.	.	242
total	3682	5781	91	2	2	9557

Table 19. Estimated Biomass (tonnes) of Herring per age group and strata.

Strata	age (winter rings)					
	0	1	2	3	4	total
K	15225	47445	1521	.	.	64190
L	17387	8365	88	9	.	25849
Q	.	106142	2562	226	438	109367
R	.	79178	2106	.	.	81284
S	99	53025	1453	.	.	56577
X	152	12054	264	.	.	12470
total	32862	308209	7993	235	438	349737

Table 20. Mean weight (gram) of Mackerel by age group and strata.

Strata	AGE									
	1	2	3	4	5	6	7	8	9	10
K	154.37	253.38	323.52	.	504.97	.	.	.	.	.
L	152.48	248.79	332.11	339.72	431.88	478.97	480.64	468.54	.	642.63
Q	161.54	233.77	294.67	351.24	.	345.00	.	.	.	.
R	181.07	225.21	271.45	272.12	243.30	302.91	302.91	485.06	500.06	.
S	178.45	232.69	259.53	240.93	307.28	.	.	.	.	.
X	212.45	249.11	278.73	280.41	240.00	302.82	302.82	485.08	500.09	.
Mean	158.67	239.35	294.84	304.73	337.18	349.97	362.11	481.77	400.07	642.63

Table 21. Estimated number (millions) of Mackerel per age group and strata.

Strata	AGE										
	1	2	3	4	5	6	7	8	9	10	total
K	1260	359	58	.	8	.	.	.	.	.	1685
L	467	171	10	8	2	2	2	1	.	1	663
Q	1913	1540	123	31	.	14	.	.	.	.	3622
R	7	69	42	19	7	1	1	1	1	.	150
S	12	23	2	2	0	.	.	.	.	.	39
X	48	315	78	40	9	3	3	3	3	.	502
total	3708	2477	312	100	26	20	6	5	5	1	6660

Table 22. Estimated biomass (tonnes) of Mackerel per age group and strata.

Strata	AGE										
	1	2	3	4	5	6	7	8	9	10	total
K	194525	90921	18876	.	3975	.	.	.	.	.	308296
L	71247	42627	3169	2671	701	878	914	270	.	418	122894
Q	309075	360045	36161	11024	.	4878	.	.	.	.	721183
R	1294	15628	11391	5127	1802	317	317	706	728	.	37312
S	2221	5260	407	472	102	.	.	.	.	.	8462
X	10183	78459	21620	11194	2217	868	868	1666	1718	.	128794
total	588545	592940	91624	30488	8796	6941	2100	2643	2446	418	1326940

Table 23. Estimated number (millions) of Cod per length group and strata.

Length in cm	Strata						
	K	L	Q	R	S	X	Total
20	0.04	.	.	.	.	.	0.04
22	0.08	.	.	.	.	.	0.08
23	0.04	0.02	.	0.08	0.13	0.09	0.36
24	0.01	0.01	.	0.04	0.04	.	0.10
25	0.08	0.01	.	0.04	0.04	.	0.17
26	.	0.00	0.08	0.02	0.02	.	0.12
27	.	0.02	.	0.13	0.23	0.19	0.57
28	0.01	.	.	.	.	.	0.01
29	0.02	.	.	.	0.06	0.09	0.17
30	.	0.04	.	0.21	0.31	0.19	0.74
31	0.01	0.01	.	0.04	0.15	0.19	0.40
32	.	.	.	.	0.06	0.09	0.15
33	0.01	0.01	.	0.04	0.10	0.09	0.25
35	.	0.00	0.08	0.02	0.07	0.09	0.27
40	0.04	0.02	.	0.13	0.17	0.09	0.46
41	.	0.01	.	0.04	0.04	.	0.09
42	.	.	.	.	0.06	0.09	0.15
45	.	0.02	.	0.08	0.08	.	0.18
46	.	0.02	.	0.08	0.08	.	0.18
50	.	0.02	.	0.08	0.08	.	0.18
51	.	0.01	.	0.04	0.04	.	0.09
52	.	.	.	.	0.06	0.09	0.15
54	.	0.01	.	0.04	0.10	0.09	0.24
55	.	0.01	.	0.04	0.04	.	0.09
57	0.04	0.01	.	0.04	0.04	.	0.13
62	.	0.02	.	0.08	0.08	.	0.18
66	.	.	.	.	0.06	0.09	0.15
67	.	0.01	.	0.04	0.10	0.09	0.24
85	.	0.00	0.08	0.02	0.02	.	0.12
87	.	.	.	.	0.06	0.09	0.15
98	.	0.00	0.08	0.02	0.02	.	0.12
Total	0.40	0.26	0.32	1.39	2.29	1.66	6.32

Table 24. Estimated biomass (tonnes) of Cod per length group and strata.

Length in cm	Strata						
	K	L	Q	R	S	X	Total
20	3.1	.	.	.	.	.	3.1
22	8.5	.	.	.	.	.	8.5
23	4.0	1.6	.	8.8	14.9	11.1	40.5
24	1.3	1.0	.	5.4	4.9	.	12.7
25	11.9	1.1	.	5.8	5.3	.	24.2
26	.	0.5	12.4	3.7	2.4	.	18.9
27	.	4.2	.	22.5	40.8	32.4	99.9
28	2.5	.	.	.	.	.	2.5
29	5.6	.	.	.	14.2	22.7	42.4
30	.	9.9	.	52.8	78.0	47.6	188.3
31	3.6	2.8	.	14.8	47.6	54.4	123.2
32	.	.	.	.	18.0	28.7	46.6
33	4.0	2.6	.	14.0	37.1	38.9	96.5
35	.	1.3	34.1	10.1	31.9	40.7	118.2
40	28.2	14.9	.	80.0	110.8	60.6	294.5
41	.	6.3	.	34.0	31.0	.	71.4
42	.	.	.	.	44.9	71.7	116.6
45	.	14.2	.	76.2	69.4	.	159.8
46	.	14.5	.	77.9	71.0	.	163.3
50	.	20.2	.	108.1	98.5	.	226.8
51	.	10.7	.	57.4	52.3	.	120.4
52	.	.	.	.	72.7	116.1	188.8
54	.	11.7	.	62.8	138.9	130.5	343.9
55	.	11.4	.	61.2	55.7	.	128.3
57	82.5	13.9	.	74.5	67.9	.	238.8
62	.	37.9	.	203.3	185.3	.	426.5
66	.	.	.	.	176.3	281.7	458.1
67	.	25.3	.	135.5	281.3	252.1	694.1
85	.	20.3	522.2	153.9	98.9	.	795.3
87	.	.	.	.	382.2	610.6	992.8
98	.	29.3	754.6	222.4	143.0	.	1149.2
Total	155.3	255.6	1323.4	1485.1	2375.3	1799.8	7394.4

Table 25. Estimated number (millions) of Whiting per length group and strata.

Length in cm	Strata						
	K	L	Q	R	S	X	Total
5	4.48	.	.	.	.	.	4.48
6	5.99	.	.	.	.	.	5.99
7	27.08	.	.	.	.	.	27.08
8	37.27	.	.	.	0.47	0.75	38.48
9	108.40	.	.	.	.	.	108.40
10	135.24	0.05	.	.	.	.	135.29
11	83.24	0.07	.	.	.	.	83.31
12	16.40	0.05	.	.	.	.	16.45
13	1.49	0.11	.	0.46	0.42	.	2.48
14	4.45	0.10	0.68	0.20	0.60	0.75	6.78
15	4.47	0.39	1.36	2.23	1.93	.	10.38
16	7.46	0.86	3.41	4.66	4.92	1.50	22.82
17	6.01	0.76	1.36	4.06	5.00	2.25	19.45
18	3.09	1.77	6.14	10.04	17.11	13.49	51.64
19	1.57	1.83	5.46	10.30	18.33	14.98	52.48
20	1.49	1.87	4.09	10.35	14.27	8.24	40.31
21	0.02	1.82	6.82	10.24	15.83	11.24	45.98
22	0.04	0.97	0.68	5.23	12.22	11.99	31.12
23	.	2.10	3.41	11.53	17.27	11.24	45.53
24	.	1.30	2.73	7.21	9.63	5.24	26.11
25	.	0.88	0.68	4.77	8.99	7.49	22.82
26	.	0.94	.	5.03	6.46	3.00	15.43
27	.	0.81	1.36	4.06	5.47	3.00	14.70
28	0.01	0.62	.	3.20	5.26	3.75	12.84
29	.	0.17	.	0.92	1.77	1.50	4.36
30	.	0.09	.	0.46	2.76	3.75	7.05
31	.	0.24	.	0.92	1.77	1.50	4.43
32	.	0.09	.	0.46	0.89	0.75	2.18
33	.	0.09	.	0.46	0.89	0.75	2.18
34	.	.	.	.	0.94	1.50	2.44
35	.	.	.	.	1.41	2.25	3.65
38	.	.	.	.	0.47	0.75	1.22
Total	448.21	17.96	38.19	96.78	155.05	111.63	867.82

Table 26. Estimated Biomass (tonnes) of Whiting per length group and strata.

Length in cm	Strata						
	K	L	Q	R	S	X	Total
5	7.7	.	.	.	.	.	7.7
6	16.8	.	.	.	.	.	16.8
7	85.3	.	.	.	.	.	85.3
8	202.9	.	.	.	2.3	3.7	209.0
9	730.4	.	.	.	.	.	730.4
10	1211.1	0.5	.	.	.	.	1211.6
11	973.5	0.8	.	.	.	.	974.4
12	268.2	0.6	.	.	.	.	268.7
13	29.8	2.1	.	9.1	8.3	.	49.3
14	111.4	3.2	17.0	5.0	10.3	11.2	158.2
15	111.6	11.8	37.5	66.4	57.5	.	284.9
16	246.1	28.0	119.3	153.1	163.0	52.4	762.0
17	226.6	29.8	47.7	158.9	199.6	93.6	756.4
18	146.5	85.9	310.3	487.6	846.5	681.8	2558.6
19	100.1	98.3	320.5	555.0	1019.7	861.6	2955.2
20	96.9	123.5	266.0	685.0	943.2	543.2	2657.7
21	1.6	138.1	528.5	775.6	1206.7	865.3	3515.9
22	2.8	84.3	61.4	457.3	1056.7	1030.1	2692.7
23	.	210.4	323.9	1155.8	1733.5	1127.5	4551.1
24	.	148.5	300.1	821.9	1088.7	580.6	2939.7
25	.	110.0	88.7	597.5	1112.0	917.7	2825.9
26	.	136.5	.	731.8	927.2	415.8	2211.3
27	.	125.9	225.0	628.4	864.4	494.5	2338.1
28	1.7	107.8	.	558.0	937.6	685.5	2290.7
29	.	32.4	.	173.8	353.0	310.9	870.1
30	.	17.1	.	91.5	608.6	839.1	1556.2
31	.	60.4	.	228.7	438.2	367.1	1094.4
32	.	21.8	.	116.6	232.9	202.3	573.6
33	.	23.5	.	125.8	245.9	209.8	604.9
34	.	.	.	.	337.6	539.4	877.1
35	.	.	.	.	391.6	625.6	1017.1
38	.	.	.	.	239.2	382.1	621.2
Total	4571.2	1601.1	2645.9	8582.8	15025	11841	44266

Table 27. Estimated number (millions) of Haddock per length group and strata.

Length in cm	Strata				
	L	R	S	X	Total
28	.	.	0.23	0.36	0.59
39	0.01	0.04	0.04	.	0.09
43	0.01	0.04	0.04	.	0.09
Total	0.02	0.08	0.30	0.36	0.76

Table 28. Estimated Biomass (tonnes) of Haddock per length group and strata.

Length in cm	Strata				
	L	R	S	X	Total
28	.	.	46.3	74.0	120.3
39	4.5	24.2	22.1	.	50.8
43	6.3	34.0	31.0	.	71.4
Total	10.9	58.2	99.4	74.0	242.4

Table 29. Estimated number (millions) of Sprat per length group and strata.

Length in cm	Strata					
	K	L	R	S	X	Total
10	7.69	.	.	.	.	7.69
10.5	8.86	1.05	.	.	.	9.90
11	25.34	3.14	.	.	.	28.48
11.5	42.92	10.29	.	0.66	1.06	54.92
12	62.46	46.53	0.84	2.75	3.17	115.75
12.5	47.19	95.35	0.84	8.47	12.31	164.16
13	19.23	36.19	0.42	12.05	18.65	86.54
13.5	1.49	6.25	.	8.15	13.02	28.90
14	2.51	1.02	.	3.30	5.28	12.10
14.5	1.25	1.02	.	2.42	3.87	8.56
15	.	.	.	0.44	0.70	1.14
15.5	.	.	.	0.22	0.35	0.57
Total	218.92	200.82	2.11	38.47	58.40	518.72

Table 30. Estimated Biomass (tonnes) of Sprat per length group and strata.

Length in cm	Strata					
	K	L	R	S	X	Total
10	64.0	.	.	.	.	64.0
10.5	95.1	15.7	.	.	.	110.8
11	298.6	47.1	.	.	.	345.7
11.5	568.6	159.4	.	9.9	15.8	753.7
12	864.9	718.2	12.6	41.2	47.5	1684.4
12.5	722.1	1556.5	14.7	145.6	211.1	2650.0
13	352.0	615.5	8.4	221.3	341.2	1538.4
13.5	22.3	121.5	.	168.9	269.8	582.6
14	50.1	16.2	.	71.9	119.6	260.8
14.5	25.1	16.2	.	60.6	96.7	198.6
15	.	.	.	11.0	17.6	28.6
15.5	.	.	.	6.6	10.6	17.2
Total	3062.8	3266.3	35.8	739.9	1130.0	8234.7

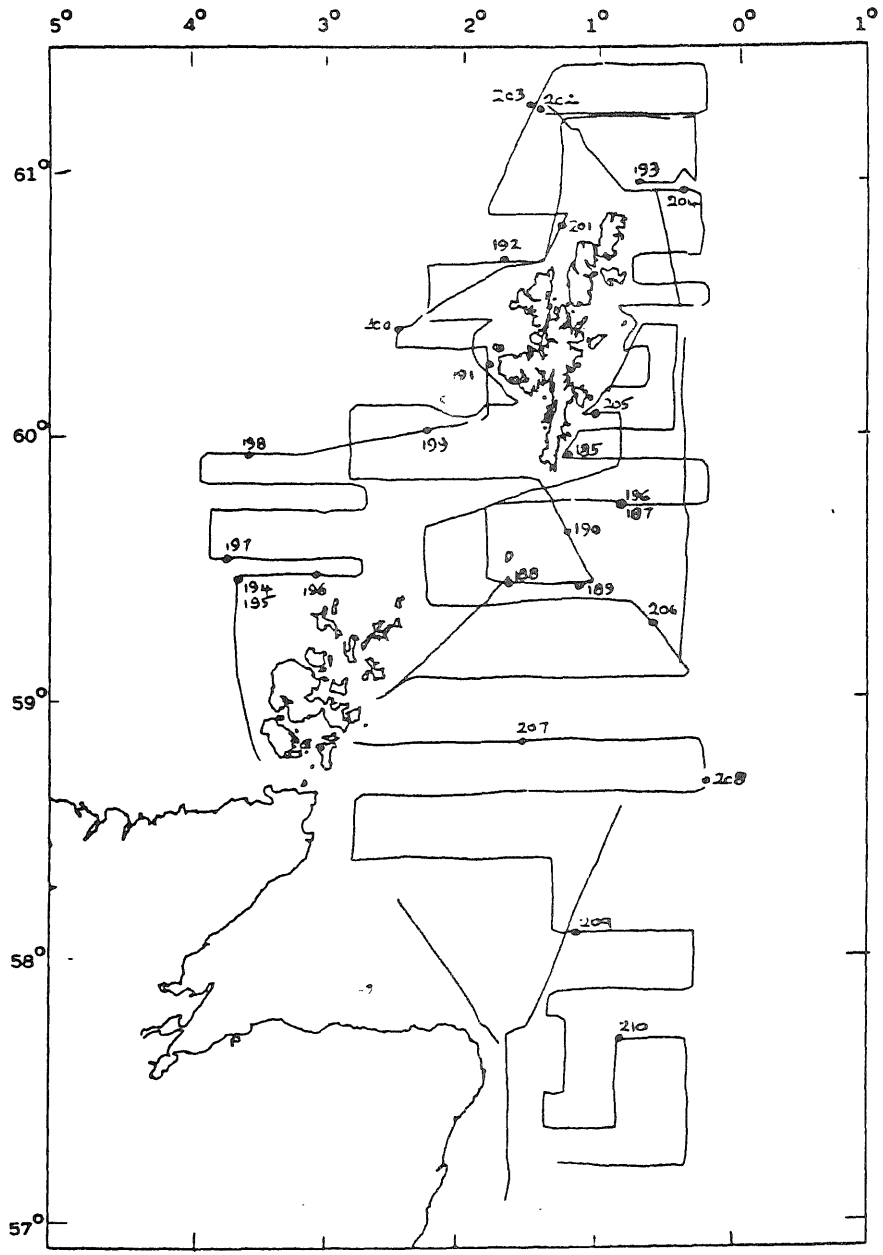


Figure 1. Cruise track and trawl haul positions for FRV 'Scotia' survey 6-23 July 1988.

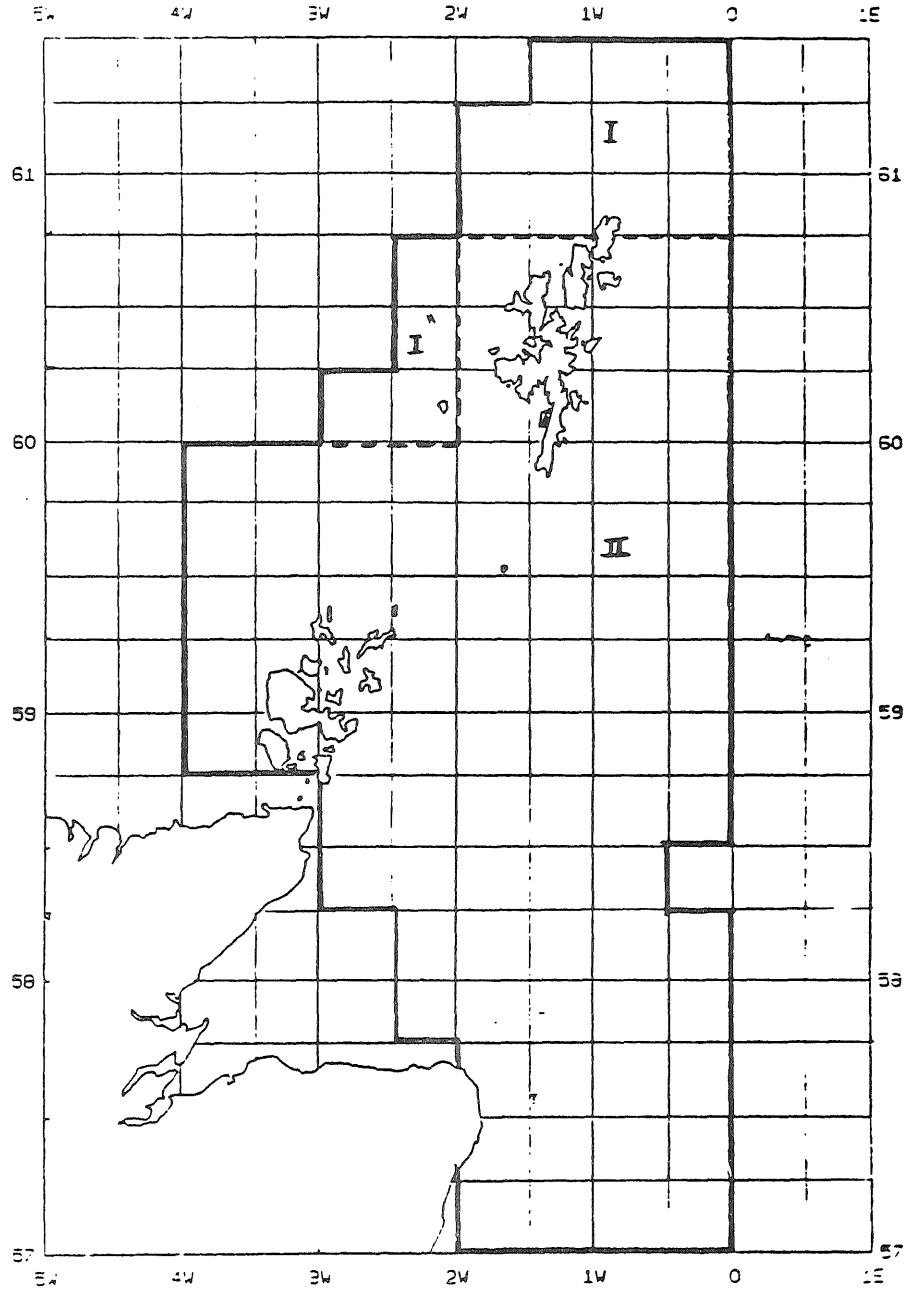


Figure 2. Areas of similar length composition used in analysis of "Scotia" data.

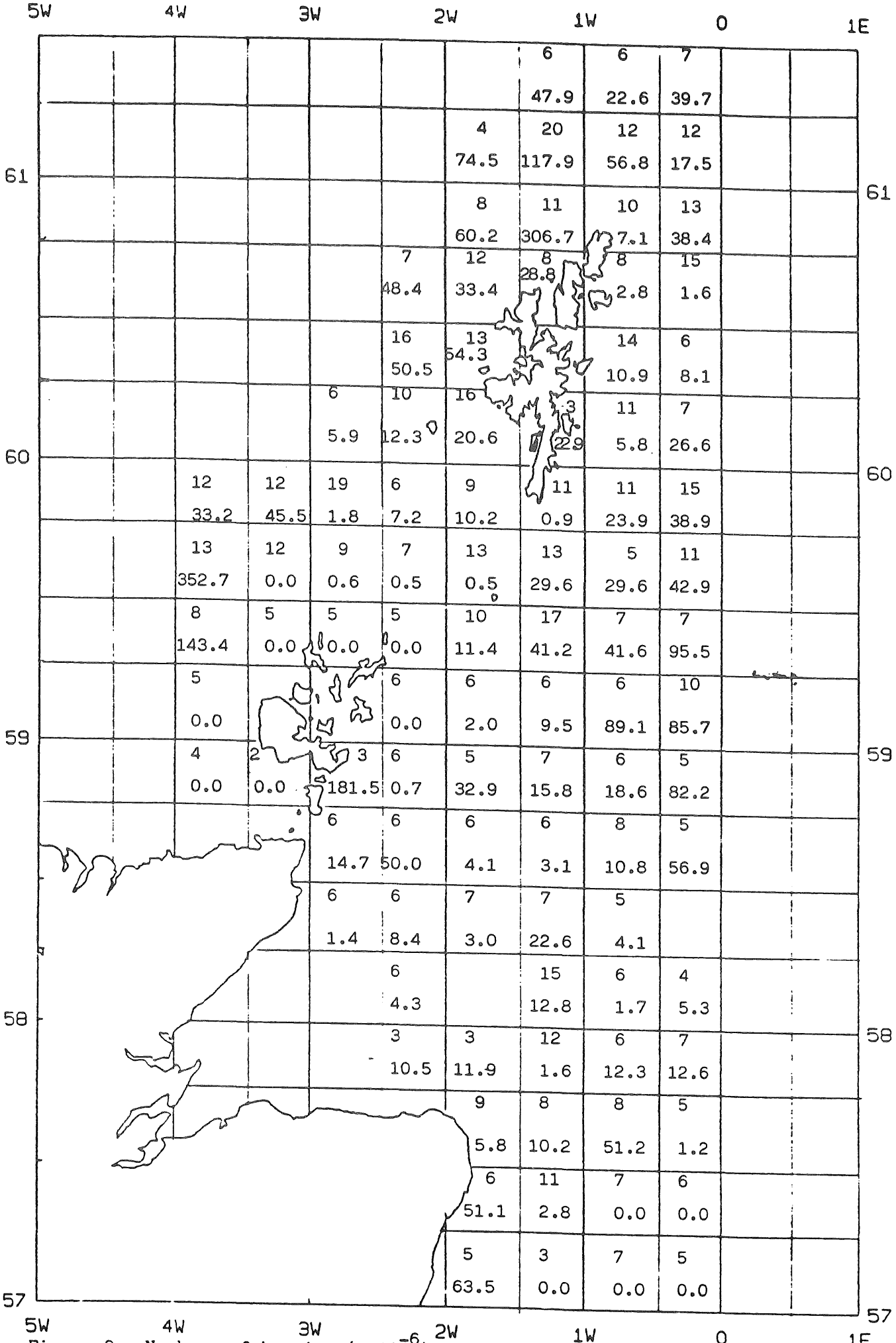


Figure 3. Numbers of herring (x 10^{-6}) by quarter statistical rectangle with number of ¼ hour integration runs in upper part of rectangle.

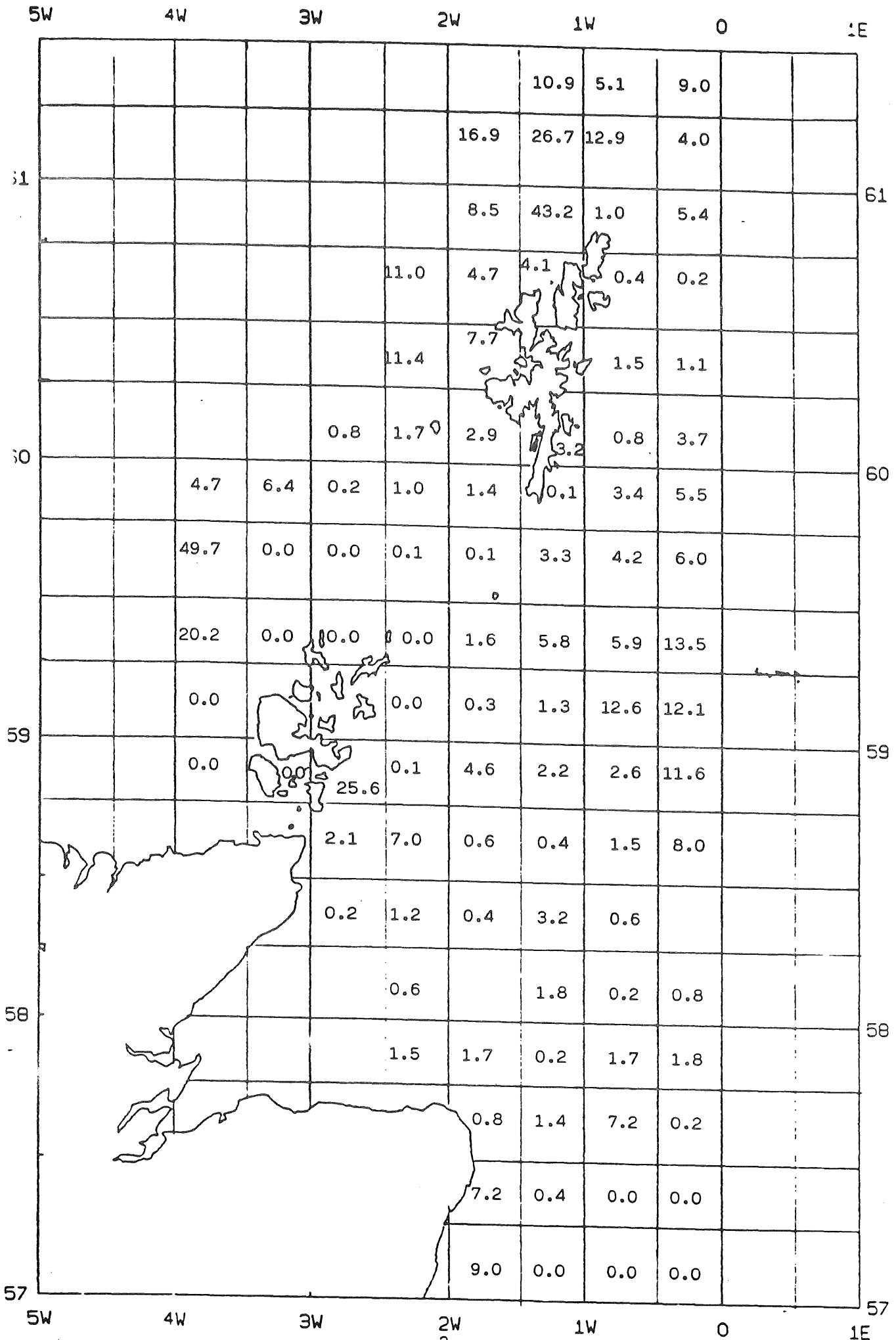


Figure 4. Biomass of herring (t x 10^{-3}) by quarter statistical rectangle.

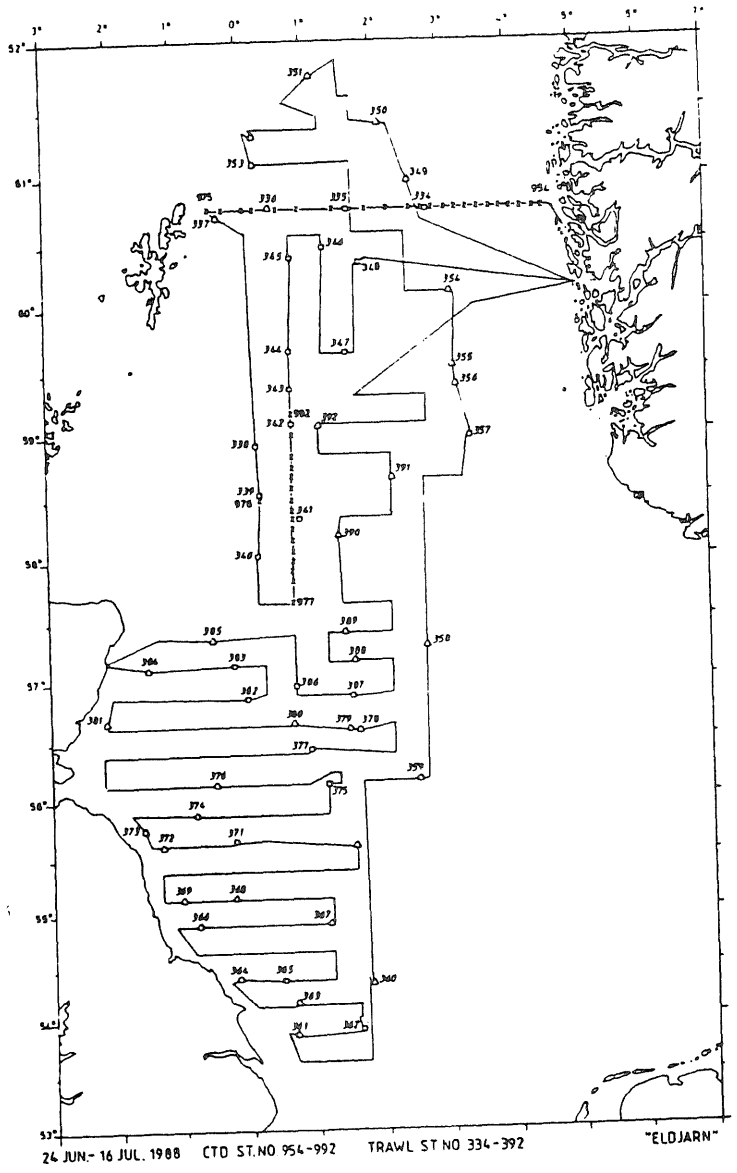


Figure 5. Survey grid and trawl stations

Δ : Pelagic trawl

□ : Bottom trawl

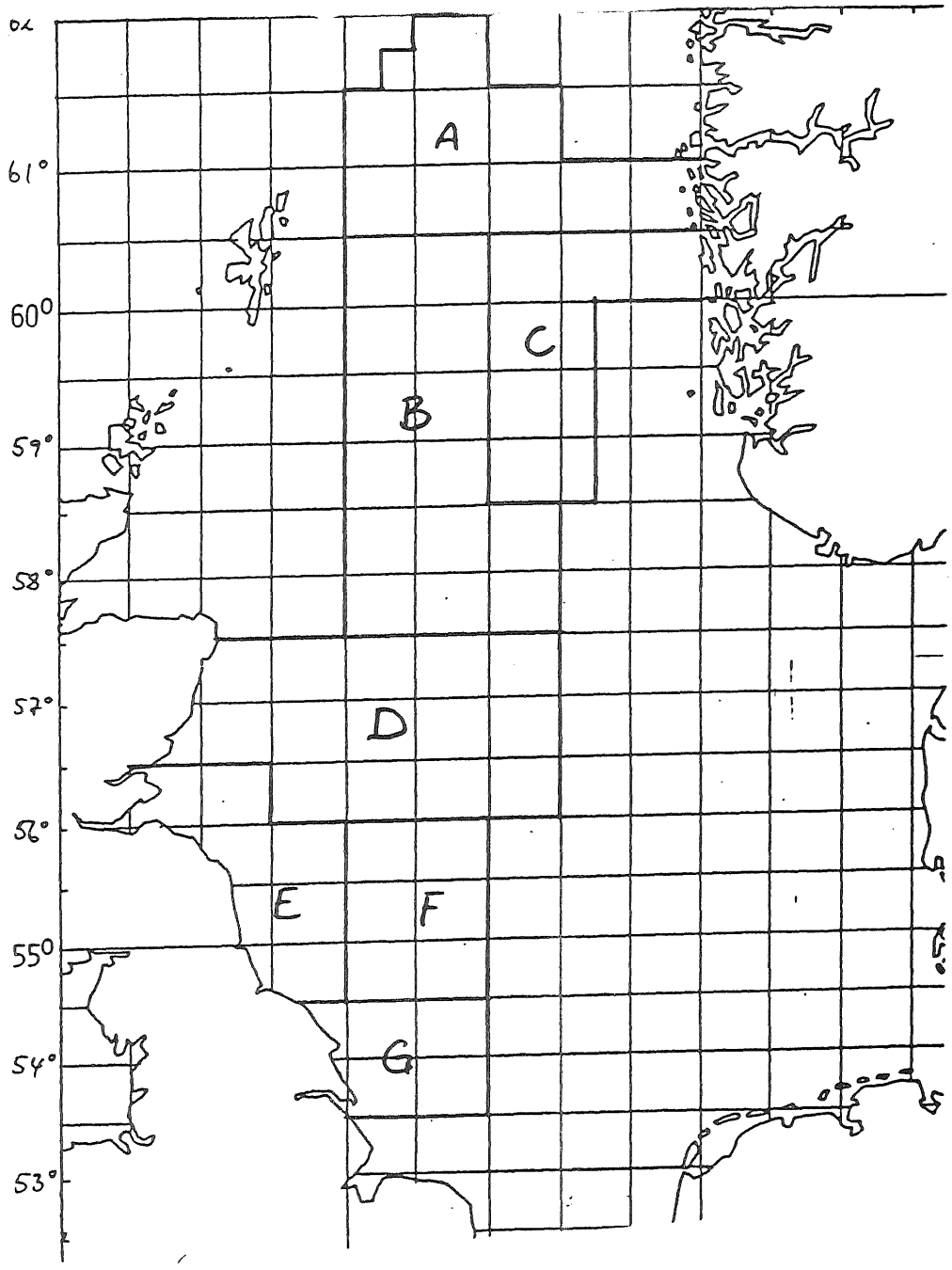


Figure 6

Definition of Sub Areas

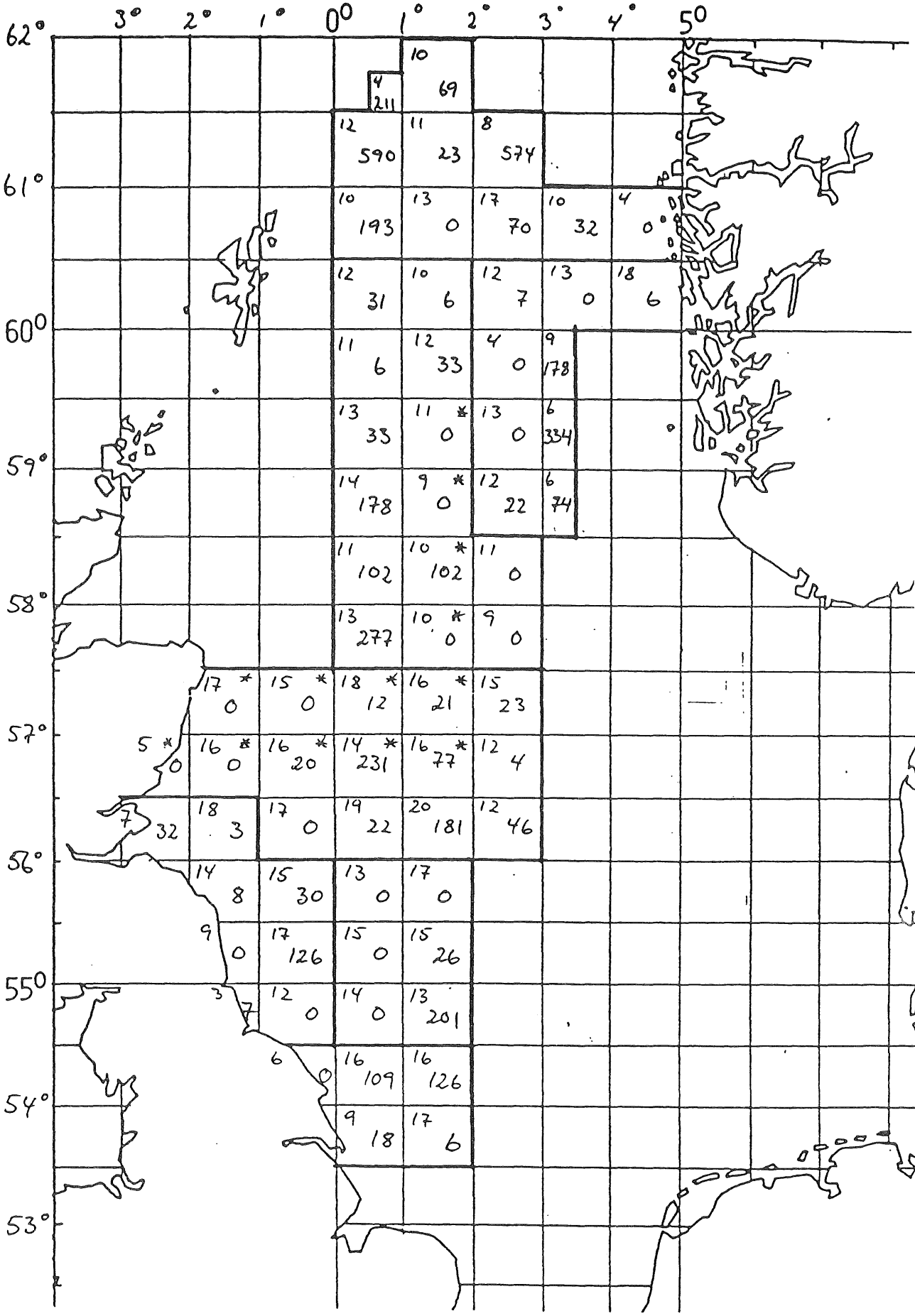


Figure 7.

1+ Herring (Millions) within rectangles

Number of 5-mile integrals in upper left corner

* = Integrator out of order

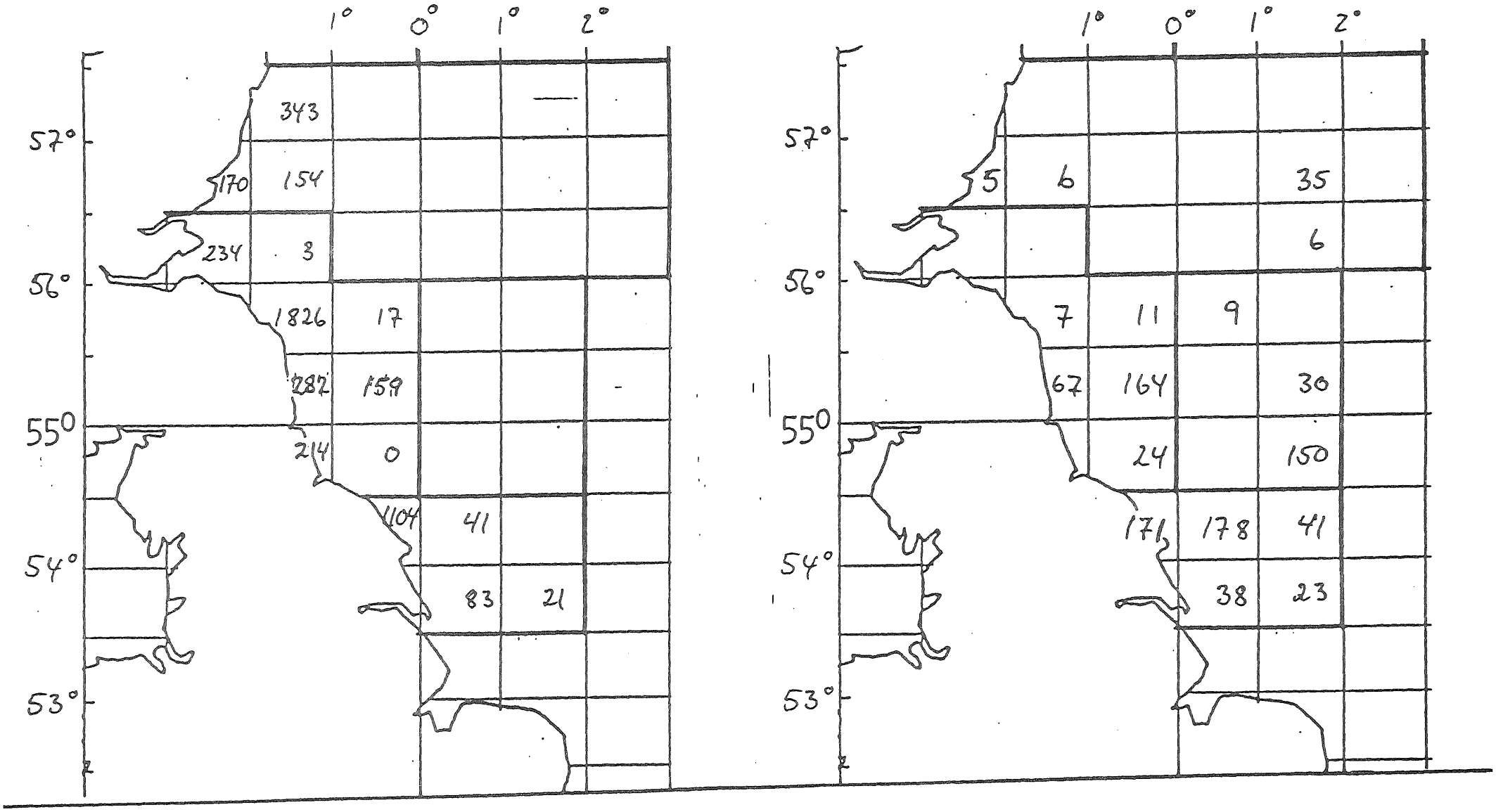
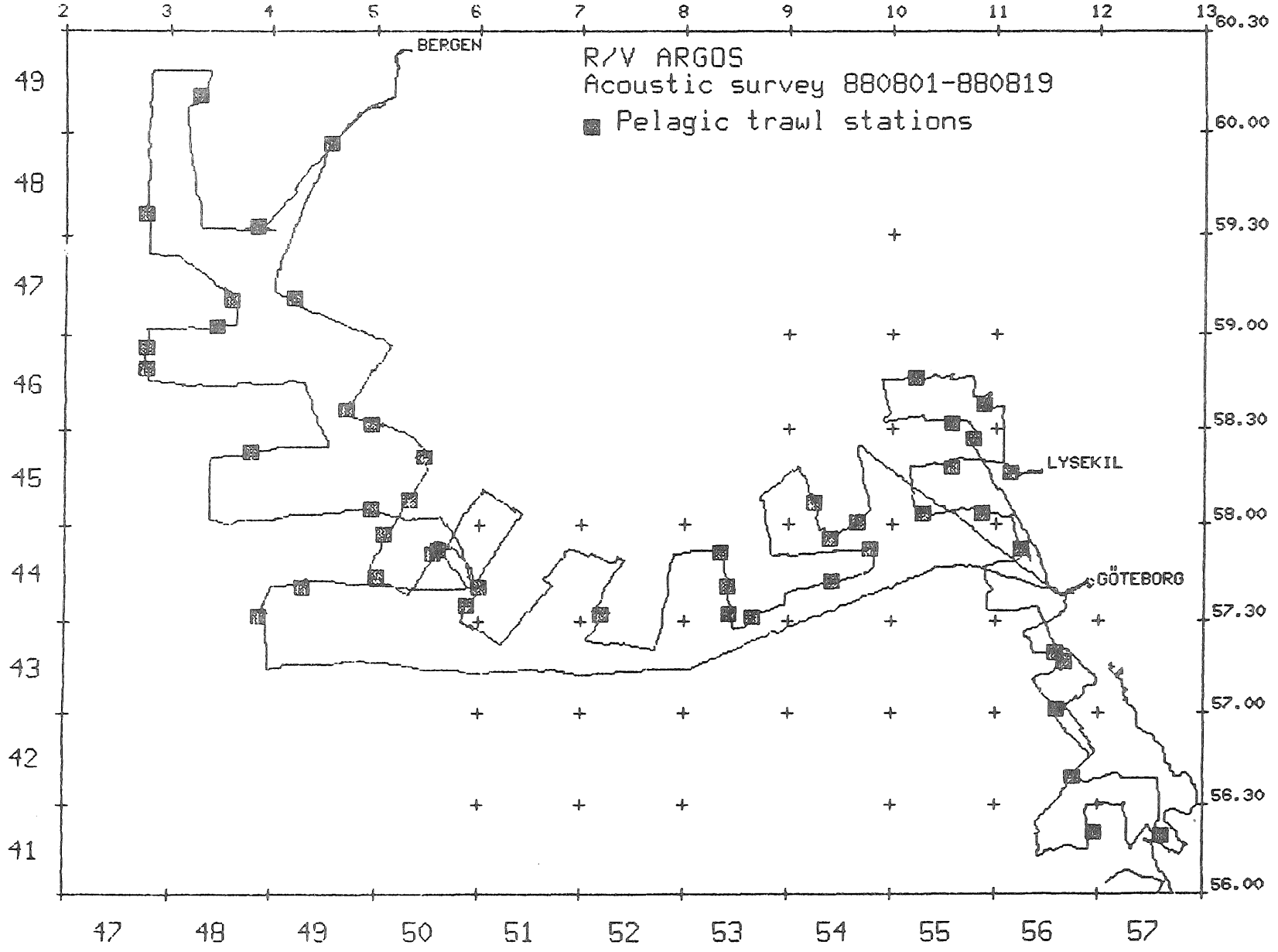


Figure 8
0-group herring (millions)
within rectangles

Sprat (Millions) within rectangles

Fig. 9 Cruise track and trawl haul positions for R/V "Argos"

DATE UTC LAT LONG HDG SPEED - MAGNAVOX
1988-08-19 0435:00 N 58.258 E 10.454 156.0 0.5



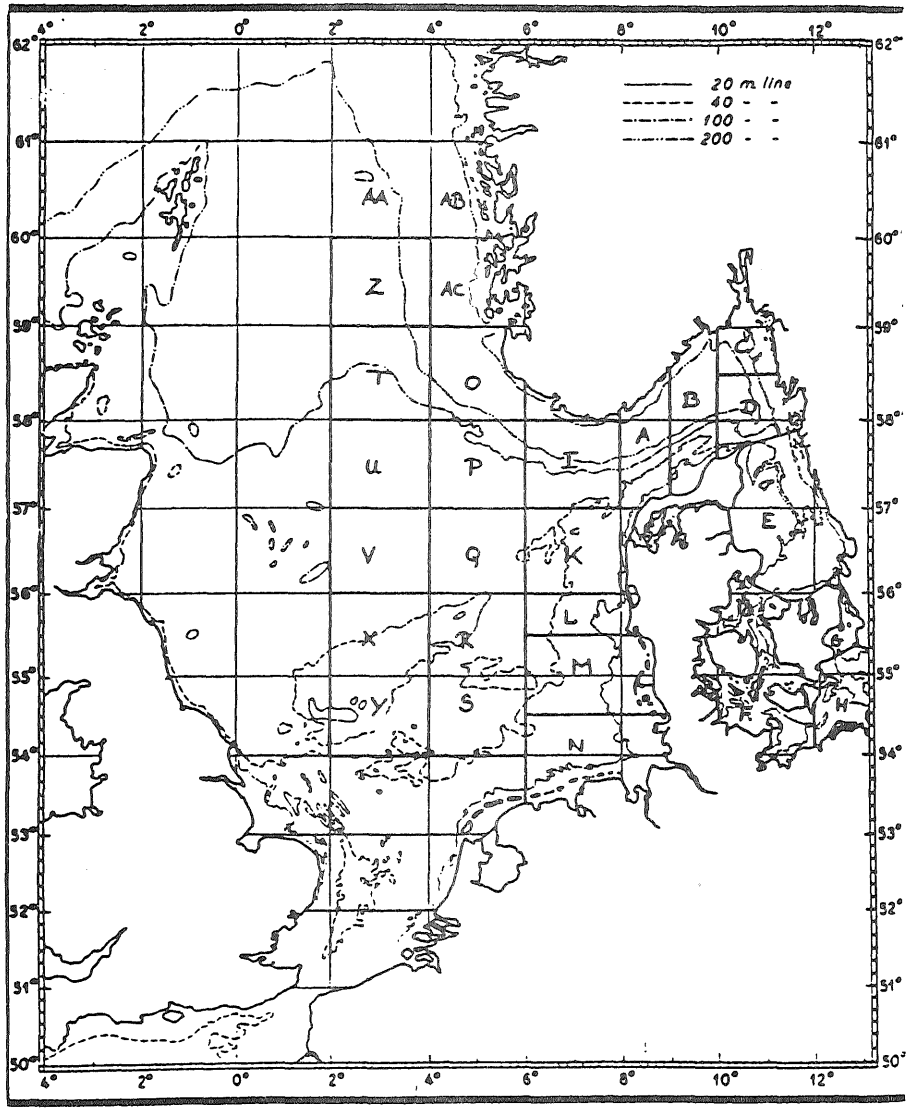


Fig. 10. The strata used for survey evaluation in the Swedish and Danish surveys

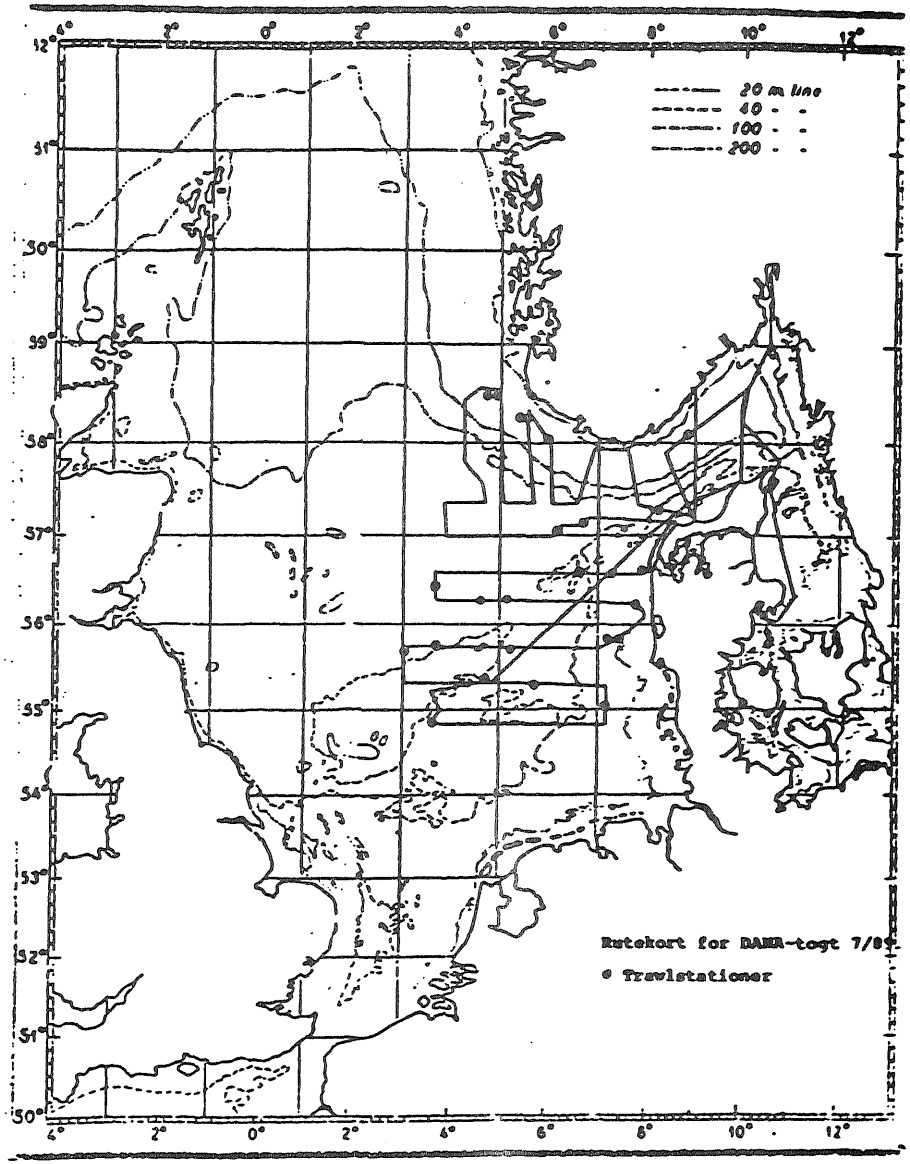


Fig. 11. Cruise track and positions of trawl hauls.