Report on the Herring Acoustic Surveys
in the North Sea, Skagerrak and Kattegat
during Summer 1989

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Abstract

Four herring acoustic surveys coordinated by ICES were carried out by Scottish, Norwegian, Swedish and Danish research vessels during the period 28 June to 9 August 1989.

The reports on the individual surveys, giving a short description of the survey, and a presentation of the results, are collected in this paper. The combined estimated spawning stock biomasses of herring were 1.6 million tonnes autumn spawners and 255 000 tonnes of spring spawners. The combined results are discussed in the paper.

REPORT ON THE 1989 HERRING ACOUSTIC SURVEY
BY FRV SCOTIA
IN THE NORTHERN NORTH SEA

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Methods

The acoustic survey on FRV "Scotia" was carried out using a Simrad EK400 38kHz sounder with echo-integration on a computer-based Aberdeen Echo Integrator. Table 1 shows the equipment settings and the results of two calibrations carried out during the survey.

The survey track was selected to cover the area in two levels of sampling density based on densities found in previous years, an area with high density sampling with transect spacing 7.5 nautical miles and a lower density area with transect spacing of 15 nautical miles. The ends of the tracks were positioned at 1/2 the actual track spacing from the area boundary, giving equal track length in any rectangle within each density area. The between-track data were then included in the data analysis. The cruise track is shown in Fig 1.

Trawl hauls were carried out during the survey on the denser echo traces and the positions of these hauls are also shown in Fig 1. Each haul was sampled for length, age, maturity and weight of individual herring. Up to 350 fish were measured to 1/2cm from each haul, otoliths were taken: 5 per 1/2 cm at all lengths. Fish weights were collected at sea from a random sample of 50 fish per haul.

Data from the echo integrator were summed over quarter hour periods (2.5Nm at 10Knots). The data were divided into three categories, by visual inspection of the echo-sounder paper record and the integrator cumulative output; "herring traces", "probably herring traces" and "probably not herring traces". For the 1989 survey 87% of the stock by number was attributable to the "herring traces" and only 13% to the "probably herring traces". The third categoty was attributable mainly to Norway pout, sprat, whiting and haddock in that order of importance. Most of these species were either easily recognisable or did not appear to occupy the same area as the herring.

To calculate integrator conversion factors the Target strength of herring 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 of fish at length was determined by weighing fish from each trawl haul with more than 50 specimens. The resulting weight-length relationship from 950 fish was:

$$W = 1.255 \; 10^{-3} \; L^{3.584} \; g$$

L measured in cm.

Survey Results

The results from 21 hauls where more than 80 herring were caught are shown in Table 2. These have been used to define 3 areas (Fig 2) within which the length compositions were not very different. A Kolmogerov Smirnov test was used to aid this area allocation procedure. The areas were defined on a 15Nmile grid equidistant from the nearest trawl haul or depth related where the distance from hauls was large. This follows the pattern of previous years data showing a size change offshore. The mean length frequency distributions for each area were derived giving equal weight to each haul with more than 80 fish and are shown in Table 3 along with the mean length, weight and target strengths for each haul and each area. The target strength per individual is derived from the TS/length formula given above and both the mean weight and the target strength per kilogramme were then derived from the length/weight fomula. The age data from each haul were combined by summing the numbers of otoliths at age for each area.

The estimated number and weight of herring in each quarter rectangle is shown in Fig. 3. These values are based on the arithmetic mean integrator output within each quarter statistical rectangle and are shown with the number of 15 minute periods of integration in the upper left hand corner. The numbers of herring at age for each of the four areas is shown in Table 4 along with the mean length, mean weight and total biomass for each age and for totals for the whole area. Two and three ring fish are split into two categories: mature and immature based upon those reaching maturity stage 3 at the time of capture.

The total stock estimate for the area north of 56° 00'N, south of 61° 15'N and between 0 and 4 degrees West is 9,064 million fish giving a biomass of 1,031 thousand tonnes. This is split between 53% mature and 47% immature by number giving a spawning stock of 4877 million fish or 831 thousand tonnes.

REPORT FROM THE NORWEGIAN HERRING ACOUSTIC SURVEY
JUNE-JULY 1989

by

Asgeir Aglen

Survey grid and trawl stations for R/V "Eldjarn" (28 June to 20 July) is shown in Figure 4. As in 1988 most of the herring was found in the northern part of the area. In most areas the herring was recorded in the upper 50 m, occasionally quite up to the surface. The upper limit for echo integration was at 8 m, which means that some of the schools were in the upper "dead zone". No corrections of the estimates are made to take this into account. Several school countings made on sonar will be analysed to get an indication of the magnitude of this error.

Integrator values allocated to herring were averaged within statistical rectangles. The number of fish estimated from these values are shown by rectangle in Figure 5. Figure 6 shows the definition of sub-areas used for averaging biological data. Table 5 shows average length distribution, number of fish sampled and average target strength by sub-area. Table 6 shows number of fish estimated by sub-areas and age groups. Special analysis for racial separation were made on 11 samples from IVa east. The location of these samples are indicated in Figure 4. Based on these analyses the estimates in IVa east (Table 6 a and b) were split on North Sea herring (autumn spawners) and Baltic/IIIa herring (spring spawners). Table 7 shows mean weights estimated for spring and autumn spawners separately.

The total estimates for the survey area are 4141 million (803 000 tonnes) of mature autumn spawners and 1045 million (157 000 tonnes) spring spawners.

REPORT ON THE ACOUSTIC SURVEY
BY R/V "DANA"
IN THE CENTRAL NORTH SEA AND SKAGERRAK
JULI-AUGUST 1989

by

Poul Degnbol
Eskild Kirkegaard

During the period 19 July-9 August an acoustic survey primarily targeted at herring was carried out by R/V "DANA" in the Central North Sea and Skagerrak. The cruise track and positions of the trawl hauls are shown in Fig. 7.

The survey was carried out using a Simad EK400 38 kHz saunder 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 9.

The surveyed area is stratified in subareas (1° lat-2°long). Subareas with large variation in depth is divided in up to six strata. 1. 0-20 m; 2. 20-40 m; 3. 40-60 m; 4. 60-100 m; 5. 100-300 m; 6. > 300 m. The subarea are shown in Fig.7.

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 allocated to species and length group using the composition of the trawl hauls. The TS-length relationships used are given below:

Herring, Sprat and Horse Mackerel
$$TS = 20 \log_{10}L - 71.2$$

Mackerel and Dogfish
$$TS = 20 \log_{10}L - 77.2$$

Gadoids
$$TS = 20 \log_{10}L - 67.5$$

Results

As shown in Table 9, herring and mackerel counted for more than 40% of the catches in weight. Very few horse mackerel were caught during the survey.

The estimated numbers, mean weight and biomass at age of herring and mackerel in each subarea are given in Table 10-15.

Compared with previous years very few juvenile herring were observed in the area.

Due to very high concentration of jellyfish, the estimated numbers and biomass is very uncertain.

The estimated numbers and biomasses of horse mackerel and sprat are shown in Table 16-19.

REPORT ON THE 1989 ACOUSTIC SURVEY
By R/V "Argos"
IN SKAGERRAK AND KATTEGAT

by

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As part of the ICES-coordinated acoustic survey of the North Sea and Division IIIa R/V "Argos" surveyed the western part of Skagerrak and Kattegat from 1-4 August 1989. The survey grid together with the pelagic trawl haul stations is shown in Figure 8. The equipment used onboard R/V "Argos" is a EK 400 and a minicomputer (NORD-10S) with a Simrad QX as an interface. The software program for integration is developed by Institute of Marine Research in Bergen. The technical data and settings of the equipment are shown in Table 20.

The methods of stratification used are the same as used in the Danish survey. A total of 12 pelagic hauls were made during the survey and the survey statistics are given in Table 21

The area back scattering strength were converted to number per length group applying the following TS/length relationships:

Herring, Sprat and Horse Mackerel $\qquad$ $TS = 20 \log_{10} L - 71.2$

Mackerel and Dogfish $\qquad$ $TS = 20 \log_{10} L - 77.2$

Gadoids $\qquad$ $TS = 20 \log_{10} L - 67.5$

The survey was carried out in good weather conditions.

Results

The estimated numbers, mean weight, biomass and mean length at age of herring in each stratum are given in Tables 22-25

The estimated numbers, mean weight, biomass and mean length per stratum for sprat, cod, haddock, whiting, blue whiting, mackerel, saithe, horse mackerel, Norway pout and dogfish are given in Tables 26-29

Based on vertebral counts all herring of 2 group and older could be assigned to local spring spawner stock. North Sea autum spawners dominated the 0- and 1-group.

COMBINED RESULTS

The surveyed area was divided into six areas as shown in Figures 10-13. As there were no overlap in area covered by the four surveys, Figure 9 the combined results were taken as the sum of the results from the different surveys. No correction was made for uncovered areas.

The combined results by area and age split into spring and autumn spawners are given in Tables 30 and 31. The geographical distributions of 0-, 1-, 2- and 3+- ringers are shown in Figures 10-13.

The estimated size of the spawning stock of autumn spawners is 9,019 million fish or 1,637 million tonnes. The total number of 1-ringers and 0-ringers was found to be 6,333 million and 3,131 million respectively.

Compared with previous years surveys, the distribution of juvenile was found to be more north-western. In 1989 relative high concentration was found in area IVaW, while the abundance of juvenile in Skagerrak-Kattegat and IVb were much lower than in previous surveys.

In 1988 the adult herring was found more northern than in previous years, and the survey area may not have covered the total distribution. In 1989 the adult herring was again concentrated in the northern areas, and the high concentration found along the north-western boarder of the surveyed area indicate, that herring may have been outside the area covered during the survey.

Table 1

Echo Sounder	EK400
Frequency	38kHz
Receiver gain	-10dB
TVG	$20 \log R + 2\alpha R$
α	.008dB/m
Pulse Length	1.0 ms
Bandwidth	3.3kHz
Range 150m	
Transducer	15 by 30 degrees
Equivalent Beam angle	-17.21 (measured)
Integrator	Aberdeen
Threshold(effective)	10mv

Source level and Voltage response referred to 1metre on the TVG function measured twice for 38 khz system using 38.1mm tungsten carbide ball.

6/7 $+53.07$ dB//$1v_{rms}$

19/7 $+53.94$ dB//$1v_{rms}$

VR + SL used for the survey = $+53.51$dB//$1v_{rms}$

Haul Number	Latitude	Longitude	Herring	Sprat	Whiting	Haddock	N Pout	Mackerel	Other	Comments
174	58 32.8 N	1 11.6 W	14176	288				32		
175	58 56.8 N	0 15.7 W	5323							
176	58 57.2 N	1 25.2 W	8119	69			23			
177	59 3.3 N	1 28.7 W	3297	1127	14		14			
178	59 17.9 N	1 44.5 W	4	37	22			0		'O' group Blue Whiting meshed
179	59 18.0 N	1 38.5 W	3890	830						
180	59 21.3 N	0 15.3 W	117		3					
181	59 34.2 N	0 58.7 W	8							
182	59 42.5 N	1 5.5 W	984							
183	60 42.4 N	0 22.2 W	1376		4	16	4	12	8	Argentina sp
184	60 48.2 N	1 36.2 W	1695							
185	60 19.1 N	2 13.0 W	434		179	48	7616	22	46	Argentina sp, Hake, gurnards
186	59 56.2 N	2 50.4 W	5	1			2422	19	1	gurnard
187	59 33.3 N	3 50.2 W								150 baskets herring – burst n
188	59 33.3 N	3 50.2 W	316		1		758	2	10	M. muelleri
189	59 12.6 N	3 49.3 W	1764	279			1963	9		
190	59 54.5 N	1 9.0 W	11040				780			
191	59 22.0 N	1 48.5 W	513	2694	518		13019	107		
192	58 25.8 N	1 43.1 W	8127	84	315					
193	58 25.7 N	1 16.0 W	5977	36	27		9			
194	57 54.0 N	2 58.4 W								Small herring 6 – 10cm meshed
195	57 52.6 N	2 19.7 W								Same as 194 and sprats as w
196	58 11.1 N	0 58.0 W	4720	20						
197	57 55.8 N	0 15.3 W	4530	860						
198	58 3.7 N	1 9.5 W	3200	80						
199	56 50.0 N	2 12.8 W								Small Gadoids, herring, Sprats meshed

TABLE 2. Position and species composition of trawl hauls

Area I   Area II   Area III

length	175	180	182	183	184	185	188	189	190	191	197	mean	174	176	177	179	192	193	196	198	mean	195	199	mean
6.5																							0.6	0.3
7.0																							3.0	1.5
7.5																							10.1	5.0
8.0																						1.1	17.2	9.1
8.5																						14.8	5.9	10.3
9.0																						48.9	1.8	25.3
9.5																						28.4	1.2	14.8
10.0																						5.7		2.8
10.5																						1.1		0.6
11.0																								
11.5																								
12.0																								
12.5																								
13.0																								
13.5																								
14.0																								
14.5																							0.6	0.3
15.0																							3.0	1.5
15.5																							8.9	4.4
16.0																	0.3			0.3	0.1		13.6	6.8
16.5										0.8		0.1						1.8	0.2	0.3	0.3		16.6	8.3
17.0										1.4		0.1						2.8	0.2	0.3	0.4		9.5	4.7
17.5										5.5		0.5			0.5			3.6	2.3	5.0	1.5		3.0	1.5
18.0								0.3		6.2			0.2	0.6	6.3		2.1	3.4	0.8	3.8			8.3	3.1
18.5								0.6		1.4			0.4	0.2	8.1		3.9	6.4	7.6	11.0	6.4		0.6	0.3
19.0							1.3		0.8	4.7	0.4	0.7	14.9	0.3	12.1	0.5	9.8	7.2	9.5	12.8	8.4		0.6	0.3
19.5							0.9		3.3	1.4	1.3	0.6	12.2	0.3	17.2	1.0	9.0	11.6	11.9	9.8	9.1		0.6	0.3
20.0							1.3	0.5	8.2	1.4	1.8	1.2	12.0	2.5	15.9	6.9	7.8	10.3	16.1	7.8	9.9		0.6	0.3
20.5							0.6		13.3		0.8	2.6	1.6	7.2	8.2	14.4	13.9	10.6	12.4	14.2	7.5			11.1
21.0	0.2			0.3					16.8			4.9	2.0	5.2	11.9	8.1	23.1	7.2	10.1	12.1	3.3			10.1
21.5	0.5	1.7					0.3		12.5		1.4	3.5	1.8	5.2	11.0	5.5	17.2	6.2	4.6	7.2	1.5			7.3
22.0	0.2	0.9						0.3	7.1			2.6	1.1	2.9	10.5	1.9	11.1	1.8	4.6	4.4	2.3			4.9
22.5	0.7	0.9	0.4	0.3					4.1		0.8	2.2	0.8	1.8	6.5	1.5	5.7	2.3	4.9	3.8	2.0			3.6
23.0	3.0			0.3			1.3		3.0		1.4	2.6	1.1	3.2	9.9	1.5	3.6	1.8	2.1	1.1	2.0			3.1
23.5	5.2	5.1	4.1	1.2	0.4		1.3	1.5	1.9	1.4	2.2	2.6	1.1	2.9	9.6	1.9	5.4	2.3	2.3	1.7	2.8			3.6
24.0	8.5	6.0	9.3	5.5	0.4		2.8	4.1	4.9	5.5	3.8	4.6	3.2	10.2	3.6	2.8	8.5	2.8	1.5	4.3	4.6			
24.5	11.5	4.3	15.9	7.0	0.9	2.8	7.9	6.1	6.5	11.7	3.5	7.1	2.5	8.8	0.8	3.1	5.7	4.1	0.6	3.8	3.7		0.6	0.3
25.0	11.7	6.0	14.2	7.8	1.9	6.9	10.4	11.7	7.6	12.9	5.7	8.8	1.6	4.5	1.5	1.5	3.1	4.1	0.4	4.8	2.7			
25.5	11.0	12.8	18.3	10.2	3.2	9.9	14.9	18.4	4.1	6.2	7.7	10.6	1.8	2.5	1.5	1.0	3.1	4.1	1.1	4.8	2.8			
26.0	10.8	8.5	14.2	14.5	4.2	16.6	12.0	28.1	2.4	9.0	8.6	11.7	0.7	1.7	1.1	1.3	1.8	1.3	0.2	3.3	1.4		1.2	0.6
26.5	11.3	18.8	13.8	11.0	4.8	16.6	6.0	14.3	1.9	10.1	7.5	10.6	0.7	0.8	0.2	0.8	0.5	2.3		1.5	0.9		0.6	0.3
27.0	8.9	6.0	4.1	10.8	9.4	14.3	8.2	9.2	0.8	9.5	8.6	7.8	1.1	0.3	0.4	0.5	0.8	0.5		0.5	0.5			
27.5	5.9	10.3	4.1	9.0	8.4	15.0	7.6	2.6		1.4	6.6	6.4		0.3	0.2	0.3	0.8	0.5		0.5	0.5			
28.0	2.8	5.1	1.6	7.8	11.7	8.1	7.0	1.5		0.5	2.7	5.2	7.7			0.2	0.3	0.3		0.3				
28.5	1.9	6.0	4.1	10.4	6.2	5.1	5.1	0.5		1.4	1.4	3.6	0.2					0.5			0.1			
29.0	2.3	3.4	2.6	10.4	1.2	1.9	0.5			0.3	1.4	2.6						0.5					0.3	0.1
29.5	0.9	1.7	2.6	9.1	0.5	1.6				1.9	1.8	1.8						0.3						0.1
30.0	0.5	0.9	2.0	7.1	1.2	2.2		0.5		0.8	1.8	1.5												
30.5	1.4	0.9	0.9	5.8	0.5	1.6				1.4	2.2	1.3						0.3						0.0
31.0	0.2		0.6	4.5						1.3	1.1	0.7												
31.5	0.5	0.9	1.5	2.2						0.9	0.2	0.6												
32.0				2.9	0.5							0.3												
32.5				1.3								0.1												
33.0				0.6								0.1												
33.5																								
34.0																								
34.5							0.3														0.0			

	175	180	182	183	184	185	188	189	190	191	197	mean	174	176	177	179	192	193	196	198	mean	195	199	mean
Number	5,323	117	984	1,376	1,695	434	316	1,764	11,040	513	4,530		14,176	8,119	3,297	3,890	8,127	3,492	4,720	3,200		88	169	
mean length	26.3	26.8	25.9	27.0	29.0	27.3	26.6	26.3	22.8	24.5	26.0	26.2	21.0	23.2	21.0	22.3	21.7	22.1	20.8	21.4	21.7	9.6	13.8	11.7
mean weight	156	168	148	174	223	177	167	155	96	130	157	159	73	100	71	87	82	87	69	80	81	4	23	14
TS/individual	-42.8	-42.6	-42.9	-42.5	-41.9	-42.5	-42.7	-42.8	-44.0	-43.3	-42.8	-42.8	-44.7	-43.9	-44.7	-44.2	-44.4	-44.3	-44.8	-44.5	-44.4	-51.5	-48.0	-49.4
TS/kilogramme	-34.7	-34.9	-34.6	-34.9	-35.4	-35.0	-34.9	-34.7	-33.8	-34.5	-34.8	-34.8	-33.3	-33.9	-33.3	-33.6	-33.6	-33.7	-33.2	-33.5	-33.5	-27.8	-31.6	-30.7

TABLE 3.   Percentage length composition by trawl and by area, showing mean weight, mean lengths and mean target strengths

	Age (ring)	Number	Mean Length	Mean Weight	Biomass
	0	0.00			0.00
	1	561.32	20.35	68.39	38.39
	2i	265.99	23.65	114.66	30.50
	2m	1,820.80	25.28	144.41	262.94
	3i	109.85	24.94	137.33	15.09
	3m	1,905.30	26.88	179.24	341.51
	4	565.69	28.01	208.86	118.15
Area I	5	129.15	29.97	262.37	33.89
	6	53.22	31.00	294.81	15.69
	7	10.69	31.10	298.62	3.19
	8	15.04	32.15	334.87	5.04
	9+	1.56	34.50	429.12	0.67
	Total	5,438.63	25.73	159.06	865.05
	0	0.00	-	-	0.00
	1	1,240.17	20.01	64.26	79.69
	2i	136.50	22.76	99.97	13.65
	2m	293.14	24.28	125.36	36.75
	3i	9.52	24.56	129.81	1.24
	3m	55.78	26.13	162.30	9.05
Area II	4	4.49	26.49	170.29	0.77
	5	0.00			0.00
	6	0.00			0.00
	7	0.00			0.00
	8	0.00			0.00
	9+	0.00			0.00
	Total	1,739.61	21.18	81.14	141.14
	0	1,321.19	8.79	3.80	5.02
	1	543.03	16.36	31.63	17.18
	2i	0.00			0.00
	2m	11.20	24.75	133.70	1.50
	3i	0.00			0.00
	3m	11.20	26.00	158.59	1.78
Area III	4	0.00			0.00
	5	0.00			0.00
	6	0.00			0.00
	7	0.00			0.00
	8	0.00			0.00
	9+	0.00			0.00
	Total	1,886.61	11.13	13.46	25.40
	0	1,321.19	8.79	3.80	5.02
	1	2,344.52	19.25	57.69	135.26
	2i	402.49	23.35	109.68	44.14
	2m	2,125.13	25.13	141.72	301.18
	3i	119.38	24.91	136.73	16.32
	3m	1,972.28	26.85	178.65	352.34
Total	4	570.18	28.00	208.55	118.91
	5	129.15	29.97	262.37	33.89
	6	53.22	31.00	294.81	15.69
	7	10.69	31.10	298.62	3.19
	8	15.04	32.15	334.87	5.04
	9+	1.56	34.50	429.12	0.67
	Total	9,064.84	21.82	113.80	1,031.59

TABLE 4. Numbers, biomass, mean length and mean weight at age for areas I, II and III and for the whole survey area. Age groups 2 and 3 have been split mature/immature on the basis of stage 3 or greater maturity

Table 5. Average length distributions (per mille) of herring within subareas, "Eldjarn" 28/6-20/7 1989 Nm = number measured, Nk = number of fish in the age length key, Nc = number of catches with more than 50 herring, TS =average target strength applied (dB ref. 1 fish)

Length (cm)	A	B	C	D	E*	F*	G	H	I	J
16									1	
17										
18			4	13		1	14	1	1	6
19			25	87			81		1	8
20			89	95			105	1	39	11
21		2	86	49	1	4	33	28	145	33
22		2	37	31	33	27	24	101	186	102
23		5	63	79	67	79	66	215	220	156
24		75	106	159	97	99	147	235	191	294
25	22	166	57	151	52	123	90	161	104	226
26	77	238	172	148	88	117	123	97	54	113
27	138	215	106	107	183	197	132	96	35	43
28	224	160	86	54	205	206	125	41	16	4
29	256	80	36	16	147	84	48	15	2	4
30	128	41	20	6	86	32	6	2	1	
31	92	14	11	5	18	16	6	5	3	
32	31	2			20	11		1		
33	18		1		1	2			1	
34+	14		1		2	2		1		
Nm	491	802	579	1077	1396	575	737	1470	1677	437
Nk	380	487	296	684	624	378	372	658	797	277
Nc	4	6	5	7	6	4	4	7	8	3
-TS	41.9	42.6	43.1	43.4	42.0	42.3	43.2	43.2	43.7	43.4

* Includes 1 commercial purse seine catch from same area and period

Table 6. Estimated number of herring (millions) by age groups and Sub-areas. Biomasses given in thousand tonnes. R/V "Eldjarn", June-July 1989.

a: Autumn spawners

Age (Winter rings)	IV a West				IV a East					IV b	TOTAL
	A	B	C	D	E	F	G	H	I	J	
1		1	111	103	+	1	85	2	16	19	339
2im	0	4	62	24	36	9	14	62	76	46	333
2ma	13	126	110	107	50	14	40	29	36	280	805
3im	0	0	6	3	21	0	4	22	44	11	111
3ma	146	527	203	137	137	45	51	28	59	215	1548
4	204	278	128	51	197	59	20	35	30	40	1042
5	115	78	36	21	71	9	10	3	8	8	359
6	90	43	10	11	63	8	2	+	1	+	229
7	50	20	2	4	17	8	6	1	1	+	109
8	10	2	3	3	6	3	2		+		29
9+	14		1		3	1		1	+		20
Total N	641	1078	671	463	601	157	234	183	272	620	4924
Total B	164	214	105	63	127	32	32	25	34	83	879
Spawn N	641	1074	493	334	544	147	131	97	135	543	4141
Spawn B	164	213	90	53	120	31	24	15	18	75	803

b: Spring spawners

Age (Winter rings)	E	F	G	H	I	TOTAL
2	7	26	36	12	74	155
3	32	118	51	113	148	462
4	30	107	42	50	51	280
5	9	30	13	19	7	78
6	2	20	15	10	3	50
7		10		3	3	16
8		3		1		4
Total N	80	314	157	208	286	1045
Total B	14	57	26	29	31	157

Table 7. Mean weight (g) at age within Sub-areas. "Eldjarn" 28/6-20/7 1989.

a: Autumn spawners

Age (Winter rings)	Sub - area									
	A	B	C	D	E	F	G	H	I	J
1	-	111	74	68	124	54	68	78	77	71
2	190	155	117	126	129	142	130	114	105	121
2im	-	119	93	104	110	120	106	104	125	96
2ma	190	156	130	131	142	156	138	135	96	125
3	217	182	171	159	185	180	190	143	129	148
3im	-	-	113	126	147	-	149	118	110	99
3ma	217	182	173	160	191	180	194	154	143	151
4	239	213	208	177	225	220	200	176	142	155
5	272	251	261	203	252	230	205	169	185	186
6	292	286	279	215	273	260	278	320	320	289
7	295	285	322	253	277	320	238	215	300	289
8	350	320	304	232	289	310	236	-	329	-
9+	371	-	378	-	304	368	-	293	370	-

b:Spring spawners

Age (Winter rings)	Sub - area				
	E	F	G	H	I
2	115	139	128	95	91
3	140	155	147	122	104
4	200	194	181	152	135
5	210	220	198	181	148
6	180	224	221	197	168
7		219		230	191
8		230		219	

Table 9. Catch in kg of horse mackerel, haddock, mackerel, herring, cod and whiting by station.

STNR	POSSITION	HORSE MAC	HADDOCK	MACKEREL	HERRING	COD	WHITING	TOTAL
486	56046N 05123E	.	.	1.67	0.04	0.08	7.05	304
549	55573N 03321E	0.71	.	117.60	0.31	.	.	1186
575	55556N 03018E	0.44	.	136.38	0.06	.	.	1372
695	55524N 00297W	.	5.50	0.72	.	1.21	18.75	615
742	55522N 01271W	0.40	.	2.31	0.26	.	2.16	622
767	55423N 01272W	.	.	0.62	1.65	.	20.11	796
907	55377N 02305E	.	5.31	23.22	36.80	16.35	208.40	4408
964	55307N 03581E	5.70	.	85.80	0.22	.	0.09	1040
993	55114N 03467E	3.96	.	38.80	111.20	0.31	17.40	2300
1136	55099N 00154W	.	56.30	.	0.64	23.70	83.48	6500
1189	54543N 00491W	0.99	.	2.04	0.61	.	17.65	1854
1216	54512N 00078W	5.28	.	40.72	.	.	2.79	1382
1364	54249N 01119E	.	.	.	.	.	63.70	1090
1377	54265N 01178E	0.35	.	0.44	.	.	21.17	257
1460	54059N 00158E	.	.	9.82	25.20	.	0.41	937
1612	54240N 03463E	0.65	.	5.60	1567.47	16.70	539.97	2447
1666	54096N 04581E	33.91	.	1678.20	4133.79	.	.	6000
1943	54448N 06434E	5.10	0.20	.	354.43	37.85	89.14	620
2002	54390N 05217E	17.40	.	4190.51	435.44	.	.	5000
2022	54415N 04581E	0.69	.	29.40	1.66	.	.	106
2158	55155N 06358E	.	4.17	2.84	473.05	538.00	28.10	1060
2216	55229N 07310E	201.90	.	96.93	.	.	.	300
2566	57403N 09385E	.	4.50	.	1056.99	197.88	179.80	1515
2618	57443N 09037E	1.00	.	18.00	930.80	.	.	951
2630	57528N 08525E	0.54	.	17.90	245.13	.	.	276
2642	58003N 08405E	0.04	.	.	14.10	.	.	109
2741	57167N 08411E	0.32	0.25	1.47	0.22	1.47	14.67	104
2783	57390N 08111E	.	.	57.00	649.56	.	.	1026
3060	56318N 06348E	.	0.57	0.14	280.75	8.62	39.88	816
3106	56234N 07500E	1.40	.	0.97	1047.84	0.13	45.81	1201
3123	56249N 07499E	0.64	.	2.33	168.56	.	4.26	200
3307	57203N 06340E	3.78	.	112.90	129.70	.	4.44	304
3324	57203N 07045E	0.95	.	23.90	39.60	.	8.51	183

Table 10. Estimated number (millions) of herring by age and strata.

STRATA	AGE 0	1	2	3	4	5	6	TOTAL
540E00.0	0.6	230.9	.	.	.	.	.	231.6
540E02.0	.	281.9	.	.	.	.	.	281.9
540E04.0	35.5	318.8	0.8	.	.	.	.	355.2
540E06.0	414.7	382.8	.	.	.	.	.	797.4
540W02.0	6.3	0.8	0.4	.	.	.	.	7.5
550E00.0	0.5	5.0	1.1	0.2	0.1	.	0.0	7.0
550E02.0	.	20.3	4.5	1.0	0.3	.	0.1	26.2
550E04.0	3.0	.	.	.	.	.	.	3.0
550E06.0	35.6	4.6	0.2	.	.	.	.	40.5
550W02.0	2.3	1.2	0.1	0.1	.	.	.	3.6
560E04.0	13.9	.	.	.	.	.	.	13.9
560E06.0	258.9	124.7	3.6	.	.	.	.	387.3
570E04.0	.	7.3	2.5	0.3	0.1	.	.	10.3
570E06.0	.	264.4	302.0	90.0	18.4	2.2	0.4	677.5
570E08.0	106.1	53.3	108.5	62.5	3.3	2.1	0.7	336.5
TOTAL	877.5	1696.1	423.8	154.0	22.3	4.3	1.2	3179.2

Table 11. Estimated biomass (tonnes) of herring by age and strata.

STRATA	AGE 0	1	2	3	4	5	6	TOTAL
540E00.0	6.5	9130.6	.	.	.	.	.	9137.1
540E02.0	.	14073.9	.	.	.	.	.	14073.9
540E04.0	554.9	14450.0	52.6	.	.	.	.	15057.5
540E06.0	6098.9	17383.5	.	.	.	.	.	23482.4
540W02.0	101.9	12.7	6.4	.	.	.	.	121.0
550E00.0	8.8	204.6	77.6	24.6	14.2	.	1.5	331.3
550E02.0	.	1247.0	589.1	145.4	60.5	.	6.5	2048.5
550E04.0	29.9	.	.	.	.	.	.	29.9
550E06.0	409.3	130.2	7.6	.	.	.	.	547.2
550W02.0	20.9	10.9	11.5	0.9	.	.	.	44.2
560E04.0	139.1	.	.	.	.	.	.	139.1
560E06.0	3123.7	5150.1	333.5	.	.	.	.	8607.3
570E04.0	.	474.0	244.4	31.8	20.4	.	.	770.6
570E06.0	.	17339.5	29361.6	10772.2	2920.3	414.3	71.3	60879.3
570E08.0	1622.9	2925.1	10436.5	7302.5	528.3	361.6	110.7	23287.6
TOTAL	12116.8	82532.3	41120.7	18277.4	3543.8	775.9	190.0	158557

Table 12 Mean weight (gram) of herring by age and strata.

STRATA	AGE							MEAN WEIGHT
	0	1	2	3	4	5	6	
540E00.0	10.0	39.5	.	.	.	.	.	24.8
540E02.0	.	49.9	.	.	.	.	.	49.9
540E04.0	15.6	45.3	62.5	.	.	.	.	41.2
540E06.0	14.7	45.4	.	.	.	.	.	30.1
540W02.0	16.1	16.1	16.1	.	.	.	.	16.1
550E00.0	16.1	41.0	67.5	142.3	187.8	.	127.0	96.9
550E02.0	.	61.4	132.0	142.3	187.8	.	127.0	130.1
550E04.0	10.0	.	.	.	.	.	.	10.0
550E06.0	11.5	28.1	31.3	.	.	.	.	23.7
550W02.0	9.3	9.3	95.0	9.3	.	.	.	30.7
560E04.0	10.0	.	.	.	.	.	.	10.0
560E06.0	12.1	41.3	92.6	.	.	.	.	48.7
570E04.0	.	129.1	193.2	236.3	302.0	.	.	107.6
570E06.0	.	263.0	389.4	478.3	628.4	562.9	515.0	129.0
570E08.0	70.1	291.9	414.5	358.5	465.1	350.4	322.0	90.9
MEAN	13.8	48.7	97.0	118.7	158.9	180.4	158.3	49.9

Table 13.   Estimated number (millions) of mackerel by age and strata.

STRATA	0	1	2	3	4	5	6	7	8	9	10	11	15	TOTAL
540E00.0	31.9	0.4	9.4	1.1	.	0.7	0.4	0.4	.	.	.	.	.	44.3
540E02.0	.	0.0	0.1	0.0	.	.	.	.	.	.	0.0	.	.	0.2
540E04.0	.	171.3	215.0	9.9	1.1	4.0	5.1	5.9	.	.	.	.	.	412.3
540W02.0	5.6	1.3	29.1	3.0	1.5	1.7	0.6	0.8	0.1	0.1	.	.	.	43.8
550E00.0	0.5	.	1.3	0.0	0.2	0.0	.	.	.	.	.	.	.	2.0
550E02.0	.	131.0	222.6	6.6	3.2	0.6	0.7	.	.	.	.	.	.	364.7
550E04.0	.	37.6	56.0	2.2	0.9	0.6	0.6	.	0.0	.	.	.	.	97.9
550E06.0	.	14.9	1.2	0.2	.	0.1	.	.	.	.	.	.	.	16.4
550W02.0	39.2	0.1	0.2	.	1.6	.	0.0	0.0	.	0.0	.	.	.	41.3
560E04.0	.	.	24.3	.	.	.	.	.	.	.	.	.	.	24.3
560E06.0	.	0.0	0.0	.	0.0	.	0.0	.	.	0.0	0.0	0.0	0.0	0.1
570E04.0	.	0.3	2.0	0.1	0.0	.	.	0.0	.	.	.	.	.	2.5
570E06.0	.	8.3	65.2	3.9	1.0	.	.	0.7	.	.	.	.	.	79.0
570E08.0	.	1.1	7.3	0.7	0.0	0.2	.	0.1	.	.	.	.	.	9.4
TOTAL	77.2	366.3	633.8	27.7	9.6	7.9	7.4	7.8	0.2	0.2	0.0	0.0	0.0	1138.2

Table 14. Estimated biomass (tonnes) of mackerel by age and strata.

STRATA	0	1	2	3	4	5	6	7	8	9	10	11	15	TOTAL
540E00.0	116.1	76.0	2522.0	328.0	.	280.0	145.0	141.0	.	.	.	.	.	3608.1
540E02.0	.	2.0	23.0	8.9	.	.	.	.	.	.	13.0	.	.	47.0
540E04.0	.	28166.6	45957.6	2321.4	341.1	1290.5	1664.6	1664.6	.	.	.	.	.	81386.4
540W02.0	9.9	288.8	7910.7	842.7	462.4	498.0	217.6	248.5	48.2	48.2	.	.	.	10575.1
550E00.0	0.9	.	346.8	13.3	99.7	4.9	.	.	.	.	.	.	.	465.6
550E02.0	.	27218.7	56769.5	2155.9	1024.4	234.5	265.3	.	.	.	.	.	.	87668.4
550E04.0	.	7125.0	13513.8	726.0	286.4	228.2	237.1	.	8.7	.	.	.	.	22125.3
550E06.0	.	2619.5	252.4	57.7	.	23.0	.	.	.	.	.	.	.	2952.6
550W02.0	46.2	15.6	64.8	.	835.2	.	20.4	20.4	.	20.4	.	.	.	1023.1
560E04.0	.	.	5722.2	.	.	.	.	.	.	.	.	.	.	5722.2
560E06.0	.	2.0	4.0	.	4.9	.	4.9	.	.	6.0	0.7	6.0	6.0	34.0
570E04.0	.	44.0	511.6	39.9	13.2	.	.	10.7	.	.	.	.	.	619.4
570E06.0	.	1330.9	16156.3	1359.9	422.6	.	.	269.8	.	.	.	.	.	19539.6
570E08.0	.	172.4	1811.8	248.7	20.8	88.5	.	25.5	.	.	.	.	.	2367.6
TOTAL	173.0	67060.0	151138	8095.0	3510.7	2647.0	2555.0	2361.0	56.8	72.0	14.0	6.0	6.0	237695

Table 15. Mean weight (gram) of mackerel by age and strata.

STRATA	\ 0	1	2	3	4	5	6	7	8	9	10	11	15	MEAN WEIGHT
540E00.0	3.6	210.0	267.0	301.0	.	385.0	400.0	390.0	.	.	.	.	.	81.4
540E02.0	.	208.0	255.0	329.4	.	.	.	.	.	.	480.0	.	.	235.0
540E04.0	.	164.4	213.8	235.2	308.8	322.5	327.5	278.8	.	.	.	.	.	198.0
540W02.0	1.8	215.2	271.7	285.2	307.7	295.7	341.8	325.8	341.0	341.0	.	.	.	241.4
550E00.0	1.8	.	267.1	300.9	530.0	284.3	.	.	.	.	.	.	.	233.0
550E02.0	.	207.8	255.1	328.4	316.5	385.0	400.0	.	.	.	.	.	.	240.4
550E04.0	.	189.5	241.3	334.6	321.3	385.0	400.0	.	367.5	.	.	.	.	226.0
550E06.0	.	175.8	207.1	252.7	.	302.5	.	.	.	.	.	.	.	180.0
550W02.0	1.2	155.0	318.8	.	513.8	.	446.7	446.7	.	446.7	.	.	.	24.8
560E04.0	.	.	235.0	.	.	.	.	.	.	.	.	.	.	235.5
560E06.0	.	170.0	203.0	.	423.0	.	400.0	.	.	485.0	485.0	485.0	485.0	390.9
570E04.0	.	319.2	502.5	704.3	960.0	.	.	780.0	.	.	.	.	.	247.8
570E06.0	.	642.9	986.5	1375.9	1690.0	.	.	1690.0	.	.	.	.	.	247.3
570E08.0	.	490.2	1477.1	1752.2	1210.0	735.0	.	1300.0	.	.	.	.	.	251.9
TOTAL	2.0	183.1	238.5	292.2	365.7	335.1	345.3	302.7	355.0	392.0	483.0	485.0	485.0	208.8

Table 16. Estimated number (millions) of horse mackerel by length group and strata.

STRATA	LENGTH (cm)																TOTAL
	4	5	20	24	25	26	27	28	29	30	31	32	33	34	35	36	
540E02.0	.	.	.	.	.	.	.	.	.	0.0	0.0	.	.	.	.	.	0.0
540E04.0	.	.	0.0	.	.	0.0	0.1	1.5	0.2	1.8	1.5	0.1	0.0	.	.	.	5.3
540E06.0	.	.	.	.	.	.	0.1	.	0.5	0.3	0.1	0.2	0.1	.	.	.	1.4
540W02.0	.	.	.	.	.	.	.	.	.	.	.	1.4	0.4	1.7	0.7	.	4.2
550E00.0	.	.	.	.	.	.	.	.	.	.	.	0.0	0.0	0.0	.	.	0.1
550E02.0	.	.	.	.	.	.	.	.	.	0.6	1.5	2.6	0.6	0.8	0.3	.	6.3
550E04.0	.	.	.	.	.	.	.	.	0.0	0.5	1.2	1.9	0.5	0.2	0.2	.	4.6
550E06.0	.	.	.	0.7	0.7	3.3	3.6	8.2	5.6	2.0	0.7	.	.	.	0.3	.	24.9
550W02.0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	0.1
560E06.0	.	.	.	.	.	.	.	.	.	.	.	0.0	0.0	0.0	0.0	.	0.0
570E04.0	0.0	0.0	.	.	.	0.0	0.0	0.0	0.0	0.0	0.0	.	0.0	.	.	.	0.1
570E06.0	0.4	0.6	.	.	.	0.1	0.2	0.4	0.6	0.8	0.4	0.0	0.2	.	0.0	.	3.7
570E08.0	0.0	0.0	.	.	.	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0	.	0.0	.	0.5
TOTAL	0.5	0.6	0.0	0.7	0.7	3.4	4.1	10.2	7.0	6.0	5.4	6.5	1.8	2.7	1.7	0.1	51.3

Table 17. Estimated biomass (tonnes) of horse mackerel by length group and strata.

	LENGTH (cm)																
STRATA	4	5	20	24	25	26	27	28	29	30	31	32	33	34	35	36	TOTAL
540E02.0	.	.	.	.	.	.	.	.	.	3.9	1.9	.	.	.	.	.	5.8
540E04.0	.	.	3.9	.	.	3.9	15.5	361.2	50.3	420.7	356.3	24.4	3.9	.	.	.	1240
540E06.0	.	.	.	.	.	.	32.2	.	128.7	80.5	32.2	48.3	16.1	.	.	.	337.9
540W02.0	.	.	.	.	.	.	.	.	.	.	.	496.1	153.9	581.6	256.3	.	1488
550E00.0	.	.	.	.	.	.	.	.	.	.	.	5.6	5.6	5.6	.	.	16.9
550E02.0	.	.	.	.	.	.	.	.	.	175.9	439.7	774.0	175.9	245.6	87.9	.	1899
550E04.0	.	.	.	.	.	.	.	.	6.6	141.4	363.6	572.4	148.1	67.4	74.1	.	1373
550E06.0	.	.	.	101.7	98.4	542.9	698.7	1753	1273	462.5	173.9	.	.	.	123.0	.	5227
550W02.0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	40.2	40.2
560E06.0	.	.	.	.	.	.	.	.	.	.	.	1.0	0.5	4.0	4.5	.	9.9
570E04.0	0.0	0.0	.	.	.	1.1	2.0	3.2	5.1	6.2	3.0	.	1.1	.	.	.	21.6
570E06.0	0.5	0.6	.	.	.	29.4	55.0	90.6	143.1	172.5	84.4	5.6	38.2	.	2.4	.	622.2
570E08.0	0.0	0.0	.	.	.	1.4	2.7	12.9	6.9	8.3	4.1	79.1	5.6	.	8.7	.	129.8
TOTAL	0.5	0.7	3.9	101.7	98.4	578.7	806.1	2221	1614	1472	1459	2007	548.9	904.2	556.9	40.2	12412

Table 18. Estimated number (millions) of sprat by length group and strata.

STRATA	3	4	5	6	9	10	11	12	13	14	15	16	TOTAL
540E00.0	4.0	47.9	43.9	1.3	.	5.4	31.9	13.2	14.0	7.8	.	.	169.4
540E02.0	.	.	.	.	.	.	.	10.6	20.9	18.1	5.1	.	54.8
540E04.0	.	.	.	.	.	0.3	6.4	10.7	4.5	0.6	.	.	22.5
540E06.0	.	.	.	.	.	7.0	82.2	160.8	102.1	27.0	.	.	379.2
540W02.0	.	.	.	.	.	3.4	8.4	9.9	19.3	42.8	19.4	0.2	103.5
550E00.0	.	.	.	.	.	0.3	0.7	0.5	0.5	0.8	0.2	0.0	3.0
550E02.0	.	.	.	.	.	.	.	.	.	0.2	0.2	.	0.3
550E04.0	.	.	.	.	.	.	.	0.4	4.0	19.9	11.3	0.3	35.9
550E06.0	.	.	.	.	.	.	0.1	1.0	0.2	0.1	.	.	1.5
550W02.0	11.3	109.9	85.4	.	0.4	1.8	3.9	5.4	19.4	50.8	21.9	1.5	311.6
560E06.0	.	.	.	.	.	.	0.4	1.2	1.3	0.4	.	0.0	3.3
TOTAL	15.3	157.8	129.3	1.3	0.4	18.3	134.0	213.7	186.3	168.5	58.1	1.9	1084.9

Table 19. Estimated biomass (tonnes) of sprat by length group and strata.

STRATA	3	4	5	6	9	10	11	12	13	14	15	16	TOTAL
540E00.0	3.3	39.4	36.1	1.1	.	86.0	503.7	208.9	221.1	122.9	.	.	1222.3
540E02.0	.	.	.	.	.	.	.	159.6	388.2	409.9	132.0	.	1089.8
540E04.0	.	.	.	.	.	5.3	102.6	172.1	72.1	9.4	.	.	361.5
540E06.0	.	.	.	.	.	58.7	1021.3	2441.8	1895.9	622.2	.	.	6039.8
540W02.0	.	.	.	.	.	33.4	100.7	145.7	363.2	982.1	529.8	6.9	2161.9
550E00.0	.	.	.	.	.	2.5	7.9	7.0	10.3	17.3	6.6	0.6	52.1
550E02.0	.	.	.	.	.	.	.	.	.	5.3	5.3	.	10.5
550E04.0	.	.	.	.	.	.	.	6.0	83.0	497.6	320.9	8.6	916.1
550E06.0	.	.	.	.	.	.	1.2	14.3	3.5	1.8	.	.	20.7
550W02.0	8.6	83.7	65.0	.	4.1	17.1	43.9	79.8	380.1	1196.5	603.0	50.9	2532.7
560E06.0	.	.	.	.	.	.	5.9	18.1	22.4	7.0	.	0.4	53.9
TOTAL	11.9	123.0	101.0	1.1	4.1	302.9	1787.1	3253.2	3439.9	3872.0	1597.6	67.5	14461.4

Table 20 Technical data and settings of the acoustic equipment onboard R/V "Argos".

Echosounder	EK 400
Frequency	38 KHz
Transducer	38-29/25 E
Beam angle	9° x 9°
Integrator	QX + ND-10S
Calibration	Copper sphere
10 Log Ψ	-19.3 dB
Attenuator coeff.	0.00801 dB/m
TVG range	581 m
Pulse length	1.0 ms
Band width	3.3 KHz
Attenuator	-10 dB
Treshold	7 mV increasing with depth

Table 21 Survey statistics. R/V"Argos".

Area	Stratum	Area sq.mile	No of mile integrated	No of trawl hauls
	C3	200	32	1
	C4	476	80	3
Skagerrak	C5	127	12	3 *
	D2	169	8	2 *
	D3	433	46	2
	D4	733	96	3
	D5	295	22	3 *
	Total:	2433	296	9
Kattegat	E0	3493	12	3 *
	E1	1216	106	1
	E2	382	72	1
	E3	137	40	1
	Total:	5228	230	3

* = Trawl data from other area

Table 22 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
Skagerrak	C3	203397	79160	77346	42549	3903	549				
	C4	108794		24955	51289	25133	6270	618	354		176
	C5	14971		3434	7058	3458	863	85	49		24
	D2	538472	256420	205050	60955	15508	538				
	D3	1103879	525667	420357	124959	31792	1104				
	D4	199835	6898	120976	45972	17144	7750	244	568	304	
	D5	8950	309	5418	2059	768	347	11	25	14	
	Total:	2178298	868455	857537	334840	97706	17421	958	995	317	200
Kattegat	E0	482577	29461	295964	120335	32154	4348	261	154		
	E1	576444	35192	353533	143742	38408	5194	311	184		
	E2	213080	13009	130682	53134	14198	1920	115	68		
	E3	82557	5040	50632	20586	5501	744	45	26		
	Total:	1354658	82702	830812	337798	90261	12205	732	433	0	0

Table 23 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
Skagerrak	C3	46,78	8,69	47,74	68,50	86,56	90,00				
	C4	79,66		48,87	67,97	95,95	110,78	140,83	148,75		197,00
	C5	79,66		48,87	67,97	95,95	110,78	140,83	148,75		197,00
	D2	45,94	23,51	45,12	65,24	87,43	116,33	165,00			
	D3	45,94	23,51	45,12	65,24	87,43	116,33	165,00			
	D4	74,78	12,15	46,48	75,26	96,32	128,64	155,62	162,47	180,34	
	D5	74,78	12,15	46,48	75,26	96,32	128,64	155,62	162,47	180,34	
Kattegat	E0	47,84	11,26	35,72	59,86	81,87	104,88	107,75	124,33		
	E1	47,84	11,26	35,72	59,86	81,87	104,88	107,75	124,33		
	E2	47,84	11,26	35,72	59,86	81,87	104,88	107,75	124,33		
	E3	47,84	11,26	35,72	59,86	81,87	104,88	107,75	124,33		

Table 24 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
Skagerrak	C3	9515	688	3692	2915	338	49	0	0	0	0
	C4	8667	0	1220	3486	2412	695	87	53	0	35
	C5	1193	0	168	480	332	96	12	7	0	35
	D2	24737	6028	9253	3977	1356	63	0	0	0	5
	D3	50711	12358	18968	8153	2780	128	0	0	0	0
	D4	14945	84	5623	3460	1651	997	38	92	55	0
	D5	669	4	252	155	74	45	2	4	2	0
	Total:	110436	19162	39176	22625	8942	2072	139	156	57	39
Kattegat	E0	23088	332	10570	7203	2632	456	28	19	0	0
	E1	27579	396	12627	8605	3145	545	34	23	0	0
	E2	10194	146	4667	3181	1162	201	12	8	0	0
	E3	3950	57	1808	1232	450	78	5	3	0	0
	Total:	64811	931	29673	20221	7390	1280	79	54	0	0

Table 25 Mean length of herring by age group and strata. Mean length by age. R/V 'Argos'

	Stratum	Mean length	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8
Skagerrak	C3	21,10	11,10	19,30	20,20	22,10	22,50				
	C4	21,70		20,10	21,40	23,20	24,00	26,50	26,80		30,7
	C5	21,70		20,10	21,40	23,20	24,00	26,50	26,80		30,7
	D2	17,20	15,10	18,30	20,80	21,80	25,30				
	D3	17,20	15,10	18,30	20,80	21,80	25,30				
	D4	20,20	13,90	19,40	21,20	22,90	24,50	26,50	27,70	29,1	
	D5	20,20	13,90	19,40	21,20	22,90	24,50	26,50	27,70	29,1	
Kattegat	E0	18,60	13,40	17,90	20,60	21,60	22,60	23,20	26,70		
	E1	18,60	13,40	17,90	20,60	21,60	22,60	23,20	26,70		
	E2	18,60	13,40	17,90	20,60	21,60	22,60	23,20	26,70		
	E3	18,60	13,40	17,90	20,60	21,60	22,60	23,20	26,70		

Table 26   Estimated number of species and strata. Numbers in thousands. Mackerel and Dogfish: TS=20log I -77.2 R/V"Argos".

Stratum	Sprat	Cod	Haddock	Whiting	Blue Whiting	Mackerel	Saithe	Horse Mackerel	Norway Pout	Dogfish
Skagerrak										
C3										
C4				6889	53599	1622	4012	1405		
C5				806	6913	273	640	142		
D2			2190	54746		27736		4280		
D3			4489	11223		56858		8774		
D4	108	215	215	18002	59467		1407		17497	
D5	5	10	10	806	2663		63		784	
Total:	113	225	6904	92472	122642	86489	6122	14601	18281	
Kattegat										
E0	29704	3040		110416					1795	623
E1	35482	3631		131893					2144	744
E2	13116	1342		48754					792	275
E3	5082	520		18889					307	107
Total:	83384	8533		309952					5038	1749

Table 27   Mean weight of species and strata. R/V"Argos".

Stratum	Sprat	Cod	Haddock	Whiting	Blue Whiting	Mackerel	Saithe	Horse Mackerel	Norway Pout	Dogfish
Skagerrak										
C3										
C4				4,42	133,78	214,29	3416,67	0,50		
C5				4,42	133,78	214,29	3416,67	0,50		
D2			2,00	4,00		186,92		570,00		
D3			2,00	4,00		186,92		570,00		
D4	20,00	1600,00	6,00	10,27	158,23		1642,86		29,11	
D5	20,00	1600,00	6,00	10,27	158,23		1642,86		29,11	
Kattegat										
E0	25,00	2080,00		57,71					50,00	3400,00
E1	25,00	2080,00		57,71					50,00	3400,00
E2	25,00	2080,00		57,71					50,00	3400,00
E3	25,00	2080,00		57,71					50,00	3400,00

Table 28   Estimated biomass metric tonnes of species and strata. R/V"Argos".

Stratum	Sprat	Cod	Haddock	Whiting	Blue Whiting	Mackerel	Saithe	Horse Mackerel	Norway Pout	Dogfish
Skagerrak										
C3										
C4				30	7170	348	13708	1		
C5				4	925	59	2187	0		
D2			4	219		5184		2440		
D3			9	45		10628		5001		
D4	2	344	1	185	9409		2312		509	
D5	0	16	0	8	421		104		23	
Total:	2	360	15	491	17926	16219	18309	7442	532	
Kattegat										
E0	743	6323		6372					90	2118
E1	887	7552		7612					107	2530
E2	328	2791		2814					40	935
E3	127	1082		1090					15	364
Total:	2085	17749		17888					252	5947

Table 29   Mean length of species and strata. R/V"Argos".

Stratum	Sprat	Cod	Haddock	Whiting	Blue Whiting	Mackerel	Saithe	Horse Mackerel	Norway Pout	Dogfish
Skagerrak										
C3										
C4				8,16	27,49	29,04	66,03	4,00		
C5				8,16	27,49	29,04	66,03	4,00		
D2			7,50	7,74		28,67		38,25		
D3			7,50	7,74		28,67		38,25		
D4	14,25	56,50	10,00	8,89	29,25		55,35		15,70	
D5	14,25	56,50	10,00	8,89	29,25		55,35		15,70	
Kattegat										
E0	15,55	56,70		16,90					16,83	80,50
E1	15,55	56,70		16,90					16,83	80,50
E2	15,55	56,70		16,90					16,83	80,50
E3	15,55	56,70		16,90					16,83	80,50

Table 30.

Estimated numbers of herring at age (millions) per spawning group and area.

N= numbers; B=biomass('000t)); I=immature; M=mature; Sp=Spring spawner; Au=Autumn spawner.

Age	IVa W	IVa E Au	IVa E Sp	IVb W	IVb E Au	IVb E Sp	Skagerrak Au	Skagerrak Sp	Kattegat Au	Kattegat Sp	Total Au	Total Sp
0	1227.5	0	0	142.8	703.0	-	975.0		82.7		3131	0
1	2492.0	104.0	0	249.7	1616.0	-	1040.0		830.8		6333	0
2I	489.3	197.0	-	51.7	56.5	-	-		-		795	-
2M	2473.5	169.0	155	288.9	0	31.5		581.0		337.8	2931	1105
3I	128.1	91.0	-	11.3	0	-	-		-		230	-
3M	2983.2	320.0	462	217.6	0	11.0		151		90.3	3521	714
4	1231.1	341.0	280	40.1	0	3.0		22		12.2	1612	317
5	379.2	101.0	78	8.0	0	0		2		0.7	488	81
6	207.2	74.0	50	0	0	0		1		0.4	281	54
7	86.7	33.0	16	0	0	0		0.3		0	120	16
8	33.0	11.0	4	0	0	0		0.2		0	44	4.2
9+	16.6	5.0	0	0	0	0		0		0	22	0
Total	11747.4	1446.0	1045	1010.1	2375.5	45.5	2015.0	757.5	913.5	441.4	19508	2289
Spwn. N	7410.5	1054.0	1045	554.6	0	45.5	0	757.5	0	441.4	9019	2289
Spwn. B	1350.0	209.9	156.6	76.7	0	5.0	0	64.9	0	29.0	1637	255.5

Table 31.

Mean weight at age (g) per spawning group and area.

I=immature; M=mature; Sp=Spring spawners; Au=Autumn spawners.

Age	IVa W	IVa E Au	IVa E Sp	IVb W	IVb E Au	IVb E Sp	Skagerrak Au	Skagerrak Sp	Kattegat Au	Kattegat Sp	Mean weight Au	Mean weight Sp
0	3.8	-	-	5.1	14.9	-	21.3	-	11.3		12.0	-
1	59.2	69.4	-	49.7	47.0	-	48.7	-	35.7		51.1	-
2I	107.4	102.9	-	97.2	100.4	-	-	-			105.1	-
2M	141.8	137.4	109.0	125.0	-	100.4	-	79.1	-	59.9	139.9	78.0
3I	135.4	122.2	-	99.7	-	-	-	-		-	128.4	-
3M	179.9	177.8	128.7	151.1	-	121.4	-	103.3		81.9	177.9	117.3
4	213.2	210.3	177.5	155.0	-	157.3	-	126.8		104.9	211.1	171.0
5	259.5	237.8	199.2	186.0	-	-	-	174.2		107.8	253.8	197.8
6	286.8	272.4	212.6	-	-	-	-	156.8		124.3	283.0	210.8
7	291.8	279.2	215.8	-	-	-	-	179.8		-	288.3	215.1
8	326.4	285.1	227.3	-	-	-	-	195.0		-	316.1	225.8
9+	376.9	314.6	-	-	-	-	-	-		-	362.5	-
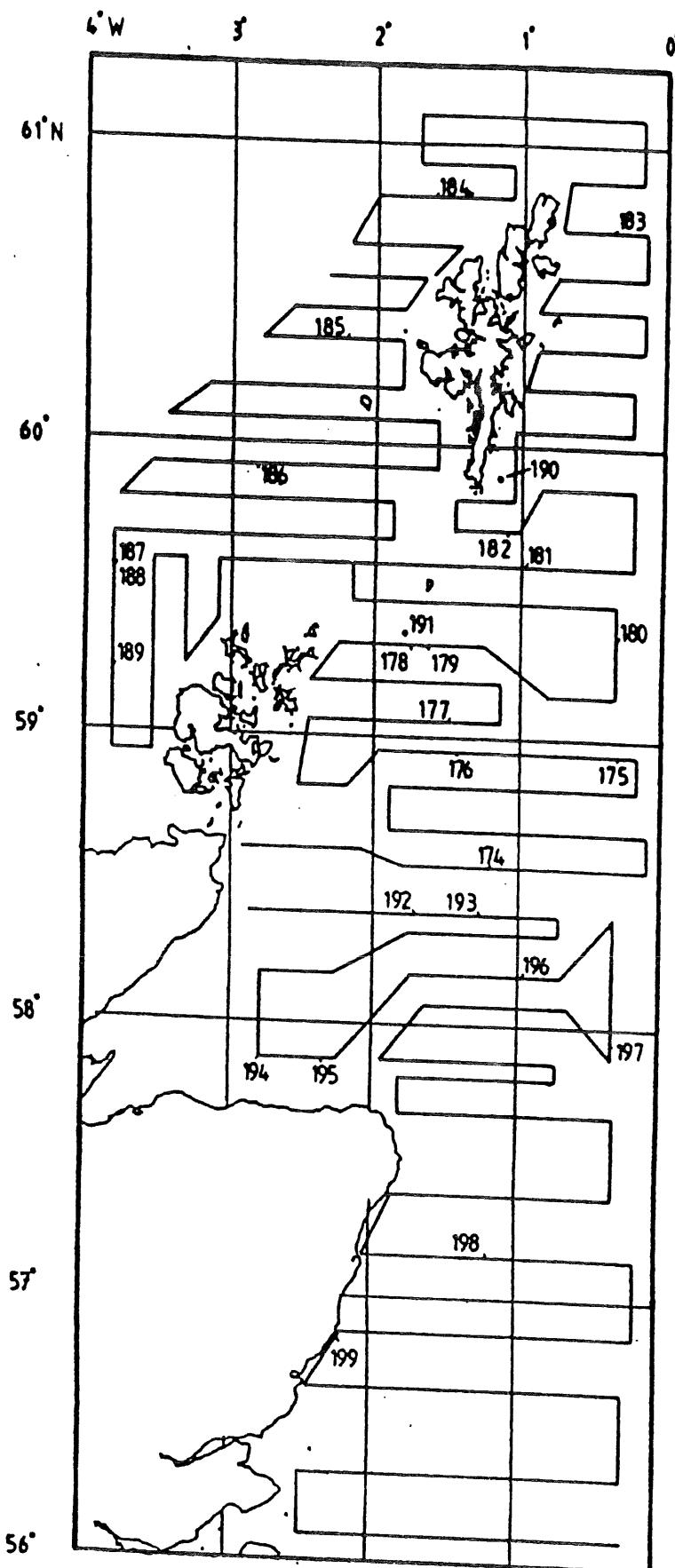
FIGURE 1.   Survey trawl and positions of trawl hauls for "Scotia"
            survey 5 to 25 July 1989
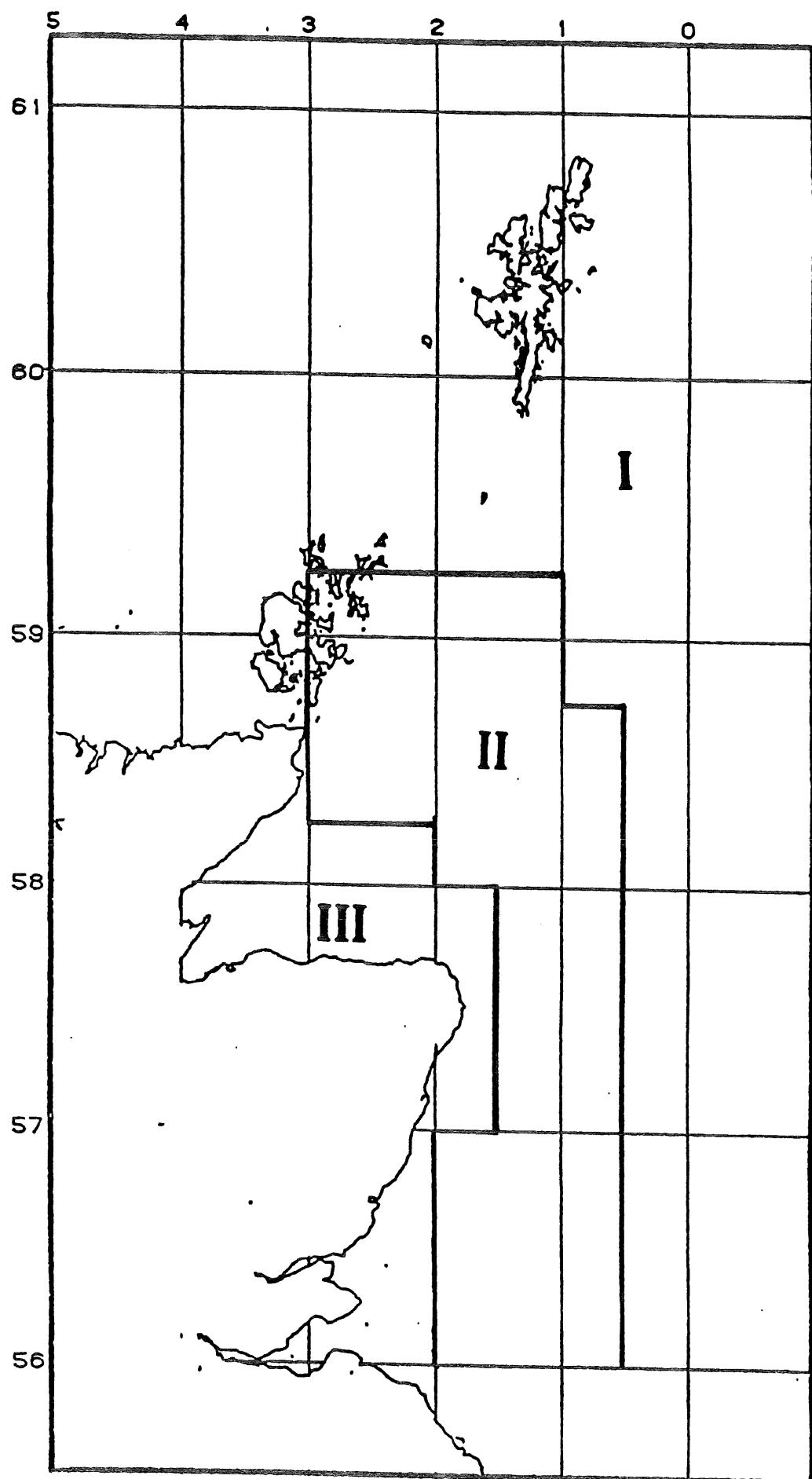
FIGURE 2 Sub areas of consistant length used for data analysis
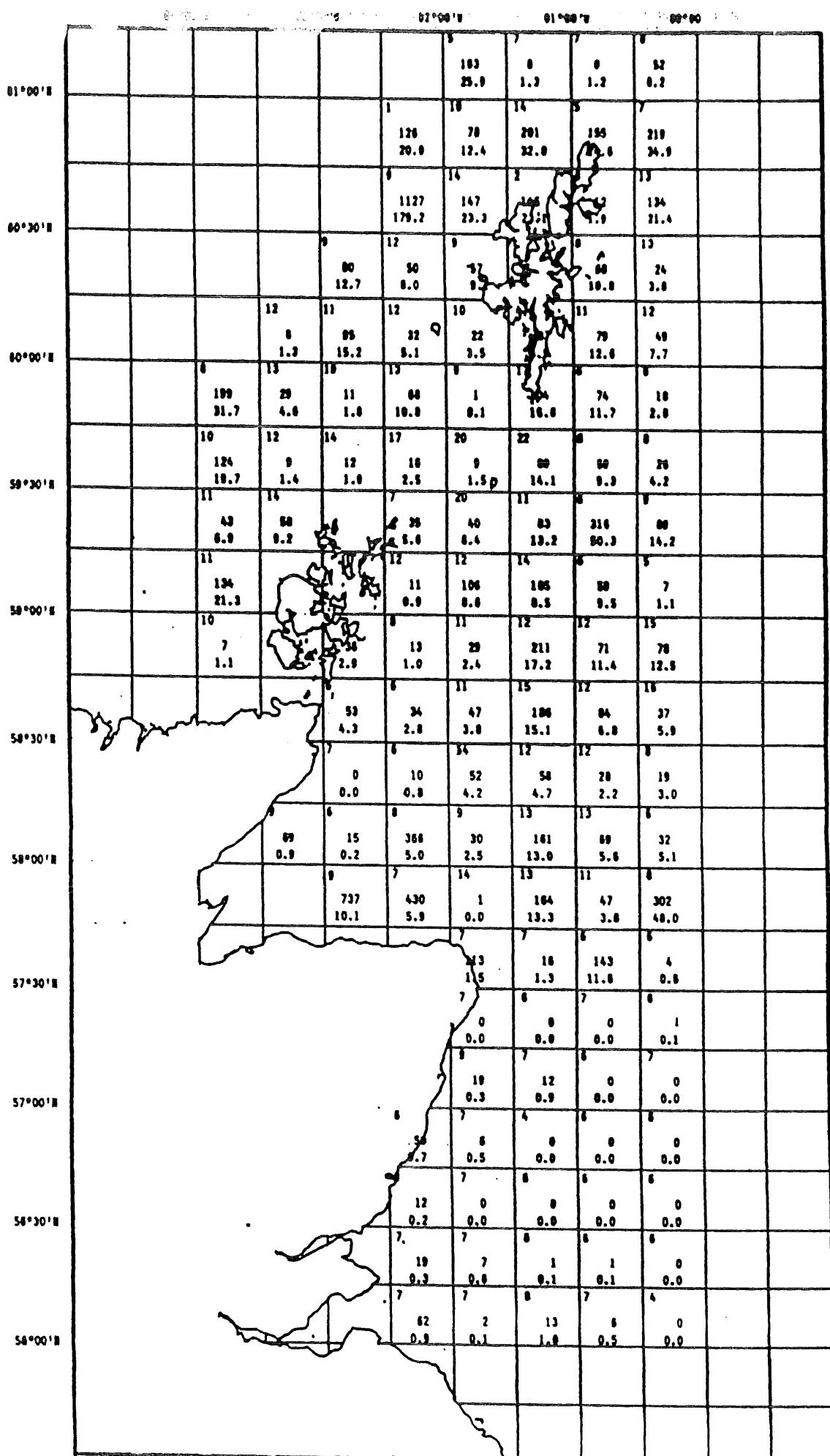
FIGURE 3. Number of integrator 15 minute runs; millions of herring and thousands of tonnes of herring from   +la" s   5-   J   1989

28 JUN.- 20 JUL . 1989 △ □ TRAWL ST NO. 272 - 349
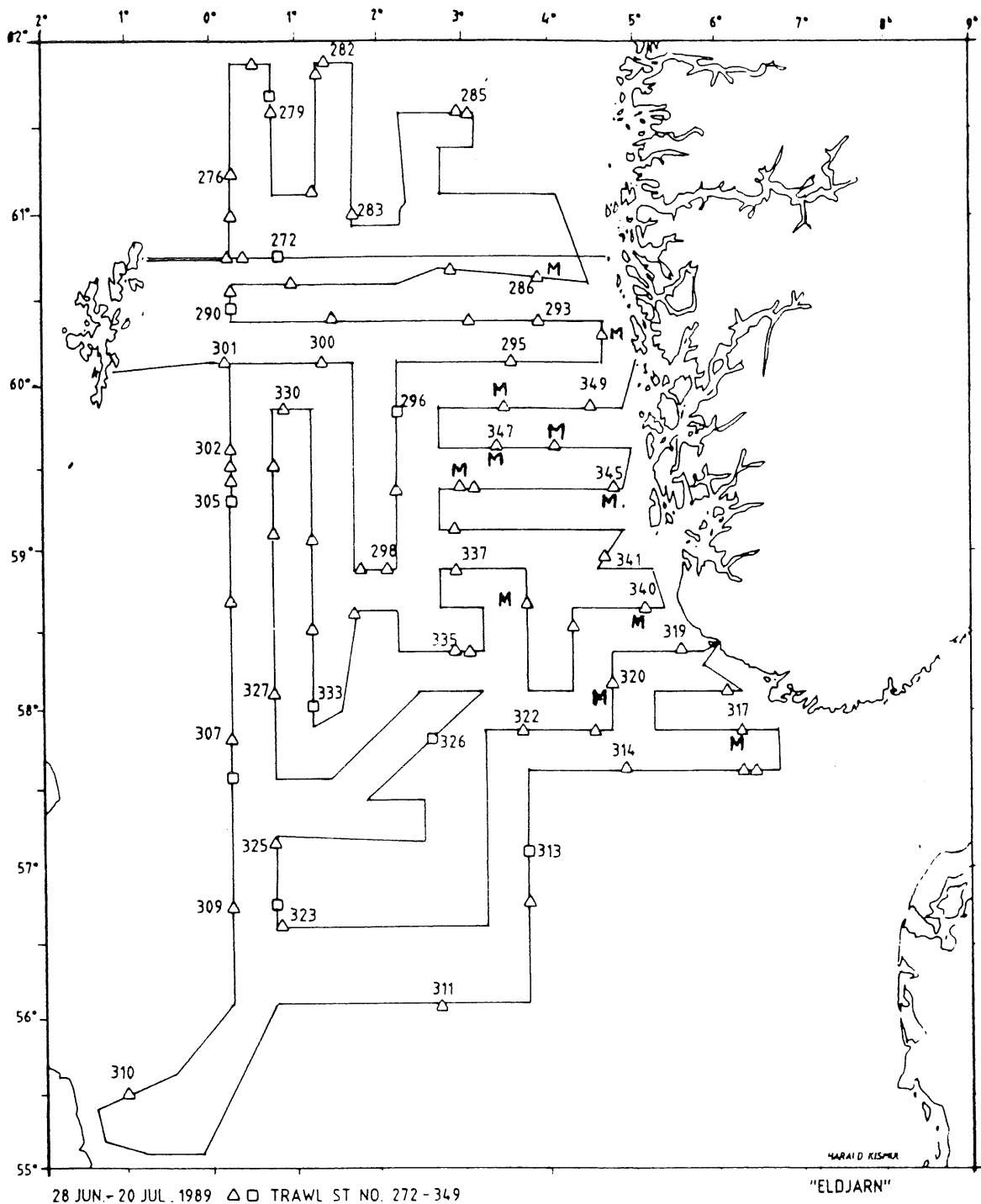
"ELDJARN"

Figure 4. Survey grid and trawl stations, R/V "Eldjarn", 28 June-20 July.

△ : Pelagic trawl

□ : Bottom trawl

M : Herring samples for morphometric/ meristic analysis
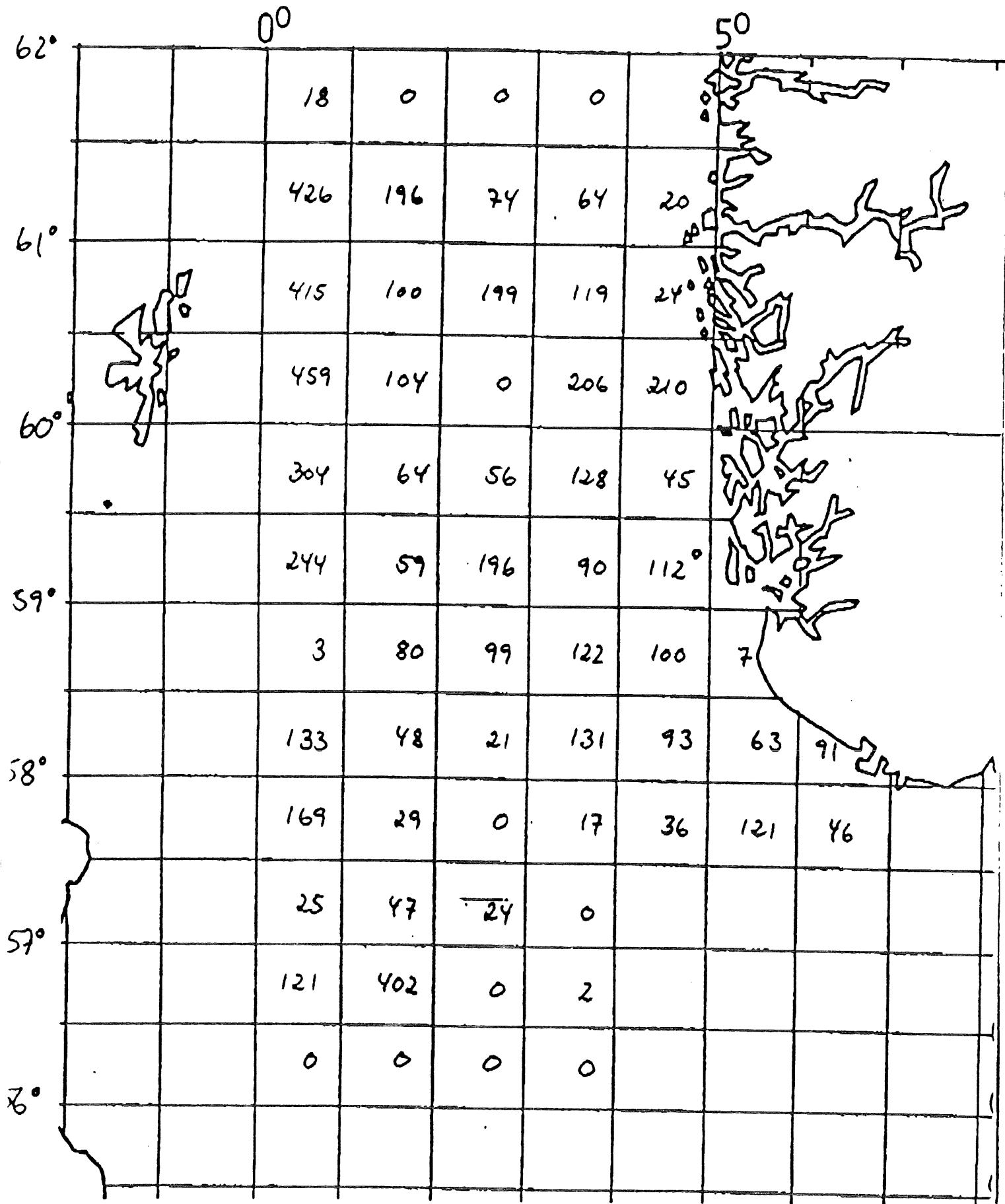
Figure 5. Estimated number of herring
(millions) by rectangle,
"Eldjarn" June-July 1989.
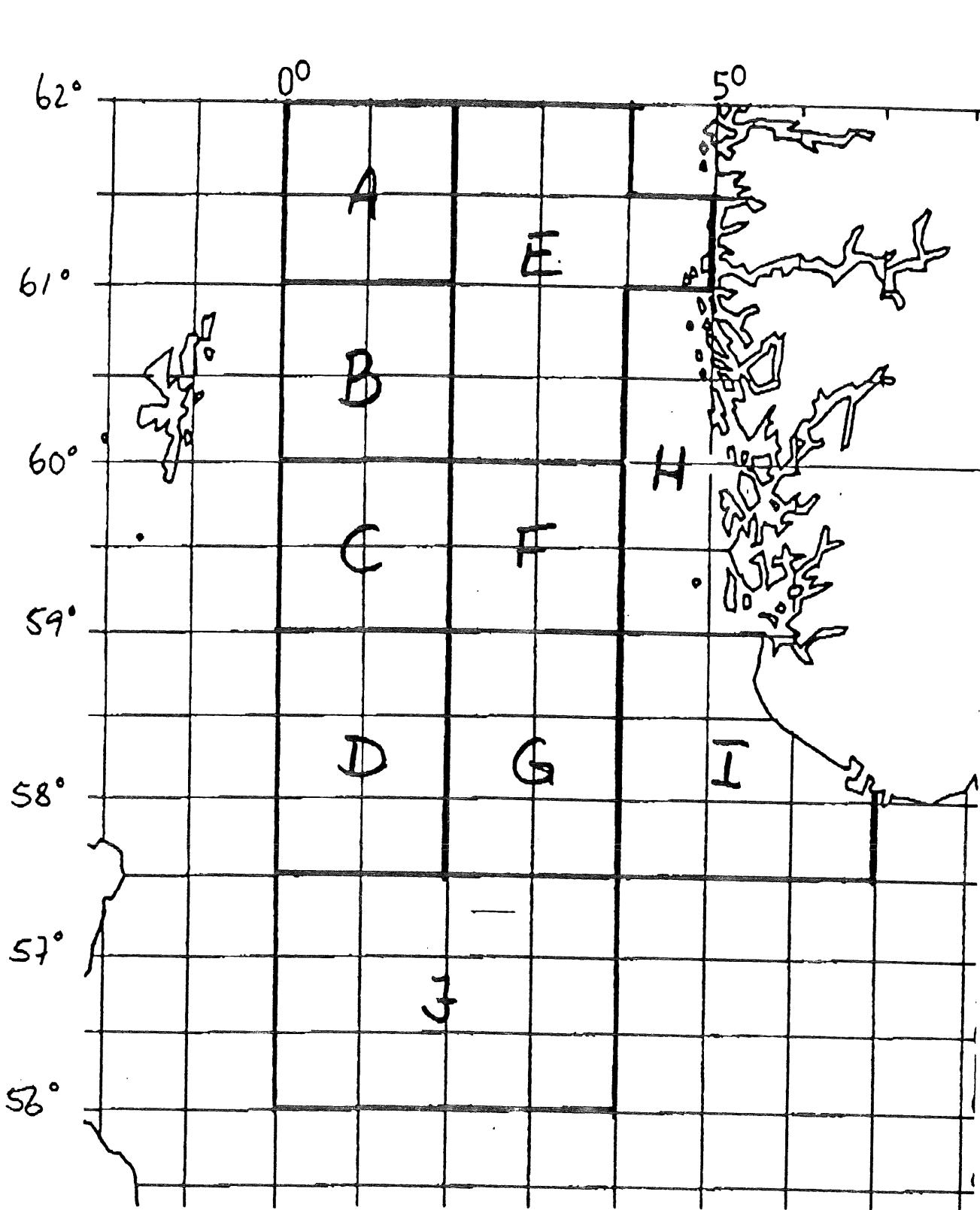
Figure 6. Definition of Sub-area
"Eldjarn" June-July 1989
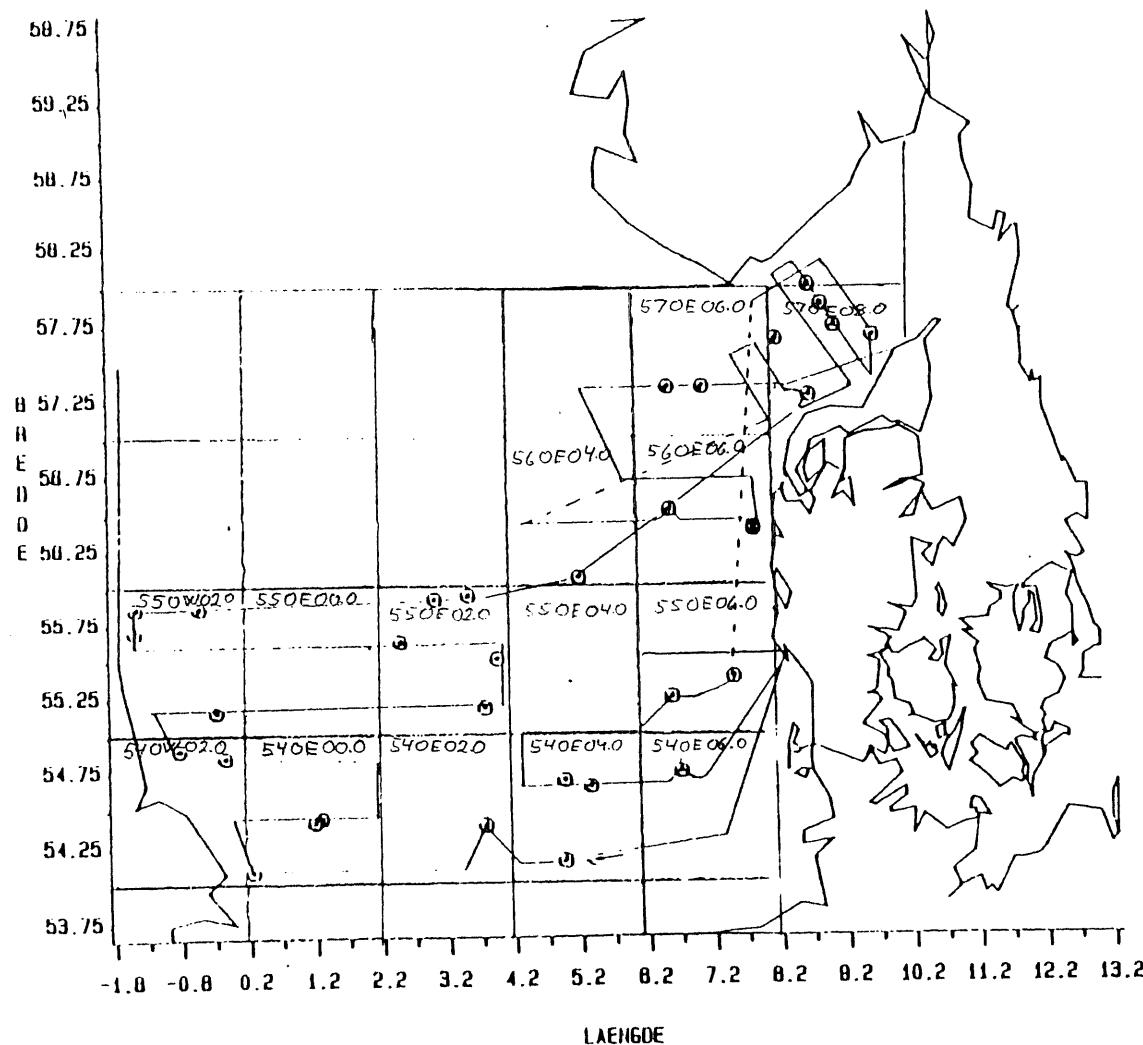
Figure 7. Cruise treck and trawl positions R/V DANA

DATE   UTC   LAT   LONG   HDG   SPEED — SHIPMATE
1989-08-03 1922:00 N 56.211 E 11.539 224.8   0.8
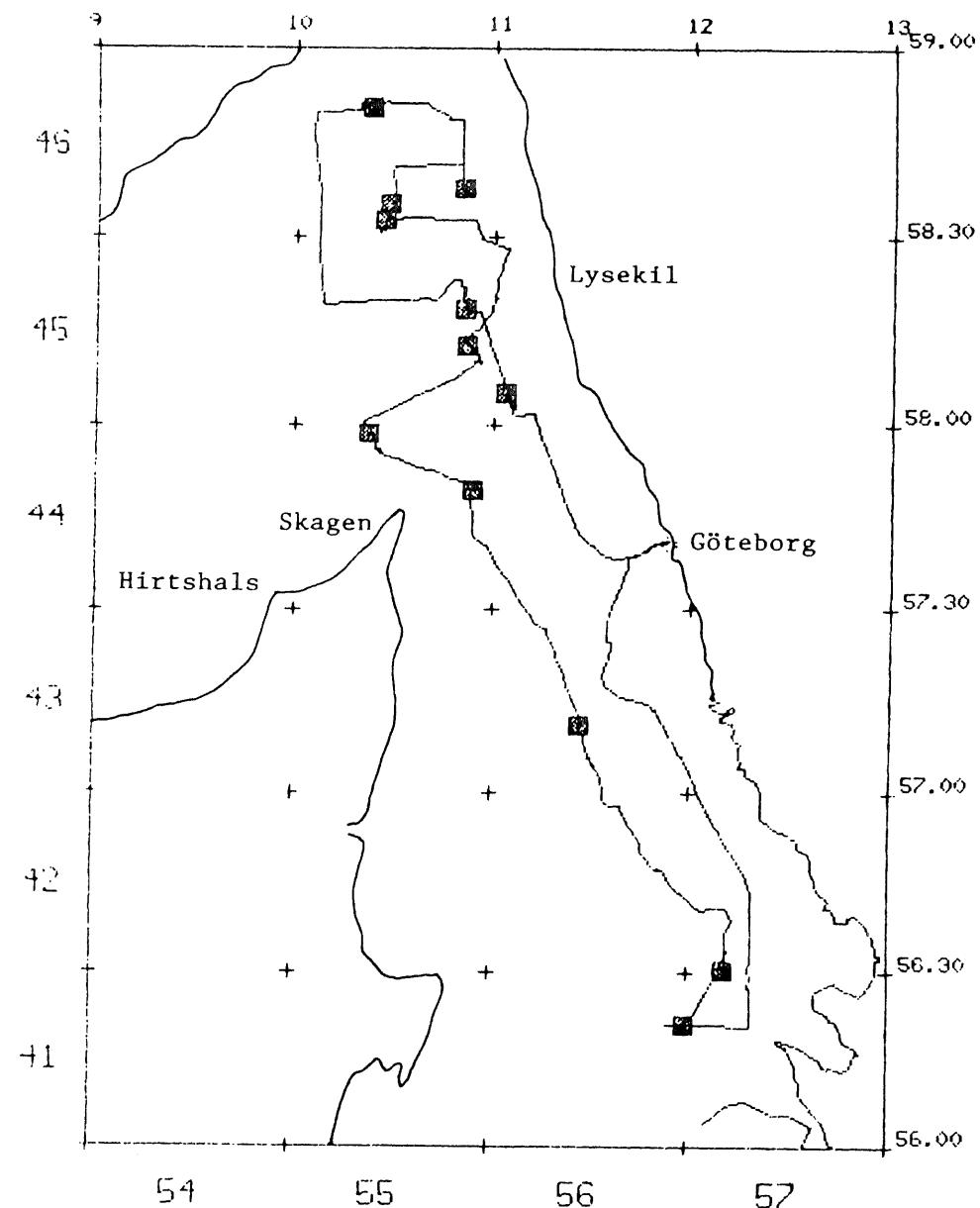
Figure 8.

Cruise treck and trawl positions for R/V "Argos"
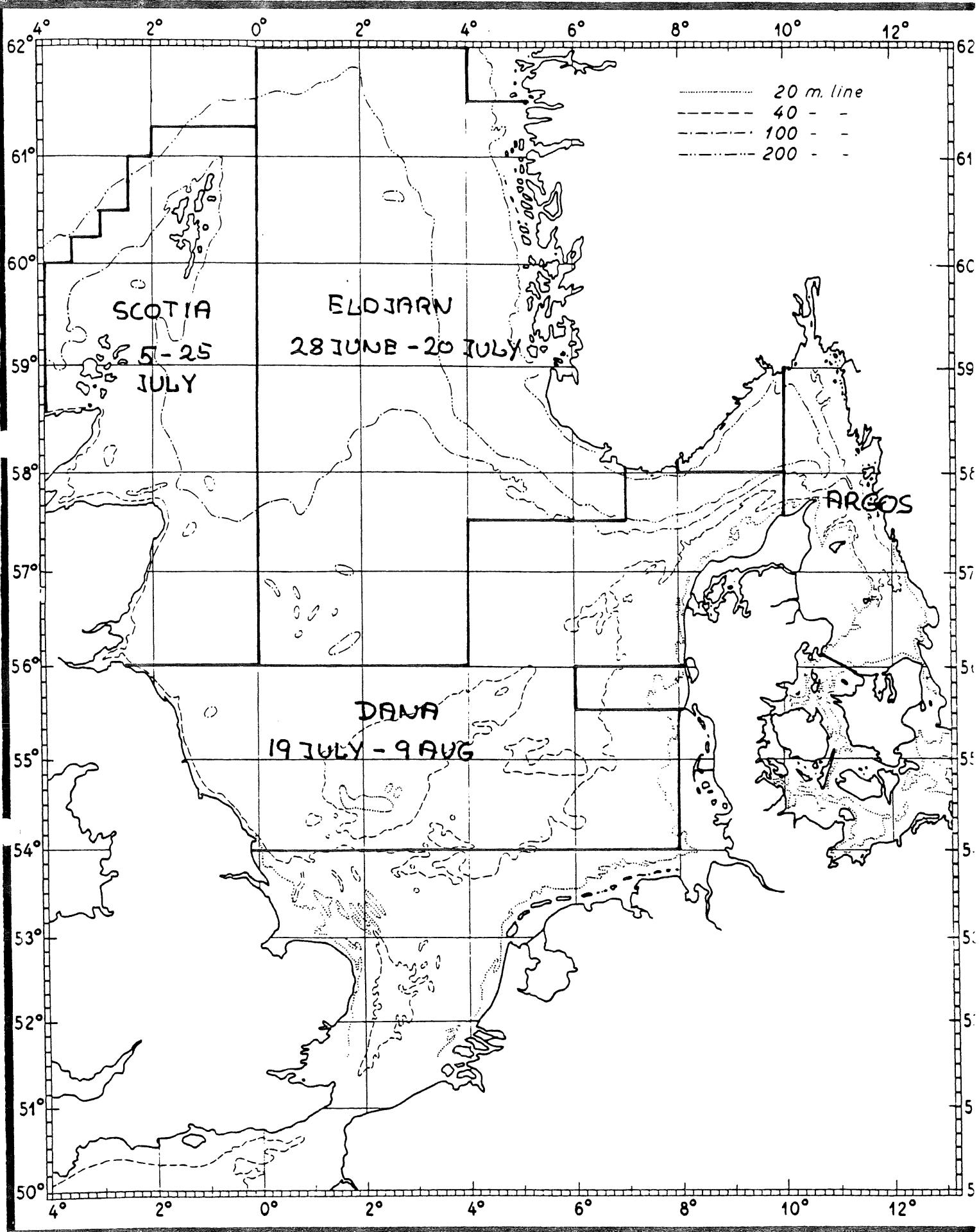
Figure 9. The areas covered during the four surveys.
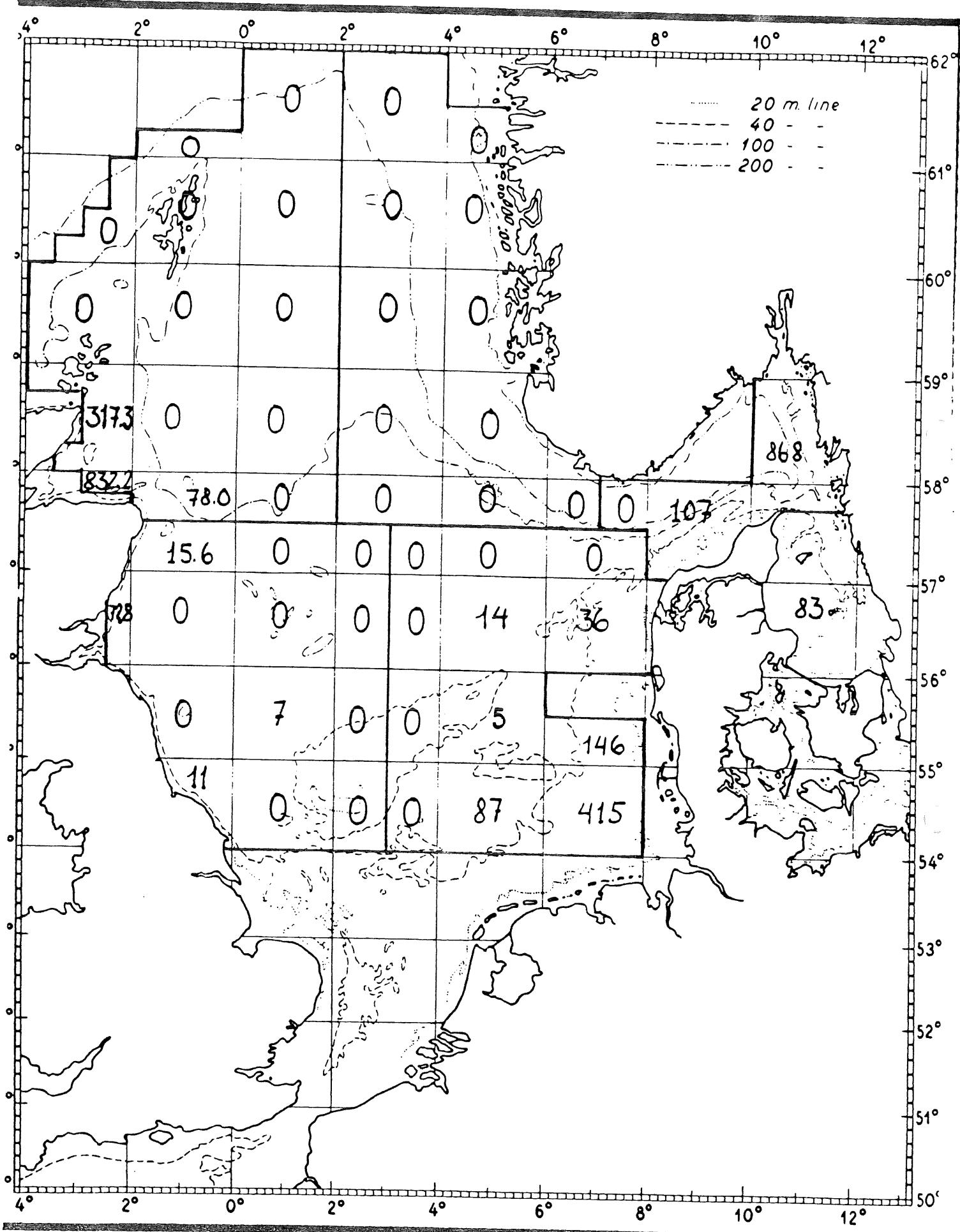
Fig. 10.Estimated numbers (millions) of O-ring Herring
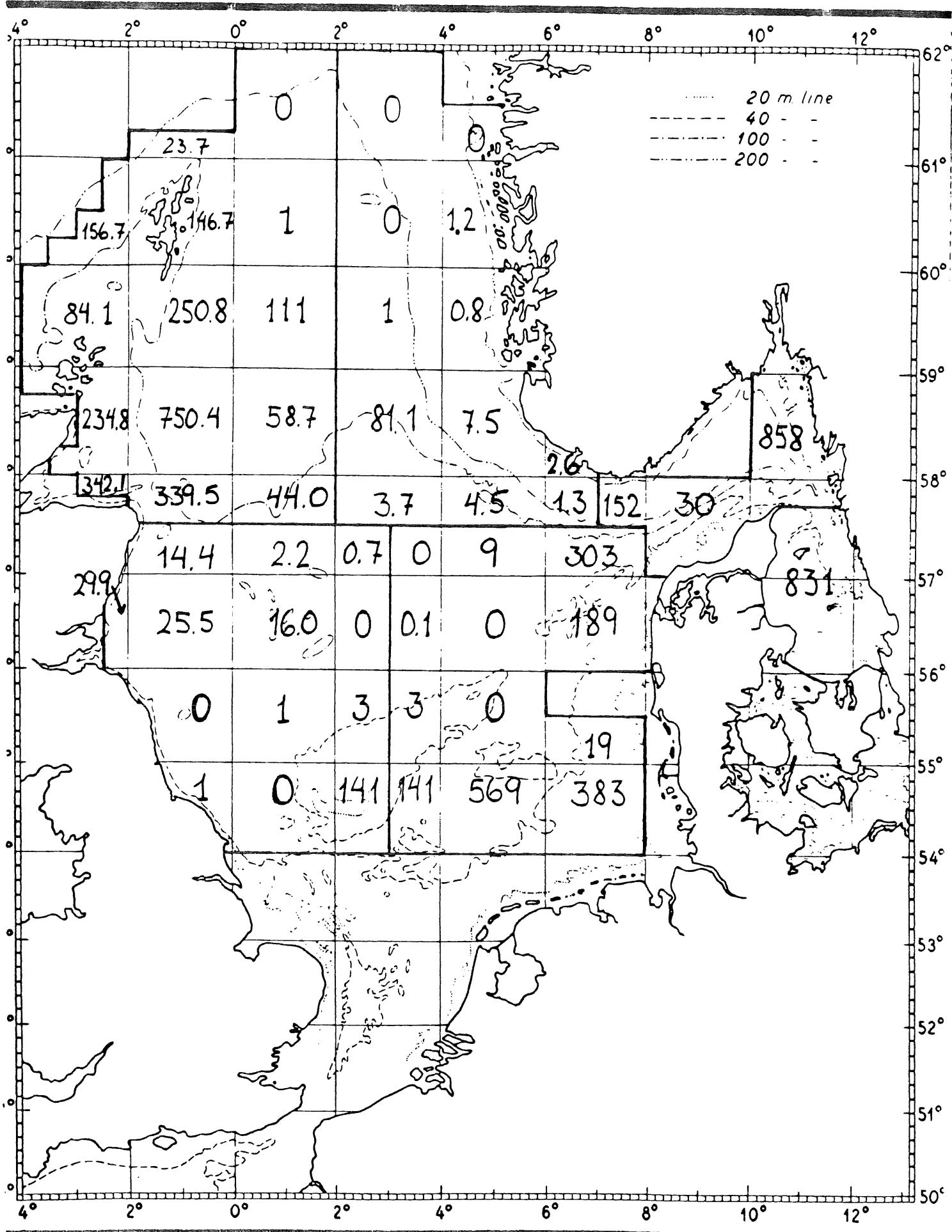
Fig. 11.   Estimated numbers (Millions) of 1-ring herring