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REPORT OF THE 1991 ICES COORDINATED ACOUSTIC SURVEY OF HERRING STOCKS IN ICES DIVISIONS VIa, IVa AND IVb

by

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METHODS

The area was surveyed by four vessels with area boundaries shown in Figure 15. The area between 1°E and 1°W north of 58°N was surveyed twice a) by FRV *Scotia* between 12 to 24 July; and b) by FRV *Johan Hjort* approximately 14 to 19 July and FRV *Tridens* between 8 and 15 July.

Survey by RV *Johan Hjort* in Eastern Parts of Division IVa and IVb

13 June to 22 July 1991
A Aglen and D Skagen, Institute of Marine Research, Bergen, Norway

Methods

Acoustic data were collected from a 38 kHz echosounder (Simrad EK500). Integrator data were stored and post-processed by "Bergen Echo Integrator" (Foote *et al.*, 1991). Fishing was carried out with a Fotø herring trawl, a GOV bottom trawl or a Campelen 1,800 meshes shrimp trawl.

Figure 1 shows the survey grid and trawl stations. The main herring survey was carried out in Division IVa during 1-22 July. A systematic grid with about 15 nautical mile distance between transects was applied. Additional data from areas south of 58°N were available from a combined bottom trawl and mackerel egg survey in the period 13-30 June. South of 56°30'N the transect spacing was 30 nautical miles.

Integrator values were allocated to "herring-like" traces, traces of other fish and plankton. "Traces of other fish" represent a number of categories; bottom fish, sandeel, blue whiting, mullers pearlside and 0-group gadoids. In many cases (particularly during night) the two latter categories could not be accurately separated from plankton recordings. Most trawl

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catches close to surface showed a mixture of herring and mackerel and some 0-group gadoids. North of 61°N a few horse mackerel occurred in most hauls close to surface. South of 57°N both horse mackerel and sprat were occasionally caught with herring and mackerel. 0-group gadoids were allocated as separate traces not included in "herring-like traces", while the other four species were all assumed to contribute to the integrator values allocated to "herring-like" traces in the upper 50 m. Estimates of these four species in the upper 50 m were based on the trawl catch compositions and the following target strength values:

Herring, sprat, horse mackerel: TS = 20 x log L - 71.2 dB
Mackerel: TS = 20 x log L - 77.2 dB (L is fish length in cm)

"Herring-like" traces at larger depths were considered to be pure herring, and herring estimates for these depths were added to the estimates for the upper 50 m. The proportion of mackerel, horse mackerel and sprat in trawl catches deeper than 50 m was negligible.

Trawl catches were combined within subareas (Fig. 2) to obtain average species composition, and for each species; average age distribution, average weight at age and average target strength. These data together with average integrator values by rectangle were used to estimate abundance by rectangle. Herring estimates were split between North Sea autumn spawners, Division IIIa/Baltic spring spawners and Atlantoscandian spring spawners. The latter group was identified using otolith criteria, while the other two components were split on the basis of vertebral count distributions as described by Anon. (1991).

Survey Results

Figures 3 and 4 show herring estimates by rectangle and age groups for North Sea autumn spawners and IIIa/Baltic spring spawners respectively. Table 1 shows herring estimates by age groups, subarea and stock. Table 2 shows mean weight at age by subarea and stock. Table 3 shows mean vertebral counts and estimated percentage of IIIa/Baltic spring spawners. Table 4 shows mackerel estimates by age and subarea.

Total estimates for the surveyed area are:

	Number $N \times 10^{-6}$	Biomass ($\times 10^{-3}$ tonnes)
Herring		
North Sea autumn spawners, mature	4,764	993
North Sea autumn spawners, immature	4,059	199
IIIa/Baltic spring spawners	953	126
Atlantoscandian spring spawners	89	23
Mackerel	2,749	697
Horse mackerel	19	7
Sprat	1,010	15

Abundance of 0-group gadoids has also estimated during previous summer acoustic surveys in north-eastern North Sea (Aglen *et al.*, 1985). Brief inspections of the results of the present survey indicate that, within the area covered, the abundance of 0-group

Norway pout and cod was higher than during the summer surveys in the years 1984-1990. High densities of 0-group Norway pout were found in subareas 1, 2, 3, 6, 7 and 8 while 0-group cod seemed to be mainly distributed in subareas 7, 8 and 14.

Discussion

The purpose of the survey was to estimate abundance of adult herring. Estimates for other species are byproducts which should be considered quite uncertain. In the upper 50 m where estimates split by trawl catches, mackerel was the only species other than herring which contributed significantly to the catches. Due to the large difference in target strength between herring and mackerel, the errors of the mackerel estimate tend to be much larger than errors of the herring estimate. If it is assumed that mackerel, horse mackerel and sprat were not included in the category "herring-like traces", the total herring estimate would increase by approximately 200,000 tonnes (15%).

In areas with bottom depths greater than 200 m nearly all herring were found in the upper 50 m. Compared to the years 1988-1990 a larger proportion of the herring was found south of 60°N. Here most of the herring was found at depths between 70 and 120 m (10 to 50 m from bottom). In subareas 2, 3, 7 and 8 schools of 0-group Norway pout sometimes showed similar shapes to herring schools, but they tended to give lower volume backscattering strength (less than -50 dB). For the total survey, species allocation errors are probably comparable to earlier years. Losses of schools in the upper blind zone of the echosounder are probably less than during the surveys in the years 1988-1990.

Survey Report for FRV *Tridens*

1-19 July 1991

A Corten, RIVO Netherlands

Methods

An Echo integrator survey was carried out between 1 and 19 July in the area from 54° to 59°N and 2°E to 2°W. The cruise track and trawl hauls are presented in Figure 5. The results of trawl hauls are given in Table 5.

Fish traces were classified as "adult herring" or "ther fish" depending on their appearance on the echosounder trace. "Other fish" included juvenile herring and sprat. The accuracy of the classification was checked by regular trawling (Fig. 6). Fishing was directed on traces believed to be adult herring, to maximise the accuracy of estimates of adult herring. Schools presumed to be juvenile herring or other species were not fished in order to economise on vessel time.

Trawl data was used to define six different age and length areas shown in Figure 6. Areas A, B and D have the same age structure and area E contains no adult herring.

Echo sounder conversion factors for numbers of fish were calculated from mean σ for each area. σ is derived from the following Target strength length formula:-

$$TS = 20\log_{10}(L) - 71.2 \text{ per individual}$$

L is fish length in cm

Fish biomass was derived from numbers by using the mean weight per individual calculated from the trawl hauls in each area.

Results

The results of the trawl hauls are given in Table 5. Total numbers and biomass are shown by area in Figure 6. Numbers and biomass of autumn and spring spawners are shown separately in Figures 7 and 8. Age keys and numbers at age for the sub areas are given in Table 6. The estimates of autumn spawners are shown split by age in Figure 9 (1 and 2 ring and above).

The total estimate for the area 54° to 59°N and 2°E to 2°W is 2,967 million autumn spawners with 31.5 million spring spawners found off the English coast between 54° and 55°N (biomass; autumn spawners 506,400 tonnes, spring spawners 4,800 tonnes).

Survey Report for FRV *Clupea* of ICES Area VIa (N)

13-26 July 1991

D G Reid, Marine Laboratory Aberdeen Scotland

An acoustic survey was conducted on the herring stocks in ICES area VIa(N), from 13 to 26 July 1991, with the FRV *Clupea*. The area covered was between 56° and 60°N, and 04°W and 10°W.

Data Collection

The survey was carried out using an EK400 38 kHz echosounder interfaced to the Aberdeen computer based Integrator. Table 7 shows the equipment settings and the results of calibrations conducted during the survey.

Data from the echointegrator were summed over 15 minute periods (2.5 Nautical nm at 10 knots). Biomass was worked up on the basis of rectangles 30 minutes latitude and one degree longitude. Integrator records were allocated to each rectangle according to the midpoint of the run. Using the analogue record and visual inspection of the echosounder paper, the counts were allocated into two categories;

1. Herring
2. Other fish species

Category 1 was further subdivided into two subcategories (definitely and probably herring) based on the operators confidence in the species allocation. Counts were allocated to the subcategory "definitely herring" when the observed schools obviously displayed a characteristic herring school structure, eg dense "plumes" on the echogram. Counts were allocated to the subcategory "probably herring" when the observed schools were less obviously herring. Due to the unsuccessful fishing operations no biological data were available to confirm the visual assessment. Counts were allocated to the subcategory "other fish species" when the observed schools were probably not herring, and did not include plankton.

To calculate integrator conversion factors the target strengths of herring and sprat were obtained using the TS/length relationship recommended by the acoustic survey planning group (Anon., 1983);

Herring TS = 20 LogL - 71.2 dB per individual (length in cm)

In the absence of trawl samples from this cruise, herring biomass was calculated using length composition and weight relationships obtained from the trawl samples taken during the same month for the nearest adjacent area, south-west of Orkney/Shetland (between 59° and 59°30'N, and 03°W and 04°W) surveyed by FRV *Scotia* (Table 8).

$$W = 0.003918 \times L^{3.27} g \text{ (length in cm)}$$

Results

A total of 27 rectangles were covered with 850, 15 minute integrator blocks. The estimated numbers and biomass of herring per rectangle are given in the distribution map in Figure 10.

Total number of herring in the survey area was 2,540 million
Total biomass estimate for the survey area was 474,960 tonnes

The results of the subdivision of the herring into two subcategories were;

definitely herring ..... 2,120 million
probably herring ..... 520 million

The proportion of the echo-integral assigned to the category "other fish species" (assuming similar target strength to herring) was 4.7%.

Herring biomass was broken down according to numbers in each age class (Tables 8 and 9). Results are given in Table 10.

Discussion

Interpretation of the results of the survey are hampered by the difficulties encountered in trawling operations from FRV *Clupea*. A total of 10 hauls were made, none of which caught any herring, or significant numbers of any fish species. It is believed this may have been the result of a number of factors; Firstly, due to the type of ground, and the relative inexperience of the crew in fishing in this area, it was impossible to trawl with the net very close to the sea-bed. Previous experience suggests that herring in this area can only be caught if the net is towed on the sea-bed. Secondly, the vessel was only able to trawl at speeds up to 4.0 knots, and this may have affected the ability to catch herring in this area. Additionally, no commercial landings data are available for the area at this time.

In the absence of biological data from the survey area, we chose to analyse the acoustic data using the results of trawl hauls taken by FRV *Scotia* in an adjacent area at the same time. This choice has two major implications: Firstly, the weight-length relationship and age key used to work up the acoustic data may not be accurate. Secondly, no validation

of the assignment of echo-integral to species was possible. The biomass estimate must, therefore, be regarded as very tentative.

Subdivision of the herring into definitely and probably herring categories indicates that 76.5% of the observed fish could confidently be considered as herring. Approximately 18.8% were identified as probably herring. The remaining category, representing 4.7% of the total fish could be confidently assigned as definitely not herring.

Survey Report for FRV *Scotia* in the northern North Sea

12 July to 1 August 1991

E J Simmonds, Marine Laboratory, Aberdeen, Scotland

Methods

The acoustic survey on FRV *Scotia* (12 July-August 1991) was carried out using a Simrad EK500 38 kHz sounder echo-integrator. Further data analysis was carried out using Simrad BI500 and Marine Laboratory Analysis systems. The survey track (Fig. 11) was selected to cover the area in two levels of sampling intensity based on herring densities found in previous years. Areas with high intensity sampling had a transect spacing of 7.5 nautical miles and lower intensity areas a 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 intensity area. The between-track data could then be included in the data analysis.

Trawl hauls (Fig. 11) were carried out during the survey on the denser echo traces. Each haul was sampled for length, age, maturity and weight of individual herring. Up to 350 fish were measured at 0.5 cm intervals from each haul. Otoliths were collected with 2 per 0.5 cm class below 22 cm, 5 per 0.5 cm class from 20 to 27 cm and 10 per 0.5 cm class for 27.5 cm and above. 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 (2.5 Nm at knots). Echo integrator data was collected from nine metres below the surface (transducer at 5 m depth) to 1 m above the seabed. The data were divided into four categories, by visual inspection of the echo-sounder paper record and the integrator cumulative output; "herring traces", "probably herring traces" below 50 m, shallow herring schools above 50 m and "probably not herring traces". For the 1991 survey 79% of the stock by number was attributable to the "herring traces" and only 10% to the "probably herring traces" and 11% to the shallow herring schools. The third category which gave 29% of total fish was attributable to Norway pout, whiting, mackerel, horse mackerel and haddock in that order of importance. Most of these species were either easily recognisable from the echo-sounder record or did not appear to occupy the same area as the herring. In general, herring were found in waters where the seabed was deeper than 110 m. Similar small schools were found close to the seabed over "hard ground" in shallower water of 70 to 90 metres depth. Fishing on these traces consistently gave considerable numbers of Norway pout through the meshes of the trawl.

Two calibrations were carried out during the survey. Agreement between these was better than 0.1dB. 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 which contained more than 50 fish. Lengths were recorded by 0.5 cm intervals to the nearest 0.5 cm below. The resulting weight-length relationship for herring was:

$$W = 3.918\ 10^{-3}\ L^{3.27} \text{ g L measured in cm}$$

Survey Results

A total of 46 trawl hauls were carried out, the results of these are shown in Table 11. Twenty-four hauls contained more than 100 herring and these hauls were used to define two survey subareas (Fig. 13). The mean length keys, mean lengths, weights and target strengths for each haul and for each sub area are shown in Table 12. 2,634 otoliths were taken to establish the two age length keys. The numbers and weights of fish by quarter statistical rectangle are shown in Figure 14 along with the number of 2.5 Nm integration intervals. A total estimate of 5,092 million herring or 1,273,000 tonnes was calculated for the survey area. 1,259,000 tonnes of these were mature. Herring were found mostly in water with the seabed deeper than 110 m, with traces being found in waters with depths of up to 250 m. The survey was continued to 400 m depth for most of the western and northern edge between 0° and 5°W. Herring were generally found in similar water depths to 1990. Table 13 shows the numbers and weights of herring by sub area by age class.

The stock found in this area is dominated by 4 and 5 ring fish with the same shortage of 2 ring fish seen in 1990, only 9% of the estimate by number. In addition the numbers of 3 ring fish were smaller. Fishing appeared to be successful and trace identification was straightforward with the exception of small schools found in water with the sea bed between 100 and 110 m deep. Twenty-five of the 46 trawls were carried out in water depths between 80 and 130 m to establish identity of these schools. A depth related division in the catch indicated that only the deeper schools contained herring with some doubt remaining for schools in the 100-110 m water depths.

In addition to the 1,270,000 tonnes of herring, approximately 400,000 tonnes of other fish were observed in mid water. Examination of the trawl data in Table 11 showing the catch by species shows the difficulty of allocating this between species so this has not been attempted although the dominant part must be considered to be "0" group and older Norway pout. The proportions of mature 2 ring and 3 ring herring were estimated at 88% and 100% respectively. This is a similar proportion of mature 2 ring fish to those found in 1990 but a higher proportion of 3 ring fish were mature.

Estimated numbers for each age class for each rectangle were combined based on an equal weighting for each survey. Survey track densities were similar for the surveys in the overlap area. Incomplete information was available on the maturity of 2 and 3 ring fish so the proportions reported by *Scotia* and *Johan Hjort* were averaged (weighted by the two stock estimates and applied to the global estimates. The effect of this was to apply weighted mean maturity splits to *Tridens* and *Clupea* data. Similarly mean weights at age were not available for all the surveys and the overall biomass at age was derived from

the surveys of *Scotia* and *Johan Hjort*. Stock estimates for the surveyed parts of IVa, IVb and VIa are derived ignoring gaps in the survey which occurred mainly over the Norwegian deeps and in the eastern part of the area with where 1 ring fish dominate.

RESULTS

Estimates for the overlap survey area 58°-62°N 1°E-1°W in thousands of tonnes were:

Scotia	848 t
Tridens/J Hjort	909 t

A difference of 7% between the estimates. This overall estimate is less similar if divided between the two parts of the area. For the southern part:

Scotia	398 t
Tridens	341 t

A difference of 17%

For the Northern part:

Scotia	450 t
Johan Hjort	568 t

A difference of 23%

The conclusions that major differences in overall system performance and methodology seem small. However, it is difficult to determine whether the differences between estimates for parts of the area are caused by migration of the fish or by random effects due to the the survey precision.

The survey results for autumn spawning fish are shown in Figure 16, numbers of fish for 0 and 1 ring combined, 2 ring and 3+ ring fish are given by stat square. The average maturity split for 2 ring and 3 ring fish was 79 and 98% mature respectively by number. A breakdown of autumn spawning stock by age, maturity and ICES area is given in Table 14.

A summary of the totals for autumn spawners is given below.

Area/Estimate	**Total Numbers $x10^{-6}$**	**Total Biomass $x10^{-3}$**
Area VIa	2,856	517
Area IVa	8,360	1,768
Area IVb	4,382	330
Total	15,597	2,615

A 31.5 million (4,800 tonnes) of spring spawning North Sea herring was found between 54° and 55°N and 0° to 2°W see Figure 8.

A part of the IIIa Baltic spring spawning fish were found mostly east of 3°E. The distribution can be seen in Figure 4 and the total abundance was 952 million (126,000 tonnes). The age composition is given in Table 1 part 4.

Small numbers of Atlantoscandian herring were found scattered over the northern and eastern parts of the survey area. The total abundance was 89 million (23,000 tonnes), and the age composition can be seen in Table 1 part 5.

DISCUSSION

Results for area VIa should be treated with caution. While overall stock estimates may be reasonably expected to reflect the abundance in the area the split by age is very uncertain and should not be used without further evidence.

The abundance of autumn spawning herring for IVa and IVb combined are 13 x 10^9 fish (2.2 x 10^6 tonnes) in 1991 the estimate for the previous year 1990 was 20 x 10^9 (2.6^6 tonnes) (ICES CM/H:40). In 1991 4 and 5 ring year classes are heavily represented, these fish were found in greater abundance in the 1990 acoustic survey as 3 and 4 ring fish. The acoustic survey found less 2 and 3 ring fish than in previous years.

The major sources of error are: a) species identification, particularly confusion in some areas between schools of Norway pout and herring, however it seems likely that doubtful schools contribute only a small proportion of the total estimate; b) survey precision is a problem, however with the level of effort applied to the area as a whole, with careful attention to survey timing this area is acceptable but probably a dominant source of error; c) estimates of age structure are dependant on trawl data carries some uncertainty; d) measurements of weights at age are effecting the abundance estimates (in tonnes) and some difference are indicated from *Scotia* and *Johan Hjort* data from the overlap area; and e) estimates of target strength must still dominate the overall stock estimate however should have little impact on the year to year total abundance estimates.

TABLE 1

Estimated number (N x 10^{-6}) of herring by area and subarea, RV *Johan Hjort*, 13 June to 22 July 1991. Biomass (x10^{-3} tonnes)

Autumn spawners, IVa overlap (between 1°W and 1°E)

Winter rings	Subarea			TOT
	1	2	3	
1	-	2.7	-	2.7
2 imm	9.4	3.5	-	12.9
2 mat	12.6	10.5	45.7	68.8
3 imm	3.1	-	-	3.1
3 mat	52.9	30.7	118.8	202.4
4	294.6	137.7	342.8	775.1
5	353.7	89.0	274.2	716.9
6	153.3	48.8	109.7	311.8
7	50.1	12.6	18.3	81.0
8	31.1	2.7	-	33.8
9+	9.0	1.4	4.6	15.0
Tot N	969.8	339.6	914.0	2,223.5
Tot B	261.8	75.9	217.6	555.3
Mat N	957.3	333.4	914.0	2,204.8
Mat B	260.2	75.3	217.6	553.1

Autumn spawners, IVa east of 1°E

Winter rings	Subarea							TOT
	5*	6	7	8	11**	12	13	
1	-	3.1	2.4	51.4	0.7	57.4	63.3	178.3
2 imm	5.1	1.4	38.7	111.3	3.5	16.6	11.2	187.8
2 mat	3.5	0.9	229.9	445.0	3.5	22.7	73.5	779.0
3 imm	0.8	0.7	-	16.0	-	-	-	17.5
3 mat	13.0	6.0	155.9	269.1	4.6	-	-	448.6
4	22.0	19.3	71.1	310.8	7.4	-	-	430.6
5	37.6	20.6	142.0	374.5	8.3	-	11.7	594.7
6	15.6	6.3	39.0	80.8	2.7	-	2.2	146.6
7	5.7	1.8	12.0	51.4	0.8	-	1.2	73.9
8	4.2	-	-	11.0	-	-	0.7	15.9
9+	2.1	-	-	11.0	-	-	-	13.1
Tot N	109.6	60.1	692.0	1,732.3	31.5	96.7	163.8	2,886.0
Tot B	27.6	10.5	131.1	285.5	4.4	9.8	231.3	490.2
Mat N	103.7	54.9	650.9	1,553.6	27.3	22.7	89.3	2,502.4
Mat B	21.7	10.0	126.1	264.5	3.6	-	3.1	429.0

*Includes 2.2 million fish in subarea 4 **Includes 0.1 million fish in subareas 9 and 10

TABLE 1 (continued)

Autumn spawners, IVb east of 2°E

Winter rings	Subarea		TOT	Aut spa all areas
	14	15		
0	-	1,237.4	1,237.4	1,237.4
1	313.6	2,053.6	2,367.2	2,548.2
2 imm	52.3	-	52.3	253.0
2 mat	57.2	-	57.2	905.0
3 imm	-	-	-	20.6
3 mat	-	-	-	651.0
4	-	-	-	1,205.7
5	-	-	-	1,311.6
6	-	-	-	458.4
7	-	-	-	154.9
8	-	-	-	49.7
9+	-	-	-	28.1
Tot N	423.1	3,291.0	3,714.1	8,823.6
Tot B	43.0	103.5	146.5	1,192.0
Mat N	57.2	-	57.2	4,764.4
Mat B	10.8	-	10.8	992.9

Spring spawners (IIIa/Baltic)

Winter rings	Subarea									TOT
	6	7	8	9	10	11	12	13	14	
2	-	-	-	-	-	-	-	45.8	73.0	118.8
3	4.7	42.0	39.9	-	0.4	7.1	28.7	118.9	118.0	359.7
4	13.5	63.5	43.5	0.2	0.3	11.2	18.1	95.3	75.9	321.5
5	14.5	8.5	-	-	0.2	13.0	7.6	28.5	32.8	105.1
6	4.4	2.3	-	0.2	+	4.2	-	5.2	18.6	34.9
7	1.3	0.8	-	-	-	1.2	-	3.0	4.5	10.8
8	-	-	-	0.2	-	-	-	1.6	-	1.8
Tot N	38.4	117.1	83.4	0.6	0.9	36.7	54.4	298.3	322.8	952.6
Tot B	6.0	18.7	11.3	0.1	0.1	5.0	6.3	35.8	42.8	125.8

TABLE 1 (continued)

Spring spawners (Atlantoscandian)

Winter rings	Subarea							TOT
	1	2	4	5	6	8	9	
1	-	-	-	-	-	-	0.9	0.9
2	-	-	-	19.2	0.8	20.2	-	40.2
3	3.1	-	0.1	6.4	0.8	-	0.2	10.6
4	-	1.4	+	0.7	-	-	-	2.1
5	-	-	-	-	-	-	-	-
6	-	-	+	0.7	-	-	-	0.7
7	-	-	-	0.7	-	-	-	0.7
8	28.0	-	0.6	5.0	-	-	0.4	34.0
Tot N	31.1	1.4	0.7	32.7	1.6	20.2	1.5	89.2
Tot B	11.2	0.4	0.2	7.3	0.3	3.3	0.3	23.0

TABLE 2

Estimated mean weights (g) of herring by age and subarea, RV *Johan Hjort*, 13 June to 22 July 1991

Autumn spawners, IVa overlap (between 1°W and 1°E)

Winter rings	Subarea		
	1	2	3
1	-	60	-
2 imm	130	119	-
2 mat	180	157	207
3 imm	138	-	
3 mat	225	189	216
4	263	212	225
5	269	232	247
6	292	269	277
7	316	289	310
8	316	321	-
9+	325	273	330

Autumn spawners, IVa east of 1°E

Winter rings	Subarea						
	5	6	7	8	11	12	13
1	-	71	94	102	49	87	89
2 imm	147	126	123	124	93	116	97
2 mat	180	149	158	171	140	127	157
3 imm	132	134	-	127	-	-	-
3 mat	240	160	207	165	136	-	-
4	255	180	212	170	145	-	-
5	258	186	220	167	153	-	185
6	260	190	211	184	172	-	225
7	305	210	230	170	197	-	240
8	321	-	-	240	-	-	185
9+	280	-	-	206	-	-	-

TABLE 2 (continued)

Autumn spawners, IVb east of 2°E

Winter rings	Subarea	
	14	15
0	-	4
1	85	48
2 imm	106	-
2 mat	188	-

Spring spawners (IIIa/Baltic)

Winter rings	Subarea								
	6	7	8	9	10	11	12	13	14
2	-	-	-	-	-	-	-	97	106
3	134	146	127	-	128	117	113	117	126
4	148	168	143	125	132	132	114	127	129
5	157	150	-	-	137	135	128	120	163
6	190	190	-	118	139	166	-	183	203
7	170	175	-	-	-	191	-	225	220
8	-	-	-	172	-	-	-	185	-

Spring spawners (Atlantoscandian)

Winter rings	Subarea						
	1	2	4	5	6	8	9
1	-	-	-	-	-	-	67
2	-	-	-	165	149	165	-
3	325	-	201	268	221	-	337
4	-	299	316	321	-	-	-
5	-	-	-	-	-	-	-
6	-	-	322	346	-	-	-
7	-	-	-	291	-	-	-
8	364	-	325	353	-	-	406

TABLE 3

Number (n) of herring sampled for vertebral counts, mean count (v) and estimated percentage (p) of IIIa/Baltic spring spawning herring by subarea. All figures refer to the sample remaining when herring classified as Atlantoscandian is removed. Underlining refers to combined age groups RV *Johan Hjort* 13 June to 22 July 1991.

Subarea	1-ringers			2-ringers			3-ringers			4-ringers			5+-ringers		
	n	v	p	n	v	p	n	v	p	n	v	p	n	v	p
4	-	-	-	-	-	-	57	56.60	0	57	56.60	0	57	56.60	0
6*	-	-	-	-	-	-	123	56.21	43	123	56.21	43	123	56.21	43
7*	-	-	-	21	56.76	0	19	56.21	45	19	55.90	100	39	56.36	12
8*	-	-	-	55	56.66	0	66	56.21	40	66	56.21	40	51	56.49	0
10	-	-	-	-	-	-	23	55.86	100	20	55.80	100	15	56.13	68
11	-	-	-	10	56.60	0	15	56.19	61	27	56.15	60	43	56.19	61
12	38	56.76	0	25	56.60	0	35	55.86	100	35	55.86	100	35	55.86	100
13	60	56.58	0	143	56.25	35	99	55.90	100	86	55.87	100	54	56.02	71
14	67	56.69	0	38	56.21	40	22	55.83	100	28	55.82	100	28	55.82	100

* Represents eastern part of the subarea (east of 3° east)

TABLE 4

Estimated number of mackerel (N x 10^{-6}) by subarea, RV *Johan Hjort*,13 June to 22 July 1991. B = Biomass (x10^{-3} tonnes)

Subarea	Age									Total	
	1	2	3	4	5	6	7	8	9+	N	B
1	-	32	4	1	+	-	-	-	-	37	10.3
2	1	4	6	10	3	3	3	-	1	30	11.1
3	-	65	51	4	-	-	1	-	1	122	31.4
4	+	8	1	1	-	-	+	-	+	10	3.0
5	26	103	18	3	-	2	-	-	-	152	37.0
6	-	15	-	1	-	-	-	-	-	16	4.3
7	2	44	5	2	2	-	-	-	-	55	14.4
8	-	170	36	20	7	2	-	-	7	241	72.6
9	-	13	5	4	1	+	1	-	4	27	11.6
11	1	25	4	2	+	-	-	-	-	32	9.8
13	1	27	12	5	1	1	1	-	1	47	14.2
14	25	233	67	34	8	5	4	-	1	377	96.4
15	442	646	213	160	63	14	29	5	29	1,603	380.7
Total	498	1,385	422	247	85	27	39	5	44	2,749	696.8

Table 5

Catch composition by trawl haul (kg). RV Tridens 1 - 19 July 1991.

haul nr.	date	time UTC	duration	latitude	longitude	herring	sprat	mackerel	whiting	N pout	others	total
1	02.07.91	9.05	20 min	54.09	00.32 E						31	31
2	02.07.91	18.50	30 min	54.25	00.13 W	18	35		27			80
3	03.07.91	19.00	30 min	54.23	00.00 E	10	337		62			409
4	04.07.91	6.20	25 min	54.40	00.44 W	70	5					75
5	04.07.91	18.55	20 min	54.55	00.49 E		44					44
6	05.07.91	11.50	15 min	55.10	00.58 E	15	337				2	354
7	05.07.91	14.55	45 min	55.10	00.23 E	3500					3	3503
8	05.07.91	19.00	20 min	55.10	00.22 W							0
9	06.07.91	9.22	18 min	55.25	00.58 W	53			5			58
10	06.07.91	15.35	10 min	55.25	00.37 E						1	1
11	06.07.91	19.40	20 min	55.25	01.27 E	70			630	50	80	830
12	06.07.91	6.50	15 min	55.55	00.15 W							0
13	06.07.91	8.32	23 min	55.54	00.03 E			8				8
14	08.07.91	13.10	35 min	55.55	00.57 E	500				100	5	605
15	08.07.91	8.20	25 min	58.55	00.58 E							0
16	08.07.91	12.05	45 min	58.55	00.25 E				140			140
17	08.07.91	19.43	18 min	58.55	00.50 E	5	2		1	3	1	12
18	12.07.91	7.17	7 min	58.55	02.09 E				88	105	2	195
19	12.07.91	19.15	10 min	58.39	00.15 E				1	320	19	340
20	13.07.91	6.25	20 min	58.40	01.23 E	1733					2	1735
21	13.07.91	13.00	20 min	58.25	00.43 E	260		8	20	15	10	313
22	15.07.91	14.10	50 min	57.24	00.12 W					35	2	37
23	15.07.91	18.50	25 min	57.24	00.50 W	1				945		946
24	16.07.91	6.25	5 min	57.10	01.49 E	25	30		5		15	75
25	16.07.91	19.10	20 min	56.54	01.00 W							0
26	17.07.91	15.00	50 min	56.39	01.24 E	1				1334	5	1340
27	18.07.91	9.00	30 min	56.25	00.53 E				1		12	13

TABLE 6 Age composition by pe entages and total number fo: autumn spawners. RV Tridens 1 - 19 July 1991.

age composition by area in percentages - autumn spawners only											
year class	89	88	87	86	85	84	83	82	81	80	total
area A	0.103	0.207	0.31	0.18	0.115	0.076	0.009				1
area B	0.103	0.207	0.31	0.18	0.115	0.076	0.009				1
area C	0.024	0.083	0.175	0.321	0.241	0.076	0.064	0	0	0.017	1.001
area D	0.103	0.207	0.31	0.18	0.115	0.076	0.009				1
area E											0
area F	0.76	0.18	0	0.04	0.02						1
area G	0.275	0.316	0.145	0.033	0.101	0.054	0.019	0.058			1.001
area H	0.267	0.461	0.143	0.03	0.029	0.034	0.016	0.02			1
area I	0.265	0.547	0.142	0.03	0.007	0.009					1
area J	0.194	0.435	0.171	0.038	0.057	0.049	0.021	0.035			1
age composition by area in total numbers (millions) - autumn spawners only											
area A	9.167	18.423	27.59	16.02	10.235	6.764	0.801	0	0	0	89
area B	146.775	294.975	441.75	256.5	163.875	108.3	12.825	0	0	0	1425
area C	0.3408	1.1786	2.485	4.5582	3.4222	1.0792	0.9088	0	0	0.2414	14.2
area D	2.0085	4.0365	6.045	3.51	2.2425	1.482	0.1755	0	0	0	19.5
area E	0	0	0	0	0	0	0	0	0	0	0
area F	22.952	5.436	0	1.208	0.604	0	0	0	0	0	30.2
area G	48.4825	55.7108	25.5635	5.8179	17.8063	9.5202	3.3497	10.2254	0	0	176.3
area H	288.093	497.419	154.297	32.37	31.291	36.686	17.264	21.58	0	0	1079
area I	22.6575	46.7685	12.141	2.565	0.5985	0.7695	0	0	0	0	85.5
area J	9.4284	21.141	8.3106	1.8468	2.7702	2.3814	1.0206	1.701	0	0	48.6
TOTAL	549.9047	945.0884	678.1821	324.3959	232.8447	166.9823	36.3446	33.5064	0	0.2414	2967.3
%	0.19	0.32	0.23	0.11	0.08	0.06	0.01	0.01	0.00	0.00	1.00

TABLE 7

Technical data for acoustic system settings

Echosounder	Simrad EK400
Frequency	38 kHz
Receiver Gain	0 dB
TVG	20 log R + 2αR
α	0.008 dB
Pulse Length	1.0 ms
Band Width	3.3 Khz
Range	0-50 m, -100 m, -150 m
Transducer	15 x 30 cm
Equivalent Beam angle (measured)	-17.5
Integrator	Aberdeen (computer based)
Threshold (effective)	20 mv

Source level and voltage response referred to 1 m on TVG function measured on 38 Khz system using a 38.1 mm diameter tungsten carbide ball (TS = -42.36 d) calibrated on 19 and 29 July 1991.

62.59 dB//1V_{RMS}

Table 8

Herring length frequency by trawl haul.
FRV Clupea 13 - 26 July 1991.

Length (cm)	Haul Number		Mean
	347	349	
12.5	0.2		0.1
13.0	0.4		0.2
19.0	0.4		0.2
19.5	0.9		0.4
20.0	0.9	0.6	0.8
20.5	4.1		2.1
21.0	6.9		3.5
21.5	9.3		4.7
22.0	9.3		4.7
22.5	4.5		2.3
23.0	3.7		1.8
23.5	2.8		1.4
24.0	5.8		2.9
24.5	5.8	1.9	3.9
25.0	5.4	3.8	4.6
25.5	3.9	12.1	8.0
26.0	4.5	7.6	6.1
26.5	3.2	8.3	5.8
27.0	7.4	12.1	9.7
27.5	5.6	14.0	9.8
28.0	6.1	18.5	12.3
28.5	3.7	7.0	5.3
29.0	1.3	7.0	4.2
29.5	1.1	2.5	1.8
30.0	0.4	1.9	1.2
30.5	0.4	0.6	0.5
31.0	0.9	0.6	0.8
31.5		1.3	0.6
32.0	0.9		0.4
Number	2310	47100	
Mean Length	24.9	27.8	26.3
Mean weight	152	208	180
TS/kg	-43.2	-42.3	-42.7
TS/individual	-35.0	-35.5	-35.3

Haul postions and dates;

Haul 347	59° 22.0N	03° 50.0W	30 July 1991
Haul 349	59° 06.0N	03° 42.0W	31 July 1991

Table 9

Herring age key
FRV Clupea 13 - 26 July 1991.

Age Class	Total at Age	Age Key
1A	22	0.165
2I	28	0.070
2M	160	0.275
3I	0	0.000
3M	119	0.204
4A	93	0.152
5A	67	0.101
6A	19	0.026
7A	3	0.004
8A	0	0.000
9+	2	0.003
Total	513	

Table 10

Age Breakdown for herring (length cm., weight g.).
FRV Clupea 13 - 26 July 1991.

Age	Number	Mean Length	Mean weight	Biomass
1A	435.79	21.16	92.72	40.41
2I	185.83	23.69	132.69	24.66
2M	727.10	25.61	169.89	123.53
3I	0.00			
3M	538.97	27.09	202.57	109.18
4A	400.94	27.88	221.98	89.00
5A	266.65	28.59	240.92	64.24
6A	69.10	29.65	272.05	18.80
7A	9.94	30.41	294.21	2.92
8A	0.00			
9+	8.84	28.96	251.92	2.23
Total	2643.16	25.82	179.70	474.96

Numbers are in millions of fish.
Biomass in thousands of tonnes.
Length in cm.
Weight in grams.

TABLE 11

Catch composition (numbers) by trawl haul. *Scotia* 12 July to 1 August 1991. (Depth is depth of seabed)

Haul number	Position		Depth (m)	Numbers caught									
	Latitude	Longitude		herring	sprat	whiting	haddock	Norway pout	mackerel	horse mackerel	gurnards	others	
304	58 07.0°N	00 43.0°W	92	15		6	15	598					Lemon sole (1)
305	58 06.8°N	00 28.6°W	120	14,592									
306	58 22.0°N	00 31.0°E	140	712									
307	58 36.77°N	02 27.11°W	67										1/2 bkt small fish.(Sandeels, Esmarkii, herring larvae)
308	58 36.86°N	00 12.10°E	144			1							Sandeels meshed
309	58 48.0°N	00 45.0°E	140	39,000									
310	58 51.97°N	00 13.02°W	145	11,640									
311	59 57.0°N	02 34.8°W	60										Small pout whiting and haddock, jellyfish and sandeels
312	59 06.72°N	01 43.41°W	82	63	117	606	33		3				
313	59 06.0°N	00 25.0°W	155	46,650									
314	59 22.0°N	00 16.0°E	137	4,590									
315	59 22.69°N	01 09.09°W	125	430		12	8	2,261	2				
316	59 22.0°N	01 30.0°W	90			855							
317	59 22.0°N	01 38.0°W	80										"0" group pout meshed in net
318	59 37.0°N	01 45.0°W	95	54		764	61		55				
319	59 37.11°N	00 11.94°W	130	3,232									
320	59 37.11°N	00 09.16°E	130	2,152									
321	59 52.17°N	00 23.27°W	105	23			22			2			Small haddock meshed 6-9 cm
322	60 52.0°N	01 03.0°W	109	12		8		31,308					
323	60 07.11°N	00 27.18°W	124	1,436		62	3	373					"0" group pout
324	60 22.14°N	00 19.02°W	100										
325	60 33.0°N	00 33.0°W	140	11,480									
326	60 32.69°N	00 09.37°W	100										Norway pout meshed. 2 grey gurnards
327	60 32.88°N	00 15.51°E	120	634		2	16		14	16			

TABLE 11 (continued)

Haul number	Position		Depth (m)	Numbers caught									
	Latitude	Longitude		herring	sprat	whiting	haddock	Norway pout	mackerel	horse mackerel	gurnards	others	
328	60 42.0°N	00 24.0°E	130	349		3							
329	60 41.92°N	00 08.65°W	90				3						1/3 bkt pout and pout meshed. 3 haddock, 1 sebastes
330	60 49.0°N	00 19.0°W	120	13		42							Small pout meshed 5-9 cm
331	61 48.73°N	00 21.74°E	133	768		22	8						*Argentina sphyraena* (15)
332	61 07.57°N	00 23.45°W	132	139		2	1			8			3 saithe, 1 ling, 1 Sebastes, 1 lemon sole
333	61 21.91°N	00 18.88°E	173	13					14				
334	61 21.97°N	00 29.72°E	170	1,120									
335	60 31.0°N	00 44.0°W	189	17				3	1	21			1 blue whiting
336	60 55.74°N	01 15.11°W	120	26,600					601	200			"0" group pout meshed
337	60 42.0°N	02 21.0°W	140			9	1						jellyfish
338	60 34.0°N	02 03.0°W	142	8,550		1				1			2 hake
339	60 27.0°N	02 17.0°W	134	1,988					1	15			
340	60 19.0°N	02 31.0°W	110										Norway pout 5-9 cm. Sandeels
341	60 19.0°N	02 41.0°W	160	1,225									
342	60 19.24°N	03 51.82°W	230	25									
343	60 04.0°N	02 17.0°W	97	61		22			1				Sandeels. "0" group pout
344	59 53.5°N	03 24.0°W	100	12		70							1 Blue whiting 1
345	59 53.0°N	04 37.84°W	124	2,784					73	24			
346	59 37.67°N	02 19.79°W	78	229					19	17			"0" group pout meshed
347	59 22.0°N	03 50.0°W	140	2,405	20								
348	59 22.0°N	04 37.0°W	104										No catch
349	59 06.0°N	03 42.0°W	135	47,100									Burst net

TABLE 12

Herring length frequency (%) by trawl haul and by area. (Mean length cm. Mean weight g). FRV *Scotia* 12 July to 1 August 1991

Haul No	309	310	313	314	319	320	323	325	327	328	331	332	334	336	338	339	341	345	346	Mean	305	306	315	347	349	Mean
12.5																								0.2		0.0
13.0																								0.4		0.1
13.5																										
14.0																										
14.5																										
15.0																										
15.5																										
16.0																										
16.5																										
17.0																										
17.5																										
18.0																										
18.5																										
19.0																								0.4		0.1
19.5																								0.9		0.2
20.0																								0.9	0.6	0.3
20.5																								4.1		0.8
21.0																					0.3			6.9		1.4
21.5																								9.3		1.9
22.0																								9.3		1.9
22.5																					0.3			4.5		1.0
23.0																					0.3		0.9	3.7		1.0
23.5																					0.3		0.9	2.8		0.8
24.0										0.4										0.0	0.3	0.3	2.8	5.8		1.8
24.5		0.3																		0.0	1.3	0.7	7.0	5.8	1.9	3.3
25.0	1.0		0.6	0.3			0.7				0.3	0.7								0.2	5.2	1.4	9.8	5.4	3.8	5.1
25.5	0.3	1.0	0.6	0.3			1.7	0.3	0.5		0.3				0.4					0.3	8.9	1.7	12.3	3.9	12.1	7.8
26.0	1.6	0.3	1.6		0.4		1.0	0.3		0.3	1.6			0.8			0.4		0.4	0.5	13.8	5.6	15.1	4.5	7.6	9.3

TABLE 12 (continued)

Haul No	309	310	313	314	319	320	323	325	327	328	331	332	334	336	338	339	341	345	346	Mean	305	306	315	347	349	Mean
26.5	2.2	4.1	0.6		0.7		4.5	1.4	0.5	0.3	0.3	0.7			2.5	0.8	1.6		0.9	1.1	19.5	10.1	14.9	3.2	8.3	11.2
27.0	4.8	10.0	10.9	1.3	1.4	1.9	7.5	1.7	2.4	0.9	3.4	0.7		1.1	3.9	3.0	4.5		2.2	3.2	22.1	19.7	14.4	7.4	12.1	15.1
27.5	9.0	16.2	10.9	12.4	9.3	5.6	19.5	10.5	3.3	3.4	3.9	2.9	1.3	3.0	8.1	6.0	5.3	0.4	9.2	7.4	16.1	14.0	11.4	5.6	14.0	12.2
28.0	20.8	25.8	18.0	18.0	19.6	17.8	18.2	17.8	5.7	5.4	15.5	3.6	1.8	10.5	15.8	9.8	7.8	1.8	10.9	12.9	7.3	21.8	5.3	6.1	18.5	11.8
28.5	19.6	17.5	18.0	19.9	16.4	17.5	22.6	16.4	10.7	8.0	17.6	7.2	4.5	14.3	15.8	12.1	8.2	1.3	16.2	13.9	2.1	11.0	3.3	3.7	7.0	5.4
29.0	15.1	9.6	16.7	19.3	18.9	20.1	10.9	15.0	14.5	15.5	17.3	12.9	9.4	13.9	17.9	15.1	15.9	9.0	14.4	14.8	0.8	6.3	0.7	1.3	7.0	3.2
29.5	13.1	6.2	7.7	10.8	10.7	14.1	4.1	11.1	14.0	13.8	13.0	14.4	14.3	11.7	10.5	17.0	11.0	10.8	14.4	11.7	0.8	2.1	0.7	1.1	2.5	1.4
30.0	5.8	3.1	4.5	7.8	8.2	8.9	3.1	5.6	13.6	12.0	10.9	18.7	17.9	12.4	6.7	9.5	12.2	13.9	11.8	9.8	0.3	2.8	0.5	0.4	1.9	1.2
30.5	2.2	2.4	3.2	5.2	4.6	7.1	2.7	5.6	11.2	9.7	7.0	11.5	14.7	9.0	4.6	9.1	9.0	15.3	7.4	7.5	0.5	0.7		0.4	0.6	0.5
31.0	1.6	2.4	3.2	2.9	4.6	3.7	1.7	7.0	8.0	11.5	3.0	10.1	14.7	12.4	4.6	6.0	10.2	16.6	6.6	6.9		1.1		0.9	0.6	0.5
31.5	1.0		0.6	1.0	2.8	2.2	0.7	3.5	7.1	10.6	2.7	5.0	5.4	5.6	4.2	4.1	3.3	13.9	2.2	4.0		0.7			1.3	0.4
32.0	0.6	0.7	2.3	0.7	1.4	0.7	0.7	1.7	4.7	3.7	1.2	4.3	3.1	2.3	2.8	3.8	2.0	9.0	2.6	2.5				0.9		0.2
32.5	1.0	0.3	0.3		1.1	0.4	0.3	1.0	1.9	2.0	0.3	2.9	2.7	1.5	1.8	2.6	3.3	3.6	0.4	1.4						
33.0	0.3							0.7	1.4	1.7	1.6	2.9	3.6	0.4	0.4	0.8	2.9	2.2	0.4	1.0						
33.5										0.9	0.3		2.7		0.4	0.4	0.8	0.9		0.3						
34.0									0.5				0.9	0.8			1.2			0.2						
34.5													0.4					0.4		0.0						
35.0								0.3		0.3		1.4	1.8	0.4				0.9		0.3						
35.5													0.9							0.0						
No	39,000	11,640	46,650	4,590	3,232	2,152	1,436	11,480	634	349	768	139	1,120	26,000	8,550	1,988	1,225	2,784	229		14,592	712	430	2,310	47,100	
Mean length	29.1	28.7	29.0	29.3	29.5	29.5	28.7	29.6	30.3	30.5	29.6	30.5	31.0	30.1	29.6	30.0	30.1	31.2	29.7	29.8	26.9	28.1	26.8	24.9	27.8	26.9
Mean weight	241	231	240	246	252	253	231	254	275	281	255	283	298	271	254	266	272	302	258	261	193	216	184	152	208	191
TS/ indiv	-41.9	-42.0	-41.9	-41.9	-41.8	-41.8	-42.0	-41.8	-41.6	-41.5	-41.8	-41.5	-41.4	-41.6	-41.8	-41.7	-41.6	-41.3	-41.7	-41.7	-42.5	-42.2	-42.6	-43.2	-42.3	-42.6
TS/kg	-35.7	-35.7	-35.7	-35.8	-35.8	-35.8	-35.7	-35.8	-36.0	-36.0	-35.8	-36.0	-36.1	-35.9	-35.8	-35.9	-35.9	-36.1	-35.9	-35.9	-35.4	-35.6	-35.3	-35.0	-35.5	-35.4

TABLE 13

Herring numbers and biomass by age, maturity and area. FRV *Scotia* 12 July to 1 August 1991

Category	Number x 10^{-6}	Mean length cm	Mean weight g	Biomass tonnes $x10^{-3}$
Area I				
1 ring	0.00			0.00
2 ring immature	23.66	26.00	177.15	4.19
2 ring mature	144.75	27.32	208.01	30.11
3 ring	493.96	27.97	224.09	110.69
4	1536.87	28.78	245.78	377.73
5	1307.03	29.64	270.38	353.40
6	492.69	30.32	291.09	143.42
7	190.15	31.42	326.10	62.01
8	77.11	31.98	345.07	26.61
9+	56.06	32.32	358.71	20.11
Total	4322.28	29.25	260.79	1127.23
Area II				
1 ring	51.20	21.35	94.46	4.84
2 ring imature	38.95	24.26	143.02	5.57
2 ring mature	241.36	25.89	175.46	42.35
3 ring	205.88	27.02	200.51	41.28
4	137.65	27.65	216.14	29.75
5	78.08	28.36	234.70	18.33
6	17.46	29.29	261.46	4.57
7	2.01	30.04	282.52	0.57
8	0.00			0.00
9+	2.27	28.77	246.28	0.56
Total	774.86	26.43	190.52	147.63
Total Area				
1 ring	51.20	21.35	94.46	4.84
2 ring imature	62.61	24.92	155.92	9.76
2 ring mature	386.11	26.42	187.66	72.46
3 ring	699.83	27.69	217.15	151.97
4	1674.51	28.69	243.35	407.49
5	1385.12	29.57	268.37	371.72
6	510.15	30.28	290.07	147.98
7	192.16	31.40	325.65	62.58
8	77.11	31.98	345.07	26.61
9+	58.33	32.8	3543	20.67
Total	5097.14	28.82	250.11	1274.85

TABLE 14

Summary of autumn spawning herring by age and maturity by ICES area. 13 June to 1 August 1991. (Mean weight in g)

Numbers of Fish (millions)					Mean Weights	Biomass (thousands of tonnes)			
Age/Mat	VIa	IVa	IVb	Total		VIa	IVa	IVb	Total
0 ring	0	0	1,237	1,237	4	0	0	5	5
1 ring	449	341	1,990	2,780	85	38	29	170	237
2 ring immature	206	329	154	689	137	28	45	21	94
2 ring mature	781	1,250	585	2,616	176	138	220	103	461
3 ring immature	11	25	4	39	132	1	3	0	5
3 ring mature	585	1,362	201	2,148	204	120	279	41	440
4 ring	441	2,054	48	2,543	225	99	463	11	574
5 ring	290	1,928	56	2,273	240	70	464	13	547
6 ring	74	697	51	821	260	19	182	13	214
7 ring	11	240	22	274	288	3	69	6	79
8 ring	0	79	33	112	260	0	21	9	29
9 ring	9	56	0	65	314	3	18	0	20
Mature Total (N)	2,190	7,666	996	10,852					
Mature Biomass						452	1,715	197	2,364
Imature Total (N)	665	694	3,385	4,745					
Imature Biomass						68	77	196	342
Total Numbers	2,856	8,360	4,382	15,597					
Total Biomass						520	1,793	393	2,706

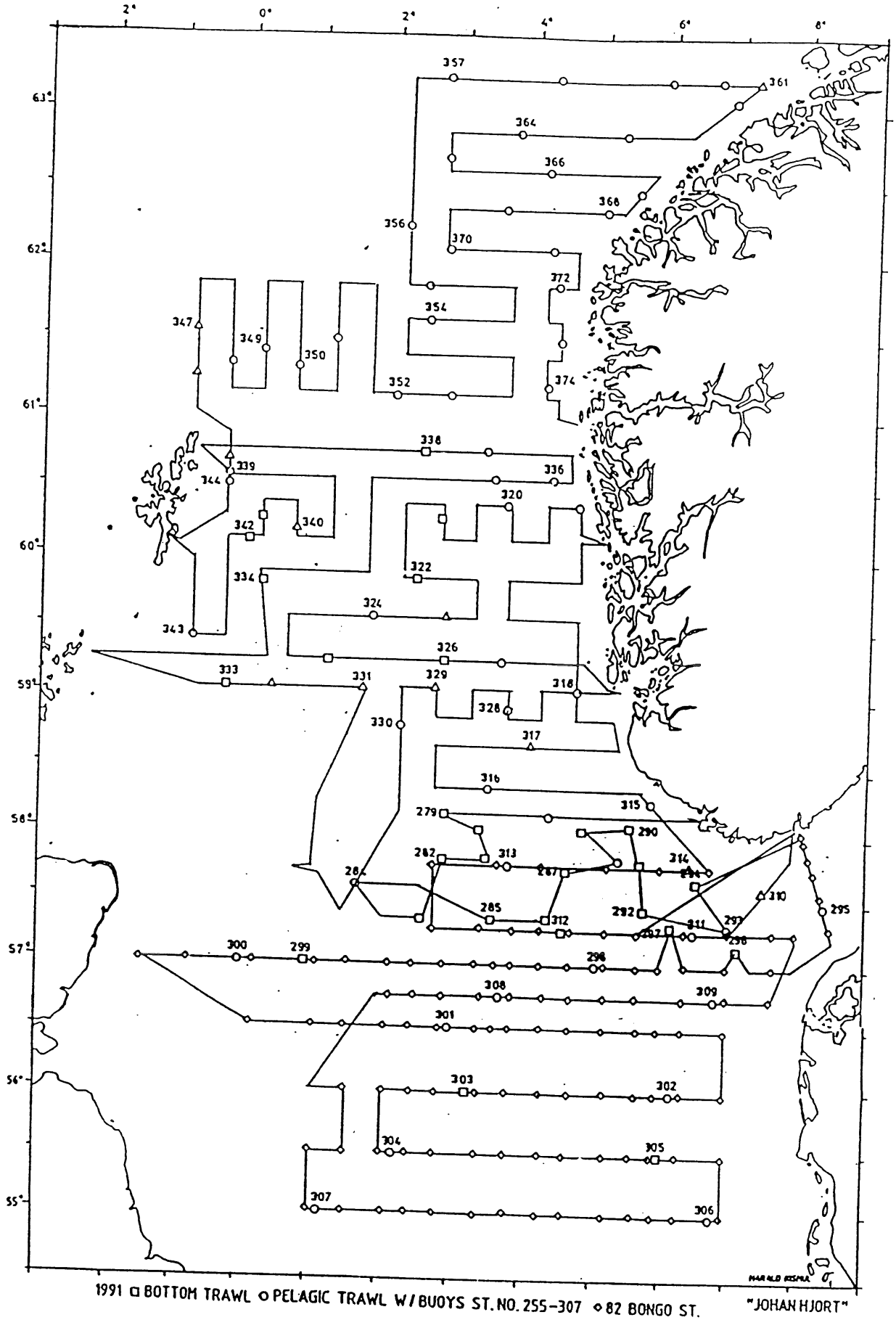


Figure 1. Survey grid and trawl stations, R/V "Johan Hjort", 13 June-22 July 1991.

: Pelagic trawl close to surface

: Pelagic trawl, midwater

: Bottom trawl

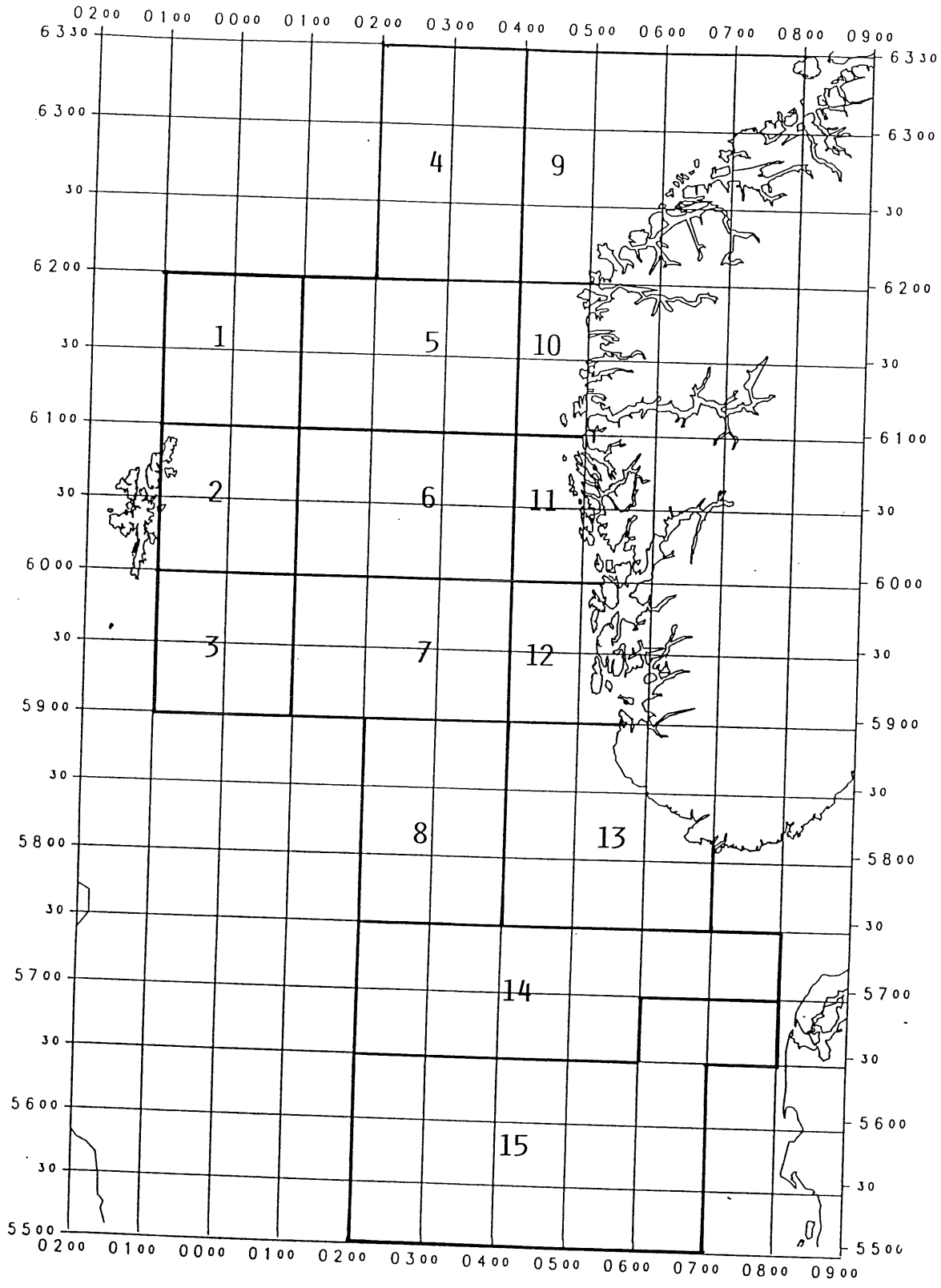


Figure 2. Definition of sub-areas, R/V "Johan Hjort, July 1991.

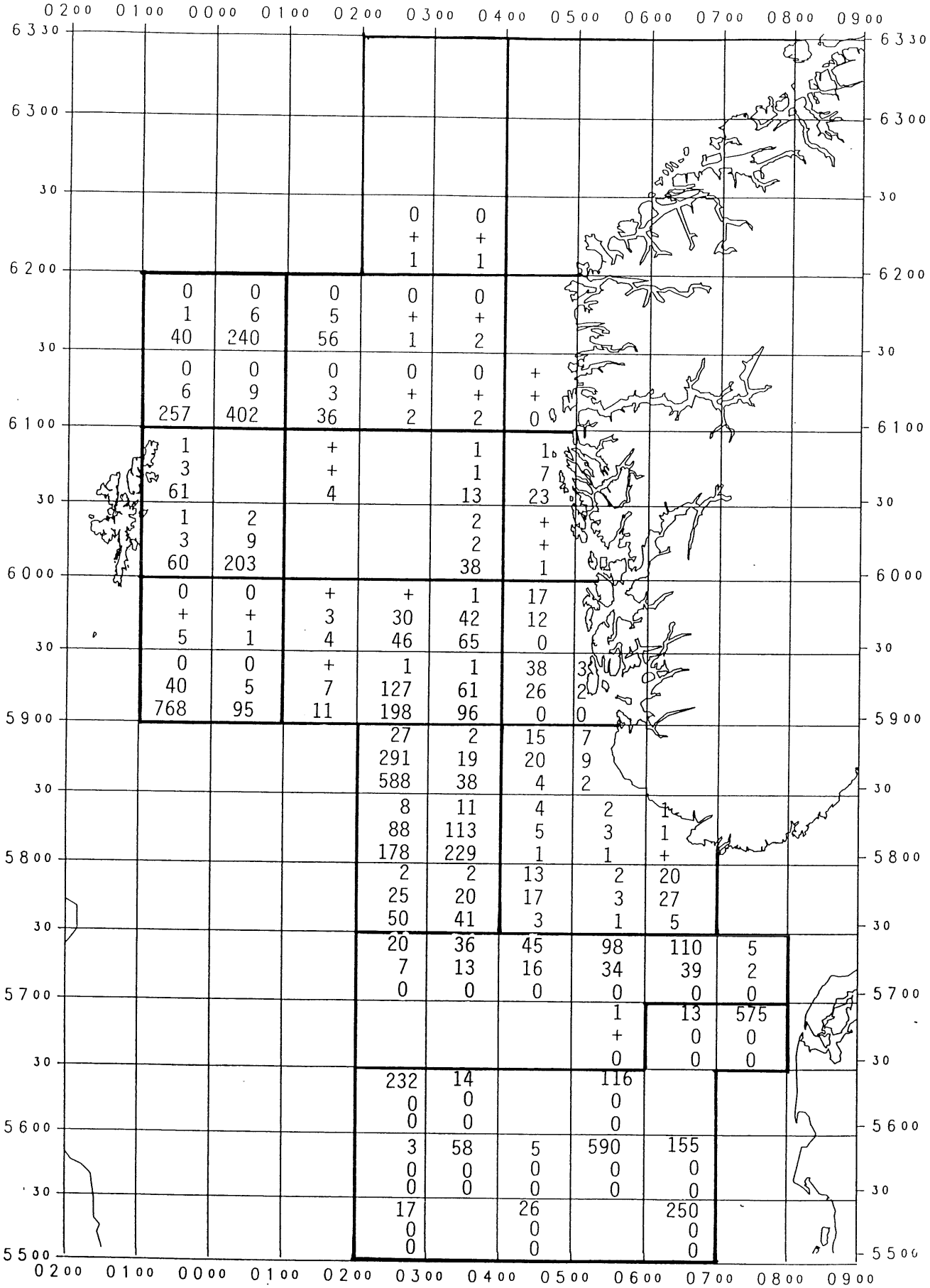


Figure 3. Abundance estimates of North Sea autumn spawning herring by rectangle and age group. (Millions of fish). "J.Hjort", July 1991.
Upper figures: 1-ringers
Middle figures: 2-ringers
Lower figures: 3+ -ringers

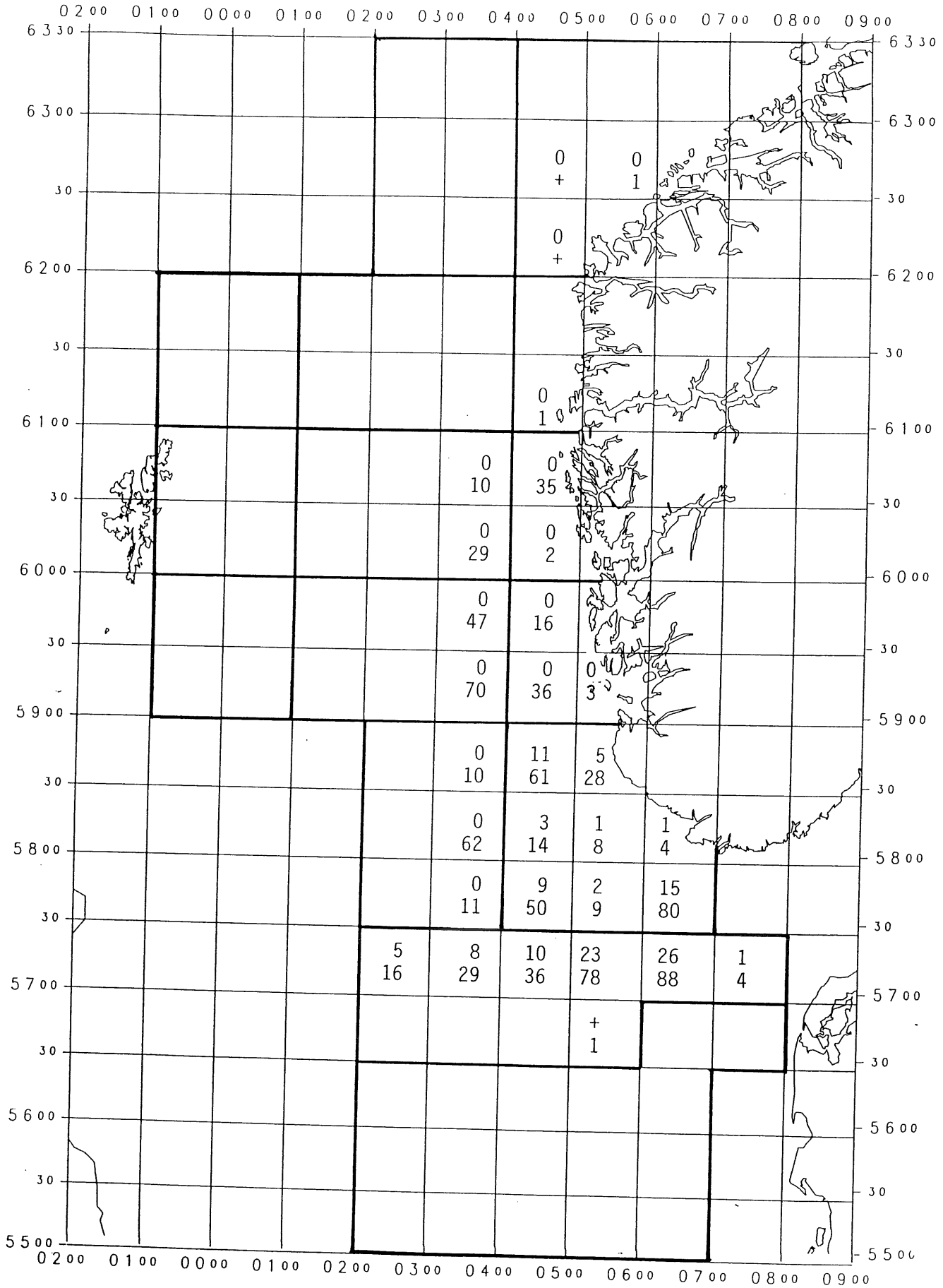


Figure 4. Abundance estimates of Division IIIa/ Baltic spring spawning herring by rectangle and age group (millions of fish). "J.Hjort", July 1991.
Upper figures: 2 -ringers
Lower figures: 3+ -ringers

Figure 5.

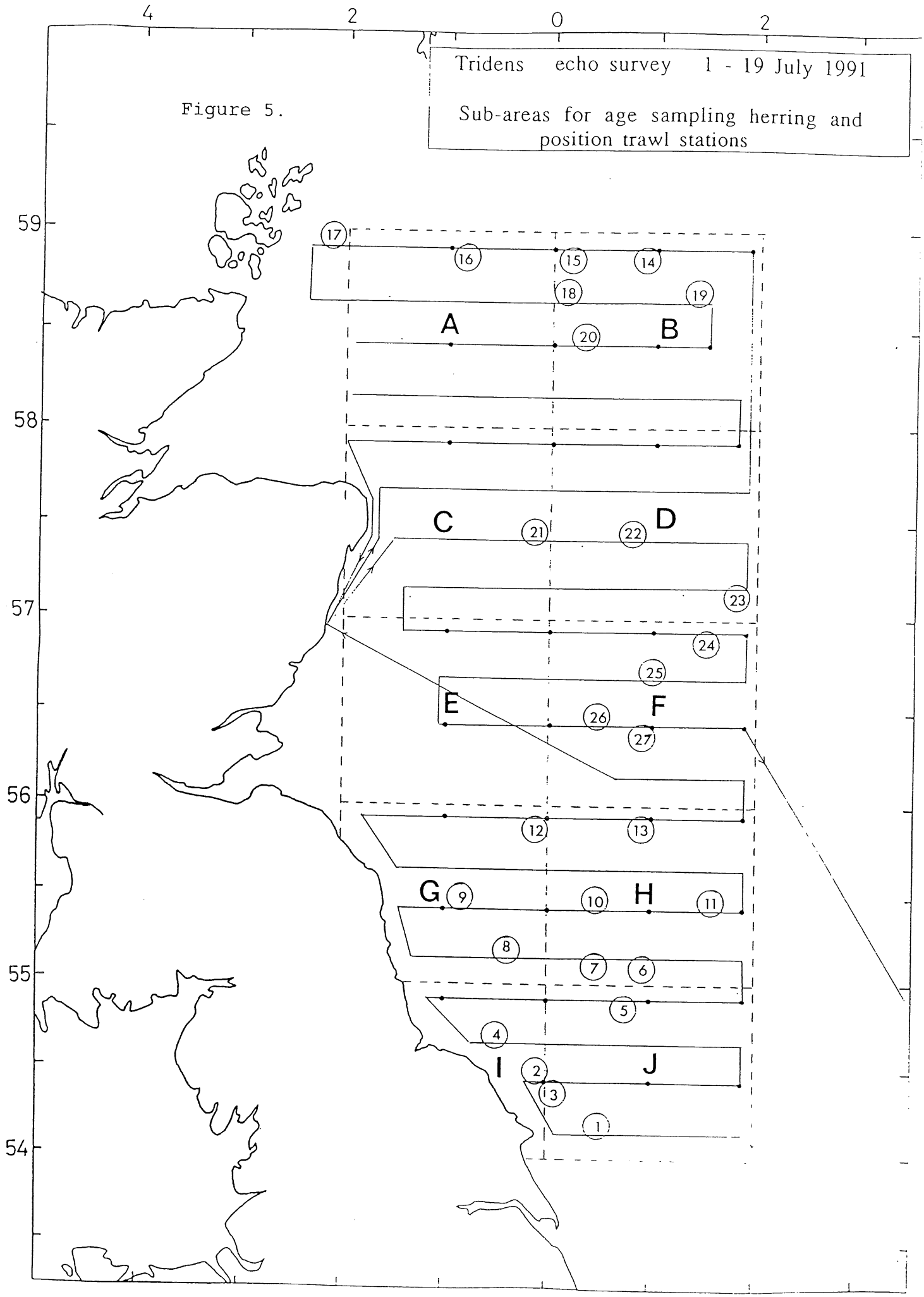

Tridens echo survey 1 - 19 July 1991
Sub-areas for age sampling herring and position trawl stations
4
2
0
2
59
58
57
56
55
54
A
B
C
D
E
F
G
H
I
J
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27

Figure 6.

Tridens echo survey 1 - 19 July 1991

spring- and autumn spawning herring combined

total number and total weight per sampling area

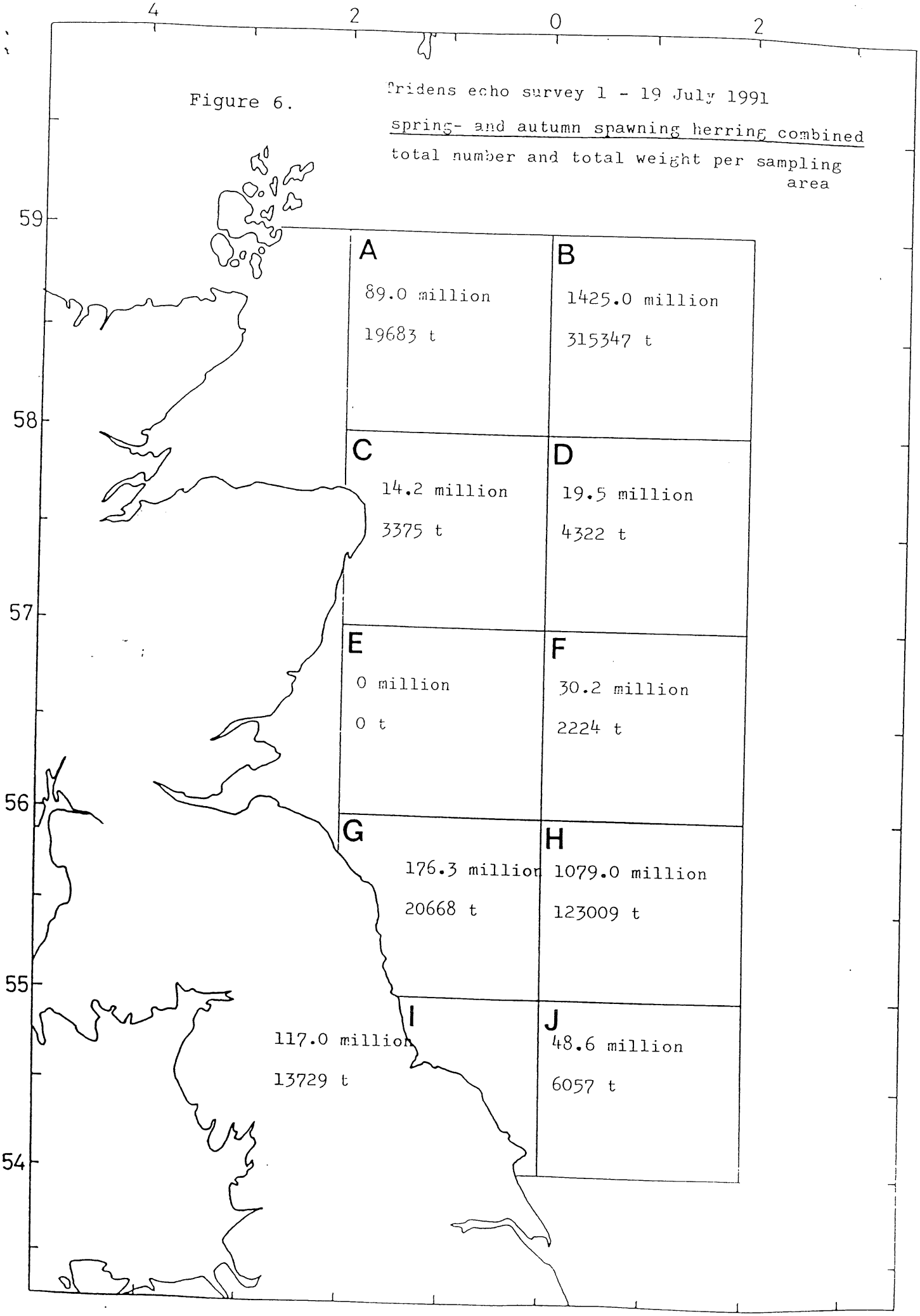


Figure 7.

Tridens echo survey 1 - 19 July 1991

autumn spawning herring only

total number and total weight per sampling area

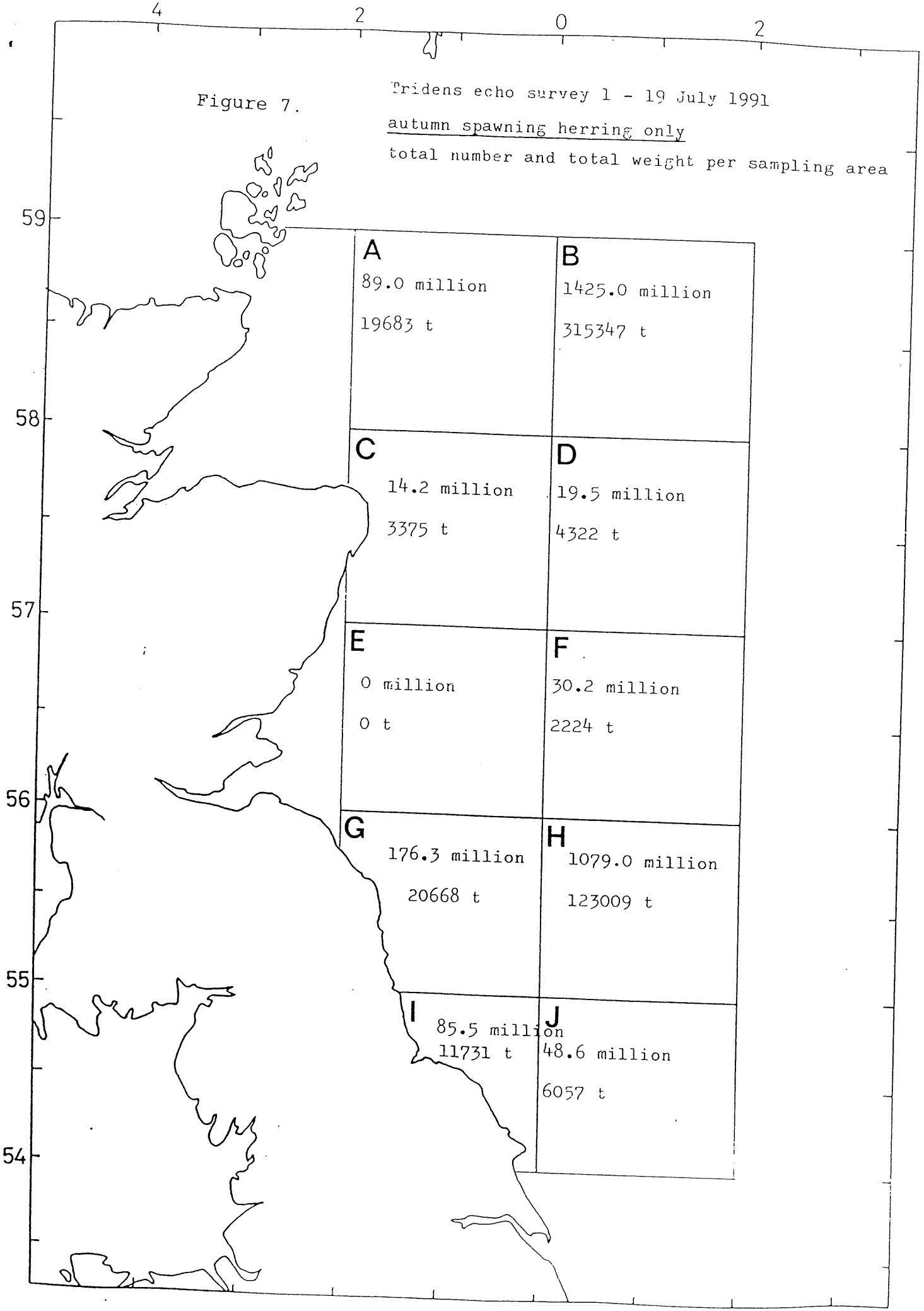


Figure 8.

Tridens echo survey 1 - 19 July 1991

spring spawning herring only

total number and total weight per sampling area

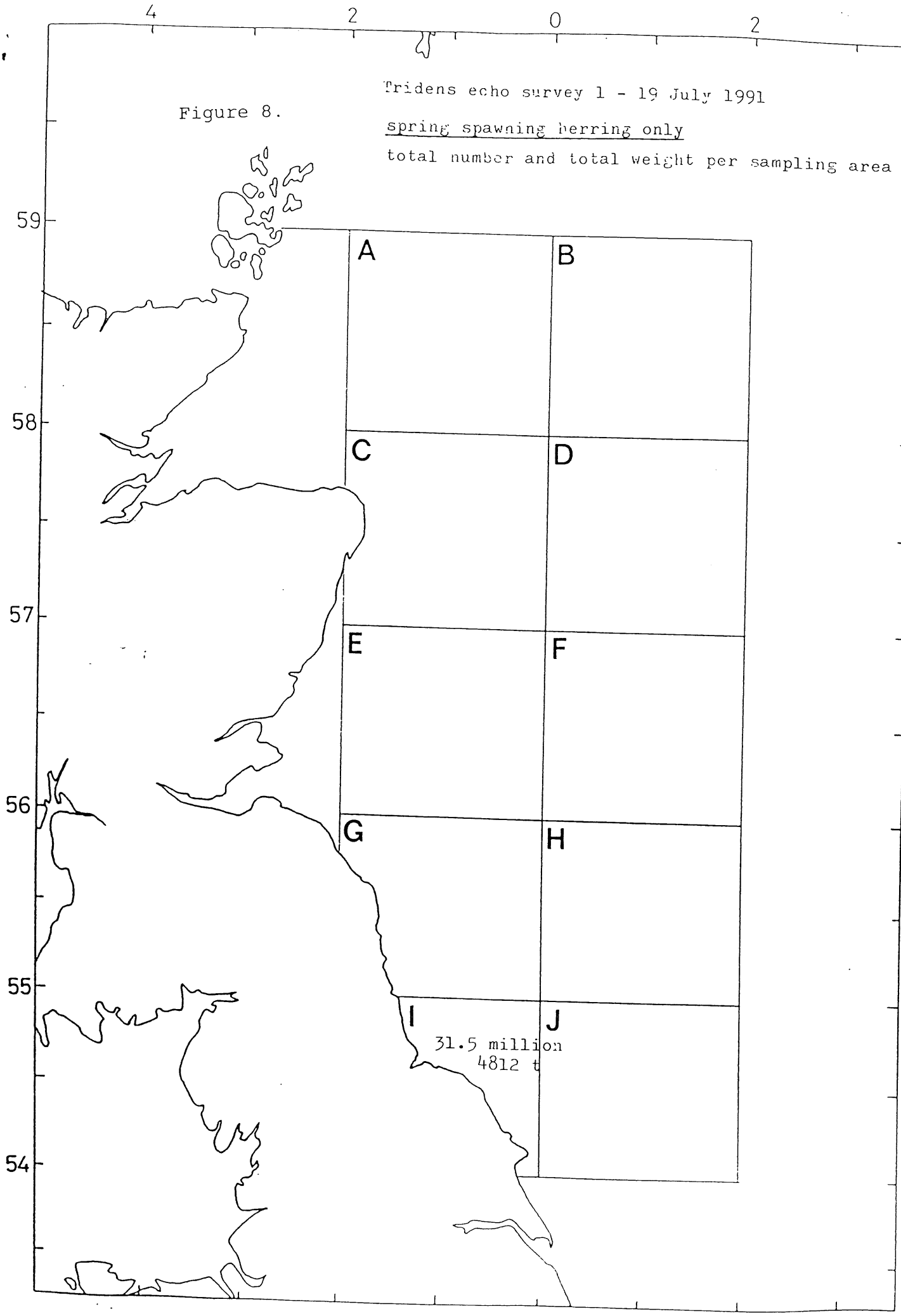


Figure 9. Tridens echo survey 1 - 19 July 1991

autumn spawning herring only

top figure: number of 1-ringers (millions)
middle figure: number of 2+ ringers (millions)
bottom figure: weight 2+ ringers (tonnes)

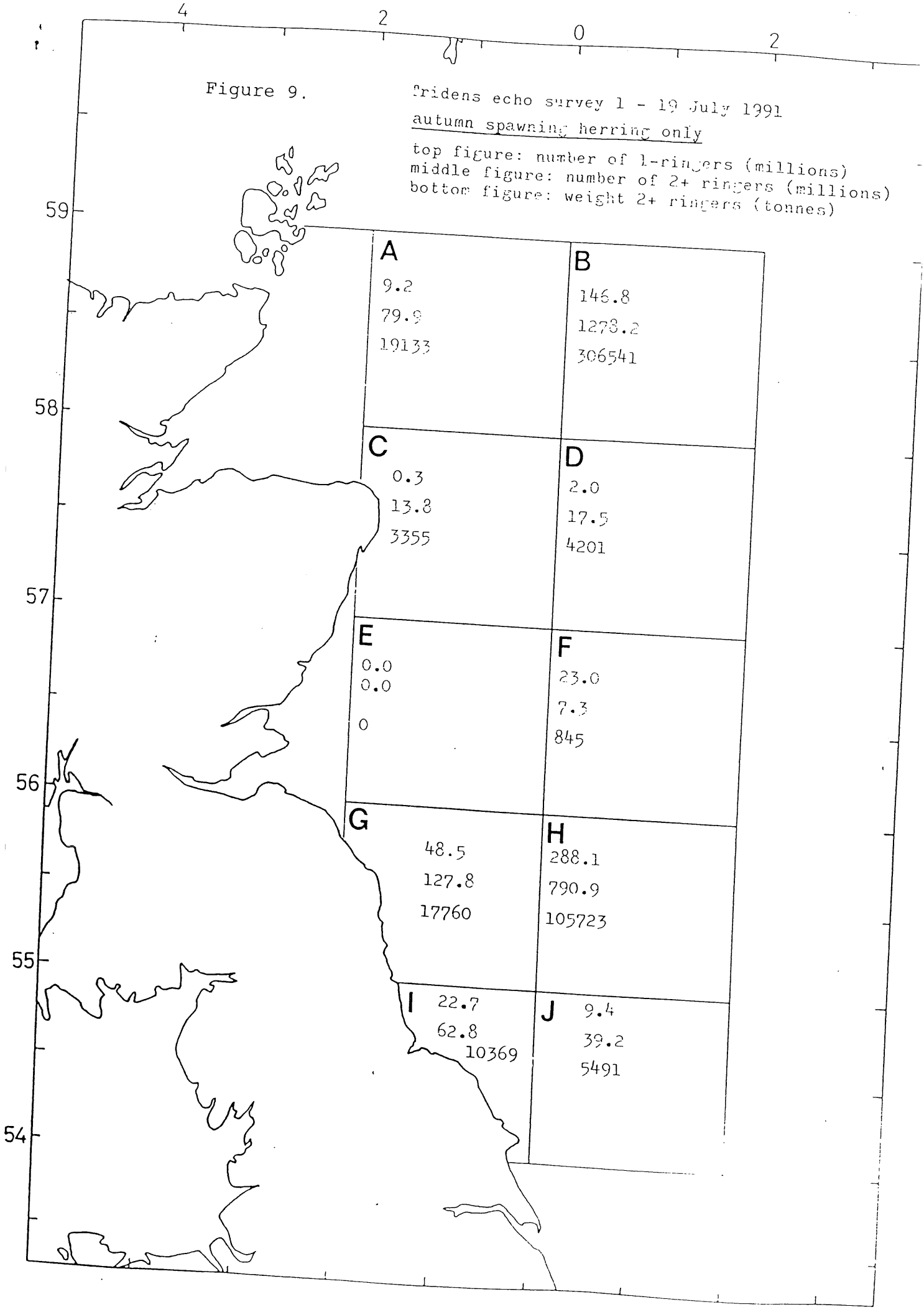


Figure 10 Survey track for acoustic survey of ICES area VIa(N); FRV Clupea 13 - 26 July 1991

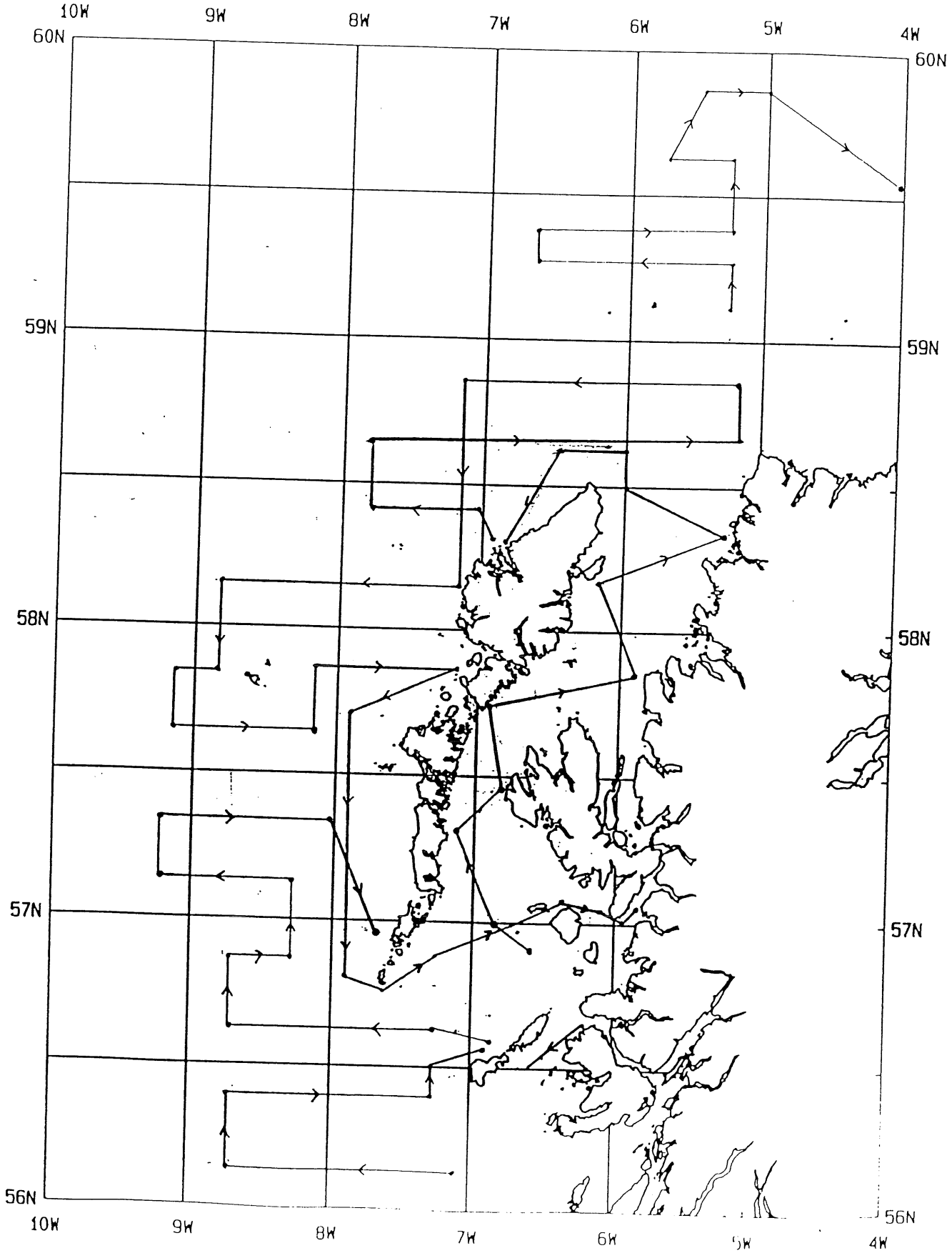
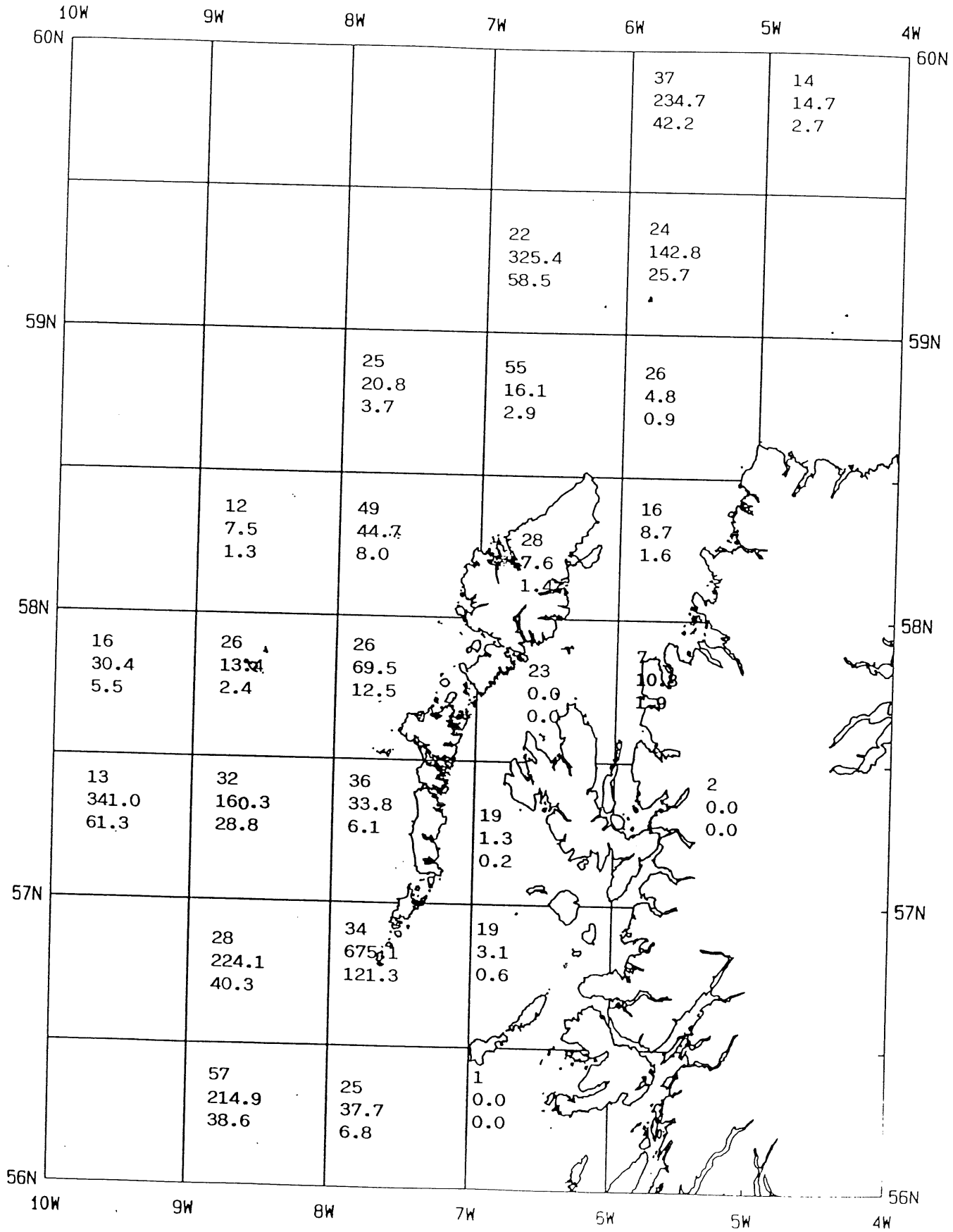


Figure 11 Number of 15 minute integrator runs (top), herring numbers (* 10^{-6}) (middle) and herring biomass (* 10^{-3} tonnes) (bottom) by ICES rectangle. FRV Clupea 13 -26 July 1991.



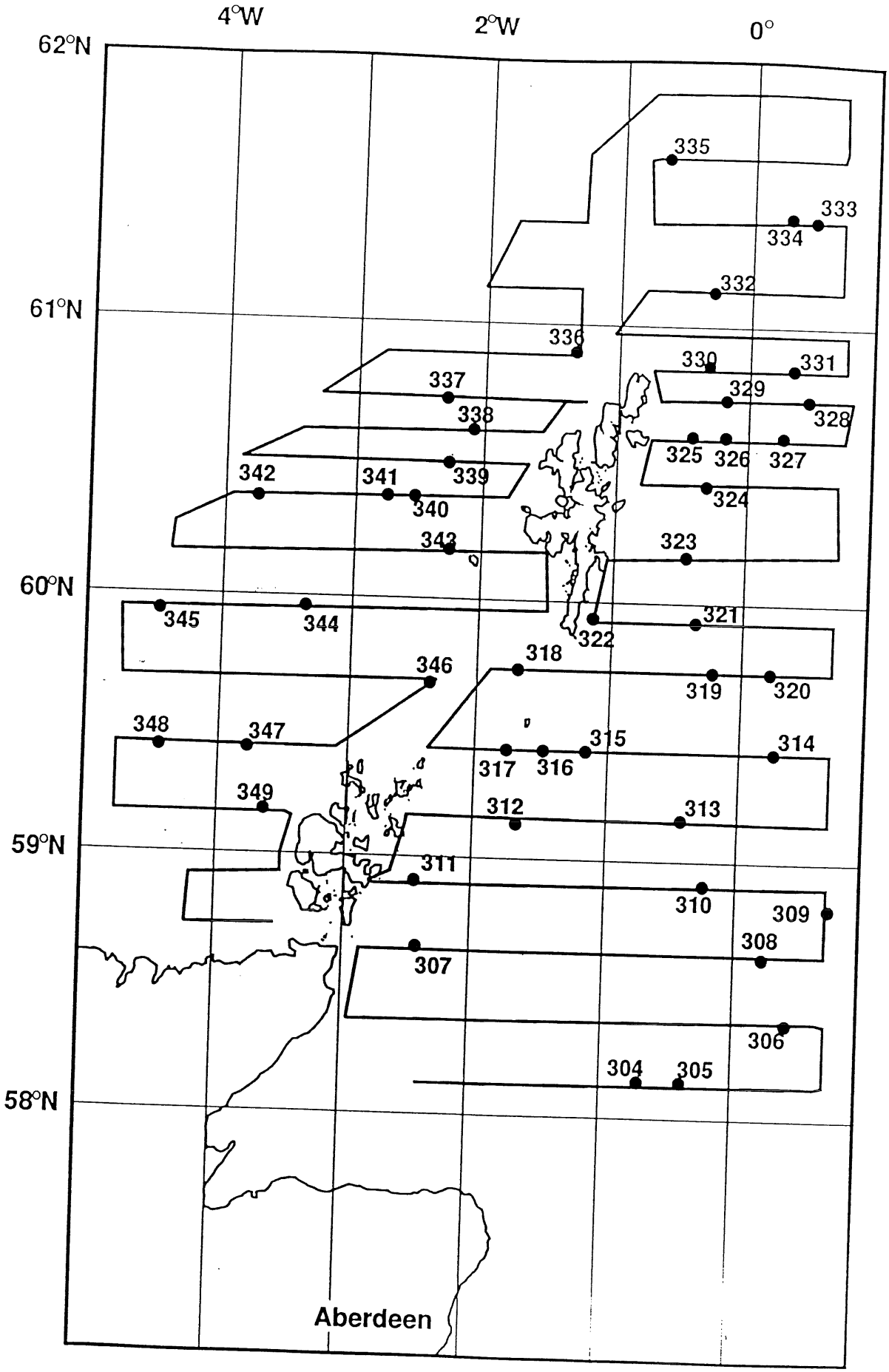


Figure 12 Survey track and trawl stations
FRV Scotia 12 July - 1 August 1991

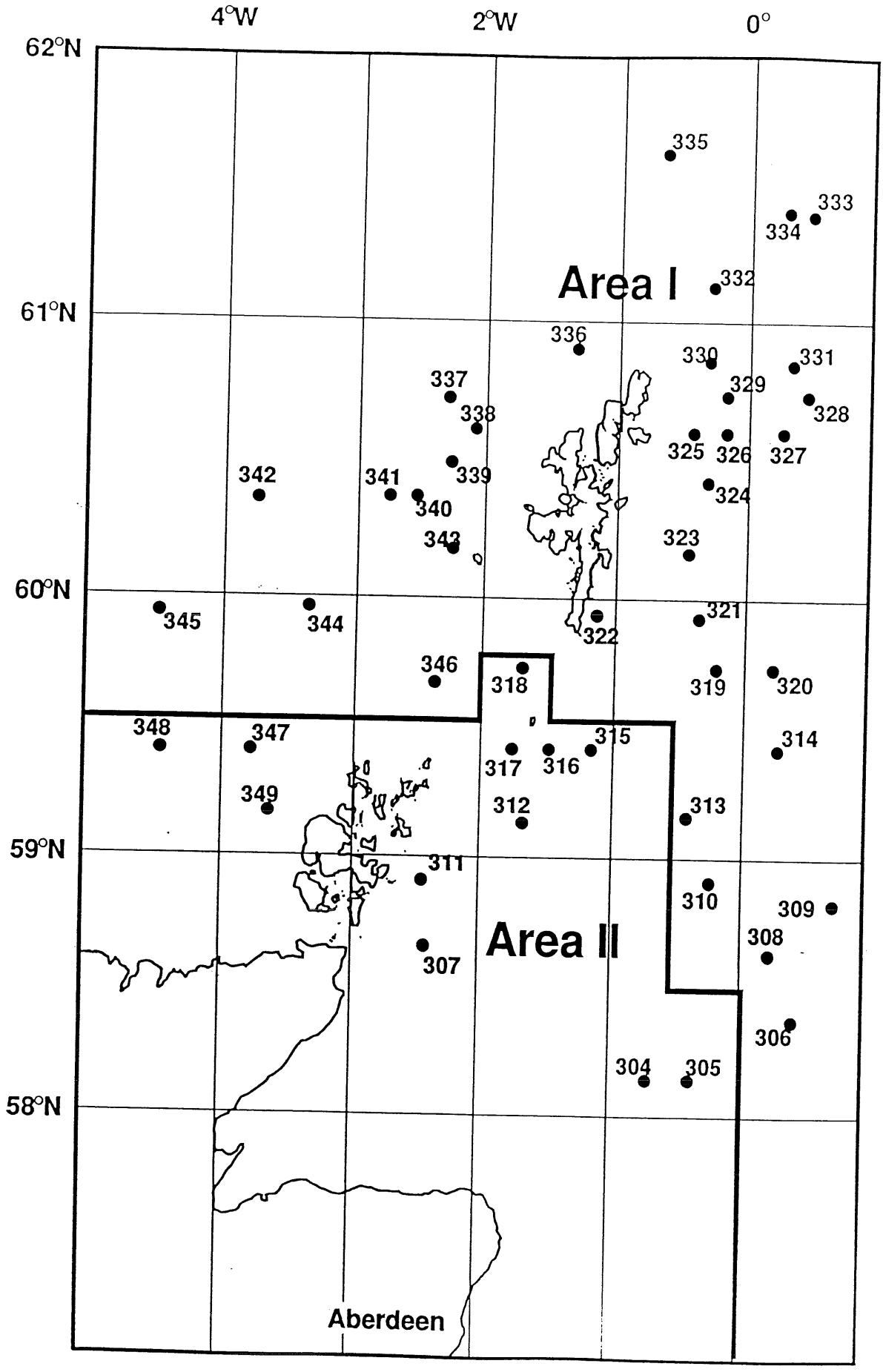


Figure 13 Definition of Sub-areas and trawl stations FRV Scotia 12 July - 1 August 1991.

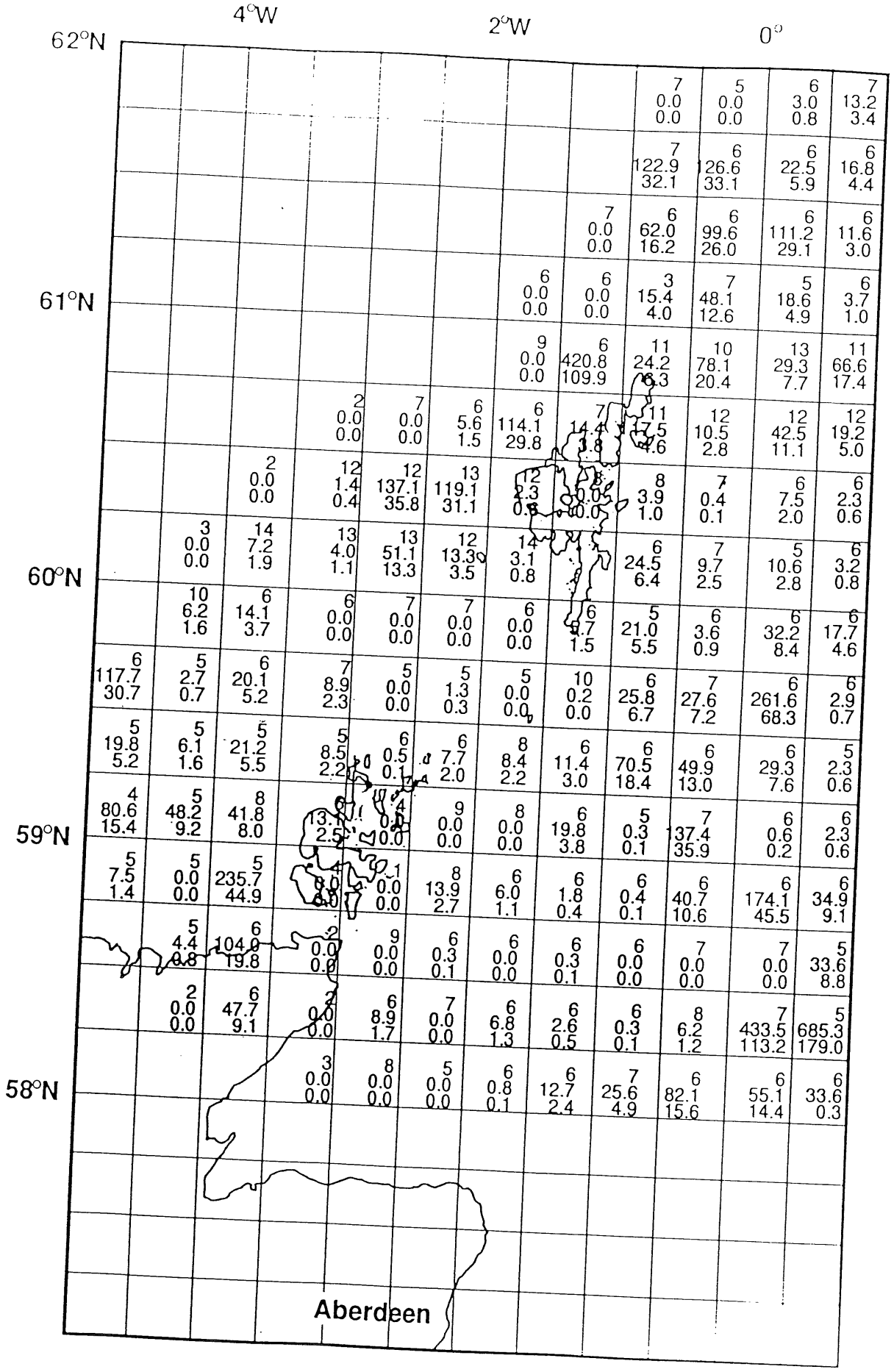


Figure 14 Number of 15 minute integrator runs (top), herring numbers(* 10^{-6}) (middle) and herring biomass (* 10^{-3} tonnes) by quarter ICES rectangle. FRV Scotia 12 July - 1 August 1991.

Figure 15 Survey areas for each vessel and ICES areas for acoustic surveys. Overlap between Scotia and Johan Hjort or Tridens is shaded. 13 June - 1 August 1991.

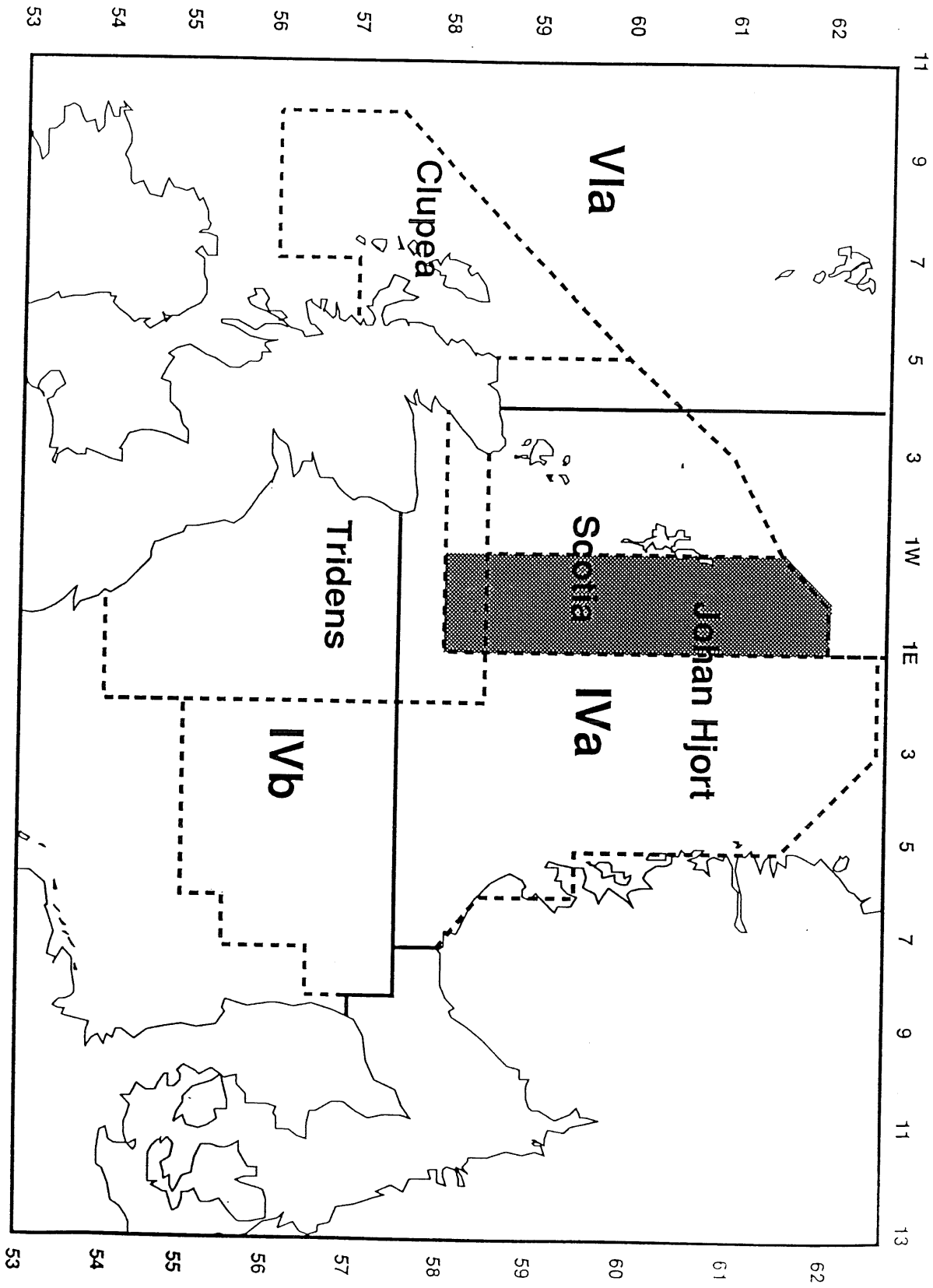


Figure 16 Number (* 10^{-6}) of autumn spawners by age (top - 0 & 1, middle - 2, bottom 3+) by ICES rectangle for acoustic surveys 13 June - 1 August 1991.