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Herring Assessment WG

1992 ICES COORDINATED ACOUSTIC SURVEY OF ICES DIVISIONS IVa, IVb AND VIa

by

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SUMMARY

This papers provides a report on the combined acoustic survey of herring stocks in the North Sea and ICES Division IVaN in July 1992. Surveys by Norway, Scotland and the Netherlands are included covering the period 24 June to 31 July. The results and distributions of herring by age are given for area by 30 Nmile statistical squares. The results are expressed in biomass and numbers of fish. In addition data on ichthyophonus infection rates determined from trawl samples obtained on the survey are reported and the infected numbers and proportions of the population are estimated. A discussion of errors in the estimation of ichthyophonus infection are included in the report.

INTRODUCTION

Four surveys were carried out during late June and July covering most of the continental shelf North of 54°N in the North Sea and 56°N to the west of Scotland to a northern limit of 62°N. The eastern edge of the survey area was bounded by the Norwegian and Danish coasts, and to the west by the Shelf edge between 200 and 400 m depth. The surveys are reported individually, and a combined report has been prepared using the data from all four surveys.

SURVEY BY R/V *JOHAN HJORT* IN THE EASTERN PART OF DIVISION IVa AND NORTHEASTERN PART OF DIVISION IVb, 24 JUNE-11 JULY 1992

Methods

Acoustic data were collected from a 38 kHz Simrad EK500 echosounder. The integrator data were stored and post-processed by a BEI system (Bergen Echo Integrator, ref Foote

2221/94

et al., 1991). Pelagic trawling was carried out mainly with a Fotö herring trawl, but also a fine meshed capelin trawl was used. A Campelen 1800 meshes shrimp trawl was used for bottom trawling.

Figure 1 shows the survey track and trawl stations. The distance between transects was about 15 nautical miles.

Integrator values were allocated to "herring", to some other categories of fish, and to plankton. From the "herring" category the mean integrator values for herring were calculated for each rectangle of approximately 30 x 30 nautical miles (30′ in the north-south direction and 1° in the east-west direction). The computation of number of individuals and biomass per age group was made with a computer program that operates according to the method described by Nakken and Dommasnes (1975). The following target strength value for herring was used:

$$TS = 20 \log L - 71.2 \text{ dB} \qquad \text{(where L is fish length in cm)}$$

Herring estimates were split between North Sea autumn spawners and Division IIIa/Baltic spring spawners on the basis of vertebral count distributions as described by Anon. (1991).

Survey Results

Figure 2 shows the herring estimate by ICES statistical rectangle. Table 1 gives numbers and biomass by age groups for spring and autumn spawners in each of the areas shown by thick lines in Figure 2. Table 2 shows percentage by age of Division IIIa/Baltic spring spawners estimated from vertebral counts.

Total estimates for herring in the surveyed area are:

	Number $N \times 10^{-6}$	Biomass ($\times 10^{-3}$ tonnes)
North Sea autumn spawners, mature	2,193	448
North Sea autumn spawners, immature	1,686	180
IIIa/Baltic spring spawners	1,229	247

Only a few specimens of Atlanto-Scandian spring spawners were found in the northern part of the investigated area.

During daytime the herring were mostly seen as small dense schools in the upper 50 m, often close to or above the upper blind zone of the integrator. At night the herring were found in a scattering layer in various depths, and then it could be difficult to differentiate from plankton and young gadoids. The schools were often so small that they could be difficult to see on the recording paper or the screen when the recordings were scrutinised for post-processing in the BEI system. This may have caused underestimation of herring. The herring schools in the upper blind zone, only some of which could be seen on the echo sounder, are also likely to have contributed seriously towards an underestimate of the herring stocks in the investigated area.

SURVEY REPORT RV *TRIDENS*, 6-23 JULY 1992

The echo integrator survey covered the western North Sea west of 2°E between 54° and 59°N. Cruise track and position of trawl stations are shown in Figure 3.

Methods

Fish densities were measured by a Simrad EK-500 system, using a 38 kHz hull mounted transducer. Prior to the actual survey, the equipment was calibrated in the Stavanger fjord in western Norway. Conditions for calibration in this area are better than in the western North Sea (sheltered, deep water, no currents). The results of the calibration are presented in Table 3.

Identification of fish traces was based on: a) the shape of fish schools on the echogramme; b) the TS distribution; and c) the results of directed trawl sets. Fishing for identification purposes was done using a 2,000 mesh pelagic trawl.

The area was covered by a grid of east/west transects spaced at 15 mile intervals. As the fish distribution was likely to show an east/west gradient (parallel to the coast), the north/south sections of the cruise track were not used for estimating fish abundance as their inclusion might bias the estimates for certain rectangles. Ship's speed during the survey was 12 knots.

Target strength and mean back scattering cross section (δ) for each length group of herring were estimated from the formulas.

$$TS = 20 \log 10 (L) - 71.2 \quad \text{and} \quad \delta = 4\pi \ 10^{(TS/10)}$$

SA values attributed to herring were averaged by statistical rectangles (1 degree longitude and 0.5 degree latitude). For each rectangle a length distribution (in absolute numbers) of all herring was calculated by using the results of one or two neighbouring trawl sets.

Age/length keys were constructed for Divisions IVa west and IVb. Length distributions for individual rectangles were combined within these sampling areas, and converted into age compositions.

Results

Catch composition of individual trawl sets is given in Table 4, and the length distribution and mean weight of herring catches in Table 5. SA-values per five mile interval, attributed to herring, are shown in Figure 3. Table 6 presents numbers of herring by age group for each sampling area. Figure 4 shows the numbers of herring by statistical rectangle.

The main concentration of herring was found between 58° and 59°N. Bottom schools of herring occurred widespread in this area. In the Moray Firth and the adjacent part of sampling area 1, the herring consisted mainly of one ringed fish. No major problems were experienced in attributing SA-values to herring, except for areas where diffuse herring occurred mixed with large plankton or small fish (euphausiids, maurolicus).

Apart from some minor concentrations, herring was remarkably absent in the area between 57°50′ and 55°30′N. A large amount of 0-group herring was detected about 120 miles east of Aberdeen. It is rather unusual to find this age class so far offshore.

In the area between 55°30 and 54°00 a mixture of adult and one ring herring was found. The adult herring occurred in a few large schools, which were hard to locate when fishing back along the track. These herring were within a few weeks of spawning.

SURVEY REPORT MFV *AZALEA* IN ICES AREA VIa(N)
16 JULY-1 AUGUST 1992

Methods

The acoustic survey on the charter vessel MFV *Azalea* 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. 5) was selected to cover the area in two levels of sampling intensity based on herring densities found in 1991. 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 (Table 7) 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 10 knots). Echo integrator data was collected from nine metres below the surface (transducer at 5 m depth) to 1 m above the sea bed. 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" and "sprat traces". For the 1992 survey 97% of the stock by number was attributable to the "herring traces" and only 3% of the "probably herring traces". The third category which was scored was for identifiable sprat traces. Other traces attributable to Norway pout, whiting, blue whiting, mackerel, horse mackerel, poor cod and haddock were not scored. 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 sea bed was deeper than 100 m. Small marks, similar to herring marks, but with lower integrator values were seen in the north part of the survey area (north of 58°N). Trawl samples showed these to be made up substantially of Norway pout and small whiting (<15 cm). In some areas these occurred together with similar herring schools, identification was based on school structure and relationship between size of mark and integrator values. Herring schools were considered as having a higher integrator value for a given size of school. One trawl sample (haul 24) was dominated by sprat in readily identifiable schools, and another (haul 16) by mackerel. These hauls allowed separation of schools of both species from herring schools.

One calibration was carried out during the survey. A further calibration of the equipment was carried out at the Marine Laboratory field site to confirm the calibration constant. To calculate integrator conversion factors the target strength of herring and sprat was estimated using the T/S length relationship recommended by the acoustic survey planning group (Anon., 1982) for clupeoids:

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

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:

$$W = 1.6286\ 10^{-3}\ L^{3.51}\ \text{g L measured in cm}$$

and the target strength relationship used for sprat was:

$$W = 1.0715\ 10^{-2}\ L^{2.88}\ \text{g L measured in cm}$$

Survey Results

A total of 39 trawl hauls were carried out, the results of these are shown in Table 7. Sixteen hauls contained more than 80 herring and these hauls were used to define three survey subareas (Fig. 6). The mean length keys, mean lengths, weights and target strengths for each haul and for each subarea are shown in Table 2, 1,696 otoliths were taken to establish the three age length keys. The numbers and weights of fish by quarter statistical rectangle are shown in Figure 6. A total estimate of 2,089 million herring of 428,600 tonnes was calculated for the survey area, 379,730 tonnes of these were mature. Herring were found mostly in water with the sea bed deeper than 110 m, with traces being found in waters with depths of up to 250 m. The survey was continued over the shelf break for most of the western edge of the survey area. Herring were generally found in similar water depths to 1990. Table 8 shows the numbers and weights of herring by subarea by age class.

The stock found in the overall area is dominated by two and five ring fish. The different areas showed varying age structures. Subarea I (shelf break), representing 34% of the total stock, was dominated by four and five ring fish (48.6%). Subarea II (south-west Hebrides), in which the bulk of the herring were found (52%) contained similar numbers in all age classes between two and five, with the largest year classes being two and five ring fish (48.7%). Subarea III (north-east Hebrides), representing 14% of the total stock, was dominated by one and two ring fish (25.5% and 63% respectively). In almost all cases fishing appeared to be successful and trace identification was straightforward with the exception of some areas west of Orkney containing small schools of herring and gadoids.

FRV *SCOTIA* SURVEY IN THE NORTHERN NORTH SEA
13-31 JULY 1992

Methods

The acoustic survey on FRV *Scotia* 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. 7) was selected to cover the area in one level of sampling intensity based on the limits of herring densities found in previous years, a transect spacing of 15 nautical miles was used. 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 the area. The between-track data could then be included in the data analysis. The origin of the survey grid was selected randomly with a 15 Nm interval and laid out with systematic spacing from the random origin.

Trawl hauls Figure 7 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 two per 0.5 cm class below 22 cm, five per 0.5 cm class from 20 to 27 cm and 10 per 0.5 cm class for 27.5 cm and above. The same fish were sampled for sex maturity and macroscopic evidence of Ichthyophonus infection. 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 10 knots). Echo integrator data was collected from 9 metres below the surface (transducer at 5 m depth) to 1 m above the sea bed. 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 56% of the stock by weight was attributable to the "herring traces" and 37% to the "probably herring traces" and 7% to the shallow herring schools. The fourth category which gave 37% 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 sea bed was deeper than 100 m. Similar small schools were found close to the sea bed 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 0.15 dB. 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:

$$W = 2.42\ 10^{-3}\ L^{3.39}\ \text{g L measured in cm}$$

Survey Results

A total of 24 trawl hauls were carried out, the results of these are shown in Table 10. Eleven hauls with significant numbers of herring were used to define three survey sub areas (Fig. 8). The mean length keys, mean lengths, weights and target strengths for each haul and for each sub area are shown in Table 11. 1,030 otoliths were taken to establish the three age length keys. The numbers and weights of fish by ICES statistical rectangle are shown in Figure 8 along with the number of 2.5 Nm integration intervals. A total estimate of 3,886 million herring or 838,000 tonnes was calculated for the survey area. 766,000 tonnes of these were mature. Herring were found mostly in water with the sea bed deeper than 100 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 1991. Table 12 shows the numbers mean lengths weights and biomass of herring by sub area by age class.

The stock found in this area has a spread of age classes with substantial numbers of 5 and 6 ring fish with a shortage of 3 ring fish but a better 2 ring age class than the one observed in 1991. This confirms the prevalence of older fish seen in previous years with lower recruitment for the current 3 and 4 ring fish. Fishing this year was a problem and trace identification was more difficult than in 1991, however, the main problems were with small schools found near the bottom with the sea bed between 100 and 120 m deep. A depth related division in the catch indicated that only the deeper schools contained large herring with some doubt remaining for schools in the 100-120 m water depths. The problems with fishing were due to the inexperience of personnel rather than a shortage of echosounder traces or any unexplained problems with the catch.

In addition to the 838,000 tonnes of herring, approximately 490,000 tonnes of other fish were observed in mid water. Examination of the catch by species (Table 1) shows the difficulty of allocating this between species so this has not been attempted. 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 60% and 100% respectively. This is a smaller proportion for mature 2 ring fish than those found in 1991.

COMBINED SURVEY RESULTS

Figure 9 shows survey areas for each vessel. The results for the four surveys have been combined. Procedures and TS values are the same as 1991 surveys (CM1992/H:35). The stock estimates have been worked out by age and maturity stage for 30 min by 1 degree statistical rectangles for the complete survey area. These data have been combined to give estimates of immature and mature (spawning) herring for ICES areas VIa North, IVa and IVb separately. Where the survey areas for individual vessels overlap the mean estimates for each overlapping rectangle have been used. Stock estimates are shown in

Table 13 for areas IVa and IVb separately and for area IVab combined for autumn spawning herring and for Baltic spring spawning herring found on the Norwegian side of the North Sea. Figure 10 shows the distribution of abundance (numbers and biomass) of autumn spawning herring for areas IVab and VIa north. Figure 11 shows the distribution split by age of 1 ring, 2 ring and 3 ring and older herring. Figures 12 and 13 show the density distribution of numbers and biomass of autumn spawning herring.

ICHTHYOPHONUS INFECTION

Figure 14 shows the prevalence found in samples which were taken during the survey and inspected for infection. Figure 14 also shows simple area averages clustering samples together on an equal basis for each fish. The samples have also been combined using linear interpolation for unsampled squares. Both unweighted and weighted method were used for squares without data. The distribution of infection rates for the weighted method is shown in Figure 15. The total numbers infected are shown in Figure 16 and tabulated along with uninfected and the percentage infection rates by ICES area in Table 13. The three columns show the different methods for averaging the samples, they are not significantly different. The right hand column is probably the best. In this study the Baltic spring spawning herring are included with the North Sea autumn spawning fish as there was no information on the proportions of infected fish from each population.

Mortality of Herring Populations in IVa, IVb and VIa Due to *Ichthyophonus hoferi*

Information on the extent of the infection and the resulting rates of mortality is limited. However, given some assumptions it is possible to obtain a very approximate estimate of mortality rates for the disease itself.

The numbers of herring in the population that will die due to the disease may be estimated from:

1.	The observed prevalence (PR)	the fraction of the total population that are found to be infected from samples.
2.	The detected infected proportion (DP)	the fraction of the infected fish in the sample that have been detected by the examination method.
3.	The disease mortality (DM)	the proportion of infected fish that will die from the infection.
4.	The life expectancy (LE)	the average duration of the illness (days) for those fish that are expected to die following infection.

$$\text{Annual Mortality Rate} = \frac{PR * 365 * DM}{LE * DP}$$

The estimated values for the parameters in this equation are:

Detection proportion	(DP)	1
Mean life expectancy	(LE)	105 days
Disease Mortality	(DM)	1
IVa and b Proportion infected	(PR)	0.045
VIa Proportion infected		0.00
Mortality rate for division	IV	16%
	VIa	0%

Assumptions

The infection rate is uniform over the year.
The infected fish are not subject to other preferential mortality.
The infected fish are correctly represented in the samples.
The life expectancy for the diseased fish is correctly known
All infected fish in a sample are detectable.

If these assumptions are incorrect the errors may be considerable.

Effects of Errors in the Assumption of Uniform Infection Rates

If the infection rate is non uniform. If the source of infection is external to the population, infection will occur only when the source and population are coincident in space and time. If the infection is transferred through ingestion the infection may only occur when feeding rates are high enough. Under these circumstances the relationship will no longer follow the simple equation given above as the numbers of infected fish will depend on the different rates of infection through the year, the life expectancy versus time relationship and the point of observation.

If the point of observation occurs immediately after a short infection period the numbers infected will represent the entire infected proportion for the year, and the above equation will cause an overestimate of the annual mortality rate. If ingestion is the major source of infection then it is likely that infection occurs mostly between April and October. By July, the observation point, the infection process will be almost fully underway giving an infection rate that is not critical to precise timing. The duration of infection will then be shorter than 365 days assumed. Using this assumption of uniform infection rate and a mean life expectancy of 105 days will give an overestimation rate of approximately 2. As the most probable cause of infection is ingestion, significantly greater overestimation of mortality seems unlikely.

If the observation point is well after the period of infection then substantial numbers of fish may have died already before being detected thus the mortality will be underestimated. For mortality to be underestimated by a factor of 2 the infection period would have to be short (significantly less than six months) and the peak infection would have to be more than 3.5 months prior to the observation point in July. This requires infection for a short period in winter.

Effects of Predation on Mortality Errors

If there is no preferential predation on any infected fish then the mortality is correctly estimated and all the mortality is excess mortality in addition to the normal annual natural mortality.

If the infected fish are subject to additional preferential mortality the life expectancy will be shorter than the 105 days. Using a figure of 105 days will cause an underestimation of the numbers of infected fish and of the mortality. However, some of the natural mortality normally experienced by the stock will almost certainly have transferred to the infected fish, compensating to some extent for the underestimation. Assuming 50% of the infected fish were lost to predation with uniform probability during the period of illness the effective life expectancy would reduce from 105 to 78 days. Thus the mortality should be increased by 1/3. However, if all of that mortality replaced natural predator mortality the effect would be to reduce the excess mortality to 50% of the total (66% of the predicted figure). The higher the proportion of ill fish that are taken in replacement of natural mortality the lower is the impact of the disease related mortality, in the extreme case where all ill fish are predated as replacement there is no excess mortality.

It is impossible to put an upper bound on the effects of predator mortality, if predator mortality on ill fish is excess over the natural mortality this will cause an underestimation of the infection mortality and this mortality should be added to the overall stock annual mortality.

Effects of Errors in the Mean Life Expectancy Due to the Disease

If the mean life expectancy caused by the illness itself has been incorrectly assessed, this will affect the calculated mortality. If unknowingly life expectancy increases by 10% then mortality will be overestimated by 10%. The estimate of mean life expectancy of 105 days is based on aquarium experiments on 2,000 one year old herring (Sinderman and Chenoweth). Stress on aquarium fish may be greater thus underestimating life expectancy. The infected fish in the North Sea stocks are often older fish and here the progress of the disease may be different. Accordingly it seems more likely that the life expectancy will be underestimated, thus the mortality overestimated.

Effects of Errors in the Detection of Illness in Samples

The numbers of diseased fish are estimated using macroscopic examination of the heart. Estimates of disease mortality at 100% are based on data from the same aquarium experiments described above and microscopic examination of tissue from samples of wild fish. These estimates seem fairly realistic but any errors in this factor will result in overestimation of the excess mortality. Errors in this parameter are expected to be small.

Effects of Errors in the Estimates of Proportion of Infected Fish

Correct estimates of the proportion of infected fish in the stock are crucial to the estimation process. Herring is migratory and the spatial distribution is non-uniform, in addition the distribution of the disease is non stationary in a statistical sense. It is necessary to obtain both estimates of abundance and proportion for the whole stock in order to establish the overall prevalence. The most obvious method for this is the use of acoustic survey data which provides estimates of abundance and coincident trawl data on the proportion of infected fish. The overall abundance does not affect the estimates of mortality but could be scaled by the results of the complete herring assessment procedure if required. The survey provides relative density figures to combine with temporally and spatially coincident estimates of infected proportions allowing calculation of total prevalence.

Studies of fishing sampling on distributions of herring (Holst) suggest non-uniform mixing of infected and uninfected fish, and preferential sampling for some fishing gears.

Comparison of demersal trawl and acoustic surveys suggest that areas of zero occurrence coincide. The highest proportions of infected fish occur in demersal trawl samples or from low density concentrations. The lowest but not exclusively so from dense aggregations using trawl or purse seine. The problems of determining the correct proportion for the areas where diseased fish are present are considerable. Determination of this factor probably gives rise to the largest source of error. In general it is easier to catch diseased fish thus the prevalence may be overestimated. However, if the spatial distribution of diseased and uninfected fish is different, for example if diseased fish migrate slowly, or not at all, they may be underestimated, because they are located in unsurveyed areas at the time of the observation.

Summary of Errors in Mortality Estimates

The major sources of error are; the non-stationary spatial distribution of diseased and uninfected fish, the excess predator mortality on diseased fish over and above the normal rates of natural mortality, and the preferential sampling of diseased fish. The first two of these errors may tend to cause underestimation of mortality, the third overestimation.

TABLE 1. Estimated number (N, millions) and biomass ('000 tonnes) by age and subarea. w is mean weight (grams)

Area	Subarea 1						Subarea 2		Subarea III					
Race	Autumn + spring		Spring		Autumn		Autumn		Autumn + spring		Spring		Autumn	
Age/W-ring	N	w	N	w*	N	w	N	w	N	W	N	w*	N	w
1	1,080	96.5	-	-	1,080	96.5	1	93.0	23	102.4	-	-	23	102.4
2	1,224	155.8	-	-	502 722	125.8[1] 176.7[2]	10 32	126.0[1] 175.1[2]	152	163.2	-	-	62[1] 90[2]	129.5[1] 186.4[2]
3	328	193.8	210	184.9	- 118	-[1] 206.9[2]	- 107	-[1] 206.9[2]	274	205.7	74	202.5	8[1] 192[2]	149.5[1] 209.3[2]
4	333	193.6	256	189.9	77	205.8	94	205.8	228	192.7	112	179.1	116	205.8
5	176	197.3	136	191.7	40	216.2	67	216.2	234	221.6	115	227.2	119	216.2
6	165	210.2	127	204.1	38	230.7	158	230.7	194	233.1	95	235.6	99	230.7
7	55	241.3	42	231.0	13	274.6	34	274.6	50	235.2	25	195.8	25	274.6
8	13	259.1	10	262.0	3	249.6	15	249.6	8	230.6	4	211.6	4	249.6
9+	18	311.6	14	302.9	4	342.1	17	342.1	18	243.8	9	145.5	9	342.1
Tot N	3,392		795		2,597		535		1,181		434		747	
Tot B	514.4		156.0		358.3		118.3		242.5		90.6		151.9	
Mat N	-		-		1,015		524		-		-		654	
Mat B	-		-		190.9		116.9		-		-		140.3	

* mean weights calculated by assuming mean weights of autumn spawners equal to those in subarea 2

[1] immature fish (maturity stage 1 or 2)

[2] maturing fish

+

TABLE 2. Percentage by age of Division IIIa/Baltic spring spawners estimated by the formula (56.50-v)/0.7. Mean vertebral count (v) is given in brackets. n is number of fish sampled for vertebral counts

Subarea	Age (winter rings)				
	1	2	3	4	n
1	0 (56.55)	0 (56.60)	64 (56.05)	77 (55.96)	569
3	-	0 (56.66)	27 (56.31)	49 (56.16)	337

TABLE 3. Calibration report EK-500 38 kHz transducer

Date and time: 7 July 1992, 2000-2200	**Position:** Stavanger fjord 59.05°N 05.36°E
Bottom depth: 50 m	**Wind:** NW 3-2
Water temperature: 10°C	**Wave height:** 0.2 m

Transceiver menu before calibration

Pulse length: medium	**Bandwidth:** wide
Max power: 4,000 W	**Angle sensitivity:** 22.1
2-way bean angle: -20.6 dB	**Sv transducer gain:** 26.5 dB
TS transducer gain: 26.5 dB	**3 dB beam width:** 7.1
Along ship offset: 0	**Athwart ship offset:** 0

Standard target:	copper sphere, -33.6 dB
Target depth:	19.90 m
TS values measured:	32.8 - 33.1
New TS transducer gain:	26.9
New TS values measured:	33.6-33.7
SA values measured:	6,500-6,600
SA value calculated:	5,455
New Sv transducer gain:	26.9
New SA values measured:	5,570-5,630

TABLE 4. *Tridens* trawl catches in kg

Haul	Date	Time UTC	Position	Herring	Norway pout	Other gadoids	Mackerel	Sprat	Others	Remarks
1	8.7	0745	58°55′N 01°01′E			70			10	invalid
2	8.7	0915	58°55′N 01°03′E	32,550	2,310	20	88			
3	8.7	1730	58°55′N 00°53′W	3,360	10	45	45			
4	9.7	0900	58°40′N 01°37′W	2,625	2	6	122			
5	9.7	1220	58°40′N 00°50′W	420	70	4	2			
6	9.7	1735	58°40′N 00°14′E	630	280	96	4		2	
7	10.7	0615	58°40′N 01°50′E		1,015	3			5	
8	10.7	0930	58°25′N 01°36′E	3,990	20					
9	10.7	1450	58°25′N 00°10′E	455		157			5	
10	10.7	1900	58°25′N 00°39′W	210	2					
11	11.7	0625	58°10′N 01°47′W	20		105				
12	11.7	0905	58°10′N 01°18′W	7		13				invalid
13	11.7	1315	58°10′N 00°14′W	6,600		3				
14	13.7	1700	57°25′N 01°15′W	7		7				
15	15.7	1535	57°10′N 01°13′W			1	250			
16	16.7	0615	57°10′N 01°54′E	1,675	785		370			
17	16.7	1455	56°55′N 01°23′E	2,070	80		10			
18	17.7	1200	56°40′N 01°09′E	1,860						
19	17.7	1930	56°25′N 00°51′E		370	5				
20	18.7	1910	56°10′N 01°26′E		25	5				
21	20.7	1255	55°10′N 00°45′W	50				2,620		
22	20.7	1545	55°10′N 00°18′W	8		5		1		
23	21.7	0625	54°55′N 00°24′E	590		10		45		
24	21.7	0940	54°55′N 00°10′E							
25	22.7	0620	54°25′N 01°28′E	5				675		
26	22.7	1650	54°10′N 00°55′E					153	7	

TABLE 5. *Tridens* Numbers (millions) Age/length distribution and mean weights for: a) Subdivision IVb

Length	Total number	Total immature	Total mature	Immature		Mature								
				1990	1989	1989	1988	1987	1986	1985	1984	1983	1982	1981
15.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16.5	1	1	0	1	0	0	0	0	0	0	0	0	0	0
17.0	27	27	0	27	0	0	0	0	0	0	0	0	0	0
17.5	46	46	0	46	0	0	0	0	0	0	0	0	0	0
18.0	59	59	0	59	0	0	0	0	0	0	0	0	0	0
18.5	62	62	0	62	0	0	0	0	0	0	0	0	0	0
19.0	64	64	0	64	0	0	0	0	0	0	0	0	0	0
19.5	25	25	0	25	0	0	0	0	0	0	0	0	0	0
20.0	43	43	0	43	0	0	0	0	0	0	0	0	0	0
20.5	22	22	0	20	2	0	0	0	0	0	0	0	0	0
21.0	22	22	0	18	4	0	0	0	0	0	0	0	0	0
21.5	29	27	2	23	4	2	0	0	0	0	0	0	0	0
22.0	16	16	0	14	2	0	0	0	0	0	0	0	0	0
22.5	24	21	3	8	13	3	0	0	0	0	0	0	0	0
23.0	27	22	4	0	22	4	0	0	0	0	0	0	0	0
23.5	49	24	34	0	24	24	0	0	0	0	0	0	0	0
24.0	21	8	13	0	8	13	0	0	0	0	0	0	0	0
24.5	38	19	19	0	19	19	0	0	0	0	0	0	0	0
25.0	27	5	21	0	5	21	0	0	0	0	0	0	0	0
25.5	44	15	30	0	15	25	0	5	0	0	0	0	0	0
26.0	69	13	57	0	13	31	6	0	13	6	0	0	0	0
26.5	62	0	62	0	0	37	19	6	0	0	0	0	0	0
27.0	88	0	88	0	0	29	19	19	10	10	0	0	0	0
27.5	81	0	81	0	0	6	44	12	12	0	6	0	0	0
28.0	106	0	106	0	0	0	56	44	0	0	6	0	0	0
28.5	97	0	97	0	0	0	49	24	8	8	8	0	0	0
29.0	109	0	109	0	0	0	52	17	23	6	11	0	0	0
29.5	71	0	71	0	0	0	24	24	12	12	0	0	0	0
30.0	43	0	43	0	0	0	17	0	9	9	9	0	0	0
30.5	33	0	33	0	0	0	17	8	0	0	0	0	0	8
31.0	2	0	2	0	0	0	0	0	0	1	1	0	0	0
31.5	11	0	11	0	0	0	0	0	0	4	4	0	0	4
Total	1418	542	876	411	131	216	302	160	86	55	45	0	0	12
Number aged				84	33	41	43	22	12	7	7	0	0	1
Mean weight				62	102	133	201	198	198	216	206			225

TABLE 5 (continued). *Tridens* Numbers (millions) Age/length distribution and mean weights for: b)Subdivision IVb

Length	Total number	Total immature	Total mature	Immature		Mature								
				1990	1989	1989	1988	1987	1986	1985	1984	1983	1982	1981
17.0	23	23	0	23	0	0	0	0	0	0	0	0	0	0
17.5	42	42	0	42	0	0	0	0	0	0	0	0	0	0
18.0	75	75	0	75	0	0	0	0	0	0	0	0	0	0
18.5	94	94	0	94	0	0	0	0	0	0	0	0	0	0
19.0	127	127	0	127	0	0	0	0	0	0	0	0	0	0
19.5	88	88	0	88	0	0	0	0	0	0	0	0	0	0
20.0	57	57	0	57	0	0	0	0	0	0	0	0	0	0
20.5	35	35	0	35	0	0	0	0	0	0	0	0	0	0
21.0	31	31	0	21	10	0	0	0	0	0	0	0	0	0
21.5	30	30	0	30	0	0	0	0	0	0	0	0	0	0
22.0	31	31	0	0	31	0	0	0	0	0	0	0	0	0
22.5	33	33	0	0	33	0	0	0	0	0	0	0	0	0
23.0	52	52	0	0	52	0	0	0	0	0	0	0	0	0
23.5	67	61	7	7	54	7	0	0	0	0	0	0	0	0
24.0	80	50	30	10	40	30	0	0	0	0	0	0	0	0
24.5	98	62	36	9	53	36	0	0	0	0	0	0	0	0
25.0	139	56	83	9	46	74	9	0	0	0	0	0	0	0
25.5	133	7	126	0	7	126	0	0	0	0	0	0	0	0
26.0	124	18	106	0	18	79	26	0	0	0	0	0	0	0
26.5	113	8	105	0	8	64	32	0	0	8	0	0	0	0
27.0	107	0	107	0	0	53	53	0	0	0	0	0	0	0
27.5	157	0	157	0	0	39	69	39	0	10	0	0	0	0
28.0	193	0	193	0	0	21	54	64	43	11	0	0	0	0
28.5	239	0	239	0	0	8	72	96	24	24	16	0	0	0
29.0	297	0	297	0	0	9	79	70	44	61	26	0	90	0
29.5	268	0	268	0	0	7	35	70	56	63	35	0	0	0
30.0	229	0	229	0	0	0	59	51	25	68	25	0	0	0
30.5	119	0	119	0	0	0	34	17	17	34	8	8	0	0
31.0	37	0	37	0	0	0	7	0	7	15	7	0	0	0
31.5	13	0	13	0	0	0	0	0	0	4	4	0	4	0
32.0	27	0	27	0	0	0	0	0	0	27	0	0	0	0
32.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33.0	10	0	10	0	0	0	0	0	0	0	10	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	3169	981	2189	628	353	554	530	408	217	325	133	8	13	0
Number aged				56	38	65	59	48	26	38	17	1	2	
Mean weight				54	106	145	201	211	227	232	239	218	248	

TABLE 6. Catch composition by trawl haul. *Azalea* 16-31 July 1992

Haul number	Position		Depth (m)	Numbers caught									
	Latitude (°N)	Longitude (°W)		Herring	Sprat	Whiting	Haddock	Pout	Mackerel	Horse mackerel	Blue whiting	Gurnards	Others
1	56 38.28	7 12.82	200	1784		9		276	150	3	3		
3	56 37.06	7 26.40	190	5561									
4	57 22.54	9 9.11	150						3				
5	57 22.46	8 19.52	150	2125					5				
7	58 24.86	6 00.72	106	4374	729	12		8					8 spurdog
8	58 09.07	5 42.23	82	4	1	5425	12	138					
9	57 26.25	6 47.77	100	3386		5		5	15				
10	58 03.97	6 19.46	150		1781	430	46	612		2	7		35 spurdog
11	58 37.58	6 03.58	130	394	1	2							
12	58 37.44	6 41.24	110	382		4	1		1				
13	58 22.64	7 01.96	100	81									
16	58 30.49	7 11.76	100						621				
17	58 33.69	7 09.95	100	207		8		6	169				
18	58 41.21	7 35.96	120	536					9				
20	58 48.61	5 55.26	110	355				994	11	2		3	2 spurdog
22	58 56.14	7 24.80	150	1109					1	4	4		
23	58 55.96	6 19.10	108	750		1		19					1 argentine
24	58 03.18	3 45.17	150	6	4809	16	2						
25	59 03.55	6 55.64	204	5		1		12		1			
28	59 11.07	4 31.05	92			212	112	30218				4	276 poor cod 8 argentine 4 dogfish
29	59 11.15	4 15.89	135			42	20	8963		1			
30	59 18.55	4 34.23	90	11		2	5	53					
32	59 26.12	5 35.01	110	122		6	16					4	13 argentine
33	59 26.28	3 47.30	150	2470	42	18	3	264	3			3	
34	59 34.00	3 30.37	140	346		1	6	96		3			
35	59 33.69	5 01.84	135			3	7	88	3	1		1	21 argentine 1 cod 3 dogfish
38	59 52.52	3 45.78	110			1		4841	129				4 saithe

TABLE 7. Herring length frequency by trawl haul by sub area. *Azalea* 16-31 July (mean length - cm, mean weight - g, target strength - dB)

Haul No	Area I						Area II									Area III			
	18	22	32	33	34	mean	1	3	5	9	12	13	17	23	mean	7	11	20	mean
18.5																1.2			0.4
19.0																7.2			2.4
19.5																16.3			5.4
20.0																23.0			7.7
20.5																11.0			3.7
21.0										0.3					0.0	9.4			3.1
21.5					0.3	0.1				0.3					0.0	6.5			2.2
22.0										0.3					0.0	3.4			1.1
22.5					0.3	0.1	0.3			0.5					0.1	3.2	0.3		1.2
23.0					1.2	0.2		0.4		0.3					0.1	5.3	2.5		2.6
23.5					2.0	0.4	1.1	0.4		1.3					0.3	3.0	8.4	1.1	4.2
24.0					3.8	0.8	0.5	1.8	0.5	4.2					0.9	3.4	15.5	2.3	7.1
24.5				0.4	2.0	0.5	2.9	4.0	0.5	5.5					1.6	2.5	21.6	6.8	10.3
25.0					9.2	1.8	5.9	8.4	0.5	8.8	2.1	2.5	0.5	0.3	3.6	1.7	17.5	22.3	13.8
25.5				0.4	8.4	1.7	11.9	17.2	3.0	8.0	6.3	2.5	2.4	2.5	6.7	0.8	14.0	20.6	11.8
26.0				0.4	8.7	1.8	12.9	13.5	12.6	5.5	17.3	6.2	1.4	6.8	9.5	0.9	7.9	24.5	11.1
26.5				0.4	9.0	1.9	9.9	11.3	17.7	8.3	17.0	9.9	3.9	10.9	11.1	0.2	2.5	7.9	3.6
27.0			1.6	1.5	6.4	1.9	5.7	12.0	27.3	16.1	17.8	13.6	12.1	13.6	14.8	0.3	2.8	4.8	2.6
27.5			2.5	1.5	7.2	2.2	10.1	8.0	21.2	12.5	16.2	18.5	17.9	19.7	15.5	0.2	2.5	3.4	2.0
28.0	1.1		6.6	5.9	6.6	4.0	6.2	9.1	12.6	11.7	14.9	12.3	27.5	17.7	14.0	0.2	2.3	2.3	1.6
28.5	0.7	1.6	19.7	6.2	9.0	7.4	7.0	4.4	3.0	4.7	6.5	13.6	19.8	13.9	9.1		1.3	0.3	0.5
29.0	2.6	2.9	26.2	12.5	9.5	10.8	9.4	5.1	1.0	4.2	0.8	7.4	9.2	6.1	5.4	0.2	0.8	1.4	0.8
29.5	8.2	6.1	16.4	11.4	6.4	9.7	7.8	2.2		3.1		6.2	0.5	4.3	3.0	0.1		0.3	0.1
30.0	18.6	11.0	16.4	12.1	3.5	12.3	4.9	1.1		3.4	0.5	1.2	2.4	0.7	1.8		0.3	0.6	0.3
30.5	21.9	16.2	3.3	10.7	2.0	10.8	2.4	0.4		1.0	0.5	3.7	1.4	2.9	1.5				
31.0	25.7	24.0	4.1	14.0	1.7	13.9	0.5	0.7		0.3		1.2	1.0		0.5			0.6	0.2
31.5	10.0	16.2	2.5	9.9	1.7	8.1	0.3					1.2		0.3	0.2			0.6	0.2
32.0	7.1	11.4	0.8	7.0	0.6	5.4	0.3							0.3	0.1			0.3	0.1
32.5	2.2	6.1		3.3		2.3													
33.0	1.5	2.4		1.5	0.3	1.1													
33.5		0.8		0.4		0.2													
34.0	0.4	0.8		0.7	0.3	0.4												0.3	0.1
34.5																			
35.0																			
35.5																			
36.0																			
36.5		0.4				0.1													
Number	538	1109	122	2470	346		1784	5561	2125	3386	382	81	207	750		4374	394	355	
mean lgt	31.2	31.5	29.7	30.6	27.7	30.2	27.8	27.1	27.5	27.3	27.5	28.3	28.4	28.2	27.8	21.5	25.5	26.4	24.5
mean wt	286	298	242	270	194	258	193	177	184	182	184	205	208	202	192	80	143	160	128
TS/ind	-41.3	-41.2	-41.7	-41.5	-42.3	-41.6	-42.3	-42.5	-42.4	-42.5	-42.4	-42.2	-42.1	-42.2	-42.3	-44.5	-43.1	-42.8	-43.4
TS/kg	-35.9	-36.0	-35.6	-35.8	-35.2	-35.7	-35.2	-35.0	-35.1	-35.1	-35.1	-35.3	-35.3	-35.2	-35.2	-33.6	-34.6	-34.8	-34.4

TABLE 8. Herring numbers and biomass by age, maturity and area. *Azalea* 16-31 July

Category	Number x 10^{-6}	Mean Length (cm)	Mean weight (g)	Biomass (tonnes x10^{-3})
Area I				
1 ring	0.41	21.50	83.89	0.03
2 ring immature	29.44	25.04	143.03	4.21
2 ring mature	45.36	26.04	162.73	7.38
3 ring	36.94	28.34	218.64	8.08
4	76.48	28.94	234.47	17.93
5	195.32	29.82	260.02	50.79
6	149.31	30.39	277.72	41.47
7	74.24	30.91	293.81	21.81
8	46.61	31.25	306.15	14.27
9+	54.48	31.39	309.70	16.90
Total	708.68	29.65	258.05	182.87
Area II				
1 ring	1.27	21.79	88.18	0.11
2 ring immature	179.16	25.67	155.10	27.79
2 ring mature	103.40	26.27	168.15	17.39
3 ring	185.14	26.80	179.76	33.28
4	189.55	27.44	195.09	36.98
5	244.68	28.05	210.07	51.40
6	111.15	28.32	217.74	24.20
7	47.03	29.00	235.74	11.09
8	13.54	29.88	261.57	3.54
9+	6.56	29.92	261.88	1.72
Total	1081.46	27.26	191.86	207.49
Area III				
1 ring	76.40	20.17	67.87	5.19
2 ring immature	84.80	24.66	135.61	11.50
2 ring mature	103.66	25.05	142.47	14.77
3 ring	14.00	26.49	173.21	2.43
4	11.23	27.17	188.22	2.11
5	6.90	28.70	228.30	1.58
6	1.52	28.63	227.36	0.35
7	0.27	30.00	264.06	0.07
8	0.00			0.00
9+	0.56	33.00	368.49	0.21
Total	299.36	23.96	127.59	38.19
Total Area				
1 ring	78.08	20.20	68.29	5.33
2 ring immature	293.41	25.32	148.26	43.50
2 ring mature	252.42	25.73	156.63	39.54
3 ring	236.09	27.03	185.46	43.78
4	277.26	27.84	205.68	57.03
5	446.89	28.83	323.18	103.76
6	261.97	29.50	251.98	66.01
7	121.53	30.17	271.28	32.97
8	60.15	30.94	296.12	17.81
9+	61.69	31.25	305.13	18.83
Total	2089.50	27.60	205.10	428.56

TABLE 9. Numbers of fish by species and trawl haul caught by *Scotia*, 13-31 July

Haul No	Position		Depth (m)	Numbers caught by species									Comments
	Latitude	Longitude		Herring	Sprat	Whiting	Haddock	Norway pout	Mackerel	Horse mackerel	Gurnards	Others	
239	58°39.88'N	02°04.21'W	80	741	337	8	1	3					Net damaged
240	58°36.12'N	00°33.21'E	138	16		81	8	3048				2	Net damaged
241	58°51.53'N	00°36.83'W	135	846		12	4						
242	58°51.06'N	01°28.72'W	110	890		18	6						
243	59°06.50'N	00°41.50'W	130	6239		52							
244	59°06.65'N	00°54.58'E	118			34	22	43					
245	59°21.10'N	00°45.64'W	125			18	3	3645					
246	59°34.07'N	00°22.41'W	125	4515									
247	59°40.49'N	01°45.43'E	124										0-group haddock, whiting and blue whiting meshed
248	59°51.00'N	01°05.71'W	40										0-group haddock meshed
249	60°07.00'N	00°42.00'E	139						2				0-group whiting and haddock meshed
250	60°21.74'N	00°33.55'W	150	1		3	20						
251	60°24.11'N	00°41.65'W	90			261	24		575			1	
253	60°49.81'N	00°21.50'W	125	6300									
254	60°51.89'N	00°43.27'W	149	2		7	1		2	57	4		
255	61°06.4'N	00°41.36'W	141	96		1	2	3	20		1	2	
256	61°37.16'N	01°29.50'E	170					2		6		2	Maurolicus meshed
257	61°51.72'N	01°38.87'W	135	253		6		548	171		1	2	
258	60°51.20'N	02°19.54'W	150	603			3		71	12		2	
259	60°21.25'N	02°03.84'W	115	336		16	1	9	5				
260	60°05.50'N	01°59.52'W	60										Few small mackerel meshed
261	59°51.06'N	02°09.96'W	90	1		7			157		8		
262	59°20.95'N	03°37.78'W	150	30	3	3	2	4	7		1	11	Others were dogfish

TABLE 10. Herring length frequency by trawl haul by sub area. *Scotia* 13-31 July (mean length - cm, mean weight - g, target strength - dB)

Length	239	242	mean	241	243	246	259	262	mean	253	255	257	258	mean
16.5	0.4		0.2											
17.0	2.4		1.2											
17.5	4.5	0.4	2.5											
18.0	5.3	1.6	3.4											
18.5	17.8	4.7	11.3				0.6		0.1					
19.0	19.4	9.1	14.3				0.6		0.1					
19.5	16.6	12.7	14.6		0.2		0.6		0.2					
20.0	15.4	21.9	18.6											
20.5	8.1	20.2	14.2				0.3		0.1					
21.0	5.3	14.3	9.8	0.2					0.0					
21.5	4.5	8.3	6.4		0.2				0.0					
22.0	0.4	3.1	1.8	1.9	0.2		0.9		0.6					
22.5	741	1.6	0.8	3.1	1.9		5.4		2.1					
23.0		0.8	0.4	4.0	0.6		13.4	6.7	4.9					
23.5		0.4	0.2	8.3	2.4	0.3	13.4		4.9					
24.0		0.8	0.4	5.4	3.2	0.3	16.1	3.3	5.7					
24.5				8.3	3.4	0.7	9.2		4.3					
25.0				6.6	2.6	2.3	7.7		3.8					
25.5				7.1	2.4	1.7	8.0	3.3	4.5	0.8				0.2
26.0				4.3	1.3	2.3	6.5	3.3	3.5		1.0			0.3
26.5				5.4	1.1	3.0	3.0	3.3	3.2	0.8	1.0	0.4		0.6
27.0				4.0	1.3	3.0	3.6	3.3	3.0	0.4	1.0	0.8		0.6
27.5				5.9	2.8	5.6	0.3		2.9	0.4		2.0		0.6
28.0				7.3	3.6	9.0	1.2	3.3	4.9	1.6	3.1	2.0	0.3	1.8
28.5				7.6	9.2	13.3	1.2	3.3	6.9	4.8	3.1	5.5	2.5	4.0
29.0				9.7	18.2	13.0	0.9	3.3	9.0	12.3	7.3	10.7	3.0	8.3
29.5				5.9	17.3	16.6	2.4	16.7	11.8	12.3	12.5	13.0	10.4	12.1
30.0				2.8	15.2	9.6	2.1	6.7	7.3	17.1	17.7	15.0	9.1	14.7
30.5				1.4	7.5	9.0	1.5	10.0	5.9	14.7	15.6	13.8	9.1	13.3
31.0				0.2	3.4	6.3	0.3	3.3	2.7	14.7	8.3	13.4	14.6	12.8
31.5					1.5	1.0	0.3	16.7	3.9	9.1	11.5	10.3	13.3	11.0
32.0				0.5	0.4	1.7		3.3	1.2	5.2	10.4	5.5	12.4	8.4
32.5						1.3	0.6	3.3	1.1	2.0	4.2	3.6	9.1	4.7
33.0					0.2				0.0	1.6	2.1	3.2	7.0	3.4
33.5								3.3	0.7	0.8	1.0	0.8	5.3	2.0
34.0								3.3	0.7	0.8			3.0	0.9
34.5														
35.0										0.8			0.8	0.4
Number		890		846	6239	4515	336	30		6300	96	253	603	
Mean length	19.8	20.8	20.3	26.8	28.9	29.4	25.3	29.8	28.1	30.8	30.9	30.8	31.8	31.1
Mean weight	61	72	66	174	222	233	142	250	204	271	274	271	302	280
TS/individual	-45.2	-44.8	-45.0	-42.6	-41.9	-41.8	-43.1	-41.7	-42.2	-41.4	-41.4	-41.4	-41.1	-41.3
TS/kg	-33.1	-33.4	-33.3	-35.0	-35.4	-35.5	-34.6	-35.6	-35.3	-35.8	-35.8	-35.8	-35.9	-35.8

TABLE 11. Numbers (millions) mean length (cm) mean weight (g) biomass (thousands of tonnes) by sub area *Scotia*, 13-31 July

Age/Maturity	Numbers (millions)	Length (cm)	Weight (g)	Biomass (thousand tonnes)
Area I				
1 ring	484.27	19.76	65.82	31.87
2 immature	2.25	22.71	103.26	0.23
2 mature	3.03	23.82	120.86	0.37
3 immature	0.00			0.00
3 mature	0.00			0.00
4 ring	0.00			0.00
5 ring	0.00			0.00
6 ring	0.00			0.00
7 ring	0.00			0.00
8 ring	0.00			0.00
9+ ring	0.00			0.00
Total	489.55	19.80	66.33	32.47
Area II				
1 ring	21.38	21.42	87.55	1.87
2 immature	315.30	23.68	119.21	37.59
2 mature	452.86	25.58	155.29	70.32
3 immature	0.00			0.00
3 mature	267.54	28.53	222.60	59.55
4 ring	257.48	29.10	236.02	60.77
5 ring	315.10	29.64	251.00	79.09
6 ring	202.15	30.35	272.09	55.00
7 ring	54.83	31.57	311.42	17.08
8 ring	21.84	33.11	363.55	7.94
9+ ring	5.73	31.50	306.39	1.76
Total	1,914.22	27.55	204.25	390.97
Area III				
1 ring	0.00			0.00
2 immature	0.00			0.00
2 mature	22.18	27.39	193.37	4.29
3 immature	0.00			0.00
3 mature	100.89	29.23	241.15	24.33
4 ring	227.38	29.70	252.85	57.49
5 ring	462.05	30.32	271.22	125.32
6 ring	416.99	30.96	290.64	121.19
7 ring	135.00	31.74	315.63	42.61
8 ring	64.84	32.19	331.36	21.49
9+ ring	53.13	32.22	332.50	17.66
Total	1,482.46	30.57	279.52	414.38
Total area				
1 ring	505.65	19.83	66.73	33.74
2 immature	317.55	23.67	119.09	37.82
2 mature	478.07	25.65	156.84	74.98
3 immature	0.00			0.00
3 mature	368.43	28.72	227.68	83.88
4 ring	484.86	29.38	243.91	118.26
5 ring	777.16	30.05	263.02	204.41
6 ring	619.14	30.76	284.59	176.20
7 ring	189.83	31.69	314.41	59.69
8 ring	86.69	32.42	339.47	29.43
9+ ring	58.86	32.15	329.96	19.42
Total	3,886.22	27.73	215.59	837.83

TABLE 12. Numbers and biomass of herring from combined surveys

	Numbers (millions)					Biomass (thousands of tonnes)				
	Autumn spawners				Baltic spring spawners	Autumn spawners				Baltic spring spawners
Areas	VIa	IVa	IVb	IVa+b	IVa+b	VIa	IVa	IVb	IVa+b	IVa+b
1 ring	74.31	1825.99	437.55	2263.54		5.04	148.25	28.03	176.29	
2 ring Immature	268.25	1101.36	143.30	1244.66		39.68	131.72	14.91	146.63	
2 ring Mature	235.18	1651.69	233.71	1885.40		36.76	266.98	31.85	298.83	
3 ring	210.98	1115.65	305.08	1420.73	284.00	39.14	235.00	61.34	296.34	53.81
4 ring	258.09	976.75	161.98	1138.73	368.00	53.19	217.28	32.09	249.37	68.67
5 ring	414.75	1008.44	87.03	1095.47	251.00	96.65	248.72	17.25	265.97	52.20
6 ring	240.11	1015.12	55.96	1071.09	222.00	60.79	260.74	12.10	272.84	48.30
7 ring	105.67	322.54	45.35	367.89	67.00	28.82	90.86	9.36	100.23	14.60
8 ring	56.71	97.72	0.07	97.79	14.00	16.93	30.50	0.02	30.52	3.47
9+ ring	63.44	87.98	12.11	100.08	23.00	19.19	28.40	2.74	31.14	5.55
Immature	342.56	2927.35	580.84	3508.20		44.72	279.98	42.94	322.92	
Mature	1584.92	6275.88	901.30	7177.17		351.46	1378.49	166.74	1545.23	
Total	1927.48	9203.23	1482.14	10685.37	1229.00	396.18	1658.46	209.69	1868.15	246.60

TABLE 13. Summary By ICES Area for infected herring from the acoustic survey June July 1992 showing numbers infected, numbers uninfected and the percentage infection

Area	Method of averaging samples		
	Boxes weighted by total numbers	Unweighed samples linear interpolation	Weighted samples linear interpolation
Numbers infected			
IVa	532.80	521.57	524.16
IVb	3.94	5.23	2.53
VIa	0.00	1.05	1.85
Total	536.73	527.85	528.53
Numbers uninfected			
IVa	10069.26	10080.49	10077.90
IVb	1308.37	1307.08	1309.78
VIa	1927.49	1926.43	1925.64
Total	13305.12	13314.00	13313.32
Total population	13841.85	13841.85	13841.85
Percentage infection			
IVa	5.29	5.17	5.20
IVb	0.30	0.40	0.19
VIa	0.00	0.05	0.10
Total	4.03	3.96	3.97

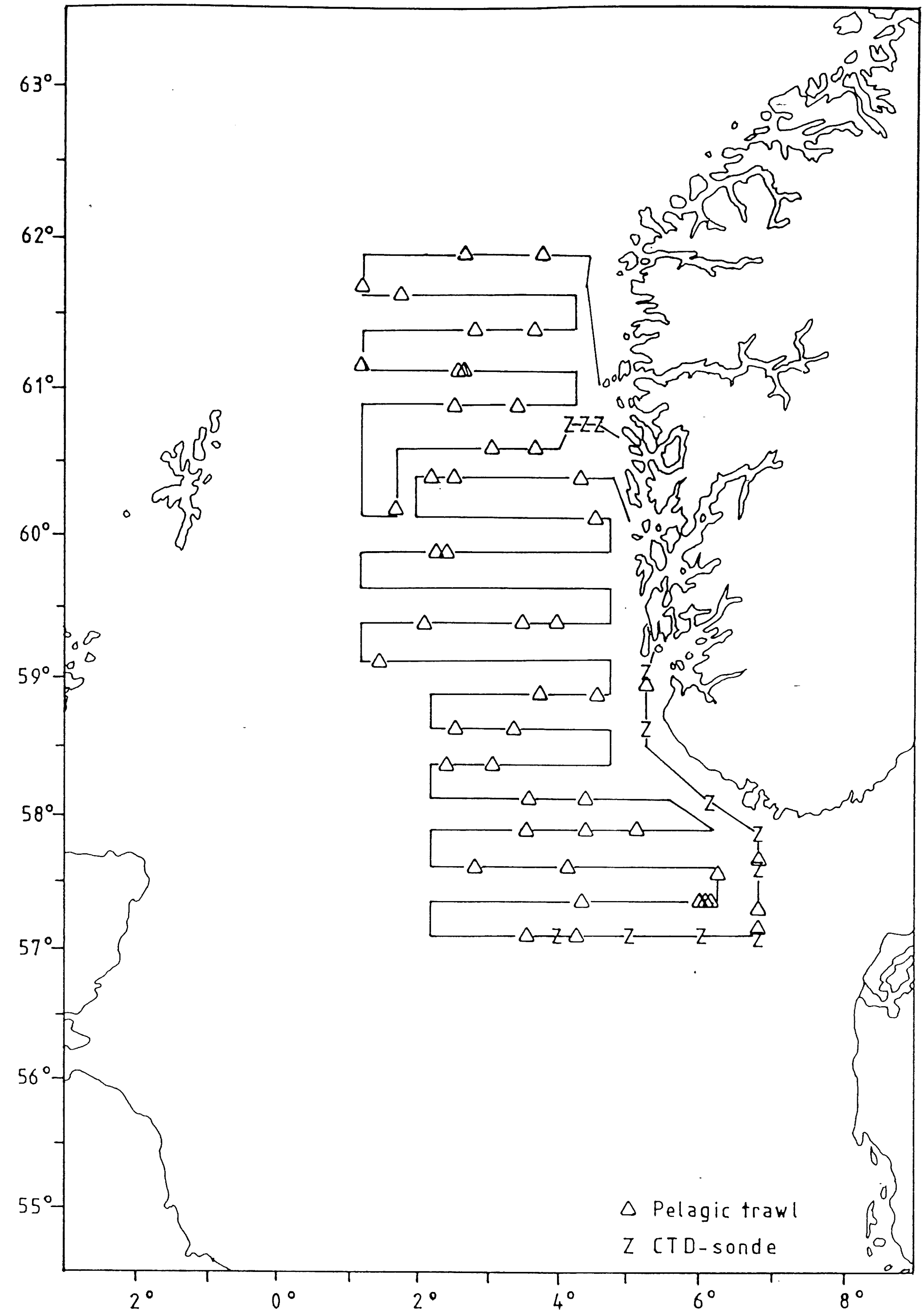

FIGURE 1
Survey grid and trawl stations, R/V"Johan Hjort", 24 June-11 July 1992.

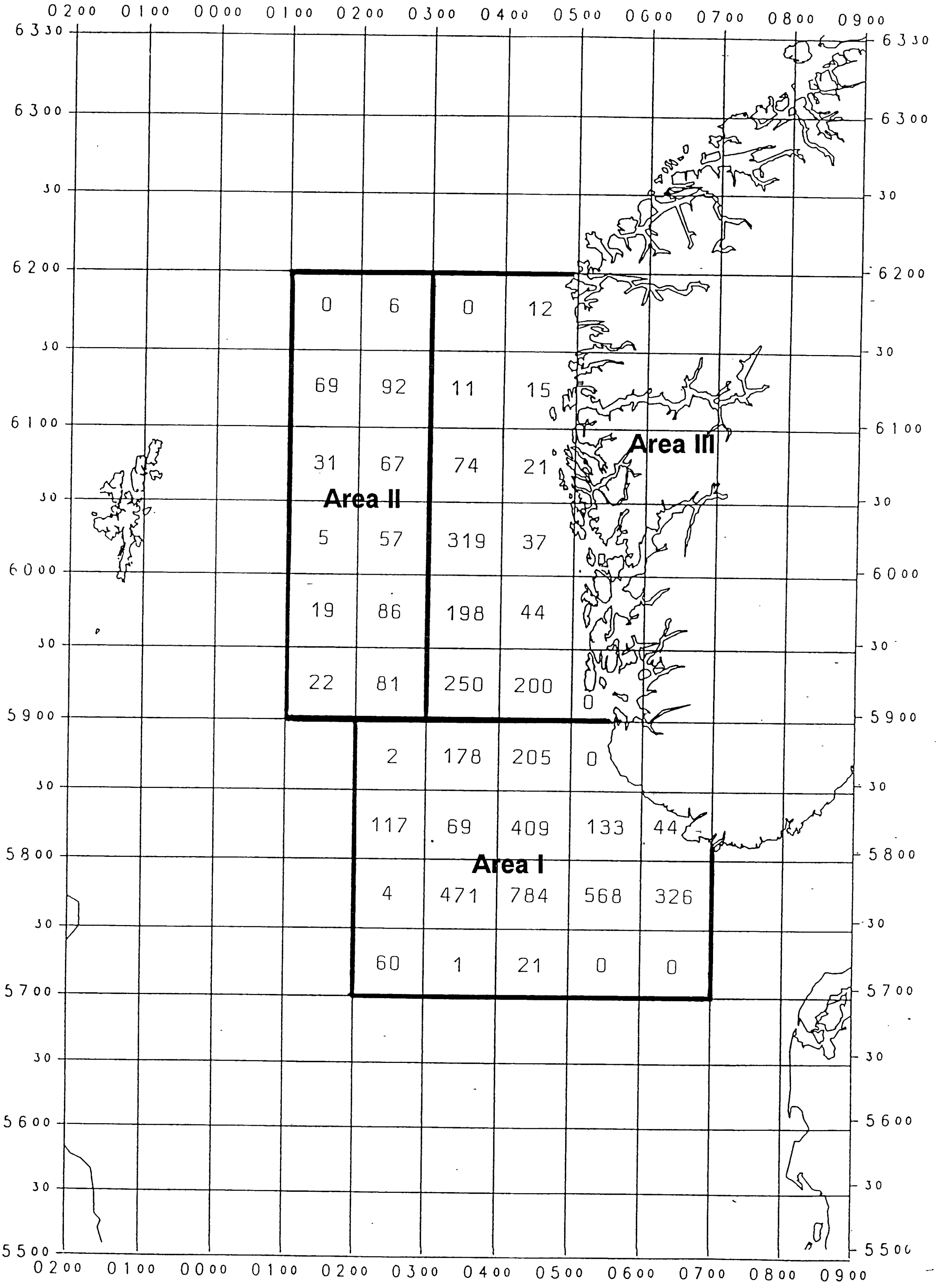

FIGURE 2 R/V "Johan Hjort" 24 June - 11 July 1992.

Number of herring with one ring or more. Unit 10^{-6}.

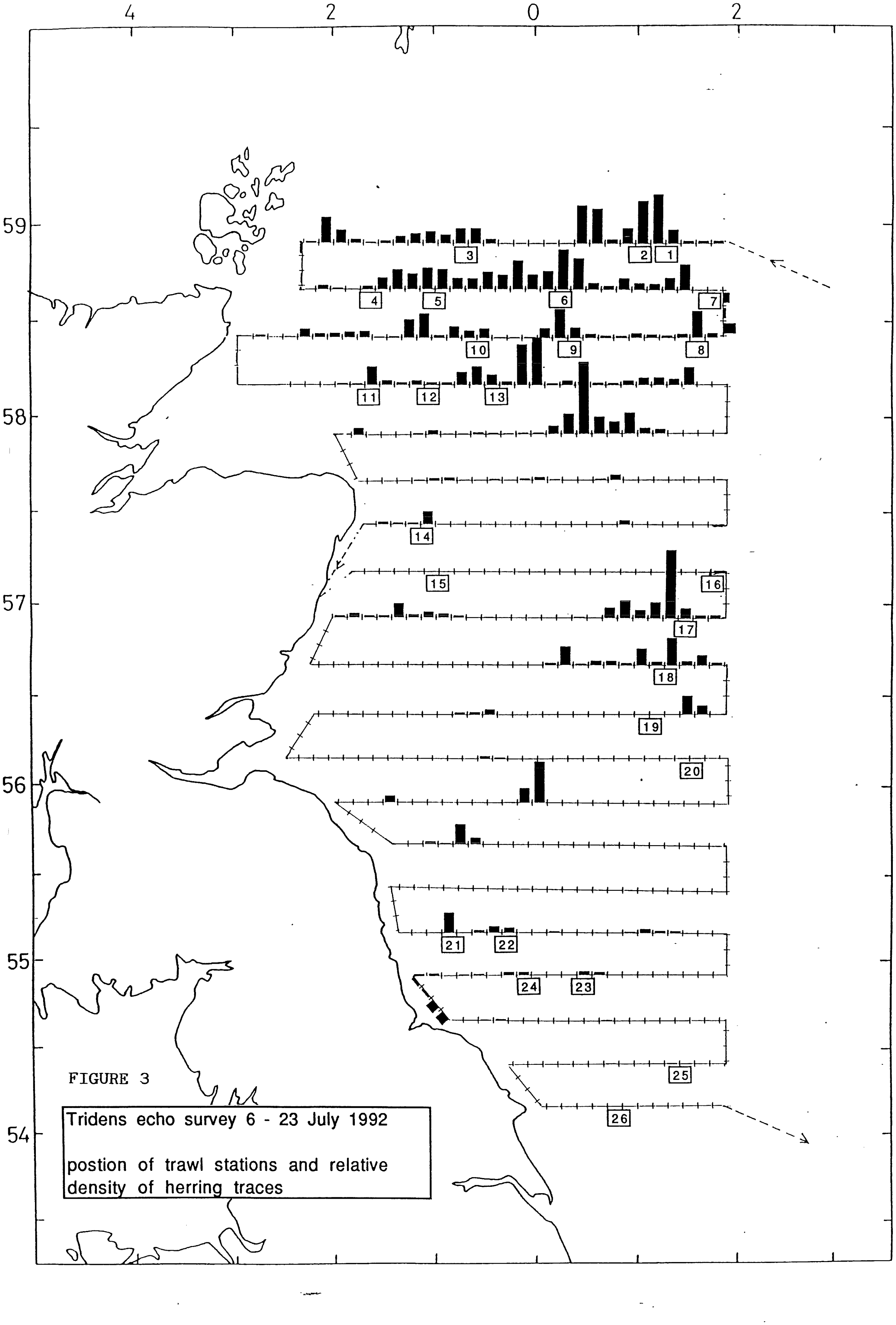

FIGURE 3

Tridens echo survey 6 - 23 July 1992

postion of trawl stations and relative density of herring traces

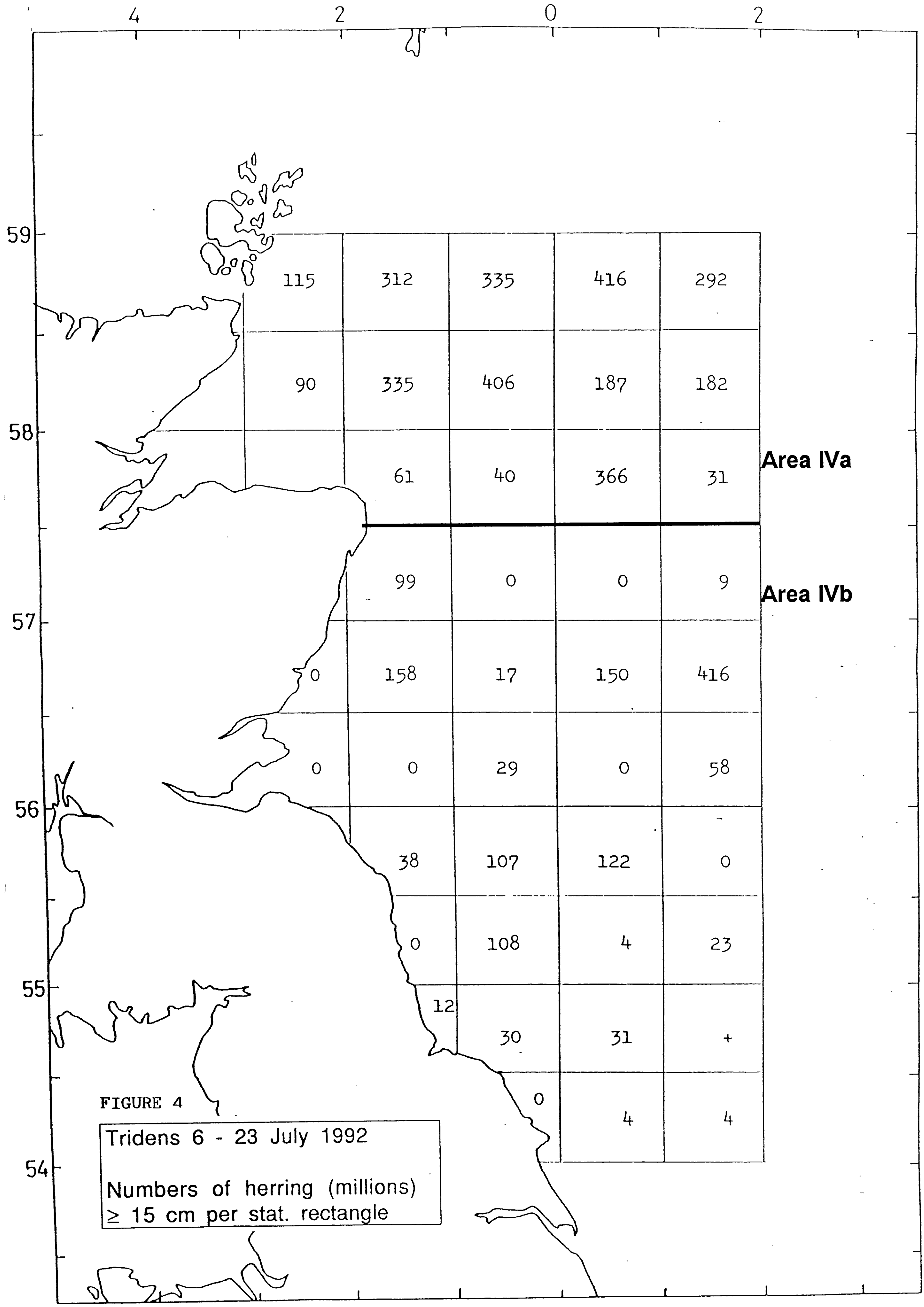

FIGURE 4

Tridens 6 - 23 July 1992

Numbers of herring (millions) ≥ 15 cm per stat. rectangle

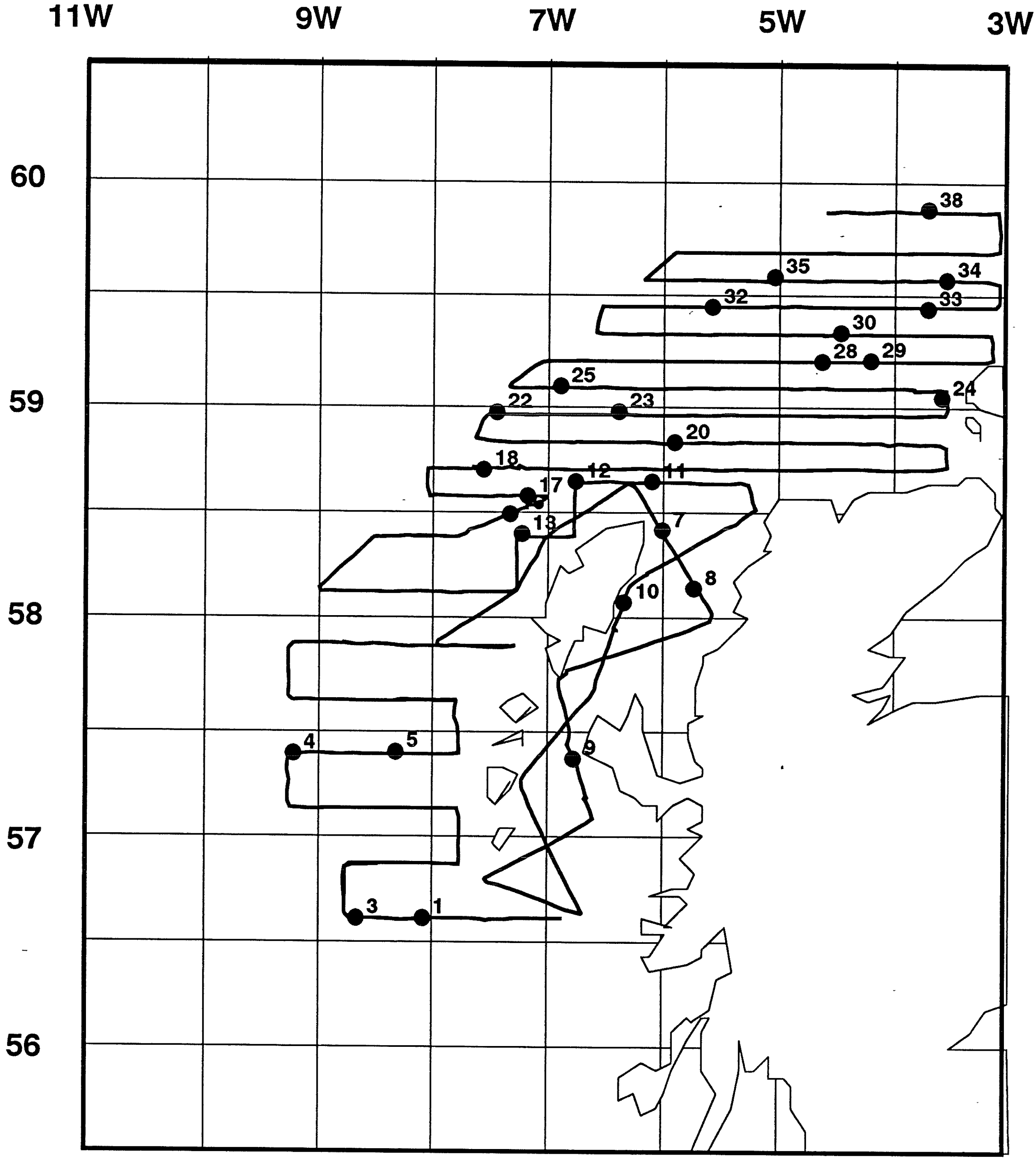

FIGURE 5. Survey track and trawl stations "Azalea" 16-31 July

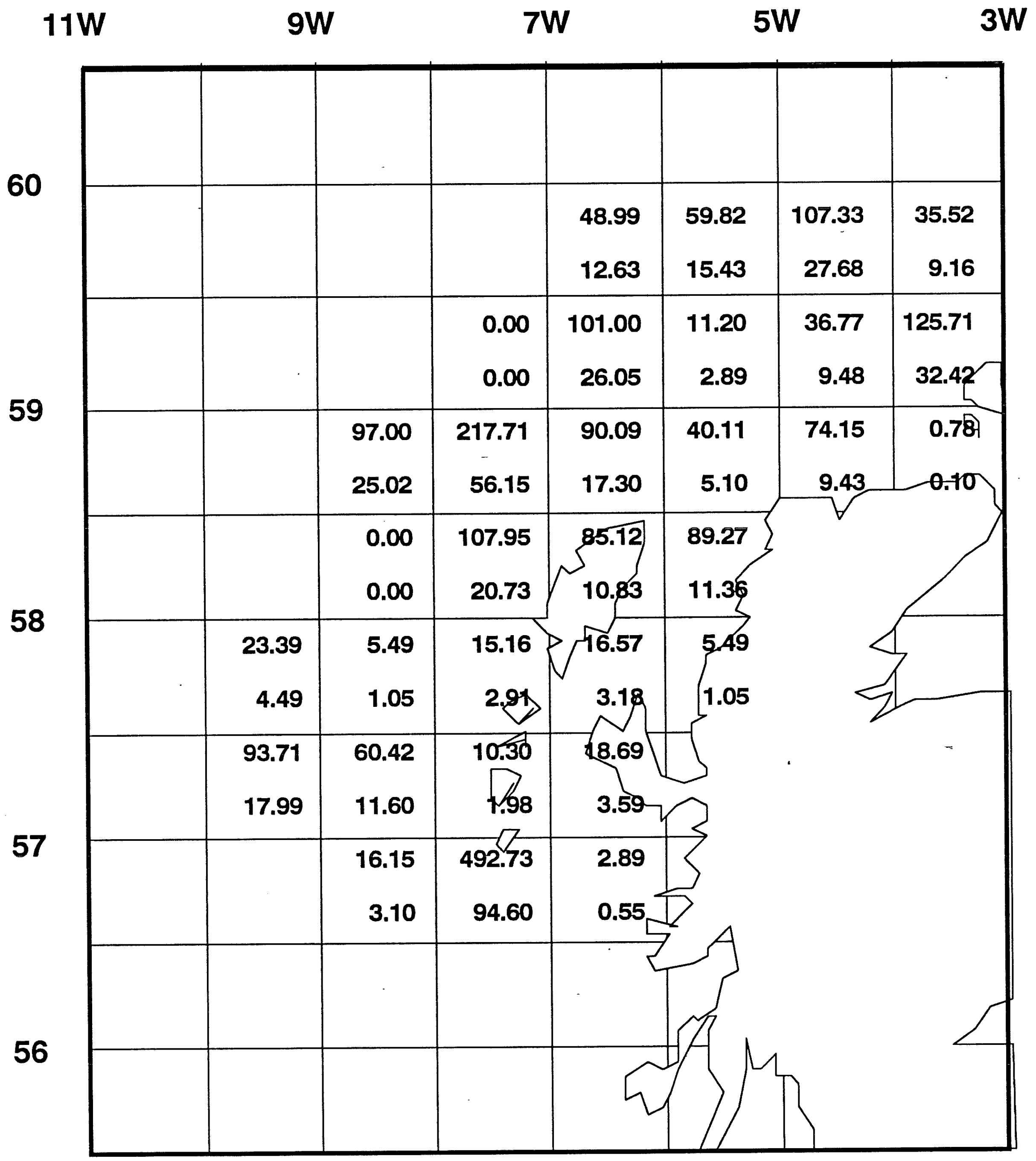

FIGURE 6. Herring abundance numbers (millions) top and bioss (thousands of tonnes) bottom. "Azalea" 16-31 July

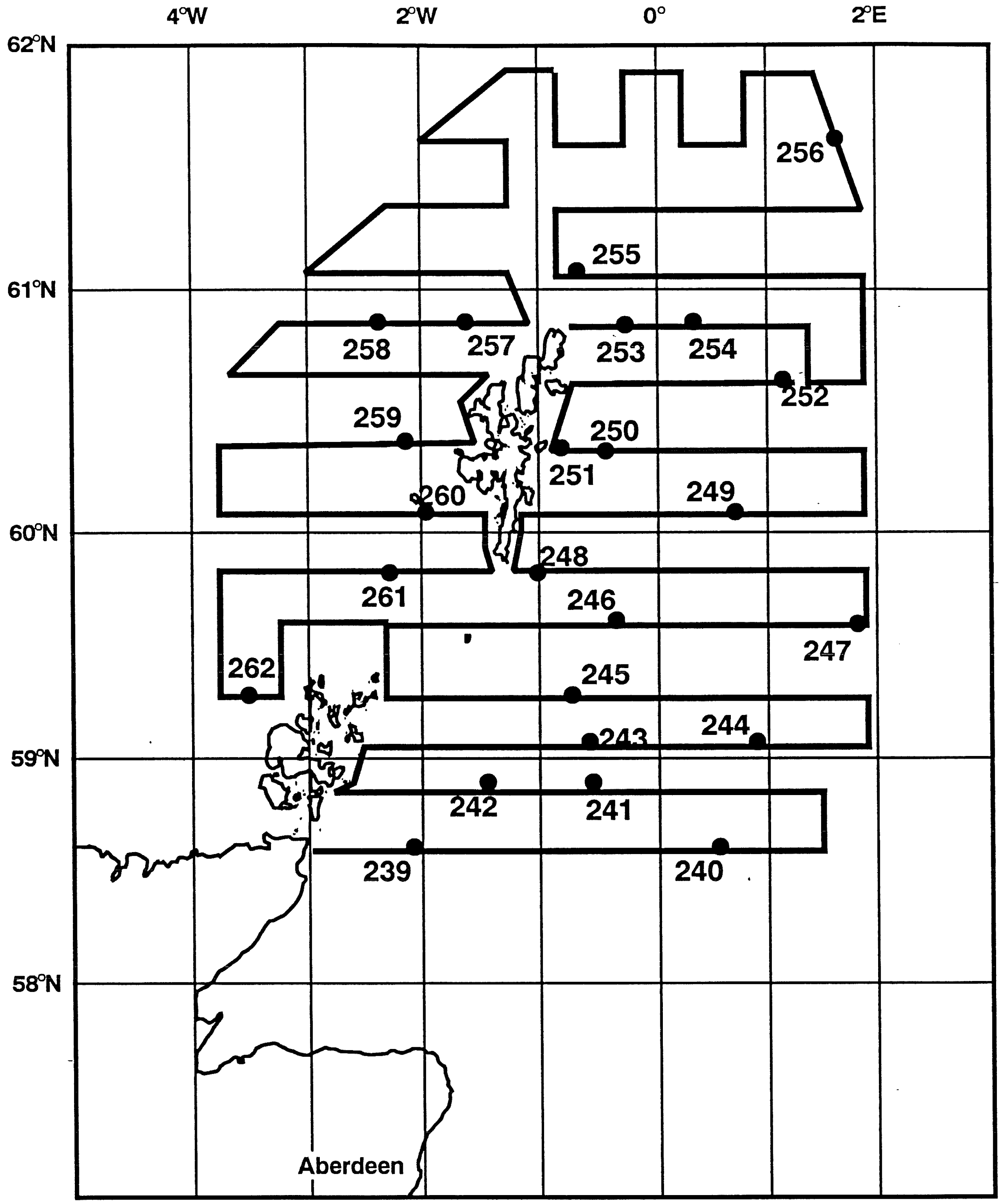

FIGURE 7. Survey track and trawl stations "Scotia" 13-31 July

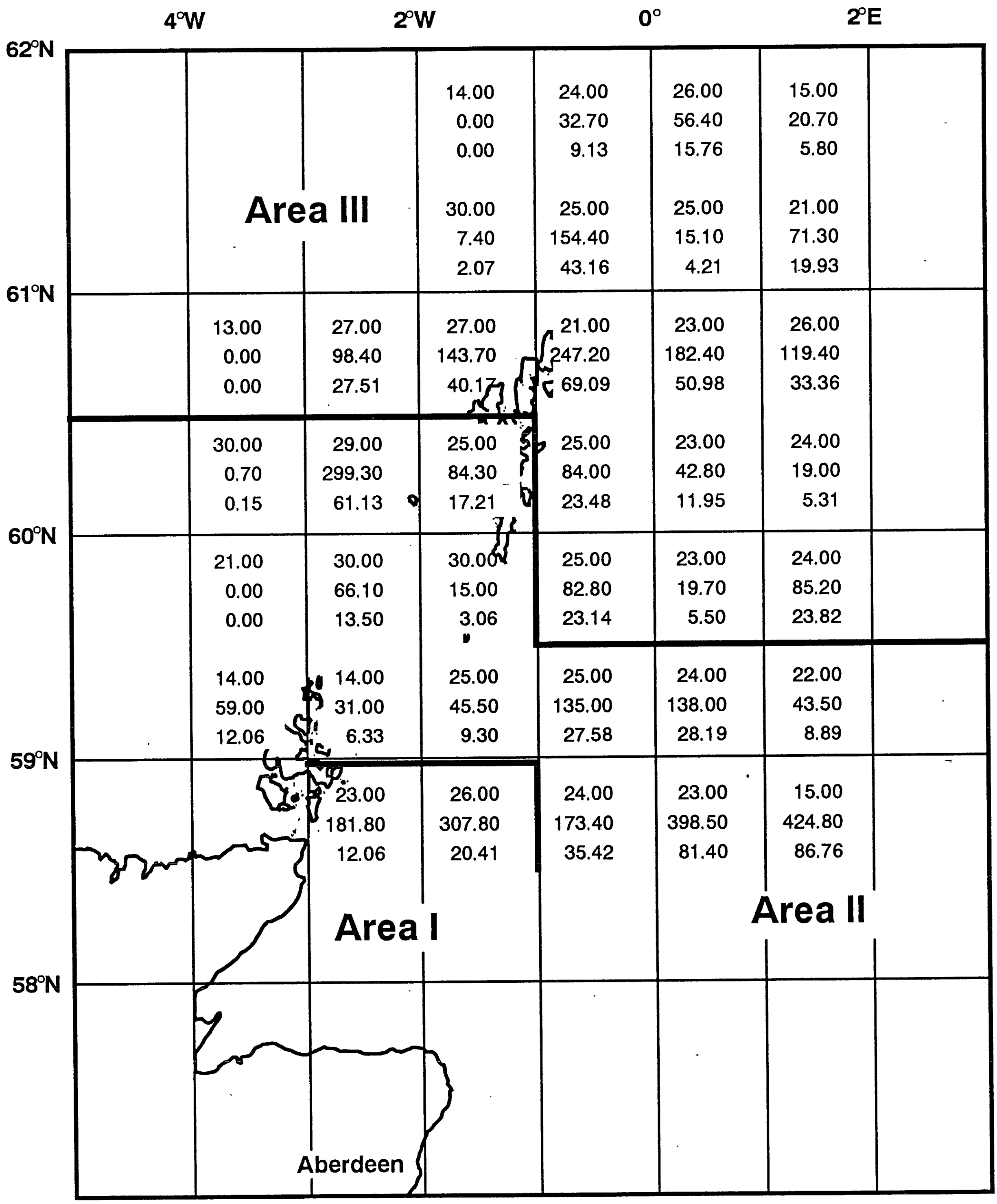

FIGURE 8. Number of integrator runs, top and herring abundance, numbers (millions) middle and biomass (thousands of tonnes) bottom. "Scotia" 13-31 July

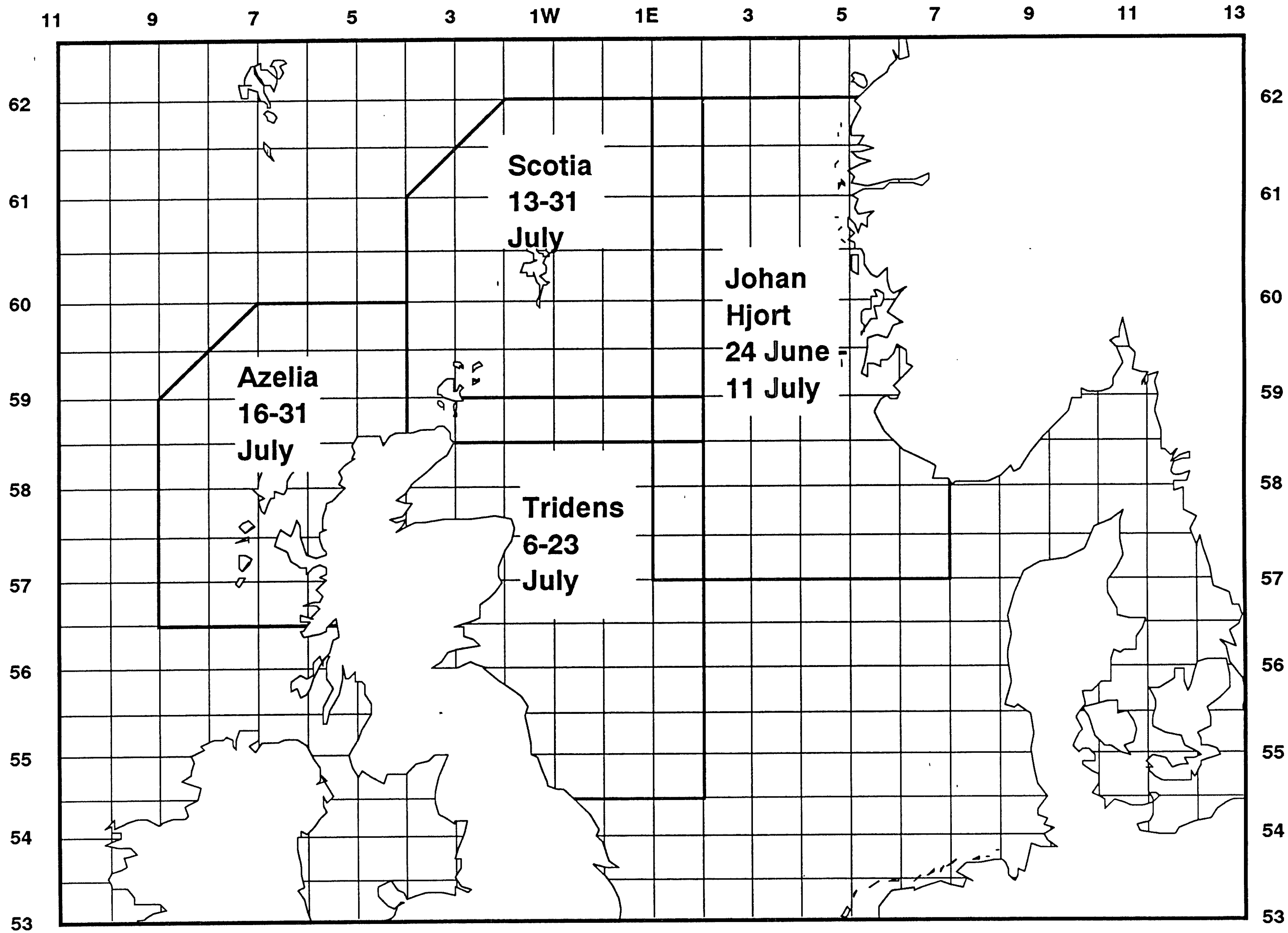

FIGURE 9. Survey areas and dates for survey vessels

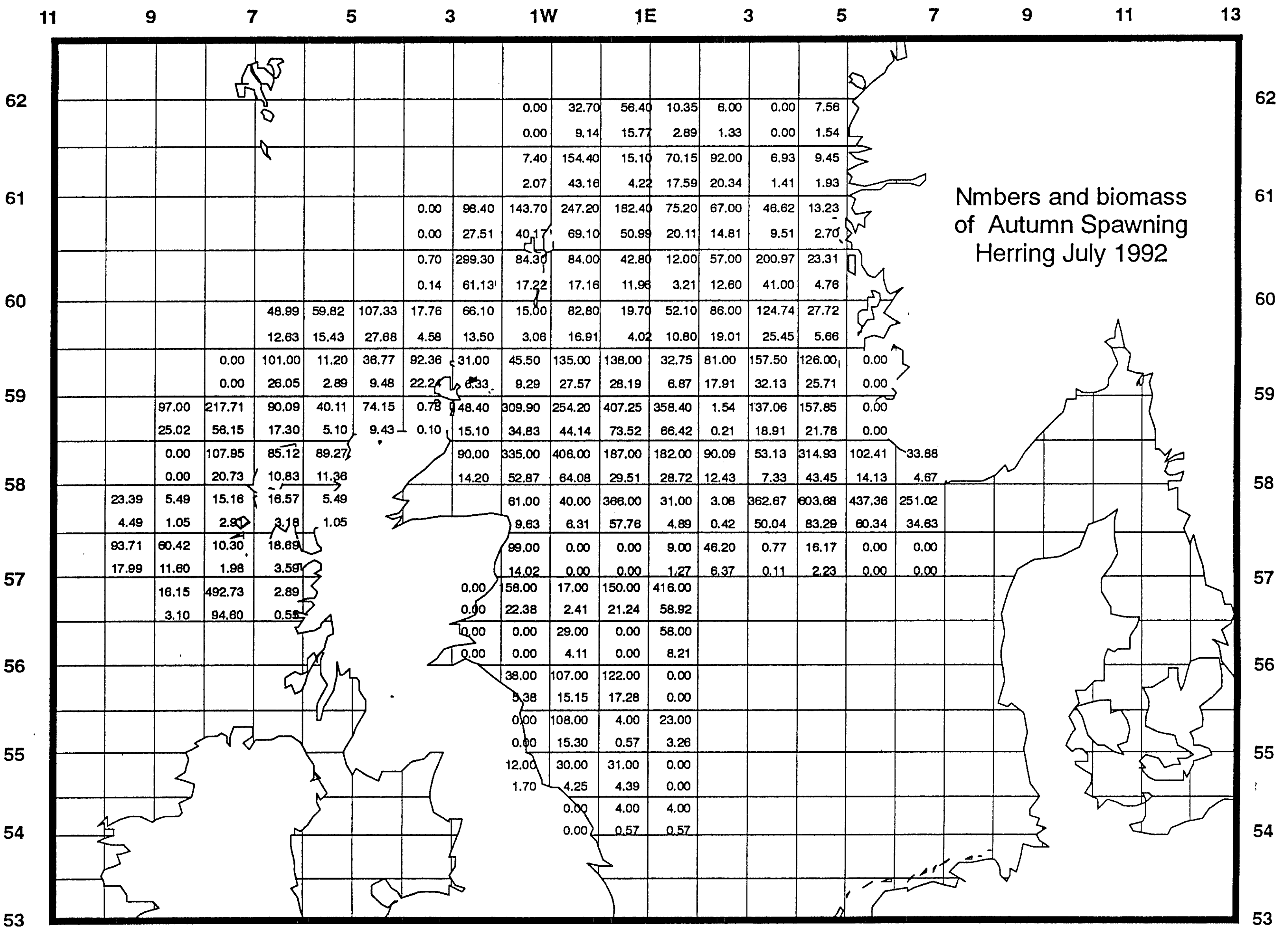

FIGURE 10. Number (top) and biomass (bottom) of autumn spawning herring from the combined survey.

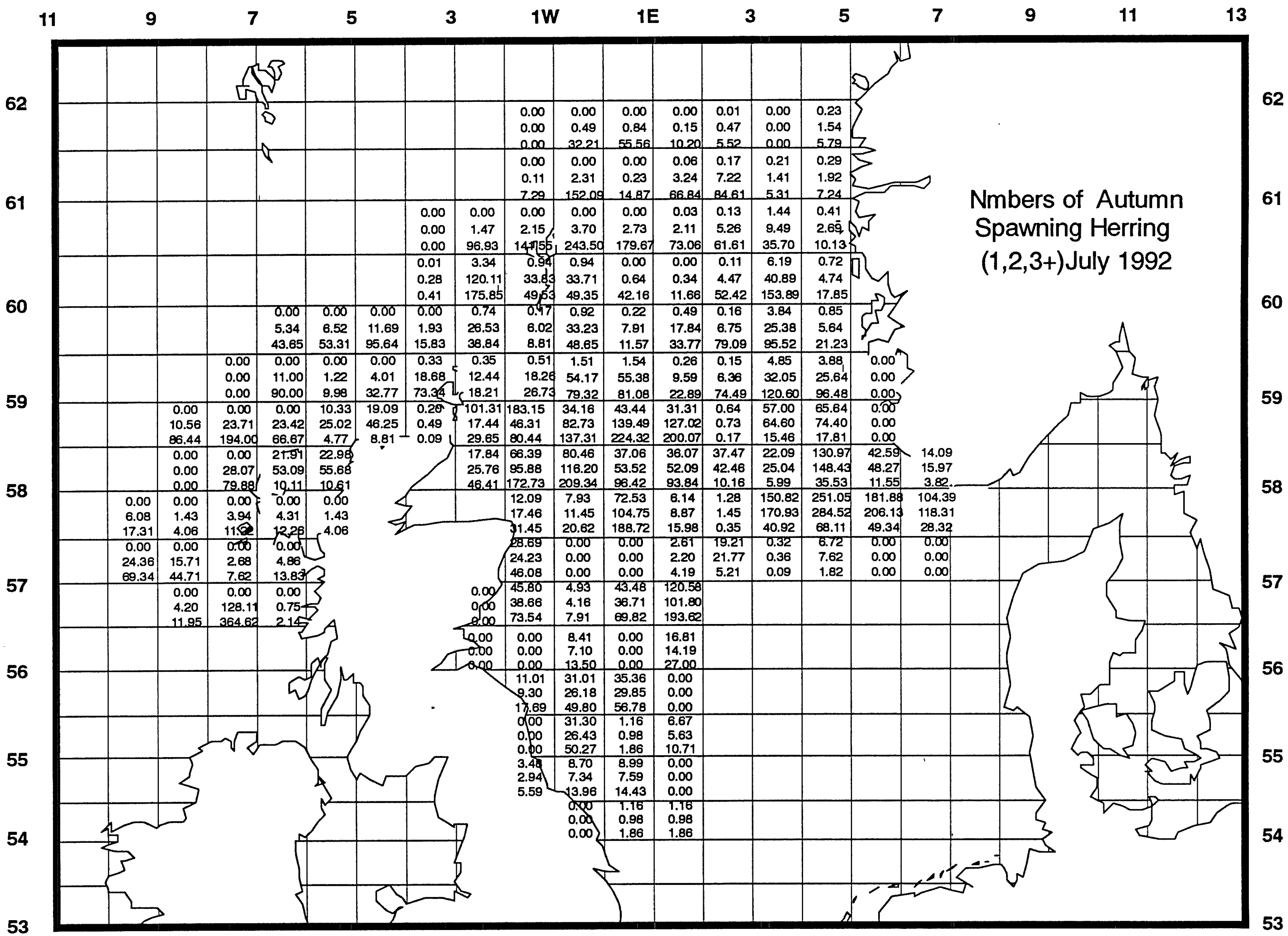

FIGURE 11. Numbers of autumn spawning herring by age 1 ring (top) 2 ring (middle) 3+ ring (bottom) from the combined survey

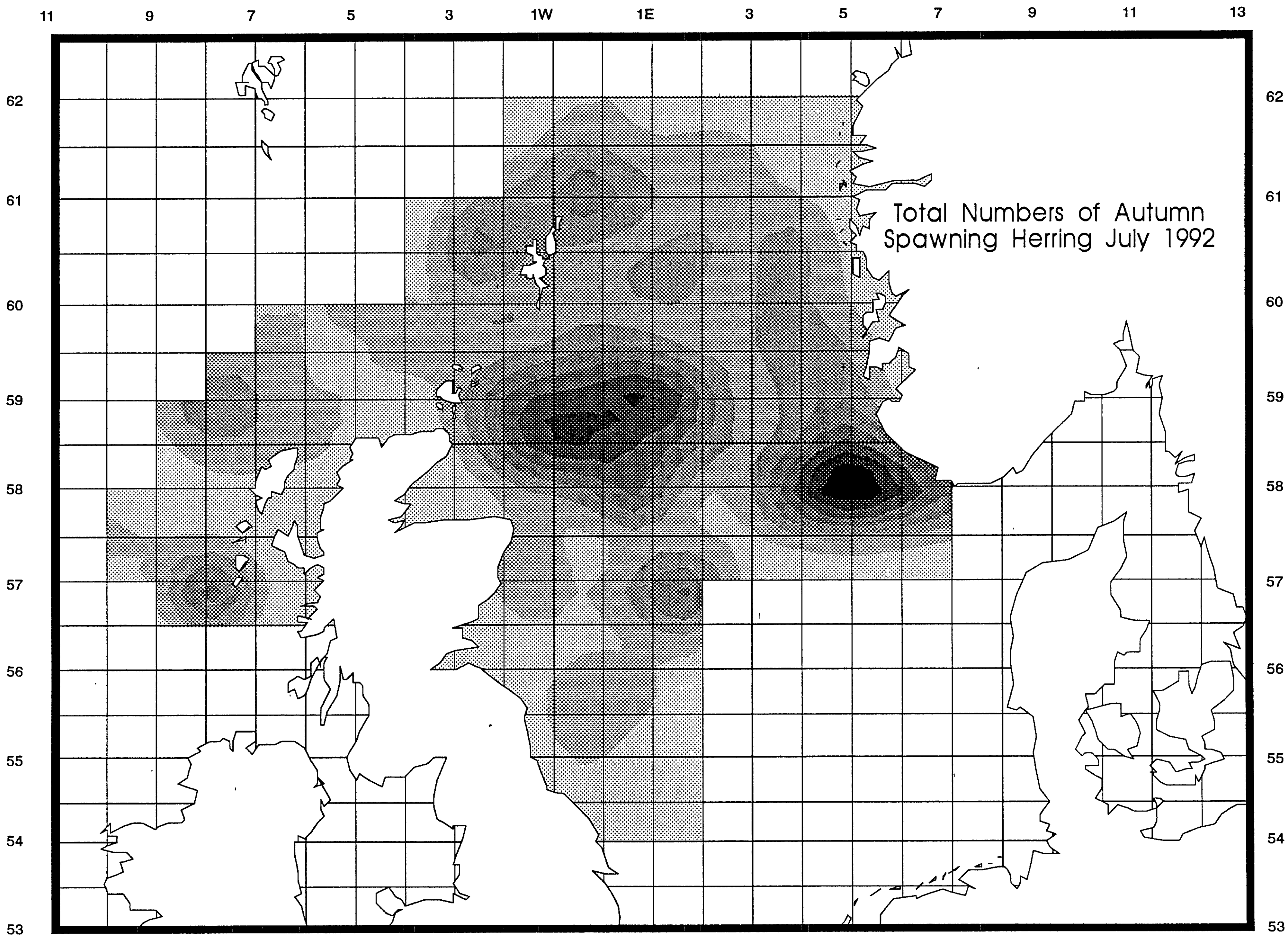

FIGURE 12. Density of autumn spawning herring by number

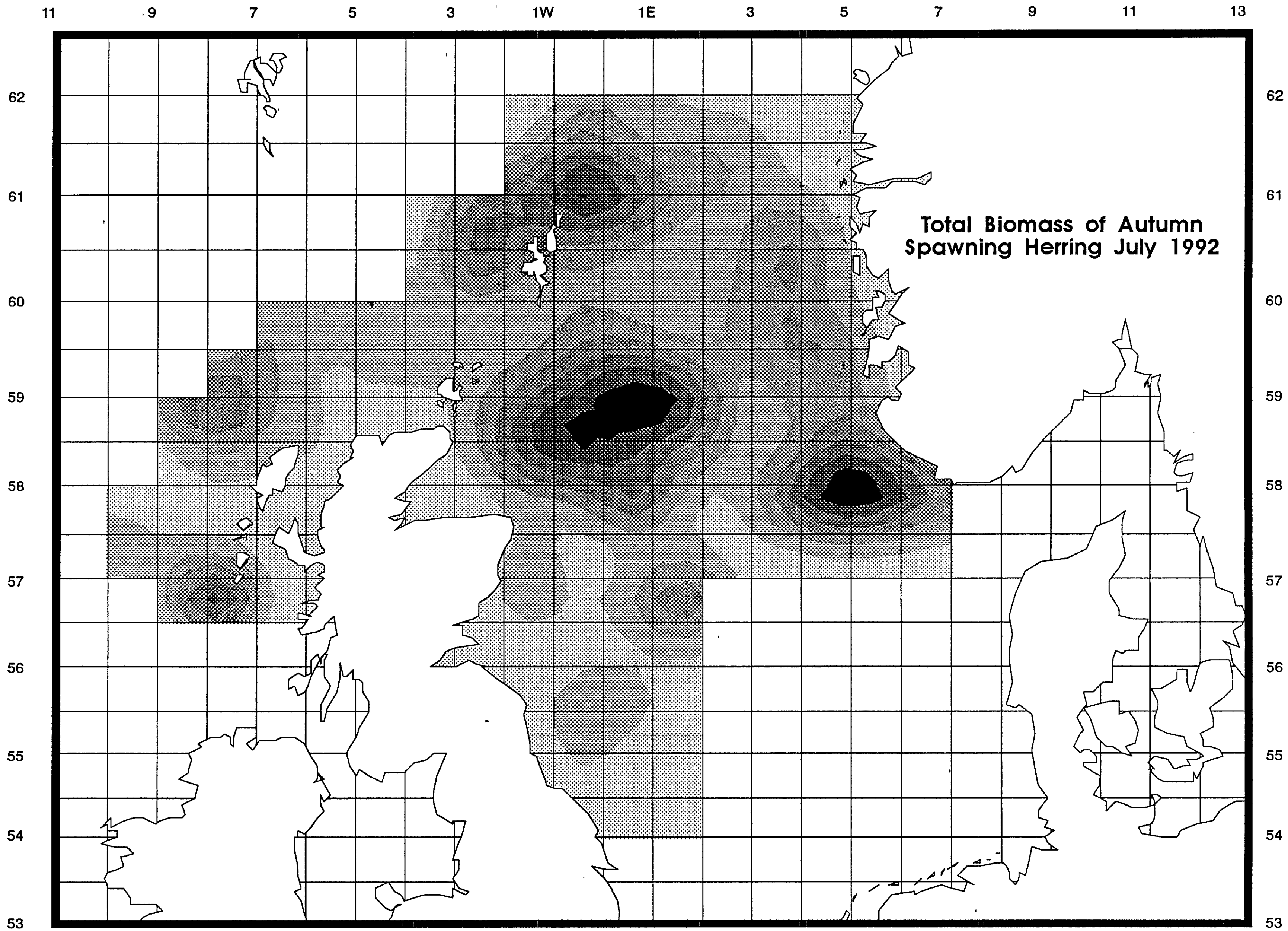

FIGURE 13. Density of autumn spawning herring by weight

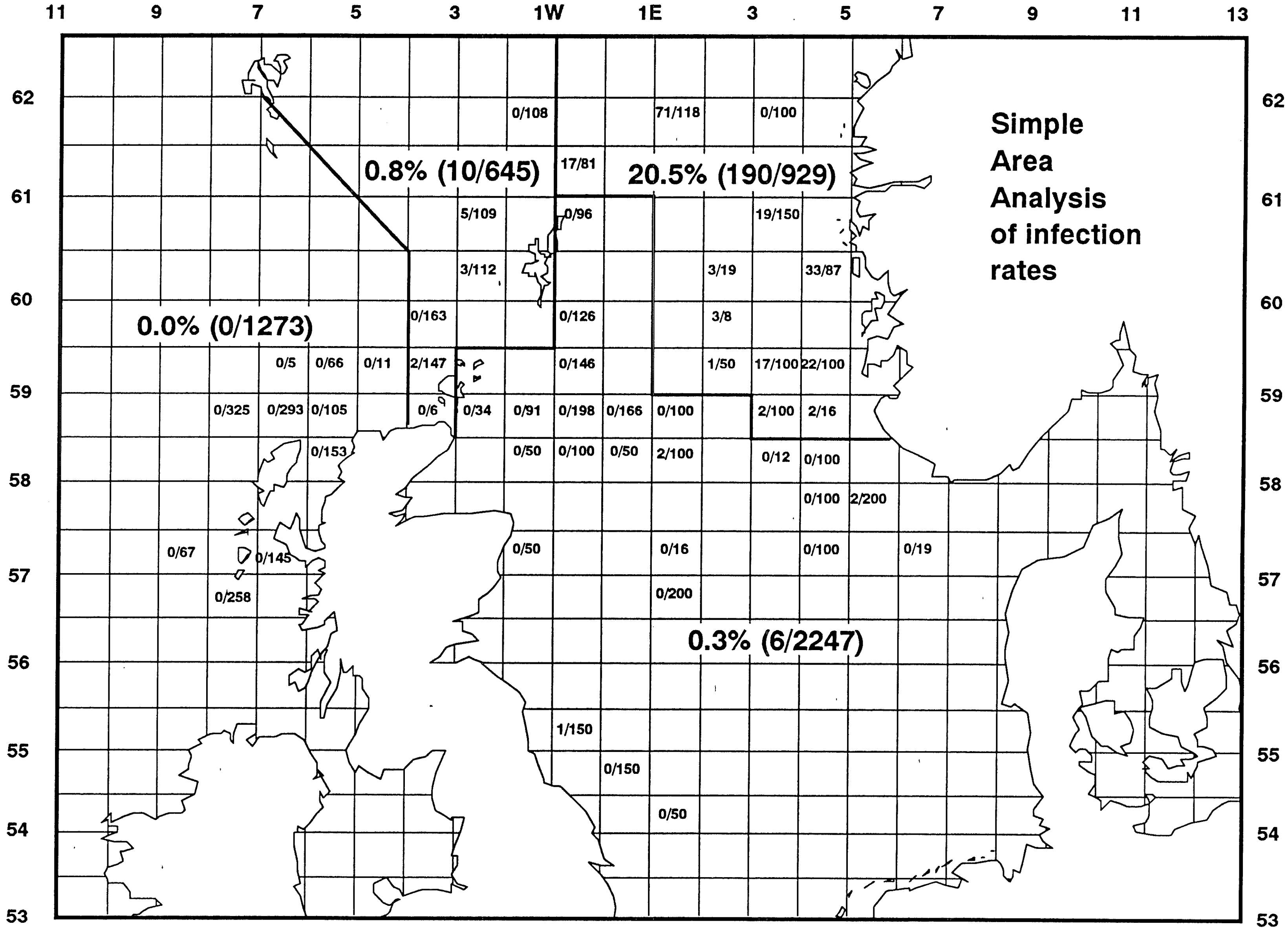

FIGURE 14. Samples values for ichthyophonus infection and simple area averages from the combined survey (all herring)

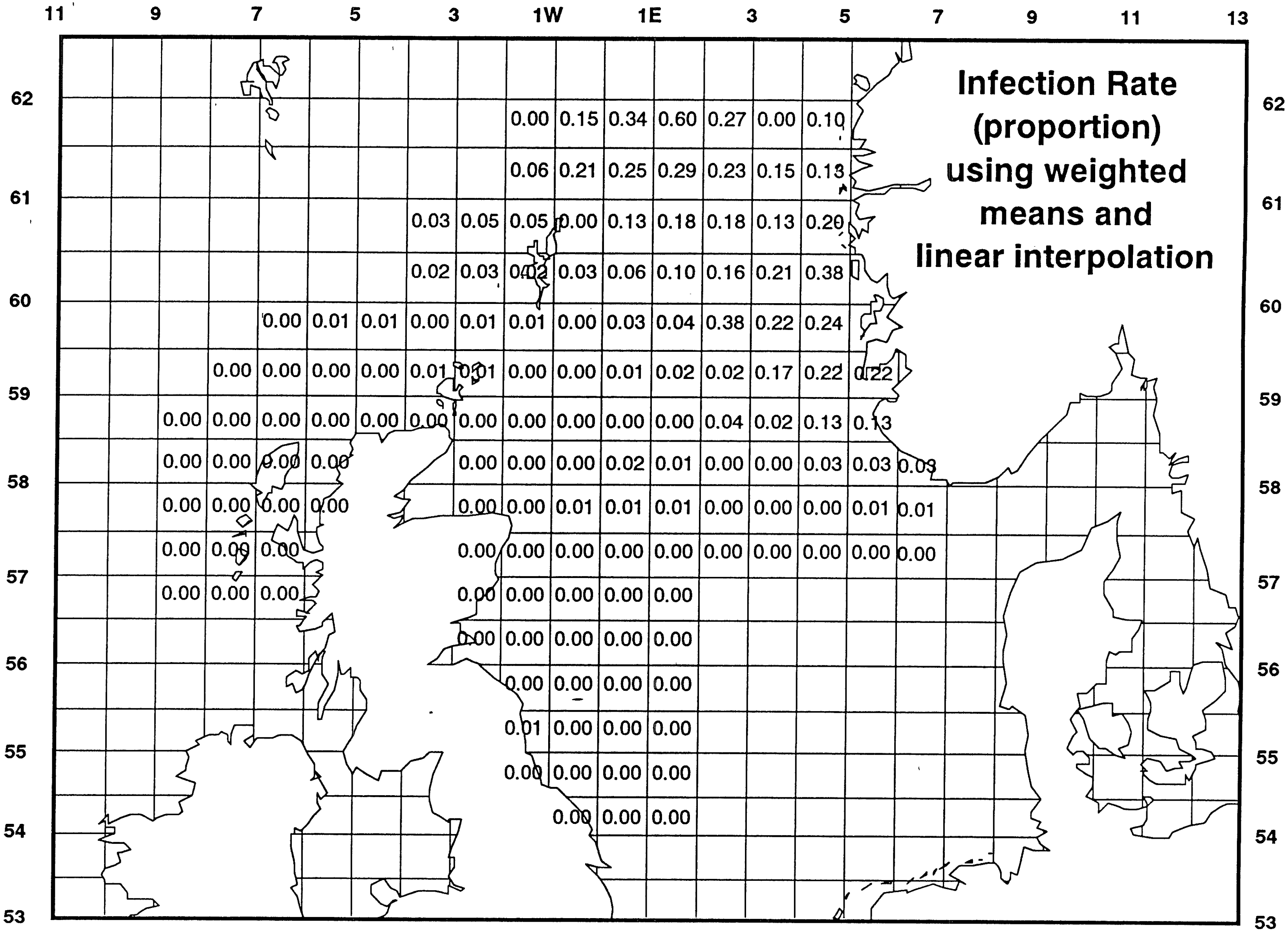

FIGURE 15. Infection rate (fraction) by linear interpolation from the samples shown in Figure 14

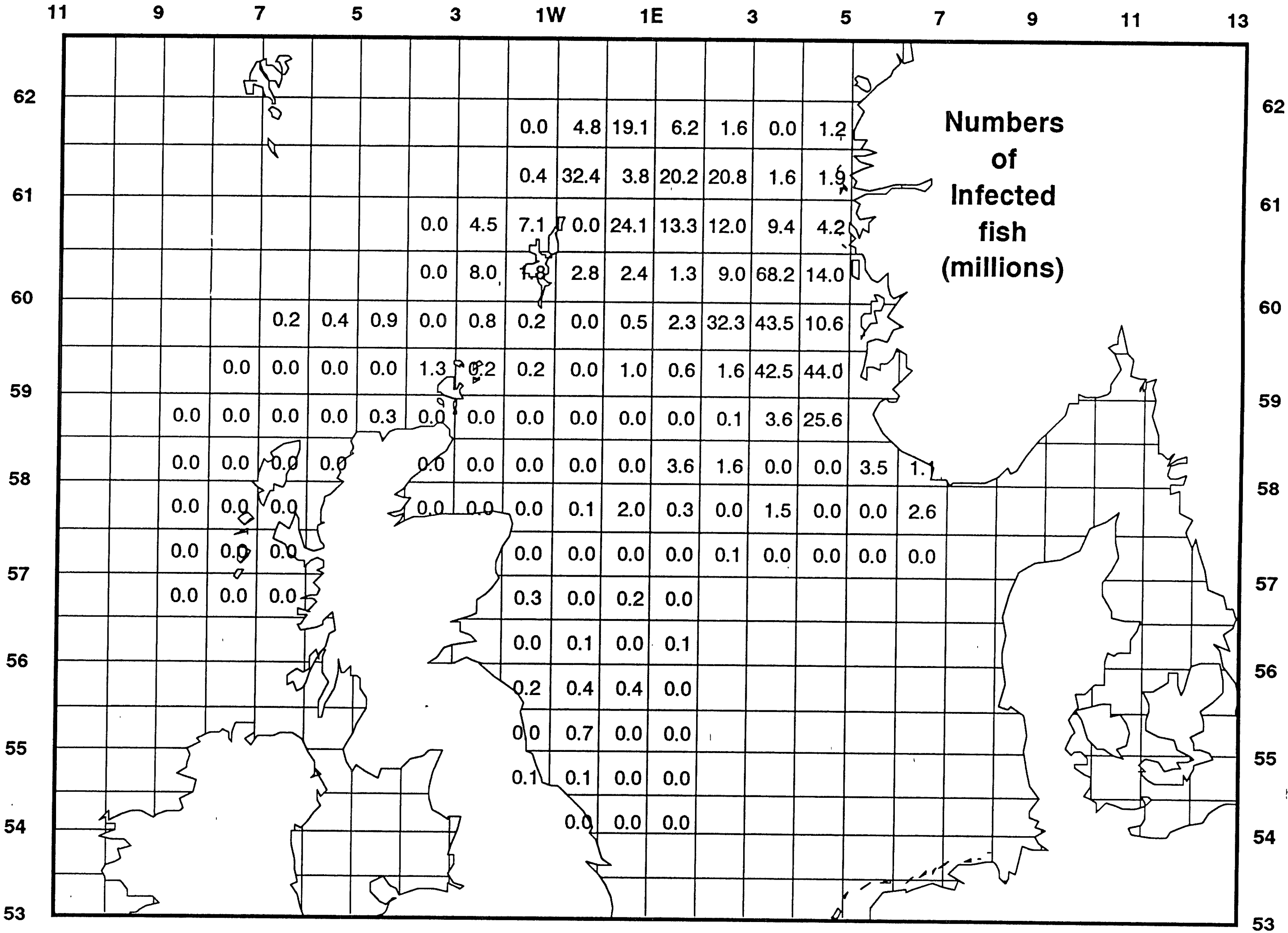

FIGURE 16. Numbers of infected herring (millions) from the combined survey (all herring)